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Nature is ours! – Psychological ownership and preferences for wind energy

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ABSTRACT

Psychological ownership (PO) is a phenomenon whereby individuals feel ownership of goods they do not necessarily formally own. A substantial body of literature in marketing, consumer psychology, and organizational sciences conceptualizes PO as value-enhancing and an underlying factor of the endowment effect. Recent psychological research has documented that people can also experience PO of environmental public goods and suggested that PO could generate land use conflicts and territorial behavior, which is particularly relevant for renewable energy development. Renewable energy represents a critical social issue with competing interests and policy objectives, often faced with severe public opposition. More research is needed on the underlying mechanisms of opposition to mitigate conflicts and increase efficiency in policy implementation. In this paper, we assess how PO influences people's economic choices and valuation of environmental effects from wind energy, illuminating psychological processes underlying decision-making. First, we provide a novel theoretical framework suggesting that PO increases people's valuation of environmental public goods and leads to resistance against their transformation due to weak substitutability between environmental protection and money income. We test these predictions in two discrete choice experiments on preferences for wind energy, where one examination is conducted from a local perspective and the other from a national perspective. The national experiment permits the analysis of spatial dimensions of PO and willingness to pay to avoid wind energy externalities. Using a hybrid mixed logit approach, we find consistent support for hypothesized effects in both experiments. Our scientific findings suggest that the PO phenomenon should be given more attention in public management of renewable energy development to overcome land use conflicts and territorial behavior.

1. Introduction

Ownership is typically understood as formal or legal rights or entitlements to objects. However, ownership is a multidimensional concept with legal and psychological components (Matilainen et al., 2017). The law protects the legal element of ownership, whereas the psychological part is recognized by individuals or communities (Pierce et al., 2001, 2003). With its origin in organizational psychology, psychological ownership (PO) is a construct that explains the psychological aspects of ownership (Pierce et al., 2003).

PO is a psychological state wherein people feel an object is *theirs*, even though they do not necessarily have formal or legal property rights (Bergstén et al., 2018; Matilainen et al., 2017; Preston and Gelman, 2020). The theory of PO suggests that when an individual feels PO over some object, the object becomes a part of the individual's self-identity (Pierce et al., 2003). PO has been predominantly studied in organizational sciences and consumer psychology.

PO is considered value-enhancing in consumer psychology, meaning consumers attach a higher value to goods when they experience PO (Bagga et al., 2019; Marzilli Ericson and Fuster, 2011; Morewedge, 2021; Morewedge and Giblin, 2015; Morewedge et al., 2021; Peck and Shu, 2009; Shu and Peck, 2011). The value-enhancing aspect of PO is an underlying key factor of the *endowment effect* (Peck and Shu, 2009; Shu and Peck, 2011). People who own a good tend to value it more than

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those who do not (Kahneman et al., 1990), leading to a disparity between willingness to accept (WTA) and willingness to pay (WTP) (Barberis, 2013; Brown, 2005; Sayman and Öncüler, 2005). In economic terms, PO then increases people's WTA compensation to give up a good they do not formally own (Morewedge and Giblin, 2015).

Recent research has documented that PO is not limited to market goods but can also extend to public goods, particularly environmental goods (Matilainen and Lähdesmäki, 2021; Preston and Gelman, 2020; Wang et al., 2022, 2023; Yim, 2021). PO is conceptualized as a driver of territorial behavior (Matilainen et al., 2017), where individuals seek to protect these public goods from perceived intruders. Correspondingly, PO can pose challenges in achieving policy objectives in public management. With the presence of PO, territorial behavior and conflicts between stakeholders with different perceptions of ownership, use rights, and economic values could emerge due to competing interests (Matilainen et al., 2017).

The role of PO in creating challenges in public goods management is particularly relevant in the context of renewable energy. For instance, wind energy presents a significant social dilemma involving global, national, and local priorities. Land-based wind energy is anticipated to be pivotal in decarbonizing the economy to mitigate climate change (IEA, 2022). Nonetheless, the escalating utilization of land from new wind energy projects exerts considerable pressure on environmental public goods, such as landscape aesthetics, biodiversity, and recreation services, thereby generating significant opposition from impacted communities (Devine-Wright, 2009; Grimsrud et al., 2023) (who feel PO for their environments), and inefficiency in policy implementation (Lindhjem et al., 2022). Therefore, understanding how PO can lead to conflicts in renewable energy development can contribute to developing more effective policies that mitigate land-use conflicts by balancing competing interests of local communities, national priorities, and national climate goals.

Arguably, deciding whether to permit new land-based wind energy projects means balancing competing interests and accounting for the nonmarket values of impacted environmental public goods. Therefore, in public management decisions of new wind energy projects, it is crucial to follow the overarching economic principle that all opportunity costs should be included, whether reflected in market transactions or hidden from the marketplace. Thus, to avoid further unsustainable environmental deterioration and sub-optimal decisions of wind energy development, these nonmarket environmental values should be measured using nonmarket valuation techniques, such as revealed and stated preference methods and incorporated into economic appraisal (Bateman and Mace, 2020; Champ et al., 2017).

This study extends the theoretical framework of PO for environmental goods by incorporating nonmarket environmental values and territorial behavior in economic decision-making. Our theoretical framework provides a better understanding of endowment effect mechanisms and territoriality for environmental public goods, where territoriality in economic decision-making implies a low degree of substitutability between environmental protection and money income (Rosenberger et al., 2003). Moreover, we test hypotheses derived from the theoretical framework on two separate stated discrete choice experiments (DCEs) from a local and national perspective, where the surveyed respondents choose between alternative wind energy expansions with differing environmental implications. We examine local and national perspectives to provide a more comprehensive and robust understanding of how PO forms wind energy preferences (Moon et al., 2023). We expect our hypotheses to be consistent across perspectives. The DCEs are analyzed using a hybrid mixed logit approach (Ben-Akiva et al., 2012).

DCEs are widely employed to capture nonmarket environmental values of renewable energy externalities (Aravena et al., 2014; Bartczak et al., 2017; Dugstad et al., 2020; Lutzeyer et al., 2018; Mattmann et al., 2016; Oehlmann et al., 2021; Oluoch et al., 2021), where surveys elicit people's WTP or WTA for incremental quality or quantity changes. One critique of this approach and economic analysis in general is the failure to recognize and evaluate the psychological complexities that drive economic choices (Costanza et al., 2017). Economic decisions are made based on preferences and constraints. However, as McFadden (2001) highlights, preferences are shaped by attitudes from affection and motivation, such as PO. Hence, this study contributes to understanding the psychological complexities that drive people's preferences for environmental goods and renewable energy development.

The paper is structured as follows. Section 2 describes and relates the PO theory to environmental goods and wind energy resistance to define our main hypotheses. Section 3 describes our methods, including the two DCE survey designs and estimation procedures. Results are presented in Section 4. Finally, Section 5 ends the paper with a discussion, conclusion, and implications for future research.

2. Extending the concept of psychological ownership to environmental public goods

Ownership is often associated with legal rights protected by the rule of law. However, PO is recognized by an individual (Pierce et al., 2001, 2003), alternatively, by a community. The individual feels an object is *mine*, meaning a sense of possession (Avey et al., 2009; Pierce et al., 2001, 2003; Van Dyne and Pierce, 2004). The object can refer to something tangible (e.g., an artwork) or intangible (e.g., ideas and knowledge) that becomes an "extended part of the self" (Pierce and Peck, 2018). PO can be extended to be collective (Paundra et al., 2017). The object becomes part of a *group's extended sense of itself*. The sense of an object being "mine" is replaced by *ours* (Pierce and Peck, 2018).

In general, PO emerges from three primary human motives (Pierce et al., 2001, 2003): (i) *having a place*, (ii) *efficacy* and *effectance*, and (iii) *self-identity*. The first motive relates to the need to have a sense of belonging. Efficacy and effectance are associated with the control of an object and the capability of controlling it. The last motive relates to how one perceives being viewed by others. Ownership can be important for individuals' self-identity, representing core values of individuality (Van Dyne and Pierce, 2004). Pierce and Jussila (2011) suggested adding a fourth need, (iv) *stimulation*. Humans seek arousal through ownership, which gives rise to stimulation. Stimulation motivates individuals to have, think about, and care for possessions (Jussila et al., 2015).

Pierce et al. (2001) described the process of acquiring object PO as having three interrelated pathways: 1) Controlling the object of ownership, 2) coming to know the object intimately, and 3) investing oneself in the object. The first pathway relates to using the object, where control can make it part of oneself or a community's identity (Csikszentmihalyi and Halton, 1981; Furby, 1978). The second pathway relates to acquiring information, familiarity, and knowledge about the object, leading to a deeper connection and stronger feelings of proprietorship. The third pathway relates to spending time and effort utilizing the object. With such behavioral investment, one identifies with the object and develops a sense of ownership. Once obtained, PO enhances the value of a defined object by becoming a part of oneself, contingent on the object being *good* rather than *bad* (Dickert et al., 2018; Morewedge et al., 2021).

Morewedge et al. (2021, p. 197) argue: "*Due to psychological ownership, traits associated with the self and positive self-associations are transferred to the good, increasing emotional attachment to the good and enhancing its perception and value.*" The endowment effect (Peck and Shu, 2009; Shu and Peck, 2011) is attributed to the value-enhancing aspect of PO, which implies that individuals tend to place a higher value on objects they own than those they do not (Kahneman et al., 1990). Notably, the effect of ownership on perceived value can be achieved even when ownership is not legally present or formally established.

While the value-enhancing aspect of PO has been demonstrated for market goods, e.g., Kirk and Swain (2015), it can also apply to nonmarket environmental public goods (Wang et al., 2022). People get PO through controlling an environmental good by direct use (e.g., harvesting natural resources such as berry picking) and indirect use (such as recreation). In turn, people develop better knowledge about the environmental good, creating a deeper and more intimate relationship between the self and the good. Incentives to protect and preserve the environmental good increase, and people are more willing to invest in its maintenance. The environmental good becomes a part of the self, enhancing its value. People with PO demand a higher value to give up (accept a transformation of) the environmental good because they value the feeling of losing the good as a part of the self.

Wind energy development generates negative externalities, including the deterioration of environmental goods for which people can have PO (Zerrahn, 2017). A large body of literature uses nonmarket valuation methods to elicit people's welfare loss of wind energy development (Mattmann et al., 2016). Several studies have shown that people are willing to pay to avoid the negative impacts of wind energy on environmental goods, or conversely, they demand compensation to accept these negative impacts (Brennan and Van Rensburg, 2016; Dugstad et al., 2020; García et al., 2016; Linnerud et al., 2022; Meyerhoff et al., 2010). As a result, we anticipate that people with a stronger feeling of PO for environmental goods put a higher value on accepting negative impacts on these environmental goods caused by wind energy development. This reasoning leads us to our first twofold hypothesis:

H1.1. *People demand compensation for negative transformations of environmental goods from wind energy.*

H1.2. *People experiencing PO of environmental goods exhibit a higher required compensation for negative transformations from wind energy.*

Another interesting aspect of PO is that it can evoke two main behavioral effects (Avey et al., 2009; Pierce et al., 2001). The first effect is to sacrifice self-interests to promote a community's well-being. The second effect is a sense of responsibility (Matilainen et al., 2017). When individuals have PO for an object, they feel responsible for protecting it through control, intimacy, and self-investment. A negative transformation proposed for the environmental good can trigger protective behavior due to the pre-existing incentives to protect it, but also through disruption of control and investment in the good. The protective behavior coincides with territoriality (Kirk et al., 2018) and can be a source of land use conflicts (Matilainen and Lähdesmäki, 2021).

Strong PO will manifest itself in preferences that imply low substitutability between environmental protection and money income. Consequently, WTA will be elevated and likely to exhibit modest sensitivity to the scope of environmental damage. In some cases, preference expressions could be consistent with (near) perfect complementarity between environmental goods and market goods (Amiran and Hagen, 2010) or weakly (modified) lexicographic preferences (Rosenberger et al., 2003). Such special but legitimate cases of preferences could go a long way in explaining high welfare estimates and low willingness to accept scenarios that trade off the PO-associated good with wind energy development and money income in stated preference research. This logic underpins our second hypothesis:

H2. *People who experience PO have a stronger tendency to reject negative transformations of environmental goods from wind energy systematically.*

The theoretical framework underpinning our two hypotheses is presented in Fig. 1. The following section explains how we explore PO and test our main hypotheses through carefully designed and implemented DCE surveys.

3. Data and methods

3.1. Discrete choice experiments

We use data from two DCEs on preferences for wind energy and associated impacts on natural areas to test the hypotheses described in Section 2. Experiment 1 is a local DCE on preferences for a site-specific, locally-proposed wind farm in Norway. The survey design is explained in more detail in Section 3.1.1. Experiment 2 is a national DCE on preferences for land-based wind energy development in multiple areas of Norway. The survey design is explained in more detail in Section 3.1.2.

3.1.1. Experiment 1 – local preferences for wind energy

In 2018, a proposal to establish a local wind farm in the rural area of Setskog was submitted to the Norwegian Water Resource and Energy Directorate (NVE), which serves as the official licensing authority in Norway. The licensing process is currently on hold. Setskog is a rural area in the municipality of Aurskog-Høland in South-Eastern Norway with around 17 thousand households, only an hour's drive from Norway's capital city of Oslo.

With the location in a natural area, the planning area for the wind farm was estimated to be around 3.2 km^2. The developer assumed that roughly ten wind turbines could be installed, with a height of up to 250 m. The wind farm would require upgrading power lines (from 22 kV to 47 kV) from the planning area to the main transformer in Bjørkelangen (about 10–15 km corridor). Depending on size, the wind farm would negatively impact recreational services, tourism, landscape aesthetics, and biodiversity.

We conducted a DCE to assess how residents in the municipality value the landscape impacts of the proposed wind farm. The described effects and DCE design were defined to be consistent with the developer's application for concession; see also Dugstad et al. (2023).

In the survey, we first asked respondents some general warm-up questions. Then, we introduced a consequentiality statement explaining i) the topic survey, ii) that the survey was on behalf of researchers from our respective research institutes, and iii) that the results from the survey might influence decision-making. The statement was included to strengthen consequentiality, in line with the current best SP guidance (Johnston et al., 2017; Vossler and Watson, 2013).

Text and a map were used to describe the proposed wind farm. The map displayed forests, wetlands, creeks, and settlements and indicated the potential site and size of the wind farm (see Fig. A.1 in Appendix A). Subsequently, the DCE part was introduced to the respondents,

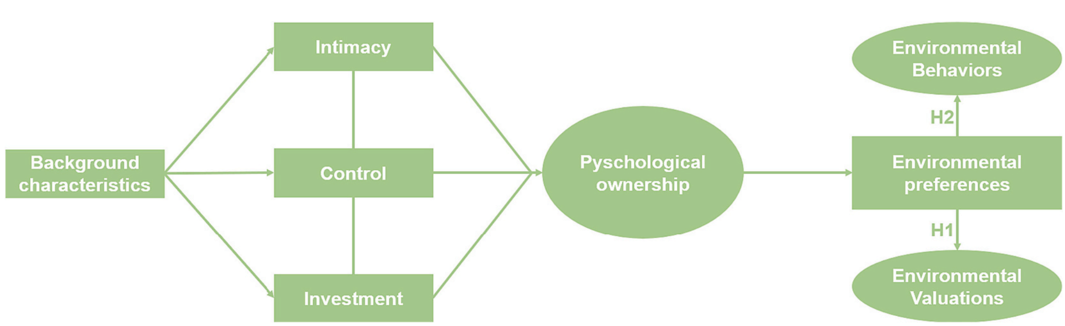

Fig. 1. Summary of the theoretical framework of PO for environmental public goods and its influence on preferences, valuations, and behaviors.

informing them that they would be asked to choose between different wind farm construction plans distinguished by four explicit attributes with financial implications. The attributes and their levels were defined to correspond with the developer's proposal. We also reviewed the SP literature on wind energy externalities (Dugstad et al., 2020; García et al., 2016) and followed SP guidelines (Johnston et al., 2017; Mariel et al., 2021) in developing the DCE design. Two local focus group meetings with one-to-one interviews were held to assess the relevance and quality of the DCE design.

The attributes and their respective levels are displayed in Table 1. The attributes were presented in writing, accompanied by illustrations and photos before the choice tasks. The number of turbines attribute represents a bundle of landscape impacts described to respondents, including area transformation, construction of new roads (approximately 700 m per turbine), and reduced recreational quality.

The power line attribute represents the landscape changes of upgrading and installing power lines. Without considering the need for underground power lines between the wind turbines, the proposed wind farm would require upgrading 15 km of overhead power lines, transecting both natural and residential areas. These could be replaced by more extensive overhead power lines, underground power lines, or a combination. As shown in Table 1, this attribute takes four levels.

Given the number of turbines, the height attribute represents changes in visual impacts from taller turbines. The developer proposed a height range of 150 to 250 m above the ground. Consequently, we informed the respondents that the wind turbines could be visible from a distance of 40 km. Two visibility maps were shown to the respondents with wind turbines 150 m and 250 m tall.

The monetary attribute is defined as reductions in annual municipal taxes. The respondents were told that the increased revenues from the wind farm to the municipality would compensate for the negative landscape impacts. The monetary attribute is non-voluntary and directly linked to the changes described in the DCE (Johnston et al., 2017).

The political administration in the municipality has organized several public meetings to discuss and vote on the wind farm proposal. In general, permission to build and operate a wind farm is rarely granted in a municipality if the residents and the political administration explicitly do not welcome it. Thus, giving the residents the implied property rights of an undisturbed natural environment seemed sensible. Nonetheless, *WTP to avoid* and *WTA to get* frameworks were tested to compare the designs.[1] However, the WTP version had to be withdrawn immediately after the initial fielding because multiple recruited subjects protested and complained against the idea that the property right was with the developer.[2] The occurrence of negative behavior could be interpreted as an early indication of residents in the municipality experiencing a sense of PO towards the natural area, which in turn may trigger territorial behavior in a local setting. This observation highlights the potential of PO to define implied property rights in SP research specific to the location.

Table 1
Attributes and levels.

Attribute	Levels
Turbines	0 (Status quo)
	2
	4
	6
	8
	10
	12
Turbine height	No construction (Status quo)
	150
	200
	250
Power line	No construction (Status quo)
	Overhead lines in forests and residential areas
	Underground lines in forests and residential areas
	Overhead power lines in forests, underground power lines in residential areas
	Underground power lines in forests, overhead power lines in residential areas
Reduction in annual municipal taxes	No changes (Status quo)
	500 NOK (USD 50)
	1000 NOK (USD 100)
	2000 NOK (USD 200)
	4000 NOK (USD 400)

Note: USD 1 ≈ NOK 10 PPP adjusted.

Each choice card had three alternatives, the first being the status quo situation with no wind farm. In this scenario, the municipality would not get increased tax revenues from the wind farm. Hence, the reduction in annual municipal taxes was set to zero. Furthermore, the respondents were informed that the natural area would remain unchanged with this option. The second and third alternatives described different wind farm development plans associated with lower municipal taxes (a 5 to 30% rebate on an average payment in annual municipal taxes).

In total, 24 choice cards were generated using 4 blocks of 6 choice cards each. A D-efficient design was used with very small non-zero priors with signs indicating the expected directions of the coefficients (ChoiceMetrics, 2021; Scarpa and Rose, 2008).[3] The signs for the different attribute preference coefficients were based on previous research, such as a negative sign for the number of turbines (Dugstad et al., 2020; García et al., 2016; Meyerhoff et al., 2010), higher turbines (Brennan and Van Rensburg, 2016; Dimitropoulos and Kontoleon, 2009), overhead power lines and combinations of overhead and underground power lines instead of underground power lines solely (Zawojska et al., 2019). As we have a WTA format, the cost coefficient had a positive sign in line with increasing utility of money (Bishop and Boyle, 2019).

Following the DCE part, the respondents were presented with three statements that collectively defined the construct of *collective* PO towards the natural area affected by the wind farm: 1) *The natural areas affected by the wind farm are ours*; 2) *I feel that the natural areas that will be affected by the wind farm belong to us;* 3) *I sense that the natural areas affected by the wind farm are ours*. The statements were adopted from a pioneer study within organization research by Van Dyne and Pierce (2004), who used them to study organizational behavior (see Table A.1 in Appendix for original statements). We rephrased the statements to make them fit our research focus. Specifically, "the organization" was replaced with "the natural area affected by the wind farm." Each statement was measured on a seven-point Likert scale (*1 = strongly disagree; 7 = strongly agree*). Since this study is the first to quantitatively assess how PO affects preferences for changes in natural areas, we carefully tested statements for individual and collective PO in two focus groups. We found collective PO more relevant based on this testing, mainly because the unique Norwegian law of *Allemannsretten* protects and guarantees public access to natural areas in Norway. Due to this law, the residents felt they owned the natural area together, not individually. The last part of the survey included a series of questions gathering the

[1] The status quo option in the WTP version of this survey was defined as having 12 wind turbines with a height of 250 m and the use of overhead power lines solely. Changes in municipal taxes was set to zero in this option. The respondents could then choose less expansive construction plans with less impact on the environment, conditional on increments in municipal taxes to compensate for the loss of necessary revenues to the municipality.

[2] Both versions were tested successfully in two focus-group meetings with no complaints.

[3] Given our local context, we did not extract priors from the pilot for the d-efficient design because we needed to field the survey efficiently to avoid the potential situation where respondents interacted and discussed the survey, which could influence responses. As recommended by Choice Metrics (2021) in situations with limited information about priors, we instead used a d-efficient design with very small priors close to zero and expected signs for the preference coefficients, which is favored over an orthogonal design because of better precision of estimates.

socioeconomic and demographic characteristics of the respondents. Fig. A.2 in Appendix A shows an example choice card for Experiment 1.

3.1.2. Experiment 2 – national preferences for wind energy

Experiment 2 aimed to assess public support for expanding renewable energy production in Norway, specifically focusing on land-based wind energy. The design of the DCE survey (including its attributes, levels, and described effects) was based on previous DCE surveys examining preferences for wind energy in Norway (Dugstad et al., 2023; García et al., 2016; Linnerud et al., 2022), a thorough literature review, stated preference guides (Johnston et al., 2017; Mariel et al., 2021), pilot tests, and focus group meetings. Specifically, the experiment was developed based on Dugstad et al. (2020), where a large DCE pilot was fielded to elicit preferences for wind energy and other renewable energy sources in two different regions in Norway. In contrast to Dugstad et al. (2020), Experiment 2 was embedded in a nationally representative survey. A pilot survey for Experiment 2 with 460 respondents was fielded in January 2022 to evaluate the design and to extract priors to generate a D-efficient design.

Design modifications were implemented to align it with the policy landscape at the time of conducting Experiment 2, prioritizing consequentiality by developing realistic policy scenarios with carefully explained attributes and information consistent with the Norwegian Water Resources and Energy Directorate's (NVE) predictions for the Norwegian power market from 2021 to 2040 (NVE, 2021). As in Experiment 1, Experiment 2 also used a credible and binding payment vehicle.

The DCE design for Experiment 2 comprised three attributes: i) increased renewable energy from all sources (excluding further land-based wind energy), ii) further increase in renewable energy from land-based wind energy, and iii) increased grid fees the next five years to fund an upgrade of the electrical grid system. Attributes and levels are defined in Table 2. Each choice scenario had two alternatives. Alternative 1 represented a scenario without further land-based wind energy development, with the turbine attribute constrained to zero (similar to the status quo option in Experiment 1). Alternative 2, in contrast, allowed for more land-based wind energy development to further increase the total renewable energy production. This approach generated the most realistic scenarios for the Norwegian power market from 2021 to 2040 (NVE, 2021) because NVE did not consider land-based wind energy a critical technology for increasing renewable energy production because of strong public resistance; see Lindhjem et al. (2022) for further discussion. NVE (2021) argued that increased renewable energy from land-based wind energy had to be politically determined after a framework plan for land-based wind energy development introduced by NVE in 2019 was shelved due to strong public opposition. Alternative 1 thus represented a status quo scenario that reflected uncertain and variable projections for renewable energy development.

Table 2
Attributes and levels in the DCE.

Attribute	Levels
TWh renewable electricity (except land-based wind energy)	10 (baseline)
	20
	30
	40
Turbines	0 (Baseline)
	700 (10 TWh)
	1400 (20 TWh)
	2100 (30 TWh)
The area devoted to new land-based wind energy	0
	294 km^2
	588 km^2
	882 km^2
Reductions in CO_2 emissions from new wind turbines (per year)	0
	5 million tons
	10 million tons
	15 million tons
Value creation from new wind turbines (per year in NOK) and FTE employment	0
	6.3 billion, 5600 FTE employment
	12.6 billion, 11,200 FTE employment
	19.9 billion, 16,800 FTE employment
Fee increase to finance an upgrade of the electrical grid system over the next five years	From NOK 1000 to 8000 per year with an interval of NOK 1000

Note 1 USD = NOK 9.5 PPP-adjusted.

The survey was structured first to elicit the respondents' perceptions of the most important public services and preferred renewable energy sources for increasing total electricity production in Norway. The respondents were informed that survey results could influence the authorities' decisions on future wind energy concessions and developments, making their personal opinions critical. This information was included to enhance survey consequentiality. The attributes were carefully explained, accompanied by objective information and visualizations. The TWh attribute description gave respondents information about current electricity production in Norway, the primary renewable energy sources used for electricity production, and a comprehensive list of relevant and realistic electricity sources to increase Norway's electricity production until 2040.

The wind turbine attribute provided information on the current level of wind energy production in Norway, the potential environmental impacts of wind turbines, and the spatial distribution of existing wind energy sites, illustrated on a map sourced from NVE's website. Respondents were also informed that decision-makers were evaluating whether to develop more land-based wind energy, which could increase the total electricity production from all renewable energy sources by 10–30 TWh, with 30 TWh requiring approximately 2100 new wind turbines, given current technology.

In 2019, NVE (2019) identified 13 geographical areas as most suitable for land-based wind energy distributed throughout Norway's Western/Southern, Northern, and Central regions, primarily encompassing natural areas. A map from NVE's website illustrated these areas to the respondents (see Fig. A.3 in Appendix A). Respondents were informed that new wind energy sites would be evenly distributed across these areas.

Notably, the wind turbine attribute is bundled with highly correlated critical spillover effects significant for people's perception of wind energy (Batel, 2020). The survey provided information about the average level of three critical attribute sub-dimensions corresponding to a typical land-based wind turbine in Norway. The three attribute sub-dimensions per new wind turbine that were described included: i) an area of 0.42 km^2 seized, ii) a reduction of 7150 tons CO2 emissions by replacing fossil fuels in Europe, and iii) 9 million NOK in value creation and eight full-time equivalents (FTE) employment. We extracted and calculated the level of these effects from NVE's information center,[4] which has been developed to provide easily accessible information about wind energy impacts for concession applications. In the choice tasks, the respondents were given information on the levels of the attribute sub-dimensions, along with the corresponding level of the wind turbine attribute.[5] The wind turbine attribute and its attribute sub-dimensions were framed as perfectly correlated by design.

As both the TWh and wind turbine attributes represent a significant increase in renewable energy production, the monetary attribute was presented as an increase in households' grid fees for the next five years, aimed at financing an upgrade of the electrical grid system to meet the

[4] https://www.nve.no/energi/energisystem/vindkraft/

[5] Experimental variations were introduced related to information about these external effects on the choice cards. As the experimental variations are not relevant to the research focus of this manuscript and therefore do not significantly impact our overall findings, we have not included a discussion of these experimental variations in this manuscript. However, a detailed description is provided in Appendix B.

increased production. The cost attribute was set to range from NOK 1000 to NOK 8000 per year based on results from the pilot. In the pilot, the cost attribute ranged from NOK 1000 to NOK 5400. However, small differences in fee amounts across scenarios combined with strong opposition against land-based wind energy resulted in a significant share of respondents who consistently chose Alternative 1. To reduce this share and to be able to capture people's trade-offs better, we decided to increase the range of amounts and have higher cost attribute levels in the main survey.

Following the DCE part, the respondents were presented with four collective PO statements framed around natural areas in Norway in general. Specifically, in addition to the similar versions of the three statements from Experiment 1, the following statement was added: *We own the natural areas*. For Experiment 2, we used a simplified five-point Likert scale to capture the scale's discrete nature. Finally, as in Experiment 1, the survey concluded with a series of questions aimed at gathering the socioeconomic and demographic characteristics of the respondents. An example choice card for Experiment 2 is presented in Fig. A.4 in Appendix A.

3.2. Modeling approach

The random utility model (McFadden, 1973) is the fundamental theoretical framework for the DCE method. The mixed logit model (Train, 2009) is typically used in the econometric analysis of DCE data. The mixed logit model accounts for unobserved heterogeneity in estimated parameters, facilitates multiple observations, and relaxes the IIA property. As such, it is more flexible than the standard fixed parameter conditional logit approach. The unobserved heterogeneity follows a specified statistical distribution across the population. To better understand drivers of unobserved heterogeneity, hybrid choice models (Ben-Akiva et al., 2012; Ben-Akiva et al., 2002) have been developed (also known as integrated latent variable models). Hybrid choice models allow the researcher to integrate latent (psychological) variables in the discrete choice model to explain heterogeneity in preferences in a statistically simultaneous or sequential approach (Czajkowski et al., 2017a, 2017b; Mariel et al., 2021).

The hybrid choice model integrates a discrete choice model (e.g., a mixed logit model), a confirmatory factor analysis to determine a specified latent variable, and a structural component for the latent variable in the estimation. In the structural component, the latent variable is specified to depend on a set of observable explanatory variables, such as socioeconomic characteristics. The discrete choice model includes the latent variable through interaction effects to explain preference heterogeneity and test hypotheses. If the discrete choice model is specified as a mixed logit, the hybrid choice model is referred to as a hybrid mixed logit (HMXL) model.

Several recent studies from the transportation literature and environmental economics have used this econometric framework, e.g., Krucien et al. (2017) and Aanesen et al. (2023). Mariel and Meyerhoff (2016) address the advantages and disadvantages of hybrid choice models. The main advantage of estimating hybrid choice models is that one can directly incorporate latent variables in the discrete choice model to assess their significance on preferences. Hybrid choice models improve our psychological understanding of preference heterogeneity. Furthermore, the simultaneous approach yields higher statistical efficiency than a sequential approach (Hess et al., 2012). However, the cost of estimating hybrid choice models in terms of time, computational power, and complexity is significantly higher than the more established models, such as the mixed logit model and the sequential hybrid choice modeling approach.

Our hybrid choice model has three components: the discrete choice component, the measurement component, and the structural model. Fig. 2 represents a visualization of our hybrid choice model (based on the conceptual model in Fig. 1). Say that respondents answered a sequence of T choice scenarios, each with J different alternatives, in a DCE. Respondent i's utility from alternative $j \in J$ in choice situation $t \in T$ can, in general terms, be expressed as:

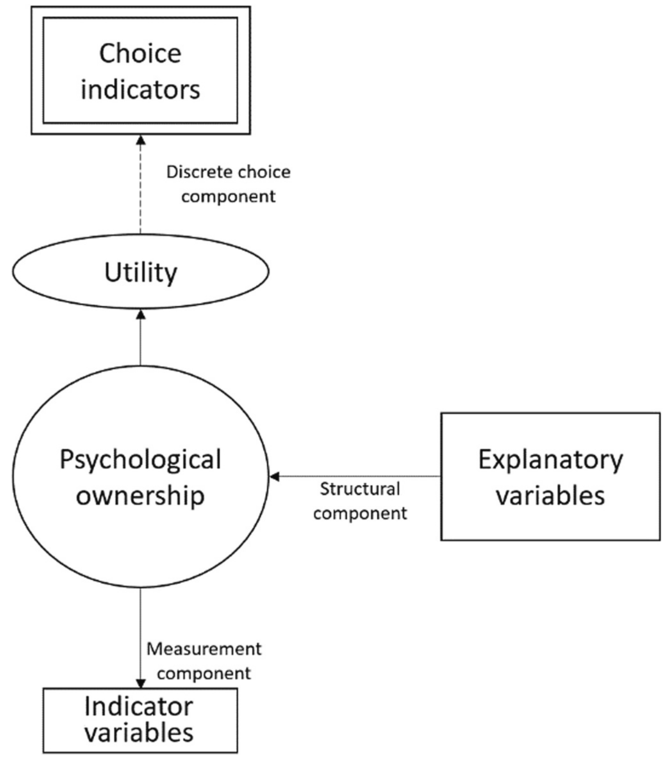

Fig. 2. Hybrid choice model. Modified after Ben-Akiva et al. (2002).

$$U_{ijt} = \sigma \alpha_i c_{ijt} + \sigma \boldsymbol{b}_i \mathbf{x}_{ijt} + \varepsilon_{ijt}, \tag{1}$$

where c_{ijt} is the monetary attribute, α_i is the individual-specific cost preference parameter, and $\mathbf{x}_{ijt}$ is a vector of non-monetary attributes with $\boldsymbol{b}_i$ as corresponding preference weights. The last term (ε_{ijt}) is the error term, representing unobserved factors influencing the individual's choices. The error term is assumed to be a Type I extreme value distributed with a constant variance of $\pi^2/6$. The scale parameter is defined by σ.

The specification in Eq. (1) estimates the model in preference space, where there is no direct interpretation of $\sigma\alpha_i$ and $\sigma\boldsymbol{b}_i$. However, the ratio $\sigma\boldsymbol{b}_i/\sigma\alpha_i$ defines the marginal rate of substitution between the non-monetary and monetary attributes and can be interpreted as marginal welfare estimates in monetary terms, as σ cancels out. As we are interested in the marginal rates of substitution, it is more convenient to define the utility function in WTP space instead:

$$U_{ijt} = \sigma \alpha_i \left[c_{ijt} + \boldsymbol{b}_i \mathbf{x}_{ijt} \right] + \varepsilon_{ijt} = \lambda_i \left[c_{ijt} + \boldsymbol{\beta}_i \mathbf{x}_{ijt} \right] + \varepsilon_{ijt}. \tag{2}$$

In this utility specification, $\boldsymbol{\beta}_i = \boldsymbol{b}_i/\alpha_i$, allowing the estimated parameters to be directly interpreted as marginal welfare estimates (WTP/WTA) for the non-monetary attributes (Train and Weeks, 2005).

The parameters $\boldsymbol{\beta}_i$ are assumed to be normally distributed (Train and Weeks, 2005) and specified to depend on the latent construct of PO, denoted as LV_i, which gives us the following specification for $\boldsymbol{\beta}_i$:

$$\boldsymbol{\beta}_i = \boldsymbol{\Lambda} \cdot \mathrm{LV}_i + \boldsymbol{\beta}_i^* \tag{3}$$

where $\boldsymbol{\Lambda}$ is a matrix of interaction coefficients to be estimated and $\boldsymbol{\beta}_i^*$ is a vector of means and a covariance matrix to be estimated that follows a multivariate normal distribution. The term λ_i in Eq. (2) is specified to follow a log-normal distribution, which gives us the following specification $\lambda_i = exp(\lambda_i^*)$, where λ_i^* follows a normal distribution with parameters for its mean and standard deviation. Our model specifies correlations between all preference parameters following a multivariate normal distribution. We assume a normal distribution of preferences for the non-monetary attributes to consider that people can experience utility or disutility with these attributes. The preference weight on the cost attribute is assumed to follow a log-normal distribution, constraining people to have a negative preference parameter for increments in the payment vehicle. Our specification follows recommendations in the literature (Daly et al., 2012; Mariel et al., 2021).

We can then specify the conditional probability of respondent i from the sequence of choices $\mathbf{y}_i$ in all choice scenarios T_i:

$$P\left(\mathbf{y}_i|\mathbf{x}_i, \boldsymbol{\beta}_i^*, \lambda_i^*, \mathrm{LV}_i, \boldsymbol{\Lambda}\right) = \prod_{t=1}^{T_i} \frac{exp\left(\lambda_i\left[c_{ijt} + \mathbf{x}_{ijt}\boldsymbol{\beta}_i\right]\right)}{\sum_{k=1}^{C} exp\left(\lambda_i\left[c_{ikt} + \mathbf{x}_{ikt}\boldsymbol{\beta}_i\right]\right)}. \tag{4}$$

The measurement component is defined by a vector of equations for which the indicator variables $\mathbf{I}_i$ (see Fig. 2) are dependent variables based on respondents' attitudes towards PO.

$$\mathbf{I}_i = \boldsymbol{\Gamma} \cdot \mathrm{LV}_i + \boldsymbol{\eta}_i. \tag{5}$$

In Eq. (4), $\boldsymbol{\Gamma}$ is a vector of factor loadings and $\boldsymbol{\eta}_i$ is a vector of normally distributed error terms with a mean of zero and an identity covariance matrix. The measurement component is estimated using ordered logit regressions.

The latent variable depends on some defined explanatory variables, denoted as $\mathbf{x}_i^{ex}$, which represent the structural model component:

$$\mathrm{LV}_i = \mathbf{x}_i^{ex}\boldsymbol{\psi} + \boldsymbol{\xi}_i\ , \tag{6}$$

where $\boldsymbol{\psi}$ is a vector of coefficients relating $\mathbf{x}_i^{ex}$ to the latent variable and $\boldsymbol{\xi}_i$ are error terms with a multivariate normal distribution. Our model specifies the latent variable of collective PO to depend on socioeconomic characteristics and levels of proximity to the closest future potential wind energy area.

Model identification is achieved by normalizing the variance of the latent variable**.** The total likelihood function of the simultaneous HMXL model is:

$$LL_i = \sum_{i=1}^{N} ln \int P\left(\mathbf{y}_i|\mathbf{x}_i, \mathbf{x}_i^{str}, \boldsymbol{\beta}_i^*, \lambda_i^*, \boldsymbol{\Lambda}, \boldsymbol{\Gamma}, \boldsymbol{\sigma I}, \boldsymbol{\psi}\right)$$
$$P\left(\mathbf{I}_i|\mathbf{x}_i^{str}, \boldsymbol{\xi}_i^*, \boldsymbol{\Lambda}, \boldsymbol{\Gamma}, \boldsymbol{\psi}, \boldsymbol{\sigma I}\right) f\left(\lambda_i^*, \boldsymbol{\beta}_i^*, \boldsymbol{\xi}_i^*\right) d\left(\lambda_i^*, \boldsymbol{\beta}_i^*, \boldsymbol{\xi}_i^*\right). \tag{7}$$

This integral must be solved numerically using a simulated maximum likelihood approach (Train, 2009). The simulated log-likelihood function is maximized using 2000 Sobol draws, which is recommended based on a large simulation exercise testing different simulation approaches by Czajkowski and Budziński (2019). The Apollo package (v0.2.8) in R[6] (Hess and Palma, 2019) is employed to estimate separate HMXL models for Experiment 1 and Experiment 2, respectively.[7]

Overall, in the model specification, we use the lowest possible impact on the natural areas as the baseline levels for the categorical attributes for Experiments 1 and 2. Further, to test **H1.2**, we interact the latent variable of PO with each non-monetary attribute (as defined above). To test **H2,** we run a logistic regression for each experiment using generalized structural equation modeling. The dependent variable takes the value one if the respondents always chose the alternative without wind energy and zero otherwise. We define PO as an independent variable, along with socioeconomic characteristics and proximity.

3.3. Data and sampling

For Experiment 1, we conducted the DCE as part of an online survey in March 2020, with the professional survey company Norstat recruiting respondents on our behalf using random sampling. The response rate was 34%, resulting in a final sample of 308 respondents drawn from a population of 17,000 in the municipality of Aurskog-Høland. Given the local geographic scope of our study, a modest sample size was expected. Each respondent answered six choice cards, resulting in 1848 observations. We determined the sample size to be consistent with other empirical studies that use the same survey method and econometric approach (Czajkowski et al., 2017a; Hess et al., 2012; Hoyos et al., 2015; Potoglou et al., 2015). Our sample was overrepresented by male respondents, individuals with university education, and higher income compared to the population of Aurskog-Høland.

Experiment 2 was conducted in April 2022 using TNS Kantar's panel of 40,000 individuals who have agreed to participate in various surveys. We aimed to target Norwegian households and recruited 3412 complete responses based on a previous national SP study (Aanesen et al., 2023) and the recommended sample size for our d-efficient design with priors. The survey was administered as an online internet survey by TNS Kantar, utilizing random sampling to draw a representative sample of the Norwegian population. The response rate was 31%. Individuals below 30 and above 60 were somewhat underrepresented, while highly educated individuals were overrepresented.

Table 3 presents descriptive statistics for the explanatory variables included in the structural component of PO for both Experiment 1 and Experiment 2. The explanatory variables capture socioeconomic characteristics and proximity to potential wind energy sites. In both experiments, we used a similar set of explanatory variables. Specifically, we included variables for age, gender, income, education, and distance to the wind energy sites. For Experiment 1, proximity was measured as dummy variables indicating how close respondents live (in a direct line) to the planned wind farm in Setskog, with the proximity of 12 to 15 km as the reference category. For Experiment 2, proximity was measured by a continuous and normalized variable of how close the respondents lived to the closest area of the 13 geographical areas NVE identified as most suitable for future land-based wind energy development.

4. Results

Before estimating the HMXL models, we evaluated the reliability of the indicator variables for PO elicited in the two DCE surveys. Reliability in this context refers to whether the indicators are statistically related. First, we observed that the correlations between pairs of indicator variables ranged from 0.67 to 0.89 in both experiments. These correlations indicate that the variables are highly but not perfectly correlated. Second, the composite reliability score was estimated to be 0.94 in Experiment 1 and 0.96 in Experiment 2, demonstrating high internal consistency.[8] Hence, we can confidently use the indicator variables in our measurement models for both experiments. Furthermore, the mean of the indicators ranges from 4.6 to 5 on a seven-point Likert scale for Experiment 1 and from 4 to 4.2 on a five-point Likert scale for Experiment 2 (as presented in Table 3), which suggests that individuals have a strong collective PO for natural areas, both locally and nationally.

[6] Our HMXL codes are provided in Appendix C, along with a description of how we obtained starting values.

[7] For Experiment 1, we used the sequential approach to estimate the explained HMXL. This approach involves estimating a confirmatory factor analysis for PO that depends on the defined explanatory variables and predicting individual-specific factor scores. These predicted PO scores are then used as an interaction variable in a mixed logit model estimated in WTA/WTP-space. We have selected the sequential estimation procedure for Experiment 1 due to the relatively modest sample size. For robustness checks, we also tested a sequential approach for Experiment 2, where the results are directly comparable to the estimated HMXL for Experiment 2 in this paper. The results from this sequential approach are presented in Table D.1 in Appendix D.

[8] The composite reliability score is, as the Cronbach Alpha, a measure of internal consistency, i.e., whether the indicator variables are statistically related. The composite reliability was calculated by estimating a confirmatory factor analysis for PO for each experiment as a pre-analysis. The confirmatory factor analysis was further estimated to evaluate validity of PO, where the results demonstrate strong validity. Detailed results are available in Appendix E.

Table 3
Summary statistics of explanatory variables entering the models.

Variable name	Description	Mean	SD	Obs.
Experiment 1				
age3039	=1 if the respondent's age is between 30 and 39, 0 otherwise	0.140	0.347	308
age4049	=1 if the respondent's age is between 39 and 49, 0 otherwise	0.192	0.394	308
age50more	=1 if the respondent's age is 50 or above, 0 otherwise	0.565	0.496	308
female	=1 if gender is female	0.416	0.494	308
university	=1 has a university education of 3 years or more	0.451	0.498	308
median_inc	=1 if household income is above the median income	0.409	0.492	308
closedist	=1 if the respondent resides 10 km or closer to the planned wind farm	0.289	0.453	308
longdist	=1 if the respondent resides 15 km or more to the planned wind farm	0.497	0.500	308
po1	Seven-point Likert scale statement: "The natural areas affected by the wind farm are ours."	4.994	1.897	308
po2	Seven-point Likert scale statement: "I feel that the natural areas that will be affected by the wind farm belong to us."	5.010	1.869	308
po3	Seven-point Likert scale statement: "I sense that the natural areas affected by the wind farm are ours."	4.578	2.019	308
Experiment 2				
age3039	=1 if the respondent's age is between 30 and 39	0.181	0.385	3412
age4049	=1 if the respondent's age is between 39 and 49	0.169	0.375	3412
age50more	=1 if the respondent's age is 50 or above	0.496	0.500	3412
male	=1 if gender is male	0.501	0.500	3412
university	=1 has a university education of 3 years or more	0.464	0.499	3412
median_inc	=1 if household income is above the median income	0.552	0.497	3412
closedist	= distance in km to the closest proposed wind farm area (standardized)	0.000	1	3412
number_areas	= number of areas suitable for wind energy in the respondents' County	0.794	1.019	3412
po1	Five-point Likert scale statement: "Natural areas are ours."	4.195	0.962	3412
po2	Five-point Likert scale statement: "I feel that natural areas belong to us."	4.162	0.991	3412
po3	Five-point Likert scale statement: "I sense that natural areas are ours."	4.034	1.098	3412
po4	Five-point Likert scale statement: "We own the natural areas."	4.112	1.015	3412

Note: Age between 18 and 29 is kept as the baseline. A small share of below 3% answered "don't know" to the PO statements in Experiment 2. The mean imputation of the PO statements was used for these respondents to have complete observations.

Table 4
Discrete choice components of the sequential HMXL model for Experiment 1.

Discrete choice component	Main effects	PO Interactions	Standard deviations
Status quo	15,185.900*** (508.119)	25,641.190*** (363.781)	48,286.590*** (769.403)
Number of turbines	−276.200*** (27.187)	−135.890*** (10.677)	277.740*** (3.734)
Height of turbines: 200 m	−674.620*** (243.038)	−424.810*** (71.244)	1405.240*** (82.207)
Height of turbines: 250 m	−654.670*** (221.884)	−595.220*** (104.341)	39.910 (55.474)
Overhead lines	−5052.460*** (298.143)	−1725.880*** (91.609)	2127.790*** (43.900)
Overhead lines forest, underground lines residential areas	−2917.920*** (265.781)	−51.690 (70.240)	1696.360*** (22.975)
Underground lines forest, Overhead lines residential areas	−1810.010*** (243.744)	−544.140*** (60.400)	411.840*** (21.340)
Municipal taxes/100	−1.737*** (0.414)		2.168*** (0.272)
Structural component			
age3039	0.151 (0.189)		
age4049	0.086 (0.170)		
age50more	0.369** (0.132)		
female	−0.189 (0.115)		
university	−0.277* (0.120)		
median_inc	−0.031 (0.118)		
closedist	−0.135 (0.157)		
longdist	0.003 (0.140)		
Measurement component			
Psychological Ownership Indicator 1	0.832*** (0.045)		
Psychological Ownership Indicator 2	0.950*** (0.045)		
Psychological Ownership Indicator 3	0.877*** (0.043)		
Discrete choice experiment log-likelihood	−783.290		
Adj. Pseudo R-square	0.589		
AIC Discrete choice experiment	1668.570		
BIC Discrete choice experiment	1950.190		
Observations	1848		

Notes: *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$. Standard errors (SE) are in brackets. Coefficients are displayed in NOK, with 1 USD = NOK 9.5 (PPP- adjusted).

4.1. PO and local preferences for wind energy

Table 4 displays the sequential HMXL model for Experiment 1. We can interpret the main effects in Table 3 as the annual sample mean WTA compensation values for the attributes and their levels. Each WTA parameter is significant. The mean WTA per additional wind turbine is NOK 276 per year. The attribute's standard deviation is significant, indicating the sample has heterogeneous preferences for turbines. The average required compensation in the sample for accepting 200- or 250-m tall turbines instead of 150-m ones is NOK 670–650 (per year). The results support **H1.1**.

On average, the sample prefers underground power lines instead of overhead and combinations of overhead and underground power lines. If the upgraded power lines are overhead instead of underground, the sample requires an average compensation of NOK 5053 per year. The mean WTA is also significant for the other underground and overhead power line combinations. It is clear from the WTA estimates that using solely overhead power lines is the least preferred transmission option if the wind farm were to be built. The status quo coefficient is sizable and significant, showing that the sample respondents, on average, prefer the status quo situation with no wind farm.

The interaction terms between the construct of PO and the non-monetary attributes are significant. The interaction terms have the expected signs, and the results suggest that PO increases compensation demanded for accepting the environmental impacts of the wind farm, supporting **H1.2**. The construct of PO was normalized to have a unit standard deviation and a mean of zero. Thus, the interaction terms can be interpreted as changes in the sample mean WTA when the PO changes by one standard deviation. Specifically, the mean WTA per turbine increases by NOK 136 for a one standard deviation increase in PO. Further, the mean WTA for 250-m tall turbines increases by NOK 595, while the mean WTA for overhead power lines increases by NOK 1726. The interaction term between the status quo option and PO is also significant, suggesting that a stronger PO increases the likelihood of choosing this option. The finding, to some degree, supports **H2**.

From the HMXL model, we can calculate the overall WTA for wind energy scenarios over different levels of PO. To illustrate, if we assume that the wind farm consists of ten 250-m tall wind turbines and the developer uses underground cables, the scenario-specific mean WTA for the overall sample is NOK 3415 per year. If PO increases by one standard deviation above its mean, the scenario-specific mean WTA is NOK 5370 per year. On the other hand, if PO decreases by one standard deviation below its mean, the scenario-specific mean WTA is NOK 1460 per year.

The structural component of PO is presented in Table 4. The estimated structural equation model allows us to evaluate stronger (lower) PO and higher (lower) WTA characteristics. The results suggest that PO is stronger among older and less-educated people. Proximity does not significantly affect PO, perhaps due to the limited spatial resolution.

4.2. PO and national preferences for wind energy

Table 5 displays the simultaneous HMXL model for Experiment 2. The main effects coefficients can be interpreted as the mean welfare estimates associated with different attribute levels in monetary terms. Again, PO is normalized to have zero mean and unit standard deviation so that the main effect coefficients represent the mean WTP of people with a mean PO score.

The main effects illustrate that the sample respondents are, on average, willing to pay to increase renewable energy production in Norway (from all relevant sources except land-based wind energy). However, significant standard deviations indicate heterogeneous preferences. WTP increases with higher levels of new production. To illustrate, WTP for a 20 TWh increase in production is NOK 992, while WTP for a 40 TWh increase is NOK 2140, indicating approximately constant marginal utility (Dugstad et al., 2021). On the other hand, the negative main effects for higher production of land-based wind energy indicate that the sample, on average, requires reductions in the grid fee to accept more land-based wind energy. WTA for 700, 1400, and 2100 turbines is NOK 3680, NOK 4981, and NOK 5360, respectively. The results support **H1.1**. As in the case of local DCE, significant standard deviations indicate that the national sample has heterogeneous preferences for the turbine attribute.

As in Experiment 1, the interaction terms between PO and the non-monetary attributes are significant and have the expected sign. This result means that PO increases the required compensation to accept the environmental impacts of new wind turbines, supporting **H1.2**. If PO increases by one standard deviation above its mean, demanded compensation for 700, 1400, and 2100 turbines increases by NOK 981, NOK 1149, and NOK 1167, respectively. Interestingly, stronger PO decreases WTP to get more renewable energy from all other relevant sources. While perhaps speculative, it may be that people with stronger PO for natural areas are more concerned about the environmental impact associated with renewable energy expansions in general. Hence, their WTP is lower. Consistent with the structural component of PO in Experiment 1, PO is stronger among older and less-educated people. However, PO is also stronger among male respondents, those above the median sample income, and respondents residing in regions with more suitable wind areas ($p < 0.10$). Perhaps surprisingly, we can see that PO is also stronger among respondents who live further away from the closest area proposed for wind energy development.

Table 5
Discrete choice components of the HMXL model for Experiment 2.

Discrete choice component	Main effects	Interactions	Standard deviations
TWh 20	991.548*** (90.831)	−203.012*** (41.285)	1829.281*** (54.290)
TWh 30	1760.418*** (141.084)	−414.095*** (64.045)	187.609*** (66.076)
TWh 40	2139.721*** (169.953)	−652.982*** (71.467)	94.740* (64.867)
700 turbines	−3679.563*** (123.115)	−980.985*** (47.356)	6934.277*** (151.289)
1400 turbines	−4981.137*** (159.478)	−1149.214*** (56.251)	356.419*** (36.734)
2100 turbines	−5359.722*** (151.101)	−1166.894*** (82.367)	872.133*** (50.742)
-Fee/100	−1.841*** (0.104)		1.54344*** (0.115)
Structural component			
age3039	0.2310*** (0.047)		
age4049	0.3333*** (0.051)		
age50more	0.4134*** (0.044)		
male	0.0931*** (0.028)		
university	−0.142*** (0.030)		
median_inc	0.070*** (0.028)		
closedist	0.049*** (0.012)		
number_areas	0.019 (0.014)		
Measurement component			
Psychological Ownership Indicator 1	3.906*** (0.132)		
Psychological Ownership Indicator 2	5.656*** (0.236)		
Psychological Ownership Indicator 3	4.262*** (0.141)		
Psychological Ownership Indicator 4	7.178*** (0.389)		
Overall log-likelihood	21,418.075		
Adj. Pseudo R-square discrete choice component	0.475		
AIC	42,974.150		
BIC	43,397.470		
Observations	27,296		

Notes: *p < 0.05, **p < 0.01, ***p < 0.001. Standard errors (SE) are in brackets. Coefficients are displayed in NOK, with 1 USD = NOK 9.5 (PPP- adjusted).

4.3. PO and systematical status quo choices

Using generalized structural equation modeling, we ran a separate model for the two experiments to assess how PO affects the likelihood of always choosing the status quo option (**H.2**). The results are displayed in Table 6. The models have two structural components each, measured simultaneously, along with the measurement component of PO. PO is specified to depend on the same explanatory variables as in the structural component of PO in the discrete choice models (Tables 4 and 5). In the status quo (SQ) structural component, SQ choices are specified to depend on PO and the same explanatory variables as in the PO structural component. Thus, we allow for mediation effects. SQ choices are coded as a dummy variable, taking the value “one” if the respondent chose the same alternative with no wind energy development in each choice situation and “zero” otherwise. Thus, we estimate the structural

Table 6
Structural equation modeling of systematic status quo choices.

	Experiment 1		Experiment 2	
Variable name	PO	SQ	PO	SQ
Structural component				
age3039	0.149	−0.239	0.191***	0.524***
	(0.189)	(0.528)	(0.051)	(0.168)
age4049	0.085	0.462	0.308***	0.867***
	(0.170)	(0.492)	(0.052)	(0.166)
age50more	0.369**	0.199	0.378***	0.996***
	(0.132)	(0.437)	(0.044)	(0.148)
male	−0.189	0.042	0.078***	0.126
	(0.115)	(0.262)	(0.028)	(0.082)
university	−0.277*	−0.087	−0.117***	0.227***
	(0.120)	(0.262)	(0.029)	(0.085)
median_inc	−0.031	0.126	0.051*	−0.024
	(0.118)	(0.260)	(0.028)	(0.083)
closedist	−0.135	−0.213	0.053***	0.001
	(0.157)	(0.361)	(0.014)	(0.042)
longdist	0.004	−0.088		
	(0.140)	(0.326)		
number_areas			0.033***	0.093***
			(0.014)	(0.047)
PO		0.855***		0.338***
		(0.143)		(0.047)
constant	–	0.078		−2.196***
		(0.486)		(0.155)
Measurement component				
Psychological Ownership Indicator 1	0.835***		4.124***	
	(0.045)		(0.054)	
Psychological Ownership Indicator 2	0.950***		6.038***	
	(0.041)		(0.098)	
Psychological Ownership Indicator 3	0.879***		4.584***	
	(0.043)		(0.058)	
Psychological Ownership Indicator 4	–		8.260***	
			(0.186)	
Log-likelihood	−1057.101		−106,603.68	
Observations	308		3412	
AIC	2162.201		213,283.400	
BIC	2251.724		213,595.500	

Note: $*p < 0.1$, $**p < 0.05$, $***p < 0.01$. Standard errors in brackets. The measurement component of PO for Experiment 2 is measured using ordered logistic regressions (as in the HMXL) to take into account the discretely ordered nature of the five-point Likert scale.

component of SQ choices as a probit regression. For Experiment 1, the share of SQ choices was 54%, while this share was 26% for Experiment 2.

The structural components of PO for the two experiments in Table 5 give the same results as the structural components of PO in the discrete choice models. In the structural component of SQ choices for Experiment 1, we can see that PO is the only significant explanatory variable ($p < 0.01$). The coefficient indicates that if PO increases by one standard deviation above its mean, the probability of always choosing the SQ option increases by 70%, holding all other variables constant.[9] The probability of always choosing the SQ option in Experiment 2 is increasing in age, education, the number of suitable wind areas in the respondent's region, and PO ($p < 0.01$). Similarly to Experiment 1, if PO increases by one standard deviation above its mean, the probability increases by 58%, holding all other variables constant.

5. Discussion and conclusion

In this study, we presented a novel theoretical framework of PO for environmental public goods (Fig. 1), from which two key hypotheses were formulated: (1) PO increases nonmarket environmental values; (2) PO triggers territorial behavior towards wind energy projects that negatively affect environmental goods. Data from two DCE studies, one local and one national, were employed to test the hypotheses and to examine preferences for renewable energy in general.

We found three main effects in both experiments. First, people have negative preferences for land-based wind energy, consistent with **H1.1**. The mean WTA was approximately NOK 300 per wind turbine installed in Experiment 1. In Experiment 2, the mean WTA associated with 700, 1400, and 2100 turbines was NOK 3680, NOK 4981, and NOK 5360, respectively. These results confirm what other nonmarket valuation studies have found: People are willing to pay to avoid or require compensation for accepting negative environmental impacts from wind energy development (Meyerhoff et al., 2010). Second, PO is associated with a higher required compensation for negative changes in the quality/quantity of natural areas, consistent with **H1.2**. Third, PO increases the likelihood of always choosing the status quo alternative without new wind energy and associated environmental impacts, consistent with **H.2**. We found that when the PO score exceeded the sample mean by one standard deviation, the likelihood of always choosing the status quo increased by 60 to 70% and correlated with a 27 to 47% higher WTA estimates for new wind turbines, with the effects being largest in the local experiment. As both experiments supported our hypotheses, these combined results indicate that PO generally strengthens preferences for protecting environmental goods, which is not an obvious finding. Environmental goods could have been viewed differently by local and national stakeholders with strong PO, with some prioritizing their preservation while others prioritizing their utilization. Below, we discuss our findings and their implications related to our hypotheses in more depth.

Consistent with consumer behavior research and **H1.2**, we found that PO is also value-enhancing for environmental goods, seemingly as an underlying mechanism of the endowment effect. The monetary value people require to accept impacts on natural areas from wind energy depends on their degree of PO. A stronger feeling of PO implies a higher welfare estimate for accepting wind energy and the associated changes in the quality and quantity of natural areas. Theoretically, people develop a sense of ownership and attachment to natural areas by exerting control, gaining intimate knowledge, and investing their emotions in them. This extended sense of self drives people to value and protect these areas. These pathways increase the natural areas' perceived value among PO holders. Higher compensation for giving up, i.e., accepting a transformation of natural areas, is required due to the cost of losing areas perceived as a part of the self. The findings provide potentially valuable insights into the psychological mechanisms underlying the endowment effect, particularly in cases where ownership is not formal (i.e., public goods) or contested.

H2 was formulated based on recent research that conceptualized the importance of PO in managing natural resources, environmental goods, and land-use conflicts. Matilainen et al. (2017) provide a qualitative assessment of PO among stakeholders in eco-tourism in private forests and bear watching. They find that stakeholders feel they have the right to use natural resources, especially in local rural communities. Matilainen et al. (2017) argue that undesired economic activities in natural areas might violate local people's PO and lead to personal loss. In turn, this may result in protest behavior and conflicts. Preston and Gelman (2020) find that *individual* PO of natural areas increases people's willingness to protect and oppose exploiting the areas. They argue that this finding also likely holds for *collective* PO. Yim (2021) finds that collective PO is a mediating variable for residents' aversion to local tourism. The authors further argue that PO can repeal benefits from local tourism because of the generated sense of possessiveness.

Consistent with these studies and **H2**, our results indicate that PO represents a social dilemma. It is one of the key elements in explaining opposition against the transformation of natural areas for wind energy and can be used to predict land-use conflicts. PO leads to resistance against wind energy by increasing the likelihood of always choosing alternatives without land-based wind energy. The resistance generated by PO could be related to the endowment effect. To a larger degree,

[9] exp.(0.855)/(1 + exp.(0.855)) = 0.70

people who feel PO will reject offers of "selling" natural areas because of their higher perceived value. However, the resistance channeled through PO is more complex and integrated with territoriality, according to Kirk et al. (2018). People experience PO in their relations with natural areas, and the prospect of wind energy in such areas is an intrusion that challenges this PO. When a negatively perceived transformation of natural areas is proposed, they infer that other people (e.g., developers) feel ownership of the same areas. As a result, proposed development plans can lead to perceptions of infringement and trigger territorial behavior by reinforcing weaker substitutability in preferences. This logic means any proposed transformation that would harm the natural areas will likely be consistently rejected because preference expressions are more consistent with (near) perfect complementarity between environmental goods and market goods or weakly (modified) lexicographic preferences.

Thus, PO can halt development in wind energy contexts due to misalignment with legal property rights. As a result, territorial behavior and conflicts may emerge when individuals or communities perceive themselves as stewards of the land, even when formal ownership lies with others. These conflicts can lead to challenges in planning and executing wind energy projects. Our framework thus provides new insights into the diverse and emerging literature on understanding support for or opposition to renewable energy developments, where the not-in-my-backyard effect and place attachment have been central concepts (Devine-Wright, 2009; Dugstad et al., 2020, 2023). Whether and how PO-related conflicts depend on individual or collective feelings are subjects for further research. However, the presence of collective PO has the potential to stimulate broader collective action through a shared sense of connection and responsibility among a group of individuals towards an environmental good. When people collectively feel a strong sense of ownership, they are more likely to collaborate, mobilize, and advocate for its protection and preservation.

Based on our findings and experiences from generating the local DCE design, PO could be used to accurately (for the respondents) define implied property rights in terms of opting for either a WTP or a WTA format in place-specific local SP environmental valuation. In other words, measuring PO can be a pre-assessment for defining implied property rights. Our analysis revealed that most of the surveyed residents in the local study held a strong collective PO for the natural area proposed as the site for the wind farm. This observation explains why a WTP to avoid format did not work well in this context. As discussed in Section 3, the WTP survey version evoked protests and complaints among residents and had to be withdrawn. In this survey version, the implied property rights were with the developer. The status quo option corresponded to the most expansive construction plan, and respondents were elicited WTP for less impact on the natural area. Residents with strong PO most likely interpreted the scenario as if the developer (infringer) seized ownership – stimulating territorial behavior and protesting. In general, whether people could and would be willing to state valid preferences with a WTP design in such local contexts is questionable. However, when the environmental goods are not place-specific or local, research favors the WTP to avoid design (Johnston et al., 2017).

We believe that examining PO in the nonmarket valuation of wind energy impacts on environmental goods holds significant implications for environmental policy and management, offering a potential avenue to address social dilemmas related to wind energy. First, assessing PO can contribute to resolving social dilemmas related to environmental goods by providing insight into conflicting perceptions of ownership and usage rights among different stakeholders. Second, assessing PO can contribute to predicting oppositional and territorial behavior, circumventing conflicts that may potentially arise, and increasing policy implementation efficiency. Third, measuring PO can help to identify highly valued environmental amenities at different geographical scales. Fourth, spatial mapping of PO for some environmental good could contribute to identifying the extent of the market for the respective good. For the latter implication, a similar suggestion has been made for place attachment; see Iversen and Dugstad (2024).

In line with the discussed implications for environmental policy and management, we conducted an illustrative spatial analysis of PO and WTP to avoid new turbines based on the results from Experiment 2.[10] Specifically, we followed the approach outlined in Campbell et al. (2009). First, conditional individual-specific estimates from the HMXL model for Experiment 2 (Table 5) were extracted by applying Bayes's theorem (Hensher et al., 2005). Second, to illuminate the geographical dimensions of WTP and PO, we computed the average individual-specific estimates for each municipality in Norway. Our original dataset included observations from 286 of 356 Norwegian municipalities. We used so-called ordinary *Kriging interpolation* to predict WTP and PO for non-observed municipalities (as a form of benefit transfer).[11] Kriging is a geostatistical method that operates on the premise that proximity influences interpolated values more than those located farther away. Municipalities sampled in close geographical proximity should have a smaller disparity in the mean estimates of WTP and PO compared to those at a greater distance; see Campbell et al. (2009) for further methodological details. Other interpolation techniques have been used in the nonmarket valuation literature, e.g., Johnston and Ramachandran (2014), Johnston et al. (2015), and Soliño et al. (2018). We chose to use Kriging because statistical tests found statistically significant positive spatial autocorrelation for PO and WTP.[12][13]

Fig. 3 provides an overview of how PO and WTP vary spatially across the 356 municipalities in Norway.[14] As can be seen, there is a tendency for stronger PO and higher WTP in Western and Central Norway, where most areas suitable for wind energy are located (see Fig. A.3), including existing sites. A noticeable exception is some of the most northern municipalities, where PO is relatively weak and WTP is high.

From Fig. 3, it is clear that PO and WTP vary spatially. From our HMXL model, we also discovered that PO was stronger in counties with more suitable areas for wind energy, further underscoring both the significance of spatial variation and the role of exposure in shaping PO. Secondly, we discovered that individuals living at distances greater than the average from the nearest area identified as suitable for wind energy development exhibited a higher degree of PO. While this latter finding may seem unexpected, it can be attributed to various underlying factors. First, people residing at greater distances might perceive themselves as having less influence over the regulating processes of wind energy development in these areas, which might contribute to strengthening their PO as a compensation mechanism. Second, higher non-use values for nature among those who are generally further away from natural

[10] We focused on Experiment 2 as the spatial resolution in Experiment 1 is very limited. We would like to thank one of the anonymous reviewers for this suggestion.

[11] We specified an exponential variogram for both WTP and PO, see Appendix F for figures of fitted variograms.

[12] Unlike other interpolation methods used in nonmarket valuation, Kriging assumes spatial autocorrelation. To test for spatial autocorrelation, we used Moran's I test. The Moran's I test yielded Moran I's values of 0.102 with $p < 0.01$ for WTP and 0.115 with $p < 0.05$ for PO. The positive and significant Moran's I value for WTP and PO suggested the presence of positive spatial autocorrelation. When testing for spatial autocorrelation, we followed Campbell et al. (2009), where we defined the spatial weights that determine the neighborhood structure based on the five closest sampled municipalities.

[13] 10-fold cross-validation was employed to evaluate the performance of the interpolation model for WTP and PO. Results from the cross-validation exercise suggest low mean errors for WTP and PO and, hence, low estimation bias, see Appendix F for results from the cross-validation exercise.

[14] The map displays the average WTP per turbine based on simulated conditional individual-specific coefficients. This value is computed as a weighted mean, taking into account the mean WTP across the three attribute levels for new wind turbines. The mean WTP for 700, 1400, and 2100 of the conditional estimates is NOK 3692, NOK 4996, and NOK 5370, respectively. These values are similar to the mean of the unconditional estimates presented in Table 5.

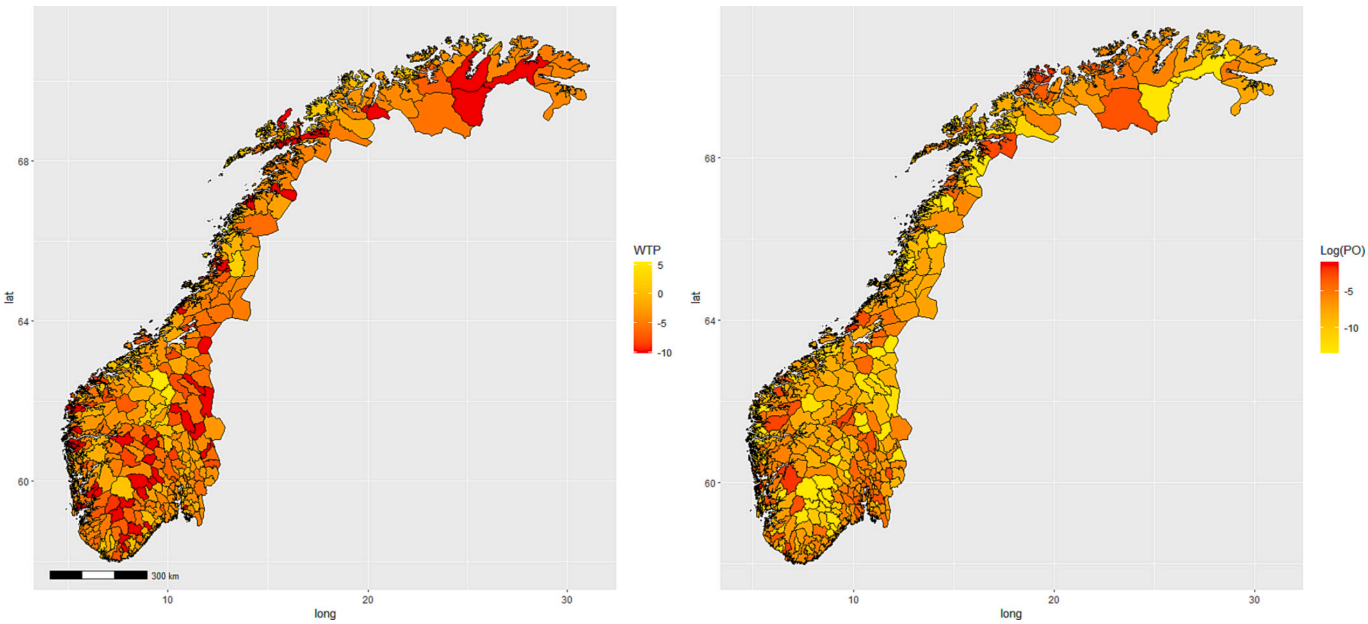

Fig. 3. Spatial distribution across municipalities in Norway of WTP to avoid new wind turbines and PO, based on results from Experiment 2. Note: The left panel displays WTP, while the right panel displays PO.

areas could also be a factor. Third, those who live closer to affected areas may perceive them as already degraded because of existing wind energy in the same areas and, therefore, feel less PO. Additional research is needed in diverse contexts to better understand the spatial aspect of PO.

We end with some recommendations for future research. First, while not explicitly examined in this paper, PO could contribute to explaining the disparity between WTP and WTA for nonmarket goods, including wind energy externalities, through endowment effect mechanisms. The endowment effect suggests that individuals tend to ascribe a higher value to an object they own, desiring a higher selling price compared to the situation where they do not own the object and wish to buy it. This asymmetry creates a disparity between WTA and WTP (Biel et al., 2011; Knetsch and Wong, 2009). In economic SP research, this becomes a question of implied property rights and how to define the status quo option. For example, suppose people are entitled to some environmental good and are offered monetary compensation for reduced environmental quality from wind energy. In that case, PO can trigger people to demand a higher compensation amount than they would be willing to pay to avoid the same reduction in level or quality. Future research should test this intuition. Second, we tested the significance of *collective* PO. As argued in Section 3, collective PO was more relevant in our setting because of the Norwegian law *Allemannsretten.* One could argue that the existence of Allemannsretten would exacerbate the issue of territorial behavior as found when analyzing status quo choices. The Allemannsretten is a unique public right to enter and make recreational use of private land in a handful of particularly Northern European countries. Therefore, it would be valuable to explore how cultural variations, such as those found in cross-country comparisons, influence people's perceptions of individual versus collective PO of environmental goods affected by renewable energy projects. Such investigation could reveal how cultural differences impact individual choices, territorial behaviors, and the expression of welfare estimates.

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CRediT authorship contribution statement

Anders Dugstad: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing. **Roy Brouwer:** Writing – review & editing. **Kristine Grimsrud:** Funding acquisition, Project administration, Writing – review & editing. **Gorm Kipperberg:** Project administration, Writing – review & editing, Investigation. **Henrik Lindhjem:** Funding acquisition, Project administration, Writing – review & editing. **Ståle Navrud:** Investigation, Project administration, 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. Supplementary data

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