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Is it really all about the return on investment? Exploring private wind energy investors' preferences

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ABSTRACT

Achieving EU climate targets requires an immense volume of investments in renewable energies, especially in the field of wind energy. Private individuals can play an essential role in raising significant parts of the necessary financial resources. This requires, however, a thorough understanding of investors' preferences. Based on choice experiments by 725 German respondents who intend to invest in wind energy in the near future, this article shows that private individuals' investment decisions are not only made with profit maximization in mind. Furthermore, this study reveals that an individual's age, asset valuation and environmental attitude significantly affect the preference for different wind energy investment attributes. The findings of this study have important implications for financial institutions and for policy, as the findings indicate that private individuals are not well informed about many aspects of wind energy investments.

1. Introduction

The EU strategy for a competitive low-carbon economy by 2050 describes scenarios to keep global warming below 2 °C. To reach that goal, an "energy technology revolution" is necessary in order to halve the global CO_2 emissions by 2050 compared with 2005 levels [1,2]. Therefore, use of Renewable Energy (RE) has strongly increased within the last decade. However, RE has not yet reached its full potential and contributes only a small fraction (4.5%) to global electricity production [3].

This is partly due to the fact that the reduction of CO_2 emissions requires an immense volume of investments in sustainable energy technologies [4–6]. The International Energy Agency estimates that $ 39 trillion worth of cumulative investments in energy supply will be required to keep global warming below 2 °Celsius [2]. Of this amount, $ 8 trillion are necessary for the RE sector, of which wind energy requires most new investments (39%), followed by hydropower (27%), solar (23%) and bioenergy (11%).

The required investments can be provided by the public sector through taxation and government expenditure (e.g., feed-in tariffs). In addition, the private sector can play an essential role in obtaining the necessary financial resources [7] and will be indispensable in future, because the required sums cannot be provided by government investments alone [8]. Therefore, a combination of public and private financing will be necessary to achieve the targets for a reduction of greenhouse gas emissions [9].

In the field of private financing, individuals are of great importance, with private households contributing a significant share (9%) to global climate financing in 2012 with investments of $ 33 billion in REs [10]. Citizens, in addition to other investor groups such as utilities and other corporate or other financial actors, have provided an important source of finance for RE projects in some countries [11,12] or more specifically for wind energy (13).

In Germany, private households owned 50% of onshore wind energy in 2010 [13], whereas energy providers (7%), project developers (21%), funds/banks (16%), and industry (2%) only invested a small amount in wind energy [13]. Thus, private individuals mainly drove the rapid expansion of wind energy in Germany, although this kind of investment can be seen as a special type of investment as they are considered to be riskier than more common financial investments such as fixed-term deposits or savings bonds. For example, they usually require larger minimum investments which are directed towards a concrete wind turbine. This demonstrates the relevance of this group of investors and reveals the importance of a better understanding of private individuals' investment decisions in wind energy.

Behavioral finance examines such investment decisions and argues that investors do not exclusively employ rational decision-making [14]. Furthermore, some authors point out that in

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additional to rational factors, behavioral factors can play an important role in the decision-making process [15]. Nevertheless, private individuals' investment preferences in RE have not been analyzed systematically. The available literature on the financial engagement of citizens and investment professionals show that investments in REs are motivated by several reasons. Demographic variables tend to affect "willingness to invest" in REs and "willingness to pay" for REs [16–18] and are used for customer segmentation in financial services [19–23]. Further, cognitive variables like knowledge (financial and technical) [24–26] and attitudes (e.g., towards the environment or the power generation system) [27–29] influence individual's investment preferences. The literature also shows that economic variables such as access to financial resources or household income [30,31] affect the propensity to invest in RE.

Against this background and by taking into account private individual's preferences for wind energy investments, we address the following research questions: (1) which attributes of direct wind energy investments are of particular importance to private individuals and (2) to what extent is the willingness to invest in wind energy influenced by an individual's age, asset valuation and environmental attitude?

2. Data and methods

2.1. Experimental design

The objective of this study is to investigate the investment preferences of private individuals in wind energy. The objective of this study refers to direct investment in specific wind turbines, not to indirect investments such as the purchase of green electricity. One particularly popular method of analyzing individuals' preferences is conjoint experiment (CE) [32], also referred to as conjoint analysis in marketing literature. This study is based on the prerequisite that investment decisions comply with the fundamental assumptions underlying conjoint analysis [33]. Specifically, it is assumed in a CE that the characteristics of an investment give rise to utility, not the investment per se. Furthermore, wind energy investments are complex products and thus have to be characterized by more than just one attribute. This implies that wind energy investments may have different characteristics to wind turbines and "typical" investment attributes like ROI, duration et cetera. In particular, the location of the wind park can be of great importance for private individuals' investment decisions.

The basic form of conjoint analysis has been adapted over the years in order to overcome certain weaknesses in the traditional method [34–37]. Among the advances are two particular variations of conjoint analysis:

(1) Full profile methods, such as choice-based conjoint analysis (CBC), where respondents make simultaneous trade-offs between all attributes of the choice alternatives.
(2) Partial profile methods, such as adaptive conjoint analysis (ACA), where respondents are first asked to rank the importance of attributes followed by choice tasks that gradually build up complexity [38]. The term "adaptive" refers to the fact that the computer-administered interview is individualized for each respondent.

Adaptive choice-based conjoint analysis (ACBC) is a hybrid method between CBC and ACA that combines the specific characteristics of both methods [39]. For this reason, ACBC is the preferred choice of method, as we argue that a private individual's choice among different opportunities to invest in wind energy is, in principle, similar to the decision by a customer to buy a product. The over-all complexity of real-life decision making cannot be reached with a survey instrument. Therefore, it is essential to imitate the real decision-making process as closely as possible.

ACBC is a well-established method in marketing research to measure customer preferences [40]. Research has utilized conjoint analysis in the discourse on clean energy, energy-efficiency and energy policy [23,41,42] as well as environmental economics [43–47]. Furthermore, conjoint analysis is well suited for investment decisions [48] and has been successfully applied to analysis of investor preferences or financial choices in other studies [32].

Most respondents pay attention to only a few attribute levels when making product choices, especially when it comes to complex product concepts as is the case in this study [49]. Therefore, ACBC screens a wide variety of product concepts but focuses on the subset of most interest to the respondent [38]. This is provided by a fixed sequence of various choice sections.

Typically, the computer-administered interview includes three sections that build on each other:

(1) In the Build Your Own (BYO) section, respondents answer questions to identify attributes and levels, as well as to let the respondent determine the preferred level for each attribute.
(2) In the Screening Section, the software generates a series of hypothetical investments based on the first section. The customized designs are near-orthogonal, generated by the software "on-the-fly" based on the information provided by the respondent in the BYO section and by following a controlled, randomized process. This allows for "controlled" randomized designs, and leads to a relatively high degree of level balance and statistical efficiency [39]. The different developed product concepts are presented to the respondent in groups of three per screen. Individuals "are not asked to make final choices, but rather just indicate whether they would consider each one a possibility or not a possibility" [39].
(3) Those concepts that passed the Screening Section are transferred to the Choice Task Section (cf. Appendix A) where the alternatives are presented in choice-groups of three. In each task, respondents have to indicate their most favored option. In the subsequent rounds of the tournament, the winning alternatives are measured against each other until the preferred concept is identified [50].

In spite of the adaptive approach and the resulting reduced number of choice tasks, ACBC surveys require more time than conventional approaches to CE, but they are perceived to be more interesting and engaging [39]. Moreover, it produces better predictions for a choice set that was custom-designed for each respondent from concepts preferred in previous choice sets [51]. It is recommended that ACBC is most appropriate for surveys with a large number of attributes (5–12) and with no more than seven levels per attribute [52]. Within this range, ACBC yields lower standard errors than conventional CE approaches, [53]. Therefore, the challenge for CEs is to find the right balance between important standard criteria that would make the choice experiment as realistic as possible and further attributes that would reflect the social influences on private individuals' decision making—and all this while keeping the complexity for respondents at an appropriate level [54].

A further requirement of CEs is, on the one hand, to include all important attributes of a product and, on the other hand, not to overwhelm the participants with too much information. Therefore, ACBC provides a smart solution by avoiding the cognitive overload of respondents despite a high number of attributes. A particular feature allows respondents to eliminate alternatives with unacceptable attribute levels from their consideration set and then to choose among the remaining alternatives using a more refined