FACULTY OF SCIENCE
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MASTER'S THESIS

How Does Landscape Quality Impact Residents' Preferences for Onshore Wind Farms in their Community? - A Choice Experiment Approach.

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CONTENT

ACRONYMS

CE	choice experiment
EU	European Union
G8	Group of Eight
GGs	greenhouse gases
GGEs	greenhouse gas emissions
GIS	Geographic Information Systems
MWTP	marginal willingness to pay
NIMBY	'Not in my backyard'
p.	page(s)
RP	Revealed Preferences
SP	stated preferences
SWF	social welfare function
TEV	total economic value
WTA	willingness to accept
WTP	willingness to pay

FIGURES

T A B L E S

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1. INTRODUCTION

1.1 Background and Motivation

Over the last two decades climate change mitigation has become a top priority for both, national governments as well as supranational organisations like the European Union or G8. The promotion of non-fossil fuels is a widely used policy instrument serving that purpose. Consequently following this idea, the Danish government developed the "most ambitious energy plan in the world" – a scenario according to which the country will entirely be supplied by energy generated from renewable fuels by 2050 (Energi Styrelsen, 2012). What might sound illusory has been proven technically feasible (Danish Energy Agency, 2014). The government's plan relies on a wide range of technologies for energy production like biomass, hydro energy or bio energy (ibid.). The focus, however, lies on wind power. By 2020 already half of the electricity consumed by Danish households and companies is supposed to be generated by wind power (Ministry of Climate, Energy and Builting, 2012) .

Compared to Norway or Sweden, Denmark has quite modest wind speeds in most parts of the country (ESPON ReRisk, 2010). Nevertheless, wind energy is the foundation for Denmark's future fossil fuel independence. Apart from wind power being the cheapest source of renewable energy at the moment, Denmark's vast experience in the field might be the reason to follow this path (ECOFYS, 2014).

As a reaction to the oil crisis in 1973, a grassroots movement of Danish wind energy pioneers started to develop turbines and lobbied the government as to create an environment supporting the diffusion of wind turbines (McLaren Loring, 2007). A policy of subsidies, tax exemptions and fixed prices was designed to encourage cooperatives of local citizens builting wind parks in their communities (Toke & Lauber, 2007). In the mid-90s, however, public support for wind power declined. The major reasons were relaxed property restrictions allowing single farmers to built turbines on their land without compensating nearby neighbours (Mendonca, Lacey, & Hvelplund, 2009). With the further upscaling of wind power, people were even less involved in the planning process, which resulted in more and more protests against planned wind power sites[1].

In order to gain fossil fuel independency, the wind power capacity in Denmark has to increase by 1800 MW over the next decades (Klima, Energi- og Bygningsministeriet, 2012). Meanwhile, the implementation of turbines of a certain size requires the agreement of citizens living in the respective community (Danish Energy Agency, 2009). In today's climate of strong resistance to local wind power projects, realizing the ambitious plans on wind power expansion will hence be rather challenging.

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[1] see for example the national association "Naboer til Vindmøller" (http://www.naboertilvindmoller.dk/index.html)

One of the guidelines for Denmark's energy transformation process is cost-efficiency (Danish Energy Authority & Transport- og Energiministeriet, 2007). Hence, decision-making aims for designing policies and regulations as to maximize welfare. Apart from technological improvements, the social net benefits of wind turbines can also be increased by minimizing their environmental impacts. Negative externalities associated with wind turbines, among others, are habitat destruction, shadow flicker, noise pollution or visual amenities (McLaren Loring, 2007; Wolsink, 2000).

By now, most of these issues have been countered (as far as possible) with strict regulations for the planning processes as well as environmental legislation (Danish Energy Agency, 2009). One of the externalities, which has long been neglected, though, is the problem of visual intrusion. In many studies asking for negative impacts of turbines the majority of the respondents named visual pollution as the major disadvantage of wind power, both on a general as well as on a local level (see e.g. Dimitropoulos & Kontoleon, 2009; Wolsink, 2007).

There is no way to improve turbines as to be more visually appealing. With the prerequisite to significantly increase wind power capacity, there also is no chance of locating all turbines in completely unpopulated areas. Hence the aim is to minimize visual disturbances. If future wind farms are designed corresponding to people's preferences, the social net benefits of wind power can be increased. Anticipating citizens' taste for the siting of turbines is likely to increase their approval of planned projects. The support is needed to implement highly efficient (and thus taller) turbines and thereby meet the goal of fossil fuel independency. Moreover, founding wind energy planning on public preferences also seems reasonable considering the enormous subsidies for wind power financed from taxes – the stakeholders' interests have to be taken into account (Danish Energy Agency, 2009).

For all these reasons, the present master thesis aims at exploring individuals' preferences for visual characteristics of wind turbines in Denmark. The analysis will cover standard characteristics such as height, proximity to nearby residences and habitat density. Particular emphasis will be put on the type of landscape turbines are sited in. More precisely, it will be investigated whether landscape quality impacts residents' preferences for onshore wind farms in their community. Do people who live in urban regions have a higher tolerance for artificial landmarks like wind turbines than residents of rural areas? Are persons who are surrounded by a particularly beautiful scenery especially sensitive to visual disturbances such as turbines? The results of the analysis could give valuable insights for future wind power planning with respect to where to site wind farms as to minimize public opposition. Thereby, the findings could make a contribution to granting Denmark fossil fuel independency.

1.2 Methodology

Assessing the external cost of wind power, the European Commission highly prioritized the visual intrusion of turbines perceived by residents (European Commission. Directorate for Science, Research and Development, 1995). From an economic perspective, the reduction in environmental quality due to turbines is an external cost since it affects neighbours and passing individuals and is not solely borne by the turbine owner. In order to calculate the welfare effects of wind power projects, the degradation of environmental quality has to be valued. This thesis aims at analysing whether the loss of environmental quality caused by the visual attributes of turbines varies according to the type of landscape the turbine is located at.

The evaluation of changes in environmental quality as well as eliciting consumers' preferences for non-market environmental goods are a central task of environmental economics. Over the last decades, several techniques for the valuation of these goods have been developed. They are applied in various sectors of politics such as energy policies, infrastructure planning or public transport and are often used in the context of cost-benefit-analysis (CBA).

The evaluation methods are divided into revealed preference (RP) and stated preference (SP) approaches. The former builts on market transactions closely related to the good which has to be evaluated (Freeman, 2003). Thus, revealed preference techniques use observations of consumers' actual behaviour to find the value of environmental goods. In contrast, SP models ask respondents to make hypothetical decisions on how much money they would spend on non-market goods (ibid.).

In the present context, a SP technique was applied for environmental quality is mainly constituted of non-use values, which can only be estimated by such methods. In the past, few studies employing hedonic pricing, a RP approach, have been conducted. I will argue why these techniques might not be appropriate to evaluate the change of environmental quality caused by the visual intrusion of wind turbines.

The stated preference method chosen for this study is a choice experiment (CE). It allows us to evaluate the characteristics of a good separately. For the purpose of wind power planning, it would not be helpful to know what respondents think about a certain scenario as a whole but how they value the distinct visual attributes, e.g. the height of the turbine. Furthermore, including a monetary attribute in the CE allows us to calculate the 'marginal willingness to pay' for every single feature (Hanley, Shogren, & White, 2007). This information is necessary to compute the welfare effects of planned wind power projects and choose the design yielding the highest social value.

1.3 Scope and Limitations of the Study

The Danish government developed a plan to supply the entire country with renewable energy by 2050 and defined milestones structuring the transformation process (Ministry of Climate, Energy and Builting, 2012).

One of these landmarks is the expansion of wind power capacity until 2020 (ibid.). The present paper does not intend to examine whether the planned development of wind energy is a Pareto-efficient goal. Instead, the analysis will focus on how the target can be realized in a Pareto-efficient manner, by exploring public preferences for visual characteristics and the placing of wind turbines.

The survey, this paper is based on, covers both on- and offshore wind power. The analysis, however, will only cover turbines situated on land. When asked to choose whether future wind parks should be built on-land or offshore, most respondents chose the second option (Söderholm, 2013). Although locating turbines offshore has advantages like higher wind speeds, it is also much more costly to generate and transport energy using this technology (ECOFYS, 2014). Therefore a substantial part of wind power will always be produced on land, which makes it necessary to examine the preferences for the environmental qualities of onshore wind power. The insights can then be used to design wind energy schemes corresponding to public preferences as to increase societal acceptance and reduce protest.

Prior studies on visual preferences for wind energy usually distinguish between turbines located in mountainous area, open landscape or off the coast. Like argued before, onshore capacities have to be created in Denmark in order to gain fossil fuel independency. That being the case, a more differentiated scrutiny is needed to identify locations where turbines can be erected without being hindered by locals' resistance.

Most of the literature on wind power externalities published so far, did not elicit preferences referring to specific projects. Instead, respondents answered rather general questions without feeling affected by potential externalities of turbines. An essential finding of wind energy research is, however, that preferences highly depend on whether the topic is dealt with on a general level or with respect to a specific facility in peoples' neighbourhood. This NIMBY-phenomenon[2] is anticipated in our survey: participants are asked to imagine the turbines would be put up in their own or a neighbour municipality so that they would actually experience the consequences of living in the vicinity of a turbine.

Thus, the decrease in environmental quality is rather evaluated from the perspective of 'affected' people than from a societal point of view. Since the results ought to be used to evaluate the welfare loss of residents actually living close to wind turbines, our approach promises better results than prior studies.

[2] NIMBY is the abbreviation for "Not in my backyard". It describes the phenomenon of people generally supporting wind power but rejecting the construction of facilities in their own neighbourhoods.

1.4 Outline

In the next section, we will lay the welfare economic foundation for the analysis to follow. Moreover the basic ideas behind economic value and economic valuation techniques will be discussed. The third chapter presents the theoretical framework for choice experiments as an instrument of eliciting preferences as well as the econometric model applied. Thereafter, we will review some concepts of landscape values, give a brief overview of social costs related to wind power and then present prior studies on visual preferences for wind energy. The fifth parts will describe the experiment's set up, followed by a presentation of our results and a concluding discussion.

2. THEORETICAL AND METHODOLOGICAL FRAMEWORK

2.1 Welfare Economic Framework

A central principle of welfare economics stems from neoclassical microeconomics: individuals strive for maximizing their own well-being (utility). As a deduction, politics face the challenge of how to allocate the state's resources as to benefit every member of society as much as possible. With respect to wind energy, authorities have to set the rules for wind power planning. Lower costs of operating tall turbines or locating offshore turbines close to the coast have to be traded off against the opposing preferences of citizens. Welfare Economics, the normative branch of economics, has been developed to solve these kinds of issues (Perman, Ma, McGilvray, & Common, 2003)[3].

2.1.1 Utility

The normative evaluation of policies and projects requires moral judgements to indicate what is right and wrong. Welfare Economics are commonly based on utilitarian norms. According to this philosophy, society's welfare is the sum of every individual's utility and ought to be maximized. The term utility describes the satisfaction a person gains from consuming a bundle of goods - it measures a person's state of happiness (Frank, 2006). Utility cannot be measured objectively. Only the respective individual can judge whether and to which extend its utility rises or decreases when the composition of its consumption bundle changes. Hence, it is necessary to know people's preferences to be able to calculate the welfare effects of policies and projects.

There are two classes of utility functions used in welfare economics: cardinal and ordinal ones. Ordinal utilities allow for a ranking of alternatives, e.g. scenario A is better than scenario B (Perman et al., 2003). It is a pure qualitative measure whereas cardinal utility functions enable quantitative comparisons of how much a person prefers scenario A to scenario B (ibid.). Therefore cardinal utility functions permit interpersonal comparisons.

Projects like the implementation of wind turbines affect the utility of a large number of individuals, for instance wind turbine owners and producers, consumers of wind power, people living in the vicinity of turbines, all tax payers since they finance wind power subsidies etc. The present analysis aims at exploring those stakeholders' preferences for visual attributes of wind turbines in order to compute the welfare effects of different wind power plant designs as to choose the one yielding the highest welfare.

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[3] The entire section draws heavily on chapter 3 in this book.

2.1.2 Welfare Maximization

Like argued before, the macroeconomic idea of individuals striving to maximize their utility is translated to the state level through the government seeking to maximize social welfare.

New welfare economics follows the idea of allocating resources, goods and services as to establish Pareto-optimality (Freeman, 2003). A Pareto-optimum is reached when a reallocation of resources intended to increase one person's utility cannot be performed without decreasing the utility of another person. Thus, this approach prevents interpersonal utility comparisons and allows for an infinite number of Pareto-efficient allocations in an economy.

Besides the multitude of possible solutions, the Pareto-optimality approach is often criticized for not being applicable in actual decision making since there will almost always be some people who lose and some who gain from a certain policy or project. To overcome this obstacle, Kaldor and Hicks developed a decision criterion based on Pareto-optimality. Kaldor's rule tests for whether it is possible that the ones who gain from a policy can compensate the losers so that they are as well off as before while after the compensation the winners are still better off than before. If this form of compensation is possible, the policy should be realized. Hicks, in contrast, proposed a criterion verifying whether the losers can bribe the winners as to prevent the policy from happening so that the winners have at least the same utility while the losers are still better off than they would be if the policy was realized. If this form of bribe is possible, the policy should not be put to practice. The criteria by Hicks and Kaldor sometimes give contradicting results giving rise to a third approach - the Kaldor-Hicks-Scitovsky-Test. A policy passes this test if Kaldor's rule is fulfilled (winners can compensate losers and still be better off) and Hick's criterion is not (losers can't bribe winners to prevent the change and still be better off). One drawback of all compensation tests is that they deal with hypothetical payments. It is thereby possible to separate the question of whether a policy or a project is efficient from the distributional consequences.

Distributional issues can, however, be dealt with by aggregating individual utilities using a social welfare function (SWF). SWFs account for distributional justice since their functional form reflects "society's judgement of the relative worth of each person's utility" (Perman et al., 2003, p.65). A popular form of an utilitarian SWF assigns every individual the same worth whereas other forms weigh underprivileged people's utility more than the utility of rich individuals. SWFs require cardinal utility functions.

2.1.3 Market Failure

The 1st Fundamental Theorem of Welfare Economics states that perfect markets result in Pareto-optimal allocations of resources, services and goods. Consumers express the utility they gain from the consumption of a certain good by their willingness to pay for the good. Ergo market prices reflect consumers' mean willingness to pay, which corresponds to the average utility gained from consumption.

The aforementioned only holds for complete markets characterized by perfect competition, no information costs, no transaction costs and well-defined property rights (Hanley et al., 2007). If one or more of these requirements are violated, markets cannot ensure Pareto-optimality. Regarding environmental goods, market failure is often caused due to insufficiently determined property rights. The characteristic most often infringed is "exclusiveness". Well-defined property rights demand all costs and benefits resulting from the use of a resource to accrue to the owner (ibid.). With respect to environmental goods, users often impose externalities on other stakeholders. They cause a change of the good's quality or quantity without baring the associated costs or benefits but impose them on society.

Externalities can arise due to the public or common good nature of most environmental goods. In general, all commodities are classified after the property of rivalry and excludability (Garrod & Willis, 1999). Rivalry refers to whether the consumption by one individual reduces other individuals' potential use of the good. All typical consumption commodities fall into this category since if one person buys the good someone else cannot buy it anymore. A good is excludable if consumers can be prevented from access. The standard example of a non-excludable good is national defence since no citizen can be excluded from being defended by the national army (ibid.). The following table shows all classes of commodities.

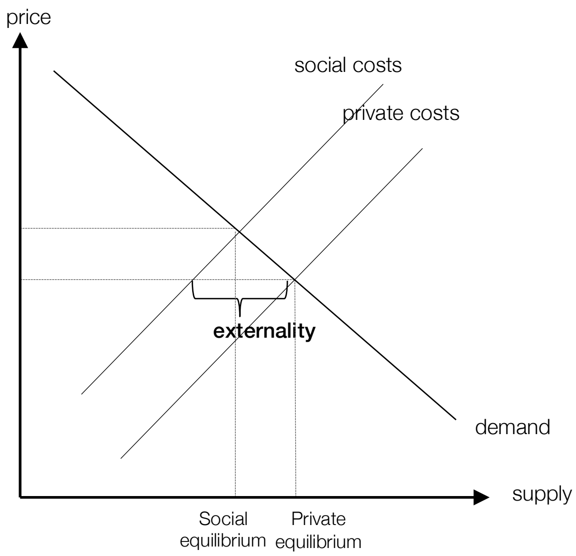
Classification of goods [Table 2.1]

		Excludability	
		Yes	No
Rivalry	yes	Private goods e.g. hot dogs, cars, houses, congested toll roads	Common goods e.g. fishing grounds, congested non-toll roads
	no	Club/ semi-public goods e.g. bridges, swimming pools, non-congested toll roads	Public goods e.g. national defence, non-congested non-toll roads

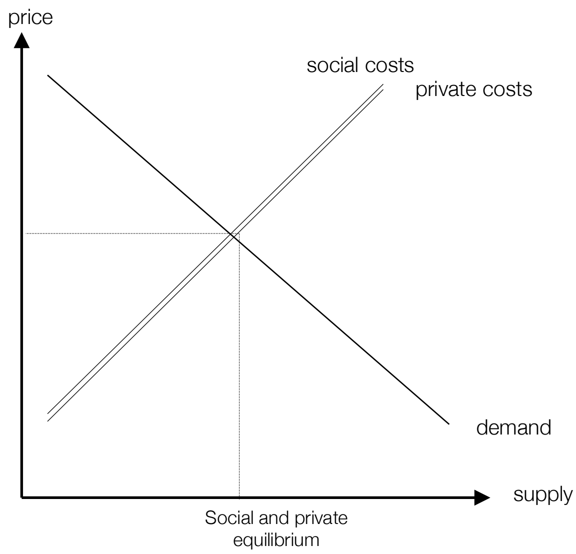
Source: Garrod & Willis (1999)

Non-excludability gives rise to negative externalities because the persons causing environmental damage cannot be hold liable. Ergo, environmental costs are not part of producers' profit maximization calculations – the social production costs exceed the private ones. This again leads to an oversupply of the good because the marginal costs, the producer faces, are too low (see figure 2.1). Market failure causes economic inefficiency since the market outcome is not socially optimal.

In order for the social equilibrium being equal to the private one, the negative externality has to be internalized so that the producer faces the same costs like society. Hence, the government has to strongly enforce property rights. Environmental goods are usually commonly owned. If someone uses and thereby decreases them in quantity or quality, all other owners (society) have to be compensated for the damage. In reality, people often do not claim their legitimate compensation due to high transaction costs or a lack of political support in the enforcement of property rights. Over the last years though, more and more compensation instruments have been introduced. Polluters, for instance, pay for the damage they cause through carbon tax or pollution permits and BP has to take responsibility for the 2010 Gulf of Mexico oil spill by paying high compensation sums. These measures make the producers anticipate the damage they bring about and thereby close the wedge between social and private costs, which results in a socially optimal and hence efficient market outcome. The collected money is usually not paid off to all affected individuals but invested in measures to compensate the incurred damage such as carbon sequestration projects.



Market in the Presence of Externalities [Figure 2.1]



Market with Internalized Externalities[4] [Figure 2.2]

Source: based on Perman et al., 2013

Visual pollution is one of the environmental externalities caused by wind power. It causes a reduction of environmental quality. Environmental quality is a public good. It is commonly owned and every member of

[4] Here the social cost function is equal to the private cost function. The gap only serves the purpose of illustration.

society has the right to the status quo level of quality. Hence, at least technically, turbine operators have to compensate society for the damage caused by the presence of turbines. That way, the external costs are internalized and made part of the operator's economic appraisal, which results in a Pareto-optimal outcome. Visual intrusion of turbines is a locally limited externality. Therefore compensation should be paid to nearby residents who actually suffer from it. Obligatory compensation payments would, however, significantly increase the operation costs of wind energy and thus reduce quantity. This is diametrically opposed to the energy supply targets of the Danish government requiring a massive expansion of wind power. Offering no compensation at all will not solve the problem but result in on-going protests on the part of citizens suffering from the visual impacts of turbines. A possible solution could be compensation paid by the government, basically a form of subsidization. Whoever finances the recompenses has an incentive for considering people's preferences in siting turbines as to minimize the payments.

Apart from the environmental costs like visual disamenity, habitat destruction, shadow flicker, noise pollution etc., wind energy also brings about a major environmental benefit: producing electricity by using wind power avoids the emission of greenhouse gases linked to other energy production technologies. This positive externality is partly internalized by customers paying higher prices for green electricity. Avoided GGEs are a classic example of a public good though - strictly seen, every human being benefits from the good which leads to the marginal benefits for a single user being really small. The "green electricity" premium customers' pay exceeds the marginal benefit they gain. Nevertheless, the premium is not sufficient to ensure the provision of a socially optimal level of wind energy. As a further means of internalizing the externality, governments pay subsidies to wind power producers, e.g. in the form of fixed feed-in tariffs.

Independent of how environmental externalities are internalized, in order to realize wind energy expansion cost-efficiently, like demanded by Danish politics, they have to be included into welfare calculations. Specifically referring to this thesis' topic, the costs of visual pollution induced by turbines have to be measured. Like explained above, we cannot drawback on market prices for evaluation but need a different approach.

2.1.4 Welfare Measures[5]

The aim is to find the monetary equivalent of the change in individuals' utility caused by the deterioration of environmental quality. Therefore utility changes are valued in terms of welfare measures, which can then be expressed in monetary units.

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[5] The entire paragraph builds on chapter 11 in Pearce, Atkinson and Mourato, 2006 and Freeman, 2003.

Like introduced above, individuals' utility levels depend on to which extend the composition of their consumption bundle corresponds to their preferences. It is further assumed that utility rises with every unit consumed – the more the better (Freeman, 2003). Also, a person can substitute a component of its consumption bundle by a certain quantity of a different commodity (ibid.). Here we suggest the consumption bundle to consist of two elements: good X is the environmental good whereas good Y is income, which represents infinite combinations of consumption goods. U_1, U_2, and U_3 are utility levels ranked from low to high. The utility curves represent combinations of good X and Y yielding the same utility. In order to value quantity changes in the provision of the environmental good, we elicit the chance in income (good Y) which substitutes the quantity change of good X as to hold utility constant. This concept was developed by Hicks as a means to isolate the substitution effect from the income effect of quantity and price changes (Perman et al., 2003). Here we only cope with the former since price changes are mostly irrelevant alluding to environmental goods. The idea is that for an increased quantity of the environmental good, people are willing to give up some share of their income and vice versa. People substitute money with the environmental good and the other way around.

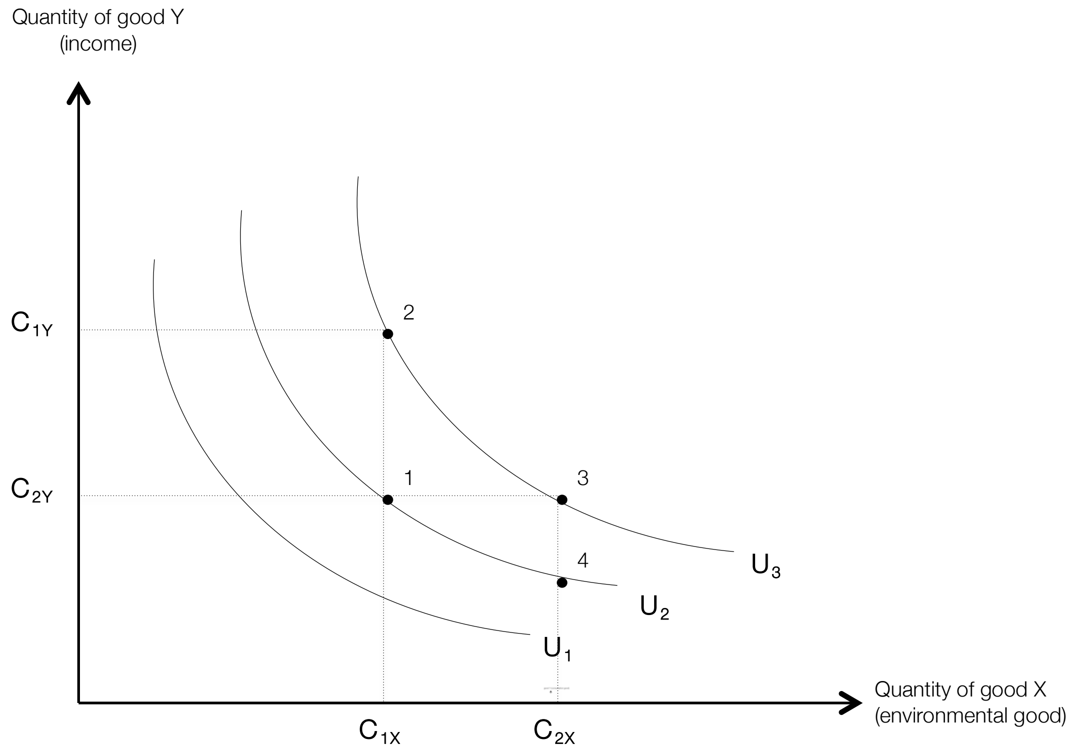
We first assume the original point of consumption being 1 and the individual being entitled to the status quo[6]. If the provision of the environmental good then increases from C_{1X} to C_{2X}, holding utility constant at U_2, the composition of the consumption bundle corresponds to C_{2X} and C_{2Y} (point 2). Hence the increased consumption of good X was substituted by a decreased consumption of good Y equating 4-3 which is the amount of money the consumer is willing to give up for the respective increase of the environmental good. Vice versa, assuming the same property rights and original consumption at 3, a decline in provision of good X from C_{2X} to C_{1X} leads to the consumption point 1. The individual has, however, the right to the ex ante utility U_3. To get back to that level (point 2) the consumer has to be compensated with an increased quantity of good Y (amount 2-1), which corresponds to his willingness to accept the loss in the provision of good X.

We now turn to a scenario where individuals are entitled to the post-change situation. Assuming the initial consumption point 1, an increase in the quantity of the environmental good would then lead to consumption point 3. According to the property rights assumption, the individual has the right to the quantity increase of good X. Therefore we are asking by how much of good Y (income) the individual has to be compensated to generate the same utility as if the amount of good X would have increased (U_3). Holding the quantity of good X constant at C_{1X} the graph shows that the provision of good Y has to rise up to C_{2y} to elevate the individual's utility up to U_3. The willingness to accept the foregone benefit is therefore equal to 2-

[6] The variables refer to figure 2.3 on the following page.

1. For the last case, the individual initially consumes at point 3. If the provision of the environmental good then declines, the new consumption point would be point 1. We are now looking for the quantity of good Y which corresponds to the utility loss caused by the decreased quantity of X. Holding the quantity of good X constant at the initial level C_{2x}, the quantity of good Y has to decrease from point 3 to 4 for the individual to experience the same loss. Hence, the individual would be willing to pay 4-3 to prevent the loss.

Indifference Curve Illustrating Welfare Measures [Figure 2.3]



Source: based on Perman et al., 2013

The following table gives an overview over the welfare measures:

Overview of Welfare Measures [Table 2.2]

	Property right to status-quo utility level	Property right to change in utility level
Quantity increase	Compensating Surplus (WTP to obtain the benefit)	Equivalent Surplus (WTA to forego the benefit)
Quantity decrease	Compensating Surplus (WTA to tolerate the loss)	Equivalent Surplus (WTP to prevent the loss)

Source: Pearce, Atkinson, & Mourato, 2006

In the context of the visual impact of wind power, it is disputable whether residents have a right to the pre-turbine environmental quality level. On the one hand, turbines are visually intruding the landscape rather strongly and residents might not have expected turbines to be built in their neighbourhood. On the other hand the expansion of wind power is politically driven and supposed to benefit the whole society. One could therefore argue that if all citizens benefit from wind power through reduced pollution etc. they also ought to bare some of the environmental costs. It might, however, be considered unfair that only people in the vicinity of turbines have to bear these costs whereas people living in cities are most unlikely to have a turbine built in their neighbourhood. Referring to the categories of welfare measures, people living close to turbines face a quantity decrease even if environmental quality or scenic beauty can hardly be measured quantitatively. Depending on the distribution of property rights, the utility loss caused by the visual impact of turbines can be measured by compensating (WTA) or equivalent surplus (WTP).

2.2 Economic Value[7]

Like for policies or projects in general, the economic value of a good or service can only be estimated with respect to its contribution to a certain target. Since economic valuation is rooted in welfare economics, economic value depends on a good's impact on human well-being. The theory thus contradicts the concept of an intrinsic value generated by the mere existence of an environmental asset. Instead, all goods and services simply serve as instruments for humans to increase their utility.

All aspects of a project or policy, which increase human well-being, are referred to as benefits whereas all elements decreasing peoples' utility are treated as costs. The sum of all costs and benefits is the total economic value (TEV) of a project. It measures the scheme's impact on welfare. Figure 2.4 below illustrates the different components of the TEV. We broadly differentiate between use and non-use values. Option values are often understood as belonging to neither of these categories. An option value expresses the possibility of using an environmental good - it covers potential use. If for example someone thinks of having kids in the future he might attribute optional value to having a playground in his neighbourhood. Actual and planned use of a service or good, on the contrary, belongs to the category of use values. Direct use means active usage while indirect use describes activities where benefits are generated without active participation of the beneficiary. Carbon sequestration, for instance, is an indirect use value of forests because it happens without human interference. Non-use values are generally more abstract which also makes it difficult to measure them (see next section). Existence value can be understood as generating utility from the pure fact that an environmental good, e.g. polar bears, exists. It implies that the respective individual will never

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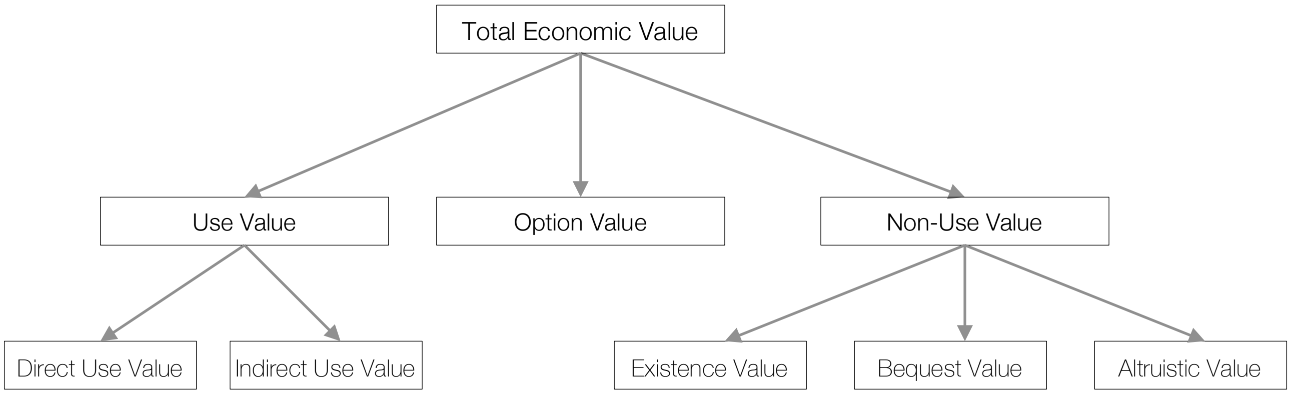
[7] This section builts on chapter 6 in Pearce, Atkinson & Mourato (2006) as well as chapter 5 Freeman (2003).

actually use the good (see any polar bears). The bequest value suggests that people gain utility from knowing that their descendants will be able to use a certain good. Coming back to the polar bear example, someone might get satisfaction from knowing that their children and grandchildren will have the chance to see polar bears in their natural habitat. If a person's wellbeing is increased because he knows that someone else benefits from a certain good, the good for him has an altruistic value.

The Components of the Total Economic Value [Figure 2.4]



Source: based on Freeman 2003 and Pearce, Atkinson & Mourato (2006)

Like most goods, the total economic value of wind power (TEV) includes many of the components described above. The major benefits are avoided greenhouse gas emissions and, to a lesser extent, the creation of job opportunities. The former refers to wind turbines producing electricity without emitting greenhouse gases (in the stage of operation). Hence, as a substitute for conventional technologies, wind energy avoids pollution and the associated damages and thereby benefits every human being. Since people are not actively involved in the process, it is an indirect use value. Indeed the marginal benefit of avoided emissions for a single person is negligible. Nevertheless customers are willing to pay a premium for being supplied with green energy, which indicates that they attribute an altruistic value to renewables. In this context, we can also argue for wind power having a bequest value. The energy transition in Denmark, for example, will take until 2050 but already consumes a large share of the state's resources now. Citizens are supporting the project since they care about future generations. Individuals who are employed in the wind power sector are direct beneficiaries (direct use value).

Turning to the cost side, the wind power literature focuses on the destruction of flora and fauna, health hazards (e.g. noise and shadow flicker) and visual impacts. The following table presents some values referring to these costs but is by no means exhaustive.

Social Costs of Wind power and Related (Non-)Use Values [Table 2.3]

	habitat destruction	**health hazards**	**visual impacts**
Direct use value	• bird watching • botanical excursions	• reduced quality of life	• profits from tourism • enjoying scenic beauty
Indirect use value	• decreased biodiversity • stability of ecosystems	• burden for public health systems (higher costs)	• cultural identity • sense of place • symbol of progress (benefit)
Option value	• possibility for bird watching or botanical excursion	• option to live a "healthy" life somewhere in the vicinity of turbines	see values listed above
Existence value	see values listed above	---------	
Bequest value		• wish to bequest property without damaging heirs' health	
Altruistic value		• empathy for other people's well-being	

Source: partly based on RETD (2013) and Australian Wind Energy Association & Australian Council of National Trust (2005)

We will just take a closer look at the visual impacts since they are in the centre of the present analysis. A detailed summary of landscape values will be given in the literature review (chapter 4). Almost all studies, no matter whether they focus on general attitudes on wind power or deal with specific sites, find the visual intrusion of turbines being their most disturbing impact (Wolsink, 2007). It seems, however, really difficult for people to describe how exactly their utility is affected by the visual qualities of turbines (see e.g. Australian Wind Energy Association & Australian Council of National Trust, 2005). Landscape often influences people unconsciously. It defines our sense of place and cultural identity. Most people are not aware of these impacts until some kind of disturbance (i.e. wind turbines) arises. For some people, however, turbines represent progress, which is an indirect value increasing well-being (ibid.). Furthermore, there are of course people who actively enjoy scenic beauty or who are afraid that such artificially altered landscapes might deter tourists as their source of income (direct use values). Although these arguments could potentially also justify non-use values, they seem by far less relevant for people who are not living in the vicinity of turbines, especially since turbines do not cause any irreversible damages. Another observation many researchers share, is that attitudes toward wind power and associated environmental costs tend to change in the process of planning, implementing and operating a site (Krohn & Damborg, 1999). Hence also the TEV of a wind power plant will vary over different stages of the project.

Comparing costs and benefits of wind energy, the costs mostly occur to a rather small group of people whereas the benefit of avoided GGEs basically affect the whole world population. Having this in mind, people might value costs and benefits within different preference systems. Sagoff argues, that there are at least two parallel universes of preferences: the first one captures peoples' private preferences determining how their individual utility is affected by changes of their consumption bundle (Sagoff, 1988). Usually choices concerning ordinary consumption goods are based on private preferences since they do not affect others (Ek, 2002). The second system of preferences builts on moral beliefs, on what is good for society – public preferences (Sagoff, 1988). Within this system, people are willing to set aside their own interests in favour of the greater good (ibid.). They take on the role of citizens instead of consumers. Referring to the benefits of wind energy, public preferences could significantly motivate consumers' behaviour. That would, for instance, explain why people are paying premiums for electricity produced from renewable sources while the associated benefits are a public good enjoyed by free-riders. Examining the preferences for wind power in Sweden, Ek found 52% of respondents making their choice based on what they think is best for society (Ek, 2002). In another study, she found people who are not affected by wind power facilities to care about citizen participation and a fair distribution of profits generated from wind energy (Ek & Persson, 2014).

The concept of altruistic and bequest value partly integrates decision-making based on public preferences into the utilitarian framework. However, if people make choices according to what is morally right and what is wrong, they disregard income restrictions and the idea of substitution, which leads to the collapse of the whole construct of environmental valuation. We will come back to how public preferences might show in our survey and how we control for potential problems related to them in chapter 6.

2.3 Economic Valuation

Economic valuation describes the procedure of eliciting the values of non-marketed goods in terms of money (Pearce & Özdemiroglu, 2002). The values are then used to calculate the welfare effects of projects or policies. The most common method to assess a project/policy's profitability from society's point of view is cost-benefit-analysis (CBA). It trades off all costs and benefits associated with the project which enables a comparison between different alternatives as well as the status quo (ibid.). For the case of wind power expansion in Denmark up to 2020, we are doing a kind of cost-effectiveness analysis: the aim is to expand onshore wind power capacity by 500 MW at least (social) cost (Ministry of Climate, Energy and Builting, 2012). Both, CEA and CBA, require an estimation of all environmental impacts. Expanding on the concept presented earlier, Bateman suggests that any benefit can be measured by identifying the corresponding cost which exactly offsets the utility increase experienced by the individual who benefits and vice versa for costs (Bateman, 2002). Linked to the concept of substitution, we are looking for the change in income which holds an individual's utility level constant when experiencing an in- or decrease in the provision of an environmental good.

We broadly differentiate between direct and indirect methods to elicit such income changes. Indirect approaches, also called revealed preference approach (RP), make use of markets, which are closely related to the non-marketed good in question, e.g. markets for substitutes or compliments of the good. For RP builts on existing markets, it uses actual demand to identify consumers' WTP for environmental goods. Therefore indirect preference techniques can only be applied to monetize use values and after a project has been realized. In contrast, direct evaluation techniques construct hypothetical markets. Respondents are then asked for how they would behave in the presented situation, which is why this branch is called stated preferences (SP). The SP methodology can be applied to all kind of goods. Although we cannot observe how consumers substitute income with environmental goods, people state how much money they would be willing to give up to secure a certain quantity of the environmental good – they make hypothetical trade offs.

2.3.1 Some Examples of Revealed Preference Techniques

Travel Cost Method

The travel cost method (TCM) serves to estimate the value or changes in value of recreational areas such as nature reserves or forests which usually are free of admission (Perman et al., 2003). The rationale of the method is that people accept certain costs (time and money) when visiting recreational sites. These costs are treated like an 'admission fee' or ‚in terms of welfare measures, peoples' WTP to enjoy the recreational benefit. The model is based on the complementary relationship between visiting such places and the associated travel costs. In a survey visitors are asked for their visiting frequencies as well as the related costs (Pearce et al., 2006). The data can then be aggregated to give a representative value of the respective recreational area. Some of the drawbacks of TCM are finding the opportunity costs for travel time and the necessity to include sites, which serve as substitutes for the one to be valued (ibid.).

Hedonic Pricing

The hedonic pricing method (HP) builds on Lancaster's theory of consumers' choice (see 4.1). The idea is that a good has to be understood as the sum of all of its attributes. Accordingly, the price consumers are willing to pay depends on the specific attribute levels of a product. A popular field of application are property prices. Environmental or other non-market goods are implicitly traded on the property market for they constitute important characteristics of a house such as noise level, surrounding landscape or infrastructure. Since the attributes' values itself cannot be observed on markets, HP models compare the prices of goods where the attribute to be valued takes different levels. Statistical methods can then be used to isolate the value of a single quality.

Averting Behaviour and Defensive Expenditure

Both of these methods serve to value public bads by looking at how consumers try to elude environmental disamenities. Averting behaviour approaches assume that consumers buy goods which are substitutes for absent environmental goods (Pearce et al., 2006). Bottled water for instance replaces qualitatively bad drinking water (Garrod & Willis, 1999, p. 42). With the drinking water quality improving, less people would buy bottled water, which indicates that expenditures for substitutive goods are related to how people value environmental goods. Defensive expenditure[8] usually relates to goods limiting the impact of environmental bads such as double-glazed windows to dam noise pollution (ibid.). One downside of these approaches is that the environmental bads are solely partly avoided and which is why the methods only yield lower bound estimates (Pearce et al., 2006).

2.3.2 Some Examples of Stated Preference Techniques

Contingent Valuation

Like every stated preferences method, contingent valuation (CV) constructs hypothetical markets which makes it possible to estimate use as well as non-use values. In an environmental economics context, the scenario presented to the respondent either aims at improving the quality or quantity of an environmental good or preserving the status quo level (Kjær, 2005). Participants are then asked to state their WTP to obtain the benefits from the improvement or sustain the benefits from preserving the status quo[9]. Thereby it is possible to value environmental changes ex-ante or even just hypothetically (ibid.).

When stating their WTP, people can either choose from a given set of amounts of money (payment cards) or they have to decide whether their WTP is higher or lower than a certain value until they reach their actual WTP sum (bidding game) (Bateman, 2002). Sometimes participants are also asked to state their WTP without being given any suggestions (open-ended) (ibid.). Another option is dichotomous choice CVM where the respondent is presented an amount and can accept or reject it (Kjær, 2005). If the respondent rejects the first amount he can be offered another one, which is then called double bounded dichotomous choice (ibid.).

Some drawbacks of contingent valuation methods are that the value of the total change is estimated which prevents conclusions on the significance of single attributes. Moreover the scenario has to be described simple enough to be understood by laymen while still being comprehensive and objective. Critics doubt the validity of CVM results for there are is a high risk of influencing participants' answers through the set-up of the experiment both on purpose and unconsciously (Bateman, 2002).

[8] There seems to be some confusion of the terms in the literature. Tiezzi, for example, considers bottled water consumption a defensive expenditure (Tiezzi, 2002).

[9] It would also be possible to use WTA, depending on the property rights assumption. For reasons I will discuss later on, it is, however, not very common ask for respondents' WTA.

Choice Modelling Methods[10]

Like CV approaches, choice modelling methods (CMM) built on hypothetical markets, which enable the valuation of every kind of good. The models are based on Lancaster's attribute theory (see section 3.1), which is also used in hedonic pricing. Respondents have to choose between mutually-exclusive representations of a good. Each of these variants is described by a range of attributes, which take different levels in each alternative. For a car these properties might be fuel efficiency, the colour, installed optional equipment etc. Equally to HP, the systematic variation of attributes allows to draw conclusions on the underlying preferences of consumers.

CMM takes different forms with respect to the design of surveys. In discrete choice experiments (DCEs), participants choose one of several alternatives presented. Contingent ranking asks the respondent to rank the scenarios from most to least preferred while contingent rating demands every alternative to be evaluated on a predefined scale. Another form of CMM combines choice experiments with contingent rating: the paired comparisons approach asks the respondent to choose between two scenarios and then evaluate how strong his preferences are within a certain scale.

In contrast to CVM, choice modelling methods are criticized for being cognitively demanding since the respondent has to consider many information while making his decision. Furthermore contingent rating and paired comparison are not welfare consistent since they built on ordinal, not cardinal preferences. Like for contingent valuation, CMMs underlie the risk of manipulation on the part of the researcher conducting the survey.

2.3.3 Revealed VS. Stated Preference

Revealed and stated preference methods are usually not competing with each other. Whenever use values should be elicited, it makes sense to draw upon RP techniques since they reflect consumers' actual behaviour and are therefore more reliable than the results collected with SP approaches that are based on hypothetical behaviour. There are, however, a number of 'use-value' commodities, of which the 'market footprint' is not strong enough to reveal consumers' preferences. The major strength of SP techniques therefore is that they are applicable to almost every kind of good and no matter whether the good or policy to be valued does already exist or is only in the state of planning. The table below summarizes different aspects of SP and RP procedures.

[10] My description of choice modelling methods follows chapter 6 in Bateman (2002)

Comparison of Stated and Revealed Preference Approaches [Table 2.4]

	Stated Preferences (SP)	Revealed Preferences (RP)
Idea	Consumers are asked how they would behave on hypothetical markets.	Real market transactions are analysed in order to reveal consumers' preferences-
Which values can be elicited?	Total economic value	Only use-values
Welfare measure	Compensating and equivalent variation[11]	Consumer surplus[11]
Demand curve	Hicks' income compensated demand curve[11]	Market demand curve
Popular techniques	• Contingent Valuation • Choice Experiments	• Travel Cost Method • Hedonic Pricing • Averting/ Defence Behaviour
Advantages	• the effects of planned projects can be evaluated • flexibility (ex-post and ex-ante, all types of values)	• low costs since data already exist • high validity since results are based on consumers' actual behaviour
Disadvantages	• decisions are hypothetical and hence incentivize strategic behaviour	• only ex-post valuation possible • not all goods with use values have closes market substitutes/ complements

Sources: Bateman et al. (2002), Pearce et al. (2006), Freeman (2003), Hanley et al. (2007)

Some authors suggest merging stated and revealed preference techniques as to combine their benefits and overcome drawbacks. Hanley at al. suggest that results from both types of models applied in the same field could be compared in order to check whether the underlying preferences are identical (Hanley et al., 2007). They advocate SP methods to be founded in actual behaviour while extending the range of environmental variables observed. One example is an extended version of the TCM where visitors do not only state the costs of the trip and their visiting frequency but are also asked how their visiting behaviour would change in case travel costs increase by a certain percentage (Englin & Cameron, 1996).

More and more countries have introduced economic valuation as an important instrument in political decision-making. It is, however, quite expensive to elicit public preferences for the specific context of every policy proposal. Economists therefore use the method of benefits transfer where they apply economic values originally estimated for a different project (Pearce et al., 2006). Such a transfer requires a thorough understanding of the originally applied methodology and context so that the primary values can be adapted to the present study site (ibid.).

[11] See part 2.4.1 for the explanation of welfare measures

2.3.4 Criticism of Economic Valuation in the Context of Environmental Goods

One major inconsistency, which can be found in many economic valuation studies, is the divergence of WTA and WTP. According to welfare economics, both measures should have the same dimensions for they only differ due to the underlying property rights assumption (see section 2.1.4). The often significant deviation of these measures contradicts the economic law of individuals making rational decision and therefore challenges the entire theoretical framework of economic valuation (Hanley et al., 2007). Besides, the divergence of WTA and WTP also induces practical problems: in many contexts property rights can be interpreted so that both measures could be applied. Hence it is possible to manipulate the results of valuation studies through the choice of welfare measures and thereby decide whether proposed projects and policies are realized or cancelled[12].

Another issue we have already touched on before, is that the idea of substitution between commodities as to hold utility constant might not be valid for environmental goods. Decisions violating the neoclassical concept of compensation are based on "lexicographic preferences" (Spash & Hanley, 1995). These preferences are rather based on rights assumptions and moral principles than on individuals' utility maximization considerations (Sen, 1977). Sen differentiates between non-use values being motivated by sympathy or commitment. According to him, the first one fits into the category of altruistic value whereas the latter does involve "counterpreferential choice" which is motivated by moral integrity and hence invalid as a welfare component (ibid. p.328). Another issue is the total refusal of assigning monetary values to environmental goods which is again driven by ethical principles and leads to incredibly high monetary estimates of environmental goods (Hanley et al., 2007). Studies try to reveal respondents' motivation for stating extremely high WTP/WTA values in order to exclude answers violating welfare economic assumptions.

Decisions concerning the degradation of environmental goods should not exclusively be based on peoples' preferences since they do not consider thresholds and non-linearity in the provision of ecosystem services (Pearce et al., 2006). In order to ensure that changes take place within the resilience range of ecosystems, irreversibility, potential large-scale effects and uncertainty have to be considered when evaluating projects and policies (ibid.).

[12] The results of economic valuation studies are also sensitive to variables other than the chosen welfare measure, such as discount rate or the handling of uncertainty. See for example Pearce et al. (2006) for more details.

3. FOUNDATION OF DISCRETE CHOICE EXPERIMENTS

To elicit public preferences for the visual attributes of wind power sites, we have chosen to conduct a discrete choice experiment. For reasons explained above, some researchers have applied the revealed preference technique of hedonic pricing in this field. The results are, however, rather mixed and extremely sensitive to the applied econometric models as well as site specific[13]. Among stated preference approaches, choice experiments allow for evaluating all visual attributes of wind power separately, which is what this thesis aims for (Bateman, 2002). By evaluating the attributes' marginal values, it is even possible to reveal the relative importance of each of the characteristics. At the same time, the estimates resulting from CE are welfare consistent (unlike contingent rating and paired choice) and the experiment itself is less cognitively demanding then contingent ranking (ibid.). For these reasons, CE meanwhile is the most preferred stated preference technique in the field of environmental economics[14] and also has often been applied in the context of evaluating wind power externalities (see section three of the literature review). In the following part, the theoretical foundation as well as the general set-up of choice experiments will be presented.

By observing peoples' hypothetical consumption decisions, CEs allow us to reveal the preferences underlying those choices. In order to do so, we need to model the decision behaviour of consumers using empirical decision data as inputs to the model. The most popular of these models is the random utility model (RUM), which we will explore in the following. The presentation of the RUM framework will be preceded by a short overview over Lancaster's consumer theory, which revolutionised the understanding of consumption behaviour.

3.1 Lancaster's Theory of Consumers' Choice[15]

Lancaster developed the idea that individuals do not gain utility from a good per se but from its distinguished characteristics. He used the striking example of wood not being a substitute for bread to illustrate his approach. According to Lancaster, classical consumer theory would explain this by a consumer having stronger preferences for either of the good. He instead argued, that the goods are no substitutes for they do not have common properties. Hence, a good is nothing but a combination of characteristics. Accordingly, substitutes are characterized by different relative proportions of the same attributes. All

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[13] Hinman (2010) provides an extensive overview of HP studies and their findings on how wind turbines affect property prices.
[14] see for example Hanley, Mourato & Wright (2001)
[15] The entire section draws on Lancaster (1966).

consumers perceive a commodity as a combination of certain properties. Varying consumption decisions are not explained by the consumers' subjective understanding of the good but their heterogeneous preferences for the good's characteristics. Individual n's utility U_{in} from consuming good *i* can be expressed as:

$$U_{in} = U(x_i, s) \quad (3.1)$$

where x_i is a vector describing good *i*'s attributes and respective levels and *s* reflects the preferences of consumer *n*.

Based on this concept, the understanding of a good's nature changed. Lancaster, for example, argued that a dinner party could be understood as a good consisting of a meal and a social gathering (ibid. p.133). This corresponds to the concept of goods in the context of environmental economics: environmental goods are rarely classical commodities traded on markets but almost always a combination of several goods exhibiting many attributes. Wind turbines, for instance, are a source of electricity characterized by certain technical parameters, production costs etc.. But they are also landmarks with certain physical attributes such as height or distance to nearby residents. Hence, Lancaster's theory is the theoretical foundation for evaluating environmental goods in all their complexity. Choice experiments explicitly built on this approach since they ask the respondents to choose between hypothetically constructed substitutes. All of the alternatives have the same attributes. Hence, consumers' choice is solely motivated by the underlying differences in taste, which thus can be revealed in CEs.

3.2 Random Utility Model

In 1927 the psychologist Louis L. Thurstone wrote a paper on "The Law of Comparative Judgement" trying to explain observed inconsistencies in consumers' decision behaviour through random components of utility (Thurstone, 1927). In 1960, Jakob Marchak introduced the concept in the field of economics (see Marschak,1960). Thurstone's model was adapted to classical economic theory by rejecting the idea of consumers making irrational decisions. Instead the inconsistencies were explained by the researcher failing to observe the complete decision making process. Furthermore, corresponding to economic theory, utility maximization was suggested to be the rule driving decisions. Beginning in the 1960s, economists like McFadden (1974) and Manski (1977) further expanded the theory and developed econometric models to analyse empirical choice data.

Following McFadden's[16] theoretical framework of choice behaviour, we assume *Y* to be the space including all alternatives a consumer could potentially choose from. Furthermore, *S* is the set of all vectors *s* representing the observable socio-demographic characteristics of decision makers. An individual randomly drawn from the sample is characterized by *any* $s \in S$ and faces a finite number *A* of alternatives to choose from with $A \subseteq Y$. $P\,(i \mid s, A)$ then describes the probability of a random person with attributes *s* choosing alternative *i* from the set of all available alternatives *A.* The scenario corresponds to drawing from a multinomial distribution where *i* is selected with a probability of $P\,(i \mid s, A)\ \forall x \in A.$

Furthermore, McFadden introduces a model of individual behaviour *H* being composed of individual behavioural rules *h*. *h* can be understood as a decision rule mapping every vector *s,* representing an individual, into a chosen alternative *i* with $i \in A$. The author gives the example of *H* being the demand function resulting from maximizing <u>some</u> utility function whereas *h* then would be the demand function resulting from the maximization of a <u>specific</u> utility function. Given the decision maker's observable attributes *s* and the set of alternatives *A,* the probability of a randomly selected person choosing alternative *i* then is:

$$P(i|s,A) = P\{h \in H\ |h(s,A) = i\} \tag{3.2}$$

The equation implies the probability for an individual characterized by *s* to choose alternative *i* from a set of alternatives *A* equals the probability of the occurrence of decision rule *h* which generates the same outcome.

Following welfare economic theory, individuals make decisions as to maximize their utility. Hence, we know the exact form of decision rule *h*. Considering a binary choice experiment, person *n* decides for alternative *i* only if utility U_{in} yielded by alternative *i* is larger than utility U_{in} yielded by alternative *j*:

$$U_{in} > U_{jn}\ \forall\ i \neq j\ \wedge\ \ i, j \epsilon A \tag{3.3}$$

The RUM attributes inconsistencies in choice behaviour to the researcher's inability to observe all parameters influencing customers' decisions. Therefore individual *n*'s utility U_{in} from choosing alternative *i* is modelled as:

$$U_{in} = V_{in}(\beta' x_{in}) + \varepsilon_{in} = \beta' x_{in} + \ \varepsilon_{in} \tag{3.4}$$

where V_{in} is the systematic (explainable) component of utility and ε_{in} the random (unexplainable) component (Louviere, Flynn, & Carson, 2010). V_{in} depends on x_{in}, a vector of levels of observable attributes of good *i* as

[16] McFadden (1974)

well as observable characteristics of person n[17], and β which is a vector of parameters relating to the attributes of the good and customer n's preferences. With $U_{in} \sim x_{in}$, Lancaster's theory is incorporated into choice experiments. Applying econometric models, we can calculate the value of the parameters β for different levels of every attribute of the alternative and thereby elicit respondents' preferences for every property. The random element ε_{in}, in contrast, covers unobservable properties of the good as well as of the decision maker (Manski, 1977). Thus, the idea of random utility theory is that an individual's choice can never be predicted with total certainty by an outside observer. It is only possible to calculate the probability for each alternative to be chosen by a certain individual. The decision maker, however, acts rational – from his perspective the choice is deterministic since he himself knows his utility function.

Above we derived the basic formula for decision-making (3.2). We can now specify decision rule h by inserting the utility maximization condition, which would result in the choice of i (3.3).

$$P_{in} = P(i|s,A) = P\{h \in H \,|h(s,A) = i\} = P(U_{in} > U_{jn}\ \forall\ i \neq j\ \wedge\ \ i,j \epsilon A)$$
$$P_{in} = Pr(U_{in} > U_{jn}\ \forall\ i \neq j) = Pr\big(V_{in} + \varepsilon_{in} > V_{jn} + \varepsilon_{jn}\ \forall\ i \neq j\big)$$

$$P_{in} = Pr(\varepsilon_{jn} - \varepsilon_{in} < V_{in} - V_{jn}\ \forall\ i \neq j\ ) \qquad (3.5)$$

The difference $V_{in} - V_{jn}$ can be observed since it is deterministic. We want to know the probability of the random value ε_{jn} - ε_{in} being smaller than the observable quantity $V_{in} - V_{jn}$. The random component's distribution is assumed to follow the density function $f(\varepsilon_n)$ which we will not specify any further for the moment. We now introduce an indicator function I with:

$$I = 1\ \ if\ \ \varepsilon_{jn} - \varepsilon_{in} <\ V_{in} - V_{jn}\ \ (individual\ n\ chooses\ altenative\ i) \qquad (3.6)$$
$$I = 0\ \ if\ \ \ \varepsilon_{jn} - \varepsilon_{in} >\ V_{in} - V_{jn}\ (\sim does\ not\ choose\ alternative\ i) \qquad (3.7)$$

The probability of individual n to choose alternative i over j then is

$$P_{in} = \mathrm{Pr}\ (I = 1)$$
$$P_{in} = \int_{\varepsilon} I(\ \varepsilon_{jn} - \varepsilon_{in} < V_{in} - V_{jn} \forall\ i \neq j\ ) f(\varepsilon_n) d\varepsilon_n. \qquad (3.8)$$

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[17]In McFadden's theoretical framework for choice behaviour these characteristics were referred to as vector s.

3.3 Econometrical Specification of the Random Utility Model[18]

The unobservable error component ε_{in} of an individual's utility can follow various distributions, which result in different specifications of the discrete choice model.

3.3.1 Logit Model

The standard logit model is one of the most common forms of DCM. In this set-up, the error terms ε_{in} are identically and independently distributed (iid) with a type 1 extreme value distribution (Gumble distribution) over all members *n* (*n=1, … ,N)* of the cohort, all choice alternatives *j (j=1,…,i,…, J)* and all choice sets *t* (*t=1,…,T)*. The density and cumulative density function of the Gumble distribution are given as:

$$f\left(\varepsilon_{jn}\right) = e^{-\varepsilon_{jn}}e^{-e^{-\varepsilon_{jn}}} \qquad (3.9)$$

$$F\left(\varepsilon_{nj}\right) = e^{-e^{-\varepsilon_{nj}}} \qquad (3.10)$$

Inserting the density function (3.9) into equation 3.8 then gives:

$$P_{in} = \int I(\varepsilon_{jn} < V_{in} - V_{jn} + \varepsilon_{in} \forall\, i \neq j\,) f(\varepsilon_n) d\varepsilon_n = e^{-e^{-(V_{in} - V_{jn} + \varepsilon_{in})}} \qquad (3.11)$$

Holding ε_{in} constant, the probability of individual *n* choosing alternative *i* over all other alternatives $j \neq i$ is[19]:

$$P_{in} | \, \varepsilon_{in} = \prod_{j \neq i} e^{-e^{-(\varepsilon_{in} + V_{in} - V_{jn})}} \qquad (3.12)$$

For ε_{in} is not given, we have to find the unconditional probability of *n* choosing *i* over all $j \neq i$. Hence we form an integral over all values of ε_{in} weighted with their distribution probability $f(\varepsilon_{in})$:

$$P_{in} = \int_i \left(\prod_{j \neq i} e^{-e^{-(\varepsilon_{in} + V_{in} - V_{jn})}}\right) e^{-\varepsilon_{in}} e^{-e^{-\varepsilon_{in}}} d\varepsilon_{in} = \frac{e^{V_{in}}}{\sum_j e^{V_{jn}}} = \frac{e^{\beta x_{in}}}{\sum_j e^{\beta x_{jn}}}. \qquad (3.13)$$

In the standard logit framework, the observed preferences *ß* do not vary across individuals *n*. Deviations and the influence of unobserved preferences and attributes are captured by ε_{in}. For the stochastic error term follows an iid distribution, also the unobserved part of preferences is assumed to be homogenous across the population. It seems quite unrealistic, though, that two respondents with identical observable socio-demographic characteristics would always make the same choices. Instead, it is likely that unobserved respondent-specific parameters have varying impact on the choices made. Therefore it would be useful to introduce parameters allowing for taste variation between respondents.

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[18] The modelling and discussion follows Train (2003) chapters 3 and 6.

[19] Since the ε_{in} are iid distributed, the probabilities can just be multiplied.

In our choice experiment we generate panel data. Respondents are asked to make four choices sequentially. Accordingly, the error terms in the probabilities for the decisions made by the same participant are likely to be correlated for example due to learning or inertia effects (Hensher & Greene, 2001). In case the correlation depends on unobserved factors, this is another violation of the assumed iid-distribution of the error terms ε_{in} (correlation of unobserved factors over time).

A third problematic property of the logit model is the "independence form irrelevant alternatives" (IIA) attribute. It implies that the relative probability of alternative a and b being chosen does not change with the introduction of a third alternative c which is quite similar to one of the existing ones[20].

3.3.2 The Mixed Logit Model

The mixed logit model (MXL) overcomes all the obstacles we have identified above. The set up of the model will be presented following Hensher & Greene (2001) as well as Train (2003). We start with formulating the utility function:

$$U_{in} = \beta_n x_{in} + \varepsilon_{in} \qquad (3.14)$$

U_{in} is the utility of individual n when choosing alternative *i* over alternatives *j=1,…,J* , within a sample of *n=1,…, N* respondents. β_n is a vector of parameters relating to the attributes of the choice alternatives. The index n indicates that it expresses the individual preferences of respondent *n* – the MXL allows for taste variation between individuals where the *β's* are distributed with density *f(β|θ)*. *θ* are parameters characterizing the distribution, such as the mean or the standard deviation for normally distributed *β's.* Just like in the standard logit model, ε_{jn} is a random term that is identically and independently distributed type 1 extreme value (Gumble distribution). β_n and ε_{jn} are known by person *n* but cannot be observed by the researcher. Thus, additionally to what we assumed in the standard logit framework, the probability P_{in} now also depends on β_n. We therefore have to integrate the standard logit probability (3.13) over the distribution of β.

$$P_{in} = \int_{\beta} \left(\frac{e^{\beta x_{in}}}{\sum_j e^{\beta x_{jn}}} \right) f(\beta) d\beta \qquad (3.15)$$

[20] see Train (2003) p.46 for the famous red bus/blue bus example

The form of distribution $f(\beta|\theta)$ depends on the nature of the related attribute and hence has to be chosen by the researcher. We will now have a closer look at the properties of the random parameters β_n. The random parameter can be split up as follows:

$$U_{jn} = \beta_n x_{jn} + \varepsilon_{jn} = \bar{\beta} x_{jn} + u_n x_{jn} + \varepsilon_{jn}. \quad (3.16)$$

$\bar{\beta}$ is the (fixed) mean of the parameters and u_n is the deviation from the mean explaining the degree of unobserved heterogeneity. In order to apply MXL for the analysis of choice experiments, we adapt the model to panel data by introducing variable *t* indicating the number of sequential choice made by the same individual with t=1, …, T.

$$U_{jtn} = \beta_n x_{jtn} + \varepsilon_{jtn} = \bar{\beta} x_{jtn} + u_n x_{jtn} + \varepsilon_{jtn} \quad (3.17)$$

Hensher and Green explain that since u_n is independent of alternative *i* and choice set *t*, there is correlation between alternatives and choices because the underlying preferences of the decision maker do not change. Thereby the MXL allows for the correlation of unobserved factors over time (or in our case over choices). With i_t being the alternative chosen from choice set *t*, the probability for person *n* to make the sequence *m* of choices $i_1, \ldots, i_T$ is:

$$L_{mn}(ß) = \prod_{t=1}^{T} \frac{e^{\bar{\beta}_n x_{itn} + u_n x_{itn}}}{\sum_j e^{\bar{\beta}_n x_{jtn} + u_n x_{jtn}}} \quad (3.18)$$

since ε_{jtn} are identically and independently distributed over all alternatives j, choices *t* and respondents *n.* Finally, the mixed logit probability for the sequence of choices *m* made by individual *n* unconditionally of β can be written as:

$$P_{mn} = \int L_{mn} f(\beta|\theta) d\beta. \quad (3.19)$$

For the resulting integral is multidimensional and does not have a closed form, we have to use a simulation method to estimate the probabilities (Croissant, 2003).

<u>The Simulation</u> [21]

The researcher defines the distribution of the random parameters. Then one specific $\beta^{r|\theta}$ is randomly drawn from the prior defined distribution $f(\beta|\theta)$ where r=1 for the first draw and so on. With $\beta^{r|\theta}$ being given, the conditional probability $L_{mn}(\beta^{r|\theta})$ can be calculated. In order to estimate the unconditional probability L_{mn}

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[21] builds on Revelt & Train (1997)

profoundly, this procedure is repeated R times. Finally, the probabilities found in all R simulations are averaged:

$$\check{P}_{mn}(\theta) = \frac{1}{R}\sum_{r=1}^{R} L_{mn}\,(ß^{r|\theta}). \tag{3.20}$$

Number of Draws

Referring to Bhat's results (2001), Hensher and Greene (2001) recommend using Halton sequences instead of pseudo-random sequences. The former covers the unit intervals quite equally whereas research has shown that the latter leaves noticeable gaps. Therefore, far less draws (and hence time) are needed to produce stable estimates when using Halton sequences. In order to find the minimum number of draws R leading to accurate estimates, a range of numbers should be tested.

Distribution of the Random Parameters

Referring to Train, Hensher and Greene explain that each parameter can be attributed a different distributional form for only the underlying parameters are assumed to be jointly normally distributed (Hensher & Greene, 2001, p.14 annotation 21). The parameter estimates are only transferred to their suggested distribution when entering the utility function. The distribution of each random parameter has to be chosen by the researcher depending on the nature of preferences he expects. Normally distributed random parameters, for instance, will be positive for some respondents and negative for others whereas the lognormal distribution is often used when estimates are assumed to be non-negative (Hensher, Rose, & Greene, 2005). Both of these distributions have, however, rather long tails (ibid.). The latter problem is avoided when using truncated forms of distribution such as the triangular distribution (the density function follows the form of a tent around the mean) or the uniform distribution (Hensher & Greene, 2001). Generally, all of these distributions have certain drawbacks, which requires the researcher to prioritize. Hensher et al. suggest to determine the parameters θ as to restrain the respective distribution and thereby avoid some of the issues described above (Hensher et al., 2005).

Maximum Likelihood Estimation

The analysis of choice data intends to estimate the parameters β_n which reflect consumers' preferences. In case of random coefficients β_n, the researcher determines the distributional form depending on the unknown parameters θ, which describe the distribution (Revelt & Train, 1997). The method of Maximum Likelihood Estimation works as to find the values of θ which result in the "best fit" of our empirical data and the estimated model, given the assumed distribution of β_i. In order to find the "most likely" θ, we have to calculate:

$$LL(\theta) = \sum_n \ln P_{mn}(\theta). \quad (3.21)$$

For 3.19 is an open integral, we cannot calculate it but have to use an approximation procedure (see above).

3.4 Marginal Rate of Substitution

The parameter β_k can be interpreted as the marginal utility for attribute *k* (Bateman, 2002). Given a linear utility the function like the one above (3.14), the ratio of two such parameters is the rate of substitution at which the consumer is willing to accept a decrease in the level of one attribute in exchange of an increase in the level of another attribute (Louviere, Hensher, & Swait, 2000). If one of the parameters refers to the monetary attribute, the quotient can be understood as the individual's WTP for the second attribute. It is calculated as:

$$WTP_k = -\frac{\beta_k}{\beta_{price}} \quad (3.22)$$ [22]

whereas using the Delta-method the variance of the WTP_k for attribute *k* is:

$$var\left(\frac{\beta_k}{\beta_{price}}\right) = \left(\frac{\beta_k}{\beta_{price}}\right)^2 \left(\frac{var(\beta_k)}{{\beta_k}^2} + \frac{var(\beta_{price})}{{\beta_{price}}^2} - \frac{2cov(\beta_k,\beta_{price})}{\beta_k * \beta_{price}}\right) \quad (3.23)$$ [22]

The interpretation of the ratio (3.22) as the WTP is only valid if a status quo alternative is included (Alpizar, Carlsson, & Martinson, 2001). In our study, there is no such opt-out for reasons discussed in section 6. We can however, still interpret the ratios as indicators for peoples' preferences. Higher ratios imply that the respective attribute has a higher impact on individuals' utility (Ek, 2006).

[22] Bateman (2002)

4. LITERATURE REVIEW

Like discussed in the section on economic valuation of the visual effect of wind power, it is difficult to define the indirect as well as non-use values impacted by turbines. Understanding this relation is, however, essential when performing a stated preference study. We will therefore present some findings on how humans' well being (utility) is linked to landscape. In what follows, we will give a short overview on the literature seeking to explain residents' protests towards planned wind power sites, which is in sharp contrast to the support of wind energy on a more general level. We thereby aim to demonstrate that the visual set-up of wind energy is crucial for acceptance, which motivates our exploration of visual preferences. The last part of this section summarises findings from prior studies analysing peoples' taste with respect to the design of wind power sites.

4.1 The Value of Landscape

The brief discussion on the economic values associated with wind power in section 2.2 already revealed the difficulties of defining the interactions between humans and their environment.

Experts from different disciplines argue that 'place' cannot be understood solely in a functional sense but that every place has its own specific identity depending on physical attributes as well as associated emotions and meanings (Gieryn, 2000; Norberg-Schulz, 2007; Tuan, 1977). Therefore, the value of a landscape is not simply the sum of all its elements but we have to account for the "genius loci". The term describes the 'spirit of place', which, according to Norberg-Schulz, is key for a human's decision to dwell somewhere. Dwelling requires the satisfaction of the psychological functions of 'orientation' and 'identification' since it means "belonging to a concrete place" (Norberg-Schulz, 2007, p.135). Hence, settling in a certain area has to be understood as a conscious decision, the wish to belong there. On the other hand, people cannot move freely but are bound to social and economic constraints. 'Orientation' and 'identification' also happen if the place of dwelling results from pragmatic considerations rather than intuitively since Norberg-Schulz considers place to be one of the most important determinants of human identity. It is, however, reasonable to assume that the nature of the human-landscape-relationship depends on the motives for dwelling. Consequently, wind turbines intruding the landscape are likely to be perceived very differently from resident to resident. Following this line of arguments, people living in rural environments can be expected to have a close relationship to the surrounding landscape for their choice of place is unlikely to be driven by the urge for employment but by the explicit desire to live in that specific environment. The reverse reasoning holds for urban regions. Thus, we can assume that different landscapes attract different kinds of people sorted by the latter's appreciation of scenic quality. If this pattern holds true, acceptance of local turbines is likely to vary with the scenic quality of a person's environment. However, we do not know yet, in which direction that relationship works. Counteracting our intuition, Krohn and Damborg find urban residents to be more strict with respect to the siting of turbines than the rural population (Krohn & Damborg, 1999). They attribute this divergence to people living in cities romanticising nature (ibid.).

The Millennium Ecosystems Assessment determined three categories of ecosystems services generated by landscapes: provision, regulating and cultural services (Millennium Ecosystem Assessment, 2005). The latter is the one being of interest here for it captures non-material benefits. Bieling et al. emphasise that technological means or replacement goods cannot easily substitute this group of services, which reinforces the importance of including landscape values in environmental assessments (Bieling, Plieninger, Pirker, & Vogl, 2014). Stephenson classifies landscape values resulting from measurable physical attributes such as land relief or vegetation, practices and processes like human activities and relationships such as sense of place or feeling of belonging (Stephenson, 2008). When asking respondents for how landscapes impact their well-being, they almost only mention cultural (non-material) aspects (Bieling et al., 2014). The mostly stated qualities are beauty and naturalness and, specifying what is perceived as beautiful, woodlands/forest, mountains, water bodies and unspoiltness (ibid.). Later on, when analysing the link between acceptance of turbines and the landscape respondents live in, we will draw on these attributes as characterizing a landscape. Besides, 17% of the respondents name the feeling of belonging and local attachment as indirect or non-use values. Devine-Wright considers place attachment to be a strong motive for place-protecting protests (Devine-Wright, 2009). He builds on a Norwegian case study demonstrating that the stronger respondents feel attached to their place of home, the more negative is their attitude towards a planned hydropower facility (Vorkinn & Riese, 2001). Devine-Wright notes that close attachment does not automatically imply disapproval of landscape changes but simply 'strong' reactions (Devine-Wright, 2009). Hence, a well-designed wind power project, which is perceived as enhancing landscape quality, could also be strongly supported by residents feeling closely attached to the respective place (ibid.). It is also important to differentiate between the nature of attachment: social attachment will result in different reaction to changes in the landscape than physical attachment (ibid.). Jones et al. provide an example for this: in a case study in the Humberhead Levels region (UK) they found community attachment to be significant for wind power acceptance, whereas place identity could not proven to have any impact (Jones, Orr & Eiser, 2011). It is likely that physical attachment is prevalent in areas with high scenic quality, which again lets us assume wind power acceptance to depend on the nature of the surrounding environment.

The only relevant socio-demographic characteristic Bieling et al. found in their interview-based study on how landscape impacts well-being is the respondent's occupation: in contrast to other residents, farmers' sense of place depends highly on landscape and their wish for unspoiled nature is considerably stronger (Bieling et al., 2014).

4.2 Social Costs of Wind Power

The core issue in the literature on wind power acceptance is to reveal the secret around the striking disparity of broad support on a national (or even global) level and the NIMBY-phenomenon. The latter refers to peoples' resistance towards wind power projects in their local environment. Comparative studies found wind power being the renewable energy source with least external costs, which is why wind energy capacities were so heavily expanded over the last decades, thereby inducing the rise of protests (Sundqvist, 2004).

Reviewing British studies on wind power acceptance from the first half of the 1990s, Simon condenses the following major concerns: noise pollution, spoiled scenery, unstable energy supply due to the dependence on wind as well as high monetary costs (Simon, 1996). Lothian adds shadow flicker, blade glint, electromagnetic interference, soil destruction and bird strike (Lothian, 2008). The number of birds killed by wind turbines supplying 600.000 Danish families, for instance, corresponds to 3% of the birds killed in traffic (European Commission, 1999). Lothian points out, however, that meanwhile most of the other objections are not valid anymore for there are ways of mitigation (Lothian, 2008). The effects of shadow flicker, soil destruction, blade glint and noise pollution can for instance be limited by thoughtful planning (Kaldellis, Kavadias, & Paliatsos, 2003). Additionally, Wolsink found bird killing and noise aspects not even being significant for respondents' attitude on wind energy (Wolsink, 2000).

A team of experts exploring the possibilities for building turbines in the Australian state of Victoria found landscape "to be the single most argued issue in any wind farm permit decision" in leading wind power countries (Planning Panel Victoria, 2002). In their 2009 study, Dimitropoulos and Konteleon asked respondents which costs they associate with wind energy in an open-ended format (Dimitropoulos & Kontoleon, 2009). 'Visual intrusion' is by far the most often mentioned consideration (around 29%) followed by ecosystem related issues with only 12%. The prevalence of turbines being perceived as visually disturbing are confirmed by various authors (see for instance Simon's meta-study (1996)). The visual impact of turbines will be even more intense in the future since an increase in the efficiency of turbines goes along with an increase in size. Devine-Wright emphasizes the difference in how people judge turbines' visual quality for planned versus existing projects (Devine-Wright, 2009). Comparing these situations, NIMBY only seems to be a problem for planned schemes whereas most studies find residents living in the proximity of turbines to not perceive them as disturbing (see e.g. Meyerhoff et al., 2010) . Fortunately, this insight does not make our research pointless since in Denmark citizens have to be involved in the process of granting permission to built turbines in their communities (Danish Energy Agency, 2009). In order to gain residents' support, turbines have to be sited and designed according to peoples' preferences.

Over the last two decades most of the external costs of wind power found in early studies have been proven irrelevant. Moreover, the NIMBY-approach, suggesting protests towards wind power to be motivated by ignorance and selfishness, has been overcome (Devine-Wright, 2009; Wolsink, 2000). Instead, researchers now attribute great importance to institutional factors such as public participation in the planning process, transparency of decision making procedures and fair allocation of profits (Wolsink, 2000, 2007) as well as the nature of the places where turbines are sited (Devine-Wright, 2009; Van der Horst, 2007).

4.3 Prior Research on Visual Preferences for Wind Energy

Based on the results presented in the prior section, the focus of researchers who examine acceptance of wind power has shifted to visual attributes of wind energy plants and single turbines. In the following, we will sum up the most important findings. We will first turn to basic parameters such as height or number of turbines before having a closer look at the connection between forms of landscape and turbines.

<u>Size of wind power facilities</u>

According to Dimitropoulos, acceptance decreases with the size of a wind farm, which seems perfectly reasonable and in correspondence with several other studies (Dimitropoulos & Kontoleon, 2009; Warren et al., 2005). Ek presents slightly different results with people preferring single turbines over large wind parks but not over small ones, whereas Navrud and Bråten show that respondents prefer large but few power plants (Ek, 2002; Navrud & Bråten, 2007). Meyerhoff et al. find a possible explanation in the responses of their focus group: some participants prefer many but small turbines for they have less of an impact on landscape whereas other ones wish for few large turbines to limit their nuisance to a few sites. All these information taken together let us expect large heterogeneity of parameters relating to the number of turbines.

<u>Height of turbines</u>

For a case study conducted in Greece, Dimitropoulos et al. found people preferring small turbines to tall ones whereas Ek estimated a positive but not significant parameter for higher turbines and also Wolsink reports higher acceptance for taller turbines (Dimitropoulos & Kontoleon, 2009; Ek & Persson, 2014; Wolsink, 2007). The latter is in line with Meyerhoff et al. who found 'height of turbines' to be the least important of the characteristic included in his CE (Meyerhoff et al., 2010). Considering the mixed findings on preferences for the size of wind power facilities, these results are not surprising, for the height of turbines often is proportional to their number (due to capacity requirements).

Distance to residential area

Meyerhoff et al. found the 'distance to residential area' to be the most important attribute for respondents' choices apart from impact on wildlife (Meyerhoff et al., 2010). Like expected, respondents strongly prefer to site turbines further away from residential areas.

Experience with turbines

Findings on how familiarity with turbines affects preferences are quite diverse. Studies, such as Warren et al., find decreasing acceptance of turbines the further respondents live from a turbine whereas an Australian survey found the exact opposite (AMR Interactive, 2010; Warren et al., 2005). Ladenburg and Dahlgaard followed a different path looking at the cumulative effect of daily wind turbine encounters (Ladenburg & Dahlgaard, 2012). They found acceptance decreasing with the number of turbines a person sees per day, with a threshold of five turbines. Another result from the same survey, denies that respondents with a view of onshore turbines have a more negative attitude on developing onshore capacities than other individuals which is in line with the observations in Ladenburg (2008) and supports Meyerhoff's finding of the majority of people living in the vicinity of a turbine feeling not disturbed at all (Meyerhoff et al., 2010). Australian researchers even found a fifth of their cohort considering turbines impacting landscapes positively, without any difference between people with wind energy experience and the control group (AMR Interactive, 2010). Surprisingly, Navrud and Bråten even explored the WTP for a shift from coal to wind power being higher if respondents have turbines in their viewshed or know someone who does so (Navrud & Bråten, 2007). Conversely, the Australian survey found lower acceptance for turbines to be built in a 1-2 km distance from residence if respondents have a turbine in their vieswhed (AMR Interactive, 2010). Finally, Warren et al. provide strong evidence for wind power experience shifting attitudes significantly: they found 24% of respondents to have a more positive opinion on wind energy after having lived in the vicinity of turbines for some time with 62% explaining the change with wind farms 'not being unattractive' (Warren et al., 2005). Van der Horst summarizes findings related to experience as follows: in the planning phase acceptance increases with distance of residence to planned site whereas the opposite holds for operating wind farms (Van der Horst, 2007).

Turbines and the landscape they are sited in

Several studies identify the type of landscape dominating all design aspects with respect to acceptance of a proposed wind energy facility (see e.g. Wolsink, 2007; Dimitropoulos & Kontoleon, 2009).

Bergmann et al. examine the impact of renewable energy plants on landscape quality depending on size and location of the project (Bergmann, Hanley, & Wright, 2006). The approach thus is very close to what we do, although they leave the respondent with a quite general description of the "landscape impact" attribute and assign it the levels "none", "low", "moderate" and "high". For these are rather subjective terms, underlying preferences can only be supposed to be ordinal which makes comparisons across respondents difficult. They solely found significant WTP-values for the "high landscape impacts"-dummy. The result indicates that respondents value a higher share of renewable energy over the visual disamenities caused by the technology as long as impacts are not high. The analysis of a rural subset, however, revealed a significant WTP for moderate landscape impacts. These finding points to the population in rural areas being closer affiliated with nature than urban residents, which is one of the hypotheses to be tested for our sample. Looking at this from another perspective, Ladenburg discovers respondents living in larger cities to be more positive towards the expansion of onshore wind power than their rural counterparts (Ladenburg, 2008). This gap can easily be explained by urban residents not having to suffer from the visual impacts of turbines.

Jones et al. explored the impact of landscape by measuring acceptance of turbines depending on respondents' opinions about how suitable their region is for wind turbines (Jones et al., 2011). They find suitability to be a highly significant parameter, which is confirmed by respondents' concerns in Warren's et al. case studies in Scotland and Ireland (Warren et al., 2005). Unfortunately, we cannot be sure about whether in Jones' survey people understood suitability with respect to landscape characteristics for the term has not been described any nearer. Molnarova et al. explore the effect of turbines in different types of landscapes based on manipulated photos (Molnarova et al., 2012). On average, 22% of respondents perceive turbines as a "significant deterioration" whereas only 3 % consider them as adding to landscape quality. The type of landscape, turbines were sited in, was highly significant for all groups of respondents, where acceptance was decreasing with the initial visual quality of the landscape (ibid.). In a survey conducted for onshore areas in Australia, Lothian found that when sited in landscapes with low scenic quality, turbines are perceived as enhancing landscape value (Lothian, 2008). On a scale from 1 (lowest landscape quality) to 10 (highest quality) 5.1 is the threshold for perceiving turbines as a (dis-)amenity (ibid.). Warren et al. also found 34% of asked residents perceiving the turbines in their vicinity to be an "attractive feature in the landscape" and another 13% judging them a "local amenity" (Warren et al., 2005). In case this also holds for Denmark, siting turbines in landscapes with a scenic quality lower than the threshold value is supposed to increase acceptance drastically. Both Molnarova and Lothian evaluated scenic quality solely based on the pictures and without defining specific variables. In our analysis, we will try to expand this approach by looking for parameters, which contribute to visual quality and thereby indirectly impact the acceptance of wind turbines. Only if we know what constitutes landscape quality, sites with low scenic value can be identified.

In the case study for two Greek islands, respondents clearly disapproved of turbines to be built in Natura 2000 protected areas, which again hints at a landscape's character having an impact on the wind power attitude and is supported by a study of the "Wadden Vereniging" reported by Wolsink (Dimitropoulos & Kontoleon, 2009; Wolsink, 2007). The Greek study finds the location of turbines and the possibility to participate in the planning process to be more crucial for acceptance than purely visual attributes such as height and number of turbines, which is in line with results from Ek (2002). Interestingly, residing close to turbines does not have an effect on respondents' satisfaction with the state of nature (Meyerhoff et al., 2010). This might be explained by 'residential sorting': people who feel highly disturbed by turbines would move elsewhere or not choose to live in the vicinity of a turbine in the first place.

Focusing on suitability of specific types of landscapes, the results are quite clear: offshore are clearly favoured over onshore locations (see e.g. Ladenburg, 2008; Ek, 2002, Ek & Persson 2014). One explanation for why respondents prefer offshore locations could be the low contrast between turbines and the horizon which leads to lower detectability (Shang & Bishop, 2000). This reasoning also goes along with respondents' strong rejection of rainbow-coloured turbines which was elicited by Lothian (Lothian, 2008). In a different survey, respondents were also found to care about the loss of cliffs due to the implementation of turbines while Australians disapproved of turbines being placed at the coast line in general (Àlvarez-Farizo & Hanely, 2002; Lothian, 2008). Moreover, Ek and Persson test for locations in mountainous areas for which respondents show significant disapproval whereas in the case of a Scottish and an Irish region respondents strongly support upland areas to site turbines (Ek & Persson, 2014; Warren et al., 2005). This example illustrates 'the spirit of place' idea elaborated in the beginning: although we could consider the examined type of landscape as belonging to the same category, Swedish people seem to perceive mountainous areas as more precious than Scottish their uplands. Consequently, planners have to be careful when transferring landscape values across borders. What is remarkable, is that in Ek and Persson's study preferences do not differ depending on where respondents live but on which types of landscape they use for recreational purposes (ibid.). Wolsink presents a study on suitable locations for siting turbines in the Wadden Sea Region (Wolsink, 2007). He also finds recreational areas not to be accepted by residents for this purpose. Accordingly, landscape seems to be evaluated mainly in terms of use values and not, like suggested by urban planning theory, be defined by rather intangible values such as 'feeling of belonging' and 'sense of place‘. Later on, we will test for the link between the respondent’s residential area and preferences for wind power based on our choice data. The most suitable types of landscapes for onshore turbines identified in the Wadden Sea survey were industry, harbour and military areas, regions with a dense network of road and rail connections as well as agricultural areas (Wolsink, 2007). Van der Horst reviews a number of studies concluding that “the existence of heavy industry and large(r) stacks in the area appears to make residents (...) more likely to support wind farms as an improvement of the image of the area“ (Van der Horst, 2007, p. 2709). When analysing the data from our CE, we will test whether these criteria also hold for the case of Denmark.

To sum up, for most visual attributes of turbines, there is no clear evidence on how they affect acceptance. The results, however, clearly limit the explanatory power of the NIMBY-approach. The findings instead illustrate that peoples’ attitudes are dynamic and their willingness to adapt to wind power landscapes might rather depend on institutional, siting and participatory issues then the purely selfish motives suggested by NIMBY. The latter is for example confirmed by Ek and Persson finding no correlation between the landscape turbines should be sited in and the respondent’s place of residence (Ek & Persson, 2014). The review also shows that public acceptance is very sensitive to the type of landscape where turbines ought to be installed, which reinforces our motivation to shed light on this specific issue.

5. EXPERIMENT SETUP

The basic idea of CEs was presented before. In the following, we will illustrate in more detail how our choice experiment was conducted.

CEs allow to attribute respondents' choices to the properties of the good. For the present analysis, the focus lies on the visual characteristics of wind power. Hence only attributes related to the visual impact of wind turbines were included and other externalities like noise pollution could be omitted. However, there is no guarantee that respondents did not subconsciously think of these omitted aspects when they made their decision. We will further discuss this and other issues in section six of this chapter.

5.1 The Choice Experiment Scenario

In our survey, participants were asked to choose between two different wind power scenarios varying with respect to their visual characteristics and associated annual costs. Both alternatives are perfect substitutes with respect to their energy output (3 MW) but their visual attributes take different levels. If the capacity was different across choice sets, peoples' choices would also express their general demand for wind power since taller turbines generate more energy. In this study, however, we want to focus on visual aspects of wind farms.

The experiment is settled in the context of the planned energy transition in Denmark, which requires the net creation of 500 MW onshore wind power capacity until 2020 (Ministry of Climate, Energy and Builting, 2012). More precisely, the study introduces a scenario as to find 150 sites with a capacity of 3 MW each, which corresponds roughly to the required expansion. The aim of informing the participants about the political background of the study was to make the choice situation more realistic and give respondents' the impression that their contribution is valuable. In each choice set, the respondents were presented two pictures visualizing the respective attributes and a table containing the attribute levels. The participants were then asked: "Which siting of wind turbines do you prefer?"

In order to avoid that people base their choice on what they think is good for society (public preferences), they were supposed to imagine the turbines to be built in their own or a neighbour municipality. Thus, they had to bear the social costs of wind energy and therefore can be expected to make their choices according to their private preferences. Moreover, respondents were asked attitudinal questions such as "What is your general opinion on onshore turbines?" which allow to draw conclusions on their motivation. We also asked whether the participants know of any plans to built new turbines in their own or a neighbour community, which serves as an indicator of how realistic the respondent considered the presented scenario to be.

5.2 The Definition of Attributes and Levels

Choosing the right attributes might be the most significant task when designing a choice experiment. On the one hand, the attributes should be relevant for policy makers and wind turbine operators. In our case, that means to include attributes which could be politically regulated as to correspond to citizens' preferences (Pearce et al., 2006). The distance from a turbine to the closest building is, for example, part of the regulation on wind power planning (Danish Ministry of the Environment - Environmental Protection Agency, n.d.). Hence public taste can be considered when developing guidelines for the siting of turbines. Furthermore, it is important to only include feasible attributes (Pearce et al., 2006). Choosing the colour of a turbine as an attribute would, for instance, be rather problematic, since most wind turbine producers do not offer a range of colours. Researchers often rely on expert interviews to determine attributes fulfilling these criteria. Considering the demand side, only characteristics, which respondents perceive as relevant, should be part of the choice alternatives (Garrod & Willis, 1999). It is obvious that we will not get meaningful results if the participant does not understand the properties or is indifferent towards them. A common instrument to obtain relevant characteristics is to conduct a focus group consisting of members, which are representative for the targeted population. For the present study, a focus group pretested the preliminary study and found all attributes to be relevant. The attribute should also be measurable in the sense that a variation of levels induces a change in respondents' utilities (Kjær, 2005). Following these considerations, Keeney and Raiffa impose the following criteria:

Criteria for Determining Attributes of Choice Alternatives [Table 5.1]

(1)	Completeness:	The chosen attributes encompass all important features of the good in question.
(2)	Operational:	The chosen attributes are relevant for consumers, policy makers and producers.
(3)	Decomposable:	The attributes can be varied over different levels.
(4)	Non-redundancy:	There should not be more than one attribute capturing a certain aspect of the good in order to avoid double-counting.
(5)	Minimum size:	The number of attributes should be as low as possible in order to avoid cognitive overexertion of the respondent.

Source: based on Raiffa & Keeney (1976) found in Kjær (2005)

With respect to visual attributes of wind power, we can draw on an extensive literature to identify relevant attributes. In section three of the literature review, we have presented significant results of prior studies on visual preferences of wind energy. Based on these findings, we included the following properties:

(1) type of turbine (implying size), (2) the distance to the closest builting, (3) the number of people living in the turbines' proximity as well as (4) an annual fee.

(1) Type of turbine

The "type of turbine"-attribute implies the turbines size (the more productive, the taller) as well as how many turbines have to be installed in order to generate a capacity of 3 MW, which is constant over choice sets. Holding capacity fixed, ensures that choices are solely driven by visual aspects and not demand for wind energy. The turbines, which are operated in Denmark right now, vary from 1 KW up to 6 MW (Energi Styrelsen, 2014). Depending on their capacity, their hub height and diameter of rotor blades vary. Generally, politics aim at replacing small turbines with low capacity by more productive ones (The Danish Government, 2008). Ladenburg and Dahlgaard also found a negative cumulative effect of daily wind turbine encounters on the attitude on wind power which supports an evenly distribution of turbines over the whole country (Ladenburg & Dahlgaard, 2012). Corresponding to these findings, the government intends to site new turbines according to the principles of maximal technical efficiency and minimal spatial impact (Danish Energy Agency, 2009). Thus, the development of wind energy will take place by spreading small groups of turbines rather than implementing large wind parks. The choice scenarios therefore consist of a small number of turbines. We determined the following levels: one 3 MW turbine, two 1.5 MW or four 750 KW turbines. On average, in Denmark 3 MW turbines are 83 m tall, 1.5 MW turbines 65 m and 750 KW turbines have a height of 45,5 m (Energi Styrelsen, 2014). The variation in turbine size and the required number to generate 3 MW are rather convenient for the purpose of our study. People are, however, not given any measures of height. If we had included both, "size" and "number of turbines", explicitly, we would have issues estimating our models for these characteristics are perfectly correlated (Kjær, 2005).

(2) Distance to closest building

In Denmark, the implementation of turbines has to be approved of the respective community (Danish Ministry of the Environment - Environmental Protection Agency). There is, however, some central regulation the communities have to obey. Referring to the distance between a turbine and the closest settlement, it has to be at least four times the total height of the turbine (ibid.). On average, 3 MW turbines operated in Denmark in 2014 had a total height of 130 m and thus would require to be built at least 520 m away from the nearest building (Energi Styrelsen, 2014). Keeping this distance and aiming at variation in the distance attribute without making the CE too complex, the attribute levels chosen are 500 m and 1000 m.

(3) Number of residents living in the turbine's proximity

The idea of introducing this attribute was to analyse whether citizens prefer turbines sited in areas where only few residents are affected by the turbine or, on the contrary, they assume that densely populated areas tend to be in industrialized surroundings where turbines do not have a distinct impact on the landscape anyway. It will be especially interesting, to look at the preferences for this attribute depending on the population density of the area the respondent lives in. The choice could then be understood as the participant agreeing to potentially have turbines built in his own residential area or following the 'not-in-my-backyard'-pattern. The number of people living in the proximity of the closest building takes the intervals 1-10 resident(s), 11-100 residents or more than 100 residents for these levels are likely to be relevant for respondents.

(4) Cost

Including a monetary attribute allows to calculate the marginal effect on an individual's welfare caused by changes in the scenarios' properties (see also 3.4). These measures can then be compared to gain a sense of which characteristics impact peoples' utility significantly and which can be neglected. Since we aim for identifying factors which influence peoples' acceptance of wind turbines, it is inevitable to incorporate a price attribute.

Before defining details of the cost attribute, a basic decision has to be made: Which welfare measure should be applied? In section 2.4.1 the welfare measures and their underlying assumptions were introduced. The central question is whether residents are entitled to landscapes free of visually intruding elements such as turbines. Turbines are installed to reduce the use of fossil fuels for energy production, which reduces GGEs and thereby benefits every human being. Besides, many environmental policy initiatives intend to maintain environmental quality for future generations to establish intergenerational justice. The latter argument is crucial with respect to the expansion of renewable energy capacities for its main purpose is climate change mitigation. From that point of view, it seems reasonable to deny residents the property rights for a 'turbine-free' landscape. Following this argumentation, the WTP for a visually appealing siting of turbines should be elicited. The WTP-approach, however, involves the risk of people living in the vicinity of turbines complaining about that they have to bear the social costs of wind energy, whereas persons living in cities are rather unlikely to have turbines built close to their residences. Prioritizing this objection would support the WTA idea and imply people having the right to the original state of the landscape surrounding their houses.

The property right discussion is not solely of theoretical importance for research has shown that WTA and WTP result in often widely differing estimates (Pearce et al., 2006). In a meta-study, Horowitz and

McConell found the ratio of WTA/WTP for non-market goods to be 10.4 (Horowitz & McConnell, 2002). Moreover, their analysis showed, that the disparity is independent of the survey design (budget reminder etc.) (ibid.). Grutters et al. add that the disparity also occurs in discrete CEs and is especially high for well-educated respondents, which make up an over-proportional share of our sample (Grutters et al., 2008). One explanation for this phenomenon is the so called 'endowment effect' (Pearce et al., 2006). It refers to people experiencing losses as more severe than gains of the same extend while economic theory would evaluate both with the same change in utility (ibid.). Risk aversion, leads to people demanding high compensations (WTA) for quality or quantity losses. Moreover, WTP values are restricted by a person's income. Respondents have to think thoroughly about how much they are willing to spend and which other consumption goods to give up, which makes WTP the "conservative estimate" of welfare effects (ibid.). In contrast, stating an amount of money to be compensated with requires less consideration and does not entail any renunciation of consumption. Bateman suggests to choose the welfare measure which has more credibility in the respective context (Bateman, 2002). Unfortunately, the credibility criterion does not really help with respect to visual attributes of wind power. On the one hand, recent Danish legislation intends to compensate losses of property value caused by turbines, which would justify a WTA approach (Energi Styrelsen, 2009). On the other hand, our survey does not only encompass use values (which are relevant regarding property prices). Furthermore, it aims for reflecting general attitudes towards turbines in respondents' municipalities without them knowing whether their property would be directly affected. Finally, almost all studies on visual wind power characteristics, which have been conducted so far, employ the WTP welfare measure. Hence, establishing a common ground with respect to the welfare measure used, allows for easier comparison of the results. For all these reasons, the present survey also elicits respondents WTP for the change of visual properties of wind energy.

Introducing a cost attribute requires careful considerations with respect to the attribute levels and the payment vehicle chosen. Bateman recommends using the payment mode, which seems most realistic (Bateman, 2002). In the case of wind power, it is clearly appropriate to use an obligatory form of payment for installing less efficient turbines causes costs, which are likely to be allocated to customers. Alternatively, the government could subsidize wind energy operators as to site turbines corresponding to peoples' preferences. This scenario also justifies coercive payments since subsidies are funded from taxes. Respondents often disapprove of taxes as payment vehicles because it is not transparent whether the money is actually used for the purpose it is claimed for (ibid.) We therefore chose the electricity bill to be the vehicle for collecting the additional fee for the wind power alternative chosen by the respondent. This form of payment is expected to meet the criteria of credibility and acceptability formulated by Bateman (ibid.). Consumers are used to price increases induced by rising operating costs on the side of producers.

Furthermore, there is a clear link between choosing several smaller turbines or a further distance to the closest settlement and the higher expenses associated with these options. The timescale for the payments results from the chosen vehicle: electricity costs are paid annually and per household and so is the additional fee.

Determining the levels of the cost attribute is more complex. In 2009, a typical Danish household had an annual electricity bill of 8400 DKK/year (Danish Energy Association, 2009). When pre-testing her study on wind power preferences in Sweden, Ek got the feedback that the costs for more visually appealing wind power designs should be modest because wind power has a comparatively small impact on the environment and all changes are reversible (Ek, 2002). We chose the following price levels: 0, 50, 100, 300, 600 and 1200 DKK/household/year. The upper limit (1200 DKK/year/ household) corresponds to an increase in annual electricity costs of 14%, which seems at the boundary of what consumers can be expected to accept given the considerations mentioned before.

Attributes of Choice Alternatives and Related Levels [Table 5.2]

Attribute	Attribute Levels
Type of turbine	3 MW, 2 x 1.5 MW, 4x 750 KW
Distance to closest residence	500 m, 1000 m
Number of people living in the proximity of the closest building	1-10, 11-100, more than 100
Annual Payment (DKK/household)	0, 50, 100, 300, 600, 1200

Reviewing DCEs, Kjær highlights the necessity to include attributes and construct levels such that the respondent is actually forced to trade off the alternatives against each other (Kjær, 2005). For the attributes chosen here, the annual payments incentivize the participant not to choose the option whereas a further distance might be worth the payment. Thus, the participant is required to trade off. For the categories of capacity and number of people living in a turbine's proximity the effect on respondents' utility is less predictable.

The chosen attribute and levels meet the criteria developed by Raiffa and Keeney presented above (Raiffa & Keeney, 1976). Prior studies as well as feedback from the focus group indicate that our attributes capture all essential visual aspects of wind energy. Like argued above, they are also operational for all stakeholders and can be decomposed into appropriate levels. Using the type of turbines instead of capacity and height avoids the problem of redundancy. All other attributes are not closely related. Furthermore, applying four attributes will most likely not overexert respondents.

A picture visualized each combination of attributes so that people could better imagine the effect of the height of the different types of turbines, the number of turbines and the distance. Respondents were reminded to open the pictures in full-screen mode. Appendix A exemplary shows one of the choice sets from our study including the accompanying picture.

Moreover, they were asked to imagine that the places they were shown are in their own or a neighbour community. Although, only one location per community has to be identified to realize the wind power expansion plans, participants should take it as the assumption for all their choices. To our knowledge, this is the first study on visual preferences for wind power, which does neither ask for general attitudes nor preferences for a specific project but confronts a group of respondents with the planned implementation of turbines in their respective environment. The setup allows to draw conclusions on the general attitudes on visual properties of wind energy based on private preferences.

Respondents were explicitly informed that independent of the type of the turbines and the distance to the closest settlement, there is no noise caused by turbines. This was done to assure that participants only think about visual attributes and do not base their choices on other considerations.

Finally, we included a short cheap talk section requesting participants to consider the scenarios as real. They were also notified that people typically overstate their WTP in such surveys and that it is really important that they thoroughly think about the costs related to the alternative they choose. Although there is no clear evidence on the effect of cheap talk, it has become standard to include it into CEs over the last decade (Ladenburg, Dahlgaard, & Bonnichsen, 2010).

The relevance of the attributes, attribute levels as well as the illustrations was confirmed when pretesting the preliminary survey in a focus group.

5.3 The Design of the Survey

Choice sets always have to include one ‘feasible‘ alternative (Hensher et al., 2005). Usually that is the status quo option allowing people to avoid any change or buy no product at all (therefore also called opt-out). Our study does not contain a status quo alternative since the planned development of wind power has been legally accomplished. The question is not whether wind power capacity should be expanded but how to site the new turbines as to minimize perceived visual intrusion. There are several studies, which argue that in cases, where the examined change is unavoidable, it is legitimate to exclude an opt-out (see e.g. Ek & Persson, 2014; Ladenburg & Dubgaard, 2009). Hensher et al. prioritize the construction of realistic scenarios over including a status quo option (Hensher et al., 2005). The only drawback of not including a status quo alternative is that the WTP values for the single attributes are only valid within the experiment and thus do not allow for drawing conclusions on welfare effects (Ek & Persson, 2014). We can, however, use the WTP value to conclude which attributes people prioritize when choosing between different wind power scenarios. With regards to our CE, respondents can be expected to be well aware of the political plans for gaining fossil fuel independency until 2050. Hence, giving them the option to support the present state of wind energy capacity would be rather unrealistic and could make them doubt the whole experiment. Instead, scenario A, which is the same for every choice set, partly fulfils the function of an opt-out. Selecting this option, people do not have to bear any additional expenses. Hence, alternative A can be understood as the scenario which will be realized if people show no interest in the visual implementation of the planned turbines or are not willing to pay an additional fee in order for their preferences to be considered. Having finished the choice process, respondents are asked why they always chose alternative A (if that is what they did). Two of the answers they can pick from are: "I cannot afford additional expenses." and "I do not think that the improvements in the siting of turbines are worth the expenses."[23]. These motives are similar to what drives people to choose the status quo option in conventional CEs. However, the respondents were not informed that alternative A always constitutes of the same attribute levels, which makes our study a generic or unlabelled form of a CE (Ek, 2002). Since people did not know ex-ante that A was always the option involving no additional costs, they actually had to look at the attributes and make trade offs. Following this reasoning, Bennet and Blamey suggest to use generic CEs when the target is to elicit the MWTP for changes in the attribute levels (Bennet & Blamey, 2001). For alternative A is the same in every choice set, its attribute levels serve as the baseline which utility changes caused by a variation of attribute levels will be compared to.

The first part of the survey asks for basic demographic data and consists of attitudinal questions on strategies for CO_2-reduction as well as the participant's general opinion on and their experience with onshore and offshore wind turbines. Some respondents were asked for their opinion on on- and offshore turbines before making their choice and some were asked after having finished the choice process. We will not differentiate between those two designs here, for it is outside the scope of this paper. The analysis of the answers to the attitudinal questions did not reveal any remarkable differences between the two subgroups.

The following section was the CE, where participants were first introduced to the choice scenario and the attributes as described in section 6.2. In the following, they had to make four choices regarding the

[23] These answers are part of question 18 in the survey „I de valgsituationer, du har svaret på, valgte du altid alternativ A. Hvad var den primære årsag dertil?" / „In the choice situations, you just have answered, you always chose alternative A. What was your primary reason for that?"

onshore wind power scenarios described above. Having made their final choice, they had to answer some questions reflecting their choice behaviour. In the next part, the same procedure was repeated for the comparison of on- and offshore scenarios, which is not of importance here. The survey ended with some questions relating to how familiar the respondent is with studies like ours. This was done to control for potential learning or fatigue effects as well as strategic behaviour and might serve as an indicator for how thoroughly the participant answered the survey. The final questions aimed at collecting respondent-specific socio-demographic data. In order to ensure, that respondents would understand the questions and consider theme relevant.

Like mentioned before, all choice alternatives where accompanied by a photo depicting the presented situation. It is quite common to use visual support for studies on offshore wind power for many people have never seen such a facility before and it is quite easy to manipulate seascape pictures as to contain offshore turbines. Meyerhoff et al. argue that, in contrast, the visual effect of onshore turbines is extremely site-sensitive and that already showing the same turbine from several perspectives has different impacts on viewers (Meyerhoff et al., 2010). Although this might be the case, we still used visualisation for it has been shown that people have great difficulties to imagine the effect of distance and height[24]. As for the problem to 'generalize' landscape, we used the photo of a rather neutral open landscape but asked people to imagine it would be in their own or a neighbour municipality. An example of an illustrated choice set can be found in Appendix A.

5.4 Experimental Design

To reduce the 102 choice alternatives in our full factorial design, we used D-efficient design with utility priors to compose attribute levels to choice alternatives and pair choice alternatives as to generate choice sets[25]. Having excluded identical and illogical choice sets, we ended up with 36. Since 36 choice sets would still be too extensive for one respondent to answer, we randomly assigned the alternatives to nine different blocks with four alternatives each. It is important to find a good balance between offering too few and too many choice sets to one participant. Having too few choice sets, involves the risk of not having enough observations to investigate preferences thoroughly (Hensher et al., 2005). Moreover, the required sample size increases with the number of blocks the totality of choice sets are broken down into. If the respondent, on the other hand, is challenged with too many choices, we might face learning effects or fatigue on the side of the respondent, which yields the risk of decreasing the quality of the choice data.

[24] Some studies name reference objects for heights and distances to avoid including pictures (see e.g. Ek, 2002).
[25] See for instance Hensher et al. (2005) p. 152-153 for an intuitive explanation of D-efficient design of choice sets.

5.5 Survey Distribution

Many authors recommend personal interviews to conduct CEs for it ensures that participants take time and understand the questions which results in high quality choice data (Bateman, 2002). On the other hand, there is a risk of the interviewer influencing the interviewee by asking questions in a certain way, his tone, body language etc. (ibid.). Major drawbacks of interviews are the enormous costs and that they are very time consuming. With respect to our study, it was important to have a rather large sample size because we had nine different blocks of choice sets and the results are supposed to represent the whole Danish population. Moreover, wind turbines are a topic which most people are familiar with, the experimental set-up was rather simple and the choice scenarios were supported by visual illustrations. For theses reasons, the study was conducted using an internet panel.

After some adaptions based on the focus group's feedback, the final survey was conducted in December 2011 and November 2012 on the internet panel "user need". From around 150,000 registered users the sample was drawn as to represent the Danish population with respect to gender, geography and education. 26,032 users, which were chosen according to these criteria, received an email inviting them to participate in the survey. Thus, there was no possibility for self-selection.

Couper objects that the risk of coverage error is high for online surveys (Couper, 2000). He argues that the frame population, having the technical means to participate in internet surveys, often differs from the target population whose preferences we wish to elicit. In Denmark 92% of the population had an internet access in 2012 (Statistics Denmark, 2013). Hence, coverage error does not seem to be an issue here. Comparing the distribution of socio-demographic variables of our study to posted surveys, however, reveals the same bias towards high education and high income[26]. The distribution of respondents' age also does not significantly differ between a comparable mail and our online survey. People who show no interest on sharing their opinion on questions like ours simply do not register on web portals like 'user need' just like they do not answer mail surveys.

2387 users completed the survey, which gives 19096 single observations[27]. The response rate of 9.17% is rather low but typical for web-based surveys. Since we addressed a large number of participants, we still have enough observations to draw valid conclusions.

[26] See for example Ladenburg, Dubgaard, Martensen, & Tranberg (2005)
[27] four choice sets comparing onshore wind power scenarios with two alternatives each

5.6 Limitations

In the introduction to the choice scenarios, respondents were told that no matter the attribute levels there will be no noise induced by turbines. However, it is probably difficult for people to completely isolate the visual aspects of wind power from externalities such as noise or shadow flicker, which depend on these exact visual attributes. Hence, we cannot be sure that the choices were only based on visual preferences. Moreover, respondents were asked to click on the pictures as to enlarge them and be able to see the turbines in all settings. Since loading the pictures took some time, some participants might not have looked at the enlarged photos. 48.9% of respondents stated they could not see the turbines in every picture and 10% could not remember whether they could or not. For the choice alternatives also contained the information on distance and type of turbines, it is difficult to say how the 'invisibility' of turbines on the pictures affected respondents' choices.

To ensure that respondents base their choices on private preferences and not what is good for society, we told them to imagine the wind power facilities will be built in their own municipalities. If respondents, however, know for sure that there will no turbine be built in their community, they are likely to have answered the questions based on their public preferences. Having this intention they would probably always choose alternative 1 since this is the cost-efficient way of producing wind power and does not require additional payments. If people did not give a good reason for always choosing option 1 we have excluded them due to strategic behaviour in order to prevent biased results.

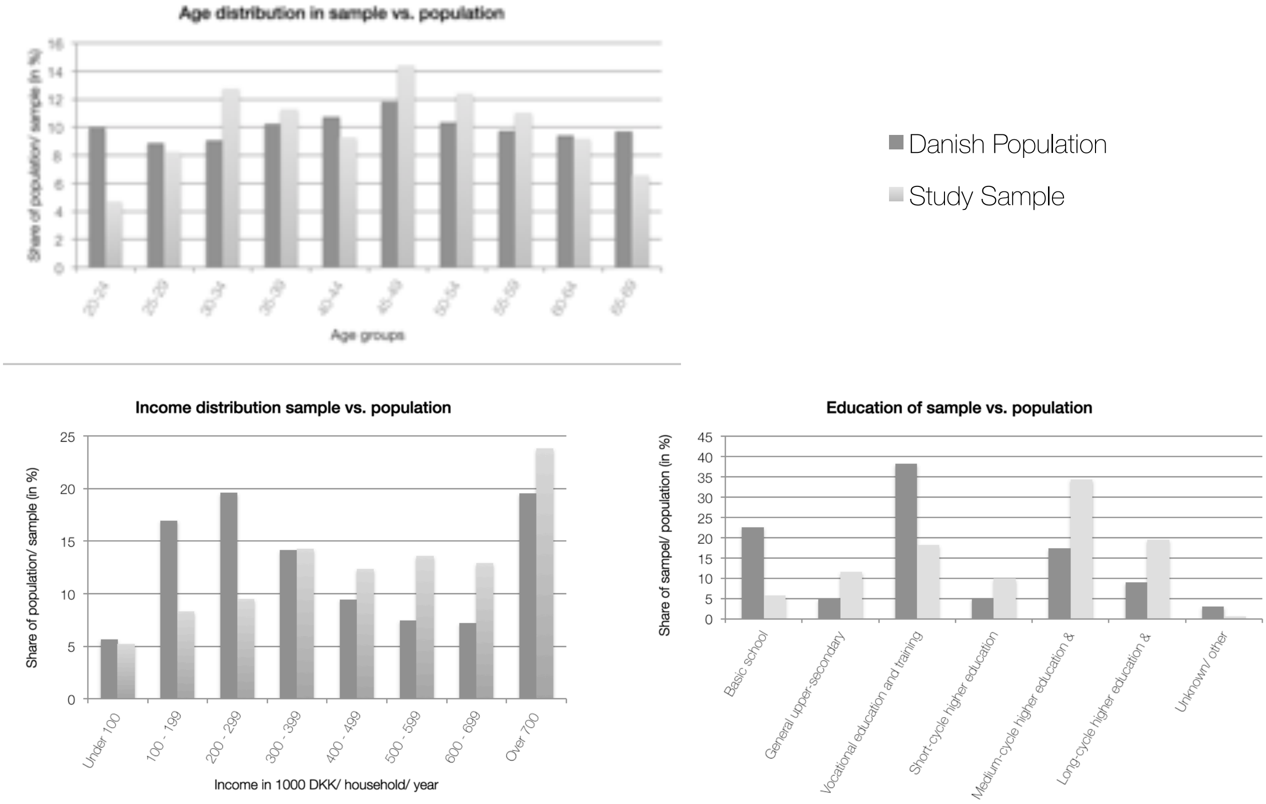
6. ANALYSIS AND RESULTS OF THE CHOICE EXPERIMENT

6.1 Descriptive Statistics

6.1.1 Socio-Demographic Characteristics and Sample Bias

Our sample includes respondents from 20 up to 69 years. Respondents had to be at least 20 and not older than 70 to participate, which accounts for the lower and upper limits. In 2012, the age group between 20 and 70 years made up around 65% of the Danish population – a third of all citizens are not represented in the study at all. Looking at the distribution of respondents within the age group of 20-70, people at both margins (20-29 years and 65-69 years) are underrepresented compared to the Danish population and middle-aged citizens (45-59 years) are slightly overrepresented (see figure 6.1). Genders are appropriately represented in the cohort. The major bias between the sample and the Danish population occurs with respect to income and education. For the most part, the participants of the choice experiment exhibit a significantly longer education than the average Dane. Appendix C contains a detailed comparison of the distribution of socio-demographic variables in our sample and the population whereas figure 6.1 below illustrates the major differences graphically. Like argued before, the overrepresentation of well-educated persons occurs in most surveys and is not specific for internet based ones. However, it seems likely that internet panels such as 'user need' rather attract highly educated people. This kind of self-selection could have been prevented using mail surveys, which address a wider range of respondents. With respect to the siting of wind turbines, the literature shows that well-educated people are more critical than those with lower levels of education (see e.g. Molnarova et al. 2012). Thus, the preferences elicited in our analysis might represent the 'worst case' scenario with respect to peoples' sensitivity for the siting of wind turbines. Moreover, the parameter of the cost attribute is likely to be correlated with the respondent's financial status. For our sample is not representative in terms of income, this effect should be controlled for.

Comparison of Socio-Demographic Characteristics of Sample Compared to Population [Figure 6.1]



6.1.2 Attitudes

The table below summarises the answers to the attitudinal questions on onshore wind power from the first part of the survey. Attitudes have been found to be essential for peoples' acceptance of wind power, especially in case they do not live in the vicinity of turbines and thus have no experience with wind energy facilities (see e.g. Ladenburg, 2008).

Overview Attitudinal Questions [Table 6.1]

	Question	very positive	rather positive	neutral	rather negative	very negative	I don't know.
1	What is your general attitude towards onshore turbines?	29.87	36.45	20.95	8.09	3.85	0.8
2	Which visual impact do onshore turbines have with respect to the landscape?	7.75	18.64	42.14	20.53	10.26	0.67
3	What is your opinion on building more onshore turbines?	25.22	36.28	20.03	10.52	7.21	0.75
4	What is your opinion on substituting many small onshore turbines with fewer but larger ones?	28.07	32.3	24.88	7.5	4.52	2.72
5	How do onshore turbines impact your use of nature/ recreational areas?	6.24	11.98	58.99	11.02	6.91	4.86

The first question confirms the standard finding of broad public acceptance of wind power. Only around 12% of respondents disapprove of onshore turbines. Furthermore, solely 26.5% of the sample thinks of turbines as impacting the landscape positively, which is coherent with visual intrusion being one of the major social costs associated with wind energy. The vast majority of participants support the government's plan of expanding wind power capacities in general (81%) and replacing small turbines by more efficient and hence taller ones specifically (85%). Therefore, we can expect the 'type of turbine' parameters for 1.5 MW and 750 KW turbines to be negative. In our survey, most participants do not feel negatively affected by turbines in their recreational activities, which is in contrast to Ek and Persson's findings (2014). However, the ordinal scale underlying the answers of these attitudinal questions theoretically does not allow for interpersonal comparisons. Accordingly, we should not worry too much about this contradiction. Moreover, Ek's study has been conducted in Sweden where people are generally less experienced with wind power, which might have caused the disparity.

6.2 Econometric Analysis of the Attributes-only Model

Before starting the actual analysis, we have to exclude all observations with respondents showing protest or strategic behaviour in order to avoid biased results. The terms refer to choice patterns which indicate that participants did not seriously consider both choice alternatives but either always picked alternative A or B (Pearce et al., 2006). If this was the case, the respondent was asked to state what motivated his choice behaviour. Appendix E illustrates which answers were considered to be strategic and protest behaviour. Excluding all persons belonging to this category, we are left with 2085 respondents. The socio-demographic profile of the cohort does not significantly change by reducing the number of observations (see Appendix C).

Additionally to the attributes introduced in the prior chapter, we add the "asc1" dummy to the model, which is 1 for all observations of the constant alternative A and 0 for all observations for alternative B. "asc1" thereby captures the average effect of all attributes of alternative A, which we do not control for but which might impact people's utility as to make them choose A (Kjær, 2005). Kjær advocates the incorporation of the alternative specific constant for all CEs including a constant choice alternative, like we do for option A (ibid.).

All other attribute levels are dummy coded as well and refer to choice alternative A as baseline. Variables 750 KW and 1.5 MW, for instance, take the value 1 if the respective capacity is part of the choice alternative and 0 otherwise. Consequently, for scenarios with 3 MW turbines, both of the former variables are equal to 0. The population and distance attributes are coded correspondingly.

In order to make sure that a random parameters model is truly superior to a standard multinomial logit, we tested the latter against a random parameter model with uncorrelated random parameters, 500 draws and without any interactions. We found the random parameters model to outperform the standard logit (see Appendix B). All variables except from the cost attribute and the alternative specific constant "asc1" were treated as random and normally distributed. We varied the distribution of some of the variables but found none of them contributing to a significant increase in goodness of fit. The cost attribute was treated as fixed for it is rather convenient in order to calculate marginal willingness to pay for the other attributes. If only one of the variables is random, the marginal rate of substitution follows the distribution of the respective parameter (Train, 2003). The "asc1" variable was also treated as fixed for it is likely to cover systematic rather than individual-specific effects. All models were estimated in "R". The codes for the main important models can be found in Appendix B. Moreover, conducting a likelihood ratio test, we cannot reject the null hypothesis of the random parameters being uncorrelated[28], which is why we allow for correlation in all of the models presented here (unless stated otherwise). Hensher and Green recommend to run the model with varying numbers of draws (R) starting from 100 to see which is the lowest number granting stable results (Hensher & Greene, 2001). Appendix D contains estimation results for a span of R from 100 up to 4000 and shows that results are stable from R=500, which we maintain throughout the whole analysis.

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[28] see Appendix D

Attributes-only Model with R = 500 and Correlated Random Variables [Table 6.2]

Variable		Baseline	Estimate	Std. Error	t-value	Pr(>|t|)	
	cost		-0.00251489	0.00017914	-14.0384	< 2.2e-16	***
	asc1		0.35074161	0.13401339	2.6172	0.0088651	**
Capacity:	1.5 MW	3 MW	-0.80128642	0.17436237	-4.5955	4.32e-06	***
	750 KW	3 MW	-1.40256049	0.19004557	-7.3801	1.58e-13	***
Distance:	1000 m	500 m	-0.04138376	0.11068254	-0.3739	0.7084817	
Population:	more than 100 people	1-10 people	-0.28926309	0.13542262	-2.136	0.0326792	*
	11-100 people	1-10 people	-0.50920463	0.14330062	-3.5534	0.0003803	***
Variance/ covariance	MW1_5.MW1_5		2.06138497	0.28295484	7.2852	3.211e-13	***
	MW1_5.KW750		1.83807994	0.24576653	7.479	7.483e-14	***
	MW1_5.dist1000		1.34835316	0.19206206	7.0204	2.212e12	***
	MW1_5.bebor100		-0.06661199	0.16780088	-0.397	0.6913892	
	MW1_5.bebor11_100		0.11321924	0.22686669	0.4991	0.6177398	
	KW750.KW750		1.07236382	0.33669458	3.185	0.0014477	**
	KW750.dist1000		0.340812	0.18304968	1.8619	0.0626235	.
	KW750.bebor100		-0.89987283	0.29593967	-3.0407	0.00236	**
	KW750.bebor11_100		-0.04370637	0.34840468	-0.1254	0.9001696	
	dist1000.dist1000		-1.25415145	0.29166997	-4.2999	0.00001709	***
	dist1000.bebor100		0.33975883	0.24089725	1.4104	0.1584249	
	dist1000.bebor11_100		0.20526777	0.31277322	0.6563	0.511642	
	bebor100.bebor100		0.47271008	0.20050205	2.3576	0.0183919	*
	bebor100.bebor11_100		-0.96823051	0.56914506	-1.7012	0.0889051	.
	bebor11_100.bebor11_100		0.42412298	1.34422382	0.3155	0.7523706	

Log-Likelihood:	-4246
McFadden R2:	0.152295
Likelihood Ratio Test:	chisq=1525.6 [p-value= < 2.2 e-16]
Number of observations	16880
Number of respondents	2085

Codes for significance levels: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Table 6.2 above gives the results from estimating the attributes only model with correlated random parameters. The estimates represent the average effects of the attributes on respondents' likelihood to choose the related choice alternative. Since we assume the participants to make their choices based on their preferences, the parameter estimates can be understood as the marginal utility change induced by the attribute. Like expected, cost has a highly significant negative parameter. Thus, the higher the monetary costs for reducing visual externalities from wind power, the weaker are respondents' preferences for mitigating these social costs. Based on the cost parameter we calculated the MWTP for all other choice attributes like displayed in table 6.3 below[29]. The confidence intervals were estimated with the delta method introduced in section 3.4.

Marginal Willingness to Pay for the Choice Attributes in DKK/ household/ year [Table 6.3]*

Attribute		Baseline	Mean WTP	95% Confidence Interval	
				Min	Max
	asc1		139.47	28.34	250.6
Capacity:	1.5 MW	3 MW	-318.62	-452.15	-185.09
	750 KW	3 MW	-557.7	-706.58	-408.82
Distance to closest settlement:	1000 m	500 m	-16.46	-102.43	69.51
Population in turbine's vicinity:	more than 100 people	1-10 people	-115.02	-223.89	-6.15
	11-100 people	1-10 people	-202.48	-314.48	-90.48

* MWTP values were calculated based on the model with correlated random parameters and no interactions (see table 6.2)

Capacity/ Size of Turbines

We compare the two 1.5 MW turbines and the four 750 KW turbines scenarios to the baseline of one 3 MW turbine. Both estimates are negative which means that respondents experience disutility compared to the attribute's level in alternative A. The preference of 3 MW turbines is in line with peoples' support of taller and more efficient turbines, which they expressed in the introductory attitudinal questions (see question 4 in table 6.1). Most of the studies presented in the literature review support our results (compare e.g. Wolsink 2007, Ek & Persson 2014). The negative MWTP estimates express the amount of money needed to compensate respondents for the disutility they experience with several smaller turbines compared to a single 3 MW turbine. The amount for compensating four 750 KW turbines is clearly higher than for two 1.5 MW turbines. Accordingly, respondents have strong preferences for few tall but very efficient turbines.

Distance

The most surprising finding in the basic model is the distance parameter being negative. Thus, people do not seem to prefer turbines placed further away from settlements like we expected them to. The estimate is, however, not significant on any conventional level. Moreover, the parameter's variance is large and highly significant. Accordingly, preferences with respect to distance appear to be quite heterogeneous. In the model with uncorrelated parameters, though, the estimate was found to be positive and significant on a 5%-level (see Appendix F). Therefore, it seems as if the distance attribute was only important due to its correlation to the size of turbines. This idea is supported by the significant covariance of the distance and

[29] The theory behind the calculation of MWTP values can be found in section 3.4.

the 1.5 MW/ 750 KW variables. In order to control for this effect, we ran another model with interactions between the distance and turbine size as well as population density properties (see Appendix F). For the latter model, we found the interaction between the distance and 1.5 MW variables to be positive and significant on a 5% level whereas the interaction with the 750 KW dummy did not result in a significant estimate. Thus, respondents prefer 1.5 MW turbines to be sited 1000 m from the closest settlement as compared to 500 m. It is not surprising that we could not find such an effect for 750 KW turbines for they are significantly smaller than 1.5 MW turbines so that a variation in distance has less of an impact.

Regarding population density, the interaction with distance is positive for both variables but only significant if more than 100 people live in the turbines' vicinity. Thus, if turbine(s) are supposed to be built close to a larger settling, people prefer them to be located further away. The intention might be that if many people experience the visual disamenity induced by turbines, the effect should be limited by siting them far away.

Controlling for the above interactions effects also changed the distance parameter: it now has a negative sign and is significant on a 1%-level. The underlying reason for this is, however, unclear. Ek and Persson experienced a similar problem with respect to their 'open landscape'-attribute and could not succeed in motivating the result (Ek & Persson, 2014). It might simply be an expression of inconsistent and not fully rational choice behaviour on the side of respondents. Moreover the variance of the distance variable is significant on a 0.1% level, which means that the samples' preferences regarding this characteristic vary a lot and could also be a reason for the counter-intuitive parameter value.

We have seen that including interaction effects between the distance parameter and the capacity/ population attributes has a relevant impact on the main effect of the distance variable. Moreover, the Log-Likelihood values show that the interactions add explanatory power to the model. The significant interaction effects will therefore be incorporated into every further model.

Number of residents in the turbines' vicinity

Both population estimates are negative suggesting that respondents prefer 1-10 people living close to the turbine (baseline) compared to 11-100 or more than 100 residents. It seems reasonable that respondents make their choice to minimize the number of people who suffer from visually intrusive turbines. The "over 100 residents"-attribute displays a highly significant variance (0.1% significance level). Hence, preferences for this attribute strongly vary across the sample, which could be the reason for the parameter itself only being significant on a 5%-level. The "10-100 residents"-variable, in contrast, is significant on a 0.1%-level and does not exhibit significant variance. Thus, the preferences for 1-10 compared to 11-100 people living in the vicinity of turbines are clearer than for 1-10 versus more than 100 residents. The calculated MWTP measures correspond to these findings (see table 6.3). They are negative for both variables since respondents experience disutility from more than 1-10 people living in the vicinity of turbines. The amount individuals have to be compensated with, however, is higher for the “11-100 people” category than for “more than 100 people”. Consequently, participants prefer 1-10 over more than 100 people residing close to turbines. The least favoured option is 11-100 residents. Hence, the WTP-curve takes a converted u-shape. Like argued before, the advantage of scarcely populated areas is quite obvious: only few people are visually disturbed by turbines. With respect to areas with more than 100 residents, respondents might assume these regions to be rather urban so that, among all the other ‘unnatural‘ landscape elements, the impact of turbines is less dominant.

Alternative-specific constant

In the attributes-only model the alternative specific constant has a positive parameter, which is significant on a 1%-level. Thus, respondents generate utility from choosing alternative A unrelated to the attributes we included explicitly. When pretesting the survey in a focus group, the general feedback was that the visual wind energy characteristics included were comprehensive. The same holds with reference to the literature. We therefore suspect that the public versus private preferences conflict could be the reason for the significant and positive “asc1” parameter. People might choose alternative A for they have been informed that operating 3 MW turbines would be cost-efficient. Accordingly, from a societal perspective, it would be best to always choose A (as long as alternative B uses smaller turbines or is sited further away from existing traffic infrastructure).

In the first part of the survey, people were asked whether they know of plans to built turbines in their own or a neighbour community. Respondents being aware of such proposals can be expected to base their choices on their private preferences only since the choice scenario represents their reality. Running the above model for the respective subgroup confirms the hypothesis. The results presented in Appendix G show that the alternative specific constant is no longer significant whereas the model itself has a significant chi-square value. The group of respondents, who will definitely experience visual disamenity from turbines make their decisions based on their personal taste and not what might be optimal for society. We created another subsample of respondents who will not live close to turbines in the future. Following our hypothesis, we expect the parameter estimate for “asc1” to be highly significant but only found significance on a 10%-level. Consequently, “unaffected” respondents seem to base their decisions at least partly on what they think is good for society. On the other hand, the distance parameter for this subsample is significant on a 10% level, whereas it was not significant for respondents who expect turbines to be built in their neighbourhood. This last finding supports the existence of altruism – although people know that they will not have to suffer from turbines' disamenity, they anticipate their visual impact. All in all, the effects of respondents knowing that no turbines will be built in their own or a neighbour municipality are rather mixed.

Another indicator for the choices being dominated by public preferences could be the overall attitude towards wind turbines. If individuals have a very positive opinion on wind turbines they might always choose alternative A simply because it employs more efficient and modern turbines. We estimated the basic model for the subsample of respondents with a very positive attitude on wind turbines[30]. For this share of respondents, the alternative specific constant was found to be significant on a 0.1%-level (see table 6.9). In contrast, the alternative specific constant was neither significant for people with a rather positive or neutral opinion nor for all individuals with a negative attitude (see table 6.9). Therefore, independent of the specific attribute levels in the scenarios to choose between, participants with a very positive attitude towards onshore turbines tend to choose alternative A. It is hard to judge whether they did so because they support onshore turbines for purely private reasons or because they are beneficial for society as a whole. Nevertheless, it is likely that some respondents' choices were motivated by public preferences.

6.3 Econometric Analysis of Interaction Effects

The overall aim of this thesis is to identify locations in Denmark where people have a comparably high ex-ante acceptance for onshore wind energy so that plans to built turbines are not met with insuperable resistance. Based on the literature review, we identified the following categories of attributes, which are likely to impact peoples' acceptance of turbines:

Attributes for Analysis [Table 6.4]

	Category	Variables
1	Socio-demographic characteristics	• income • age • education • gender
2	Experience with/ exposure to turbines	• number of turbines daily encountered • turbines in viewshed from permanent residence or summer house • distance to closest turbine
3	Attitude towards wind power	• general attitude towards onshore turbines
4	Urbanization of region	• distance to motorway junction • distance to closest city centre • distance to closest industry complex

[30] We included all respondents who answered the question "What is your general attitudes towards onshore turbines?" with "very positive".

5	Landscape	• distance to closest forest • distance to closest nature reserve • time lived in that area (local attachment) • effect of turbines on recreational activities

6.3.1 Socio-Demographic Variables

From the wind energy literature we know, that preferences depend on age (see e.g. Ladenburg, 2008). Moreover, it is likely that respondents with lower income perceive the cost attribute as more utility restricting than those with higher income. We control for this correlation by introducing an interaction of the respondent's household income and the annual payments for the respective wind turbine setup. Furthermore, Molnarova et al. found preferences for the siting of turbines to strongly depend on individuals' level of education (Molnarova et al., 2012). Referring back to the earlier discussion on the alternative specific constant, we interacted the "asc1" variable with both, the level of education as well as respondents' gender. If we assume "asc1" to represent the prevalence of private preferences on the side of respondents, highly educated people might attribute more importance to society's welfare. With respect to gender, men might make more rational decisions than women. If this assumption holds, they would rather choose the cost-effective 3 MW option and attribute less importance to residents feeling negatively impacted by tall turbines.

When testing for interactions of education level and choice attributes, however, we did find no significant effects. Therefore the interactions with respondents' education level were not included in the final model presented here.

Table 6.5 below presents the results of interacting socio-demographic variables with visual wind power characteristics. Compared to the attributes-only model where interacting distance with the "1.5 MW" as well as the "more than 100 people" attribute, all main parameters keep their signs. Like expected, the interaction effect between cost and income is positive. Thus, respondents with high household income experience relatively less disutility from paying additional annual fees for reduced social costs of wind power than those with low earnings. The interaction of gender and "asc1" is only significant on a 10%-level but has the suggested sign. Independent of the specific attribute levels, men generate higher utility from choosing alternative A, which might be rooted in higher rationality with respect to decision making. Age is significant when interacting it with all but the "11-100 residents" choice attributes. From prior research, it is well known that older people generally exhibit stronger dislike of wind power facilities than younger generations (see e.g. Ek, 2006; Ladenburg, 2008). The major argument put forward to explain this phenomenon is that younger people were born into a world with turbines being an integral part of the environment whereas older people still perceive them as alien elements and take more time to get used to them. The former reasoning explains the direction of the interaction effects: proportional to their age, people favour turbines to be sited 1000 m away as compared to 500 m. Furthermore, the older a respondent the stronger he prefers smaller turbines, probably because they are perceived as less visually intrusive. The interaction effect of the number of people living in a turbine's vicinity is only significant for more than 100 residents (5%-level). One explanation could be that people do not perceive a substantial difference between areas where 1-10 or 11-100 people live. Moreover, the impact of population density is ambiguous: scarce settling implies only few people suffering from the disamenity. On the other hand, low population density can be understood as an indicator for the surrounding landscape to be more natural and therefore more worthy of protection. Vice versa, densely populated areas are likely to be highly urbanized. Thus, respondents might assume that the population in such an environment is less sensitive towards visual intrusion by turbines, which could explain the significance of the "more than 100 people" attribute. Interacting respondents' age with the alternative specific constant generates a significant negative parameter. Accordingly, regardless of the choice attribute levels, older people tend not to choose alternative A. The finding is in line with the acceptance of wind energy decreasing with age for alternative A symbolizes the extreme of technological progress.

All of the interactions with the age-variable counteract the main effects in the model for they have opposite signs. We can thus calculate 'threshold'-values for respondents' age beyond which the interaction effect outweighs the main effect. We will, however, only compute these thresholds for the 'KW750', the 'bebor100' and 'asc1' variables for they are at least significant on a 5%-level[31]. For the four 750 KW turbines scenario, disapproval turns into support with respondents being 70 years or older. Thus, the effect is not relevant four our sample. The interaction effect of age and 'asc1', in contrast, outweighs the main effect from age 23 or older. On average, the specific attribute levels left out, respondents hence generate higher utility from not choosing scenario A. Since the effect increases with age one could interpret it as peoples' perspective on landscape shifting towards a conservative ideal over their lifetime. For the 'bebor100'-attribute, the threshold is 20 years. From this age on, ceteris paribus, respondents prefer turbines to be sited in areas with a population of more than 100 people as compared to areas with 1-10 residents. The latter two effects basically affect the whole sample. Considering the signs of the main effects, there have to be other attributes strongly counteracting the age effects.

Like several prior studies, we found acceptance for wind power to significantly vary with age. The results, however, point to the presence of more dominant factors determining wind power acceptance.

[31] The MWTP-values used to calculate the threshold values can be found in Appendix G.

Moreover, Johansson and Laike found the argument not to be invertible: age does not significantly impact peoples' willingness to protest (Johansson & Laike, 2007).

Model with R = 500, Correlated Random Variables and Interacted Socio-Demographic Variables [Table 6.5]

Variable		Baseline	Estimate	Std. Error	t-value	Pr(>|t|)	
	cost		-0.0030036	0.00030672	-9.7928	< 2.2e-16	***
	asc1		1.5173	0.50087	3.0293	0.0024514	**
Capacity:	1.5 MW	3 MW	-2.103	0.57917	-3.631	0.0002824	***
	750 KW	3 MW	-2.2583	0.4278	-5.279	1.299e-07	***
Distance to closest settlement:	1000 m	500 m	-0.89504	0.34042	-2.6292	0.0085587	**
Population in turbine's vicinity:	more than 100 people	1-10 people	-1.5801	0.47779	-3.3072	0.0009424	***
	11-100 people	1-10 people	-1.056	0.41529	-2.5428	0.0109976	*
	I(dist1000 * bebor100)		0.81129	0.24883	3.2604	0.0011125	**
	I(dist1000 * MW1_5)		0.90828	0.28971	3.1352	0.0017177	**
	I(age * KW750)		0.023972	0.0078806	3.0419	0.0023506	**
	I(age * MW1_5)		0.016412	0.0096621	1.6986	0.0893902	.
	I(age * dist1000)		0.011336	0.0068046	1.6659	0.0957403	.
	I(age * bebor11_100)		0.010324	0.0083726	1.233	0.2175702	
	I(age * bebor100)		0.017732	0.0090408	1.9613	0.0498425	*
	I(cost * q31_indkomst)		0.00013019	0.000043551	2.9895	0.0027947	**
	I(age * asc1)		-0.022113	0.0092481	-2.391	0.0168008	*
	I(gender * asc1)		0.14467	0.082389	1.756	0.0790947	.
Covariance/ Variance	MW1_5.MW1_5		2.4064	0.32664	7.367	1.745e-13	***
	MW1_5.KW750		1.5702	0.22997	6.8278	8.624e-12	***
	MW1_5.dist1000		0.90206	0.18686	4.8276	0.000001382	***
	MW1_5.bebor100		-0.16102	0.19534	-0.8243	0.4097651	
	MW1_5.bebor11_100		-0.094482	0.24854	-0.3802	0.7038314	
	KW750.KW750		1.1023	0.33835	3.2578	0.001123	**
	KW750.dist1000		0.86621	0.20904	4.1437	0.00003418	***
	KW750.bebor100		-0.60574	0.29706	-2.0391	0.0414359	*
	KW750.bebor11_100		0.18484	0.35768	0.5168	0.6053117	
	dist1000.dist1000		-1.1404	0.33387	-3.4157	0.0006363	***
	dist1000.bebor100		0.13107	0.26359	0.4972	0.6190188	
	dist1000.bebor11_100		-0.011285	0.35554	-0.0317	0.9746797	
	bebor100.bebor100		-0.6388	0.19659	-3.2494	0.0011565	**
	bebor100.bebor11_100		0.8262	0.38534	2.1441	0.0320267	*
	bebor11_100.bebor11_100		-0.17502	1.4578	-0.1201	0.9044417	
Log-Likelihood:			-4198.6				
McFadden R2:			0.1617645				
Likelihood Ratio Test:			chisq=1620.5 [p-value= < 2.2 e-16]				
Number of observations			16880				
Number of respondents			2085				

Codes for significance levels: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

6.3.2 Experience with Turbines

In the literature review we presented several studies which found acceptance for wind energy sites to depend on experience and familiarity with such facilities (see e.g. Meyerhoff et al., 2010; Warren et al., 2005). Like illustrated in section 4.3, acceptance for specific wind energy projects is usually higher once the plan is realised than apriori. This, however, is of no use in our context because public support is required to get permission for building turbines in the first place. Moreover, many studies revealed that support decreases with distance to the closest turbine, which indicates that the more familiar respondents are with turbines the higher their support. Nevertheless, it is likely that there is a threshold for the 'experience' factor, turning acceptance into disapproval.

Attributes-only Model with R = 500 and Correlated Random Variables:
Subsamples of Respondents Who Are Aware of Plans to Built Turbines in Their Community [Table 6.6]

		subsample Currently no turbine in viewshed from permanent residence/ summer house			subsample Currently turbine in viewshed from permanent residence/ summer house		
Variable		Estimate	Pr(>|t|)		Estimate	Pr(>|t|)	
	cost	-0.001279	0.0000821	***	-8.27400000	0.51977280	
	asc1	0.04178421	0.9116240		-10.18800000	0.28317900	
Capacity:	1.5 MW	-0.7490984	0.0450120	*	2.16350000	0.41711510	
	750 KW	-1.63317779	0.0040270	**	-1.88370000	0.88621840	
Distance to closest settlement:	1000 m	-0.2227586	0.4881410		2.60800000	0.84714470	
Population in turbine's vicinity:	> 100 people	-0.14676026	0.7080280		-0.01408900	0.08315320	.
	11-100 people	-0.47093121	0.1895960		3.49450000	0.73250450	
Covariance/ Variance	MW1_5.MW1_5	1.04708781	0.0474830	*	126.36000000	0.00000008	***
	MW1_5.KW750	1.86024275	0.0231160	*	58.15200000	< 2.2e-16	***
	MW1_5.dist1000	1.70784564	0.0095550	**	65.30700000	< 2.2e-16	***
	MW1_5.bebor100	-1.18074359	0.0306230	*	-71.50600000	0.00010300	***
	MW1_5.bebor11_100	-0.22844292	0.7328700		-115.00000000	0.00000002	***
	KW750.KW750	-1.10461309	0.2367700		26.43900000	0.00027070	***
	KW750.dist1000	0.46694777	0.4561740		23.34100000	0.01593190	*
	KW750.bebor100	1.10715763	0.2009540		70.66600000	0.00022840	***
	KW750.bebor11_100	0.6714321	0.4417600		85.02700000	0.00019400	***
	dist1000.dist1000	-0.00347339	0.9974200		-196.43000000	< 2.2e-16	***
	dist1000.bebor100	-0.76670507	0.7961370		92.37300000	< 2.2e-16	***
	dist1000.bebor11_100	-0.13434853	0.9735380		72.98000000	0.00000000	***
	bebor100.bebor100	0.32322136	0.9655030		85.78700000	0.00000000	***
	bebor100.bebor11_100	0.09732474	0.9922290		114.89000000	0.00000000	***
	bebor11_100.bebor11_100	100 0.101296	0.9787920		-26.73700000	0.00326050	**
Log-Likelihood:		-494.74			-183.19		
Likelihood Ratio Test:		chisq=183.55 [p-value= < 2.2 e-16]			chisq=86.172 [p-value= < 2.2 e-16]		
Number of observations		1840			728		
Number of respondents		230			91		

Codes for significance levels: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Like argued earlier, residents who expect turbines to be built in their vicinity, are supposed to make choices based on their private preferences. Thus, we analyse the effect of experience on the preferences for wind power attributes for this subsample. Table 6.6 above summarises the results.

People, who expect turbines to be built in their community and currently have no turbines in their viewshed, prefer 3 MW turbines to the smaller alternatives. Again, this is in line with our findings for the whole population as well as prior studies and intends to spatially limit the “visual disamenity” induced by turbines. Moreover, for this subsample cost has a negative parameter, which expresses respondents' disutility from spending money for the mitigation of social costs of wind power. The parameter is not significant for the group who currently have turbines in their viewshed indicating that costs are not the main factor motivating their choices. Likewise, none of the other visual characteristics of wind energy facilities are significant for the latter respondents. The highly significant variation for all random parameters might explain this surprising finding: the taste for visual wind power attributes varies extremely. Thus, people can see turbines from their residence seem to be affected by them very differently. Consequently, their ideas of how to reduce the visual impact of turbines are also diverse which is why we find no clear effects in our estimated model. The varying perception certainly depends on individual characteristics such as age or attitude but can also be assumed to be related to the landscape respondents live in. A person living in a flat and open landscape might think that several smaller turbines appear more organic than a single tall one whereas in other regions it might be preferred to limit visual pollution to a small area and thus erect only one turbine. The findings support the common belief that the visual impact of turbines is rather site specific and can hardly be generalized, which of course complicates our search for meaningful landscape attributes. It is, however, significant to keep in mind that this second subsample consists of only 91 respondents, which clearly limits the validity of these insights.

For the analysis of the whole sample, we interacted choice attributes with the number of daily turbine encounters (q9_antal_vindm[32]), how many turbines the respondent can see from his house (q11_antal_vindm_hus[32]) as well as the general distance from residence to the closest turbine (dist_turbine_km). Table 6.7 below refers to the final ‘experience'-model. It includes only the interaction effects for which we found significant estimation parameters in prior models. The cost attribute is significantly and positively correlated to respondents' experience with turbines. Including both, number of turbines encountered daily and the number of turbines respondents can see from their residence, leads to the latter one not being significant anymore. Thus, turbines seen from residence do not seem to impact

[32] The variable is coded based on 5 categories (1-5) with increasing numbers of turbines encountered daily/ seen from residence.

respondents' preferences distinguishable from turbines seen elsewhere – the number of daily turbine encounters dominates the other interaction effect. The more turbines respondents see during a day or from their residence, the more willing they are to pay an additional fee to have turbines sited according to their taste.

Model with R = 500, Correlated Random Variables and Interacted Experience Variables [Table 6.7]

Variable		Baseline	Estimate	Std. Error	t-value	Pr(>|t|)	
	cost		-0.00308	0.00033	-9.32580	< 2.2e-16	***
	asc1		0.72799	0.20217	3.60080	0.00032	***
Capacity:	1.5 MW	3 MW	-1.40250	0.33495	-4.18730	0.00003	***
	750 KW	3 MW	-1.04820	0.22017	-4.76080	0.00000	***
Distance to closest settlement:	1000 m	500 m	-0.41454	0.12234	-3.38840	0.00070	***
Population in turbine's vicinity:	more than 100 people	1-10 people	-0.78096	0.21016	-3.71610	0.00020	***
	11-100 people	1-10 people	-0.60029	0.14348	-4.18380	0.00003	***
	I(dist1000 * bebor100)		0.83686	0.28513	2.93510	0.00333	**
	I(dist1000 * MW1_5)		0.86192	0.25509	3.37880	0.00073	***
	I(cost * q9_antal_vindm)		0.00031	0.00008	3.98790	0.00007	***
	I(cost * q11_antal_vindm_hus)		0.00007	0.00009	0.80850	0.41881	
	I(cost * dist_turbine_km)		0.00003	0.00005	0.54570	0.58525	
	I(MW1_5 * dist_turbine_km)		0.01902	0.03885	0.48960	0.62442	
	I(KW750 * dist_turbine_km)		-0.05596	0.03485	-1.60580	0.10832	
	MW1_5.MW1_5		2.40310	0.32039	7.50040	0.00000	***
	MW1_5.KW750		1.78450	0.24766	7.20540	0.00000	***
	MW1_5.dist1000		1.03560	0.19258	5.37710	0.00000	***
	MW1_5.bebor100		-0.11084	0.18391	-0.60270	0.54672	
	MW1_5.bebor11_100		-0.02689	0.24181	-0.11120	0.91148	
	KW750.KW750		1.19980	0.37453	3.20360	0.00136	**
	KW750.dist1000		0.63783	0.20002	3.18880	0.00143	**
Covariance/ Variance	KW750.bebor100		-0.65599	0.30072	-2.18140	0.02916	*
	KW750.bebor11_100		0.15380	0.36337	0.42330	0.67211	
	dist1000.dist1000		-1.22490	0.31286	-3.91520	0.00009	***
	dist1000.bebor100		0.37126	0.23768	1.56210	0.11827	
	dist1000.bebor11_100		0.05868	0.31537	0.18610	0.85239	
	bebor100.bebor100		0.53030	0.20628	2.57070	0.01015	*
	bebor100.bebor11_100		-0.84730	0.52446	-1.61560	0.10619	
	bebor11_100.bebor11_100		0.44751	1.08970	0.41070	0.68132	

Log-Likelihood:	-4213.3
McFadden R2:	0.1588173
Likelihood Ratio Test:	chisq=1569 [p-value= < 2.2 e-16]
Number of observations	16880
Number of respondents	2085

Codes for significance levels: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

However, the model allows for no conclusion on the visual preferences of respondents who are familiar with wind turbines since none of the interactions with specific visual attributes is significant. Trying to understand this result, we can draw back on the explanation presented for the earlier analysis of subsamples: although respondents are familiar with turbines, the nature of their experiences differs widely with respect to the type of turbines, number, formation and the character of the landscape they are sited in. These various impressions result in as least as many ideas on how to limit the visual pollution induced by turbines because all respondents think within their individual context. Thus, the results again indicate that there is no universally valid best practice to locate and design wind turbines but it is necessary to find place-sensitive solutions. For that purpose, we will try to identify site-specific patterns of preferences for visual wind energy attributes in section 6.3.4.

Given our data, we cannot analyse the level of wind power acceptance as such but only the draw conclusions on which visual characteristics impact acceptance. It is therefore difficult to compare our results to other surveys, which often focus on how experience is related to the overall acceptance of onshore turbines (see section 4.3). Generally, incorporating the 'experience'-dimension could not increase the explanatory power of the model a lot. The chi-square-value shows though, that the model is significant.

6.3.3 Attitudes

Like in almost every field, general attitudes are an import component of citizens' acceptance of wind energy. Ladenburg, for instance, found the explanatory power of modelling attitudes towards more onshore turbines significantly increasing, when controlling for the respondents' opinion on the general impact of turbines (Ladenburg, 2008). In our choice experiment, respondents answered the attitudinal question by choosing an option from the following scale:

Choice Options for Attitudinal Questions [Figure 6.2]

Very positive (1)	(2)	**Neutral** (3)	(4)	**Very negative** (5)	**I don't know.** (6)
O	O	O	O	O	O

For this is an ordinal scale, interpersonal comparisons are difficult, especially when incorporated as a variable in the econometric analysis. We therefore split the group of respondents according to their general attitude towards onshore turbines into following subsamples. We group "rather positive" and "neutral" together to have a sharp distinction from respondents with a "very positive opinion".

Subsampling of Respondents According to Overall Attitude Towards Onshore Wind Power [Table 6.8]

Choice options	Attitude	Size of subsample
(1)	very positive	623 respondents
(2) & (3)	neutral	1197 respondents
(4) & (5)	negative	250 respondents

* respondents who answered “I don’t know.” have not been considered.

The following table contains the estimation results from running the basic model[33] for the respective subsamples. All three models have significant chi-square values.

Attributes-only Model with R = 500 and Correlated Random Variables: Subsamples with Respect to Respondents' Overall Attitude Towards Onshore Turbines [Table 6.9]

		subsample very positive opinion towards onshore turbines			subsample neutral opinion towards onshore turbines			subsample negative opinion towards onshore turbines		
Variable		Estimate	Pr(>|t|)		Estimate	Pr(>|t|)		Estimate	Pr(>|t|)	
	cost	-0.00206094	2.26e-12	***	-0.00277271	< 2.2e-16	***	-0.0030423	5.74e-07	***
	asc1	0.78435474	0.004981	**	0.27354523	1.11e-01		-0.0951609	8.28e-01	
Capacity:	1.5 MW	-1.35674935	0.001121	**	-0.5987599	0.003823	**	-0.2263349	0.5617297	
	750 KW	-1.70682936	1.66e-05	***	-1.34530079	8.52e-08	***	-0.733349	7.19e-02	.
Distance to closest settlement:	1000 m	-0.71543123	0.009212	**	0.04953557	7.15e-01		1.6949017	1.12e-05	***
Population in turbine's vicinity:	> 100 people	-0.35766738	0.231164		-0.25961804	0.131238		-0.7360456	0.1157103	
	11-100 people	-0.26529333	0.352183		-0.58987043	0.00103	**	-0.6366707	0.1477221	
Log-Likelihood:		-1117			-2439.8			-552.62		
Likelihood Ratio Test:		chisq=350.45 [p-value= < 2.2 e-16]			chisq=853.11 [p-value= < 2.2 e-16]			chisq=278.94 [p-value= < 2.2 e-16]		
Number of observations		4984			9576			2000		
Number of respondents		623			1197			250		

The alternative specific constant is positive and significant on a 1%-level for respondents with very positive opinions. Thus, regardless of the specific level the choice attributes take, individuals from this subgroup generate utility from choosing alternative A. They strongly support onshore wind energy and therefore have a higher tendency to choose the ‘most progressive’ wind power scenario compared to the rest of the sample population. It is also interesting that participants who disapprove of onshore wind energy facilities do not seem to care about the size of the turbines but solely about how far they are located from

[33] see code in Appendix B

the nearest building. Their taste might be driven by concerns about shadow flicker, noise or other distance-sensitive issues, which many opponents draw upon when protesting against planned wind energy facilities (Simon, 1996). In contrast, the share of people with “very positive” opinions disapprove of turbines being sited 1000 m away and prefer them to be located at a 500 m distance. A possible explanation could be that they perceive them as enhancing scenic value. Their appreciation of turbines, however, is limited to the distance attribute – individuals with very positive attitudes towards onshore wind energy do not explicitly favour densely populated areas as locations for turbines.

6.3.4 Landscape Attributes

To be able to analyse the link between peoples’ acceptance for wind turbines in their municipality and the landscape character of the respective region, we used GIS-analysis[34]. For not all respondents specified their address in detail, the exactness of the spatial analysis varies. 78% of respondents stated their zip code and street. In order to minimize potential deviations in the geographical analysis, we then suggested them to live in the centre of the stated street (with respect to house numbers). 4% of the sample only gave their zip codes and thus were assumed to live in the middle of the zip code area to again minimize the deviations from their actual place of residence. For the remaining 18% we could generate the exact coordinates of their houses or apartments. Based on this data, we analysed the area surrounding respondents’ homes.

For such an analysis has never been conducted before, we drew on the literature to identify landscape characteristics, which are likely to impact the acceptance of wind turbines. Our sample is considerably large which made the spatial analysis time and resource consuming. Moreover, respondents are not equally spread over the whole country but cluster in the Copenhagen area and other major cities. The concentration of geographical points makes it difficult to compute more complex attributes like density parameters because the areas surrounding each single point extremely overlap. Since the present thesis is a first attempt in this field of analysis, we therefore focus on rather simple distance parameters to explore the link between landscape characteristics and wind turbine acceptance. The data, the landscape analysis is based on, are distributed by “Geodatastyrelsen”, a division of the Danish Environmental Agency (Miljøstyrelsen)[35]. Apart from the purely linear relationship between a distance parameter and a choice attribute we will also test for threshold levels.

[34] The analysis was executed in ArcGIS Maps.

[35] The data can be assessed via Geodatastyrelsen’s online portal *www.kortforsyningen.dk.*

Urbanization attributes

The literature review revealed that people prefer turbines to be sited in cultural[36] compared to unspoilt, natural landscapes, see e.g. Wolsink (2007) or Van der Horst (2007). In the following we will present our attempts to model the impact of 'human made'/ urbanized landscapes as compared to unspoilt and natural ones. Table 6.10 presents the attributes we tested for and their respective coding.

Overview of Urbanisation Variables Tested for Interactions with Choice Attributes [Table 6.10]

	Attribute	**Proxy for …**	**Analytical results**	**Code**
1	Distance to motorway junction in m	density of traffic network	not significant	Dist_motorway
2	Threshold distance motorway junction of 2km [1 – if "dist_motorway" < 2000 ; 0 – otherwise]		not significant	near_motorway_1
3	Threshold distance motorway junction of 3km [1 – if "dist_motorway" < 3000 ; 0 – otherwise]		not significant	near_motorway_2
4	Population density in respondent's (administrative) region	degree of urbanisation/ human interference with landscape	not significant	pop_density
5	Region of respondent's place of residence		not significant	region
6	Distance to closest city centre in m		not significant	dist_city_m
7	Threshold distance to closest city centre of 3km [1 – if "dist_city_m" < 3000 ; 0 – otherwise]		not significant	near_city
8	Distance to closest industrial complex in m	degree of industrialisation	not significant	Dist_industry
9	Threshold distance to closest industrial complex of 200 m [1 – if "Dist_industry" < 200 ; 0 – otherwise]		significant	near_industry

In his study Wolsink found areas with dense traffic networks to be one of the most accepted surroundings to install turbines (Wolsink, 2007). In our analysis we use the distance to the closest motorway junction as a proxy for dense traffic infrastructure. It is, however, not significant when interacted with any of the choice attributes and hence excluded from the model presented here. Using distances of 1 km and 2 km between a respondent's home and a motorway junction as a threshold value also does not give significant results. It is rather likely that the proxy used is simply too weak to express the density of road networks.

The most obvious proxy for the degree of urbanization of a geographical unit is population density. We used the population density of respondents' administrative district[37] as a rudimentary indicator for population density. Interacting this proxy with all choice attributes, we could find no significant effects though. It is reasonable to assume that the chosen scale is too large. The average population density in the rather big administrative districts does not reflect the much smaller geographical dimensions, which define

[36] Here cultural is used referring to landscapes which have been formed by humans.
[37] These districts are Hovestaden, Sjæland, Syddanmark, Midtjylland and Nordjylland.

peoples' everyday life. The same correlation thus should be examined on a small local scale, e.g. within a radius of 3 km from participants' residences. Generally, all of the regions have their own character: the Hovestaden area, for instance, is the most urban whereas Nordjylland is rather characterized by its nature. Accounting for these identities by interacting choice attributes with an effect coded regional variable did not generate any significant results neither.

A fourth proxy is the distance to the closest city, which we expected as being especially relevant with respect to the prevalence of a NIMBY-effect. Distance to the city centre is suggested to be inversely related to population density. If a respondent lives in a highly populated zone and supports the erecting of turbines in zones with only 1-10 inhabitants, he implicitly excludes his own neighbourhood as a site for future turbines. Besides, distance to city centre theoretically appears to be an excellent parameter for degree of urbanization for settlements historically evolved around these cores – areas close to the centre have been part of the cities for a long time and thus are strongly formed by humans, whereas the boarder regions (suburbs) are the result of the latest expansions and often merge into open landscapes. We tested the distance to the closest city centre in the form of a linear effect as well as a 3 km threshold. Both approaches did not generate any valid estimation results. As for the pure distance, the problem might be the high share of respondents living in relatively large towns. In cities such as Copenhagen, the concept of a city centre in the sense of a specific point is rather useless. Unlike in smaller towns, where the market place mostly is the centre of the city, larger areas constitute the centre in bigger cities. Thus, in cities such as Copenhagen, the degree of urbanisation is not lower at a 4km distance from the centre than in the centre itself. Consequently, the 'city centre' parameter fails in modelling respondents' living conditions and hence has no explanatory power. With respect to the threshold, we might just have not chosen the 'right' distance. We assumed 3 km to be a distance people can travel by bike or public transport in a reasonable amount of time so that the 'city' is still part of their spatial identity and thereby impacts their preferences. It seems necessary to test a wider range of distances to find a relevant threshold level.

Van der Horst found residents of industrial zones to be particularly open towards onshore turbines because they are perceived as visual enhancements in such 'stigmatized' places (Van der Horst, 2007). Here we use the distance between a respondent's home and the closest industrial facility to examine whether this correlation also holds for our sample. We did not define a minimum size for the industrial complex. Hence, all kinds of industrial activities, no matter how small the businesses are, are considered in the analysis. Table 6.10 below presents the results. We used the exact distance to test for a linear relationship whereas the 'near_industry'-dummy estimates a threshold effect. It takes the value 1 if the respondent lives within a 200 m distance of an industrial complex and 0 otherwise.

Model with R = 500, Correlated Random Variables and Interacted Urbanisation Attributes [Table 6.11]

Variable		Baseline	Estimate	Std. Error	t-value	Pr(>|t|)	
	cost		-0.00230939	0.00017798	-12.9753	< 2.2e-16	***
	asc1		0.7391306	0.20030363	3.6901	0.0002242	***
Capacity:	1.5 MW	3 MW	-1.001909	0.310014	-3.231800	0.001230	**
	750 KW	3 MW	-1.340694	0.217896	-6.152900	0.000000	***
Distance to closest settlement:	1000 m	500 m	-0.418328	0.121789	-3.434800	0.000593	***
Population in turbine's vicinity:	more than 100 people	1-10 people	-0.896484	0.228444	-3.924300	0.000087	***
	11-100 people	1-10 people	-0.856206	0.203178	-4.214100	0.000025	***
	I(dist1000 * bebor100)		0.85440084	0.28425061	3.0058	0.0026488	**
	I(dist1000 * MW1_5)		0.86736865	0.2526784	3.4327	0.0005976	***
	I(MW1_5 * near_industry)		-0.80666096	0.25307824	-3.1874	0.0014356	**
	I(KW750 * near_industry)		-0.04455579	0.22056294	-0.202	0.8399094	
	I(bebor100 * near_industry)		0.08954072	0.1694739	0.5283	0.5972598	
	I(bebor11_100 * near_industry)		0.52426444	0.25571054	2.0502	0.0403424	*
	I(MW1_5 * Dist_industry)		-0.00018657	0.00015751	-1.1845	0.2362241	
	I(KW750 * Dist_industry)		0.00017899	0.00012349	1.4494	0.1472155	
	I(bebor100 * Dist_industry)		0.00013406	0.00010201	1.3141	0.1887994	
	I(bebor11_100 * Dist_industry)		0.00019792	0.00015361	1.2885	0.1975831	
Covariance/ Variance	MW1_5.MW1_5		2.38744001	0.3183933	7.4984	6.46e-14	***
	MW1_5.KW750		1.75717768	0.24153928	7.2749	3.47e-13	***
	MW1_5.dist1000		1.03755985	0.18956665	5.4733	4.42e-08	***
	MW1_5.bebor100		-0.11033034	0.18033938	-0.6118	0.5406748	
	MW1_5.bebor11_100		-0.00426094	0.23866159	-0.0179	0.9857557	
	KW750.KW750		1.1405351	0.3719957	3.066	0.0021695	**
	KW750.dist1000		0.62160386	0.20189809	3.0788	0.0020784	**
	KW750.bebor100		-0.65330234	0.3019964	-2.1633	0.0305198	*
	KW750.bebor11_100		0.12373684	0.36520362	0.3388	0.7347483	
	dist1000.dist1000		-1.20808016	0.31218549	-3.8698	0.0001089	***
	dist1000.bebor100		0.38326725	0.23754889	1.6134	0.1066523	
	dist1000.bebor11_100		0.06061986	0.31744188	0.191	0.8485541	
	bebor100.bebor100		0.51661665	0.20840645	2.4789	0.0131792	*
	bebor100.bebor11_100		-0.81931005	0.5127857	-1.5978	0.1100957	
	bebor11_100.bebor11_100		0.37317621	1.18175678	0.3158	0.7521688	

Log-Likelihood:	-4217.1
McFadden R2:	0.1569564
Likelihood Ratio Test:	chisq=1569 [p-value= < 2.2 e-16]
Number of observations	16880
Number of respondents	2085

Codes for significance levels: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Comparing the McFadden-R^2 values of the present model with the baseline model, virtually shows no increase in explanatory power induced by the industry interactions. Nevertheless the Likelihood-Ratio-test proofs the validity of the model. Interestingly, we could not find any significant interaction effect with the linear distance parameter. The threshold dummy, however, exhibits significant interactions for the 1.5 MW scenario as well as 11 to 100 people living in the turbine's vicinity. None of the main effects change remarkably with the introduction of the industry attribute (compare basic model with interactions in Appendix F). The reason for the linear effect not being significant might be the lenient definition of an industrial site. It seems convincing that a rather small industrial facility will not impact the landscape preferences of respondents living 3 km away. We therefore decided for the 200 m radius as a reasonable threshold. Living within this distance, the industrial unit can be assumed to be an integral part of residents' day-to-day life. Respondents living in the 200 m sphere of an industrial complex generate a higher disutility from choosing two 1.5 MW turbines instead of one 3 MW turbine compared to residents of non-industrial areas. The effect is highly significant (1%-level). Thus, living in an area with an industrial character strengthens the general preferences for few tall and efficient turbines. The finding is in line with Van der Horst's case study and can be easily motivated: being under permanent influence of 'technical' landscape features like factories, smokestacks etc. results in a process of habituation. Moreover, in contrast to industrial structures, turbines will probably be perceived as positively connoted and therefore as improving scenic quality. From this perspective, it is comprehensible that respondents strongly favour the most progressive form of turbines. The interaction effect between the 200 m industry threshold and the 11-100 residents population parameter is significant on a 5% level and positive. Accordingly, respondents living within 200 m of an industrial facility are more willing to accept 11-100 citizens residing in turbines' vicinity than respondents living in less industrialized areas. One possible explanation could be, that they assume scarcely populated areas (1-10 residents) to be less industrialised and more natural and therefore consider them as more valuable and worthy of protection than regions with a higher population density. Krohn and Damborg found similar patterns of urban residents romanticising nature (Krohn & Damborg, 1999). Additionally, people who are used to visual intrusion by technical elements consider the visual pollution as less of a problem than the unaffected population. The higher tolerance for disturbances might also cause a higher indifference regarding the number of people affected by the disamenity. Similar to the experience effect for turbines, living close to an industrial complex downshifts the benchmark for acceptable visual pollution.

Nature Attributes

Having found only one significant attribute reflecting the degree of urbanisation of a respondent's place of living, we will now test for interactions with nature characteristics. Again, the interaction effects in the model presented in table 6.13 are those, which have generated significant parameter estimates in preceding models. The McFadden-R^2-value indicates that the interactions with nature attributes add more explanatory power to the basic choice data analysis than any of the interactions we have tested for earlier. Accordingly, landscape analysis has the potential of granting new insights into what motivates individuals' acceptance of onshore wind turbines.

Overview of Nature Variables Tested for Interactions with Choice Attributes [Table 6.12]

	Attribute	**Proxy for …**	**Analytical results**	**Code**
1	Distance to closest forest in m	Scenic quality of landscape	not significant	dist_forest_m
2	Threshold distance closest forest of 500 m [1 – if "dist_forest_m" < 500 ; 0 – otherwise]		not significant	near_forest
3	Distance to closest nature reserve in m		not significant	Dist_nature
4	Threshold distance closest nature reserve of 10 km [1 – if "Dist_nature" < 10000 ; 0 – otherwise]		significant	near_nature
5	Perception of wind turbines as negatively impacting the respondent's recreational use of the environment [1 – for "rather / very negative" impact; 0 – otherwise]	turbines' impact on recreational use of landscape	significant	impact_recreation
6	Time respondent has lived in the current place [effect coded 5-year-intervals from 1-"less than 5 years" up to 5 – "20 or more years"]	community attachment/ feeling of belonging	significant	q8_nuv_bopael

In their interview based survey, Bieling at al. found scenic quality depending on the presence of forests and woodlands (Bieling et al., 2014). We therefore use the distance between a resident's home and the closest forest as a proxy of scenic quality[38]. Like before, we test for a linear relationship as well as a threshold effect. For the threshold, we chose a radius of 500 m from peoples' home. Living within this distance, the forest can easily be reached by foot. Moreover, residents are likely to see the forest from their house or at least pass it frequently, which leads to the forest being part of their local identity. We could, however, find no significant threshold effects. Whereas the distance parameter itself was significant when interacted with the costs attribute in a prior model, we did not find significant estimates in the model presented below. The other nature attributes thus seem to better explain the variation in respondents' taste.

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[38] Forest here are considered as such if they have a size of 500 m^2 or more, which corresponds tot he official definition used in the Kyoto protocol (Kant, 2006).

For future research, it would be useful to interact visual wind turbine characteristics with not only the distance to the closest forest but also the size of the forest.

Another reason for the forest attribute not being significant could be that respondents do not actively use nearby woodlands. Ek and Persson found people to care for how turbines impact the spaces they use for recreation but not their residential areas (Ek & Persson, 2014). In the following, we will examine whether this pattern also holds for our sample. One of the introductory attitudinal questions asked for how respondents consider turbines to impact their recreational use of nature. If the effect is perceived as rather or very negative, the 'impact recreation'-dummy takes the value 1 and 0 otherwise. The interaction of this dummy is significant for both the 1.5 MW as well as the 750 KW capacity scenarios. The positive estimate suggests that, ceteris paribus, people who feel restricted by turbines in their use of recreational areas prefer several smaller turbines to one taller 3 MW turbine. Accordingly, the size of the turbine does matter if people spend time in the immediate proximity of turbines. Moreover, for recreational activities such as strolling, biking or running, scenic beauty is an explicit incentive and contributes to the recreational value. Having a turbine in the viewshed of one's residence, in contrast, has a less prominent effect. Being at home, people are mainly concerned with activities others than looking out the windows. Furthermore, turbines will usually be in the viewshed from just one direction so that their visibility can be avoided in parts of the house where people spend much time (such as the living room or terrace). These considerations make the significance of the 'impact on recreational areas'-parameter appear perfectly reasonable. When interacting the alternative specific constant with respondents' attitude towards turbines' impact on recreational activities, we found a highly significant and negative parameter. People who perceive turbines as negatively impacting recreational zones, generate disutility from choosing alternative A compared to B, regardless of the specific attribute levels. Opposed to the effect of a very positive opinion on onshore wind energy, the recreation parameter indicates a general rejection of the progressive wind power scenario (alternative A). Thus, for the respective respondents the restriction of their recreational use of nature seems to be a considerable negative externality of wind power. Generally, these findings let us conclude that we should focus on spaces used for recreational purposes and not the surroundings of residences when analysing peoples relation with landscape which corresponds to the results from prior studies (Ek & Persson, 2014; Wolsink, 2007).

The aforementioned approach can also serve to explain the significant interaction effect of the 10 km threshold in distance to the closest nature reserve ('near_nature') with the 750 KW capacity dummy. If people live within a 10 km radius from a protected site, their support for single 3 MW turbines is stronger as for people living further away. Protected areas represent the ideal of nature, which people described in Bieling et al. study: unspoilt and natural landscapes (Bieling et al., 2014). Having such a little piece of "paradise" within a 10 km distance, respondents are likely to go there for recreational purposes.

Consequently, they make less use of the nature, which immediately surrounds them and are therefore less strict about tall wind turbines negatively impacting their recreational possibilities. The results support the sharp differentiation of recreational and residential areas with respect to visual preferences for onshore wind power which have also been found by other authors such as Wolsink (2007).

The last interaction attribute is the time a respondent has lived in his current place of residence (q8_nuv_bopael). The variable is considered to be a proxy for community attachment, which Jones et al. stated to be a significant determinant of wind power acceptance (Jones et al., 2011). We find that the longer respondents have lived in their current community, the more likely they are to prefer four small 750 KW turbines compared to one 3 MW turbine, which counteracts the main effects strongly supporting tall turbines. One possible motive for this choice behaviour could be that people who are closely attached to their community aim to prevent the heavier visual impact of taller turbines. They hence prioritize the welfare and satisfaction of their fellow citizens over cost-effectiveness. The same argumentation holds for the positive and significant estimate when interacting the community attachment proxy with the cost attribute. The longer a person has lived in the current place, the less disutility he generates from paying an additional annual fee for having his preferences considered in wind power planning. To put it differently: respondents deeply rooted in their community are more interested in participating in the planning of projects which heavily impact their place of home for they strongly identify with this place and are also closely affiliated with their fellow citizens. These last finding illustrate the prevalence of altruistic values as well as the importance of non-use landscape values such as feeling of belonging. Similar to Vorkinn and Riese's study, community attachment in our sample has only few direct implications for the preferences for visual wind energy characteristics but mainly implies strong reactions (Vorkinn & Riese, 2001). Thus, in case a site is designed as to enhance scenic quality, residents with a strong feeling of belonging could also be the major supporters of such a project (see also Devine-Wright, 2009).

Model with R = 500, Correlated Random Variables and Interacted Nature Variables [Table 6.13]

Variable		Baseline	Estimate	Std. Error	t-value	Pr(>|t|)	
	cost		-0.00264	0.00028	-9.46670	< 2.2e-16	***
	asc1		0.89475	0.18494	4.83800	0.00000	***
Capacity:	1.5 MW	3 MW	-2.13620	0.61381	-3.48020	0.00050	***
	750 KW	3 MW	-0.60014	0.43382	-1.38340	0.16655	
Distance to closest settlement:	1000 m	500 m	-0.36797	0.11384	-3.23230	0.00123	**
Population in turbine's vicinity:	more than 100 people	1-10 people	-0.77950	0.18917	-4.12070	0.00004	***
	11-100 people	1-10 people	-0.56914	0.13286	-4.28380	0.00002	***
	I(dist1000 * bebor100)		0.97916	0.28489	3.43700	0.00059	***
	I(dist1000 * MW1_5)		0.81211	0.24060	3.37530	0.00074	***
	I(MW1_5 * impact_recreation)		0.66568	0.27312	2.43730	0.01480	*
	I(KW750 * impact_recreation)		0.66072	0.25495	2.59160	0.00955	**
	I(asc1 * impact_recreation)		-0.98190	0.15596	-6.29570	0.00000	***
	I(MW1_5 * q8_nuv_bopael)		0.06279	0.06068	1.03490	0.30072	
	I(KW750 * q8_nuv_bopael)		0.16909	0.05390	3.13740	0.00170	**
	I(cost * q8_nuv_bopael)		0.00021	0.00007	3.07220	0.00212	**
	I(cost * dist_forest_m)		0.00000	0.00000	-1.35540	0.17528	
	I(MW1_5 * near_nature)		0.41209	0.48573	0.84840	0.39623	
	I(KW750 * near_nature)		-1.18440	0.40205	-2.94590	0.00322	**
Covariance/ Variance	MW1_5.MW1_5		2.38420	0.31973	7.45710	0.00000	***
	MW1_5.KW750		1.58440	0.22433	7.06310	0.00000	***
	MW1_5.dist1000		0.83141	0.16926	4.91190	0.00000	***
	MW1_5.bebor100		-0.15919	0.18826	-0.84560	0.39778	
	MW1_5.bebor11_100		-0.09135	0.23306	-0.39200	0.69508	
	KW750.KW750		0.96808	0.28430	3.40520	0.00066	***
	KW750.dist1000		0.90961	0.19469	4.67220	0.00000	***
	KW750.bebor100		-0.66782	0.29857	-2.23670	0.02530	*
	KW750.bebor11_100		0.29282	0.36005	0.81330	0.41606	
	dist1000.dist1000		-0.93307	0.31923	-2.92290	0.00347	**
	dist1000.bebor100		-0.16249	0.30748	-0.52850	0.59717	
	dist1000.bebor11_100		0.19549	0.41709	0.46870	0.63928	
	bebor100.bebor100		-0.47927	0.30507	-1.57100	0.11619	
	bebor100.bebor11_100		0.69839	0.50775	1.37550	0.16899	
	bebor11_100.bebor11_100		-0.10521	1.54630	-0.06800	0.94575	
Log-Likelihood:			-4154.8				
McFadden R2:			0.1692222				
Likelihood Ratio Test:			chisq=1679.3 [p-value= < 2.2 e-16]				
Number of observations			16880				
Number of respondents			2085				

Codes for significance levels: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Summary

To complete the econometric analysis, we run a model containing all interaction effects we have found to be significant throughout the analysis. The results are presented in table 6.14.

Model with R = 500, Correlated Random Variables and Interacted Variables which Have Been Found Significant in Prior Models [table 6.14]

Variable		Baseline	Estimate	Std. Error	t-value	Pr(>|t|)	
	cost		-0.0032016	0.00034118	-9.3838	< 2.2e-16	***
	asc1		1.0281	0.46614	2.2056	0.0274144	*
Capacity:	1,5 MW	3 MW	-1.594	0.47707	-3.3413	0.000834	***
	750 KW	3 MW	-1.0655	0.58283	-1.8281	0.0675366	.
Distance to closest settlement:	1000 m	500 m	-0.11995	0.29192	-0.4109	0.6811498	
Population in turbine's vicinity:	more than 100 people	1-10 people	-1.3412	0.39716	-3.3768	0.0007332	***
	11-100 people	1-10 people	-0.67636	0.13824	-4.8925	9.957E-07	***
	I(dist1000 * bebor100)		1.0483	0.24061	4.357	0.00001319	***
	I(dist1000 * MW1_5)		0.98235	0.23494	4.1812	0.000029	***
	I(age * MW1_5)		0.010508	0.0076774	1.3687	0.1711079	
	I(age * KW750)		0.015778	0.0087536	1.8025	0.0714657	.
	I(dist1000 * age)		0.0015462	0.0061056	0.2532	0.80008	
	I(bebor100 * age)		0.010315	0.0070034	1.4729	0.1407784	
	I(asc1 * age)		-0.015657	0.0082558	-1.8965	0.0578968	.
	I(cost * q31_indkomst)		0.00011459	0.000039591	2.8944	0.0037987	**
	I(gender * asc1)		0.19807	0.076037	2.6049	0.0091893	**
	I(MW1_5 * near)		-0.08552	0.24909	-0.3433	0.7313491	
	I(KW750 * near)		-0.15741	0.27108	-0.5807	0.5614455	
	I(cost * near)		0.00011288	0.00028675	0.3937	0.6938312	
	I(MW1_5 * positive_attitude)		-0.31191	0.21723	-1.4359	0.1510389	
	I(KW750 * positive_attitude)		-0.31704	0.22347	-1.4187	0.1559759	
	I(cost * positive_attitude)		0.00026711	0.00021793	1.2257	0.2203114	
	I(asc1 * positive_attitude)		0.66932	0.12544	5.3358	9.511E-08	***
	I(MW1_5 * near_industry)		-0.47562	0.19827	-2.3988	0.0164476	*
	I(bebor11_100 * near_industry)		0.35055	0.17072	2.0534	0.0400323	*
	I(MW1_5 * impact_recreation)		0.49193	0.25342	1.9411	0.0522402	.
	I(KW750 * impact_recreation)		0.9156	0.27452	3.3353	0.0008521	***
	I(asc1 * impact_recreation)		-0.57986	0.14228	-4.0756	0.00004589	***
	I(KW750 * q8_nuv_bopael)		0.11686	0.066957	1.7453	0.0809373	.
	I(cost * q8_nuv_bopael)		0.00013001	0.000059091	2.2002	0.0277958	*
	I(KW750 * near_nature)		-1.2211	0.41897	-2.9144	0.0035638	**
Log-Likelihood:			-4178				
McFadden R2:			0.16459				
Likelihood Ratio Test:			chisq=1646.3 [p-value= < 2.2 e-16]				
Number of observations			16880				
Number of respondents			2085				

Codes for significance levels: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

The final model has a McFadden-R^2—value, which is higher than in most of the models estimated earlier. Thus, the combination of attributes explains the variation in respondents' preferences better than variables of only one class. The difference in explanatory power is rather small though, which might be due to some interactions effects dominating others. Generally, we only succeeded in explaining a very small share of the total variation although we tested for a wide range of interactions. Accordingly, wind power acceptance seems to depend on a variety of individual specific attributes. Moreover, the variance of the main effects for the 750 KW attribute and the alternative specific constant are less significant than in the basic attributes-only model, which indicates that the included interactions successfully explain the origin of peoples' preferences.

Conveniently, the negative parameter for the distance attribute is not significant anymore. It is still surprising, however, that the parameter is not positive and significant. Lothian found the same counterintuitive result in his study and concluded that distance might not be a crucial attribute for wind power acceptance (Lothian, 2008). The age variable is not significant in any interaction term anymore. The interaction between gender and the alternative specific constant, in contrast, is now highly significant on a 1%-level. Accordingly, men have systematic preferences for choosing alternative A regardless of the specific choice attribute levels, which might be explained by a more rational choice behaviour. The interaction between cost attribute and respondents' income is significant and simply explains that people experience the disutility from additional annual costs relative to their income. The 200 m threshold to the closest industry complex is significant on a 5%-level when interacted with the 1.5 MW capacity and the 11-100 population density attribute. Living close to an industry complex, intensifies the support for single but tall turbines and weakens the preferences of scarcely populated areas. The opinion on how turbines effect recreational areas as well as an overall positive attitude towards onshore turbines are both significant when interacted with the alternative specific constant. The interaction parameters have opposing effects though, for reasons elaborated above. Finally, the remaining interactions with nature variables kept their signs and are still significant.

To sum up, the nature and urbanization attributes contribute significantly to the explanatory power of the model which support the hypothesis of wind power acceptance being related to the type of landscape respondents live in. It is, however, difficult to model and interpret these interactions correctly for prior research has mainly been qualitatively and rather general. The experience effect, which many prior studies focused on, is not significant at all in our final model. Less surprising, general attitude towards onshore wind energy still is a significant determinant of acceptance.

7. CONCLUSION

The purpose of this thesis has been to examine how landscape quality impacts residents' preferences for the siting of onshore wind farms in their community. Apart from analysing the standard visual characteristics of wind turbines, we examined how acceptance depends on the character of the landscape turbines are sited in. Our analysis was based on a choice experiment and draws on the theoretical framework of Lancaster's Theory of Consumers' Choice as well as random utility theory. We found landscape attributes to explain variation in visual preferences for onshore wind power. Nevertheless, all of the models could only explain a rather small share of the variation.

We found respondents to prefer one tall and highly efficient turbine to several smaller ones. The distance between a turbine and the closest residence did not generate significant estimation results. Moreover, the sample population supports to locate turbines in very scarcely populated areas. When testing for interactions with socio-demographic variables, age was identified as significantly determining peoples' taste. The effect was, however, not significant when combing different types of attributes in the final model. When analysing the latter, we found that men's choices are driven by rationality and that they thus seem to care less about how wind turbines impact persons living in their vicinity. Experience has been found to be significant when testing for experience-related variables only, but not in the final model. It might be that the landscape attributes capture some of the effects formerly explained by experience for turbines have mostly been installed in similar types of open landscapes. Like in many prior studies, attitudes have a high significance in our model. People who have a very positive opinion on onshore wind power in general tend to choose the high capacity scenario, regardless of the specific attributes. Thus, they seem to have positive associations with wind power and therefore support the most progressive form.

With respect to the impact of landscape characteristics, we tried to model the degree of urbanization as well as scenic quality of a landscape and the impact of respondents' use of nature. Drawing on former studies, residents of urban areas are supposed to be more open towards wind power for they are surrounded by artificial landmarks and already live in an 'industrialized' landscape. It was quite difficult though, to find suitable variables serving as proxies for the degree of urbanization. The only one, which was significant for our choice data, was a respondent living within a 200 m distance of an industry complex. Like expected, this group of people shows even stronger support for tall turbines and is more open towards siting turbines in more densely populated areas.

The model with the highest explanatory power was the one including interactions with nature variables. An important finding was that people seem to care more for the impact of turbines in areas they use for recreational activities than the space surrounding their residences. The finding is in line with results from earlier studies and reveals that the restriction of recreational possibilities seems to be an external cost of wind power which has long been neglected (Ek & Persson, 2014; Wolsink, 2007). Moreover, we found non-use values like ‘community attachment’ to be a substantial part of the value people attribute to landscapes. Similarly, we could not find choices to be dominated by the NIMBY-issue. In contrast, especially with respect to community attachment, respondents’ choices seem to be motivated by trying to reduce the negative visual impacts of turbines to enhance the well-being in the whole community.

Generally, the link between wind power acceptance and the quality of the landscape, turbines are supposed to be sited in, is not as subtle as expected. People seem to consciously differentiate between landscapes, which they actively use for recreational activities and the ones they are surrounded by in their everyday life. For the latter category, preferences for visual wind power attributes are characterised by rather pragmatic considerations: people prefer the most effective type of turbines and the least number of citizens to be impacted by them. Moreover, persons living in industrialized areas are even more open towards tall turbines being installed in their municipality since they do not significantly decrease the scenic quality of their neighbourhood. Another aspect of pragmatism has been found regarding respondents living close to nature reserves: for they can use these protected areas for recreational purposes, they have less strict preferences for the siting of wind turbines in their immediate neighbouring landscape.

In the past, public participation in wind power planning was often be doomed to failure by experts arguing with citizens’ being emotionally involved with the topic. Our analysis, however, showed the exact opposite: citizen participation is a promising instrument for successful wind power planning. The majority is aware of the necessity to expand wind power capacity but also have clear ideas of where not to site turbines. In the course of the paper, we have seen over and over again that solutions in wind power planning are extremely site-specific for they depend on residents’ perceptions of their environment. Such individual planning schemes can only be developed by incorporating citizens into the process. They know best, which sites they value for recreational purposes and which areas have a more ‘functional’ value.

Nevertheless, further research is required on the relationship between wind power acceptance and specific landscape attributes in order to identify suitable locations for wind power expansion, which can then be assessed in more detail by cooperating with the local population. The majority of former studies analysing how landscape quality affects wind power acceptance used rather general attributes and only examined the effects qualitatively. This thesis was a first attempt to find more generally valid patterns of which specific characteristics constitute scenic quality.

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APPENDIX

Appendix A

Hvilken placering af vindmølle(r) foretrækker du?

Billedet viser møllernes afstand til den nærmeste bebyggelse. Vindmøllernes størrelse på billedet svarer til det visuelle udtryk, man vil få, hvis man stod ved den nærmeste bebyggelse og så ud mod vindmøllerne.

Hvis du klikker på ét af billederne, kan du se dem i en større størrelse.

Alternativ A	Alternativ B
	
Mølle: 3 MW Afstand: 500 m Beboere: >100 Betaling: 0 kr./år	Mølle: 4*750 kW Afstand: 500 m Beboere:>100 Betaling: 300 kr./år

◯	Alternativ A
◯	Alternativ B

....

Appendix B - R-code for main models

Definition of protest variable

```
protest_1 <- factor ( with ( data, ifelse  (q18_altid_a ==3 | q18_altid_a ==4 |
 q18_altid_a ==5|  q19_altid_b ==1 |q19_altid_b ==4 | q19_altid_b ==5 , 1 ,
 0 )) )
```

Exclusion of protestors

```
data1 <- subset(data, protest_1==0)
```

Creation of dataset for choice analysis

```
CNLdata <- mlogit.data(data1, choice="choice", shape = "long", id="id",
alt.levels=c("1","2"), print.level="1")
```

Attributes-only random parameter model with correlated random parameters, R=500 and no interactions

```
standard_rpm <- mlogit(choice ~ MW1_5 + KW750 + dist1000 + bebor100 +
bebor11_100 + cost + asc1| 0, data = CNLdata, rpar = c(MW1_5 = "n", KW750 =
"n", dist1000 = "n", bebor100 = "n", bebor11_100 = "n"), R = 500, halton = NA,
panel = TRUE, shape = "long", alt.var = "alt",  id = "id", print.level = 1,
correlation=TRUE, ref.level="1")
```

Random parameter model with correlated random parameters and interacted socio-demographic attributes

```
mxl_R500_3 <- mlogit(choice ~ MW1_5 + KW750 + dist1000 + bebor100 + bebor11_100
+ cost + asc1 + I(age*KW750)+ I(age*MW1_5)+ I(age*dist1000)+ I(age*bebor11_100)
+ I(age*bebor100) + I(cost*q31_indkomst) + I(age*asc1)+ I(gender*asc1)+
I(dist1000*bebor100)+I(dist1000*MW1_5)| 0, data = CNLdata, rpar = c(MW1_5 =
"n", KW750 = "n", dist1000 = "n", bebor100 = "n", bebor11_100 = "n"), R = 500,
halton = NA, panel = TRUE, shape = "long", alt.var = "alt",  id = "id",
print.level = 1, correlation=TRUE, ref.level="1")
```

Appendix C – Socio-demographic profile of sample vs. Danish population in 2012

Characteristics		Original Sample (in %)	Subsample[1] (in %)	Population[2] (in %)
Age	20-29	12.94	13.19	18.84
	30-39	24.05	23.61	19.34
	40-49	23.75	24.13	22.55
	50-59	23.5	22.76	20.1
	60-69	15.75	16.3	19.17
Gender	Female	50.06	50.80	50.40
	Male	49.94	49.20	49.60
Education	Basic school	5.74	5.36	22.6
	General upper-secondary education	11.56	12.09	4.8
	Vocational education and training	18.22	17.61	38.2
	Short-cycle higher education	9.93	9.78	5.1
	Medium-cycle higher education & Bachelor	34.39	34.7	17.3
	Long-cycle higher education & Research	19.52	20.45	9
Household income	Under 100.000 DKK/year	5.24	4.74	5.67
	100.000 - 199.000 DKK/year	8.34	8.57	16.97
	200.000 - 299.000 DKK/year	9.51	9.25	19.58
	300.000 - 399.000 DKK/year	14.29	13.88	14.15
	400.000 - 499.000 DKK/year	12.36	12.46	9.44
	500.000 - 599.000 DKK/year	13.57	13.67	7.47
	600.000 – 699.000 DKK/year	12.9	12.93	7.19
	Over 700.000 DKK/year	23.8	23.87	19.54

[1] original sample with all protestors and respondents showing strategic behaviour removed
[2] based on data from Statistics Denmark, retrieved from *www.dst.dk*

Appendix D

Test*: attributes-only standard logit against random parameter model with uncorrelated pa*

score test
data: rpar(MW1_5='n',KW750='n',dist1000='n',bebor100='n',bebor11_100='n')
chisq = 1099.141, df = 5, p-value < 2.2e-16
alternative hypothesis: no uncorrelated random effects

Test: *attributes-only random parameter model with R=500 – uncorrelated vs. correlated ra*

score test
data: correlation = TRUE
chisq = 208.2277, df = 10, p-value < 2.2e-16
alternative hypothesis: uncorrelated random effects

Appendix E

Motivation for one-sided choices – Test for protest and strategic behaviour

For the choices, you just made, you always chose alternative A. What was the major reason for this?

Answer possibilities	*Protest behaviour?*	*Number of respondents who chose the answer*
(1) I cannot afford higher expenses.	no	102
(2) I do not think that the improvements are worth the costs.	no	531
(3) Reducing the impacts of turbines has a value for me but I am not willing to pay more.	yes	139
(4) I cannot understand that I should pay more.	yes	86
(5) I did not know what to choose.	yes	48
(6) Other	no/ yes	200
Total number of protestors:		**273**

For the choices, you just made, you always chose alternative B. What was the major reason for this?

Answer possibilities	*Strategic behaviour?*	*Number of respondents who chose the answer*
(1) I did not take the payment into account.	yes	17
(2) I think that the improvements related to the siting of turbines are worth the costs.	no	52
(3) Reducing the negative impacts of onshore turbines has a value for me and I am willing to pay for that.	no	62
(4) Since it is no real money, I did not really consider the payment when making my choices.	yes	8
(5) I did not know what to choose.	yes	11
(6) Other	no/ yes	15
Total number of respondents with strategic behaviour:		**36**

Appendix F – Modifications of Attribute-only Model

Attributes-only Model with R = 500, uncorrelated parameters, no interactions

Attribute		Baseline	Estimate	SD	t-value	Pr(>|t|)	
	cost		-0.0026289	0.0002132	-12.331	< 2.2e-16	***
	asc1		0.5354557	0.1457817	3.673	0.0002397	***
Capacity:	1,5 MW	3 MW	-0.6240771	0.1725137	-3.6176	0.0002974	***
	750 KW	3 MW	-1.028166	0.1767757	-5.82	6.02e-09	***
Distance to closest settlement:	1000 m	500 m	0.0684577	0.1174166	0.583	5.60e-01	
Population in turbine's vicinity:	> 100 people	1-10 people	-0.2141717	0.1449125	-1.4779	0.1394244	
	11-100 people	1-10 people	-0.499663	0.1423474	-3.51	0.0004478	***
Standard deviation:	1,5 MW		2.0397082	0.2833512	7.20	6.09e-13	***
	750 KW		-1.8116163	0.3686532	-4.91	8.92e-07	***
	1000 m		-2.7180799	0.2733864	-9.9423	< 2.2e-16	***
	> 100 people		2.0267398	0.1806427	11.2196	< 2.2e-16	***
	11-100 people		0.9471209	0.3961087	2.3911	0.0167997	*
Log-Likelihood:			-4384.8				
McFadden R2:			0.1245845				
Likelihood Ratio Test:			chisq=1248 [p-value= < 2.2 e-16]				
Number of observations			16680				
Number of respondents			2085				

Codes for significance levels: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Model with R = 500, correlated random variables and <u>interacted turbine properties</u>

Variable		Baseline	Estimate	Std. Error	t-value	Pr(>|t|)	
	cost		-0.00225667	0.00017804	-12.6753	< 2.2e-16	***
	asc1		0.74101728	0.21161463	3.5017	0.0004622	***
Capacity:	1,5 MW	3 MW	-1.37360666	0.30406101	-4.5175	6.26e-06	***
	750 KW	3 MW	-1.17352411	0.18386343	-6.3826	1.74e-10	***
Distance to closest settlement:	1000 m	500 m	-0.46093877	0.15099439	-3.0527	0.002268	**
Population in turbine's vicinity:	> 100 people	1-10 people	-0.80215789	0.21036432	-3.8132	0.0001372	***
	11-100 people	1-10 people	-0.65684231	0.16751721	-3.921	8.82e-05	***
	I(dist1000 * MW1_5)		0.79808442	0.31794074	2.5102	0.0120674	*
	I(dist1000 * KW750)		-0.08805791	0.22636928	-0.389	0.6972753	
	I(dist1000 * bebor100)		0.89883184	0.27034073	3.3248	0.0008848	***
	I(dist1000 * bebor11_100)		0.22782998	0.23115131	0.9856	0.324314	
Covariance/ Covariance	MW1_5.MW1_5		2.4698701	0.32867374	7.5147	5.71e-14	***
	MW1_5.KW750		1.65260669	0.23044562	7.1714	7.43e-13	***
	MW1_5.dist1000		0.95729888	0.18843297	5.0803	3.77e-07	***
	MW1_5.bebor100		-0.13876549	0.18807867	-0.7378	0.4606326	
	MW1_5.bebor11_100		-0.08870018	0.24177959	-0.3669	0.7137206	
	KW750.KW750		1.07145671	0.31333269	3.4195	0.0006272	***
	KW750.dist1000		0.89197065	0.2008961	4.44	9.00e-06	***
	KW750.bebor100		-0.71209159	0.30145036	-2.3622	0.0181659	*
	KW750.bebor11_100		0.2161601	0.37598461	0.5749	0.5653472	
	dist1000.dist1000		1.18206353	0.32587845	3.6273	0.0002864	***
	dist1000.bebor100		-0.0661082	0.2565818	-0.2576	0.7966774	
	dist1000.bebor11_100		-0.02569424	0.3416335	-0.0752	0.9400477	
	bebor100.bebor100		0.55116252	0.24744445	2.2274	0.0259193	*
	bebor100.bebor11_100		-0.71400136	0.55350086	-1.29	0.1970599	
	bebor11_100.bebor11_100		0.50104618	0.86758524	0.5775	0.5635895	

Log-Likelihood:	-4226.7
McFadden R2:	0.1561399
Likelihood Ratio Test:	chisq=1564.2 [p-value= < 2.2 e-16]
Number of observations	16880
Number of respondents	2085

Codes for significance levels: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

APPENDIX G – Models for subsamples

Attributes-only Model with R = 500 and correlated random variables:
Subsamples with respect to turbines planned in respondents' vicinity

		subsample no turbines planned			subsample turbines planned		
Variable		Estimate	Pr(>|t|)		Estimate	Pr(>|t|)	
	cost	-0.0027009	1.81E-08	***	-0.00131436	7.94E-06	***
	asc1	0.618576	0.070863	.	0.00270893	0.9932564	
Capacity:	1,5 MW	0.0512769	0.876846		-0.93145282	0.0109291	*
	750 KW	-1.3903722	0.005323	**	-1.73068275	0.0006765	***
Distance to closest settlement:	1000 m	0.4801767	0.064868	.	-0.35326491	0.2546706	
Population in turbine's vicinity:	> 100 people	-0.2533482	0.48298		-0.04237794	0.9033282	
	11-100 people	-0.2851452	0.409312		-0.37115807	0.2528196	
Covariance/ Covariance	MW1_5.MW1_5	1.694496	0.011591	*	1.6373372	0.0024461	**
	MW1_5.KW750	1.7546933	0.004435	**	2.21708675	0.0034161	**
	MW1_5.dist1000	0.7325076	0.098146	.	1.84623215	0.0014426	**
	MW1_5.bebor100	0.4208148	0.517604		-1.31614036	0.0240776	*
	MW1_5.bebor11_100	0.9609707	0.190827		-0.58653364	0.3943147	
	KW750.KW750	2.7758547	0.001681	**	0.65507056	0.3969948	
	KW750.dist1000	-0.1960853	0.591561		-0.48718103	0.4293318	
	KW750.bebor100	-0.9831354	0.054051	.	-1.25150938	0.3559956	
	KW750.bebor11_100	0.9009709	0.148152		-0.85731701	0.5872433	
	dist1000.dist1000	1.4775411	0.010599	*	-0.4111676	0.6940977	
	dist1000.bebor100	-1.045208	0.115755		0.90490713	0.7435373	
	dist1000.bebor11_100	-1.0982927	0.163162		0.6128282	0.865456	
	bebor100.bebor100	-1.1170887	0.392127		0.97264924	0.8009543	
	bebor100.bebor11_100	-1.1585874	0.476267		0.65390332	0.894294	
	bebor11_100.bebor11_100	0.0309817	0.991884		-0.00791196	0.9988299	
Log-Likelihood:		-803.87			-667.54		
Likelihood Ratio Test:		chisq=47.86 [p-value= < 2.2 e-16]			chisq=291.05 [p-value= < 2.2 e-16]		
Number of observations		2568			2936		
Number of respondents		321			367		

APPENDIX H – Marginal Willingness to Pay for Interaction Effects with 'Age'

	Mean WTP	95% Confidence Interval Min	Max
I (age*asc1)	-7.362	-13.58	-1.444
I (age*bebor100)	5.903	-0.122	11.685
I(age*KW750)	7.9811	2.704	15.481