D1.1

Framework for research on energy citizenship emergence structure and dynamics

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Executive summary

Energy citizenship has been explored in a small number of studies as a promising conceptualisation to best achieve the energy transition. Within the concept of energy citizenship, the public is conceived as active rather than passive stakeholders in the evolution of the energy system. Therefore, the engagement of citizens in behaviours and activities in support of the energy transition (such as the adoption of renewables and energy efficiency), instead of against it, is central. The inclusion of citizens into energy-related decision-making processes influences community response and uptake to decarbonisation solutions, especially when the energy transition reveals existing inequalities and steps that must be taken to overcome them. However, for policy interventions to be effective, a better understanding of energy citizenship is needed before providing recommendations for policy design.

This report offers a framework to study the structure and dynamics of energy citizenship emergence. In relation to the structure of energy citizenship, a preliminary definition of energy citizenship is contingent on the level of engagement that people might have (or not have) in actions supporting the energy transition. These actions are defined in specific behaviours that manifest differently across different types of individual and collective actors in an ecosystem of change (i.e., consumers, prosumers and prosumagers, participants in protests and movements, policymakers, energy communities and business entities). The types of behaviours identified (e.g., investments, consumption, storage, pursuing efficiency, using specific technologies and practices, etc.) all are context and actor specific. This produces a large set of potential incentives and disincentives.

The report offers an extensive review of the literature addressing aspects of energy related behaviours for each of the actors who/that are relevant in an energy transition ecosystem. All the actors mentioned above have different rationales to engage in the energy transition. Therefore, their energy citizenship has a different structure of incentives and disincentives to engage in green energy transition actions. Such a review will serve as first insights into what drives specific behaviours and engagement for each type of actor.

Concerning the emergence of energy citizenship, there has been a great deal of interest in studying and designing policies that support the energy transition. Different streams of research on social and sustainable innovations, sustainable business models, and energy transitions are pointing to the need for understanding the underlying social dynamics that limit change towards sustainability. Only as recently as in 2021, the importance of better understanding the human dimension of the energy transition was recognised (Steg et al., 2021), with a research agenda for the next decade with broad questions such as which factors encourage different actors in sustainable energy behaviour; which interventions can be effective to encourage sustainable energy

behaviour of different actors and which factors enhance its effects; and which factors affect public support for energy policy and changes in energy systems.

Most research remains focused on the individual as the unit of analysis. Few efforts are given to deepen the understanding of behavioural dynamics that are contingent on the interaction of the individual and the collective. The framework proposed in this deliverable uncovers such a gap and provides clear heuristics to understand the structure and dynamics of the human and institutional dimension that limit the cultural emergence of energy citizenship. The model proposed for this aim enables the understanding of energy citizenship emergence at three levels of analysis:

- Stage 1: The individual link to the collective via the notion of relational models.
- Stage 2: It defines the link between individual energy behaviour and collective dynamics in a given ecosystem of change (e.g., adoption of new practices, investment in new technologies or durable energy appliances, etc.).
- Stage 3: It links the dynamics of small ecosystems of change to a larger scaling up of four basic relational models that structure human interaction.

Testing for energy citizenship emergence is therefore analysed at three levels. The three-stage model enables the identification of bottlenecks of energy citizenship emergence whether this resides at the individual or the collective level. It will enable also to identify in detail the sources of energy citizenship emergence and the potential convergence to common decarbonisation goals. In addition, this serves as the primary input for the exploration of the nature of new social and community energy contracts as well as broad redesign of policy approaches targeting specific but also generic aspects of the behavioural change required in the energy transition.

These premises will guide the conduction of GRETA case studies addressing specific areas of human activity where the common tread is the link with energy requirements and the consequent reductions of CO2 emissions. This will also enable the testing of at what level of geographical aggregation, energy citizenship might arise.

The report is structured into four sections. The first section presents the general premises of the framework to be proposed. Section 2 investigates definitional aspects of energy, citizenship and finally energy citizenship, and offers a broad review of the general wisdom on drivers and barriers that might influence the upcoming of energy citizenship and what kinds of behaviours might characterise and define different types of energy citizens. Section 3 proposes a comprehensive approach to explore and predict the conditions upon which energy citizenship might arise. It proposes a new theory and approach to integrate disparate theories from social sciences and humanities and offers a framework to understand the structural and dynamic factors that act as drivers and barriers that have not been identified or defined before in the literature. Section 4 highlights key findings and offers reflexions on the contribution to knowledge and the next steps in the framework implementation in subsequent work packages of GRETA.

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Summary (for dissemination)	This report offers a framework to study the structure and dynamics of energy citizenship emergence. A preliminary definition of energy citizenship is made contingent on the level of engagement that people might have (or not have) in actions supporting the energy transition. These actions refer to specific context and actor specific behaviours that manifest differently across various types of individual and collective actors in an ecosystem of change. This produces a large set of potential incentives and disincentives. To untangle the large number of drivers and variation across actors and settings, the framework proposed offers clear heuristics to understand the structure and dynamics of the human and institutional dimension that limit the cultural emergence of energy citizenship. The three-stage model proposed enables the identification of bottlenecks of energy citizenship emergence at the individual or the collective level. This will enable the exploration of the nature of new social and community contracts as well as broad redesign of policy approaches aiming to support the transition to clean energy.
Keywords	Energy citizenship, energy citizenship emergence, energy policy, energy transition, emergent behaviour, collective behaviour, transformative innovation, relational models, innovation and behaviour, social contracts, sustainable behaviour, behavioural insights

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Abbreviations and acronyms

AR	Authority ranking
CS	Community sharing
EMSICA	Encapsulated Model of Social Identity in Collective Action
EM	Equality matching
GRETA	Green energy transitions actions
MP	Market pricing
RMT	Relational models theory
SE	Social enterprise
SIMCA	Social Identity Model of Collective Action
SIMPEA	Social Identity Model of Pro-Environmental Action
SME	Small-medium enterprises
TPB	Theory of planned behaviour
XR	Extinction rebellion

1 Introduction

Energy citizenship has been explored in a small number of studies as a promising conceptualisation to best achieve the energy transition (Campos and Marin-Gonzalez, 2020). Within the concept of energy citizenship, the public is conceived as active rather than passive stakeholders in the evolution of the energy system (Devine-Wright, 2004). Therefore, the engagement of citizens in behaviours and activities in support of the energy transition (such as the adoption of renewables and energy efficiency), instead of against it, is central. The inclusion of citizens into energy-related decision-making processes influences community response and uptake to decarbonisation solutions, especially when the energy transition reveals existing inequalities and steps that must be taken to overcome them (Sovacool et al., 2020). However, for policy interventions to be effective, a better understanding of energy citizenship is needed before providing recommendations for policy design.

At the core of GRETA is the premise that there is an interplay and interdependence between the individual type of energy citizen – who/that may act with either a positive or negative impact towards the energy transition – and the context where these energy citizens live. Such a context includes other people, but also institutions and rules with predispositions that affect behaviours supporting as well as opposing sustainable energy. In principle, such a context with the behavioural options it offers is internalised at the individual and collective levels such that it generates behavioural patterns leading to the emergence of different forms of energy citizenship. The interplay and aggregation of converging and diverging patterns from the local to the supranational levels define where energy citizenship is likely to emerge and consolidate and whether such patterns support or detriment decarbonisation policy goals. This is depicted in Figure 1.

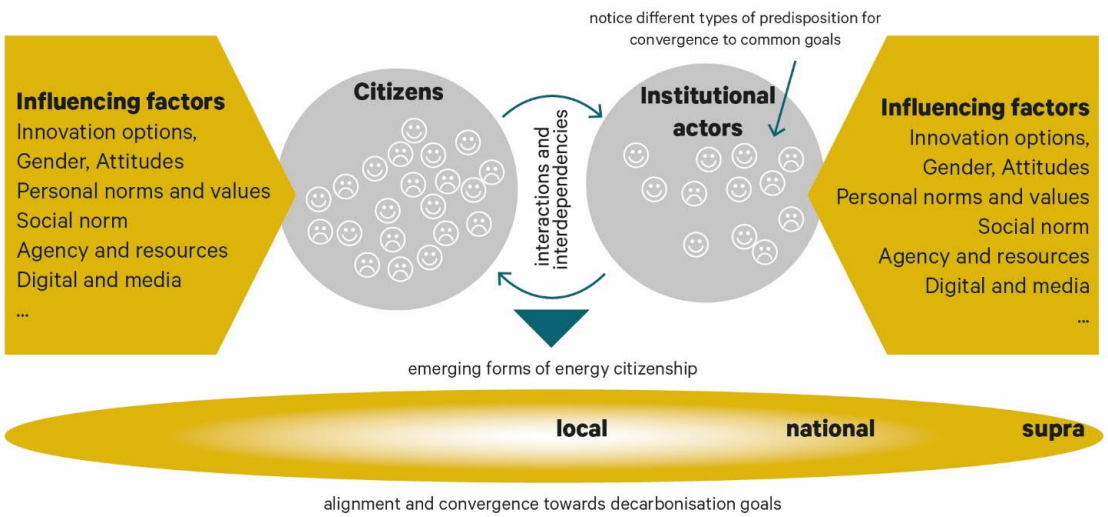

Figure 1. GRETA premise.

The concept indicated in Figure 1 implies that there are four major milestones that must be achieved that help define the structure and dynamics of energy citizenship emergence. There is the need:

- for a common accepted definition of energy citizenship
- to understand what types of engagement and behaviours characterise energy citizenship, and who – as well as in what context of social activity – are energy citizens
- to find out what factors (determinants) influence the behaviours characterising energy citizens and have an influence on the emergence of energy citizenship
- to understand what the conditions are that determine collective behavioural patterns which in turn enable the emergence of energy citizenship.

This report offers a general framework for assessing the conditions upon which the emergence of energy citizenship might arise in specific settings. This will guide the conduction of GRETA case studies addressing specific areas of human activity where the common tread is the link with energy requirements and the consequent reductions of CO2 emissions. This will also enable finding out at what level of geographical aggregation, energy citizenship might arise.

The report is structured into four sections. The first section presents the general premises of the framework to be proposed. Section 2 investigates definitional aspects of energy, citizenship and finally energy citizenship, and offers a broad review of the general wisdom on drivers and barriers that might influence the upcoming of energy citizenship and what kinds of behaviours might characterise and define different types of energy citizens. Section 3 proposes a comprehensive approach to explore and predict the conditions upon which energy citizenship might arise. It proposes a new theory and approach to integrate disparate theories from social sciences and humanities and offers a framework to understand the structural and dynamic factors that act as drivers and barriers that have not been identified or defined before in the literature. Section 4 highlights key findings and offers reflexions on the contribution to knowledge and the next steps in the framework implementation in subsequent work packages of GRETA.

2 Energy citizenship and behaviour

The goal of the GRETA project is to develop a broad understanding and raise awareness of energy citizenship within the EU. To reach this goal, energy citizenship must be defined and the enablers and barriers towards its emergence must be identified. Additionally, the nature of interactions and interrelations among actors within the energy system will be examined. Before any of the above can be done, there are key questions that require an answer. In this section, we give answers to the following questions: ”What is energy citizenship?”, “How is it characterised?”, ”What drives energy citizenship?” and “Who are and are not energy citizens?”. We offer a preliminary definition of energy citizenship and discuss the types of drivers associated to behaviours that support energy citizenship, as reported in the literature.

2.1 Method towards an energy citizenship definition

To create a holistic definition and framework of energy citizenship, we made use of the Google Scholar search engine, using keywords such as ”energy citizenship”. By using this method, we identified and reviewed existing definitions. Reading through the first results, we quickly found out that Devine-Wright (2004) was the first author who used and defined the term of energy citizenship. Based on that, we found a very recent article by Beauchampet and Walsh (2021) called ”Energy citizenship in the Netherlands: The complexities of public engagement in a large-scale energy transition”. As this article gives an overview of some of the most important literature in the field, we used the snowball method by consulting the bibliography in the article to find other relevant titles on the subject. Regarding types of energy citizens and their behaviours, we also made use of the Google Scholar search engine. After defining each energy citizen type and their specific behaviours, we reviewed the determinants of each behaviour separately.

2.2 Understanding energy

“Energy’s meaning is capacious: it is provided by coal, oil, wind; it is a scientific entity; a metaphor; an indicator of vigour, tinged with virtue. Energy feels trans-historic and cosmic, but it is also material: it pumps through pipelines, sloshes in gas tanks, and spins wind turbines. Most importantly, energy has a foundational status in modern physics: it is the quest to understand change in the cosmos.” (Daggett, 2019, p.1).

The origin of the word *energy* lays with Aristotle (384–322 bc) and was connected to work and its relationship with human virtue (i.e., Greek: *en-*, meaning “in” or “within” and *-ergon*, meaning “work”). In fact, prior to the nineteenth century, references to *energy* had little in common with its future incarnation as a unit of thermodynamics. The definition of *energy* in the second edition of the Oxford English Dictionary (1989),

was still based on Aristotelian connotations of vigour, actuality, motion, and change: (1) "force or vigour of expression"; (2) "exercise of power, actual working, operation, activity"; (3) "vigour or intensity of action, utterance, etc."; (4) "power actively and efficiently displayed or exerted"; (5) and "ability or capacity to produce an effect." In the Western world the meaning of energy expressed a bias toward dynamism over stasis (Daggett, 2019), which is in line with the concept of trajectorism (i.e., the assumption that there is a cumulative journey from here to there or from now to then), introduced by Arjun Appadurai (2013). In the nineteenth century, thermodynamics adopted the term *energy* as a concept of physics and added connotations such as unlimited progress and infinite growth to the term. However, as the original meanings of *energy* are still used alongside with its scientific connotation, Daggett (2019, p.19) argues: "*Energy* continues to be a slippery word, traveling easily between vigour, virtue, and fossil fuels, and implicitly disparaging its opposites: rest, stasis, stillness, lassitude."

As energy is a complex subject, it can be conceived in multiple ways and is approached with very different social representations of the role of the public or energy users. According to Stern and Aronson (1994), there are four principal ways of understanding energy:

- Energy as commodity, which is mainly about the supply, demand and price of energy.
- Energy as ecological resource, meaning that energy is seen as a resource which is depleted and can have environmental impacts.
- Energy as social necessity through being available to social groups and meeting essential needs.
- Energy as strategic material which is about geopolitics and the availability of domestic substitutes.

For each way of framing energy, Table 1 shows the central values and interest groups.

Table 1. Principal ways of understanding energy (source: Stern and Anderson, 1994).

Energy as	Important properties	Central values	Interest groups
Commodity	Supply, demand, price	Choice, individualism, private sector provision of energy services	Energy producers, consumers with sufficient resources (fuel rich)
Ecological resource	Resources, depletion, environmental impacts	Sustainability, frugality, choice for future generations, preference for renewables	Future generations, green movement
Social necessity	Availability to social groups, meeting essential needs	Equity, justice	The poor (fuel poverty) and other vulnerable social groups
Strategic material	Geopolitics, availability of domestic substitutes	National military and economic security	Military, energy suppliers

While acknowledging the diversity of these perspectives on energy, Devine-Wright (2012) argues that they do not carry equal weight in energy policy making. According to him, 'energy as commodity' has always been, and continues to be, the most dominant social representation of energy held by policymakers. A clear indication of his point of view being true is the privatisation and liberalisation of the electricity market in the European Union which officially entered into force on 19 February 1996 (with the UK having started this process earlier on). Even though issues of environment and social justice are embedded within the policy mix, the view of 'energy as commodity' takes the dominant position.

2.2.1 Centralised and decentralised energy systems

The four different representations of energy identified by Stern and Aronson (1984) are embedded within and have been shaped by the centralised approach to energy generation and supply. The centralised energy system is defined as: "large-scale energy generation units (structures) that deliver energy via a vast distribution network, (often) far from the point of use" (Vezzoli et al., 2018, p.25). Figure 2 shows an illustration of a centralised energy system.

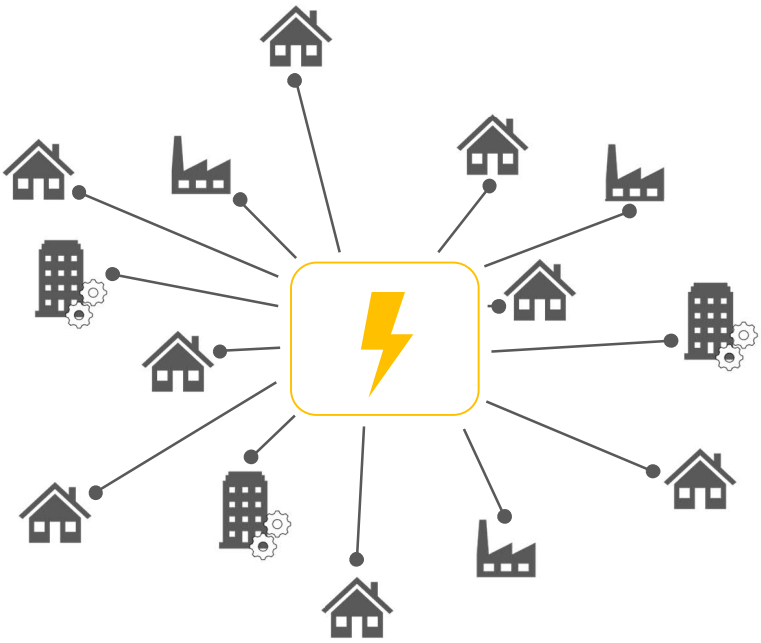

Figure 2. Centralised energy system (elaborated after Vezzoli et al., 2018).

According to Devine-Wright (2012), the public can be represented in several ways in relation to energy generation, supply and use within this approach: as 'customers' or 'consumers', fuel 'rich' or 'poor' as well as 'environmentally concerned'. In general, however, the centralised system coexists with the image of energy users having deficits in interest, knowledge, rationality, and environmental and social responsibility.

Devine-Wright (2012) criticises this view as it leads to a self-fulfilling prophesy, where decision makers do not take the public into account when developing energy policies and designers, and developers and installers of new energy technologies do not include the public to minimise resistance, leading to delays in planning and inefficient or incorrect use of technologies by the public.

An opposing approach is the decentralised energy system which is "characterised by small-scale energy generation units (structures) that deliver energy to local customers" (Vezzoli et al., 2018, p.25). Figure 3 shows an illustration of a decentralised energy system.

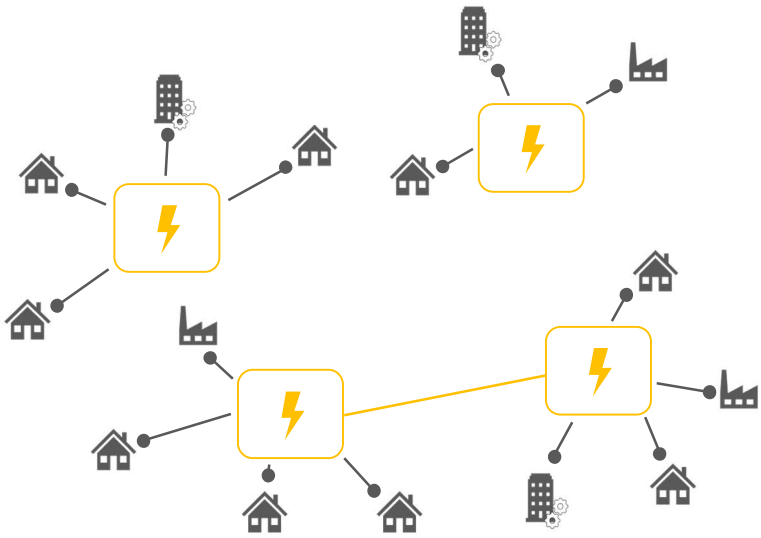

Figure 3. Decentralised energy system (elaborated after Vezzoli et al., 2018).

In contrast to the centralised approach, within the decentralised energy system, the public is socially and psychologically attached to energy systems and as energy users. This is also described as energy citizenship (Devine-Wright, 2004) which will be further explained in Section 2.3.

2.3 Understanding citizenship

2.3.1 The liberal-individualist view and the civic-publican view

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 (2017) distinguishes between three dimensions of citizenship: legal status and rights, activity, and membership. According to her, these dimensions are imbedded in two influential contemporary conceptions of citizenship. The first being the civic-publican view, which identifies citizenship as an active

process. Within this view, citizens are not mainly *homines economici* but are involved and active in the political community. The second conception of citizenship is the liberal-individualist view, which describes citizenship as a formal and legal status that establishes a significant 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.

2.3.2 Different notions of citizenship

In line with the civic-publican view, Isin (2017) argues that making rights claims is about the performativity or practice of citizenship. The concept of the so-called *performative citizenship* therefore involves the exercise of one's rights: citizenship is practised both with the enacting of rights and by claiming them. It is part of the daily life: the practise of citizenship is situated within everyday practices and thus moves beyond legal and constitutional definitions and conceptualizations. According to Isin (2017, p.501), there are five overlapping aspects to *performative citizenship*: "citizenship involves political and social struggles over who may or may not act as a subject; these struggles feature not only citizens but also non-citizens as relational actors; citizens and non-citizens include different social groups making rights claims; people enact citizenship by exercising, claiming and performing rights and duties; and when people enact citizenship they creatively transform its meanings and functions."

The notion of *environmental citizenship*, on the other hand, is argued 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, Halim, and Nadeson, 2010, p.5715). The idea is that everyone should take responsibility for how one interacts with the environment. However, like performative citizenship, environmental citizenship is also about the active participation of citizens. According to Hawthorne and Alabaster (1999), participation in environmental education and training is the most important enabler of environmental behaviour, followed by affect. Also, definitions of environmental education and education for sustainability (e.g., Sterling, 1992; UNESCO, 1993) imply that it is a process with the aim to create an environmentally responsible population that contributes to sustainable development and consists of 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, or Barnett et al., 2005).

Another notion of citizenship, which Dobson (2003) argues to go beyond the distinction of the liberal-individualistic and civic-publican views, is *ecological citizenship*. According to Dobson and Sáiz (2005, p. 157), a "turn to citizenship" has occurred in some of the literature on environmental politics, which led to a debate on *ecological citizenship* (e.g., Dobson, 2006, Dobson and Bell, 2006, Gabrielson, 2008, Hayward, 2006). Dobson (2003) argues that *ecological citizenship* is neither liberal nor

civic republican, but rather an example of "post-cosmopolitan" citizenship. Post-cosmopolitanism he defines as commitments beyond the nation-state that grow out of understanding globalization as the source of inequalities and injustice. In line with that, 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 change the motivational basis underlying environmental action.

In summary, both *performative citizenship* as well as *environmental citizenship* are about the active participation of citizens. However, key features of *performative citizenship* are enacting and claiming rights which makes this notion of citizenship civic-publican, while the key feature of *environmental citizenship* is taking responsibility for one's interaction with the environment which makes this notion of citizenship rather liberal-individualistic. *Ecological citizenship* goes beyond this distinction and is described as post-cosmopolitan. Key features are the focus on both duties as well as rights and the requirement of deep shifts of attitudes to motivate environmental action.

2.3.3 Energy citizenship

In line with earlier mentioned notions of citizenship, the transition from a fossil fuel-based energy system to a renewable one brought a new facet to "energy as social necessity". Devine-Wright (2004) describes it as *energy citizenship*. Within this specific kind of citizenship "the public is 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, 2004, p.71). Thus, like performative, environmental, and ecological citizenship, the idea of *energy citizenship* builds on a view of citizens as active participants, who are, however, specifically engaged in sustainable energy transitions. It is argued that citizens play an important role in transitions and should be conceptualised as "important stakeholders in the innovation process shaping new routines and enacting system change" (Schot et al., 2016, p.1). Citizens are not perceived as merely users of energy technologies and innovation, but participants in the energy system in a more comprehensive way (Devine-Wright, 2004). This active participation can take several forms (see Section 2.4 for the different types of energy citizens).

Energy citizens can act both socially and politically either as individuals, for example through energy efficiency measures in households, or in larger groups, for example through engagement with energy policy in climate activist groups (Radtke, 2014), in local energy (Hasanov and Zuidema, 2018) or grassroots initiatives (Koij et al., 2018). Engagement in energy systems can therefore take many forms: from investment or ownership of energy projects to participation in decision-making processes, as well as the implementation of just and equitable energy planning processes (see Section 2.4 for

a more detailed elaboration on the different behaviours). According to Koirala and colleagues (forthcoming), two types of engagement can be defined:

- First, consumer engagement, which is about products and services that should be usable, deliver value and a good user experience to users to be successfully adopted and used.
- Second, citizen engagement, which is about the role and inclusion of citizens and public society actors in transitional processes themselves, their designs, implementation and execution and their outcomes facilitated by inclusive and decentralised governance modes and collaboration structures (Koirala et al., forthcoming).

Important to mention is that engagement can either be positive or negative. Positive forms of public participation in the energy system are, for example, supporting the clean energy transition, investing in energy efficient appliances or participating in a local energy initiative. Negative and/ or problematic forms are manifested as public resistance to new forms of renewable energy, such as individual failure to take up alternative and greener forms of energy or adopt energy efficient behaviours when in a position to do so. A widely discussed example of an active resistance is the NIMBY (not in my backyard) movement. In both academic literature as well as public discourse, NIMBY is used to describe a locally based action group protesting a proposed development. However, the label is often used without any clear definition and is simply equated with local opposition (Burningham, Barnett, and Thrush, 2006). Even more so, NIMBY is frequently used to dismiss the arguments of a group as purely self-interested or to discredit the activities of the protesters. Instead, NIMBYs are, as Wolsink (2000, p.53) defines them, “people that combine a positive attitude and resistance motivated by calculated personal costs and benefits.” In other words, they are people who voice their concerns and doubts about certain actions. NIMBYism is thus a good example of the common misconception that negative forms of engagement are based on illegitimate or irrational, selfish (or narrow) reasons (Hunter and Leyden, 1995). Based on this inadequate conventional conceptualisation of NIMBYs, McClymont and O'hare (2008) argue that utilizing a strict dichotomy between “good” and “bad” participation can be misleading and should therefore be avoided.

2.3.4 Levels of energy citizenship emergence in terms of engagement

The notion of energy citizenship suggests energy consciousness and literacy as well as sustainable energy actions. Devine-Wright (2004, p.72) stresses both awareness and action aspects: “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.” That is why awareness plays an important role in GRETA’s concept of energy citizenship emergence (see Figure 4), which suggests that energy citizenship can take different forms and levels, from being unaware to being aware, involved, fully active to advocating for change. Within GRETA, we hypothesise that energy citizens can transition between engagement levels by means of

changes of their (physical and/ or mental) condition and context. An unaware energy citizen, for example, transits towards being aware of the energy transition by being interested. However, feeling indifferent also has an impact on the level of energy citizenship as either the indifferent person continues to be unaware of the energy transition or has the urge to voice that indifference and by that becomes involved.

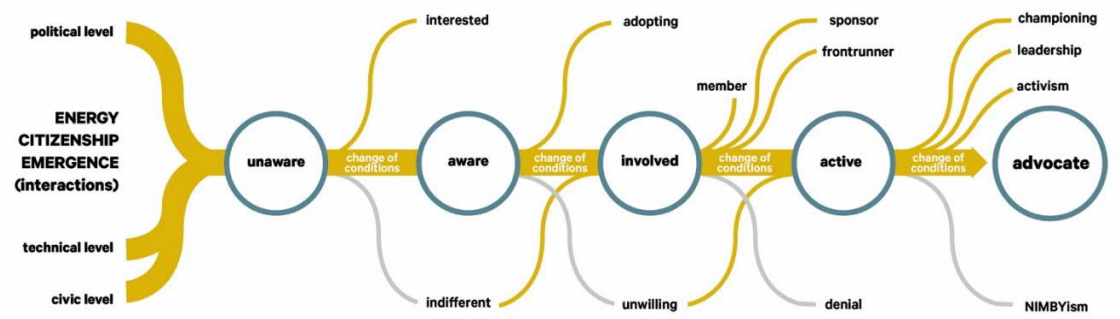

Figure 4. Concept of energy citizenship emergence in terms of engagement. Source: Adapted from Massari (2020).

The levels of engagement that a citizen might perform defined in Figure 4 are contingent on a myriad of incentives and disincentives as well as the interaction with the context and other actors in a green energy ecosystem. In this sense, the levels of engagement in specific actions and behaviours are by nature an emergent behaviour. As will be shown below, such emergent behaviour features will also be contingent on the type of citizen that we consider and their role in an ecosystem of change.

2.4 Types of energy citizens and related behaviours

As we will see below, energy citizenship manifests itself in an embryonic form in multiple behaviours that citizens carry out in their daily activities that have an impact in the energy transition. Without suggesting a clear distinction between them, several types of energy citizens can be distinguished which are either individuals (e.g., consumers, prosumers and prosumagers, participants in protests and movements, and policymakers) or collective entities (e.g., energy communities and business entities) that are actively involved in the energy transition (see Table 2). Although there may be combinations of types of energy citizen, and their behaviours may overlap, a distinction between behaviours can be made specific to the role of the type of energy citizen within the energy system. In the following, we will thus discuss each type of energy citizen separately, explain their behaviours and involvement in the energy system and review the factors that drive, enable as well as those that prevent their behaviours. We do not claim for the following overview to include all types of energy citizens (i.e., one may also think of knowledge brokers, influencers or researchers). It is an overview however of the, what we consider, most important stakeholders in the

energy system. Further, this overview is based on the state-of-the-art knowledge on individuals' and collective entities' behaviours that are involved in the energy system.

Table 2. Types of energy citizens.

Category	Types of Energy Citizen
Individuals	Consumer Prosumer and prosumager Participant in protests and movements Policymaker
Collective entities	Energy community Business entity

2.4.1 Consumer

The first type of energy citizen we will discuss is the consumer, which is the type of citizen most researched in the energy transition research. Consumers are not merely end-users who are intended ultimately to use a product or service but also people who support and/or maintain the product. Specifically, Lopes (2016) distinguishes between three behaviours of consumers within the energy system, namely investment, maintenance and usage. Investment is defined as "actions involved in the purchase of new equipment" (Lopes, 2016, p.3). Maintenance is described as "actions involved in the repair, maintenance and improvement of energy consuming equipment, including the building" (Lopes, 2016, p.3). Lastly, usage is defined as "actions of usage of buildings and equipment therein installed that may be characterised by the frequency, duration, and intensity" (Lopes, 2016, p.3). Usage behaviours can again be divided into three categories (Wang, Shen, Springer, and Hou, 2021):

1. energy consumption at home or at work, including space heating and air conditioning as well as common appliances, lighting and other energy uses
2. personal transportation methods, such as public transportation, shared bicycles, and cars as well as alternative fuel vehicles and (holiday) travel; and
3. recycling.

In the literature, actions with the goal of consuming energy more responsibly are often referred to as efficiency behaviours (Black et al., 1985; Gardner and Stern, 2002; Breukers et al., 2011). Decreasing the usage of energy and contributing to achieve energy savings are commonly referred to as curtailment or conservation behaviours (Black et al., 1985; Gardner and Stern, 2002; Breukers et al., 2011). Important to mention is the side effect of consumers' and users' buying power: they do not merely satisfy their needs, but also reveal to the providers of products and services their specific preferences as consumers, also referred to as "authority of consumers" (Abercrombie, Keat, and Whiteley, 1994; Spaargaren and Oosterveer, 2010).

Emergence of investment behaviours

In a recent study, Neves and Oliveira (2021) summarised the drivers of energy-saving investments. They found that classical theories, such as the theory of planned

behaviour (TPB, Ajzen, 1991) and the prospect theory (PT, Kahneman, and Tversky, 1979) are widely used to explain energy-efficient investments. The TPB proposes that behaviour and behavioural intention are determined by three constructs: attitude towards a behaviour, subjective norm (i.e., perceived social pressure to (not) engage in the behaviour) and perceived behavioural control (i.e., perceived ease/ difficulty to perform the behaviour). It has been applied and found to be a suitable framework in a wide array of research areas of pro-environmental behaviour, including those concerning energy-efficient equipment and appliances (e.g., Ali, Ullah, Akbar, Akhtar, and Zahid, 2019; Bhutto, Liu, Soomro, Ertz, and Baeshen, 2021).

Also, Tan, Ooi and Goh (2017) found that moral norm, which refers to the "perceived moral obligation or responsibility to perform or not to perform certain behaviour" (Tan, Ooi, and Goh, 2017, p.15; Kaiser, 2006), affects purchase intention of energy-efficient household appliances, such as energy-efficient freezers, air-conditioners, domestic fans, and televisions. Although there are mixed results about the effect of providing information and price signals (e.g., McKenzie-Mohr, 2000), a study by Li, Li, Jin and Wang (2019) found that environmental concern and environmental knowledge have a positive effect on attitudes and indirectly affect people's willingness to purchase energy-efficient appliances. Taghikhah, Voinov and Shukla (2019) explained that if consumers do not understand the benefits of low-carbon products they may be reluctant to buy them due to their tendency to be more expensive than regular products. Heutel (2019) found that the decision to invest in energy-efficiency entails some risk and uncertainty and that consumers thus behave according to the prospect theory, meaning that they place more weight on perceived gains versus perceived losses (i.e., loss aversion).

Other studies focused on more physical, economic and/ or socio-demographic variables. For example, Yang and Zhao (2015) found that household income positively moderates the relationship between the purchase attitude towards energy-efficient energy equipment and the behavioural intention. They further conclude that subsidy incentives positively affect the moderator effect of household income. According to Shuai, Ding, Zhang, Guo and Shuai (2014), also factors such as age, gender, and education influence the purchase intention of low-carbon products. Specifically, they found that willingness to pay for low-carbon products is highest for 40–49-year-old consumers and lowest for under 19-year-old as well as over 50-year-old consumers. The reasoning behind this is the lack of economic self-sufficiency of under 19-year-old consumers and low awareness of low-carbon products of over 50-year-old consumers. When it comes to gender, men were found to be more willing to pay for low-carbon products than women. Finally, the higher the educational level, the stronger the willingness to pay. A study by Baldini, Trivella and Wente (2018) showed that the housing type, number of inhabitants, and their age predict their purchase of energy-efficient appliances. Specifically, farmhouses and single-family homes residents were found to be more likely to choose energy-efficient appliances than apartment residents. The higher the number of inhabitants, the higher the probability energy-efficient appliances are being purchased. Regarding age, consumers younger than 30 years were found to be less likely to invest in energy-efficient appliances. In line with that,

Michelson and Madlener (2012) found that the age of the house determines the choice in energy-efficient heating systems (i.e., gas-fired heating systems are more often found in younger homes, whereas the appliance of solid fuel-based or oil-fired heating systems increases with the age of the house), indicating the relevance of characteristics of the house as determinants of energy-efficient investments. In recent research by Niamir and colleagues (2020), socio-economic and psychological aspects were combined and found to be similarly important when it comes to energy-saving investments. Specifically, they found that awareness and personal as well as social norms are as important as monetary factors when it comes to energy-saving behaviours and investments in efficient appliances and house insulation.

However, there are also barriers when it comes to energy-saving investments (Gillingham, Newell, and Palmer, 2009). For example, Kempton and Montgomery (1982) argue that consumers tend to use heuristic decision-making regarding energy-efficient investments, meaning that they use mental shortcuts to solve problems and to make judgments more quickly and efficiently. Specifically, consumers were found to ignore future changes in real fuel prices by using the energy price of the moment while calculating the payback measure, rather than the price at the time of the savings. Later, Kempton, Feuermann and McGarity (1992) found that consumers systematically miscalculated payback for air conditioner investments. Besides that, according to Yates and Aronson (1983) consumers tend to disproportionately weight factors that are more vivid and observable (e.g., comfort or temperature) while ignoring those that do not grab their attention (e.g., impact on the environment), also called the salience bias. Wilson and Dowlatabadi (2007) therefore argue that the salience bias influences energy efficiency decisions, potentially contributing to an overemphasis on the investment costs of an energy-efficient purchase. Future research should, however, include a disaggregation by gender since important information may remain hidden by not considering differences in gender.

Emergence of maintenance behaviours

In the literature, maintenance behaviours regarding energy consuming equipment are mostly about home retrofitting, which is why we will mainly focus on drivers and barriers of the emergence of this specific part of maintenance behaviours. Hrovatin and Zoric´ (2018) distinguish five areas of drivers and barriers when it comes to residential retrofit decisions: technical factors, economic factors, socio-economic characteristics of households, behavioural factors and information and policy measures. Technical factors contain building characteristics, such as the age and lifetime of building elements and thermal comfort. In numerous studies, these factors have been found to stimulate of energy-efficient retrofit decisions (e.g., Achtnicht and Madlener, 2014; Gamtessa, 2013; Judson and Maller, 2014). Therefore, energy-efficient retrofits are more likely to happen if the house is old and when residents experience lower thermal comfort (i.e., cold).

Similar to investment behaviours, maintenance behaviours are often discouraged by economic factors, such as high upfront costs and a lack of financial resources (e.g., Bjørneboe, Svendsen, and Heller, 2018). The availability of public or private funding

would therefore help to overcome this financial barrier. However, it is important to note that there are mixed results found. In Switzerland, for example, economic factors such as financial needs and economic viability do not represent a barrier as they are often embedded in other general amenity renovations (Jakob, 2007); and for UK homeowners, financial constraints do not prevent renovation decisions but may merely extend the time for making the decision (Wilson, Chrysochoidis, and Pettifor, 2013). The strongest economic drivers for energy-efficient building retrofits are the expected energy cost savings and economic viability (e.g., Achtnicht and Madlener, 2014; Gamtessa, 2013; Gösche, Schmidt, and Vance, 2013; Jakob, 2007). Besides that, the fear of a future increase in energy prices is found to drive retrofitting (Alberini, Banfi, and Ramseier, 2013). Uncertainty, however, about future price movements encourage consumers to prefer the current state of their home (Jakob, 2007).

According to Hrovatin and Zoric´ (2018), important household socio-economic characteristics that drive or inhibit retrofitting are income, age and education. Regarding income, even though high income is assumed to reflect on a high likelihood of retrofit, the results are mixed (e.g., Achtnicht and Madlener, 2014; Gamtessa, 2013; Gösche, Schmidt, and Vance, 2013; Poortinga, Steg, Vlek, and Wiersma, 2003). When it comes to age, the older house owners (> 64 years old), the lower the likelihood to retrofit (e.g., Achtnicht and Madlener, 2014; Gamtessa, 2013). It is assumed that older house owners may be discouraged by health issues, diminishing capabilities and financial constraints. Finally, education is found to have a positive impact on the likelihood to retrofit as a high education is assumed to be linked to a greater understanding of information and being able to turn information into action (e.g., Achtnicht and Madlener, 2014). Only a few studies have included gender. A study by He and colleagues (2019) for example shows that there are gender differences when it comes to the intention of retrofitting. Specifically, men are shown to be influenced by policy factors, which refer to direct control, intervention, or encouragement of policies at the government level, in their intention to retrofit and women are not. On the other hand, women were found to be influenced by social norms in their intention to retrofit and men are not. A study by Alliander N.V. (2019) on the role of different family members in the decision-making process for energy-saving and energy-generating measures in the home also shows some differences between men and women. Men were found to start installation measures (e.g., of solar panels) more often than women. The reasons for men are technical interest and financial considerations. More research is needed however to draw a more precise conclusion when it comes to the impact of gender on retrofitting behaviours. However, there are also studies that do not find an impact of socio-economic variables, showing that when accounting for the role of other factors relating to income and everyday life conditions, socio-economic variables lose their explanatory power (Wilson, et al., 2013; Poortinga, et al., 2003).

Again, like investment behaviours, the TPB was found to explain the intention toward green retrofitting (e.g., Fransman and van Timmeren, 2017; He, et al., 2019). Another behavioural factor that is known to drive home retrofitting is environmental awareness (Hrovatin and Zoric´, 2018). Another behavioural driver of home retrofit is having previous renovation experiences since it builds the skills of homeowners (Nair,

Gustavsson, and Mahapatra, 2010). Further, according to Murphy (2014), comfort drives energy-efficient retrofits more than detailed 'technical tailored' energy- and environment-saving information. In contrast to comfort, the hassle which is associated with transitioning a home was found to be a possible barrier for homeowners (Beauchampet and Walsh, 2021). Routines, such as dining, socialising and entertaining also influence whether energy-efficient aspects of renovation are considered (Judson and Maller, 2014). They can either be drivers or barriers. When it comes to information and knowledge, the results in the literature are mixed. While positive effects of energy audits or information is found in multiple studies (e.g., Achtnicht and Madlener, 2014; Gösche, et al., 2013; Nair, Gustavsson, and Mahapatra, 2010), there are also several studies questioning their effectiveness (e.g., Fondel, and Vance, 2013; Gamtessa, 2013; Wilson, et al., 2013). Finally, 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 discussed. While some studies report a stimulating effect (e.g., Gamtessa, 2013; Nauleau, 2014), other studies express concern about the effectiveness of fiscal incentives for overcoming the financial gap (e.g., Jakob, 2007; Pettifor, et al., 2015).

Emergence of usage behaviours

Influencing factors of usage behaviours are predominantly built on classic behaviour theories, such as the TPB, the norm activation model (NAM, Schwartz, 1977) and the value–belief–norm theory (VBN, Stern et al., 1999). The TPB has been demonstrated as an effective framework for energy-saving behaviours in multiple studies (e.g., Harland, et al., 1999; Nie, et al., 2019). According to the NAM, personal norms are determined by two factors: the awareness that performing (or not performing) a particular behaviour has certain consequences, and the feeling of responsibility for performing the specific behaviour (Schwartz, 1977). It was designed and found to explain altruistic and pro-social behaviour, such as energy saving behaviours (e.g., van der Werff and Steg, 2015; Zhang, et al., 2013). Li, Xu, Chen, and Menassa (2019) combined TPB and NAM and concluded that both motivations, defined as personal norms and attitude, and opportunity directly affect energy-saving behaviours, while opportunity has the greatest effect.

The VBN which proposes a causal series of variables (i.e., values, beliefs, and personal norms), was also found to be an effective framework for pro-environmental behaviours. According to Burger and colleagues (2015), different values may drive energy-saving behaviour. Self-interest values, for example, may lead to energy-saving behaviour because of the consequences for one's own well-being; social altruism values may drive energy-saving behaviour as they refer to concerns about a larger group of individuals; and biospheric altruism values may drive energy-saving behaviour as they refer to concerns about all living species and the state of ecosystems. Indeed, VBN was found to predict, for example, intentions to reduce car use (Nordlund and Garvill, 2003) or to recycle (Guagnano et al., 1995). Burger and colleagues (2015) also suggest that socio-economic factors, such as income, age and gender have an influence on energy-saving behaviours. However, there is no research yet done on the differences in impact these socio-economic factors have.

In the following, we will respectively discuss three categories of usage behaviours, namely household energy consumption, personal transportation methods and recycling. According to a review by Wang, Shen, Springer, and Hou (2021), these categories contain several behaviours that are influenced by various factors.

Household energy consumption

First, we will discuss findings about household energy consumption. In general, there is a difference between energy demands in urban and rural households which is linked to many factors, such as household income, education level, family size, size of living space as well as heating and cooling days (Du, et al, 2017). However, according to a study by Vainio et al. (2020), socio-psychological variables explain sustainable energy behaviours more than socio-economic variables. They found that pro-environmental attitude, considering future consequences, efficacy beliefs and action-related subjective knowledge drive behaviours such as lowering the temperature at home and switching electronic devices off when they are not in use (i.e., private-sphere environmentalism). Additionally, according to a study by Chen and colleagues (2020), building energy consumption can be significantly affected by perceived behavioural control and injunctive norms. Schultz and colleagues (2007) even argue that both descriptive norms (i.e., feedback about average consumption in the neighbourhood) and injunctive norms (i.e., evaluation of own consumption relative to neighbourhood consumption) are important for promoting electricity savings for whole households.

A study in Spain found that heating costs are affected by thermal comfort temperature, economic factors such as price and income, and regulatory interventions such as taxes and attitudes towards the environment (Lopez-Bernabe, et al., 2020). Another study showed that the willingness to adopt and pay for alternative heating systems in Beijing was influenced by income, scientific literacy, and local environmental issues (Jingchao, et al., 2018; Wade, et al., 2016). When it comes to usage of air conditioning, dwelling age, dwelling size, and occupation were found to be influential factors (Zhang, et al., 2020). Specifically, households in more recently built dwellings as well as with bigger homes use their air conditioning less often and for a shorter period. Furthermore, households where the main earner works in the private sector were found to use their air conditioning more than households where the main earner works in the public sector.

In general, when it comes to household energy consumption, a study by Huebner, Cooper and Jones (2013) has found that habits may be the key barrier to behavioural change, while saving money is the most powerful driver of it, while the energy consumption in houses was significantly higher than in flats. However, when economic incentives are removed, they are not always effective in the long run. Also, for other household CO2 emissions though for example the usage of water heating, lighting, cooking appliances, washing machines, computers, mobile phones, TV, etc., demographic factors were found to be influential. However, the correlation between demographic factors and household CO2 emissions is not completely clear (Zhang, et al., 2015; Wang, et al., 2021). Additionally, households' energy-related behaviours and the widespread use of energy-efficient appliances are the main factors influencing

household electricity consumption (Adua, 2020). A study from the UK revealed that providing technical appliances, such as timer switches, low-flow showerheads and smart meters can help reduce energy and water consumption (Hayles and Dean, 2015). According to Webb, Soutar, Mazzarol, and Saldaris (2013), the effect of autonomous motivation to change energy-saving behaviour is greater than other factors such as intention, subjective norms, or past behaviour.

Personal transportation

The second category of usage behaviours is personal transportation. In general, when people make travel decisions, pro-environmental attitudes may not necessarily lead to low-carbon behaviours, but they are mostly influenced by factors such as comfort, convenience, and personal safety (Geng, Long, Chen, Yue, Li and Li, 2017). However, a study by Lind, Nordfjærn, Jørgensen and Rundmo (2015) showed that preferring environmentally friendly travel methods may be influenced by ecological values, beliefs in sustainability and environmental consciousness. When it comes to the use of public transportation, for example, a study in the Netherlands found that people who pay more attention to the environmental issues that arise through private vehicle usage may reduce their use while others focus more on their personal freedom as a representation of their psychological values and therefore use their private vehicles (Steg, 2003).

In terms of bicycle use, an important determinant is the existence of a cycling culture – the more people use bicycles, the more attractive it is to others (Goetzke and Rave, 2011). This cycling culture is both informative, meaning that people see each other cycling and talk about the benefits, and normative, in the sense of creating the social norm that cycling is healthy and eco-friendly. Regarding the use of shared bicycles, the awareness of its environmental benefits was shown to affect people's willingness to use shared bicycles (Yang and Long, 2016). Additionally, the feeling of responsibility towards the environment, the ease of access to public transit systems, and safety concerns such as poor road awareness of riders and imperfect cycling facilities affect people's willingness to use shared bicycles. According to Fishman, Washington, and Haworth (2012), safety concerns, such as poor road conditions and inadequate bike parking facilities, are the main obstacle for bike sharing.

For car-sharing, the most common drivers are cost savings and convenience (Shaheen and Cohen, 2007). According to a recent review by Nansubuga and Kowalkowski (2021), other drivers are socio-demographic [i.e., higher demand among single-person households, young age (in their 20s and 30s), male, city centre residents], geographic (i.e., car availability, reliability and parking conditions), socio-economic (i.e., high education levels, moderate upper income levels), population density (i.e., the higher the population density and social activity in a given area, the more car-sharing), high service quality (i.e., fleet management, tutorials, ability to access help) and environmental benefits in combination with other factors, such as convenience of access to a car (e.g., Julsrud and Farstad, 2020). Barriers that Nansubuga and Kowalkowski (2021) identified were limited availability of car-sharing, low public

awareness, and burdens of sharing, such as insecurity and uncertainty regarding contractual conditions.

The willingness to adopt or pay for cars that have lower CO2 emissions is linked to demographic factors, such as education. Specifically, a study in Germany showed that higher educated people are more interested in driving clean fuel vehicles for protecting the environment (Achtnicht, 2012). Additionally, environmental attitudes and external factors, such as infrastructure, technical support, or economic incentives, also have positive impacts on the adoption of alternative fuel vehicles (Li, Long, Chen, and Geng, 2017). In contrast, the so-called "range anxiety" is a well-documented barrier of the adoption of plug-in electric vehicles. This makes having access to sufficient and convenient charging infrastructure a crucial factor for the consumers' use of plug-in electric vehicles (Bühler, Cocron, Neumann, Franke, and Krems, 2014).

In regards of the intention to reduce car usage in general, VBN was found to be an explanatory framework. Specifically, Nordlund and Garvill (2003) found that values and problem awareness influence personal norms, which in turn influence the willingness to reduce personal car use. In line with the reduced car usage, a study by Burghard and Dütschke (2019) showed that, next to perceived compatibility with daily life, social norms also drive the attitudes towards electric car-sharing. They also found that particularly for younger people who (i) live as a couple but without cars or (ii) are starting a family and use car-sharing as a supplement to their own cars, car-sharing of EVs seems attractive. Finally, the results showed that the affinity for car-sharing and EVs is closely connected.

Recycling

Finally, recycling and waste separation is part of usage behaviour. According to Babaei and colleagues (2015), knowledge, attitude, and practice are significant predictors of recycling behaviour. These factors again, were found to be influenced by demographic factors of age, education level, gender, and occupation. Besides that, VBN was found to partially predict recycling, as self-transcendence, especially universalism was found to have a strong positive effect on environmental awareness as well as on reuse behaviours (Dursun, et al., 2017). There is also evidence for the TPB to explain recycling behaviours among university staff (Karim Ghani, Rusli, Biak, and Idris, 2013), in households (Bortoleto, Kuriso, and Hanaki; 2012; Davis and Morgan, 2008) and among university students (Ramayah, Lee, and Lim, 2012). Other research shows that self-identity successfully predicts recycling intention (Nigbur, Lyons, and Uzzell, 2010). Further, moral obligation was found to be a significant predictor of both recycling intention among undergraduate students (Largo-Wight, Brian, and Lange, 2012) and waste prevention behaviour (Bortoleto, Kuriso, and Hanaki, 2012). Finally, Pakpour and colleagues (2014) showed that action planning and past recycling behaviour were significant predictors of household waste behaviour.

Summary

In the following table (Table 3), we summarise the determinants and factors that influence investment behaviours, maintenance behaviours and usage behaviours of

consumers, while demonstrating the overlap between determinants of these behaviours.

Table 3. Overview of determinants of consumer behaviours.

	Determinants	Consumer		
		Investment Behaviours	Maintenance Behaviours	Usage Behaviours
Theory of planned behaviour	Attitude	x	x	x
	Subjective norm	x	x	x
	Perceived behavioural control	x	x	x
Prospect theory	Loss aversion	x	x	
Norm-activation model	Awareness of consequences			x
	Ascription of responsibility			x
	Personal norms	x		x
	Social norms	x		x
	Moral obligation	x		x
	Awareness/ Knowledge	(x)	x	x
	Costs (time, money, etc.)	x	x	x
	Environmental benefits			x
	Habits		x	x
	Comfort		x	x
	Convenience			x
	Safety			x
	Infrastructure/ geographic factors			x
	Population density			x
	High service quality			x
	Subsidies	x	x	x
	Gender	x	(x)	x
	Age	x	x	x

	Determinants	Consumer		
		Investment Behaviours	Maintenance Behaviours	Usage Behaviours
Socio-demographic determinants	Occupation			x
	Household income	x	x	x
	Education level	x	x	x
	Household size	x		x

2.4.2 Prosumer and prosumager

The second type of energy citizen is the prosumer. Some authors define prosumers very broadly as a "type of energy user who both consumes and generates energy" (Rathnayaka, Potdar, and Ou, 2012: p.483), while others include a financial element, such that prosumers are those customers who produce energy and sell their excess electricity to make it available on the network (Karnouskos, 2011). In the case of electricity, they can "provide flexibility by optimising the timing of their electricity production and consumption, and by making decentralised storage available", for example by "investing in batteries or providing heat reserves through a more flexible heating behaviour" (Kubli, Loock, and Wüstenhagen, 2018, p.540). Active prosumers are prosumers who are self-driven in the adoption of energy generation of technologies, whereas passive prosumers are prosumers who are externally influenced, or where the adoption of general technologies is a by-product of other decisions (Whitaker, Ford and Stephenson, 2016). However, in reality, there is no dichotomy of prosumers but rather varying degrees of "active" and "passive" prosumerism. Active prosumers, who are influenced by a subsidy, meaning by an external factor, are less active than prosumers who do not have this support.

Recently Sioshansi (2019) has defined a subtype of prosumerism, namely the so-called prosumager. This type of energy citizen not only consumes and produces energy but also stores electricity. Therefore, when it comes to the behaviours of both prosumers and prosumagers, one can conclude that besides investing in energy-efficient equipment, maintaining energy-consuming equipment, and using buildings and equipment (like a consumer does), they also produce and store energy. Since, apart from some theoretical contributions (Green and Staffell, 2017; Schill, Zerrahn, and Kunz, 2017; Sioshansi, 2019; von Hirschhausen, 2017), research findings on prosumagers are generally non-existent and on prosumers are rare, in the following we will review the factors that drive, enable as well as those that prevent the production and storage of energy.

Emergence of energy production

In an exploratory research approach, Khan (2019) recently reviewed the evolution of prosumerism in Bangladesh. In this study seven drivers, five enablers, and eight

barriers for prosumerism were found which were then compared to the drivers, enablers, and barriers of prosumerism in developed countries, found in a study by Whitaker, Ford and Stephenson (2016). Common enablers of prosumerism in both developed and least developed countries, were financing option and financial benefit on income (Khan, 2019). Common barriers were technology, management, cost, trust, and suitable policy in action (legislation). There were no common drivers found which Khan (2019) explained by the fact that prosumerism in developed countries was initiated by different forms of social and environmental awareness, whereas in the least developed countries, prosumerism was initiated by the basic need to survive. In Bangladesh, drivers of prosumerism are high total annual income of a household, high education of the head of a household, the women's education of a household, woman as head of the household, the household's indoor air pollution (i.e., the higher the indoor air pollution, the higher the need to reduce it), non-agricultural occupation, and cell phone ownership. In developed countries, such as New Zealand, drivers are local income, maintaining local control, bargaining power, independence from grid, energy conservation, sustainability, multiplicative effect on income, cost, and social cohesion.

Additionally, Inderberg, Tews and Turner (2018) found environmental awareness to be a driver towards prosumerism and that the presence of a third-party installing market can enable the development of prosumerism in Norway, Germany, and the United Kingdom. In line with that, Palm (2018) suggests that environmental motives have been consistently put in focus over the years, despite changing market conditions. Also, awareness of local benefits (von Wirth, Gislason, and Seidl, 2018) and achieving energy self-sufficiency are perceived as benefits (Korcaj, Hahnel, and Spada, 2015). A study done by Rode and Weber (2016) about the spatial dimension of PV diffusion in Germany shows that there is significant local imitative adoption. This points to the relevance of social norm settings.

Additional barriers include regulations (von Wirth, Gislason, and Seidl, 2018), lack of relevant information, poor product quality and lack of economic and institutional support (Nygrén, Kontio, Lyytimäki, Varho, and Tapio, 2015). Palm (2018) suggests further that the upfront capital costs are often a barrier. Finally, a socio-techno-economic study in Israel shows that health and privacy concerns, low trust in technologies, and low public support in reducing demand are dominant barriers to prosumerism (Michaels and Parag, 2016).

Emergence of energy storage

Research on the social dimension of smart grids, which are described as an upgraded electricity networks enabling two-way information and power exchange between suppliers and consumers through pervasive incorporation of intelligent communication and management systems (Giordano et al., 2011), also sheds some light on drivers, barriers, and enablers of prosumers. Participation in smart grids, and therefore taking the role of a prosumer or prosumager in the energy system, is found to be driven by added comfort, energy independence, extended chance for electricity market participation, innovative control of appliances and devices, environmental benefits, economic incentives, energy bill reduction, clear and periodic billing, detailed

information of energy consumption and enhanced energy supply reliability (Mengolini and Vasiljevska, 2013). A study specifically about the adoption of residential solar photovoltaics with energy storage (Ardani, O'Shaughnessy, Fu, McClurg, Huneycutt, and Margolis, 2016) suggests that cost and value barriers continue to hinder the large-scale-deployment. Other barriers are related to the permission to install and operate an energy storage, which can turn out to be a complicated, expensive, and uncertain process. Examples of these barriers are the lack of cohesive industry-accepted standards or best practices or the pervasive unfamiliarity of citizens with storage. More research is needed to explain the determinants that influence consumers to produce and store energy at the same time.

Summary

In the following table (Table 4), we summarise the determinants and factors that influence energy production and storage by prosumers. For this summary we will mainly focus on determinants for developed countries. In general, however, there seems to be more research needed to explain when and why citizens decide to produce and/or store energy.

Table 4. Overview of determinants of prosumer and prosumager behaviours.

Determinants	Prosumer and prosumager	Prosumager
	Energy Production	Energy Storage
Environmental awareness	x	
Awareness of local benefits	x	
Sustainability	x	x
Social cohesion	x	
Social norm	x	
Local control	x	
Innovation control of devices	x	x
Technology	x	
Product quality	x	
Financing option	x	x
Local income	x	
Financial benefit	x	x
Management	x	
Cost	x	x
Comfort	x	x

Determinants	Prosumer and prosumager	Prosumager
	Energy Production	Energy Storage
Health concerns	x	
Privacy concerns	x	
Relevant information	x	
Trust	x	
Legislation/ Regulations	x	x
Bargaining power	x	
Energy self-sufficiency/ Independence from grid	x	x
Electricity market participation	x	x
Energy conservation	x	
Insights in energy consumption	x	x
Energy supply reliability	x	x

2.4.3 Participant in protests and movements

The third type of energy citizen is the participant in protests and movements (e.g., Hoppe, Graf, Warbroek, Lammers, and Lepping, 2015). This type of energy citizen takes part in the energy system by being either for or against the energy transition. Behaviours of the participant in protests and movements are being politically engaged by voting and getting active in a party, being active by attending demonstrations, writing to politicians and/or getting active in an organisation. Considering citizens that are active in a supporting way, Wynes (2019) argues that actions, such as voting for a party with a green agenda or attending environmental demonstrations, are effective in reducing environmental pollution. In support of that, a study by Bernauer and Koubi (2009) showed that when green parties have a stronger position in a country, lower levels of air pollution are more likely. Another study shows that having local environmental NGOs present not only directly reduces power plants' emissions but also indirectly does so by enhancing the effectiveness of subnational climate policies that encourage energy efficiency (Grant and Vasi, 2017).

Although we argue that participants in protests and movements include both citizens that are for and citizens that are against the energy transition, in the following we will focus on the factors that drive, enable as well as those that prevent the participation in protests or movements in favour of environmental benefits/ climate change and energy

transitions. This choice is mainly due to the availability of literature and research on this type of energy citizen. Specifically, we will review determinants of political engagement and environmental activism.

Emergence of political engagement

Political engagement, such as voting for, or getting active in a green party, is mainly determined by the interes t in environmental issues (e.g., Vasilopoulos, and Demertzis, 2013). In line with that, a study by Comin and Rode (2013) showed that German households that adopted PV systems became more supportive of the German green party. They argue that these results are driven by cognitive dissonance (Festinger, 1957). To experience a greater utility from past decisions, PV adopters change their appreciation for green actions which is also reflected in an increased likelihood to vote for the green party. Besides that, a study by Rüdig, Benni and Franklin (1991) showed that age, type of area one lives in, education, occupation, religiousness and membership in environmental organisations and other groups are related to the membership in the green party of Great Britain. Specifically, they found the middle-aged (25- to 49-year-olds) to be overrepresented, making party members younger than the average British citizen.

Further, the population of small towns and rural areas is more likely to join the green party (Rüdig, Benni, and Franklin, 1991). The education level of the average member is considerably higher than that of the average British citizen, with a large number of academic qualifications and a preference for arts subjects. Additionally, more than two third British green party members do not consider themselves part of a church or a religious movement. Finally, about half of the members joined Britain's two major environmental campaigning organisations, Greenpeace, and Friends of the Earth. Reasons why people join the green party were mainly reading the newspaper/magazine article or book(s), reading the party manifesto or other literature, and catastrophic events highlighting major national and global environmental problems. Other reasons that had a smaller influence on the decision to join the green party were TV programmes/ documentaries/ films, the political broadcast of the green party, talking to party members, and specific environmental problems.

In 2019, the European green parties celebrated their record overall result. A recent analysis by Pearson and Rüdig (2020) showed that there are, however, major differences in the strength of the ‘green wave’ across Europe. This is argued to be due to the differences in environmental concern, the salience of environmental issues and the public attitudes concerning the environment, climate, and energy issues. Also, economic affluence, meaning the higher the gross domestic product per capita, the higher the number of green votes. In line with that, Pearson and Rüdig (2020) conclude that the ‘green wave’ of 2019 is mainly based on the successful mobilisation of voters in northern and western European countries, despite the efforts to support the green parties in east-central and southern Europe. Even though these studies already give some insight in the emergence of political engagement, more research is needed to identify all determinants there are.

Emergence of environmental activism

Contacting authorities and members of parliament as well as active involvement in environmental organisations and demonstrations, behaviours that Vainio, Pulkka, Paloniemi, Varho and Tapio (2020) define as environmental activism, are shown to be related to pro-environmental attitude, considering future consequences, efficacy beliefs and action-related subjective knowledge. Besides that, a study by Liarakou, Kostelou and Gavrilakis (2011) showed that volunteers involved in environmental action believe in the power of citizenship and express a high internal locus of control. Some authors argue that political ideological orientations (such as left-right orientation and party affiliation) are predictors of environmental action (Clements, 2012). Based on two meta-analyses, Cruz (2017) found that political ideology has indeed positive associations with the dimensions of environmental concern. Fraune and Knodt (2018) showed that socio-political processes, such as right-wing populism, post-truth politics and local resistance, influence sustainable energy transitions. Specifically, right-wing populism, and post-truth politics argued to indicate rising political polarisation on climate and energy policies.

In contrast to established models of collective protest, anger and outrage do not influence collective action in the climate protection, suggesting that variables such as hope for constructive change (Ojala, 2012) and moral emotions, such as a guilty conscience for damages done to the environment (Rees, Klug, and Bamberg, 2015) may better explain collective action in climate protection. However, Furlong and Vignoles (2021) suggest that emotions, such as anger, fear and guilt/shame, could play a role in fostering group identification and action. Also, according to Fritsche, Barth, Jugert, Masson, and Reese (2018), emotions and motivations, such as guilt, anger, fear, and threat are expected to drive the appraisal of environmental crisis which may lead to individual and collective pro-environmental action. More research is needed to draw final conclusions on the role of emotions.

By integrating insights of the Social Identity Model of Collective Action (SIMCA, van Zomeren, Postmes, and Spears, 2008) and the Encapsulated Model of Social Identity in Collective Action (EMSICA) to explain participation in the specific movement, Extinction Rebellion (XR), Furlong and Vignoles (2021) further found that identification with XR has the strongest relationship with collective action. This is in line with other studies showing that identity related concepts, such as sense of community and group identification are positively associated with increased participation and attitudes regarding the environment (Forsyth, van Vugt, Schlein, and Story, 2015; Mannarini, Roccato, Fedi, and Rovere, 2009). Confirming and extending the SIMCA, Haugestad, Skaue, Kunst and Power (2021) found that that attributing responsibility for climate change and a shared sense of collective identity, helped to stimulate the participation in the prolonged social movement. Finally, Fernandes-Jesus, Lima and Sabucedo (2020) found that moral motivation and identification as an environmentalist are the key variables in explaining actual protest.

In line with that, in their Social Identity Model of Pro-Environmental Action (SIMPEA), Fritsche and colleagues (2018) proposes to look at pro-environmental behaviour as a

group-based process, suggesting that group identification, but also efficacy and in-group norms and goals (i.e., perceptions of the in-group norms of thinking and behaviour as well as ingroup goals) influence pro-environmental behaviour. Similarly, Bauer, Rees and Seebauer (2015) found that collective action in the climate protection field is motivated by collective efficacy and social identity. Also, in their study to explain participation in XR, Furlong and Vignoles (2021) showed that participative efficacy (i.e., provision of a contribution so that XR can achieve its aims) was found to predict XR identification and collective action. Finally, by integrating insights of the collective interest model, Lubell (2002, p.446) argues that "fortunately for the goals of the environmental movement, many people perceive a high level of personal efficacy".

Lubell (2002) further studied the role of typical demographic variables, such as age, gender, education, and income. Results show that the younger and the higher educated a person, the more likely to engage in environmental activism behaviour. Gender and income, however, did not make a difference. Regarding income, Lubell (2002) assumes that at the same time, high income allows people to absorb the costs of environmental activism (i.e., income effect), but it also raises the price of time spent on nonwork activities (i.e., substitution effect). This in the end leads to no effect of income on activism. However, more research is needed to confirm this assumption.

Summary

In Table 5 below, we summarise the determinants and factors that influence the behaviours of participants in protests and supporters of movements. Due to the limited amount of research in this area, we will summarise our findings as political engagement and environmental activism. In general, however, there seems to be more research needed to explain when and why specifically energy citizens act politically or support movements.

Table 5. Determinants of participation in protests and support for movements.

Determinants		Participant in protests and movements	
		Political Engagement	Environmental Activism
Behavioural determinants	Pro-environmental attitude	x	x
	Interest in environmental issues	x	
	Action-related subjective knowledge		x
	Identification as an environmentalist		x
	In-group norms		x
	Sense of community		x

Determinants		Participant in protests and movements	
		Political Engagement	Environmental Activism
	Social identity/ group identification		x
	Group identification		x
	Locus of control		x
	Efficacy beliefs (collective and individual)		x
	Considering future consequences		x
	Moral emotions (e.g., guilty conscience)		x
	Cognitive dissonance	x	
	Salience of environmental issues	x	
	Reading the newspaper, party manifesto and other literature	x	
	Catastrophic events	x	
	GDP/ Economic affluence	x	
	Political ideology		x
	Believe in the power of citizenship		x
Socio-demographic determinants	Age	x	x
	Type of living area	x	
	Education	x	x
	Occupation	x	
	Religiousness	x	
	Membership in environmental organisations and other groups	x	

2.4.4 Energy community

The fourth type of energy citizen is the energy community, which is defined as a group of energy consumers, that “share common interest and/or attitudes in services provided by energy communities (e.g., activities of generation, storage, consumption and sale of energy). Energy communities are supported by a legal framework or are a legal entity (Koirala et al., forthcoming, p.27). Indeed, energy communities have been included in the EU energy legislation. Specifically, the term energy community is used in the context of (1) “citizen energy community” (CEC) which is defined in the Electricity Directive 2019/944 of the European Parliament (Directive, 2019) and (2) “renewable energy community” (REC) which is defined in the Renewable Energy Directive 2018/2001 of the European Parliament (Directive 2018). Both types of energy communities are entities that are set up as a legal person, they must be controlled by their shareholders or members and their primary goal is to provide economic, environmental, and social community benefits rather than financial ones. Differences between those types of energy communities are connected to membership which is more regulated in RECs than in CECs.[1]

In the current report, the term energy communities is used as an umbrella term, including (1) local energy communities (LECs), which are groups of energy consumers or prosumers that live within certain geographic boundaries; (2) virtual energy communities, which are groups that do not live in a geographically bounded area, but are grouped according to certain criteria (e.g., communities of people willing to purchase green energy, i.e., green cooperatives). In the literature, other concepts are local energy initiatives (LEIs), which are defined as "decentralised, non-governmental initiatives of local communities and citizens to promote the production and consumption of renewable energy" (Oteman, Wiering, and Helderman, 2014, p.2). Besides that, terms such as community renewable energy, energy renewable community or community energy (CE) have emerged, which describe social groups at the local level that generate and distribute renewable energy (Walker and Devine-Wright, 2008). Finally, prosumer collectives are social groups that consist of prosumers only (see definition of prosumers in Section 2.4.2).

Energy communities have several activities that differentiate them from the individual in the energy system, such as community services, joint purchase, and collective ownership, energy supply, exchange and selling, implicit demand response, explicit demand-side flexibility, or cross-domain services (Koirala et al., forthcoming). Due to limited research available, in the following, we will focus on the barriers and drivers

[1] For more detail on the similarities and differences between CECs and RECs, see Energy community - Emissions-EUETS.com.

that influence the participation and development of local energy initiatives, community energy as well as prosumer collectives.

Emergence of local energy initiatives (LEIs)

Recent research suggests that a degree of 'ownership' is crucial for the success of LEIs (Hinshelwood, 2001). Reasons for that is that it positively influences people's attitude towards them (Devine-Wright, 2005), public support (Warren and McFadyen, 2010). It fosters social acceptance (e.g., Cass, Walker, and Devine-Wright, 2010) and enhances motivation (Li, Birmele, Schaich, and Konold, 2013). Stürmer and Kampmeier (2003) found social identification, meaning feelings of belonging in a group or social network, to be a motivational basis for civic participation. Specifically, when starting a LEI, Hoffman and High-Pippert (2010) found that social gratification (i.e., the excitement and enjoyment of working together), civic gratification (i.e., the sense of duty to contribute to the welfare of the community), and the desire to influence policy outcomes are important drivers. According to Bomberg and McEwen (2012), LEIs may emerge because of an aversion of citizens to closed and entrenched policymaking. In line with that, Arentsen and Bellekom (2014) found disappointment with centralised government coordination to be a driver for local initiatives. Besides that, they report environmental concern, local economic development and strengthening social cohesion to be important factors. Finally, various studies show that economic incentives as well as self-sufficiency are reasons to participate in or initiate LEIs (e.g., Seyfang, Park, and Smith, 2013).

Emergence of communities energy (CEs)

Social norms, trust, and environmental concern were found to be strongly associated with the willingness to participate in CE projects (Kalkbrenner and Roosen, 2015). According to Walker, Hunter, Devine-Wright, Evans and Fay (2007), energy insecurity is one of the main drivers for the development of CEs. Walker (2008) also suggests that projects may be developed to increase job opportunities or to reduce the price of energy. Also, the ability of CEs to promote behavioural change and social cohesion may lead to their development (Devine-Wright, 2007). In their 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 development for CEs. Further, influencing local energy policy, local control of resources and load management as well as lower energy costs and reliable supply were reported to be the most important drivers. Aspects that were less important but still had an impact on the development of CEs were strong cooperative enterprise history and tradition in the region, supportive policy environment for cooperative enterprise, sufficient average regional personal income and/ or wealth as well as supportive policy environment for renewable energy system deployment (Soeiro and Dias, 2020).

Emergence of (prosumer) collectives

When looking specifically at prosumer collectives, Whitaker, Ford, and Stephenson (2016) found that they are driven by the attractiveness of self-empowerment, meaning more local control, less reliance on centrally generated electricity and an increase in

energy security. Besides that, prosumer collectives are also driven by financial benefits. Self-production is becoming comparatively more affordable since some forms of distributed generation decrease in cost and energy from traditional sources in many instances increase in cost. Additionally, local collective projects often have a better potential for financial return than individual prosumers as they have lower upfront costs per capita, the ability for bulk purchasing, and reduced need to outsource labour. In the long run collectives can also potentially create employment and sale surplus electricity to other users or back into the grid. Finally, collective prosumer alliances require social cohesion (Whitaker, Ford, and Stephenson, 2016). Therefore, a lack of collective commitment can be a barrier. Commitment can be built with strong community-level engagement, specifically when accompanied by local aspirations for community resilience and the presence of community members with high levels of technical know-how.

Other barriers for prosumer collectives are the lack of trust and fairness in the collective, the lack of funding and the requirement of high investments as well as the lack of viability and practicality (Ford, Whitaker and Stephenson, 2016). The emergence of new technologies and infrastructure (e.g., smart grid, smart technologies), as well as financing and the pooling of funds and resources were found to be important enablers. For the financing of projects another strong enabler is the sense of purpose and the "collective" nature of projects. This makes people want to be part and want to invest in projects. Finally, social media can be an important enabler of collective prosumerism (Ford, Whitaker and Stephenson, 2016).

Summary

In Table 6 below, we summarise the determinants and factors that influence the emergence of LEIs, CEs, and prosumer collectives. In general, there is more research needed to explain when and why energy communities emerge and to understand which determinants enable, drive, or prevent their behaviours.

Table 6. Overview of determinants of behaviours of LEIs, CEs and collectives.

Determinants	Participation in and development of...		
	Local Energy Initiative	Community Energy	(Prosumer) Collective
Environmental concern	x	x	
Ethical and environment commitment		x	
Technical know-how			x
Sense of purpose			x
Social cohesion	x	x	x
Social norms		x	
Social gratification	x		

Determinants	Participation in and development of...		
	Local Energy Initiative	Community Energy	(Prosumer) Collective
Civic gratification	x		
Collective commitment			x
Trust		x	x
Ownership	x		
Self-sufficiency	x		
Lower energy costs	x	x	x
Economic incentives	x	x	x
Financing and the pooling of funds			x
Energy insecurity		x	x
Increase in job opportunities		x	
Disappointment in government and policymaking	x		
Desire to influence policy outcomes	x	x	
Local control of resources and load management		x	x
Local economic development	x		
Local investment and income generation		x	
Supportive policy environment for cooperative enterprise		x	
Strong cooperative enterprise history and tradition in the region		x	
Sufficient average regional personal income and/ or wealth		x	
Supportive policy environment for renewable energy system deployment		x	
Emergence of new technologies and infrastructure			x
Social media			x

2.4.5 Business entity

The fifth type of energy citizen is the business entity which can, like an energy community, be a legal entity. There are three general forms of legal entities through which business can be conducted: (1) sole proprietorship, (2) corporation, and (3) partnership. Companies and organisations, including subtypes such as small-medium

enterprises (SME's) and social enterprises (SE's), engage in business activities, charitable work, or other activities that also play a crucial role in the energy system. Due to their specific role as developers, suppliers, and investors, they are defined as a separate type of energy citizen.

Within the field of Work and Organisational Psychology, Organ (1988, p.4) introduced the concept of *organisational citizenship behaviour* (OCB), defined as "individual behaviour that is discretionary, not directly or explicitly recognised by the formal reward system, and that in the aggregate promotes the effective functioning of the organisation". This definition includes three critical aspects of OCBs: (1) they are discretionary behaviours and are performed by personal choice; (2) they go beyond the enforceable requirements of a job description; (3) they contribute positively to the overall organisational effectiveness. The growing literature of the past 30 years has shown that OCBs contribute to the efficient operation of an organisation through voluntary behaviours, including mutual help among employees, participation in various unrewarded organisational activities, personal development efforts and the support of the image and values of an organisation (MacKenzie et al. 1998; Van Dyne et al. 1994; Niehoff 2005). In terms of environmental issues, Boiral (2009, p.223) defined the so-called 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". According to Boiral and Paillé (2012), the three main types of OCBEs are: (1) eco-initiatives (i.e., discretionary behaviours or suggestions that are not recognised by the formal reward system and that cumulatively help to improve the organisation's environmental practices or performance); (2) eco-civic engagement (i.e., voluntary and unrewarded participation in environmental activities (events, initiatives or projects) that have been instituted by the organisation and that contribute to improving its image or practices); and (3) eco-helping (i.e., support behaviours and camaraderie that take environmental issues into consideration).

Unfortunately, there is hardly any research available on these behaviours in relation to the energy system, even though business entities are likely to harbour substantial potential for CO2 emissions reductions and for power balancing in electricity networks (Wesche and Dütschke, 2021). However, in line with investments, research has been conducted on the adoption of energy efficiency and new technologies. In the following, we will therefore give an overview on factors influencing businesses to adopt energy efficiency and new technologies which in turn gives a first impression of the role of a business entity within the energy system.

Emergence of energy efficiency

According to a study by De Canio and Watkins (1998), the characteristics of companies play a role in whether they make energy investments. This means that general economic conditions and incentives may be insufficient to encourage companies to adopt of energy saving technologies. However, other authors still conduct research on the role of incentives and providing information to improve energy consumption patterns in companies. A study by Schall and Mohnen (2017) on eco-driving in

different branches of a logistics company showed that that a non-monetary reward results in an average reduction of fuel consumption of 5%. They found only a small reduction when offering a monetary reward. Handgraaf, de Jeude and Appelt (2013) found that in the short- and long-term, 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 to compare grade points with colleagues) and monetary rewards were outperformed by social rewards. Again, this implies that private monetary rewards may be ineffective, although they are popular.

In line with that, a review by Lawrence, Thollander and Karlsson (2018) on the energy efficiency in the pulp and paper industry showed that a main driver are economic conditions, such as high and unstable energy prices. They also found the need to remain internationally competitive and collaboration to be influential factors. Examples of important barriers are technical risks, lack of access to capital, lack of time and other priorities, and slim organisation. In order to overcome barriers, continuous energy accounting, energy related collaboration, energy-efficiency programmes, and benchmarking were found to be effective.

When it comes to the provision of information, a study by Siero, Bakker, Dekker, and van den Burg (1996) showed that receiving comparative feedback (i.e., including information of the performance of another unit in the same company) makes employees to save more energy than employees who only received information about their own performance. This effect was still persistent after six months. Other studies found that simplifying the annual email received by energy coordinators of firms led to more frequent downloading of the annual report which again was related to the consideration of further measures for energy conservation (Rosenkranz et al., 2017). A field experiment conducted by Loureiro and Labandeira (2019) showed that providing managers of retail stores with information that indicates the importance of energy savings and in line with that suggests avoiding large gaps between indoor and outdoor temperatures, lead to improvements in energy savings.

An international study, involving national energy agencies, governmental and industrial organisations by Cagno, Trianni, Abeelen, Worrell and Miggiano (2015) with the aim to collect their views on the decision-making process concerning energy efficiency identified the main drivers of energy efficiency. From most important to less important, the following drivers are identified: Long-term energy strategy, clarity of information, cost reduction from lower energy use, public investment subsidies, technical support, trustworthiness of information, availability of information, increasing energy tariffs, staff with real ambitions, awareness, voluntary agreements, 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, programs of education and training, and technological appeal.

Similarly, a recent study by Wesche and Dütschke (2021) indicated four kinds of motives for organisations to invest in prosuming infrastructure: (1) environmental protection, (2) financial gains, (3) improved image, and (4) energy self-sufficiency. Drivers that were identified are: (1) access to technical knowledge, (2) access to administrative knowledge, and (3) access to financial support schemes. Barriers concern uncertainty (e.g., about the disposal of solar panels) and the local physical circumstances (e.g., doubts about the impact on current buildings).

Emergence of adopting new technologies

According to Montalvo (2002), the theory of planned behaviour can be used to understand the adoption of new technologies by companies. He found that the attitude toward innovation, social norm and control over innovation influences the willingness to innovate and through those innovative activities. Further, Montalvo (2002) argues that attitude is influenced by environmental risk and economic risk. Social norm is influenced by community pressure, market pressure and regulatory pressure. Finally, behavioural control is determined by technological capabilities and organisational capabilities. Additional factors are strategic alliances and networks of collaboration that impact the adoption of new technologies.

Summary

In Table 7 below, we summarise the determinants and factors that influence energy efficiency and the adoption of new technologies in businesses. In general, there is more research needed to explain when, why and how business entities play a role in the energy transition.

Table 7. Overview of determinants of behaviours of business entities.

	Determinants	Business Entity	
		Energy Efficiency	Adoption of New Technologies
Theory of planned behaviour	Attitude		x
	Subjective norm		x
	Perceived behavioural control		x
	Awareness	x	
	Organisational learning		x
	Knowledge of non-energy benefits	x	
	Programs of education and training	x	
	Availability, clarity and trustworthiness of information	x	

Determinants	Business Entity	
	Energy Efficiency	Adoption of New Technologies
Social norm (comparative feedback)	x	
Environmental risk		x
Economic risk		x
Market pressure		x
Community pressure		x
Regulatory pressure		x
Public or social rewards	x	
External competition/ collaboration (strategic alliances)	x	x
Image (green/ improved)	x	
Efficiency due to legal restrictions	x	
Economic conditions (e.g., high, and unstable energy process)	x	
Increasing energy tariffs	x	
Information about real costs	x	
Financial gains	x	
Access to capital: private or public investment subsidies	x	
Cost reduction from lower energy use	x	
Long-term energy strategy	x	
External energy audit/submetering	x	
Technical support	x	
Technological appeal	x	
Technological capabilities		x
Staff with real ambitions	x	
Management with ambitions	x	
Management support	x	
Voluntary agreements	x	

2.4.6 Policymaker

The sixth and final type of energy citizen is the policymaker, who, from the outset, takes in a double role in the energy system. On the one hand, the policymaker is a representative of the preferences of the institution, and on the other hand, they are individuals who are subject to internal and external pressures and demands. As a representative in a government or political party, the policymaker decides on new courses of action or sets of regulations adopted by the government, businesses, or other institutions designed to influence and determine decisions or procedures (i.e., policies). Other behaviours of the policymaker are deciding on subsidies, promoting change and investments, and the regulation of innovations. Due to the limited amount of research on these kinds of behaviours, in the following we will merely focus on the regulation of innovations. According to Rothwell (1992, p.451), regulation is "the control of a particular situation for the benefit of society". A regulation normally arises due to social issues, such as safety or health issues, pricing practices, quality of products and environmental protection.

Emergence of regulation of innovations

By means of a dynamic model, Montalvo (2007) identified determinants of regulation regarding innovation. According to him, the theory of planned behaviour forms the basis to understand the behaviour of policymakers, meaning that attitude toward regulation, social norm and control over regulation influence the willingness and ability of regulators to design and enforce schemes (i.e., to regulate), which in turn influences the innovative behaviour of the firm (i.e., governance of innovation). Further, Montalvo (2007) argues that social outcomes and economic and political outcomes determine the attitude of regulators towards regulation. Social norm is influenced by corporate lobbying, political pressures, and communities' pressure. Finally, control over regulation is determined by institutional capabilities and organisational capabilities.

Summary

In Table 8 below, we summarise the determinants and factors that influence the behaviours of policymakers. In general, there is more research needed to explain when, why and how policymakers play a role in the energy transition.

Table 8. Overview of determinants of policymakers' behaviours.

	Determinants	Policymaker
		Regulation of innovations
Attitudes towards regulations	Social outcomes	x
	Economic and political outcomes	x
Social norm	Corporate lobbying	x
	Political pressures	x
	Community pressures	x

	Determinants	Policymaker
		Regulation of innovations
Control over regulation	Institutional capabilities	x
	Organisational capabilities	x

2.4.7 Summary of types of energy citizens and related behaviours

In the current report, six types of energy citizen have been established based on their involvement in the energy system, without suggesting a clear distinction between them. These six types are either individuals (i.e., consumers, prosumers and prosumagers, participants in protests and movements, and policymakers) or collective entities (i.e., energy communities and business entities). As we have seen, the emergence of their behaviours is influenced by factors that do not account for each type of energy citizen. In the following, we summarise the findings of the review conducted above. In order to cluster and summarise the determinants that were found in the literature for each type of energy citizen, we distinguish between cognitive, normative, instrumental, emotional, and socio-demographic determinants (Table 9). This choice is based on human decision-making and behavioural research dating back to the early works of Simon (1955) and Guttman (1954) as well as influential models of decision making and behaviour (Ajzen, 1985; Ajzen and Madden, 1986) and more recent research in innovation adoption and innovations of new technologies (Corral, 2003; Montalvo, 2006).

Table 9. Summary: Overview of determinants per type of energy citizen.

Energy Citizen	Determinants				
	Cognitive	Normative	Instrumental	Emotional	Socio-demographic
Consumer	Attitude Awareness of consequences Comfort Convenience Safety Moral obligation Loss aversion Ascription of responsibility Environmental benefits	Subjective Norm Personal Norm	Awareness/ Knowledge Perceived behavioural control Costs (time, money, etc.) Infrastructure/ geographic factors High service quality		Gender Age Occupation Household income Education level Household size Subsidies Population density
Prosumer and prosumager	Environmental awareness Awareness of local benefits Insights in energy consumption Health concerns Privacy concerns Comfort Sustainability Energy conservation	Social norm Social cohesion Legislation/ Regulations Economic and institutional support/ permissions	Relevant information Technology Management Financial benefit Cost Local control Bargaining power Independence from grid		Financing option

Energy Citizen	Determinants				
	Cognitive	Normative	Instrumental	Emotional	Socio-demographic
	Energy self-sufficiency		Innovation control of device Electricity market participation Energy supply reliability Product Quality		
Participant in protests and movements	Pro-environmental attitude Interest in environmental issues Cognitive dissonance Sense of community Efficacy beliefs (collective and individual) Belief in power of citizenship Political ideology	In-group norm Social identity (Identification as environmentalist) Group identification	Action-related subjective knowledge Salience of environmental issues Catastrophic events Considering future consequences Locus in control	Moral emotions (e.g., guilty conscience)	Age Type of living area Education level Occupation Religiousness Membership in environmental organisations and other groups Reading the newspaper, party manifesto and other literature GDP/ economic affluence
Policy-maker	Social outcomes Economic and political outcomes Corporate lobbying	Political pressures Community pressures	Institutional capabilities Organisational capabilities		
Energy community	Environmental concern Ethical and environment commitment Sense of purpose Self-sufficiency Energy insecurity Social gratification Civic gratification Desire to influence policy outcomes	Social norm Social cohesion Collective commitment	Technical know-how Ownership Local control of resources and load management Emergence of new technologies and infrastructure Lower energy costs Social media	Disappointment in government and policymaking Trust	Local economic development Economic incentives Financing and the pooling of funds Increase in job opportunities Local investment and income generation Strong cooperative enterprise history and tradition in the region Supportive policy environment for cooperative enterprise Sufficient average regional personal income and/ or wealth Supportive policy environment for renewable energy system deployment
Business entity	Attitude Awareness	Subjective norm Social norm Market pressure	Knowledge of non-energy benefits		Economic reductions

Energy Citizen	Determinants				
	Cognitive	Normative	Instrumental	Emotional	Socio-demographic
	Willingness to compete Organisational learning Technological appeal Environmental risk Economic risk	Community pressure Regulatory pressure External collaboration/ competition Image (green/ improved) Voluntary agreements Strategic alliances External cooperation	Technological capabilities Perceived behavioural control Public and social rewards Long-term energy strategy Availability, clarity and trustworthiness of information Information about real costs Financial gains Management with ambitions Management support Staff with real ambitions Efficiency due to legal restrictions External energy audit/ submetering Technical support Cost reduction from lower energy use		Economic conditions Access to capital: private or public investment subsidies Public investment subsidies Increasing energy tariffs Private financing Programs of education and training

2.5 Policies supporting energy citizenship emergence

2.5.1 The role of policy interventions for energy citizenship

As described earlier in this section, energy citizenship is defined as citizens who engage with the energy system. This engagement can take place as consumers, as participants in the transition process, or as both. Importantly, through a lens of energy citizenship, the public is viewed as an active stakeholder in the energy system transition. Energy citizens can act socially and politically as individuals as well as a community and their engagement can take different forms and levels as depicted in figure 4 above. If – as hypothesised – energy citizens and energy communities can transition between engagement levels, the drivers of and barriers for transitions between these engagement levels are of interest for research on energy citizenship. While the previous sections provided an overview of types of energy citizens and the attitudes, values, norms, habits, and demographic factors the literature has identified as potential drivers for their behaviour on a micro level, this section takes a more systemic view and outlines literature contributions to highlight the role of government and policy interventions that might affect people's and communities' attitudes, norms, and habits toward new energy technologies and infrastructures. Policy interventions

involve any cause of action, program, or activity mandated by national and international authorities. This section limits its scope to policies, regulations, and measures initiated by local, national or regional government authorities.

2.5.2 Toward a decentralised and participatory energy system

The current energy system is characterised by a centralised approach. As already mentioned in Section 2.2.1, the centralised system coexists with the image of energy users as having low levels of interest, knowledge, and environmental and social responsibility. Rather than offering a socio-political space for engagement, the centralised system is often highly technocratic, which has resulted in an (intended) low level of active involvement from citizens and local government. To pave the way toward an effective low carbon energy transition, it is urgent to involve and integrate local, regional, and national authorities to mobilize effective policies that enable active participation of citizens in the energy system (World Energy Council, 2019). That means that a new energy ecosystem needs to be designed, which not only involves active consumers in energy usage but also enables citizens to participate in the co-management of energy-related choices regarding the forms, scales, and sources of energy as well as the shaping and structuring of its usage (Olivadese et al., 2019; Schelly et al., 2020; Laldjebaev and Sovacol, 2015). Moreover, citizens' and local communities' perspectives are central for achieving a just ecological transition that specifically addresses social and environmental aspects within the justice theoretical framework (Galende-Sánchez and Sorman, 2021). Achieving a just transition involves a series of steps and actors actively engaged. It is important that these actors participate in the co-production of multiple approaches that can create transformational opportunities (UN, 2021).

Energy citizenship can help facilitate the achievement of several SDGs, but this requires "systematic and ambitious changes" to current energy and development policies, which must be well-designed and gender-responsive (UN, 2021). In this regard, Komendantova, Neumueller and Nkoana (2021) suggest that a polycentric governance is paramount to build more distributed energy systems. Hierarchical dynamics need to be replaced by a policy design characterised by horizontally integrated actors and institutions that value stakeholder engagement and co-production of knowledge as working principles.

2.5.3 The role of local authorities and public participation

In order to achieve a just and sustainable solution, it is crucial to develop local low carbon energy transition policy frameworks that can transform energy systems while simultaneously guaranteeing their accessibility and reliance through a coherent collection of technology, business, and policy plans. According to the World Energy Council report (2019), putting local authorities in a position to act on energy policy at their own level is paramount in energy transition policy decision-making and implementation. This report also suggests a series of key findings and recommendations, such as the following aspects:

- the necessity to elaborate frameworks to empower local governments and to provide local authorities with capacity and regulatory support
- the enabling of proactive local political leadership through transparent, accountable, and participatory processes
- the dissemination of sufficient awareness at all levels
- an increase in financial support and
- new private-public partnerships that can pave the way to innovative business models.

Moreover, it is suggested that a combination of environmental regulation and innovation support is pivotal to foster a sustainable energy transition (Jaffe, Newell and Stavins, 2005).

In addition to empowering local authorities, it is equally essential to implement dialogues and design successful deliberative spaces to enable public engagement. And while local institutions or research councils are key actors in these processes, mainstream public engagement initiatives have been criticized for lacking transformative power on their own (Hagendijk and Irwin, 2006; Irwin, 2015). Indeed, engagement is often conceptualised in an uncritical manner that does not lead to a socio-political transformation of the current technocratic models of energy management or to making the energy decision-making processes more democratic (Flores-Fernández, 2020). To overcome such limitations, policy interventions must enable individuals to make their own decisions and clarify their own roles toward collective engagement in the energy transition process. For instance, the performance of energy citizenship can be enabled through material participation, a key-concept in the body of STS that shows how introducing and using emergent energy technologies may create new energy practices that can involve active levels of energy citizenship behaviour. As Ryghaug, Skjølsvold, and Heidenreich (2018) show, in Norway the electric vehicle (EV) can be framed as a “distinctly climate-connected political object” whose usage can be seen as a political choice, and this was enabled by identifying EVs as the target of public multi-scalar policy.

Citizen knowledge and a deep understanding of policies are key aspects to consider in this regard. As van der Bergh (2013) suggests, high levels of active citizen engagement in energy transition require a deep understanding of the environmental impacts of technologies, products, and industries. And while citizens might engage in energy transitions without being fully aware or have a deep understanding of key policy aspects or potential consequences of their own behaviour, active forms and levels of energy citizenship engagement might require both: knowledge of policies and an understanding of the consequences of individual behaviour. At the same time, governments need to be held responsible and accountable in their role as energy service providers. Citizenship defines a relationship between the state and its population. Energy citizenship refines this relationship as iterative, interactive, and participatory. A trend toward privatisation and "individualisation of responsibility" in the energy sector needs to be avoided.

2.5.4 Acceptance and citizen responses to policy interventions

To enable active engagement as energy citizens, policy interventions thus need at best be understood and potentially even co-produced by the public. At a general level, following Wüstenhagen et al.'s three dimensional approach to social acceptance (Wüstenhagen et al., 2007), effects of policy interventions can be categorized according to the audience level targeted and affected by the policy. The first level describes socio-political acceptance and includes policy interventions that aim at changing attitudes, values, and preferences of the general public (see for example Stadelmann-Steffen, 2019, on public opinion on new and conventional energy technologies). At the second level, policies aim at affecting communities (Fernandez, 2021; Maleki-Dizaji et al., 2020). This level is especially important for energy citizenship aimed for in GRETA. Gregg et al. (2020), for instance, have underlined the relevance of Collective Action Initiatives (CAIs) within the energy sector by suggesting a framework that supports social innovation, which is identified as new ideas that “simultaneously meet social needs and create new social relationships” (p.3). Energy communities can be considered as key examples of CAIs, which are identified by multiple factors such as “local involvement and ownership, grassroots innovation, citizen participation, individual motivations, consumer demand and incentives, and financial and legislative support mechanisms” (Gregg et al., 2020, p.4). Finally, at the third type of acceptance - namely market acceptance - policies target the economic market.

In reality, the three types of acceptance are often highly interrelated leading to a variety of possible effects on levels of energy citizenship engagement. Figure 4 in the previous section introduces some of the possible responses actors can have to policy interventions and how they might transition from being unaware of an issue to becoming active energy citizens. Responses from the public often extend beyond a simple support/resist-dichotomy - it is thus not as simple as acceptance versus rejection - and responses can vary significantly at different stages of the policy-making process. Additionally, policy interventions can affect behaviour at any stage of the energy-citizenship-transition process. For example, at the agenda-setting stage, where a policy solution is still searched and discussed, actors might have "preferences" for different options rather than either accepting or resisting the entire agenda. Once a solution is found, "support" or "resistance" becomes a viable response (Dermont et al., 2017). Yet even here the response is not always clearly cut. As research on local energy projects has shown, people's behaviour often deviates from previous choices, preferences, and attitudes (Batel und Devine-Wright, 2015). Moreover, as Figure 4 indicates, both negative and positive responses can vary in duration and intensity of engagement.

Komendantova et al. (2021) refer to the Austrian Climate and Energy Strategy 2030 as a valuable example for how to reframe discourses on acceptance from technologies towards acceptance of social innovations and new forms of governance such as a decentralised, polycentric system (Komendantova et al., 2021). Social acceptance, awareness, attitudes and willingness to engage with policies, technologies and infrastructure play a crucial role. Yet, the Austrian Strategy does not specify any targets or instruments to achieve participatory or polycentric governance in the energy

system, showing the need to enhance knowledge and collect successful examples on how to realise actor engagement toward active energy citizenship frameworks.

This section identified the empowerment and integration of local authorities into broader regional energy frameworks, the opening of spaces for public engagement and participation, and more horizontally designed polycentric governance as key principles for the transition toward a low-carbon energy sector. To be effective, policies need to be accepted as legitimate interventions by citizens. Depending on their design, they can result in positive or negative responses and different levels of engagement with regard to energy citizenship. Citizens' and local communities' perspectives are central for achieving a just ecological transition that specifically addresses social and environmental aspects. Policy interventions can successfully affect behaviour at any stage of the energy-citizenship-transition process. Hence, the role of policies needs to be considered for successful energy citizenship.

3 Energy citizenship emergence

3.1 Summary state-of-the-art

From Section 2, we can see a great interest and abundant literature aiming to improve our understanding as to why people (primarily seen as consumers or technology adopters) might engage (or not) in the use of new technologies that are more efficient or link to renewable energy sources. Most attention in research addressing business has been focused on understanding why people and business adopt (or not) new technologies or practices that increase energy efficiency. It is only recently that the notion of energy citizenship is emerging, to go beyond purchasing more energy efficiency appliances and durable goods, acceptance of products and energy or sustainability policy initiatives. The need to conceptualise energy as a finite resource and actively engage citizens in optimising its use at different levels is recent. This is seen not only in the sphere of energy but in other realms of public policy. Currently there is an increased interest in policy communities to guide collective behaviour to address great societal challenges. An example is the explicit inclusion of "behavioural topics" in the current Horizon Europe Program not only in energy topics but also in most other areas of the new European research program (European Commission, 2019). This new orientation has resonance also in the interest in the role that citizens engagement plays in the energy transition. The importance of interactions and interdependences (i.e., views, goals, resources and power) between the collective has been highlighted in the research agenda of energy transitions as well (Sovacool et al., 2020; Köhler et al., 2019). Most approaches to sustainable energy practices have focused on the individual consumer (or citizen) (e.g., Pellizzone et al., 2017) or in collective action and practices (e.g., van Zomeren, 2019).

The interplay between the individual and the collective actions has been so far neglected (Hoffman and High-Pittert, 2010, Steg et al., 2021). This is the case in fields like social psychology (Straßheim and Beck, 2019; DeRidder et al., 2020), economics (Ostrom, 1990), sociology (Fiske, 1992), socio-technical systems transitions (Köhler et al., 2019). Similarly, theories and approaches looking into the systems emergent behaviour like systems dynamics (Barile, 2018), actor network theory or agent-based simulations (Rai and Robinson, 2015) often make simplifications on behavioural and contextual drivers to favour systems patterns. These approaches use the basic rule of complex systems research that suggests a few simple rules guide human behaviour (e.g., utility, price, convenience, routines, values, etc). It is only recently that attention has been turned to the need to look into the importance of creating models that give more attention to gain a deeper understanding of individual behavioural drivers and motivations, interactions between actors and emerging behavioural patterns (Schlüter, et al., 2017).

Despite the above interest there are knowledge gaps that remain. Recently, for example, in the literature of energy transitions it has been accepted that three major gaps require urgent attention:

- First, which factors encourage different actors to engage in sustainable energy behaviour
- Second, which interventions can be effective to encourage different actors and which factors can enhance their effects to engage in sustainable energy behaviour
- Third, which factors affect public support for energy policy and changes in energy systems (Steg et al., 2021).

Similar interest with similar questions is growing in policy making concerning how behavioural sciences can contribute to make policy more effective (UN, 2021; Van Bavel et al., 2013). Most of the research available gives attention into understanding what drives the individuals and designing incentives and "nudges" that affect the architecture of decision making (e.g., see behavioural interventions edited by Straßheim and Beck, 2019). Recently, it has been acknowledged that putting "nudges" into practice is rather difficult and gains little efficacy in policy. It has been accepted that interventions targeting only the individual citizens without considering the context and other influencing actors renders ineffective policy interventions with behavioural underpinning (De Ridder et al., 2020).

In synthesis concerning the structure and dynamics of energy citizenship transition research takes a systemic approach but does not deepen on behavioural aspects of key actor types in the system (i.e., citizens, business, policymakers). In behavioural change research, research often indicates the systemic character of transitions but actually focuses on single actors. It seems that there is an assumption that by understanding and intervening upon the individual rationales it is possible to change the system. Systemic interdependences are acknowledged but so far not explored at the level of detail required. Lack of deeper understanding based on more detailed disaggregation of these may further hinder opportunities to change the system. This is the premise depicted in Figure 1 above at the outset of this report.

3.2 The way forward: a three-stage individual-collective behaviour disambiguation model

In order to address the gaps outlined above, we follow the approach recently developed by Montalvo (2021) to look into the structure and dynamics of energy citizenship emergence. The notion of emergence in this report is understood as the appearance of a phenomenon that occurs when an entity is observed to have properties its parts do not have on their own; properties or behaviours which emerge only when the parts interact in a wider whole.

In this sense, the proposed approach to explore and understand the emergence of energy citizenship aims to disambiguate: i) the internal structure and influences of different constructs (following Table 9 in Section 2.4 above, these constructs are attitudes, norms, values, agency, goals, emotion, etc.) upon the decision and behaviour of the individual citizens towards energy; ii) the sources of influences that the citizens' individual decisions and behaviours might have from the collective and *vice versa*; and iii) the structure and dynamics of the relationship between the individual citizen and the collective that lead to social behavioural patterns that mediate the form of social contracts. The model represents a three-stage heuristic for disambiguation of the relationship of the individual with the collective that can be used independently for research looking at three different levels of social aggregation. In the following, the three-stage model is presented with an indication of the types of analyses it enables. Figure 5 shows the sequence of analysis to structurally disambiguate and shows that the interaction of individual and group rationales and behaviours are concatenated into large scale relational models to generate macro-dynamics at the population level.

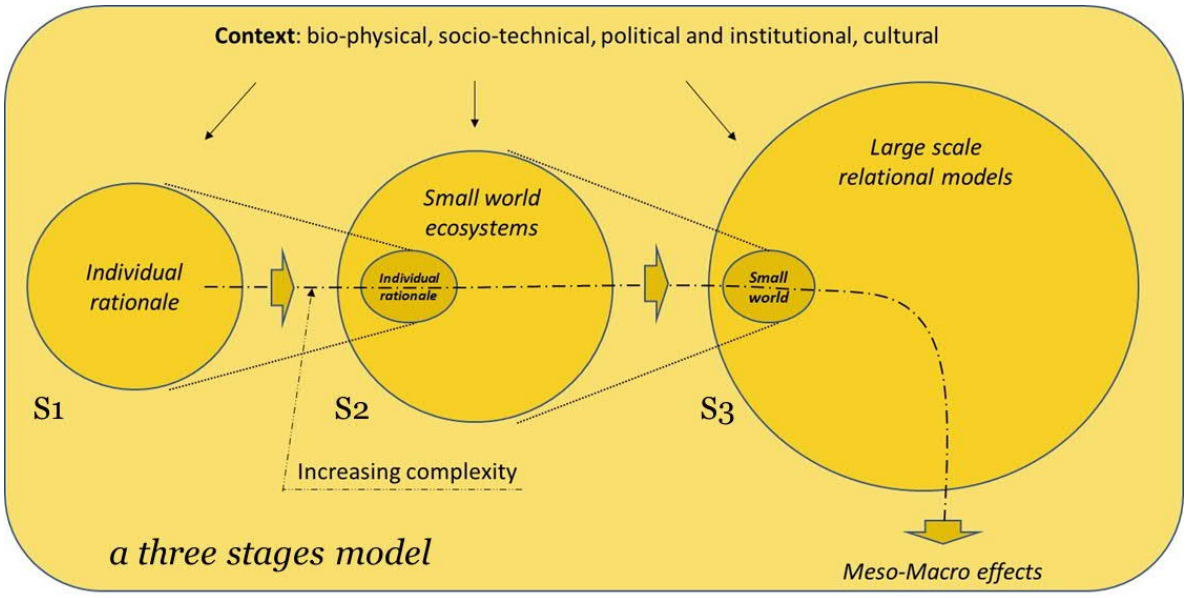

Figure 5. Energy citizenship emergence: a three-stage model.
Adapted from Montalvo (2021).

3.2.1 Stage one: citizens' decision making and relational behaviour

Human decision making and behaviour research has produced an abundant literature dating back to the early works of Simon (1955) looking in to cognitive determinants (e.g., rational choice, bounded rationality, prospect theory, etc.), normative determinants (e.g., Berkowitz, 1972), values and personal moral norms (Schwartz, 1977, Schwartz and Howard, 1981; Schwartz and Bilsky, 1987), instrumental determinants like self-efficacy (de Vries et al., 1988), habits and routines, emotion (Lerner et al., 2015). With the exception of emotion research, these different strands of literature were integrated later in the early 90's in influential models of decision making and behaviour, the theory of planned behaviour (TPB) (Ajzen, 1985; Ajzen and Madden,

1986) and the norm activation and structure of values model (NAM) (Schwartz, 1992).The TPB postulates that behaviour is mediated by intentions and in turn intentions depend upon the attitude towards the behaviour, the perceived subjective norm and motivation to comply with and the perceived and actual control upon the behaviour in turn. This simple postulation integrated disparate insights in the literature integrating cognitive, normative and instrumental aspects that affect behaviour and action in specific situations and time. In addition, its simplicity is backed up by hundreds of empirical studies confirming its structure and content. Similarly, the NAM model of personal normative influences on behaviour (primarily altruism) is the idea that behaviour is influenced by feelings of moral obligation to act on one's personally held norms. Research supporting this central tenet of the model has demonstrated associations between personal norms and behaviour rather than causal relations. There is evidence that variables that foster movement through the activation process—according to the theoretical model—are themselves related to altruistic behaviour (e.g., seriousness of need and uniqueness of responsibility).

The TPB and NAM have dominated the landscape of decision making and behaviour over the last two decades and recently have been an upsurge of applications on sustainability research. Despite such dominance the models have been called to have a number of shortcomings (Klöckner and Matthies, 2004; Klöckner, 2013; Sniehotta et al., 2014). Amongst others, those are: i) the static nature of the models; ii) focusing on single behavioural categories and not considering behavioural options; iii) behavioural beliefs often explain higher proportion of the variance than the main constructs of the models (e.g. attitude, norm, values and perceived control; iv) not considering the decision making process; v) considering the social group targeted providing no feedback to the context that influences the group behaviour; vi) not allowing for feedback to other actors, etc. (Sniehotta et al., 2014; Montalvo, 2021). Recent reviews of the NAM indicate that values are related to behaviour via held norms and their importance rests on the importance given to other people and contextual factors (Schwarz, 2021). Points one to five have been acknowledged to be shortcomings in explaining individuals' social behaviours. Criticisms four to six arise from the ambition to apply or extend the TPB and NAM beyond what they were not designed for, that is, explaining the dynamics of individual and collective behaviours. As will be noticed further below such simplicity and empirical evidence is at odds with the complexity of the relation between the individual and collective behaviours to explain social behavioural patterns.

In order to improve the available frameworks for individual social behaviour that integrates other recognised constructs, like emotion and relational models, that affect behaviour, a new model was proposed by Montalvo (2021). Such a model integrates the known and valuable components of the TPB and NAM and complements with:

i) how the components of the TPB and NAM are internalised by the decision maker in a throughput model (see Parker et al., 1995; Schwartz et al., 2012)

ii) introduces emotion and the relational model mediating interaction with other citizens (or other actors like policymakers or businesses) as part of an evaluative moment before an intention is formed in the decision-making process
iii) partitions the new model in three moments for a dynamic decision-making process into inputs (perceptions), throughput (thought) and outputs (intention-behaviour).

The model integration is depicted in Figure 6 below.

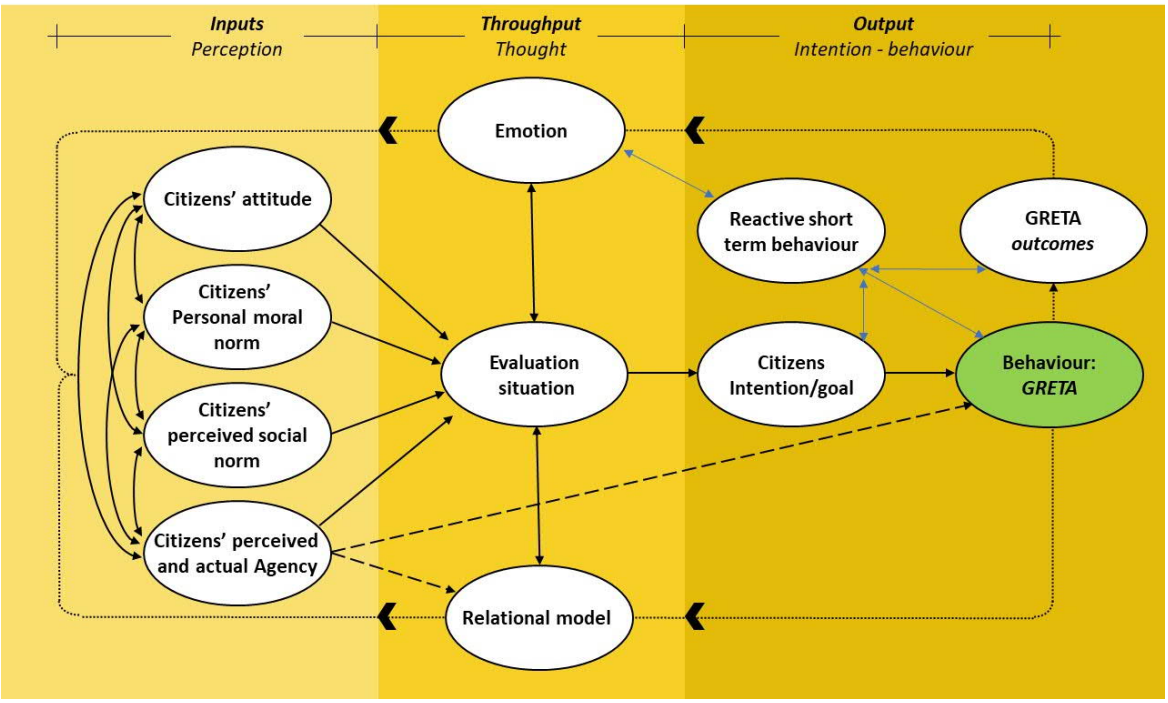

Figure 6. Stage 1: citizens in relational behaviours.
Source: Adapted from Montalvo (2021).

Following Montalvo (2021), a throughput model that considers inputs (perceptions), throughput (appraisal or situational evaluation) and output (intention and behaviour) is here conceptualised to integrate the different constructs of the TPB and NAM mentioned above. The structural features of the relationships between constructs are organised around an interplay between the three phases of the decision making throughput model depicted in Figure 6 above. The model proposes that in an *input phase* at any given time and context an individual perceives its reality, this generates in the first instance attitudes, confrontation of internalised values in moral norms, the pressure from peers and social context, as well as his/her degree of agency with respect to resources and options, goals and target behaviour in mind (e.g., energy generation, storage, usage, etc.).

Then in an *evaluation phase*, the behaviour in turn is appraised in reference to: potential outcomes of behaviours supporting the energy transition generating attitudes, the peer and social norm (pressing or not for green energy behaviours) present in a given relational model that might generate pressure to comply with prevalent norms, the

personal moral norm congruence with the current relational model, the level of individual agency on time and resources to actually carry out the behaviour and congruence and appropriateness of the behaviour within the operating relational model between people and institutions. High levels of congruence with the reference goals (own or external), attitudes, moral and social norm as well as sufficient degree of agency will generate positive emotion whereas high levels of dissonance can be expected to generate negative emotion. Negative or positive emotion must not be understood here as an adjective but as the numeric valence of any type of emotion generated in any situation. Given the above, this implies that the appraisal of a course of action and behavioural activation of energy citizenship engagement can be started by any of the constructs in the model.

In the *output phase*, intentionality, actual behaviour and the corresponding perceived outcomes come to retrofit the previous two phases reassessing the reactive behaviour of others and the effect on the individual condition and the welfare of others. In the first place, emotion is moderated depending on behavioural outcomes as well as the effect on the disruption or permanence of the operating relational model. In turn a new phase of *inputs* restarts. Here it is important to highlight the expected strong relationship between agency and the mediating relational model with the performance of behaviours supporting energy citizenship.

The generation and emergence of behaviours supporting energy citizenship might have two paths. The first path is related to emotion and to the short term perceived or expected consequences, normative pressures and perceived agency of an action determined by an instant evaluation of an outcome. This is a path unlikely to be present in the type of behaviours related to green energy transition actions. The second path is characterised by medium and long-term actions that allow in the citizens' decision making for the evaluation of all other constructs in the model. It is hypothesised that perceptions in the realm of citizens' attitudes, moral and social norms as well as perceived agency will serve as inputs to be weighed in an evaluation moment mediated by a relational model and to a lesser extent an emotional state to generate an overall propensity, plans and intentions and ultimately behaviours supporting energy citizenship.

The model presented in Figure 6 above addresses core criticisms and gaps of previous models focusing primarily on the structure of decision making of individuals by making direct reference to the interaction with other people. This enables to state new research hypotheses and questions not allowed before in previous models that focused primarily on the individual. The stage one model offers a more comprehensive understanding of the determinants of the overall propensity and intention to engage in actions supporting the transition to green energy. The scheme presented has all the constructs that will be present in the next two steps to further disambiguate between the individual and the collective behavioural patterns. This will facilitate comparison of behavioural traits across diverse actors in an ecosystem of change or energy transition arena to be defined in each of the case studies of GRETA.

3.2.2 Stage two: definition of citizens' preferences mediated by interactions

The second stage of the model starts taking into account systemic influences. Following from the model stage one, the premise of the stage two model is that the initial attitudes, norms, agency, intentions, etc., of each actor in the system towards a specific behaviour evolve according to the interdependence of their actions with other actors. In turn the evolution of the whole system is an aggregate of interdependent individual behaviours. In other words, the individual behaviour cannot be understood fully if we do not consider the individual rationales of individuals' behaviour as part of a system of interdependent actors.

This second stage addresses the structure and the type of influences and interactions that might lead to define and determine collective behavioural patterns. This implies an assessment of whether the interactions' dynamics between a number of actors might converge to a common societal goal. In Section 2, a number of actors and also a number of behaviours related to energy transition actions were identified. The second stage of the model underscores the likely sources of convergence or divergence towards common goals in the energy transition. Such convergence or divergence will be assessed by computational methods but can be traced back to the structure and dynamics of decision making outlined in the stage one model. Figure 7 below, in its left side, utilises a simplified Figure 6 considering only four major constructs (attitudes, norms, agency and behaviour) to illustrate the interaction between two actors (i.e., citizens and policymakers).[2] Such a model highlights the interaction and the likely sources of convergence or divergence towards a common societal goal of performing behaviours that support the clean energy transition.

The *model stage two* indicates that, despite having a common overarching societal goal, the behaviours of different actors might not confluence to such societal goal of performing green energy transition actions. The potential mismatch between both actors (i.e., citizens and policymakers) arises from diverse sources: i) the actors might be targeting immediate different goals and follow different rationales (for example, citizens might have the goal of extending the life cycle of a durable good with a low energy efficiency while the policymaker might want to increase aggregated energy efficiency in a given region by promoting investments by citizens accompanied with subsidies); ii) even when there are behaviours that match at the goal levels, the underlying determinants might bring mismatches between the two actors (for example, citizens despite having a positive attitude and pressing sustainability values and norms might have limited resources to invest in new more efficient durable goods). Similarly, the policymakers might have a very positive attitude towards a policy initiative giving monetary incentives but have no support from higher government or parliament to enact subsidies for energy efficiency due to budgetary restrictions or partisan

[2] Here we use one (i.e., policymakers) of the institutional actors identified in Section 2 to illustrate the interaction of citizens with institutional actors.

preferences. The mismatch between drivers and barriers is likely to derive in a lack of convergence in a given point in time towards a common goal.

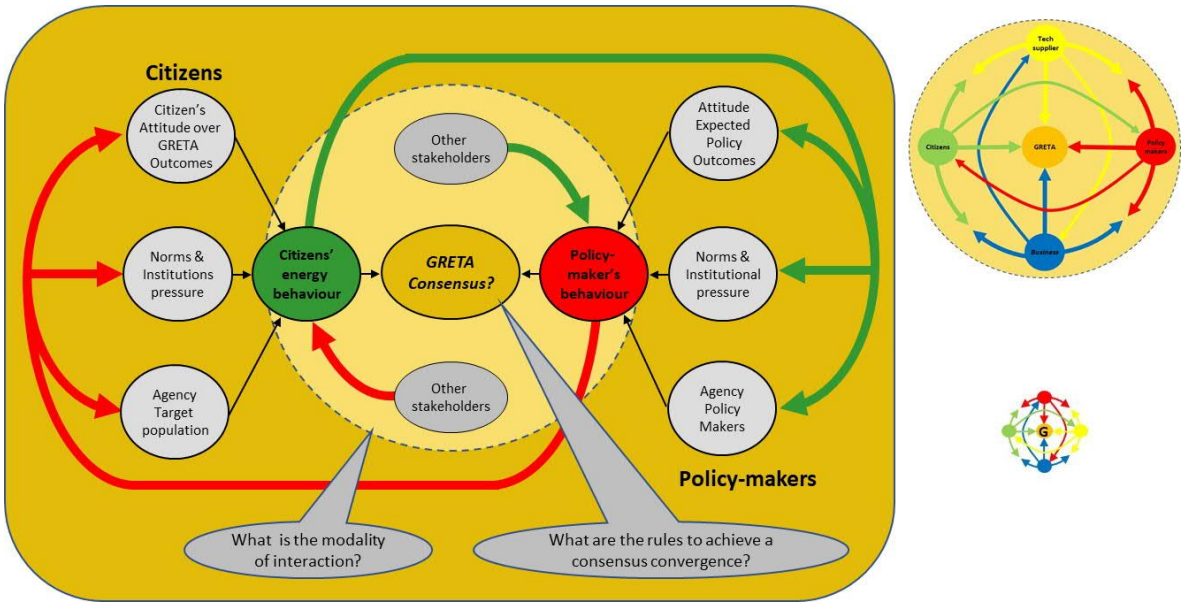

Figure 7. Stage 2: citizens' preferences and behaviour mediated by interactions. Source: Based on Montalvo (2007; 2021).

The right side of Figure 7 indicates that the same analysis can be extended to include more actors interacting with citizens and policymakers (e.g., banks, equipment suppliers, representatives of energy communities, etc.). All these types of actors in a transition ecosystem have their own goals and stakes towards actions supporting energy citizenship (e.g., investments in energy efficiency measures). Whereby the stakes can be positive or negative depending on the specific behavioural option or technology considered for a specific application. The analysis of the interplay of the different rationales at stake in a dynamic fashion enables to identify the critical factors determining not only the investment behaviour of citizens but also the roles of other actors in the system. This can bring light onto the limitations of current policy instruments that are designed with a single targeted actor without consideration of the interdependent systemic features of investments or any other behaviour supporting the transition to green energy.

The concept of behavioural asymmetries describing traits in attitudinal, normative instrumental, emotional and relational aspects provides a definition of the structure of the determinants across groups of actors and the likely sources of convergence towards energy citizenship engagement. Previous efforts to implement the approach have achieved the identification of asymmetries between two actors in a qualitive fashion (see Wehn and Montalvo, 2018). Attitudes, norms, agency and intentionality might evolve over time across diverse actors. In turn the interdependences between actors are likely to change as well. Depending on the changes in such predispositions the aggregated behavioural patterns are likely to evolve, too. Table 10 provides the

structure of a matrix to define and analyse differences and similarities in behavioural drivers and reported levels of engagement in behaviours supporting energy citizenship and the energy transition.

Table 10. Matrix of behavioural patterns and asymmetries.

Constructs	Actor 1	Actor 2	Actor 3	…	Actor *n*
Engagement level/type	E_1	E_2	E_3		E_n
Goal/behaviour	A_1 B	A_2 B	A_3 B	…	A_n B
Attitude	A_1 AT	A_2 AT	A_3 AT	…	A_n AT
Social Norm	A_1 SN	A_2 SN	A_3 SN	…	A_n SN
Values/moral norm	A_1 VMN	A_2 VMN	A_3 VMN	…	A_n VMN
Agency	A_1 A	A_2 A	A_3 A	…	A_n A
Relation Model	A_1 RM	A_2 RM	A_3 RM	…	A_n RM
Emotion	A_1 E	A_2 E	A_3 E	…	A_n E

Table 10 outlines and helps define the structure of the behavioural patterns of a given target population that might or might not engage in actions supporting the energy transitions. This provides elements for an initial analysis of the sources of mismatch between actors towards common goals and differences in the levels of engagement. It makes possible to account for sources of mismatches and make a preliminary identification of areas of policy intervention in a given population.

The type of analyses (descriptive and statistical) to validate the structure and content of the model proposed will be described in Task 1.3. The possibility of conducting a simulation of the potential scenarios of convergence or divergence is enabled by the model offered in Montalvo (2007). Such modelling enables the assessment of which actor might have more influence in the relationship and interaction. The current model works with a generalised Lotka-Volterra[3] model adapted to discern situations of collaboration (actors in agreement) or situations of competition (actors in disagreement) where feedback loops and the time and temporality of behavioural action play a role.

The analyses above are complemented with a characterisation of the population sample by a number of contextual variables that affect and condition all behavioural predispositions outlined above. These contextual socio-demographic variables help the

[3] Lotka–Volterra model is also known as the predator–prey equations. The model consists of a pair of first-order non-linear differential equations, frequently used to describe the dynamics of biological systems in which two species interact, one as a predator and the other as prey. The model has been later modified to describe collaboration-competition dynamics.

conduction of socio-economic and behavioural analyses that bridge to socio-economic policy analysis and design. Some of the most important socio-demographic determinants to be taken into account are listed in Table 11 below.

Table 11. Energy citizenship: socio-demographic determinants.

Demographic					
Age	Ag_1	Ag_2	Ag_3	…	Ag_n
Gender	G_1	G_2	G_3	…	G_n
Education	Ed_1	Ed_2	Ed_3	…	Ed_n
Income	In_1	In_2	In_3	…	In_n
Family size	Fm_1	Fm_2	Fm_3	…	Fm_n
Housing space	Hs_1	Hs_2	Hs_3	…	Hs_n
Digital literacy					
Internet access					
Computing facilities					
Mobile telephone					

The socio-demographic factors affecting energy citizenship are explored and outlined in Deliverable D1.2 of WP1, Vision document on energy citizenship-based Energy Union.

Up to this point, the stage two of the overall three-stage model assumes that the only dynamic that dominates in the interaction and collective action is characterised by collaboration or competition between a number of actors in an energy transition ecosystem. Theories developed in sociology bring light to the underlying mechanisms of collective action and relationships between and amongst people. This will be addressed in the stage three of the model proposed.

3.2.3 Stage three: upscaling collective behavioural patterns

According to Montalvo 2021, the concept of collective action has been addressed from different angles. Influential theories in the literature include network theory (Jones, Hesterly and Borgatti, 1997; Ahuja, 2017), social contagion theory (Christakis and Fowler, 2013; Guibeault, Becker and Centola, 2018), relations and social organisation theory (Fiske, 1991; Blau, 1964; Weber, 1978), neuro-sociology theory (Ten Houten, 2016, 2017), the theory on collective action (Ostrom, 1998), and plural rationality theory (Douglas, 2013; Thomson, Ellis and Wildavsky, 1990). The review of these theories revealed promising overlaps that indicate a universal structure of the “social mechanisms” underlying the interaction of individuals and resulting collective action. In particular, the main tenants and propositions of relations and social organisation theories have a similar structure around four ordered categories. Fiske’s (1991) relational model theory (RMT) is based in the concepts of community sharing, authority ranking, equality matching and market pricing. Blau’s (1964) model of social

interaction is based on social attraction, social power, balanced reciprocity, and economic exchange. Finally, Weber's (1978) model of social relations is based on communal or associative, authority based, mutually responsible and market participation. In agreement with Ten Houten (2019), these models tap into basic forms of social interactions.

The review in detail of the three theories favoured the insights offered by the relational model theory (RMT) developed by Fiske (1991, 1992; Table 12) concerning the structure of social relations. Fiske's RMT provides unique insights, theoretical and empirical underpinnings to look into the modes and structures that the interaction of the individual with the collective might have. The RMT builds on the central assumption that relationships are patterns of coordination between people. The unit of analysis of the RMT, in contrast with most models to analyse decision making focusing on the individual, focuses on behaviour in a relational context. According to Fiske, these four structures operate when people interact (e.g., transferring things and ideas, bilateral exchange, contribution, distribution, etc.) and they set the terms defining the primary standards of social justice manifest in group decisions and social influence. In addition, RMT argues that all social relationships can be understood and organised by the combination of these four models and that over time one archetypical relation can evolve, combining models or mutate from one model to another (Fiske, 1992).

Table 12. Relational models.

Community Sharing (CM)	Authority ranking (AR)	Equality matching (EM)	Market pricing (MP)
Relationships are based on a conception of some bounded group of people as equivalent and undifferentiated. In this kind of relationship, the members of a group or dyad treat each other as all the same, focusing on commonalities and disregarding distinct individual identities. People in a CS relationship think is natural to be altruistic with people of their own kind (e.g., blood, ethnic, religion, ideology, etc.). In CS relationships, *resources* (e.g., food, land, capital, durable and non-durable goods, information, expertise, etc.) are regarded common rather than individual property. People pool their resources and treat	Relationships are based on a model of asymmetry among people who are linearly ordered along some hierarchical social dimension. People could be ranked according to different hierarchies. In AR relationships agency on resources denotates and displays rank differences. High rank individuals control access to resources implying knowledge and power asymmetry. Individuals in a higher rank (superior organisational hierarchy, wealthier, older, wiser, etc.) facilitate or give resources access to lower rank people (a layman or a subordinate), while in return expect deference, acknowledgement,	Relationships are based on a model of even balance and one-for-one correspondence (as in turn taking, egalitarian distributive justice, tit-for-tat retaliation, or compensation by equal replacement). People are primarily concerned whether an EM is balanced, keeping track of any asymmetry. The underlying principle is that each person is entitled to the same amount as any other person in the relationship, the direction and magnitude of an asymmetry are meaningful. Favours taken are expected to be paid off at least in equal proportion as received, lack of mutualism in EM any	Relationships are based on a model of proportionality in social relationships people attend to ratios and rates. People in a market pricing relationship usually reduce all the relevant features and components under consideration to a singular value or utility metric that allows the comparison of many qualitatively and quantitatively diverse factors. What matters is how an individual in proportion to other and the social value of an exchange is defined by the ratio of what I given and received (e.g., prices, wages, commissions, rents, interest rates and any other exchange organised in terms of cost-benefit and

them as belonging to a larger whole that transcends its individual members. The model motivation is apparently based on intimacy and idealism but has strong basis on mutual structural support of the group and the individual.	loyalty, etc. Lower rank while acknowledging superiority and following given guidelines expect some kind of pastoral care or recognition from higher-ranking person (or entity) in retribution of deference given. Resources exchanges in AR relationships are motivated by power asymmetry underpinned by a sense of duty, honour or fear.	exchange dynamic is likely to collapse.	rational calculations of efficiency or expected utility. Within market pricing relationships people will tend not engage in exchanges when the exchange ratio is unfavourable to them.

Source: Fiske, 1992.

The complementarity of the RMT with the previous two model stages presented above rests in several premises:

i) No rational actor or bounded rationality is assumed in the operation of the four models.
ii) RMT assumes that the permanence or confrontation of an operating relational model between two actors rest on preferences, values, and agency waged by each actor participating in a relationship.
iii) RMT enables the description of the underlying rationale of interdependences between the individual and the collective. This is applicable to different realms of human activity related to the more intimate level of dyadic or group dynamics but also to large scale societal challenges like the energy transition and the emergence of energy citizenship.
iv) The notion that there are rules and structures that are valid across societies gives an indication of the operating *social contract* amongst groups of people interacting. This is relevant for the analyses to be conducted in the GRETA project concerning Energy Citizenship Contracts.
v) In turn, such rules and implicit social contracts (i.e., CM, AR, EM and MP) in the interaction and behaviour of people brings further light into the potential sources of mismatches between the individual rationales of citizens and other institutional actors.

From the above it can be stated that relational models are a likely additional source of mismatch and asymmetries between the individual and the collective behaviour towards common goals in the energy transition. Such potential mismatch originates from differences between the individual rationality and the collective aims between actors or groups of actors operating with an implicit or explicit assumption of differentiated relational models. As outlined in Table 12 above, each relational model implies different assumptions of what is or should be the rules in operation in any exchange and relationship in a desirable new social contract that supports the

emergence of energy citizenship. The conceptual upscaling and operation of social contracts at the societal level is depicted in Figure 8 below.

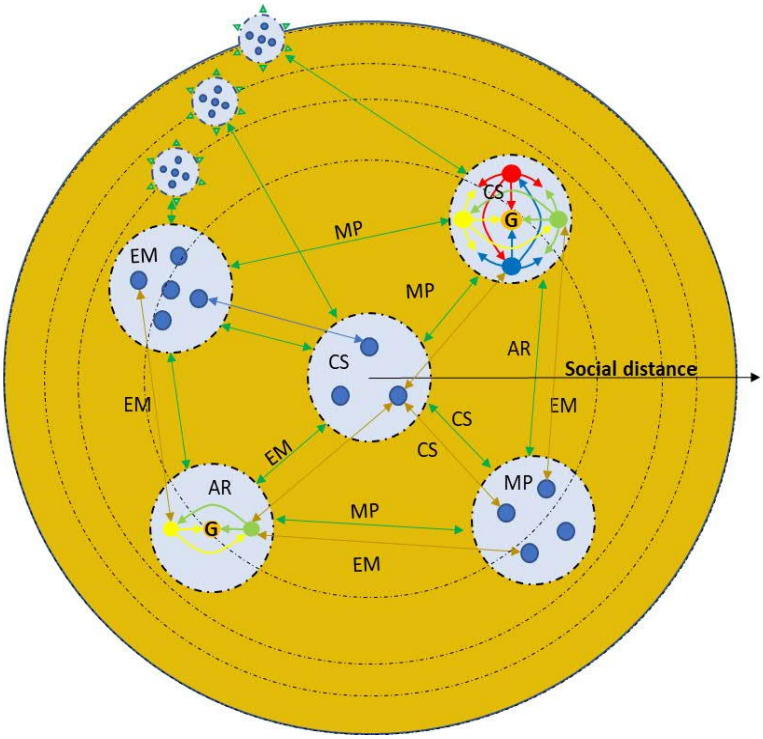

Figure 8. Upscaling collective behavioural patterns and relational models.
Source: Adapted from Montalvo (2021).

The idea of upscaling diverse relational models in a group or societal settings is depicted in Figure 8 above. This indicates the need to take into account the optimal relational model in energy citizenship promotion initiatives with specific policy goals. Figure 8 indicates for example tensions and mismatches or asymmetries in expectations and rules for exchanges from actors operating with a logic of community sharing (where the benefits of exchanges are communal) with market pricing (where the benefits of exchanges are private). The mismatches might occur in situations where individuals have decision power, but their institutional embedding (households, companies or government) might have an implicit relational model in operation. For example, the two cells at the right in Figure 8 indicate three different models in operation. An energy community sharing cell of actors (cell upper right) might be operating under a communal contract and in need of operating with a company or other entity that operates under the logic of market pricing (cell lower right). Such interaction might be moderated by a relational model based on authority ranking dictated by the standards or laws ruling a trading or commercial exchange. Such relation needs a congruent social contract that makes the matching of different logics of the operating relational models for each actor in the energy transition ecosystem.

3.2.4 Energy citizenship emergence: the three-stage model integration

The key intuitive insight of the three-stage model is that there are micro-motivations and decision making at the individual level that via interaction and concatenation with other citizens and institutional actors lead to meso and macro effects at the societal level. From Section 2, we can state that energy citizenship is manifested in levels of engagement in the energy transition that vary from the citizen and institutional actors being unaware to actively advocating pro- or against the green energy transition. The literature reviewed in Section 2 reports several types of citizens with varied roles and behaviours addressing the same societal goal. Each actor type with their own underlying motivations and capacities participates in the energy transition. Such conditions lead to situations where there could be a great propensity at the individual level to engage in the energy transition. This could be agreement with the political discourse of institutional actors that *change is needed* but the change is slow or does not happen. The latter dynamics is a paradox that receives an intuitive response in the three-stage model proposed. The puzzle and issues related to the emergence of energy citizenship to untangle are:

- What are the motivations driving the behaviours that manifest energy citizenship across actors?
- What type of relational model and inherent underlaying rules of interaction prevail? Which relational model dominates? CM, AR, EM or MP?
- How do individuals affect the collective and how do the collective dynamics affect the individual engagement?
- Is there congruence in expected relational modes between citizens and institutional actors? Incongruence would lead to divergence of collective dynamics from desirable common decarbonisation goals.

The three previous sections have described elements of a three-stage model to understand the dynamics of individual and collective behaviours related to energy citizenship emergence. The integration of the three-stage model is shown in Figure 9 below. The emergent features of energy citizenship are implicit in each of the three stages of the model depicted below. The emergent properties of behavioural change supporting energy citizenship occur at the individual and collective levels.

The model in Figure 9 advancing our knowledge on individual and collective levels offers a staged model that can be used in a progressive level. The stage one (S1) gives elements to start the analysis by providing the basis for a better understanding of the individual energy behaviour. The stage two (S2) enables the analysis of asymmetries and the simulation of interactions between several actors to find the conditions that enable the convergence to common goals. The stage three (S3) provides an intuition of the likely social sources of mismatches between civil and institutional actors moderated by a limited number of relational models that define the rules for social interaction and social justice.

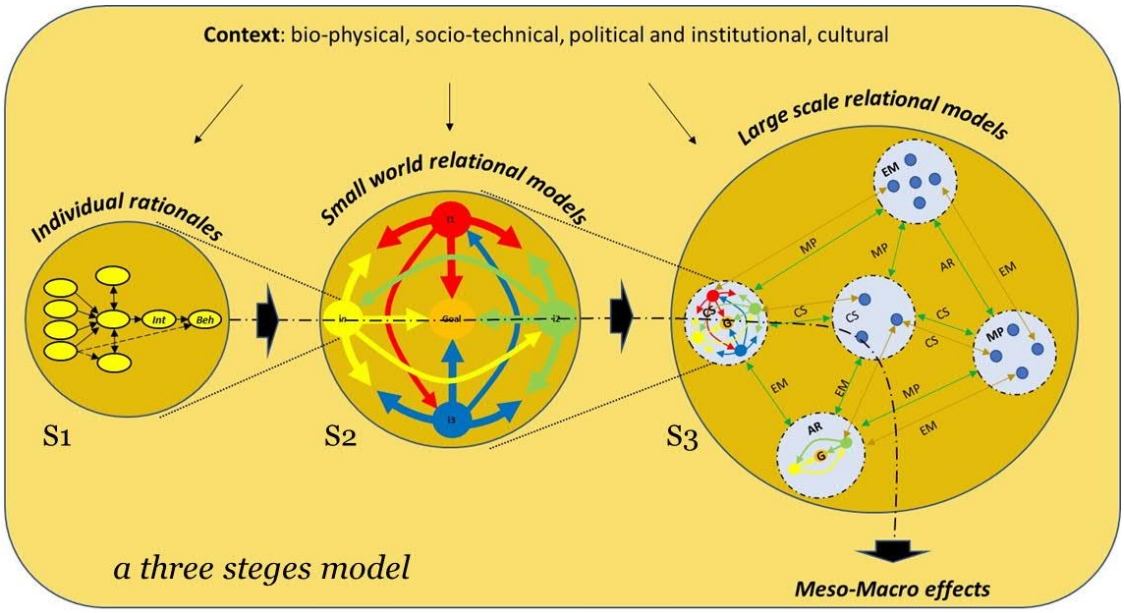

Figure 9. Structure and dynamics of energy citizenship emergence: the three-stage model.

Source: Adapted from Montalvo (2021).

Energy citizenship emergence at the individual level

The literature review conducted in Section 2 provides ample evidence that many factors may affect the emergence of energy citizenship and that these factors might vary depending on the actors considered and their roles in the energy system. The approach proposed here offers an organising heuristic for the very many factors described to few correlates that enable a more scientific analysis and the testing of hypotheses in content and structure of the factors affecting energy citizenship emergence. Energy citizenship emergence at the individual level is contingent on the concatenation of influences stemming from attitudinal traits, prevalent norms, the availability of resources and knowledge, the relational model ruling the relation with others and the context where the individual lives and the emotional state. The latter is an important trigger that arises from the situational evaluation of the previous factors where outcomes, values and agency must be in congruence with the relational model dominant. The interplay of all these constructs lead to emergent properties of energy citizenship at the level of the individual.

Energy citizenship emergence at the collective level

The stages two and three of the model proposed offer a new understanding of how energy citizenship could emerge at the collective and societal levels. By building on the model stage one, the stages two and three offer insights as to what could be the dynamic aspects of energy citizenship emergence. At the core of the three stages of the model are the concepts of *interactions of individuals* and the *relational model* that mediates the interactions. The emergence of energy citizenship at the societal level rests on the interactions and the dominant rules that guide such interactions. At the core of the model are the actions and reactions of several stakeholders. The link between the correlates (attitudes, norms, agency and behaviour) at the individual level enables the

upscaling of the analysis from the individual to meso and macro effects at the community and societal level.

4 Conclusions

A few conclusions can be put forward regarding the advancement done in the framework proposed to study the structure and dynamics of energy citizenship emergence. The conclusions refer to 1) the definition of energy citizenship and the behavioural performance that supports the engagement in the energy transition, and 2) the proposed approach to study the emergence of energy citizenship.

4.1 On energy citizenship definition and characterisation as behavioural performance

The report set at the outset the ambition to develop a framework to study the structure and dynamics of energy citizenship emergence. We proceeded first to draft a preliminary definition of energy citizenship based on past research on the topic. The definition of energy citizenship was made contingent on the level of engagement that people might have (or not have) in actions supporting the energy transition. These actions are defined in specific behaviours (investing new energy appliances, reducing energy usage, selling renewable energy equipment, enacting policies and regulations, etc.) that manifest differently across different type of actors in an ecosystem of change. A number of actor types were identified in Table 2.

Table 2 (repeated). Types of energy citizens.

Category	Types of Energy Citizen
Individuals	Consumer Prosumer and prosumager Participant in protests and movements Policymaker
Collective entities	Energy community Business entity

The literature review presented in Section 2 had three purposes. First, it facilitated a preliminary definition of energy citizenship in terms of engagement and behaviour supporting the energy transition.

Second, it made an extensive review of the literature addressing aspects of energy related behaviours for each of the actors that are relevant in an energy transition ecosystem. All the actors listed in Table 2 above have different rationales to engage in the energy transition. Therefore, their energy citizenship has a different structure of incentives and disincentives to engage in green energy transition actions. Such a review will serve as first insights into what drives specific behaviours and engagement

for each type of actor. This will be used as input in GRETA's WP3 for case study implementation that will engage with actors in the energy transition ecosystem.

Third, the types of behaviours identified (e.g., investments, consumption, storage, pursuing efficiency, using specific technologies and practices, etc.) all are context and actor specific. This produces a large set of potential incentives and disincentives. An analysis of all the qualitative data gathered enabled the reduction of behaviours and their respective drivers into few behavioural constructs that are amenable to be included, measured and modelled in the three-stage model proposed (see summary Table 9 in Section 2).

4.2 On energy citizenship emergence

The review of the literature conducted in Section 2 indicates that there has been a great deal of interest in studying and designing policies that support the energy transition. Different streams of research on social and sustainable innovations (Howaldt et al., 2021), sustainable business models (Boons et al., 2013), and energy transitions (Köhler et al., 2019) are pointing to the need for understanding the underlying social dynamics that limit change towards sustainability. Only as recently as in 2021, the importance of better understanding the human dimension of the energy transition has been recognised (Steg et al., 2021), with a research agenda for the next decade outlined as follows:

- Which factors encourage different actors in sustainable energy behaviour?
- Which interventions can be effective to encourage sustainable energy behaviour of different actors and which factors enhance its effects?
- Which factors affect public support for energy policy and changes in energy systems?

Their proposed agenda to understand the human dimension remains focused primarily on the individual as the unit of analysis. Little attention is given to deepen the understanding of behavioural dynamics limiting the advance of the energy transition; dynamics that are contingent on the interaction between the individual and the collective.

The framework proposed in Section 3 uncovers such a gap and provides clear heuristics to understand the structure and dynamics of the human and institutional dimension that limit the cultural emergence of energy citizenship. The model proposed for this aim enables the understanding of energy citizenship at three levels of analysis:

- Stage 1: The individual link to the collective via the notion of relational models.
- Stage 2: It defines the link between individual energy behaviour and collective dynamics in a given ecosystem of change (e.g., adoption of new practices, investment in new technologies or durable energy appliances, etc.).

- Stage 3: It links the dynamics of small ecosystems of change to a larger scaling up of Fiske's (1992) four basic relational models that structure human interaction at the dyadic and societal levels.

Testing for energy citizenship emergence is therefore analysed at three levels. The three-stage model enables the identification of bottlenecks of energy citizenship emergence whether this resides at the individual or the collective level. It will enable also to identify in detail the sources of energy citizenship emergence and the potential convergence to common decarbonisation goals.

4.3 Next steps for the implementation and validation of our approach

The next steps of the model implementation will be conducted in Task 1.3 where the analytical framework is developed to test hypotheses of relationships between the constructs that compose the model. Task 1.3 also includes detailed instructions to conduct the case studies following the approach proposed. In addition, Task 1.3 will include detailed heuristics for data analysis testing the structural and content validity of the model. This last activity is closely related to the generation of scenarios of behavioural change dynamics to be explored in WP4.

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