Study on mapping of regulatory frameworks and barriers for individual and collective renewables self-consumption in EU Member States

Annex A – Case studies

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Annex A – Pilot Case Studies

1. Improvement of conditions for households' self-consumption in Latvia

Title	Improvement of conditions for households' self-consumption in Latvia
Location	Latvia
PV production	Gross electricity production from solar PV: 0.027 TWh
General barriers addressed by the case study	Economic & financial barriers: Affordability of self-consumption technologies for average households; Technical barriers: Low maturity and cost-competitiveness of technologies; Challenges related to network operation; Institutional barrier: Complex and burdensome administrative and authorisation procedures for renewable energy projects
Type	Individual and collective self-consumption
Target sectors	Residential
Technologies	Solar PV, Smart meters
References	• Latvian National Energy and Climate Plan 2021-2030 lv_final_necp_main_en_0.pdf (europa.eu) • Latvian Recovery and Resilience Plan 2020 Latvia's recovery and resilience plan (europa.eu) • Latvian DSO Electricity Distribution Systems Development Plan 2022-2031 Attīstības plāns_SPRK_gala.pdf • Climate Action Network (2022). *Engaging citizens and local communities in the solar revolution*. Rooftop Solar PV Country Comparison Report. Rooftop-Solar-PV-Country-Comparision-Report-2.pdf (caneurope.org)
Contacts	• Latvian DSO 'Sadales Tikls': Alīna Kozlovska (Media and Communications Manager) alina.kozlovska@sadalestikls.lv • Ministry of Economics (also in charge of Energy): Department of Energy Financial Instruments – Gatis Slovs (Head of Department) gatis.silovs@em.gov.lv ; Ieva Plavina (Deputy Director of Department) Ieva.Plavina@em.gov.lv ; Ilze Eberharde (Deputy Director of Department) Ilze.Eberharde@em.gov.lv

1.1. General description

The uptake of self-consumption of households has for a long time been relatively low in Latvia. In 2020, 573 microgenerator connections (up to 11.1 kW) were registered (of which 98% used solar energy), with a total installed electrical capacity of 3.4 MW.[1] This represented only around 0.1% of the total electrical capacity in Latvia. However, over the last two years the total number of microgenerator connections has significantly increased, reaching 15,000 by June 2023, with a total production capacity surpassing 120 MW.[2]

[1] Lebedeva et al. (2021). *Analysis of Latvian Households' Potential Participation in the Energy Market as Prosumers.*
[2] https://sadalestikls.lv/en/preses-relizes/number-self-producing-electricity-households-latvia-reaches-15000

One of the main action lines of the Latvian NECP 2021-2030 is to promote economically justified self-generation and self-consumption of energy. This case study explores several measures that have been implemented in order to improve the conditions for households' self-consumption in Latvia. These administrative, technical and financial support measures can be divided into three different categories:

- Category 1 - Measures that incentivize the installation of solar PVs for self-consumption;
- Category 2 - Measures that incentivize individual and/or collective self-consumption (instead of exporting energy not self-consumed to the energy into the grid);
- Category 3 - Other incentives to simplify both.

All measures described below would fall into Category 1. Hence, this case study supports primarily the development of self-generation, rather than self-consumption.

Complete roll-out of smart meters

The government indicates that promoting self-consumption is impossible without the large-scale deployment of smart meters[3] as these allows consumers to fully participate in the market and value their flexibility. It also enables data sharing and increases awareness of consumers about their energy consumption. The Latvian DSO Sadales Tikls has committed to complete the smart meters roll out by 2023 for 98% of residential and commercial connections.[4] In May 2023, the DSO announced that it had finalized the implementation of the smart electricity metering program.[5] More than 1 million smart meters have been installed, representing around 99% of customer connection points. The remaining customers (around 15,000) will be contacted by the DSO to change their meters. Smart meters allow for remote and automated electricity metering, enabling the DSO to provide electricity market participants with various data services on consumed and generated energy with different reading frequencies (previous day, twice a day or even on hourly basis) and other benefits. The rollout of smart meters in Latvia has also allowed to improve the DSO's operational efficiency through reductions in necessary workforce (-500 FTEs), electricity losses (from 4.77% in 2014 to 3.67% in 2022, representing -4.5 TWh), and number of company vehicles (-226 cars).[6] The total cost of the smart metering program was € 44.5 million, with the cost to install a single smart meter equalling to € 40. This is one of the lowest costs compared to similar programs in other EU countries.[7]

It is important to indicate, however, that a correlation between the rollout of smart meters and the deployment of self-consumption does not seem to exist systematically. For example, in Germany, the rollout of smart meters is lagging[8] (0.32% metering points equipped with smart meters in 2021[9]) but the deployment of solar PV is booming. Smart meters are necessary for net billing from a single supply point, but for net metering old meters are sufficient (i.e. the meter will roll back when you export electricity). In Germany, owners of solar PV need to have a second meter that records how much is exported to the grid. Although smart meters are not a necessary condition for the development of self-consumption, they simplify the management of solar PV and allow to unlock demand-side flexibility potential of self-consumers.

Digitalisation of the electricity distribution network

In parallel to the rollout of smart meters, Sadales Tikls has foreseen to implement several projects to modernize, digitalise and automate the grid and to deliver new digital self-service solutions to customers as part of its Electricity Distribution Systems Development Plan 2022-2031, among which:

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[3] lv_final_necp_main_en_0.pdf (europa.eu)
[4] Rooftop-Solar-PV-Country-Comparision-Report-2.pdf (caneurope.org)
[5] Noslēdz viedo elektrības skaitītāju ieviešanu Latvijā: vairā... (sadalestikls.lv)
[6] Noslēdz viedo elektrības skaitītāju ieviešanu Latvijā: vairā... (sadalestikls.lv)
[7] *Ibid.*
[8] Germany is lagging behind as until 2018, the uptake of smart meters had stymied because of legal uncertainties and bureaucratic hurdles related to their deployment. (Source: Germany announces 'acceleration' of smart meter rollout – EURACTIV.com)
[9] The Smart Meter Rollout in Germany and Europe - FFE Website

- The development of a national energy data hub.[10] In this context, the DSO published the first open data set with anonymized smart metering data. These data are available at any time and free of charge on the DSO customer portal in order to stimulate the analysis of energy consumption patterns and increase energy efficiency. As per the DSO, more than 50% of customers have already accessed their data to keep track of their energy consumption or engage in energy management activities.[11] The communication of real-time data on generation, consumption and price signals to self-consumers can also contribute to facilitating collective self-consumption.[12] The transparency of data allows participants to adjust electricity consumption to local generation and enables load shifting.
- The establishment and development of a low-voltage grid management and control system allowing for a greater integration of self-consumption technologies, including the introduction of voltage level control and regulation equipment.[13]

From a broader perspective, the Latvian Recovery and Resilience plan aims to allocate € 80 million to the modernization of transmission and distribution grids in order to adapt to the new requirements of e-mobility and prosumerism. Early 2023, Sadales Tikls signed an agreement with the Latvia Ministry of Economy to draw € 49.1 million from the EU Recovery Fund for investments in the modernization of the electricity distribution system until 2026.[14] This amount will serve to implement projects such as the development of an IT system for smart electricity metering and the establishment distribution system connections to publicly available charging equipment for electric vehicles and microgeneration equipment (solar panels).

Support mechanism for households that generate their own electricity (net-metering system)

In addition to different public support programs which co-fund the purchase and installation of generation plants[15], Latvia has one support scheme to encourage households to participate in the energy market as prosumers – the Latvian net-metering system. It was introduced by Article 30 of the Electricity Market Law of 2014. In 2020, around 520 household self-consumers used the net metering system, representing a total capacity of 2.8 MW.[16] Given the significant increase in the number of microgenerator connections between 2020 and 2023, the number of participants to the net-metering system is likely to have increased as well but exact numbers are not publicly available.

This scheme allows households that produce their own electricity from renewable sources and inject the surplus of electricity into the grid to use a net-metering system. The latter allows them to accumulate generated electricity (in kWh) that has not been consumed, to use it during the year, paying only for the network tariffs (i.e. not the energy costs). In Latvia, electricity bills are composed of the following elements for every household:[17]

- Charges for electricity (i.e. the energy component);
- Network tariffs.

[10] Rooftop-Solar-PV-Country-Comparision-Report-2.pdf (caneurope.org)
[11] Noslēdz viedo elektrības skaitītāju ieviešanu Latvijā: vairā... (sadalestikls.lv)
[12] Final_collective_self_consumption_report_133b88bb28.pdf (solarpowereurope.org)
[13] Attsīstības plāns_SPRK_gala.pdf
[14] "Sadales tīkls" signs a contract for € 41.9 million. receiving the euro from the EU Recovery Fund | Ministry of Economics (em.gov.lv)
[15] These programs are not further addressed in this case study as investment support do not directly promote self-consumption, but rather self-generation.
[16] Lebedeva et al. (2021). *Analysis of Latvian Households' Potential Participation in the Energy Market as Prosumers.*
[17] download (em.gov.lv)

Textbox 1-1 The mandatory procurement mechanism (MPC)

Before January 2023, electricity bills in Latvia were also composed of the mandatory procurement component (MPC). The MPC is a public support mechanism to encourage the generation of electricity from renewable energy sources and efficient cogeneration. It accounted for 40% of the total retail electricity price and consisted of a fixed part (based on connection capacity) and a variable part (based on electricity consumed). Producers could sell the electricity produced through mandatory procurement.

The MPC was paid by all Latvian electricity consumers. The variable part of the MPC was determined in function of the electricity consumption. Hence for households and companies that consumed more energy, the monthly electricity bill was higher. However, households (not companies) that produced electricity from renewable sources were exempt from the variable part of the MPC for electricity injected into the grid and taken back. This aspect of the net-metering scheme did not encourage self-consumption (i.e. onsite consumption at the same time electricity is produced) nor incentivised demand response (i.e. consumption when prices are low, feeding-in when prices are high) because it reduced the costs of exporting energy to the network and reimporting it. However, it allowed to improve the energy bills of self-generating households (compared to non-self-generating households), which meant the case for the installation of PV systems was improved.

Since January 2023, the MPC is completely paid by the state budget, and is hence equal to 0 € for households.

In the current system, households that produce electricity from renewable sources can save only on the charges for electricity. The billing period of the net-metering system is one calendar month. Electricity transferred by self-consumers into the grid must be used within one year, otherwise provisions disappear. Net consumption is calculated by subtracting electricity transferred into the grid from electricity consumed (in kWh).

- If during the billing period (1 month), the amount of energy transferred into the grid is higher than the amount of energy consumed, the difference between electricity injected into the grid and electricity consumed will be available for consumption in the next month (up to one year). The consumer does not have to pay for electricity this month and thus the consumer saves on the charges for electricity.
- If during the billing period (1 month), the amount of energy transferred into the grid is lower than the amount of energy consumed, the difference between electricity consumed and electricity injected into the grid is included in the electricity bill for the given billing period.

Considering that net-metering system is not a market-based support mechanism, as the amount of the electricity which is injected into and imported from the grid is only measured in kWh and not taking into account its market value and grid use, the Latvian government has decided to gradually phase out current net-metering system and replace it by a new net-accounting (or net-billing) system. In July 2022, Latvian Parliament adopted amendments to the Electricity Market Law which introduces net-accounting system. The Cabinet Regulation on the rules for trade and use of electricity has been amended, to set the conditions and procedures for the net accounting scheme in November 2023.[18] The new scheme will become available as of 2024.

This new net-accounting system will be market-based, as it will take also into account the market value of the electricity injected into the grid and imported from it. If the total value of the electricity generated by a self-consumer that is not directly consumed and injected into the grid is larger than the total value of the electricity imported from the grid, the difference in monetary terms can be

[18] Rules for the trade and use of electricity (likumi.lv)

credited in the next billing period.[19] The accrual period is to be determined by the energy supplier.[20] The DSO will be responsible for equipping consumers applying to the net-accounting scheme with meters (for the accounting of electricity injected into and imported from the grid) and sending to energy suppliers customer data on electricity injected into and imported from the grid.[21] This will enable government to offer more opportunities for active consumers, e.g., net-accounting system will also be opened to legal entities; and, the limit of allowed installed power capacity within net accounting system will be raised above the current 11.1 kW (i.e. the exact limit is still under consideration, but it will probably not be less than 50 kW). Households which are already using current net-metering system, will be offered a transition period of 5 years during which they will be entitled to continue to use net-metering system.

Simplified permitting procedure for microgenerators

The Ministry of Economy also introduced simplified permitting procedure for small-scale renewable energy systems (PV and wind) in 2020, which was revised in 2022. Microgeneration equipment below 500 kW are subject to a simplified approval process, which exempts them from environmental impact assessments (EIA) and building permits.[22] Microgeneration equipment should however still be approved by the Latvian DSO to ensure it does not cause any disturbance to the electricity grid.

For power plants with an electricity generation that is higher than 500 kW, a permit provided by the Ministry of Climate and Energy is still required.[23]

1.2. PESTLE analysis

The table below provides an overview analysis of the barriers, success factors and enabling conditions using PESTLE (i.e. Political, Economic, Social, Technological, Legal and Environmental[24] context and factors influencing the case study).

Table 1-1 PESTLE for Latvian's improvement of conditions for self-consumption

Aspect	Barriers/ hindering factors	Success factors
Political	• Only one support scheme (net metering) for self-generation available • Self-consumers have limited access to incentive mechanisms, nor regulations that encourage initiatives aimed at self-consumption	• Policy led smart meter roll-out such that the net-metering scheme could be easily implemented The roll-out of smart meter is likely to facilitate the shift towards a net-billing scheme. • Decrease in complexity of permitting for small-scale renewable energy generation technologies • Introduction of a new, more market-based net accounting system planned with more opportunities for its users
Economic	• Accessibility of self-consumption for vulnerable households (high upfront cost, limited financial support available)	• There are different public support schemes which support the purchase and installation of generation plants. This allows to increase affordability of equipment. • As per the Latvian net-metering system, self-consumers need to consume the electricity they have produced within a 1-year time period (see business case below for more details) -> strong incentive for

[19] Net accounting and net settlement (sadalestikls.lv)
[20] Net accounting and net settlement (sadalestikls.lv)
[21] Rules for the trade and use of electricity (likumi.lv)
[22] Introduction of a power plant and start of electricity production | Ministry of Climate and Energy (kem.gov.lv)
[23] Elektrostacijas ieviešana un elektroenerģijas ražošanas uzsākšana | Klimata un enerģētikas ministrija (kem.gov.lv)
[24] Legal aspects to be included later on in consultation with Task 1 country experts.

Aspect	Barriers/ hindering factors	Success factors
		installation of PVs but not for market integration (flexibility of demand). • Financial support programmes are available for households investing in solar and wind installations
Social		• Increased awareness of energy consumption patterns and energy literacy through free and easy access to smart electricity metering data on the DSO national energy data hub • Simplified permitting procedure decreases psychological barriers to the installation of self-consumption by households
Technological	• Lack of incentive to shift consumption of electricity to times where self-generation is low (during the winter) and thus putting a strong pressure on the electricity system	• Complete, rapid and cost-effective rollout of smart meters, which enable self-consumption • Better integration of self-consumption technologies in the grid, through digitalisation and modernisation projects • Development of a national energy data hub to facilitate communication of real-time on generation, consumption and price signals to self-consumers.
Legal		• There is no need to obtain a permit from the Ministry of Economics for most generators for self-consumption (under 500 kW). There is only one institution who safeguards and permits the installation of generation plants for self-consumption (Sadales Tīkls), therefore the alignment procedure is not complicated. • New legal regulations are being drafted frequently to simplify the procedure of installation of generation plants for self-consumption, as well as targeted to citizens to encourage the process of using "green energy".
Environmental	• High seasonal variation in lightening needs in Latvia. Households use most energy in the winter when there is less sun (e.g. for heating and lighting purposes), and less in the summer (mainly for electrical appliances).	

1.3. Scalability and Replicability

The level of scalability and replicability differs for each of the measures improving conditions for self-consumption in Latvia. The level of scalability and replicability of the measure(s) is rated via a traffic light system:

High replicability/scalability
Limited replicability/scalability
Low replicability/scalability

This section will only address the aspects of the Latvian self-consumption context that are likely to have an impact on self-consumption (i.e. not the rollout of smart meters).

Digitalisation of the electricity distribution network

High replicability

The uptake of self-consumption should be accompanied by grid modernization and digitalization measures to enable the integration of distributed renewable energy sources, as in Latvia.

Limited scalability

Digitalization and modernization of the grid takes place at a large-scale (entire country).

Support mechanism for households that generate their own electricity

Low replicability

Support mechanisms should be defined taking into account the national regulatory framework. Net-metering schemes do not encourage self-consumption, but rather self-generation and thus should not be considered by other EU Member States. This is also in line with Article 15(4) of the IMED, which indicates that Member States with existing net-metering schemes cannot grant new right under such schemes as of 2024.

Low scalability

Public support for renewable self-consumption remains insufficient in Latvia. The net-metering system does not incentivise to self-consume as the cost of exporting energy to the network and reimporting it is attractive. Therefore, this scheme should not be scaled up towards other sectors.

Simplified permitting procedure for microgenerators

High replicability

As permitting is one of the main barriers to the deployment of renewable projects in the EU, a simplified procedure for small-scale technologies (e.g. microgeneration through solar PV) may significantly contribute to the uptake of self-consumption in other Member States.

High scalability

The simplification of permitting procedure has already been scaled up to larger renewable self-consumption projects (for installations below 500 kW) in Latvia. As recommended by the EC SWD on good practices to speed up the permit granting procedures for renewable energy projects, Member States should ensure to decrease the lead time for renewable energy projects by lifting barriers associated with permit-granting procedures. For solar PV in particular, this can be done by:

- Allowing conditional exemption from building permits for solar PV projects;
- Implementing a tri-zonal 'traffic light' system based on geological surveys, indicating (1) zones where a simple notification is required; (2) zones where a permit is required and (3) zones where drilling is prohibited.

1.4. Business case analysis

Impact of the current net-metering support scheme in Latvia

The impact of the current support scheme on the business case can be summarized as follows: Savings on the final energy bill associated with electricity charges improve the business case for self-generating households. However, the current support scheme is a net-metering scheme, which by itself discourage self-consumption (households do not have interest to directly self-consume as they can just generate electricity and consume it later).

The table below compares a base case (with no self-generation or self-consumption); a low self-consumption case, where there is self-generation but a limited amount of self-consumption, with most of the energy being injected to the grid); and a high self-consumption case (where a large part of the self-generated energy is directly self-consumed, and the remainder is injected to the grid). Indicative data on costs have been retrieved from the DSO website.[25]

Table 1-2 Business case comparison (monthly energy bills)

	Base case	Low self-consumption case	High self-consumption case
Total energy used	395 kWh	395 kWh	395 kWh
Total energy generated	NA	400 kWh	400 kWh
Self-generated energy used directly	NA	100 kWh	210 kWh
Excess energy (injected into grid)	NA	300 kWh	190 kWh
Energy consumption from the grid	395 kWh	295 kWh	185 kWh
Energy stored into grid from previous period	NA	180 kWh	100 kWh
Fixed costs (6,1 €/month)	6,08 €/month	6,08 €/month	6,08 €/month
Variable costs (0,2 €/kWh)	0,1594 €/kWh	0,1594 €/kWh	0,1594 €/kWh
Variable costs (0 €/kWh), for energy from previous period	NA	0 €/kWh	0 €/kWh
Total monthly energy bill	69 €	24 €	20 €

The table shows that if households self-consume more (in this case, a self-consumption rate of 53% compared with a self-consumption rate of 25% in the low case), they can save on their energy bills compared to the base case (no self-generation or self-consumption). However, this doubling of the self-consumption rate is accompanied with very modest savings on the energy bill (€4, or 17%), so the economic case is limited. The economic case would marginally improve if the householders cannot consume the excess energy before this expires (the end of the period).

Assumptions to calculate the above business case

Energy bill components	Value	Unit
Electricity supply charge	0,1594	€/kWh
MPC* variable part	0	€/kWh
MPC* fixed part	0	€/month
Capacity maintenance charge (DSO services)	6,08	€/month
Total fixed costs	6,08	€/month
Total variable costs	0,1594	€/kWh

**The MPC (Mandatory Procurement Component) is a component of the Latvian electricity bill that has been brought to zero as it is financed by State budget since January 2023.*

[25] ST tarifu vertibas_22052023.pdf (sadalestikls.lv)

2. Landlord-to-tenant electricity act

Title	Improvement of conditions for households' self-consumption in Latvia
Location	Germany
PV production	Gross electricity production from solar PV: 60.8 TWh[26]
General barriers addressed by the case study	**Social and behavioural barrier:** Split incentives
Type	Individual self-consumption*
Target sectors	Residential
Technologies	Solar PV
References	• Bundesministerium für Wirtschaft und Energie (2017), Mieterstrombericht nach § 99 Erneuerbare-Energien-Gesetz 2017 • Bundesministerium für Wirtschaft und Energie (2021), Was ist eigentlich Mieterstrom? • BH&W (2017), Mieterstrom Rechtliche Einordnung, Organisationsformen, Potenziale und Wirtschaftlichkeit von Mieterstrommodellen (MSM) • BDEW (2023), Die Energiewende in die Städte tragen – Mieterstrom und Gebäudestrom voranbringen
Contacts	• German Association of Energy and Water Industries (BDEW) – info@bdew.de • German Solar Association (BSW) – info@bsw-solar.de • TenneT TSO GmbH – info@tennet.eu

**The electricity provided by the landlord to the tenants of the same building is not considered to be self-consumption in German law*

2.1. General description

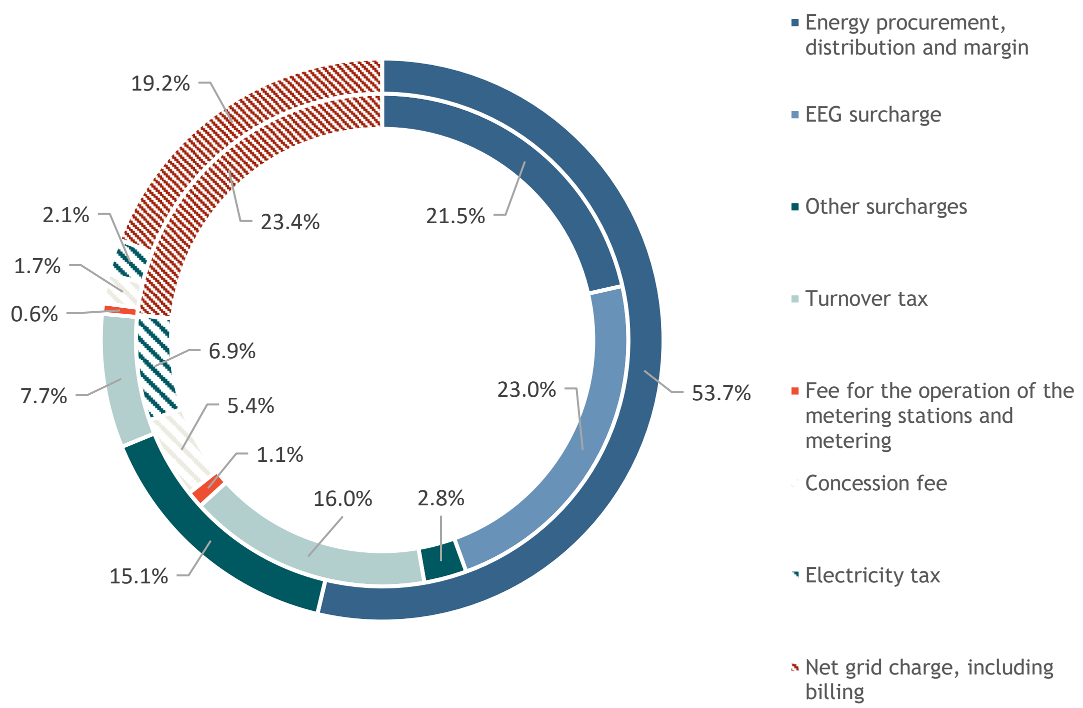
The uptake of self-consumption in Germany is still relatively low. In 2022, 60.8 TWh of electricity was generated by photovoltaic systems, making up only about 10.6% of the total electricity generation in the country. About 5 TWh of this (8.2% of all PV generation) was self-consumed[27], the rest was fed into the public grid. This represented less than 1% of the total electric generation (571.3 TWh in 2022[28]).

In Germany, electricity generated by solar PV installations on rooftops of residential buildings not occupied by their owners but rented to tenants can be sold by the owner of the solar PV installation directly to the final consumers (the actual tenants of the building) within the landlord-to-tenant electricity supply scheme. Only the surplus electricity not used by the tenants is fed into the public grid. This is a mutually beneficial arrangement for both tenants and landlords, as it exempts the tenant from paying grid surcharges (for the use of the grid), electricity tax (or ecological tax, for the compensation of environmental costs of electricity generation) and the concession levy (paid to municipalities for the rights of way), and it allows the landlord (or the operator of the PV generation facility) to sell the produced electricity with a premium received from the government on top of the price paid by the tenant. The tenants remain free to choose their electricity provider, the law prohibiting the landlord from making the tenancy conditional on the additional electricity agreement. This way, the price of electricity provided by the landlord is set via a competition between the landlord and the grid provided electricity. The landlord-to-tenant electricity price is capped by law at 90% of the total energy price in the relevant grid area. The landlord is further eligible for a subsidy, received from the grid operator – a 'premium' on every kWh of provided electricity. Originally introduced in 2017, the scheme was meant to promote the deployment of PV generation capacities, and the local utilisation of electricity, therefore relieving the pressure on the public grid.

[26] DeStatis (n.d), Gross electricity production in Germany from 2019 to 2022
[27] Fraunhofer (2023), Net Electricity Generation in Germany in 2022: Significant Increase in Generation from Wind and PV
[28] DeStatis (n.d), Gross electricity production in Germany from 2019 to 2022

Figure 2-1 below shows how the composition of household electricity price evolved between the introduction of the scheme in 2017, and 2023. The slash pattern shows the cost components of the price (and their relative share) that can be avoided by a landlord-to-tenant agreement, as already described above.

Figure 2-1 The evolution of household electricity price in Germany between 2017 (inner circle) and 2023 (outer circle) (Source: own visualisation based on BMWK[29] and BDEW[30] data)



The average annual household electricity price changed between 30.48 c/kWh in 2017 and 33.18 c/kWh in 2023[31] – reflecting the energy crisis brought on by the war in Ukraine. Most notable differences in the composition of the electricity price from the introduction of the scheme in 2017 are the share of procurement costs, and that from 2023 onward the federal government eliminated the EEG surcharge. A landlord-to-tenant electricity agreement reduces the household electricity price by about 29% (average 9.23 c/kWh between 2017-2023) in the period between 2017-2023 compared to electricity obtained from the grid, as it exempts the tenant from paying the grid surcharges (23.4% in 2017), the electricity tax (6.9% in 2017) and the concession levy (5.4% in 2017). However, even with the discontinued EEG surcharge, the increased procurement costs meant a decreasing share of these costs in 2022-2023, and the share of costs components affected by the scheme shrank to only 23% by 2023.

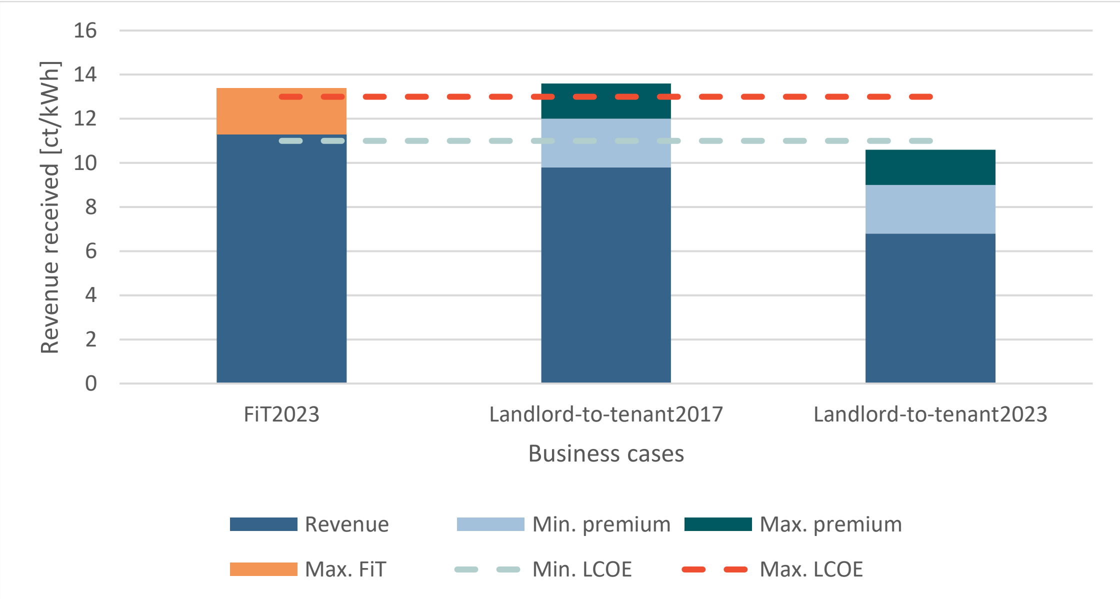
Furthermore, billing and metering of the generated electricity creates additional expenses and administrative burden for the landlords, radically reducing their financial incentive. In the five years between its introduction in 2017 and mid-2022, only about 60 MW of generation capacity have been making use of the landlord-to-tenant electricity option, which fell far behind the government's expectations[32]. 215 GW of installed solar PV generation capacity is expected to come online by 2030, 50% of it on rooftops[33] with a 1000 GW overall technical capacity in the country[34]. With 80% of the urban

[29] BMWK (n.d.), Composition of the electricity price for private households
[30] BDEW (2023), Strompreis
[31] EUROSTAT (2023), Electricity prices for household consumers
[32] BDEW (2023), Die Energiewende in die Städte tragen – Mieterstrom und Gebäudestrom voranbringen
[33] BDEW (2023), Die Energiewende in die Städte tragen – Mieterstrom und Gebäudestrom voranbringen
[34] Eggers et al. (2020), PV-Ausbauerfordernisse versus Gebäudepotenzial: Ergebnis einer gebäudescharfen Analyse für ganz Deutschland

population living in multi-family rented accommodations, it is estimated that around 4 million apartments (18% of all households, requiring about 15 GW installed PV capacity, based on 3190 kWh average household electricity consumption[35]) could potentially be supplied with electricity through a landlord-to-tenant contract[36] – making the concept crucial in achieving the federal government's climate and energy security goals. The slow uptake of the landlord-to-tenant electricity concept can be explained by the complex and narrow legal framework that forced the landlord to become a registered energy provider with all the related administrative burdens. In combination with the low limit on the eligible power generation capacity (100 kW) and the insufficient financial incentive, the concept did not become attractive enough for landlords. The rapidly increasing costs of installation (due to the increasing demand for PV systems) and a monthly degression of the premium, as defined by the Renewable Energy Sources Act (EEG)[37] together means little return on investment for the owners of these installations.

Figure 2-2 below shows the financial comparison between the feed-in tariff (FiT) and the landlord-to-tenant electricity contract option in 2017 and 2023 from a landlord's perspective. The levelized cost of electricity (with dash line) is 11-13 ct/kWh for small, rooftop PV installations in Germany[38]. The figure shows the potential feed-in tariff for installations up to 10 kW (single family homes), and 10-40 kW (multifamily homes) in the first column. The other two columns show the landlord-to-tenant agreement's performance when introduced (and pre-energy crisis) in 2017, and based on the most recent electricity prices (2023) separately. The premium received from the government in the landlord-to-tenant electricity agreement is changing between 2.2-3.8 ct/kWh (as also shown on the figure).

Figure 2-2 Comparison of the different business cases from a landlord's point of view



Based on this, the landlord-to-tenant agreement offered minimal financial advantage when introduced in 2017, and falls far behind a simple feed-in arrangement for the landlords in 2023.

Additionally, the law requires the landlords willing to provide electricity to their tenants to register a business, and enter into formal contractual agreements with both tenants and public grid operators[39]. From 2021, part of the administrative burdens were also relieved by the government, and the option to lease the PV system to established suppliers was introduced. Furthermore, until the amendment of

[35] DeStatis (n.d), Environmental-economic accounting Private households
[36] BH&W (2017), Mieterstrom Rechtliche Einordnung, Organisationsformen, Potenziale und Wirtschaftlichkeit von Mieterstrommodellen (MSM)
[37] BDEW (2023), Die Energiewende in die Städte tragen – Mieterstrom und Gebäudestrom voranbringen
[38] Fraunhofer (2023), Recent facts about photovoltaic in Germany
[39] RESMonitor (2022), Tenant electricity surcharge not well designed in Germany

2021, electricity could only be used in the immediate spatial proximity as part of the landlord-to-tenant concept, meaning that tenants could only connect to solar PV generation capacities installed on their own rooftop. This, in principle, was expanded to a district level distribution system in 2021, however, in practice the legal definition remains vague and therefore hard to make use of.

The landlord-to-tenant electricity contracts remain limited to solar PV installations, thereby excluding all other possible renewable small-scale generation options.

The new amendment(s) of the landlord-to-tenant electricity act aims to close the financial gap and to eliminate the bureaucratic hurdles (of legally becoming an energy provider) for the landlords by providing a clear legal framework and options to lease their installations to established energy providers, and a premium on the electricity sold directly to their tenants, creating a sufficient financial incentive for them to pursue an agreement with their tenants instead of feeding the produced electricity into the grid[40]. This premium is calculated as a deduction from the statutory feed-in tariff, based on the size of the solar installation and the national photovoltaics expansion rate – as set out in the Renewable Energy Sources Act – and it applies to every landlord who began operating their PV panels on or subsequent to 25 July 2017.

With the latest 2023 draft amendment of the EEG (the so-called 'Solarpaket 1')[41] the government aims to tackle part of the described barriers. Specifically, the draft extends the landlord-to-tenant-electricity premium to commercial buildings and ancillary facilities such as garages, as long as the electricity is consumed without being fed through the grid. In addition, rules for system aggregation shall be simplified to avoid disproportionate technical requirements.

Independent of the established landlord-to-tenant model, the draft also introduces a new model allowing the supply of PV electricity within a building. In this context, the passing on of PV electricity to, for example, residential or commercial tenants or apartment owners is to be exempted from supplier obligations, as far as possible, and the operators of the PV system are to be exempted in particular from the obligation to supply residual electricity. In this new model no additional subsidy or premium is to be paid. The excess feed-in to the grid is remunerated as usual in accordance with the EEG.

Textbox 2-1 Legal barrier: landlord-to-tenant electricity is not recognised as self-consumption in German law

Landlord-to-tenant electricity is not considered to be self-consumption by German law. While the scheme carries some of the notable benefits and technical attributes of self-consumption (decentralised, local generation at the point of consumption, relieving the grid and saving additional costs), therefore furthering the same policy goals as self-consumption, the owner of the generation capacity and the consumer of the electricity are not the same person/entity. As a consequence, the scheme doesn't qualify as self-consumption in a legal context in Germany right now. This incoherence between the legal practicalities and the policy-makers' goals potentially creates further confusion in the reporting of the levels of self-consumption within the EU and between the Member States, and it further disadvantages the scheme via overlooking its added benefits, and potentially excluding it from support schemes relevant to other self-consumption schemes.

[40] Bundesministerium für Wirtschaft und Energie (2021), Was ist eigentlich Mieterstrom?
[41] Bundesministerium für Wirtschaft und Klimaschutz (2023), Solarpaket erleichtert Ausbau Photovoltaik.

2.2. PESTLE analysis

The table below provides an overview analysis of the barriers, success factors and enabling conditions using PESTLE (i.e. Political, Economic, Social, Technological, Legal and Environmental context and factors influencing the case study).

Table 2-1 PESTLE for improvement of conditions for self-consumption

Aspect	Barriers/ hindering factors	Success factors
Political	• Unequal distribution of the tax burden, lack of financial solidarity	• Flexibility to choose (for landlord) between several sale options (feed-in to grid; landlord-to-tenant)
Economic	• Premium paid by the government is too low to make the contract economical (for the landlord) • Increased feed-in tariffs from the grid operators for unused electricity (for the landlords) • 90% cap on tenant electricity price provided by the landlord (compared to grid electricity)	• Produced electricity allowed to be sold not just to tenants in the same building but within the same district • Produced electricity allowed to be sold not just to tenants, but all kinds of consumers (owners, businesses in the building) • Monthly degression of feed-in tariffs discontinued in 2023, semi-annual degression introduced in 2024 • EEG levy abolished from 2022 •
Social	• Electricity labelling (for the landlords) • Fire protection regulations limiting the available roof surface (for all PV installations) • Cross-property border development is not possible	• Unbundling the supplier obligations, and making it possible for landlords to outsource some of these while still benefitting from the premium
Technological	• The legal framework does not extend to any other small-scale renewable generation capacity, only solar PV • Only PV installations on residential buildings (and not commercial ones) are eligible* • Skilled worker and component shortage (for all PV installations)	
Legal	• Complex legal framework • Registration and supplier requirements for landlord	

**Barrier/success factor is being revised in ongoing legislative process (2023)*

2.3. Scalability and Replicability

The level of scalability and replicability of the measure(s) is rated via a traffic light system:

High replicability/scalability
Limited replicability/scalability
Low replicability/scalability

High replicability

No particular element of this scheme is unique/specific to Germany, it can be implemented in any Member State with the possibility to rent in the residential and/or commercial sectors. The regulatory possibility and the feasibility for the state to offer a premium in peer-to-peer electricity trading should be further investigated. The necessary amount of subsidy in the scheme is also dependent on the member states' household electricity price composition and existing feed-in tariffs, and should be adjusted accordingly to make the arrangement attractive to landlords and tenants alike.

High scalability

The measure currently has large limitation in place regarding both the technology (only households, and only PV) and the capacity extension rate (500 MW/year). This means that there is substantial potential in upscaling and extending the measure to further technologies (wind, biomass, etc. for household and commercial use), sectors (PV for commercial buildings), and/or in adjusting the legal framework, allowing for larger capacity extensions.

2.4. Business case analysis

The landlord legally cannot offer a higher electricity price for its tenants than 90% of the basic retail energy price in force (including all price components as displayed in Figure 2-1) in the relevant grid area[42] (average 29.86 c/kWh in 2023), and the tenant remains free to choose its electricity provider, as the landlord-to-tenant electricity agreement cannot be a condition to the rental agreement itself – ensuring that the arrangement remains beneficial for both parties. The landlord is then compensated via a state-funded scheme, receiving a premium for the electricity sold to its tenant on top of the set electricity price received. The funding ('premium') received by landlords is dependent on the size of the solar installation and the national photovoltaics expansion rate (between 2.2 - 3.8 c/kWh)[43]. No further support, or tax exemptions are given to the landlords, meaning that the full EEG surcharge (until 2023), turnover tax and other surcharges, as well as metering costs are to be paid by them. Table 2-2 provides a detailed overview and a comparison of the resulting electricity price for the tenant between the options of a landlord-to-tenant agreement and using grid supplied electricity. The numbers are approximations based on the average electricity price calculated in 2023.

Table 2-2 Comparison of detailed household electricity price by components in competing arrangements (based on average household price in Germany in 2023)

Cost components	Landlord-to-tenant	Grid supplied
Procurement [c/kWh]	-	17.82
Concession fee [c/kWh]	-	0.56
Other surcharges [c/kWh]	4.51	5.01
Electricity tax [c/kWh]	-	0.70
Turnover tax [c/kWh]	2.30	2.55
Grid tariff [c/kWh]	-	6.37
Metering [c/kWh]	0.18	0.20
Total energy bill [c/kWh]	(maximum) 29.86	33.18
Premium [c/kWh]	2.2-3.8	-

The comparison shows that the landlord-to-tenant agreement is financially beneficial for the tenant, as the maximum electricity price is capped at 90% of the usual, grid-supplied price. With the maximum price and the highest premium applied, the landlord gets 13.67 c/kWh for the electricity.

Electricity unused by the tenants of the building is fed into public grid, and the landlords receive the usual feed-in tariff, as calculated above. The feed-in tariffs will be raised in the new, 2023 version of the EEG.

Figure 2-3 The calculation of the increased feed-in tariff from 2023 onward

Up to 10kW
- 8.60 c/kWh + 4.80 c/kWh = 13.40 c/kWh

Between 10-40 kW
- 7.50 c/kWh + 3.80 c/kWh = 11.30 c/kWh

Between 40-100 kW
- 6.20 c/kWh + 5.10 c/kWh = 11.30 c/kWh

[42] BMWK (n.d), Frequently asked questions about landlord-to-tenant electricity
[43] BMWK (n.d), Landlord-to-tenant electricity supply: the energy transition in your own home

3. Spain's Roadmap for Self-consumption and the simplified compensation approach

Title	Improvement of conditions for households' self-consumption in Latvia
Location	Spain
PV production	Gross electricity production from solar PV: 29.617 TWh[44]
General barriers addressed by the case study	**Institutional barrier:** Absence of roadmap/strategy for developing self-consumption; complex burdensome procedures **Economic and financial barriers:** Inadequate remuneration and support schemes
Type	Individual and collective self-consumption
Target sectors	All
Technologies	PV, wind and hydro micro turbines, smart meters, etc.
References	• Spanish government (2021), https://www.miteco.gob.es/es/ministerio/planes-estrategias/hoja-ruta-autoconsumo/hojaderutaautoconsumo_tcm30-534411.pdf • CAN Europe (2022), Engaging citizens and local communities in the solar revolution. Rooftop solar PV country comparison report. • Spanish government website • ESIOS website
Contacts	• MITERD • IDEA

3.1. General description

In Spain there is around 5 GW of installed capacity for self-consumption[45], and this is expected to reach between 9 and 14 GW of installed power by 2030.[46] The Spanish government has taken measures to further incentivise self-consumption including the simplified compensation mechanism introduced in 2019 (as one of the different self-consumption modalities introduced by RD 244/2019) and the self-consumption roadmap published in 2021. Further, the draft National Energy and Climate Plan (NECP) includes a more ambitious target of 19 GW of installed capacity for self-consumption by 2030.

Spain has developed a complete, advanced, and flexible frame for self-consumption which considers the self-consumption needs of all types of consumers, allowing different configurations (individual & collective), multiple connection modes (inland consumer's grid & through the public distribution network) and various options for surplus management (WITHOUT surplus, WITH surplus and compensation or WITH surplus and sale to the market).

Self-consumption roadmap

In Spain, a roadmap for self-consumption was approved by the Spanish Government in December 2021, that develops the National self-consumption strategy contemplated in the NECP, establishing a 9 GW (up to 14 GW) installed capacity target by 2030. This target is further increased by the updated draft NECP to 19 GW. The targets are defined based on a self-consumption potential study in which data from the urban cadastre, power density and generation curve assumptions, electricity prices, demand for type of consumer, payback and other more qualitative barriers (i.e. lack of information, split incentives, conflicts among neighbours, etc.) were analysed.

[44] EurObservER (2023), Photovoltaic barometer 2023.
[45] Direct communication with IDAE, based on UNEF / APPA data
[46] Spanish government (2021), Hoja de Ruta del Autoconsumo

The roadmap includes more than 30 measures to promote self-consumption and "*aims to identify the challenges and opportunities of self-consumption to ensure its massive deployment in Spain, as well as to eliminate existing barriers to its implementation and promote its development in all productive sectors*". The measures foreseen (listed in the table below) are holistic and tackle the relevant challenges: improving institutional collaboration, training programmes, awareness raising campaigns, strengthening the value chain, legal reforms, increasing flexibility, easing the dynamic distribution of electricity, improving decision making in collective self-consumption (CSC), enhancing energy communities, improving communication with and among electricity suppliers and DSOs, easing access to the grid and others.

Table 3-1 Measures from the Spanish Roadmap for Self-consumption

Measure	Classification
1- Incentives to self-consumption	Urgent
2- Set-up national round table on self-consumption	Urgent
3 – Set-up working group with local stakeholders	Urgent
4- Publication of guidelines for municipalities to promote self-consumption	Urgent
5- Publication of technical guidelines for professionals	Awareness
6- Awareness and dissemination campaigns	Awareness
7- Creation of the self-consumption office	Awareness
8- Training courses to improve technical skills of professionals	Value chain
9- Inclusivity in training	Value chain
10- Adaptation of training and curricula in vocational training courses, university diplomas, etc.	Value chain
11- Enhancement of the value chain	Value chain
12- Strengthen value chain	Value chain
13- Update Law on Horizontal Property	Engagement
14- CER Working group on self-consumption	Engagement
15- Flexibility for collective self-consumption	Engagement
16- Collective self-consumption manager	Engagement
17- Self-consumption through grid on any voltage level	Engagement
18- Variable and dynamic distribution	Engagement
19- Boost energy communities	Engagement
20- Adapt protocols	Management
21- Improve communication with electricity providers	Management
22- Adequate access and connection procedures	Management
23- Transparent access and connection costs	Management
24- Corrective measures against infractions	Management
25 – Adaptation of technical regulations	Management
26 – Boost self-consumption in just transition areas	Priority
27- Social collective self-consumption	Priority
28- Research, Development & Innovation in isolated and low interconnected areas	Priority
29- Boost self-consumption with storage	Opportunity
30- Promote independent aggregator	Opportunity
31- Boosting access to energy data for citizens	Opportunity
32- Cybersecurity in self-consumption	Opportunity
33- Improve waste management and circular economy	Opportunity
34- Boost incorporation of second-life batteries	Opportunity
35- Boost business models that value self-consumption waste	Opportunity
36- IDAE observatory for self-consumption	Opportunity
37- Follow-up/update roadmap	Opportunity

The regulatory frame for self-consumption (Royal Decree 244/2019) considers a set of 3 modalities for self-consumption:

- Self-consumption WITHOUT surplus – consisting of installations which will not inject energy into the grid.

- Self-consumption WITH surplus - – consisting of installations which inject energy that is not self-consumed into the grid.
    - Self-consumption WITH surplus, WITH simplified compensation – where the consumer receives the value of the surplus as a direct discount on his/her energy bill.
    - Self-consumption WITH surplus, WITHOUT simplified compensation – where the surplus is sold in the market by the producer. This producer can be the consumer and receive the income for this energy sale directly, but can be also another figure, so this modality opens the door to different and innovative business models.

In addition, the consumer can choose between individual or collective self-consumption:

- Individual self-consumption has a single associated consumer who receives 100% of the energy generated for self-consumption.
- Collective self-consumption has two or more associated consumers who share the energy generated for self-consumption according to the distribution criteria that the consumers themselves have agreed.

Also, different ways of connection can be chosen, depending on the technical needs of each consumer:

- to the inland consumer's grid, where the self-consumption installation is directly connected to the consumer (in collective it is connected to the grid inside the building) or,
- through the public distribution grid, where the consumers will receive the energy using the public grid without any additional electricity distribution infrastructure.

Textbox 3-1 Self-consumption in different voltage levels

The roadmap promotes self-consumption through the public distribution grid by allowing industrial or commercial installations (connected at any voltage level) to share their energy surplus with homes or other buildings in the surroundings..

What is the simplified compensation mechanism (net-billing) and how does it work?

According to RD 244/2019, self-consumers with a surplus can choose between selling their excess energy to the electricity market[47] or make use of the simplified compensation mechanism ("*compensación simplificada*"). The mechanism allows self-consumers to get a compensation for their excess energy through their energy bill. This implies that the consumer directly uses the energy produced by his/her installation and values, through the compensation, the energy that was not instantly consumed. The result of the bill will never be negative (i.e. revenue) as the fixed capacity-based charges are not compensated. It is applicable to both individual and collective self-consumption. This means that a consumer can take advantage of the surpluses of his/her neighbour and self-consumption partner if he/she is not consuming, and vice versa.

[47] Which would require registering as an energy producer, which implies other obligations (taxes, VAT etc.) so is rarely done by domestic self-consumers.

The key requirements are:

- Linked to installations of up to 100 kW
- Renewable energy generation.
- Generation plants have not been granted an additional or specific remuneration regime.

At the end of the billing period, a discount to the electricity bill is applied based on the kilowatts that have been fed into the grid as read by the bidirectional meter. The compensation will depend on the type of energy supply contract that the consumer has:

- **Consumers with regulated market contract (PVPC contracts)**[48]: using the hourly energy price, which is obtained from the market, and can be transparently consulted on the ESIOS website.
- **Liberalized market:** valued according to the price agreed between the consumer and the retailer by contract.

Figure 3-1 Example energy bill. Source: MIWEnergia

Término Potencia (Término fijo):	
P1 3,464 kW x 28 Días x 0,084035 €/kW día	8,15 €
P3 3,464 kW x 28 Días x 0,003902 €/kW día	0,38 €
Término Energía	
P1 31 kWh x 0,229980 €/kWh	7,13 €
P2 38 kWh x 0,132814 €/kWh	5,05 €
P3 84 kWh x 0,089540 €/kWh	7,52 €
TOTAL SIN DESCONTAR EXCEDENTES	**19,70 €**
Excedentes de Autoconsumo	
P1 36,68 kWh x 0,214010 €/kWh	-7,849 €
P2 16,98 kWh x 0,214010 €/kWh	-3,633 €
P3 23,92 kWh x 0,214010 €/kWh	-5,119 €
AHORRO TOTAL POR EXCEDENTES	**-16,601 €**
TOTAL TÉRMINO ENERGÍA (MENOS EXCEDENTES)	**3,099 €**
TOTAL ENERGÍA + POTENCIA	11,629 €
Impuesto Electricidad: 0,5 % sobre 11,629 €	0,058 €
Alquiler Equipo Distribuidora	0,83 €
Importe Total	15,616 €
Impuesto IVA 10%	1,561 €
TOTAL IMPORTE FACTURA	**17,18 €**

It is important to bear in mind that the maximum value that can be compensated in the electricity bill is the amount of the energy purchased in Euros. This means that the amount to pay for the energy charge (price for energy consumed minus compensation for excess energy) can never be negative, nor deduct the price of the charge for power capacity.

Textbox 3-2 Simplified compensation mechanism (net-billing) in collective self-consumption. Source: MITERD website

Simplified compensation in collective self-consumption modalities works very similarly, though the generated energy must first be distributed among the different participating supply points. The generation counter, during a period of one hour, counts the energy generated by the self-production system (**net hourly energy generated**). This energy is multiplied by the agreed **distribution coefficient** of each participant, defining what part of the generated energy corresponds to each person in the period of one hour (**individualized net hourly energy generated**). From this, during this hour, each participant uses whatever they need or can take advantage of (**individualized self-consumed hourly energy**). The generated energy that corresponds to each participant in each time slot, and that is not used at that time, is counted as surplus (**individualized surplus hourly energy**), and is what can be compensated. The individualized surplus hourly energy is transformed into an economic value according to the kWh price established by the supplier and this economic value is subtracted from the energy used.

In collective self-consumption with surplus, with simplified compensation, each participant can thus choose their retail supplier and thus has an individual compensation price.

In Spain, electricity bills are composed of the following elements for every household:

- Charges for power capacity - a general, fixed charge for the contracted power capacity, covering access tariff or tolls as well as the fixed retail margin.

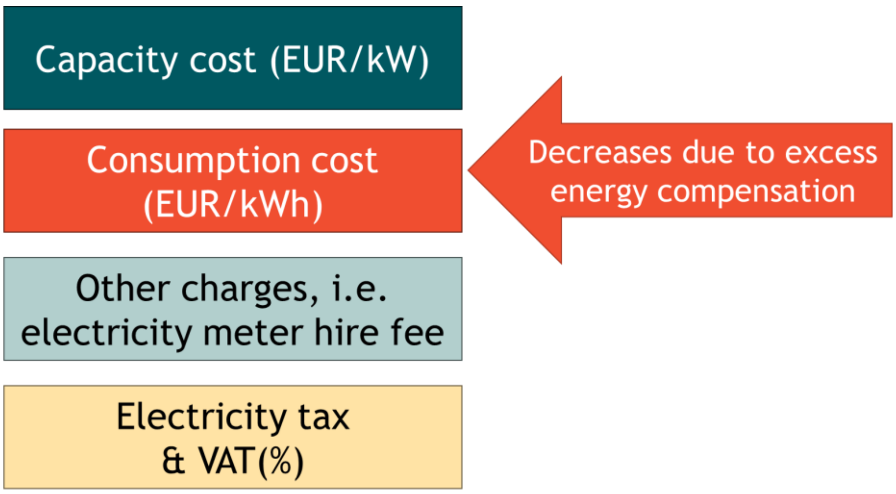
[48] The PVPC (*Precio Voluntario del Pequeño Consumidor)* is applied in the regulated market (by reference suppliers) across the national markets a dynamic price indexed to the wholesale market. It adds up: 1) the cost of electricity production; 2) network costs; 3) cost of commercialization (operations & remuneration).

- Charges for electricity – which consist of the **energy consumption cost** as well as access **tariff or tolls**, which depend on the amount of energy used.
- Other charges – Including for example the electricity meter hire fee charged by retailers since it belongs to the distributor. Hire fees for digital meters vary between €0.81 and €1.36 per month. If the consumer has his own meter, this charge will not apply.
- Electricity tax – Applied to the power and energy charges.
- VAT

Individual and collective self-consumers can save on the charges for electricity component of the energy bill (and therefore also on the electricity tax and VAT in proportion to the energy consumption cost):

- Amount of energy consumed – The charge for electricity depends on the energy consumed from the grid. This means that a self-consumer will only pay for the energy consumed from the grid and not the self-generated energy that was used directly (using hourly net accounting). In Spain, the law establishes that self-consumed energy is free from taxes and charges.
- Compensation – The amount of excess energy injected into the grid will be compensated and deducted from the electricity charge. The cost of the electricity bought from the grid will be reduced directly with this compensation. This reduction has the limit of the total electricity cost, so the total electricity charge cannot be negative (i.e. the consumer can only compensate the energy that was not consumed). It is also important to note that compensation is based on the energy cost only (thus the €/kWh are lower than those charged for energy consumption from the grid, which include access tariffs).

Figure 3-2 Energy bill components in Spain, and impact of the simplified compensation mechanism



What are the required administrative procedures?

The requirements are listed in the table below.

Table 3-2 Requirements. Source: RD 1183/2020 & IDAE (2023)[49]

Requirement	Up to 15kW	>15kW and up to 100kW
Installation design	Up to 10kW, technical memoir ('*memoria técnica*') prepared by installation company	Technical report ('*proyecto técnico*') by qualified professional
Access permit	Not required for installations with power ratings of less than 15 kW	Access permit required above 15 kW

[49] https://www.idae.es/publicaciones/guia-profesional-de-tramitacion-del-autoconsumo

Requirement	Up to 15kW	>15kW and up to 100kW
	that have urban land with the facilities and services specified in the legislation	
Warranties	Not required	Not required
Certificate of installation and completion	Installation certificate is sufficient	Both installation certificate and completion (end of work) certificate
Operating authorization	Installation certificate is sufficient	Consult with CCAA if any additional documentation is required
Self-consumption code (CAU)	Must always be requested to the distribution company before installation	
Building permit and tax (ICIO)	Consult with Town Hall	
Initial and period inspections	Consult with CCAA	
Sharing agreement	Collective self-consumption installations must submit an "Energy Sharing Agreement" signed by all associated consumers and a "txt" file with the percentage of energy assigned to each consumer in each hour following a specific published format.	
Registrations	Register in the Registry of Self-consumption of Electric Energy (<100kW the registration is made by the CC.AA. directly). Consult with CCAA whether a self-consumption registry is established	

There are other simplifications available in some cases:

- In general, it is not necessary to submit environmental impact and public entity authorizations.[50]
- Installations WITHOUT surplus or below 500 kW, do not need to submit prior administrative and construction authorizations.
- Installations WITHOUT surplus or WITH surplus and compensation do not need to obtain an activity license.
- Installations below 100 kW do not register in the administrative registry of electricity generating facilities (RAIPRE).
- All installations register in the Administrative Register for Self-consumption (RADNE), but the registration for installations below 100 kW is done directly by CC.AA.

3.2. PESTLE analysis

The table below provides an overview analysis of the barriers, success factors and enabling conditions using PESTLE (i.e. Political, Economic, Social, Technological, Legal and Environmental[51] context and factors influencing the case study)

Table 3-3 PESTLE for Spain's Roadmap for Self-consumption

Aspect	Barriers/ hindering factors	Success factors
Political	• Slow permitting process in some municipalities (6-8 months for construction permit) affects self-generation. • The geographical limits placed on self-consumers connected by the distribution grid [52] reduces the options for energy sharing and collective self-consumption particularly with regard to rural areas and	• Regulation in place addressing administrative, technical and economic conditions for self-consumption (RD 244/2019) • Roadmap as a stepping stone towards a self-consumption strategy. • By 2023 all Autonomous Communities removed permitting requirements for self-consumption (under 100 kW), and

[50] Though this is carried out at CCAA level, so should be consulted/confirmed at that level
[51] Legal aspects to be included later in consultation with Task 1 country experts.
[52] The self-consumers connected using the distribution grid (individual or collective) must fulfil at least one of the following criteria: 1) be located within the LV distribution grid derived from the same transformer station; 2) respect a maximum distance of 500m between production and consumption or 2000m in the case of PV; or 3) be in the same cadastral area. Source: IDAE (2023), Guía Profesional de Tramitación del Autoconsumo

Aspect	Barriers/ hindering factors	Success factors
	the use of roofs from industrial areas, as well as choice of technology (in particular wind turbines). • Delays during the registration and commissioning (specially in collective self-consumption) due to the procedures of electricity distributors and retailers.	now only ask for prior notice or declaration of start of activities. • Guide available for municipalities to support self-consumption.[53] • Spain allows the use of the public grid for collective self-consumption or energy sharing. • The distance limit has been increased from 500 to 2000m for PV which it's enough distance to cover most collective self-consumption projects.
Economic	• Size restriction for the simplified compensation modality[54] (installed capacity of max. 100kW). (Noting that those with higher capacity can make use of other self-consumption modality to sell surplus) • No remuneration of surpluses is possible in the simplified compensation modality, only compensation of the electricity bill. Remuneration of surpluses is possible under a different modality. • Difficulties in accessing bank credit derived from the general increase in interest rates.	• Strong self-consumption value chain in Spain (i.e. PV/mini wind-turbine manufacturers, etc.) • Simplified compensation modality for self-consumption as of 2019 with no local tariffs for energy sharing or financial guarantees to access the grid. • Self-consumers do not pay VAT and electricity taxes on the excess energy compensation.
Social	• Stakeholder consultation process on the roadmap was perceived to lack visibility and to be short.[55] However, there were two feedback moments in 2020 and 2021, receiving over 140 reactions	• National round table and working group on self-consumption will be set up • Simplified requirement to install rooftop solar PV based on recent modification of the Horizontal Property Law encourages self-generation.[56] • Distribution of energy production within a collective (distributed according to their best interests) is made on hourly variable coefficients which can be modified every four months, so that the sharing can be adapted to the needs of each consumer
Technological	• Low availability of network access capacity for new installations that affects self-consumption installations WITH surpluses and power above 15 kW. •	• Clear installed capacity target for self-consumption of 19GW in the NECP • Close to 100% penetration of smart meters following government mandate eases self-consumption
Environmental		• Spain has one of the highest solar irradiation levels in Europe, facilitating self-generation

3.3. Scalability and Replicability

The level of scalability and replicability differs per specific measure. The level of scalability and replicability of the measure(s) is rated via a traffic light system:

[53] IDAE (2022), Guía de orientaciones a los municipios para el fomento del autoconsumo
[54] Net billing between the surplus energy generated and the deficit consumed from the network.
[55] CAN Europe (2022), Engaging citizens and local communities in the solar revolution. Rooftop solar PV country comparison report
[56] It is enough to carry on with the installation if the number of "yes" votes outweighs the number of "no's" only taking owners present at the meeting into account.

High replicability/scalability
Limited replicability/scalability
Low replicability/scalability

In general, Member States should be encouraged to set up strategies to promote self-consumption, including ambitious goals and clear targets based on an assessment of barriers and the potential for the uptake of self-consumption. The Roadmaps and strategies should be holistic and take into account different technologies (i.e. PV, wind, hydropower and storage) as well as different types of self-consumers (i.e. commercial, residential, industrial), as included in the Spanish roadmap. The specificities of the country and its context should be taken into account when developing these strategies and roadmaps.

High replicability for the simplified compensation mechanism

Support mechanisms should be defined taking into account the national regulatory framework. However, some success factors from the Spanish simplified compensation mechanism could be replicated when developing support mechanisms in other countries, as :

- Dynamic compensation prices (including the regulated PVPC).
- Self-consumers do not pay VAT and electricity taxes on the excess energy compensation.
- Simplified access through limited permitting and administrative requirements.
- Inclusion of both individual and collective self-consumption (based on energy sharing).
- Inclusion of both inland grid and distribution grid connection.
- Focus on all renewable technologies (not limited to PV).

In particular, the PVPC exposes households and small prosumers to market prices, in that their injection tariffs changes with time, so that consumers can self-consume more when market price is low, and self-consume less when market price is high, thus maximising the value of self-consumption.

It is important however, to recognise the impact and budgetary implications of VAT and electricity tax exemptions, which would need to be carefully monitored as self-consumption levels increase.

Limited scalability for the simplified compensation mechanism

The simplified compensation mechanism already applies to both individual and collective self-consumption, as well as to all renewable technologies in Spain. However, it could be expanded to cover installed capacities above 100kW.

3.4. Business case analysis

This section focuses on the impact of the simplified compensation approach where a net billing is made between the surplus energy generated and the deficit consumed from the network. Non-self-consumed energy would offset part of the energy that had to be purchased from the grid, at the freely agreed price with the chosen supplier (consumers with a market supply contract) or the hourly average price of the electricity market minus deviation costs (consumers with a PVPC supply contract).

The simplified compensation mechanism can lead to significant savings for the self-consumer. The table below compares a base case (with no self-generation or self-consumption); a low self-consumption case, where there is self-generation but a limited amount of self-consumption, with most of the energy generated being injected to the grid); a medium self-consumption case (where around half of the generated energy is self-consumed); and a high self-consumption case (where a large part of the self-generated energy is directly self-consumed). In all cases, the energy price and compensation are the same (assumed contract prices), with the compensation price being lower than the energy cost. The example below shows significant savings in the energy cost component compared to the cases without self-consumption or with low self-consumption. It is important to note that in case of a regulated market contract the compensation price would be higher.

Table 3-4 Business case comparison

	Base case	Low self-consumption case	Medium self-consumption case	High self-consumption case
Total energy used	395 kWh	395 kWh	395 kWh	395 kWh
Energy consumption from the grid	395 kWh	295 kWh	185 kWh	95 kWh
Cost (0.2 €/kWh)	79 €	59 €	37 €	19 €
Total energy generated	NA	400 kWh	400 kWh	400 kWh
Self-generated energy used directly (hourly net accounting)	NA	100 kWh	210 kWh	300 kWh
Excess energy	NA	300 kWh	190 kWh	100 kWh
Compensation (0.08 €/kWh)	NA	24 €	15.20 €	8 €
Charges for electricity (Energy consumption cost)	79 €	35 €	21.80 €	11 €
Average €/kWh	0.2	0.09	0.06	0.03

4. Portugal's net billing scheme

Title	Improvement of conditions for households' self-consumption in Latvia
Location	Portugal
PV production	Gross electricity production from solar PV in 2022: 3.509 TWh57
General barriers addressed by the case study	Economic and financial barriers: Absent or inadequate remuneration and support schemes for injection; Affordability of self-consumption to average households
Type	Individual and collective self-consumption
Target sectors	Residential, industrial, commercial
Technologies	All (not restricted to RES)
References	• IRENA (2019), Net billing schemes: innovation landscape brief • SWD(2015) 141, Best practices on Renewable Energy Self-consumption • IEA (2021), Portugal 2021: Energy policy review • Portugal (2019), NECP 2030 • ERSE website & ERSExplica Autconsumo • Macedo Vitorino (2021), Portuguese small production and Self-consumption solar plants. • Directorate General of Energy and Geology (Direcao Geral de Energia e Geologia), Estatisticas rapidas
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4.1. General description

4.1.1. Evolution of self-consumption

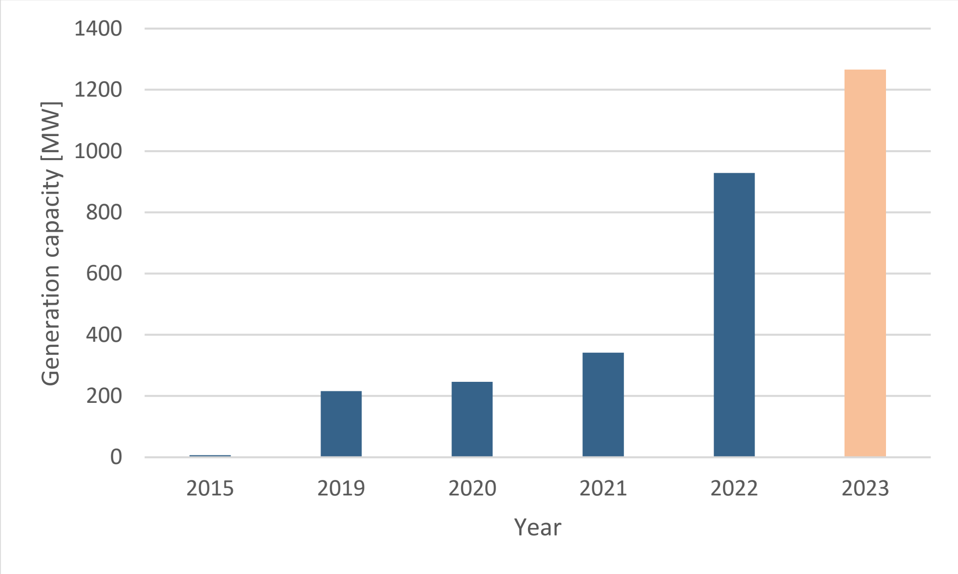
Portugal's NECP of 2020 declared the goal to reach 9.0 GW of installed solar capacity by 2030 – 2.0 GW of which is to be decentralised/rooftop capacity specifically.[58] Due to the shift in climate and energy policies throughout Europe, the Portuguese government recently revised this goal and increased its ambition to 20.4 GW – 5.5 GW of which is to be rooftop capacity.[59] In 2022, total installed solar PV capacity already surpassed 2.5 GW, generating 3.471 TWh of electricity the same year. Between 2015 and 2019, installed capacity of self-consumption generation units (UPAC, as abbreviated in Portuguese) specifically also increased from 6.4 MW to 215.7 MW (205 MW of which realised in 2019 alone[60]), reaching 1.0% of the total 2019 generation capacity.[61] By 2022, the UPAC installed capacity surpassed 929 MW and by August 2023, it reached 1266 MW.[62]

Portugal's NECP highlights its drive to promote production and self-consumption of renewables, particularly involving citizens and energy communities.[63] To enable this, the legal framework was adjusted in 2019 allowing and promoting energy communities and self-consumption of renewable generation (Decree-Law No 162/2019 of 25 October 2019). This law, along with the Self-Consumption Regulation published in 2020, have simplified the rules and licensing of self-consumption units, also speeding up the process for obtaining the necessary permits and authorizations. The energy produced is accounted for in 15-minute periods, and used to offset energy consumption during the same period only.

[57] Direcao Geral de Energia e Geologia (2023). Estatisticas rapidas - Agosto de 2023
[58] Resolution of the Council of Ministers (2020). National Energy and Climate Plan
[59] Resolution of the Council of Ministers (2023). National Energy and Climate Plan 2030 - Revision
[60] Macedo Vitorino (2021), Portuguese small production and Self-consumption solar plants.
[61] IEA (2021), Portugal 2021: Energy policy review
[62] Direcao Geral de Energia e Geologia (2023). Estatisticas rapidas - Agosto de 2023
[63] Portugal (2019), NECP 2030

Following these new regulations, in 2020, the installed capacity of PV UPACs reached 246 MW, a 20% increase compared to the previous year[64], then 342 MW by 2021, and 929 MW by 2022 and 1266 MW by August 2023.[65] This evolution of solar self-generation capacity is shown in Figure 4-1 below.

Figure 4-1 Evolution of installed UPAC (solar self-consumption) capacity in Portugal in recent years (source: own elaboration)



**The data for 2023 does not include capacity installed in the second half of the year, and therefore is incomplete*

4.1.2. Regulatory framework for self-consumption

The first net-metering scheme was introduced in Portugal in 2014, replacing the original feed-in tariff system, as a response to the declining interest in small-scale solar PV installations and the resulting lag behind other renewable capacities (mainly wind generation) and the renewable generation goals.[66] Net-metering was subsequently replaced by a net-billing scheme.

The 2019 amendment of the legal framework (applicable from 1 January 2020) was replaced in 2022 by the new "Code" of the National Electric System (Decree-Law No. 15/2022), consolidating the different electricity sector regulations of the country[67] and establishing the permitting procedures applied for different installed capacities, including for self-consumption. It provides that the collective self-consumption model is based on the association of consumers and nearby production units to share energy. The Collective Self-Consumption Management Entity (EGAC) – to be designated by its members – represents collective self-consumption before operators and administrative entities. The Code addresses the commercial relationships between parties in self-consumption, metering and data handling, energy sharing methods in collective self-consumption[68] and energy communities, and applicable regulated tariffs. The Code also covers issues regarding the Commercial Relations Code, the Smart Grid Services' Code and in the Guide for Measurement, Readings and Data handling, which, because of the particularities of self-consumption regime, need a specific regulatory framework.[69] The Electricity Services Regulatory Entity (ERSE) also published a Regulation for self-consumption which

[64] Macedo Vitorino (2021), Portuguese small production and Self-consumption solar plants.
[65] Direcao Geral de Energia e Geologia (2023). Estatisticas rapidas - Agosto de 2023
[66] PV Magazine (2014). Portugal's net-metering law raises faint hopes
[67] Lexology (2023). the legal framework for renewable energy in Portugal
[68] The collective self-consumption model is based in the association of consumers and generation units in proximity in order to share energy. The Managing Entity for Collective Self-Consumption (EGAC) is assigned by the participants and it represents the collective self-consumption before operators and administrative entities. Source: https://www.erse.pt/en/activities/regulations-electricity/self-consumption/
[69] ERSE website

makes EGAC responsible for the relationship with the grid operator, for the purposes of managing energy sharing and making production data available, as well as for the relationship with the aggregator for the purposes of selling surpluses from collective self-consumption.[70]

The Decree-Law establishes the necessary permitting procedure for UPACs based on the installed capacity also:

- For self-consumption < 700 W: Exempt of procedure (for projects without surplus grid injection);
- For self-consumption > 700 W and ≤ 30 kW: Prior notice (for projects without surplus grid injection);
- For 100% grid injection (≤ 1 MW) and for self-consumption (> 30 kW and ≤ 1 MW): Prior registration and certificate of operation and requires DSO approval (for grid injection)

4.1.3. Remuneration for self-consumption

The net-billing scheme, also known as 'Compensation of Energy Injected into the Grid' or 'Compensação da Energia Injetada na Rede' in Portuguese, is a policy that allows electricity consumers who generate renewable energy to offset their electricity consumption with the excess energy they produce by feeding back directly into the grid. Within the net billing scheme, the quarterly-hour balance is the difference between the consumption data in kW and the data injected into the network in kW, in each 15-minute period. This means that everything that is produced in that 15-minute interval must be consumed in that same interval. What is not consumed is injected into the network and another 15-minute cycle begins. Excess injection of electricity into the grid is settled at 90% of the average Iberian spot price; with 10% being deducted to cover the grid integration costs of renewable electricity.[71] Issues related to the sale of surpluses are contracted through the electricity markets, namely organized markets, bilateral contracts or peer-to-peer trading schemes, directly or through third parties (aggregators).

The regulations also give a seven-year exemption on payment of 50-100% of grid access tariffs for energy communities and self-consumption of renewable electricity.[72]

To encourage conscious consumer behaviour, data registered by the meter on consumption and injection into the grid, installation consumption balance, and balance of energy injected into the network by the installation is shared with the self-consumer/prosumer on the same 15-minute basis.

This model is available to:

- individual self-consumers;
- collective self-consumers, organized in condominiums/ apartments/ houses located in the same geographical area; industrial, commercial or agricultural units, and other infrastructures; and
- renewable energy communities (RECs).

4.2. PESTLE analysis

The table below provides an overview analysis of the barriers, success factors and enabling conditions using the PESTLE (Political, Economic, Social, Technological, Legal and Environmental context and factors influencing the case study) method.

[70] ERSE (2023). Regulamento do autoconsumo
[71] IRENA (2019), Net billing schemes: innovation landscape brief
[72] IEA (2021), Portugal 2021: Energy policy review

Table 4-1 PESTLE analysis Portugal - Net billing scheme

Aspect	Barriers/ hindering factors	Success factors
Political		• Regulatory framework allowing and promoting individual and collective self-consumption
Economic	• Financial incentive more dependent on level of self-consumption and market prices than other support schemes. • Installation costs of advanced metering infrastructure (AMI)	• Allows for the recovery of network costs (as opposed to net metering) • Prevents the harmful spiral of more prosumers leading to less stable grid, and more investment in the grid leading to higher costs and more prosumers, potentially ending in the bankruptcy of utilities
Social	• Requires more consumer-awareness than any other supporting mechanism	• Results in a more equal distribution of burden by not over-subsidizing the prosumers, favouring the lower income households
Technological	• Additional metering need, including smart meters and inverters, energy management and communication software's • The potential need for storage (batteries) on the consumer side to make the scheme financially more lucrative for the prosumers • The net-billing scheme requires investments into IT infrastructure for matching, deduction and communication of relevant metering data within 15 minutes	• Prevents the prosumers from using the grid for 'storage' • More predictable grid, the prosumers themselves acting as a balancing service
Legal	• Lack of clarity of the law regarding the possibility of changing the remuneration scheme from a feed in tariff to a net billing scheme	• Allows suppliers to buy the surplus at a competitive price from prosumers
Environmental	• Less financial incentive for the prosumers to invest in RES	• Advancing the integration of RES technologies into the existing energy system via promoting grid stability without further investment

4.3. Scalability and replicability

The level of scalability and replicability of the measure(s) is rated via a traffic light system:

High replicability/scalability
Limited replicability/scalability
Low replicability/scalability

High replicability

From a technical point of view, net-billing in PT requires a smart meter registering the flow of electricity in both directions. While not strictly a requirement, affordable battery storage would make the scheme more profitable for the consumers. The current investment costs of these storage solutions is a hindering factor in the deployment of such schemes. There are no other constraints limiting the uptake of net-billing, and therefore can be applied anywhere where developed renewable energy markets allow for a more mature compensation mechanism. Net-billing has already been in use in 19

Member States of the EU-27 since 2018, as opposed to net-metering in the rest (with the exception of Bulgaria, where neither was applied).[73] Key points that are relevant to replicate involve:

- **15 minutes interval**: potentially opens up the floor for highly dynamic tariffs (though may be costly to replicate)
- **Injection price (for surplus electricity injected into the grid) based on the spot price**: excellent for cost-reflectivity and DR with automated systems, a little less to incentivise behaviour shift by consumers.
- **Real time data feeds to users**, also to help behavioural shift and operationalise collective self-consumption.

High scalability

Net-billing in Portugal is currently limited to the same 15 minutes period, and otherwise the excess electricity of prosumers are taken over by the grid operator at retail price (for the fraction of consumer price). This forces the prosumers to install battery capacities instead increasing the investment costs, favouring the higher income households and disincentivizing the lower income ones. This gives substantial room for the government to considerably upscale the scheme with more leniency in the billing time, giving a larger window for the settlement of the bill and the self-consumption of electricity instead of using more expensive grid-electricity, making it more attractive to lower income households. However, such a larger time window should not exceed the imbalance settlement period to avoid causing imbalances in the system and disincentivising demand-response.

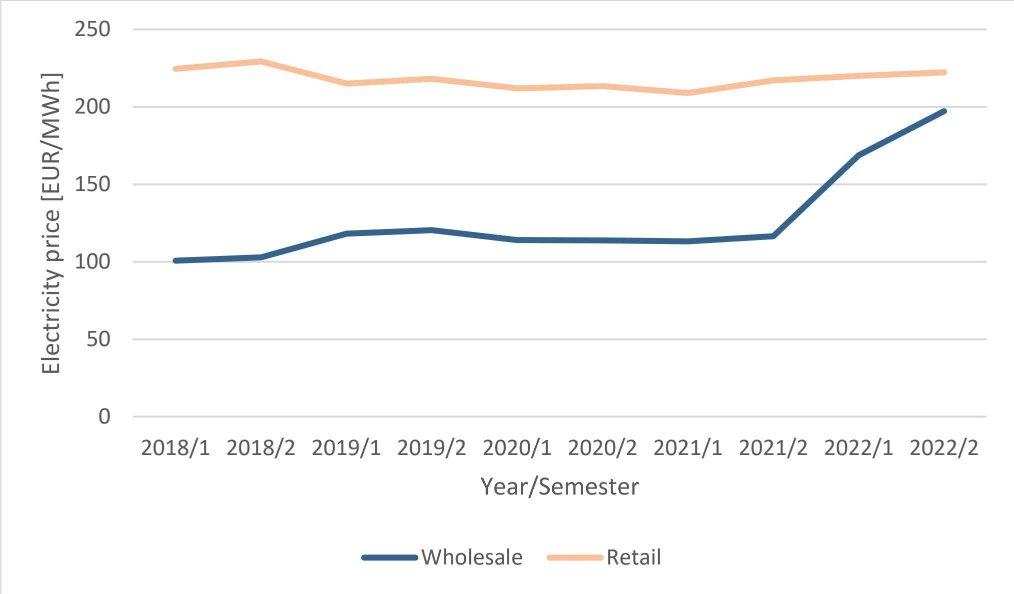
There is also an opportunity to extend the scale of the collective self-consumption model beyond the local level (i.e. same geographical area). This would allow the participation of more remote households and other market actors (industries, businesses). A clear framework with specific conditions for extending the collective schemes should be designed in this regard.

4.4. Business case analysis

Figure 4-2 below shows the evolution of the wholesale and retail electricity prices in Portugal over the past 5 year period (between 2018 and 2022). The data shows that before the beginning of the energy crisis in 2021 the wholesale electricity price made up between 45-55% of the final consumer electricity price. This rose sharply to 75-90% after the crisis started. This means that from a consumer perspective, the net-billing scheme has become a lot more advantageous in the past year than it was before, which can partially explain the increasing uptake of UPACs (as shown above in Figure 4-1), independently from the Portuguese government's policy actions. The impact of the increased electricity prices on consumers were cushioned by the government via subsidies, in-turn largely covered by windfall taxes on the electricity generators instead.

Figure 4-2 The evolution of the electricity price in Portugal (source: own elaboration based on Eurostat data)

[73] Gautier et al. (2018) The prosumers and the grid



This data shows that between 2018-2021, the average household consumer using 3420 kWh of electricity in a year[74] would have paid between 65-85 EUR more (assuming 20% UPAC utilisation based on Nagel et al.[75]) for electricity than in a net-metering scenario, roughly corresponding to a 10% increase in the yearly electricity bill. This difference shrank to 17-35 EUR in recent years due to the energy crisis. Keeping this regime and assuming the Portuguese government's above described policy goals, net-billing saves the government 180-240 million EUR annually in subsidies, in pre-energy crisis electricity prices and 50-100 million EUR within the current conditions still.

[74] Instituto Nacional de Estatistica (2021). PRELIMINARY RESULTS OF THE SURVEY ON ENERGY CONSUMPTION IN HOUSEHOLDS (2020)
[75] Nagel et al. (2023). Financial Analysis of Household Photovoltaic Self-Consumption in the Context of the Vehicle-to-Home (V2H) in Portugal

5. Energy sharing in Flanders (Belgium) and the Klimaan-Wijk Otterbeek project

Title	Improvement of conditions for households' self-consumption in Latvia
Location	Flanders (Belgium)
PV production	Gross electricity production from solar PV in 2022 (Belgium): 7.062 TWh[76] Total electricity production from solar PV in 2020 (Flanders): 3.230 TWh[77]
General barriers addressed by the case study	Economic and financial barriers: Affordability of self-consumption to average households Social and behavioural barriers: Complex arrangements with neighbours, Split incentives Technical barriers: Restrictive proximity requirement & other requirements
Type	Collective self-consumption (energy community)
Target sectors	Residential, Commercial
Technologies	Solar PV
References	• Klimaan Cooperatieve Vennootschap Home - Klimaan CVSO energiecoöperatie in het Rivierenland • Vlaams Energie- en Klimaatplan 2021-2030 (NECP): Vlaams Energie- en Klimaatplan (VEKP) 2021-2030 | Vlaanderen.be • Belgian NECP 2021-2030: What is the NECP | NEKP (nationalenergyclimateplan.be)
Contacts	• Klimaan cvso: coop@klimaan.be • Vlaamse Energie- and Klimaatagentschap: veka@vlaanderen.be

5.1. General description

In 2020, Flanders had a solar PV capacity of 3.6 GW, generating 3.2 TWh of electricity. In its NECP, the regional government states it aims to increase this capacity to 6.7 GW in 2030 and to generate 6.2 TWh of electricity.[78] To reach this objective, Flanders has planned an annual capacity growth of 300 MW between 2021 and 2025, and 318 MW from 2025 onwards. The average self-consumption rate in Flanders is estimated to be around 28%.[79]

Energy sharing in Flanders

In Belgium, policy competences related to energy are shared between the federal government and the 3 regions (Brussels-Capital, Flanders and Wallonia). The distribution of energy (gas and electricity) and the production of renewable energy are both a regional competence.[80] Therefore, regional governments are responsible for any policy and legislation related to renewable self-consumption. Moreover, all regions have their own energy regulators:

- Flanders Electricity and Gas Market Regulator (Vlaamse Regulator van de Elektriciteits- en Gasmarkt): VREG;
- Wallonia Energy Commission (Commission Wallonne pour l'Energie) : CWaPE;
- Brussels Energy Regulator (Brusselse regulator voor energie): Brugel.

[76] EurObservER (2023), Photovoltaic barometer 2023.
[77] pnec-version-finale.pdf (nationalenergyclimateplan.be)
[78] pnec-version-finale.pdf (nationalenergyclimateplan.be)
[79] Thuisbatterij | Vlaanderen.be
[80] Artikel 6, § 1, VII, eerste lid, a) en b), van de bijzondere wet van 8 augustus 1980 tot hervorming der instellingen

The integration of the definition of 'active customer' in 2021 into the Flemish Law on Energy[81] from 2009 allows for the occurrence of different forms of energy sharing. The law allows for a natural person or a legal entity (e.g. government, corporation) to engage in the following activities: energy production[82]; self-consumption of energy produced; energy storage; participation to energy services; acting as a service provider of flexibility or as a participant in flexibility or aggregation; peer-to-peer trading of energy; selling energy and/or sharing energy.

The different forms energy sharing can take in Flanders are presented in Table 5-1.

Table 5-1 Forms of energy sharing in Flanders

Form of energy sharing	Description
Peer-to-peer trading	An active customer sells the excess of its self-generated renewable electricity to another active customer (e.g. neighbour, friend, family member). Donating excess electricity for free is also allowed.
Multiple peer-to-peer trading	Multiple active customers sell or give away excess electricity to the one single active customer. However, the inverse is not allowed – an active customer may not sell or give away its excess electricity to multiple active customers.
Energy sharing with oneself	An active customer who owns another residence or building can share the energy produced in one owned building with another (or even with multiple other buildings). This can, for example, be suited for companies which can share energy between their different sites.
Energy sharing in an apartment building or multipurpose building (office complex, warehouse, etc.)	Active customers can jointly invest in solar panels on the roof of the building and share the generated power among themselves free of charge, for example, according to the amount invested.
Energy selling in an apartment building or multipurpose building	The association of co-owners, the owner (if there is no association of co-owners) or a third party can sell the renewable electricity generated to the residents or users of the apartment building or multipurpose building.
Citizens energy community	A citizens energy community is a group of active consumers who together form a legal entity so that they can produce energy, self-consume, store and/or sell energy (electricity or heat), and offer energy grid support services or electric vehicle charging services.
Renewable energy community	A renewable energy community is a citizens energy community focusing only on renewable energy (e.g. solar, hydropower, wind, etc.). Unlike the citizens energy community, the renewable energy community itself (the legal entity) owns the energy production installation. The installation and operation may be delegated to third parties.

Source: Flemish government[83] [84]

There are certain conditions that apply to all forms of energy sharing:[85]

- Energy sharing may not become a commercial or professional activity.
- Each participant must be connected to the electricity grid and be equipped with a digital meter (which can read quarterly values – see next point).
- The settlement is made on a quarter-time basis.
- Energy sharing only affects the energy component (i.e. the amount of electricity supplied by the electricity supplier). Other components of the energy bill such as taxes and network tariffs remain unchanged.
- The active customer who shares the electricity must register on the DSO's platform, which will

[81] Decreet van 8 mei 2009 houdende algemene bepalingen betreffende het energiebeleid, of "het Energiedecreet".
[82] Either at its own residence or establishment unit, or through a direct line that crosses the boundaries of its own site, where the production facilities are connected directly or indirectly through its connection to the electricity distribution network, the local electricity transmission network, a closed electricity distribution network, or a heat or cold network
[83] Energiedelen en persoon-aan-persoonverkoop | Vlaanderen.be
[84] Energiegemeenschappen | Vlaanderen.be
[85] *Ibid.*

share energy distribution data every quarter hour to the active customer and to the electricity supplier. This allows the electricity bill to be adjusted.
- Since 2023, participants do not need to have the same electricity supplier. Some electricity suppliers may apply additional fees or other constraints for energy sharing.

Klimaan - Wijk Otterbeek project

The following example illustrates a case in which energy sharing can contribute to addressing social and economic barriers to self-consumption (i.e. affordability of self-consumption to average households and split incentives) by including vulnerable households and people affected by energy poverty in an energy community. Hence, it was deemed relevant to keep this example in the scope of this study.

Klimaan vzw is a civil non-profit organisation that was created in 2018 in the aim to build a climate-neutral and sustainable society in and around the city of Mechelen (Flanders, Belgium).[86] To generate their own local renewable energy, Klimaan vzw established in 2019 a cooperative called Klimaan cvso, which would invest in renewable energy, energy efficiency and green heat projects. Currently, the primary focus of the cooperative is energy but in the longer term, the cooperative hopes to implement projects around the so called 'commons', i.e. land, resources, aid and water. Klimaan cvso currently mainly installs solar PV for private individuals, local governments, companies or associations. It also has the ambition to install wind turbines in the future.[87]

The cooperative's projects are financed by capital raised only from citizens. In exchange for their investment, they receive voting rights in the cooperative, co-ownership of the installations and share in the profits the cooperative makes.

One of the ongoing projects by Klimaan cvso is located in the neighbourhood of Otterbeek in Mechelen. This is a social housing neighbourhood in which funds raised from citizens by Klimaan allowed to equip 70 housing units with solar PV panels and an additional 15 apartments also to use the produced energy.[88] Hence tenants did not have to invest themselves and incur upfront costs but provide financial contribution to the investment through their energy bill (only for tenants with a solar PV on their rooftop, not those in apartment buildings). In addition, they may benefit from savings on their energy bills. The project was started in 2022, a total of 730 solar PV panels have been installed for a capacity of 288 kW. This is expected to generate around 262 000 kWh/year and save annually 55 tons of CO_2. The total investment cost of the project is 250 000 €.[89] The cooperative also estimated the total consumption of inhabitants to be equal to 202 720 kWh/year[90], with a self-consumption rate around 30%, i.e. 62 000 kWh/year.

The project responsibilities are divided between the energy cooperative Klimaan and the local government/social housing authority 'Woonpunt Mechelen' (renamed as 'Woonland' after merging with other organisations) as presented in Table 5-2.

Table 5-2 Task division between Klimaan cvso and local government/social housing authority

Klimaan cvso	Local government/social housing authority
• Investment capital through citizen participation • Installation, maintenance and repairs of equipment (solar PV, inverters, cabling, communication material) • Administration of the energy sharing community	• Upfront roof renovation, adequate electrical installation • Formal communication with social tenants (e.g. on major issues), ensuring access to housing • Concession on rooftops for the installation of solar panel

[86] Klimaan is een burgerbeweging in groot Mechelen
[87] Klimaan - Klimaan CVSO energiecoöperatie in het Rivierenland
[88] Eerste energiegemeenschap van ons land ligt in Otterbeek-wijk: bewoners betalen minder dan sociaal tarief door delen van 729 zonnepanelen op hun daken (Mechelen) | Het Nieuwsblad
[89] Otterbeek, Mechelen - Klimaan CVSO energiecoöperatie in het Rivierenland
[90] Based on an average consumption of 2 896 kWh/inhabitant and 70 inhabitants.

Klimaan cvso	Local government/social housing authority
• Information sharing as input for calculation of contributions per social tenant • Informal communication with social tenants (e.g. awareness raising)	• Collection of social tenant contribution to solar installation via rent charges

Source: PowerPoint-presentatie (vvsg.be)

Tenants all have different energy suppliers. The Flemish DSO (Fluvius) plays a crucial role in this project as it collects all data on production and consumption on a platform and ensures that the solar energy is shared and everything is settled correctly on the energy bill. In 2022, the price paid by tenants with a solar PV on their rooftop was 0.16 €/kWh + VAT (compared to a total average price[91] of 0.23 €/kWh[92] with a social tariff and 0.6 €/kWh without social tariff).[93] The price paid by tenants without a solar PV on their rooftop, but with whom electricity is shared was 0.07 €/kWh (+ VAT, taxes and network tariffs). This price was lower as they do not contribute to the solar PV investment. This represents huge savings for the beneficiaries of the project. It can also have a positive impact on the Flemish public budget by, e.g. contributing to lifting households out of energy poverty.

The form of energy sharing that this project is taking is an **energy community** (both citizens and renewable, as the energy community owns the renewable energy production installation), in which the solar PV equipment is owned by the cooperative Klimaan cvso and the energy community benefits from solar power.[94] For individual consumers that do not have the means (e.g. vulnerable households, people affected by energy poverty…) or the motivation to engage in renewable self-consumption, this kind of project (i.e. joining an energy community or any other type of energy sharing project, at zero/low cost) is a rather good solution as it ensures sustainable participation and access to remote renewable energy for the purpose of self-consumption without having to carry the entirety of the investment cost.

5.2. PESTLE analysis

The table below provides an overview analysis of the barriers, success factors and enabling conditions using PESTLE (i.e. Political, Economic, Social, Technological, Legal and Environmental context and factors influencing the case study).

Aspect	Barriers/ hindering factors	Success factors
Political	• Subsidies are irregular (up and down and no long term approach) • Slow deployment of electronic meters is slowing down the deployment of collective self-consumption • Price for power reshared to the grid should be market conform •	• There is a framework for energy sharing in Flanders, which includes various forms.
Economic	• In Flanders, energy sharing only affects the energy component of the energy bills. Network tariffs remain unchanged. As network tariffs do not differ in light of peak demand, it fails to incentivise self-consumption whenever it is beneficial for the grid. • Energy providers charge high administrative fees per year to share	• Tenants did not have to incur any upfront costs in the Klimaan Otterbeek project and benefit from reduced energy bills. • The price paid by tenants for electricity is lower than the market price (and social tariff) for electricity.

[91] Including energy cost, network tariffs, taxes and VAT.
[92] In 2023, the social tariff has increased to 0.29 €/kWh. Source: PowerPoint-presentatie (vvsg.be)
[93] Eerste energiegemeenschap van ons land ligt in Otterbeek-wijk: bewoners betalen minder dan sociaal tarief door delen van 729 zonnepanelen op hun daken (Mechelen) | Het Nieuwsblad
[94] PowerPoint-presentatie (vvsg.be)

Aspect	Barriers/ hindering factors	Success factors
	surplus electricity from solar PV with neighbours, family or oneself .[95]	
Social	• Not every energy supplier allows energy sharing.	• The Klimaan Otterbeek project includes vulnerable households into a local renewable energy project. • It also enables collaboration between various local stakeholders (i.e. municipality, social housing company, energy community, citizens).
Technological	• Both the sender and receiver must have a digital meter. • Incompleteness of the data platform Atrias: energy suppliers must do net-accounting of relevant metering data themselves (instead of receiving this data from Atrias); real-time data communication on shared electricity is delayed.	• Since 2023, participants to energy sharing do not need to have the same electricity supplier which used to be a barrier to the sharing of self-produced energy.
Legal	• Lack of national strategy plans & policies for self-consumption.	• Simple administrative procedure.
Environmental	• Permits take too long.	•

5.3. Scalability and replicability

The level of scalability and replicability of the Klimaan Wijk Otterbeek project is rated via a traffic light system:

High replicability/scalability
Limited replicability/scalability
Low replicability/scalability

High replicability

No particular element of this project is unique/specific to Flanders (Belgium), it can be implemented in any Member State as long as the local legal and regulatory framework allows for energy sharing and the appropriate data platform and IT infrastructure is in place. This project can contribute to addressing energy poverty of households. The implementation of such a project however requires the rollout of digital meters to monitor the production and consumption of energy and adapt energy bills accordingly. In addition, it requires significant participation of citizens into the cooperative to raise sufficient funds as well as of DSOs that are responsible for collecting production and consumption data and settling energy bills.Finally, it requires third party ownership for energy sharing projects.

High scalability

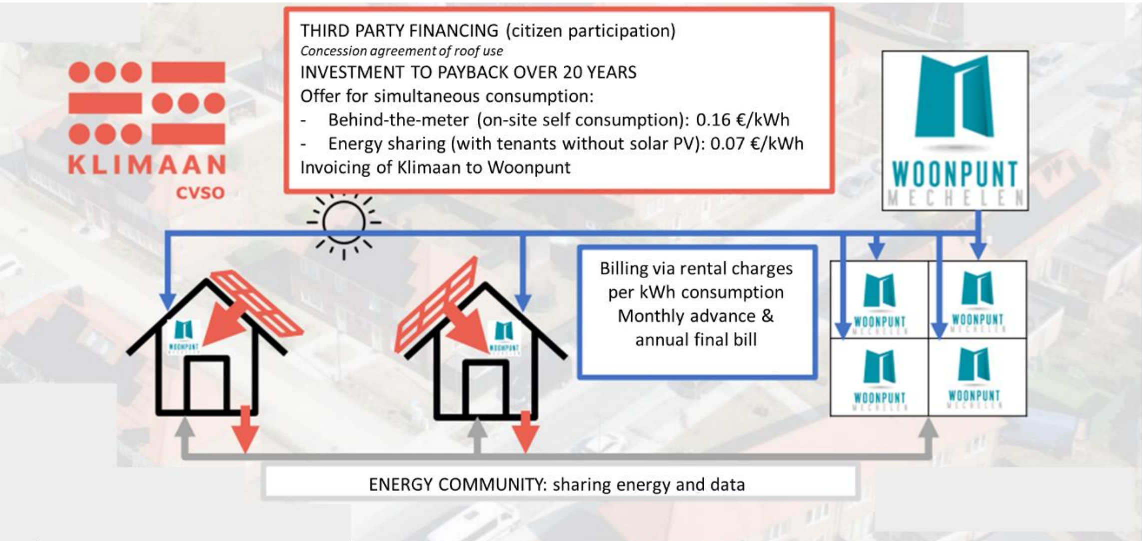
The project Klimaan Otterbeek focuses on the installation of solar PV in a social housing neighbourhood. However, this kind of energy sharing projects through a citizen cooperative can be easily scalable to other sectors (e.g. commercial or local government buildings) and with other technologies (e.g. wind turbines, heat or cold network). A key factor for the success of such initiatives is a good collaboration between various local actors involved (i.e. authorities, social housing companies, energy community).

[95] https://www.test-aankoop.be/woning-energie/hernieuwbare-energie/nieuws/hoge-kosten-leveranciers-nekken-energiedelen?updateBeanConsent=true

5.4. Business case analysis

Figure 5-1 presents visually the organisation of the Otterbeek project. Klimaan finances the equipment through citizen participation. The investment is paid back over a period of 20 years. Social tenants participating in the energy community can either self-consume their energy at a fixed energy tariff of 0.16 €/kWh (which is derived from the 20-year amortisation period) + VAT or share it with other tenants participating in the energy community (tenants that do not have a solar PV) at a tariff of 0.07 €/kWh + VAT, taxes and network tariffs. Energy charges are collected from beneficiaries by Woonpunt via rental charges, and are then invoiced by Klimaan.

Figure 5-1 Financial organisation of the Klimaan Wijk Otterbeek Project



Source: Translated to English from PowerPoint-presentatie (vvsg.be)

In April 2023, Klimaan cvso calculated the financial benefit for a tenant that participates in the Otterbeek project, based on the following assumptions:[96]

- Social tariff: 0.29 €/kWh[97];
- Market price (all included): 0.38 €/kWh[98];
- Offer for simultaneous consumption of energy:
  - Behind-the-meter (on-site self-consumption by social tenants with rooftop solar PV) at 0.16 €/kWh (+ VAT);
  - Energy sharing with tenants in apartment buildings without a rooftop solar PV at 0.07 €/kWh (+ VAT, taxes and network tariffs);
- Self-consumption rate (i.e. simultaneous consumption during solar hours based on a simulation) of 30%.

The benefits are shown in Table 5-3, which compares annual financial savings of Otterbeek project beneficiaries compared to households with/without social tariff.

[96] PowerPoint-presentatie (vvsg.be)
[97] Based on 2023 data (VREG)
[98] Based on 2023 data (VREG)

Table 5-3 Comparison of annual financial savings of Otterbeek project participants compared to households with/without social tariff

Annual consumption	Annual savings compared to social tariff		Annual savings compared to market price	
	Self-consumption PV	*Energy sharing*	*Self-consumption PV*	*Energy sharing*
2896 kWh/household *(Wijk Otterbeek avg. consumption)*	113 €	122 €	191 €	139 €
800 kWh/household	31 €	34 €	53 €	38 €
1200 kWh/household	47 €	51 €	79 €	58 €
3500 kWh/household	137 €	148 €	231 €	168 €

Source: Translated to English from PowerPoint-presentatie (vvsg.be)

The table shows that households with an average annual consumption of 2 896 kWh participating in the energy community and living in a house with rooftop solar PV can save:

- 113 €/year compared to households paying the social tariff; and
- 191 €/year compared to households paying the market price.

Those living in an apartment building with which energy is shared can save:

- 122 €/year compared to households paying the social tariff; and
- 139 €/year compared to households paying the market price.

In addition, we have compared three cases for households living in a house with rooftop solar PV: a base case (with no self-generation or self-consumption); a low self-consumption case, where there is self-generation but a limited amount of self-consumption, with most of the energy generated being injected to the grid); a medium self-consumption case (where around half of the generated energy is self-consumed); and a high self-consumption case (where a large part of the self-generated energy is directly self-consumed). We assume that there is no energy sharing with other participants of the energy community. The higher the self-consumption rate, the lower the energy bill.

	Base case	Low self-consumption case	Medium self-consumption case	High self-consumption case
Total energy used	395 kWh	395 kWh	395 kWh	395 kWh
Total energy generated	NA	400 kWh	400 kWh	400 kWh
Self-generated energy used directly	NA	100 kWh	210 kWh	300 kWh
Behind the meter tariff	*0,16 €/kWh*	*0,16 €/kWh*	*0,16 €/kWh*	*0,16 €/kWh*
Total cost for self-consumption (excl. VAT)	*0 €*	*16 €*	*34 €*	*48 €*
VAT	*21 %*	*21 %*	*21 %*	*21 %*
Total cost for self-consumption (incl. VAT)	0 €	19 €	41 €	58 €

	Base case	Low self-consumption case	Medium self-consumption case	High self-consumption case
Excess energy (injected into grid)	NA	300 kWh	190 kWh	100 kWh
Energy consumption from the grid	395 kWh	295 kWh	185 kWh	95 kWh
Market price	*0,38 €/kWh*	*0,38 €/kWh*	*0,38 €/kWh*	*0,38 €/kWh*
Social tariff	*0,29 €/kWh*	*0,29 €/kWh*	*0,29 €/kWh*	*0,29 €/kWh*
Total cost for electricity from the grid (without social tariff)	150,10 €	112,10 €	70,30 €	36,10 €
Total cost for electricity from the grid (with social tariff)	114,55 €	85,55 €	53,65 €	27,55 €
Total energy bill (without social tariff)	150,1 €	131,5 €	111,0 €	94,2 €
Total energy bill (with social tariff)	114,6 €	104,9 €	94,3 €	85,6 €

6. One-Stop Shop for renewable energy technologies

Title	Improvement of conditions for households' self-consumption in Latvia
Location	Central and Eastern Europe: Bulgaria, Cyprus, Lithuania, North Macedonia, Slovakia & Slovenia
General barriers addressed by the case study	**Social and behavioural barriers**: Lack of awareness/misconceptions **Institutional barriers**: Complex/ burdensome procedures for RES projects, lack of staff/expertise on RES **Economic and financial barriers:** Affordability of self-consumption to average households
Type	Individual, Collective
Target sectors	Residential, commercial and industrial
Technologies	Renewable and energy-efficient technologies (PV, Heat Pumps, AC, Heat pump tumble dryers)
References	• https://www.clear-x.eu/ • JRC (2021), One-stop shops for residential building energy renovation in the EU
Contacts	• Sara Patrone. Project Manager: sara.patrone@beuc.eu

6.1. General description

CLEAR-X stands for "Consumers Leading the EU's Energy Ambition Response, Expansion". It aims to enable consumers to lead the energy transition by investing in renewable energy and energy-efficient technologies. CLEAR-X aims to engage 38,000 consumers to trigger €27 million worth of renewable installations in Bulgaria, Cyprus, Lithuania, North Macedonia, Slovakia & Slovenia. The project has four specific objectives:

- Make reliable information available on RES and EE technologies suitable for consumers' homes;
- Encourage consumers to collectively invest in suitable RES technologies through trusted collective purchase schemes;
- Provide consumers with relevant information and advice on RES and EE technologies;
- Facilitate consumers' adoption of RES and EE technologies and relevant market offers via improved regulatory frameworks.

Consumers will have access to a selection of lab-tested products, a selected installer, and a trusted third-party contact point throughout their purchase journey, facilitating the adoption of renewable and energy-efficient technologies. The project aims to get the best possible deal for consumers through collective actions resulting in group purchases, and to generate learnings that can be built upon, so that further roll-out of renewables across Europe is more consumer-centric.

CLEAR-X has enabled self-consumption by supporting consumers to install PV panels on their homes (in LT, CY, SK) – or in Lithuania to purchase a segment of a solar park in a collective purchase. CLEAR-X has, in particular, helped bring down the barriers to installation of PVs (the first step often being to install a smart meter and become a more informed energy consumer) and thus engaging in self-consumption. CLEAR-X has encouraged the following through advocacy work:

- Improvement of the roll-out of smart meters in Cyprus by the Electricity Authority agreeing not to charge consumers for smart meters.
- Update of the "Obnov Dom" or "Renovate a House" scheme by the Slovakian Agency for the Environment (Slovenská Agentúra Životného Prostredia), increasing the costs covered, adding pre-approved products such as PV panels and heat pumps and removing support for gas

boilers, as well as providing advice and administrative support to consumers.

- Update of the "Green to Households (Zelená Domácnostiam)" scheme by the Slovak Innovation and Energy Agency (Slovenská Inovačná a Energetická Agentúra), increasing budget for RES installations and improving the allocation system.
- Increase in funding for RES and EE measures under the Slovakian Recovery and Resilience Plan
- Redirecting unused funds in 2022 to funds for EE and RES installations by the Minister for the Economy.

Textbox 6-1 Consumer platform for purchasing solar energy in remote PV plants (Lithuania)

Lithuania has passed legislative amendments which enable self-consumption of offsite generated electricity. As such, citizens can buy or rent a remote solar panel through an online platform.[99]

CLEAR-X has launched a campaign 'ALCO collective action for solar park purchasing in Lithuania' which also focuses on providing consumers with access to remote solar parks.[100]

CLEAR-X has prepared advocacy documents, including for example consumer checklists for PV panels and heat pumps. With regards to self-consumption, CLEAR-X identified the following key barriers and provided the following recommendations:

Table 6-1 Policy recommendations for empowering prosumers[101]

Barrier	Policy Recommendations
High financial cost (especially upfront costs) of renewable technology purchases and installations	National governments should create ambitious financial support schemes for households with average or low income. Communicate these support schemes offline and allow time for less digitally savvy consumers to apply. Upfront costs should be tackled by covering as much of the costs as possible in advance of the works taking place, through for instance tripartite contracts (e.g. Slovenia and Lithuania) or voucher schemes (e.g. Portugal). Promote financial instruments such as on-bill schemes that allow consumers to pay back their renovation in instalments. Consider income tax relief schemes for RES installations and energy renovations. Promote low and zero-VAT schemes for RES purchases and installations.
Multi-unit Buildings: Complicated governance and lack of decision-making capacity to install RES technologies	Consumer organisations should assist local and regional authorities in providing a strong governance and leadership role in ensuring the transition to renewable energy. Tackle national regulatory frameworks around property law and governance of multi-unit buildings (e.g. Spain), such as special status in terms of consensus and governance issues for the installation of renewables in multi-units.
Split incentives between tenants and landlords	Increase tenant access to renewables through dedicated legislation (e.g a tenant right to electricity). Consider mandates on landlords – such as the "solar obligation" introduced across some states in Germany – to ensure increased uptake of solar technologies, as well as the role of Energy Performance Certificates or similar enforcement tools.
Difficulty in Accessing Smart Meters	Public authorities should be responsible for the roll-out of smart meters and clearly communicate about it. This should be done in collaboration with relevant stakeholders such as energy suppliers, consumer organisations and the construction sector. National regulators should run a cost benefit analysis on the benefits of smart meter rollout. This would highlight the benefits that flexible energy consumption would have in terms of lower costs for the management and operation of electricity grids.

[99] E.g. Solar community (Lith. "Saulės bendruomenė") government-led project. Source: Infrastructure case study : Lithuania's Prosumer Solar Community Model &
[100] https://www.clear-x.eu/lithuanian-consumers-collective-purchase-solar-energy/
[101] As presented in: CLEAR-X Advocacy Two-pager

Barrier	Policy Recommendations
Consumer Access to Information, Advice and Installation	Public authorities should put in place single points of contact (such as one-stop-shops) to facilitate administrative and operational procedures for housing renovations and RES installations. Consumer organisations can play a role in developing such one-stop-shops, in collaboration with local authorities. Public authorities must oversee an increase in training and accreditation of the workforce to ensure an adequate number of RES installers. Member States should fully implement Article 12 of the EED (2012) and Article 16 of the RED (2018).
Administrative Barriers, Grid Connections, and Regulatory Framework for PV installations	Implement a stable regulatory framework that simplifies administrative processes such as permit-granting. Ease the grid connection process by investing in the grid, while also monitoring grid operators and sanctioning in cases of ineffective operation. Monitor that distribution system operators use distribution fees correctly (and properly enforce Article 15 of the Electricity Directive (2019).
Lack of Incentives for Demand Side Flexibility	Ensure consumers have access to energy contracts with dynamic electricity pricing and access to aggregation contracts (ensure this through full implementation of Articles 11 and 13 of the Electricity Directive (2019).
Lack of Consumer Rights and Benefits as a Prosumer	Ensure self-consumers are appropriately remunerated for selling their electricity back to the grid. Expand consumer rights and protections for prosumers. Allow prosumers to switch suppliers. Provide prosumers with a single contact point for dispute resolution such as an energy ombudsman.

6.2. PESTLE analysis

The table below provides an overview analysis of the barriers, success factors and enabling conditions using PESTLE (i.e. Political, Economic, Social, Technological, Legal and Environmental context and factors influencing the case study).

Aspect	Barriers/ hindering factors	Success factors
Political & Legal	• Various, depending on the national context. Collective purchasing of offsite solar PV capacity should be allowed by law.	• Provides policy recommendations for empowering prosumers across Europe • Legislation that enables self-consumption of electricity generated in remote locations
Economic	• Consumers can often not afford the upfront costs of RES products	• Group procurement to lower costs: Economies of scale encourage consumers to collectively invest in RES technologies via trusted collective purchase schemes
Social	• Consumers often are more concerned with the upfront purchase cost and are not strongly convinced that self-consumption will save them money in the long run.	• Elements to increase trust: Provides reliable, relevant information and advice on RES and EE technologies through dedicated digital tools in the target countries. The tools enable consumers to – for example - explain the potential savings of installing solar PVs, taking into account net-metering scheme's impact and calculate how much CO_2 is saved as well as how many trees need to be planted to absorb the resulting CO_2.
Technological		• IT infrastructure to extract relevant data and allow for self-consumption of offsite generated electricity • Online, easy to use platforms

6.3. Scalability and replicability

The level of scalability and replicability is rated via a traffic light system:

High replicability/scalability
Limited replicability/scalability
Low replicability/scalability

High replicability

CLEAR-X covers six Member States (Bulgaria, Cyprus, Lithuania, North Macedonia, Slovakia & Slovenia), and follows the projects CLEAR 2.0 and CLEAR, which covered Italy, Spain, Portugal, Slovenia, Czechia, Belgium and the UK. The One-Stop-Shop concept developed can be replicated in the rest of the EU27.

High scalability

CLEAR-X targets specific technologies, one of which is PV (only in Lithuania, Slovakia and Cyprus). PV could be addressed consistently for all countries. Further emphasis could be placed on individual and collective self-consumption in the platform.

7. Denmark's net-settlement scheme: special grid tariffs and taxes for self-consumption

Title	Improvement of conditions for households' self-consumption in Latvia
Location	Denmark
PV production	Gross electricity production from solar PV in 2022: 2.181 TWh102
General barriers addressed by the case study	**Institutional barriers**: Insufficient grid planning for the integration of self-consumption
Type	Individual self-consumption
Target sectors	Residential and tertiary sector
Technologies	PV, EV, heat pump
References	• SWECO (2019), Distributed electricity production and self-consumption in the Nordics. • CE Delft (2021), Potential of prosumer technologies in the EU. PROSEU results. • Ziras, c. et al (2021), The effect of net metering methods on prosumer energy settlements • Martín, H. et al (2021), Analysis of the Net Metering Schemes for PV Self-Consumption in Denmark
Contacts	• Danish energy agency (ens@ens.dk)

7.1. General description

As of 2021, the electricity generated by prosumers in Denmark was over 5% of the electricity demand of the residential and tertiary sector (the highest share in the EU).[103] Denmark pioneered in the self-consumption field implementing annual net metering with electricity tax exemption already in 1999.[104] Since then, several regulatory changes have taken place, involving a FiT for surplus electricity and the exemption of an additional surcharge of the network tariff, i.e., the public service obligation (PSO – which was in the meantime phased out).[105] The combination of decreasing PV costs and rising electricity prices, along with the regulatory support towards self-consumption, resulted in a surge in the adoption of PV systems. Given that in Denmark network tariffs and taxes comprise around two thirds of the retail electricity price, the increase in self-consumption led to a significant reduction of fiscal income.[106] New regulatory changes shifted from annual to hourly compensation (instantaneous netting as of 2012[107]), and entailed progressive reductions and eventual elimination of the FiT. As of 2021, the only advantage for new PV prosumers was the total or partial exemption on certain tariffs and taxes (which differs per customer segment) on self-consumed energy.[108]

Net settlement scheme (net billing)

The Danish BEK 999/2016 regulatory framework sets the methodology for the hourly net settlement scheme for PV self-consumption. Under this scheme, the self-producer can obtain partial or total exemption of certain taxes and tariffs for the self-consumed electricity.[109] A distinction is made between

[102] EurObservER (2023), Photovoltaic barometer 2023.
[103] CE Delft (2021), Potential of prosumer technologies in the EU. PROSEU results.
[104] Martín, H. et al (2021), Analysis of the Net Metering Schemes for PV Self-Consumption in Denmark
[105] Martín, H. et al (2021), Analysis of the Net Metering Schemes for PV Self-Consumption in Denmark
[106] Martín, H. et al (2021), Analysis of the Net Metering Schemes for PV Self-Consumption in Denmark
[107] Ziras, c. et al (2021), The effect of net metering methods on prosumer energy settlements
[108] Martín, H. et al (2021), Analysis of the Net Metering Schemes for PV Self-Consumption in Denmark
[109] Martín, H. et al (2021), Analysis of the Net Metering Schemes for PV Self-Consumption in Denmark

direct- and installation-connected PV, where direct connected refers to systems located at the place of consumption but directly connected to the public electricity supply and installation-connected refers to system connected to a private supply system.

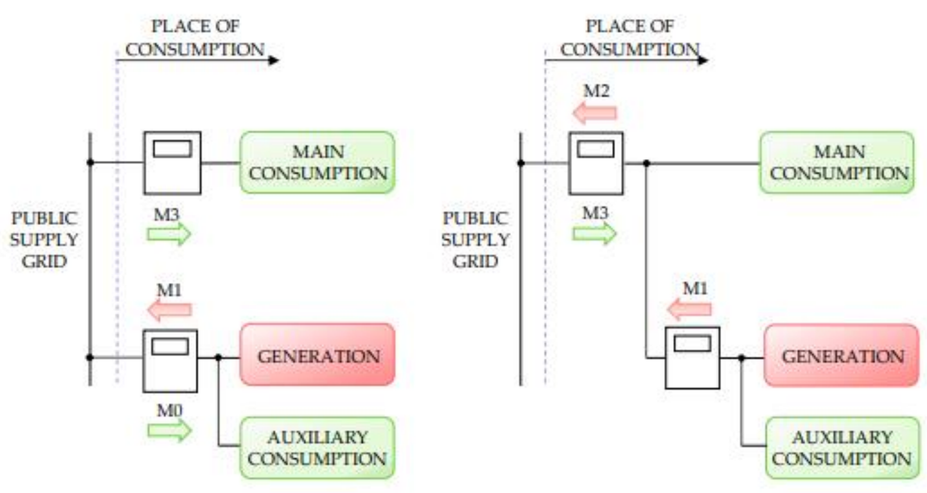
Plants approved for entering into hourly net settlement can also opt to sell all production (group 1) or only their surplus (group 2). New plants not applying or waiting for approval enter into an instant net settlement scheme where net power demand (consumption minus production) is sampled instantaneously, and then these samples are accumulated separately as imports and exports as opposed to sampled in one hour intervals.[110]

Table 7-1 Net settlement scheme for PV. Source: Adapted from Martín, H. et al (2021)

Connection	Rated power	Electricity sold	Taxes and tariffs
Direct-connected	>50kW	Group 1: All & Group 2: Surplus	Partial PSO exemption
	=<50kW	NA	No exemption
Installation connected	>50kW	Group 1: All & Group 2: Surplus	Partial PSO exemption
	=<50kW	Group 1: All & Group 2: Surplus	Total PSO exemption

Figure 7-1 Types of connection and metering points[111]

Direct connected (a) Installation-connected (b)



The metering points (data read on 15/60 min basis):

- M0 – Auxiliary or own consumption of the facility
- M1 – Net energy production
- M2 – Energy delivered to the public supply grid
- M3 – Energy obtained from the public supply grid

The main difference between the connection types lies on the location of their respective M3 metering points (measuring energy obtained from the public supply grid). Different metering points are then calculated which allow to define the billing concepts. For facilities with the same generation and consumption, the measured imports (NFN) and exports (NTN) from/to the grid, as well as gross consumption (BF) and self-consumption (EP) are the same regardless of the connection type.

[110] Martín, H. et al (2021), Analysis of the Net Metering Schemes for PV Self-Consumption in Denmark
[111] Martín, H. et al (2021), Analysis of the Net Metering Schemes for PV Self-Consumption in Denmark

In Denmark, electricity bills are composed of the following elements[112]:

- Market electricity price – for the purchase and sale of electricity at net settled facilities
- Feed in tariff - is paid by the net settled facilities to the TSO for the net electricity to supplied network.
- Balance consumption / production tariff – are applied on the consumption and production metering points respectively and are related to the costs for the TSO of the system services and the balance market.
- PSO tariff – to cover the costs incurred by the TSO mainly for subsidizing renewables, but also decentralized cogeneration and related research and development. This tariff was phased out in 2022 (though still considered in the context of this case study).
- Availability tariff – a tariff applied by the DSO to installation-connected facilities with which prosumers pay for the availability of the distribution grid in proportion to their self-consumption. (Replaced by a fixed yearly availability subscription for group 2 facilities with rated power 50 kW or lower not having M1).
- TSO system and grid tariffs – cover respectively the costs of security and quality of the electricity supply, and the operation and maintenance of the transmission grid and its international connections.
- DSO grid tariff – which covers operation and maintenance costs, losses, depreciations, meter reading and other expenses of the distribution grid.
- Electricity tax –Tax levels depend on the customer type and the final use of energy, and certain corporate customers can be entitled to either almost full or partial reimbursement of the paid electricity tax.
- VAT - A 25% VAT rate is charged in the electricity bill. VAT registered business customers may be entitled to full or partial VAT deduction.

Self-consumers can save on the following elements[113]:

- Market electricity price - Avoided purchase cost before taxes of the self-consumed energy.
- Availability tariff – since prosumers pay in proportion to their self-consumption.
- TSO grid and TSO system tariffs – Paid on the net electricity from network instead of the total consumption.
- PSO tariff – Paid on the net electricity from network instead of the total consumption. A reduced PSO tariff is applied which excludes the part intended to subsidize renewables and is applied to the self-consumed electricity of the net settled facilities above 50 kW. PV facilities up to 50 kW have whole PSO exemption on their self-consumption.
- Electricity tax – Self-consumption can be exempted from this tax if it is consumed by the producer himself, i.e., within an internal electricity grid.[114] While residential PV facilities up to 6 kW retain the hourly net settled basis for the electricity tax (net electricity from network), instantaneous settlement applies for the rest of cases.
- VAT - Private net-settled customers neither deduct the input VAT nor charge VAT on their electricity sales. A study from Martin et al. (2021) indicates that in cases where these commercial customers are not entitled to full electricity tax and VAT reimbursement, they can also save on the avoided electricity tax and VAT on the self-consumed energy. [115] This means that these customers can benefit from paying this tax on M3 rather than on the BF metering point (with installation connected type). The same (as the installation-connected commercial customers not entitled to full electricity tax and VAT reimbursement) applies to residential customers, with the added benefit of hourly rather than instant settled electricity tax.

[112] Martín, H. et al (2021), Analysis of the Net Metering Schemes for PV Self-Consumption in Denmark
[113] Martín, H. et al (2021), Analysis of the Net Metering Schemes for PV Self-Consumption in Denmark
[114] This requirement excludes direct-connected facilities from the electricity tax exemption on the self-consumed electricity, which therefore must pay this tax on their gross consumption.
[115] Martín, H. et al (2021), Analysis of the Net Metering Schemes for PV Self-Consumption in Denmark

The main billing items and their application to the different connection type facilities are listed below.

Table 7-2 Main billing items applied on the energy registered at the different metering points of PV net settled facilities. Source: Adapted from Martín, H. et al (2021)

Main billing items (c€/kWh)	Connection type*	Metering point
DSO grid tariff + Electricity tax	Direct / Installation	(M0+)M3 (Energy from the grid)
Market price + Balance consumption tariff	Direct / Installation	CMP (Consumption metering point)
Market price + Balance production tariff	Direct / Installation	PMP (Production metering point)
TSO grid tariff + TSO system tariff + PSO tariff	Direct	NFN (net from network)
TSO grid tariff + TSO system tariff + PSO tariff + Electricity tax**	Installation	
Feed in tariff	Direct / Installation	NTN (net to network)
Reduced PSO tariff	Direct / Installation	EP (Self-consumption)
Availability tariff	Installation	RH (Availability payment)

** Billing concepts applicable for both Group 1 and 2.*

***Only for residential facilities up to 6kW*

Flexible grid connection agreements

Non-Firm contracts contain restrictions that limit export capacity, under certain conditions. Flexible grid connection agreements allow to connect a PV system or EV / heat pump despite insufficient zonal grid capacity. This arrangement foresees the possibility for the DSO to temporary curtail these connection (under compensation), and this will be valid until additional grid capacity is available. Currently these type of agreements are only available to large scale producers but are not possible for self-consumers in Denmark, but will be further discussed under best practices in Task 4.

7.2. PESTLE analysis

The table below provides an overview analysis of the barriers, success factors and enabling conditions using PESTLE (i.e. Political, Economic, Social, Technological, Legal and Environmental context and factors influencing the case study).

Aspect	Barriers/ hindering factors	Success factors
Political	• Complex regulatory regime[116] • Varied set of regulations in force for different groups of facilities is highly complex[117] • The present fixed tax structure hampers the adoption of dynamic pricing schemes for the household customers, by hiding the price signal incentive for demand-side flexibility[118]	
Economic	• Complexity of the framework hinders the evaluation of the most profitable scheme from an economic perspective. [119] • Price fluctuations are not well reflected in consumer prices, which decreases the economic feasibility of systems taking advantage of increased flexibility such as	• Net settlement incentivises self-consumption through the saved cost of the self-consumed energy and the application of the TSO grid and system tariffs as well as the PSO tax on the hourly

[116] SWECO (2019), Distributed electricity production and self-consumption in the Nordics
[117] Martín, H. et al (2021), Analysis of the Net Metering Schemes for PV Self-Consumption in Denmark
[118] Martín, H. et al (2021), Analysis of the Net Metering Schemes for PV Self-Consumption in Denmark
[119] Martín, H. et al (2021), Analysis of the Net Metering Schemes for PV Self-Consumption in Denmark

Aspect	Barriers/ hindering factors	Success factors
	distributed electricity production combined with internal storage.[120] • The economic incentive to invest in flexible systems are limited by the current non-dynamic tariffs and taxes on energy which make up the bulk of the consumer prices.[121] • The phasing-out of the PSO and electricity taxes decrease the incentive to invest in own production.[122] • Legislation on connection for new production units (tilslutningsbekendtgørelsen): Shift in the regulation regarding the connection of new RE units to the grid is shifting the economic burden from DSO to the production unit owner. [123]	net from network imports, rather than on the gross consumption. [124] • The different impact of the electricity tax depending on the customer segment can be an indirect incentive favouring the adoption of PV self-consumption for the small residential systems and for those commercial customers not entitled to full electricity tax and VAT reimbursement. Customers may avoid electricity tax and VAT on the self-consumed electricity, as well as calculate the electricity tax on a lower energy amount than pure consumers. [125]
Social	• The administrative processes related to negotiating prices with local DSOs for most installations are deemed to be a complex task for households[126]	
Technological	• Lack of flexible grid-connection agreements for self-consumers may have a negative impact (delayed connections due to congestion)	
Legal	• A minor barrier exists to installation and maintenance of self-consumption plants. If a solar plant is not considered a complete product per the relevant legislation,[127] and must be assembled from various components, the plant must be installed, connected to the grid, and maintained only by authorised electrical installation companies. • If—while installing, maintaining, etc. a self-consumption plant—an authorised electrical installation company identifies a fault or deficiency in the self-consumption plant, the fault must be rectified and the owner/user becomes liable for risks associated with not rectifying that fault/ deficiency • Public law such as local plans, municipal plans, conservation measures or easements can in certain cases be a legal	• Favourable regulatory regime for self-consumption plants feeding energy into the grid[128] • Denmark's state-owned grid operator Energinet is responsible for all reporting requirements related to self-consumption plants' contributions to the grid (not home or small office owners/ users of self-consumption plants)[129] • Favourable tariff and subsidy scheme for self-consumption plants[130] •

[120] SWECO (2019), Distributed electricity production and self-consumption in the Nordics
[121] SWECO (2019), Distributed electricity production and self-consumption in the Nordics
[122] SWECO (2019), Distributed electricity production and self-consumption in the Nordics
[123] SWECO (2019), Distributed electricity production and self-consumption in the Nordics
[124] Martín, H. et al (2021), Analysis of the Net Metering Schemes for PV Self-Consumption in Denmark
[125] Martín, H. et al (2021), Analysis of the Net Metering Schemes for PV Self-Consumption in Denmark
[126] SWECO (2019), Distributed electricity production and self-consumption in the Nordics
[127] *Bekendtgørelse af lov om autorisation af virksomheder på el-, vvs- og kloakinstallationsområdet,* LBK nr 30 af 11/01/2019 (Promulgation of the Act on the authorization of companies in the area of electricity, plumbing and sewage installation).
[128] § 58. *Bekendtgørelse af lov om elforsyning* 17/01/2019 (Promulgation of the Electricity Supply Act).
[129] § 5, subsection 6, Promulgation of the Electricity Supply Act.
[130] *Kompensationsordningen* (Compensation Scheme), which sets out the currently effective Market Model 3.0, effective as of January 1 2023.

Aspect	Barriers/ hindering factors	Success factors
	barrier for establishment of RE-generation plants for self-consumption. • Building permits or land zone permits from the municipality can be required prior to establishment of RE-generations plants for self-consumption. • The complexity of the Danish Market Model regulation makes negotiating unreasonable for most residential energy producers.	

7.3. Business case analysis

This case study, as presented in Martín et al (2021), refers to a PV system with rated power of 60 kW (65 kWp) connected to low voltage grid, with hourly electricity market price for each month of 2019, ranging from 25-63 €/MWh and representative averages or regulated values for tariffs, taxes and other supplier surcharges and fixed monthly subscriptions. It exemplifies the direct-connected schemes and the different levels of exemptions on the taxes applied to electricity. The PV facility performance was simulated under the different connection types and groups from the Danish hourly net settlement regulatory framework BEK 999/2016.

When comparing yearly cost of electricity during 2019 (and the different billing concepts that make it up), the cheapest scheme corresponds to installation-connected group 2, followed by installation-connected group 1 (with 2.8% of cost increment), and at a significant distance come direct-connected group 2 and direct-connected group 1 (with 14.9% and 17.7% cost increase, respectively). The electricity tax has the greatest impact on the yearly electricity cost[131], and causes the major cost difference between the several schemes. However, its effect is cancelled in case of being entitled to full electricity tax and VAT reimbursement. The yearly cost of electricity in the case of conventional consumption not entitled for electricity tax and VAT reimbursement almost triples that of full reimbursement of taxes. This provides an indirect incentive for those producers not entitled for full tax reimbursements for adopting self-consumption.

When looking at the annual total cost of electricity excluding electricity tax and VAT (i.e. the cost to be considered in the event that the commercial customer is entitled for full electricity tax and VAT reimbursement), the installation-connected group 2 remains the cheapest scheme, but is closely followed by direct-connected group 2 (with 0.7% of cost increment), installation-connected group 1 and direct connected group 1 (with 3.7% and 4.4% of cost increment respectively).

The table below provides an overview of the different billing concepts and their impact for the different connection types and groups.

Table 7-3 Classification of the different tariffs and taxes according to their impact on the different schemes. Source: Based on Martín, H. et al (2021)

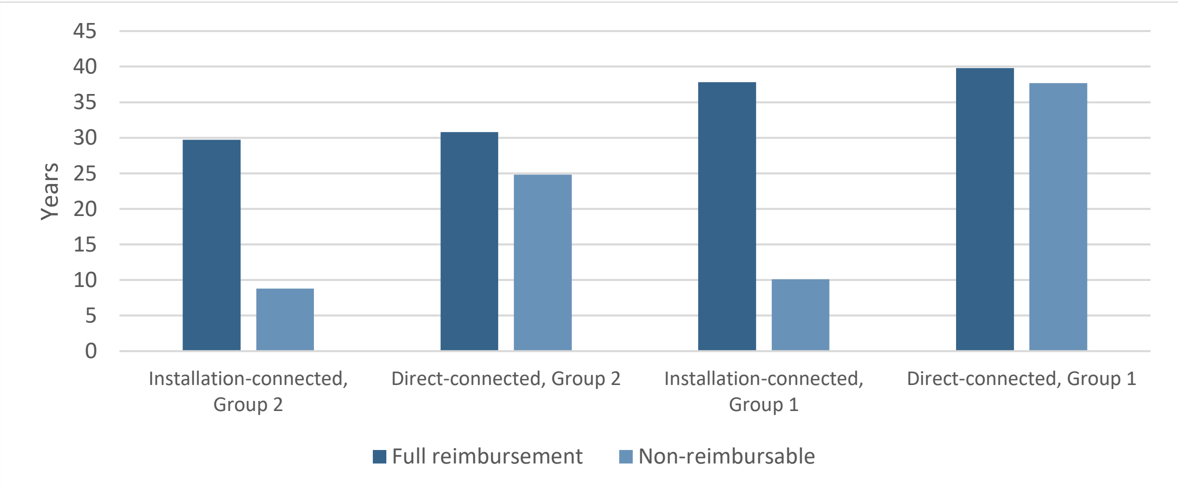
Billing concept	Impact	Explanation
Electricity tax	Uneven economic impact (depends mainly on connection type[132])	It is applied on different metering points depending on the PV facility connection type, customer segment and rated power. The electricity tax is 30% higher for direct-connected type compared to installation-connected.
VAT	Different for all schemes	This tax is applied on base amounts that vary with the connection type and group. The cost due to the electricity tax approximately doubles the cost of VAT,

[131] Specifically, the electricity tax represented above 44% and VAT the remaining 20% of the final household electricity price.
[132] If the particular case of residential customers up to 6 kW is excluded, then the charge imposed by the electricity tax is only dependent on the connection type

Billing concept	Impact	Explanation
		and translates to the total cost of electricity its greater value for the direct-connected schemes, in case of not being entitled for electricity tax reimbursement.
DSO grid tariff & availability tariff	Depends on connection type	Both depend on the grid use, and consequently they only result in an equal economic burden for facilities of the same connection type. For the case study, the DSO grid tariff imposes a yearly cost for direct-connected types that exceeds in more than 2000 € that of the installation-connected types but this is compensated by the cost above 1850 € of the availability tariff, exclusively borne by installation-connected schemes.
Electricity price, balance consumption/ production tariffs	Depends on group	Electricity purchase/selling prices (including eventual supplier surcharges) and the balance consumption/productions tariffs, are applied on the CMP and the PMP, respectively, and therefore they will affect equally to facilities of the same group. When valued at the same market price, the net cost of electricity purchases minus sales is equal for all connection types and groups. What implies a major cost for group 1 schemes with respect to group 2 ones is the impact of the consumption supplier tariff, and to a lesser extent, the production supplier tariff and the balance consumption and production tariffs.
TSO grid & system tariffs, FiT, PSO & reduced PSO tariff	Equal for all schemes	The TSO grid & system tariffs and the PSO applied on the net imports (NFN), as well as for the FiT on the net exports (NTN) and the reduced PSO on the self-consumption (EP) are the same, since the measured values are the same.

The figure below provides a rough analysis of the simple payback time for the different schemes, considering full reimbursement or no reimbursement of electricity tax and VAT. These results highlight the significantly different indirect incentive degree entailed by the high share of taxes in the final price of electricity in Denmark, depending on the customer segment. To a certain extent, saved electricity tax, rather than the mere value of the produced energy, drives the profitability of the residential PV facilities.

Figure 7-2 Analysis of the simple payback time for the different schemes, considering full reimbursement or no reimbursement of electricity tax and VAT. Source: Based on Martín, H. et al (2021)



8. Collective self-consumption in France

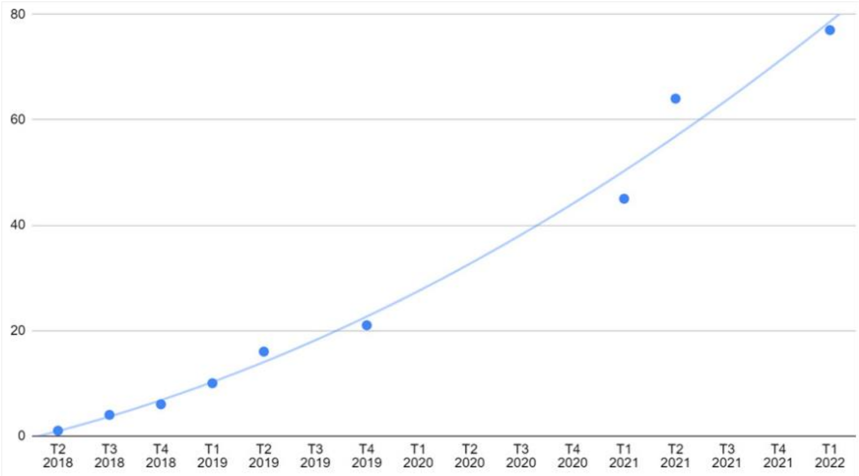
Title	Improvement of conditions for households' self-consumption in Latvia
Location	France
PV production	Gross electricity production from solar PV in 2022: 20.607 TWh[133]
General barriers addressed by the case study	**Economic and financial barriers**: Affordability of self-consumption to average households **Social and behavioural barriers**: Complex arrangements with neighbours
Type	Collective self-consumption
Target sectors	Residential, Services, Industry
Technologies	Solar PV, Smart meters
References	• McKenzie Banker (2020). Collective Self-consumption in the European Union. Universitat Politecnica de Catalnuya. Collective Self-Consumption in the European Union (upc.edu) • Climate Action Network (2022). *Engaging citizens and local communities in the solar revolution*. Rooftop Solar PV Country Comparison Report. Rooftop-Solar-PV-Country-Comparision-Report-2.pdf (caneurope.org)
Contacts	• Commission de Régulation de l'Energie (NRA) - press contact : presse@cre.fr • Enedis (DSO) - contact@enedis.com • Enerplan (Solar energy association) - contact@enerplan.asso.fr • Sia Partners (made a study on collective self-consumption in France) - charlotte.delorgeril@sia-partners.com / segolene.forestier@sia-partners.com / helene.quillien@sia-partners.com • Enogrid titouan@enogrid.com

8.1. General description

In France, individual self-consumption has been increasing since 2017, following the integration of the definition of self-consumption in the legislation the law and the introduction of public support mechanisms (feed-in-tariffs). In 2021, there were 100 000 individual self-consumption installations connected to the grid.[134] Collective self-consumption has started to slowly develop since 2018 after the introduction of collective self-consumption into the European and French legislation. As shown in Figure 8-1, there were less than 80 active collective self-consumption operations in 2022, which corresponded to an installed capacity of 3844 kW and included a total number of 977 participants (on average 13 participants/operation). Most operations are carried out by local authorities/municipalities and social landlords. In 2023, there are 246 collective self-consumption operations active on the French DSO network (Enedis).

[133] EurObservER (2023), Photovoltaic barometer 2023.
[134] Autoconsommation collective, principe et état des lieux en France en 2021 - Encyclopédie de l'énergie (encyclopedie-energie.org)

Figure 8-1 Number of active collective self-consumption operations in France since 2018



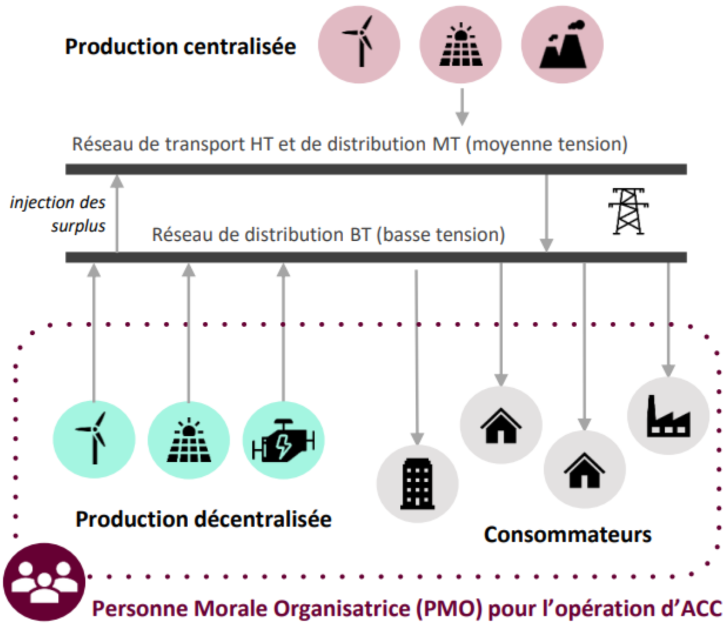
Source: Enedis[135]

In France, collective self-consumption is the sharing of electricity production for self-consumption between several producers and consumers located in close geographical proximity, without the need for supplier licence. The electricity generated in a collective self-consumption operation is always injected into the public distribution network and then distributed among the participating consumers based on a defined distribution methodology.[136] This is why collective self-consumption in France refers to an issue of economic valuation (i.e. contractual accounting of self-consumption) rather than physical distribution of electricity production. The concept of collective self-consumption as defined in the legislation in France goes beyond the EU definition of 'jointly acting renewables self-consumers' introduced by the Renewable Energy Directive (RED II), which aims to ensure that collective self-consumption can at least take place in the scope of the same building or multi-apartment block.

The French legislation requires producers and consumers to form a single legal entity (association, cooperative, company, etc.) which organises the sharing of electricity produced among its members.[137] This entity is called the 'organising legal entity'. The below figure presents an example of the organisation of a collective self-consumption operation.

135 *Ibid*.
136 Présentation PowerPoint (enerplan.asso.fr) – p.6
137 Enedis (2023), Guide pédagogique sur l'autoconsommation collective. Available at : Devenez acteur de la transition énergétique grâce à l'autoconsommation collective ! | Enedis

Figure 8-2 Organisation of collective self-consumption in France



Source: Sia Partners (2019)[138]

In the default case, collective self-consumption happens within the same building, which is connected to the low-voltage grid. The collective self-consumption perimeter can however be extended under certain conditions:[139]

- To a perimeter of 2 km – As long as the farthest load and injection points are not more than 2 km apart; the cumulative capacity of generating installations must be less than 3 MW in France's mainland or 0.5 MW in non-interconnected areas and participants must be connected to the public low-voltage distribution network.
- To a perimeter of 20 km – The organising legal entity must submit a request to the Ministry of Energy. The latter takes a decision based on the remoteness of the operation location; the dispersed nature of housing and its low population density.

All participants (producers and consumers) to the collective self-consumption operation must have a smart meter. In addition, participating consumers can choose their electricity supplier for the share of additional electricity they take from the grid.[140]

Distribution of electricity in a self-consumption operation

The organising legal entity must decide how to distribute the electricity generated among the participating consumers.[141] The DSO calculates every 30-min the total electricity generation and total consumption resulting from the collective self-consumption operation, and analyses:[142]

- The share of production that is self-consumed by the collective;
- The share of production that is not consumed and thus represents the energy surplus.

The surplus or excess electricity can be sold either on the market (at the market price or at a mutually agreed with a buyer[143]) or via a feed-in tariff. It is not subject to any public support mechanism. The

[138] Présentation PowerPoint (enerplan.asso.fr)
[139] Photovoltaique.info - Autoconsommation collective
[140] Présentation PowerPoint (enerplan.asso.fr)
[141] Climate Action Network (2022). *Engaging citizens and local communities in the solar revolution*. Rooftop Solar PV Country Comparison Report. Rooftop-Solar-PV-Country-Comparision-Report-2.pdf (caneurope.org)
[142] Présentation PowerPoint (enerplan.asso.fr)
[143] Présentation PowerPoint (sia-partners.com)

share of production that is self-consumed is allocated to each consumer according to a 'distribution coefficient'. There are three types of distribution coefficients:

- Fixed coefficient: The distribution of electricity among consumers is made based on a fixed criteria, e.g. the surface area of each consumer's home, the share invested in the collective self-consumption operation or the share of building co-ownership. This coefficient is the simplest but it is not optimal for the operation. For example, when a consumer is temporarily absent, the production he/she has not consumed cannot be allocated to the other participants in the operation and must thus be sold as excess electricity. Table 8-1Table 8- presents an example of the evolution of electricity distribution among collective self-consumption participants over time, with a fixed coefficient distribution.

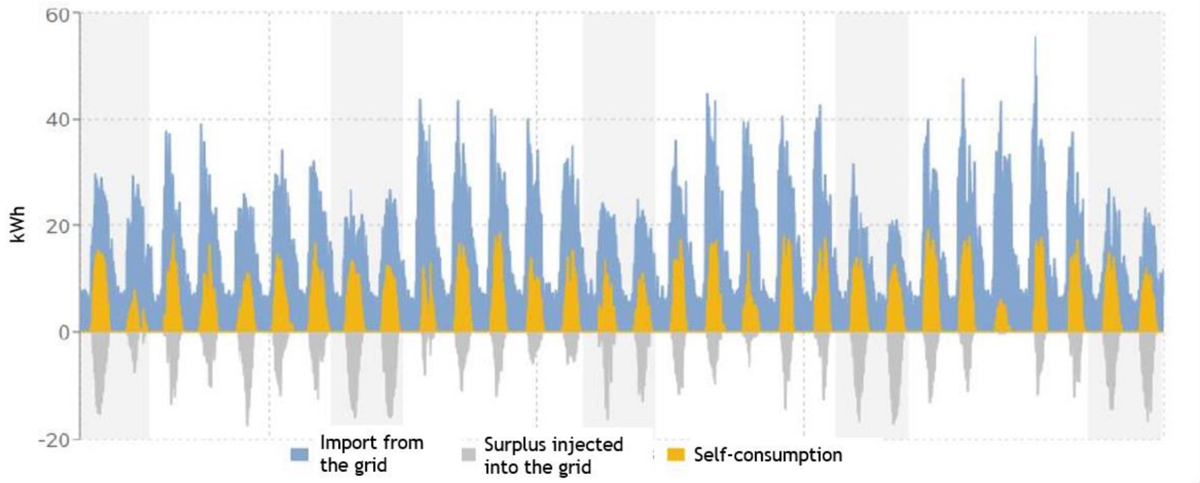
Table 8-1 Example of the evolution of electricity distribution among collective self-consumption participants over time, with a fixed coefficient distribution

Time	Consumer A	Consumer B	Consumer C
From 12:00 to 12:30	50%	20%	30%
From 12:30 to 13:00	50%	20%	30%
...	50%	20%	30%
From 22:00 to 22:30	50%	20%	30%

Source: Enogrid (2023)

Figure 8-3 shows an indicative load curve with a fixed coefficient. Due to the fixed set-up of electricity distribution, a large amount of electricity is injected back into the grid (grey area) whereas it could have been redistributed to other participants instead of importing electricity from the grid (blue).

Figure 8-3 Example of a load curve with a fixed coefficient



Source: Enogrid (2023)

- Dynamic coefficient (default): For each time period (30-min), the coefficient is calculated by the DSO in proportion to the actual consumption of each consumer. Table 8-2 presents an example of the evolution of electricity distribution among collective self-consumption participants with a default dynamic coefficient distribution. The default dynamic coefficient allows to maximise self-consumption rates as every 30 minutes, the largest consumer gets the largest share of electricity production. However, a dynamic coefficient benefits large consumers more (i.e. the high the consumption, the higher the distribution key).

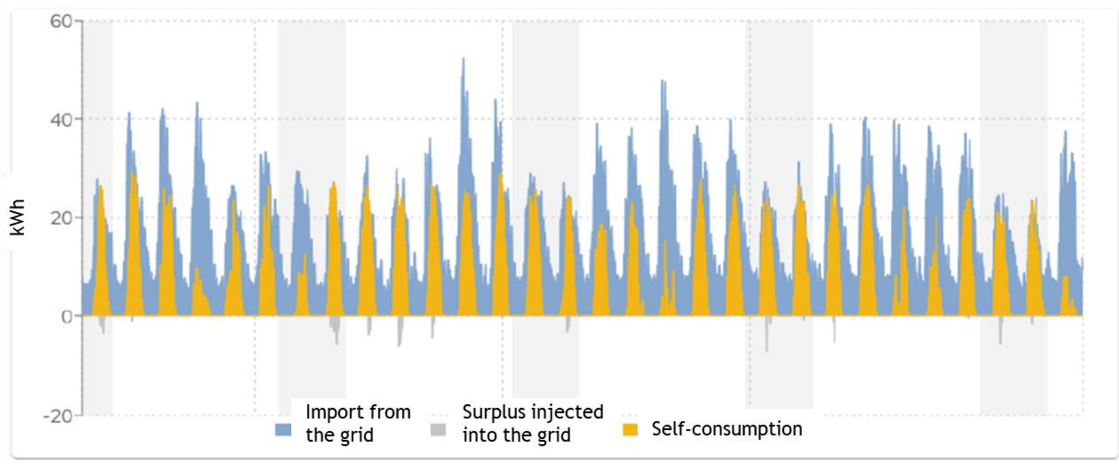
Table 8-2 Example of the evolution of electricity distribution among collective self-consumption participants with a default dynamic coefficient distribution

Time		Consumer A	Consumer B	Consumer C	Total
From 12:00 to 12:30	Consumption	15 kWh	25 kWh	10 kWh	50 kWh
	Distribution key (dynamic coefficient)	30%	50%	20%	100%
	Distribution of electricity production	12 kWh	20 kWh	8 kWh	40 kWh
	Additional electricity supply	3 kWh	5 kWh	2 kWh	10 kWh
From 12:30 to 13:00	Consumption	22 kWh	43 kWh	15 kWh	80 kWh
	Distribution key (dynamic coefficient)	27%	54%	19%	100%
	Distribution of electricity production	16.2 kWh	32.4 kWh	11.4 kWh	60 kWh
	Additional electricity supply	5.8 kWh	10.6 kWh	3.6 kWh	20 kWh

Source: Enogrid (2023)

Figure 8-4 shows an indicative load curve with a default dynamic coefficient. The level of self-consumption is higher in this dynamic distribution set-up, as electricity that is not used by one participant can be distributed to another.

Figure 8-4 Example of a load curve with a default dynamic coefficient



Source: Enogrid (2023)

- Dynamic coefficient (based on chosen calculation formula): The organising legal entity determines itself a calculation formula that allows to distribute the production and the surplus among the consumers at each time period (30-min). Operations with such dynamic coefficients are often those requiring a certain level of economic optimisation (e.g. prioritising sites with the highest electricity prices; or selling more in winter to some participants and more in summer to others depending on electricity prices) or for specific governance needs (e.g. distribution in several rounds: first round with fixed criteria; then in the second round, the surplus is allocated to whoever can consume it). The main constraint of this methodology is that the distribution must be calculated each month according to a defined rule and sent back to the DSO within a short timeframe. This requires significant computing power. Table 8-3 presents an example of a distribution with a personalised dynamic coefficient. It mainly shows that distribution coefficients can be completely different from one time period to another, depending on the rule that is used.

Table 8-3 Example of the evolution of electricity distribution among collective self-consumption participants over time, with a personalised dynamic coefficient distribution

Time	Consumer A	Consumer B	Consumer C	Total
From 12:00 to 12:30	50%	20%	30%	100%
From 12:30 to 13:00	42%	27%	31%	100%
...	12%	66%	22%	100%
From 22:00 to 22:30	77%	8%	15%	100%

Source: Enogrid (2023)

Energy bill in a collective self-consumption operation

In a collective self-consumption operation, the local producer is not considered as a conventional energy supplier and is thus not subject to all obligations associated with the supply of electricity. The electricity generated by the local producer can be sold to customers participating in the collective self-consumption operation at a price that is lower than the market price. Nonetheless, the sale of electricity to consumers remains subject to excise taxes[144] and network tariff (i.e. called 'Tarif d'Utilisation du Réseau Public d'Électricité' or TURPE).

The TURPE is an instrument used to finance the transport of electricity from production plants to the location where it is consumed. It represents respectively around 15% and 20% of professional and household consumers' electricity bills.[145] It contains a variable component associated with the quantity of energy consumed and a fixed component which represents the subscription to the network.[146] In 2018, the French NRA has included as part of the TURPE an optional specific tariff component for consumers connected to the public low-voltage distribution network and participating in a collective self-consumption operation.[147] This specific tariff aims to maximise self-generation and self-consumption rates. Above a certain level of self-consumption, the specific network tariff for collective self-consumption participants is lower than the network tariff for standard consumers, which stimulates participants to increase their self-consumption rate.[148] It is however worth to mention that this specific tariff is used by only a small number of collective self-consumption operation due to the complexity of its implementation in practice (i.e. each individual consumer must make the request to their energy supplier; high amount of self-generation are required otherwise it is not profitable; all participants must be on the same electrical substation). For self-consumption operations, there is a slight increase in the fixed part of the TURPE, to account for the burden beard by system operators of managing the distribution of electricity among participants.

8.2. PESTLE analysis

The table below provides an overview analysis of the barriers, success factors and enabling conditions using PESTLE (i.e. Political, Economic, Social, Technological, Legal and Environmental[149] context and factors influencing the case study).

Table 8-4 PESTLE for Latvian's improvement of conditions for self-consumption

Aspect	Barriers/ hindering factors	Success factors
Political		• The number of collective self-consumption operations has grown significantly (from 8 in 2021 to 246 in 2023).

[144] The excise tax on electricity is equal to zero if the producer and the consumer are under the same legal entity.
[145] Tarif Acheminement Electricité Electricité | Enedis
[146] *Ibid.*
[147] Délibération de la CRE du 7 juin 2018 portant décision sur la tarification de l'autoconsommation, et modification de la délibération de la CRE du 17 novembre 2016 portant décision sur les tarifs d'utilisation des réseaux publics d'électricité dans les domaines de tension HTA et BT - CRE
[148] Présentation PowerPoint (enerplan.asso.fr)
[149] Legal aspects to be included later on in consultation with Task 1 country experts.

Aspect	Barriers/ hindering factors	Success factors
Economic	• Complexity of implementation of the specific network tariff for collective self-consumption in practice. • The lower variable network tariff for collective self-consumers may have an impact on other network users if this results in an increase in network tariffs for them. However, as the use of the specific TURPE is currently limited, the impact is not (yet) experienced.	• Collective self-consumption operation are free to choose the methodology that is best suited to allocation electricity among participants. Dynamic coefficients allow to maximise self-consumption rates. • Network tariffs aim to stimulate collective self-consumption as they are lower than normal network tariffs above a certain level of self-consumption. In other words, the higher the share of self-consumption, the lower the network tariff. • Local producers participating in a collective self-consumption operation may sell the electricity at a price that is lower than the market price. The excess electricity is sold on the market, at the market price or at a mutually agreed price with a buyer.
Social		• Collective self-consumption allows to decrease the energy bills of participants. Hence, it increases the affordability of self-consumption for average households.
Technological	• Collective self-consumption as defined in the French legislation does not allow to release the pressure on electricity networks.	• Collective self-consumption can be extended to a perimeter of 2 km (outside the same building) or even 20km under special conditions. • Consumers with different consumption profiles (municipalities, households, schools, production plants, etc.) may participate in self-consumption operation, which allows to flatten the overall consumption curve.[150]
Environmental		• Extension of the self-consumption perimeter to 20 km for remote or low population density areas.

8.3. Scalability and Replicability

The level of scalability and replicability of the measure(s) is rated via a traffic light system:

High replicability/scalability
Limited replicability/scalability
Low replicability/scalability

High replicability

The French framework for collective self-consumption has successfully stimulated the development of collective self-consumption projects. It includes measures to improve conditions for collective self-consumption participants (i.e. methodology for allocating electricity that can be adapted depending on the needs; specific TURPE; extended geographical limit, beyond the building/multi-apartment block as foreseen at minimum by RED II) in France. In addition, the dynamic distribution of electricity

[150] Autoconsommation collective, principe et état des lieux en France en 2021 - Encyclopédie de l'énergie (encyclopedie-energie.org)

among participants allows to maximise self-consumption. However, the main limit is that collective self-consumption operations always rely on the network, even if it happens within the same building. Hence, it does not release the pressure on the electricity grid.

High scalability

Given the exponential growth of collective self-consumption operations, the French government could consider expanding the geographical scope of collective self-consumption operations even further to allow for more use cases.

8.4. Business case analysis

In France, electricity bills are composed of the following elements for every household:

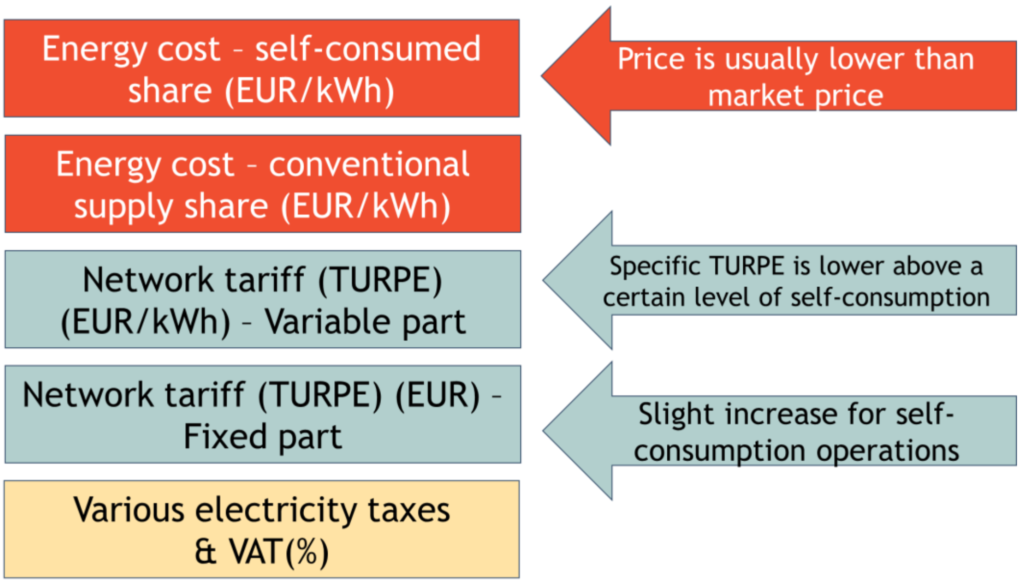
- Cost of electricity supply – which consists of the price of electricity and **depends on the amount of energy used**. This component includes both electricity supplied from the grid based on market price and supplied via the grid from the collective (thus often at a lower price);
- Network tariffs (TURPE) – represent **around 15 to 20% of the consumers'** energy bills and are **composed of a variable and a fixed part**.
- Taxes – which consist of **taxes that are proportional to overall consumption (from grid + from the collective)** (excise tax) and **taxes on the previous components of the energy bill** (VAT and CTA).

Collective self-consumers can save on two elements of the electricity bills (see Figure 8-5):

- **Energy cost**, for the self-consumed share – The price of electricity for the self-consumed share can be set by the local producer at a lower price than market prices, depending on his remuneration and payback objectives.
- **Network tariffs** – Above a certain level of self-generation and self-consumption, the specific TURPE for collective self-consumers is lower than the TURPE for standard consumers.

However, collective self-consumers face a slight increase in the fixed component of the TURPE as mentioned earlier.

Figure 8-5 Energy bill components in France and impact for collective self-consumption



9. One-Stop Shop – On the Sunny Side Croatia

Title	Improvement of conditions for households' self-consumption in Latvia
Location	Croatia
PV production	Gross electricity production from solar PV in 2021: 148.9 GWh[151]
General barriers addressed by the case study	**Institutional barriers:** Complex/burdensome procedures for RES projects **Social barriers:** Lack of awareness/misconceptions **Technical barriers:** Difficulties to find appropriate installer or third-party operator
Type	Individual self-consumption
Target sectors	Residential
Technologies	Solar PV
References	• EWS Energiewende-Magazin (February, 2023) - CROATIA GOES OVER TO THE SUNNY SIDE • Ministerie van Buitenlandse Zaken (2023) – Factsheet Renewable Energy in Croatia
Contacts	• Lahorko Wagmann Director – Electricity Division, HERA - lwagmann@hera.hr • Zelena Energetska Zadruga (ZEZ) - contact@zez.coop, Kristina.Laus@zez.coop

9.1. General description

While about 63% of Croatia's gross electricity production of 15.21 TWh in 2021 came from renewable sources (mostly hydropower and wind), only about 1% came from solar PV.[152] In 2022, there were about 3.000 solar installations in the entire country, amounting to 309 MW installed capacity[153]. Another source states that 244 MW of rooftop solar capacity was installed by January 2023, according to the state-owned power utility, Hep[154] - about 79% of the total installed PV capacity, based on data from IRENA.[155] The potential for installed solar PV in Croatia is estimated to be around 6.8 GW, 1.5 GW of which is for rooftop installation[156], yet the Integrated National Energy and Climate Plan for the Republic of Croatia foresaw a modest 144 to 387 MW increase of the generation capacity connected to the transmission grid between 2020 and 2040.[157] With hours of sunshine estimated between 2000-2700 yearly, the generation potential of 4 TWh could eliminate the need for imported electricity in the country.[158]

The Government of Croatia announced new incentives for electricity generation from renewable sources recently, simplifying administrative procedures with the intention of paving the way for renewables growth.[159] The new incentives include market premiums and/or guaranteed purchase prices, awarded by the energy market operator at least once in every three years. The decree covers land-based and floating solar PV, as well as hydropower, on- and offshore wind, biomass/biofuel and geothermal generation, and it specifies the methodology for calculating the maximum price and reference market price – but makes no mention of the grid connection price yet.

On the Sunny Side is a non-profit initiative which was launched by Zelena Energetska Zadruga (Green Energy Cooperative, ZEZ) – an independent umbrella organisation in the field of energy cooperatives, operating in Croatia since 2013 – with the goal of establishing a decentralised, affordable renewable

[151] Eurostat (2023), Gross and net production of electricity and derived heat by type of plant and operator dataset
[152] Eurostat (2023), Gross and net production of electricity and derived heat by type of plant and operator dataset
[153] PV Magazine (2022). Croatia investing in storage amid slow solar development
[154] Energetika.net (2023). Demand for rooftop solar in Croatia continues to grow - HEP
[155] PV Magazine (2022). Croatia investing in storage amid slow solar development
[156] RVO (2023), Renewable energy in Croatia - Factsheet
[157] Ministry of Environment and Energy (RoC) (2019). Integrated National Energy and Climate Plan for the Republic of Croatia
[158] Balkan Green Energy News (2023). Croatia could fully replace electricity imports with 1 GW of new wind capacity
[159] Balkan Green Energy News (2023). Croatia adopts regulations to facilitate renewables growth

energy system owned by citizens. The initiative brings the Croatian equipment manufacturers, installers, and designers together, and offers professional support to citizens interested in the joint procurement of small solar power plants.[160] The support ZEZ offers to citizens contacting them extends to the complete coordination of the collection of necessary documentation, the obtaining of a permit and the procurement and installation procedure through the verified network of professionals linked to the project.

ZEZ reached and provided specific advice to about 2.000 households so far and built a network of 35.000 people actively engaged in information sharing regarding solar energy.[161] The cooperative aims to support a total of 100.000 (20% of the country) households in switching to solar power by 2030.

9.2. PESTLE analysis

The table below provides an overview analysis of the barriers, success factors and enabling conditions using PESTLE (i.e. Political, Economic, Social, Technological, Legal and Environmental context and factors influencing the case study).

Table 9-1 PESTLE for improvement of conditions for self-consumption in Croatia

Aspect	Barriers/ hindering factors	Success factors
Political	• Solar installations on rooftops of rental buildings are not allowed • Lobby power of the monopolistic national power company and general unavailability/lack of cooperation of institutional actors • Lack of institutional capacity to process the (increased number of) applications	• Simplified permitting procedures for rooftop PV if the electricity is used for self-consumption, behind-the-meter[162]
Economic	• Underdeveloped solar market; only one producer, hard to get in direct contact with distributors, lack of competition, price flexibility and willingness to negotiate • Much more applications than installation subsidy	• Global electricity/energy price increase • Decreasing Weighted Average Cost of Capital (WACC)
Social	• Strong anti-collectivist sentiment, individualism • Lack of post-installation service providers (i.e. cleaning) • Too conservative and constraining heritage laws for the built environment • Lack of general awareness, knowledge and professional experience in applicability and design of solar PV in heritage areas	• The uptake of and increased (media) interest for solar PV generates more trust
Technological	• Lack of transparency (map) for grid congestion	• Grid capacity • Technological development of solar PV (more energy per panel area)
Legal	• Burdensome and lengthy permitting procedure • Lack of administrative (governmental) one-stop-shop where the citizens could get information about the legal and technical requirements for development of self-consumption facility	• Facilitation of the self-consumption projects through legislation amendments loosening the permitting and establishment of a governmental body that would be in charge of helping citizens with legal (including any incentives they might get) and technical

160 ZEZ (n.d), Na sunčanoj strani
161 EWS (2023), Croatia goes over to the sunny side
162 Clean energy for EU islands (2022), Regulatory barriers in Croatia: findings and recommendations

Aspect	Barriers/ hindering factors	Success factors
	• More favourable electricity payment mechanism for the prosumers exporting less electricity than importing • Lack of knowledge and resources on how to design the facility in order to fit in the more 'favourable' prosumer category	requirements for development of the self-consumption facility.
Environmental	•	• Energy security considerations of islands where connecting to the main grid poses environmental threat

9.3. Scalability and Replicability

The level of scalability and replicability of the measure(s) is rated via a traffic light system:

High replicability/scalability
Limited replicability/scalability
Low replicability/scalability

High replicability

No particular element of this scheme is unique/specific to Croatia, it can be implemented in any other Member State as well with existing energy communities by setting up a similar organisation familiar with the local regulation and contractors, to provide administrative support in the cost-benefit analyses and permitting process. Especially important in countries where the complicated administration is identified as a hindering factor for the uptake of solar PV.

High scalability

The initiative successfully advised thousands of households so far and reached tens of thousands of people through their social media initiative, which can easily be scaled up to reach magnitudes more, requiring only simple financial support for expanding the expert staff. The initiative can also be scaled further by expanding to institutional, commercial and industrial actors, requiring only some further expertise.

10. Full permitting exemptions for solar PV and flexible grid agreements

Title	Improvement of conditions for households' self-consumption in Latvia
Location	The Netherlands
PV production	Gross electricity production from solar PV in 2022: 16.8 TWh163
General barriers addressed by the case study	**Institutional barriers**: Complex/burdensome procedures for DER projects; Insufficient grid planning
Type	Individual and collective self-consumption
Target sectors	All
Technologies	Solar PV
References	• Bosch & Van Rijn (2023). *Onderzoek verdere verankering Voorkeursvolgorde Zon* • RVO (2022). *Monitor Zon-PV 2022 in Nederland*. • RVO (2023). *Monitor Zon-PV 2023 in Nederland.* • Eclareon (2021). Technical support for RES policy development and implementation – Simplification of permission and administrative procedures for RES installations (RES Simplify) • CEER (2023), CEER Paper on Alternative Connection Agreements
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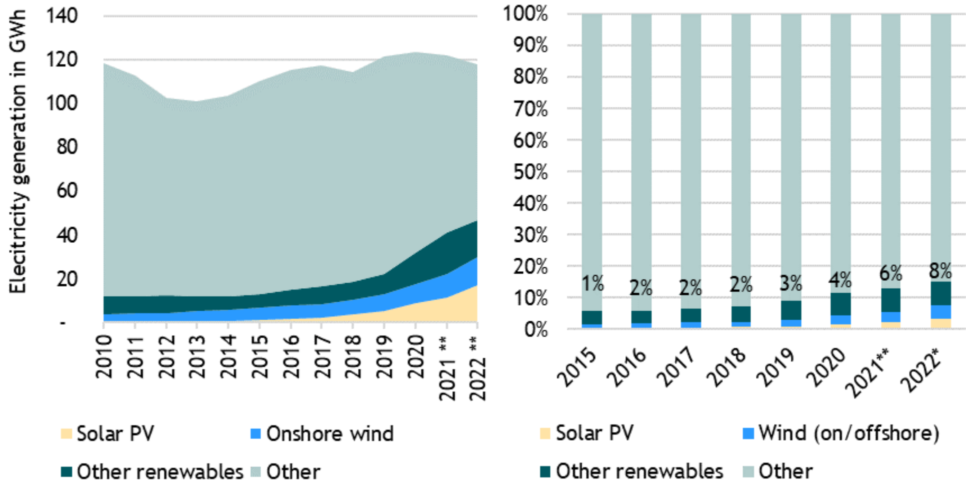
10.1. General description

The Netherlands has a technical potential of 145 GW installed capacity for rooftop (and façade) solar panels[164]. The total installed capacity in 2022 stood at 19 GW[165], with a 4.2 GW increase from 2021 to 2022 alone[166].

Over the past decade, renewable energy generation has accelerated. As shown in the left panel of Figure 10-1, electricity generation by solar PV and onshore wind increased sharply, in particular since 2017. In 2022, 26% of the generated electricity was generated by onshore wind and solar PV installations. The Netherlands is among the countries with the highest shares of solar PV generation globally, only leaving Chile and Jordan ahead.[167] In 2022, the Netherlands generated more electricity from solar PV than from coal fired power plants.[168] **While the Netherlands is among the global leaders in terms of growth rates and generation, renewable energy only accounted for 15% in the total *energy* consumption.** The share of onshore wind and solar PV in total energy consumption only equalled 8% in 2022. The main reason for the gap between high generation and low consumption is due to the fact that in the Netherlands electricity represents a relatively small share in total energy usage compared to other countries. However, vast upscaling is still required.

[163] RVO (2023). Monitor Zon-PV 2023 in Nederland
[164] Tweede Kamer (2023). BRIEF VAN DE MINISTER VOOR KLIMAAT EN ENERGIE
[165] CBS (2023). Renewable energy share rose to 15 percent in 2022
[166] CBS (2023). 46 percent more solar energy production in 2022
[167] Ember (20230. Global Electricity review 2023.
[168] Ember (2023). European Electricity Review 2023.

Figure 10-1 Electricity generation in the Netherlands by source (in GWh), left panel. Renewable energy generation as share of total energy consumption in the Netherlands, right panel.



*Right panel: the percentage in each bar shows the cumulative share of solar PV and wind. "Other renewables" does not include the statistical transfer in 2020. ** Indicate preliminary data. Source: CBS (2023).*

Current support for solar PV: the SDE++

Currently, solar PV is eligible for financial support via the SDE++, which offers a minimum revenue per MWh at times when the wholesale market price is insufficient to cover project costs.[169] Virtually all medium to large-scale solar PV (>15kWp) in the Netherlands is supported by the SDE++ or its predecessors. However, this is not the case for smaller projects (e.g., residential solar PV) – where regulation and net-metering/billing have had a large impact.

The SDE++ aims to reduce greenhouse gas emissions at the lowest costs, by supporting e.g., renewable energy projects. Projects supported by the SDE++ receive a subsidy, which complements market revenues at times when the market price is below the price which is required for a bankable project. As a result, the SDE++ provides additional income to renewable energy projects and it lowers the risk profile, which lowers the financing costs.[170] Next to the SDE++, the Dutch government offers a variety of instruments to support investments targeting different profiles, as shown in the Table .[171]

Table 10-1 Instruments to support solar PV in the Netherlands

Name	Target group	Type of instrument
Energy tax rebate	Citizens	Taxes and duties
Support of sustainable energy production and climate transition (SDE++) and predecessor (SDE and SDE+)	Businesses and non-profit organisations	Operational support
Net metering	Citizens / households	Output support
Sustainable energy investment grants (ISDE)	Businesses	Investment aid
Subsidy for cooperative energy generation (SCE)	Energy cooperations	Operational support
Energy Investment Allowance (EIA)	Businesses	Taxes and duties

Source: Government of the Netherlands (nd). Stimulating the growth of solar energy.

The Solar Ladder and permitting

[169] Parliamentary Letters from the Ministry of Economic Affairs and Climate - 26 April 2023, p. 16, state that the budget for SDE++ will also be granted after 2025 though there is no certainty regarding the technologies that are eligible.
[170] For more information on how the SDE+(+) improves the business case for RES projects, we refer to Trinomics (2022). Review overgangsregeling hernieuwbare elektriciteit na 2025 and/or Trinomics (2021). Evaluatie SDE+.
[171] For more information on the SDE, please refer to RVO (2023). Feiten en cijfers SDE (+)(+).

In August 2019, the Ministry of Energy adopted the Solar Ladder ('zonneladder'), specifying a hierarchy of preferred locations for new solar PV. Rooftop solar PV is at the top of the preference list, followed respectively by urban areas and non-urban areas, with agricultural land on the bottom (only to be used when all other options are exhausted). In July 2023, it was announced that the ladder would get a more binding character and restrictions for solar PV projects on farmland and natural grounds were further operationalised.[172,173] In 2021, 72% of total ground-mounted PV installed capacity was on farmland (and 27% of total solar PV capacity, including rooftop PV).[174]

Facilitating the increased share of PV is rooftop solar PV's exemption from some of the permitting procedures providing substantial administrative ease for the interested stakeholders[175]. Permits are required in some specific cases only (i.e. in case of buildings of heritage/monument status, or if the panels do not fulfil the general technical criteria, as described in the 2012 Building Decree's relevant sections[176]). If the conditions are not met, the rooftop PV installation requires an All-in-one Permit for Physical Aspects, just like any other (ground-mounted) PV installation. The standard procedure for this takes 8 to 14 weeks, complicated cases requiring an extended procedure could take up to 6 months.

After installation, no permits are required for operating PV installations either.

Grid congestion and flexible grid agreements

In the Netherlands, electricity grid congestion is one of the most pressing infrastructure related challenges. Grid congestion refers to the situation in which the electricity grid does not have sufficient capacity to transport generated electricity to the electricity consumer. In case of consumption congestion, the grid's capacity is insufficient to meet the demanded electricity at the consumer's side at certain times. Projects across all sectors with electricity demand are currently delayed or even cancelled, as a result of consumption congestion. In case of generation congestion, grid capacity is insufficient to meet the available electricity at the generator's side. Generation congestion is particularly relevant for intermittent electricity sources, such as solar PV and wind. During sunny/windy times, the electricity grid may not have sufficient capacity to transport the available electricity generated by solar PV and wind installations. Grid congestion is time dependent and affected by e.g. weather conditions and electricity demand.

Grid operators state it is increasingly difficult to connect (likely large-scale) rooftop PV and often these projects have to wait longer than 2 years in order to reinforce the grid.[177] Important to note that SDE++ application should contain a transport indication from the grid operator (though this does not guarantee that the estimated free capacity will be available for the applicant). The connection difficulties also impact the business case, as according to the SDE decree, in order to be eligible for the SDE++ subsidy, the PV project needs to be realised within 2 to 4 years from the moment of the granting decision depending on project size and location (rooftop/land/water). If this is not the case, the project developer cannot apply for a SDE++ subsidy for one other year. [178] There is no postponement possible on the grant start date. If realisation is postponed, the project only gets an exemption to commission the installation one year later, and the subsidy period starts on the original commissioning deadline.

[172] Ministry of Economic Affairs and Climate (2023). *2e zonnebrief over ontwikkeling zonne-energie.*
[173] For more details on further operationalization of preference order: Bosch & Van Rijn (2023). *Onderzoek verdere verankering Voorkeursvolgorde Zon*
[174] RVO (2022). *Monitor Zon-PV 2022 in Nederland*.
[175] Eclareon (2021). Technical support for RES policy development and implementation – Simplification of permission and administrative procedures for RES installations (RES Simplify)
[176] Ministerie van Binnenlandse Zaken en Koninkrijksrelaties (n.d.). Zonnecollectoren en zonnepanelen
[177] Eclareon (2021). Technical support for RES policy development and implementation – Simplification of permission and administrative procedures for RES installations (RES Simplify)
[178] Eclareon (2021). Technical support for RES policy development and implementation – Simplification of permission and administrative procedures for RES installations (RES Simplify)

Dutch association of power network operators Netbeheer Nederland, as well as Dutch TSO TenneT, have published online maps showing congestion levels in the power grid.[179] These tools facilitate grid planning and allow a better understanding of the congested areas. It shows additional capacity becoming available due to an expansion of infrastructure or if a station has reached its maximum capacity due to new grid-connection requests.

Grid operators, in principle, are currently obliged to provide transmission capacity – with the justified exceptions of congestions.[180] Flexible grid agreements are being discussed in the Netherlands to address grid congestion and facilitate connection of new projects.[181] Further, the Network Code has been modified and now allows DSOs to enter 'dispatch limitation contracts' with users to temporarily limit the use of their contracted firm capacity (with negotiated compensation), enabling more efficient use of the available network capacity and faster connection to the grid for new users.[182] The Dutch association for network operators has recommended oversizing generating capacity to the grid connection for all voltage levels, also for solar panels on small-scale users' roofs. They mention this could include the same connecting conditions for 40% of the maximal solar capacity and accepting that individual transformers have to limit net exports to the transmission grid when it is very sunny and demand for energy is low.[183] The latest SDE++ round (from 2023) states that all PV facilities have a limited *feed-in capacity of up to 50% of the peak output of the solar panels*. This change enables more renewable energy projects at the same grid capacity.

Peer to peer trading

According to the new proposed Dutch energy law, peer-to-peer trading will be implemented as a special form of supply of renewable electricity between 'active customers' and 'end customers'. This is in line with the set-up of ENTRNCE as facilitator of suppliers who provide this service to their customers. ENTRNCE facilitates local energy markets by providing consumers and producers with a local exchange to trade energy directly with each other.

Local4local

The Local4local project is an energy community which aims to develop and implement a cooperative model for a renewable, collective energy supply with minimal impact on energy infrastructure, using cost-plus pricing of renewable energy to community members. The model aims for end users to pay a end user pays a fair and stable price for locally generated electricity and heat, minimizing impact on local energy infrastructure, avoiding unnecessary transmission costs and lowering imbalance costs through reconcilement of generation, consumption and local storage.

10.2. PESTLE analysis

The table below provides an overview analysis of the barriers, success factors and enabling conditions using PESTLE (i.e. Political, Economic, Social, Technological, Legal and Environmental context and factors influencing the case study).

Table 10-2 PESTLE for improvement of conditions for self-consumption

Aspect	Barriers/ hindering factors	Success factors
Political	• Lack of universal definition for the solar ladder policy (applied differently at province/municipality level)[184].	• Priority for rooftop solar in the Solar Ladder • Rooftop solar PV's exemption from permitting procedures eases administrative procedures

[179] https://capaciteitskaart.netbeheernederland.nl/; https://www.tennet.eu/nl/de-elektriciteitsmarkt/congestiemanagement/netcapaciteitskaart
[180] CMS (2017). Practical legal aspects of solar PV projects in the Netherlands
[181] CEER (2023), CEER Paper on Alternative Connection Agreements
[182] CEER (2023), CEER Paper on Alternative Connection Agreements
[183] Netbeheer Nederland (2023), Transition of the Dutch energy system: scenario's 2030-2050
[184] https://www.osborneclarke.com/insights/dutch-government-shifts-policy-solar-panels-farmland

Aspect	Barriers/ hindering factors	Success factors
		• All-in-one permit (one-stop-shop) for projects not exempted from permitting
Economic	• Relatively high upfront costs for self-consumers, while future revenues are uncertain and volatile	• SDE++ support
Technological	• Grid congestion: as the grid reinforcement costs are not borne by project developers, the rapid solar PV expansion reduces optimal planning of grid reinforcements. • Delayed connection of rooftop PV, which may also affect business case (SDE++ conditions) • SDE++ distorts some market signals[185] which should provide the right incentives for an efficient electricity system. This results in less efficient dispatch and counteracts incentives to invest in flexibility, including storage.	• Availability of 'grid capacity maps' that reflect congested areas to facilitate planning • Dispatch limitation contracts enabling more efficient use of the available network capacity and faster connection to the grid for new users
Legal	• Current legal framework does not allow peer-to-peer trading or consumers directly supplying to other consumers / small-scale users (*kleinverbruikers*). Even within the current legislative proposal of the Dutch Energy Act.	• Intended abolition of the Dutch Rules on net metering (*salderingsregel*). • Generally speaking, no permit required to install solar panels on rooftops that do not exceed the eaves. • The legislative proposal for a new Energy Act allows owners of an apartment to collectively establish a generation plant for self-consumption. As outlook, the legislative proposal for a new Energy Act provides more clarity on the concept of the 'renewable self-consumer' (*actieve afnemer*) and therefore also implements Electricity Directive 2019/944.

10.3. Scalability and Replicability

The level of scalability and replicability of the measure(s) is rated via a traffic light system:

High replicability/scalability
Limited replicability/scalability
Low replicability/scalability

Solar ladder

High replicability

The uptake of a similar approach (solar ladder) prioritising rooftop solar in other Member States could be considered, though it would need to be paired with other instruments to ensure it leads to self-consumption (rather than self-generation only). The ladder provides increased support according to the prioritisation, providing rooftop PV – and related self-consumption with the most support. Especially for MS with serious peak demand congestion at higher voltage lines, a longer-term strategy of decentralised generation and consumption as is done by the Netherlands could alleviate pressure

[185] For instance, at times of low electricity prices, the SDE++ still compensates project owners for additional production, which makes investments in storage or demand response less attractive.

from higher voltage lines, with overall system efficiency (through balancing of the system and optimal use of RES assets).

Limited scalability

The solar ladder is already applied at country level. A possibility for scalability would be to include west and east facing roofs at the top of the ladder. These installations would peak when most PVs are ramping up or down. Further, improvements could be made by providing more clear guidance and enforcement towards provinces and municipalities.

Permitting exemptions for rooftop solar

High replicability

As permitting is one of the main barriers to the deployment of renewable projects in the EU, a generalised permitting exemption for rooftop solar PV may significantly contribute to the uptake of self-consumption in other Member States.

High scalability

Such measure could be scaled up to other technologies. As recommended by the EC SWD on good practices to speed up the permit granting procedures for renewable energy projects, Member States should ensure to decrease the lead time for renewable energy projects by lifting barriers associated with permit-granting procedures.

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