Wind Farms – Where and how to put them?

A choice experiment approach to measure consumer preferences for characteristics of wind power developments in Sweden

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Abstract

This paper aims at measuring preferences for attributes related to the establishment of wind power farms among the general public in Sweden. The method applied is a choice experiment where people are asked to choose between two hypothetical wind farms, each characterized by different attributes. Five attributes are included in the experiment: (i) type of landscape, (ii) ownership, (iii) the extent to which the local public is invited to participate in the planning process, (iv) the choice to transfer revenue to the society in a pre-specified way, and (v) a monetary cost in terms of an additional electricity certificate fee. The results are based on the survey responses from 1500 individuals and show that all attributes have a significant impact on the choice of the preferred wind farm. The results indicate that the electricity consumers in Sweden are more likely to accept the higher costs (through the renewable electricity certificate fee) if; (a) wind power farms in areas used for recreational purposes are substantially avoided, (b) if the establishment is anchored by whole or partly ownership in the local community and, (c) if the local population is involved in the planning and implementation process. Our policy simulation exercise shows that respondents are willing to pay a higher electricity fee corresponding to about four öre to avoid wind farms located in the mountainous area and to avoid private ownership. People consider extended consultation processes and earmarked transfers for nature conservation to the local community as changes for the better, while the opposition towards wind energy in the mountainous areas and privately owned wind farms dominates the positive effects from consultation and transfers.

Keywords: *wind power farm establishment; preferences; choice experiment; public opinion*
JEL codes:

1 Introduction

It is fair to say that the development of the energy sector and its composition are important issues for the near future. In the European Union, policies are implemented to increase the share of wind power in the energy portfolio so as to facilitate the EU 2020 targets for renewable energy (IEA, 2010). Although costs associated with wind power has declined over time, financial support is typically required to make wind power attractive from an investment perspective. Countries such as Belgium, Italy, The Netherlands, Sweden, and UK have introduced systems with tradable renewable certificates to support wind power expansion. In the Swedish system the electricity consumers pay a premium on top of the electricity price (per kWh) to ensure that a certain proportion of the total electricity production, or consumption, origins from renewable energy sources (e.g. wind). Accordingly, the legitimacy of a renewable certificate system requires that the general public accept the goals for renewables, as well as the measures used to implement the goals. If goals and/or means are considered improper the willingness to accept the higher price of renewable electricity might rapidly erode. This paper aims to measure preferences for attributes related to the establishment of wind power farms among the general public in Sweden. The method applied is a choice experiment (CE) where people are asked to choose between hypothetical wind farms described by a number of characteristics (attribute levels).

In general, wind power is perceived as a clean and environmentally benign source of energy (Ek, 2005; Krohn and Damborg, 1999), although the establishment of wind power appears to be a complicated matter in countries where local opposition can be fierce (e.g., Söderholm et al., 2007; Wolsink, 2007). During the last decade, substantial research has been devoted to the understanding of drivers of public acceptance and/or opposition towards wind power at the local level. The local level studies are typically case studies and explore the external costs and benefits of wind power for the local community. On the cost side, results show that there are negative impacts on the view of the landscape, flora and fauna (e.g., Meyerhoff et al., 2010; Dimitropolous and Kontoleon, 2009; Bergmann, et al., 2006; Alvarez-Farizo and Hanley, 2002).[1] Benefits are often associated with reduced greenhouse gases (when renewables are substitutes for fossil fuel energy) and additional job opportunities in the region (e.g., Longo et

[1] Clearly, the impact on landscape arising from wind farm establishments is highly case dependent and general results of these case studies can therefore not easily be drawn from previous research. There are however studies suggesting that the external environmental cost are lower for offshore wind power establishments and that the external costs associated with offshore establishments declines with the distance of the wind farm from the coast (Ladenburg and Dubgaard, 2007; Krueger, 2007, Ek, 2005).

al., 2008; Bergmann et al., 2006). In addition, researchers have been addressing the importance of the planning and implementation process of wind power for local acceptance and/or opposition. The so-called NIMBY (Not In My Back Yard) effect, often referred to as explaining locals opposing wind power from pure self-interest motives, has been questioned as being too simplistic (Swofford and Slattery, 2010; Waldo and Klintman, 2010; Jones and Eiser, 2010; 2009; Wolsink, 2007; Devine-Wright, 2005). Instead, the literature stresses that local attitudes are affected by how the project is introduced and the extent to which planning and permit processes enhance local participation (Swofford and Slattery, 2010; Waldo and Klintman, 2010; Jones and Eiser, 2010; 2009; Dimitropoulos and Kontoleon, 2009; Wolsink, 2005; Devine-Wright, 2005). Local attitudes are also claimed to be more positive if local wind farm establishments are perceived to provide possibilities for the local economy in e.g., terms of job opportunities and local ownership (Warren and McFadyen, 2010; Longo et al, 2008; Bergmann, et al., 2006).

The literature gives valuable insights on factors related to wind power establishment at the local level but lacks the perspective of the general public, which is highly relevant considering the renewable energy price premium prevailing in many countries. The present study fills this gap by focusing on the establishment of wind power in a general setup. The purpose is to measure preferences over a number of important attributes related to wind power establishments in Sweden. The analysis is carried out in a choice experiment framework where the attributes (levels) are varied to reveal preferences for selected characteristics that are highly relevant for wind farm establishments in a Swedish context. Respondents are asked to choose between two hypothetical wind farms, each associated with different characteristics/attributes. There are five attributes characterizing wind farm establishments in the experiment: (i) type of landscape, (ii) ownership, (iii) the extent to which the local public is invited to participate in the planning process, (iv) the choice to transfer revenue to the society in a pre-specified way, and (v) a monetary cost in terms of an additional electricity certificate fee. The levels of each respective attribute are chosen to represent relevant and realistic scenarios without being case specific. For example, the ownership attribute is varied so as to reflect the current, and possibly future, situation – i.e. state owned, municipality owned, private owned and private cooperatives. Note that the policy relevant question is not whether or not wind power should be established, but rather in what way to establish wind power farms.[2]

In the given framework it is possible to perform statistical tests of whether each of the attributes and the corresponding levels has significant impact on the choice probability. From the monetary cost attribute, the choice probability of each respective (non-monetary) attribute can be translated into a monetary measure. For the present study, and from a cost benefit point of view, this is one of the novelties of the experiment. It is possible to analyse the relative size of the utility-impact associated with the different attribute levels. In that respect, this study is rather unique since it provides measures that can be undertaken so as to increase the acceptance and general support for wind farms – which is important for maintaining and strengthening the legitimacy of the renewable energy certificate.

The paper proceeds as follows. Section 2 presents the survey as such, together with its associated development and design. The section also presents selected descriptive statistics. The paper then continues with the economic/econometric specification in section 3, while section 4 presents the econometric results. Finally, section 5 discusses the results and their implications together with some concluding remarks.

2 The Survey

2.1 The choice experiment

The questionnaire consisted of three parts. The first part gave background information on the political goal to increase wind power capacity, and the characteristics included in the choice experiment. Respondents were also asked about their general opinions and experience regarding wind power. Next, the choice experiment was introduced and the attributes with corresponding levels were repeated briefly before each respondent were faced with the choice sets. The final part of the survey collected socio-economic information.

In the experimental design, the choice of attributes and their corresponding levels are of course a challenging task where the results of previous research together with deliberations in a number of focus groups and pre-tests constitute important inputs for the development. In general, results of pre-tests and focus groups indicated that the task to choose between the two

[2] The presumption is that wind power will increase to a considerable degree, meaning that it is not relevant to include an opt-out alternative in the choice experiment.

hypothetical wind power projects in the choice experiment in the present study was manageable, reasonable and relevant. Based on the focus group discussions and the existing literature – and not least the missing/very few studies on how institutional differences may affect how wind power projects are viewed by the general public – the attributes in table 1 were selected to characterize each hypothetic wind power project.

Table 1. Attributes and their corresponding levels

Attribute	Levels
Landscape	- Offshore - Open landscape - Mountainous area - Forest
Ownership	- State - Municipality - Privately - Cooperative
Consultation	- Mandatory consultation - Extended consultation
Transfer of revenue to local community	- 0,5 percent of annual revenue is transferred to the municipality - 0,5 percent of annual revenue is transferred to the local community and earmarked to nature conservation measures in the neighbourhood
Renewable electricity certificate fee	Higher cost corresponding to 3, 6, 12 öre per kWh

The levels of each respective attribute are based on relevant real world examples and on the information obtained in the focus groups. Besides, the four levels of the landscape attribute are all relevant alternatives for planned wind farms in Sweden. Most of the early wind power establishments in Sweden were located close to the coast, often in open landscape areas in the south or at the island of Gotland. The general view has been that wind resources are most favourable offshore and along the coast. However as wind mapping has developed to cover increasing parts of Sweden, mountainous areas have been pointed out as of particular interest given its advantageous wind characteristics and so has some of the sparsely populated areas in the northern parts Sweden. In addition, as the height of wind turbines has increased over time, more forest-type areas have become potential areas for wind power establishment (Ibid.). In the questionnaire, pictures illustrating these four types of landscapes (without turbines) were presented to the respondents.[3]

[3] Note that the aim was not to show fully authentic pictures; instead the aim was to give the respondent an idea of the types of landscapes to consider.

Turning to the current situation of wind power producers, the largest producer is a state owned company while the market also consists of several privately owned companies with varying market shares. In addition, there are examples where the local population and/or the local municipality own parts of wind farms. In this experiment, state owned, municipality owned, private owned and private cooperative are considered to be the most relevant types of ownership.

According to Swedish state law, the establishment of wind power farms must be preceded by consultations with potential stakeholders (stakeholders must have been given the opportunity to express their opinion). The purpose of the consultation is to inform authorities and local residents about the planned project, and to create an opportunity to influence the process of establishment. The level called "extended consultation" is defined as a situation where the developer contacts potential stakeholders at an early stage and then actively asks for their input during the whole process. The extended consultation level is thus defined to cover a higher and more active degree of participation of the local stakeholders compared to the base level of the consultation process, as required by legislation. The inclusion of the extended consultation level thus makes it possible to capture whether people in general have strong preferences for local participation associated to wind power establishment.

Starting with the large scale hydropower development in Sweden in the early 20th century, there has been a tradition of transferring money from the power producer to local communities in the affected are. This type of reallocation compensates, to some extent, for the negative impact (externalities) and creates an opportunity to invest (compensate) in other local projects. There are similar examples of voluntary agreements between wind power developers and local communities; wind power developers may for instance agree to transfer a certain amount to the local municipality to support a local folklore society or a local association for nature conservation. The attribute levels included in the experiment allows the analysis to examine respondents' preferences for monetary support in general (to the municipality) in relation to monetary support that is "earmarked to nature conservation" within or close to the area of the establishment.

Finally, the cost attribute in this experiment is related to the renewable electricity certificate fee. The renewable electricity certificate system works to promote renewable energy sources and is defined so that a specified proportion (increasing over the years) of total electricity consumption must come from renewable sources (18 percent in 2012). Therefore, all Swedish electricity consumers pay a so-called certificate fee via the electricity bill. As of today, the fee amounts to about 6 öre per kWh (corresponding to about 0.6 Euro cents per kWh). In order to facilitate choices and give respondents an idea about how different changes of certificate fees would affect their own household electricity expenses, a table describing the annual cost arising from each change in certificate fee for "typical" households were presented prior the choice sets. Given the current fee of about 6 öre as a reference, levels ranging from 3 to 12 öre were considered relevant for the experiment.

Prior to the choice sets, respondents were informed that they would be asked to choose between two alternatives of wind parks, each consisting of about 30 wind turbines. They were also told that the wind conditions were about the same in the two alternatives and that the number of new job opportunities was the same. Hence, the two alternatives were identical in relevant aspects except the specific attributes of interest.

2.2 Experimental design

The choice set was introduced as a choice between two generic alternatives of wind power projects, alternative A and B. The respondent was then supposed to choose the alternative that renders him/her the highest utility. By choosing the preferred project, the respondent implicitly make trade-offs between the attributes associated with each project. The impact from each attribute on the choice of project is then measured by altering the level of each attribute for each respective project, A and B. In this survey, respondents were faced with six randomly ordered choice situations. The number of choice sets is of course debatable; too many choice sets may imply "tired" respondents (possibly giving habitual or routine response), while too few choice sets may create biased responses given that the choice may be considered complex and time consuming (e.g., Hensher et al., 2001; Carlsson and Martinsson 2008).

The design of choice sets follows a process originating from a L^{AC} factorial (a full factorial), where C is the number of alternatives and A the attributes with L levels. A D-optimal procedure (OPTEX) in SAS was used to create the choice sets; (see e.g., Kuhfeld, 2005). Basically, the procedure considers orthogonality meaning that the variation of the attributes should be uncorrelated within and across each alternative. In total, twelve choice sets were used in the final experiment, which were then divided into two blocks with 6 choice-sets each.

Half of the respondents faced one block of choice sets, while the other half faced the other block.[4]

2.3 Survey method and sampling

The survey was conducted on the Internet and the sample of respondents was collected from a web-based panel of approximately 90,000 Swedish citizens. The sample was collected according to age, gender and place of residence to be representative for the Swedish population. Web-surveys are typically less costly, more flexible and imply faster data collection than traditional mail surveys. For example, it is very convenient to randomize questions, do more complex follow-ups etc., while drop-outs or 'blanks' does not exist (it is not possible to skip a question).[5] There are of course also potential drawbacks with web-based surveys. One common argument is that there may be a selection problem – only individuals with access to a computer and Internet can be part of the study. This is however not necessarily a problem in all cases and the issue of selection bias must be considered and analysed in each individual case. The access to computers and Internet varies significantly over countries and population groups within countries.[6] In line with this argument, the bias of using the Internet would presumably be smaller in say Sweden than in a less "computerized" country. In some countries, a substantial part of the population may not have access to Internet continuously, and more importantly, those who have access may not be representative for the population. As for the Swedish case (our case), a clear majority of the population has continuous access to a computer and Internet. The only significant difference in access and use of Internet in Sweden is between the most elderly people (more than 64 years) and the rest of the population.[7] Furthermore, the panel itself is randomly phone-recruited (self-recruitment is prohibited). By comparison to the common method of advertising and self-recruitment, this

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[4] The number of choice sets was determined according to a macro (MktRuns) in SAS suggested by Kuhfeld, 2005. The software ranks different designs according to efficiency measures; see e.g. Street et al., 2005 for a discussion regarding efficiency measures and their importance.

[5] The web format made it possible to vary the order of the alternatives and to randomize the order of choice questions.

[6] There is a rather extensive literature dealing with issues related to the choice of surface mail surveys and web-based surveys (email), see e.g. Dillman et al., 2009 and Kaplowitz et al. 2004. The latter of these two compare response rates of web- and mail surveys. Among other things, they find that a web survey and a surface mail survey have comparable response rates in a population where each member has web access, if the web survey is preceded by a surface mail notification.

[7] In 2008 88% of the population, between 16 and 74 years of age, had access to Internet in their home (Statistics Sweden, 2008). Furthermore, 84% of the population (16-74) states that they use Internet at least one time per day (Statistics Sweden, 2008). If we break down these numbers for different groups, concerning age, income, employment, unemployment, etc., the conclusion is that differences are small, except for the most elderly.

procedure guarantees a non-zero probability of being included in the panel (see e.g. Dillman et al., 2009).

Still, our sample may give rise to other statistical issues to keep in mind while interpreting the results. Examples are panel drop-outs that may cause a statistical problem if they are "different" from the rest of the panel, and "panel conditioning" in the sense that participation in previous surveys may affect respondents' answers in the present survey. The latter phenomenon may however also be advantageous since it could be interpreted such that respondents are experienced and thereby may answer in a more correct and truthful way (see e.g., Dillman et al., 2009 for a more extensive and general discussion on these issues).[8]

2.4 Descriptive statics

In December 2011, a sample of 1,500 respondents was collected. Table 2 summarizes a selection of descriptive statics among the respondents and compares some of the sample characteristics with estimates reported by Statistics Sweden (or other national samples).

Table 2. Descriptive statistics

Variable	Sample mean	Swedish population
Proportion women	0.50	0.50[a]
Average age	54	41[a]
Proportion older than 65 years	0.34	0.19[a]
Proportion with higher education	0.46	0.39[a]
Proportion living in a large city (> 200 000 inhabitants)	0.21	0.20[a]
How much should Sweden invest in wind power during the coming 5-10 years? Proportion answering "as today" and "more".	0.87	0.88[b]

[a] Statistics Sweden, 2012
[b] Reported by the national SOM-institute (Hedberg and Holmberg, 2012)

The comparison of our sample with the corresponding estimates reported by Statistics Sweden reveal that the gender distribution and the proportion living in large cities are similar while elderly people and respondents with a university education seem to be somewhat over-represented in the sample. Similar differences with respect to age and educational level have been found in other studies (see e.g., Ek and Söderholm, 2008; Ek, 2005).

[8] There is an existing literature trying to investigate possible bias from panel based studies. For example, it is found in a very specific setup by the Gallup Organization (people had the opportunity to choose between attending a panel and mail) that panel members where different from mail respondents. Specifically, mail respondents were in general older, had lower incomes and were less educated (Rookey et al., 2008).

The questionnaire included a question inspired (identical) from the national SOM-institute questionnaire so as to operationalize a general attitude towards wind power. The question was phrased "How much should Sweden invest in wind power during the coming 5-10 years?" In our sample, 87 percent of the respondents report that they think Sweden should invest the same amount as today or more, while the corresponding figure for the national poll was 88 percent (Hedberg and Holmberg, 2012). Hence, although our respondents are somewhat older and more educated than the average Swede, there is no evidence that the general attitude towards wind energy differs significantly, at least not from what has been reported in other national surveys.

3. Empirical specification

In the survey, each choice question implies a discrete choice between two wind power projects (A and B) characterized by the attributes presented above. It is assumed that each alternative corresponds to a specific utility level, and that the respondent chooses the alternative that provides the highest expected level of utility. From an econometric point of view, this can be interpreted as the probability of choosing project A or B, given the attribute levels characterizing each project. The analysis of this type of data is typically done within the logit framework. The standard logit model assumes that unobserved factors affecting the choice of alternatives are strictly independent of each other, which may be very implausible in many cases. It is perhaps likely that unobserved factors affecting the utility of project A and B are more or less correlated with observable factors included as attributes in the experiment. Given this shortcoming of the standard logit model, the approach in this paper was to analyze the responses in the random parameter logit (RPL) framework[9]. The RPL model is a more general version of the logit model and allows unobserved factors to be random and to follow any distribution; see e.g Train (2003). This method is rather standard in the literature and will not be formally derived in this paper. Still, some basics should be mentioned to increase the ability to interpret and discuss the results.

In general, individual q's utility from choosing alternative j in choice situation t can be defined as

$$U_{jtq} = \beta'_q X_{jtq} + \varepsilon_{jtq} \qquad (1)$$

[9] Also known as the mixed logit model in the literature.

where X_{jtq} is a vector of observable variables (attributes) related to the alternative and the respondent. The unobserved parts of equation (1) are β_q, which is a vector of coefficients corresponding to the variables, and ε_{jtq}, which is the error component. Given this specification, β_q represents individual taste among the respondents. In the behavioral process, the utility is known to the respondent and he/she knows the true value of his own β_q and ε_{jtq} for all j and chooses the alternative with the highest utility. In the RPL framework taste is allowed to vary across individuals and the coefficients are characterized by a distribution $f(\beta)$, which is assumed to depend on underlying parameters captured by θ. These underlying parameters could be the mean and the covariance of the distribution. Note that the researcher observes only the variables X_{jtq} in equation (1). Hence, assuming that β_q is observable and that ε_{jtq} is independent and identically distributed (IID) extreme value type 1, the choice probability would be of a standard logit type. That is, given the values of β_q the probability is defined by

$$L_{jq}(\beta_q) = exp(\beta'_q X_{jq}) / \sum_k exp(\beta'_q X_{kq}) \qquad (2)$$

However since β_q is unknown (follows a random distribution) it is not possible to use this probability. Instead, the unconditional probability is defined as the integral of $L_{jq}(\beta_q)$ for all possible values of the coefficients,

$$P_{jq} = \int \left(\frac{exp(\beta' X_{jq})}{\sum_k exp(\beta' X_{kq})} \right) f(\beta|\theta) d\beta \qquad (3)$$

Given a specified distribution for the coefficients, the parameters, θ, of the distribution for the coefficients, $f(\beta)$, can be estimated through a simulated maximum likelihood estimator using Halton draws.[10] As for the choice of distribution, it can take on any distributional form such as normal, lognormal, triangular, etc. However without any clear cut prior information, or other obvious indicators, it is most straightforward to assume a normal distribution for all attributes (except the changed cost of the certificate fee in the present experiment).

The output of the RPL model described above gives estimates of the coefficients with its corresponding standard error. In general, the interpretation of the coefficients as such is analogous to the standard logit and measures the effect on the probability of choosing an alternative (although the absolute numbers requires a "transformation"). In addition, the

[10] Halton draws are more efficient than standard random draws. The number of draws has been discussed in the literature; see e.g. Bhat (2001) and Train (2000). With the Halton procedure, it has been found that 25 draws may produce stability, but larger numbers are preferred.

standard deviation of each random coefficient is obtained. A statistically significant standard deviation is interpreted such that the coefficient actually varies across individuals. This is in contrast to the standard logit where the coefficients are assumed to be the same for all individuals in the population, i.e. the mean is a good approximation for the population.

4. Estimation results

The results presented in this section are divided in two parts, the base-model and the interaction-effects model. In the base-model, attributes and their respective impact on the probability of preferring one alternative over another are analysed. In the interaction effects-model, we hypothesise that the valuation of attributes may depend on other/additional factors than the attributes themselves. To be specific, socioeconomic factors such as e.g. gender and previous experience of wind energy are included to the specification. In all cases, estimation is done with the NLOGIT 4 software.

4.1 The base-model

The empirical specification suggests the RPL model for analysing our response data. It is standard procedure to compare results obtained from the RPL with results from the Logit model. In our RPL specification all parameters, except for the certificate fee attribute, are characterised as random parameters with a normal distribution. Few of the estimated standard deviations are however statistically significant and thus give weak evidence for heterogeneity in preferences among the respondents. It could be argued that the assumption of normal distribution is inappropriate and that alternative distributions possibly become significant. However considering our experiment and the attributes there is no obvious reason to assume any other distribution than the normal. Other distributions such as e.g. a log-normal would impose a substantial restriction on the estimates. To compare the RPL and Logit specification a likelihood ratio test is performed. The result of this test is however somewhat inconclusive; the RPL specification is preferred at 5 percent significant level, but not at the 1 percent level. The results are presented in Table 3 where the base levels of the attributes are: forest, state owned, general to municipality and standard consultation, respectively.

Table 3. Base model estimates, standard errors within parenthesis.

	Logit	Marginal WTP	Random parameter logit	Random parameter logit	Marginal WTP
	Coefficient	Swedish cent	Coefficient	Standard error	Swedish cent
Mountainous area	-0.290***	-2.424***	-0.615***	0.774*	-2.230***

	(0.027)	(0.236)	(0.154)	(0.404)	(0.270)
Open landscape	0.019 (0.027)	0.161 (0.231)	0.007 (0.079)	0.328 (0.319)	0.026 (0.289)
Offshore	0.310*** (0.034)	2.590*** (0.280)	0.631*** (0.160)	2.930*** (1.020)	2.287*** (0.317)
Cooperative	0.078*** (0.078)	0.649*** (0.239)	0.168* (0.088)	0.294 (0.256)	0.607** (0.291)
Municipality	0.131*** (0.030)	1.100*** (0.245)	0.407*** (0.146)	0.492 (0.355)	1.474*** (0.296)
Private	-0.370*** (0.027)	-3.091*** (0.238)	-0.855*** (0.221)	0.282 (0.411)	-3.100*** (0.252)
Ear marked	0.093*** (0.012)	0.774*** (0.103)	0.232*** (0.070)	0.001 (0.172)	0.841*** (0.122)
Extended consultation	0.039*** (0.014)	0.324*** (0.116)	0.053 (0.042)	0.730** (0.318)	0.193 (0.157)
Certificate	-1.197*** (0.039)		-2.760*** (0.682)	Fixed parameter	
Log-likelihood	-5515.726		-5506.020		
McFadden Pseudo R-squared			0.117		
No. of respondents	1,500		1,500		
No. of observations	9,000		9,000		
No. of Halton draws			60		

*** Significant at 1%-level, ** Significant at 5%-level and * Significant at 10%-level
The Krinsky and Rob method with 1,000 draws has been used for the standard errors of the WTP estimates.

The outcome in terms of estimation results is similar across the two model specifications. All estimated coefficients have the same sign in the Logit model as in the RPL model. It is not meaningful to compare the size of the estimated coefficients between these two models (measured on different "scales"), but it is found that the estimates of the relative importance of the attributes, the marginal WTP, are similar across the two specifications. The statistical significance differs between model specifications for two parameter estimates only; the *cooperative* parameter is statistically significant at the 10 percent level in the RPL model while it is significant at the 1 percent level in the Logit model, and the *extended consultation* coefficient is not statistically significant in the RPL model while it is highly significant in the Logit model.

Our results suggest that wind farms in the *mountainous* area are less preferred than wind farms located in *forests* while; on the contrary, *offshore* wind farms are preferred over wind farms in the *forests*. These results are similar to a previous Swedish study by Ek (2006). It is interesting that the size of the WTP estimates indicate that the location of wind power in different landscapes seems to have a relatively large impact on the utility, although nothing was made to make respondents believe that the hypothetical wind farm would affect them personally. There is however no statistically significant support for the notion that wind farms in *open landscapes* has any impact on the utility. One plausible explanation for this lack of statistical significance can be that different respondents, e.g., living in different parts of the country, may have interpreted the open landscape type differently.

According to our results, the ownership of wind farms affects the respondents' utility. Respondents tend to prefer wind farms owned by the *municipality*, or a *cooperative*, before a *state* owned wind farm. *Private* ownership has however a negative impact on the choice of preferred farm, compared to a *state* owned wind farm. Considering the marginal WTP for *privately* owned farms, it is the attribute with the largest impact on the utility (choice) in the experiment. Previous research suggest that local ownership may be an issue of importance; Warren and McFayden (2010) show that community owned wind farms could have a positive effect on public attitudes towards and acceptance of wind farm developments. Moreover, Toke et al. (2008) argue that the presence of local ownership in e.g., Denmark and parts of Germany, is one factor behind the higher speed at which wind energy has been diffused in these countries, compared to e.g., UK and the Netherlands, where wind energy has been developing more slowly and where local ownership is less common. Although only *municipal* and *state* owned attributes were explicitly specified geographically in this study, it is possible that the respondents interpreted the *cooperative* ownership attribute as being more closely linked to the local community than *privately* owned attribute and that such assessments may to some extent, explain these results.

Respondents have preferences for redistribution of revenue to "*earmarked to nature conservation*" before a general transfers to the municipality. Furthermore, respondents typically prefer an "*extended consultation process*" to a non-extended process. These results are consistent with, e.g., Dimitropoulus and Kontoleon (2009) who found that the governance characteristics of the planning procedure are important for local acceptance of wind farm developments (in a choice experiment conducted in two Greek Aegean Islands). Given the size of the WTP estimates, the importance of redistribution and consultation is however less pronounced than geographic location (landscape) and ownership. Still, it is important to keep in mind that these results do not imply that consultation processes and repayment to the local community per se are unimportant; rather it indicates that people in general do not have strong preferences for these specific forms of extensions and/or earmarking.

Finally, the statistically significant and negative estimate for the *certificate* parameter suggests that people in general prefer low electricity certificate fees to high, which was expected.

4.2 The interaction effects-model

Although the somewhat limited statistical support for the RPL model and the implicit heterogeneity in preferences, it is an interesting and policy relevant exercise to test for interaction effects. By including a number of interaction variables, we test whether there are additional factors that may explain the probability of choosing a specific wind farm, i.e. factors influencing the preferences for the attributes in the experiment. We analyze whether the attributes are valued differently depending on gender, what type of landscape the respondents live in and/or spend time in for recreational purposes, and with respect to environmental orientation of respondents. The results are presented in Table 4. The signs, the statistical significance and the relative importance of the attributes (i.e., the estimates of the implicit prices) are rather stable across the different model specifications. The statistical significance for the mountain area parameter is however lower in this specification compared to the one presented above (in Section 4.1). The willingness to pay to avoid a wind farm in the mountainous area is also lower while the parameter for open landscape has become statistically significant.

As a starting point, it is hypothesized that gender may affect the willingness to pay for different attributes. Since there is no obvious argument for gender to just affect preferences for some of the attributes, all attributes were tested for gender interactions. Results show that men and women seem to value the attributes differently. Men dismiss wind power in the mountainous area more, while they attach a lower value to earmarked redistribution than women. The size of the negative implicit price (male*earmarked) implies that it is only women who are willing to pay for an earmarked redistribution to nature conservation. Men also tend to be more sensitive to higher costs (higher renewable electricity fees) than women.

It is also interesting to note that respondents living in the mountainous area are less negative towards wind farms in the mountainous region than respondents living in other environments. We find no statistically significant support for the idea that people living in other types of landscapes consider their own type of landscape as more or less suitable for the proposed wind farm. In contrast to the type of landscape in which the respondents live, areas where they spend time for recreational purposes seem to be of vital importance. Respondents with summerhouses, and respondents that regularly visit coastal or marine environments for recreational purposes, consider offshore wind power worse than respondents who not visit coastal or marine environments for recreation. The same result is found for open landscape.

People with summerhouses and/or people that regularly visit open landscapes for recreational purposes are less willing to accept a wind farm in open landscapes. For the mountainous area, the results provide statistically significant support for the notion that people visiting the mountainous area regularly for recreational purposes are less willing to accept the wind farm in such landscapes, while the summerhouse parameter is not statistically significant.

Table 4 Interaction model estimates, standard errors within parenthesis.

	Logit	**Marginal WTP**
	Coefficient	Swedish cent
Mountainous area	-0.084*	-0.786*
	(0.051)	(0.472)
Open landscape	0.125***	1.171**
	(0.049)	(0.487)
Offshore	0.363***	3.413***
	(0.064)	(0.611)
Cooperative	0.084***	0.789***
	(0.029)	(0.276)
Municipality	0.134***	1.262***
	(0.031)	(0.296)
Private	-0.373***	-3.506***
	(0.027)	(0.309)
Ear marked	0.140***	1.313***
	(0.018)	(0.175)
Extended consultation	0.035***	0.331***
	(0.014)	(0.127)
Certificate	-1.064***	
	(0.053)	
Male*Mountainous area	-0.221***	-2.073***
	(0.050)	(0.462)
Male*Open landscape	-0.014	-0.127
	(0.048)	(0.443)
Male*Offshore	0.188***	1.763***
	(0.057)	(0.543)
Male*Earmarked	-0.121***	-1.139***
	(0.024)	(0.229)
Male*Certificate	-0.319***	-2.992***
	(0.078)	(0.827)
Living*Mountainous area	0.213**	1.999**
	(0.104)	(0.992)
Living*Open landscape	0.030	0.281
	(0.049)	(0.466)
Living*Seaside	-0.029	-0.271
	(0.056)	(0.526
Cottage*Mountainous area	0.034	0.320
	(0.099)	(0.911)
Cottage*Open landscape	-0.193**	-1.810**
	(0.082)	(0.785)
Cottage*Seaside	-0.134**	-1.261**
	(0.069)	(0.633)
Recreation*Mountainous area	-0.083***	-0.775***
	(0.027)	0.249
Recreation*Open landscape	-0.042***	-0.398***

	(0.017)	(0.158)
Recreation*Seaside	-0.049** (0.022)	-0.459** (0.209)
Environmental organization* Ear marked	0.092 (0.036)	0.860*** (0.326)
Log-likelihood	-5447.881	
No. of respondents	1,500	
No. of observations	9,000	

*** Significant at 1%-level, ** Significant at 5%-level and * Significant at 10%-level
The Krinsky and Rob method with 1,000 draws has been used for the standard errors of the WTP estimates.

Summing up, the results suggest that, in general, people tend to be most skeptical towards wind power in environments they visit for recreational purposes compared to environments in which they live permanently. Moreover, the results suggest, not surprisingly, that people reported as members of environmental organizations are more positive towards earmarked redistribution than others.

4.3 Policy simulations

Before concluding, the results can be used to illustrate possible real world scenarios, or "policy packages". By combining attribute levels and their corresponding implicit prices, it is possible to calculate the utility difference between different policy packages in monetary terms. The point of reference will be a scenario characterized by attribute levels that are relatively common as of today. Starting with landscape, it is not clear cut which type that has been the most common for wind farm establishments so far. However given that mountainous and offshore areas are considered attractive alternatives in the coming years, we believe that it is illustrative to use the forest as the reference.[11] For the ownership attribute, state owned will work as the reference level; the motive for this choice is that the state owned company Vattenfall is the leading energy company in Sweden today. For the consultation attribute, the level "mandatory" was chosen as the reference category. Wind power producers are required to facilitate the participation of relevant stakeholders, while the company itself defines relevant stakeholders as well as the forms for participation; e.g., whether locals receive information about the planned wind farm or if they are asked actively about their opinion and their use of the area where a wind farm is planned. Finally, it has not been common to redistribute revenues from wind energy generation to the local community until now but we

[11] Since there is no large difference between the valuation of forest and open landscape, there is no strong argument for choosing one before the other. We decided to have forest as our reference landscape.

have chosen a general transfer of revenue to the municipality (non earmarked) to be the reference scenario.

The first alternative scenario (SC-1) is supposed to illustrate a "worst case" package although characterized by extended consultation and ear marked transfers to the municipality. The second alternative scenario (SC-2) is, on the other hand, supposed to illustrate the "best possible" scenario according to our results.[12]

Table 5 Policy packages (standard error within parantheses)

Attribute	Reference scenario	SC-1	SC-2
Landscape	Forest	Mountainous	Offshore
Ownership	State	Private	Municipality
Consultation	Mandatory	Extended	Extended
Transf. of revenue	Non earmarked	Earmarked	Earmarked
WTP for a change, öre SEK[a]	-	-4.343** (0.647)	4.853** (0.721)

[a] The WTP for a change from the reference scenario was calculated as the utility difference. The standard errors (within brackets) were calculated with the Wald command in Limdep, and the Krinsky and Rob method with 1,000 draws. ** Significant at 1%-level.

The result (see Table 5) shows that a change to SC-1 will generate a substantial loss in utility although people consider extended consultation and earmarked transfers for nature conservation to the local community as changes for the better. The driving forces behind this result are that there is a rather strong opposition towards wind farms in the mountainous areas and towards privately owned wind farms, which dominates the positive effects from consultation and transfers. Moreover, the magnitude of approximately four Swedish öre is rather large, given that the present electricity certificate fee corresponds to about six Swedish öre. Turning to a change to SC-2, which instead would generate a substantial increase in utility, people are willing to pay almost five Swedish öre to obtain SC-2 instead of our reference scenario. In this case, all attribute levels are chosen to be as advantageous as possible given our previous results. Again, although all attribute levels are considered as changes for the better, the location of wind power constitute the most important in the SC-2.

5. Summary and discussion

[12] These scenarios are hypothetical and other combinations of attribute levels are of course possible in a hypothetical scenario.

Given the choice experiment framework and the monetary cost attribute, the purpose of this study has been to measure public preferences over a number of attributes related to wind power establishments. It is worth noting that the focus has been on wind power establishment in general and not on case- (or site-) specific conditions. The motivation for this type of study is the rapid increase in the number of wind farms over the last decade(s), the expected continued expansion in the future but also the required (implicit) support from the general public for this expansion (via the requirement to pay the renewable certificate fee on top of the electricity price). The focus in this study has not been on site-specific attributes, but rather attributes that are relevant alternatives for wind power establishment in general. The attributes of interest have been (i) type of landscape, (ii) ownership, (iii) the extent to which the local public is invited to participate in the planning process, (iv) choice to transfer revenue to the society in a pre-specified way, and (v) a monetary cost in terms of an electricity certificate fee. The approach for studying this type of issues has been the choice experiment framework where respondents are asked to choose between hypothetical wind farms characterized by varying levels of the attributes defined above. In addition, there was no opt-out alternative since the point of reference was the politically set targets for renewable electricity (such as wind power). The analysis was based on data from 1,500 respondents and the sample was collected through a web panel consisting of approximately 90,000 Swedes.

In general, the results of the experiment show that all attributes, except the open landscape, have significant impact on the choice of the preferred wind farm. Turning to each of the attributes, it is found that respondents prefer wind power located offshore but dislike wind power in the mountainous area, in comparison with wind power located in the forests. In order to maintain/obtain positive attitudes towards wind power among the general public, one could thus argue that based on these results offshore developments should be enhanced and promoted before mountainous areas.[13] Moreover, these results reveal that people are rather sceptical to wind power establishments in landscape types that respondents tend to use for recreational purposes while such scepticism is not apparent for the types of landscape where respondents live permanently. When it comes to the types of landscapes where respondents

[13] It is however important to note that these results do not necessarily imply that actual projects offshore will be easily implemented while the opposite is true for developments in the mountainous. It is still important to keep in mind that a real world establishment is potentially very site specific, meaning that local conditions are of vital importance. The local opinion depends, among other things, on how they experience their local environment and the social conditions and the impacts wind power is expected to cause (e.g., Waldo, 2012; Johansson and Laike, 2007; Devine-Wright, 2005). The results of a more local study on wind farm projects in the same types of landscapes as in this study show that the motives for opposing and/or rejecting wind power are about the same in the different landscapes (Waldo et al., 2012).

report that they live, there is however one somewhat unexpected but interesting result. Respondents reporting to have their place of residence in mountainous areas are, on average, more positive towards wind power establishments in mountainous areas. The scepticism towards wind power in mountains areas typically comes from people visiting for recreational purposes rather than from the locals living in, or close to, the mountainous area.

Furthermore, the results in this study are consistent with the qualitative literature pointing at the importance of issues related not only to *where* but also *how* wind farms are developed, e.g., on the importance of local ownership and local participation in the planning process. It is claimed that wind turbines that are owned, in whole or in part, by the local community may experience greater acceptance than those owned by more "external" firms (Warren & McFayden, 2010). There are also studies indicating that the local community receives more benefit from the revenue generated by the locally owned farms (Lantz and Tegen, 2008, Goldberg et al, 2004) and that countries where local ownership of wind farms are more frequent have experienced a more rapid diffusion of wind technologies (Toke et al., 2008). It should be noted that according to the results presented in this study, people that are not directly affected by wind power establishments put value on how locals are involved and how they can benefit from the establishment of wind farms. Our results show that private ownership of wind farms is an inferior alternative to state ownership while both cooperatively and municipally owned farms are viewed as better than state ownership. Perhaps, these results could be related to the understanding/interpretation of the "ownership attribute" as such. Specifically, only state owned and municipally owned wind farms are defined to have a direct geographical anchoring, although the cooperative ownership may have been interpreted as a locally based ownership alternative to a higher extent than privately owned wind farms. Private ownership is potentially perceived to have the weakest attachment to the local community.

Although rendering a relatively low implicit price, the valuation of extended consultation process is worth noting. The results show that people are willing to make monetary trade-offs so as to ensure that the local population is involved in the planning and implementing process, despite that people are not necessarily affected themselves. The policy simulation exercise shows that respondents are willing to pay a higher electricity fee corresponding to about four öre to avoid the scenario with wind farm located in the mountainous area and to avoid private ownership. Still, people consider extended consultation and earmarked transfers for nature conservation to the local community as changes for the better. The driving forces behind this result are a rather strong opposition to mountainous areas and privately owned wind farms, which dominates the positive effects from consultation and transfers. The magnitude of approximately four Swedish öre is quite substantial, given that the present electricity certificate fee corresponds to about six Swedish öre.

Hence as electricity consumers, not surprisingly, prefer low electricity costs over high, the cost of implementing the renewable energy target is not an unimportant issue. Our results indicate that the electricity consumers in Sweden are more likely to accept the higher costs (through the renewable electricity certificate fee) if; (a) wind power parks in areas used for recreational purposes are substantially avoided, (b) if the establishment is anchored by whole or partly ownership in the local community and, (c) if the local population is involved in the planning and implementation process.

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