Preferences for community renewable energy investments in Europe: A choice experiment across 31 nations

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Abstract

This paper presents the results of a choice experiment for investments in community renewable energy (CRE) projects administered across 31 European nations. Across the full sample of 18,037 respondents, a high level of interest in the CRE investments is observed, with 79% of respondents choosing to invest in at least one of the eight investment scenarios shown to them. Along with financial concerns, operational and siting aspects of the investment options are shown to be highly relevant to potential investors. Specifically, investments that are administered as an energy cooperative and run by a local organization are strongly preferred to investments administered by utility companies. Strong heterogeneity across European nations is noted in the preference for the installation to be visible from an investor's home, and thereby potentially impact the viewshed, but on the other hand allow for feelings of pride and self-sufficiency. Results suggest that energy policies hoping to increase the uptake of the CRE model across Europe would do well to focus on supporting local organizations to build the operational capacity to administer such projects, and highlight any positive local economic impacts from renewable generation projects to potential investors.

Keywords: Energy cooperatives, community investment, citizen participation, energy transition, choice experiment

1 Introduction

Increasing the capacity of low-carbon, renewable electricity generation is seen as a key step in building a sustainable electricity grid. Encouraging private investments in such generation capacity has been the subject of much applied research and the goal of many regulatory incentive programs. For instance, in 2016 it was calculated that the EU-28 + Norway dedicates €56.76 billion annually to support the development of renewable generation sources, predominantly solar and wind (CEER, 2018). Increasing the stock of solar and wind generation capacity been studied primarily as a household adoption, or firm investment decision (e.g. Balcombe et al., 2014; Borchers et al., 2014; Sarzynski et al., 2012; Cohen et al., 2019).

However, there is an increasing interest in the potential for investments in renewable generation capacity to be made at the community level through cooperative energy arrangements (e.g. Rommel and Sagebiel, 2017; Salm et al., 2016; Funkhouser et al., 2015). These community renewable energy (CRE) projects are defined herein as a group of private citizens together investing in an electricity generation facility and earning a rate-of-return from selling the produced power back into the grid or using it to offset their own electricity consumption. CRE projects of this type are characterized most notably by collective ownership of the electricity generation resource, as similarly defined in (Nolden, 2013; Haggett and Aitken, 2015; Brummer, 2018). Such a scheme can also be referred to as an "energy cooperative," depending on the contractual and administrative specifics of the arrangement. Energy cooperatives as a social innovation are in their nascent stage but already they exhibit strong potential for growth. For example in the U.S., 119 MW of community-based capacity has been installed from 2010-2016 from 112 separate projects and 14 MW are added annually (O'Shaughnessy et al., 2016). Leading the way in this sector is the European Union, where over 1,500 energy cooperatives are up and running involving over 1 million private citizens (REScoop, 2019). However, the vast majority of currently existing energy cooperatives in Europe come from two nations with nearly 900 examples in Germany and about 300 in Denmark, making it clear that this social innovation has not yet successfully transferred across all European nations (DGRV, 2019; Danmarks Vindmolleforening, 2019). Despite heavy subsidies and regulatory incentives promoting renewable energy in the EU, renewable sources provide just 17%[1] of gross final energy consumption, which is still shy of the European Commission's 2020 goal of 20% and the 2030 goal of 32%, illustrating the long road still remaining towards a low-carbon energy system (Commission, 2018).

Citizen participation in energy cooperatives directly addresses the ambitions of the European Union (EU) Strategic Energy Technology (SET) Plan for the energy transition to increase the role of 'prosumers' in the energy system, citizens that both consume and produce energy, and to increase participation in the energy transition (European Commission, 2017). Community-based investments have four benefits over and above the more traditional single-entity investment framework:

1. Smaller investment amounts across many individuals can help overcome the large initial capital requirement that has been identified as a major barrier to renewable generation investments amongst private entities (Branker et al., 2011).

2. Community-based investments can alleviate social equity concerns regarding the renewable energy transition by allowing individuals who would not be able to invest alone to participate in the investment opportunity and in the renewable energy market (EnergySage, 2017). For example, many households have no option to invest in solar PV units either due to income constraints or the lack of a desirable location for PV, such as a suitable rooftop on a building that they own.

3. Community-based renewable energy installations generally lower the per-unit cost of capacity purchases and increase the per-unit revenue by utilizing economies-of-scale and installing the generation facility in an optimal location (Funkhouser et al., 2015).

4. Community-based investments can decrease local opposition to energy infrastructure projects, which has become a substantial hurdle for the energy transition in Europe (Langer et al., 2017; Loring, 2007; Commission, 2018).

Given these noted benefits, and the parallel aims of increasing 'prosumerism' and citizen engagement with their energy use, community financing of renewable generation capacity has high potential to aid the transition to a sustainable energy system. However, questions remain regarding how best to set-up and engender participation for community-based financing schemes (Yildiz, 2014). In particular, varying degrees of success of the energy co-operative model have been noted across European nations and case studies (Loring, 2007; Bauwens et al., 2016; Toke et al., 2008; Ek and Persson, 2014).

This paper presents and explores the results from a choice experiment (CE) survey administered to citizens across 31 European nations. The CE is designed to assess respondents' interest in participating in a community-based investment in a wind or solar energy installation and to investigate what attributes of such investments are most favorable. The goals of the exercise are to better understand the preferences of potential investors for attributes of renewable energy schemes, and evaluate heterogeneity across nations with regards to these preferences. The results can be used as a guide to spreading the idea and uptake of CRE projects as a mainstream concept across Europe, and to gain further understanding into households' financial and energy-related behaviors.

1.1 Background

CRE projects have received much attention in recent years, most notably in the EU, a trend that should continue with the adoption of the Clean Energy for all Europeans package in 2019, wherein energy communities play a central thematic role. This package aims to provide the organisational, legal and regulatory framework for the set-up and operation of such communities within the existing national energy markets. For this legislation to succeed participation in CRE investments will need to increase and spread across Europe.

Households consider joining a CRE project as a way to reduce energy costs and create revenue, but also to deliver additional, societal and environmental benefits at both the local and global scales (e.g. Becker et al., 2017; Bauwens et al., 2016; Brummer, 2018). The motivations behind joining a CRE are as diverse as these potential benefits. For example, Doci and Vasileiadou (2015) show that, next to economic and normative (such as addressing climate change) considerations, social factors, such as having fun and being integrated in a community, play a role in the participation decision. Their work analyses individual motivations for partaking in local renewable projects and generating energy jointly in Germany and the Netherlands. The importance of the social dimension is emphasised by Hoffman and High-Pippert (2010) who conclude that [e]ven very visible personal benefits such as lower electric bills do not provide the same degree of motivation as do more amorphous community benefits. This conclusion is echoed in other case studies of community energy initiatives (e.g. Holstenkamp and Kahla, 2016; Becker et al., 2017; Sloot et al., 2019). In contrast, Fleiss et al. (2017) argue that the adoption of community solar projects in Austria is mainly driven by financial factors.

In an effort to classify the various motivations for joining a CRE Bauwens (2016) distinguishes the institutional, innovation diffusion, and spatial dimensions as relevant to whether environmental or material incentives are the predominate factors in joining CRE projects. Nolden (2013) looks deeper into national institutional frameworks and how they can influence the spread of privately (co-)owned community energy projects. The comparitive case study in Nolden (2013) of the British and German development of CRE suggests the need for a diversification of policy instruments, going beyond the implementation of single, specific policy measure in order to foster the rise of community energy projects. Similar findings are given in Koirala et al. (2016), and Holstenkamp and Kahla (2016). Changes in the institutional frameworks will not only affect energy-related businesses, whose mode of operation is undergoing a significant and profound change, but will also need to accommodate new entities and energy market participants, such as coopertives (Roby and Dibb, 2019; Gorrono-Albizu et al., 2019; Brummer, 2018). In the few nations where CRE models are prevalent, the variety of societal changes accompanying the CRE model has resulted in a "double edged phenomenon," whereby growing hostility towards CRE entities develops, while CRE entities come up with coordinated strategies to deal with more hostile social and market environments (Bauwens et al., 2016).

The comparative results of the CE survey presented in this study for the first time allow for a large-scale comparison of the preferences for, and interest in, CRE investments across 31 European nations. These data and insights can help to understand the heterogeneity observed across previous studies as to the motivations for, and effects of CRE uptake, and serve to inform policies that hope to spread the CRE model to nations where it is not yet mainstream, such as the Clean Energy for all Europeans package.

2 A survey across 31 European nations

2.1 Survey methods

The CE offered respondents two hypothetical investment opportunities in each of eight choice scenarios[2]. In each scenario either a wind park or solar farm was the object of investment with four attributes that varied between choice options. A third 'opt-out' option was provided in each scenario where the respondent could refuse to invest. This ensures a feasible choice set, allowing the CE to be interpreted in a random utility framework (Louviere et al., 2010), and improves compatibility of the choice sets with respondents' incentive structures (Johnston et al., 2017).

The attributes included within each choice set are: *profit rate*, the amount of money above the initial investment that is paid out after the holding period expressed as a percentage of principle, *holding period*, the number of years until the principle and profit is repaid, *visibility*, whether or not the installation is visible from the respondent's home, and *administrator*, the group that oversees the investment, which is defined as either a utility company, community organization, or governmental entity. The investments are defined as lump sum transfers that are repaid in full at the end of a holding period, also in a lump-sum fashion. The specific vehicle of the payment was not specified as this survey was given across 31 nations with differing banking and investment infrastructures and financial customs. Leaving the payment vehicle unspecified ensures that some respondents would not view a chosen vehicle as unrealistic for their situation, which would be inadvisable (Johnston et al., 2017). A specific payment vehicle can increase the immersion of the respondent with the choice scenario, but can also lead to increases in protest or free-rider type responses (Bateman et al., 2002), which may be especially likely in the case of a 31 country survey. Furthermore, for an investment CE the standard environmental economic preoccupation with payment vehicles may be less salient, as respondents will likely believe in the credibility of an investment transfer and not consider free-riding a feasible option.

The design of the investment repayment as a one-time transfer at the end of the holding period was done to simplify the choice option presentation and allow the respondents to consider the tradeoffs in investment features without the need to calculate compound interest and make predictions about future economic climates. Specifically, this feature allows for rate of return and holding period to be disentangled, whereas if the rate of return on the investment were an annual payment respondents might prefer longer holding periods based on their expectations of future investment options in comparison to the rate of return presented in the choice option. Our study design abstracts from this more complex investment choice to give a clear tradeoff between the return on investment and the length of time funds are unavailable. While this is not the standard presentation of an investment option, such a framework is feasible has precedents; for example, permanent life insurance policies and some government bonds have a similar set holding period with lump sum payments at the time of maturity. The attributes and their descriptions are included in table 1 as shown to respondents, additionally the table shows the levels of each attribute, which was not shown to respondents.

[Table 1 about here.]

The attributes and their levels were chosen based on the findings of prior research and to be relevant to policy discussions in the EU. Profit rates can be influenced by renewable energy subsidy schemes, which are prevalent across Europe, and serve as the price attribute in our study design. We expect profit rates to be positively associated with choice probabilities, as return-on-investment concerns have been shown to be important in past studies of renewable energy investments (e.g. Crago and Chernyakhovskiy, 2017; Mills and Schleich, 2009; Lizin et al., 2016; Sarzynski et al., 2012; Jeong, 2013).

In regards to the visibility attribute, the predictions from past literature are unclear. On one hand visible wind farms can be seen as impairing the viewshed, and have been shown to decrease nearby property values (Sims and Dent, 2007; Dimitropoulos and Kontoleon, 2009). However the viewshed effects may vary strongly by landscape type (Ek and Persson, 2014), and have not negatively impacted local experiences in some cases (Warren and McFadyen, 2010). Large solar arrays can suffer from similar viewshed complaints and local opposition to siting (Brinkley and Leach, 2019; Florio et al., 2018). On the other hand nearby and visible renewable power generation may have positive effects by increasing the perception of 'green' power consumption. Past research has shown that consumers are willing to pay more for renewable-sourced power, and experience welfare gains from consumption of such (Rommel et al., 2016; Scarpa and Willis, 2010; Vecchiato and Tempesta, 2015; Cicia et al., 2012). Moreover, some consumers have preferences for locally produced power and power from distributed generation sources (Kalkbrenner et al., 2017; Rommel and Sagebiel, 2017; Sagebiel et al., 2014). Thus, the visibility of a wind farm or solar array in the respondent's local area may be associated with both the potentially negative viewshed effects, and the positive aspects of locally-sourced green power consumption, making the visibility attribute an interesting test case in our study.

Other papers have shown that the procedural aspects of collective energy arrangements matter for participation rates, most notably participation in the siting and negotiation process and community/local (partial) ownership of the generation site (Tabi and Wustenhagen, 2017; Warren and McFadyen, 2010; Ek and Persson, 2014; Kalkbrenner and Roosen, 2016; Sagebiel et al., 2014; Li et al., 2013; Salm et al., 2016; Haggett and Aitken, 2015). In the CE design all investment options are depicted as 100% community owned. However, we allow for three types of administrators of the generation technology and the investment, utility company, government entity, and community organization. We expect to see that community organizations are preferred in most nations, due to past findings that such organizations can have positive effects on renewable energy adoption and participation in group investments (Viardot, 2013; Bauwens and Devine-Wright, 2018; Noll et al., 2014).

Additional to the varying attribute levels across choice alternatives, the CE contained three other tests for effects of interest: one relating to the support of government officials, one relating to the technology used (solar or wind), and one relating to the amount of money initially required for the investment. Respondents were shown a primer script which explained the set-up and premise of the investment opportunities[3]. Randomly selected respondents were also shown one of three treatment scripts, which told them that a hypothetical local government, national government, or EU official had endorsed the investment opportunities. These treatment scripts test for a preferred policy-marketing strategy related to CRE projects, as local vs. national vs. international framings have been shown to drive acceptance of energy infrastructure (Devine-Wright and Batel, 2017; Azarova et al., 2019). Along with a treatment script, or lack thereof, respondents were randomly assigned an investment level, which stipulated the amount of money they would have to pay today in order to join in any of the offered community investment opportunities. These amounts were shown in national currency adjusted for exchange rates to be equal to 100, 500, 1000, 2000, or 5000 Euros. Respondents were then shown eight choice scenarios (sets) with three choice options in each set, and were asked to choose their most preferred option. The order of the choice scenarios shown to respondents was randomized and 3 blocks of eight scenarios were created with 24 total choice scenarios being used in the survey. An example choice scenario is given in figure 1.

[Figure 1 about here.]

A particular choice set only referenced one renewable energy technology, solar or wind, thus keeping the technology attribute constant between alternatives. This was done to avoid dominant alternatives in some nations where respondents could feel that only one of the two technologies is a credible option. For instance in the northern Scandinavian countries wind power is much more common than solar, with wind capacities of 1,565 MW and 6,434 MW and solar capacities of 35 MW and 153 MW in Finland and Sweden respectively, as of 2016 (Directorate General for Energy, 2019). In nations where wind greatly outperforms solar it could be seen as infeasible to make financially sound investments in solar capacity. In these cases, allowing technology type to vary between alternatives, as do the other attributes would create a strong potential for respondents to use heuristic choice patterns and automatically eliminate solar-based investment options. Such a dynamic would cause attribute non-attendance problems within the choice sets with varied technologies, as outside knowledge of the situation causes respondents to ignore certain attributes (Sandorf et al., 2017). For this reason we keep technology constant within choice sets, and present each respondent with both solar and wind-based investment options. This design still allows for statements about technology preferences, without the risk of dominant choice options in many European nations. In the conjoint analysis study by Salm et al. (2016) of German citizens willingness to join community investments, technology was allowed to vary across wind, solar and hydro within choice sets, with the finding that solar is the preferred technology. Interestingly, Germany is one nation where solar and wind technologies have nearly equal capacity installed, which could drive the Salm et al. (2016) result. This is not the norm however, as across the EU-28 wind capacity is about 50% greater than solar with 154,325 MW wind installed and 103,114 solar installed as of 2016 (Directorate General for Energy, 2019).

The experimental design for the CE uses the D-efficiency criteria where choice sets were assigned Bayesian priors for the coefficients relating choice attributes to the utility level of the respondent from making a given selection. The signs and magnitudes of these priors are based on the results presented in Salm et al. (2016) who investigated the propensity for renewable adoption based on attributes of the hypothetical energy project. The Salm et al. (2016) study did not include an attribute for the administrator of the generation facility, and instead simply specified a financial intermediary, so we set the prior parameters associated with this attribute to zero to indicate a lack of prior knowledge. In the case of the other attributes we follow the results of Salm et al. (2016) and impose weak priors that favor positive coefficients on the profit rate and visibility attributes, and a negative coefficient for holding period. Since we specify that some parameters are more likely to take a certain sign via priors, our study design should minimize the occurrence of dominant alternatives (Crabbe and Vandebroek, 2012). The survey underwent a pre-testing phase that included Austrian, German, Norwegian, and Italian respondents, where feedback was requested. Respondents did not report any substantial problems with the framing of the choice task or with understanding the attributes, though minor changes were made to the visualizations of the investment options as a result of pre-tester feedback.

Since many survey participants may not have real-world experience with investments in renewable energy, or other investment vehicles, there is a concern for hypothetical bias in the responses to the CE that could stem from either uncertainty regarding the product, or an overestimation of their own willingness to commit time and money to participating in a real CRE. In this case hypothetical bias might lead to positive responses to investment options, whereas when confronted with the same investment opportunity in real-life a respondent would decline to invest. This is analogous to the common concern over hypothetical bias in non-market WTP studies whereby respondents inflate their true WTP (Loomis, 2014). The context of our study differs from more common uses of CE methods that directly assess WTP for a non-market good, whereas we assess interest in investment options and derive WTP for attributes of the investments. Thus, we address hypothetical bias using an uncommon tactic whereby a follow-up question to the choice experiment is included in the survey, as reproduced below:

> Are you interested in the possibility of a real investment in renewable energy? If so, we could forward your email address to respected companies that offer community-based investments in green power. Your email would be used for sending you investment opportunities, while you can withdraw your confirmation to receive such offers at any time.

Response options to this question were "No", or "Yes, forward my email address to an investment company offering such options".

Asking respondents for their email contact imposes a cost on their choice, albeit a small one. This question also introduces community investments as a real-world possibility, increasing the perceived consequences of the choice (Holmes et al., 2017). We then follow an *ex ante* data screening approach to reduce hypothetical bias as exhibited in the stated preference literature (Loomis, 2014). Respondents who exhibit improbable response patterns are dropped from the sample and the choice models are re-estimated with the reduced sample as a robustness check. We deign respondents who accept all investment options and do not give their email, or those who reject all investment options and give their email, as subject to hypothetical bias. The implications of this data screening approach are explored in section 4.3.

2.2 The survey sample

The survey was administered over 31 European countries by the market research company Ipsos. The survey was presented to respondents over the internet in their native language with all monetary values translated from Euros into an equivalent value of national currency. About 600 respondents were recruited in each nation from maintained survey panels with a total sample of 18,037 completed surveys. The country specific respondent counts and the geographic coverage of the survey are shown in figure 2. A representative sample from each nation's population was ensured via quota sampling methods in the dimensions of income, age, and gender. The quotas were filled based on pre-survey screening questionnaires, which are maintained and administered by the survey panel companies. The success of the quota methods are verified in table 7 for the dimensions of income, age, and gender. Respondents were compensated with 5 Euros upon completion of the survey. The full survey took about 20 minutes to complete and also obtained information of the respondent's socio-demographics and environmental/energy-related values and behaviors.

[Figure 2 about here.]

For the purpose of this analysis, the socio-demographic information, including the attitudes, and beliefs of respondents, was distilled down into the variables shown in table 2. Specifically, socio-demographic information is captured by the respondents' age, gender, employment status, education level, income, and household composition. Income information was collected from respondents as five categories based on the quartiles and the 90th percent quantile of national household income statistics[4]. The categorical incomes were converted to a continuous *income* variable, summarized in table 2, by taking the midpoint of each nation-specific category as a respondent's income estimate and converting to euro equivalents using average 2018 exchange rates for non-Euro Zone nations. The histogram of the *income* variable in the full sample is given in figure 3 showing a skewed right distribution with a mode of 1,000 Euros per month net income, a median of 1,500 and a mean of 2,000.

[Figure 3 about here.]

We expect disposable income, education, and life-cycle elements to drive interest in community investment options, as has been found with personal renewable energy investments (e.g. Schelly, 2014; Sarzynski et al., 2012; Botelho et al., 2017). Location-based aspects of each respondent are captured by an indicator for respondents living in areas with over 10,000 inhabitants, and a suite of tranche variables for how long the respondent has lived in the area. These elements can relate to the siting possibilities of the CRE project and 'place attachment' concerns, whereby citizens may be less accepting of changing the landscape in locations they have grown attached to (Bauwens and Devine-Wright, 2018; Devine-Wright and Clayton, 2010; Devine-Wright and Batel, 2017). Finally, environmental beliefs and attitudes are captured by four self-reported variables including, pro-environmental self-image, beliefs that renewable energy is positive for the environment or for employment, and belief that climate change is anthropogenic. Such beliefs have been shown to be important determinants towards acceptance of local renewable energies (e.g. Dimitropoulos and Kontoleon, 2009; Schelly, 2014; Bauwens, 2016).

Selected variable means are compared across the 31 sample nations in table 8. Many of the variables in table 8 are dummy variables, taking a value of either 0 or 1, the means of these variables represent the proportion of the sample that fall into the referenced group, or answered affirmatively to the referenced belief. Urbanism, as measured by living in a town with more than 10,000 inhabitants, varies across the nations in our sample with Turkey being the most urban (98%), and Luxembourg (29%) and Switzerland (47%) being the least urban, as it is common in these nations to live in small villages around the cities. The proportion of respondents with full or part time employment is relatively consistent across nations. On the other hand, the proportions of respondents with university degrees is highly dispersed between nations, and interestingly some of the higher income nations show lower values in this variable. This likely reflects the difficulty in translating education levels across languages, and cultures, as some nations, for example Austria and Switzerland, have many equivalent higher-education degrees that are not considered "university" degrees. Thus, we must interpret the results with respect to this variable with care when making inference or comparisons in a multinational context.

Perhaps most interesting is the comparison of attitude/belief variables between nations from table 8. The *renewables environment*[5] variable is relatively consistent across nations (std. dev. of 10.27 percentage pts.) with a mean value of 82%, showing that Europeans generally believe that the transition to renewable energies will benefit the environment. In contrast, the belief that renewable energy transition will create jobs is not as prevalent, with a mean of 56% across nations, and is slightly more heterogenous between nations (std. dev. of 11 percentage pts.) with over 80% of the respondents in Portugal and Turkey professing this belief while only 33% and 40% of Swedish and Danish respondents hold this belief, respectively. Similarly, the *environmentalist*[6] variable exhibits some heterogeneity across nations (std. dev. of 12.4 percentage pts.), with an overall mean of 63% and lower figures in Sweden and Norway of 33% and 43% respectively. Finally, the figures for the variable *climate change anthropogenic*[7], suggest that just over half of Europeans believe that rising temperatures are mostly due to human activities as opposed to natural causes, and this variable is more stable across nations (std. dev. of 9.8 percentage pts.).

[Table 2 about here.]

2.3 Descriptive analysis of the choice experiment responses

As a first look at the response data to the CE scenarios is given in figure 4 with the observed proportion of respondents that chose to invest in at least one investment option across the eight choice scenarios, and the proportion who gave permission for their email to be used for follow-up offers in each nation. In Appendix 2, the country-wise data used to build figure 4 can be seen in table 9, where the figures are further broken down by respondents who gave their email address to receive follow-up information about real investment options and those that did not, as described at the end of section 2.1. Asking respondents to give their email address for follow-up contact is a way to assess, and address, hypothetical bias in responses as the provision of an email address shows a concrete interest in real-world investments in CRE projects. Over the full sample, 79% of respondents preferred an investment option in at least one choice scenario. This figure rises to 92% of respondents who chose to give their email address and falls to 67% of respondents who did not give their email. With respect to hypothetical bias, we interpret these results to mean that the sub-sample of respondents who gave their email are robust to this concern, as nearly all respondents in this group affirmed their interest by preferring an investment option in at least one choice scenario. On the other hand, the sample of respondents that did not provide their email may exhibit hypothetical bias, since 67% of them still answered affirmatively to an investment option in at least one choice scenario. However, this finding could also be explained by respondents not believing that real-world investments are possible that mirror the attributes of their preferred options, or time constraints of respondents if they believed that they would actually have to enter, or perhaps verify, their email, which was not the case. Overall, an investment option was chosen over the opt-out option in 57% of choice scenarios, 70% of scenarios for those that gave their emails and 45% for those that did not. In total, 48% of respondents chose to provide their email. This question seems to be a good indicator for interest in CRE investments, as the country-level percentages of email provision are highly correlated with the proportions of positive responses in the full sample, as is evident in figure 4[8].

[Figure 4 about here.]

Next we examine the rate of positive responses in relation to the financial variables that define each choice scenario. The first of these variables is the profit rate of a given choice alternative. Figure 5 shows the relationship between the profit rate of an investment option and the proportion of investment options with this profit rate that were chosen. Figure 5 only uses profit rate data from the two choice options in each scenario that gave an investment option and omits all of the opt-out options that by default have a profit rate of zero. Also note that for some choice sets both investment options have the same profit rate. If one of these options is chosen then the other option is not chosen, leading to a selection rate of 50% of this profit rate in this choice scenario. Figure 5 shows the strong positive relationship between offered profit rates and the acceptance of the investment option, as expected. We interpret this as a sign that respondents were focused and cognizant during the choice tasks and that their observed choices follow a rational preference structure. The high levels of interest in CRE investments observed in the CE may also be explained by the relatively favorable profit rates available in some of the choice options[9].

[Figure 5 about here.]

For the first time in a CE of renewable energy adoption, we test the effects of initial investment requirements on the propensity to join the energy cooperative. In the context of CRE projects, such a concern is especially poignant, as administrators of the scheme bear a cost from on-boarding each investor and may impose minimum investments to reduce this cost. Similarly, participants in CRE bear a time cost from administering the investment on their side, for example by monitoring the transfer of funds, the progress of the project, and taking part in any referendum or group discussion. On the other hand, maximizing the overall investment amounts obtained allows for greater economies-of-scale and more renewable energy capacity to be installed, making it desirable to obtain more funding and more investors for a given CRE project, in general. Thus, understanding this interplay and the preferences for investors with respect to minimum investments is a critical issue in growing the CRE market, especially given the heterogeneity in European nations with respect to disposable income and financial culture. Within our CE framework, the initial capital investment is paid in full today, and paid back in full plus any profit earned at the end of the holding period. As noted above this implements a simplified double-lump-sum payment vehicle that enables respondents to more easily internalize the costs and benefits associated with a given investment option. We make an initial inquiry into the effects of investment requirements in figure 6, which gives the proportion of choice sets where an investment option was chosen over the opt-out option by investment requirement.

Of interest in figure 6 is that the proportion accepting the investment decreases with higher investment requirements, with the exception of the last step from €2000 to €5000. If the effect of investment requirement on acceptance was linear, a large decrease in acceptance would be expected for the highest investment requirement, which is decidedly absent. This may signify the existence of a u-shape, or trough, in acceptance levels for higher investment requirements. This would occur if some respondents only find it worthwhile to bear the time and administrative costs of a CRE investment if they can invest a significant part of their capital into the project. At the very least figure 6 suggests a non-linear effect of investment requirement, which we take into account in the choice models as show in section 4.

[Figure 6 about here.]

3 Choice probability model

The CE presented herein can be grounded in random utility theory (RUT) due to the presence of an opt-out option, which ensures a feasible choice set (Louviere et al., 2010). RUT holds that while individuals know their utility with certainty, there is random error when observing this utility level on the part of the researcher. Following the common assumption that utility is linear in explanatory variables (Holmes et al., 2017), we can specify a respondent i's utility level U_{ij} from choice option j as in (1).

$$U_{ij} = \boldsymbol{\beta} X_{ij} + \alpha_j Z_i + \epsilon_{ij} \quad j \in S \tag{1}$$

Where X_{ij} is a vector of alternative-specific variables that reflect the attribute levels of alternative j, as shown in table 1, and Z_i is a vector of choice set specific variables, including respondent characteristics, the technology (solar or wind) referenced and the capital requirement randomly assigned to the respondent. We will observe alternative j selected as the most preferred option out of choice set S if the condition in (2) holds.

$$U_{ij} > U_{ik} \quad \forall k \neq j \in S \tag{2}$$

The RUT model in (1) becomes an estimable statistical model when an assumption is made about the structure of ϵ_{ij} and when U_{ij} is conceptualized as a latent quantity that is not fully observed, but is related to observed choices as in (3).

$$\begin{aligned} v_i = A \quad iff \quad U_{iA} > U_{ik} \quad \forall k \neq A \in S \\ v_i = B \quad iff \quad U_{iB} > U_{ik} \quad \forall k \neq B \in S \\ v_i = C \quad iff \quad U_{iC} > U_{ik} \quad \forall k \neq C \in S \end{aligned} \tag{3}$$

Where v_i is the observed choice of respondent i for choice set S, and A, B, and C correspond to the three choice alternatives in each choice set from our CE as explained in section 2.1. Specifically, options A and B correspond to hypothetical investment opportunities that were offered to respondents, and option C is the opt-out option, when no investment is preferred. We assume that ϵ_{ij} is normally distributed leading to a mulitnomial probit model. The model can now be expressed as the probability a given option is preferred as a function of the alternative-specific and choice set specific variables as in (4).

$$Prob\big[v_i = j\big] = Prob\big[\boldsymbol{\beta} X_{ij} + \alpha_j Z_i + \epsilon_{ij} > \boldsymbol{\beta} X_{ik} + \alpha_k Z_i + \epsilon_{ik}\big] \quad \forall k \neq j \in S \tag{4}$$

The model is operationalized by setting a base alternative, which we choose to be option C, the opt-out response. Thus the α_j vector is set to 0 when $j = C$ and we interpret the coefficients of the model with respect to the change in probability of the option C being the preferred option. For each respondent i we observe the preferred choice option from amongst options A, B, and C in eight choice scenarios. Respondents were reminded to consider each scenario separately, such that investment options chosen are not cumulative, and the order the choice scenarios were presented in was randomized. The model error variance terms ϵ_{ij} are clustered at the respondent level such that the within-cluster mean is assumed to be zero.

We test the independence from irrelevant alternatives (IIA) assumption via Hausman test and find that this assumption is likely violated. Thus, we employ the multinomial probit model with alternative specific constants as our model of choice, which avoids making the IIA assumption (Paetz and Steiner, 2018). We specify a respondent's latent random utility from choosing a given option as a function of the household variables shown in table 2, and the attributes of the choice options shown in table 1, including the required investment level, treatment script applied (if any), and technology (wind or solar) offered.

4 Results

4.1 Full sample results

The multinomial probit model in (1) is estimated using the full sample of choice scenario responses from 18,037 respondents across 31 European nations. We first consider the parameter estimates relating to the variables in Z_i that are constant within a choice scenario. The results are presented in table 3 as marginal effects of a one unit increase in the referenced variable on the probability that a respondent chooses option A or B in a choice scenario over option C, the opt-out response. Positive marginal effects thus signify that a variable has a positive effect on the attractiveness of an investment option. The results indicate a slight preference for wind energy across the sample, and no effect from the opinion leader treatment variables, on average. The results with respect to these variable are likely to be heterogenous across nations and thus will be investigated further in the country-specific models presented in section 4.2.

The estimated marginal effects of the investment requirement reinforce the descriptive results in figure 6, namely that smaller investment requirements meet with higher acceptance on average across the sample. We do not find a statistical distinction in the probability of acceptance between asking respondents for a €1000 investment and a €5000 investment. This suggests that cooperatives with the goal of engendering high participation allow minimum investments at the €500 level or below, but that cooperatives trying to maximize funding achieved could set a minimum investment requirement near the €5000 level. Our study is the first where CRE investment requirements were allowed to vary across choice scenarios. Overall, the findings suggest that respondents do respond to investment requirements and that setting empirically-informed minimum requirements could help to accomplish the goals of the cooperative. However, further research would do well to test a wider scale of minimum funding levels to check for the non-linear effects and a potential u-shape of acceptance with respect to investment requirement, as alluded to in figure 6.

[Table 3 about here.]

The respondent characteristics tested in table 3 generally show strong effects on choice probabilities. Older respondents are significantly less accepting of investment options than respondents in the 18-34 year range, possibly suggesting that younger groups are more open to the idea of group financing as a social innovation. Interestingly, the years spent living in the area only shows a positive effect on investment interest in the 5-10 year group, while those who have lived over 10 years in their area do not exhibit lower acceptance of the investment options, as may be predicted from feelings of 'place attachment', whereby people oppose changes to their local areas they are accustomed to (Devine-Wright and Batel, 2017). Males, employed persons, university graduates and respondents from more populated households have higher probabilities of accepting investment options, perhaps due to a greater interest in personal finance and willingness to make long term investments on the part of these groups. In terms of the stated belief variables tested as covariates, beliefs that renewable energy improves the environment and adds jobs, and self-identification as an environmentalist are all positively associated with accepting the investment options. This shows that joining a CRE cooperative is a way for individuals to express their self-identity as environmentalists. However, the belief in renewable energy as a job creator is a much stronger predictor of investment acceptance than the belief that renewables improve the environment[10]. This shows the importance of highlighting ancillary economic benefits of the CRE project that appeal to the social responsibility concerns of potential investors beyond environmental issues. Corroborating this finding is the fact that individual's beliefs of the causes of climate change are not shown to influence their decision to join a CRE.

Results pertaining to the choice option attributes begin with the effect of profit rate. Over the full sample the marginal effect of a one unit increase in profit rate is estimated to increase the probability of choosing options A or B over option C by 0.8% (std. err = 0.0075%, p-value = 0.00). The other attributes of the choice options are analyzed in terms of the The willingness to pay (WTP) in forgone profit rate percentage points for one unit changes in the attribute values. WTP is calculated as $\frac{-\beta_k}{\beta_c}$, where β_c is the coefficient related to the profit rate variable, and β_k is the coefficient from the other attribute variable listed. Thus, this calculation gives the compensating variation in terms of the change in profit rate needed to offset a one unit increase in the considered attribute and keep the respondent at the same utility level, on average. The 95% confidence intervals for WTP estimates are calculated via the delta method[11], where the large sample in our study validates the asymptotic normality assumption of the WTP random variable (Hole, 2007a).

[Table 4 about here.]

4.2 Country-wise results

One of the novelties of this CE data is the large geographic coverage of responses from 31 European nations. This makes it possible to uncover preference heterogeneity in CRE investments amongst European citizens in the hope of better understanding the varied success of the CRE model across Europe (Loring, 2007; Bauwens et al., 2016; Toke et al., 2008; Ek and Persson, 2014), and improving the uptake of this model in underdeveloped CRE markets.

Country-specific probit models of equation (1) are estimated, one per nation, using only the choice responses from participants within a given nation. The marginal effects estimates for selected variables from these country-specific model runs are given in table 5. The estimates reveal significant heterogeneity in the effects of opinion leaders from governmental levels, as represented by the treatment scripts that stated a governmental official recommended the CRE investments (See Appendix 2). In particular, the results show that Czech and Danish respondents were less likely to accept an investment option after being told that local or national officials support these options, while Germans and Norwegians responded positively to the support of a local politician. For the Czech respondents this result may be driven by general mistrust of government, as 82% of Czech citizens indicate that they have either, 'not very much' or 'no' confidence in government according to the European Values Study[12]. Denmark has a long history of wind energy production and is one of the two nations, the other being Germany, where the idea of CRE wind farms has taken off (REScoop, 2019). However, in 2009 Danish legislation was put forward to 'solve' the issues around local opposition to wind parks and to promote the CRE model (Johansen and Emborg, 2018). Our finding of a lower Danish willingness to invest in CRE options supported by local or national officials may indicate a backlash from these policies, as was identified as the "double edged phenomenon" in Bauwens et al. (2016). It is also of interest to note that the only positive effects from EU-level opinion leaders are detected in the non-EU countries of Norway and Turkey. These nations usually assume the role of following EU policy even so they are not under a strict obligation to do so, and our results suggest that Turkish and Norwegian citizens may take a similar route in following EU opinion leaders.

In terms of the preferred technology, the country-specific results show that the slight general preference for a wind investment over a solar investment is primarily driven by respondents in a select few nations, Austria, Greece, Spain, the Netherlands, and the UK. All of these nations have relatively high proportions of electricity generation from solar sources[13], suggesting that a familiarity effect may exist whereby respondents are less interested in investing in common technologies.

From the selected marginal effects in table 5, the most consistent effect across nations is that of the belief that renewable energy creates jobs, which is positive and statistically significant in all but five nations. This highlights the importance of ancillary benefits in gaining acceptance for aspects of the energy transition, as has been shown in previous large-scale international surveys in the EU (e.g. Cohen et al., 2016, 16b). A key takeaway from this study is the suggestion to stress the regional employment and economic stimulus benefits of CRE options to potential investors.

[Table 5 about here.]

To further explore potential CRE preference heterogeneity across European nations we estimate country-specific WTP for the attributes of the choice options from country-specific multinomial probit model runs. The results of this process are collated in table 10 in Appendix 1, where a positive WTP indicates the attribute is preferred and a negative value indicates that the attribute is a disamenity. The WTP for a longer holding period is strongly negative in all nations, indicating an implicit discount rate for energy investments exists across European citizens, as was shown in Schleich et al. (2019). Also from table 10 the preferences for administrators of the CRE installation are elicited. Utility companies as administrators are shown to be seen as a disamenity in nearly all European nations, suggesting that this business model would suffer from a lack of citizen participation. On the other hand a community organizations or government administrators are seen as positive in many European nations. Specifically for the community led initiatives, the results suggest that expanding the REScoop model (See REScoop (2019)) of supporting community organizations to undertake energy investments would improve participation in CRE initiatives in Finland, Greece, Ireland, Italy, Portugal, Romania, Slovenia, Sweden, the Netherlands, and the UK. In other nations setting up a local government entity as administrator of CRE investments is an attractive option.

The preference for a CRE installation to be visible from the investor's home varies strongly across the sample nations, with Baltic and Scandanavian citizens showing a dis-amenity value of visibility, while central and eastern European citizens see visibility as an amenity, on average. This geographic clustering of visibility preferences is illustrated in figure 7. This result could be due to the varied landscapes and viewshed valuations across European nations, as energy infrastructure has been shown to have heterogeneous impacts depending on where it is installed (Jobert et al., 2007). Similarly, the importance of spatial factors can vary across groups of consumers, as shown for latent classes of consumers in a German sample (Sagebiel et al., 2014), a finding that likely translates in to our cross-national context as well. An investigation of visibility preferences at the respondent level would be fruitful to uncover these spatial drivers, and is left to future work.

[Figure 7 about here.]

4.3 Hypothetical bias check

As a robustness check for the effects of hypothetical bias on the results we follow an *ex ante* data screening approach similar to that of past stated preference literature (Loomis, 2014). The strategy uses a follow-up question where respondents are asked to allow access to their email address so that real CRE offers could be sent to them, as described in section 2.1. From figure 4 we see that 48% of respondents provided their email, which verifies the high interest in CRE investments observed in the CE responses. Even so, some respondents exhibit improbable response patterns and are candidates for hypothetical bias. These respondents are dropped from the sample and the choice model is re-estimated with the reduced sample using the remaining data from all nations. We deign respondents who accept all investment options and do not give their email, or those who reject all investment options and give their email, as subject to hypothetical bias. Following this method 2,660 respondents are dropped from the sample, or 15% of the sample population.

The multinomial probit model in (1) is then re-estimated on the reduced sample and WTP for the attributes of the investment options are calculated as described above, with the results presented in table 6. Comparing these results to those in table 4 of the estimation with all respondents, we find nearly identical WTP estimates even when the potentially biased responses are dropped. This leads us to conclude that the estimated tradeoffs between attribute values do not suffer from hypothetical bias effects, and thus the full sample is employed in the main estimations.

[Table 6 about here.]

5 Discussion and Conclusion

Across the full sample of completed choices an investment opportunity was chosen in 57% of choice scenarios and 79.2% of respondents chose an investment option in at least one choice scenario, with heterogeneous values noted between nations. This indicates that, under the hypothetical setting of this investment choice, Europeans are generally willing to consider such investments and would accept them under the right conditions.

This paper presents the results from a choice experiment survey administered across 31 European nations. The CE investigates the interest and preferences for investments in CRE projects. Overall, the responses show high interest in such investment options with 79% of the respondents choosing an investment option in at least one scenario and choosing to invest in 57% of the scenarios. This high interest likely reflects the favorable terms of the investments, which were specified to be risk-insured, and often offered competitive interest rates. Furthermore, many European nations currently have very low or even negative interest rates[14], and/or a lack of legitimate investment options, which may allow CRE investments to fill the demand for both environmentally-positive actions, and financial securities with positive returns. The CE contained a novel check for hypothetical bias where respondents were asked a follow-up question regarding their interest in receiving real-world CRE offers via email. Encouragingly, respondents who gave consent for follow-up offers also showed a markedly higher rate of choosing to invest in the choice scenarios, suggesting that respondents were connecting the hypothetical scenarios with real-world consequences. By using the email follow-up question to remove potentially biased respondents, a robustness check for hypothetical bias is completed. The preferences for CRE attributes were shown to be robust to this concern.

The results of a multinomial probit model estimation show that younger, male, employed and university-educated socio-demographic categories are more likely to invest in CRE. Self-identification as an environmentalist and beliefs that renewable energy creates jobs and improves the environment are also strongly associated with willingness to invest. Interestingly, the belief that RE creates jobs has a much stronger positive effect than the belief that RE improves the environment, suggesting that highlighting local economic benefits from CRE projects will improve participation more so than highlighting general environmental benefits.

In terms of the configuration of the CRE scheme, higher profits and shorter holding periods on invested capital are, as expected, strongly preferred. On average across the full sample of 31 nations, the preferred administrative entity for the CRE project is a community non-governmental organization, while a utility company administrator is a strong disamentiy. This result suggests a good policy action to increase the uptake of CRE schemes would be to support local organizations with navigating the procedural and legal burdens of administering the scheme, following the REScoop model that has worked well in select EU nations (notably Denmark and Germany). Secondly, in the Salm et al. (2016) conjoint experiment of German CRE investment preferences, over 50% of respondents considered CRE investments to be relatively high risk[15]. In our CE setup, the CRE options were presented as risk-insured with guaranteed lump-sum paybacks, which may explain the higher interest shown by German respondents in our study (74% showing interest versus 51% in Salm et al. (2016)). Thus, another policy implication of this work is the importance of fostering a low-risk environment to increase CRE uptake. This includes reductions in regulatory risk through consistent policy environments and reduced market risk exposure through, for example, subsidized insurance for CRE installations.

Comparing choice model results across the 31 sample nations illuminates interesting preference heterogeneity between European nations. The effects of treatment scripts denoting the support of opinion leaders from various levels of government were not statistically significant in the full sample. However, a few select countries show a positive effect from local (Germany and Norway) and national (Cyprus) opinion leaders, while the non-EU countries of Turkey and Norway both show a positive association with the support of EU-level officials. The choice experiment also contained a *visibility* attribute, where the CRE installation is specified to be visible or not visible from a respondent's home. The *ex ante* expectation for the effect of this attribute was unclear given the competing potential effects of a negative viewshed impact (e.g. Sims and Dent, 2007; Dimitropoulos and Kontoleon, 2009; Florio et al., 2018; Brinkley and Leach, 2019), and the positive effects from the perception of consuming 'green' and local electricity (e.g. Rommel et al., 2016; Scarpa and Willis, 2010; Vecchiato and Tempesta, 2015; Cicia et al., 2012). These competing effects may be driving the results of this study that show a strongly heterogeneous effect of this attribute across the sample nations. Furthermore, this effect appears to be geographically clustered, with northern European nations showing a negative amenity value from visibility while southern and eastern nations show a positive amenity value.

Overall, the results offer policy relevant suggestions, and justify the academic and policy interest in the potential for CRE to positively affect the transition to a low-carbon energy system. Specifically, stressing the local employment gains from community investments and supporting community groups to administer the investment opportunities are shown to be promising avenues for policymakers to increase the spread and uptake of the CRE social innovation model.

Notes

[1]Value is for year 2016 from Eurostat t2020_31 data series.

[2]For the full English version of the survey and related documentation please see Reichl et al. (2019).

[3]Please see Appendix 2 for the English version of the CE script.

[4]The national statistics used come from (Eurostat, 2010) and are given as equivalised income, i.e. net household income per household member. Since these values do not correspond to a person's own understanding of their income we converted the equivalised figures into estimates of net household income following the formulas for EQ_INC given by Eurostat at each considered quantile and presented these values to respondents as the category cutoffs.

[5]This variable takes a value of 1 if the respondent answered "probably" or "definitely" to the statement "the use of more renewable energy sources will benefit the environment."

[6]The *environmentalist* variable takes a value of 1 if the respondent answered "strongly agree" or "moderately agree" to the question: "Acting pro-environmentally is an important part of who I am."

[7]The *climate change anthropogenic* variable takes a value of 1 if a respondent answered "mostly by human activities" to the question: "Assuming that the worlds temperature is rising, do you think this is caused mostly by natural causes, about equally by natural causes and human activity, or mostly by human activity?"

[8]Correlation coefficients of 0.76 and 0.60 are calculated between the 'pct. of respondents who gave their email' and the 'pct of respondents choosing to invest in at least one choice set' and 'pct. of choice sets where an investment option was chosen' series in table 9, respectively.

[9]The effective annual interest rate in the CE options ranges from 0-20% compared to German savings accounts with p.a. rates between 0.2-1%. Other European nations may have higher interest rates on savings accounts but these may come with higher risks, whereas the CRE investment was stipulated to be risk-free.

[10]Coefficients of *renewables environment* and *renewables jobs* variables are significantly different statistically, as determined by Wald test $p > \chi^2 = 0.00$.

[11] The WTP for the government administrator variable is uncovered using effects coding as in Holmes et al. (2017). The 95% confidence interval of WTP for this variable is calculated via the delta method as in Hole (2007b) with the assumption that all covariances in this calculation are zero. This assumption greatly simplifies the calculation and has the effect of slightly widening the confidence interval giving more conservative estimates of the statistical significance of the estimated WTPs.

[12]This statistic is based on the European Values Study 2017 Integrated Dataset question 38C.

[13]From Eurostat 2018 'Net electricity generation' dataset (#16_107100B, #16_107105C): Greece generates 7.5% of electricity from solar, Spain 4.7%, UK 4% and Netherlands 2.15%. Austria has 5% of total elec.

generation capacity from solar sources (EU nr. 543/2013, Installed generation capacity aggregated)

[14]See for example Austrian or German government bond rates for 2019, which have both been negative at points in the year.

[15]Over 50% of 1,041 respondents in Salm et al. (2016) equated the risk profile of a CRE investment with an investment in a small firm or start-up.

Appendix 1: Tables

[Table 7 about here.]

[Table 8 about here.]

[Table 9 about here.]

[Table 10 about here.]

Appendix 2: Survey Script

Below is reproduced the English version of the introductory script for the choice experiment as it was shown to respondents.

> *Imagine you are being offered the opportunity to buy a share of a renewable electricity project that will cost you [randomly assigned capital requirement] EUR [or natl. currency].*
>
> ***You choose*** *to invest in the presented opportunities or not. If you choose to invest you would have to pay [capital requirement] today.*
>
> ***You get*** *to own a part of a solar or wind power plant that is co-owned by you and other private citizens. The power plant sells carbon-free renewable power into the electricity grid to make money over time.*

You are paid *back your initial investment plus any profits made from selling the power. You get one lump-sum payment after a period of time called the "holding period".*

[75% of respondents additionally saw the following treatment paragraph, which had three versions differing based on the government entity specified.]

Suppose also that [your municipalitys / the country you live in's / the EU's] government recommends these projects as a good way to increase the penetration of renewable electricity and contribute to the renewable energy transition.

[After the table of choice option attributes and their descriptions the following paragraph was shown:]

Please select your most preferred option for each of the questions below. Please consider each question separately, such that A and B are the only community renewable investment options available to you in each question.

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Figures

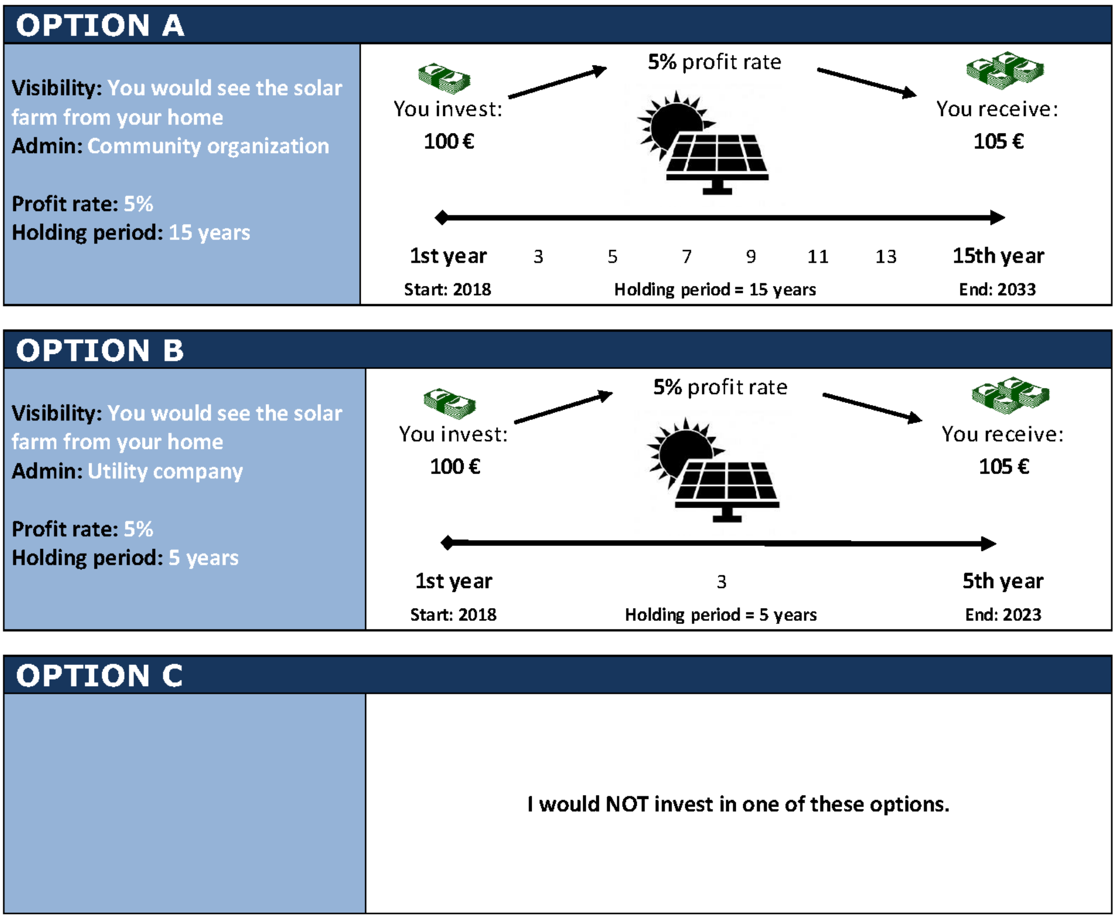
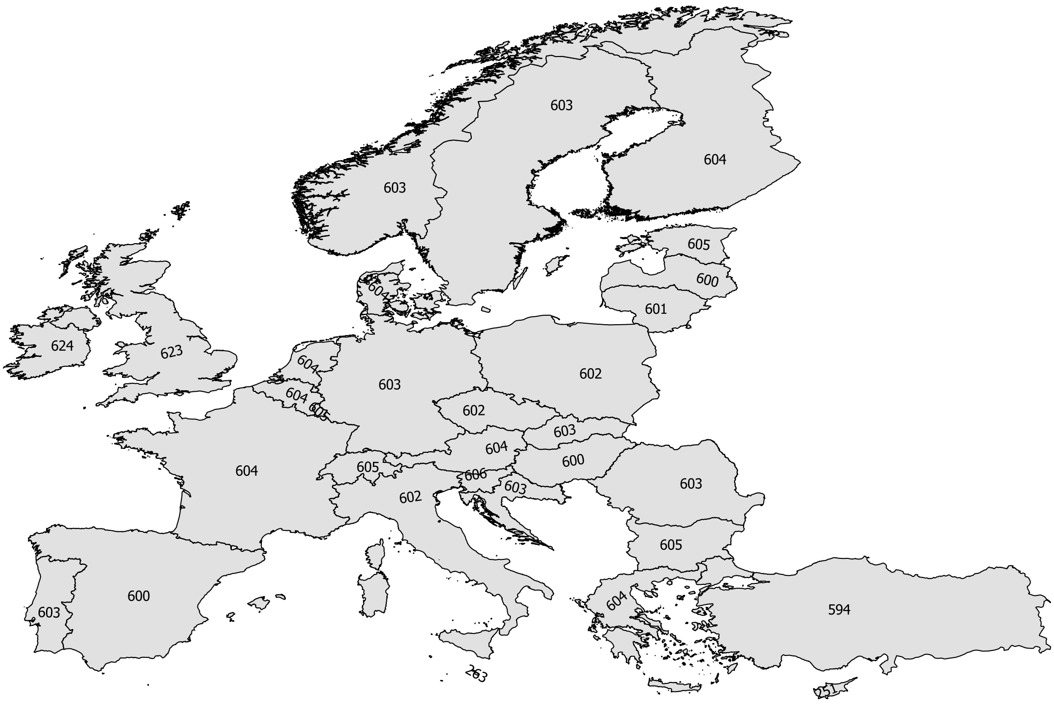


Figure 1: Example choice scenario from English version of the survey

Figure 2: Survey sample nations and total respondents in each nation



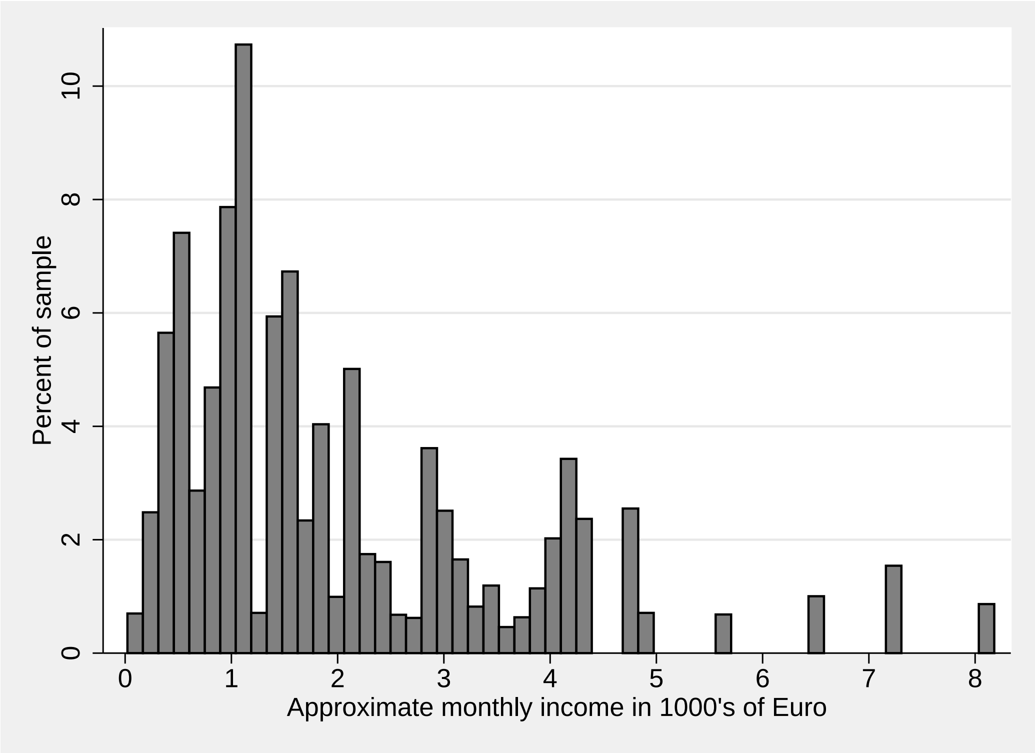


Figure 3: Histogram of *income* variable across full sample of survey respondents

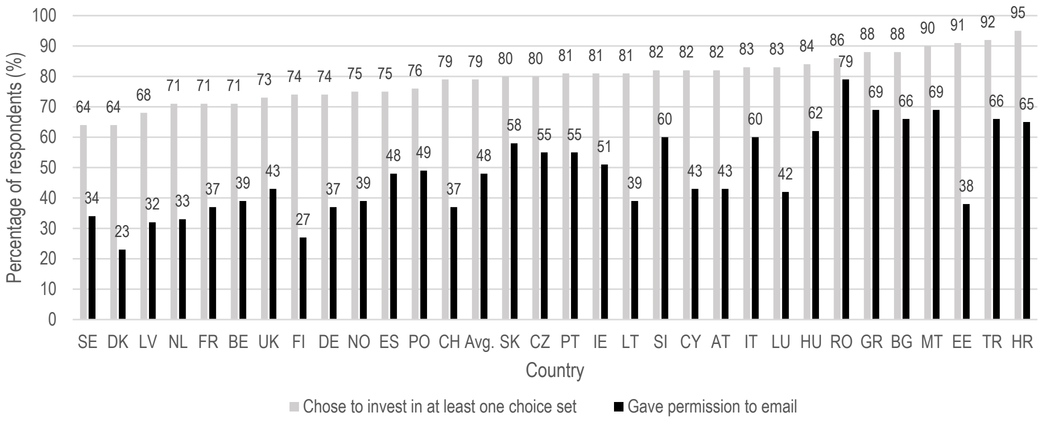


Figure 4: Percentages of respondents choosing to invest in at least one hypothetical investment and giving permission for email follow-up offers

Figure 5: Percentage of available investment options receiving a positive response by profit rate

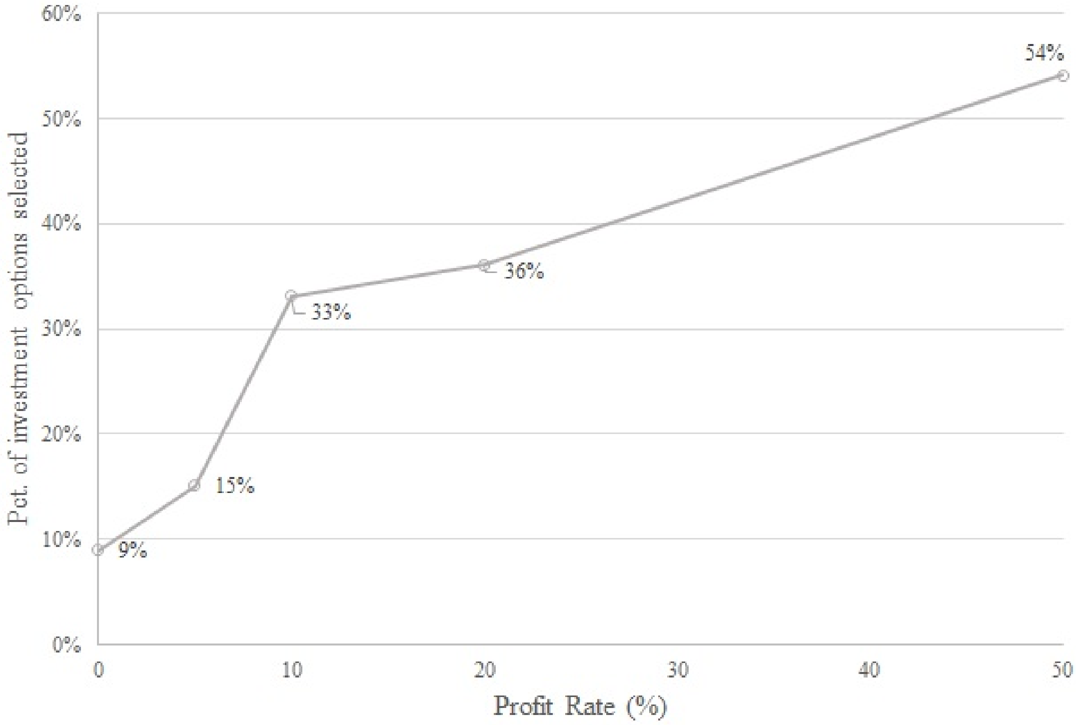


Figure 6: Percentage of positive responses to investment scenarios by investment requirement

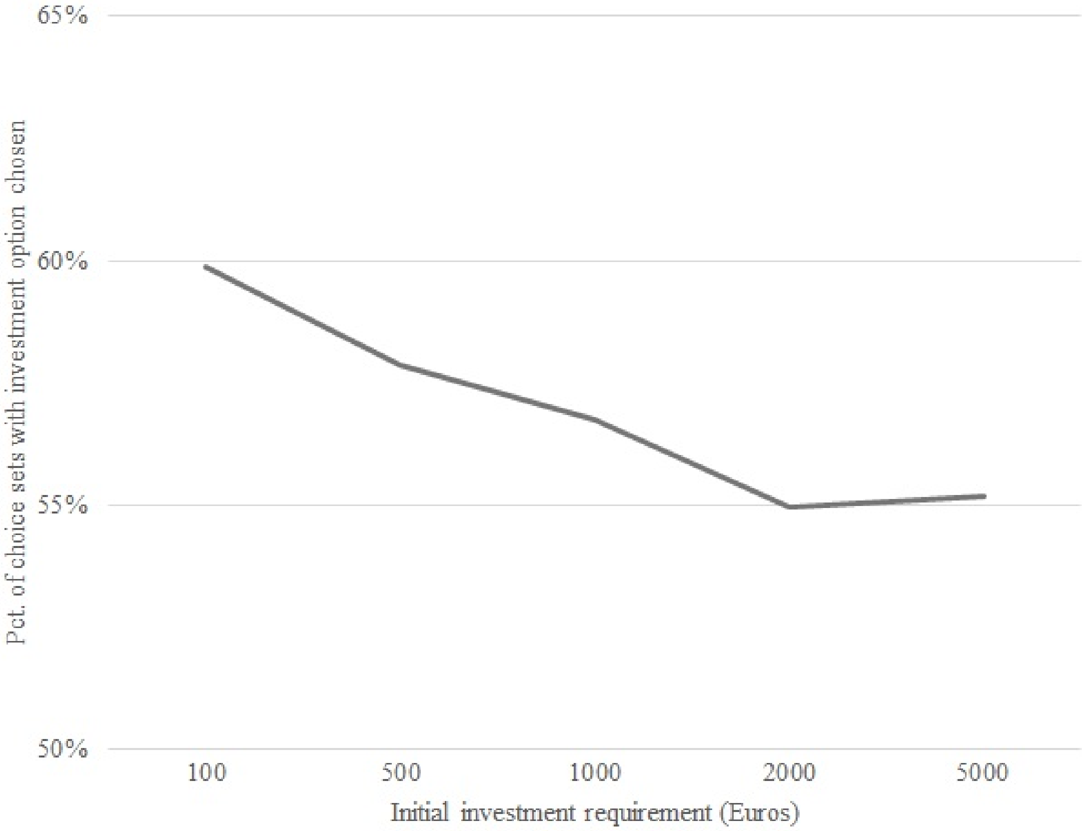
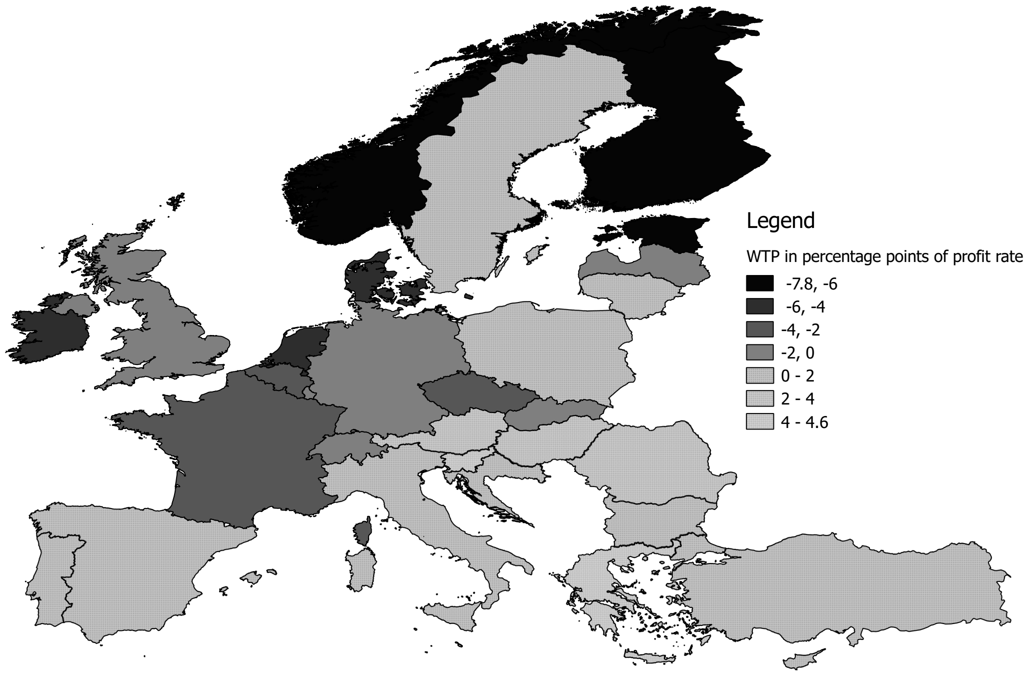


Figure 7: Average WTP in percentage points of profit rate for a visible CRE installation



Tables

Table 1: Attribute levels and descriptions

Attribute	**Description**	**Levels**
Profit Rate	The percent of money you get on top of your initial investment. For example if the profit rate is 10% then you receive the equivalent of: **100 EUR profit + your 1,000 EUR = 1,100 EUR*** at the end of the holding period. Consider this a risk-free investment, where the profit rate is a real rate that already accounts for inflation.	0%, 5%, 10%, 20%, 50%
Holding Period	The number of years until you get your money back, including any profits.	5, 10, 15 years
Visibility	If the proposed wind or solar park is visible from your home.	visible or not visible
Administrator	The group that handles your investment and is in charge of building and running the power plant. This can be either a community organization, which is a group of private citizens, a utility company, which is a company that provides energy, or a government entity.	community organization, utility company or government entity

* the amount shown in this calculation varied based on the capital requirement randomly assigned to the respondent, and the relevant currency.

Table 2: Respondent characteristics included in the choice models

Variable Name	Description	Mean	Median	Min	Max
age 18-34	respondent age 18-34	0.35	0	0	1
age 35-44	respondent age 35-44	0.23	0	0	1
age 45-54	respondent age 45-54	0.20	0	0	1
age 55+	respondent age 55+	0.23	0	0	1
urban	=1 if respondent lives in town with less than 10,000 inhabitants	0.69	1	0	1
male	=1 if respondent identifies as male	0.51	1	0	3
years1	respondent has lived in their area for 5 years or less	0.28	0	0	1
years2	respondent has lived in their area for 5-10 years	0.18	0	0	1
years3	respondent has lived in their area for 10-20 years	0.21	0	0	1
years4	respondent has lived in their area for more than 20 years	0.32	0	0	1
household size	number of residents in the household	2.74	3	1	6
kids	=1 if there are children under age 14 in the household	0.60	1	0	1
employed	=1 if person is full or part time employed	0.62	1	0	1
university	=1 if respondent has univeristy or equivalent degree	0.48	0	0	1
income	estimated net monthly income based on income tranches in €1000's	2.02	1.5	0.02	8.18
renewables environment	=1 if person believes renewable energy will benefit the environment	0.82	1	0	1
renewables jobs	=1 if the person believes renewable energy creates jobs	0.56	1	0	1
environmentalist	=1 if the person is self-reported pro environmental	0.64	1	0	1
climate change anthropogenic	=1 if person believes climate change is mostly anthropogenic	0.55	1	0	1

N = 18,037 respondents
These variables populate Z_i matrices from (1); Z_i also contains an indicator for the technology referenced in the choice set, a suite of 4 indicators for the capital requirement level randomly assigned to the respondent, indicators for the treatment script a respondent may have seen, and country fixed effects in some models.

Table 3: Marginal effect estimates of respondent and choice scenario variables on the probability of accepting an investment option

Variable	**Marg. Eff.**	**p-value**
Scenario and survey version variables:		
investment req.[†]*: €100*	0.053***	0
investment req.: €500	0.029***	0.003
investment req.: €1000	0.015	0.117
investment req.: €2000	-0.005	0.603
solar technology	-0.009***	0
municipal treatment	-0.003	0.704
country treatment	-0.003	0.767
EU treatment	0.0003	0.975
Respondent characteristics:		
age[††] *35-44*	-0.075***	0
age 45-54	-0.112***	0
age 55+	-0.147***	0
urban	0.009	0.23
male	0.091***	0
years2[†††]	0.036***	0
years3	0.021	0.026
years4	0.015	0.105
household size	0.014***	0
kids	-0.001	0.898
employed	0.038***	0
university	0.046***	0
income	0.005	0.127
renewables environment	0.034***	0
renewables jobs	0.11***	0
environmentalist	0.094***	0
climate change anthropogenic	0.007	0.306

Variables shown comprise the Z_i matrix in (1), Z_i also includes country fixed effects terms and alternative specific constants that are omitted for brevity.
N=432,888 choice options observed over 18,037 respondents and 31 European nations; marginal effects gives the change in predicted probability of a respondent selecting investment options A or B over option C, the opt-out option.
*** denotes statistical significance at $\alpha = 0.01$, ** at $\alpha = 0.05$, * at $\alpha = 0.1$
[†]interpreted relative to the omitted category *€5000*; [††] interpreted relative to the omitted category *age 18-34*; [†††] interpreted relative to the omitted category *years1* (<5 years living in current area)

Table 4: WTP in percentage points of profit rate for attributes of CRE investments

	holding period	visible installation	community administrator	utility company administrator	government administrator†
WTP Est.	-2.49	-0.09	3.77	-3.88	0.11
95% CI	(-2.56, -2.42)	(-0.52, 0.34)	(3.44, 4.11)	(-4.19, -3.57)	(-0.34, 0.55)

N=432,888 choice options observed over 18,037 respondents and 31 European nations; marginal effects gives the change in predicted probability of a respondent selecting investment options A or B over option C, the opt-out option.
†The WTP calculation for the government administrator is given in footnote [11].

Table 5: Countrywise marginal effect estimates of respondent and choice scenario variables on the probability of accepting an investment option

Country	*Solar Technology*	*Municipal Treatment*	*Country Treatment*	*EU Treatment*	*Renewables environment*	*Renewables jobs*
Austria	-0.025**	-0.04	0.019	-0.04	0.035	0.105***
Belgium	0.008	-0.031	-0.075	-0.054	0.042	0.119***
Bulgaria	0.028***	0.015	0.027	0.035	0.14***	0.101***
Croatia	-0.003	0.063	0.022	0.039	-0.029	0.043
Cyprus	0.02	0.083	0.136**	0.05	-0.106*	-0.037
Czech Republic	-0.008	-0.126***	-0.087*	-0.016	0.028	0.122***
Denmark	-0.001	-0.129***	-0.1**	-0.025	0.071	0.156***
Estonia	0.002	0.011	0.018	0.029	0.104**	0.024
Finland	-0.001	0.053	0.029	0.069	0.084	0.133***
France	-0.006	0.028	0.001	-0.006	0.074	0.087**
Germany	-0.008	0.093**	0.064	0.045	0.139***	0.096***
Greece	-0.028***	0.067	-0.031	-0.014	-0.009	0.057*
Hungary	0.018	0.01	-0.019	-0.046	-0.106*	0.045
Ireland	-0.015	-0.062	-0.036	-0.033	-0.001	0.142***
Italy	-0.016	-0.027	0.016	0.052	0.028	0.125***
Latvia	-0.002	-0.022	-0.013	-0.005	0.083**	0.133***
Lithuania	0.008	-0.057	-0.006	-0.053	-0.03	0.131***
Luxembourg	-0.008	0.001	0.032	0.014	0.08	0.105***
Malta	0.002	0.057	0.07	0.029	-0.056	0.064
Norway	0.006	0.137***	0.067	0.142***	0.091*	0.111***
Poland	-0.005	-0.012	0.02	-0.061	0.086*	0.124***
Portugal	-0.019*	-0.098**	-0.042	0.038	-0.072	0.077**
Romania	-0.016*	-0.073	-0.041	-0.031	0.064	0.094**
Slovakia	-0.006	0.000	0.009	-0.042	0.004	0.105***
Slovenia	-0.007	0.059	-0.033	0.052	-0.099**	0.182***
Spain	-0.043***	0.033	0.041	0.045	-0.106*	0.111***
Sweden	-0.008	0.046	0.033	-0.018	0.053	0.181***
Switzerland	0.004	-0.004	-0.046	-0.037	0.079	0.125***
The Netherlands	-0.037***	-0.062	-0.048	-0.075	-0.013	0.096***
Turkey	-0.01	0.049	0.029	0.092***	0.06	0.038
United Kingdom	-0.035***	0.006	-0.025	-0.049	0.066	0.151***

Results are derived from country-specific multinomial probit models; marginal effect gives the change in predicted probability of a respondent selecting investment options A or B over option C, the opt-out option. *** denotes statistical significance at $\alpha = 0.01$, ** at $\alpha = 0.05$, * at $\alpha = 0.1$

Table 6: WTP in percentage points of profit rate for attributes of the investment options: full sample of nations with potentially biased respondents removed

	holding period	visible installation	community administrator	utility company administrator	government administrator†
WTP Est.	-2.56	0.025	3.75	-3.78	0.037
95% CI	(-2.63, -2.48)	(-0.44, 0.50)	(3.38, 4.11)	(-4.12, -3.45)	(-0.45, 0.53)

Respondents were removed if they accepted an investment in all choice scenarios and then did not provide their email for follow-up offers or if they did not accept any investment options and gave their email for follow-up offers.

N=369,048 choice options observed over 15,377 respondents and 31 European nations; marginal effects gives the change in predicted probability of a respondent selecting investment options A or B over option C, the opt-out option.

†The WTP calculation for the government administrator is given in footnote [11].

Table 7: Comparison of quota sampling variables to national indicators

	Indicator					
	age		gender		monthly income	
Country	mean age in sample	median age of population	% males in sample	% males in population*	Sample**	Population***
Austria	42.8	43.2	0.53	0.49	€1,487.00	€2,063.00
Belgium	42	41.6	0.5	0.49	€1,543.00	€1,899.00
Bulgaria	42.6	44.2	0.5	0.49	€324.00	€299.00
Croatia	42.6	43.5	0.5	0.49	€465.00	€518.00
Cyprus	42.2	38.2	0.51	0.49	€1,058.00	€1,208.00
Czech Rep.	42.7	42.3	0.5	0.49	€680.00	€690.00
Denmark	47.7	41.8	0.51	0.49	€2,093.00	€2,449.00
Estonia	40.1	42.1	0.55	0.49	€805.00	€782.00
Finland	42.7	42.7	0.52	0.49	€1,772.00	€1,999.00
France	42.7	41.4	0.51	0.49	€1,682.00	€1,840.00
Germany	42.8	46	0.49	0.49	€1,653.00	€1,827.00
Greece	42.4	44.7	0.5	0.49	€587.00	€633.00
Hungary	42.9	42.6	0.48	0.49	€379.00	€416.00
Ireland	42.8	37.5	0.5	0.49	€1,685.00	€1,907.00
Italy	42.7	46.3	0.5	0.49	€1,102.00	€1,379.00
Latvia	41.1	43.5	0.53	0.49	€600.00	€551.00
Lithuania	43	43.8	0.55	0.49	€549.00	€511.00
Luxembourg	46.5	39.6	0.53	0.51	€3,076.00	€3,006.00
Malta	42.1	41.6	0.48	0.51	€1,079.00	€1,208.00
Norway	42.7	39.5	0.5	0.49	€2,780.00	€3,206.00
Poland	42.8	40.7	0.5	0.49	€498.00	€495.00
Portugal	39.6	44.9	0.5	0.49	€745.00	€756.00
Romania	43.7	42.2	0.5	0.49	€222.00	€229.00
Slovakia	42.7	40.2	0.5	0.49	€521.00	€599.00
Slovenia	42.6	43.7	0.5	0.49	€777.00	€1,059.00
Spain	42.8	43.8	0.5	0.49	€1,096.00	€1,184.00
Sweden	42.7	40.8	0.51	0.51	€1,746.00	€1,948.00
Switzerland	47.1	42.5	0.46	0.49	€3,056.00	€3,688.00
Netherlands	42.7	42.6	0.5	0.49	€1,684.00	€1,963.00
Turkey	38.4	31.4	0.52	0.51	€414.00	€313.00
UK	42.9	40	0.49	0.49	€1,675.00	€1,750.00
Total	42.8	41.9	0.51	0.49	€1,228.00	€1,367.00

* ratio of women per 100 men

** equivalised mean monthly income using 1st - 4th quartile values and the 90th percentile value (for calculation method see: (Eurostat, 2010))

*** for the purpose of comparing with Eurostat statistics, mean of equivalised monthly income is calculated; equivalised income is net household income per household member following formulas in (Eurostat, 2010)

Table 8: Means of selected respondent characteristics by country

Country	*urban*	*employed*	*university*	*renewables environment*	*renewables jobs*	*environmentalist*	*climate change anthropogenic*
Austria	54%	58%	18%	85%	58%	63%	53%
Belgium	58%	59%	44%	80%	50%	58%	59%
Bulgaria	89%	67%	65%	84%	60%	79%	47%
Croatia	68%	64%	40%	87%	65%	74%	57%
Cyprus	80%	57%	58%	42%	51%	63%	50%
Czech Republic	62%	67%	34%	72%	36%	65%	53%
Denmark	68%	50%	23%	78%	48%	40%	50%
Estonia	71%	70%	50%	83%	45%	58%	41%
Finland	83%	51%	53%	85%	55%	62%	62%
France	57%	71%	58%	83%	65%	57%	63%
Germany	70%	63%	35%	81%	47%	60%	53%
Greece	87%	50%	61%	57%	66%	77%	68%
Hungary	63%	66%	37%	92%	69%	76%	62%
Ireland	64%	63%	57%	89%	62%	60%	63%
Italy	77%	54%	40%	86%	63%	69%	58%
Latvia	69%	70%	60%	74%	43%	52%	37%
Lithuania	71%	67%	75%	78%	41%	54%	39%
Luxembourg	29%	63%	37%	85%	52%	61%	56%
Malta	54%	78%	83%	93%	63%	77%	70%
Norway	65%	59%	25%	87%	47%	43%	48%
Poland	74%	69%	52%	81%	52%	60%	38%
Portugal	81%	68%	55%	93%	71%	82%	74%
Romania	88%	70%	73%	91%	72%	76%	61%
Slovakia	66%	62%	45%	82%	55%	73%	60%
Slovenia	52%	60%	48%	82%	60%	73%	53%
Spain	88%	64%	53%	89%	65%	74%	69%
Sweden	74%	52%	39%	80%	49%	33%	53%
Switzerland	47%	54%	28%	88%	56%	67%	58%
The Netherlands	72%	65%	38%	75%	37%	57%	44%
Turkey	98%	64%	75%	88%	83%	86%	70%
United Kingdom	74%	62%	55%	80%	47%	51%	50%
Total	69%	62%	48%	82%	56%	64%	55%

Figures represent the percent of respondents that gave an affirmative answer to the associated question/variable
Variables defined in table 2
The survey sampling used quotas in the dimensions of income, gender, and age.

Table 9: Percentage of positive responses to CE investment opportunities by country

Country	Pct. Of respondents choosing to invest in at least one choice set			Pct. Of choice sets where an investment option was chosen			Pct. Of respondents who gave email*
	Full sample	**gave email**	**did NOT give email**	**Full sample sample**	**gave email**	**did NOT give email**	
Austria	82%	94%	73%	57%	68%	48%	43%
Belgium	71%	91%	59%	48%	67%	37%	39%
Bulgaria	88%	94%	76%	64%	72%	47%	66%
Croatia	95%	97%	91%	80%	81%	77%	65%
Cyprus	82%	95%	72%	60%	71%	52%	43%
Czech Republic	80%	96%	60%	56%	72%	36%	55%
Denmark	64%	91%	57%	44%	67%	37%	23%
Estonia	91%	95%	88%	84%	86%	82%	38%
Finland	74%	93%	67%	49%	65%	43%	27%
France	71%	92%	58%	48%	70%	35%	37%
Germany	74%	91%	64%	49%	66%	39%	37%
Greece	88%	94%	74%	62%	68%	49%	69%
Hungary	84%	94%	67%	60%	71%	43%	62%
Ireland	81%	90%	71%	51%	61%	41%	51%
Italy	83%	94%	66%	61%	73%	43%	60%
Latvia	68%	91%	57%	44%	63%	35%	32%
Lithuania	81%	89%	75%	59%	71%	51%	39%
Luxembourg	83%	95%	75%	62%	74%	53%	42%
Malta	90%	97%	76%	64%	68%	54%	69%
Norway	75%	89%	66%	52%	66%	43%	39%
Poland	76%	90%	63%	55%	70%	40%	49%
Portugal	81%	87%	73%	59%	66%	50%	55%
Romania	86%	90%	70%	67%	71%	50%	79%
Slovakia	80%	90%	66%	55%	65%	41%	58%
Slovenia	82%	92%	66%	63%	72%	48%	60%
Spain	75%	91%	60%	49%	63%	37%	48%
Sweden	64%	83%	54%	44%	62%	35%	34%
Switzerland	79%	93%	71%	58%	73%	50%	37%
The Netherlands	71%	85%	63%	49%	63%	42%	33%
Turkey	92%	92%	90%	73%	74%	70%	66%
United Kingdom	73%	90%	59%	46%	62%	34%	43%
Total	79%	92%	67%	57%	70%	45%	48%

Data include 8 choice responses from 18,037 respondents
* this column is not derived from responses to the CE, but from responses to the email follow-up question reproduced above

Table 10: Countrywise WTP in percentage points of profit rate for attributes of the investment options

Country	holding period		visible installation		community administrator		utility company administrator		government administrator	
Austria	-2.2	(-2.54,-1.91)	2.5	(0.09,4.91)	1.3	(-0.98,3.58)	-3.1	(-4.64,-1.57)	1.8	(-0.97,4.58)
Belgium	-2.9	(-3.23,-2.51)	-3.3	(-5.76,-0.83)	0.4	(-1.82,2.64)	-3.7	(-5.46,-1.85)	3.3	(0.34,6.16)
Bulgaria	-2.9	(-3.33,-2.52)	0.9	(-1.82,3.52)	-0.9	(-3.54,1.79)	-4.6	(-6.88,-2.24)	5.4	(1.71,9.16)
Croatia	-2.7	(-3.06,-2.24)	1.2	(-1.01,3.43)	0.6	(-1.68,2.93)	-4.1	(-6.08,-2.11)	3.5	(0.09,6.84)
Cyprus	-1.1	(-1.44,-0.73)	0.1	(-2.53,2.69)	-3.8	(-6.1,-1.45)	-0.2	(-2.42,2.05)	4.0	(0.47,7.45)
Czech Republic	-2.9	(-3.21,-2.54)	-2.4	(-4.51,-0.33)	-1.9	(-4.05,0.18)	-4.2	(-5.91,-2.55)	6.2	(3.32,9.01)
Denmark	-2.3	(-2.73,-1.91)	-5.5	(-8.38,-2.64)	0.3	(-2.5,3.03)	-2.6	(-4.63,-0.59)	2.3	(-1.09,5.79)
Estonia	-3.2	(-3.65,-2.81)	-6.3	(-8.85,-3.66)	-2.3	(-4.52,0.02)	-2.2	(-4.32,-0.09)	4.5	(0.97,8.03)
Finland	-2.6	(-2.93,-2.24)	-7.8	(-10.24,-5.31)	2.1	(0.05,4.14)	-7.3	(-9.18,-5.4)	5.2	(2.25,8.14)
France	-2.8	(-3.15,-2.44)	-2.1	(-4.43,0.23)	1.7	(-0.38,3.76)	-5.2	(-6.91,-3.56)	3.5	(0.77,6.31)
Germany	-2.6	(-2.93,-2.29)	-0.6	(-2.9,1.62)	-0.8	(-2.97,1.4)	-4.7	(-6.53,-2.89)	5.5	(2.56,8.43)
Greece	-2.3	(-2.66,-2.01)	4.4	(2.38,6.35)	4.0	(2.16,5.87)	-2.5	(-4.19,-0.81)	-1.5	(-4.05,1.02)
Hungary	-3.0	(-3.33,-2.58)	2.4	(0.2,4.62)	0.9	(-1.07,2.91)	-4.6	(-6.4,-2.79)	3.7	(0.93,6.43)
Ireland	-2.5	(-2.8,-2.16)	-4.5	(-6.88,-2.1)	3.4	(1.47,5.26)	-5.5	(-7.14,-3.9)	2.2	(-0.4,4.7)
Italy	-2.4	(-2.77,-2.08)	0.3	(-1.76,2.34)	2.5	(0.62,4.36)	-5.2	(-6.88,-3.55)	2.7	(0.03,5.43)
Latvia	-2.6	(-3.02,-2.23)	-1.2	(-3.84,1.39)	-3.6	(-6.1,-1.02)	-0.1	(-2.17,1.91)	3.7	(0.38,7)
Lithuania	-3.0	(-3.46,-2.46)	1.1	(-1.58,3.81)	1.1	(-1.71,3.96)	-2.5	(-4.65,-0.42)	1.4	(-2.16,4.98)
Luxembourg	-2.1	(-2.46,-1.73)	-0.1	(-2.65,2.53)	0.4	(-2.15,2.93)	-6.4	(-8.38,-4.42)	6.0	(2.4,9.62)
Malta	-2.5	(-2.95,-2.12)	-1.1	(-3.98,1.77)	0.1	(-2.59,2.71)	-6.2	(-8.35,-3.95)	6.1	(2.37,9.81)
Norway	-1.7	(-1.98,-1.32)	-6.5	(-9.09,-3.95)	0.4	(-1.86,2.7)	-3.6	(-5.45,-1.75)	3.2	(0.25,6.11)
Poland	-2.8	(-3.27,-2.35)	0.3	(-2.53,3.19)	-1.2	(-4.03,1.69)	-0.2	(-2.27,1.93)	1.3	(-2.2,4.87)
Portugal	-2.6	(-2.91,-2.28)	0.6	(-1.44,2.69)	2.9	(0.84,4.87)	-5.0	(-6.83,-3.07)	2.1	(-0.75,4.95)
Romania	-2.2	(-2.58,-1.72)	2.9	(0.25,5.63)	4.6	(2.05,7.2)	-2.2	(-4.2,-0.22)	-2.4	(-5.88,1.05)
Slovakia	-3.1	(-3.4,-2.72)	-1.6	(-3.85,0.64)	-0.1	(-2.17,1.98)	-3.4	(-5.24,-1.63)	3.5	(0.72,6.35)
Slovenia	-2.3	(-2.72,-1.93)	4.6	(2.24,7.05)	3.5	(1.08,5.84)	-3.5	(-5.35,-1.56)	0.0	(-3.11,3.1)
Spain	-2.7	(-3.17,-2.3)	0.7	(-1.37,2.68)	-2.0	(-4.59,0.65)	-2.6	(-4.71,-0.56)	4.6	(1.16,8.06)
Sweden	-2.1	(-2.52,-1.76)	1.3	(-1.22,3.83)	1.8	(-0.72,4.28)	-3.4	(-5.51,-1.23)	1.6	(-1.77,4.94)
Switzerland	-2.5	(-2.85,-2.13)	-1.9	(-4.11,0.32)	0.5	(-1.64,2.67)	-6.8	(-8.56,-4.99)	6.3	(3.15,9.36)
The Netherlands	-3.1	(-3.47,-2.67)	-4.4	(-7.18,-1.68)	5.0	(2.58,7.34)	-5.9	(-7.99,-3.86)	1.0	(-2.22,4.15)
Turkey	-3.1	(-3.52,-2.66)	1.8	(-0.62,4.21)	-3.8	(-6.32,-1.35)	-3.0	(-4.82,-1.1)	6.8	(3.03,10.57)
United Kingdom	-2.4	(-2.67,-2.03)	-1.8	(-3.91,0.41)	3.3	(1.49,5.16)	-5.7	(-7.31,-4.02)	2.3	(-0.2,4.88)

Results are derived from country-specific multinomial probit models
95% confidence intervals for WTP estimates given in parentheses, generated via the delta method