Energy Policy 148 (2021) 111993

Contents lists available at ScienceDirect

Energy Policy

journal homepage: http://www.elsevier.com/locate/enpol

Effects of coordinating support policy changes on renewable power investor choices in Europe

Marc Melliger [a,*], Johan Lilliestam [a,b]

[a] Institute for Advanced Sustainability Studies (IASS), Potsdam, Germany
[b] University of Potsdam, Germany

ARTICLE INFO

Keywords:
Policy change
Policy coordination
Renewable energy
Investment decision
Choice experiment
Adaptive conjoint analysis

ABSTRACT

The economic context for renewable power in Europe is shifting: feed-in tariffs are replaced by auctioned premiums as the main support schemes. As renewables approach competitiveness, political pressure mounts to phase out support, whereas some other actors perceive a need for continued fixed-price support. We investigate how the phase-out of support or the reintroduction of feed-in tariffs would affect investors' choices for renewables through a conjoint analysis. In particular, we analyse the impact of coordination – the simultaneousness – of policy changes across countries and technologies. We find that investment choices are not strongly affected if policy changes are coordinated and returns unaffected. However, if policy changes are uncoordinated, investments shift to still supported – less mature and costlier – technologies or countries where support remains or is reintroduced. This shift is particularly strong for large investors and could potentially skew the European power mix towards an over-reliance on a single, less mature technology or specific generation region, resulting in a more expensive power system. If European countries want to change their renewable power support policies, and especially if they phase out support and expose renewables to market competition, it is important that they coordinate their actions.

1. Introduction

To limit climate change, rapid and deep decarbonisation is necessary (IPCC, 2018). Because the electricity sector is among the largest greenhouse gas emitters, policy-makers have accepted that it needs to be fully decarbonised by mid-century (European Commission, 2018; United Nations, 2015). Such a decarbonised electricity system will mainly be based on intermittent renewables like photovoltaics (PV), onshore and offshore wind. In the EU-28, the share of renewable electricity generation by PV and wind power increased from about 2% in 2005 to 15% in 2018 (European Commission, 2020), driven by national support policies (IRENA et al., 2018).

Most EU countries have supported renewables with feed-in tariffs (FITs), which reduce price risks by offering a fixed remuneration, thus making investments in renewables more attractive (Polzin et al., 2019). Up to 2014, FITs were the dominant scheme in European national renewables policy (Cointe and Nadaï, 2018). Since then, a few countries completely or de-facto abandoned their support, such as Spain did in the wake of the Euro crisis (Gürtler et al., 2019). In most countries, FITs are being or have been reformed into auctioning schemes, which are now the default support scheme following changes in the European Union state aid guidelines (European Commission, 2014) and the revised Renewables Directive (European Union, 2018). These rules mean that EU member states must adapt their support to become more market-friendly and increase the degree of competition among investors. The auctions result in fixed-price or premium tariffs, so investors still do not – or not exclusively – achieve their returns in the general power market.

This instrument shift happened mainly in response to increasing political pressure to expose renewables to market forces as their costs plummeted and approached parity with other power sources (Fraunhofer ISE, 2015; IRENA, 2019). The European Parliament (EP) and the Council still consider support essential for long-term investments and for reaching the renewable energy target of 32% (of final energy consumption) by 2030. Nevertheless, the EP argues that support for mature renewable power technologies should be gradually phased out when they become cost-competitive with conventional power sources (European Parliament, 2017; European Union, 2018).

If policy-makers equate mature technologies with cost-competitive technologies, countries may phase out support schemes for different renewable power technologies at different times, depending on which

* Corresponding author. Institute for Advanced Sustainability Studies (IASS), Berliner Strasse 130, 14467, Potsdam, Germany.
E-mail address: marc.melliger@iass-potsdam.de (M. Melliger).

https://doi.org/10.1016/j.enpol.2020.111993
Received 10 October 2019; Received in revised form 28 August 2020; Accepted 18 October 2020
Available online 9 November 2020

technology becomes competitive first in each national context, given the resources and regulations of each single country and the way they quantify competitiveness (Nissen and Harfst, 2019; Webb et al., 2017; Hirth, 2015; Breyer and Gerlach, 2012). For example, PV may become competitive, and support phased out, first in sunny southern countries and then in the north, whereas wind power may become competitive in the windy north first.

Policymakers and scholars debate whether support should be phased out entirely but there are good reasons to continue support (Held et al., 2019), including problems such as cannibalisation: wind power and PV cannot shift their generation in time, but depend on the weather – and hence, prices will be lowest when these technologies generate the most, reducing or eliminating their profitability in the market (Hirth, 2015; López Prol et al., 2020). Of particular interest is the shift in investment environment following a support phase-out: the price risk would increase (Polzin et al., 2019), which leads to higher capital costs for renewables (Held et al., 2019). As de-risking is a key reason why fixed-price support is both effective and efficient (Fleiβ et al., 2017; Lüthi and Wüstenhagen, 2012; Mitchell et al., 2006), investors will reconsider whether the new risk-return ratio is acceptable, or if another investment – in another renewable technology or another country – is more attractive (Kitzing, 2014; Salm, 2018). Also, if support is phased out, investors could seek other, non-renewables, investment options.

In particular, an uncoordinated, i.e. country-by-country and/or technology-by-technology phase-out of support could influence both national and the aggregated European decarbonisation pathways strongly if investors shift to the less mature and still supported technologies or move their activities to countries that still provide support.

Furthermore, phasing out support may affect investor types differently. In some countries like Germany, citizens and cooperatives own a large share of renewable capacity and are substantial drivers of the successful expansion of renewables (Bergek et al., 2013; Dóci and Gotchev, 2016). In other countries, small-scale investors have a large but yet unutilised potential to contribute to the energy transition (CE Delft, 2016). Small- and large-scale investors differ in their investment motives (Bergek and Mignon, 2017; Fleiβ et al., 2017), in the size of their investments and in their ability to manage risks: whereas large, financially strong investors like utilities have several risk management tools at their disposal, small investors and strictly regulated ones, like pension funds, do not (Salm, 2018). Others find that such differences may exist but that small and large investors have similar investment preferences (Lüthi and Prässler, 2011). To enable continued expansion of small-scale, decentralised renewables, the EU has exempted small projects (<1 MW) from the FIT phase-out (European Commission, 2014; European Union, 2018).

Here, we empirically investigate the effects on investors' choices in renewables if different countries change support policies at the same or at different times, i.e. if they coordinate or do not coordinate their changes. We analyse two types of policy changes: the phase-out of auctioned premiums, i.e. exposing renewables to competition on the general power market – the path current EU policy follows – and the reintroduction of FITs – the policy that triggered most of the renewables expansion to date. We define coordination as the coordinated action between different countries and analyse three levels: countries coordinate policy changes (1) fully (all countries change policies for all technologies simultaneously), (2) partially (all countries change policies for single technologies simultaneously) or (3) not (across countries).

We represent countries from an investor's perspective using three levels of familiarity (own, known and unknown country). Despite this abstraction, we focused our sampling on countries in the EU, and in particular on Germany, the UK[1] and, to a lesser degree, on adjacent states such as Switzerland (which also includes investors active in Germany).

We do the analysis for the three main renewable power technologies in Europe: PV, onshore and offshore wind. We find that coordination of policy changes matters: weak coordination can cause geographical and technological investment shifts and lead to a more expensive power system, whereas coordination may prevent such problems.

2. Method

We investigate investment choices based on investors' preferences for investments in renewables. These preferences are expressed as utility functions and describe how much the project country, the technology type, the availability of support policies and the expected return contribute to investors' preferences. We carry out a choice experiment, distributed as an online survey and in the form of an adaptive choice-based conjoint (ACBC) analysis to measure these preferences. Based on the preferences, we simulate investment choices in a range of different policy scenarios and under different levels of coordination.

2.1. The theory behind choice experiments

We apply the ACBC analysis, which is a modern, computer-assisted type of choice experiment rooted in basic mathematical research (Luce and Tukey, 1964). It is usually applied in marketing research to investigate the preferences for different products and to improve a company's competitive advantage. Previous scientific literature has adopted and applied choice experiments to study energy investment decisions as a function of policy and/or market attributes (Bergmann et al., 2006; Lüthi and Prässler, 2011; Lüthi and Wüstenhagen, 2012; Chassot et al., 2014; Salm et al., 2016; Salm, 2018). We choose conjoint analysis over alternative methods (such as e.g. semi-structured interviews) as it forces participants to carefully consider trade-offs during their choices, and hence, to reveal preferences they might not be aware of or are unwilling to admit (McCullough, 2002).

In contrast to other discrete choice methods like choice-based conjoint (CBC) or adaptive conjoint analysis (ACA), ACBC is more engaging for participants, improves choice predictions and generates better estimates for small sample sizes below 100 (McCullough, 2002; Cunningham et al., 2010; Orme, 2010a, 2014). Although the advantages of ACBC over the other methods are less pronounced for studies with few attributes (Orme, 2014) – such as ours based on only 4 attributes – its merits in working with smaller sample sizes motivate our method choice.

ACBC describes preferences for products or renewables investment options based on the discrete choice (Lancaster, 1966) and random utility theories (Manski, 1977). In these, the preference for a product or investment is described by the sum of the part-worth utilities of its attributes, i.e. its characteristics, and a random error term as

$$U = \sum_{i=1}^{m} (u_i + e)$$

with U as the total utility, u_i as the part-worth utility function of attribute i, m as the number of attributes and e as a random error. Moreover, the relative importance of an attribute describes what difference each attribute could make in the total utility of a product. It is expressed as

$$I_a = \frac{\Delta u_a}{\sum_{i=1}^{m} (\Delta u_i)}$$

with I_a as the importance of attribute a and Δu_a, Δu_i as the difference between the maximal and minimal part-worth utilities of all levels in attribute a or i. This means that the more an attribute spreads, the higher is the attribute importance (Orme, 2010b).

2.2. Selection of attributes and attribute levels

A suitable selection of attributes is essential to get reasonable

[1] At the time of sampling, UK was still part of the EU.

decisions from investors. Our selection of the four *attributes* and *attribute levels* is listed in Table 1.

The *Policy* attribute describes the mechanism of support for the investment option. The three levels represent the main support schemes in past, some current and, possibly, future EU renewables policy, namely *feed-in tariff* (FIT), auction resulting in a *premium,* and *no* support, respectively. For FITs, policymakers set fixed remuneration levels, while premiums are auctioned and paid on top of the realised power market prices. If there is no support, the income of investors fully depends on market outcomes. Hence, with FITs, investors bear no price risk, but they carry some in auctioned premium schemes and the full price risk if there is no support. Moreover, FITs and the auctioned premiums offer a priority feed-in, and hence eliminate the volume risk.

The *Country* attribute describes the investment country from an investor's perspective, i.e. how familiar a country and its investment environment is to them. The *own country* is the country from which the investor's company is operating, the *known EU country* is any other country an investor has invested in before and the *unknown EU country* is any other country in which the investor has no experience. Using these generalised terms instead of specific countries, we cover a broader range of investment options with fewer levels. We assume that for most investors, the own country is most familiar, followed by the known and unknown country; this assumption holds for most participants as respondents' core activity and their home country are generally identical (Fig. 2).

The *Technology* attribute describes the technology of an investment. We choose the three technologies that most investors are familiar with and that may have significant potential in the future expansion of renewables in the EU: PV, onshore and offshore wind power.

The *Return* attribute describes the expected return on equity (ROE) used by investors to evaluate the economic feasibility of an investment. Literature shows that 5%, 6% and 7% are realistic and common ROE levels for our technology selection in 2017 & 2018, both for Germany (Egli et al., 2018; Egli, 2020) and the UK (Steffen, 2020; Egli, 2020). Although these returns cover the upper end of observed returns for PV in Germany and the lower end for offshore wind projects in the UK, we conclude that they are acceptable for our sample due to the feedback from study participants and pre-interviews (which were conducted from September to November 2018 with three asset managers, one utility company and one cooperative; from Germany, Switzerland and Denmark). As we focus on policy changes (with constant returns) rather than return sensitivity, we use a static instead of continuous attribute.

Overall, the pre-interviews and previous literature confirm that all of the four attributes and their levels are relevant in decisions. In particular, the interviewees mentioned that an economic evaluation using risk-adjusted returns and the attractiveness of countries – determined by regulatory stability and the potential for new capacity – are very important criteria. A similar study (Salm, 2018) also considers return, technology and policies (in the form of price risks).

Nevertheless, our attribute list is not exclusive and investors in our pre-interviews and surveys (from the feedback webpage) also consider policy duration, the quality of contracts, the asset lifetimes, the type of cooperation and the establishment of manufacturers to be influential factors in decisions. Furthermore, literature states that other attributes such as the duration of the administrative process, legal security, access to low-interest financing and business models are relevant, as well (Lüthi and Prässler, 2011; Lüthi and Wüstenhagen, 2012; Salm, 2018). To simplify the analysis and focus it towards the relationship we investigate – how does policy change coordination affect investor behaviour – we implicitly assume that all these factors are acceptably given or comparable in all countries: for example, investors willing to invest can get permits and access to loans at reasonable conditions and speed, and promised support payments are paid for the whole support duration.

Table 1
Attributes and levels of the ACBC.

Attribute	Label in study	Levels
Policy	Support mechanism	FIT, auction with premium and no support
Country	Country	Own country, known EU country and unknown EU country
Technology	Technology	PV, onshore wind and offshore wind
Return	Expected return on equity	5%, 6% and 7%

2.3. Design of our choice experiment and firmographic questionnaire

To structure our choice experiment, we follow the design guidelines by Orme (2014). ACBC-designs usually consist of three sections: a *build your own (BYO)*, a *screening* and a *choice task* section. The BYO section serves to reduce the number of levels in the survey, but as our study already starts with a low number of levels, we omit this section.

Ahead of the screening section, we provide detailed descriptions of the attributes to the participants, which is necessary to align the expectations of investors (the survey is included in the Supplementary Material). We then ask participants whether they have invested in any other country than their own. If they have not, we remove the *known country* level from the *country* attribute.

In the screening section, participants express whether investments were a possibility or not, without making final choices between investments. Based on the responses, we also assess and ask if any levels are entirely unacceptable. Such unacceptable levels are removed to reduce the number of choices in the upcoming choice task section and to calculate the *None* option, which indicates that none of the available level combinations constitute an investment possibility and that investors prefer investing in something else (in the renewables sector or elsewhere) or abstain from investing at all.

In the choice task section, the ACBC software generates multiple sets of investment options, the so-called consideration sets. Each consideration set consists of three options, and we ask participants to choose their most preferred option in each set. Depending on their answers in the screening section and previous consideration sets, each participant performed two to six of these tasks.

The survey also includes questions about the professional background of investors and company characteristics. We use these to segment results (e.g. by typical investment ranges of projects) and to filter out inexperienced participants.

2.4. Sampling and fielding

To achieve diversity, we sample participants from different countries including Germany, the United Kingdom and Switzerland. These countries qualify because they underwent support policy changes in the past, and hence, we assume that investors in these countries have experience with the effects of policy changes and are suitable participants for a study like ours (Table 2). Although other countries underwent similar policy changes in the past, our sampling and selection of focus countries was restricted by practical reasons such as the size of our network, language barriers and the accessibility of investors on energy fairs and in databases. Also, we applied the snowballing method to expand our sample, which steered the focus towards these three countries.

We include investors of different types in the analysis: utilities, banks, project development companies, investors from cooperatives and asset management companies. For most of our sampling, we relied on two extensive commercial databases of power plant owners (Bloomberg New Energy Finance and The Wind Power) and acquired contact information such as e-mail addresses, names, job positions and preferred languages using the public websites of the companies. Furthermore, we personally contacted some investors on industry fairs and in our group's network.

In September 2018 and March 2019, we sent personalised invitation letters by e-mail, first focusing on investors in Germany and Switzerland,

Table 2
Overview of renewable electricity generation, investment structure and current and past policy schemes in Germany, the UK and Switzerland. Sources: European Commission (2020); BFS (2019); Hafner and Lilliestam (2019).

	Renewable electricity generation. In brackets: share on total generation and trend.	Renewableinvestment structure in 2020	Main support policy for renewables	Past policy changes
Germany	Wind in 2018: 110.0 TWh (17% of total; + 7.8% since 2014) PV in 2018: 45.8 TWh (7.1% of total; + 1.4% since 2014)	Traditionally strong in both PV and wind; recently a shift to PV as permits for onshore wind are delayed by opposition.	Auctions (technology-specific and technology-neutral) resulting in market premiums; FIT for small plants (<100 kW).	Between 2015 and 2017, tenders for PV, onshore and offshore wind introduced and FITs phased out (for >100 kW).
UK	Wind in 2018: 56.9 TWh (17.2% of total; + 7.8% since 2014) PV in 2018: 12.9 TWh(3.9% of total; + 2.7% since 2014)	Focus on larger investments, especially in wind power; world-leading in offshore wind.	Contract for Differences scheme (auctions resulting in market premiums); FIT for small plants (<5 MW).	Since 2017 only CfD. FIT support levels changed in the past.
Switzerland	Renewables (excl. hydro) in 2018: 2.7 TWh (4.3% of total; + 2.0% since 2014)	Minor market for new renewables in Switzerland.	FIT	FIT support levels changed in the past

and in 2019 on investors in the UK. After 2–3 weeks, we reminded the potential participants. To expand our sample, we asked participants for contact information of other investors using the snowballing method. To increase response rates, we translated the invitation letter and survey from English to German. Because our survey conveys the same content in both languages, we merged the resulting data into one final dataset, which increases our final sample size. We also posted invitation letters to social media channels (Twitter and LinkedIn) and a German mailing list (Strommarkttreffen). In the invitation letters, we briefly describe the study and goals and guarantee strict anonymity of all data and results.

Like similar studies about renewables investors' preferences (Loock, 2012; Lüthi and Wüstenhagen, 2012; Chassot et al., 2014; Salm, 2018), we base our study on a small sample size as the population of high-level decision-makers such as CEOs or renewables investment managers is both small and likely to have little time to participate in studies. ACBC is the most suitable type of conjoint analysis in such small sample sizes (Orme, 2019). To estimate the impact of the low sample sizes and the precision of our mean estimates, we calculate 95% confidence intervals.

2.5. Data preparation and analysis

In total, we received responses from 226 respondents. We removed one respondent with less than one year of experience in renewable energy investments. We also excluded respondents that did not complete the conjoint analysis or were obvious test responses. This left us with 93 respondents that completed the entire survey (82) or only the choice experiment (11). Using the software Sawtooth Lighthouse Studio, we perform a utility estimation, market simulation and calculate relative importances for each attribute.

We estimate the part-worth utilities using the Hierarchical Bayes (HB) estimation and calculate the relative importances of attributes for each participant separately. We then average these individual-level part-worth utilities and importances to derive estimates for all segments and the entire sample using R (the R project, excluding the confidential data and Sawtooth project is open source[2]).

For participants that have not invested abroad, the *known EU country* level was removed during the choice experiment. However, to estimate the aggregated part-worth utilities using HB, every level needs to be present for every participant in the data, so we set the level to be absolutely unacceptable in these cases. This results in very low part-worth utilities for this level but implicitly considers investors' previous knowledge in the utility function (see also section 4.3.1).

As the country attribute describes how familiar a country is to an investor, its levels have a logical order: most investors have the highest preference for their own, followed by a known and an unknown country. Nevertheless, for investors mainly active abroad (see Fig. 2), a known country can be more familiar than the own country. To nudge the utility estimation towards this preference order, we imposed partial utility constraints upon the country attribute using settings in Lighthouse Studio.

Furthermore, there is evidence (e.g. Steffen, 2020; Egli et al., 2019) that WACCs differ between countries and technologies, suggesting that investors evaluate ROEs differently depending on the country. We look for such interactions and consider significant ($p < 0.05$) ones to improve the fit of the utility model. To avoid overfitting of the model, we only include interactions for which solid evidence exists, here the one between country and return (Appendix D).

We perform a market simulation using the randomised first choice simulation (RFC) method to calculate actual choices (again, we first simulate the individual results and second, take averages in R). This simulation method calculates shares of preferences to estimate which investment option each participant is most likely to choose in a market consisting of a set of predefined options. RFC improves choice predictions in comparison to simpler market simulation methods (Huber et al., 2001) because it is based on an iterative process involving random error estimations. Both HB and RFC are among the best available methods for estimating utilities and simulate choices on a hypothetical market (McCullough, 2002).

To answer our research question, we calculate the differences between the shares of preferences from each policy change scenario and those of the auction scenario simulation: this difference corresponds to the share of investors that would shift to another investment option if the investment environment changed as described in each policy scenario. To investigate the effects on different types of investors, we segment our data by company characteristics (e.g. company type or investment range). We apply a Kruskal-Wallis Rank Sum test, and pairwise, two-sided Mann-Whitney U tests (we consider the family-wise error rate) to evaluate if segments differ significantly. We choose these non-parametric methods because they do not require normally distributed data, which are unlikely to occur in small samples.

The variables presented in the results are aggregated. We summarise the *country of a company's headquarter*, *company type* and *investor's job position* with low numbers (N) in the "Other" category, and summarise similar types of companies. The *investment range of projects* variable consists of 4 groups; small projects are < €1 million, medium projects €1–10 million, large projects €10–100 million and very large > €100 million. We focus on the monetary range instead of a project's capacity as money, not MW-size, is most likely the more relevant variable when deciding on a potential investment.

[2] Scripts on Zenodo: https://doi.org/10.5281/zenodo.3994896.

Table 3
Sample sizes and maximum response rates by country and data source (E-mail, e-mail-list or social media).

Country of company's headquarter	Sample size[a]			Total	Response
	E-mail	E-mail-list	Social media		
1. Sent surveys					
Germany	177	<4110	?	177	–
Switzerland	22	<4110	?	22	–
United Kingdom	333	0	?	333	–
Other[b]	28	0	?	28	–
Total	560	<4110	>3169	**560**	**-**
2. Accessed survey					
Total	161	48	17	**226**	**<40.4%**
3. Completed ACBC					
Germany	42	6	0	48	27.1%
Switzerland	12	1	0	13	59.1%
United Kingdom	13	0	0	13	3.9%
Other[b]	13	5	1	19	67.9%
Total	80	12	1	**93**[c]	**<16.6%**
4. Completed firmographic questionnaire					
Total	74	8	0	**82**	**<14.6%**

[a] E-mail-list numbers based on https://www.strommarkttreffen.org/mitglieder/. However, this also includes members that have unsubscribed, and hence, the number is not reliable to estimate the response rate. Twitter numbers are the number of people who have seen the tweet on Twitter, however, the majority of these people is probably not part of our population of investors; LinkedIn numbers are unknown. Because of these estimation issues, we add these numbers for reference but do not use them in the response rate calculations. To be able to know which social media channel or mailing list reached a respondent, we sent different links to each media channel. However, these links cannot be used to link responses to individuals.
[b] Other countries (of company's headquarter) include the Netherlands (N in completed ACBC: 1), Ireland (1), Italy (1) and Denmark (3); 13 respondents did not give an answer.
[c] One participant did not complete the questionnaire but indicated his investment range, so we consider this for the segmentation.

2.6. Scenarios in the market simulations

Our policy scenarios (listed in Figs. 6, 8 and 10) consist of investment options in different market environments: either under an auction scheme, a FIT or without any support. In each of these scenarios, there are ten investment options (all the combinations of the country and technology attributes in Table 1, plus the *None* option).

The first type of policy scenario is the *auction scenario* in which all technologies in all countries are supported by auctioned premiums. This is the base case for all investment shift analyses as auctioned premiums are currently the dominant form of support (for projects above 1 MW) in the countries that we mainly focus on (except for Switzerland).

Second, we define two types of *policy change scenarios*: the *policy phase-out* and the *FIT reintroduction* scenarios. The former define situations in which auctions have been phased out and all or single technologies are traded only on the general electricity market, in one or all countries, while the latter define situations in which feed-in tariffs have been reintroduced. We grouped these policy change scenarios by different levels of policy coordination (full, partial and none).

Third, we define the *return scenarios* to analyse the sensitivity of lower return (on equity) levels – namely 5% and 6% – on investment choices.

In all scenarios, we assume favourable conditions and an open market so that all investors, if they choose to do so, have the possibility to invest in any country and any of three technologies. Moreover, in the auction and policy change scenarios, we assume high and constant returns – namely one single return level of 7% – so that the change between scenarios is the price risk (and volume risk) rather than the remuneration level.

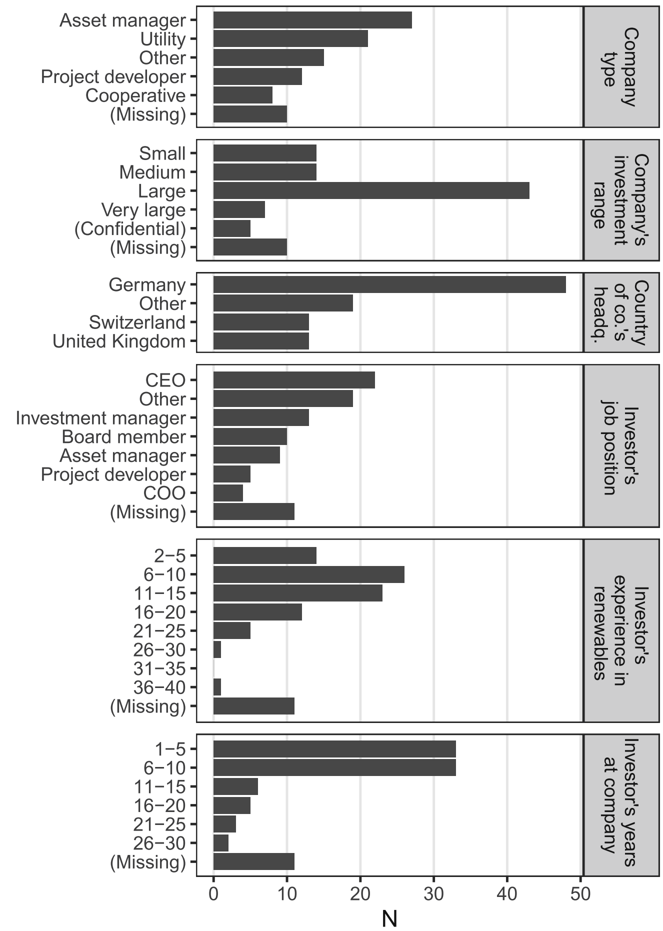


Fig. 1. Characteristics of respondents and their companies.

3. Results

3.1. Sample description

We sent 560 survey invitations to our population of renewables investors. Of those, 93 completed the ACBC part, and 82 completed the entire firmographic questionnaire (Table 3), which equals response rates of 16.6% and 14.6% relative to all e-mail invitations. The number of invitations sent by the e-mail-list is a rough estimation; the social media numbers are unknown.

Most investors in our final sample are high-level decision-makers such as CEOs, board members or investment managers with an experience of 11 years with investments in renewables and have worked for 6.5 years (both median) at their current companies (Fig. 1). These companies are either asset management companies or utilities, which primarily invest in large, medium or small projects. Of 93 investors, 83

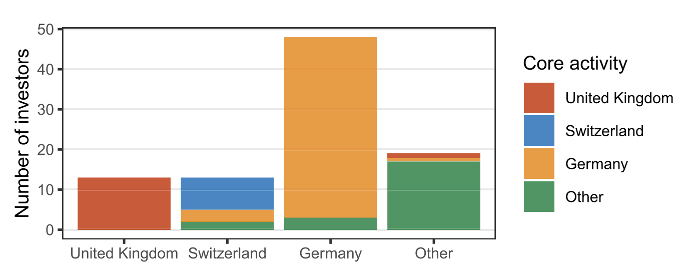


Fig. 2. Overview of the main country market of investors, by own (headquarter) country.

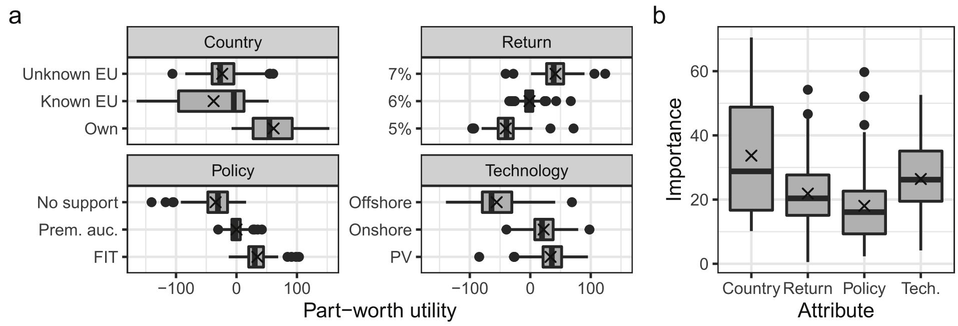


Fig. 3. Preferences (part-worth utilities) of all participants (a) and the resulting importances of the attributes (b). The boxplots depict the mean (cross), median (thick line) and the 25th and 75th percentiles. The result data including mean values, SDs, 95% CIs and interaction terms are also presented in Table A1–A3 in Appendix A; N = 93.

indicated that their core activity is in their own country, i.e. where the headquarter of their company resides (Fig. 2). This is particularly true for investors from Germany and the UK, whereas Swiss investors – while also mainly active at home – are also active abroad. This confirms our assumption that investors are most familiar with their own countries.

This sample of investors conducted in total 372 choices in the screening section and 273 choices in the choice tasks section. Each investor concluded 4 screeners and on average 3.1 choice tasks.

3.2. Investment preferences

If investors could choose freely, most would invest in their own country in PV or onshore wind projects that generate high returns and are supported by feed-in tariffs. As depicted in Fig. 3a (and Table A1–A3 in Appendix A), these are the levels with the highest average part-worth utilities in each attribute (for both mean and median averages). All level means, except those of *Unknown EU (*country*)* compared to *Known EU* (p = 0.97), are significantly different from the part-worth utilities of other levels ($p < 0.001$; pairwise Mann-Whitney *U* test). In any investment decision, the project's country and technology are the most decisive attributes because they exhibit the largest spread of part-worth utilities and hence, the highest importances (Fig. 3b).

The spread of the part-worth utilities and importances is the largest in the country attribute, which indicates that investors' country preferences vary strongly. In large parts, this can be explained by how we treat investors without investment experience abroad, namely 86% of small, 64% of medium, 16% of large and 14% of very large investors. If all investors had experience investing abroad, the variability for known EU countries would be smaller and the importance of the country attribute would decrease (see section 4.3.1.)

We compare different segmentation variables and find that the investment range provides the highest number of significant differences between segments (Appendix B). Hence, we explain the remaining part of the variability by the typical investment range of projects. Fig. 4a depicts that the small and medium investors exhibit a very high preference for investments in their own country, whereas the large and very large investors exhibit similar preferences for investments in their own and a known country.

The investment range also explains some variability in the other attributes. A comparison of all importances shows that large and very large investors value return, policy and technology equally or more than the country of an investment (Fig. 4b). In contrast, small and medium investors consider return and policy to be less important.

Some of the levels are completely unacceptable for some of the investors (Table 4). In particular, the *known EU country* level is unacceptable for 41% of investors, which is also caused by missing experience abroad, whereas no investor indicated that their own country would be unacceptable. Furthermore, 20% of investors view 5% return as unacceptable – revealing that 80% see it as acceptable, which supports our return level selection. Finally, whereas almost all investors accept PV and onshore wind as options, offshore wind is unacceptable for 18% of investors.

3.3. Market simulations

In the previous section, we described investors' most preferred investment options. However, on the actual European renewables market, investors will not find investments with all possible combinations of attribute levels, and hence, cannot choose freely. Although the policy attribute is of comparably low importance (Fig. 4b), we show that partially and fully uncoordinated policy changes may strongly affect investors' choices.

3.3.1. How investors choose in a market with auctioned premiums

Based on the preferences found in the previous section, we simulated choices of investors in a hypothetical market that supports renewables with auctioned premiums in all countries (Fig. 5). In this market, most investors would invest in their own country, particularly small and medium investors. In contrast, large and very large investors also choose investments in known countries. Considering all investors, most choose PV, followed by onshore wind. Only a small share of investors chooses to invest in offshore wind, of which most are very large investors. A small share of investors in the auction scenario would not invest in any of the investment options but choose the *None* option (which could include non-renewables investments).

The results of the auction scenario simulation confirm what we already learned about investors' preferences (in Fig. 3): most prefer investments in PV in their own country. Next, we compare the simulation of the auction scenario to simulations of the policy change scenarios in order to investigate policy changes at different levels of coordination.

3.3.2. How investors choose if support is phased out and price and volume risks increase

In the policy phase-out scenarios, the auctioned premiums are removed, but returns remain constant at 7%. Hence, we can attribute all investment choice changes in these scenarios to a changed perception of the price risk (uncertain expected return) and/or volume risk (uncertain energy purchases) rather than the level of expected return. Most investors – at least 73% in all scenarios – make the same investment choices as in the auction scenario, while up to 27% of investors change their choices (Fig. 6). This is in line with the comparatively low importance of the policy attribute (Fig. 4). The general effects of the policy phase-out scenarios are that investments shift away from the countries and technologies that change policies towards the still

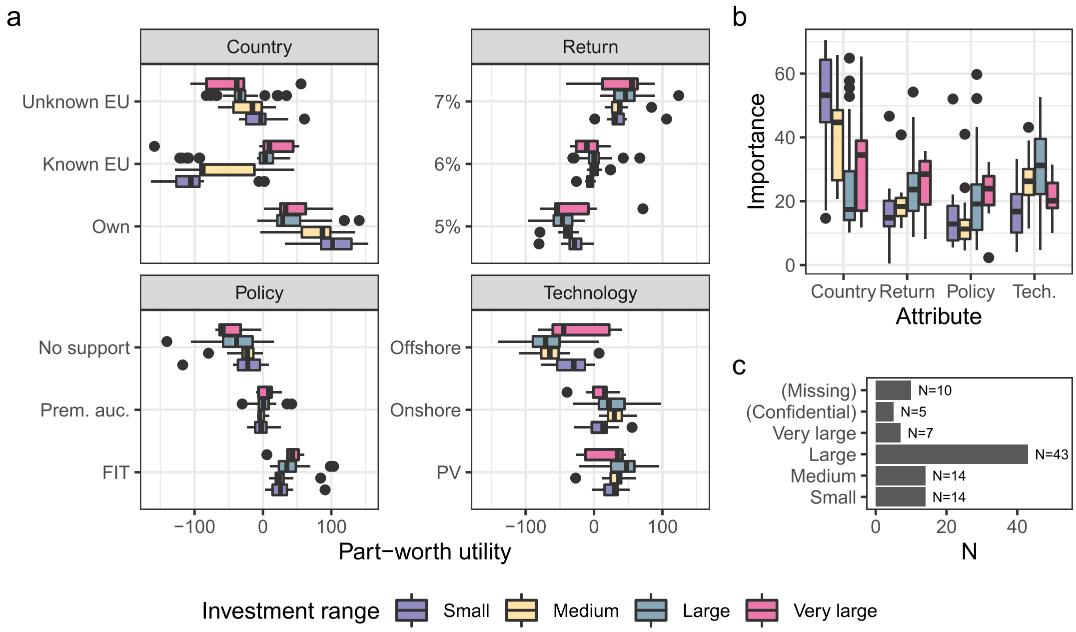


Fig. 4. Preferences (part-worth utilities) by investment range (a) and the resulting importances of the attributes (b) per investment range. The boxplots depict the median (thick line) and the 25th and 75th percentiles. The result data including mean values, SDs, 95% CIs and interaction terms are also presented in Table A1–A3 in Appendix A; N depicted in (c).

Table 4
Unacceptable levels for the entire sample (N = 93).

Attribute	Level	Unacceptable for investors
Technology	Photovoltaics	2.2%
	Onshore wind	1.1%
	Offshore wind	18.3%
Country	Own country	0%
	Known EU country	40.9%
	Unknown EU country	14.0%
Policy	Feed-in tariff	0%
	Auction & premium	1.1%
	No support	5.4%
Return	5%	20.4%
	6%	0%
	7%	0%

supported investment options (Fig. 7).[3]

If countries fully coordinate the phase-out of auctioned premiums for renewables (Fig. 6, scenario 1), most investors would choose equally as in the auction scenario, but 6–8% of all investors shift to the *None* option. Differences between the groups remain small, and no shifts between technologies or countries occur.

If countries partially coordinate the phase-out of auctioned premiums for renewables, up to 27% of investors would choose differently than in the auction scenario and shift their choices to technologies that are still supported, but keep investing in the same countries (Figs. 6 and 7, scenarios 2 & 3). Concretely, investors' choices shift from PV to onshore wind if PV support is phased out, and vice versa. More small than large investors keep choosing the same options even if policies change, indicating that small investors are inflexible, and stay with their preferred technology in countries where they are already active. Phasing

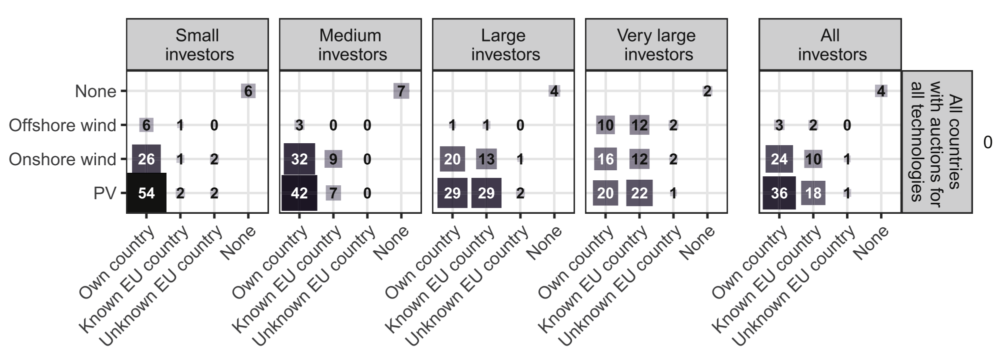


Fig. 5. Investment choices in the auction scenario. The numbers are percentages of investors (of each investment range) who choose one of the ten investment options. These results are the baseline for all other comparisons in the remaining result sections.

[3] Example: In Fig. 6, the percentage for *all investors* in *scenario 2* is 22% (for shifts to a different country or technology). Fig. 7 depicts the same percentage for *all investors* in *scenario 2* but in more detail, namely as increases of +13%, +7%, +1% and +1% (the sum is 22%). (Differences of ±1% due to rounding may occur).

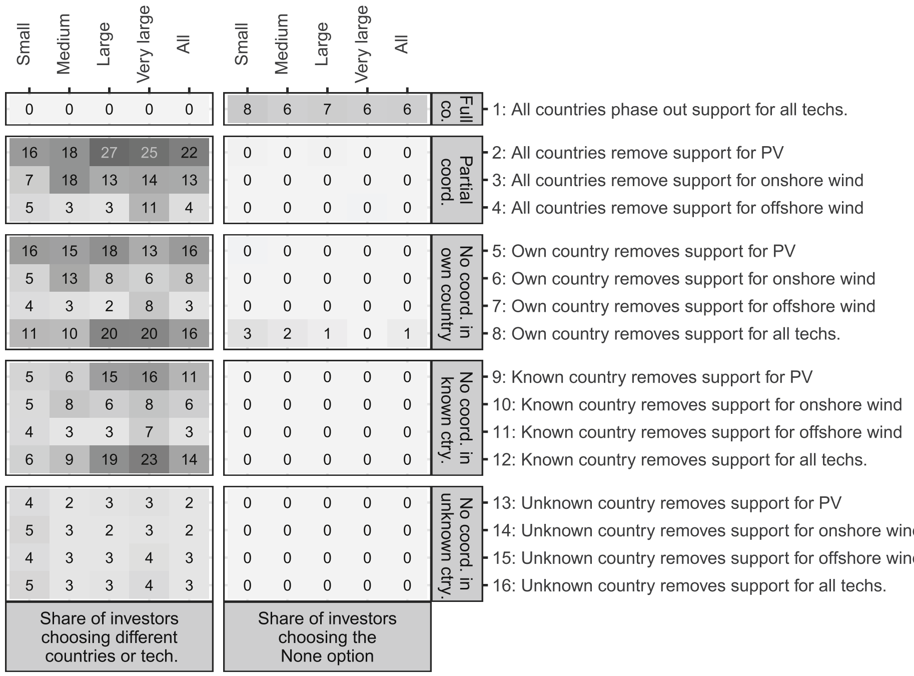


Fig. 6. Shifts of investment choices in all policy phase-out scenarios. The numbers are percentages of investors (of each investment range) who choose differently than in the auction scenario (Fig. 5). Left: shifts to different countries or technologies; right: shifts to the None option. The shares are equal to the sums of increases in Fig. 7.

out support for offshore wind does not strongly affect choices in most segments, as very large investors – who are most flexible regarding the country attribute – dominate this option (Fig. 6, scenario 4).

If countries do not coordinate the phase-out of auctioned premiums for renewables, up to 23% (in scenario 12) of investors will choose differently compared to the auction scenario and invest in technologies and countries that still support renewables (Figs. 6 and 7, scenarios 5–16). The main observed effect is a move to other countries if the own country phases out support; the effect is strongest if support for PV or all technologies is phased out (Figs. 6 and 7, scenarios 5 & 8).

If known countries phase out auctioned premiums (while they are still available in investors' own countries), investors that previously invested abroad will shift their choices to the same technologies in their own country (Figs. 6 and 7, scenario 12). Finally, choices change very little if the phase-out occurs in an unknown country (Fig. 6, scenarios 13–16).

3.3.3. *How investors choose if feed-in tariffs are reintroduced and price risks decrease*

In the FIT reintroduction scenarios, FITs are reintroduced, but returns remain constant at 7%. In these scenarios, we can attribute all investment choice changes to a changed perception of the price risk (uncertain expected returns) rather than the volume risk (as both auctions and FITs offer priority feed-in) or the level of expected returns. Most investors make the same investment choices as in the auction scenario, while up to 32% of investors change their choices (Fig. 8). In comparison to the policy phase-out scenarios, the shifts are larger, while the direction of effects is reversed because investments shift towards (and not away from) the countries and technologies that change policies (Fig. 9). This means that investors in both types of scenarios follow the same logic: they shift to still supported investment options with lower price risks.

If countries fully coordinate the reintroduction of FITs for renewables (Fig. 9, scenario 17), almost all investors would choose equally as in the auction scenario. In contrast to the corresponding policy phase-out scenario 1 (Fig. 6), no investor shifts to the *None* option.

If countries partially coordinate the reintroduction of FITs for renewables, up to 29% of investors would choose differently than in the auction scenario and shift their choices to technologies that will be supported by FITs, but keep investing in the same countries (Figs. 8 and 9, scenarios 18–20). Compared to the policy phase-out scenarios, the FIT reintroduction scenarios cause a larger share of investors, in particular more small investors to shift their choices. This has the effect that large investors will not dominate the shifts. Also, reintroducing support for offshore wind affects choices (Fig. 8, scenario 20).

If countries do not coordinate the reintroduction of FITs for renewables, up to 32% (in scenario 22) of all investors will choose differently compared to the auction scenario and invest in technologies and countries that are now supported by FITs (Figs. 8 and 9, scenarios 21–32). As in the policy phase-out scenarios, the effect is strongest if the own country changes policies without coordination. In contrast to the policy phase-out scenarios, policy changes in a known or unknown country have an influence on investments across all investors, particularly on large investors. This illustrates that a single country could affect investments in Europe as a whole if they reintroduced FITs without coordination, by attracting investments from other countries.

3.3.4. *How investors choose if returns decrease*

Investment choices are sensitive to the return level. If investors expect lower returns than in the auction or policy change scenarios – 5–6% instead of 7% – some investors would choose other countries or technologies, or shift to the *None* option, i.e. they could choose non-renewables unless they find suitable alternatives (Fig. 10). The share of *None* choices is considerable, even if no policy change occurs: in the 5% return case, up to 29% of investors choose the *None* option (scenario 35). In contrast, in the 6% return case, choices rather shift between technologies and countries, and only for larger investors (scenario 36).

If support is phased out (with full coordination), the sensitivity to the return level further increases: up to 43% of investors lose interest in the available investment options (scenario 37) and shift to the *None* option –

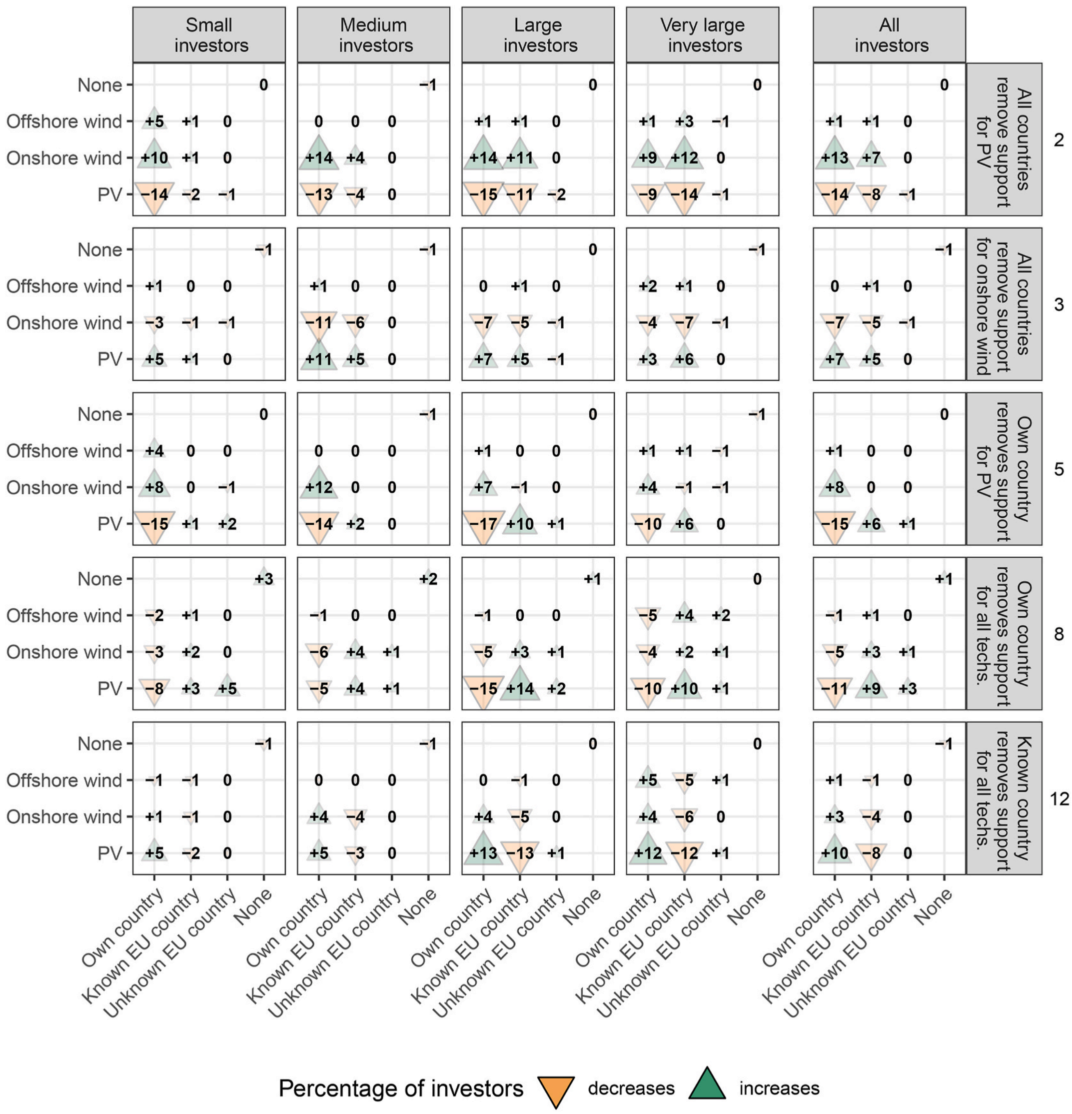


Fig. 7. Detailed shifts of investment choices in selected policy phase-out scenarios. The numbers are percentages of investors (of each investment range) who choose differently than in the auction scenario. This figure depicts the same result as Fig. 6 but in more detail, highlighting how investors shift between countries and technologies.

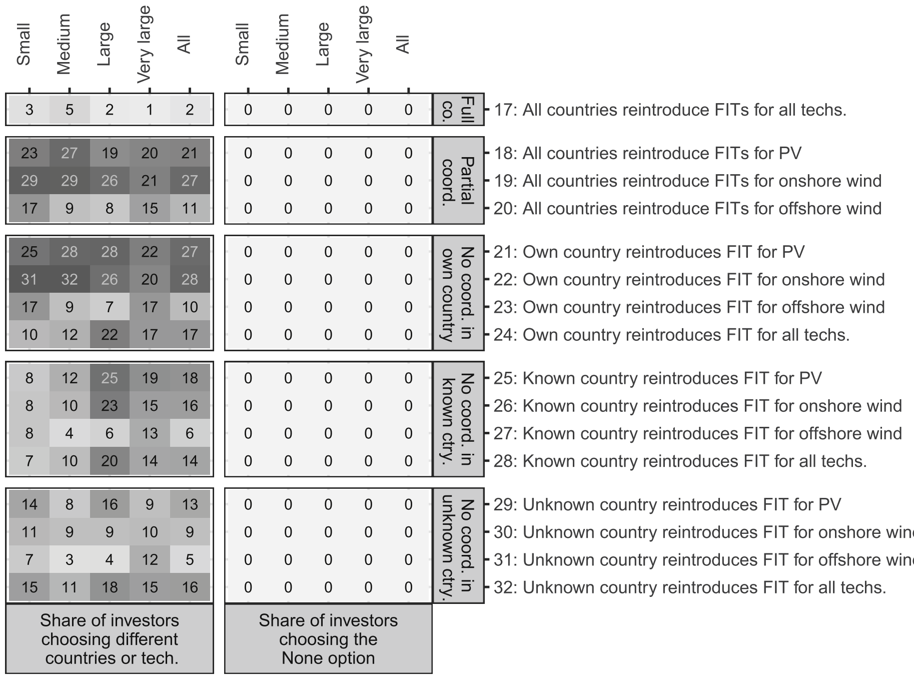


Fig. 8. Shifts of investment choices in all FIT reintroduction scenarios. The numbers are percentages of investors (of each investment range) who choose differently than in the auction scenario. Left: shifts to different countries or technologies; right: shifts to the None option. The shares are equal to the sums of increases in Fig. 9.

the largest effects observed in this study. For these investors, a return of 5% (and sometimes also 6%) is too low to compensate for the increased risks in an open market.

Reintroducing FITs (with full coordination) alters the sensitivity to the return level: if the return drops to 5% under reintroduced FITs, up to 16% of investors shift to the *None* option, while up to 33% of investors shift to other countries or technologies; for FITs, 6% is acceptable to almost all: only few investors shift to None if return drops to this level.

4. Discussion

4.1. Findings: policy change coordination matters as investors prefer lower price risks

We find that the level of coordination matters: if countries coordinate and carry out their policy changes for all technologies simultaneously, the triggered investment decision shifts are small, given that the expected returns on equity remain unaffected. This is true for both phasing out auctioned premiums in favour of trading renewable power in the general market and a shift back to feed-in tariffs. In contrast, if countries do not coordinate their actions, particularly if auctioned support is phased out country-by-country or technology-by-technology, investment choices shift towards the technologies and countries that offer lower price risks (given that the expected returns remain unaffected). For both types of policy changes – phase-out of auctioned premiums and reintroduction of feed-in tariffs – less than one third of investors shift their behaviour, but the effects are more pronounced if feed-in tariffs are reintroduced (up to 32% shift investment choices) than if support is phased out (27%).

As energy markets may show a complex reaction to policy changes, we cannot easily predict how returns will develop, and hence, we assumed that returns stay constant in the policy change scenarios, and thereby, focused on the impact of the changed price (or also volume) risks. Our results show that, indeed, investors are sensitive to decreasing returns, particularly if the price risk increases (due to phasing-out support). With this, we provide evidence that the price risk is a key parameter for investment choices and support findings in the literature; first that price risks have become the most important investment risk-type (Egli, 2020), and second, that exposure to higher price risks triggers higher risk premiums, so that investors require higher returns to maintain their investment activity (Salm, 2018). Whether investors will actually receive higher returns in a non-supported market is entirely unclear: this depends not on their preference, but on how the market plays out.

As decreasing risk premiums and capital costs have been an important driver in the past cost reduction of renewables (Egli et al., 2018; Held et al., 2019; Egli, 2020), we argue that the total cost will not necessarily decrease in a competitive market as higher price risks may increase risk premiums, and thus the costs of capital. Because of the complexity of market dynamics, and its high importance for the energy transition, we suggest that this link between policy changes and capital cost is strengthened in future research.

4.2. Findings: effects on smaller and larger investors differ

We also show that investors with different investment ranges are affected differently by uncoordinated policy changes. Large investors shift their investments following both phase-out of support and reintroduction of feed-in tariffs, while small investors mainly shift their investments if feed-in tariffs are reintroduced. All investors shift towards the lower price risk choice. Further, investors respond in different ways: small and medium investors shift between technologies but stay within the same countries if support is phased out, whereas large and very large investors shift both between technologies and countries. This confirms our expectation that smaller investors struggle to handle the difficulties of stepping into new markets, which may exaggerate the effects of an uncoordinated support scheme phase-out: it risks crowding out smaller investors. In contrast, as larger investors invest in more capital-intensive projects, their resources (like capital, personnel and knowledge) tend to be higher than those of smaller investors. Hence, they have a higher

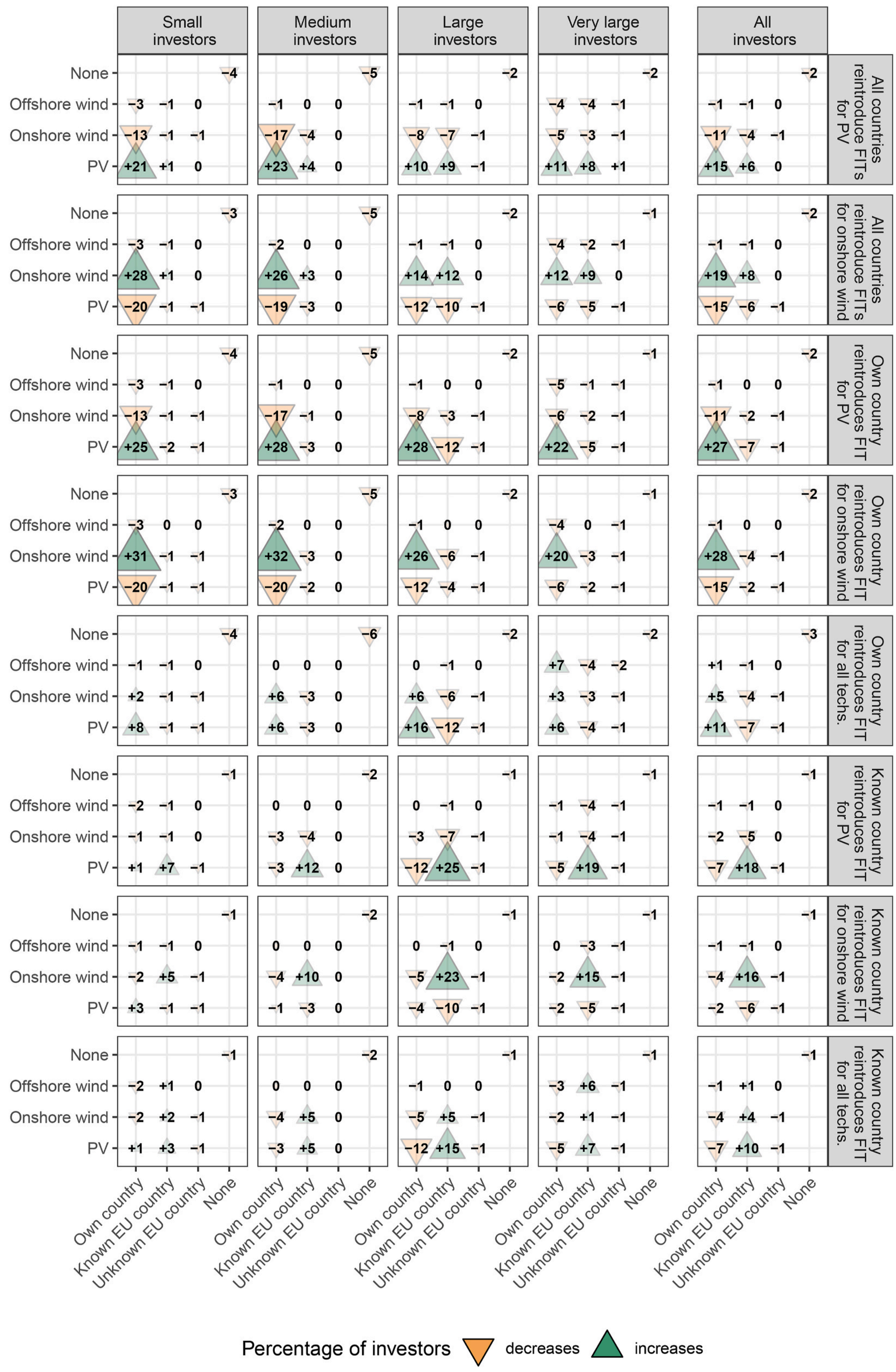


Fig. 9. Detailed shifts of investment choices in selected FIT reintroduction scenarios. The numbers are percentages of investors (of each investment range) who choose differently than in the auction scenario. This figure depicts the same result as Fig. 8 but in more detail, highlighting how investors shift between countries and technologies.

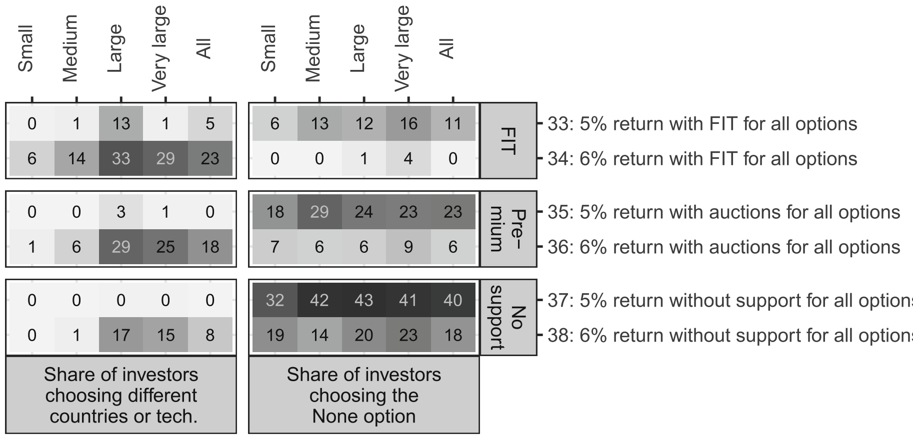


Fig. 10. Shifts of investment choices if the return decreases in scenarios 33–38. The numbers are percentages of investors (of each investment range) who choose differently than in the auction scenario. Left: shifts to different countries or technologies; right: shifts to the None option.

capacity to adapt to changing conditions by moving their investments to other countries.

Additionally, investment choice shifts among larger investors could strongly affect the European power mix trajectory as they have an over-proportional influence (compared to their number) on added renewable capacity. Although only up to a quarter of these investors will shift to other technologies or countries if policies change, a larger share of new capacity additions will be shifted because of their large projects. Hence, an uncoordinated policy change strategy could trigger larger power system changes than the numbers in our analysis suggest and bias national and European power mixes and transition trajectories towards overemphasising single technologies, particularly towards still supported technologies and towards countries that phase out support later.

With these findings, we add to the research about the characteristics of investor types. While some authors find few differences in investment preferences between small and large investors (Lüthi and Prässler, 2011), others conclude that investors do have differing behaviours and risk-return expectations (Bergek and Mignon, 2017; Lüthi and Wüstenhagen, 2012; Salm, 2018). Our results are more in line with the latter stream, but we advocate for a nuanced consideration as characteristics may play out differently in changing policy/market situations, and hence encourage future research to explore more policy situations and their effects on investors.

4.3. Reliability and limitations

In the previous sections, we showed that policy change coordination matters as investors change their investment behaviour if policies are changed country-by-country and technology-by-technology. This finding is robust. However, our study also comes with some caveats and limitations.

4.3.1. Sensitivity: influence of omitting the known EU country level

We assume that investors who have not invested abroad cannot have a preference for the *known EU country* level because they have no *known* country except their own. Hence, we removed this level in their surveys and set their preferences to a low level (the *absolutely unacceptable* option in Lighthouse Studio). This, however, also results in very low utilities and may influence the results.

Possibly, investors without experience abroad may have hidden preferences for known countries. To assess the sensitivity of our main results to our original assumption, we recalculated them assuming that these investors had such hidden preferences. Under this alternative assumption, we estimated missing known country preferences based on

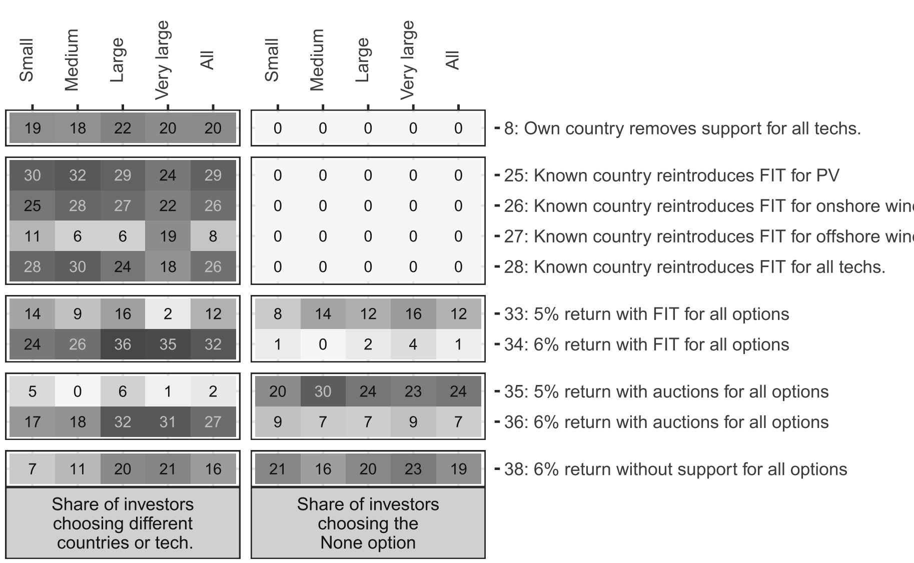


Fig. 11. Simulations under an alternative assumption, i.e. shifts of investment choices if all investors had experience investing abroad in the most sensitive scenarios. The numbers are percentages of investors (of each investment range) who choose differently than in the auction scenario. Left: shifts to different countries or technologies; right: shifts to the None option.

those of the other colleagues with foreign experience (from the same segments; using the *missing randomly* option in Lighthouse Studio).

Although the alternative assumption does not affect our main finding that investment decision shifts are small if countries take coordinated policy action, we observe three effects. First, compared to the main simulations (Figs. 6, 8 and 10), the differences between smaller and larger investors decrease (particularly in scenarios 8, 33–36 & 38, Fig. 11). Second, more investors would shift choices if a known country introduced FITs without coordination (scenarios 25–28, Fig. 11). Third, the variability of the part-worth utilities of the known EU country level decreases from 62.6 to 15.2 (SDs, see Tables A1 and A4 in Appendix A), and with it the importance of the country attribute; making return the most important one (Tables A3 and A6).

Such effects are to be expected: most smaller investors indicated to lack experience investing abroad, hence the changed assumption affects them stronger; and if a further investment option – investments in a known country – becomes eligible to more investors, choice shifts are more likely.

The sensitivity of these scenarios and these effects mainly need to be considered if more investors gain (or had) experiences abroad. If they do not, even if they had hidden preferences, we argue that it is reasonable and justified to not overemphasise investment shifts to a known country, as on an actual market, such choices would not occur.

4.3.2. Generalisability of our findings

We base our work on a comparably small sample, due to the limited number and availability of high-level decision-makers. Thus, one could suspect that our results are an inaccurate estimate for the entire population. Nevertheless, our simulation results for the entire sample (i.e. all investors) and for the large investors have narrow 95%-confidence intervals (CIs) of generally less than ±5% (Figure C1 in Appendix C). Similarly, most 95%-CIs of the small and medium investors segments are less than ±10%. Hence, we are confident that the percentages in Figs. 6, 8 and 10 are a precise estimate for the entire population of all and large investors, and that the shares for small and medium investors are quite precise.

In some scenarios of the *small investors* segment and many of the *very large investors* segment, the 95%-CIs are larger than ±10%, as we have comparatively few *very large* respondents. However, we also expect that there are fewer *very large* investors in the population than other investors, and that it may not be possible to achieve much narrower CIs in studies such as ours.

Furthermore, our policy puzzle is related to Europe, and how European renewable power trajectories may be affected by uncoordinated policy changes. For this, we analysed the behaviour of investors from three European countries (and a handful of "other" European countries), of which half were from Germany, in 2018. In other countries and years, financing and technology costs may be different, and investors' experience with policy schemes or markets may change their perception of the investment environment. We have no reason to believe that investors behave fundamentally different in other countries or times, but we do not know.

However, we do know that the return level differs strongly between countries and over time (Egli et al., 2019; Egli, 2020; Steffen, 2020), and hence, it may play a large role to determine investor behaviour. We show that preferences change as the expected return changes, especially when the price risk increases simultaneously (i.e. when support is phased out). Possibly, the investor sensitivity to price risks is different – higher – in countries with higher country risk than the ones we investigated here, and possibly even our highest assumed return attribute level (7%) is too low in other contexts. For the cases we assessed, our results confirm that the chosen return range is reasonable: the return levels were accepted by most investors in our study. However, 20% of investors considered a ROE of 5% to be unacceptable, which seems surprising given generally low interest rates; it may be that some investors accept higher shares of debt in investments to reach higher returns as shown by Egli et al. (2018).

Future studies need to consider if and how the investment environment and returns affect behaviour in their particular country and temporal context, and what drives return expectations. We also suggest that future studies quantify the price sensitivity in a broader context, potentially using a broader and continuous range of return values.

4.3.3. Potential bias due to the limited access to offshore wind

Access to offshore wind investments is limited in some countries. Prominently, this applies to Swiss investors, who cannot invest in offshore wind projects in their own, landlocked country. This could add a potential bias to the estimation of the technology preferences, and partly explain that this technology is unacceptable to 18% of all investors (Table 4). However, we believe that Swiss investors who are primarily active abroad can find opportunities to participate in offshore wind projects, and assume that the effects of this potential bias are minor.

4.3.4. Our results reveal shifting investment choices, but do not predict capacity developments

As we report the shares of investors shifting their choices, rather than the amount of capacity investors invest in, we do not know how policy changes influence these amounts. We can, however, claim that by far most investors remain primarily active in the renewables sector as very few choose the *None* option in both policy change cases; it is thus likely that the total investment is not vastly affected by policy change coordination. We encourage further research based on our empirical findings using appropriate models, e.g. agent-based models, to simulate the deployment of renewables in the context of policy changes and to substantiate our findings. Furthermore, such research can be an opportunity to evaluate the effects of policy changes and coordination on the European power system stability.

5. Conclusions and policy implications

If renewable policy support changes or is phased out without coordination, many investors shift their activity to still (or again) supported technologies. In addition, larger investors shift their investments to countries that still provide low-risk support.

Policy-makers need to be aware that an uncoordinated phase-out could skew renewable power investments away from countries that phase out support first towards countries following later, and away from the most mature technologies – which become competitive earliest – towards less mature technologies that are still supported. As the least mature technologies are the most expensive ones, phasing out support of the cheapest technologies could increase the immediate policy cost if it triggers increased investments in immature, more expensive technologies. On the other hand, this would also help speeding up cost reductions in emerging technologies.

Further, as larger investors are more capable than smaller investors to move their activity to new countries, if they find an attractive market situation, policy changes in one country may have large effects on the deployment in another.

Our findings do not mean that policies should not change, or that change is necessarily bad for investors or the deployment of renewables. We show that if support policies are to be changed, coordination across countries is essential to achieve the desirable result of low-cost and cost-effective deployment, whereas uncoordinated changes in single countries or technology-by-technology may affect investor behaviour and skew the renewables deployment to increase, not decrease, the cost of the energy transition.

Although coordination with the EU has increased in recent years, countries retain a high degree of freedom in policy design and implementation. Increased coordination would increase complexity and raise the policy effort needed, but it could also help to keep investments on track and reduce total policy costs.

CRediT authorship contribution statement

Marc Melliger: Conceptualization, Methodology, Formal analysis, Visualization, Investigation, Writing - original draft, Writing - review & editing. **Johan Lilliestam:** Conceptualization, Supervision, Writing - original draft, Writing - review & editing.

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.

Acknowledgements

Marc Melliger and Johan Lilliestam received funding from the European Research Council (ERC) under the European Union's Horizon 2020 research and innovation programme (grant agreement 715132).

We thank two anonymous reviewers for their advice and expertise to improve this paper, Sawtooth Software for granting Marc Melliger a student license to conduct the online survey, Nicoletta Brazzola and Yash Kashyap for their assistance in the investor sampling, and the members of our research group at IASS Potsdam for providing feedback on the drafts of this paper.

Appendix E. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.enpol.2020.111993.

Appendix A. Tables of results

Tables A1/A2 & Tables A4/A5A5 list average zero-centered part-worth utilities, their standard deviations and lower & upper 95% confidence intervals (95% CI). Tables A3 & A6 list average importances, their standard deviations and lower/upper 95% confidence intervals (95% CI). We list numbers for the entire sample and all four segments separately.

Tables A1, A2 and A3 are based on the same data points depicted in the boxplots in Figs. 3 and 4, but here, the average values are means instead of medians (we do however, also depict the mean values in Fig. 3). The data on which Tables A4, A5 and A6 are based, are not depicted in the main paper (instead we show the resulting simulation results in Fig. 11).

Table A1
Preferences for all attributes of the main simulations (under the assumptions that the omitted country level is *absolutely unacceptable*). Depicted are average zero-centered part-worth utilities (U), standard deviations (SD) and lower/upper 95% confidence intervals for the entire sample and four segments.

Level	All investors (N = 93)			Small investors (N = 14)			Medium investors (N = 14)			Large investors (N = 43)			Very large investors (N = 7)		
	U	95% CI	SD	U	95% CI	SD	U	95% CI	SD	U	95% CI	SD	U	95% CI	SD
Own	61.4	[53.2; 69.6]	40.3	100.6	[80.9; 120.3]	37.5	78	[59.4; 96.7]	35.6	42.4	[32.4; 52.4]	33.5	44.9	[19.6; 70.1]	34.1
Known EU	−37.9	[-50.6;-25.1]	62.6	−99.4	[-123.4;-75.5]	45.8	−57.8	[-86.6;-29]	55	−9.8	[-23.4; 3.9]	45.6	−0.7	[-54.9; 53.6]	73.2
Unknown EU	−23.5	[-30.2;-16.9]	32.7	−1.2	[-15.6; 13.3]	27.5	−20.2	[-33.4;-7]	25.2	−32.6	[-39.6;-25.6]	23.4	−44.2	[-84;-4.4]	53.7
FIT	34.6	[30.4; 38.8]	20.7	28.4	[16.8; 40]	22.1	28.8	[19; 38.6]	18.7	39.2	[32.7; 45.6]	21.4	40.6	[27.3; 54]	18
Prem. auc.	0	[-2.6; 2.7]	12.9	−2.3	[-9.4; 4.7]	13.5	−2.5	[-5.3; 0.3]	5.4	1.4	[-2.8; 5.6]	14	5.4	[-5; 15.7]	14
No support	−34.6	[-40.5;-28.7]	28.8	−26.1	[-42.5;-9.6]	31.4	−26.3	[-36.7;-15.9]	19.8	−40.5	[-50;-31]	31.7	−46	[-64.2;-27.8]	24.6
PV	33.5	[27.9; 39.1]	27.7	25.2	[17.1; 33.2]	15.4	31.6	[20.7; 42.6]	20.9	43.1	[35.5; 50.8]	25.7	16.1	[-7.7; 39.9]	32.1
Onshore	22.1	[16.8; 27.3]	25.8	9.3	[-2.6; 21.1]	22.6	31.5	[23.1; 40]	16.2	25.7	[17.2; 34.2]	28.4	6.9	[-11.7; 25.6]	25.2
Offshore	−55.6	[-63.1;-48]	37.1	−34.4	[-47.6;-21.3]	25.1	−63.2	[-78.6;-47.7]	29.5	−68.9	[-78.6;-59.1]	32.6	−23	[-60.6; 14.5]	50.7
5%	−40.5	[-45.6;-35.5]	24.9	−29.6	[-39.6;-19.6]	19.1	−39.8	[-47.1;-32.5]	14	−48	[-54;-42]	20.1	−27.3	[-65.5; 10.8]	51.5
6%	−1.2	[-4.3; 1.8]	15.1	−6.8	[-10.7;-3]	7.4	2.7	[-2.9; 8.3]	10.7	0.1	[-5.3; 5.5]	18	−9.1	[-25.4; 7.1]	22
7%	41.8	[36.8; 46.7]	24.4	36.4	[24.1; 48.6]	23.4	37.1	[28.5; 45.7]	16.4	47.9	[41.4; 54.5]	21.9	36.5	[3.7; 69.3]	44.3

Table A2
Preferences for the interactions of the main simulations (under the assumptions that the omitted country level is *absolutely unacceptable*). Depicted are average zero-centered utilities (U), their standard deviations (SD) and lower and upper 95% confidence intervals for the entire sample and the four segments.

Level	All investors (N = 93)			Small investors (N = 14)			Medium investors (N = 14)			Large investors (N = 43)			Very large investors (N = 7)		
	U	95% CI	SD	U	95% CI	SD	U	95% CI	SD	U	95% CI	SD	U	95% CI	SD
Known EU country x 5%	−2.7	[-4.2;-1.1]	7.8	−3.1	[-6.8; 0.5]	7	−4.5	[-7.6;-1.4]	5.9	−3.8	[-6.2;-1.5]	7.9	5.3	[-2.5; 13.1]	10.5
Known EU country x 6%	−13.6	[-16.7;-10.5]	15.2	−8.1	[-11.1;-5]	5.8	−6.4	[-12;-0.8]	10.7	−14.9	[-19.1;-10.7]	14.1	−31.1	[-53.3;-8.9]	30
Known EU country x 7%	16.3	[13.1; 19.4]	15.7	11.2	[7.5; 14.9]	7	10.9	[6.1; 15.8]	9.2	18.7	[13.5; 24]	17.5	25.9	[5.3; 46.4]	27.7
Own country x 5%	1.5	[0.1; 2.8]	6.6	4.7	[0.8; 8.6]	7.4	4.3	[1.4; 7.3]	5.6	1.2	[-0.7; 3]	6.2	−5.1	[-9.9;-0.2]	6.6
Own country x 6%	13.5	[11.6; 15.4]	9.3	8.6	[6.1; 11.1]	4.8	11.3	[9.4; 13.2]	3.6	15.6	[12.6; 18.5]	10	20.6	[7.7; 33.5]	17.4
Own country x 7%	−15	[-16.9;-13.1]	9.2	−13.3	[-17.4;-9.3]	7.7	−15.6	[-18.5;-12.7]	5.6	−16.7	[-19.7;-13.8]	9.8	−15.6	[-26.3;-4.9]	14.4
Unknown EU country x 5%	1.2	[-0.1; 2.4]	6.2	−1.5	[-4.7; 1.6]	6	0.2	[-2.3; 2.7]	4.8	2.7	[0.6; 4.7]	6.9	−0.2	[-5.2; 4.8]	6.7
Unknown EU country x 6%	0.1	[-2.1; 2.3]	10.7	−0.6	[-3.3; 2.2]	5.2	−4.9	[-10.4; 0.7]	10.6	−0.7	[-3.1; 1.8]	8.2	10.5	[-2.6; 23.6]	17.7
Unknown EU country x 7%	−1.3	[-3.7; 1.1]	11.8	2.1	[-1; 5.2]	5.9	4.7	[-0.3; 9.7]	9.6	−2	[-5.5; 1.5]	11.6	−10.3	[-23.2; 2.6]	17.4

Table A3
Importances for all attributes of the main simulations (under the assumptions that the omitted country level is *absolutely unacceptable*). Depicted are average importances (I), standard deviations (SD) and lower/upper 95% confidence intervals (95% CI) for the entire sample and four segments.

Attribute	All investors (N = 93)			Small investors (N = 14)			Medium investors (N = 14)			Large investors (N = 43)			Very large investors (N = 7)		
	I	95% CI	SD	I	95% CI	SD	I	95% CI	SD	I	95% CI	SD	I	95% CI	SD
Country	33.7	[30; 37.4]	18.3	51	[41.9; 60.2]	17.5	40.1	[33.2; 47]	13.2	24.1	[19.6; 28.5]	14.9	32	[18.1; 45.8]	18.6
Policy	21.9	[19.9; 23.9]	9.9	16.5	[11; 22]	10.5	19.4	[15.7; 23.1]	7	24.5	[21.7; 27.4]	9.6	25.1	[16.7; 33.4]	11.3
Technology	18	[15.7; 20.4]	11.4	15.3	[9; 21.5]	11.9	13.9	[9; 18.8]	9.4	20.6	[16.9; 24.3]	12.4	21.7	[14.2; 29.2]	10.1
Return	26.4	[24.1; 28.8]	11.6	17.2	[12.7; 21.7]	8.7	26.6	[21.7; 31.5]	9.4	30.8	[27.1; 34.5]	12.2	21.3	[16; 26.6]	7.2

Table A4
Preferences for all attributes of the alternative simulations (under the assumptions that the omitted country level is *randomly missing*). Depicted are average zero-centered part-worth utilities (U), their standard deviations (SD) and lower and upper 95% confidence intervals (95% CI) for the entire sample and the four segments.

Level	All investors (N = 93)			Small investors (N = 14)			Medium investors (N = 14)			Large investors (N = 43)			Very large investors (N = 7)		
	U	95% CI	SD	U	95% CI	SD	U	95% CI	SD	U	95% CI	SD	U	95% CI	SD
Own	44.6	[39.4; 49.8]	25.6	65.3	[49.4; 81.2]	30.4	54.2	[42; 66.4]	23.2	35.6	[28.7; 42.5]	23.1	37	[19.9; 54.1]	23
Known EU	10.5	[7.5; 13.6]	15.2	7.7	[2; 13.4]	10.9	9.4	[1.9; 16.9]	14.3	9.6	[5.7; 13.5]	13	22.8	[5.2; 40.5]	23.8
Unknown EU	−55.2	[-60.4;-50]	25.6	−73	[-90.3;-55.8]	33	−63.6	[-73.1;-54.1]	18.1	−45.2	[-51.8;-38.7]	21.9	−59.8	[-82.7;-36.9]	30.9
FIT	38.6	[34.2; 43]	21.6	37.6	[24.9; 50.3]	24.3	33	[23.6; 42.4]	18	40.5	[34.3; 46.7]	20.8	46.8	[29.5; 64.2]	23.4
Prem. auc.	−0.8	[-3.8; 2.2]	14.8	−5	[-15.7; 5.7]	20.4	−3.4	[-6.7;-0.2]	6.2	1.4	[-2.9; 5.7]	14.3	3.7	[-8.7; 16]	16.6
No support	−37.9	[-43.8;-31.9]	29.2	−32.7	[-50.4;-14.9]	34	−29.5	[-39.5;-19.6]	19.1	−41.9	[-51.4;-32.5]	31.6	−50.5	[-67.9;-33.1]	23.5
PV	36.5	[30.4; 42.6]	29.9	34.7	[23.7; 45.7]	21	36.5	[23; 50]	25.8	44.5	[37.1; 52]	24.9	12.2	[-16.3; 40.8]	38.6
Onshore	25.6	[19.6; 31.7]	30	14.4	[-3.7; 32.4]	34.5	36.9	[27.7; 46]	17.4	27.3	[18.3; 36.3]	30.3	9.7	[-10.6; 30.1]	27.5
Offshore	−62.2	[-70;-54.3]	38.5	−49	[-68.2;-29.8]	36.7	−73.4	[-90.5;-56.2]	32.7	−71.8	[-81.6;-62]	32.8	−22	[-60.1; 16.1]	51.5

(*continued on next page*)

Table A4 (*continued*)

Level	All investors (N = 93)			Small investors (N = 14)			Medium investors (N = 14)			Large investors (N = 43)			Very large investors (N = 7)		
	U	95% CI	SD	U	95% CI	SD	U	95% CI	SD	U	95% CI	SD	U	95% CI	SD
5%	−45.7	[-50.9;-40.5]	25.5	−37.7	[-48.1;-27.3]	19.8	−46.1	[-52.5;-39.7]	12.2	−50.3	[-56.4;-44.2]	20.4	−30.6	[-68.9; 7.7]	51.7
6%	−1.2	[-4.4; 2.1]	16	−8.7	[-13.1;-4.2]	8.5	2.4	[-3.7; 8.6]	11.7	0.2	[-5.3; 5.7]	18.4	−7	[-25.6; 11.6]	25.1
7%	46.9	[41.9; 51.9]	24.5	46.4	[34.1; 58.6]	23.4	43.7	[34.7; 52.7]	17.2	50.1	[43.7; 56.5]	21.5	37.6	[5.4; 69.8]	43.5

Table A5

Preferences for the interactions of the alternative simulations (under the assumptions that the omitted country level is *randomly missing*). Depicted are average zero-centered utilities (U), their standard deviations (SD) and lower and upper 95% confidence intervals for the entire sample and four segments.

Level	All investors (N = 93)			Small investors (N = 14)			Medium investors (N = 14)			Large investors (N = 43)			Very large investors (N = 7)		
	U	95% CI	SD	U	95% CI	SD	U	95% CI	SD	U	95% CI	SD	U	95% CI	SD
Known EU country x 5%	−3.1	[-4.9;-1.3]	8.8	−5.2	[-10.6; 0.1]	10.3	−5.3	[-8.7;-1.8]	6.6	−4	[-6.4;-1.5]	8.3	5.6	[-2.1; 13.3]	10.4
Known EU country x 6%	−15.3	[-18.6;-12.1]	16	−11.8	[-17.4;-6.3]	10.6	−7.3	[-13.1;-1.5]	11.1	−15.4	[-19.6;-11.3]	14	−34.5	[-56.6;-12.3]	29.9
Known EU country x 7%	18.5	[15.1; 21.9]	16.8	17.1	[8.8; 25.3]	15.7	12.6	[7.7; 17.4]	9.2	19.4	[14.2; 24.6]	17.3	28.9	[8.2; 49.6]	27.9
Own country x 5%	1.8	[0.2; 3.5]	8.2	6.9	[1.2; 12.7]	11	5.3	[2.1; 8.5]	6.1	1.3	[-0.7; 3.3]	6.8	−6.3	[-12.1;-0.5]	7.8
Own country x 6%	15.2	[13.2; 17.2]	9.7	12.1	[8.2; 16]	7.4	13.2	[11.3; 15.1]	3.6	16.3	[13.3; 19.3]	9.9	23.9	[9.6; 38.3]	19.4
Own country x 7%	−17.1	[-19.2;-14.9]	10.5	−19	[-25.9;-12.1]	13.2	−18.5	[-21.6;-15.3]	6	−17.6	[-20.7;-14.6]	10.2	−17.7	[-28.7;-6.6]	14.9
Unknown EU country x 5%	1.3	[-0.1; 2.7]	7	−1.7	[-6.1; 2.7]	8.4	−0.1	[-3.1; 3]	5.8	2.6	[0.5; 4.8]	7.1	0.7	[-5.2; 6.6]	7.9
Unknown EU country x 6%	0.1	[-2.4; 2.6]	12.3	−0.3	[-4; 3.5]	7.2	−5.9	[-11.9; 0.1]	11.4	−0.9	[-3.4; 1.7]	8.6	10.5	[-2.6; 23.6]	17.7
Unknown EU country x 7%	−1.4	[-4.2; 1.4]	13.9	1.9	[-2.9; 6.7]	9.2	5.9	[0.7; 11.2]	10	−1.8	[-5.4; 1.9]	12.1	−11.2	[-24.1; 1.6]	17.3

Table A6

Importances for all attributes of the alternative simulations (under the assumptions that the omitted country level is *randomly missing*). Depicted are average importances (I), standard deviations (SD) and lower/upper 95% confidence intervals (95% CI) for the entire sample and four segments.

Attribute	All investors (N = 93)			Small investors (N = 14)			Medium investors (N = 14)			Large investors (N = 43)			Very large investors (N = 7)		
	I	95% CI	SD	I	95% CI	SD	I	95% CI	SD	I	95% CI	SD	I	95% CI	SD
Country	25.7	[23.3; 28.1]	11.8	34.6	[26.4; 42.8]	15.6	30.3	[26; 34.7]	8.3	21	[17.9; 24.1]	10.3	26.2	[17.8; 34.7]	11.4
Policy	24.4	[22.5; 26.4]	9.6	21	[15.5; 26.6]	10.6	22.6	[19.1; 26.1]	6.7	25.6	[22.8; 28.4]	9.4	26.5	[19.6; 33.3]	9.3
Technology	20.1	[17.9; 22.4]	11.2	20.1	[13.7; 26.5]	12.3	15.8	[11.2; 20.5]	8.9	21.3	[17.7; 24.9]	12.2	24.4	[16.3; 32.4]	10.8
Return	29.7	[27.4; 32]	11.4	24.3	[17.2; 31.4]	13.5	31.2	[26.2; 36.2]	9.5	32.1	[28.4; 35.7]	12.2	22.9	[19; 26.8]	5.2

Appendix B. Differences between levels of the segmented samples

We can split the entire sample by the variables *type of company*, *country of company's headquarter* and *typical investment range of projects*. In this paper, we chose to base our study on the *typical investment range of projects* because it causes more differences between attribute levels than the other variables, namely 8 significant differences (compared to 7 and 6). Table B1 reports the levels that differ significantly and the corresponding statistics.

Assuming that the omitted known EU country level is randomly missing (Table B2) instead of absolutely unacceptable (Table B1), fewer differences are significant. Nevertheless, the *typical investment range of projects* has still more significant differences than the other potential segmentation variables (3 compared to 1 and 2).

Table B1
Kruskal-Wallis test for significant differences between segments in the main simulations. Tests are for each level. The segments are derived from the three variables. H(df) denotes the test statistic and degree of freedom. $p < 0.05$ is marked by *.

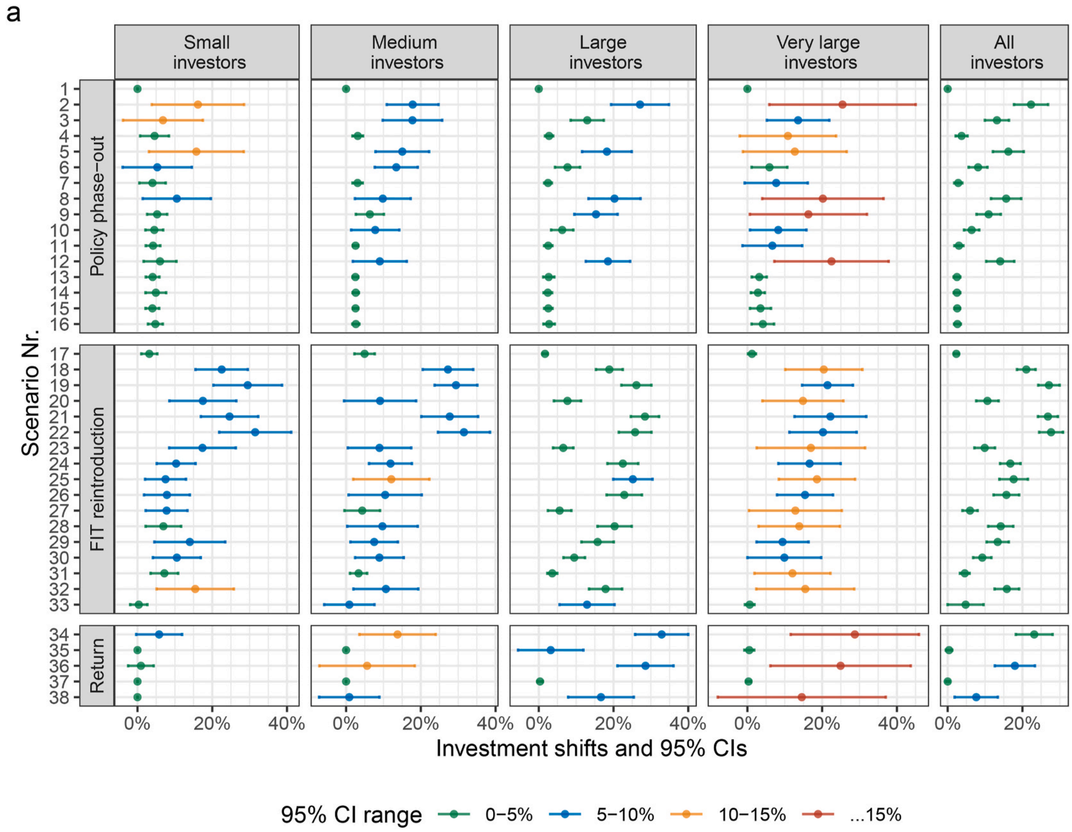
Level	Type of company	Country of a company's headquarter	Typical investment range of projects
Own	H(5) = 30.59, p = 0*	H(3) = 14.14, p = 0*	H(5) = 28.13, p = 0*
Known EU	H(5) = 26.92, p = 0*	H(3) = 17.7, p = 0*	H(5) = 26.52, p = 0*
Unknown EU	H(5) = 16.3, p = 0.01*	H(3) = 20.85, p = 0*	H(5) = 17.3, p = 0*
FIT	H(5) = 18.77, p = 0*	H(3) = 9.44, p = 0.02*	H(5) = 8.69, p = 0.12
Prem. auc.	H(5) = 8.3, p = 0.14	H(3) = 2.27, p = 0.52	H(5) = 12.48, p = 0.03*
No support	H(5) = 12.3, p = 0.03*	H(3) = 7.22, p = 0.07	H(5) = 8.46, p = 0.13
PV	H(5) = 7.94, p = 0.16	H(3) = 7.72, p = 0.05	H(5) = 12.82, p = 0.03*
Onshore	H(5) = 6.84, p = 0.23	H(3) = 3.49, p = 0.32	H(5) = 12.17, p = 0.03*
Offshore	H(5) = 7.68, p = 0.17	H(3) = 10.21, p = 0.02*	H(5) = 17.18, p = 0*
5%	H(5) = 10.04, p = 0.07	H(3) = 7.92, p = 0.05*	H(5) = 15.07, p = 0.01*
6%	H(5) = 7.74, p = 0.17	H(3) = 0.46, p = 0.93	H(5) = 7.63, p = 0.18
7%	H(5) = 6.83, p = 0.23	H(3) = 6.49, p = 0.09	H(5) = 10.46, p = 0.06

Table B2
Kruskal-Wallis test for significant differences between segments in the alternative simulations. Tests are for each level. The segments are derived from the three variables. H(df) denotes the test statistic and degree of freedom. $p < 0.05$ is marked by *.

Level	Type of company	Country of a company's headquarter	Typical investment range of projects
Own	H(5) = 21.72, p = 0*	H(3) = 5.65, p = 0.13	H(5) = 20, p = 0*
Known EU	H(5) = 3.29, p = 0.66	H(3) = 1.14, p = 0.77	H(5) = 7.39, p = 0.19
Unknown EU	H(5) = 18.84, p = 0*	H(3) = 9.72, p = 0.02*	H(5) = 16.63, p = 0.01*
FIT	H(5) = 10.62, p = 0.06	H(3) = 5.56, p = 0.14	H(5) = 5.12, p = 0.4
Prem. auc.	H(5) = 8.46, p = 0.13	H(3) = 2.23, p = 0.53	H(5) = 12.98, p = 0.02*
No support	H(5) = 7.44, p = 0.19	H(3) = 3.88, p = 0.27	H(5) = 5.6, p = 0.35
PV	H(5) = 5.91, p = 0.31	H(3) = 4.93, p = 0.18	H(5) = 9.71, p = 0.08
Onshore	H(5) = 7.27, p = 0.2	H(3) = 3.65, p = 0.3	H(5) = 10.69, p = 0.06
Offshore	H(5) = 4.7, p = 0.45	H(3) = 5.22, p = 0.16	H(5) = 10.81, p = 0.06
5%	H(5) = 6.36, p = 0.27	H(3) = 7.1, p = 0.07	H(5) = 10.88, p = 0.05
6%	H(5) = 8.57, p = 0.13	H(3) = 0.55, p = 0.91	H(5) = 7.46, p = 0.19
7%	H(5) = 5.46, p = 0.36	H(3) = 4.1, p = 0.25	H(5) = 8.57, p = 0.13

Appendix C. 95% Confidence intervals

In Figure C1, we report the 95% confidence intervals (CIs) for the numbers in Figs. 6, Figs. 8 and 10, both for (a) investors who shift their investment choices to different countries or technologies, and (b) investors who shift their investment choices to the None option. For instance, in Figs. 6 and 16% of small investors in scenario 2 shift their choices to other countries or technologies. The same value is shown in Figure C1 for small investors and scenario number 2, but here including the 95% CI that has a range of between 10 and 15% (orange, i.e. 20–30% to both sides).



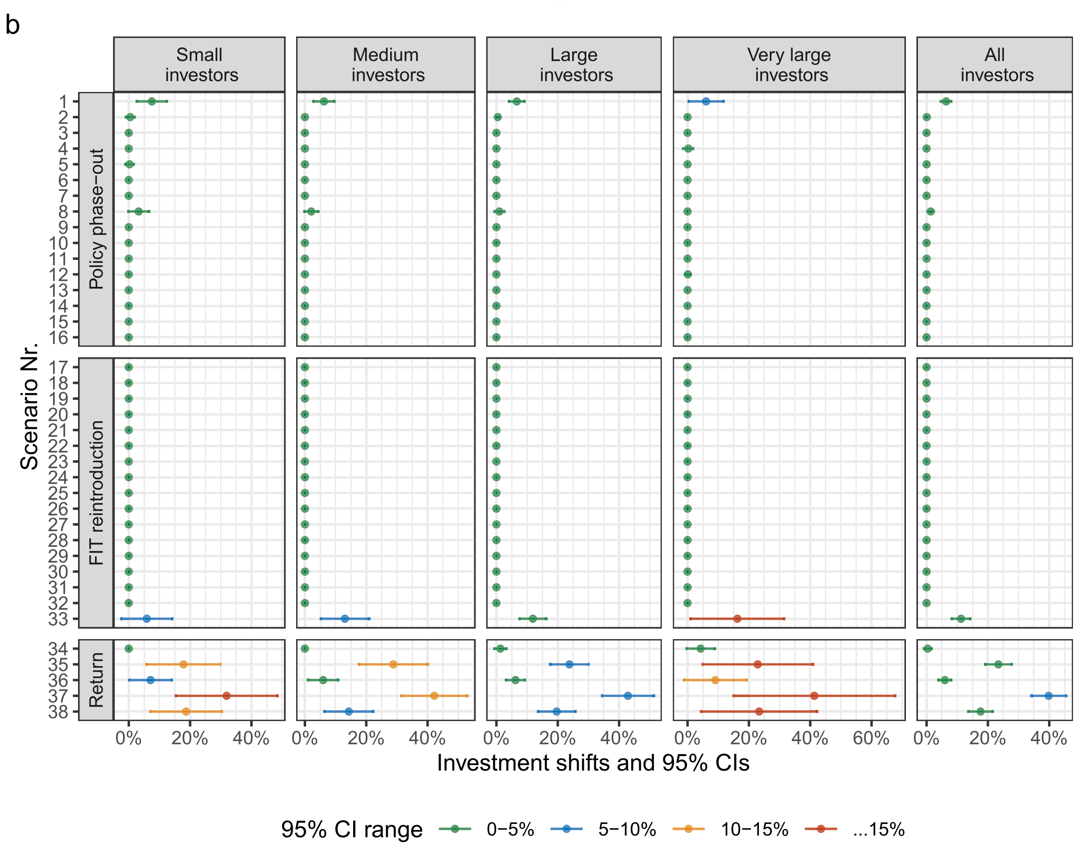


Fig. C1. Shifts of investment choices (a) to different countries or technologies or (b) to the None option; in all scenarios. The points are percentages of investors (of each investment range) who choose differently than in the auction scenario; these are the same numbers as in Figs. 6, 8 and 10. The intervals and colours are the 95% confidence intervals of these percentages; colour coded to better differentiate 95% CI ranges.

Appendix D. Interaction effects

An analysis of interaction effects between attributes reveals two significant interaction effects (Table D1). Adding the most significant interaction effect between country and expected return on equity ($p < 0.001$) improves the model fit by 0.7%. Egli et al. (2019) show that differences in capital costs between countries should be considered to improve modelling, and hence, we include this interaction effect in our model. As Sawtooth suggests that interaction effects should only be included if such compelling evidence exists (to avoid an overfitting of the model[4]), we omit the other interactions.

Table D1
Results of interaction effects search in Sawtooth Lighthouse Studio. Significant ($p < 0.05$) effects are highlighted bold.

Run	Log-Likelihood Fit	Chi Square Value	2LL P-Value for Interaction Effect	Gain in Pct. Cert. over Main Effects
Main Effects	−1381.1			
+ Country x Return	−1370.0	22.2	**0.0002**	0.65%
+ Country x Policy	−1375.7	10.7	**0.0306**	0.31%
+ Technology x Country	−1376.4	9.4	0.0521	0.27%
+ Technology x Return	−1380.0	2.2	0.7001	0.06%
+ Technology x Support	−1380.1	1.9	0.7528	0.06%
+ Policy x Return	−1380.6	0.8	0.9351	0.02%

References

Bergek, A., Mignon, I., 2017. Motives to adopt renewable electricity technologies: evidence from Sweden. Energy Pol. 106, 547–559. https://doi.org/10.1016/j.enpol.2017.04.016.

Bergek, A., Mignon, I., Sundberg, G., 2013. Who invests in renewable electricity production? Empirical evidence and suggestions for further research. Energy Pol. 56, 568–581. https://doi.org/10.1016/j.enpol.2013.01.038.

Bergmann, A., Hanley, M., Wright, R., 2006. Valuing the attributes of renewable energy investments. Energy Pol. 34, 1004–1014. https://doi.org/10.1016/j.enpol.2004.08.035.

Bundesamt für Statistik (BFS), 2019. Elektrizitätserzeugung. https://www.bfs.admin.ch/bfs/de/home/statistiken/energie.assetdetail.9306227.html accessed 6.5.2020.

Breyer, C., Gerlach, A., 2012. Global overview on grid-parity. Prog. Photovoltaics Res. Appl. 21, 121–136. https://doi.org/10.1002/pip.1254.

CE Delft, 2016. The Potential of Energy Citizens in the. European Union, Delft.

Chassot, S., Hampl, N., Wüstenhagen, R., 2014. When energy policy meets free-market capitalists: the moderating influence of worldviews on risk perception and renewable energy investment decisions. Energy Res. Social Sci. 3, 143–151. https://doi.org/10.1016/j.erss.2014.07.013.

Cointe, B., Nadaï, A., 2018. Feed-in Tariffs in the European Union, Renewable Energy Policy, the Internal Electricity Market and Economic Expertise. Springer, Oslo.

Cunningham, C.E., Deal, K., Chen, Y., 2010. Adaptive choice-based conjoint analysis: a new patient-centered approach to the assessment of health service preferences. The Patient 3, 257–273. https://doi.org/10.2165/11537870-000000000-00000.

Dóci, G., Gotchev, B., 2016. When energy policy meets community: rethinking risk perceptions of renewable energy in Germany and The Netherlands. Energy Res. Social Sci. 22, 26–35. https://doi.org/10.1016/j.erss.2016.08.019.

Egli, F., 2020. Renewable energy investment risk: an investigation of changes over time and the underlying drivers. Energy Pol. 140 https://doi.org/10.1016/j.enpol.2020.111428, 111428–15.

Egli, F., Steffen, B., Schmidt, T.S., 2018. A dynamic analysis of financing conditions for renewable energy technologies. Nat. Energy 1–12. https://doi.org/10.1038/s41560-018-0277-y.

Egli, F., Steffen, B., Schmidt, T.S., 2019. Bias in energy system models with uniform cost of capital assumption. Nat. Commun. 1–3. https://doi.org/10.1038/s41467-019-12468-z.

European Commission, 2014. Communication from the Commission - guidelines on State aid for environmental protection and energy 2014-2020. Off. J. European Union 1–55, 2014/C 200/01.

European Commission, 2018. A Clean Planet for All. A European Strategic Long-Term Vision for a Prosperous, Modern, Competitive and Climate Neutral Economy (Brussels).

European Commission, 2020. Biannual energy statistical country datasheets. https://ec.europa.eu/energy/data-analysis/energy-statistical-pocketbook_de accessed 6.5.2020.

European Parliament, 2017. European Parliament Resolution of 13 September 2016 on towards a New Energy Market Design (Brussels).

European Union, 2018. Directive (EU) 2018/2001 of the European Parliament and of the Council of 11 December 2018 on the promotion of the use of energy from renewable sources. Off. J. European Union L 328, 82–209.

Fleiß, E., Hatzl, S., Seebauer, S., Posch, A., 2017. Money, not morale: the impact of desires and beliefs on private investment in photovoltaic citizen participation initiatives. J. Clean. Prod. 141, 920–927. https://doi.org/10.1016/j.jclepro.2016.09.123.

Fraunhofer ISE, 2015. Current and Future Cost of Photovoltaics. Long-Term Scenarios for Market Development, System Prices and LCOE of Utility-Scale PV Systems. Study on Behalf of Agora Energiewende (Berlin).

Gürtler, K., Postpischil, R., Quitzow, R., 2019. The dismantling of renewable energy policies: the cases of Spain and the Czech Republic. Energy Pol. 133, 110881. https://doi.org/10.1016/j.enpol.2019.110881.

Hafner, S., Lilliestam, J., 2019. The Global Renewable Power Support Dataset. Institute for Advanced Sustainability Studies (IASS) & Anglia Ruskin University, Potsdam & Cambridge. https://doi.org/10.5281/zenodo.3371375.

Held, A., Ragwitz, M., del Río, P., Resch, G., Klessmann, C., Hassel, A., et al., 2019. Do almost mature renewable energy technologies still need dedicated support towards 2030? Economics of Energy Environ. Pol. 8 (2), 1–18. https://doi.org/10.5547/2160-5890.8.2.ahel.

Hirth, L., 2015. Market value of solar power: is photovoltaics cost-competitive? IET Renew. Power Gener. 9, 37–45. https://doi.org/10.1049/iet-rpg.2014.0101.

Huber, J., Orme, B., Miller, R., 2001. Dealing with product similarity in conjoint simulations. https://www.sawtoothsoftware.com/download/techpap/prodsim.pdf accessed 26.9.2019.

IPCC, 2018. Summary for policymakers. In: Global Warming of 1.5C. An IPCC Special Report on the Impacts of Global Warming of 1.5C above Pre-industrial Levels and Related Global Greenhouse Gas Emission Pathways, in the Context of Strengthening the Global Response to the Threat of Climate Change, Sustainable Development, and Efforts to Eradicate Poverty.

IRENA, 2019. Renewable Power Generation Costs in 2018. Abu Dhabi.

IRENA, IEA, REN21, 2018. Renewable Energy Policies in a Time of Transition.

Kitzing, L., 2014. Risk implications of renewable support instruments: comparative analysis of feed-in tariffs and premiums using a mean-variance approach. Energy 64, 495–505. https://doi.org/10.1016/j.energy.2013.10.008.

Lancaster, K.J., 1966. A new approach to consumer theory. J. Polit. Econ. 74 (2), 132–157. https://doi.org/10.2307/1828835.

Loock, M., 2012. Going beyond best technology and lowest price on renewable energy investors' preference for service-driven business models. Energy Pol. 40, 21–27. https://doi.org/10.1016/j.enpol.2010.06.059.

López Prol, J., Steininger, K.W., Zilberman, D., 2020. The cannibalization effect of wind and solar in the California wholesale electricity market. Energy Econ. 85 https://doi.org/10.1016/j.eneco.2019.104552, 104552–15.

Luce, R.D., Tukey, J.W., 1964. Simultaneous conjoint measurement: a new type of fundamental measurement. J. Math. Psychol. 1, 1–27. https://doi.org/10.1016/0022-2496(64)90015-X.

Lüthi, S., Prässler, T., 2011. Analyzing policy support instruments and regulatory risk factors for wind energy deployment—a developers' perspective. Energy Pol. 39 (9), 4876–4892. https://doi.org/10.1016/j.enpol.2011.06.029.

Lüthi, S., Wüstenhagen, R., 2012. The price of policy risk - empirical insights from choice experiments with European photovoltaic project developers. Energy Econ. 34, 1001–1011. https://doi.org/10.1016/j.eneco.2011.08.007.

Manski, C.F., 1977. The structure of random utility models. Theor. Decis. 8, 229–254. https://doi.org/10.1007/BF00133443.

McCullough, D., 2002. A user's guide to conjoint analysis. Market. Res. 14, 18–23.

Mitchell, C., Bauknecht, D., Connor, P.M., 2006. Effectiveness through risk reduction: a comparison of the renewable obligation in England and Wales and the feed-in system in Germany. Energy Pol. 34, 297–305. https://doi.org/10.1016/j.enpol.2004.08.004.

[4] https://www.sawtoothsoftware.com/help/lighthouse-studio/manual/hid_web_cbc_designs_3.html and https://www.sawtoothsoftware.com/help/lighthouse-studio/manual/interactioneffects.html.

Nissen, U., Harfst, N., 2019. Shortcomings of the traditional "levelized cost of energy" [LCOE] for the determination of grid parity. Energy 171, 1009–1016. https://doi.org/10.1016/j.energy.2019.01.093.
Orme, B., 2010a. Sample size issues for conjoint analysis. In: Getting Started with Conjoint Analysis. Research Pub Llc, Madison, pp. 1–10.
Orme, B., 2010b. Interpreting the results of conjoint analysis. In: Getting Started with Conjoint Analysis. Research Pub Llc, Madison, pp. 1–12.
Orme, B., 2014. Sawtooth software technical paper series: ACBC technical paper. https://www.sawtoothsoftware.com/support/technical-papers/adaptive-cbc-papers/acbc-technical-paper-2009 accessed 26.9.2019.
Orme, B., 2019. Analysis with tiny sample sizes. https://www.sawtoothsoftware.com/help/lighthouse-studio/manual/analysiswithtinysamplesize.html accessed 26.9.2019.
Polzin, F., Egli, F., Steffen, B., Schmidt, T.S., 2019. How do policies mobilize private finance for renewable energy? - a systematic review with an investor perspective. Appl. Energy 236, 1249–1268. https://doi.org/10.1016/j.apenergy.2018.11.098.
Salm, S., 2018. The investor-specific price of renewable energy project risk - a choice experiment with incumbent utilities and institutional investors. Renew. Sustain. Energy Rev. 82, 1364–1375. https://doi.org/10.1016/j.rser.2017.04.009.
Salm, S., Hille, S.L., Wüstenhagen, R., 2016. What are retail investors' risk-return preferences towards renewable energy projects? A choice experiment in Germany. Energy Pol. 97, 310–320. https://doi.org/10.1016/j.enpol.2016.07.042.
Steffen, B., 2020. Estimating the cost of capital for renewable energy projects. Energy Econ. 88 (C), 104783. https://doi.org/10.1016/j.eneco.2020.104783.
United Nations, 2015. Paris Agreement, Paris.
Webb, J., Wilson, C., Steinberg, T., Stein, W., 2017. Solar grid parity and its impact on the grid. In: Innovation and Disruption at the Grid's Edge. Elsevier Inc., pp. 389–408. https://doi.org/10.1016/B978-0-12-811758-3/00019-X