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Valuing the Environmental Impacts of Wind Power

A Choice Experiment Approach



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A Choice Experiment Approach

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ABSTRACT

There exists a political goal in Sweden to increase the use of renewable energy, and wind power seems to be a favorable choice from an environmental perspective. Although the public generally expresses a positive attitude towards wind power, specific projects often face resistance from the local population. This study aims at examining the general attitude towards wind power among Swedish house owners, and in particular at analyzing their valuation of the external impacts associated with wind power using a choice experiment approach. The results are based on a postal survey sent out to 1000 Swedish residential homeowners. The non-monetary attributes included in the choice experiment were: the noise level, location, height, and the grouping of windmills. An electricity price change was included as a cost attribute. According to the results wind power incurs external costs, and the impacts represented by the noise, location, group, and the price change attributes all had statistically significant effects on the utility of the average respondent. Among the non-monetary attributes, the location of windmills seems to have the biggest impact on the utility of the respondents, i.e., the highest implicit price. The average respondent perceives wind power capacity located offshore as a change for the better while locating windmills in the mountains is perceived as a change for the worse, all compared to a location onshore. In addition, the respondents appear willing to pay a positive amount to avoid large wind farms. Furthermore, noise reductions are considered as improvements and lower electricity prices are preferred over higher, as is to be expected. However, there is no evidence that the height of windmills affects the utility of the average respondent. Hence, if the environmental external costs associated with wind power are to be minimized, our results suggest that new schemes should be located offshore rather than in the mountains and that large wind farms should be avoided. This also provides important lessons for wind power producers who wish to market wind power as a “green” electricity source and adapt their generation portfolio accordingly. However, all future measures towards decreasing the external impacts of wind power must be relatively low-cost; according to the results the Swedish house owners are cost conscious and prefer low electricity prices over higher.

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Chapter 1
INTRODUCTION

1.1 Background and Purpose

An important element of energy policies in Sweden and the European Union is to promote the commercialization of renewable energy sources in the power sector. The recent wave of liberalization and deregulations of electricity markets may in itself benefit renewable energy as it allows for product differentiation; customers can choose among producers of electricity with different generation portfolios. If consumers are willing to pay a premium for electricity generated from renewable sources, such as wind power, the amount of renewable electricity capacity can be expected to increase.

Swedish consumers have had the opportunity to buy “green” electricity since 1996, at the time when the electricity market was deregulated and the Swedish Society for Nature Conservation initiated a system for the labeling of “green” electricity. The energy sources considered “green” according to this scheme are: existing hydropower, solar power, biomass power, and wind power. All the major electricity distributors in Sweden offer their consumers “green” electricity, and some of them also offer electricity generated exclusively from wind. Still, so far wind power represents a small share of total electricity production in Sweden. In 2000 0.4 TWh wind power was generated, corresponding to about 0.3 percent of total power generation in the country (Swedish National Energy Administration, 2001a). However, the political intention is to increase wind power production to 10 TWh by 2015 (Prop 2001/02:143).

The results of a study on the externalities arising from electricity generation, in which more than 40 different electricity externality studies were summarized and compared, indicate that wind power is an electricity source with relatively small negative impacts on the environment (Sundqvist, 2002). However, although wind power may be considered a clean electricity source that, for example, does not give rise to any emissions, there are several environmental impacts involved in wind power generation. For instance, the presence of windmills can affect the view of the landscape in an unpleasant way, and the generation of wind electricity creates noise pollution. The experience in Sweden and in many other European countries is that although the public opinion is, in general, positive towards wind energy, specific wind power projects often face resistance from the local population due to these negative impacts (Krohn & Damborg, 1999).

To sum up, consumers have the option to choose to buy “green” electricity and wind power seems to be a favorable choice from an environmental perspective. Given this, it is important to understand how the public, and not the least the consumers of “green” electricity, view the environmental effects related to wind electricity. Thus, the overall purpose of this thesis is to examine the attitudes towards wind power among Swedish households, and in particular to analyze how the public values the environmental attributes associated with wind power generation.

According to the welfare economics literature the expansion of wind power capacity should be developed so as to maximize the net social benefits associated with wind power. The present study should be able to provide important guidance in this respect. Specifically, the study provides an assessment of some of the external costs and benefits associated with wind power. Improved information about the opinions for and against wind power is important to wind power producers as well. It is essential for them to know more about how the different characteristics of wind power are perceived by the consumers. This information could be used to differentiate their product as well as to market “green” wind energy more efficiently. Besides, knowledge about the relative importance of the environmental impacts linked to wind power and the sources of the opinion for and against wind power would make the producers better equipped at responding to any opposition towards new wind power installations.

1.2 Methodology

The estimation of the preferences for environmental non-market goods and for changes in environmental quality constitutes an important element of the environmental economics literature. Applications of non-market valuation techniques are common in public transport, infrastructure projects, and in different environmental studies. Damage assessment cases, in particular in the United States, have also prompted considerable research activities in this area.

The contingent valuation method has been used extensively during the last decades in different environmental applications, although it has also been questioned (e.g., Garrod & Willis, 1999). Problems associated with the contingent valuation technique have made elicitation formats that ask respondents to choose between discrete alternatives rather than to state their maximum willingness to pay for a particular environmental good increasingly popular.[1] Discrete choice contingent valuation methods were the first to be applied in an environmental economics context, but other stated preference techniques, such as choice experiments, have also become increasingly common. Hence, there exist several different discrete choice methods, of which the choice experiment method is one. In a choice experiment application, the respondents are asked to state their most preferred among two or more alternatives, where each alternative is described in terms of their different characteristics at different levels, rather than stating their maximum willingness to pay for an environmental good.

In the present study, the choice experiment approach is used.[2] The theoretical basis of the choice experiment methodology is drawn from characteristics theory of value and the random utility theory. The major strength of the choice experiment approach, given the purpose of this thesis, is that it provides more information about the respondents' preferences than does the contingent valuation approach.[3] While a typical contingent valuation study generally examines the actual environmental scenario as a package, the choice experiment approach permits the analyst to examine the preferences over the different attributes (or characteristics) included in the scenario. Hence, for our purposes the choice experiment approach facilitates the analysis of the perceptions about the different attributes of wind power rather than the elicitation of preferences for the "service" wind power as a package. In addition, the marginal rates of substitution for each included attribute relative to a monetary attribute are useful outputs from choice experiments since they indicate the relative importance of each of the attributes included in the experiment.

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[1] One of the recommendations of the National Oceanic and Atmospheric Administration (NOAA) report by Arrow et al. (1993) was that discrete choice formats should be used over open ended formats to elicit values for non-market environmental goods.

[2] A potential alternative approach would have been the so-called contingent ranking approach. In a contingent ranking study the respondents are asked to rank the alternatives instead of just choosing the alternative that they prefer. The contingent ranking approach would have generated a richer data set. However, it would also have increased the cognitive burden on the respondents and would have imposed rather restrictive assumptions on the ranking behavior. It has also been discussed whether the responses from contingent ranking experiments are consistent with the axioms of consumer theory. See Bennett & Blamey (2001) or Louviere et al. (2000) for details.

[3] See chapter eleven in Bennet & Blamey (2001) for a more comprehensive discussion on the pros and cons of choice experiments.

One concern about stated preference environmental valuation techniques has been that respondents may include other elements than those intended by the analyst when stating their preferences. If the sole aim with a choice experiment is to estimate environmental values, the impact of other factors can be controlled for through the design of the experiment and isolated within a choice experiment by including these factors among the attributes.[4] Therefore, the embedding problem is likely to be reduced in a choice experiment compared to open ended contingent valuation applications (Bennet & Blamey, 2001; Boxall et al., 1996).

Since respondents are asked to choose from a scenario, which has been designed by the analyst, it may also be difficult for respondents to behave strategically. For instance, attribute levels change over the choices, and it may not be clear which of the alternatives that is the "good" one. Therefore, problems with yeah-saying, where the respondents face a moral dilemma when deciding whether to pay for an environmental improvement or not, are likely to be reduced in a choice experiment (Garrod & Willis, 1999; Adamowicz et al., 1995).

Furthermore, since the respondents in a choice experiment are asked to choose between at least two alternatives, the substitution possibilities are included in the design of the choice sets. Boxall et al. (1996) compare the results generated from a choice experiment approach and a referendum contingent valuation approach, both applied on recreational moose hunting in Alberta. They find that the average willingness to pay for an increased moose population was considerably higher when calculated from the contingent valuation data than the corresponding value based on the choice experiment data. One plausible explanation for this result, according to the authors, may be that respondents in the contingent valuation sample ignored substitution possibilities, such as the option to visit another site than any of the two in the scenario presented to them.

To sum up, there seem to be several potential advantages with discrete choice methods compared to open ended questions in environmental valuation applications. Given the purpose of the present study the discrete choice experiment method seems to be a suitable approach. The theoretical and methodological foundations for choice experiment applications are discussed in more detail in chapter 3.

[4] For example, in a study on the preferences towards wetland protection (Bennet et al., 2001), the estimated values for improved wetland condition were reduced by between 30 and 40 percent when the impacts on employment were included in the experiment.

1.3 Scope and Limitations of the Study

The results of the present study are based on a postal survey that was sent out to 1000 Swedish house owners. The reason for limiting the survey solely to people living in owner occupied houses is that they have the opportunity to actively and freely choose among different electricity suppliers. Consequently, they are familiar with the choice situation to which they are confronted within the questionnaire. Of course, this also implies that the results of the study reflect the attitude of the average Swedish homeowners rather than the attitude of the average Swedish electricity consumer or household.

There were two alternatives included in each choice set, alternative A and alternative B. The different attributes associated with wind power and its levels varied in alternative A, while alternative B represented the attributes and levels of wind power generated in Sweden today, i.e., alternative B was the status quo option. There was no opt-out option included in the experiment. Therefore, since the respondents were only allowed to choose between two different wind power options, they were "forced" to choose a wind electricity alternative. The motive for omitting the opt-out option is that if it had been included it would likely have been the preferred alternative for many of the respondents. This would have made the task of identifying the attitudes towards the attributes of wind power more difficult. In addition, given the political goal in Sweden to increase wind power capacity, the opt-out option is, in some sense, of minor interest. The policy-relevant question examined in this study is, thus, how the introduction of more wind power capacity can be facilitated by altering its characteristics and in this way increase the public acceptance of wind power. However, the exclusion of the opt-out alternative does make the interpretation of the welfare measures calculated from the results hypothetical.[5] Yet, since the aim in this thesis is to examine how the environmental effects associated with wind power generation are perceived as well as the relative importance of these effects, rather than how the Swedish consumers value wind power *per se*, this is not considered a major problem.

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[5] The exclusion of the opt-out option may also have bothered respondents with a negative attitude towards wind power since they did not have the option to refuse to buy wind power. In order to find out to what extent this was the case respondents were asked about their general attitude towards wind power (and some of its related effects) and the choices made in the choice experiment were followed up with a debriefing question. Results from these exercises are presented in chapters 5 and 6.

1.4 Outline

The thesis proceeds as follows. Chapter 2 briefly presents the development of Swedish wind power generation followed by a review of previous studies on the subject of "green" electricity and on attitudes towards wind electricity. The theoretical and methodological framework is described in detail in chapter 3. Chapter 4 discusses the development of the survey and survey design issues. In chapter 5 sample descriptives are provided and the sample is compared with the relevant population. Some results of the survey, primarily related to the general attitude towards wind power among Swedish homeowners, are also presented in chapter 5. In chapter 6, the results of the choice experiment are presented and analyzed. Finally, in chapter 7, the main findings of the study are summarized and some important policy implications are discussed.

Chapter 2

WIND POWER DEVELOPMENT AND THE IMPORTANCE OF PUBLIC ATTITUDES

2.1 Wind Power in Sweden: Current Status and Future Potential

In 2000 the electricity generated from renewable sources represented 58 percent of the total electricity production in Sweden. This relatively high share of renewable electricity in Sweden mostly comes from hydropower, which represents roughly 50 percent of total production. The installed wind power capacity has however increased significantly since the beginning of the 1990s. Figure 2.1 shows the yearly development of wind power generation in Sweden between 1982 and 2000. The annual average increase in wind power generation between 1994 and 2000 was 35 percent. Still, in 2000 only 0.4 TWh, or 0.3 percent of total electricity generation, came from wind (Swedish National Energy Administration, 2001a). The political intention is that wind power capacity should reach 10 TWh by 2015 (Prop 2001/02:143). If total electricity generation would remain at its 2000 level, this would amount to a 7 percent share stemming from wind (which would require about four times the existing number of wind turbines) (Swedish National Energy Administration, 2001b).

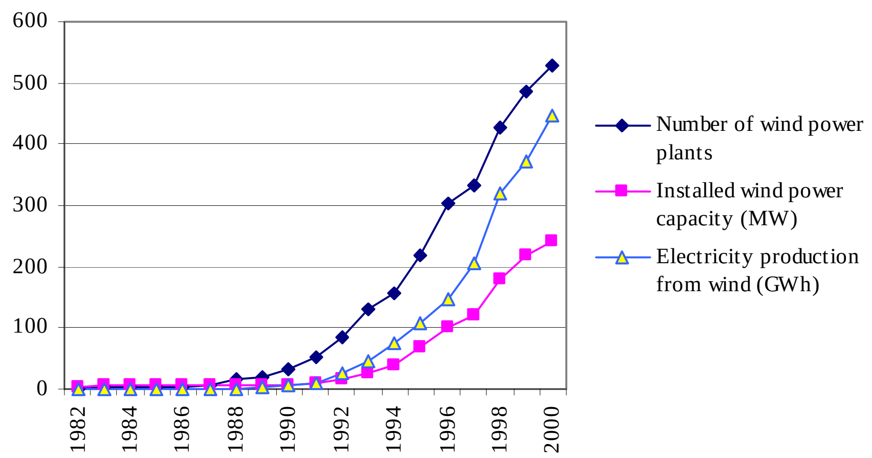

Figure 2.1: Wind Power Production in Sweden 1982-2000
Source: Swedish National Energy Administration (2001a).

A crucial criterion determining the location of wind power plants is the wind potential. Areas with an estimated energy potential of at least 1600 kWh per square meter and year has been mapped and classified by the Swedish Meteorological and Hydrological Institute. However, only areas with an energy potential of at least 4000 kWh per year and square meter are considered suitable for wind power development (Swedish National Energy Administration, 2001b; SOU 1999:75b). Furthermore, in order to utilize the wind energy efficiently, windmills should ideally be located freely, primarily in open areas. For this reason wind power installations can affect the view of the landscape. Other important aspects regarding the choice of location of windmills include: (a) the distance to nearby residents must be far enough so as to avoid high noise levels and problems with shadows from the rotor blades; (b) sensitive biotopes and bird areas should be avoided if negative consequences on flora and fauna can be expected; (c) virgin mountainous areas should be protected from wind power developments; and (d) wind power plants should not disturb the equipment of the means of the national defense (Swedish National Energy Administration, 2001b). Furthermore, in order to qualify for the "Bra Miljöval" labeling, wind electricity is not allowed to be located in natural parks or in areas of particular interest for wildlife (Swedish Society for Nature Conservation, 2002). Still, according to the criteria for labeling "green electricity", introduced in 1996 and revised in 2002, the generation of hydropower should (in order to qualify for the "Bra Miljöval" labeling) be complemented with power from at least one other renewable electricity source (such as wind power) (Ibid.). Hence, these sharpened criteria for the "Bra Miljöval" labeling for hydropower producers are likely to increase the demand for wind power.

A majority of the windmills in Sweden are located in the southern part of the country, near the coast. There is, however, favorable wind potential in the mountainous areas up north as well as offshore. The wind potential does, however, vary substantially among different locations in the mountains and these areas therefore need to be examined and mapped thoroughly (Swedish National Energy Administration, 2001b). According to the Swedish National Energy Administration future increases in capacity should mainly be achieved through the expansion of wind power capacity located onshore, alongside the Swedish coast. Nevertheless, in order to achieve the goal of 10 TWh, at least some large windmill parks must also be developed offshore (Ibid.). At Utgrunden, between the southeast coast and the island of Öland, seven wind turbines with a total capacity of 100 MW were taken into operation in 2001 ("Wind Power: The

Offshore Race", 2001). However, the environmental effects of large-scale offshore wind power facilities are not well known and further research into these is necessary (Swedish Environmental Protection Agency, 2000; SOU 1999:75a).

The majority of the electricity generated in Sweden is consumed in the southern part of the country. In addition, the distribution of electricity from the north to the south is limited by the capacity of the distribution net, which is presently fully utilized and occasionally even overloaded. A significant increase in the wind power capacity up in the north would thus require substantial investments in amplified transmission capacity. For this reason the Swedish National Energy Administration recommends that the major part of the expansion of wind power capacity should take place in the southern part of the country (Swedish National Energy Administration, 2001b).

The lifetime production cost for new Swedish wind power capacity ranges between 35 and 43 öre per kWh (about 0.4 US cents), depending on the size of the plant and on the wind energy potential (Swedish National Energy Administration, 2001b).[6] Investment costs constitute a high share of the total production cost, while operation and maintenance costs for a typical wind power plant have been estimated at only about 5 öre/kWh (Ohlsson, 1998). Technological progress has reduced wind power production costs significantly during the last decade (Klaassen et al., 2002; McDonald & Schrattenholzer, 2001). However, in spite of these cost reductions the generation of wind power is at present not commercially profitable without economic subsidies. A wind power plant in Sweden can currently receive subsidies corresponding to a total maximum amount of about 32 öre/kWh generated electricity (Swedish National Energy Administration, 2001b).[7] Hence, financial support seems to be a necessary condition for future expansion of wind power capacity, although it is probably not a sufficient condition. The attitudes towards wind electricity among the public are another important aspect. For instance, if consumers have preferences for "green" wind electricity and if they are willing to express these preferences in the market (i.e., if they are willing to pay

[6] These production cost estimates are based on a depreciation time of 20 years and a discount rate of 6 percent.

[7] However, during 2003 the present support scheme for renewable energy is planned to change. The present system with various subsidies available to the producers of renewable power will be superseded by a system with tradable renewable energy certificates which will be equal to all producers of "green" electricity (SOU 2001:77; Näringsdepartementet, 2000).

a premium for buying wind electricity), this would increase the demand for wind electricity and consequently be a complement to the more traditional political instruments (such as taxes and/or subsidies). However, public attitudes may also be expressed in order to affect the outcome of the decisions concerning wind power expansion and siting, either within the political system or via public participation in activities which either supports or opposes local wind power projects.

2.2 The Demand for "Green" Electricity

Although the output (in terms of kWh) provided from electricity generated from different sources is perfectly homogenous, electricity can be perceived by the consumers as a differentiated product due to its production conditions. If consumers have preferences for the environment, they may well perceive electricity generated with a relatively low impact on the environment as a different and a more preferable product compared to electricity production associated with higher degrees of environmental deterioration. That is, if consumers have preferences for the environment, the deregulated electricity market has made it possible for these consumers to reveal their "green" preferences by paying a premium for "green" electricity.

Many of the major electricity suppliers in Sweden offer their customers to choose electricity labeled "Bra Miljöval". Some of the larger suppliers also give their customers the option to buy electricity generated exclusively from wind. If a consumer chooses to buy wind electricity, the supplier guarantees that the amount of electricity the consumer use will be generated from wind power. Even though this would not imply that the electricity delivered to a specific consumer would be produced from wind it would imply an increase in the demand for wind power and thus in wind power capacity.

A number of willingness to pay surveys have demonstrated a significant market for "green" electricity. It has also been recognized, however, that the stated willingness to pay differs from the level of actual contribution and participation in "green" electricity schemes (Wiser, 1998). When Byrnes et al. (1995) compared the results of several different previous willingness to pay surveys with market simulations or real tariff schemes, they found that less than 10 percent of those who stated that they were willing to pay a premium for renewable electricity could be expected to do so when given the opportunity.

The consumption of "green" electricity (labeled "Bra Miljöval) in Sweden has increased significantly during the last years. In 1999 only 4.6 percent of the total electricity consumption was “green”. In 2001 this share had doubled to 9 percent of total electricity consumption. However, this increase in demand for “green” electricity can to a large extent be explained by government authorities and public companies (such as the Swedish railroad company SJ) choosing to buy electricity labeled “Bra Miljöval” (Wickström, 2002).

In a review including about 700 US surveys on the public opinion regarding renewable electricity, results suggest that the majority of US households prefer renewable energy and energy efficiency over alternative electricity characteristics (Farhar, 1996). In a study on the UK “green” power market, Batley et al. (2001) found that renewable electricity is a concept supported by the majority and that willingness to pay for renewable electricity is positively related to income and to social group. They also found that 34 percent of the respondents stated that they were willing to pay a premium for electricity generated from renewable sources. However, even if actual willingness to pay equaled stated willingness to pay, Batley et al. (2001) claim that it is unlikely that any new renewable electricity capacity in the UK will be generated from a green tariff approach only.

Roe et al. (2001) analyze the preferences towards green electricity in the US, and their results indicate that US consumers are willing to pay a small premium for reduced air emissions within the present fuel mix. However, the willingness to pay was found to be significantly higher for reduced emissions through a shift towards increased reliance on renewable electricity sources compared to reductions within the present fuel mix (Ibid.).

Hence, there seems to be strong support for a general willingness to support renewable energy sources such as wind power in the literature. However, we do not know whether we can expect that this willingness to support renewable electricity is likely to be expressed in the electricity market or not. Neither do we know much about whether the public considers some characteristics of renewable energy as more “green” than others.

2.3 Public Attitudes towards Wind Power: Some Evidence from the Literature

There exists an extensive qualitative literature on the attitudes towards wind power and on how the related characteristics of wind power are perceived by the public. In general, public acceptance towards wind energy has been found to be high (e.g., Krohn & Damborg, 1999). However, this general acceptance does not seem to be valid when it comes to actual local projects. The occurrence of local resistance towards wind power developments is often explained by the NIMBY-phenomena (Not In My BackYard). However, Wolsink (2000) claims that this NIMBY-explanation is too simplistic. According to Wolsink the expression of NIMBY-behavior is at most only a secondary issue for people opposing local wind power projects; instead institutional factors are highly important. Local resistance may express suspicion towards the people or the company who want to build the wind turbines or a rejection of the process underlying the decision to build new wind plants rather than a rejection of the wind turbines themselves.

Hammarström (1997) summarizes five different qualitative surveys, based on both personal interviews and postal questionnaires, on the attitudes towards wind power among people living close to existing wind turbines. She found that those with a generally positive attitude towards wind power were less likely to state that they were negatively affected by the visual effects and the noise pollution arising from windmills than respondents with a negative attitude. She concludes that the initial attitude is an important determinant of the degree of acceptance of windmill projects among the local population. She also claims that the participation in the project process itself is an important factor that affects the attitudes towards wind power. Hammarström found that when the local population is involved in the process already at an early stage they are, in general, more likely to accept the wind power project. The positive effects related to wind power most frequently stated by the respondents were that electricity from wind turbines is a clean, environmentally benign energy source, which does not give rise to emissions of any hazardous substances. The most commonly stated negative effects were that wind power is an insecure energy source, that it is costly, and that each windmill has a low capacity compared to other power plants.

Within the wind power program in the city of Fort Collins in the USA, by paying a premium of 2 US cents per kWh the electricity consumers were ensured that the same amount of electricity as they consumed was produced by wind turbines. About 700 customers, or 2 percent, of the total population in Fort Collins subscribed to the program. The main purpose of the study on the so-called Fort Collins Wind Power Pilot Program (Collins et al., 1998), was to identify who subscribed to the program and why. The results indicate that citizens with high incomes and with high levels of education were more inclined to subscribe to the program. Those who subscribed motivated their choice by their commitment to improve the environment. Many of the subscribers were of the opinion that the environment should take precedence over cost considerations and that all customers should contribute to the cost of generating energy from "green" sources. Furthermore, in the study 83 percent of those who subscribed to the program were categorized as "egalitarian green" while the corresponding share for all electricity consumers was 35 percent.[8]

In a study on public attitudes towards wind farms in Scotland, Dudleston (2000) found that the attitudes of local residents towards nearby wind facilities were generally positive. Although all respondents lived within 2 kilometers from a wind farm, only 13 percent could see it from their home. About 27 percent of the respondents had expected the landscape to be spoilt by the wind farm but only 5 percent maintained this view after the wind farm was developed. Noise pollution did not seem to be a factor of major importance; only 2 percent stated that they disliked the wind farm because it was noisy. Generally, the proportion of respondents who anticipated problems was significantly higher (40 percent) than the proportion that actually experienced problems (9 percent) (Ibid.).

However, the noise perception is likely to be influenced by the actual noise level. The results of a Swedish study by Pedersen & Persson Wayne (2002) on attitudes towards wind power among people living near existing wind power installations indicate that the share of respondents who experienced that they were disturbed by the noise generated from the windmills increased with the level of noise. Noise from the rotor blades was the most commonly stated source of disturbance (16 percent stated that they were disturbed by this). The perception of visual effects (negatively affected view caused by wind turbines) was stated as being disturbing by 14 percent of the respondents (Ibid.).

In a contingent valuation study on the environmental impacts of windmill development at Smola, Norway, Nordahl (2000) estimates both the willingness to pay to avoid a windmill park and the willingness to accept compensation if the park was built. The mean willingness to pay was estimated to be in the range of 271 and 742 Norwegian kroner per year and the willingness to accept was estimated at 887 Norwegian kroner per year. The respondents were further asked to specify what they

[8] In the study respondents that strongly supported environmental protection measures, were less cost-conscious, and also expressed the view that everybody should pay for increased reliance on renewables rather than only those who want renewable energy, were labeled "egalitarian green".

considered to be the most important positive and negative effects associated with the wind power project at Smola. According to the respondents the most important positive effects from the specific wind power project were that: (a) wind power is a clean and renewable energy source (stated by 49 percent); (b) it would generate employment (40 percent); and (c) it would generate income to the community (44 percent). The dominating negative effect was, according to 70 percent of the respondents, that the project would affect the view of the landscape in an undesirable way. The positive effects were expected to exceed the negative effects among 53 percent of the respondents, while 19 percent expected the negative effects to be bigger (Ibid.).

Alvarez-Farizo & Hanley (2002) apply and compare the choice experiment and the contingent ranking approach in a Spanish study on household preferences over the environmental impacts of wind power installations. They find that there are significant social costs involved in wind farm developments. In the experiment, respondents were told that there was a project planned on La Plana (an important natural heritage), which would involve the following effects: (a) loss of a natural area; (b) increasing development threats through provision of access roads; (c) visual impacts; and (d) loss of a migratory bird corridor. Respondents were asked to choose between (or rank) three alternatives, the attributes included were: whether to protect the cliffs or not, whether or not to undertake measures in order to prevent the loss of habitat on flora, and whether to protect the landscape or not. The results show that the protection of flora and fauna were valued more highly by Spanish households than the aesthetic impact on the landscape (Ibid.).

2.3 Summarizing Comments

Improved knowledge on the public's attitudes towards the environmental impacts of wind power is important for the future diffusion of wind power. With this information the future development (including location choices as well as innovation activities) of windmills could be carried out in a way that minimizes the social costs of wind power development, and the producers of renewable electricity could market and develop their product, "green" wind electricity, more efficiently.

The main lesson to be drawn from previous research efforts on public attitudes towards wind power is that the visual impacts from wind power installations seem to be of major importance. Furthermore, although problems with noise pollution are often mentioned in the media when wind power is discussed and debated, previous research on the relative importance of the noise pollution seems to be inconclusive. In addition, overall there seems to be strong support for renewable electricity and for wind power among the public. However, it is unclear to what extent this generally positive attitude in practice will imply an increased demand for "green" electricity. It is also unclear to what extent wind power in general, and its characteristics (such as the environmental effects arising from wind power generation) in particular, are considered favorable from an environmental point of view.

The present study differs from most of the previous research on attitudes towards wind power due to its quantitative approach. The study aims at analyzing the households' general attitude towards wind power by using quantitative statistical methods, and at examining their attitudes towards the most important environmental effects (attributes) arising form wind power generation by using the choice experiment approach. The output from the choice experiment will provide information not only about whether the environmental effects included in the choice set are perceived as improvements or deteriorations but also about the relative importance of each environmental effect.

However, before the survey construction and the results of the analysis are presented, the theoretical foundations of the choice experiment model and the methodological framework for the analysis need to be developed. This is done in chapter 3.

Chapter 3

THEORETICAL AND METHODOLOGICAL FRAMEWORK

Traditional microeconomic theory constitutes the basic theoretical foundation of the choice experiment approach. Hence, consumers are assumed to seek to maximize utility subject to a budget constraint. Specifically, the choice experiment approach combines the characteristics theory of value (Lancaster, 1966) and the random utility theory (McFadden, 1974). Choice experiment applications have been commonly used in marketing, psychology, and transport research, and have recently become increasingly popular in environmental valuation applications (see, for instance, Adamowicz et al., 1995; Boxall et al., 1996; Hanley et al., 1998). The theoretical framework and the empirical model specification presented in this chapter draw heavily on this literature.

3.1 The Characteristics Theory of Value

The basic assumption in choice experiment applications is that consumers derive utility from the different characteristics that a good possesses, rather than from the good *per se*. The characteristics associated with the commodities are thus assumed to provide services to the individual (Lancaster, 1966).

According to the characteristics theory of value, the probability of choosing a specific alternative (i.e., a good) is a function of the utility linked to that same alternative. Moreover, the utility derived from each alternative is assumed to be determined by the preferences over the levels of the characteristics (or services) provided by that alternative. In the original model presented by Lancaster (1966), the goods consumed are transformed into objective characteristics, through the utility function, which is assumed to be objective and equal among all consumers. Hence, according to the characteristics theory of value, utility is a function of the services provided by the commodities.

In general, the characteristics of a good or service can be divided into objective characteristics and quantitative characteristics. Following Loueviere et al. (2000), the objective characteristics attached to a commodity are called “features” and the quantitative dimensions of the characteristics are called “attributes”. An attribute could map exactly into a feature, but it may well be a function of more than one feature and vice versa. For instance, the services provided by electricity can by a consumer be considered to possess the features "green" or "environmentally friendly". One attribute that could be related to this feature could be "renewable". An important element of choice models is the conversion of features into attributes. The difference between features and attributes can be explained either through the process of perception (for example, one feature of a specific transport mode is the perceived transport time which may differ from actual transport time) or through differences in dimensions (different properties of electricity could, for example, be considered as "green"). The term characteristic is assumed to cover both features and attributes (Ibid.).

The assumption that individuals derive utility from the characteristics of a good rather than from the good itself, implies that a change in one of the characteristics (such as the price) may result in a discrete switch from one good to another rather than in a continuous change in the quantity demanded. A discrete switch from one good to another will however affect the probability of choosing that specific commodity on the margin. Hanemann (1984) states that many of the choices made by individuals can be divided into two parts: (a) which good to choose; and (b) how much to consume of the chosen good. The first part of the choice process represents the discrete aspect while the second part represents the continuous aspect of consumer choice. When choice experiments are applied in the valuation of non-market goods, the design of the experiment is in general carried out such that the discrete dimension of the choice situation is isolated. For instance, given their annual electricity consumption, respondents participating in a choice experiment could be asked which of a number of different electricity suppliers (providing electricity services with different characteristics) they would prefer.

The characteristics theory of value outlined here is consistent with the general microeconomic theory of consumer choice, although the analysis of the relation between consumption and the sources of utility begins one step earlier in the decision process of the individual. The individual chooses to consume a specific good in the amounts that provide the quantities of the characteristics that provide the amount of desired services that in turn maximize his/her utility. However, in order to make the paradigm of choice outlined here empirically operational, it needs to be linked to the random utility theory.

3.2 Random Utility Theory

In a choice experiment, where the respondent is asked to choose the most preferred among a set of alternatives, random utility theory can be used to model the choices as a function of attributes and attribute levels. According to the random utility theory, the individual is assumed to make choices based on the attributes of the alternatives with some degree of randomness. The random utility theory thus provides a link between the deterministic model outlined above and a statistical model (McFadden, 1974).

Following McFadden (1974), let X denote the set of alternatives in a choice set, and S the set of vectors of measured attributes. A random individual will face some attribute vector $\mathbf{s} \in$ S. The set of alternatives available to the decision maker is assumed to be finite and denoted by A $\in$ X.

Let P($z|\mathbf{s}$, A) represent the conditional probability that a random individual will choose alternative z, given the attributes **s** and the available alternatives, A. If there are only two possible outcomes, the observed choice can be viewed as drawing from a binomial distribution (or a multinomial one if there are more than two possible outcomes) with the selection probabilities given by P($z|\mathbf{s}$, A) $\forall\ z \in$ A. Here z denotes consumption services, and it is defined in terms of attributes.

A model of individual behavior is a set of individual behavioral rules, H. An individual behavior rule is a function h, where h $\in$ H, which maps each vector of attributes, **s**, and possible alternative set, A, into a chosen alternative of A. The selection probability that a random individual will choose z, given the observed attributes, **s** and alternative set A, is given by:

$$P(z|\mathbf{s}, A) = P\{h \in H | h(\mathbf{s}, A) = z\} \qquad [3.1]$$

where the right hand expression states that the probability of choosing a particular behavior rule, given that the actual rule, defined on s and A, is to choose *z*. Hence, it defines the probability of the occurrence of a behavior rule that generates the choice *z*.

Let us now relate the selection probabilities to the utility maximization assumption. The utility function through which the individual is assumed to derive utility can be expressed as (Louviere et al., 2000):

$$U_{iq} = V_{iq} + \varepsilon_{iq}. \qquad [3.2]$$

U_{iq} represents the utility to individual q, derived from alternative i. Assume further that the utility can be separated into two components: a systematic component, V_{iq}, and a random component, ε_{iq}. The systematic component represents that part of utility that is provided by the attributes observed by the analyst; it is thus assumed to be equal across individuals. The random component is the utility provided by attributes unobserved by the analyst, which is assumed to be individual specific and to reflect the individual idiosyncrasies of taste. Thus, the random component does not imply that individuals maximize utility in a random manner (Ibid.). Furthermore, V_{iq} can be written as:

$$V_{iq} = \boldsymbol{\beta}\mathbf{X} \qquad [3.3]$$

where **X** is a vector of levels of observable attributes, socio-economic characteristics, attitudes towards the environment and policies interacting with these attributes while **β** is a vector of utility parameters to be estimated.

Utility maximization postulates that individual q will choose alternative i over alternative j if and only if:

$$U_{iq} > U_{jq,} \ \forall \ i \neq j \in A. \qquad [3.4]$$

Equations [3.2] and [3.4] combined imply that alternative i is chosen if and only if:

$$(V_{iq} + \varepsilon_{iq}) > (V_{jq} + \varepsilon_{jq}) \qquad [3.5]$$

which is equivalent to:

$$(V_{iq} - V_{jq}) > (\varepsilon_{jq} - \varepsilon_{iq}). \qquad [3.6]$$

Since the random component is not observable, the analyst has to calculate the probability that (V_{iq} – V_{jq}) will be larger than (ε_{jq} - ε_{iq}). So far in this representation, the theoretical relationships between the selection of alternatives and the sources of utility have been specified. The random utility model will now be related to a more operational econometric specification.

3.3 Econometric Model Specification

Assume that we have a binary choice situation where the individual *q* has the option to choose between alternative *i* and alternative *j*. Let us define the binary variable y_{iq}, which is equal to 1 if the individual chooses alternative *i*. The choice probability as outlined in equation [3.1] can then be expressed as:

$$P(y_{iq} = 1) = P(\varepsilon_{iq} > -V_{iq}(\boldsymbol{\beta}\mathbf{X}_{iq})). \qquad [3.7]$$

However, in order to calculate these choice probabilities some assumptions about the distribution of the random component have to be made. In the commonly used Multinomial Logit Model the random components are assumed to be independently and identically distributed. However, since the respondents in our case make repeated choices (see chapter 4), the assumption of statistical independence between observations may be violated; the random component may well be correlated within the individual choices. Following Butler and Moffit (1982) and Hammar and Carlsson (2001), the error term is therefore specified as:

$$\varepsilon_{iq} = u_{iq} + v_{iq};\ u_q \sim N(0, \sigma_u^2); v \sim N(0, \sigma_v^2) \qquad [3.8]$$

where u_{iq} is the unobservable individual-specific random effect, v_{iq} is the remainder disturbance and σ^2 represents the variance in *u* and *v*, respectively. The components of the error term are consequently independently distributed across individuals as follows:

$$Corr(\varepsilon_{iq}, \varepsilon_{jq}) = \rho = \frac{\sigma_u^2}{\sigma_u^2 + \sigma_v^2}. \qquad [3.9]$$

This specification of the error term gives us the standard random effects binary Probit model, which assumes equal correlation across choices for each individual. The implications for the choice experiment are that it assumes no learning or fatigue effects over choice sets and that the preferences are stable. These assumptions should, however, hold reasonably well in this experiment since respondents are confronted with relatively few attributes and choice sets in the experiment. In this study a test of one aspect of preference stability is provided and the results of this exercise are presented in section 6.3.

The estimation of the random effects binary Probit model will generate parameter estimates as specified in equation [3.3] above according to the following underlying indirect utility function:

$$V_{iq} = \beta_1 X_1 + \beta_2 X_2 + ... + \beta_k X_k \qquad [3.10]$$

Hence, estimation of the random effects binary Probit model yields utility parameter estimates for each attribute included in the experiment. From the parameter estimates the rate at which the respondents are willing to trade off between the attributes can easily be calculated. For a linear utility function, the marginal rate of substitution between two attributes is simply the ratio of their coefficients (e.g., Alpizar et al., 2001; Louviere et al., 2000). If a monetary attribute is included in the experiment the willingness to trade-off between the attributes can be interpreted as the implicit price for attribute k, IP_k, which equals:

$$IP_k = -\left(\frac{\beta_k}{\beta_p}\right) \qquad [3.11]$$

where β_k is the coefficient of attribute k and β_p is the coefficient of the monetary attribute. If the implicit price turns out to be positive it can be interpreted as the marginal willingness to pay for a change in the attribute, within the experiment. However, this is theoretically correct only if a status quo option is included in the experiment (Bennet & Blamey, 2001; Alpizar et al., 2001).

Hence, in this particular study the choice experiment approach allows us to estimate the preferences over the environmental effects of the different characteristics of wind energy generation rather than the value of wind electricity as such. For instance, the output of the analysis will facilitate a comparison of the public's perception of the relative importance of the noise pollution from windmills and the visual impacts. However, in order to be able to estimate these utility parameters and implicit prices, the relevant attributes and their levels have to be selected and defined. These issues are discussed in detail in chapter 4.

3.4 Public versus Private Preferences

According to traditional microeconomic theory, individuals are assumed to have exogenously determined and well-articulated preferences which they seek to satisfy by maximizing their utility. Within this theoretical framework the environment is treated as any other commodity and consumers are assumed to accept to trade environmental quality for other goods. Furthermore, if social choice is to be based on the theory of welfare economics, policy makers should always choose the option that generates the maximum amount of total utility. Consequently, the underlying ethical stance is that the *outcome* of an activity (in terms of gains and losses in utility) determines whether the activity should be undertaken or not. An important task for environmental economists is, thus, to provide decision makers with accurate estimates of the value of environmental goods through the aggregation of individual preferences.

However, the extensive use of stated preference valuation techniques in environmental economics, including choice experiment applications, has been questioned since these methods may rely on too restrictive assumptions about how individuals form their decisions. It has been argued (e.g., Sagoff, 1988) that decisions involving pronounced moral aspects, such as decisions about whether to undertake measures to reduce negative environmental effects arising from power generation, are likely to be made – and *should* be made – based on another preference ordering than private utility.[9]

According to Sagoff (1988) people have at least two different preference orderings, *private* preferences, which reflect how goods affect their personal utility, and *public* preferences that reflect moral values about what people, in their role as citizens, think is right for society as a whole. For instance, it is reasonable to expect that the decision whether to buy a lipstick of one brand or the other is based solely on the *private* preferences of the individual, while the decision whether the emissions of hazardous substances arising from power generation should be limited or not may well be considered an ethical issue that for instance, should be discussed in terms of right and wrong rather than in terms of gains and losses in personal utility. Thus, when people adopt public rather than private preferences their environmental position may well be rights-based rather than utilitarian (Spash & Hanley, 1995). Within a rights-based

[9] The recognition that individuals may adopt different preference maps in different contexts is not new, it has received the attention of prominent economists such as Arrow (1963) and Sen (1977).

context, people base their decisions on whether the action in itself is *right* or *wrong* rather than on the outcome of the action. For instance, an individual may believe that everyone has the *right* to be protected from emissions of hazardous substances.[10] If so, the individual would reject the idea of making tradeoffs between, for example, the level of environmental quality and income. In addition, the presence of public preferences may imply that people believe that some decisions with a pronounced ethical context should be based on public deliberations, in which preferences are assumed to be endogenous, rather than on the aggregation of exogenous private preferences.

Empirical support for the existence of public preferences towards environmental goods has been found by, for instance Spash & Hanley (1995), Russel et al. (2001), and Blamey et al. (1995). Previous research also suggests that the presence of a public preference ordering is more frequent among those with a profound interest in environmental issues (Spash, 1997). In a study on eco-democracy, Lundmark (1998) finds that Green Party sympathizers in Sweden were more likely to support a proposal involving constitutional protection of all beings (human beings, animals and plants) while people on the political right wing showed the weakest support for this proposal.[11] People on the political left were also found to be more supportive towards the idea of constitutional protection of the environment than people on the political right (Ibid.). The support for this proposal is consistent with the presence of public preferences and a moral-based belief system since it articulates the *rights* of beings. Hence, we should expect that people with a strong interest in environmental protection and people on the political left to be, on average, more likely to express public preferences towards environmental goods than people on the right.

With respect to wind power and the environmental effects associated with wind power, however, the presence of public preferences among the respondents could lead to problems in interpreting the results from the survey. For instance, if any of the environmental impacts from the generation of wind power is considered to have a pronounced ethical dimension it could imply that respondents would reject trade-offs

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[10] For a more extensive discussion on this issue and the implications of the consumer versus citizen distinction, see e.g., Jacobs (1997), Spash (1997), and Blamey et al., (1995).

[11] Lundmark (1998) specifically asked whether the respondents supported the protection of environmental rights for human beings (to clean air, water, and healthy food-stuffs) and the rights for animals and plants (to life and development) through the constitution.

between the level of the environmental characteristic and the consumption of other goods. This is in conflict with the underlying theoretical foundations of the choice experiments model. However, if wind power is considered to be an electricity source with a relatively small impact on the environment, respondents with public preferences and a rights-based ethical belief system may well support the expansion of wind power capacity because they are in support of wind power *per se*. If so, since respondents equipped with public preferences are likely to have lower confidence in market-based solutions, they would probably be more inclined to accept political measures targeted towards increasing wind power capacity than people with private preferences would. In sum, for our purposes it is important to distinguish between private and public preferences since: (a) our interpretation of the responses in the choice experiment as marginal rates of substitution may be invalid; and (b) the underlying preference orderings of the respondents are likely to affect the respondents' view on how wind power choices should be made (i.e., through the green electricity market or through political decisions).

The survey was constructed so as to permit an analysis of the attitudes and the motives of respondents. In order to facilitate a test of the presence of respondents with public preference maps in the sample, the respondents were asked to what extent they agreed with eight different statements out of which four expressed typically moral-based values while the other four were intended to be consistent with utility-maximizing behavior. They were also asked about their motives when stating their most preferred alternatives in the choice sets in a debriefing question, which followed directly after the choice experiment. The results from these questions are outlined and discussed in sections 5.4 and 6.3.

Chapter 4
SURVEY CONSTRUCTION AND DESIGN ISSUES

4.1 The Choice Experiment Scenario

In this study, respondents were asked to choose between the two different wind power alternatives, A and B, each associated with different environmental attributes and prices. Hence, respondents were asked to choose between two alternatives of perfectly homogenous electricity (in terms of output per kWh) although differentiated with respect to environmental quality and cost.

The choice scenario was formulated in a way that it would mimic the decision that the respondent normally faces when choosing electricity supplier. In each choice set, respondents were asked the following question: *Given that you could only choose among the two alternatives below the last time you chose electricity supplier, which alternative, A or B, would you have chosen?* The aim was to construct a realistic choice task in order to trigger respondents to act as consumers in the electricity market when stating their most preferred wind power alternative. One could expect that this scenario would primarily induce the respondents to express their private preferences. Still, some respondents may also think that the "green" electricity market provides an efficient way of expressing altruistic or moral values towards the environment.

In order to examine to what extent respondents actually were triggered to express their private preferences or not, they were also asked some attitudinal questions (about, for example, how they think that choices related to the Swedish electricity portfolio should be made). Their choices in the experiment were also followed up with a debriefing question (in which they were asked why they chose as they did).

4.2 Defining Attributes and Levels

Clearly, choosing the attributes to be included in the choice set is a task of crucial importance. First, the attributes included in the experiment should, in one way or another, be relevant for the policy making process as well as for the wind power producers. This implies, in general, that attributes included in the experiment should ideally be associated with actual potential measures or choices. For instance, the location of windmills is likely to be a highly relevant attribute. If wind power producers are interested in differentiating and developing their product in accordance with what electricity consumers actually prefer they should locate new wind power schemes where the perceived negative environmental impacts are relatively small. Similarly, if the noise pollution from the windmills is judged to constitute a significant negative attribute, the energy companies will have an incentive to lower this impact. Clearly, these choices could also be influenced by the policy making process through regulation and/or different economic instruments. Second, the respondents must also perceive the attributes as relevant. This implies that the environmental impacts that are considered important by the public should also be included as attributes in the choice experiment. Furthermore, the attributes should vary across levels that are considered realistic by respondents. If the included attributes or the levels of the attributes are not perceived as relevant by respondents or if an attribute considered as being important is excluded, this might influence the responses negatively and the number of valid responses would decline (Bennet & Blamey, 2001; Garrod & Willis, 1999).

As was mentioned in chapter 2, there exists an extensive literature, mainly qualitative, on the public attitudes towards wind power. When the attributes and the levels of attributes included in the present study were chosen, these previous research efforts constituted an important input (e.g., Hammarström, 1997; SOU, 1999:75a; Nordahl, 2000; Pedersen & Persson Wayne, 2002). According to the previous research on the attitudes towards wind power and the environmental impacts of wind power, the amenity effect seems to be of major importance. The attributes included in the experiment that aimed at capturing the attitudes towards the visual impacts from wind power installations were the location, the height, and the grouping of windmills.

Although the relative importance of the noise pollution impacts from wind power is inconclusive according to previous studies, a noise attribute was also included in the experiment. The noise attribute was included because problems with noise are often claimed to be important sources of disturbances in the discussions and the debate in the media. Noise pollution was also mentioned as an important aspect in the focus group deliberations (see also section 4.2). Two levels of the noise attribute were included. The status quo level was the highest level allowed outdoors in residential areas in Sweden (40 decibel), and the other included level represented a reduced noise level (30 decibel) (SOU 1999:75a). To facilitate comparisons between noise levels, different sounds at similar levels as the ones included in the choice experiment were described and used as reference objects. These reference sound sources were the following: the ticking from a clock (20 decibel), rustling leaves (30 decibel), a new refrigerator (40 decibel), and a normal conversation (65 decibel) (Electrolux, 2002; Clayman, 2000). However, the perception of noise may differ with regard to the source of the noise. For example, to have to put up with soughing leaves at the same sound level as a distant windmill is probably perceived as a much more pleasant and tolerable experience than the mechanical sound from the rotor blades of a windmill.

In 2002 the majority of the existing wind power capacity in Sweden consisted of separately located windmills, onshore near the coastline and on the islands Gotland and Öland. However, the wind potential is also good offshore and in the mountainous areas and these areas might be of interest for future wind power installations. In order to identify how the public views the different location options, “onshore”, “offshore”, and “in the mountains”, were included in the experiment representing different levels of the location attribute. The levels of the location attribute were illustrated with color photographs visualizing windmills located offshore, onshore and in the mountains, respectively. The pictures were chosen so that the windmills appeared to be of the same size and so that the weather conditions appeared similar.

Windmills are relatively high objects, generally located in open areas, and are often visible over far distances. For instance, in a Danish study 60 meter high windmills located on a very flat and open area were found to be clearly visible at a distance of at least seven kilometers (Miljö- og Energiministeriet, 1996). The most common height of windmills in Sweden is at present about 60 meters, although significantly higher mills are becoming increasingly common. The following two levels of the height attribute were included in the experiment: the most common height at present (60 meters) and a level that represents higher windmills (100 meters). To make comparisons of height easier, a few high well-known buildings and their heights were referred to as reference objects. These reference objects were: a flagpole (10 meters), a ten-storey building (30 meters), and the tower of Stockholm City Hall (112 meters).

Although separately located windmills have been the most frequent, large wind parks including up to fifty windmills or more have been developed. The world’s largest offshore wind park is sited in Denmark and consists of 80 wind turbines. To facilitate the analysis of whether the average Swedish electricity consumer considers wind parks as being something positive or negative, compared to individually located windmills, one attribute for the grouping of windmills was incorporated in the choice experiment.

Three levels of the grouping attribute were included: separately located windmills, small groups (less than ten windmills) and large groups (between ten and fifty windmills). The levels of the grouping attribute were described verbally in the questionnaire.

The electricity price facing the households represents the cost attribute in the choice experiment. Only for the noise attribute we would expect that a change from the status quo level represents an unambiguous improvement since it is reasonable to expect that a lower noise level is preferred to a higher one. For this reason the respondents were confronted with both increased and lowered prices of the cost attribute. Six price levels were included, three that represented a higher electricity price, two a lower price and one level representing the status quo option with a zero price change. An approximate average electricity price (including taxes) was presented to make comparisons easier. In addition, two examples, where the effects on household expenses from changes in electricity prices (per month and per annum) were described, were included in the questionnaire to facilitate comparisons between different prices. The first example described the change in expenditures for a low-consuming household (without electricity heating) and the second example outlined the corresponding change for a high-consuming household (with electricity heating). The included attributes, their levels, and coding are summarized in Table 4.1. The levels of the qualitative attributes (i.e., all included attributes except the price attribute) were effect-coded.

Table 4.1 Attributes, Corresponding Variables, Levels, and Coding

Attribute	***Variable***	***Levels and Coding***
Noise	Noise	1 if 30 dB, –1 if 40 dB
Location	Mountain	1 if mountain, 0 if offshore, -1 if onshore
	Off-shore	1 if offshore, 0 if mountain, -1 if onshore
Height	Height	1 if higher than 60 meters, -1 otherwise
Group	Small	1 if small group, 0 if large group, -1 if separate
	Large	1 if large group, 0 if small group, -1 if separate
Price	Price	6 levels ranging between –10 öre/kWh and +15 öre/kWh

Since all the qualitative variables were effect-coded, as with dummy variables, the main effect of a qualitative variable can be defined by L–1 effects-coded variables that represent L–1 of its levels. That is, if an attribute has L levels, L–1 will be included as variables in the model (Louviere et al., 2000).

4.3 The Development and the Design of the Questionnaire

The questionnaire was developed by using the experiences from: (a) an early test on a group of graduate students; (b) a pretest involving about 30 respondents; and (c) a focus group deliberation in the concluding stage of the development.[12] The early check on the group of students aimed primarily at testing the relevance of the attributes chosen. In the pretest of the questionnaire and in the focus group, the formulation of the questions, the descriptions of the attributes in the choice sets, and the levels of the price attributes were tested.

The general impression after these different exercises was that the task of choosing the most preferred alternative in the choice sets seemed to be manageable. There were no indications that some attributes were missing or were in any other way inadequate. For instance, no participant argued that impacts on wildlife (such as birds colliding with wind turbines) or employment effects were important aspects which should have been included in the experiment. A spontaneous comment from some of the participants in the focus groups and in the early check on students was, however, that it was a quite demanding questionnaire to answer. When the pictures illustrating the three levels of the location attribute were discussed, some of the participants stated that they considered the pictures to be beautiful, although nothing indicated that any of the location attributes were considered as being more or less beautiful than the other. Furthermore, clarifications in the descriptions of the included attributes were made as a result of the early student test.

During the focus group deliberation, some of the participants argued that wind power is already a power source with a relatively small impact on the environment and that none of the negative effects on the environment are irreversible.[13] Consequently, these participants argued that their overall willingness to pay for improvements were

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[12] Seven individuals participated in the focus group. The age, occupation, gender, and social status of the participants varied.

[13] For instance, noise impacts from wind turbines are essentially local, and if the operation of the turbines is stopped these noise impacts will entirely disappear. This is in sharp contrast to the long lasting waste from the nuclear fuel chain, with which society has to deal over thousands years after the shut-down of the plant.

somewhat limited and that the price changes would have to be relatively modest for them to consider choosing anything else than the status quo option. The price changes were also kept relatively small (the highest price change represents about 25 percent of the average electricity price including taxes) and in the pretest the choices were distributed fairly even between the two alternatives in the choice sets. Finally, some minor changes in the formulations of some of the attitudinal questions were brought about as a result of the pretests, primarily due to the focus group discussion.

The first part of the questionnaire contained questions about the respondents' attitude towards the environment, towards electricity production in general, and towards wind power generation in particular. In the second part, the attributes and their levels were described. Respondents were then asked to state their choices in six different choice sets, and the choices were followed up with a question about why the respondents had answered the way they did. The debriefing question was included to make it possible to analyze whether respondents expressed primarily their private preferences and made their choices based on the how the alternatives would affect their own private utility or if they adopted their public preferences and made their choices based more on what they considered was best for society as a whole. The third and last part of the questionnaire collected socio-economic information. The entire questionnaire can be found in the appendix, the English version in appendix A and the Swedish version in appendix B.

The alternatives in a choice experiment can be presented to respondents in a generic (unlabeled) form or in an alternative specific form (labeled). An advantage with labeled alternatives is that the respondent may associate the label with the context; if so the cognitive burden of the respondent is reduced. However, the respondent may focus on the label rather on the attributes associated with the alternative. Thus, the labels may prompt respondents to select their most preferred alternative based on the label, rather than on the characteristics of the alternative. For instance, if one of the alternatives is labeled as the "green" wind power alternative, environmentally oriented respondents may be prompted to choose that "green" alternative as a result of its label rather than after considering the levels of the attributes included in the alternative. Hence, generic rather than labeled alternatives should therefore be used when the major focus in the analysis is on the marginal rates of substitution between the attributes (Bennet & Blamey, 2001; Alpizar et al., 2001). In the present study, the main interest is directed towards these marginal rates of substitution between the attributes included and the alternatives were consequently presented to respondents as generic, i.e., the respondents were not told that alternative A represented "changed attributes of wind power" and alternative B the "characteristics of existing capacity". One example of a choice set to which respondents were confronted in the questionnaire is given in Table 4.2.

Table 4.2 Choice Set Example

Given that you could only choose among the two alternatives below the last time you chose electricity supplier, which alternative, A or B, would you have chosen?

	Alternative A	***Alternative B***
Noise	40-decibels	40-decibels
Height	100 meters	60 meters
Grouping	Individual	Individual
Location	Mountains	Onshore
Price change per kWh	- 5 öre	0 öre

( ) Alternative A ( ) Alternative B

The levels of the attributes included varied over all choice sets in alternative A, while alternative B represented the status quo option, and thus the characteristics of existing wind power capacity. These characteristics are: a maximum allowed noise level of 40 decibel outdoors in residential areas, wind turbines with a height of 60 meters, separately located, situated onshore, and no change in the electricity price (Swedish National Energy Administration, 2001b; SOU 1999:75a).

4.4 Experimental Design

Experimental design deals with how to create choice sets in an efficient way, i.e., how to combine attribute levels into alternatives and choice sets. The most common approach in economic applications has been to use orthogonal designs, in which the levels of the attributes of the different alternatives are uncorrelated in the choice sets.

The five attributes included in the experiment, which can take between two and five different levels, resulted in a full factorial with 180 combinations (2 * 3 * 2 * 3 *

5).[14] This would be more than the respondents could be expected to cope with. Although the main effects are of primary interest in this study, the presence of at least some interactions is likely and the design should permit the testing for some of these potential interactions. For example, it seems reasonable to expect that the noise perception would differ with respect to where the wind power capacity is located. In order to facilitate the estimation of all main effects and at least some of the two-way interactions, a main effect orthogonal design was combined with an endpoint design (following Louviere et al., 2000, pp. 94-96). This means, in short, that randomly drawn choice sets from the full factorial were combined with randomly drawn choice sets from another factorial where only the lowest and highest levels of each attribute were included. The experimental designed was accomplished by using the statistical software SPSS. After reducing identical combinations and combinations that seemed unreasonable, 30 combinations remained.[15] These 30 choice sets were then randomly assigned to five blocks such that a single respondent would be confronted with six choice sets.

In order to permit a test of whether the order of the attributes within the choice sets may have affected the outcome, i.e., one aspect of stability of preferences, the ordering of the attributes was varied (see also chapter 3). 50 percent of the respondents received choice sets with the attribute noise described and placed first in the choice sets and the other 50 percent received choice sets with the noise attribute described and placed last. If the cognitive burden on respondents was too heavy they may have used some simplifying decision rule when they stated their most preferred alternative in the choice sets rather than choosing after a comprehensive judgment of all the included attributes. For instance, one such simplifying strategy could be to give more weight at the noise attribute when it was the first respondents faced in the choice set than on the subsequent ones. The results of this exercise are given in section 6.3.

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[14] Although there were six levels of the price attribute, the price change was never set equal to zero in alternative A. Therefore in the alternative with varying characteristics of the attributes, there were only five levels of the price attribute, and the zero price change was only used in the status quo option, i.e., alternative B.

[15] For instance, combinations in which the only change in alternative A compared to the status quo option was a lowered noise level in combination with a lowered electricity price, implying an economic compensation for an unambiguous improvement, were considered unreasonable and were thus removed.

4.5 Questionnaire Logistics and Sample

In this study, a postal survey was chosen over an interview approach, primarily since it was considered cost efficient. In the literature on non-market valuation it is generally recommended that personal interviews should be used over postal surveys (e.g., Arrow et al., 1993). There are, however, pros and cons associated both with postal surveys and with personal interviews. Personal interviews permit the interviewer to greater extent to use visual material to help respondents if necessary, but interviews are relatively high cost. Also, personal interviews normally generate high response rates, although they may be subject to "interviewer bias". Postal surveys are relatively low cost and provide the respondents with time to contemplate on their answers more, but can also lead to low response rates and consequently also sampling selection biases (e.g., Bennett & Blamey, 2001).

In early march 2002, the questionnaire, together with an introductory letter, was mailed to 1000 Swedish residential homeowners, randomly selected from the Swedish Official Register of Persons and Addresses (Postens adressregister). About two weeks after the questionnaire had been sent out, a follow-up reminder was sent out to non-respondents. Within an additional three weeks, a second reminder was sent to the remaining non-respondents. The second reminder was however not complete in the sense that it included only a short reminder note and no new copy of the questionnaire was included. In chapters 5 and 6, the results from the survey investigation are presented and analyzed.

Chapter 5
SURVEY RESPONSES

5.1 The Response Rate

Choosing not to respond to a postal survey is an easy strategy for the respondent, primarily since he or she does not generally have to inform or confront anyone about the decision not to respond. Therefore, the non-response rate is, as was acknowledged in the previous chapter, generally higher in postal surveys than in personal interviews. In the present study 1000 questionnaires were sent out, and 547 completely or partially usable answers were returned. There were thus 453 non-responses to the questionnaire. Adjusting for the 15 respondents that were unable to answer due to unknown addresses, severe illness or death, the overall response rate was 56 percent. The responses were rather uniformly distributed among the five different blocks (see section 4.3); the distribution of the response rate among the blocks is described in Table 5.1.[16]

Table 5.1 Response Rates within the Five Different Blocks

	Block A	*Block B*	*Block C*	*Block D*	*Block E*
Main sample	200	200	200	200	200
Undeliverable	3	1	4	3	4
Real sample	197	199	196	197	196
Responses	107	104	109	110	117
Response rate (%)	54	52	56	56	60

Note: The real sample is the main sample minus the undeliverable (due to unknown addresses, severe illness or death).

A few of the respondents stated, as a general comment, that it was a quite demanding task to complete the questionnaire. One consequence of the complexity of the questionnaire may have been that it was too demanding for respondents that do not

[16] There were 12 anonymously returned questionnaires. Since these respondents could not be identified, they received two follow-up reminders. Hence, there exists a possibility that more than one answer were received from some of these anonymous respondents.

have Swedish as their native language and this group may therefore be underrepresented in the sample. Among the responses that were incomplete, the majority refused to state their preferred alternatives in some or all of the choice sets. The respondents to three of these non-complete questionnaires stated explicitly that they had refused to answer because they were negative towards wind power and they did not accept having to choose between two wind power options only. In other words, at least these three respondents refused to participate in the study because no opt-out alternative was included in the experiment.

5.2 Testing for the Existence of Sample Bias

To be able to consider the results of the survey as being representative for the relevant population, it is important that the respondents do not, in any substantial way, differ from the population from which they are drawn. Therefore, in Table 5.2 the characteristics of the respondents within the sample are compared to the characteristics of the typical Swedish house owners.

Table 5.2 Sample Characteristics

Variable	***Sample***[a]	***Typical Swedish House Owners***
Age (percentage share of older than 65 years)	28 %	24 % (1997)
Average household income (SEK per month)	30000 – 40 000	32000 (1997)
Membership in environmental organization	14 %	4 % (2002)[b]
Family situation (share of sample with at least two adults with children)	34 %	30 % (1997)
Education (percentage share with university degree)	27 %	24 % (2000)[b]

Source: Statistics Sweden (2002).

[a] Number of observations: 520.

[b] Estimate for an average Swede.

A potential problem associated with postal surveys is that the presence of non-responses can lead to a bias caused by sample self-selection. It is reasonable to expect that those with a strong positive or negative opinion towards "green" electricity and wind power are more likely to answer and return the questionnaire. For instance, if homeowners with a strong interest in the environment are overrepresented in the sample, it could be interpreted as an indication of the presence of sample self-selection bias.

Within the sample, 14 percent of the respondents stated that they are members of an environmental organization, and this is a significantly higher share than among Swedish homeowners in general. The null hypothesis that these two estimates are equal can be statistically rejected at the one percent significance level.[17] In 1992, 8.5 percent of the population between 16 and 84 years reported that they were members of an environmental organization. By 2000 this share had decreased to 4.2 percent. However, an additional 9 percent declared that they belong to recreational organizations, and since the definition of environmental and recreational organizations may overlap, it is not possible to make direct comparisons of the averages of this sample and the national averages reported in the study by Statistics Sweden (2002). That is, some of the respondents in the sample that declared membership in environmental organizations might belong to organizations, which are categorized as recreational organizations by Statistics Sweden.[18] Consequently, respondents which are members of environmental organizations are likely to be overrepresented in the sample, although the difference may be less pronounced than is indicated in Table 5.2.

The share of respondents older than 65 years, with children in the household and the share with a university degree are slightly higher in the sample compared to the estimates reported by Statistics Sweden. For both the share of older than 65 and the share with children in the household, the null hypothesis that the share in our sample is equal to the estimate reported by Statistics Sweden can be rejected at the 5 percent significance level. However, the interval in which the average income for the sample is found coincides with the average income for the population. Although the share of respondents with a university degree is higher in this sample than in the estimate for Swedes on average, this difference is not statistically significant at the 5 percent significance level. Hence, when comparing the socio-economic characteristics of the realized sample with the estimates of Statistics Sweden, the respondents seem to be

[17] The sample sizes for Statistics Sweden's estimates on age, membership in environmental organizations, family situation, and education are not known. For this reason, our sample estimates for each of these variables was compared to the estimates of Statistics Sweden based on the assumption that these latter estimates reflect the "true" values.

[18] In a contingent valuation study on Swedish households Vredin (1997) found that 18 percent of the respondents declared membership in environmental organizations.

slightly older than the relevant population, and respondents with children seem to be somewhat overrepresented in the sample.

The respondents were asked whether they had ever bought electricity labeled "Bra Miljöval". 10 percent stated that they had done so. This is a surprisingly high share, given that the major part of the consumption of "green" electricity (which amounted to 9 percent in 2001) is consumed by government authorities and companies (Swedish Society for Nature Conservation, 2002; Wickström, 2002). There may be at least two possible explanations for this relatively high share. *First*, it can be interpreted as an indication of the presence of self-selection bias, i.e., respondents with a strong interest in the environmental effects related to electricity production are over-represented in the sample. *Second*, it could be due to a misunderstanding of the concept "green" electricity among the respondents. Since a high share of the total electricity production in Sweden comes from hydropower (about 50 percent), respondents may have interpreted this fact as indicating that they must have consumed "green" electricity, i.e., hydropower.

5.3 Attitudes towards the Environment, Different Power Sources and Wind Power

This section presents the findings of the first part of the questionnaire that consisted of questions about the respondents' attitudes towards the environment, towards the environmental impacts of electricity production in general and towards wind power in particular. The extent at which the different electricity sources are considered by the respondents to be relatively environmentally benign is summarized in Table 5.3.

Table 5.3 Attitudes towards the Environmental Impacts of Different Electricity Sources

Electricity source	***Low impacts on the environment (%)***
Electricity from combustion of biomass	55
Electricity from combustion of coal	2
Electricity from combustion of natural gas	47
Electricity from combustion of oil	3
Nuclear power	55
Solar power	93
Hydropower (existing capacity)	93
Wind power	88

Number of responses: 528.

According to the results, coal fired power is considered to be an electricity source with low environmental impacts by only 2 percent of the respondents, while 93 percent of the respondents express that existing hydropower and solar power should be considered clean electricity sources. Wind power is considered to be an environmentally benign electricity source by 88 percent of the respondents. Since such a high share considers wind power to be a clean source, the potential for future wind energy expansions in the market for "green" electricity might be substantial. However, it is important to know more about how the different environmental characteristics associated with wind power are perceived by the Swedish electricity consumers. Such information could reveal whether some of these characteristics are perceived as more (or less) "green" than the others (see chapter 6). Furthermore, nuclear power and biomass fueled power are considered to be clean electricity sources by an equivalent share of respondents, 55 percent. This result is interesting since electricity generated from biomass combustion can be labeled as "Bra Miljöval" while nuclear power cannot (Swedish Society for Nature Conservation, 2002).

The respondents were further confronted with eight statements about some of the positive and negative characteristics associated with wind power generation. They were asked to mark on a scale ranging between one and five, to which extent they agreed with each statement. The results are summarized in Table 5.4.

The positive statements related to wind power generation that gained support from a large proportion of the respondents were that it is a renewable and an environmentally benign electricity source. The most important negative effects associated with wind power were according to the Swedish homeowners the visual impacts on the landscape (75 percent). In addition, wind power is considered an insecure electricity source (since it is not always windy) by 40 percent of the respondents. Furthermore, 21 percent of the respondents stated that wind power generation gives rise to disturbing noise. The negative impacts from wind power installations on wildlife, such as colliding birds, were considered to be an important problem by about 16 percent of the respondents. It is also interesting to note that almost half of the respondents (43 percent) declared that they do not know whether wind power is an expensive electricity source or not.

One reason for this expressed ignorance may be that in Sweden the economics of wind power depend heavily on state subsidies; without the subsidies wind power is substantially more expensive than, for instance, gas-fired power, but with the present (2000) subsidies wind power appears rather economical from an investment point of view (Elforsk, 2000). Thus the relative expensiveness of wind energy is not clearcut and depends largely on the perspective chosen.

Table 5.4 Percentage Share (%) of Respondents Agreeing with Statements about Wind Power

Statement	***5 Fully agree***	***4***	***3 Partly agree***	***2***	***1 Do not agree***	***0 Do not know***
Environmentally benign is important characteristic	64	12	16	2	3	3
Creates disturbing noise	12	9	34	8	8	28
Expensive	16	8	20	6	7	43
Makes the landscape more beautiful	3	0	13	14	61	8
Insecure electricity source	28	12	35	9	5	12
Colliding birds important problem	11	5	24	13	17	30
Renewable important characteristic	71	10	12	1	1	5
Negative effect on the value of nearby real estates	18	13	29	10	8	22

Number of responses: 541.

When asked about their experience of wind power, 95 percent of the respondents stated that they have seen a windmill and 60 percent that they have been close enough to hear the sound of wind power generation. 10 percent stated that they have windmills in sight from their residence or summerhouse, a share that is surprisingly high given that there are “only” about 550 windmills in Sweden. This may be an indication of sample selection bias, which was discussed in section 5.2.

5.4 Public versus Private Preferences in the Sample

To facilitate the analysis of whether the respondents appear to have accepted the way in which the scenario of the choice experiment was designed (i.e., simulating a real market situation), they were asked to consider eight statements which aimed at capturing their attitudes towards how social choice in the energy field should be resolved. Four of the statements were formulated such that they are more or less consistent with typically private preferences, or “consumer behavior”, and the other four are roughly consistent with public preferences, or “citizen behavior”. For our purposes “citizen behavior” builds on such preferences that are not consistent with the axioms of traditional welfare economics (while our definition of "consumer behavior" does). Most importantly, we interpret the existence of a rights-based ethics and the rejection of trade-offs, in particular in relation to environmental goods, as an indication of "citizen behavior".[19] Respondents were asked to mark on a scale ranging between one and five, to which extent they agreed with each statement. The precise formulation of these statements is found in appendix A. The distribution of the answers is presented in Table 5.5.

According to these results, both the statements coherent with "consumer behavior" and the statements coherent with "citizen behavior" generally appear to be supported among respondents. It is interesting to note, though, that although the implication of the first and the fourth statement is equivalent, the fourth statement receives stronger support among the Swedish house owners. Note further that the statement reflecting the attitudes towards trade-offs is supported and rejected by about the same share of respondents, 29 percent in support versus 25 percent rejecting the statement.

Table 5.5 Percentage Share (%) of Respondents Agreeing with Attitudinal Statements about Social Choice in the Energy Field

Statements consistent with "consumer" behavior	***Fully agree 5***	***4***	***Partly agree 3***	***2***	***Do not agree 1***	***Do not know 0***
Those who want to buy "green" electricity must be prepared to pay for it	19	8	32	7	26	7
Costs and prices must be considered as well as the degree of the environmental impact	47	18	27	2	2	3
Accept trade-offs between environmental quality and private consumption goods	19	10	32	10	15	14
It is good if everyone chooses whether to buy "green" electricity or not	36	10	29	7	12	6

[19] This is a somewhat more restrictive definition of pubic preferences than that outlined in the literature (e.g., Sagoff, 1988). According to this literature "citizen behavior" does not necessarily exclude any ethical codes (including utilitarianism and trade-offs).

Table 5.5 Continued

Statements consistent with "citizen" behavior	*Fully agree 5*	*4*	*Partly agree 3*	*2*	*Do not agree 1*	*Do not know 0*
Reject commodification of energy issues	31	13	30	3	4	18
Decisions should be made in the political arena	16	8	27	9	33	7
Human beings have an absolute right to be protected, no matter of costs	40	13	31	5	7	4
Every consumer should choose electricity sources with a relatively small environmental impact	14	10	46	10	14	6

Number of responses: 536.

Furthermore, the statement that decisions related to the Swedish electricity portfolio should be made in the political arena rather than in the market (i.e., by the individual consumers), was supported by 24 percent of the respondents while 42 percent rejected the statement. Hence, according to these results, Swedish house owners do not seem to reject a market solution for increasing the share of renewable electricity in the Swedish electricity market. In addition, the share of respondents in support and in opposition appear to be the same with respect to the statement that every consumer should always choose the electricity source with the smallest environmental impact, even if it means higher costs.

To sum up, these answers to the attitudinal question indicate that there exist respondents that express public preferences within the sample, while there is also significant support for decisions based on private preferences. Many respondents appear to be in support of both statements that aimed at capturing "consumer behavior" and those that aimed at capturing "citizen behavior". In section 5.5 we examine whether the consumer – citizen distinction helps us understand the general attitude towards wind power among respondents. Furthermore in section 6.3 we discuss whether the presence of "citizen behavior" among the respondents has affected the results of the choice experiment.

5.5 The Determinants of the General Attitude towards Wind Power

In the questionnaire, respondents were asked to state their general attitude towards wind power by marking a scale ranging between 1 and 5, where 1 represented a negative attitude and 5 a positive. Respondents that did not have any opinion or did not know were told to explicitly mark this. The distribution of the answers to this question is given in Table 5.6.

Table 5.6 General Attitude towards Wind Power

	***Positive* 5**	***4***	***3***	***2***	***Negative* 1**	***Have no opinion***
Percentage	45 %	19 %	23 %	3 %	7 %	2 %

Number of responses: 544.

The general impression is that the majority of the respondents appear to be positive towards wind electricity. Only 10 percent of the homeowners marked 1 or 2 while 64 percent of respondents marked 4 or 5. Only 2 percent stated that they have no opinion or that they do not know.

Previous research suggests that the attitude towards “green” electricity, expressed in the form of stated willingness to pay for renewable electricity, is positively related to income, to social group and to education (e.g., Collins et al., 1998; Roe et al., 2001; Batley et al., 2001). We hypothesize the general attitude to be influenced by socio-economic factors, the environmental orientation of the respondent, the previous experiences of wind power and by whether the respondent is expressing primarily public preferences in relation to energy choice issues or not. These potential determinants of the attitude towards wind power were scrutinized by estimating the following binomial logit model .[20]

$$P[Y=1]=\frac{e^{\boldsymbol{\beta}'\mathbf{X}}}{1+e^{\boldsymbol{\beta}'\mathbf{X}}}=\Omega(\boldsymbol{\beta}'\mathbf{X}) \qquad [5.1]$$

[20] The logistic distribution is similar to the normal distribution except in the tails, which are heavier than in the normal distribution. See for instance Green (2000) for a more comprehensive discussion on logit models.

Hence, **β** is a vector of parameters to be estimated. The dependent variable, *positive attitude,* was set equal to one for the occurrence of a positive attitude towards wind power (representing respondents who marked four or five in the question on the general attitude towards wind power). Consequently, the dependent variable is equal to one if the respondent was stated a positive attitude towards wind power, zero otherwise. The socio-economic variables included in the model were the following: *age*, *income*, *education* (dummy variable set equal to one for respondents with a university degree), *gender* (dummy variable with female equal to one), and *children* (dummy variable, one if children under 18 are present in the household). Drawing from previous research, we should expect the coefficients for *income* and *education* to be positive while there are no *a priori* expected signs for the other socio-economic variables.

The variable *environmental organization* indicates whether the respondent is a member of an environmental organization or not (dummy variable equal to one if respondent stated membership), and it is included to capture a "general" attitude in favor of environmental investments and policies. Since wind power is considered to be an electricity source with a relatively small impact on the environment, we expect the coefficient for the *environmental organization* variable to be positive. The variable *"green"* indicates whether the respondent has ever bought green electricity or not (dummy variable set equal to one for consumers of "green" electricity). We expect the average consumer of "green" electricity to be more likely to be positive towards wind power than the average consumer who has not bought "green" labeled electricity, i.e., we expect the sign of the coefficient for the variable *green* to be positive. The variable *near* indicates whether the respondent has any wind power installations in sight of his/her residence or summerhouse (dummy variable set equal to one if that is the case), and it is included to capture whether the attitudes of these respondents differ significantly from those who do not live close to wind power installations. There are no *a priori* expectations about the sign of the *near* coefficient.

Finally, in order to test whether a respondent with public preferences could be expected to differ from the average respondent with regard to general attitude towards wind power, a *public/private* index variable was constructed on the basis of the attitudinal questions described in section 5.4. The index *public/private* included as an explanatory variable was constructed by dividing the sum of the scores for the statements consistent with public preferences (citizen behavior) with the scores for the statements consistent with private preferences (consumer behavior). A respondent with a preference map with a strong public orientation is expected to be more positive towards wind power than the average individual with a preference map that is primarily driven by private interests. Results from previous research have shown, for instance, that people with a strong interest in environmental matters are, in general, more likely to have an ethics-based belief system than people who pay less interest to the environment. This implies, among other things, that they are (as citizens) reluctant to accept trade-offs between environmental quality and material welfare. Drawing from these previous results (e.g., Lundmark, 1998), we expect the sign of the coefficient for the *public/private* index to be positive since wind power generally is considered to be an electricity source with a relatively low impact on the environment. The results from the binomial logit model are given in Table 5.7. A likelihood ratio test of the joint hypothesis that all coefficients are zero was concluded with a chi-squared value of 34. With a critical value on the one percent significance level of 21.67, the hypothesis of all coefficients being equal to zero can thus be rejected.

Table 5.7 Determinants of the Attitude towards Wind Power

Variable	***Parameter estimate***	***t-value***
Constant	-0.91***	-2.39
Age	-0.007	0.71
Gender	0.01	0.96
Children	0.42**	1.96
Education	-0.25	-1.10
Income	-0.001	-0.77
Environmental organization	-0.03	-0.12
Green	0.38	1.62
Near	0.11	0.34
Public/private index	1.50***	4.78

Sample size: 520 individuals
Restricted log likelihood: -341
Log-likelihood: -324
Chi-squared: 34

*** Statistically significant at the 1 percent level.
** Statistically significant at the 5 percent level.

According to the results the general attitude towards wind electricity does not seem to differ among respondents with respect to socio-economic factors such as *age*, *gender, education*, or *income* since none of these parameter estimates are significant form a statistical point of view. However, the positive sign of the parameter estimate for *children* indicates that respondents with children in the household are more likely to be positive towards wind power than those without children in the household. There is no support for the hypothesis that individuals who are members of an environmental organization are more positive towards wind power than individuals who are not. The negative sign of the coefficient for *environmental organization* even indicates the opposite; the parameter estimate is however not statistically significant. The positive sign of the parameter for *green* suggest that consumers of “green” electricity are more likely to be generally positive towards wind power than non-consumers. However, neither this parameter estimate is statistically significant. Nor do the results suggest that the attitudes of people with more experience of wind power (living close to wind power facilities) differ from the attitude of people with less experience. The coefficient for the variable *near* is not statistically significant.

According to the sign of the parameter estimate for the *public/private* index, respondents with more pronounced public preferences are more likely to be positive towards wind power in general than the average respondent. The parameter is also highly significant from a statistical point of view. This support for wind electricity among respondents with public preferences may have some interesting implications for policy makers. According to the results people expressing public preferences are also likely to be in support of wind power. Since people equipped with public preferences are likely to have limited confidence in market-based solutions compared to people expressing solely their private preferences, they are probably likely to be in support of different political interventions aiming at increasing wind power capacity.

Chapter 6
RESULTS OF THE CHOICE EXPERIMENT

6.1 Data Descriptives

The results of the choice experiment are based on 488 individuals and 2928 observations. We received 547 more or less complete answers; 18 of the respondents refused to participate in the choice experiment and 26 additional respondents did not participate completely and stated their most preferred alternative in less than six of the choice sets. After removing these incomplete answers and the 15 additional that were incomplete (due to respondents refusing to state their income and/or age and gender), 488 individuals remained in the sample. Descriptive statistics for the variables included in the random effects binary Probit model and their coding are given in Table 6.1.

There were no *a priori* expectations about whether the attributes related to location, height, and grouping would be considered by respondents as improvements compared to the present situation or as a change for the worse. For instance, large groups of high windmills may be considered to have a negative visual impact while large wind parks may also be considered as more efficient than smaller separately located windmills. Furthermore, the average respondent could consider the mountainous area and the archipelago either as areas worth protecting from exploitation (since they are widely used for recreation) or as being suitable for wind power developments (since they are in general at a far distance from more densely populated areas). The coefficient for the *noise* attribute, however, was expected to have a positive sign since the change represented a lower noise level than the presently allowed noise level.

It would be reasonable to expect that the perception of at least some of the environmental characteristics included in the model would be different with regard to location. For instance, groups of windmills located offshore or in the mountainous area may be perceived differently by the average respondent compared to groups located onshore. The interaction variables included in the model were therefore *large groups offshore* and *small groups in the mountains*.

Table 6.1 Descriptive Statistics

Variable	*Coding*	*Mean*	*Std*	*Min*	*Max*
Choice	1 for alternative A	0.44	0.50	0	1
Noise	1 if reduced noise level, -1 otherwise	-0.07	0.99	-1	1
Mountain	1 if located in mountainous area, 0 if offshore, and -1 if onshore	0.18	0.79	-1	1
Offshore	1 if located offshore, 0 if in the mountainous area and -1 if onshore	0.09	0.75	-1	1
Height	1 if higher than 50 meters, -1 if not	0.11	0.98	-1	1
Small	1 if small group, 0 if large, and -1 if separately located	0.03	0.75	-1	1
Large	1 if large group, 0 if small, and -1 if separately located	0.18	0.82	-1	1
Large offshore	1 if large groups offshore	0.07	0.63	-1	1
Small mountain	1 if small groups in the mountains	0.02	0.61	-1	1
Visit mountains	1 if visited mountains and located in mountains	0.06	0.44	-1	1
Price change	-10, -5 , +5, +10, +15 per kWh	2.75	10.08	-10	+15
Environmental organization	1 if member of an environmental organization	0.14	0.35	0	1
Near	1 if windmill exists in sight of residence or summerhouse	0.11	0.31	0	1
Age	Age of respondent	55	13	22	86
Social choice	1 if choices are based on what is best for society as a whole	0.53	0.49	0	1

Some socio-economic and attitudinal variables were also included in the analysis, interacting with the attributes or as shift variables. The socio-economic variables included were *age* and *environmental organization*.[21] There were no *a priori* expectations about the signs of any of these parameter estimates. The *age* variable was included so as to test whether the probability of choosing alternative A over alternative B differs with respect to the age of respondents. The variable *environmental organization* is included to capture a general interest in environmental issues; this interest is expected to imply a higher probability for respondents to choose the "green" alternative. However, since there was no clear-cut "green" alternative in the experiment

[21] Alternative specifications was also estimated, with more socio-economic variables included (such as for instance gender, income, education). However, these specifications were not preferred since none of these socio-economic variables proved to be significant from a statistical point of view.

and since it was not known in advance whether the varied environmental characteristics included in alternative A would be interpreted as improvements or deteriorations, any specific expectation about the sign of the parameter estimate for the environmental organization variable was not deemed relevant. The variable *visit mountains* indicates whether respondents have visited the mountainous areas during the last year. Respondents that visit mountainous areas regularly for recreation could be expected to be less likely to accept wind power facilities located in these areas. Therefore the coefficient for *visit mountains* was expected to be negative. The variable *near* shows whether respondents have wind power installations in sight of their residence or summerhouse or not, and it was included to facilitate a test of whether respondents familiar with wind power generation were more or less likely to choose wind power with different characteristics (i.e., alternative A) than the average respondent.[22] Furthermore, the variable *social choice* is based on answers given in the debriefing question. The variable is equal to one if the respondents stated that they had chosen their most preferred alternatives in the choice sets based on what they considered was best for society as a whole.[23]

6.2 Empirical Results

The results obtained by estimating the random effects binary Probit model, pooled by individual, are reported in Table 6.2. The estimated correlation between the error terms (*Rho*) is 0.57 and highly statistically significant, which implies that we cannot reject the random effects model in favor of a more restrictive model that assumes no correlation between the error terms. A likelihood ratio test of the hypothesis that all coefficients are equal to zero was performed. With a chi-squared value of 488, the hypothesis of all coefficients being equal to zero could be rejected at the one percent significance level. Given that the alternatives were generic (not labeled), and since there was no systematic

[22] An alternative specification was estimated in which the variable *near* was interacted with each of the attributes in the choice set, this specification was not preferred since none of these interaction terms proved to be statistically significant.

[23] An alternative specification was estimated in which the *public/preference* index discussed previously (see chapter 5) was included as an explanatory variable. This specification was however rejected since the variable did not prove to be statistically significant.

difference between the two alternatives included no constant was included in the model (see section 4.2).[24]

Table 6.2 Random Effects Binary Probit Model Results

Variable	***Coefficient***	***t-statistic***
Noise	0.06*	1.68
Mountain	-0.19***	-3.93
Off-shore	0.31***	5.95
Height	0.02	0.60
Small	0.13**	2.38
Large	-0.15***	-2.85
Large offshore	0.06	0.92
Small mountainous area	-0.12*	-1.91
Visit mountains	-0.25***	-3.28
Price	-0.09***	-26.47
Environmental organization	0.17**	2.35
Near	0.41**	2.03
Age	-0.01***	-3.12
Social choice	0.41***	3.22
Rho	0.57***	21.63
Sample size: 488 individuals		
Log-likelihood: -1424		
Restricted log-likelihood: -1668		
Chi-squared: 488		

*** Statistically significant at the 1 percent level.

** Statistically significant at the 5 percent level.

* Statistically significant at the 10 percent level.

In the choice experiment, respondents chose alternative A in 44 percent of the choice sets. The behavior in the experiment were “lexicographic” in the sense that 9 percent of the respondents always chose alternative A and 20 percent always chose the status quo option, alternative B. In section 6.3.2 we analyze to what extent this behavior may have affected the outcome of the experiment.

[24] When a constant was included in the model, the hypothesis that it was equal to zero could not be rejected at the 10 percent significance level. In addition, the estimated slope coefficients proved to be rather stable between the two different specifications.

Estimated coefficients with a positive sign imply that a change from the status quo option to the corresponding attribute increases the probability of choosing alternative A over alternative B, and a negative sign implies consequently a reduced probability of choosing alternative A. Hence, each estimated attribute-coefficient with a negative sign is perceived by the average respondent as an environmental deterioration compared to the status quo option. Inversely, positive coefficients indicate that the related attributes are viewed as environmental improvements.

The positive sign of the coefficient for the *noise* attribute indicates that a reduced noise level is considered to be an environmental improvement, as was expected. The coefficient is statistically significant at the 10 percent significance level. The results indicate further that windmills located *offshore* are considered by the average respondent to be an environmental improvement while a location in the *mountainous area* is considered to be a change for the worse, all compared to wind power capacity located onshore. The coefficients representing the two location attributes, *offshore* and in the *mountainous area,* are both highly statistically significant.[25]

The positive sign of the coefficient for the *height* attribute indicates that the average homeowner considers higher wind turbines as an improvement compared to lower. However, the parameter estimate of the *height* coefficient is not significant from a statistical point of view. Hence, we are unable to present any reliable evidence that the height of windmills do affect the utility of the average Swedish homeowner.

Furthermore, separately located windmills are, according to the results, preferred over *large* wind parks while *small* wind parks seem to be preferred over separately located windmills. One possible explanation to this somewhat puzzling result may be that respondents dislike the impact on the landscape from large parks while small parks are considered as not affecting the landscape much more than separately located turbines. Both the group coefficients are statistically significant.

It is interesting to note that although *large* groups onshore are considered to be a change for the worse, there is no evidence in this study that *large groups offshore* do affect the utility of the average respondent since the coefficient for the interaction effect

[25] The positive sign of the parameter for the location attribute offshore should, however, be interpreted with some caution since the environmental impacts from offshore wind power developments are not well known. For instance, offshore wind facilities may have negative impact on fish life; our investigation though, focuses primarily on the visual impacts. Further research on this issue is thus necessary.

for *large groups offshore* is not significant from a statistical point of view. This is, however, not the case for small groups of wind turbines in the mountainous area, since *small groups in the mountains* is perceived to be an environmental deterioration, compared to separately located windmills onshore. This coefficient is also statistically significant. Respondents who recently had visited the mountains also seem to be more negatively affected by the presence of wind turbines in these areas compared to the average homeowner since the sign of this coefficient is negative.[26] The *price* coefficient has a negative sign and is clearly significant from a statistical point of view. This means, as expected, that respondents prefer low electricity prices to high.

The positive sign of the coefficient for *environmental organization* indicates that members in these organizations are, in general, more likely to choose the alternative with different wind power characteristics than the present, i.e., they were more likely to choose alternative A. This coefficient was also statistically significant. Elderly respondents were, as indicated by the negative sign of the *age* coefficient, less likely to choose wind electricity with other characteristics than the present. The *age* coefficient was also significant from a statistical point of view.

Respondents that stated in the debriefing question that they made their choices on the basis of what they considered was best for society as a whole were more likely to choose the alternative with changed wind power attributes, i.e., alternative A. The same result was found for respondents with existing wind turbines in sight of their residence or summerhouse (*near*); these respondents were more inclined to choose the alternative with different attributes than the present capacity. Both these coefficients were statistically significant.

From the parameter estimates, the rate at which respondents are willing to tradeoff costs for changes in any of the other attributes, were calculated, i.e., the implicit price. The implicit price for the noise attribute, for instance, is the ratio of the *noise* coefficient and the *price* coefficient (see section 3.3). The implicit prices derived from the above parameter estimates are presented in Table 6.3. The corresponding *t*-statistics were calculated using the delta method (Greene, 2000). The 95 percent confidence intervals

[26] The perception of wind power offshore did not differ with respect to whether the respondent visited the archipelago during the previous year, since the coefficient for this interaction was not statistically significant when included in the model. It is therefore not included in table 6.2.

were in turn estimated using the Krinsky and Robb (1986) procedure with 5000 random draws from the asymptotic normal distribution of the parameter estimates.

These implicit prices provide information about how important each of the included attributes is in relative terms. They can be interpreted as the willingness to trade off between each of the attributes included and the price attribute, and this is equivalent to the marginal willingness to pay or willingness to accept a change from the status quo level of each attribute to another level of the same attribute.

Table 6.3 Implicit Price Estimates (öre/kWh)

	Model Estimates		***95 % Confidence Interval***		
Attribute	**Mean**	**t-statistic**	**Mean**	**Min**	**Max**
Noise	0.67	1.67	0.67	-0.01	1.32
Mountain	-2.18***	-4.03	-2.18	-3.05	-1.32
Offshore	3.47***	6.50	3.47	2.55	4.30
Height	0.26	0.60	0.26	-0.46	0.98
Small	1.55**	2.44	1.55	0.49	2.60
Large	-1.64***	-2.91	-1.63	-2.54	-0.70

*** Statistically significant at the 1 percent level.

** Statistically significant at the 5 percent level.

* Statistically significant at the 10 percent level.

For instance, if wind power capacity is located in the mountains, the average homeowner wants a lowered electricity price of -2.18 öre/kWh to be as well off as if the characteristics of present wind power capacity were the prevailing. Similarly the implicit price estimate for offshore implies that the average respondent would be willing to pay a premium of 3.47 öre/kWh to receive wind electricity generated offshore compared to wind electricity generated onshore, everything else held constant. Furthermore, according to the implicit price estimates, the relative importance of the negative perception of windmills in the mountains is higher than the negative perception of large wind parks, all compared to the characteristics of present capacity.

The most essential information provided from these implicit prices is thus whether the average Swedish homeowner considers these changes as improvements or as deteriorations and the relative importance of each of these attributes. The willingness to pay interpretation is only valid *within* the experiment, given that the levels of all the other attributes are held constant. Also, since we did not include any opt-out option in the choice experiment, respondents were somewhat forced to choose to buy wind power. If given the option, it is likely that some respondents with positive implicit prices in this experiment would have preferred to buy electricity not stemming from wind or not paying any premium at all for electricity labeled as “green”.[27]

6.3 Testing for Consistency

In this part of the chapter, we will discuss some of the potential drawbacks related to economic valuation applications and test whether there is any evidence that the results presented above suffer from any of these. A large number of potential errors are brought up in the literature. Here we will focus on two. *First*, we will discuss whether the cognitive burden on respondents may have been too heavy, i.e., if choices have been made after some simplified strategy rather than after a comprehensive judgment of the levels and attributes to which the respondent were confronted in the choice sets. Specifically, we will analyze whether the ordering of the attributes in the choice sets may have affected the results of the choice experiment and also whether the presence of lexicographic behavior may have affected the outcome. *Second,* the motives of the respondents and the existence of public preferences will be examined and discussed, specifically, we investigate whether there are any signs of some respondents rejecting the fundamental base for decision making underlying economic valuation applications such as the present.

6.3.1 Does Order Matter?

The application of stated preference techniques, such as choice experiments, requires respondents to undertake a number of tasks. For instance, in a choice experiment the respondent is required to understand the attributes of the alternatives in general terms, the way in which attribute levels vary across alternatives and thus to make a number of choices between two or more alternatives. The complexity of the task facing choice experiments respondents is thus likely to exceed that of conventional contingent valuation studies (Bennet & Blamey, 2001). The task’s complexity depends on the number of alternatives in each choice set, on the number of attributes and levels of attributes used to describe the alternatives, and on the number of repetitions.

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[27] When the respondents that had not previously bought electricity labeled “Bra Miljöval” were asked why they had not, 19 percent stated that they were not interested or that they did not see any positive environmental effects associated with “Bra Miljöval” electricity.

One aspect of task complexity is related to whether preferences are stable, i.e., learning and fatigue effects. Although individuals may become more proficient after completing a few choice sets, and thus become more familiar with the choice situation, a point may be reached when fatigue effects occur. This may be associated with the occurrence of status quo biases in which respondents simply give up the choice task and opt to stay with the status quo option. Carlsson and Martinsson (2001) test for stable preferences in a study on the validity of choice experiments. When testing whether responses were affected by the order of the choice sets - half of the respondents received choice sets in the order (A, B) and the other half received the choice sets in the order (B, A) - they could not reject the null hypothesis that preferences are stable.

In the present study, however, the order of the attributes was varied. Half of the respondents received a questionnaire in which the noise attribute was described first in the informative part preceding the choice experiment, and the noise attribute was also the first attribute that respondents faced in the choice sets. The other half received a questionnaire in which the noise attribute was described last and was placed as the last of the environmental attributes included in the choice sets, only succeeded by the price attribute.

To facilitate a test of whether the order of the attributes affects the parameter estimates, a model with a dummy variable for order was estimated (coded as one when the noise attribute was the first attribute, and as zero if not). The results from estimating the random effects binary Probit model with the dummy variable for order included are given in Appendix C. The parameter estimate for the order-dummy is equal to 0.07; the positive sign indicates that noise was considered as having a greater impact on the utility of the average respondent when the noise attribute was presented first. However, since this coefficient is not statistically significant (*t*-statistic of 1.45), we cannot reject the hypothesis that the parameter estimates are independent of the order in which the attributes have been presented and located within the choice sets. The parameter estimates of the other included attributes and socio-economic and attitudinal variables proved to be relatively stable across the two model specifications.

6.3.2 Analyzing the Presence of Lexicographic Behavior

Lexicographic behavior may arise in choice experiments: (a) if the included alternatives are not sufficiently different to ensure trade-offs; (b) as a result of “yeah” saying (where the respondent, for instance, consistently chooses the “green” alternative); or (c) as an indication of strategic behavior or genuinely lexicographic preferences.[28] If the choice situation is too complex, lexicographic behavior may also be a result of respondents simplifying the choices by using some lexicographic decision rule. If respondents use a simplifying decision rule, it might lead to biased results while genuine lexicographic preferences would not (although it would not provide much information either) (Alpizar et al., 2001). One such simplifying decision rule can, for instance, be to stick with the status-quo option in all the choice sets. The behavior in the experiment were "lexicographic" in the sense that 9 percent of the respondents always chose alternative A and 20 percent always chose the status quo option, alternative B.

In order to test whether lexicographic behavior appears to have affected the results the random effects binary Probit model was also estimated for a restricted sample in which respondents that consistently chose alternative A were removed. The results from this exercise are given in appendix D. The parameter estimates proved, however, to be relatively stable. The signs of all the attributes and the socio-economic and attitudinal variables were unchanged while there were some changes with respect to statistically significance in this alternative model specification. For instance, the coefficient for the *small group* attribute did not prove to be significant within this model specification, nor did the coefficients for the variables *environmental organization, near or age*. However, the coefficients for the levels of the location attribute are highly significant within this model specification as well. Overall this suggests that the results appear to be quite robust with respect to alternative model specifications.

6.3.2 Do Public Preferences Matter?

To facilitate the analysis of the underlying motives for the choices made in the experiment a debriefing question succeeded the choice sets. In the debriefing question respondents were asked to state why they chose the way they did in the choice experiment. The distribution of the answers is given in Table 6.4.

More than half of the sample, 58 percent, stated that they made their choices after comprehensively considering the alternatives and then choosing the option that gave them most value for the money, something which appears consistent with utility maximizing behavior.

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[28] In a lexicographic preference relation one of the commodities in the consumption bundle has the highest priority in determining the preference ordering (Mas-Colell et al., 1995).

Table 6.4 Results from the Debriefing Question

Statement about Motives	*Percentage Share*
Best value for the money	57 %
Can not afford to pay more for better wind power	43 %
Choices based on what is best for society	52 %
Low prices most important	42 %
Noise most important	16 %
Location most important	40 %
Height most important	14 %
Grouping most important	30 %

Number of observations: 488.

The statements in which respondents were asked whether their perception of any of the included attributes dominated when they made their choices were included to capture lexicographic behavior. However, since many respondents marked several of these alternatives the results should primarily be interpreted as information about the relative importance of each of the included attributes. These results are also consistent with the results from the choice experiment. For instance, according to the results in Table 6.4 the location of windmills seems to have a larger impact on the utility of respondents than the height of windmills or the noise pollution impacts from wind power generation. In addition, the average respondent prefers low electricity prices; 42 percent of the respondents stated that they primarily chose the cheapest alternative.

Furthermore, 53 percent of respondents stated that they made their choices according to what they considered was best for society as a whole. Hence, more than half of the respondents made their choices within a wider context than solely maximizing their private utility. This behavior can be interpreted as an indication of respondents expressing public preferences (previously discussed in chapters 3 and 5). The *public/private* index, which in section 5.5 above was found to be a statistically significant determinant of the general attitude towards wind power, is another indication of the presence of public preferences among respondents. However, when the same index was used as an explanatory variable in the choice experiment it was not possible to reject the hypothesis that the coefficient was equal to zero. Hence although the average respondent that expresses public preferences is generally more positive towards wind power than the average house owner expressing private preferences, there is no evidence that an individual with pronounced public preferences values the environmental effects arising from wind power generation differently from the average individual.

It is important to note, though, that the presence of public preferences and rights-based ethical set of values in economic valuation studies does not imply in any sense that valuation studies in general are worthless. For instance, Harrison (1992) argues that if people perceive that their own well-being is affected by the well being of other species and expresses altruistic or moral values in economic valuation studies this is not a problem. After all, utility is utility regardless of the underlying motives.

Since the aim of this study is to examine how the environmental impacts of wind power are perceived in relative terms, rather than to aggregate individual preferences into a total value of wind power *per se* or the total social cost, or benefit, associated with wind power generation, the presence of public preferences is not considered to be a major problem in this study. Furthermore, if the aim is to elicit only the private preferences, Bjorner et al. (2000) and Russel et al. (2001) show that this behavior can be triggered in a predictable and controllable way through the framing of the questionnaire. This was also the attempt in our questionnaire, by framing the scenario so as to mimic a choice situation in the electricity market.

However, knowledge about the motives of the respondents and the presence of public behavior in the sample is important for the policy makers, given the politically stated goal to increase wind power capacity since the presence of public preferences among house owners is likely to affect the outcome of the different policy measures available. The respondents that expressed public preferences were more positive towards wind power than the average respondent. They are also likely to be more positive towards political interventions aiming at increasing wind power capacity because people with public preferences have, in general, less faith in market based solutions than people with primarily private preferences. In addition, this may imply that a market based system only for renewable electricity will not be sufficient in order to reach the politically stated goal of 10 MWh by 2015.

Chapter 7
CONCLUDING REMARKS

The purpose of this study has been to examine the general attitudes towards wind power among the public, and in particular to analyze how the public values different environmental attributes associated with wind power employing a choice experiment approach. A combination of the characteristics theory of value and the random utility theory constitutes the theoretical underpinnings for choice experiments. The estimated model appears to have performed well, overall. For instance, the model proved to be fairly robust, with respect to alternative model specifications.

The majority of the Swedish house owners are generally positive towards wind power, which is considered to be an electricity source with a relatively small impact on the environment. Among the included attributes in the experiment the visual impact in general, and the location of wind power capacity in particular, appear to have a significant impact on the utility of Swedish house owners. According to the results, wind power offshore is considered as an environmental improvement, compared to wind power located onshore while a location of wind capacity in the mountainous areas is considered as an environmental deterioration. In addition, reduced noise levels would increase the utility of respondents, small wind farms are considered as a change for the better while large wind farms are perceived as changes for the worse compared to separately located windmills. According to the results of the choice experiment the electricity price also has a significant impact on the utility of the respondents.

Thus, if an expansion of wind power capacity in Sweden is to be accomplished in a way that minimizes the environmental external costs associated with wind power development and, thus, gains support from the public, new schemes should primarily be located offshore rather than in the mountainous area. Consequently, if wind power producers are interested in differentiating their product further and market wind power as a "green" electricity source, they should primarily give prominence to offshore installations and avoid large wind farms (if not located offshore) rather than investing in the development of less noisy wind turbines. However, if the aim is to increase the market share of wind electricity these measures should also be taken at a low cost;

according to the results the Swedish house owners are cost conscious and clearly prefer low electricity prices over higher.

This cost consciousness may, however, limit the potential for future offshore expansions since the production of offshore facilities are more costly than installations onshore (Hartnell & Milborow, 1998). However, since the results presented here suggest that the external costs from offshore wind power facilities are significantly lower than onshore installations, this may compensate, at least partially, for the higher production costs offshore.

Finally, the results of the survey suggest that some people form their opinion about the environmental aspects of the electricity consumption in a wider context than solely on the basis of maximizing their net personal benefits. For instance, more than half of the respondents stated that they made their choices in the experiment based on what they considered was best for society as a whole. These indications of the presence of public preferences imply that the results should be primarily be interpreted as a public opinion survey rather than as estimates of the total welfare effects associated with wind power development. The presence of respondents that express public preferences may also imply that the outcome of a market-based system, i.e., a “green electricity” market, for increasing wind power capacity will be limited and that additional political measures targeted at increasing wind power capacity will be necessary. These measures are also likely to be supported by the advocates of wind power, and in particular by individuals that expresses public preferences.

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Appendix A: Letter and Questionnaire in English

LULEÅ TEKNISKA UNIVERSITET

Luleå date month

Dear Sir or Madam,

The Division of Economics at Luleå University of Technology is carrying out a survey on the Swedish public's opinion about wind power. There exists a political goal in Sweden, and in many other countries, to increase the share of electricity generated from wind power. Hence, research about the public's perception of windmills and wind power is becoming increasingly important.

Through a random selection, you have been selected as one of the 1000 persons selected to answer this survey. **We hope that you will take the time to answer the questionnaire as soon as possible and return it to us in the prepaid envelope.**

In a scientific study like this, it is important that people with different opinions – including those who are not necessarily interested in electricity generation and its impact on the environment – participate. Please keep in mind that the results of this study depend on as many people as possible answering the questionnaire. Your reply cannot be replaced by someone else's. Naturally, your response will be treated confidentially.

If you have any questions about the questionnaire or about the project, please do not hesitate to contact Kristina Ek, by telephone 0920-492301, or via e-mail: Kristina.Ek@ies.luth.se.

Thanking you in advance for your participation!

Yours sincerely,

Patrik Söderholm
Associate Professor

SOME QUESTIONS ABOUT YOUR ATTITUDE TOWARDS WIND POWER AND TOWARDS ENERGY- AND ENVIRONMENTAL ISSUES IN GENERAL

1) Do you consider the following electricity sources to be environmentally benign? Mark with a cross.

	Yes	No	Do not know
Electricity from combustion of biomass (wood, wood residues, pellet)	( )	( )	( )
Electricity from combustion of coal	( )	( )	( )
Electricity from combustion of natural gas	( )	( )	( )
Electricity from combustion of oil	( )	( )	( )
Nuclear power	( )	( )	( )
Solar power	( )	( )	( )
Existing hydro power	( )	( )	( )
Wind power	( )	( )	( )

2) Electricity stemming from solar power, wind power, existing hydropower, and power from biomass can, if it meets the criteria set up by the Swedish Society for Nature Conservation, be labeled ”Bra Miljöval”. Have you, or anyone else in your household, ever purchased electricity labeled ”Bra Miljöval”?

( ) yes ( ) no ( ) do not know

If **no**, what are the main reasons?

( ) Did not know that the possibility existed
( ) Lack of knowledge, not sure what it is
( ) Have no possibility to choose electricity supplier
( ) Too expensive
( ) Not interested
( ) I see no positive effects on the environment
( ) Other, namely: ______________________________________

3) Are you or anyone else in your household a member of an environmental organization (World Wide Fund for Nature, Greenpeace, Swedish Society for Nature Conservation or equivalent organization)?

( ) yes ( ) no ( ) do not know

4) Do you, or anyone else in your household regularly buy “green” products or products labeled as environmentally benign (e.g., labeled “Bra Miljöval”,”KRAV”)?

( ) yes ( ) no ( ) do not know

5) Have you ever seen a windmill?

( ) yes ( ) no

6) Have you ever been close enough to a windmill to hear the sound of it?

( ) yes ( ) no

7) Are there any windmills within sight of your residence or summerhouse?

( ) yes ( ) no

8) There are positive as well as negative effects related to wind power. To what extent do you agree with the following statements?

a) One important advantage of wind power is that it is an environmentally benign electricity source.

5	4	3	2	1	0
Fully agree		Partly agree		Do not agree	Have no opinion

b) Wind power gives rise to disturbing noise.

5	4	3	2	1	0
Fully agree		Partly agree		Do not agree	Have no opinion

c) Wind power is an expensive electricity source.

5	4	3	2	1	0
Fully agree		Partly agree		Do not agree	Have no opinion

d) Windmills make the view of the landscape more beautiful.

5	4	3	2	1	0
Fully agree		Partly agree		Do not agree	Have no opinion

e) A major disadvantage of to wind power is that it is an insecure electricity source, since it is not always windy.

5	4	3	2	1	0
Fully agree		Partly agree		Do not agree	Have no opinion

f) It is a major problem that birds, or other species, may collide with or be disturbed by windmills.

5	4	3	2	1	0
Fully agree		Partly agree		Do not agree	Have no opinion

g) An important advantage associated with wind power is that it is renewable (i.e., it cannot be depleted since it is produced from wind).

5	4	3	2	1	0
Fully agree		Partly agree		Do not agree	Have no opinion

h) The development of wind power facilities in an area would most likely reduce the value of nearby real estates.

5	4	3	2	1	0
Fully agree		Partly agree		Do not agree	Have no opinion

9) What is your general attitude towards wind power?

5	4	3	2	1	0
Positive		Neither positive nor negative		Negative	Have no opinion

10) What is your attitude towards increased use on wind power?

5	4	3	2	1	0
Positive		Neither positive nor negative		Negative	Have no opinion

11) To what extent do you agree with the following statements?

a. If “green” electricity can be produced only at relatively high cost, those who want to consume “green” electricity should then be prepared to pay extra for it.

5	4	3	2	1	0
Fully agree		Partly agree		Do not agree	Have no opinion

b. When deciding upon what kind of electricity sources we should use in Sweden, we have to consider aspects such as costs and prices in addition to the degree of environmental impacts.

5	4	3	2	1	0
Fully agree		Partly agree		Do not agree	Have no opinion

c. It is difficult to consider the pros and cons of wind power without at the same time considering the electricity sector at a whole (with respect to aspects such as the presence of other electricity sources, market structure, and the overall energy policy).

5	4	3	2	1	0
Fully agree		Partly agree		Do not agree	Have no opinion

d. Decisions concerning what kind of electricity sources we should use in Sweden should be made in the political arena, and not be determined by the preferences of individual consumers.

5	4	3	2	1	0
Fully agree		Partly agree		Do not agree	Have no opinion

e. All human beings have the right not to be exposed to emissions of hazardous substances due to the generation of electricity, regardless of whether this leads to higher electricity costs and hence prices.

5	4	3	2	1	0
Fully agree		Partly agree		Do not agree	Have no opinion

f. People who are being disturbed by wind power generation (by, for instance, the noise from a wind plant) can be compensated for this unease with some kind of economic remuneration.

5	4	3	2	1	0
Fully agree		Partly agree		Do not agree	Have no opinion

g. It is important that every consumer chooses the electricity sources with the lowest environmental impacts, even if these sources are more expensive.

5	4	3	2	1	0
Fully agree		Partly agree		Do not agree	Have no opinion

h. It is good if every consumer chooses electricity supplier according to his or her preferences. Those who are not willing to pay more for ”green” electricity should not be forced to do that.

5	4	3	2	1	0
Fully agree		Partly agree		Do not agree	Have no opinion

SOME QUESTIONS ABOUT YOUR ATTITUDE TOWARDS DIFFERENT CHARACTERISTICS OF WIND POWER

This part of the questionnaire is about wind power in Sweden. We are interested in how you, as an electricity consumer, perceive Swedish wind power and its different characteristics. It is possible to change these different characteristics, though this would normally affect the production costs and thus also the electricity price.

Most of the major electricity suppliers offer their customers electricity labeled “green”; the labeling provided by the Swedish Society for Nature Conservation is available for electricity from wind power, hydropower (existing plants), biomass and for solar power. If you choose to buy electricity labeled “green” it means that the same amount of electricity that you consume will be generated from “green” electricity sources. However, it does not mean that the electricity you are using in your household is “green”. Hence, if the demand for electricity labeled as “green” increases, this will increase the production of electricity stemming from sources labeled as ”green”. It does not mean, however, that those who will consume this “green” electricity will be the same as those who actually choose to buy such electricity.

Before we continue with the questions, please familiarize yourself with the different characteristics of wind power. There are other important characteristics than those included in this questionnaire. Those included are, however, the most important for this specific investigation.

DESCRIPTION OF SOME OF THE CHARACTERISTICS ASSOCIATED WITH SWEDISH WIND POWER

Noise level

Windmills generate noise. This noise is partly mechanical, and partly a ”swishing” sound from the rotor blades. The Swedish Environmental Protection Agency’s standards for noise levels apply also to windmills; these standards are not allowed to be exceeded under normal circumstances. For housing areas, the maximum level is 40 decibels and for recreation areas, the maximum level is 35 decibels. This requires that windmills, under normal circumstances, are located at such distance from housing areas that the outdoor noise level does not exceed 40 decibels. See the table below for a comparison with other noise levels.

Source of noise	*Approximate noise level*
Ticking from a clock	20 decibels
Rustling leaves	30 decibels
New refrigerator	40 decibels
Normal conversation	65 decibels

Location

Windmills affect the view of the landscape. To utilize the wind efficiently, the windmills must be sited freely which means that they often can be seen over considerable distances. Most of the windmills in Sweden today are located onshore or near the coast. However, there is a good wind potential both offshore and in the mountainous areas. It is possible to locate offshore windmills several kilometers from the coast. The pictures below provide examples of how windmills located onshore, in the mountains, and offshore may look like.

Windmill onshore

Windmill in the mountains

Windmill offshore

- ***Height***
  Windmills have become higher over time. Today, a total height of about 60 – 70 meters is common, but considerably higher windmills with a total height of about 100 meters meter can be found. Total height includes the height of the tower and half the diameter of the rotor. See the following table for a comparison with other high objects.

Object	*Approximate height*
Flagpole	10 meters
Ten-storey building	30 meters
The tower of Stockholm City Hall	112 meters

- ***Grouping***
  Windmills can be sited individually or in groups. In Sweden today, individually sited windmills are the most common but groups of windmills can also be found. Windmill groups can be large and include up to about fifty windmills. In the questions that follow, you will face the following three different grouping alternatives.

  Individual: one windmill
  Small group: between two and ten windmills
  Large group: between eleven and fifty windmills

- ***Electricity prices***
  At present, the household electricity price in Sweden is about 50 – 65 öre per KWh, depending on electricity supplier and in which part of the country an individual lives. A change in the different characteristics of wind power would normally affect the cost of producing electricity and hence electricity prices. To better understand how a change in the price of electricity (per kWh) would affect the expenses of your household, consider the following examples. In the first example, see table 1 below, you can see how five different price changes would affect the expenses of a household living in a house not heated by electricity and that consumes about 400 kWh per month. Note that a positive sign before the price change means a higher electricity price and a minus sign means a lower electricity price.

*Table 1. Household **without** electricity heating, consuming about 400 kWh per month*

Change in price per kWh	Change in monthly electricity cost	Change in yearly electricity cost
+ 15 öre	+ 60 SEK	+ 720 SEK
+ 10 öre	+ 40 SEK	+ 480 SEK
+ 5 öre	+ 20 SEK	+ 240 SEK
- 5 öre	- 20 SEK	- 240 SEK
- 10 öre	- 40 SEK	- 480 SEK

In the second example, see table 2 below, you can see how the same price changes would affect the expenses of a household that lives in a house with electricity heating and that consumes about 2 000 kWh per month.

*Table 2. Household **with** electricity heating, consuming about 2 000 kWh per month*

Change in price per kWh	Change in monthly electricity cost	Change in yearly electricity cost
+ 15 öre	+ 300 SEK	+ 3 600 SEK
+ 10 öre	+ 200 SEK	+ 2 400 SEK
+ 5 öre	+ 100 SEK	+ 1 200 SEK
- 5 öre	- 100 SEK	- 1 200 SEK
- 10 öre	- 200 SEK	- 2 400 SEK

NOW WE WANT YOU TO CHOOSE BETWEEN TWO ALTERNATIVES OF WIND POWER

Consider carefully what is being offered by the alternatives A and B below. Please go back to pages x – x if you need to be reminded about what the different characteristics mean. Mark with a cross the alternative you would have chosen the last time you chose electricity supplier, if the two alternatives had been your only alternatives. Please note that a positive sign means a higher electricity price and that a minus sign means a lower price.

12) If you only had been able to choose between alternative A and B the last time you chose electricity supplier, which alternative would you then have chosen? Mark with a cross.

	Alternative A	**Alternative B**
Noise	30-decibels	40-decibels
Location	Mountains	Onshore
Height	100 meters	60 meters
Location	Individual	Individual
Price change per kWh	*+ 5 öre*	*0 öre*

( ) Alternative A ( ) Alternative B

13) If you only had been able to choose between alternative A and B the last time you chose electricity supplier, which alternative would you then have chosen. Mark with a cross.

	Alternative A	**Alternative B**
Noise	40-decibels	40-decibels
Location	Mountains	Onshore
Height	60 meters	60 meters
Location	Individual	Individual
Price change per kWh	*+ 15 öre*	*0 öre*

( ) Alternative A ( ) Alternative B

14) If you only had been able to choose between alternative A and B the last time you chose electricity supplier, which alternative would you then have chosen. Mark with a cross.

	Alternative A	**Alternative B**
Noise	30-decibels	40-decibels
Location	Mountains	Onshore
Height	100 meters	60 meters
Location	Small group	Individual
Price change per kWh	*+ 10 öre*	*0 öre*

( ) Alternative A ( ) Alternative B

15) If you only had been able to choose between alternative A and B the last time you chose electricity supplier, which alternative would you then have chosen. Mark with a cross.

	Alternative A	**Alternative B**
Noise	40-decibels	40-decibels
Location	Onshore	Onshore
Height	60 meters	60 meters
Location	Large group	Individual
Price change per kWh	*+ 5 öre*	*0 öre*

( ) Alternative A ( ) Alternative B

16) If you only had been able to choose between alternative A and B the last time you chose electricity supplier, which alternative would you then have chosen. Mark with a cross.

	Alternative A	**Alternative B**
Noise	40-decibels	40-decibels
Location	Mountains	Onshore
Height	60 meters	60 meters
Location	Small group	Individual
Price change per kWh	*- 10 öre*	*0 öre*

( ) Alternative A ( ) Alternative B

17) If you only had been able to choose between alternative A and B the last time you chose electricity supplier, which alternative would you then have chosen. Mark with a cross.

	Alternative A	**Alternative B**
Noise	30-decibels	40-decibels
Location	Offshore	Onshore
Height	100 meters	60 meters
Location	Large group	Individual
Price change per kWh	*- 10 öre*	*0 öre*

( ) Alternative A ( ) Alternative B

18) Which of the following statements best explains your reasoning when you made your choices in the previous six questions?

a. I compared all the characteristics and chose the alternative that gave me the most value for the money.

( ) yes ( ) no

b. I consider noise as being the most important characteristic and chose, in all the questions, the alternative with the lowest level of noise.

( ) yes ( ) no

c. I consider location (onshore, offshore or in the mountainous area) as being the most important characteristic and chose, in all the questions, the alternative based on this.

( ) yes ( ) no

d. I consider the height of the windmills as being the most important characteristic and made all my choices according to that characteristic.

( ) yes ( ) no

e. I consider the grouping (individually, or in a group) of windmills as being the most important characteristic and made all my choices according to that characteristic.

( ) yes ( ) no

f. I consider low electricity prices as being the most important characteristic and chose, in all the questions, the cheapest alternative.

( ) yes ( ) no

g. I would like to pay more for more environmentally benign electricity but I cannot afford to do that.

( ) yes ( ) no

h. I made my choices according to what I believe is best for society as a whole, not according to what I as a consumer can or will pay for wind power.

( ) yes ( ) no

i. Other, namely: ……………………………………………………………………….

…………………………………………………………………………………………...

…………………………………………………………………………………………...

A FEW QUESTIONS ABOUT YOUR BACKGROUND

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19) Are you a woman or a man? ( ) woman ( ) man

20) How old are you?______ years

21) Which of the following alternatives best describe the education that you have?

( ) Elementary school or equivalent
( ) Senior high school or equivalent
( ) Residential college for adult education
( ) College or university
( ) Other, namely: ______________________________

22) How many persons are there in your household, yourself included? ____ persons

23) How many children (younger than 18) are there in your household? _____ children

24) Is your house heated by electricity?

( ) yes ( ) no ( ) do not know

25) Did you visit the Swedish mountains during the last year?

( ) yes ( ) no ( ) do not know

26) Did you visit the Swedish archipelago during the last year?

( ) yes ( ) no ( ) do not know

27) Which of the following alternatives best describes your total monthly household income, before taxes? Include all types of income such as pensions, unemployment- and sickness benefits.

( ) Less than 5 000 SEK
( ) Between 5 001 and 10 000 SEK
( ) Between 10 001 and 15 000 SEK
( ) Between 15 001 and 20 000 SEK
( ) Between 20 001 and 25 000 SEK
( ) Between 25 001 and 30 000 SEK
( ) Between 30 001 and 40 000 SEK
( ) Between 40 001 and 50 000 SEK
( ) Between 50 001 and 60 000 SEK
( ) Between 60 001 and 70 000 SEK
( ) More than 70 000 SEK

Thank you for your cooperation!

If you have other comments on the issue of wind power, please use the space below.

Appendix B: Letter and Questionnaire in Swedish

LULEÅ TEKNISKA UNIVERSITET

Luleå datum månad

Hej,

Avdelningen för nationalekonomi vid Luleå tekniska universitet genomför för närvarande en undersökning om hushållens inställning till produktion av elektricitet i vindkraftverk. Det finns en politisk målsättning i Sverige och i många andra länder att produktionen av vindkraft ska öka i framtiden, och antalet vindkraftverk kommer därför med stor sannolikhet att öka under de närmaste åren. Av denna anledning är det viktigt med forskning om människors inställning till vindkraft och vindkraftsanläggningar.

Du är en av de 1000 personer som genom ett slumpmässigt urval har utsetts att besvara denna enkät. **Vi hoppas att du vill hjälpa oss genom att ta dig tid att fylla i enkäten och vi är tacksamma om du så snart som möjligt besvarar det frågeformulär som du fått och återsänder det i det frankerade kuvertet.**

I en vetenskaplig undersökning som den här är det viktigt att människor med olika uppfattning får tillfälle att delta, även de som kanske inte har ett direkt intresse av elproduktion, vindkraft eller miljöfrågor. Värdet av undersökningens resultat är beroende av att så många som möjligt besvarar frågeformuläret. Ditt svar kan inte ersättas av någon annans. Ditt svar behandlas naturligtvis helt konfidentiellt.

Om du vill fråga om något i frågeformuläret eller om undersökningen i allmänhet, tveka inte att kontakta Kristina Ek på telefon 0920-492301 eller via e-post: Kristina.Ek@ies.luth.se.

Ett stort tack på förhand för din medverkan!

Med vänliga hälsningar,

Patrik Söderholm
Docent vid Luleå tekniska universitet

NÅGRA FRÅGOR OM DIN ALLMÄNNA INSTÄLLNING TILL VINDKRAFT OCH TILL ENERGI- OCH MILJÖFRÅGOR I ALLMÄNHET

1) Uppfattar du nedanstående elenergikällor som miljövänliga? Markera med kryss.

	Ja	Nej	Vet ej
El från förbränning av biobränsle (ved, flis, pellets, skogsavfall)	( )	( )	( )
El från förbränning av kol	( )	( )	( )
El från förbränning av naturgas	( )	( )	( )
El från förbränning av olja	( )	( )	( )
El från kärnkraftverk	( )	( )	( )
El från solkraftverk	( )	( )	( )
El från befintligt vattenkraftverk	( )	( )	( )
El från vindkraftverk	( )	( )	( )

2) Elektricitet från solceller, vindkraftverk, biobränsle och redan utbyggd vattenkraft som uppfyller Svenska naturskyddsföreningens kriterier kan få märkas med Bra Miljövals logotyp. Har du, eller någon annan i ditt hushåll, köpt sådan miljömärkt el vid något tillfälle?

( ) ja ( ) nej ( ) vet ej

Om **nej**, av vilken eller vilka orsaker?

( ) Har inte vetat att det finns möjlighet
( ) Anser att jag vet för litet om miljömärkt el/har fått för lite information
( ) Har inte haft möjlighet att välja
( ) Anser att det är för dyrt
( ) Är inte intresserad
( ) Ser inte några positiva miljöeffekter med miljömärkt el
( ) Annan orsak, nämligen ______________________________

3) Är du eller någon annan i ditt hushåll medlem i någon miljöorganisation? (Till exempel Världsnaturfonden, Greenpeace, Svenska Naturskydds-föreningen, Fältbiologerna eller liknande)

( ) ja ( ) nej ( ) vet ej

4) Brukar du eller någon annan i ditt hushåll köpa ”gröna” eller miljömärkta produkter? (Till exempel livsmedel märkta med Bra miljöval, svanen eller KRAV-märke)

( ) ja ( ) nej ( ) vet ej

5) Har du någon gång sett ett vindkraftverk?

( ) ja ( ) nej

6) Har du någon gång varit tillräckligt nära ett vindkraftverk för att kunna höra det?

( ) ja ( ) nej

7) Finns det vindkraftverk inom synhåll från din bostad eller ditt fritidshus?

( ) ja ( ) nej

8) Det finns både positiva och negativa effekter med vindkraft. I vilken utsträckning instämmer du i nedanstående påståenden om vindkraft?

a. En viktig fördel med vindkraft är att det är en miljövänlig elenergikälla.

5	4	3	2	1	0
Instämmer helt		Instämmer delvis		Instämmer inte alls	Har ingen uppfattning/Vet ej

b. Vindkraftverk ger upphov till störande ljudeffekter.

5	4	3	2	1	0
Instämmer helt		Instämmer delvis		Instämmer inte alls	Har ingen uppfattning/Vet ej

c. Vindkraft är en dyr elenergikälla.

5	4	3	2	1	0
Instämmer helt		Instämmer delvis		Instämmer inte alls	Har ingen uppfattning/Vet ej

d. Vindkraftverk gör landskapet vackrare.

5	4	3	2	1	0
Instämmer helt		Instämmer delvis		Instämmer inte alls	Har ingen uppfattning/Vet ej

e. En viktig nackdel med vindkraft är att det är en osäker elenergikälla eftersom den är beroende av vind, och det inte alltid blåser.

5	4	3	2	1	0
Instämmer helt		Instämmer delvis		Instämmer inte alls	Har ingen uppfattning/Vet ej

f. Det är ett stort problem att fåglar eller andra djurarter kan kollidera med eller störas av vindkraftverk.

5	4	3	2	1	0
Instämmer helt		Instämmer delvis		Instämmer inte alls	Har ingen uppfattning/Vet ej

g. En viktig fördel med vindkraft är att det är en förnybar elenergikälla (med förnybar menas att den inte tar slut eftersom den produceras av vind).

5	4	3	2	1	0
Instämmer helt		Instämmer delvis		Instämmer inte alls	Har ingen uppfattning/Vet ej

h. Om det byggs vindkraftverk i ett område innebär det troligen att priserna på intilliggande villor och sommarstugor sjunker.

5	4	3	2	1	0
Instämmer helt		Instämmer delvis		Instämmer inte alls	Har ingen uppfattning/Vet ej

9) Vad är din allmänna inställning till vindkraft?

5	4	3	2	1	0
Positiv		Varken positiv eller negativ		Negativ	Har ingen uppfattning/Vet ej

10) Vad är din inställning till ökad användning av vindkraft?

5	4	3	2	1	0
Positiv		Varken positiv eller negativ		Negativ	Har ingen uppfattning/Vet ej

11) I vilken utsträckning instämmer du i nedanstående påståenden?

a. Om miljömärkt el är relativt dyr att producera måste de som vill köpa sådan el också vara villiga att betala ett högre pris för den.

5	4	3	2	1	0
Instämmer helt		Instämmer delvis		Instämmer inte alls	Har ingen uppfattning/Vet ej

b. Det är inte enbart graden av miljöpåverkan som avgör vilken elenergikälla som är bäst, produktionskostnaderna och elpriset är också viktiga faktorer.

5	4	3	2	1	0
Instämmer helt		Instämmer delvis		Instämmer inte alls	Har ingen uppfattning/Vet ej

c. Det är svårt att ta ställning till vindkraftens fördelar och nackdelar utan att samtidigt ta hänsyn till hur elsystemet som helhet ser ut (med avseende på exempelvis förekomsten av andra elenergikällor, ägarstrukturen samt den övergripande energipolitiken).

5	4	3	2	1	0
Instämmer helt		Instämmer delvis		Instämmer inte alls	Har ingen uppfattning/Vet ej

d. Det är det politiska systemet (riksdagen, kommunfullmäktige etc) som borde avgöra vilken slags elektricitet vi ska producera och använda i Sverige, inte de enskilda konsumenterna.

5	4	3	2	1	0
Instämmer helt		Instämmer delvis		Instämmer inte alls	Har ingen uppfattning/Vet ej

e. Alla människor har rätt att slippa bli utsatta för utsläpp av miljöfarliga ämnen i samband med elproduktion, även om det innebär högre kostnader och därmed också högre elpriser.

5	4	3	2	1	0
Instämmer helt		Instämmer delvis		Instämmer inte alls	Har ingen uppfattning/Vet ej

f. De som störs av utbyggnaden av vindkraft (till exempel av ljudet från ett vindkraftverk) kan kompenseras för detta obehag med någon form av ekonomisk ersättning.

5	4	3	2	1	0
Instämmer helt		Instämmer delvis		Instämmer inte alls	Har ingen uppfattning/Vet ej

g. Det är viktigt att alla konsumenter väljer de elenergikällor som är mest fördelaktiga ur miljösynpunkt, även om de är dyrare.

5	4	3	2	1	0
Instämmer helt		Instämmer delvis		Instämmer inte alls	Har ingen uppfattning/Vet ej

h. Det är bra om alla konsumenter väljer elleverantör efter eget tycke och smak. De som inte är villiga att betala mer för miljövänligt producerad el ska inte heller vara tvungna att göra det.

5	4	3	2	1	0
Instämmer helt		Instämmer delvis		Instämmer inte alls	Har ingen uppfattning/Vet ej

NÅGRA FRÅGOR OM DIN INSTÄLLNING TILL OLIKA EGENSKAPER HOS VINDKRAFT

Denna del av frågeformuläret handlar enbart om elproduktionen i vindkraftverk. Avsikten är att vi ska få en uppfattning om hur du, som elkonsument, ser på vindkraft och dess olika egenskaper. Det är fullt möjligt att förändra vindkraftens olika egenskaper men det skulle påverka kostnaden för att producera vindkraft och därmed också priset på vindel.

De flesta större elleverantörer i Sverige erbjuder sina kunder så kallad miljömärkt el. Idag är det el från befintliga vattenkraftverk, solceller, vindkraftverk och biobränsleeldade kraftvärmeverk som har möjlighet att klara Naturskyddsföreningens kriterier för miljömärkning. Om du köper miljömärkt el innebär det att samma mängd el som just du som konsument förbrukar kommer att produceras från miljömärkta resurser. Det innebär dock inte att just den elektricitet som du får levererad hem till ditt hushåll är miljömärkt el. Om fler konsumenter beslutar sig för att köpa miljömärkt el kommer alltså den totala produktionen av sådan el att öka men det betyder inte att det är just de som valt att köpa miljömärkt el som kommer att förbruka den.

Innan vi fortsätter med frågorna kommer en kort beskrivning av några av vindkraftens egenskaper. Dessa beskrivningar är inte heltäckande, det finns fler viktiga egenskaper än de som ingår här. De som vi valt att inkludera är dock de som är mest intressanta för just den här undersökningen.

BESKRIVNING AV NÅGRA AV VINDKRAFTENS EGENSKAPER

- ***Ljudnivå***
  Vindkraftverk ger upphov till ljud, dels till ett mekaniskt ljud och dels till ett ”svischande” ljud, bland annat från rotorbladen. För vindkraftverk i Sverige tillämpas idag Naturvårdsverkets riktvärden för buller. Med riktvärde menas värden som normalt inte bör överskridas. För bostäder är nuvarande riktvärde 40 decibel och för område avsett för fritidsbebyggelse och friluftsliv gäller riktvärdet 35 decibel. Det innebär att vindkraftverk ska placeras så att ljudnivån utomhus i närheten av bostäder inte överskrider 40 decibel, i normala fall. Se tabellen nedan för en jämförelse med några andra ljudnivåer.

Ljudkälla	*Ungefärlig ljudnivå*
Tickandet från en klocka	20 decibel
Lövprassel	30 decibel
Nytt kylskåp	40 decibel
Normalt samtal	65 decibel

- ***Lokalisering***
  Vindkraftverk påverkar landskapsbilden. För att vindenergin ska kunna utnyttjas effektivt måste vindkraftverken ligga fritt, det innebär att de ofta syns på långa avstånd. Merparten av dagens svenska vindkraftverk är placerade på land eller nära kusten. Det finns dock goda förutsättningar vindmässigt både ute till havs och i fjällområdena. Det är möjligt att placera havsbaserade vindkraftverk ett flertal kilometer från kusten. Bilderna nedan visar exempel på hur vindkraftverk placerade i landskapet, fjällnära eller till havs kan se ut.

Vindkraftverk på land

Fjällnära vindkraftverk

Vindkraftverk till havs

- ***Höjd***
  Vindkraftverken har blivit större med åren. Idag är det vanligt med en totalhöjd på cirka 60 - 70 meter, men även betydligt större vindkraftverk med en totalhöjd på cirka 100 meter förekommer. I totalhöjden ingår tornets höjd och halva rotordiametern. Se tabellen nedan för en jämförelse med andra höga objekt.

Objekt	*Ungefärlig höjd*
Flaggstång	10 meter
Hus i 10 våningar	30 meter
Stockholms stadshus torn	112 meter

- ***Gruppering***
  Vindkraftverk kan placeras enstaka eller i grupp. I Sverige idag är enstaka vindkraftverk vanligast men det förekommer även att kraftverken placeras i grupper med flera vindkraftverk i varje grupp. Det kan handla om vindkraftsparker med grupper som innehåller upp till ett femtiotal kraftverk. Du kommer att få ta ställning till nedanstående alternativ av gruppering.

  Enstaka kraftverk: ett vindkraftverk
  Liten grupp: mellan två och tio kraftverk
  Stor grupp: mellan elva och femtio kraftverk

- ***Elpriser***
  Idag kostar elektriciteten i Sverige ungefär 50 - 65 öre per kWh, beroende på elleverantör och var i Sverige man bor. Att förändra vindkraftens egenskaper skulle innebära att elpriserna förändras. För att du lättare ska kunna ta ställning till hur de olika prisalternativ som du ställs inför skulle påverka ditt hushålls elkostnader visar vi två olika exempel. I det första exemplet, se tabell 1 nedan, visar vi hur fem olika prisförändringar skulle påverka elkostnaderna för ett hushåll som bor i en villa som inte värms med elektricitet och som förbrukar cirka 400 kWh per månad. Ett plustecken betyder att elektriciteten blir dyrare och ett minustecken betyder att elektriciteten blir billigare.

*Tabell 1. Hushåll i villa som **inte** värms med el, förbrukar cirka 400 kWh per månad*

Prisförändring per kWh	Förändring i elkostnad per månad	Förändring i årlig elkostnad
+ 15 öre	+ 60 kronor	+ 720 kronor
+ 10 öre	+ 40 kronor	+ 480 kronor
+ 5 öre	+ 20 kronor	+ 240 kronor
- 5 öre	- 20 kronor	- 240 kronor
- 10 öre	- 40 kronor	- 480 kronor

I det andra exemplet, se tabell 2 nedan, visar vi hur samma prisförändringar skulle påverka elkostnaderna för ett hushåll som bor i en villa som värms med elektricitet och som förbrukar cirka 2000 kWh per månad.

*Tabell 2. Hushåll i **eluppvärmd** villa, förbrukar cirka 2000 kWh per månad*

Prisförändring per kWh	Förändring i elkostnad per månad	Förändring i årlig elkostnad
+ 15 öre	+ 300 kronor	+ 3600 kronor
+ 10 öre	+ 200 kronor	+ 2400 kronor
+ 5 öre	+ 100 kronor	+ 1200 kronor
- 5 öre	- 100 kronor	- 1200 kronor
- 10 öre	- 200 kronor	- 2400 kronor

NU VILL VI ATT DU VÄLJER MELLAN TVÅ OLIKA ALTERNATIV AV VINDKRAFTPRODUCERAD EL

Överväg nu alternativ A och alternativ B nedan noggrant. Gå gärna tillbaka till sidorna x - x för att påminna dig om vad de olika alternativen innebär. Markera sedan vilket alternativ du skulle ha valt om de två alternativen var de enda du kunde välja mellan när du senast valde elleverantör. Ett plustecken framför en prisförändring innebär högre elpris medan ett minustecken innebär en prissänkning.

12) Under förutsättning att du endast hade kunnat välja mellan nedanstående två alternativ när du senast valde elleverantör, vilket av alternativen, A eller B, skulle du då ha valt? Markera med kryss.

	Alternativ A	**Alternativ B**
Ljudnivå	40 decibel	40 decibel
Lokalisering	fjällnära	på land
Höjd	100 meter	60 meter
Gruppering	liten grupp	Enstaka
Prisförändring per kWh	*+ 5 öre*	*0 öre*

( ) Alternativ A ( ) Alternativ B

13) Under förutsättning att du endast hade kunnat välja mellan nedanstående två alternativ när du senast valde elleverantör, vilket av alternativen, A eller B, skulle du då ha valt? Markera med kryss.

	Alternativ A	**Alternativ B**
Ljudnivå	30 decibel	40 decibel
Lokalisering	fjällnära	på land
Höjd	100 meter	60 meter
Gruppering	stor grupp	enstaka
Prisförändring per kWh	*- 5 öre*	*0 öre*

( ) Alternativ A ( ) Alternativ B

14) Under förutsättning att du endast hade kunnat välja mellan nedanstående två alternativ när du senast valde elleverantör, vilket av alternativen, A eller B, skulle du då ha valt? Markera med kryss.

	Alternativ A	**Alternativ B**
Ljudnivå	40 decibel	40 decibel
Lokalisering	till havs	på land
Höjd	100 meter	60 meter
Gruppering	liten grupp	enstaka
Prisförändring per kWh	*+ 15 öre*	*0 öre*

( ) Alternativ A ( ) Alternativ B

15) Under förutsättning att du endast hade kunnat välja mellan nedanstående två alternativ när du senast valde elleverantör, vilket av alternativen, A eller B, skulle du då ha valt? Markera med kryss.

	Alternativ A	**Alternativ B**
Ljudnivå	30 decibel	40 decibel
Lokalisering	på land	på land
Höjd	100 meter	60 meter
Gruppering	enstaka	enstaka
Prisförändring per kWh	*- 10 öre*	*0 öre*

( ) Alternativ A ( ) Alternativ B

16) Under förutsättning att du endast hade kunnat välja mellan nedanstående två alternativ när du senast valde elleverantör, vilket av alternativen, A eller B, skulle du då ha valt? Markera med kryss.

	Alternativ A	**Alternativ B**
Ljudnivå	40 decibel	40 decibel
Lokalisering	till havs	på land
Höjd	100 meter	60 meter
Gruppering	stor grupp	enstaka
Prisförändring per kWh	*- 10 öre*	*0 öre*

( ) Alternativ A ( ) Alternativ B

17) Under förutsättning att du endast hade kunnat välja mellan nedanstående två alternativ när du senast valde elleverantör, vilket av alternativen, A eller B, skulle du då ha valt? Markera med kryss.

	Alternativ A	**Alternativ B**
Ljudnivå	40 decibel	40 decibel
Lokalisering	fjällnära	på land
Höjd	60 meter	60 meter
Gruppering	stor grupp	enstaka
Prisförändring per kWh	*- 10 öre*	*0 öre*

( ) Alternativ A ( ) Alternativ B

18) Vilka av nedanstående alternativ beskriver på ett bra sätt hur du resonerade när du valde mellan de olika alternativen i de föregående sex frågorna?

a. Jag gjorde en helhetsbedömning av samtliga effekter och valde det alternativ där jag fick mest för pengarna.

( ) ja ( ) nej

b. Jag tycker att ljudeffekterna är de viktigaste och valde hela tiden det alternativ som hade lägst ljudnivå.

( ) ja ( ) nej

c. Jag tycker att hur vindkraftverkens placeras (fjällnära, till havs eller i landskapet) är det viktigaste och valde endast alternativ utifrån det.

( ) ja ( ) nej

d. Jag tycker att vindkraftverkens höjd är det viktigaste och valde endast alternativ utifrån det.

( ) ja ( ) nej

e. Jag tycker att hur vindkraftverken grupperas (enstaka eller i grupp) är det viktigaste och valde endast alternativ utifrån det.

( ) ja ( ) nej

f. Jag tycker att låga elpriser är det viktigaste och valde därför hela tiden det billigaste alternativet.

( ) ja ( ) nej

g. Jag skulle vilja betala mer för att få bättre vindkraft men jag har inte råd.

( ) ja ( ) nej

h. Jag gjorde mina val utifrån vad jag tror är bäst för hela samhället, inte utifrån vad jag som konsument kan eller vill betala för vindkraft.

( ) ja ( ) nej

i. Annat, nämligen: ………………………………………………………………………..

…………………………………………………………………………………………

…..…..……………………………………………………………………………………

NÅGRA FRÅGOR OM DIN BAKGRUND

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19) Är du kvinna eller man? ( ) kvinna ( ) man

20) Hur gammal är du? ____________ år

21) Vilken utbildning har du?

( ) Grundskole- eller folkskoleutbildning

( ) Gymnasieutbildning

( ) Folkhögskoleutbildning

( ) Högskole- eller universitetsutbildning

( ) Annan: ____

22) Hur många personer ingår i ditt hushåll, inklusive dig själv? ________ personer

23) Hur många barn (under 18 år) ingår i ditt hushåll? _________ barn

24) Värms din bostad med elektricitet?

( ) ja ( ) nej ( ) vet ej

25) Vistades du i de svenska fjällen vid något tillfälle förra året?

( ) ja ( ) nej ( ) vet ej

26) Vistades du i den svenska skärgården vid något tillfälle förra året?

( ) ja ( ) nej ( ) vet ej

27) Ungefär hur stor är ditt hushålls sammanlagda inkomst per månad, före skatt? (Inkludera alla slags inkomster, till exempel eventuell sjukpenning, föräldrapenning, studiemedel eller arbetslöshetsersättning etc).

( ) Mindre än 5 000 kronor

( ) Mellan 5 001 och 10 000 kronor

( ) Mellan 10 001 och 15 000 kronor

( ) Mellan 15 001 och 20 000 kronor

( ) Mellan 20 001 och 25 000 kronor

( ) Mellan 25 001 och 30 000 kronor

( ) Mellan 30 001 och 40 000 kronor

( ) Mellan 40 001 och 50 000 kronor

( ) Mellan 50 001 och 60 000 kronor

( ) Mellan 60 001 och 70 000 kronor

( ) Mer än 70 000 kronor

Tack för din medverkan!

Använd gärna utrymmet nedan om du har några övriga kommentarer eller synpunkter.

Appendix C: RESULTS WITH ORDER DUMMY INCLUDED IN THE MODEL

Table C Random Effects Binary Probit Model Results with Dummy for Order Included

Variable	***Coefficient***	***t-statistic***
Noise	0.06*	1.69
Mountain	-0.19***	-3.96
Offshore	0.31***	6.04
Height	0.02	0.63
Small	0.14**	2.42
Large	-0.15***	-2.87
Large offshore	0.06	1.13
Small mountainous area	-0.16'*	-1.90
Visit mountains	-0.24***	-3.07
Price	-0.09***	-26.58
Environmental organization	0.25	1.30
Near	0.42**	2.05
Age	-0.007***	-3.26
Socially motivated choice	0.41***	3.21
Order	0.07	1.50
Rho	0.57***	21.56
Sample size: 488 individuals		
Log-likelihood: -1419		
Restricted log-likelihood: -1663		
Chi-squared: 488		

*** Statistically significant at the 1 percent level.

** Statistically significant at the 5 percent level.

* Statistically significant at the 10 percent level.

Appendix D: RESULTS BASED ON RESTRICTED SAMPLE

Table D Random Effects Binary Probit Model Results from the Restricted Sample

Variable	***Coefficient***	***t-statistic***
Noise	0.08**	2.38
Mountain	-0.21***	-4.23
Offshore	0.28***	5.68
Height	0.05	1.18
Small	0.11	1.83
Large	-0.10*	-1.91
Large offshore	0.10	1.50
Small mountainous area	-0.13**	-2.15
Visit mountains	-0.25***	-3.27
Price	-0.08***	-24.71
Environmental organization	0.03	0.23
Near	0.15	1.05
Age	-0.002	-1.15
Socially motivated choice	0.36***	3.29
Rho	0.35***	10.46
Sample size: 390 individuals		
Log-likelihood: -1227		
Restricted log-likelihood: -1305		
Chi-squared: 156		

*** Statistically significant at the 1 percent level.

** Statistically significant at the 5 percent level.

* Statistically significant at the 10 percent level.