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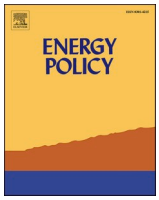

Energy citizenship: Accounting for the heterogeneity of human behaviours within energy transition

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ABSTRACT

According to the European Green Deal, achieving energy transition, which aims to establish a shift towards a more sustainable and low-carbon energy system, requires the active participation of citizens. Consequently, the concept of energy citizenship has emerged as a means of understanding the role of citizens in this process. This study conducts an integrative literature review with the objective of providing a comprehensive definition of energy citizenship and distinguishing between different types of energy citizens based on their engagement within the energy system. Six different types of energy citizens (i.e., consumer; prosumer and prosumager; participant in protests and movements; policymaker; business entity; and energy community), acting as either individuals or as collective entities or both, have been defined. This differentiation highlights the heterogeneity of human behaviours within energy transition. We argue that policymaking aimed at fostering energy transition should consider the behavioural dimensions of all types of energy citizens. In order to effectively support a fair, inclusive, and just energy transition, policy measures and intervention instruments need to account for various barriers, drivers as well as the socio-economic context of the diverse stakeholders participating in innovation ecosystems.

1. Introduction

The European Green Deal, the European Union's (EU's) ambitious plan to become climate neutral by 2050, highlights the importance of citizen engagement in achieving a clean and effective energy transition (European Commission, 2019). Specifically, involving citizens in the design and implementation of policies is seen as a cornerstone of increased legitimacy and effectiveness in government policy. It has been argued that citizens should be conceptualized as "important stakeholders in the innovation process […] shaping new routines and enacting system change" (Schot et al., 2016, p.1). Furthermore, citizen engagement has been found to be a critical factor in achieving a clean and effective energy transition (Campos and Marín-González, 2020). Including citizens in energy-related decision-making processes can influence community response and any adoption to decarbonization solutions, especially when energy transition reveals existing inequalities and the steps that must be taken to overcome them (Sovacool et al., 2020). Achieving a fair, inclusive, and just energy transition requires suitable policies, good collaboration between stakeholders, realistic business models, and citizens who play an active role (van Wees et al., 2022). As a result, the concept of *energy citizenship* has recently emerged and has been found to be a useful framework that encapsulates a new definition of citizens in the energy system. Within this concept, the public is conceived as active, rather than passive, stakeholders in the evolution of the energy system (Devine-Wright, 2004, 2007). Instead of being perceived as mere users of energy technologies and innovations, citizens are seen as participants in the energy system in a more comprehensive way (Devine-Wright, 2007). However, despite the initial conceptualization of Devine-Wright, 2004, 2007, the concept of energy citizenship remains undertheorized in the existing literature.

Besides that, recent literature (Schill et al., 2019; World Bank, 2015) has emphasized the importance of acknowledging the diversity of human behaviours in policymaking concerning human-environmental interactions. Specifically, the report of the World Bank on "Mind,

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Society and Behaviour" (World Bank, 2015) highlighted the need to incorporate the latest insights about human cognition and how it is shaped by the surrounding context when designing and implementing policies. In line with that, Steg et al. (2021) argue that considering key factors that either enable or hinder sustainable energy behaviours among different actors is crucial for achieving effective policy and system changes. In fact, some scholars claim that the current emphasis on a limited range of theories related to human decision-making in policy assessments, such as climate policy, undermines the relevance of these endeavours (Victor, 2015). Therefore, neglecting the expertise of social sciences in comprehending the heterogeneity of human behaviours within energy transition may restrict the usefulness and effectiveness of policies.

To address the above mentioned gaps in the literature and to improve the design of policy interventions that promote citizen engagement, a better understanding of energy citizenship and of the emergence of active participation is needed. This study aims to conduct a literature review that broadens the definition of (energy) citizenship to include different types of stakeholders and the heterogeneity of their behaviours within the energy system. By offering a typology of energy citizens and the features that enable or restrict their engagement in energy transition, this study makes a unique contribution to the existing literature and provides a valuable foundation for future intervention programmes and policy-design efforts.

The study is organised as follows: The methodological design and data collection methods that have been applied are presented in the next section, followed by an overview of different notions of citizenship and the emergence of the construct of energy citizenship in section 2. In section 3, energy citizens are defined and six types of energy citizens are established on the basis of their involvement and behaviour in the energy system. In section 4, the results of the literature review are discussed, based on the insights established in section 3, a holistic definition of energy citizenship is proposed and limitations of the research are presented. Finally, section 5 covers the main conclusions and in section 6 policy recommendations and considerations for energy citizens are provided.

2. Methodology

In order to develop a holistic definition and framework of energy citizenship and to investigate related (behavioural) insights, an integrative review was conducted. Unlike a systematic review, which is used to synthesise and compare all available empirical evidence in a field, we used an integrative-review approach, combining ideas from different fields to generate new theoretical frameworks and perspectives (Snyder, 2019). The content analysis of the literature was guided by the hypothesis that the heterogeneity of human behaviours plays a central role in the process of energy transition, leading to the concept of energy citizenship.

The literature review was conducted using search terms such as "energy citizenship"; "energy citizen"; combinations of "energy transition" AND "drivers" OR "barriers"; "energy transition" AND "participation" AND "drivers" OR "barriers"; and combinations of "prosumer" or "energy community" or "(social) movement" or "policymaker" or "business" AND "drivers" OR "barriers". In addition, we employed the snowballing technique (Johnson, 2014). In total, 145 articles were reviewed, including 16 articles on the different notions of citizenship and the emergence of energy citizenship (see sections 3.1 and 3.2), and 129 articles on the human behaviours of energy citizens and their determinants (see section 3.3). All articles examined were published between 1985 and 2022, with the majority being published after 2000, thus highlighting the increasing attention paid to the concept of energy citizenship and citizen engagement in energy transition in recent years.

3. Literature review

3.1. Different notions of citizenship

In the Cambridge Dictionary, *citizenship* is defined as (a) "the state of being a member of a particular country and having rights because of it" and (b) "the state of living in a particular area or town and behaving in a way that other people who live there expect of you". In line with that, Honohan (2002) distinguishes between three dimensions of citizenship: legal status and rights, activity, and membership. These dimensions are embedded in two contemporary views of citizenship – the first being the civic-republican view, which identifies citizenship as an active process. According to this view, citizens are not viewed mainly as *homines economici*, that is, in economic terms, but are people involved and active in the political community. The second view is the liberal-individualist view, which describes citizenship in formal and legal terms, embodying a range of rights against the state and others. Within this view, citizens are obliged to obey the laws, pay taxes and engage in business transactions, while political participation is not central.

In line with the civic-republican view, Isin (Isin et al., 2017) argues that making claims related to rights is about the performativity of citizenship. Therefore, the concept of *performative citizenship* entails exercising one's rights: Citizenship is practised both by the enactment of rights and by citizens claiming them. It is an integral part of daily life, with the practice of citizenship being rooted in everyday practices, thus transcending legal and constitutional definitions and conceptualizations. According to Isin (Isin et al., 2017), there are five overlapping facets to *performative citizenship*: (1) Citizenship involves political and social struggles that determine who has the right to act; (2) these struggles concern not only citizens, but also non-citizens who are involved as relational actors; (3) citizens and non-citizens include diverse social groups who make rights claims; (4) the act of citizenship entails the exercise, claim, and performance of both rights and duties; and (5) by enacting citizenship, people transform its meanings and functions.

The notion of *environmental citizenship*, on the other hand, is said to align with the liberal-individualist view (Dobson, 2003). This concept "redefines the relationship of people and nature and reiterates that environmental conservation is everybody's sole responsibility at all times, based on one's life choices in minimizing ecological impact on earth" (Meerah et al., 2010, p.5715). The idea is that individuals should take responsibility for how they interact with the environment. Nonetheless, like performative citizenship, environmental citizenship is also about the active participation of citizens. According to Hawthorne and Alabaste (Hawthorne and Alabaster, 1999), participation in environmental education and training is the most important factor in enabling changes in environmental behaviour, followed by affect. Furthermore, definitions of environmental education and education for sustainability (Sterling and Croall, 1992; UNESCO, 1993) suggest that it is a process which has as its objective the creation of a population that is environmentally responsible, contributing to sustainable development and comprising several components. These components of environmental citizenship include information, awareness, concern, attitudes/beliefs, education and training, knowledge, skills, literacy, and responsible behaviour (for more information, see Hawthorne and Alabaster (1999).

Another notion of citizenship, which Dobson (2003) claims goes beyond the distinction between liberal-individualistic and civic-republican views, is *ecological citizenship*. According to Dobson and Sáiz (2005, p. 157), there has been a "turn to citizenship" in some of the literature on environmental politics, which has led to a discussion on ecological citizenship (Dobson, 2003; Dobson and Bell, 2006; Gabrielson, 2008; Hayward, 2006). Dobson (2003) argues that ecological citizenship is neither liberal-individualistic nor civic-republican, but rather an example of "post-cosmopolitan" citizenship. He defines post-cosmopolitanism as commitments beyond the nation-state that stem from an understanding of globalization as the source of inequalities

and injustice. Dobson (2003) further claims that ecological citizenship focuses on duties as well as rights, while its conception of political space is the ecological footprint. According to Dobson and Sáiz (2005, p. 157), ecological citizenship requires "shifts in attitudes at a deep level – deeper than those reached by fiscal measures". In other words, ecological citizenship refers to the conscious choice to alter the motivation behind environmental actions.

In short, both performative citizenship and environmental citizenship are about active citizen participation. However, key features of performative citizenship are enacting and claiming rights, thus defining it as a civic-republican form of citizenship. Meanwhile, the key feature of environmental citizenship is the responsibility individuals take for their interaction with the environment, making this notion of citizenship liberal-individualistic. Ecological citizenship transcends this distinction and is considered to be a post-cosmopolitan form of citizenship, one which focuses on both duties and rights, and the need for fundamental changes in attitudes to drive environmental action.

3.2. Energy citizenship

Historically, political discussions on energy typically focused on technical and economic issues (Devine-Wright, 2007). However, the transition from a fossil fuel-based energy system to a sustainable one has prompted the redefinition of citizens' social roles and responsibilities (Lennon et al., 2020). As a result, a new notion of citizenship, referred to as *energy citizenship* by Devine-Wright (2004), has emerged. Energy citizenship posits that "the public are conceived as active rather than passive stakeholders in energy system evolution and where the potential for action is framed by notions of equitable rights and responsibilities across society for dealing with the consequences of energy consumption, notably climate change" (Devine-Wright, 2007, p.71).

Devine-Wright (2007, p.72) emphasizes that both awareness and action are part of energy citizenship, stating that it involves "[an] awareness of responsibility for climate change, equity and justice in relation to siting controversies as well as fuel poverty and […] the potential for (collective) energy actions, including acts of consumption and the setting up of community renewable energy projects […]." Thus, similar to performative, environmental, and ecological citizenship (see section 3.1), energy citizenship also views citizens as active participants, who are, however, specifically engaged in sustainable energy transition. Mullally et al. (2018, p.71) interpret Devine-Wright's conceptualization of energy citizenship as, "[…] rights and responsibilities, underpinned by sustainability principles of participation, local action, equity, justice and the remediation of poverty facilitated by procedural mechanisms supporting the co-production of responses to contemporary challenges". This implies that energy citizenship, like ecological citizenship, transcends the dichotomy of civic-republican and liberal-individualistic citizenship by focusing on both the duties and rights of citizens.

Recent research indicates that energy citizens can act both socially and politically, whether as individuals, for example through energy efficiency measures in households, or as part of larger groups, such as climate activist groups (Radtke, 2014), local energy groups (Hasanov and Zuidema, 2018), or grassroots initiatives (Kooij et al., 2018). Engagement in the energy system can, therefore, take many forms (see section 3.3 for a more detailed elaboration on the different behaviours within energy citizenship). However, in line with McClymont and O'hare (McClymont and O'hare, 2008), we argue that energy citizenship does not divide engagement into a binary between "good" and "bad", but rather is contingent upon the level of engagement that individuals might have (or lack) in supporting energy transition.

3.3. Energy citizens

Previously, the term *energy citizen* has primarily been defined in relation to energy consumers (Lennon et al., 2020; Vihalemm and Keller, 2016; Goulden et al., 2014). For example, Goulden et al. (2014, p.24)) stated that "in contrast with the consumer, for whom energy is simply a good to be expended in pursuit of personal goals, the energy citizen engages with energy as a meaningful part of their practices". In this paper, however, energy citizens are defined on the basis of their roles, behaviours and forms of engagement in society. We argue that energy citizenship can be seen in the various actions citizens undertake in support of energy transition. These energy-related actions are manifested differently across different types of energy citizens. Although no clear distinction exists between them, it is possible to identify several types of energy citizens who actively participate in energy transition, including individuals such as consumers, prosumers, and prosumagers, as well as collective entities, such as energy communities and business entities (see Fig. 1 for an overview). While there may be blends of different types of energy citizen, we argue that it is possible to differentiate between behaviours based on the role of the particular type of energy citizen within the energy system.

In the following, we will distinguish between six types of energy citizen; explain their behaviours and involvement in the energy system; and review the factors that drive or enable those behaviours, as well as those that prevent their behaviours. While we do not claim that this overview includes all possible types of energy citizens (e.g., one could also consider knowledge-brokers, influencers, or researchers as energy citizens), it presents what we consider to be the most prominent categories of stakeholders in the energy system. This selection is based on the current state-of-the-art knowledge about the behaviours of individuals and collective entities that are involved in the energy system.

3.3.1. Consumer[1]

To fully understand the role of consumers in the energy system and take into account the heterogeneity of their behaviours, one needs to be aware that consumers are not merely end-users who ultimately use a product or service. Specifically, Lopes (2015) distinguishes between three behaviours of consumers within the energy system: investment, maintenance, and usage. Investment refers to "actions involved in the purchase of new equipment"; maintenance involves "actions involved in the repair, maintenance and improvement of energy consuming equipment, including the building"; and usage encompasses "actions of usage of buildings and equipment therein installed that may be characterised by the frequency, duration, and intensity" (Lopes, 2015, p.3). In the following, we will review the existing literature on these three behaviours and summarise the key factors that influence their emergence in the energy system.

3.3.1.1. Emergence of investment behaviours. In a recent study, Neves and Oliveira (2021) summarised the key factors that drive energy-saving investments. They found that the theory of planned behaviour (TPB, Ajzen, 1985),) is widely used to explain such investments. The TPB posits that behaviours and behavioural intentions are determined by three factors: attitudes towards the behaviour, subjective norms (i.e., perceived social pressure to either engage or refrain from the behaviour); and perceived behavioural controls (i.e., perceived ease or difficulty of performing the behaviour). In addition, non-standard preferences, decision-making, and beliefs can impact investment in energy-efficient equipment (Della Valle and Bertoldi, 2022). For example, loss aversion can cause individuals to be reluctant to invest if they believe the investment may result in a loss (Heutel, 2019) and they may be less inclined to invest because of a limited ability to plan ahead (Ballinger et al., 2003). Other factors that have been found to influence investment behaviours, or the willingness to invest, are status quo bias

[1] The authors of this paper recognize the impact of energy poverty and illiteracy on the engagement in energy efficiency and conservation measures. While this specific group is not addressed within the scope of the current literature review, the paper identifies contextual factors that may serve as barriers to engagement in energy transition.

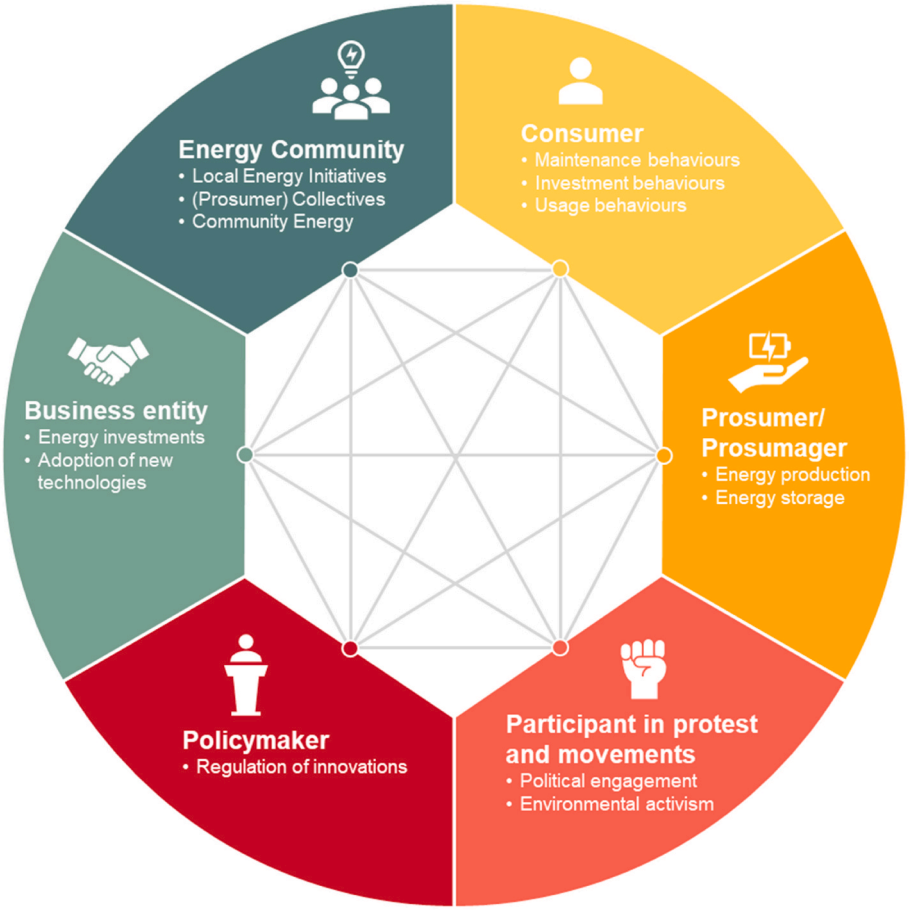

Fig. 1. Overview of energy citizens and their behaviours in the energy system.

(i.e., individuals tend to overuse current appliances instead of investing in energy-efficient equipment) (Schubert and Stadelmann, 2015); moral obligations (Tan et al., 2017); environmental concerns and knowledge (Li et al., 2019); understanding (Taghikhah et al., 2019); discount rates (i.e., individuals with high discount rates place higher value on present rewards compared to future energy savings), risk-aversion, rational attention (i.e., individuals tend to pay less attention to the ongoing costs of a product compared to the initial purchase price) and bounded rationality (i.e., when faced with complex situations, individuals tend to rely on simple mental shortcuts and rules of thumb to simplify the decision-making process) (Cattaneo, 2019); trust, and experience (De Ayala et al., 2021).

Physical, economic, and/or socio-demographic variables that were found to influence investment behaviours, or the willingness to invest, are household income and subsidy incentives (Yang and Zhao, 2015); age (i.e., individuals aged 40 to 49 have a higher willingness to pay for energy-efficient products than individuals under 19 or those over 50), gender (i.e., men are more willing to pay for low-carbon products), and education (i.e., the higher the education level, the stronger the willingness to pay more for energy-efficient products) (Shuai et al., 2014); housing type (i.e., residents of farmhouses and single family homes are more likely to choose energy-efficient appliances than apartment residents) and number of inhabitants in a household (i.e., the larger the number of residents, the higher the probability of purchases of energy-efficient appliances) (Baldini et al., 2018). Recently, Niamir et al. (2020) combined socio-economic and psychological factors and found that both are equally important in energy-saving investments. Specifically, they found that awareness and personal and social norms are just as important as monetary factors in shaping energy-saving behaviours and investments in energy-efficient appliances and in home insulation.

3.3.1.2. Emergence of maintenance behaviours. The literature on maintenance behaviours with regard to energy-consuming equipment focuses primarily on home retrofitting. Hrovatin and Zorić (2018) have identified five key factors that influence residential retrofit decisions: behavioural factors; technical factors; economic factors; information and policy measures; and the socio-economic characteristics of households. In order to give a better understanding of how consumers make energy-efficient retrofit decisions, in the following, we will provide a short summary of these five factors.

Similar to investment behaviours, the TPB has been found to explain intentions towards green retrofitting (He et al., 2019; Fransman and van Timmeren, 2017). Other behavioural factors that influence home retrofitting, or the willingness to retrofit, include environmental awareness, previous renovation experiences (Hrovatin and Zorić, 2018; Nair et al., 2010); comfort (Murphy, 2014); convenience of transitioning a home (Beauchampet and Walsh, 2021); trust in contractors, professionals and the retrofit process (De Wilde, 2019; Wilson et al., 2015); routines, such as dining, socialising, and entertaining (Judson and Maller, 2014); and cognitive burdens (i.e., high costs for information searches) (Wilson et al., 2013; Bertoldi et al., 2021a). In terms of information and knowledge, the results in the literature are mixed. While multiple studies have demonstrated the positive effects of energy audits or of the acquisition of knowledge (Nair et al., 2010; Achtnicht and Madlener, 2014), there are also several studies questioning their effectiveness (Wilson et al., 2013; Gamtessa, 2013; Frondel and Vance, 2013). Technical factors include building characteristics, such as the age and lifespan of building components and thermal comfort (Judson and Maller, 2014; Achtnicht and Madlener, 2014; Gamtessa, 2013). For instance, energy-efficient retrofits are more likely to occur in older homes and when residents experience lower thermal comfort. Economic

factors that influence maintenance behaviours are upfront costs and a financial resources (Bjørneboe et al., 2018; Bertoldi et al., 2021b); loan aversion (Schleich et al., 2021); expected energy cost savings and economic viability (Achtnicht and Madlener, 2014; Gamtessa, 2013; Jakob, 2007); uncertainty about future price movements (Jakob, 2007); fear of future increases in energy prices (Alberini et al., 2013); split incentives (i.e., landlords may be reluctant to invest in energy efficiency due to concerns about recouping costs through rent increases) (Bertoldi et al., 2021a; Melvin, 2018); and obstacles in reaching a consensus among residents of multi-unit buildings or households regarding energy-efficient investments (Economidou et al., 2018). Policy measures, such as tax reductions, subsidies, rebates, and favourable loans (i.e., fiscal incentives) have been designed to resolve financial constraints. However, the role of fiscal incentives is controversial and heavily debated. While some studies report a stimulating effect (Gamtessa, 2013; Nauleau, 2014), other studies express concern about the effectiveness of fiscal incentives for enhancing energy efficiency levels (Jakob, 2007; Pettifor et al., 2015). Household socio-economic characteristics that impact home retrofitting, or the willingness to retrofit, are income (i.e., high income is assumed to result in a high likelihood of retrofit, but results are mixed) (Bertoldi et al., 2021a; Achtnicht and Madlener, 2014; Gamtessa, 2013; Poortinga et al., 2003); age (i.e., homeowners over 64 are less likely to retrofit) (Bertoldi et al., 2021a; Achtnicht and Madlener, 2014; Gamtessa, 2013); education (i.e., a high level of education is assumed to be linked to a greater understanding of the information concerned and the ability to turn it into action) (Bertoldi et al., 2021a; Achtnicht and Madlener, 2014); and gender (i.e., men are influenced by policy factors, while women are influenced by social norms) (He et al., 2019).

3.3.1.3. Emergence of usage behaviours. Usage behaviours can be divided into (Wang et al., 2021): (1) energy consumption at home or work, including space heating, air conditioning, appliances, lighting and other energy uses; and (2) personal transportation methods, such as public transportation, shared bicycles, cars, alternative-fuel vehicles, and (holiday) travel. In the following, we will summarise the factors that were found to (in-)directly influence these categories of usage behaviours.

According to a review by Wang et al. (2021), household energy consumption encompasses space heating, air conditioning, and the usage of common appliances and lighting. In general, there is a difference between energy demands in urban and rural households, something which is linked to socio-economic factors such as household income, education level, family size, and size of living space (Du et al., 2017). Regarding the use of air conditioning, factors such as dwelling age, dwelling size, and occupation were found to be influential (Zhang et al., 2020). According to studies by Vainio et al. (2020) and Chen et al. (2020), pro-environmental attitudes, consideration of future consequences, efficacy beliefs, and action-related subjective knowledge drive behaviours such as the lowering of temperatures at home and the turning off of electronic devices when they are not in use (i.e., private-sphere environmentalism). Schultz et al. (2007) found that both descriptive norms (i.e., feedback about average consumption in the neighbourhood) and injunctive norms (i.e., the evaluation of own consumption relative to neighbourhood consumption) are important for promoting electricity savings for households as a whole.

In terms of personal transportation, various factors such as comfort, convenience, and personal safety can encourage low-carbon behaviours (Geng et al., 2017). A study by Lind et al. (2015) found that people's preference for environmentally-friendly travel methods may be shaped by their ecological values, beliefs in sustainability, and environmental consciousness. In line with that, values, beliefs and personal norms have been found to predict intentions to reduce personal car use (Stern et al., 1999; Nordlund and Garvill, 2003). When it comes to using bicycles, important determinant are the presence of a social norm (Goetzke and Rave, 2011); awareness of the environmental benefits of shared bicycles, sense of environmental responsibility, ease of access to public transit systems, safety concerns, such as the poor road awareness of riders, number of cycling facilities (Yang and Long, 2016); and bike-parking facilities (Fishman et al., 2012). For car-sharing, cost savings and convenience are the main drivers (Shaheen and Cohen, 2007). A recent review by Nansubuga and Kowalkowski (2021) has identified other factors influencing the adoption of car sharing, including socio-demographics (e.g., higher demand among single-person households, young people in their 20s and 30s, males, and city-centre residents); geographic factors (e.g., car availability, reliability, and parking conditions); socio-economic factors (e.g., high education levels, moderate upper income levels); population density (e.g., higher population density and social activity in an area corresponding to more car-sharing); high service quality (e.g., fleet management, tutorials, ability to access help); and environmental benefits. Accessibility to a car, availability, public awareness, insecurity and uncertainty regarding contractual conditions have also been found to influence car sharing (Julsrud and Farstad, 2020). Finally, attitudes towards electric car-sharing have been found to be influenced by perceived compatibility with daily life (i.e., younger couples without cars or young families who use car-sharing as a supplement to their own vehicles) and social norms (Burghard and Dütschke, 2019).

3.3.2. Prosumer and prosumager

The second type of energy citizen is the prosumer. Some authors define a prosumer as an "energy user who both consumes and generates energy" (Rathnayaka et al., 2012, p.483), while others add a financial component, defining prosumers as customers who generate energy and sell their excess electricity to the network (Karnouskos, 2011). In the case of electricity, they can "provide flexibility by optimizing the timing of their electricity production and consumption, and by making decentralized storage available", for example by "investing in batteries or providing heat reserves through a more flexible heating behaviour" (Kubli et al., 2018, p.540). Some authors categorize prosumers as either "active" or "passive", with active prosumers being self-driven in the adoption of energy-generating technologies, and passive prosumers being externally influenced or having the adoption of these technologies as a by-product of other decisions (Whitaker et al., 2016). However, in reality, there is no dichotomy between active and passive prosumers, but rather varying degrees of prosumerism. Prosumers who are influenced by subsidies or other external factors are less active than those who do not receive this support. Recently, Sioshansi (2019) has defined a subtype of prosumerism known as the prosumager. This type of energy citizen not only consumes and produces energy, but also stores electricity. Apart from some theoretical contributions (Sioshansi, 2019; Green and Staffell, 2017; Schill et al., 2017; von Hirschhausen, 2017), research findings on prosumagers are generally non-existent and research on prosumers is limited, the following will review the factors that drive, enable, and prevent the production and storage of energy.

3.3.2.1. Emergence of energy production. Recently, Khan (2019) reviewed the evolution of prosumerism in Bangladesh and identified seven drivers, five enablers, and eight barriers encouraging prosumerism; these were then compared with drivers, enablers, and barriers in developed countries found in a study by Whitaker, Ford, and Stephenson (Whitaker et al., 2016). Common enablers in both developed and least-developed countries were financing options and the financial benefits related to income (Khan, 2019). Common barriers included technology, management, cost, trust, and the enactment of suitable policies (i.e., legislation). No common drivers were found, which Khan (2019) explained by the fact that prosumerism in developed countries was initiated by different forms of social and environmental awareness, while in least-developed countries, prosumerism was initiated by the basic need to survive. In developed countries like New Zealand, drivers

of prosumerism are local income; maintaining local control; bargaining power; independence from the grid; energy conservation; sustainability; and the multiplicative effect on income, cost, and social cohesion. Other factors that influence prosumerism are environmental awareness (Inderberg et al., 2018); social norms (Rode and Weber, 2016); regulations (von Wirth et al., 2018); availability of relevant information, product quality, availability of economic and institutional support (Nygrén et al., 2015); health and privacy concerns, trust in technologies, public support for reducing demand (Michaels and Parag, 2016); upfront capital costs, uncertainty and mistrust in the system, aesthetics, negative impacts on the residence, availability of objective experts, routines, technical flaws, compatibility with existing infrastructure, availability of "good" installers, technical interests, symbolic reasons, social networks, peer effect (Palm, 2018); moral obligations, comfort and the quality of life, and confidence in the pro-environmental consequences of behaviours (Stikvoort et al., 2020).

3.3.2.2. Emergence of energy storage. The participation in smart grids is found to be driven by several factors, including added comfort; energy independence; the opportunity for electricity market participation; innovative control over appliances and devices; environmental benefits; economic incentives; reduced energy bills; clear and periodic billing; detailed information on energy consumption; and enhanced energy supply reliability (Mengolini and Vasiljevska, 2013). However, a study specifically focusing on the adoption of residential solar photovoltaics with energy storage (Ardani et al., 2016) suggests that cost and value-related barriers continue to hinder widespread deployment. Another barrier is the process of obtaining permission to install and operate energy storage, which can be complicated, expensive, and uncertain. This is due to factors such as the lack of cohesive industry-accepted standards or best practices or the general unfamiliarity of citizens with storage technology. Further research is needed to fully understand the factors that influence consumers to both produce and store energy.

3.3.3. Participant in protests and movements (for or against energy transition)

The third type of energy citizen is the participant in protests and movements (Hoppe et al., 2015). These individuals engage with the energy system by participating in protests and movements for or against energy transition. The actions of participants in protests and movements can include political activities, such as voting and becoming active in a political party, as well as attending demonstrations, writing to politicians, and joining an organisation. Although participants in protests and movements can include both those in favour and those against energy transition, this study will focus on the factors that drive and enable, as well as those that prevent, participation in protests or movements in support of environmental benefits, energy transition, and measures to reduce the impact of climate change. This particular focus has been adopted because of the availability of literature and research on this type of energy citizen, particularly on the determinants of political engagement and environmental activism.

3.3.3.1. Emergence of political engagement. Political engagement, such as voting for or becoming active in a green party, is primarily determined by an interest in environmental issues (Vasilopoulos and Demertzis, 2013). Besides that, a study by Rüdig, Benni, and Franklin (Rüdig et al., 1991) found that factors such as age, place of residence, education, occupation, religiousness, and membership in environmental organisations and other groups are related to participation in the Green Party of the United Kingdom. In particular, middle-aged individuals (those 25–49 years old), highly educated, and non-religious citizens who live in small towns and rural areas are more likely to join the Green Party. Furthermore, Pearson and Rüdig (2020) found that European participation in green parties is influenced by environmental concerns; the salience of environmental issues; and public attitudes towards the environment, climate, and energy. Economic affluence also has an impact on citizens voting for a green party, meaning that higher GDP per capita results in more votes for green parties. More research is needed to fully understand the heterogeneity of factors influencing political engagement.

3.3.3.2. Emergence of environmental activism. Contacting authorities and members of parliament, as well as active involvement in environmental organisations and demonstrations, behaviours that Vainio et al. (2020) define as environmental activism, have been found to be related to the development of pro-environmental attitudes; the consideration of future consequences; efficacy beliefs; and action-related subjective knowledge. Other factors that influence individual and/or collective environmental action are believe in the power of citizenship, internal locus of control (Liarakou et al., 2011); political ideological orientations (Clements, 2012); hope for constructive change (Ojala, 2012); moral emotions, such a guilt for damage done to the environment (Rees et al., 2015); and other emotions, including anger, fear, and environmental threat (Furlong and Vignoles, 2021; Fritsche et al., 2018). Furlong and Vignoles (Forsyth et al., 2015) further found that identification with Extinction Rebellion (XR) was the strongest predictor of collective action. This supports the results of other studies indicating that concepts related to identity, such as a sense of community and group identification, are positively associated with increased participation and favourable attitudes towards the environment (Forsyth et al., 2015; Mannarini et al., 2009). Other factors that influence participation in social movements and protests are attributing responsibility for climate change, a shared sense of collective identity (Haugestad et al., 2021); moral motivation, identification as an environmentalist (Fernandes-Jesus et al., 2020); collective efficacy, social identity (Bamberg et al., 2015); personal efficacy, age (i.e., the younger an individual, the more likely to engage in environmental activism), and education (i.e., the higher educated an individual, the more likely to engage in environmental activism) (Lubell, 2002).

3.3.4. Policymaker

Policymakers occupy a unique role in the energy system, as they are both subject to internal and external pressures and demands, and are responsible for representing the preferences of the collective entities they belong to, such as a government or political party. As representatives of these entities, policymakers are charged with making decisions on new courses of action and for implementing regulations that are designed to influence and determine decisions and procedures, otherwise known as policies. Policymakers also play a crucial role in determining subsidies, promoting change and investment, and regulating innovations. Given the limited amount of research in this area, this study focused specifically on the regulation of innovations by policymakers. According to Rothwell (1992, p.451), regulation is defined as "the control of a particular situation for the benefit of society". Regulations often arise in response to social issues, such as safety and health concerns, pricing practices, product quality, and environmental protection.

3.3.4.1. Emergence of regulation of innovations. Using a dynamic model, Montalvo (2007) identified determinants of innovation regulation, while focusing on the interaction between policymakers and decision-makers in companies. He found that attitudes towards regulation, social norms, and control over regulation influence the willingness and ability of policymakers to design and enforce regulation schemes, which in turn affects the innovative behaviour of firms (e.g., governance of innovation). Montalvo (2007) further argues that attitudes of policymakers towards regulation are shaped by social, economic and political outcomes; social norms are influenced by corporate lobbying, political pressures, and community pressure; and control over regulation is determined by institutional capabilities and the organisational

capabilities of policymakers. In line with that, recent studies by Braams et al. (2021, 2022), have shown that policymakers are perceived as citizens with their own political orientations regarding sustainability. At the same time, however, they are constrained by factors such as the organisational structures of governments, conflicting political agendas across ministries, and lobbying pressures from businesses and political partisans. These factors impact their preferences and ability to support and shape the development and implementation of policies that promote energy transition and citizen engagement.

3.3.5. Business entity

The fifth type of energy citizen is a business entity, which can be defined as an individual legal entity. There are three main forms of legal entities through which businesses can operate: sole proprietorships, corporations, and partnerships. Companies and organisations, including small and medium-sized enterprises (SMEs) and social enterprises (SES), play a crucial role in the energy system through, for example, their business activities and charitable work. Boiral (2009, p. 223) defined organisational citizenship behaviours for the environment (OCBEs) as "individual and discretionary social behaviours that are not explicitly recognised by the formal reward system and that contribute to a more effective environmental management by organisations". Despite their potential for reducing CO2 emissions and for power balancing in electricity networks, there is little research available on OCBEs in the context of the energy system (Wesche and Dütschke, 2021). However, there has been research conducted on the factors that influence businesses to adopt energy efficiency and new technologies, thus providing insights into the role of business entities in the energy system.

3.3.5.1. Emergence of energy efficiency. According to a study by DeCanio and Watkins (1998), the characteristics of companies play a role in whether they invest in energy efficiency. This implies that general economic conditions and incentives may be less relevant in energy efficiency investments. Nevertheless, a review by Lawrence, Thollander, and Karlsson (Lawrence et al., 2018) found economic conditions, such as high and unstable energy prices, to be the main driver of energy efficiency in the pulp and paper industry. Additionally, a study by Schall and Mohnen (2017) on eco-driving in different branches of a logistics company demonstrated that a non-monetary reward resulted in an average reduction of fuel consumption of 5%. Handgraaf, de Jeude, and Appelt (Handgraaf et al., 2013) found that private rewards (i.e., a personal grade point accompanied by an explanatory comment) were outperformed by public rewards (i.e., a personal grade point accompanied by an explanatory comment, as well as the possibility of comparing grade points with colleagues) in the short- and long-term, while monetary rewards were outperformed by social rewards. This suggests that private monetary rewards may be ineffective, despite their popularity.

Other factors that have been found to influence energy efficiency in business entities are the need to remain internationally competitive, (energy-related) collaboration, technical risks, access to capital, time and priorities, slim organisation (Lawrence et al., 2018); energy-efficiency programmes, and benchmarking (Handgraaf et al., 2013). Regarding the provision of information, a study by Siero et al. (1996) found that employees who received comparative feedback, including information on the performance of another unit in the same company, save more energy than employees who received information only about their own performance. Other studies found that simple information (Rosenkranz et al., 2017) and emphasising the importance of energy savings (Loureiro and Labandeira, 2019) can lead to improvements in energy savings. According to an international study by Cagno et al. (2015), which involved national energy agencies and governmental and industrial organisations, the main drivers of energy efficiency are, from most important to least important: long-term energy strategy; clarity of information; cost reductions from lower energy use; public investment subsidies; technical support; trustworthiness of information; availability of information; increasing energy tariffs; motivated staff members; awareness; voluntary agreements; having a green image; management with ambitions; management support; information about real costs; efficiency due to legal restrictions; external energy audit/submetering; private financing; knowledge of non-energy benefits; external cooperation; willingness to compete; programmes of education and training; and technological appeal. Finally, a more recent study by Wesche and Dütschke (2021) identified four main motives for organisations to invest in infrastructure for energy production: environmental protection, financial gains, improved image, and energy self-sufficiency. Drivers to invest in infrastructure for energy production were access to technical knowledge, access to administrative knowledge, and access to financial support schemes. Barriers included uncertainty, such as doubts about the disposal of solar panels, and local physical circumstances, such as the impact on existing buildings.

3.3.5.2. Emergence of measures for adopting new technologies. According to Montalvo (2002) and Freire (2018), the willingness of companies to adopt new technologies is influenced by their attitude toward innovation, social norms, and control over innovation. Montalvo (2002) further argues that attitudes are shaped by environmental and economic risks, while social norms are influenced by the community and by market and regulatory pressures. Lastly, control over innovation is determined by technological and organisational capabilities. Other important factors to consider include strategic alliances and networks of collaboration, which have an impact on the adoption of new technologies.

Similarly, the findings of Montalvo (2002) regarding the influence of environmental and economic risks on attitudes towards innovation are supported by the research of Elahi et al. (2022). They suggest that the pressing issue of climate change is motivating the agricultural sector to mitigate vulnerability by adopting efficient technology and management strategies, such as photovoltaic greenhouses, water pumps, and agricultural machinery. Additionally, Harris and Khare (2002) proposed efficient environmental management strategies for the Alberta oil industry to ensure its long-term survival and sustainability.

3.3.6. Energy community

The sixth and final type of energy citizen is the energy community, which encompasses a group of energy consumers who "share common interests and/or attitudes in services provided by energy communities (e.g., activities of generation, storage, consumption and sale of energy) […] [and] are supported by a legal framework or are a legal entity" (Koirala et al., 2021, p.27). Indeed, energy communities have been included in EU energy legislation. Specifically, the term energy community is used in the context of (1) the "citizen energy community" (CEC), which is defined in the European Parliament's Electricity Directive, 2019/944 (Directive, 2019) and (2) "renewable energy community" (REC), defined in the European Parliament's Renewable Energy Directive, 2018/2001 (Directive, 2018). Both types of communities are set up as legal entities, with the primary objective of providing economic, environmental, and social benefits for the community, as opposed to financial ones. The key difference between CECs and RECs lies in the nature of their membership, which is more regulated in RECs.[2]

In this report, the term energy community is used as an umbrella term, and includes local energy communities (LECs) and virtual energy communities. LECs are groups of energy consumers or prosumers who live within specific geographic boundaries, while virtual energy communities are groups that are brought together on the basis of certain criteria, such as the willingness to purchase green energy (i.e., green cooperatives). Other related concepts include local energy initiatives (LEIs), which are defined as "decentralized, non-governmental

[2] For more detail on the similarities and differences between CECs and RECs, see for example: https://emissions-euets.com/internal-electricity-market-glossary/2095-energy-community.

initiatives of local communities and citizens to promote the production and consumption of renewable energy" (Oteman et al., 2014, p.2); community renewable energy; and energy renewable community or community energy (CE), which describe local social groups that generate and distribute renewable energy (Walker and Devine-Wright, 2008). Prosumer collectives, on the other hand, are social groups that consist solely of prosumers (see section 3.3.2 for the definition of prosumers).

Energy communities engage in several activities that differentiate them from individuals in the energy system, such as community services, joint purchasing activities, collective ownership, energy supply, exchange and selling, implicit demand response, explicit demand-side flexibility, or cross-domain services (Koirala et al., 2021). Due to the limited research available, this study focused on the barriers and drivers that impact the participation and development of LEIs, CEs, and prosumer collectives.

3.3.6.1. Emergence of local energy initiative (LEI). Recent research emphasized the importance of ownership in the success of LEIs (Hinshelwood, 2001). Having a sense of ownership positively affects people's attitudes towards LEIs (Devine-Wright, 2005) and increases public support (Warren and McFadyen, 2010), social acceptance (Cass et al., 2010), and motivation (Li et al., 2013). Stürmer and Kampmeier (2003) found that social identification, or a sense of belonging in a group or social network, is a strong motivator for civic participation in LEIs. The beginning of an LEI is found to be driven by various factors, including social gratification (i.e., the excitement and enjoyment of working together), civic gratification (i.e., the sense that contributing to the welfare of the community is a duty), and a desire to influence policy outcomes (Hoffman and High-Pippert, 2010). According to Bomberg and McEwen (2012), LEIs may emerge as a result of citizens' aversion to closed and entrenched policymaking. Similarly, Arentsen and Bellekom (2014) found that disappointment with centralised government coordination is a major driver for local initiatives. Other factors that contribute to the formation of LEIs include environmental concerns, local economic development, and the strengthening of social cohesion. Finally, participation in or initiation of LEIs is, according to various studies (e.g. Seyfang et al., 2013,), often driven by economic incentives and a desire for self-sufficiency.

3.3.6.2. Emergence of community energy (CE). Social norms, trust, and environmental concerns were found to be strongly associated with the willingness to participate in CE projects (Kalkbrenner and Roosen, 2016). According to Walker et al. (2007), energy insecurity is also a major factor that drives the development of CEs. Walker (2008) further suggests that CEs may also be developed as a way of creating job opportunities or of lowering energy prices. The promotion of behavioural change and social cohesion through CEs may also be a contributing factor in their development (Devine-Wright, 2007). In a study with Portuguese, Spanish, and Belgic energy communities, Soeiro and Dias (2020) found that ethical and environment commitment, as well as local investment and income generation, have the greatest impact on the development of CEs. The most important drivers identified were the ability to influence local energy policy, local control of resources, load management, lower energy costs, and reliable supply. Other factors that had some impact on the development of CEs included a strong cooperative enterprise; the history and traditions in the region; a supportive policy environment for cooperative enterprise; sufficient average regional personal income and/or wealth; and a supportive policy environment for renewable energy system deployment (Soeiro and Dias, 2020).

3.3.6.3. Emergence of (prosumer) collectives. According to Whitaker, Ford, and Stephenson (Whitaker et al., 2016), prosumer collectives are driven by the desire for self-empowerment, which translates to more local control, less dependence on centrally generated electricity, and an increase in energy security. Furthermore, prosumer collectives are driven by financial benefits, given that self-production is becoming more affordable since the costs of some forms of distributed generation decrease while the costs of energy from traditional sources often increase. Local collective projects also often have a greater potential for financial returns than individual prosumers, as these projects have lower upfront costs per capita, the ability to bulk purchase, and a reduced need for outside labour. In the long run, collectives can also create employment opportunities and sell surplus electricity to other users or back to the grid. For a prosumer collective to succeed, social cohesion is required (Whitaker et al., 2016). In turn, a lack of collective commitment can be a barrier, as well as a lack of trust and fairness in the collective, insufficient funding, high investment requirements, and a lack of viability and practicality (Whitaker et al., 2016). Besides that, the emergence of new technologies and infrastructure, such as smart grid and smart technologies, as well as financing options and the pooling of funds and resources were found to be important enabling factors. Additionally, a sense of purpose and the collective nature of projects are strong motivators for financing, since they make people want to participate and invest in projects (Whitaker et al., 2016).

4. Discussion

Over the recent years, the EU has placed a strong emphasis on the central role citizens play in energy transition. To improve policies that promote citizen engagement in this process, a deeper understanding of energy citizenship and the roles and requirements of the various stakeholders involved in energy transition are crucial. Based on an extensive literature review, we have addressed the existing gaps in the literature by not only establishing a framework for energy citizenship, but also identifying six types of energy citizens on the basis of their engagement in the energy system. These six types include individual energy citizens, such as consumers and participants in protest and movements, as well as collective entities, such as energy communities and business entities. The engagement of these different types of energy citizens in the energy system has been found to be influenced by factors that vary across each type. These factors, which are based on human decision-making and behavioural research dating back to influential models (Ajzen, 1985) and more recent research on the adoption of innovations and new technologies (Montalvo, 2003, 2006), can be clustered into cognitive, normative, instrumental, emotional, and socio-demographic determinants (as depicted in Table 1 in Appendix A). This clustering reduces complexity and enables the quantitative testing of relationships between stakeholders and their engagement to take place. We argue that accounting for the heterogeneity of behaviours among the diverse group of energy citizens is crucial for the design of policy measures and of intervention instruments towards promoting a fair, inclusive, and just energy transition.

Based on our insights into citizenship, the roles of citizens and their engagement in the energy system, the following definition of energy citizenship can be formulated:

Energy citizenship refers to the active participation of individuals and collective entities in the energy system within a specific geographical area. Active participation can be both social and political, and can include actions such as installing solar panels, participating in community-based renewable energy projects, or supporting policies that promote sustainable energy. The effects of energy citizenship can be positive (e.g., supporting clean energy transition, investing in energy efficient appliances, or participating in local energy initiatives); negative (e.g., public resistance to new forms of renewable energy); or neutral. The concept of energy citizenship is often seen as a way of empowering individuals and communities to take control of their energy future and promote a more sustainable energy system.

4.1. Limitations

The following section highlights several limitations in relation to the literature review.

1. There is the possibility of selection bias, given that the focus of this review was on literature mainly from the field of social sciences, with a majority of the studies conducted in Western or European countries. Consequently, the review was limited to a selection of studies which raises questions about the generalizability of the results of this paper to other regions or cultures.
2. The review was limited by the present lack of research on the behavioural dimensions impacting energy transition, particularly with regards to the roles of policymakers, businesses, and energy communities; this restricted the scope and depth of the review and may have affected the generalizability of the conclusions.
3. The established overview of types of energy citizens may in reality be more extensive than was portrayed in this literature review. For example, according to Kythreotis et al. (2019), scientists and experts have the potential to play an important role in energy transition by acting as mediators between consumers and policymakers. They could help citizens understand the types of knowledge that are relevant to policy decisions and vice versa. The review also did not specifically consider the experiences of energy poor or illiterate individuals. Although the established overview of drivers and barriers for energy citizens included socio-economic conditions, it did not address the significant impact of energy poverty on the engagement of energy citizens in energy transition.
4. Finally, while acknowledging the importance of understanding the interactions between types categories of energy citizens, it was not within the scope of the present research to thoroughly examine these aspects.

These limitations should be taken into account during any interpretation of our findings and when established insights are being used to inform policy decisions. Future research is needed to address these limitations in order to deepen our understanding of the complex and dynamic interactions between energy citizenship and energy transition.

5. Conclusions

In essence, this review highlights that taking the heterogeneity of human behaviours into consideration across different stakeholders can provide new perspectives in relation to the analysis and design of behavioural public policies that promote just, fair, and inclusive changes within socio-technical systems. Given the extensive range and variations of determinants that influence behaviours across stakeholders, it is crucial to gain a better understanding of such pervasive differences so that future policy instruments can be effectively designed and implemented. To enhance the effectiveness of policy frameworks aimed at promoting action and change among all types of energy citizens that support a fair, inclusive and just energy transition, new policy analyses and policy implementation approaches that incorporate human and behavioural dimensions to innovation and change are needed. Our framework of energy citizenship which takes into account the heterogeneity of behaviours of all types of energy citizens poses a first step towards the design of more useful and successful behavioural public policies.

6. Policy recommendations and considerations for energy citizens

When accounting for the heterogeneity of human behaviours within energy transition, the concept of energy citizenship emphasizes the necessity of implementing comprehensive and multifaceted actions to achieve its goals. Building on our comprehensive review, we propose the following policy recommendations aimed at supporting and nurturing the engagement of each type of energy citizen.

1. To encourage active consumer participation, policy measures could include access to financial incentives, the creation of a sense of comfort, and the raising of awareness through campaigns. Digital and physical forums could also be established for information exchange and the sharing of experiences. Additionally, a meta-analysis by Delmas et al. (2013) found that individualized audits and consultations are the most effective measures in ensuring energy savings.
2. To support the actions of prosumers and prosumagers, policy measures could include access to financial support, tax credits, knowledge resources, and relevant networks. Additionally, measures could be introduced to facilitate the production and saving of electricity.
3. To engage those who participate in protests and movements, policy measures could include promoting membership in environmental parties and creating opportunities for citizen involvement in policymaking processes related to energy transition.
4. To support policymakers, it could be beneficial to improve organisational and institutional capabilities, consult research institutes, and create opportunities for citizen input and engagement in policymaking processes.
5. To encourage business entities to engage in energy transition, financial incentives, training programmes, networking opportunities, and collaborative projects should be provided. Public and social awards to recognize and reward their efforts could also be introduced.
6. To engage energy communities, information policies that highlight the collective benefits of those communities' actions could be developed, and local financial support should be provided. Social cohesion within energy communities could be increased through the promotion of shared goals, common projects, and the provision of opportunities for citizen involvement in policymaking processes related to energy transition.

In addition to these policy recommendations, it is important to note that all actors are responsible for enhancing the process of energy transition and can support it through their actions. For example, citizens could undertake the following: (1) seek information on the environmental benefits and the available relevant subsidies; (2) participate in community-based energy projects; (3) bring socio-economic disparities to the attention of the government; and (4) suggest supporting transition actions to local and national representatives. Business entities could, for example, undertake the following: (1) support energy citizenship by investing in renewable energy; (2) implement energy-efficient practices; (3) offer sustainable and environmentally friendly products and services; and (4) invest in research and development. Collaboration and communication among the different types of energy citizens could help to build trust, to share information, and to align collective actions. Partnerships and coalitions could help to align incentives and build capacity for sustainable energy practices. Enabling and encouraging sustainable energy practices could ultimately help to level the playing field for all actors involved.

Credit author statement

Luise F. Schlindwein: Methodology, Investigation, Writing, Visualization, Project administration. **Carlos Montalvo**: Conceptualization, Supervision, Funding acquisition

Declaration of competing interest

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Data availability

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Appendix A

Table 1
Overview of cognitive, normative, instrumental, emotional and socio-demographic determinants per type of energy citizen

Energy citizen	Determinants				
	Cognitive	Normative	Instrumental	Emotional	Socio-demographic
Consumer	Attitude Values Beliefs Self-identity Loss aversion Limited ability to plan ahead Status quo bias Moral obligation Discount rates Risk-aversion Rational attention Bounded rationality Comfort Convenience Loan aversion Routines Cognitive burden Efficacy belief Personal safety Sense of responsibility Perceived compatibility with daily life Action planning	Social norms Personal norms Descriptive norms Injunctive norms	Perceived behavioural control Opportunity Environmental awareness/ knowledge Experiences/past behaviours Costs (incl. time) Expected cost (savings) Financial benefits (incl. Economic incentives) Consensus between owner and household member(s) Future consequences Infrastructure/geographic factors Service quality (incl. Technical support, management)	Environmental concern Trust Uncertainty/fear of future energy prices	Household income Economic viability Split incentives Policy measures (incl. subsidies) Age Gender Education Occupation Dwelling type, age and size Household size Population density in area of living
Prosumer and prosumager	Values Moral obligation Energy conservation Sustainability Comfort Quality of life Routines Energy self-sufficiency Technical interests	Legislation/Regulations Social cohesion Social norms (incl. Social networks, peer effect) Economic, institutional and public support (incl. permissions) Symbolic reasons/image Aesthetics	Financial benefits (incl. Economic incentives, energy bill reduction) Technology Management Costs Environmental awareness Environmental benefits (Pro-environmental) consequences Local control Bargaining power Grid-independence Information Product quality Electricity market participation Innovation control Clear periodic billing Energy supply reliability Objective and good experts/ installers	Trust Uncertainty Health concerns Privacy concerns	Policy measures (incl. subsidies) Household income Local income
Participant in protests and movements	Environmental concern (incl. Interest in environmental issues) Attitude Political ideology Feeling of responsibility Moral motivation Efficacy beliefs (collective and individual)	Membership in environmental organisations Public attitude Social and collective identity Social norms	Salience of environmental issues Locus of control Awareness of consequences Knowledge	Hope Moral emotions (incl. Guilty conscience)	Age Type of living area Education Occupation Religiousness GDP/economic affluence

(*continued on next page*)

Table 1 (*continued*)

Energy citizen	Determinants				
	Cognitive	Normative	Instrumental	Emotional	Socio-demographic
Policymaker	Attitude Social outcomes Economic and political outcomes Corporate lobbying	Social norms Political pressures Community pressures	Perceived behavioural control Institutional capabilities Organisational capabilities		
Business entity	Awareness Willingness to compete Technological appeal Environmental benefits Uncertainty (e.g., about disposal of solar panels) Attitude Environmental risk Economic risk	External collaboration/ competition Voluntary agreements Image (green/improved) Management and staff with real ambitions Social norm Community pressure Market pressure Regulatory pressure Strategic alliances Networks Collaboration	Public and social rewards Technical risk Time Energy-efficiency programmes Benchmarking Information (incl. Comparative feedback) Long-term energy strategy Financial benefits (incl. Cost reduction) Service quality (incl. Technical support) Management support External energy audit/ submetering Knowledge Training programs Self-sufficiency Perceived behavioural control	Trustworthiness of information	Economic conditions Access to capital: private or public investment Policy measures (incl. Public investment subsidies, increasing energy tariffs) Private financing
Energy community	Desire to influence policy outcomes Environmental concern Attitude Efficacy belief (collective and individual) Political ideology Security (incl. Energy security) Sense of purpose	Social identification Social and civic gratification Social cohesion Social norms Ethical and environment commitment Collective commitment	Sense of ownership Financial benefits (incl. Economic incentives) Self-sufficiency/self-empowerment Management Costs Reliable supply Viability Practicality Infrastructure New technologies	Disappointment in policymakers Trust Fairness	Local economic development Local investment Income generation Cooperative enterprise history in living area Policy measures (incl. funding) Personal/regional income

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