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Acceptance of wind power development and exposure – Not-in-anybody's-backyard

Anders Dugstad [a,*], Kristine Grimsrud [b], Gorm Kipperberg [c], Henrik Lindhjem [d,e], Ståle Navrud [a]

[a] School of Economics and Business, Norwegian University of Life Sciences (NMBU), Ås, Norway
[b] Statistics Norway, Oslo, Norway
[c] UiS Business School, University of Stavanger, Stavanger, Norway
[d] Menon Centre for Environmental and Resource Economics, Oslo, Norway
[e] Norwegian Institute for Nature Research (NINA), Oslo, Norway

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ABSTRACT

Despite a large stated-preference (SP) literature on wind power externalities, few SP studies employ a case-control approach to examine whether people's acceptance of new wind power developments and renewable energy initiatives increases or decreases with exposure. 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 (WTA) 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 to increase general domestic renewable energy production (from all sources) as non-exposed people, 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 differ somewhat across studies.

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 (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.[1]

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 wind power developments (WPDs) in Norway (NVE, 2019). The NFWP was released on April 1st, 2019 (NVE, 2019), and was 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, other stakeholders argue that additional 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). The NFWP was later discarded by the government due to fierce opposition at both local and national levels.[2]

Wind power is not equally distributed across Norway, and the NFWP

* Corresponding author.
E-mail address: anders.dugstad@nmbu.no (A. Dugstad).

[1] **Abbreviations:** Discrete Choice experiment (DCE); National Framework for land-based Wind Power (NFWP); Norwegian Water Resources and Energy Directorate (NVE); Stated preference (SP); Wind power development (WPD); Willingness-to-accept (WTA); Willingness-to-pay (WTP).

[2] At the time of our survey used in this study, the NFWP was viewed as the government's proposed plan for additional WPDs, and thus was very real to the survey respondents

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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 County (or at least a large share thereof) lives closer to and therefore sees and encounters WPDs more often than the population of Oslo County. It may also imply that the population of Rogaland County 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; Wilson and Dyke, 2016; Krekel and Zerrahn, 2017; 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 Bråten, 2007; Meyerhoff et al., 2010; Meyerhoff, 2013; Ek and Persson, 2014; Ek and Matti, 2015; 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.

We use willingness-to-pay (WTP) and willingness-to-accept (WTA) compensation to have additional WPDs in Norway and increased renewable energy production, as measures of acceptance to make our results more comparable with other social science studies on this topic. Acceptance, in our case, measures societal acceptance of technologies and policies (Wüstenhagen et al., 2007). 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 exposure 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. Among the Rogaland-respondents, we also examine whether different types of exposure affect their level of acceptance. Using areas affected by WPDs for recreational purposes is one type of exposure (García et al., 2016; Brudermann et al., 2019). Another type of exposure is proximity to functioning or planned WPDs and hence more exposed 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 that 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.[3] 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 panel study of acceptance over time. A case-control approach contributes to provide better understanding of whether and why exposure to WPDs results in disparity 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 derives 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.

2. Literature review and hypotheses

This section reviews studies that have examined the relationship between exposure and acceptance of WPDs. Wüstenhagen 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 among stakeholders in local contexts, whereas market acceptance measures the market adaption of technologies. Some studies use terms other than but closely related to 'acceptance', such as preferences, attitudes, perception and support (Huijts et al., 2012). We group these related terms as indicating acceptance. However, in the literature review, we use the studies' original terms.

2.1. Exposure to wind turbines and acceptance

Zerrahn (2017) reviews the literature on wind power and associated externalities and 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 low accetpance of WPDs.

Overall, Zerrahn (2017) identifies three fundamental factors explaining people's low acceptance; (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 near residential areas (Meyerhoff et al., 2010; Brennan and Van Rensburg, 2016). WPDs in scenic landscapes lead to lower acceptance (Zerrahn, 2017). However, Zerrahn (2017) finds that 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

[3] 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).

study from Sydthy in Northern Jutland and find that the distance to the nearest turbine and number of turbines do not affect attitudes toward wind turbines (Andersen, 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 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 like the wind farm less 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 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 with no 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 (Shepherd et al., 2011; Krekel and Zerrahn, 2017; 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 that examines how acceptance to WPDs change over time. Most of these temporal studies find a U-shaped pattern of acceptance levels for a nearby development over time; see Fig. 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 begin, 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. The U-shaped pattern implies that people with higher levels of familiarity adapt to the negative externalities, i.e. habituation (Wilson and Dyke, 2016).

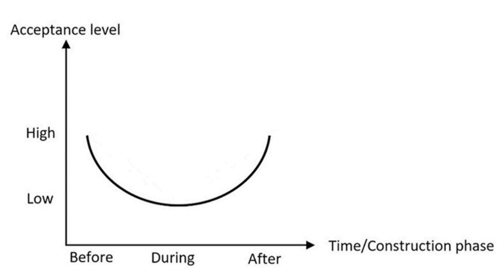

Fig. 1. U-shaped relationship between acceptance and time. Source: Devine-Wright (2005).

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 to explain 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 an established 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 such developments 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:

$$U_n = v(\text{TURB},\ \mathbf{X},\ \text{C},\ \mathbf{E}_n; \boldsymbol{\Lambda}), \tag{1}$$

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

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

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

Equation (2) represents the respondent n's acceptance of additional wind turbines in monetary terms. In the equation, exposure and familiarity are important factors to explain variation in acceptance. We now define six hypotheses based on the literature review:

H1. People have positive WTP for the production of additional renewable energy in general.

H2. People have positive WTA for additional WPDs.

H3. People from Rogaland county have different WTA for additional WPDs than people from Oslo county.

H4. Among people from Rogaland, those living closer to a wind farm have higher WTA for additional WPDs than those who reside further away.

H5. 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).

H6. Among people from Rogaland, people exposed to WPDs have different WTA for additional WPDs than non-exposed people.

H1 is supported by the findings in the literature review by Zerrahn (2017). H2 is supported by Meyerhoff et al. (2010), García et al. (2016), Brennan and Van Rensburg (2016) and Zerrahn (2017), which imply 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 upgrading 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, H2 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 H3 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 could expect a lower acceptance level among people from Rogaland, as the acceptance of developments is at its lowest level during the planning/construction phase (Wolsink, 2007; Devine-Wright, 2005). This implies that we can expect higher WTA among the exposed people defined in H3, but also in H5, if we use the same reasoning.

H4 is supported by Knapp and Ladenburg (2015), Swofford and Slattery (2010), Krekel and Zerrahn (2017) and Zerrahn (2017). We use the distance of 4 km, as Krekel and Zerrahn (2017) find that living 4 km away or closer significantly reduces people's life satisfaction. This hypothesis (as well as H3, H5 and H6) could also be supported by Sunak and Madlener (2016) who find a significant reduction in property prices for homes affected by WPDs. Conversely, H4 could be rejected in accordance with Andersen (1997) and Warren et al. (2005).

To evaluate H6, we use a wide definition of exposure. Respondents from Rogaland are exposed if they fall into one or several of the following categories: (1) own land where a WPD will or might be constructed, (2) are affected through having a job in the tourist industry, (3) own land 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 H5 is defined by (1) and (3) above.

3. Survey design and administration

We collected the data 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 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 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 Figs. 2 and 3). As shown in Figs. 2 and 3, there are no suitable areas in Oslo Country, whereas Rogaland County has several suitable areas. 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.

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 (see Table 1 for an overview). The first two attributes are not perfectly correlated, as other renewable sources can be used to expand the 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.[4] 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 Mkt block macro. The D-efficiency for the design was 0.89.

The selection of salient 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 a 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), García et al. (2016), and Brennan and Van Rensburg (2016). The attribute is associated with the environmental impact of wind turbines.[5] 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 1200–1300 turbines. The respondents 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. Production can increase to 25 TWh by 2030, and the respondents were therefore informed that up to 3000 additional turbines will be installed by 2030.[6] The number of turbines necessary to produce 25 TWh depends on technological advances.

[4] One 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.

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

[6] Production in 2018 was 4 TWh.

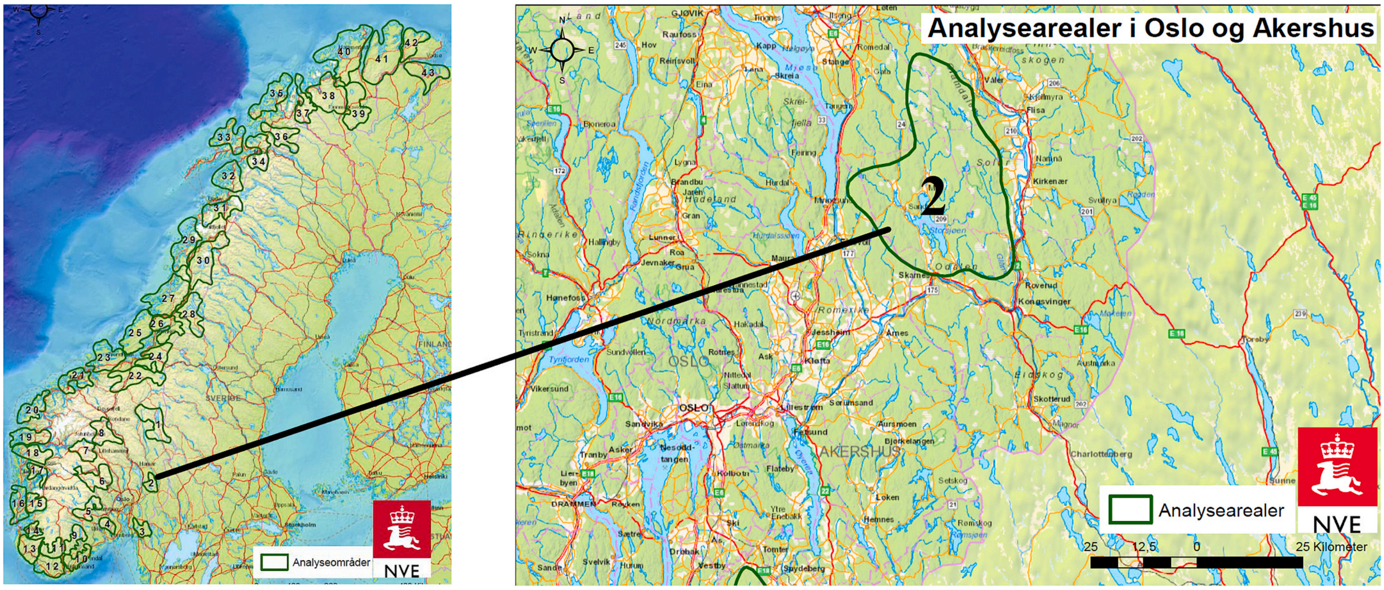

Fig. 2. Areas in Norway. No areas in Oslo county will be analyzed for suitability for wind power, and only one in the neighboring county of Akershus (now part of Viken County). Source: NVE (2019).

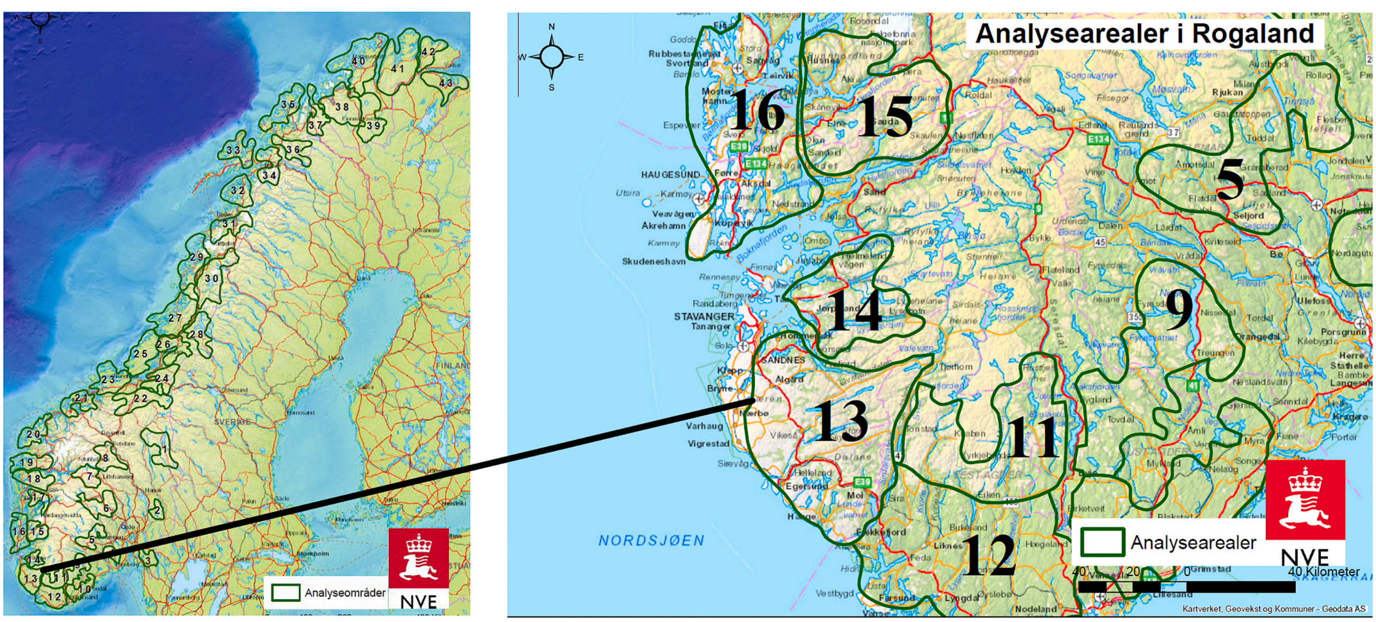

Fig. 3. Areas in Norway as a whole and in Rogaland county that will be analyzed for wind power suitability. Source: NVE (2019).

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 the need for a secure electricity supply. Increasing production is also a political goal. NVE (2017) expects Norwegian energy production to increase from 147 TWh in 2018 to 180 TWh by 2030. The levels of the attributes were chosen to correspond to predictions from the 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 turbine attributes, the levels were set as lower than, equal to, and higher than NVE's predictions.

We wanted to separate the preferences for increasing renewable energy production in general from 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

Table 1
Attributes and levels.

Attribute	Level
Turbines	No increase (Status quo)
	600
	1200
	3000
TWh Renewable Energy	No increase (Status quo)
	10
	20
	30
Prioritized regions	No prioritization (Status quo)
	Northern Norway and Central
	Western Norway
	Eastern Norway 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.

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, 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 roads, biodiversity loss and noise was then shown; see Fig. 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 future 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 in Sweden.[7]

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 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, NVE and the government aimed for a more general approach. This in turn would allow for specific regions of Norway to be prioritized for future WPDs (NVE, 2019).

The last attribute was defined as changes in the respondents' monthly household electricity bill. 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 and other external factors might have the opposite effect and result 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 scenarios, 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. Fig. 4 provides an example of a choice-set. 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.

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 among the status quo option and the $J = 2$ alternative options for the wind power development scenarios in choice situation t. Equation (1), which represents respondent n's indirect utility function, may be decomposed into two parts, a deterministic and a random part, and can be specified as:

$$v_{int} = \sigma\left[C_{int}\alpha + \mathrm{TURB}_{int}\beta_{n,\mathrm{TURB}} + \mathbf{X}_{int}\boldsymbol{\beta}_{n,\mathbf{X}} + \mathbf{E}_n\boldsymbol{\gamma}\right] + \varepsilon_{int.} \quad (3)$$

In Equation (3), TURB is the number of additional wind turbines, **X** is the vector of the other non-priced attributes and C is the change in monthly electricity bills associated with the choice situation, where α is the associated fixed preference paremeters of C. The parameter σ is the scale parameter. For TURB and **X**, there is a vector of individual specific random preference parameters, denoted $\boldsymbol{\beta}_n$. We assume heterogenous 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). The error term (ε_{int}) is the random part of Equation (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, which are incorporated by interaction effects, denoted as $> \boldsymbol{\gamma}$.

It is not possible to estimate the scale and the preference parameters 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 $\sigma = \mathrm{O} + \mathrm{R}\cdot\frac{\lambda_2}{1}$, 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 et al., 2016). With this specification, the scale parameter of the Oslo-sample is normalized to one.

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

[7] 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.

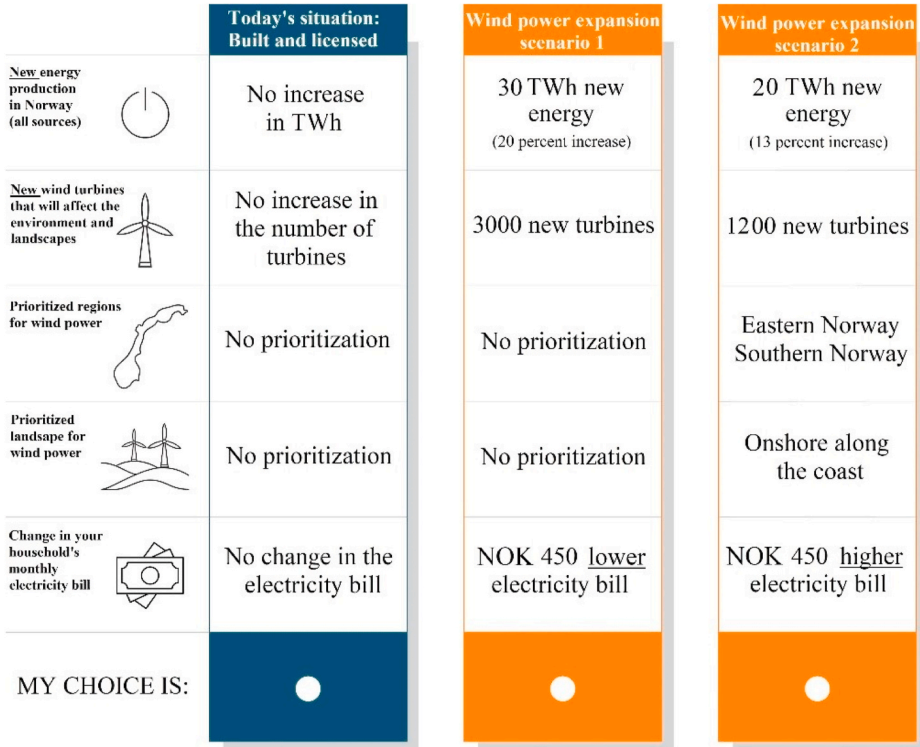

Fig. 4. Example of a choice card. Note that NOK 450 is about €45 PPP adjusted.

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

over all possible values of $\boldsymbol{\beta}_n$. The log likelihood function, specified in Equation (5) is derived by transforming Equation (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)

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

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.

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 Oslo-respondents have a significantly ($p < 0.05$) higher age and education level than the Rogaland-respondents.[8] 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 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

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

Table 2
Socio-economic characteristics of the sample.

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

engage in recreational activities outside Oslo, as there are no developments in that region.

For the attitudinal questions on renewable energy and wind power, we find 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 the Oslo-respondents. Additionally, the Oslo-respondents are significantly ($p < 0.01$) more positive to future WPDs. This was measured with a seven-point Likert scale.

5.2. Estimation results

We estimate three mixed logit models with correlated random parameters.[9] 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 respondents 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 cost attribute is negative and significant, as is expected if individuals have positive marginal utility of income. Preferences for increased renewable energy are significant and positive in each model, whereas we find significant negative preferences for additional wind turbines.

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

The standard deviations of the random coefficients are highly significant and sizable in each model. In addition, 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 among the Rogaland-respondents, indicating that they have lower error variance (Swait and Louviere, 1993; Train, 2009). A likelihood-ratio test (Louviere et al., 2000) confirms a significant difference in preference parameters between the two samples ($p < 0.01$).

To evaluate acceptance for the different levels of attributes in monetary terms and to test H1 and H2, we calculated the welfare estimates for each model. The estimates are displayed in Table 4.

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 respective numbers are NOK 197 and NOK 373 per month for respondents from Rogaland and Oslo, respectively.

With 3000 additional turbines in Norway (excluding wind power projects that are already licensed for building), respondents accept on average compensation of NOK 415 per month. The compensation is slightly lower with 1200 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 3000 additional turbines, whereas the amount is NOK 246 per month among the Oslo-respondents.

To test H3, and the apparent differences in welfare measures between the two 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-respondents have significantly higher WTA for installation of 3000 and 1200 additional wind turbines than the Oslo-respondents. Conversely, the Oslo-respondents have significantly higher WTP for each level of increased TWh renewable energy production.[10]

To further validate the test results, we use 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).[11] The Rogaland-respondents have significantly higher WTA than the Oslo-respondents ($p < 0.05$), for installation of 3000 turbines, 1200 turbines and 600 turbines. The difference in WTA for 3000,1200 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-respondents having higher values.

There were also Likert scale 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 ($p < 0.01$) for the Oslo-respondents than the Rogaland-respondents. Interestingly, the negative environmental externalities of wind power production, such as

[9] We use 1000 Halton draw simulations to solve the integral, allowing for correlated parameters.

[10] The differences in WTA for 3000 and 1200 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.

[11] The respondents were matched on age, gender, education and the following attitudinal variables: More Renewable = 1 if think producing more renewable energy is the most important environmental goal in Norway, 0 otherwise; Preserve Nature = 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: Prefer Forest Lowland = 1 if prefer forest and lowland landscape, 0 otherwise; Prefer Coast = 1 if prefer coastal landscape, 0 otherwise. The variables should be important for where the respondents reside.

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	−5185.706		−2687.8		−2445.6	
Pseudo R-squared	0.2813		0.2719		0.3061	
Observations	6568		3360		3208	

Note: ***p < 0.01, **p < 0.05, *p < 0.1.

Table 4
Willingness-to-pay (WTP) values.

Sample	Attributes and levels	WTP/WTA	95% 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 estimates were calculated using the Delta method.

biodiversity loss, blinking lights, ice throwing and size of land area occupied by turbines and other necessary infrastructure, are significantly ($p < 0.05$) more important for the choices made by the Rogaland-respondents.

5.3. Exposure

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 levels of the wind turbine attribute and the following three separate dummy variables: (1) whether the respondents live 4 km or less from a wind farm, (2) whether the respondents frequently (more than 25 days per year) engage in recreational activities in areas where they can see wind farms, and (3) whether the respondents own land that are exposed to future WPDs.[12]

In the second model (EXPOSURE2), we only include interactions between the levels of 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.[13] 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 models are displayed in Table 5. In EXPOSURE1, the estimated interaction coefficients for whether the respondents live 4 km or less

[12] The dummy variable takes the value of 1 if the respondents: 1) own land where wind power farms will or may be constructed and/or 2) own 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.

[13] 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.

Table 5
Mixed logit Parameters Estimates 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)
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	−2428.9		−2437.2	
Pseudo R-Squared	0.3108		0.3085	
Observations	3208		3208	

Note: ***p < 0.01, **p < 0.05, *p < 0.1.

from a wind farm are not significant. This can be used to test H4. The estimated interaction coefficients of whether the respondents frequently engage in recreational activities in areas where they can see wind farms are all significant with a negative sign. *t*-tests confirm significant differences in WTA for additional turbines at all common levels of significance.

To test H5, 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, to further test H5, we use PSM (see Table A1 for treatment effects). The test results ($p < 0.1$) indicate that future exposed people have higher WTA for each additional level of wind turbines.

To test H6, 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 3000 turbines, is significant. Here, too, we apply PSM to test H6. The test results suggest that the exposed respondents from Rogaland have a significantly higher WTA for each additional level of wind turbines (see Table A1).

6. Discussion

The literature suggests that people have in general high acceptance for increasing the production of renewable energy (Zerrahn, 2017). H1 states therefore that our sample is willing to pay to increase Norwegian renewable energy production. Our results support this, which could, as Zerrahn (2017) argues, point to climate considerations. It could also point at consideration of secure energy supply, as this was found to be important among the focus group respondents in both counties.

H2 suggests that the sample demands compensation for additional WPDs in Norway, i.e. people dislike wind power externalities. This has been confirmed in several SP studies that examine wind power externalities in local contexts (Meyerhoff et al., 2010; García et al., 2016; Brennan and Van Rensburg, 2016). Our results support this. 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., 2005). 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 experiences welfare loss with additional WPDs, and thus needs sizable compensation in order to be equally well off as without additional WPDs. 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) 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-respondents have lower acceptance for additional WPDs in Norway compared to the Oslo-respondents. The results from the DCE supported this indication, and thus support H3, 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 without additional WPDs, the Rogaland-respondents demand higher compensation with additional WPDs in Norway than the Oslo-respondents. The negative wind power externalities were found to be significantly more important for the choices made in the DCE by the Rogaland-respondents. Thus, they are seemingly more familiar with the respective externalities. The Oslo-respondents, however, have higher acceptance for increasing Norwegian renewable energy production. In addition, we find higher error variance among the Oslo-respondents, which could be because they are less familiar with WPDs and thus answer more randomly.

The results indicate that exposure to, and perhaps familiarity with, WPDs and the associated negative externalities lead to lower acceptance for additional or future 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 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 H5, 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 to those from Rogaland who will not be exposed in the future. Another potential explanation of the lower acceptance is potential negative effects on their property price (Sunak and Madlener, 2016).

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 (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 between the samples. 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 (García et al., 2016).

Among the Rogaland-respondents, 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 García 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 disparity in people's acceptance for new initatives. Thus, the results do not support H4. 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 found a significant difference in acceptance between an exposed and a non-exposed group from Rogaland, which supports H6. The exposed group has higher WTA for 600, 1200 and 3000 additional wind turbines. This further supports our main finding, namely that exposure and perhaps familiarity lead to lower acceptance. Here, too, an explanation 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. Conclusion and policy implications

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 choice experiment study, we have examined exposed and non-exposed people's acceptance for 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 3000 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 validates 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 expansion in Norway and for future planning and expansion of Norwegian wind power. The results further illustrate well why green-on-green conflicts emerge. 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 respondents have low acceptance for the former, and seemingly high acceptance for the latter.

The literature that examines exposure to and familiarity with WPDs continues to be inconclusive. As seemingly the first case-control DCE study to examine this, we find that exposure results in even lower acceptance for additional WPDs in a national context. The WTA for accepting installation of 3000 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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No potential conflict of interest was reported by the authors.

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CRediT authorship contribution statement

Anders Dugstad: Data curation, Formal analysis, Writing - original draft, Writing - review & editing, Conceptualization. **Kristine Grimsrud:** Formal analysis, Funding acquisition, Writing - original draft, Writing - review & editing, Conceptualization. **Gorm Kipperberg:** Formal analysis, Funding acquisition, Writing - original draft, Writing - review & editing, Conceptualization. **Henrik Lindhjem:** Formal analysis, Funding acquisition, Writing - original draft, Writing - review & editing, Conceptualization. **Ståle Navrud:** Conceptualization, Funding acquisition, Writing - review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix B. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.enpol.2020.111780.

Appendix A

Table A1
Average treatment effect, propensity score matching using nearest neighbor matching

Sample	Attribute	Attribute level	Average treatment effect
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)

(*continued on next page*)

Table A1 (*continued*)

Sample	Attribute	Attribute level	Average treatment effect
		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, ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

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

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

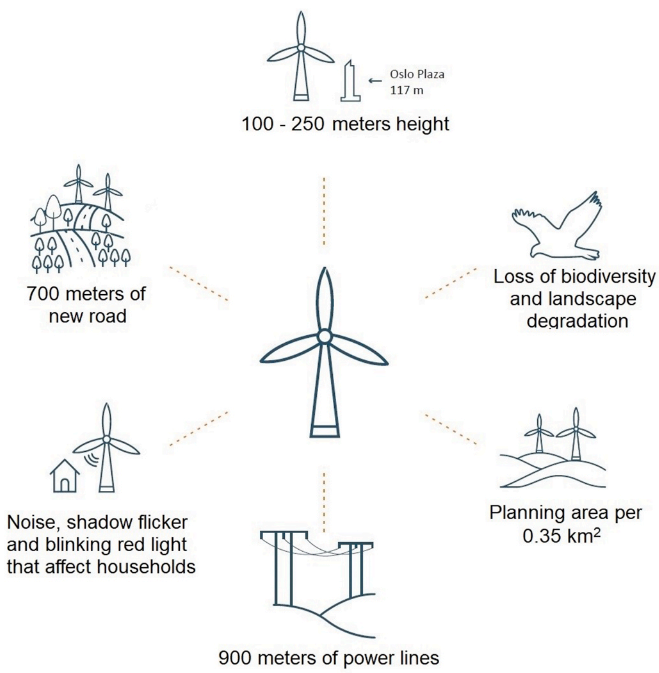

Fig. A1. Summary of externalities from a wind turbine.

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