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Do people prefer offshore to onshore wind energy? The role of ownership and intended use

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ABSTRACT

Global investments in offshore wind energy are expected to escalate over the coming decades, fueled by improvements in technology, declining costs, and increasing political support. The complexity, scale, and location of these developments make international ownership and export of electricity more feasible. We examine how the general public's acceptance of wind energy will be affected by a political shift in focus from onshore to nearshore or offshore locations, from local or national dominance of ownership to international dominance, and from meeting local or national needs to meeting international ones. We use a nationwide choice experiment with 1612 individuals in Norway to reveal the preferences for these attributes and apply a mixed logit regression model to estimate the willingness to pay to avoid certain outcomes. We show that, although respondents prefer offshore and nearshore locations to onshore ones, they are even more concerned with maintaining local or national control both through ownership and intended use of the added electricity. Although the preferences for national ownership are strong for both nearshore and offshore alternatives, the preference for meeting national needs becomes less important when wind energy developments are located farther off the coast. Three wind energy scenarios are used to further investigate these preferences: 1) international consortium for offshore wind energy, 2) national alliances for nearshore wind energy, and 3) local energy communities for onshore wind energy. We also discuss how a shift to nearshore and offshore wind energy can be enabled by paying greater attention to people's concerns over national control of wind energy resources.

1. Introduction

Through their design of policies, regulations, and energy targets, national governments may affect wind energy developments in the coming decades. That is, it is within their power to direct wind energy developments towards specific technologies and locations, and more indirectly, to influence who owns and controls these installations and for what purpose the generated electricity will be used [e.g., 1]. In this study, we ask the following question: How will the general public's acceptance of wind energy be affected by a political shift in focus from onshore to nearshore or offshore locations, from local or national dominance of ownership to international ownership, and from serving local or national needs to international ones? The answer to this question is relevant for three reasons.

First, investment in offshore wind energy is expected to escalate in the next few decades, fueled by improvements in technology, declining costs, and increasing policy support in Europe, the United States, China, and other key markets in Asia. The offshore wind energy market grew by 30% between 2010 and 2018 [2] and is expected to quadruple between 2020 and 2025 [3], raising its share of new wind energy installations from 6.5% to 21%. In a special report on offshore wind energy, the International Energy Agency (IEA) [2] concludes that the untapped potential for offshore wind energy is vast. This is particularly the case in the EU, where offshore wind energy is expected to have the largest share of electricity generation by 2040 in the IEA's Sustainable Development Scenario. Even when wind energy sites are limited to shallow water locations close to the coast, IEA [2] claims that "the best offshore wind sites could supply more than the total amount of electricity consumed worldwide today". Moving farther from shore and into deeper waters, floating turbines could meet the world's total electricity demand 11

Abbreviations: DCE, discrete choice experiment; (M)WTP, (marginal) willingness to pay; NOK, Norwegian kroner.

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times over by 2040. We refer to these two locations as nearshore and offshore, respectively.

Second, the complexity, scale, and location of nearshore and offshore wind energy installations make international ownership models and export of electricity more feasible. One example is Hywind Scotland, a floating wind power park located on the UK continental shelf but operated by the Norwegian energy company Equinor. In their recent strategy for offshore renewable energy, the European Commission recommends the development of so-called hybrid projects where energy islands and hubs are directly connected to cross-border interconnectors [4,5]. Development of a meshed grid will enable hybrid projects to serve more than one member state, and moreover, ensure the exchange of power between countries even in situations where the hybrid project is not producing.

Third, these shifts towards large and complex offshore wind projects, primarily owned by multinational consortia and where the power serves the needs in more than one market are not fully addressed in the research literature on social acceptance, neither by the part of this literature applying discrete choice experiments (DCEs), which we review in Section 2, nor by studies applying other methods. Admittedly, there is a growing research literature on social acceptance for offshore wind energy, and most of these studies address the various impacts of siting decisions. This research supports the contention that offshore wind energy facilities are often (but not always [6]) preferred over nearshore and onshore production facilities [7–14], and that locations farther off the coast are often (but not always [15]) preferred to locations closer to the coast for offshore production facilities [9,10,16–20].

However, research on how social acceptance for wind energy is influenced by ownership and intended use of the added electricity is mostly delimited to land-based projects and comparisons of alternative domestic ownership models and uses. These studies support the contention that local control over ownership and use are preferred over national control or use [11,21–29], as illustrated in our literature review in the next section. With one exception [23], none of these studies investigate attitudes toward international ownership and export.

Thus, to enable more nearshore and offshore wind energy, we need knowledge on how a shift towards international ownership models and export of the added electricity influence social acceptance for wind energy. More importantly, we need knowledge on which of these attributes – location, ownership and intended use – are most important in forming social acceptance for governments' wind energy developments. To meet these knowledge needs, we use a discrete choice experiment (DCE) where we ask individuals to state their preferences among alternative wind energy developments. The attributes describing the wind energy developments are choice of location (onshore, nearshore, or offshore), intended use (i.e., meeting local, national, or international needs), dominant owner type (local, national, or international), turbine height, and changes in the household's monthly electricity bill. We apply a mixed logit model to estimate the willingness to pay to avoid certain outcomes and to examine three plausible wind energy scenarios.

The paper is structured as follows. In section 2, we review relevant DCE studies and present the research questions. In sections 3 and 4, we present the methodology and results, respectively. Finally, in section 5, we suggest how authorities can facilitate a shift to nearshore and offshore wind energy.

2. Literature review

2.1. Concepts

Social acceptance is recognized as an important issue shaping the achievements of climate and energy policy targets. Broadly speaking, social acceptance can be defined as "a favorable or positive response (including attitude, intention, behavior and—where appropriate—use) relating to a proposed or in situ technology or socio-technical system by members of a given social unit (country or region, community or town and household, organization)" [30]. Thus, social acceptance incorporates the narrower concept of preference, which can be elicited in DCEs.

Social acceptance is generally thought of at three scales [31]. Socio-political acceptance is related to acceptance of technologies and policies by the public, policy makers and key stakeholders; community acceptance is related to acceptance of specific renewable energy projects among local stakeholders; and market acceptance is related to market adoption of technologies. Here, we focus on socio-political acceptance in that the preferences of the general public are highly relevant because wind energy strategies deal with the global challenge of climate change and has nationwide impacts on energy security, electricity price levels, and conservation of nature for future generations [e.g., Refs. [11,22,32]].

2.2. Discrete choice experiments (DCEs)

Discrete choice experiments (DCEs) are used to elicit preferences of attributes of goods by asking respondents to choose among a set of alternatives. The method has been widely used to assess acceptance of renewable energy development, where respondents are faced with trade-offs between different attributes that define renewable energy developments. In this section, we review some important findings related to acceptance of location, intended use, and ownership.

Dugstad et al. [33] deployed a case-control DCE to examine people's preferences for new onshore wind energy developments and renewable energy initiatives. They showed that the surveyed Norwegian households are willing to pay to increase renewable energy production, but they also demand compensation for having more land-based wind power developments. This suggests that Norwegians prefer other sources of renewable energy, such as offshore wind power, but this preference has not yet been examined explicitly.

DCEs that ask respondents to choose between hypothetical onshore and offshore locations have often revealed stronger preferences for offshore locations [11–14]. As an example, in a nationwide DCE in Chile, where the respondents could choose among offshore, coastal, onshore, and mountainous locations, offshore was the most preferred location and coastal was the least preferred [12]. Furthermore, in a nationwide DCE in Sweden, where the respondents could choose among offshore, open landscape, mountainous, and forest locations, offshore was the most preferred and mountainous areas were the least preferred locations [11].

A set of other DCEs have established the visual or environmental disamenity effect of offshore wind energy at different distances from the shore, all else equal. These studies revealed a preference for moving wind energy projects from nearshore to offshore locations [9,10,17–20], although the preferences are context specific and may be insignificant and/or vary across individuals [15]. For example, Ladenburg and Dubgaard [19,20] conducted a DCE on Danish residents. The experiment included offshore wind energy at varying distances from the shore (8, 12, 18, and 50 km). They found that residents are willing to pay an increasing amount to move projects farther off the coast. A similar experiment was conducted by Krueger et al. [18] on residents of the state of Delaware (US). For turbines located at 0.9, 3.6, 6, and 9 miles offshore, they found that nearshore development would cause considerable welfare costs to residents, especially those living close to the coastline.

Kim et al. [17] used a DCE to evaluate the environmental costs of the 40 MW Cheongsapa offshore wind energy farm, which is planned off the coast of Pusan, the second-largest city in South Korea. Presented with three distance levels from land (1.2, 15, and 30 km), respondents were willing to pay USD 0.13 per kilometer per year to move wind energy developments farther offshore.

A few experiments have assessed how ownership and intended use of the energy influence acceptance for renewable energy. These experiments have often found a clear preference for projects controlled by and serving local interests. Ek and Persson [11] asked respondents to choose between two hypothetical wind farms characterized by type of ownership, type of landscape (including offshore), the degree of local participation in the planning process, the choice to transfer revenue to society in a pre-specified way, and monetary cost. They found an increased willingness to pay for wind energy farms that were wholly or partially owned by the local community. The alternative ownership models were state, cooperative, and private ownership, and private ownership was the least preferred option.

Liebe et al. [22] used a factorial survey experiment to investigate local acceptance of wind energy in Germany and Poland. Here, the hypothetical windfarms were characterized by the type of ownership, degree of local participation in the planning process, distribution of turbines across regions, and motivation for developing the resource. Similar to Ek and Persson [11], they found that respondents were more willing to accept new turbines in their vicinity if the turbines were owned by a group of citizens from the surrounding area (the alternatives being the municipality or a non-local investor) and the local residents could participate in decision making. Moreover, local acceptance was higher if the generated electricity was consumed in the region rather than being exported to other regions.

Tabi and Wüstenhagen [23] used a DCE to examine social acceptance of hydropower projects in Switzerland. The respondents were asked to choose between three run-of-the river projects that varied with respect to ecological impact, public participation, employment, income from a water tax, and ownership of the plant. The plant's owner could be a local utility, a cantonal utility, a private domestic company, or a private German company. They concluded [23] "that for the majority of the respondents, ecological considerations and/or type of owner are key factors that determine social acceptance of a hydropower project". The respondents stated that they would strongly prefer a local or regional owner over a private domestic or foreign company. The foreign company was the least preferred owner.

Taken together, these experiments show that citizens prefer projects that more directly serve local or at least national needs and where local or at least national investors control how they are managed However, as stated in the introduction, the impact of ownership and intended use are hardly addressed for offshore facilities, nor is the interaction between these attributes and onshore, nearshore and offshore locations. This is the main contribution of our study.

2.3. Research questions

Based on our review of previous research and trends in global wind energy production, we posed three research questions:

1. Do our results confirm the contentions that offshore/nearshore locations are preferred to onshore and that local/national ownership and use are preferred to international ones?
2. Is the general public willing to trade off national/local ownership and use to move wind farms to nearshore or offshore locations?
3. Is the general public less concerned with national/local ownership and use when wind farms are moved to nearshore or offshore locations?

3. Methodology

3.1. Study object

Norway was among the top five countries that installed the most onshore wind power in 2020 [3] and arguably has Europe's best untapped wind energy resources that will enable future investments in onshore, nearshore, and offshore wind energy facilities [1]. Thus, Norwegian authorities can choose among alternative wind energy developments when designing policy and technology packages. Here, we study the general public's preferences for alternative wind energy scenarios through 2040 in Norway.

To understand the role that ownership and intended use (i.e., the proposed uses of the power and benefits to society) may play in forming preferences for wind energy scenarios, we must acknowledge that Norway has a long tradition for ensuring national control over its natural energy resources. Hydropower has been produced for more than 100 years, and laws ensure that these energy-production facilities are mainly owned and controlled by state and municipal enterprises. Moreover, following an equity argument, where the aim is to capture rents for the public, hydropower is most often subject both to income and natural resource taxes.

With the discoveries of oil and gas in the North Sea in the 1970s, Norway gained new industrial and energy-export opportunities. Although international petroleum companies are invited to bid for licenses to operate in the North Sea, control over national petroleum resources from the start was ensured through natural resource taxation, the establishment of a large state-owned company (Statoil), and the introduction of regulatory institutions and regulations to ensure sustainable resource management.

Globally, Norway has the highest share of renewable energy (98%) in its electricity supply [34], and its electricity production has until recently relied almost entirely on hydropower. Access to reasonably priced hydropower has led to the development of a large energy-intensive manufacturing sector, widespread use of electricity for heating, and more recently, electrification of transport and industry [34, 35]. The average income is high (67,339 current USD/capita[1]) and equally distributed (Gini index equal to 27.7 in 2019[2]), making electricity affordable for most households.

Norway has gone from having almost no onshore wind energy production in 2010, to installing 1.53 GW in 2020; in 2020, only China, the US, Brazil, and Germany installed more onshore wind energy capacity [3]. Although these investments have resulted in the net export of electricity, further investments in wind energy will be needed. The Norwegian Water Resources and Energy Directorate (NVE) expects Norwegian electricity consumption to increase by 23 TWh by 2040, an increase of approximately 15–20% from the current level [35].

However, this high rate of investment has resulted in conflicts and a temporary halt in granting new licenses to construct wind energy facilities. Criticism has focused on the significant increase in turbine height and plant sizes, negative impacts on the natural environment, and procedural and distributive inequity. People have also been skeptical of the dominance of international owners in onshore wind energy, which had increased during the 2010s to approximately 58% foreign ownership [36], and to whether wind energy would benefit their local communities [37]. In an annual survey of Norwegians' attitudes to wind energy, the support for onshore wind power is reduced from 65% (2018) to 33% (2021) while the support for offshore wind power is reduced from 72% (2018) to 58% (2021) [38].

To accommodate these criticisms, the government suggested improvements in licensing procedures for onshore wind energy facilities in 2019 in which more consideration would be given to the environment and local communities and a newly introduced production fee where the revenues would be allocated to municipalities [36]. Moreover, the Norwegian Parliament has identified two offshore locations for the first round of license applications, one close to the coast (Utsira Nord) and one farther into the sea (Sørlige Nordsjø II). The government aims for Norway to take a leading role in the development of floating offshore wind energy facilities. Substantial subsidies have been granted to the Norwegian offshore company Equinor (earlier named Statoil) to construct the Norwegian Hywind Tampen project. The project consists

[1] Downloaded 11th of May 2022 at https://data.worldbank.org/indicator/SI.POV.GINI?locations=NO.

[2] Downloaded 11th of May 2022 at https://data.worldbank.org/indicator/NY.GDP.PCAP.CD.

of 11 floating wind turbines; it will be the largest floating offshore wind energy installation in the world when it is finished at the end of 2022.

Thus, Norwegian authorities are about to make decisions that will direct future wind energy developments, and we will pay particular attention to three distinct scenarios. They represent plausible combinations of technology, location, ownership, and markets and are therefore relevant for wind energy markets globally, as well as for our study object, Norway.

(A) *International consortium for offshore wind energy.* Norway cooperates with countries around the North Sea to develop hybrid projects directly connected to cross-border interconnectors. Investors are large international corporations with offshore experience, such as petroleum companies. The turbines are tall and located far away from the coast where the resources are best, and they are not limited by access to the national power grid. The hybrid projects serve several national markets in Northern Europe, as suggested by the EU Commission [39].

(B) *National alliance for nearshore wind energy.* Norwegian industry, the supplier industry, power companies, and the Norwegian petroleum company Equinor form a national alliance. Wind energy developments are located near the coast (providing cheap and easy access to onshore wind power), the projects are owned by national owners, the focus is on national climate gains and electrification, and the best technology (tall turbines) is chosen.

(C) *Local energy communities for onshore wind energy.* Norwegian authorities are inspired by the concept "energy community" introduced by the EU in the Clean energy for all Europeans package [40]. "Small is beautiful" is a guiding concept both in terms of visual interventions in nature, local ownership and local use of power. Authorities have learned from previous conflicts related to onshore wind energy developments and adjusted the course to ensure local legitimacy. Wind energy developments are located on land to ensure local ownership and that power use is also local.

These scenarios were chosen because they reflect actual developments being discussed in political and academic circles in Norway, as well as internationally. Moreover, they all include *á priori* expected trade-offs between more preferred and less preferred characteristics of wind energy development. For instance, scenario (A) combines an offshore location away from the coast (preferred) with tall turbines, international ownership, and the export of power (not preferred). Therefore, the ranking of these three scenarios is not obvious; that is, we did not know in advance which scenario the respondents would value the most or how much they would be willing to pay to achieve this scenario.

The survey design and DCE approach, which we turn to next, are designed to enable a comparison of these three wind energy developments and to answer the research questions posed in section 2.2.

3.2. Survey design

The survey and DCE design was developed by following the stated preference guidance in Johnston et al. [41]. To ensure that the choice experiment and questions were meaningful, understandable, and that the survey was not too time-consuming/demanding, the survey was pretested on and discussed with students, researchers, and stakeholders taking part in three research projects (see the Acknowledgments), and necessary adjustments were made. We also sent out a small pilot survey for evaluation purposes.

The survey was carried out by the Norwegian branch of YouGov, an international research data and analytics group. Invitations to take part in the survey were sent by e-mail between December 14, 2020 and January 5, 2021 to YouGov's proprietary panel[3] for Norway, and computer-assisted web interviews were conducted. The 1612 respondents were selected to ensure representativeness with respect to gender, age (18+), and geography according to a standard set by Statistics Norway. YouGov presented the responses in datafiles, and those responses form the basis for our analysis.

3.2.1. Background information

In part one of the survey, we informed the respondent that Norwegian authorities expect an increase in electricity consumption through 2040, that a significant part of this will be met by wind energy investments, and that onshore, nearshore, and offshore were potential locations. To enhance consequentiality and truthful responses, we explained that the survey was funded by the Research Council of Norway and that knowledge of citizens' preferences for wind energy attributes could influence political choices.

3.2.2. Choice experiment

In part two of the survey, we presented the choice experiment. The choice experiment approach is survey-based and relies on the theory of random utility maximization [41]. According to this theory, individuals make discrete choices that generate the highest possible utility level [42]. The respondents are presented with choice cards; for each card, they are asked to choose their preferred alternative among two or more alternatives. Each alternative comprises several attributes of concern, including price or cost. This approach is useful for estimating the relative values of different environmental and non-market attributes [43]. The utility of a change in the level of each attribute can be obtained by analyzing data on the respondents' choices. The economic value is expressed as willingness to pay (WTP) and is usually measured as marginal WTP (MWTP) for a continuous or discrete change in an attribute.

The alternative wind energy developments were described by five attributes presented sequentially to the respondents. The attributes and corresponding levels are described in Tables 1 and 2. The cost attribute is in Norwegian kroner (NOK), where EUR 1 = NOK 15 PPP adjusted in 2020 prices. For the location attribute, we presented photos that illustrate onshore, nearshore and offshore locations, as it is generally recommended to use visualization techniques to better describe the impacts of attributes in choices experiments [16,44].

We also gave a brief and very general summary of advantages and disadvantages for each location. These summaries include impacts that are normally addressed when governments decide on whether to grant a license to construct a wind power project. Including such information is consistent with recommendations in the stated preference guideline [41]. Potential advantages of onshore locations are the use of a mature technology with low costs and proximity to power grids and consumers, and potential disadvantages are visible landscape encroachment, loss of biodiversity, bird death, noise, shadow casting, ice throwing, and potential negative consequences for leisure interests and reindeer herding in the planning area. For both nearshore and offshore locations, potential disadvantages are loss of biodiversity, bird deaths, and negative impacts for fisheries, the oil industry, communications, and military defense. In addition, nearshore wind energy projects will potentially be visible from land, affect animal/plant species in the coastal zone, and conflict with local businesses, such as aquaculture, but the benefits include easy and low-cost connection to the grid. Offshore wind energy projects are potentially less visible, but grid connection will be more complicated and could limit or increase the expense of national use of the electricity.

A d-efficient design was employed to generate the choice cards, using

[3] A group of pre-screened respondents who have expressed a willingness to participate in surveys and/or customer feedback sessions.

Table 1
Description and levels of the attributes.

Attribute	Description	Levels	Information given to the respondent
Location	Land/seascape	1: Onshore * 2: Nearshore 3: Offshore	The wind energy developments are located either onshore in a mixture of lowlands/forests, mountainous areas, and coastal landscapes, or they are approximately 10 km off the coast or approximately 100 km off the coast. Photos illustrate the locations (Table 2)
Turbine height	Total height above sea/land level	1: 100–150 m 2: 200–250 m*	An illustration was provided comparing turbines with a well-known building. Taller turbines would require fewer turbines to produce the same amount of energy.
Intended uses	Stated political purpose for the wind energy development	1: Local 2: National 3: International *	Authorities can influence how the additional electricity is used through policies, regulations, and investments. These can be directed towards creating new jobs and economic activity locally, reducing CO_2 emissions nationally through electrification of industry and transport, or reducing CO_2 emissions in Europe through export of renewable electricity.
Ownership	Dominant owner(s) controlling the project	1: Local 2: National 3: International *	The owner(s) controlling the project is either a traditional utility from the region (e.g., Troms Kraft, BKK, and Agder Energi), a national energy corporation (e.g., Equinor, Norsk Hydro, and Statkraft) or an international investor (e.g., the BlackRock [US], Stadtwerke Munchen [Germany], Credit Suisse [Switzerland], and Enbridge [Canada]).
Cost	Increase in electricity bill per household	1: 0 NOK/month 2: +150 NOK/month 3: +300 NOK/month 4: +600 NOK/month	On average, a household pays 1500 NOK per month. These levels imply increases of 0%, 10%, 20%, and 40%, respectively.

Notes: For each attribute, * indicates the baseline state. The exchange rate was 15 NOK/EUR at the time of the survey.

the software Ngene [45]. To allow for a greater variety of attribute combinations with a manageable number of choice cards per respondent, we generated two blocks of choice cards, with eight choice cards in each [46] (see Table 3 for an example of a choice card). In the survey design, the respondents were then randomly allocated to one of the two blocks. Reflecting the results of social acceptance studies, we specified the utility coefficients in the Ngene design to have signs corresponding to expected impact on utility of the attributes. For example, we assumed *á priori* that a location offshore is preferred to a location nearshore or onshore, all else equal.

Moreover, offshore and nearshore wind energy were specified to be associated with higher electricity cost compared to the onshore wind energy attribute level because the technology of offshore and nearshore wind power is currently more expensive. This would contribute to make a more efficient design, and these restrictions are then used in the Ngene design to create challenging trade-offs between the two alternatives presented on each choice-card.

3.2.3. Control variables

Part three included a set of questions revealing respondents' political orientation and socio-demographic characteristics such as age, gender, education, profession, income, family situation, and location of residence [47]. The variables included in our econometric analysis are presented in Table 4.

3.3. Econometric approach

According to discrete choice consumer theory, individuals obtain utility from the attributes of a good, rather than utility from the good itself [48]. The DCE approach is consistent with this idea and can be used to estimate an individual's MWTP for marginal changes in these attributes [49]. This section describes the general econometric specification that we use.

The respondents in our study were presented with a set of eight choice cards with two alternatives. In accordance with the random utility theory, individuals are assumed to choose the alternative that yields the highest expected utility [42]. The conventional utility function for the representative respondent n who chooses alternative i among the $J = 2$ alternatives in choice situation t can be specified as follows:

$$U_{int} = \sigma[-\alpha c_{int} + \boldsymbol{\beta}' \boldsymbol{X}_{int}] + \varepsilon_{int}, \tag{1}$$

where σ is the scale parameter, and the error term (ε_{int}) is assumed to be i.i.d. extreme value distributed with constant variance $\pi^2/6$. Furthermore, $\boldsymbol{X}_{int}$ and $c_{int}$are levels of the non-monetary and the monetary attributes in the respective choice situation, respectively, $\boldsymbol{\beta}$ is a vector of preference parameters for the non-monetary attributes, and α is the cost preference parameter, referred to as the marginal utility of money.

This conventional specification is referred to as the "utility-in-preference" space. However, we are interested in the WTP estimates to measure acceptance, so it is more useful to work with the WTP-space specification [50,51]. If we define $\boldsymbol{\omega} = \boldsymbol{\beta}/\alpha$, the WTP-space utility specification is as follows:

$$U_{int} = \sigma[-\alpha c_{int} + (\alpha\boldsymbol{\omega})' \boldsymbol{X}_{int}] + \varepsilon_{int}. \tag{2}$$

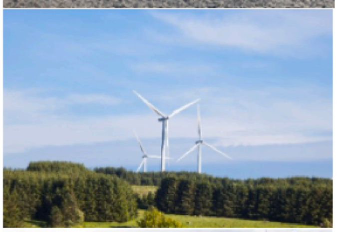
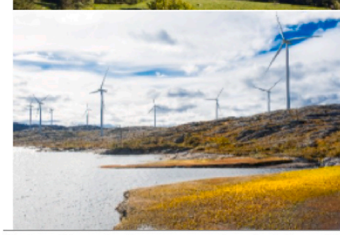
Given our assumption about the distribution of the error term, the probability that respondent n chooses alternative i in the sequence of choices (y) can be represented by the multinomial logit model:

$$\mathrm{Prob}(y_n|\alpha, \boldsymbol{\omega}, c_n, \boldsymbol{X}_n) = \prod_{t=1}^{T} \frac{\exp(\sigma[-\alpha c_{int} + (\alpha\boldsymbol{\omega})' \boldsymbol{X}_{int}])}{\sum_{j=1}^{J} \exp(\sigma[-\alpha c_{jnt} + (\alpha\boldsymbol{\omega})' \boldsymbol{X}_{jnt}])}. \tag{3}$$

The multinomial logit model is a useful starting point, but the model specification is restricted by the assumption of homogenous preferences. A common practice in the stated preference literature is to allow for heterogenous preferences using the mixed logit specification, where preferences for α and $\boldsymbol{\omega}$ are then allowed to vary randomly. However, we then need to specify a joint distribution of these random parameters. Let $\boldsymbol{\Theta}_n$ represent a vector of all random preference parameters and $\boldsymbol{\Omega}$ represent their means and variances. The joint distribution of the random parameters $f(\boldsymbol{\Theta}_n, \boldsymbol{\Omega})$ gives us the following unconditional probability:

$$\mathrm{Prob}(y_n|c_n, \boldsymbol{X}_n, \boldsymbol{\Omega}) = \int \prod_{t=1}^{T} \frac{\exp(\sigma[-\alpha_n c_{int} + (\alpha_n\boldsymbol{\omega}_n)' \boldsymbol{X}_{int}])}{\sum_{j=1}^{J} \exp(\sigma[-\alpha_n c_{jnt} + (\alpha_n\boldsymbol{\omega}_n)' \boldsymbol{X}_{jnt}])} f(\boldsymbol{\Theta}_n, \boldsymbol{\Omega}) d(\boldsymbol{\Theta}_n), \tag{4}$$

Table 2
Locations of wind energy developments.

Onshore	Nearshore
  	 Offshore 

Notes: The photos were extracted from Shutterstock iStock (ID: 637402824, 470020426, 181061404) Shutterstock (ID: 705635179) and public Norwegian documents.

Table 3
Example of a choice card.

	Alternative 1	Alternative 2
Location	Nearshore	Offshore
Ownership	National energy corporation	Local energy corporation
Intended use	Local use/employment	Export/emission reduction in Europe
Turbine height	Tall, 200–250 m	Small, 100–150 m
Cost	An extra 600 NOK per month	An extra 300 NOK per month
Preferred alternative	Alternative 1	Alternative 2

Table 4
Control variables used in the econometric analyses.

Variable	Response alternatives	Dummies
Education	Primary school	High education: University (college) = 1, otherwise 0.
	Secondary school	
	University (college)	
Income (NOK)	Annual gross household income:	High income:
	<300,000	Income >700,000 = 1, otherwise 0.
	300,000–699,999	
	>700,000	
Gender	Female	Female:
	Male	Female = 1, otherwise 0.
Political orientation	Left-wing	Right-wing:
	Moderately left-wing	Moderately right-wing or right-wing = 1, otherwise 0.
	Center	Center:
	Moderately right-wing	Center = 1, otherwise 0.
	Right wing	

which defines the mixed logit model in WTP-space. We further need to make assumptions regarding the distribution of the random parameters [52]. Recognizing that the random parameters of the non-monetary attributes can take different signs for different individuals, we specify that the preferences for these attributes are normally distributed. However, it is likely that all individuals experience disutility with an increased electricity bill. Hence, we specify the cost preference parameter to follow a negative log-normal distribution. In this specification, each individual has a negative cost preference parameter, but preferences for increased cost vary across individuals. The WTP-space utility specification implies that the WTP estimates are distributed as the product of the distribution of α_i and $\boldsymbol{\beta}_i$; in other words, they are the product of a log-normal and a normal distribution. This has the advantage of avoiding potentially extremely large and undefined WTP values [50].

The unconditional probability defined in equation (1) relies on simulations that must be solved [53]. Czajkowski and Budzinski [54] found that Sobol draws perform best in a large simulation study on mixed logit data. We therefore used 2000 scrambled Sobol draws to estimate the mixed logit models [54]. The apollo package in R was used to estimate our models [55].

4. Results and discussion

4.1. Descriptive statistics

Table 5 compares the socio-demographic characteristics of our respondents with the Norwegian population. Our sample is representative for the target group with respect to gender, age, and geography, but it consists of relatively more highly educated and high-income people. We should bear this in mind when we discuss the results from our econometric analyses.

Tables A1 and A2 provide more information about our respondents.

Table 5
Sample representativeness.

Variables	Response alternatives	Sample	Norway (2020)
Gender	Female	50% (804)	50%
	Male	50% (808)	50%
Age (years)	18–34	29% (465)	29%
	35–54	34% (555)	35%
	55+	37% (592)	37%
Geography	East Norway (incl. Oslo)	43% (700)	43%
	South Norway	14% (221)	14%
	West Norway	26% (414)	26%
	Middle and north Norway	17% (276)	18%
	No answer	(1)	
Education	Primary school	6% (103)	25%
	Secondary school	36% (570)	40%
	University (college)	58% (916)	35%
	No answer	(23)	
Household gross annual income (NOK)	<300,000	17% (220)	Median income: 529,000
	300,000–699,999	41% (533)	Mean income: 587,600
	≥700,000	41% (533)	
	No answer	(326)	

Notes: The statistics for Norway are provided by Statistics Norway. To make the percentages for our sample comparable with those from Statistics Norway, we did not include the number of "no answer" responses.

About half of the respondents report having average or above average knowledge on wind energy, and two-thirds have seen onshore wind energy developments in Norway. Less than one-third are exposed to planned or existing wind energy developments in the daily lives. Young and/or male respondents report having more knowledge about wind energy, having more often seen onshore wind energy developments, and being more exposed to wind energy developments. Respondents with high levels of education or income report having greater knowledge of wind energy than others, but respondents with high income are the least exposed to planned and existing wind energy developments.

4.2. *Estimated mixed logit models*

Table 6 shows three estimated mixed logit models, where the coefficients can be interpreted as MWTP in NOK. Table A.3 in the Appendix provides further details on the standard deviations. The mixed logit model approach estimates respondent's MWTP for attributes based on the choices that they make in the presented choice cards. The reference project in our mixed logit models is located onshore, predominantly owned by international investors, contributes to the export of electricity, and consists of the tallest turbines. The reference project is representative for recent wind energy development in Norway, and we will refer to it as "business as usual".

For model 1, all coefficients are statistically significant at the 5% level, and the signs are as expected. For example, citizens are on average willing to pay almost NOK 240 extra per month to move this development from onshore to offshore locations, keeping the other attribute levels unchanged. Recall that Norwegian households pay on average NOK 1500 per month for their electricity, so this represents a 16% increase in an average electricity bill. Nearshore is also preferred to onshore, but the estimated MWTP for this change is substantially smaller.

Table 6
Mixed multinomial logit models in WTP-space.

Models	Model 1 Basic	Model 2 With attribute interactions	Model 3 With attribute interactions
Variables			
ASC	0.1*** (0.0)	0.1*** (0.0)	0.2*** (0.0)
Location nearshore	+88.9*** (14.1)	+85.5*** (23.2)	−5.3 (14.5)
Location offshore	+240.2*** (16.5)	+260.7*** (22.2)	+241.5*** (12.2)
Ownership local	+464.6*** (12.9)	+468.2*** (17.1)	+509.5*** (13.0)
Ownership national	+400.2*** (9.4)	+407.1*** (14.5)	+382.7*** (12.7)
Intended use: local	+185.2*** (10.4)	+173.8*** (14.9)	+202.6*** (11.0)
Intended use: national	+165.9*** (12.6)	+211.0*** (15.6)	+161.3*** (11.2)
Small turbines	+69.3*** (8.6)	+67.2*** (10.7)	+62.5*** (8.1)
- Cost(in NOK)	−2.3*** (0.2)	−2.3*** (0.1)	−2.2*** (0.2)
Offshore x national ownership	–	+38.2*** (10.1)	–
Offshore x national use	–	−105.3*** (15.7)	–
Nearshore x national ownership	–	–	+145.7*** (6.8)
Nearshore x national use	–	–	+188.4*** (11.2)
Estimated parameters	45	47	47
Log-likelihood final	−6659.47	−6656.83	−6640.22
Adjusted Rho-squared	0.25	0.25	0.26

Notes: The variables are defined in Table 1. ASC refers to the alternative-specific constants that present dummies for the respondent's choice of the alternative 1. The other coefficients represent MWTP in NOK. *, **, and *** indicate statistical significance at the 10%, 5% and 1% level, respectively. Standard errors are reported in parentheses. The null hypothesis is that all the parameters are zero.

Citizens are, however, most concerned with ownership, and are willing to pay NOK 400–500 more per month to ensure that future wind energy developments are predominantly owned by national or local, rather than international, investors. Furthermore, they are willing to pay approximately an additional NOK 200 per month if the stated political purpose for future wind energy developments is to serve local or national, not international (i.e., exporting electricity), needs.

Models 2 and 3 in Table 6 show how preferences for ownership and intended use depend on location. More specifically, they show how preferences for national ownership and use change when wind energy development moves from onshore to nearshore or offshore locations. Note, however, that the three models presented in Table 6 are not directly comparable. Whereas we indirectly assume there are no interactions between preferences for attributes in model 1, we assume that there are interactions between selected attributes in the two others. In model 2, for example, we expect *á priori* that the general public's preference for national ownership will be different for projects located offshore instead of onshore.

The preference for national ownership is particularly strong for nearshore locations. The MWTP for a shift from international to national ownership is, all else equal, NOK 400 per month in model 1, but increases to NOK 445 per month for offshore locations in model 2 and NOK 529 per month for nearshore locations in model 3.

Similarly, the preference for serving national needs is particularly strong for nearshore locations. The MWTP for a shift from serving international needs (i.e., export) to national needs, all else equal, is NOK

166 per month in model 1, but increases to NOK 349 per month for nearshore locations in model 3. However, as wind energy developments move farther offshore, serving national needs becomes less important. The MWTP to ensure that the added energy serves national needs now decreases to NOK 106 NOK per month for offshore locations in model 2 (i.e., a 7% increase in the average electricity bill).

Table 7 shows how preferences for attributes interact with selected individual characteristics. We use dummy variables for university education, high household income (≥700,000), female, and political right-wing and center orientation (Table 4). Thus, the reference person is a male with low levels of education and income who has a left-wing political orientation. The first column in Table 7 shows the reference person's MWTPs (i.e., the main effect), while the following columns show the additional impact of a change in an individual characteristic, all else equal. Although the coefficients for these interaction variables are most often significant, gender and political orientation do often not explain differences in peoples' preferences for attributes.

We find that the preference for offshore locations is particularly strong among people with university education and high income. The preferences for local and national ownership are particularly strong among university educated respondents, and higher income respondents have a particular strong preference for national ownership. Moreover, females have a stronger preference for national ownership and a weaker preference for local ownership. The preference for serving national needs is particularly strong among men and among respondents with university education. The preference for serving local needs is particularly strong among people with university education and high income.

4.3. Discussion

We started this paper by asking three questions on the relative ranking of citizens' preferences for location, ownership, and intended use of wind energy scenarios (section 2.3). We find that, although citizens prefer offshore and nearshore to onshore locations, they are even more concerned with keeping national or local control through ownership and intended use. Moreover, moving wind energy developments from onshore to nearshore locations, citizens are more, and not less, concerned with national ownership and intended use. However, they become more willing to export the energy as the developments move farther offshore, as long as the offshore installations are predominantly controlled by Norwegians.

It is not straightforward to interpret why the general public prefer national/local ownership and serving national/local needs. That is, we cannot, based on our survey, identify the most important factors that influence these preferences. Three plausible, yet speculative, factors are as follows. First, the preferences may reflect a sense of economic rationality; national/local control over ownership and use will benefit Norway as a society through employment, industrial development, and tax revenues. Second, the preferences may reflect a sense of fairness; ownership and use should reflect that wind energy is created from natural resources and has costs for local communities. Third, the preferences may reflect a sense of control; national or local ownership and use will better ensure that national goals for security of energy supply and protection of the natural environment are met.

These preferences are location dependent. Most noteworthy, perhaps, is that offshore wind energy may be exported as long as national control over ownership is maintained. A plausible, yet speculative, explanation is that citizens view electricity produced onshore and offshore as two different goods. Whereas electricity produced onshore is viewed as a common good, on a par with health care, the road system, and public transportation, electricity produced offshore is viewed as a private good, like oil, gas, and salmon. Thus, while authorities must ensure that onshore electricity serves common interests, offshore electricity can be freely traded in an international market.

It is more puzzling that citizens become more concerned with national ownership when wind energy is moved from onshore to nearshore and offshore locations. Possibly this shift reflects a window of opportunity. While existing onshore wind energy plants in Norway are to a great extent owned by international investors, almost no nearshore and offshore wind energy facilities have so far been built. Thus, respondents may have felt that their responses with respect to ownership would have a greater influence on future policies and regulations for nearshore and offshore wind energy.

To further explore the trade-offs between preferences for location, ownership, and intended use, we calculated the WTP for the three wind energy scenarios presented in Section 3.1 (Table 8). Although the reference scenario is probably the least costly from the investors' perspective, it is also the least preferred by citizens. People are willing to

Table 7
Mixed multinomial logit model in the WTP-space with attribute and individual characteristic interactions.

Model 4	Main effect	University education	High income	Female	Political right	Political center
Variables						
ASC	0.1***					
	(0.0)					
Location nearshore	85.3***	+8.9	+85.1***	+14.3	−14.6	−24.1**
	(185)	(9.0)	(6.9)	(8.8)	(9.4)	(12.2)
Location offshore	195.5***	+85.4***	+103.7***	+3.4	−31.1***	−53.0***
	(14.7)	(6.8)	(6.4)	(6.6)	(7.5)	(7.4)
Ownership local	402.4***	+142.6***	+11.9	−51.9***	−3.7	−35.3***
	(15.2)	(8.3)	(8.1)	(7.9)	(9.3)	(13.2)
Ownership national	317.8***	+89.0***	+41.0***	+24.5***	+15.2**	−25.6**
	(13.3)	(6.3)	(6.2)	(6.1)	(6.8)	(12.2)
Intended use: local	171.0***	+27.7***	+17.2**	+10.1*	+3.5	+14.3
	(12.9)	(6.9)	(7.1)	(6.1)	(8.2)	(12.1)
Intended use: national	168.8***	+44.0***	−2.8	−42.8***	−1.1	+6.8
	(13.8)	(8.1)	(7.5)	(7.1)	(8.2)	(12.1)
Small turbines	43.0***	+32.5***	−13.3**	+22.0***	−1.6	+23.5**
	(10.2)	(6.3)	(6.1)	(6.3)	(7.6)	(10.1)
- Cost(in NOK)	−2.2***					
	(0.2)					
Est. parameters	80					
Log-likelihood final	−6628.76					
Adj. Rho-squared	0.25					

Notes: The variables are defined in Table 1. ASC refers to the alternative-specific constants that present dummies for the respondent's choice of the alternative 1. The other coefficients represent MWTP in NOK. *, **, and *** indicate statistical significance at the 10%, 5% and 1% level, respectively. Standard errors are reported in parentheses. The null hypothesis is that all the parameters are zero.

Table 8
WTP for wind energy scenarios, model 1 Table 6.

	Reference (business as usual)	International consortium for offshore wind energy	National alliances for nearshore wind energy	Local energy communities for onshore wind energy
Location	Onshore	Offshore +240	Nearshore +89	Onshore
Ownership	International	International	National +400	Local +465
Intended use	International	International	National +166	Local +182
Turbine height	Tall	Tall	Tall	Small +69
WTP (NOK)	0	+240 (208, 272)	+655 (625, 724)	+716 (672, 767)

Notes: WTP in NOK per month is given relative to the reference scenario. Confidence intervals for each scenario are given in parentheses; they are computed using the Krinsky and Robb method with 10,000 simulations [56]. Average monthly household electricity bill is 1500 NOK per month.

pay most for a shift to local energy communities for onshore wind energy. However, a shift to national alliances for nearshore wind energy may be equally socially desirable, if nearshore tall turbines can generate electricity at lower costs than small turbines onshore, which again reduces the electricity bill. Finally, a shift to international consortium for offshore wind energy is the least preferred strategy. Yet, the WTP of this scenario may be substantially increased by strengthening the case for national ownership (WTP = 240 + 400 = NOK 640 per month). In the concluding section, we discuss this and other strategies for enabling a shift from onshore to nearshore and offshore wind energy.

5. Conclusion

Investments in nearshore and offshore wind energy are expected to escalate in the upcoming decades, and the complexity, scale, and location of these installations make international ownership models and export of electricity more feasible.

Using a choice experiment, we examined how the general public's preferences for wind energy developments in Norway are affected by a shift from onshore to nearshore or offshore locations, from local or national dominance of ownership to international, and from serving local or national needs to serving international ones (i.e., exporting the electricity).

We show that, although citizens prefer offshore to nearshore and onshore locations, they are even more concerned with keeping national or local control through ownership and intended use. Of the three scenarios evaluated, "Local energy communities for onshore wind energy" is preferred over "National alliances for nearshore wind energy", which in turn, is preferred over "International consortium for offshore wind energy".

These results may be used to design technology and policy packages that facilitate a shift from onshore to nearshore and offshore wind energy. However, there is a dilemma. Our results suggest the use of policy measures that reduces foreign investments and exchange of power across borders, but such protective measures may not be feasible nor socially desirable. For instance, they may be in conflict with international competition law and prevent access to capital, industrial knowledge and markets. However, our survey cannot be used to draw firm conclusions on what alternative policy measures can be used to alleviate the respondents' concerns. We choose to solve this dilemma in two steps: First we present potential policy measures based on the discussion of plausible (yet speculative) factors presented in Section 4. Then we discuss the need for further research to draw firmer conclusions and more confidently provide policy recommendations.

First, people are seemingly concerned with keeping national control over how their wind energy resources are managed. Perhaps, they want to feel that they benefit from how the energy is used and how the added value is distributed, as well as know that proper care is taken to respect environmental limits and ensure energy security and social justice. A strategy for future wind energy development must assess and acknowledge these concerns as legitimate and important, and clearly explain how they will be dealt with. This is important irrespective of location.

Second, nearshore wind energy could be viewed as more acceptable if it is made clear that they serve local and/or national needs. The more explicit these examples are, the better. An idea worth examining, is whether international ownership of nearshore installations may be viewed as more acceptable if authorities introduced a natural resource tax that captured part of the rent created and distributed it locally/nationally. Another idea is whether tightening the regulation of wind energy to safeguard the environment could improve local acceptance. A nearshore wind energy strategy that focuses primarily on exporting energy may receive little public support, particularly if it is perceived as being in conflict with industrial needs or challenging national energy security.

Third, policies enabling a shift toward offshore wind energy with hybrid installations serving an international market and including international investors may build on the experience gained from the Norwegian petroleum sector. Policy measures worth examining are natural resource taxation, the presence of a dominant national offshore company, and licensing procedures that ensure sustainable resource management may be crucial building blocks in the development of this new technology.

There is, however, a need for more research to understand the role that ownership and stated political purposes (i.e., intended uses) play in forming preferences for different wind energy scenarios. The following two research areas may be of particular interest.

First, DCEs that enable more nuanced examinations of attributes should help explain the strong preference for domestic ownership and use in our study. They may include a more detailed description of attributes such as intended use, taxation regimes, licensing procedures and requirements, and other factors.

Second, an international comparative analysis would be useful. The included countries should have established offshore wind energy targets but vary with respect to political governance (i.e., they would have different regulatory institutions, tax regimes, and policy measures) to enable an evaluation of how national and local control impact the development, management, and distribution of wind energy resources. New research should not be restricted to DCEs, but also include qualitative research methods.

Author statement

Kristin Linnerud: Conceptualization, Formal analysis, Project administration; Supervision; Writing – original draft preparation. Anders Dugstad: Data curation; Formal analysis; Investigation; Methodology; Writing – methodology/review and editing. Bente Johnsen Rygg: Formal analysis; Funding acquisition; Visualization; Writing -review and 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

Table A1
Relation between individual characteristics.

			Gender		Age			Education			Household income			Political orientation		
			Female	Male	18–34	35–54	55+	Primary	Secondary	High	Low	Medium	High	Left	Center	Right
Base		1612	804	808	465	555	592	103	570	916	220	533	533	505	304	520
Gender	Base	1612														
	Female	50%			49%	49%	52%	49%	48%	51%	48%	49%	43%	50%	48%	43%
	Male	50%			51%	51%	48%	51%	52%	49%	52%	51%	57%	50%	52%	57%
Age	Base	1612														
	18–34	29%	28%	29%				36%	31%	26%	49%	23%	20%	29%	37%	17%
	18–34	34%	34%	35%				28%	34%	36%	32%	32%	43%	35%	31%	35%
	55+	37%	38%	35%				37%	34%	38%	19%	44%	36%	37%	32%	49%
Education	Base	1612														
	Primary	6%	6%	7%	8%	5%	6%				10%	7%	4%	6%	4%	7%
	Secondary	35%	34%	37%	39%	35%	33%				48%	35%	28%	33%	39%	31%
	High	57%	58%	56%	51%	59%	59%				41%	58%	67%	61%	56%	61%
Household income	Base	1612														
	Low	14%	13%	14%	23%	13%	7%	21%	19%	10%				16%	15%	11%
	Medium	33%	33%	33%	27%	31%	40%	34%	33%	34%				35%	32%	37%
	High	33%	29%	38%	23%	42%	33%	21%	26%	39%				32%	33%	38%
Political orientation	Base	1612														
	Left	32%	32%	31%	32%	31%	31%	27%	29%	34%	36%	33%	30%			
	Center	19%	18%	20%	24%	17%	16%	12%	21%	19%	21%	20%	19%			
	Right	33%	29%	37%	19%	33%	43%	33%	29%	35%	27%	35%	38%			

Notes: All percentages are calculated by dividing the number of responses by the total (base). However, because response alternatives such as "do not know" and "will not answer" are not shown in this table, the percentages for each variable do not necessarily sum up to 100%. The income categories are given in Table 4.

Table A2
Prior knowledge of and experience with wind energy.

			Gender		Age			Education			Household income			Political orientation		
	Response alternatives		Female	Male	18–34	35–54	55+	Primary	Secondary	High	Low	Medium	High	Left	Center	Right
		1612	804	808	465	555	592	103	570	916	220	533	533	505	304	520
How do you assess your knowledge of wind energy?	Above average	11%	6%	17%	15%	9%	10%	9%	8%	13%	18%	11%	12%	13%	12%	12%
	Average	48%	42%	55%	41%	48%	55%	41%	47%	50%	40%	50%	54%	48%	53%	55%
	Below average	35%	47%	24%	37%	38%	32%	40%	37%	34%	38%	36%	32%	35%	30%	31%
	Don't know	5%	6%	4%	7%	6%	3%	9%	7%	3%	4%	3%	3%	3%	5%	2%
Have you seen onshore wind energy developments in Norway?	Yes	63%	56%	70%	65%	56%	67%	54%	60%	66%	68%	61%	65%	62%	67%	66%
	No	33%	38%	28%	28%	40%	32%	41%	35%	32%	31%	36%	32%	34%	28%	33%
	Don't know	4%	6%	2%	7%	4%	2%	5%	5%	3%	1%	3%	3%	3%	5%	1%
Do you live/spend your leisure time in areas where wind energy is developed, under development, or being planned?	Yes	28%	24%	32%	37%	25%	25%	28%	29%	28%	31%	31%	27%	62%	38%	27%
	No	60%	61%	58%	44%	64%	68%	57%	59%	60%	55%	59%	64%	27%	54%	64%
	Don't know	12%	15%	10%	19%	12%	7%	15%	12%	12%	14%	10%	9%	11%	9%	10%

Notes: All percentages are calculated by dividing the number of responses by the total (base). However, because response alternatives such as "do not know" and "will not answer" are not shown in this table, the percentages for each variable do not necessarily sum up to 100%. The income categories are given in Table 4.

Table A3
Estimation results of the mixed multinomial logit models in WTP-space. Supplementary material to Table 6.

Models	Model 1	Model 2	Model 3	Model 4 with explanatory variable interactions
	Basic	With attribute interactions	With attribute interactions	
Standard deviations				
Location nearshore	366.4***	380.4***	371.8***	367.7***
	(5.9)	(7.6)	(4.2)	(6.6)
Location offshore	364.6***	389.5***	365.0***	357.3***
	(5.4)	(8.2)	(4.6)	(4.2)
Ownership local	18.5***	35.3***	27.3***	41.1***
	(2.4)	(4.2)	(2.1)	(2.8)
Ownership national	299.7***	280.0***	300.5***	293.8***
	(4.0)	(7.8)	(3.8)	(5.0)
Intended use: local	71.2***	63.0***	9.2***	60.1***
	(2.4)	(4.1)	(2.4)	(3.1)
Intended use: national	8.4***	16.3***	5.4**	23.8***
	(3.2)	(5.3)	(2.3)	(2.4)
Small turbines	130.3***	140.4***	126.9***	121.4***
	(3.6)	(4.6)	(2.5)	(3.3)
- Cost/10 (in NOK)	2.3***	2.3***	2.5***	2.5***
	(0.3)	(0.2)	(0.3)	(0.3)
Estimated parameters	45	47	47	80
Log-likelihood final	−6659.47	−6656.83	−6640.22	6628.76
Adjusted Rho-squared	0.25	0.25	0.26	0.25

Notes: The variables are defined in Table 1. The coefficients represent standard deviation of random parameters in MWTP in NOK. *, **, and *** indicate statistical significance at the 10%, 5% and 1% level, respectively. Standard errors are reported in parentheses. The null hypothesis is that all the parameters are zero.ormal

References

[1] NVE, *Forslag til nasjonal ramme for vindkraft*. Norges vann og energidirektorat. NVE; 2019.
[2] International Energy Agency. Offshore wind outlook 2019. In: World energy outlook special report, in international energy agency; 2019.
[3] Global Wind Energy Council, *Global wind report 2021*. 2021, Global Wind Energy Council: Brussels, Belgium.
[4] European Commission. An EU strategy to harness the potential of offshore renewable energy for a climate neutral future. 2020, COM; 2020. p. 741. final.
[5] Olje og energidepartementet. Energi til arbeid - langsiktig verdiskapning fra norske energiressurser. M.S. (2020-2021); 2021.
[6] Westerberg V, Jacobsen JB, Lifran R. Offshore wind farms in Southern Europe–Determining tourist preference and social acceptance. Energy Res Social Sci 2015;10:165–79.
[7] Wolsink M. Near-shore wind power—protected seascapes, environmentalists' attitudes, and the technocratic planning perspective. Land Use Pol 2010;27(2): 195–203.
[8] Ladenburg J. Attitudes towards on-land and offshore wind power development in Denmark; choice of development strategy. Renew Energy 2008;33(1):111–8.
[9] Parsons G, et al. The effect of offshore wind power projects on recreational beach use on the east coast of the United States: evidence from contingent-behavior data. Energy Pol 2020;144:111659.
[10] Parsons G, Yan L. Anchoring on visual cues in a stated preference survey: the case of siting offshore wind power projects. Journal of choice modelling 2021;38: 100264.
[11] Ek K, Persson L. Wind farms—where and how to place them? A choice experiment approach to measure consumer preferences for characteristics of wind farm establishments in Sweden. Ecol Econ 2014;105:193–203.
[12] Aravena C, Martinsson P, Scarpa R. Does money talk?—the effect of a monetary attribute on the marginal values in a choice experiment. Energy Econ 2014;44: 483–91.
[13] Ladenburg J. Visual impact assessment of offshore wind farms and prior experience. Appl Energy 2009;86(3):380–7.
[14] Ek K. Quantifying the environmental impacts of renewable energy: the case of Swedish wind power. In: Pearce D, editor. Environmental valuation in developed countries: case studies; 2006. p. 181–210. Cheltenham.
[15] Landry CE, et al. Wind turbines and coastal recreation demand. Resour Energy Econ 2012;34(1):93–111.
[16] Lutzeyer S, Phaneuf DJ, Taylor LO. The amenity costs of offshore wind farms: evidence from a choice experiment. Energy Econ 2018;72:621–39.
[17] Kim H-J, Kim J-H, Yoo S-H. Social acceptance of offshore wind energy development in South Korea: results from a choice experiment survey. Renew Sustain Energy Rev 2019;113:109253.
[18] Krueger AD, Parsons GR, Firestone J. Valuing the visual disamenity of offshore wind power projects at varying distances from the shore: an application on the Delaware shoreline. Land Econ 2011;87(2):268–83.
[19] Ladenburg J, Dubgaard A. Willingness to pay for reduced visual disamenities from offshore wind farms in Denmark. Energy Pol 2007;35(8):4059–71.
[20] Ladenburg J, Dubgaard A. Preferences of coastal zone user groups regarding the siting of offshore wind farms. Ocean Coast Manag 2009;52(5):233–42.
[21] Söderholm P, Ek K, Pettersson M. Wind power development in Sweden: global policies and local obstacles. Renew Sustain Energy Rev 2007;11(3):365–400.
[22] Liebe U, Bartczak A, Meyerhoff J. A turbine is not only a turbine: the role of social context and fairness characteristics for the local acceptance of wind power. Energy Pol 2017;107:300–8.
[23] Tabi A, Wüstenhagen R. Keep it local and fish-friendly: social acceptance of hydropower projects in Switzerland. Renew Sustain Energy Rev 2017;68:763–73.
[24] Devine-Wright P. Local aspects of UK renewable energy development: exploring public beliefs and policy implications. Local Environ 2005;10(1):57–69.
[25] Warren CR, McFadyen M. Does community ownership affect public attitudes to wind energy? A case study from south-west Scotland. Land Use Pol 2010;27(2): 204–13.
[26] Toke D, Breukers S, Wolsink M. Wind power deployment outcomes: how can we account for the differences? Renew Sustain Energy Rev 2008;12(4):1129–47.
[27] Maruyama Y, Nishikido M, Iida T. The rise of community wind power in Japan: enhanced acceptance through social innovation. Energy Pol 2007;35(5):2761–9.
[28] Linnerud K, et al. Does change in ownership affect community attitudes toward renewable energy projects? Evidence of a status quo bias. Energy Pol 2019;131: 1–8.
[29] Jobert A, Laborgne P, Mimler S. Local acceptance of wind energy: factors of success identified in French and German case studies. Energy Pol 2007;35(5):2751–60.
[30] Upham P, Oltra C, Boso À. Towards a cross-paradigmatic framework of the social acceptance of energy systems. Energy Res Social Sci 2015;8:100–12.
[31] Wüstenhagen R, Wolsink M, Bürer MJ. Social acceptance of renewable energy innovation: an introduction to the concept. Energy Pol 2007;35(5):2683–91.
[32] Bertsch V, et al. Public acceptance and preferences related to renewable energy and grid expansion policy: empirical insights for Germany. Energy 2016;114:465–77.
[33] Dugstad A, et al. Acceptance of wind power development and exposure–Not-in-anybody's-backyard. Energy Pol 2020;147:111780.
[34] Energy Agency International. Norway 2017 review. In: Energy policies of IEA countries. Internationbal Energy Agency; 2017.
[35] Resources TNW, i Norge Elektrifiseringstiltak, NVE. In: Rapport NVE, editor. Hva er konsekvensene for kraftsystemet? Oslo: Norwegian Water Resources and Energy Directorate (NVE); 2020.
[36] Meld St. 28, Vindkraft på land. Endringer i konsesjonsbehandlingen, D.K.O.-o. Energidepartement, Editor. 2019-2020, det kongelige olje- og energidepartement: Oslo.
[37] Vasstrøm M, Lysgård HK. What shapes Norwegian wind power policy? Analysing the constructing forces of policymaking and emerging questions of energy justice. Energy Res Social Sci 2021;77:102089.
[38] Aasen, M., Klemetsen, Marit, Vatn, Arild, Folk og klima: utvikling i nordmenns oppfatninger om klimaendringer, klimapolitikk og eget ansvar 2018-2021, in *CICERO report*. 2022, CICERO: Oslo.
[39] COM. In: Commission E, editor. An EU strategy to harness the potential of offshore renewable energy for a climate neutral future. Brussels, Belgium: European Commission; 2020.
[40] European Commission. Clean energy for all Euoropeans. Luxembourg: Publications Office of the European Union, 2019; 2019.
[41] Johnston RJ, et al. Contemporary guidance for stated preference studies. J Assoc Environ Res Econ 2017;4(2):319–405.
[42] McFadden D. Conditional logit analysis of qualitative choice behavior. 1973.

[43] Bateman IJ, et al. *Economic valuation with stated preference techniques: a manual.* Economic valuation with stated preference techniques: a manual. 2002.
[44] Hevia-Koch P, Ladenburg J. Where should wind energy be located? A review of preferences and visualisation approaches for wind turbine locations. Energy Res Social Sci 2019;53:23–33.
[45] ChoiceMetrics Ngene 1. 2 user manual & reference guide. 2018.
[46] Mariel P, et al. Environmental valuation with discrete choice experiments: guidance on design, implementation and data analysis. Springer Nature; 2021.
[47] Ladenburg J. Attitudes towards offshore wind farms—the role of beach visits on attitude and demographic and attitude relations. Energy Pol 2010;38(3):1297–304.
[48] Lancaster KJ. A new approach to consumer theory. J Polit Econ 1966;74(2): 132–57.
[49] Adamowicz W, et al. Stated preference approaches for measuring passive use values: choice experiments and contingent valuation. Am J Agric Econ 1998;80(1): 64–75.
[50] Train K, Weeks M. Discrete choice models in preference space and willingness-to-pay space. In: Applications of simulation methods in environmental and resource economics. Springer; 2005. p. 1–16.
[51] Scarpa R, Thiene M, Train K. Utility in willingness to pay space: a tool to address confounding random scale effects in destination choice to the Alps. Am J Agric Econ 2008;90(4):994–1010.
[52] Hensher DA, Greene WH. The mixed logit model: the state of practice. Transportation 2003;30(2):133–76.
[53] Train KE. Discrete choice methods with simulation. Cambridge university press; 2009.
[54] Czajkowski M, Budziński W. Simulation error in maximum likelihood estimation of discrete choice models. Journal of choice modelling 2019;31:73–85.
[55] Hess S, Palma D. Apollo: a flexible, powerful and customisable freeware package for choice model estimation and application. Journal of choice modelling 2019;32: 100170.
[56] Krinsky I, Robb AL. On approximating the statistical properties of elasticities. Rev Econ Stat 1986:715–9.