

Analyzing policy support instruments and regulatory risk factors for wind energy deployment—A developers' perspective

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ARTICLE INFO

Article history:

Received 1 September 2010

Accepted 13 June 2011

Available online 16 July 2011

Keywords:

Renewable energy policy

Wind energy development

Conjoint analysis

ABSTRACT

A transition to a renewable energy system is high on the policy agenda in many countries. A promising energy source for a low-carbon energy future is wind. Policy-makers can attract wind energy development by providing attractive policy frameworks. This paper argues that apart from the level of financial support, both the risks stemming from the regulatory environment (legal security, administrative process and grid access) and the ability to finance projects play a critical role in determining the attractiveness of the development environment. It sheds light on how project developers trade off these different aspects and to what extent the attractiveness of a certain policy framework increases with the introduction of specific measures. Conjoint analysis is employed to provide empirical evidence on the preference of wind energy developers in the EU and the US. The analysis shows that developers' preferences are very similar across the studied regions and for different types of developers. Which policy measures could be most valuable depends on the specific existing environment. In some southeastern European countries, a reduction of administrative process duration may yield the highest utility gains, whereas, in the US, improvements in grid access regulation and an increase in remuneration levels may be more effective.

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1. Introduction

Although the overall share of renewable energy in global electric power supply is still low, there is significant growth in some subsectors. A relevant indicator for this trend is the investment flow in new power stations. In 2008, global power generation investment in renewable power technologies exceeded investment in fossil-fueled technologies for the first time (Hohler et al., 2009). Among the various renewable energy sources, wind energy is one of the most prominent: in 2009, it accounted for 64% in the EU and 90% in the US of all new renewable generating capacity and for 39% of all new US and EU electric generation capacity (Bloem et al., 2010; EWEA, 2010a; Wiser and Bolinger, 2010). While the cost of wind energy has come close to grid parity in locations with consistently strong winds, its growth has been, and still is, largely driven by policy incentives.

Among the most prominent instruments to support wind energy and other renewable energy technologies are those that subsidize revenues from electricity sales, for instance feed-in tariffs and renewable obligation certificates. However, attractive return levels alone are not sufficient to effectively drive the

diffusion of wind energy. The OECD and the IEA find in a report on the wind energy policies effectiveness in OECD and BRICS¹ countries (OECD/IEA, 2008) that “[b]eyond some minimum threshold level, higher remuneration levels do not necessarily lead to greater levels of policy effectiveness” (OECD/IEA, 2008, p. 17). They argue that high non-economic barriers are one reason for this result. Therefore, financial support schemes need to be complemented by policy measures that address non-economic barriers to deployment (OECD/IEA, 2008; EWEA, 2010b; Valentine, 2010).

The question is which deployment barriers are most relevant and how policies can help to remove them. According to the IPCC, “[b]arrier removal includes correcting market failures directly or reducing the transactions costs in the public and private sectors by, for example, improving institutional capacity, reducing risk and uncertainty, facilitating market transactions, and enforcing regulatory policies” (IPCC-WGIII, 2007, p. 77). A substantial body of literature has identified a broad variety of such barriers and development risks for wind energy. They include administrative hurdles such as lengthy, ill-structured authorization and permitting procedures (OECD/IEA, 2008; EWEA, 2010b); nontransparent and costly procedures for grid connection (RETD, 2006; Swider et al., 2008; EWEA, 2010b); strict environmental regulations

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¹ Brazil, Russia, India, China, and South Africa.

(EWEA, 2010b); support policy instability with sudden policy changes and stop-and-go situations (Wiser and Pickle, 1998; Meyer, 2007; Barradale, 2010); and lack of social acceptance (Jobert et al., 2007; Nadaï, 2007; Wüstenhagen et al., 2007).

To understand how these factors influence decision making on a company level and how the resulting risks for deployment can best be mitigated, it is useful to study them from an investors' perspective. Such a perspective was adopted by academics as early as the nineties. Wiser et al. (1997) identify perceived resource and technology risks and high support policy risk as the main hurdles that renewable energy project developers face in obtaining financing. Langniss (1996) categorized different types of investors and recognized that the type of support and taxation scheme has implications on which type of investor will be attracted. Dinica (2006) proposes to adopt an investor perspective and shows conceptually how developers evaluate the ratio of risks and profitability associated with renewable energy projects. Bürer and Wüstenhagen (2009) emphasize that the understanding of investor perceptions may provide policy-makers with the opportunity to leverage private investment to reach renewable energy targets. All these studies provide valuable insights for a better understanding of the drivers of development and diffusion of new wind energy capacity. The applied methodologies have been either conceptual analyses or qualitative case studies. The maturing of markets with an ever growing number of companies engaged in wind energy development now allows this paper to employ a large scale quantitative empirical analysis. The paper largely builds on the findings of existing literature and intends to add to them in three ways. First, it employs a relatively novel methodology to energy policy research: multivariate adaptive choice-based conjoint analysis. The paper suggests that conjoint analysis could be a helpful scenario tool for estimating potential effects of specific policy measures on wind energy project developers' investment behavior. Second, the paper provides a quantitative, empirical dataset of developers' preferences. The preference data quantifies how much value specific measures provide to developers. Third, it gives some indication of how these findings differ among different groups of developers and across different regions within the two most mature wind energy markets: the EU and the US.

The paper is structured as follows. The next section specifies the method by introducing conjoint analysis and explaining the experimental design as well as the data analysis approach. Section 3 describes the study sample. Section 4 presents and discusses the results. It includes a breakdown of developers' preferences for the studied attributes and levels, simulations of the effects of policy measures on developers' preferences in specific investment environments and an analysis of preference differences between different subgroups of project developers. Finally, section five concludes by highlighting main findings, outlining policy recommendations, indicating the limitations of this study and making suggestions for further research.

2. Methodological approach and experimental design

2.1. Conjoint analysis

Conjoint analysis methods are based on work done in the sixties by the mathematical psychologists and statisticians Luce and Turkey (1964) and were introduced into marketing research in the early 1970s (Green and Srinivasan, 1990; Orme, 2007b). The key characteristic of conjoint analysis is that respondents evaluate product profiles composed of multiple conjoined elements (attributes). The main objective is to mimic real decision-making processes as closely as possible. The respondents'

evaluation of the combined sets of attributes (the product scenarios) makes it possible to calculate the preference scores that they implicitly assign to individual components of the product.

Conjoint analysis is based on the Discrete Choice Theory (Ben-Akiva and Lerman, 1985; Train, 2009). Microeconomic consumer theory and utility maximization provide the first foundation to discrete choice theory. However, it is not possible to completely describe any option's utility in terms of its attributes; there will always be some unknown or intangible characteristics, which may provide additional utility. Random Utility Theory (Mansky, 1977) is thus the second foundation of discrete choice theory and the direct utility function of a person can be broken down into observable (deterministic) and unobservable (stochastic) parts.

The utility of a policy framework can be described as

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

where U is the utility of the chosen policy framework, n the number of policy attributes, u_i the part-worth utilities of the attributes i , and e the unknown or intangible characteristic.

The probability that a project developer k chooses the policy framework j from choice set C_k is given by the following (adapted from Ben-Akiva and Lerman (1985)):

$$P_{kj} = \Pr(U_{kj} \geq U_{km}; \forall j \neq m; j, m \in C_k) \quad (2)$$

where P_{kj} is the probability that a project developer k chooses the policy framework j , U the utility of the policy framework alternatives, j the chosen policy framework alternative, m the all other alternatives, and C_k the choice set available to the project developer k .

The conjoint analysis technique applied in this study is adaptive choice-based conjoint analysis (ACBC). ACBC captures more information at the individual level than traditional, non-adaptive surveys and may be used even with small samples of about 60 participants (Shepherd and Zacharakis, 1999; Orme, 2010b). ACBC prevents respondents from focusing on paramount attributes and neglecting others as it recognizes such attribute levels and then focuses in subsequent questions on the remaining ones. Hence, the questions generated during the course of the survey are based on factors that are identified as being relevant to the survey respondent (Sawtooth Software, 2007). Additionally, the customized approach decreases the time required to complete the survey and prevents respondents from potential information overload or confusion (Sawtooth Software, 2007).

2.2. Selection of attributes—investigating the drivers for project development decisions

In this paper, we assume that renewable energy project developers choose their projects' locations by looking for the bundle of attributes that provides the highest utility. In this choice among alternatives, there is an inevitable trade-off between the different attributes, and any attribute change influences the attractiveness of the respective country for the project developer. A higher level of support, for example, increases the utility and thus the attractiveness of a country, whereas longer administrative duration decreases the utility.

In order to determine the relevant drivers for the development decision to investigate in this study, we have (a) screened existing literature that cover drivers of wind energy development and (b) conducted a qualitative pre-study with experts in the field. As mentioned above, studies have shown that developers do not exclusively focus on the level and type of financial support when making the development and siting decision. Risks that are

Table 1

Overview of factors influencing the development decision, not exhaustive. Shaded area shows the focus of this study.

Factors	Controlling entity	Use in study
Policy factors		
<i>Risk factors</i>		
• Administrative approval duration/complexity/transparency • Grid access regulation (e.g., access guarantee, priority dispatch/connection costs) • Legal security (contract enforceability) • Renewable energy policy stability	Policy-makers	Included; explaining variable Included; explaining variable Included; explaining variable Not included
<i>Return factors</i>		
• Level of production-based support (e.g., feed-in tariff, tradable green certificates, production tax credit) • Duration of production-based support • Level of investment based support (e.g., cash grants, investment tax credit) • Level of financing support (e.g., soft loans)	Policy-makers	Indirectly included; “total remuneration” as explaining variable Defined in survey as 20 year Included; explaining variable Included; explaining variable
Organizational and behavioral factors		
• Type and size of developer company • Experience with wind development • Knowledge of and attitudes towards energy policy, financial markets and market environment • Local/national investment culture • Personal factors (e.g. risk propensity, personal networks)	Mostly within sphere of control of developer, some beyond control	No explaining variable but discrimination in results No explaining variable but discrimination in results Not included Not included Not included
Market based factors		
• Electricity demand • Competition • Access to local partners and trained employees • Price of electricity • Infrastructure • Currency risk	Mostly driven by markets, only indirectly controlled by policy-makers, however not specific to wind energy	Not included Not included Not included Indirectly included; “total remuneration” as explaining variable Not included Not included
Wind resource quality	None	Defined in survey as “high wind quality location that yields an average capacity factor of ~25% (~2200 full load hours)”

inherent to the development process and lead to uncertainty and higher costs are also decisive. Nontransparent, lengthy processes for acquiring building consent and grid connection permits can be major barriers to the development of new wind energy plants and their integration into the energy markets (Johnston et al., 2008; EWEA, 2010b). Table 1 shows an overview of the most important factors influencing the decision-making process of wind energy developers.

The goal of the study is to measure the impact that policy settings and regulations have on developer decision making and to assess what policy-makers can do to increase the attractiveness of the policy support system for wind energy developers. We therefore focus on factors that can be influenced by policy-makers. These include all aspects, which involve some sort of governmental action, or at least the possibility of such (Butler and Joaquin, 1998).

Besides these regulatory factors, there are many organizational and behavioral factors that influence the choices of project developers. These include, for instance, expertise, fast, and efficient development processes at the developer's end, procurement of turbines, choosing turbines that best match the wind regime, etc. These factors are not included as explaining variables in the study because they are competencies incumbent on the developers themselves. Also, factors that are largely beyond the control of wind energy policy-makers and developers are excluded as explaining variables of the study. These are mostly market based

factors such as access to local partners and trained employees, competition levels, currency risks or existing infrastructure.

Analogously, the quality of the wind resource was excluded as an explaining variable, but expectations regarding the quality of the wind resource were homogenized among respondents.²

To verify that we included the most relevant aspects (attributes) in the conjoint analysis and to determine which parameter specifications (levels) were most appropriate for each attribute, we conducted 24 interviews with wind energy experts in Europe and the US. The sample included small, medium and large wind energy developers, utilities with their own development activities, development banks, policy-makers, and researchers in the field of wind energy policy. The interviews were semi-structured, following interview guidelines.

Based on the expert interviews, six attributes and relevant levels were chosen to reflect the current market conditions in the studied regions and included in the ACBC experiment (cf. Table 2). The identified attributes included in the conjoint analysis are both

² In order to control expectations about the total number of electricity produced, a disclaimer prior to the survey instructed respondents: “For all of the following questions please assume you want to develop a generic onshore wind energy project of 10 MW at a high quality wind location that yields an average capacity factor of ~25% (~2200 full load hours).” This disclaimer aligns ingoing assumptions about electricity production (2200 h × 10 MW = 22.000 MW h).

Table 2

Attributes and attribute levels used in the ACBC experiment.

Attributes	Description provided in survey	Attribute levels used in survey
Administrative process duration	Total time to obtain all required permits from first application to final authorization of plant. Not included: time for technical site evaluation, PPA negotiations, construction, etc.	1 year 3 years 5 years 7 years
Legal security	Confidence in contract enforcement and predictability of legal decisions	Not given, corruption possible Given in some cases Given in most cases Given in all cases
Grid access	Arrangements in place to regulate access to transmission and distribution systems.	Access not guaranteed, negotiated on project-by-project basis; Access guaranteed; no priority dispatch (output curtailment likely) Access guaranteed, mostly priority dispatch (minor output curtailment possible); Access guaranteed, priority dispatch (no output curtailment)
Total remuneration	Sum of all income streams related to electricity sales (feed-in tariff, power purchase agreement, tax credit, premium, certificate, etc.) over 20 years.	5 € ct/kW h//7 \$ ct/kW h 8 € ct/kW h//11 \$ ct/kW h 11 € ct/kW h//15 \$ ct/kW h 14 € ct/kW h//19 \$ ct/kW h
Credit financing		No support Gov. guaranteed soft loans 0.5% below market rate Gov. guaranteed soft loans 1% below market rate Gov. guaranteed soft loans 1.5% below market rate
Investment cash grants	Non-reimbursable cash payments as percentage of total investment costs.	0% 10% 20% 30%

relevant for the development decision and independent from each other (i.e., the utility of the attribute and the perceived utility of a level should not interact with other attributes) (Backhaus et al., 2006). To avoid unrealistic return level combinations, three prohibitions were included.³

“Administrative process duration”: Obtaining all permits required to build the wind energy plant is the key to a developer's business. The efficiency of the administration process depends, among other things, on its transparency, on the reliability of permit approvals and on the total number of authorities involved (Strom, 2010). It is impossible to assess all these aspects individually in a conjoint analysis, but they are combined in the total average duration to get final authorization for a project.

“Legal security”: Legal security includes overall legal stability, a country's track record as to legal conduct, corruption levels, enforceability of contracts and reliability of business partners.

“Grid access”: Grid access is a complex issue that comprises multiple aspects: (1) the capacity of the grid to deal with the quantity and quality of wind electricity, (2) the availability/proximity of access points, (3) the national/regional long term strategy for grid expansion, (4) regulations regarding access guarantee and cost sharing between grid operators and developers, and (5) regulations regarding the dispatch of wind electricity. To concentrate on the issues that can both be directly influenced by policy-makers and have an immediate impact on developers, we chose levels to reflect access guarantee and dispatch regulations.

“Credit financing”: Many wind energy plants are debt financed, especially in Europe. In the aftermath of the credit crisis, many developers have difficulties in securing debt financing at attractive prices. Government-backed soft loans are an effective way of providing funds for wind energy development. In Germany, for instance, the “Renewable Energy Program” of the KfW bank is involved in almost 2/3 of all installed wind energy plants (Bickel et al., 2009).

“Investment cash grants”: Apart from production-based support, policy-makers can opt to subsidize part of the initial upfront investment of a project. Especially in the US, this is a widely used instrument.

“Total remuneration”: The total remuneration describes the total production-based income per kW h. This may include electricity sales (e.g., through power purchase agreements), feed-in tariff, production tax credit, tradable certificates, etc. From the project developers' point of view, the type of income source is less decisive, as long as the sum of all operating income sources is sufficiently high and sufficiently stable. For the survey, we therefore defined this attribute to comprise all sources of income that can be seen as reliably stable for 20 years. This definition of cash inflows renders the study applicable across different policy regimes. It is important to note, that the remuneration level, taken on its own, is not a good indicator of attractiveness. It may often be the most visible feature of a support scheme, but the attractiveness can only be assessed together with associated costs and risks.

2.3. Utility and profitability

The selected study attributes impact “utility”, the dependent variable of the study as defined in (1). At the same time, they have direct influence on project profitability. The two concepts are closely linked: project profitability is the monetary target dimension many project developers strive to maximize, whereas utility can be understood as the perceived attractiveness of a set of policy measures. The latter encompasses more aspects because there may be factors that have no impact on profitability but still influence utility. However, measures that improve profitability will generally also improve utility.

Fig. 1 illustrates how the notion of project profitability breaks down into its drivers. The study attributes relate to key profitability drivers, indicated in parenthesis. In the quest to maximize project profitability developers have some elements of this equation under their own control (such as park design, matching turbines to the wind regime, procurement of turbines and other equipment, fast and efficient development processes at the

³ (1) 14 € ct/kW h//19 \$ ct/kW h and 30%; (2) 14 € ct/kW h//19 \$ ct/kW h and 20%; (3) 11 € ct/kW h//15 \$ ct/kW h and 30%.

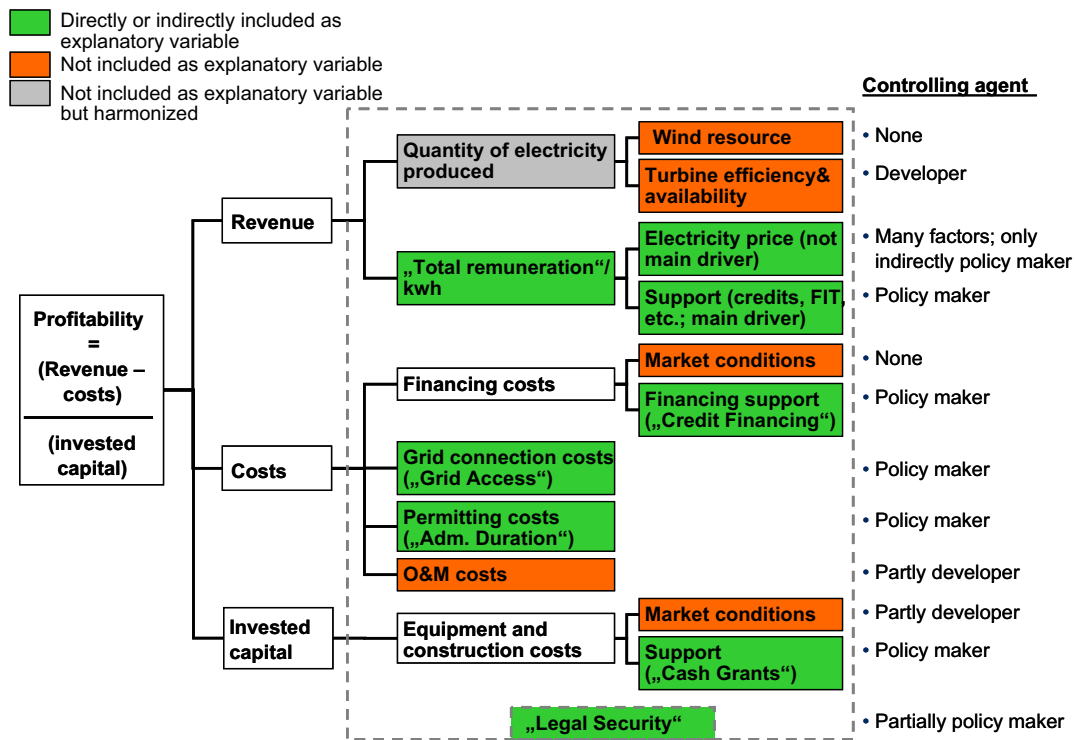


Fig. 1. Drivers of project profitability and controlling agents.

Among these three options, which is your preference? (Any features that are the same are grayed out, so you can just focus on the differences.)

Some explanations are provided when you move your cursor over the respective words.

(1 of 6)

Administrative process duration	3 years	5 years	5 years
Legal security	Not given; corruption possible	Given in some cases	Given in some cases
Grid access	Access guaranteed; no priority dispatch (output curtailment is likely)	Access guaranteed; no priority dispatch (output curtailment is likely)	Access not guaranteed, negotiated on project-by-project basis
Total remuneration	11 Ct/kWh	8 Ct/kWh	5 Ct/kWh
Credit financing	Gov. guaranteed soft loans 1% below market rate	Gov. guaranteed soft loans 1% below market rate	Gov. guaranteed soft loans 1% below market rate
Investment cash grants	20%	0%	20%

Fig. 2. Screenshot of choice section of ACBC survey.

developer's end, etc.). However, for elements they have not under their control they will look for the best available conditions. These can often be influenced by policy-makers, for instance, by setting attractive remuneration levels, subsidizing investment and/or financing, minimizing costs stemming from grid access regulations, or streamlining administrative procedures. The green boxes indicate where the study attributes relate (directly or indirectly) to these key drivers of project profitability. The attribute "Legal security" cannot be allocated directly to a profitability driver. However, an instable and insecure legal environment has impact on key profitability drivers. It is usually reflected in higher financing costs, it can lead to higher grid connection costs as well as permitting costs and it might also lead to limited enforceability of off-take agreements on the revenue side.

2.4. Questionnaire design

The online survey (<http://www.windinvestment.ch>) consisted of two parts: (1) the conjoint analysis experiment to analyze the part-worth utilities and importance of different policy attributes and (2) background questions about the participants and the companies at which they were employed. It was designed with

Sawtooth Inc. (SSI Web), which is a standard software solution for the design and the analysis of conjoint analysis experiments (Sawtooth Software, 2008).

The ACBC experiment started with screening questions presenting four policy-framework scenarios at a time. Each respondent was asked to indicate whether he/she would consider developing a wind energy project under the indicated conditions. The alternative scenarios were constructed using a factorial random design with an orthogonal set of attributes. This section recognized if respondents used cutoff rules focusing just on a few attributes instead of evaluating the scenarios as a whole. If so, he/she could indicate critical attribute levels as a "must have" (i.e., as an absolute requirement) or as "unacceptable". All further scenarios shown then satisfied those requirements.

In the subsequent choice tasks section, the respondent selected the preferred scenario out of three scenarios previously marked attractive for investment (cf. Fig. 2). The chosen scenarios of each triple then showed up again in subsequent choice tasks until the most preferred scenario was identified.

The conjoint section was concluded by a so-called holdout task. Holdout tasks are not used to estimate part-worth utilities but to assess the quality and performance of the model used for

the utility estimations (see Section 4). If the responses to holdout questions can be predicted accurately using estimated part-worth utilities, it lends greater credibility to the model.

2.5. Data analysis approach

The 4749 choices of the 119 respondents (39.9 tasks per person) were used to assess the value of the different attributes and levels. The estimations of the part-worth utilities as well as the preference simulations were conducted using Sawtooth Software, Inc. programs (SSI Web and SMRT). In addition, SPSS 18 was used to do further statistical analysis.

Part-worth utilities measure the contribution of attribute levels to the overall utility, i.e., the influence of a change of the respective variable on the developer's likelihood to develop a specific project. The average part-worth utilities are calculated from the individual part-worth utilities of each respondent, using the hierarchical Bayes (HB) estimation model (Rossi and Allenby, 2003; Orme, 2007a), which has become the standard estimation method for conjoint analysis (Lenk et al., 1996; Rossi and Allenby, 2003; Netzer et al., 2008). Individual utilities allow assessing heterogeneity among customer segments, which is more difficult with traditional conjoint approaches based on aggregated preferences measures (e.g., standard multinomial logit (MNL) (McFadden, 1986)).

HB assumes that the respondent answers choice tasks according to a MNL model. MNL considers the probability of the specific alternative being chosen (P_{kj}) related to the proportion of the total utility for that concept relative to the total utility for all the concepts according to the following formula (adapted from Howell (2009)):

$$P_{kj} = \left(\frac{e^{U(j)}}{\sum_{l=1}^m e^{U(l)}} \right) \quad (3)$$

where P_{kj} is the probability that the developer chooses policy framework j , m the number of alternatives, and l the policy framework alternative.

The HB model consists of two levels. At the upper level, respondents are considered as members of a population of similar individuals (Orme, 2010c). Their part-worth utilities are assumed to have a multivariate normal distribution described by a vector of means and a matrix of variances and covariances. At the lower level, each individual's part-worth utilities are calculated by a linear regression model according to the respondent's choices within the conjoint analysis experiment. Discrepancies between actual and predicted choices are assumed to be distributed normally and independently of one another. With several thousands of iterations (for this study, 40,000 iterations were done), each respondent's utilities are adjusted so that they reflect the optimal mix of the individual respondent choices and the sample averages (Howell, 2009).

Part-worth utilities are interval data and scaled to an arbitrary additive constant within each attribute (Orme, 2010b). It is thus not possible to compare utility values between attributes. Zero-centered differentials (diffs) part-worth utilities are scaled to sum to zero within each attribute, and the sum of the average differences between best and worst levels across all attributes is equal to the number of attributes times 100 (Orme, 2010c). This makes it possible to compare the differences between the attribute levels.

The importance scores of each attribute are calculated taking the range of the attributes' utility values, i.e., the highest and the lowest part-worth utility of each attribute. A bigger range signifies a higher importance (Backhaus et al., 2006). The relative importance of each attribute is calculated using the following

formula (adapted from Clark-Murphy and Soutar (2004)):

$$RI_i (\%) = \frac{(MaxU - MinU)_i}{\sum (Max - Min)_i} 100 \quad (4)$$

where RI_i is the relative importance of attribute i , $MaxU$ the maximum utility of attribute i , and $MinU$ the minimum utility of attribute i .

The counts analysis provides insights about the “unacceptable” or “must have” levels and indicates how often specific levels have been chosen in the winning scenario of the choice section.

Preference simulations allow gauging the impact on developers' preferences of certain attribute level changes within specific policy environments (i.e., sets of attribute levels). The simulations estimate the probability that project developers would develop a project in different policy frameworks by summing scaled utilities and applying the following transformation (adapted from Orme, 2010c):

$$p (\%) = \frac{e^u}{1 + e^u} 100 \quad (5)$$

where p is the probability of investment, e the constant e , and u the utility of the policy framework in question. Values created by the preference simulations indicate ratio scaled relative preferences.

3. Data collection and sample

The wind energy project developers included in this study are experts who work or have worked for companies engaged in the project development business. These include

- highly specialized, typically small firms whose exclusive business focus is the development of renewable energy projects. Due to the lack of capital or financing, they often sell the project during or after the development process;
- vertically integrated, typically larger firms, who plan, build, own, and operate renewable energy projects.

In total, 1260 wind energy developers active in the US and Europe were contacted individually between April and July 2010. The contact information of the target sample was gathered via personal contacts, wind energy conferences,⁴ profiles on professional network websites,⁵ collaboration with wind energy associations⁶ and publicly available contact information (mainly member directories of associations such as AWEA and RENUK). Where email addresses were available, a reminder was sent after 4 weeks.

The response funnel is shown in Fig. 3. With 102 complete data sets, the final conversion rate was 8.1%. For the regional analysis (Section 4.4), 108 respondents could be used, as they completed the conjoint analysis section and indicated in which countries they were active. The choice data of 119 respondents could be used for the preference calculations as 17 respondents quit the survey only during the background questions.

Table 3 summarizes the sample characteristics. The majority of respondents have 3 or more years of experience with wind energy development. Most developer companies are independent developer or independent power producer companies, are engaged in

⁴ EWEC 2010, Warsaw, April 20–23, 2010, and Wind Energy Forum 2010, Davis, May 10, 2010.

⁵ www.xing.de; www.linkedin.com

⁶ Bundersverband für Windenergie and the Finnish wind energy association supported the study with direct mailing to their members; the American Wind Energy Association and IG Windkraft Österreich published the survey link in member newsletters or websites.

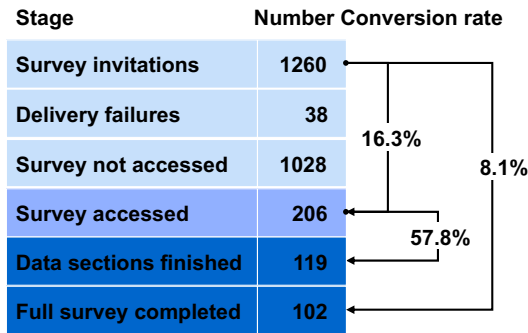


Fig. 3. Response funnel.

Table 3
Descriptive statistics of wind energy project developer in our sample.

Characteristic	Levels	Share (%)
Developer type (n=105, multiple choices possible)	Independent developer	70
	Independent power producer	28
	Utility	8
	Other	18
Investment phase (n=105, multiple choices possible)	Greenfield development	74
	Early maturity	67
	Late stage, financing	54
	Operations	55
	Construction	39
	Other	10
Respondent's experience with wind development (n=105)	< 2 years	38
	3–5 years	23
	6–12 years	29
	> 12 years	8
Company experience with wind development (n=105)	< 2 years	20
	3–5 years	13
	6–12 years	26
	> 12 years	33
Average project size (n=95)	< 6 MW	9
	6–15 MW	24
	16–30 MW	31
	31–100 MW	28
	> 100 MW	7
Cumulative investments over last 3 years (n=73)	< 15 mio €	38
	16–100 mio €	18
	101–300 mio €	16
	301–1000 mio €	15
	> 1000 mio €	12

Table 4
Geographic distribution of development activities in our sample.

County	Development activities (n=105) count/(percentage) (multiple choices possible)	Headquarter (n=105) count/(percentage)
Northwest Europe	162	60/(57)
Germany	47/(45)	36/(34)
France	38/(36)	2/(2)
Great Britain	31/(30)	8/(8)
Sweden	19/(18)	2/(2)
Denmark	10/(10)	5/(5)
Austria	6/(6)	1/(1)
Finland	3/(3)	2/(2)
Other (Ireland, Netherlands, Belgium, Norway)	8/(8)	4/(4)
Southeast Europe	194	23/(22)
Poland	40/(38)	2/(2)
Italy	33/(31)	4/(4)
Romania	26/(25)	0/(0)
Spain	25/(24)	7/(7)
Bulgaria	25/(24)	2/(2)
Greece	14/(13)	1/(1)
Turkey	12/(11)	0/(0)
Croatia	7/(7)	0/(0)
Portugal	4/(4)	3/(3)
Slownia	3/(3)	0/(0)
Other (Hungary, Serbia, Slovakia,)	5/(5)	4/(4)
US	40/(38)	22/(21)

Table 5
Holdout task: comparison of directly stated preference (SP) and model data.

	Option 1 (SP/model)	Option 2 (SP/model)	Option 3 (SP/model)
EU	76.71%/76.42%	21.92%/23.26%	0.01%/0.32%
US	70.00%/75.16%	30.00%/23.94%	0%/0.90%
Total	74.76%/75.74%	24.27%/23.87%	0.01%/0.39%

The RLH for each individual is the geometric mean of the probabilities of the different choices made by the individual. The probabilities are calculated using the posterior means of an individual's part-worth utilities in the MNL model (Wonder et al., 2008). The RLH of the model is the arithmetic average of all the individual RLH values (the upper level normal distribution is thus ignored). The RLH is between 1.0 (best possible value) and the probability of the different choices in the average task, i.e., our model with three choices has a minimum RLH of 0.33.

The analysis of the responses to the holdout task provides an indication of how well the utility values estimated from the ACBC model (indirectly stated preferences) were able to predict the respondent's actual holdout choices (directly stated preferences). The share of preference results are displayed in Table 5. The simulated share of preference values were within 6% of the actual preferences indicated in the holdout data.

4.1. Importance scores

Fig. 4 presents the means and standard deviations of the relative importance scores of the attributes examined in this study. "Legal security" (28.2%) and "Remuneration" (27.4%) have the highest importance scores, followed by "Administrative process duration" (17.1%). "Investment cash grants" (11.0%), "Grid access" (10.1%) and "Credit financing" (6.3%) are of lower importance.

Importance scores can be best interpreted as the degree to which the difference in utility between the best and the worst level of a given attribute impact the overall utility of the

multiple parts of the development, and are of small to medium size with annual development of up to 100 MW wind energy installation.

Table 4 shows the regional distribution. While many companies have their headquarters in Germany or the US, most are active in multiple European and US markets. Actual development activities are spread over the US and 25 countries throughout Europe.

4. Results and discussion

The root likelihood (RLH) indicates the goodness of fit of the HB model. In our model, it amounts to 0.751 indicating a good fit.

respondents. They are calculated based on attribute level part-worth utilities (see formula (4)), i.e., if the partial utility scores of a given attribute show a large discrepancy between the lowest and highest level, this attribute is important for determining the overall utility and thus its importance score is high. As a result, the importance scores are slightly influenced by the survey design (Wittink et al., 1992; Orme, 2010c), i.e., by the number and the range of attribute levels. More specifically, this means that if the levels of, e.g., the attribute “Administrative process duration” were designed to show extreme values—for instance, ranging from 3 months to 15 years—it would result in a slightly higher importance score than in the current study because such high discrepancies in development duration would make a big difference to developers. To include an adequate choice of attribute levels, they were selected with respect to the actual market conditions in the analyzed countries and verified by the expert interviews and own research on prevailing policy settings. Using real-world parameterization of the attribute levels ensures that the results are meaningful for both practitioners and policy-makers. As a result, some attributes show pronounced ranges in attribute levels (in particular, “Legal security” and “Remuneration”), reflecting the current differences of policy and regulatory situations.

The results indicate that factors representing sources of risks to the development process of wind energy projects such as legal security and the administrative process duration are very important to developers. As expected, “Remuneration” is an important attribute, but it is worth noting that it is not dominating. Many policy discussions tend to place a very strong focus on the level of

FIT or credits, but this analysis suggests that the majority of total utility is derived from other aspects. Remuneration during the operating phase of the project is more important than upfront investment support measures (i.e., investment cash grants and credit financing). This does not mean that these measures do not have value for wind developers, but the lower importance scores of “Credit financing” and “Cash grants” reflect their lower impact on the internal rate of return (IRR) of a wind energy project. Using a simple discounted cash flow (DCF) model, we estimate that the impact of a one-level increase in “Remuneration” on the internal rate of return (IRR) of a wind energy project is three to four times higher than a one-level increase in “Cash grants” and almost ten times higher than for a one-level increase in the attribute “Credit financing”. These considerations are well reflected in the importance score results, which indicate that respondents adopt rational behavior when stating their preferences.

4.2. Unacceptable and most preferred attribute levels

In the screening section, 55% of the respondents indicated that they would not develop a wind energy project in a country where legal security is “Not given, corruption possible” (Fig. 5). For 31% of the respondents, the total remuneration needs to be higher than “5 € ct (7 \$ ct)/kW h” and 26% see a “7 years” administrative process duration as a knock-out criterion. This shows that many project developers have critical minimum requirements and that they use, in the case of very high risks (e.g., very low “Legal security”) or low remuneration, non-compensatory decision-making rules when evaluating opportunities.

Fig. 6 shows how often certain attribute levels have been included in the winning scenario of the choice task section. The most frequent attribute level is “1 year” administrative process duration (55%), followed by “Guaranteed, priority dispatch” grid regulations (48%) and the most favorable levels for “Legal security” and “Remuneration” (47% and 45%, respectively). For all attributes, the preferences consistently decline from the most favorable to the least favorable level. The frequency of the attribute levels of “Financing support” and “Cash grants” cannot be analyzed because their appearance frequency was influenced by the included prohibitions.

It is noteworthy that the two most preferred attribute levels in the winning scenarios (“1 year” and “Guaranteed; priority dispatch”) are not from the attributes with the highest importance scores (“Legal security” and “Remuneration”). While the importance scores discussed above indicate the attributes for which developers show the largest preference differences between the worst and best levels, the winning scenario analysis provides insights into which aspects are most important to developers when they are looking for the ideal set of policy conditions in an investment environment. The results thus underline the high

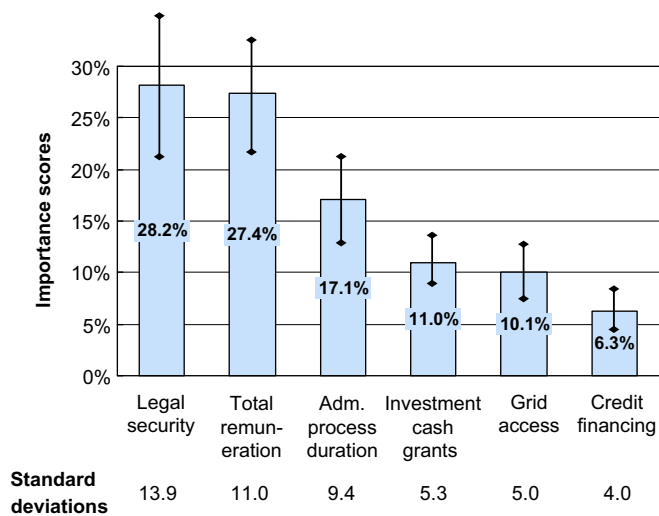


Fig. 4. Importance scores and standard deviations.

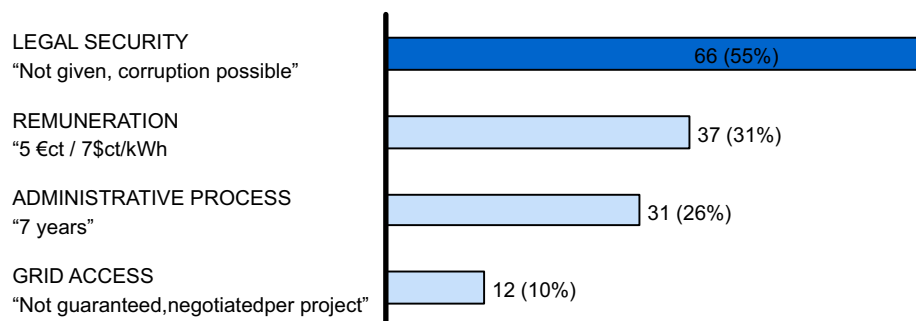


Fig. 5. Number of respondents that consider given attribute levels “unacceptable” for project development.

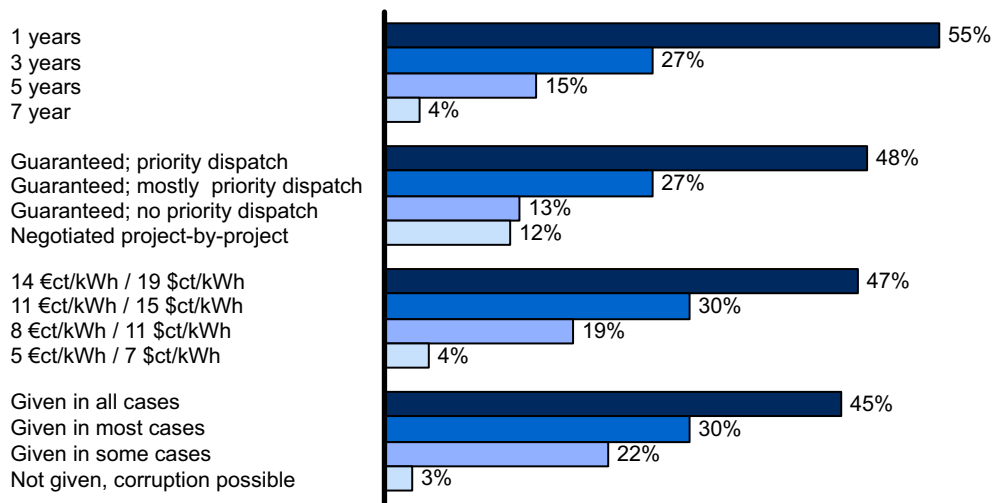


Fig. 6. Share of attribute level appearance in winning scenarios.

Table 6

Part-worth utilities (zero-centered diffs) and standard deviations for all attributes and levels.

Attribute	Attribute levels	Average part-utility	Standard deviation
Administrative process duration	7 years	−59.2	33.8
	5 years	−8.1	14.3
	3 years	28.1	16.7
	1 year	39.1	27.7
Legal security	Not given; corruption possible	−110.7	56.4
	Given in some cases	15.6	18.3
	Given in most cases	39.0	22.1
	Given in all cases	56.1	31.5
Grid access	Negotiated project-by-project	−27.5	23.3
	No priority dispatch	−7.0	16.9
	Mostly priority dispatch	14.8	12.4
	Priority dispatch	19.8	19.2
Total remuneration	5 € ct/kW h/7 \$ ct/kW h	−93.4	42.7
	8 € ct/kW h/11 \$ ct/kW h	−8.0	19.2
	11 € ct/kW h/15 \$ ct/kW h	34.1	21.6
	14 € ct/kW h/19 \$/kW h	67.3	33.2
Credit financing	No support	−15.0	18.7
	Gov. guaranteed soft loans	4.2	14.1
	0.5% below market rate	2.9	12.6
	Gov. guaranteed soft loans 1% below market rate	7.9	14.4
Investment cash grants	0%	−31.9	23.3
	10%	−7.1	11.6
	20%	12.3	17.4
	30%	26.7	16.6

importance of short administrative processes during the development phase and grid access regulations that strictly favor renewable energy.

4.3. Part-worth utility estimation

Table 6 shows the average zero-centered diff part-worth utilities and standard deviations for all attributes levels.

Due to the considerations mentioned in Section 2.4, we compared the utility differences between the different levels of each attribute (cf. Fig. 7). In general, the amelioration of the worst situation delivered the highest utility gain. This is especially true for improving “Legal security” from “Not given; corruption possible” to “Given in some cases” (+126 utility points) and “Remuneration” level from “5 € ct/kW h/7 \$ ct/kW h” to “8 € ct/kW h/11 \$ ct/kW h”

(+85 utility points). This finding corresponds well with the “unacceptables” identified above and explains the high importance scores of “Legal security” and “Remuneration.” The low utility of the worst levels of these attributes (from people marking it as unacceptable) gives the importance scores a boost.

Any further improvement to the second and third best level of each attribute yields diminishing utility increases. There are only two notable exceptions. First, in the case of the attribute “Remuneration”, respondents value the two subsequent increases of 3 € ct/kW h/4 \$ ct/kW h revenue with similar utility gains. This makes sense as the impact on project profitability is equal. Second, in the case of “Grid access”, the improvement from level 2 (“No priority dispatch”) to level 3 (“Mostly priority dispatch”) yields the highest utility gain within this attribute indicating the importance of priority dispatch for project developers.

4.4. Preference differences between various respondent groups

Within the literature concerned with deployment of wind energy some authors worked out that companies developing and investing in wind energy projects cannot be regarded as homogenous group. There is a multi-faceted variety of actors that drive wind energy development and they differ in aspects such as their motivation, risk aversion and profitability expectations (Enzensberger et al., 2002; Langniss, 1996). Various cluster analyses were conducted to further verify findings of these studies and also add new dimensions of differentiation of developers. Preference results were analyzed for differences with respect to type, size, and value chain focus of the developer companies, share of debt financing, the respondents’ level of experience with wind energy development, and regional focus of development activities.

However, we find that preferences appear to be quite homogeneous across various subsets of the total sample. The fact that there are little discrepancies in policy preferences between different groups of developers may be a finding in itself. The following cluster analyses reveal small and thus statistically insignificant differences among subgroups. The findings regarding the following aspects are therefore indicative only:

Company size: Dinica (2006) has discussed how small and large developers will show different investment patterns in different investment contexts, partly because they differ in their financing capabilities and equity requirements. The empirical study results now show that respondents from large companies show an above average preference for “Credit financing support”

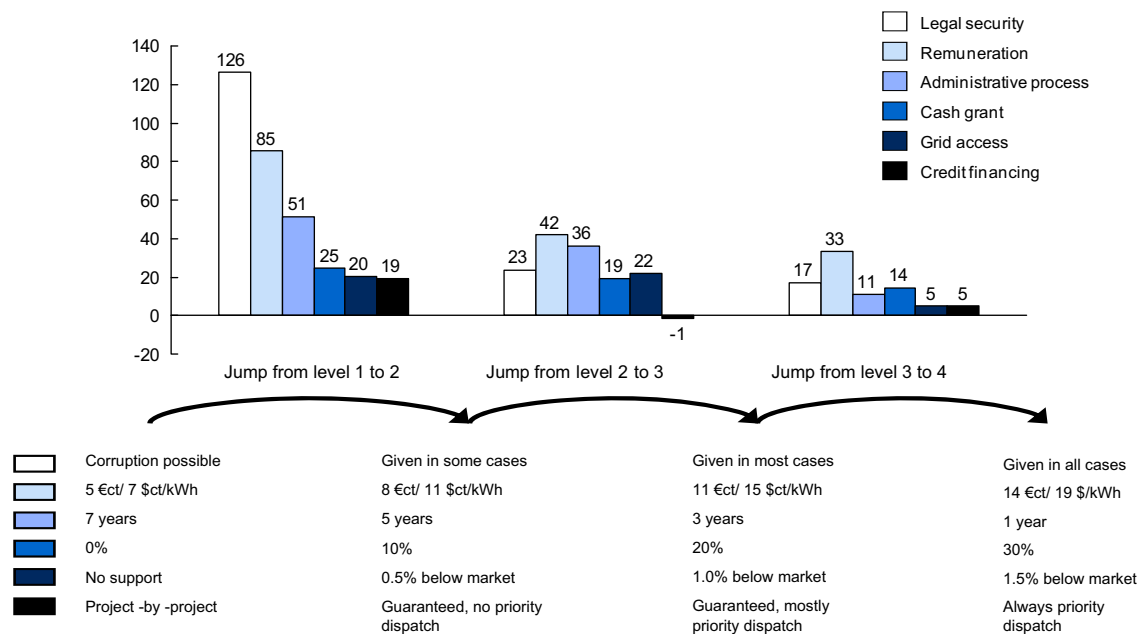


Fig. 7. Part-worth utility gains (zero-centered diffs) for improvement to the next higher level within a specific attribute.

(small companies vice versa)⁷ compared to small companies. It seems plausible that financing becomes a more constraining factor with higher total capacity and capital volumes. The more projects a developer company keeps in its portfolio the more difficult it gets to provide sizable equity portions to the project finance and hence the more reluctant banks will be to provide debt finance. Financing guarantees or refinancing models with below market rate conditions⁸ are helpful to overcome this constraint.

Value chain focus: Developer companies that integrate across the entire development value chain show some preference particularities. Compared to those that engage only in early development stages (greenfield and early maturity) they have a noticeably lower preference for “Legal security”,⁹ and place higher importance on “Grid access” and “Credit financing” support. These differences in preferences seem to reflect the respective issues that companies face: companies covering the entire value chain might be less susceptible to corruption risk in early siting and administrative procedures and at the same time are more concerned with securing financing and getting the wind park connected to the grid.

Project size: Developers of small projects (< 10 MW) place substantially lower importance on “Remuneration” and higher importance on “Legal security” than developers of large projects (> 50 MW).¹⁰ This could be due to the fact that costs incurred by legal services and legal disputes are proportionally higher for small projects than they are for large projects. As a result, developers might be willing to accept lower remuneration levels in exchange for a more reliable legal environment.

Experience: Respondents who have little experience in wind energy development (< 2 years) deem the duration of the

administrative process less important than very experienced developers (> 8 years of experience).¹¹ The latter possibly have experienced the risks and challenges that come with lengthy administrative procedures whereas the former might not yet have developed a project to completion.

Yet other analyses that were conducted do not deliver statistically significant results because the respective groups sizes are too small. As for the type of developer company, studies suggest that different types of developer companies have different financing capabilities, costs of equity and risk appetites (Wiser, 1997; Enzensberger et al., 2002). Unfortunately, the study data cannot back their categorizations with new empirical findings because the respondent sample contains an insufficient number of utilities and independent power producers.¹² Therefore, the results cannot be reasonably interpreted. Similarly, less than ten respondents focus on late stage development only (financing and/or construction); too few for a reliable analysis.

The results of the regional cluster analyses are more conclusive and will thus be covered in more detail. To test for preference differences with respect to geographic focus of development activities, we clustered the respondents into three regional groups (US, NW- and SE-Europe). Table 7 presents an indicative assessment of the relevant criteria based on the expert interviews. While the conditions for wind energy projects are mainly specific to national policy regimes in Europe and state policy regimes in the US, the defined regions share some characteristics.

We found the wind energy development market to be quite international; German and Danish development companies have expanded their business into other European countries, many with a focus on Eastern and Southeastern Europe. A precise one to one allocation of respondents to regional groups is difficult as the majority of developers are active in two or three regions (only 45 out of the 108 respondents who indicated their activity countries confine their development activities to only one of the specified regions). As an approximation, we based regional clustering of

⁷ Spread of Importance Score (IS) between the two groups: 2.2 points (full sample: IS 6.3).

⁸ As offered by some development banks, e.g., the “Erneuerbare Energien Programm” of the German KfW Bank.

⁹ Spread of Importance Score (IS): Legal security: 6.1 points (full sample: IS 28.0); grid access: 3.2 points (full sample: IS 10.0); and Credit financing: 1.6 points (full sample: IS 6.3).

¹⁰ Spread of Importance Score (IS) between the two groups: Remuneration: 6.2 points (full sample: IS 27.5) and Legal security: 6.1 points (full sample: IS 28.0).

¹¹ Spread of Importance Score (IS): Adm. process duration: 4.4 points (full sample: IS 17.2).

¹² Less than ten per group.

Table 7
Characteristics of wind markets in different regions (two moons indicate variations within the region)

Criteria	US	Northwest Europe	Southeast Europe
	Countries		
	US	Germany, Netherlands, Belgium, UK, Ireland, Sweden, Denmark, Austria, France, Norway, Finland	Bulgaria, Croatia, Greece, Italy, Poland, Romania, Slovenia, Spain, Turkey, Bulgaria, Portugal, Czech Republic, Slovakia, Serbia
Maturity of wind market			
Legal security			
Grid capacity for wind power			
Administrative effectiveness			
Share of debt financing for wind energy projects			

= very low
 = very high

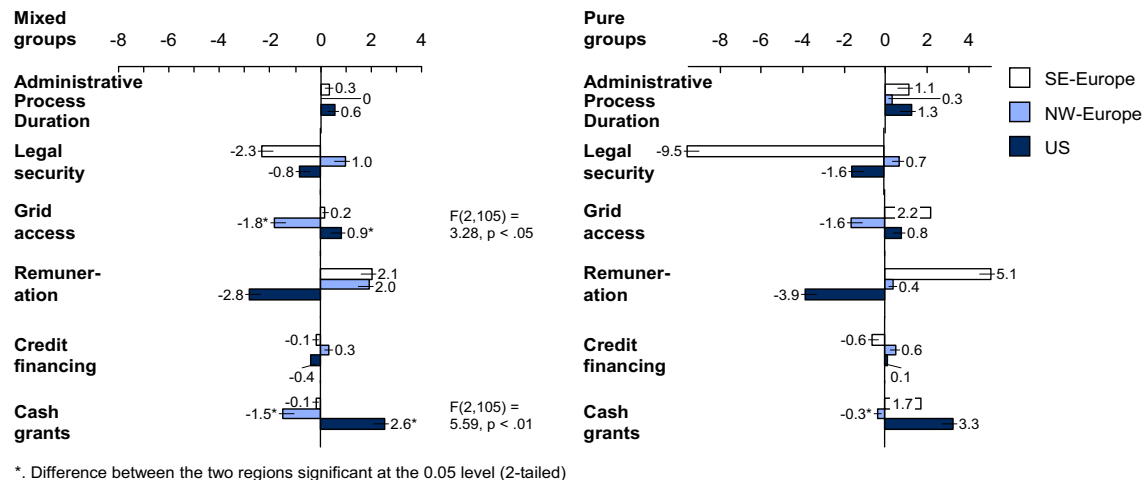


Fig. 8. Regional differences in importance scores—left hand side: mixed groups; right hand side: pure groups.

respondents on where the majority of their development activities take place (number of mentioned countries). This led to some overlap of preferences and diffused regional discrepancies to some extent. ANOVA was conducted to assess significant differences between groups. If the variable F from the ANOVA was significant, a Gabriel *post hoc* test was conducted to see which specific groups showed significant differences (Field, 2009). The p -values reported below are those derived through the Gabriel *post hoc* procedure. Differences that were not statistically significant are discussed as indicative trends.

Fig. 8 (left hand side) displays the regional differences of the importance scores. In general, the preference differences between the regional clusters were small. This makes sense, as, in theory, the impact of cash flows and risks resulting from the different attribute levels on project profitability and project quality should be in the same order of magnitude in different regions. However, the similarity was also due to the non-bijective regional allocation of respondents. Using only the 45 respondents (“pure groups”) with activities in a single region, most discrepancies were more pronounced (cf. Fig. 8 (right hand side)). The “pure groups” results were indicative only, given the rather small sample sizes for such groups in each region (SE: $n=13$ /NW: $n=13$ /US: $n=19$).

We found three main differences in the preference structure of wind energy project developers from the three different regions.

The US developers seem to have a higher preference for short-term support (“Cash grant”) and place less value on “Remuneration” during the operational phase of the wind project compared to the European developers. This could imply an implicit higher discount rate when evaluating development options. The analysis of the underlying part-worth utilities (cf. Annex) indicates that the US developers derive significant higher utility from cash grants above 20% and see the absence of a cash grant support as much worse than the NW-European developers. On the other hand, the US developers have lower importance scores for “Remuneration”, mainly driven by the fact that they are more willing to accept the lowest remuneration level of 7 \$ ct/kW h. The analysis of the “pure groups” indicates that this difference in preference is most pronounced between the US and SE-European developers. The latter place higher value on remuneration to compensate for comparatively higher development risks, such as the possibility of corruption.

The SE-European developers have a lower importance score for “Legal security” than both the NW-European and the US developers. The part-worth utility comparison shows that this is

Table 8
Illustrative policy scenarios representative of the regions NW-Europe, SE-Europe, and US.

Attributes	NW-Europe	SE-Europe	US
Administrative process duration	3 years	7 years	2 years
Legal security	Given in all cases	Given in some cases	Given in all cases
Grid access	Access guaranteed priority dispatch (no output curtailment)	Access guaranteed no priority dispatch (output curtailment is likely)	Negotiated on project-by-project basis
Total remuneration	8 € ct/kW h	11 € ct/kW h	5 € ct/kW h
Credit financing	Gov. guaranteed soft loans 1% below market rate	No support	No support
Investment cash grants	0%	10%	30%
Relative preference	83.33	31.02	38.36

mainly because the SE-European developers tend not to see corruption as a knock-out criterion, contrary to the other two developer groups (cf. Annex). This difference is even more pronounced in the “pure groups”; with a large difference between the SE- and NW-European developers.

“Grid access” seems to be a less severe bottleneck for the NW-European developers than for the US and SE-European wind energy developers. Their importance score is significantly lower because, on the one hand, they have less negative part-worth utilities for project-by-project negotiations and grid regulations without priority dispatch for wind, and on the other hand, value priority dispatch significantly less than other developers (cf. Annex). The developers from the US, for instance, show a much higher preference (+15 utility points) for a priority dispatch provision. The explanation for these differences could be that, in the US, most jurisdictions do not provide for guaranteed priority dispatch of wind energy. This poses a significant risk to wind energy plant owners as frequency of wind energy curtailments increases (e.g., in Texas in 2009, 17% of all potential wind energy generation was curtailed because of transmission inadequacy (Wiser and Bolinger, 2010)).

The observed differences in preference structures may (1) result from familiarity of the respondents with specific policy instruments, as in the case of higher preference for cash grants of the US developers; (2) reflect region-specific barriers to wind energy project development, as in the case of the preference regarding grid access; or (3) reflect cultural factors, such as the prevalence of corruption, which leads SE-European developers to accept lower legal security or the preference of US developers for a higher discount rate, which is shown by their higher preference for upfront cash grants and lower preference for remuneration. The importance scores for “Administrative process duration” are quite similar for developers from all three regions, in both mixed and pure groups.

4.5. Region-specific policy analysis

Preference simulations based on the conjoint analysis experiment data allow the gauging of the investment intent of wind energy project developers under specific policy conditions. Using formula (5), they provide a means of simulating the preference for a given policy environment as if in a stand-alone context, without having to contrast it to a set of alternatives:

$$p = (e^u / 1 + e^u)$$

The simulations allow testing the extent to which the relative preferences p change when the levels of an attribute change, while keeping all other attribute levels constant. For each policy environment, changes in policy measures will have a different impact on the country's attractiveness for project developers. The preference simulations are not to be interpreted literally but are meant to serve as a gage or “barometer” for investment intent.

We have constructed three illustrative scenarios of attribute level settings that roughly reflect northwest(NW)-Europe (scenario 1), southeast(SE)-Europe (scenario 2),¹³ and the US (scenario 3) (cf. Table 8). Note that the scenario simulations shown here are based on the preference data of the entire sample to make them more robust and allow for a variety of scenarios.

4.6. Scenario NW-Europe

The hypothetical NW-Europe scenario (Fig. 9) has a high relative preference of 83%, mainly due to low policy risks (highest levels of “Legal security” and “Grid access”). Significant increase in perceived market attractiveness can only be reached by additional financial support. A “Remuneration” increase of 3–11 € ct/kW h or the introduction of a 10% “Cash grant” would yield the highest gain for developers (+11% and +9%, respectively). As the current market attractiveness is quite high, further policy changes need to be evaluated carefully to avoid over-subsidization. On the flip side, a reduction of the “Remuneration” would be very detrimental to the relative preference (–48%) and have serious implications for wind energy development activities in this market.

4.7. Scenario SE-Europe

The hypothetical scenario for SE-Europe (Fig. 10) has a relative preference of 31%. The attractiveness of this policy framework can be strongly increased by shortening the “Administrative process duration”. A shorter process would increase the preference share to 62% (5 years) or to 82% (3 years). Substantial improvements could also be achieved by improving “Legal security”, “Remuneration,” or “Grid access”.

4.8. Scenario US

The hypothetical US scenario (Fig. 11) has a relative preference of 38%. Its attractiveness would benefit most from increasing the “Remuneration” (+46% for an increase from 5 to 8 € ct/kW h). The reason is that the four levels within this attribute (5/8/11/14 € ct) have unevenly distributed part-worth utility values—the jump from 5 to 8 € ct delivers by far the highest gain (see Fig. 7). This is the case in any scenario with a low remuneration level. While this effect dominates, it does not contradict the finding from the importance score analysis above, which showed that US developers do not value the attribute “Remuneration” in comparison to other attributes quite as much as developers from other regions. If we take into account only preference data of

¹³ As corruption is possible in many SE-European countries, we decided not to include this level in our simulation, as it has been shown (Section 4.2) that corruption is a knock-out criterion for many developers and should thus be addressed first.

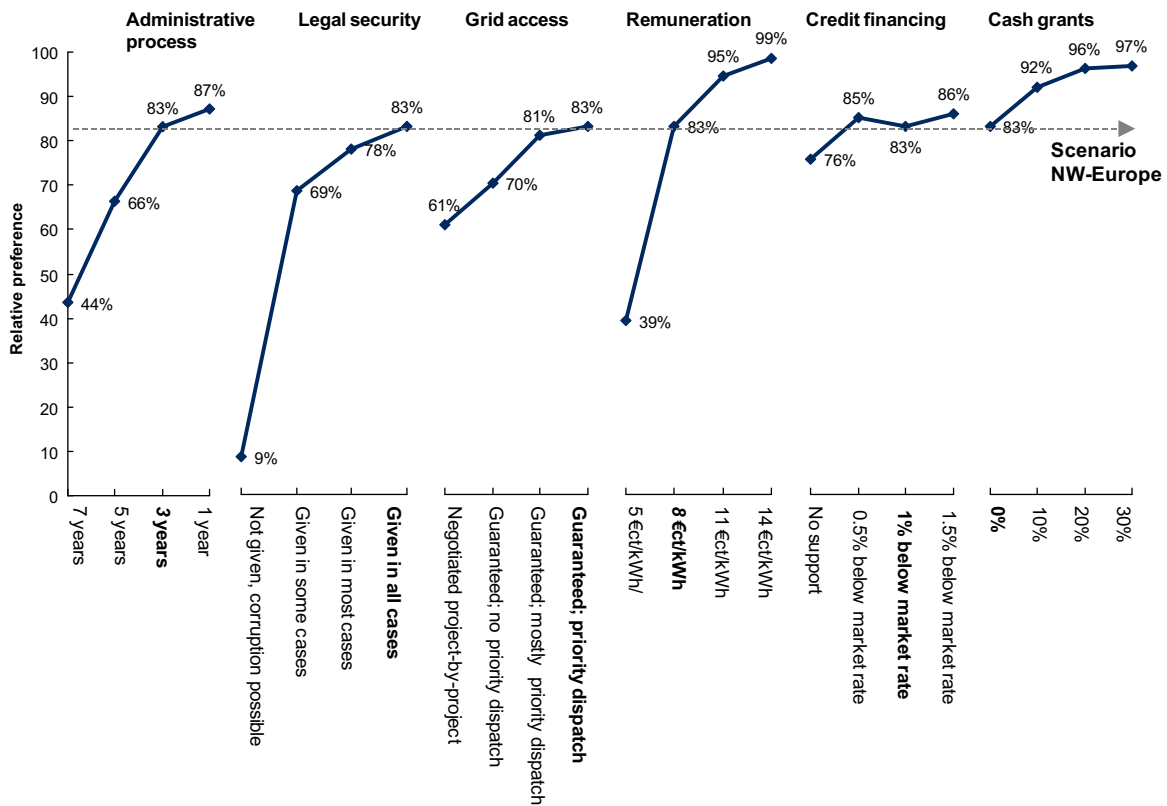


Fig. 9. Relative preference simulations for the NW-Europe scenario.

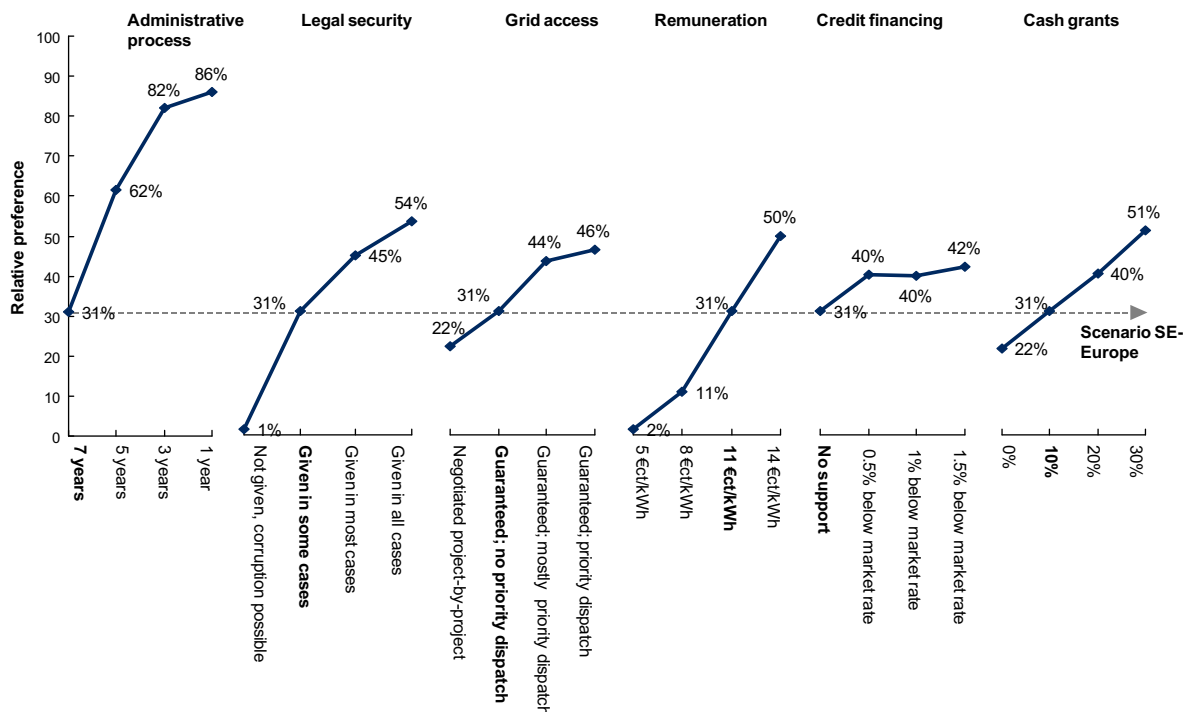


Fig. 10. Relative preference simulations for the SE-European scenario.

SE-European developers, the effect would be more pronounced than in the case of US developers data.

Improving “Grid access” so that priority dispatch is mostly given yields an increase of +24% in the relative preference. An increase in the relative preference of the scenario could also be

reached by “Credit financing” opportunities. The introduction of government guaranteed soft loans 1% below market rate would increase the attractiveness of the base case scenario by 10%.

The importance score analysis in Section 4.4 showed for which aspects and by how much the preferences of developers from

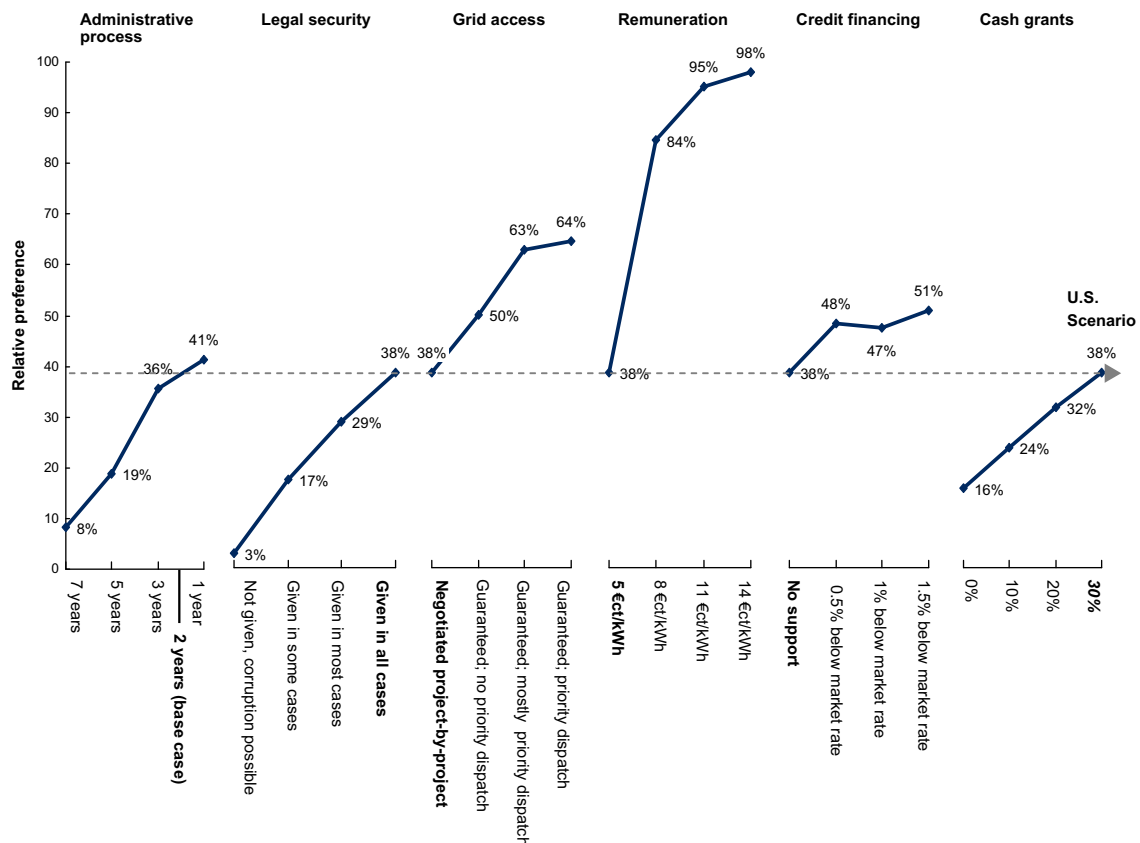


Fig. 11. Relative of preference simulations for the US scenario.

different regions differ. This can be important for policy-makers, for example, when adopting best practice policies from other regions. While the described regions share some common characteristics, policy-makers usually act on a national level. The results from the scenario analysis in Section 4.5 give guidance on which policy improvements could provide the highest utility gains for developers given a specific (national) context.¹⁴ This section showed that the respective starting point is crucial to understand in which areas policy improvements have the biggest impact on developers' utility.

5. Conclusion

5.1. Summary and implications for policy-makers and project developers

The objective of this paper was to examine project developers' policy preferences to enhance the deployment of wind energy. This study builds on the findings of existing literature and substantiates them by employing a novel research methodology, providing an empirical dataset of wind developers' preferences and making the impact of various policy factors on developers' utility measurable. It also suggests that conjoint analysis could be a helpful tool for the estimation of potential effects of specific policy measures.

Key findings can be summarized as follows:

First, wind energy project developers value risk mitigation highly. Legal security, short administrative process duration,

and favorable grid access regulations are very important to developers. These findings are in line with the conclusions of previous studies (Langniss, 1996; Wiser and Pickle, 1998; Dinica, 2006 among others) and confirm their results with empirical preference data. "Legal security" and "Remuneration" have the highest importance scores, whereas, when selecting the most preferred policy scenario, developers indicated the highest preference for very short "Administrative process duration" and "Grid access" regulation that guarantees priority dispatch.

Second, developers have critical minimum requirements for development and as a result they use non-compensatory decision-making in the case of very unfavorable attributes. More than 50% of the wind energy developers see the possibility of corruption, and about 30% see the lowest remuneration level included in the study (5 € ct/kW h respective 7 \$ ct/kW h) and an administrative process duration of 7 years, as knock-out criteria. The study also shows that in most cases, the amelioration of the worst situation brings the highest utility gain.

Third, the preferences of the surveyed developers are quite similar across different types, sizes, value chain foci of the developer companies, and the respondents' level of experience with wind energy development. Indicative findings suggest that developers of small projects and less integrated companies show stronger preferences for "Legal security", whereas large and more integrated companies show above average preferences for "Credit financing support" measures. With respect to the three different regions US, SE-Europe and NW-Europe preferences are also quite similar in general, but show some differences resulting from different regional wind energy barriers, familiarity with different policy instruments, and cultural factors. First, the US developers show a higher

¹⁴ While the presented scenarios are illustrative for regions, the data could be used to conduct similar analyses on a national level.

preference for upfront investment cash grants and a lower preference for production-based remuneration than the European developers. This difference could be caused by an implicitly higher discount rate of the US developers or policy schemes familiarity (i.e., US developers are more familiar with cash grants, while European developers are more familiar with a feed-in tariff support scheme). Second, in SE-Europe where corruption is comparatively more common, this issue tends to be seen as less problematic. In return, the remuneration expectations are higher. Third, the US and SE-European developers state a higher preference for grid access regulations that secure priority dispatch for wind energy than NW-European developers. The latter usually have the benefit of such provisions and the former experience the lack thereof and thus have higher awareness for the need.

Fourth, the most valuable policy measures for developers differ depending on the specific policy framework in place. The preference simulations indicate that in a scenario emulating SE-Europe, streamlining of the administrative processes and increasing legal security are of the highest value to increase market attractiveness. In the US scenario, improvements in grid access regulation and higher remuneration would render the development of wind energy plants more attractive. In the NW-Europe scenario, market attractiveness is already very high and could only be significantly enhanced further by higher financial support.

These results have important implications for policy design:

- When designing support policies for wind energy promotion, policy-makers should focus on risk minimization measures, especially regarding legal security, administrative process duration and grid access issues (compare [Bürer and Wüstenhagen, 2009](#); [Lüthi, 2010](#)).
- Policy-makers should first address knock-out criteria such as corruption and very low remuneration to avoid obstacles to the deployment of wind energy.
- When designing support policies, policy-makers should take into account that the most effective support measures are strongly dependent on the current policy environment. The illustrative regional analyses can help policy-makers to identify the policy measures that result in the biggest utility impact in the developer community and to gauge the relative importance of these changes in terms of preference increase for project developers.
- Finally, the result that the preferences of the surveyed developers from the three different regions are generally quite similar indicates that the results of this study are transferable to individual countries or other regions with comparable investment environments. However, when designing or changing wind energy policies, policy-makers should take into account support policy familiarity of the project developers active in their region, cultural factors like investment discount rate and, as mentioned above, especially address problems that are of primary concern for the development of wind energy projects in their region.

The results of this study are also relevant to wind energy project developers and allow them to learn more about their own decision-making and gain insights that help them benchmark their decision-making process with industry peers.

5.2. Limitations and further research

This study suggests that conjoint analysis can serve as a useful scenario tool for assessing the effect of policy measures on

developer utility, but there are several limitations regarding its use, which should be taken into account in further studies. First, the insights are based on stated preferences and not on revealed actual behavior. What developers say about their decision-making process might be different from how they decide in reality. Real life complexity cannot be mirrored 100% with a limited number of attributes. This tends to lead to overestimation of the studied aspects ([Orme, 2010a](#)).

Second, preference simulations based on conjoint analysis data do not provide the functionality of a market model. Typical market based factors influencing the development decision (cf. [Table 1](#)) such as competition, demand, capital availability, or alternative investment options in other forms of energy generation are not considered. Hence, our results inform about preferences of developers for certain policy measures and how small changes to these policies might improve the perceived attractiveness of policy schemes. However, these results taken on their own cannot predict market reactions to changes in policy schemes.

Third, the study employs the same approach and survey across different national wind energy markets. While the assessed attributes are important decision-making drivers in all national policy schemes, most of the “Organizational and behavioral factors” (cf. [Table 1](#)) that were beyond the scope of the study are distinctive to national investment cultures and can have a great bearing on the conduct and decision making of developers. Studies found that relevant national and local institutional factors include spatial planning institutions, landscape protection concerns, ([Nadaï, 2007](#); [Toke et al., 2008](#); [Prados, 2010](#)), ownership structures ([Delmas and Montes-Sancho, 2011](#); [Agterbosch et al., 2004](#); [Toke et al., 2008](#); [Munday et al., 2011](#)), and peculiarities in national business cultures ([Dinica, 2008](#)). A good example of the latter is the crucial role that government participation played via public–private partnerships (PPPs) for expediting wind energy development in Spain up to the mid-1990s. Despite reasonable risk/return conditions, investors had only been willing to invest in wind energy when public authorities took on part of the risks and equity shares via PPPs. Even with the advance of fully private investments, ‘partnering’ persisted as a successful development practice and became enrooted in the Spanish wind energy industry ([Dinica, 2008](#)). In sum, these factors are crucial for the development decision making, and developers will thus evaluate a preference survey against their specific national backgrounds and development experiences.

Furthermore, the large scale quantitative design of the study limits its insights into individual attributes of the respondents of which we could only cover the experience level. Other relevant attributes include for instance the respondents’ level of risk aversion, confidence in policy development or project management capabilities. To capture these less tangible aspects, further research could deliver more granular insights by employing qualitative in-depth case studies on wind energy development projects.

Finally, as discussed in Section 4.4., differences in preference structure of different types of developers could not unequivocally be assessed due to the low representation of some groups in the respondent sample. Larger and more balanced samples, including more utility developers and more developers engaging in late stage financing could deliver more solid insights into their specific preference structures.

Our findings could be extended by further research in other regions, such as developing countries. Such a study would need to consider including other region-specific attributes such as overall political stability, investment costs and currency risk. Similarly, a study focusing on other renewable energy technologies would yield interesting results for comparison, but is likely to require other attributes to accommodate different economics and diffusion barriers. Further research could explore possibilities of linking

Table A1

Zero-centered diffit worth utilities and standard deviations (SD) for all attributes and levels for the total regional three regional groups (SE-Europe, NW-Europe, and US).

Attribute	Attribute levels	Total utility (SD)	SE-Europe utility (SD)	NE-Europe utility (SD)	US utility (SD)
Administrative process duration	7 year	−60.4 (33.3)	−60.8 (32.5)	−59.9 (32.5)	−60.5 (35.7)
	5 years	−8.3 (14.7)	−6.9 (15.2)	−8.1 (13.9)	−10.2(15.2)
	3 years	28.8 (16.6)	27.9 (17.7)	28.2 (15.2)	30.4 (17.3)
	1 years	39.9 (27.8)	39.7 (23.9)	39.8 (27.4)	40.3 (32.6)
Legal security	Not given; corruption possible	−107.4 (54.3)	−98.8 (59.0)	−113.2 (48.8)	−110.3 (55.1)
	Given in some cases	15.3 (18.0)	10.8 (15.6)	14.3 (17.1)	21.4 (20.1)
	Given in most cases	37.8 (21.2)	34.7 (24.0)	38.9 (19.4)	40.1 (19.9)
	Given in all cases	54.2 (29.2)	53.3 (34.6)	59.9 (26.6)	48.8 (24.9)
Grid access	Negotiated project-by-project	−25.5 (22.5)	−29.9 (19.4)	−19.4 (22.1)	−27.5 (25.1)
	No priority dispatch	−7.5 (17.2)	−6.4 (16.7)	−2.6 (15.1)	−13.9 (18.4)
	Mostly priority dispatch	14.3 (12.2)	14.5 (14.2)	12.7 (11.2)	15.7 (11.1)
	Priority dispatch	18.7 (18.9)	21.8 (17.8)	9.4 (18.2)	25.6 (17.3)
Total remuneration	5 € ct/kW h/ 7 \$ ct/kW h	−95.9 (42.0)	−100.8 (48.2)	−104.6 (32.1)	−81.0 (41.5)
	8 € ct/kW h/ 11 \$ ct/kW h	−7.5 (19.4)	−5.3 (18.3)	−5.4 (22.7)	−12.3 (16.2)
	11 € ct/kW h/ 15 \$ ct/kW h	34.6 (22.0)	34.9 (22.4)	39.2 (20.8)	29.3 (22.3)
	14 € ct/kW h/ 19 \$/kW h	68.8 (33.0)	71.2 (38.5)	70.8 (28.8)	64.0 (31.0)
Credit financing	No support	−14.1 (18.9)	−15.7 (17.6)	−13.7 (23.4)	−12.8 (14.9)
	Gov. loans 0.5% below market rate	4.4 (14.4)	6.4 (12.5)	6.5 (16.0)	−.1 (13.8)
	Gov. loans 1% below market rate	2.1 (12.4)	.7 (11.4)	.6 (13.7)	5.3 (11.6)
	Gov. loans 1.5% below market rate	7.6 (14.8)	8.6 (14.5)	6.6 (16.8)	7.6 (13.0)
Investment cash grants	0%	−32.8 (24.0)	−32.0 (20.2)	−24.1 (22.9)	−43.2 (25.7)
	10%	−7.0 (11.6)	−6.4 (13.6)	−6.3 (10.1)	−8.4 (10.9)
	20%	12.8 (17.8)	10.6 (15.1)	7.6 (17.4)	20.9 (18.6)
	30%	27.0 (17.1)	27.7 (18.3)	22.9 (16.6)	30.6 (15.8)

stated preference data with actual revealed data such as wind capacity installations. This would allow the calibration of choice data with market data. These techniques have mainly been used in the study of travel choices (Hensher et al., 2001). Another extension could be to include additional factors that potentially influence the project developers' choices such as competition levels, the influence of industry networks and the level of social acceptance of wind energy. Lastly, the activities of project developers are also steered by the preferences and investment strategies of their customers, including a variety of investor classes such as large utilities, financial institutions or welfare funds. Thus, an investigation about how developers' preferences are influenced by the preferences of final wind asset holders could provide a more holistic understanding of wind energy development dynamics.

Acknowledgments

The authors would like to thank the anonymous reviewers for their insightful and constructive comments.

Annex

See Annex Table A1.

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