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A case-control choice experiment approach

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DISCUSSION PAPERS

933

Discussion Papers No. 933, June 2020
Statistics Norway, Research Department

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Abstract:
Despite a large stated-preference literature on wind power externalities, few SP studies employ a case-control approach to examine whether people´s acceptance of new wind power developments increases or decreases with exposure to and familiarity with wind turbines. Furthermore, the existing studies are inconclusive on this issue. In a case-control discrete choice experiment we measure the level of acceptance in terms of people´s willingness-to-accept compensation for having future land-based wind power developments in Norway; comparing exposed and non-exposed people's WTA. We find that exposure lowers acceptance. Furthermore, exposed people are also unwilling to pay as much as non-exposed people to increase general domestic renewable energy production (from all sources), and thus have lower acceptance for such renewable energy policy initiatives. After testing for type of exposure, we argue that the inconclusiveness in the literature of how exposure affects acceptance of wind power developments could be due to the fact that impacts considered differs somewhat across studies.

Keywords: Discrete Choice Experiment, exposure, wind power, willingness-to-accept, societal acceptance, familiarity

JEL classification: Q48, Q51, Q57

Acknowledgements: The authors would like to thank Øyvind Nystad Handberg and Eirik Kløw for their participation in developing the survey design. Additionally, the authors would like to thank Jurgen Meyerhoff, Jacob Ladenburg and Søren Bøye Olsen for their contributions to the initial discussions, Cathrine Hagem and Terje Skjerpen for comments on the manuscript. The research was funded by the Norwegian Research Council (grant numbers 267909 and 255777).

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ISSN 1892-753X (electronic)

Sammendrag

Til tross for at mange studier bruker betingete verdsettingsmetoder for å verdsette vindkraftseksternaliteter, er det få av disse som bruker en case-kontroll tilnærming til å undersøke om folks aksept for vindkraft øker eller avtar med eksponering for og kjennskap til vindkraftanlegg. De studiene som har brukt denne tilnærmingen har ikke konkludert entydig når det gjelder hvordan eksponering og kjennskap til vindkraft påvirker verdsettingsestimatene. Ved bruk av et case-kontroll, diskret valgeksperiment kartlegger vi aksept, som målt gjennom folks betalingsvillighet, for å få eller unngå fremtidig vindkraftutvikling på land, nasjonalt i Norge. Videre sammenligner vi betalingsvilligheten i eksponerte og ikke-eksponerte geografiske områder. Vi finner at eksponering reduserer aksepten for vindkraftanlegg på land nasjonalt. Folk som bor i eksponerte geografiske områder er villige til å betale mer, i form av høyere månedlige strømregninger, for å unngå installasjoner av vindkraftanlegg på land, nasjonalt, enn folk som bor i ikke-eksponerte geografiske områder. Etter å ha testet for effekten av type eksponering, argumenterer vi for at de ulike funnene i litteraturen kan skyldes at eksponeringstypene en har sett på er noe forskjellige og at eksponeringstype ser ut til å være viktig for å forklare variasjoner i graden av aksept.

1 Introduction

Hydropower has been Norway's most important source of energy for decades, currently accounting for 94 percent of the country's electricity production (NVE, 2019), which is 100 percent renewable. Thus, investment in and development of land-based wind power have been limited in Norway compared to similar European countries, such as Denmark and Sweden (Inderberg et al., 2019) even though Norway has some of Europe's best land-based wind resources (NVE, 2019). Motivated by the increasing integration between the Norwegian and the European energy markets, large investments in wind power elsewhere in Europe, falling installation costs (Inderberg et al., 2019), and increasing demand for renewable energy, the Norwegian government has grown increasingly supportive of land-based wind power.

In 2017 the Ministry of Petroleum and Energy requested the Norwegian Water Resources and Energy Directorate (NVE) to propose a long-term National Framework for land-based Wind Power (NFWP) in Norway. The NFWP identified 13 geographical areas considered to be the most suitable for future land-based windpower developments (WPDs) s in Norway (NVE, 2019). The NFWP was released on April 1st, 2019 (NVE, 2019), and met with strong opposition during the public hearing process that followed. As a result, land-based wind power became even more heavily debated in Norwegian media than it had been in recent years. On the one hand, stakeholders are concerned about degradation of Norwegian pristine nature, landscape aesthetics and other negative externalities. On the other hand, many individuals argue that additional wind power developments (WPDs) in Norway are important for reducing European emissions from fossil fuels, resulting in a nation-wide "green-on-green" conflict (Warren et al., 2005; Ruus, 2019). Although the NFWP was later discarded by the government due to fierce opposition at both the local and the national levels, the NFWP was viewed as the government´s proposed plan for additional WPDs, and was, therefore, very real to the survey respondents.

Wind power is not equally distributed across Norway, and the NFWP would have reinforced this unequal geographic distribution. Out of the 13 geographical areas identified in the NFWP, four were located in Rogaland County, while no areas were found to be suitable for wind power in Oslo County (NVE, 2019). Compared to the population of Oslo County, the population of Rogaland County, located on the south-west coast, is more exposed to WPDs and associated externalities, as they live in an area with a higher density of wind turbines (NVE, 2019). This likely implies that the population in Rogaland (or at least a large share thereof) lives closer to and therefore sees and encounters WPDs more often than the population of Oslo. This may also imply that the population of Rogaland is more familiar with WPDs and negative wind power externalities (Zerrahn, 2017). Exposure over time leads to higher levels of familiarity (Devine-Wright, 2005). The plans for additional WPDs will reinforce the potential differences in exposure and familiarity between these two counties.

The social science literature suggests that exposure and familiarity are important for people's acceptance of WPDs (especially local developments). People who live close to WPDs or frequently encounter them seem to have a different acceptance level than people without such exposure (Thayer and Freeman, 1987; Simon, 1996; Warren et al., 2005; Navrud and Bråten, 2007; Wolsink, 2007; Swofford and Slattery, 2010; Ladenburg and Dahlgaard, 2012; Baxter et al., 2013; Knapp and Ladenburg, 2015; Mariel et al., 2015; Krekel and Zerrahn, 2016; Wilson and Dyke, 2016; Zerrahn, 2017). However, overall the literature is inconclusive as to whether exposure to WPDs leads to a higher or lower level of acceptance, than not being exposed (Zerrahn, 2017).

There is a large literature on stated preference (SP) studies, i.e. contingent valuation (CV) and discrete choice experiment (DCE) surveys, that examine wind power externalities (e.g. Navrud, 2004; Ladenburg and Dubgaard, 2007; Navrud and Bråthen, 2007; Meyerhoff et al., 2010; Meyerhoff, 2013; Ek and Matti, 2014; Ek and Persson, 2014; Mariel et al., 2015; García et al., 2016; Brennan and Van Rensburg, 2016; Lutzeyer et al., 2018). However, as far as we know, no SP studies have employed a case-control approach to assess disparity in valuation of wind power externalities as a result of being exposed to existing and future WPDs. This study is, to our knowledge, the first case-control DCE study to assess this specific feature.

Wühstenhagen et al. (2007) define three dimensions of acceptance, socio-political acceptance, community acceptance and market acceptance. Socio-political acceptance is related to acceptance of technologies and policies by the public, policy makers and key stakeholders. Community acceptance measures acceptance of among stakeholders in local context, whereas market acceptance measures the market adaption of technologies. We use willingness-to-pay (WTP) and willingness-to-accept (WTA) compensation to have additional land-based WPDs in Norway and increased renewable energy production, as measures of socio-political acceptance. If people are willing to pay for more WPDs (or to increase the renewable energy production) they have high acceptance. Conversely, if people demand compensation, they have low acceptance. Clearly, variation in welfare measures implies variation in acceptance level.

We compare acceptance between a "case group" and a "control group", where the treatment is that the respondent has been or is exposed to WPDs. Respondents from Rogaland County are the case group. They are currently exposed to WPDs and more exposed to future developments. The control group is respondents from Oslo County, where there are no current developments nor plans for future developments. In the Rogaland-sample, we also examine whether different types of exposure affect respondents' level of acceptance. Using areas affected by WPDs for recreational purposes is one type of exposure (Garcia et al., 2016; Brudermann, 2019). Another type of exposure is proximity to functioning or planned WPDs, which causes more exposure to noise, shadow flicker and visual intrusion (Devine-Wright, 2005; Zerrahn, 2017). The inconclusiveness of the literature on exposure to WPDs and acceptance could be attributable to different types of exposure being important for explaining the variation in acceptance.

Walker (1995) argues that generalizing the results of a case-control approach can be problematic and misleading. The case and the control group may have different cultural, ideological and informational identities, which limits the comparability of the groups. This may also affect the outcome variable.[1] However, these issues can be limited (or assessed) by matching methods, which we use in this study (Dehejia and Wahba, 2002). The approach is also less costly and time consuming than e.g. a study of acceptance over time. A case-control approach contributes to providing a better understanding of whether and why exposure to WPDs results in a difference in acceptance, and why conflicts related to WPDs emerge. This has important policy implications.

The paper is structured as follows: First, Section 2.1 reviews findings from previous studies that have examined how exposure and familiarity with WPDs affect acceptance. Based on this, Section 2.2 derive hypotheses to be tested. Section 3 describes our DCE survey design and section 4 presents the econometric approach, before Section 5 presents our analysis of the results. Section 6 ends the paper with a summarizing discussion of policy implications and recommendations for future research. A list of the ackronyms used in the paper is provided in the Appendix.

2. Literature Review and Hypotheses

This section reviews studies that have examined the relationship between exposure and acceptance of WPDs. Some studies use terms other than but closely related to 'acceptance', such as preferences,

[1] Walker argues that: "attitudes can be highly variable, dynamic and sometimes contradictory. They may be rooted in deep-seated cultural and ideological identities and formed from a variable and interacting mix of influences and sources of information" (Walker, 1995, p. 49).

attitudes, perception and support. We group these related terms as indicating acceptance. However, in the literature review, we use the studies' original terms.

We first provide a general introduction to the literature. Then we address the studies that find that exposure leads to higher acceptance or detect no correlation at all, and subsequently studies that find the opposite effect. The literature review ends by considering cohort studies that assess acceptance over time. Based on findings from the literature, we then formulate six hypotheses.

2.1 Exposure to wind turbines and acceptance

Zerrahn's (2017) review of the literature on wind power and associated externalities finds that people are positive to renewable energy, including wind power. However, WPDs imply negative externalities, including adverse impacts on plants and wildlife (e.g. ecosystem fragmentation, habitat disruption) and humans (e.g., noise, landscape deterioration), and therefore, ultimately, on human health and welfare (Zerrahn, 2017). Therefore, people may have negative attitudes to WPDs.

Overall, Zerrahn (2017) identifies three fundamental factors relating to people's negative attitudes; (1) proximity to turbines, (2) habituation, and (3) type of landscapes in which the turbines are installed. People seem to be willing to pay more to avoid WPDs closer to residential areas (Meyerhoff et al., 2010; Brennan and Van Rensburg, 2016). Zerrahn (2017) finds that WPDs in scenic landscapes lead to lower acceptance. According to Zerrahn (2017) the literature on exposure, familiarity and habituation, i.e. exposure over time, is inconclusive. Thus, we believe more research is needed. Some studies find higher acceptance of WPDs in exposed communities, or a U-shaped pattern of acceptance among exposed people over time. Other studies find that exposure leads to lower acceptance (Zerrahn, 2017).

Simon (1996) summarizes research conducted on attitudes to wind power from 1990 to 1996. A comparison between people who live in areas with wind farms and people who live in areas without wind farms shows that WPDs are less accepted in areas without wind farms where the people have limited knowledge about the externalities of wind farms.

Krohn and Damborg (1999) summarize findings from public attitude surveys on wind power in western countries. They consider a Danish study from Sydthy in Northern Jutland and find that the distance to the nearest turbine and number of turbines does not affect attitudes toward wind turbines (Andersen et al., 1997; Krohn and Damborg, 1999).

Warren et al. (2005) examine attitudes toward WPDs in regions of Scotland and Ireland where wind farms were already built or were planned to be built. A general finding in their analysis is a positive correlation between proximity to a wind farm and support for it. People who live further away from a wind farm exhibit greater opposition, while people close by express strong support for their local wind farm (Warren et al., 2005).

In a more recent study, Baxter et al. (2013) conduct a case-control study to examine local support for wind turbines. In the study, they sample from two different areas in Ontario, Canada. In one of the areas, wind turbines are already installed. This is the case community. In the control community, there are no wind turbines or planned installations. Their results show that the control community is less supportive to wind turbines compared to the exposed community.

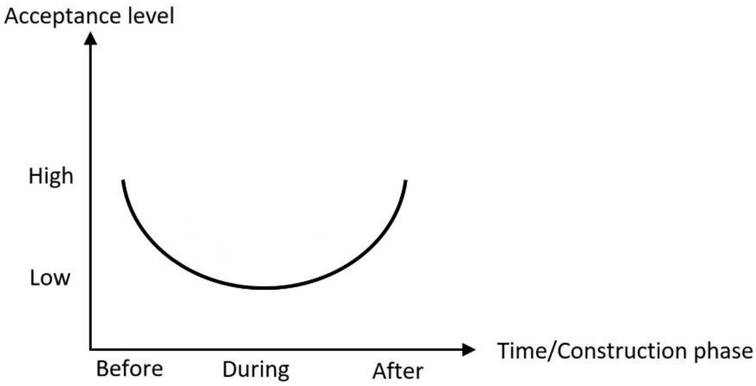
As mentioned, other studies find the opposite effect, e.g. Thayer and Freeman (1987) find that people living closer to the Alamont wind farm in California, USA and people familiar with the area dislike the wind farm more than people living further away and people unfamiliar with the area. Similarly, Ladenburg and Dahlgaard (2012) find that people encountering wind turbines more than five times daily are more negative toward existing wind turbines. Swofford and Slattery (2010) find that people living the closest to a wind farm in Texas, USA show less support for wind power compared to people living further away.

Navrud and Bråten (2007) conducted a case-control DCE of preferences for different types of energy sources in Norway with exposure to WPDs as the treatment. They find that people in rural areas with prior experience of WPDs are willing to pay less to increase domestic wind power production to reduce import of Danish coal power than people living in urban areas without such experience.

Findings from the life-satisfaction and revealed-preference (RP) literature on wind power externalities could also explain why one finds low acceptance among exposed people. Studies find that living near WPDs reduces people’s life satisfaction and health quality (Shepard et al., 2011; Krekel and Zerrahn, 2016; von Möllendorff and Welsch, 2017). Zerrahn (2017) and Knapp and Ladenburg (2015) conclude that proximity of WPDs to residential areas affects attitudes negatively. In addition, WPDs affect property prices and recreational demand negatively (Jensen et al., 2014; Sunak and Madlener, 2016; Kipperberg et al., 2019).

The previous studies have investigated how acceptance of WPDs varies in space at a given point in time. However, there are also studies examining how attitudes to WPDs change over time. Most of these temporal studies find a U-shaped pattern of acceptance levels for nearby developments over time, see Figure 1 (Wolsink, 2007; Devine-Wright, 2005). People have a high acceptance level initially, before they are confronted with a nearby project. However, as the planning and construction of a WPD begins, the acceptance level falls to a low level. When the WPD is installed, acceptance grows and approaches the initial or an even higher acceptance level (Wolsink, 2007; Devine-Wright, 2005). The U-shaped pattern is supported by Wilson and Dyke (2016), who examined pre- and post-installation community perceptions of a wind farm project in Cornwall, UK.

Figure 1: U-shaped relationship between acceptance and time



Source: Devine-Wright (2005).

The U-shaped pattern implies that more exposure over time, and thus higher levels of familiarity with a WPD and associated externalities, lead to equal or higher acceptance (Devine-Wright, 2005). This further implies that people with higher levels of familiarity adapt to the negative externalities, i.e. habituation (Wilson and Dyke, 2016).

Overall, the literature review shows mixed results with regards to how exposure affects the acceptance of WPDs. This could indicate that the type and level of exposure is important in explaining the variation in acceptance level. Another factor that could be related to this inconsistency, is whether the exposed and non-exposed groups are directly comparable. Based on our literature review, this concern seems to have received little attention. We use the propensity score matching technique to manage this issue. We also use a different methodological approach (i.e. DCE) that may be better able to capture the trade-offs between the externalities of WPDs and increasing domestic renewable energy production more generally.

2.2 Hypotheses

Discrete choice consumer theory suggests that individuals obtain utility from attributes of a good as opposed to the whole good (Lancaster, 1966). The DCE approach is consistent with this idea and can be used to monetize marginal changes in attributes of environmental goods and ecosystem services (Adamowicz et al., 1998). Choice set questions provide respondents with several response alternatives with varying levels of attributes, which define the environmental good, and then ask respondents which alternative they prefer.

Let the indirect utility function of respondent n, which implicitly is based on an additive separability assumption, be expressed as the following function:

$$U_n = v(\mathrm{TURB}, \boldsymbol{x}, \mathrm{C}, \mathrm{E}_n; \boldsymbol{\Lambda}), \tag{1}$$

where TURB refers to additional wind turbines to be installed in Norway, $\boldsymbol{x}$ is a vector of other non-priced attributes of a wind power development scenario, C is the cost attribute, E refers to exposure (familiarity; exposure) and household characteristics, and $\boldsymbol{\Lambda}$ is a vector of parameters that relate the exogenous factors $(\mathrm{TURB}, \boldsymbol{x}, \mathrm{C}, \mathrm{E}_n)$ to deterministic indirect utility.

Respondent n's WTA or alternatively WTP for additional wind turbines can be expressed as:

$$\text{P or WTA}_{n,\mathrm{TURB}} = \frac{\partial v(\cdot)/\partial \mathrm{TURB}}{-\partial v(\cdot)/\partial C} = f(\mathrm{TURB}, \boldsymbol{x}, \mathrm{C}, \mathrm{E}_n; \boldsymbol{\Lambda}). \tag{2}$$

Eq. 2 represents respondent n's acceptance of additional wind turbines in monetary terms. In the equation, exposure and familiarity are important factors for explaining variation in acceptance. We now formulate six hypotheses based on the literature review:

H_1: People have positive WTP for the production of additional renewable energy in general.
H_{01}: People have zero WTP for the production of additional renewable energy in general.

H_2: People have positive WTA for additional WPDs.
H_{02}: People have zero WTA for additional WPDs.

H_3: People from Rogaland County have a different WTA for additional WPDs than people from Oslo County.

H_{03}: People from Rogaland County do not have a different WTA for additional WPDs than people from Oslo County.

H_4: Among people from Rogaland, those living closer to a wind farm have higher WTA for additional WPDs than those who reside further away.

H_{04}: Among people from Rogaland, those living closer to a wind farm do not have higher WTA for additional WPDs than those who reside further away.

H_5: Among people from Rogaland, people who will be exposed to WPDs in the future have higher WTA for additional WPDs than those who are not exposed (and those that do not know whether they will be exposed).

H_{05}: Among people from Rogaland, people who will be exposed to WPDs in the future do not have higher WTA for additional WPDs than those who are not exposed (and those that do not know whether they will be exposed).

H_6: Among people from Rogaland, people exposed to WPDs have different WTA for additional WPDs than non-exposed people.

H_{06}: Among people from Rogaland, people exposed to WPDs do not have different WTA for additional WPDs than non-exposed people.

H_1 is supported by the findings in the literature review by Zerrahn (2017). H_2 is supported by Meyerhoff et al. (2010), Garcia et al. (2016), Brennan and Van Rensburg (2016) and Zerrahn (2017), which implies that we can generally assume low acceptance within the sample. With this hypothesis, we implicitly assume that the respondents prefer other sources of renewables with less environmental impact, such as increasing production capacity for existing Norwegian hydropower, new small-scale hydropower developments and offshore wind power, to land-based wind power. These alternatives are discussed by Norwegian politicians and stakeholders as possibilities for increasing renewable energy production (NVE, 2019). However, H_2 is based on a limited number of studies. We could also find that people are willing to pay for additional WPDs.

The recent studies that examine acceptance of WPDs and exposure at a given point in time clearly suggest that we should expect a significant difference in acceptance level between people living in the county with existing and/or planned developments (Rogaland) and people living in the county without existing or planned developments (Oslo) (Baxter et al., 2013). However, as the literature is inconclusive, defining the direction of the effect in H_3 is challenging.

Several wind farms were under construction and planned for construction in Rogaland at the time of the survey, whereas there were no existing nor planned developments in Oslo. Thus, in accordance with the U-shaped relationship between level of acceptance and time, we might have expected a lower acceptance level among people from Rogaland, as the acceptance of developments is at its lowest level during the construction phase (Wolsink, 2007; Devine-Wright, 2005). This implies that we can expect higher WTA among the exposed people defined in H_3, but also in H_5, if we use the same reasoning.

H_4 is supported by Knapp and Ladenburg (2015), Swofford and Slattery (2010), Krekel and Zerrahn (2016) and Zerrahn (2017). We use the distance of 4 km, as Krekel and Zerrahn (2016) find that living 4 kilometers away from or closer to a WPD significantly reduces people's life satisfaction. This hypothesis (as well as H_3, H_5 and H_6) could also be supported by Sunak and Madlener (2016) who find a significant reduction in property prices for homes affected by developments. Conversely, H_4 could be rejected in accordance with Andersen et al. (1997) and Warren et al. (2005).

To evaluate H_6, we use a wide definition of exposure. Respondents from Rogaland are exposed if they fall into one of the following categories: (1) own areas where a WPD will or might be constructed, (2) are affected through having a job in the tourism industry, (3) own areas close to where a WPD will or might be constructed, (4) frequently (more than 25 days per year) engage in recreational activities in areas where they can see wind farms, (5) live 4 km or less from a wind farm, and (6) own a recreational home 4 km or less from a wind farm. The "future exposed group" in H_5 is defined by (1) and (2) above.

3. The Survey

The data were collected in April 2019 by conducting a web panel survey through the professional survey agency Norstat. The survey was designed to determine preferences regarding additional land-based WPDs in Norway. To assess how exposure affects acceptance for developments, samples were collected in two counties in Norway: Rogaland and Oslo. The first wind turbines in Rogaland County were installed in 2004. When the survey was conducted, there were 138 functioning wind turbines, 100 wind turbines were under installation, 11 projects had received construction licenses and 3 projects were under review for construction license. In contrast, there were no developments in Oslo County and no construction licenses had been applied for or been given in this region.

In the survey, the respondents were first asked to state which environmental and resource policies they consider to be most important. They were further informed that electricity demand in Norway is increasing and asked how they thought Norway should meet the increased demand.

The questionnaire then informed respondents about current Norwegian wind power capacity, the NFWP of the Norwegian Water Resources and Energy Directorate (NVE) and NVE's suggestion for the most suitable wind power production areas, shown on maps. The maps showed the suggested suitable areas in the whole of Norway as well as in the respondents' own geographical region (see Figures 2 and 3). To mitigate hypothetical bias (Vossler et al., 2012), we stressed that the results of the survey would be important (consequential) for further policy decisions regarding wind power.

Figure 2: Suggested suitable areas to analyze for WPDs in Norway. Note: No areas in Oslo County were considered suitable for wind power, and there was only one suggested area in the former neighboring County of Akershus (now part of Viken County)

Source: NVE (2019).

Figure 3: Suggested suitable areas to analyze for WPDs in Norway as whole and areas in Rogaland County that were considered suitable

Source: NVE (2019).

The next section of the questionnaire thoroughly explained each of the choice experiment attributes, the structure of the choice cards and the choice experiment, in order to prepare the respondents for the choice experiment questions. The DCE consisted of 5 attributes; (1) increased electricity production from all renewable sources, (2) the number of additional wind turbines installed in Norway, (3) prioritized regions for WPDs, (4) prioritized landscapes for WPDs and, (5) changes in monthly household electricity bill. The first two attributes are not perfectly correlated, as other renewable sources can be used to expand energy production in Norway (NVE, 2017, 2019). The software SAS® and the procedures described by Kuhfeld (2010) were used to generate the CE design. The design had two constraints to prevent unrealistic scenarios.[2] We used the Choiceff-macro, with zero priors and standardized orthogonal coding to put the relative D-efficiency on a (0,1) interval (Kuhfeld, 2010), in order to generate 24 choice sets. Finally, we generated three blocks, each consisting of 8 choice sets, using the Mktblock macro. The D-efficiency for the design was 0.89.

The selection of attributes and identification of appropriate/realistic attribute levels were based on a combination of multiple sources: i) a careful review of previous wind power valuation literature; ii) input from project-specific workshop with an external expert group; iii) insights from two focus group meetings; iv) considerations related to ensuring the generation of useful policy information for the NFWP, and v) the stated preference survey design recommendations by Johnston et al. (2017). The focus group meetings were held in December 2018 (county capital of Stavanger in Rogaland) and January 2019 (Oslo). Each of the focus groups meetings had ten participants recruited by Norstat. The focus groups had semi-structured discussions on nature and the environment, wind power and permitted us to test out and receive feedback on earlier versions on the survey from real respondents.

The number of turbines (or wind farms) is an essential attribute in DCE studies that examine wind power externalities; see e.g. Meyerhoff et al. (2010), Garcia et al. (2016), and Brennan et al. (2016). The attribute is associated with the environmental impact of wind turbines.[3] At the time of questionnaire development, Norway had about 600 functioning land-based wind turbines, and 37 new wind power projects producing about 10 TWh had been approved (NVE, 2019). The status quo scenario described the existing 600 turbines and the realization of the 37 new approved projects with an additional 600-700 new land-based wind turbines, a total of 1,200-1,300 turbines. The respondents

[2] One constraint penalizing a combination where attribute (1) was equal to zero while attribute (2) was greater than zero and where priority was given to a region or landscape for WPD. The second constraint penalized a combination where attribute (1) was equal to zero and priority was given to a region or a landscape for WPD.

[3] We chose to define the environmental effects of a single attribute, as these effects are often perfectly correlated with the number of turbines.

were informed that the lowest height of the currently installed wind turbines is 80 meters, whereas future installed turbines can reach a height of 250 meters.

The hypothetical response scenarios that were included in the DCE were consistent with NVE's predictions for future land-based wind power production (see Table 1 for attribute-levels used). Production can increase to 25 TWh by 2030, and we therefore informed the respondents that up to 3,000 additional turbines will be installed by 2030.[4] The number of turbines necessary to produce 25 TWh depends on technological advances.

Increased production of renewable energy was an important and heavily discussed issue in the focus group meetings, because of the ongoing electrification of the Norwegian transportation system and need for a secure electricity supply. Increasing production is also a political goal. NVE expects Norwegian energy production to increase from 147 TWh in 2018 to 180 TWh by 2030 (NVE, 2017). The levels of the attributes were chosen to correspond to predictions from NFWP for levels by 2030, and NVE's predictions for the Norwegian energy market by 2030 (NVE, 2017). To obtain variation in the energy and turbines attributes, the levels were set lower than, equal to, and higher than NVE's predictions.

We wanted to separate the preferences for increasing renewable energy production in general from preferences for wind power preferences in particular. With the two first attributes, we can investigate the welfare impact of installing additional wind turbines in Norwegian natural and cultural landscapes, holding the nation's renewable energy production capacity constant. In the case of Norway, this is a realistic set-up, as only a small fraction (4 percent) of Norway's total electricity production is associated with wind power, while virtually all of the current production is renewable (NVE, 2019). Land-based wind power is currently an economically viable source of additional renewable energy production. However, there are alternative sources such as offshore wind, upgrading existing hydropower plants, reducing transmission losses through upgrading the grid, and permitting new small to medium size hydropower projects (NVE, 2019). These alternatives are generally associated with lower environmental impacts but higher installation costs.

An illustration of a wind turbine with keywords for facts and environmental effects caused by an average wind turbine such as visual disamenities due to their height, necessary infrastructure like

[4] Production in 2018 was 4 TWh.

roads, biodiversity loss and noise was then shown, see Figure A1 in Appendix A. The respondents could hold their mouse on the keywords to obtain additional information.

The prioritized landscape attribute represents different landscapes (i.e. forest, mountain and coast) that should be prioritized for additional land-based WPDs. The levels of the attribute correspond with landscape types in the potential production areas defined by NVE. Opposition to wind power projects in Norway has been related to location and type of landscape. It was therefore an interesting attribute for the study. Ek and Persson (2014) used a similar attribute in their design when conducting a study for Sweden.[5]

Table 1: Attributes and levels

Attribute	Level
Turbines	No increase (Status quo)
	600
	1,200
	3,000
TWh Renewable Energy	No increase (Status quo)
	10
	20
	30
Prioritized region	No prioritization (Status quo)
	Northern and Central Norway
	Western Norway
	Eastern and Southern Norway
Prioritized landscape	No prioritization (Status quo)
	Coast
	Lowland and forest
	Mountains
Electricity bill	No change (Status quo)
	NOK 450 (USD 44) lower per month
	NOK 150 (USD 15) lower per month
	NOK 150 (USD 15) higher per month
	NOK 450 (USD 44) higher per month

Note: USD 1 = NOK 10.142, PPP adjusted.

[5] Offshore wind power was not chosen as an attribute level, even though it was discussed in the focus groups. The deep sea along the Norwegian coast makes floating wind turbines the most realistic means of producing offshore wind power since the sea is too deep for installing turbines in/on the seabed. Since the technology of floating wind turbines is currently not profitable, it received little political priority when the survey was conducted.

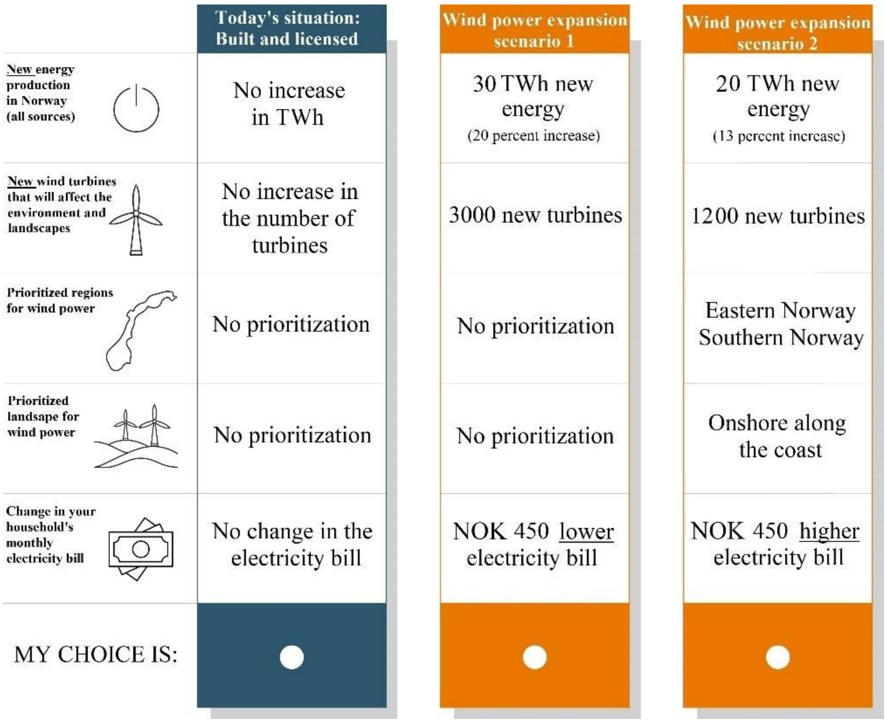
The attribute for prioritized region and the associated levels are also relevant. The licensing application process by NVE has been conducted on a case-by-case basis without a national framework. This means that no regions have not been prioritized by the national authorities. Nonetheless, the case-by-case licensing process has resulted in concentration of WPDs in a few areas. With the NFWP, the NVE and the government aimed for a more general approach. This in turn would allow for specific regions of Norway to be prioritized for the installation of new WPDs (NVE, 2019).

The last attribute was defined as changes in the respondents' monthly household electricity bills. According to NVE (2017), Norwegian energy prices might increase by 2030. Reasons include increased European CO_2 prices, which affect the prices of Norwegian oil and gas production, and that the Norwegian and European energy markets are becoming more integrated, with the latter markets having higher electricity prices (NVE, 2017). This results in higher electricity prices for Norwegian households. However, increased Norwegian renewable production might have the opposite effect and results in lower electricity prices for Norwegian households. To make the attribute more realistic, we allowed for both increments and reductions in their monthly electricity bill, which corresponds to WTP and WTA questions in the survey, respectively.

In each of the 8 choice-sets, the respondents could choose between the status quo scenario (today's situation) with no change in their monthly electricity bill and two wind power development scenarios with different attribute levels. Figure 4 provides an example of a choice-set. Each respondent answered eight choice questions.

After answering the choice sets, respondents were asked to assess, on a seven-point Likert scale, how important the attributes and other effects of wind power had been for their responses to the choice questions. Finally, the respondents were asked attitudinal questions and questions about their socio-economic characteristics, such as income, age, education and gender.

Figure 4: Example of a choice card



4. Econometric Approach

The fundamental econometric framework of the DCE approach is the random utility model, where individuals make discrete choices that provide them with the highest possible utility (McFadden, 1974). In the econometric analysis, we employ the mixed logit model with simulations (Train, 2009), which is well established in environmental economics (Schaafsma et al., 2013).

Each respondent was faced with $T = 8$ choices. Respondent n chose scenario i in the status quo option and the $J = 2$ alternative options for the wind power development scenarios' in choice situation t. Eq. (1), which represents respondent n's indirect utility function, which may be decomposed into i) a deterministic and ii) a random part, can be specified as:

$$v_{int} = \sigma\left[\mathrm{C}_{int} + \mathrm{TURB}_{int}\beta_{n,-x} + \boldsymbol{x}_{int}\boldsymbol{\beta}_{n,-\mathrm{TURB}}\boldsymbol{x}_{int} + \gamma\mathbf{E}_{n}\right] + \varepsilon_{int} \quad (3)$$

In Eq. (3), TURB_{int} is the number of additional wind turbines, $\boldsymbol{x}_{int}$ is the vector of the other non-priced attributes and C_{int} is the change in monthly electricity bills associated with the choice situation. The parameter σ is the scale parameter, which reflects the variance of the unobserved portion of utility. For TURB and $\boldsymbol{x}$, there is a vector of individual specific random preference parameters, denoted $\boldsymbol{\beta}_n$. We assume heterogeneous preferences, so $\boldsymbol{\beta}_n$ varies in the population and has an unknown density $f(\boldsymbol{\beta}|\theta)$, where θ is an underlying taste parameter. Most commonly, $\boldsymbol{\beta}_n$ is assumed to be normally or log-normally distributed (Train, 2009, p. 138). The error term (ε_{int}) is the random part of Eq. (3) and is independently and identically Type I extreme value distributed. Our specification indicates that the utility of respondent *n* depends on exposure and household characteristics $(\mathbf{E}_n)$, which are incorporated by interaction effects, denoted as γ.

It is not possible to estimate the scale and the preference parameters $(\sigma, \boldsymbol{\beta}_n)$, separately (Swait and Louviere, 1993). Instead, one can estimate the relative scale parameter (λ) by merging the samples from Oslo and Rogaland if one normalizes the scale parameter to one $(\lambda_1 = 1)$ for one of the samples (Swait and Louviere, 1993; Sandorf et al., 2016). Similarly, we define the scale parameter as $\sigma = O + R \cdot \frac{\lambda_2}{1}$, where λ_2 will be estimated and *O* and *R* are indicator variables for whether the respondent is in the Oslo- or the Rogaland-sample (Sandorf, 2016). With this specification, the scale parameter of the Oslo-sample is normalized to one.

Given our specifcations, the unconditional probability of the sequence of choices is:

$$\text{Prob}(y_n|\text{TURB}, \boldsymbol{x}, \mathbf{E}, \theta) = \int \prod_{t=1}^{T} \frac{\exp\left(\sigma\left[\text{C}_{int} + \text{TURB}_{int}\beta_{-x} + \boldsymbol{x}_{int}\boldsymbol{\beta}_{,-\text{TURB}}\boldsymbol{x}_{int} + \gamma\mathbf{E}_\text{n}\right]\right)}{\sum_j^J \exp\left(\sigma\left[\alpha\text{C}_{int} + \text{TURB}_{int}\beta_{-x} + \boldsymbol{x}_{int}\boldsymbol{\beta}_{,-\text{TURB}}\boldsymbol{x}_{int} + \gamma\mathbf{E}_\text{n}\right]\right)} f(\boldsymbol{\beta}_n|\theta)d\boldsymbol{\beta}_n \quad (4)$$

over possible values of $\boldsymbol{\beta}_n$. The log likelihood function, specified in Eq. (5), is derived by transforming Eq. (4) into logarithmic form and aggregating over the whole sample. The integral in this equation has no analytical solution and must be solved numerically by means of simulations (Train, 2009, p. 144).

$$\log L = \sum_{n=1}^{N} \log \int \prod_{t=1}^{T} \frac{\exp\left(\sigma\left[\text{C}_{int} + \text{TURB}_{int}\beta_{-x} + \boldsymbol{x}_{int}\boldsymbol{\beta}_{,-\text{TURB}}\boldsymbol{x}_{int} + \gamma\mathbf{E}_\text{n}\right]\right)}{\sum_j^J \exp\left(\sigma\left[\alpha\text{C}_{int} + \text{TURB}_{int}\beta_{-x} + \boldsymbol{x}_{int}\boldsymbol{\beta}_{,-\text{TURB}}\boldsymbol{x}_{int} + \gamma\mathbf{E}_\text{n}\right]\right)} f(\boldsymbol{\beta}_n|\theta)d\boldsymbol{\beta}_n. \quad (5)$$

5. Results and analysis

5.1 Data Collection and Descriptive Statistics

The complete sample consists of 821 complete responses with a response rate of 24 percent and a dropout rate of only 12 percent. 421 of the complete responses were from Oslo and 401 from Rogaland.

Table 2: Socio-economic characteristics of the sample

		Whole sample	Oslo-sample	Rogaland-sample
Gender				
	Male (percent)	49	46	51
	Female (percent)	51	54	49
Income				
	Mean annual gross household income (NOK)	575,906	564,438	588,235
Education				
	Higher Education, (Bachelor or more) (percent)	59	70	47
Age				
	(years)	43	41	44
Region				
	Oslo (percent)	51	100	0
	Rogaland (percent)	49	0	100
Obs.(N)		821	420	401

In terms of socio-economic characteristics, we find that the two samples differ significantly in terms of age and education (see Table 2). *t*-tests indicate that (at 5 percent level), Oslo-respondents have a significantly higher age and education level compared to the Rogaland-respondents.[6] Furthermore, the two samples are not particularly representative in terms of the socio-economic characteristics of their population, see Table A2. This affects the external validity of the results and needs to be accounted for when generalizing the results within a region. The descriptive statistics confirm that the Rogaland respondents are significantly more exposed to WPDs. 86 percent of the Rogaland-respondents have seen a wind farm in Norway, whereas this share is only 33 percent for the Oslo-respondents. 18 percent of the Rogaland-respondents frequently (i.e. more than 25 days per year) engage in

[6] We also find a significant difference between the two sub-samples in the share of females at the 10 percent level.

recreational activities in areas where they can see wind farms, while only 3 percent of the Oslo-respondents do so. This difference is statistically significant and indicates that some of the Oslo-respondents engage in recreational activities outside Oslo, as there are no developments in that region.

For the attitudinal questions on renewable energy and wind power, there is no significant difference between the two samples in terms of how concerned the respondents are about the effects future WPDs will have on pristine Norwegian nature. However, the share of respondents who think producing more renewable energy is the most important environmental goal in Norway is significantly higher ($p<0.05$) among Oslo respondents. Additionally, the Oslo respondents are significantly ($p<0.01$) more positive to more WPDs. This was measured with a seven-point Likert scale.

5.2 Estimation results

We estimate three mixed logit models with correlated random parameters.[7] As in most applications and for the sake of simplicity (Train, 2009), the parameters are assumed to be normally distributed, whereas the cost attribute is non-random. The first model (FULL) includes the whole sample, including a relative scale parameter as specified in Section 4, whereas the OSLO-model and the ROGALAND-model only include the samples from Oslo and Rogaland, respectively. The model estimates are displayed in Table 3. As the two samples differ significantly in several socio-economic characteristics, we employ propensity score matching (PSM) using the "nearest neighbor approach", i.e. the individual from the comparison group is chosen as a matching partner for a treated individual that is closest in terms of propensity score to estimate the causal treatment effect (Caliendo and Kopeinig, 2008). This acts as a robustness check of the test results of the hypotheses.

In each model, the variables with significant coefficients enter with the same sign, and thus the two samples have equal preferences in qualitative terms. The estimated coefficient of the cost attribute is negative and significant, as is expected if individuals have positive marginal utility of income. The estimated coefficient of preferences for increased renewable energy are significant and positive in each model, whereas we find a significant and negative coefficient for the preferences for additional wind turbines.

[7] We use 1000 Halton draw simulations to solve the integral, allowing for correlated parameters. The software R was used to estimate the models, using the GMNL and the Apollo package (Sarrias & Daziano, 2017; Hess & Palma, 2019).

Table 3: Mixed logit Parameters Estimates

Attributes and level	FULL		OSLO		ROGALAND	
	Coef.	SD	Coef.	SD	Coef.	SD
asc	0.0896*		0.1241		0.1673*	
	(0.0503)		(0.0875)		(0.0902)	
cost	-0.0036***		-0.0038***		-0.0046***	
	(0.0002)		(0.0003)		(0.0002)	
3000 turbines	-1.4954***	1.3926***	-0.9304***	2.4276***	-2.2999***	3.9642***
	(0.2255)	(0.1872)	(0.2942)	(0.4430)	(0.3945)	(0.6208)
1200 turbines	-1.4508***	0.8517***	-0.8721***	2.3222***	-2.1278***	3.8167***
	(0.2616)	(0.1917)	(0.3194)	(0.3911)	(0.4523)	(0.5491)
600 turbines	-1.0902***	2.3743***	-0.6935**	1.6236***	-1.2832***	2.3709***
	(0.2352)	(0.2736)	(0.2937)	(0.3117)	(0.4090)	(0.5621)
30 TWh Energy	0.9826***	0.2351	1.4094***	2.5820***	0.9079***	2.6166***
	(0.1372)	(0.1817)	(0.2188)	(0.2837)	(0.2225)	(0.2932)
20 TWh Energy	0.8668***	0.9652***	1.2163***	2.6229***	0.8445***	2.4962***
	(0.1246)	(0.2005)	(0.2111)	(0.2688)	(0.2154)	(0.2840)
10 TWh Energy	0.7393***	1.1157***	1.0147***	1.7507***	0.6937***	1.3601***
	(0.1016)	(0.1716)	(0.1636)	(0.2686)	(0.1602)	(0.2461)
Mountain	0.2943	0.5739	-0.0922	1.7476***	0.4840	2.7228***
	(0.2592)	(0.4195)	(0.3680)	(0.4985)	(0.5466)	(0.5847)
Lowland	0.3179	0.2539	0.2088	1.5914***	0.2389	2.4598***
	(0.2388)	(0.2657)	(0.3206)	(0.4893)	(0.4885)	(0.5542)
Coast	0.3241	0.1639	-0.2373	2.1047***	0.6850	2.3854***
	(0.2264)	(0.2762)	(0.3396)	(0.4232)	(0.4684)	(0.4792)
Northern Norway	-0.3414*	0.0596	-0.3630	2.0535***	-0.2734	3.0474***
	(0.1975)	(0.2633)	(0.2839)	(0.4070)	(0.3776)	(0.5833)
Western Norway	-0.5132***	0.0453	-0.4361*	3.2056***	-1.0364***	3.7531***
	(0.1661)	(0.2341)	(0.2514)	(0.4451)	(0.3876)	(0.5005)
Eastern/Southern Norway	-0.3579*	0.2189	-0.5282*	1.6731***	-0.4213	3.6087***
	(0.1896)	(0.2723)	(0.3042)	(0.3489)	(0.3645)	(0.5628)
Relative scale	1.2142***					
	(0.0788)					
Log likelihood	-5,185.706		-2,687.8		-2,445.6	
Pseudo R-squared	0.2813		0.2719		0.3061	
Observations	6,568		3,360		3,208	

Notes: ***p<0.01, **p<0.05, *p<0.1. asc = alternative specific constant, an indicator variable for the status quo and wind power scenario 1 in the choice cards. SD = Standard deviation of the random parameters. Standard errors (s.e.) are given in brackets.

Neither of the models suggests significant preferences toward prioritizing different types of landscape. However, both models suggest significantly negative preferences for prioritizing specific regions. In the full model, each region is significant, indicating a NIABY (Not-in-anybody's-backyard) effect.

The Oslo-sample has negative preferences for prioritizing Eastern, Southern and Western Norway for additional WPDs. The Rogaland-sample has negative preferences only for prioritizing Western Norway, indicating a NIMBY (Not-in-my-backyard) effect.

The estimates of the standard deviations of the random coefficients are highly significant in each model. In addition, the estimate of the relative scale parameter is highly significant and significantly greater than one in the FULL model ($p>0.01$). Thus, the scale is relatively larger in the Rogaland-sample, indicating lower error variance within this sample (Swait and Louviere, 1993; Train, 2009). A likelihood-ratio test (Louviere et al., 2000) strongly supports a significant difference in the estimated preference parameters between the two samples ($p<0.01$).

To evaluate acceptance for the different levels of attributes in monetary terms and to test Hypotheses 1 and 2, we calculated the welfare estimates, i.e. WTP and WTA, for each model. The estimates are displayed in Table 4.

Table 4: Willingness-to-pay/willingness-to-accept (WTP/WTA) values

Sample	Attributes and levels	WTP/WTA	95 percent CI	
Full sample	3000 turbines	-415.37	-561.02	-269.71
	1200 turbines	-402.96	-579.18	-226.75
	600 turbines	-302.81	-468.85	-136.77
	30 TWh	272.93	197.24	348.63
	20 TWh	240.76	173.27	308.25
	10 TWh	205.35	149.41	261.29
Oslo	3000 turbines	-246.34	-396.08	-96.60
	1200 turbines	-230.90	-394.58	-67.21
	600 turbines	-183.62	-337.27	-29.97
	30 TWh	373.15	265.88	480.41
	20 TWh	322.03	217.33	426.72
	10 TWh	268.64	182.04	355.25
Rogaland	3000 turbines	-498.55	-658.65	-338.45
	1200 turbines	-461.24	-645.42	-277.06
	600 turbines	-278.16	-448.79	-107.53
	30 TWh	196.81	102.56	291.07
	20 TWh	183.06	91.32	274.81
	10 TWh	150.37	81.98	218.76

Note: €1 = NOK 10 PPP-adjusted. Negative sign = WTA, Positive sign = WTP. The estimate confidence intervals were calculated using the Delta method.

In general, respondents are on average willing to pay NOK 273 per month in increased electricity bills in order to increase Norwegian renewable energy production by 30 TWh, where €1 = NOK 10 PPP-adjusted. The numbers are NOK 197 and NOK 373 per month for respondents from Rogaland and Oslo, respectively.

With 3,000 additional turbines in Norway (excluding wind power projects that are already licensed for building), respondents accept on average compensation of NOK 415 per month to be equally well off as in the status quo scenario. The compensation is slightly lower with 1,200 additional turbines (NOK 403/month). The small difference indicates diminishing marginal utility of additional turbines. On average, the Rogaland respondents accept compensation of NOK 500 per month with 3,000 additional turbines, whereas the amount is about NOK 246 per month among the Oslo respondents.

To test H_3, and the apparent differences in welfare measures between the two sub-samples, we apply the complete combinatorial test of difference in empirical welfare measure distributions, as suggested by Poe et al. (2005). The test results suggest that the Rogaland-sample has significantly higher WTA compensation for installation of 3,000 and 1,200 additional wind turbines than the Oslo-sample. Conversely, the Oslo-sample has significantly higher WTP for each level of increased TWh renewable energy production.[8]

To further validate the test results, we use propensity score matching (PSM). First, we determine individual specific welfare estimates. Then, using the nearest neighbor approach, we match respondents on socio-economic and attitudinal variables that potentially explain where the respondents live and the variation in the welfare measures, see e.g. Liebe et al. (2015) and Skeie et al. (2019). Utilizing PSM produces consistent results with the complete combinatorial test (see Table A1 for treatment effects). The Rogaland-sample has significantly higher WTA than the Oslo-sample (below the 5 percent level), for installation of 3,000 turbines, 1,200 turbines and 600 turbines. The difference in WTA for 3,000, 1,200 and 600 turbines is NOK 218, NOK 176 and NOK 53, respectively. We also find a significant difference in WTP for each level of the renewable energy attribute, with the Oslo-sample having higher values.

There were also Likert questions asking respondents which attributes and environmental effects of wind turbines affected their answers to the choice-set questions. Here, we find that concern about climate change is significantly more important (at the 1 percent level) for Oslo respondents than Rogaland respondents. Interestingly, the negative environmental externalities of wind power

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[8] The differences in WTA for 3,000 and 1,200 turbines are significant at the 1 and 5 percent levels, respectively. The differences in WTP for 30 TWh, 20 TWh and 10 TWh are significant at the 1, 5 and 5 percent level, respectively.

production, such as biodiversity loss, blinking lights, ice throwing and size of land area occupied by turbines and other necessary infrastructure, are significantly (at the 5 percent level) more important for the choices made by the Rogaland respondents.

5.3 Exposure

In order to further explore whether proximity and exposure to WPDs affect people's acceptance, we estimate two additional mixed logit models with interaction terms. In the first model (EXPOSURE1), different forms of exposure are explored. We include interactions between the categorical level variables for the wind turbine attribute and the following three separate dummy variables: (1) whether the respondent lives 4 kilometers or less from a wind farm, (2) whether the respondent frequently (more than 25 days per year) engages in recreational activities in areas where she/he can see wind farms, and (3) whether the respondent owns areas that are exposed to future WPDs.[9]

In the second model (EXPOSURE2), we only include interactions between the categorical level variables for the wind turbine attribute and a dummy variable indicating whether the respondents are in any way exposed to WPDs. As noted earlier, exposure is defined by several factors (see Section 2 for a definition of the exposed group), and in total about 40 percent of the respondents from Rogaland are exposed.[10] As the Oslo-sample in most cases is not directly affected by WPDs, we only estimate the models with the Rogaland-sample. We also test for difference in welfare measures between different groups (in the Rogaland-sample) to evaluate disparity in acceptance.

The model results are displayed in Table 5. In EXPOSURE1, the estimated interaction coefficients for whether the respondent lives 4 kilometers or less from a wind farm are not significant. This can be used to test H_4. The estimated interaction coefficients of whether the respondent frequently engage in recreational activities in areas where they can see wind farms are all significant with a negative sign. A *t*-test confirms significant differences in WTA for additional turbines at all common levels of significance.

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[9] The dummy variable takes the value of 1 if the respondent: 1) owns land where wind power farms will or may be constructed and/or 2) owns land close to where wind power farms will or may be constructed. About 15 percent of the respondents from Rogaland own land that is exposed to future WPDs.

[10] The share of exposed people in Rogaland is perhaps larger and will be larger with the NFWP. In retrospect, we recognize that we should have asked the respondents how often they encounter wind turbines, not only when they engage in recreational activities.

To test H_5 we explore whether there is a difference in WTA for additional turbines between people exposed to future WPDs and non-exposed people (or people who do not know if they will be exposed). The interaction terms for whether the respondents will be exposed in the future are also negative, but not significant. However, we also test H_5, by using PSM (see Table A1 for treatment effects). The test results (significant at the 10 percent level) indicate that future exposed people have higher WTA for each additional level of wind turbines.

To test H_6 we investigate whether there is a difference in WTA between exposed and non-exposed people from Rogaland for additional turbines. In EXPOSURE2, the interaction terms all have negative coefficients. However, only one of the interaction terms, the one that indicates preference for 3,000 turbines enters significantly. Here, too, we apply PSM to test H_6. The test results suggest that exposed people from Rogaland have a significantly higher WTA for each additional level of wind turbines.

Table 5: Mixed logit Parameters Estimates for the models EXPOSURE1 and EXPOSURE2

Attributes and level	EXPOSURE1		EXPOSURE2	
	Coef.	SD	Coef.	SD
asc	0.1724*		0.1527*	
	(0.0926)		(0.0884)	
cost	-0.0046***		-0.0046***	
	(0.0002)		(0.0002)	
3000turbines	-1.5185***	3.8206***	-1.6648***	4.1819***
	(0.3979)	(0.4646)	(0.4488)	(0.5219)
1200turbines	-1.3445***	3.3698***	-1.4350***	3.8915***
	(0.4253)	(0.4422)	(0.4615)	(0.5028)
600turbines	-0.8868**	2.1780***	-0.8321**	2.4193***
	(0.3659)	(0.4387)	(0.4112)	(0.4926)
30TWhEnergy	0.9498***	2.9428***	1.0266***	2.8803***
	(0.2301)	(0.2926)	(0.2314)	(0.3056)
20TWhEnergy	0.9569***	2.6901***	0.9537***	2.7902***
	(0.2193)	(0.2859)	(0.2232)	(0.3126)
10TWhEnergy	0.7107***	1.7852***	0.7211***	1.5537***
	(0.1736)	(0.2438)	(0.1640)	(0.2370)
Mountain	0.4335	2.5612***	-0.0145	2.4307***
	(0.4416)	(0.5093)	(0.4572)	(0.5613)
Lowland	-0.0479	2.3364***	-0.2671	2.0569***
	(0.4049)	(0.5038)	(0.4162)	(0.5300)
Coast	0.5726	1.9049***	0.2659	2.1961***
	(0.3906)	(0.4388)	(0.4010)	(0.5308)
Northern Norway	-0.6281*	3.0689***	-0.3706	3.3795***
	(0.3561)	(0.5239)	(0.3682)	(0.6215)

Attributes and level	EXPOSURE1		EXPOSURE2	
	Coef.	SD	Coef.	SD
Western Norway	-1.0710***	3.8390***	-0.9230***	4.2538***
	(0.3422)	(0.5508)	(0.3530)	(0.6772)
Eastern/Southern Norway	-0.6211*	3.3998***	-0.4261	3.5842***
	(0.3499)	(0.4945)	(0.3537)	(0.6259)
3000turbines*FutureExposed	-0.1830			
	(0.6258)			
1200turbines*FutureExposed	-0.1174			
	(0.5535)			
600turbines*FutureExposed	-0.1674			
	(0.4639)			
3000turbines*Home4kmFromWindFarm	0.0782			
	(0.7947)			
1200turbines*Home4kmFromWindFarm	0.9218			
	(0.6917)			
600turbines*Home4kmFromWindFarm	0.8244			
	(0.5733)			
3000turbines*RecreationNearWindFarm	-2.2121***			
	(0.6986)			
1200turbines*RecreationNearWindFarm	-1.8743***			
	(0.5999)			
600turbines*RecreationNearWindFarm	-1.0264**			
	(0.4913)			
3000turbines*Exposed			-1.3384**	
			0.5692	
1200turbines*Exposed			-0.6377	
			0.4901	
600turbines*Exposed			-0.5978	
			0.4090	
Log-likelihood	-2,428.9		-2,437.2	
Pseudo R-Squared	0.3108		0.3085	
No of observations	3,208		3,208	

Notes: ***p<0.01, **p<0.05, *p<0.1. SD = Standard deviation of the random parameters. Standard errors (s.e.) are given in brackets.

6. Discussion

The literature suggests that in general, people have high acceptance for increasing the production of renewable energy (Zerrahn, 2017). H_1 is therefore that our sample is willing to pay to increase Norwegian renewable energy production. Our results support this hypothesis, which could, as Zerrahn (2017) argues, point to climate considerations.

H_2 suggests that the sample demands compensation for additional WPDs in Norway, i.e. people dislike wind power externalities. This has been confirmed in several stated preference studies that examine wind power externalities in a local context (Meyerhoff et al., 2010; Garcia et al., 2016; Brennan and Van Rensburg, 2016). Our results support this hypothesis. We find that our sample has a low acceptance level for additional WPDs in Norway and for prioritizing regions for such developments. The results can be explained as a NIABY (not-in-anybody's-backyard) effect (Warren et al., 2007). By looking at the ROGALAND-Model, we also find a NIMBY effect (not-in-my-backyard), as Rogaland respondents only have a negative preference for prioritizing their own region for additional WPDs. The sample respondents experience welfare loss with additional WPDs, and thus need sizable compensation to be equally well off as in the status quo situation. We find a diminishing return for WTA. A potential explanation for this (and an element of conflict emergence), is that WPDs in Norway tend to be located in pristine/untouched natural landscapes, which hold important environmental and cultural amenities. Exposing such areas to developments could be perceived as fundamentally damaging. Thus, the non-market economic values do not necessarily depend as strongly on the scope of damage as on the decision to initiate a development. Overall, significant (and sizable) estimated standard deviations indicate heterogeneous preferences and limit the internal validity of the result. Implicitly, some respondents experience increased welfare with additional WPDs, but the average effect is still negative.

The low acceptance is most likely related to the negative externalities caused by WPDs, e.g. noise, visual intrusion and impacts on wildlife (Thayer and Freeman, 1987; Zerrahn, 2017). These impacts cause conflicts and opposition (Walker, 1995). The NFWP was initiated by the government to reduce these conflicts by creating an overview over the best potential wind power areas in Norway when several aspects are taken into considerations, such as aspects related to conflicts (NVE, 2019).

The descriptive analysis indicated that the Rogaland-sample has lower acceptance of additional WPDs in Norway compared to the Oslo-sample. The results from the DCE supported this indication, and thus support H_3, which postulates that exposure to WPDs and familiarity with the associated negative externalities are important for people's acceptance. To be as well off as in the status quo scenario, the Rogaland-sample demands higher compensation for additional WPDs in Norway than the Oslo-sample. The negative wind power externalities were found to be significantly more important for the choices made in the DCE by the Rogaland-sample. Thus, they are seemingly more familiar with the respective externalities. The Oslo-sample, however, has higher acceptance for increasing Norwegian renewable energy production. In addition, the estimated error variance within the Oslo-sample is higher, which could be because this sample is less familiar with WPDs.

The results indicate that exposure to, and perhaps familiarity with, WPDs and the associated negative externalities lead to lower acceptance of new WPDs. This is comparable to findings in Thayer and Freeman (1987), Swofford and Slattery (2010), Ladenburg and Dahlgaard (2012), and Navrud and Bråten (2007), whereas it contradicts findings by Warren et al. (2005) and Baxter et al. (2013).

The finding can perhaps also be explained by the U-shaped pattern of acceptance of a WPD over time (Wolsink, 2007; Devine-Wright, 2005). When the survey was conducted, several projects were under construction or at the planning stage in Rogaland. The biggest project under construction was Bjerkreim wind farm, which will consist of 70 wind turbines. As mentioned, there were no developments and no project licenses granted or applied for in Oslo. In accordance with the U-shaped pattern, one might have expected lower acceptance among people from Rogaland, since acceptance is lowest during the planning and construction phase (Devine-Wright, 2005; Wolsink, 2007).

The same reasoning goes for H_5, where we found that respondents in the Rogaland-sample who own land that will be exposed to WPDs in the future have higher WTA for additional WPDs than those from Rogaland who will not (as far as the respondents in the subsample know) be exposed in the future. Another potential explanation of the lower acceptance is potential negative effects on their property price.

As both samples demand compensation for additional WPDs, the monetary values reflect both use and non-use values. Compared to people from Rogaland that can be affected both directly and indirectly, people from Oslo will to a lesser extent be directly affected unless they for instance own a property in Rogaland (NVE, 2019). Implicitly, we would expect that the WTA values among people from Oslo to a larger extent reflect non-use values, whereas the WTA values among people from Rogaland reflect both use and non-use values. This could perhaps explain the significant difference in acceptance. We can expect that the welfare effects are larger among the exposed people as they are more likely to hold both use and non-use values (Garcia et al., 2016).

For the Rogaland-sample, we found that people who encounter wind farms frequently when they engage in recreational activities have lower acceptance of additional WPDs. This is consistent with Garcia et al. (2016), who found that people who used a hypothetical planning area of wind power for recreational purposes demanded higher compensation for the installation of turbines than people who only hold non-use values.

Lastly, we failed to corroborate that proximity to a WPD is important for people's acceptance. Thus, the results do not support H_4. This could be explained by the habituation process expressed by the U-shaped pattern of acceptance, but with low acceptance both before and after the installation of a WPD nearby. However, we find a significant difference in acceptance between an exposed and a non-exposed group from Rogaland, which supports H_6. The exposed group has higher WTA for 600, 1,200 and 3,000 additional wind turbines. This further supports what our conclusion, namely that exposure and perhaps familiarity lead to lower acceptance. Here, too, an explanation for this potential finding could be the balance between use-values and non-use values. We expect larger welfare effects among exposed people, as they hold both use and non-use values.

7. Concluding remarks

Norwegian wind power accounts for a small share of total domestic renewable energy production compared to other similar European countries. Many of the developments that currently exist in Norway have generated public debate and opposition due to environmental impacts on pristine nature and biodiversity. Motivated by declining installation costs, a political push to increase renewable energy production while also recognizing the public debate, the Norwegian government initiated an extensive framework for further land-based WPDs to reduce the conflict level. The framework was shelved after only six months due to public opposition.

By conducting a case-control DCE study, we have examined exposed and non-exposed people's acceptance of additional WPDs in Norway and of increasing domestic renewable energy production. Consistent with the literature, we find that people in general have a high acceptance level for increasing domestic renewable energy production. The respondents in the sample are on average willing to pay NOK 273 more on their monthly electricity bill to increase Norwegian renewable energy production by 30 TWh annually.

However, we find low acceptance for additional WPDs in Norway. On average, the respondents in the sample demand a reduction of NOK 415/month for the installation of 3,000 wind turbines in Norway, and they have a negative preference for prioritizing regions for installation of WPDs. This illustrates a national NIABY (not-in-anybody's-backyard) effect and the high WTA for additional wind turbines confirms this effect. This implicitly means that the sample respondents prefer other sources of renewables to increase production, such as upgrading Norwegian hydropower and offshore wind power. These have been put forward as alternative measures with less environmental impact but are also costlier. The overall results have policy implications for renewable energy explansion in Norway and illustrate well why green-on-green conflicts emerge and have implications for future planning and expansion of Norwegian wind power. There is a trade-off between environmental impacts from WPDs and potential reductions in greenhouse gas emissions achieved by replacing non-renewable with renewable energy. The sample has low acceptance for the former, and seemingly high acceptance for the latter. We found deviations in the socio-economic characteristics between the samples and their population, which implicitly affect the external validity of the results. To generalize the results to the two regions, one needs to take this into account.

The literature examining exposure to and familiarity with WPDs continues to be inconclusive. As one of the first case-control DCE studies that examine this, we find that exposure results in even lower acceptance of new WPDs in a national context. The WTA for accepting installation of 3,000 additional wind turbines in Norway among exposed people is between NOK 150 and NOK 200 per month higher than for non-exposed people.

What is clear from the recent literature is that exposure to, and perhaps familiarity with WPDs, is important for people's acceptance. In line with the results of our study, a possible explanation for the inconclusiveness of the habituation literature on WPDs may be that types of exposure in terms of the impacts assessed are important for explaining variation in acceptance level. Thus, future research should explore how different impact categories and levels affect people's acceptance of WPDs, and whether psychological and cultural factors may also provide an explanation.

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Appendix A. Additional tables and figures

Table A1: Average treatment effect, propensity score matching using nearest neighbor matching[11]

Sample	Attribute	Attribute level	Average treatment effect (WTP)
Oslo vs Rogaland			
	Turbines	3000	217.817*** (46.561)
		1200	175.752*** (42.428)
		600	53.153* (28.245)
	TWh Energy	30	120.355*** (38.870)
		20	85.687** (37.389)
		10	87.792*** (21.863)
Future exposed vs non-future exposed from Rogaland			
	Turbines	3000	-158.452* (94.004)
		1200	-164.836* (88.850)
		600	-103.294* (58.399)
	TWh Energy	30	-108.359 (76.152)
		20	-119.481 (75.958)
		10	-44.107 (35.600)
Exposed vs non-exposed from Rogaland			
	Turbines	3000	-191.002*** (75.844)
		1200	-144.391*** (74.214)
		600	-104.930** (46.472)
	TWh Energy	30	-94.101* (52.432)
		20	-95.280** (50.864)
		10	-32.295 (25.651)

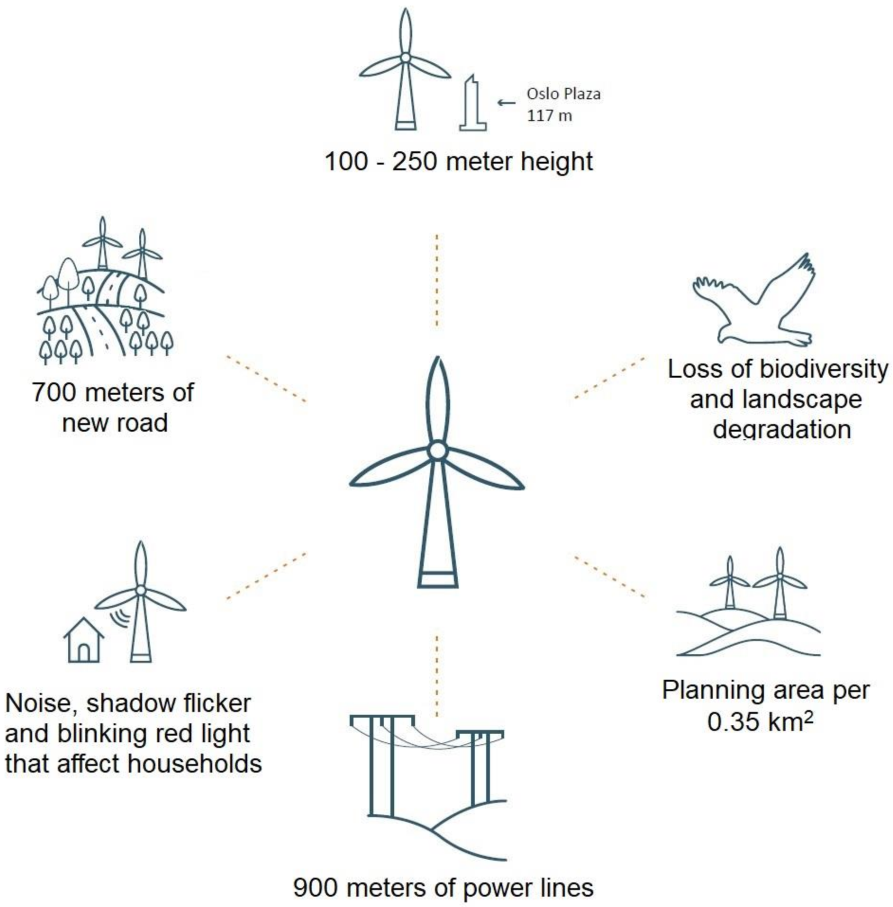
Note: Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

[11] The respondents were matched on age, gender, education and the following attitudinal variables: MoreRenewable = 1 if think producing more renewable energy is the most important environmental goal in Norway, 0 otherwise; PreserveNature = 1 if find it important to preserve pristine Norwegian nature and not reduce such areas, 0 otherwise. Respondents from Oslo and Rogaland were also matched on two additional variables: PreferForestLowland = 1 if prefer forest and lowland landscape, 0 otherwise; PreferCoast = 1 if prefer coastal landscape, 0 otherwise. The variables should be important for where the respondents reside.

Table A2: Socio-economic characteristics of the populations and the samples

		Oslo population	Oslo-sample	Rogaland population	Rogaland-sample
Gender					
	Male (percent)	50	46	51	51
	Female (percent)	50	54	49	49
Income					
	Mean annual gross household income (NOK)	624,000	564,438	735,000	588,235
Education					
	Higher Education, (Bachelor or more) (percent)	31	70	23	47
Age					
	(years)	44	41	38	44

Figure A1: Summary of externalities from a wind turbine



Ackronyms

CV contingent valuation

DCE discrete choice experiment

NFWP National Framework for land-based Wind Power in Norway

NVE Norwegian Water Resources and Energy Directorate

PSM propensity score matching

SP stated preference

WPD wind power development

WTA willingness-to-accept

WTP willingness-to-pay