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ANALYSIS

Development and test of a dual-pathway model of personal and community factors driving new energy technology adoption - The case of V2G in three European countries

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ABSTRACT

Understanding the drivers that underpin the adoption of new energy technologies is key to fostering a successful energy transition. Increasingly, studies focus on non-economic factors but are often limited to personal motivations such as ecological values. While there is increasing recognition that community factors can be key for behavioral change, the role of these factors with regard to energy technology acceptance is so far not well understood. To address this gap, we propose a new theoretical model to explain adoption interest of innovative energy technologies, such as vehicle-to-grid technology. Our model comprises two levels and suggests that both a personal-motivation route and a community-motivation route can uniquely explain adoption interest. We further propose an interplay between personal and community factors. We test this model through an empirical study based on representative samples from three European countries (Germany, France, Switzerland, total $N = 979$). Our results support the notion that different motivational routes can drive adoption interest. In particular, we find that initiative membership predicted adoption interest directly and indirectly via personal norm. Finally, we test our model for differences between countries, finding evidence that community factors might differentially affect adoption interest across national contexts.

1. Introduction

Many countries worldwide aim to decarbonize their energy system in order to combat climate change and protect the environment. To this end, a fundamental system transformation is needed that is based on renewable and decentralized energy production, as well as flexible energy consumption (Koirala et al., 2018b). As novel technologies emerge within this transformation, the role of individuals shifts away from being mere passive consumers. In their new role, individuals are becoming active energy citizens in the energy transition by adopting and using new energy production or distribution technologies (Sintov and Schultz, 2015; Steg et al., 2018). The increase of rooftop photovoltaic systems during the last years is a prominent example, and bears witness of consumers becoming prosumers, by producing their own electricity while feeding in the surplus (Hahnel et al., 2020; Hahnel and Fell, 2022). Empowered with these new opportunities, an individual's behavior can drive or hinder the energy system transformation (Nielsen et al., 2024), which makes it necessary to investigate the factors driving individuals' adoption decisions in the context of novel energy technologies.

Research increasingly points to the notion that economic factors and rational self-interest are not the only factors that determine individual behavior in the energy transition, but non-economic factors often play an important role as well (Nilsson et al., 2018; Dreyer et al., 2022). This builds on more general insights on decision-making and bounded rationality from psychology and behavioral economics (e.g., Kahneman, 2003). Previous research has highlighted the importance of individual energy behavior in this transition and focused on identifying personal motivations beyond economic and self-interest motives such as ecological or altruistic motives, that underlie sustainable energy use or technology adoption (Steg et al., 2015; Steg, 2016). In addition, individuals often act within particular social contexts or groups, which can influence their decision-making (e.g., Fielding and Hornsey, 2016; Fritsche et al.,

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2018; Sloot et al., 2019). This suggests that not only individual behavior but also collective efforts can drive the system transformation. In particular, recent research has pointed to the role of community energy initiatives as one type of collective to facilitate the sustainable energy transition (Schwanitz et al., 2023). Community energy initiatives can raise their members' awareness of renewable energy technologies and create acceptance for these technologies (Seyfang and Smith, 2007; Sloot et al., 2018). Moreover, by facilitating collective investments in energy technologies, these initiatives enable individuals to take on a more active role in this transformation (Hamann et al., 2023). By fostering collective ecological efforts over individual actions, they enable citizenship practices (Hamann et al., 2023) and can uniquely motivate sustainable energy behavior (Sloot et al., 2018). Importantly, however, little is known about the extent to which membership in these initiatives has the potential to motivate the adoption and use of *novel* technological innovations that have not been widely established yet. Equally important, more research is needed to understand the process by which the community context, alongside personal values of citizens, can motivate technology adoption.

In this study, we address these research gaps by examining the potential of community factors — in particular, membership in community energy initiatives — as drivers of novel technology adoption. We propose a new theoretical model that considers both personal and community factors as potential drivers of technology adoption, suggesting that adoption can be driven jointly by personal values and norms, and membership in community energy initiatives. Specifically, we present an empirical study based on nationally representative data collected in three European countries, namely Germany, France, and Switzerland, to explain whether membership in a community energy initiative increases the likelihood to engage in additional energy transition practices. Our sample comprises 229 energy initiative members and 690 non-members across all three countries. Energy systems differ between countries, and there is a variety of initiatives, varying in their organizational form, amount of members, success rate, and strategies (Oteman et al., 2014; Koirala et al., 2018a), which results in a 'patchwork of definitions' (Schwanitz et al., 2023, p. 7). To acknowledge this diversity, we use the term *community energy initiative* to emphasize the locally-rooted dedication to fostering the energy transition, which does not necessarily have to adhere to existing legal structures and definitions.

Our empirical test of the theoretical model focuses on the adoption of vehicle-to-grid (V2G) technology for electric vehicles (EVs). V2G can be defined as a storage technology with a bidirectional power flow (Kempton and Tomić, 2005; Sovacool and Hirsh, 2009). That is, EVs that are connected to the grid can both be charged and feed electricity back into the grid when necessary. On a household level, people may benefit financially by providing flexibility (Sovacool et al., 2017). On a system level, V2G provides temporal and distributed flexibility (Knezovic et al., 2017), and thus can be seen as an approach to balance short-term production and consumption based on renewable energy sources (Hargreaves et al., 2013; Hossain, 2016). On a regional level, this technology can specifically benefit local communities that generate renewable energy and promote autonomous energy systems, by allowing for different energy services (Koirala et al., 2018b; Proka et al., 2020; Reis et al., 2021; Schram et al., 2021), or by providing flexibility to enable electricity sharing (e.g., peer-to-peer-trading) within a community (Huber et al., 2019; Hahnel et al., 2020). While this technology holds many advantages and benefits for the system and the user, V2G comes along with disadvantages, too, especially for the EV owner. One of the main disadvantages is that mobility needs may be restricted (Franke and Krems, 2013; Franke et al., 2018). Another relevant constraint is higher costs, also due to a potentially shortened battery life (Krueger and Cruden, 2020).

We aim at understanding the role that community energy initiatives can have in promoting additional energy transition practices, namely the adoption of V2G technology for EVs. We thus consider the complex interplay between personal and social motivations in influencing citizenship behavior and sustainable practices beyond mere monetary motivations assumed by classic models of ecological economics (Verburg et al., 2016; Schlüter et al., 2019). We additionally examine how those motivational factors are shaped by the local and national environment in which individuals operate, thus accounting for the important role of contextual factors in driving sustainable practices. Specifically, this paper has two main objectives:

i. Proposing a theoretical model that considers both personal and community factors as potential drivers of novel technology adoption
ii. Testing the theoretical model through an empirical study based on nationally representative data collected in three European countries – Germany, France, and Switzerland – for the case of vehicle-to-grid technology.

The paper is structured into five parts. The first part focuses on the theoretical foundations and introduces the novel theoretical model. We derive our hypotheses and then proceed with the description of the study design, data, and analysis method. Based on this, we present our findings, starting with the results of the model before delving into the multigroup analysis, comparing the effects between the three target countries. Finally, we discuss and reflect upon the theoretical implications and limitations of our research.

2. Personal and community factors

2.1. Values and personal norm

The energy transition with its goals as defined by the Paris Agreement requires a system transformation, which will only succeed with citizens actively engaging in the transition, for example through changing their behavior and adopting novel energy technologies (Steg, 2016). To date, a variety of different models exist that have been used to explain technology adoption. One prominent model that is widely used to understand decision-making processes within an environmental context is the theory of planned behavior (TPB) (Azjen, 1991), introduced as an expectancy-value model of attitude-behavior relationships (Conner and Armitage, 1998). The model explains behavior mainly based on attitudes and perceived behavioral control, and was adapted and applied to various contexts, for example to explain EV adoption (Haustein et al., 2021; Lee et al., 2023), V2G acceptability (van Heuveln et al., 2021), or engagement in environmental activism (Fielding et al., 2008). Yet, this theory remains grounded in the assumptions of rational choices and self-interest, and is limited in capturing social contexts, such as the influence of particular groups (Jackson, 2005; López-Mosquera and Sánchez, 2012). Behavioral economics emphasizes that decision-making often departs from the rational actor model, shaped by cognitive shortcuts like heuristics, emotional influences, and biases that simplify complex choices. Beyond these processes, intrinsic motivations, such as values and norms, play a critical role, particularly in the context of sustainability (Simon, 1955; Simon, 1982; Kahneman, 2003; Evans, 2008; Gigerenzer and Gaissmaier, 2011).

An alternative model giving more weight to these normative factors is the value-belief-norm theory (VBN) developed by Stern et al. (1999), which assumes (pro-environmental) behavior to be based on environmental and altruistic values (Jackson, 2005; López-Mosquera and Sánchez, 2012; Dietz, 2015). Previous empirical research has highlighted the role that personal factors, such as the values and moral obligations captured by the VBN theory, play in explaining ecological behavior (Steg et al., 2015; Steg, 2016; van der Werff and Steg, 2016). Specifically, individuals who pursue biospheric (i.e., ecological) values are more likely to engage in sustainable energy behavior, as these values reflect an intrinsic personal motivation to protect the environment and thus engage in behaviors consistent with this goal (de Groot and Steg, 2008). Next to biospheric values, egoistic values might underpin the adoption of novel energy technologies. Egoistic values reflect a propensity to strive for individual status, power, or monetary gains. These values may therefore hinder the acceptance and adoption of new technologies if they are perceived as costly (Steg, 2016). Conversely, egoistic values can in certain situations promote the adoption of a specific technology if it promises monetary benefits (Steg, 2012), or enhances one's status (Steg, 2016). For example, van der Werff and Steg (2016) found egoistic values to be significantly positively related to participation in smart energy systems. Moreover, Jansson et al. (2011) found that values could successfully explain the early adoption of novel technologies. Due to the importance of egoistic and biospheric values in explaining sustainable energy behavior and adoption, we consider both values as potential antecedents of adoption interest in V2G technology. Previous research has emphasized that values reflect relatively stable overarching goals in life, serving as the underlying motivation for more specific factors. In particular, biospheric values are often assumed to affect sustainable energy behavior via increasing individuals' feeling of moral obligation, commonly referred to as a personal norm (Stern et al., 1999; Steg et al., 2005; Brandsma and Blasch, 2019; Namazkhan et al., 2019; Sloot et al., 2022).

While a large number of studies has provided evidence on the relationships between values, personal norm, and different sustainable energy behaviors (including membership in community energy intitiatives), fewer studies have examined these variables in relation to the adoption of novel energy technologies (van der Werff and Steg, 2016; Lee et al., 2023). To our knowledge, no research has investigated how personal motivational factors are related to individuals' interest in V2G technology, a technology that may lead to personal financial benefits but also introduces constraints on individual flexibility. Drawing upon these findings we state the following hypotheses:

Hypothesis 1a. (H1a): Biospheric values are positively related to an individual's personal norm and, in turn, lead to a higher interest in V2G adoption.

Hypothesis 1b. (H1b): Egoistic values are negatively related to an individual's personal norm and, in turn, lead to a lower interest in V2G adoption.

2.2. Community motives

Despite the important role of personal values, individuals do not act in a vacuum, but their decisions and behaviors are influenced by the social context in which a person resides (Barth et al., 2016). Research has highlighted the importance of social identities for sustainable energy behavior (Fielding and Hornsey, 2016; Fritsche et al., 2018). Local communities and community energy initiatives have received particular attention as potential facilitators of sustainable energy transition practices (Rees and Bamberg, 2014; Bamberg et al., 2015; Sloot et al., 2018). Notably, Walker et al. (2022, p. 2) distinguish between the concepts of 'community of interest' and 'community of place'. While the latter puts focus on the geographic aspect and highlights the close distance between members, the previous describes a group of individuals that are bonded by a common interest, but not necessarily by close proximity (Walker et al., 2022). In the context of energy initiatives, the concept of the 'community of place' is particularly relevant and is closely intertwined and interrelated with the local neighborhood, thereby emphasizing the relationship with distinct spatial environments (Ptak et al., 2018). In other words, although community energy initiatives are distinct groups, they are commonly embedded in a wider local neighborhood, which can itself act as an overarching group with relevance for individuals' decision-making (Goedkoop et al., 2022). Moreover, community energy initiatives rely on active participation from the members of the neighborhood, which is easier to attain through direct contact, when neighbors are emotionally attached to their neighborhood (Oteman et al., 2014; Kalkbrenner and Roosen, 2016; Goedkoop et al., 2022), or when there is a general appreciation of place (Devine-Wright and Howes, 2010; Hoffman and High-Pippert, 2010).

Two community factors seem particularly relevant in this regard. First, the perceived goals and norms of a community can guide individuals' behavior, motivating them to act in accordance with what they believe the community stands for (Fielding et al., 2008; Fielding and Hornsey, 2016). These norms are assumed to affect decision-making not via the mechanism of social pressure but via the internalization of what the relevant social group stands for in terms of their goals and values. From a behavioral economic perspective, this can be understood through the theory of social preferences, which posits that individuals derive utility not only from their own outcomes but also from outcomes that align with group norms or shared values (Fehr and Schmidt, 1999). For instance, community members might participate in shared community projects to demonstrate their commitment to group norms of collective benefit. We refer to this factor as the perceived community sustainable energy motivation (CSEM) and propose that it might not only influence sustainable energy behavior in general, but might also be relevant for technology adoption, particularly in the early adoption phase (Klöckner, 2014; Barth et al., 2016). If individuals perceive other community members to support sustainable energy transition practices, this might in turn affect their own decision through mechanisms like reciprocity (Nowak, 2006; Hilbe et al., 2018). Moreover, previous research indicates that CSEM correlates with higher levels of participation in local sustainable energy projects, including membership in community energy intitiatives (Goedkoop et al., 2022).

A second community factor is an individual's identification with their local community. Community identification is a specific type of group identification and reflects the emotional attachment that a person feels to their community (Postmes et al., 2013). Studies have provided empirical evidence for the idea that a stronger identification with one's local community is positively related to the willingness to participate in energy projects or initiatives with others in the community (e.g., Bomberg and McEwen, 2012; Rees and Bamberg, 2014; Kalkbrenner and Roosen, 2016; Goedkoop et al., 2022). Additionally, bounded rationality may play a role in this process: individuals embedded in a community often use social cues or peer behavior as heuristics for what actions are desirable or normative, reducing cognitive effort in decision-making (Conlisk, 1996). While these studies have tended to examine local communities and initiatives with similar objectives, strategies, and organizational forms, we expect this relationship to generally hold across different types of local communities.

Community energy initiatives can play a vital role in fostering the energy transition (Bauwens et al., 2016; Wierling et al., 2023). By bringing individuals from a local community together, they can go beyond individual change and provide an additional motivation to act as part of a particular group. However, there is little quantitative empirical research on how membership in an energy community can promote sustainable energy behaviors on an individual level and which behaviors are specifically affected. One study tested the relationship between energy initiative membership and different sustainable energy behaviors the initiative aimed to promote, such as energy saving, while accounting for different personal ecological motivations (Sloot et al., 2018). This study found that membership was related to stronger sustainable energy behavior, but the effect differed across different types of behaviors. To our knowledge, no research has examined the relationship between initiative membership and the willingness to adopt novel energy technologies in early adoption phases, in particular when these technologies are not specifically targeted by the initiative. This way, community energy initiatives might foster a sustainable energy transition in a more indirect way by creating involvement in the system transformation beyond their immediate goals. Another reason why membership in community energy initiatives might drive the adoption of new technologies is because these technologies could complement the current goals of the initiatives. This alignment could create additional synergies and benefits, particularly for initiative members. For example, in the changing energy landscape, storage systems are becoming more important to enable a higher integration of renewable energies. V2G is one of those technologies creating synergies between technologies, enabling local communities to become more autonomous (Koirala et al., 2018b) or trade electricity (Hahnel et al., 2020; Hahnel and Fell, 2022). The combination of both, trading and storing, was shown to achieve significant electricity savings for the members of a local community (Lüth et al., 2018). Thus, V2G can bring new opportunities for citizens to actively participate on a local scale and to raise awareness of energy consumption (Parra et al., 2017). Based on the above review of community factors and their relevance in the energy transition as a whole, and regarding energy behavior change more specifically, we expect the following:

Hypothesis 2a. (H2a): Community sustainable energy motivation is positively related to an individual's membership in a community energy initiative and, in turn, lead to a higher interest in adopting V2G.

Hypothesis 2b. (H2b): Community identity is positively related to an individual's membership in a community energy initiative and, in turn, lead to a higher interest in adopting V2G.

Aside from these two distinctive motivational routes, it is plausible that personal values and the social context are equally relevant in explaining sustainable citizenship behavior, and can be seen as complementary and interdependent. While personal values describe the focus on the self, social values are outward-looking, considering the context within the decision-making process (Bradley et al., 2024). Yet, only a few studies have analyzed the interplay of personal values and community motives on sustainable citizenship practices. Initial research has shown that personal motivations such as non-monetary values can significantly explain energy initiative membership (Sloot et al., 2018, 2019), particularly so for pro-environmental values and motives. While values may increase the likelihood of engaging in collective sustainable initiatives in the first place, initiative membership may itself become internalized as a personal motivation. Specifically, being a member of a community energy initiative might reflect on one's self by strengthening the personal norm to engage in behaviors consistent with the initiative membership. Additionally, to the direct involvement in an energy initiative shaping an individual's personal norm, the perceived goals and values of the initiative might motivate the members to act accordingly. Thus, the perceived goals might strengthen the specific motivation to engage in sustainable energy behavior at the community level as well.[1] In a different context, Sharpe et al. (2022) found that an organization's corporate social responsibility strategy (aking to a group value) increased employees' motivation to behave pro-environmentally at work via increasing the personal norm. Yet, this mechanism of personal norm as a mediator of the relationship between initiative membership and technology adoption has not been tested in the context of community energy initiatives.

Based on these considerations, we suggest that biospheric values positively influence the likelihood to be member of an community energy initiative, which in turn increases adoption interest. In contrast, strong egoistic values may have the opposite effect. Moreover, we propose that community factors likely increase ones personal norm and in turn lead to a higher adoption interest. We propose the following three hypotheses:

Hypothesis 3a. (H3a): Biospheric values are positively related to adoption interest via individuals' membership in a community energy initiative.

Hypothesis 3b. (H3b): Egoistic values are negatively related to adoption interest via individuals' membership in a community energy initiative.

Hypothesis 4a. (H4a): Community sustainable energy motivation is positively related to personal norm, and lead to a higher adoption interest of V2G.

Hypothesis 4b. (H4b): Initiative membership is positively related to personal norm, and lead to a higher adoption interest of V2G.

2.3. Dual-pathway model of energy technology adoption

Based on our review of the literature, we developed a theoretical model of energy technology adoption that considers both personal motivations and community motivations as determinants of individuals' adoption interest (Fig. 1). We denote this model dual-pathway model of energy technology adoption. This model suggests that specific factors on both levels can explain energy transition practices such as the adoption and usage of V2G. The personal-motivation route is based on biospheric and egoistic values, with biospheric values influencing adoption decisions positively (H1a), and egoistic values influencing adoption decisions negatively (H1b), both mainly via personal norm (H1a-H1b). The community-motivation route includes community factors, including community sustainable energy motivation (CSEM) and community identification, predicting adoption decisions mainly via initiative membership (H2a-H2b). Next to these two main routes, we propose that personal and community factors can also influence each other, suggesting an interplay between personal and community-based motivations (personal-community motivation route). More specifically, we suggest that biospheric values are associated with initiative membership and in turn lead to a higher V2G adoption interest (H3a), while we propose the opposite for individuals with strong egoistic values (H3b). Moreover, we hypothesize that community motives (CSEM, initiative membership) have a positive effect on personal norm, and lead to a higher adoption interest of new energy technologies (H4a-H4b, community-personal motivation route). Thus, our hypotheses are related to a decision route as a whole (i.e., an indirect effect) as opposed to a particular relationship between two factors.

3. Current study

In 2023, we conducted an online questionnaire study among homeowners in France, Germany, and Switzerland. In addition to sampling participants from the general population, we specifically contacted members of energy communities in the three countries. As V2G technology has yet to be implemented in these three countries, we used a hypothetical adoption decision task to study citizens' adoption interest in the context of V2G. In particular, we created concrete scenarios describing various types of V2G tariffs (see Section 4.2.2) and used the ratings of these scenarios to measure respondents' interest in adopting V2G.

In line with our reasoning above, we hypothesized that an individual's decision is not only guided by personal values and norms (H1a-H1b), but also by the social context in which a person resides and acts (H2a-H2b). The study, therefore, examined the unique role community energy initiatives can play in *novel* energy technology adoption decisions, focusing on V2G technology, a technology that is not yet implemented on a large scale. Specifically, the objective of our study was to analyze adoption interest in an integrated, dual-pathway model that considers both individuals' personal values and their embeddedness within the relevant community context.

We focused on the community energy initiative context, as these initiatives have been playing a significant and influencing role in decentralizing and transforming the energy system over the past decades and will be likely to do so in the near future. As of 2023, more than 10,000 local initiatives existed in Europe, with more than two million

[1] We draw a direct link between CSEM and personal norm, because these factors specifically refer to the community members' motivation to engage in sustainable energy behavior at the community level. Community identification, on the other hand, is referring to community members' identification with their local community (i.e., their neighborhood) in general, independent of the energy domain.

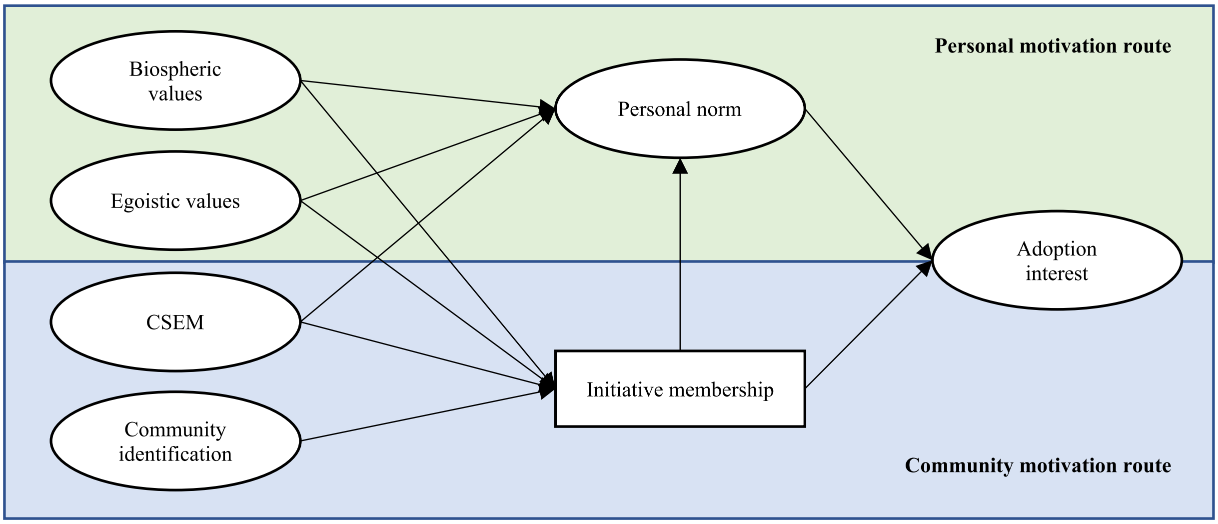

Fig. 1. Dual-pathway motivation model of energy technology adoption.
Note: The figure only depicts the paths relevant to our hypotheses. Our hypotheses state that adoption interest can be either motivated by personal values via personal norms (H1a-H1b), by community motivations via initiative membership (H2a-H2b), or jointly, by personal values influencing adoption interest via initiative membership (H3a-H3b), and by community factors (CSEM and initiative membership) influencing personal norms and thus resulting in a higher adoption interest (H4a-H4b). Please note that, while we propose a direct link between initiative membership and personal norm and CSEM and personal norm, we do not draw this link between community identification and personal norm, as this factor is not specifically referring to the energy domain, but captures participants' general attachment to their local community.

people involved in them (Schwanitz et al., 2023). Their story of success lies, among others, in the bottom-up approach, their regional rootedness, allowing individuals to play an active role in this transition, creating acceptance towards energy technologies, and motivating individual and collective sustainable energy behavior. Initiative members are, therefore, likely to have shared goals and to identify with the goals and values of other members (Sloot et al., 2019). To this end, being part of a community energy initiative might influence an individual's technology adoption decision, especially for those technologies that hold benefits for the community energy initiative in addition to the energy transition as a whole. We thus expect community motives to positively influence adoption interest (H2a-H2b).

Apart from these two motivation routes – through personal motivations and community-based motives – we hypothesized that personal values might also influence adoption interest positively via initiative membership. This "personal-community motivation route" emphasizes personal values, i.e., biospheric and egoistic values, as antecedents of initiative membership, while membership might be positively related to adoption interest as well (H3a-H3b). In contrast, community-based motives and community energy initiative membership might also influence adoption through personal norm (H4a-H4b). This "community-personal motivation route" considers that community motives might not only explain membership, but being part of a community energy initiative might in turn be related to increased personal norm, which might impact the adoption decision of a person. Consequently, we suggest that adoption can be driven either solely or jointly by personal motivations and membership in community energy initiatives.

In addition to analyzing the overall model, we examined systematic differences in the assumed adoption processes between Germany, France, and Switzerland. Even within Europe, countries follow different trajectories regarding their energy transition, with likely impacts on the decision-making of individuals in these countries. For example, France relies on nuclear power plants as a core pillar of the energy transition strategy, supporting a system that is (historically) more centralized, with only few main energy actors (Vernay et al., 2023), whereas Germany already phased out nuclear power plants, and Switzerland prohibits the construction of new plants. Moreover, all three countries have differing histories regarding energy communities. While Switzerland has a long history of energy communities (Rivas et al., 2018), this is not the case in France (Vernay et al., 2023). Therefore, it is important to not only study one country, but to investigate the effect of initiative membership in different European countries. To the best of our knowledge this is the first study that systematically examines the joint influence of motivational drivers on energy initiative membership *and* energy technology adoption in early adoption stages.

4. Materials and methods

4.1. Procedure

We collected data for this online study in 2023 via two ways. First, we collected data through a market research institute to obtain a sample of homeowners in Germany, France, and Switzerland. We targeted only homeowners because the decision to adopt V2G technology is particularly relevant for this group, and aimed for this sample to be representative in terms of gender and age for the total population in each country. Second, as we were interested in the influence of initiative membership on V2G adoption and expected the share of initiative members to be relatively low in this sample, we additionally targeted energy community members directly via contacting several energy community initiatives in the three countries.

With the market research institute, we targeted 400 homeowners per country, using a randomized sampling strategy and leading to a total of $N = 1352$. Furthermore, we followed purposive sampling in several energy communities ($N = 47$). Complete responses included participants who passed at least one of two attention check items, straight-lining checks, and were not identified as speeders. For our analysis, we excluded eight further IDs due to incomplete answers. The final sample included 979 valid responses ($M_{\text{age}} = 50.54$, $SD_{\text{age}} = 16.50$; 482 male, 494 female, 3 other genders). Due to the fact that we targeted homeowners, the household income within our sample is slightly left-skewed. Moreover, the sample data collected by the market research institute also included a significant share of energy initiative members in all three countries. Together with the sample data based on direct engagement with energy community initiatives this resulted in nearly a quarter (23 %) of our final sample being part of a community energy initiative[2] (M_{age} = 45.43, SD_{age} = 17.08; 147 male, 80 female, 3 other genders). It is likely that this is also an outcome of our sampling strategy to target homeowners only rather than the general population.

The survey was structured into five parts. In the first part, we assessed participants' age, gender, and current home country. Moreover, we asked participants whether they were part of any community energy initiative. Second, we queried the respondents' previous experience with EVs. Unexpectedly, with a total of 433, nearly half of the respondents (44 %) already gained experience with driving an EV or owned an EV. To create a common understanding of V2G, we introduced the concept in a second part. To make sure that people understood the concept, they had to pass a comprehension question. Afterward, participants received eight V2G scenarios sequentially, describing a V2G tariff option (see Fig. 2). The scenarios differed on three attributes with two levels each. Participants rated their interest in each tariff option after it was presented. The attributes were varied so that every combination was rated once. The fourth part of the survey assessed individual and community factors. Lastly, we assessed household characteristics, such as owning electricity-generating technologies. The survey was developed in English and translated into French and German by native speakers. Currencies and income groups were adapted for each country.

4.2. Measures

4.2.1. Predictors

Unless specified otherwise, we used Likert scale-type items to measure our constructs. Values were measured on a scale ranging from −1 (opposed to my values) to 7 (extremely important). All other items were measured on a 7-point Likert scale ranging from strongly disagree to strongly agree. Compound scales were computed based on mean scores across items (Appendix A).

Biospheric values. Biospheric values capture the extent to which the protection of the environment and nature is a guiding principle in a person's life. The scale is based on Schwartz (1992) and Stern et al. (1998). We used a shortened version, including four items (respecting the earth; unity with nature; protecting the environment; preventing pollution) (Steg et al., 2014).

Egoistic values. Egoistic values capture the importance of power, dominance, and influence as a guiding principle in a person's life. The scale is based on Schwartz (1992) and Stern et al. (1998). We used a shortened version, including five items (authority, wealth, social power, influence, and ambitious) (Steg et al., 2014).

Personal norm. Schwartz (1973) defines personal norm as 'the extent to which one feels morally obliged to perform a certain action'. We measured this scale using three items (I feel morally obliged to use smart energy systems; I would feel guilty if I would not use smart energy systems; I would feel proud if I would use smart energy systems) according to van der Werff and Steg (2016).

Community identification. Community identification was measured based on Postmes et al.'s (2013) four-item group identification scale. This scale captures the extent, to which a person identifies with a particular group, in this case the local neighborhood.[3] We adopted the scale to: 'I feel committed to my neighborhood', 'I am glad to be part of my neighborhood', 'being part of my neighborhood is an important part of how I see myself', and 'I identify with my neighborhood'.

Community sustainable energy motivation (CSEM). CSEM measures whether people believe that members from the neighborhood find it important to engage in sustainable energy behavior. This scale was assessed using three items: 'Members of my community find it important to be conscious about their energy behavior', 'Members of my neighborhood find it important to reduce their energy consumption', and 'Members of my neighborhood find it important to use sustainable energy' (Goedkoop et al., 2022).

Initiative membership. This item assesses whether respondents were at the time of responding part of a community energy initiative by asking 'Are you currently a member of an energy community?' (cf., Fielding et al., 2008). We provided a definition of energy community when asking this question. This item was answered with yes/no and is, therefore, a binary variable.

4.2.2. Outcome variable

We measured interest in adopting V2G technology with a ratings-based choice experiment. To this end, we developed a V2G charging tariff scenario with three attributes and two attribute levels ($2^3 = 8$ unique charging tariffs). Participants rated their interest in V2G based on the eight tariffs sequentially on a scale from 1 (not interested at all) to 7 (very interested). For our analysis, we created a compound variable from all ratings based on the mean values.

Based on previous literature (Gschwendtner et al., 2023) the following three attributes and levels were varied between V2G tariff scenarios:

1. Time on the grid: This attribute describes the time that an EV has to be connected to the grid within this charging tariff. Two levels were defined. Level 1: the vehicle has to be connected to the grid for a total of 6 h/day, but the time of connection is freely selectable; level 2: the vehicle has to be connected to the grid for a total of 6 h/day for five days a week and at least for one hour between 11 a.m. to 2 p.m.
2. Minimum range: The minimum state of charge describes the energy in the battery that is always available for unplanned shorter trips and should, therefore, also be understood as a safety reserve. Two levels were defined. Level 1: the minimum range is individually selectable; level 2: the minimum range is 30 % / 100 km.
3. Maximization of renewable energies: This attribute measures the optimization of the feed-in of renewable energy sources into the entire energy system vs. the local grid of the neighborhood.

The scenario included an introductory text describing a V2G contract to the respondents. The full scenario text and a table depicting the attributes and levels of the scenarios can be found in Appendix B. The scenarios were presented in a randomized order. Fig. 2 displays an example of how the scenario was presented.

Furthermore, half of the participants received a scenario that

[2] As of 2016, there were ~ 300 registered energy communities with ~115 members on average in Switzerland (Rivas et al., 2018). In France, the number of energy community initiatives has significantly increased since 2016, with reaching 54,000 members in 2020, assembled under the umbrella association Enercoop (Château Terrisse et al., 2022). Lastly, in 2022–877 registered energy cooperatives with a total of 220.000 members existed in Germany (Energy Cooperatives in Germany: State of the Sector 2023 Report, 2024). This indicates that the share of members compared to non-members in all three countries is rather low. Yet, these numbers have to be read with caution, as nearly no sources reliably indicating the share of energy initiative members compared to the whole population in all three countries. This is due to the fact that the landscape of energy initiatives is very diverse, with different existing definitions and understandings. Moreover, the field of energy initiatives is very dynamic. To this end, based on existing statistics of energy initiatives, we assume the real share of energy initiative members in all three countries to be far lower than in our sample.

[3] Please note, that we used both terms 'neighborhood' and 'community' in our constructs and combined them into 'community factors'. While the construct 'initiative membership' depicts whether a respondent is part of an energy initiative, the other two community constructs (CSEM and community identity) employed the term neighborhood. We chose to use two distinct, but interrelated terms, because we distributed the survey to initiative members and non-members, and therefore had to align the wording so that both parties were able to answer the respective questions.

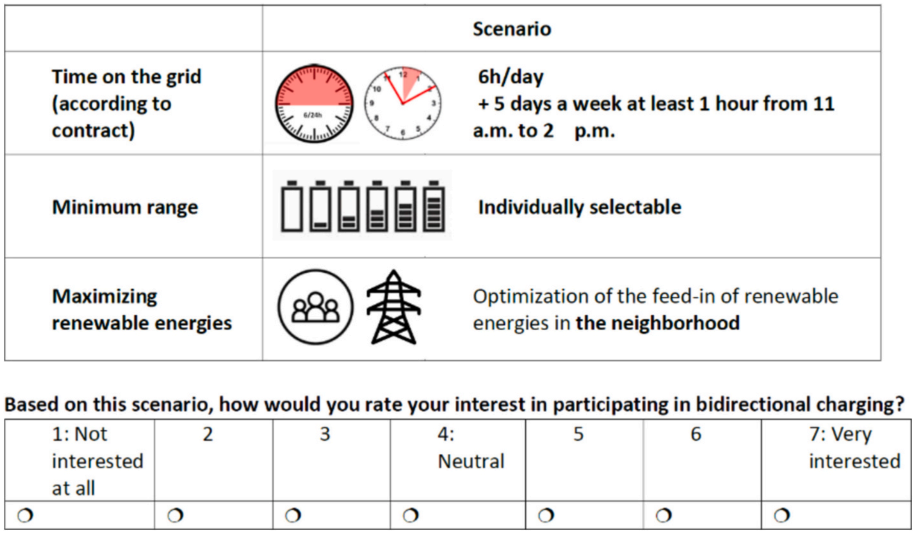

Fig. 2. Example of one of the eight V2G tariff options.

displayed the minimum range in km, while the other half was randomly assigned to a scenario displaying the minimum range in percent. However, as a *t*-test revealed no significant difference between these two approaches ($t(967) = 0.983$, $p = .326$), we do not consider them in the following analysis. We assumed that the ratings of the different variations of the V2G tariff reflected an overall propensity to be interested in adopting V2G and thus formed a mean score out of the eight individual items. An analysis of the effects of the tariff attributes on adoption interest is provided in the supplementary material (Table 5, Supplementary material).

4.3. Data analysis

We used structural equation modeling to test our overall theoretical model and analyze the relationships between personal and community drivers on V2G adoption decisions. This method is well suited for testing our theoretical model and in particular the indirect decision routes, as it allows the modeling of simultaneous regression equations as well as assessing overall model fit. In the main results, we first present the results of a model for all three countries and subsequently a multigroup model used to examine differences in effects between the three countries. Before testing the structural model part, we performed a confirmatory factor analysis (CFA) to test whether our item measures load appropriately on their underlying constructs. Due to the number of parameters included in the model and given our sample size, we limited the analysis to an observed path model using mean scores and tested the measurement model in a separate CFA, which showed a good overall model fit as well as acceptable item loadings for the variables included (see Table 1).[4] As the structural model contained both continuous and binary endogenous variables (i.e., initiative membership), we estimated the model fit and the coefficients using a diagonally weighted least squares (DWLS) estimator in place of the more common maximum likelihood (ML) estimator, which cannot handle endogenous categorical variables. This is because categorical variables are assumed to violate the normality assumption. Indirect effects (corresponding to the decision routes of the theoretical model) were specified as additional parameters and were calculated as the product of two or more coefficients. Age and gender[5] were included as control variables in the model. The model results with control variables can be found in Appendix C and D. To test for the significance of the indirect effects, we used a bootstrapping procedure for standard errors, with 10,000 bootstrap draws in each model. All continuous variables were mean-centered. The multigroup model was tested by adding country as grouping factor to the model. We lastly compared a constrained model in which all regression parameters were set to be equal across countries to an unconstrained model in which all parameters were allowed to vary freely across the three countries.

5. Results

5.1. Descriptive statistics and correlations

Prior to the analysis of the overall path model, we examined the bivariate correlations (based on Pearson's correlation coefficient) between all variables of the proposed model (Table 2). Generally, the direction of the correlations was as expected. Specifically, biospheric values and personal norm were significantly correlated. Interestingly, egoistic values were positively correlated with personal norm. Moreover, CSEM and community identification were correlated to all latent variables of the model. The relationships were especially strong between CSEM and personal norm and community identification and personal norm.

5.2. Dual-pathway model of energy technology adoption: Overall results

We first tested the overall model (Fig. 3) without accounting for country differences. The final path model showed a good model fit, with model fit indices being within acceptable range, $\chi^2 = 12.266$, $p = .015$,

[4] Estimating the multigroup model with an integrated measurement and structural part was not possible due to the high number of parameters that need to be estimated ($N = 300$) in relation to the number of observations in the data ($N = 269$, 352, and 358 for the three countries). For the overall model, the integrated model did converge, but the estimation was unstable and most of the bootstrap draws were invalid. Therefore, and to retain consistency between the different model results, we only present results for the observed path model in the main text. The estimated integrated model containing both the measurement and structural model part for all three countries can be found in the Supplementary Materials. For both the integrated and the observed path model, model fit was good and the parameter estimates produced a very similar pattern of results, increasing confidence in our estimation procedure.

[5] Please note that due to the small number of other genders ($N = 3$), we coded gender as 0 for male and 1 for other genders, including females. Recoding this variable such that other genders were included in the male category (instead of the female category) did not change the results.

Table 1
Confirmatory factor analysis (CFA): Factor loadings.

Scale items	Standardized factor loading
Biospheric values	
Respecting the earth: harmony with other species	0.830
Unity with nature: fitting into nature	0.828
Protecting the environment: preserving nature	0.887
Preventing pollution: protecting natural resources	0.821
Egoistic values	
Social power: control over others, dominance	0.490
Wealth: material possessions, money	0.934
Authority: the right to lead or command	0.819
Influential: having an impact on people and events	0.789
Ambitious: hardworking, aspiring	0.548
Community sustainable energy motivation (CSEM)	
Members of my community find it important to be conscious about their energy behavior.	0.850
Members of my neighborhood find it important to reduce their energy consumption.	0.854
Members of my neighborhood find it important to use sustainable energy.	0.871
Community identification	
I feel committed to my neighborhood.	0.737
I am glad to be part of my neighborhood.	0.828
Being part of my neighborhood is an important part of how I see myself.	0.881
I identify with my neighborhood.	0.823
Personal norm	
I feel morally obliged to use smart energy systems	0.885
I would feel guilty if I would not use smart energy systems	0.852
I would feel proud if I would use smart energy systems	0.829
Scenario	
Based on this scenario, how would you rate your interest in participating in bidirectional charging? Scenario rating 1	0.856
Scenario rating 2	0.864
Scenario rating 3	0.857
Scenario rating 4	0.861
Scenario rating 5	0.881
Scenario rating 6	0.858
Scenario rating 7	0.866
Scenario rating 8	0.867

Note: Model fit indices for the full SEM. $\chi 2 = 20094$, $p < .001$. CFI = 0.928. RMSEA = 0.069. SRMR = 0.046.

CFI = 0.947, RMSEA = 0.046, SRMR = 0.006.

Fig. 3 shows the standardized coefficients for the direct effects in the overall model. A table with path coefficients, standard errors, and exact p-values can be found in Appendix C. Both personal norm (β = 0.255, $p < .001$) and initiative membership (β = 0.188, $p < .001$) were positively related to the main outcome adoption interest. That is, participants with a stronger personal norm and who were part of a community energy initiative were more likely to report higher interest in V2G adoption. Moreover, biospheric values and CSEM significantly predicted adoption interest whereas egoistic values and community identification showed no direct effect on adoption interest. Initiative membership also had a significant effect on personal norm (β = 0.263, $p < .001$), indicating that those who were part of a community energy initiative held a stronger personal norm than those who were not. As expected, biospheric values and CSEM were also related to a stronger personal norm. Somewhat surprisingly, there was also a small positive effect of egoistic values on personal norm (β = 0.110, $p = .001$). In line with our expectations, stronger community identification increased the likelihood of initiative membership (β = 0.169, $p = .004$), but there was no significant effect of CSEM or biospheric values on membership. However, stronger egoistic values increased the likelihood that people were initiative members (β = 0.122, $p = .012$).

5.3. Indirect effects on adoption interest

We first tested indirect effects that would indicate adoption interest via a personal motivation route (H1a-H1b). In support of this, there was an indirect effect of biospheric values via personal norm on adoption interest (β = 0.068, $p < .001$) (Table 3). Contrary to our expectations, egoistic values predicted adoption interest positively via personal norm as well (β = 0.28, $p = .004$). Next, we examined indirect effects indicating a path to adoption interest via community factors. In line with H2b, community identification predicted adoption interest indirectly via an increased likelihood of initiative membership (β = 0.032, $p = .026$). Moreover, we explored a joint personal-community path, which would mean that personal motivations are related to adoption interest via community factors. As there was no direct effect of biospheric values on initiative membership, the indirect effect was also non-significant (β = 0.012, $p = .224$). However, egoistic values were indirectly related to adoption interest via an increased likelihood of initiative membership (β = 0.023, $p = .038$). We also found support for the reverse route, namely a community-personal motivation path. Specifically, initiative membership predicted adoption interest indirectly via personal norm (β = 0.067, $p < .001$). Additionally, there was an indirect effect of CSEM on adoption interest via personal norm (β = 0.061, $p < .001$).

5.4. Dual-pathway model of energy technology adoption: Multigroup results

In a second step we conducted a multigroup analysis to explore country differences in the paths to adoption interest. The final model in which all parameters could freely vary between countries showed a good overall model fit, and model fit indices were within acceptable range, $\chi^2 = 16.648$, $p = .163$, CFI = 0.970, RMSEA = 0.035, SRMR = 0.009. This model had a slightly better model fit than a constrained model in which the regression parameters were fixed to be equal across all countries, $\chi^2 = 55.026$, $p = .170$, CFI = 0.941, RMSEA = 0.025, SRMR = 0.043. Yet, a Chi-square test comparing both models was not significant, suggesting that accounting for differences between countries neither improves nor worsens the explanation of adoption interest. Nevertheless, as we expected to find differences between countries due to different approaches to community energy initiatives and energy transition strategies, we explored the different motivational routes between the three countries.

Fig. 4 shows the standardized coefficients for the direct effects in the multigroup model. A Table with path coefficeints, standard erros and *p*-values can be found in Appendix D. For the personal route, biospheric values significantly predicted adoption interest in France (ß = 0.144, $p = .009$), whereas, in Switzerland, both biospheric and egoistic values played direct predictive roles. Personal norm were consistently influenced by biospheric values and by CSEM across all three countries. Additionally, stronger egoistic values increased personal norm for the Swiss sample (ß = 0.154, $p = .012$), but not in France and Germany. Initiative membership only predicted personal norm in France (ß = 0.378, $p < .001$) and in Switzerland (ß = 0.295, $p < .001$), but not in Germany. On the community route, we found differences in the predictors of initiative membership and the relation between membership and adoption interest. In France, initiative membership was influenced by egoistic values, whereas in Switzerland, it was solely predicted by community identification (ß = 0.193, $p = .022$). Strikingly, no significant predictors for initiative membership were found in Germany. However, only in Germany, initiative membership (ß = 0.274, $p < .002$) significantly predicted adoption interest directly.

5.5. Country differences in indirect effects on adoption interest

As we had no specific hypothesis on country differences, we pursued

Table 2
Descriptive statistics and correlations of the measures used in the model.

Variable	*M*	*SD*	1	2	3	4	5	6	7	8
1. Adoption interest	4.05	1.63								
2. Biospheric values	7.84	1.77	0.20** [0.14, 0.26]							
3. Egoistic vaues	5.04	1.65	0.24** [0.18, 0.30]	−0.02 [−0.08, 0.04]						
4. Personal norm	4.17	1.70	0.45** [0.39, 0.49]	0.35** [0.29, 0.40]	0.25** [0.19, 0.31]					
5. CSEM	4.07	1.38	0.33** [0.27, 0.38]	0.23** [0.17, 0.29]	0.27** [0.22, 0.33]	0.44** [0.39, 0.49]				
6. Community identification	4.25	1.42	0.25** [0.19, 0.31]	0.22** [0.16, 0.28]	0.23** [0.17, 0.28]	0.38** [0.33, 0.43]	0.60** [0.56, 0.64]			
7. Initiative membership[a]	0.23	0.42	0.27** [0.21, 0.33]	0.02 [−0.04, 0.08]	0.19** [0.12, 0.25]	0.25** [0.19, 0.31]	0.17** [0.10, 0.23]	0.15** [0.09, 0.21]		
8. Gender[b]	0.51	0.50	−0.19** [−0.25, −0.13]	0.14** [0.08, 0.20]	−0.15** [−0.21, −0.08]	−0.04 [−0.10, 0.03]	−0.07* [−0.13, −0.01]	−0.09** [−0.15, −0.03]	−0.17** [−0.23, −0.10]	
9. Age	50.58	16.50	−0.23** [−0.28, −0.17]	0.21** [0.15, 0.27]	−0.23** [−0.29, −0.17]	−0.05 [−0.11, 0.01]	−0.06 [−0.12, 0.00]	0.03 [−0.04, 0.09]	−0.17** [−0.23, −0.11]	0.06* [0.00, 0.13]

Note. *M* = mean. *SD* = standard deviation.
**p* < .05; ***p* < .01; ****p* < .001.
[a] Initiative membership coded as 0 = non member, 1 = initiative member.
[b] Gender coded as 0 = male, 1 = other.

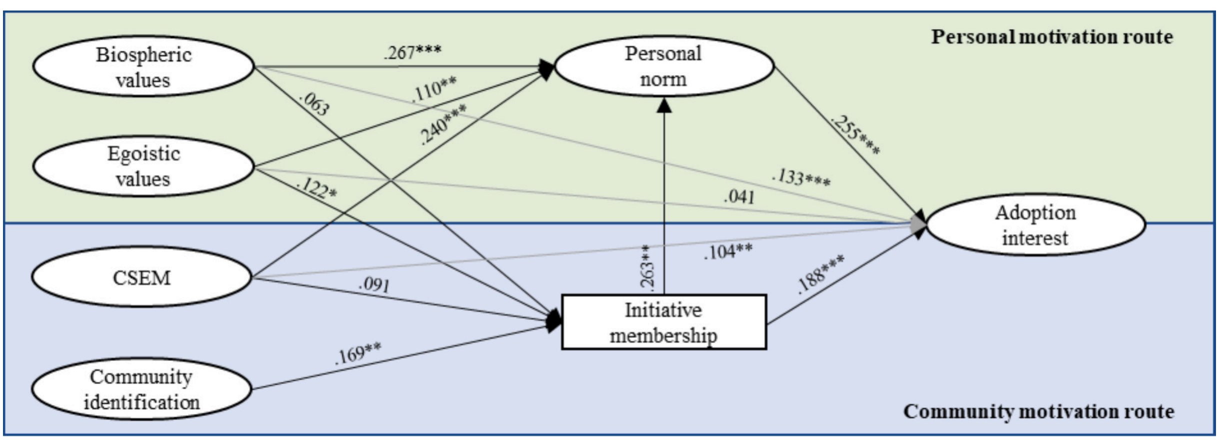

Fig. 3. Dual-pathwaymodel of energy technology adoption showing direct standardized effects; * *p* < .05; ***p* < .01; ****p* < .001. *Note:* Paths that are part of our hypotheses are depicted in black. For better readability, the paths representing direct effects that are not part of the hypotheses are greyed out.

Table 3
Dual-pathway model of energy technology adoption - indirect effects.

Predictor	→ personal norm → adoption interest	→ initiative membership[a] → adoption interest
Biospheric values	0.068***	0.012
Egoistic values	0.028**	0.023*
CSEM	0.061***	0.017
Community identification		0.032*
Initiative membership[a]	0.067***	

**p* < .05; ***p* < .01; ****p* < .001; coefficients are standardized.
[a] Initiative membership coded as 0 = non member, 1 = initiative member.

an explorative analysis of the indirect effects of the multigroup model. Table 4 shows the indirect effects across countries. Results show that personal norm was the only relevant mediator for all three countries. Contrary to our expectations, initiative membership did not play a significant role when examining the countries separately.

Analysis of the personal motivation route showed that only biospheric values significantly predicted adoption interest via personal norm. This indirect effect was consistent in all three countries. Yet, we found no support for a solely community-based route. Instead, results suggested a community-personal route. Specifically, we found that CSEM predicted adoption interest indirectly via increased personal norm, but only for France and Germany. As already expected from the direct effects, initiative membership solely predicted adoption interest indirectly via personal norm for France and Switzerland. The results highlight that values – both, personal and community sustainable energy motivation – influence adoption interest through personal norm for all three countries.

6. Discussion

In this study, we investigate different non-monetary motivational factors that underpin the adoption of new technologies by individuals,

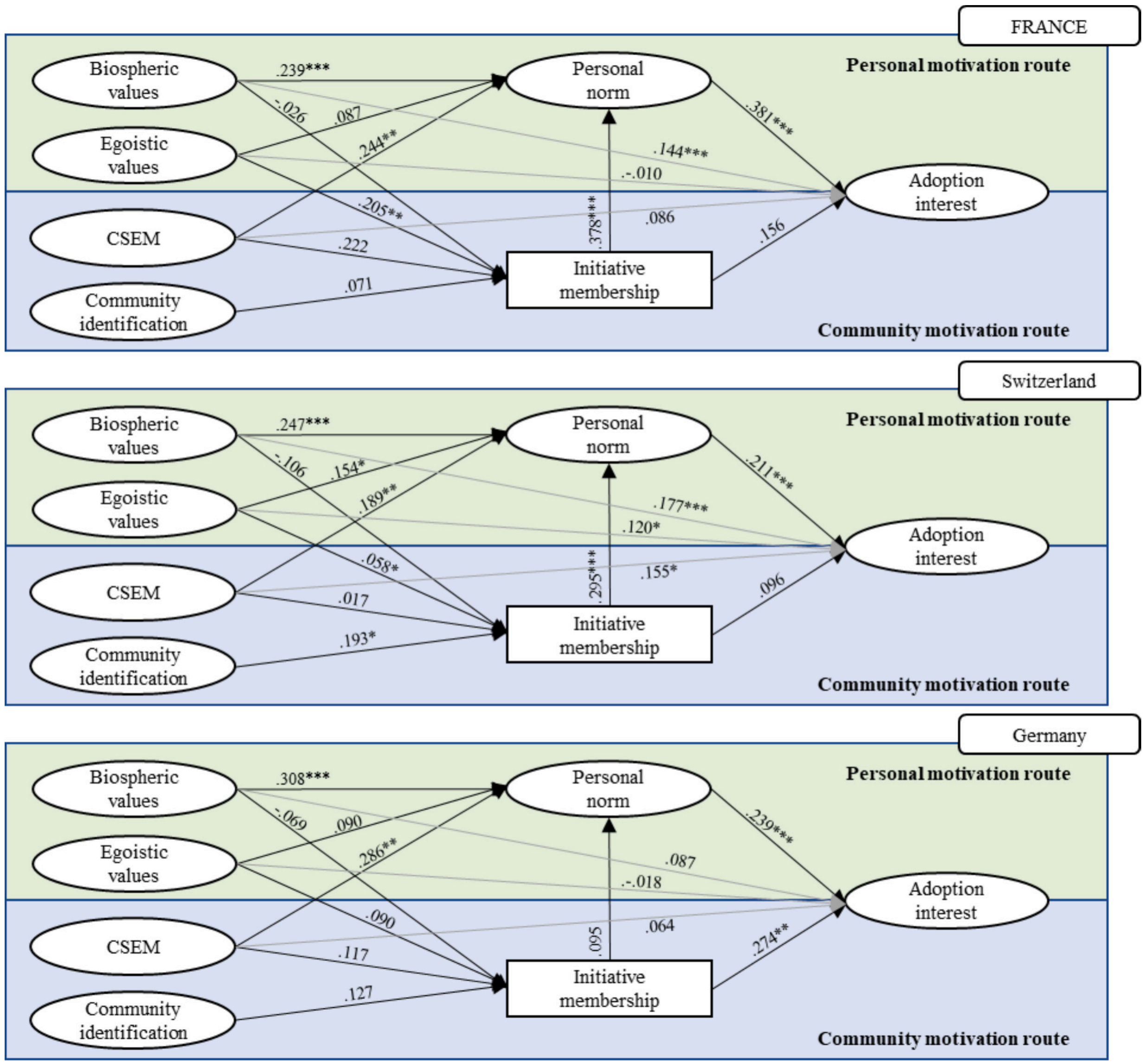

Fig. 4. Dual-pathway model of energy technology adoption showing direct standardized effects; * $p < .05$; ** $p < .01$; *** $p < .001$. Note: As our focus is on indirect effects, some paths representing direct effects are greyed out for better readability. Read paths highlight significant direct effects.

with a special focus on community factors as potential drivers of adoption. By doing so, we transcend mere rationally-based motivations that are often assumed by classic ecological economics (Verburg et al., 2016; Schlüter et al., 2019). Specifically, we focus on the adoption of novel energy technologies, which is a precondition to a successful energy transition. This is important, as the energy transition brings about new technologies, such as EVs that are able to feed electricity back to the grid. Thus, the individual is given a new and active role in this transition and, consequently, needs not only to accept these technologies but also to engage with them. Our objectives were twofold. First, we proposed and empirically tested a new theoretical model that considers the community context as a motivational route to technology adoption, next to the more commonly studied personal (e.g., ecological) motivation route. In particular, we focused on the role of membership in community energy initiatives, which has received relatively little attention next to the role of personal motivations. Second, as the effects of community factors could be heterogeneous between countries, we analyzed a sample from three European countries and tested for differences in effects between them.

6.1. Summary and theoretical implications

Our analysis provides new insights with valuable theoretical implications. Our study is unique in that we aim to understand novel technology adoption interest by interlinking personal factors, such as values, with the community context in which a person resides and acts. We do so by developing a new theoretical model and testing it with an empirical study considering energy initiative members and non-members in three neighboring European countries. We thereby focused on V2G, a technology that could provide benefits on a system, community, and household level. In line with our central predictions, we find that not only personal factors but also community factors can act as drivers of adoption interest in novel energy technologies. First, our results corroborate previous findings by showing that personal motivational factors (e.g., ecological values) can explain different types of sustainable energy behavior, including energy technology acceptance. In line with a large body of literature, we find support for a personal motivation path to adoption interest (Huijts et al., 2012). Specifically, adoption interest is driven by biospheric values via increased personal norm (cf., van der Werff et al., 2013; van der Werff and Steg, 2016). Unexpectedly, we also find a positive effect of egoistic values on personal norm. As theorized by

Table 4
Dual-pathway model of energy technology adoption - indirect effects.

Predictor	→ personal norm → adoption intention	→ initiative membership[a] → adoption intention
France		
Biospheric values	0.091**	−0.004
Egoistic values	0.033	0.032
CSEM	0.093*	0.011
Community identification		0.035
Initiative membership[a]	0.144**	
Switzerland		
Biospheric values	0.052**	0.010
Egoistic values	0.032	0.006
CSEM	0.040	0.002
Community identification		0.019
Initiative membership[a]	0.062*	
Germany		
Biospheric values	0.074**	0.019
Egoistic values	0.021	0.025
CSEM	0.069**	0.032
Community identification		0.035
Initiative membership[a]	0.023	

*$p < .05$; **$p < .01$; ***$p < .001$, coefficients are standardized.
[a] Initiative membership coded as 0 = non member, 1 = initiative member.

Groot and de Groot and Steg (2008) and Steg (2016), one explanation might be that people with strong egoistic values either pursue an environmentally-friendly behavior because this behavior is perceived to increase a person's social status or due to expected benefits or perceived savings. The latter argument in particular applies to the case of V2G. Abundant literature shows that individuals can expect to receive monetary benefits from V2G (Sovacool et al., 2017). However, as EVs are a visible expression of a certain status (Axsen et al., 2018; McBain et al., 2023), V2G might also indirectly enhance a person's status, as this technology adds significant costs on top of the investment of an EV (Heilmann and Friedl, 2021; Lanz et al., 2022).

Notably, we show that community factors are also uniquely related to adoption interest, even when accounting for the role of personal motivational factors. Accounting for the role of personal motivations is important for ruling out the possibility that any effects of initiative membership are merely due to a self-selection of individuals with strong ecological values into these initiatives (cf., Sloot et al., 2018). Specifically, we found support for a community-based route, which is driven by community identification and initiative membership. This finding corroborates and extends previous research that found initiative membership to be positively related to sustainable energy behavior (Middlemiss, 2011; Sloot et al., 2018) but did not specifically study adoption interest in new energy technologies. Unexpectedly, we found no support for a community route by CSEM via initiative membership. This finding is in contrast to previous research on social identity and collective action (Fritsche et al., 2018). It suggests, however, that the degree of identification with one's community is more important in explaining adoption interest via inititiave membership than what a person beliefs other members to find important. In line with this, Goedkoop et al. (2022) suggested that community identification in general might be more important than specific beliefs of other initiative members. Yet, the non-significant relationship between CSEM and initiative membership might also be explained by the strong correlation between CSEM and community identification. Interestingly, while we find no indirect effect of CSEM via intitiative membership on adoption interest, we find CSEM to be a significant direct predictor of both personal norm and adoption interest. Thus, while initiative membership is not motivated by what people from the neighborhood believe to be important, CSEM is important with regard to personal norm and the adoption interest of new technologies. Especially with regard to the latter, the perceived motivations of others in the local community seem to matter and influence a person's interest in V2G technology directly. This is particularly interesting in the early adoption phase when a technology is not yet that known, during which these perceived community motivations seem to have an influence on an individual's interest in this technology (cf., Barth et al., 2016; Klöckner, 2014), and thus might influence, among others, the uptake of new energy technologies. More generally, the role of CSEM as a predictor of adoption interest underscores the role of group motivations. Other research has shown this influence to work via social norms (e.g., Cialdini et al., 1990) or group values (e.g., Bouman et al., 2020). Our findings on CSEM thus extend this literature by showing intrinsic group motivations as an additional social influence mechanism.

Additionally, our results underline the interdependencies between the two distinct routes – the personal motivation route and the community motivation route. In other words, both, personal and community factors jointly play a role for an individual's decision to adopt novel energy technologies. More specifically, our results reveal that adoption interest is indirectly predicted by initiative membership via personal norm. When looking at the direct effects, initiative membership was found to be a strong predictor of personal norm. This suggests that, next to being linked to adoption interest directly, initiative membership might strengthen the members' personal norm, implying that identities such as one's initiative membership can become internalized. Sharpe et al. (2022) found evidence for this phenomenon in the context of corporations, showing that employees' motivation to act pro-environmentally within their working environment is increased when the company is perceived to follow an environmentally responsible strategy. We further find evidence for a reverse, personal motivation-community route, suggesting that adoption interest is increased indirectly by egoistic values via an increased likelihood of being an initiative member. This finding is interesting, as we expected this motivation path to be primarily driven by non-monetary values, and the motivation to collectively foster a just and participatory energy transition (Koirala et al., 2018a; Sloot et al., 2019). Yet, even though joining an energy initiative is seemingly not egoistic, it is important to recognize that the outcomes of such initiatives may directly benefit the individual in monetary terms, e.g., in the sense of lower electricity prices. By pooling resources and collectively investing in renewable energy sources, energy initiatives often achieve cost savings that translate into reduced electricity bills for members. In this light, joining a community energy initiative could become a choice informed by egoistic considerations.

With regard to country differences, our findings are mixed and somewhat ambiguous. As energy systems differ between the European countries in our study and they pursue different energy transition strategies, we expected that an individual's interest to adopt a novel energy technology might be influenced by these variations and thus be linked to different underlying factors in these countries. While we find some differences in the strength of the direct effects, our results show that indirect effects are similar for all three countries. This could suggest that the process by which individuals form an adoption interest in novel energy technologies is more universal than it is distinct across the countries we studied. Indeed, the most consistent result is that all statistically significant motivation routes are indirectly affecting adoption interest via personal norm, which is true for all three countries. In contrast, personal and community factors do not consistently explain adoption interest via initiative membership.

To summarize, in this study, we emphasized that adoption interest of novel energy technologies can be explained either by a personal or a community motivation route, or jointly by both routes, pointing to interdependencies between individual community factors. Importantly, we find evidence that community factors such as initiative membership can become internalized as personal norm. These processes seem to hold across nations.

6.2. Limitations and future research

Our study is, of course, not without shortcomings and opens up new avenues for future research. First and foremost, we primarily targeted homeowners as they are the stakeholders who would most likely be the first ones to adopt V2G. This is due to the fact that homeowners are more independent in their energy-related decisions compared to tenants, especially when they are associated with an investment decision, such as the installation of a wall box. As we did not expect the sample to include many energy initiative members, we addressed energy initiatives in all three countries directly to distribute the survey among their members. In sum, we achieved an unexpectedly high share of energy initiative members and the analysis of the overall model revealed interesting insights. Yet, for the multigroup model, the low number of initiative members per country might be a reason why we couldn't detect more pronounced differences between countries. Moreover, especially the imbalanced and low numbers of initiative members might be one reason why we, for example, could not explain initiative membership in Germany, where, comparably, we had the smallest sample of initiative members. Another reason might be that the adoption processes are universal across the countries we studied. Future research could, therefore, explore country differences in more detail. In our study, we focused on three neighboring, European countries. It would be particularly interesting to study countries that are more diverse in their political ambitions, their culture, and political structures.

Furthermore, we used a very specific, not yet established energy technology as a use case, which confronted us with two major challenges. First of all, we were not able to assess the respondents' behavior, but only their V2G adoption intention. Future research could examine to what extent such intentions translate into actual adoption. Additionally, constructs that refer to actual behavior, such as the willingness to receive further information, could be an interesting avenue for future research to measure acceptance of innovative technologies more directly. Secondly, understanding the technology in focus required some basic understanding of EV technology and the functioning of the energy system in order to anticipate and understand the challenges that come along with higher shares of EVs and the potential benefits that could arise from V2G for the individual. To measure the respondents' intention to adopt V2G, we created a scenario with three attributes, putting much emphasis on providing sufficient and intuitive information to the respondents in order to create a common knowledge base, and to provide a balanced description of the associated advantages and disadvantages. Yet, providing sufficient information to rate the choices adequately, while at the same time influencing the participant as little as possible is a challenging task. As the energy transition holds many other relevant energy technologies it would be interesting to test whether our model is transferrable to other, more widely established energy technologies, such as household or community battery storage technologies. Moreover, it would be interesting to test technologies, that are societally contested, such as heat pumps.

Furthermore, various social contexts exist that directly or indirectly influence a person's decision to adopt innovative technologies and that are noteworthy to investigate. In this study, we focus on energy initiatives as one particular context, uniting individuals who wish to actively participate in the energy transition. We do so by drawing from literature based on social identity, thus, emphasizing that norms and values of the group become internalized and affect decision-making. Future research could consider other contexts that socially influence an individual's decision-making and, furthermore, operationalize it with constructs capturing social influence in terms of perceived social norms or expectations. One example would be subjective norms from the TPB. This would be particularly interesting in a time, where energy technologies are strongly contested and individuals perceive policies to intrude on their private lives and sovereignty in energy-related decision-making (Spence et al., 2015).

6.3. Practical implications and conclusion

Our results emphasize that the adoption interest in novel energy technologies can be explained based on personal and community factors, as well as on their interplay. To summarize, an individual's interest to adopt novel energy technologies, such as V2G, is guided not only by the personal values and norms a person holds, but also by the community context in which a person resides and acts. This points to the opportunity that community energy initiatives can also play a leading role when it comes to creating interest in and acceptance towards novel energy technologies among intitiative members. Adoption of key energy transition technologies is thus not only a question of how environmentally-friendly a person is or how much value the technology is perceived to bring about, but also a question of whether people identify with their initiative and local neighborhood. This underlines the important and unique role energy initiatives hold in the energy transition, suggesting that they can foster sustainable energy transition practices.

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CRediT authorship contribution statement

Nora Baumgartner: Writing – original draft, Visualization, Validation, Software, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Daniel Sloot:** Writing – original draft, Visualization, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Anne Günther:** Writing – review & editing, Validation, Methodology, Investigation, Conceptualization. **Ulf J.J. Hahnel:** Writing – review & editing, Validation, Supervision, Project administration, Methodology, Funding acquisition, Conceptualization.

Declaration of generative AI and AI-assisted technologies in the writing process

During the preparation of this work the authors used Grammarly and ChatGPT in order to avoid grammatical and spelling errors. After using this tool/service, the authors reviewed and edited the content as needed and take full responsibility for the content of the publication.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

Appendix A

Table 1
Descriptive statistics and reliabilities: Mean scores latent variables.

	N	Mean	Std error	Std deviation	Variance
bios latent	981	7.84	0.06	1.77	3.13
ego latent	981	5.05	0.05	1.66	2.74
norm latent	980	4.17	0.05	1.70	2.89
SI latent	979	4.25	0.05	1.42	2.00
CSEM latent	979	4.07	0.04	1.38	1.92

Table 2
Descriptive statistics and reliabilities: Mean scores latent variables per country.

Country		N	Mean	Std error	Std deviation	Variance
Germany	bios latent	358	7.67	0.10	1.85	3.41
	ego latent	358	4.93	0.08	1.60	2.55
	norm latent	358	3.95	0.09	1.79	3.19
	SI latent	358	4.19	0.08	1.45	2.10
	CSEM latent	358	3.92	0.08	1.42	2.02
France	bios latent	271	8.05	0.10	1.66	2.76
	ego latent	271	5.10	0.10	1.70	2.90
	norm latent	270	4.36	0.10	1.65	2.72
	SI latent	269	4.44	0.08	1.34	1.79
	CSEM latent	269	4.24	0.08	1.35	1.81
Switzerland	bios latent	352	7.84	0.09	1.76	3.09
	ego latent	352	5.13	0.09	1.68	2.81
	norm latent	352	4.26	0.09	1.62	2.63
	SI latent	352	4.17	0.08	1.43	2.05
	CSEM latent	352	4.09	0.07	1.36	1.85

Table 3
Descriptive statistics and reliabilities: Mean scores of aggregated variables for initiative membership.

Community membership		N	Mean	Std error	Std deviation	Variance
Members	bios latent	229	7.75	0.12	1.77	3.12
	ego latent	229	4.99	0.10	1.55	2.41
	norm latent	228	4.23	0.11	1.68	2.82
	SI latent	228	4.31	0.09	1.37	1.89
	CSEM latent	228	4.11	0.09	1.32	1.75
Non-members	bios latent	752	7.87	0.06	1.77	3.14
	ego latent	752	5.06	0.06	1.69	2.84
	norm latent	752	4.16	0.06	1.71	2.91
	SI latent	751	4.23	0.05	1.43	2.04
	CSEM latent	751	4.06	0.05	1.40	1.97

Appendix B. Scenario introduction

{constantly shown above every scenario; use CHF for Swiss version}.

Imagine you own a bidirectional electric car with a range of 350 km. To be able to charge your electric car bidirectionally, you sign a contract with a service provider. The contract allows you to charge your electric car bidirectionally at home, at your workplace and at public charging stations. Assume, the charging infrastructure is available. Additionally, you have the possibility to flexibly pause the contract.

As soon as you plug in your electric car, it is initially charged to a minimum range without interruption. The minimum range corresponds to the range that is always available for unplanned shorter trips and should therefore also be understood as a safety reserve. Once the minimum range is reached, the bidirectional charging phase begins. In an app, you can set your planned departure times and the desired destination range at departure. In addition, your system has an opt-out function that allows you to cancel the bidirectional charging mode and charge your vehicle directly. You will receive a monthly compensation of 50€ for providing your battery. Below we present eight different contract conditions. The introductory text remains the same. We ask you to read the contract conditions carefully and then evaluate them. There is no right or wrong answer. Your opinion alone counts.

Table 4
Scenario attributes and levels.

Attributes	Level 1	Level 2
Time on the grid	The vehicle has to be connected to the grid for a total of 6 h/day, but the time of connection is freely selectable	The vehicle has to be connected to the grid for a total of 6 h/day for five days a week and at least for one hour between 11 a.m. to 2 p.m.
Minimum range	The minimum range is individually selectable	The minimum range is 30 % / 100 km
Maximization of renewable energies	Optimization of the feed-in of renewable energy sources into the entire energy system	Optimization of the feed-in of renewable energy sources into the local grid of the neighborhood

Appendix C

Table 5
Path analysis to predict adoption interest in energy technologies - direct effects.

	Dependent variables		
	Membership	Personal norm	Adoption interest
Personal norm			0.255*** [SE = 0.038, p < .001]
Biospheric values	0.063 [SE = 0.030, p = .182]	0.267*** [SE = 0.032, p < .001]	0.133*** [SE = 0.030, p < .001]
Egoistic values	0.122* [SE = 0.032, p = .012]	0.110** [SE = 0.034, p < .001]	0.041 [SE = 0.101, p = .202]
Initiative membership[a]		0.263*** [SE = 0.062, p < .001]	0.188*** [SE = 0.069, p < .001]
CSEM	0.091 [SE = 0.044, p = .096]	0.240*** [SE = 0.045, p < .001]	0.104** [SE = 0.044, p = .006]
Community identification	0.169** [SE = 0.047, p = .004]		
Gender[b]	−0.173*** [SE = 0.095, p < .001]		−0.130*** [SE = 0.101, p < .001]
Age	−0.200*** [SE = 0.003, p < .001]		−0.177*** [SE = 0.003, p < .001]
R^2	0.188	0.309	0.320

CSEM = Community sustainable energy motivation.
*p < .05; **p < .01; ***p < .001; coefficients are standardized.
[a] Initiative membership coded as 0 = non member, 1 = initiative member.
[b] Gender coded as 0 = male, 1 = other.

Appendix D

Table 6
Path analysis of the multigroup model to predict adoption interest in energy technologies – direct effects.

	Dependent variables		
	Membership	Personal norm	Adoption interest
France			
Personal norm			0.381*** [SE = 0.066, p < .001]
Biospheric values	−0.026 [SE = 0.054, p = .732]	0.239*** [SE = 0.064, p < .001]	0.144** [SE = 0.056, p = .009]
Egoistic values	0.205** [SE = 0.055, p = .010]	0.087 [SE = 0.065, p = .201]	−0.010 [SE = 0.058, p = .865]
Initiative membership[a]		0.378*** [SE = 0.125, p < .001]	0.156 [SE = 0.138, p = .106]
CSEM	0.222 [SE = 0.081, p = .062]	0.244** [SE = 0.093, p = .002]	0.086 [SE = 0.083, p = .191]
Community identification	0.071 [SE = 0.080, p = 196]		
Gender[b]	−0.135 [SE = 0.167, p = .056]		−0.086 [SE = 0.006, p = .131]
Age	−0.253*** [SE = 0.005, p < .001]		−0.211*** [SE = 0.064, p < .001]
R^2	0.287	0.377	0.419
Switzerland			

(continued on next page)

Table 6 (*continued*)

	Dependent variables		
	Membership	Personal norm	Adoption interest
Personal norm			0.211*** [SE = 0.061, p = .001]
Biospheric values	0.106 [SE = 0.045, p = .138]	0.247*** [SE = 0.052, p < .001]	0.168*** [SE = 0.045, p = .001]
Egoistic values	0.058 [SE = 0.048, p = .424]	0.154* [SE = 0.057, p = .012]	0.120* [SE = 0.049, p = .025]
Initiative membership[a]		0.295*** [SE = 0.108, p < .001]	0.096 [SE = 0.116, p = .253]
CSEM	0.017 [SE = 0.071, p = .844]	0.189** [SE = 0.084, p = .010]	0.155* [SE = 0.072, p = .015]
Community identification	0.193* [SE = 0.066, p = .022]		
Gender[b]	−0.270*** [SE = 0.147, p < .001]		−0.181*** [SE = 0.156, p < .001]
Age	−0.162* [SE = 0.005, p = .017]		−0.179*** [SE = 0.005, p = .001]
R^2	0.189	0.302	0.336
Germany			
Personal norm			0.239*** [SE = 0.061, p 〈001]
Biospheric values	0.069 [SE = 0.057, p = .483]	0.308*** [SE = 0.054, p < .000]	0.087 [SE = 0.053, p = .160]
Egoistic values	0.090 [SE = 0.063, p = .061]	0.090 [SE = 0.060, p = .105]	−0.018 [SE = 0.053, p = .736]
Initiative membership[a]		0.095 [SE = 0.131, p = .246]	0.274** [SE = 0.132, p = .002]
CSEM	0.117 [SE = 0.086, p = .089]	0.286*** [SE = 0.075, p < .001]	0.064 [SE = 0.086, p = .404]
Community identification	0.127 [SE = 0.084, p = .095]		
Gender[b]	−0.091 [SE = 0.184, p = .284]		−0.147** [SE = 0.170, p = .006]
Age	−0.243** [SE = 0.006, p = .007]		−0.131* [SE = 006, p = .036]
R^2	0.144	268	0.265

CSEM = Community sustainable energy motivation.
*p < .05; **p < .01; ***p < .001; coefficients are standardized.
[a] Initiative membership coded as 0 = non member, 1 = initiative member.
[b] Gender coded as 0 = male, 1 = other.

Appendix E. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ecolecon.2024.108514.

References

Axsen, J., Cairns, J., Dusyk, N., Goldberg, S., 2018. What drives the pioneers? Applying lifestyle theory to early electric vehicle buyers in Canada. Energy Res. Soc. Sci. 44, 17–30. https://doi.org/10.1016/j.erss.2018.04.015.

Azjen, I., 1991. The theory of planned behavior. Organ. Behav. Hum. Decis. Process. 50, 179–211.

Bamberg, S., Rees, J., Seebauer, S., 2015. Collective climate action: determinants of participation intention in community-based pro-environmental initiatives. J. Environ. Psychol. 43, 155–165. https://doi.org/10.1016/j.jenvp.2015.06.006.

Barth, M., Jugert, P., Fritsche, I., 2016. Still underdetected – social norms and collective efficacy predict the acceptance of electric vehicles in Germany. Transport. Res. F: Traffic Psychol. Behav. 37, 64–77. https://doi.org/10.1016/j.trf.2015.11.011.

Bauwens, T., Gotchev, B., Holstenkamp, L., 2016. What drives the development of community energy in Europe? The case of wind power cooperatives. Energy Res. Soc. Sci. 13, 136–147. https://doi.org/10.1016/j.erss.2015.12.016.

Bomberg, E., McEwen, N., 2012. Mobilizing community energy. Energy Policy 51, 435–444. https://doi.org/10.1016/j.enpol.2012.08.045.

Bouman, T., Verschoor, M., Albers, C.J., Böhm, G., Fisher, S.D., Poortinga, W., Whitmarsh, L., Steg, L., 2020. When worry about climate change leads to climate action: how values, worry and personal responsibility relate to various climate actions. Glob. Environ. Chang. 62. https://doi.org/10.1016/j.gloenvcha.2020.102061.

Bradley, G.L., Deshpande, S., Paas, K.H., 2024. The personal and the social: twin contributors to climate action. J. Environ. Psychol. 93, 102194. https://doi.org/10.1016/j.jenvp.2023.102194.

Brandsma, J.S., Blasch, J.E., 2019. One for all? – the impact of different types of energy feedback and goal setting on individuals' motivation to conserve electricity. Energy Policy 135, 110992. https://doi.org/10.1016/j.enpol.2019.110992.

Château Terrisse, P., Karmouni, H.E., Maignan, M., 2022. The construction of a citizen-centered ecosystem for renewable energies in France. In: Energy Communities. Elsevier, pp. 183–193.

Cialdini, R.B., Reno, R.R., Kallgren, C.A., 1990. A focus theory of normative conduct: recycling the concept of norms to reduce littering in public places. J. Pers. Soc. Psychol. 58 (6), 1015–1026. https://doi.org/10.1037/0022-3514.58.6.1015.

Conlisk, J., 1996. Why bounded rationality? J. Econ. Lit. 34 (2).

Conner, M., Armitage, C.J., 1998. Extending the theory of planned behavior: a review and avenues for further research. J. Appl. Soc. Pyschol. 28 (15), 1429–1464. https://doi.org/10.1111/j.1559-1816.1998.tb01685.x.

de Groot, J.I.M., Steg, L., 2008. Value orientations to explain beliefs related to environmental significant behavior. Environ. Behav. 40 (3), 330–354. https://doi.org/10.1177/0013916506297831.

Devine-Wright, P., Howes, Y., 2010. Disruption to place attachment and the protection of restorative environments: a wind energy case study. J. Environ. Psychol. 30 (3), 271–280. https://doi.org/10.1016/j.jenvp.2010.01.008.

Dietz, T., 2015. Environmental Value. Oxford University Press, pp. 329–350. https://doi.org/10.1093/acprof:oso/9780198716600.003.0016, 329-350.

Dreyer, H., Sonnenberg, N., van der Merwe, D., 2022. Transcending linearity in understanding green consumer behaviour: a social–cognitive framework for behaviour changes in an emerging economy context. Sustainability 14 (22), 14855. https://doi.org/10.3390/su142214855.

Energy Cooperatives in Germany: State of the Sector 2023 Report, 10 pp. https://www.dgrv.de/news/energiegenossenschaften-2023/. Accessed 6 July 2024.

Evans, J.S.B.T., 2008. Dual-processing accounts of reasoning, judgment, and social cognition. Annu. Rev. Psychol. 59, 255–278. https://doi.org/10.1146/annurev.psych.59.103006.093629.

Fehr, E., Schmidt, K.M., 1999. A theory of fairness, competition, and cooperation. Q. J. Econ. 114 (3), 817–868.

Fielding, K.S., Hornsey, M.J., 2016. A social identity analysis of climate change and environmental attitudes and behaviors: insights and opportunities. Front. Psychol. 7, 121. https://doi.org/10.3389/fpsyg.2016.00121.

Fielding, K.S., McDonald, R., Louis, W.R., 2008. Theory of planned behaviour, identity and intentions to engage in environmental activism. J. Environ. Psychol. 28 (4), 318–326. https://doi.org/10.1016/j.jenvp.2008.03.003.

Franke, T., Krems, J.F., 2013. Understanding charging behaviour of electric vehicle users. Transport. Res. F: Traffic Psychol. Behav. 21, 75–89. https://doi.org/10.1016/j.trf.2013.09.002.

Franke, T., Schmalfuß, F., Rauh, N., 2018. Human factors and ergonomics in the individual adoption and use of electric vehicles. In: Thatcher, A., Yeow, P.H. (Eds.), Ergonomics and Human Factors for a Sustainable Future. Springer Singapore, Singapore, pp. 135–160.

Fritsche, I., Barth, M., Jugert, P., Masson, T., Reese, G., 2018. A social identity model of pro-environmental action (SIMPEA). Psychol. Rev. 125 (2), 245–269. https://doi.org/10.1037/rev0000090.

Gigerenzer, G., Gaissmaier, W., 2011. Heuristic decision making. Annu. Rev. Psychol. 62, 451–482. https://doi.org/10.1146/annurev-psych-120709-145346.

Goedkoop, F., Sloot, D., Jans, L., Dijkstra, J., Flache, A., Steg, L., 2022. The role of Community in Understanding Involvement in community energy initiatives. Front. Psychol. 12, 775752. https://doi.org/10.3389/fpsyg.2021.775752.

Gschwendtner, C., Knoeri, C., Stephan, A., 2023. The impact of plug-in behavior on the spatial–temporal flexibility of electric vehicle charging load. Sustain. Cities Soc. 88, 104263. https://doi.org/10.1016/j.scs.2022.104263.

Hahnel, U.J., Fell, M.J., 2022. Pricing decisions in peer-to-peer and prosumer-centred electricity markets: experimental analysis in Germany and the United Kingdom. Renew. Sust. Energ. Rev. 162, 112419. https://doi.org/10.1016/j.rser.2022.112419.

Hahnel, U.J., Herberz, M., Pena-Bello, A., Parra, D., Brosch, T., 2020. Becoming prosumer: revealing trading preferences and decision-making strategies in peer-to-peer energy communities. Energy Policy 137. https://doi.org/10.1016/j.enpol.2019.111098.

Hamann, K.R., Bertel, M.P., Ryszawska, B., Lurger, B., Szymański, P., Rozwadowska, M., Goedkoop, F., Jans, L., Perlaviciute, G., Masson, T., Fritsche, I., Favaro, T., Hofer, A., Eisenberger, I., Gutschi, C., Grosche, C., Held, J., Athenstaedt, U., Corcoran, K., 2023. An interdisciplinary understanding of energy citizenship: integrating psychological, legal, and economic perspectives on a citizen-centred sustainable energy transition. Energy Res. Soc. Sci. 97, 102959. https://doi.org/10.1016/j.erss.2023.102959.

Hargreaves, T., Hielscher, S., Seyfang, G., Smith, A., 2013. Grassroots innovations in community energy: the role of intermediaries in niche development. Glob. Environ. Chang. 23 (5), 868–880. https://doi.org/10.1016/j.gloenvcha.2013.02.008.

Haustein, S., Jensen, A.F., Cherchi, E., 2021. Battery electric vehicle adoption in Denmark and Sweden: recent changes, related factors and policy implications. Energy Policy 149. https://doi.org/10.1016/j.enpol.2020.112096.

Heilmann, C., Friedl, G., 2021. Factors influencing the economic success of grid-to-vehicle and vehicle-to-grid applications—a review and meta-analysis. Renew. Sust. Energ. Rev. 145, 111115. https://doi.org/10.1016/j.rser.2021.111115.

Hilbe, C., Chatterjee, K., Nowak, M.A., 2018. Partners and rivals in direct reciprocity. Nat. Hum. Behav. 2 (7), 469–477. https://doi.org/10.1038/s41562-018-0320-9.

Hoffman, S.M., High-Pippert, A., 2010. From private lives to collective action: recruitment and participation incentives for a community energy program. Energy Policy 38 (12), 7567–7574. https://doi.org/10.1016/j.enpol.2009.06.054.

Hossain, M., 2016. Grassroots innovation: a systematic review of two decades of research. J. Clean. Prod. 137, 973–981. https://doi.org/10.1016/j.jclepro.2016.07.140.

Huber, J., Schaule, E., Jung, D., Weinhardt, C., 2019. Quo Vadis smart charging? A literature review and expert survey on technical potentials and user acceptance of smart charging systems. WEVJ 10 (4). https://doi.org/10.3390/wevj10040085.

Huijts, N., Molin, E., Steg, L., 2012. Psychological factors influencing sustainable energy technology acceptance: a review-based comprehensive framework. Renew. Sust. Energ. Rev. 16 (1), 525–531. https://doi.org/10.1016/j.rser.2011.08.018.

Jackson, T., 2005. Motivating Sustainable Consumption: a review of evidence on consumer behaviour and behavioural change. a report to the sustainable development research network. Sustain. Dev. Res. Netw. 29.

Jansson, J., Marell, A., Nordlund, A., 2011. Exploring consumer adoption of a high involvement eco-innovation using value-belief-norm theory. J. Consum. Behav. 10 (1), 51–60. https://doi.org/10.1002/cb.346.

Kahneman, D., 2003. Maps of bounded rationality: psychology for behavioral economics. Am. Econ. Rev. 93 (5), 1449–1475.

Kalkbrenner, B.J., Roosen, J., 2016. Citizens' willingness to participate in local renewable energy projects: the role of community and trust in Germany. Energy Res. Soc. Sci. 13, 60–70. https://doi.org/10.1016/j.erss.2015.12.006.

Kempton, W., Tomić, J., 2005. Vehicle-to-grid power fundamentals: calculating capacity and net revenue. J. Power Sources 144 (1), 268–279. https://doi.org/10.1016/j.jpowsour.2004.12.025.

Klöckner, C.A., 2014. The dynamics of purchasing an electric vehicle – a prospective longitudinal study of the decision-making process. Transport. Res. F: Traffic Psychol. Behav. 24, 103–116. https://doi.org/10.1016/j.trf.2014.04.015.

Knezovic, K., Martinenas, S., Andersen, P.B., Zecchino, A., Marinelli, M., 2017. Enhancing the role of electric vehicles in the power grid: field validation of multiple ancillary services. IEEE Trans. Transp. Electrific. 3 (1), 201–209. https://doi.org/10.1109/TTE.2016.2616864.

Koirala, B.P., Araghi, Y., Kroesen, M., Ghorbani, A., Hakvoort, R.A., Herder, P.M., 2018a. Trust, awareness, and independence: insights from a socio-psychological factor analysis of citizen knowledge and participation in community energy systems. Energy Res. Soc. Sci. 38, 33–40. https://doi.org/10.1016/j.erss.2018.01.009.

Koirala, B.P., van Oost, E., van der Windt, H., 2018b. Community energy storage: a responsible innovation towards a sustainable energy system? Appl. Energy 231, 570–585. https://doi.org/10.1016/j.apenergy.2018.09.163.

Krueger, H., Cruden, A., 2020. Integration of electric vehicle user charging preferences into vehicle-to-grid aggregator controls. Energy Rep. 6, 86–95. https://doi.org/10.1016/j.egyr.2020.02.031.

Lanz, L., Noll, B., Schmidt, T.S., Steffen, B., 2022. Comparing the levelized cost of electric vehicle charging options in Europe. Nat. Commun. 13 (1), 5277. https://doi.org/10.1038/s41467-022-32835-7.

Lee, S.S., Kim, Y., Roh, T., 2023. Pro-environmental behavior on electric vehicle use intention: integrating value-belief-norm theory and theory of planned behavior. J. Clean. Prod. 418, 138211. https://doi.org/10.1016/j.jclepro.2023.138211.

López-Mosquera, N., Sánchez, M., 2012. Theory of planned behavior and the value-belief-norm theory explaining willingness to pay for a suburban park. J. Environ. Manag. 113, 251–262. https://doi.org/10.1016/j.jenvman.2012.08.029.

Lüth, A., Zepter, J.M., Del Crespo Granado, P., Egging, R., 2018. Local electricity market designs for peer-to-peer trading: the role of battery flexibility. Appl. Energy 229, 1233–1243. https://doi.org/10.1016/j.apenergy.2018.08.004.

McBain, S.M., Axsen, J., Wilson, C., 2023. Function, symbolism or society? Exploring consumer interest in electric and shared mobility. Transp. Res. Part D: Transp. Environ. 118, 103675. https://doi.org/10.1016/j.trd.2023.103675.

Middlemiss, L., 2011. The effects of community-based action for sustainability on participants' lifestyles. Local Environ. 16 (3), 265–280. https://doi.org/10.1080/13549839.2011.566850.

Namazkhan, M., Albers, C., Steg, L., 2019. The role of environmental values, socio-demographics and building characteristics in setting room temperatures in winter. Energy 171, 1183–1192. https://doi.org/10.1016/j.energy.2019.01.113.

Nielsen, K.S., Cologna, V., Bauer, J.M., Berger, S., Brick, C., Dietz, T., Hahnel, U.J.J., Henn, L., Lange, F., Stern, P.C., Wolske, K.S., 2024. Realizing the full potential of behavioural science for climate change mitigation. Nat. Clim. Chang. 14 (4), 322–330. https://doi.org/10.1038/s41558-024-01951-1.

Nilsson, A., Lazarevic, D., Brandt, N., Kordas, O., 2018. Household responsiveness to residential demand response strategies: results and policy implications from a Swedish field study. Energy Policy 122, 273–286. https://doi.org/10.1016/j.enpol.2018.07.044.

Nowak, M.A., 2006. Five rules for the evolution of cooperation. Science (New York, N.Y.) 314 (5805), 1560–1563. https://doi.org/10.1126/science.1133755.

Oteman, M., Wiering, M., Helderman, J.-K., 2014. The institutional space of community initiatives for renewable energy: a comparative case study of the Netherlands, Germany and Denmark. Energy Sustain. Soc. 4 (1). https://doi.org/10.1186/2192-0567-4-11.

Parra, D., Swierczynski, M., Stroe, D.I., Norman, S., Abdon, A., Worlitschek, J., O'Doherty, T., Rodrigues, L., Gillott, M., Zhang, X., Bauer, C., Patel, M.K., 2017. An interdisciplinary review of energy storage for communities: challenges and perspectives. Renew. Sust. Energ. Rev. 79, 730–749. https://doi.org/10.1016/j.rser.2017.05.003.

Postmes, T., Haslam, S.A., Jans, L., 2013. A single-item measure of social identification: reliability, validity, and utility. Br. J. Soc. Psychol. 52 (4), 597–617. https://doi.org/10.1111/bjso.12006.

Proka, A., Hisschemöller, M., Loorbach, D., 2020. When top-down meets bottom-up: is there a collaborative business model for local energy storage? Energy Res. Soc. Sci. 69. https://doi.org/10.1016/j.erss.2020.101606.

Ptak, T., Nagel, A., Radil, S.M., Phayre, D., 2018. Rethinking community: analyzing the landscape of community solar through the community-place nexus. Electr. J. 31 (10), 46–51. https://doi.org/10.1016/j.tej.2018.11.006.

Rees, J.H., Bamberg, S., 2014. Climate protection needs societal change: determinants of intention to participate in collective climate action. Euro J. Soc. Psych. 44 (5), 466–473. https://doi.org/10.1002/ejsp.2032.

Reis, I.F., Gonçalves, I., Lopes, M.A., Henggeler Antunes, C., 2021. Business models for energy communities: a review of key issues and trends. Renew. Sust. Energ. Rev. 144. https://doi.org/10.1016/j.rser.2021.111013.

Rivas, J., Schmid, B., Seidl, I., 2018. Energiegenossenschaften in der Schweiz: Ergebnisse einer Befragung. WSL Berichte 71, Birmensdorf, p. 108. www.wsl.ch/berichte. Accessed 16 February 2023.

Schlüter, M., Müller, B., Frank, K., 2019. The potential of models and modeling for social-ecological systems research: the reference frame ModSES. E&S 24 (1). https://doi.org/10.5751/ES-10716-240131.

Schram, W.L., Aghaie, H., Lampropoulos, I., van Sark, W.G., 2021. Insights on the capacity value of photovoltaics, community batteries and electric vehicles. Sustain. Energy Grids Netw. 26, 100421. https://doi.org/10.1016/j.segan.2020.100421.

Schwanitz, V.J., Wierling, A., Arghandeh Paudler, H., von Beck, C., Dufner, S., Koren, I. K., Kraudzun, T., Marcroft, T., Mueller, L., Zeiss, J.P., 2023. Statistical evidence for the contribution of citizen-led initiatives and projects to the energy transition in Europe. Sci. Rep. 13 (1). https://doi.org/10.1038/s41598-023-28504-4.

Schwartz, S.H., 1973. Normative explanations of helping behavior: a critique, proposal, and empirical test. J. Exp. Soc. Psychol. 9 (4), 349–364. https://doi.org/10.1016/0022-1031(73)90071-1.

Schwartz, S.H., 1992. Universals in the content and structure of values: Theoretical advances and empirical tests in 20 countries. In: Zanna, M.P. (Ed.), Advances in Experimental Social Psychology, vol. 25. Academic Press, I. N.C, pp. 1–65.

Seyfang, G., Smith, A., 2007. Grassroots innovations for sustainable development: towards a new research and policy agenda. Environmental Politics 16 (4), 584–603. https://doi.org/10.1080/09644010701419121.
Sharpe, E., Ruepert, A., van der Werff, E., Steg, L., 2022. Corporate environmental responsibility leads to more pro-environmental behavior at work by strengthening intrinsic pro-environmental motivation. One Earth 5 (7), 825–835. https://doi.org/10.1016/j.oneear.2022.06.006.
Simon, H.A., 1955. A behavioral model of rational choice. Q. J. Econ. 69, 99–118.
Simon, H.A., 1982. Models of Bounded Rationality. MIT Press.
Sintov, N.D., Schultz, P.W., 2015. Unlocking the potential of smart grid technologies with behavioral science. Front. Psychol. 6, 410. https://doi.org/10.3389/fpsyg.2015.00410.
Sloot, D., Jans, L., Steg, L., 2018. Can community energy initiatives motivate sustainable energy behaviours? The role of initiative involvement and personal pro-environmental motivation. J. Environ. Psychol. 57, 99–106. https://doi.org/10.1016/j.jenvp.2018.06.007.
Sloot, D., Jans, L., Steg, L., 2019. In it for the money, the environment, or the community? Motives for being involved in community energy initiatives. Glob. Environ. Chang. 57, 2–10. https://doi.org/10.1016/j.gloenvcha.2019.101936.
Sloot, D., Lehmann, N., Ardone, A., 2022. Explaining and promoting participation in demand response programs: the role of rational and moral motivations among German energy consumers. Energy Res. Soc. Sci. 84, 1–15. https://doi.org/10.1016/j.erss.2021.102431.
Sovacool, B.K., Hirsh, R.F., 2009. Beyond batteries: an examination of the benefits and barriers to plug-in hybrid electric vehicles (PHEVs) and a vehicle-to-grid (V2G) transition. Energy Policy 37 (3), 1095–1103. https://doi.org/10.1016/j.enpol.2008.10.005.
Sovacool, B.K., Axsen, J., Kempton, W., 2017. The future promise of vehicle-to-grid (V2G) integration: a sociotechnical review and research agenda. Annu. Rev. Environ. Resour. 42 (1), 377–406. https://doi.org/10.1146/annurev-environ-030117-020220.
Spence, A., Demski, C., Butler, C., Parkhill, K., Pidgeon, N., 2015. Public perceptions of demand-side management and a smarter energy future. Nat. Clim. Chang. 5 (6), 550–554. https://doi.org/10.1038/nclimate2610.
de Groot, J.I.M., 2012. In: Steg, L. (Ed.), Environmental Values. Oxford University Press.
Steg, L., 2016. Values, norms, and intrinsic motivation to act Proenvironmentally. Annu. Rev. Environ. Resour. 41 (1), 277–292. https://doi.org/10.1146/annurev-environ-110615-085947.
Steg, L., Dreijerink, L., Abrahamse, W., 2005. Factors influencing the acceptability of energy policies: a test of VBN theory. J. Environ. Psychol. 25 (4), 415–425. https://doi.org/10.1016/j.jenvp.2005.08.003.
Steg, L., Perlaviciute, G., van der Werff, E., Lurvink, J., 2014. The significance of hedonic values for environmentally relevant attitudes, preferences, and actions. Environ. Behav. 46 (2), 163–192. https://doi.org/10.1177/0013916512454730.
Steg, L., Perlaviciute, G., van der Werff, E., 2015. Understanding the human dimensions of a sustainable energy transition. Front. Psychol. 6, 17, 805.
Steg, L., Shwom, R., Dietz, T., 2018. What drives energy consumers?: engaging people in a sustainable energy transition. IEEE Power Energy Mag. 16 (1), 20–28. https://doi.org/10.1109/MPE.2017.2762379.
Stern, P.C., Dietz, T., Guagnano, G.A., 1998. A brief inventory of values. Educ. Psychol. Meas. 58, 984–1001.
Stern, P.C., Dietz, T., Abel, T., Guagnano, G.A., Kalof, L., 1999. A value-belief-norm theory of support for social movements: the case of environmentalism. Hum. Ecol. Rev. 6, 81–97.
van der Werff, E., Steg, L., 2016. The psychology of participation and interest in smart energy systems: comparing the value-belief-norm theory and the value-identity-personal norm model. Energy Res. Soc. Sci. 22, 107–114. https://doi.org/10.1016/j.erss.2016.08.022.
van der Werff, E., Steg, L., Keizer, K., 2013. It is a moral issue: the relationship between environmental self-identity, obligation-based intrinsic motivation and pro-environmental behaviour. Glob. Environ. Chang. 23 (5), 1258–1265. https://doi.org/10.1016/j.gloenvcha.2013.07.018.
van Heuveln, K., Ghotge, R., Annema, J.A., van Bergen, E., van Wee, B., Pesch, U., 2021. Factors influencing consumer acceptance of vehicle-to-grid by electric vehicle drivers in the Netherlands. Travel Behav. Soc. 24, 34–45. https://doi.org/10.1016/j.tbs.2020.12.008.
Verburg, P.H., Dearing, J.A., Dyke, J.G., van der Leeuw, S., Seitzinger, S., Steffen, W., Syvitski, J., 2016. Methods and approaches to modelling the Anthropocene. Glob. Environ. Chang. 39, 328–340. https://doi.org/10.1016/j.gloenvcha.2015.08.007.
Vernay, A.-L., Sebi, C., Arroyo, F., 2023. Energy community business models and their impact on the energy transition: lessons learnt from France. Energy Policy 175, 113473. https://doi.org/10.1016/j.enpol.2023.113473.
Walker, C., Poelzer, G., Leonhardt, R., Noble, B., Hoicka, C., 2022. COPs and 'robbers?' Better understanding community energy and toward a communities of place then interest approach. Energy Res. Soc. Sci. 92. https://doi.org/10.1016/j.erss.2022.102797.
Wierling, A., Schwanitz, V.J., Zeiss, J.P., von Beck, C., Paudler, H.A., Koren, I.K., Kraudzun, T., Marcroft, T., Müller, L., Andreadakis, Z., Candelise, C., Dufner, S., Getabecha, M., Glaase, G., Hubert, W., Lupi, V., Majidi, S., Mohammadi, S., Nosar, N. S., Du Pont, Y.R., Roots, P., Rudek, T.J., Sciullo, A., Sehdev, G., Ziaabadi, M., Zoubin, N., 2023. A Europe-wide inventory of citizen-led energy action with data from 29 countries and over 10000 initiatives. Scientific data 10 (1), 9. https://doi.org/10.1038/s41597-022-01902-5.