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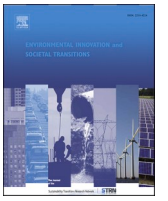

A socio-economic examination of participation in socially innovative energy projects

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ABSTRACT

This paper aims to examine the role of citizen investment in scaling up renewable generation through participating or investing in social innovation in energy. It presents an explorative study demonstrating results of large-scale surveys of the general public across twelve countries (11 European plus the USA), representing the views of over 10,000 individuals. These surveys focus on three types of innovative energy business models, namely: energy cooperatives, crowdfunding and peer-to-peer platforms. In particular, we study the socioeconomic, demographic and attitudinal attributes of self-reported early participants in similar energy organizations, and also separately among those who express an unwillingness to participate in the above business models. The findings suggest that factors such as age, education, gender, risk preferences, previous general investment experience and trust in the carbon saving claims of organizations are important in explaining both self-reported previous and future participation in energy initiatives.

1. Introduction

Without drastic cuts to greenhouse gas emissions, global warming will adversely affect ecosystems, food security and human health (IPCC, 2018). The EU is seen as a leader in the mitigation of global warming, and policies and legislation have been put in place to contribute to increased renewable energy generation and energy efficiency. Many EU countries have achieved a goal of 20% renewable energy in final energy consumption, with some countries such as Sweden leading with over 70% renewable share. While the EU has achieved its 2020 20% renewable target, it is clear that considerably more investment will be required in the coming decades. In this regard, the EU's 2030 target (32%) is currently being considered for amendment (42.5%), which would imply a doubling of the renewable share in less than a decade. Such a change represents an unprecedented shift in technology and investment.

Social Innovation in Energy (SIE) promotes people-centered changes in the way we organize and think about energy (COMETS, NEWCOMERS, SocialRES and SONNET, 2022). SIE in the form of energy cooperatives, crowdfunding and peer-to-peer (P2P) energy trading platforms can contribute significantly towards reaching renewable energy targets, and these models have seen increased popularity throughout Europe in recent years. Energy cooperatives and crowdfunding platforms allow citizens to co-own or co-fund local renewable projects and obtain financial returns. Whilst only members of cooperatives are entitled to decision rights regarding, for example, profit reinvestment and reallocation, both business models seek to attract investment by using more participatory approaches. In addition, an increasing number of EU citizens are opting to generate their own electricity at the household level and to sell

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excess energy to smart grids or their neighbours. P2P energy trading platforms facilitate direct trade between small-scale micro-generators (such as household PV) and other consumers within the same distributed renewable networks.[1] Compared with traditional energy providers, these SIE niches not only reduce distribution, transmission and communication costs by adopting innovative organizational approaches and information and communication technology (Walker et al., 2010; Sagebiel et al., 2014; Wu et al., 2019), but also transform citizens from passive recipients of energy to proactive renewable advocators, and also enablers and facilitators of the renewable energy transition.

This paper explores the role of citizen investment in scaling up renewable generation through participating or investing in SIE by using large-scale surveys of the general public in twelve countries. We seek to answer two distinct research questions. Firstly, we attempt to identify differences between self-reported early adopters/participants in energy initiatives and the rest of the general public. We distinguish between individuals who indicate that they have previously participated in an energy organization (such as an energy cooperative, crowdfunder or P2P platform) from those that have not by exploring socioeconomic, demographic and attitude differences. Secondly, we focus specifically on individuals who express an unwillingness to participate in any of the above business models using data drawn from Discrete Choice Experiments (DCE) which aim to elicit preferences for participation in energy cooperatives, crowdfunding and P2P platforms. Specific business model attributes in relation to cooperatives and crowdfunding platforms (such as type of energy and CO_2 reduction) are studied in more detail in Wu et al. (2022). However, in this paper we aim to pool the data from all countries and business models studied (cooperative, crowdfunder and P2P platforms) and leverage additional questions collected in the survey in order to identify common patterns in the general public's willingness to participate in SIE across multiple country and business model contexts. Specifically, we study individuals who opt-out of participating in multiple DCEs both from a quantitative standpoint by exploring correlations with other sociodemographic/attitudinal characteristics, and also by analyzing qualitative self-reported reasons for non-participation. Several common themes emerge from both analyses. Factors such as age, education, trust in carbon saving claims, and previous general investment experience are important in explaining both previous and future participation in energy organizations. Thus, this paper will present insights which attempt to capture some of the nuances of agent involvement in SIE. It will also provide key insights for policy makers to ensure that an increase in SIE participation does not contribute to further social inequalities.

The remainder of this paper is organized as follows. In the next section we provide some background to the business models studied and an overview of the relevant related literature. In section three we describe the survey used to collect the data employed in our analyses. In section four we provide some descriptive statistics of the variables collected and present our results in two parts – firstly focusing on previous self-reported participation in similar energy initiatives and secondly on individuals who express an unwillingness to participate in such entities. Finally, sections five and six provide a brief discussion and conclusion which aim to synthesize the preceding findings.

2. Background

Energy cooperatives and crowdfunding are becoming more common in Western and Northern Europe, particularly in countries such as Germany, UK and Sweden, yet are much less prevalent in Southern and Eastern Europe due to different levels of domestic regulatory support and environmental awareness (Candelise, 2016; De Broeck, 2018; Capellán-Pérez et al., 2018; Caramizaru and Uihlein, 2020). Western Europe is leading in the development and diversity of energy initiatives due to an established regulatory framework encouraging different forms of citizen investment in the energy sector. In Germany, there are 1,750 energy communities existing in different legal forms (Caramizaru and Uihlein, 2020). Small energy initiatives are emerging in France, Italy and Spain. For example, following the legislation of the Transition Law for Green Growth in 2015, the French government introduced an incentive mechanism called participatory bonuses to promote local renewable projects (Sebi and Vernay, 2020). However, renewable development in these countries may be more effectively supported by regional/municipal governments rather than the central government (Hewitt et al., 2019). In Eastern Europe, the development of citizen-led energy initiatives faces significant challenges, as large energy providers or municipality-led projects rather than citizen-owned small initiatives are dominant (Bauwens et al., 2016). There are only eight existing energy cooperatives in Croatia and one registered energy cooperative in Poland (Hewitt et al., 2019; Capellán-Pérez et al., 2020). The absence of relevant legislation and citizens' distrust towards social organizations play a role in the low popularity of energy cooperatives and crowdfunding (Capellán-Pérez et al., 2020).

In addition to cooperatives and crowdfunding platforms, P2P energy trading platforms are a novel SIE model which can allow citizens to engage with the energy system and contribute to low carbon electricity production/consumption. P2P trading platforms are embedded in smart grids and typically rely on information and communication technology. Small prosumers generate their own electricity through, for example, rooftop solar panels or wind turbines and are incentivized to sell excess energy to consumers on the same network who seek cheaper green electricity (compared with the central grid). P2P energy trading is still in its infancy when compared with other SIE initiatives in the energy sector – only seven existing European projects are recorded in the literature (Zhang et al., 2017). Although its feasibility is still largely unknown and regulatory support is absent in most European countries, several existing P2P projects, such as *Piclo* in the UK and *Sonnencommunity* in Germany, provide novel paradigms for the practicality of this

[1] Other prosumer-based models include prosumers selling excess energy to independent microgrids or microgrids connected to the central grids (Espe et al., 2018).

innovative tool.[2]

The literature on energy initiatives (including cooperatives and crowdfunders), most of which is qualitative in nature, has focused on the development of these energy organizations, supportive policies from central/local governments, and barriers for further development in one or multiple Western European countries where energy communities are relatively developed, such as in the UK and Germany (Rogers et al., 2008; Hielscher, 2011, Tarhan, 2015; Yildiz et al., 2015; de Broeck, 2018; Brummer, 2018; Klagge and Meister, 2018), with only a few papers investigating the potential of scaling up innovative energy niches in Spain, Poland and Croatia where these initiatives are less developed (Capellán-Pérez et al., 2018; Hewitt et al., 2019; Capellán-Pérez et al., 2020).

Several quantitative studies have explored consumers' and investors' motivations to engage with energy initiatives using surveys (Walker et al., 2010; Bergmann et al., 2016; Kalkbrenner and Roosen, 2016; Koirala et al., 2018; Bourcet and Bovari, 2020; Bögel et al., 2021).[3] According to Rommel et al. (2018), a typical profile of investors in Germany is a well-educated male whose salary is above the average with both financial (investment returns) and non-financial (e.g., carbon emission reduction) motivations. Using a survey of French citizens, Bourcet and Bovari (2020) conducted a profile comparison between the general public and current crowdfunding investors in France and found significant differences in attitudes towards renewable energy, perceived risk in crowdfunding investment, and the perception of the platform's transparency on investment offers. Results from their regression analysis suggest that citizens' intention to invest in crowdfunded renewable energy is positively associated with their general perception of renewables, legal transparency of the invested projects, and the perception of risk related to the energy projects. Some studies find that levels of social trust and social norms, and institutional trust are important determinants of individuals' willingness to engage with community-based energy projects (Walker et al., 2010, Kalkbrenner and Roosen, 2016). In addition, socio-cultural motivations, such as energy autonomy and independence, and strong ties among community members (Koirala et al., 2016) can also play significant roles.[4]

Most studies in the area of P2P energy trading focus on the design of an optimal trading scheme or a customer contract that incentivizes the participation of different players (e.g., prosumers, consumers) which maximizes social benefits (see Abdella & Shuaib (2018) and Soto et al. (2020) for literature review of the state-of-the-art approaches to P2P energy trading). Several studies examine citizens' acceptance of smart grids using surveys or case study methods and suggest that motivations to participate in smart grids include environmental benefits, economic benefits, energy independence, energy supply reliability and increased access to the energy market, and factors leading to consumer disengagement include poor data privacy, and insufficient information about smart grid technologies (Park et al., 2014; Ma et al., 2018; Lopes et al., 2016; also see Ellabban & Abu-Rub (2016) and Espe et al. (2018) for literature reviews). Willingness to participate in P2P trading is investigated in several European countries, but the results vary depending on region, individual characteristics (e.g., younger and more educated people are more likely to join) and characteristics of the P2P trading platform (e.g., localness of the peer) (Fell et al., 2019; Mengelkamp et al., 2019; Hahnel et al., 2020). Similarly smart grids, energy autarky and autonomy, and a sense of community are also found to be motivations of participating in P2P (Ecker et al., 2018; Hahnel et al., 2020; Klein et al., 2021). However, complexity, lack of transparency and distrust towards the operators are factors that discourage participation (Mengelkamp et al., 2019; Kirchhoff & Strunz, 2019; Pumphrey et al., 2020).

Despite the body of research currently available on SIE engagement, the existing empirical data is fragmented and tends to represent anecdotal evidence from a small number of, often non-comparable projects. In addition, the existing data has limited information on socioeconomic, demographic, gender, and socio-political aspects. Limited data has made it difficult to implement evidence-based policies and initiatives to help grow SIE and make it more inclusive and equitable. This paper addresses this gap and presents, for the first time, an empirical study demonstrating results of thirteen large scale surveys across twelve countries (11 European plus the USA) representing the views of over 10,000 members of the general public. We use this multinational dataset to make comparisons across a wide range of EU countries (some of which have not been quantitatively investigated in the literature in terms of individuals' views on energy initiatives, e.g., Romania) as well as across different types of SIE projects, which have not been investigated previously.

3. The survey

The data in this analysis comes from a large-scale survey distributed to multiple countries as part of a large EU project.[5] The aim of the project is to close some of the non-technical research gaps that impede the widespread uptake of social innovation business and service models in the European energy sector. As such, business models which enable citizens to participate in the energy transition are considered. Three versions of the survey were designed to investigate citizens' attitudes towards energy cooperatives, energy crowdfunding, and P2P energy trading platforms. These surveys were distributed across twelve countries – ten EU states (Croatia, France, Germany, Italy, Ireland, Poland, Portugal, Romania, Spain and Sweden) and also the UK and US, with approximately 800 respondents in each survey. The general structure of the survey is presented in Fig. 1. The survey questions were determined through

[2] The EU has set up a regulatory framework in the "Clean energy for all Europeans" package for P2P energy trading, although not explicitly stated (Frieden et al. 2020).

[3] Some identified studies are listed by business model in Appendix Table A1.

[4] Another strand of quantitative studies investigates individuals' preferences for different service characteristics of energy initiatives using discrete choice experiments (DCEs) or conjoint analysis (Sagebiel et al., 2014; Salm et al., 2016; Kalkbrenner et al., 2017; Langer et al., 2017; Knoefel et al., 2018; Curtin et al., 2019).

[5] https://socialres.eu/

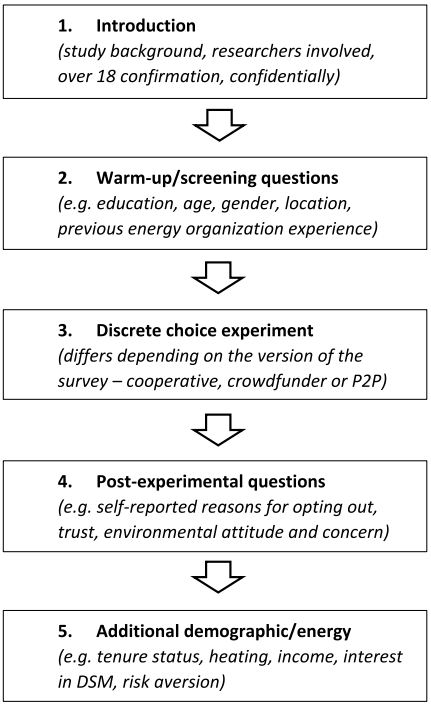

Fig. 1. Survey outline.

collaborative effort with the wider project team, and draw on questions from multiple Eurostat/Eurobarometer surveys.[6]

Respondents in each country received one of either the Cooperative, Crowdfunder or P2P platform focused surveys, except in the case for the German population where both the cooperative and P2P versions were distributed. We purposely select major countries across multiple European regions (i.e., Western, Southern, Eastern and Northern Europe) to attempt to provide a balanced sample of EU citizens. This allows us to capture the views of respondents from a diverse set of contexts, which as identified in the literature review may differ significantly in relation to SIE due to historical, cultural and regulatory reasons (for example Eastern European vs Western European countries). Further reasons for choosing this set of countries include: to reflect potentially contrasting energy profiles (e.g. Southern vs Northern Europe), energy behaviour, renewable energy development and popularity of energy initiatives, which are identified in several existing studies (De Broeck, 2018; Capellán-Pérez et al., 2018; Hewitt et al., 2019; Caramizaru and Uihlein, 2020; Wierling et al., 2018). Specifically in our sample, Germany, France and Sweden were selected for the energy cooperative survey, as the cooperative model is relatively established in these countries, whilst Spain and Poland were chosen as a contrast due to relative underdevelopment of this business model. A number of well-known energy crowdfunding platforms exist in the UK and Portugal, such as Abundance and Goparity, whilst we are only aware of a limited number of small energy crowdfunders in Italy and Croatia. For similar reasons, the German population was also selected for the P2P energy trading survey, as about half of existing P2P projects are in Germany, while Romania was selected since P2P energy trading is relatively unknown. Finally, the US population was surveyed as energy consumption and behaviour are potentially distinctive compared with those of EU countries, and also as a comparative non-EU context. To determine this set of countries, we collaborated with several experts in the energy sector and employees (CEOs/owners/project managers) of cooperatives, crowdfunders and P2P platforms partners in several of the above countries. Data collection was conducted with the assistance of a panel provider company, and respondents completed surveys on a leading online survey platform (Qualtrics). All surveys were translated to the languages of corresponding countries. Quotas regarding respondents' age, gender and region of residence were used to secure a representative sample of participants in each country.[7]

4. Results

4.1. Descriptive statistics

Table 1 presents mean values of responses to the homogenous sociodemographic, investment behaviour and attitude questions used in this study, both for the entire sample and by country and business model. Significant heterogeneity in responses exists across

[6] See for example DG CLIMA (2019).

[7] Please refer to Appendix Table A3 for a summary of sample representativeness. Respondents below the age of 18 years were ineligible to participate, and age quotas were adjusted to reflect internet access/use.

Table 1
Summary statistics by business model and country.

		Cooperative					Crowdfunder					P2P		
	Full	DE	FR	ES	SE	PL	PT	UK	IE	HR	IT	RO	DE	US
Female (*proportion*)	0.51	0.51	0.52	0.51	0.49	0.50	0.49	0.51	0.54	0.50	0.50	0.50	0.51	0.50
Age (*years*)	43.11	44.18	44.05	41.62	42.21	41.13	41.69	46.53	45.83	38.11	43.24	40.79	44.66	46.59
Tertiary education (*proportion*)	0.56	0.48	0.62	0.73	0.63	0.57	0.57	0.51	0.53	0.56	0.45	0.69	0.50	0.44
Number of children (*number*)	0.88	0.90	0.86	0.85	0.83	0.97	0.88	0.65	0.82	0.87	1.11	1.03	0.92	0.75
Number of adults (*number*)	2.26	1.97	2.03	2.45	1.93	2.45	2.36	2.10	2.42	2.68	2.59	2.46	1.87	2.09
Location *(proportion)*														
Urban	0.51	0.45	0.51	0.74	0.44	0.76	0.56	0.28	0.30	0.56	0.56	0.77	0.46	0.27
Suburban	0.27	0.27	0.24	0.16	0.30	0.10	0.25	0.52	0.36	0.27	0.24	0.07	0.23	0.54
Rural	0.21	0.28	0.24	0.11	0.26	0.15	0.19	0.20	0.34	0.17	0.19	0.16	0.31	0.19
Tenure status *(proportion)*														
Owner with a mortgage	0.28	0.20	0.27	0.41	0.37	0.18	0.38	0.30	0.30	0.19	0.24	0.24	0.18	0.39
Owner w/o mortgage	0.39	0.23	0.32	0.35	0.14	0.64	0.34	0.40	0.33	0.54	0.56	0.61	0.26	0.35
Renter	0.29	0.57	0.39	0.21	0.46	0.15	0.22	0.27	0.34	0.15	0.16	0.10	0.55	0.24
Other	0.04	0.01	0.02	0.04	0.03	0.03	0.06	0.03	0.04	0.11	0.04	0.05	0.01	0.02
Type of heating *(proportion)*														
Electricity	0.32	0.20	0.44	0.45	0.63	0.19	0.60	0.21	0.22	0.23	0.18	0.17	0.17	0.43
Gas	0.42	0.45	0.40	0.46	0.03	0.33	0.17	0.72	0.34	0.39	0.69	0.59	0.50	0.44
Oil	0.09	0.20	0.07	0.07	0.03	0.04	0.03	0.04	0.32	0.03	0.02	0.04	0.18	0.06
Wood	0.09	0.05	0.08	0.02	0.07	0.11	0.19	0.01	0.05	0.32	0.08	0.17	0.04	0.02
Coal	0.02	0.01	0.00	0.00	0.01	0.21	0.00	0.01	0.06	0.00	0.00	0.01	0.00	0.00
I don't know	0.06	0.09	0.02	0.01	0.24	0.12	0.01	0.02	0.01	0.03	0.02	0.02	0.09	0.05
Upgraded heating system *(proportion)*	0.45	0.27	0.48	0.52	0.33	0.50	0.48	0.42	0.40	0.46	0.56	0.69	0.31	0.37
Air conditioning *(proportion)*	0.39	0.17	0.25	0.62	0.34	0.24	0.33	0.15	0.07	0.66	0.64	0.53	0.20	0.85
Electricity spend (*scale 1-10*)	3.66	4.02	3.81	3.57	4.04	2.37	3.12	3.36	4.24	3.09	3.66	2.95	3.99	5.38
Heating temperature required (*scale 1-10*)	5.99	5.89	5.25	6.28	5.60	6.70	5.93	4.91	5.14	7.32	5.68	7.16	5.68	6.13
Can afford to adequately heat *(proportion)*	0.83	0.92	0.73	0.80	0.89	0.88	0.68	0.84	0.81	0.83	0.82	0.88	0.91	0.87
Comfort with income (*scale 1-5*)	3.10	3.37	2.82	3.11	3.17	3.23	2.77	3.33	3.08	2.81	3.21	2.64	3.41	3.41
Previous involvement with an energy organization *(proportion)*	0.14	0.17	0.21	0.15	0.15	0.12	0.10	0.13	0.10	0.06	0.14	0.19	0.18	0.17
Previous general investment experience *(proportion)*	0.35	0.45	0.28	0.33	0.49	0.31	0.24	0.37	0.30	0.19	0.42	0.29	0.40	0.47
Risk averse *(proportion)*	0.67	0.71	0.60	0.64	0.59	0.68	0.64	0.75	0.70	0.64	0.69	0.72	0.72	0.70
Trust in carbon-saving claims (*scale 1-5*)	3.15	3.01	2.97	3.36	2.96	3.44	3.38	2.98	3.10	3.19	3.13	3.37	3.00	3.07
Climate change seriousness (*scale 1-5*)	4.06	3.83	4.04	4.22	3.72	4.11	4.55	3.82	4.04	4.26	4.22	4.24	3.96	3.68
EU/state responsibility to empower (*scale 1-5*)	2.15	2.13	2.20	1.84	2.47	2.22	2.03	2.12	2.36	1.82	2.19	2.14	2.11	2.36
Considerable interest phone app *(proportion)*	0.37	0.25	0.25	0.48	0.30	0.41	0.55	0.24	0.45	0.46	0.34	0.46	0.30	0.30
Considerable interest DSM device *(proportion)*	0.38	0.30	0.27	0.46	0.28	0.44	0.59	0.24	0.45	0.47	0.36	0.51	0.30	0.31
Considerable comfort data sharing *(proportion)*	0.31	0.32	0.23	0.24	0.28	0.25	0.43	0.26	0.35	0.29	0.31	0.38	0.34	0.32
Considerably varying electricity tariff *(proportion)*	0.24	0.15	0.36	0.28	0.15	0.17	0.24	0.17	0.19	0.48	0.35	0.16	0.17	0.25
Observations	10373	790	806	800	800	801	800	795	791	805	799	797	792	797

Note: Mean values are presented for each variable. Where respondents chose "Prefer not to answer", these are treated as missing values. For more details on each variable please refer to online Appendix.

countries for the majority of the collected covariates. For example, we see significant variation between countries in sociodemographic characteristics such as location, tenure status, type of heating system, heating/cooling requirement, energy spend, comfort with income,[8] and education. This illustrates that our sampling strategy has been successful in capturing a diverse set of respondents in different settings and with differing backgrounds and energy requirements.

We also observe significant variation in previous energy initiative experience, general investment experience, trust in carbon-saving claims made by organizations, and attitudes towards climate change. Previous energy initiative experience was recorded using responses to the question "*Have you ever been involved in an energy organization (such as an energy cooperative, an energy peer-to-peer platform or a crowdfunded energy project)?"*. The definition of an energy organization is left broad to capture general self-reported previous involvement in SIE initiatives across multiple cultural and language contexts, which could include involvement in any one of the above types of projects, or other similar social energy projects. This may also include participation in unregistered/unofficial energy initiatives, which can be difficult to measure. In total only 14% of respondents from the entire pooled sample indicated that they had previously been involved in an energy organization at some point in the past. This reflects the fact that the energy business models studied here are still in their infancy, and the majority of respondents from the general public have not yet participated in such schemes. We also see significant heterogeneity in previous participation in energy initiatives which ranges from 6% of respondents in Croatia, to 21% of respondents in France – indicating significant cross-country differences in the proliferation of SIE initiatives even at this early stage. We will explore differences in individuals that have indicated participation in energy initiatives and those that have not in more detail later in this article.

Significant variation in general previous investment experience (such as with stocks, bonds and investment funds) is observed between countries, with a higher share of respondents in countries such as Sweden and the US (49% and 47% respectively) indicating that they have made such investments in the past. By comparison, only 19% of respondents in Croatia and 24% of respondents in Portugal have general previous investment experience. This may reflect differences in disposable incomes or investment appetites across countries, which may influence the likelihood of investment or participation in future energy initiatives. Interestingly however, we observe comparatively lower variation in the proportion of risk averse individuals between countries, with the majority of respondents across all countries in our sample exhibiting risk aversion using a simple test for risk preferences.[9] Mean risk aversion for the sample as a whole is 67% with lowest risk averse proportion observed in Sweden (59%) and highest risk aversion proportion observed in the UK (75%).

Trust in the carbon-saving claims made by organizations was measured using five-point Likert scale responses to the statement "*In general, to what extent would you trust the carbon-saving claims of organizations like this?"*, ranging from 1 "*I don't trust*" to 5 "*I fully trust*" such claims. Mean values for the trust variable from Table 1 indicate that respondents have trust levels which fluctuate close to the central value of 3. Looking at the detailed breakdown of responses in Appendix Fig. A1 we can see that the majority of respondents chose the central value of "3" in the scale, with some variation in the not-trusting and trusting extremes. Overall however, respondents appear to be more likely to trust than distrust carbon-saving claims with some heterogeneity in levels of trust between countries. Interestingly, higher levels of trust are observed in Poland, Spain and Romania, with no apparent differences in trust between business models.

Attitudes towards climate change were also measured using a 5-point Likert scale, ranging from 1 "*Not at all a serious problem to*" to 5 "*Its an extremely serious problem*". Mean values of the climate-change-seriousness variable indicate that the majority of respondents believe that climate change is at least a very serious problem. Cross-country differences and a detailed breakdown by category are presented in online Appendix Fig. A1. From Fig. A2. We see that upwards of 60% of respondents believe that climate change is at least a very serious problem in almost all countries, with the most popular response being that it is an "*extremely serious problem*". The extent to which participants believe the EU should be involved in empowering citizens to participate in energy initiatives is measured by responses to the statement: "*It should be the EU's responsibility to empower cities and local communities to move towards clean energy"*. Respondents were asked to indicate their level of agreement through a 5-point Likert scale ranging from "*Strongly agree (1)"* to "*Strongly disagree (5)"*. We see that most respondents either agree or strongly agree with the statement across all countries (Appendix Fig. A3), with the majority of respondents expressing moderate agreement. This suggests that respondents believe that the EU has an important role to play in encouraging citizens to participate in energy organizations such as cooperatives, crowdfunding and P2P platforms. This view appears to be held particularly strongly in Spain, Croatia, Portugal and Germany.

Other variables presented in Table 1 include interest in a phone app which communicates real time energy consumption, interest in demand side management (DSM), whether respondents currently have varying electricity rates and how comfortable respondents are with sharing electricity use data. Less than half of respondents express considerable interest in any of these technologies/tariffs overall, however we again observe significant heterogeneity between countries, depending on technology/tariff.

4.2. Previous experience with an energy organization

In order to gain an understanding into the characteristics of individuals who may be more/less likely to participate in SIE business

[8] Comfort with income is used as opposed to self-reported household income due to missing responses. In addition, comfort with income has the advantage of being easily comparable between countries.

[9] Respondents were asked to imagine that they have €1000 euros to invest, with two investment options: Option A - a definite annual return (payment) of €50; Option B - a 50:50 chance of getting either €90 or €30. Respondents were classified as risk averse if they preferred Option A. While this is a very simplified measure of risk aversion, we chose this approach rather than multiple price lists to reduce cognitive burden (Meki, 2022).

models, we begin by exploring differences between individuals who indicated that they have already participated in similar energy organizations, and those that have not. We study correlations between self-reported previous energy organization experience and the covariates described above in detail using a logit model. For ease of understanding, the logit regression results are presented as average marginal effects (AMEs). Our dependent variable is binary, indicating self-reported previous involvement in an energy organization. AMEs illustrate an average change in the probability that an individual has been involved in an energy organization for a change in an explanatory variable. AMEs and associated standard errors for the pooled dataset and including country-specific fixed effects to control of unobserved country differences are presented in Table 2. We also present individual country level estimates separately for each country in Appendix Table A4.

The direction of observed effects appears to be consistent with our expectations. For example, those that have recently upgraded their heating system are more likely to have previous energy organization experience by on average 4.8 percentage points (ppt), and these findings appear to be consistent across the majority of countries studied. This effect is observed separately in both of our German samples, Spain, Portugal, Ireland, Croatia and the US. This may be related to increased engagement with, or attention paid to energy use. In a similar energy usage vein, households with air conditioning (an appliance with high energy consumption) have a higher likelihood to report previous experience with an energy organization (by 5.2ppt), however this effect is observed individually in comparatively fewer countries in our sample (Germany, Poland and Romania).

Looking at previous general investment experience, there is also a higher chance that those that have had previous financial market investment experience have also had energy organization involvement (5.3ppt) and this effect is observed individually in both German samples, Italy, Ireland and Portugal. Looking at the pooled sample, we also find that considering climate change as extremely serious compared to mildly serious (a 3 out of 5 on a Likert scale of seriousness) reduces the likelihood of previous energy organization experience by 5.1ppt. However, this result should be interpreted with caution since it is inconsistent when looking at country level results independently, particularly in the case of our two samples from Germany. Nevertheless, such a results may raise the question whether the energy sector is seen as polluting as a whole by some, and that climate friendly energy investments such as the renewable energy crowdfunders, cooperatives and P2P platforms are not well known. We also find, trust in organization's carbon saving claims also affects likelihood positively, by 1.5ppt for the pooled sample of countries, and this effect is observed consistently in several of the studied countries individually (Sweden, Portugal, Ireland, Italy and the German cooperative sample).

Socio-demographic factors surveyed also seem to have significant links with the likelihood of indicating participation in an energy organisation, and these observations might help target energy programmes. Those with a tertiary education are more likely to report previous energy organisation experience by 6.7ppt, with significant effects observed individually in 11 out of the 12 countries studied. This does not seem to be a proxy for income factors, as 'comfort with income' and 'can afford to adequately heat' are not consistently significant across the sample of countries studied, despite standardised questions being applied in all countries.

Age is negatively linked with energy organization experience, as illustrated in Fig. 2 which plots the AMEs associated with age categories for the pooled sample of countries. Those in the 30-to-39-year-old group are roughly 5 percentage points less likely to have previous energy organization involvement than 18-to-29-year-olds. All subsequent age groups have an even lower likelihood of reporting previous participation, with the 70+ cohort being 13 to 14ppts less likely to have been involved with an energy organization than 18-to-29-year-olds. The age relationship seems surprising for the age groups between 30 and 70, who may have more disposable income/wealth than the youngest group of 18-to-29-year-olds. This might be linked back to the newness of these types of organizations, with regards to early adopters or shifting norms in investment portfolios. We also note that there seems to be a turning point at the 60-69 age group, or at least a flattening out of the average marginal effect of age on previous energy organization experience, we could hypothesize that this is linked to some retirement effect. With regard to cross country comparisons, the increasing negative effect of age on previous energy organisation experience is observed in multiple countries individually, including: France, Sweden, Portugal, UK, Ireland, Italy, Romania and the US.

In terms of additional demographic characteristics, the number of children in the household exhibits a small positive effect on previous participation, however this is observed individually in only three of our country samples independently. Sharing a household with other adults appears to be weakly associated with previous energy organization participation, however this result is not generalizable across countries since it is only significant in one country in our sample (Poland). The size of the household's monthly energy bill does not exhibit a consistent relationship with previous participation, which is worth considering the observed positive association between owning an air conditioning unit(s) and past involvement in energy organizations. In addition, we do not observe any significant relationship between prior energy organization experience and the energy source used for heating, and neither is there a consistent relationship observed between energy organization involvement and home ownership status.[10] This is an interesting result, given that space heating accounts for 63% of domestic energy consumption in the EU (Eurostat, 2022). In addition, we might expect that homeowners may be more likely to engage in energy initiatives, given a potentially more permanent residency. On the other hand, perhaps there is some psychological association between 'owning one's own property' and 'owning the services to that property', the latter of which might be perceived as being diluted through cooperative/P2P participation. Further research is necessary to understand the relationship and underlying mechanics between home-ownership and participation in SIE initiatives, especially given the ongoing concurrent housing and energy crises faced by many EU states.

[10] We observe a weakly significant relationship between renting one's property and previous energy organization experience in only two countries from our sample (Italy and the US), though with opposing signs (positive and significant at the 10% level in Italy and negative and significant at the 5% level in the US).

Table 2
Average marginal effects – previous participants.

Variable	AME	SE	Variable	AME	SE
Female	-0.015*	(0.007)	Electricity spend		
Age			€0 - €25	-0.023	(0.015)
18-29	*ref.*		€25 - €50	*ref.*	
30-39	-0.058***	(0.013)	€50 - €75	-0.009	(0.01)
40-49	-0.089***	(0.013)	€75 - €100	0.008	(0.012)
50-59	-0.122***	(0.014)	€100 - €125	0.013	(0.015)
60-69	-0.152***	(0.014)	€125 - €150	0.007	(0.018)
70+	-0.147***	(0.018)	€150 - €175	0.028	(0.022)
			€175 - €200	0.052*	(0.026)
Tertiary education	0.067***	(0.009)	> €200	-0.034	(0.022)
Number of children	0.011***	(0.003)	I don't know	-0.02	(0.026)
Number of adults	0.009*	(0.004)			
			Upgraded heating system	0.048***	(0.008)
Location			Air conditioning	0.052***	(0.008)
Urban	0.009	(0.01)	Heating temperature (scale 1-10)	-0.004*	(0.002)
Suburban	0.008	(0.011)	Can afford to adequately heat	0.023*	(0.012)
Rural	*ref.*		Comfort with income (scale 1-5)	-0.011**	(0.004)
			Previous investment experience	0.053***	(0.008)
Tenure status			Risk averse	0.01	(0.008)
Owner with a mortgage	-0.001	(0.009)	Trust in energy saving claims	0.015***	(0.004)
Renter	-0.003	(0.011)	EU/state responsibility to empower	-0.004	(0.004)
Other	-0.051	(0.027)			
Owner without a mortgage	*ref.*		Climate change seriousness		
			Not at all a serious problem	0.022	(0.025)
Type of heating			2	-0.018	(0.018)
Electricity	*ref.*		3	*ref.*	
Gas	-0.007	(0.009)	4	-0.011	(0.011)
Oil	0.000	(0.015)	Its an extremely serious problem	-0.051***	(0.011)
Wood	-0.007	(0.015)			
Coal	0.027	(0.029)	Considerable interest phone app	-0.013	(0.008)
I don't know	-0.023	(0.023)	Considerable interest DSM device	-0.000	(0.008)
			Considerable comfort data sharing	0.029***	(0.008)
			Considerably varying electricity tariff	0.032***	(0.008)
			Country fixed effects	Yes	
			N	8,014	

Note: Average marginal effects from logit model with dependent variable indicating previous participation in an energy organization. Standard errors in parentheses. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

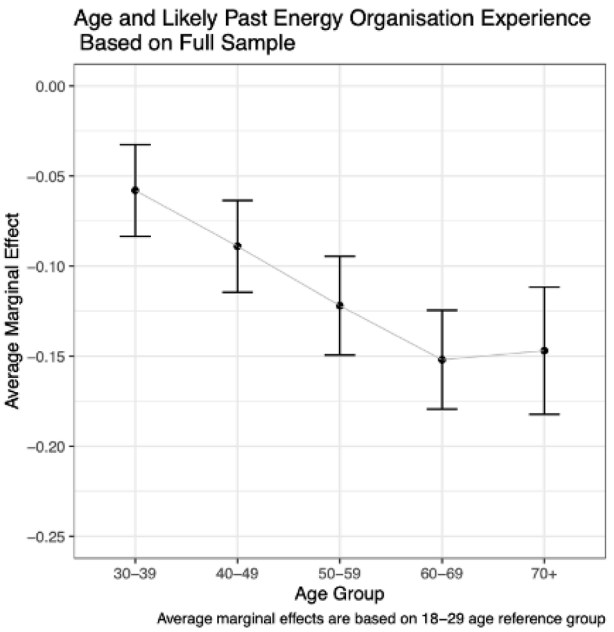

Fig. 2. Relationship between age and previous participation.

4.3. Reasons for choosing to not participate in energy initiatives

In this section we explore some of the reasons why survey respondents chose to opt-out from the Discrete Choice Experiments (DCE) studied in more detail in Wu et al. (2022). In the DCE section of the survey, each participant was presented with a total of eight choice sets, with each choice set containing three options – two energy initiative investment options with varying attribute levels and a third "*I would not choose either*" option. By focusing on individuals who choose the opt-out option, we aim to identify members of the general public who may be unwilling participate in the presented business models. We hypothesise that individuals who choose the option to opt-out more often may be more averse to, or dissatisfied with the business models presented when compared with individuals who choose the out option fewer times (or not at all). In turn, these individuals may therefore be harder to reach when attempting to scale up the deployment of SIE business models.

A limitation of this approach is that as with all DCE analyses, there is potential for hypothetical bias in that respondents may not behave in a similar manner in a real-world setting. While we attempt to alleviate hypothetical bias using a cheap talk protocol whereby respondents are urged to answer in a truthful manner at the beginning of the DCE (Cummings et al., 1999), given that opting to choose a project in the DCE does not involve any physical costs (either monetary or time commitment),[11] we expect that non-participation in the DCE will be understated when compared to a real-world scenario.[12] In that sense, individuals who choose to opt-out even in this hypothetical setting may be more likely to hold negative views towards the studied models.

Examples of the choice cards presented to respondents for each business model survey are presented in Fig. 3. Attributes for the cooperative and crowdfunder samples are broadly consistent with the exception of the level of participation (specific to the cooperative sample, and the type of issuer (specific to the crowdfunder sample). Given that P2P platforms involve energy trading at the household level, the attributes chosen include energy saved and specific platform characteristics. This section focuses on respondents who chose the opt-out option in each of these surveys. We explore both self-reported reasons, and correlates with other sociodemographic, risk preference, and climate awareness characteristics.

4.3.1. Opt-out correlation with other characteristics

We construct a count variable equal to the number of times each respondent chooses the opt-out option from the set of DCE choice cards. This variable takes on an integer value of 0 to 8, with a clustering of responses at the zero value (i.e. individuals who have not opted out from any of the business model choices presented) which is illustrated by business model in Fig. 4. We see some differences in clustering at the zero value between business models, with a higher proportion of individuals not selecting the opt-out option in the P2P DCE relative to the crowdfunding and cooperative DCEs. A possible explanation for this could be the time/participation commitments required with participating in a cooperative or a crowdfunding platform. Among individuals who do choose the opt-out option at least once, the distribution of number of opt-outs appears to be broadly speaking similar between business model surveys. To analyze the relationship between number of opt-outs and the demographic, attitude and experience variables used in our analysis we employ a Zero Inflated Negative Binomial Model (ZINB).[13] The results from the count part of the ZINB model are presented for each business model separately in Table 3.

Some interesting patterns emerge from Table 3. When looking at socio-demographic characteristics, we find that females were significantly more likely to opt-out or abstain from choosing an investment option more times than males in the cooperative sample only. The results from the ZINB model indicate that the expected number of times a female opts-out is 1.21 times that of males, holding all other characteristics constant, and if respondents are not certain/structural zeroes.[14] Results from the inflation model in Appendix Table A4 illustrate a similar pattern, with females also being less likely to report a zero value (or being more likely to opt-out) overall.

Age appears to be very strongly correlated with number of opt-outs, with increases in age being associated with an increasing number of opt-outs for all age categories relative to the baseline category of 18-29 years. This effect is largest for age groups over 50 years old. For example, respondents in the 70+ age category choose the opt-out option 1.72 times as often as the 18-29 age group in the cooperative sample. As will be discussed in more detail, this is consistent with some of the findings from qualitative questions in the

[11] Respondents were explicitly told at the beginning of the DCE that these choices do not have a real financial impact, however they should try to choose an option as they would in reality.

[12] In addition, in order to limit errors and to allow respondents to familiarise themselves with the format of the DCE a practice choice card was presented before responses were collected. Detailed descriptions of the each of the attributes studied were also shown to respondents prior to beginning the experiment.

[13] Given that the dependent variable in our analysis is a count variable we begin by using a Poisson regression model. Since we observe a significant concentration of values in the dependent variable at zero (approximately 70% of observations overall), we use zero-inflated Poisson regression (ZIP). In addition, a zero inflated model allows us to study the factors which are correlated with a participant reporting a zero value separately. As per Yang *et al.* (2017) the zero inflated negative binomial model (ZINB) may be preferrable to a zero inflated Poisson model (ZIP) in cases where overdispersion is present. In our case the variance of the opt-out count variable is considerably larger than the mean, indicating overdispersion. When overdispersion is present, the Poisson model may deflate or underestimate the standard errors of the coefficient estimates (Yang *et al.*, 2017). We report the results from the ZIP and ZINB models in columns (2) and (3) of Appendix Table A5 respectively for the pooled sample of responses. We also report the results from a simple linear model in column (1) for comparison. The results are broadly consistent across all three models. For the ZIP and ZINB models, we present the results of the count models in Appendix Table A5, with the logit part of the models presented in Appendix Table A6.

[14] $e^{0.192} = 1.21$

	Project A	Project B
Annual Return	2.5%	5%
Type	Solar	Wind
Annual CO2 Reduction	3,000 tonnes	12,000 tonnes
Land Cover	5 football pitches	20 football pitches
Location	Within your region	Outside your country
Minimum Investment	€100	€500
Minimum Duration	5 years	2 years
Participation	Quarterly meetings	None

○ Project A
○ Project B
○ I would NOT choose either

(a) An example choice card for the energy cooperative model

	Project A	Project B
Annual Return	5%	2.5%
Type	Solar	Wind
Annual CO2 Reduction	600 tonnes	3,000 tonnes
Land Cover	1 football pitch	5 football pitches
Location	Within your country	Within your local area
Minimum Investment	£100	£500
Investment Duration	25 years	20 years
Issuer	Private company	Community organization

○ Project A
○ Project B
○ I would NOT choose either

(b) An example choice card for the energy crowdfunder model

	Contract A	Contract B
Monthly Energy Saved	€18	€12
CO2 Reduction	100 kg	200 kg
Type of Green Electricity	Mostly wind	Mostly solar
Green Alert System	Daily	Weekly
Platform Goal	Reduce CO2 and bill	Reduce bill
Contract Length	9 months	12 months

○ Contract A
○ Contract B
○ I would NOT choose either

(c) An example choice card for the energy P2P platform

Fig. 3. DCE choice card examples.

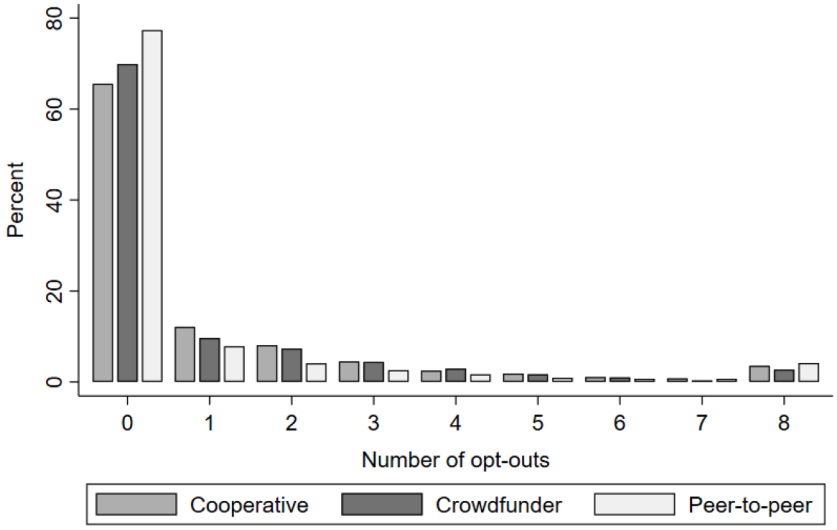

Fig. 4. Distribution of opt-out count variable by business model.

survey, whereby older respondents express concern in engaging with investment opportunities which have a long payback period. The age of respondents appears to important for opting out across all business types, but with differing patterns. Among cooperative respondents, only the oldest age categories (50+) exhibit a strong effect on the number of opt-outs chosen. By comparison, in the crowdfunding samples, we find that all older age groups (relative to 18-29) are associated with increases in opt-out rates, with a lower effect for the oldest age category (70+). Among P2P platform respondents, we observe a slightly different pattern still, with the strongest effect observed in the oldest age category (70+) which indicates that individuals in this group opt out 2.34 times as often as individuals in the 18-29 age group.

Those with tertiary education are also likely to opt-out fewer times than those without (by a factor of 0.84) in the cooperative sample only. Respondents that have upgraded their heating system in the last 10 years are significantly less likely to opt out of energy initiatives relative to those that have not and this result is observed both in the cooperative and crowdfunder samples. Similar to the findings in the previous section, this may be correlated with an awareness of one's energy use. We also find that those in the lowest and highest categories of electricity spend are likely to opt out more often, relative to those with an electricity spend ranging between €25-€50p.m, with some variation between business model types.

General previous investment experience appears to be strongly negatively related with opting-out of energy initiative investment/participation in the DCE. This is consistent with prior expectations, as such individuals may be more likely to have an interest in taking on other investments, and hence be less likely to abstain from energy initiative investment. Interestingly however, previous general investment experience influences opt-out rates for the cooperative and P2P business models, but not in the crowdfunder sample, despite that these types of investments perhaps most resembling traditional stock/bond investments. In a related vein, risk averse individuals are likely to opt-out more often, however this result is driven primarily by the crowdfunding sample.

Individuals with high levels of trust in the carbon saving claims made by organizations are likely to opt out less from participation/investment in energy initiatives in the DCE. This finding appears to be consistent across all of the business models studied, with perhaps

Table 3
ZINB count model results.

	(1)		(2)		(3)	
	Cooperative		Crowdfunder		P2P	
Female	0.192**	(0.065)	0.054	(0.065)	0.063	(0.106)
Age						
18-29	*ref.*		*ref.*		*ref.*	
30-39	0.246*	(0.120)	0.350**	(0.128)	0.114	(0.218)
40-49	0.274*	(0.119)	0.374**	(0.122)	0.287	(0.205)
50-59	0.450***	(0.122)	0.459***	(0.124)	0.665**	(0.209)
60-69	0.403**	(0.126)	0.591***	(0.131)	0.599**	(0.211)
70+	0.545***	(0.157)	0.443**	(0.159)	0.852***	(0.240)
Tertiary education	-0.170**	(0.065)	-0.123	(0.067)	0.048	(0.115)
Number of children (number)	-0.035	(0.033)	0.067*	(0.030)	-0.005	(0.055)
Number of adults (number)	-0.000	(0.040)	-0.118**	(0.038)	0.130	(0.068)
Location						
Urban	0.156	(0.084)	0.002	(0.089)	0.289	(0.156)
Suburban	0.084	(0.093)	-0.090	(0.083)	0.085	(0.146)
Rural	*ref.*		*ref.*		*ref.*	
Tenure						
Owner with a mortgage	-0.150	(0.083)	-0.042	(0.084)	-0.124	(0.136)
Renter	-0.061	(0.092)	0.040	(0.092)	-0.091	(0.156)
Other	-0.041	(0.277)	-0.122	(0.171)	0.095	(0.320)
Owner without a mortgage	*ref.*		*ref.*		*ref.*	
Type of heating						
Electricity	*ref.*		*ref.*		*ref.*	
Gas	0.017	(0.084)	0.116	(0.088)	-0.127	(0.130)
Oil	0.104	(0.130)	0.083	(0.139)	-0.401*	(0.202)
Wood	0.221	(0.136)	0.166	(0.133)	-0.163	(0.263)
Coal	-0.076	(0.234)	0.102	(0.242)	-2.407**	(0.777)
I don't know	0.245*	(0.110)	0.127	(0.261)	0.360	(0.281)
Electricity bill						
€0 - €25	0.038	(0.113)	0.307**	(0.113)	0.289	(0.223)
€25 - €50	*ref.*		*ref.*		*ref.*	
€50 - €75	-0.023	(0.088)	0.022	(0.081)	-0.271	(0.169)
€75 - €100	-0.096	(0.106)	-0.148	(0.106)	-0.043	(0.179)
€100 - €125	0.324*	(0.136)	0.001	(0.132)	0.053	(0.199)
€125 - €150	0.326*	(0.147)	-0.147	(0.192)	0.218	(0.233)
€150 - €175	-0.429	(0.246)	-0.616	(0.347)	-0.196	(0.300)
€175 - €200	-0.336	(0.322)	0.249	(0.283)	0.058	(0.365)
> €200	0.705**	(0.237)	0.386	(0.336)	0.195	(0.255)
I don't know	0.108	(0.148)	-0.201	(0.204)	0.528*	(0.253)
Upgraded heating system	-0.260***	(0.074)	-0.228***	(0.065)	0.008	(0.121)
Air conditioning	0.049	(0.074)	0.094	(0.092)	0.074	(0.140)
Heating temperature (scale 1-10)	-0.021	(0.019)	-0.001	(0.016)	0.067*	(0.029)
Can afford to adequately heat	0.097	(0.094)	-0.012	(0.091)	-0.035	(0.167)
Comfort with income (scale 1-5)	-0.008	(0.035)	0.039	(0.040)	0.035	(0.051)
Previous investment experience	-0.291***	(0.075)	-0.122	(0.073)	-0.362**	(0.127)
Risk averse	0.037	(0.063)	0.166*	(0.070)	0.189	(0.118)
Trust in carbon saving claims (scale 1-5)	-0.242***	(0.035)	-0.168***	(0.036)	-0.169**	(0.054)
EU/state responsibility to empower (scale 1-5)	0.035	(0.030)	0.027	(0.034)	0.099*	(0.050)
Climate change seriousness						
Not at all a serious problem (1)	0.410**	(0.143)	0.015	(0.159)	0.047	(0.198)
2	0.101	(0.128)	-0.042	(0.146)	-0.117	(0.192)
3	*ref.*		*ref.*		*ref.*	
4	0.104	(0.087)	0.006	(0.091)	-0.134	(0.147)
Its an extremely serious problem (5)	0.025	(0.086)	0.085	(0.090)	-0.240	(0.148)
Considerable interest phone app	-0.144	(0.079)	-0.197*	(0.085)	-0.232	(0.148)
Considerable interest DSM device	-0.188*	(0.083)	-0.072	(0.085)	-0.061	(0.153)
Considerable comfort data sharing	-0.083	(0.084)	-0.228**	(0.082)	-0.054	(0.145)
Considerably varying electricity tariff	-0.124	(0.090)	-0.188*	(0.084)	-0.099	(0.169)
Country FE	Yes		Yes		Yes	
N	3,091		3,143		1,780	

Note: Standard errors in parentheses. * $p < 0.05$
** $p < 0.01$
*** $p < 0.001$.

the strongest effect exhibited in the cooperative sample.[15]

Finally, those with considerable interest in a phone app which monitors electricity consumption, interest in DSM, those that are comfortable with sharing energy data with organizations, and have significantly varying electricity tariffs are also weakly significantly less likely to opt-out of participating in energy initiatives (at the 5% level), and these results are observed primarily in the crowd-funding sample.

In general, the results from the analysis of opt-outs are broadly consistent with the differences observed when comparing those who have already participated in an energy organization and those that have not. Those that are younger, are male, have previous general investment experience, trust the carbon saving claims of organizations and are interested in energy/electricity use are likely to opt out fewer times from energy initiative participation/investment in the DCE.

4.3.2. Self-reported reasons for opting out

Subsequent to the DCE, respondents were given the option to provide one or more reasons for their opt-out from a predetermined list as well as an open-ended "Other" category. The proportion of respondents who reported that they opted out, and the reasons for their opt-out are presented in Table 4.

From Table 4 we can see that 33% of the entire sample report that they have opted-out from at least one of the DCE choice sets. Self-reported opt-out is very consistent with actual observed opt-out studied in the previous section, whereby 34% of respondents did indeed opt-out at least once. The most common reason given for opting out is that respondents could not afford to invest in energy projects, followed by deeming such investments to be unrealistic/unconvincing. The least common cited reasons include *"I don't have time to go through the details*" and *"I don't think is the public's responsibility to reduce emissions"*. Some heterogeneity in opt-out reasons exists between countries and business models. For example, unaffordability and an unrealistic/unconvincing project description appears to be a less common response among the P2P study samples.[16]

Among the open-ended *"Other reasons"* option some interesting patterns also emerge in the data. A very common reason cited for opting out is the duration of investment (particularly in the crowdfunder study) and its relationship to respondent age. For example, a very typical response observed was:

> *"My age. 10 years or more are not viable for me."*

Or

> *"Most are too long term for someone at my time of life"*

This is consistent with the pattern observed in the regression analysis, whereby older respondents are considerably more likely to opt-out of energy investment or participation across all business models. For example, in the UK, of the 120 or so respondents that chose to justify their opt-out, 46% explained it was due to the length of the project, generally linked to the age of the participant, i.e., too old to see the investment returned. The second most popular reason was that the financial return was seen as too low (12.5%), or too low for the timescale (further 11%). Some respondents were concerned by having both public or private bodies associated with energy initiatives.

5. Discussion

The results from the hypothetical opt-out analysis and respondent's prior engagement with SIE initiatives overlap in several ways. Firstly, the findings that age and gender play an important role in the likelihood of opt-out are consistent with what we observe by comparing previous energy organization participants and non-participants. Females were found to be less likely to be current/previous members of energy organizations and are also more likely to opt out from cooperatives in our discrete choice experiments. Older individuals were also found to be on average less likely to be current/previous participants in energy organizations and are also considerably more likely to opt-out of SIE participation in a DCE setting. This is particularly true for the oldest age categories.

This alludes to an age-old problem in relation to investment in general: older generations may have the resources to invest, but not the time or energy to participate in such initiatives; while the young have the time but may not necessarily have the financial means to invest in such projects. This is confirmed by the qualitative open-ended questions in the survey, whereby a considerable share of older respondents expressed concern that investments might have a too long payback period for their stage in life. On the other hand, when looking at previous energy organization participation, we find that older individuals are significantly less likely to indicate previous participation which implies that previous (self-declared) participants are more likely to younger. However, given the limited overall share of respondents that have indicated previous participation, these younger respondents may not be representative of younger people in general. Indeed, the most cited self-reported reason overall for opting out is unaffordability, suggesting that among younger cohorts a lack of disposable income may be a significant barrier to widespread participation. These findings suggest that energy initiatives may need to provide a range minimum investment duration and return options to cater for differing age profiles of

[15] In terms of placement within the survey, this question was asked as part of a group of post-experimental questions directly after respondents completed the DCE, implying that it refers to the preceding business model.

[16] It should be noted that in the case of the P2P DCE, the levels of energy savings represent savings net of any potential investment or subscription fees to join the platform. Respondents were however also informed that in order to participate in a P2P platform they may need to upgrade their electricity meter to a smart meter.

Table 4
Self-reported reasons for opting out.

		Cooperative					Crowdfunder					P2P		
	Full	DE	FR	ES	SE	PL	PT	UK	IE	HR	IT	RO	DE	US
Self-reported opt-out	0.33	0.48	0.41	0.26	0.41	0.26	0.26	0.45	0.33	0.22	0.34	0.24	0.32	0.35
I cannot afford to invest in these projects	0.16	0.23	0.22	0.16	0.23	0.15	0.14	0.19	0.12	0.13	0.20	0.12	0.08	0.10
I think there is enough solar and wind energy in the EU already	0.06	0.06	0.06	0.03	0.07	0.04	0.03	0.07	0.04	0.02	0.05	0.09	0.14	0.13
I don't think the project will be effective enough to reduce carbon emission	0.08	0.10	0.10	0.07	0.09	0.10	0.05	0.12	0.09	0.05	0.11	0.05	0.08	0.09
I don't think it is the public's responsibility to reduce emissions	0.05	0.08	0.04	0.03	0.05	0.02	0.02	0.06	0.03	0.02	0.04	0.08	0.10	0.12
I think the description of the project is not realistic/convincing	0.10	0.13	0.15	0.10	0.11	0.12	0.09	0.12	0.12	0.09	0.15	0.03	0.07	0.07
I don't have time to go through the details	0.04	0.07	0.03	0.01	0.04	0.04	0.02	0.02	0.01	0.03	0.02	0.02	0.05	0.10
Other reasons, please specify	0.05	0.09	0.06	0.05	0.10	0.03	0.05	0.15	0.09	0.04	0.05	0.00	0.00	0.00

investors/participants. The ability to join a project at a later date and/or to withdraw participation from a project may also be a way of attracting participants who favor shorter participation/investment durations.

Investment experience seems to play an important role in the intention to invest in energy projects, with those who have had previous general investment experience being less likely to opt out from the DCE. We also find that risk averse respondents are more likely to choose the opt-opt option more often. Linking these two pieces of evidence suggests that risk and uncertainty (e.g., uncertainty about the renewable projects and the business models) are important factors being considered in investment decisions. The findings echo the results in Bourcet and Bovari (2020) where investment opportunity transparency and risk perception were found to be important factors for crowdfunding renewable energy initiatives. To increase citizens' willingness to engage with energy initiatives, operators should actively promote the benefits and risks of investing in renewables through different forms of educational campaigns and increase the level of information transparency to the public.

The findings in relation to previous investment experience and risk aversion can also be linked directly to results in relation to trust in the carbon saving claims made by organizations. Trust was found to be correlated with a reduction in opt-outs across all of the energy initiatives studied. Previous participants in energy organizations also had on average higher levels of trust in carbon saving claims made by such institutions. These correlational findings together illustrate the importance of trust in organizations in order to mobilize investment. Building trust could perhaps be achieved by promoting the positive experiences of previous investors. Trust specifically in relation to the carbon saving claims made is also crucial, since CO_2 reduction is also a primary motivator for investors/participants (Wu et al., 2022).

Our results also confirm the findings from several studies on the impact of demographic and socio-cultural factors on individuals' willingness to participate in citizen investment schemes (Walker et al., 2010; Bauwens and Defourny, 2017; Capellán-Pérez et al., 2018; Özgül et al., 2020). Notably, our results are consistent with Fraune (2015) on the role of gender in citizen participation. Whilst these findings suggest that males are more engaged with energy projects, perhaps motivated by financial returns, women have also been found to play a role in leading energy transition (Pearl-Martinez and Stephens, 2016; Łapniewska, 2019; Clancy et al., 2019). This gap emphasizes a potential issue of gender equality in sustainable energy services, and future research can focus on non-monetary incentives that facilitate female participation.

We also acknowledge several limitations existing in this study. First, although several quotas are used to collect samples that are representative of the country populations, we did not set quotas for all relevant individual characteristics due to budget constraints. The results suggest that our samples tend to be more educated and wealthy compared with national census data, which might lead to over-estimation of the intention to invest in energy projects and services.[17] Secondly, the findings from this study should be interpreted as being purely descriptive and correlational in nature due the lack of exogenous variation in treatments. Future studies on energy initiatives should focus on individual aspects (such as trust and risk preferences) in an experimental setting. Thirdly, our measure of previous energy organization participation is self-reported in nature and does not distinguish between different nuances of involvement, such as investment or voluntary participation. This can be corrected in future studies by collecting more detailed information on the type and level of individual involvement. In addition, like most studies using survey methods, acquiescence bias and hypothetical bias may be present in this study. For example, respondents may tend to agree to participate in a project that makes them feel ethically better (Bowling, 2005; Nederhof, 1985), and the extent of bias could be large when the choice is not bound with actual cost (i.e., hypothetical bias), both of which may pose challenge to the external validity of the results. However, to counteract this we applied a cheap talk approach where respondents were reminded to think of their disposable income before making choices, which should theoretically reduce the extent of hypothetical bias (Cummings et al., 1999). Future cross-country studies using experimental, observational and qualitative data are needed to shed further light on the motivations and barriers for widespread participation in SIE.

[17] Sample representativeness statistics are presented in Appendix Table A3.

6. Conclusion

Using a standardized survey covering twelve countries and three business models, this study has explored socio-demographic and attitude associations with participation in SIE initiatives. We explore differences between past self-reported participants and non-participants in energy initiatives and those who choose to opt-out of participating/investing in SIE models in a DCE setting.

The findings illustrate significant socio-demographic differences based on previous energy organization participation. Those with previous SIE initiative experience are more likely to be younger, male, better educated, with previous general investment experience and with higher levels of trust in the carbon saving claims of organizations. When studying individuals who choose to opt-out or not participate in energy initiatives in a hypothetical setting, we find that socio-demographic characteristics such as age, gender and education are strongly correlated with opting-out of participation/investment. In particular, older individuals are considerably less likely to choose an investment option, if investment return durations are long. This is confirmed by responses to qualitative open-ended post experimental questions. Finally, findings from the analysis of opt-outs further suggest that trust in the energy saving claims made by organizations, previous general investment experience and risk preferences are also significant predictors of non-participation.

The findings from this international study, coupled with similar findings from the literature present several policy implications. Firstly, despite the broad definition of an energy organization used in this survey, we find very low previous self-reported engagement with such energy models (approx. 86% of the general public report no previous involvement of any kind). This demonstrates that the majority of the general public may lack access to and/or awareness of these models (COMETS et al., 2022). Policy should aim to raise the general public's awareness of these types of models, through highlighting the benefits associated with participating in such initiatives, the associated supports (if available) and the previous positive experiences of past participants.

Secondly, similar to other studies we find that those who indicate previous energy organization experience are different to those that don't based on several demographic and attitude characteristics. On the one hand, this gives insight into the types of individuals that could be targeted to increase adoption of these models in the short term. On the other hand, these differences may point to inclusivity and distributional issues which need to be addressed early by policy in order to achieve wider participation (Fell, 2021; Adams et al., 2021; Skjølsvold & Coenen, 2021).

Third, our analysis on opt-outs in a DCE setting may shed some further light on the type of individuals who could be difficult to reach when attempting to scale participation in SIE. Older individuals in particular appear to express a concern with long-periods of investment lock in. One way to potentially alleviate this problem is to allow individuals to easily transfer/trade investments. Since trust was also found to be correlated with the number of opt-outs, energy organizations could partner with local institutions/municipalities in order to bolster credibility (Schneller et al., 2021) or perhaps with existing energy retailers. Our findings on individuals' general previous investment experience also suggest that experienced investors are less likely to opt-out of participation. Improving financial literacy in general would allow individuals to make better autonomous informed decisions regarding participation/investment in such schemes (COMETS et al., 2022).

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

The data that has been used is confidential.

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Supplementary material

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