ENERGY TRANSITION

FINANCING CONSUMER CO-OWNERSHIP IN RENEWABLES

EDITED BY
Jens Lowitzsch

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Editor

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Foreword by Theresa Griffin

First of all I would like to thank Professor Dr iur. Jens Lowitzsch for inviting me to contribute to this very important book, on a subject that is dear to my heart and one that I have fought tirelessly to bring to the forefront of European energy policy.

Energy is something we can sometimes take for granted. However, we know that our energy security is at risk, we know the threat posed by climate change and we know that the most vulnerable in our society struggle to pay their energy bills. So it is crucial we keep improving energy policy at all levels. We have the privilege to be part of the debate on energy at a time when so many aspects of our energy system are experiencing a transition: incredible growth in the share of renewables and storage; digitalisation of our economies enabling the development of smart homes, smart meters and demand-side management; increased awareness from ever-growing numbers of Europeans that green energy is the way forward.

For each of these challenges, it is my deeply held belief that, when developing legislation, when taking any decision, the EU needs to think how that legislation will directly affect its citizens, and indeed its most vulnerable citizens. Specifically, we need to be mindful of legislation that puts the onus on the activism of individual consumers in 'shopping around' for the best deal. Citizens are not able to compare offers easily; many of our poorest consumers are on out-dated energy contracts, unaware of their ability to switch. And in digitalisation, we must ensure we legislate against a digital divide.

As many as 80 million people live in damp and leaky homes. Proposing a meaningful level of ambition can help reform this crisis, demonstrate the EU's *raison d'être* and boost employment and competitiveness. We know that for every 1% improvement in energy efficiency, 3 million homes can be properly renovated and 7 million people lifted out of energy poverty. Therefore, the solutions to energy poverty are structural and institutional, not individual.

The responsibility for ending energy poverty lies with governments who have the power to shape energy markets, but also with the energy providers, taking into account their dominant position.

Energy legislation must be taken as a package with consumers at its heart, because tackling climate change, ending energy poverty, providing training and finance for a just transition to a low-carbon economy and improving energy efficiency are all different parts of the same thing: securing energy justice. Europe needs to be a leader in tackling climate change, in revolutionising the way we use energy—and the Energy Union is a very powerful tool to achieve this if we put our citizens first. We now need to achieve the targets set out in the Clean Energy Package for energy efficiency and renewable energy, 32.5% and 32% respectively by 2030. We cannot allow this to be diminished or we will struggle to meet our Paris Climate Change commitments and vulnerable consumers will continue to suffer unduly.

We know that the energy retail market in Europe is not functioning properly and consumers are directly impacted by this failure. Throughout Europe, energy markets are not transparent or competitive enough. In this context, industry is still failing to pass falling wholesale prices onto consumers. Consumers must be enabled to be "prosumers" and part of the market, but this must never come at the expense of our most vulnerable citizens.

A Europe that works for its citizens, allowing them to be part of the solution and empowering them to create their own energy in a just manner, while also protecting its most vulnerable consumers, benefits us all.

I hope you enjoy reading this book and help us fight for a just energy transition for all.

Theresa Griffin
European Forum on Renewable Energy Sources
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Foreword by Dörte Fouquet

COP21 in Paris underlined the crucial role of renewable energy in slowing climate change to a level still bearable for human life and nature. Citizens increasingly want to contribute to turning around and away from the dangerous spiral.

According to IRENA, renewable energy targets have become a defining feature of the global energy landscape: As of mid-2015, 164 countries around the world have adopted at least one type of renewable energy target, up almost four-fold from 43 countries in 2005. Two more countries have set renewable energy targets at the sub-national level only (Canada and the United Arab Emirates). While the expansion of targets in the early 2000s was driven by the Organisation for Economic Co-operation and Development countries, in recent years, developing and emerging economies have taken a leading role in the growing adoption of targets and now account for 131 of the 164 countries with renewable energy targets in place. Taking this good overview into account for the EU level, in many Member States we can expect strong growth of renewable energy technologies rollout.

As a rule of thumb, Member States which started with well-established feed-in mechanisms and legalization register a strong and positive attitude and interest of citizens in the energy system change. With decreasing renewable technology costs and increasing linkage between demand-side management, storage and renewable production at the local level, the interest of citizens to install technologies in their own homes, to engage in citizen cooperatives, to invest in renewable technologies or to be open for options of tenant renewable energy models grows.

In its "New Deal for Energy Consumers" the EU Commission, while introducing the so-called Clean Energy Package, aims to deliver on the following objectives:

- To establish a competitive, technology-driven and fair energy market which delivers high-quality energy services to consumers.
- To remove barriers for companies with innovative products and services which try to enter the market.

Subsequently, on 30 November 2016 the European Commission published this package of legislative measures to keep the European Union competitive as the clean energy transition changes global energy markets.

The EU has committed to cutting CO_2 emissions by at least 40% by 2030 while modernising the its economy and delivering on jobs and growth for all European citizens. The proposals have three main goals: putting energy efficiency first, achieving global leadership in renewable energies and providing a fair deal for consumers. Two important pieces of legislation are already agreed upon between the Institutions: the new Renewable Energy Directive and the so-called Governance Regulation.

Following several months of Trilogue negotiations, lead negotiators of the European Commission, the European Parliament and the Council managed by mid-June 2018 to conclude a deal on the future of renewable energies for the period 2020–2030.

The new Renewable Energy Directive foresees an EU-wide legally binding target of 32% of renewable energy in the energy mix by 2030, with an upward review clause by 2023 at the latest. Additionally, if the sum of the national contributions is found to be lower than the overall EU target, gap-filler measures are foreseen with the monitoring of the Commission, a mechanism now ensured in the other piece of importance regulation, the Governance regulation.

The renewable heating and cooling has an indicative target of 1.3 pp of annual increase; the target for renewables in the transport sector has been set for 14% by 2030. It gives encouragement for consumers to stay out of the mineral oil equation. In addition, a sub-target for advanced biofuels of 3.5% by 2030 is also part of the directive. The new Directive foresees a phase-out of palm oil from biofuels by 2030, starting with a freeze on existing quantities of imported palm by 2020. It also includes a freeze on so-called first generation biofuels such as ethanol with an identical deadline.

Another important part of the Directive relates to support schemes and the organisation of tenders for renewable energy installations. In this recast, Member States keep the right to apply technology-specific tenders and provide for alternative competitive bidding procedures or exemptions. In addition, retroactive changes to existing support schemes will be prohibited from 2021 on. This is paramount to secure investors' confidence in renewable energy projects

Next to the establishment of so-called one-stop shops and streamlined administrative and permitgranting procedures for new renewable energy installations, the major innovation of the new Renewable Energy Directive is the enshrinement of the right of European citizens, local authorities, small businesses and cooperatives to produce, consume, store and sell their own renewable energy, without being subject to punitive taxes or excessive red tape. It bans discriminatory measures that some countries introduced to prevent their citizens from participating in the energy transition, such as the Spanish 'sun tax', which dis-incentivised small-scale renewable energy production with high fees and administrative barriers.

The EU has recognized that citizens are active and central players on the energy markets of the future. Increased transparency and better regulation give more opportunities for civil society to become more involved in the energy system and respond to price signals.

A recent report[1] estimates the number of energy citizens that exist today, as well as how many could exist by 2030 and by 2050, in individual EU Member States and in the EU as a whole. This is the estimation of the potential number of energy citizens, provided the right legislation is in place. It shows that over 264 million European Union citizens, half of the EU population, could be producing their own electricity by 2050. These energy citizens could be producing 611 TWh of electricity by 2030 and 1557 TWh by 2050. Therefore, by 2030, energy citizens could be delivering 19% of the EU's electricity demand, and 45% by 2050. This is a significant contribution to achieving the EU's 2030 renewable energy target and moving towards a 100% renewable energy system.

Citizens provide additional investment and activities for the implementation of renewable energy projects. These activities contribute to local jobs and local wealth creation as money for energy stays within the community (instead of paying for energy imports). Their projects contribute to the reduction of energy poverty and to the increase of energy security, as neither import nor transport is required. The democratisation of the energy system leads to increased social acceptance of renewables and increased energy consciousness, resulting in decreased energy consumption.

The EU policy-makers also managed to reach an agreement on the Governance Regulation, the purpose of which is to highlight the importance of meeting the EU's 2030 energy and climate targets and sets out how Member States, together with the Commission, should cooperate to achieve the targets set in the other pieces of legislation. It is essentially a roadmap for the implementation of the EU contribution to the Paris Agreement's objectives. Notably, it requires Member States to provide national action plans which lay out their individual paths to meet their collective obligations under the Renewable Energy Directive. In addition, the Governance Regulation enshrines the concept of "carbon budget" in European law together with the need to achieve at EU level a net-zero carbon economy in the next couple of decades.

Negotiations on the Clean Energy Package might be finalised by the end of 2018 ending with legislation development for a new EU electricity market design. The main challenge within this Trilogue negotiation will be to be coherent with or even enhance the provisions of the new Renewable Energy Directive and Governance Regulation. Yet, the EU needs to become still more ambitious to fulfil its commitments under the Paris Agreement.

Against this background, it is a pleasure to introduce this sound research project on how to empower citizens to go renewable, to organise (co-)ownership and to achieve comprehensive financing schemes.

Consumer Stock Ownership Plans and market-based innovative financing models are at the heart of the project analysing what enables and what discourages them in the current energy system and regulatory environment.

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1. CE Delft, 2016. The Potential for Energy Citizens in the European Union, available at bit.ly/energycitizenstudy.

Preface

The transition from fossil fuels to renewable energy sources (RES) not only requires a new energy infrastructure but also requires that the consumers be motivated to change their consumption habits in particular so as to balance demand with a volatile energy supply and to accept new technologies such as smart meters. Consumer (co-)ownership in RES—"Citizen Energy"—has proved successful in engaging consumers in financing RES, thus becoming "prosumers" which in turn induced positive behavioural changes in energy consumption. Prosumer models, however, are still not widely implemented across Europe or the world. Guaranteed feed-in tariffs have facilitated the repayment of RES installation loans, but now a shift to auction systems favouring large-scale projects threatens this powerful incentive to citizen investment. Moreover, the typical "prosumer" is male, middle aged, well educated and with a higher income; the participation of women and social groups vulnerable to fuel poverty is uncommon. Additional problems are the rebound effect and insufficient use of ICT solutions.

In June 2018, the European Union agreed on a corresponding enabling framework as part of a recast of the Renewable Energy Directive (RED II). Although this legislative initiative paves the way toward a coherent EU-wide legal framework, it still needs to be complemented by the Internal Electricity Market Regulation (IEMR) and Directive (IEMD), transposed into national law and subsequently backed by implementing provisions. But legislation to support prosumership has also been implemented or is progressing in other parts of the world. What is much needed now is an innovative financing system which enables consumers to become (co-)owners of the RE installations independent of income or their access to capital credit. The challenge is to advance to economies of scale while including municipalities and/or commercial investors like SMEs and retaining the benefits of individual consumer participation.

Against this background, the authors here suggest ideas for advancing the *energy transition*. They present new models of consumer ownership from both the European Union and other countries worldwide. Their analysis of policy recommendations is—for the first time—based on 18 country studies, organised so as to enable a cross-country comparison of both policy approaches and feasibility. The realisation of consumer (co-)ownership particularly in local RE communities requires developing, implementing and rolling out business models that broaden the capital participation. To facilitate this process the authors discuss financial, organisational, legal and social aspects of a new system of decentralised energy production (co-)owned by consumers of RE. While the energy transition includes heating and cooling as well as transport sector, we focus on the electricity sector since it has the largest prosumership potential and is the centre of most of the activity so far. Geographical coverage is limited; for example, China, Russia, South-East Asia or African countries are not included.

The book addresses energy consumers in local communities, their municipalities and policy makers that represent them. Non-EU countries, particularly those whose rural areas have limited access to (clean) energy, for example, in Asia, Africa and Latin America, may also be interested in the benefits of consumer ownership.

The book is divided into four parts.

Part I describes prospects for implementing consumer ownership in the renewable energy (RE) sector. Chapter 2 provides an overview of national policy issues as well as of forces driving and obstacles hindering the transformation of energy systems from fossil to renewable energy sources (RES), that is, the energy transition. It also includes the challenges of digitalisation, for example smart grids, micro-grids and peer-to-peer marketing via blockchain technology. Chapter 3 discusses the question of why ownership in renewables is an “educational mission” and also the master key in motivating consumers to accept new technologies, grid extension and new RE energy production facilities. It further explores the role of consumers in adjusting their consumption habits to accommodate the volatility of RE supply, that is, demand-side flexibility and the contribution of consumers to energy efficiency as well as—in the context of energy poverty—the question of how financing techniques can be more inclusive. Chapter 4 deals with energy justice; again the case is made for promoting consumer ownership as a way to democratise access to energy, a resource essential to human life. Chapter 5 surveys the current state of empirical research on the relationship between (co-)ownership and changes in human behaviour. Also discussed is how and to what extent economic experiments can contribute as an analysis tool.

Part II discusses the problem of financing RE more in detail; it introduces a new financing technique, the Consumer Stock Ownership Plan (CSOP), and compares it to traditional models of financing consumer ownership. Chapter 6 provides an overview of the principal financing issues of consumer ownership, particularly with regard to participation in decision-making which the different models offer. It analyses the factors involved, the economic setting and the legal framework. Chapter 7 discusses the challenges confronting RE cooperatives. Chapter 8 deals with the legal structure of the CSOP, together with a case study of the first CSOP invented in 1958. How this innovative financing technique might modernise the cooperative model is explored. Chapter 9 presents the life cycle of a CSOP as exemplified in a wind turbine project.

Part III compares the existing consumer (co-)ownership models in four different areas of the world, namely, Europe, North America, South America and Asia. The 18 country studies of Chapters 10–27 cover the Czech Republic, Denmark, France, Germany, Italy, the Netherlands, Poland, England and Wales, Scotland, Spain, Switzerland, the US state of California, Canada, Brazil, Chile, India, Pakistan and Japan. The country profiles are all organised on the same pattern:

1. Energy mix, main challenges to the energy market, ownership structure of RE.
2. The political context of putting the consumer at the heart of the energy market, including policies which support consumer ownership and those intended to alleviate energy poverty.

3. Current government policy and the environment for promoting renewables, including the legal and fiscal framework for self-consumption and sale to the grid.
4. Existing models of consumer ownership, their regulatory environment and examples of best practice.
5. Barriers to consumer ownership: political, legal, administrative, economic, managerial and cultural.
6. Future trends in consumer (co-)ownership.

Part IV summarises the results of this survey, compares the best practice cases, presents a cost-benefit analysis of "prosumage" and against this background analyses implications for policy recommendations. Chapter 28 takes a sociological approach in a cross-country analysis of the cases of consumer (co-)ownership presented in the 18 country chapters, identifying their similarities and differences; we discuss organisational and contractual arrangements, local profiles and common interests determining the success or failure of RE consumer (co-)ownership projects. An Annex to this chapter provides an overview of the examples of consumer (co-)ownership that are reported in the 18 country chapters. Chapter 29 assesses the economic pros and cons of a large-scale decentralised deployment of prosumption and storage. Chapter 30 discusses the consequences for policy recommendations from the standpoint of the European Union, analysing the interaction of policies at the national level with a common European policy; this includes harmonisation of EU legislation, the implications for the "Energy Union" and in particular a policy approach that promotes prosumership and consumer (co-)ownership. Conclusions in Chapter 31 follow.

Frankfurt (Oder), Germany — Jens Lowitzsch
October 2018

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Introduction: The Challenge of Achieving the Energy Transition

Jens Lowitzsch

Renewable energy (RE) has made considerable progress in the last 25 years. Its percentage share of total energy production in the EU-28 between 2005 and 2015 grew from 8.7 to 16.7 per cent,[1] closing in on the 20 per cent goal set by the 2020 Climate and Energy framework. Reducing greenhouse gas by 20 per cent also seems attainable.[2] Similar progress in lessening the effects of global warming is taking place in other parts of the world although the key drivers and priorities are diverse. The ambitious objectives of the EU together with the bold steps taken by some Member States have prepared the ground for shifting to an energy supply that is competitive, sustainable and secure. Financing investments in renewable energy sources (RES), however, remains key to achieving

[1] https://publications.europa.eu/en/publication-detail/-/publication/2e046bd0-b542-11e7-837e-01aa75ed71a1/language-en/format-PDF/source-search; EU energy in figures, 2017.

[2] http://www.eea.europa.eu/media/newsreleases/policies-put-the-eu-on.

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the 2030 and 2050 goals of a low-carbon economy with increased energy efficiency. Switching energy systems from fossil fuels to RES requires financial, technical and social innovation. A new energy infrastructure must be built and individuals must be motivated to adopt flexible consumption habits to match demand with the supply of volatile energy sources.

The development and market rollout of innovative financing schemes for sustainable energy are also necessary to attain the EU-wide target of at least 27 per cent[3] renewable energy consumption by 2030, as well as for the success of the new energy policy generally. Other nations have announced similar targets. China, for example, aspires to meet 15 per cent of primary energy demand with renewables by 2020 and 30 per cent by 2030. But these goals confront the same financing challenge. In a market historically dominated by large suppliers heavily invested in fossil fuels, citizens investing in RES have become a new category of market participants and an important impetus for meeting this challenge. For example, in Germany, a pioneer in renewables, more than 40 per cent of the installed renewable power capacity was owned by private citizens at the end of 2016 (trend:research 2016). As more and more renewable energy technologies (RETs) reach grid parity, a growing number of citizens will become *prosumers*,[4] that is, producers of the energy that they consume.

At the same time, however, legislative conditions across the EU and worldwide which have so far limited financial risk and facilitated repayment of bank loans for RES installations have become less favourable; the change from guaranteed feed-in tariffs (FITs) to auction models especially is inclined to discourage individual commitment because they favour large-scale projects that can diversify risks through broad project portfolios. Simultaneously, politics is discovering the

[3] Or even 32 per cent if the provisional agreement reached between the European Parliament and Council on 14 June 2018 is confirmed by the official co-decision procedure after the summer break (Euractiv et al. 2018).

[4] As early as 1972, Marshall McLuhan and Barrington Nevitt suggested in their book *Take Today* (p. 4) that technological progress would transform the consumer into a producer of electricity. The artificial word stemming from the Latin was probably first introduced by Alvin Toffler in his book *The Third Wave* (1980).

consumer to be a vital market player whose behaviour—whether as co-producer, self-consumer or investor—is crucial not only to energy efficiency but to acceptance of new RE installations and other new technologies, for example, smart meters.[5] Educating and motivating individual consumer households to accept sustainable energy and their personal role in energy markets depends in part on the motivational power of ownership of RE installations be it at consumer premises or commercial production facilities. Although models for prosumership and consumer ownership in RES have made considerable progress in a few pioneering countries like Denmark and Germany, they are not yet widely implemented across Europe.

This raises the question of whether consumer ownership in RES is a transitory phenomenon or a necessary condition for transforming energy systems from fossil to renewable sources, in short, the energy transition. If a necessary condition, then how do we go about broadening participation? Is consumer ownership of RE production facilities merely politically desirable to satisfy expectations of participation arising from a concern for distributive justice or simply from expediency, that is, to make infrastructure projects publicly acceptable? Or do sound economic arguments exist for broad public ownership in RES, arguments related to the structural differences between renewables and fossils on which the success of the energy transition depends?

1.1 Background: Reorganising Energy Production and Ownership in RES

In many countries the energy transition goes along with decentralised, small-scale RETs which are changing the energy supply infrastructure (Arnold and Yildiz 2015). The most common energy production facilities

[5] See, for example, the Commission Communication "Delivering a New Deal for Energy Consumers" (COM(2015) 339 final) stemming from the "summer package" of July 2015, focusing on energy efficiency, electricity market design, consumers and the Emission Trading System; furthermore, the EU "winter package" emphasising the role of energy security, intergovernmental agreements, gas infrastructure and a heating and cooling strategy.

are small- and medium-scale wind farms, solar and bioenergy projects. Wind and solar power are particularly suitable for schemes involving citizen participation, as the underlying technology, and thus the energy generation process, is not as complex as in bioenergy structures. The size and mix of the installed distributed generation capacity will depend on the relative costs and benefits of the specific technology (Pepermans et al. 2005). It is interesting that neither traditional finance schemes nor large investors are as relevant for RE as one might expect because of two factors which favour individual ownership participation schemes in RES:

- Established energy companies and other related technologies and networks are "locked in" to fossil fuel-based infrastructures (Unruh 2000) because of their heavy financial commitments and the relatively low risk-return ratios of RE projects (Arnold and Yildiz 2015).
- In comparison, RE projects with substantial citizen ownership do not need to concern themselves with worry about shareholder value and quarterly profit reports; they also lack the financial resources to take on large projects and thus are more likely to accept the relatively high capital costs per kW of installed power compared to large central plants (IEA 2002).[6]

1.1.1 The Financing Gap and Consumer Financial Participation

In order to limit global warming to 2 °C and avoid the worst effects of climate change, it is estimated that the world needs to invest an additional USD 1 trillion per year through 2050 (Fulton and Capalino 2014). While the year 2015 saw global investment in the energy sector of approximately USD 1.8 trillion, a total of about USD 3.5 trillion would

[6] Differences in capital costs between the different distributed generation technologies are also quite large, ranging from EUR 1000 per kW to over EUR 20,000 per kW for combustion turbines and fuel cells, respectively. The capital costs of large central plants, on the contrary, vary per kW from approximately EUR 800 for gas-fired plants to EUR 2500 for IGCC and EUR 6000 for nuclear plants (Schröder et al. 2013).

be required each year from 2016 through 2050.[7] Local authorities in charge of energy efficiency and climate policy with limited budgets often lack means to initiate new and innovative projects.

Closing the financing gap becomes even more important since investments in RE are an important driver of economic development and employment. A Commission study (European Commission 2014)[8] finds that "new industries with a strong lead market potential have been created, which contribute a value added of about EUR 94 billion or about 0.7 per cent of the total GDP and an increase in total employment of about 2 million, that is, about 0.9 per cent of the total workforce in Europe in 2011". RES investments would positively impact job generation (EC Expert Group 2016; Lehr et al. 2008; critical though Lambert and Silva 2012 and Böhringer et al. 2013). Different types of power plants require different installation and maintenance schedules. For example, a wind energy power plant requires intensive work during the installation period, construction, network connection and so on, but requires less maintenance than a photovoltaic plant which has to be cleaned frequently. The European Economic and Social Committee (EESC 2015) concludes that the growth in renewables brings about new jobs along its value chain "with this job generation effect being particularly high in the sectors of energy efficiency (0.38 job-years/GWh), PV (0.87), biofuels (0.21) and wind (0.17) when compared to coal and gas (0.11)".

Prevalent business models—Present business models which fund RE investments of private individuals fall into two categories (Holstenkamp et al. 2017):

1. Genuine, more egalitarian ownership schemes, for example, energy cooperatives, that typically are small- or medium-sized projects confronting the problem of being "sub-scale" investments.[9]

[7] At the same time the decline in fossil fuel investment would be largely offset by a 150 per cent increase in RES investments between 2015 and 2050; IRENA estimates that total demand-side investments in low-carbon technologies would need to surge by a factor of ten over the same period (IRENA 2017; IRENA 2014).

[8] The gross value added of the RES sector may increase to about EUR 100 (120) billion and employment in the RES sector would amount to 1.6 (2.1) million persons by 2030 if a target of 30 per cent (35 per cent) in terms of the gross final energy is implemented.

[9] That is, optimisation of the size of technical installation, for example, a 100 kW "citizen wind turbine", is not economically sound; scalable financing techniques on the other hand would help

2. Profit-oriented, market-centred investment schemes such as closed-end funds that attract money for large-scale projects but do not permit investor participation in decision-making.

If RE projects are to be combined with active citizen participation, both financially and in decision-making, new models must be innovated. The question is how do we retain the benefits of individual consumer participation when advancing to economies of scale while simultaneously including low-income households? Support for business models that facilitate consumer ownership in RES must first level the playing field; the objective is "equality of arms". If investments in RE at the local/regional level are to succeed in an environment of regulatory conditions which favour large investments, that is, the worldwide trend towards direct marketing and auction models, consumer ownership models must be able to coexist with their competing commercial counterparts. This is ever more important in the light of the rent-seeking behaviour of large investors—often heavily invested in fossil fuels—aiming at securing advantages of their established market position and thus profits regardless of increasing cost efficiency.

Stakeholder involvement and financial participation—Financial participation has a complex relationship with participation in decision-making and stakeholder involvement in general. In addition to helping to close the financing gap, the involvement of all stakeholders is now recognised as crucial to the success of policies responding to climate change, including the shift to green energy. Participation can take diverse forms and occur at different stages of project implementation: (1) information about the ongoing development, (2) participation in decision-making during the planning process and (3) financial participation in the project. While the first two forms of participation involve all stakeholders, the last one is reserved to shareholders. In addition to the obvious benefits of engaging citizens in decision-making during the planning phase (Devine-Wright 2005), financial participation in the project itself

small investors pool their investment, boost it with leverage and build a more efficient standard industrial 1.2 MW wind turbine.

has material benefits, namely, the right to share in the investment profits. With regard to participation in decision-making, the involvement of citizens as consumers that become (co-)owners can take either of two forms:

- *Passive financial participation* which involves no role in decision-making and where investment return is the principal objective (e.g. bonds, loans, silent partnerships and limited partnerships)
- *Active financial participation*, where citizens-owners also assume a role in the governance of the utility (e.g. coops, limited liability companies and partnerships)

While financial participation in general may provide consumers with the incentive for maximum involvement, active direct participation, including voting rights, provides shareholders with the power to exercise it. The literature defines these two types of financial participation as citizen/consumer participation in a *broader*, that is, passive sense, and a *narrower*, that is, active sense (Yildiz 2014; Holstenkamp and Degenhart 2013).

1.1.2 Defining Consumer Ownership

In this book we use the term "consumer ownership" and in some instances "consumer (co-)ownership"[10] for *all participation schemes that (1) confer ownership rights in RE projects (2) to consumers (3) in a local or regional area*.[11] Our definition refers to participation in the narrower sense, that is, financial participation combined with some degree of participation in decision-making in an enterprise located in a specific geographic area

[10] The notion of (co-)ownership is used here not in the technical sense of joint ownership but to indicate that there may be other owners next to the consumers amongst the shareholders such as municipalities or conventional investors.

[11] A related definition of a project as community power is that of the World Wind Energy Association (WWEA) requiring at least two of the following three criteria: (1) local stakeholders own the majority or the whole project, (2) voting control rests with the community-based organisation, (3) the majority of social and economic benefits are distributed locally; available at: http://www.wwindea.org/communitypowerdefinition/.

where the consumer lives; the term may also apply to the involvement of municipalities and/or commercial investors, both important in practice but often difficult to combine. A comprehensive definition of citizen financial participation in RE does not yet exist inasmuch as forms vary greatly from country to country.[12] In accord with the above criteria, the term *consumer ownership* may embrace a wide variety of participation models from different categories, depending on specific characteristics. In our discussion of an ownership-oriented approach, we address the participation models practised in the countries under consideration as they relate to consumer ownership. However, the three core elements of our definition may not be present in every case:

- Schemes summed up under *citizen energy*, also referred to as *energy citizenship*,[13] for example, typically will involve consumer ownership while these schemes are not necessarily local/regional.
- While *community energy/community power* models represent locality and common interest of resident consumers,[14] they may not include individual ownership rights, in particular voting rights; they may, however, involve other participatory mechanisms such as decision-making at the local level.
- The *prosumer*, that is, a consumer who (co-)produces the goods or services he consumes, is not necessarily an individual but may be a micro enterprise or an SME; furthermore, this term would not apply to situations where direct self-consumption is not feasible.

Consumer ownership thus intersects with "citizen energy", "prosumership" and "community energy" (see Fig. 1.1), while national schemes summarised under one of these descriptions may include some

[12] Definitions in the literature often refer to unique national concepts shaped by historical development and their corresponding business models (e.g. Walker and Simcock 2012) or stem from technological, economic and political characteristics (cf. Radtke 2016, p. 174).

[13] The term "citizen" in this context encompasses both natural persons individually and organised, for example, civil society groups, social entrepreneurs, schools, micro enterprises, faith groups.

[14] See Holstenkamp and Degenhart (2013); commonly used in Anglo-American countries and in particular in the UK, this term stresses the participation of local authorities, government departments and utility companies (REN 21 2016; Walker and Devine-Wright 2008).

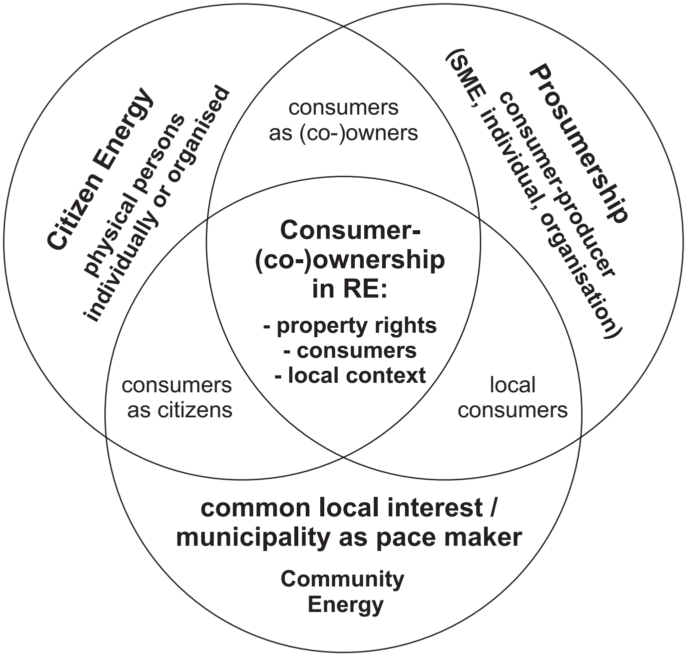

Fig. 1.1 Consumer ownership in RE and its relationship to citizen energy, prosumership and community energy

key elements of our definition but not all. The umbrella term used for all cases presented in this book involving one of these three participatory approaches is RE communities (see Chaps. 6, 28 and 30).

Distinguishing consumer ownership from conventional forms of investment begins with the question of who initiates the project and who its immediate beneficiaries are (Walker and Devin-Wright 2008). Secondly, is it collective or individual (Radtke 2016; REN21 2016)? We also discuss broader concepts related to this ownership-oriented approach. For example, "energy democracy" implies equality of access to an adequate supply of affordable green energy and *democratic ownership of production facilities* (Morris and Jungjohann 2016; Becker and Kunze 2014). In these cases which may not involve individual ownership, we discuss the schemes' features from an ownership perspective in order to determine compatibility and pathways for further development.

1.1.3 Determining Factors for Different Ownership and Participation Models

In the 18 country studies presented in this volume (see Part III, Section 4.3 of each chapter) we find a wide variety of models featuring different combinations of organisational and contractual arrangements, identities and interests. Each of these factors influences the size, type and implementation of a consumer (co-)owned RE project; it is their combination in a particular setting, however, that limits or supports success. This interdependency, together with the geographic and cultural diversity of the cases under consideration, is too complex for "one size fits all" solutions even within a given country. While "identity" and "interest" are deeply rooted in geography and culture, the underlying business models, understood as organisational and contractual arrangements, depend on policy and procedure and thus can adapt to the former. Adopting a sociological approach Chapter 28, groups the mentioned key factors around two notions, namely, communities of place and communities of interest as well as their intersection to identify patterns of success or failure. This chapter also provides an overview of all the best practice projects presented in this book.

Both "place", used here as a synonym for "identity", and "interest", meaning "common interest", strongly influence the design of successful RE consumer ownership models. Another related dimension, namely, energy justice, must also be taken into account. The main question here is how to structure the energy transition as a level playing field so that all citizens have the same opportunity to acquire an ownership stake in RES. Energy justice recognises that the different groups in society confront different barriers to consumer ownership ranging from cultural tradition over economic opportunity to the geographic situation (see Sect. 1.5 of the country chapters). Energy justice requires that the approach chosen be elastic. It is their contractual and organisational arrangements that link business models to the larger social issues of energy democracy and distributive and social justice. Not only location, rural or metropolitan, but attitudes, motivations and differences in economic status that affect the ability to acquire ownership in RE installations within a given community as well as the relationship with strategic partners must be taken into consideration. Trusteed plans like the Consumer Stock Ownership Plan (CSOP) allow participating consumers to speak with one voice vis-à-vis other shareholders such as a municipality or a commercial investor after an internal decision-making process supported by a professional trustee (see Sect. 1.2.3.).

An important aspect of distributional justice and inclusion finally involves the ability of socially disadvantaged groups to make sound economic decisions. Vulnerable consumers living on the margins of society are typically affected by energy poverty. Their attention is often so distracted by worries over how to make ends meet that they can seem disinterested in the energy transition and their meaningful participation in RE. However, it is often their ability to assess the benefits which may be impaired by the scarcity they live in (Mullainathan and Shafir 2013). For economically disadvantaged consumers, questions of energy efficiency or RE ownership will typically be secondary to more immediate problems such as adequate housing, food, health, education or childcare. These short-term needs pre-empt attention from long-term issues such as acquiring RE ownership. But besides energy-impoverished households women are also underrepresented, a phenomenon linked to economic equality of opportunity but also to other factors (see Chap. 3); empowering them to participate in RE projects is equally important.

This situation has implications for who is perceived to be a potential owner and how to engage with them—issues which not only touch upon justice as recognition but also procedural justice. Becoming an owner of a RE installation may require a period of apprenticeship, especially when complex technical issues are involved or the opportunities of participation are unequal because of educational and economic differences. In this context, trusteed plans like the CSOP will level the playing field and provide disadvantaged groups with genuine equality of opportunity. These issues are discussed in depth in Chapter 4.

1.2 The Potential of Consumer Stock Ownership Plans to Meet the Challenge of Consumer Ownership

To harness the potential of citizens' investments in RES and preserve its dynamic in a changing regulatory environment requires innovative solutions—solutions based on conventional best practice but which include all strata of society and meet the needs of retail investors. Best practice models presently implemented across the EU such as energy cooperatives and limited partnerships can be adapted to these purposes and updated to include municipalities and/or commercial investors. Advancing and developing successful models is particularly important as they differ in some respects from traditional commercial models. Cooperatives, for example, make less suitable partners for municipalities or commercial investors (see Chap. 7), while limited partnerships lack both participation in decision-making of shareholders and local involvement of stakeholders (see Chap. 6). Neither of these conventional models combines the potential for scalable investments with direct consumer participation—both important prerequisites for decentralised RE production.

1.2.1 Changes in Subsidies and Incentive Systems

The efficient integration of distributed energy generation in the electricity market depends on market structure, pricing mechanisms and available subsidies (Pepermans et al. 2005). In many countries, the structure of the electricity market is currently undergoing significant change with transition from guaranteed FITs to auction models, the most apparent trend. Under the auction model, installed capacity or electricity production is determined through tenders organised by public institutions. This procedure usually takes the form of a so-called reverse auction (Fürstenwerth et al. 2014). Unlike conventional auctions where an increase in bids to buy drives prices up, in RE auctions bids to sell cause prices to fall. Thus the lowest-price bidder wins the tender and is typically rewarded with a FIT or feed-in premium (FIP) for a specific period of time.

Tender systems, whether applying to all RE technologies or differentiating between them, were introduced in many countries as an alternative or addition to existing FITs and FIPs (IRENA 2013). Tendering the installed capacity (in kilowatts) rather than generated electricity (in kilowatt-hours) is technology-dependent and thus serves as a benchmark for project developers and investors; the downside is that it does not allow electricity generation to be exactly predicted. Although one of the main goals of a tender system is to facilitate and control the expansion of RE infrastructure, bidders, in order to win a tender, may provide an idealised version of their proposal. Consequently, a winning bid sometimes cannot be implemented because of difficulties or delays arising from omissions in the original presentation. Thus the remuneration awarded may not cover the actual expense. "Underbidding" may result in unfulfilled expansion goals. Economies of scale generally favour large projects and deep-pocket bidders rather than small projects of limited potential in either installed capacity or generated electricity with a possible discounted price (Richter 2012; Fürstenwerth et al. 2014).

Tender systems involve investor risk. Additional capital or bank guarantees may be required. These uncertainties can discourage private investors and small enterprises in particular. As an example, despite the fact that citizen participation is regarded as important to the success of Germany's energy transition, experts warn that the tendering system may discourage small-scale investment (Fürstenwerth et al. 2014). One idea for correcting this problem would be to provide preferential conditions in the tenders for local agents, such as municipalities, SMEs, energy cooperatives or private citizens. Investment risk and capital requirements could be limited, for example, by reducing pre-qualification requirements and potential fines.

1.2.2 Market Integration of RE: What Role for Prosumers and Local Small-Scale Generation?

Market integration of RES aims at creating competitive energy markets with renewables generally subject to normal market rules. This entails the question of how to align subsidies with normal market rules and how to provide a level playing field for all market participants (see preceding section). Here the ownership structure of the RE sector is crucial. The optimal market design will avoid both concentrated ownership in the hands of a few—an oligopoly detrimental to competition—and a fragmented market with a plethora of small players driving up transaction costs and impeding governance. The Spring 2018 negotiations between the European Commission, Parliament and Council (so-called Trilogue) concerning the "Clean Energy Package",[15] a bundle of legislative acts to further advance the Energy Union, are a good example of the policy challenges involved. While there seems to be consensus amongst policy makers to postulate a sufficiently large number of market participants to guarantee competition and prevent market domination by a few large players, there is disagreement about the degree of "actor diversity" necessary. At the root of this controversy lies the question of what constitutes a level playing field and particularly the question of whether or not small RE producers can coexist and compete with the large incumbent energy suppliers without regulatory support. This issue directly impacts the development prospects for (co-)owned consumer projects which are typically medium or small.

The European Council, on the one side, stressed liberalisation of markets and was reluctant to grant any preferential conditions for small players as proposed above. The European Commission and the European Parliament (EP) in particular, on the other, favoured modest preferential conditions for prosumers and local small producers in order to ensure a level playing field. Above all the question of a "right to prosume" and the right to market generated energy directly (stipulated in Art. 21 of the recast of the Renewable Energy Directive (RED II)) as well as the framework to facilitate "renewable energy communities"—now aligned with the definition of local energy communities[16] (Art. 22 RED II)—were controversial (for more details see Chap. 31). On the one hand, the involvement of consumers as (co-)owners is inclined to facilitate their new role as active consumers which is key amongst others for demand flexibility (see Chap. 3). On the other hand, a disperse ownership structure, acknowledging the numerous actors on the RE markets and particularly the phenomenon of "Citizen Energy", raises the problem of market fragmentation. With an expanding number of small units owned

[15] The European Commission presented a *package* of measures on 30 November 2016 to keep the EU competitive as the clean energy transition changes global energy markets with four main goals, that is, putting energy efficiency first, achieving global leadership in RE, providing a fair deal for consumers and redesigning the internal electricity market.

[16] Local energy community as defined in Article 2 of the recast Directive on common rules for the internal market in electricity (2016/0380(COD)).

by individuals, governance, control and predictability of the market become increasingly complex and thus problematic.

Moreover, with increasing battery capacity accompanied by decreasing prices decentralised energy storage enabling the decoupling of electricity generation and consumption is a clear trend (see Chap. 29 on "prosumage"). Policy makers and regulators will seek to realise system-oriented integration of prosumage installations in order to tap their full flexibility potential for the power market. Here sector coupling, increasing electricity usage for heating and mobility purposes encompassing heat or hydrogen storages requires the interconnection both of the different actors as well as the various RES. This equally applies to smart grids and peer-to-peer marketing via new digital technologies like the blockchain which by enabling this interconnection of energy consumers and producers can be key to enabling an improved balance of electricity supply and demand in decentralized grid control (see Sect. 2.3.1 on smart grid technology). However, this requires substantial investments that in Western Europe alone are estimated to reach EUR 110 billion until 2027 (Northeast Group 2017).

Against the background of the RED II compromise reached in June 2018 confirming both fair conditions for self-consumption and collective local organisation thereof, one way out of this dilemma again is to innovate and deploy new organisational models for prosumership. Such contractual arrangements would allow pooling and scaling of RE investments (co-)owned by consumers while opening them up to various combinations of municipal or commercial investment, especially by SMEs. In particular as "renewable energy communities" (regulated in Art. 22 RED II) according to the legal definition in Art. 2 RED II require that local shareholders or members, that is, "natural persons, local authorities, including municipalities, or SMEs", control them[17] they necessitate a multi-purpose corporate vehicle allowing joint investments by the various agents mentioned.

[17] The RED II proposal of the European Commission and Parliament was even stronger requiring a minimum of 51 per cent ownership stake and corresponding control rights of these groups.

1.2.3 A Market-Based Financial Innovation: The CSOP

But how is consumer (co-)ownership to be achieved? How is the average low-income consumer to invest funds he may not have in an RE installation? How are consumers to become prosumers? That is a question conventional finance falls short to answer. Yet there is a financial innovation that was invented expressly for this purpose, the CSOP.[18] The CSOP as a low-threshold method of finance enables individuals to invest in an existing RE facility or invest to form a new one, large or small (Lowitzsch and Goebel 2013). Designed to facilitate scalable investments, it is open to co-investments by local partners such as municipalities or energy suppliers. In particular, poor citizens—who as a rule do not dispose of savings necessary for conventional investment schemes—are enabled to repay their share of the acquisition loan from the future earnings of the investment. This is how the CSOP works:

- A fiduciary trust set-up, for example, by the local community or a consumer organisation, to be managed by independent trustees, borrows funds to invest or acquire shares in a RE plant on behalf of participating energy consumers.
- The funds, often provided by a state bank under a specific programme to promote RE investments, for example, KfW's "Renewable Energy Standard", are channelled through a commercial bank.
- The funds are then invested and shares held by the trust on behalf of the CSOP consumer-beneficiaries and allocated in proportion to their individual energy purchases.
- Income earned by the shares minus depreciation is distributed to the CSOP and used to repay the acquisition loan.
- Once the debt is amortised, CSOP earnings are distributed as income to the consumer-beneficiaries.

[18] The CSOP was applied with spectacular success in the USA by its innovator, Louis O. Kelso, a business and financial lawyer (see Chap. 8). It is related to Kelso's best-known financial innovation, the ESOP, which has enabled millions of American workers to become owners of their employer corporations, repaying the acquisition loan not from their wages but from the future earnings of their shares in the company. Today the ESOP is an integral part of American corporate finance. At the end of 2016 there were 6717 ESOP and 2898 ESOP-like plans in the USA, with about 14 million employees participating, that is, 13 per cent of private sector employees holding around USD 1.3 trillion in assets (NCEO n.d.).

Under continental law, a financing structure employing two limited liability companies—one an operating entity and one a trust—allows to pool individual investments while benefiting from the borrowing power of the corporation. Individual citizen participants are exempt from liability. The consumers acquire, in addition to access to cheaper energy, an additional source of income from their indirect share ownership. The trust is a separate intermediary entity which manages the shares held in trust for the consumer-beneficiaries and pools voting rights executed by the trustee, implying a due "professionalisation" of management: participation in decision-making is channelled through the trustee; individual consumer-shareholders may execute control rights as members of a supervisory board or an advisory council. The CSOP has an additional advantage: municipalities or external investors may invest in the project while being guaranteed voting rights proportional to their capital investment (Lowitzsch 2017). Together with the potential of scalability being compatible with conventional investments gives the CSOP the advantage to avoid concerns of market fragmentation (see Sect. 1.2.2 and Chap. 31): sub-scale investments can be avoided, local projects pooled and partnerships with municipalities set up, thus advancing to economies of scale while retaining the benefits of individual consumer participation.

Specific features of the CSOP approach for financing consumer ownership in RES, which explain its potential to both modernise and adapt best practice models for RES objectives, are discussed in Chapter 8 with a model calculation illustrating the life cicle of a CSOP in Chapter 9.

1.3 Political Setting in the EU and Potential Barriers

In 2015 the European Commission issued two Communications[19]: "Delivering a New Deal for Energy Consumers" and "On a New Energy Market Design". Their message was that the three pillars of future consumer energy policy would be consumer empowerment, smart homes and networks, as well as data management and protection. The

[19] COM(2015) 339 final and COM(2015) 340 final both of 15 July 2015.

Commission explicitly emphasises the role of *prosumers*[20] and thus advocates for both reducing energy costs through self-generation and consumption,[21] and expanding the consumer role through intermediation and collective participation schemes.[22] The EESC further issued two initiative opinions (TEN 578 and TEN 577) which strongly advocate the "prosumer approach". The ITRE committee of the EP is taking considerable interest in these issues and took a positive stand when tabling amendments to the Commission proposal of the RED II (discussed in Sect. 1.2.2). The RED II sections on self-consumption and collective local organisation thereof as proposed by the EU Parliament and the Commission asked Member States to "provide a more conducive investment environment for self-generation and self-consumption" and "to suppress administrative and market barriers to new self-generation capacity, to replace lengthy authorisation procedures with a simple notification requirement and to put in place efficient one-stop shops". However, Member States like Germany have been reluctant to support this approach in the European Council perceiving consumer ownership, be it individual or collective, more as an obstacle to market integration than as a lever to achieve the energy transition.

Nevertheless, after long-lasting and controversial negotiations, the outcome of the Trilogue on the Clean Energy Package (see also Sect. 1.2.2) confirms the prominent role prosumers and their local collective organisations will have across the EU in the future. Recital (54) of RED II thus states:

[20] See in particular "Best practices on Renewable Energy Self-consumption" (SWD(2015) 141 final), accompanying document to the Commission Communication "Delivering a New Deal for Energy Consumers" (COM(2015) 339 final).

[21] See COM(2015) 339 final p. 6, (*c*) *Reducing energy bills through self-generation and consumption*: "Decentralised renewable energy generation, whether used by consumers for their own use or supplied to the system, can usefully complement centralised generation sources. Where self-consumption exhibits a good match between production and load, it can help reducing grid losses and congestion, saving network costs in the long-term that would otherwise have to be paid by consumers".

[22] See COM(2015) 339 final p. 6, (*d*) *Increasing consumer participation through intermediation and collective schemes*: "Collective schemes and community initiatives have been emerging with increasing frequency in a number of Member States. More and more consumers engage in collective self-generation and cooperative schemes to better manage their energy consumption. This innovation *by* consumers is also resulting in innovation *for* consumers and opens up new business models".

> The participation of local citizens and local authorities in renewable energy projects through renewable energy communities has resulted in substantial added value in terms of local acceptance of renewable energy and access to additional private capital which results in local investment, more choice for consumers and greater participation by citizens in the energy transition. This local involvement will be all the more crucial in a context of increasing renewable energy capacity in the future. Measures to allow renewable energy communities to compete on an equal footing with other producers also aim to increase local citizen participation in renewable energy projects and therefore increase acceptance for renewable energies.

Furthermore, Art. 2 RED II defines three categories of actors that benefit from preferential conditions with regard to market access and authorisation procedures, namely, "renewable self-consumers" and "jointly acting renewable self-consumers" (both regulated in Art. 21 RED II) as well as "renewable energy communities" (see Art. 22 RED II). The introduction of jointly acting prosumers is a major step ahead with regard to tenant energy projects that empower in particular low-income households that typically rent their home and do not own real estate with the same "right to prosume". When transposing, the RED II Member States shall thus ensure that prosumers, individually or through aggregators, are entitled to generate and store RE as well as to sell excess production to the grid at a market-based fair remuneration without being subject to discriminatory charges and—with regard to electricity that remains in their premises—any charges or fees. However, the Internal Electricity Market Regulation (IEMR) and Directive (IEMD) still in negotiation between the European Commission, Parliament and Council as of September 2018 will define a large part of the concrete market rules applicable (see Sect. 30.2). The legislative schedule foresees the IEM Trilogue negotiation to be closed until the end of 2018 and the adoption of the whole legislative package before the European elections in May 2019. After that, Member States will still have some room for manoeuver in the transposition of the directives 18 months after their entry in force, that is, by the end of 2020.

As to political and communication barriers to consumer ownership, we believe that the political climate which previously hindered implementation of new business models, like the CSOP, has now improved because of the structural particulars of the RE market. Measures necessary for decentralising energy production, such as planning designation or grid extensions, are more likely to gain acceptance when participants from the society at large are involved. Not only have policy makers changed their attitude, but the renewables industry and even large energy suppliers are more receptive to consumer (co-)ownership, regarding it beneficial to the implementation of local supply concepts and smart grids.[23] Also, broad consumer ownership in RE projects actually increases investment opportunities for the entire RE sector. Consumer-owned projects do not compete with or replace other investors. Instead, consumer ownership expands the society's renewable capacity. Barriers to consumer ownership are discussed in Sect. 1.5 of the individual country studies in Part III.

1.4 Consumer (Co-)Ownership, a Prerequisite for Energy Transition and Energy Market Reform

During the past 25 years, communities, small businesses and particularly consumers as individuals and households have invested heavily in energy from wind, solar and biomass. As of 2018, RES provide already well more than a quarter of Germany's total electricity production, while private citizens own roughly a third of installed RE (see country Chap. 13). Decentralised energy production has proved to be an efficient means for fostering both the *energy transition* and a low-emission economy. Essential measures such as planning designation or grid extensions are more likely to gain acceptance when civil society is involved (Ethik-Kommission 2011; Schomerus et al. 2014). The local community can educate citizens in responsible energy use. In addition to economic impe-

[23] In the UK, as part of DECC's Community Energy Strategy, published on 27 January 2014, the renewables industry and the community energy sector committed to work together to facilitate a substantial increase in the shared ownership of new, commercial onshore renewables developments; an example of large suppliers supporting citizen (co-)ownership is the "Citizen's RES Coop" initiated by RWE in Germany.

tus, community involvement offers other advantages. Local social capital[24] is not limited to projects of self-organisation but can be a resource for future endeavours. Moreover, by reducing its carbon footprint and improving its sustainability profile, communities make themselves more attractive.

The broadened RE ownership structure innovated in countries like Germany, the Netherlands, Denmark or Great Britain primarily depends upon the particular form of *energy transition* those countries have chosen and the type of FITs at the core of those reforms.[25] Guaranteed FITs have proved to be the most effective means of repaying RE installation loans, providing at the same time investment security and a more accurate assessment of project risk while widening the investor circle, particularly citizens as individuals. By stimulating innovation, this model has enabled renewables to achieve grid parity, that is, reducing production costs to a level competitive with fossil energy (McKenna 2015). The success of this concept in promoting RES is exemplified by Germany, where the share of RE rose to 25.8 per cent already in September 2014, edging out brown coal as the country's primary energy source (AGORA 2015).

The consumer ownership model although already a proven success is slowed in its adaptation by two factors:

- Firstly, potential is sacrificed by inadequate potential for the scaling of investments; fewer medium- and large-sized projects with citizen participation are being realised (Rommel et al. 2018).[26]
- Secondly, FITs are being replaced by auctions, resulting in worsening refinancing prospects for RE plants. This trend particularly disadvantages small producers who cannot compete with the large ones.

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[24] Social capital is a sociological term, which describes the rate of social cohesion (the "social climate" so to speak), willingness for cooperation and the potential for mobilisation.

[25] The 2000 model law EEG is one of the legal acts most often copied in other countries around the world; it has been adopted and transferred worldwide: 71 countries and 28 states/provinces enacted some form of feed-in policies as of early 2013, led by developing countries with regard to number of FITs in place (REN21 2013).

[26] There are a few large- and medium-scale projects in Germany that are financed via closed-end funds, but other business models suffer from high intra-organisational costs and high transaction costs (Yildiz 2013).

This policy change will eventually impact the ownership structure. This already is the case in Germany where the ownership share of individual citizens and farmers decreased from about 50 to a little above 40 per cent between 2012 and 2016 (trend:research and Leuphana 2013; trend: research 2016). Large concerns are now investing in the RE business, for example, the German company RWE. The question is whether the resulting market consolidation and ownership concentration are compatible with the decentralised ownership structure essential to the energy transition as argued above (Rommel et al. 2018). If the energy transition is to continue to progress, and if the share of renewable energies is to reach 50 per cent of the total energy consumption, structural changes need to be made. Financing systems must be redesigned so as to include more and eventually all groups of society (Graichen 2015).

On a broader scale, transforming consumers into owners of RE installations strongly motivates them to more efficiently use energy. It also makes consumers more aware of energy use and triggers a learning process (Roth et al. 2018). This is a consumer educational process which in turn contributes to:

- Facilitating the use of ICT solutions, like smart metres and fostering closer alignment of consumption with volatile RE supply by increasing demand-side flexibility (economic)
- Encouraging the public to accept the energy transition, particularly grid extension and installation of new RE production facilities, for example, wind turbines, and also to provide practical information to civic and public agencies including public procurers in this field (social)
- Accelerating the energy transition by reducing emissions and the impact of energy production on climate and current externalities as well as contributing to sustainability goals (ecologic)

Expanding RE production installations and facilities would benefit not only individual consumers but also the small communities and entire economy of the European Union. While most households' energy needs would be provided by the jointly owned local facility, with excess energy sold to the grid, cheaper energy and an additional source of household income would motivate people to become more knowledgeable consumers. As owners of the RE production facility, consumers now have an incentive to sell as much of the energy produced as possible in order to quickly amortise their investment. This provides an incentive to increase energy efficiency by conserving it, since every non-consumed kilowatt-hour increases profits of the consumer-owners.

Transition countries, in which rural areas often have limited access to energy, for example, Asia and Africa, may also be interested in the benefits of consumer ownership in RES. Access to energy is crucial to economic growth and for improving the quality of life. Demand for energy in developing countries is growing. Africa, for example, has 15 per cent of world population but only 5 per cent of global energy production; per capita energy consumption there represents only one-third of the world average—one-sixth if traditional biomass is excluded. The same situation obtains in Asia. Furthermore, many households in developing countries are not only poor but located in remote areas with no access to electricity at all.

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Part I

Rationale for Consumer Ownership in Renewable Energies

2

From Fossil to Renewable Energy Sources

Carsten Croonenbroeck and Jens Lowitzsch

The transformation of energy systems from fossil to renewable sources, the *energy transition*, is a global trend. The shift towards green and sustainable energy systems that has gained momentum over the past 25 years is reflected by policy decisions of governments around the world encompassing around 144 countries having corresponding policy targets in place already in 2014 (REN21 2014). It was confirmed by the landmark agreement to combat climate change and to accelerate and intensify the actions and investments needed for a sustainable low-carbon future reached by the parties to the United Nations Framework Convention on

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Climate Change in Paris on 12 December 2015.[1] In 2015, renewables including traditional biomass, bioenergy, hydropower, wind, solar, geothermal, waste, and marine energy made up 19.3 per cent of global total final energy consumption (TFEC) (REN21 2017).

This chapter provides an overview of the forces driving the energy transition in the countries under consideration. Comparing countries with each other in particular with regard to the current energy production landscape, the present challenges, and the future prospects for policy development, we describe common elements as well as differences thus identifying—where possible—clusters and drawing brief conclusions in Section 2.1. A discussion of structural differences of fossil and renewable energy (RE) production follows in Section 2.2. We conclude with a short summary of the impact that digitalization has on the energy transition in Section 2.3.

2.1 Forces Driving the Energy Transition

The motivations underlying the *energy transition* are diverse and manifold. They differ from country to country and sometimes even between regions of the same country rooting in the specific challenges determined by geography, the historical development of national energy markets, and cultural factors. We also observe that these motivations often are heterogeneous including conflicting elements resulting in discrepancies between the declared goals regarding the deployment of RE and the actually implemented energy policies. Interestingly, this phenomenon does not seem to be connected to the level of economic development and the available resources both financially and geographically but more to general political settings and the public opinion and decision-making. Thus while declared goals and aims are easy to identify, the chances for realisation need to be carefully evaluated against the background of the current

[1] See the 2015 Paris Agreement of COP 21 that entered into force on 4 November 2016 and had been ratified already by 178 of 197 parties to the convention in July 2018; for Europe see the 2018 agreement on the recast of Renewable Energy Directive setting rules for the EU.

challenges and the driving forces behind policy making which show a strong path dependency (Unruh and Carrillo-Hermosilla 2006).

To illustrate the discrepancy between declared goals and implemented energy policies observed, Table 2.1 summarizes the main challenges the countries of investigation currently confront and contrasts them with both officially announced RES targets and climate goals, and general declared energy policy aims. We focus on oil/coal/gas usage, greenhouse gas (GHG) emissions, electricity imports and exports, and RE usage.

A discussion of individual countries follows in Sects. 2.1.1 and 2.1.2 interpreting the findings from the country chapters as reflected in Table 2.1. Here, we also elaborate on the sobriety of the declared goals and shed light on several countries' special conditions briefly discussing the current state of climate/RE policy in place, if any.

2.1.1 Current Challenges in the Energy Production Landscape

2.1.1.1 Nuclear Power

A large subset of countries employs nuclear power in their energy mix. Nuclear has the advantage of being comparably cheap and "CO_2 neutral", that is, nuclear power plants emit virtually zero GHGs. However, the disadvantages of this technology are possible dependence on uranium imports and questionable safety of plant operation as well as of waste disposal. Some countries are locked into nuclear power as it is economically hard to substitute the technology, because no other fuels are available or because of the problem to divest from past investments in the magnitude of billions of euros but are willing to exit from it in the long run. Other countries, however, see nuclear power as a viable way to manage GHG emissions and do not only refrain from reducing nuclear usage but plan to increase it. Among others, the Czech Republic, France, the UK, Switzerland, California, Canada, India, Pakistan, and Japan use noteworthy amounts of nuclear power.

Table 2.1 Drivers of the energy transition

Country	Main challenges	RE targets and climate policy	Policy goals
Czech Republic	Coal-related air pollution; loop flows from neighbouring countries; shift from net exports (mostly coal and nuclear) to net imports foreseeable	13.5% of TFEC from RES by 2020; 14% RES in heating and cooling; 14% RES in electricity	Energy independence; security of supply; reduction of nuclear and coal share in gross production
Denmark	Balancing levels of taxation for fuels and electricity; flexibility in energy consumption due to variable wind power	50% of TFEC from RES by 2030, 100% by 2050; 40% reduction of CO_2 emission by 2020 (since 2012)	Further reduction of oil imports; electrification of heat and transportation
France	Dominant role of nuclear power; power market highly centralised, obstructing access for new players; lagging on RES targets	23% of TFEC from RES by 2020, 32% by 2030; reduction of nuclear share in energy mix from 75% to 50% by 2025	Reduce strong dependence on nuclear power, oil and coal imports, as well as electricity imports during the winter
Germany	Exit from coal; high energy prices for households stemming from RES surcharge; cleaner natural gas-fired thermal power plants are unprofitable most of the time (operating reserve is affected)	60% of TFEC from RES by 2050; gross consumption targets by 2020: 35% in electricity, 14% in heat, 10% in transport; 80% reduction of GHG emission by 2050 (since 1990)	Foster greater market proximity; competitive determination of electricity prices; exit from nuclear power by 2022

(*continued*)

Table 2.1 (continued)

Country	Main challenges	RE targets and climate policy	Policy goals
Italy	High dependence on fossil fuel and electricity imports (highest worldwide, mostly French nuclear energy); market concentration obstructing access for new players; coal-related air pollution	28% of TFEC from RES and 55% of electricity consumption by 2030 (mostly from hydropower, geothermal power, and PV)	Reduction of TFEC; strengthen supply security; narrowing energy price gap (high industrial electricity prices); maintain 1990 nuclear exit; phase out coal
The Netherlands	High dependence on fossil fuel import; focus on centralised planning, with large-scale fossil generation plants	14% of TFEC from RES by 2020, 16% by 2023; phase out coal plants by 2030	Decrease gas extraction; reduce import dependence expanding (offshore) wind energy; modernisation of heating systems
Poland	Energy import dependence from Russia; dominance of domestic coal (89% of electricity generation in 2012); poor air quality related to low-stack emissions; old energy infrastructure; insufficient interconnection junctions	15% of TFEC from RES by 2020	Energy independency; improve air quality

(*continued*)

Table 2.1 (continued)

Country	Main challenges	RE targets and climate policy	Policy goals
UK (England and Wales/ Scotland)	Strong lock-in on fossil power (80% of electricity production in 2004); high GHG emission (7th largest worldwide); grid constraints hampering RES transmission	80% reduction of GHG emission by 2050 (since 1990); electricity carbon-free by 2030; *England*, *Wales*, 15% of TFEC from RES by 2020; *Scotland*, 30% of TFEC from RES by 2030, 50% by 2030; 500 MW community/locally owned RE by 2020	Secure and resilient energy system; keep energy bills low; reduce carbon emissions cost-effectively (also by new nuclear power plants); increase offshore wind power (UK owns one third of total worldwide capacity); *Scotland*, smarter model of local energy provision (switched from quota system to FIT in 2010)
Spain	Dependence from imported oil as the main power source (however, 40% of electricity stem from RES); increasing energy prices	20% of TFEC from RES by 2020	Security of supply; competitiveness of RE sector; foster wind energy (being one of the largest EU wind power producers) and solar heat
Switzerland	Dependence on uranium imports (40% of electricity stems from nuclear power)	Increase by 3.5 times of electricity from wind, solar, biomass, and geothermal sources by 2035 (since 2016)	Phase out nuclear energy; streamlining of permitting procedures for RE plants; increase CO_2 tax and foster prevalent FIT to reduce GHG emissions; EE measures in building sector

(*continued*)

Table 2.1 (continued)

Country	Main challenges	RE targets and climate policy	Policy goals
California	Closure of the last nuclear power plants by 2025; extreme weather events; reducing the use of natural gas; high solar penetration at peak hours	Mandate to procure 33% RES of supply by 2020; 50% by 2030; legislative proposals for transition to 100% RES by 2050	Balance demand-supply gap from excess PV supply at peaks; promote energy storage; zero net energy construction; local resilience and decentralised energy infrastructure
Canada (focus Ontario)	High, volatile electricity prices; incoherent national energy policy; askew spatial distribution of natural resources; dependence on nuclear power (15% in total electricity consumption)	37% reduction of GHG emissions by 2030 (since 1990), mainly through nuclear expansion	Ensure competitiveness of oil sand production even in times of low oil prices (coupled by decreasing commitment of RES expansion); set incentives to handle the east-west imbalance; keep up energy net exports
Brazil	Diversification of electricity portfolio; reliance on large-scale hydropower; rising electricity demand and illegal consumption; energy accessibility in rural areas and reduction prices	43% reduction of GHG emissions by 2030 (since 2005); 10% of electricity production from wind power by 2020	Keep FIT financially feasible; reduce dependence on hydropower; level out hydropower in the south by wind power in the north

(*continued*)

Table 2.1 (continued)

Country	Main challenges	RE targets and climate policy	Policy goals
Chile	Dependence on hydropower; diversification by means of combined cycle plants and coal plants implying energy imports; increasing GHG emissions; increasing energy prices	20% of RES in electricity companies' portfolio until 2025; 250 MWp installed capacity for distributed PV generation by 2025	Unification of electricity market through unified national grid; energy security; diversification of electricity generation; foster grid connection of RES plants
India	Energy poverty in rural areas; steeply increasing energy demand and CO_2 emissions; strong dependence on oil imports	Increase by five times of installed wind power capacity by 2022 (since 2015); RE target of 175 GW installed capacity by 2022	Access to energy at affordable prices; improve energy security and independence from imports; economic growth; foster sustainability as well as wind and solar power
Pakistan	Dramatic supply-demand gaps with strongly increasing demand; power outages; poor grid and plant infrastructure; energy theft; energy poverty, especially in rural areas; dependence on oil imports and increasingly on gas imports	Double electricity generation capacity to 45 GW by 2025 also through implementation of hydro and other RE projects	Bridge demand-supply gap by 2018; electricity access to over 90% of the population; optimise energy mix by indigenous resources with due environmental consideration; investments in infrastructure and institutions; foster oil and gas pipelines

(*continued*)

Table 2.1 (continued)

Country	Main challenges	RE targets and climate policy	Policy goals
Japan	Very low energy self-sufficiency; very high electricity prices; increasing GHG emissions since 2011; large oil, coal, and gas imports (80% of electricity generated from fossils)	RE share of 22% to 24% for power generation in 2030	Target of nuclear power share in energy mix of 20%–22% by 2030; energy security, economic efficiency and environmental protection; support for solar-, wind-, geothermal-, hydro-, biogas-, and biomass-based electricity productions

Source: Respective country chapters

2.1.1.2 Oil/Coal/Gas Usage, Imports and Exports, GHG Emissions

Many countries abdicate nuclear power. To satisfy their electricity demand, these countries import electricity from abroad—if possible from neighbouring countries. Of course, countries also generate their own electricity from RES, including hydropower or geothermal power; the opportunities primarily depend on and are bound by geographical, geological, and topological circumstances. Finally, fossil fuels like oil, coal, or gas (OCG) are used to generate electricity with or without dependence on imports. While oil is dominant in the transportation sector even in countries where electricity is predominantly generated with nuclear and/or RE sources, some countries burn oil as well as coal and gas for electricity generation. In certain cases OCG is mainly used because it is locally available; Poland, for example, is strongly locked into using domestic coal with abundant resources providing independence from imports. Cheaply available OCG makes expensive RES subsidies dispensable. While not being dependent on nuclear power may be an asset, OCG has the strong disadvantage of GHG emissions. Therefore, the extent of OCG usage is influenced by (a) nuclear use, (b) import dependence, (c) RES alternatives and the will and/or the ability to subsidise RES, and (d) GHG emissions. Technologies for carbon capture and storage (CCS) are not market compatible yet, mostly due to high prices. Therefore, CCS is not considered at this point. Countries with extensive OCG usage are the Czech Republic, France, Germany, Italy, the Netherlands, Poland, the UK, Spain, Chile, India, Pakistan, and Japan, each for their own respective reasons.

2.1.1.3 Electricity Imports and Exports

Based on natural resources and dominant technology branches, countries may be electricity importers or exporters impacting the question of sustainability of the energy supply in a very different way. For example, Denmark is an exporter of RE while Switzerland imports electricity from French nuclear power plants, a circumstance not evident when one only looks at domestic energy production. We find similar settings in the cases of the Czech Republic, Denmark, France, Germany, Italy, California, and Canada.

2.1.1.4 RES Share in the Energy Mix

The role of RE is still most important in electricity while only slowly increasing in transportation and heating. RE in the narrower sense is energy produced from sources not using fuels at all, that is, wind and solar power (PV and solar thermal), geothermal power, and hydropower as well as "marine" power (tidal power and wave power). These sources are mostly used for electricity generation. RE in the wider sense is based on sustainable fuels like biomass, biogas, and sometimes also energy from waste. As these fuels emit GHG, they are merely considered renewable, as they at least do not emit more GHG as they bound before, for example, while the underlying plants were growing. However, the advantage of these sources, especially biofuels, is that they can be easily employed in the transportation sector. These issues concern in particular Denmark, France, Germany, Italy, the Netherlands, Spain, California, Brazil, India, Pakistan, and Japan.

2.1.2 Countries/Regions by Future Prospects in Energy Production

2.1.2.1 Nuclear Power

Switzerland uses a lot of nuclear power, but plans to exit are in place due to public pressure. Subsidising RES is regarded to be economically more expensive, but this type of investment is favoured over continued foreign import dependence. Exit plans seem to be ambitious but may be considered merely moderate at the same time; in its post-nuclear era, Switzerland is likely to import lots of nuclear electricity from neighbouring countries, especially France. **California** has two nuclear power plants running, both are to be shut down by 2025. With nuclear power production being negligible the US state is likely to be able to replace the amount of energy generated by these plants with RES. In the **Czech Republic**, plans are to reduce the nuclear share. This is, in part, due to public pressure. Also, nuclear power is considered to be less and less economically competitive in comparison to RES, esp. from neighbouring countries. However, substituting its share in electricity by non-nuclear power may not be easy, but other energy sources are available. After the Fukushima incident in 2013, **Japan** reduced the share of nuclear in its power mix, only to bring a set of reactors back online in 2015. Plans to exit from nuclear power emerge from time to time and seem to reflect public opinion. However, this would increase the dependence on oil, coal, and gas imports even more, which are drastic already. Japan subsidises RES by means of an FIT, but there is still a long way to go until the fraction of RES in the electricity mix will be noteworthy.

France is strongly dependent on nuclear power and undertakes little to reduce this dependency. As private household heating is mostly based on electricity, the electricity demand, especially during wintertime, is enormous. Therefore, public support of the use of nuclear power is extensive.

Plans to exit are negligible; policy makers mostly argue pro-nuclear with regard to GHG emissions and keeping the technological advantage in place to be able to sell this expertise worldwide. Similarly, in the **UK**, which suffers from extensive CO_2 emissions, nuclear power is seen as a way to reduce GHG emissions. The country does not plan to exit from nuclear power but seeks to replace older reactors by newly built ones. Nuclear power usage is common in **Canada**, although the country is rich in hydropower and oil/gas resources, but these resources are unevenly spatially distributed. Plans to exit from nuclear power are absent; on the contrary the country is currently planning to build new plants. The nuclear share in the **Indian** electricity mix is minor. Households have, on average, very low electricity demand, and many households are not connected to the grid. The country could substitute the electricity amounts easily, especially due to huge advances in RES usage. However, there are no plans to exit. Quite to the contrary, new plants are currently being built. **Pakistan**, the only Islamic country worldwide to employ nuclear energy, has a minor fraction of nuclear in its energy mix. Presently there are no plans to exit—the fourth and most recent pressurised water reactor went online in Chashma, Pakistan (Chashma Nuclear Power Plant, CHASNUPP-IV) in 2017; CHASNUPP-V is currently being built. However, the most important components in the energy mix are hydropower (electricity) and imported oil (transportation) as well as natural gas (mostly self-extracted), while RES like wind and solar are still negligible. There is potential for biogas usage, but its exploitation has so far not progressed significantly, and plans to do so are not in place.

2.1.2.2 Oil/Coal/Gas Usage, Imports and Exports, and GHG Emissions

The **Czech Republic** produces more than half of its electricity from coal, while oil/gas proportions are negligible. Most coal comes from own natural resources, which, however, will be depleted within the next few decades. Also, GHG emissions are seen as an increasingly serious problem. Therefore, the country plans to drastically decrease the OCG-based electricity fraction. This can be considered ambitious because, at the same time, the country plans to exit from nuclear power as discussed above. Both measures will likely lead to increasing electricity imports. **Poland** produces the bulk of its electricity from domestic coal; however, cheaper Russian coal is imported. There are almost no electricity imports, and RES investments are negligible. GHG emissions are tremendous, but as the coal-based energy landscape is self-sufficient for now, Poland openly argues against current and future climate protection targets. In the **UK**, the contribution of fossil power to electricity production is almost as high as in Poland. Natural resources in OCG are rich, which is why OCG is also exported. As the resulting GHG emissions from OCG usage are considered to be a serious problem, nuclear power is on the rise. CO_2 emissions are planned to be reduced by 80% until 2050—compared to 1990 values—and the electricity sector is planned to be CO_2-free by 2030. These plans are ambitious. In addition to the CO_2 emission "prices" from the European Union Emissions Trading System (ETS), the UK adds a premium for emissions to imply an additional economic incentive to decrease emissions. In March 2018, it was announced that the UK would retain its ETS membership—which is questionable due to "Brexit"—at least until the third trading phase expires in 2020.

The **Spanish** OCG dependence is severe, and large amounts of needed OCG have to be imported from abroad. However, as geographical conditions are appropriate for wind and solar power usage, the Spanish government plans to shift further from OCG towards RES while at the same time exiting from nuclear power. Plans to do so are considered to be ambitious. **Japan** is aware of its strong OCG import dependence. Electricity is dominantly generated from gas and coal. While subsidies for RE are being reduced, nuclear power is currently the only way to keep GHG emissions under control. In the long run, the plan is to keep the nuclear fraction in the electricity mix below the level from before the Fukushima incident. However, the only way to do so is seen in increased OCG usage. As a result, plans to exit are negligible.

OCG imports are prevalent in **France** while mostly necessary for the transportation sector. In the past, France exploited its own natural coal reserves, which are depleted to such an extent today that domestic extraction is economically inefficient in comparison to imports from abroad. Electricity mostly comes from nuclear power, which makes the country an electricity exporter, at least most times of the year as mentioned above. Still, GHG emissions are severe. In order to reduce them, electricity generation from coal must be reduced drastically, which is why RES are being increasingly subsidised. Furthermore, the transportation sector is to be electrified and total energy efficiency is to be enhanced, for example, by means of better thermal insulation of buildings. These plans are considered to be ambitious. The **Italian** energy sector is driven by OCG import dependence. Nuclear power plants are off the table as all previously used plants have been shut down back in 1990, RES are in use, and additional investments in this sector are forthcoming. The country is dependent on electricity imports, mostly from French nuclear power plants. Based on that, Italian GHG emissions are not as severe, and plans to reduce them are negligible. **Germany** is also strongly dependent on OCG imports, especially oil for the transportation sector. A large fraction of the electricity mix stems from RES, which is to be increased even further. Electrified transportation is seen as an opportunity for oil dependence reduction but at the same time is a big challenge. Achieving the declared EU goals for GHG emissions may depend on success in that area, which is why the country's OCG usage reduction plans are ambitious.

The **Netherlands**, a relatively small country, imports oil and coal, while natural gas is a common commodity. GHG emissions are not the most pressing issue and expected to be kept under control by several measures of action, for example, increasing the use of biofuels in the transportation sector, energy efficiency improvements, and agricultural adjustments such as more efficient use of fertilizers and sustainable animal feed. As RES opportunities are present, notably offshore wind farms, few actions are assumed to be necessary to reduce OCG dependence. **Pakistan** is rich in natural gas but uses a lot of oil which needs to be imported from abroad. New power plants will require additional imports in the future. Hopes are set on new nuclear power plants to reduce the pressure a little. However, as new oil- and gas-fired plants are being built as well, there are only negligible tendencies to exit from OCG usage.

India is among the top-three GHG emitters worldwide due to OCG usage in electricity production, mostly from imports. Nuclear power is seen as one key to reduce GHG emissions, and new nuclear plants are being built. RES, mostly wind and solar, are on the rise as well. However, the promotion effect of the current minor subsidy system is far from sufficient. India announced in 2018 to re-evaluate its subsidy system soon, yet RES could still be taken more seriously. Currently, plans to reduce dependence on OCG imports and power production can be considered only moderate. **Chile**, while producing large amounts of hydropower, is also dependent on natural gas imports from abroad as well as on coal. In 2018, Chile announced plans to exit from coal and use RES—mainly wind and solar—by a larger extent. Although presently no time plan for the exit from coal has been presented yet, this goal is considered ambitious. Geographical conditions are favourable for wind and solar; the current support programme turns out to work quite well, even without a FIT system.

2.1.2.3 Electricity Imports and Exports

Currently, the **Czech Republic** is an electricity net exporter (henceforward, for an electricity net exporter and an electricity net importer, the shorter terms "exporter" or "importer" are used). This is due to the huge amounts of nuclear and coal power produced in the country. However, it is projected that on the one hand, renewable electricity in neighbouring countries will continue to put the prices under pressure, so that nuclear- and coal-based electricity will not be competitive for much longer. On the other hand, the domestic electricity demand is expected to increase to such an extent that by 2040 the domestic production will not suffice to satisfy the demand anymore. The country expects to be an importer by then. **Denmark** is rich in oil and gas and produces lots of wind power, so that the country is an important RES-based electricity exporter. **France** produces huge amounts of nuclear-sourced electricity and is therefore, on average, a net exporter. However, the exports/imports are unevenly distributed over time: Since many households use electricity for heating, electricity demand outweighs supply during the wintertime, especially on cold days and nights. At these times, the country is unable to export electricity and needs to import additional amounts from abroad, which has been posing challenges to the grid. Due to increasing production of RE,

Germany is now an established electricity exporter. Most exports are directed towards its neighbours Austria, Switzerland, the Netherlands, Poland, and France—the latter mostly during cold days/nights in winter as discussed above. **Canada** is known to be the largest electricity net exporter worldwide; almost the entire exported amount is direct towards the United States. This electricity is generated by hydropower but also by nuclear power.

Italy meets up to 15 per cent of its electricity demand by imports from abroad and is among the largest net importers worldwide. Only the United States imports even greater amounts. As it is not a sovereign country, **California** is not represented in many statistics, but it is reported that the state imports about a quarter of its electricity on average. There is high RES usage with typical peaks during sunny and windy days and resulting stress for the grid, marked by storage and transmission issues. If electricity demand is significant during cloudy and calm weather, the state imports around 200 GWh of electricity a day on average.

2.1.2.4 RES Share in the Energy Mix

Denmark is known for having the largest share of RE in its electricity mix, mostly due to wind energy. The share of wind energy is expected to increase even further, based on additional offshore exploitation. This is also a means of decreasing GHG emissions and strengthening energy autarky. The country's plans are ambitious. **Germany** already has a large RES share but keeps pushing forward. The country is currently in transition from a FIT to a tendering system. Plans are ambitious, resulting especially from not being on track to satisfy the set GHG emission reduction goals. The **Netherlands** is moving towards an adequate RES share, mostly tied to the development of offshore wind power. Ambitious plans to boost this sector were presented. In **Spain** potential for RES such as wind and solar—PV as well as solar thermal—is huge. Current usage is noteworthy already; goals to increase both wind and solar are on track and ambitious. **California** suffers from "too much" RES, as the infrastructure is not capable of handling wind and solar power at peak times. Investments into the power transmission lines are necessary but so far remain low. Cutting down the progression of RE subsidies makes current plans for expansion negligible; other limiting factors are technical constraints marked by too much pressure on the grid and the absence of storage technology. **Brazil** already uses a lot of hydropower but without space or geographical and topological opportunities for additional hydropower plants. Thus, the country plans to increase subsidies, mostly in the form of an FIT system, for wind and solar, which seems to work out well lately. Plans are considered to be ambitious. **India** is among the greatest solar power producers worldwide. To decrease import dependence and GHG emissions, solar usage is to be pushed forward. Plans are considered to be ambitious.

Pakistan exploits natural opportunities for hydropower contributing to a good RE share. However, although solar, wind, and biogas also have considerable potential in the country, actions to foster these sources are negligible so far. **Japan** installed an FIT system in 2012 which led to a solar boom. Also, Japan puts emphasis on research addressing storage issues. However, as additional opportunities in geothermal and—offshore—wind power usage could be pushed more eagerly the current plans are only considered to be moderate. In **France**, the RES share is minor. However, the country is eager to reduce import dependence and GHG emissions. Thus, RES investments are huge, while nuclear power is also pushed forward. Interestingly, although the electricity dependence is even greater than in other countries—mostly due to electric heating as discussed above—the country does not aim to decrease electricity dependence. Rather, it is incentivized by subsidising electrified transportation. In 2017 the remarkable sum of EUR 20 billion to be invested in the energy sector by 2022 was announced. This includes improved insolation for reduced electricity demand but also subsidies for RES and electrified transportation. **Italy** makes minor use of RES but seeks to improve in this field. Geothermal energy and hydropower opportunities are being exploited, the country has a huge potential for solar and wind energy. The latter leaves room for improvement—however, investments are in a stalemate, possibly due to political disaccord. Current plans to improve on RES usage are moderate, at most.

2.2 Fossil vs. Renewable Energy Production: Discussing Structural Differences with a Focus on Wind and Solar Power

The following section offers a discussion of fossil versus RE production in particular, focussing on the structural differences of countries with regard to wind and solar power. To illustrate the state of affairs in the countries under consideration, Table 2.2 provides an overview of the energy mix for each country, regarding total energy production, consumption, and, especially, electricity production. We focus on wind and solar, mostly photovoltaic power, as they differ from fossils in two important ways:

1. They depend on weather and thus are volatile in electricity generation.
2. Their marginal cost of production is close to zero.

As shown above (see Sect. 1.1.3), under an incentive system changing from FITs to tendering schemes, investments in both energy sources are increasingly difficult to refinance in marginal cost-based energy markets since they have a price disadvantage on these markets (see Sensfuß et al. 2008 for a discussion of marginal cost-based electricity markets). Furthermore, different types of RES and their respective value-added processes have different transaction costs relative to the institutional setting and the allocation of property rights. Coase (1937) developed an analytical framework to explain why it is sometimes cost-efficient to execute transactions within a hierarchical organization, that is, not employing market mechanisms. Different implications with respect to ownership structure result: Bioenergy projects show particularly high transaction costs due to the heterogeneous agents and financial risks inherent in the project; therefore, from the perspective of transaction costs, an integrated company seems to be the most efficient organizational form. Solar and wind energy production, in contrast, involves comparatively low transaction costs, thus not necessitating an integrated hierarchical organizational form (Yildiz 2013).

Finally, the principle of coordinating investment on the basis of a long-term forecast in the regional or national area of the legal monopolies is no longer valid. Volatility of markets in peak and extreme peak periods combined with low prices during seasonal or structural overcapacity makes revenue predictions uncertain (Finon 2006). Furthermore, the counter-cyclical effect of this volatility—RES being fed into the grid with priority during overcapacity—causes average annual prices to drop (merit-order effect[2]). This increases risk for lenders and investors. In other words, the very volatility of RES destroys their market price, thus discouraging financial investment. This constitutes a fundamental contradiction of the objective of increasing RE's share in the energy mix by closing the financing gap. In 2015 even a pioneering country like Denmark -that boasts with 68 per cent of RE and waste in electricity generation- had a share of merely 24 per cent of RE in total energy production. This picture is sobering. Consequently, the energy transition is all but straightforward, and it is not surprising that most of the countries under consideration show a similar picture: (1) The energy mix with regard to total energy production is still dominated by conventional fossil fuels and nuclear power and is sometimes driven by dirty imports accompanied by low levels of autarky; (2) the share of RE in primary energy consumption which includes processing and transmission losses is also low; (3) only the share of RE in total electricity consumption is usually higher, while "unsustainable" RES may be included.

Table 2.2 gives an overview of these three indicators with the columns organised as follows: *Column B: Energy production* presents the total energy production in 2015 and provides a rating of "conventional" or "clean" production (share of fossil and nuclear power vs. share of RE and waste) and "high", "medium", or "low" independence from imports (fraction of net imports from total production). *Column C: Energy consumption* shows "low", "medium", or "high" RES share in 2016 primary

[2] When selling into the energy markets, variable renewables tend to earn less than the average market price as prices tend to be lower during periods when they are most available and higher when they are less available. In contrast, non-volatile resources can earn more during periods when variable renewable energy production is low and demand is up. This results in a separate market for operating reserve. The necessity of allowing capacity mechanisms (as state aid) to ensure security of supply is discussed at the European level.

Table 2.2 RES in the Energy mix in the countries under consideration

Country	B: Production: Fossil vs. RE / Autarky	C: RE in Consumption	D: RE in Electricity
Czech Republic	Conventional: 84% vs. 16% Medium: 32%	Low: 6%	Biofuels 5.6% Hydro 3.7%, solar PV 2.7%, wind 0.7% Medium: 13%
Denmark	Conventional: 75% vs. 25% High: 14%	High: 24%	Biofuels 11.4%, waste 5.8% Wind 48.8%, solar PV 2.1%, hydro 0.1% High: 68%
France	Conventional: 83% vs. 17% Medium: 47%	Low: 9%	Biofuels 0.7%, waste 0.7% Hydro 10.4%, solar PV 1.3%, wind 3.7% Medium: 17%
Germany	Conventional: 64% vs. 36% Low: 64%	Medium: 13%	Biofuels 6.9%, waste 2.0% Wind 12.2%, solar PV 6.0%, hydro 3.8% High: 31%
Italy	Conventional: 68% vs. 32% Low: 80%	Medium: 16%	Biofuels 6.0%, waste 1.7% Hydro 16.6%, solar PV 8.1%, wind 5.2% High: 40%
The Netherlands	Conventional: 88% vs. 12% Low: 64%	Low: 4%	Biofuels 2.7%, waste 3.3% Wind 6.9%, hydro 0.1% Medium: 14%
Poland	Conventional: 86% vs. 14% Medium: 30%	Low: 5%	Biofuels 6.0% Wind 6.6%, hydro 1.5% Medium: 14%
Spain	Clean: 56% vs. 44% Low: 80%	High: 17%	Biofuels 1.8% Hydro 11.1%, solar PV 2.9%, solar thermal 2.0% High: 36%

(*continued*)

Table 2.2 (continued)

Country	B: Production: Fossil vs. RE / Autarky	C: RE in Consumption	D: RE in Electricity
UK: England, Wales, Scotland	Conventional: 89% vs. 11% Medium: 40%	Low: 10%	Biofuels 7.8%, waste 1.9% Wind 11.9%, hydro 2.7% High: 27%
Switzerland	Clean: 49% vs. 51% Medium: 55%	High: 33%	Biofuels 0.8%, waste 3.4% Hydro 58.9%, wind 0.2% High: 65%
Canada	Conventional: 90% vs. 10% High: −74% (net exporter)	High: 29%	Biofuels 1.9%, mega hydro 56.8% Wind 3.9% High: 63%
Brazil	Clean: 57% vs. 43% High: 8%	High: 36%	Biofuels 8.4%, mega hydro 61.8% Wind 3.7% High: 74%
Chile	Conventional: 75% vs. 25% Low: 66%	High: 18%	Biofuels 7.4%, mega hydro 31.7% Wind 2.8%, solar PV 1.7% High: 44%
India	Clean: 62% vs. 38% Medium: 36%	Low: 6%	Biofuels 1.8%, mega hydro 10.0% Wind 3.1%, solar PV 0.4% Medium: 15%
Pakistan	Clean: 50% vs. 50% High: 25%	High: 31%	Mega hydro 30.7% Wind 0.8% High: 41%
Japan	Conventional: 82% vs. 18% Low: 95%	Low: 8%	Biofuels 3.3%, waste 0.7% Hydro 8.8%, solar PV 3.4%, geothermal 0.2% Medium: 17%

Various sources: IEA (2017), EIA (2016), BP (2017)
Column B, thresholds for “high”: ≤ 25%, “medium”: 26–60%, “low”: ≥ 61%.
Column C, thresholds for “low”: ≤ 10%, “medium”: 11–16%, “high”: ≥ 17%.
Column D, thresholds for “low”: ≤ 12%, “medium”: 13–17%, “high”: ≥ 18%.

energy consumption (which, contrary to energy production, includes losses). *Column D: Electricity* depicts the share of RE and waste in 2016 gross electricity consumption, showing unsustainable RES like biofuels, waste and large, potentially environmentally harmful hydro power plants ("mega hydro"), sustainable RES (up to three most important sources), and a marker for "low", "medium", or "high" total RE share in electricity.

Against this background, countries can be grouped according to the following criteria:

1. Countries that are rather clean energy producers are Spain, Switzerland, Brazil, India, and Pakistan, while the Czech Republic, Denmark, France, Germany, Italy, the Netherlands, Poland, the UK, Canada, Chile, and Japan are still considered to be on the conventional path. However, each of these countries has its own circumstances (see Sect. 2.1 for details).
2. The import dependence is strong for Germany, Italy, the Netherlands, Spain, Chile, and Japan, while Denmark, Canada, Brazil, and Pakistan are rather autarkic.
3. RE shares in electricity production and/or consumption may be low or medium, as for the Czech Republic, France, the Netherlands, Poland, India, and Japan. But high shares must be separated by their origin: are those high RES shares due to unsustainable RE sources like waste, biofuels, or "mega hydro" plants or due to sustainable energy sources like wind, solar, geothermal, and/or low-impact hydro plants? The former may be true for Canada, Brazil, Chile, and Pakistan, while the latter is the case for Denmark, Germany, Italy, Spain, the UK, and Switzerland.
4. Some countries show political stability in the sense that there is a clear political will to implement courses of action for green energy usage/energy transition. Note that although some countries claim nuclear power, biofuels, or "mega hydro" to be "green", we do not follow that assessment. Seen that way, the political climate for sustainable RES is suitable for Denmark, Germany, Italy, the Netherlands, Spain, India, and Japan.

5. The share of RE in electricity generation is in all cases greater than that in primary energy consumption. Countries that exhibit great shares of RES primary energy consumption usually show high shares of "clean" energy production and, often, low levels of import dependence (and vice versa). Conclusions are that RE shares in total energy consumption are rather poor in comparison to the RE shares in electricity production (the latter are the figures countries are eager to present) and that "dirty" energy production, not surprisingly, is often linked to a strong import dependence.

2.3 Digitalization—Opportunities and Challenges for Energy Transition

Over more than two decades since the 1990s the increasing connectedness of digital processes via telephonic or fibre-optic or satellite transmission has resulted in computers today being interlinked across local and global networks. The Internet started out as a communication tool for military and research purposes and over time morphed into a commercial entity with ever-faster emerging web services and shared computing resources provided via what is dubbed "the cloud". Interconnected machines and software not only make it possible to execute physical actions digitally but dramatically reduced the dependence on geographical locality (Arthur 2017), a key element in the development of decentralised RE production.

2.3.1 Smart Grid Technology

This development also gave birth to smart grid technology, that is, smart meters and information and communication technologies (ICT) enabling active interface between the supply and demand sides in energy value chains. The opportunity for electronic communication based on decentralised interaction no longer necessarily brokered by the incumbent energy companies and their intermediaries also brought along prospects for trade between small-scale energy producers. Today, with decentralised production schemes and local self-consumption technologically practicable and economically feasible, consumer owners of RES in principle have the opportunity for a second source of income from capital ownership in RE. However, a prerequisite for this economic incentive unleashing its potential to influence prosumers' consumption behaviour is the availability of choice between self-consumption and sale (for more details see Chap. 3, Sect. 3.3.2). This type of trade can take place either in a closed circuit, that is, a micro grid, or using the existing distribution networks, in both cases, however, relying on smart grid technology.

In enabling peer-to-peer trading of self-produced energy, digitalization thus has the potential to solve a core problem of distributed generation and in particular prosumership, that is, how to trade the energy produced and on which market. In the fossil energy world this market has been characterised by pre-formulated bilateral agreements and a structural asymmetry between vast numbers of consumers on the one side and a few retail energy suppliers on the other, with the latter imposing the conditions of contract. Limiting the economic prospects of prosumership, this structural asymmetry impaired the large-scale deployment and diffusion of micro-generation (Kounelis et al. 2017). With decentralised RE production, for the first time access to energy markets that used to be the privileged playing field of incumbent energy suppliers seems to be opening up to the prosumer. While having the obvious advantage of interconnecting energy consumers with energy producers, smart grid technology can be key to enabling an improved balance of electricity supply and demand in decentralized grid control, but that requires substantial investments. Global smart grid investments in Western Europe alone are estimated to reach EUR 110 billion by 2027 (Northeast Group 2017) as compared to EUR 3.15 billion in 2014, with the bulk of investments in smart grid projects stimulated by public funding.

2.3.2 Micro Grids

A micro grid (MG), that is, "a group of interconnected loads and distributed energy resources within clearly defined electrical boundaries that act as a single controllable entity with respect to the grid" according to the

U.S. Department of Energy (Ton and Smith 2012), can operate in both modes, grid-connected or off-grid. MGs are an integral part of smart grids and can (1) facilitate combined heat and power (CHP) generation, (2) help to mitigate system instability resulting from intermittent RE production, (3) enhance reliability with intentional "islanding", and (4) increase local reliability especially during energy outages. While most MGs are still military or research installations, they are increasingly employed in commercial, island, or remote community settings. When interconnected to the grid, an MG allows import and export with the macro grid while deferring capacity investments, reducing system losses, and improving local reliability. When disconnected from the grid, an MG can operate autarkically, requiring the coordinated dispatch of distributed energy resources to ensure voltage and frequency regulation, typically providing service to remote locations not connected to the grid (Bahramirad et al. 2014).

As MGs are a disruptive, new technology system, barriers include a lack of standards especially for interconnection procedures, as well as of financing models as the majority of MG projects, so far, have been end-user financed with limited access to third-party capital (Soshinskaya et al. 2014). Furthermore, with MGs being highly customized with no or few scalable prototypes, involving long-term large-scale investments and implying cyber-security concerns when connected to the macro grid, their field of application remains narrow.

2.3.3 Peer-to-Peer Trading for Prosumers Using Blockchain Technology

Blockchain technology relies on the concept of tracking single transactions simultaneously on a shared ledger that the parties to the transaction trust to be accurate and permanent (Siegel 2009). The Internet, being inherently decentralised, is the natural information grid for blockchain technology.[3] The name blockchain stems from the way information is

[3] The majority of research projects are centred around direct exchanges of energy between customers, that is, "peer-to-peer" marketing of energy and offering electricity based on crypto currencies. However, the fields of application include managing the trade of REC and the charging of electric vehicles or optimizing internal and business-to-business processes in large energy companies (Emerton 2017).

stored: Transactions are periodically bundled into blocks to create an immutable chain. Each time a new block is confirmed, it is synchronised between all nodes having to agree on the new block, enabling immutability of all entries independent of a centralised clearing intermediary. Applied to energy prosumage (see Chap. 29), the blockchain technology creates a transparent, secure, flexible and distributed consumer-owned platform which can store the energy prosumption information collected from smart metering devices in a tamper-proof manner (Grid+ 2017). When this electronic ledger is combined with self-enforcing "smart contracts", that is, a contract which is executed between the two parties when predefined parameters are fulfilled without any further physical action or expression of will, necessary standard transactions can be executed automatically within guaranteed intervals. This type of automated trading would allow the definition of expected energy flexibility at the level of each prosumer ex ante and the setting of rules for balancing energy demand with energy production at grid level, including the associated rewards or penalties (Pop et al. 2018).

As of 2018, both demand and small-scale energy production of prosumers are non-controllable parameters in the energy system. Under the current technology and policy framework, a decentralised grid system with an increasing share of RE is economically inefficient as it requires an extensive need for backup power plants, resulting in vast redundancies on the supply side. Blockchain technology promises a first step towards a possible real-time consumer (co-)owned energy economy, as it would permit the allocation of resources in real time through the price-driven infeed and exit of energy. For the trading of excess energy production, prosumers would no longer rely on a middleman charging them transaction costs but instead have the economic incentive to act as local suppliers. At the same time a broader choice with regard to both energy supply and demand, entices to take a more active role which in turn will favour local RE production (Emerton 2017).[4] This would facili-

[4] A virtual microgrid in Brooklyn, New York, enabling prosumers to buy and sell energy produced locally between neighbours without exiting the local distribution infrastructure is one of the most advanced projects run by LO3ENERGY and Consensus Systems, two US start-ups. A LO3ENERGY blockchain-based trading platform is combined with a Siemens microgrid management solution (LO3ENERGY n.d.).

tate self-consumption as well as on- and off-grid sale: Peers are able to buy and sell energy directly from other peers in the same micro grid in line with their production and consumption behaviour or—depending on market prices—opt for feeding it into the public grid. For example, energy produced in an RE installation of one apartment building can be balanced between the different parties, avoiding levies for the use of the public grid when prices are low as a result of excess supply, or can be sold to other consumers in times of high demand when prices offset these levies.[5]

However, the potential to render cost-efficient numerous, small-sized energy transactions between two private parties depends on the cost of the blockchain transaction itself. While economies of scale tend to favour larger transactions, there are also bandwidth issues limiting individual blockchain protocols: A centralised system can immediately verify and record transactions. On a distributed ledger, transactions must be recorded, verified, and accepted by a majority of participating nodes in very short intervals to guarantee independence and trustworthiness. The required synchronicity of a transmission within a certain time frame to a large number of nodes in the Internet imposes limits of the possible number of transactions in a given interval depending on the bandwidth of the communication channels used (Guinard 2017). For example IOTA, a blockchain designed for the Internet of Things, can handle over 100 transactions per second on a small network of less then 250 nodes (Schiener 2017). In comparison, VISA had an average of 1667 transactions per second in 2016 (Vermeulen 2017). These latency issues put the blockchain technology in competition with mature alternative technologies such as mobile payments for electricity offers in Africa (Emerton 2017). Furthermore, the security and privacy of consumption and trading data pose challenges requiring encrypted messaging streams and multi-signatures to guarantee anonymity (Aitzhan and Svetinovic 2017). Finally, the "proof-of-work" consensus mechanism underlying early blockchains, such as Bitcoin (Nakamoto 2008), is unsustainable in its current form as it requires computationally very hard problems for mining a block. With computational

[5] Furthermore, as blockchains would allow the formation of smart contracts between all involved parties with a transparent documentation of transactions open to scrutiny, the certification of green energy products is possible proving that electricity is from renewable or regional sources.

power increasing exponentially according to Moore's Law, the complexity for mining new blocks must also increase over time, requiring an ever-greater amount of electricity. Nonetheless, research is in progress to replace "proof-of-work" by "proof-of-stake" approaches that make time-consuming and electricity-intensive "mining" unnecessary. If feasible, the "proof-of-stake" alternative would avoid "computational puzzles" required for both mining and authentication by choosing each creator of the subsequent block in the chain via various combinations of random selection and wealth or age (i.e., the stake).

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3

The Consumer at the Heart of the Energy Markets?

Jens Lowitzsch

In contemplating the launch and the implementation of an Energy Union, the European Commission envisioned a regulatory framework "with citizens at its core, where citizens take ownership of the energy transition, benefit from new technologies to reduce their bills, participate actively in the market, and where vulnerable consumers are protected".[1] Regarding the question of how consumers benefit from these objectives, the Commission Communication "Delivering a New Deal for Energy Consumers" (COM(2015) 339 final) identified a number of obstacles and highlighted areas for improvement with respect to the three mentioned pillars of consumer policy, that is, consumer empowerment, smart homes and networks, as well as data management and protection. The empowerment of consumers in particular poses three challenges, namely, (1) how to motivate them to increase demand-side flexibility and (2) improve energy efficiency while (3) reducing energy poverty—a structural

[1] See Energy Union Framework Strategy COM (2015) 80 final.

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challenge in the energy transition not limited to the European Union. Carefully calibrated policy action is required if the "consumer at the heart of the energy markets" is not to remain an empty slogan. As this chapter will argue, consumer ownership can contribute to meet each of the mentioned challenges.

3.1 Introduction: Socio-economic Function of Ownership

To fully understand the importance of direct and local/regional consumer ownership, it is necessary to understand the development of property as a historical not a logical category (Roggemann 2010, 1997); property is both a legal and a socio-economic concept:

- The general assignment of liability and risks deals with one aspect of this duality; its mirror image is the economic essence of property, that is, the owner's right to receive the income it earns (Kelso and Adler 1958).[2] This economic function is also the foundation of a credit system based on collateral, in particular on mortgage of private real estate ownership. The legal institute of property not only provides the indispensable foundation of a market economy, including competition, it is also the basis and the connecting point of related economic categories: "Property does not exist outside the economy, but it rather gives significance to all terms and concepts that are meaningless in non-ownership economies; this applies especially to interest, money and credit, but also to value, price, profit and market" (Heinsohn and Steiger 1997; Hölscher 1996).
- Another aspect of this duality is the delimitation of the individual in relation to society. After all, *inclusion* and *exclusion* are often defined in

[2] Referring to Pollock v. Farmers' Loan & Trust Co., United States Supreme Court Reports, Vol. 157, 1895, p. 429ff: "For what is the land but the profits thereof? … A devise of the rents and profits or of the income of lands passes the land itself both at law and in equity".

terms of owners and non-owners; social integration in the modern consumer society increasingly entails economic opportunities often facilitated by the revenues from property ownership. At the same time, property also serves an important emancipatory impulse—the need to distinguish oneself from others. This function is a mirror image of the power of property ownership to enable participation (Reich 1964[3]).

Both of these aspects are inextricably linked to the importance of property ownership for political stability in a functioning democracy. Alexander Hamilton expressed a truism of political democracy in his Federalist Papers of 1788: "[…] power over a man's support is a power over his will". Economic independence is an important condition for the development of personal and political freedom. These legal functions of property and the constitutional principles backing them have a variety of implications for consumer ownership of renewable energy sources (RES). They impact not only production and consumption of energy but the role of the individual in society.

3.1.1 Ownership and Control of Productive Property

Economic differentiation, particularly the rise of the business corporation,[4] has made earlier, simpler forms of property acquisition and utilisation by the typical owner-possessor inadequate. This has led to the development of ownership surrogates in different forms of so-called economic property. These have become increasingly abstract especially securitised share ownership. "Economic property" has led to a situation where the *possessor* holds the right to—but not abusively—use, possess, and dispose; the

[3] "[P]roperty performs the function of maintaining independence, dignity and pluralism in society by creating zones within which the majority has to yield to the owner. Whim, caprice, irrational and 'antisocial' activities are given the protection of law…."

[4] As legal entity it benefits of an important privilege, the limitation of the personal liability of its shareholders to the amount of the fully paid share. In the sixteenth century, this privilege used to be granted under the condition that the purpose of the enterprise served the common good; thus in the majority of corporations, shareholders were personally liable for the debt of the corporation; but in the nineteenth century, the privilege of limited liability became ubiquitous, a structural change with unanticipated impact.

formal owner, on the other hand, does not have the right of physical control over the object of ownership ("right of rule over an object") but merely an abstract control right which is in no respect identical with the typical rights of a model owner.

The original context of liability has therefore been attenuated by new forms of conveyance of capital. These, for example, investment funds, have no identifiable owner, are largely disconnected from corporate responsibility, and therefore severed from general and specific social ties. They constitute a new form of economic ownership which is usually international and supra governmental, resulting in an anonymisation of private property. As globalisation continues to lengthen value chains, anonymous international ownership makes it more and more difficult to identify the direct (negative) consequences of production processes often fragmented and delocalised. The legally unchecked property right to dispose of natural resources has wide-reaching consequences. Not only does it exclude non-beneficiaries from accessing these things. But as rising consumption will ultimately deplete the resources needed for production, continuing to exercise the right as traditionally interpreted would inevitably lead to a gradual curtailment and the abrogation of private property altogether. To achieve a balance of interests, particular account must be taken of this unique structure and its negative effects on liability.

3.1.2 Direct Local Ownership and the Obligation of Sustainability Under Property Law

As the conveyance of property rights becomes more and more abstract, for example, share ownership in umbrella funds compared to sole proprietorship, the link between the owner and the object of ownership becomes more and more attenuated and the allocation of responsibility correspondingly tenuous and opaque. Given the social and environmental impact of the economic activities of the corporation, this is of particular importance. The discussion focuses on the question of whether, and if so, to what extent, owners of productive property benefit from natural resource depletion and environmental degradation in the form of reduced production costs. Further, do the benefits derived from "externalisation" assign the corporation with the corresponding duty of preserving and restoring the resources and conditions essential to human and animal life (Lowitzsch et al. 2015)?

At this point the sustainability obligation enters the picture. This obligation is inherent in the recognition of both Common Law and Continental Law that property has a social function, expressed by the linking of every legal privilege to a corresponding legal duty. This logic supports the imposition of a sustainability obligation to balance the privilege of exploiting natural resources and the environment. This obligatory duty would compensate, on the one hand, for the ever-weakening link between the formal owners, unable to exercise their legal property rights or their corresponding social obligations, and the corporate property administered by management, on the other. In other words, an obligation of sustainability would impose at least some restraint on market forces, mitigate to some degree the principal-agent problem, and restore the lost reciprocity between privilege and duty. Such the obligation of sustainability would address the increasingly abstract relationship between the corporation as a commercial entity and its shareholders as formal owners.

Given the difficulties to introducing a sustainability obligation into property law, business models that confer direct local consumer ownership are an alternative. This is especially true for the energy sector where owner's decisions affect the living conditions and well-being of every citizen as well as society as a whole. However, the "local" reference is not determined by the business model itself but by its design; grounding consumer ownership in the local community will increase acceptance of RE projects when all citizens are welcome to participate, regardless of their income. Instead of being solely profit-oriented, it is precisely the participatory ownership approach embracing also decision-making that distinguishes consumer (co-)ownership from conventional investment models (Rommel et al. 2018). This approach facilitates the involvement of municipalities as the vanguard of the energy transition. Furthermore, the (optional) inclusion of ownership stakes of commercial investors is nothing new in itself. Citizens' energy models, for example, in the wind sector in the legal form of limited partnerships often involve professional partners. Depending on the type of technology, it may be useful to include professional operators, inasmuch as operation and maintenance of infrastructure can be very complex, particularly as to wind energy and even more so for bioenergy (Enzensberger et al. 2003; Holstenkamp et al. 2017).

3.2 Facilitating a "Learning Society" While Increasing Demand-Side Flexibility

Inasmuch as storage and transport—under current market parameters—are not yet economically feasible, demand-side flexibility is essential to respond to supply-side volatility of solar and wind energy fed into the grid and to mitigate resulting excessive peaks both in production and in consumption. The prerequisite to offering dynamic pricing to those wishing to participate and to remove barriers to participation by demand in day-ahead and intraday energy markets is the implementation of "smart grids", "intelligent meters", and so on, which allow for a decentralised connection between production and consumption. In conventional settings conflicting incentives of energy producers and consumers are separate and distinct with the only link between them being the contractual supplier-customer relationship. When citizens themselves produce some of the energy they themselves consume, the consumer-producer incentives become complementary: The main benefit of planning and matching consumer behaviour with market supply is an optimal price for the energy produced which goes directly to the consumer-producer. Instead of creating price effects with negative effects for refinancing of RES and conflicting incentives on energy markets, the consumption behaviour is aligned with the production capacities, and such can unfold their full potential(Roth et al. 2018).

Therefore the reform of energy markets must actively engage the demand side. In many energy markets serving large industrial customers, direct participation in responsive demand schemes has long been possible. But extending this direct market participation model to residential and small commercial energy consumers remains a challenge. Most of these consumers cannot be expected to initiate the actions and investments necessary in any reliable fashion given the substantial costs involved. Generally, the customers of the large suppliers lack an economic incentive to install the technical infrastructure required. When consumers become (co-)producers, this situation changes. They are now economically motivated to consume the energy they produce in times of low prices on the markets due to oversupply as sale to the grid is not profitable; further, they will be willing to collectively coordinate their consumption patterns in order to economically benefit from responsive demand schemes.

In this context two mechanisms both related to energy consumption at consumer premises are relevant, namely, cogeneration and demand aggregation:

- Making combined heat and power (CHP) more flexible using distributed thermal energy storage systems can achieve responsive demand. Here the provision of heating (or cooling) when demanded by consumers can be physically decoupled from the CHP plant using thermal energy storage to make the production of electricity more flexible in response to the needs of the power system. While it is technically feasible and relatively inexpensive to apply this technique directly to thermal cogeneration appliances at consumer premises, the main barrier to implementation is the economic incentive.
- Implementing demand aggregation in collective consumer-producer schemes is another way to achieve responsive demand. Ideally consumption by individual loads at a significant number of consumer premises is managed under contract to a single service provider, the aggregator. In return for whatever form of compensation, the aggregator and the consumers agree the aggregator—using the demand under contract—then sells the equivalent of energy into the market (AGORA 2014). In the case of a collective—and if possible scalable—consumer-producer model (like, e.g., a CSOP), the aggregator and the consumer-producers are one; this provides them with an additional option to sell the equivalent of energy produced but not consumed to a balance responsible party (BRP).[5]

[5] The BRP is the entity taking financial responsibility vis-à-vis the Transmission System Operator (TSO) for possible imbalances in its contractual portfolio, that is, between, on the one side, all

Both solutions are much easier to be implemented when the concerned consumers are involved in some form of ownership arrangement of the CHP or the RE production facility. Thus a dispersed ownership structure provides an economic incentive on the demand side which the conventional monopolistic supply structure of fossil energy sources does not. CSOPs and CSOP-like schemes are low-threshold financing tools which facilitate broad consumer ownership in renewables and thus are pivotal to tapping the potential for demand-side flexibility when, for example, implementing smart grids.

3.3 Contributing to Energy Efficiency

Consumer ownership promotes energy efficiency by educating consumers and encouraging emulation ("learning device"). It is widely recognised that energy efficiency is highly cost-effective. It is the lowest-cost method of meeting demand and, as levelised cost analysis demonstrates, is cheaper than any other conventional or alternative energy source (Lazard 2014). Turning consumers into owners fosters involvement, commitment, and responsibility, thus contributing to increased energy efficiency (Bauwens and Eyre 2017; Holstenkamp et al. 2017).

3.3.1 Broader and Smarter Use of Consumer Engagement Programmes (CEPs)

To take full advantage of the cost-effective social and economic benefits of energy efficiency, broader and smarter use of CEPs is necessary. In comparison to conventional technology installation programmes (TIPs), which are characterised by high barriers to entry for consumers and a lack of scalability, these "behaviour-based" programmes leverage innovative engagement strategies more effectively (Laitner et al. 2013). In addition to modifying consumers' operating behaviour, CEPs aim at increasing

consumers and sales and, on the other side, all generation and purchases contractually included in its portfolio. In the summer of 2018 balancing responsibilities were still being negotiated under the Electricity Internal Market regulation and directive at the EU level.

investments in technology. However, while CEPs have generally proven to dramatically increase both the scale and cost-effectiveness of consumer-funded efficiency investments,[6] the installation cost of new technologies to the consumer (especially Smart Grid related technologies) often impedes their implementation.

Furthermore, although CEPs enable a large variety of measures without any technology-related restrictions and have the potential for a much more rapid educational process than TIPs, avoiding conflicting interests and aligning incentives is paramount for their success. In order to fully unleash their self-reinforcing features, they require all stakeholders to be involved in contrast to TIPs that are implemented unilaterally by the utility. Involving consumers as owners and co-producers is a holistic approach which activates a group of agents which so far have been difficult to include. Since men, due to gender socialisation, are still considered more technology-oriented and consequently more receptive to innovation, it is important to make CEPs also accessible to women; ownership encourages that. Energy consumers are a heterogeneous group with diverse social settings and habits, but combining ownership incentives with sustainability, energy autonomy, and maximised revenue can tap the enormous potential contributions of consumers to energy efficiency.

3.3.2 Mitigating the Rebound Effect: Ownership, a Driver for Energy Efficiency

Reciprocal dynamics explain the paradox that increased efficiency goes hand in hand with increased consumption, that is, the "rebound effect" (European Energy Agency 2013). Applied to consumer ownership as savings from RE production increase, the end-user assumes that he is already saving enough energy/money and thus becomes less willing to adjust his energy demand to accord with production levels. This reluctance is exacerbated when he has no choice but to self-consume the energy produced, as storage may not be available or too expensive, leading to the waste of excess production.

[6] Also known as ratepayer or customer-supported energy efficiency investments; see http://emp.lbl.gov/sites/all/files/lbnl-5803e-brief.pdf.

Based on a sample of 2143 completed questionnaires collected in an online survey, Roth et al. (2018) have empirically tested the prediction that consumer ownership positively influences demand-side flexibility. Their results show a statistical correlation between (co-)ownership of RE production facilities and the willingness of private households to coordinate their consumption of electricity with production levels. However, this relationship seems to be complex: Only when consumers have a choice between self-consumption and sale of their surplus electricity to the grid, that is, fully fledged prosumership, do the authors observe a statistically significant change of consumption habits. The explanation they provide is that only when prosumers have this choice does every kilowatt-hour not consumed become a kilowatt-hour potentially sold to the grid, as profits are a strong incentive for energy-efficient behaviour. Following this argument, to realise the potential of increased consumer energy efficiency, the regulatory framework for prosumership should include a choice between self-consumption and sale to the grid.

3.4 Empowering Vulnerable Consumers in the Light of Energy Poverty

The Third Energy Package requires Member States to identify vulnerable consumers and put measures in place that among others address energy poverty. It is estimated that about 54 million EU citizens (10.8 per cent of the EU population) were affected by energy poverty in 2012 (Pye et al. 2015). However, less than a third of the EU Member States directly recognise the condition of energy/fuel poverty[7] and treat it as a problem distinct from the protection of vulnerable consumers in their national policies. When recognised, the condition is addressed in social policies that mainly deal with supportive subsidies. Policies which actually encourage behavioural changes within vulnerable groups or which transform them into owners of RES are rare in Europe. Table 3.1 provides an

[7] The EC distinguishes energy poverty as including electricity and gas only, while fuel poverty includes other energy sources. For some countries, esp. in CEE with a high share of population using coal, wood for heating fuel poverty captures the problem better.

Table 3.1 Energy/fuel poverty in the countries under investigation

Country	Extent of energy/fuel poverty	Relevant national policies (general/specific)
Czech Republic	Estimated up to 20% endangered by energy poverty; 3.8% of households are unable to keep their home adequately warm in winter (EU-SILC 2016)	• General: Subsidies partially cover rent and energy bills (housing subsidy schemes)
Denmark	In 2012 2.6% of Danish population were unable to afford to keep their home adequately warm; 3.6% of Danish households reported arrears on utility bills (Nierop 2014)	• General: 2010 tax-free and income-dependent "green check" • Specific: Act on Social Pensions of 2016 enables retired people to receive a subsidy to cover part of the heating bill
France	In 2011 20.9% of French population had an income below the Eurostat poverty threshold of 60% of the national median income, and 9.2% met the "low income-high costs" indicator (Hills 2012)	• General: Tariffs of primary need giving households an average annual total bill reduction • Specific: Annual lump sum deduction in the form of energy cheques amounting to EUR 22–15 per household
Germany	In 2016 3.7% population (3 million citizens) lived in households with insufficient income to heat their homes and suffered from energy poverty (Eurostat 2017)	• General: Policies addressing the energy poverty in Germany rely on support in line with the social security system • Specific: Municipal energy savings check programme targeting low-income households
Italy	In 2015 approx. 4 million households (17% of total HH) were affected by energy poverty (European Commission 2016)	• General: Household benefit package granted to low-income households • Specific: Bonus directly applied to all the utility bills of eligible households

(*continued*)

Table 3.1 (continued)

Country	Extent of energy/fuel poverty	Relevant national policies (general/specific)
The Netherlands	In 2017, 750,000 households (10% of total number) faced difficulty in paying their monthly energy bills (Straver et al. 2017)	• General: not addressed through targeted policies; considered a general poverty issue • Specific: Regulation prevents energy suppliers from disconnecting vulnerable, end-users without prior communication
Poland	2016 estimates (Lis et al., 2016): 44% (17.2. million citizens) spend 10% of income on energy/heat; 4 mio. suffer from energy poverty	• General: Social subsidies and tax reductions for low-income families • Specific: Vulnerable consumers are secured from grid disconnection by right to appeal and can have prepaid meters installed
England/ Wales	2016 estimates (BEIS, 2017): England, 11% (2.5 million households); Wales, 23% (291,000 households)	• Specific: Programme implementing domestic energy efficiency measures in low-income households; direct financial subsidies for energy bills for eligible households
Scotland	2014 estimates (Scottish Government 2015): 34.9% (845,000 HH) fuel poor and spend 10% of income on energy; 9.5% lived in extreme fuel poverty spend 10% of income on energy	• Specific: Government has set up a Scottish Fuel Poverty Strategic Working Group; new Fuel Poverty Strategy and Warm Homes Bill expected in 2018
Spain	2014 estimates (ACA 2016): 11% of households (5.1 million citizens) incapable of adequately heating homes during winter; 6% (2.6 million citizens) spend over 15% of household income on energy expenses	• Specific: 35% discount on the electricity tariff for vulnerable consumers; impediment for electric companies to cut off electricity supply without contacting the local or regional administrations; national "Strategy for the Fight against Energy Poverty" to be approved in Spring 2019

(*continued*)

Table 3.1 (continued)

Country	Extent of energy/fuel poverty	Relevant national policies (general/specific)
Switzerland	Energy poverty barely existent: Universal electrification and ranks fourth in energy equity globally	–
California	A third of California's low-income households faced difficulties paying their energy bills, suggesting that over a million Californian residents suffer from energy poverty (Bryce 2015)	• Specific: State-level programmes providing a discount on vulnerable households' energy bills and implementing energy efficiency measures and energy education for low-income households
Canada	In 2005 20% of Ontarians (2.5 million citizens) spent over 12% of their income on utilities (Canadian Housing for Renewal Association 2005)	• General: The 2017 Fair Hydro Act lowered electricity bills by 25% so far • Specific: Ontario Electricity Support Program supports low-income residents with electricity bills
Brazil	2015 estimates (Carvalho Natalino 2016): 197,000 households suffering from energy poverty defined as no access to electricity; 10.million citizens have no access to clean cooking resources	• Specific: Social electricity tariff system by ANEEL, that is, discount on electricity for the first 50 kWh/month for indigenous people, low-income households
Chile	High electrification rate (only 20,000 households without access in 2014) yet expensive electricity tariffs and scarce quality of service in rural areas (Feron et al. 2016)	• General: Law 20.928 of 2014 aiming to reduce the significant differences in energy tariffs across Chile; regulation including indigenous communities in local energy policy
India	Rural areas face lack of access and still rely on polluting biomass as energy source while accessibility and a broader variety of sources in urban areas are steadily improving (Pachauri et al 2004)	• Specific: Three federal programmes address the issues of dirty cooking fuel in rural areas, inaccessibility to energy infrastructure, and heating in cold climates

(*continued*)

Table 3.1 (continued)

Country	Extent of energy/fuel poverty	Relevant national policies (general/specific)
Pakistan	In 2017 about 20% of the urban and 80% of the rural population suffered from energy poverty (Mahmood and Shah 2017); about 28% of the population (51 mln people)—10% urban and 37% rural—not yet connected to the national grid	• Specific: Tariff differential subsidies to aid poorest energy consumers, yet inadequately targeted
Japan	2013 estimates (NIES, 2013): 2.6% households (1.3 million)	• Specific: Policy measures to combat the projected surge in energy poverty due to the continued rise of the FIT-related surcharge

Please note that there is no common definition of energy/fuel poverty even within countries; therefore, the data presented in the table only include the data referred to in the country chapters
Source: Country chapters

overview of both the extent of energy/fuel poverty and the policies to alleviate it in the countries of investigation.

The overview also illustrates that a lack of specific measures is not a European problem, but that in the countries under consideration, energy-related problems of vulnerable groups have not been sufficiently identified as a policy field as of yet. However, the compromise on the 2018 RED II contains an explicit postulate for the inclusion of vulnerable consumers (for details see Sect. 30.3). Member States are called on to assess "the possibility to enable participation by households that might otherwise not be able to participate, including vulnerable consumers and tenants". Obviously, the causes and effects that energy poverty has are complex and interconnected with other economic, technological, and social factors. The role of renewables in this setting is illustrated in Fig. 3.1 providing a conceptual map of interconnected causes of energy poverty, its effects, and potential measures to alleviate it (Energy Atlas 2018). Facilitating vulnerable consumers to acquire (co-)ownership in RE is key

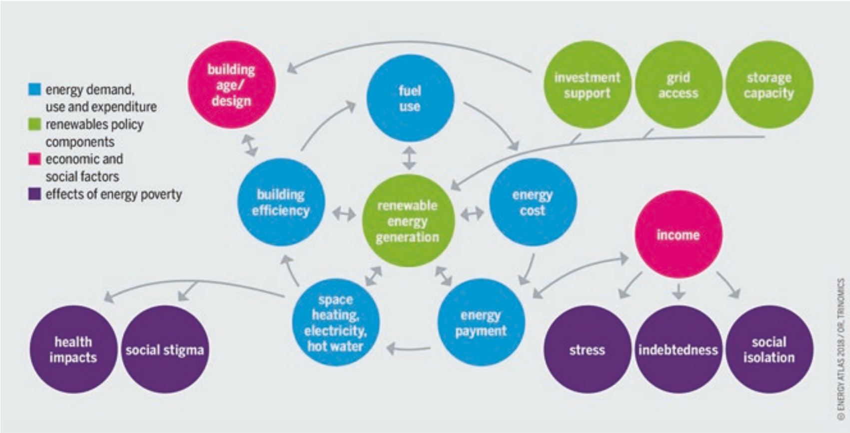

Fig. 3.1 How consumer ownership in renewables could help fight energy poverty. (Trinomics 2016; Bartz/Stockmar, CC BY 4.0)

to enable them to generate RE and tackle this complex issue (see also Sects. 3.1 and 3.2 and Chap. 4).

Existing studies further show that women's contribution to climate change is significantly lower than men's (European Institute for Gender Equality 2012). Gender-sensitive aspects of climate change are mostly confined to studies of developing countries, whereas the industrialised countries seem unaware that these two issues are connected. Empirical data shows that women (1) are less represented in employment in the energy and transport sectors, (2) tend to travel less than men, for example, due to lower car ownership, (3) feel less informed about RE, and (4) invest less in RE projects than men inasmuch as women's income in the EU is only about 80 per cent of men's while they tend to be more risk averse.[8] The CSOP concept expressly addresses gender inequalities as an equal investment opportunity without regard to income or financial limitations.

Both energy-impoverished households and women are underrepresented (Roth et al. 2018) among consumer-owners for reasons ranging from socio-economic like lower education and general literacy in the case

[8] See http://www.genanet.de/: A Powerful Connection: Gender & Renewables. Gender Perspectives in Industralised Countries; details on the gender pay gap: http://ec.europa.eu/eurostat/statistics-explained/index.php/Gender_pay_gap_statistics; both accessed 5 May 2017.

of low-income households and long-term unemployment to psychological and behaviour-based issues for women. The CSOP financing technique as an inclusive low-threshold financing model open to all consumers regardless of status or income directly addresses this complicated issue. Turning (vulnerable) consumers into owners potentially impacts their consumer behaviour, improving energy efficiency as well as providing an additional source of income. These are two important steps towards improving their economic situation so that they can afford to consume the energy they need while providing an incentive to conserve it. This requires a new financing model—one that does not require savings, which low-income and unemployed consumers do not have.

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4

Energy Justice, Energy Democracy, and Sustainability: Normative Approaches to the Consumer Ownership of Renewables

Kirsten E. H. Jenkins

4.1 Introduction

The evolution of consumer ownership models for renewable energies is not a solely financial issue; it is a social justice one too. Energy transitions geared towards renewables are often promised with the "best in mind"—low carbon production, greater energy efficiency, greater awareness from consumers around their consumption habits, and in the case of this book, increasingly distributed ownership (Bergman and Eyre 2011; O'Rourke and Lollo 2015). Positioned as part of this transformational change, the implementation of consumer ownership schemes in general and that of a Consumer Stock Ownership Plan (CSOP) in particular could, in theory, increase the success and speed of these energy transitions by increasing the integration of low-income, hard-to-reach consumers, enabling participation and distribution at low-threshold levels, and avoiding energy efficiency rebound effects as we move towards energy prosumption

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(Lowitzsch, this volume; Ellsworth-Krebs and Reid 2016). In this context, (co-)ownership appears to be a positive motivator for more sustainable practices. What is more, this could occur not only in relation to what we classically consider to be "renewable technologies", such as wind, solar, and wave, but also increasingly in relation to the smart technologies that will become part of consumer life (Sovacool et al. 2017a). Yet consumer ownership approaches are not entirely unproblematic or without danger. This brief synthesis chapter explains why from an energy justice perspective.

Even transitions away from fossil fuels towards renewable energies (RE) can have negative externalities. These are often cited as being the outcomes of resource mining for the components of RE systems, instances of unwanted siting, where facilities are placed next to homes and businesses that were otherwise detached from the realities of energy production, and, more technically, grid instability as volatile energy supply threatens the grid balance (Yaqoot et al. 2016). But beyond the technical, social justice concerns arise too. Does RE provision mean that we will overcome some environmental externalities associated with fossil fuels, reducing health impacts from pollutants and mining? Will these positive effects be available evenly to all citizens? Will renewables be cheaper, increasing affordability? Will they be accessible, and if so, to all groups in society? And perhaps most importantly within the scope of this book, do renewables provide the opportunity to change the ownership model of energy technologies from more centralised to more *decentralised* approaches? If so, how can we provide a level playing field in the energy transition to give all citizens as consumers the same opportunities to acquire an ownership stake?

Whilst such issues are being discussed across a wide range of disciplines and bodies of literature, the social justice nature of these questions is frequently forgotten. Despite the broadening utilisation of the transition concept, it is increasingly acknowledged that the "socio-" or social element is frequently missing in the transition literature and transition plans, including failures to recognise their social justice and equity implications, for example (Jenkins et al. 2018; Sovacool et al. 2016; Jamieson 2014; Markowitz and Shari 2012). Yet failure to engage with such justice issues throughout the transition process is dangerous. As Sovacool et al.

(2016) outline, without a focus on justice, transitions may fail to acknowledge the burdens of having too much energy or too many energy services, including wastage, overuse, and pollution, as captured by the notion of "rebound effects" (Sorrell and Dimitropoulos 2008). Burdens may also arise from not having enough energy services, where some individuals lack access, may face health burdens and shortened lives as a consequence of restricted energy choices, and are challenged by underconsumption and as seized by the phenomenon of energy/fuel poverty (Sovacool et al. 2016). The result is the potential aggravation of poverty, further entrenchment of gender bias, and non-participation as outcomes or by-products of "blinkered" decision-making.

The first statement, then, is that social justice issues must be part of our transition thinking. The question that follows is how do we correctly and equitably conceptualise this challenge in the context of different contractual arrangements to facilitate consumer ownership? This chapter opens this discussion through the concept of energy justice. In this context, the issue is not only one of providing inclusive, low-threshold financing techniques but equally importantly of recognising and facilitating access to the mindset of citizens. This includes the mindsets of "vulnerable consumers", those often affected by fuel/energy poverty that *may* be comparatively impaired in their ability for decision-making as scarcity captures their minds (Mullainathan and Shafir 2013).

The overall aim of this brief piece is to introduce the issue of normative approaches to RE transitions, provide background on the developments in this area, and, through a select reflection on the country case studies presented throughout this book, offer a first interpretation of the emergent challenge, ready for future research and debate.

4.2 Normative Frameworks for (Co-)Ownership Models

In every academic discipline or field of study, parallel or closely related terms emerge. To begin, and in order to make its contribution clear, this section touches upon three such topics: energy justice, energy democracy, and sustainable development, before developing the energy justice theme for the remainder of its approach.

The energy justice concept has emerged amidst growing interest in the justice implications of energy consumption and energy's societal impacts (Hall 2013). Evolving from the environmental and climate justice literatures, it aims "to provide all individuals, across all areas, with safe, affordable and sustainable energy" that is, fundamentally, socially justice (McCauley et al. 2013, p. 1; Jenkins et al. 2018). In order to conceptualise this goal and the means of achieving it, a range of tenet frameworks have emerged. McCauley et al. (2013) use three frameworks—distributional justice, procedural justice, and justice as recognition—which are the models also employed here. Within, they are used in the order distribution, recognition, and procedure on the logic that if injustice is to be tackled, you must (a) identify the concern (distribution), (b) identify who it affects (recognition), and only then (c) identify strategies for remediation (procedure) (Jenkins et al. 2016). Through these tenets, energy justice takes on both empirical and normative roles questioning what *is* happening and what *ought to be* (Jenkins et al. 2016).[1]

Almost in parallel to the growing popularity of the energy justice concept, discussions of "energy democracy" have arisen. While there is no set definition of "energy democracy", it consistently manifests as a concern for who controls the means of energy production and consumption. This

[1] Although there are many existing and relevant examples of the applications of these tenets, I focus on two. First, Healey and Barry (2017) apply them to considerations of labour markets, suggesting that energy justice scholarship does not currently give sufficient attention to the concept of "just transition", a strategy original proposed by global labour unions. Healey and Barry (2017) outline that "labour unions have historically sought to influence the distribution of benefits and harms within energy systems by advocating and seeking just distribution, recognition and participation largely within the existing fossil fuel (and nuclear) energy systems" (see also Fraser 2005; Rosemberg 2010). In this context, they position the energy justice tenets as a tool for imagining labour trade-offs, as well as highlighting the need for more research using this frame. Forman (2017), on the other hand, investigates the community ownership of renewables (a very pertinent example) as he used the tenet framework to examine "how energy justice is negotiated and contested at community-scale through a focus on issues of distributive and procedural justice". Forman emphasises the ways in which community energy is often involved in a wide range of local objectives and directs attention to how best to support such initiatives to further stimulate local action and deliver more widespread equity gains. Both approaches, arguably, have a role in considerations of consumer ownership models, especially when considering increasing shifts away from centralised fossil fuel production.

includes the question of who owns energy production means, albeit within the framework of a strongly regulated market that implies multiple restrictions on property rights. In the context of shifts towards the integration of higher levels of distributed renewables, it appears, then, as an opportunity for "genuine popular control over energy choices", including greater procedural engagement with decision-making (McHarg 2016, p. 313; Van Veelen 2018; Baker 2016). Here contractual arrangements confer property rights in a different way, especially with regard to voting rights and, therefore, participation in decision-making. While the allocation of voting rights in a cooperative is democratic and (generally speaking) pursuant to the rule of "one member, one vote", in business, representation is frequently proportional to the shares of capital held and therefore follows economic power, for instance.[2] Alternatively, as shown in the Danish example of Hvide Sande Community Foundation (Chap. 11), the leaders of the community foundation installing three offshore wind turbines must deliver the initial capital, but they do not receive ownership rights and therefore cannot decide how the profits are used.

Baker (2016) positions the conceptualisation of energy democracy wider as she explains that it provides affected communities with a role in determining the types of energy distributed to them (whether clean or fossil fuel based) *as well as* the types of entities that distribute them. In this sense, Baker provides a more consumption-oriented focus. This mode of ownership is in line with the concept of "ownership as an office" (Katz 2018) in that ownership arguably entails a normative power to resolve complex human interactions and grants the ability to determine what is done with that asset in relation to others. This "society of owners" has to be understood alongside a "society of non-owners", however, where the social function of ownership is key to resolve the issue of diverging interests between these two groups (Lowitzsch et al. 2015). To meet the challenges of globalisation, climate change, and energy democratisation and justice, the introduction of an obligation of sustainability into

[2] It is acknowledged too that there are many contractual arrangements in conventional investment schemes that avoid participation in decision-making altogether, for example, limited partnerships, silent partnerships, or bond holdings, with the latter not conferring property rights at all.

property law could be derived from the social function of ownership (Lowitzsch 2018).

The obligation of sustainability is a particularly interesting concept, which, although it sounds radical, has a history extending back to landmark legal decisions of constitutional courts, in particular of the German Federal Constitutional Court in the 1970s. In simple terms, the concern, first and foremost, is that contemporary industrial practices are overusing finite resources and shifting or externalising the costs of such resource use to communities. What follows is the logic that if we continue to overexploit resources at such levels, then the resource itself will diminish, leading to the long-term scarcity of the capital and consumer goods it creates—the next in the line of disposal private property. The idea of an "obligation of sustainability", then, is to enshrine the preservation of such assets in economic, legal, and property policy, thereby recognising the social function of ownership (Lowitzsch 2018). The ability of and structure to do this depend on the structures of ownership that are in place and the forms of power that it represents, of course. Take a park, for instance. If it is held publicly, the state as owner typically oversees the park for the benefit of all citizens which provided that they respect the defined set of rules have access. If private, however, exclusively the owner decides who has access and who has not. In these cases, the different forms of ownership necessitate different forms of economic, legal, and property policy. In transforming these ownership models, movements for energy democracy carry implications for how we own property and how we achieve sustainability, act responsibly, and internalise externalities. Here, property therefore represents an essential social, economic, and political power factor removed from the power of corporations, who may not be stable or transparent (Lowitzsch 2018).

Szulecki (2018) questions whether "energy justice" and "democracy" are synonyms—a question to which this chapter would say "yes". These literatures share a concern for where ethical, normative, or political considerations overlap with areas of social justice, environmental protection, energy transitions, and sustainability, for example (Szulecki 2018). In this regard, energy democracy can be positioned as one element of an energy justice frame or, indeed, as one means through which energy justice can be achieved. Energy justice is, equally, one element of sustainable development. Sustainable development is embedded in the notion of equity and justice (Hopwood et al. 2005), and the desire for a sustainable energy system necessitates policy developments that have these concepts at their core. With regard to (local) consumer ownership in renewables, the owner's obligation of sustainability corresponds to the preservative function of property vis-à-vis future generations. In this regard the contribution of energy justice agenda is both fundamental and timely (Jenkins 2016).

4.3 The Energy Justice Framework

In the following sections, each of energy justice tenets is introduced in turn alongside a necessarily brief example of what the kinds of questions they would raise in relation to community ownership plans.

4.3.1 Distributional Justice

The first tenet of energy justice, which has a strong foundation in the environmental justice movement, is distributional justice. Energy justice is an inherently spatial concept that includes both the physically unequal allocation of environmental benefits and ills and the uneven distribution of their associated responsibilities (Walker 2009, p. 615). It calls, specifically, for the distribution of benefits and ills on all members of society regardless of income, race, and other social variables (Bullard 2005). Past research focused on the physical siting of infrastructures, and the locational effects of environmental risk, for instance (Mitchell and Norman 2012; Walker and Bulkeley 2006). These "risk" or distributional justice concerns occur on both sides of the production/consumption dualism (Fuller and McCauley 2016).

In consumption terms, distributional justice is typically discussed as access to affordable energy, as exemplified by the ready application of energy justice literature to the issue of fuel poverty (Fuller and McCauley 2016; Walker and Day 2012; McCauley et al. 2013; Sovacool 2015). Beyond this, there are clear overlaps with issues of infrastructure ownership and consumer ownership schemes—especially those that are scalable and compatible with municipal and commercial investments like the CSOP. Here, distributional justice manifests as an equitable distribution of benefits between both developers and communities and *within* communities. Implicitly, the latter concerns the possibility to acquire ownership in the first place, that is, the ability to gain access to the savings or capital credit necessary to invest or the trade-offs this necessitates. For example, successful prosumership by one group of citizens may lead to a de-solidarisation of those who cannot afford to own RE installations as the former group in not paying levies to use the grid, shifting the burden onto the remaining consumers. This comes, in part, as acknowledgement that benefit provision can increase intra-community tension - whether or not the scheme is developer or community-led (Geodkoop and Devine-Wright 2016).

Consumer ownership may also compensate for unwanted siting, as exemplified by the Dutch case of Windpark Krammer, where a "wind fund" provides financial compensation for residents within two-and-a-half kilometres of the turbines as long as they opt for a green energy contract (see Chap. 15). It can also motivate siting as, for example, customers of the Sunraising Bern scheme who finance the scheme by buying a certain number of square metres of local solar plant receive a share of this solar power free for 20 years—approximately half the life time of the array (see Chap. 20). This has knock-on implications for the equitable distribution of benefits. Property ownership is not without risk, however, as differing forms of property ownership (which depend on the contractual arrangement and legal vehicle employed, for instance) can be limited to the value of the share held, for example, when attributed to individuals as sole proprietors. Therefore, the different schemes for consumer ownership employed in practice (as reported in this book; see also overview tables in Chap. 28) have quite different implications for both the issue of voting rights and the distribution of risk.

Distributional justice does recognise that some resources are naturally and unavoidably unevenly distributed—access to ground source heat pumps, for example. Thus, Walker and Bulkeley (2006) and Eames and Hunt (2013) note that unequal distribution is not always unjust. Instead, it is often the "fairness" of the processes surrounding infrastructural development that is important (Walker and Bulkeley 2006), and as such claims for distributional justice require that evidence of inequality are combined with an argument for fair treatment (Eames and Hunt 2013). Throughout this piece such arguments are taken to manifest as calls for justice as recognition and procedural justice.

4.3.2 Justice as Recognition

The inclusion of the tenet of justice as recognition as a core tenet of energy justice is widely debated. For some the focus is primarily on matters of distribution (Vincent 1998; Dobson 1998), yet it is included here as a means of explicitly engaging with the questions of "who" is energy justice for and who is responsible for its provision. In terms of property ownership, the justice as recognition tenet raises, first and foremost, the question of the role and responsibility of municipalities as pacemakers for the energy transition and as natural stewards for citizen-/consumer-owned RE projects. In this context, the compatibility of a given capital participation scheme with municipal or conventional investors becomes increasingly important.

Beyond concern for the responsibility of particular groups, justice as recognition also appears as a concern for "how people are involved in environmental decision-making, or "who (and what) is given respect"" (Eames 2011). Drawing on Fraser (1999), Schlosberg (2007) conceptualises the concerns around justice as recognition as three separate issues: (1) practices of cultural domination, (2) patterns of non-recognition (invisibility of people and their concerns), and (3) disrespect through stereotyping and disparaging language: misrecognition. This includes recognition of the diversity of the barriers to consumer ownership for different groups in society. These may stem from different factors including cultural tradition, economic opportunity, and geographic situation, for example (see Section 5 of the country reports). We must also consider not only whether a project is located in a rural or metropolitan area and what attitudes and motivations the concerning constituency share but the heterogeneity of economic capacities for the acquisition of ownership in RE installations within a given community. Within this context justice as recognition is more than tolerance and requires that individuals must be fairly represented, that they must be free from physical threats, and that they must be offered complete and equal political rights (Schlosberg 2003). Each of these three points is now described in turn.

For consumer ownership schemes in particular, this would emerge as a normative questioning of *who* should hold responsibility for and the ownership of renewable electricity facilities and who might be excluded from this process (Schlosberg 2007). In this context, trusted plans like those offered by CSOPs grant the opportunity to level the playing field and provide disadvantaged groups with "equality of arms". As a warning, however, justice as recognition also includes a call to acknowledge diversity within and between social groups (and the dangers of assuming that all individuals in a community accept proposals and are economically rational) (Hall et al. 2013; Cowell et al. 2011). Here the distinction offered by Baigorrotegui and Lowitzsch (see Chap. 28) between communities of place and communities of interest offers a point of departure for differentiation. This also includes the acknowledgement of the potentially divergent perspectives held by different ethnic, racial, and gender groups (Sovacool et al. 2017b; Fraser 1999).

Finally, concerns may also arise not over a failure to recognise, but as misrecognising, a distortion of people's views that may appear demeaning or contemptible (Schlosberg 2003). As one example of justice as recognition as a process of disrespect, McCauley et al. (2013) highlight the potential for organised misrecognition in the case of UK energy siting. They state, for example, that many regulators in the renewable power industry, and environmental NGOs, often deride local campaigns against wind farms as "not-in-my-backyard" protests by self-interested and misinformed individuals. This lack of recognition, it is claimed, can go on to damage the reputation of communities in the larger cultural and political realm.

This argument of misrecognition also is to be extended to the mindset of "vulnerable consumers" affected by fuel/energy poverty, as well as to the perception of their ability for sound economic decision-making by others (Mullainathan and Shafir 2013). Arguably, consumer ownership models provide the opportunity to bring in the excluded or socially marginalised—those who appear to be disinterested but, in fact, may be suffering from scarcity thinking, for instance. To explain this concept further, it refers to the fact that in instances of poverty, energy dilemmas may rank as lower amongst other pressing priorities—the pursuit of food, adequate shelter, health, and education, for example. Under these circumstances, energy affordability, access, and ownership may represent longer-term priorities in contrast to these shorter-term goals. This has implications for who and how we imagine people to be stakeholders and therefore how we engage with them: elements not only of justice as recognition but also of procedural justice.

4.3.3 Procedural Justice

The last tenet, or the "how" of energy justice, is procedural justice. Procedural justice concerns access to decision-making processes that govern the distributions outlined above and manifests as a call for equitable procedures that engage all stakeholders in a non-discriminatory way (Walker 2009; Bullard 2005). It states that all groups should be able to participate in decision-making and that their contributions should be taken seriously throughout. It also requires participation, impartiality and full information disclosure by government and industry (Davies 2006), and the use of appropriate and sympathetic engagement mechanisms (Todd and Zografos 2005). This may involve a period of apprenticeship, especially when complex technical issues are involved or where the heterogeneity of the consumer group in question implies different opportunities for participation due to prior access to education and training. It is concerned, then, about the fairness of decision-making processes, or justice in "doing", and emerges as a claim for representational space and free speech (Sayer 2011; Sze and London 2008). For Walker (2012) and later Sovacool and Dworkin (2014), these requirements can be split into four key rights:

1. Access to information
2. Access to and meaningful participation in decision-making
3. Lack of bias on the part of decision-makers
4. Access to legal processes for achieving redress

Procedural justice manifestations include, as an illustration, questions arising around how and for whom community renewable projects are developed (Walker and Devine-Wright 2008) and the ethics of the emergent voluntarism debate, where communities volunteer to host facilities (Butler and Simmons 2013). For consumer ownership schemes, this might include a concern for how the balance of power between developers, communities, and decision-making bodies is acknowledged and dealt with during the development or ownership process (Cowell et al. 2011). One model proposed in the country cases is the Enercoop project—a collective interest cooperative company that is the only one of its kind currently sanctioned by the French State. In this model, citizens can either become consumers of or members of the organisation, both of which allow access to procedural mechanisms (see Chap. 12). Again, trusteed plans like the CSOP that allow the participating consumers to speak with one voice vis-a-vis other shareholders following an internal decision-making process supported by a professional trustee may play an important role.

However, with regard to procedural justice, it is crucial to distinguish between the underlying business models. Different contractual arrangements under company law allow for or hinder meaningful participation in decision-making on the one hand, while on the other, they render combination with municipal or conventional investments more or less attractive. To illustrate the span of possibilities, Table 4.1 shows an overview of four types of participation schemes. Each of these will undoubtedly impact energy justice outcomes in very different ways.

4.4 Conclusion

When we consider consumer ownership schemes and, in particular, CSOPs, the use of the term "equity" would most likely occur in relation to financial equity—the amount invested in renewables in each of the featured countries or community, or the amount that *could* be invested (as in the example from Chap. 15, focusing on the Duurzame Energie Coöperatie Regio Alkmaar in Northern Holland, for instance). What this chapter has tried to illustrate, however, is that "equity" or "justice" means much more than this. Specifically, through a necessarily brief exploration, it has shown that the three-tenet energy justice framework of distribution, justice as recognition, and procedural justice provides a means of exposing both current justice risks and benefits created by consumer ownership models as well as *future* injustices that *could* be created.

The biggest conclusion, perhaps, comes as consideration of the links between energy justice and business models. Much as consumer ownership schemes have great potential to influence energy justice thinking—introducing revolutionary restructurings of ownerships models that distribute income from productive property differently or recognise new social groups—energy justice thinking can inform these schemes according to their respective underlying business models, reminding them of normative calls for not just distributive justice but for procedural and justice as recognition too. Although it is an underexplored aspect of the literature to date, there is great potential here to consider the *most* productive business models and contractual arrangements from an energy justice perspective. This stems, first and foremost, from the recognition that appropriate business models require meaningful participation.

As this volume shows in many ways, CSOPs represent, in effect, a modernised version of the cooperative model that is designed to integrate with the business world. This comes in contrast to small-scale social business models, which risk isolation and may not be taken seriously. To return to the phrase "equality of arms" used earlier in the text, this means that business models need support mechanisms that enable marginalised groups full access to ownership potential. In effect, they need to reach out to consumers as engaged, responsible actors. As a less technical and more precise example, someone appearing in court would have the right to court-appointed defence to enable equal opportunity to defend themselves. In ownership models, therefore, you need to enable mechanisms for people that haven't had apprenticeships or prior experience, to learn *how* to participate and why it might be beneficial. Using business models to enable this may get such proposals past small-scale isolated schemes, to become the mainstream norm, with myriad implications for energy justice outcomes, and vice versa.

It is without the scope of this chapter to provide an analysis of every country case presented in this book in terms of its contribution to justice

Table 4.1 Overview of characteristics of four consumer ownership models

	Individual ownership	Private law partnership	Limited partnership	Cooperative	Trusteed scheme like CSOP
Characteristics	Typically for small-scale projects driven by individuals	Typically for small-scale projects driven by individual partners	Typically for larger investor-led projects—consumers contribute capital	Democratic—typically mid-size; led by cooperative principles	Democratic—scalable; participation according to consumption share
Influence on decision-making	Owner in full control, with oversight from local councils and other such stakeholder groups	Consumer-partners in full control: voting rights according to contributions/full information rights	Right to demand information; control and veto rights for consumer-shareholders only under exceptional circumstances	Direct: "one member one vote"; general assembly concentrates decision-making power	Indirect: trustee exercises rights for consumer-shareholders, for example, participation in management meetings or the right to demand information
Liability	Unlimited personal liability	Unlimited personal liability jointly with partners	No personal liability; liability instead limited to value of share	No personal liability; liability instead limited to value of share	No personal liability; liability instead limited to value of share
Transferability of shares	Not required, unless because of inheritance between individuals	Consent of all consumer-partners needed	Managerial consent needed; entry into the commercial register	Transferable albeit with restrictions; entry into the commercial register	Freely transferable; low transaction cost; only trusteeship agreement is altered

(*continued*)

Table 4.1 (continued)

	Individual ownership	Private law partnership	Limited partnership	Cooperative	Trusteed scheme like CSOP
External management	Not foreseen	Not foreseen	General partner (usually Ltd.) that manages project can hire external staff	Not possible; principle of self-organship elected by and from general assembly	Trustee controls management board; can hire external expertise
Costs	Low initial setup costs	Low initial setup costs	Higher initial costs to enter commercial register; higher administrative expenses	Higher initial costs to enter commercial register; higher administrative expenses	Expenses of incorporating trusteeship (and holding Ltd. if required due to absence of trust legislation); administrative expenses
Compatibility with municipal/ conventional investments	Limited	Limited	Full compatibility	Limited	Full compatibility

Source: The author, with recognition of extensive guidance from Jens Lowitzsch goals. What it can say, however, is that justice *should* be fundamental to the discussions in each. Moreover, it would certainly be possible to use the energy justice framework to analyse the current state of affairs in able to evaluate and, where possible, to anticipate future injustice. More than anything, and as illustrated by the French case of the Le Mené's energy self-sufficiency project (Chap. 12), this provides the opportunity to assure the development of CSOPs that really could increase the acceptance of and therefore success and speed of energy transitions.

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5

Consumer (Co-)Ownership and Behaviour: Economic Experiments as a Tool for Analysis

Özgür Yildiz and Julian Sagebiel

5.1 Introduction

Across Europe and worldwide, the sustainable transition of energy systems from fossil fuels towards renewables and higher energy efficiency led to the emergence of business models involving citizens. This involvement included participation in renewable energy (RE) project planning and financing with self-consumption having either a subordinate or no importance at all (e.g., Yildiz 2014; Holstenkamp et al. 2017) as well as business models that explicitly foster consumer (co-)ownership conferring ownership rights in renewable projects to prosumers in a local or regional area (see Chap. 28 and the individual country chapters). Proponents of these business models have identified positive aspects such

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as technical system benefits associated with distribution and local balancing (e.g., Koirala et al. 2016), energy democracy (e.g., Becker and Naumann 2017), creation and mobilization of local social capital (e.g., Radtke 2014), and potential of small-scale and decentralised citizen-related energy projects as precursors of a sustainable degrowth society (e.g., Rommel et al. 2018). Furthermore, the potential to provide electricity and heat at a lower cost to local consumers (e.g., Haney and Pollitt 2013) and changes in individual consumption behaviour towards improved energy efficiency through the assistance and advice on the adoption of environmental friendly technologies and energy efficiency measures are also highlighted (e.g., Akasiadis et al. 2017). However, methodological concerns on these results remain as a clear examination of the causal effects between an individual's membership in a consumer (co-)owned energy initiative and his energy use requires collecting experimental or quasi-experimental data which has not been done so far (Höfer and Rommel 2015).

The aim of this chapter therefore is twofold: First, we provide an overview on existing studies related to the behaviour of members of consumer (co-)owned models (CCOM). Second, starting from this short review, we will assess the potential contribution of experimental methods for the analysis of the behaviour of CCOM members and give recommendations for further experimental research.

5.2 Citizen and Consumer (Co-)Ownership in the Energy Sector: Findings on Motives and Behaviour

The academic literature on members of business models involving citizens as investors or prosumers in the energy sector mainly addresses issues of motives and energy consumption behaviour. Regarding the issue of motives, observational data has been collected in several countries. A survey conducted among the members of two RE cooperatives in Flanders, Belgium, with observations from 4061 respondents empirically analyses motivations that drive individuals to join RE cooperatives. The statistical analysis reveals that economic incentives connected to electricity supply, socio-psychological motives (e.g., social identification, pro-environmental orientation), and spatial and relational antecedents (e.g., spatial proximity) are correlated with an individual's decision to join an energy cooperative (Bauwens 2016).

A study from Germany based on observational data of 323 members from citizen energy projects, in this case energy cooperatives and limited partnerships, suggests that the motives of environmental concern and social/political goals seem to dominate, while economic motives, specifically the return on investment, play a subordinate role. However, there are also differences to be considered. For example, members of citizen energy projects that are organised through the legal form of a limited partnership put a higher value on economic incentives than the members of cooperatives (Holstenkamp and Kahla 2016). Further country studies using observational data complement these findings.[1] Hence, the emerging general picture suggests that various motives are important in different contexts, but socio-psychological and material motives seem to play a dominant role.

Concerning the issue of energy consumption behaviour, existing studies mainly draw their findings from observational data comparing a sample of members from citizen or community energy projects with non-members in terms of specific aspects related to energy consumption behaviour. In this regard, a study focusing on a RE cooperative in Flanders, Belgium, based on a total of 4068 observations (3567 members and 501 non-members) using correlation analysis and regression analysis indicates that people with higher electricity consumption are more likely to join a RE cooperative. This finding in turn serves as a link to the issue of motives. That is, households or individuals with high electricity consumption have higher incentives to join a RE cooperative since the social context of these business models serves as a vehicle to exchange on energy use with familiar and trusted people who often provide assistance and advice on the adoption of green technologies and energy efficiency measures (Bauwens and Eyre 2017).

[1] See, for example, Rogers et al. 2008 for England, Bomberg and McEwen 2012 for Scotland, Dóci and Vasileiadou 2015 for the Netherlands and Germany, and Yildiz et al. 2015 for Germany.

A second example from Germany addresses the question of demand flexibility. Based on observational data from 2143 (co-)owners and non-(co-)owners of RE facilities gathered through an online survey and tested through propensity score matching, the study investigates whether (co-) owners of RE infrastructures show differences in their willingness to adapt their consumption behaviour. The results indicate a relationship between the characteristic of being a (co-)owner of RE production facilities and individuals' willingness to adjust their consumption behaviour. However, this relation is not fully supported by the statistical analysis. A statistically significant correlation could only be found when (co-)owners have the option for self-consumption and sale of the surplus electricity production to the grid (Roth et al. 2018).

A third case study assesses the impact of energy efficiency interventions on consumption reductions among 300 members of a Danish district heating cooperative and 33,596 customers of a large Belgian electricity cooperative. The econometric analysis using statistical tests and correlation measures shows that the treated members respectively customers achieved reductions in their consumption after receiving an energy efficiency intervention (Akasiadis et al. 2017). To conclude on the issue of energy consumption behaviour, the current academic literature suggests that there are differences in consumption behaviour between members and non-members of CCOM. However, there is no evidence that such differences have not already existed ex ante before joining a CCOM. Insights on the possibility of changes in behaviour from joining a CCOM are missing in the literature.

As a general conclusion from this overview on behavioural insights on members of CCOM, it can be seen that the existing literature lacks in particular experimental work. Since members self-select into CCOM, causal links between methods of internal governance, member characteristics, and behavioural aspects are difficult to identify. Findings on these issues are important from a policy perspective. The concept of evidence-based policy has received increasing attention in energy policy as a means to find effective strategies to foster demand flexibility, to mitigate rebound effects, and to promote new technologies (e.g., RE, smart meter) (Sorrell 2007). Economics as the main scientific discipline providing the basis for evidence-based policy has seen in recent years a growing use of experimental methods, but in the context of socio-economic energy research, experimental work hardly exists. Hence, experimental methods can provide useful extension from a methodological perspective (Höfer and Rommel 2015). The next section will give a brief introduction to experimental methods and give some examples of application in the energy sector.

5.3 Experimental Methods: A General Overview on the Methodology

Unlike observational studies, where most analysis investigates correlations between variables, experiments offer the advantage to explicitly analyse causal effects. An experimental design assures the unbiased estimation of individual effects of each variable and avoids endogeneity and selection bias of the treated objects of analysis. Classical experiments were developed in the early twentieth century in the fields of agriculture and biology (Fisher 1937) yet have been quickly adapted in the social sciences, especially in psychology, and later in economics (e.g., Camerer 2003). Several applications such as discrete choice experiments (DCEs), randomised trials, game theory experiments (e.g., public good games), decision theory experiments, and market experiments are commonly used in economics. As an example for a method which is frequently applied in energy research (e.g., Sagebiel et al. 2014; Rommel et al. 2016; Salm et al. 2016; Knoefel et al. 2018), DCEs are briefly described in the following.

In DCE people are asked in a questionnaire how they *would* choose between alternative configurations of a well-defined good or service, policy, or contract (Ben-Akiva and Lerman 1985). Each alternative configuration is characterised by attributes, one attribute reflecting the costs. The values of the attributes (attribute levels) are aligned between the alternatives according to an experimental design. The experimental design assures the unbiased estimation of the effect of each attribute on the probability to choose the good. Using economic theory—esp. the random utility model (McFadden 1974) and the household production framework (Lancaster 1966)—one can transform the choice probabilities into willingness to pay (WTP) values and calculate market shares and demand curves. The data is generated by observing the choices of the respondents. Thereby, the choice of a respondent is the endogenous variable, and the attributes are the explanatory variables. As the researcher aligns the attribute levels to the choice sets, the attributes are clearly exogenous, and a causal effect between the choice and the attributes can be estimated. However, this causal relationship only holds for the attributes, not necessarily for other (socio-demographic) variables, that also may influence the choice. Therefore, the results of a DCE can only be generalised and aggregated to the whole population if the sample is randomly drawn. Data collection for a DCE requires the same standards as observational data.

If results of a DCE are to be compared between different groups (e.g., members vs. non-members CCOM), potential selection bias is present. This problem can be solved by combining DCEs with randomised control trials (RCTs) (e.g., Costa and Kahn 2013), another experimental method. An RCT has the aim to identify differences in an outcome variable (e.g., energy consumption or WTP) between a treated and an untreated (control) group. Given a sample from the target population, people are typically randomly assigned to one of these groups. The key difference to observational data is that the likelihood to be assigned to the treated group is equal for each person in the sample and independent of the person's observed and unobserved characteristics. In energy research, RCTs are often used to investigate behavioural changes induced by incentives or nudges. For example, an RCT conducted with 1452 Danish households that were randomly assigned to three experimental groups and two control groups analyses the effect of feedback about electricity consumption via text messages (SMS) and email on the level of total household electricity consumption (Gleerup et al. 2010).

5.4 Experimental Methods in CCOM Research: Where Do We Go from Here?

Main challenges in the study of CCOM are (i) to investigate the success chances of and behavioural changes induced by new and proposed projects and (ii) to compare behaviour between members and non-members of a CCOM. A key empirical issue is that observational data may simply not be available to the researcher. For example, the performance of a new project cannot be observed before the project has existed for a long enough time span to collect sufficient data for statistical analysis. Another serious issue is that the comparison between members and non-members is statistically not valid as long as members and non-members come from different populations. This is likely the case as members of CCOM have different characteristics than the countries' population. In fact, members of CCOM are often constituted from a rather homogenous group of individuals considering their personal characteristics such as gender, age, and formal education (e.g., Yildiz et al. 2015). Starting from these deliberations on existing research gaps, two examples for experimental analysis addressing questions relevant in the context of CCOM are outlined in the following.

5.4.1 Developing New Business Models

The energy transition requires new business models to allow consumers to become prosumers. A priori, it is unclear if a business model is successful and accepted by the potential stakeholders (members of a cooperative, customers, and investors). A DCE conducted before the business model is launched can help to determine the success chances of business models and to fine-tune them. DCEs are especially powerful here because they can investigate various attributes of the business model simultaneously and estimate trade-offs between these attributes. For example, a DCE can incorporate several attributes related to economic incentives and attributes related to environmental effects. It is possible to create rankings of attributes and to derive an "optimal" business model. Further, DCEs allow to investigate the impact of socio-demographic variables on preferences and to predict market shares of various alternative combinations of attributes.

Once a business model is about to be established, an ex ante DCE can reduce the chances of failure and inform developers, investors, and policymakers on the specific business design.

In the following we demonstrate the application of a DCE with an example: Assume a policymaker wants to know if participation possibilities and increased returns of investment increase the number of people joining a CCOM. The answer to this question provides information on effective legislation on participation possibilities and on the effectiveness of subsidies for RE projects. The good to be valued is thus the CCOM and the attributes describing it. For simplicity, we focus on only two attributes: The first one is the possibility of participation which is binary (yes/no), the second one is the expectation of the return on investment, which is ordinal (high, medium, and low). Respondents are asked, repeatedly under different combinations of the attribute levels, if they would join the project or not. Table 5.1 shows an experimental design with four choice questions per respondent.

Table 5.1 Example of a discrete choice experiment with two attributes

Choice Question 1		
Attribute	**Proposed project**	**Opt out**
Participation possibilities	No	
Return on investment	Low	
I would choose		
Choice Question 2		
Attribute	**Proposed project**	**Opt out**
Participation possibilities	No	
Return on investment	High	
I would choose		
Choice Question 3		
Attribute	**Proposed project**	**Opt out**
Participation possibilities	Yes	
Return on investment	Low	
I would choose		
Choice Question 4		
Attribute	**Proposed project**	**Opt out**
Participation possibilities	Yes	
Return on investment	High	
I would choose		

The table shows four choice sets that allow estimating the effects of each attribute separately

This example can be easily extended. The number of attributes can be increased and the alternatives can be labelled with additional information, such as the organizational form of the project.

5.4.2 Behavioural Changes of CCOM Members

As mentioned in the introduction, possible changes in behaviour after having joined a CCOM are one argument that proponents often refer to. To verify this statement statistically, a combined approach using DCE and RCT could investigate changes in WTP for RE resulting from joining a CCOM. To do so, a random sample from a population will be confronted with a DCE on WTP for RE. Afterwards the respondents will be randomly assigned to join a CCOM. Those who were not assigned to the project serve as the control group. After a certain time span, the same DCE will be conducted again, with both the treatment group and the control group. The WTP results between the two groups can then be compared and statistically analysed. If the WTP of the treated is larger than the WTP of the control, the CCOM leads to additional WTP for RE—a causal effect that could otherwise not be determined.

Another example could be the question of changes in energy consumption behaviour. In analogy to the above-mentioned studies analysing the treatment effect of providing feedback, two treatment groups—one treatment group consisting of randomly assigned members of a CCOM and another treatment group consisting randomly assigned customers of a supplier in private ownership—could be formed and compared with two analogous control groups in order to see whether relative differences in energy consumption behaviour are higher among CCOM members. One difficulty in these approaches is random assignment. It may be difficult or even impossible to force randomly selected people to join a CCOM. The researcher can, however, do the experiment with people who have already applied for a CCOM. Only half of the interested people will then be assigned to the project. The remaining people will not be assigned at all or to a different (dummy) CCOM project with only limited participation possibilities. Of course such an approach is less general, yet the causal effect can still be measured.

Besides these two examples, further research questions related to CCOM can be answered by using the whole toolset of experimental methods, including, in addition to DCE and RCT, further applications such as public good experiments or game theory experiments as well or combining these approaches as described above for the question of differences in WTP resulting from joining a CCOM. Table 5.2 lists some research questions related to issues relevant to CCOM and the adequate experimental methods, which researchers can use to generate statistically valid data.

5.5 Conclusions

This chapter identified research gaps in the analysis of CCOM and their members and offered ideas for further research based on experimental methods. As described, experimental methods can contribute to overcome methodological limitations from studies based on observational data such as missing control groups or bias from self-selection. However, experiments require a careful design which is in some cases difficult or even impossible to achieve. Many mistakes can happen in the design phase leading to erroneous experimental designs and, consequently, misleading results. Furthermore, methodological problems are also inherent to experiments. For example, as DCEs are embedded into questionnaires, the same problems regarding randomness and representativeness as in all quantitative surveys arise. As soon as the sample is not a random sample, upscaling and aggregation of results is not valid.

Still, experimental methods can result in substantial findings that might help to better understand CCOM. For example, findings on behavioural changes from CCOM membership can be used to design effective incentives for demand-side flexibility. Improvements in this domain can transfer into reduced costs for suppliers for system operation and maintenance which ultimately can result in reduced electricity prices for customers with the latter being object to controversial discussions in the context of the sustainable transition of national energy sectors. Another aspect is the design of compensation mechanisms for households that are directly affected by RE facilities in their neighbourhood.

Table 5.2 Research questions that may face challenges with observational data

Methodical challenge	Affected research questions	Solution	Experimental method
Selection bias: To compare outcomes between differently treated groups, identifying causal relationships is only possible, when other variables apart from the outcome of the treatment (e.g., age, sex, attitudes) are kept constant between groups. This strong assumption is likely violated with observational data as people self-select into treatments.	• Do people change their attitudes (e.g., with respect to environment) after they have joined a CCOM project? • Do people show changes in energy consumption behaviour (e.g., more flexible demand, more energy efficient behaviour) after joining a CCOM model? • Do members of CCOM respond more to policy measures related to energy or environmental issues?	Random assignment: People have to be randomly assigned to a treatment.	RCT
Data availability: For several research questions, observational data does not exist. Policies or projects that have not or only recently been launched cannot be evaluated with observational data as outcomes cannot be observed.	• Which factors can explain people's willingness to join a CCOM project? • Are economic motives (e.g., return on investment) dominating in the choice to join a CCOM project? • How many people will join a new CCOM project? • Which policies and incentives will effectively make people invest into renewable energy? • Which attributes are likely to increase the success of a specific CCOM?	Hypothetical data: The researcher has to create a "as-if" situation, where respondents are confronted with choices in a hypothetical situation.	DCE, PGE, GTE, DTE

RCT randomised control trial, *DCE* discrete choice experiment, *PGE* public good experiment, *GTE* game theory experiment, *DTE* decision theory experiment

Here, experimental work can be used to design schemes that effectively share burden among directly affected and not affected people which is often the cause of discord in local project planning. Hence, in sum, these findings might increase the acceptance of the energy transition.

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Part II

Consumer (Co-)Ownership: Conventional Models and Consumer Stock Ownership Plans

6

Financing Consumer (Co-)Ownership of Renewable Energy Sources

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Financing and governance in the renewable energy (RE) sector differ across countries and regions. The country reports in Chapters 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, and 27 illustrate this wide variance of structures to be found around the world, summarised in the comparative tables in Chapter 28 with regard to the resulting ownership structures distinguishing between communities of interest, communities of place and communities of interest and place. This chapter investigates commonalities and differences in the financing of consumer (co-)ownership in the countries analysed in this book. As the country chapters illustrate, contractual arrangements vary significantly within and between countries. Unlike geography or culture—within the boundaries of the legal framework—it is up to the contracting parties to choose the contractual settlement they deem most appropriate for the given project. To cast light on the reasons and

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the process of this choice, we present principles and decision criteria to select "appropriate" financing structures complementing this normative perspective with a description of financial and legal structures observed in the countries under examination. As investment motives largely determine what to be considered "appropriate" for the parties involved, we start with a brief overview of research on investment behaviour and motives, focusing on investments involving consumer (co-)ownership. Besides, we summarise some of the observations from the country chapters regarding the link between consumer co-financing and social investment.

An overview of financing instruments and their main characteristics follows in Section 6.2 to understand why people with particular preferences choose certain types of financing. As has been argued elsewhere (Williamson 1988), finance and governance are two sides of the same medal: Financial contracts not only contain stipulations on payments like amount, timeframe, interest, fees and repayment, which determine the risk-return profile of the investment. In addition, they include rules for participation in decision-making like voting rights and rights to information, which depend on the type of financing chosen. Building on previous work (Holstenkamp 2014; Holstenkamp et al. 2018), we illustrate the trade-off between level of participation and risk in different types of financing. There are various ways to balance the interests of the parties involved, for example, combining different types of financing ("capital structure", see Sect. 6.3.1) or using intermediary and co-financing structures ("ownership structure", see Sect. 6.3.2).

We conclude the chapter with a brief overview of institutional environments that influence financial decisions and structures. RE investments take place on a highly regulated market. Changes in the regulatory environment pose challenges to all market actors but especially to small-scale actors having capacity bottlenecks. As most RE projects are characterised by relatively high upfront costs and lower operating costs, payback periods tend to be longer than for typical industrial projects—a problem for investors with a short investment horizon not disposing of sufficient capital or access to credit.

6.1 Investment Behaviour and Motives

6.1.1 General Findings on Investment Behaviour

Consumers may participate in RE investments in the form of equity, mezzanine or debt capital. Generally, these kinds of financial decisions by consumers are a subject of "household finance" (Campbell 2006; Guiso and Sodini 2013; Renneboog and Spaenjers 2012). Private households form a heterogeneous group. Research has shown that investment behaviour depends on, among others, sex, age, marital status, educational background, life situation and investment motivation (Barber and Odean 2001; Ricciardi 2008; Riley and Chow 1992; Schooley and Worden 1999). Generally, private households tend to show a risk-averse investment behaviour (Barasinska et al. 2008; but see also Guiso et al. 2018). However, these general observations on private households' investment behaviour cannot sufficiently explain the diversity of forms of finance found in RE markets in different countries. Consumers pursue various goals when they make capital available for RE investments, be they financial, for example, return on investment or saving of money for energy supply, or non-financial, for example, political goals or energy autarchy. Conventional financial theory usually focuses on the former, that is, on return and risk. However, empirical studies clearly show that investors in general and private households specifically may pursue non-financial aims, which play a significant role for their investment behaviour (Gamel et al. 2016; Kalkbrenner and Roosen 2016; Masini and Menichetti 2013). The literature emphasises differences among types of investors requiring a segmentation whenever policy and management issues are addressed (Bergek et al. 2013; Mignon and Bergek 2016). This differentiation is important not only between corporate, financial and retail investors (Wüstenhagen and Menichetti 2012) but also among the latter group and even within the group of consumer-investors (Holstenkamp and Kahla 2016).

6.1.2 Empirical Work on Energy Communities

Besides studies on financial market agents like venture capitalists (Bürer and Wüstenhagen 2009; Wüstenhagen and Teppo 2006), several studies—many of them single or comparative case studies—analyse the motivation of citizens to jointly invest in RE projects. Methods employed vary significantly, as do definitions of the study objects; a meta-analysis of these case studies and other analyses does not exist yet. However, certain patterns regarding consumer's motives to invest in RE installations collectively seem to emerge (Bauwens 2016; Dóci and Vasileiadou 2015; Ebers Broughel and Hampl 2017; Fleiß et al. 2017; Gamma et al. 2017; Holstenkamp and Kahla 2016; Radtke 2016; Volz 2012):

- In most cases, ecological, social/political/normative and financial motives are present contemporaneously, though to a different degree or with different emphasis.
- Ecological and, partly, social/political considerations generally dominate financial motives (Gamma et al. 2017; Holstenkamp and Kahla 2016). However, there are also cases where private investors from the region in which a power plant is located are motivated mainly financially by prospects of return or cheap energy supply, while ecological or other motives are secondary motives (Fleiß et al. 2017).
- According to Holstenkamp and Kahla (2016), the return motive seems to be less important for board members/managers, often working unsalaried for their community energy company, compared with ordinary members; if this relation holds true, these divergent goal frames may cause principal-agent conflicts (Laffont and Martimort 2009).
- Women put less emphasis on return and "participation in the energy transition" but more on ecological motives than men (Holstenkamp and Kahla 2016).
- Using the example of Germany, the motivation to participate seems to be broader and more specific in the case of cooperatives compared with limited partnerships; in addition, Holstenkamp and Kahla (2016) find higher scales for the return motive in those community energy companies, which were incorporated from 2009 to 2011 during times of relatively high feed-in tariffs in Germany.
- Bauwens (2016) hypothesises that normatively motivated members are crowded out during organisational growth.
- Return expectations tend to be significantly lower than for other types of actors, perhaps with the exemption of municipal utilities (Leuphana University of Lüneburg and Nestle 2014). Even in this regard, membership is heterogeneous, though.

- Ebers Broughel and Hampl (2017) identify a difference in the valuation of economic factors between Austria (higher; see also Fleiß et al. 2017) and Switzerland (lower); hence, the finding by Fleiß et al. (2017) that economic motivations dominate seems context-dependent.

Moreover, there are indications that rural and urban dwellers differ in their motivations (Ebers Broughel and Hampl 2017 with reference to Dóci and Vasileiadou 2015; Kalkbrenner and Roosen 2016): Urban investors tend to put more emphasis on interdependence and interconnectedness, whereas investors living in rural areas emphasised self-reliance and independence.

6.1.3 Social Investment

As the brief overview of investment motives above illustrates, RE investments by citizens are situated somewhere between non-profit and for-profit and can often be considered part of the “social finance universe” (Anheier 2014) or of the “social and solidarity economy” (Laville 2014). Related examples are the community investment funds (CIFs) in Canada (Chap. 22) or the support and loans targeting the social economy in France (Chap. 12). Along the spectrum of organisations, we find several provisions that aim at increasing impact at the expense of financial returns:

- Energeia (Czech Republic; see Chap. 10) applies an investment approach but gives returns as charitable funds to projects as a specific form of philanthropy.
- Profit-oriented organisations, which either dedicate part of the returns to local or regional development funds to finance projects at the local or regional level (e.g. Windpark Krammer, the Netherlands, Chap. 15; Brixton Energy, UK, Chap. 17; Aga Khan Rural Support Program, Pakistan, Chap. 26).
- Individual members of projects donate—through voluntary fees/levies—a certain amount of money to be invested into such projects (e.g. “Germinador Social” programme by Som Energía and ethical finance service provider Coop57, Spain, Chap. 19).

6.2 Types of Financing

6.2.1 Equity, Debt and Mezzanine Capital

A general distinction to classify financing instruments is made between equity and debt (see Table 6.1). **Equity-holders** become owners by acquiring shares of a company that grant participation in profits but also

Table 6.1 Characteristics of equity and debt capital

	Equity	Debt
Legal position	Ownership = company shares	Obligation = funds owed towards other parties
Control rights	decision-making/voting rights and rights to information Voting rights depending on legal structure and stipulations in bylaws	Usually limited to information or specific covenants No decision-making rights
Return	Dividends and/or share price appreciation = participation in profit and loss Generally high	Interest = contractually defined; no participation in profits or losses Generally lower
Taxation	Dividends generally non tax-deductible	Interest payments fully tax-deductible
Variability of return	Variable, irregular	Fixed or floating, regular
Maturity	Principally permanent but right of termination	Temporary
Liability	Depending on legal structure from limited to capital contribution to full personal liability	No liability
Tradability	Depending on legal structure and markets, from highly tradable to not tradable	Depending on contractual stipulations and markets, from highly tradable to not tradable
Collateral	Not required	Depending on type but generally required
Priority in payment, esp. upon liquidation	Junior = paid later	Senior = paid first

Source: Own compilation based on Bieg et al. (2016) and Perridon et al. (2017)

losses as well as control rights, especially voting rights. The extent and definition of these rights depend on the legal structure chosen (see Sect. 6.2.3). Expected returns are generally higher than interest payments for debt. On the other hand, returns depend on economic success, which varies over time. In addition, liability is higher, and equity-holders are paid after debt-holders in case of bankruptcy. Overall, equity investments are more risky than debt investments. **Debt investors**, on the other hand, typically receive interest and principal repayments as agreed upon in the financial contract. They typically only have very limited control rights, mainly rights of information. However, they may put restrictions on actions, specify rights of information (reports, inspections) and assume control if debtors violate contractual obligations. Such stipulations in debt contracts are called “covenants” (Aghion and Bolton 1992; Hart 1995). While returns are generally lower, so are risks.

In debt financing, usually, not all monies come from consumers but also from financial intermediaries in the form of loans. Consumer loans are used for small installations of single households (retail banking/bank loans, microfinance). In the case of large-scale RE installations and accordingly high investments, a single bank, consortium or bank club may provide loans based on the project’s cash flows and assets rather than the creditworthiness and assets of the borrower. This type of financing, called project finance (Esty 2004; Morrison 2012; Nevitt and Fabozzi 2000), has developed into an international standard for larger-scale electricity generation projects by independent developers and utilities that are not able or do not want to rely on on-balance-sheet corporate finance (Agrawal 2012; Wiser and Pickle 1998). It is based on stable cash flows due to robust public support schemes and/or long-term power purchase agreements (PPAs).

Mezzanine financing is a third type with characteristics of both equity and debt capital (Pratt and Crowe 1995). It can take various forms like junior or subordinated debt, that is, debt paid after senior debt, or convertible debt, that is, an option for the investor to convert from debt to equity. Banks and rating agencies classify mezzanine financing economically as equity capital under certain conditions, while interest payments are deductible according to national tax laws. Thus, initiators can use mezzanine financing to optimise the capital structure of their firm

(Holstenkamp and Ulbrich 2010). On the other hand, it is a way to limit consumers' say in business matters temporarily or permanently. Sometimes authors use liquidity as an investment criterion separate from risk. In this respect, there is no general difference between equity, mezzanine and debt but rather between private and public placements: If securities are publicly traded at organised markets and if there are many market participants, investors can sell them at any time, that is, these investments are liquid. This is an advantage over illiquid investments like private equity in limited partnerships, for instance. Overall, the level of participation increases with growing "juniority" from debt over mezzanine to equity. So do return expectations. At the same time, risks are higher in the case of equity investments compared with mezzanine or debt.

6.2.2 Optimal Choice: Perspectives from Normative Investment Theory

We have shown elsewhere (Holstenkamp 2014; Holstenkamp et al. 2018) that depending on the risk-return or risk-participation preferences, the optimal type of financing may differ for individual consumers. Since equity is associated with higher risks than mezzanine or debt financing instruments, more risk-averse households should prefer mezzanine or debt to equity investments. On the other hand, investors may wish to have the right to participate in the decision-making processes of the firm. Assuming that investors have consistent risk-participation preferences, this would lead to the choice of an optimal instrument for each consumer—but choices will most probably differ between individual consumers because risk-participation preferences are not the same. Figure 6.1 shows debt, mezzanine and equity types of financing according to their inherent risks and levels of participation with the trade-off between decision-making power of investors and associated risks. In an idealised version, all optimally attainable combinations of risks and levels of participation form a curve depicted by the dotted line.

In summary, consumers should choose different types of investments—equity, mezzanine or debt or a mix of these—according to their

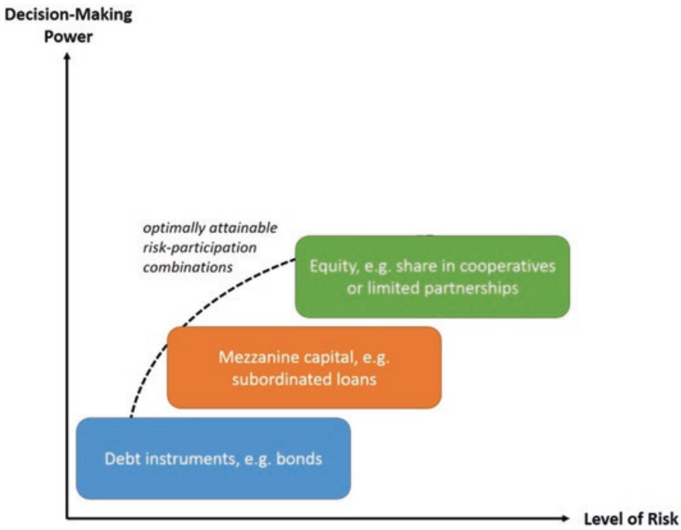

Fig. 6.1 Types of financing and risk-participation trade-off. Source: Own presentation based on (Holstenkamp 2014)

individual risk and participation preferences. Shares in cooperatives or other types of equity are not always the optimal type of investment for all investors. These considerations hold for heterogeneous but stable preferences from an economic perspective. However, further aspects like sense of ownership and social acceptance—often mentioned as a rationale to set up citizen participation models—should be taken into account (see Chaps. 3 and 4). In addition, designing bespoke arrangements adapted to particular local conditions may produce high transaction costs.

6.2.3 Types of Equity: Legal Structures

Control rights differ among the group of equity investments depending on the legal structure chosen, and project initiators, as well as consumers willing to invest, may choose different legal forms accordingly. Legal structures used for collective investments differ in the countries discussed in this volume:

- Foundations and charities (e.g. Hostetín, Czech Republic, Chap. 10; England/Wales, Chap. 17): In this case, investors do not have any residual claims and do not participate in profit or loss of the organisation (for-the-public-good companies).
- Trusts in the Anglo-Saxon world (e.g. in Scotland, Chap. 18): Assets are held and managed on behalf of consumers by a trustee that decides on payments to beneficiaries. Challenges include management of trusts and alignment with consumers' goals (Wlokas 2015).
- Associations and partnerships (including Comunidades de Bienes in Spain, Chap. 19): These organisations are usually not legally registered. Hence, they are easy to start, but full personal liability makes investments in these forms risky.
- Cooperatives: There are several countries with long-standing cooperative traditions like Denmark, Germany or Italy (see Chaps. 11, 13, and 14), including in the electricity and heating sector.
- Other countries have developed specific legal forms: CIGALES (Club d'Investisseurs pour une Gestion Alternative et Locale de l'Épargne Solidaire) in France (see Chap. 12) or community benefit societies (CBSs) in the UK (Chaps. 17 and 18). Usually, residual claims are restricted (common ownership). Current challenges in many countries include capacity building and professionalisation.
- Limited partnerships, limited liability companies and joint stock companies (e.g. Drahany, Czech Republic, Chap. 10; Eolpop, S.L., Spain, Chap. 19): These are all common incorporated forms in the for-profit investment world. Shares of stock companies may be publicly traded (stock corporations) or not (e.g. Société par actions simplifiée, SAS, in France, see Chap. 12).

Table 6.2 gives an overview of some of the general legal structures found and their characteristics.

Often, local communities use existing networks to gather equity needed for their projects. In some cases, capital is raised in several rounds, usually starting with the local community and then extending to non-local investors. Other channels to raise equity, or funds in general, are digital platforms: crowdfunding (Vasileiadou et al. 2016). Examples from the country reports include BPI's crowdfunding platform in France (Chap. 12) and CollectiveSun's crowdlending model in California (Chap. 21).

Table 6.2 Contractual arrangements for citizen participation in renewable energy sources

Form of financial participation	Leasing arrangements	Individual ownership	Partnerships	Limited partnership	Intermediary entities	LLCs	Cooperatives
Voting rights	–	–	Direct, often proportional to shares	Direct, proportional to shares	Conveyed through trustee/ representative	Direct, proportional to shares	Direct, one member, one vote
Rights of information	–	–	Given	Limited rights of LPs	Given/ delegated?	Given	Given
Compatibility with strategic commercial investors	–	–	Unusual	Given	Given	Less common	Unusual
Compatibility with municipal investments	–	–	Not possible	Given	Given	Given	Limited
Personal liability	Unlimited	Unlimited	Unlimited	Limited to investment (GP: personal, unlimited)	Limited to investment	Limited to investment	Usually limited to investment
Changes in participants	–	–	Possible, no registration	Limited/costly unless trustee relationship	Possible, easy	Limited/costly	Possible, easy
Start-up costs	Low	Low	Low	Medium	Medium	Medium	Medium

Source: Own compilation

6.2.4 Alternatives to Equity and Bank Loans

The country examples show that consumer co-financing may take forms complementary to equity or debt. In general, large projects in well-developed markets tend to have more sophisticated financial structures, as illustrated by the case of Windpark Krammer BV in the Netherlands (Chap. 15): Cooperative members give loans to the special-purpose vehicle (SPV), that is, the company created specifically for the project. Public entities issued bond loans totalling EUR 10 million with preference given to local inhabitants. Moreover, the financing structure of the wind park includes operating grants from SDE+. Other examples of individual financing through bonds include England and Wales (see Chap. 17) and the USA with its clean RE bonds and qualified energy conservation bonds (see Chap. 21 on California; both now terminated). In the USA, several programmes include issuance of bonds with tax exemption. We do not know of any study that analyses the effect of bond investment on social acceptance. However, bonds are not linked to any control rights on behalf of the investor. Thus, consumers only participate financially in the respective project. Against this background, we hypothesise that the sense of ownership and the associated positive effects on social acceptance would be small. Moreover, due to high transaction costs, issuing bonds makes economically sense only for larger amounts of funds to be raised limiting its use for small- or medium-sized projects, unless these are bundled into a larger portfolio.

Besides bonds, the country chapters include examples of leasing (rooftop PV in France, Chap. 12) and third-party financing (California, Chap. 21) with the latter making sense if users do not have the financial means and/or the necessary expertise to implement the project. Similarly, leasing is a financing tool used to divide upfront costs into smaller regular payments. In addition, it has less impact on the balance sheet, and payments are tax deductible. Sale and leaseback, a model often applied in the Austrian PV sector (Mautz et al. 2018), also belongs to this group of financing tools: Usually a municipality, municipal utility or project developer sets up the project, sells the modules to citizens and leases them back with citizen investors receiving a fixed payment. In addition, the contract typically includes a clause regarding the repurchase of the RE plant after a fixed period.

6.3 Structuring Finance

6.3.1 Capital Structures

Usually, different types of financing are mixed in projects or at company level. The optimal mix of equity, debt and mezzanine financing is a prominent topic within finance (see also Holstenkamp et al. 2018). Due to the different goals pursued by non-profit organisations (NPOs) and the constraints regarding debt financing, the optimal capital structure for NPOs differs from that of for-profit companies (Achleitner et al. 2007; Vilain 2006). In Sect. 6.1 we have shown that, depending on the specific case, consumer (co-)ownership can take hybrid forms somewhere in between the non-profit to for-profit continuum. This finding has implications for the optimal capital structure: Equity ratios tend to be higher (Holstenkamp et al. 2018; Yildiz et al. 2015). In Eastern European countries, mainly public funds and grants are used (see Chaps. 10 and 16 on Czech Republic and Poland, respectively). We find a similar trend in the heating sector, for example, in Germany or the case of Brixton Energy (Chap. 17) where community equity in a community benefit society (CBS) is combined with local and national grants and some debt. In general, the examples show that capital structures start to resemble those of typical for-profit investment vehicles in well-developed markets and larger-scale projects like wind power plants.

6.3.2 Co-investments Involving Heterogeneous Ownership Structures

We also observe (co-)ownership structures, that is, joint projects involving mixed ownership of communities and other actors like utilities and project developers. We observe different degrees of political support or corresponding legal frameworks for (co-)ownership in various countries, mainly with regard to wind energy projects:

- In Denmark, the government introduced a law that requires project developers to offer at least 20 per cent of the shares to local inhabitants (Olsen 2014; Olsen 2018).

- In the German federal state of Mecklenburg-Western Pomerania, developers have to make an offer to the local municipality or municipalities as well in addition to citizens (Maly 2014; Maly et al. 2018); in this respect the regulations deviate from the Danish model. They can choose which type of financing—for example, equity participation, subordinated loans or saving certificates—they offer to local inhabitants.
- In several countries, community shared ownership is legally supported, for example, through a "participatory bonus" for local authorities and inhabitants (France, see Chap. 12) or specific regulations for community wind (Germany, see Chap. 13).
- In the UK, the former government politically promoted share ownership through an initiative, which has not been taken up by the new government after 2015, though (see Chap. 17).
- In the Netherlands, there are several soft planning instruments which, however, are not often used (Chap. 15).
- In other cases like the Energy Invest Group in Poland (Chap. 16), shared ownership is offered on a voluntary basis.

There are different legal and financial structures for (co-)ownership models. In Scotland, three of the four models identified are types of (co-)ownership: the commercial developer-led model, the joint venture model and the community developer model. Even if (co-)ownership appears to be less common than community trust models, it is present especially among larger projects (Chap. 18). In general, there are three types of joint projects: (1) shared revenues, that is, citizens co-invest in the plant but do not acquire ownership of shares; (2) joint ventures of citizens, who together with a partner form a company that they own together; and (3) pooled ownership, that is, citizens and the partner each own a part of the assets, for example, citizens one or two wind turbines and municipal utilities the rest of the wind park.

The Béganne community wind project in France (Chap. 12) is a case of (co-)ownership on different levels: Énergie Partagée, itself a national fund financed by citizens, helps local initiatives to setup projects and co-invests in these projects. In Béganne, it co-invested next to founding members, local citizens' investment clubs and a regional investment fund. Regional and national, public funds or public-private partnerships that co-invest in these types of projects exist not only in France (here also: EnRciT; Chap. 12) but also in the Netherlands (DECRA, regional; Chap. 15) and Wales (Robert Owen Community Banking's "Community Energy Fund"; Chap. 17). There are several examples, where municipalities act as facilitators and (co-)owners, especially if municipal utilities play a strong role (see Chaps. 13, 14, and 15 on Germany, Italy and the Netherlands, respectively). The large PV plant of Duurzaam Ameland is such a case; it is (co-)owned by the municipality, a cooperative (Amelander Energie Coöperatie) and Eneco, a smaller part by the province of Friesland and a provincial environmental fund. The cooperative share in the SPV is refinanced through bond loans. SNE in Poland also has municipal shareholders (Chap. 16).

Examples of community-commercial developer partnerships include Windpark Krammer BV in the Netherlands (Chap. 15) and Braydon Manor Solar Array in southwest England (Chap. 17). In both cases, the local community holds a majority of the shares in the project company. In the former case, two cooperatives—Deltawind and Zeeuwind—formed a joint venture that has invested in the SPV. WeForGreen Sharing in Italy (Chap. 14) differs from these cases insofar as energy professionals created a cooperative that recurrently co-invests in renewable energy sources (RES). Most of these examples are legal and financial structures tailor-made for single instances where the necessary legal and financial structuring, however, involve high transaction costs. Therefore, there is a need to develop standard models that can be scaled up to larger numbers of cases and investment volumes, especially in the wind energy sector where project volumes tend to increase. Another challenge for the establishment and management of shared ownership are imbalances and missing trust between partners (Goedkoop and Devine-Wright 2016).

6.4 Framework Conditions Influencing the Types of Financing Used

Several framework conditions influence the choice of financing: (1) corporate and contract laws, (2) financial and energy market regulations, (3) development and type of financial system and (4) environmental protection policy.

(1) Corporate laws and contract laws—Financial contracts are subject to specific legal provisions. Corporate laws or laws of business organisations govern the rules for the establishment of business organisations and the rights and obligations of shareholders, who provide the organisation with equity capital (see Sect. 2.2). Changes in corporate law can make it easier or more difficult to establish a certain type of business entity or restrict the type of activities that these organisations can execute. For example, the 2006 amendment of the German Cooperative Societies Act included a reduction of the minimum number of founders from seven to three and a relaxation of audit requirements for small cooperatives (Brockmeier 2007); in 2014, the Financial Conduct Authority (FCA) in the UK stopped registering energy cooperatives because of a reinterpretation of what constitutes a bona fide cooperative (Vaughan 2014). Furthermore, contract laws or laws of obligations are relevant for other types of financing than equity (see Sects. 2.2, 2.4). Similar considerations regarding legal changes apply as in the case of corporate law.

(2) Financial and energy market regulations—Every person active in financial and in energy markets has to abide to specific laws. Financial market regulations at the national but also at the supranational level—as in the case of the EU—exert an influence on the financing instruments used under a certain jurisdiction. An illustrative case in this respect is the Alternative Investment Fund Managers (AIFM) Directive and the introduction of the German Investment Code (Holstenkamp 2014): Due to uncertainties regarding the interpretation of the code, many energy cooperatives were reluctant to start new projects directly after the code entered into force. Furthermore, energy market regulation like energy laws and public support schemes determine the cash flow of projects and consequently the financing instruments available in the respective country. As the history of RE in the USA (Mendonça et al. 2009; Toke 2011), in Spain (de la Hoz et al. 2016) and in the Czech Republic (see Chap. 10) illustrates, frequent changes in the legal framework and retroactive adjustments can be detrimental to RE investments as investors and lenders lose confidence. In a similar vein, scholars argue that stable favourable conditions under FiT regimes in Denmark and Germany provided the basis for financial institutions to engage in the sector (Morris and Jungjohann 2016; Toke 2011).

(3) Development and type of financial system—The set of financing instruments available depends on the development of the financial sector and the type of financial system. With regard to the latter, scholars differentiate between bank-based and market-based financial systems (Beck and Levine 2002). The use of specific instruments generally corresponds with a country's stage of development and type of financial system (Hall et al. 2018). Germany, for instance, is characterised by a bank-based financial system with strong local banking structure and RE financing segment that grew along with the FiT system and favourable refinancing offered by the German development bank KfW and Rentenbank, the development agency for agribusiness. Against this background, crowdfunding does not play a significant role in the German RE finance market beyond certain niches. In contrast, it is much more important in the UK with its market-based financial system having a small number of large banks. Other examples include France, where local banks that invest in these types of decentralised, small-scale projects are lacking (Chap. 12), and Italy, where bank loans for small PV projects are available (Chap. 14). In less developed markets, in particular in many developing countries, small-scale investors have to look for alternative sources of finance due to the low preparedness to issue credits for RE projects and high interest rates that banks charge—these alternatives may include, for instance, combinations of contributions in kind by local communities, development aid monies and/or philanthropic funding like in India and Pakistan (see Chaps. 25 and 26).

(4) Environmental protection policies—Environmental protection policies in general or climate protection policies specifically can influence the types of RE financing used by consumers: In more economically advanced countries, communities with the help of intermediaries or service providers make use of international instruments to regulate greenhouse gas emissions, that is, carbon finance (Labatt and White 2007). The Argentinean electricity cooperative Sociedad Cooperativa Popular Limitada (SCPL) raised USD 1.2 m from the Japan Carbon Fund under the Clean Development Mechanism (CDM) for a wind energy project (Helmke 2009), while the Brazilian Cooperativa Regional de Eletrificação Rural do Alto Uruguai Ltda (CRERAL) made use of voluntary carbon markets to finance their hydropower projects (Ashden Trust 2008).

6.5 Conclusions

This brief overview of financing consumer (co-)ownership of RE systems shows a very specific field of finance dominated or at least strongly influenced by non-financial motives of private households as co-investors. Moreover, there are considerable differences between the countries under consideration that depend not only on the respective state of development of the country in general and the energy systems specifically but also on the development/type of financial system in the country or region. This said, there seems to be a need to further study this co-development or co-evolution of financial and energy systems globally (Hall et al. 2016, 2018). Depending on risk and participation preferences, consumers should choose different types of investment. Due to different control and decision-making rights assigned by law and/or contract, this choice of financial structure affects not only the risk-return profile of investments and cash flows for the consumer-investors, but also the level and type of their participation. This is the governance perspective of financing structures.

As illustrated in Sect. 6.4, consumer financing of RES operates in highly regulated markets. Through these legal frameworks, politics influences the decisions of consumers and initiators of consumer (co-)ownership projects on legal and financial structures while at the same time having an effect on who governs the energy system. This, in turn, seems to be relevant on two grounds: First, ownership—and sense of ownership—has an impact on social acceptance of RE installations. Second, a diversity of actors may make the sector more resilient. Scholars have demonstrated the latter effect for the banking sector (Ayadi et al. 2010), and there are good reasons to think that this also applies in other sectors. The country chapters show that there is considerable diversity within the consumer (co-)ownership sector. However, the strength of this sector also varies considerably from country to country. (Co-)ownership, the use of intermediaries and/or cooperation strategies are employed to address a variety of challenges faced by actors from the RE sector. These are all areas that need further studies.

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7

Renewable Energy Cooperatives

Jens Lowitzsch and Florian Hanke

The realisation of the Energy Transition and the compliance of climate and sustainability goals are among the greatest political challenges in Europe inseparably connected with a shift towards a decentralised renewable energy (RE) supply. The question is no longer whether this process is to be continued but how this transition can be facilitated. In this context RE cooperatives have gained importance as the collective organisation of a common objective in the form of a cooperative is based on particular benefits for all stakeholders and hence a cooperative surplus (Huybrechts and Mertens 2014). Optimistic assessments surmise that by 2050 half of the EU population could be producing its own energy from RES and that collective projects, such as RE cooperatives, could contribute 37 per cent of the electricity produced by "energy citizens" (Kampman

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et al. 2016). There are currently about 3500 RE cooperatives, mainly in Western European countries, of which 1500 and their one million members are represented by the European federation of RE cooperatives, REScoop.eu (REScoop.eu 2018c; Huybrechts et al. 2018) and registered as a Renewable Energy Sources Cooperative (REScoop). Thereby RE cooperatives have the potential to not only become a successful model for consumer ownership in RE projects all over Europe but substantially contribute to the success of the Energy Transition as such. This chapter introduces the concept of RE cooperatives, discusses its advantages and disadvantages as a business model and investigates their potential as well as the obstacles to further development in the context of the energy transition. This analysis draws on examples from the countries under consideration as well as on information provided by REScoop.eu.

7.1 Background and Definition of Renewable Energy Cooperatives

Cooperatives are autonomous associations with open membership and the purpose to support the economic, cultural or social activity of their members through commonly owned or collective business operations (George 2012). These business activities are guided by a set of underlying values and principles as adopted by the International Cooperative Alliance (ICA 1995).[1] Supported by King William, one of the first successful, modern consumer cooperatives, the "Rochdale Society of Equitable Pioneers" was founded in 1844 strongly influenced by the ideas of the leading pioneer of the modern cooperative movement, Robert Owen, a British entrepreneur. Based on the principle of voluntariness, self-administration and distribution of profits among its members, the project is known as the first of its kind (Fairbairn 1994). Since then the cooperative movement developed into a popular model across Europe and the world.

[1] Those principles are voluntary and open membership; democratic member control, economic participation by members; autonomy and independence; education, training and information; cooperation among cooperatives; and concern for community (ICA 1995).

A general distinction can be made between consumer cooperatives owned and managed by the consumers of the particular good or service produced by the respective cooperative and worker cooperatives owned by the employees of the cooperative. Additional hybrid forms of cooperatives exist, for example, in the form of a consumer cooperative that is also a credit union (Viardot 2013). With respect to RE cooperatives based on Porter's corporate value chain concept in the energy sector (Porter 1998), we follow the activity-based approach and distinguish between cooperatives according to their primary activities: generation/production, distribution/transmission or trading.[2] Thus three forms of RE cooperative emerge from this classification: RE production cooperatives, RE consumer cooperatives (purchase and distribution of RE to end consumers) and RE service cooperatives (consulting on energy efficiency, production, supply and/or distribution). Hybrid forms of the three RE cooperative types exist (Yildiz et al. 2015).

Cooperative law is the organisational law of cooperative entities and entails rules, among other aspects, for the definition, formation, organisational and financial structure, profit allocation and business operations. Cooperative law may inter alia be found in a single document, in several documents or in a more general instrument such as a civil code (Fici 2013a).[3] Furthermore, provisions in other legal areas like labour, tax, competition and insolvency law, and even civil procedure, property and contract law regulating the activities of cooperatives are part of their legal framework (Fici 2013a). Since the 1980s attempts have been made to form common European statutes for social economy entities. However, until present, only the Statute for a European Cooperative Society has been adopted and is an example of supranational cooperative law in the European Union (Fici 2013b; Liger et al. 2016). Although a comparative

[2] Resource-based and activity-based RE cooperatives are commonly distinguished. The former focuses on the relevant resources they use, for example, photovoltaic, wind energy, bioenergy and service and marketing cooperatives. The latter refers to the main type of business activity and the value chain approach in the energy sector.

[3] With respect to a comparative approach across jurisdictions, the fact that sources of cooperative law vary according to the respective legal system complicates the analysis with differences in regional or state competence for cooperative regulation adding complexity.

presentation of cooperative law or detailed reports on national legislations remain outside the scope of this chapter, we will briefly draw a general function of cooperative law as described by Fici (2013a).[4]

Cooperative law generally adopts the principles of company law with respect to "priority with liquidation protection" and "member limited liability" as the prevailing asset partitioning types are found also in business corporations (Hansmann and Kraakman 2000; Fici 2013a). The stipulation of the cooperative identity by defining the purpose of cooperative activity is the major distinction of cooperative law from company law conceiving cooperatives as entities operating business activities in the interest of their members; this definition is however not limited to a cooperative's objectives but comprises financial and organisational structural elements as well (Fici 2013a).

7.2 Advantages and Disadvantages of RE Cooperatives as a Business Model

The cooperative model, based on the cooperative principles, provides the framework for a discussion of advantages and disadvantages of RE cooperatives. Guiding elements, common to most RE cooperatives, are democratic decision-making, organisational structure and access to financial capital.

7.2.1 Members, Ownership and Profit

With respect to RE cooperatives—although the specific objective may vary—a common vision entails the global transition from fossil to renewable energy sources considering private citizens as central actors with the concept of energy democracy (see Chap. 4) being an element (REScoop 2015). The cooperative model provides benefits when its particular organisation of ownership results in low transaction costs between stake-

[4] For an international overview of cooperative law, see Cracogna et al. (2013): Part III Cooperative Law: An International Overview.

holders and prevents opportunistic behaviour (Hansmann 2000; Bonus 1986). Traditionally cooperative members are simultaneously owners of the organisation and consumers of its collectively produced or organised goods or services. This linkage of ownership and consumption often (although not always) determines the structure of decision-making, control and financing in RE cooperatives and shapes the prevailing cooperative approach (Yildiz et al. 2015). The main attributes of distinction are summarised in Table 7.1 comparing them to those of business corporations.

In line with the aforementioned cooperative principles, RE cooperative activities are community-based and contribute to local value creation and redistribution (Klagge et al. 2016). The notion of a common goal as well as high transparency with respect to the cooperatives' activities is important to enhance social coherence locally (Zenke and Dessau 2013). RE cooperatives play a major role in creating local acceptance for the installation of new RE installations (Schweizer-Ries 2010; Knoefel et al. 2018) and as such facilitate the Energy Transition as a whole (Musall and Kuik 2011). Incentives for membership are the mentioned values and principles not merely financial performance (Holstenkamp et al. 2017; see section access to finance).[5] The inclusion of local stakeholders alongside with the protection of member interests in contrast to a convergence on market requirements and/or financial indicators is exemplified in the realisation of projects, which provide important community benefits but low financial returns. Based on this observation, the cooperative model enables participation of multiple stakeholders, fosters open-innovation, knowledge and resource sharing and, in RE cooperatives, ensures the project's feasibility especially in cases where transaction costs of small-scale projects are high (REScoop.eu 2015b).

The cooperative model provides a number of advantages as an organisational form and in particular its form of organising ownership: Traditionally it allows for everyone to become a member of the collective venture reflected in three central principles, that is, openness, inclusiveness and the pursing of a collective purpose. Cooperatives enable individuals to form a collective in order to realise a project relatively

[5] For an in-depth analysis of institutional factors (community, locality and cooperative tradition) on the emergence of RE cooperatives in South Tyrol (Wirth 2014).

Table 7.1 Comparison between cooperatives and corporations

Attributes	Cooperatives	Business corporations
Ownership	Separate legal entity with members holding equity shares	Separate legal entity with its shareholders owning equity interest
Control	Democratically controlled; one member, one vote; equal voice regardless of equity share; members are involved in the day-to-day business operations	Controlled by shareholders proportional to their investment share; business decisions are taken by a board of directors and corporate officers
Board membership, compensation	Made up of cooperative members elected by them: usually, they do not work for the cooperative and serve on an uncompensated, volunteer basis; cost of board meetings reimbursed	Board is comprised of a combination of independent directors, management and other directors with financial or business ties to the organisation; financial compensation is provided for board service
Board nomination, elections	Candidates nominated either directly or by a nominating committee made up of members; usually, any member can nominate a director candidate; board is elected by members on a one member, one vote basis	Candidates nominated by the board of directors and management, often by a nominating committee; shareholders have limited ability to nominate and elect director candidates
Earnings/ dividends	Any profits earned by the cooperative are reinvested and/ or returned to members; many cooperatives are obliged to return a portion of their profits to members each year; members share losses and earnings	Profits returned to shareholders based on ownership share; corporations are generally not obligated to pay out dividends; timing and amount of dividend payout are determined by the board of directors
Motivation	Maximise customer service and satisfaction	Maximise shareholder returns
Source of funds	Typically raise resources through the equity of members: (1) direct investment, (2) retained margins and (3) per-unit capital retains	Typically raise money through capital markets
Community	Promote and assist community development	May engage in selected CSR activities

Source: Modified after ICA (2007) Factsheet: Differences between Co-operatives, Corporations and Non-Profit Organisations; US Overseas Cooperative Development Council, 2007 independent from other market actors. Democratic control as well as the safeguarding and representation of the collective benefit limits opportunistic behaviour. Consequently, membership and the active involvement of members in control and decision-making constitute an important resource for the cooperative, distinguishing it from other organisational forms. On the other hand, this strong focus on membership entails increased internal organisational costs; most importantly this regards a general dependency on members' financial, operational and managerial participation but also on the skills and competences contributed by members. Although not considered non-profit organisations, cooperatives often appear less attractive for investments which limits the scalability of many RE projects (Yildiz 2013). Low cognitive legitimacy of the cooperative models generally leaves many stakeholders and decision-makers ignorant of the advantages of the cooperative model as an efficient market solution.

7.2.2 Organisational Structure

The organs of a cooperative are usually the general assembly, the board of directors and the managing board. As long as not specified otherwise by the statute, the general assembly elects the board of directors and is involved in all major decision-making. The board of directors controls and elects the managing board, which represents the cooperative to the outside and manages daily operations. Characteristic for RE cooperatives is the principle of self-help, independence and self-governance or self-administration in contrast to concepts allowing for representation by third parties. Hence members of the cooperative take all management and board positions. Divergence of interests and opportunistic behaviour, common to the principal-agent dilemma, is prevented and influence of outside interests limited (Holstenkamp and Degenhart 2013). Generally, direct participation can lead to lower employee turnover and better preservation of professional experience within the cooperative and serves as an incentive to join a cooperative. However, direct participation increases internal organisational costs with potentially negative effects on management efficacy. Here the participatory system results in less authority and discretionary power with managerial input possibly less productive (Yildiz and Radtke 2015).

Furthermore, a potential downside is the restricting character of self-administration: In the inception phase and in particular in small-scale projects, self-administration is feasible and within the manageable scope of cooperative members; however, with increased scale, a professionalisation of administration and management to develop the needed skill to enhance efficiency and growth of a RE project may become necessary. At this point, the principle of self-management may prevent or complicate the involvement of external experts, for example, in management positions and the development of needed expertise. This applies in particular to large-scale projects like offshore wind parks or those with high technical demands, for example, biogas, but also wind projects where expertise determines the project's feasibility. To balance these effects, members involved in managerial and administrative functions need to acquire competences and skills with additional training needed being cost intensive and resulting in an increase of internal organisational cost (Dethier and Defourny 2015).

In summary, the organisational structure facilitates the protection and representation of members' interests by providing direct control and democratic structures restricting external influence and opportunistic behaviour. However, this implies a lack of access to third-party expertise, cooperation with other actors and managerial efficacy. As professionalisation is an advantage in terms of scalability, market position and feasibility of projects, various examples of cooperation between RE cooperatives, in particular skill sharing, demonstrate the potential of the cooperative model in this area (REScoop.eu 2015a).

7.2.3 Democratic Decision-Making

Democratic control exercised by the cooperative's members is essential for the representation of their interests enshrined in the principle "one member, one vote". The resulting active role of all members entails direct participation and involvement in all major decision processes, be it at the strategic or the operational level. The statute as constitution of the cooperative stipulates all major aspects such as purpose, minimum capital requirements, distribution of shares among members, share transfer, investing members and so on. Its content is decided by the general assembly usually requiring a majority vote of three quarters for amendments. Each member has a voice in both the selection of the board of management and board of directors. Decision-making is linked to membership irrespective of differences in financial participation or benefits from the cooperative's activity ensuring equal representation of each member's interests and preventing the overrepresentation of sectional interests (Yildiz 2014).

Local authorities are central for any RE cooperative project, not only in terms of regulations but often also financially. However, the respective national and local regulations—often in the form of a municipal code—define prerequisites for municipal economic activities like, for example, the involvement in a RE venture (for Germany see Zenke and Dessau 2013). To legitimise investments of public funds, the financial involvement of local municipalities in a project usually requires exercising control rights with respect to project management and future developments; thus municipalities will habitually be obliged to be represented in the supervisory or executive board of the concerning RE cooperative. However, with the distribution of voting rights independent of the level of financial involvement[6] and the general assembly electing the board members, the representation of the municipalities' interests on the board cannot be guaranteed. This restricts co-investments of cooperatives and local municipalities in many cases, even though creative solutions exist, for example, in the form of voting agreements.[7]

In contrast to concepts allowing for delegation to management, in the cooperative context, each member has to gather relevant information about the cooperative's performance to control operational activities

[6] Some cooperative laws acknowledge "investing members" which may be granted additional voting rights; however, these still are not proportional to capital contributions and are limited by the principle that no member may have a dominating influence.

[7] Voting agreements in company law may stipulate the utilising of voting rights according to instructions by a third party or codify behaviour during elections or voting. In Germany under certain restrictions, this applies also to cooperative law although in conflict with the principle of exercising individual suffrage (Lehnhoff et al. 2016).

effectively. To gain access to this type of information is time consuming and requires a certain understanding of key processes, hence implying significant increase of individual internal organisational costs (Yildiz et al. 2015). Likewise, the overall internal organisational costs increase as accessibility of information discussed, additional reporting and administrational and physical organisation of democratic decision-making, for example, regular general assemblies are required (Holstenkamp and Degenhart 2013). Efficiency regarding collective decision-making also depends on the degree of variation between existing preferences among members, whereas high member heterogeneity translates to increasing transaction costs (Sykuta and Cook 2001). To balance these factors, either the number of members is restricted, for example, through a higher minimum capital requirement that, however, potentially collides with the principle of open membership or more cost-effective ways for decision-making are to be applied.[8]

In summary, decision-making organised alongside democratic principles and safeguarding members' interests irrespectively of financial participation is a core function in cooperatives and motivation for their members. Consequently, cooperatives display a high degree of control and require member's involvement. However, decision-making here often implies high individual as well as internal organisational costs; such, depending on the degree of heterogeneity in preferences, efficiency of decision-making is low and time consuming when compared to delegation in business corporations.

7.2.4 Access to Finance

At the core of any new project stands the capability of a RE cooperative to allocate required initial funding. The funding of the inception phase of a RE project is most challenging as it typically requires substantial initial investments to install the RE production facilities, to finance

[8] In Germany, in cooperatives with more than 1500 members, representative's meetings are allowed. This however limits direct participation and increases the dynamics common to the principal-agent problem. The introduction of alternative formats such as virtual assemblies is discussed in this context, but the legal basis for such methods remains unclear (Holstenkamp and Degenhart 2013).

supplementary infrastructure and to cover insurance costs as well as administration and human resource expenses.[9] Traditionally cooperatives aim at raising a significant amount of membership equity through membership shares. The perception of risk associated with investing in decentralised, small-scale RE projects as well as high national capital market requirements on disclosure of investment policies and the Prospectus Directive 2003/71/EC creates barriers in particular for small cooperative project.[10] Although local citizens come on board more easily once a project is operational established RE cooperatives report having sometimes difficulties to attract additional funding.[11]

Member equity plays a major role in the financing mix of RE cooperatives. According to a REScoop report (2012), second to membership shares are loans and public subsidies in capital. This raises issues of inclusion and the role of investing members:

- Taking Germany as an example, the importance of member equity in the financial mix is reflected in the social structure of RE cooperatives with an overrepresentation of high-income households. Based on this assessment, low-income households often are underrepresented as members in RE cooperatives (Rommel et al. 2018). The respective cooperative's statute defines the minimum as well as maximum number of shares per member as well as the possibility for differences in the amounts of equity per member. However, a minimum amount of equity per member typically required by the respective statutes may prove to be an obstacle for low-income households to participate. This may condition either disproportional high membership of wealthy members or

[9] A European cooperative financing tool will provide financing solutions to start RE cooperatives and take ownership in their projects; the REScoop MECISE project (http://www.rescoop-mecise.eu/) will then push the local cooperative to raise funds from local citizens and support their fundraising campaign (REScoop.eu 2018a).

[10] National support instruments like FITs provide security for citizens as investors making it easier for them to assess a project's earnings (Yildiz 2014); however, with a Europe-wide trend to auction schemes substituting FITs, this will change in the foreseeable future.

[11] Return on investment is often not the only reason, indeed, not the main reason why people participate in RE cooperatives. During the development phase, it may turn out that a RE cooperative is less profitable than initially expected or not profitable at all. By communicating such changing risks and their consequences openly, it is possible that members of a RE cooperative still decide to continue with the project (REScoop 2015a).

the increase of the total number of members leading to a steep increase of internal and individual organisational costs (George 2012).

- Cooperatives can have a specified proportion of investing members (European Union 2003) with the specifications being subject to regulations as stated in the respective statutes. Since investing members do not use the cooperative's service or that of third parties who benefit from the cooperative's activities, their interest is usually restricted to capital investment. Usually the general assembly decides upon the admission of investing members. Even though national legislation may deviate, in general not more than 25 per cent of all votes may be accumulated by investing members.[12]

Many RE projects in general and decentralised, small-scale RE projects in particular are confronted with a number of financial constraints such as relatively high transaction costs and low return on investment rates. Furthermore, as profitability is not the core purpose of RE cooperatives, they may appear unattractive for investors seeking to maximise their return on investment (Huybrechts and Mertens 2014). Be it for private individuals, large-scale energy companies or investment funds as long as they expect high or market-oriented returns on investment, RE cooperatives are not the most attractive investment. Besides these financial aspects, the aversion of large energy companies towards decentralised energy infrastructure investments is further exacerbated by general lack of experience with small-scale projects. In addition, the underlying bias is fuelled by the negative competitive impact that such decentralised projects have on the economic efficiency of existing fossil energy plants owned by nationwide operating energy suppliers. Hence, especially decentralised, small-scale infrastructures are affected by a lack of investment (Yildiz 2014).

In addition to the outlined barriers, commercial market actors operate in legal contexts where, in contrast to cooperatives, third-party representation is the rule, voting rights are proportional to equity held and capital commitment is flexible. To protect its members, cooperative statutes usually bind its members and their equity to the purpose of the cooperative

[12] For detailed country reports on national legislations and cooperative law, see Cracogna et al. (2013); for country reports on policy frameworks for the social economy, see Liger et al. (2016).

defining mechanisms for capital commitment and restricting the transfer of ownership. While this provides sustainability and protection to the RE cooperative by ensuring its membership base, external investments are discouraged especially if they foresee a disproportional allocation of financial risk and voting rights. Other legal forms such as joint stock companies or limited liability companies provide more adequate conditions for conventional investors (George 2012, p. 511).

In general municipal (co-)financing for cooperative ventures particularly when of small size is important especially in the inception phase. However, limited compatibility and compliance of the cooperative model with prerequisites for municipal investments stipulated by law in effect limit financial engagement. The particular legal form of a cooperative in combination with the prevailing nature of decentralised RE projects creates difficult conditions for investments. This becomes especially clear when compared to conventional investment instruments and challenges the further development of RE cooperatives (George 2012).

7.3 Country-Specific Barriers to the Further Development of RE Cooperatives

The major challenges for cooperative forms of consumer ownership and involvement in RE projects are uncertainty of regulations, bureaucracy, low compatibility with local municipal or commercial investments and difficulties with market integration and scalability. The countries under investigation in this book confirm this observation: Although RE cooperatives play a role in the RE sector in most countries, a supporting regulatory framework and concrete supportive measures exist only in a few. However, this assessment is based merely on the country chapters who do not claim to be a comprehensive in-depth analysis of RE cooperatives and their regulatory framework. We can, nonetheless, present a general overview with regard to (1) whether RE cooperatives play a role as actors in the RE sector and (2) whether the regulatory framework for RE cooperatives is supportive or not. The results of the brief assessment of the countries under consideration are summarised in Table 7.2.

Table 7.2 RE cooperatives: comparative overview of countries under investigation

Country	Cooperatives in the RE sector	Regulations for RE cooperatives
Czech Republic	No RE cooperatives	No specific regulation for RE cooperatives; low support for RE in general
Denmark	Long tradition for RE cooperatives; today coops and municipalities own the majority of electricity distribution companies	Supportive; for example, tax exemptions, finance schemes, FITs for RE cooperatives
France	Some examples but RE sector dominated by large commercial actors	Centralised energy system not supporting RE cooperatives; unstable RE support policies negatively affect RE cooperative access to finance
Germany	Long tradition for RE cooperatives with 2008–12 peak of newly founded RE cooperatives	A number of supportive regulations for the RE sector also provide favourable conditions for RE cooperatives; although recent amendments to the RE act pose a threat to RE cooperatives
Italy	Long tradition for RE cooperatives; some examples but no central actor in the RE sector	Lack of support and comprehensive legislation for the RE sector; grid connection for smaller producers is difficult
Netherlands	Some examples but no central actor in the RE sector	No specific RE regulation; no specifications for RE cooperatives
Poland	One example only	Frequent amendments to legal framework for RE lead to uncertainty for investments; however, favourable condition for RE cooperatives in RES act
England/ Wales	Most common form for community ownership but no numbers for RE cooperatives	Some favourable regulations, but amendments to the FIT policy lead to uncertainty; for smaller installations securing PPA is difficult

(*continued*)

Table 7.2 (continued)

Country	Cooperatives in the RE sector	Regulations for RE cooperatives
Scotland	Only 12 per cent of community energy capacity exist through community cooper-atives (compared to 92 per cent in England)	Community and local ownership in RE is an integral part of energy policies, hence positive for RE cooperatives; policy changes in the UK have a negative effect
Spain	Two waves: In 1940 2,000 electric cooperatives; in 2016, 33 consumer cooperatives registered in the production and distribu-tion sector of electricity, gas and water	Energy consumer cooperatives allow direct consum-er (co-)ownership in RE; "public service cooperatives" introduced at the regional level in 2014 in Andalusia and in 2015 in Valencia
Switzerland	Since 1990, more than a 100 new RE-cooperatives have been founded; mainly electricity from solar PV (but overall share in installed capacity small) and heat from wood-chips	A long tradition of cooperative legal framework; however lack of market regulation; monopolistic position of municipalities and new RE act hinder RE cooperatives
California	Five rural electric cooperatives serve approximately 32,000 member-customers; Some more recent examples also in urban areas but no central actor in the RE sector	Federal Rural Electrification Act in 1936 to extend electricity distribution to isolated communities; coops set up to purchase power in bulk and distribute electricity through their own transmission net-work; ambitious goals for the RE sector and supportive policy framework for RE sector and for smaller installations hence for RE cooperatives
Canada	RE cooperatives are among the most commonly used forms of consumer (co-)ownership in RE	No consistent national RE policy framework; instead local regulations vary considerably; in Ontario: supportive RE policies
Brazil	In rural areas cooperatives began to play a role in the 1940s; after regulations in the 1990s, only some are left, mostly small hydro plants and in the solar sector	In general, the legal framework for RE is supportive, but some administrative processes are slow; financial instruments for smaller installations exist

(*continued*)

Table 7.2 (continued)

Country	Cooperatives in the RE sector	Regulations for RE cooperatives
Chile	Minor role; 9 RE cooperatives registered with Ministry of Economy; 7 FENACOPEL cooperative concessionaries provide electricity to rural areas in central Chile	Law on Cooperatives of 1978, was modified in 2016 (Law 20.881) highlighting inclusion criteria and aiming to facilitate management processes in electricity distribution; educational initiatives promoting ecological and energy cooperatives in several counties.
India	No central actor in the RE sector; but present along models like "self-help groups", that is, village-based financial intermediary committees	Lack of comprehensive policies for RE; captive generation plants (CGPs) requiring min. 26% ownership stake in the RE installation held by the consumers which have to consume at least 51 per cent of the aggregate electricity generated can be set up by a registered cooperative
Pakistan	Despite long tradition of cooperatives especially in the agricultural sector not common in RE sector;	Cooperative Societies Act 1925 and Rules 1927 without specific rules pertaining to the RE sector; consumer (co-)ownership in RE may extend to the grid-served areas through housing cooperatives
Japan	No central actor in the RE sector	RE cooperatives are legally forbidden; however cooperatives can and do own/invest in companies in RE sector

Source: Compilation by the authors based on the country reports in this book

7.3.1 Uncertainty of the Regulatory Framework and Bureaucracy

The respective national regulatory framework is one of the main factors determining the success of RE projects and, respectively, of RE cooperatives. For the latter, explicit legal restrictions, disproportionate administrative and planning procedures and punitive tariffs are among the highest barriers, particularly for those of small-scale (Ecorys 2010). In addition, inconsistencies and amendments of regulations lead to uncertainty and thus limit the further development of RE cooperatives. Generally various studies come to this conclusion and highlight the importance of a supportive and consistent policy framework (European Economic and Social Committee 2017; Ecorys 2010; Liger et al. 2016; Kampman et al. 2016; Holstenkamp et al. 2017).

Poland, Czech Republic and Japan are countries where RE cooperatives either are not existing or only playing a marginal role in the RE sector. In Poland, although the legal term "energy cooperative" was introduced into the RES act, RE cooperatives are not supported by any implementing provisions. In Japan, due to specific regulations, cooperatives are not allowed to engage in business activities in the energy sector. Hence RE cooperatives as such do not exist, although other cooperative forms such as farmer cooperatives invest considerably in RE projects appearing, however, merely as investors. In the Czech Republic, national regulations support corporations rather than cooperatives, especially in the energy sector.

Canada, Denmark and Germany on the other hand are countries where RE cooperatives traditionally play an important role and—in the context of the Energy Transition—have boomed performing a central function today with respect to realising the climate objectives. The case of Germany in particular highlights the importance of a supportive regulatory framework for RE projects: While the Renewable Energy Act initially provided favourable conditions needed for many RE cooperative ventures to be economically feasible, recent amendments became less and less favourable lowering profitability and increasing financial risk and administrative requirements.

Interesting developments are observed in countries such as Chile, India and Pakistan where impulses for the development of RE cooperatives come mainly from rural areas where access to electricity is scarce; however, housing cooperatives investing in RE in the context of tenant electricity models, for examples, could also play an increasing role in the future. It should be stressed that the examples from the country chapters are manifold and illustrate the potential broad variety of activities of RE cooperatives.

In sum, the country examples in this book and notably the case of Germany illustrate the importance of a supportive stable legal framework for the further development of RE cooperatives. At the same time, unclear and unstable legislative frameworks in general are probably the most restricting factor for investments in the RE sector. Cooperation between existing RE cooperatives and the representation of common interests at the national and supranational policy levels prove a vital instrument in shaping a supportive regulatory environment (Huybrechts et al. 2018).

7.3.2 RE Cooperatives and Local Municipalities

Local municipalities are a key stakeholder for RE cooperatives in particular with respect to trust building in the local community and facilitating knowledge transfer between local actors (Boon and Dieperink 2014). In many cases local authorities not only deliver support with regard to regulatory and bureaucratic aspects but act as a major financial contributor (REScoop.eu 2015a). Such beneficial cooperation between RE cooperative and local municipality often determines the success of a cooperative venture (Peeters and Schomerus 2014). At the same time, local authorities themselves often are limited in their ability to cooperate and support local RE cooperatives due to a restricting character of the respective national regulation (see Sect. 7.2.3).

The situation in the countries subject to this book varies considerably. We find both examples for a mutually beneficial cooperation between RE cooperatives and municipalities and negative examples, sometimes within the same country. In Denmark, for instance, a small community launched a cooperative venture with the objective to take back control over the local district heating plant as under corporate ownership, heating prices had increased significantly; once in ownership of the local community, operating costs dropped and translated to much lower than average heating cost (II.1 Slagslunde District Heating Cooperative). Needed financial market capitalisation was secured by public guarantees making the success of this venture highly dependent on the cooperation with the municipality. In Spain, the first RE cooperative was established in 2010 (X.1 Som Energia Cooperative) developing despite an unsupportive economic and regulatory environment into one of the best practice examples in the country. Its membership boomed from 178 founding members in 2010 to around 46,500 members in 2018 with an average of 8000 new members per year managing a total of 72,500 electricity contracts. However, during the founding process, the cooperative reported considerable difficulties to cooperate with local authorities and highlighted this as a major obstacle (REScoop.eu 2015b).

7.3.3 Market Integration and Scalability of RE Projects

Although RE cooperatives and other forms of consumer (co-)ownership in RE often convince with efficient solutions, these remain theoretical when macroeconomic conditions prevent fair competition. In this respect, barriers to market entry pose a substantial threat to many RE cooperatives and limit their further development. Most prominently discussed are unfavourable government regulations as well as low potential to benefit from economies of scale and a resulting lack of bargaining power on the one hand and high required initial investments, a lack of access to land and finally inappropriate possibilities to market produced energy on the other (Huybrechts and Mertens 2014; Rommel et al. 2018). In countries such as France and Britain, dominated by a few large energy companies, the prevailing oligopolistic structure of the energy market and respective policy frameworks prevent smaller actors such as RE cooperatives from market entry. In this context, regulations for grid access and feed-in-tariffs (FITs) are the most important instruments to either facilitate market integration of RE cooperatives or to hinder or at least complicate market entry through restrictive regulations.

The country reports in this book reflect this analysis and confirm that, generally, a supportive regulatory framework for RE implies priority grid access and some form of FITs for small actors or supportive conditions to participate in auctions where they have substituted FITs. However, while an optimal market design will seek to avoid an oligopoly with concentrated ownership detrimental to competition, a fragmented market with a plenitude of small players driving up transaction costs and impeding governance is not desirable either. Therefore, to demonstrate their potential for scalability and economic efficiency poses an important challenge for RE cooperatives. To meet this challenge successfully, RE cooperatives need to modernise themselves and become compatible with both municipal and commercial investments. This development will be the future touchstone for whether small RE producers can coexist and compete with the large incumbent energy suppliers. Of course, without regulatory support, this task will be more difficult, and therefore it is promising that the European Commission and in particular the European Parliament favour an approach that provides modest preferential conditions for prosumers and local small producers.

7.4 Outlook: RE Cooperatives in the 2018 Renewable Energy Directive

The RED II compromise reached in the June 2018 Trilogue confirms both fair conditions for self-consumption and collective local organisation thereof. Consumers, individually (households and nonenergy SMEs), collectively (tenant electricity) or in communities (cooperatives and other business models), will have the right to consume, store or sell energy generated on their premises across the European Union.

RED II also invites the Member States to provide an "enabling framework" for "renewable energy communities" (regulated in Art. 22 RED II) "on the basis of an assessment of financing, administrative and regulatory barriers as well as discrimination in procedures or charges concerning support schemes, grid interaction and market rules". The implementation process of this framework will be integrated to the national reports and action plans mandated by the governance regulation. Finally, the REDII emphasises in its recitals that "The specific characteristics of local renewable energy communities in terms of size, ownership structure and the number of projects can hamper their competition on equal footing with large—scale players, namely competitors with larger projects or portfolios". Thereby the RED II recognises the possibility of having specific rules for collective models including RE cooperatives and opens the field for possible discrimination since the general principle of equality in EU law states that "similar situations should be treated equally, while dissimilar situations can be treated differently". This is in particular safeguarded by referring to the principle of autonomy, an explicit acknowledgement of the important role that RE cooperatives play today.

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8

The CSOP-Financing Technique: Origins, Legal Concept and Implementation

Jens Lowitzsch

Property ownership is one of the material prerequisites for the development of personal, political and economic freedom. As the German Federal Constitutional Court has ruled: “The guarantee of ownership shall preserve—in the field of property rights—a free sphere for the bearer of fundamental rights, and thus it shall enable the individual to develop and self-responsibly conduct his life” (BVerfGE 1993). This confirms property ownership as a fundamental right, essential to individual freedom as well as to material welfare. Despite this formal acknowledgment of the centrality of property ownership to the individual and society, most of the citizens of industrial countries possess no productive property of any kind. Thus they are denied not only economic opportunity but the opportunity to actively participate in civil society and the opportunity to enjoy security and leisure. All the more, the average citizen has no property rights even in the entities, which provide basic public services such as energy, water and transport.

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8.1 A Low-Threshold Concept Allowing for the Inclusion of Groups So Far Excluded

How are people born without property—the majority in every country—to acquire an ownership stake in the economy's energy structure? The answer lays in new methods of finance, which utilize the future earnings of an enterprise to repay formation or purchase costs instead of past earnings, that is, savings. The Consumer Stock Ownership Plan (CSOP) applies the future savings principle to the financing of new utilities in the energy sector. This technique, invented in the 1950s by the American lawyer and investment banker Louis O. Kelso, is especially applicable to financing public utilities on regulated markets so that they are owned by consumers rather than outside investors; due to guaranteed prices, investments in the sector involve lower risk and thus are easier to finance.

In order to enable people without sufficient financial means to acquire capital and, at the same time, stimulate economic growth, Kelso proposed a range of financial methods enabling access to capital through credit guarantees; the prototype of the "leverage buyout" was born (Kelso 1989). These financial methods were designed for different constituencies—most notably, the Employee Stock Ownership Plan (ESOP) for employees, the CSOP for consumers and the General Stock Ownership Plan (GSOP) for citizens are all based on three main ideas (Ashford 1994):

(1) The allocation of borrowed investment funds sequestered in a special vehicle with its own legal personality, that is, a trust or a similar intermediate company, invested in a business enterprise or equity interest on behalf of the individual plan participants, namely, consumers, employees or citizens
(2) The repayment of the loan from future earnings of the credit-financed shares—the essence of every profitable investment—instead of savings from foregone consumption
(3) The securing of the loan by the investment entity, preferably backed by a state guarantee

8.1.1 Background of CSOP-Financing

The CSOP concept was designed specifically for publicly traded companies, which offer their services on regulated markets with natural monopolies. These are usually firms providing public services. However, CSOPs can also be used to finance public infrastructure projects like water purification and sewage systems (Lowitzsch 2017). CSOP-financing requires, first, the establishment of an appropriate fiduciary fund, possibly under the supervision of a competent authority.[1] Normally, consumers are bound to the utility company through either long-term contractual obligations, for example, electricity, gas, water, telecommunications, or a de facto monopoly, for example, transport. Managed by an independent trustee, using public guarantees, the CSOP fund is permitted to take out a loan in order to acquire shares in an existing utility such as a power plant or invest in a new facility such as biogas reactor, wind turbine or a solar panel. The shares in the acquired productive entity are then allocated to the consumers proportionally to their consumption of the utility product, for example, in the case of a CSOP in the energy sector as reported on their electricity bills. The profits earned by the CSOP shares flow first to the CSOP trust to repay the loan. As the shares are paid for, they are distributed to their new consumer owners who then receive the full dividend yield as consumer-shareholders. They may designate the utility to apply this income to their monthly utility bill, thus creating a closed-loop feedback system linking supply and demand.

As the enterprise in which the CSOP is investing in general operates in a regulated market, where a government-appointed authority sets prices, the repayment risk for both the CSOP and its creditors is low (Gauche 2000). Market and price continuity are virtually assured. In the case of a CSOP in the RE sector, feed-in tariffs provide especially favorable credit terms. Once the investment is repaid off, profits from energy sales become dividends to shareholders. Thus consumer-shareholders now enjoy a second income source as new owners of productive capital. In cases of investment in an existing utility, the advantages of a CSOP include a

[1] Regarding the plan participants the ESOP limited to the employees of the company is narrower while the GSOP involving citizens of a geographical region is wider.

stable anchor shareholder, as well as additional financial resources, which may be used for internal development or for other investments at low transaction costs. Moreover, due to a well-documented positive correlation between financial participation and participation in decision-making (Pendleton and Robinson 2010), the involvement of the consumer-shareholders could contribute to improved corporate governance and sustainable corporate strategy. Fully vested consumer-shareholders, moreover, have voting rights, which they may use to influence corporate policy and to improve the quality of service.

8.1.2 Successful Implementation: Valley Nitrogen Producers, Inc., 1958

Kelso implemented the first CSOP in 1958 in Fresno, California. Local farmers—the main consumers of fertilizer—utilized the CSOP to organize a new corporate entity for the production of anhydrous ammonia, Valley Nitrogen Producers Inc. (Kelso Institute 1976). Several large petro-chemical companies, who also set prices, controlled the fertilizer market at that time. Carl Haas, the founding president of Valley Nitrogen Producers, later explained that he took this initiative because the oil companies had been raising the price of anhydrous ammonia to a level—USD 250 per ton—which he considered exorbitant. He took the problem to business and corporate lawyer, Louis Kelso. Upon learning that Haas himself had no capital to invest, Kelso invented the CSOP and then persuaded the farmers of the Central Valley to become consumer-shareholders of this radically new kind of company.

Framework of the first CSOP—Although not a regulated public utility, Valley Nitrogen Producers Inc. had a utility's main characteristics. Central Valley farmers, as long-term consumers of fertilizer, were bound to their suppliers exactly as consumers of electricity, gas or water are bound to the suppliers of these necessities. As the need is constant, the relationship is secured by mutual dependency. The proposed corporation also met Kelso's other criteria for a CSOP (Kelso Institute 1976):

- The investment subscriptions were proportional to long-term needs for the product.
- The shares' subscriptions were acceptable to the bank.
- Limited corporate income tax.
- Investors contractually committed to buying fertilizer for the maximum period permitted by antitrust laws, in this case, seven years.
- The earnings of capital to be paid out fully and regularly to shareholders after debt amortization and operational costs.

Since the corporation, under tax regulations then in force, qualified as a farmer cooperative, income and dividends were tax-exempt, making the loan even more feasible. Nevertheless, when Kelso applied to the major banks for financing the first CSOP, initially asking for USD 20 million with an additional later installment of USD 100 million, to his amazement, the banks one after the other refused to make the loans. Finally Kelso persuaded the Berkeley Bank of Cooperatives, a cooperative bank, to finance Valley Nitrogen Producers as a cooperative even though it was not conventionally structured.

Implementation of the pilot model CSOP—The CSOP made 4580 farmers instant shareholders of the new fertilizer manufacturer, Valley Nitrogen Producers, Inc., an investment of USD 120 million (which inflation adjusted would equal today about EUR 915 million). Each farmer subscribed to buy the percentage of shares proportional to his fertilizer needs over a period of seven to ten years. He himself made no financial contribution. The CSOP was mainly secured by the bank loan from the Berkley Bank of Cooperatives, which was backed in turn by the farmers' stock subscriptions. In the management board's report on the project nine years after its founding, a sample calculation for a typical shareholder was as follows (Valley Nitrogen Producers Inc. 1969):

- He subscribed shares valued at USD 19,095 and agreed that the dividend yield of these shares would be used to repay the Berkeley Bank of Cooperatives loans over a period of ten years.
- In turn he was entitled to USD 30,271 dividends during the first nine years of the plan.

- Of these dividends, USD 21,131 were paid out, of which USD 16,398 was used to pay down his subscription obligation with a remaining balance of USD 2697 for the last year of the plan.
- The difference between the dividends serving the principal and total payments, that is, USD 4733, was the farmer's interest payments for the loan financing the acquisition of his stock.
- Additionally, the farmer received the remaining portion of his dividends, that is, USD 9139 in the form of credits representing loans granted to the company during the last three years.
- This credit was used for the company's growth and geographical expansion. By 1978 Valley Nitrogen Producers Inc. had already four production facilities in California and one in Arizona, as well as a network of distributors in these two states (Stockton's Port Soundings 1978).
- Moreover, the long monopoly, which the big petro firms had maintained over the fertilizer industry in the Central Valley, was broken. The price of the top-selling fertilizer dropped from USD 250 to USD 66 per ton (Kelso Institute 1976).
- Even with this drastic price reduction, Valley Nitrogen Producers Inc. quickly became debt-free and profitable.

Dissemination of Kelso's financing techniques—The Valley Nitrogen CSOP not only created significant assets for 4580 farmer-shareholders, but according to estimates of the Kelso Institute, it also saved California farmers more than one billion dollars in fertilizer costs over a 15-year period, when fertilizer prices began to rise worldwide. The first CSOP was a great success—for the company, for its farmer-consumer-shareholders and for consumers in general—despite the fact that conditions were less than optimal. Unlike a utility, the company had to operate on an unregulated market. Today Kelso's best-known financing technique, the ESOP, is an integral part of corporate America. At the end of 2016, there were 6717 ESOP and 2898 ESOP-like plans in the USA, with about 14 million employees participating, that is, 13 percent of private sector employees holding around USD 1.3 trillion in assets (NCEO n.d.). The overwhelming majority of ESOPs are found in unlisted private companies (firms whose shares are not traded on public stock exchanges); in about 4500 companies, employees are majority owners, and in about 3500, the ESOP holds 100 percent of the employer company's shares (ESOP Association n.d.). However, the Valley Nitrogen CSOP remained the only practical example of a classical CSOP implemented by Kelso.

8.2 Implementation of Renewable Energy CSOPs Today: The German Example

The CSOP was designed for regulated markets with guaranteed prices, regulated market access and long-term relationships between producer and consumer. Therefore the energy market is predetermined. A CSOP is particularly suitable for a RE plant, for example, a biogas reactor, a solar panel plant, a wind turbine or a geothermic drill, as the investment cost is relatively small. Implementation in large conglomerates would be more complicated. Not only would the investment cost be much larger, but the resistance of competitors, usually big quasi-monopoly energy companies, might be difficult to overcome. Moreover, while decentralization of energy production is a major trend across the EU member states, the CSOP could help achieve this goal in the RE sector, as it is naturally composed of small energy-producing units. By utilizing CSOPs regionally organized consumer associations could become energy producers. But residential communities could also initiate the construction of a power plant by means of this technique. Adequately financed, CSOPs are also suitable for larger projects. In the following, Germany as a pioneer of the energy transition is used as an example to illustrate the potential implementation of a renewable energy CSOP (Lowitzsch and Goebel 2013).

8.2.1 Factors for a Successful Implementation

The key element for successfully implementing an Energy CSOP is the active involvement of the beneficiary-consumers—in case of the investment in an existing utility together with professional energy producers—on the one hand and that of the commercial banks financing the project on the other. Therefore, the participation of local and regional bodies, such as municipalities, communities or public institutions, acting as an intermediary between the CSOP investment and participating consumers and, if necessary, their representatives, is recommended. As for loan terms, it would be advisable to link the CSOP with an appropriate state support program, so as to provide banks, enterprises and consumers with institutional support for a concept still in its introductory phase. Political support and, if possible, tax concessions are desirable but not essential. Constituent contracts (statute, partnership agreement, etc.) stipulate the rights and obligations of the consumer-shareholders including provisions pertaining to purchase and sale of shares or termination of participation either through death or relocation; under either circumstance, CSOP participants should be obliged to sell their shares back to the CSOP trust. In order to prevent capital depletion, installment payments over a period of time would be appropriate. Consumer-shareholders' rights in the decision-making process are contingent on the number of shares owned. As a rule, a knowledgeable person capable of protecting their interests should represent shareholders.

Although the CSOP has many obvious advantages, some difficulties in its implementation have to be reckoned with. The first hurdle is potential opposition by major energy companies seeking to retain their monopoly control of the market. Although decentralization of energy production is a trend in current energy policy, the lobbyists of the big energy companies often pressure governments. In the case of larger CSOPs, it might be politically expedient to offer such companies an opportunity to participate. This might take the form of a credit guarantee to the CSOP similar to that made in the case of a company subsidiary or perhaps an investment in or a joint venture with the CSOP. Consumers, moreover, are a heterogeneous group. Public relations events together with an information campaign, which explains the purpose of the CSOP and how it works, can help to resolve the problem of innovation. Since education can be conducted through existing organizations and networks, these costs of CSOP implementation are comparable with those of conventional investments.

8.2.2 Legal Aspects of the Corporate Structure of CSOP-Financing and Taxation

The aim of the contractual model of the CSOP is above all to facilitate the application for a bank loan and to limit the liability of individual consumer-shareholders to no more than the value of their shares. Other important issues are easy tradability of the shares deferral of taxation of profits for the consumer-shareholders and pooling of voting rights. In the German CSOP model, the legal form of the intermediary entity, which administers the CSOP shares until their earnings have repaid the initial loan, is derived from the Anglo-American Common Law trust (Lowitzsch et al. 2012). In the absence of genuine trust legislation, this leads to a two-tier structure (see Fig. 8.1),[2] that is, a trust limited liability company (Trust-LLC) setting up a operating limited liability company (Operating LLC):

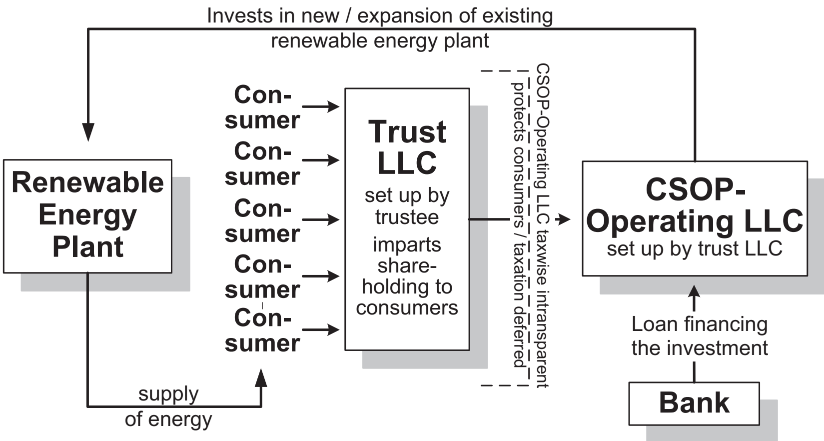

Fig. 8.1 Corporate structure of the German CSOP

[2] This structure is generally appropriate for countries without Common Law tradition.

– A trustee founds the Trust-LLC (with a nominal capital of EUR 25,000), while the consumers enter into a trust agreement and as trustors pay a capital contribution.
– The capital contribution similar to an "entrance ticket" (in our example EUR 250 per 50 families, i.e., EUR 12,500)[3] is used as initial capital for the Trust-LLC founded by the trustee.
– The Trust-LLC in turn sets up the CSOP-Vehicle, that is, the CSOP-Operating LLC, as a 100 percent daughter company.
– Subsequently the CSOP-Operating LLC takes on the loan to invest in the new RE plant or to purchase shares of an existing one.

Facilitating shareholding of individual consumers under company law—To ensure easy tradability of the shares while avoiding transaction costs,[4] the CSOP-Vehicle's shareholding is facilitated through a trust company. Thus, consumer shareholding in the CSOP-Vehicle is "brokered" by a limited liability company (Trust-LLC); a trust agreement between the consumers and the Trust-LLC is sufficient to render consumer shares easily transferable[5]: It is the Trust-LLC which—entering into a trust agreement with the consumer-trustors—now holds the shares of the CSOP-Vehicle on behalf of them. In the event of a change of the consumer-shareholder, the buyer or heir simply steps into the trust agreement in lieu of the former trustor. Indirect share ownership using a separate intermediary entity, which manages the shares held in trust for the consumers and pools the voting rights executed by the trustee, has the additional advantage of a certain "professionalization" of management. Participation in decision-making in the energy utility is channeled

[3] Of the initial capital of EUR 25,000, only 50 percent, that is, EUR 12,500, actually need to be actually paid down.

[4] Direct shareholding in German limited liability companies has the disadvantage that the transfer of shareholders' positions follows a formal procedure, that is, a notary's acknowledgment of execution, which in turn increases transaction cost for the tradability of the shares.

[5] This structure is a standard solution in Germany tested many times by so-called public companies ("Publikumsgesellschaften") in real estate investments, who face a similar problem: A very large number of investors is intended to participate in the equity of a company where every change in ownership, whether it be due to death, sale of shares or seizure, has to be signed into the commercial register following the relevant formal procedures.

through the trustee while individual consumer-shareholders may execute control rights on a supervisory board or an advisory council.

8.2.3 Taxation of the CSOP and Its Consumer-Shareholders

Deferred taxation for consumer-shareholders—Under German tax law, the Trust-LLC is treated "transparent", that is, the shares of the CSOP-Operating LLC remain ownership of the consumer-shareholders, since they continue to be the beneficial owners of the CSOP-Operating LLC (§ 39 Abs. 2 Nr. 1 S. 2 AO). However, the standard trusteeship agreement stipulates that the consumer-shareholders cannot dispose of the shares held in trust until they are paid for and until they decide to leave the CSOP; such deferred taxation of the appreciation of their investment is guaranteed as taxation occurs not until the moment of being actually able to economically dispose thereof. In this way the parallel structure of the Trust-LLC holding the shares of the CSOP-Operating LLC ensures that only dividends paid out are taxed at the level of the consumer-shareholders, while the value of the appreciation of their shares is not taxed until they exit the plan.

Tax treatment of profits at the level of the CSOP-Operating LLC—The Operating LLC, being taxwise not transparent, shelters the consumer-shareholders with regard to profits at the level of the CSOP-Operating LLC: (1) The transaction is financed by bank loans with—if possible—preferred interest rates given by state development banks (IKB/KfW/EIB), for example, in the context of programs that specifically promote RE; (2) due to the financing cost of the leveraged investment, the CSOP-Operating LLC as a rule will make losses or in the best case very small profits throughout the first years; (3) pro rata profits/losses are either directly allocated to the CSOP-Operating LLC as sole shareholder in the case that it invests in a new facility or indirectly through dividend payments/depreciation of shares when investing in an existing incorporated utility. As the CSOP-Operating LLC normally will be an investment in a corporation, 5 percent of the dividends are taxed as corporate spending, while all refinancing costs are deductible as corporate expenses, which results in 95 percent of paid-out dividends being tax-free at the level of the CSOP-Operating LLC (§§ 8b I and § 8b V of the German Corporate Tax Code apply). Such in both cases taxation of profits incurs only once at the level of the intermediary entity, that is, that of the CSOP-Operating LLC.

Tax treatment of the financing cost—In the case of RE projects with a comparable small investment, volume buying into an existing utility will be the exception; thus as a rule a project vehicle is set up and capitalized, in our case the CSOP-Operating LLC. With regard to leveraging this CSOP investment through capital credit, it is important that the bank loan is taken directly at the level of the CSOP-Operating LLC to install, for example, a wind turbine and that it is the CSOP-Operating LLC that repays the loan from its profits. Paying out profits to the Trust-LLC and thus to plan participants incurs only once the bank loan is repaid. As the CSOP-Operating LLC itself builds and runs the newly installed facility and profits/losses incur directly with the CSOP-Operating LLC, both deduction of interest payments and depreciations and carry forward of losses can be used to lower the tax burden increase liquidity and thus accelerate principal payments.

When the CSOP-Operating LLC makes a leveraged investment in an existing incorporated utility, the treatment of interest payments is less advantageous. They incur at the level of the CSOP-Operating LLC but not at that of the utility where they would lower the tax burden and would generate liquidity to repay principal. As a rule the CSOP-Operating LLC will make losses or—if at all—very small profits throughout the first years as the deductible financing cost (interest on the bank loan) is not met by any taxable income. Of course, the CSOP-Operating LLC must serve both interest and principal of the bank loan and thus generate more income than necessary to cover the cost of financing (otherwise it could never repay the loan), but CSOP dividends are as mentioned above not taxed with the exception of 5 percent.[6]

[6] Thus double taxation in general is avoided, and the CSOP-Operating LLC generates a tax shield for the consumer-shareholders, which, however, has only limited benefits here. Nevertheless, the benefits of the first scenario, that is, to accelerate principal payments, can be achieved by a debt pushdown through a merger of the CSOP-Operating LLC with the target utility.

8.2.4 Conditions for Implementation

Economic and political conditions—The German RE sector is the worldwide leader in the installed solar power capacity and on the second place with regard to the wind power.[7] In 2016 around 42 percent of the plants belonged to private persons (31.5 percent private individuals, 11 percent farmers), 14.4 percent of them were in the hands of project planers, 13.4 percent of funds and banks and 13.4 percent of commercial enterprises; only 5.4 percent belonged to the "big four" energy suppliers (E.ON, RWE, EnBW and Vattenfall), 10.3 percent to both regional and international energy suppliers and 1 percent to others (trend:research and Leuphana Universität Lüneburg 2017). A strive to decentralize the energy supplies constitutes perfect conditions for the CSOP, as its implementation is in smaller investments easier and more efficient. In contrast to conventional energy resources, RE production is based on small power plants, for which the CSOP-financing is particularly suitable. The parallel development of technology for storage and power grid, such as "smart grids" and "virtual power plants", ensures more effective and profitable energy production from such investments. In view of the German government's objective to increase the share of RES in the final consumption to 60 percent by 2050 and the share of renewable in the electricity production to 35 percent by 2020 and 80 percent by 2050,[8] this trend will definitely continue.

Funding options—To structure the loan necessary for CSOP implementation, the following sources (in various financing variants) are available:

– European programs promoting energy policy, such as the Program Connecting Europe Facility (focus on energy infrastructure), European Energy Efficiency Fund (EEF) and others

[7] "Aktuelle Daten und Fakten—Erneuerbare Energien", http://www.unendlich-viel-energie.de/de/wirtschaftlaktuelle-daten-und-fakten.html, [login 3.04.2013].

[8] "Erneuerbare Energien—ein neues Zeitalter hat begonnen", http://www.bundesregierung.de/Webs/Breg/DE/Themen/Energiekonzept/Energieversorgung/ErneuerbareEnergien-Zeitalter/_node.html, [login 3.04.2013].

- EU programs to support SMEs, for example, the Competitiveness of Enterprises and Small and Medium-sized Enterprises (SMEs) running from 2014 to 2020 (COSME)
- Funds from EU regional policy (the Structural Funds and the Cohesion Fund)
- Financial assets from the European Investment Bank (EIB) or the European Bank for Reconstruction and Development (EBRD)
- German federal and states government's development programs, such as KfW program "Renewable Energy Standard" ("Erneuerbare Energien Standard", No. 270)
- The previously mentioned in combination with private investments

Phasing of the CSOP investment—Against this background, the CSOP-financing of a RE plant has the following steps (see Fig. 8.2):

- Setting up of a trust vehicle (here a fiduciary LLC) administrating the consumers' accounts; share capital is contributed by the participating households.

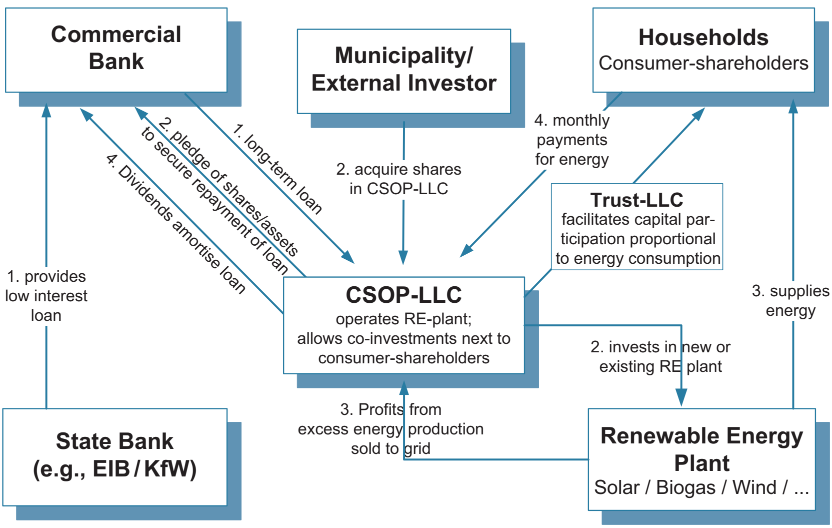

Fig. 8.2 Financing of a RE facility through a Consumer Stock Ownership Plan

– Completion of trust agreements (trustee/consumers) defining the value of their share in the CSOP corresponding to the energy consumption of each household.
– Setting up of an intermediary entity, the CSOP-Operating LLC (100 percent daughter of the fiduciary LLC), which invests in an existing or a new energy plant.
– Completion of supply agreements between consumers and the CSOP-Operating LLC, designed according to standard energy contracts with the usual conditions.
– The CSOP-Operating LLC applies for a bank loan (here to KfW) and provides collateral to secure the loan.
– Repayment of loan: Interest and principal are serviced by revenues from the sale of the power plant's surplus energy production and each household's monthly payments for energy.
– After the repayment of the capital acquisition loan, profits from the power plant are paid to the consumer-shareholders as dividends in proportion to the amount of their shares.

8.3 Overview of the Advantages of the Renewable Energy CSOP

Decentralization of energy production enhances in particular energy security, efficiency and stability of deliveries, all aims the CSOP potentially contributes to. The diversification of energy resources amplifies this effect, and such further improves national energy security. Moreover a growing share of RES in energy consumption reduces dependency on energy imports from other countries. Finally, competitiveness among energy companies improves, positively influencing the development of the whole energy sector. Finally, the technological development in RE has a potential to reduce electricity costs (Mühlenhoff 2011) and to improve energy efficiency of power plants. However, this potential can only be harnessed with the involvement of citizens. Today, both the new installation of RE plants—especially in the case of wind power—and the expansion of the energy grid, a prerequisite to increase the share of renewables due to their volatility, are still hampered by a general lack of public acceptance of infrastructure projects (Puka and Szulecki 2014). In particular with regard to new grids, the burden of the investment is to a large part transferred to the consumers who will pay for the grids through tariffs exacerbating the problem of societal acceptance (Kogdenko 2013). In this regard the CSOP can contribute to increase acceptance by turning CSOP participants into (co-)owners with a vested interest in local energy facilities and a solid grid.

As the consumer-shareholder's additional income will most likely be spent in their place of residence for consumption purposes, positive impulses for the economic growth of the region can be expected. Thus at the regional level, above all, the regional economy and indirectly the whole community benefit from the CSOP. Furthermore, access to the acquisition of productive capital through the CSOP provides citizens with the opportunity of asset formation. Such a wider distribution of productive property among citizens has a long-term positive impact on growth, stability and international competitiveness of the economy. Finally, the RE sector in Germany already in 2013 employed more than 380,000 people (Röttgen 2013). Such an implementation of CSOPs and thereby the expansion of RE installations create new jobs.

8.3.1 Involving Citizens in Local RES Projects with the Option to Include Municipalities and Commercial Investors

The CSOP is explicitly aimed at involving citizens in local RE projects with the option to include municipalities and commercial investors—The "local" reference is not determined by the business model per se but by its design; rooting the CSOP in the local community will increase acceptance of RE projects as the concept is open to all citizens independent of their income. Instead of being solely profit-oriented as, for example, bonds or silent partnerships, it is precisely the ownership-oriented participatory approach also in decision-making that distinguishes the CSOP from conventional investment models.[9] This approach facilitates

[9] However, even some energy cooperatives lack the local reference, an example in Germany being Greenpeace Energy, where 110,715 electricity customers, 9280 gas customers and 22,841 members are involved.

the involvement of municipalities as a pacemaker of the energy transition. Other than bringing together the interests of local citizens, this is an important prerequisite for preferential conditions when participating in auctions for which the new EEG 2017 now requires a minimum of 10 percent participation of municipalities.[10] With regard to cooperatives, for example, the necessity of representation on management and supervisory bodies has been reported an obstacle as coop law does not acknowledge a right of delegation familiar to legislation on joint stock companies. This is of particular importance with regard to public procurement law and the possibility of in-house arrangements (Teckal criteria of the ECJ).

The (optional) inclusion of minority or majority stakes of commercial investors in itself is nothing new, as citizen's energy models in the wind sector in the legal form of a limited partnership often collaborate with professional partners. Depending on the underlying technology, it may be very useful to include professional operators, as operation and maintenance of infrastructure can be very complex; this concerns wind energy and especially bioenergy (Holstenkamp et al. 2017).

8.3.2 Modernizing and Extending the Cooperative Model

The cooperative model has been around since the nineteenth century and can be extended and modernized as a business and organizational model to meet the challenges in the RE sector (Herbes et al. 2017). In contrast to cooperatives, the CSOP allows the involvement of strategic partners and public authorities, for example, local municipalities. Furthermore, it avoids obstacles related to the principle that the members of the management consist of cooperative members and to the question of representation of municipalities on the board (see Chap. 7). Of course, members of an energy cooperative itself can participate in a CSOP when expanding an existing facility together with strategic partners. Regarding the exercise of

[10] In particular municipal law typically stipulates four main prerequisites for participation of municipalities in RE projects, that is, public purpose, capacities for the investment, subsidiarity and appropriate representation.

the consumer's voting rights, the CSOP offers flexibility. The articles of partnership may stipulate which subjects are to be deliberated either by the trustee or by CSOP members. As a rule the CSOP will hold more than 50 percent of the shares in the ltd. operating the RE facility and thus will have control. Finally, as mentioned the CSOP business model has particular features and advantages (leveraged financing), which enable the participation of groups that are neglected so far.

At the same time, the CSOPs can enable consumers of energy utilities without savings or access to capital credit to acquire productive property of RE plants. At the microlevel all actors benefit from the CSOP, that is, consumers and their local community as well as energy companies, should they be involved. While the monthly payments of the consumer-shareholders for their energy bill are initially used to service the acquisition loan, they cease to be necessary once that loan is repaid. By then the consumers have become (co-)owners of the power plant which covers their future electricity consumption. From now on the proceeds from the sale of the surplus energy production to the grid provide CSOP shareholders with an additional income from ownership of productive capital. Furthermore, as shareholders consumers influence the corporate governance of the utility and thus have the possibility to actively influence their nearest environment. If an energy company is involved, it can benefit from external capital for investment at relatively low cost and the loyalty of its consumer-shareholders.

8.3.3 Advantages in Administration and Delineation to Other Existing Models on the "Grey Market"

The administration of the shares by a trustee (ltd) while avoiding personal liability of participating citizens also allows a minimization of transaction costs and more flexibility with regard to (1) share transfers (notarial documentation but no registration in the Register of Commerce), (2) share distribution (allocated according to the consumption of each CSOP participant) and (3) tax liability esp. for low-income households providing for deferred taxation of the benefit. As regards the financing technique, consumer ownership conveyed by a CSOP does not qualify for the "grey market" and is therefore not covered by the regulations of the new capital investment legislation. It is a form of investment, where the CSOP will only invest in one local project and then—in contrast to investment funds—operates the RE plant on its own and is therefore operationally active outside of the financial sector. Therefore, for example, the German Capital Investment Law does not apply; neither is the German Asset Investment Law applicable to CSOPs as the latter is not a public offer with regard to the restricted group of persons targeted—that is, the particularity of the energy consumers living in the location the energy plant is to be operated in. In contrast to the YieldCo model, the shares are not tradable in the financial markets. Furthermore, the CSOP ltd. holds at least 50 percent of the energy plant shares, which she administrates effectively.

8.4 Outlook: The 2018 Renewable Energy Directive as a EU-Wide Legal Basis for CSOPs

The Renewable Energy Directive II compromise reached in June 2018 confirms both fair conditions for self-consumption and collective local organization thereof. It not only introduces a "right to prosume" and the right to market generated energy directly (Art. 21 RED II) but a framework to facilitate "renewable energy communities" (Art. 22 RED II). RED II will provide an EU-wide legal framework for CSOPs as contractual arrangements that allow pooling and scaling of RE investments (co-) owned by consumers while opening them up to various combinations of municipal or commercial investment, especially by SMEs. And indeed, the newly introduced "renewable energy communities" (regulated in Art. 22 RED II) require that local shareholders or members, that is, "natural persons, local authorities, including municipalities, or SMEs", control them as defined in Art. 2 of RED II. This necessitates a multipurpose corporate vehicle like the CSOP allowing joint investments by the agents mentioned.

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9

The Life Cycle of a CSOP Investment: Sample Calculation for a German Wind Turbine

Carsten Croonenbroeck and Pasqual Slevec

Please note that the following sample calculations are based on the German Renewable Energy (RE) Act before the 2017 reform. This reform ushered the transition from a plain feed-in tariff (FIT) system to a tendering-based scheme. The main differences with regard to projects of a size that now fall under a tender scheme, as the example for the wind turbine below, are twofold: (1) investors interested in a project now need to bid for the contract, that is, they offer to implement the project based on an individually agreed FIT—the bids are those tariffs. Thus, the lowest bidder wins the procurement contract and later operates on the agreed FIT. (2) Winners are no longer allowed to self-use the produced energy—all produced electricity has to be fed into the electricity system. While this contradicts the prosumer idea, for the sample calculations, both differences are unimportant: Firstly, instead of referring to the FIT as

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stipulated by in the RE Act, the FIT that was determined in the tender applies. Secondly, Consumer Stock Ownership plans (CSOPs) in the renewable ernergy (RE) sector are now lucrative if and only if the investors decide to sell the entire energy production. However, this has been the assumption of many simulated RE-CSOP implementations before; the following model calculations will illustrate why. Nonetheless, it should be noted that this circumstance is a specific feature of the recent German RE policy, not having universal validity for other countries, either in the EU or worldwide. Therefore, we use the regulatory conditions prior to the 2017 reform in Germany to illustrate the life cycle of a CSOP under a conventional FIT system as they are still in place in many other countries.

9.1 Investment Volume and Financing Requirements

When calculating the profitability of a power plant in Germany, it has to be taken into account that:

- Installed standard power plants as a rule have a capacity of at least 800 kW.
- The necessary installation costs[1] currently amount to about EUR 1000 per kW, resulting in a total investment of at least EUR 800,000.
- Priority of the CSOP-financing is a fast repayment of the bank loan.

Following Croonenbroeck (2016) and Croonenbroeck and Slevec (2016), we assume that 1000 two-person households participate with an annual total electricity consumption of all participants of 3,140,000 kWh, as an average German two-person household consumes 3140 kWh of electricity per year (co2online 2015). The location of the town under investigation may vary: There are locations in Germany at which the wind power potential is outstanding requiring a strong wind turbine to

[1] These are wind turbine, foundations, transport, transfer station, connection to the grid, accessibility, planning, tax and legal advices, as well as all unforeseen costs.

Table 9.1 Description of the turbine scenarios

Scenario	Rated power	Hub height	Rotor aperture	Reference yield	Full load hours
Vestas V90	2000 kW	95 m	90 m	29,868,622 kWh	2200 h
Vestas V112	3000 kW	119 m	112 m	48,817,688 kWh	2750 h

be installed; for our scenario, we select a Vestas V90 2.0 MW-type turbine. If the setting is only a weak-wind scenario, the selected turbine type is a Vestas V112 3.0 MW. Table 9.1 presents the selected scenarios, including expected full load hours (Fürstenwerth et al. 2013) and reference yield as provided by the German EEG (2014) [Erneuerbare-Energien-Gesetz, German Renewable Energy Act] in its version from 2014.

The strong wind turbine (V90) is smaller and cheaper. The turbine itself costs about EUR 2,000,000, but together with costs for planning, allotment, grid connection, baseplate and others, we calculate installation costs of EUR 2,768,000. Operational costs for the turbine consist of maintenance and repairs, lease of land, insurance, business operation, capital surplus and others, and sum up to EUR 106,040 per year during the first ten years. As we assume higher costs for maintenance after ten years, we calculate operational costs of EUR 117,920 per year after the first ten years of operation. The weak-wind turbine (V112) is larger and more expensive but is capable of providing a good energy harvest even on suboptimal wind conditions. It costs EUR 3,450,000, and its installation costs sum up to EUR 4,572,000. Operational costs are calculated to be EUR 198,825 in the first ten years of operation and EUR 221,100 afterwards (all values are expert estimations based on Wallasch et al. 2013).

Together with the rated power of the turbine, the full load hours determine the energy output and, therefore, the earnings of the project. In principle the CSOP earnings are split into two components: One part of the energy output can be sold to the participants at EUR 0.0839 per kWh (Doerr and Lange 2012) or at higher prices, due to the financing scheme (see below). The residual energy is fed into the grid and gets merchandized. For the feed-in, a minimum starting value of EUR 0.089 per kWh was guaranteed by the EEG 2014 during the first five years of

Table 9.2 Description of the economic climate scenarios

Scenario	Inflation rate	Nominal base rate
Crisis	1%	3%
Non-crisis	3%	6%

operation. Depending on the actual wind conditions (in comparison to the reference yield of the turbine), this guarantee will either stand after the first five years, or it will be reduced to the base value of EUR 0.0495 per kWh (§ 49 I and II EEG 2014).

As for the economic climate, we assume a crisis and a non-crisis scenario. In a crisis scenario, we set the inflation rate to 1 per cent and the nominal base rate to 3 per cent. In a non-crisis scenario, we assume an inflation rate of 3 per cent and a base rate of 6 per cent summarized in Table 9.2. For the roll-out scenarios, finally, we assume a normal speed scenario and a quick scenario. The scenarios discriminate between (a) yearly average annex and (b) average degression of EEG compensation. The normal scenario assumes an average yearly annex of 2400 to 2600 MW and an average degression of 0.4 per cent, while the quick scenario is at a yearly annex of 2900 to 3100 MW and a degression of 0.8 per cent (§ 29 I EEG 2014); Table 9.3 provides an overview.

To sum up, Table 9.4 provides unique and distinct labels for all of our eight scenarios. For each of them, a set of economic indicators is to be evaluated.

9.2 Indicators and Assumptions

We assume that once the wind scenario for the location at hand is determined and the decision for one of the two types of turbines is made, the turbine is installed in the year of 2015. Thus, we can consider the subsidy conditions for that year, as given by the EEG 2014. As for the CSOP structure, the necessary holding is set up. Since we assume that the citizens at a local village or town jointly form the CSOP, these citizens formerly bought electricity from their utility. As the turbine produces electricity, these citizens now consume the electricity from their turbine. As the turbine produces more electricity than consumed by the citizens,

Table 9.3 Description of the roll-out scenarios

Scenario	Yearly average annex	Average degression of EEG compensation
Normal	2400 to 2600 MW	0.4%
Quick	2900 to 3100 MW	0.8%
Scenario	Yearly average annex	Average degression of EEG compensation
Normal	2400 to 2600 MW	0.4%
Quick	2900 to 3100 MW	0.8%
Scenario	Yearly average annex	Average degression of EEG compensation
Normal	2400 to 2600 MW	0.4%
Quick	2900 to 3100 MW	0.8%
Scenario	Yearly average annex	Average degression of EEG compensation
Normal	2400 to 2600 MW	0.4%
Quick	2900 to 3100 MW	0.8%

Table 9.4 All scenarios combined

Scenario	Vestas V90	Vestas V112
Crisis, normal roll-out speed	1.1a	1.1b
Crisis, quicker roll-out speed	1.2a	1.2b
Non-crisis, normal roll-out speed	2.1a	2.1b
Non-crisis, quicker roll-out speed	2.2a	2.2b

the surplus is fed into the grid and is repaid by the utility.[2] At times where the citizens consume electricity and the local turbine does not generate (enough) power to cover the consumption, the remaining electricity gap is bought in addition from the utility.

Each participating household pays a small amount of money in order to participate (entrance fee). In addition, during amortization time, all households continue to pay their former electricity prices as if still bought from the utility. As the electricity their own turbine produces is much cheaper, the difference between actual costs and payments is used to repay the loan, in addition to cash flows generated by the FIT. Once the loan is paid off, participants can switch to paying the electricity production costs only and participate in the FIT, so in general, they may generate profits instead of paying. The entrance fee of each household depends on the equity ratio. The German KfW (Kreditanstalt für Wiederaufbau,

[2] In Germany, the utility is obligated by the law to buy the electricity and to pay for it, as determined by § 49 I and II, EEG 2014.

Development Loan Corporation) has a programme setup called "Renewable Energy Standard (no. 270)" at which renewable energy investments are supported. It provides earmarked funds at low interest rates (3 per cent of nominal interest rate in 2014).[3] Since the KfW programme requires a considerable equity ratio, we target at an equity ratio of 22 per cent, such that the amount of money each participant has to pay is calculated by

$$EF = \frac{TIC \cdot 0.22}{NOP},$$

where *EF* refers to the entrance fee, *TIC* is the total installation costs (dependent on the turbine type) and *NOP* is the number of participants. Considering 1000 participants, for the V90 (at which *TIC* = EUR 2,768,000), *EF* = EUR 608.96. For the V112, *TIC* = EUR 4,572,000, such that *EF* = EUR 1005.84, provided that the yearly energy output of the V112 is greater than the energy consumption of 1000 households. If not, it could be conceivable to increase the total number of participants in order to reduce the individual EF. To sum up, the questions at hand, as seen from a potential investor's point of view, are (1) amortization time, (2) free cash flow and, of course, (3) the time structure of repayment and return. Since we consider an operation time of 20 years for the turbine, the investment project ends in 2035.

9.3 Results

The renewable energy investment is redeemed within the turbine's operation time in all considered scenarios. Not surprisingly, investing into the larger (and more expensive) V112 results in longer times of amortization, especially during non-crisis times and at quicker roll-out speeds. Scenario 2.2b (V112, non-crisis and quick roll-out) is the only one that tends to being critical, showing an amortization time of 13 years. Figure 9.1 visualizes the amortization times for all scenarios.

[3] Additional information is available at KfW (n.d.).

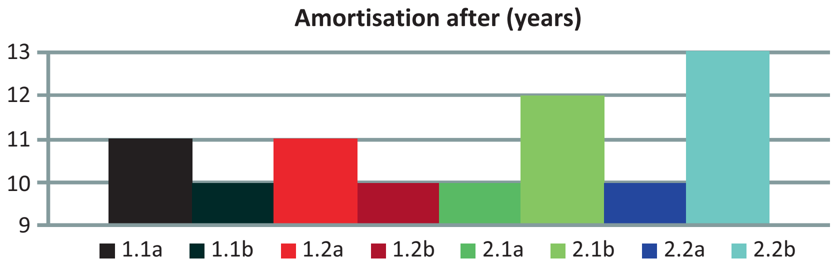

Fig. 9.1 Amortization time

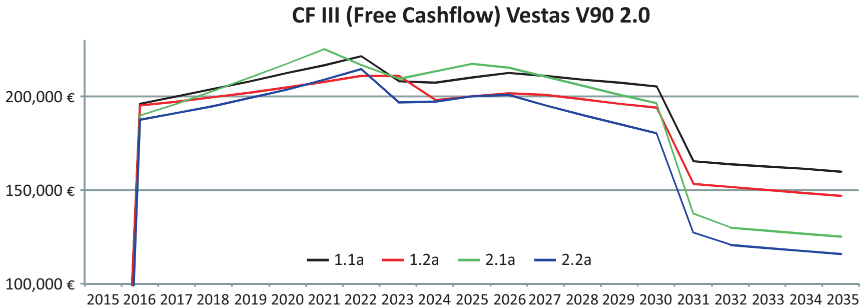

Fig. 9.2 Discounted free cash flow V90

Figure 9.2 shows the time-dependent structure of discounted free cash flow for the V90 projects, while Fig. 9.3 presents the development for the V112 projects. Caused by the great loan amount and its consequential heavy interest of borrowed capital, in the non-crisis scenarios, the free cash flows are much lower during the amortization time for the V112 projects. In scenario 2.2b, this effect is intensified once more due to the strong degression of the FITs. Thereby, the impact on interest constitutes the main reason for the longer amortization time of the scenarios 2.1b and 2.2b. This impact is so profound that in the non-crisis and quick roll-out speed scenario, the total revenue of the lower investment into a V90 is higher than the revenue of the more powerful V112. Generally, the cash flows increase during the first years due to the diminishing interest amount of borrowed capital.

The development of the tax burden is shown in the upper panel of Fig. 9.4, while the lower panels show the average values. Between the years 2020 and 2023, the first curve buckle represents an enhanced tax

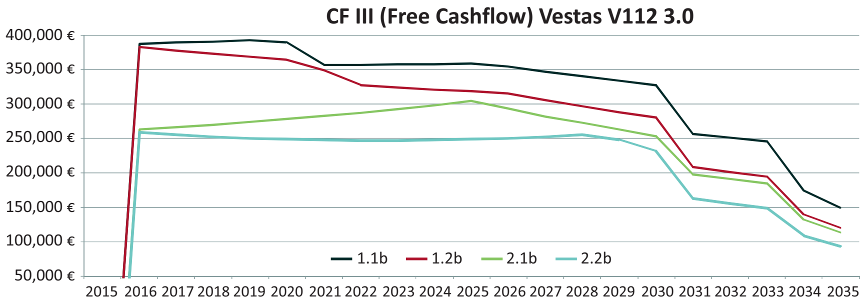

Fig. 9.3 Discounted free cash flow V112

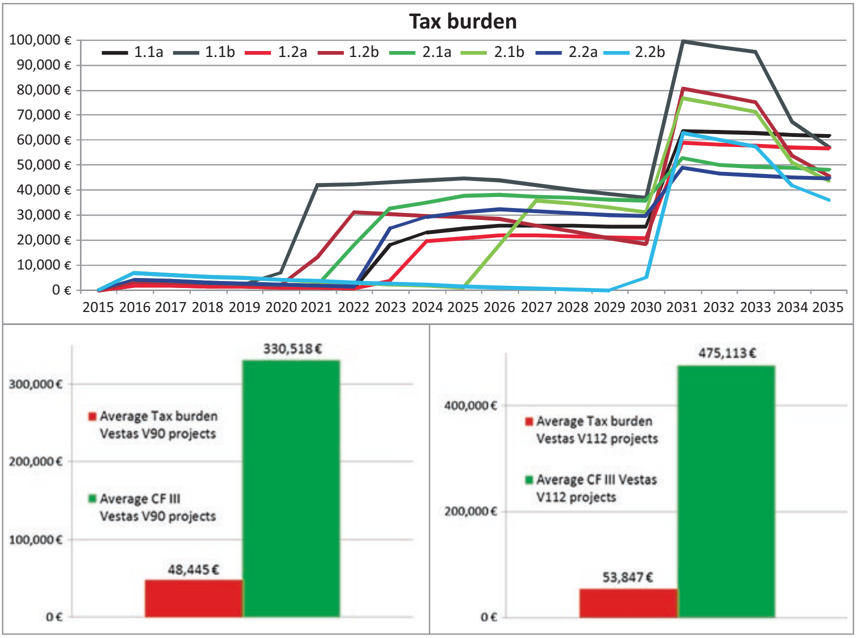

Fig. 9.4 Average tax burden and free cash flow (CF III), V90 and V112 projects

burden because of the exhaustion of the accumulated deficit, which was generated by the high interest payments. The second curve buckle in 2031 mirrors the end of the depreciation time and a repeated increase of tax burden. The last curve buckles (which are only seen in the V112 scenarios) are caused by the assumed local conditions: In 2034, the subsidy of high FITs ends and is replaced by lower FITs (§ 49 I and II EEG 2014). In 2035, the free cash flow will continue to decrease: The high FIT will be replaced by the lower one, entirely. In the following years, the cash flows would stand, but this is not relevant in our time frame.

In Fig. 9.5 we show the repayments and return structure. Again, as can be seen, most projects are fully repaid after around ten years. After that, significant returns are generated.

To provide a more detailed insight, we summarize the investment plan for the example 1.1b (V112, crisis, normal roll-out speed):

Total loan amount	EUR 3,676,454.00
Sum of interests (borrowed capital)	EUR 677,596.00
Brought equity per household	EUR 1005.84
Return after 20 years (total)	EUR 2,488,636.00
Return after 20 years (per household)	EUR 2489.00

After all, the discounted yield per household amounts to

$$2489 = 1005.84 \cdot (1+i)^{20} \Leftrightarrow i = 4.63\%,$$

where i denotes the internal rate of return (IRR). Tables 9.5 and 9.6 show the IRRs for all scenarios. In all cases, the IRR is positive. Depending on the crisis/non-crisis scenarios, the nominal IRRs are greater than the

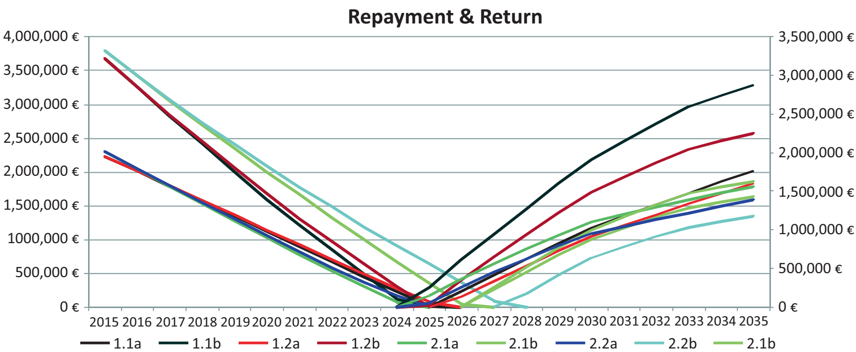

Fig. 9.5 Repayments (left scale) and returns (right scale)

Table 9.5 Internal rates of return, Vestas V90

1.1a	1.2a	2.1a	2.2a
4.76%	4.04%	6.63%	5.81%

Table 9.6 Internal rates of return, Vestas V112

1.1b	1.2b	2.1b	2.2b
4.63%	2.78%	3.31%	0.47%

inflation rates, except for scenario 2.2b, that is V112, non-crisis, quick roll-out speed. Seen that way, all projects return a positive real IRR, except for 2.2b (V112, non-crisis, quick roll-out speed). Other ratios support the results: The leverage costs of energy (LCOE) of all scenarios reside within a range between EUR 0.059 and EUR 0.075 per kWh.

As Kost et al. (2013) point out, LCOE are considered to be competitive below EUR 0.073 per kWh. Figure 9.6 shows that scenario 2.2b does not satisfy this value. Finally, the net present values (NPVs) of the projects verify the predicated statements; see Fig. 9.7. The NPV is the sum of all discounted cash flows which are triggered by the investment. It indicates that the scenarios with low inflation rates possess better conditions for implementing a CSOP-financed project. Again, we advise against an implementation of a Vestas V112 under the conditions of scenario 2.2b.

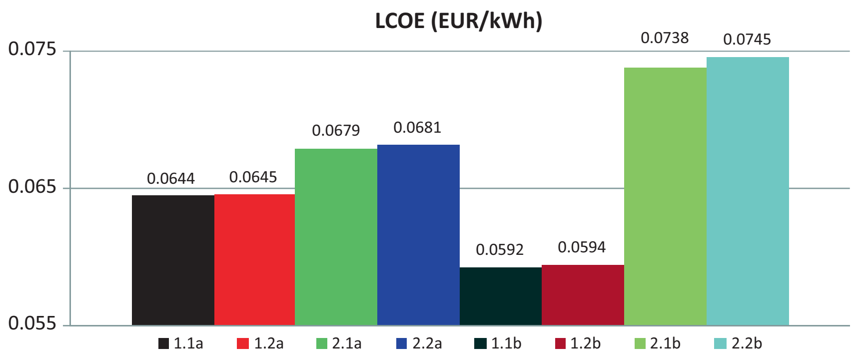

Fig. 9.6 Leverage costs of energy (LCOE) for all projects

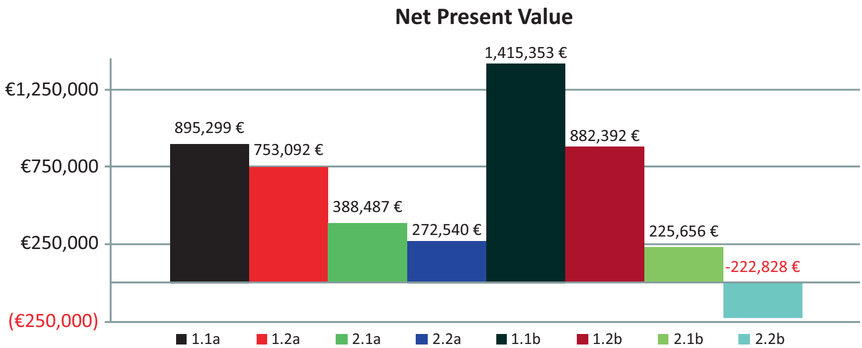

Fig. 9.7 Net present value (NPV) for all projects

9.4 Conclusion

In the following we digest the profitability of CSOP-based direct renewable energy (wind power) investments under the above given scenarios. We find that in seven of the eight scenarios, the investment projects are profitable and should be competitive to alternative investment instruments. Only for the scenario "weak wind, non-crisis, quick roll-out speed", the real IRR is negative. However, although that project possesses the longest amortization time, it is still redeemed way within the turbine's operation lifetime. To sum up, the CSOP investment turns out to be a competitive way to implement RE projects. Not only do participants benefit financially, but the scheme helps customers to gain participation in productive capital, fosters the decentralized energy supply landscape necessary for a renewable energy grid and may even increase the consumers' awareness regarding sustainable behaviour, such as responsible energy saving. The localized power supply also poses an incentive to implement a small smart grid installation, while incentives on larger-scale smart power supply are still expected to show up, eventually. The analysis shown here is however limited to the scenarios we present. Whenever the conditions considered are exceeded, the results are not reliable.

After repayment of the acquisition loan, each of the 1000 households holds an average equity participation in the wind turbine of approximately EUR 2500. Furthermore, the surplus energy production will continue to be sold to the grid. For the remaining seven to ten years of the plant lifetime (dependent on the scenario investigated), the profits are estimated to range between approx. EUR 1.4 and 2.8 million. This corresponds to EUR 140 to 400 per household per year of (taxable) profit, for the remaining lifetime after repayment of the bank loan. Additionally, as each household benefits from the low LCOE, each household saves up to EUR 58.88 euros per month in terms of the electricity bill. Finally, especially during current times of low interest rates for investments, the instrument presented here is attractive for any investor, as internal rates of return for the investigated project amount to up to 5.8 per cent.

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Part III

Country Reports

The European Union and Associated Countries (Bilateral Agreements)

10

Consumer (Co-)Ownership in Renewables in the Czech Republic

Vítězslav Malý, Miroslav Šafařík, and Roman Matoušek

10.1 Introduction

10.1.1 Energy Mix

One of the principal strengths of the Czech domestic energy sector in the light of the State Energy Policy's (SEP) main goals being energy independence and security of supply is that nearly 50 per cent of the primary energy consumption is covered by domestic sources with the import energy dependence indicator including nuclear fuel at about approximately 50 per cent. The Czech Republic is fully self-sufficient in its production of electricity and heat. There is a gear towards nuclear, and an extension of nuclear

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capacity is planned to replace coal energy (IEA 2016b). In 2015 TPES per capita was 3.9 Toe, derived from coal 39 per cent, oil 21 per cent, natural gas 16 per cent, nuclear 17 per cent and renewable energy sources (RES) 9.4 per cent (biofuels and waste 8.6 per cent, solar 0.5 per cent, hydro 0.2 per cent, wind 0.1 per cent) (IEA 2016a). Since the 1980s oil has represented a fifth of the energy mix, while the contribution of gas has been steadily declining in the new millennium mainly due to climatic conditions, economic recession and volatile gas prices for end users (IEA 2016b).

In 2015, electricity generation output was 83 terawatt-hours (TWh), with coal power as a main source having a share of 54.0 per cent. Nuclear power provided 32.5 per cent and renewables 10.7 per cent (biofuels and waste 6.3 per cent, solar 2.7 per cent, hydro 1.0 per cent and wind 0.7 per cent) (IEA 2016b). The share of renewable energy (RE) in final energy consumption per the Eurostat SHARES methodology was around 15 per cent in 2016 (Ministry of Trade 2017). Between 2004 and 2014, renewable power capacity increased from 2309 megawatts (MW) to 5366 MW. While hydropower still has the largest share of capacity, its extension opportunity has reached its limits. Still an insignificant source in 2004, in the ensuing decade, solar power capacity has grown significantly to 2068 MW. Wind capacity stood at 278 MW in 2014, adding 32.2 per cent per year since 2004. Biofuel electricity capacity increased from 128 MW to 722 MW between 2004 and 2014 (IEA 2016b).

Domestic fuels cover approximately 60 per cent of Czech heat production and more than 80 per cent in heat supply systems. Combined heat and power is widely used in the Czech Republic; in the case of large and medium sources, the proportion of cogeneration is almost 70 per cent of total gross heat production. The ratio of cogeneration heat production to overall heat production including decentralised sources but excluding households is, however, less than half. Cogeneration also produces 12–13 per cent of gross electricity production.

10.1.2 Main Challenges of the Energy Market, National Targets and Specific Policy Goals

The country aims to have at least 80 per cent of input for electricity generation covered by domestic sources. Furthermore, the government strives to diminish import dependency and levelling electricity prices for non-residential consumers to surrounding countries (IEA 2016b). Coal-fired domestic heating systems, which are not subject to environmental regulation, cause serious air pollution (IEA 2016b). Another significant challenge is loop flows from neighbouring countries, which negatively influence Czech electricity security (IEA 2016b).[1]

National implementation targets of EU 20-20-20 directive aim for 13.5 per cent of generated RES in gross final energy consumption, 14 per cent of heating and cooling demand met by RES, 14 per cent of electricity demand met by electricity generated RES and 11 per cent of transport energy demand met by RES (MIT 2012). Except with regard to the goals for transport, progress on 2020 targets on emissions and renewables is satisfactory with the expectancy of surpassing them (IEA 2016b). However, the Czech transmission grid operator argues that in its current state, there is insufficient grid capacity for the extension of RES, which may constitute an obstacle for its development (IEA 2016b). Another challenge to RES is the unfavourable geographic and climatic situation for solar and wind energy in the country (MIT 2014). However, the government does see potential for the extension of biomass[2] and (to a lesser extent) geothermal energy (MIT 2014).

The State Environmental Policy of the Czech Republic 2012–2020 approved in May 2015 replaced the previous 2004 policy focusing on meeting EU climate and energy targets by 2020; furthermore, a Climate Protection Policy was approved by Czech government in July 2016 (IEA 2016b). The corresponding targets for the energy sector are a 40 per cent reduction in carbon dioxide emissions by 2030 in comparison with 1990, an increase in energy savings in 2020 by 20 per cent and improved energy efficiency by 2040 (IEA 2016b).

[1] Loop flows occur when power is diverted due to insufficient grid infrastructure from Germany through neighbouring countries' grids and then back.

[2] However, the multi-annual programme to support sustainable biofuels in the transport sector for the period 2015–2020 approved in August 2014 was abandoned in 2015 (IEA 2016b).

10.1.3 Ownership Structure in the Renewable Energy Sector

Despite liberalisation of the energy market, state ownership remains pervasive throughout the sector, especially through the state-owned company ČEZ a.s. which has a diversified portfolio in both the fossil and the RE sector. The state-owned company ČEPS solely controls the electricity transmission system; three large distribution companies, of which besides ČEZ a.s. two are privately owned, control most of the power distribution with the exception of local distribution networks[3] which are developing since 2015; one company operates the entire gas transmission system (IEA 2016b). There are about 390 licensed electricity merchants, but only several dozens of them are active in the market.

Overall, 15 per cent of RE power plants belong directly to limited liability companies, 4 per cent to joint-stock companies, 79 per cent to individual owners and less than 1 per cent to cooperatives. Cooperative forms of ownership are much less frequent mainly due to the legal framework implying a lack of compatibility with municipal and commercial investments' lengthy decision-making processes when compared to business corporations (see Chap. 6 in this volume). Large projects are typically owned by joint-stock companies, followed with regard to size by limited liability companies; estimates on the ownership of RE in 2017 (PORSENNA 2018) according to the type of owner in the most important sectors are as follows:

- The ownership structure in the solar sector is dominated by small photovoltaic (PV) installations in private, individual ownership: There are about 20,500 PV micro installations of up to 5 kWp mostly in individual ownership,[4] while of the 3100 PV installations larger than

[3] Local distribution network operators like ČEZ ESCO offer services on their networks with the advantage of avoiding levies and fees for the use of the large-scale distribution networks which are of particular importance for RE installations for self-consumption.

[4] A 2016 amendment to the Energy Act enabled the operation of micro PV installations up to 10 kWp without a license (more details in Sect. 10.3.2) which, however, are not included in official statistics; it is estimated that 80 per cent of these are in individual ownership and about 12 per cent are in cooperative ownership (PORSENNA 2018).

10 kWp, about 80 per cent belong to private individuals and about 15 per cent to private corporations with the latter typically owning larger installations (ERÚ 2017); of these 343 PV plants range between 0.5 and 1 MWp, 467 between 1 and 5 MWp, 30 between 5 and 10 MWp and only 8 above 10 MWp.

- Of the 115 hydropower plants, 73 per cent are owned and operated by corporations, often under state control through either a state enterprise or a private corporation in which the state holds the controlling share (ERÚ 2017); individual owners are a small minority with about 4 per cent, while cooperatives are not present at all.
- About 40 per cent of wind power plants ranging from 100 kW to 3 MW are owned by corporations, while as much as 57 per cent have individual owners with an average size of 30 kW; cooperatives are a rare exception (http://www.csve.cz/clanky/aktualni-instalace-vte-cr/120).
- The vast majority of biogas stations and biomass installations are owned by private corporations in the agricultural sector with 38 per cent joint-stock companies and 34 per cent limited liability companies; agricultural cooperatives with 23 per cent and individuals with 5 per cent are much less frequent (ERÚ 2017; Czech Biomass Association https://biom.cz/cz/produkty-a-sluzby/bioplynove-stanice).

10.2 The Consumer at the Heart of the Energy Market?

10.2.1 Consumer (Co-)Ownership in Renewable Energy Sources as Policy Goal

The support of consumer ownership of RES is not explicitly mentioned as a goal in any policy document as neither citizen energy nor community energy or prosumership as concepts so far have received government recognition. At the same time, citizens can use a variety of ownership types without any restrictions if national and international rules and legislation are complied with (see Sect. 10.4.1). Consequently, as the topic is not on the political agenda, there are no current legislative or other reform proposals related to consumer ownership in RES. It can be expected that if political bodies are interested in supporting RE, they will support it regardless of the type of ownership. Furthermore, since 2016 policy support for rooftop PV provides a series of funding schemes available to citizens (see Sect.10.4.2.1.); in 2017 alone there were 788 applications under the New Green Savings Programme for residential and 273 und the OPPIK programme for commercial PV installations (Czech Solar Association n.d.). However, consumer (co-)ownership received explicit recognition of its crucial role in the 2018 recast of the Renewable Energy Directive (RED II) as part of the Clean Energy Package. The transposition of the RED II into Czech law until 2021 will be an important legislative impulse as it introduces a legal framework for consumer (co-)ownership. Consumers, individually (Art. 21, households and nonenergy SMEs), collectively (Art. 21, tenant electricity) or in communities (Art. 22, cooperatives and other business models) will have the right to consume, store or sell energy generated on their premises. RED II also invites the Member States to provide an "enabling framework" for local "renewable energy communities". The directive links prosumership to so different topics as fighting energy poverty, increasing acceptance, fostering local development, incentivising demand flexibility and so on defining citizen's rights and duties and evenly important clear definitions (Art. 2 RED II).

In 2016, the Czech Community Coalition for the promotion of RE made up of more than 60 cities and municipalities, associations, industry experts and the Hnutí DUHA was established.[5] The coalition aims to push for energy self-sufficiency and independence. At the same time, it wants to improve conditions for small roof photovoltaics and wind power plants. In 2017 the coalition put forward a proposal for an amendment to the act on supported energy sources (Law No. 165/2012 Coll.) which would restore support for municipal and community wind power projects. There are other examples of private initiatives to promote RE like the public benefit corporations "Energeia" that built a hydropower plant with a capacity of 5.4 MW in Štětí using what they call "beneficial investments" which has been in operation since 2014 (http://www.energeia.cz/

[5] See http://www.hnutiduha.cz/aktualne/vznikla-nova-koalice-pro-komunitni-obnovitelne-zdroje-energie.

en/home-page) and whose profits are used to finance charitable projects.[6] Furthermore, in April 2018 the Horizon 2020 project SCORE[7] was launched with the aim to facilitate consumers to become (co-)owners of RE in three European pilot regions employing a Consumer Stock Ownership Plan (see Chap. 8). One of the pilot projects is the city of Litoměřice, a municipality of 25,000 located northwest from Prague which develops the installation of solar thermal system for houses since 2000. The pilot project envisages an extension on public and private buildings with a new capacity of 1.5 MWp, securing a higher level of energy self-sufficiency for the households and the municipality and in particular with the aim to include vulnerable consumers.

10.2.2 Fuel/Energy Poverty and Vulnerable Consumers

Neither there is an official definition of fuel/energy poverty in Czech legislation nor are there social energy tariffs or a targeted policy approach to deal with this issue. However, with the issue being addressed at the EU level, it recently appeared on the agenda: There is a working group of several ministries on energy poverty which started working on a national definition of energy poverty. Some Czech NGOs call for dealing with energy poverty as a separate issue. Various reports—using, however, different definitions of energy poverty—state that up to 20 per cent of the Czech households are endangered by energy poverty (EU SILC 2016). In the latest EU SILC 2016 survey, 3.8 per cent of households declared that they are unable to keep their home adequately warm in winter which is a decline of about 6 per cent in comparison to data from 2014; this decline relates to the country's economic cycle with increasing economic activity, lowest unemployment rate in the EU and growing wages and pensions.

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[6] Of the total investment of 964 million CZK (EUR 37.3 million), the Department of Industry and Trade of the Czech Republic granted the project with 250 million CZK covering 26 per cent of the investment, while 10 per cent were contributed by donations. The remaining 64 per cent were refinanced with a loan from Komerční banka.

[7] "SCORE" = **S**upporting **C**onsumer **O**wnership in **R**enewable **E**nergy (CSA 2018–2021) Grant Agreement 784960.

Energy poverty as an integrative part of poverty in general is dealt with by overall social policies. It is, for example, addressed since 2003 by a housing subsidy scheme for the economically disadvantaged act on state social support (Law no. 117/1995 Coll.). Government subsidies partially cover rent and energy bills under the framework of social support. The latest available statistics show that the social subsidy scheme costs the state budget a total of CZK 12 bn per year with a declining number of recipients and that 50–60 per cent of this sum is used to cover energy bills (https://www.mpsv.cz/en/1603).[8] Although the social housing programme helps resolve the energy problems of individual families by enabling them to move to more affordable flats, the issue of energy-inefficient buildings remains unresolved. The new tenants pay high energy costs without decreasing energy demand, which is desirable when trying to reduce energy poverty.

Furthermore, to achieve objectives related to final energy consumption savings, several subsidy schemes were set up. These schemes are aimed at households struggling with substantial energy loss, for example, heat losses through the building envelope, heat losses in production, heat distribution and heat losses in lighting systems. The focus of these programmes is almost identical to that of programmes aimed at reducing energy poverty. However, as a rule households affected by energy poverty do not have sufficient financial means to invest, and since they must cover the expenses up front with the subsidy granted only retroactively, a loan is the only option which will be difficult to obtain (Karásek and Pavlica 2016). Although the Panel 2013+ programme (SFRB 2016) has a positive attitude towards energy poverty, providing a low interest loan to finance the refurbishment and renovation of houses (European Commission 2016), the major shortcoming in this context is that they do not cover tenants.

[8] In 2016 a Czech household used roughly about 21 per cent of net income to cover housing cost and energy bills. Energy bills compose on average as much as 11 per cent of households' income. However, price to income ratio is higher for low-income households especially for single-headed households or families with multiple children (Czech Household budget survey 2017).

10.3 Regulatory Framework for Renewable Energy

The main regulations are Act No. 458/2000 Coll., on Business Conditions and on the Exercise of State Administration in the Energy Sectors and on the Amendment to Certain Acts (Energy Act), as amended, and the Amendment to the Energy Act by Act No. 131/2015 Coll.

10.3.1 Regulations for Connecting Renewable Energy Plants to the Grid

Electricity production can be with or without a licence, with licences falling into two categories, that is, those for plants with an installed production capacity of up to 200 kW and those exceeding 200 kW. Since the end of 2015, plants with a nameplate capacity of up to 10 kW whose production is destined mainly for self-consumption installed directly at the supply point may operate without a licence under certain conditions (see Sect. 10.3.3) requiring only registration and a permit from the Distribution System Operator (DSO). Furthermore, neither a licence nor a permit is required if a micro installation up to 10 kw does not feed electricity into the grid at all but simply register with the DSO provided that the grid is suitable. All other plants must obtain a licence from the Energy Regulatory Office, which is granted for 25 years as a rule conditional on (1) integrity of the license applicant and the responsible representative as well as professional competence of either of them; (2) fulfilment of the proprietary as well as financial and technical preconditions; and (3) compliance with various reporting duties.

RE plant operators are entitled to priority connection to the grid. The grid operator must also guarantee non-discriminatory use of the grid for the transmission or distribution of electricity from RES and is obliged to enter transmission agreements (§ 7 par. 1 Act No. 165/2012).[9]

[9] However, in the past there has been a controversy (IEA 2016b) between stakeholders and Transmission System Operator with the former claiming that Czech authorities seek to limit con-

Furthermore, electricity producers are divided into two categories (§53 and 54 of Decree No. 408/2015 on Electricity Market Rules), that is, those who supply at least 80 per cent of their annual production to the grid and those who feed in less. Only the latter need to negotiate, reserve and pay for "booked capacity" monthly or yearly.[10]

10.3.2 Support Policies (FITs, Auctions, Premiums, etc.)

Between 2004 and 2014, RE was supported through either a guaranteed feed-in tariff (FIT) or a green bonus[11] paid on top of the market price with operators having the choice between the two. Although the bonus mechanism in principle still exists, it has been reduced to zero. Furthermore, with the exception of hydropower, for wind, PV, biomass and so on, in 2014 access to the FIT system was ended for newly built capacity creating uncertainty in the market (IEA 2016b). In practice with the bonus being reduced to nil and the feed-in tariffs being abolished, RE producers of newly installed capacities that sell electricity to the grid rely solely on the current market prices.

Only PV and biogas plants put into operation before 31 December 2013 are still eligible (§ 4 par. 10 Act No. 165/2012 as amendment by Act No. 310/2013 Coll.) as well as wind, hydro, geothermal or biomass plants up to 100 kW put into operation before 31 December 2015 conditional on the building permit being issued before 2 October 2013 (Transitional Provision No. 1 and No. 2 Act No. 165/2012). Only in these cases an FIT is granted to operators of RE plants with an installed capacity up to 100 kW in general and up to 30 kW in case of rooftop or façade PV installations and up to 10 MW in case of hydropower.

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nection of variable renewable electricity as the grid capacity is deemed insufficient to which TSOs strongly disagreed (Zane et al. 2012).

[10] "Producers of the second category" that are selling less than 80 per cent of the electricity produced to the grid have to deliver electricity in accordance with their daily diagram.

[11] With regard to the calculation of the bonus, an additional choice between the annual green bonus and an hourly-based green bonus was introduced in 2013 with installations exceeding 100 kW eligible only for the hourly rate (§ 9 par. 4 Letter b Act No. 165/2012).

10.3.3 Specific Regulations for Self-Consumption and Sale to Grid

Pursuant to a 2015 amendment of the Energy Law (Act No. 131/2015 Coll.) that came into force from 1 January 2016, RE plants with an installed output of up to 10 kW are allowed to operate without a power generation licence provided that they fulfil the prerequisites of what is called "simplified process of connecting micro installation to the grid" (§16 of Decree No. 16/2016 Coll.). This exemption from the obligation to obtain a licence for micro installations requires apart from compliance with technical specifications (1) connection to the grid at low voltage level at an already existing supply point, (2) no other installation already being connected to the supply point (3) and production for self-consumption at the supply point without remuneration for electricity supply to the grid. However, electricity suppliers competing on the market offer specific favourable tariffs with discounts for the electricity supplied to the prosumer in return for excess production fed into the grid.[12] Upon fulfilment of the above conditions, the DSO at request of the RE producer is obliged to modify the connection agreement entitling him to put the micro installation into operation. On the contrary case, the RE producer has to apply for a regular licence to the Energy Regulatory Office (see Sect. 10.3.1). Other specific regulations for micro installations concerning, for example, net metering do not exist.

10.4 Concepts for Consumer (Co-)Ownership in Practice

10.4.1 Contractual Arrangements and Corporate Vehicles Used

Besides individual ownership, the following legal forms of business can be used as corporate vehicle for consumer (co-)ownership: associations of entrepreneurs, that is, an association of several self-employed persons invoicing under one name but otherwise mostly independent, interest

[12] An example is ČEZ's "pro solary" tariff (https://www.cez.cz/edee/content/file/produkty-a-sluzby/obcane-a-domacnosti/elektrina-2018/moo/20180124-ele-pro-solary.pdf) or E.ON's "E.ON-solar" (https://www.eon-solar.cz/).

associations of legal entities, limited partnerships, limited liability companies, joint-stock companies, cooperatives, foundations and finally non-profit organisation. It is difficult for individuals to take out long-term loans. After the abolition of the FITs in 2013 renewable electricity, the situation worsened, making this type of electricity production financially unviable for municipalities.

The most commonly used form for general consumer ownership in the Czech Republic is the cooperative with more than 3000 existing in 2016 of which 2362 were housing cooperatives and 517 agricultural cooperatives (DACR 2017). Most of the country's 700 biogas plants are owned by agricultural companies, of which estimated 30–35 are cooperatives. In general, cooperative ownership of RES is not widely used in the Czech Republic yet with approximately 80–100 small cooperatives in the off-license sector of PV micro installations and two wind projects (PORSENNA 2018). Approximately 45 municipalities own decentralised RE power plants, 31 of which are biomass heating plants. Three municipalities own wind power plants, four small hydropower plants and seven PV plants (Community Power n.d.); however, municipalities have limited possibilities to develop energy projects as they face problems of human resources and capacities.

10.4.2 Financing Conditions for Consumer (Co-)Ownership in Renewable Energy

10.4.2.1 State Subsidies, Programmes, Credit Facilities and Preferential Loans

In the Czech Republic, no specific programmes for consumer (co-)ownership and subsidies exist. However, several forms of subsidies are available from different subsidy schemes.

Households may apply for an investment grant under the "New Green Savings Programme (SFŽP)", oriented to support the construction of new family houses and new residential buildings and renovation of apartment buildings and family houses in low-energy and passive standards. The programme is open to the owners or builders of family houses, that is, physical persons, both business and non-business, cities and municipalities including city districts and business entities. The subsidy varies according to the type of action and is calculated either fix or as a percentage. With regard to the installation of PV systems, solar thermal collectors for heating or water heating and other RES, financial support is granted up to CZK 155,000 depending on the type of RE installation which covers 33–48 per cent of the investment costs (Ministry of the Environment n.d.).

The operational programme “Entrepreneurship and Innovation for Competitiveness 2014–2020 (OP PIK)”, which is funded by the European Regional Development Fund, supports the construction or reconstruction of electricity or heat-generating plants, for which the energy produced is primarily intended for distribution rather than own consumption. Eligible for support is the construction, reconstruction or modernisation of small hydropower plants up to 10 MW but also biomass and biogas. However, in the case of biomass and biogas, priority is given to the promotion of combined heat and power with a maximum installed capacity of 10 MW. Companies may receive investment grants between CZK 1 million and 100 million, which is approximately EUR 39,000–3.9 million (Ministry of Industry and Trade 2015).

The “Integrated Regional Operational Program (IROP) Goal 2.5 Energy Efficient Living” supports energy efficiency, smart energy management systems and RE use, in particular the installation of PV systems, solar thermal collectors for heating or hot water preparation, and combined heat and power. Potential applicants are, above all, homeowners and owners of residential units; the capital Prague is excluded. The subsidy is set at 30–40 per cent of the overall cost with specific conditions of particular calls corresponding to the type of energy efficiency measure, amongst others minimal energy savings to be achieved fixed at 30 per cent (European Commission 2014).

The “Operational Program Environment (OPŽP)” Priority Axes 5 “Energy savings” aims at the optimisation of the energy performance of public buildings and the increase of the use of RES though measures like the installation of PV systems, solar thermal collectors for heating or hot water preparation, combined heat and power, energy efficiency measures and the construction of buildings in passive standard. The programme is open to municipalities, state and local governments, research and scientific institutes, educational establishments, legal and physical entities and non-profit organisations. The amount of subsidy provided corresponds to the technical parameters achieved and ranges from 35 to 50 per cent of total eligible costs (State Environmental Fund n.d.).

The "Business and Innovation Operational Program (OPPIK)" includes the call "Renovation and exchange of sources in commercial buildings" supporting almost all types of energy efficiency measures and the installation of RES. The programme is open to small, medium and large enterprises with the capital Prague being excluded. Subsidies range from CZK 0.5 to 250 million with the maximum grant amount expressed as a percentage of eligible expenditure set at 40 per cent for small, 30 per cent for medium and 20 per cent for large enterprises (Ministry of Industry and Trade 2015).

10.4.2.2 Agencies Supporting Investment in Renewable Energy Sources

Since the dissolution of the Czech Energy Agency, an official government agency, in 2008 by Minister of Industry and Trade, only regional agencies and private entities are supporting energy efficiency and RES investments. Regional energy agencies are working only in several regions and support mainly projects owned by regional offices or local municipalities; an example is the energy agency of Zlin Region (www.eazk.cz) that participates even in international projects. Traditional consultancy agencies like PORSENNA o.p.s. or SEVEn o.p.s. and companies supported by Ministry of Industry and Trade under the common notion of "EKIS—Energy Consultancy and Information Centres"[13] are active across the country.

Furthermore, there are several professional associations established to support and lobby for the development of RE like the Chamber for RES (www.komoraoze.cz), the Czech Society for Wind Energy (http://www.csve.cz/), the Czech Solar Association (www.solarniasociace.cz), the

[13] For a list of these EKIS, see https://www.mpo-efekt.cz/cz/ekis/strediska-EKIS.

Czech Photovoltaic Association (www.cefas.cz), the Czech Biomass Association (www.czbiom.cz), the Czech Biogas Association (www.cszba.cz) and the Alliance for Energy Self-Sufficiency (www.alies.cz).

10.4.3 Concepts for Consumer (Co-)Ownership in Practice

I. Drahany wind farm—An example of consumer (co-)ownership, although with the majority ownership held by Eldaco a.s., a joint-stock company set up in 1995, is Drahany wind farm (http://vpdrahany.webnode.cz/). Wind Park Drahany a.s. was established in 2008 as a joint-stock company aiming at the construction of wind power plants. Individual citizens or municipalities can become shareholders of the farm entitled with full voting rights and a corresponding share in the profits; by the end of 2017, the company had several hundreds of shareholders (VP Drahany 2017). In total, the construction of up to 13 wind turbines of the Vestas V112–3 MW type, with a total installed capacity of 39 MW, is planned. The total investment was CZK 1.56 million (EUR 60 million) of which CZK 312 million (EUR 12 million) is equity with Eldaco contributing CZK 234 million (EUR 9.1 million) and its citizen shareholders CZK 78 million (EUR 3 million) as well as a CZK 1.248 billion (EUR 48 million) bank loan with a maturity of 13 years. The Drahany wind farm will be located in the municipalities of Drahany, Otinoves and Rozstání (VP Drahany 2014).

II. RE self-sufficient village Hostětín[14]—With the municipal biomass central heating plant having an installed capacity of 732 kW fuelled by wood chips of waste wood from the nearby sawmills in operation since 2000 and the installation of a solar power plant in 2008, Hostětín's energy consumption is mostly covered by RE. The overall investment in the heating plant of CZK 36.4 million (EUR 1.4 million) was financed by contributions of 54 per cent or CZK 19.8 million by the State Environmental Fund of the Czech Republic, of 31 per cent or CZK 11.4 million by a Dutch grant, of 9 per cent or CZK 3.2 million by the Czech Energy

[14] https://hostetin.veronica.cz/sites/default/files/model_projects_of_hostetin.pdf.

Agency and of 6 per cent or CZK 2 million by the residents connected to the heating plant. The PV power plant on the other hand (https://hostetin.veronica.cz/fotovoltaicke-elektrarny-v-obci) was a CZK 4.4 million (EUR 0.17 million) joint investment of four entities, namely, the village of Hostětín as owner of the installation site contributing 7 per cent and three foundations (Nadace Partnerství, Nadace Veronica and Nadace české architektury) in equal parts 31 per cent. The installed capacity is 50 kWp with an annual output of about 49 MWh (Labohý 2013). In summer when PV electricity production reaches its peak, the heating plant is out of operation and the entire electricity production accounting to about 85 per cent of the annual production is fed into the grid. During the heating season accounting for about 30 per cent of the annual production, about half of which is consumed in the heating plant directly.

III. Kněžice bioenergy centre (http://www.obec-knezice.cz)—A bioenergy centre project was set up in the small Czech village Kněžice in 2007 consisting of a biogas plant with combined heat and power (CHP) having an electrical output of 330 kW and a thermal output of 405 kW and a municipal heating plant consisting of two boilers of 800 and 400 kW. With an overall investment of CZK 138 million (EUR 5.34 million), the installation supplies heat to around 90 per cent of the village population though an autonomous heating grid and feeds the electricity produced to the grid making it formally the first Czech energy self-sufficient municipality (energy consumption balance is in plus, but the electricity is not consumed by inhabitants directly). The biomass heating plant is fired by wood chips and straw. In addition, the centre, which is fully operated by the municipality, produces energetic pellets from herbal material for the heating of family houses in its direct surroundings. Cereal and flaxen straw, energetic sorrel stalks in large bundles and organic waste are provided mainly by local farmers. Ashes and the biogas station's digestate are then used for land fertilisation. The village obtained CZK 83.7 million (EUR 3.2 million) from the European Regional Development Fund and CZK 11.1 million (EUR 0.43 million) from the State Environmental Fund. The remaining CZK 43.2 million (EUR 1.7 million) were financed by a bank loan to be paid back over a period of 15 years.

10.5 Factors Affecting the Financing of Renewable Energy Sources and Barriers to Consumer (Co-) Ownership

10.5.1 Political, Legal and Administrative Factors

One of the main barriers to the development of RE consumer ownership in the Czech Republic is the lack of government support of RES. The drastic reduction of support schemes for RES since 2013 with the green bonus being reduced to nil and RE feed-in tariffs abolished for newly installed capacities (see above Sect. 10.3.2) significantly deteriorated market conditions for the deployment of RES (IEA 2016b). The introduction of these corrective measures by the government aimed at minimising the impact of support measures on electricity prices to protect both consumers and the treasury. In particular large investors, often opaque corporations with anonymous shareholders, benefited from the generous support schemes driving up end consumer prices though the RES surcharge.[15] This development is also reflected by controversies about the grid connection procedure. Despite priority connection of RE producers to the grid in February 2010, the Czech Transmission System Operator (TSO) declared a temporary connection moratorium for variable RES plants arguing that grid capacity was not sufficient for additional RE installations which was terminated by the end of 2011 (Jirouš et al. 2011). A—most probably unintended—side effect of the government abolishing RE support for all RES with the exception of heating plants fuelled by biomass to prevent large opaque corporations taking advantage of state subsidies was that economic feasibility for small projects decreased dramatically.

[15] At the time two-thirds of the subsidies for RES were going to solar power, which produced only 5 per cent of RE, and the Czech Republic became the fourth largest solar PV market as a result of a combination of favourable market conditions, a decline in prices for solar panels and generous FITs (IEA 2016b).

10.5.2 Economic and Management Factors

Among the economic factors affecting the RES consumer (co-)ownership are the costs of the DSOs incurred by the connection of small-scale RE plants and the provision of the required reserve power to the customer and the power plant output which are to be borne by the owner(s) of the new RE installation. As a consequence, big players with ample financial resources will be in a better position than small citizen-led projects, contributing to market concentration at a very early stage. At the same time, with the possible exception of small-scale solar PV installations, potential consumer owners will be reluctant to undergo the process of the preplanning stage as technical complexity is perceived as a reason for potential failure (Jirouš et al. 2011).

More generally as the market price of electricity is comparatively low and in the absence of FITs or similar support mechanisms, new RE installations are only economically feasible if the energy produced is consumed on site, that is, before the public grid thus avoiding levies and taxes (PORSENNA 2018). This business model is restricted to housing associations, private residencies or public buildings which practically excludes, for example, RE cooperatives that produce electricity to be fed into the grid. Another feasible business model is CHP which receives substantial subsidies and can be built profitably (PORSENNA 2018); its bankability, however, depends on the continuity of these subsidies which is questionable taking the volatility of energy policy in the Czech Republic.

10.5.3 Cultural Factors

The interest of individual citizens in RE projects in general is low, and they seem not to be inclined to actively and financially participate in RE investments as the topic is not widely promoted or present in the media. Here, the role of municipalities as project initiator could be significant. However, municipalities are burdened by their duties and lack in motivation to undertake several years of negotiations and the preparation of a project which can be halted due to local opposition or failure in negotiations. Furthermore, the deployment of RE and the necessary investments are viewed somewhat sceptically by the population with regard to expected returns. In particular the PV boom 2009/2010 discredited PV as public subsidies financed by consumer levies added to electricity prices were paid to large opaque corporations massively expanding installations without any benefits for local communities.

At the same time, the public is influenced by the communication strategies of the large energy distributors and state policy oriented to conserve the status quo. Moreover, local RES owned by citizens are not in line with current plans of the extension of nuclear power and centralisation of the power grid as an increase in the number of local prosumer projects would imply more decentralisation (SEP 2014).[16] However, it is important to note that the number of small PV installations without licence owned by households is increasing rapidly with a variety of companies offering construction of "turnkey PV installations".

10.6 Possible Future Development Trends for Consumer (Co-)Ownership

An interesting development stems from synergies between energy efficiency measures and investments in RES in an area where consumers already are owners: Consumer ownership is common in the case of privatised blocks of flats which were bought by the tenants from former state communal housing cooperatives in the 1990s. As a result of this type of privatisation, many flats today are owned by a consortium of owners. Energy efficiency projects for such flats can be a lever for consumer-owned RE projects where the installation costs partly overlap with energy efficiency measures as, for example, insulation of rooftops and installation of rooftop PV systems. These energy efficiency projects typically qualify for subsidies to financing energy efficiency improvement of flats and municipal buildings and thus can cross-subsidise also the investment in micro RE installations. An example of this approach combining energy

[16] Cf. https://www.mpo.cz/assets/en/energy/state-energy-policy/2017/11/State-Energy-Policy-_2015__EN.pdf.

efficiency measures with the implementation of PV installations is the business model of "ČEZ Bytové domy" (www.cezbytovedomy.cz/technologie). Amongst others they offer replacing individual metres in apartment blocks and installing a central low-voltage meter thus pooling the base load of all flats. RE installations for self-consumption can such flexibly supply all tenants in the block while avoiding levies and fees for the use of the large-scale distribution networks. Besides that residents pay only for electricity not covered by the common PV installation, their electricity bills are further reduced as the apartment block pays only for one central breaker. This approach has the additional advantage of being bankable as it involves only one bank loan to the housing association instead of hundreds of microcredits.

A good example is Brno retrofitted apartment blocks where between 2001 and 2010, a total of more than 1000 apartments as well as the local elementary school and kindergarten were successfully insulated.[17] With the initial investment requiring the housing association to borrow against the future savings it would receive from the tenants, the insulation costs were effectively covered by monies saved on heating bills.[18] In the same way, part of the investment cost of rooftop PV systems could be covered from the future savings in electricity bills. Such synergies between subsidies available for the retrofitting of apartments using, for example, Panel+ programme and the implementation of RE installation esp. PV panels could be used by private owners of formerly state-owned apartments or by housing cooperatives.

A similar cofinancing mechanism for consumer investments in RE could be used when converting heating systems for fossil to RES in smaller buildings in little municipalities that are often not connected to district heating supply with their heat source often being coal. Combined heat and power from local biomass or biogas, for example, automatic pellet boiler using Stirling engines, are employed to substitute oil or coal

[17] The total energy consumption of the apartments was monitored prior to and after the refurbishment with impressive results: The average annual energy consumption fell by 80 per cent.

[18] Participants were also educated on how to change their everyday behaviour to save more energy (http://www.foeeurope.org/sites/default/files/publications/community_power_briefing_nov2013.pdf).

heating systems while also offering stabilisation for the grid. Again subsidies for this conversion would be directly complementary to citizen's investment leading possibly to substantial consumer ownership in RE installations.

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11

Consumer (Co-)Ownership in Renewables in Denmark

Anita Rønne and Flemming Gerhardt Nielsen

11.1 Introduction

11.1.1 Energy Mix

The Danish energy sector is in transition from a coal-based towards a wind- and biomass-based power production. Over the past 25 years, coal has dropped by more than 80 per cent and accounted in 2016 for 29 per cent of fuel for the total gross electricity production. Natural gas was a bridge fuel in the 1990s. Now natural gas is being phased out and accounted for 7 per cent in 2016. In that same year, renewables made up 54 per cent of domestic electricity supply. In 2017 the largest power producer Ørsted (formerly DONG Energy) decided to stop the use of coal by 2023. During the UN Climate Change Conference in Bonn in

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November 2017, more than 20 countries, including Denmark, agreed to phase out existing traditional coal power by 2030 and place a moratorium on any new traditional coal power stations without operational carbon capture and storage (Powering past coal alliance 2017). The share of RE in total final energy consumption was 31 per cent in 2016.

In Denmark, wind reached 42 per cent of total gross electricity production in 2016; biomass had a share of 14 per cent and solar 2 per cent. With respect to the heat sector, in 2016, there were 2.8 million heating installations. District heating installations are mostly powered by combined heat and power production (CHP) and accounted for 64 per cent, natural gas fuelled installations for 15 per cent, oil fuelled for 10 per cent and others, including heat pumps, electric heating and wood burning stoves 11 per cent. Renewables accounted in 2016 for half of the energy consumption for district heating (Danish Energy Agency 2017).

Denmark's energy intensity and carbon intensity are among the lowest of all IEA (International Energy Agency) member countries. The country has also become a world leader in system integration of variable renewable energy (VRE); it has the highest share of wind power in electricity generation, and electricity supply is stable and secure at both transmission and distribution levels. Denmark is also among the global leaders in using energy-efficient technologies, including CHP, which provides half the electricity and two-thirds of heat supplied in the country.

11.1.2 Main Challenges of the Energy Market, National Targets and Specific Policy Goals

Electricity generation in Denmark has changed fundamentally over the past two decades. Coal generation has been steadily replaced, and the bulk of power generation now comes from wind and bioenergy. More offshore wind and more biomass resources will increasingly decarbonize Denmark's energy system in the coming years. The heating sector is also critical for Denmark's low-carbon ambitions. Denmark is already switching from coal to biomass in district heating powered by large-scale power plants. Moreover, renewables are favoured over oil and natural gas in individual heating systems. These trends will have to continue in order for Denmark to meet its energy targets. Denmark's large-scale use of combined heat and power plants with heat storage capacity and the increasing deployment of wind power offer great potential for efficient integration of heat and electricity systems, for example, through large heat pumps. Policies and measures to promote such technologies are essential to realize that potential at least cost. The present energy tax system was designed to an energy system based on thermal electricity production. Finding the right levels of taxation for fuels and electricity is particularly important.

Denmark has a long tradition of setting ambitious national energy targets, based on nationwide political Energy Agreements. The Energy Agreement of 2012 sets targets for 2020 (Energy Agreement 2012-2020). The Government aims for renewables to cover at least half of the country's total energy consumption by 2030 (Government Agreement 2016). By 2050, Denmark aims to be a low-carbon society independent of fossil fuels. The IEA's latest review of Denmark's energy policies finds it is moving convincingly to meet these world-leading targets (IEA 2017). The growing share of wind power however creates new challenges and opportunities for the Danish electricity and heating sectors, as well as for end-use sectors such as transport, building and industry. As wind power production is variable, there is a need for greater flexibility in consumption. Under the EU Renewable Energy Directive (RED) of 2008, Denmark is required to meet 30 per cent of gross final consumption of energy with renewable sources by 2020. As mentioned in Sect. 11.1.1, Denmark has already met that target.

11.1.3 Ownership Structure in the Renewable Energy Sector

In 2016, 42 per cent of the electricity was produced by large-scale power and CHP units, 42 per cent by wind turbines and small hydropower units, 7 per cent by small-scale CHP units, 6 per cent by automobile manufacturers and 2 per cent by solar PV.

Out of 14 large-scale power and CHP units, 3 units are coal-fired, 3 are gas-fired and 8 are or are being converted to biomass (Danish Energy Association n.d.). Most large-scale power plants are owned by Ørsted A/S, formerly DONG Energy A/S. The Danish state holds 50.1 per cent of the shares in Ørsted A/S. Other shareholders holding more than 5 per cent of the shares are The Capital Group Companies, Inc. and SEAS-NVE A.m.b.A. (Orsted n.d.). Shareholders holding less than 5 per cent remain anonymous according to Danish law. All large-scale power plants plan to or have already converted from coal to biomass. Copenhagen and two large municipalities have recently bought large-scale power plants in their cities from the former owner of the Swedish company Vattenfall. In Copenhagen, a new biomass-fired plant is under construction and will replace a coal-fired unit in 2019 in order to contribute to the goal of Copenhagen to be the world's first CO_2-neutral capital. In the district heating sector, cooperative and municipal ownership is common. Of the suppliers, 83 per cent are cooperatives with 34 per cent of the total heat supply. Municipalities account for 12 per cent of the suppliers and 58 per cent of the supply. Among the municipalities are the four largest cities in Denmark. Only two per cent of the suppliers are commercially owned with a total supply of 5 per cent.

Cooperatives and municipalities own the major part of the electricity distribution companies (distribution system operators [DSOs]). On Zealand in Eastern Denmark, there are two large DSOs and four smaller municipality-owned DSOs. The two large DSOs are Radius—owned by Ørsted—with 1 mio consumers and Cerius owned by the cooperative energy company SEAS-NVE with 390,000 consumers. In the rest of Denmark, there are 34 DSOs owned by municipalities and three DSOs owned by cooperatives (Danish Energy Association n.d.). Almost all the district heating companies are owned by cooperatives and municipalities.

There are no available estimates of the proportion of (co-)owned power plants within the RE market. However, examples from the most important RE sectors are as follows:

- In 2017, district heating was supplied by nearly 400 utilities owned by cooperatives or by municipalities (Danish District Heating Association 2017). About 50 of them are municipality-owned companies, accounting for half of the district heating supply. The other half is produced by about 350 cooperatives. As subsidies for small-scale CHPs cease by the end of 2018, district heating utilities are in a transition towards biomass boilers, solar heating, large heat pumps and so on (Act no 495 of 9 June 2004, amendment to the Act on Electricity).

- In 2017, there were 80 biogas plants owned by farmers, while municipalities own 78 plants producing biogas from sewage treatment or landfill (Danish Energy Agency 2017).
- In December 2017, there were 9405 wind turbines with a nameplate capacity of over 6 kW registered in the central data register in the Danish Energy Agency (DEA) with a total installed capacity of 6248 MW. Onshore turbines accounted for 64 per cent of the production in 2016 and offshore turbines 36 per cent (Danish Energy Agency 2017). Today the large power companies, Ørsted, Vattenfall and E.ON, and private investment funds own the offshore wind farms. The creation of cooperative wind farms began in the beginning of the 1980s, and from 1984 to 1994, most wind turbines were installed by cooperatives.[1] During the following decades, the wind turbines and thus the required investments became larger (DK Vind n.d.).[2]
- More than 100,000 households have installed solar PV, and a few large solar PV plants have been installed by private investors (Danish Energy Agency 2017).

11.2 The Consumer at the Heart of the Energy Market?

11.2.1 Consumer (Co-)Ownership in Renewable Energy Sources as Policy Goal

Historically either consumers or municipalities have owned electricity utilities and district heating companies in Denmark, while the larger cities have usually owned both. The Electricity Reform Agreement of 1999 between the Government and a broad majority in Parliament restructuring the electricity market stated that in the grid companies, directly or indirectly,

[1] Based on the experience of the cooperative movement, families bought shares of wind turbines in relation to their electricity consumption. At its peak 100,000 Danes were (co-)owners of a wind turbine (DK Vind n.d.).

[2] In 2001 of 2332 MW installed capacity, 60 per cent was owned by individual investors, 24 per cent by cooperatives, 15 per cent by power companies and 1 per cent by other investors (DK Vind n.d.).

elected consumer representatives must have a controlling influence. The energy policy agreement 2008–2012 between almost the same parties included four initiatives to support further development of onshore wind turbines. Those initiatives were included in a new Act on Renewable Energy (Act no 1392 of 27/12 2008): (1) a green scheme to enhance local scenic and recreational values of about EUR 25,000 per turbine site (Chaps. 18, 19 and 20); (2) the second one involves a guarantee fund to support financing of preliminary investigations by local wind turbine owners' associations, including a state guarantee for loan taken by local groups to investigate for local turbines (Chap. 21); (3) a requirement to offer a 20 per cent ownership of production facilities (Chaps. 13, 14, 15, 16 and 17); and (4) finally compensation for losses of property value to neighbours to a wind turbine project (Chaps. 6, 7, 8, 9, 10, 11 and 12). For 2018 and 2019, the right to local ownership of 20 per cent for land turbines will also apply for large-scale solar PV as mentioned in Sect. 11.3.2.

Furthermore, consumer (co-)ownership received explicit recognition of its crucial role in the 2018 recast of the RED (RED II) as part of the Clean Energy Package. The transposition of the RED II into Danish law until 2021 will be an important legislative impulse as it introduces a legal framework for consumer (co-)ownership. Consumers, individually (Art. 21, households and nonenergy SMEs), collectively (Art. 21, tenant electricity) or in communities (Art. 22, cooperatives and other business models) will have the right to consume, store or sell energy generated on their premises. RED II also invites the Member States to provide an "enabling framework" for local "renewable energy communities". The directive links prosumership to so different topics as fighting energy poverty, increasing acceptance, fostering local development, incentivizing demand flexibility and so on, defining citizen's rights and duties and evenly important clear definitions (Article 2 RED II).

11.2.2 Fuel/Energy Poverty and Vulnerable Consumers

Since the oil crisis of the 1970s, fossil fuel used by households has been heavily taxed in Denmark. The industry is to a wide extent exempted from taxation in order not to harm international competitiveness. In

2010, a tax-free and income-dependent "green check" was introduced, which is given as a reduction on the estimated income tax. The background for the green check was a desire by the Government and Danish People's Party to compensate citizens with relatively low income for a number of green tax increases that occurred in connection with the 2009 tax reform—Spring Package 2.0. Some small-scale CHP plants with very high costs have been compensated by individual subsidies several times to avoid too high prices on district heating.

According to EU Statistics on Income and Living Conditions, only an estimated 2.6 per cent of the Danish population were unable to afford to keep the home adequately warm, while 3.6 per cent of Danish households reported arrears on utility bills in 2012 (Nierop 2014). Retired people can receive a subsidy to cover part of the heating bill as included in the Act on Social Pensions of 2016 (Consolidated Act no 1239 of 13 October 2016 Act on Social Pensions). The authority responsible for the payment of social pensions (Udbetaling Danmark) calculates how much a retired person can receive in heat subsidy based on the person's heating costs over the last three years. Only heating costs up to DKK 21,600 (EUR 2900) per year can be covered (Borger n.d.).

11.3 Regulatory Framework for Renewable Energy

The main statutory provisions regulating the renewable sector in Denmark are included in the Act on Renewable Energy (Consolidated Act no 1288 of 27 October 2016 on Renewable Energy), the Act on Electricity Supply (Consolidated Act no 418 of 25 April 2016 on Electricity Supply) and the Act on Environmental Assessment of Plans and Programs and of Specific Projects (Consolidated Act no 448 of 10 May 2017 on Environmental Assessment of Plans and Programs and of Specific Projects).

The central authority is the energy agency with its main tasks regulating energy and supply in Denmark as well as climate initiatives, supervising transmission system operators (TSOs) and DSOs, granting licences and collecting information on the energy market (Rønne 2015).

The Act on Electricity Supply includes rules on the DSO's determination of the price of the service. Pricing must be based on reasonable, objective and non-discriminatory criteria and the methodologies approved by the National Energy Regulatory Authority (NERA).

11.3.1 Regulations for Connecting Renewable Energy Plants to the Grid

When connecting CHP and power plants using waste or producing renewable electricity to the electricity grid, the owner of the plant must only pay the expenses associated with connecting to the 10–20 kV network, even if the grid operator, based on objective criteria, chooses another connection point. If the choice of other connection point affects the transmission network, the network operator must enter into an agreement with the transmission company. Other costs, including reinforcement of the grid, shall be bore by the DSO if the costs relate to the distribution grid or by the TSO if the costs relate to the transmission grid (Sec. 67 of the Electricity Supply Act).

Danish Energy Association (Dansk Energi) issued guidelines concerning the technical and economic conditions for the connection of producers' installations to and the use of the grid operated by the DSO. The guidelines have been notified to the Danish Energy Regulatory Authority (DERA) in accordance with the Electricity Supply Act.

11.3.2 Support Policies (FiTs, Auctions, Premiums, etc.)

Wind, solar, biomass, biogas and hydro energy are subsidized. RE used as a fuel is exempted from taxation, while energy taxes are levied on all fossil fuels, that is, oil, natural gas and coal with the exemption of fossil fuels for power production; instead electricity consumed is taxed in order to avoid influencing the costs of exported electricity. The most important categories for the support of power production from renewable energy sources (RES) are wind energy and biomass. In 2017, there were no FiTs or premiums for newly installed solar PV plants.

Wind on land receives a feed-in premium of DKK 0.25/kWh with a ceiling of DKK 0.58/kWh for the combined market price and premium. With the approval by the EU Commission, the DKK 0.25/kWh premium expired after ten years on 21 February 2018. This premium is succeeded by a new support tender model in 2018 and 2019 where project developers can offer projects with either solar PV, onshore wind turbines or coastal offshore wind turbines in 2018 and 2019, to be assessed against each other based on objectively determined criteria. The best projects receive support until the budget of the approximately DKK 1 billion is allocated (Ministry of Energy, Supply and Climate 2017b). Offshore wind farms receive feed-in tariffs allocated through tendering procedures. Tender prices for offshore wind turbines have fallen significantly in recent years with the winning bids decreasing from DKK 1.05/kWh (2010-prices) for Anholt offshore wind farm with 400 MW installed capacity to DKK 0.37/kWh (2016-prices) for Kriegers Flak with 600 MW installed capacity. The 2016 bid from the Swedish state-owned Vattenfall for Kriegers Flak wind farm is the lowest ever bid for offshore wind turbines globally (Ministry of Energy, Supply and Climate 2016).

Since 2009, biomass for power production has received a premium of DKK 0.15/kWh. With approval of the EU Commission, this premium expires by April 2019; it is unclear whether and if so how the subsidy will be continued. More general, power and heat producers can share the saved tax on the fuel in CHPs for heat production with the district heating company enabling them to make a positive business case of conversion from fossil fuels to biomass over the past years. Prices of heat can only include actual costs.

11.3.3 Specific Regulations for Self-Consumption and Sale to Grid

Denmark experienced a dramatic increase in installation of solar PV over the last years due to global large decrease in prizes of solar PV technology. Consequently, Denmark—like other countries—has reduced the subsidies for solar PV. A shift from annual to hourly net metering occurred between 2012 and 2017, which reduced the advantage of solar panels that no longer can save production in the summer period with plenty of sunshine until wintertime with little sunshine. In May 2017, hourly net metering has been changed to instant metering for newly installed PV. That means that the producer must pay for all purchases of electricity from the grid and thus only save electricity expenses when the PV system is generating. This has reduced the advantage of PV even further. The bill was introduced in Parliament without prior notice on 23 May 2017 as the installed capacity of PV had exceeded the planned capacity (Proposal no L 214 of 23 May 2017 of amendment to the Electricity Tax Act. Adopted as Act no 1049 of 12 September 2017).[3] The incentives to self-consumption have been gradually reduced to limit the subsidies after an agreed capacity of PV (918 MW) has been exceeded. Smart meters must be installed in all households before the end of 2020. ToU rates are introduced after installation of smart meters in some areas.

Since 2017 all new solar PV installations' sale to the grid receives the market prize of DKK 0.20–0.30/kWh and is included in the new support tender model mentioned in Sect. 11.3.2.

11.4 Concepts for Consumer (Co-)Ownership in Practice

11.4.1 Contractual Arrangements and Corporate Vehicles Used

There is a long historic tradition for cooperative ownership in the Danish energy sector. Electricity and district heating companies were founded by municipalities in the larger cities and by consumer cooperatives outside the large cities, and small wind turbines are often owned by cooperatives or individuals. Today, cooperatives and municipalities own DSOs and district heating companies.

[3] After limiting the capacity of PV to 800 MW in a 2013 agreement between the Government and a broad majority in Parliament, in 2014, the parties agreed to increase the limit to 914 MW. After new estimates showed that the total capacity would reach 1350 MW in 2020 and 2235 MW in 2030, legislative action was taken to limit the subsidies to PV. The 85,700 small PV up to 6 kW will keep their existing net metering until 2032 (see commentaries to the proposal).

In the 1980s and 1990s, large power utilities focused on the development of large wind turbines and wind farms. In recent years, power companies have played a key role in offshore developments. When setting up wind turbines of over 25 metres on land today, there is an obligation to offer 20 per cent of ownership stake to citizens living in the area (Lila Barrera-Hernández et al. 2016). As from 2009, the Danish legal regime has thus included a requirement to make an offer of a 20 per cent ownership stake in wind production facilities if the height of the turbine is more than 25 metres (RES Act, Chaps. 13, 14, 15, 16 and 17). A recent amendment to the Renewable Act (Chap. 13) applies the system also to the near-shore area meaning a coastline within a distance of 16 km from the nearest wind turbine. If the project developer does not comply with this condition, he loses the public price supplements for energy produced and may also be fined. The option to purchase wind turbine shares is a (co-)ownership scheme that imposes an obligation on developers of all wind energy projects onshore and near-shore but only in favour of private individuals. It is open to citizens over 18 years old who have their permanent residence (according to the National Register of Persons) at a distance of not more than 4.5 km from the installation site at the time of the offer for sale. If shares are left unpurchased by residents in the vicinity of the wind farm, they are offered to citizens with permanent residence in the municipality. Project developers that can show that at least 30 per cent of a project is owned by local citizens and enterprises will receive an additional price supplement.

Furthermore, individual farmers and cooperatives of farmers installed biogas plants, while almost 100,000 solar PV systems have been installed primarily on individual houses over the past five years. Although there are no official statistics for the sale of wood pellet heaters and heat pumps, the Danish Energy Association estimates that in 2017, among the 2.7 million households, about 60,000 heat pumps and about 100,000 wood pellet heaters are in use (Household Statistics Denmark n.d.).

11.4.2 Financing Conditions for Consumer (Co-)Ownership in Renewable Energy

11.4.2.1 State Subsidies, Programmes, Credit Facilities and Preferential Loans

Heavy taxation on fossil fuels incentivizes the switch to RE in private households and in district heating companies. The Heat Supply Act (Consolidated Act no 523 of 22 May 2017 on Heat Supply) regulates investments in district heating companies. Per the price chapter of the act, all necessary costs can be included in the prices. Municipalities can issue guaranties for loans to investment in district heating companies. District heating companies can in this way obtain favourable loans. In addition, it is possible to obtain a loan in a special Credit Institution for Local and Regional Authorities in Denmark (KommuneKredit) (Act no 383 of 3 May 2006 on the Credit Institution for Local and Regional Authorities in Denmark).

The DEA has several programmes supporting investments in renewable energy. The Energy Technology Development and Demonstration Program (EUDP) supports private companies and universities to develop and demonstrate new energy technologies. For 2018, EUDP has a total funding of DKK 400 million. Projects are typically supported with about 50 per cent of the investment.

In 2016, the DEA presented a new support scheme for heat pumps where DKK 25 million over three years are earmarked to support a number of companies for the purchase of heat pumps, which they subsequently install and operate with homeowners. In addition, there is a subsidy scheme for large heat pumps for district heating for small-scale CHP in place until the end of 2018 as in Sect. 11.1.3. The DEA supports electricity-based heat pumps with DKK 23.4 million in 2017 and DKK 27.9 million in 2018. Up to 15 per cent of the investment costs of the electrically powered heat pump are covered.

11.4.2.2 Agencies Supporting Investment in Renewable Energy Sources

Danish Governments developed a tradition of implementing energy policies with broad political support, which is often reflected in written political agreements. This has enabled a stable energy policy course to the benefit of industries and society as such. Since the first energy plan of the Danish Government of 1976, there has been a constant focus on extending renewables (Ministry of Trade 1976). The general policy for the energy sector is developed by the Ministry of Energy, Utilities and Climate. The Danish Energy Agency (DEA) is responsible for the implementation of the Government's energy policy. The agency implements tasks connected to production, supply, consumption and research in the energy sector. Moreover, the agency is responsible for the subsidy schemes to renewables. Prices and supply conditions for electricity, gas and heat are regulated by the Danish Energy Regulator Authority (DERA). DERA also supports structure development and improvements in efficiency within the energy sector. The main tasks of DERA are laid down in the three acts on energy supply (the Electricity Supply Act, the Heat Supply Act and the Natural Gas Supply Act) and further elaborated in the Energinet.dk Act. The members of the DERA are appointed by the Minister for Energy, Utilities and Climate. A reform of DERA will take place so that the board of seven will be replaced by a director general in July 2018. The decision of DERA can be referred to the Energy Board of Appeal.

In addition to administrative authorities, the Danish energy sector is also characterized by active and ownership involvement by public utilities. In 2004 a state-owned undertaking, Energinet.dk, was set up as the TSO. Energinet.dk has an important role in integrating increasing volumes of variable renewables into the system. Furthermore, Ørsted (formerly DONG Energy)—originally founded already in 1972 as a fully state-owned company to develop natural gas and oil resources—today is directed towards the progressive extension of renewables. Acts regulating the supply of electricity, district heating and natural gas explicitly grant municipalities the right to have a stake in utilities in these areas. Municipalities are involved not only in an increasing part of the administration, but they also hold considerable ownership of energy companies within the sectors of natural gas, district heating and to a lesser degree in electricity. Moreover, several municipalities have implemented their own climate and energy plans.

The Electricity Supply Act and Heat Supply Act contain provisions to ensure that end users have some influence on the suppliers, notably through the election of consumer representatives on the companies' boards (Chap. 40 of the Electricity Supply Act and Sec. 23h of the Heat Supply Act).

11.4.3 Examples of Consumer (Co-)Ownership

I. In 2013 inhabitants of the town of Slagslunde formed a cooperative to counter a spike in heating prices after a commercial takeover of the local plant (Danish Energy Regulatory Authority 2012). They received a guarantee from the municipality and bought the district heating plant back from E.ON. The system consists of 1 MW electric and 4 MW of heat installed capacity and was acquired with a total investment of DKK 13 million (EUR 1.7 million). Three years later, in 2016, the 231 consumers of Slagslunde paid an annual heat bill of on average DKK 17,278 down from DKK 39,775, a daily water spill of 2000 litres of water decreased to nine litres, and annual administrative costs decreased from about DKK 1 million to only 250,000. In addition, annual interest expenses for the repayment of the acquisition loan have fallen from 7 per cent per year to about 2 per cent. At the annual meeting of the Danish District Heating Association, **Slagslunde District Heating**—managed by committed local residents who saw an interest in strengthening the community and disregarding commercial interests instead of a professional management board—received the District Heating Award (Politiken 2017; Dansk Fjernvarme 2017).

II. A world-renowned best practice example of citizen (co-)ownership of a wind farm is the offshore wind farm outside the Harbour of Copenhagen at Middelgrunden. The **Middelgrunden Wind Turbine Cooperative** was established in 1996 by a group of wind turbine enthusiasts (www.middelgrunden.dk). A partnership I/S with all partners being personally, directly, jointly and severally liable for all obligations of the company was formally formed in May 1997, with the aim to produce electricity based on the construction, establishment and management of wind turbines. All jointly owned wind turbines in Denmark are organized as partnerships I/S. The Middelgrunden Wind Farm was established with the installation of 20 turbines with an installed capacity of 40 MW and total investment sum of DKK 334 million (EUR 44.8 million). 8650 citizens joined the cooperative due to environmental concerns and/or the possibility of receiving some financial benefits. The City of Copenhagen originally owned the ten northern turbines, whereas Middelgrunden Wind Turbine Cooperative owned and still owns the ten southern turbines. However, following the market reforms in 1999, the City of Copenhagen sold all of its power production capacity to Ørsted.

III. In the biogas sector, most plants are owned by cooperatives or by individual farmers. In 2015, there were 38 cooperatives and 47 individual plants (Danish Energy Agency 2016). A new generation of biogas plant delivering biogas to the natural gas grid was inaugurated in August 2015. **NGF Nature Energy Holsted** (http://holsted.natureenergy.dk/) is a subsidiary of NGF Nature Energy A/S and is jointly owned by the farmer-owned supplier association Brørup-Holsted Biogas A.m.b.a. and NGF Nature Energy. The plant has a value of approximately DKK 200 million (EUR 26.8 million) and is delivered by the main contractor Xergi, which owns 10 per cent of the plant. The project has received construction support of approximately DKK 40 (EUR 5.4 million) from the state. The plant can annually process approximately 400,000 tons of biomass and has the capacity to produce 13 million square metre of upgraded biogas per year. Seventy per cent of the biomass is slurry from cattle, pigs and mink from local suppliers. Other biomass comes from, among other things, deep bedding, organic industrial waste and energy crops. All biogas from the plant is upgraded, that is, cleaned for CO_2, water and sulphur, so it gets the same quality as natural gas. The plant employs three technical staff members as well as six full-time drivers who pick up the landfill and ship manure in the form of de-gassed manure returning to the farmers.

11.5 Factors Affecting the Financing of Renewable Energy Sources and Barriers to Consumer (Co-) Ownership

11.5.1 Political, Legal and Administrative Factors

In recent years attempts to be more cost-efficient are questioning the efficiency of cooperative endeavours in electricity distribution, district heating, biogas and onshore wind. A political agreement states the district heating sector must be streamlinedby DKK 0.5 billion by 2020

(Agreement of 2 June 2017 between the Government and a majority in Parliament on economic regulation of the district heating sector). An analysis of the competitive situation has been initiated in the heat production sector to uncover barriers, the need and possibilities for adapting regulation after 2020. A report describes the results of the competition analysis and presents recommendations to increase competition in the district heating sector (Ea Energianalyse 2017). A main result of the analysis is that effective competitive pressure in the district heating sector especially depends on the heat consumers' ability and willingness to choose another supply, for example, shift from district heating to individual heating. Secondarily, there may be competition between heat producers, when new production is to be established. The analysis also shows that competition in the heat market among existing producers is weak, even in the largest Danish district heating systems. Seven groups of actions are recommended to improve competition. Among the recommended actions are removal of obligations to be connected to the district heating system for consumers, free choice of production methods for producers and decrease of the electricity tax.

11.5.2 Economic and Management Factors

In recent years, consumer investments in small-scale solar PV and micro wind turbines have increased due to attractive subsidy schemes and large decrease in installation costs. At the beginning of 2012, there were about 4000 small solar PV installations rising to 70,000 by the end of that year. To avoid excessive costs for the energy transition, subsidy schemes were adjusted several times in 2012 and 2013, slowing down the pace of the expansion. This resulted in about 100,000 solar PV installations in 2017. The Government's policy to get the maximum green energy supply in relation to subsidies offered led to the introduction of market mechanisms to control costs. Recently, an agreement between the Government and a majority in Parliament was drafted to introduce a technology-neutral bidding process in 2018/2019 where wind on land and solar PV can compete as mentioned in Sect. 11.3.2 (Ministry of Energy, Supply and Climate 2017b). However, auction mechanisms in particular may hinder citizen projects as they are at a competitive disadvantage to commercial large-scale projects—in particular with regard to the capability to absorb sunk costs.

Another economic factor relevant for renewable projects involving (co-)ownership is that land wind turbines are cheaper than offshore wind turbines. Popular support for land wind turbines is vital to limit costs for a green energy transition. Therefore, incentives and support that does not respect the specific needs of citizen financial participation while favouring large-scale commercial projects may fall short with regard to increasing citizen's support. More municipal-owned turbines and support for independent energy advice for the establishment of local wind turbines could enhance the local investments in wind turbines.

Financing of renewables and establishment of consumer (co-)ownership have been used for many years for onshore wind and biogas. Planning processes and financing methods are well known to the relevant shareholders, that is, power companies, farmers, consultants and law firms. Over the years, costs, subsidies and interest rates have been crucial economic factors in the development of RE projects (Danish Energy Agency 2011). Local acceptance is also crucial for the success of a project (cf. the following section).

11.5.3 Cultural Factors

Following the Danish market reforms of 1999, the commercial undertakings of the electricity sector, that is, the production and sale of electricity, were sold by the cooperative and municipal owners to two state-owned companies: Vattenfall owned by the Swedish Government and DONG Energy owned by the Danish Government. The non-commercial energy sector, that is, the grid operating companies, remained in cooperative and municipal ownership. Both the commercial and the non-commercial energy undertakings are today committed to the transition of the energy sector from fossil fuel to renewable energy. The largest owner of the power plants (Ørsted) has decided to end all use of coal by 2023. In addition, at the COP23 in Bonn in November 2017, the Danish Government joined a number of other countries in deciding to stop the use of coal for electricity and heat production by 2030.

For the expansion of onshore wind power, local ownership fostering acceptance of new installations is particularly important. Wind turbine projects are received very differently, depending on whether the turbines are owned by local or external investors with the latter receiving most opposition from surrounding areas. For example, in Hvide Sande, once a local investment fund was set up, wind turbines gained strong support, while previous wind turbine projects were cancelled due to local resistance. The fund is 100 per cent locally owned with 400 local shareholders. The installation site was sold by the local harbour authority, and the revenue was used for an expansion of the harbour (www.hvidesande.dk/hvide-sande/de-tre-vindmoeller-i-hvide-sande).

According to research by the Danish Technical University, resistance to wind turbines may be reversed, if citizens are advised and included in the development of municipal strategic energy plans (Danish Technical University 2017). They should be involved by the municipalities from the start of the planning phase of renewable energy installations. Resistance to onshore wind projects observed is thus largely due to poor handling and communication of the project planning and implementation process.

11.6 Possible Future Developments and Trends for Consumer (Co-) Ownership

The 2012 energy policy outlining for 2012–2020 included subsidy schemes for wind on land. The schemes were approved by the EU Commission but expire in February 2018. Approval of a new subsidy scheme is pending. The policy covers wind on land and solar PV and includes a bidding process for the years 2018 and 2019. The current Government with support of the majority of the political parties declared in 2016 that Denmark is prepared to embark on an ambitious 2030 target for reducing emissions outside the quota system aiming at a 50 per cent share (The Government Agreement, 27 November 2016). The specific initiatives for the period 2020–2030 are expected to be presented by the Government in the spring of 2018. It is thereby going beyond the EU targets of 27 per cent renewables in 2030. The Government appointed an Energy Commission in 2016 with the purpose of presenting recommendations for the energy and climate policy for the period 2020–2030. In its report of April 2017, the Energy Commission recommended a paradigm shift for energy policy, focusing on an international perspective, increased electrification, market-based solutions and digitization (Ministry of Energy, Supply and Climate 2017a).

A future energy system must thus be based on an increased degree of electrification and must be flexible both on the production and consumption sides with the integration and balancing of a high share of volatile renewables. These goals provide the biggest challenges for the Danish energy system. Strong interconnectors to Denmark's neighbouring countries and innovations like the coupling of electricity and heat supply feeding into district heating systems including thermal energy storage are crucial to increase system flexibility. Consumer involvement is important as smart homes, heat pumps and electric vehicles can contribute to system flexibility. A challenge for the energy stakeholders is to develop services that are attractive to the consumers. In addition, the regulation must provide the right incentives for smart energy solutions enabling the accommodation the use of new production and end-use technologies.

By improving information and communication technologies and ensuring smart metering and automatic devices, electricity supply is expected to match more effectively consumer demand while stabilizing the electricity system and reducing peak demand (Rønne 2012). A 2013 executive order aims to have smart meters installed for all consumers by 2020 (Administrative Order no 1358 of 3 December 2013 on smart meters). As of December 2017, several electricity companies are offering consumers flexible settlement of electricity.

However, a smart energy system involves much more than a smart grid. There must be a wider interoperability among various energy systems and infrastructures such as electricity, heating and gas. A smart energy system will also call for a closer interaction between the energy system and the end users than is present on an hourly basis. All this implies that in the future, consumers must be allowed to play a bigger part and participate in optimizing the operation of the system, to receive improved information and options for the choice of supply.

The Government and a majority in Parliament have agreed to reduce the tax on electricity for heating purposes to enhance the use of heat pumps in private homes and in district heating systems (Ministry of Taxes 2018). Further initiatives to continue the green transition are expected to be presented by the Government in the spring of 2018.

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12

Consumer (Co-)Ownership in Renewables in France

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12.1 Introduction

12.1.1 Energy Mix

In 2016 the gross inland consumption of nuclear power amounted to 41.8 per cent, petroleum and other products 30.2 per cent, gases 15.4 per cent, RES 9.9 per cent, all solid fuels 3.4 per cent, and non-renewable waste 0.7 per cent of 248.7 Mtoe (Eurostat 2018a). In this energy market dominated by nuclear power, RES do not play a significant role yet. From the

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130.79 GW installed capacity and 556.2 TWh generation in electrical power in 2016, nuclear represented 48.3 per cent of the capacity and 72.5 per cent of the generation, whereas RES made up for 34 per cent of the installed capacity and 18.4 per cent of the generation (Eurostat 2018a). However, RES installed capacity is in expansion (2188 MW added in 2016 and 2763 in 2017) and offsets contraction in other power types (RTE 2017, 2018). And while the energy mix stayed mostly stable between 2016 and 2017, nuclear power achieved an all-time low in 2017 (RTE 2018). While France is not planning to exit or put a moratorium on nuclear, as many of his neighbours (Germany, Switzerland, Italy, Belgium, Spain) did, it still plans to reduce the share to under 50 per cent by 2025. However, already in November 2017, the then- minister in charge of the energy transition claimed this would not be achieved in time, except by going back on a planned coal exit by 2022 (L'Usine Nouvelle 2017a, b).

RES come second in electricity production with 18 per cent in 2017, after nuclear with 71.6 per cent and before coal-, gas-, and oil-fired facilities with 10.1 per cent (RTE 2018). However, RE is dominated by large, established sources of hydropower, which makes up for 10 points. It accounts for nearly 56 per cent of installed renewable capacity with 25.5 GW. Meanwhile wind and solar power account for 40 per cent with 11.7 and 6.8 GW, respectively. France also has 1.9 GW of electricity generated by thermal renewables, that is, biogas, biomass, and particularly waste (RTE, SER, Enedis and ADEeF 2016; Observ'ER 2017). All in all, RES represented 16 per cent of gross final energy consumption in 2016, that is, 21.1 per cent in heating and cooling, 19.2 per cent in electricity generation, and 8.9 per cent in transport (Eurostat 2018a, b, c).

12.1.2 Main Challenges of the Energy Market National Targets and Specific Policy Goals

Since the 1990s, the EU liberalization agenda pushed France into bringing down many barriers and hurdles on the energy markets, indeed, making it less difficult for new actors to emerge. However, the energy sector is still characterized by *meso-corporatism*, where policies are set by bargains between state representatives and economic actors, with little or no civil society involvement (Szarka 2010). France is still frequently ranked among the most centralized countries from an energy regulation perspective where powerful national operators such as Électricité de France (EDF) and Enedis limit the room for local authorities and new entrants (Poupeau 2014). Local authorities are owners of the distribution grid and thus responsible for awarding electricity grid concession contracts in the context of their administrative competencies (CRE 2018). However, they are constrained in their choice of grid operator, which is set by law. Enedis and the 160 local companies operating in the electricity distribution market have a monopoly in their exclusive service areas in accordance with Article 111-52 of the French Energy Code. There is also no limit to the maximum legal duration of concession contracts.

According to its European engagement under the directive for the promotion of RES of 2008, France committed to reach a share of 23 per cent of gross final energy consumption of RES by 2020 in its national action plan representing an additional 20 Mtoe in RE generation, which is the double of that of 2006. This target was then detailed in sub-target for electricity with 27 per cent, heating and cooling with 33 per cent, and transport with 10.5 per cent translating in investment targets for each power type in the 2009 multiannual investment plan for electricity generation (France, Ministry for Ecology and Energy 2010). Accordingly, France should reach a capacity of 25 GW in wind power, 8 GW solar, an additional capacity of 2.3 GW in biomass, and an additional 3 TWh/year in hydropower.

However recent reports underline that France is one of the Member States not on track: By the end of 2016, it was still at 16 per cent, away from its 2020 target of 27 per cent, while 11 of the 28 Member States had already reached theirs (Eurostat 2018b, c). Meanwhile, the country recently committed to increase the share of RE in gross final energy consumption from 15 per cent in 2015 to 32 per cent in final consumption and 40 per cent in electricity production by 2030[1] (French Government 2018). In the actual state, it is highly uncertain that France will fulfil its commitments for the energy transition, both for 2020 and 2030. Additionally, the other closely timed and ambitious policy targets (nuclear reduction, coal exit) strain the planning and cast doubts on the

[1] The EU-wide target is currently was set at 20 per cent for 2020 and 27 per cent for 2030 by the European Council in 2014 but is likely to be augmented in order to align with the EU's engagement within the Paris Agreement. The final compromise, which still need to be adopted by the end of 2018, foresees a target of 32 per cent (see Chap. 30).

overall discourse and credibility of France's energy transition. The publication of the new multiannual energy plan for the period 2018-2023 and 2024-2028 as well as the draft National Energy and Climate Plans foreseen by the Energy Union Governance regulation, both by December 2018, should provide some guidance to national and European actors.

12.1.3 Ownership Structure in the Renewable Energy Sector

France is characterized by a high degree of monopolistic concentration, both at the market and grid levels. The two main producers' cumulative market share for capacity and generation is 85.7 and 92.4 per cent with 82.5 for the main producer, the publicly owned utility EDF, alone, and the two main retailers have a combined 86.7 per cent share (Eurostat 2018a). On 30 September 2017, 83.4 per cent of EDF's shares were owned by the French government, 12.6 per cent by institutional investors, 2.6 per cent by retail investors, 1.3 per cent by employees, and 0.1 per cent were treasury shares (EDF 2015). Both the transmission and distribution grids are managed as monopolies by EDF's subsidiaries, RTE[2] and Enedis,[3] with the latter managing 95 per cent of the electricity distribution grid in France through more than 730 concession contracts with local authorities. The remaining 5 per cent are managed by 160 local distribution companies, with only 4 of them having over 100,000 clients (CRE 2018).

Regarding the proportion of (co-)owned power plants within the RE market, in 2015, only 3 per cent of the wind power and 0.7 per cent of the photovoltaic generation capacities were projects (co-)owned by citizen groups, commercial developers, and/or local authorities (ADEME 2016). The French Agency for Environment and Energy Management (ADEME) database (accessed February 2018) covers (co-)owned projects across France set up since 2003 and gives the following picture for the year 2017 in the different RE sectors:

[2] RTE (*Réseau de Transport d'Electricité*) was established in 2000 as a result of European Directive No. 96/92/EC of December 1996, requiring France to liberalize its electricity market by unbundling its generation and transmission activities, which until then had been directly controlled by EDF.

[3] Previously Électricité Réseau Distribution France and renamed Enedis in 2016.

- Consumer (co-)ownership is a recent phenomenon with merely four (co-)owned projects developed before 2011, whereas 34 were established between 2013 and 2017.
- Among the 54 (co-)owned projects, 42 produce electricity from photovoltaic and 12 from wind power while they are typically small: 78 per cent of the total 54 projects have a generation capacity of less than 1 MW; only four of them, all wind energy projects, have a generation capacity of over 10 MW.
- Most (co-)owned generation infrastructures, that is, 41 out of 54, involve municipalities and/or local authorities, while notably, half of (co-)owned projects are located in four regions: Bretagne, Pays de la Loire, Occitanie, and Auvergne-Rhône-Alpes.
- Projects in full citizen ownership, that is, 13 out of 54, are a minority and mostly photovoltaic initiatives with 11 projects, whereas only 2 are wind power projects.

12.2 The Consumer at the Heart of the Energy Market?

12.2.1 Consumer (Co-)Ownership in Renewable Energy Sources as Policy Goal

In the French context, two terms are mainly used when it comes to deal with (co-)ownership models: participatory (*participatif*) and citizen-led (*citoyen*). The former refers to projects involving citizens and/or local authorities in terms of financial participation in debt or capital. The latter refers to initiatives including two forms of participation: the financial mentioned above and involvement in the governance and the management of the power plant. The national organization Énergie Partagée wrote a convention related to define the criteria of citizen-led approach with the following principles: (1) local anchorage, which materializes by the control of the project by local individuals or local authorities; (2) a nonspeculative purpose, through the limitation of remuneration of capital and, ideally, the allocation of a portion of the profits to new citizens' projects or solidarity and awareness actions regarding issues of the energy transition in the territory; and (3) democratic governance of the cooperative type, around the principle of transparency on decision-making and financial aspects.

Despite the central and constraining role of the state regarding energy decisions and citizen initiatives in the field of RE, recently energy policy drafts, in particular the 2015 Energy Transition Act, include provision favourable to community and participative projects (Rudinger 2017) reflecting a "French localism" (Nadaï et al. 2015) that seems to be emerging. We observe a dynamic development over time from only four (co-)owned renewable power plants in the field of energy in 2008 to 54 in 2016 (ADEME 2016; Wokuri 2017). In particular during the public debate on the Energy Transition Act from 2012 to 2015, environmental NGOS and citizen organizations involved in renewable energy activities like Enercoop and Énergie Partagée published proposals[4] advocating for (1) the creation of a public fund helping the first phase of citizen-led initiative emergence, (2) the simplification of citizen investment including the suppression of restrictions imposed by the Financial Markets Authority (FMA) Autorité des marchés financiers (AMF) (see below Sect. 12.4.2), and (3) the instauration of a feed-in tariff with financial bonuses for citizen-led initiatives. Support was expressed beyond the network of citizen organizations involved in RE (Commission spéciale 2014): The president of the sustainable development commission of the association of the French regions, Jean-Jack Queyranne, proposed a 10 per cent bonus to public operators and 20 per cent to citizen operators for the call for tenders; the confederal secretary of the trade union, Confédération française démocratique du travail, Dominique Olivier, assumed that citizens and their organizations should be able to participate to electricity generation projects.

Thereafter, several articles of the Energy Transition Act reduced hurdles for citizen-led initiatives: (1) According to Art. 111, a section dedicated on "participative financing in RE project companies" was introduced in the Energy Code; (2) Art. L314-27 states that physical persons, in particular nearby residents, and local public entities can now invest in RES projects by acquiring shares in private or public companies as well as cooperatives devel-

[4] Press conference, "What NGOs want", p. 16, 19 February 2013.

oping RES projects; (3) Art. 109 opens the right for local authorities to invest in (co-)owned projects and gives exemptions for local associations organized as simplified joint-stock company (SAS) and the cooperative company of public interest (SCIC) to invest without the financial visa, which was previously required and issued by the French Authority of Financial Markets (AMF) by modifying L2253-1, L3231-6, and L4211-1 of the General Local Authorities Code; and (4) finally, a decree related to call for tenders settled a bonus for commercial societies including citizen financial participation. The decree promulgated on 29 September 2016 opens the “participatory bonus” to three types of organizations developing photovoltaic projects: (1) local public authorities, (2) joint-stock companies, of which at least 40 per cent of the capital is held, separately or jointly, by 20 citizens and one or more local authorities, and (3) cooperatives of which at least 40 per cent of the capital is held jointly or distinctly by 20 natural persons and one or more local authorities or groupings of local authorities (France, Prime Minister 2016).

Finally, consumer (co-)ownership received explicit recognition of its crucial role in the 2018 recast of the Renewable Energy Directive (RED II) as part of the Clean Energy Package. The transposition of the RED II into French law until 2021 will be an important legislative impulse as it introduces a legal framework for consumer (co-)ownership. Consumers, individually (Art. 21, households and nonenergy SMEs), collectively (Art. 21, tenant electricity), or in communities (Art. 22, cooperatives and other business models) will have the right to consume, store, or sell energy generated on their premises. RED II also invites the Member States to provide an “enabling framework” for local “renewable energy communities”. The directive links prosumership to so different topics as fighting energy poverty, increasing acceptance, fostering local development, incentivizing demand flexibility, and so on, defining citizen’s rights and duties and evenly important clear definitions (Article 2 RED II).

12.2.2 Fuel/Energy Poverty and Vulnerable Consumers

Applying three different main indicators to measure the proportion of population considered as affected by fuel/energy poverty (Legendre and Ricci 2015), the picture is as follows: 16.6 per cent of the French population live in households with a ratio between expenses and income in excess of 0.1, while 20.9 per cent live in households with an income below the Eurostat poverty threshold of 60 per cent of the national median income, and 9.2 per cent meet the "Low Income-High Costs" indicator (Hills 2012). Policies addressing energy poverty in France relied on special energy tariffs and financial deductions before 2018. The former was mainly organized around "tariffs of primary need" (*Tarifs de première nécessité*) giving households an average annual total bill reduction of EUR 94 on electricity. The latter gave an annual lump sum deduction in the form of energy cheques amounting to EUR 22-15 per household depending on household composition and annual energy bill (Dobbins et al. 2016). Since January 1st 2018, energy cheques are the only measure addressing energy poverty, replacing tariffs of primary need. It can be used to directly pay the energy bill (both electricity and gas) but also for energy retrofitting. The sum depends on the household composition and fiscal revenue and ranges between EUR 48 and 227 per year (chequeenergie.gouv.fr, n.d.)

12.3 Regulatory Framework for Renewable Energy

The main statutory provisions regulating the RES sector in France are contained in the Energy Code, which is divided in a legislative (adopted in 2011) and a regulatory part (adopted in 2016). It was substantially amended following the adoption of the so-called Energy Transition Act 2015-992 on 17 August 2015 and the law 2017-1839 on 31 December 2017.[5] The central authority is the Energy Regulatory Committee (Commission de Régulation de l'Energie—CRE) with its main tasks regulating the energy and fuel markets, supervising transmission system operators (TSOs) and distribution system operators (DSOs), granting licences, and collecting information on the energy market.

[5] See in particular Book II "Demand side management and the development of Renewable Energy Sources", Book III "Dispositions related to electricity", title I "production", Chapter 4 "particular dispositions for energy produced from RES", and Chapter 5 "self-consumption".

12.3.1 Regulations for Connecting Renewable Energy Plants to the Grid

L342-1 to L342-12 of the Energy Code provide for the general obligation of the grid operator to connect RES systems to the grid. Still, the grid operator is only obliged to conclude a contract on a non-discriminatory basis. RE installations do not enjoy a privileged access to the grid, except in the context of the regional schemes for grid connection of RE foreseen by the *Grenelle II* Act distinguishing between installations with a capacity below and above 12 MW; while the former are generally connected to the distribution grid, the latter are connected to the transmission grid. The grid connection process is highly complex. Up to 20 authorities have to be contacted for the permitting procedure, and developers of the RE projects have to bear both direct connection costs and reinforcement costs at the next higher level of the grid. Developers are entirely dependent on the will of the grid operators, who are not bound by legal obligations regarding the deadlines for grid connection, which sometimes results in significant delays (Mignon and Rudinger 2016). However, the law 2017-1839 now foresees DSOs' penalties for connection delays of two months for RES installations smaller or equal to 3 kVA and of eighteen months for RES installations superior to 3 kVA.

12.3.2 Support Policies (FiTs, Auctions, Premiums, etc.)

Before the adoption of the Energy Transition Act, technology-specific feed-in tariffs were the preferred form of financial support to RES. For example, onshore wind generation should receive fixed prices for electricity generation amounting to 8.2 euros cent/kWh for the first ten years and between 2.8 and 8.2 euros cent/kWh for the next five, depending on the reference annual operation duration (France, Ministry for Environment and Energy 2014). France also organized specific tenders periodically focusing on industrial-sized projects to ensure reaching its targets set in the multiannual investment plan (Agora Energiewende 2015).

Art. 104 of the Energy Transition Act modified existing dispositions on FiT (art. L314-1 to 314-13 of the Energy Code) and introduced the market premium (art L314-18 to 314-27). Common dispositions to both instruments are to be found in the regulatory part, Articles R314-1 to D314-14-1. This new regulatory framework is technology-specific and foresees the progressive phase-out of the purchase obligation of electricity from RE based on feed-in tariffs. As of 1 January 2017, most installations are eligible for premiums allocated either through direct guaranteed contracts or through two bidding procedures which are mentioned in Article R311-12 of the Energy Code: call for tender or a competitive dialogue. Eligible for the guaranteed contract are, for example, wind installations with a maximum capacity equal or below 3 MW per turbine, hydropower strictly below a maximum capacity of 1 MW, and solar installations with a peak capacity comprised between 500 kW and 12 MW with no maximum duration given and per default 20 years (France, Ministry for Environment and Energy 2016, 2017; France, Prime Minister 2018a). The bidding procedure is organized by the responsible ministry for the implementation of the multiannual energy programme at irregular intervals. Support through market premium is foreseen up to 20 years but can be further limited by technology.[6]

Moreover, another permanent concern is constant efforts to ease the administrative procedures for the implementation of projects. This is why a one-stop-shop procedure with a single authorization is being tested since 2014 to validate the processing of applications for wind, biogas, and hydropower projects (Observ'ER, REN21 2017).

12.3.3 Specific Regulations for Self-Consumption and Sale to Grid

Art L315-1 to 315-8 and D315-1 to D315-15 of the Energy Code provide the framework for self-consumption. For installations smaller than 3 kW which are connected to the distribution grid, the surplus not sold is injected without financial compensation for the producer. Installations greater than 3 kW are required to agree on a feed-in contract, which can

[6] However, Decree 2018-112 of February 2018 stipulates which technologies and capacities can still benefit from FiT according to previous decrees (France, Prime Minister 2018b), provided they applied before the decree publication and complete the installation or are connected to the grid in a given amount of time (highly variable depending on the installation's characteristics).

include support through a guaranteed tariff or a market premium. Although FiTs are being phased out, small installations are still eligible according to Article D314-15 and the Decree 2018-112 aforementioned. This concerns solar plants with a maximum peak capacity of 100 kW or those smaller than 9 kWp, which applied prior to the decree publication, provided they are connected to the grid in the 36 months following the publication. The FiT guaranteed for solar plants under 100 kW is digressive and revised every quarter since 2017. Traditional hydropower and wave and tidal power plants under 500 kW are eligible and guaranteed a FiT between EUR 88 and 132 per MW/h depending on technology and other characteristics. Biogas plants under 500 kW are guaranteed a FiT up to 15 cents per kWh. Installations smaller than 36 kVa are still eligible and guaranteed the same FiT as before if they complete the installation in the 18 months following the publication of the decree.

Moreover, self-consumers benefit from specific grid tariffs when their installation is smaller than 100 kW. Collective self-consumption schemes, that is, energy supply between one or several producers and one or several consumers, are also exempted from particular dispositions concerning the commercialization of electricity (related to security of supply), the provision of social tariffs, and specific rules regulating energy supply contracts in the Consumption Code.

12.4 Concepts for Consumer (Co-)Ownership in Practice

12.4.1 Contractual Arrangements and Corporate Vehicles Used

In principle participation in RE projects is possible via any available type of corporation, partnership, or individual business activity, similar to those in other European countries. Cooperatives as a legal vehicle are also available, and RE cooperatives are expressly mentioned in Article 111 of the Energy Transition Act. Individual investments in solar collectors and photovoltaic installations on private buildings, often facilitated by municipalities making use of financing programmes offered by the state, are gaining popularity. However, in France, (co-)ownership projects have first appeared only in the early 2000s. These pioneer projects, developed mainly by citizens and supported by local governments, have all come across obstacles—among other things to find financial and legal tools and to gain recognition from the authorities and banks who have been finding their initiatives and statuses unusual (Yalçın-Riollet et al. 2012). These projects are, however, increasing in number and are becoming more and more common. Programmes such as the village centrals ("Centrales villageoises") supported by European and French regional funds also contribute to creating legal tools, for example, company statutes, leases for rooftop installations, and shared services like insurance policy or accounting adequate for these projects (Fontaine and Labussière forthcoming; Poize and Labie 2017).

While RE projects take diverse forms, the simplified joint-stock company (SAS, *Société par actions simplifiée*) and the cooperative company of public interest (SCIC, *Société cooperative d'interet collectif*) are the most widely used corporate vehicles. The former is preferred by citizen projects for being easy to set up as no minimum registered capital is required and having a simple corporate governance structure with its only management body being the president; only individuals or corporations may be shareholders of a SAS. The latter is a form of social enterprise that allows a more democratic governance following the principle one member, one vote and the involvement of local authorities. These advantages are however offset by constraints that reduce their financial attractiveness such as the obligation to have an auditor and to set aside at least 57.5 per cent of the net surpluses as a reserve (Poize and Rüdinger 2014).

12.4.2 Financing Conditions for Consumer (Co-)Ownership in Renewable Energy

12.4.2.1 State Subsidies, Programmes, Credit Facilities, and Preferential Loans

As of 2017, there are no specific policies dedicated to support (co-)ownership projects. However, some regional authorities started to develop their own schemes to foster (co-)ownership models like the "cooperative and community energy" call for projects co-funded by the Occitanie Regional Council and ADEME. This scheme is a financial support dedicated to foster the emergence of RE projects owned by associations and/or local authorities. This programme is organized in three phases: (1) a grant for feasibility studies with a threshold of 70 per cent out of expenses with a cap of EUR 50,000, (2) a loan to help the creation of the (co-)owned organization from EUR 10,000 to EUR 50,000, and (3) a matching premium for citizen participation (*prime à la participation citoyenne*) which is a subsidy supporting the financial investment in the (co-)owned organizations of EUR 1 provided by the region for each euro invested by citizens in the (co-)owned power plants. In 2017, the third edition of this scheme was launched.

In January 2018, the Minister of Energy Transition, Nicolas Hulot, announced the creation of a national fund, Enercit, with the purpose to co-invest in RE projects with a threshold of 40 per cent ownership by associations and local authorities with a requirement of 20 per cent of the shares owned by citizens' associations. This fund is specifically dedicated to help participatory and citizen-led initiatives in the development phase of RE projects. Enercit will have a budget of EUR 10 million, willing to support 150 projects within 10 years and is funded by a cooperative bank, the Crédit Coopératif EUR 2.5 million, a public investment bank, the Caisse des Dépôts EUR 5 million, and a national pension fund for civil servants, the Ircantec EUR 2.5 million.

Otherwise RE projects can be financed through general financing programmes or funding mechanisms linked to the development of the social and solidarity economy and the adoption of a dedicated law in 2014. Items include:

- Funding mechanisms of France Active, a network and movement supporting job creation or safeguard, and the ESS created in 1986, whose latest strategy (called "Ambition 2020" from 2016) explicitly refers to the energy transition as an element of its ambition.
- A crowdfunding platform from the Investment Public Bank (BPI), however, not restricted to energy projects, was launched on September 2013: As of March 2018, the platform was partnering with 38 other

crowdfunding platforms and had collected EUR 46.9 million (donations, loans, and shares) to fund 777 environmental projects (RES but also agriculture/food, biodiversity, and transport/smart city) for a success rate from 45 per cent for donations, 69 per cent for loans, and 96 per cent for shares (BPI, n.d.). Private crowdfunding platforms specialized in RES projects are lumo, enerfip, or lendosphere among others.
– The activities of the BPI are also reinforced through the creation of the social and solidarity participatory loan (PPSS), an investment fund dedicated to cooperatives, and the extension of investment guarantees from corporations to big associations.
– The NovESS fund (NovESS, n.d.) created in 2016 by Caisse des dépôts et consignations with public and private financial actors, whose first project was to invest EUR 2.5 million in Enercoop (see Sect. 12.4.3).

These funding capacities complement a tax incentive arsenal for persons investing in RES such as an income tax credit for taxpayers residing in France or a reduced VAT for services, equipment, and delivery for nonbusiness entities.

12.4.2.2 Agencies Supporting Investment in Renewable Energy Sources

VALOREM founded in 1994 to promote renewable energy as a sustainable alternative to fossil fuels became a market leader in green energy production within 15 years. *VALOREM*'s objectives are the investment in research and development, the development of environmentally friendly projects anchored locally involving multiple stakeholders, and the promotion of eco-friendly energy production. In 2012 it was a pioneer in crowdfunding a wind turbine project in cooperation with the Crédit Coopératif Bank. As of 2018 more than EUR 3.5 million in 14 campaigns have been raised thanks to the participation of over 1800 citizens (VALOREM n.d.).

Énergie Partagée Investissement was founded in 2010 by eight organizations: two cooperative banks, La Nef and Crédit Coopératif; the green energy cooperative supplier, Enercoop; the local association initiating the Béganne wind power project, Eoliennes en Pays de Vilaine; an association supporting photovoltaic development since the 1980s, Hespul; a national association advocating for renewable energy development and energy efficiency, the CLER; a local energy agency from the eastern part of France (Champagne-Ardenne), ALE08; and a consulting group, INDDIGO. The rationale behind the creation of Énergie Partagée was to raise resources to first obtain the certification given by the Autorité des Marchés Financiers (AMF) and needed to do public campaigns to raise funds for project development and then use it to support local initiatives willing to (co-)own and/or develop renewable energy projects.

12.4.3 Examples of Consumer (Co-)Ownership

In France, citizen energy initiatives and local projects open to the public are few in number and often in an embryonic state when it comes to concrete achievements.

I. Le Mené's energy self-sufficiency project—One of the most advanced cases is a rural Communauté de Communes (CdC)[7] in Central Brittany called Le Mené, which is a pioneer in local energy autonomy (See Yalçın-Riollet et al. 2014). In this region, a group of local officials and individuals, mostly farmers, conduct various initiatives: a methane plant, an oil mill, a wood-fired heating plant and network, a participatory wind energy project, low-energy buildings, an incubator for companies dedicated to renewable energy, eco-construction, and others. Three flagship projects stand out:

(1) *Collective methane production*—In the Géotexia project developed in response to regional regulations on the reabsorption of excess nitrogen, 30 or so farmers founded a cooperative in partnership with the municipalities and the agro-industry processing manure from pig farms and other organic matters like slaughterhouse waste to produce electricity and heat. As industrial partner Idex of Paris took up 32 per

[7] In France, municipalities can choose to group together into "communautés de communes" (CdC, community of municipalities) to exercise a certain number of competences on the members' behalf (economic development, town and country planning, environment, roads, sports and cultural infrastructures, etc.).

cent of the shares, the public bank Caisse des Dépôts et Consignation[8] owns 34 per cent, while the cooperative provided EUR 500,000 also equivalent to 34 per cent. The project was subjected to the discontent of local residents concerned about smell, noise, and pollution. A local association challenged the operating authorization in the administrative courts causing considerable delay until the methane plant went into operation in 2011 producing electricity and supplying greenhouses with heat.

(2) *Production of fuel oil*—Ménergol, a cooperative oil mill bringing together around 40 farmers, started its operation in 2007 with the objective to replace diesel in farming machines with locally produced rapeseed oil and imported soya meal with rapeseed meal (the solid residue). EU and other grants financed 60 per cent of the EUR 480,000 investment with the remainder covered by equity capital a loan taken out by the cooperative (Carré et al. 2007).

(3) *Participatory wind energy*—In 2007, energy operator Idex sought to build a second wind turbine park in the region. The region's inhabitants initiated a civic dynamic to invest in the park and negotiated a 30 per cent shareholding with the operator. Additionally, the Caisse des Dépôts owns 20 per cent, and Oxyan Energies (to which Idex sold its holding) owns 50 per cent. Approximately 140 people have invested in the park, in the form of investment clubs called CIGALES,[9] a novel organizational form for wind energy. In 2013 the six wind turbines started to operate encountering—unlike numerous other installations in France—no opposition, with the citizen's participation appearing to have considerably improved acceptance of the project (Chataignier and Jobert 2003).

II. Enercoop—The *Enercoop* project (http://www.enercoop.fr) was founded in September 2005 as a collective interest cooperative company. *Enercoop* is the only supplier of energy in the form of a cooperative

[8] The Caisse des Dépôts is a public group made up of a public institution and subsidiaries. See http://www.caissedesdepots.fr/en.

[9] A CIGALES (*Club d'Investisseurs pour une Gestion Alternative et Locale de l'Épargne Solidaire*) is a solidary risk capital structure which uses its members' savings to create and develop small local companies and cooperatives; its disadvantage is that it is limited to 20 persons.

society, sanctioned by the French State as a “social enterprise”. The organization acts as a supplier of green energy which purchases energy directly from renewable energy producers (solar, wind, hydraulic, and biogas) with profits being ploughed back into RE projects with a cumulative capacity of 150 MW in 2018. Citizens can either become consumers or members of the organization, which allows them to participate in the decision-making process. To become an active member, citizens pay EUR 100 for the acquisition of a capital share; in the beginning of 2018, *Enercoop* counted 56,000 clients and 30,000 active members. A long-term goal of Enercoop is to create local citizens’ cooperatives for energy. Between 2009 and 2018, ten regional cooperatives had been set up across France (Enercoop 2018).

III. Béganne community-owned windmill farm—The wind farm consists of four wind turbines with 2 MW installed capacity each, an investment of about EUR 12 million (Le Hir 2016). The financing of the construction and operation phases took place under the legal form of a simplified joint-stock company in which a limited liability company (*SARL*) invested its capital. Voting rights are not assigned proportionally to investment, the decision-making process is similar to that in cooperatives, and meetings are held regularly to actively involve the project’s stakeholders. Four groups within the joint-stock company contributed the equity share of around EUR 2.5 million: EUR 400,000 by the funding members, 30 private individuals, the association *Eoliennes en Pays de Vilaine* and the local company *Site à Watts* obtaining 35 per cent of the voting rights constituting a blocking minority; EUR 1.4 million by 53 investment clubs of about 800 local citizens obtaining 31 per cent of the voting rights; EUR 300,000 by the Regional Investment Fund *Eilan* with 18 per cent of the voting rights; EUR 500,000 by the National Investment Fund *Énergie Partagée Investissement* with 1 per cent of the voting rights; and EUR 50,000 by local, social, and solidarity-based enterprises with 15 per cent of the voting rights (Eoliennes en Pays de Vilaine, Annual report, 2017).

IV. Parc éolien de la régie communale de Montdidier—While planning took off in 2003, the Montdidier wind farm commenced operating in 2010 (Chauveau 2010). The European Regional Development Fund (ERDF), the Regional Council of Picardie, and the municipality of Montdidier each contributed EUR 1 million and the General Council of Region of Somme EUR 120,000 supplemented by a EUR 8.5 mln loan contracted by the municipality of Montdidier covering the cost of approximately EUR 11.2 million. The wind farm has a nominal capacity of 8 MW and a production capacity of 19 GWh per year, which covers 53 per cent of the annual energy consumption of the city of Montdidier.

12.5 Factors Affecting the Financing of Renewable Energy Sources and Barriers to Consumer (Co-) Ownership

12.5.1 Political, Legal, and Administrative Factors

Three key barriers to consumer (co-)ownership are related to political, legal, and administrative factors: the financial institutions, the lack of political legitimacy for renewable energy, and the opposition against wind power. Regarding the financial institutions, a striking difference is that none of the financial infrastructure existing in Germany (e.g., KfW; see Chap. 13) is available, and due to the lack of stability for renewable energy support policies, banks have been reluctant to grant loans for renewable energy projects (Mignon and Rüdinger 2016).

The lack of political legitimacy for renewable energy in France has been outlined by many scholars. Mignon and Rüdinger have mentioned that "French policies are over shadowed by the general lack of legitimacy of renewables in the field of electricity, given that most politicians argue that France already has a competitive and low-carbon power system, thanks to the historical development of nuclear energy", whereas Szarka (2007) has outlined that due to the hegemony of a meso-corporatism policy style, France is transforming only from inadvertent to reluctant pioneer regarding climate and energy policies. In a comparative study of renewable energy integration within national policies in Denmark, Germany, and France, Evrard (2013) has demonstrated that France is still ranked as a "laggard with a controlled openness towards renewable energy". This lack of political legitimacy of renewable energy is directly related to the third barrier, the strong opposition against wind power.

This energy is highly controversial in France with many associations like Vent de Colère advocating against it through an emphasis on landscape and environmental potential consequences. This strong opposition translated into a dramatic slowdown of wind power development with a critical number of projects cancelled over the last years. The French decision-making process for wind power is based on a regional pattern identifying potential areas for development made by regional authorities. In 2016, 14 out 22 wind power regional patterns were cancelled due to lawsuits from anti-wind associations.

12.5.2 Economic and Management Factors

Due to the lack of stability for RES support policies, banks have been reluctant to grant loans for RE projects. The issue of financing is considered by practitioners as one of the key barriers. To circumvent burdensome bureaucracy imposed on RE cooperatives, *Énergie Partagée Investissement* (see Sect. 12.4.2) was founded. By limiting citizen participation projects to 90 persons, financing of larger projects remains possible without incurring bureaucratic hurdles otherwise encountered. This is directly related to the lengthy and complex process of obtaining a visa from the financial market authority to raise private equity. Considering this, the new law on the energy transition should clarify the status of RE cooperative projects and facilitate the capital raising process needed for such projects (Mignon and Rudinger 2016).

Size of RES prosumership projects (subscale investments)—As underlined before although there is a growing number of (co-)owned power plants in the French market, a key issue lies in the size of these initiatives. Most of them are small-scale projects. In 2017, only 4 out of 54 (co-)owned projects have a generation power above 10 MW, a level corresponding to the electricity consumption of 5000 households.

12.5.3 Cultural Factors Affecting

Regarding the cultural factors affecting consumer (co-)ownership projects, a key issue lies in the attitudes of market actors. Three core elements need to be highlighted: the increasing interest of commercial developers for (co-)ownership models, the controversy around these models, and the reluctance of market actors to support mandatory policies fostering local ownership. Citizen participation has become an important factor for projects' viability due to legal hurdles caused by local opposition. An increasing number of commercial developers have thus started to work with citizens' groups.[10] After looking at the energy portfolios of the top 20 wind power developers in the French market, we have noticed that 70 per cent of them include cooperation with individuals' citizens or organizations within their business activities (Wokuri 2017). For these enterprises, working with citizens is a way to differentiate themselves from other companies. Some of them dedicate specific sections of their activity report to the question of citizen involvement like JP Energie Environnement. Others published specific reports related to this question like Quadran, who released a report called "Our references of citizen and participatory projects". Finally, other enterprises dedicate a section of their website to citizen participation like the German developer ABO Wind who has a section called "L'éolien citoyen".

However, when looking at commercial developers' attitudes towards (co-)ownership, two key issues stand out: tensions related to the decision-making process[11] and reluctance to implement mandatory policies to foster (co-)ownership. These tensions around the governance organization translate sometimes into legal conflicts between developers and citizen organizations like the Clamecy wind power park. This project was supposed to be a cooperation between a developer, ABO Wind, and a citizen group, Le Varne, but both actors disagreed on the return on investment levels. This disagreement

[10] An employee of Taranis, a regional network based in Brittany supporting citizen organizations for the development of RE projects, noticed commercial developers increasingly solicit citizen groups; interview, Redon, January 2016.

[11] A civil servant from the French Agency for the Environment and Energy Management (ADEME) speaks of a cleavage of governance: those citizens pushing to be involved in every step of the decision-making process at the cost of slowing it down and those merely interested in the financial benefits and thus pushing for rapid project development; interview, Rennes, October 2015.

led the citizen organization to file a lawsuit against the developer. Regarding the reluctance of developers to support mandatory instruments fostering (co-)ownership, the hearings and discussions around the Energy Transition Act help to understand this attitude. During the debates and auditions related to this law, environmental NGOs and organizations like *Enercoop* or *Énergie Partagée* advocated for policies to make (co-)ownership schemes compulsory for developers when it comes to start a project[12]: With regard to the capital of RE project companies, the *Réseau Action Climat* advocates a compulsory opening to all, not only to local residents. The *Fondation Nicolas Hulot* assumed that citizen funding could eventually be made compulsory like in Denmark after simplifying citizen investment.

An amendment (no. 343 of 19 September 2014) tabled by two MPs reflected the mentioned proposal as it mandates the opportunity to access to RE production capital by local authorities and citizens. However, the wind power and photovoltaic developers were sceptical about this compulsory approach.[13] In a policy paper on the Energy Transition Act, the wind power trade association *France Energie Eolienne* argued against the amendment citing delays in project development and an amalgamation of projects with relatively low-risk citizen participation and those with higher risk initiated by citizens (FEE 2015). The amendment was rejected by the National Assembly.

12.6 Possible Future Developments and Trends for Consumer (Co-) Ownership

Three recent evolutions might influence the development of future (co-) ownership models: the direct electricity selling from (co-)ownership projects to a national cooperative, Enercoop, a feed-in tariff with financial bonuses for (co-)owned power plants, and the Enercit fund mentioned before.

[12] Audition of Thursday, 11 September 2014, p. 240.

[13] The head of the renewable energy trade union, *Syndicat des Energies Renouvelables* (SER), assumed that "we are all open to the possibility not only for companies in the social and solidarity economy sector but even for private individuals or for mixed companies to participate in the capital of project companies that develop renewable energy. However, we must not have any obligations in this area"; Audition Séance du jeudi 11 septembre 2014, p. 82.

Before 2016, the national utility EDF was the only company allowed to receive the tax levy recovering charges related to renewable electricity purchase (so-called Contribution au Service Public de l'Electricité, CSPE). This had a direct influence on energy suppliers that got into the market during the last decade like the cooperative Enercoop. This cooperative sources its electricity supply from 100 per cent renewable sources but does not have access to the tax levy recovering charges. That means their electricity is more expensive than the one sold by EDF. In September 2016, a decree from the Environment and Energy Ministry opened the tax levy recovering charges related to renewable electricity purchase (CSPE) to Enercoop with, however, a cap of 75 purchase contracts equivalent to a maximum of 100 MW installed capacity.[14] Extending this right to the tax levy would provide a new market integration opportunity for (co-)ownership initiatives.

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13

Consumer (Co-)Ownership in Renewables in Germany

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13.1 Introduction

13.1.1 Energy Mix

The German energy sector is characterized by a heterogeneous portfolio of production technologies. In 2016, RE had the highest share in primary energy production with a share of 43.2 per cent followed by lignite with 38.8 per cent, natural gas with 6.3 per cent, hard coal with 2.9 per cent, and petroleum with 2.5 per cent, while other sources including nuclear energy made up for 6.1 per cent (AGEB 2017).

In contrast to primary energy production, RE has a subordinate role in primary energy consumption where in 2016 it came in third place with an overall share of 12.6 per cent—with bioenergy having the largest share with 6.5 per cent—after petroleum with 34.0 per cent and natural gas with 22.6 per cent; hard coal and lignite had a share of 12.2 per cent and 11.4 per cent, respectively, and nuclear energy 6.9 per cent. However, the share of RE increased from 2015 to 2016 by 2.8 per cent and the share of natural gas by 9.5 per cent, while the share of nuclear energy decreased by 7.8 per cent and the shares of hard coal and lignite by 5.1 per cent and 2.8 per cent, respectively (AGEB 2017). Regarding RE in gross energy consumption, the share in 2015 was 31.7 per cent in electricity, 13.4 per cent in heat, and 5.1 per cent in transport; in electricity, onshore wind with 34.5 per cent, solar energy with 20.3 per cent, and hydro energy with 11.2 per cent had the highest shares (Umweltbundesamt 2017).

13.1.2 Main Challenges for the Energy Market, Specific Policy Goals, and National Targets

Recent developments indicate that Germany will follow the international trend, where the growth of primary production from RES exceeds that of all other energy types. One of the major challenges of this development is high energy prices for private households[1] which are, among others, due to specific surcharges that were introduced to compensate network opera-

[1] An international comparison of prices for private households in EU countries in 2016 reveals that German households bear the second highest costs for electricity per kilowatt-hour (kWh) in the EU with an average of around 33 euro cent per kWh for an annual consumption below 2500 kWh per year although the wholesale prices for electricity are low.

tors that otherwise would have to bear the difference between the fixed feed-in tariff (FIT) for RE and the lower wholesale price (BMWi 2017). Among further challenges is the shutdown of a substantial number of environmentally friendly natural gas-fired thermal power plants that were decommissioned due to the drop in wholesale electricity prices and led to a higher share of electricity produced from hard coal and lignite.

To foster greater market proximity and competitive determination of electricity prices, the recast of the German Renewable Energy Sources Act (EEG) in 2014 introduced mandatory direct marketing and a change from a fixed FIT to a variable premium system, implying that whoever produces electricity must also market it, except for electricity produced from small-scale photovoltaic (PV) installations (BMWi 2016). The 2017 recast of the EEG introduced tenders for onshore and offshore wind as well as for biomass and large-scale PV installations with more than 700 kWp. Overall national targets include a share of RE in gross electricity consumption of at least 35 per cent, 14 per cent in gross heat consumption, and 10 per cent in transport by 2020. For electricity, a particular emphasis is set on the development of wind energy with flexible targets for expansion by 2800 MW per year until 2019 for onshore wind and by 500 MW per year in 2021 and 2022 for offshore wind. Furthermore, an 80 per cent reduction goal of GHG missions compared to 1990 levels has been established (Henning and Palzer 2014).

13.1.3 Ownership Structure in the Renewable Energy Sector

In the course of the transition towards a more sustainable production portfolio, particularly the renewable electricity sector has witnessed the entrance of numerous new actors. An assessment of the ownership structure in 2016 estimated that citizens including farmers owned the highest share with 42 per cent of the installed capacity, that is, 42 GW_{el}, followed by institutional and strategic investors with 41.2 per cent, while established nationwide and regionally operating energy companies and others owned merely 16.8 per cent (trend:research 2017). However, these estimates should be handled carefully due to methodological restrictions; for example, around 30 per cent of citizen ownership in a wider sense captures bond holdings, minority shareholding, and interregional investments in

RE facilities where either the exact ownership share is not clear, property rights are allocated without voting rights, or schemes may be included that do not confer property rights at all voting rights.[2]

Therefore, this assessment should be read against the background of data on citizen-owned energy projects in a narrower sense where citizens are majority shareholders:

- Here recent estimates find around 1700 citizen energy projects in 2016 of which 1500 are in energy production and the rest are in distribution and energy services; while the bulk of RE production projects is in solar and wind energy with an even share of about 43 per cent, bioenergy with 6.2 per cent and hydropower with 0.7 per cent play a minor role, and other RES are negligible.
- 54.6 per cent of these projects are energy cooperatives; limited partnerships with a limited liability company as general partner (GmbH & Co. KG) come second with 36.6 per cent. The latter are expected to increase in number due to the significance of this business model in the onshore wind sector while the number of energy cooperatives is stagnating. Other legal forms like limited liability companies (GmbHs) or civil law partnerships (GbRs) are less widespread and not well documented (Holstenkamp et al. 2017).
- In terms of regional distribution, around 92 per cent of citizen-owned projects are located in the federal states of former West Germany amongst others due to differences in household income and available RE resource potentials, the latter being an indicator for regional concentration of specific RE technologies. Accordingly, consumer (co-)ownership business models in wind energy are often located in federal states at the northern coastline, like Schleswig-Holstein, Lower Saxony, and North Rhine-Westphalia, while the southern federal states Bavaria and Baden-Wuerttemberg are preferred locations for solar energy (Kahla et al. 2017).

[2] Furthermore, the 2016 survey excludes data from sectors such as offshore wind, geothermal energy, facilities producing energy from biogenic waste, and pump-storage power plants, all sectors where consumers as investors play a minor role so that the overall share of citizen ownership in RE is somewhat overestimated (Holstenkamp et al. 2017).

13.2 The Consumer at the Heart of the Energy Market?

13.2.1 Consumer (Co-)Ownership in Renewable Energy Sources as Policy Goal

The German discussion focuses on what is termed "citizen energy" ("Bürgerenergie"), that is, the ownership of energy assets and/or projects by citizens or communities of locality. In this regard, the national legislator has made the "… preservation of the diversity of actors…" an explicit policy goal introduced into the 2014 recast of the Renewable Energy Sources Act (EEG) and keeping it in sec. 2 para. 3 sentence 2 of the 2016/2017 recast of the EEG. Furthermore, sec. 3 no 15 EEG defines citizen energy companies as consisting of at least ten natural persons who are members eligible to vote or in which at least 51 per cent of the voting rights are held by natural persons with a permanent residency in the administrative district of the project location and where no member or shareholder of the undertaking holds more than 10 per cent of the voting rights.[3] However, the practical meaning of this aim for consumer ownership remains unclear so far as discussions about its implications are continuing and the legal specification and implementation of what is to be perceived as actors deserving protection at the beginning of 2018 were still pending.

Besides this superordinate but vaguely formulated support for direct ownership of energy assets by citizens, further less or more explicit measures at the national (see Sect. 13.3.2 for details) and federal states (Länder) level exist to support citizen energy. An example for the latter is the Federal State of Mecklenburg-Western Pomerania, which, in 2016 inspired by the option to purchase for citizens from the Danish Renewable Energy Act of 2009, was the first state to introduce a law for citizen ownership in wind power in Germany (Maly et al. 2014). The legislation aims to improve public acceptance of new wind turbines and lift local value creation by providing opportunities for the economic participation of

[3] In the case of an association of several legal persons or unincorporated firms to form an undertaking, it is sufficient if each of the members of the undertaking fulfils these preconditions.

local residents and neighbouring municipalities. This legislation requires that project developers set up a company for each new wind energy project and offer a stake of up to 10 per cent to citizens and municipalities located within a 5-kilometre radius of the project, respectively (in total up to 20 per cent). Alternatively, the law allows for other financial models to distribute economic benefits among residents such as a fixed-term deposit scheme or preferential electricity pricing schemes. While municipalities are free to choose one of the two options, citizens only have the possibility to invest in shares (Gotchev 2016).[4]

Finally, consumer (co-)ownership received explicit recognition of its crucial role in the 2018 recast of the Renewable Energy Directive (RED II) as part of the Clean Energy Package. The transposition of the RED II into German Law until 2021 will be an important legislative impulse as it introduces a legal framework for consumer (co-)ownership. Consumers, individually (Art. 21, households and nonenergy SMEs), collectively (Art. 21, tenant electricity), or in communities (Art. 22, cooperatives and other business models) will have the right to consume, store, or sell energy generated on their premises. RED II also invites the Member States to provide an "enabling framework" for local "renewable energy communities". The directive links prosumership to so different topics as fighting energy poverty, increasing acceptance, fostering local development, incentivizing demand flexibility, and so on, defining citizen's rights and duties and evenly important clear definitions (Article 2 RED II).

13.2.2 Fuel/Energy Poverty and Vulnerable Consumers

In 2016, 3.7 per cent of the German population, that is, three million people, lived in households that did not have sufficient income to heat their home and suffered from energy poverty (EUROSTAT 2017). This situation is amongst others a result of steadily increasing prices for housing and energy, stagnating incomes taking inflation into account, and small pensions. Policies addressing the energy poverty in Germany rely on support in line with the social security system. Additional albeit only punctual support

[4] By the time of writing this book chapter, no project was realized under the scheme. This is due to lengthy project planning horizons and the complexity of implementing actual projects according to the legal requirements.

is provided by projects like the Municipal Energy Savings Check ("Stromspar-Check Kommunal" www.stromspar-check.de), a project that since 2008 is available in 190 German municipalities with 220,000 checked households; its genuine approach involves the training of long-term unemployed as energy consultants and using established channels of social work in particular with regard to measures for energy savings (Pye et al. 2015).

Although policies for self-supply are generally supported by the public, controversial aspects should also be considered. In this regard, redistribution effects are an important drawback in Germany. The more consumers supply themselves with electricity, the less they receive from the public grid and the less they contribute to grid and other surcharges and levies, for example, renewables surcharge, concession levies, and electricity tax. The resulting loss of revenue is subsequently compensated by increasing levies for the remaining consumers who do not have the economic means for self-supply among which are disproportionately many low-income households (Haas 2017). As a result, the group that cannot afford to invest in RE production facilities bears higher costs for energy supply aggravating their already precarious financial situation while indirectly supporting RE investments of the group that is better off. Hence, the gap between low-income households and other consumer segments widens so that political measures are needed to avert an erosion of solidarity.[5] A discussion about how to integrate less well-equipped urban populations has started.

13.3 Regulatory Framework for Renewable Energy

13.3.1 Regulations for Connecting Renewable Energy Plants to the Grid

In general, network operators are required under the German Energy Industry Act (EnWG) to connect end consumers, other energy supply networks and their lines, and generation and storage facilities to their

[5] The low rate of participation in RE projects of low-income households is also reflected in recent surveys, for example, one among members of energy cooperatives showing that membership is not socio-economically balanced (Holstenkamp et al. 2017) favouring homeowners and financially better-off people.

networks on reasonable, non-discriminatory and transparent terms. Operators of "general supply networks" are required to publish their general terms and conditions for network connection and use of connection points for end consumers in low-voltage and low-pressure networks and are required to connect requesting customers to their networks under these terms and conditions. They are entitled to charge customers appropriate connection costs and contributions towards installation costs (BNetzA 2017). In addition, the EEG regulates that electricity from RES has feed-in priority implying that RE must preferably be utilized as long as the network is technically capable of absorbing the energy.

13.3.2 Support Policies (FITs, Auctions, Premiums, etc.)

General support policies for RE technologies are included in the national and regional legal frameworks. Examples at the national level are a market premium determined and assigned by an auction mechanism and the provision of a flexibility surcharge where operators of new biogas plants can claim additional support for providing capacity for on-demand use. The most significant change of the legal framework was a paradigm shift from fixed FITs for electricity produced from renewable sources to competitive auctions in order to steer the expansion and limit costs.[6] In detail, tendering procedures were introduced for onshore and offshore wind projects starting from 750 kW installed capacity, PV projects starting from 750 kW installed capacity, and biomass plants starting from 150 kW installed capacity.

With further amendments of the EEG in 2016, the German government enacted explicit rules for "citizen energy companies and energy cooperatives" (see definition in Sect. 13.2.1) in onshore wind and PV auctions. Even though citizen and energy cooperatives' projects still have to participate in auctions for remuneration unless they bid for projects

[6] At the national level, the fixed feed-in tariff for energy produced from renewable sources in place until the 2014 recast of the EEG served as support for citizen investors by providing high investment security to small actors (Mendonça et al. 2009).

smaller than 750 kW installed capacity, they enjoy preferential treatment. They benefit from further financial privileges such as reduced security payments of EUR 15/kW. But most importantly such projects receive the highest FIT accepted in the tender by default (sec. 3 and sec. 36 of EEG 2017). These preferential rules are considered as one measure to ensure the superordinate goal of preserving the diversity of actors mentioned above.

13.3.3 Specific Regulations for Self-Consumption and Sale to the Grid

Specific regulations for self-consumption were introduced in the EEG of 2009 with regulations for self-supply with electricity from photovoltaics and later expanded in the 2014 recast of the EEG, among others by a legal definition of self-supply. According to the legal definition in section 3 no. 19 EEG, a self-supply is the consumption of energy which is not routed through a public grid by a natural or legal person in immediate proximity from an electricity generating plant they operate themselves. The most significant change from the previous legal framework introduced in 2017 is that any electricity delivered or self-generated is charged with the full renewables surcharge ("EEG-Umlage"). Even though a number of exceptions allow a full or pro-rata exemption, in practice the regulations leave little room for manoeuvre, especially in the case of new self-supply constellations and business models such as tenant's electricity supply ("Mieterstrom").

As a transitory regulation, investments made in confidence in the previous legal situation are protected and exempted from the new rules. In case the owner/operator and consumer are not identical, yet the consumers use the electricity in close proximity to the generation facility, not all levies and surcharges have to be paid. A measure which may further enable self-consumption is the 2016 Law on the Digitalization of the Energy Transition ("Gesetz zur Digitalisierung der Energiewende"), which sets a timeline for the roll-out of smart meters in households.

The Tenant's Electricity Supply Act (Mieterstromgesetz) was adopted in June 2017 to safeguard the economical soundness of tenant's supply projects yet limit the disparity in levies paid due to growing self-consumption. Accordingly, operators pay only a reduced renewables surcharge for electricity from their solar or bioenergy installation if it is installed on, affixed to, or installed in a building and the electricity is supplied to a third party for use within the building the energy production facility is installed on, affixed to, or installed in. Furthermore, electricity produced by "Mieterstrom" projects can be supported by surcharges between 2.2 cent per kWh and 3.8 cent per kWh under certain conditions. Thus tenants buy electricity that is produced in the same building via PV or combined heat and power, generated locally without the need to be transferred through long grids with cost benefits for the operator and for the participating tenants (Großklos et al. 2016).

13.4 Concepts for Consumer (Co-)Ownership in Practice

13.4.1 Contractual Arrangements and Corporate Vehicles Used

Initially consumer ownership consisted mainly of individual self-supply concepts, for example, through solar panels on rooftops, but lately, newer models aiming at realizing collaborative consumer ownership models have been gradually entering the market. As of today, financial participation of citizens in RE comes in different forms: (1) individual ownership and/or leasing arrangements, especially for small PV or battery storage projects, but also for heat pumps with self-sufficiency being a major motivation as the legal framework is shifting away from guaranteed FITs; (2) bearer bonds (e.g., Hamburg Energie Solar), sub-ordinated loans (e.g., in combination with cooperative shares), or savings certificates issued mostly by local savings or cooperative banks are typical investment products[7] although they mostly do not confer voting rights; (3) collective

[7] About one fifth of the German municipal utility companies offer such products to their customers and/or local inhabitants (Holstenkamp 2014).

investments differing with regard to motivation (Holstenkamp and Kahla 2016), organizational form, that is, bottom-up/grassroots vs. initiated by intermediate organizations vs. investor-owned projects initiated by developers or issuing houses (Enzensberger et al. 2003a), and legal structure. Three legal structures have become "standards" for collective investments in the German RE sector (Holstenkamp 2014):

- Civil law partnerships are in use mainly for small PV installations but also in some other cases like bioenergy villages. Since all investors are personally, jointly, and severally liable, they are mainly restricted to early phases of development, for example, the association of property owners for the development of a wind farm and to cases where other legal structures are not economically feasible due to the higher costs (Yildiz 2014).[8]
- Limited partnerships with a limited liability company as a general partner are a common structure for medium- to large-scale projects, especially in the wind energy sector, but also in the case of ground-mounted solar PV installations. Usually, the limited partnership company is set up for individual projects, that is, functions as a special-purpose vehicle for projects where citizens are to be involved with minority shareholdings (Enzensberger et al. 2003a).[9]
- Energy cooperatives whose number has increased significantly in the past, especially in the period 2008–2012. A large part of the energy cooperative sector is made of PV cooperatives and cooperatives operating mainly biomass-fired district heating grids, dubbed "bioenergy villages" (Yildiz et al. 2015).[10]

A smaller number of cases exist for joint-stock corporations (e.g., Solarcomplex AG, Green City Energy AG), foundations (e.g., Christoph 2014), limited liability companies (e.g., Wärmenetz Ortlfing GmbH), or

[8] Registered associations active in the promotion of solar energy often initiate civil law partnerships in some cases taking over main project-related risks to shield private investors from liability risks.

[9] With the professionalization in the RE sector this structure common in the German direct investment market led to a shift towards investor-oriented projects (Enzensberger et al. 2003b) making it difficult to filter community-owned RE projects.

[10] While the number of newly founded energy cooperatives has been decreasing since 2013 due to changes in the EEG, lately there are signs of a diversification of business models among them (Kahla et al. 2017).

mezzanine equity schemes like silent partnerships (e.g., plusPOWER GmbH). Public bodies, especially municipalities, may join forces in a public-law institution (e.g., AöR Solarpark Börrstadt), and sometimes different types of legal structures are combined like silent partnerships in limited partnership models or sub-ordinated loans besides shares in cooperatives. All in all, the sector is characterized by a large degree of heterogeneity. This diversity is often ascribed to the favourable legal environment but also to the characteristics of the financial sector with its strong role of local banks in financing projects (Hall et al. 2016). A third factor may be the large number of municipal utility companies that partly engage in these citizen energy projects.

13.4.2 Financing Conditions for Consumer (Co-)Ownership in Renewable Energy

Institutional support for citizen energy is widely available and well advanced in Germany characterized by a network of state-, private-, or self-regulated institutions, which provide knowledge, expertise, or financial support mostly on federal state, regional, and local levels.

13.4.2.1 State Subsidies, Programmes, Credit Facilities, and Preferential Loans

Financial support is available through preferential loans granted by the state-owned development bank Kreditanstalt für Wiederaufbau (KfW) and the aforementioned involvement of private local banks in project financing. As there is a multitude of such programmes available, we refrain from listing the individual programmes.

13.4.2.2 Agencies Supporting Investment in Renewable Energy Sources

Among the support mechanisms in this domain are more than 39 energy and climate protection agencies on federal state or regional level in Germany, of which many actively support citizen (co-)ownership by providing information and knowledge as well as networking activities. Support for the legal form of cooperatives is available from the German Cooperative and Raiffeisen Confederation (DGRV) and regional cooperative confederations in forms of advocacy and financial counselling.

13.4.3 Examples of Consumer (Co-)Ownership

I. Heidelberger Energiegenossenschaft eG (HEG) is an example of the application of tenant solar supply. In 2012, HEG started to think about developing solar direct-use business models, because the FIT had fallen below electricity rates for private households. In the following year, with an initial investment sum of EUR 1 million, HEG installed 12 PV plants with a combined capacity of 700 kWp in Ladenburg on top of a local school and in Nußloch on top of a multi-storey dwelling, a village near Heidelberg. The tenants consume part of the electricity produced, which HEG sells at a slightly lower rate than the primary provider, that is, the local utility company, does. HEG developed the model together with a building cooperative, EUROSOL Energy Solutions, and NaturStrom Aktiengesellschaft (Will and Zuber 2016). More generally, HEG plans, finances, and realizes PV projects on rooftops of companies and public and private buildings based on bank loans and citizen participation. Citizens can get involved in different ways and at different levels of activity: (1) they can join the cooperative, co-decide on the energy transition in Heidelberg, and become (co-)owner of a PV plant with a share of 100 or rather EUR 1000; (2) they can participate by purchasing local and green electricity from HEG in a producer-consumer community from PV or wind power plants and a hydropower station; (3) they can make an investment in HEG projects; or (4) they can install a PV power plant on their roof in cooperation with HEG or its network partners such as Bürgerwerke eG.

II. An example for the involvement of different stakeholders and participation of citizens are district heating grids or bioenergy villages like **Bioenergiedorf Jühnde eG** (Bioenergiedorf Jühnde 2017). In 2005, Jühnde was the first German village being self-sufficient and producing RE with consumer participation, in particular through bioenergy plants and CHP systems with a local heat network delivering heat to households. Farmers, the municipality, and some consumers founded a cooperative and work closely together with players such as grid operators and suppliers, scientists from the University of Göttingen, and engineers. Around the core project with an initial investment of EUR 5.8 million, that is, the district heating system, the cooperative has developed other projects: the community installed PV and wind power plants and implemented mobility concepts as well as concepts to mitigate fluctuating demand and supply from PV and wind energy. Beyond heat consumers and local supporters, up to 25 per cent of the shares can be sold to other communities/regions. The cooperative's members benefit from an average EUR 750 in energy cost savings yearly per household. Furthermore, from 2013 onwards dividends have been paid out to the members. A support association for climate protection and responsible use of natural resources aims at transferring the Jühnde concept to other regions.

III. Elektrizitätswerke Schönau (EWS) eG is an example for a business model with a membership base of over 5000 in 2016 and providing energy to 160,000 households, small businesses, and industrial corporations. It integrates various processes along the energy sector's value-added chain, that is, energy production, distribution, grid operation, and energy services, and operates even outside the funding region (EWS 2017). The EWS cooperative in the village of Schönau in the Black Forest region emerged from a transformation process of the existing civil law partnership Netzkauf GbR founded in 1994 with around 650 investing citizens with an initial investment sum of Deutsche Mark 8.7 million (EUR 4.35 million), of which around 4 million were member contributions. It has been operating the local electricity grid since 1996. In the years that followed, EWS subsequently extended its business offering energy services, locally producing and distributing green energy, and in 2009 acquiring a local gas grid. As of 2018, EWS has five subsidiary companies governing its different activities, shares of 30–40 per cent in three further suppliers, for example, Stadtwerke Stuttgart Vertriebsgesellschaft, and has become a nationwide distributor for electricity and gas and a turnover of EUR 43 million.

13.5 Factors Affecting the Financing of Renewable Energy Sources and Barriers to Consumer (Co-) Ownership

13.5.1 Political, Legal, and Administrative Factors

Lowered profitability, perceived higher financial risk, and higher administrative and organizational requirements for RES investments resulting from recent reforms of the EEG can be identified as the main legal barriers to the establishment of consumer (co-)ownership models in Germany. Even though the government's political commitment can generally be described as stable, a politically driven prioritization of the overarching policy goal to provide for *affordable energy* has translated in recent years into subsequent reforms of the EEG. First, the 2012 and 2014 reforms resulted in substantially lower remuneration rates for PV and a stepwise switch from fixed FITs and guaranteed purchase of electricity from RES to market premiums. The reforms reduced the profitability of PV projects and subsequently led to less citizen energy projects.[11] In addition, the increased complexities of projects and requirements for electricity marketing via aggregator companies have reduced trust in RE investments (Müller et al. 2015). Second, the 2015 and 2016 reforms introduced auctions as a price-finding mechanism for remuneration rates for onshore wind power and large PV installations. There have been repeated concerns over a demise of community wind projects due to increased administrative requirements, higher transaction costs, and relative competitive disadvantages to professional actors resulting from auctions and direct marketing requirements (Maly et al. 2014).[12]

[11] The establishment of cooperatives also slowed down by uncertainties concerning the adoption and interpretation of the Capital Investment Act between 2013 and 2015 (Holstenkamp 2014).

[12] However, the number of community wind projects has been growing overall since 2010 (Kahla u. a. 2017), and the effects of auctioning mechanisms on citizen-owned energy projects in the wind power sector remain to be evaluated yet.

In addition, there are several challenges at the local level: in the case of wind power, for example, (co-)ownership projects compete with investors for appropriate sites and access to land. Often these projects are in disadvantage to investors who have more financial resources; even if a local municipality wants to support a (co-)ownership model on public land, it may be effectively hindered to create a level playing field because of EU competition law (Holstenkamp 2014; see Teckal decision of the ECJ). Furthermore, local support in the form of local authorities investing directly in an energy project is difficult in some cases due to lack of funds and high regulatory requirements on the public authority's side. Hence, this can lead to frustration and resignation at (co-)ownership companies (Radtke 2016).

To sum up, changes of political goal prioritization towards affordable energy have translated into policy changes posing a barrier for established citizen investment business models. Finding new business models within the current legal framework remains a major challenge (Herbes et al. 2017).

13.5.2 Economic and Management Factors

Challenges from a management perspective include conflicts arising from multiple identities of owners in consumer (co-)ownership models and from their difficulty to permanently attract people with the required know-how on a voluntary basis. First, a multiplicity in owners' identity derived from the variety of motives that guide them can trigger management problems in consumer ownership models similar to those in cooperatives (Yildiz et al. 2015). Specific problems may further result, for instance, from different time horizons of members of tenant's electricity projects with regard to their investment decision if they only want to spend a short period of time in an apartment. Finally, there is always the problem of free riding if members of the group do not behave appropriately in using the common assets (Brummer 2018). Furthermore, expertise is often expensive, and companies founded for one or a few projects cannot bear the costs associated with the staff required. As a result, many consumer (co-)ownership models are based on voluntary commitment that is difficult to keep up and may not provide the needed expertise (Müller et al. 2015). A solution for the know-how deficit of voluntary staff lies in partnerships and the involvement of service providers. However, such solutions are associated with a sharp increase in costs, which requires equity, especially early-stage venture capital.

Economic challenges mainly regard fund-raising with the acquisition of the required risk capital being a key problem. Capital is exposed to a high risk, especially at the early stages of a project where, in particular, consumer (co-)ownership models that only realize one project have the decisive disadvantage that they cannot build a portfolio and diversify their risks. There are very few offers of financial investors for venture capital in this area while venture capital is expensive and, in addition, often means losing control for the consumer (co-)owners. Furthermore, depending on the technology to be implemented, capital requirements vary significantly: PV projects and local district heating networks have the advantage that they are largely scalable and require smaller investment volumes; in comparison, wind power projects are not scalable and require large sums of capital (Holstenkamp et al. 2017).

13.5.3 Cultural Factors

Local, social, participative, and ecological social movements, for example, the German anti-nuclear movement or the cooperative tradition in Germany, and topics such as climate change and the energy transition (*Energiewende*) are important cultural factors. The *Energiewende* discourse is strongly influenced by external factors such as climate change and environmental concerns related to nuclear power technologies. A recent example is the nuclear disaster in Fukushima, which induced a preference change among European citizens towards the utilization of nuclear power technologies, fostering a more sceptical perspective, and led to a higher personal participation and activation in energy-related issues in general (Welsch and Biermann 2014). General aspects like benefits, conflicts, and the acceptance of RE play a central role for the orientation and organization of citizen energy projects as well (Yildiz and Radtke 2015).

Another cultural aspect related to the *Energiewende* discourse and affecting the establishment of citizen energy projects is the question of existing mental models, especially in relation to centralized versus decentralized supply solutions triggering differences in the assessment of projects

(Schmid et al. 2017). People that are involved in a local decentralized energy project consider possible drawbacks thoroughly as they are eventually affected personally, while when assessing renewables and citizen energy projects on an abstract level, people are less likely to consider drawbacks. This can strongly influence attitudes towards RE in general and citizen energy in particular, both positively and negatively (Sütterlin and Siegrist 2017). For example, small projects are mostly located in the countryside implying stronger direct contact between the parties which is likely to foster trust and higher involvement; this in turn is likely to have a positive influence on peoples' perspective on (co-)ownership and even increase peoples' willingness to pay for electricity from suppliers that emphasize co-determination rights, transparency, and profit redistribution (Knoefel et al. 2018). On the other hand, possible drawbacks, for example, changes in the living environment, noise emissions from installations that affect people close to the project site directly might raise questions related to distributional justice regarding costs and benefits of an energy project and ultimately lead to an opposition to citizen energy projects on a specific site (Reusswig et al. 2016).

Finally, the long tradition of the cooperative movement in the German energy sector may also play a role as a cultural factor affecting the establishment of citizen-led energy projects. In the first half of twentieth century, a total of around 6000 rural electrification cooperatives existed in the former German Reich forming the second largest group in the German rural cooperative association in 1930; in the late 1990s, their number had shrunk to around 40. By then, the cooperative experienced a revival as it lends itself as a model for citizens to join forces and establish themselves in the German energy sector (Rommel et al. 2018).

13.6 Possible Future Development Trends for Consumer (Co-)Ownership

The first auction results in the onshore wind energy sector led to controversial discussions about the preferential conditions for citizen's projects. In 2017, more than 90 per cent of the bids in the first two rounds of auctions were assigned to "citizen energy companies and cooperatives" leading to a temporary suspension of the exemptions from permission procedure (see Sect. 13.3.2) for the first two auctions in 2018 as there appears to be evidence that commercial investors tried to free ride on "citizen projects". The general public debate on the actual role of larger companies in "citizen energy projects" is still ongoing, and the implications for consumer ownership remain unclear. Another topic that will have implications for consumer ownership is the discussion to phase out coal which gained fresh momentum with the government coalition talks after the parliamentary elections for the Bundestag in autumn 2017. However, the result of this debate and the possible path towards a coal-free German energy system is unforeseeable and difficult as coal makes up for a large share of the produced energy in Germany and larger energy companies—who already suffer from the nuclear phase-out—have made substantial long-term investments in lignite-powered facilities (Leipprand and Flachsland 2018).

With regard to initiating future developments in the domain of laws, defining consumer (co-)ownership and establishing specific rights could be introduced and existing legal frameworks adapted. For example, specific regulations to foster civic electricity trading could be introduced in order to reduce barriers to electricity trading by prosumers which is an important element to use regenerative surplus electricity and improve the efficiency of consumer-owned production facilities (Roth et al. 2018). More generally, future developments in the energy sector, for example, digitization, e-mobility, and integrated energy, offer a number of possibilities for new business models and actors entering the market or strengthening their position.

What is currently missing in the domain of citizen investments and consumer (co-)ownership in the German energy sector is a vehicle that allows the participation of people with low income. As described before, empirical data shows that the group of "energy citizens" and consumer (co-)owners is a rather homogeneous group with comparable high income. Against this background, consumer stock ownership plans (CSOPs) as a financing model could be an approach to involve groups of citizens in the financing of energy production facilities that have been mainly neglected so far. Based on the principle of leveraged finance, CSOPs are a low-threshold approach for consumers investing into energy production projects as the major share of the required investment is raised through debt capital. Hence, investments in large-scale infrastructures are possible without necessarily needing a large share of equity capital, one of the limiting factors in energy cooperatives. Furthermore, the CSOP structure is also appealing to collaborations of citizens and corporative actors such as project developers and energy companies as voting rights and decision processes can be designed in a flexible way to address the needs of the involved stakeholders (Lowitzsch and Goebel 2013).

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14

Consumer (Co-)Ownership in Renewables in Italy

Andrea Borroni and Felicia van Tulder

14.1 Introduction

14.1.1 Energy Mix

The Italian energy sector relies mainly on fossil fuels. In 2015, the gross inland consumption of oil and its derivatives amounted to 45.5 per cent, natural gas to 32 per cent, all solid fuels to 5 per cent, and renewable energy sources (RES) to 17.5 per cent (GSE 2018). 80.7 per cent of natural gas and crude oil were imported in that year. Hard coal and gas accounted for nearly 62 per cent of electricity produced (DGSAE 2016). Renewable energy (RE) does not play a significant role yet. In 2015, RES covered 33.5 per cent of electricity consumption, 19.2 per cent of heating and cooling, and 6.4 per cent of transportation (GSE 2018).

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Since the beginning of the 2000s the development of RES has been slow but steady: from 7.5 per cent in gross final energy consumption including biomass in 2005 to 17.5 per cent in 2015. In that year, RES covered 33.2 per cent of domestic energy production with 270.7 TWh of which 44.8 TWh from hydropower, 5.8 TWh from geothermal, 14.6 TWh from wind and 24.7 TWh from solar power (GSE 2018). In 2015, the most significant RES was wind power accounting for 41.1 per cent of primary energy production followed by solar power with a 30.1 per cent share and hydropower—already widely in use since the 1950s—with 19 per cent and bio-energy gaining importance over the last years especially for commercial use with 9.2 per cent (GSE 2018). In line with global trends, 2012-2015 were a record-breaking years for investments in wind and solar energy also in Italy (Frankfurt School-UNEP Centre and BNEF 2018).

14.1.2 Main Challenges of the Energy Market, National Targets, Specific Policy Goals

Liberalisation of the Italian energy market started in 1988. Amongst other measures, it allowed industrial operators to build plants generating electricity from RES with an installed capacity of over 3 MW while obliging the National Board for Electricity (Enel) to distribute the energy produced recognising a favourable baseline energy price and additional incentives. This effectively ended Enel's monopoly. By 2007, the retail market was fully privatised. Today, Italian customers have full freedom of choice of electricity suppliers. The Italian energy sector, however, is not fully liberalised yet considering the role of the national government in setting and controlling prices. The sector still faces issues of supply security, socio-environmental conflicts, along with market concentration and the liberalisation of access to the energy supply market by new companies. Since 1979, there has been a gradual increase in oil and gas imports reaching its highest point in 1984; Italy is currently still highly dependent on gas and oil imports, highlighted by a major supply cut in 2012 by its main suppliers Saudi Arabia and Russia (Ministry of Economic Development 2015). In terms of electricity, the country has one of the highest import ratios in the world—mainly French nuclear energy (World

Nuclear Association 2018)—as well as significant industrial electricity prices (Statista 2016).

The 1975 National Energy Plan envisaged a strong development of nuclear power production.[1] However, between 1988 and 1990, as the result of a referendum, the government decided to abandon nuclear power replacing it with fossil fuel-sourced energy which had a negative impact on air quality. A comparison of air quality levels of the twentieth century and nineteenth century demonstrates a worsening related to low-stack emissions caused by decentralized heating systems using fossil fuels. As a result, in 2017 the air quality in Italy was deemed the worst in Europe (World Health Organization 2017). A contributing factor is that 74 per cent of residential buildings have autonomous heating systems mainly fuelled by hard coal and natural gas (Ungaro 2014). Positive developments however are that lignite is no longer used in domestic heating and the last two power plants using lignite in the country were closed.

The core targets of the National Energy Strategy (NES) 2017[2] are as follows: (1) a reduction of final energy consumption by a total of 10 Mtoe by 2030, (2) reaching a 28 per cent share of RES in total energy consumption by 2030 and a 55 per cent share of RE in electricity consumption by 2030, (3) strengthening supply security, (4) narrowing the energy price gap, (5) promoting sustainable public mobility and eco-friendly fuels, and (6) phasing out the use of coal in electricity generation by 2025 (Ministry of Economic Development 2017).

14.1.3 Ownership Structure in the Renewable Energy Sector

In the context of the privatisation of the former state distributor, Enel started offering quotas of its shares to the public. At the beginning of 2017, the state still owned 24 per cent of the shares, while retail investors owned

[1] In Italy the production of electricity from nuclear power commenced in the early 1960s. In these years Italy was the third largest producer in the world after the UK and the USA.

[2] Italy's National Energy Strategy 2017 lays down the actions to be implemented by 2030 in accordance with the long-term scenario drawn up in the EU Energy Roadmap 2050, which provides for a reduction of emissions by at least 80 per cent compared to 1990 levels.

22 per cent and institutional investors 54 per cent (Enel 2017). Today, private companies play a central role in the production of electricity from fossil energy sources. In 2017 the six largest energy companies[3] in the country owned over 90 per cent of renewable installed capacity, while the contribution of independent power producers remains marginal. In 2017 installations with a nameplate capacity below 10 MW made up only 25 per cent of the market share of wind power and 40 per cent of total installed solar capacity. In the hydropower sector, the installations up to 18.5 MW made up only 15 per cent (Energy & Strategy Group 2017). While investments aimed at improving energy efficiency of buildings are crucial, the relevant subsidies and loans are only accessible to the wealthier strata of society that have reliable credit scores and savings potential. The exploitation of geothermal and solar energy sources—altogether 0.1–0.2 Mtep—is still limited in 2016, while heat pumps are becoming increasingly important amounting to 2.6 Mtep for residential use (Toscano 2016).

Examples from the most important RE sectors are as follows:

- By the end of 2016, photovoltaic (PV) plants with a total capacity of 19.3 GW were operating in Italy. New systems with a total capacity of 382 MW were installed during that year, almost all with net metering connections.[4] The average capacity of the total of 732,053 installations is around 26.3 kW while 91 per cent are small-sized with a capacity below 20 kW. They are mostly owned by private small and micro enterprises and individual citizens (GSE 2016).[5]
- The most important RE source for thermal energy production in 2016 was bio-energy from solid biomass, in particular firewood and pellets used for heating in the residential sector accounting for 7.5 Mtep (GSE 2016). In that same year, an estimated 540 residential and small block heating installations with a capacity below 20 MW owned by individual citizens were counted (ENEA n.d.).

[3] ENEL Distribution is the national DSO, covering 86 per cent of Italy's electricity demand. The most important local operators are A2A, ACEA, IRIDE, DEVAL, and HERA.

[4] An optimally oriented and inclined PV system can produce on average 1000 kWh per kWp when installed in Northern Italy and 1500 kWh per kWp when installed in Southern Italy (GSE 2016).

[5] It is difficult to separate the two categories as Italy's economy is characterised by a large population of micro enterprises mostly in sole proprietorship by individuals or families.

- The largest biogas plant in Italy was opened in October 2010 in Bondeno and is owned by the German company *Schmack Biogas*. Its site extends over 9 hectares, with an installed power amounting to 4 MW generating energy for nearly 10,000 families annually (LT rinnovabili n.d.). The country's few small biogas and bio-energy plants are mostly located in the north of Italy and owned by agricultural businesses under the legal form of limited liability companies or limited partnerships.[6]
- As of 2016, a total of 4,852 wind turbines were installed in Italy, with an average generation capacity of 1195 kW per unit. 83 per cent of these turbines were owned by the state and large energy companies, 11 per cent by organised groups of citizens, and only 6 per cent by commercial investors (Barbetti 2017).[7] During that year new systems with a total capacity of 948 MW were installed, mainly in the southern regions of Sicily, Puglia, Campania, and Sardinia. All systems are onshore located mostly in hilly areas or mountains.

14.2 The Consumer at the Heart of the Energy Market?

14.2.1 Consumer (Co-)Ownership in Renewable Energy Sources as Policy Goal

Due to favourable government incentives, and spatial and financial accessibility,[8] the prevalent technology for prosumership has been solar PV. However, it should be noted that in Italy a legal framework addressing

[6] For more details see the list of government approved biomass plants, available in Italian at http://www.salute.gov.it/consultazioneStabilimenti/ConsultazioneStabilimentiServlet?ACTION=gestioneSingolaCategoria&idNormativa=3&idCategoria=6.

[7] The largest wind power farm in Italy is located in the Sardinian municipalities of Buddusò and Ala dei Sardi and is owned by Falck Renewables. With an installed capacity of 138 MW, it is also one of the largest in Europe (Windpower n.d.).

[8] That is, the relatively small size of solar PV installations and the favourable financing options provided by banks developing a specific line of credit for the purchasing of installations in accordance with government incentives.

prosumership is still absent, nor is there an official definition of prosumership. Although no national regulation concerning prosumer rights has been enacted yet, many proposals have been debated or are awaiting discussion in parliament. An example is the proposal by the MP Tamburrano concerning the collaboration of citizens, institutions, and SMEs in the production, distribution, consumption of RE, and energy storage which, however, missed the required quorum to be passed by only 47 votes out of a total of 650 members of parliament. The proposal postulated to consider RE produced by prosumers and local cooperatives a so-called common good since it reduces the socio-economic costs of energy production and consumption (Tamburrano 2017). Two further proposals concerning prosumership were put forward: one by Italy's largest environmentalist association *Legambiente* regarding the exchange of electricity from RES between companies with adjacent lots and high-efficiency cogeneration through private grids (Legambiente 2015) and the other by the sustainable energy association *Coordinamento Free* concerning the simplification of RE production for self-consumption and in particular economic incentives for domestic use (CoordinamentoFree 2017).

However, consumer (co-)ownership received explicit recognition of its crucial role in the 2018 recast of the Renewable Energy Directive (RED II) as part of the Clean Energy Package. The transposition of the RED II into Italian Law by 2021 will be an important legislative impulse as it introduces a legal framework for consumer (co-)ownership. Consumers, individually (Art. 21, households and non-energy SMEs), collectively (Art. 21, tenant electricity), or in communities (Art. 22, cooperatives and other business models), will have the right to consume, store, or sell energy generated on their premises. RED II also invites the member states to provide an "enabling framework" for local "renewable energy communities". The directive links prosumership to diverse topics such as fighting energy poverty, increasing acceptance, fostering local development, incentivising demand flexibility and so on, as well as defining citizens' rights and duties (Article 2 RED II).

Furthermore, in April 2018 the Horizon 2020 project SCORE[9] was launched with the aim to facilitate consumers to become (co-)owners of RE in three European pilot regions employing a Consumer Stock Ownership Plan (see Chap. 8). One of the pilot projects is located in Susa Valley in the metropolitan area of Turin, an Alpine zone counting about 90,000 inhabitants. The core of the project is substituting existing heating facilities run on diesel oil with new ones using local biomass, that is, wood chips as a heating source and in some cases insulating the existent buildings. Implementation is foreseen in ten communities all situated in Susa Valley in particular with the aim to include vulnerable consumers.

14.2.2 Fuel/Energy Poverty and Vulnerable Consumers

Between 1997 and 2012, end-consumer prices for each gas unit calculated in standard cubic metres increased by 76 per cent and those of electricity by just under 50 per cent. This increase is much larger than that of the general consumer price index for these years, which amounted to 27 per cent. Pre-tariff components and taxes also increased, amounting to 33 per cent in 2013 compared to 22 per cent in 2008. In that same period, household energy expenditure including electricity and heating expenditure grew from 4.8 per cent to 5.6 per cent with an increase for the latter components (Faiella and Lavecchia 2014).[10]

It is estimated that in 2005 approximately 11 per cent of Italian families were in vulnerable conditions with regard to energy (Miniaci et al. 2008).[11] A European Commission study found that in 2015 about 4 million Italian households, that is, 17 per cent of the total number of households,

[9] "SCORE" = **S**upporting **C**onsumer **O**wnership in **R**enewable **E**nergy (CSA 2018–2020) Grant Agreement 784960.

[10] The average consumption for a flat of 75 square metres is 101 kWh of electricity per month; the average consumption for a family with an autonomous heat system is around 1000–1100 cubic metres of gas per year (see https://luce-gas.it/faq/consumo-gas-medio-famiglia).

[11] Miniaci et al. (2008) point out families' vulnerability due to the elevated incidence of their energy expenses amounting to 4.7 per cent for electric energy and 11.9 per cent for heating on average of households' monthly income.

were affected by energy poverty (European Commission 2016). To mitigate energy poverty, the Italian government created a dedicated fund of EUR 13 billion/year to apply a bonus directly to all the utility bills of eligible households (Ministry of Economic Development 2016; Faiella Lavecchia 2014). Moreover, the household benefit package granted to low-income households was increased to EUR 165 per month in 2017 covering around 30 per cent of the households' annual energy expenditures in 2017, compared to 20 per cent in 2016.[12]

14.3 Regulatory Framework for Renewable Energy

The main statutory provision regulating the RES sector in Italy is the Decree for Renewable Energy number 28 of 2011. The central authority is the Italian Regulatory Authority for Energy, Networks and Environment (ARERA), whose main task is to protect consumer interests and promote competition, efficiency, and dissemination of services with appropriate levels of quality through regulation and controlling activities.

14.3.1 Regulations for Connecting Renewable Energy Power to the Grid

All installations—both on and off grid—need to be registered in a public registry. Power plants between 60 kW and 5 MW installed capacity for wind power, between 12 kW and 1 MW for PV installations sited on buildings with a maximum of 200 kW if on a net metering connection, between 100 kW and 5 MW for biogas, between 200 kW and 5 MW for biomass, and between 50 kW and 20 MW for hydropower must be listed in the Register for Small Power Plants (Il Sole 24 Ore 2015). TERNA, Italy's Transmission System Operator (TSO), is responsible on the entire territory for the grid connection of RE installations capable of feeding

[12] Adjustment introduced by the Decree of the Office of Economic Development of 29 December 2016.

surplus electricity production into the grid.[13] Depending on the size and the capacity of the installation, a simplified authorisation procedure may be applicable.[14] As a rule, to provide any type of service in the RE sector, a licence for commercial activities issued by the local government is required (Legislative Decree 504/1995—DPR 160/2010 Art. 2, 7, 5). However, provided that the production capacity of the operated plant is below 200 kW and thus is not qualified as commercial activity, small energy producers, for example, cooperatives are exempted from licensing.

14.3.2 Support Policies (FITs, Auctions, Premiums, etc.)

In 2018 the main support system for RE is the auction system introduced in 2011 by means of Decree number 28 of 2011 transposing EU Directive 2009/28/CE and establishing incentives and setting a target level of investment for each RES. With the Interministerial Decree of 23 June 2016, the Italian government launched support for RES other than PV with a ceiling of EUR 5.8 billion per annum for a 20-year period and a 25-year period for thermodynamic solar. The incentives are allocated through a reverse auction procedure based on the offer of a discount on the installation costs and targeted at plants with over 5 MW of installed capacity (Dec. Intermin. 23 June 2016). By the end of the auctioning procedure in 2016, all wind power plants were offered the maximum discount available of 40 per cent.

With the exception of PV, all small RE plants with a capacity between 1 kW and 5 MW are eligible for receiving a production-oriented premium tariff for installed capacity, while those between 1 kW and 500 kW can additionally choose between the premium and a feed-in tariff (FIT), the *Tariffa Onnicomprensiva* (Art. 7, c. 6 DM 23/06/16 in conjunction with Art. 7, c. 4 DM 06/07/12; see Sect. 14.3.3). Receiving benefits from this

[13] Electricity from RES other than PV fed into the grid is charged by the electricity system operator GSE at a 10 per cent VAT—instead of the usual 22 per cent (delibera n. 74/2008 AEEG).

[14] Planned installations below certain capacity thresholds, that is, 60 kW for wind energy, 20 kW for PV, 200 kW for biomass, and 250 kW for biogas, can be authorised through a relatively simple procedure, which covers all required permits and environmental impact assessments. A simplified procedure, based mainly on written communication between the project developer and the local authorities, is also in place for most micro plants (detailed information available in Italian on https://www.gse.it/normativa/autorizzazioni).

system prohibits the application for any other public incentive. Furthermore there is the *Ritiro Dedicato* regulation, which is not a classic FIT but rather regulates the sale of electricity. Through *Ritiro Dedicato* the Italian Agency for Energy Services (GSE) manages the sale on behalf of the producers and acts as a mediator between the producers and the market, facilitating the access to the grid and the market (Art. 7 AEEG 280/07 in connection with Art. 4 AEEG 34/05). The regulation applies to all RE technologies.[15] In 2018 newly installed PV is only supported by the *Ritiro Dedicato* and net metering (see Sect. 14.3.3).[16] Finally a premium tariff scheme for concentrated solar power, that is, thermodynamic solar plant using mirrors, applies depending on actual output. Power producers are no longer dependent on the market to obtain Green Certificates[17] as the FIT and premium payments are made directly by the GSE. They can continue to sell their output on the market or through bilateral contracts with the duration of support not being affected.

14.3.3 Specific Regulation for Self-Consumption and Sale to the Grid

The main incentive scheme for micro installations is a FIT, the *Tariffa Onnicomprensiva*, introduced in 2008 and currently regulated by Ministerial Decree of 23 June 2016. This FIT is directed at RE plants with an installed capacity between 1 kW and 500 kW. The awarded incentive differs per technology and is calculated according to the kWh fed into the grid. For example, in the year 2018, the incentive for wind

[15] If production exceeds 2 million kWh, the surplus is subject to the market price (Art. 7 AEEG 280/07). The *Ritiro Dedicato* programme is not eligible for plants that benefit from other incentive schemes.

[16] The first FIT system for PV in Italy was the so-called *Conto Energia* established by Ministerial Decree 28 July 2005. Government Decree no. 91 of 16 October 2014 introduced retrospective changes for this FIT reducing the amount of subsidies. This was contested by plant operators but in the end upheld by the Constitutional Court.

[17] Until 1999 support for RES was based on a quota system, in which plant operators producing electricity from RES received a tradable certificate of origin, Green Certificate, for each MWh produced. Electricity suppliers were obliged to acquire the certificates issued by the GSE per Bersani Decree no. 79/1999. Fossil energy producers unable to convert a percentage of their production into RES production each year were obliged to buy the corresponding amount of Green Certificates. Installations that went into operation before 4 April 1999 can still use the certificate scheme. In these cases the scheme functions parallel to the auction system.

energy was EUR 0.30 per kWh and for biomass EUR 0.28 per kWh (MISE 2018). Plants with an installed power between 1 kW and 500 kW are entitled to choose between this FIT and the premium tariff (Art. 7, c. 4 DM 06/07/12; see Sect. 14.3.2). While initially all renewable technologies were eligible, the above-mentioned Ministerial Decree excluded PV from the scheme as the available budgets for this segment had been exhausted.

Article 2 of DL 387/2003 introduced net metering for all RES for plants with up to 500 kW installed capacity. As of 2009 combined-heat-power stations with an installed capacity of up to 200 kW are also eligible. In that same year, Law 99/09 allowed installations on public buildings of municipalities with a maximum of 20,000 inhabitants to enter a net metering scheme with different interconnection points for consumption and feeding into the grid. All other plants under a net metering scheme must make use of one and the same connection. Once a year, the balance between fed-in and consumed electricity is calculated through a complex formula.[18] In case of a surplus, the difference is paid out by the GSE to the plant operator (Jimeno 2017).

Interministerial Decree of 5 July 2012 introduced a premium called *premio sull'autoconsumo* for energy destined for self-consumption from PV installations disbursed as a monthly payment over a 20-year period. The EUR 6.7 billion cap of the cumulated yearly budget of this incentive was reached in 2013, and access to the premium was halted (GSE n.d.). While the *Tariffa Onnicomprensiva* is linked solely to the amount of energy fed into grid, the *premio sull'autoconsumo* concerned both the energy produced and consumed.

14.4 Concepts for Consumer (Co-)Ownership in Practice

RE projects open to participation by the public are not widely established in Italy yet. On the other hand, investments in solar thermal collectors and PV installations on private and public buildings are becoming increasingly popular and are often facilitated by municipalities making

[18] See Deliberazione 570/2012/R/efr AEEG—Testo integrato dello scambio sul posto (TISP).

use of national and regional funding programmes. In general, participation in RE projects is possible via any available type of corporation, partnership, or any type of business in sole proprietorship, similar to those in other European countries.

14.4.1 Contractual Arrangements and Corporate Vehicles Used

In particular consumer (co-)ownership can be set up in the form of a cooperative. Succesful examples are Prato Stelvio in Tuscany and Funes in Alto Adige, which are described below. Energy cooperatives emerged from the beginning of the twentieth century onwards in Italy. They are regulated like other types of cooperatives in the absence of a specific regulatory regime for energy cooperatives. Their number is reportedly increasing (ForGreen 2017), yet statistics on the exact amount of active energy cooperatives is not available. If cooperatives are non-profit, only 30 to 55 per cent of their revenues are taxed (see Art. 12 of the Law 904/1977; Art. 7 of the Law 59/92; Art. 11 of the Law 59/92). Furthermore, a full exemption of taxes is in place in case the output of the cooperative is entirely consumed by its members.

Municipalisation of energy services was established already by Law no. 103 of 29 March 1903, and is open to privatisation since Law no. 142 of 8 June 1990. Municipal utilities play an important role as they attempt to attract investment in RE infrastructure with the goal of increasing tax revenues and boost growth of the local economy often through the establishment of public-private partnerships. Public utilities in the energy sector usually have the legal form of joint stock companies with a majority of public ownership, that is, 51 per cent with the remaining 49 per cent in the hands of various shareholders such as SMEs, citizens as individual investors, associations, and NGOs. Examples of these public utility companies are ACEA (Azienda Comunale dell'elettricità e delle Acque), one of the most important municipal endeavours in the sale of green electricity with an average sales volume of 8.3 TWh per year (ACEA 2017), and ANEA (Agenzia Napoletana Energia e Ambiente) offering information, training, and technical assistance to local authorities and businesses to carry out innovative projects in the energy and environmental sector allowing commercial entities to participate through calls for tender (ANEA n.d.).

14.4.2 Financing Conditions for Consumer (Co-)Ownership in Renewable Energy

14.4.2.1 State Subsidies, Programmes, Credit Facilities, Preferential Loans

Incentives related to energy efficiency measures in the building sector and sustainable cooling and heating are the so-called *EcoBonus* introduced in 2007 and the *Conto Termico* introduced in 2012. The *EcoBonus* is a fiscal incentive which as of 2018 enables a deduction on personal or corporate tax of 50 per cent of the total costs spent on the insulation of buildings, the installation of biomass heating systems, heat pumps, and solar heat collectors (L. 205/2017); it has a cap per building unit of, for example, EUR 30,000 for heat pumps. The *EcoBonus* has been widely used so far as it is easily accessible. Public buildings are however excluded from this tax deduction as public entities are tax exempt in Italy. The *Conto Termico*, partially reformed by Interministerial Decree of 16 February 2016, is a cash incentive granted for up to 40 per cent of upfront costs of biomass boilers, biomass heating systems, solar thermal plants, and building management systems; the exact subsidy is calculated according to installed capacity, emission class, and climatic zone. This incentive has been widely applied for public buildings.

The annual national Economic and Financial Planning Document of 2018 granted novel fiscal incentives also available to facilitate consumer (co-)ownership. It introduced a fiscal reduction of 50 per cent for the expenses of energy efficiency measures in the building sector including for the installation of RE plants and smart meters replacing the current deduction of 65 per cent for the same expenses related to building restructurings from 1 January 2018 onwards. More elevated reductions up to a deduction of 75 per cent with a cap on expenses of EUR 40,000 for each apartment unit are granted if the refurbishment is related to the whole block of apartments. At the same time, Law no. 19 of 27 February 2017 stipulates that general levies only apply to energy consumed from the grid for all owners of self-production systems.[19]

[19] These levies include expenses for the promotion of RES and research in this sector, the financing of special tariffs, the dismantling of nuclear plants, the coverage of the electric bonus, the promotion of energy efficiency, and compensations for small energy companies.

The European Regional Development Fund 2014–2020 with a budget of EUR 180 million for the years 2016–2020, earmarks 150 million for research and development projects including RE in Italy's underdeveloped regions, namely, Basilicata, Calabria, Campania, Puglia, and Sicily, and 30 million for research and development of RE in the transition regions of Abruzzo, Molise, and Sardinia. Other types of support measures include special loans for investments in RES and energy efficiency measures offered by commercial banks. Examples are the *Prestito risparmio energetico* from Unicredit ranging between EUR 5,000 and 75,000 and the *Energicamente Gran prestito* of Crédit Agricole amounting up to EUR 75,000.

In addition to these programmes, many regional and local RE tenders have been issued. For example, in the year 2016, the regional government of Lombardy offered incentives for the dissemination of residential PV installations with a total budget of EUR 2 million. The incentive consisted of a deferred grant of up to EUR 5,000 for up to 50 per cent of the costs incurred for the purchase and installation of a storage system for generated electricity by a residential PV installation, plus a EUR 300 cap of additional expenses for services, and a quota on the efficiency of the energy produced.[20] Furthermore, the decision of the Regional Council of Abruzzo of 22 December 2017 established a cash incentive of up to 55 per cent for the costs of the installations for self-consumption with a total budget of EUR 8 million. Another example is incentives offered by the regional government of Puglia for activities aimed at improving energy efficiency with the eligible investment projects requiring a size equal to or greater than EUR 80,000 for local building units while achieving energy savings of at least 10 per cent in the local building unit subject to investment (Bando n. 95, 10 August 2017).

14.4.2.2 Agencies Supporting Investment in Renewable Energy Sources

Among the state actors relevant for the development of RE are the Ministry of the Environment, the Ministry of Economic Development,

[20] See Decree 3821 of 3 May 2016 issued by the regional government of Lombardy.

and the Authority for Electricity, Gas and Water (ARERA). ARERA is responsible for setting base electricity tariffs, the related parameters and reference elements, the renewal and the variation of licences, the compliance with competition rules and consumer protection. Municipalities are responsible for outlining and implementing energy efficiency measures, and they are increasingly active in this field: over 7900 municipalities have already applied for funding to develop low-emission plans (ARERA n.d.).

Agencies promoting the development of RES and energy efficiency by granting economic incentives and supporting policymakers at the national and local level are the Italian Federation for Rational Use of Energy (FIRE), the National Agency for New Technologies, Energy and Sustainable Economic Development (ENEA), and the above mentioned Agency for Energy Services (GSE). They promote RE by converting existing fossil power plants to sustainable plants and building new ones. In addition, in Italy there are numerous regional programmes. The *Osservatorio Politiche Energetico-Ambientali Regionali e Locali* and FIRE provide updated overviews of announcements for regional support schemes in the field of RE (ENEA n.d.).

Finally, local organisations, associations, schools, and churches have facilitated citizen participation in RE projects. Noteworthy is an initiative by the National Body for Agricultural Mechanisation, *Progetto Biomasse Enama*, aimed at providing technical, financial, and normative instruments to stakeholders of the agricultural sector to facilitate the establishment of more efficient agro-energetic spinnerets (ENAMA n.d.).

14.4.3 Examples of Consumer (Co-)Ownership

I. One of the most significant cooperatives in terms of innovation and size of projects is **RETENERGIE**, founded in 2008 aiming at the production of RE from plants financed through its members, the sale of the produced energy to its members through daughter company *enostra*, and the provision of energy-related services to the members. RETENERGIE aims to provide citizens throughout the country unable to install RE systems the opportunity to become (co-)owners of cooperative facilities. Other goals of this cooperative are the realization of a new type of energy development based on citizen energy prosumership and the proposal of an investment model with strong ethical and social connotations. In 2018 the cooperative had 1,116 members and 13 running projects, mainly solar PV, throughout the country. The cumulative installed capacity amounts to 936 kWp so far with a total invested sum EUR 2,055,000 (Rete energie n.d.)

II. Funes is the oldest energy cooperative of Italy, founded in 1921. Funes, a small community in Alto Adige, today has three small hydroelectric plants, two district heating grids, and photovoltaic plants. The entire energy demand of the community is met by RES with excess production sold to the grid while employing residents for the maintenance of the plants. The entire distribution grid is underground making it safer and less intrusive of the landscape. The first modern hydroelectric plant installed was that of Santa Maddalena in operation since 1966, refurbished in 2010, with an output capacity of 225 kWps. Further plants followed: in San Pietro in operation since 1987, with an output capacity of 482 kWps, and in Meles inaugurated in 2004 with a power of 2.7 MW. The proceeds of Funes are reinvested in the territory, and in 2010 its members paid as little as 8.5 cents per consumed kWh (Zanchini et al. 2017).

III. Another example is **ForGreen**, a joint stock company established in 1999 by professionals from the energy sector who decided to share their skills and experience to develop sustainable projects and advance the RE market. ForGreen is part of the corporate group ForGreen Life Spa and is active in the fields of energy production, energy trading, and energy solutions development as well as citizen energy projects and had 12 running projects in 2016 (ForGreen n.d.). To allow local consumers who are not owners of real estate to become prosumers and (co-)owners of RE, ForGreen founded the energy cooperative WeForGreen Sharing in 2015. In 2018 WeForGreen Sharing had over 626 members and 466 households supplied with RE. Amongst the prosumer projects that WeForGreen Sharing invested in are 3 PV installations with a total installed capacity of 3 MWp and an annual production of 4,200,000 kWh equivalent to the energy consumption of 1500 households. Members can subscribe for up to 20 shares of a value of EUR 1,000 of which EUR 750 constitutes a loan with 15-year maturity with an expected return of EUR 1,510. An example of a project facilitating consumer ownership launched by ForGreen is *Lucense 1923*, a mini hydropower plant project started in

2016 in Montorio with an installed capacity of 112 kW and an annual production of around 700,000 kWh. It is operated by the joint stock company Finanziaria della Valpantena e Lessinia founded by 90 local shareholders amongst them 35 local enterprises and 55 citizens of Verona. The project with an initial investment sum of EUR 950,000 opened its shareholding to WeForGreen Sharing, an offer which 123 members took up with a quota of EUR 500 per member of which EUR 450 constituted a loan with 20-year maturity. Apart from interest payments between 1 and 4.5 per cent, the cost of supplied electricity was about 17 per cent below the market price in 2016 (ForGreen 2016).

IV. One example of a self-reliant energy community in the form of a cooperative is the **E-Werk Prad** in Prato Stelvio, established in 1926 (EwerkPrad n.d.). It is composed of 4 biomass stations with a total installed capacity of 7.4 MW, 210 solar thermic plants covering a surface of 2,200 square metres, 5 micro hydro plants with an output capacity of 4,082 kW, and 141 PV installations with a total nameplate capacity of 6.87 MW. The cooperative was founded upon agreement and in cooperation with 40 families. In 2018 there are 1,300 participating families all of which are shareholders and (co-)owners of the power plants. Today the energy community is managed by means of a cooperative that charges the households 12 cents per kWh for electricity—in comparison with national average prices of 21 cent per kWh (see Sect. 14.5.2)—and 7 cents per kWh for heating. The average profit of the cooperative is around EUR 1 million a year (Italiacooperativa n.d.).

14.5 Factors Affecting the Financing of Renewable Energy Sources and Barriers to Consumer (Co-) Ownership

14.5.1 Political, Legal, and Administrative Factors

Major obstacles so far have been the lack of comprehensive legislation regarding the energy market and RES and the sluggish transposition of European directives. Over the last few years however, the Italian legislature has been more geared towards energy policy planning. In this line, the adoption of the NES 2017 described more in detail in Sect. 14.1.2. is considered a major step forward for the country's energy transition. Another hampering factor is the lack of necessary measures to inform and assure businesses and citizens about the effectiveness of RE investments. A further barrier is the lack of coordination between different energy projects and planning implemented by the various administrations during the shift from the FIT to the auction regime in the RE sector.

At the same time, the asymmetrical remuneration for electricity fed into the grid, as compared with that acquired from the grid, impairs self-consumption models for prosumers. For purchasing energy from the grid the prosumer is charged EUR 0.1/0.15 per kWh, while he or she is remunerated EUR 0.05/0.09 per kWh for injecting into grid (GSE 2016). Furthermore, although the procedures for grid connection were simplified, they remain complex especially for residential small-scale installations. In its present form, the regulatory framework favours traditional market players and does not offer incentives sufficiently attractive to develop citizen energy projects. A dedicated legal framework including legal definitions of the prosumer and the energy cooperative is necessary to move forward.

As a result of continuous alternating national governments over the past 15 years, the legislative approach to energy policy has been volatile hindering advancement of RE. For example, the government of the years 2014–2017 set out a public investment budget of EUR 9 billion, while the government before barely addressed the RE sector (Decree of the Ministry of Economic Development 23 June 2016). Furthermore, in the auction year of 2014, many planned projects for the construction of onshore wind plants failed. This was due to a lack of specific rules for the preliminary evaluation of environmental impacts of this type of plants as well as the failed identification of protected areas and modes to inform residents. Projects that were rewarded in the auctions were mainly biomass and geothermal plants (Giugno 2015).

14.5.2 Economic and Management Factors

Electricity generation is currently still dominated by large companies like Enel, which controlled 25.4 per cent of Italian power production in the year

2012 followed by ENI with 9.5 per cent, EDISON with 7.2 per cent, and E.ON with 4.4 per cent thus creating an economic barrier for new entrants (Deloitte 2015). There is still a significant cost hurdle for investments in RES and energy efficiency measures, while amortisation of investments takes a long time and access to capital credit for citizens is scarce. The average costs of a solar power plant range between EUR 3,000 per kWp for small plants with less than 10 kW and EUR 1,300 per kWp for large plants with more than 1 MW of installed capacity (RSE 2016).[21]

The shift from a FIT model towards an auction system favoured professional investors realising medium- or large-scale projects hampering the extension of small RE projects. The progressive abolition of incentives for PV systems caused a decrease in the development of prosumership among households, farmers, and small businesses. Another problem is that Italian consumers pay as much as EUR 0.21 per kWh of electricity partly due to an increase in energy tax in 2017. The high level of energy prices in Italy is partly due to the historic preference of fossil fuels for electricity generation and the state's conflict of interest due to being heavily invested in this sector (ARERA 2015).

A further discouraging factor is the lack of expert knowledge on technical and legal issues related to residential installations. Expert knowledge is offered only by private consultants; there is no public service in this regard (Norton Rose Fulbright 2013). A general lack of professionalisation in the management of public and private energy projects is encountered. This is the consequence of the lack of university curricula and professional formation focusing on issues related to the positive and negative aspects of RES.

[21] The typical 3 kW domestic plant costs about EUR 6,000, which, thanks to a 50 per cent tax deduction, comes down to around EUR 3,000 in actual cost (Gravina n.d.). In some parts of the country, it is necessary to requalify the the building stock, as old buildings have high walls, inefficient isolation features, and suboptimal locations of heating and lighting points.

14.5.3 Cultural Factors

RES and energy efficiency are often associated in the collective imagination with a minimalistic lifestyle, characterised by austerity. Thus far, there have been no adequate information campaigns on RES; therefore awareness programmes are needed to dispel unnecessary prejudices. Another cultural barrier is the opposition of citizens to especially wind turbines but also other RE plants because in their opinion they spoil the landscape and may negatively affect the ecosystem. There are low levels of awareness on the importance of a sustainable energy system, as well as an indifference to climate change (Forni and de Felice 2011). Education on energy efficiency measures is therefore crucial.

Although the cooperative model has a long history in Italy, there is still some reluctance to its application in the energy sector. This is odd as there is a de facto practice of employing the cooperative model also for commercial activities in Italy, due to its favourable fiscal regime (see Sect. 14.4.1). The business community generally regards the FIT system as positive. Entrepreneurs have exploited the incentives in this regard to increase returns because, as mentioned previously, energy costs are particularly high in Italy, especially for electricity.

14.6 Possible Future Developments and Trends for Consumer (Co-)Ownership

To promote (co-)ownership of RES among businesses, farmers, and consumers at large, but also to foster the energy cooperative movement, Zanchini et al. (2017) propose the following: (i) a central role for the prosumer following the principles of the EU Clean Energy Package; (ii) a combined approach for the application of RES in smart grids, electric cars, and energy storage and investments in innovation of grids and energy storage; (iii) simple and transparent rules for the approval of projects; (iv) revamping of wind and hydroelectric plants and implementation of offshore wind power projects; (v) the elimination of subsidies for carbon sources; and (vi) a central role for municipalities in the energy transition. The above-mentioned proposals could potentially boost prosumership of small-scale projects and that of cooperative/(co-)ownership entities for medium-sized RE projects. This in turn could decrease energy poverty, dependency on energy imports, and the consumption of carbon sources.

With regard to potential business models facilitating consumer (co-)ownership, energy service companies (ESCOs) providing all technical, commercial, and financial services needed to carry out all operations aimed that improving energy efficiency could facilitate consumer ownership in RE. ESCOs take on investment costs and economic risk in exchange for a compensation corresponding to the energy savings over a period of time agreed upon in advance often under Energy Performance Contracting. Ownership of the installations involved is transferred to the owner(s) of the building once the investment has amortised. As of April 2018, FIRE enlisted 346 active ESCOs in the field of sustainable energy.[22] Finally, the network contract "Contratto di RETE", a specific legal form of cooperation available since 2008, is worth mentioning. As a type of inter-business collaboration of entrepreneurs to combine skills and experience and to benefit from economies of scale both individually and collectively, it could be applied to small-scale RE projects in particular involving family businesses (Borroni 2015).

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[22] For a list of current Italian ESCOs with UNI CEI 11352 certificate see http://fire-italia.org/elenco-esco-certificate-11352/.

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15

Consumer (Co-)Ownership in Renewables in the Netherlands

Sanne Akerboom and Felicia van Tulder

15.1 Introduction

15.1.1 Energy Mix

The Dutch energy mix is highly dependent on fossil fuels with final gross consumption of energy in 2016 consisting of 39 per cent gas, 38 per cent oil, 15 per cent coal, 5.9 per cent renewable energy sources (RES) and 1.1 per cent nuclear energy (Schoots et al. 2017). While the share of RES has been low compared to the EU average, projections for the year 2020 are between 11 and 13 per cent and for 2023 between 14 and 18 per cent (Eurostat 2018). With 87.5 per cent, the bulk of the electricity production in 2016 stemmed from fossil fuels led by natural gas with 42 per

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cent, coal with 35 per cent and other resources such as nuclear electricity accounting for 10 per cent; the share of RES was 12.5 per cent (CBS 2017). With domestic gas production decreasing, the Netherlands is expected to become a net importer of natural gas by 2030 (Schoots et al. 2017). In 2016 RES contributed 12.5 per cent to gross electricity consumption, 5.5 per cent to heating sector and 4.6 per cent to transport (Eurostat 2018).

Wind power contributed 7 per cent to total electricity production in 2016. Given the plans to increase wind power both on- and offshore with 6000 and 4450 MW by 2020 and another 7000 MW by 2030, respectively, the share of wind power is likely to increase (Schoots et al. 2017). The second most significant RES are biofuels and waste with a share of six per cent. The share of solar electricity is increasing rapidly from half a per cent in 2014 to 2 per cent in 2016 but overall remains small, and hydropower is barely present with 0.1 per cent of the total production (IEA 2017a). Of the 5.5 per cent of heat produced through RES in 2016 (CBS 2017), 82.8 per cent came from biomass, 15.3 per cent from geothermal and 1.9 per cent from solar heat.

15.1.2 Current Main Challenges of the Energy Market, National Targets and Specific Policy Goals

The Dutch energy industry is characterized by a de facto technical regulation and slow implementation of changes. The current energy legislation, consisting of the Electricity, Gas and Heating Act, is based on centralized planning, with large-scale fossil generation plants and a traditional role divide of the producer, grid operator and supplier. Due to this the Dutch energy transition is not very dynamic. However, three major developments will significantly influence the production of energy in the next decades in the Netherlands. Firstly, earthquakes in the province of Groningen, caused by gas extractions, necessitate a substantial decrease of gas production in the Netherlands. To reduce dependence on third countries via gas imports, the government has decided to remove the obligatory gas grid connection for new buildings as of July 2018 (Akerboom & Van der Linden 2018), including household end-use, and to enact the right to a heating connection instead. Newly constructed buildings will be heated in alternative ways, through renewable heating technologies or even all-electric (Rijksoverheid 2017a). Secondly, the current government has announced to phase out the country's five remaining coal-fired plants by 2025 and 2030 (Rijksoverheid 2017b) which equally necessitates alternative resources. As of now, the government has not announced specific plans with respect to these alternatives. Naturally, to achieve European and international objectives, the best scenario would be to substantially increase the share of renewable energy. Thirdly, the government is currently engaged in negotiations with several private parties to enter into a Climate Agreement, which is expected to be finalized in December 2018. By means of this agreement, all parties commit themselves to a CO_2 emission reduction target of 49 per cent by 2030. As this agreement covers energy-intensive industries, branch organizations, NGOs, governmental bodies, and private and commercial parties such as banks, aggregators, energy companies, and others, it could lead to broad bipartisan consent, possibly accelerating the Dutch energy transition.

Objectives set on an international level however push the country's transition forward. Pursuant to the EU Renewable Energy Directive 2009/28/EC, the Netherlands must have realised a share of RES of 14 per cent in total energy consumption by 2020, a target based on the country's RES share of 2.4 per cent in 2005. This goal has been reconfirmed in the public-private Energy Agreement closed in September 2013. The Climate Agreement will be the successor of this Energy Agreement. As of 2016 the Netherlands was the furthest away from its target amongst EU member states—by eight points (Eurostat 2018b)—casting doubts on its implementation. The follow-up target of an RES share of 16 per cent is to be realized by 2023. According the Dutch Energy Research Centre, the latter target is achievable based on current wind energy policy (Hekkenberg and Lensink 2013).

15.1.3 Ownership Structure in the Renewable Energy Sector

The Netherlands has a strict divide between the grid on the one hand and commercial activities such as production, supply and trade on the other hand. The grid network is owned and operated by state-owned companies, divided into a transmission system operator (TSO) and distribution system operators (DSOs). There is one TSO for the entire Dutch transmission grid, TenneT, and a total of seven DSOs for the distribution grids that operate in assigned areas. Only under strict conditions could a small, decentralised grid be owned and operated by an alternative private party.[1] Grid operation is legally separated from commercial activities,[2] such as production and supply. Supply and production in the Netherlands are completely privatised, and only commercial private parties can own and operate generation units. The largest generation plants are a nuclear plant, which is owned by Delta and RWE, and five coal-fired plants, two of which are owned by RWE and the remaining by Vattenfall, Engie and Uniper. The gas-fired plants, although not all operational, most notably are owned by Uniper, RWE, Engie and Nuon (van Santen and van der Walle 2017).

With respect to RE, the same rule applies: only private companies can own and operate generation plants. Biomass, wind and solar energy are the main sources for renewable generation. Examples characterising the ownership structure from the most important RE sectors are as follows:

- In the year 2017, the installed capacity of solar power was an estimated 2.9 GWp, and several solar fields are planned to be realised in 2018 (Rabobank 2018). The ownership structure in the solar sector varies and does not necessarily entail the traditional energy companies. In 2017 about 450,000 households and over 5000 companies had solar capacity installed (Rabobank 2018). Indeed, end-users increasingly use small solar rooftop PV installations with an estimated capacity of 1,407 MW in 2016, corresponding to 1.29 per cent of all renewable electricity production of which 78 per cent was owned by small end-users like households (PWC 2016).
- The offshore wind farms are owned by traditional energy companies. Since Dutch wind energy policy is aimed at large-scale wind farms of 150 MW installed capacity or more, this scenario is likely to persist in

[1] This concerns a so-called closed distribution system. An exemption to the traditional situation in which a DSO is responsible for the grid (see Article 10 of the Electricity Act and Article 10 of the Gas Act) can only be granted if the grid is small and serves less than 500 non-household consumers and the exemption is requested due to specific technical or safety reasons caused by a specific business or product.

[2] Articles 10b of the Electricity Act and 2c of the Gas Act.

the future. With respect to onshore wind however, there is a rising trend of cooperative ownership, in which citizens and businesses organise and realise collectively owned wind energy installations. With circa 3,000 MW installed wind capacity onshore (PBL 2016), 115 MW was owned by wind cooperatives in 2016 (PBL 2016; Hieropgewekt 2017b). Although in 2017 this constituted a minor contribution to total generation capacity, new initiatives are currently being developed.

- Energy from biomass is mostly produced through waste incineration with a share of 35 per cent in government-run facilities and about 30 per cent by households through wood heating of private consumers (CBS Statline 2018) with the remaining share comprised of biogas and biofuel production in facilities owned by energy companies.

15.2 The Consumer at the Heart of the Energy Market?

15.2.1 Consumer (Co-)Ownership in RES as a Policy Goal?

In 2017 over 500 projects were counted in the Netherlands, aiming at creating a joint ownership structure for local, RE utilities, often with solar panels. These projects however run into many legal and financial barriers given the current regulation (HierOpgewekt 2017a). The number of energy cooperatives has substantially increased (see Sect. 15.4). For instance, "Windvogel" with 3350 members owns five wind turbines and three solar PV rooftop projects (Windvogel n.d.). In summary, there is not only potential for consumer activism and (co-)ownership in the Netherlands, there is also societal momentum. However, even though the energy transition is bringing about changes in the Dutch energy industry, policy and legislation are still falling behind on these developments in the energy industry as they still very much depend on large-scale generation scenarios in which security of supply seems to be the most important policy goal. The aforementioned current legislation packages, consisting of the Electricity, Gas and Heat Act, all presume a passive role of the consumer, most especially the household end-user with emphasis on security of supply and affordability (Rijksoverheid 2017a). While technology measures such as the roll-out of the smart meters, could potentially contribute to community supply, administrative and financial barriers persist.

Although these developments have not escaped political attention and distributed energy was emphasised in the Energy Agreement (SER 2013, p. 79),[3] a wide legal operationalization has not yet taken place. There is, however, one exception, Crown decree of 2014 (Rijksoverheid 2014) concerning "Experimental decentral sustainable energy production". The decree addresses experimental energy projects aimed at the production and self-supply of energy for 10,000 or less end-users for a period of ten years. To ten projects a year that meet the objectives and conditions, an exemption from certain Dutch regulation with respect to the grid operations and supply to household end-users is provided. The so-called "Experimentation Decree" has been envisaged for a period of 4 years, thus resulting in an experimental space of a maximum of 14 years with a maximum of 40 projects. The Decree was closed mid-2018, and now the functioning of the Decree will be evaluated. Possibly, based on the results, the Dutch government will adapt energy legislation to facilitate more diverse (co-)ownership and supply models.

With respect to onshore wind energy, a soft-legal instrument outlines that onshore wind farms should be open to financial and non-financial participation of residents (NWEA 2016). Upon drafting the Energy Agreement in September 2013, it was decided to increase the onshore wind capacity to 6,000 MW by 2020 by means of 11 wind farms each with a capacity of circa 350 MW. Given this substantial challenge in a small yet densely populated country such as the Netherlands, the government quickly realised that this objective could be met with opposition. To increase the acceptance of a wind farm by residents in its proximity, a procedure was planned that would involve the residents in an early stage in the decision-making and to include the option of financial participation of those residents. For instance, 25 per cent of one of the wind farms in planning will be owned by the residents along the country's A16 highway.[4] Given the soft character of this instrument however, as of 2016 it had not been applied too often (Van Rijn et al. 2016).

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[3] In this agreement it was recognized that distributed energy can provide 1,000,000 households by 2020, which translates into 40 PJ. It was furthermore acknowledged that any barriers, be it organizational, legal and/or financial, should be removed as much as possible. Apart from the above-described "Experiment Decree", substantiation however lacks.

[4] See http://www.boschenvanrijn.nl/green-deal-windenergie-a16/.

Furthermore, consumer (co-)ownership received explicit recognition of its crucial role in the 2018 recast of the Renewable Energy Directive (RED II) as part of the Clean Energy Package. The transposition of the RED II into Dutch law until 2021 will be an important legislative impulse as it introduces a legal framework for consumer (co-)ownership. Consumers, individually (Art. 21, households and non-energy SMEs), collectively (Art. 21, tenant electricity) or in communities (Art. 22, cooperatives and other business models), will have the right to consume, store or sell energy generated on their premises. RED II also invites the member states to provide an "enabling framework" for local "renewable energy communities". The directive links prosumership to so different topics as fighting energy poverty, increasing acceptance, fostering local development, incentivizing demand flexibility and so on, defining citizen's rights and duties and evenly important clear definitions (Article 2 RED II).

15.2.2 Fuel/Energy Poverty and Vulnerable Consumers

A 2017 study finds that 750,000 Dutch households, equivalent to about 10 per cent of all households, face difficulty in paying their monthly energy bills. This is the result of insufficient insulation of homes especially affecting low-income households and rising energy prices (Straver et al. 2017). With energy poverty not being a subject of energy policy, but of general poverty policy, there is no specific definition of energy poverty nor any specific legal regime or provision battling energy poverty (ibid.).[5] However, Dutch energy legislation specifically addresses the small end-user segment, legally defined by a grid connection of 3.8 ampere and less (Article 95a Dutch Electricity Act) granting them special protection with respect to security of supply and affordability. Applicable since August 2013, the "Policy for disconnection of small-end users of electricity and gas" regulation prevents energy suppliers from disconnecting small, and especially vulnerable, end-users without communication, even if they are

[5] For this reason, the Netherlands pushes for the removal of all energy poverty provisions as presented in the Winter Package by the EU. See *Kamerstukken II* 2017–2018 21 501-33 nr. 666.

late with payments. Supply to vulnerable end-users—defined as consumers to whom the termination of energy supply would lead to serious health risks for themselves or other members of the household—can only be suspended or terminated under specific circumstances, such as proven fraud, certain unsafety of the supply of energy and in case a contract ends.[6]

15.3 Regulatory Framework for Renewable Energy

Dutch energy regulation consists of three main Acts: the Electricity, Gas and Heat Act. These Acts primarily regulate the energy system and roles and obligations for the actors in this system but also pricing mechanisms and protection of small end-users. There is no specific RES regulation in the Netherlands.

15.3.1 Regulations for Connecting Renewable Energy Power Plants to the Grid

The Electricity Act regulates that the transmission (TSO) or distribution system operator (DSO) is obliged to connect anyone who requests it to the grid without a legal distinction between renewable and fossil energy production units (Article 23 of the Electricity Act 1998). The Electricity Act includes conditions for the regulation on the tariffs for this connection with the pricing mechanism stipulated in the Tariff Code distinguishing between the capacities of the connection to identify the class of user. The tariffs do not contain any special rules for prosumers.

15.3.2 Support Policies for RE (FITs, Auctions, Premiums, etc.)

Most notably, there are two support policies for large-scale production of RE: a general support policy and a specific policy for offshore wind energy.

[6] Regeling afsluitbeleid voor kleinverbruikers van elektriciteit en gas.

The general support policy concerns a subsidy for incentivising sustainable energy capacity with a subsidy maximum defined for every RE technology. This subsidy is however only open to large-scale producers, not to prosumers. The costs of the subsidy programme are covered by a sustainable energy levy charged for electricity and gas consumption (RVO n.d.-a). For the 2017 autumn phase, EUR 6 billion were made available in subsidies (RVO 2017). There are several categories, including solar and wind, for which subsidies are granted via an auction mechanism with two application rounds for auctioning per year, divided into four phases each with an increasing maximum applicable amount of subsidy. The Offshore Wind Energy Act uses a combined permit and subsidy phase in which both are granted simultaneously by the Ministry of Economic Affairs and Climate Policy in a tender procedure to guarantee the realization of large-scale wind farms with over 350 MW installed capacity (IEA 2017b).

15.3.3 Specific Regulations for Self-Consumption and Sale to Grid

For micro-installations, there are two support policies in place: net metering and the "postal code" subsidy. Most prosumers of solar electricity make use of net metering where prosumers' produced kWh fed into grid are subtracted from their electricity bill monitored and metered by the electricity supplier (Article 31c of the Electricity Act 1998).[7] For the Dutch prosumer, this implies a relatively high discount on their electricity bill, as the subtracted kWh also includes grid tariffs and electricity taxes. As these taxes are an important source of income for the government, the current system will likely be adapted with the increase in solar prosumers.

As this net metering scheme is not open to prosumers operating RE generation units collectively, the Energy Agreement of September 2013 introduced a specific financial incentive, the so-called "postal code

[7] This rule emerged as prosumers with smart meters were disadvantaged compared to prosumers with analogue meters with which the supplied kWh is automatically deducted from the consumed kWh.

subsidy". Every household in one postal code area and all four adjacent areas is able to receive an electricity tax refund if they consume electricity produced from a (co-)owned renewable generation unit, like solar PV or a small wind turbine (Hieropgewekt 2017c). Furthermore, there is a complementary exception from the obligation to obtain supply permits for community supply. According to Article 95a of the Electricity Act, supply to small end-users is limited to those who have a supply permit. There are five exemptions to this rule, and one includes supply from a generation unit that is (co-)owned by consumers in equal parts. If, for example, three consumers are to be supplied from a (co-)owned generation unit, they should each own a share of 33 per cent of the generation unit.

15.4 Which Concepts Are Being Used for Consumer (Co-)Ownership?

RE initiatives with an active participation of energy consumers have significantly increased since 2007 but recently fell into decline. As mentioned above, in 2017 over 500 local RE projects were registered and aimed to attain a variety of goals: from self-production of RE to self-sufficient communities (Hieropgewekt 2017a). Furthermore, increasingly wind farms are partly owned by locals, as a solution to increase social acceptance of wind farms but also to distribute profit to the community that is mostly affected by that farm. There are also many smaller projects aimed at setting up decentralized RE generation plants; solar fields, for instance, are mushrooming, and smaller wind farms with an installed capacity of up to 150 MW are in development (Hieropgewekt 2017a).

Initially collective projects concerned with sustainable energy were primarily occupied with wholesale of solar panels and energy-saving measures. A 2016 report from the monitoring organization of collective activities in RE, *HierOpgewekt*, showed an interesting development: in that year about half of the total 313 projects and initiatives were occupied with the generation of energy (Hieropgewekt 2016) with most projects generating energy through solar or wind technology. Collective solar generation witnessed a significant growth; in 2017 269 collective projects had a combined installed capacity of 36.6 MWp, a 53 per cent increase compared to 2016.[8] In 2016 and 2017, the largest collective solar projects so far were installed. Yet, compared to the total installed solar capacity of 2000 MW by the end of 2017, projects in collective ownership still payed a minor contribution to total energy production (Hieropgewekt 2017a).

15.4.1 Under Which Form/Cooperative Vehicle Is Consumer (Co-)Ownership Realized

There is little to no specific legal support, nor is a specific legal model for (co-)ownership present. Collectives of prosumers face difficulties as this model is not targeted by a specific policy, nor is it enabled through legislation (see also Sect. 15.2.1). Most collective RE projects in the Netherlands opt for the legal form of a cooperative with limited liability; others opt for a foundation or a limited liability company (Blokhuis et al. 2012; Elzenga and Schwenke 2015).

Many of the cooperatives that have emerged in the Netherlands aim at the collective purchasing of solar panels or an investment in one or more wind turbines. In this way, 14 MWp installed capacity of solar panels were realized in 2016 (Hieropgewekt 2016). With regard to wind energy, *HierOpgewekt* counted 19 cooperatives with a total membership base of 12,000 in 2016 (ibid.). By then, 16 had set up energy-generating wind turbines. Remarkably, four had started collective solar projects to expand production capacity as the extension of wind capacity proved difficult (Proka and Hisschemöller 2017). Between 10 and 30 per cent of the projects' costs were financed through cooperative members' paid-in capital, while the remainder was financed by banks and other funds. It is estimated that three per cent of onshore wind turbines was in cooperative ownership in 2016 (Hieropgewekt 2016).

The role of Dutch municipalities in RE generation and supply is one of facilitation and collaboration. Many collective RE projects are sited on

[8] HierOpgewekt defines collective solar as projects developed, managed and/or owned collectively by citizens, including those where citizens can participate financially (Hieropgewekt 2017a, p. 20).

communal property such as schools or libraries. Local authorities also provide advice and support in the planning phase of collective projects (Elzenga and Schwenke 2014). In 2016 four generation and supply projects with municipalities in an active role could be counted. *Energiecooperatie Dordrecht*, a collaboration between a municipality and a private company started in 2012, placed solar PV panels on public buildings making them effectively energy neutral. In the east of the Netherlands, eight municipalities initiated the *Cooperatieve Achterhoekse Energie Maatschappij*. The cooperative supplies energy through purchasing contracts with commercial renewable generation facilities (Hieropgewekt 2016).

15.4.2 Conditions for Consumer (Co-)Ownership

15.4.2.1 State Subsidies/Programmes/Credit Facilities/Preferential Loans

The Energy Investment Allowance provides a tax credit for enterprises that invest in renewable energy plants, energy-saving projects or technologies improving energy efficiency. Admissible technologies are outlined on a yearly basis in the so-called Energy List published by the Netherlands Enterprise Agency (Rijksdienst voor Ondernemend Nederland, RVO). The amount of permitted funding depends on the RES and type of plant used (RVO n.d.-b). Furthermore, the Green Funds Scheme, launched in 1995 and run by the Ministry of Housing, Spatial Planning and the Environment, provides a tax credit for citizens who invest or confer part of their savings into a green fund. The bank that administers this fund can give out loans at a lower interest rate to projects qualifying under the regulation as an environmentally friendly project. All RES apart from biomass and biogas are qualified (RVO 2010). Finally, the Energy Conservation Fund stems from the above-mentioned Energy Agreement and is funded by the government and two banks. Through the fund, loans are granted at a fixed low interest rate of 2.5 per cent for homeowners and associations of owners of multifamily complexes investing in energy conservation measures, including the installation of solar PV panels and boilers (Milieucentraal n.d.).

15.4.2.2 Agencies Supporting Investment in RES

The Netherlands Enterprise Agency supports sustainable, agrarian and innovative businesses. It manages several subsidies and programmes for sustainable energy undertakings (RVO n.d.-c). An example is the ISDE programme, which grants subsidies to households and enterprises for RES heating installations. The Stimulation Fund for Social Housing (Stimuleringsfonds Volkshuisvesting, SVn) manages the Regional Sustainability Loan programme. Loans under this programme are granted by participating municipalities to homeowners implementing energy efficiency measures (SVN n.d.). Furthermore, Alfam, a daughter company of ABN AMRO Bank, manages the GreenLoans programme which grants loans for energy efficiency measures and solar PV installations to homeowners (Alfam n.d.).

15.4.3 Examples of Consumer (Co-)Ownership

I. TexelEnergie is the first RE cooperative of the Netherlands founded in 2007 by a group of citizens on the North Sea island of Texel as a cooperative with limited liability. By the end of 2015, the cooperative had 3,100 members. With a total of 13,582 inhabitants counted on the island that year, TexelEnergie's membership base is significant. In its first years of operation, the cooperative was only occupied with the purchase and supply of green energy to its members. However, the cooperative's bylaws explicitly state the goal of setting up production capacity. To this end, in 2010 TexelEnergie set up four solar PV projects with a total of 1.4 MW installed capacity. The construction behind the solar project is noteworthy. The solar arrays are sited on the roofs of commercial complexes through a rental contract between TexelEnergie and the property owners. The produced solar electricity that the property owners consume is directly billed by the cooperative. When the contract period finishes, the hosts are entitled to keep the installation without further payments due (TexelEnergie n.d.-a–n.d.-f).

II. The Netherlands' two largest cooperatives for wind energy generation are **Zeeuwind and Deltawind** having a combined membership base of 5000 citizens. They cooperated on the country's largest civil society initiative so far: the construction of a wind farm with 34 turbines of a total of 103 MW installed capacity at the Krammer locks on the North Sea coast of the province of Zeeland. To this end, the two cooperatives started an LLC, *Deltawind and Zeeuwind Holding BV*. Through this LLC *Zeeuwind and Deltawind* obtained 51 per cent in equity in the LLC founded for the construction of the wind farm: Windpark Krammer BV. The project is financed by writing out loans to the cooperatives' members. Additional funding is collected through direct public participation with bond loans for a total of EUR 10 million, to which the members of the founding cooperatives and residents in the surroundings of the wind farm have priority access. The remaining 49 per cent of the shares in the *Windpark Krammer LLC* are in the ownership of Enercon, a large German wind turbine manufacturer. Enercon also provided the turbines for the park. The project obtained an operating grant through the SDE+ programme. The total investment sum of the project amounted to approximately EUR 30 million. Construction started in 2016 and it is expected the project will be operative in 2019 (Windpark Krammer n.d.).

III. Duurzame Energie Coöperatie Regio Alkmaar (DECRA) was founded in 2014 by the municipalities of Alkmaar, Bergen, Castricum and Heerhugowaard and waste management and energy company HVC ltd. in the province of North Holland. The cooperation took the form of a stimulus fund to boost sustainable energy production in the region with the intention to reinvest any profit in new projects. Each participating municipality has one elected official on the management board of the fund. DECRA was started to follow up on the participating municipalities' emission reduction goal of 20 per cent by 2020. A remarkable project initiated by DECRA is the investment in 2015 in wind turbine *Alckmaer* with a 2.5 MW nameplate capacity part of a wind farm in the region. To this end a limited liability company, *Wind Alckmaer BV*, was set up to manage the plant, which functions as a subsidiary of HVC. Each participating municipality contributed to the starting capital proportionally to their number of inhabitants, with a total sum of EUR 470,000. In this way, DECRA obtained 37 per cent in equity in the turbine, while HVC made the additional investment, thus becoming owner of the rest of the stocks in *Wind Alckmaer*. Remarkably, DECRA transferred its 37 per cent equity in the turbine to five local energy cooperatives in the region in September 2017. The cooperatives had requested the transfer to enhance participation in the project by local citizens (ODE Decentraal 2017).

IV. Another island in the North Sea, Ameland, started **Duurzaam Ameland** (Sustainable Ameland) in 2007, a cooperation project between the island's municipality and corporations, research institutes and the island's energy cooperative *Amelander Energie Coöperatie*. This is in line with the municipality's goal to have an independent and sustainable energy provision by 2020. Initially the organisation was occupied with small experimental projects in the field of RE. In the years after its foundation, scaling up of projects has taken place. For this reason, the municipality is currently developing the largest smart electricity grid of the Netherlands. To this end, it has obtained permission for this project to deviate from the Electricity Act per the above-described Experimentation Decree (Duurzaam Ameland n.d.-a). In 2016 a solar farm was co-founded by the municipality, the local energy cooperative and *Eneco*, a large energy company. The three parties own an equal share of the solar PV panels. The cooperative's share was partially financed by its membership base—consisting of 300 locals—and other inhabitants of the island through bond loans. Other financiers are the province of Friesland and a provincial environmental fund. The farm has an installed capacity of 6 MWp and in 2016 could provide for almost the entire electricity demand of the 3600 registered inhabitants of the island in the low season (Duurzaam Ameland n.d.-b).

V. The residents of **Collegepark Zwijsen**, an apartment building, obtained an exemption also under the Experimentation Decree, allowing them to own and operate solar PV panels and supply this energy to the tenants. The association of owners, of which all tenants are members, manages and is the legal owner of the generation units. Therefore, any supply of energy produced to non-owners, the tenants, is legally subject to a supply licence pursuant to Article 95a Electricity Act unless residents held direct ownership over the generation units qualifying for an exemption (see Sect. 15.2.1). However, as this project concerns an apartment building, having a management association is legally obligatory (Art 5:112 Civil Code), and therefore any generation unit automatically is owned by this association with the exception to the supply licence rule therefore not being applicable. Since the residents still wished to supply themselves and the communal spaces of the building with their own produced electricity, an exemption on the basis of the Experimentation Decree was granted. This project will be part of a future evaluation of the Experimentation Decree (Collegepark Zwijsen n.d.; ACM 2017).

15.5 What Are the Barriers to Consumer (Co-)Ownership?

15.5.1 Political, Legal and Administrative Factors Affecting the Financing of RES and Establishment of Consumer (Co-)Ownership Models

Until the Netherlands was obliged to implement the binding EU sustainability targets,[9] sustainable energy policy had been inconsistent due to the fast alternating of cabinets since 2000. This unstable regulatory environment had negative repercussions on the investment climate regarding RE generation (Blokhuis et al. 2012). Prior to the 2013 Energy Agreement, the Netherlands had no long-term energy and climate goals which obstructed a clear vision both in terms of public contracting and political commitment to renewables (SER 2014). Hufen and Koppenjan (2015) point out the lack of legislation obliging energy companies to produce power with RES as well as tax exemptions for large-scale energy consumption which, they find, triggered a decrease of energy prices, contributed to energy inefficiency and impeded innovation in the field of renewables (2015). Furthermore,

[9] Directive 2012/27/EU of the European Parliament and the Council of 25 October 2012 on energy efficiency, amending Directives 2009/125/EC and 2010/30/EC and repealing Directives 2004/8/EC and 2006/32/EC, OL J 315, 14 November 2012, pp. 1–56; Directive 2009/28/EC of the European Parliament and the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC.

with the conventional energy industry being largely dependent on energy generation with a high carbon impact, the transition to renewables does not match the economic interests of incumbent actors. However, their reluctance to contribute to the energy transition is also ascribed to the abovementioned lack of consistent policy (Blokhuis et al. 2012.

Political rhetoric is generally favourable towards the energy transition, yet significant investments in high carbon impact industry continue as the domestic gas and heavy industry is protected (HierOpgewekt 2016). While the fossil lobby representing the national gas company *Gasunie* and Shell has close ties to Dutch government, market actors in the RE sector have far less political clout, and state interventions tend to favour fossil fuel-generated energy (Oteman et al. 2014). Furthermore, the market-oriented policy approach in the Netherlands undermines initiatives at the local level. Subsidies and policy are generally aimed at large corporate projects with high profitability. Citizen projects with their typically modest revenue models do not fit in this picture. Policy-making focuses on reaching energy security and improving the Dutch position on the international energy markets. Also, legislation on RE follows an economic rationale since it is primarily drafted by the Ministry of Economic Affairs and Climate Policy. The current subsidy system rewards projects with the highest potential, based on their economic viability. The economic rationale underlying policy clashes with the environmental and social concerns that motivated the foundation of many existing citizen RE cooperatives (Oteman et al. 2014).

The insufficient government support has had repercussions on operational capacities of citizen cooperatives. Initiators of several citizen (co-) ownership projects have indicated they would prefer more public contracts and flexible loans instead of subsidies (Elzenga and Schwenke 2014). A problem however is that municipalities are bound to capacity limits when tendering to energy cooperatives. Beyond these limits, cooperatives must compete with commercial parties, which has proven to be tough (Elzenga and Schwenke 2014). Also, Oteman et al. note that generally municipalities are more inclined to cooperate with commercial parties than citizen projects (2014). Overall, Elzenga and Schwenke (2014) lament that a clear vision on the role of citizen initiatives in RE and how to provide financial and other means of support is absent in local energy and climate policy.

15.5.2 Economic and Management Factors Affecting the Financing of RES and Establishment of Consumer (Co-)Ownership Models

Boon and Dieperink (2014) find civil society-based initiatives in RE generation in the Netherlands face three common economic constraints: the requirement of a high upfront investment, long payback periods and a low price-performance ratio. Attema-van Waas and Rijken (2013) confirm the main barrier to be financial as well with local initiatives lacking the capacity to amass capital for the initial investment and maintenance of RE projects; they underline the importance of situational awareness for the success of a citizen RE project implying to build a network, create supportive structures and maintain relations with external actors.

Furthermore, technical experience and knowledge are important for the setting up of a RE project (Attema-van Waas & Rijken 2013). All of this requires a certain level of professionalisation. However, Dutch citizen RE cooperatives rely mostly on volunteers for their functioning. Volunteers are limited in their time and expertise. The procedure to obtain licences for RE installations is a lengthy and complicated process in the Netherlands (Boon and Dieperink 2014). Projects in their initial phase often suffer from a knowledge and network gap. This prevents them from effectively drafting project plans, applying for licences and grants and creating a local support network (Hoppe et al. 2015). The lack of professionalisation and financial restraints thus constitutes a vicious circle. Experts from advocacy organizations for local sustainable energy projects also mention the need for professionalisation and knowledge sharing. Even non-profit organizations need funds to start new projects and pay professionals for larger projects. Bringing in consultants and project development companies might ease the burden (Hieropgewekt 2016). Hoppe, however, warns for a trade-off: professionalisation implies alienation from the grassroots movement and may corrode local trust (2015).

A 2016 evaluation finds that the budget of the main feed-in tariff programme had been underutilised over the previous years. This had the positive effect that the 2016 budget could be raised without having to increase energy taxes. On the other hand, this implies theoretically more projects could have been awarded support. Also, the realisation rate of projects that won the auction is too low. To counter this, the authors of the report recommend higher qualification criteria and more flexible budgets. The report also considers the share of participation groups in the scheme. Most participants are SMEs, followed at 11 per cent by the non-profit group of which most citizen cooperatives are part (Noothout and Winkel 2016). This may be related to over-bureaucratised and complex application processes for funding Blokhuis et al. mention (2012). The authors generally find the effectiveness of Dutch subsidy schemes low compared to, for example, Sweden and Germany. An additional important issue is investor security being jeopardised due to changing regulations. This hampers long-term continuity in funding. Also, funding budgets are considered too low, and budgets change on a yearly basis, which makes financial planning difficult. Furthermore, there is no differentiation in incentives for specific technologies and locations. Solar and biomass projects' registration for the feed-in tariff programme exceed the budget, while for other categories funding is not nearly used up. This may explain why there is an overall low score on financial efficiency in the Blokhuis et al. study of 62 local energy companies (2012).

15.5.3 Cultural Factors Affecting the Financing of RES and Establishment of Consumer (Co-) Ownership Models

A set of economic goals many citizens involved in starting RE projects share are energy security, energy efficiency, boosting the local economy, more control over energy provision and finally commercial opportunities (Vasileiadou, Huijben & Raven 2016). The domination of the energy market by large international companies triggered citizens to consider a more autonomous provision (Hoppe et al. 2015). Boon and Dieperink (2014) find another common motivation is the attempt to reinstall community values in an increasingly alienating society. Local energy production is a measure to obtain goals such as local employability, prevention of energy poverty and the recovery of social cohesion. Money currently paid for individual energy bills to large companies is thought to be better spent on the setup of local energy production, of which the profits can then be reinvested in local facilities, such as community centres and sports fields.

A survey carried out among initiators of citizen projects founded after 2010 found that environmental and climate concerns do not so much result in energy generation activities but rather in energy-saving measures and advocacy (Roos 2015). Whereas the government's push to switch to renewable energy production may stem from climate agreements, citizens often have other motivations. The Dutch government's inertia in implementing the energy transition may imply that climate and environmental concerns do not constitute a strong-enough incentive. The socio-economic motivations underlying citizen initiatives could prove more effective at boosting renewable energy production.

15.6 Possible Future Developments Trends for Consumer (Co-)Ownership

With regard to the potential contribution of civil society, the Energy Agreement sets out the specific goal of one million small segment users, which include households and SMEs, meeting their energy demand with their own RE installations by 2020. The document does not list specific RE technologies to be incentivised. Rather, it states the expectation that solar energy, solar heat and heat pumps will be the prevalent sources (SER 2013). The Energy Agenda of 2016 is the succeeding policy document to the Energy Agreement and outlines transition policy until 2050. This Agenda emphasises the importance of the low carbon economy and reconfirms earlier targets, such as the on- and offshore wind energy targets (Rijksoverheid 2017c).

More recently, the coalition agreement of the newly elected government, as presented in October 2017, specifically focuses on sustainable action and suggests a rather ambitious policy. As mentioned above, the closure of the five remaining coal-fired plants is part of this policy. Furthermore, the coalition agreement states per sector specific CO_2 emission reduction targets to be achieved by 2030. For instance, industries will be responsible for a reduction of 22 Mton, transport for 3.5 Mton, the built environment for 7 Mton and the electricity industry for 20 Mton. Savings in the latter should be realized through the closure of the coal-fired plants, namely, 12 Mton, offshore wind energy with 4 Mton and solar energy with 1 Mton (Van Santen 2017).

With respect to (co-)ownership and measures to be taken by households, the coalition agreement puts forward plans to subsidise energy efficiency and to replace the net metering scheme by a new financial incentives regime, which closely resembles a feed-in tariff. In September 2018 the Minister of Economic Affairs and Climate Policy announced the current scheme is to be maintained until 2021, whilst preparing a new subsidy regime (Rijksoverheid 2018) Moreover, the national government will work closely with municipalities, provinces, waterworks and system operators to create sustainable regional plans, supported by subsidies if necessary. These regional plans will focus on programmatic approaches to energy savings, sustainable heating and energy production on a local level. A separate measure will be created for sustainable cooperatives to facilitate participation of locals (Bureau Woordvoering Kabinetsformatie 2017, pp. 38–39). These plans are a confirmation of the acknowledged importance of distributed sustainable energy with the participation of non-traditional parties. However, government has emphasised this before already. Dutch government pledged to focus on the new Climate Agreement and simultaneously on a Climate Act in 2018 (ibid., pp. 41–43). Much will depend on these two processes with respect to (co-)ownership, active consumerism and local sustainable energy.

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16

Consumer (Co-)Ownership in Renewables in Poland

Katarzyna Goebel

16.1 Introduction

16.1.1 Energy Mix

The Polish energy sector is mainly based on fossil fuels. Hard coal and lignite account for nearly 90 per cent of electricity production (PAIZ 2013; CSO 2017).[1] In 2015 the gross inland consumption of all solid fuels amounted to 50.6 per cent, petroleum and products 25.1 per cent, gases 14.4 per cent, renewables 9.4 per cent and waste 0.5 per cent (Eurostat 2017a). Natural gas and crude oil—mainly imported—are also important primary sources of energy. Similar to the majority of EU countries, this causes an increased dependence on foreign energy supplies,

[1] In the 1970s Poland was among the biggest coal exporters in the world, but exports today are constantly decreasing, resulting from lower demand, dropping coal prices and a shift towards alternative energy resources worldwide (Rudźko 2012).

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especially from Russia. As of 2015 (IEA 2017), total primary energy supply per capita was 2.5 toe with a 51 per cent share of coal, 24 per cent of oil, natural gas of 15 per cent and RES of 10 per cent, of which biofuels and waste 9 per cent, wind 1 per cent, hydro 0.2 per cent, solar 0.03 per cent. In this fossil fuel-based energy market, renewable energy sources (RES) do not play a significant role yet (Schnell 2016). Since the beginning of the 2000s, the development of renewables is slow but steady: from 6.9 per cent in the gross final energy consumption including hydropower in 2004 to 11.8 per cent in 2015 with 13.8 per cent in electricity, 14.3 per cent in heating and cooling and 6.4 per cent in transport (Eurostat 2017b).

The only significant RES is biomass mainly used in fossil fuel-fired power plants for co-generation with 89 per cent of primary energy production from green energy in 2014; the size of rural areas in Poland implies a great potential for further development. The second largest renewable technology in use is wind energy, which in that year had an 8.2 per cent share in renewable energy (RE) production. Hydropower, placed third, is traditionally used since the 1950s and accounted for 2.3 per cent in 2014. Although solar power gained importance over the last years, especially for private use, its share among other RES is still marginal with 0.2 per cent in 2014, respectively (Eurostat 2016). In 2015 in electricity generation, wind was placed first with 6.6 per cent, followed by biofuels and waste 6.1 per cent, hydro with 1.1 per cent and solar with only 0.04 per cent (IEA 2017). However, in line with the global trend, 2015 was a record-breaking year for investments in wind and solar energy also in Poland (Frankfurt School-UNEP Centre and Bloomberg Energy Finance 2016; IEO 2016).[2]

16.1.2 Main Challenges for the Energy Market, Specific Policy Goals and National Targets

The main concern of the Polish government is energy security with regard to dependence on fossil fuel imports in particular from Russia, therefore stressing domestic energy resources, particularly hard coal and lignite and

[2] Shift towards sustainable energy and decreasing technologies prices resulted in the record of newly added capacity in the power sector of RE in 2015 (especially wind and solar energy) that exceeded fossil fuels (see REN 21 2016).

the diversification of the energy mix, among others, through the introduction of nuclear power.[3] However, as some of the economically unprofitable coal companies relying on subsidies are expected to close, paradoxically, Poland may face coal shortages in the future (Schwartzkopff and Schulz 2017). At the same time, tackling disastrous air quality resulting from low-stack emissions caused mainly by decentralized heating systems based on fossil fuel is high on the political agenda; air quality in Poland is among the poorest in Europe (EEA 2016).

Furthermore, the Polish power system is in urgent need for investments as the existing energy infrastructure—mostly built in the 1960s and 1970s—is rapidly ageing.[4] This may cause problems for the power system's stability such as during the 2015 summer crises, when due to a heat wave generation units facing the imminent threat of blackouts had to be switched off, provision was declined, and consumers were obliged to reduce their consumption (Sudak 2015). Besides old generation units, Poland has insufficient gas and electricity interconnectors (Mezosi et al. 2015; Gawlikowska-Fyk 2013). Especially in rural areas, its high- and medium-voltage transmission grids—important for local governments responsible for basic services such as electricity, water and sanitation—need modernization and extension as well.

Within the EU 20-20-20 energy and climate policy goals, Poland is obliged to increase the share of RES in its final energy consumption by at least 15 per cent until 2020.[5] As determined in the latest official Polish Energy Policy until 2030 adopted in 2009, domestic coal remains the main instrument for providing energy security (Polish Ministry of Economy 2009). The strategy until 2050 is still in preparation. Climate issues are part of the National Plan for Responsible Development, which covers all economy sectors (Polish Ministry of Economic Development 2017).

[3] However due to controversies surrounding this topic, as of now, no concrete decisions have been taken (see Berenda 2017).

[4] With almost 40 per cent of power blocks being over 40 and 15 per cent over 50 years old, some qualify for immediate decommissioning, and, indeed, power plant owners plan to decommission some 5.2 GW between 2014 and 2028 (PAIZ 2013).

[5] According to the National Action Plan, the 15 per cent goal should be achieved by a composition of 54 per cent in heating and cooling, 25 per cent in electricity and 21 per cent in transport.

16.1.3 Ownership Structure in the Renewable Energy Sector

The liberalization of the energy market started in the early 1990s and deeply changed its landscape. However, due to the described energy mix, the bulk of the assets—especially in the fossil sector—remain centralized by large companies, in many of which the state retained a controlling stake. The technical and economic features of biogas and hydropower—in contrast to solar energy—typically requiring substantial investments favour concentrated ownership in the RE market. In the RE power sector, the six largest energy companies in the country own over 90 per cent of the installed capacity, while the contribution of independent power producers remains marginal. Installations below 1 MW make up only 10 per cent of the market, below 200 kW—0.6 per cent—while micro-installations up to 40 kW only 0.2 per cent (Wiśniewski 2016). Seventy per cent of residential buildings have autonomous heating systems dominated by hard coal and natural gas (Firląg and Staniaszek 2015; Dworakowska 2016).[6] However, only anecdotal information on the heat market is available.

Examples from the most important RE sectors are as follows:

- From 303 biogas power plants in 2016, the majority operate at landfill sites and wastewater treatment plants. However, the interest in agricultural biogas power plants is growing. As of 2016, among the investors of now 67 projects (Wiśniewski and Oniszk-Popławska 2015) are large farms, food, energy, trade and building companies, as well as investment funds, often with foreign capital (Oil and Gas Institute—National Research Institute in Poland 2014).
- Wind parks are installed mostly along the coastline in northern Poland and owned by five big investors: EDPR, Iberdrola, Vortex, Dong, RWE Innogy. They combine for around 46 per cent of the installed

[6] The majority of over six million buildings in Poland are houses, a half of them single-family houses. Seventy per cent of them, that is, some 3.8 million houses, use hard coal in old furnaces (Dworakowska 2016).

capacity (EWEA 2013). In other regions, smaller individual and often privately owned projects dominate (Ciżkowicz et al. 2012). Among municipalities, schools, local companies and private persons invest mostly in photovoltaic (PV) systems.

- It is estimated that nearly 4000 people in Poland produce electricity and/or heat from green energy sources for their own use in an off-grid mode, while only 2000 are connected to the grid (Bolesta 2015; Wiśniewski 2016). Thanks to favourable financing options available at the municipal level, their number is steadily growing, so that solar energy in general predominate the market of micro-installations (see Wiśniewski and Oniszk-Popławska 2015).

16.2 The Consumer at the Heart of the Energy Market?

16.2.1 Consumer (Co-)Ownership in Renewable Energy Sources as Policy Goal

In line with the trend towards decarbonization based on decentralized RE production and a pro-active role of consumers, the Renewable Energy Sources Act of 2015 (RES Act) introduced the definition of prosumers as end consumers, who also generate electricity from RES in micro-installations of up to 40 kW for their own needs (Art. 2 §27a RES Act). In practice, due to its characteristics with regard to accessibility, size and falling costs, the prevalent technology among prosumers is solar energy.

To be included in the RES Act, the long-debated so-called prosumer amendment (Polish *poprawka prosumencka*) was designed to provide individual prosumers with favourable conditions for micro renewable installations, that is, all installed electricity generation units under 40 kW and heat generation capacity under 70 kW, which were to be granted (1) simplified administrative procedures, including no obligation to register a company for self-consumption, (2) feed-in tariffs (FITs) for electricity produced in units up to 10 kW installed capacity guaranteed for 15 years with an option for net metering and (3) compulsory net metering for installations between 10 kW and 40 kW. However, the amendment did not pass the legislative procedure in 2015; instead of the proposed incentives, a 2016 amendment of the RES Act finally introduced incentives—focusing, however, on non-volatile RE technologies, especially biogas.[7] Owners of micro-installations (with a capacity up to 40 kW) can exchange the surpluses of electricity production for provision of electricity in times of insufficient generation (modified net metering) in relation 1 to 0.8 or 0.7 depending on installation size. Corresponding to the EU Clean Energy Package, the 2018 amendment not only opens two remunerations possibilities, that is, FITs and FIPs, but also increases the maximal capacity of micro-installations to 50 kW and that of small installations to 500 kW. Furthermore, the new regulation reduces administrative effort of new installations as, for example, building permits will no longer be required.

More general, the RES Act focuses on individual prosumers, while collective models for citizens' financial participation in RE as known in other European countries are not widespread yet. The law recognizes, however, energy cooperatives as defined in the Cooperative Law (CL) from 1982. The RES Act enumerates the possible activities of energy cooperatives with regard to production of electricity from RES in installations not exceeding 10 MW, biogas of not more than 40 m^3 annually and heating from RES in combined heat and power (CHP) of not more than 30 MW, as well as distribution, trade and balancing of electricity, biogas or heat for own consumption of the cooperative or its members, who are connected to the local grid (Art. 2 §33a RES Act). Additionally, the legislator introduced so-called energy clusters (Polish *klastry energetyczne*), that is, models binding together diverse actors adapted to the local needs and tackling local challenges, including physical and legal persons,

[7] Existing biogas power plants embraced by the previous support system enjoy incentives as regards the certificates of origin—so-called blue certificates for electricity generated from agricultural biogas and certificates for co-generation (Art. 44 RES Act). The amount of blue certificates to be purchased by enterprises operating in the energy market was set on a relatively high level (0.65%). Increased demand results in higher certificate prices at the energy stock exchange. Under the tendering system, biogas installations are treated as a separate category (Art. 73 RES Act), while Art. 77 §2 RES Act sets the minimal reference price in tender only for biogas at 550 PLN/MWh (ca. EUR 137 MWh). These regulations ensure investment certainty.

research institutions and local governments (Art. 2 §15a RES Act). The practical functioning of this model is in its initial phase with the city of Słupsk being amongst two selected pilot projects that were awaiting validation in early 2018.[8]

However, consumer (co-)ownership received explicit recognition of its crucial role in the 2018 recast of the Renewable Energy Directive (RED II) as part of the Clean Energy Package. The transposition of the RED II into Polish Law until 2021 will be an important legislative impulse as it introduces a legal framework for consumer (co-)ownership. Consumers, individually (Art. 21, households and non-energy SMEs), collectively (Art. 21, tenant electricity) or in communities (Art. 22, cooperatives and other business models), will have the right to consume, store or sell energy generated on their premises. RED II also invites the member states to provide an "enabling framework" for local "renewable energy communities". The directive links prosumership to so different topics as fighting energy poverty, increasing acceptance, fostering local development, incentivizing demand flexibility and so on, defining citizen's rights and duties and evenly important clear definitions (Article 2 RED II).

Finally, in April 2018 the Horizon 2020 project SCORE[9] was launched with the aim to facilitate consumers to become (co-)owners of RE in three European pilot regions employing a Consumer Stock Ownership Plan (see Chap. 8). One of the pilot projects is the city of Słupsk located in Pomerania with a population of 90,000 which aspires to eliminate energy poverty and become one of the cleanest cities with regard to the EU/WHO air quality standards in Poland. The pilot project envisages adding 0.78 MWp to existing PV installations involving prosumer investments of at least 200 households in particular with the aim to include vulnerable consumers. For citizens wanting to equip their houses with PV installations and energy efficiency measures, the city plans a special credit programme without own contribution of citizens taking into account income levels based on a municipal revolving fund with a compulsory energy efficiency audit to maximize the outcome.

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[8] The study commissioned by the Ministry of Energy concerning the realization of the concept was first published in the beginning of 2017.

[9] "SCORE" = **S**upporting **C**onsumer **O**wnership in **R**enewable **E**nergy (CSA 2018–2020) Grant Agreement 784960.

16.2.2 Fuel/Energy Poverty and Vulnerable Consumers

As estimated in the 2016 study "Energy Poverty in Poland—Diagnosis and Recommendations", 44 per cent of the population, that is, 17.2 million people, spend 10 per cent of their income on energy and heat consumption, while more than 4 million cannot satisfy their energy needs and suffer from energy poverty (Lis et al. 2016). This situation is a result of low income, on the one hand, and energetically inefficient building stock (20 per cent of buildings were erected before 1945 and a total of 69 per cent before 1989; Schumacher et al. 2015) on the other.[10] While efforts to improve energy efficiency in public buildings are significant, comparably little support is offered for the private sector (Schwartzkopff and Schulz 2017).

Policies addressing the energy poverty in Poland rely on financial support for low-income families, that is, social subsidies and tax reductions.[11] Moreover, consumers are secured from grid disconnection by the right to appeal against the decision, which has suspensory effect and needs to be examined within 14 days to be upheld (Art. 6c EL). Vulnerable consumers can also have prepaid meters installed (Art. 6a EL). While investments in energy efficiency of buildings are crucial, the housing policy based on subsides and loans is accessible only for the wealthier part of the society, which has reliable credit scores, savings potential or at least real estate ownership. It is suggested to alleviate this lock-in effect by a combination of social and housing policy instruments, for example, by allowing the recipients of social subsidies to dedicate these as own contribution often required for programmes financing energy efficiency measures (Lis et al. 2016); this could also include investments in RE installations.

[10] Combined with a domination of fossil fuels, mostly coal, for heating, residential buildings are costly to maintain, especially single-family homes.

[11] For example, the programme 500+ granting PLN 500 monthly per child indirectly helps to overcome this problem by an estimated 1.4 per cent. A targeted subsidy for energy expenses is less popular (Lis et al. 2016).

16.3 Regulatory Framework for Renewable Energy

The main statutory provisions regulating the RES sector in Poland are the Energy Law (EL) and the 2015 RES Act. The central authority is the Energy Regulatory Office (ERO) with its main tasks regulating the energy and fuel markets, supervising transmission system operators (TSOs) and distribution system operators (DSOs), granting licences and collecting information on the energy market.

16.3.1 Regulation for Connecting Renewable Energy Plants to the Grid

The connection of a prosumer's micro-installation willing to feed his surplus electricity production into the grid lies in the DSO responsibility. The prosumer is not charged with any fees but contractually bound to the DSO. For installations larger than 40 kW, the ERO following the principle of RES priority obliges DSOs to acquire the electricity produced from green energy (Art. 41 RES Act). Owners of installations of up to 5 MW and CHP units smaller than 1 MW pay only a half of the regular fee for their connection (Art. 7 EL).

As a rule, to provide any services in the energy sector, a licence issued by the ERO is required. However, for energy cooperatives, this obligation does not apply, if the distribution system comprises electricity provision only to members and their number does not exceed 1000. Cooperatives, or local energy suppliers on their behalf, are exempted of obligations such as development planning, admission of new consumers, grid maintenance and operation and so on (Art. 38b RES Act).

16.3.2 Support Policies (FITs, Auctions, Premiums, etc.)

Until 2015 the support for RES was based on a quota system, in which plant operators producing electricity from RES received a tradable certificate of origin, a green certificate, for each MWh produced.

Electricity suppliers were obliged to acquire certificates pursuant to the RES Act. Since the law's amendment of 2016, RES installations smaller than 500 kW receive a feed-in tariff, while those larger receive a sliding feed-in premium with the remuneration being determined in tenders based on the pay-as-bid principle[12] granted for up to 15 years but not beyond 2035; with these incentive systems, the Ministry of Energy targets especially the development of biogas and large photovoltaic installations.[13] Installations operating before July 1, 2016, can still use the certificate scheme that will function parallel with the auction system.

Further incentives for producers of electricity from RES include priority access to the grid (Art. 7 §1 EL) and excise tax exemption on electricity consumption (Art. 30 §1 Tax Act). Additionally, producers of green electricity can receive targeted loans and subsidies from the National Fund for Environmental Protection and Water Management (NFEP&WM) and the regional counterparts.

16.3.3 Specific Regulations for Self-Consumption and Sale to the Grid

Prosumers with an installed capacity of less than 40kW have a right to network access within 30 days. Owners of micro-installations with a capacity of up to 10 kW can exchange the surpluses of electricity production for provision of electricity in times of insufficient generation in relation 1 to 0.8 and those of installations with capacity between 10 and 40 kW in relation 1 to 0.7 with a balancing period of 12 months. However, agricultural biogas and bioliquids are excluded from this modified net metering system. The 2018 reform increased the size of installations eligible for remuneration to 50 kW as well as its amount to 0.9 (IEO 2018).

[12] In pay-as-bid auctions, the winners receive remuneration in the amount offered in their bids.

[13] See Polish Ministry of Energy (2017) https://legislacja.rcl.gov.pl/docs//3/12292350/12392584/dokument281972.pdf, accessed 01.08.2017.

16.4 Concepts for Consumer (Co-)Ownership in Practice

16.4.1 Contractual Arrangements and Corporate Vehicles Used

Citizen energy projects open to the public are not popular in Poland yet; we find only anecdotal evidence. Gaining popularity are investments in solar collectors and photovoltaic installations on private buildings, often facilitated by municipalities making use of financing programmes offered by the state. With the exception of the limited liability partnership (*spółka partnerska*),[14] participation in RE projects is possible via any available type of corporation, partnership or individual business activity, similar to those in other European countries. Cooperatives as a legal vehicle are also available and as stated previously expressly mentioned in the RES Act when defining specific forms of activities in the energy sector.

Municipalities attempt to attract investors to invest in RE infrastructure themselves or enter public-private partnerships to increase tax revenues and ensure growth of the local economy. An example is energy service companies (ESCOs); the financing is often secured by state programmes.

16.4.2 Financing Conditions for Consumer (Co-)Ownership in Renewable Energy

16.4.2.1 State Subsidies, Programmes, Credit Facilities, Preferential Loans

The main financial institution for investments in green energy projects is the NFEP&WM. The fund distributes national and EU sources, such as the Operational Programme 'Infrastructure and Environment' or

[14] According to Art. 86 §1 of the Code of Commercial Companies, the legal form of limited liability partnership is reserved for freelance work.

LIFE[15], as well as the European Economic Area and Norway Grants.[16] Municipalities can participate in regional competitions; once successful, within this financing scheme, citizens can receive loans and subsidies for RE installations in electricity, heating and cooling of up to 85 per cent of the total investment. Under this programme, municipalities secure all investments during the payback period under retention of title until the redemption of the loan. Loans on preferential terms are also offered by the Bank Ochrony Środowiska S.A. Programmes offered by municipalities, financed by the NFEP&WM, are also very popular for investments in private buildings. The NFEP&WM's PROSUMENT programme 2014–2020 incentivizes prosumer self-consumption through subsidies and/or loans for micro and small RE producing electricity or heat.

16.4.2.2 Agencies Supporting Investment in Renewable Energy Sources

Among the state actors relevant for the development of RE are the Ministry of Energy, the Ministry of Environment, the Ministry of Economy and the ERO. At the municipal level, local governments are responsible for shaping and implementing the energy and climate policy, as well as providing basic needs for the inhabitants. RE and energy efficiency are gaining interest: over 800 municipalities have already applied for funding to develop low-emission plans, while 40 are members of the EU Covenant of Mayors (Węglarz et al. 2015).[17]

Among Polish civil society organizations supporting RE, a few stand out. The Institute for Renewable Energy which advocates RE and merges research with consultancy services makes a remarkable contribution to RE development. Further examples are the Institute for Sustainable

[15] LIFE is the EU's financial instrument supporting environmental, nature conservation and climate action projects throughout the EU; for the 2014–2020 funding period, LIFE will contribute approximately EUR 3.4 billion to the protection of the environment and climate.

[16] For details see http://www.nfosigw.gov.pl.

[17] A 2013 study by the Hertie School of Governance shows that over 85 per cent of municipalities would like to invest in green energy (Ancygier and Caspar 2013).

Development, the Association Polish Green Network and the Alliance of Associations Polish Green Network. National and regional energy agencies are active as well, for example, the National Energy Conservation Agency, the Baltic Energy Conservation Agency and the Mazovia Energy Agency, supporting both public and private sector in all energy-related aspects. Finally, locally rooted organizations, associations, schools and the church have proven successful in involving citizens to actively participate in RE projects. In the beginning of 2017, one of the winners of the first auction round for wind energy, the *Energy Invest Group*, offered 30 per cent of their wind project's shares to citizens. The financing is based on equity crowdfunding, whereas the minimal capital to be invested amounts to PLN 30,000, around EUR 7500 (Gramwzielone.pl 2017). Furthermore, the project *Eko-lokator* ("Eco tenant") launched in 2017 collects best practices with regard to the refurbishing of apartment blocks to educate and encourage climate protection among others by promoting the approach of implementing energy efficiency measures combined with RE installations among professionals responsible for housing management. The project is financed from the EU funds via the national Operational Programme Infrastructure and Environment 2014–2020, which is the biggest fund in this thematic area, and realized by NAPE in cooperation with InE.

16.4.3 Examples of Consumer (Co-)Ownership

I. The joint project of four municipalities led by the **city of Niepołomice** is internationally recognized as a best practice for financing RES. The Polish-Swiss Cooperation Fund co-financed 60 per cent of the EUR 17.3 mln. investment in RE installations for public and private buildings between 2012 and 2015; 40 per cent were covered by municipalities' own contributions, a third of which came from citizens, who then could receive a 70 per cent subsidy for installing RES, mostly solar thermal, on their buildings (CoM 2016). Participants had to contribute 30 per cent of investments on their properties: from PLN 4020 to PLN 5730 (ca. EUR 1000–1400). This sum could have been granted from a loan on favourable conditions with a rate of return of max. 4.5 per cent. Depending on the household's size they received between two and five solar panels and a 250- to 500-litre water tank. The contractors and types of installations were chosen in a tender. As of 2016 the project resulted in 25,000 m^2 of solar collectors, 5000 m^2 of PV installations, nine heat pumps, biomass heating system of 65 kW and others. Some of the investments paid back within two to four years. The comprehensive approach to reduce air pollution in the region involved other measures, such as green public procurement, thermal modernization of buildings, new street lighting, monitoring of energy production. The project was also accompanied by a series of campaigns and seminars and monitored throughout its duration (Nowacki 2016). Similar programmes were offered in other Polish cities. However, their results were not that impressive as those in Niepołomice and neighbouring municipalities, which may be a consequence of many factors, such as building types (the landscape is filled with single-family houses), demographic structure (high percentage of working-age population), level of wealth (cf. UStat 2017).

II. Despite a long history of the cooperative movement in Poland, only one energy cooperative was initiated so far—**Cooperative Our Energy** (*Spółdzielnia Nasza Energia*, *SNE*), which started in 2014 in south-eastern Poland. The cooperative is a joint project by Bio Power Sp. z o.o., Elektromontaż Lublin Sp. z o.o. and four municipalities: Sitno, Skierbieszów, Komarów-Osada, Łabunie. The main motivation behind the project was to locally produce energy using the agricultural potential and hence tackle regional problems of energy provision and prices, as well as a lack of investments. The plan comprises building 12 interconnected biogas power plants ranging from 0.5 to 1 MW. These facilities are to deliver electricity to all public buildings, street lighting and many households. The membership in SNE is open to all private and legal persons, including local governments, and is not limited geographically. The democratic values and social control over the enterprise are the main principles listed in the bylaw. The entrance fee to be paid is PLN 1000, circa EUR 250, while one share costs PLN 500, circa

EUR 125.[18] The total investment shall amount to PLN 150 mln. (ca. EUR 38 mln.) (PAP 2016). Due to the focus of the RES Act on clusters rather than cooperatives, the latter suffer from lack of dedicated support.

III. The housing sector[19] has great potential for RE with examples of investments by housing associations and cooperatives reported. Increasingly single apartment owners or their tenants become (co-) owners of micro- and small installations covering their own heat and electricity needs in solar collectors, heat pumps and photovoltaic installations (Wolańska 2017a). For example, a **housing association in Szczytno** in north-east Poland produces its own energy on five houses from 120 kW heat pumps and 39.7 kW photovoltaic installation. Since 2014 they produce around 38 MWh of electricity yearly, generating financial and environmental values for the local community. Installations are centrally controlled and their operation can be viewed online. This total of PLN 625,000 (ca. EUR 156,000) investment was co-financed by loans on preferential terms (1 per cent rate of return) from NFEP&WM and Bank Ochrony Środowiska (see Sect. 16.4.2) of PLN 500,000 (ca. EUR 120,000), while the housing association brought in PLN 125,000 (ca. EUR 30,000). This investment reduced the maintenance costs by almost 80 per cent (unit cost from PLN 7 to 1.8–2.4 per kWh). In order to convince the residents, the housing association organized a meeting with representatives of other successfully implemented undertakings. Now the project is extending—in 2017 the community received financial sources for solar water heaters. Plans are to increase the capacity of renewables to 30 MW (Wolańska 2017b). Even more housing associations follow this example. They normally complete the investments in renewable energy in buildings with a comprehensive thermal modernization to maximize savings.

[18] See *Bylaws of the Cooperative Our Energy from 27. March 2013*.

[19] Buildings account for around 40 per cent of total energy consumption across the EU, while around 70 per cent of them are inefficient (Impact Assessment for the amendment of the Energy Performance of Buildings Directive, SWD (2016) 414).

16.5 Factors Affecting the Financing of Renewable Energy Sources and Barriers to Consumer (Co-) Ownership

16.5.1 Political, Legal and Administrative Factors

The main barrier for consumer (co-)ownership in RES in Poland is the unstable legal system, especially as regards the energy market and RES (Wiśniewski and Dziamski 2015; Buzek and Księżopolski 2017). The 2015 RES Act was amended several times over the last years—sometimes with contradicting aims—while no specific long-term strategy emerged. Current developments drastically slowed down RE investments in Poland in general; the tender system itself poses an investment uncertainty. The controversies around the technical problems during the first auction round at the end of December 2016, making it impossible for some investors to submit their offers, increased the distrust towards public institutions (see Janicka et al. 2017). Particularly criticized is the stipulation allowing the Ministry of Energy to shorten the 15-year support period (Kukula and Adamczewski 2016). Moreover, investors in the wind energy sector bear higher costs under the new tax regulation,[20] the requirements as regards the local spatial plans and licences and so on complicate project development.

FITs that would potentially trigger investments in micro-installations were not introduced. At the same time, the asymmetrical remuneration for electricity fed into the grid as compared with that acquired from the grid, that is, 0.8 or 0.7 for 1 (see Sect. 16.3.3), impairs self-consumption models for prosumers. This problem is exacerbated by distribution levies due for prosumers when feeding the electricity into the grid. Further, although the procedures of grid connection were simplified, they still remain complicated in particular from the viewpoint of consumers (Federacja Konsumentów 2016).

[20] Since 2016 wind power plants underlie new tax regulations. According to the newly introduced definition, a wind turbine is treated as a building and can thus be a subject to higher taxes. Moreover, the distance to the nearest houses has to amount at least ten times their heights (in practice 1.5–2 km).

In its present form, the regulatory framework favours traditional market players and does not offer incentives sufficiently attractive to develop citizen energy projects. However, introducing the legal definitions of the "prosumer" and the "energy cooperative" can be regarded as an important step forward.

16.5.2 Economic and Management Factors

A discouraging factor, contributing to the relative small amount of private investments in RES, is the high initial capital required in relation to the level of wealth and liquid assets among the Polish society; while prices for RE installations are similar across the European Union, purchasing power and household savings are not.[21] Many private persons cannot afford RE installations, while state subsidies and loans are not available for everyone, for example, due to credit ratings or a lack of equity. Additionally, the cost structure is complex, future yields uncertain and the related payback period long (see Bukowski et al. 2014). A lack of expert knowledge on technical and legal issues is also a discouraging factor for the average citizen (see Federacja Konsumentów 2016).

16.5.3 Cultural Factors

Obstacles of social nature include reluctance towards the cooperative model that proved successful across Europe. Despite its popularity in Poland starting in the beginning of the twentieth century in other areas, it was never adopted in the energy sector. The model remains associated with bad experience of the communist era and hence not conversable into a business model that can be competitive in the modern market. This already-negative image is intensified by Poles' distrust to each other and to public institutions which is among the lowest in Europe.[22] The literature emphasizes also a low level of awareness of energy and climate issues, which is an important driver for many non-profit-oriented citizen

[21] Cf. Comparison of purchasing power parity in the European Union (Eurostat 2017c).

[22] See report by the Chancellery of the Prime Minister "Poland 2030" (Boni 2009, p. 339).

energy projects in other countries. This, although rising, is still lower than in western societies (cf. Kachaniak et al. 2014; Dworakowska 2016). From the financial perspective, small investments in RE are perceived as not sufficiently profitable, while related energy costs reduction may not be recognized (cf. Ropuszyńska-Surma and Węglarz 2017).

However, the general attitude to EE and RE is positive. Opinion polls carried out in the pro-ject "Implementation of Sustainable Development based on Socially Responsible Transfor-mation" under the EU Life+ programme in 2016 and 2018 indicate a stable and consistent support of citizens for the development of RES in Poland significantly exceeding that for fos-sil energy sources (Energiaodnowa 2018). While levels of support for RE and EE have not changed significantly between 2016 and 2018 fluctuating around 95 per cent they increased significantly when compared to those in similar surveys conducted nationwide in 2013.

16.6 Possible Future Developments and Trends for Consumer (Co-) Ownership

The 2016 RES Act amendment (see Sect. 16.2.1) aiming to steer and limit the uncontrolled development of wind, biomass and hydropower deemed too expensive introduced the auction system and favoured professional investors realizing medium-size projects which hampered the development of large-scale RE projects. It also blocked the development of prosumership among households, farmers and micro-enterprises; in particular the abolishment of favourable FIT for small installations is seen as an obstacle to consumer (co-)ownership.

Against this background and to foster (co-)ownership of RES among entrepreneurs, farmers and citizens in general, as well as to promote energy cooperatives and housing associations, the Institute for Renewable Energy (Instytut Energetyki Odnawialnej, IEO)[23] proposes (1) FITs for

[23] IEO's president Grzegorz Wiśniewski is member of the National Development Council and has been actively involved in agenda setting in the energy sector for many years.

micro RE installations up to 10 kW with special conditions for installations up to 5 kW for the poorest citizens (e.g., micro credit programmes, tax incentives) and lower support for bigger installations, respectively, (2) increasing the size limit for regulations supporting self-consumption and feed-in of surplus electricity production of RE installations to 100–500 kW (presently the limit is 50 kW), (3) FITs for the surplus electricity production of energy cooperatives, (4) introducing isolated micro grids with the possibility for tax exempt net metering of electricity especially in areas without reliable electricity supply and (5) providing access to information on price components for consumers, prosumers and energy cooperatives, increased disclosure on energy bills in a clear and comprehensible way, as well as compulsory information disclosure on the potential and possibilities for grid access for RE installations, and so on.

Above proposals—should they be implemented—would have the potential to effectively boost small-scale RE production. However, at the same time, we observe a trend to limit support for micro-installations in order to reduce complexities and decrease the number of market actors.

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17

Consumer (Co-)Ownership of Renewables in England and Wales (UK)

Rebecca Willis and Neil Simcock

17.1 Introduction

Energy policy within the UK differs significantly between its countries. This chapter will mainly focus on England and Wales,[1] while referring to the overall situation where necessary.

[1] Scotland is treated in a separate chapter in this volume. Note that the regulatory system in Northern Ireland differs, as Northern Ireland shares an 'all-island' electricity network with the Republic of Ireland; thus some regulation is shared with the UK as a whole, and other aspects are treated separately. This chapter does not go into detail about the specifics of the Northern Irish market or regulation.

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17.1.1 Energy Mix

Levels of energy use in the UK, measured as final energy consumption, have been falling over the past decade, though energy use for transport is rising. Energy use in industry has seen significant declines (BEIS 2017a). In terms of energy source, the UK's energy mix has shifted significantly over the past 50 years; solid fuels (primarily coal) reduced from 47 per cent in 1970 to 16 per cent in 1999. Gas has increased from just 5 per cent in 1970 to a peak of 43 per cent in 2010, due to its availability from the North Sea; it has declined slightly since.

Meanwhile, renewable energy (RE) has increased, largely due to policy measures. As a share of all energy, it increased from 1 per cent in 1999 to 7.4 per cent in 2016 and is continuing to increase (BEIS 2017a). There is now a total of 38 GW renewable electricity capacity, and the sector has been growing quickly, with a 13 per cent increase in the year from 2016 to 2017 (BEIS 2017b). Wind and solar energy account for most of this increase. Overall, renewables' share of electricity generation reached a record 29.8 per cent in mid-2017 (BEIS 2017b). However the UK is still languishing at the bottom of the renewables league table, coming 24th out of 28 EU member states. With 69 per cent, heating in the UK is dominated by gas with a smaller share of electricity and negligible amounts of renewable heat such as bioenergy (BEIS 2017a).

17.1.2 Main Challenges of the Energy Market, National Targets, Specific Policy Goals

The UK's energy goals are stated as follows: (1) ensure the UK has a secure and resilient energy system; (2) keep energy bills as low as possible for households and businesses; (3) secure ambitious international action on climate change and reduce carbon emissions cost-effectively at home; (4) manage the UK's energy legacy safely and responsibly (Ares et al. 2016). These goals are often referred to as the 'trilemma', referring to the three main aims of energy security, cost reduction, and carbon reduction. Decentralisation and diversification are not explicit aims of UK policy, though they are seen by some as ways of achieving the above goals.

The UK has strong, legally binding carbon budgets, with a long-term goal of 80 per cent carbon reduction by 2050, and interim five-yearly carbon budgets, introduced in the 2008 Climate Change Act, widely seen as a world-leading piece of legislation (Nachmany et al. 2014). The first two carbon budget periods, 2008–2012 and 2013–2017, were over-achieved, with a saving of 25 per cent from 1990 levels by 2012 and 31 per cent by 2017. Reductions in carbon emissions came about primarily because of reductions in economic output, following the financial crisis, and the long-term decline in coal power. However, the Committee on Climate Change, who monitor progress against the budget, have warned that subsequent carbon budgets will be harder to achieve due to insufficient policy measures (Committee on Climate Change 2016). The UK has a RE target of 15 per cent of final energy consumption (both electricity and heating) by 2020 (UK Government 2009), part of the overall EU target. This will be a challenge, given the UK's relatively low levels of RE compared to other EU states. The country's electricity production is still marked by a strong lock-in on fossil power (Climate Change Act 2008). To reach the set targets, policy will focus primarily on an increase in offshore wind power (Global Wind Energy Council 2016).

17.1.3 Ownership Structure in the Renewable Energy Sector

The UK's energy market is highly centralised and dominated by large commercial players (Willis and Eyre 2011). This is as a result of the process of privatisation of electricity and gas infrastructure and supply, which until the 1980s was state owned and run. Energy, both heating and electricity, supply is largely dominated by the so-called 'Big Six' companies: British Gas, EDF Energy, E.ON, Npower, Scottish Power, and SSE. Between them, the Big Six supplied nearly 95 per cent of households in 2014 (Ofgem 2014a), although smaller suppliers are increasing their market share slowly. As a result, much political attention has focused on encouraging consumers to switch supplier in order to reduce domestic energy prices, culminating in an investigation by the Competition and Markets Authority (CMA) which reported its findings in 2016 (Competition and Markets Authority 2016). These same companies own about 70 per cent of electricity generation capacity (Ofgem 2014a) though ownership of RE assets is a little more diverse, with a greater proportion of independent generators.

Large energy companies also have considerable influence over government, with a 2011 investigation by Green MP Caroline Lucas revealing that companies had provided 50 seconders to work within government, paid for by the companies themselves (The Guardian 2011). Transmission and distribution networks for electricity and gas are also privately owned; the transmission network is owned by National Grid and the distribution networks by regional distribution network operators (DNOs). As these networks are natural monopolies, price controls are enforced by a regulator, Ofgem. Wind farms are located across the UK, offshore, in coastal areas, and inland. However, large-scale RE developments are not permitted in national parks and other protected areas. Recently, tighter planning restrictions for onshore wind have been introduced, effectively preventing further developments onshore, though development of offshore wind continues.

Municipal or community ownership of RE assets is at a low level in the UK compared to some other countries. The country's first community-owned wind farm, Baywind, was built in 1997 but remained a rarity until the advent of Feed-in Tariffs (FiTs) in 2010, which led to rapid growth in community projects (Simcock et al. 2016). However, cuts in funding to FiTs and other support measures in 2015 (discussed further in Sect. 17.2.1) have slowed down the emergence of new projects (Community Energy England 2017). The exact number of community energy schemes in the UK is difficult to state with precision, as the number varies depending on how a 'community' project is defined. A recent study, focusing on Wales, Northern Ireland, and England, identified 222 community energy organisations (Community Energy England 2017):

- Of the 222 community energy projects in Wales, Northern Ireland, and England, 179 were generating energy, with the vast majority of the remainder focusing on energy efficiency and 12 generating heat (Community Energy England 2017). This amounts to 121 MW of electricity generating infrastructure, although further capacity is

currently within the planning system (Community Energy England 2017). Added to the 67 MW of community energy capacity installed in Scotland, across the UK as a whole, this amounts to 188 MW of generation capacity owned by communities.
- The breakdown of community projects between different technology types in England, Wales, and Northern Ireland is as follows: 101 solar PV projects with a total capacity of 99 MW, 16 wind power projects with a total capacity of 20.6 MW, and 20 hydro-electricity projects with a total capacity of 1.7 MW. This totals to 137 projects with 121.3 MW capacity, with solar by far the most popular technology both in terms of number of projects and total capacity.
- Geographically, meanwhile, England has the highest concentration of active community energy organisations. Wales has the highest number of groups per capita, with greater concentrations towards the North of the country (Community Energy England 2017).

Given that the total energy generation capacity across the UK is 97.8 GW (BEIS 2017c), with 38 GW coming from renewables alone (BEIS 2017b), community energy clearly makes up only a very small proportion with 0.19 per cent of total supply. Partly this is because projects involving community ownership are relatively small, both physically and in terms of generation capacity—the mean project capacity size (total capacity/number of projects) amounts to 676 kW. Larger solar projects of up to 9 MW in capacity are emerging, although these are relatively rare. There are very few community-owned heat schemes in the UK, with only 12 communities identified as engaged in heat-generating activities (Community Energy England 2017). District heating is not commonplace in the UK, with most individual dwellings having stand-alone gas-fuelled systems or, more rarely, electric heating.[2] Despite the low levels of community ownership, the ownership of renewables by individuals and households has increased considerably over recent years, due to the advent

[2] Around 4 million households, or about 14 per cent of all households, have no connection to the national gas grid using other fuel sources for heating, primarily kerosene heating oil or electricity (Office of Fair Trading 2011). The vast majority of households in the UK are connected to the national electricity grid, the exceptions being some remote farms and houses and some sparsely populated islands.

of Feed-in Tariffs and falling costs of solar PV. Over a million households now have solar PV or solar thermal installations (Solar Trade Association 2014).

17.2 The Consumer at the Heart of the Energy Market?

17.2.1 Consumer (Co-)Ownership in Renewable Energy Sources as Policy Goal

As discussed above, in the UK energy market consumers are largely thought of in terms of their role as individual purchasers of electricity and gas from commercial companies. The market regulator, Ofgem, is tasked with representing the interests of consumers. They state that 'Our principal objective when carrying out our functions is to protect the interests of existing and future electricity and gas consumers' and claim that this is achieved by promoting value for money, security of supply, and sustainability (Ofgem 2018). Demand-side measures have been understood and treated as distinct from the supply side. A succession of government-backed schemes has provided funding, or required energy companies, to help householders install energy efficiency measures such as cavity wall insulation or loft insulation. In 2012 a policy called the Green Deal was introduced, aiming to provide loans to householders to pay for energy efficiency improvements that would be paid back over time through savings in energy costs. However, the scheme saw very limited take-up, due to lack of awareness amongst householders, the high interest rates being charged, and uncertainties about the legal status of the loans. As a result the scheme was scrapped in 2015. The Clean Growth Strategy of 2017 has announced that other measures to improve home energy efficiency will be considered.

In 2014, a Community Energy Strategy was introduced, to find ways of overcoming the barriers faced by community energy. Some improvements were made—notably encouraging community organisations and commercial developers to work together through shared ownership arrangements (Simcock et al. 2016). However, with a change of government in 2015, this strand of work did not continue. 2015 also saw sharp reductions in FiT rates, alongside reductions in tax incentives and the closure of early-stage funding and support instruments (Community Energy England 2017). This all means that, on the whole, community energy across the UK is facing challenging circumstances. In this environment, community groups are attempting to adapt and innovate—ideas are being floated for new business models (e.g. by entering the energy supply business or operating private wire networks), new sources of funding (such as a greater degree of funding coming via co-operative shares), and new technologies (such as energy storage) (Community Energy England 2017). However, many of these future options are relatively untested and without established business models or precedents, and there also barriers such as high financial costs and an unsupportive regulatory environment. The exact future of community energy in the UK therefore remains uncertain. The situation is slightly less challenging in Wales compared to England and Northern Ireland (the circumstances in Scotland are discussed in a separate chapter in this book), due to some regionally specific support mechanisms in Wales—namely, the Ynni'r Fro and Ynni Lleol programmes and the EU-funded LEADER programme and the Robert Owen Community Banking Funding's (ROCBF) Community Energy Fund (Forman 2017). These various Wales-specific programmes support community energy projects particularly in the development stage, either through grants or loans.

Finally, consumer (co-)ownership received explicit recognition of its crucial role in the 2018 recast of the Renewable Energy Directive (RED II) as part of the Clean Energy Package. However, in the light of the UK's decision to leave the EU, the transposition of the RED II into UK law until 2021 is uncertain. If implemented, it would be an important legislative impulse as it introduces a legal framework for consumer (co-)ownership. Consumers, individually (Art. 21, households and non-energy SMEs), collectively (Art. 21, tenant electricity), or in communities (Art. 22, cooperatives and other business models), will have the right to consume, store, or sell energy generated on their premises. RED II also invites the member states to provide an 'enabling framework' for local 'renewable energy communities'. The directive links prosumership to different topics including fighting energy poverty, increasing acceptance, fostering local development, incentivising demand flexibility and so on (Article 2 RED II).

17.2.2 Fuel/Energy Poverty and Vulnerable Consumers

Although rates of fuel poverty in the UK are lower than other European nations, particularly those in Eastern and Southern Europe (Thomson and Snell 2013), the nation nonetheless still faces a significant problem with this issue. To a large extent, this is due to an old and inefficient building stock. In England, fuel poverty is measured using the Low Income High Costs (LIHC) indicator, which states that a household is considered to be in fuel poverty if (1) they have required fuel costs that are above average (the national median level) and, (2) were they to spend that amount, they would be left with a residual income below the official poverty line. Governments in the devolved nations use a different definition, which states a household is deemed to be in fuel poverty if it needs to spend more than ten per cent of household income for electricity and heating.

Official figures that estimate the number of households living in fuel poverty in 2015 are as follows: 2,502,000 households in England, equivalent to 11 per cent of all households; 294,000 households in Northern Ireland, equivalent to 42 per cent of all households; and 291,000 households in Wales, equivalent to 23 per cent of all households (BEIS 2017d). The fuel poverty charity National Energy Action estimates that 4 million households across the whole UK households live in fuel poverty—approximately 15 per cent of all households (National Energy Action 2015).

Since 2013, the main strategy to deal with fuel poverty has been the Energy Company Obligation (ECO), which provides subsidies for the upfront cost of installing domestic energy efficiency measures to those on low incomes or in properties that are difficult or expensive to retrofit. However, this programme has been critiqued for (1) being funded in a socially regressive manner (the policy is funded via levies on energy bills, which means the poorest households pay relatively more to cover the cost of the policy) and (2) simplistic eligibility criteria that means many fuel poor households are not entitled to assistance (Thomson et al. 2017). In 2017, the annual budget for the programme was also cut by 40 per cent (Energy Saving Trust 2017).

Alongside the ECO programme, two other UK-level policies exist to support fuel poor households—the Winter Fuel Payment and the Cold Weather Payment. These provide direct financial payments to eligible households in order to help them afford the cost of their energy bills. The Winter Fuel Payment gives a one-off payment of GBP 100–300 (EUR 112–338) to all households of pensionable age during the winter period, whilst the Cold Weather Payment targets households on low incomes and provides a payment of GBP 25 (EUR 28) for every seven-day period when temperatures drop below zero-degrees Celsius (Simcock and Walker 2016).

17.3 Regulatory Framework for Renewable Energy

17.3.1 Regulations for Connecting Renewable Energy Plants to the Grid

Grid connection is managed by distribution network operators, regional grid managers operating as private companies regulated by Ofgem. Any power generation project seeking connection to the grid must negotiate with the DNO. When a customer connects, they pay the cost of connection, plus a share of wider costs if network reinforcements or upgrades are required. This system is designed to keep costs to the consumer down, by encouraging developers to locate power plants where there is capacity on the network. However, a 2014 working group report chaired by Ofgem acknowledged that the system poses problems for community energy projects, which are often geographically constrained (i.e. they work in one particular location) and also often do not have sufficient funds to pay high grid connection costs. The working group considered a number of solutions to improve grid connection for community energy projects, but these have not been implemented (Ofgem 2014b).

17.3.2 Support Policies (FiTs, Auctions, Premiums, etc.)

The policy framework for renewable and low-carbon energy has seen considerable shifts in recent years, leading to calls for stability and certainty in the market. Previously, there were specific policies to promote RE, notably the Renewables Obligation, which required energy suppliers to source a proportion of electricity from renewable sources. However this system was replaced with 'Contracts for Difference' (CfDs), offering price support for low-carbon power including nuclear power and RE. The main policies in place now are as follows:

- The Carbon Price Floor, which puts a price on fossil fuels used for generating electricity and complements the EU Emissions Trading Scheme.
- CfDs which fix the price which low-carbon generators receive. This replaces the previous Renewables Obligation.
- The Emissions Performance Standard, which sets limits for emissions from power plants—coal-fired generation will only meet the standard if carbon emissions are captured.
- The Renewable Heat Incentive (RHI) which offers payments for renewable heat in buildings.
- The Feed-in Tariff (FiT) scheme to support smaller-scale renewable generation, including solar, hydro, and biomass, though tariff rates have been drastically reduced in recent years and will soon be phased out.

17.3.3 Specific Regulations for Self-Consumption and Sale to the Grid

Community and consumer owners of RE generation can choose not to connect to the national electricity grid and instead rely on a private wire network. However, this is rare and mostly happens in remote locations or in situations where RE is installed to provide power to large energy users, such as factories or farms. The vast majority of community projects do connect and sell their electricity to the national electricity grid. Sale to the grid is managed through the Feed-in Tariff system with varying rates depending on technology, size of scheme, and installation date. However, FiT levels have been reduced greatly in recent years. Larger installations are managed through Power Purchase Agreements (PPAs)—long-term contracts to buy electricity that are arranged with electricity supply companies. Since many energy supply companies own their own generation capacity (see Sect. 17.1) and are under no obligation to buy electricity from community-owned installations, it can be difficult for projects to secure a PPA. However, some independent suppliers such as Cooperative Energy and Good Energy offer PPAs to community generation projects.

There are alternative ways in which community-owned installations can sell their output, summarised by a recent report by REGEN (RegenSW 2016). Nearly all options (with the exception of private wire schemes) involve a partnership with a licensed supplier. Options include:

- 'Licence Lite': This scheme was introduced by the energy regulator Ofgem in 2009. It is intended to provide a simpler route to the supply market for smaller suppliers by avoiding the need to adhere directly to complex industry codes. It requires the small supplier to partner with an existing licences supplier, who follows the industry codes on their behalf. Although Licence Lite was introduced in order to simplify access to the supply market, in practice it is still far too complex for community groups to access. Only one Licence Lite has so far been granted, in 2017, to a private operator.
- 'White Label': Under this arrangement, a community group can work with a licensed supplier to provide their own offer to consumers. They essentially sell electricity under their own 'brand', through a deal with the licensed supplier. However, the licensed supplier retains control over the supply and retains responsibility for meeting codes and regulatory obligations. An example of this is the Ovo Communities scheme offered by Ovo Energy.
- Private Wire ESCO: Under this model, a community-owned or municipal energy company sells energy services in a local area, through a private wire network. This model is used very rarely. One example is Thameswey Energy, established by Woking Borough Council in 1999.

It generates and supplies low-carbon and RE to public and private sector customers in the local area.
- 'Sleeving': This is a variant of the PPA model, allowing a customer to buy energy directly from a local generating plant (e.g. a community-owned renewable installation) via a licensed supplier, who is responsible for regulatory compliance.

17.4 Concepts for Consumer (Co-)Ownership in Practice

17.4.1 Contractual Arrangements and Corporate Vehicles Used

There are a number of different models for consumer (co-)ownership in the UK, listed below.

Individual ownership: An individual household can own a RE installation and use the power or heat directly or sell it to the grid. Alternatively, individuals can finance RE schemes through investing in bonds, which are used to finance projects established by commercial, community, or municipal organisations. Whereas interest payments on bonds and similar products are normally taxed as part of the tax structure for individuals, investment in so-called ISAs (Individual Saving Accounts) is free of tax. Companies such as Abundance have recently established RE ISAs which benefit from this tax relief (The Guardian 2016). However, another form of tax relief, the EIS (Enterprise Investment Scheme), was removed from community energy projects in 2015.

Community ownership: This takes a number of legal forms. In England and Wales, the most common type is the IPS (Industrial and Provident Society), a form of cooperative. Members of an IPS invest up to GBP 100,000 (EUR 112,765), with each member having a single vote regardless of the size of their investment. Members are paid interest on their investment and receive tax relief. There are two types of IPS—bona fide cooperatives, who operate for the mutual benefit of their members, though they may decide to distribute profits more widely, and Community Benefit Societies, which are run for the benefit of the community, with members deciding how to distribute profits whilst receiving a relatively smaller individual return on their investments compared to the bona fide cooperative model. Another option is the Community Interest Company (CIC), which is essentially a company working for the benefit of the community or a registered charity.

Shared ownership: The coalition government of 2010–2015 promoted the concept of shared ownership, whereby community groups would take a share in the ownership of all significant RE developments. They established a 'Shared Ownership Taskforce' to broker a deal between the commercial RE sector and the community sector and to establish a voluntary agreement whereby communities would be offered a stake in commercial projects (DECC 2015). As a result, some such schemes have come to fruition, such as Braydon Manor (see below). However, the change of government in 2015 meant that the government's commitment in this area has not been followed up.

New business models: Following the decline in support from the Feed-in Tariff in 2015–2016, community groups have been looking at new business models for consumer (co-)ownership of energy. Such models do not rely on generating and selling energy to the grid; instead they look at options for self-supply, where energy is used locally, not sold through the grid. Community involvement in smart meters, demand response, and other ICT-enabled innovations as well as partnership with local authorities and housing associations to further local ownership of RE are also cnosidered.

17.4.2 Financing Conditions for Consumer (Co-) Ownership in Renewable Energy

Until the Community Energy Strategy of 2014, the UK had no agreed definition of community ownership or consumer (co-)ownership. The strategy uses a broad definition of community energy, as follows: 'community projects or initiatives focused on the four strands of reducing energy use, managing energy better, generating energy or purchasing energy' (DECC 2014). Ofgem, the energy regulator, has developed a narrower definition of community energy as part of its role as manager of the

Feed-in Tariff scheme. They define a ‘community organisation’ as ‘any of the following which has 50 or fewer employees: a charity; a subsidiary, wholly owned by a charity; a community benefit or cooperative society; or a community interest company’ (Ofgem 2016).

17.4.2.1 State Subsidies, Programmes, Credit Facilities, Preferential Loans

There is only one specific government-backed fund for community energy in England (there are separate arrangements for Wales, Scotland, and Northern Ireland). This is the Rural Community Energy Fund. It provides grants for feasibility and pre-planning development work. It is funded through EU funds. There was also a short-lived scheme providing the same support in urban areas, the Urban Community Energy Fund, from 2014 to 2016. Some community energy projects have received funding from the Big Lottery Fund, which is a government body distributing money raised through the National Lottery. Again, this is grant funding. In addition, there are a range of local and regional funding sources, including charitable trusts and local government. Community Energy England, Community Energy Wales, and Community Energy Scotland maintain lists of funding sources. Such funds tend to cover early-stage development costs only.

17.4.2.2 Agencies Supporting Investment in Renewable Energy Sources

The sector is supported by a number of organisations, including Community Energy England, Community Energy Wales, and Community Energy Scotland, which act as umbrella groups and spokespeople for the sector, as well as a wide range of voluntary organisations. In addition, a number of commercial energy companies offer support to community schemes, through buying energy or providing technical support. Examples are Cooperative Energy, Good Energy, and Ovo Energy.

17.4.3 Examples of Consumer (Co-)Ownership

I. Wiltshire Wildlife Community Energy (WWCE) owns two ground-mounted solar farms in a rural area in the South West of England. The first of these is 1 MW in capacity and is 100 per cent owned by WWCE, a Community Benefit Society. The project was started in 2013 funded solely via a community share offer, enabling people to invest from GBP 500 (1 share; EUR 564) up to GBP 100,000 (200 shares; EUR 112,765) into WWCE, although in line with the rules of Community Benefit Societies all shareholders have the same voting rights regardless of the size of their holding. A second much larger project of 9.1 MW, known as the Braydon Manor Solar Array, adopts a 'split ownership' arrangement—5 MW of the solar panels are owned by WWCE, and 4.1 MW are owned separately by a commercial company. The WWCE-owned element of the site was partially funded by a community share, following the same rules as the previous 1 MW scheme, with the remaining funding from debt finance. The splitting of ownership in this way enabled the overhead costs of grid connection to be shared between two partners and increased the total amount of RE generated. Both of these projects benefited from the support of other community energy organisations and intermediary actors operating in the region, who provided advice and experience on the practicalities of bringing community energy schemes to fruition. The delivery of the split ownership project at Braydon Manor resulted in tensions between 'commercial' and 'community' ideals and ways of working during project development, with the commercial actor who purchased the additional 4.1 MW operating on a different set of expectations and timescales. In this case, a local intermediary actor proved invaluable in mediating between the two parties.

II. Brixton Energy is a cooperative owning three rooftop solar schemes in the Brixton area of south London. Since 2012, the group has established three community solar energy projects in London, of 37 kW, 45 kW, and 50 kW in capacity, respectively, with an initial investment of GBP 54,000 (EUR 60,900). Each individual project is a registered Community Benefit Society owned by its shareholders. The shareholders are a mixture of local residents or organisations and investors from further afield, with each project having around 80–100 investors. In Lambeth over 70 per cent of investors are locals, while in Brixton around 50 per cent. The shares sold helped to finance the installation of each project, with further funding coming from local and national grants and some debt finance. The first two projects had a minimum shareholding of GBP 250 (EUR 282), but in the third project, this was lowered to GBP 50 (EUR 56) for residents living in the housing estate where the panels would be installed—the rationale for this being that it would enable those with less financial resources to invest in the project. Electricity generated is first sold to users within the buildings, and any excess is sold to the National Grid. Alongside energy generation, the Brixton Energy projects provide financial revenues to project investors, who receive a 3 per cent return, and the local community—20 per cent of project profits are spent on energy saving and efficiency initiatives in the local area. The projects put a strong emphasis on community engagement and education, for example, by offering an apprenticeship scheme for young people in the area. Like Wiltshire Wildlife Community Energy, Brixton Energy has also benefited from the support of other local actors and organisations. In particular, the support of the municipal government (Lambeth Council) has been an important success factor.

III. In Wales, **TGV Hydro** is a hydropower developer owned by a Community Interest Company, The Green Valleys CIC. A Community Interest Company is a specific type of social enterprise, with profits reinvested into social aims. Since 2010, TGV Hydro has developed 28 micro-hydro sites, with a total capacity of 558 kW. It employs 8 staff, has a turnover of just under GBP 1 million (EUR 1.13 million), and is estimated to support a further 16 full-time jobs in the local area (Ashden Awards 2015). TGV Hydro develops projects on behalf of private clients including local farmers, community-owned energy companies such as cooperatives, and the conservation charity the National Trust. Profits from TGV Hydro go to the parent company, The Green Valleys CIC, which comprises a paid staff team, volunteer directors, and member groups. Each group is registered as a member of the CIC and is entitled to a vote at general meetings. The Green Valleys CIC uses the funds from TGV Hydro to develop its work and mentor community energy groups who are developing hydro projects. The success of TGV Hydro stems from its ability to pool expertise and resources across a large number of small projects. Each project may not be financially viable if developed independently, but with access to TGV Hydro's specialist experience and project management, efficiencies increase and projects become viable. For example, TGV Hydro has worked closely with local authorities, to ease the process of planning and permitting for individual sites. It has also helped to establish a new company, Hydrolite, which manufactures turbines locally, reducing costs and keeping jobs local.

17.5 Factors Affecting the Financing of Renewable Energy Sources and Barriers to Consumer (Co-) Ownership

17.5.1 Political, Legal, and Administrative Factors

As described in Sects. 17.1 and 17.2, the primary barrier to consumer (co-)ownership in the UK is the nature of the regulated energy market, which is dominated by large commercial companies who are vertically integrated (responsible for energy generation and supply). In this system, the consumer is seen as a passive buyer of heat and power, not an active citizen (Willis 2006), and the particular design of the market meaning that access for new entrants is constrained (Walker and Cass 2007; Willis and Eyre 2011). The complexity of regulations, together with the financial demands and the administrative burden placed on participants, limits the scope for engagement by smaller-scale and community entrants. Before the 2014 Community Energy Strategy, consumer (co-)ownership was not understood or explicitly acknowledged by government. This is in stark contrast to other countries, such as Denmark and Germany, where consumer (co-)ownership has long been recognised and encouraged. By contrast, in some areas local governments have been an important factor in the success of some UK schemes, such as the Wiltshire and Brixton examples profiled above.

The publication of the Community Energy Strategy in 2014 was a significant step forward, in that government acknowledged community energy and its potential benefits and identified a number of barriers to its development. These included difficulties with the land-use planning process and the permits required for development, difficulties with obtaining a connection to the grid, and a range of specific problems facing hydropower. In each of these three areas, working groups were established, with government, regulators, and community energy representatives working together to examine possible solutions. Other commitments were made, such as working with the energy regulator Ofgem to improve Licence Lite (see above) and make it more accessible to community groups.

However, the change of government, from the Conservative-Liberal Democrat coalition to a majority Conservative administration, effectively put all these plans on hold. In addition, as described above, Feed-in Tariffs were gradually phased out, and tax relief schemes were closed to community energy. As a result of these changes, it is even more difficult than previously to develop a community-owned generation project. Community Energy England's Chief Executive, Emma Bridge, wrote that '2016 saw record levels of community energy activity but we know that policy and regulatory changes have since impacted dramatically on this success, with many projects put on hold or even abandoned' (Community Energy England 2017).

17.5.2 Economic and Management Factors

The 2014 Community Energy Strategy (DECC 2014) published by the government identified the following barriers to community electricity generation projects: (1) access to investment from commercial sources; (2) reliable income streams for electricity generated; (3) lack of ability to supply consumers directly, due to regulatory difficulties; (4) difficulty in navigating systems related to regulation, planning, and network access. These are discussed in turn below.

Following the Community Energy Strategy, a 'Community Energy Finance Roundtable' was established, to investigate barriers to finance (Community Energy Finance Roundtable 2014). Participants included finance providers, community energy representatives, and government officials. The Roundtable identified four areas of difficulty. First, community energy projects sometimes struggle to develop projects that are ‘investment ready’. They are often small projects, run by community groups, who might have limited experience of project finance and management. This could be addressed through better support services for community projects, provided through intermediaries such as Community Energy England, and developed with government backing. Second, the Roundtable identified that community projects struggle to access development risk capital. Commercial developers work on a portfolio of projects at the same time, meaning that the successful projects can fund the unsuccessful projects. However, community groups are often only developing a single project, so the risks are higher. This could be addressed through better provision of risk capital for social investment, through government and philanthropic schemes. Third, community energy projects often raise funds from individuals, through shares or loans; the Roundtable identified a need for better procedure for ensuring that such investments are sound and compliant with regulation. Last, the Roundtable reported that it is difficult for community projects to access debt finance at viable rates, because projects are often small in size, with the size of loan typically required being GBP 0.5–2 million (EUR 0.56–2.26 million). The transaction costs for such small loans are very high. This could be addressed by standardising documentation and working with commercial banks to develop their offer to the community sector.

The difficulty of accessing reliable income streams for community-owned energy projects, identified by the Community Energy Strategy, has actually worsened since the strategy’s publication in 2014, due to the decline in Feed-in Tariffs (as described in Sect. 17.3). Without the guaranteed income stream provided by these Tariffs, community projects now have to look for alternative business models, such as self-supply or private wire projects. A further option is for community groups to raise funds to buy existing commercial projects, with Feed-in Tariffs attached. For example, a Community Interest Company called Communities for Renewables (CfR) bought a 9.3 MW solar farm from a commercial developer, in 2016 (Solar Power Portal 2016). The lack of ability to supply consumers directly is another barrier for consumer (co-)ownership of RE. As described in Sect. 17.3, it is very difficult and costly to register as a supplier in the UK. Various options, including Licence Lite, ‘White

Label' offers, and 'Sleeving', have been put forward, but these all rely on partnership with an existing registered supplier. Other options, such as a private wire network or self-supply, are possible in theory but often not economically viable.

Last, as described in Sects. 17.2 and 17.3, community groups have difficulty in navigating systems related to regulation, planning, and network access. Grid connections have been identified as a particular barrier, and the energy regulator Ofgem established a working group in 2014 (as part of the Community Energy Strategy process) to address this issue. The group confirmed that accessing the grid was a major barrier to the success of projects due to regulatory structures governing grid connection and capacity issues on the grid. Since then, Ofgem has been working with the DNOs to address some of these issues. However the report also acknowledged that more 'transformational' measures could be used, but these would require 'a clear public policy steer from government' (Ofgem 2014b). The Community Energy Strategy also identified a range of barriers for heat schemes, including a lack of awareness of community renewable heat, no tradition of district heating in the UK, complex finance and regulatory requirements, and complexities of heat systems. As a result of this, the government established a Heat Network Delivery Unit (HNDU) to support the development of district heating, including provision of funding for feasibility studies. Overall, the period 2013–2015 saw big steps forward in the understanding of consumer and community involvement in RE in the UK, due to political attention, the 2014 Community Energy Strategy, and subsequent working groups addressing particular barriers. However, since the change of government in 2015, many of these reforms have stalled, and in some cases, such as the removal of Feed-in Tariffs and the removal of tax incentives, the position has worsened.

17.5.3 Cultural Factors

As described in Sect. 17.2, institutional and political cultures in the UK are geared towards centralised and commercialised energy systems. This creates problems for consumer (co-)ownership. Regulations governing energy generation, supply, and trading are geared towards very large commercial companies. Similarly, the financial sector is accustomed to dealing with large commercial entities and does not have the mechanisms in place to support or finance smaller projects. This is in marked contrast to the energy system in Denmark or Germany, for example, in which a wide range of participants, including individuals, small social enterprises, municipalities, and large companies, all inhabit different parts of the energy system (Simcock et al. 2016).

A further barrier is the lack of understanding of social enterprise. In the UK, in comparison with other countries, there has been a focus on smaller-scale, volunteer-led projects. However, if the community sector is to scale up, to achieve the 3 GW of community energy referred to in the UK Community Energy Strategy, investment of around GBP 4 billion by 2020 will be required. This will not be achievable just through small-scale projects relying on grants and volunteer input; it will require larger projects raising investments through a combination of shares and commercial loans. This poses challenges to a community sector not used to operating on a commercial footing (Simcock et al. 2016).

17.6 Possible Future Developments and Trends for Consumer (Co-) Ownership

Currently, it is difficult to envisage community-owned energy moving beyond being a niche player in the UK's energy supply sector. Although the sector grew rapidly between 2010 and 2014, since then less favourable policy changes have resulted in a rapid slowdown in new project developments. For example, Community Energy England, a not-for-profit organisation that acts as a 'voice' for the community energy sector, stated in 2017 that 'the sector is at risk: unprecedented reductions and early retractions of subsidies and tax incentives are negatively impacting on the viability, and subsequent success, of projects throughout the community energy sector' (Community Energy England 2017).

Although, as mentioned in Sect. 17.2.1, community groups are attempting to overcome this challenging environment through innovation in business, organisational, and funding models, for community-owned RE to truly flourish in the UK, a more conducive policy environment is necessary.

Overall, for community-owned energy to become mainstream in the UK, the government would need to establish a consistent, long-term framework for community energy, with simple, consistent regulation. To achieve this, the Department for Business, Energy and Industrial Strategy (BEIS; formally DECC) needs to build on the 2014 Community Energy Strategy and work with the Cabinet Office, HM Treasury, and Ofgem to create a clear and consistent policy framework for community energy. The recent changes to the Feed-in Tariff regime have made this more important—community energy projects need transitional support to develop new business models, as described below. The establishment of a community energy team within DECC (now BEIS) played an important role in integrating community needs into a policy-making framework that instinctively offers larger-scale, more centralised policy solutions. However, the community energy unit was short-lived, having now been incorporated into a broader unit covering home and local energy.

Beyond this general requirement for reorientation, there is also a range of potential policy measures, suggested by Simcock et al. (2016), to promote community-owned energy and increase its market share:

(1) **Financial support**. Although community energy projects are usually financially self-sustaining once they are generating and selling energy, getting to this stage is often very challenging and often requires substantial resources (e.g. to conduct feasibility studies or navigate the planning system). Early-stage funding is critical in enabling communities to assess options, conduct feasibility studies, navigate the planning system, and invest time into energy ventures. This could be coupled with support for projects once they are up and running, for example, through tax incentives or Feed-in Tariffs.
(2) **Capacity building**. As well as finance, undertaking community energy projects also requires time, knowledge, and 'cultural' capital.

Building capacity by offering training and vocational schemes would be valuable. The support and advice offered by intermediary organisations and established community energy groups are frequently crucial in enabling projects to come to fruition. Funding for peer support schemes and for independent, not-for-profit organisations such as Community Energy England could be provided.

(3) **Simplified regulations**. In the UK, complex regulatory structures and high barriers to entry in the supply market often prevent community energy projects selling energy directly to consumers. A tailored, simplified regulatory model for community energy supply could be developed in order to overcome this. This would allow community energy schemes to receive the retail price for electricity sold, which is far higher than the wholesale price received if electricity is sold into the grid.

(4) **Incentivising local energy economies**. Community energy has greatest potential when it forms part of a wider move towards the devolution of power in energy decision-making towards the local level. This could be enabled by, for example, giving local municipal government responsibility for energy generation and carbon reduction; encouraging partnerships between local municipalities, other local service providers such as housing associations, and community energy projects; creating local 'innovation spaces' where new approaches (such as alternative regulations) can be tested; supporting community enterprises to deliver energy efficiency and demand reduction, not only energy generation.

(5) **Cultural change**. If community energy is to move into the mainstream, energy action needs to be embraced more fully within wider community norms. More communities need to regard energy projects as 'for them' rather than the sole preserve of big companies, regulators, and governments. Central and local government could express clear support for community energy in order to strengthen and validate local voices. A stronger focus on success stories and creating positive media coverage around community energy could help make it more mainstream.

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18

Consumer (Co-)Ownership in Renewables in Scotland (UK)

Maria Krug-Firstbrook, Claire Haggett, and Bregje van Veelen

18.1 Introduction

Energy policy within the UK differs significantly between its countries. This chapter will mainly focus on Scotland[1] while referring to the overall situation where necessary.

[1] England and Wales are treated in a separate chapter in this volume. Note that the regulatory system in Northern Ireland differs, as Northern Ireland shares an 'all-island' electricity network with the Republic of Ireland; thus some regulation is shared with the UK as a whole, and other aspects are treated separately. This chapter does not go into detail about the specifics of the Northern Irish market or regulation.

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18.1.1 Energy Mix

Prima facie, the Scottish energy mix is still dominated by oil and gas with renewable energy (RE) only playing a minor role. In 2014, renewables accounted for 2 per cent of Scotland's final energy supply, with oil and gas remaining the key sources of energy (Scottish Government 2017a). Yet the RE consumption target is 30 per cent in 2020. This apparently large gap can be explained as follows: the energy used in Scotland is only 16 per cent (=final energy consumption—169 TWh) of the energy originally generated there (=primary energy supply—1029 TWh), as 84 per cent is lost and most of that share is exported, mainly to other parts of the UK (Scottish Government 2017a). A closer look at the different energy sectors (electricity, heat, and transport) reveals marked differences in RE capacity and demand. The energy demand in Scotland divides between 53 per cent for heat, 25 per cent for transport, and 22 per cent for electricity consumption (Scottish Government 2017a).

Heat, being the biggest share of the overall demand, is mostly generated from gas—79 per cent of primary heating is from gas (Scottish Government 2017a). Only 3.8 per cent of the heat demand came from renewable energy sources (RES) in 2015 with a total renewable heat output of 4165 GWh coming from 1504 MW of total installed capacity (Scottish Government 2017a). In RE heat, the biggest share with 901 MW or 60 per cent comes from biomass and 391 MW or 26 per cent from biomass CHP (combined heat and power), thus accounting for a combined 86 per cent of the generated heat in RE (Scottish Government 2016c).[2] Transport sees similar levels of RE uptake, with biofuels making up 3.3 per cent of road fuels in the UK in 2015 (Scottish Government 2016a).

From the limited adoption of RE in the transport and heat sectors, it is thus evident that the most significant gains have been made in the Scottish electricity market with RE being the single largest contributor to electricity generation for the first time in 2014 (Scottish Government

[2] Biomass is officially counted as RE by the Scottish Government, keeping in mind the mixed opinions on whether biomass is RE, see e.g. Oxfam 2015, recommendations highlighting the mixed role of bioenergy which is also causing carbon emissions.

2016a). RES generated 49.7 per cent of the gross electricity consumption in 2014. At the end of 2016, Scotland has met and exceeded its renewable electricity target of 50 per cent with 59.4 per cent, the biggest share of it being in wind, with more than 70 per cent of all RE produced by onshore wind (Scottish Renewables 2017).[3] Hydro with 19.3 per cent also makes up an important share of RE capacity, with solar PV, biomass, and offshore wind all contributing a relatively small 2–4 per cent share to total RE capacity.

18.1.2 Main Challenges of the Energy Market, National Targets, Specific Policy Goals

One of the current main challenges are the changing and uncertain conditions of the energy market environment, which cause an insecurity about (future) investments. While Brexit negotiations create a cloud of uncertainty for the UK and its energy market, at this current stage, there is not much to be said about the outcome on the specific field of energy and RE. As Scottish energy policies and strategies appear more in line with those of the EU than with the rest of the UK, it can be anticipated, however, that the Government may need to adjust its strategies post-Brexit. Another ongoing challenge, which particularly affects the 608 MW of community and locally owned RE projects in Scotland that are still to be built, is grid constraint—which limits the capacity to export renewable electricity from rural parts of the country, where most technologies are located, to Scottish cities, as well as to England (Energy Saving Trust 2015). To tackle some of these challenges, the Government published its Draft Scottish Energy Strategy in early 2017 which sets out a 2050 vision, divided into three main themes: a whole-system view; a stable, managed energy transition; and a smarter model of local energy provision (Scottish Government 2017a). Increasing energy supply from RES goes hand in hand with the reduction in energy demand and hence energy efficiency. Therefore, the strategy highlights SEEP—Scotland's Energy Efficiency Programme—as a cornerstone of the whole-system approach.

[3] The Scottish Government also underlines the importance of this technology in its 'Onshore Wind Policy Statement' from January 2017 (Scottish Government 2017e).

The 2020 RE target was set at 30 per cent of total energy consumption from renewables, which amounts from targets in the following four main areas: a goal of 100 per cent of gross electricity consumption from RE in 2020, was 59.5 per cent in 2015; 11 per cent of non-electrical heat demand from RE in 2020, was 3.8 per cent in 2015; 10 per cent of energy used in transport from RE by 2020, was 3.2 per cent in 2015 (Scottish Government 2017c). Furthermore, a reduction of energy consumption by 12 per cent by 2020, which was already reached and surpassed with −14.1 per cent in 2014 and −15.2 per cent in 2015 (since baseline 2005–2007). The recently published Draft Scottish Energy Strategy 2017 sets the 2030 RE target at 50 per cent of total energy consumption (heat, transport, and electricity) from renewables (Scottish Government 2017a). In 2014, it was 15.2 per cent, which means that Scotland is slightly above EU average, which lies at 15 per cent, and three times higher than UK levels at 5.1 per cent (Scottish Government 2016a). In addition to RE targets, the Government has set a separate target for community and locally owned RE (see Sect. 18.2.1).

18.1.3 Ownership Structure in the Renewable Energy Sector

Both the Department of Energy and Climate Change (DECC) and the Office of Gas and Electricity Markets (Ofgem) divide onshore renewables generating capacity into four sectors: commercial, community, domestic and industrial (ClimateXChange 2014). The commercial and non-commercial, that is, community and locally owned, have evolved separately to some extent (ClimateXChange 2015). At the end of June/Q2 2016, an estimated minimum of 595 MW of community and locally owned RE capacity (Energy Saving Trust 2016) mostly connected to the grid (Van Veelen 2017) was operational in Scotland equalling 6.1 per cent of the total installed RE technology apportioned as follows[4]:

[4] Based on the following calculation, 8263 MW of RE in electricity in 2016 Q3 plus 1504 MW of RE in heat 2015 Q4 equals 9767 MW of total RE, 595 MW thus equals 6.1 per cent. All community- and locally owned projects can be found in Local Energy Scotland's Project Database: http://www.localenergyscotland.org/projects/.

- Most of it is owned by farmers and estates with 244 MW and local authorities with 108 MW, together accounting for 352 MW and thus more than half which is 59.2 per cent of the capacity of community and locally owned RE, while the actual 'communities' account for only 67 MW and 11.3 per cent (Energy Saving Trust 2016). As we will discuss in Sect. 18.4, even the term 'communities' includes a variety of different ownership models.
- Most of the community- and locally owned operational RE installations are onshore wind installations with a capacity of less than 1 MW (Scottish Government 2015a). Geographically, the vast majority of community energy schemes operating in Scotland are in rural and remote areas (Scottish Government 2015a).
- As the different ownership categories own different technological mixes of RE, the percentage of the operational installations on the one hand and the operational capacities on the other hand differ. Farmers and estates own only 3 per cent of the operational installations but 41 per cent of the operational capacity as they mostly own wind projects with a higher generating capacity. The reverse is true for housing associations, due to the large share of small-scale installation such as heat pumps, solar PV, and solar thermal (Energy Saving Trust 2016).

18.2 The Consumer at the Heart of the Energy Market?

18.2.1 Consumer (Co-)Ownership in Renewable Energy Sources as Policy Goal

The Scottish Government makes community and local ownership in RE an integral part both of its climate change policy and its energy policy, as well as its rural and community development policies (Scottish Government 2017a, b, Van Veelen 2017). To support their development, the Government has released a Community Energy Policy Statement and has set a target for community and local ownership of RE (Scottish Government 2015a) of 500 MW by 2020, which was met in late 2015

(Energy Saving Trust 2015). As a result, the Government's Draft Energy Strategy 2017 sets out two further aims of 1 GW of community and locally owned energy by 2020 and 2 GW by 2030 (Local Energy Scotland 2017).

While there is thus a focus on collective consumer ownership, the definition of this is broad. Included in the Government's definition of 'community and local ownership' are community groups, local businesses, farms and estates, local authorities, housing associations, and other public sector and charitable organisations including charities, including faith organisations, public bodies or publicly owned companies, further or higher education establishments such as universities and colleges, and recipients of previous community energy grants (Energy Saving Trust 2016). Furthermore 'ownership' is not restricted to sole ownership but also includes forms of shared ownership. Models of shared/(co-)ownership have become increasingly important, particularly in the case of onshore wind (ClimateXChange 2014). This is most clearly expressed in the Scottish Government's 2017 Draft Energy Strategy, in which it sets a goal of at least half of newly consented RE projects to have an element of shared ownership by 2020 (Local Energy Scotland 2017).

Finally, consumer (co-)ownership received explicit recognition of its crucial role in the 2018 recast of the Renewable Energy Directive (RED II) as part of the Clean Energy Package. However, in the light of 'Brexit', the transposition of the RED II into UK law until 2021 is unsure although it would be an important legislative impulse as it introduces a legal framework for consumer (co-)ownership. Consumers, individually (Art. 21, households and non-energy SMEs), collectively (Art. 21, tenant electricity), or in communities (Art. 22, co-operatives and other business models), will have the right to consume, store, or sell energy generated on their premises. RED II also invites the member states to provide an 'enabling framework' for local 'renewable energy communities'. The directive links prosumership to such different topics as fighting energy poverty, increasing acceptance, fostering local development, incentivising demand flexibility and so on, defining citizen's rights and duties and evenly important clear definitions (Article 2 RED II).

18.2.2 Fuel/Energy Poverty and Vulnerable Consumers

Tackling fuel poverty is a matter of great importance, as fuel poverty affects approximately a third of the population. In 2014, 34.9 per cent or around 845,000 households were fuel poor, and 9.5 per cent were living in extreme fuel poverty (Scottish Government 2015b). This means that 34.9 per cent of the households had to "in order to maintain a satisfactory heating regime, […] spend more than 10 per cent of [their] income on all household fuel use [and 9.5 per cent of the households had to invest] over 20 per cent of income" in fuel use (Scottish Government 2002).

Fuel poverty mainly results from three drivers: the level of household income, energy efficiency of the housing, and fuel prices (Scottish Government 2016d). The main explanation of the increase in fuel poverty from 2002/2003 to 2014 lies in the extraordinary rise in fuel prices of 185 per cent in this period (Scottish Government 2016d). In general, fuel poor households are found in all income bands, but households in the lower income bands have the highest rates of fuel poverty (Scottish Government 2015b). The ones most affected are pensioners—especially those living alone, of which 58 per cent suffer from fuel poverty, and home owners, of which 47 per cent face fuel poverty (Scottish Government 2015b).

Recently, the Government has set up a Scottish Fuel Poverty Strategic Working Group, who published the report "A Scotland without fuel poverty is a fairer Scotland" in 2016 (Scottish Government 2016e). It is expected that this leads to a new Fuel Poverty Strategy and Warm Homes Bill, which the Government plans to introduce in 2018.

18.3 Regulatory Framework for Renewable Energy

Energy policy in Scotland is a matter reserved to the UK parliament. The statutory provisions regulating the RES sector are diverse, the main ones being the Energy Act 2008, 2013, and 2016, the Promotion of the Use of Energy from Renewable Sources Regulations 2011, the Renewable Heat Incentive Scheme 2011, Domestic Renewable Heat Incentive Scheme 2014 (with amendments), and the Renewable Transport Fuel Obligations Order 2007 (with amendments).

18.3.1 Regulations for Connecting Renewable Energy Plants to the Grid

There are different regulations for connecting RE to the grid, depending on the size of the installation. Large-scale generators, greater than 50 kW, must connect to the transmission network of the energy grid. This is done by National Grid, which owns and operates the National Electricity Transmission System (NETS) in England and Wales and operates it in Scotland, while there it is owned by Scottish Power Transmission Ltd (SPTL) and Scottish Hydro Electric Transmission Ltd (SHETL) (Ofgem 2010). Furthermore, National Grid is the electricity system operator (SO) of the whole NETS (Ofgem 2010). For connecting to the transmission network, generators will have to file a connection application form and pay the relevant application fee, which is calculated based on the area of the generating plant and the installed capacity in MW. Furthermore, Transmission Network Use of System (TNUoS) and Balancing Services Use of System (BSUoS) charges have to be paid for the ongoing connection to the grid (Ofgem 2010).

Smaller generators with a capacity up to 50 kW, such as small-scale RE and microgeneration installations, are called distributed generation (DG) and connect to the distribution network via their local distribution network operator (DNO) (Scottish & Southern Electricity Networks 2017). The relevant DNOs in Scotland are Scottish & Southern Electricity Networks (SSEN) for North Scotland and SP Energy Networks for Central and Southern Scotland (National Grid 2017). The connection to both the above-named distribution network operators can be easily done with an online application form. The connection process differs depending on the size of the generator(s) (Energy Networks Association 2015). For installations connected to the distribution network, Distribution Use of System (DUoS) and transmission charges have to be paid.

18.3.2 Support Policies (FITs, Auctions, Premiums, etc.)

A variety of support mechanisms for RE technologies exist in the UK[5] and Scotland, most of them in the electricity market, more recently also some in the heat market. The three main support schemes in the UK are Contract for Difference (CfD), Feed-in Tariffs (FITs), and the Renewable Heat Incentive (RHI). They are all administered at the UK level. The CfD scheme is managed by delivery partners of the DECC (Ofgem 2017). FITs and the RHI, also for Scotland, are managed by the 'Energy Saving Trust' (EST), which is a foundation and hence a non-profit organisation. EST is under the control of the Government, British Gas, and the electricity and gas producers and distributors (Enerdata 2011). In addition to managing FITs and RHI, the 'Energy Saving Trust' also provides loans and other financial support (Energy Saving Trust 2017).

The first measure introduced by the UK Government in 2002 was the Renewables Obligation (RO), which is a support scheme for large-scale renewable electricity projects and obliges electricity suppliers to source an increasing proportion of electricity from renewables. It changed in 2009 with variable rates paid to different types of RE technology and replaced in 2012, when the Electricity Market Reform (EMR) introduced Contracts for Difference (CfD). The first round of CfD auctions took place in 2014; the second round of CfD auction should take place in April 2017 (provisional) (BEIS 2017). Since April 2010 the FIT is in place for small-scale generation. It pays consumers and other small-scale producers (e.g. community groups) money for generating electricity from renewables. Furthermore, the RHI enables the consumer to receive money for generating heat from renewables.

In addition to these UK-wide schemes, the Scottish Government also provides various support mechanisms, such as the Low Carbon Infrastructure Transition Programme (LCITP) and Scotland's Energy Efficiency Programme (SEEP), the Home Energy Efficiency Programme

[5] A good overview/timeline of the subsidies introduced over time by the UK Government can be found on page 17 of House of Lords Select Committee on Economic Affairs 2017; also see House of Commons Scottish Affairs Committee 2016.

for Scotland (HEEPS), the Community and Renewable Energy Scheme (CARES), and the Renewable Energy Investment Fund (REIF) (Scottish Government 2016b). The LCITP is financed by the European Regional Development Fund (ERDF) and is a support mechanism for low-carbon projects across the country. As energy efficiency is a cornerstone of the Scottish Energy Strategy, there are two specific programmes designated to do that. SEEP, which is a part of the LCITP, is directed at improving energy efficiency for local authorities, while HEEPS is a loan scheme designed for individuals improving energy efficiency of their homes (Energy Saving Trust 2017). Also, the REIF is a 'discretionary fund' managed by Scottish Enterprise (SE) and delivered by its financial arm, the Scottish Investment Bank (SIB), which provides financial assistance for RE projects in form of loans, guarantees, and equity investments (Scottish Enterprise 2017). Finally, CARES provides start-up grants and pre-development loans for local and community projects (for details see Sect. 18.4.2).

18.3.3 Specific Regulations for Self-Consumption and Sale to Grid

Microgeneration is the production of heat with less than 45 kW capacity and/or electricity with less than 50 kW capacity (Scottish Executive Development Department 2006). The Government is actively promoting community and local ownership in RE plants as well as the microgeneration and local energy economies approach (see Sect. 18.5.1). Advancing the concept of microgeneration again[6] as a "smarter model of local energy provision" is one of the three main themes of the Government's 2050 energy vision set out in the Draft Scottish Energy Strategy 2017. Microgeneration installations can be stand-alone (off-grid), or they can be connected to the grid. When it is intended to use the generated energy only for self-consumption, off-grid solutions can be considered as there are no special regulations for them.

[6] There had not been much development since the publication of the Scottish Government's 'Microgeneration Strategy in 2012'—Scottish Government 2012.

18.4 Concepts for Consumer (Co-)Ownership in Practice

18.4.1 Contractual Arrangements and Corporate Vehicles Used

There is not a single citizens' energy concept but a variety of concepts with a range of different characteristics. In general, one may differentiate between full community ownership and shared (community-commercial) ownership schemes. Distinguishing by the degree of ownership, there exist various models enabling community and individual's investment, such as owner operator, commercial developer led, joint venture, and community developer (Local Energy Scotland 2015c)—the first being a model of full community ownership and the last three being forms of shared ownership.

It is notable among Scottish community energy projects that the majority of projects are fully community owned and that, unlike in many other countries, the dominant finance/development model employed is that of a 'development trust',[7] in which a group is the full owner of an RE installation and raises funds through grants and loans and distributes income from RE to community projects (Haggett and Aitken 2015). This also means that such projects are not administered on the one-member, one-vote principle but rather by an independent body formed by the community—the development trust (ClimateXChange 2013). For comparison, in Scotland only 12 per cent of community energy capacity exists through community co-operatives, compared to 92 per cent in England (Harnmeijer et al. 2013).

Only approximately 5 per cent of all known community energy projects involve some form of shared ownership with a developer or community investment in a commercial project, although due to the often larger scale of these projects they account for approximately 30 per cent of all community-owned generating capacity (Scottish Government 2015a).

[7] Note: 'development trust' is a not a legal model. Rather, development trusts can choose from a number of legal structures, as long as it is owned and led by a geographical community.

Despite their small number, significant diversity exists in the legal arrangements and business models used (ClimateXChange 2014). The most common legal structures used by communities to invest in a commercial energy are development trusts and co-operatives (ClimateXChange 2014). Seven of the 17 operational commercial RE projects, with some form of community or individual investment, involve local development organisations, and 5 involve co-operatives (Scottish Government 2015a).

To stimulate this form of community involvement, the Government has created a framework for shared ownership models and has listed some common options available in its "Good Practice Principles for Shared Ownership of onshore renewable energy developments" (Local Energy Scotland 2015a). Differentiating by the project ownership, in general, there exist three options, that is, (1) shared revenue, (2) joint venture, and (3) split ownership:

(1) The developer may own the project (and may set up a new private company for this purpose), and the community can buy the right to a defined percentage of revenues but does not own any shares or physical assets and thus does not have any voting rights on the company's activities (Local Energy Scotland 2015a).
(2) A joint venture vehicle or special purpose vehicle (SPV), which is partly owned by both community group and developer, may own the RE project. The community group will co-invest. It will own shares, receive a dividend, and thus have the right to vote on the company's activities; depending on the structure of the joint venture vehicle, the voting rights will be equal or not. Joint venture vehicles are generally set up as private limited company (Ltd.), or a limited liability partnership (LLP) (Local Energy Scotland 2015a).
(3) The community group and the developer may own two (or more) separate generating units, as the scheme is divided, and the development is split.

Multiple variations of these models exist. The investment could be pre- or post-planning, and the financing can be raised through, for example a trust, the community body and taken forward by a local development organisation or through individuals and taken forward by co-operatives and crowdfunding. The ‘community group’ is most commonly a development trust and thus is limited by guarantee and often with charitable status (ClimateXChange 2014). But it can also be a charity, a private limited social enterprise, a community benefit society, or a bona fide co-operative.

Additionally, Community Energy Scotland has developed a microgeneration approach named ‘Local Energy Economies Programme’ (LEEP) (Community Energy Scotland LEEP). It is not a concrete concept but rather a programme with a variety of possible models. It is centred on four pillars—local generation, local supply, local demand, and local finance. The financing for the energy generation and energy supply facilities is obtained by the community; thus the energy plant is in full community ownership. Local households and businesses use the locally generated energy. Conjointly, the introduction of a system of electric cars supports the levelling of the supply and demand side as the energy can be used for charging them. The leftover energy, which cannot be used locally, can be sold to the National Grid. There exists a cash flow between the local households and businesses and the local energy plant, as the individuals pay for the energy they use but also get money from the energy generation and supply as they own the energy plant.

18.4.2 Financing Conditions for Consumer (Co-)Ownership in Renewable Energy

18.4.2.1 State Subsidies, Programmes, Credit Facilities, Preferential Loans

The main support mechanism for local and community energy is the CARES, financed by the Government (Scottish Government 2013). CARES offers a range of support at different stages of development of the project, including small start-up grants to help with preparatory costs and pre-planning loans that cover up to 95 per cent of the pre-planning costs (Local Energy Scotland 2015b). The loans are allocated by the SIB, which is the investment arm of SE, a non-departmental public body. Recently, additional funding under the CARES programme has been provided through the Local Energy Challenge Fund (LECF), specifically to support the development of local energy systems that link energy generation and use. Some funding may also be available from other sources, including the Scottish Climate Challenge Fund and the UK's Big Lottery Fund. Several organisations, including Local Energy Scotland, Community Energy Scotland, and Highlands and Islands Enterprise, also offer free advice and guidance to community groups.[8]

18.4.2.2 Agencies Supporting Investment in Renewable Energy Sources

To promote local energy development, the Government has committed to long-term support (Scottish Government 2017a). This support is currently primarily delivered by Local Energy Scotland, a consortium made up of five social enterprises led by Energy Saving Trust, and ranges from the project development to the grid connection stage including funding and financing in the form of grants and loans (Scottish Government 2015a).

18.4.3 Examples of Consumer (Co-)Ownership

I. Isle of Eigg, off-grid example—One example of a project, where all energy generated is used locally, is the Isle of Eigg, a small island west of the mainland. The Eigg electricity system was established in 2008 and is a stand-alone or off-grid system. Most of the GBP 1.6 million (EUR 2 million) investment came from EU funds while residents contributed GBP 500 or 1000 (EUR 625 or 1250) for a 5kW domestic or 10kW business connection. GBP 125,000 (EUR 156,000) needed for extras, were financed by overdrafts from Triodos

[8] For example: Local Energy Scotland's Renewables handbook; the CARES toolkit, which provides a step-by-step guide for projects from conception to completion; and a network of local development officers who provide a central contact point for community groups.

bank and later turned into a bank loan (Community Power n.d.). The system is completely powered by renewables, which are community owned, and is powered from three different renewable sources—water, sun, and wind—with a combined capacity of around 184 kW supplying the 84 inhabitants with electricity. The individual consumption is limited to 5 kW per household in order to sustain that everyone is supplied with electricity. An off-grid FIT, Renewable Obligation Certificates (ROCs) and a local energy tariff for residents and businesses cover the running cost of Eigg Electric (Community Power n.d.). The system is operated and maintained for the community by Eigg Electric Ltd, which is a community-owned, community-managed, and community-maintained company and a wholly owned subsidiary of the Isle of Eigg Heritage Trust, a community organisation which owns the island. The Isle of Eigg Heritage Trust is a company limited by guarantee and thus a separate legal entity with limited liability of its three members. It is a partnership between the residents of Eigg (Isle of Eigg Residents' Association), The Highland Council, and the Scottish Wildlife Trust. Each of these members appoints directors to the board of the trust. The Isle of Eigg Residents' Association has four directors who are elected by the community. The Highland Council and the Scottish Wildlife Trust appoint one director each. The trust has an independent chairperson. The project has won the award for Best Community Initiative at the 2008 Scottish Green Energy Awards and was recognised by the Scottish and Southern Energy Innovation and Energy Efficiency award 2009.

II. Aberdeen Community Energy (ACE)—Aberdeen Community Energy is a more conventional grid-connected energy project. This project is nonetheless somewhat unusual as it is one of the few urban community energy groups, located on the edge of Scotland's third-largest city. The Donside community has only been in place for a few years, the result of a new-built sustainable and affordable housing scheme in 2012. A year later the local people established the Donside Community Association, who in turn set up Aberdeen Community Energy in 2015 to build, own, and operate the Donside Hydro scheme on behalf of the local community. ACE's 'Donside Hydro' project started generating energy in late 2016. Although the site has the potential to generate up to 400 kW of power, the community decided on a 100 kW run-of-river scheme, as this was more economically feasible under the UK's FIT regime. ACE is structured as a community benefit society, which enabled them to issue shares and raise GBP 500,000 (EUR 567,000) towards the building costs with 197 investors—most of them investing between GBP 100 and 999 (45 investors; EUR 112–1126) and between GBP 1000 and 4999 (48 investors; EUR 1127–5637). In general, the levels of investment range from GBP 5 to 20,000 (EUR 5.64–22,553; Crowdfunder n.d.). Investors can expect a return of up to 7 per cent. The remainder of the money generated from the scheme will go to the local community, to be spent on community development projects. The project was named Best Scottish Community Energy project at the 2016 Scottish Green Energy Awards.

III. Horshader Community Wind Turbine—The project consists of a single, 900 KW turbine located in the small community of Horshader in the north-west of the Isle of Lewis, Scotland. The project is owned by Horshader Community Development Trust (HCDT), a charitable organisation comprised of local volunteers that aims to support local development. Since its completion in 2012, the project has provided a substantial income to HCDT that has been spent on local development and regeneration—example initiatives include community transport projects, a local shop, fuel poverty alleviation measures, and a children's play park. The project with a total cost of GBP 1.8 million (EUR 2.1 million) was funded via bank loans and some grant funding, with the Scottish Government's CARES providing financial support for the project's feasibility study and pre-construction site checks. A strong community spirit and high levels of trust between local residents, along with support from the intermediary organisation Community Energy Scotland, were also crucial factors in enabling the scheme to come to fruition.

18.5 Factors Affecting the Financing of Renewable Energy Sources and Barriers to Consumer (Co-) Ownership

18.5.1 Political, Legal, and Administrative Factors

There have been recent reforms in changes in UK energy policies, which also affect Scotland (Scottish Government 2017d). The Energy Act 2013 put in place an EMR with which the electricity market in the UK is currently undergoing its biggest reform since privatisation (Scottish Renewables 2017). These include restricting access to some subsidies, reducing the level of support which is offered by others, and delaying the process of awarding new contracts to support the deployment of new renewable electricity generators (House of Commons Scottish Affairs Committee 2016). For example, there have been cuts in the FIT scheme, and a CfD mechanism was introduced, to replace the RO (UK Parliament 2016). As most community energy projects in Scotland feed in to the grid, the reduction in FIT has had a particularly high impact on community projects that were still under development (Harvey 2016). The RO closure, with an early closure to onshore wind, also especially affected Scotland, because most of the installed RE capacity is in onshore wind (see Sect. 18.1.1). Furthermore, with CfD it is not clear which RE technologies will be included in the auctions and whether or not onshore wind or solar will be amongst them in the CfD mechanism, as the second round of CfD auctions was delayed as well (Scottish Renewables 2016).[9] To continuously secure that Scotland meets its RE 2030 targets, the Government has declared repowering existing onshore wind farms an important area of policy development (Scottish Government 2017e).

In general, there are problems with grid connections and pricing, market constraints, as well as balancing supply and demand. In remote areas, the access to the electricity network can be problematic, especially for

[9] Although recent announcement indicates UK Government's intention to include island onshore wind, see http://sse.com/newsandviews/allarticles/2017/10/ssens-response-to-the-uk-governments-clean-growth-strategy/.

community energy projects looking to get CARES support, of which up to two-thirds may face long lead times, partially over 18 months, to grid access (ClimateXChange 2013). Besides, there remains a range of barriers to entry into the retail market that may limit the opportunities for improving the balance between supply and demand on a community scale (Scottish Government 2015a). As the intermittency of supply, especially in wind energy, can pose problems, the ongoing development of energy storage systems plays a crucial role (Scottish Renewables 2016). The Government is promoting this through its local energy economies approach (Scottish Government 2015a).

18.5.2 Economic and Management Factors

Community energy projects face different challenges concerning the planning, organisation, and financing of the energy scheme. Communities face unique—especially financial—barriers during the pre-planning stage, which ensure that the cost, risk, and time to develop a project are higher for communities compared to commercial developers (ClimateXChange 2015).[10] Firstly, the community project's 'bottom-up' organisational structure leads to a slower decision-making process and thus higher internal process costs. Besides, community projects can face greater challenges in accessing finance and investment as they are new entrants to the market; thus they have more expensive legitimacy costs (ClimateXChange 2015). Furthermore, the internal diseconomies of scale: as community organisations are much smaller than commercial ones, they do not benefit from the same economies of scale in terms of bargaining power, finance, and the ability to manage risks (ClimateXChange 2013).

Another influential aspect is the lack of internal knowledge and expertise, especially as many community energy projects are located in small (often rural) communities (Van Veelen 2018). This can result in a higher risk of project failure, particularly at the feasibility stage, where 57 per cent of all project fail (ClimateXChange 2015). The high reliance on

[10] For example, "pre-planning costs (for non-capital items) for onshore wind are on average 70% higher for communities as a proportion of total project costs, than for a commercial wind developer".

often a small number of volunteers also enhances a project's vulnerability due to the possibility of the sudden departure of key members (ClimateXChange 2013).

18.5.3 Cultural Factors

In general, the broader public opinion is supportive towards the deployment of new RE. A 2016 poll by Scottish Renewables found that 70 per cent of respondents wanted to see more RE such as wind, solar, wave, and tidal and two-thirds of respondents agreed that the next Government should continue to take forward policies that tackle greenhouse gas emissions and climate change (House of Commons Scottish Affairs Committee 2016). There is some concern regarding the adverse impacts of onshore wind on the local environment and scenery, the local residents' health, as well as the demand constraint, but it is important to note that such concerns may not apply to the same extent to smaller-scale, community-owned installations (House of Commons Scottish Affairs Committee 2016).

Furthermore, environmental motivations to start the project, having a shared community identity and being part of an existing community group, being able to raise finance, and having a supportive local council are most likely to lead to a successful outcome (ClimateXChange 2013). The dominance of the place-based development trust model for community energy in Scotland also affects the development of it. While it has enabled many rural community groups—especially ones with ownership of, or access to, land—to develop community energy projects, it also means that such projects are primarily based in rural Scotland (Van Veelen 2017). The lack of energy co-operatives, among other factors, has made it more difficult for consumers in urban areas to participate in community energy.

Finally, the attitude of energy companies should be considered, and it is worthwhile taking into consideration the responses to the consultation regarding the Draft Scottish Energy Strategy 2017.[11] The lack of detailed engagement from the large energy companies with community energy in this consultation[12] is perhaps indicative of a certain indifference towards community energy.

[11] http://www.parliament.scot/parliamentarybusiness/CurrentCommittees/104212.aspx.

[12] http://sse.com/newsandviews/allarticles/2017/01/response-to-scottish-energy-strategy/.

18.6 Possible Future Developments and Trends for Consumer (Co-) Ownership

A "smarter model of local energy provision" is one of the three main themes of the Government's 2050 energy vision set out in the Draft Scottish Energy Strategy 2017 (Scottish Government 2017a). Additionally, local energy economies are highlighted in the 'Community Energy Policy Statement' as one of the main points to support the Government's ambition to develop a localised, robust, more distributed energy system to meet Scotland's energy needs (Scottish Government 2015a). Recently, the Government has especially promoted shared ownership models, particularly in onshore wind, to open up to community ownership to more communities (Scottish Government 2017e, ClimateXChange 2014). Hence, the introduction of CSOPs would be politically viable. There already exist various models of community ownership of RE in Scotland, thus the legal integration of the CSOP would be unproblematic and rather introducing another form of ownership and a defined concept. As regards the financing, the presence of well-developed state financial support programme, especially CARES, facilitates the integration of CSOPs in the energy market.

CSOP structure and financing technique—a Holding in the form of a limited liability company (LLC) and a Trust (Lowitzsch 2017)—can be found in UK law.[13] For CSOPs the trust may take the form of a 'mixed trust'—a combination of a 'discretionary trust' and a 'accumulation trust' so that the trustee can make certain decisions about how to use the trust income, and sometimes the capital, and can accumulate income within the trust and add it to the trust's capital (UK Government 2017a). A loan can be provided through CARES, which complies with the CSOP model as well. The overall benefit for Scotland and its policy goals on climate

[13] A 'holding company' is defined in the UK Companies Act 2006 in its section 1159. The UK also has a variation of forms of 'trusts' and a broad range of legislation on 'trusts', such as the Trustee Act 1925, the Trustee Investments Act 1961, the Recognition of Trusts Act 1987, the Financial Services and Markets Act 2000, the Trustee Act 2000, the Pensions Act 1995, the Pensions Act 2000 and the Charities Act 2011.

change and renewable energy, is that CSOP complies with Scotland's 2050 energy vision. It translates the decentralized approach into practice and enables a stable energy transition. It helps securing energy supply and reducing fuel poverty, which are two major problems.

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19

Consumer (Co-)Ownership in Renewables in Spain

Millán Diaz-Foncea and Ignacio Bretos

19.1 Introduction

19.1.1 Energy Mix

The Spanish energy sector is mainly based on fossil fuels, as is the electric system, which has a fairly stable mix of generation based on hydroelectric power plants, thermal power plants, mainly coal and fuel oil, and on nuclear power plants until 1990, when renewable technologies, mainly wind and solar, were introduced gradually (Riutort 2016). Similar to the majority of EU countries, Spain has an increasing dependence on foreign energy supplies. In 2015 the amount of imported fuels was equal to around 73.3 per cent of gross inland consumption, 20 percentage points more than the European average (INE 2017a). In this fossil fuel-based

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energy market, renewable energy sources (RES) do not play a significant role yet.

In 2015 the gross inland consumption of energy was 123,868 ktep (thousands of tonne of oil equivalent): petroleum and carbon at 53.9 per cent, gases at 19.9 per cent, nuclear at 12.1 per cent, RES at 13.9 per cent, and waste at 0.2 per cent; the share of RES consists of hydropower at 1.9 per cent; wind, solar, and geothermal combined at 6 per cent; as well as biomass and biofuels also at 6 per cent (MINETAD 2016). In 2015 the contribution of renewable energies (RE) suffered a slight decrease as a result of the decrease in hydropower and wind power production due to the lack of both resources of rain and wind.

The share of electricity consumption from RE has increased over the years, from 9.1 per cent in 2004 to 26.9 per cent in 2015 (Eurostat 2017). Regarding domestic production, in 2015 RE was the most important source of primary energy amounting to 50.8 per cent—subdivided by 22.4 per cent of wind, solar, and geothermal combined, 21.2 per cent of biomass and biofuels, and 7.2 per cent of hydro. This was followed by nuclear energy production at 44.8 per cent and, with less relevance, by carbon at 3.6 per cent and by petroleum and gas at 0.9 per cent (INE 2017a). Among production from RES in 2015, wind energy had the largest share with 17.5 per cent, followed by hydropower with 11.1 per cent, and solar energy, both photovoltaic (PV) and solar thermal, with 4.8 per cent. The remaining RES play a negligible role in the energy production mix with, for example, biomass, the main energy applied to heating, representing only 1.4 per cent of total production (MINETAD 2016).

19.1.2 Main Challenges of the Energy Market, National Targets, Specific Policy Goals

The challenges facing the energy market include security of supply, competitiveness of the sector, and sustainability goals (Marín and García 2012; Álvarez 2015). The security of supply is linked, on the one hand, to changes in the energy mix, since over the next decade the bulk of Spanish nuclear power plants will have been in operation for more than

40 years (Marín and García 2012), and, on the other hand, the increase in RES brought by the new era of the energy transition to renewables and the process of decarbonization of the system linked to the 2030 EU goals. The need for competitiveness in the energy market is marked by the increase in energy prices, since energy costs for electricity, gas, and other fuels imply a greater weight on the operating costs of companies (Álvarez 2015). In this sense, from 2012 to 2018, the average daily market price of electricity in Spain has risen from EUR 47.2 to 52.3/MWh, an increase of close to 10.6 per cent (AEGE 2018).[1] Sustainability is linked to the promotion of RE by EU policies and to problems with pollution throughout Spain, mainly the big cities. Despite a greater penetration of RES and the positive effect of energy efficiency measures, hydrocarbons, mainly natural gas which application has increased in both distribution and on land and maritime transport, are expected to continue to be of great importance in Spain's energy mix, and it remains necessary to organize their exploitation (Álvarez 2015).

Regarding governmental goals, the objectives of EU Directive 2009/28/EC were transposed into national law through the National Renewable Energy Action Plan, which specifies that RE must reach 20 per cent of gross final energy consumption by 2020—from 13.9 per cent in 2015—as well as a percentage in transportation of 10 per cent.[2]

19.1.3 Ownership Structure in the Renewable Energy Sector

The liberalization of the electric market started in 1997, after the promulgation of the European Directive 96/92/CE and its adaptation to the Spanish context, which deeply changed the sector's landscape. Afterwards,

[1] This evolution is even more striking when compared to the evolution of countries with a similar size at European level, for example, France with a reduction of 4 per cent and Germany with a decrease of 20 per cent (AEGE 2018).

[2] In 2015 transportation accounted for 40.4 per cent of final energy consumption, being 2.8 per cent from RE (INE 2017a; IDAE 2017a).

a multitude of legislative measures has appeared to regulate the electric and energy sector. Between 1997 and 2014, 37 regulations on different levels were promulgated. Currently, the Spanish Association of Electric Power Industry (UNESA) assembles the five major companies in the energy and electricity sector, Endesa, Iberdrola, Gas Natural-Fenosa, E.ON, and EDP, and controls 70 per cent of electricity generation assets, 97 per cent of the distribution business, and 86 per cent of commercialization activities of electricity (UNESA 2013). This oligopolistic situation observed at the general level is mirrored in the renewable energy sector, with the addition of other companies such as Acciona Energía, the sixth largest company in the sector. This ownership structure causes these companies to have an important weight in the political decisions associated with the process of technological substitution from carbon to renewable energies. In 2010, the government approved legislation that altered the support system for renewable energies, reinforcing the oligopolistic structure of the sector, which, however, was partially removed in 2018 (see Sec. 19.3.3).[3]

Other associations of companies have appeared in the development of RE, playing a key role in addressing above described regulations that have been detrimental to the economic feasibility of RE projects and impair legal certainty for companies operating in the RE sector. Among them stand out the Wind Business Association (AEE) with about 200 associated companies, the Spanish Photovoltaic Union (UNEF) with some 300 companies representing over 85 per cent of PV commercial activity in the country, the Association of Producers of Renewable Energies (APPA) that groups about 500 companies, and the National Association of Photovoltaic Energy Producers (ANPIER), which brings together more than 5000 members across Spain, among them both individuals and legal entities (Maugard 2016).

Typically, projects involving consumer (co-)ownership are small. From the 967 installations for self-consumption connected to the grid registered at the official registry of self-consumption of electric energy,[4] 317 have an

[3] The cuts to RE began with the Act 1565/2010 and Act 14/2010, removing the RE production bonuses that existed until then and other measures of negative economic impact on the remuneration of PV installations.

[4] The registry includes co-generation from natural gas as self-consumption of electricity, reaching 153 installations, of which 147 installations are over 100 kW. These numbers were not included in order to focus on RE.

installed capacity above 100 kW equal to 40 per cent, 293 between 10 and 100 kW equal to 27 per cent, and 356 micro-installations below 10 kW equal to 33 per cent. More specifically, 87 per cent amounting to 845 installations applying solar PV and heat technology, 7 per cent biogas amounting to 69 installations, 1 per cent wind amounting to 13, and hydro amounting to 6 (MINETUR 2018).

Examples from the most important RE sectors are as follows:

- Wind farms are installed mostly in Central Spain with 41 per cent in both Castillias, in the South with 14.5 per cent in Andalusia, and in the North-West with 14 per cent in Galicia. They are owned by three large investors: Iberdrola with 24.2 per cent, Acciona Energía with 18.5 per cent, and EDPR with 9.8 per cent, while other companies own less than 7 per cent of the market share. Smaller individual and privately owned projects with an average installed capacity of 21.33 MW exist, which represents 13.1 per cent of market share, although less than 0.5 per cent are owned by individuals (AEE 2017).
- From 139 biogas, biomass, and particularly waste power plants in 2014 (EBA 2015), the majority operate in the waste industry equal to 35 per cent of capacity and agro-industry equal to 33 per cent, following by those of sewage treatment plants equal 20 per cent and others associated with the food industry at 11 per cent.
- Regarding the solar sector, UNEF counted 60,698 PV installations in 2013 (2014). Among them, most installations have a size between 5 and 100 kW amounting to 46,539 or 70 per cent, followed by installations with a size of less than 5 kW amounting to 13,165 or 22 per cent, and far away those with a size of less than 1 MW and greater than 100 kW amounting to 655 or just 1 per cent. However, there are also large PV projects, located mainly in the Spanish plateau of Castilla—La Mancha and Extremadura. Specifically, the largest plants are the Puertollano PV farm in Ciudad Real with 70 MW installed capacity, the 60 MW Olmedilla de Alarcón PV Park in Cuenca, and the 30 MW La Magascona Solar Plant in Cáceres (Pvresources 2018).
- Hydropower plants are typically owned by large commercial companies: the ten biggest installations represent 36.5 per cent of the

hydropower installed capacity equal to 6219 MW. The six largest plants are owned by Iberdrola, three by Endesa, and one by Viesgo. By contrast, hydroelectric mini-installations of under 10 kW, representing around 8.6 per cent of hydropower installed capacity amounting to 2199 MW, are owned by municipalities and private initiatives at a similar share and located in Galicia, Castile and Leon, Catalonia, and Aragón (IDAE 2006; Espejo et al. 2017).

19.2 The Consumer at the Heart of the Energy Market?

19.2.1 Consumer (Co-)Ownership in Renewable Energy Sources as Policy Goal

In response to the oligopolistic tradition and the centralized distribution of the energy market in Spain, the state has barely promoted energy consumer (co-)ownership. Until the new left-wing government was elected in May 2018, the approach was quite the contrary, restricting, for example, legislation for the development of net metering, which is currently not regulated by federal legislation resulting in a situation where excess production of prosumers fed into the grid is not remunerated (for details see Sect. 19.3.3). Among these restrictions is the prohibition of providing electricity generated by a single installation to several different end consumers, preventing installations being set up in multi-tenant buildings and hampering the diffusion of RE technology in urban areas (Prol and Steininger 2017). However, this prohibition pursuant to Art. 4 of Act 900/2015 regulating the administrative, technical, and economic requirements for supply and generation of electricity for self-consumption was removed by the Constitutional Court on May 2017 after an appeal by the Government of Catalonia.

Nonetheless, the regional governments of Navarre, the Balearic Islands, Extremadura, and Murcia are pushing for regulation in this field, yet they risk contravening the national regulations as this area is considered the competence of the federal legislator. An example is Murcia, where in

2015 the regional government updated the Law on Renewable Energy and Energy Saving and Efficiency on the assumption that the legal competences on micro-installations of below 10 kW reside with the regional lawmaker. The newly introduced Article 20 defines two types of installations, that is, (1) "isolated" installations identified as both those not connected to the grid and those that have a zero injection device that makes it impossible to feed electricity into the grid and (2) "energy exchange" installations that are connected to the grid and can balance the energy fed into the grid in energetic terms. However, in December 2016 the Constitutional Court abolished this article arguing that it contradicts the basic state regulation on self-consumption of electric power, a competence residing with the federal government. This regulation requires paying a tax for RE installations connected to the grid discussed more in detail in Sect. 19.3.3. In this sense, the PV industry association (UNEF) has criticized said regulation arguing that it sets unnecessary administrative barriers and that it is discriminative against PV with respect to other RE technologies, resulting in a lower use in urban areas and micro-installations. Indeed, all the political parties in parliament, except the one in government, promised to repeal this regulation (Prol and Steininger 2017).

The outcome of the final trilogue already points in this direction: in June 2018 and following recent governmental change in Spain (and Italy) backing more strongly the energy transition, the position of the EU Council shifted and became more in line with the supporting position of the commission and parliament concerning self-consumption schemes. Part of this agreement foresees the removal of all charges on self-consumed energy, that is, energy produced and consumed on the same premises, effectively banning the Spanish "solar tax" (Euractiv 2018a and 2018b) (see also Sect. 19.3.3 specific regulation for self-consumption). Furthermore, consumer (co-)ownership in general received explicit recognition of its crucial role in the 2018 recast of the Renewable Energy Directive (RED II) as part of the Clean Energy Package. The transposition of the RED II into Spanish law until 2021 will be an important legislative impulse as it introduces a legal framework for consumer (co-)ownership. Consumers, individually (Art. 21, households and non-energy SMEs), collectively (Art. 21, tenant electricity), or in communities (Art. 22, cooperatives and other business models), will have the right to consume, store, or sell energy generated on their premises. RED II also invites the member states to provide an "enabling framework" for local "renewable energy communities". The directive links prosumership to such different topics as fighting energy poverty, increasing acceptance, fostering local development, incentivizing demand flexibility and stipulates citizen's rights and duties as well as, evenly important provides clear definitions (Article 2 RED II). Anticipating the transposition of the RED II, the promulgation of Law 15/2018 in October implemented a bundle of measures to accelerate the transition to a de-carbonised economy, through greater integration of RE, the promotion of prosumership, sustainable mobility, and energy efficiency (see Sec. 19.3.3).

19.2.2 Fuel/Energy Poverty and Vulnerable Consumers

According to the 3rd Energy Poverty Study in Spain—New Approaches to Analysis (ACA 2016)—in 2014, 11 per cent of households in Spain amounting to 5.1 million citizens declared themselves incapable of maintaining their homes at an adequate temperature during winter, an increase of 22 per cent since 2012. This situation is especially problematic in southern Spain, marked by a higher incidence of energy poverty (ACA 2016). However, the situation of vulnerability goes beyond energy poverty, and up to 21 per cent of Spanish households are experiencing conditions close to energy poverty, and 6 per cent equal to 2.6 million citizens spend more than 15 per cent of their family income on energy bills.[5] ACA (2016) emphasizes the socio-economic characteristics of these highly vulnerable households: mostly elderly people, single-parent families, or families with three or more dependent children, often affected by unemployment and a low level of education.

Since 2016, a state regulation is in place to protect families with scarce resources.[6] Until 2018, this protection was limited to support for elec-

[5] Although households with lower incomes spend EUR 3 less per square metre and person than households with higher income, the former dedicate 12 per cent of their income to the payment of domestic energy bills compared to 3 per cent of the latter (ACA 2016).

[6] Act 7/2016, of December 23, which regulates the mechanism for financing the cost of the social bonus and other measures to protect vulnerable consumers of electricity. Available at https://www.boe.es/boe/dias/2016/12/24/pdfs/BOE-A-2016-12267.pdf.

tricity consumption through a 35 per cent discount on the electricity tariff for vulnerable consumers and the impediment for electric companies to cut off electricity supply without contacting the local or regional administrations. Act 15/2018 amended this protection by (i) revising the discount adapting it to the needs of vulnerable households targeting less efficient appliances and less isolated homes, (ii) introducing a social bonus for thermal energy sources other than electricity, and (iii) specifying the characteristics of households that cannot be cut off from electricity supply during the winter. The government is expected to approve a 'Strategy for the Fight against Energy Poverty' at the beginning of 2019.

19.3 Regulatory Framework for Renewable Energy

The main statutory provisions regulating the RES sector in Spain are the 2013 Energy Sector Law (ESL), Act 413/2014 that regulates the activity of electricity production from renewable energy sources, co-generation, and waste, as well as 15 other regulations promulgated since 2007. The main public body involved in the renewable energy sector is the Ministry of Energy, Tourism and the Digital Agenda (MINETAD in Spanish), responsible for federal policy which is subsequently implemented by the Institute for Diversification and Saving of Energy (IDAE in Spanish). On the other hand, the competence of setting economic rules mainly concerning competition and remuneration in this sector and of the requirements for the distribution and consumption of energy resides with the National Commission of Markets and Competition (CNMC in Spanish), an independent body of the state government (IEA 2015).

19.3.1 Regulations for Connecting Renewable Energy Plants to the Grid

RE plant operators are entitled to priority access and connection to the grid (Act 413/2014). The grid operator must also guarantee non-discriminatory use of the grid for the transmission or distribution of electricity from RES and is obliged to enter transmission agreements

(Art. 6.2, Act 413/2014). Electricity production can occur with or without a licence distinguishing between two categories, that is, plants with an installed capacity of up to 100 kW exempted from licensing duty and those exceeding 100 kW. The obligation to register plants with a nameplate capacity of up to 10 kW whose production is destined exclusively for self-consumption and which are installed directly at the supply point with the Administrative Registry of the Energy Regulatory Office (Act 900/2015) was abrogated in October 2018 (Act 15/2018). Section 19.3.3 outlines the rules of these micro-installations, which have no preferential conditions with regard to connecting to the grid.

On the other hand, the Spanish Transmission System Operator REE made an effort for the integration of renewables establishing in 2006 the Control Centre of Renewable Energies (CECRE), the first national control centre in the world dedicated to monitoring and controlling RES. Its objective is to maximize RES integration in the electricity grid and markets whilst assuring the overall security of the electrical system, taking into account the intermittency of renewable electricity and the scarce interconnection capacity of the Iberian Peninsula with France. Both issues mark the importance of CECRE's coordination, aggregation, and control of the overall electricity production fed into the grid (IDAE 2017b).[7]

19.3.2 Support Policies (FITs, Auctions, Premiums, etc.)

Since 2013 RE have been deployed within the framework of the ESL. Before that in 2004, the Spanish government established a premium system to encourage investments in the development of these technologies and co-generation (Riutort 2016). This allowed a rapid and unplanned increase in RE, mainly in the PV sector (Gari et al. 2013).[8] In

[7] More info at the website of the Spanish Transmission System Operator (REE): http://www.ree.es/es/sala-de-prensa/infografias-y-mapas/centro-de-control-de-energias-renovables-cecre-con-locucion.

[8] In 2008 about 50 per cent of the world's production of photovoltaic modules was destined for Spain (Gari et al. 2013).

2012, the Spanish government changed its incentive policy and applied a moratorium on renewable premiums, in reaction to the economic crisis and to the high costs of the premiums being adjusted to the reduction in the technology price, extending the differential cost-premium year by year.

In 2014, an auction mechanism for the production of RE was introduced replacing FITs and FIPs by a compensation for investment-related outlays to be allocated based on the plant's installed capacity (Ceña 2016).[9] This capacity-based reverse auction model guarantees RE operators a rate of return based on the average yield of Spanish government bonds plus a spread that in 2016 for the first regulatory period was set at 300 basis points for a given volume of MW without discrimination of technology type (del Río 2016).[10] For already-existing installations, the reform introduced the possibility to receive an additional remuneration to cover investment costs that an efficient, well-managed company does not recover on the market against a benchmark of 7.5 per cent return on investment (del Río 2016). Such the state ensures a minimum price, regardless of the market price, provided that the installations approved in the auction are built within the established time frame. The absence of capacity caps for wind, solar PV, and others resulted in an initial dominance of wind energy projects. Furthermore, the conditions of the auction mechanism seem to be inclined to favour large companies relegating smaller citizen energy projects (del Río 2016).

19.3.3 Specific Regulations for Self-Consumption and Sale to the Grid

Act 15/2018 approved in October 2018 regulates the administrative, technical, and economic requirements for supply and generation of electricity for self-consumption. This legislation removed a number of

[9] The regulatory package consists of four pieces of legislation: Royal Decree Law (RDL 9/20134), a law (Law 24/20135), a royal decree (RD413/20146), and a ministerial order (Order IET/1045/20147).

[10] Taking into account overall investment cost, operation costs during the regulatory lifetime, and the wholesale market income, the return is calculated on the asset base of a standardized facility over its lifetime.

obstacles to the development of self-consumption, that had led the International Energy Agency to conclude that Spanish legislation is one of the most restrictive, discouraging self-consumption (Masson et al. 2016). The most outstanding example being the "backup toll" also known as "solar tax", through which self-consumption installations were taxed.[11] With this reform simplifying the articles on self-consumption of Law 24/2013 of the Electricity Sector, Spain anticipates the 2018 RED II and its transposition in national law aligning its support system with more supportive European standards.

In its preface, Act 15/2018 introduces three fundamental principles governing prosumership: (i) the right to self-consume produced electricity without charge; (ii) the right to self-consumption shared by one or several consumers taking advantage of economies of scale; and (iii) the principle of administrative and technical simplification, especially for small installations. The Act defines self-consumption as consumption of electricity produced by one or several consumers at production facilities in proximity to those of consumption and associated with them. Besides introducing the concept of shared self-consumption, the law extends it beyond the immediate neighbourhood to communities that are in the reach of a common transformer (Art. 18 of Law 15/2018 modifying Art. 9.2 of Law 24/2013). This will allow strategies to collectively produce, save, manage, and store energy-sharing production surpluses without having to feed them into the grid (Herrera 2018).[12]

Net metering, however, is not regulated yet in Spain. Legislation allows owners of micro-installations below 100 kW to feed surplus electricity production into the grid, but for the time being they will not receive any type of compensation for this, de facto disabling net metering. Nonetheless, Law 15/2018 foresees the possibility to introduce regulation for net metering for installations below 100 kW. Furthermore, add-

[11] The "solar tax" incorporated by the Act 900/2015 is understood as the tax that is applied to self-consumed energy instantaneously without going through the electricity grid.

[12] Local renewable energy communities are thus enabled not only to become a market actor, but also to economically stimulate towns and cities that move towards a more distributed and democratic generation model, while at the same time limiting network losses and increasing energy awareness (Herrera 2018).

ing battery storage is subject to an additional tax, virtual net-metering or peer-to-peer compensation is not allowed yet (Masson et al. 2016).[13]

19.4 Concepts for Consumer (Co-)Ownership in Practice

19.4.1 Contractual Arrangements and Corporate Vehicles Used

The consumer (co-)ownership in RES occurs through three main models in Spain, that is, joint purchasing, collective investment in RE production, and participation in RE cooperatives.

- Firstly, in the joint purchase model, consumers participate collectively in the electricity market, either by purchasing kW directly on the electricity market (see OCU 2017) or through the collective purchase of PV module kits for self-consumption. A remarkable example for this model is the "Solar Surge" project ("Oleada Solar"), promoted by Ecooo (http://ecooo.org), a non-profit business created in 2005 as the first collective purchasing campaign for PV installations for residential use promoting self-consumption and thus encouraging consumer (co-)ownership. This campaign aims to assemble 100 solar homes in communities, reducing the final price for self-consumption installation up to 30 per cent.
- Secondly, community energy takes the form of local ownership with citizen participation in generation, distribution, and energy efficiency activities (Community Energy Coalition 2012; Riutort 2016). These projects intend to favour popular participation, although primarily in the role of an investor, while ownership, management, and formal promotion responsibilities reside mainly with the promoter organization. The leading experiences in this field have been

[13] Unlike other countries that implement some specific levy to compensate for avoided grid levies, the Spanish grid tax was the only example of a specific tax directed solely at self-consumers (Masson et al. 2016).

promoted by Ecooo that enables citizen participation in rooftop PV installations with a contribution from EUR 100 to 5000, through the legal form of "comunidad de bienes", a joint ownership model established under the Spanish Civil Code, characterized by unlimited personal liability and the indivisibility of the common good, however, avoiding joint liability.[14] Besides amortizing the investment of the participants and rewarding it by paying dividends, profits are often devoted to social purposes and RE promotion campaigns. This model has developed over time allowing more than 65 installations since 2005 with more than 1000 participating consumers.[15]

- Thirdly, energy consumer cooperatives allow direct consumer (co-) ownership in RE. Spain witnessed two waves in the creation of energy cooperatives (Riutort 2016): the first occurred in the first decades of the twentieth century mainly to supply rural communities facing a lack of public or private investments with electricity. In 1940, 2000 electric cooperatives were counted in Spain (Defourny and Develtere 2000). The second wave in Spain followed the surge of the European RE cooperatives in the second half of the twentieth century, although this organizational model was not established in Spain specifically with regard to RE until 2010 when Som Energía and other similar initiatives emerged (Riutort 2016). In 2016, 33 consumer cooperatives were registered in the production and distribution sector of electricity, gas, and water (MEYSS 2016).

A fourth emerging model is "public service cooperatives" (cooperativas de servicios públicos), so far introduced at the regional level in Andalusia

[14] The "comunidad de bienes" is a legal vehicle for business activities carried out in common where the property ownership of a good or right belongs to several physical persons. It does not have an own legal personality, and it is registered through a private contract, taxing the benefits that the participating individuals obtain. The responsibility is unlimited and personal, although the participation of the owners is proportional to the quotas they subscribed both with regard to benefits and burdens (Articles 392 to 406 of the Spanish Civil Code).

[15] This initiative is being expanded in collaboration with the RE cooperative Som Energía (see Sect. 19.4.3) and with the initiative "Recuperate the Sun" ("Recupera el Sol") whose aim is to recuperate distressed PV plants for citizens that due to the economic crisis and the latest energy market reforms are likely to be acquired by banks or "vulture funds" focusing on economic profitability instead on promotion of RE. In 2016 seven solar plants had been recuperated with a total RE generation of more than 430,000 kW (Ecooo 2016).

in 2014 and Valencian Community in 2015. According to Act 123/2014 enacted in Andalusia, potential members of these cooperatives are the competent public entity(ies), private entities with proven experience in the sector, users of services, as well as worker members with the latter being allowed to hold a maximum of 20 per cent of the ownership stake. Nonetheless, the public promoter entities will retain control over the conditions for the provision of public services, which in practice means that they either own 51 per cent of the capital or have reserved political rights in terms of decision-making. Although this legal form had not been applied in the RE sector as this chapter was written (neither any sector), it represents a potential vehicle to allow the collaboration of consumers and municipalities in the collective investment or management of public goods or resources focused on RE.

Furthermore, there are RE projects developed by public administrations, mainly municipalities, which represent an energy transition towards more sustainable environments. These projects usually do not include consumer (co-)ownership or direct participation in the control bodies but—in a growing number of cases—favour indirect participation through the institutions in which the citizenship is represented.

19.4.2 Financing Conditions for Consumer (Co-)Ownership in Renewable Energy

19.4.2.1 State Subsidies, Programmes, Credit Facilities, Preferential Loans

State support for financing RE projects is mainly managed by the Institute for Energy Diversification and Saving (IDEA in Spanish). Most of the direct investments made by this body use the contractual philosophy of Third-Party Financing, facilitating the financing of defined projects by loans, either through European Regional Development Fund programmes dedicated to the low carbon economy, the National Energy Efficiency Fund, budgets of the state, or private financing. This type of financing is mainly focused on facilitating large investments in RE plants or projects to improve energy efficiency.

No specific state programmes or subsidies dedicated to improving the position of consumer (co-)ownership projects exist. However, there are initiatives to stimulate RE investments promoted by the private and cooperative sphere, although they have a small overall weight. An example is the "Germinador Social" project (https://www.germinadorsocial.com/), a financing tool focused to kick off innovative models of social initiatives, RE, and energy efficiency. It takes shape as a contest promoted by Som Energía, S. Coop. (see Sect. 19.4.3), and "Coop57", a cooperative of ethical financial services offering EUR 25,000 of subsidy divided between successful projects.[16] This fund is created from the voluntary donations by clients, stipulated in the electricity contracts with Som Energía, and the possibility of accessing loans granted by Coop57 under preferential conditions.

19.4.2.2 Agencies Supporting Investment in Renewable Energy Sources

The financing of large projects is mainly managed through the Institute for Energy Diversification and Saving (IDEA), with state-level legal competences. Likewise, some regional governments also have grants to finance RE projects. In the field of consumer (co-)ownership, among the main agents that facilitate financing of RE projects are Ecooo and Som Energía. Both organizations are developing campaigns to obtain financing such as *Depósito Solar* (https://ecooo.es/participa/) and *Recupera el Sol* (https://blog.somenergia.coop/recupera-el-sol/) allowing to finance projects, mainly PV installations, which demonstrate solvency and the economic viability of long-term RE production.

[16] The first round was 2017 when among 41 candidates 5 projects were granted with EUR 4500 each; these were the neighbourhood community for joint consumption in Barcelona, Ecotxe—Som Moviment (software and web for electric carsharing), Eeeepa! (entrepreneurship, saving, and energetic efficiency of proximity with self-production), La Ermineta—Electra—Regadio, and Som Mobilitat (sharing electric and renewable mobility). The second round was launched until the end of May 2018.

19.4.3 Examples of Consumer (Co-)Ownership

I. Som Energía, S. Coop.—Som Energía, S. Coop., is a non-profit consumer cooperative founded in December 2010 on the basis of agreements between various citizen projects concerning the energy transition in Girona, Catalonia. The first REScoop in Spain, Som Energía sells RE generated in small-scale projects to its members and other clients (Riutort 2016). From 178 founding members in 2010, Som Energía has seen an exponential growth to around 46,500 members in 2018 with on average 8000 new members per year, a total of 72,500 electricity contracts.[17] Members make an initial contribution of EUR 100 to the cooperative to enjoy its services, there is no annual fee, and the initial contribution is refunded upon termination of the contract (REScoop 2015). Its articulation as a social movement carried by its members enables significant collective investment opportunities; for example, EUR 5 mln. were collected in seven days for three PV plants in Valencia, Catalonia, and Andalusia in October 2017 and EUR 800,000 in two hours for a hydroelectric power plant in Castile and Leon in September 2015.[18] More general, the aim is to create RE investment opportunities for both new installations and the acquisition of plants already in operation financed by the cooperative's capital and then owned by it.

Currently, there are 15 projects of which 9 in operation, with 4.4 MW installed capacity and a combined budget of EUR 6.6 million, and 6 under construction, with 6.3 MW and EUR 4.8 million. Of these 8 are located in Catalonia, 4 in Andalusia, 2 in Castile and Leon, and 1 in Valencia marked by a variety of RE technology: 11 PV plants, 2 hydropower plants, and 1 biogas plant.[19] Currently, Som Energía facilitates financial participation of its members in projects externally managed but linked to entities close to the cooperative in terms of organizational philosophy such as Ecooo and Eolpop.

[17] This growth is related to the emergence of local support groups, 64 in 2018, located in most Spanish regions, which are meeting and participation points for members. Som Energía can therefore be understood as a social movement formed by volunteer members, Furthermore, Som Energia spends no money on advertising and members participate as sales personnel (REScoop 2015).

[18] More information about characteristics of investment in RE is available in https://www.somenergia.coop/es/inversion-en-renovables/.

[19] All information about these investment projects is available in https://www.somenergia.coop/es/produccion.

II. Eolpop, SL—This limited company was created in 2009 to promote the construction and management of a (co-)owned grid-connected wind turbine through the acquisition of small shares by citizens. The wind turbine has a nameplate capacity of 2350 kW and a life cycle of 25 years and is located on private land leased in the municipality of Pujalt, west of Barcelona. Currently, there are seven shareholders with ample experience in the wind sector amongst the shareholders Eolpop, SL, including the Som Energía and other RES cooperatives and ecological movements. The legal vehicle used for the economic participation of citizens in the investment is "accounts of participation" ("cuentas en participación"), a modality regulated in the Spanish Commercial Code (Art. 239 to 243).[20] In a first step Eolpop, SL, pre-registration of participants occurred through three participatory models: EUR 100 for individuals, EUR 250 for families, and EUR 500 for entities, which have the goal to reach a total investment of EUR 2.8 million. The collected contributions functioned (which reached EUR 2.36 million by 533 people/entities by May 2018)[21] as pending payment until the project required capital input in 2016. Each year, the surpluses will be distributed among the participants proportionally to the investment made. The expected annual return for these contributions is 2 per cent. In March 2018, nine years after the launch of the company, the wind turbine began to inject renewable energy into the grid (Eolpop 2018).

III. Fundacion Terra—Created in 1994, among its objectives is to channel and promote initiatives that favour greater responsibility of society in environmental issues. In particular, the Fundacion Terra promoted the "Ola Solar" project in 2007, which implemented the collective financing of a 41.4 KW PV installation on the roof of the Mercat del Carmel (Barcelona); through small shares ranging from EUR 1000 to 3000, the 140 investors reached the total amount of EUR 301,000. All the investors are private consumers. The investment was formalized through "accounts in participation" (see the example above) with the

[20] This tool allows transferring money to the bank account of a legal entity, which has the obligation to dedicate it to a previously agreed business activity, without the need to create a new legal form or to separate assets. The responsibility is limited and bilateral vis-a-vis the manager of the bank account. Consumers do not become owners of a company but participate by the capital contributed in the "accounts in participation" contract.

[21] The updated information is available at http://www.viuredelaire.cat/es/el-proyecto/participacion-eolica-popular.html.

foundation. The project did not contemplate greater participation of the consumers than investment in the capital, although it is possible to participate in the foundation itself as a member of the same.

IV. Barcelona Energía—The city of Barcelona founded in 2017 its public electric power distributor, Barcelona Energía, managed through the public company TERSA.[22] The objective of Barcelona Energía (http://energia.barcelona) is, in its first phase starting in February 2018, to feed locally produced green energy into the grid; in a second phase starting in July 2018, it will provide electricity to the City Council and municipal companies focusing on self-consumption; finally, in the third phase starting in 2019, the supply of energy to Barcelona's citizens is envisioned (Barcelona Energía n.d.). The energy supplied by Barcelona Energía comes from 41 PV plants installed on buildings that are property of Barcelona City Council, a waste-to-energy plant in Sant Adrià de Besòs,[23] and a biogas plant supplied by the Garraf landfill,[24] with a total installed capacity of 45 MW. Despite the fact that citizen participation is restricted to the delegation in local governments, this model allows electric power coverage as a public service of the city councils, considering the city as the engine of a new energy system (FER 2017).

19.5 Factors Affecting the Financing of Renewable Energy Sources and Barriers to Consumer (Co-) Ownership

19.5.1 Political, Legal, and Administrative Factors

In Spain the main hurdles for consumer (co-)ownership in the RE sector were the complex and changing regulatory framework of the renewable

[22] Treatment and Selection of Residues, SA, 100 per cent owned by the public authorities of Barcelona and surrounding localities.

[23] The Energy Recovery Plant (PVE) of Sant Adrià de Besòs is an installation that performs the process of minimizing the volume of waste through combustion and uses the energy generated by this process to produce steam and electricity (Source: http://www.tersa.cat/es/planta-de-valorizaci%C3%B3n-energ%C3%A9tica_2172).

[24] More info: http://www.tersa.cat/es/tersa-gestionar%C3%A1-la-planta-de-aprovechamiento-energ%C3%A9tico-del-biog%C3%A1s-del-garraf_96863.

and non-renewable energy market, as well as the complex administrative requirements to enter the industry. Since the approval of Directive 96/92/EC in 1997 until 2014, the Spanish electricity sector has experienced a total of 37 regulatory modifications (Energía y Sociedad 2015). The changing legislative framework related to the Spanish political and economic situation generated legal insecurity for potential actors in the RE sector (Sevilla et al. 2013). Furthermore, commentators claim that Spanish legislation protects the maintenance of an energy oligopoly and hampers the emergence and development of citizen-owned renewable energy projects and self-consumption systems (e.g., Riutort 2016, 96–97). Until 2018 Spain had one of the most restrictive self-consumption regulations in Europe, which includes the backup charge widely known as "solar tax" described above and, unlike in other European countries, does not apply net metering or net billing schemes (Masson et al. 2016; Prol and Steininger 2017). However, this has already changed with Law 15/2018 and will further improve with the transposition of the recast of the abovementioned Renewable Energy Directive.

The administrative requirements also represent an important barrier to entering the RE sector, especially considering there are three administrative levels in Spain: national, regional, and municipal. While administrative requirements do not involve a high financial cost, they are highly complex and time-consuming due to regional heterogeneity in terms of regulation and inefficiency in administrative procedures (Klessmann et al. 2011). For instance, around 60 different regulations apply to the process of building, connection to the grid, and the beginning of the energy production of a wind farm involving more than 40 procedures between different administrative levels. This results in lead times of four to eight years (Del Río and Unruh 2007).

19.5.2 Economic and Management Factors

An important disincentive for private investments in RE in Spain stems from the high initial investment and the long payback period involved, adding to the lack of public financial aid and the difficult accessibility of loans in this market (Creutzig et al. 2014). Between 2004 and 2010, the Spanish government promoted the generation of electricity from RES by means of feed-in tariffs (FITs). However, in 2010 these incentives begin to be severely curtailed until 2012, when all FITs to new RE production projects were halted. This situation was aggravated by the penalization of electric power generation by renewable technologies with a production tax of 7 per cent (Prol and Steininger 2017; Jacobs 2016).

Furthermore, one of the criticisms of Spain's auction scheme introduced in 2014 is that, instead of rewarding the project that produces more energy at the lowest price, it incentivizes those likely to build the cheapest installations, regardless of the amount of energy that will be generated (CincoDias 2017). On the other hand, the reduction of installation costs has caused bidders to waive 100 per cent of the public assistance premium for the installation (see Sect. 19.3.3). This affects all the bidders in the auction, since the minimum price offered establishes the premium to be received by all the bidders, even if it is zero. Thus citizen energy projects have significant difficulties to compete with large companies, especially because there is no preferential measure that favours them (del Río 2016).

On the other hand, the scarce fluidity of credit derived from the 2008 financial crisis which severely hit Spain, in conjunction with the legal insecurity and the dismantling of a large part of the state subsidies for RE, has generated considerable uncertainty among investors and lenders to finance RE projects (Fritz-Morgenthal et al. 2009; Hofman and Huisman 2012). In a way, RE projects based on consumer (co-)ownership, such as REScoop, were the least affected by this scenario, since they do not depend so much on the conventional financial system. Instead they rely on the contributions of the members themselves, as well as other innovative solutions such as citizen investment, joint ventures, and public partnerships (Huybrechts and Mertens 2014). This is clearly seen in community projects in Spain that continued to advance in a situation of economic crisis through models of self-financing, like the case of Som Energía (see Kunze and Becker 2015).

With regard to knowledge and expertise on technical and legal issues in the field of RES, some argue that this is generally insufficient and that the requirements set by the law on the certifications and training of installers are often not fulfilled in practice (Del Río and Unruh 2007). However, this situation seems to have changed in recent years in Spain, with greater professionalization of the sector and a significant increase in the number of courses on the installation and maintenance of wind farms provided by vocational colleges and universities (ILO 2011). Furthermore, the State Plan for Scientific and Technical Research and Innovation 2017–2020 establishes various objectives and priorities to promote research, technological development, and innovation in the field of RES (MINECO 2017).

19.5.3 Cultural Factors

Spain boasts one of the largest and most influential cooperative sectors in Europe, with 30,192 cooperative enterprises that employ 319,792 people (MEYSS 2017). However, cooperatives barely represent 1 per cent of the total of the 3,282,346 existing companies in Spain (INE 2017b). One of the principal reasons lies in the lack of supportive informal institutions for cooperative entrepreneurship in Spain (Díaz-Foncea and Marcuello 2015). The cooperative formula lacks a solid legitimacy in Spanish society, due, among other issues, to the scant degree of knowledge about these organizations among citizens (Martínez-Carrasco and Eid 2017). Furthermore, the cooperative sector is quite fragmented throughout the Spanish territory, having a greater presence in certain regions where a "cooperation culture" is more ingrained. It is no coincidence that the largest renewable generation and consumption cooperative projects are found in Catalonia, Andalusia, and País Vasco, three of the Spanish regions with a greater tradition of self-management and the most significant number of cooperatives (Díaz-Foncea and Marcuello 2015).

The tradition of social activism on energy matters at the local level is found to be weak in Spain, at least in comparison with other European countries such as Germany, Denmark, and the Netherlands (Toke et al. 2008). According to the Barometer of the Centre for Sociological Research (CIS), environmental concerns rank only 21st among a total of 47 options. In addition, only 38.7 per cent of citizens would be willing to pay higher prices to protect the environment (CIS 2016). However, from a historical perspective, a positive evolution is observed regarding Spanish society's awareness of climate and energy issues (comparing to CIS 1996), equally reflected in the prominent attention drawn to RE by media coverage and their increased public acceptance in the last years (Heras-Saizarbitoria et al. 2011).

19.6 Possible Future Developments and Trends for Consumer (Co-) Ownership

As has been pointed out in recent years by Fundación Energías Renovables (FER 2017, 2018), one of the most active think tanks in the Spanish RE sector, the move towards political and legislative support of prosumership is crucial for the energy transition. Among other measures that favour the energy transition, Fundación Energías Renovables (FER 2018) proposes three areas of action: firstly, in terms of energy demand, understanding the city as the protagonist in changing the energy system, focusing on the eradication of energy poverty, the promotion of building efficiency, self-consumption, as well as sustainable mobility and transport. Secondly, on the supply side, the promotion of RE and the limitation of the use of coal and other hydrocarbons to generate electricity. Thirdly, in relation to other transversal actions, to review the functioning of the electricity sector, especially regarding taxation and the promotion of citizen participation. The change of government in June 2018 and the subsequent reform of prosumership in October 2018 were much in line with these postulates and align the regulatory framework with that of the 2018 RED II at the European level.

Prol and Steininger (2017) propose the following to promote the diffusion of PV self-consumption at a minimum cost for the electricity system: (1) to remove the charges in order to make the development of grid-connected PV systems economically feasible[25]; (2) to promote net billing rather than net metering, which helps to mitigate the negative impacts of PV self-consumption on the electricity system; (3) to monitor the prices of the surplus electricity in order to provide a controlled

[25] Law 15/2018 already reduced some obstacles and simplified regulations in this area; however, its impact on the diffusion of PV systems remains to be seen (see Sect. 19.3.3).

profitability and as such increase the sustainability of PV systems; and (4) to allow the sharing of a single installation between several different end consumers.

Another key aspect is that the current RE auction mechanism should be revised to ensure actor diversity creating a level playing field for both large corporate projects and sustainable energy projects with citizen participation (Álvarez 2017; FER 2018). This is in line with legislation in countries like Germany, where community projects are awarded a large part of the power auctioned (WindEurope 2017). Since 2015, several municipalities have begun to promote citizen participation in the energy sector at the local level through various mechanisms such as the introduction of social and environmental clauses for the contracting of electricity supply that favour REScoops, the establishment of collaboration agreements with local cooperatives and other community projects (Vélez 2017), and the promotion of the role of cooperatives in the rehabilitation and improvement of the energy efficiency of buildings (Falcón-Pérez and Fuentes-Perdomo 2017).

Finally, besides the start-up of new renewable facilities, another important action measure is the recovery of solar plants threatened to be transferred to bank ownership as their current owners cannot repay the loans financing them through collective ownership. This path can be marked by initiatives such as "Recuperate the Sun", driven by the non-profit organization Ecooo and Som Energía. Through this initiative, over 10 plants have been recuperated since 2015 (Ecooo 2016).

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20

Consumer (Co-)Ownership in Renewables in Switzerland

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20.1 Introduction

20.1.1 Energy Mix

With a total final consumption of 854,300 TJ of energy in 2016 (Swiss Federal Office of Energy (SFOE) 2017a), Switzerland has one of the lowest CO_2 per capita emissions among the developed nations (World Bank 2017). Still, Swiss final energy consumption is heavily reliant on fossil fuels: 34.2 per cent of energy comes from motor fuels (gasoline, diesel), 16.1 per cent from crude oil fuels, and 13.7 per cent from natural gas (SFOE 2017a). Renewable energy (RE) accounts for 22.1% of the overall

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energy mix, most of which is made up by hydropower (12.3 per cent), while solar photovoltaics (PV) and wind energy jointly contribute less than one per cent (0.85%) (SFOE 2017b). RE contributes a similar share in the heating sector (20.2 per cent), with around half (52 per cent) of renewable heat originating from wood-fired boilers, followed by heat pumps (28 per cent) and waste (14 per cent) (ibid.).

In contrast, the Swiss electricity mix has traditionally been composed of non-fossil sources, mainly hydropower (59 per cent) and nuclear (32.8 per cent) in 2016 (SFOE 2017c). With around 500 large and 1000 small hydropower stations and 100 storage power plants, Switzerland is one of the countries with the highest shares of hydropower in the world (SFOE 2017b). Non-hydro renewable energy resources account for less than 6 per cent of the total electricity mix but are expected to grow in the future (SFOE 2017c).

20.1.2 Main Challenges of the Energy Market, National Targets, and Specific Policy Goals

Following the Fukushima nuclear meltdown in 2011, the Swiss government and parliament decided to phase out nuclear energy proposing an Energy Strategy 2050 (*Energiestrategie 2050*) (SFOE 2018). Nuclear is a major source for electricity generation in the country, marked by high uranium imports (Bundesamt für Energie 2016). After long deliberations, the Energy Strategy, now incorporated into the Energy Law (Energiegesetz, EnG), was put to public vote, and the first set of measures (*erstes Massnahmenpaket*) was approved by the majority of the Swiss population in a referendum in 2017 (ibid.). The updated Energy Law, in effect since 1 January 2018, stipulates several measures to increase energy efficiency and expand renewable energy generation. In addition, the existing five nuclear power plants are to remain operational as long as they are safe, but they will not be replaced by new ones, manifesting a gradual nuclear phase-out (ibid.). The first set of measures for the year 2020 includes the following: streamlining of the permitting procedures for building and interconnecting RE generation, increase of the CO_2 tax (*CO_2-Abgabe*) to EUR 71.7 per ton,[1] investment of EUR 384.3 million in the energy efficiency measures in the building sector. Starting from 2018, the grid surcharge on electricity consumers has been increased from EUR 0.013 to 0.02 per kilowatt hour, which will be collected to the fund (*Netzzuschlagsfonds*) that supports RE and energy efficiency projects (ibid.). The increase in the grid surcharge was necessary to somewhat close the gap between the limited availability of funds and large number of RE projects, which resulted in a substantial waiting list. For example, there were 568 hydropower, 379 wind, 369 biomass, and more than 34,000 (34,447!) solar photovoltaic projects on the waiting list to receive the feed-in tariff (FIT) at the end of 2017 (Pronovo 2018).

The Energy Strategy also defines several ambitious targets for 2035. Relative to the year 2000, average energy and electricity consumption per capita should be reduced by 43 per cent and 13 per cent, respectively, while the production of electricity from wind, sun, biomass, and geothermal sources should increase to 11.4 terawatt hours, 3.5 times more than the total RE output in 2016 (SFOE 2017b; EnG, Art. 2 and 3).

20.1.3 Ownership Structure in the Renewable Energy Sector

The Swiss energy system is still dominated by large incumbent utilities, more than 80 per cent of which are owned by the public sector, such as cantons and municipalities (VSE 2018). Some of these energy companies are horizontally or vertically integrated. They are active at multiple stages of the value chain: electricity production, trading, distribution, or even across several divisions supplying electricity, gas,

[1] As of 1 January 2018, the exchange rate of Swiss franc to EUR was 0.8541. http://www.finanzen.ch/waehrungsrechner/schweizer-franken-euro.

heat, or water (ibid.). Power-producing facilities, such as hydropower plants, are often (co-)owned by several utility companies (*Partnerwerke*), which receive the energy produced by the power plant in accordance with their ownership share (SFOE 2014). This ownership structure has a long history in Switzerland, making it difficult for small private investors to enter the market. At the same time, public ownership means that the country's citizens own the electricity-generating facilities.

- The up-to-date statistics about specific ownership structure of RE installations is hard to come by. Among the entities that receive the feed-in tariff, private investors and commercial entities (*Gewerbe*) hold less than 10% of installed capacity in small hydropower, while two-thirds of the capacity is owned by conventional energy companies and public entities (Chassot 2012). In contrast, almost half of the installed capacity in solar photovoltaic belongs to private individuals and about 30 per cent to commercial entities active outside the energy sector (ibid.). New cooperatives, founded after 1990, only own a very small share of PV capacity (Salm and Schmid 2016).
- Wind parks are built mostly in western Switzerland and are usually owned by big cantonal and city utilities. Smaller individual and community-owned projects exist, notably Goms and St Brais (ADEV 2018). Unlike in Germany, community ownership of wind installations (*Bürgerwindenergiepark*) is rare.
- As of 2016, there were about a hundred biogas facilities (found at large farms), while energy from waste was mainly sourced from paper, cardboard, waste, and sludge remaining from paper production (SFOE 2017b).
- No reliable statistics could be found for energy production by municipalities, schools, or small- and middle-sized enterprises and private persons.

20.2 The Consumer at the Heart of the Energy Market?

20.2.1 Consumer (Co-)Ownership in Renewable Energy Sources as Policy Goal

For the purpose of this chapter, we define community finance broadly as a participation scheme that allows individuals, that is, small-scale retail investors, to invest in RE projects and receive compensation in form of electricity, certificates of origin (*Herkunftsnachweis*), and/or interest payments for a certain amount of time. Swiss Energy Law (EnG) does not contain specific targets for expansion of consumer (co-)ownership of renewable energy sources (RES), but it does contain several provisions that encourage and support such (co-)ownership schemes (see also Sect. 20.3). One of them is an explicit authorization of self-consumption (*Eigenverbrauch*), which states that producers can consume self-generated electricity entirely or partially at the place of generation (Federal Council 2016). Furthermore, the new version of the Federal Energy Law (2016) that was enacted in the beginning of 2018 allows the formation of self-consumption communities (*Eigenverbrauchsgemeinschaften*).

In the future, more institutional investors like pension funds might become active in financing RE infrastructure, due to the new legislation that creates a separate asset class for infrastructure investment (Weibel 2015). At the time of writing, one chamber of the parliament and the commission of the second chamber have approved this proposal, which makes the legislation likely to pass. However, due to significant investment volumes necessary for involvement of the institutional investors, large pension funds might not be the most appropriate actors for financing small-scale RE developments (Wüstenhagen et al. 2017). The scale issue might be addressed by the increased use of innovative platforms, which connect buyers and sellers of RE in a virtual marketplace (Reuter and Loocke 2017). Such platforms create new opportunities for crowdsourcing (gathering incremental contributions) to finance large RE projects but might potentially be used by the institutional investors to finance a portfolio of small-scale RE projects.[2]

20.2.2 Fuel/Energy Poverty and Vulnerable Consumers

The problem of energy poverty does not seem to loom large in Switzerland, which enjoys a universal electrification and ranks fourth in energy equity globally (World Energy Council 2018). This ranking suggests that energy is accessible and affordable to the Swiss population. The International Energy Agency defines 'modern energy access' as a consumption of over 500 kWh/year per urban household (OECD/IEA 2010). The annual consumption of an average Swiss household is more than ten times greater: 5400 kWh (Energieschweiz 2014). An average electricity bill for a Swiss household in 2015 was EUR 795, while the average gross annual household income was slightly below EUR 102,500 (Federal Statistical Office 2017; Statista 2018). Note that the electricity accounted for less than 0.8% of the average household's annual income, hardly a significant share. With proliferation of self-production and self-consumption of electricity, the average electricity consumer could face a slight increase of the electricity bill by EUR 10.7 per year, due to the distributive effect of recovering power grid costs (Kubli 2018).

20.3 Regulatory Framework for Renewable Energy

Due to the federalist structure, Swiss energy market is regulated on the federal, cantonal, and the municipal levels. Among the main federal statutory provisions are Energy Law (*Energiegesetz*, EnG) that incorporates the Energy Strategy 2050, Federal Energy Directive (*Energieverordnung*, EnV), Federal Electricity Supply Ordinance (*Stromversorgungsverordnung*,

[2] A recent survey has indicated that 20% of Swiss respondents would 'absolutely' participate in such local electricity trading and sharing marketplace, while another 60% would 'probably consider' that option (Reuter and Loocke 2017).

StromVV), and Federal Act on the Reduction of CO_2 Emissions (*Bundesgesetz über die Reduktion der CO_2-Emissionen*, CO_2 Gesetz) (Federal Council 2008, 2011, 2016, 2017). There are several federal agencies closely involved in energy questions: Swiss Federal Office of Energy (SFOE), Federal Department of the Environment, Transport, Energy and Communications (DETEC), and Environment, Spatial Planning and Energy Committees (ESPEC). More information on agencies and other players involved in the Swiss energy market is in Sect. 20.4.2.

The cantons often adopt their own cantonal energy directives and have cantonal agencies involved in steering cantonal energy policies. Large RE projects fall under the cantonal jurisdiction, while several federal authorities (including agencies in charge of civil aviation, military, meteorology, and spatial development) also have to issue appropriate permits (for detailed description of permitting process for large RE projects, see Wüstenhagen et al. 2017). Large RE projects need to be integrated into cantonal (or regional) structure (*Richtplan*) and land use (*Nutzungsplan*) plans and to receive a building permit, which might involve a referendum.

20.3.1 Regulations for Connecting Renewable Energy Plants to the Grid

Grid operators are obliged to purchase surplus electricity from small generators with installed capacity below 3 MW or annual production below 5000 MWh (SFOE 2017d). There are no special provisions for connecting the RE capacity installed by energy cooperatives to the grid. However, the remuneration for fed-in electricity is sometimes negotiated between the grid operator and the small generator. For additional income, small producers of RE can trade certificates of origin, which indicate the place and technology of production (SFOE 2016). Note that the Swiss electricity market is only partially liberalized and not integrated with the European market (UVEK 2018). Small end consumers of energy cannot switch between monopolistic electricity providers, and only larger consumers with annual consumption over 100,000 kWh can choose their electricity supplier and can negotiate the electricity price.

An important new regulatory provision is that a load course measurement requirement has been introduced for energy-generating systems over 30 kVA that were installed before 31 December 2017 (UVEK 2017). Smart meters measure the fed-in electricity every 15 minutes and transmit these data to the measurement service provider, usually, the distribution grid operator (VESE 2018). This is another potential barrier for small RES producers, since measuring services cost between EUR 85.40 and EUR 1195.75 per year (ibid.). High costs might motivate small RES producers to opt for independent measurement services providers with more competitive rates.[3]

Long permitting and interconnection procedures are problematic for large and small installations alike. To address this bottleneck, the Energy Strategy obliged the cantonal authorities to establish more rapid permitting procedures for RE generators, while also granting them the status of 'national interest' (SFOE 2018). These measures are likely to reduce preconstruction risks of energy projects, especially in the wind sector.[4] Moreover, wind energy permitting will be coordinated by a federal one-stop shop called 'guichet unique', considerably reducing project management complexity (Wüstenhagen et al. 2017).

20.3.2 Support Policies (FITs, Auctions, Premiums, etc.)

Year 2018 brings about a number of changes to the existing federal support policies for RE. Since 2009, electricity production from renewable sources has been supported through the payment of a feed-in tariff (*Kostendeckende Einspeisevergütung*, *KEV*). Updated legal provisions

[3] It is currently an object of political debate, whether the grid operators can reject the involvement of the independent providers and, thus, to monopolize the measurement services. The new Energy Directive stipulates that 80% of measuring devices in the grid should be replaced by smart meters by the end of 2027 (SFOE 2017d).

[4] Putting energy generation on equal footing with other national interests like nature and landscape protection will provide guidance to the 'weighting of interests' procedure performed by courts, which need to decide on the ecological and societal desirability of the proposed project. This change may be especially important for wind power projects that often take more than a decade in Switzerland to be approved and built (Wüstenhagen et al. 2017).

stipulate that *new* projects may be considered for the feed-in-tariff payments until the end of 2022, while existing generators that already receive KEV will continue receiving the payments as planned (SFOE 2017d). In 2018, the average KEV payment is cut by 10–20% (except for wind and hydropower), and the duration of the KEV payments is reduced from 20 years to 15 years (except for biomass) (ibid.). Starting from January 2020, larger electric generators with an installed capacity of over 100 kW will need to start directly marketing the generated electricity (*Direktvermarktung*), allowing the producers to receive the negotiated price and a feed-in premium (*Einspeiseprämie*).

A few additional technology-specific changes have also been announced.[5] Instead of a feed-in tariff, solar photovoltaic installations between 2 kW and 50 MW can apply for an investment subsidy (*Einmalvergütung*, EIV), which reimburses up to 30 per cent of the investment costs, determined by the investment costs of a reference solar plant (ibid.). The investment subsidies will be approved until 2030 and then phased out. Solar PV projects under 100 kW will not be eligible for the feed-in-tariff KEV and will only receive the investment subsidy EIV. Given the size of most residential systems, the investment subsidy EIV will be the dominant policy support instrument for solar prosumers in the coming decade. In addition, all Swiss cantons, except Lucerne, offer deductions of investment costs from taxable income (Swissolar 2015).

20.3.3 Specific Regulations for Self-Consumption and Sale to the Grid

Current energy statutes explicitly authorize consumption of self-generated electricity entirely or partially at the place of production (EnG, Art. 16). Moreover, prosumers do not have to pay additional charges (e.g. grid charges, KEV surcharges, ecological charges) for self-consumed electric

[5] Geothermal power will be supported with either a federal guarantee (*Geothermie-Garantie*) or an exploration subsidy (*Erkungundsbeitrag*), aimed at reducing the upfront risks of site exploration (SFOE 2017d). EIV will be used to support most of small-scale installations in biomass. Bioenergy installations will only be eligible for EIV (up to 20% of reference investment cost), while the bioenergy plants of regional importance may apply for either EIV or KEV.

power (EKZ 2017). It has been estimated that self-consumption of electricity will become increasingly attractive to Swiss solar prosumers, resulting in up to 333 MW of cumulative solar PV capacity by 2050 (Kubli 2018).

Another important legislative provision is the possibility to form self-consumption communities (*Eigenverbrauchsgemeinschaften*) on adjacent plots of land, given that the community's electricity-generating capacity amounts to at least 10 per cent of the connected load (EnV, Art. 15). The law stipulates that the grid operator shall regard such a community as a single consumer. Thus, large self-consumption communities with electricity consumption of more than 100,000 kWh a year could enter the liberalized market for large consumers. This provision opens new opportunities to community ownership projects, when neighbouring landowners or tenants at multi-family homes pool their demand for electricity and take advantage of self-consumption models or even electricity trading.

20.4 Concepts for Consumer (Co-)Ownership in Practice

20.4.1 Contractual Arrangements and Corporate Vehicles Used

The most basic form of consumer ownership is direct ownership of a generating facility. Despite it being the most widespread form of RE ownership, it has the disadvantage of making (co-)ownership dependent on the available infrastructure, for example, the availability of an appropriate rooftop for a solar PV installation, which excludes a large portion of the population like tenants from RE (co-)ownership. An alternative concept for (co-)ownership is 'solar leasing' paired with self-consumption and potentially energy storage. In this constellation, the interested citizen allows a solar installer to use their rooftop to produce electricity, which is subsequently self-consumed at the site based on a power purchase agreement. The installer takes care of the permitting and the technical side of the installation, including maintenance, making it easier for the rooftop owner to engage in the project (Ammann 2016). Interestingly, the leasing concepts give rise to new joint models, such as the case of an energy start-up Younergy (http://www.younergy.ch), which partners with both the rooftop owners but also institutional investors whose funds are used to finance the solar installations (Ammann 2016).

Cooperatives are an established vehicle for consumer (co-)ownership both at the national and regional levels.[6] A cooperative is an organization with 'the primary purpose of promoting or safeguarding the specific economic interests of the society's members by way of collective self-help' (Federal Council 1911, Code of Obligations, Art. 828). It is open to private individuals as well as to corporate and state actors (ibid., Art. 828, 926), with each member receiving exactly one vote based on the equity principle (ibid., Art. 855). Cooperatives have to be entered in the commercial register, but the cooperatives do not have an audit obligation (Purtschert 2005). Since 1990, more than a hundred new RE cooperatives have been founded, which are mainly active in the production of electricity from solar photovoltaics and heat from woodchips (Rivas et al. 2018).[7] In 2016, around 30 per cent of the energy cooperatives active in electricity generation were applying self-consumption schemes (ibid.).

Swiss energy cooperatives often remain local with respect to their membership and location for installations (ibid.). Only around 10 per cent of the cooperatives own energy-generating capacity outside of their or neighbouring municipality, and only 3 per cent expand to another canton (ibid.). This might be a wise strategy, given that energy cooperatives consisting of citizens from the neighbourhood are considered as the most trustworthy actors to initiate and govern local electricity markets (Reuter and Loocke 2017). However, at least three cooperatives have a national or multi-regional reach: ADEV, Energiegenossenschaft Schweiz,

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[6] Cooperatives have a long-standing tradition in Switzerland in a variety of economic sectors such as food retail, banking, insurances, dairy, and water supply (Purtschert 2005). Neither are cooperatives new to the energy sector. Already at the beginning of the twentieth century, several hundred of cooperatives emerged (mainly in rural areas) to build and manage the local distribution grids (Gugerli 1996). From estimated 1500 original energy cooperatives (Klemisch and Vogt 2012), roughly 150 are still active today with a few also engaging in the production of electricity from renewable sources (Schmid and Seidl 2018).

[7] Typically, these new cooperatives invest in a photovoltaics installation on a large rooftop of a school or a municipal building (ibid.). The produced electricity and the certificates of origin can be subsequently sold to the grid operator, to the cooperative members for self-consumption, or to other individual actors.

Optima Solar (Rivas et al. 2018; Swissolar 2017). Similar to a cooperative, the establishment of a non-profit association is relatively simple, but unlike public ownership of a municipal plant, membership in an association requires active participation.[8] There were at least 25 solar cooperatives and associations currently active on the regional level (Swissolar 2017).

In recent years, consumer (co-)ownership provided new opportunities for joint projects of different partners. For example, an installer, often a non-profit start-up, develops a RE project and partners with the utility to sell the project's shares to the utility's clients. The utility, in turn, delivers the produced 'green' electricity to their clients through their grid and manages the billing. In this setup, the consumer does not have to be a (co-)owner, which might prove attractive to a wider segment of population, especially tenants. New schemes can also involve a public entity (e.g. a cantonal or federal agency in charge of promotion of RES) and a non-energy company that promotes RES as part of their new business strategy (e.g. IKEA's solar business) or corporate social responsibility (e.g. COOP). There are emerging institutional investors and funds (like SUSI Partners) entering the RES business.

20.4.2 Financing Conditions for Consumer (Co-) Ownership in Renewable Energy

Swiss community finance projects obtain the same type of support from the agencies and associations as RES projects with a different ownership model. On the federal level, the most relevant agencies for RES are the Swiss Federal Office of Energy that oversees the energy transition in general, including the implementation of the SwissEnergy (EnergieSchweiz) programme (SFOE 2015); Pronovo AG (as subsidiary company of the

[8] Under Swiss law associations do not require certification or registration in the trade registry if the association does not conduct commercial operations nor is subject to an audit requirement. The audit is required when two of the following conditions are met in two consecutive years: total assets above EUR 8.5 million, turnover over EUR 17 million, and over 50 full-time jobs (Federal Council 1907, Swiss Civil Code (ZGB), Art. 61 and 65). This simplicity and flexibility make associations an attractive legal model for consumers interested in RES (co-)ownership; at the same time, the limited liability of their members, paired with low audit requirements, may restrict access to credit, making them reliant on equity capital.

national transmission grid operator Swissgrid) that manages the feed-in-tariff (KEV) system, as well as the platform tracking the trade with the certificates of origin; the Swiss Federal Electricity Commission (ElCom) that acts as an independent regulatory authority in the Swiss electricity sector settling disputes regarding payments of the feed-in tariff; and the Federal Department of the Environment, Transport, Energy and Communications (UVEK) that oversees the grid surcharge fund.

In addition, there is a multitude of federal civil-society associations promoting and supporting RES. *AEE Suisse* (https://www.aeesuisse.ch) and the *Swiss Energy Foundation* (SES, https://www.energiestiftung.ch) are umbrella organizations representing interests of thousands of companies and energy producers all over Switzerland. The association of independent power producers (VESE, www.vese.ch) advises and represents RES producers that do not own their own distribution grid. Other associations have a technology-specific focus: *Suisse Eole* (http://www.suisse-eole.ch) represents wind power industry, while *Swissolar* (http://www.swissolar.ch) works to promote solar interests, *Holzenergie Schweiz* represents wood, and *Verband Fernwärme Schweiz* (https://www.fern-waerme-schweiz.ch) represents district heating producers, while *Ökostrom Schweiz* (https://oekostromschweiz.ch) works with agricultural biogas plant operators. Many other associations operate on the regional, cantonal, or local level, and they are too numerous to list. For example, the regional Albert-Köchlin-Foundation (http://aks-stiftung.ch/stiftung) promotes the establishment of new energy cooperatives in central Switzerland. Solarplattform Seeland (http://www.solarplattformseeland.ch) supports regional, sustainable energy production with solar PV in the Northwest of Switzerland. A number of cantons have a specialized energy agency like Energieagentur (http://www.energieagentur-sg.ch) in the canton of St Gallen, which assists citizens and project developers alike with their energy questions.

Public-private partnerships (PPP) can help promote RES projects, even involving the players outside of energy industry. For example, EnergieSchweiz collaborated with COOP (a large Swiss retailer, itself a cooperative) and Swiss dairy farmers (Märki and Angele 2012). While EnergieSchweiz provided important informational and technical guidance to the involved farmers, the financial support for the project came from the sustainability fund of COOP. The supported bioenergy projects received a grant of up to EUR 171,000 for reimbursement of investment costs and an optional zero-interest rate loan. This financial support allowed the projects to successfully obtain further necessary financing from the banks, which is often not an easy task given the large upfront investment (ranging between EUR 1 and 2 million).

20.4.3 Examples of Consumer (Co-)Ownership

Consumer (co-)ownership is still an emerging form of ownership model of renewable energy generation in Switzerland, yet some interesting examples can be found.

I. Elektrizitätswerke Zürich (EWZ), a utility of the city of Zürich, has offered its customers the possibility to purchase shares of locally installed solar plants since 2014 (EWZ 2017). After buying a certain number of 'square metres' of a chosen solar plant, the EWZ customers annually receive 80 kWh of solar electricity per purchased square metre, for the duration of 20 years. If the consumer wants to cancel their contract due to a move or some other circumstances, these shares can be sold back to EWZ. The model's success is evident from the fact that the EWZ sold out within a matter of days six large solar plants (between 1000 and 2500 m^2) (EWZ 2017). As of 2018, there were several more examples of municipal solar schemes in Switzerland, for example, Miinstrom (http://www.miinstrom.ch) and Waldsolar (http://waldsolar.ch/solar-beteiligung/).

II. Another example of a partnership that promotes citizen (co-)ownership of renewable energies is the collaboration between **Sunraising Bern** (https://sunraising.ch), a non-profit start-up founded in 2015, and electric utility **Energiewerke Bern** (EWB) (SunRaising 2017). As its name suggests, *Sunraising* stands for a combination of sun power and fundraising, offering the residents of Bern the possibility to buy a share representing a certain number of square metres of a locally installed solar plant. As compensation, the customers of *Sunraising* receive a respective share of electricity from solar power for free for 20 years, which roughly corresponds to the life cycle of a solar plant. In this setup, *Sunraising* is in charge of installing the solar panels and their maintenance, as well as selling the shares of the solar plant. The produced solar power is fed into the electric grid managed by the EWB, which delivers the electricity to the *Sunraising* customers. Since 2016 more than 250 consumers invested CHF 385,000 (EUR 338,000) in eight rooftop PV installations with a capacity of about 100kWp.

III. Energiegenossenschaft Schweiz (EGch) was founded in 2012 with the aim of setting up the largest decentralized solar power plant in Switzerland by creating 'electricity commons' (*Stromallmende*) that consist of small energy producers and consumers (Energiegenossenschaft Schweiz 2018). In the starting year 2012 around CHF 350,000 (EUR 310,000) were invested. The annual general assembly of EGch acts as an exchange platform for certificates of origin, where electricity consumers and producers negotiate a price for purchase and sales. In 2017, the certificates cost EUR 0.06/kWh for the consumer, of which EUR 0.043/kWh were received by the producer and EUR 0.071/kWh by EGch to cover its administrative costs (ibid.).

IV. Energiegenossenschaft Buttisholz (www.energie-buttisholz.ch) founded in 2013 has a local reach operating under the slogan 'locally produced—locally consumed'. The aim is to provide opportunities for the inhabitants of Buttisholz to collectively shape their energy future. In cooperation with the municipality, the cooperative finances and runs solar PV installations on the rooftop of the local school (Energie Genossenschaft Buttisholz 2018). The cooperative is firmly embedded in the local community by organizing informational events at schools and at industrial exhibitions, as well as forming partnerships with local businesses (ibid., personal correspondence). Most Swiss energy cooperatives resemble the local *Energiegenossenschaft Buttisholz* (Rivas et al. 2018).

V. Founded in 1991 in the canton of Appenzell with the slogan 'action instead of words', the association **Appenzeller Energie** (www.appenzeller-energie.ch) was a reaction by a bi-partisan group of politicians to the nuclear accidents in the Three Mile Island and Chernobyl. In 2017, the association had about 200 members, with the aim to promote the purchase, distribution, and use of RE. *Appenzeller Energie* has been involved in the construction of RE-generating facilities, including two solar photovoltaic installations, three small hydroelectric power stations, one wind turbine, and one solar thermal system, cumulatively generating between 400 and 500 MWh of electricity annually (Appenzeller Energie 2017). The generated electricity is sold to the grid operator as 'grey' electricity, while the consumers in the region can purchase the certificates of origin for EUR 0.136/kWh (ibid.). Membership in the association is not required for the purchase of the certificates, neither is the certificate purchase necessary for the membership (ibid.). *Appenzeller Energie* has a strong regional focus offering workshops for self-building of solar thermal system and cooperating with students in energy-related school projects (ibid.).

20.5 Factors Affecting the Financing of Renewable Energy Sources and Barriers to Consumer (Co-) Ownership

20.5.1 Political, Legal, and Administrative Factors

Consumer (co-)ownership of RES might be harmed by the absence of electricity market liberalization in the small-consumer segment. Since utilities have a stable customer base, an interactive relationship between customers and municipalities is rare (Schicht et al. 2012). Moreover, the incumbent utilities have significant market power when negotiating with new market entrants, be it an interconnection issue or a power purchase agreement (Girod et al. 2014). New market entrants, who offer consumer (co-)ownership of RES, must collaborate with the local utilities to dispatch the produced electricity to private consumers via the local power grid. It is likely that with market liberalization and increased consumer (co-)ownership of RES, the utilities will change from product-oriented towards more service-oriented organizations, paying more attention to customer satisfaction and retention rates (Schicht et al. 2012).

Despite having been introduced to help RES projects, the feed-in-tariff system created obstacles to the development of community RES projects.[9] The KEV feed-in-tariff system suffers from underfinancing, which leads to a very long waiting list of energy projects waiting to be considered for the payments. It is estimated that only a third of currently producing solar projects receive the feed-in tariff (VESE 2016). Even though most wind projects receive the feed-in tariff, the exact remuneration rates are not determined until the project is operational, which again creates considerable uncertainties for project developers with respect to their cash flows and hinders project finance (Wüstenhagen et al. 2017). Wind projects also face considerable risks in the pre-construction stage, which make wind project development prohibitively long and expensive for smaller players (ibid.). Finally, the new Energy Law (EnG) stipulates altered support schemes for RE projects (notably, phase-out of KEV). Some of these projects, which are suitable for citizen participation, will never materialize without the feed-in tariffs.

20.5.2 Economic and Management Factors

In case of small non-profit organizations, a major barrier is their limited administrative capacity. For example, only about 25 per cent of cooperatives have paid positions, while the majority of cooperatives rely solely on voluntary work (Rivas et al. 2018).[10] This makes it difficult for many cooperatives to handle complex and costly regulatory procedures or to set up effective marketing campaigns. Being civic organization with participatory decision-making and flat hierarchical structures, cooperatives might struggle to find their identity as a professional organization with growth aspirations.

[9] It should be noted that Swiss feed-in-tariff levels are rather generous in international comparison (RES Legal EU 2018). This might be a necessity given the differences in price levels and smaller size of the Swiss electricity market compared to other countries.

[10] Despite the high approval of energy cooperatives, the recent survey has shown that the Swiss respondents are generally not willing to volunteer their time for cooperatives (Reuter and Loocke 2017).

Furthermore, there is a remarkable heterogeneity among the potential investors.[11] The community finance sector might benefit from addressing the issues that are most important for their target investor group. One of the major reasons for the Swiss population to forego investment into community RE projects is limited information about community finance (Ebers and Hampl 2016; Gamma et al. 2017). To realize the considerable market potential for community finance in Switzerland, these barriers need to be addressed through consumer education and spread of information about risk-return profile of community energy projects, while adapting the projects to the heterogeneous tastes of different investor segments (Ebers and Hampl forthcoming).

20.5.3 Cultural Factors

Over the recent years, the surveys observe a high and consistently growing preference for renewable and locally produced energy sources among the Swiss citizens (Ebers and Wüstenhagen 2016; Gamma et al. 2017; Reuter and Loocke 2017). Indeed, contribution to environmental protection and energy transition (65%) was cited as the main motivation to invest into community finance, followed by increased independence from electricity imports (54%) and a contribution to the local community (26%) (Gamma et al. 2017). RES community projects might also become increasingly attractive due to their positive, although conservative, return potential.[12] Even though financial motivations lag behind other considerations, about a fifth (21%) of the Swiss consumers regard financial returns as one of the two main reasons for investing in renewable energy projects (ibid.).

[11] The largest group of potential investors into community RES projects can be described as 'urban wind energy enthusiasts' (55.8% of all investors), who are predominantly renters (56.4%) with college education (46.4%) (Ebers and Hampl 2017). Yet, there was a significant segment of investors, who lived in the rural areas (28.9%) or were not welcoming to wind power near their residence (22.0%) (ibid.).

[12] For example, solar cooperative ADEV has offered the annual returns of 2%–2.5% to its members in the last decade, while the savings accounts in the major Swiss banks have lower or even negative interest rates (ADEV 2017; Ebers and Hampl 2016).

Generally, consumer surveys identify a considerable market potential for community projects in Switzerland: about 60% of respondents said that they would be interested (or may be interested) in investing into a community-owned RES (Ebers and Wüstenhagen 2015; Gamma et al. 2017). On average, potential investors tended to have higher level of education, be more optimistic about renewable energy achieving the grid parity, believe into the future without fossil fuels, and be more welcoming to wind energy projects in their communities (Ebers and Hampl forthcoming). About 1.9% of the German- and French-speaking population in Switzerland have already invested into community finance (compare to 7% in Austria) (Ebers and Hampl forthcoming; Gamma et al. 2017).

20.6 Possible Future Developments and Trends for Consumer (Co-) Ownership

Energy issues have been the centre of the public discourse in the last few years in Switzerland, resulting in several energy referenda and the adoption of the Energy Strategy 2050. However, Swiss energy policy is likely to remain in flux in the coming years. One of the major changes will be the replacement of the current feed-in-tariff system with a steering policy, which could include an energy steering charge (*Lenkungsabgabe*). The Department of Finance is also considering an ecological tax reform. It is yet to be seen whether these policy proposals would have a positive or negative impact on community finance. Similarly, it is unclear whether liberalization of the electricity market, as currently discussed in the Swiss parliament, would address the current challenges faced by the community RE projects.

Market liberalization might have both positive and negative effects on consumer (co-)ownership of RE. A liberalized market is likely to boost the number of consumer (co-)ownership offers by utilities, who would be seeking to respond to customer preferences for local projects. Another advantage of a liberalized market is a higher bargaining power of the small-scale generators with respect to the electricity prices and certificates of origin, as they might be able to market those directly to the end consumer. On the other hand, market liberalization is likely to create even more economic pressure on the incumbent utilities. In turn, small energy producers (especially energy cooperatives) will be put under pressure to innovate their business models and to professionalize their operations. It should be remembered that consumer (co-)ownership models thrive with local embeddedness and a democratic and equitable decision-making (Tabi and Wüstenhagen 2017), which might run contrary to the efforts of professionalization and streamlining.

Perhaps unlikely, a liberalized market might lead to a price battle between incumbent utilities and new market entrants, who will become direct competitors rather than partners. Even if the prices for electricity drop considerably, it might not motivate the consumers enough to switch the providers, as nearly a half (44 per cent) of Swiss electricity customers were not aware of the size of their electricity bill (Gamma et al. 2017). In sum, a fully liberalized electricity market will create a number of opportunities and threats for community finance projects, while specific regulatory provisions will determine the final outcome.

There are several approaches to further scale up and diffuse consumer investments in RES in Switzerland, which rely on intensified cooperation between all involved stakeholders. Intensified collaboration could take place among small-scale RES project developers themselves, safeguarding their common interests in the political arena. The second type of collaboration could be between community finance project developers and the grid operators to agree on the fair pricing for the fed-in electricity. Currently, the remuneration for solar electricity varies massively among geographic regions and grid operators (there are 650 of them in Switzerland), ranging from less than EUR 0.034/kWh to more than EUR 0.17/kWh (VESE 2017). To reach such an agreement, small-scale producers may want to secure the support from local municipalities that often own the grid operators. Municipalities might also have the necessary resources with respect to marketing, know-how, and access to potential clients, which could be helpful for promotion of RES projects organized by the smaller non-profit entities.

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North America

21

Consumer (Co-)Ownership in Renewables in California (USA)

Felicia van Tulder, Sharon Klein, and Erika Morgan

21.1 Introduction

21.1.1 Energy Mix

In 2016, California's power mix was led by natural gas which accounted for about 54 per cent of a total of 79 GW installed capacity (CEC 2016). In that same year, California's gross consumption of electricity amounted to about 290,000 GWh, with 36 per cent derived from natural gas, 25 per cent

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from renewable energy sources (RES) other than large hydro, 14 per cent from petroleum and waste heat, 10 per cent from large hydro, and 9 per cent from nuclear (ibid.; EIA 2017a). While California's energy market is still dominated by fossil fuel power (natural gas and petroleum), RES play an increasingly significant role (EIA 2017b). Since 2010, about 80 per cent of new installed capacity has come from RES (Bushnell 2017). For heating, natural gas is the main source, with electricity second. Interestingly, on average, Californians use less electricity for heating and air conditioning compared to other US areas due to both the mild climate (EIA 2017a) and its history of aggressive energy efficiency programmes.

In 2017, roughly 30 per cent of California's retail electricity sales came from in and out-of-state RE facilities (CEC 2017a).[1] In that same year, out of approximately 80 GW of installed electric capacity (CEC 2017b), RE production capacity amounted to 27.8 GW. California's main RES by installed capacity in October 2017 was by far solar photo voltaic (PV) with 16.2 GW, followed by wind with 5.6 GW, geothermal with 2.7 GW, small hydro with 1.8 GW, and biomass with 1.3 GW (CEC 2017a). Customer-sited solar generation amounted to 4.2 per cent and utility scale solar generation[2] to 9.6 per cent of the state's power generation in 2016 (EIA 2017a).

21.1.2 Main Challenges of the Energy Market, National Targets and Specific Policy Goals

Among the concerns of the California government are reducing the use of fossil energy, high and increasing electricity and transmission prices, siting and control. Main challenges remain the closure of the last nuclear power facilities by 2025 (Cama 2018), pressure to reduce the use of natural gas and legislative proposals to transition to 100 per cent renewable electricity by 2050. At the same time, regulators are tackling extreme weather through increased emphasis on local resilience and decentralised energy infrastructure while confronting issues arising from a transitioning

[1] The state leads the country in terms of generation from solar, geothermal and biomass sources, and ranks fourth nationally in terms of installed wind capacity (EIA 2017a).

[2] Plants with an installed capacity over 1 MW and a Power Purchase Agreement with a utility (EIA 2017b).

electricity market in particular integrating energy storage to address high solar penetration which creates challenges in meeting consumer demand at peak hours.[3] Steps taken to balance the demand-supply gap include: The Western Energy Imbalance Market (EIM) in 2014; energy storage mandates on all load-serving entities; a shift of peak pricing to evening hours and mandatory Time of Use rates on all customer classes.

California is a frontrunner both in the US and globally in terms of climate and sustainable energy policy. California's Renewable Portfolio Standard (RPS), established in 2002, is among the most ambitious in the US with now a mandate for load-serving entities to procure 33 per cent of the supply by the end of 2020.[4] In 2015, Senate Bill 350, also called the Clean Energy and Pollution Act, set out a more ambitious effort to transform the energy system by expanding California's RPS to 50 per cent by 2030 (CEC 2015).[5] Historic and present emphasis on energy efficiency policy has resulted in California's Title 24 Building Code with aggressive mandates for Zero Net Energy construction targets by 2020 for new construction in both residential and commercial and industrial sectors, and in existing buildings by 2030. Combined with Proposition 39's California Clean Energy Jobs Act funds for public sector efficiency and renewables, under these two mandates few new schools or public sector buildings are built now other than on Zero Net Energy basis.

[3] The so-called "Duck Curve" phenomenon—creating a sitting duck image in the graphic representation of California's net electricity load—implies an over-generation risk in the afternoon when the solar contribution is highest and a dip thereafter, requiring the need for a fast ramp up of conventional energy to satisfy peak demand (EIA 2014).

[4] In the US, no RE targets are set at the national level; states at their own initiative have adopted RPS as a policy instrument to obligate their electricity supply companies to derive defined amounts of electricity from RES.

[5] Since the 1980s California's electricity consumption pattern has flattened opposite to the national trend: in 2005 the average Californian consumer used 75 per cent of the energy the average American consumer uses: 7000 kWh per capita compared to 12,000 kWh. This development relates to a decoupling policy introduced in 1982 when utilities' revenue was detached from sales volume to incentivise the promotion of energy conservation amongst their consumers. Utilities collect revenue according a pre-determined revenue requirement set by the California Public Utilities Commission (Food Service Technology Center 2013).

21.1.3 Ownership Structure in the Renewable Energy Sector

The ownership structure of the California electricity market is dominated by investor-owned utilities (IOU). California's three main IOUs are Pacific Gas and Electric in the north and Southern California Edison and San Diego Gas & Electric in the south. Together, these three companies supply approximately 75 per cent of California's electricity and maintain transmission and distribution networks making them Participating Transmission Owners, while more than 40 smaller publicly owned utilities (POUs) supply the other 25 per cent at a local level. POUs are run by municipal districts, city governments, irrigation districts, and rural cooperatives and can range from 3.9 million customers in Los Angeles as the largest to less than 400 customers in the smallest, with one-third of POUs accounting for over 90 per cent of POU electricity sales. The five rural electric cooperatives serve approximately 32,000 member-customers (CEC n.d.-a).[6] The IOU and POU renewable electricity supply is mostly guaranteed by Power Purchase Agreements (PPAs) with large-scale renewable projects operated by commercial developers and customer-sited rooftop solar PV.

California's Community Choice Aggregation (CCA) model adopted in 2002 empowered municipalities and other units of government, that is, associations of cities, counties and other public entities, to take control of the procurement of electricity supply in their territory.[7] While the incumbent IOUs continue to deliver customer supply, provide billing and all distribution services, CCAs procure electricity supply for their customers through contracts with alternative, RE generation facilities. California's CCAs offer their customers a minimum of two electricity

[6] The federal government enacted the Rural Electrification Act in 1936 to extend electricity distribution to isolated communities. Cooperatives, owned by members of a community, were set up to purchase power in bulk and distribute electricity through their own transmission network.

[7] This alternative supply model for the electricity market was developed in several US states in the 1990s. A jurisdiction can found a CCA after plans are approved by vote of the local governing body, which also appoints a board to manage the programme. In California residents of jurisdictions starting a CCA are automatically enrolled through an opt-out scheme (See California Assembly Bill 117 of 2002).

products—a default product similar in price to the IOU's standard product, yet with a higher percentage of renewables and one or more additional products, with higher and often 100 per cent renewable kWh, in some cases sourced from their own communities. CCA programmes are rapidly growing across California, from the first "Marin Clean Energy" in 2010, to eleven operating programmes in early 2018; nineteen additional CCAs are planned to launch before 2020 (Lean Energy U.S. 2017).[8] Various estimates place at 50–60 per cent the volume of California's eligible customer load that will be served by CCAs by 2020 leaving the IOUs with less than half of their traditional customer load (CPUC 2017a).

In the absence of a centralised location for reporting RE (co-)ownership in the US, the US Community Energy Website (USCEW) tracks RE projects with a "community" element.

- USCEW lists 1097 such projects in California with a combined reported capacity of 388 MW (USCEW n.d.). Of this total, 99 per cent or 1088, are solar projects and 974 are K-12 schools[9] with solar installations. The remaining 114 projects include: 54 projects at colleges and universities, 20 projects of non-profit organisations; 11 bulk purchase campaigns; 10 municipal solar projects; 9 CCA projects; 3 new utility-sponsored community solar farm programs; 2 multi-family residence projects; and 2 Green Planned Housing Developments. Projects on colleges, universities, non-profit organisations, and K-12 schools are not typically (co-)owned, even though they may have community benefits.
- In terms of household energy generation in California, rooftop solar eclipses all other RES. Between 2007 and 2017, a total of 550,000

[8] Pursuant to CPUC Resolution E-4907, approved February 8, 2018 an additional 10 programmes will launch or expand in 2018, adding 3600 MW of new CCA load; a further five programme launches and/or expansions totally 1700 MW have been delayed until January 2019, under the Commission's modified timeline for CCA launch.

[9] Mainly due to the accessibility of solar school data compared to other community-based energy types. It should be noted though that the data in the USCEW were largely collected in 2014–2016 and are based on what was publicly available about these projects at the time.

utility net energy metering (NEM) customers using solar PV were counted (CPUC 2017a). As of November 2017, there was 5900 MW behind-the-meter solar PV installed (CEC 2017a).[10] Statistics for the years 2010–2016 show over two-thirds of residential solar PV were enabled by third-party arrangements, that is leasing and power purchase agreements between solar installation companies and customers (Energy Solutions n.d.-a).[11] However, as economies of scale have brought down the cost of PV panels, since 2015 direct ownership of installations has been on the rise again (Evans et al. 2016). By the end of 2016, over 50 per cent of residential installations were purchased directly by the host parties, without a third-party arrangement (Energy Solutions n.d.-b).

21.2 The Consumer at the Heart of the Energy Market?

21.2.1 Consumer (Co-)Ownership in Renewable Energy Sources as Policy Goal

Although there is no common definition of consumer (co-)ownership in the US, the US Department of Energy's (DOE) National Renewable Energy Laboratory's (NREL) definition of "offsite shared solar" is probably the most commonly used definition in 2018: "individuals, businesses, or other entities subscribe to a portion of generation from a solar project that is not located on their home or property" (Cook and Shah 2018). Klein and Coffey's definition of "community energy" in contrast is wider and more focused on common, local interest (Klein and Coffey 2016).

[10] The CEC defines behind-the-metre as smaller systems sited at residential or commercial customers with NEM connections (CEC 2017a).

[11] Usually a third party instals and maintains the solar system on the building after signing a 10 to 30 year contract outlining fixed payments with the building owner and is entitled to any rebates as it remains the owner of the system (see Maehlum n.d.).

There were and are only a few support policies focusing directly on consumer (co-)ownership. California Senate Bill 1 of 2006 set a renewable distributed generation target of 12 GW installed capacity by 2020, which included 3 GW for self-generation. The self-generation goal specifies 2000 MW for existing commercial property and households through the investor-owned utilities (IOUs), 700 MW for the publicly owned utilities and 360 MW for newly constructed homes also through the IOUs. These allocations to the IOUs were targets to be realised in each IOU's geography through the California Solar Initiative. By 2016, however, each IOU had reached its target and the implementation program ended (CEC 2017b). Furthermore, to incentivise prosumership and thus also consumer (co-)ownership in the US, states also need to adopt aggregate and virtual net metering policies also known as "community" net metering. California is one of 17 states with these policies, which allow individual residential or commercial customers to buy energy generation together as a group, a key component to permitting community solar farms, for example. However, California's enabling statute, Senate Bill 594, restricts this type of net metering to adjacent or contiguous properties, unlike other states that allow aggregation within a utility territory (National Conference of State Legislatures 2017).

Senate Bill 43 of 2015, enactment of the Green Tariff Shared Renewables Program (GT/SRP) supports a utility-sponsored community solar initiative. This programme allows the three main IOUs to offer their customers unable or unwilling to instal solar PV panels themselves to meet up to 100 per cent of their electricity demand from solar generation.[12] However, unlike in CCAs there is no opportunity for consumer ownership, no sharing of tax credits, no consumer involvement in pricing, governance or project-related decisions (California Legislative Information 2013; Trabish 2017).

[12] The IOUs started the implementation of the programme between 2016 and 2017, it runs until 2019, and has a statutory cap of 600 MW (CPUC n.d.-a).

21.2.2 Fuel/Energy Poverty and Vulnerable Consumers

Although Californians spend a relatively low part of their income on energy compared to the rest of the country (Evergreen Economics 2016), a 2016 survey found that a third of California's low-income households had at some point experienced difficulties paying their energy bills, suggesting that over a million Californian residents suffer from energy poverty (Bryce 2015). This situation may reflect electricity rates 40 per cent higher than the 2013 US national average on the one hand (ibid.; Elias 2015), and California having the nation's highest poverty rate on the other (McMaken 2018; Jackson 2018).[13] The state government has implemented several programmes (CPUC n.d.-a) to assist the economically disadvantaged with their energy expenses: (1) the California Alternate Rates for Energy (CARE) and (2) the Family Electric Rate Assistance Program (FERA) programmes provide a discount on vulnerable households' energy bills; while (3) the Energy Savings Assistance (ESA) is aimed at implementing energy efficiency measures and energy education for low-income households.[14] In 2016, 4.3 million consumers had been served through the CARE programme with an estimated of 5.4 million households eligible for CARE out of a total population of 38 million (Evergreen Economics 2016; CPUC 2017b).

21.3 Regulatory Framework for Renewable Energy

The two main state-level governing institutions for energy matters are the California Energy Commission (CEC) and the California Public Utilities Commission (CPUC). The CEC is the primary energy policy planning

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[13] According to the Supplemental Poverty Measure, an alternative measure to the official poverty rate, which includes not only household incomes but also other items such as geographical cost of living and housing costs, taxes and the value of government assistance programmes.

[14] The primary programme in the US that addresses fuel poverty is the Low Income Home Energy Assistance Program (LIHEAP), through the US Department of Human Services Office of Community Services, with a total annual budget of USD 3.39 billion in 2016 distributed amongst the states according to a formula that accounts for the region's weather, fuel prices, and low income population (HHS n.d.).

institution, while the CPUC regulates retail rates and distribution services. CPUC's regulatory authority includes rates—except for CCAs; integrated resource planning across all load-serving entities; resource adequacy and consumer protection including disclosures. The main statutory provisions regulating the RE sector are Senate Bill 350 of 2015 (CEC 2015), codifying climate and sustainable energy goals and the supporting Assembly Bill 802 codifying building energy benchmarking (CEC n.d.-b). These bills grant the CPUC and CEC executive powers to implement these goals. At the federal level, the Federal Energy Regulatory Commission (FERC) has jurisdiction over all hydropower generation, as well as interstate transmission of electricity and natural gas (FERC n.d.).

21.3.1 Regulations for Connecting Renewable Energy Plants to the Grid

The CEC first adopted Rule 21 in 1982. Revised up until 2016, it regulates interconnection of NEM facilities and non-exporting facilities, the generation from which is not intended for the wholesale market. Each IOU implements its own version of Rule 21 in its territory (CPUC n.d.-c). Customers pay a one-time interconnection fee for NEM.[15] Senate Bill 395 of 2009 established the Direct Access Program, which allows a limited MW of California's largest industrial, municipal, and other non-residential customers to access wholesale markets and procure from electric service providers without utility intervention (CPUC n.d.-e).

21.3.2 Support Policies (FITs, Auctions, Premiums etc.)

In 2016, with 268 programs, California was the state with the most incentive programmes to support renewables and energy efficiency (NC Clean Energy Technology Center n.d.). The Renewable Market Adjusting Tariff (ReMAT) of 2008 is a feed-in tariff programme for renewable

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[15] The interconnection fee for systems with a nameplate capacity up to 1MW varies per IOU and goes up to USD 145; systems over 1MW are charged USD 800 (See http://www.cpuc.ca.gov/General.aspx?id=3800).

generators with less than 3 MW installed capacity. The CPUC set a state-wide goal of 750 MW installed capacity to benefit from the programme, of which 500 MW was assigned to the three main IOUs. Every two months the respective IOU sets out fixed prices for a desired capacity in every product type. The first applicant with the ability to develop a profitable project within this framework is awarded the contract. However, in practice ReMAT has been criticised as overly complicated, which explains the low take-up of the programme (Warren 2017). FiTs and auctions for smaller, consumer-owned RES also exist via CCAs discussed above in Sect. 21.1.3.[16] CCAs can also incentivise consumer-owned RES with enhanced NEM and/or FITs and have the potential to offer additional financing options, such as wholesale bilateral contracts, third-party financing, PPAs, and Property Assessed Clean Energy (PACE) loans.

In 2011, the CPUC authorised the use of tradable Renewable Energy Credits (RECs) for RPS compliance, with the percentage of a utility's RPS requirement that can come from tradable RECs initially capped at 25 per cent, decreasing to 10 per cent, and price caps on a single REC initially set at USD 50. Every REC represents 1 MWh of electricity generated from RES (NC Clean Energy Technology Center n.d.).

21.3.3 Specific Regulations for Self-Consumption and Sale to the Grid

In California, generators utilising solar, wind, biogas, and fuel cells with a nominal capacity of up to one MW are deemed eligible for NEM. NEM customers receive financial compensation in the form of a credit on their utility bill. In 2016, CPUC revised the "NEM 1.0" rates,[17] requiring implementation of the less advantageous "NEM 2.0". Under "NEM 2.0"

[16] See https://www.mcecleanenergy.org/faq-items/how-does-mce-procure-power/.

[17] The NEM credit was initially calculated based on bundled retail rates, which makes it more attractive than compensation based merely on the utility's avoided cost or wholesale energy prices. Crediting based on bundled rates means prosumers are compensated up to four times the market price of energy based on the portions of transmission, distribution and other "non-bypassable charges" also included on the bill (McCrary 2015).

customers are required to pay "non-bypassable charges" which can no longer be netted against excess production. New NEM installations are moved to Time of Use rates immediately; these are mandated for all other customers by 2019 (McRary 2015). Since 2009, California's regulators have also allowed Net Energy Metering Aggregation (NEM-A) where generated electricity from one source is used to offset multiple metres, especially relevant for agricultural customers and Virtual Net Metering. The latter allows residents of multitenant properties to benefit from an on-site RES installation, by receiving individual bill credits from a percentage of the generated electricity as well as a single Distributed Energy Resource (DER) system to serve multiple accounts (CalCom Solar n.d.).[18]

The Self-Generation Incentive Plan (SGIP) provides rebates for grid-connected projects through the four main utilities for electricity and gas, PG&E, SDGE, SCE and CalGas. SGIP incentivises customer-sited energy generation, both through renewable, emerging, and waste energy recovery technologies, including wind turbines up to 5 MW, Advanced Energy Storage, waste heat to power, biogas, pressure reduction turbines and fuel cells and non-renewable technologies like gas turbines.[19] SGIP was overhauled in 2009 to include performance payments over five years in combination with rebates for customers to install energy storage in their buildings. The programme was updated in 2016–2017 and now focuses 85 per cent on energy storage (Maloney 2017).

21.4 Concepts for Consumer (Co-)Ownership in Practice

Participation in RE projects is possible via any available type of corporation, partnership or individual business activity, similar to those in other countries. Cooperatives as a legal vehicle are available but not common.

[18] See http://calcomsolar.com/aggregated-net-metering/what-is-aggregated-net-metering.

[19] SGIP was started originally to reduce customer electricity demand by incentivising distributed energy after California's electricity crisis of 2001. Only in 2007, the programme started to focus more on reducing GHG emissions and energy demand at host sites through renewable technologies.

Municipalities can invest in RE infrastructure directly themselves, through CCAs or can enter public-private partnerships to increase tax revenues and ensure growth of the local economy.

21.4.1 Contractual Arrangements and Corporate Vehicles Used

Investments in solar collectors and photovoltaic installations on private buildings, often facilitated by municipalities making use of state financing programmes, are gaining in popularity (see above Sect. 21.1.3). The Californian IOUs track NEM connections, distinguishing between direct and third-party ownership with the former now becoming the prevalent model. The 2006 implementation of the California Solar Initiative (CSI) is considered the starting point for widespread residential solar adoption (CPUC 2017b). Statistics show a steady growth of households' NEM connections (Energy Solutions n.d.-b). A CPUC report found that the opportunity to use CSI incentives in combination with federal tax credits did indeed spur growth (Hobbs 2012; CPUC n.d.-b). The role of CCA incentives like enhanced NEM programmes, FiTs, and other programmes is also expected to increase the volume of consumer-owned DERs in the near-term.

All California's operating CCAs state the goal of progressively increasing their ownership of RE plants to meet their customers' requirements for renewable electricity supply. So far only the longest-running California CCA, MCE, was the first to set up its own 10.5 MW renewable project, although other CCAs have contracted with large RES projects and several emerging CCAs have stated this as a priority (MCE Clean Energy n.d.). CCAs also enhance citizen participation in the programme through their use of Citizen Advisory Committees (CAC) to advise decision-making by the governing board, usually comprised of elected officials (PCE n.d.-a). Of the 14 CCAs operating in the beginning of 2018, five make use of this participatory tool.[20] Although these programmes do not provide partici-

[20] Information compiled by the Operations Coordinator of the CA Alliance for Community Energy (See http://cacommunityenergy.org/).

pants directly with an ownership stake in the CCA programme, through the CCAs' locally oriented policies and in particular enhanced NEM and FIT and similar incentives, CCAs can enable higher penetration of consumer-owned RE projects in their geographies.

21.4.2 Financing Conditions for Consumer (Co-) Ownership in Renewable Energy

21.4.2.1 State Subsidies, Programmes, Credit Facilities, Preferential Loans

In 2006 the already existing *Federal Production Tax Credit (PTC)* and the *Federal Investment Tax Credit (ITC)* were adapted to provide financial incentives for private investments in US RE installations. The ITC functions as a personal and corporate tax credit, through which 30 per cent of expenditures for renewable systems sited at the taxpayer's residence or business property can be claimed against personal or corporate tax liability. Currently the largest credits are provided for solar energy installations, whereas the ITC eligibility of wind and geothermal projects expired in 2016. The PTC, a USD 0.019/kWh tax credit for the first 10 years of operation, is currently only for wind facilities but formerly applied to other renewable energy technologies as well.[21] Both the ITC and the PTC were extended in 2016 for five years, with modifications: the ITC will provide credits for solar water heaters and solar PV only; and the PTC for wind energy installations will decline to 40 per cent of the credit's 2016 value by 2019 (U.S. Department of Energy n.d.-a; EIA 2017c). Furthermore, two types of tax credit bonds aimed at renewables were developed as part of a wider federal tax stimulus programme in 2008. Clean Renewable Energy Bonds and Qualified Energy Conservation Bonds are awarded to electric cooperatives, public power providers and government bodies to finance renewable projects (NC Clean Energy Technology Center 2017).

[21] All ITC/PTC policies have a gradual step-down in incentives through the expiration date of 2022 for the former and 2019 for the latter.

To reach California's target of 12 GW in distributed renewables by 2020 as set out in Senate Bill 1, the *California Solar Initiative (CSI)* was launched in 2007. The programme had a total budget of more than two billion dollars and was administered by the three main IOUs mentioned above. The programme closed for applications by the end of 2016 and will continue payments for on-going projects through the end of 2019. The New Solar Homes Partnership Program (NSHP) was launched in 2007 as part of the CSI to place solar systems on half of California's homes by 2020. The programme is supported by the CEC with an initial total budget of USD 400 million (CPUC n.d.-a).

The *Property Assessed Clean Energy (PACE)* model enables municipal and state governments to fund the up-front cost of clean energy projects on commercial and residential properties, paid back over time by the property owners (DOE n.d.-a). As of 2017 PACE is authorised by state law in 35 US states (PACENation n.d.-a). PACE was implemented in California in 2007 by Assembly Bill 811 and extended funds for residential use were made available with Senate Bill 77 in 2010. Currently there are 12 different programmes operating on a municipal level in the state. The HERO Program, which is dedicated to residential applications, is the most widely adopted residential PACE Program in the US accounting for slightly over two-thirds of all projects (PACENation n.d.-b).

Two federally administered programmes are the *National Community Solar Partnership (NCSP)* and the *Solar-in-Your-Community Challenge (SIYCC)* (DOE n.d.-b, c). The NCSP was started in 2015, in collaboration with four other federal agencies, namely US Department of Energy (DOE), US Environmental Protection Agency (EPA), US Housing and Urban Development Department (HUD), and US Department of Agriculture (USDA) and several state agencies, municipal governments, non-profit organisations, businesses, and educational institutions across the country, as a year-long effort to make solar accessible to all Americans, including low and moderate income (LMI) in particular (ibid.). The SIYCC is an 18-month USD 5-million prize competition that was launched in November 2016, as an outcome of the NCSP. Teams represent 33 programmes and 137 projects across the country, including 3 programmes and 12 planned projects in California, working to make solar accessible to LMI communities and/or non-profit organisations (DOE n.d.-d).

CollectiveSun's proprietary financing platform allows non-profit organisations of any size to acquire PV for their property at 85 per cent of the installer's bid price. CollectiveSun utilises a performance-based lease with a deposit feature. CollectiveSun serves as owner and lessor for the lease period, assuming initial ownership to qualify for the ITC. CollectiveSun passes on the ITC benefit through the reduced deposit cost, pegged at 85 per cent of the purchase price. CollectiveSun allows the non-profit to provide the deposit funds using whatever combination of cash, savings, loans/PACE, that the non-profit chooses. An additional option uniquely available through CollectiveSun is their CrowdLending platform. Under this option, the non-profit's members lend their cash, in return for a debt instrument that pays them an annual return until its retired. Regardless of how the non-profit raises the funds for the deposit, it enjoys a 15 per cent discount and a pathway to transfer ownership at the end of six years once the tax benefits are fully consumed. Founded in 2011, CollectiveSun has completed projects in multiple states and is available nation-wide (CollectiveSun n.d.).

21.4.2.2 Agencies Supporting Investment in Renewable Energy Sources

In order to demonstrate compliance with RPS policies, California has joined 14 states and 2 Canadian provinces in using the Western Renewable Energy Generation Information System (WREGIS) to track RE generation and create WREGIS certificates for REC generated (see above). At the federal level, the US DOE Office of Energy Efficiency and Renewable Energy (EERE) supports RES projects, research, and initiatives that "create and sustain American leadership in the transition to a global clean energy economy" (DOE n.d.-e) and has offices in several areas of energy efficiency, renewable energy, transportation, business, and strategic programmes (DOE n.d.-f). The DOE Solar Energy Technology Office (SETO) administers the above described NCSP and SIYY programmes.

The CEC is the main state actor supporting the investment in RE as the authority overseeing programmes executing energy efficiency in building sector and RE development described above. On the civil society level, action groups for CCAs extension such as the Local Clean Energy Alliance (LCEA), group buying schemes for solar PV systems, advocacy groups to alleviate energy poverty and environmental injustice, and educational institutions engaging in information campaigns are actively pushing the Californian energy transition forward.

21.4.3 Examples of Consumer (Co-)Ownership

With the exception of Anza Electric Cooperative described below, no established bottom-up initiative for community (co-)ownership of generation assets was found as this chapter was written. However, CCA examples stand out for both the potential to facilitate consumer (co-) owned RE-projects and their ability to enhance customer participation in project decision-making.

I. Anza Electric Cooperative, situated in southern California, is the state's only electricity cooperative to set up its own renewable generation project. To supply its 3900 consumer-members Anza has a wholesale agreement with a generation and transmission cooperative, which generates energy mainly through fossil fuels. Anza's board of directors is elected by its members and has two directors for each district of the service area. The cooperative's first solar project, Anza Solar Farm, was started in 2011, upon instigation by members interested in sustainable electricity provision who were unable to instal their own solar systems. Anza installed and maintains the arrays of the Solar Farm. The cooperative's members could then participate in the project purchasing a subscription to the output of the PV panels. Based on their respective subscription, participants receive a credit on their electricity bill through virtual net metering. Due to overwhelming participation, Anza decided to start another project, SunAnza, open to member participation through a similar virtual NEM construction. A lot next to the coop's main office was acquired for placement of a four MW solar array in late 2016. To realise the USD 4.8 million (EUR 4.2 million) project, Anza obtained grants from several parties, notably the DOE, the National Rural Electric Cooperative Association and the National Rural Utilities Cooperative Finance Corporation. Since the cooperative is a not-for-profit corporation all excess revenues must be returned to members. As an incentive towards energy conservation, Anza assigns capital credits positively related to each connected household's electricity consumption (Anza Electric Cooperative n.d.-a, b, c)

II. Marin Clean Energy (MCE) was founded in 2010 as California's first CCA. Having doubled in size since then, in 2018 it consists of 17 participating towns, cities, and counties. Most of MCE's RE is acquired through PPAs with local, corporation owned medium- to large-scale solar projects and one waste-to-energy project. In 2017 MCE spent approximately USD 152 million (EUR 133 million) for the purchase of electricity through these PPAs. Power from local solar projects of up to one MW is purchased through a 20-year guaranteed FiT. MCE offers the option to its customers to become a "founding member" of such projects through its Local Sol Programme. By subscribing to Local Sol, customers receive 100 per cent locally generated solar energy in exchange for a premium on their electricity bill proportional to MCE's FiT rate. Participation in Local Sol, however, does not entail an ownership stake in the related projects. In 2016, MCE first took steps towards ownership of Solar One, a 10.5 MW solar farm in Richmond, west of San Francisco. Launched in early 2018, Solar One provides enough electricity to power 3400 homes. Development costs are financed through revenues from MCEs customers' rate payments. With SolarOne's use of 50 per cent of its labour from the local community, the project fulfils another CCA commitment, to maximise social and economic benefits to their communities. Expected to launch in the first quarter of 2018, MCE's feed-in-tariff FIT Plus is a good example of how CCAs in effect can help finance local consumer (co-)owned RE projects. It serves one to five MW-sized projects located in MCE's service area with a fixed price per kWh generated over a standardised, 20-year term helping to secure project financing. Citizens may benefit from MCE's FIT Plus if they have property within MCE's existing service area or new communities and 25,000 sq. ft. of available space or more (MCE Clean Energy n.d-b).

III. Founded in 2016, **Peninsula Community Energy (PCE)** is the CCA programme of San Mateo County. Like MCE described above PCE provides its customers with electricity acquired through PPAs with in-state power generators. In 2017 PCE spent USD 60.4 million (EUR 53 million) for the purchasing of electricity. In addition to hosting open meetings of its governing board as required under California's Brown Act,[22] PCE set up a

[22] See https://firstamendmentcoalition.org/open-meetings-3/facs-brown-act-primer/.

CAC to enhance community participation comprised of original members from the Advisory Committee which participated in the foundation of PCE. Elected officials from all 20 cities in the County and the County itself, as well as representatives from several labour, environmental, and other community organisations were part of this committee (PCE 2015). At the end of 2016, PCE's board of directors decided to appoint a permanent committee of 15 members to assist in management matters (PCE n.d.-a). PCE's CAC holds monthly meetings which are accessible to the public. Its tasks include encouraging customers to "opt up" to the 100 per cent renewables product, to provide feedback on PCE policy and discuss strategies with the PCE Board (PCE n.d.-b).

IV. The **East Bay Community Energy (EBCE)** CCA, launching in 2018, intends to set up its own generation projects. This commitment was made to the community in the form of a "Local Development Business Plan", referenced in EBCE's founding agreement, the "joint powers agreement" between all jurisdictions participating in EBCE's formation. The commitment to local development was supported by community environmental advocacy groups for local energy, who both support maximising local community benefits and oppose the tendency of early CCAs to procure supplied energy through deals with remote plants. EBCE, which also has a CAC, has already begun "best-in-class" analysis of opportunities to bring local benefits to EBCE communities through tailored NEM, FiTs and other community-centric programme designs, to be in place at its launch in June 2018 (Baruch and Weinrub 2014).

21.5 Factors Affecting the Financing of Renewable Energy Sources and Barriers to Consumer (Co-) Ownership

21.5.1 Political, Legal, and Administrative Factors

California's two-track approach to energy policy—with the Legislature on the one side and the regulators on the other—can represent a major hurdle to consumer (co-)ownership. While the Legislature sets ambitious goals for RES extension, regulators are tasked with implementing these goals. This is done in a framework that still favours a central role for the utilities (Penn 2017), which led as one example to the construction of new natural gas plants under the guise of the IOUs' need to make up for fluctuating renewable supply.

Another noteworthy example is the controversy surrounding the successor NEM tariff to be implemented by 2019, NEM 2.0. Californian net metering policy has been highly effective: in March 2016, nine out of ten customer-sited solar PV installations in the IOUs service areas were on an NEM contract (CPUC n.d.-a). Under current legislation, the expected returns of NEM connections tied to bundled retail rates have functioned as a catalyst for residential solar PV adoption in California (McRary 2015). While generally accepted throughout the California solar industry, NEM 2.0 was perceived as the regulators' accommodation to the utilities' concern for revenue losses (ibid.). With the advent of NEM 2.0, however, the inability to net "non-bypassable charges" cuts NEM credits slightly, and is therefore expected to render a small subset of projects economically unfeasible. In a study based on econometric calculations McCrary argues NEM 2.0 will act as a disincentive for customer investment in small-scale renewable installations as the new programme is notably more complex than its predecessor (ibid.). The state's feed-in tariff program for projects with an installed capacity up to 3 MW, known as ReMAT, is widely criticised for obstructing applicants' access through its significant administrative and cost barriers. In 2017, almost four years after the programme started, only 25 per cent of the capacity allocated to IOUs had been awarded (Warren 2017). Generally, (co-)ownership between private companies, citizen groups, and state agencies is limited in California, due to in part to factors like the IOU's control over price-setting, interconnection requirements, and aggregate net metering rules that limit applicability to adjacent properties.

21.5.2 Economic and Management Factors

A type of community ownership called "community solar" or "shared solar" is already established in 23 states across the country, with Colorado, Vermont, Minnesota, and Washington leading the way (Klein and Coffey

2016). California policy aims at catching up with the abovedescribed Green Tariff/Shared Renewables Program adopted in 2015. However, this programme implies utility management of the programmes rather than consumer participation in decision-making on the projects (Trabish 2017). In 2016, very few bids were made under the ECR programme (Orion 2017). Orion attributes this to significant administrative and legal costs for project developers, and the high premium charged to customers participating in the scheme. A 2009 report from the National Renewable Energy Laboratory finds the ITC and PTC credits have become the most important US incentives for renewables (Bolinger et al. 2009). One key issue resulting from this reliance on the federal tax credits as the primary incentive for RE adoption is that these credits only work for people and entities that pay enough taxes to be able to utilise the credit. As a result, such tax credits are not helpful in incentivising RE ownership by tax-exempt organisations such as public schools, non-profit organisations, municipal governments, community-based initiatives or people with low income (Trabish 2015). Renewable Portfolio Standards and RECs also present challenges for (co-)ownership, through their significant administrative costs. In addition, the steep learning curves associated with obtaining and selling RECs can often be difficult to overcome or even understood by individuals or small entities.

21.5.3 Cultural Factors

California is a frontrunner both in the US and globally in terms of climate and sustainable energy policy. Scholars argue that historically this is the result of economic and (geo-)political dynamics enabling increasingly progressive policy and regulation (Meckling et al. 2015). Environmental and fuel crises in the decades spanning 1940–1980 caused the enactment of emission restrictions in California. The shift to a non-carbon intensive industry, mostly high tech and green, was a partial consequence. The expansion of these industries paved the way for a positive policy feedback loop of more aggressive legislation (ibid.). Positive attitudes towards RES are not limited to industry: there is significant civil society advocacy for RES. Last but not least, the “California culture” of progressive values, based on environmental concern going back to the 1970s coastal oil spills, has given rise to more than 40 years of cutting-edge clear air and leading environmental and energy policy. However, civil society organisations have focused their actions mainly on either pressing for the extension of the RPS, increased support for CCAs, and residential rooftop solar PV adoption (Noll et al. 2014). Thus, as of 2018, a broader movement calling for community ownership of RES facilities had not been established. This lack can be attributed, at least in part, to the IOU-based requirements of the GTSR programme which does not incentivise community ownership.

21.6 Possible Future Developments and Trends for Consumer (Co-) Ownership

The movement to create CCAs has been sparked in significant part by consumers seeking "community ownership" of electricity decisions, although not—as yet—of the generation assets. This movement has been entirely grassroots led, and has been based predominantly on the imperative to reach environmental and social goals in as short a timespan as possible. The desire to reach "0 Greenhouse Gases" as soon as possible, to have greater local control and local benefits, especially to communities of concern, and to build local resiliency in the face of growing climate emergencies, all have sparked and sustained the momentum for "community ownership" of electricity decision-making overall. Moreover, this movement has been strong enough to disrupt the IOU model significantly. Once a sufficient number of CCAs are in operation it is likely that this movement will focus on local ownership of the DERs themselves. An interesting development in this regard is the LCEA's East Bay Shared Solar Collaborative. This initiative is the first in California to press for community ownership of generation plants outside of the predominant California legislative framework for IOUs. Instead, ownership would be implemented within the framework of the Alameda-wide CCA East Bay Community Energy as described above, to be launched in June 2018 (LCEA n.d.).

Senate Bill 1399 introduced in February 2018 advances a revision by the CPUC in 2019 to allow non-residential energy consumers unable to host DER on their own property to benefit from the installation of solar PV on the many unused sites in California such as warehouses and parking lots. This could potentially boost mid-scale size projects. The said 2019 CPUC revision also includes a decision on NEM. California's energy storage mandate as established by Assembly Bill 2514 of 2010, mandates POUs and IOUs to adopt an energy storage system procurement target which is to be achieved by each LSE by the end of 2020 (CEC n.d.-c) The California Environmental Justice Alliance (CEJA) sponsored two bills to expand the benefits of renewable energy to the wider population of the state, especially disadvantaged communities. Through Assembly Bill 523, still under review in the beginning of 2018, quotas of a quarter of Electric Program Investment Charge (EPIC) funds[23] must be collocated to RE and energy efficiency projects in disadvantaged communities, and ten per cent to the advantage of low-income households. Senate Bill 366, adopted in 2017 for two years, on the other hand aims to lower the consumer fee for subscribing to GTSR projects in communities faced with economic and environmental challenges, and to extend the assigned capacity in those communities (Caleja 2017).

The mission of California's CCAs—more so than CCAs in other states—is tightly related to the extension of RE. All CCAs state the goal of integrating supply with their own renewable projects, even though they are not legally bound to do so. Whether and to what extent they realise this goal, and furthermore how the abovementioned legislative proposals, measures, and the NEM successor tariffs are implemented, will significantly affect how quickly California succeeds in realising its clean energy transition and to what extent individuals, communities, and businesses can participate as owners in the process.

[23] EPIC provides approximately USD 162 million annually from 2012–2020 primarily to address policy and funding gaps related to the development, deployment, and commercialisation of next generation clean energy technologies (See http://www.energy.ca.gov/research/epic/).

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22

Consumer (Co-)Ownership in Renewables in Ontario (Canada)

J. J. McMurtry and M. Derya Tarhan

22.1 Introduction

Given Canada's fractured national energy landscape, this chapter will mainly focus on the province of Ontario while referring to the overall situation in Canada where necessary.[1] The key rationale behind choosing

[1] Canada lacks a set of strong national energy policies and is instead characterized by a fractured and provincialized energy market. The fracturing of the Canadian energy market has its foundation in the Constitution Act of 1867, which institutionalized a clear division of powers between provincial and federal governments. As a result of this political reality and the geographical distances involved, in the first half of the twentieth century, each province incorporated their own utility companies and subsequently began building their provincial grids and large-scale production facilities depending on most readily available and economically viable resources. This initial fracture expanded in magnitude over the years and today the Canadian electricity landscape is often marked by inter-provincial

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Ontario, the largest and most industrialized provincial economy with the highest energy consumption within Canada, is its pioneering experiments with renewable energy (RE) and community energy (CE) policies over the past decade as it transitioned out of heavy reliance on coal, nuclear, and large-scale hydro, which have made Ontario a case of international interest in energy transition.

22.1.1 Energy Mix

Ontario's publicly owned electricity system was established in 1906, almost entirely relying on abundant hydroelectricity resources for its energy supply until the 1950s (Tarhan and McMurtry 2018). With the economic boom following the end of the Second World War, Ontario turned initially increasingly to coal in the 1950s and 1960s and subsequently to nuclear energy, building on its competitive advantage as the only province with uranium reserves. Ontario's move towards nuclear was also supported by the federal government, which partnered with Ontario in CANDU Energy Inc. in developing, building, and selling nuclear reactors nationally and internationally. While energy generation from coal has been entirely phased out in 2014, more on which in Sects. 22.3.2 and 22.4.2, nuclear reigns as the leading source of energy in the province. Overall, gross inland energy consumption was 3050 petajoules in 2015, with refined petroleum and products accounting for 1402 PJ equivalent to 46 per cent, natural gas for 919 PJ equivalent to 31 per cent and electricity for 494 PJ equivalent to 16 per cent (National Energy Board 2018).

In 2017, Ontario's yearly energy output was 144.3 TWh, which amounts to a per capita supply of 10.6 MWh. The principal source of energy in Ontario as of December 2017 is nuclear, with a share of 63 per cent of all supplied energy. Hydroelectricity follows with 26 per cent,

competition and a variety of policy frameworks—or lack thereof—and practices. As such, one cannot talk about Canadian RE, but rather a patchwork of policies and practices that form an emergent and increasingly dynamic ecosystem within Canada. A province-by-province breakdown of RE and CE legislation and activity across Canada has been conducted as part of our research partnership. While the statistics are available at http://peoplepowerplanet.ca, an in-depth analysis of each province is featured in another book chapter by McMurtry (2017).

with a great majority of this supply capacity coming from medium- and large-scale dams rather than run-of-the-river schemes. Ontario's Feed-in Tariff (FIT) Program, introduced as part of the Green Economy and Energy Act of 2009, is responsible for most of the non-hydro renewable energy sources (RES) capacity in province, as this share grew from 1.5 per cent of which 0.9 per cent wind and 0.6 per cent biofuel and solar in 2008 (IESO 2009) to 7 per cent in 2017 (IESO 2018b). Today, among non-hydro RES, wind energy is the principal source with a 6 per cent share of the entire power supply, accounting for 84 per cent of all non-hydro RES output. Meanwhile, despite gaining importance since the Green Energy and Green Economy Act (GEEA) with individual/household and community-owned projects, solar energy still only accounts for 0.5 per cent of all energy output. The other significant non-hydro RES is biofuels, also accounting for 0.5 per cent of Ontario's energy supply. Finally, gas and oil accounts for 4 per cent of Ontario's total energy output (IESO 2018b).

In terms of heating, natural gas is responsible for 58.1 per cent for all of Ontario's space heating supply as of late 2015 (Natural Resources Canada 2018). Hence, most of the 10,277 MW installed capacity of natural gas is used for heating rather than electricity generation (IESO 2018b). Electricity at 25.5 per cent, wood at 10.5 per cent, heating oil at 4.3 per cent and coal and propane at 1.7 per cent are the other sources for space heating in the province (Natural Resources Canada 2018).

22.1.2 Main Challenges of the Energy Market, National Targets, and Specific Policy Goals

Ontario has had traditional reliance on coal and nuclear power for electricity and is significantly transitioning its energy production to meet greenhouse gas reduction targets, primarily through alternative and "clean" energy technologies. However, in the face of greater and greater electricity demand, energy capacity development has been not focused on energy transition, but has led to "energy poverty" through significantly variant and high electricity prices across the country, and even inequitable and contentious relationships between provinces in terms of defining a coherent national energy direction (McMurtry 2017). The province's current policy environment and direction can be deciphered through five key recent developments:

- First, the province's decision to refurbish the Darlington nuclear plant signals a continued over-reliance on centralized and dangerous nuclear energy at the expense of further expansion of decentralized RES that is more conducive to community involvement with less negative environmental impact.
- Second, the discontinuing of the microFIT and FIT programmes (see Sects. 22.3.2 and 22.3.3), with specific incentives for individuals and community groups in December 2016 and the subsequent return to a tender system which prioritizes through policy and economics large-scale corporate projects, further disadvantaging decentralized community (co-)ownership. One bright spot in this policy landscape is the fact that individual solar projects are supported by a net metering scheme.
- Third, another incentive in the form of a household solar rebate programme was to be introduced in Summer 2018 through the Green Ontario Fund, a provincial agency established by the Liberal government and funded by the province's cap-and-trade programme (Cision 2018). However, the Conservative Party under Doug Ford's leadership won majority government on June 7, 2018 and immediately announced on June 19 that both Green Ontario Fund and the cap-and-trade programme that funded it would be scrapped (CBC 2018).
- The fourth key development is the sale of over 50 per cent of Hydro One's, the public body responsible for electricity transmission in Ontario, shares to private investors in September 2017, marking a move away from public ownership towards corporate control of the electricity system, signalling the further erosion of public accountability, participation, and control (Tarhan and McMurtry 2018).
- Fifth and finally, the 2015 Ontario Climate Change Strategy, which commits to reducing 1990 emissions levels by 15 per cent in 2020, 37 per cent in 2030 and 80 per cent in 2050, commits to doing so mostly through a continued reliance on nuclear energy combined with energy efficiency and conservation measures (Government of Ontario 2015). The 2017 Long Term Energy Plan (LTEP), which builds on the 2015

Strategy, is further proof that the government's focus is shifting away from supporting the emergence of RES and community-owned RE projects, as it was in the two previous LTEP editions (2010 and 2013), towards "choice and fairness" for ratepayers and energy efficiency and conservation (Government of Ontario 2017b).

Overall, these five developments collectively taken into account reveal a decreasing commitment to the expansion of RES, specifically community (co-)ownership, and a continued reliance on centralized, environmentally suspect, energy generation and transmission at the expense of democratic control.

22.1.3 Ownership Structure in the Renewable Energy Sector

A key trend in Canada's fractured energy landscape is the dominance of corporate as opposed to community ownership in "new" RE generation. While large-scale hydro projects have historically been undertaken by provincial utilities, most of the new generation capacity from wind, solar and biomass installed since the early 1990s has been corporate-owned (MacArthur 2016, pp. 93–96). These predominantly large-scale projects either sell the generated electricity to provincial grids through a power purchasing agreement at favourable rates or benefit from a FIT law. Meanwhile, despite a significant growth in activity over the past five years, community-owned RE remains peripheral in terms of total electricity contribution fed into to the grid, and is not a policy priority, both at federal and provincial levels, despite rhetoric to the contrary.

Ontario, despite its support for community ownership as part of the FIT Program, is not an exception to this national pattern of corporate dominance. As of March 2018, 72 per cent of all FIT contracts amounting to almost 4.8 GW in Ontario were awarded to corporate projects, while 24 per cent amounting to 1.171.3 MW to projects with Aboriginal full or (co-)ownership, and 4 per cent amounting to 201.6 MW to projects with community full or (co-)ownership (IESO 2018c). Typically, projects involving consumer (co-)ownership in Ontario are medium or small-scale solar projects. The following is a summary of key activities and figures related to some of these community ownership models:

- Over 230 MW of residential solar energy with an installed capacity below 10 kW has been procured in an estimated number of 26,000 households through the microFIT Program between 2009 and 2017.
- In Ontario, 83 RE generation cooperatives have been incorporated since the introduction of the first FIT Program in 2009, while about 30 of these are estimated to be actively pursuing projects. As of early 2016, 225 MW of FIT contracts have been awarded to projects with cooperative (co-)ownership, with 75 MW of that capacity being directly owned by RE cooperatives. By that point, these cooperatives have raised almost CAD 27 million (EUR 18 million) in community capital through shares, bonds, and debentures (Lipp et al. 2016, p. 14). As of March 2018, this figure stands at just over 160 MW with just over 115 MW of this capacity being taken up by solar projects. Second largest capacity is taken up by cooperative wind projects at 34 MW, and third and final is bioenergy at 11 MW (IESO 2018c).
- An increasing number of municipalities across Canada are installing RE especially solar energy systems on their facilities. The increasing uptake of RE projects by schools across Canada is most evident in Ontario. Since the introduction of the FIT Program in 2009, the Toronto District School Board (TDSB) received 311 contracts as part of their Solar Schools Program (TDSB n.d.), while the Ottawa District School Board installed solar projects at 41 schools (Carbon 613 n.d.). Except for a few successful projects, the uptake of renewable energy projects by universities and hospitals has been rather slow across Canada (People Power Planet 2016).
- Among all (co-)ownership models, the Aboriginal ownership model is the fastest growing in Canada.[2] Renewable energy projects with Aboriginal participation (including minority and majority partnerships)

[2] Aboriginal communities across the country are investing in RE projects to generate additional income for their communities, spur job training, and overcome over-reliance on diesel generators and energy poverty. While British Columbia and Alberta are witnessing increasing interest and activity from Aboriginal communities, the majority of installed and in-development capacity can

were awarded 1171.3 MW of FIT contracts in Ontario as of March 2018, with an unknown percentage of direct ownership (IESO 2018c). The majority of this awarded contract capacity is for wind projects at 827.3 MW, with solar PV following at 270.5 MW, hydro projects at 74.4 MW, and finally bioenergy projects at 0.5 MW (IESO 2018c).

22.2 The Consumer at the Heart of the Energy Market?

22.2.1 Consumer (Co-)Ownership in Renewable Energy Sources as Policy Goal

The practical definition of RE (co-)ownership in Canada is community energy (CE), that is, community ownership of, and participation in, energy utilizing RE technology. Community RES ownership is currently not an issue on the political agenda in most of the country, with the exception of New Brunswick[3] and Nova Scotia with its Community Feed-in Tariff Program (COMFIT) Program.[4] While Ontario had generated the most community-owned RE across the country, as noted above, the political agenda in the province has shifted away from community ownership and RE towards consumer choice and price fairness.

Seen from a political economy standpoint (co-)ownership in RE across Canada reveals two key tendencies: (1) where they exist, RE policies often disproportionately benefit large corporate actors, despite the fact that

again be found in Ontario, followed by Nova Scotia, the only two provinces that enacted FIT programmes.

[3] New Brunswick invited community and Indigenous groups to apply for its Locally-Owned Renewable Energy Projects that are of Small Scale (LORESS) Program in February 2017, but no further information has been released by the provincial government as of February 2018.

[4] Launched in September 2011 and terminated in August 2015, the COMFIT Program awarded a total of 200 MW of FIT contracts to wind, tidal, run-of-the-river hydroelectricity, and biomass projects that are at least 51 per cent owned by community groups (Nova Scotia Department of Energy 2017). The COMFIT Program, which excluded solar projects, is now supplemented by the Solar Electricity for Community Buildings Pilot Program, which enables Indigenous communities, non-profit organizations, municipalities and higher education institutions to install solar systems of up to 50 kW on the roofs or properties and sell it to their utility under a 20-year contract (Government of Nova Scotia 2017).

such incentives are funded by all provincial taxpayers; (2) these policies do not automatically translate into an increase in sustainable CE activity or consumer ownership of energy. As community-owned projects often have to compete with corporate actors, and therefore find themselves at a competitive disadvantage in terms of scale, expertise, and capital, it is not surprising that the dominant majority of CE activity in Canada has taken place in the only two provinces that enacted FIT policies with CE specific components or "set-asides": Ontario and Nova Scotia. Consumer ownership has consequently been marginalized in policy and practice from the outset, and renewable energy followed by "choice" and "price fairness" has dominated the discourse and government action.

22.2.2 Fuel/Energy Poverty and Vulnerable Consumers

There have been no exact figures published on energy poverty in Ontario since a 2005 study revealed that at least 20 per cent of Ontarians amounting to over 2.5 million people spend over 12 per cent of their income on utilities (Canadian Housing for Renewal Association 2005). With a steep hike in electricity prices since early 2010s, it is evident that the threat of energy poverty is all the more real for many Ontarians, but especially for vulnerable groups such as Indigenous and low-income urban communities. This situation is caused by structural elements of the economy and hence the energy system in Ontario that prioritized short-term profits and competitive edge against other jurisdictions over the basic human needs of Ontarians. While this recent price hike is often associated with the FIT Program, a historical analysis by Tarhan and McMurtry (2018) revealed that the hike is rather a result of years of delayed debt due to centralized mismanagement and corporate give-aways. Furthermore, as this chapter will later argue, while the FIT Program was a positive step towards the expansion of RES and CE in the province, it was geared towards middle class communities instead of Indigenous and low-income rural communities that suffer directly from energy poverty.

As of February 2018, the only available official support mechanisms for energy poverty in Ontario is The Fair Hydro Act, 2017 that lowered electricity bills by 25 per cent (Government of Ontario 2017a) and the

Ontario Electricity Support Program that supports low-income residents with their electricity bills (OEB 2015). This act however has been paired with a doubling down on nuclear energy in Ontario that, as history shows, leads to cost overruns and further price increases in the long run. Many have also argued that the costs of this programme will be passed on to future consumers so is not actually addressing energy poverty with anything other than a short-term fix developed to address the political challenges of the current government.

22.3 Regulatory Framework for Renewable Energy

In Canada's provincialized and fractured legislative landscape, the most significant legislation spurring renewable energy growth across the country have been the FIT programmes enacted by Ontario and Nova Scotia.[5]

22.3.1 Regulations for Connecting Renewable Energy Plants to the Grid

The main statutory provisions regulating the RES sector in Ontario are Regulation 359/09 (*Renewable Energy Approvals*) and Bill 150 (*Green Energy and Green Economy Act, 2009*). There are four key authorities regulating and managing Ontario's electricity system: (1) Ontario Power Generation (OPG) is responsible for electricity generation, (2) Hydro One is responsible for the transmission grid, (3) Ontario Energy Board regulates the utility infrastructure connecting generating facilities to the electric grid or natural gas distribution system, and (4) Independent Electricity System Operator (IESO) is responsible for overseeing the operations of the electricity market.

[5] New Brunswick is in the process of rolling out the Locally-Owned Renewable Energy Projects that are Small Scale (LORESS) Program with 40 MW capacity for Indigenous projects and 40 MW for community proponents, that is, cooperatives, non-profits, community investment funds, MUSH sector, and partnerships with private organizations that are majority owned by community groups. No contracts have been awarded as of August 2017 (Government of New Brunswick 2017).

22.3.2 Support Policies (FITs, Auctions, Premiums, etc.)

Although programmes to encourage RE development such as net metering and other modest tariff schemes exist, these policies do very little in stimulating CE activity given the issues of capital, capacity, and scale.[6] Meanwhile, the most successful support policies have proven to be guaranteed procurement programmes such as Ontario's FIT Program (see Sect. 22.4.2) and Nova Scotia's COMFIT Program (see Sect. 22.2.1), which, however, are discontinued as of 2018.

Municipalities can also incentivize RE generation through various mechanisms including preferential procurement programmes such as the FIT, improving building and land codes, and offering loan and/or grant schemes. One of the most innovative incentive structures in Canada has been developed by the City of Banff in Alberta. Banff is the first municipality in Canada to introduce a FIT programme in February 2015. The Banff City Council allocated CAD 300,000 of its environmental reserve fund, fed by the municipal franchise fee paid by local utilities, to a FIT programme that aims to add 165 kW of solar PV installed on residences, multi-family units and businesses (Green Energy Futures 2015). However, these types of innovations at the municipal level are still rare in Canada generally and, outside of some district heating and cooling projects, are not present in Ontario yet. The majority of municipal projects which have been initiated are a result of the FIT legislation.

22.3.3 Specific Regulations for Self-Consumption and Sale to the Grid

Ontario's Net Metering Program was initially introduced in 1998 through Ontario Regulation 541/05. However, the programme that really generated volumes of new micro installations was the microFIT Program,

[6] A list of these programmes can be found on PPP's website at http://peoplepowerplanet.ca/.

introduced as part of the GEEA in 2010, which provided household installations smaller than 10 kW attractive procurement rates. Since its inception, the province of Ontario has awarded 26,000 contracts to microFIT participants, representing over 230 MW of new renewable energy installations (IESO 2017). The programme however has been discontinued as of December 2017, returning to net metering as the only available option for micro installations.

Meanwhile, household renewable energy projects that want to benefit from net metering must first get approval from their local distribution companies (LDCs) at the local level and Hydro One at the provincial level (Hydro One 2018). In the case that a household produces more electricity than it consumes in a month, it receives a credit towards future energy bills that is valid for 12 months. Initially the Net Metering Program was available for projects smaller than 500 kW in capacity, but that limit was eliminated in 2017, which means the programme is now open to RE projects of any size (Ontario Energy Board 2018).

22.4 Concepts for Consumer (Co-)Ownership in Practice

22.4.1 Contractual Arrangements and Corporate Vehicles Used

The concept most commonly used in Canada for referring to consumer (co-)ownership of RE is "community energy". The acceptance of this concept can be linked to the term "community" being widely used to frame broader social economy practice in Canada (McMurtry et al. 2015). Within Canada's CE field, there are five ownership models that are most commonly applied to develop projects: (1) cooperatives; (2) Aboriginal ownership; (3) community investment funds (CIFs); (4) non-profit organizations[7]; and (5) municipalities, universities, schools, hospitals (MUSH sector).

[7] In Canada, non-profit entities, charities, and other forms of social enterprises are becoming increasingly involved with renewable energy generation. Legal structures of these non-profit entities

While cooperatives are involved in numerous energy-related activities in all jurisdictions of Canada,[8] over 70 per cent of them are RE cooperatives whose primary business activity is electricity generation.[9] Ontario is home to almost 95 per cent of RE cooperatives across Canada, as the province had a FIT Program that incentivized RE cooperatives specifically. CIFs are locally sourced and controlled pools of capital contributed to by individual investors within a specific geography or community. The most noteworthy CIF legislation in Canada is Nova Scotia's Community Economic Development Investment Fund (CEDIF) Program, which is the pioneering CIF legislation in Canada and the Program after which other provinces' programmes are modelled. By combining tax credits and RRSP (Registered Retirement Savings Plan)-eligibility for investments with preferential securities regulations and the support of a network of Business Service Centres (Amyot et al. 2014, p. 28), the CEDIF Program reduced the legal, financial and knowledge barriers that many community initiatives face in raising capital.[10]

22.4.2 Financing Conditions for Consumer (Co-) Ownership in Renewable Energy

22.4.2.1 State Subsidies, Programmes, Credit Facilities, Preferential Loans

Introduced in 2010, *Ontario's FIT Program* was initially open to various parties including Indigenous proponents, community groups, individuals, cooperatives, charities, educational and health institutions, as

generating RE show a great deal of diversity across the country, which include but are not limited to (1) housing associations and cooperatives, (2) faith-based organizations, (3) cultural associations, (4) professional societies, and (5) foundations and charities.

[8] Including but not limited to electricity distribution, district heating, renewable fuels, and installation and service.

[9] On assignment to Cooperatives and Mutuals Canada (CMC), TREC Renewable Energy Coop and the People, Power, Planet Partnership undertook an assessment of the status of RE cooperatives across Canada in early 2016 (Lipp et al. 2016). This report provides a more detailed account of the current trends, challenges and best practices pertaining to RE cooperatives in Canada, and concludes with policy recommendations for both federal and provincial governments.

[10] The involvement of CIFs in RE investments is also most prevalent in Nova Scotia. Besides having the most established CIF Program in Canada, Nova Scotia was also home to the Community Feed-in Tariff (COMFIT) Program (see Sect. 22.2.1). The COMFIT Program awarded contracts to 10 CEDIFs for a total generation capacity of 115 MW (Nova Scotia Department of Energy 2017).

well as commercial developers. In the first round (FIT 1.0) of contracts, a price-adder of 1 cent per kWh for wind and hydro projects—but not solar—was available for community groups and a 1.5 cent/kWh adder for Indigenous participation. The adder was reduced for these "social" groups if ownership participation was lower than 50 per cent to a minimum threshold of 15 per cent (Lipp et al. 2016, p. 16). A grant-funding programme called the *Community Energy Partnership Program (CEPP)* was also introduced by the GEEA legislation, which allowed community proponents, including cooperatives, to apply for funds to help with project and cooperative development costs. A similar funding stream, the *Aboriginal Energy Partnerships Program (AEPP)*,[11] and the Aboriginal Loan Guarantee Program[12] were also created for Indigenous communities. Despite these support mechanisms and a great public interest, only a small number of CE projects emerged from the first stream of the FIT Program in Ontario.[13] Ontario has also introduced the *Smart Grid Fund* in 2011 to invest in Ontario-based micro and smart grid projects (Government of Ontario 2018).

Recognizing the disadvantage of community groups in competing with corporate actors, the province made some changes to the second tranche of the FIT Program (FIT 2.0). The definition of "community groups" was limited to RE cooperatives and a 25 MW capacity set-aside of grid access was earmarked each for projects with majority, that is, over 50 per cent, cooperative or Aboriginal ownership. Under the commercial stream, the province also introduced a points system where proponents who had a cooperative or Aboriginal partner of at least 15 per cent stake would receive additional points on their application. The introduction of

[11] The CEPP and AEPP were later joined together under the name of Energy Partnerships Program (EPP). EPP as of early 2018 continues to provide due diligence and project development support to Indigenous and other community groups awarded FIT contracts but do not yet have operational projects (IESO 2018a).

[12] The CAD 650 million. Indigenous Loan Guarantee Program provides a Provincial guarantee for a loan to an Indigenous corporation to purchase up to 75 per cent of an Indigenous corporation's equity in an eligible project, to a maximum of CAD 50 million. The Program is available to corporations that are wholly-owned by Indigenous communities. (Ontario Financing Authority 2018).

[13] Many CE groups applied but did not receive a FIT contract, largely since their applications were submitted more than seven months into the Program, at which point most of the available contracts were awarded to corporate projects that had immediate access to human and financial resources to submit their applications expediently (Lipp et al. 2016, p. 16).

this point system resulted in a burst of new cooperative incorporations prior to the FIT 2.0 submission deadline (Lipp et al. 2016, p. 17). The changes made to the FIT 2.0 pertaining to CE carried over to the third,[14] fourth, and fifth tranches. On December 16, 2016, the province announced that the FIT Program would be discontinued on December 31, 2016, effectively shaving off the last scheduled year of the programme (IESO 2016).

As of March 2018, RE cooperatives had been awarded 160 MW of FIT capacity, with most of these projects at 106 MW still being under development (IESO 2018c) due to reasons to be discussed in Sect. 22.5. Furthermore, as mentioned earlier in Sect. 22.1.3, projects with Aboriginal participation were awarded 1171.3 MW of FIT contracts as of March 2018, with an unknown percentage of direct ownership (IESO 2018c). As for non-profit entities and the MUSH sector, most of their activity took place during the FIT 1.0 phase, as the parameters to qualify as a "community group" were changed with the second stream.

In terms of policy, the reforms to the GEEA to have targeted grid access for community groups had a significant impact on creating a CE sector in Ontario. This is a success. In terms of economic impact, CE projects in Ontario have been found to generate CAD 2 in economic activity for every CAD 1 invested in them; create twice as many jobs as corporate projects; and contributed to a 78 per cent acceptance among Ontarians for CE (TREC 2016). Again, this is a success. However, the relatively small amount of grid access granted to community groups, along with the structural barriers of capital, capacity, and scale to their development from incorporation to generation (to be further discussed in Sect. 22.5) has meant that the sector is still marginal in the landscape of power generation in Ontario.

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[14] With the third tranche, the province cancelled FITs for projects over 500 kW (both community and corporate-owned) and moved them to a competitive bidding process (MacArthur 2016, p. 110).

22.4.2.2 Agencies Supporting Investment in Renewable Energy Sources

Energy Partnerships Program: Besides providing project development support to community and Indigenous groups already awarded FIT contracts as described in footnote 18, the Energy Partnerships Program also supports the development of solutions to reduce reliance on diesel use specifically for the four remote First Nation communities in Ontario that are not connected to the provincial grid (IESO 2018a).

Green Investment Fund—The Government of Ontario provided CAD 325 million to the Green Investment Fund for projects in the province that foster energy efficiency, conservation, local environmental organizations, and specifically for Indigenous communities to address their reliance on diesel and energy poverty through solutions based on RES and CE planning (Government of Ontario 2016).

Clean Energy Innovation Program (Federal programme): The Federal government committed to providing CAD 49 million between 2016 and 2019 to support clean energy innovation in fields including but not limited to renewables, smart and micro grids, energy efficiency, and conservation (Natural Resources Canada 2018).

22.4.3 Examples of Consumer (Co-)Ownership

I. TREC and SolarShare In 1998, TREC Renewable Energy Co-op (http://www.trec.on.ca) developed the first community-owned wind turbine in Canada at the Exhibition Place in downtown Toronto. TREC in effect was the incubator and developer of the ExPlace turbine, however, the cooperative that TREC developed to own and manage the turbine is WindShare, a for-profit cooperative. When the FIT Program was announced in 2009, partly building on WindShare's success and TREC's advocacy efforts, TREC began to pursue solar rooftop opportunities. To develop and own these projects, TREC incubated SolarShare (http://www.solarbonds.ca), a non-profit cooperative, in January 2010. Today, SolarShare boasts a portfolio of over 14 MW consisting of 31 projects, ranging in size from 10 kW rural systems to 600 kW (DC) arrays on industrial rooftops and in non-arable fields. Together, these projects are valued at nearly CAD 55 million (EUR 37 million). SolarShare has over 1500 members who invested over CAD 35 million (EUR 24 million) in their "solar bonds" and earned over CAD 3.3 million (EUR 2.2 million) in returns (SolarShare 2018). Meanwhile, TREC continues to incubate renewable energy cooperatives while offering member management and investment services to the CE and broader renewable energy sectors.

II. Mother Earth Renewable Energy (MERE)—MERE is the first project in Ontario that is 100 per cent owned by a local Indigenous community—HIAH Corp., an Indigenous Economic Development Corporation owned by the M'Chigeeng First Nation on Manitoulin Island. The project consists of two wind turbines with 2 MW installed capacity each that required an initial investment of CAD 12.5 million (EUR 8.4 million) M'Chigeeng First Nation made an initial investment of CAD 3 million (EUR 2 million) in the project, while the federal government provided additional funding worth CAD 980,000 (EUR 657,000), and the remaining amount was raised through financing worth CAD 8.6 million (EUR 5.8 million) (Market Wired 2011). MERE benefited from Ontario's FIT Program and its specific incentives for Indigenous communities and became operational in 2012. According to its business model, the project is estimated to generate about CAD 300,000 (EUR 200,000) of surplus funds annually in the first 14 years of operation and CAD 1.2 million (EUR 0.8 million) annually for the succeeding six years after financing loans are repaid (Northern Ontario Business 2013).

III. Agricola Lutheran Church Solar Project (http://www.agricola.ca/)—Located in Toronto, the Agricola Lutheran Church turned two of its members' ambitions of installing solar panels on its roof into reality through the FIT Program. The project cost a total of CAD 85,000 (EUR 57,000), paid for by a late congregation member's donation. The 10 kW solar system began feeding electricity into the grid in early December 2011, and the church received its first FIT cheque from the government in March 2012. The system is expected to generate between CAD 12,000 and 13,200 (EUR 8000 and 8850) per year and is on track to pay for itself by late 2018. With a 20-year FIT contract, this means 13 years of net financial benefit for the church (Community Power Report 2012).

22.5 Factors Affecting the Financing of Renewable Energy Sources and Barriers to Consumer (Co-) Ownership

22.5.1 Political, Legal, and Administrative Factors

Overall, based on our research through the People, Power, Planet partnership, we noticed that the political struggle for a just energy transition appears to be happening in three key fronts in Canada: First, communities in provinces reliant on "old" energy are pushing for a transition towards renewable sources and are facing significant pushback from policy-makers with strong connections to the fossil fuel industry. Second, in provinces where the transition towards RES is already taking place to varying degrees, the key struggle is for communities to be main beneficiaries of RE-friendly legislations instead of large corporations. Finally, within the CE movement, the lack of meaningful participation within existing organizations and low levels of participation by marginalized communities seems to be the third front of political struggle in the transition towards an ecologically sound and just energy system in Canada. Seen from this political economy lens, CE appears as a dynamic field with ongoing contestation. The extent of social demand and mobilization for a green and just energy system will tell the future direction of CE legislation and activity in Canada.

In Ontario, it is evident that the FIT Program was at least as much about industrial development as it was about environmental stewardship. The goal, especially made clear with the 51 per cent domestic component rule and procurement deals made with energy giants such as Samsung, was to increase Ontario's competitiveness in the emerging global RE market and to spur economic development. While special considerations for community and Aboriginal components in FIT 1.0 appear on the surface to be CE-specific policy, in practice the policy ended up pushing community groups into direct competition with corporate giants for limited grid access. From a political economy perspective, despite nurturing most of Canada's RE cooperatives activity, Ontario's FIT policy was not necessarily conducive to meaningful participation by Ontarians in the energy system. The overwhelming majority of contracts and benefits, as highlighted in Sect. 22.1.3, went to corporate actors whereas all Ontarians bore the costs of the programme. The underlying political economy reality of this policy, demonstrated by these figures, is that the GEEA served to privatizing the energy sector through the guise of environmentalism as Ontario's energy grid has been publicly owned until recently (Tarhan and McMurtry 2017). This we believe is an essential and hidden component of the political and economic motivation behind RES development in Ontario.

22.5.2 Economic and Management Factors

RE projects involving consumer (co-)ownership schemes whose primary economic activity is the sale of electricity and/or heat to the grid face significant challenges where *specific policies to support CE* are not in place. This is mostly due to collective ownership and management schemes of these organizations, which require longer gestation periods to plan and finance projects. Without specific support policies, these projects are often put in direct competition with larger-scale corporate projects that have immediate access to adequate human and financial resources. The result is the generalized exclusion of CE projects from power purchasing agreements. The case of FIT 1.0 in Ontario proves that FIT schemes with CE incentives can also create the same result without specific capacity allocated to CE projects (Lipp et al. 2016).

RE systems are capital-intensive. Whether a community group is aiming to generate additional income by selling the electricity and/or heat to the grid or to directly use the produced energy at the local level, it will most often need access to debt financing. Accessing such financing from conventional lenders can be a challenge due to these actors' unfamiliarity with the ownership models utilized by CE to facilitate democratic participation. Furthermore, CE projects are often seeking relatively small size loans, which makes them less attractive to financial lenders and investors who are primarily looking for profit maximization (Lipp et al. 2016).

An appropriate solution to this problem can be for CE projects to develop relationships with the credit union sector, but the PPP research revealed that such ties are almost non-existent across Canada.

Unable to access adequate financing from lenders, most CE projects turn to their members/participants for a significant portion of their project equity and to the third sector organizations for grants and/or loans. Raising equity and accessing grants also involves costs and requires a strong reputation within the community, which CE projects may not necessarily have built prior to developing a successful project. This creates a vicious cycle where funding cannot be raised until a group develops expertise and reputation, whereas those two elements are built through realizing successful projects. This vicious cycle proves be to an especially difficult barrier to surmount for marginalized communities and often results in under-capitalization and various organizational capacity challenges that this chapter turns to now. Finally, under-capitalized CE projects in Canada also turn to private developers for jointly-owned projects. While such partnerships allow CE groups to partially own an operational project, the payoff is a significant loss of control over the project and thereby its economic and participatory benefits for the community group (MacArthur 2016, p. 147).

Closely tied to a lack of access to financing and adequate support mechanism, CE projects in Canada often experience difficulties and/or setbacks in the early development stages of their projects. Most CE projects' emergence coincides with the introduction of FIT programmes or other opportunities without adequate time to develop human and financial capacity and reputation. Consequently, these projects depend heavily on the voluntary efforts of pioneering individuals. Given how involved CE project development can be, the workload may soon prove to be overwhelming and technical and organizational expertise insufficient. The need to bring in technical experts and/or hired staff emerges at this stage is paramount, and yet the organizations often lack the financial capacity to contract their services or develop them internally through education (Lipp et al. 2016). Even if a CE organization manages to develop an operational project, the lack of experience running participatory and/or democratic organization can persist as an issue.

22.5.3 Cultural Factors

CE projects in Canada also experience challenges related to the newness of the sector, and the lack of familiarity among the public and the financial and public sectors about their activities. This lack of familiarity may present itself in several ways: (1) Communities and/or individuals' unwillingness or intimidation in undertaking a costly energy-generation project (Tarhan 2015); (2) Provincial policy-makers' embeddedness in "old" energy relations and patterns, that is, fossil fuels, centralized and large-scale generation and transmission, and preference to incentivize corporate instead of community projects (McMurtry 2017); (3) Conventional financial lenders' unwillingness to invest in what they see as niche and small-scale initiatives. Another vicious circle appears in the form of perceptual barriers, as CE in Canada can only build its reputation through more successful projects but successful projects are hard to develop given the structural and perceptional barriers.

On the other hand, participation is a key cultural and practical issue affecting existing and future CE projects in Canada. Our research revealed that while ownership model is an important factor in how and to what extent people actively participate in CE projects, these models do not necessarily automatically generate a certain level of engagement. For instance, while the cooperative model would be expected to generate the highest level of member participation, we found that RE cooperatives in Ontario that benefit from FITs are often not place-based, with investments coming from across the province and an organizational focus more on project financing instead of nurturing a culture of meaningful participation. Members in most of these cooperatives are investors, and therefore participate on this basis. Meanwhile, Indigenous projects were found to cultivate the most hands-on participation by the local community in decision-making, job training, and installation and maintenance. CIF model appears as the most finance-oriented and therefore least actively democratic of these five models. Interestingly this finance focus has not dampened its popularity; it is spreading across Canada often under the name of social finance. The same issue of community member participation is true for the non-profit and MUSH-sector-owned RE projects, as people who directly or indirectly benefit from these projects are not directly involved in the decision-making processes. Nonetheless, all members or residents of non-profit or MUSH organizations have the right to indirectly participate in the governance of these organizations through their boards or elected municipal representatives. Overall, as we argue that CE groups must specifically implement measures to cultivate a culture of participation within and beyond their organizations, strengthened by effective policy and support mechanisms.

22.6 Possible Future Developments and Trends for Consumer (Co-) Ownership

In overcoming the *interrelated* barriers mentioned above, specific legislation to support consumer (co-)ownership, project development support, and democratic best practices appear to be critical. In contrast to the Ontario FIT Program, the COMFIT Program in Nova Scotia for example was open *only* to projects that are majority community-owned, which appears as more conducive to community benefit, control, and meaningful participation. That being said, most COMFIT contracts were awarded to CEDIFs, which appear as, at least in organizational form, the least democratic among Canadian CE models. Despite often having a place-based connection, CEDIF participants' main involvement with the organization is largely limited to investing and receiving dividends. Even with FIT programmes specifically designed for community groups, *meaningful* participation of communities was discussed but not articulated in policy. This disconnect must be prioritized by policy-makers and community groups alike if there is to be meaningful energy democracy.

Against this background, to foster (co-)ownership of RES in an attempt to contribute to overcome barriers, the PPP research project makes the following recommendations for strengthening the CE movement in Ontario (Lipp et al. 2016):

- Public demand and political action for specific FIT policy that can be in the form of: (1) FITs with community capacity set-asides; (2) CE-specific FITs, such as the discontinued COMFIT in Nova Scotia; (3) Mandates for corporate/government RE projects to offer a certain percentage of the project to local community ownership.
- Project development grants, technical and democratic management support as well as feasibility loans at favourable rates and federal and/or provincially guaranteed loans from the financial/credit union sector.
- Supportive securities legislation for cooperatives and streamlined legislative processes, especially for incorporation, power purchasing agreements and FITs.
- Financial support and target-setting for CE at the federal level and inter-provincial cooperation for the proliferation of CE.

Particularly in the light of the threat that the national government of Justin Trudeau has posed with its approval of three oil pipelines connecting tar sands to trade routes and the environmental threat these pose to indigenous and Western Canadian communities and the environment, CE's potential as a clean, viable, just, and community-based alternative for these communities has become even more important.[15]

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[15] For instance, Standing Rock Sioux tribe in North Dakota canalized its post-pipeline resistance efforts towards a wind energy project 100 per cent owned by their community (Democracy Now 2017).

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South America

23

Consumer (Co-)Ownership in Renewables in Brazil

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23.1 Introduction

23.1.1 Energy Mix

Brazil is the world's ninth largest economy and the eighth largest total energy consumer (Statista 2017a, b). Ranked as the tenth largest oil producer in 2017, the country possesses huge reserves of pre-salt oil besides gas and coal reservoirs. Brazil is known for its huge hydropower plants, and the energy sector is one of the least carbon intensive in the world. However, notwithstanding the enormous potential for PV generation, large-scale solar power plants do not play a significant role yet (Pereira et al. 2017). Despite a high increase in demand in the last decades, the total primary energy supply (TPES) per capita is lower than the global average. As of

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2016, TPES was 1.39 toe with a 5.5 per cent share of coal and coke, 36.5 per cent of petroleum and oil products, 12.3 per cent of natural gas, 1.5 per cent of uranium, 1 per cent other non-renewables and 43.5 per cent of RES. More in detail, contributions from RES amounted to 12.6 per cent from hydro, 25.5 per cent from biofuels, 1 per cent from wind, 0.002 per cent from solar, and 4.4 per cent from other renewables. The share of RES in total final energy consumption amounted to 41.1 per cent, including 17.5 per cent of electricity (EPE 2017; MME & EPE 2017).

Brazil's electricity matrix has an even higher share of RES with 81.7 per cent as of 2016 of which 68.11 per cent hydro, 8.2 per cent biofuels, 5.4 per cent wind and 0.01 per cent solar. Besides centralized generation of electricity through large-scale plants, a small share of Distributed Generation (DG) that comprises consumer-owned micro and mini RE installations connected to the public distribution grid exists.[1] In February 2018, the installed capacity of around 22,000 mini and micro units reached a total of 260.5 MW accounting for 0.16 per cent of overall electricity production with around 187 MW solar energy making up the largest share (ANEEL 2018a, b). Looking at the energy consumption of the residential sector, almost half of it is satisfied by electricity while the other half is met by liquefied petroleum gas, firewood and other sources. Peculiarities with regard to water heating in the residential sector set Brazil apart from other countries as one of the main appliances adding to electricity consumption in a typical Brazilian home is electric shower heads that are used for heating water since buildings are usually not equipped with hot water plumbing (Villareal and Moreira 2016; Eletrobras and Procel 2007).

23.1.2 Main Challenges of the Energy Market, National Targets and Specific Policy Goals

Considering the high share of hydropower, diversification of the electricity portfolio remains a major challenge to increase energy security in times of weather extremities. Nonetheless, new plants are expected to

[1] Installations of installed capacity below 3 MW (for hydro 5 MW) are defined mini, those below 75 kW micro.

increase the national capacity by around 10,700 MW until 2026 per the Ten-Year Energy Expansion Plan with the energy mix reaching a 48 per cent share of RES (MME & EPE 2017). At the same time, growing criticism centres around the social and environmental compatibility of large-scale hydropower projects. This development could cause changes in the national energy mix, with the entry of more wind and solar power plants, small hydroelectric plants and the decentralization of generation (MME & EPE 2017, p. 102; Ventura 2018). The government set the goal of 10 per cent of electricity production to be sourced from wind power by 2020 (Juárez et al. 2014). It is envisaged that an increase in wind power in the north of the country will level out the decrease in hydro production in the south (Forero 2013). Other challenges are the electricity demand expected to grow at an annual rate of 1.9 per cent, the reduction of electrical power tariffs, inapt regulatory innovations, illegal consumption, energy efficiency and universal access to electricity in rural areas (MME 2015a; MME & EPE 2017).

Against this background the Brazilian energy sector faces a paradigm shift driven by two factors: international goals for reducing greenhouse gas emissions and the country's reliance on hydropower. The country actively participates in international climate negotiations and plans to continue the reduction of emissions by 43 per cent compared to 2005 levels by 2030. Currently, deforestation puts upward pressure on emissions (IEA 2013; MME 2015a).

23.1.3 Ownership Structure in the Renewable Energy Sector

Major players in Brazil's energy sector are government-controlled stock companies like the power conglomerate Eletrobras and the national oil and gas giant Petrobras. The federal government owns 50.26 per cent of Petrobras' and 51 per cent of Eletrobras' common shares with voting rights thus maintaining ownership interests in the generation and distribution sectors at both the federal and state levels. In the electricity sector, this reaches as much as 83 per cent of total generation capacity in 2016. The other 17 per cent of the sector are owned mostly by industrial self-producers that mainly produce energy for their own consumption (ANEEL 2017c; Eletrobras 2017; Petrobras 2017; EPE 2017).

A special feature of the Brazilian electricity sector is the rural electricity cooperatives that were initially formed by pioneers joining forces to electrify their remote properties. In 1999, a nationwide process of regularization began that authorized only 14 cooperatives to maintain their status of energy producers for the exclusive use of their members whereas the other cooperatives were classified as concessionaires. As of December 2017, ANEEL lists 50 RE plants that belong to 27 cooperatives as well as joint stock companies and limited liability companies that operate under the name of a cooperative of which 74 per cent are hydro power plants. The other 26 per cent are biomass plants that are run by agricultural cooperatives (ANEEL 2017b; Francisco 2016).

With regard to the ownership structure of the DG facilities involving prosumers, only limited information is available. Examples from the most important RE sectors are as follows:

- The installed capacity of small hydro plants was 15.2 MW in December 2017, making up only 0.01 per cent of the total installed RE capacity. Of this, 60 per cent of installations ranged between 750 kW and 3 MW nameplate capacity, and micro installations were the minority with 20 per cent. While 44 per cent of installed capacity was used for commercial purposes, 37 per cent was used for industrial purposes, which was held by seven limited liability companies. Moreover, there are three cooperatives (800–1840 kW) accounting for 23 per cent of installed capacity (ANEEL 2017a).
- In the biomass sector, the capacity of DG amounted to 19.8 MW, which makes up only 0.02 per cent of the total installed RE capacity. As for the average size, 38 per cent of the units were micro installations below 75 kW and 54 per cent ranged between 75 kW and 500 kW. Almost all the plants are fuelled by biogas from agricultural enterprises. One-third of installed capacity is in the hands of 51 individual owners. Larger projects are owned by 11 limited liability companies with 27 per cent installed capacity and three stock companies with 36 per cent. Cooperatives are the exception in this sector (ANEEL 2017a).
- Regarding wind energy, small-scale installations are also still very rare with a total of 10.3 MW equating to 0.01 per cent of total installed RE capacity. Almost all of them were micro plants with a nameplate

capacity below 25 kW and the majority were used for commercial purposes with individuals and limited liability companies as the owners. Two larger projects owned by a commercial consortium and a food retailer, with 5 MW each, constituted an exception. No cooperatives were involved (ANEEL 2017a).

- The solar sector is more dynamic with a DG capacity of 154 MW accounting for 0.13 per cent of total installed RE capacity. The facilities are mostly owned by private individuals for residential use with 15,628 units accounting for 51 per cent of installed solar DG capacity; about 40 per cent were used for commercial purposes; and 99.3 per cent were micro installations, most of them below 10 kW. Among the owners are 55 cooperatives mostly with micro installations. The public sector held 290 units with 7.5 per cent (ANEEL 2017a).

With regard to off-grid power generation, the number of installations is negligible. At the turn of the millennium, around 9000 small photovoltaic power generation projects with a total nominal capacity of around 5 MWp were set up during the implementation of the national Prodeem programme, mainly for the supply of electricity in rural and isolated communities in the north and northeast of Brazil. It can be assumed that communities benefited from energy access more so than individuals with ownership rights (ANEEL 2008).

23.2 The Consumer at the Heart of the Energy Market?

23.2.1 Consumer (Co-)Ownership in Renewable Energy Sources as Policy Goal

The federal government promotes consumer (co-)ownership in the form of prosumership of individuals and organizations with micro and mini installations. Since April 2012, when the Normative Resolution N° 482/2012 on DG came into force, the Brazilian consumer can generate electricity from RES for self-consumption and feed the surplus into the local distribution network through a net metering system. In 2015, the resolution was revised by the Normative Resolution N° 687/2015 to increase the target audience by scaling up the power limit, improving net metering and allowing for new collective forms of DG. These goals are bundled in the Programme for the Development of Distributed Generation of Electric Energy (ProGD) (ANEEL 2012, 2015). In addition, first socio-ecological pilot projects that link energy access with income-generation for disadvantaged communities are set up and funded by the government (ANEEL 2017a; MME 2015a; Pereira et al. 2017). The dissemination of DG is also supported by several interest groups of the private sector, for example, the Brazilian Association of Distributed Generation (ABGD), the Brazilian Association for Photovoltaic Solar Energy (ABSOLAR), the *Energia para a vida* (Energy for life) campaign for new energy politics in Brazil and the Organisation of Brazilian Cooperatives (Sinimbu 2017).

23.2.2 Fuel/Energy Poverty and Vulnerable Consumers

The economic power, and the associated energy consumption, is distributed very unevenly among the 27 states of the federal republic, concentrated in the south and southeast of the country in the triangle of the metropolitan areas São Paulo, Rio de Janeiro and Belo Horizonte. Even though universal access to electricity has been achieved in the urban areas, the rural areas, especially the northern region, remain undersupplied. This affected around 197,000 households in 2015, not even taking into account the thousands of homeless people (Carvalho Natalino 2016; IBGE 2015, 2016). With regard to access to affordable, reliable and modern energy, 10 million Brazilians did not have access to clean cooking and therefore relied on the traditional use of solid biomass (IEA 2017). On that account, the Federal Government extended the *Luz Para Todos* (LpT—Light for all) programme that was launched in 2003 by decree N° 8.387 by the Ministry of Mines and Energy (MME) to improve access to modern energy services until December 2018.[2]

[2] Another programme adding to that policy goal was Prodeem—Program for Energy Development of States and Municipalities. It was designed by Presidential Decree as of 27 December 1994 in order to foster the development of isolated communities that were not connected to the supply

Additionally, Brazil is affected by high social inequality and a significant share of people living in poverty. In 2015, 8.7 per cent of the population lived in poor conditions with a monthly income below 140 BRL and 3.4 per cent in extremely poor conditions having below 70 BRL at their disposal resulting in at least 17.7 million Brazilians affected by energy poverty. Similar to the lack of access to electricity rural areas characterized by unfavourable conditions show a higher rate of energy poverty (IBGE 2017; Soares et al. 2016; Skoufias et al. 2017).

23.3 Regulatory Framework for Renewable Energy

In Brazil, generation, transmission and distribution activities are assigned to different organizations to preserve the competitiveness of the market. Additionally, the rules applying to large power plants are different from the ones for DG involving self-consumption. The main agents of the electricity sector on the federal level[3] are the MME, the National Electric Energy Agency (ANEEL), the Energy Research Company (EPE), the National Energy Policy Council (CNPE), the National Electricity System Operator (ONS) and the Chamber for the Commercialisation of Electrical Energy (CCEE). The entity responsible for regulating the sector is ANEEL. The agency acts in the regulation of the generation, transmission, distribution and sale of electric energy, and supervises the concessions, permissions and energy services. The agency is also tasked with ensuring the quality of services, universal service and the design of electricity tariffs for final consumers.

network, especially through photovoltaic installations and for public schools. In 2005, Prodeem was incorporated into LpT (ANEEL 2005).

[3] In addition to federal legislation, projects must conform to state legislation. In some cases, there is no homogeneity regarding the framework of wind installations in the federal and state spheres.

23.3.1 Regulations for Connecting Renewable Energy Plants to the Grid?

For the construction and operation of RE power plants, an authorisation or concession must be requested from ANEEL. Authorisation is granted for 20 to 30 years under a simplified procedure set out in the Normative Resolutions N° 343/2008, N° 390/2009, N° 391/2009 and N° 0235/2006. This applies to hydroelectric generation up to 30 MW, co-generation, wind, solar and biomass. For larger hydro plants, concessions are granted for usually 35 years under a bidding process set out in Decrees N° 4.970/2004 and N° 4.932/2003. Besides the technical, financial and legal capacity of the applicant, environmental licences are obligatory to prove that the project meets the implementation and operation standards set out in environmental law. The Brazilian Institute of the Environment and Renewable Natural Resources (IBAMA) is the responsible authority for the environmental licensing process on the federal level. The access to the grid must be requested from ONS, the transmission company or the distribution company (Gallo and Lobianco 2015).

23.3.2 Support Policies (FITs, Auctions, Premiums etc.)

Special auctions for RE are held regularly pursuant to Decrees N° 6.0487/2007 and N° 5.163/2004. Additionally, projects that potentially inject up to 30 MW into the national grid receive discounts of 50 per cent on the transmission (TUST) and distribution fees (TUSD) per Law N° 9.427 of 26 December 1996 updated by Law N° 11.488/2007. In most federal states, RES projects are exempt from value-added tax. Loans at reduced interest rates granted by the National Bank for Economic and Social Development (BNDES) are an additional incentive. The feed-in system that was part of the successful Alternative Energy Sources Incentive Programme (Proinfa, established by Law N° 10.438/2002) is no longer used as an incentive tool. In 2014, an auction for solar PV projects was conducted to set contract prices for 500 MW of solar capacity with more than 400 projects having a total capacity of over 10,000 MW bidding. The average price for more than 1080 MW of accepted bids was EUR 67/

MWh, among the lowest solar energy prices anywhere in the world and cheaper than building new coal or gas plants.

More generally, the Brazilian electricity market is marked by a division into regulated supply contracts and freely negotiated supply contracts. In the free market, contracts are negotiated bilaterally between non-regulated agents starting from a minimum demand of 0.5 MW generation capacity for renewable and 3 MW for non-renewable sources. Long-term supply contracts between electricity generation companies and distribution system operators are concluded on the regulated market through public reverse auctions determined by MME and carried out by ANEEL and CCEE.[4] In case of unanticipated demand requirements, special contractual arrangements are proposed for additional power generation (ANEEL 2008; Gallo and Lobianco 2015).

23.3.3 Specific Regulations for Self-Consumption and Sale to the Grid

The specific regulations on DG are applicable to self-consumption and sale to the grid with the central agent being the local concessionaire. ANEEL established the rules and regulations for the distributed micro and mini generation with Normative Resolution N° 482/2012. Micro generation includes installed capacities up to 75 kW per consumer unit and mini generation ranges between 75 kW and 3 MW for hydro power, and 5 MW for the other renewable energy types. With Normative Resolution N° 687/2015, Brazil adopted net metering, allowing RE installations connected to the public grid to inject surplus production accumulating energy credits to be compensated in kWh for the 60 following months such decreasing the amount of the consumer unit's electricity invoice. In addition, the coverage was extended to condominiums, consortiums, cooperatives and remote self-consumption. Thereby, several energy customers are allowed to share the benefits of DG as if they were a single consumer unit.

[4]To define the amount to be purchased, the distributor must anticipate the total demand of its captive customers. The auctions differ according to the delivery time of the electricity that can either take one, three or five years. The contract is awarded to the project developer offering the lowest price.

DG consumers are classified as follows: (1) Group B, low voltage; (2) Group A, high voltage; (3) Group B, low voltage with remote self-consumption[5]; (4) organizations with multiple consumer units for condominiums; and (5) shared generation for cooperatives and consortia.

Virtual net metering can be applied to collective models as condominiums, aggregate multiple consumer units, consortia, communities and cooperatives in order to share the generated energy (ANEEL 2015; MME 2015b). Residents of condominiums, which are a widespread form of residency in Brazil, can pool prosumption together in a multiple consumer unit. Each participant accounts for an individual consumer unit and common areas like the lighting system, gatekeeper or janitor make up a separate unit. In this configuration, the generated energy can be divided among the units in percentages defined by the consumers themselves. The only requisite is for the consumer units to be located on the same premises. By 2017 only one multiple consumer unit had made use of this option (ANEEL 2015, 2017a).

23.4 Concepts for Consumer (Co-)Ownership in Practice

(Co-)ownership of DG facilities can be realized in the form of individual ownership, community projects or using any kind of corporate vehicle. As the regulatory scenario has changed recently, DG is currently still in its first stages of development. Despite this, the sector is already displaying considerable dynamism. So far, individual prosumers with micro solar installations—acquired through sales contracts—is the prevailing form of consumer (co-)ownership in Brazil (Pereira et al. 2017).[6] The

[5] For example, consumers who live in an apartment and do not have a roof to "solarize" can generate solar electricity in another location, for instance, a country house or beach house owned, and use the energy credits generated for their apartment in the city, provided that it is located within the same concession area of the distributor.

[6] With the recent flexibility taking effect, ANEEL estimates that by 2024, there will be more than 1.2 million solar generators in the country. Most of these generators will be installed in buildings, with the panels integrated into the roof or front of the building where the generated energy will be consumed (Pereira et al. 2017).

shared generation model described in Sect. 23.3.3 above allows the cooperation of different stakeholders like natural persons or corporate entities in a cooperative or a consortium to prosume energy and reduce the organization's energy bills regardless of their place of residence. This model is currently used by 64 units with a total capacity of around 14,500 kW (ANEEL 2015, 2017a). Overall 60 cooperatives active in the RE sector were accounted for in 2017 (see Sect. 23.1.3) with 14 rural electrification cooperatives exclusively serving their members (ANEEL 2017b; Francisco 2016).

23.4.1 Financing Conditions for Consumer (Co-) Ownership in Renewable Energy

The ProGD launched by the MME in 2015 provides framework dedicated to solar energy installations. One of the benefits is that the net metering rules allow injecting the generated surplus into the grid at a competitive price with annual reference values. In addition, DG owners are exempted from specific taxes in most of the federal states.[7] Thereby, investments are predicted to amount to around EUR 27.5 billion up to 2030, with 2.7 million consumers generating energy from renewable energy sources in their homes, commerce and industries (MME 2015b).

Although there are currently no preferential loans for individuals, major energy companies, integrators and installers of PV systems have recently begun to offer financing mechanisms, through which customers can request the installation of a solar roof at their residence and repay the installation cost with the energy savings. The Banco Bradesco (n.d.) offers the leasing scheme *Leasing Ambiental* for the acquisition of RE plants of private customers. The Caixa Econômica Federal finances solar energy projects through its *Construcard* credit line programme for the purchase of construction materials (Camilo et al. 2017; MME 2015b; Pereira et al.

[7] Namely, ICMS which is a value-added tax on sales and services which applies to the supply and movement of goods, transportation and communication services, PIS/Pasep, a contribution for social integration programmes and the formation of public servants' patrimony and Cofins, a tax for social security financing.

2017). Furthermore, Banco do Brasil—"Pronaf Eco" offers loans on preferential terms for rural, agricultural family businesses up to a total investment of EUR 44,500 at an interest rate of 2.5 per cent p.a., with a credit period up to 12 years including a grace period of up to 8 years (Banco do Brasil n.d.). In contrast, the public sector receives preferential loans by BNDES for solar energy projects in universities, federal technical schools, federal hospitals and public buildings (MME 2015b).

For-profit organizations can choose from a range of financing options. Examples are (1) "FNE SOL" by Banco do Nordeste a financing line especially designed for DG with renewable sources for commercial self-consumption offering financing of up to 100 per cent of the investment at interest rates from 6.65 to 9 per cent per annum with an additional 15 per cent compliance bonus, a credit period up to 12 years, a grace period from 6 months to 1 year (Banco do Nordeste n.d.); (2) Desenvolve SP (Agency for the Development of Sao Paulo)—"Linha Economia Verde" financing up to 80 per cent of the investment for purchase and installation of equipment for RE production at interest rates from 0.53 per cent per month, a credit period until 10 years including a grace period of up to 2 years (Desenvolve SP n.d.); (3) BNDES—"BNDES Finem—Geração de energia" financing investments of over EUR 5.3 million for the expansion and modernization of the energy generation infrastructure at interest rates calculated with 8.45 per cent per annum plus a risk premium, a credit period until 20 years including a grace period up to 3 years (Banco Nacional de Desenvolvimento n.d.); and (4) AgeRio, Rio de Janeiro's state agency for development offering credits for sustainable electricity, solar energy and wind energy projects up to EUR 5.58 million at an interest rate starting from 0.90 per cent per month, a credit period of up to 6 years and a grace period up to 2 years (AgeRio n.d.).

23.4.2 Examples of Consumer (Co-)Ownership

I. Juazeiro, Bahia—The socio-ecological solar energy project in Juazeiro, situated in the state of Bahia in the northeast region of Brazil, serves as a flagship example for consumer (co-)ownership. It was initiated by the federal government in 2014 as a project to generate RE and income for two condominiums of a social housing complex and was funded by *Minha Casa Minha Vida programme*. More than 9000 photovoltaic panels have been installed on the roofs of the buildings making it the largest residential solar power plant of the country at that time; in addition to that, two small-scale wind turbines were installed. BRL 6 million (EUR 1.4 million) were invested by the federal fund FSA Caixa and the company *Brasil Solair* contributed BRL 880,000 (EUR 211,000) of non-refundable investment (Caixa Econômica Federal 2012, 2015). The combined installed capacity of the project amounts to 2.1 MW, enough to serve 3600 houses for a whole year. The generated energy however is only used for the common areas and not for the self-consumption of the households, as they already participate in a social electricity tariff system. The project seeks to change the living conditions of the community with extra income being generated for the residents of the condominiums by selling the surplus energy and technical training provided to locals for the maintenance of the installations. Brasil Solair sells the generated energy to the free market through a contractual agreement with the associations of the two condominiums. The energy that was sold to the local distributor between February and June 2014 yielded almost EUR 527,000. The residents receive 60 per cent of the revenue, 30 per cent go to a fund for investments in the community areas and 10 per cent pay for the maintenance costs for the condominiums. This way, the participating families having an average monthly income of BRL 1600 get up to BRL 110 extra every month which is enough to pay the monthly instalments to pay for their houses. The two condominium associations also serve as decision-making bodies for the investment objectives of the community fund (ibid.).

II. RevoluSolar, Rio de Janeiro—Another pioneering initiative of social and energy-related empowerment is the solar community project implemented in 2016 by the non-profit association *RevoluSolar* in Morro da Babilônia, an underprivileged community in Rio de Janeiro. The association was formed by a group of residents with the goal to found a cooperative and install solar panels on least one per cent of the district's homes. As a first step, two local companies, a restaurant and a hostel, were equipped with PV panels. The funding for the facilities was made through *AgeRio*, which offers microcredits up to 15 thousand BRL for residents and entrepreneurs of communities at an interest rate of 0.25 per cent per month. For a single resident, the initial investment would have been too high and the credit period too short. So far, the installations belong to the two companies and cannot be shared until the founding process of the cooperative is concluded. Until then, *RevoluSolar* will continue informing and educating the local population about the social, economic and environmental benefits of using solar energy (Meyer 2016; Nitahara 2016; RevoluSolar 2016).[8]

III. Coober, Brazilian Cooperative for Renewable Energy—Coober is the first cooperative that made use of the new *shared generation* model of DG. It is based in Paragominas in the northern region traversed by the lower Amazon River and consists of 23 members. The implementation phase was very quick: After its foundation in February 2016, Coober invested EUR 167,000 in its first project, a solar micro-plant with a capacity of 75 kWp. The cooperative was supported by the DGRV—German Confederation of Cooperatives, which sent a consultant and a technician to assess the production of energy at the chosen location and the construction of the micro-plant finished in August. The average production capacity of 11,550 kWh per month is entirely injected into the grid of the local distributor CELPA (Central Electrics of Pará). By the end of the year, the contributing members received the first credits in the form of a discount on their electricity bill (Sinimbu 2017).

23.5 Factors Affecting the Financing of Renewable Energy Sources and Barriers to Consumer (Co-) Ownership

23.5.1 Political, Legal and Administrative Factors

Stakeholders express disappointment over the sluggish regulatory process facilitating DG in the country, when compared to progress observed in

[8] According to an expert interview on 13 January 2018, the RevoluSolar cooperative has not yet been founded due to the extensive bureaucratic effort that is needed.

this field in the United States and Europe in the last decade (Pereira 2018). The legal and administrative framework is still characterized by huge barriers. In this context the time needed to complete the connection process of the generating plant to the grid assumes greater relevance. Although the connection process between the request to the local concessionaire and the implementation has been sped up, the process is still long compared to the standards in other countries. According to Alonso et al. (2017), this period amounts to on average 60 days in the United States. In comparison, in Brazil this is 90 days, and can reach up to 120 days if the application process has inconsistencies. Besides this, domestic and foreign companies have problems regarding the certification of equipment as the number of certifying agencies is still insufficient to meet current demand.

Another hampering factor is Brazil's reverse auction system. Auction models favour large-scale projects, because of the high competition and the bureaucratic process of participating in the energy markets. This obstructs the accessibility by smaller consumer groups. Other incentives like feed-in-tariffs that are popular in some countries of the world are not available in Brazil. On top of that, *Greener Tecnologias Sustentáveis* (2018) finds that the distribution and transmission networks of the Northeast Region, which has high solar irradiation, are overloaded. In fact, Bruce da Silva (2016) argues that the dissemination of DG requires a smart grid and that the required modernization of the national grid has not started yet. In conclusion, the speed of regulatory changes still falls short of the technological development even though barriers are progressively removed.

23.5.2 Economic and Management Factors

Accessibility to funding options is a central issue for the promotion of DG. According to Camilo et al. (2017), the initial investment cost is too high. This is true especially for the residential consumer sector, with investment costs starting at a value of almost 40 times the minimum wage (Camilo et al. 2017) and thus are too costly for most Brazilian households. Besides that, the average payback time proved to be very long, often exceeding the life cycle of PV modules. Furthermore, the offered interest rates for financing of small RE installations by far surpass international standards, reaching 2.5 per cent per month. The risk premiums also increase due to the impossibility of repurchasing the equipment in case of default. Investors and banks lack the expertise and consumers lack the technical knowledge to assess the costs and potential benefits in the current regulatory structure.

An important cost barrier relates to electricity meters. The prosumer must bear the costs for the placement of a bidirectional meter, which not only the measures the energy consumed but also the energy injected into the grid. As mentioned before, the current net metering system only allows collecting energy credits. The fact that prosumers cannot sell the surplus hampers the establishment of prosumership and its beneficial effects. The power utilities and concessionaires on their end are reluctant towards the expansion of the DG applying the net metering system. This relates to the fear of loss of future revenues and bearing higher costs for grid management (Bruce da Silva 2016; Camilo et al. 2017).

Another issue that affects the establishment of the solar sector specifically lies in the quality of locally produced equipment. The fragility of the national production chain obstructs compliance with quality requirements and fails to produce the quantity needed for the expansion of the sector. This concerns the provision of products and services, as well as skilled labour. According to Greener (2018), the costs of locally produced modules are 35 to 45 per cent higher than imported ones. At the same time, the financing conditions of the BNDES limit or prevent the use of imported modules. Those factors compromise the technical efficiency and social acceptance of the technology in Brazil.

23.5.3 Cultural Factors

The pre-purchase stage for a DG system tends to be complex and extensive, and the interested consumer is faced with an innovative market that has recently undergone significant regulatory revisions and adjustments. Consequently, the topic is still poorly understood by consumers. The acceptance of RE policies by society depends highly on the way their effects on tariffs, the labour market and other aspects are communicated to the public (Holzer 2005). Camilo et al. (2017) argue that, in Brazil, the general public has never been adequately informed about the essence and possible benefits of the Normative Resolution N° 482, for instance. In a recent study by Pereira and Montezano (2017) on the main drivers of investments in small wind turbines, a positive bias towards that technology in the perception of potential consumers was observed. The majority of respondents, that is, 74 per cent stated they had an interest in purchasing a small wind turbine with the future reduction of the electricity bill being the main motivation for 65 per cent. Nevertheless, the study also showed that up to 9 per cent of the survey participants were not able to assess the degree of importance of several characteristics, suggesting that some lacked knowledge on several topics such as energy credits, available sites and quality of the produced energy. This points to the need of information dissemination on the opportunities of prosumership, a reduction of information asymmetry and providing sufficient conditions for potential prosumers to make the best decision within their range of priorities. However, not enough scientific research conducted on consumer behaviour and renewable energy projects has been conducted yet in Brazil, particularly regarding small-scale generators.

23.6 Possible Future Developments and Trends for Consumer (Co-) Ownership

With the flexibility introduced by Normative Resolution N° 687/2015 taking effect, investments are predicted to amount to around EUR 27 billion by 2030, with 2.7 million residential, commercial and industrial consumers generating energy from RES. As a consequence, a 50 per cent reduction in prices is expected that would keep payback time of the total investment within 10 years (ANEEL 2017a; MME 2015b; Pereira et al. 2017). Among the variety of small-scale technologies, solar PV panels turn out to have the biggest potential, because of their scalability and decreasing acquisition costs. ANEEL estimates that by 2024, there will be more than 1.2 million solar generators in the country. Most of these generators will be installed on buildings, with the panels integrated into the roof or front of the building where the generated energy will be consumed (Pereira et al. 2017). Brazil has already experienced the beneficial effects of additional income from capital in a pilot project with two disadvantaged communities in Juazeiro. This best practice example also proves the technical feasibility of selling electricity through net metering connections (Caixa Econômica Federal 2012, 2015).

A revision of the regulatory framework is currently discussed in Public Consultation N°33. In line with the ProGD objective, consumer units could soon be enabled to sell their produced energy instead of just collecting energy credits providing a strong incentive for the dissemination of consumer (co-)ownership in Brazil (MME 2017). One of the main objectives of ProGD is also the creation and expansion of credit lines and other financing forms. Its implementation would highly improve the capability for individual prosumers to participate in the development of DG. The Brazilian government acknowledges the various benefits of DG for the country's power system and society: (1) as a means to handle the current investment gap for the grid expansion, (2) the low environmental impact of RES, (3) the possible reduction in network utilization, (4) the minimisation of losses, and (5) the beneficial social aspects and the diversification of the energy matrix (MME 2015b). From this point of view, the Brazilian consumer is likely to move closer and closer to the heart of the energy market in the future.

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24

Consumer (Co-)Ownership in Renewables in Chile

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24.1 Introduction

24.1.1 Energy Mix

Chile's energy sector mainly relies on fossil fuels with 70 per cent of the primary energy stemming from crude oil, natural gas, and coal in 2015 (CNE 2016). The greatest energy demand during that year came from the transportation sector with 35 per cent, followed by industry with 23 per cent, the mining sector with 17 per cent, and electricity with 22 per cent (Ministerio

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de Energía 2017a). Chile remains dependent on energy imports—mainly oil, coal, and natural gas—that represent about 60 per cent of Chile's primary energy consumption (Ministerio de Energía 2017a).

Until recently, the role of RE in Chile was mainly restricted to large-scale hydro power plants that amounted to about 35 per cent of the overall installed capacity in 2015 (CNE 2016). However, since 2011 their construction has been paralysed by citizen protests. When excluding hydro power plants larger than 20 MW though, RE have soared during the year 2017. While there was only 286 MW of RE installed capacity in 2005 (Ministerio de Energía 2015), in July 2017 statistics show RE installations with a combined nameplate capacity of 3990 MW. This was mainly due to the growth of solar PV to 1748 MW and wind power to 1305 MW installed capacity (CNE 2017a). Indeed, excluding large-scale hydro power plants, RE already accounts for 17 per cent of electricity power capacity of the country, with RE plants being predominantly large-scale projects carried by international investors (CNE 2017a).

In 2016, the share of RE in total final energy consumption was estimated at 32.8 per cent. This share was made up by 0.3 per cent biogas, 0.7 per cent wind, 6.2 per cent hydro power, 0.7 per cent solar, and 24.5 per cent biomass (CNE n.d.-a). The upward trend from the last years is expected to persist: more than 800 MW of which 600 MW solar power and 200 MW wind power are currently under construction; furthermore, roughly 26,000 MW with 17,219 MW solar and 8964 MW wind power of planned projects obtained environmental permission (CNE 2017a). Non-energy companies can use their waste to produce biogas, for example, for domestic heating and cooking, as well as for power generation and for vehicles.

24.1.2 Main Challenges of the Energy Market, National Targets, Specific Policy Goals

As in most liberalized markets, energy sector development in Chile has faced security of supply concerns, price fluctuations, socio-environmental conflicts, and market concentration. Chile is still highly dependent on energy imports and experienced a major natural gas supply cut in 2007/2008 from its sole gas supplier, Argentina. This supply cut coincided with a drought period in Chile that further curbed its energy supply significantly, as hydroelectric power accounted for more than 50 per cent of Chile's generated power during that time (IEA 2009). This situation of supply deficiency had an impact on energy prices, which soared from EUR 57/MWh on average in 2006 to an average of EUR 112/MWh in 2013 (Ministerio de Energía 2014) triggering the first policy reforms since liberalization, which sought to diversify energy sources in electricity generation and to facilitate access to the national grid for RE power plants of a capacity under 20 MW. However, the top-down approach to energy policy decisions in Chile led to social movements against the development of large-scale hydro and fossil fuel power plants in 2010/2011 (Baigorrotegui and Santander 2018).

Within the national energy and climate policy goals, Chile aims at gradually increasing the share of RES in its final electricity consumption to reach 20 per cent of the electricity companies' portfolio until 2025. Moreover, as determined in the latest official Chilean Energy Policy until 2050 ("E2050") adopted in 2015, by 2035 at least 60 per cent of Chile's energy portfolio must stem from RE and a target of 70 per cent by 2050. E2050 stipulates the need for interconnecting Chile's energy grids with neighbouring countries for assured energy security (Ministerio de Energía 2015). Climate issues are also part of the E2050: considering that the energy sector was responsible for 75 per cent of Chile's greenhouse gases (GHGs), the country committed in conjunction with the Paris Agreement to reduce its emissions by at least 30 per cent per unit of GDP by 2030 by imposing a carbon tax of EUR 4.4 per ton of CO_2 produced by electric power plants with a capacity greater than 50MW. For the on-grid sector, the Solar Energy Program (PES) of the government set a goal of 250 MWp installed capacity for distributed PV generation by 2025 (CORFO 2015).

24.1.3 Ownership Structure in the Renewable Energy Sector

The Chilean energy sector is highly concentrated, as about 70 per cent of total installed capacity is provided by only four electricity generation companies: ENEL, AES GENER, COLBUN, and ENGIE, most of which are publicly traded companies (Generadores de Chile 2017). The RE sector is not an exception: large-scale hydro power plants larger than 100 MW are mostly owned by these generation companies; similarly, the current PV boom in the Atacama Desert is based on utility-scale power plants with an installed capacity of at least 4 MWp run by international companies of which the biggest four have a combined installed capacity of 580 MW with an overall investment of EUR 1123 million (Electricidad 2017).

Distributed generation, regulated by Law 20.571—also called the "Net Billing" Act—with a cap set at 100 kW of installed capacity (CNE 2017b), in contrast is scarce, with a total of less than 12 MW installed since 2014. Larger distributed generation projects, up to 20 MW, accounted for just under 400 MWp by the end of 2017 (Electricidad 2018). Unsurprisingly, (co-)ownership in RE has been and still is limited. Although initiatives for community involvement have been promoted, real participation in developing, managing, and financing RE by communities has been rare. For the different sectors, the characterizing scale and ownership structure are as follows:

- Before the "Net Billing" Act small-scale RE systems had been programmatically installed only in the framework of the rural electrification programme 1994–2010 that increased access to electricity in rural areas from 50 per cent of households to 96 per cent providing more than 9000 families with access to electricity through RE, such as Solar Home Systems (SHS), wind and micro-hydro mini-grids (Opazo 2014).
- A total of nine cooperatives of RE are registered on the official web site of the Ministry of Economy, some in the form of worker cooperatives and others in services. The National Federation of Electric Cooperatives (FENACOPEL) consists of seven cooperative concessionaries that provide electricity to rural areas in central Chile where the other large energy distribution companies (EDCs) are not willing to supply electricity.
- Wind farms are present all across Chile, mainly owned by large private investors: ENEL, Latin American Power, Antofagasta Minerals & Pattern Energy, EPM, and Gamesa (Ministerio de Energía 2017b).

In the Aysén and BíoBío region, smaller privately owned projects of up to 10 MW installed capacity exist, namely, El Toqui, Cabo Negro, Lebu–Cristoro, Alto Baguales, Huajache, Raki, and Las Peñas (Acera 2018).

- Municipalities, schools, local companies, and private persons invest mostly in PV systems. It is estimated that 20,000 people in Chile produce electricity from green energy sources for their own use in an off-grid mode, while 2076 systems were registered for being connected to the grid by December 2017 (Ferron et al. 2016).[1] Another 100,000 houses benefit from on-grid or off-grid thermal solar systems in Chile (Ministerio de Energía 2017c).
- From the 31 biogas, biomass and particularly waste power plants in 2016, the majority operate in Southern Chile. As of 2018, the investors are principally energy companies, but also wood processing and pulp companies, farms, and water service companies (Acera 2018).

24.2 The Consumer at the Heart of the Energy Market?

24.2.1 Consumer (Co-)Ownership in Renewable Energy Sources as Policy Goal

Against the background of supply deficiency and citizen opposition against the construction of large-scale hydro power plants, the Ministry of Energy enacted Law 20.698 on the promotion of RE in 2013, which expanded the RES mandate.[2] This law stipulates that 6 per cent of the energy from generating companies with supply contracts signed after July 2013 had to come from RES other than large-scale hydro power plants in

[1] As stated by a representative of the Ministry of Energy in an interview from 12 January 2018.

[2] The first RES mandate was implemented in 2008 through Law 20.257, the so-called non-conventional RE Law, which defined the types of renewables considered as non-conventional and defined a progressive quota of renewable electricity generation from 5 per cent in 2014 up to 10 per cent in 2024.

2014, and that this quota will be progressively increased up to 20 per cent by 2025.

Nevertheless, numerous movements against energy projects followed, and ultimately paved the way for a participatory energy policy design process in Chile. The "Energy 2050" was developed through a participative process that lasted over 18 months (Garrido et al. 2015). "Energy 2050" aims at gaining technical, political, and social legitimacy through the involvement of energy experts, civil society, bureaucrats, and government officials (Alvial and Opazo 2018). "Energy 2050" set a shared vision of a long-term sustainable energy future which translated in a series of policy goals, of which the most relevant are a 70 per cent RE share in the electricity system by 2050 and the creation of partnership and shared value mechanisms between energy companies and communities (Ministerio de Energía 2015). Although the RE market is skewed towards international utility-scale projects, RE consumer (co-)ownership schemes have still been able to evolve both on-grid and off-grid.

24.2.2 Fuel/Energy Poverty and Vulnerable Consumers

Access to electricity has been a policy priority in Chile over the last 20 years. According to the Ministry of Energy only about 20,000 households had no access in 2014, and half of them were scheduled to get electricity service by 2018 (Ministerio de Energía 2014). However, electricity tariffs are among the most expensive in Latin America and inequality is still an issue in Chile, since the poorest part of the population is still lacking access to reliable electricity (Feron et al. 2016). Additionally, although the electrification rate is high, the quality of service is inadequate in many cases, particularly in rural and off-grid areas (see, e.g. Feron et al. 2016). In response to the inequality issue, "Energy 2050" includes a special chapter on indigenous communities, which aims to grant a participatory role to these communities in the definition of local energy policy, ratifying Convention No. 169 on indigenous populations and tribes from 2008. The projects will be based on RE, and the collection of information started recently for the Araucanía and Biobío regions in central-southern Chile (Ministerio de Energía 2017b).

Further inequalities in the energy sector have been recently tackled by Law 20.928, enacted in 2014, which is supposed to reduce the significant differences in energy tariffs across Chile. The Law forbids energy prices to diverge by no more than 10 per cent from national average for households that consume less than 200 kWh per month. The law further provides a discount to 63 counties where most of the country's energy is generated to acknowledge their contribution. The law establishes a cross-subsidy mechanism operated by distribution companies and financed by electricity consumers through a surcharge.

24.3 Regulatory Framework for Renewable Energy

The main statutory provisions regulating the RES sector in Chile are Law 20.698 on the "Extension Of The Energy Matrix, Using Non-Conventional Renewable Sources"; Law 20.257 "General Law On Electrical Services Regarding The Generation Of Electrical Energy With Non-Conventional Renewable Energy Sources", and Law 20.571, which regulates the payment of electrical tariffs for residential generators. The central authority is the Ministry of Energy, which oversees the development and coordination of energy policies. The National Energy Commission (CNE) has a technical role and is responsible for analysing and setting the sector's prices, tariffs, and technical norms, whereas the Superintendence of Electricity and Fuels (SEC) is the main public agency responsible for supervising the Chilean energy market.

24.3.1 Regulations for Connecting Renewable Energy Plants to the Grid

Law 19.940-2004 also known as "Ley-Corta I" stipulates that while plants below 9 MW are exempted from payment for using the grid, systems between 9 MW and 20 MW pay a proportional fee, and plants above 20 MW pay the regular utility fee. In 2005, Law 20.018 Ley-Corta II modified the regulatory framework of the electricity sector amongst others by guaranteeing the sale of electricity directly to customers not subject to price regulation on the spot market, by reducing or completely removing tolls for using the trunk transmission system for RE plants; by providing conditions for greater stability and security for the remuneration of energy from small generating plants, it established a more favourable scenario for the development of electricity generation projects for small RE units less than or equal to 20 MW (PNUD 2007).

The "Net Billing" Act allows regulated[3] consumers with RE installations smaller than 100 kW to generate their own electricity, consume it, and inject surpluses into the grid. The EDCs are obliged to allow the connection of the prosumers' RE power generators. The Superintendence of Electricity and Fuels (SEC) defines and supervises technical standards, authorizes electric installations and provision companies, and is the body where all prosumer installations must be registered. Government Decree No. 71 further defines the process of connection to the grid, its time frames, and the rights and obligations of both the prosumer and the EDC. Prosumers need to assure the compliance of the devices and their installations with technical standards[4] while the EDC must either install or supervise the installation, which the prosumer then must register with the SEC. So far, about 2000 RE installations of which all but one is solar PV systems have been registered with the SEC corresponding to about 12 MWp (CNE 2017b).

24.3.2 Support Policies (FITs, Auctions, Premiums, etc.)

To comply with the quota of 20 per cent of its energy stemming from RE by 2025, the Ministry of Energy conducts up to two public reverse auctions per year as stipulated in Law 20.698 on the promotion of RE with

[3] Understood as final electricity consumers whose electric load is less or equal to 2000 kW, and who are therefore considered to be subject to natural monopolistic electricity markets, whereas consumers above that threshold are considered free customers; customers with an electric load above 500 kW may choose which system (regulated or free) to be subject to (CNE n.d.-b).

[4] Prosumers need to send a request for connection to the EDC, which must respond within 5–30 days. If the prosumer agrees with the terms, the EDC delivers the contract, which specifies the tariff model that applies to the prosumer, the installed capacity, and technical specifications of the installation.

the bidding process regulated by Decree No. 29. For instance, in 2015, 12.430 GWh of electricity, of which two-thirds were solar and wind, were auctioned to 84 companies (Ministerio de Energía 2016b). Only the size of hydroelectric plants is further defined in the law, as they must be between 20 MW and 40 MW. Before 2014, RE were basically non-existent in Chile (except big scale hydroelectric plants), such that support policies for RE are a relatively new concept in Chile.

24.3.3 Specific Regulations for Self-Consumption and Sale to the Grid

Medium-sized RE generators with a nameplate capacity of up to 9 MW are subject to the General Law of Electric Services DFL-1 and its particular provisions for this matter: DS 244 of 2005 and modified in 2014. They underlie net metering with the option to either sell the energy according to the marginal cost of electricity or at a stabilized nodal price as regulated by the National Energy Commission (CNE) (Barrett et al. n.d.). The nodal price is calculated based on the average marginal costs, which implies that depending on historic marginal costs, it may fluctuate; in 2016 for instance, the nodal price was EUR 58.6/MWh, whereas the marginal costs amounted to EUR 42/MWh (CNE 2016).

Furthermore, the Net Billing Act stipulates that the EDCs must reimburse small-scale producers with less than 100 kW installed capacity for the energy fed into the grid; this includes prosumers that want to consume their own energy and sell excess energy. The price paid for energy fed into the grid is approximately 60 per cent of the price of the energy consumed from the grid, although this percentage may vary according to the difference between the nodal price paid by the EDC to the generator and the tariff charged by the EDC to the end user; the difference results from a fee paid by the prosumer to the EDC for the use of the grid to sell their energy. The law further stipulates that additional costs arising from the connection of the systems be borne by the prosumers; the benefit from the energy fed into the grid is either deducted from the user's bill, or it is carried over to the next month in cases where the prosumer generates a surplus. To further incentivise self-consumption, tax benefits are offered to construction companies for installing Solar Thermal Collectors (STCs) in new apartments.

24.4 Concepts for Consumer (Co-)Ownership in Practice

24.4.1 Contractual Arrangements and Corporate Vehicles Used

Although no prevalent definition exists of (co-)ownership in Chile, a variety of laws offer different options for citizens to generate their own energy. The code of commerce defines the Chilean forms of partnerships *Sociedad comercial* and *Sociedad colectiva*. Though legally allowed, partnership participation in RE projects has not been reported for energy generation projects. Limited Liability companies that are regulated under Law 3918 being restricted to 2–50 partners with each partner only liable up to his or her personal capital contribution, while no minimum amount is required are used. Furthermore, electricity distribution cooperatives[5] are active for whom per DFL-1 law it is mandatory to provide electricity to interested parties in a geographical area for which they own the concession even if a loss is expected.

Net Billing for instance can be used by individuals or by organized groups of people sharing an electric connection to the grid. In the latter case, when RE plants are installed on buildings that consist of several apartments with different co-owners, communal areas are owned by the whole group, and as such regulated under Law 19.537 on Real Estate Co-Ownership (GIZ 2016). As such, per Decree 46, an extraordinary co-owner assembly has to approve the proposed co-owned RE project requiring the support of at least 80 per cent of the voting co-owners and representing at least 75 per cent of the ownership interest in favour. In the off-grid sector, electrification projects for poor and isolated communities may take different organizational structures, including private, municipal or community managed models depending on the local conditions, the commitment of local government, as well as on the engagement of the community (Opazo 2014).

[5] The general Law on Cooperatives of 1978, was modified in 2016 (Law 20.881) highlighting inclusion criteria and aiming to facilitate management processes.

24.4.2 Financing Conditions for Consumer (Co-)Ownership in Renewable Energy

24.4.2.1 State Subsidies, Programmes, Credit Facilities, Preferential Loans

The Ministry of Energy has launched the energy programme *Comuna Energética encouraging municipal energy models*. These models must be designed by the community in coordination with all key players of the sector, including civil society. The counties need to define their local long-term energy strategy based on RE and energy efficiency, which entails executing a number of RE projects before 2030 to apply for funding. The 23 counties which successfully participated in the contest presented an energy strategy by April 2017, and the Ministry of Energy provides a total of CLP 2053 million, about EUR 2.6 million, for a two-year period under this programme (Ministerio de Energía 2017b). While the funding is dedicated to planning stage costs, the implementation of the programmes needs to be funded by the municipalities themselves.

Housing/social housing—Law No. 20.365 of 2009 provides tax benefits to construction companies for installing STCs in newly build houses, apartments and social housing units. STCs then are discounted from the income tax return of these companies. The discount rate depends on the value of the houses, but ranges between 20 and 100 per cent of the STC costs. Between 2010 and 2014, a total of 42,214 STCs were installed in properties, such that due to its success, the law was renewed and slightly modified for installations between 2015 and 2019 (Muñoz 2015). As of December 2017, more than 100,000 houses already benefited from this law, including 57,276 new houses/apartments, 5638 refurbished houses, and 37,290 social housing units (Ministerio de Energía 2017c).

The government established the *National Fund for Regional Development—Rural Electrification (FNDR-ER)* in 1994 to electrify poor and remote households in rural areas of the country with a funding volume of CLP 122,700 million (EUR 165 million) between 1995 and 2008. Thanks to these funds, the electrification rate increased from about

50 per cent in 1994 to 96.5 per cent in 2011 (Argomedo 2012). Aiming to address energy poverty that persists for community services of rural areas, the Rural and Social Energization Program (PERYS) was launched in 2008 and planned until 2020 in cooperation with regional governments, municipalities, different ministries, and National Services (Ministerio de Energía 2017d). It consists of three main scopes: (1) to electrify rural public schools and health centres; (2) to implement small-scale demonstration RE projects and in turn raise technology awareness; and (3) to strengthen the capacities of municipalities, regional governments, and other public entities for deploying and operating RE projects (Ministerio de Energía 2017d). The pilot programme's budget amounted to EUR 700,000 (IEA 2013) while the yearly budget needs to be annually approved and therefore varies. Between 2013 and 2018, CLP 26 billion (about EUR 37 million) were assigned to PERYS (DIPRES 2018). Between 2014 and 2017, 70 rural schools and 24 rural medical centres were provided with electricity; moreover, 13 demonstration projects based on RE were implemented in 2015 and 2016 including thermal energy for schools and medical centres, benefiting more than 6150 students (Ministerio de Energía 2017d).

Furthermore, in 2012/2013 the Ministry of Agriculture launched "National Program of Photovoltaic Pumping" with a budget of almost CLP 3.800 billion (about EUR 5.5 million) within its Agency for Agrarian Development (INDAP), which promotes the substitution of water pumps powered by diesel generator with PV-powered pumps. INDAP funds up to 90 per cent of these pumps, including the installation costs, with a total amount of up to CLP 6 million, which equals to about EUR 8100 for families, and CLP 10 million, which equals to about EUR 13,500 for small business (Ministerio de Agricultura 2013). For the remaining 10 per cent, additional credits are available (Feron et al. 2016). The number of beneficiaries amounted to over 1500 in 2013 (Ministerio de Agricultura 2013).

Specific technologies—Given the large potential in Chile for geothermal energy, direct financial support has also been provided in this area; in 2016 subsidies amounting to a total of EUR 26 million were granted by the Clean Technology Fund (CTF) for the "Cerro Pabellón" project, aiming to mitigate risks when drilling geothermal steam field wells. The power capacity of Cerro Pabellón amounts to 48 MW, and is expected to generate about 340 GWh electricity per year to be fed into the grid (Ministerio de Energía 2017e). Since 2012, the Chilean government has furthermore given significant financial incentives for pilot programmes based on RE, through the "Support for Non-Conventional Renewable Energy Development Programme" (IEA 2013b). For instance, this programme subsidizes the construction of a Concentrated Solar Power (CSP) plant amounting to EUR 17.5 million (CORFO 2017a), or the EUR 10.5 million funding programme for the development of Solar PV technologies adapted to desert climates and high radiation (CORFO 2017b). Yet, as compared to the total resources spent on RE in Chile, after a period of strong public investments before 2009, public investment in 2015 was relatively lower (García 2016).

24.4.2.2 Agencies Supporting Investment in Renewable Energy Sources

The Ministry of Energy has established an online platform, which offers a search tool for citizens trying to find funding for their RE projects. The platform, which is updated every month, joins funding opportunities for small-scale RE projects from various public institutions, including the Ministry of Housing, INDAP, the Technical Service Cooperative (SERCOTEC), the National Irrigation Commission (CNR); and the Cooperation of Promotion for Production (CORFO). The Ministry of Environment also fosters RE through its competitive fund for environmental protection (FPA), which was established by Law 19,300 to support citizen initiatives such as neighbourhood meetings, cultural and environmental groups, NGOs, and associations. Although in recent years educational initiatives promoting ecological and energy cooperatives were carried out in several counties, their scope is still incipient. In October 2017, the first energy community fair organized by the Energy Ministry was held, where more than 500 projects led by municipalities and local communities were shown. These projects are currently seeking public or private funding (Comuna Energética 2017).

In addition to the government, a major facilitator of RE for communities has been the University of Chile, particularly for indigenous communities with a programme based on micro-grids substituting diesel power with solar and wind combined with smart-farm technologies[6] (Cárdenas Dobson et al. 2015).[7] Funds for these projects have been approved either by public funds such as CORFO or diverse research projects, or by the private sector, that is, usually the mining industry in northern Chile motivated by corporate social responsibility (CSR). These projects are characterized by a strong engagement of the communities. For instance, locals are introduced to technical details of the project, but also become responsible for the management of the micro-grid. Other non-governmental efforts have also been made to foster (co-)ownership, although these can still be considered pilot projects. The Ecological Policy Institute (Instituto de Polítia Ecológica), for instance initiated a citizen initiative that aims to set up a 10 kWp PV system funded by citizens who are willing to invest in shares of that plant (Camino Solar 2016). In turn, they receive the profits from selling the energy to a local partner or to the grid (Camino Solar 2016).

In general, a favourable attitude towards RE is wide within the elites linked to the energy and mining sector, including local community leaders, as studied in different regions of Chile (e.g. Parker 2018). Moreover, the RE is promoted by NGOs such as the Chilean Association of RE (ACERA) and the Chilean Association of Solar Energy (ACESOL). In addition to informing their members and general society about RE, for example, by providing courses on RE, organizing events and exhibitions, these associations also aim to actively shape the energy policy to reflect their interests.

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[6] Smart farming is based on Information Communication Technologies (ICT) and big data analytics aimed at increasing crop productivity by conducting electronic monitoring of crops, environmental, soil, fertilization, and irrigation conditions.

[7] Micro-grids have already been installed in Aacondo, (Tarapacá region); Ollagüe (Antofagasta region); El Romeral (Coquimbo region), and Robinsoe Crusoe Island (Valparaíso region) (Aracena and Farías 2013).

24.4.3 Examples of Consumer (Co-)Ownership

I. COCHAMO—Though cooperatives are one of the most frequently used legal forms of doing business in Chile and are common in RE project planning, consultation, and installation of RE plants, they are still unusual for energy generation projects. In the off-grid rural electrification sector, for example, four mini-hydro plants with a nameplate capacity of 145 kW, 19 kW, 19 kW, and 17 kW were installed in 2010 with an initial investment sum of EUR 2.6 million in the Cochamó parish in the Los Ríos region. The installations are owned by the Chilean Ministry of Energy yet managed and maintained by an electric cooperative and supply 132 households and 15 public buildings (DAEE 2010).

II. SOLAR BUIN 1—Since the RE boom in Chile is mainly driven by international utility-scale projects, the Ecological Policy Institute has launched a project called “Solar Buin 1” to foster the involvement of civil society in energy projects. Founded as a hybrid configuration with a private corporation managed by the cooperative *Enercoop Metropolitana,* this initiative received assistance from the German development agency GIZ and is supervised by the Institute of Political Ecology. It consists of a 10 kW solar power plant generating approximately 15,300 kWh of electricity per year. Seventy-five per cent of the generated energy is aimed at self-consumption, while excess production is fed into the national grid under the Net Billing Act (Camino Solar 2016). The initial investment in the plant was approximately EUR 16,200 and divided into 240 shares of EUR 67 each (Futuro Renovable 2017). The members who are citizens from many different cities in the country purchased a total of 240 shares via crowdfunding (CLP 12 million which is about EUR 17,700) to finance the installation of the solar plant in December 2017. Projections set out a 2 per cent return on investment. This income is distributed annually after the assembly meets every December. Each member is allowed to hold a maximum of 10 per cent of the total shares. After its commercial operation in the first 10 years, the plant will be owned by the shareholders, while main energy consumer during the first 10 years is the Technological Center for Sustainability (CTS), where the panels are installed. The model of this project is planned to be scaled and replicated in other localities (Camino Solar 2016).

III. HUATACONDO—Micro-grid projects conducted by the University of Chile and funded by the mining company Doña Inés de Collahuasi, have already been operational for several years. The Huatacondo micro-grid project in northern Chile with an initial investment sum of EUR 373,676 for instance consists of a hybrid system that contains a 22.68 kW solar plant, a 120 kVA diesel group, and a 129 kWh storage system. The importance of the active involvement of the community has been iteratively repeated in numerous studies, as it does not only assure that the project is designed according to the community's necessities, but also allows community members to do some basic maintenance on the system (see Aracena and Farías 2013; Cárdenas Dobson et al. 2015; Jiménez-Estévez et al. 2014; Hernández and Vargas 2016). Thanks to the micro-grid, diesel consumption in Huatacondo decreased by about 50 per cent, and power reliability improved, which ultimately also had a positive impact on the economic development of the village (Jiménez-Estévez et al. 2014). Yet, the community members did not fund any of the investment costs, nor do they pay for the energy, as only a monthly fee of about EUR 3.5 is charged for emergencies; labour costs are covered by the municipality.

IV. ENERCOOP AYSEN—Under the national energy community programme more than 500 RE locally based projects (http://www.minenergia.cl/comunaenergetica/?p=1813) are in different phases of developing commercial models and funds through assistance and certification from municipalities. One of the first RE cooperatives in Chile is Enercoop Aysén located in the city of Coyhaique. A large part of its members, circa 98 people in total, comes from the mobilisations against the construction of large hydro dams in Patagonia. After these hydro projects were halted the cooperative as a political collective is planning a local development project locally known as Aysén Reserve of Life, which aims for 100 per cent renewable energies for auto-consumption (Walker and Baigorrotegui 2016). Enercoop Aysén has made educational and public policy participation in voluntary activities at multi-levels possible. In its assembly of December 2016, the necessity to a proper model to manage a collective (co-)ownership generation project was discussed (Baigorrotegui 2018).

24.5 Factors Affecting the Financing of Renewable Energy Sources and Barriers to Consumer (Co-) Ownership

24.5.1 Political, Legal, and Administrative Factors

With the enactment of the Net Billing Act in October 2014, the Ministry of Energy expected to trigger more decentralized generation based on RE. Yet, since its implementation, less than 2000 systems have been installed, including installations on public buildings. A major issue of this law is the price received by the regulated prosumers with an installed capacity smaller than 100 kW for feeding their excess electricity into the grid, corresponding to 60 per cent of the tariff customers pay for electricity (see below Sect. 24.3.3).

The administrative burden of acquiring the licence for grid connection was high in the past, as the process was lengthy and uncertainties regarding evaluation remained. To address these obstacles, regulation DS 244 was modified in 2015. This modification aimed to simplify the process of registering a RE plant by reducing the permit periods for small-scale projects with no significant impact on the grid; by cutting red tape for the connection process, and by making the application documents available online. As a result, the time of the approval process was reduced by a factor of four, and this is expected to substantially increase the number of prosumers (Ministerio de Energía 2016a).

24.5.2 Economic and Management

Energy Service Companies (ESCOs), which offer services that range from funding, planning, and installing to operating power plants, are not directly regulated under Chilean Law (GIZ 2016). Financial mechanisms are moreover scarce for ESCOs (Barrett et al. n.d.). Aiming to improve the financial conditions for prosumers, the GIZ has elaborated a business model for energy companies to develop ESCOs (GIZ 2016). Yet, although some energy companies, currently 17, already offer these ESCO models to their clients, they are not yet widespread in Chile (Ministerio de Energía 2016a).[8]

The vast majority of the prosumers that have made use of Law 21.571 have opted for PV systems. Yet, the "hard costs", that is, PV hardware, of these systems are higher in Chile than in other markets; this can be attributed to the lack of domestic manufactures, leading to the intervention of wholesalers, as well as to a lack of economies of scale (Barrett et al. n.d.). Although previously the capital accumulation due to the high initial costs of RE plants may have been a significant barrier for households to invest in RE, recent financial innovations in Chile (see, e.g. http://www.sunplicity.cl) make the installation of PV systems more affordable, as companies take over the financing of the initial costs and the installation of PV solar systems. The households pay off the initial investment by paying monthly instalments instead of their electricity bill.

Concerning the off-grid sector, the micro-grid projects implemented by the University of Chile are exclusively funded either by public funds or by donations from the mining industry (Hernández and Vargas 2016). Moreover, the University of Chile remains responsible for the maintenance in case of complex technical issues, as experts are hard to find in small rural areas. The local lack of experts also holds true in the case of SHS in remote and disperse areas of the country. Indeed, due to a lack of local technical know-how, SHS have been often abandoned (Feron et al. 2016).

24.5.3 Cultural Factors

A recent research project in three counties of Chile, Coyhaique in Southern Chile, San José de Maipo in the Metropolitan Region and Copiapó in Northern Chile, revealed that adoption of clean energy technologies is still incipient. On average, only 8 per cent of the social leaders

[8] As opposed to the Energy Efficiency sector, which has made great progress in terms of Energy Service Companies (ESCOs) on behalf of the National Association of Energy Efficiency Companies (ANESCO).

consulted apply solar PV or RE for electricity or heating in their homes. In most of the studied cases, a prosumer culture and relevant experience socialized within the local population is non-existent or very incipient, yet of high potential. Although the opinion on (co-)ownership was not a topic in this research, the oral interviews with local leaders in these counties reveal a very favourable attitude towards the idea of partnering to promote RE.[9] There is, however, no experience in generalized (co-)ownership and, on the other hand, private property in the energy sector has been a source for mistrust. In this context, it is important to note that in many cases local communities rejected RE projects. This has been the case with several indigenous communities in certain regions that opposed investments in hydro, wind or PV generation. When the energy solution is implemented by large private companies without opportunity for participation, resistance of the local population arises (Hernándo and Blanco 2016).

However, in the off-grid sector, socio-cultural challenges have also been reported. As stated above, the participation of the community is vital for micro-grid projects. Yet, asymmetric relationships between its members, as well as the lacking communication between the technicians and the community have impeded the participation of the whole community (Hernández and Vargas 2016). Similar experiences were reported for wind energy projects in Chiloé, where the communities rejected the projects.[10] The main reason was that people expected a negative impact on the environment and local productive activities, and showed mistrust towards institutions and investors (Garrido et al. 2015). The top-down planning was a major issue; neither local governments nor the population were involved in the planning (Opazo 2014). In any case, (co-)ownership

[9] 20 interviews in Copiapó, 16 interviews in San José de Maipo and 20 in Coyhaique to local avowed leaders. Cfr. National Fondecyt Research 1150607.

[10] In order to take advantage of the excellent wind conditions in Chile, the Chiloé Wind Park Project (PECh) aimed to construct and operate 42 wind turbines of 2.4 MW each, with a total power capacity of 100.8 MW (Garrido et al. 2015). Its energy was meant to be fed into one of the four main electricity interconnected systems in Chile (Garrido et al. 2015). Although the Chilean-Swedish Company Ecopower declared that the selected area Mar Brava was an unprotected and uninhabited area to avoid an evaluation of environmental impacts, about 5000 persons including three indigenous communities inhabit that area (Garrido et al. 2015).

was not considered as a tool for achieving a more favourable attitude from the local communities.

Another major cultural barrier for RE is short-term mindset of the Chilean population in general. The reduced price paid to the prosumers for selling their energy excess results in a relatively long payback period of approximately nine years in the case of PV systems (Barrett et al. n.d.). The extremely short time horizon of Chilean citizens concerning their investment decisions makes these technologies unappealing (Feron et al. 2016). Indeed, although the Chilean population seems to be aware of the potential of RE, their expectations on the technology are unrealistic, since they would request a return of investment of below five years (Bennett et al. n.d.).

24.6 Possible Future Developments and Trends for Consumer (Co-) Ownership

Although the "Net Billing" Act has the potential to increase distributed generation, given the short time horizons of the Chilean population for investments discussed before, it seems that a massive adoption is unlikely in the near future. (Co-)ownership projects like the Solar Buin 1, though profitable, remain the exception and seem hard to expand on a large scale, as they depend on efforts from motivated individuals. Instead, the approach used for the installation of STC, that is tax benefit granted to construction companies for installing the systems on buildings, seems to overcome many of the obstacles faced by individuals, as the construction company would take over the lead for the installation.

Another opportunity lies in the expansion of ESCO models. If the companies manage to take over full management, that is, looking for funding institutions, installation, and operation of the systems, they may become a viable solution for potential Chilean prosumers. Medium-voltage generators are subject to the net metering approach, which makes the investment more attractive than the net billing approach for citizen consumers. Moreover, these investors are more likely to be better informed and willing to take decisions based on a longer time frame. Hence, with the development of ESCOs and matching financial services, these businesses are much more likely to become (co-)owners.

In the off-grid sector, micro-grids and SHS can be a promising energy solution for isolated communities. However, a major challenge of these projects is the fact that the communities usually lack local know-how and the infrastructure to operate the systems. Given the difficult access to the remote communities, investing in these projects is unprofitable for private energy companies. Moreover, the communities are generally poor, and therefore hardly able to cover the full operational and maintenance costs, not to mention the initial investment. Lessons from the successful PV-powered pump programme sponsored by INDAP suggest that a decentralized rural electrification agency is necessary for ensuring the sustainability of rural electrification projects based on off-grid systems, micro-grids, or SHS.

In any case, the opposition of local communities against energy projects in recent years have shown that energy policies need to consider the cultural and local circumstances, and should foster the participation of citizens. Unfortunately, with the exception of isolated initiatives, RE projects have most commonly been planned and imposed by the public sector, thus disregarding the opportunities that community engagement and (co-)ownerships may offer.

Against this background, and considering the poorly developed (co-)ownership segment in Chile in which consumers are conferred ownership rights in RE projects, policies that empower consumers and put them to the forefront should be fostered. In this regard, possible policies include (1) the Production Development Corporation (CORFO), a governmental organization founded in 1939 to promote economic growth could provide funds aimed at distributed generation; (2) an agency that remunerates certified goals of annual energy efficiency could act beside CORFO to promote and fund communal energy efficiency projects under mandatory plans; (3) social development corporations, that is, private non-profit associations, usually situated in municipalities could act as an intermediary between municipalities and groups of prosumers; (4) the Ministry of Energy in collaboration with the Municipalities could promote and create awareness of the concept of (co-)ownership; (5) ESCOs should be directly regulated under Chilean Law; (6) in rural areas where private energy companies are usually not operating due to unprofitability, CORFO or the Ministry of Energy may create a rural electrification agency for providing technical and financial support to community cooperatives, and reach out to and engage potential prosumers.

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Asia

25

Consumer (Co-)Ownership in Renewables in India

Satyendra Nath Mishra and Jens Lowitzsch

25.1 Introduction

25.1.1 Energy Mix

With an energy consumption growth of 4.6 per cent in 2016, India is the third largest consumer of energy in the world after China and the United States (Energy Yearbook n.d.). The future demand for energy in India will only increase considering the rising economic activities, urbanization and incremental spread of basic amenities in rural areas. Since economic liberalization in the 1990s, India's primary energy consumption has doubled to a level of 775 million tons of oil equivalent. The major source for energy in India is coal with 44 per cent share of total primary energy consumption, followed by traditional biomass with 24 per cent, petroleum

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oil with 23 per cent, natural gas with 6 per cent, nuclear with 1 per cent, hydropower with 2 per cent and other RE with less than 1 per cent (IEA 2016; IEA 2015a).

The growing demand for electric energy in the power sector puts a lot of pressure on the conventional energy sources used for electricity generation, that is, coal and large-scale hydropower. In 2017, the total installed capacity of electricity generation in India was 330,861 MW. Of this, the private sector produced 44.5 per cent followed by Government of India (GoI)-owned production facilities with 31.1 per cent, while state governments produced the remaining 24.4 per cent. Coal contributes 58.3 per cent of total installed capacity followed by large hydropower plants with 13.6 per cent, gas with 7.6 per cent, nuclear with 2 per cent, oil with 0.3 per cent and RES with 18.2 per cent (Ministry of Power 2018). By the end of 2017, the cumulative RE electricity production in India was 60,158 MW (MNRE 2017a), which constituted a 66 per cent increase compared to the previous year (Live Mint 2017); the off-grid capacity thereof is only 2 per cent and sourced mostly by biomass, that is, non-bagasse cogeneration with 42 per cent and solar photovoltaic (SPV) systems with 36 per cent (MNRE 2017a). Excluding large-scale hydropower, the grid-interactive RE electricity capacity is sourced by wind power with 52.27 per cent, ground-mounted solar with 25.57 per cent, bio-power including biomass, gasification and bagasse cogeneration with 13.39 per cent, small hydropower with 7.03 per cent, solar rooftop with 1.56 per cent and waste to power with 0.18 per cent (MNRE 2017a).

25.1.2 Main Challenges of the Energy Market, National Targets and Specific Policy Goals

In 2017 India is the world's fastest growing economy with the level of urbanization having increased by 31.2 per cent in the last decade; about 69 per cent of the population residing in rural India still lacks regular and required access to electricity (Census of India 2011; Jain et al. 2015) while per capita energy consumption of India represents only one-third of the global average (USEIA 2016). Considering the existing social and economic conditions with spatial-temporal variation in energy requirement of its population, India needs innovative solutions to address the challenges of energy production and distribution. India's draft energy policy of 2017 set up four key objectives: (1) access to energy at affordable prices, (2) improved security and independence from import, (3) greater sustainability and (4) economic growth (Niti Aayog 2017). To fulfil these objectives, measures were initiated to reduce electricity transmission and distribution losses as well as theft and to improve fiscal discipline of distribution companies across states; furthermore, subsidies in petroleum produce were reduced, the regulatory burden for the installation and distribution of power decreased and incentives for renewable energy technology and production introduced (USEIA 2016). However, India is also facing challenges in terms of increasing net imports of crude petroleum oil, which rose from 42 per cent in 1990 to about 75 per cent in 2015 (USEIA 2016). By 2022, the federal government has set the target for reducing the oil and natural gas import by 10 per cent (ToI 2015).[1]

For all the RE objectives set for the year 2017–2018, grid interactive and off-grid, only SPV power generation target of 100 MW off-grid was achieved.[2] This shows the bottleneck that exists in the implementation and policy design of RE in India. The issues of implementation are compounded as implementation of RE at the village, block and district levels is left to the state governments, while the role of the federal government is limited to providing broad policy guidelines and incentives to actors. Major obstacles exist in the fulfilling the RE target of 175,000 MW by 2022 as proposed by the federal government (PIB 2016). This is to be partially achieved by a five-fold increase in installed wind capacity compared to 2015 levels (Buckley 2015). The large areas of land needed for wind and ground-mounted solar generation facilities are an obstacle to implementation of new projects in any state of India, when superimposed

[1] After liberalization India has also been burdened with increasing coal imports for power generation and demand from the iron and steel industry for coking coal. In 2015, India surpassed China in terms of import of coal (~226 million tons). However, after 2015 the growth in import was reduced to 5 per cent due to facilitative domestic policies (IEA 2015b).

[2] All the figures are till December 2017 (MNRE 2017a). The success of off-grid SPV lies in the very nature of socio-economic fabric and power scarcity in India as it provides access especially in rural area to electricity for lighting, ventilation, cooling, charging, irrigation, street lighting, educational institutions and so on.

with the limitation of areas with proper wind speed and solar light availability. Off-grid RE options face challenges in terms of access to technology, proper financial support to sustain power generation beyond project implementation period, people's acceptance, access to biomass and proper markets for biomass procurement.

25.1.3 Ownership Structure in the Renewable Energy Sector

From India's Independence to the time of economic liberalization in the early 1990s, a state monopoly was in place for power generation, transmission, trading, financing, planning and regulation. After the 1990s, a paradigm shift set in with various state electricity boards unbundling production, transmission and distribution of power. The initial phase of liberalization in 1991 which created space for independent power producers (IPPs) faced its own challenges, like financial arrangements, issue of litigation, fuel supply and the role of SEBs (D'Sa et al. 1999) with implications on the slow growth of RE in India in the 1990s. In 2017, the total installed capacity of RES was about 57,260 MW with the private sector contributing 97 per cent of capacity and state governments the remaining 3 per cent (CEA 2017). Although the main actors in the RE sector are private, in some cases projects as, for example, a large solar park of capacity 500 MW, like "Shakti Sthala",[3] are government supported by land allocation and implemented in partnership with private players (GoI 2017; ToI 2018).

In rural India, due to the remoteness of area and lack of proper physical infrastructure for power distribution, over 400 million people still do not have regular access to electricity. Although in these areas the "RE option" has a large potential, the design, implementation and ownership of RE installations depend a lot on the type of use like street light, family use biogas, solar water heating, solar cookers, wind pumps, solar

[3] 'Shakti Sthala' project started in Karnataka. It spans across 13,000 acres spread over five villages. The park development is supported by the Karnataka Solar Power Development Corp. Ltd (KSPDCL) as joint venture between Karnataka Renewable Energy Development Ltd (KREDL) and Solar Energy Corporation of India (SECI) (ToI 2018).

irrigation pumps, micro hydel plants, solar lanterns for lighting or for small/micro enterprise (MNRE n.d.-a). Together with the wide variation in capacity and distribution of RES across the country, this poses challenges to policy making. Detailed information on the ownership structure in the RE sector are not available. Examples from the most important RE sectors are as follows:

- Private investments in large wind farms[4] with policy support from States exist with projects built by IPPs (GWEC 2016). There are also small wind parks (like Odanthurai village council in Karamadai Block, Coimbatore District, Tamil Nadu) implemented by village councils (VC). The Odanthurai project was financed by VC savings, loan from commercial bank and with technical support from government (ENVIS n.d.).
- Small hydropower installations were set up in hilly states with capacity less than 25 MW (CES 2017)[5] supported by the State government with the involvement of village level institution, like the SHP potential in Ladakh region (Pareek et al. 2007) and in the state of Himachal Pradesh.
- The largest rooftop SPV plant with a nameplate capacity of 7.52 MW was installed at Larsen and Toubro in Punjab as a PPP with the generated electricity fed into the local grid through the state distribution company (MNRE n.d.-b). Decentralized SPV installations for lighting, irrigation, village use and other household purpose with capacities varying between 40 Wp and 500 kWp supported financially by the federal government with ownership by individuals of beneficiary households or local institutions like village councils (MNRE n.d.-c).
- In most cases, biomass based off-grid cogeneration units are owned by the producer while energy from waste under municipalities is promoted by the GoI or State governments, for example the Narela-Bawana plant in New Delhi (Sharma 2017).

[4] In particular in states like Tamil Nadu with 7614 MW, Maharashtra with 4654 MW, Gujarat with 4038 MW, Rajasthan with 3994 MW, Karnataka with 2869 MW, Andhra Pradesh with 1431 MW and Madhya Pradesh with 2141 MW (CSO 2017)

[5] In India, small hydropower plants with capacity of less than 25 MW are considered as renewable (MNRE 2009).

25.2 The Consumer at the Heart of the Energy Market?

25.2.1 Consumer (Co-)Ownership in Renewable Energy Sources as Policy Goal

There is no clearly defined concept of consumer (co-)ownership of RES in the Electricity Act of 2003. However, to promote RE both federal and state governments provide facilitative measures through schemes, incentives and so on for consumer (co-)ownership at varying levels. This is often limited to pro-active support of state and donor agencies for rural users. As the RE sector—in particular wind parks, cogeneration, large SPV parks and so on—is dominated by the interests of commercial actors there seems to be little space for policies supporting individual consumer (co-)ownership in RE except for "captive power generation" for self-consumption for commercial or industrial use.[6] Pursuant to section 3 of the Electricity Rules of 2005 to be qualified as Captive Generation Plant (CGP) requires a minimum of 26 per cent ownership stake in the RE installation held by the captive users which have to consume at least 51 per cent of the aggregate electricity generated; in case the RE power plant is set up by a registered cooperative or an association, these conditions have to be satisfied collectively by their members (MoP 2005).

In 2011 to support the Jawaharlal Nehru National Solar Mission, a joint initiative of the federal and state governments to promote solar power, the Solar Energy Corporation of India (SECI) was established under the Ministry of New and Renewable Energy (MNRE). The mandate of the SECI is to fulfil the target of generating 20,000 MW power and connecting it to the grid by 2022 which also includes support to solar rooftop PV systems. In rural areas, decentralized off-grid RE installation are implemented, most of which are triggered by social policies—usually off-grid electricity production from SPV, biofuel, biogas, small hydro power units, cogeneration from waste and so on—are project

[6] A good example is the sugar industry which even has a separate quota of Renewable Purchase Obligation (RPO) under non-solar RES (Krishnan 2015).

based, with public financial support be it from the government or donor agencies. However, consumer ownership has not been an explicit issue and the involvement of the local community and its consumers often has been limited to day-to-day operation and maintenance of the installations without transferring ownership rights to them. In many cases it was found that the RES projects were halted as budgets for funding, operation and maintenance or technical supports dry out, which is directly linked to the vulnerable nature of the local socio-economic profile of rural users (Gambhir et al. 2012; Mishra 2016).[7]

25.2.2 Fuel/Energy Poverty and Vulnerable Consumers

Access to energy especially in rural areas is closely linked with social-economic development and a tool to alleviate energy poverty, one of the prerequisites to fulfil the Sustainable Development Goals (UNCSD 2012). Biomass, that is, mainly wood fuel, dung, agricultural waste and so on, still fulfils about 90 per cent of energy need in rural India. Most of the biomass is used in rural areas and biomass contributes about 30 per cent of the total primary energy requirement (~565.93 mtoe) of India. In the year 1999–2000, the rural population which amounts to about 72 per cent of total households used nearly 90 per cent of biofuels (~172 million tonnes) and 74 per cent of kerosene (~13.75 million kilolitres), while the urban population consumed about 68 per cent of LPG and about 65 per cent of electricity. This is direct evidence that energy sources other than biomass, which are often associated with health risks when used for cooking and heating, are unavailable to and unaffordable for the lower strata of rural India (Pachauri et al. 2004; Reddy 2004). The accessibility and availability of energy resources in urban area is helping the consumer to move up on the energy ladder while in rural areas there is still huge gap to be addressed.

Public policy approaches to alleviate energy poverty focus on large-scale programmes. The federal governments flagship programme (Ujjwala Yojana, http://www.pmujjwalayojana.com/) to provide Liquefied

[7] A comprehensive review was made by Prayas Energy Group on "Decentralized Renewable Energy Micro-grid in India"; for details see Gambhir et al. (2012).

Petroleum Gas (LPG) connection to below poverty line families addressed the drudgery in rural area for cooking fuel with about 33 million families across 713 districts benefited from the scheme till the end of 2017. However, this addresses only the partial issue of energy poverty dimension leaving behind the issue of electricity access and issue of heating in cold weather, which is tackled by the programme Deendayal Upadhyaya Gram Jyoti Yojana (DDUGJY, http://ddugjy.gov.in/mis/portal/index.jsp) launched by the federal government in 2015; in April 2018, out of 597,464 census villages, 597,222, that is, 99.9 per cent, had been electrified under DDUGJY. Furthermore, to provide regular access of electricity to each household, the federal government launched Pradhan Mantri Sahaj Bijli Har Ghar Yojana, dubbed "Saubhagya" in September 2017 (http://saubhagya.gov.in/). The programme, with the Rural Electrification Corporation as its nodal agency, targets about 40 million un-electrified households in the country planning to provide free electricity connections to all households, both above poverty line and poor families in rural areas and poor families in urban areas by December 2018. The access to energy to the users in rural area is still and will be a challenge in near future, especially for low income and landless people, who are still largely dependent on biomass based fuel.

25.3 Regulatory Framework for Renewable Energy

The development of grid-interactive renewable power took off with the coming into force of the Electricity Act of 2003 (MoL&J 2003), the statutory provision for regulation of RES.[8] The National Tariff Policy 2006 requires the State Electricity Regulatory Commissions (SERCs) to fix a minimum percentage of Renewable Purchase Obligation (RPO).[9]

[8] Among others, it stipulates regulatory interventions for the promotion of RES through (1) determination of tariffs; (2) specifying renewable purchase obligation (RPO); (3) facilitating grid connectivity; and (4) promotion of development of the market.

[9] Currently pursuant to the 'Central Electricity Regulatory Commission's Terms and Conditions for Tariff determination from Renewable Energy Sources Regulations 2017' for all types of RES.

25.3.1 Regulations for Connecting Renewable Energy Plants to the Grid

The Generating Company or Distribution Licensee in coordination with Central Electricity Regulatory Commission (CERC) connects RES projects to the grid pursuant to the model guidelines.[10] Agencies are involved in running daily operation and providing RE to grid to fulfilling the mandatory RPO. The Ministry of Power (MoP) issued a guideline to the state distribution companies to draw at least 2.75 per cent of total power consumption from solar plants under the mandatory RPO with the final target left to each state's electricity regulatory commission (SERC), which between 2013 and 2016 varied from 0.25 per cent to 1 per cent in the solar sector (CEA 2013).

The federal government has regulated grid connectivity of SPV units and CGP in a distinct way. Rooftop SPV installations with capacity below 10 KW do not require permission. If the capacity of rooftop SPV exceeds 10 KW, then permission is required from the local distribution company, as per the guidelines of the SERC. To avoid congestion in the local grid, restrictions on supply to the grid were enacted, which vary from state to state.[11] CGP on the other hand do not require an operating licence and they are not liable to pay surcharge over and above transmission and/or wheeling charges for carrying the generated electricity from its plant to the destination of auto-consumption or for the use of its members (MoL&J 2003).

25.3.2 Support Policies (FITs, Auctions, Premiums etc.)

In 2011, the GoI launched the Renewable Energy Certificates (REC) as a market based instrument to promote RE and facilitate compliance with the RPO addressing the mismatch between availability of RES

[10] These projects include CGP generating electricity from RES such as small hydro, wind, solar including its integration with combined cycle, biomass, biofuel cogeneration and urban or municipal waste (CEA 2013).

[11] For example, in Tamil Nadu grid connectivity of rooftop SPV is restricted to 30 per cent of the distribution transformer capacity on a first-come-first-served basis; the supply given to the grid in this way does not qualify for the REC as it is counted as part of state distribution companies' RPO (EAI n.d.).

across States and the obligated entities with one REC being treated as equivalent to 1 MWh (Shrimali and Tirumalachetty 2013). Based on a quota system, plant operators producing electricity from RES receive REC as tradable certificates of origin for each MWh produced and electricity suppliers are obliged to acquire certificates.[12] Besides the REC system no single federal support system for RE exists. However, different national and state-level initiatives encompass FITs, mandatory renewable purchase obligations (RPO), net metering (see section c below), bundling RE with thermal output, accelerated depreciation schemes and preferential financing conditions (IEA 2015a). Furthermore, tenders and auction mechanisms for solar and wind energy have been introduced. In 2016 SECI tendered 4307 MW for large-scale solar projects with 675 MW commissioned and 200 MW for SPV rooftop projects with 46.5 MW commissioned (MNRE n.d.-d). By the end 2017, India had a RE capacity of 60,158 MW (MNRE 2017a) of which by 12 April 2018 only about 5568 MW was accredited under REC (REC Registry India 2018) indicating that the remaining RE capacity was implemented under FITs, auctions and through captive power generation instruments.

An example of FITs for small hydropower plants is the state Himachal Pradesh (HP), where by 2015, 655 small hydroelectric projects up to 5 MW capacity with an aggregate capacity of 1.6 GW have been realized under a FIT regime. The HP Electricity Regulatory Commission has divided the SHP projects into three capacity categories with differing levelized tariffs, that is, (1) INR 3.20 from 100 kW to 2 MW, (2) INR 3.13 from 2 MW to 5 MW and (3) INR 3.04 per kWh from 5 MW to 25 MW. Within these tariffs, variations exist depending on whether or not an adjustment of accelerated depreciation benefit was made accounting the capital subsidy provided by the MNRE (HPERC n.d.).

[12] Pursuant to the CERC Terms and Conditions for recognition and issuance of Renewable Energy Certificate for Renewable Energy Generation Regulations of 2010 (as amended; last 16 March 2018).

25.3.3 Specific Regulations for Self-Consumption and Sale to the Grid

With regard to small or micro installations in particular in SPV, electricity generated can be fed into the grid at a regulated FIT or used for self-consumption with a net-metering approach. With gross metered self-owned systems, the owner pays for the consumption and receives revenue from generation; net metered self-owned on the other hand receives government supported funding to manage debt and equity.[13] The 2014 guidelines for RE net metering foresee amongst others that the available capacity provided by the distribution licensee shall not be less than 20 per cent of the capacity of the local distribution transformer and that the tariff for surplus energy fed in to the grid shall be paid for net energy credits which remain unadjusted at the end of the financial year at the rate of Average Power Purchase Cost (MNRE n.d.-b). The sanctioned capacity of rooftop SPV units varies from 1kWp to 1MWp and differs from state to state, considering the variation of supply voltage for customers; usually consumers are free to choose either net or gross meter option with the applicable tariff determined by the competent state Electricity Regulatory Commission every year; for the period 2013–2014 in the State of Andhra Pradesh for example this tariff was set at INR 5.25 per unit kWh over 25 years (APG 2015).

25.4 Concepts for Consumer (Co-)Ownership in Practice

25.4.1 Contractual Arrangements and Corporate Vehicles Used

Depending on how the consumer is defined for example in captive power generation for commercial use, in community projects in villages or simply as individual users and on the choice of RES and location there is a

[13] Third-party-owned SPV units are categorized in a similar manner based on net and gross metering.

wide variation of forms of RE consumer (co-)ownership promoted across India. The concepts vary with regard to the contractual arrangement chosen like, for example, PPP, business corporations, cooperatives, trusteeship and to the involvement of actors like federal government, state government, donor agencies, industries, community and individual citizens. In rural areas, off-grid RES is often built and operated by state as well as donor agencies with ownership typically shared under the legal form of a cooperative and the responsibility for day-to-day operations and collection of electricity bills and so on assigned to local institutions.

25.4.2 Financing Conditions for Consumer (Co-)Ownership in Renewable Energy

25.4.2.1 State Subsidies, Programmes, Credit Facilities, Preferential Loans

Open competitive bidding processes have resulted in lowering the benchmark costs of rooftop SPV projects from INR 130/Wp to 80/Wp (EUR 1.56–0.96). The financial support for large-scale SPV units created both a healthy competitive environment across the country and a market for inter-state trading. The SECI provides a 30 per cent subsidy for the installation of a total of 500 MWp of rooftop projects across India with state governments implementing the projects possibly with support of third parties. The MNRE provides central financial assistance (CFA) through capital in terms of INR 51 per Watt (EUR 0.61) or as 30 per cent of project costs, whichever is less and an interest subsidy offering a soft loan at 5 per cent interest per annum.[14] For rooftop SPV accelerated depreciation of 80 per cent is available under the Income Tax Act (EAI n.d.). In addition to this, other financial instruments are also in use to support RES. This includes viability gap funding, a generation based incentive and bundling approach (MNRE n.d.-d).

[14] In hilly states like Himachal Pradesh, Uttarakhand, Assam, Arunachal Pradesh, Jammu and Kashmir, Nagaland, Manipur, Meghalaya, Mizoram, Tripura and Sikkim the capital subsidy is up to 90 per cent. Rooftop SPV plants can also generate revenue through REC. For availing the REC the SPV has to be of capacity 250kW or more. Each 1 MWh (1000 units) of electricity generated is equivalent to one (1) REC. The REC can be traded on power to fill the obligation of RPO.

In addition, each state government provides specific incentives such as rent-a-roof schemes and tariff-based competitive bidding based on the energy market's requirements. All public sector banks are advised by the Department of Financial Services to provide loans for grid-connected rooftop solar systems as part of "home/home improvement loans". For commercial and industrial categories, the following support is provided by the state governments (GOI 2017; MNRE n.d.-b): (1) custom duty concessions, (2) excise duty exemptions, (3) accelerated depreciation and fiscal and other concessions. In 2014, the Reserve Bank of India included rooftop and ground-mounted SPV projects in priority sector lending with banks being able to lend up to INR 150 million to borrowers with 15 per cent of the benchmark costs available as CFA grant for residential, institutional and social sectors. Since 2015, for a special category States,[15] 70 per cent CFA is made available, while for other states, CFA is set at 30 per cent (MNRE 2017b). Furthermore, CGP are supported by (1) low interest loan to industries for captive plant equipment; (2) free energy banking facilities; (3) energy wheeling facilities at reasonable rates and (4) purchase of surplus captive energy at reasonable rate by utility in the state (Argelwar and Dani 2017).

25.4.2.2 Agencies Supporting Investment in Renewable Energy Sources

The MNRE is a nodal ministry overseeing the development of new and renewable energy options in India. The MNRE is responsible for the development of new and renewable energy technologies, processes, materials, components, sub-systems, products and services to address the issue of energy security, clean power and affordable access of energy. The focus area of MNRE includes the development, production and application of SPV and managing small hydro power plants with an installed capacity below 25 MW (see Sect. 25.2.1). The Indian Renewable Energy Development Agency (IREDA, http://www.ireda.gov.in/) acts under the

[15] These states are Arunachal Pradesh, Assam, Meghalaya, Manipur, Mizoram, Nagaland, Tripura, Sikkim, Uttarakhand, HP, J&K, Lakshadweep and A&N Islands.

authority of the MNRE as a Non-Banking Financial Institution for the promotion, development and extension of financial assistance to set up projects relating to RES. Policy instruments announced by the MNRE for the promotion of RE include issuing of fiscal subsidies, interest subsidies, production subsidies, implementation of demonstration projects and R&D. For the implementation of grid-connected SPV, state distribution companies play an important role with their responsibilities amongst others including fast track approval for feasibility, connection and installation of meters and earmarking of at least 10 per cent of available funds for rooftop SPV.

25.4.3 Examples of Consumer (Co-)Ownership

I. Varanasi Hybrid Solar and Grid Charging Station for Handloom Weavers in Uttar Pradesh—Since July 2017, the hybrid solar and grid solar system backed by a smaller lithium battery is providing uninterrupted supply of electricity to a cluster of weaver communities in and around Varanasi, Uttar Pradesh. Earlier due to shortage of grid electricity supply, the communities were dependent on a costly diesel generator set. A base level study by the Energy and Resource Institute (TERI) identified issues and potential solutions. It was observed that the weaver's power looms run for 18–20 hours a day. However, the grid connectivity was accessible only up to 12–14 hours. Plans for an SPV system were then designed to supply additional electricity for 6–8 hours. TERI managed to get financial support from Indus Tower under their corporate social responsibility head. A total of 102 hybrid units were installed to supply electricity to 408 power looms. As the lithium battery is small, it fitted in well at the congested spaces where the power looms are located. The beneficiaries contributed 30 per cent, that is, INR 135,000 (EUR 1615) of the total project costs of INR 450,000 (EUR 5386) for each unit, while Indus Towers provided the remaining 70 per cent was as grant (Choudhary et al. 2018). The ownership of the hybrid solar unit remains with the individual beneficiary involving a trusteeship agreement to ensure that it will be used for running the power loom.[16]

[16] Information provided by Mr Kishor Kumar Choudhary, principle investigator of the project, on 26 March 2018.

II. Renewable Energy Development Cooperative Society (REDCO) Limited—Sparsely populated Durbuk block in Leh district of Jammu and Kashmir state is geographically suitable for solar energy harvesting. Until 2005 a diesel generator provided electricity to most households with an electricity connection while about three fifth of the energy needs of the population were covered by animal dung fuel wood. As problems related to the availability of diesel and maintenance interrupted supply for 40 to 50 days annually, the NGO Ladakh Ecological Development Group (LEDeG) initiated a solar project. To raise the large initial investment and provide regular maintenance REDCO was constituted on 14 October 2003, under the "Jammu and Kashmir Self Reliant Cooperative Act of 1999" with the aim of replacing electricity production from the diesel generator through a SPV installation.[17] The average yearly expenditure for running the REDCO was about INR 1.05 million (EUR 12,567) including payments for TATA-BP Solar India Limited maintenance work, electricity tariffs to state government and administrative expense of REDCO office and staff as well as maintenance cost of INR 3 million (EUR 35,906) for battery replacement every fifth year.[18] On 26 February 2005, a four SPV unit with each 25 kWp started supplying electricity to the local grid, replacing the DG station. On 5 June 2006 the cooperative obtained permission for the use of existing infrastructure of transmission and distribution of electricity from state authorities. The organizational structure of the REDCO is comprised of general body members, an elected Board of Directors and a Power Management Committee. As beneficiaries, households with an electricity connection were members of the general body. As of May 2007, about 79 per cent, that is, 392 households from the three villages with grid connectivity were members of the cooperative. The one-time membership fee for villagers amounted to INR 105 (EUR 1.26), totalling INR 41,160 (EUR 493) with REDCO holding the ownership of the SPV unit.

[17] The programme was funded as grant-in-aid of INR 89 million (EUR 1,065,238) by the India-Canada Environment Facility with INR 35 million, the MNRE with INR 18 million and Ladakh Autonomous Hill Development Council with INR 17 million while LEDeG provided administrative support for conception and design worth INR 19 million. The beneficiaries contributed about INR 5.7 million (EUR 68,223) in kind.

[18] The operating cost of the diesel generator included i) average consumption of high-speed diesel of about 48,000 litres per year at a cost of about INR 1,638,300 (EUR 19,608), and ii) average annual maintenance cost of about INR 221,500 (EUR 2,651).

Since February 2005 the cooperative has been supplying electricity to ten hamlets of the Durbuk Block for 4–5 hours daily at a satisfactory level (Mishra 2013).

III. Odanthurai Village in Tamil Nadu—Under the leadership of the president of the village council, Rangaswamy Shanmugan, Odanthurai Village started a green energy programme in 1996 installing solar street lighting. With increasing demand for electricity, the village council took the next step in 2006 investing in a 350 kW wind turbine at cost of INR 15.5 million (EUR 186,000) developed by Suzlon. Of the total cost, INR 4 million (EUR 48,000) was paid by the villagers from savings while rest of INR 11.5 million (EUR 138,000) was taken as loan from Central Bank of India, at annual interest rate of 8.5 per cent. The village council has been repaying the loan with the revenue of about INR 2 million (EUR 24,000) from selling 200,000 units of electricity of a total average production of 0.67 million units to the Tamil Nadu Electricity Board (TNEB) at INR 2.90 per unit. TNEB allows power banking which is fed to the grid and credited to the producer's account and the remaining 475,000 units are supplying the village (Lakshmi 2013).

IV. DESI[19] Power—Decentralised Energy System (DESI Power, http://www.desipower.com) registered as a private limited company under the Company Act was established in 1996 promoted by DASAG Switzerland and Development Alternative, India. DESI Power was established to develop, package, promote, build and operate RE-based Independent Rural Power Plants (IRPPs), and transfer them to local partners over time. DESI Power built 29 pilot and demonstration power plants in Tamil Nadu, Karnataka, Bihar, Orissa and Madhya Pradesh. The company uses hybrid RE options developing integrated models to facilitate the development of villages in an economically, socially and environmentally sustainable manner. Depending on the geographical situation the technologies used are SPV, SHP, biomass charcoal production, energy plantation, biogas biomass combustion and biomass gasification. The company builds and operates the power plant with local partners and then transfers the ownership of the plant to the partner

[19] Colloquial Hindi term used in varied context to represent 'local'.

which can be a village organization, a NGO, a cooperative, a company or a group of people. They also encourage microenterprises to use RE and to become project partners with a cluster based approach (Sharma 2007).

25.5 Factors Affecting the Financing of Renewable Energy Sources and Barriers to Consumer (Co-) Ownership

25.5.1 Political, Legal and Administrative Factors

A hampering factor for the RE sector is the lack of a single comprehensive policy. Policies, scheme and plans are implemented mainly to facilitate distinct RES, like solar, biofuel, wind and cogeneration. Due to the absence of policy at the national level, the state-level policies are also not comprehensive in nature and are outlined based on funding allocation for programmes. There is also a need for rationalization of RPO at state level by the SERC. Each RES has a unique potential in specific geographical areas, with the aid of the appropriate technology. By keeping a single slab of RPO, one type of RES is facilitated, irrespective of the potential of other options (IDFC 2010). Furthermore, fiscal and tax incentives are not harmonized with wind power growth that has hinged on the 80 per cent accelerated tax depreciation provided by the federal government. In view of this, a bulk of wind power capacity has been set up on the balance sheets of existing companies with the main aim of saving income tax; many of these projects are located in low wind speed areas and have failed to deliver a satisfactory energy production (IDFC 2010, p. 9). This situation was exacerbated when in 2017, the growth of wind power was stalled with the federal government introducing auctions to determine tariffs, instead of FITs.[20] The lack of clear policy

[20] Accessed from <https://qz.com/1036577/indias-wind-energy-sector-is-a-complete-mess-right-now-thanks-to-the-narendra-modi-government/>, dated 26 March 2018.

guidelines in turn is reflected in a lack of coordination and cooperation within and between various ministries, agencies, institutes and other stakeholders.

25.5.2 Economic and Management Factors

High interest rates for financing the developing RES varying from 9.55 to 11.25 per cent depending on technology and implementing partners (IREDA 2017) is one of the most pressing concerns. High interest together with elevated costs and unfavourable terms for debt creates conditions where return on equity is comparatively low. In addition, the macro environment of the Indian economy embracing issues such as inflation and slow infrastructure growth also has implications on the financing of RES (Nelson et al. 2012). The presently dominating government driven market limits management options with the state being the key actor setting incentives, taxation and tariffs for the sustainable growth of RES. Furthermore, in the case of biomass-based projects, the uncertainty of raw material access and prices creates operational problems. For grid-interactive projects like solar and wind parks, access to the grid at appropriate locations creates functional challenges for RE project implementation. Finally, the lack of funds and capacity for research and development across all RES and of dissemination of appropriate information to potential beneficiaries hampers the progress of RE in India (IDFC 2010).

25.5.3 Cultural Factors

The acceptance of RE infrastructure differs between urban and rural consumers. For the former, favourable state incentivized terms to facilitate grid-based reliable and affordable electricity supply are an affordable option. For the latter, on other hand, RES do not come simply as a mode for electricity supply but have implications on the social dimension of life, like lighting, access to clean fuel and water for irrigation. Against this background capital and technology intensive RES create issues of both affordability and acceptance when State or donor agencies leave after the project implementation period (Miller and Hope 2000; Mishra 2013). To make RES successful in such social environment policy makers have to address the unique issues faced in the respective geographical areas (Sisodia and Singh 2016). Of course, RES requiring large financial investments upfront create the perception of risk and hamper demand (Miller and Hope 2000). More general, in this environment group based models like cooperatives or "self-help groups", that is, village-based financial intermediary committees usually composed of 10–20 residents, interact with and are influenced by distribution network operators as well as service providers for installation, infrastructure and marketing (Cabraal et al. 1996). Finally, there is a need of entrepreneurial culture across institutions like the federal or state governments, NGOs, industries and technical support agencies, who are supporting the development of RES.

25.6 Possible Future Developments and Trends for Consumer (Co-) Ownership

RE has potential to provide clean energy options for present and future generations. Dynamic economic development, expanding coverage of basic amenities in rural areas and urbanization will require an innovative approach in all dimensions of the energy cycle to address future challenges. In this context, there is an urgent need to address the issues of policy support, enabling a financing structure, providing organizational assistance for set up, inter-institutional cooperation as well as research and development on technology for RE projects in a coordinated manner. Although the Electricity Policy of 2005 provides scope for local communities to become part of generation and distribution of RE, the future success of the energy transition in India will hinge on creating an institutional space that addresses the energy needs of communities of space, that is, locality. Only when input variables like finance, technology, raw material are accessible also to poorer communities and low income groups of society and when they are combined with enabling organizational structures providing appropriate know-how and skills as well as information to set up stand-alone or hybrid RE systems will consumer (co-)ownership have a wider diffusion.

It is important to understand that energy access should not be simply seen as households' access to electricity but as overall electrification which includes lighting, cooking, heating and cooling. These issues will have to be tackled by facilitative policies at the federal, state and local levels providing innovative financial instruments for all types of users, like individual, group owned and captive power generation backed by creating suitable institutional structures. In September 2015 Piyush Goyal, the GoI's Union Minister, stated that the decentralization of electricity is the fastest way to provide energy access to the people of the country and that in order to make available energy to the last mile, decentralized power production across the country should be ensured (PIB 2015). Furthermore, India's Prime Minister Narendra Modi postulated at the inaugural session of the 16th International Energy Forum on 11 April 2018 amongst others that energy security in India stands on four pillars, namely, (1) access to energy, (2) efficiency of use, (3) sustainability and (4) energy security (Modi 2018). India's large consumer base with varied avenues for energy uses provides plenty opportunities for RES across different spatio-temporal dimension to innovate in every sphere of energy cycle. In the light of the above policy aim of decentralised production innovative approaches taken should include the promotion of prosumership.

There have been acknowledged success stories of grassroots initiatives in the 1970s and 1980s with other commodities like for example with milk in Amul and sugar in the cooperative movement of Maharashtra that were also based on the principle of access to production. More recently the accomplishments of a new generation of cooperatives and farmer producer organization could be extended to the field of RES. In this context, the story of world's first solar irrigation cooperative "Dhundi Saur Urja Utpadak Sahakari Mandali (DSUUSM)" at Dhundi village in Gujarat is worth mentioning. The members of the irrigation cooperative are today solar entrepreneurs with the Dhundi project being "a energy-water-livelihood solution rather than an energy substitute" (Chandra 2018). The successful Dhundi project is providing multiple benefits to its members with positive externalities including preventing groundwater overexploitation, reducing the subsidy burden on the state's electricity distribution companies, as well as the carbon footprint of agriculture, and last but not the least increasing farmer incomes (Shah et al. 2017). Against this background, however, the diffusion of RES in future will depend on facilitative policies and institutional spaces provided by the state.

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26

Consumer (Co-)Ownership in Renewables in Pakistan

Junaid Alam Memon and Anwar Hussain

26.1 Introduction

26.1.1 Energy Mix

The composition of Pakistan's 74 MTOE of total primary energy supply in the year 2016 was covered from a variety of sources, led by natural gas with 41.2 per cent and oil with 34.2 per cent, followed by hydroelectricity with 11.2 per cent, coal with 6.9 per cent, LNG import with 3.3 per cent, nuclear electricity with 1.5 per cent, LPG with 1.2 per cent, renewable electricity with 0.5 per cent, and finally imported electricity with 0.15 per cent (HDIP 2017); total primary energy supply per capita was 0.5 toe (IEA 2017). The total final energy consumption in 2016 was 45

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MTOE—distributed to different sectors of the economy in the following proportion: industry 35.1 per cent, transport 33.7 per cent, domestic 3.2 per cent, commercial 4 per cent, agriculture 1.6 per cent, and government 2.5 per cent (HDIP 2017). With an installed capacity of 25,374 MW, the total amount of electricity generated in 2016 was 112,000 GWH, led by thermal at 63.6 per cent, hydro at 30.8 per cent, nuclear at 3.7 per cent, imports at 0.4 per cent, and finally renewables comprising energy from wind, solar, and bagasse at 1.3 per cent (NEPRA 2017a).

Although largely untapped, Pakistan has huge wind and solar energy potential, which it only recently has started to exploit. Recent estimates suggest that with a mean daily solar insolation of 19.0 MJ/m^2, the country could potentially produce 175,800 GWh of solar energy per year (Tahir and Asim 2018) while 120 GW of viable wind energy potential are available along the Sindh coastline and other discrete locations (Baloch et al. 2016; Mohsin et al. 2018). Starting with negligible renewable energy sources (RES) installation capacity in 2013, 438 MW in 2015, and 902 MW by June 2016, Pakistan was able to generate 1550 GWh of renewable energy from solar, wind, and bagasse sources in 2016 (HDIP 2017). Furthermore, numerous mini-hydro, solar, wind, and bagasse power plants are under construction or planned (Kamran 2018; NEPRA 2017a).

26.1.2 Main Challenges of the Energy Market, National Targets, and Specific Policy Goals

Providing reliable, clean, and affordable energy to different sectors of the economy has been a daunting task, as it is facing various challenges such as capacity, governance, and financial sustainability. In recent years, Pakistan has faced acute energy crisis due to an increasing gap between levels of supply and demand reaching at times as high as 6500 MWh during peak hours (NEPRA 2017a; Wakeel et al. 2016). As a result, the population has been suffering long power outages of 10–12 hours a day in urban areas and 16–18 hours a day in rural areas, adversely impacting economic activity (Zameer and Wang 2018). According to the International

Energy Agency, in 2015, about 38 per cent of the population lacked access to electricity (IEA 2017). Furthermore, poor and outdated grid infrastructure led to energy losses, while poor management and energy theft are increasing the cost of electricity.

In the absence of long-term energy planning, as a quick fix, various governments resorted to procuring energy from thermal power plants through deals with independent power producers (IPPs). A significant portion of this energy is produced through imported fuels. In 2017, the imported fuel bill was EUR 9.7 billion, equivalent to 22 per cent of the total import transactions (PBC 2018; SBP 2017a). Untargeted power subsidies amounting to around 1 per cent of GDP (Walker et al. 2016), transmission and distribution losses amounting to 18 per cent of the net supply, and poor cost recovery from customers (both government and private) has resulted in an accumulated recovery bill of about EUR 5.4 billion (NEPRA 2017a; Pakistan Today 2017), further complicating management of the power sector. Adding to the list of challenges is poor governance at various levels of power transmission and distribution (Raheem et al. 2016; Shaikh et al. 2015).

Against this backdrop, in 2013, the government envisioned diversified yet integrated efforts to address power sector problems. Key among these are to bridge demand-supply gap by 2018 and double electricity generation capacity to 45,000 MW by 2025, through the implementation of various hydro, coal, and RE projects; to increase electricity access to over 90 per cent of the population; to optimize the energy mix by using indigenous energy resources with due economic and environmental consideration; and to maximize distributional efficiency through investments in infrastructure and institutions (MPDR 2014).

This is to be achieved primarily through National Power Policy 2013, with the support of various previous and new policies and directives amongst others dedicated to RE and co-generation.[1] Noteworthy in particular is the 2011 medium-term Alternative and Renewable

[1] Like the Transmission Line Policy 2015 or the Power Generation Policy 2015 with the latter, however, not applicable to RE projects. There are also various guidelines, directives, and procedures which are still in force and support NPP 2013 such as: 2014 Distributed Generation/net-metering rules; 2010 Guidelines for Setting-up Private Power Projects; 2005 Guidelines for Determination of Tariff for IPPs.

Energy (ARE) Policy that targets generating 5 per cent of the energy from alternate and renewable sources by the year 2030, and use it for commercial purposes. Recent research reports suggest that over the years there have been some improvements with regard to the above-mentioned challenges, but there is still a long way to go to achieve a sustainable power system (Aziz and Ahmad 2015; SBP 2017a; Walker et al. 2016).

26.1.3 Ownership Structure in the Renewable Energy Sector

Various reforms introduced in Pakistan's energy sector since 1998 have substantially altered the ownership structure of the sector.[2] Pakistan's installed electricity production capacity of 25,374 MW is owned by diverse set of public and private entities respectively at 53 and 47 per cent (NEPRA 2017a). Government-owned installations generated about 97 per cent of hydroelectricity, under 21 per cent of thermal energy, and a negligible percentage of non-hydro renewable energy. As of 2016, the government owned nine large and eleven small hydro units equivalent to 97 per cent of the installed hydro capacity, whereas independent power producers (IPPs) own only four small hydro units equivalent to the remaining 3 per cent of the installed hydro capacity (NTDC 2016). Thermal power is generated through government-owned generation companies, 28 IPPs, and Karachi Electric (K-Electric)[3] installations, whereas the country's two nuclear plants are controlled by state-owned entities (NTDC 2016). In 2016 all non-hydro RE installations were owned by IPPs (NTDC 2016).

[2] Prior to 1998, the Water & Power Development Authority (WAPDA) and state-owned Karachi Electricity Supply Company (KESC) owned the country's entire power infrastructure. Since then, major reforms were introduced to attract private sector participation in energy market resulting in KESC's privatization which is now K-Electric serving Karachi and its vicinity. WAPDA's functions were also reorganized into 10 public sector Distribution Companies, 4 Generation Companies and the National Transmission and Distribution Company (IFC 2016).

[3] Established as Karachi Electric Supply Corporation in 1913, K-Electric was nationalized in 1952, privatized in 2005, and ultimately taken over by The Abraaj Group, which has 66.4 per cent stake in it. K-Electric is engaged in power generation, transmission, and distribution services. In 2016, it had around 2.226 million consumers in Karachi and its surroundings. See https://www.ke.com.pk/ for more details.

Transmission and distribution infrastructure in the country is mainly owned by a federal government entity called the National Transmission and Dispatch Company (NTDC) that owns about 87 per cent of the 17,300 km long infrastructure with the remaining 13 per cent split between K-Electric, two other private companies and the Sindh Transmission and Dispatch Company (NEPRA 2017a). To distribute power to 26.47 million consumer connections, there are ten public distribution companies (DISCOs) handling 91.6 per cent of the connections, with K-Electric as the only private distribution company handling 8.2 per cent, and two private housing associations handling the remaining connections (NEPRA 2017a).

The existing companies in the RE sector belong to the private sector focussing mostly on mid to large scale, that is, above 1 MW, wind, solar, and biomass projects while distributed generation below 1 MW through three-phase consumer connection is a very recently developing category. Examples from the most important RE sectors are as follows.

- Wind parks are installed mostly along the coastline in the southern Pakistan and owned by the private sector. By 2016, about 27 wind power licences had been issued for varying installation capacities ranging from 2.5 MW to 250 MW with a cumulative installed capacity of 1500 MW (NEPRA 2017a).
- By 2016, total 17 solar power licences had been issued to solar IPPs ranging from 1 MW to 100 MW installed capacity, with a cumulative installation capacity of 523 MW (NEPRA 2017a).
- By 2016, 17 co-generation licences had been issued to sugar mills utilizing bagasse and other biomass for an installed capacity ranging from 9.1 MW to 74 MW, with a cumulative installation capacity of 497 MW. Many of these plants have yet to provide electricity (NEPRA 2017a).[4]
- By the start of 2018, about 270 distributed generation or net-metering licences had been issued to various households, universities and other organizations such as the Ministry of Planning, Development and

[4] These power plants are not fully operated on bagasse due to seasonal fluctuations and that for the remaining period most of these plants utilize imported coal (PPIB 2008).

Reforms, and the Parliament. These licences ranged from 1.6 KW to 800 KW (below 1 MW) with a cumulative capacity of 5.5 MW.[5] An estimated 4 MW of solar power is already fed into the national grid through net metering (The News 2018).

26.2 The Consumer at the Heart of the Energy Market?

26.2.1 Consumer (Co-)Ownership in Renewable Energy Sources as Policy Goal

In September 2015, the National Electric Power Regulatory Authority (NEPRA) published the 2015 Alternate and Renewable Energy Distributed Generation and Net Metering Regulations, allowing domestic, commercial or industrial electricity consumers to install up to 1 MW capacity solar and wind power systems for personal use as well as feed into the national grid. With the aim of bridging the demand-supply gap while providing access to clean, reliable, and affordable energy, the government furthermore abolished the import tax duty of 32.5 per cent on solar energy equipment announced in the 2014–15 budget to incentivise consumers to install rooftop solar panels and thus acquire ownership of RE installations. In May 2010, the Federal Government mandated the Alternative Energy Development Board (AEDB) to develop national plans, policies and strategies for RE and the expansion and advancement of RE projects and technologies by efficient coordination of local and foreign bodies. The mentioned ARE policy developed by the AEDB also encouraged private investments in RE projects by providing fiscal and tax incentives and the promotion of off-grid solutions for underdeveloped areas. Finally, it encouraged the manufacturing of renewable technology locally to create employment opportunities and improve technical skills

[5] Data stemming from the NEPRA (http://www.nepra.org.pk/Lic_netmetering.htm) refers to licences issued until February 1, 2018; thus, some of these projects may have yet to become operational.

of the local workforce. Consumer (co-)ownership is not directly conceived as a policy goal, except for the indirect mention in off-grid power projects to be commissioned through public sector financing and/or through community/NGO/donor participation (Government of Pakistan 2006).

26.2.2 Fuel/Energy Poverty and Vulnerable Consumers

Pakistan is among the countries with the highest levels of energy poverty. In 2016, the per-capita final energy consumption was 261 kilogram of oil equivalent, and it has shown a declining trend since 2008.[6] Per-capita electricity consumption in 2016 was 462.5 KWh with downward trend since 2006 (NEPRA 2017a; HDIP 2017)[7]. A recent representative survey by the World Bank suggests that people use on average 10 per cent of their income for electricity expenditures (Enclude and Foresight Research 2016). Yet, an average household fulfils about 74 per cent of its energy needs from biofuels—mostly wood—and waste (Imran 2016). Mahmood and Shah (2017) calculated the multidimensional poverty index based on a Pakistan Social Living Standard Measurement sample and found that in relative terms, about 20 per cent of the urban and 80 per cent of the rural population suffered from energy poverty. In addition, in 2017, about 28 per cent of the population or 51 million people—10 per cent urban and 37 per cent rural—were not yet connected to the national grid (IEA 2017). The unconnected population mostly live in remote areas and find themselves at the margins of the society (Enclude and Foresight Research 2016).[8]

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[6] Calculated from NEPRA figures: Each of the 2016's Primary Energy Supply (74 MTOE) and Final Energy Consumption (45 MTOE) divided by 2016's Population (176.20).

[7] Calculated from NEPRA and HDIP figures: 2016's Electricity Sale (81,489.75 GWh) divided by 2016's Population (176.20).

[8] Electricity use intensity is significantly higher in Pakistan compared to other south Asian countries primarily due to inefficient appliances and household design. It is estimated that at least 29 per cent of household electricity can be saved with minor adjustments in building design parameters (Aized et al. 2017).

Policies addressing energy poverty in Pakistan mostly rely on Tariff Differential Subsidies. Although implemented to aid the poorest consumers, these subsidies remain inadequately targeted. Walker et al. (2016) reported that even with the recent reforms, the richest 20 per cent of households still enjoy 40 per cent higher average subsidies compared to the poorest 20 per cent of households. Furthermore, the Government attempts to phase out electricity subsidies, which were reduced from over 2 per cent of the GDP in the past to 0.8 per cent in 2014–2015 and around 0.4 per cent in 2015–2016 (Walker et al. 2016); however, the lowest household slab that uses less than 200 MW/h of electricity per month would continue to receive power and gas subsidies. As the targeting issue still persists, various proposals, such as poverty scorecards linked to electricity subsidies, are considered.

26.3 Regulatory Framework for Renewable Energy

The main statutory provisions regulating the RES sector in Pakistan are the Regulation of Generation, Transmission and Distribution of Electric Power Act, 1997. NEPRA was set up in 1997 as the independent regulator for the provision of electric power services. As for all other sources of energy, the energy generation, transmission and distribution licences and tariffs for RES are also determined by NEPRA.

26.3.1 Regulations for Connecting Renewable Energy Plants to the Grid

Pursuant to the Companies Ordinance 1984, RE IPPs are required to create a company for energy generation and acquire licence from NEPRA to supply electricity to the grid. Per NEPRA regulations, an Alternative or Renewable Energy (ARE) producer, like all other power producers, has to close a power purchase agreement with the respective DISCO or bulk power purchaser. For power producers with installed capacity up to 5 MW which are not connected to the national grid, the above requirement does not apply; however, they do need to register with the AEDB and a provincial agency and get approval from the local administration.

The procedures for grid connections by IPPs distinguish between solicited and unsolicited RE projects, while for RE projects involving small-scale distributed generation (DG) below 1 MW, no such defined procedures exist. In unsolicited proposals, a security package, involving the PPA with the power purchaser and the Implementation Agreement with the Government to guarantee the payment of the power purchaser to the RE project investor for sale of power, is issued after a feasibility study and the attainment of a generation licence as well as a tariff from NEPRA. In solicited proposals, AEDB initiates a competitive bidding process, with successful bidders asked to submit a guarantee for performance after which the project can attain a generation licence from NEPRA. The tariff that is reached after competitive bidding shall not be re-opened by NEPRA and will be considered as the final tariff.

RE Wheeling is also allowed, that is, feeding power from RES into the grid at one interconnection point and retrieve the same amount of power from different interconnection point, thus making possiblility of selling power directly to end-use customers based on bilateral agreements. For direct sales, where RE power producers use national/regional transmission and/or distribution grid networks to transport power from their project site to the point of interconnection of the power purchaser, transmission and interconnection services are charged—wheeling charges—as determined by NEPRA for the respective utility. Captive renewable power plants with a nameplate capacity over 1 MW can inject excess energy to the grid by entering into bilateral contracts with the power purchaser at rates established by NEPRA, so called RE Grid Spill over (Government of Pakistan 2006).

26.3.2 Support Policies (FITs, Auctions, Premiums, etc.)

The 2006 RE Policy provides three methods of tariff determination, namely: Competitive bidding for solicited proposals, direct negotiations for a cost-plus tariff for unsolicited proposals, and feed-in tariffs (FITs). Pursuant to rule 3(1) of the Tariff Standards and Procedure Rules 1998, NEPRA determines the most suitable approach to set the concerning RE tariff. Until recently, RE solar and wind generation was to be regulated through FIT regime, whereas, the remaining two methods were dormant (Mustafa et al. 2016a). Currently, despite reservations of investors and some of the relevant provincial and federal government entities, in view of the globally declining trend of RE equipment prices and improving capacity factors, NEPRA has turned to the competitive bidding method to award tariffs to new RE projects. To solar and wind power projects, reverse auction schemes are applied. while the latter include benchmark levelized tariffs on build, own, operate basis.[9] In determining FITs, NEPRA may consider regional differences in RE potential where these exist.[10]

26.3.3 Specific Regulations for Self-Consumption and Sale to the Grid

To encourage small-scale RE projects between 1 KV and 1 MW capacity, NEPRA introduced a 'Distributed Generation' or 'Net-metering' facility in September 2015 (NEPRA 2015). This allows three-phase 400 V or 11 kV residential, commercial and industrial customers to produce energy with solar PV or wind turbines and feed excess energy into the grid through a net-metering agreement, however without a guaranteed grid access, for example if the consumer installation is located far from the grid. The net balance is paid by the concerned party at relevant off-peak retail tariff rates, that is, residential, commercial, or industrial tariff.[11] A rolling account of net energy units similar

[9] In the beginning of 2017 for wind power these were set at US¢ 6.7 per kWh for 100 per cent foreign debt and 7.7 per kWh for 100 per cent local debt, respectively. Authors' calculations and currency conversions based on information given in NEPRA notification No. NEPRA/TRF-WPT/2017/1542-1544 of January 27, 2017.

[10] For example, northern and southern zones of solar irradiance, benchmark capacity factors, project costs, indexations with consumer price indices distinguishing between local and foreign funds, operation and maintenance, debt servicing, construction periods, insurance fee, and applicable taxes.

[11] The tariff payable by the Distribution Company shall only be the off-peak rate of the respective consumer category of the respective month; other rates such as variable charges for peak time, fixed charges, fuel price adjustment, duties/levies are not to be paid by the Distribution Company.

to a bank account was introduced to enable net billing. The account is reconciled at the end of each monthly billing cycle and, in the case of customers receiving a net export bill each month, every 3 months. The consumers are required to register their connection with NEPRA and bear the expenses for the establishment of the interconnection. The term of the purchase agreement between prosumers and DISCO, previously just three years (Mustafa et al. 2016a, b), was now increased to seven years (NEPRA 2017b).

26.4 Concepts for Consumer (Co-)Ownership in Practice

26.4.1 Contractual Arrangements and Corporate Vehicles Used

RE consumer (co-)ownership in Pakistan is conceptualized at connection level, that is, three-phase residential, commercial, or industrial consumers.[12] Under this concept, gaining popularity are investments in grid-connected solar collectors and PV installations on private buildings, often financed through the owners' equity. On-grid citizen energy or community projects open to the public are not popular yet. However, off-grid community power projects, mostly hydro, having micro/mini grids have been present in the northern areas of Pakistan for more than two decades (Maier 2007). Most of these projects are conceived by general purpose or specialized Village Organizations (VOs), registered with any NGOs like the Agha Khan Rural Support Program (AKRSP) and Sarhad Rural Support Program (SRSP).[13] Although VOs and NGOs jointly finance these projects usually at 20 and 80 per cent respectively, ownership rests with communities with the NGO being a mere facilitator to channel government and donor grants.

[12] Current, single-phase residential, commercial, or industrial consumers are not included and not covered in distributed regeneration or net-metering scheme.

[13] Each NGO has its own terminology to describe a village organization. Most popular terminologies are Village Organizations (VOs), Community Organizations (COs), Village Development Organizations (VDOs) and alike. Also, see footnote 28.

However, participation in RE projects is possible via any available type of corporation, partnership or individual business or institutional activity, similar to those in other countries. Cooperatives as a legal vehicle are also available under Cooperative Societies Act 1925 and Rules 1927, without specific rules pertaining to the RE sector.

26.4.2 Financing Conditions for Consumer (Co-)Ownership in Renewable Energy

26.4.2.1 State Subsidies, Programmes, Credit Facilities, Preferential Loans

The ARE Policy (Government of Pakistan 2006) bestows various incentives to producers including guaranteed market, guaranteed grid access, tax exemption on income derived from electricity generation as well as a conditional exemption on custom and import duties including on construction materials and machinery[14], exemption on Zakat tax[15] for non-Muslims, sales tax pass-through to off-takers, conditional permission on equity repatriation of dividends, and permission to raise local and international finances including corporate bonds (See also, IFC 2016). As a result, RE utility plant profits are exempted from tax with the exception of a withholding tax of 7.5 per cent charged on the dividends paid to shareholders.

With the need for credit facilities for the promotion of RE being recognized, the first such scheme was introduced by the State Bank of Pakistan (SBP) in 2009. The SBP Financing Scheme for Renewable Energy, however, was a failure with only one application until its revision in June 2016 due to a high interest rate of 12.5 per cent, a lack of skills to comprehend energy related financing on the side of bankers, low trust in success of RE technologies and collateral issues. Some of these issues

[14] For the latter two see clause (132) from part I of the second schedule of Income Tax Ordinance 2001 (Federal Board of Revenue 2011).

[15] One of the five Pillars of Islam, Zakat is an Islamic tax levied on certain kinds of property and used for charity.

have been addressed in the "Revised SBP Financing Scheme for Renewable Energy". It allows banks and development finance institutions to provide RE projects from 1 KW to 50 MW with a loan facility up to PKR 6 billion (~EUR 51 million) at 6 per cent subsidized interest and a repayment duration of 10–12 years. Reportedly, within less than two months of its promulgation on August 15, 2016, 11 RE projects applied for the loans. Furthermore, this policy seems well integrated with other policies such as the recently introduced "Policy for Promotion of SME Finance" (SBP 2017b), and the co-generation and net-metering facility.

26.4.2.2 Agencies Supporting Investment in Renewable Energy Sources

There are various national and international entities supporting investments in RES. Under the SBP's revised financing scheme for RE, all commercial banks and Development Finance Institutions can support investments RES. Pakistan Poverty Alleviation Fund (http://www.ppaf.org.pk/what-we-do.html) also supports community-level investment in RE systems through various partner organizations, such as NGOs like AKRSP, Thardeep Rural Development Program—TRDP, SRSP, and community organizations (COs). A number of multilateral and bilateral organizations such as Asian Development Bank, the World Bank, Deutsche Gesellschaft für Internationale Zusammenarbeit, Swiss Agency for Development and Cooperation (SDS) and other agencies also support RES investments either through relevant government entities[16] or through NGOs (e.g., INTEGRATION 2014).

A number of other governmental and non-governmental agencies support RES investments either indirectly or as their side mandate (Bakhtiar and Ahmed 2017), IFC (2016). AEDB was established in May 2003 for fast-track introduction of RE technologies in the country, being amongst others, responsible for the development of national plans, policies and

[16] For example, AEDB is implementing the countrywide RES mapping program under the World Bank's Energy Sector Management Assistance Program (ESMAP) to facilitate RE investments.

strategies for RE and the expansion and advancement of RE projects and technologies by efficient coordination with local and foreign bodies. The Pakistan Council for Renewable Energy Technologies (PCRET) and its provincial and field offices are mandated to coordinate R&D in renewables to make them affordable, and to carryout promotional activities. The Renewable and Alternative Energy Association of Pakistan is engaged in promotional activities to reduce Pakistan's dependence on fossil fuels. Last but not the least, the US-Pakistan Centre for Advanced Studies in Energy (USPCAS-E) is engaged in renewable energy research and policy development along with energy from other sources.

Furthermore, each state has its designated departments of energy and specialized agencies to support RE investments. Examples are the Pakhtunkhwa Energy Development Organization (http://pedo.pk/Main), the Energy Department, Government of Punjab (http://www.energy.punjab.gov.pk/_pages/attachedDeptts.html), the Energy Department, Government of Balochistan (http://www.energy.gob.pk), the Directorate of Alternative Energy, Energy Department, Government of Sindh (http://sindhenergy.gov.pk/brief-energy-projects/) that are assisting investments in RES by attracting independent power producers through their customized policies and other facilitation arrangements.

26.4.3 Examples of Consumer (Co-)Ownership

A variant of prosumership in hydropower projects is used at community level in the northern areas of Pakistan since more than two decades. The *AKRSP* being the pioneer, has helped communities build and operate more than 200 small run-of-the-river micro-hydropower plants (MHPs). Locals are engaged through Village Organizations[17] and clear terms of the partnership are determined based on several rounds of dialogues (Maier 2007). The terms of partnership normally include division of

[17] AKRSP operates through a two-tier system of local communities' engagement. First-tier is a village or community-level organization separately set-up for males called a Village Organization (VO), and females called a Women Organization (WO). The second-tier organization is called Local Support Organization (LSO) which set-up through the representation of VOs and WOs in the area.

responsibilities between the communities represented by VOs and the AKRSP. This includes cost sharing between the community (20–30 per cent of the total cost) and AKRSP (70–80 per cent of the total cost). Communities' contribution often implies physical involvement mostly in kind or at nominal wage but sometimes also with cash. Typical examples of in kind contribution include provision of land, local materials, such as wooden poles for the construction of micro-grids, or stones for the construction of the channel and powerhouse. The resolution of conflicts related to the project site or land use is also the responsibility of local communities.

AKRSP provides finances for non-local materials such as mechanical and electrical equipments and skilled labour. Besides this technical support for the construction and design of the units and training to the operating staff is also provided.[18] The source of AKRSP's financial contribution is often the national and international donors and government grants such as the Pakistan Poverty Alleviation Fund and Khyber Pakhtunkhwa Government. Over the years, the AKRSP has developed its MHP programme through various institutional experiences and innovations (Maier 2007), including the community-owned power utility company (PUC) model being the latest addition (INTEGRATION 2014). Since 2010, AKRSP has facilitated the registration of at least four PUCs with the Securities and Exchange Commission of Pakistan (SECP). We present the cases of **I. Shandur Utility Company Limited (SUCL)** and **II. Yadgar Utility Company Limited (YUCL)**, set up under the SDS and AKRSP's financial agreement in April 2011 to implement "Water and Energy Security through Microhydels Project" in Chitral (INTEGRATION 2014).

Both SUCL and YUCL are located in the Upper Chitral area of Khyber Patkhtunkwa province in Pakistan.[19] SUCL has set-up and operates a

[18] The initiative is not only contributing to the sustainable energy but also create employment for local villagers. In 2010, AKRSP Chitral office employed more than 20 people, with a further 350 people, including hydro operators and watchmen in the villages, as result of this initiative (www.ashden.org). Around 16,000 households (150,000 individuals) in 32 scattered valleys of Chitral are benefiting (www.ashden.org).

[19] The information regarding these two cases has been obtained mostly from INTEGRATION (2014) with some minor clarifications and updates made through a telephonic interview with Mr Darjat Muhammad (Director PD) of AKRSP.

500 KW Harchin MHP Project in the Laspur Valley to provide uninterrupted electric supply to about 1140 local households, 13 sawmills, 6 flourmills, and 30 micro-businesses in three villages. The financial outlay of the Harchin MHP, launched on May 5, 2011 and completed on June 7, 2015, was about EUR 0.87 million (Chitral Today 2015). Similarly, the YUCL has set-up and operates an 800 MW Pawoor MHP Project in Yarkhun Valley to provide power supply to about 1300 local households, 16 sawmills, 7 flourmills, and 26 micro-businesses in Pawoor village. The Pawoor MHP completed in 2016 with financial outlay of around EUR 1.14 million. Since the PUC experience was first of its kind for AKRSP, the V/WOs and LSOs, PUCs, and local contractors, both MHPs exhibited significant delays, cost overruns, and technical design problems (INTEGRATION 2014).

The major share of the project finances, that is, around 51 per cent is in the form of SDC's grants channelled through AKRSP. Each household in the respective PUC has a fixed equity participation of PKR 9000[31] in the Harchin MHP project and PKR 7000 in the Pawoor MHP besides a limited possibility to purchase PUC shares up to 10 per cent of the total investment. In both PUCs, more than 90 per cent of the households hold equity. About 30 per cent of the funds were obtained from Acumen Fund[20] under the loan guarantee of AKRSP. Communities will pay back this amount over seven to ten years through the tariff revenue earned by the PUCs. Finally, the AKRSP's civil works contractor, the Green Alternative Power (GAP), has converted part of its service fees into equity and owns 9 per cent shares in each PUC. Upon the repayment of the loan, the AKRSP will transfer the remaining shares to the concerned communities as per the partnership agreement between both parties.[21]

[20] Acumen is a non-profit global venture fund for entrepreneurs who want to address, poverty, health and educational issues. For OUCL (not presented as a case study), the AKRSP has facilitated a local credit facility from Habib Bank Limited (HBL).

[21] The AKRSP' exit strategy is however unclear on how it will withdraw its technical support for MHPs' O&M, accounts and financial administration issues and future expansion activities.

26.5 Factors Affecting the Financing of Renewable Energy Sources and Barriers to Consumer (Co-)Ownership

26.5.1 Political, Legal, and Administrative Factors

There are a number of inter-woven political, legal, and administrative barriers affecting the financing of RES and establishment of consumer (co-)ownership models in Pakistan. Historically, the energy planning and management remained centralized, supply-driven, and in favour of large-scale hydro and thermal power plants. Problems that follow this policy are huge subsidies and environmental concessions to keep the prices of electricity produced through these sources artificially low, and an inadequate institutional capacity for the decentralized and demand-driven management of the sector (Mirza et al. 2009; Yazdanie 2010). This created an unequal playing field for RES projects which are often relatively small, decentralized, and demand -driven (Ali et al. 2015). Although policy, financial, and legal support for RES has gradually increased since 2006, below are some of the most important regulatory and administrative hurdles in the large-scale adoption of RES in general and consumer (co-)ownership models in particular.

Policy shifts—The NEPRA has recently abolished the upfront tariff regime for wind and solar in favour of competitive bidding arguing that this shift is logical and timely since the global prices for RES equipment have fallen considerably and that the consumers must get benefit out of this development in the form of cheap energy. This policy shift has created a shock situation for RES investors such as companies like Zhenfa or Zonergy and the Government of Sindh who considers this move "arbitrary and impugned" (NEPRA 2017c). This type of policy shifts in early stages of RE development, when the total share of RES is negligible in overall energy mix, may adversely impact investors' confidence in nascent RE sector of Pakistan.

Financing and Banking issues—Despite SBP's generous re-financing policy covering RE installations up to 50 MW, banks are reluctant to extend their credit facility due to a variety of reasons including: low technical capacity in RE related financial applications; lack of trust in success of RE technologies; concerns over the long-term sustainability of RES due to absence of performance guarantees and responsible RE vendors; and collateral issues with SME and cooperatives (Riccardo 2014). The commercial banking system is used to the corporate sector and individuals providing collateral and may have apprehension with regard to community-based finance applications. The existing RES credit policy has no provision to support working capital requirements that may be a matter for investors' concern over long-term sustainability of their investments in RES. Furthermore, there is no effective mechanism to help RES fully benefit from sources such as carbon credit facilities.[22]

Grid connectivity—Grid connectivity has its own set of barriers hindering RES investments. Regardless of the size of RES facility, the licencing from NEPRA and electricity purchasing agreements with DISCOs involve large transaction costs.[23] Additionally, at the consumer level, the law bestows net metering to three-phase connection holders, whereas the bulk of domestic consumers belong to the single-phase category. The reason for this discrimination is DISCOs' reluctance to maintain millions of petty power and payment accounts.[24] Furthermore, there is only a vague idea of the overall amount of electricity that can be injected into the national grid without any site-specific details.[25] These issues may also systematically discourage small household or a neighbourhood level investment in the energy sector.

[22] For example, in case of AKRSP initiated community-based PUCs, the CDM source was overestimated and that too benefited AKRSP from whatever income earned through CDM but not to the communities. See INTEGRATION (2014).

[23] It takes months of continuous follow up even for the privileged persons to get grid connectivity for < 1 MW RES installation (Phone interview with a net-metering licence holder, dated March 1, 2018).

[24] Phone Interview with Executive Secretary, Renewable & Alternative Energy Association of Pakistan (REAP), dated March 1, 2018.

[25] NEPRA (2017a) suggest that many of the grid lines are overloaded. In view of the fact that most thermal installations are operating below their full capacity, this itself indicates the carrying capacity of the national grid.

26.5.2 Economic and Management Factors

The foremost economic factor affecting the investments in RES is poverty (Mirza 2015). A recent report on multidimensional poverty index (MPI) in Pakistan held that compared to the national benchmark, nearly 40 per cent of Pakistanis are poor (Government of Pakistan 2016). Access to institutional credit is also negligible as only 9 per cent of the adults (15+ population) have a full-service bank account and 0.1 per cent have access to non-banking financial institutions such as investment banks, leasing companies (Finclusion 2017). The formal financial sector does not fulfil the financial need of micro, small, and medium enterprises which in 2014 received just 7 per cent of bank credit to the private sector (Finclusion 2017). Furthermore, there is a very slow and inefficient downward flow of information regarding RES and many may not be even aware of the limited RES financing possibilities in the country.

Furthermore, equipment for most of the RE technologies is imported into Pakistan without adequate market infrastructure resulting in a lack of after-sales services, loose quality controls, and lack of qualified firms for import, installation, operation, and maintenance of RES. In November 2017, the AEDB introduced a very strict quality control certification facility for vendors of grid-connected RES installations below 250 kW.[26] Under this facility, just 45 vendors from a few major cities were given installation certificates—triggering criticisms that regulations are too strict to find sufficiently qualified firms and could create a monopolistic market and thus raising the cost of RES installations. In response, the AEDB has recently issued a modified version of certification regulations having three flexible categories of service providers, besides creating a category of RE consulting firm certification. Until an efficient market is established, the lack thereof would continue to serve as a major barrier in RES investment as can be observed from the bankers apprehensions mentioned above.

[26] See AEDB Notifications: SRO. [not numbered], dated: November 22, 2017; and, SRO [not numbered], dated: February 6, 2018.

26.5.3 Cultural Factors

Cultural factors affecting financing of RES and establishment of consumer (co-)ownership are on the one hand formal institutional-level barriers and on the other local and consumer-level barriers. At the formal institutional level, the favour had always been on mega hydro and thermal projects sponsored either by government or by strategic investors. Although awareness of renewables' potential to solve Pakistan's power crisis has increased over the years, attention is still towards large-scale investments be it public or by institutional investors from the private sector. Furthermore, RE is often perceived as a supplementary source but not necessarily as a real alternative (Sahir and Qureshi 2008), and communities are generally considered merely as a group of consumers to be served individually either by public or by quasi-public agencies.

This discourse shapes the on-grid consumers' perception of energy provision as a third-party domain with renewables as an inferior and low-powered energy source (Mirza 2015) thereby not worthy of investment from a (co-)ownership perspective. Therefore, despite the absence of specific legal barriers, the legally possible contractual arrangements are rarely perceived as a vehicle for community (co-)ownership. Although Pakistan has a long tradition of cooperatives, especially in the agricultural sector, the fact that the idea of energy cooperatives in grid-served areas is not present might be the result of this consumer-level cultural barrier. Finally, credit finance in general faces a majority bias against the receipt and payment of interest for loans (Finclusion 2017) promoted through different cultural and religious institutions, a factor that may also hinder investments in RES.

26.6 Possible Future Developments and Trends for Consumer (Co-)Ownership

Consumer (co-)ownership of RES in Pakistan is clearly evolving in off-grid and remote areas as a result of government's, NGOs', and international donors' support. This relatively recent development is moving rightly towards a self-sustained and community-funded utility model. Provincial governments and NGOs such as SRSP and TRDP have also shown their interest in the power utility model introduced by AKRSP (see Sect. 26.4.1) and are working on its customization to suit their particular situations.[27] It also seems possible that the consumer (co-)ownership model of RES may extend to the grid-served areas through housing cooperatives, if supported through appropriate policy and institutional arrangements. In 2016, a little over 2.3 million households were organized in 2686 housing cooperatives with an average membership of 866 households representing about 12 per cent of the housing stock in the country that could undertake investments in RE or set up energy cooperatives (Co-operative Housing International n.d.).[28] Although this sector of activity seems not to be present yet, energy efficiency measures and refurbishing of housing stock could be a lever for consumer owned RE projects as in other countries (see, e.g., Chap. 10 on the Czech Republic). When RE installation costs partly overlap with energy efficiency measures as, for example, insulation of rooftops and installation of rooftop PV systems, subsidies for energy efficiency projects can render RE projects economically feasible. Such an approach for cross subsidizing investments in micro RE installations, however, depends on availability of subsidies to finance energy efficiency improvement of flats and municipal buildings as well as access to credit.

Nevertheless, two important recent developments, namely the shift towards auctions for tariff determination and the planned merger of AEDB with the Private Power Infrastructure Board (PPIB), will determine the future course of RE investments in Pakistan. Since the RE industry is still juvenile and plagued with risk perceptions, many of the risk-averse players including housing cooperatives and small investors may hesitate to participate in the auction systems (Ashfaq 2016).

[27] SRSP has requested NEPRA for 2 MW hydropower generation licence from a plant located at village Birmogh Golen, Union Council Koh, District Chitral (Ref: SRSP/CEO/870 Date: August 15, 2017). The TRDP's CEO has also registered of a utility company to provide affordable energy to remote consumers (Personal Interview with TRDP Chief Executive Officer on March 15, 2018).

[28] During the 1960s, agricultural and non-agricultural cooperatives in Pakistan gained momentum as a result of government's financial assistance and loans through cooperative banks.

Furthermore, the PPIB, which has valuable experience but only in developing large-scale fossil and hydropower projects through corporate investments, may show little respect for small- and medium-scale and not-for-profit consumer (co-)owned RE projects for whom the reliable and affordable energy is the prime motivation. Although the actual impact of these two developments is yet to appear, they have certainly created an uncertain policy and institutional environment inclined to slow down the dynamic progress of the RE sector during 2015–2017. It has also raised the concerns on how Pakistan will materialize its Vision 2030 target of meeting at least 5 per cent of its electricity demand from RES systems.

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27

Consumer (Co-)Ownership in Renewables in Japan

Jörg Raupach-Sumiya

27.1 Introduction

27.1.1 Energy Mix

More than 90 per cent of Japan's primary energy production is based on fossil fuels, mainly oil with 41 per cent, hard coal with 26 per cent, and natural gas with 24 per cent, while renewables account for less than 9 per cent including large-scale hydro (METI 2017a, p. 140).[1] In 2016, the estimated share of RE in total final energy consumption was 6.3 per cent (World Bank n.d.).

[1] The Fukushima nuclear disaster in 2011 resulted in a shutdown of nuclear power, which had accounted for 11–13 per cent of Japan's primary energy prior to the disaster, thereby further increasing Japan's traditionally high dependency on fossil fuels.

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In respect to electricity generation, the share of RE has risen to 15 per cent in 2016, up by 5 per cent since 2010 (ISEP 2017). Large-scale hydro traditionally commands the top share with 6 per cent, while solar power has risen sharply to 4.8 per cent, followed by biomass with 1.7 per cent, and a notably low share for wind power with merely 0.6 per cent. RE plays only a marginal role in heat generation and is estimated at about 200 PJ in 2015 with 191 PJ from bioenergy, 11 PJ from solar-thermal, equivalent to about 1.5 per cent of Japan's final energy consumption (REI 2017a).

The introduction of a feed-in-tariff (FIT) system for RE in July 2012 triggered a boom in RE-related investments (IEA 2016, p. 123ff; UNEP/BNEF 2017). The installed generation capacity of RE excluding large-scale hydro above 30 MW installed capacity increased from 18.3 GW to 55.5 GW in 2016 (REI 2017a). Solar power accounted for 94 per cent of the newly installed RE capacity, making Japan the world's second largest market for solar power after China (REN21 2017, p. 166).

27.1.2 Current Main Challenges of the Energy Market, National Targets, Specific Policy Goals

Next to safety, the Japanese government proclaims energy security, economic efficiency, and environmental protection as the three key strategic goals of its energy policy (METI 2015). As 93 per cent of its energy resources are imported, Japan has the second lowest energy self-sufficiency ratio among the OECD countries. It ranks highest in respect to electricity prices among the major economies, and greenhouse gas emissions increased sharply since 2011 due to the shutdown of nuclear power. To achieve its policy goals, the Japanese government has enacted a comprehensive set of policies in three areas: fostering competition in the energy sector through deregulation and market liberalization, promoting energy savings and RE, and promoting nuclear and "clean" coal technology.

Deregulation and market liberalization of the Japanese power and gas markets started in 1995 with the aim to gradually open up the regional monopolies of vertically integrated power and gas utilities to competition (Raupach-Sumiya 2017). In 2013, the government enacted a policy package that—in three steps—strengthens regulatory oversight, market integration, and cross-regional management, expands free competition to the consumer and retail market, as well as enforces the legal unbundling of generation, transmission/distribution, and retail operations by 2020.

Promotional policies for RE seek to enhance energy security and to reduce greenhouse gas emissions in line with Japan's COP21 commitments, aiming for a RE share of 22–24 per cent for power generation in 2030 (METI 2015).[2] Japan started to promote RE in the mid-1970s, introduced a Renewable Portfolio Standard (RPS) scheme in 1997/2002, and a mandatory buyback program at fixed prices for residential solar power in 2009, a precursor of the current FIT scheme (Jordan-Korte 2011). The RPS law and PV buyback program was replaced by the Act on Special Measures Concerning Procurement of Electricity from Renewable Energy Sources by Electric Utilities (FIT law), which came into effect on July 2012 and introduced a full-fledged FIT scheme for RE to Japan.

27.1.3 Ownership Structure in the Renewable Energy Sector

The ownership structure of RE facilities reflects a bi-polar pattern (Raupach-Sumiya and Tezuka 2017). About 2.1 million households or 8 per cent of all standalone houses in Japan have installed residential PV modules on their rooftops at the end of 2016 (REI 2017b, p. 10). As of November 2017, solar power installations with less than 50 kW account for 54 per cent (~19.6 GW) of the total installed generation capacity for solar power (36.5 GW) supported by the FIT scheme (own calculation based on METI 2017b). This notable high level of household ownership of solar power indicates the effectiveness of the longstanding promotion of residential PV by the Japanese government since the early 1990s.[3] Yet,

[2] The Japanese government continues to also promote nuclear power, which it considers an important base-load technology; the targeted share for nuclear power in the energy mix is 20–22 per cent by 2030 (METI 2015).

[3] For example, 1.2 million small-scale PV units with a capacity less than 10 kW having a total capacity of 4.7 GW that had been installed before July 2012 and were transferred into the FIT system.

since the enactment of the FIT system in July 2012, large-scale solar facilities above 1 MW that are usually financed and owned by financial investors or large companies like ORIX or Softbank have seen particularly high growth rates. These facilities account for only 0.1 per cent of the total number of solar power installations, but for 29 per cent of the total installed generation capacity.[4] The middle segment of facilities between 50 kW to 1 MW, which are prominent in countries like Germany or Denmark and often (co-)owned by consumers, is notably less important in Japan.

Ownership of other RE sources such as wind power, biomass, hydro, or geo-thermal power is markedly different from those in the solar power sector and dominated by large companies and financial investors:

- A few commercial operators and large companies dominate the market for wind power and solid biomass (EU-Japan Centre for Industrial Cooperation 2014).
- In case of solid biomass for power generation large-scale facilities with an average capacity of 30 MW hold almost the entire market, while facilities with less than 2 MW usually owned by citizens, communities or small business struggle to gain a foothold (own calculation based on METI 2017b; MAFF 2017).[5]
- In case of solid biomass for heat generation, smaller-scale facilities with less than 300 kW hold the dominant market share. These

[4] A major issue with Japan's FIT system is the large number of "non-operating projects", referring to the high difference between certified facilities (80.9 GW as of November 2017) and FIT-certified facilities that actually operate (36.5 GW) (REI 2017b). This is due to a facility registration procedure that guarantees investors the feed-in-tariff at the point of project certification, but allows them to postpone operation in expectation of falling investment costs. The bi-polar structure of ownership becomes even more distinct when considering certified facilities. Large-scale solar power plants (>1 MW) account for almost 49 per cent of the certified capacity compared to 40 per cent for facilities less than 50 kW. The revisions of the FIT system have severely tightened the certification process, but the number of "non-operating projects" is still very high.

[5] Many facilities are owned by the woodworking, paper and pulp, and chemical industry for captive use of power and heat, while some power companies have invested in large facilities to sell power under the FIT scheme (MAFF 2017). Also a significant number of large-scale facilities using solid biomass use waste materials and wood or crop residues with a comparatively low biomass content.

facilities are often owned by small business (e.g., hotels, hot springs, healthcare), schools, or farmers to use for heating or warm water (MAFF 2017).

- Ownership of hydropower is dominated by the large power utilities and public companies (mostly owned by prefectures). However, under the FIT scheme for small- and medium-scale hydropower (<30 MW), a surge in the number of small-scale projects (<200 kW) has been recorded which are often initiated by local communities and farmers (REI 2017b; ISEP 2016).
- Ownership of the relatively small number of biogas facilities operated under the FIT scheme is naturally concentrated on farmers.

Besides individual, private ownership Japan can look back on a rather long history of jointly financed, collectively owned community-based projects (Raupach-Sumiya and Tezuka 2017). Since the first solar power plant owned and finance collectively by local citizens was launched in 1994, the number of such initiatives has grown to about 200 groups who have invested into more than 1000 facilities with a total capacity of 89 MW (Toyoda 2017). While most of the projects are for solar power (984 projects/42 MW), there are 30 facilities for wind power (46 MW) and 10 for small-scale hydro (1 MW). Yet, despite its well-established track record and recent surge of initiatives the key challenge remains the scaling up of project size in order to have a significant market impact.

27.2 The Consumer at the Heart of the Energy Market?

27.2.1 Consumer (Co-)Ownership in Renewable Energy Sources as Policy Goal

There is no legal definition of consumer (co-)ownership in Japan. The term “community power” is commonly used for projects that are collectively financed and owned by consumers and local citizens, and apply the three principles of "community power" as defined by the World Wind Energy Association. The Japanese Ministry of the Environment (MOE) is actively supporting the spread of "community power" initiatives (ISEP 2016). The FIT law itself apparently does not actively seek to promote consumer (co-)ownership. An indication is the fact that the FIT scheme applies only two tariff classes for solar power (<10 kW and >10 kW) which implies that medium-scale projects (e.g., 100–500 kW) are thought to possess similar characteristics in terms of project management, finance and economic viability as large, megawatt-level projects. This works at a disadvantage for citizen- and community-based projects as investment cost for medium-scale projects are comparatively higher than for large-scale projects. At the same time, the Japanese government views distributed RE as an important vehicle to promote regional economic growth and employment, as well as resilience against natural disasters and has initiated budgetary measures to promote regional deployment under the guidance of various ministries such as the Ministry of Economy, Trade and Industry (METI), the Ministry for Agriculture, Forestry and Fisheries (MAFF), or the Ministry of Environment (METI 2017a).

27.2.2 Fuel/Energy Poverty and Vulnerable Consumers

Energy poverty has not yet become a major social and political issue in Japan despite the rise of income disparities, child poverty, and the growing number of citizens receiving public assistance. However, the continued rise of the surcharge under the FIT scheme has become a major concern of the Japanese government (METI 2017a). The National Institute for Environmental Studies estimates that energy cost consume more than 10 per cent of family income for about 1.3 million households or 2.6 per cent of all Japanese households, and recommends policy measures to combat the projected surge in energy poverty due to the continued rise of the FIT-related surcharge (NIES 2013).

27.3 Regulatory Framework for Renewable Energy

Specific regulations for the RE sector are laid down in the Act on Special Measures Concerning Procurement of Electricity from Renewable Energy Sources by Electric Utilities (FIT law) which came into force on July 1, 2012 (METI 2017a).[6] The Agency for Natural Resources and Energy (ANRE) within the METI has the overall responsibility for energy policy in Japan including RE, while the Electricity and Gas Market Surveillance Commission (EGC), which was established in 2016 under the administrative supervision of METI, monitors the electricity, gas, and heat markets, supervises the neutrality of electricity and gas networks and, thereby, strives to ensure fair and free competition and the protection of consumer rights (IEA 2016). The Organization for Cross-regional Coordination of Transmission Operators (OCTTO), established as an industry self-regulatory body in 2015 as part of Japan's regulatory reform of its power industry, is responsible to coordinate and control short- and long-term, cross-national supply and demand of electricity in Japan, to review the utilities' power supply and demand plans, and to construct interregional transmission lines (IEA 2016).

27.3.1 Regulations for Connecting Renewable Energy Plants to the Grid

The FIT law generally obliges power utilities to connect RE facilities to the grid, but RE is not given priority access at connection stage as in Europe (Matsubara 2015a). In fact, ordinances by METI stipulate the right of the power utilities to refuse grid connection, if the power utility anticipates that adjustment of supply and demand may become difficult and, therefore, possible require power curtailment for the RE facility for

[6] Furthermore, three basic laws regulating the Japanese energy industry generally also affect the RE sector, for instance in respect to obligations of power providers and power retailers, namely the Electricity Business Act of 1964, the Gas Business Act of 1954 and the Nuclear Power Basic Law of 1955.

more than 30 days annually in the respective service area (REI 2017b). Following such claims by four utilities in autumn 2014,[7] METI further tightened the rules for grid connection and power curtailment. It specified a so-called "accepted capacity" for the 10 regional service areas in Japan and allowed for uncompensated curtailment beyond 30 days in areas in which grid connection applications exceed the "acceptable capacity"; grid operators in these areas are recognized as "designated electric utilities". In addition, the cost for the grid connection and possibly required grid enhancement are to be fully borne by the RE producer requesting connection, not by the grid operator as in Europe where the cost for grid connection and enhancement are distributed thinly to all consumers (Matsubara 2015a, b).

These provisions on grid connection, power curtailment and connection costs have further strengthened the bargaining power of the power utilities and further raised the costs and risks for RE investors. In particular for projects by individuals or with consumer (co-)ownership these provisions have become formidable barriers, leading citizen groups to demand substantial changes to the connection rules (Gotôchi Enerugi Kyôkai 2017). Next to the rising surcharge fees, the issue of grid connection and limited transmission capacity is presently considered the most important issue that could inhibit further growth of RE in Japan causing METI to establish a special working group in December 2017 to deal with this issue (Yasuda 2017; METI 2017c).

27.3.2 Support Policies (FITs, Auctions, Premiums, etc.)

The FIT law obliges electric utilities to connect RE power plants to the grid and to purchase the generated electricity at initially generous FITs guaranteed for 20 years with an exception for PV power installations

[7] In autumn 2014, four of Japans ten regional power utilities (Kyushu Electric, Tohoku Electric, Hokkaido Electric, Shikoku Electric) used this provision to announce their suspension to accept new application for grid connections from RE producers, citing limits to their connection capacity within their service area (Matsubara 2015b).

below 10 kW, where purchases are limited to surplus energy at tariffs guaranteed only for 10 years. It certifies and promotes five categories of RE which were further divided into sub-segments with the following FITs in 2018: for photovoltaic power below 10 kW JPY 26/kWh (2012: JPY 42/kWh); 10 kW and above JPY 21/kWh (2012: JPY 40/kWh); up to 2 MW JPY 17/kWh and above 2 MW by means of auction; for onshore wind less than 20 kW JPY 55/kWh and 20 kW and above JPY 20/kWh (2012: JPY 22/kWh); for small- and medium-scale hydropower less than 200 kW JPY 34/kWh, between 200 kW and 1 MW JPY 29/kWh as well as between 1 and 3 MW JPY 27/kWh (2012: JPY 24/kWh up to 5 MW); JPY 20/kWh for 5 MW to 30 MW; for geo-thermal power less than 15 MW JPY 40/kWh and 15 MW and above JPY 26/kWh; and for biogas JPY 39/kWh and certain forms of biomass JPY 13–40/kWh depending on the type of material and capacity, for example, for wood and crop residues: less than 2 MW JPY 40/kWh and 2 MW and above JPY 32/kWh (IEA 2016; METI 2017b). The subsequent rapid growth of RE, in particular solar power, has raised concerns in regard to rising surcharge cost and issues of grid connection and market integration, which led to several revisions of the FIT law. However, in order to cope with rising surcharge cost, the government has introduced an auction scheme for solar power projects exceeding 2 MW (METI 2016a).

Another scheme to promote investment into RE is the Green Energy Certificate System (Raupach-Sumiya 2017). The mechanism splits the generated volume of RE into two components, the physical energy to be sold on the market and a tradable certificate that represents the environmental value added of the energy generated from the certified RE sources.

27.3.3 Specific Regulations for Self-Consumption and Sale to the Grid

Facilities with less than 10 kW can only sell surplus power for a period of 10 years while for facilities with 10 kW or more capacity can sell all the generated power for 20 years at the given tariff, which discriminates against small-scale projects that already have relatively higher investment cost per installed kilowatt. This design of the FIT system may also be intended to promote the self-use of residential solar power, in particular as the government subsidizes the combination of residential solar power with heat pumps (so-called "eco-cute") or energy storage devices (e.g., lithium-ion or fuel cell batteries) (METI 2017a). The national government also offers subsidies for off-grid RE installations (METI 2018).

Under the revised FIT law, the transmission or distribution operator (TSO/DSO) in a designated service area is required to purchase the generated power and to feed it into the wholesale market (METI 2016b). Curtailment allows the utility to curtail power without compensation to the RE producer for up to 30 days annually, and even beyond 30 days, in case the utility is recognized as a "designated electric utility" (REI 2017b). At present, power generated under the FIT scheme cannot be marketed by the RE producer directly to the wholesale market; a Feed-in-Premium scheme has not been established, yet. RE producers can also market the generated RE directly to power retailers. However, in case of RE that is enjoying the benefits of the FIT system, RE producers are not allowed to claim the specific environmental benefit of RE as additional value added, because the cost for the investment into RE are borne by the general public via the FIT surcharge (Raupach-Sumiya 2017).[8]

27.4 Concepts for Consumer (Co-)Ownership in Practice

27.4.1 Contractual Arrangements and Corporate Vehicles Used

With the exception of cooperatives[9] RE business can take all possible legal forms of business associations under Japanese commercial and corporate law such as a joint stock company (KK), limited liability company

[8] However, the Japanese government has decided to establish a new market for trading the environmental value added of zero-emission RE (and nuclear power) as separate certificates in order to promote procurement of clean energy (METI 2017d)

[9] The Japanese law for cooperatives does not cover energy, making it impossible for citizens to incorporate collectively owned enterprises as "energy cooperatives" (Wada et al. 2014).

(LLC), or limited liability partnership (LLP), but also not-for-profit organizational schemes (Wada et al. 2014). The RE project itself is often housed in a Special Purpose Company (Tokubetsu mokuteki kaisha/SPC) for transactional, tax, and accounting reasons. To avoid capital market regulation (see below Sect. 27.5.1), citizens often form an anonymous partnership (Tokumei Kumiai) with less than 49 members that will invest the privately solicited funds in RE projects; such a scheme only requires notification, not registration with the Local Financial Bureau. Alternatively, citizens entrust their funds with a trust company (Shintaku Kaisha) registered with the Financial Service Agency (FSA) that will establish an SPC to invest and operate RE projects (People's Power Network 2017).

27.4.2 Financing Conditions for Consumer (Co-)Ownership in Renewable Energy

27.4.2.1 State Subsidies, Programs, Credit Facilities, Preferential Loans

Investment into RE is supported by a broad and varied set of programs that offer subsidies, tax incentives as well as preferential loans. For example, the METI guidebook for 2017 lists a total of 61 programs that support investment, research and development, business investigations, and project planning for RE by private entrepreneurs and local governments (METI 2018). Other ministries like the MOE, the Ministry of Agriculture, Forestry and Fisheries (MAFF), the Ministry of Internal Affairs and Communications (MIC), or the Ministry of Land, Infrastructure, Transport and Tourism (MLIT) have similar programs. Interestingly, the MOE has launched the Green Finance Organization that pursues equity investment into business ventures such as renewable energy generation to reduce greenhouse gas emissions (MOE 2018). On regional level (prefectures, municipalities) there are also various schemes that subsidize the purchases of RE equipment. For example, Nagano Prefecture has initiated an innovative subsidy program for RE business ventures that initially provides a grant for RE investment which, however, has to be repaid when the venture generates a profit (Tanaka 2018).

27.4.2.2 Agencies Supporting Investment in Renewable Energy Sources

On national level, the METI has the overall responsibility for implementing Japan's energy policy including RE (IEA 2016). However, other ministries also influence RE-related jurisdiction and policies like the MOE, which oversees Japan's climate policy and implements environmental protection laws (e.g., environmental impact assessment, natural parks), the MAFF, which supports rural initiatives in the field of bioenergy, or the MLIT, which devises infrastructure-related regulations (e.g., off-shore wind). Japan's Cabinet Office extends substantial political power to promote the government's energy and climate policies. At the municipal level, local governments are called upon to support and implement energy- and climate policies responsible under the guidance of the MIC. The MOE is also supporting projects and initiatives on municipal level as part of their de-carbonization strategy.

Japan can look back on more than 20 years of history for its movement of citizen-owned RE plants, which gained momentum after the COP3 conference in Kyoto (Raupach-Sumiya and Tezuka 2017). An important role to spread the movement nationwide was played by the National Forum of Citizen-Owned Power Plants, which for the first time gathered in Shiga Prefecture in 2002. Today, consumer (co-)ownership of RE initiated and supported a number of civil society organizations like Kiko Network, the People's Power Network or Zenkoku Gotôchi Enerugi Kyôkai (National Community Power Association). The Institute for Sustainable Energy Policies (ISEP) and the Renewable Energy Institute (REI) are vocal advocates for RE deployment in Japan, and engage in independent RE-related research and consultancy support.

Furthermore, a number of municipalities are taking an active stance and adopt "Local Renewable Energy Directives" that promote local participation and ownership of RE power. The town of Nichinan in Tottori Prefecture was the first town to issue such a directive, and the number has increased to at least 20, for example Konan City in Shiga Prefecture, Shinshiro City in Aichi Prefecture, and Iida City in Nagano Prefecture. Also, some municipalities like Kyōto have established a scheme for citizen-owned renewable energy power plants that provides the municipal land and buildings to local renewable energy investors (Wada et al. 2014). Based on this scheme local citizens jointly invest into solar power, set up a local organization, engage in environmental education, and design schemes like local vouchers to ensure that returns from the renewable energy investment are circulated in the local economy. Some municipalities issue municipal bonds to finance local renewable energy investment, thereby striving for local energy autonomy and a sustainable local development. These initiatives by municipalities attempt to regain decision-making power over energy and climate policy and to revitalize local communities.

27.4.3 Examples of Consumer (Co-)Ownership

Today, there are more than 200 groups who initiate and manage RE projects based on consumer (co-)ownership (Toyoda 2017). Besides the establishment of anonymous partnerships and other forms of business association, consumer (co-)ownership through citizen-initiated funds have gained a prominent role (METI 2017e).

I. In September 2001, the Japan's first citizen (co-)owned wind power plant **"Hamakaze"** with 990 kW and an investment of JPY 200 million (equal to ~EUR 1.5 million) started operation in the town of Hamatonbetsu in Hokkaido (Hokkaido Green Fund 2018). 217 citizens co-invested 80 per cent of the investment, while the Hokkaido Green Fund provided the remaining 20 per cent through its "green electricity pricing" fund. These funds had been collected through a scheme by which citizens agree to a surcharge of 5 per cent of their electricity bill, which is donated to Hokkaido Green Fund, which had been established in 1998 by Seikatsu Club Hokkaido consumer cooperative. The "Hamakaze" project served as a model case of RE consumer (co-)ownership for a series of other projects throughout Japan. In order to organize the fund raising process and manage the individual funds, the Renewable Energy Citizen Fund Corporation (Kabushikikaisha Shizen Enerugi Shimin Fando) was established in 2003 (Shizen Enerugi Shimin Fando 2018). By December 2010, over 3800 citizens had invested a total of JPY 3670 million (~EUR 28 million), 47 per cent of which financed by citizens, into 12 wind power plants throughout Japan with a total capacity of 17.8 MW.

II. In May 2004, a 3 kW solar power facility on the rooftop of the Myôjo Child Day Care Center in the city of Iida, Nagano Prefecture, financed by donations from Iida citizens (Ohisama Shinpô Enerugi homepage). The project had been initiated by a citizen group that promoted the spread of RE and led to the establishment of the **Ohisama Shinpô Energy fund** management company in December 2004 with the objective to raise and manage funds from citizens to co-invest into RE facilities and energy efficiency. The first fund was established in March 2005 and invested into 38 solar power facilities with a total capacity of 208 kW placed on rooftops of public buildings like elementary schools and child day care centers. As of March 2017, Ohisama Shinpô Energy has established 10 funds in which more than 3200 citizens have invested about JPY 2 billion Japanese Yen (~EUR 16 million) nationwide to build 357 solar power facilities throughout Japan totaling more than 7 MW. The company pioneered innovative business model such as the Zero Yen scheme where it rents rooftops, set-ups the solar power facilities at no cost for the homeowner and generates revenue as a third-party operator. The company also established a fund to invest into small-scale hydro which attracted more than 500 citizens to investing 780 million Japanese Yen (about ~EUR 6 million). The company's business has expanded beyond fund management into operation and maintenance, energy management services, energy efficiency, carbon certificates, consulting, and education.

III. The nuclear disaster in Fukushima has triggered many citizen initiatives to promote citizen-owned RE projects in Fukushima. With the support by the *Citizens the People's Association for Renewable Energy Promotion* (PARE), that has promoted citizen-owned renewable energy power since the mid-2000s (Wada et al. 2014), the *Fukushima Coalition of Farmers* completed the **"Fukushima Ryōzen Citizen Power Plant"** in the Date city in 2013. The 50 kW solar installation is operated by PARE and was constructed at costs of JPY 20 million yen (~EUR 150,000) fully paid by citizen investments at 200,000 yen per share. Another solar power plant nearby with a capacity of 105 kW is operated by the Fukushima Coalition of Farmers and Citizen. In 2014, the Coalition and PARE formed a Limited Liability Partnership and built a 210 kW solar plant with an investment of JPY 78 million (~EUR 590,000) in Koriyama city with 2 per cent of the revenue from electricity sales of the projects being donated to The Fukushima Reconstruction Fund (Raupach and Tezuka 2017). The coalition also attempts to turn devastated land into locations for solar power plants and to promote energy autonomy of the region. Solar power installations with a total capacity of 3 MW are planned at 14 locations.

27.5 Factors Affecting the Financing of Renewable Energy Sources and Barriers to Consumer (Co-)Ownership

27.5.1 Political, Legal, and Administrative Factors

Although the introduction of the FIT law in 2012 gave new momentum to the community power movement in Japan as it substantially lowered the financial risks, promised attractive returns, and created a supportive political environment and public interest. As a result, the number of citizen groups promoting consumer (co-)ownership grew rapidly and also the scale of projects increased (People's Power Network 2017; Toyoda 2017). However, the subsequent revisions of the FIT law, in particular the one in 2016, significantly raised the barriers especially for citizens as FITs were lowered and administrative processes became more burdensome. Investment into new community power projects for solar have almost come to a halt, while little progress is seen in the area of wind, biomass, small- and medium-scale hydro or smaller-scale geo-thermal power due to time consuming administrative procedures (e.g., environmental impact assessment), extensive local consensus building, growing resistance by environmental groups (e.g., wind power), and the still high investment cost.

In addition, the rapid growth of large-scale, ground-mounted solar power plants of large companies and financial investors has provoked growing resistance in regional communities who do not participate in the commercial benefits, but feel as victims to the destruction of landscape scenery and potential increase of safety risks (ISEP 2015). The root cause of these issues are a “ambiguous and rigid” land-use classification scheme which, on the one hand, severely restricts development of protection forests and agricultural land and, on the other hand, allows developments without sufficient communication with local authorities and considerations of the concerns of local residents (REI 2017b). As a consequence, the central government and local authorities have enacted a flood of guidelines and procedural regulations that have made developments more cumbersome. In fact, citizen groups cite difficulties of site identification and selection as well as time consuming consensus building with local authorities and residents as key issues when implementing new projects (Toyoda 2017). Difficulties with grid connection and land lease, as well as increased risks of power curtailment are further obstacles for project implementation. As a result, support and pro-active policies by local authorities are seen as important factors for future growth of community power projects.

Furthermore, in case of fund-based RE projects, the entrepreneur has to observe the regulations of the Financial Instruments and Exchange Act (FIEA) which regulates collective investment schemes and associated financial products, and to register with Japan’s FSA (FSA 2017). These requirements, which are intended to protect investors against financial abuses, can add a substantial administrative burden and additional costs on community-based RE projects with consumer (co-)ownership.

27.5.2 Economic and Management Factors

Fund raising and financial management still rank as the highest factor affecting the implementation of RE projects based on consumer (co-)ownership (Toyoda 2017). At the same time, citizen groups have become more professional and experienced in respect to funding and financial management (People’s Power Network 2017). In the early days of consumer (co-)ownership, when commercial banks were still reluctant to provide loans, projects were often financed through partnership investments or privately-placed notes or bonds (shibôsai/giji shibôsai) which naturally limited the number of investors and the scale of the project. Donations and public subsidies also were an important source of finance. In recent years, equity-based finance by incorporated legal entities has become a common source of finance, and lending from commercial banks has increased significantly, allowing for investment into larger-scale projects, which are still economically viable despite lower FITs.

Although citizen groups have become more experienced and professional, the lack of managerial and technical know-how, as well as organization building continue to challenge community power projects (Toyoda 2017). Capacity building and strengthening network ties with other citizen groups are, therefore, considered to be important factors for future growth.

27.5.3 Cultural Factors

For Japan, social and cultural factors are not considered to be major obstacles to the acceptance of RE and the spread of consumer (co-)ownership. In fact, the consumer and farmer cooperative movements have a long and rich history in Japan, and are the largest cooperative organizations in the world (Raupach-Sumiya 2017). A number of leading consumer cooperatives are aggressively investing in RE and have established subsidiaries for power retailing. Awareness of climate and energy issues among the Japanese public is well developed, in particular after the nuclear disaster in Fukushima.

27.6 Possible Future Developments and Trends for Consumer (Co-)Ownership

Future developments of RE in general, and consumer (co-)ownership in particular, depend largely on the direction of policies by the Japanese government. Five years after the introduction of the FIT law, RE deployment—especially solar—has grown rapidly, investment and operating cost have come down significantly, and employment in the RE sector has surged (REI 2017b). At the same time, the rapid rise in the FIT-related surcharge, growing difficulties with grid connection and integration of RE, and growing resistance by local residents and municipalities have led to revisions that increase the administrative burden and often jeopardize the economic feasibility of projects. Furthermore, while solar power has surged, other RE sources like wind, biomass, geo-thermal or small- and medium-scale hydropower have lagged behind, mainly due to lengthy administrative procedures (e.g., environmental impact assessment), time consuming local consensus building as well as still high investment and operating cost (METI 2017a; REI 2017b).

A promising development is the growing interest of Japanese local governments to promote RE and to localize energy generation and consumption (chisan chishô) as a means to revitalize regional economies (Raupach-Sumiya 2017). For this purpose, a growing number of municipalities have established power retail companies, often in cooperation with local business and professional energy management service firms. Collaborative arrangements of local governments with local citizen groups may emerge as an interesting approach to mobilize funding of local RE projects based on consumer (co-)ownership. At the same time, the trend toward prosumership may well further accelerate. In 2019, the solar buyback program introduced in 2009 will end for many residential solar owners (Kankyô Bijinesu Online 2017). These owners will either have to invest in energy storage devices to enable full-fledged self-consumption and off-grid solutions, or engage in sales contracts with aggregators at substantially lower prices. This development may also trigger new business models such as Virtual Power Plants (VPP) that integrate various micro-grid facilities.

Fundamental issues, however, are the cost of investment and operation of RE in Japan, which are still very high in international comparison, in particular in respect to construction and balance-of-system costs (REI 2017b). It remains to be seen, whether the recently introduced auction scheme for solar power (above 2 MW) will produce the desired reduction of investment cost. The first auction of 500 MW in September/October 2017 produced mixed results: on the one hand, the lowest offer (JPY 17/kW) was well below the minimum target price (JPY 21/kW) but, on the other hand, only 9 projects amounting to only 141 MW materialized although initially 29 projects amounting to

490 MW had registered for application in the auction (Smart Japan 2017). Those bidders who finally decided not to participate cited the difficulties to secure land use, the lack of a grid connection contract and limited grid capacity as the three main reasons for their retreat. Even so, the price of the lowest bidder is still about twice as high as, for example, the prices achieved in Germany during similar auction.

The Japanese government will, therefore, have to review its bidding process, in particular also, because it is considering the introduction of an auction scheme also for biomass. It is clear that growth of RE is likely to decelerate under the prevailing FIT scheme unless significant reductions of RE-related investment and operating cost are achieved. If not, further promotional policies for RE are inevitable despite growing concerns about the rising FIT-related surcharge and emerging calls for abandoning the scheme. In addition, it is also essential to ease grid access, to curb and fairly distribute grid connection costs, and to accelerate the market integration of RE (REI 2017b).

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Part IV

Summary of the Results and Their Implications for Policy-Making

28

Institutional Aspects of Consumer (Co-) Ownership in RE Energy Communities

Gloria Baigorrotegui and Jens Lowitzsch

The flourishing field of RE communities presents multiple challenges for their joint analysis, due to the broad variety of organizational, technological, ownership, and regulatory forms in which citizens are engaged. RE community in the context of this book is understood as an umbrella term of concepts like "citizen energy", "prosumership", and "community energy" with a focus on consumer (co-)ownership (see Section 1.1.2 above for the delineation). The cases of consumer (co-)ownership from all over the world presented in Section 4.3 of each of the country chapters (Chaps. 10 to 27) show a broad variety of patterns involving different combinations of (innovative) organizational and contractual arrangements,

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(local) identities, and (common) interests. The implementation of consumer (co-)owned RE projects is influenced by each of these factors, but it is the combination of them in a particular setting that hinders or facilitates its accomplishment. The geographic and cultural diversity of the RE projects in combination with this interdependency lead to complexities that forbid "one size fits all" solutions even within a given country. However, while "identity" and "interest" are deeply rooted in geographies and cultures, organizational and contractual arrangements are a political and procedural factor that is more flexible and can be adapted to the former two. In an attempt to identify patterns of success (and failure)—following a socio-technical approach—the mentioned key factors can be grouped around two notions, namely that of communities of place and communities of interest and their intersection.

To this end the chapter first makes a distinction between communities of interest, communities of place and communities of interest and place. Second, the notion of legitimacy in the context of RE projects is considered. Third, aspects of the applied technologies and the geographical situation of the projects are reviewed, followed by a discussion of the results of the study.

28.1 (Co-)Ownership Between Communities of Interest and Communities of Place

Institutional arrays are considered important in projects of RE communities in general (Simcock et al. 2016; Wirth 2014) and key in projects of rural and low-income communities in particular (Feron et al. 2016; Feron 2016; Opazo 2014). The institutional sustainability[1] of RE communities entails a precarious balance between norms, interests of their members, construction of identities, and material restrictions of RE technologies in

[1] This notion considers a type of stabilized relationship between different networks and systems concerning humans but also animals, plants, biosphere, stratosphere, and so on. With regard to the four areas of sustainability that Feron (2016) considers, that is, institutional, economic, environmental, and socio-cultural sustainability, we would like to emphasize the institutional concern for a stable coexistence between them.

place (Baigorrotegui 2018; Walker et al. 2010). In RE communities in particular ownership, democratic control of the RE installations, and distribution of economic and social benefits of the project are often anchored locally. Local ownership rights increase the decentralization of energy generation, amplify the access to autochthonous RES, and enable an improvement of indigenous lifestyle. However, there are also many projects that define themselves via the common interest of their participants which are not necessarily consistent with the local population and who may come from different regions. Thus, local identity and common interest may be congruent but not necessarily. With a rising awareness of the global dimension of environmental protection and increasing internationalization of the movement for sustainability and green energy it is often the care of biodiversity and localities wellbeing as elements of the common interest that bridge differences in geographical origin. Again, ownership rights can play an important role to channel commitment, ensure participation in decision-making, and trigger change vis-à-vis traditional models. A transnational community power network, for example, is emerging in relation to global climate change concerns supported by Japanese and German public institutions from the energy field, coalitions of local governments and UNESCO: in the first World Community Power Conference held in Fukushima in November 2016 relevant policy instruments for a (co-)ownership approach were highlighted, namely FITs in place, access to financing for small investors, availability of insurance, and non-discriminatory practices.[2] Where a community of place is congruent with a community of interest, the motivations of the citizens involved typically transcend the local context either by strategic partners or by a specific mission which can also be political influence, for example, to bring forward the energy transition and climate goals.

Of course, as local identity and common interest often overlap, RE projects can be sorted in three groups, that is, (1) communities of place, (2) communities of interest, and (3) of communities of interest and place (see Fig. 28.1). In these settings, collective and individual ownership

[2] See the Fukushima Manifest Declaration 2016 available at http://www.wcpc2016.jp/en/about/declaration/, accessed 24 April 2018.

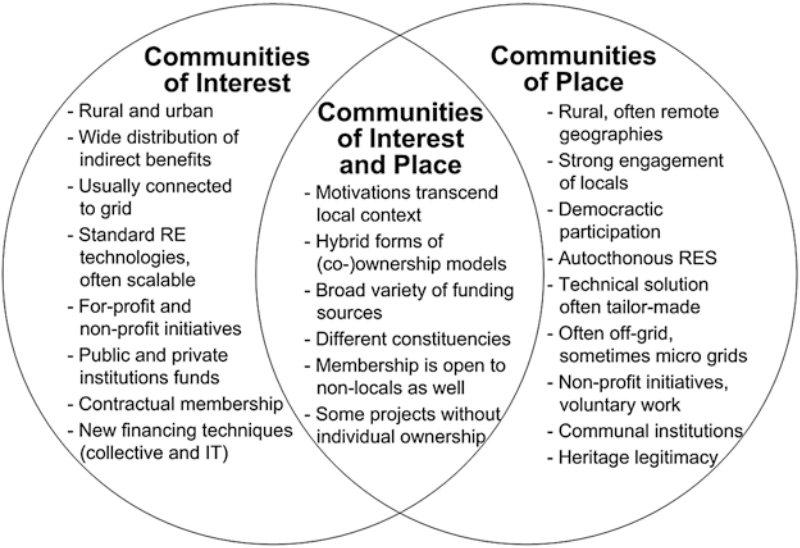

Fig. 28.1 Consumer (co-)ownership RE projects on the intersection of communities of place and interests

rights have a crucial function as driver at three levels, that is, providing economic incentives, motivating to learn, and facilitating acceptance in a more democratic way (for a broader discussion of these functions see Chap. 3).

28.2 Consumer Ownership and Legitimacy

Independent of the expectations of initiators or facilitators the technical-economic and even the environmental viability of RE projects ultimately depend on local or community legitimacy. In this context, issues such as who manages the project, modes of decision-making, and conflict resolution are crucial. These in turn are interdependent with what is perceived as desirable, proper, or appropriate within the concerned localities, their norms, values, beliefs, and definitions (adapted from Suchman 1995). Legitimacy has been considered a multifaceted concept embracing ex ante legitimation as well as being accepted ex post in the process of evaluation (Desmond 2018; Hurrelmann et al. 2007). With respect to the trajectory of communities and the implementation of their RE projects, the reasons for initiating the projects (Jeong et al. 2012), the agreements on the distribution of benefits among members, and the financing of the projects are key (Vancea et al. 2017; Becker and Kunze 2014).

Although identity and value aspects are important in communities of place, the predominant concern seems the distribution of social and economic benefits both direct and indirect, between the individuals. RE communities of place typically focus on a collective dimension and lifestyle changes while they are less occupied with individual investment gains and more focussed on collective local benefits (Howe et al. 2015). More general, the scale of collective, grassroots group-owned RE projects is small and their benefits are re-distributed in its locality. The focus is typically on access to energy for the community as a whole, issues of savings, literacy, efficiency, and distributive justice between different groups of that community. Communities of interest on the other hand are often intermediate ways to achieve specific objectives that in communities of place would be, if at all, considered secondary objectives, such as improvements in levels of unemployment, local development and reduction of energy poverty, and sustainable energy supply. The legitimacy of these projects is dependent on the way these business models cater to local RE demands.

Community of interest and place at the same time are concerned with new forms of funding, including new markets spaces for RE initiatives focused on RE demands. Funding experiments through online platforms create new collectives besides grassroots groups. Individual and collective contractual agreements increase their legitimacy through democratic and participative accountability. However, with groups often being heterogeneous risks linked to social frictions in previous collective relationships as well as historical conflicts between communities and public policy makers need to be taken into account (Vancea et al. 2017). Here the business models and the financial commitments that convey ownership to local inhabitants are key factors (Cass and Walker 2010; Walker and Devine-Wright 2008). Therefore, in communities of place RE initiatives based on common identities, specific cultural assets, interpretations widely shared by a community are easier legitimized as they are based on a common heritage.

28.3 Different Technologies for Different Places and Distances

The geography of energy has various material aspects like the location of territories, the dependence/independence or autarky of projects, the contiguity of energy supply, and the possibility of (inter-)connection with other points of distribution of the network (Bridge et al. 2013). In this context, distance is an important factor for both communities of place and of interest, as they take shape in different ways (Devine-Wright 2010). In the former, RE communities usually translate the needs of their remote, rural places, while in the latter, politics shaping the design are coordinated with communication networks between members often located in different geographies. In the communities of interest and place, the communication networks contribute to shape virtual communities supporting RE local demands. The RE technologies in communities of place typically match autochthonous RES and distributed systems. These technologies tend to focus on self-consumption and increasing awareness of energy conservation and efficiency. Hence, projects are managed at smaller scales and are often tailor-made in particular if they involve micro grids (see Sect. 2.3). Properties where technologies are sited will usually belong to the founding members of the RE project and the most active consumers in the locality (Smith 2005). In the case of communities of interest, the choice of RE technologies is typically market or incentive driven and more often installed by international, large-scale companies and therefore standardized and scalable. This last issue has been proved to be sensitive to locals. Ownership in these communities may or may not relate to the consumers' premises with their indirect benefits available also for actors only connected by information networks on the installation site and beyond it (Walker and Devine-Wright 2008). Typically they will be connected to the grid and allow for both self-consumption and sale to the grid.

28.4 Discussion of the Examples from the Country Chapters

The wide range of experiences convened in this book is marked by their diversity and to articulate the 60 experiences from the 18 countries under investigation we place each of the experiences on three axes of analysis: (1) (Co-)ownership models and funds, (2) technology and geography, and (3) participation of locals and distribution of benefits. The following discussion uses only exemplary cases to illustrate the arguments without being exhaustive. Furthermore, as the delineation between categories is not strict and information on individual cases provided in the country chapters has a summary character, cases we discuss under one category could move to another, as more detailed information becomes available. In summary, grouping the cases reported from the countries under consideration summarized in three overview tables (see Tables 28.1, 28.2, 28.3 in the Annex to this chapter) we find the following main characteristics:

1. **Communities of Interest:** We observe a large variety of projects both in rural (IND I. VARANASI hybrid solar plants powering local businesses) and urban settings (CH IV Energy Cooperative in the city of Buttisholz) with a wide distribution of indirect benefits (CAD I. TREC & Solar Share: 1500 members earned over CAD 3.3 mln. in return on their "solar bonds"). They are usually connected to the grid and thus besides self-consumption involve sale of excess electricity produced often involving net metering (CHI II. Solar Buin 1) and permit supplying energy also to businesses (NL II. Windpark Krammer). In general, these projects involve standard RE technologies that are scalable (Wind power plants in the case JP I. Hamakaze RE-Cooperative & RE Citizen Fund Corp.; or the PV projects of IT I. RETENERGIE). We observe both for-profit (CZ I. Drahany wind park) and non-profit initiatives (ES I. SOM ENERGIA Cooperative in Spain) sometimes with elements of both present (CAD I. TREC & Solar Share in Canada where a for-profit corporation incorporates a not-for-profit entity). As a rule both public and private institutions

provide funds (CZ I. Drahany Wind Park and JAP I. Hamakaze RE-Cooperative and RE Citizen Fund Corporation both having corporate and citizen investors). Membership is typically contractual (FR II. ENERCOOP with 27,000 members or ES I. SOM ENERGIA Coop with an exponential growth in membership base across Spain from 178 founding members in 2010 to ca. 46,500 members in 2018). Sometimes new financing techniques with a collective character and linked to digitalisation are involved as, for example, crowdfunding (CHI II. Solar Buin 1; see also the French Internet platforms lumo, enerfip, or lendosphere in Chapter III).

2. **Communities of Place:** Typically the setting is in rural, often remote geographies (IND II. the RE Development Cooperative where PV installations supply villages) and in urban geographies too, but with a strong emphasis of local and collective ownership (ENG II. Brixton Energy and BRA II. RevoluSolar). The strong engagement of locals typically involves democratic participation with associative financial sources (CAL I. Anza Solar Farm & SunAnza started upon instigation of the local cooperative members or SCOT II. Aberdeen Community Energy where the community co-decided on project planning) and profits are reinvested to local developments (JAP III. Fukushima Coalition of Farmers, BRA II. RevoluSolar). As a rule these projects involve autochthonous RES (DK III. NGF Nature Energy Holsted with a Biogas plant processing local cattle slurry; SCOT II. Aberdeen Community Energy with a 100 kW run-of-river scheme). Technical solutions are often tailor-made to the local needs (the self-sufficiency projects of FR I. Le Mené and CZ II. Power plant in Hostětín). Projects are often off-grid in island situations (SCOT I. Isle of Eigg involving an off-grid system with water, sun, and wind energy; NL IV. Duurzaam Ameland with a micro grid on the Island of Ameland) or in remote areas involving micro grids (CHI III. Huatacondo micro grid project). Often these non-profit initiatives involve voluntary work (BRA II. RevoluSolar, a cooperative set up by residents of a disadvantaged community or SCOT I. Isle of Eigg, CHI III. Huatacondo micro grid project where basic maintenance activities are carried out by locals). Finally, communal institutions have a strong element of legitimacy rooted in common heritage (NL IV. Duurzaam

Ameland co-founded by the municipality and a local energy cooperative).

3. **Communities of Place and Interest:** Typically where a community of place is congruent with a community of interest the motivations of the citizens involved transcend the local context either by strategic partners (IT III. Lucense 1923, a cooperation by an investment company and a RE cooperative in Italy) or a specific mission (training local labour in the case of BRA I. Juazeiro or to implement experimental models of micro grid connection in remote places in CHI III. Huatacondo) which can also be political influence, for example, to bring forward the Energy Transition and climate goals (JAP III. Fukushima Coalition of Farmers and Citizens & PARE and CH V. Appenzeller Energie founded as a reaction to nuclear disasters). We observe hybrid forms of (co-)ownership models (PL II. Cooperative "Our Energy" involving two corporations and four municipalities; DE II. Cooperative Bioenergiedorf Jühnde started by farmers, the municipality and consumers) and a broad variety of funding sources (CZ II. Power plant in Hostětín, where national and foreign grants, three foundations and local consumers contributed to funding) sometimes with state or state-owned actors (DK II. Middel-grundens Wind Farm I/S involving 51% ownership of Orsted, a state-owned company). The cases also included different constituencies like tenants (DE I. Heidelberger Energiegenossenschaft involving tenants of a multi-dwelling building) and micro enterprises (PAK I. Shandur Utility Company Limited). More general, local consumers and their premises are invited to participate while membership is open to others as well (ES III. Fundacion Terra, which allows external investors not belonging to the membership base) and sometimes involves new financing concepts (different investment blocks consisting of citizen associations, companies and banks contributed to the financing of the wind turbines of FRA III. Béganne community-owned windmill farm). Finally, there are RE community projects without ownership of individuals (Community Choice Aggregation by municipal energy suppliers CAL II. Marin Clean Energy and CAL III. Peninsula Community Energy).

In all the practice examples from the countries under consideration, varying contractual arrangements conveying ownership rights are in place that, however, seem to show similarities within the three categories discussed above. There are different political motivations, for example, civil advocacy groups for wind energy, municipal RE implementation, reaction to nuclear accidents, citizens pressing municipal utilities for local RE supply, and battling energy poverty. For some experiences, the ownership was a generative source of business and social innovations related to a place. However, (co-)ownership of RE projects may also trigger novel controversies. The communities of interest and the communities of interest and place, at the same time showed new and varied forms of financing, distribution of returns and ownership where individuals (not necessarily geographically close to each other) were able to influence the decisions of commercial cooperatives, limited liability companies, cooperatives, and so on. The experimental experiences of Japanese fundraising, the Chilean crowdfunding or the modalities of virtual net-metering stand out. Certainly, citizen empowerment influenced certain innovations to face the lack of institutional support and national or regional market rules. Solar technology appears as one of the most prevalent technologies. More technologically varied RE projects appear urban. The experiences of the generation of own district heating technologies in Denmark should be highlighted. The types of contracts with energy companies in relation to installation and maintenance appear as an important issue. In terms of local development, only in some cases we find an emphasis on apprenticeship for young and unemployed.

The Danish, English and German experiences show the benefits of promoting long-term national policies for energy communities to hedge against political changes modifying previous agreements. In the event that governments change the rules of the game, market mechanisms such as FITs could compensate, in part, for these instabilities that reduce the economic viability of these initiatives (Simcock et al. 2016). Financing projects with the aim of developing vulnerable communities often conflicts with external investors in regard to legitimacy and consensual trust. This is particularly the case when the intended participation turns out to be compensation for damages or unintended consequences of the project for those communities.

28.5 Annex–Overview of the Examples of Consumer (Co-)Ownership from the Country Chapters

Jens Lowitzsch and Felicia van Tulder

This Annex provides an overview of the examples of consumer (co-)ownership that are reported in the 18 country chapters following the analytical framework developed in Chapter 28. To enable a like-to-like comparison, other than grouping the country examples in the three categories developed, i.e., communities of interest, communities of place and communities of interest and place we have organised the information on the examples in three columns. The first column summarises the contractual arrangement and the type of project indicating—where available—the amount of the total investment and giving information on the contributions of the partners involved and legal peculiarities of the model. The second column provides information on the RE technology, the installed capacity and the geography of the given project. The third column characterises the participation of the local population, the distribution of benefits and the drivers and motivations involved. Of course, not all pieces of information described above were always disclosed for the examples reported. To render the financial data comparable all currencies in the tables have been converted into euro as of October 2018, for the original amounts please consult the individual country chapters.

Table 28.1 Communities of interest

Name (country)/year setup	Contractual arrangement (total investment); contributions of partners	Technology (installed capacity) and geography	Participation of locals; distribution of benefits; motivation
CZ I. Drahany Wind Park, 1995	JSC with majority ownership held by Eldaco JSC (EUR 60 mln.); EUR 12 mln. Equity: Eldaco EUR 9.1 mln.; citizens EUR 3 mln.; EUR 48 mln. Bank loan	13 wind turbines Vestas V112—3 MW (39 MW); municipalities of Drahany, Otinoves and Rozstání	Citizens or municipalities can acquire shares; full voting rights and share in profits; dominant position of Eldaco as pacemaker
FR II. Enercoop, 2005	Energy supplier under the legal form of a cooperative; profits ploughed back into setting up RE projects with cumulative capacity of 150 MW in 2018 (EUR 8 mln.)	Solar, wind, hydraulic, and biogas projects through ten regional cooperatives across France	Citizens can become consumers or members; active members pay EUR 100 per share; members participate in decision-making process
IT I. RETENERGIE, 2008	Energy cooperative with local offices; (EUR 2 mln. in 2018) in own projects financed through members' financial participation. Each member has a minimum of one share; shares are EUR 50 each	13 running projects, mainly solar, spread over the country (936 kWp)	1116 members in 2018; sale of energy to members through daughter company cooperative enostra; provision of energy efficiency services to members; allow citizens to become RE-(co-)owners

(*continued*)

Table 28.1 (continued)

Name (country)/year setup	Contractual arrangement (total investment); contributions of partners	Technology (installed capacity) and geography	Participation of locals; distribution of benefits; motivation
ENG I. Wiltshire wildlife community energy (WWCE) 2013	Community benefit society; first project funded solely via a community share offer, enabling people to invest between EUR 564 (one share) and EUR 112,765 (200 shares) into WWCE; second project split ownership between WWCE and commercial company	1 MW and 9.1 MW ground mounted solar farm in rural south West England	All shareholders have the same voting rights regardless of the size of their holding
NL II. Windpark Krammer BV, 2016	LLC (EUR 30 mln.); combined membership base of 5000 citizens of two existing wind cooperatives holding 51% and Enercon, a large German wind turbine manufacturer, holding 49%;	Wind farm with 34 turbines (total 103 MW); Krammer locks are situated on the North Sea coast of Zealand	A wind fund provides monetary compensation for residents within a radius of 2.5 km of the turbines; locals have priority access to financial participation through bond loans

(*continued*)

Table 28.1 (continued)

Name (country)/year setup	Contractual arrangement (total investment); contributions of partners	Technology (installed capacity) and geography	Participation of locals; distribution of benefits; motivation
ES I. SOM ENERGIA, S. COOP, 2010	Non-profit consumer cooperative founded on basis of agreements between citizen projects concerning energy transition in Girona, Catalonia (EUR 6.6 mln.); six projects pending (EUR 4.8 mln.)	15 projects across Spain (wind, solar, biogas, biomass), 9 in operation (4.4 MW); and 6 under construction (6.3 MW)	From 178 founding members in 2010 to ca. 46,500 members in 2018; on average 8000 new members per year; members initial contribution EUR 100, total of 72,500 electricity contracts
CH III. Energiegenossenschaft Schweiz, 2012	Cooperative assembling small energy producers and consumers (around EUR 310,000 in 2012)	Collection of solar PV panels across Switzerland	Yearly GA acts an exchange platform for certificates of origin, where electricity consumers and producers negotiate a price for purchase and sales
CAD I. TREC & SolarShare, 1998	RE-cooperative TREC incubated SolarShare, a non-profit cooperative, in 2010. (SolarShare's projects are valued at nearly EUR 37 mln.)	SolarShare has a portfolio of over 14 MW, consisting of 31 projects (10 kW rural systems to 600 kW); arrays on industrial rooftops and in non-arable fields across Canada	SolarShare has over 1500 members who invested over EUR 24 mln. in their "solar bonds" and earned over EUR 2.2 mln. in returns

(*continued*)

Table 28.1 (continued)

Name (country)/year setup	Contractual arrangement (total investment); contributions of partners	Technology (installed capacity) and geography	Participation of locals; distribution of benefits; motivation
CHI II. Solar Buin 1, 2017	Private corporation managed by cooperative Enercoop Metropolitana (EUR 16,200); assisted technically by German development agency GIZ; individuals from across Chile became members purchasing 240 shares—EUR 67 each—via crowdfunding platform	Solar power plant (10 kWp) generating ca. 15,300 kWh per year in the city of Buin	75% for self-consumption of participating households under net billing; excess production fed into grid; each member allowed holding max. 10% shares; profits re-distributed among members annually
IND I. Varanasi Solar & Grid Charging Station 2008	70% by Indus towers company (EUR 5386); handloom weavers contributed 30% of total costs i.e., EUR 1615	Hybrid solar and grid charging station with PV panels and grid system in rural Uttar Pradesh	408 power looms are supplied by 102 hybrid units; ownership of each hybrid solar unit remains with individual beneficiary involving trusteeship agreement to ensure use for running power looms

(*continued*)

Table 28.1 (continued)

Name (country)/year setup	Contractual arrangement (total investment); contributions of partners	Technology (installed capacity) and geography	Participation of locals; distribution of benefits; motivation
JAP I. Hamakaze RE-cooperative & RE citizen fund Corp., 2001	Cooperative's first project EUR 1.5 mln. financed 80% by 217 citizens, remaining 20% by Hokkaido green pricing fund co-financed by 5% customer surcharge on electricity bill (2010 total investment of EUR 28 mln. of which 47% financed by citizens)	First 2001 project 990 kW; subsequent 12 wind power plants across Japan in 2010 (total 17.8 MW)	By Dec. 2010, over 3800 citizens invested in cooperative's projects; supply of cooperative members
JAP II. Ohisama Shinpô energy fund 2015	Ohisama Shinpô energy company established 10 funds in 2017 with more than 3200 citizens investors nationwide (EUR 16 mln.) for RE plants	357 PV plants across Japan (more than 7 MW) by 2017; placed on rooftops of public buildings like elementary schools and child day care centres	Through zero yen scheme company rents rooftops and sets up PV plants at no cost for homeowners; generates revenue as a third-party operator

Table 28.2 Communities of place

Name (country)/year set up	Contractual arrangement (total investment); contributions of partners	Technology (installed capacity) and geography	Participation of locals; distribution of benefits; motivation
DK I. Slagslunde District heating coop, 2013	Cooperative founded to buy back a district heating plant from E.ON with guarantee from municipality (EUR 1.7 mln.)	District heating system managed by committed local residents; 1 MW el + 4 MW heat	Average heat bill of 231 consumers of Slagslunde decreased by 50%; counter spike in heating prices after a commercial takeover of local plant
DK III. NGF nature energy Holsted 2015	Jointly owned by farmer-owned supplier association Brørup-Holsted biogas A.m.b.a. And NGF nature energy (EUR 26.8 mln.); main contractor Xergi owns 10% of plant; EUR 5.4 mln. construction support from state	Biogas plant processing 400,000 tons biomass per year; 70% slurry from cattle, pigs, and mink from local suppliers; capacity to produce 13 mln. Kbm upgraded biogas per year	The plant help meet the goals of reducing CO_2; it makes it easier for livestock production to be independent of farmland; centralized treatment gives less odour, better utilization of the nutrient of livestock manure, and, in particular, less transport on the roads
FR I. Le Mené's energy self-sufficiency project 2007	A group of local officials and individuals, mostly farmers, conduct various sustainable energy initiatives through the association of municipalities *Le Mené* (over EUR 1 mln.); region's inhabitants negotiated a 30% shareholding with the operator of planned wind farm	Three flagship projects: Collective methane production, bio fuel production, wind energy (>6MW); in Le Mené in rural Brettony	Approx. 140 citizens invested in the park, through small investment associations; two cooperatives with 30 and 40 members; local energy autonomy

(*continued*)

Table 28.2 (continued)

Name (country)/year set up	Contractual arrangement (total investment); contributions of partners	Technology (installed capacity) and geography	Participation of locals; distribution of benefits; motivation
FR IV. Montdidier Wind Park, 2010	Joint-stock company (EUR 11.2 mln.); European regional development fund FEDER, the regional Council of Picardie and the municipality of Montdidier each contributed EUR 1 mln.; rest covered by loan contracted by municipality	Wind farm (8 MW) in the city of Montdidier	Covers 53% of the city's annual energy consumption; revenues reinvested in local sustainability projects. Motivation: Municipality aims to increase consumption RES
NL I. TexelEnergie, 2007	Cooperative with limited liability (EUR 500,000); initial PV projects 2010 financed by ASN bank loan	4 solar PV projects (total 1.4 MW); solar arrays are sited on the roofs of commercial complexes through a rental agreement with cooperative; island of Texel	Cooperative's board of directors discuss with membership base (total 3100 in 2017) in the bi-annual general meeting; members can acquire panels in projects, which output will be deducted from energy bills by net billing

(*continued*)

Table 28.2 (continued)

Name (country)/year set up	Contractual arrangement (total investment); contributions of partners	Technology (installed capacity) and geography	Participation of locals; distribution of benefits; motivation
NL III. Wind Alckmaer BV, 2015	LLC (EUR 470,000) stimulus fund of 3 municipalities obtained 37% in the turbine with each contributing to investment capital proportionally to their number of inhabitants; remaining shares held by energy company	Wind turbine *Alckmaer* (2.5 MW) part of regional wind farm in province of North-Holland	Municipalities agreed to transfer their 37% share to five local citizen energy cooperatives to enhance citizen participation; municipalities' GHG emission reduction goal of 20% by 2020
NL V. Collegepark Zwijsen, 2017	Association of owners of condominium complex; obtained exemption from energy supply licence obligation per experimental projects regulation	Association of owners owns and operates solar PV panels and supply this energy to the tenants	Sustainable living; projects aims to minimize energy costs tenants
NL IV. Duurzaam Ameland 2010	A solar farm (EUR 7 mln.) co-founded by the municipality, the local energy cooperative and Eneco, a large energy company, each holding equal shares (total EUR 4 mln.); state subsidy EUR 3 mln.; deviation from electricity law allowed per experimental projects regulation	Solar PV farm on the island of Ameland (6 MWp); development of largest micro grid of the Netherlands	Cooperative's share in project partially financed by 300 members and other inhabitants of island via bond loans; output covers entire island's electricity demand in summer; energy autonomy of the island

(*continued*)

Table 28.2 (continued)

Name (country)/year set up	Contractual arrangement (total investment); contributions of partners	Technology (installed capacity) and geography	Participation of locals; distribution of benefits; motivation
IT IV. E-Werk Prad, 1926	1300 participating families in 2018 all of which are shareholders and (co-)owners of the power plants	4 biomass stations (total 7.4 MW), 210 solar thermic plants 2200 m^2, 5-micro hydro plants (4082 kW) and 141 PV installations (total 6.87 MW)	Energy community managed by a cooperative; provides electricity at 12 cents per kWh (compared to national average price 21 cent per kWh)
PL I. City of Niepolomice, 201–2015	Municipal project (EUR 17.3 mln.); 60% Polish-Swiss cooperation fund; 40% municipalities' own contribution	3841 households and 32 public buildings equipped with solar collectors, PV installations and thermal systems in four municipalities	Citizen contributed a third of installation cost as co-investment; in return received subsidies for RE installations
PL III. Housing association in Szczytno, 2014	Investment co-financed by loans from NFEP&WM and Bank Ochrony Środowiska (EUR 156,000)	120 kW heat pumps and 39.7 kW photovoltaic installations on 5 of the association's buildings	Reduction of maintenance costs by 80%

(*continued*)

Table 28.2 (continued)

Name (country)/year set up	Contractual arrangement (total investment); contributions of partners	Technology (installed capacity) and geography	Participation of locals; distribution of benefits; motivation
ENG II. Brixton energy, 2012	Cooperative support by a grant from Lambeth council (EUR 60,900); each individual project is a registered community benefit society owned by its shareholders having around 80–100 investors	3 solar PV plants (37 kW, 45 kW and 50 kW) in Brixton district in London	Shareholders mixture of local residents (Lambeth over 70%); or organizations and investors from further afield
SCOT I. Isle of Eigg electricity grid, 2008	Operated and maintained by Eigg electric ltd. (EUR 2 mln.); wholly owned subsidiary of the isle of Eigg heritage trust, the community organization that owns the island. The trust's members are the isle of Eigg Resident's association, the Highland Council and the Scottish wildlife trust	Stand-alone or off-grid system with water, sun, and wind energy (combined 184 kW)	Community-owned, managed, and maintained energy system; energy self-sufficiency; residents contributed EUR 625 or EUR 1250 for a 5 kW domestic or 10 kW business connection
SCOT II. Aberdeen community energy, 2012	Community benefit society (EUR 567,000) raised through issuing of shares between EUR 5.64 and 22,553; the total 197 investors can expect a return of up to 7%	2016 Donside hydro' project 100 kW run-of-river scheme in Aberdeen	Community co-decided on project planning; not reinvested revenue goes to community development projects

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Table 28.2 (continued)

Name (country)/year set up	Contractual arrangement (total investment); contributions of partners	Technology (installed capacity) and geography	Participation of locals; distribution of benefits; motivation
SCOT III. Horshader community wind 2012	Community development trust, charity organization (EUR 2.1 mln.). Funded through bank loans and the Scottish Government's community and renewable energy scheme CARES	Wind turbine (900 kW) in small community of Horshader in north-west of the Isle of Lewis, Scotland	The project has provided a substantial income to HCDT that has been spent on local development and regeneration
ES II. EOLPOP SL, 2009	LLC; "accounts of participation" as legal vehicle for participation of citizens (by May 2018, EUR 2.36 mln. collected); aim set at EUR 2.8 mln.	Wind turbine (2350 kW) located in municipality of Pujalt, west of Barcelona	Acquisition of small shares by citizens; EUR 100 for individuals, EUR 250 for families and EUR 500 for entities; each year the surpluses will be distributed among participants proportionally to their investment. Expected annual return of 2%
ES IV. Barcelona Energia, 2017	Municipal utility (planned investment of EUR 17,2 mln between 2017 and 2019)	41 PV plants installed on Barcelona City Council buildings, waste-to-energy plant and biogas plant (total 45 MW)	Planned supply of energy to public institutions and residents; citizen participation is restricted to the delegation in local governments

(*continued*)

Table 28.2 (continued)

Name (country)/year set up	Contractual arrangement (total investment); contributions of partners	Technology (installed capacity) and geography	Participation of locals; distribution of benefits; motivation
CH II. Sunraising Bern, 2015	Collaboration between Sunraising, a non-for-profit start-up, a local electric utility and its customers (EUR 338,000); PPA allows electricity consumers purchase electricity from Sunraising, while the utility manages billing and maintains the grid	8 rooftop solar PV plants (ca. 100 kWp) with an annual output of 139,150 kWh in the city of Bern	Bern residents can buy shares corresponding to surface of a locally installed PV plant; solar power fed into Bern city managed grid, supplying *Sunraising* customers for a 20-year period
CAL I. Anza solar farm & SunAnza, 2011–2016	Owned by the cooperative SunAnza (EUR 4.2 mln) financed by several governmental grants	Solar PV projects (4 MW) sited at the property of Anza electric cooperative, in rural southern California	Members can purchase subscription to output of PV panels; each participant receives credit on their electricity bill through virtual net-metering scheme; project started by member instigation

(*continued*)

Table 28.2 (continued)

Name (country)/year set up	Contractual arrangement (total investment); contributions of partners	Technology (installed capacity) and geography	Participation of locals; distribution of benefits; motivation
CAD II. Mother earth renewable energy (MERE) wind farm, 2012	Installations 100% owned by HIAH Corp., an indigenous economic development corporation owned by the local community—The M'Chigeeng first nation (EUR 8.5 mln.); community contributed EUR 2 mln., rest through federal government funding of EUR 657,000 and additional financing of EUR 5.8 mln. 20 year FIT contract with province's energy supplier	2 wind turbines (4 MW) on Manitoulin Island	Project is estimated to generate about EUR 200,000 of surplus funds annually in first 14 years of operation and EUR 0.8 mln. Annually for succeeding six years after loans are repaid
CAD III. Agricola Lutheran church solar project, 2011	The project cost (EUR 57,000) paid for by a late congregation member's donation. 20 year FIT contract with province's energy supplier	Solar PV installations (10 kW)	Started upon instigation church's members; 20 year FIT contract; after pay-off 13 years of net financial benefit for church

(*continued*)

Table 28.2 (continued)

Name (country)/year set up	Contractual arrangement (total investment); contributions of partners	Technology (installed capacity) and geography	Participation of locals; distribution of benefits; motivation
BRA II. RevoluSolar 2016	Non-profit association RevoluSolar in collaboration with the AgeRio fund aim to set up a cooperative	To date, only advisory activities for residents of the community; plans for PV panels on at least 1% of homes in Morro da Babilônia, a poor community in Rio de Janeiro	Ownership of installations cannot be shared until the foundation process of the cooperative will be concluded; AgeRio offers microcredits to residents and entrepreneurs to participate
BRA III. Coober RE-cooperative, 2016	First RE cooperative in Brazil (EUR 167,000); supported by German Confederation of Cooperatives; funded by equity capital of the members	Solar micro-plant (75 KWp) in Paragominas	23 members in 2016, who receive credits through net billing; average production capacity of 11,550 kWh per month entirely injected into local distribution grid
CHI I. Cochamo, 2010	Electric cooperative (EUR 2.6 mln.); installations owned by Ministry of Energy	Four mini-hydro plants (145 kW, 19 kW, 19 kW, 17 kW) in off-grid electrification in Cochamo, rural Chile	Supplies 132 households and 15 public buildings

(*continued*)

Table 28.2 (continued)

Name (country)/year set up	Contractual arrangement (total investment); contributions of partners	Technology (installed capacity) and geography	Participation of locals; distribution of benefits; motivation
CHI III. Huatacondo micro grid project 2010	Initial project supported by University of Chile and funded by the mining company Doña Inés de Collahuasi (EUR 373,676)	Hybrid system of a 23 kW PV plant, a 3 kW wind turbine, a 120 kVA diesel group, and a 129 kWh storage system based on micro grid; remote Andes Mountains community	Basic maintenance activities carried out by locals; the 150 inhabitants only pay a monthly emergency fee (EUR 3.5); ownership to be conferred to community
CHI IV. Enercoop Aysén 2014	Cooperative providing services on volunteer basis	Offers workshops for energy efficiency measures; first official RE cooperative initiated in Chile by citizens. Active in rural and urban areas of Aysén region in Hautacondo, Tarapaca (northern Chile)	98 members participate as volunteers in public policies initiatives at multi-levels; currently discussing plans for (co-)owned generation projects

(*continued*)

Table 28.2 (continued)

Name (country)/year set up	Contractual arrangement (total investment); contributions of partners	Technology (installed capacity) and geography	Participation of locals; distribution of benefits; motivation
IND II. RE development Cooperativem (REDCO) 2003	Cooperative of residents of Durbuk supported by an NGO in initial phase financial support from various actors, including an Indian-Canadian fund agreement (EUR 1,133,461); benefiting municipalities contributed EUR 68,223 in kind; cooperative owns generation units	Four PV unit (each 25 kWp) supply to the local grid, replacing the previous diesel generation station in rural Durbuk village; EUR 12,567 yearly operating cost + EUR 35,906 battery replacement every fifth year	REDCO members are villagers paying a one time membership fee of EUR 1.26 totalling EUR 493 with 392 households being coop members and electing its Board of Directors and Power Management Committee
IND III. Odanturai, 1996	Local government's green energy programme; wind turbine (INR 15.5 mln.), INR 4 mln. By villagers, INR 11.5 mln. Bank loan taken on by village council	1996 solar street lighting; 2006 a 350 kW wind turbine in village	Amortized loan by selling part produced electricity to local grid operator; remaining part supplies residents

Table 28.3 Communities of interest and place

Name (country)/year set up	Contractual arrangement (total investment); contributions of partners	Technology (installed capacity) and geography	Participation of locals; distribution of benefits; motivation
CZ II. Power plant in Hostětín, 2000 heating/2008 PV	Heating: Village of Hostětín (EUR 1.4 mln.); 63% state funding, 31% Dutch grant, 6% residents connected the heating plant; PV: Joint investment (EUR 0.17 mln.) of village and three foundations each holding 31%	Biomass central heating plant fuelled by wood chips (732 kW); PV panels (50 kWp); village of Hostětín, rural area	Village Hostětín owner of PV site; heating for entire village; in summer PV surplus production sold to grid; energy autonomy
CZ III. Kněžice bioenergy Centre, 2007	Owned by village of Kněžice (EUR 5.34 mln.): EUR 3.2 mln. European regional development fund; EUR 0.43 mln. state environmental fund; EUR 1.7 mln. Bank loan	Biogas plant with CHP (output: Electrical 330 kW, thermal 405 kW); a municipal heating plant consisting of two boilers (800 and 400 kW); rural village of Kněžice	Plants and heating grid managed by the municipality
DK II. Middelgrundens wind farm I/S, 1996	General partnership, 50% owned by Middelgrunden wind turbine cooperative, 50% by state-owned energy company Ørsted; EUR 44.8 mln.	20 off shore wind turbines (2 MW each); situated in the harbour of Copenhagen	Middelgrunden wind turbine cooperative is a citizen initiative; 8650 citizens joined the coop due to environmental concerns and/or the possibility of receiving some financial benefits

(*continued*)

Table 28.3 (continued)

Name (country)/year set up	Contractual arrangement (total investment); contributions of partners	Technology (installed capacity) and geography	Participation of locals; distribution of benefits; motivation
FR III. Béganne community-owned windmill farm, 2014	Simplified joint-stock company (EUR 12 mln.); four blocks consisting of citizen associations and local companies within the joint-stock company contributed the equity share of around EUR 2.5 mln.	Four wind turbines (2 MW each) in the village of Béganne	53 investment associations of about 800 local citizens invested EUR 1.4 mln. and obtaining 31% of the voting rights; voting rights not assigned proportionally to investment; decision-making process cooperative-style
DE I. Heidelberger Energiegenossenschaft eG HEG, 2012	Registered cooperative (EUR 1 mln.); HEG developed a solar direct-use model for customers together with a building cooperative and energy provider	Twelve PV plants (700 kWp) in Ladenburg (on top of a local school) and in Nußloch (PV plants on top of a multi-storey dwelling), a village near Heidelberg	Tenants consume part of electricity produced, which HEG sells at a slightly lower rate than the primary provider; the FIT had fallen below electricity rates for private households

(*continued*)

Table 28.3 (continued)

Name (country)/year set up	Contractual arrangement (total investment); contributions of partners	Technology (installed capacity) and geography	Participation of locals; distribution of benefits; motivation
DE II. Cooperative Bioenergiedorf Jühnde e.G., 2005	Registered cooperative (EUR 5.8 mln.); founded by farmers, the municipality, and some consumers in close collaboration with grid operators, energy suppliers, scientists and engineers	Bioenergy and CHP plants (CHP: 716 kW el; woodchip plant: 550 kWth; peak load boiler using biodiesel: 1600 kWth) with own district heating grid in the village of Juehnde	Beyond heat consumers and local supporters, up to 25% of the shares can be sold to other communities/ regions; energy cost savings around EUR 750 per year per member household; paid dividends to the members from 2013 onwards
DE III. Elektrizitätswerke Schönau eG, 2016	Civil law association bought the grid in 1996 (EUR 4.35 mln.); around EUR 2 mln. member investments at that time; extended activities to five subsidiary companies; now a registered cooperative with EUR 43 mln. turnover in 2018	Offers energy services, locally producing and distributing green energy and in 2009 acquiring a local gas grid in village of Schönau in Black Forest region	Emerged from a transformation process of the existing civil law partnership Netzkauf GbR founded in 1994 with around 650 investing citizens; currently 5000 members; and more than 160,000 customers (priv. Households, small businesses, and industrial corporations)

(*continued*)

Table 28.3 (continued)

Name (country)/year set up	Contractual arrangement (total investment); contributions of partners	Technology (installed capacity) and geography	Participation of locals; distribution of benefits; motivation
IT III. Lucense 1923, 2015	Initial investment by Finval (EUR 1 mln.), participation of citizen cooperative WeForGreenSharing founded by energy consulting company ForGreen; further state grants	Refurbishment of a small hydroelectric plant (112 kW) in the village of Montorio, rural area	Locals can purchase shares in *Lucense 1923* and become associates of the energy cooperative; the produced energy is distributed in the plant's surroundings
PL II. Cooperative "our energy", 2014	Cooperative is joint project of bio power LLC., Elektromontaż Lublin LLC. and four municipalities (EUR 38 mln.)	12 interconnected biogas power plants (0.5 to 1 MW) in four municipalities in South-Eastern Poland	Membership open to private and legal persons, incl. Municipalities; not limited geographically; entrance fee EUR 250, share price EUR 125; locally produce energy using agricultural potential

(*continued*)

Table 28.3 (continued)

Name (country)/year set up	Contractual arrangement (total investment); contributions of partners	Technology (installed capacity) and geography	Participation of locals; distribution of benefits; motivation
ENG III. TGV hydro, 2010	Hydropower developer owned by a community interest company, the green valleys	Provided support in the development of 28 micro-hydro sites with a total capacity of 558 kW across Wales	Develops projects on behalf of private clients including local farmers, community-owned energy companies such as cooperatives, and the conservation charity the National Trust
CH IV. Energy cooperative Buttisholz, 2013	Energy cooperative; set up in cooperation with the municipality of Buttisholz	Cooperative finances and runs solar PV installations (ca. 150 kWp) amongst others on rooftop of local school	Organizing informational events at schools and at industrial exhibitions, as well as forming partnerships with local businesses; promotes local production and consumption
ES III. Fundacion Terra, 1994	Foundation; 2007 solar project (EUR 301,000); 140 investors (all private consumers) participated through "accounts of participation"	41.4 kW PV installation on the roof of the Mercat del Carmel in the region of Barcelona	Participation of investors in solar project does not exceed investment in the capital, yet possible to become member of foundation

(*continued*)

Table 28.3 (continued)

Name (country)/year set up	Contractual arrangement (total investment); contributions of partners	Technology (installed capacity) and geography	Participation of locals; distribution of benefits; motivation
CH I. Elektrizitätswerke Zürich, 2017	Solar participation scheme (EUR 2.2 mln.) from the municipal electric utility of Zürich; PPA between the utility and its customers	Eight solar installations between 1000–2500 square metres (1.03 MWp) with an annual output of 14.41 MWh installed in the city of Zürich	Customers purchase shares (measured in surface area) of locally installed solar panels; customers annually receive 80 kWh of electricity per purchased square metre of the solar panel, for a period of 20 years
CH V. Appenzeller Energie, 1991	Energy association of canton of Appenzeller; sale of certificates of origin from installations owned by association	Two PV plants, three small hydropower stations, one wind turbine and one solar thermal system; generating 400 to 500 MWh annually in the canton of Appenzeller	200 members in 2017; membership in association not required for purchase of certificates of origin tied to output of plants; founded by a bi-partisan group of politicians to the nuclear accidents in the three Mile Island and Chernobyl

(*continued*)

Table 28.3 (continued)

Name (country)/year set up	Contractual arrangement (total investment); contributions of partners	Technology (installed capacity) and geography	Participation of locals; distribution of benefits; motivation
CAL II. Marin clean energy, 2010	MCE, California's first CCA, functions as alternative municipal electricity provider; RE bought through PPAs with local, medium–/large-scale PV projects (2017 EUR 133 mln.); 20-year guaranteed FiT and one waste-to-energy project; financed through customer rate revenues	Flagship project: Solar one solar farm (10.5 MW) launched 2018; provide electricity for ca. 3400 homes	MCE offers customers membership in PV projects; 100% locally generated solar energy and net billing, without ownership stake; more local and sustainable RE production and municipal control of energy provision
CAL III. Peninsula community energy, 2016	*CCA,* launched collaboratively by the county of San Mateo and all 20 of its cities; power purchased through PPAs with in-state RES plants (2017 EUR 53 mln.)	Municipal electricity provider, PPAs with in-state RES plants; encourages customers to "opt up" to their 100% RE product	Elected officials from 20 cities in county on governing board; representatives from labour, environmental, community organizations participate in citizen advisory committee; monthly meetings accessible to public; meet climate action goals

(*continued*)

Table 28.3 (continued)

Name (country)/year set up	Contractual arrangement (total investment); contributions of partners	Technology (installed capacity) and geography	Participation of locals; distribution of benefits; motivation
CAL IV. EBCE, 2018	CCA to be launched June 2018 by the 11 municipalities of Alameda County through a joint powers agreement	Plans to set up PPAs only with local plants	Citizen advisory committee; plans tailored NEM, FITs, and other community-centric programme designs
BRA I. Juazeiro, Bahia, 2012	Associations of two social-housing condominiums (EUR 1,6 mln.); co-investment by federal fund with EUR 1.4 mln. and the company Brasil Solair with EUR 211,000 of non-refundable investment	Micro grid of PV panels (2.1 MW) for 3600 houses in two condominiums of a social-housing complex in Juazeiro, Bahia	Revenue redistribution: Residents 60%, 30% to fund for community areas and 10% for system maintenance costs; generate extra income for two condominiums and providing training of local labour
IND IV. DESI, 1996	Private limited company promoted by DASAG Switzerland and Development Alternatives, India	29 pilot/demonstration hybrid RES projects in Tamil Nadu, Karnataka, Bihar, Orissa, and Madhya Pradesh	After construction ownership of the plant transferred to local organization (village council, NGO, cooperative)

(*continued*)

Table 28.3 (continued)

Name (country)/year set up	Contractual arrangement (total investment); contributions of partners	Technology (installed capacity) and geography	Participation of locals; distribution of benefits; motivation
PAK I. Shandur utility company limited, 2011	Shandur utility company limited SUCL (EUR 0.87 mln.) set up by Agha Khan Rural Support Program (AKRSP) supported by Swiss development agency (51% grant); contractor owns 9 %; 30% loan acumen fund; upon the repayment of loan, AKRSP transfers ownership to concerned communities	Micro-hydro plant SUCL Harchin (500 kW) Laspur Valley in upper Chitral area of Khyber Patkhtunkwa province, rural Pakistan	Harchin supplies about 1140 local households, 13 sawmills, 6 flourmills, and 30 micro-businesses in three villages; each household has fixed equity participation of PKR 9000 and has possibility to purchase up to 10 % shares
PAK II. Yadgar utility company limited, YUCL, 2011	Yadgar Utility Company Limited, YUCL (EUR 1.14 mln.) set up by AKRSP supported by Swiss development agency (51% grant); contractor owns 9%; 30% loan acumen fund; upon the repayment of loan, AKRSP transfers ownership to concerned communities	Micro-hydro plant YUCL Pawoor (800 kW) in Yarkhun Valley upper Chitral area of Khyber Patkhtunkwa province, rural Pakistan	Pawoor supplies about 1300 local households, 16 sawmills, 7 flourmills, and 26 micro-businesses in Pawoor village; each household has fixed equity participation of PKR 7000 and has possibility to purchase up to 10% shares

(*continued*)

Table 28.3 (continued)

Name (country)/year set up	Contractual arrangement (total investment); contributions of partners	Technology (installed capacity) and geography	Participation of locals; distribution of benefits; motivation
JAP III. Fukushima Coalition of Farmers and Citizens & PARE, 2013	The coalition and the People's Association for Renewable Energy Promotion, PARE, set up limited liability partnership for two solar plants (EUR 150,000 and EUR 590,000); the smaller 50 kW PV plant fully paid by citizen investments at EUR 1565 per share	PV plant in the city of date (50 kw); PV plant in the city of Koriyama (210 kW) both in the Fukushima prefecture	Revenue from electricity sales of projects donated to Fukushima reconstruction fund; triggered by nuclear disaster; coalition attempts to turn devastated land into locations for PV power plants and promote energy autonomy of region

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29

Solar Prosumage: An Economic Discussion of Challenges and Opportunities

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Decentral self-consumption of renewable electricity has gained relevance in power markets around the world, driven by decreasing technology costs and favourable regulatory conditions. In Europe, the future role of prosumers was also strengthened by the outcomes of the Trilog on the Clean Energy package 2018 (for additional information, see Sect. 1.2.2 and Chap. 31). In this chapter, we adopt an economic perspective on the potential role of "prosumage" of renewable electricity for the low-carbon energy transition. To do so, we extend the concept "prosumption" (production and consumption) to "prosumage" (production, consumption, and storage): decentral energy storage by batteries enables prosumers to detach the moments of electricity generation and consumption. Thus, prosumagers can seize the advantages of self-consumption also at times when weather conditions do not allow for renewable electricity generation.

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First, we define prosumage and give an overview of recent literature on the subject, including a brief digression on the role of network charging schemes. While research has discussed various generation technologies and energy uses, we focus on small-scale solar PV systems that are combined with stationary battery storage. Here, we leave the aspect of complete energy autarky aside and assume that households are still connected to the electricity grid. We also restrict this analysis to current uses of electricity. A more comprehensive decarbonisation of the energy system is likely to also encompass increasing electricity usage for heating and mobility purposes. Such sector coupling could make use of heat or hydrogen storages as well. Likewise, we focus on private households only and, here, on prosumage of solar electricity. We do not focus on other decentral measures that are likely to be relevant for the European energy transition, such as energy efficiency and demand-side management (DSM), not only in households but also in the commercial and industry sector storage (cf. European Commission 2015, 2016). Yet we briefly discuss several of these related aspects.

Second, we examine arguments in favour of and against increasing prosumage in the context of the low-carbon energy transformation. For comparability, we discuss likely benefits and drawbacks of prosumage against the reference of a centrally optimised electricity system assuming the same renewable generation capacities, and not against a system based on fossil fuels. Some of the pros and cons apply only to the perspectives of certain actors; for instance, households, utilities, or grid operators. As such, our discussion does not aim at an overall societal cost-benefit analysis.

Third, we present a quantitative, model-based analysis to illustrate possible effects of increased prosumage on the electricity system. To this end, we use the open-source electricity system model DIETER. The model simulates the hourly use of different electricity generation technologies and flexibility options, such as storage. Results mimic the outcome of a perfectly competitive market or, in more economic terms, the long-run equilibrium on the electricity market. We devise the analysis for a future German electricity system of the year 2035, with input data following established projections.[1]

[1] This book chapter is based on a journal article published earlier (Schill et al. 2017a) and a respective policy report (Schill et al. 2017b).

29.1 Definition of "Prosumage" and Overview of the Related Literature

We define prosumage as follows: a prosumager is a grid-connected residential electricity consumer who owns both a small-scale PV installation and a battery; she draws electricity from the grid at times, uses these installations to generate own electricity at times, and feeds electricity to the grid at yet other times. In this respect, we explicitly consider further interactions of the decentral battery with the grid: these comprise using the battery to store both self-generated and grid electricity and discharge the stored electricity either to consume it or to feed it into the grid. Our analysis connects to a diverse literature on technical and socio-economic aspects of decentral power systems, distributed generation, self-consumption, and, in a broader sense, the low-carbon energy transformation. Several studies focus exclusively on the consumer perspective of prosumage and do not take repercussions for the power system into account.

Potential—An early work by Castillo-Cagigal et al. (2011) provides experimental evidence on prosumage systems from a technical angle. The authors find that oversized storage hardly increases self-consumption. In a detailed review of model-based research on prosumage with PV and battery systems, Luthander et al. (2015) consolidate that 0.5–1.0 kWh storage per kW of installed PV capacity can raise self-consumption by around 13–24 per cent. Another review on the economics of prosumage from a consumer perspective by Hoppmann et al. (2014) focuses on Germany: the authors conclude that economic viability will be reached for small-scale systems first. Profitability of large-scale systems would require higher retail electricity prices and lower wholesale prices. Simulating residential self-consumption of PV for different EU countries, Quoilin et al. (2016) find self-consumption rates of 30 per cent to 37 per cent if no batteries are installed. With higher battery and PV capacities, the self-consumption rate increases. However, complete autarky would require an excessive oversizing of both the PV and battery systems. In any case, the regulatory environment would have to provide indirect subsidies for PV systems to be profitable from a household perspective. In a more recent study, Dietrich and Weber (2018) derive related findings for two specific German households, also taking on a pure consumer perspective.

Grid versus Load Defection—a study for the U.S. points out that PV and batteries together may lead to a mass "grid defection" of consumers in the long-run (RMI 2014) as grid parity of PV-plus-battery systems may be reached in five U.S. regions in the coming 30 years. Grid parity describes the situation in which the total costs for self-consumption are below the costs of grid electricity. If consumers decide to disconnect from the grid, this may lead to stranded assets among utility-owned centralised infrastructures. Specifically, the study argues that grid defection could become profitable in New York State already by 2025 and in California by 2030. The more likely case of "load defection" could be reached in the U.S. much sooner (RMI 2015). Here, consumers with PV-storage systems are still connected to the grid.

Regulatory and Socio-economic Aspects—Another stream of research analyses regulatory and socio-economic dimensions of prosumage. Römer et al. (2012) highlight that positive external effects of decentral energy infrastructures such as storage or smart-grid devices could impede a socially optimal deployment. Eid et al. (2014) put a specific focus on distributional effects: they argue that net-metering schemes may foster inequality. Such schemes have been used in the U.S. for instance, in California (Borenstein 2017), but also in several EU countries (European Commission 2015); see also next paragraph. Under net-metering schemes, grid feed-in and consumption of a customer are netted over a certain period of time. They thus enable to save on grid fees, taxes, and other components of the end-user electricity price. However, this advantage only applies for rather wealthy households who can afford decentral generation systems. Picciariello et al. (2015) find that cross-subsidies from prosumagers to non-prosuming consumers can become substantial in 12 U.S. regions, particularly in lower-density grids. Parag and Sovacool (2016) propose strategies for integrating prosumagers into competitive electricity markets and discuss potential market design issues. Pérez-Arriaga et al. (2017) deal with the regulatory framework and derive recommendations for scenarios with different types of electricity users.

Network Charges for Prosumagers—Network charges are retail price components that are raised by network operators and ultimately paid by electricity consumers. They are used to finance the past and future costs of installing and operating the electricity grids. Different types of network charges are used in different countries and markets. Apart from a fixed component that is typically charged for services such as metering and to cover other administrative costs, network charges can be volumetric, that is, energy-based, or capacity-based, or sometimes a mix of both (European Commission 2015). Table 29.1 provides an overview of different types of network charges and the implied incentives for engaging in prosumage under the assumption that network charges only apply to grid consumption.[2] While the traditional and still dominant model in the EU is a (fixed) volumetric model (Ecke and Hermann 2016), there is increasing pressure to move to more cost-reflective schemes such as time-of-use volumetric, capacity-based or hybrid models (Eurelectric 2013). The European Commission (2015) does not recommend one particular scheme because models should be adapted to different market conditions. Importantly, different types of network charges have different impacts on prosumers. Exempting self-consumption entirely from network charges may not only give rise to what has been described as the "utility death spiral" (see below), but also means that a potential mechanism to steer consumption behaviour is lost.

Drivers for Growth of the Prosumage Segment—Drivers potentially spurring the further growth of the prosumage segment include decreasing costs for PV-battery systems and rising retail electricity prices, network charges, behavioural factors such as environmental awareness, a desire for energy autonomy, and technological factors such as breakthroughs in storage technology (IEA 2014). In addition, specific national conditions like the availability of rooftop space, the ownership structure of buildings, and the layout of distribution grids are relevant.

Clearly, a "prosumage revolution" has not taken place by the mid-2010s (IEA 2014). Prosumage is still less profitable than PV self-consumption without storage systems in most jurisdictions today (SPE 2016).

[2] Here we do not compare absolute prosumage incentives between volumetric and capacity-based models. This comparison would require a more detailed specification of technical and regulatory settings.

Table 29.1 Overview of different types of network charges

Network tariff	Model	Impact on behaviour of prosum(ag)ers
Volumetric: applies to each kWh of electricity consumed from the grid (kWh)	*Lump-sum*: lump-sum price for a pre-specified amount of electricity	Prosumage incentives depend on specified amount of electricity and the consequences of exceeding this amount
	Fixed (flat): consumers pay the same fee per kWh, independent of volume level	Incentivises prosumage, but does not provide incentives for system-friendly behaviour
	Progressive: the tariff per kWh increases with an increasing consumption level	Potentially stronger incentives for prosumage than fixed model
	Time of use/event-driven (peak): tariff depends on time of consumption (e.g. peak/off-peak), or specific events, for example, critical peak periods	Can help to align incentives for prosumage with network (and partly also market) conditions
	Dynamic: depends on wholesale prices	Incentives for market-oriented prosumage; network-orientation depends on market design
Capacity based: based on peak load (kW)	*Fixed (flat)*: fixed charge based on connection capacity or measured capacity	Can incentivise prosumage that reduces peak usage (in case of measured capacity)
	Variable: different capacity levels with different tariffs	Potentially stronger incentives for network-oriented prosumage than fixed model
	Time of use/event-driven: different tariffs in line with the available grid capacity (e.g. peak/off-peak)	Potentially stronger incentives for network-oriented prosumage than fixed model
Hybrid (also referred to as two-part tariff, kW and kWh)	*Combination*: mix of volumetric and capacity-based models	See above, depending on design
Interruptible tariff options	*Additional option*: To be combined with volumetric or capacity-based models; rebate for allowing grid operators to interrupt the grid connection	Increasing incentives for uptake of decentral batteries

Source: Derived from Eurelectric (2013), pp. 15–19 and European Commission (2015), p. 7

This situation is likely to continue because costs for PV systems without storage would also decrease further and even over-proportionally compared to the costs of PV systems with storage (Prognos 2016).

In a stylised simulation for Germany, Bardt et al. (2014) highlight that the economic case for PV self-consumption strongly depends on the regulatory framework: it is profitable in case of continued indirect support, but profitability may cease if regulation changes. By the time of writing, the levelised cost of electricity (LCOE)[3] for decentral PV are well below the consumer retail electricity price in many countries, rendering self-consumption advantageous. Specifically, the retail price contains components—such as grid fees and taxes—that often do not (or only partly) accrue for self-generated electricity. Depending on the regulation of these price components, the situation may also change in the future.

29.2 Discussion of Pros and Cons

In the following, we sort and discuss pros and cons of prosumage in the context of the low-carbon energy transition. While many arguments only apply to the perspectives of certain actors, several can be regarded to speak either in favour of or against increasing prosumage. Others appear to be more ambiguous. An overview is presented in Table 29.2. IEA (2014), CEER (2016), and NREL (2013) devise related overviews of pros and cons.

29.2.1 Arguments in Favour of Prosumage

Consumer Preferences—Private households may have the preference to generate their own renewable electricity for reasons other than economic advantages. This comprises a desire for independence, or even autarky, although potentially only perceived (IEA 2014; Prognos 2016),

[3] The LCOE are given in Euro per megawatt hour (MWh), or Cent per kilowatt hour (kWh), and describe the discounted total costs for a PV installation, divided by the total electricity generation over its lifetime.

as mentioned by German homeowners who invested in PV-battery systems (RWTH 2017). However, large-scale empirical evidence is scarce: there are two surveys that conclude on a preference for independence from utilities as major driver to install PV-plus-battery systems (Gährs et al. 2015; Oberst and Madlener 2015). Yet, more research is required to substantiate the relevance of such preferences, also in other countries. From a higher-level perspective, McKenna (2018) puts motivations and challenges for energy autonomy aspiration on a community level into perspective.

Lower/More Stable Electricity Costs—Consumers equipped with PV-battery systems can profit from less volatile and potentially also lower electricity costs because they are, to a certain extent, detached from the evolution of retail prices (SPE 2015). Studies highlight this aspect for Germany (Hoppmann et al. 2014), the U.S. (RMI 2015), and Pakistan (Aqeeq et al. 2018). Importantly, the argument only applies to prosumagers and neglects effects on other electricity consumers as well as the electricity system as a whole. Likewise, the overall costs for households engaging in prosumage depend on the regulatory framework. In particular, the remaining grid consumption of prosumagers may be subject to changing grid charges and other levies.

Table 29.2 Pros, cons, and ambiguous arguments

Arguments in favour of prosumage	*Arguments with ambiguous conclusions*	*Arguments against prosumage*
Consumer preferences	Transmission grid relief	Increasing system costs
Lower/more stable electricity costs	Flexibility	Distributional impacts
Participation/acceptance of energy transformation	Driver for sector coupling	
Activation of private capital	Energy efficiency versus rebound effects	
Distribution grid relief	Local and macroeconomic benefits, increased competition	
	Political economy, path dependency, and policy coordination	
	Data protection and security	

Participation/Acceptance of the Energy Transformation—Several studies point out that active participation in the energy transition can foster its acceptance and thus help to achieve goals of energy policies. Conversely, Gährs et al. (2015) and RWTH (2017) highlight that the active participation in the transformation to a low-carbon energy system constitutes an important motivation for households to adopt prosumage. However, acceptance may be impeded by negative distributional effects on those consumers who cannot engage in prosumage (compare below, Sect. 29.2.2). Decentral prosumage could also mitigate controversies around more centralised (renewables-related) infrastructures such as transmission grid expansion or large pumped hydro storage projects (cf. SPE 2015, 2016). Moreover, increased prosumage could unlock a larger proportion of the available rooftop space for solar PV.

Activation of Private Capital—Related to realising rooftop PV potentials, prosumage may also unlock "cheap" private capital for investments into both PV and storage systems (SPE 2015). By the time of writing, interest rates are low in many European and other countries, so there should be no shortage of capital. However, this may change in the future. Importantly, from the macro-perspective, capital should be allocated to those investments that are most beneficial for the electricity system. These are not necessarily those investments that are most beneficial to individual prosumagers (cf. Sect. 29.3). Related, several studies highlight that additional storage may not be required in the coming years in Germany and other countries, depending how power systems develop with respect to other flexibility options or sector coupling (cf. Pape et al. 2014; Schill and Zerrahn 2018).

Distribution Grid Relief—Increased prosumage may also have beneficial effects on the distribution grid. First, if the storage defers the timing of peak feed-in levels of PV, this can mitigate potential grid expansion needs and enable a more parsimonious dimensioning of the network. Figure 29.1 illustrates this point: a grid-oriented battery use (right panel) yields a lower peak feed-in than a myopic storage operation (left panel). Second, system-oriented prosumage can also lead to lower feed-in gradients and thus relieve network stress. Achieving a system-oriented battery use requires appropriate incentives—for example, through network charges, or a centralised optimisation of the batteries by aggregators.

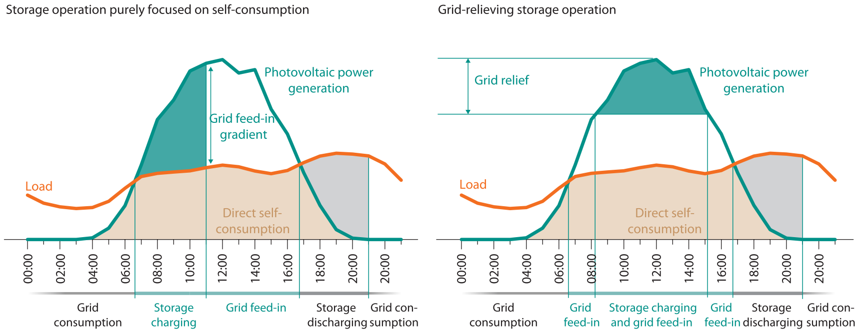

Fig. 29.1 Illustration of load, PV generation, and storage use under myopic (left panel) and grid-relieving (right panel) charging. Source: Schill et al. (2017a)

Further, respective communication interfaces and the willingness of owners to cease at least part of control over their installations are needed. System-oriented prosumage behaviour might, however, be also achieved without remote control by making use of simple, decentral forecasting methods (Moshövel et al. 2015; Weniger et al. 2015). In any case, an efficient approach would trade off the expenses for implementing such system-friendly prosumage behaviour and distribution network expansion. This calculation strongly depends on the physical grid structure. Generally, prosumage relieves the grid if peak demand and peak PV generation correlate strongly and if grid expansion is difficult (CEER 2016).

29.2.2 Arguments Against Prosumage

Increasing System Costs—Assuming the same capacity of renewable energy, prosumage brings about additional costs to the power system, compared to a centrally planned optimal system. These can be referred to as efficiency losses. As such, greater levels of prosumage shift the need to balance the variability of demand and renewable electricity supply from an area-wide scale to a more local scale. However, the temporal patterns of variable renewable electricity feed-in and electricity demand are smoother over larger areas (Fraunhofer IWES 2015), thus reducing the need for balancing fluctuations. Likewise, more flexibility options at different locations can be accessed in wider geographical areas. With more decentral PV-plus-battery systems, the benefits of these complementarities cannot be seized to their full extent, even if batteries are operated in a system-friendly manner. In consequence, redundant infrastructure for renewable integration may be required, particularly with respect to electricity storage (compare numerical illustration in Sect. 29.3). Decentralised small-scale batteries generally also have higher specific costs compared to large-scale central storage technologies. Prosumage may further result in sub-optimal siting and dimensioning of PV installations. In particular, individual prosumage-oriented PV systems could be too small from a system perspective (cf. European Commission 2015; Borenstein 2017).

Batteries that are coupled with decentral PV installations may also be used in a sub-optimal way from a system perspective (Green and Staffell 2017). Without system-oriented charging, guided by wholesale market prices, prosumage may also result in larger gradients of PV feed-in (left panel of Fig. 29.1). This could require additional system flexibility measures. The Council of European Energy Regulators (CEER 2016) accordingly argues that renewable self-generation tariffs should reflect the full system costs of energy exchanged with the grid, and that regulation should generally adhere to market and efficiency principles.

Distributional Impacts—Prosumage can lead to unintended distributional impacts which are largely related to grid charges. As described above, volumetric network charges are used in many countries. In this case, increasing prosumage implies that fixed grid costs must be distributed among ever fewer customers. This could develop into a self-enforcing "utility death spiral." This argument has been discussed in general (cf. Parag and Sovacool 2016) and more specifically for different regions of the world, including the US (NREL 2013; RMI 2014), Colombia (Castaneda et al. 2017), South Africa (Mayr et al. 2015), Pakistan (Aqeeq et al. 2018), and Switzerland (Kubli 2018). This may erode utilities' business models even before a mass defection from grids would take place (RMI 2014). In case of volumetric grid charges, this would also put an additional burden on consumers that are not able to engage in prosumage. The distributional impact can be regressive as prosumage is rather implemented by wealthier consumers who more frequently own their property (cf. Bardt et al. 2014; Borenstein 2017).[4] The same reasoning applies to other volumetrically charged parts of the retail price that do not accrue for self-consumed electricity, for example, energy taxes and other surcharges.

The Council of European Energy Regulators thus called for avoiding cross-subsidies between prosum(ag)ers and non-prosum(ag)ers (CEER 2016). NREL (2013) provides a U.S. perspective on the respective regulation. In the literature, net-metering schemes are often found to be particularly challenging in the context of a growing prosumage segment because net metering neglects the time value of electricity and does not adequately value the backup service provided by the grid (cf. Eid et al. 2014). As a substitute for volumetric network charges, different types of capacity-based and hybrid charges have been proposed (NREL 2013; European Commission 2015; Pérez-Arriaga et al. 2017; see also Table 29.1).

Several offsetting factors may mitigate adverse distributive impacts. For example, if PV capacities were increasingly deployed within the prosumage segment, other remuneration schemes would have to be used less, and renewable support payments could decrease. For Germany, it has further been argued that the distributive impacts of prosumage are likely to remain small as the potential for PV self-consumption is limited (Prognos 2016). Kubli (2018) draws a similar conclusion for a Swiss case study.

29.2.3 Arguments with Ambiguous Conclusions

Transmission Grid Relief—Prosumage may also relief congestion in transmission grids and contribute to deferring respective investments (NREL 2013). Yet the mechanisms are not straightforward. Transmission networks differ from distribution grids as they are designed for spatially balancing generation and load. As this spatial distribution varies over time, electricity flows also vary in magnitude and direction. The impact of increased prosumage on the transmission grid thus depends on the

[4] This may be less of an issue for CSOP projects discussed throughout this book.

distribution of renewable generation and load. If decentral batteries are used to take up PV peaks, this may result in lower transmission grid usage. Prosumage could thus help to defer transmission grid investments if congestion is caused by PV peaks. In contrast, if transmission congestion is driven by peak load, this may not be the case. If, for instance, peak load in summer is correlated with high PV generation, PV prosumage may indeed reduce transmission investment needs. Yet if peak load and PV generation do not coincide, prosumage would hardly affect transmission investments.

Further, if the flexibility potential of prosumage batteries is available for further market interactions, this may have unintended transmission network impacts in case wholesale market prices do not adequately reflect transmission congestion. Considering a specific German example, PV prosumagers located in southern Germany could use their batteries to charge electricity from the grid in periods with low market prices and low PV feed-in. Because of Germany's single price zone, this may occur in hours characterised by both high demand and high feed-in of wind power in the northern part of Germany and, thus, add to congestion of north-south transmission lines. A numerical analysis of such a situation would be desirable, but is not available at the time of writing.

Flexibility—It has been argued that increased prosumage can make the power system more flexible. For example, it may unlock residential DSM potentials (cf. Anda and Temmen 2014, Roth et al. 2018). Based on choice experiments, Kubli et al. (2018) compare willingness to provide flexibility to grid for PV plus storage, electric mobility, and heat pumps. Assuming that additional flexibility comes at the expense of lower self-consumption and lower control of data, people do not seem be much concerned about this "discomfort" related to flexible use of battery, as compared to other aspects such as their electricity mix. Palm et al. (2018) do not focus on batteries but are generally skeptical on demand-side flexibility: most of the prosumers they interviewed in Sweden considered that the benefits of temporally shifting their electricity consumption were too small to compensate for respective inconveniences. In any case, realising such additional flexibility potentials not only depends on technical prerequisites, but also requires an appropriate regulatory framework (CEER 2016).

Otherwise prosumagers may just care for maximising their self-consumption or self-generation levels. With aggregation and remote control, prosumage systems could also contribute to the provision of a range of ancillary services.

Driver for Sector Coupling—Prosumage may also spur decentral sector coupling measures. For example, self-generated electricity may be used to charge electric vehicles. Likewise, prosumagers could invest in power-to-heat applications to further increase self-consumption levels (Prognos 2016; SPE 2016). In many countries, such sector coupling is assumed to be required to achieve energy and climate policy targets. Yet decentral sector coupling may not be optimal from a system perspective, if compared to more centralised options such as heating networks (cf. the Bloess et al. 2018) or large-scale power-to-gas installations where economies of scale play a major role (cf. Schiebahn et al. 2015).

Energy Efficiency versus Rebound Effects—Prosumage may lead to energy efficiency improvements, driven by increased awareness of prosumagers and respective behavioural change. A review of studies on households' (stated) behavioural responses to PV installations indicates that there may be adjustments with respect to better energy efficiency (Luthander et al. 2015). The same could also apply to prosumage. Yet the opposite effect may also materialise. Prosumagers may be less willing to invest in energy-saving measures if cheap self-generated electricity is available. Without focusing on batteries, Palm et al. (2018) find selective evidence of a rebound effect of solar prosumers in Sweden. Some persons perceived their self-generated solar electricity to be some kind of "free energy"—even when their overall consumption of grid electricity increased. Fikru et al. (2018) partly formalise this argument with an economic model of households' energy consumption, according to which prosumers may actually have a lower shadow price for energy services.

As such, small-scale prosumage systems should, on average, not generate any excess electricity such that self-generated electricity would actually not be cheap at the margin; accordingly, a rebound effect should not occur. Also for larger prosumage systems, particularly under consumer (co-)ownership, every kWh that is not self-consumed could potentially be sold to the grid, which provides incentives for energy savings. While empirical evidence is scarce so far, a study by Roth et al. (2018) indicates that (co-)ownership in renewables has a positive effect on the willingness of consumers to adapt their consumption behaviour towards more demand flexibility and energy efficiency.

Local and Macroeconomic Benefits, Increased Competition— Prosumage may give rise to greater local economic benefits compared to systems with more centralised infrastructures owned and operated by other agents (IEA 2014). Yet the overall economic effect when taking anto account changes in grid charges, taxes, and other retail price constituents is not clear. In terms of macroeconomic effects, Flaute et al. (2016) make the point that prosumage may incur (small) overall economic benefits in Germany. Yet they also state that the results of their economic modeling analysis are preliminary and depend on the several assumptions. They further point out that prosumage-oriented PV systems may be too small in size from a system perspective. Another argument in favour of prosumage relates to increased competition in electricity markets. This may be facilitated by the entry of new players such as service providers and aggregators. Likewise, increased decentral self-generation reduces the size of traditional wholesale and retail markets (SPE 2015, 2016).

Political Economy, Path Dependency, and Policy Coordination— From a political economy perspective, prosumage may incentivise PV deployment without requiring direct renewable support schemes, which are often politically contentious. Further, prosumage may result in lower rent-seeking activities of well-organised incumbent energy industry lobby groups such as network operators or large utilities. On the downside, an ongoing shift towards prosumage, spurred by current network charging schemes, may lead to a situation in which residential and commercial prosumagers form a politically relevant interest group. The IEA (2014) asserts that the deployment of small-scale residential PV systems has in many countries already created what could be considered a new class of "solar voters". A further adoption of decentralised PV-battery systems could accordingly lead to a new class of "prosumage voters." Likewise, both positive and negative effects may materialise with respect to technological path dependencies. On the one hand, the prosumage segment may foster innovation with respect to hardware and software development and with respect to new business models. On the other hand, the design of battery systems may be such that system-oriented operations are impeded, for example in case of missing or underdeveloped communication interfaces or default operation modes that lack system orientation. A growing prosumage segment could also impede policy coordination. Meeting political targets for renewable energy use can be easier with direct support schemes that focus on grid feed-in, as compared to decentral investment decisions guided by self-consumption considerations.

Data Protection and Security—Concepts of system-oriented prosumage, in which decentral batteries provide additional flexibility to the energy system, likely require communication interfaces and remote control. Without specifically focusing on PV-battery systems, Wilson et al. (2017) argue, based on a UK survey, that ceding autonomy is the main risk for the adoption of smart home technologies. Prosumagers may likewise be concerned about data protection and loss of control over their batteries. Empirical evidence on this issue is scarce. Based on an Israeli study, Michaels and Parag (2016) point towards significant concerns about data protection and low acceptance of remotely controlled household appliances. Likewise, they find that people have substantial privacy concerns with respect to smart meters and low trust in institutions that oversee these technologies. A slightly more positive finding emerges from a descriptive study for Germany (Gährs et al. 2015).

With respect to system security, decentral PV installations and batteries operated by prosumagers are sometimes described as vital components of resilient (smart or micro) grids (Michaels and Parag 2016). Compared to large-scale central infrastructure, a greater number of decentral installations may respond better to failures of single components. Then again, remote-controlled prosumager batteries may constitute new security risks in case the communication interfaces are vulnerable for attacks. An assessment of potential benefits and threats with respect to system security requires further research.

29.3 A Model-Based Illustration of System-Wide Efficiency Losses

29.3.1 Model Description

To study the effects of increased prosumage in a future German electricity system, we use the electricity system model DIETER. This model minimises the total cost of providing electricity for one year, comprising both investment and operational costs. Model inputs are data on costs and availabilities of technologies, hourly electricity demand, and hourly availability of variable renewable electricity. Input data follow established projections for the German electricity system in 2035. Model outputs comprise generation capacities and their hourly use for different purposes.[5] A basic description of the complete model can be found in Zerrahn and Schill (2017) as well as on DIETER's website (www.diw.de/dieter). Past model applications dealt, amongst others, with the role of central electricity storage for renewable integration (Schill and Zerrahn 2018).

While DIETER generally models the wholesale market, the version used here also features a representation of a prosumage segment. A specified share of overall solar PV capacities is attributed to prosumage, and electricity demand is split into a prosumager and a wholesale market share. Figure 29.2 illustrates the prosumage setup: in each hour, electricity generated by prosumage PV is either consumed directly, sold to the market, curtailed or charged to the prosumager battery. An equation in the mathematical model makes sure that energy demand of prosumagers is satisfied in each hour: either by direct self-consumption, consumption of electricity from the market or from the decentral storage. Generally, the prosumager battery can charge electricity from both prosumagers' self-generation and the market, and it can discharge electricity to both prosumagers and the market (Fig. 29.2). Thus, the

[5] For transparency and replication, we follow good practice in energy research and provide code and data are open-source under a permissive licence (Pfenninger 2017). Additional information on the model and input data is provided in Schill et al. (2017a) as well as the underlying discussion paper referenced there.

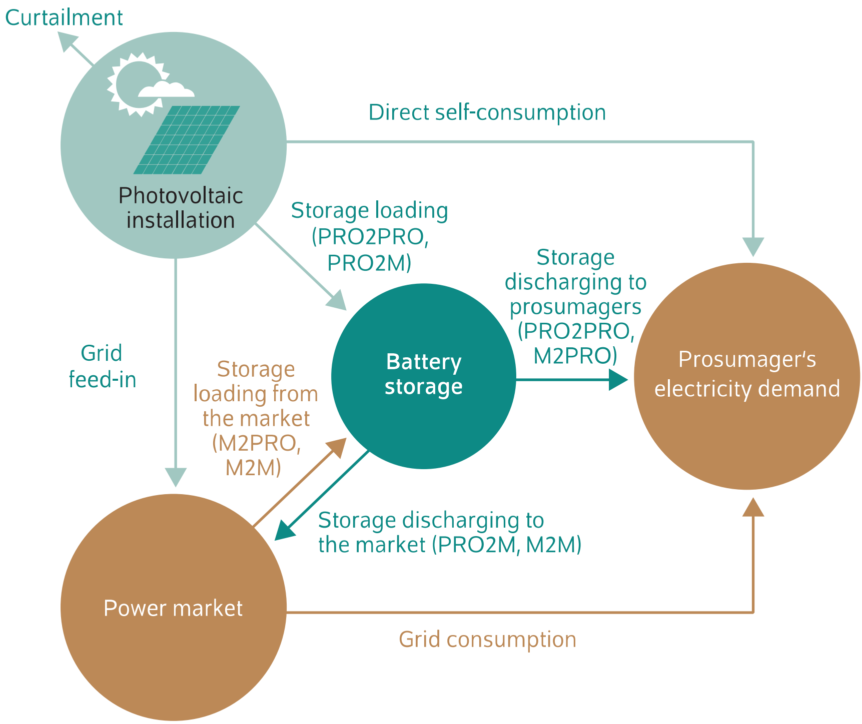

Fig. 29.2 Schematic illustration of prosumage in the model

storage can act in four possible ways: market-to-market (M2M), market-to-prosumage (M2PRO), prosumage-to-market (PRO2M), and prosumage-to-prosumage (PRO2PRO). Irrespective of its use, the storage capacity is limited by a power rating, restricting the overall hourly electricity intake, and an energy capacity, restricting the overall energy inside the storage.

To analyse different shares of self-generation in the model, we impose a minimum share of annual electricity demand by prosumagers to be satisfied by decentral PV installations; either directly in the hour of generation or indirectly through storage. Accordingly, only the storage use for PRO2PRO (Fig. 29.2) adds to self-generation. As the minimum self-generation share must hold for the entire year, hours with low self-generation may be offset by hours with high self-generation.

29.3.2 Input Data and Scenarios

We pursue a so-called brownfield approach. Input data follows established projections for the German electricity system in 2035. We assume capacities of conventional and renewable power plants as given by the medium scenario B1 of the German Grid Development Plan (*Netzentwicklungsplan*), which constitutes a projection of the future German electricity system on which transmission grid investments are based on. The power plant portfolio corresponds to a 66 per cent share of renewables in total electricity consumption. While all generation capacities are fixed, we allow the model to optimally decide on storage investments, both with respect to central pumped hydro and lithium-ion batteries as well as decentral prosumager batteries. By assumption, we attribute 25 per cent, corresponding to 15 GW, of the overall solar PV capacities of around 60 GW to the prosumage segment. With a standard household size, this would be equivalent to 2.6 million decentral prosumage systems with a rooftop PV panel of around 5.9 kWp each.

We analyse four prosumage strategies, differentiated by the degree of market interaction of the storage, as illustrated by Fig. 29.2.

(1) Pure prosumage without system orientation: decentral battery storage can only be used to temporally align prosumagers' load with self-generated electricity (PRO2PRO)
(2) Pure prosumage with system orientation: as (1), but decentral storage operations optimised in line with system needs
(3) Grid consumption smoothing: as (2), and the prosumager battery can additionally charge electricity from the market (PRO2PRO and M2PRO)
(4) PV profiling: as (2), and the battery can additionally discharge electricity to the market (PRO2PRO and PRO2M)
(5) Full market interaction: no restrictions on storage use (PRO2PRO, M2PRO, PRO2M, and M2M)

Model run (1) represents the least optimistic case with respect to prosumagers' consideration of system effects. Here, batteries are fully charged as soon as PV generation exceeds demand, and fully discharged again as soon as the opposite is true.[6] The other four cases assume that storage operations follow the overall cost-minimisation objective of the model. This means, for instance, that a household sells electricity to the grid in times when it is most profitable, while keeping up the minimum self-generation restriction over the entire year. This could be rationalised by the existence of service providers who carry out the management of decentral PV-storage systems.

29.3.3 Results

To analyse the impact of rising prosumage shares on the electricity system, we vary the minimum annual self-generation requirement between 40 per cent and 70 per cent, in 5 per cent increments. First, we evaluate optimal investments into decentral storage. Given the model parameterisation, the requirement of 40 per cent decentral self-generation is reached without any battery storage. Beginning with a requirement of 45 per cent self-generation, decentral battery storage is built in all four scenarios. For instance, under a self-generation requirement of 55 per cent and full market interaction of decentral storage (case 5), the model invests in around 2800 MW of battery power capacities and around 6700 MWh of energy capacity. On average, this amounts to a battery with 1.1 kW and 2.6 kWh for each of the 2.6 million prosumagers. While decentral storage requirements rise moderately for self-generation requirements up to 65 per cent, they increase sharply beyond.

If prosumage batteries are operated without any consideration of system effects (case 1), the smallest decentral storage capacities materialise. Differences between prosumage strategies (2) to (4) are negligible; only in the full market interaction case (5), optimal decentral storage capacities are substantially greater. Likewise, model results show that decentral storage capacities offset central storage capacities only to a very minor extent under prosumage strategies (1) to (4). Only under strategy (5), they substitute considerable amounts of central storage. Thus, disproportion-

[6] This additional model run is not included in Schill et al. (2017a).

ately increasing decentral battery storage is necessary to fulfil rising self-generation requirements above a certain threshold, and the decentral storage infrastructure is largely redundant to central storages if it does not interact fully with the market.

Both of these findings have an impact on overall system costs. The least-cost prosumage solution materialises only if the flexibility potential of decentral batteries is available for the electricity market to the largest extent possible (case 5), while still ensuring required self-generation shares. In contrast, cases (2) to (4) incur higher system costs because of redundant storage installations from an overall system perspective. Battery operations that purely focus on maximising self-generation and do not consider any system effects (case 1) incur highest costs. Yet overall costs are always higher compared to a system without prosumage, that is, without imposing self-generation constraints; again due to redundant storage investments. Figure 29.3 exemplarily illustrates these findings for the cases (1), (2), and (5). The bars show the average additional system cost in euro per megawatt hour of self-generation compared to the situation in which no storage is needed for self-generation, that is, a self-generation share of 40 per cent. The additional costs

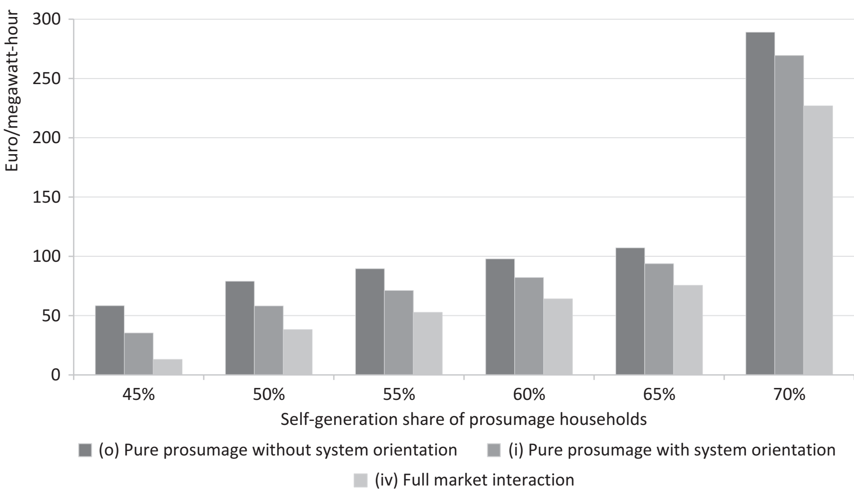

Fig. 29.3 Additional system costs related to additional prosumage electricity integrated by storage

are greater for both a lower degree of system orientation and a higher self-generation requirement.

A closer look at the hourly use of decentralised storage systems in the full flexibility setting (case 5) sheds more light on the drivers of these findings (Fig. 29.4). If PV generation (black dotted line) begins to exceed the household's electricity demand (black solid line) on a given day, the electricity is first sold to the market (grey dotted line). In this way, the size of the storage can be kept minimal because energy does not have to be stored for long periods of time. In the afternoon, the storage then charges PV electricity and releases it for self-consumption in the evening and early night hours (PRO2PRO, dark grey area). At night-time, under-utilised storage capacities are further used to charge cheap electricity from the market. This electricity may both serve consumption of the household (M2PRO, medium grey area) and provide flexibility to the market (M2M, light grey area). This allows making use of cheap electricity when available and, thus, lowers the operational costs of the system.

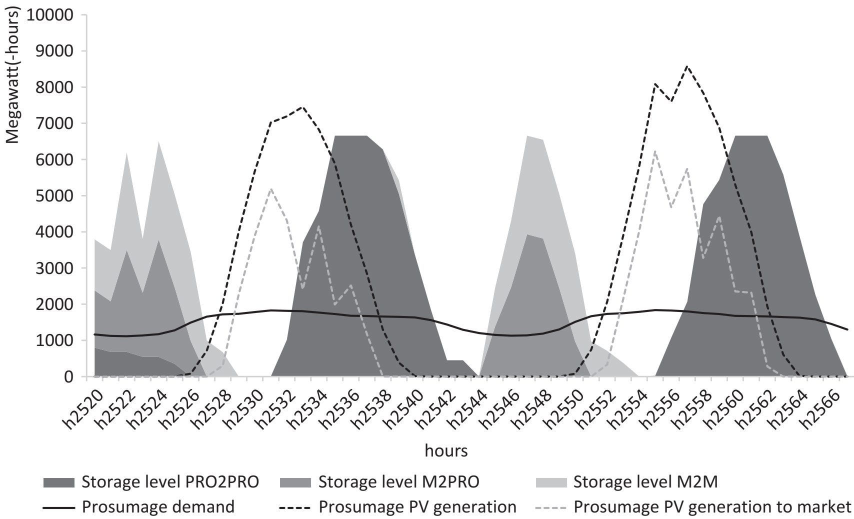

Fig. 29.4 Prosumagers' load, PV generation, and storage operations over two days for case (5) with 55 per cent self-generation

29.4 Summary and Conclusions

In the academic and policy debate on prosumage, several arguments can be identified that tend to speak in favour of or against increasing levels of prosumage in the context of the energy transition. On the pro side, consumer preferences for renewable self-generation, a perception of lower or at least more stable electricity costs, a desire to actively participate in the energy transformation, and better public acceptance generally appear to be plausible, even if challenging to quantify. On the con side, the concept of decentral PV self-generation by means of batteries is challenged by increasing system costs and distributional impacts, especially if compared to system optimisation unconstrained by self-generation restrictions. Other arguments have to be categorised as ambiguous given the current state of knowledge. In particular, it is not clear whether increased prosumage will have overall beneficial system impacts with respect to system flexibility, sector coupling, energy efficiency or data safety and security. Additional quantitative and qualitative evidence is necessary to shed more light on these (and several other) aspects. In any case, most arguments depend on the perspective adopted.

Our model-based illustration of possible system effects of prosumage, calibrated to a German 2035 scenario, shows that growing self-generation shares require disproportionately increasing battery storage capacities. At the same time, the deployment of decentral batteries only leads to a substantial substitution of central storage capacities in case they are fully available for additional market interactions. Under such flexible prosumage operations, system cost increases related to rising shares of self-generation are also lowest. Facilitating such system-oriented prosumage will likely require remote control by aggregators, respective communication infrastructure, and an appropriate regulatory framework.

We conclude that the development of prosumage should not unnecessarily be restricted in order to realise the various benefits that speak to its positive potential. At the same time, policy makers and regulators should aim to minimise system cost increases, unintended distributional impacts, and undesirable path dependencies. Most importantly, policy makers and regulators should work towards realising system-oriented design and operation of prosumage installations to make their flexibility potential available for the power market to the largest extent possible. This may be facilitated by providing wholesale price signals to prosumagers, either directly or indirectly via aggregators. In addition, network charges should better reflect actual prosumagers' impacts on the grids.

Ideally, the regulatory framework should incentivise prosumage in a way that its positive potential for the low-carbon energy transformation is realised, while minimising distributive impacts between prosumagers and non-prosumagers. At the same time, system-oriented design and operation of prosumage installations should be ensured. How to facilitate this, also considering country-specific characteristics, requires more detailed research.

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30

Outlook: Energy Transition and Regulatory Framework 2.0: Insights from the European Union

Claire Gauthier and Jens Lowitzsch

30.1 Common Trends, Challenges, and Convergence Patterns in the Energy Transition

For the first time ever, in 2016, the electricity sector[1] was the largest recipient of energy investments, mainly in renewable capacity (IEA 2017c; IRENA 2018a). Despite a steady and impressive growth rate since

[1] While the energy transition is not limited to the electricity sector but includes the heating and cooling as well as the transport sectors, this chapter focuses on the former as it has the largest potential for decarbonisation and is the one where the most action has been undertaken so far (Welsch et al. 2017).

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1990, the share of renewable energy sources (RES)—especially variable RES (vRES) such as wind and solar power—is still limited in the worldwide total energy supply and ranks third behind coal and natural gas but closing in on them (IEA 2017a, b). However, recent forecasts underline that this investment trend and increased deployment of vRES[2] are unlikely to subside and, on the contrary, may even accelerate due to cost reduction,[3] provided regulatory adaptions are undertaken worldwide but particularly by regional leaders such as China, the United States of America, India, Japan, and the European Union (EU) (IEA 2017b).

Three policy goals—sometimes mutually reinforcing each other, sometimes contradicting each other—define energy policy. Those are energy security, affordable/competitive energy prices, and sustainability/decarbonisation (concept of trilemma Sect. 17.1.2; see also Buchan 2015). They can be reformulated more precisely, for example in terms of (de)centralisation of the energy system, market regulation, fight against energy poverty, or nuclear phase-out. While each country has different drivers, faces specific problems, and responds to them differently in the political arena (see Sects. 2.1 and 2.2), common trends, challenges, and convergence patterns can be identified in transitioning to a low-carbon economy:

(1) *Due to their volatility, the increasing deployment and market penetration of vRES paradoxically hampers their integration in energy systems, both at the grid and market levels*. On the one hand, uncertainties in predicting supply entail difficulties for grid management and therefore higher integration costs, which are increasing retail prices and are passed on to final

[2] In spite of a dip in the amount of investment in RES (IEA 2017c; IRENA 2018a), capacity has increased and will continue to do so. Global RE capacity should increase by 43 per cent between 2017 and 2022, twice the growth of coal and natural gas combined. Wind and solar are expected to account for 80 per cent of this growth. By 2022, Denmark will be the world leader with 70 per cent of its electricity-generation capacities coming from renewables while other European countries, such as Germany, should attain 25 per cent. Most BRIC countries will probably double their share of vRES generation to reach 10 per cent (IEA 2017a).

[3] The International Energy Agency (IEA 2017d) observes that the cost of clean energy technologies, that is, vRES but also battery storage, has dramatically decreased in the last years: 25 per cent for wind energy, 40 per cent for battery storage, and 70 per cent for solar power since 2010. The competing International Renewable Energy Agency (IRENA 2018d) even mentions a reduction of 81 per cent for solar energy for the same period and states that cost reductions are constantly underestimated (IRENA 2018c, d). All in all, this shows that renewables are becoming the “least-cost source of generation” (IEA 2017d; IRENA 2018d).

consumers. On the other hand, vRES bear the risk to lose their value with increasing market penetration as wholesale prices decrease due to the merit-order effect, thus threatening their attractiveness as an investment opportunity (IEA 2017a). To cope with this variability, better integrate vRES, and secure investments, various solutions in system flexibility are investigated: grid reinforcement, extension, and interconnection; the complementarity of other flexible (renewable) supply sources like power-to-gas; the development of storage and smart technologies; and demand-side response to name a few (IEA 2017a; Welsch et al. 2017).

(2) *Doubts are raised about the actual level of investments in RES being sufficient to meet long-term growth of electricity demand (IEA 2017c), not to mention the low-carbon target set by the Paris Agreement in late 2015*. All in all, the IRENA (2018a) estimates that USD 25 trillion have to be invested in RES by 2050 to meet the latter requiring to triple the actual annual investment rate. For the EU to meet a 34 per cent RES share in final consumption by 2030,[4] would necessitate USD 73 billion per year, that is, 0.3 per cent of the current EU-28 GDP and an increase of around USD 20 billion per year compared to the 2016 investment level (IRENA 2018c). At the same time fossil industries are carbon locked-in and although exponential in growth the movement for divestment is still limited.[5] Therefore, it seems unrealistic to rely solely on traditional energy investors to pursue this effort, independently of favouring a decentralised energy system or not. New actors, such as households, communities, and businesses, are increasingly important as (co-)investors effectively blurring the traditional market roles between investor, producer, and consumer to become prosumers (IEA 2017c; IRENA 2017; Welsch et al. 2017).

[4] In 2014, the European council agreed to a target of 27 per cent share of RES in energy consumption by 2030. However, a report ordered by the Commission (IRENA 2018c) estimates that a share of 34 per cent could be attained with a saving potential compared to the reference scenario. Thus considering political (Paris Agreement) and technological developments (unexpectedly quick cost reductions), 27 per cent is considered a conservative and inadequate hypothesis. More on the 2030 EU RES target in Sect. 30.3.

[5] Carbon lock-in describes the technological and institutional path-dependency of energy systems based on fossil fuel (Unruh 2000). Divestment here refers to the disposition or sale of an asset by a company as a way for a company to restructure the portfolio of its assets, in this case all investments in fossil energy sources; this amounted to 50 billion in 2014, 2.6 trillion in 2015, and 5 trillion (probably underestimated) in 2016 (Arabella advisors 2015, 2016)

The issue of an investment gap is even more important considering that with around 90 per cent of investments private investors carry the bulk of the effort (IRENA 2018a).

(3) *The role of public institutions is specific and cannot be reduced to their investment capacity or financial support*. Public financial institutions complete or enable private investments as they tend to invest in international projects or provide guarantees against different risks or market failures, like technology immaturity, early-stage project development, unpredictability of revenues, and high transaction costs[6] (IEA 2017d; IRENA 2018a). While public investment was estimated to just USD 14 billion, support policies for RES amounted to USD 66 billion in 2015 (IRENA 2018a); at the same time subsidies for fossil fuels are still estimated to make up almost the double those for RES in 2016 (IEA 2014). Nonetheless, a recent trend in policy is a decrease in policy support and a generalised move away from regulated feed-in tariffs (FITs) and towards auction mechanisms, independently of the market structure or the type of policy support (IEA 2017a, c; IRENA 2018b, d). Additionally, a recurring concern for the deployment of RES is regulatory and policy instability, in particular retroactive decisions like those undertaken in Spain in 2013 and 2014 (IEA 2017a, c; IRENA 2018a, b, see Section 19.5.1). Given the sensitivity of investments to economic cycles and regulatory instability, governments are responsible for the coherence between their actions and their international engagement to fight climate change; however, these are or were often traded off against other political and economic priorities (Buchan 2015; IRENA 2018a). Thus maybe more than their role as economic agent, it is their role as policy-makers building a long-term, stable, and secure strategy and framework, which becomes increasingly important.

[6] For example, the European Investment Bank (EIB) analyses market failures in the energy efficiency sector: the lending activity is often unattractive for conventional financial institutions due to the multiplication of small loans leading to high transaction costs. The same can be said for investment in RES. Bundling loans through platforms or specific instruments have a role to play to correct this (https://ec.europa.eu/commission/priorities/jobs-growth-and-investment/investment-plan-europe-juncker-plan/investment-plan-results/efsi-energy-sector_en). The Consumer Stock Ownership Plan (CSOP) presented in Chapters 1 and 8 would be an alternative to pool resources.

(4) *Finally, the energy transition faces various acceptance problems*. The classical example is the "not in my backyard" (NIMBY) reaction against grid extensions or the installation of new plants, in particular wind turbines. Acceptance has also decreased as rising costs of the energy transition are passed on to end consumers while commercial consumer groups are spared. For example in Germany, energy-intensive industries are exempted from the renewable energy levy (EEG-Umlage) financing FITs allegedly to avoid competitive disadvantages on international markets; however, this privilege also applies to self-consumption leading to concerns about the impact on retail prices. The discussion about distributive justice (see also Chap. 4), either framed as burden-sharing of support policy costs (Ecofys et al. 2014), fair contribution to grid costs (Welsch et al. 2017), or access to ownership, highlights the relationship between acceptancy on one hand and allocation of resources, benefits, and costs on the other. Furthermore and although not specific to energy, technological change coming with digitalisation, for example, smart meters or (semi) automated load management systems, is viewed with suspicion by many energy consumers. The deployment of these technologies has implications for data protection as well as privacy issues, and is accompanied by a push for new behavioural norms such as demand-flexibility to the individual. Therefore, the energy transition holds not only a technical or economical but also a sociological dimension important to acknowledge in terms of economic modelling and policy-making.

Thus, while forecasts predict further deployment and acceleration of investment in RES, they do so conditionally that the market and policy framework is substantially adapted. These challenges point towards major changes of energy systems worldwide and the emergence of new social, political, economic, and legal models. Considering that this book focuses on consumer (co-)ownership, this chapter centres on the future role consumers will have and the European strategy to put them in the centre of a new market design. Therefore, while some considerations are general and can apply outside of Europe, some others are specific to the EU, which pursues liberalisation and market integration policy in parallel to its energy transition. Drawing on similar developments in other countries demand-flexibility and price incentives as crucial tools for market design are of particular interest.

30.2 The EU's New Market Design: Harnessing the Potential of Consumer (Co-)Ownership?

In the light of the rapid deployment of RES,[7] the EU was perceived as a front-runner of the energy transition for more than two decades. Long-term targets and important policy support, both contributing to investment security, are considered the two key factors which enabled this development (IEA 2017b; IRENA 2018c). However, since 2011, efforts faltered, in terms of both investment and deployment (IEA 2017a; IRENA 2018c) with the EU losing its pole position.

(1) *Background: EU energy policy and Energy Union*: To address this as well as other persistent issues specific to the EU energy policy, the 2014-nominated Juncker Commission launched the so-called Energy Union (European Commission 2015a). Often presented as a new start for the EU's energy policy by the European Commission (2015a), its reception has been, however, lukewarm with a lot of actors adopting a wait-and-see approach (Friedrich Ebert Stiftung et al. 2016; Turmes 2017; Zachmann 2015). One likely reason is that this policy merely reaffirms previous consensual goals, that is, competitive, secure, and sustainable energy in an internal energy market to the benefit of consumers, which are, however, persistently lacking implementation as the European Commission admits (2015a). The Energy Union thus does not so much redefine the EU energy policy as it aims at improving implementation through better coordination and coherence between different policy strands, in particular market integration and vRES promotion. The reference to "citizens at its core", "new deal for energy consumers", "clean energy for all Europeans", used by the Commission in relation to the Energy Union, should not merely be understood as consumers being the main beneficiaries but truly as a policy target group to be activated. The achievement of those goals requires the transformation of the energy system as well as traditional market roles and institutional configurations (European Commission 2015a, d).

[7] RE consumption increased from 9 per cent in 2005 to 16.7 per cent in 2015 and is on track to meet the 20 per cent target for 2020 (Eurostat 2017; IRENA 2018c).

Using the energy transition as an opportunity to achieve a more general goal of supranational integration, the European Commission (2015d) requires "a market fit for renewables" (liberalised internal market) and "promoting renewables fit for the market" (market integration of vRES). While the internal market and climate and environmental policy arose at different points in time and moved at a different pace, they merged in a common energy policy in 2007 with the Lisbon Treaty and are now handled conjointly (Berrod and Ullestad 2016; Buchan 2015).[8]

(2) *Developing a new market design*: Drawing back on the challenges identified in Sect. 30.1, that is, system integration, RE investments, role of public institutions and public acceptance, it is clear and acknowledged by the EU that providing the right framework for consumers is crucial for success. Following the launch of the framework strategy in February 2015, the Commission published three preparatory documents and a public consultation in July, focusing on market design, especially market compatibility of RES and their support schemes on one hand and on the role of energy consumers as active market players—producing their own energy among other things—on the other (European Commission 2015b, c, d). The test with regard to consumer (co-)ownership models is whether the final result of the "Clean Energy Package", in particular the recast of the Renewable Energy Directive (RED II) and of the Internal Electricity Market (IEM) regulation and directive, will harness its potential to facilitate both "renewable self-consumers" and "renewable energy communities" (for the EU definitions see Sect. 30.3). A positive outcome would harmonise standards at the European level and provide a model

[8] The legal basis for the EU energy policy is to be found at the article 194 of the Treating on the Functioning of the EU (TFEU). It is a shared competency, that is, the Member States can legislate on the matter unless the EU, which has precedence, does. It combines a supranational approach but still grants important prerogatives to the Member States. In particular the second paragraph states that Member States are free to choose their energy mix and the form of support schemes without prejudice to state aid and competition policy. The third introduces a derogation to the ordinary legislative procedure where taxation is concerned. Thus, while the EU sets a frame and a convergence path, the Member States still have a lot of room of manoeuver and possible veto power to safeguard their sovereignty. For the topic of this book the main pieces of relevant secondary law are the renewable energy directive (2009/28/EC) and the internal electricity market directive (2009/72/EC).

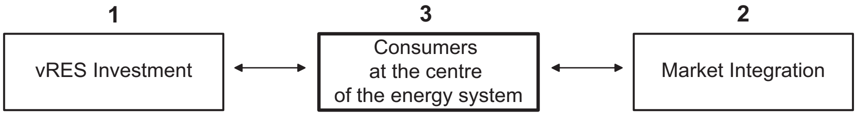

Fig. 30.1 Goals of a new energy market design in the EU

for other legislations worldwide like Germany's Renewable Energy Act almost two decades ago replicated in many countries worldwide.

In developing a new market design, the Commission's identified priorities are (1) (variable) RES promotion and deployment, (2) market integration, and (3) putting "[consumers] at the centre of the future energy system" which includes making them self-consumers and (co-)owners (European Commission 2015a, d). The attractiveness of RES in general is assessed on the wholesale market, where they compete with other generation sources while the attractiveness of self-consumption depends on retail prices (Welsch et al. 2017). The challenge is how to frame a coherent policy approach to incorporate prosumers, be they individuals, communities, or SMEs, as central actors linking vRES investments and market integration as shown in Fig. 30.1. The following sections focus on those three goals and their respective challenges.

30.2.1 Supporting (Variable) RES Investment: Remuneration and a Stable Regulatory Framework

It is widely agreed that the EU managed to successfully promote the deployment of RES through the adoption of the 2020 Climate and Energy package—in particular the RED (2009/28/EC)—in 2008, providing a stable framework with long-term binding targets and leaving Member States in charge of incentives for investments to reach them (Fig. 30.2). However, a number of problems, which would impede further deployment, arose.

(1) *Adequacy of support schemes and sufficient remuneration*: Performance criteria for support schemes are (1) policy effectiveness, that is, the ability

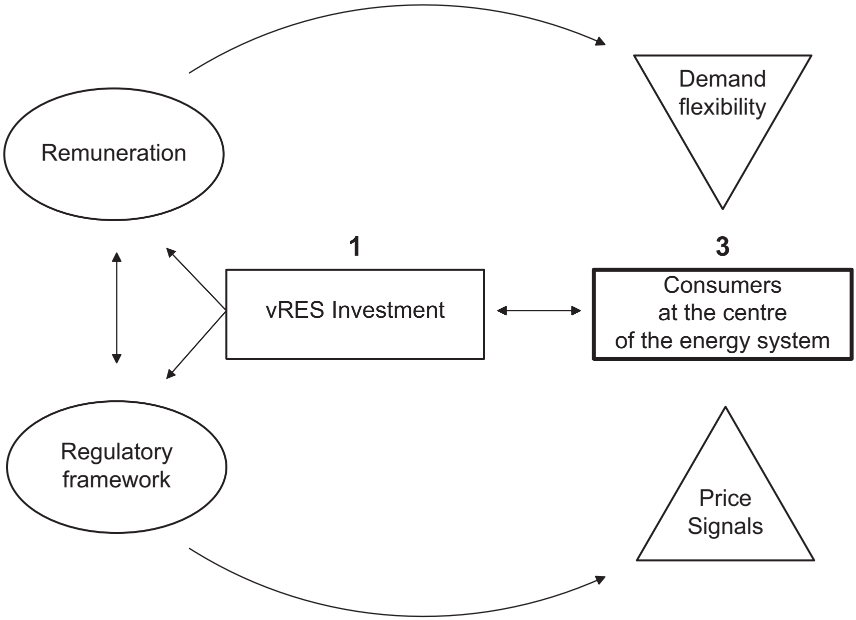

Fig. 30.2 Unlocking (variable) RES investment

to trigger new investments; (2) static effectiveness, that is fulfilling set target at the lowest possible overall costs; (3) dynamic efficiency, that is target achievement over a long-term considering whether a policy instrument helps drive down costs of less mature technologies; and (4) compatibility with market principles and distributional effects, that is, an equitable distribution of rising costs (Ecofys et al. 2014). There is, of course, no perfect solution and trade-offs are permanent between those criteria.

While the European level provided a framework and binding national targets, achieving the set share of RES in final consumption in particular through support schemes is the responsibility of national governments. As a result of the lack of RES' competitiveness and some national industrial policies, RES promotion schemes had been initially disconnected from market mechanisms (European Commission 2015a; Zachmann 2011). Such national policies had the merit to remunerate sufficiently, trigger investments and achieve or retain an innovation leader position. However, they are not considered apt for the current state of technological development, increasing RE market penetration requiring demand-flexibility, strict rules on public finance and the principle of free movement in the internal market. While the first two are general considerations which apply around the world, the last one is specific to the EU. In particular, the use of price signals as a steering instrument is impeded by the lack of common rules, a problem exacerbated by national segmentation within the EU single market where support schemes are nationally designed and therefore not only incompatible with market principles but also with each other (Friedrich Ebert Stiftung et al. 2016; Zachmann 2011). The possibility of designing joint RE support foreseen by the RED 2009/28/EC remained unexploited. Therefore, today European policy-makers are concerned with pricing issues as current wholesale and retail prices do not reflect the competitive (internal) market equilibrium. With liberalisation, price convergence, and cross-border flows in the single market leading to increased competition and reduction of prices for end consumers, pressure on national policy-makers is rising. However, despite action since the 1990s, liberalisation is incomplete and remainders of historically national markets like regulated and social tariffs as well as high market concentration are still present (European Commission 2015a; Eurostat 2017, see also section 1.c of the country chapters).[9]

In short, the current setup managed to trigger investment (criterion a) and drive down costs for less mature technologies (criterion c) but is not adapted to reaching RES target at the least cost (criterion b) nor taking into account market compatibility or distributional effects (criterion d). Following the multiplication of cases and important decisions of the European Court of Justice on national support schemes,[10] the European Commission (2014) published the Environment and Energy State aid guidelines and envisaged that support schemes should be market based

[9] In at least 12 out of 28 Member States, the market share of the largest electricity producer is over 50 per cent. In this book, only the Czech Republic and France are examples of this ownership structure.

[10] See in particular Case C-573/12 Åland Vindkraft.

when possible with a gradual introduction of auctions and tenders to allocating support instead of administrative procedure, and premiums as operating aid instead of FITs, not waiting for the recast of the RED and following a worldwide trend.

The question is to which extent this change will still provide sufficient remuneration to keep on triggering investment, especially when considering that the increasing penetration of vRES paradoxically destroys their attractiveness (see Sect. 30.1). This development is inclined to hamper the commitment of individuals as it favours large-scale (commercial) projects (see Chap. 1 as well as Sect. 13.6 on auctions round in Germany in 2017). Therefore, an efficient support scheme is not necessarily a market-based one. Both the EESC and the EC emphasise the need to maintain FITs with a close monitoring to adjust tariffs and avoid over-compensation (SWD141 European Commission 2015d; EESC 2015). As many others (Ecofys et al. 2014), the EESC proposes FITs as the main form of support for small-scale RE-projects with citizen participation as it provides security for small investors. The European Commission (2014) considered exemptions for small installations in its guidelines and some were, indeed, included in the RED II recast (see Sect. 30.3). The regulatory framework should therefore offer remuneration schemes for investors, in particular prosumers, sufficient to remunerate the investment under different levels of transaction costs while providing enough stability and simplicity to reduce risk and transaction costs altogether. Otherwise investments will decrease as risk premiums rise and policy costs with them (Ecofys et al. 2014).

(2) *Regulatory framework*: The RED 2009/28/EC aimed at a share of 20 per cent of RES in gross final consumption in the EU by setting national binding targets to the Member States and mandating the reporting and monitoring of their national actions plans, which were deemed strong governance tools providing stability and investment security. It also provided common rules on guarantees of origin (Article 15 RED) and for access to and operation of the grids (Article 16 RED), in particular a priority dispatch for RES. These were strong measures to trigger RES investment but not sufficient to unlock citizen energy in Europe, as highlighted by the European Economic and Social Committee (2015) in its study on the role of civil society in the implementation of the RED. Specific

barriers for citizen energy identified were, amongst others, grid connection hurdles as well as tenders and direct marketing increasing the administrative burden. The aforementioned guidelines foresaw important exemptions for installations smaller than 500 kW (except wind: smaller than 3 MW or no more than 3 generation units). Those installations, for which market integration of RES "may not be feasible or appropriate" (European Commission 2014), do not have to be supported by premiums, their operators do not have standard balancing responsibilities and no measures are put in place to disincentives generation in time of negative prices. Installations up to 1 MW (6 MW or 6 generation units for wind) are exempted also from participating in tenders. While the RED and the guidelines provided positive long-term price signals, other regulatory measures sent contradicting ones to the market and vRES investors; this concerns the asymmetric level of support between fossil fuels and RES (see Sect. 30.1) and the lack of credibility of the Emission Trading System, Europe's carbon price market (European Commission 2015a). Therefore, as vRES investments become less attractive than they could, their market integration is hampered in case of high base load or overcapacity. However, wholesale prices are continuously decreasing since 2009 as these distortions are progressively removed and as a result of the merit-order effect, aggravated by increasing penetration of vRES and overcapacities in some markets (European Commission 2015a, 2016; Welsch et al. 2017).

To conclude, an enabling framework for RES investment should reconcile contradictory objectives: long-term commitment to predictability and sufficient remuneration of investment with adaptation to changing conditions. In particular with regard to support schemes, it is important to keep close to technological progress, to avoid possible over-remuneration impairing efficiency and to control policy costs and distributive effects (Ecofys et al. 2014). Furthermore, it has to balance market competition and efficiency with sufficient guarantees for new actors like prosumers which being not entirely profit driven, are likely to behave different from incumbent actors (see Chap. 5), and bear higher transaction costs. This argument will be developed further in Sect. 30.2.3.

30.2.2 Market Integration: Supply Management and Price Formation

As mentioned before, market integration implies making the market fit for vRES and vice-versa, both with a long-term and a short-term perspective. While the previous section focused on both aspects with a long-term perspective on price and regulatory measures for the promotion of vRES, this section will discuss the short-term market integration, that is, coping with volatility through quantity management and price formation (see Fig. 30.3).

(1) *Quantity management*: Whereas the energy system was previously driven by demand, the intermittency of vRES' generation reverses that logic, especially because of priority dispatch and merit-order effect. On the supply side, with an increasing vRES share, conventional power generation units see their role reduced to flexible back-up facilities. However, considering that some units are not flexible—such as nuclear power plants providing base load—and that in general their marginal cost is higher than

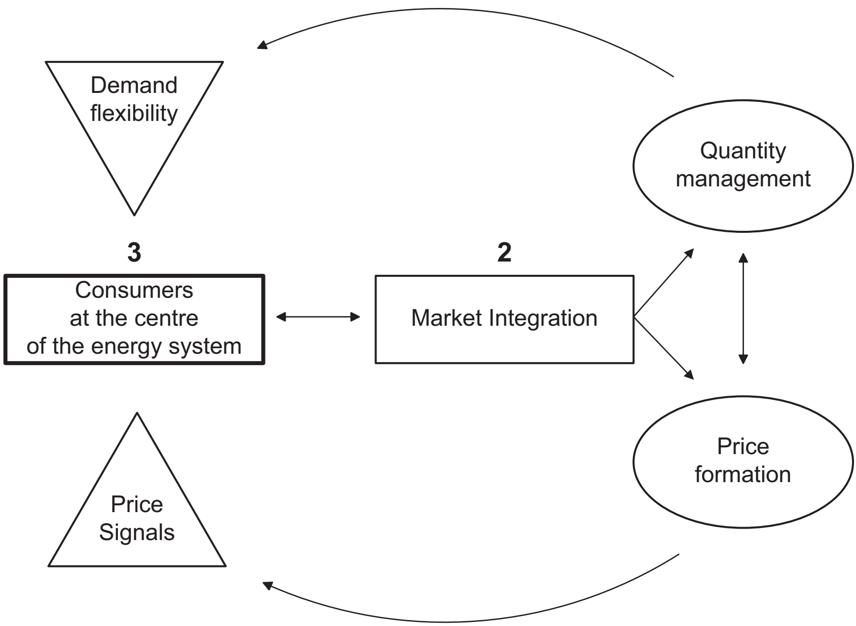

Fig. 30.3 Market integration

that of vRES reduces their overall economic profitability. This threatens their ability at providing ancillary services[11] to ensure security of supply (Welsch et al. 2017; Zachmann 2011). Therefore, the introduction of capacity support mechanisms are envisaged by some Member States but cautiously assessed at the European level (European Commission 2015a; Welsch et al. 2017).[12] Further solutions on the supply side are: (i) increasing grid interconnection and expansion, including through regional cooperation and the European Projects of Common Interest List, (ii) technological innovation such as long-term storage, including power-to-gas, and (iii) improving the reliability of forecasts, including through algorithms and artificial intelligence (European Commission 2015a, d; Welsch et al. 2017). These investments require long-term price signals and regulatory stability. Finally, with increasing penetration, priority dispatch and the refrained use of curtailment of vRES may become less judicious from a grid stability and cost-efficient perspective (Welsch et al. 2017). On the demand side, there are various possibilities, including short-term storage through (car) batteries and sector coupling, aggregation and (automated) load-control, dynamic pricing. However, in the current state, many flexibility solutions to cope with variability face obstacles: immaturity of available technologies and prohibitive costs as well as their unclear distribution and thus lack of acceptance from the demand side. Examples for this are smart meters or batteries. Therefore, the European Commission (2015a) is adamant that the future market design should remove regulatory barriers to facilitate long-term price signals for investments in these technologies, infrastructures, and business models, which would enhance the potential of demand-flexibility. Meanwhile it should enable short-term price formation to be dynamic and incentivise flexible consumption patterns.

(2) *Price formation*: Current short-term price signals are not adapted to increasing vRES share as the link between price formation and quantity management still based on previous measuring patterns is distorted, both

[11] Ancillary services are services required to maintain grid stability and security of supply. It includes frequency control, spinning, and operating reserves (Welsch et al. 2017).

[12] Strong political oppositions on the necessity of supporting conventional actors to ensure security of supply exists considering that (1) fossil fuel are already subsided more than RES (see Sect. 30.1), (2) overcapacity already exists in some markets, and (3) introducing capacity mechanisms could further distort the internal market as non-market-based RES support schemes did.

at wholesale and retail level. Many factors hampering the formation of competitive market equilibrium (see Sect. 30.2.1) were already mentioned as distorting long-term price signals. However, they also distort short-term price signals in the wholesale market. For example, volatility is not reflected if the electricity sold to the grid is remunerated through FIT or sliding premiums.[13] Thus some support schemes can make generation insensitive to market signals and are particularly harmful in times of negative prices. Also because of the lack of interconnection and price convergence at the European level, there are, not one, but many wholesale markets, which hamper the balancing of volatility over larger zones (Welsch et al. 2017).

Demand-flexibility is considered primordial for coping with volatility in the short-term. Therefore, compared to flexibility solutions which still need to mature (see above), price formation will focus on retail prices giving short-term price signals for consumers. Retail prices, that is, final energy prices, are made up of an energy component—wholesale price of energy consumed—and a tax-and-levies component, including grid tariffs and support scheme surcharges. Further distortions stem from distributional effects putting a burden on private end consumers as already mentioned. Indeed, while wholesale prices are decreasing, retail prices are increasing because of taxes and levies (European Commission 2016). This is particularly visible with front-runners like Denmark and Germany.[14] While high retail prices incentivise self-consumption, they bear the risk to further increase imbalances between the actors. This leads to a self-enforcing "utility death-spiral" (see Sect. 29.2.2), provided grid tariffs are not adapted to changing conditions (Welsch et al. 2017). Furthermore because an increasing share of retail prices are constituted of fixed tax and levies, the variable share (wholesale price) diminishes, making variation in prices less perceptible for consumers. Furthermore, measuring and billing consumption patterns are not yet adapted. Dynamic pricing and the technologies required for this are not rolled out on a large scale yet.

[13] FIT are regulated tariffs disconnected from market price. FIP combine market price with either a fixed premium (independent of market price) or a sliding premium (variable to match market price with a predetermined tariff level).

[14] Denmark and Germany have the highest share of taxation in total electricity cost and overall the highest total electricity cost for households (http://ec.europa.eu/eurostat/statistics-explained/index.php/Electricity_price_statistics#Electricity_prices_for_household_consumers).

As prices are distorted and less volatile, generation and demand is inclined to become less reactive and elastic to short-time prices and vice-versa. Thus, the current setup might incentivise self-consumption to the detriment of demand-flexibility. Consequently, recalibrating long-term price signals through a competition policy and linking wholesale and retail markets are priorities for a new market design (European Commission 2015d).

30.2.3 Promotion of Consumer (Co-)Ownership: Fair Competition Conditions and Remuneration

The following section discusses the challenges of promoting consumer (co-)ownership in the countries under consideration against the background of the previous two sections on the promotion of RES and market integration. We provide an overview of relevant regulatory and support measures for self-consumption in Table 30.1 combining two approaches: one focusing on prices (with regard to RES generation in general and self-consumption where applicable) and one focusing on regulatory measures for self-consumers or consumer (co-)ownership. Chapters 5 and 28 highlighted that the drivers for participating in prosumership and (co-)ownership models are diverse and not necessarily motivated by economic factors like profitability, and showed a broad variety of prosumership and (co-)ownership models. This induces that there is not a one-size-fits-all regulatory framework and that different forms and levels of support are the basis for an effective promotion. The recognition of a variety of actors, organisational forms and specific measures to ensure a level-playing field taking transaction costs into account are necessary to ensure the promotion of RES and a fortiori of (co-)ownership in a competitive market. Against this background, the indicators outlined in Table 30.1 are organised as follows: *Column B* lists the types of support schemes and their allocation (restricted to operating and excluding initial investment aid); *Column C* focuses on net metering; *Column D* assesses if energy collective schemes or (co-)ownership enjoy recognition (implicit or explicit); *Column E* lists specific regulatory measures.

Table 30.1 Regulations and support for self-consumption in the countries under investigation

A: Country	B: Types and allocation of support schemes	C: Net metering policy	D: Recognition of collective schemes or (co-)ownership	E: Specific regulatory measures (+facilitating/–hindering)
Czech Republic	FIT (phase-out) for small installations	No	No	+ Exemption from connection permit and generation licence for micro-installations
Denmark	FIT or FIP (except PV); tenders	Yes	Yes	No
France	FIT (phase-out) or FIP	No	Yes	+ Specific grid tariffs for small installation, exemption for collective consumption schemes in operating rules
Germany	FIT (phase-out) and FIP; tenders	No	Yes	+ Specific rules for collective schemes in tenders, restricted exemptions to RE surcharge for self-consumers
Italy	FIT or FIP for small installations (except PV)	Yes	Yes	+ Connection, license exemption for small installations or non-commercial producers
The Netherlands	No support schemes	Yes	Yes	+ Supply permit exemption
Poland	FIT or premiums in tenders	Yes	No	– Connection fees, licensing for cooperatives, permit
England/Wales	FIT (phase-out)	No	Yes	No
Scotland	FIT (phase-out)	No	Yes	+ Connection procedure

(*continued*)

Table 30.1 (continued)

A: Country	B: Types and allocation of support schemes	C: Net metering policy	D: Recognition of collective schemes or (co-)ownership	E: Specific regulatory measures (+facilitating/–hindering)
Spain	FIT or FIP (phase-out); tenders	No (but legally possible since 10/2018)	No before 10/2018; Yes after 10/2018	+ since 10/2018: right to self-consumption and self-consumption-sharing, administrative and technical simplification for small installations – before 10/2018: compulsory registration and additional taxation ("solar tax")
Switzerland	FIT (phase-out) or FIP	No	Yes	+ Obligation of purchase the excess, exemption from direct marketing – Costly measuring requirement
California	FIT	Yes	Yes	No
Canada	FIT	Yes	Yes	No
Brazil	FIT (phase-out); tender	Yes	Yes	No
Chile	No support schemes; tender	Yes	Yes	+ Total or partial exemption from grid costs for small installations, obligation of connection
India	Quota or FIT; tender	Yes	Yes	+ Exemption from connection permit, licence
Pakistan	FIT; tender	Yes	Yes	No
Japan	FIT	No	Yes (but de facto prohibition of energy cooperatives)	+ Exemption from direct marketing – All other rules concerning grid connection or feed-in are detrimental for prosumers

Source: Own elaboration from country chapters

(1) *A level-playing field*: Considering that consumer investment projects are mostly small- to medium-scale, and often motivated by non-economic (local element, social interactions, environmentalism, etc.) or non-commercial factors (saving consumption costs but not primarily selling), they tend to bear higher transaction costs than conventional actors. Clear, simple, and stable rules are important for such actors to consider investment in the first place. Heterogeneous and heavy administrative and operating requirements as well as a long project development phase are important barriers to consumer (co-)ownership and the implementation of the 2020 strategy (European Economic and Social Committee 2015; Welsch et al. 2017). Recognition of the specificity of consumer investment, individually, collectively or as co-owners, in the legislation is a first step (see Column D). This can be done explicitly by introducing a definition of those new actors or implicitly by enacting specific rules (Column E) under certain conditions, like small capacity and spatial restriction. While almost all analysed countries recognise explicitly or implicitly individual consumer ownership, the picture is somewhat unclear for collective or (co-)ownership schemes. The recognition is sometimes explicit, in France, Germany, Denmark, Switzerland, Pakistan, Brazil, California, and so on. Sometimes it is implicit by relying on the already existing cooperative movement and regulation, in Poland, Czech Republic, Italy, Chile, and so on; however, in a few cases, namely in Japan RE cooperatives are de jure prohibited. Some European countries not covered in this book recently adopted comprehensive legislation, for example, Greece in January 2018.[15]

Specific rules for consumer ownership concern mostly grid interaction. They are often beneficial, especially for individuals/small installations which are exempted from specific requirements, enjoy simplified procedures or reduced costs. However, they are also a few examples

[15] The law provides with guidance on the role of citizens in the energy transition, insisting on the social economy and energy poverty aspects as well as the role of municipalities in particular on the many islands, includes new technologies (storage) and innovative approaches as virtual power sharing investments. For more information, go to https://www.rescoop.eu/blog/energy-communities-in-greece-new-legislation.

highlighting increased administrative or financial burden. In Spain, prosumers suffered from additional taxation (until 2018), and in Switzerland, they have to disburse a prohibitive amount of money to comply with measuring requirements. Concerning long-term price signals, the move from guaranteed tariffs to market-based remuneration and to administrative allocation in tenders is observed in almost every country under consideration. This is especially true for the EU countries as consequence of the European state aid guidelines of 2014. The impact of this trend on the consumer investment has already been highlighted in this book (see Chap. 1 and Sect. 30.1 amongst others). Furthermore, the high upfront capital costs and the difficulties to access conventional financing exclude a large share of potential consumer-investors. Investing aid—as opposed to operating aid such as guaranteed tariffs—or the existence of innovative business models was not made into a category of this table to beware of complexity. But this remains a key point and the premises of this book (see in particular Chap. 4 on Energy Justice and Chap. 8 on the Consumer Stock Ownership Plan (CSOP) as inclusive financing technique) to enter into the second phase of the energy transition.

In summary, market-based long-term price signals, complexity of regulatory framework, and application of competitive market rules without exemptions are often considered as hampering consumer investment. The fact that rules (or their exemptions) are moved from the RED to the IEM in the Clean Energy Package is a sign that consumer investment in RES is increasingly being considered with a market approach. There are, however, uncertainties on what consumer (co-)ownership is really capable of. While it is important to keep a variety of actors and a level-playing field, the levelling part may not be as demanding and inefficient from a cost or system perspective.

(2) *Remuneration*: Producers and consumers behave according to price and financial incentives. Prosumers are reactive to retail prices as consumers and to the remuneration of the electricity fed into the grid as producers. By combining price signals of both sides, they are by definition flexible, provided those price signals are not distorted (see Sect. 30.2.2). More general, the potential of prosumership is boosted by two factors: (1) vRES achieved grid parity and having marginal costs of pro-

duction close to zero are cost-competitive (European Commission 2015d); (2) self-generated energy is on average cheaper than energy bought on the retail market (Zachmann 2011). However, price differential plays an important part in cases of peaks and slumps for incentivising demand-flexibility. Although the EC favours self-consumption, selling electricity to the grid is still a crucial driver for refinancing RE investments and demand-flexibility (Roth et al. 2018). The EC estimates that commercial consumers can achieve a rate of self-consumption of between 50 and 80 per cent since business activity and consumption are aligned with on-site production (SWD141 European Commission 2015d). This is especially true for PV because of parallel daily patterns of production and consumption (see Fig. 30.4). For residential consumers, the estimated self-consumption rate ranges between the base line scenario of 30 per cent and a scenario with flexibility measures such as Information and Communication Technologies (ICT) and co-generation like power-to-heat and cooling available of up to 70 per cent (SWD141 European Commission 2015d). Furthermore, commercial prosumers, especially SMEs, are increasingly present on the RE markets with demand load profiles that are complementary to those of private households from a system stability perspective (see Fig. 30.4 and Chap. 29). Here again business models that permit combining investments of private individuals, SMEs and municipalities as the CSOP will be

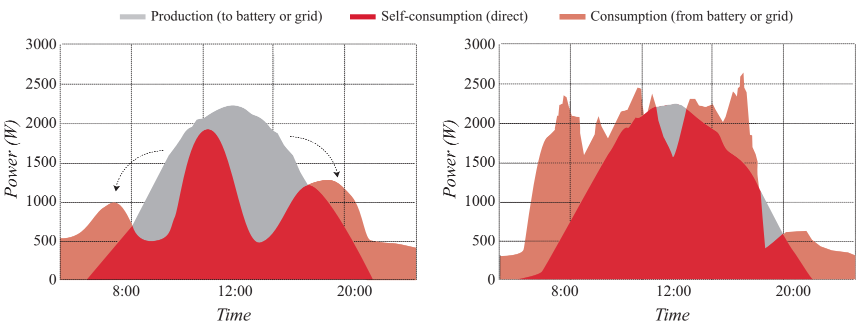

Fig. 30.4 Effects of electrical storage on direct self-consumption for prosumers: residential consumption left side; commercial consumption right side. Source: Fronius, SMA 2015

important to facilitate RE (co-)ownership. Therefore, price components in particular network charges (see Sect. 29.1) and remuneration need to be adapted accordingly.

Network charges for prosumers (for details see Sect. 29.1 and Table 29.1)—Because increasing market penetration of RE drives up the costs of network operators, there is growing pressure to adapt network tariffs to changing conditions. The design of network charges has an influence on consumption behaviour. For this reason, although total or partial exemption from network charges for prosumers may constitute a possible support measure, it risks to lose an important steering mechanism for demand-flexibility. Exemption from grid costs exists for example in France and Chile (Column E) but also in other European countries not covered by this book, such as Croatia or Malta (European Commission 2015b).

Remuneration of electricity fed into the grid for prosumers—Three options to design support schemes are available: (1) whether schemes are generation or capacity based, (2) volume or price based, and (3) whether support is total or partial (Ecofys et al. 2014). Different models for remuneration and price signals like FITs, premiums, and quotas exist with different impact on production behaviour as well as on the decision between self-consumption and selling. The most important criterion is whether support is total or partial.

Feed-in Tariffs (FITs) are long-term purchase agreements over 10–25 years for the supply of RE into the grid sold on the market by the grid operator with the producer receiving the fixed tariff and being freed of direct marketing requirements (European Economic and Social Committee 2015). As prices are guaranteed, regulated, and disconnected from market functioning (Ecofys et al. 2014) prosumers do not receive market signals indicating whether self-consumption or sale is economically more feasible. Nevertheless, with remuneration above the market price and without fluctuation, there is a higher probability of feeding electricity into the grid in periods of negative prices (Ecofys et al. 2014) congesting the network while in periods of low supply and high prices, feeding into the grid would be beneficial for the network; these effects are, however, ambiguous and difficult to control. An advantage of FITs in this context is that they can be adapted to be more flexible by removing support in periods of negative price or be designed to be dependent on the load by linking them to an peak/off-peak classification or residual demand (Ecofys et al. 2014).

Feed-in Premiums (FIPs) and quotas on the other hand are a partially guaranteed tariff, where the variable market price is complemented by an additional premium. This additional revenue covers the costs of direct marketing and can be fixed (fixed premiums) or variable (floating premiums and quotas) and can be restrained by caps and/or floors (Ecofys et al. 2014). Quotas combine an electricity price and a certificate price, which are both market based. Since volume targets are set, the price is therefore the variable of adjustment and price signal. All in all, quotas allow better competitive price formation than premiums. With the market price being part of the remuneration they imply a price signal for prosumers to be demand-flexible.

Self-consumption and net metering—In net metering approaches the grid functions as a back-up storage for the prosumer. The exact quantity of electricity fed into the grid can be taken out of the grid at a later time while paying only the grid costs (European Economic and Social Committee 2015). While—during a set period of time: monthly, hourly, or even instant in the case of Denmark—net metering is the physical compensation for production volume exceeding self-consumption, that is, the meter turns back, net billing is the economical compensation of the production value over the self-consumption value. The remuneration can be the market price or combined with support schemes such as FITs or FIP (see above). The compensation often is at a retail price exceeding the value of generation to the electricity system (SWD141 European Commission 2015b) but can also be less than the price paid for energy consumed from the grid.

While net metering is beneficial to the prosumer it is problematic for the energy system as a whole, above all when large deployment levels are reached (SWD141 European Commission 2015b). Price variation and grid constraints, that is, peaks or slumps are not taken into account and thus, as with FITs, price signals and demand-flexibility are impaired. Therefore, a number of restrictions and adaptations have been implemented to make net metering "grid-friendlier" and more flexible. The EESC promotes the combination of FITs with net metering to provide small investors with guaranteed fixed prices while at the same time benefitting from grid flexibility measures (European Economic and Social Committee 2015). In many countries, net metering is restricted in time (Denmark) or to small-scale projects (Netherlands, Belgium) or by evaluating at wholesale price the electricity fed in, which is then paid or credited to the prosumer (Italy) (SWD141 European Commission 2015b). Finally, net metering requires that the owner of the RE system and the self-consumer are identical while it is not possible when the plant's owner is a third party (SWD141 European Commission 2015b). Exceptions are virtual net metering, the "postal code" approach in the Netherlands or the new German tenant electricity model (see the respective country reports). In Czech Republic, net metering does not officially exist. However, in practice, distributors provide preferential tariffs for self-consumers.

During the trilogue concerning the recast of the RED (February to June 2018), that is, the negotiation between the two co-legislators (European Parliament and Council of the EU) moderated by the European Commission, net metering and exemption from grid costs were one of the primary bones of contention. However, the final compromise (for details see Sect. 30.3) stresses that prosumers are the link for reconnecting market integration and vRES promotion, both as demand-flexible consumers and potential new investors. Their potential, however, can only be harnessed conditional on a market design offering a level-playing field and allowing for dynamic market-based price signals that have the potential to kick-start demand response and foster a stable but adaptable framework for long-term investments. Further advantages of prosumership include ownership as a learning process for energy efficiency (see Chap. 3) and addressing energy poverty issues in a deregulated market through energy efficiency (European Commission 2015b) and savings from self-consumption (European Commission 2015d). Figure 30.5 illustrates the interdependency of (1) investments in vRES, (2) vRES' market integration, and (3) demand-flexibility under the new market design that promotes prosumership and consumer (co-)ownership and sees the consumer at the heart of the energy markets.

However, merely stating the theoretical arguments and advantages of prosumership for achieving other goals does not address challenges con-

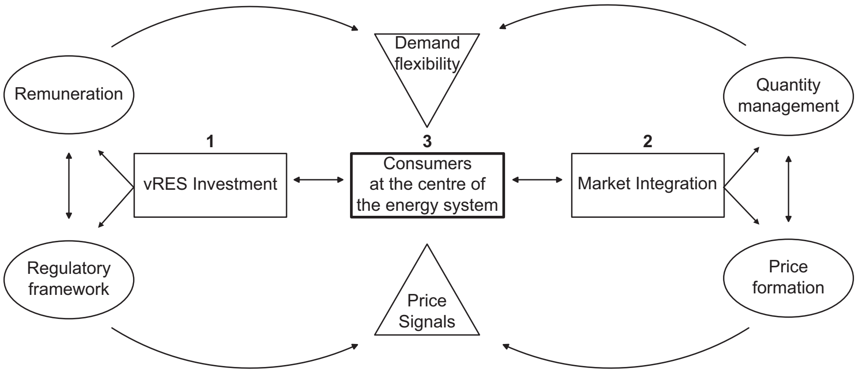

Fig. 30.5 Overview of a new market design addressing vRES integration and investment through promotion of prosumership/consumer (co-)ownership

cerning the promotion of prosumership, such as competitiveness, which can sometimes contradict those primary goals. Considering that storage technology is not yet feasible, prosumers have to choose between self-consumption and sale. One of the goals of a new market design integrating vRES production efficiently is to make prosumers demand responsive and to avoid network congestion.

30.3 Policy Options to Support Consumer (Co-)Ownership: The Example of the EU Clean Energy Package

In order to implement the approach described above, the European Commission published the Clean Energy Package for all Europeans[16] in November 2016. The Directive on Energy Performance on Buildings was adopted and published in the Official Journal. As of September 2018, the proposals on the Energy Efficiency Directive, the RED II and the

[16] Over 1000 pages: eight proposals of legislation covering energy policy governance, RE, EE, energy performance of buildings, electricity internal market, cooperation of energy regulators, innovation, and so on. For more information on the content and state of play, go to https://ec.europa.eu/energy/en/topics/energy-strategy-and-energy-union/clean-energy-all-europeans.

Governance Regulation reached political agreement in the inter-institutional negotiations (so-called Trilogue); the negotiations on the IEM Regulation (IEMR) and Directive (IEMD), however, had just started. Furthermore, the Energy State Aid Guidelines for the period 2020-2030 containing rules on support schemes and tenders were under revision and the final national energy and climate plans are scheduled to be published by the end of 2019 (drafts by December 2018).

Going back on what made the first RED a success, namely strong governance tools to ensure long-term signals and regulatory stability, the Clean Energy Package takes a step back: (1) instead of national binding targets a binding EU-wide RES share target for 2030 is set to 32 per cent (along with a reduction of 40 per cent of Greenhouse Gas and 32.5 per cent for energy efficiency savings); (2) the level of 32 per cent is an improvement from the 2014 European council decision of 27 per cent but still coming short, which could be corrected by using the planned upward review clause in 2023; (3) the governance tools (national action plans, reporting, and monitoring) are not set in the RED anymore but in a specific governance regulation, which extends the reporting requirement, like including indicators on consumer (co-)ownership if applicable (Article 18 Governance regulation), and also include a corrective mechanism should Member States strategies diverge from the collective path (European Commission 2018a, b). Consumer (co-)ownership received explicit recognition of its crucial role—in terms of fighting energy poverty, increasing acceptance, fostering local development, incentivising demand-flexibility, and so on—and of its rights and duties in the recitals 52 to 55. But, more importantly, it includes clear definitions (Art. 2 RED II) and two dedicated articles (Arts. 21 and 22 RED II). Figure 30.6 provides an overview.

To sum up, consumers, individually (households and non-energy SMEs), collectively (tenant electricity) or in communities (cooperatives and other business models), have the right to consume, store, or sell energy generated on their premises. It also invites the Member States to provide an "enabling framework" on the basis of an assessment of financing, administrative, and regulatory barriers as well as discrimination in procedures or charges concerning support schemes, grid interaction, and market rules. This will be integrated to the national reports and actions plans mandated by the governance regulation. Finally, the RED II emphasises in its recitals

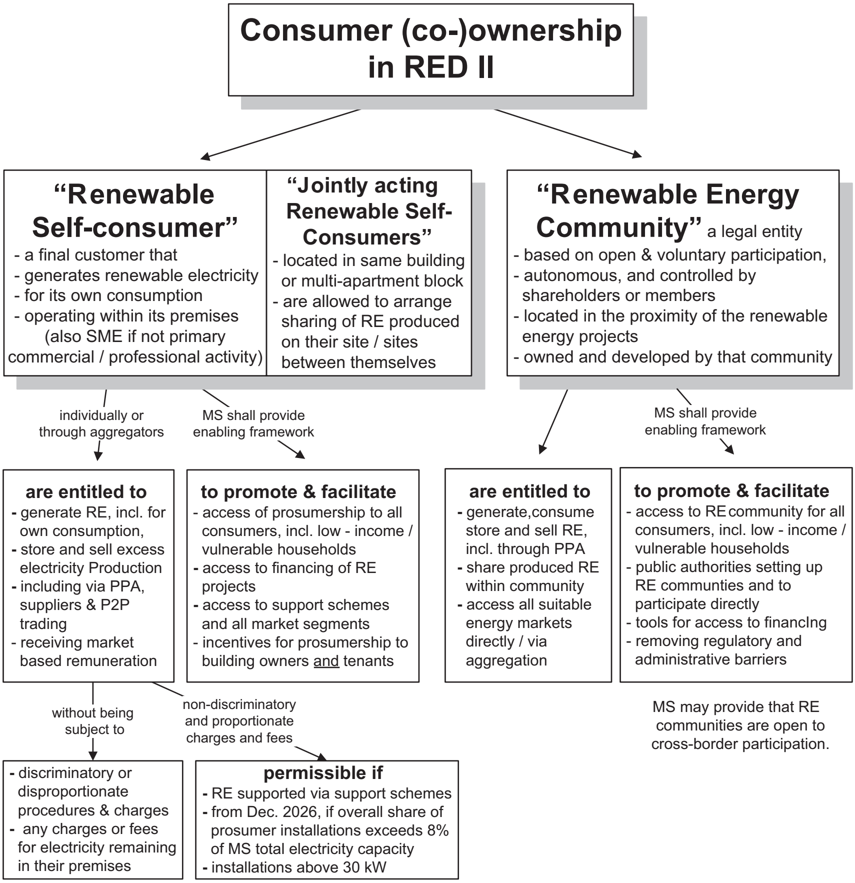

Fig. 30.6 Overview of the RED II regulation with regard to consumer (co-) ownership. Source: Own elaboration after (Council of the EU (SG) 2018)

that "[t]he specific characteristics of local renewable energy communities in terms of size, ownership structure and the number of projects can hamper their competition on equal footing with large—scale players, namely competitors with larger projects or portfolios". Such the directive recognises the possibility of preferential rules for consumer (co-)owned projects in coherence with the general principle of equality in EU law stating that "similar situations should be treated equally, while dissimilar situations can be treated differently". The independence of such local renewable energy is in particular safeguarded by referring to the principle of autonomy stemming from the cooperative world (see Chap. 7 on RE cooperatives).

Interestingly, the final oppositions against the RED II proposal concentrated inter alia around the level of the RE target ambition and on framework for consumer (co-)ownership with the result that they were negotiated against each other (Council of the European Union, 2018c). While the European Parliament and the European Commission adopted a progressive position, the Council was more reserved, insisting that those new actors have not only rights but also obligations towards the system. In the end, it were the recent changes in the Italian and Spanish governments becoming more favourable of prosumership, and the strong resistance of Germany—giving up its reputation as front-runner—against the target that somewhat unexpectedly tilted the balance towards a strong framework for consumer (co-)ownership against a lower target (Euractiv and Keating 2018; Euractiv et al. 2018). However, many proponents of the energy transition actually rejoice because they believe that systemic change is more important and that with the right framework conditions it will actually be easy to exceed the target. In October 2018, the Spanish government anticipated the transposition of the RED II promulgating law (Act 15/2018) that promotes prosumership and removes obstacles to consumer (co-)ownership (see Chap. 19).

However, a large part of the concrete market rules applicable will be defined by the IEMD and IEMR, still in negotiation between the European Commission, Parliament and Council. As of September 2018 (Council of the European Union, 2018a), all three institutions foresee derogations from fundamental market rules for small installations and demonstration projects for innovative technologies "to avoid unnecessary administrative burden for certain actors, in particular households and SMEs" (recital 11 IEMR). This concerns for example balancing responsibility (Art. 4 IEMR) and market-based dispatch (Art. 11 IEMR). The IEMD defines the "active consumer" (Art. 15) and the (local) "energy community" (Art. 16) reflecting the RED II definitions of "renewable self-consumer" and "renewable energy community" (Council of the European Union, 2018b). Potential dissent between the European Parliament and the Commission on the on side and and the Council on the other regards a) the exemption capacity threshold for small installations (Arts. 4, 11 IEMR), b) cost-reflective network charges (Art. 16 IEMD), and c) whether energy communities have to be local or not (Arts. 2 and 16 IEMD). The legislative schedule foresees the IEM Trilogue negotiation to be closed until the end of 2018 and the adoption of the whole package, that is, IEMD and IEMR, RED II, Energy Efficiency Directive as well as Governance Directive before the European elections in May 2019. After that, Member States will still have some room for manoeuver in the transposition of the directives 18 months after their entry in force, that is, by the end of 2020.

30.4 Conclusions

An optimal market design will seek to avoid both, an oligopoly with concentrated ownership in the hands of a few detrimental to competition as well as a fragmented market with a plethora of small players driving up transaction costs and impeding governance/system balancing (see Sect. 1.2.2). While thus a future market design should preserve the plurality of actors on the energy markets enabling diversity in prosumership—including SMEs, small-scale citizen projects, and individual producers with for example rooftop PV installations—it has to ensure proper market integration (see also Chap. 1). This involves contradictory goals and entails a series of trade-offs: (1) *policy efficiency and simplicity*: integrating new (and most of the time small and inexperienced) actors in a complex setting requires an efficient but simple framework to reduce transaction costs, for example, concerning balancing forecast responsibilities (Ecofys et al. 2014) and allocation schemes like tenders (Ecofys et al. 2014); (2) *predictability and flexibility*: support schemes should be predictable both for investors and public finances but should be flexible for adapting to evolving market conditions (Ecofys et al. 2014); (3) *sharing of benefits and costs*: exemptions for some consumers lead to a higher end-price supported by the remaining consumers, which threatens their acceptance of vRES (Ecofys et al. 2014).

These trade-offs touch upon particular interests of different actors that may be conflicting like those for example of consumers as (co-)owners on the one side and grid operators and other final end consumers on the other side. One way to reconcile these interests and align them with EU regulatory policy is the support and deployment of innovative organisational and contractual arrangements that would allow to pool and scale RE investments (co-)owned by consumers while opening them to combinations of municipal or commercial investments. An example of such an innovative financing concept is the CSOP discussed in Chapters 8 and 9. It seems furthermore clear that brokering between different actors—incumbent and new—their interest and their roles will become increasingly complex. Creating a level-playing field for RES and self-consumption to compete against other generation sources or flexibility measures in a non-discriminatory manner is important but meets opposition from incumbent actors fearing adverse consequences on their market position. Crucial in this debate is to determine who is responsible for overall system stability and at what cost as any economic inefficiency directly impacts retail electricity prices consumers pay (European Commission 2015b; Friedrich Ebert Stiftung et al. 2016).

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31

Conclusions: The Role of Consumer (Co-)Ownership in the Energy Transition

Jens Lowitzsch

Consumer ownership of renewable energy (RE) is essential to the overall success of the energy transition. Politicians across the planet are discovering its power to make energy infrastructure projects publicly acceptable. In some cases this has even led to compulsory participation schemes, for example, in Denmark and Germany. We also are witnessing demand for consumer participation by more and more citizens concerned with distributive and energy justice. Countless grassroots initiatives rising across the board—some at the municipal level, some led by individuals and yet others by organised local citizens—testify to the rising awareness of the necessity of shifting away from fossil to renewable energy sources (RES) to arrest global warming. But, perhaps more important, there are sound economic reasons for broad public ownership in RE, which this book explains. These arguments relate to the structural differences between renewables and fossils but also to the new role the active consumer is to play at the heart of the energy markets.

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We are now confronted with the task of developing, implementing and rolling out business models that broaden capital participation of consumers in RE. The challenge is to advance to economies of scale while retaining the benefits of individual consumer participation. This implies a corresponding regulatory framework supported by a well-balanced incentive system and flanked by a concerted set of coherent measures to promote and facilitate the integration of the consumer-owners (Roth et al. 2018). However, a level playing field providing equal opportunities for all actors also implies a fair share in the burden of the Energy Transition. Inclusiveness—often merely a buzzword—is crucial as the success of this undertaking requires a joint effort of society as a whole and will deeply affect our behaviour and routines in everyday life (Rommel et al. 2018). Only if all strata of society are taken on board can we expect citizens to accept these changes as well as the technological infrastructure involved. We must thus seek to avoid a division of society in well-off prosumers deserting from the public grid and benefiting from returns from RE-ownership on the one side and vulnerable consumers confronted with rising energy prices left with a growing share in maintaining the network cost unable to afford basic energy needs on the other side.

Nonetheless, a sustainable economy can most probably be achieved only by measures that make more efficient use of resources, doing more with less, and—while decreasing our dependency on growth—at the same time downsize environmentally harmful production. It will require rational use of existing resources instead of growth for the sake of growth. Although maybe smaller and less dynamic, the sustainable economy will be many times more efficient and also far less wasteful than those we have now (Jackson 2009; Seyfang 2009). Moreover, many products could be produced in a nature-benign way and become a part of a new type of closed circle economy. John Maynard Keynes himself considered a steady-state economy as the foundation for a potential "good society" and argued for consistent, long-lasting energy regimes, a postulate later included in the Havana Charta of the UN in 1949. In this context the problem of "the Tragedy of the Commons" (Hardin 1968), in which freely available, but limited resources are not efficiently used, but are threatened by overuse, is foremost related to fossil fuels. In contrast, with regard to RES a potential to harness "intelligent growth" might exist (Fücks 2013). This, however, will require foresighted policy-makers, citizens and their municipalities aware of the environmental and social dimension of the Energy Transition as well as committed economic leaders.

Against this background the following conclusions sum up the findings of this book and give an outlook at the enterprise that now lies before us.

31.1 Where Do We Start From?

While established energy companies often are still "locked-in" to fossil fuel-based infrastructures which they find difficult to divest from, citizens as energy consumers, co-investors and producers of renewables have triggered the rise of the notion of the "prosumer" over the last decade in an astounding short period of time. However, drivers and political motivations underlying the Energy Transition often are heterogeneous including conflicting elements resulting in discrepancies between the declared goals regarding the deployment of RE and the actually implemented energy policies (see Chap. 2). We observe that while declared aims—including, for example, prosumership—are easy to identify the chances for realisation need to be carefully evaluated against the background of the current challenges and the driving forces behind policy making which show a strong path dependency.

Despite impressive declarations of intent for the deployment of RES and the set RE targets when only looking at the facts the picture is still sobering: even a pioneering country like Denmark recognised as front runner with its 68 per cent of RE and waste in electricity generation had merely a share of 24 per cent of RE in total energy production. In short, the Energy Transition is all but straightforward and most of the countries under consideration show a similar picture: (1) the energy mix with regard to total energy production is still dominated by conventional fossil fuels and nuclear power and is sometimes driven by dirty imports; (2) the share of RE in primary energy consumption is low; (3) only the share of RE in total electricity consumption is usually higher, although "unsustainable" RES may be included.

At the same time energy/fuel poverty remains a problem in the majority of countries under consideration while the absence of a common definition stresses that the problem is not sufficiently acknowledged. In the EU, less than a third of the Member States directly recognise the condition of energy/fuel poverty and treat it as a problem distinct from the protection of vulnerable consumers in their national policies. This problem is exacerbated with a disproportional burden of RE surcharges on low-income households in relation to household revenue (IdW 2012). Across the board, when recognised, the condition is addressed predominantly in social policies which mainly deal with supportive subsidies. Policies which actually encourage behavioural changes within vulnerable groups or which transform them into owners of RES providing them with an additional source of income are the exception.

31.2 Active Consumers as a Driver for the Energy Transition

The analysis of the best practice examples from the countries presented in this book shows that both “place”, used here as a synonym for “identity”, and “interest” meaning “common interest”, strongly influence the design of successful RE consumer ownership models. While “identity” and “interest” are deeply rooted in geography and culture, the underlying business models, understood as organisational and contractual arrangements, depend on policy and procedure and thus can adapt to the former. The main question in this context is how to structure the energy transition as a level playing field so that all citizens have the same opportunity to acquire an ownership stake in RES. Both energy-impoverished households and women are underrepresented (see Chap. 3) among consumer-owners for reasons ranging from socio-economic like lower education and general literacy in the case of low-income households and long-term unemployed to psychological and behaviour-based issues for women. Energy justice recognises that the different groups in society confront different barriers to consumer ownership ranging from cultural tradition over economic opportunity to the geographic situation. In this respect we observe that:

1. It is their contractual and organisational arrangements that link business models to the larger social issues of energy democracy and distributive and social justice. Not only location, rural or metropolitan, but attitudes, motivations and differences in economic status that affect the ability to acquire ownership in RE installations within a given community as well as the relationship with strategic partners must be taken into consideration.
2. For economically disadvantaged consumers, questions of energy efficiency or RE-ownership will typically be secondary to more immediate problems such as adequate housing, food, health, education or childcare. These short-term needs pre-empt attention from long-term issues such as acquiring RE-ownership. But becoming an owner of a RE-installation may require a period of apprenticeship, especially when complex technical issues are involved or the opportunities of participation are unequal because of educational and economic differences.

Against this background, trusteed plans like the Consumer Stock Ownership Plan (CSOP) not only allow participating consumers to speak with one voice vis-à-vis other shareholders such as a municipality or a commercial investor after an internal decision-making process supported by a professional trustee. They also level the playing field and provide disadvantaged groups with genuine equality of opportunity. With these considerations in mind, we advocate the CSOP as a technique for financing decentralised RE production. This financial innovation links energy production with energy consumption at the household level; individuals and families are, on the one hand, as shareholders of a utility, producers of energy, and, on the other hand, consumers of the energy they, through their ownership, have produced. This concept is a financial realisation of the traditional cooperative principle of "production for use". This technique could be central to a remodelled European energy policy, as well as to European development cooperation with, for example, the nations of North Africa.

31.3 The Way to a Well-Balanced Legislative Framework for RE Consumer (Co-)Ownership

As the discussion transcends ideological grounds and centres on the question of how to most efficiently achieve the Energy Transition, policy-makers are more and more perceptive to arguments in favour of consumer ownership in RE and have begun to react. We observe a broad variety of policy initiatives resulting in legislative support for RE consumer (co-) ownership and prosumage. While the majority of these regulations remain piecemeal, some indicate the way to a coherent legal framework for consumer ownership in RE. The most prominent and also most recent example for such an enabling framework is the 2018 recast of the Renewable Energy Directive (RED II) as part of the Clean Energy Package of the European Union. The transposition of the RED II into national Law until 2021 introduces a legal framework for consumer (co-) ownership in all EU Member States:

1. Consumers, (1) individually, that is, households and non-energy SMEs (Art. 21 RED II), (2) collectively, for example in tenant electricity projects (Art. 21 RED II), or (3) in communities organised as cooperatives, CSOPs and other business models (Art. 22 RED II) will have the right to consume, store or sell RE generated on their premises. The directive introduces clear definitions in Article 2.
2. RED II also obliges the Member States to provide an enabling framework for local "renewable energy communities". Defining citizen's rights and duties the directive links prosumership to such different topics as fighting energy poverty, increasing acceptance, fostering local development and incentivising demand-flexibility.
3. Member States are called on to assess "the possibility to enable participation by households that might otherwise not be able to participate, including vulnerable consumers and tenants".

Although this legislative initiative paves the way to a coherent EU-wide legal framework, it still needs to be complemented by the Internal Electricity Market Regulation (IEMR) and Directive (IEMD), transposed into national law and subsequently filled with implementing provisions. Taking into account the complexity of the issues involved as described in the two policy chapters of this book (Chaps. 29 and 30) consistent solutions are much needed, solutions that coherently link the role of the prosumer with the other agents on tomorrow's energy markets. The—sometimes conflicting—goals of this process require trade-offs and pose tasks in three areas, namely (1) policy efficiency and simplicity, (2) predictability and flexibility, and (3) the sharing of benefits and costs. To reduce transaction costs associated with integrating new, typically small- or medium-sized actors in a complex policy setting demands an efficient but simple framework. While support schemes should be predictable both for investors and for public finances, they need to adapt flexible to evolving market conditions. Exemptions from fees and levies for some consumers lead to higher end-prices for the remaining threatening their acceptance of RE.

Thus, five important challenges remain:

1. Creating a coherent incentive system for RES and RE prosumage based on market-related price signals.
2. Designing a consistent structure of network charges permitting adaptation of network tariffs to changing conditions with a view to their influence on consumption behaviour.
3. Market integration of consumer (co-)owned RE projects while avoiding sub-scale investments, allowing pooling of local projects and partnerships with municipalities.
4. Integration self-consumption and net metering into a future decentralised electricity storage system including sector coupling and e-mobility.
5. Regulating aggregation and direct marketing including peer-to-peer as well as the challenges of digitalisation such as smart grids, micro grids and blockchain technology.

31.4 Outlook: Future Tasks for Research and Policy

A society based on a paradigm that tends to overload the capacity of its ecosystem must inevitably change in time or perish. The history of the mythical Easter Island Rapa Nui illustrates the doom that awaits a people who destroys its own habitat. In the year 800, when Polynesian settlers arrived, Rapa Nui was entirely wooded with palms. The islanders began to cut down the trees, at first for farmland and firewood, then to build canoes and houses, and finally to manufacture sledges for transporting their enormous stone statues to the coast. At some point a fierce competition broke out between clans and tribes to build statues even more monumental. Some 850 years later, the last tree fell. Erosion set in, bringing agriculture to a stop. Materials needed for making canoes to hunt tunas were no longer to be had. Hunger set in; then war, and an ancient once-thriving civilization came to its end.

The crucial question, thus, is not so much whether to downsize our economies but to determine how sustainability can be achieved without causing more environmental harm. Nor will mere substitution of processes or products be sufficient. The changes required must also repair the damage that has been done. Climate change illustrates the problem. If energy consumption were arrested at the current level, global warming and resource depletion would only be slowed down, not stopped. Reducing consumption and waste by prolonging the lifecycle of products, for example, is equally important. These changes need not have a negative impact on the quality of life, which is an important dimension, as sustainability also depends on lifestyle changes acceptable to people. However, they require us to adapt both energy consumption as well as energy production when employing RES. This is a task for both research and policy.

It should, therefore, be recalled that in the EU of the money spent on energy research over the past decades only about one euro out of ten went to renewables while nuclear energy was in the focus with almost two thirds of spending (EC/Ecofys 2014).[1] The successful adoption of the Clean Energy Package should be a welcome occasion to set new priorities in energy research. This is of particular importance as estimates of the worldwide energy investment stock for 2040 by energy sources see renewables dominated by wind and solar with USD 7.4 trillion far ahead of

[1] Results of a cross-country study in 19 EU Member States on expenditure for research, development and demonstration in energy between 1974 and 2007 (EC/Ecofys 2014).

fossils with merely USD 2.8 trillion (Frankfurt School 2017; IEA 2015). With regard to subsidies this shift to RE long overdue has already somewhat happened: in 2012 direct subsidies for RE amounted to EUR 40.3 billion while those for fossil and nuclear energy was only at EUR 22.9 billion plus EUR 13.7 billion additional free EU emission allowances (ENERGY ATLAS 2018; EC/Ecofys 2014). At the same time, in 2016, Europe already created more than a million jobs in RE (IRENA 2017). In the light of these figures and the potential environmental impact of ill-advised investments it is even more important to develop a sustainable strategy towards a carbon-free economy.

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Correction to: Consumer (Co-)Ownership in Renewables in California (USA)

Felicia van Tulder, Sharon Klein, and Erika Morgan

Correction to:

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The original chapter was inadvertently published with incorrect affiliation of one of the authors 'E. Morgan'. The affiliation has been corrected in the chapter as below:

E. Morgan
California Alliance for Community Energy, San Diego, CA, USA

Changed to:
E. Morgan
Energetic Management Associates, San Diego, CA, USA

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