

Empowering onshore wind energy: A national choice experiment on financial benefits and citizen participation

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ABSTRACT

This paper examines a representative choice experiment for Ireland ($n = 1014$) to understand the trade-offs citizens are willing to make between the distribution of financial benefits from a nearby wind farm and procedural measures for citizen participation in decision-making. Both participatory processes and outcomes which recognise local impacts are necessary for the acceptance of onshore wind farms. This paper distinguishes between shared community benefit funds, near-neighbour compensation, and citizen investment relative to issues of ownership, modes of engagement and the management of financial benefits during siting, construction, and operation of a wind farm respectively. Citizens willing to accept place greater importance on factors associated with distributive and procedural justice, while proximity and related visual impacts have comparatively more importance for citizens unwilling to accept. Willingness to accept is associated with early, in-person, engagement with a community liaison officer during siting and citizen participation in the governance and distribution of financial benefits during operation. However, citizens who show conditional support for wind farm developments prefer compensation of near-neighbour households, semi-state developers, and town hall engagement meetings. Strong supporters are more influenced by financial benefits for the wider community and local (co-)ownership of wind farms, particularly joint ventures between the developer and community.

1. Introduction

Onshore wind energy is set to remain the predominant source of renewable energy in Europe and installed capacity is expected to increase by 827 GW by 2050, almost tripling current capacity (WindEurope, 2022). New wind projects will chiefly be delivered by largescale developers (EirGrid, 2022; IEA, 2022) and will have an impact on the 'backyard' of communities living in small to mid-size towns in otherwise rural landscapes (Wolsink, 2007; Wüstenhagen et al., 2007). These impacts have a bearing on perceived justice at a local level, which can influence citizens' acceptance for nearby wind farms (Rand and Hoen, 2017). Community acceptance is a primary issue for the delivery of onshore wind farms (Ellis and Ferraro, 2017). In light of this, policy-makers and developers have sought to introduce financial benefits (Kerr et al., 2017) and citizen participation measures (Bidwell, 2016) at different stages of wind farm development and operation to support the social acceptance of wind farms. Nevertheless, a small proportion of

society will invariably be unwilling to accept wind farm development, and most will only be willing to accept if various conditions are met (Bell et al., 2013). This presents a challenge for policy development and highlights the need for representative analysis which jointly considers the influence of distributive and procedural characteristics of wind farm projects on social acceptance (Brennan and Van Rensburg, 2020; Hoen et al., 2019). This paper uses Ireland as a case to study distributive compensation mechanisms (e.g. community benefit funds, near-neighbour payments and citizen investment) in connection with procedural characteristics of wind farm projects (e.g. citizen engagement during siting/construction, community benefit fund governance, and wind-farm ownership).

Social decisions about the development of onshore wind energy requires trade-offs between numerous factors (Sovacool et al., 2018). At a local level, these considerations include wind farm impacts on the surrounding area and landscape (Wüstenhagen et al., 2007), the scale and ownership of wind farms (Baxter et al., 2020), the perceived adequacy of

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processes for citizen participation and decision-making (Cowell et al., 2011; Devine-Wright and Sherry-Brennan, 2019) and potential financial benefits for residents within the vicinity of a wind farm (Jørgensen et al., 2020; Walker and Baxter, 2017). Questions of proximity and power are implicit in such arrangements, meaning that citizen participation in a private wind farm development is often limited (Bristow et al., 2012; Kerr et al., 2017). Considering these multiple conditions for the local acceptance of wind farms, analysts have noted the need for research into the procedural considerations for the provision of financial benefits, proposing that it is processes, more so than outcomes, which facilitate relationship-building between developers and communities (Cowell et al., 2011; Hoen et al., 2019; Jørgensen et al., 2020).

Authors such as Lienhoop (2018), Knauf (2022) and Stadelmann-Steffen and Dermont (2021) have called for deeper analysis into the trade-offs between the design of financial benefits and procedural measures for citizen participation, and for groups with differing propensities to accept onshore wind farms. Towards these aims, this paper examines a representative choice-based conjoint experiment of 1014 Irish citizens. A variety of approaches (and deficiencies) have been described for specific projects' financial benefits arrangements (Devine-Wright and Sherry-Brennan, 2019; Jørgensen et al., 2020; Munday et al., 2011) and citizen participation efforts (Dwyer and Bidwell, 2019; Goedkoop and Devine-Wright, 2016; Knudsen et al., 2015). However, less supportive and ambivalent attitudes tend to be underrepresented in national research (Batel and Devine-Wright, 2015). Building on existing evidence (e.g. Hoen et al., 2019), this paper considers groups unwilling to accept, but who nevertheless stand to be impacted by further onshore development. It asks the research question, "Which conditions for wind farm development are most important to citizens both willing and unwilling to accept onshore wind farms?" It is critical to research this aspect of wind farm development to understand the priorities of all relevant stakeholders towards the design of fair projects.

While Vuichard et al. (2022) have examined the link between acceptance, financial benefits and citizen participation in wind farms for Switzerland, Estonia and Ukraine respectively, this paper addresses an important gap highlighted by these authors and focuses explicitly on the combination of different mechanisms relevant to 'conditional' supporters who show greater ambivalence towards wind development. It extends analysis into the governance of community benefit funds, and modes of financial benefit-sharing and wind farm ownership, accounting for the different economies of scale associated with commercial developments and local wind farms. These countries also have comparatively less developed wind sectors than Ireland.¹ Ireland is an interesting case, being one of the highest potential wind regions in Europe with a firm commitment to onshore wind development as supported by infrastructure development (EirGrid, 2022), citizen assemblies (Fitzgerald, 2020) and national policies prioritising citizen participation in renewable energy (DECC, 2015). To explore these issues, the second research question asks, "How do strong supporters and conditional supporters of wind farms trade-off between different features of financial benefits and citizen participation?" It is important to address this question to understand the barriers to the deployment of wind energy for the design of

projects which are likely to foster greater acceptance.

The design of this experiment also offers methodological value in three areas. Firstly, the dataset is representative of the general population unlike other quantitative (Dimitropoulos and Kontoleon, 2009; Langer et al., 2017; Mueller, 2020; Stadelmann-Steffen and Dermont, 2021), case-based (Devine-Wright and Sherry-Brennan, 2019; Dwyer and Bidwell, 2019; Jørgensen et al., 2020), or mixed-method approaches (Brennan and Van Rensburg, 2020; Lienhoop, 2018; Walker and Baxter, 2017) which have explored these relationships. Research ahead of project development (Devine-Wright and Wiersma, 2020) and which is nationally-representative (Hoen et al., 2019) can contribute to more acceptable implementation designs, processes and outcomes, particularly for country-wide policies. Secondly, the dual-response approach to segmentation in the national choice experiment has not been undertaken in previous research and enables new research into the specific features of wind farm proposals that contribute to (un)willingness to accept wind farm development (see e.g. Ek and Matti; Wolsink, 2018b). Finally, this study integrates a comprehensive set of attributes to examine the perceived value of established and emergent measures for the social acceptance of wind farms increasingly common during the planning, development, and operation of commercial onshore wind farms (e.g. Bidwell, 2016).

The remainder of this paper proceeds as follows. Section 2 reviews the literature to contextualise how different forms of financial benefits and citizen participation influence citizens' willingness to accept wind farm development. Section 3 provides details on the method and sample. Section 4 presents and discusses the empirical findings. The concluding section sets out recommendations for policy and future work.

2. Background: influences on social acceptance

The manifestation of social acceptance is a dynamic process which arises through reciprocal interactions at three scales (Wolsink, 2019). At a macro scale, socio-political acceptance for wind energy describes foundational governance enacted by regulators and policymakers. Market acceptance is the meso-level of support from consumers, investors, producers, and distributors, for instance in distributing and using wind-generated electricity. Finally, community acceptance concerns the level of support from residents and local authorities for specific wind farm projects at the micro scale (Wüstenhagen et al., 2007). Community acceptance of wind farms and trust in wind farm developers are facilitated by perceived distributive and procedural justice, where distributive justice concerns the balance of benefits and risks in decided outcomes, and procedural justice concerns the openness and inclusivity of the decision-making process (Baxter et al., 2020; Rand and Hoen, 2017). In the next section we examine the relationship between these considerations for willingness to accept onshore wind farm developments.

2.1. Distributive considerations

While wind farm developments disproportionately inconvenience the 'affected community' within their direct vicinity (Bristow et al., 2012), citizens located further away from developments might also identify as 'communities of relevance' and have a relational day-to-day interest in the specifics of a project (Batel, 2018). As members of these communities, citizens view onshore wind farms in relation to factors

¹ Ireland is one of the highest potential wind regions in Europe, with 36% (86%) of all electricity (renewable electricity) provided by onshore wind farms (SEAI, 2021). Ireland intends to deliver 80% renewable electricity by 2030 (DECC, 2019). Under a single policy framework, Ireland will add up to 14,000 GWh onshore capacity by 2025 through a series of national renewable energy auctions (DECC, 2022). The disperse nature of the population means that communities that will be impacted by onshore wind farms are widely distributed in small settlements across Ireland (Hallan and González, 2020). In 2018, Ireland introduced a mandatory community benefit fund for all new onshore developments which requires a payment of €2/MWh into the fund to support sustainable local initiatives and near-neighbour compensation payments. National policy requires community involvement in how this money is spent.

which affect them personally,² for instance noise annoyance (Hübner et al., 2019), shadow flicker (Peri et al., 2020), local economic impacts (Ek and Matti, 2015) or environmental impacts (Vuichard et al., 2022).

Amongst these, the visual impact on the landscape is related to proximity and is a central issue for onshore wind farm development (Devine-Wright, 2009; Wolsink, 2018a). All else being equal, citizens would typically prefer to live further away from private onshore wind farms and have been shown to trade-off between proximity and other features of wind farms, including financial incentives (e.g. Brennan and Van Rensburg, 2016; Sardaro et al., 2019), ecological impacts (e.g. Meyerhoff et al., 2010; Peri et al., 2020), and representation in decision-making (e.g. Langer et al., 2017).

Therefore, the distance to a wind farm is an encompassing variable for stakeholder concerns about the spatially-concentrated impacts of wind farms (Peri and Tal, 2021). It has been described as a proxy measure for anticipated impacts on, and for likely compensation of, residents located near to wind farms (Hoen et al., 2019).

Financial benefits offered to a community by a wind farm developer are becoming more common. These are usually annual contributions calculated on generated output (i.e. during the operational phase of a project) which are usually localised both to the context and geography of the project (Bristow et al., 2012). For instance, community benefit funds might be delivered as education initiatives, local infrastructure or environmental or energy efficiency projects. Payments may also be made in-kind, as local taxes or rents. Some studies have found that the preference for collective benefits for the wider community or municipality are consistent with community-oriented attitudes (García et al., 2016; Strazzera et al., 2012; Vuichard et al., 2019). Further, the provision of public facilities (García et al., 2016), electricity discounts (Brennan and Van Rensburg; Knauf, 2022; Strazzera et al., 2012), household subsidies (Dimitropoulos and Kontoleon, 2009), landowner rent payments (Sardaro et al., 2019; Walter, 2014), and revenue-sharing with landowners, residents, or municipalities (Vuichard et al., 2022) have been associated with increased willingness to accept onshore wind farm development.

However, even in instances where financial benefits such as community benefit funds (Devine-Wright and Sherry-Brennan, 2019), compensation of near-neighbours (Jørgensen et al., 2020) or citizen investment schemes (Johansen and Emborg, 2018) are viewed as necessary distributive provisions for local acceptance of specific projects, addressing residents' non-financial concerns is also necessary for the perceived fairness of outcomes.

2.2. Procedural considerations

Processes which support citizen participation are critical for perceived fairness and social acceptance. Relations between the developer and community commence from the time a wind farm is first proposed to the local community, and continue during the construction and operation phases. The early stages of wind farm development during planning and construction are key stages for community acceptance (Wolsink, 2007).

There is growing recognition that engagement during wind farm

development which includes local residents in planning and decision-making is more conducive to trust-building and fairness (Langer et al., 2017; Lienhoop, 2018; Stadelmann-Steffen and Dermont, 2021). This foregrounds issues of quality of information, transparency of processes, confidence in developers, the representation of stakeholders and citizen control (Firestone et al., 2020; Knudsen et al., 2015). There is less consensus as to how citizen engagement might serve to deliver on these principles in practice, and over the long-term.

There is some evidence that a local representative (Brennan and Van Rensburg, 2016), an impartial advisor (Jørgensen, 2020) or community liaison officer employed from within the community (Dwyer and Bidwell, 2019) could facilitate engagement during the early stages of wind farm development. In theory, citizen participation is more likely to secure outcomes which are acceptable to locals and has democratic value (Bidwell, 2016). However, power imbalances between actors limit the extent to which communities might influence decision-making in onshore wind projects and in negotiating financial benefits (Aitken, 2010; Cowell et al., 2011; Kerr et al., 2017).

Therefore, the scale of the wind farm developer and the project also influences perceived procedural and distributive justice (Baxter et al., 2020). Some studies have found that largescale projects owned by external corporations were regarded as less acceptable than semi-state (Brennan and Van Rensburg, 2020) or locally-owned (Ek and Persson, 2014; Walker and Baxter, 2017) projects. Locally-owned 'collective' wind farms are usually smaller-scale and supported by a wider range of communitarian motivations than private projects operated for profit (Walker and Devine-Wright, 2008). By contrast, institutional commitments to the capabilities of the private sector to provide largescale, affordable renewable electricity projects has weakened citizen participation in wind farm (co-)ownership (Cowell et al., 2011; Grashof, 2019). Private developers are increasingly pressured to maintain a competitive advantage in energy auctions (Côté et al., 2022; Grashof, 2019) and are unlikely to "put their fate in the hands of the public" (Bidwell, 2016: p.3), which narrows the scope for citizen influence over decisions on commercial wind farms.

From this viewpoint, co-ownership by joint venture with a community or establishing local governance of a shared community benefit fund provide opportunities to involve citizens in decisions about the allocation of local financial benefits (Munday et al., 2011). However, the representation of local interests generally resides with volunteers and groups with specific interests who are required to contribute considerable effort, skill and time towards the wider benefit of the community (Boyle et al., 2021; Bristow et al., 2012). Notwithstanding these potential caveats for relationship-building and local acceptance, the spatial boundaries associated with financial benefits schemes will undoubtedly produce debate as to the fairest distribution of benefit, based on impact and locality (Devine-Wright and Sherry-Brennan, 2019).

3. Data and methodology

Conjoint experiments have become an established economic valuation method to measure citizens' acceptance of environmental change (Pearce and Özdemiroglu, 2002) and are especially well suited to contexts where there is limited revealed/historical information available (Côté et al., 2022; Dimitropoulos and Kontoleon, 2009). Through a series of repeated choice tasks, respondents are presented with many opportunities to indicate their environmental preferences, which allows for estimation of the value of individual attributes that make up an environmental or a social good (Hanley et al., 1998: p.416).

Choice-based conjoint analysis uses random utility theory (McFadden, 1973) and consumer demand theory (Lancaster, 1966), and it is assumed that respondents when required to make a choice between two proposed wind farms will choose the option they perceive to be the most salient. A specialised form of dual-response as is employed here is recommended to reduce hypothetical biases (Brazell et al., 2006; Wlömert and Eggers, 2016; Orme and Chrzan, 2017). Dual-response extends the

² Factors which influence the social acceptance of onshore wind farms are numerous and do not occur in isolation. Interested readers are referred to Ferraro and Ellis (2017) who have reviewed over fifty influences on the social acceptance of wind energy projects in a European context, classified as individual attitudes, relationships, contextual issues, perceived impacts and process-related issues. Further to this, Rand and Hoen (2017) have reviewed three decades of literature centered on onshore wind farm acceptance in the United States and highlighted socioeconomic outcomes, perceived procedural and distributive fairness, the relationship between distance from turbines and stakeholder attitudes, as well as auditory, aesthetic, and environmental factors as prominent.

traditional ‘forced choice’ conjoint experiment to preserve preference information for non-accepters which would otherwise be lost (e.g. Ek and Matti, 2015; Wolsink, 2018b), thereby allowing for comparison between citizens with a greater/lesser willingness to accept wind farm developments.

Citizens’ preferences for different features of wind farms were calculated by decomposing the choice between two wind farms into particular trade-offs (for instance, between a wind farm which can be seen from the home, or not) using hierarchical Bayes multinomial regression (Train, 2001). This separates the total utility (perceived value) of a wind farm into numerical scores which show how much each feature of a wind farm influences citizens’ choices (referred to as part-worth utilities indicating relative preference). This method has become a standard estimation technique for conjoint data (Tabi and Wüstenhagen, 2017; Train, 2001; Vuichard et al., 2022) and produces more consistent estimates relative to classical methods of maximizing simulated likelihood given the better handling of differences between individuals (Train, 2001). To facilitate comparisons between segments and respondents on the same scale, utilities were normalized relative to each other and expressed as zero-centered differences to allow for comparisons between segments (e.g. those willing or unwilling; strong or conditional supporters) along specific levels of attributes (Orme and Chrzan, 2017). Positive values show increases in willingness to accept compared to the average for that attribute (set to zero). The total utility of a particular wind farm proposal is the sum of the constituent part-worth utilities estimated for its levels.³

3.1. Attributes and levels

Following best practice (Álvarez-Farizo and Hanley, 2002; Orme and Chrzan, 2017; Tabi and Wüstenhagen, 2017), the experiment’s choice of attributes and their associated levels were derived from a detailed literature review and refined through focus groups with a steering panel of industry professionals, academics and policymakers.⁴ This was followed by question testing, pilot-testing and recruiting respondents to complete the survey. Similar co-design approaches have been described as a safeguard for the credibility of the technical, environmental and economic characteristics of specific wind farm projects (Devine-Wright and Wiersma, 2020: p.3) and to ensure close representation of the real-world policy context without becoming case specific (Ek and Persson, 2014: p. 194). The instrument was piloted twice (first pilot: $n = 170$; second pilot: $n = 136$) with minor adjustments in phrasing and placement of the experiment relative to demographic/location questions before the full dissemination to a panel of approximately 108,000 households nationally.⁵

Table 1 shows the attributes and levels tested within this study. The accompanying descriptions presented to respondents are also provided. A total of 100 wind farms comprising different features were included in the experiment, and of these each respondent saw a random set of 8

paired choices. These choices were used to examine a respondent’s preference for particular features (levels) of wind farm attributes. In a second dual-response step, a respondent was asked to what extent they would be likely to accept their chosen wind farm in their community on a 4-point Likert. These choice sets were generated using Sawtooth Software’s balanced overlap procedure which is considered best practice where interactions might be of interest (Orme and Chrzan, 2017).

3.2. Sample characteristics

This study recruited a sample of 1014 Irish citizens. Representative population criteria were applied based on age and gender as per the most recent national census (2016). To over-sample those most likely to be impacted by wind farms in Ireland, the capital, Dublin, was under-sampled because it accounts for 25% (39%) of all (urban) residents (Central Statistics Office).

Table 2 shows the sample demographics.

Respondents living outside of cities (population under 50,000) made up 80.2% of the sample. 14.6% of the sample were located within 3 km of a wind farm and 39.8% within 10 km. This indicates adequate sampling of areas likely to be impacted by onshore wind development.

Using the dual-response format, we segmented the sample into two subgroups, those who were willing to accept a wind farm with at least one set of features (878; 86.6% overall), hereafter referred to as the ‘willing to accept’ or those who were unwilling to accept any wind farm development proposal within the conjoint experiment (136; 13.4%) referred to hereafter as the ‘unwilling to accept’.⁶ The locational characteristics of these groups appear in Appendix Table A1. The group willing to accept contained 27.9% more 18–44 year-olds and 15.4% more respondents living within 10 km of a wind turbine. The group unwilling to accept contained 19.2% more respondents who have lived in their community for longer than 11 years, 12.7% more rural respondents and 9.8% more women. Focusing on those citizens willing to accept, 528 citizens (60.1% relative)⁷ were likely to accept all eight wind farm proposals they chose within the experiment synonymous with ‘strong supporters’ (see Cousse et al., 2020), while 350 (39.9% relative) accepted only a subset of proposed developments as acceptable for development in their community referred to as ‘conditional supporters’ (see Stadelmann-Steffen and Dermont, 2021).

Where appropriate, tests of significance between levels of attributes were performed by one-sided t-tests and confirmed using the classical/frequentist multinomial logit.⁸ This confirmed significant differences relative to the mean utility for each attribute, (i.e. zero preference). The average relative importance of each attribute was calculated for each group as the utility range within each attribute as a proportion of the total range of all attributes (Orme and Chrzan, 2017).

4. Results and discussion

This section presents the results of the choice-based conjoint experiment. First, it examines the relative importance of wind farm attributes for citizens willing to accept and unwilling to accept onshore wind farm development. Next, it considers citizens’ preferences for features of financial benefits and citizen participation mechanisms from onshore wind farms with particular focus on strong/conditional supporters.

³ A respondent (i) choosing a particular wind farm community benefit fund arrangement (j) in a given choice task (t) would choose to maximise personal utility (U_{ijt}). The individual error term models random differences between respondents (ε_{ijt}). This establishes β_j as a vector of estimable part-worth utility parameters representing the strength of preference for each level: $U_{ijt} = V_{ijt} + \varepsilon_{ijt} = \beta_j X_{ijt} + \varepsilon_{ijt}$

⁴ During this consultation process, experts with first-hand involvement in designing and delivering financial benefits from onshore wind farms provided valuable feedback on the practicality and realism of the levels and attributes included in the design. Changes included setting realistic values on community benefit funds and electricity production costs associated with local (co-) ownership. Question-testing with individuals with no particular involvement/interest in renewable energy helped to gather feedback on the experiment to ensure the study was comprehensible and consistently interpreted by the general population.

⁵ Dynata: www.dynata.com.

⁶ A subgroup of those unwilling to accept wind farms included 52 citizens (5.1%) who stated they were ‘very unlikely to accept’ the wind farm development in every choice during the conjoint experiment.

⁷ A subgroup of those willing to accept wind farms included 113 citizens (11.1%) who were ‘very likely to accept’ their chosen wind farm in every instance during the conjoint experiment.

⁸ Estimates showed consistency for both methods ($r = 0.995$). Both models are shown in Appendix Table A4.

Table 1
Attributes and levels as presented to respondents.

Attribute	Description	Levels
Distance to the wind farm	Distance from your house to the proposed development: Distance of the wind farm to your house	(1) Outside immediate community (3–10 km) (2) Close to community (2–3 km) (3) Close to community (1–2 km) (4) Near-neighbour (within 1 km)
Visual impact	I will be able to see the wind turbines from my house: When “yes” imagine you will see one or more turbines from your house. When “no” imagine you cannot see wind turbines from your house.	(1) Yes (2) No
Engagement during site selection	Initial engagement in site selection phase: Modes through which the developer informs you and your neighbours of their desire to build the wind farm	(1) One-on-one with a community liaison officer (2) Meeting of a small group of people living very close to the proposed site (3) Town hall style meeting that includes the wider community (4) Leaflet from the developer (5) The developer uses local radio and newspaper to announce their plans
Community liaison officer	A community liaison officer is available during the construction phase: A community liaison officer is an available point of contact for locals to raise any problems they are experiencing due to construction	(1) Yes (2) No
Governance of community benefit fund ^a	The community benefit fund is managed by: The community benefit fund must be managed in a fair and transparent manner, and proposals must be assessed for their value to the community, fairness and sustainability	(1) Local authority (2) Wind farm developer with community input (3) Local enterprise development company (4) Local development company with community input (5) A committee composed of community members
Sharing of community benefit fund	Sharing of the community benefit fund: Sharing of the €180,000 annual community benefit fund between community projects for the common good, & household payments to neighbours within 2 km	(1) €130,000 p.a. to community projects & €50,000 p.a. between neighbours (2) €100,000 p.a. to community projects & €80,000 p.a. between neighbours (3) €80,000 p.a. to community projects & €100,000 p.a. between neighbours
Opportunity for citizens to invest	There is an opportunity for citizens to invest into the wind farm: An opportunity for citizens to invest in the development once planning and grid connection are granted	(1) Citizens must live close to the windfarm (within a radius of 10 km) (2) Citizens can live anywhere in Ireland (3) There is no opportunity to invest
Developer ^b	The wind farm developer is: The wind farm developer offering the investment	(1) Irish semi-state companies (2) Private companies or developers (3) Joint developer and community venture (4) Local landowners/farmers (5) A community sustainable energy group (6) New venture for an existing community network group
Electricity production cost ^c	Additional electricity production costs associated with community ownership: Commercial wind farms can produce electricity at a lower cost than either a community-led development or a joint developer/community development	(1) No added cost (2) 20% added cost (3) 30% added cost (4) 50% added cost

Note: Incompatible levels were restricted in the design so as not to be shown together.

^a Irish policy formalises that wind projects must provide community benefits at a level of €2/MWh for 15 years. Of this fund, at least €1000 must be paid to households within 1 km annually, and it is recommended to also offer discretionary payments to households within 1–2 km radius of a turbine.

^b In Ireland, locally-domiciled citizens may bid in the onshore wind energy auctions within a preferential community category, provided at least one member is part of a Sustainable Energy Community registered with the semi-state organisation Sustainable Energy Authority Ireland (SEAI). From 2021, 100% local representation is required.

^c Attribute models electricity production costs associated with community ownership. The average price of community projects in the first onshore renewable energy auction in Ireland was €104.15/MWh while the average across all projects was €74.08/MWh (EirGrid, 2020). These figures were €116.41/MWh and €97.87/MWh in the second cycle (EirGrid, 2022). These are included in the public levy on renewable electricity. The relationship between *Developer* and *Electricity production cost* were coupled in the design. Semi-state/private ownership of wind farms represent a 0% increase; joint-ownership a 20% increase and local ownership a 30% or 50% increase.

Overall, the model demonstrates good fit with a root likelihood⁹ of 0.78 (sd = 0.12) and a percent certainty (analogous to McFadden pseudo-R²) of 0.74.

Fig. 1 shows the relative importance of attributes and Table 3 contains the relative preferences for different levels of these attributes. Fig. 1 and Table 3 address our first research question to identify which conditions for wind farm development are most important to citizens both willing and unwilling to accept onshore wind farms. For those citizens willing to accept, Figs. 2–4 offer further insight into the relative

preferences of strong supporters and conditional supporters. This addresses the second question to understand how strong supporters and conditional supporters of wind farms trade-off between different forms of financial benefit and measures for citizen participation.

4.1. Relative importance of attributes

The average relative importance of wind farm attributes in Fig. 1 shows attributes which most influenced citizens' choices. The dark-coloured bars indicate the average relative importance of attributes for citizens who were willing to accept one or more proposed wind farm developments in the conjoint experiment (87%), and contains bounded

⁹ Root likelihood is the geometric mean of likelihoods, indicative of fit.

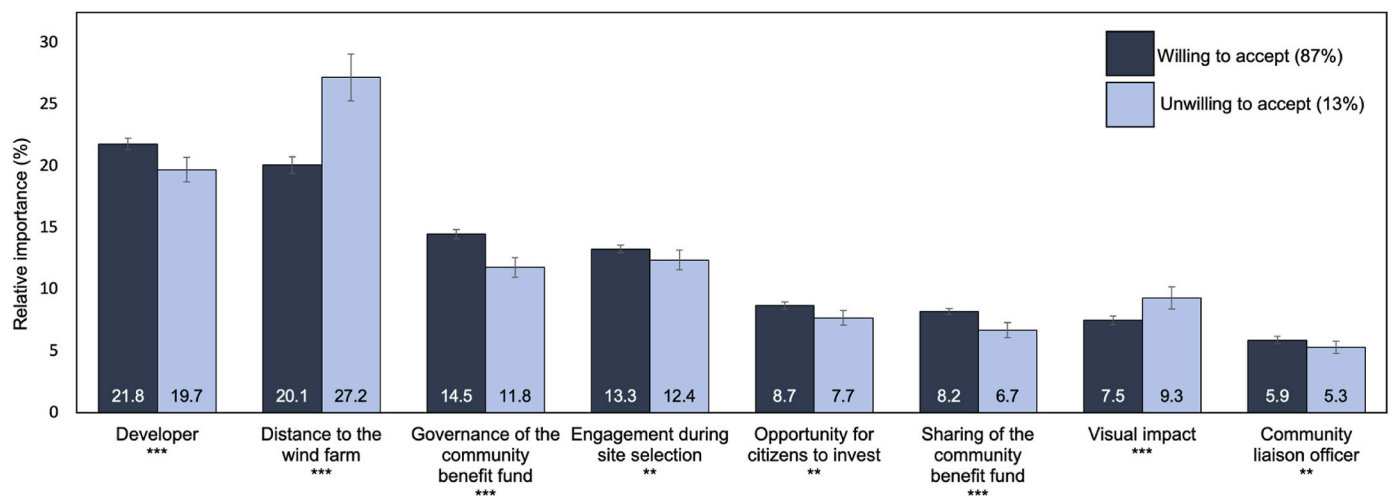
Table 2

Demographic characteristics of the sample compared to the national census.

	Characteristics	Sample	2016 Census	Deviation
Gender	Male	49%	49%	0%
	Female	51%	51%	0%
Age	18–24	11%	11%	0%
	25–34	18%	18%	0%
	35–44	21%	21%	0%
	45–54	18%	18%	0%
	55–64	14%	14%	0%
	65 and older	18%	18%	0%
Region	Border	10%	8%	+2%
	Dublin	17%	28%	–11%
	Mid-East	11%	14%	–3%
	Midlands	8%	6%	+2%
	Mid-West	12%	10%	+2%
	South-East	11%	9%	+2%
	South-West	19%	15%	+4%
	West	11%	10%	+1%

design of a wind farm development (*engagement during site selection*) could enhance perceived fairness, while engagement later on does not have the same effect. It is also interesting to note that procedural issues (i.e. the wind farm developer, engagement during siting and construction, and the management of financial benefits) show greater relative importance than attributes for the distribution of financial benefits. Specifically, these latter two attributes examine the *sharing of the community benefit* fund between the wider community and near-neighbour households and the *opportunity for citizens to invest* after planning and grid connection.

Conversely, citizens unwilling to accept perceive the *distance to a wind farm* to have the greatest relative importance (27.2%, SD = 11.2).¹⁰ For this group, *visual impact* (i.e. the ability to see the wind farm from home) also has greater importance than for citizens willing to accept (9.3%, SD = 5.4 versus 7.5%, SD = 5.4). Nevertheless, *distance to the wind farm* has relatively less importance for both citizens willing and unwilling to accept. This suggests that the ability to see wind farms from home and proximity are valued differently, and that there may be other

**Fig. 1.** Average relative importance of attributes of a wind farm development (%).

Note: *Developer* also includes the cost of electricity production associated with local ownership. Relative importance, RI (%): averaged individual utility range within each attribute as % of the total range of all attributes. Bounded lines show 95% confidence intervals (CI) = (RI) $\pm$ 1.96(SE). T-test * p < 0.1; ** p < 0.05; *** p < 0.01.

lines showing the 95% confidence interval around these means. Corresponding values for citizens unwilling to accept any proposed wind farm (13%) can be compared as the light-coloured bars. Further details and standard deviations (SD) are provided in the Appendix.

Fig. 1 indicates that citizens willing to accept place significantly greater importance on six attributes. In order of relative importance, these are: The wind farm *developer* (21.8%, SD = 6.4); *governance of the community benefit fund* (14.5%, SD = 5.5); *engagement during site selection* (13.3%, SD = 4.9); *opportunity for citizens to invest* (8.7%, SD = 4.6); *sharing of the community benefit fund* (8.2%, SD = 4.4) and *community liaison officer* (5.9%, SD = 4.0).

For this group, the attribute for the *developer* (owner of the wind farm) is the most important attribute of those included in the experiment. Similarly, these findings indicate that *governance of the community benefit fund* (the actors involved in administration for spending on local initiatives) and modes of initial *engagement during site selection* rank within the four most important features of onshore wind farms. These procedural attributes represent opportunities for citizen participation during siting and operation of the wind farm.

The availability of a *community liaison officer* during construction has the lowest relative importance. This indicates that access to a developer's contact person alone has little influence on respondents' choices. Further, it suggests that early involvement of citizens during the

proximity-related aspects which contribute to the relative importance of the latter (e.g. noise-related annoyance).

These findings show that most citizens willing to accept place greater importance on the developer of the wind farm, engagement during site selection and the administrators of a community benefit fund than the potential to financially benefit from onshore wind development in their area. However, the proximity and associated impacts of a project are generally more important to citizens who are unwilling to accept. The following subsection examines the conditions associated with willingness to accept a wind farm in the local area in greater depth.

4.2. Part-worth utilities of attribute levels

Table 3 shows the relative strength of preferences (i.e. part-worth utilities) for each level of each attribute for citizens willing to accept

¹⁰ There was less consistency in the perceived importance of *Distance to the wind farm* versus other attributes, reflected in comparatively wider standard deviations (Appendix Table A3). Investigation at the individual level shows that 41.9% (n = 57) of those unwilling to accept considered proximity to be much more important than the average for this group (p < 0.001). In contrast, this was 25.1% for the representative sample.

Table 3

Relative preferences (i.e. part-worth utilities) for different features of wind farm developments. Positive values show increasing preference for a particular feature of a wind farm compared to the average of the attribute (at zero).

Attribute	Levels of attribute	Relative preference (SD) ^a	
		Willing to accept (87%)	Unwilling to accept (13%)
Distance to the wind farm	Outside immediate community (3–10 km)	62.1 (63.9)	111.1 (47.5)
	Close to community (2–3 km)	22.1 (37.0)	25.5 (33.4)
	Close to community (radius of 1–2 km)	–21.4 (33.2)	–36.2 (36.2)
	Near-neighbour (within 1 km radius)	–62.8 (64.5)	–100.4 (56.6)
Visual impact	Able to see one or more turbines from home	–15.4 (33.6)	–33.8 (26.7)
	Cannot see turbines from home	15.4 (33.6)	33.8 (26.7)
Engagement during site selection	One-on-one with a community liaison officer	26.0 (30.8)	27.2 (22.2)
	Small meeting of residents very close to proposed site	11.5 (36.0)	5.0 (28.6)
	Town hall style meeting including wider community	20.5 (35.0)	37.1 (24.5)
	You receive a leaflet from the developer	–27.6 (31.3)	–35.8 (23.1)
Community liaison officer	The developer uses local radio and newspaper to announce their plans	–30.4 (39.4)	–33.6 (31.9)
	Available during construction	20.6 (20.0)	19.1 (16.4)
	Not available during construction	–20.6 (20.0)	–19.1 (16.4)
	Local authority	–15.4 (57.7)	–28.6 (37.4)
Governance of the community benefit fund	Wind farm developer with community input	–11.9 (34.8)	–8.5 (27.7)
	Local enterprise development company	–0.1 (45.2)	4.5 (36.1)
	Local development company with community input	13.6 (32.6)	6.8 (23.6)
	A committee composed of community members	13.8 (38.6)	25.9 (28.5)
Sharing of the community benefit fund	Community projects: €130,000 p.a. & Near-neighbours: €50,000 p.a.	–17.3 (31.4)	–18.9 (23.9)
	Community projects: €100,000 p.a. & Near-neighbours: €80,000 p.a.	7.8 (25.1)	2.0 (18.4)
	Community projects: €80,000 p.a. & Near-neighbours: €100,000 p.a.	9.5 (30.3)	16.9 (21.4)
Opportunity for citizens to invest	Residents within 10 km	17.0 (28.4)	16.7 (24.7)
	Residents anywhere within Ireland	1.7 (29.6)	3.7 (25.2)
	There is no opportunity to invest	–18.7 (32.8)	–20.4 (26.3)
Developer (No added cost)	Irish semi state companies	45.9 (68.8)	74.1 (41.7)
	Private companies or developers	12.6 (51.8)	19.9 (36.4)
(20% added cost)	Joint developer and community	30.6 (32.6)	17.5 (21.1)
(30% added cost)	Local landowners/farmers	13.4 (57.8)	3.5 (40.7)
	A community sustainable energy group	12.9 (34.0)	2.2 (24.8)
	New venture for an existing community network	1.6 (27.0)	3.1 (22.3)
(50% added cost)	Local landowners/farmers	–39.3 (45.7)	–56.9 (31.2)
	A community sustainable energy group	–29.9 (50.3)	–17.7 (37.9)
	An existing community network group	–47.8 (35.3)	–45.8 (31.6)
Status quo	How likely is it that you would accept such a wind farm in your community?	403.3 (399.6)	740.2 (66.9)

^a **Note:** Hierarchical Bayes multinomial logit was used to obtain respondents' part-worth utilities (part-strength preferences), which were rescaled to allow for comparison for different levels of an attribute and between segments. Coefficients are expressed zero-centered differences. Positive values indicate preference for an attribute level. The part-worth utilities of each level sum to the total utility of the wind farm development, which are implicitly counterbalanced by the utility of maintaining the stated quo (no further wind development).

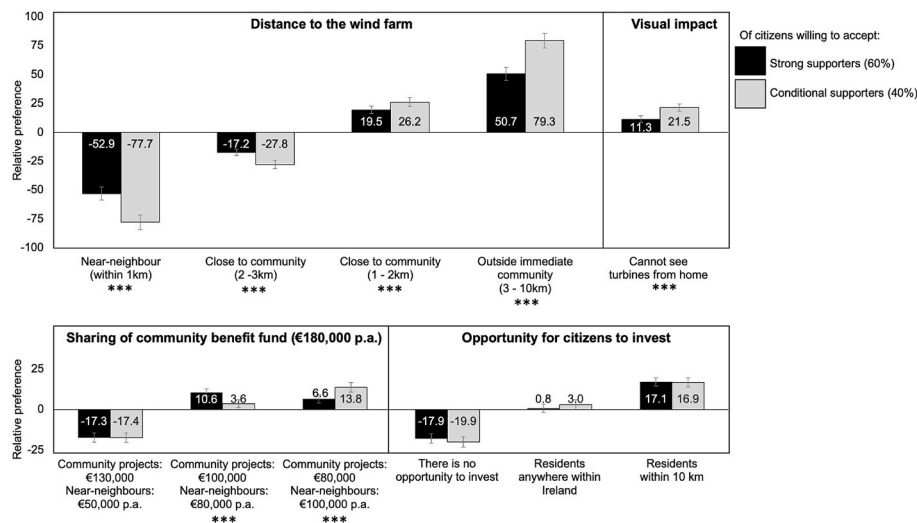


Fig. 2. Relative preferences (i.e. part-worth utilities) for proximity, visual impact and financial benefits, contrasted between strong supporters and conditional supporters. Positive values show increasing preference for a feature of a wind farm compared to the average (at zero).

Note: Bounded lines show 95% confidence intervals. T-test * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

and unwilling to accept. The section is ordered to first present citizens' trade-offs between distributive features of wind farms (proximity, visual impact and financial benefits) and second, citizen participation in the ownership of the wind farm, engagement and the governance of community benefit funds.

As might be expected (e.g. Brennan and Van Rensburg, 2016; Meyerhoff et al., 2010; Peri et al., 2020), and building on Fig. 1, the results presented in Table 3 show that respondents preferred wind farms located further away from their immediate community in principle, and that this effect is stronger for citizens unwilling to accept than for those willing to accept. Comparing between columns, the relative preference for wind farms located 3–10 km away is greater for citizens unwilling to accept (111.1) than willing to accept (62.1). There is evidence that wind farms disrupt place-protective values for some individuals who perceive visual and proximity-related impacts strongly (Devine-Wright, 2009).

These preferences contextualise the analysis of citizens' trade-offs concerning the *sharing of the community benefit fund*. We observe a general preference for localised community benefit funds directed preferentially towards stakeholders closest to a proposed wind farm (Table 3). Specifically, citizens willing to accept wind farms (column 1) prefer modes of community benefit-sharing which allocated a larger overall sum to near-neighbour households (€100,000) than to community initiatives 'for the common good' (€80,000, see Table 1 for more details). The relative preference is stronger in citizens unwilling to accept any proposed wind farm (Table 3, Column 2, 16.9). This could reflect disbenefit associated with visual/proximity-related impacts, since these would disproportionately affect near-neighbours.

In contrast, those willing to accept and unwilling to accept show similar preference for proposals with an *opportunity for citizens* to invest if living within 10 km (17.0; 16.7). Investment opportunities into wind farms might have different appeal to citizens who perceive community involvement in wind farms as beneficial (Munday et al., 2011; Slee, 2020) and/or who value the financial characteristics of wind technology as an investment asset (Curtin et al., 2019).

While localised financial benefits are generally preferred, given the lower relative importance of financial benefits in comparison to proximity (see Fig. 1), they cannot be assumed to adequately compensate for the disbenefit of hosting a wind farm locally and are therefore not sufficient for distributive fairness. Similar evidence has emerged within

studies of the mandatory compensation and co-ownership schemes introduced under the Danish Renewable Energy Act (2008) which have reported for some unwilling to accept, perceived non-financial losses and financial benefits were incompatible (Johansen and Emborg, 2018; Jørgensen, 2020). In light of these findings, we turn to address the preferred modes of citizen participation in wind farm ownership, engagement during siting and construction, and the governance of the community benefit fund in detail below.

Relative preferences for the developer of the wind farm are shown in Table 3. In the first instance, Irish semi-state companies are most widely preferred as potential owners of wind farms, notably more for citizens unwilling to accept (74.1) than citizens willing to accept (45.9). Some studies have found that Irish communities consider semi-state companies more accountable and trustworthy, which would appear to support this interpretation (Brennan et al., 2017). The comparatively lesser preference for private developers by both groups suggests that this ownership model is considered less conducive to acceptance and fairness. Local communities have been shown in various analyses to exhibit varying degrees of scepticism surrounding private developers' commercial motives, which can position private developers as 'external' and distanced from local interests (Jørgensen, 2020; Walker and Baxter, 2017).

In the second instance, citizens willing to accept prefer joint ventures between a professional developer and local community (30.6). This is despite the associated increase in development costs associated with local wind farms (Grashof, 2019). In the design of the study, this co-ownership model was represented as having a 20% greater development cost. Citizens willing to accept also show similar preference for private ownership and local wind farm developments (with a 30% added electricity production cost). Those unwilling to accept, however, prefer private ownership in favour of local ownership. Choice experiments conducted in contexts more familiar with community ownership of wind farms including Germany (Lienhoop, 2018) and Sweden (Ek and Matti, 2015) have reported that citizens are more willing to accept with local ownership and participation. Nevertheless, individual tolerance for the risks associated with wind farm ownership have been suggested as constraints for citizen developments in Ireland, particularly for citizens less convinced of the benefits of onshore wind farm development (Brennan et al., 2017; Hyland and Bertsch, 2018). From this view, the

findings presented here suggest that wind farms owned locally are not necessarily fairer for groups unwilling to accept a wind farm in the area.

Table 3 also shows that citizens willing and unwilling to accept exhibit similarly strong preferences for engagement with a community liaison officer during the site selection phase of development (26.0; 27.2 respective preference), as well as during construction of the wind farm (20.6; 19.1). Despite the fundamental importance of information in guiding the consultation process (Knudsen et al., 2015; Walker et al., 2015), one-directional modes of sharing information (i.e. use of leaflets, local radio and local newspaper by the developer) have little influence on either group's preferences. This proposes that greater levels of citizen influence are required for process fairness in general (Arnstein, 1969).

Finally, we consider the administration of community benefit funds. Local involvement in the governance of shared financial benefits can provide an opportunity for citizen participation during the operation of the project, which is when wind farm developments typically begin contributing to a community benefit fund (Bristow et al., 2012). Similar to the above, we note that citizens generally preferred governance structures associated with deeper levels of citizen involvement.

Specifically, citizens willing to accept one or more wind farm proposals are divided in their preferences for a committee composed of community members (13.8), or a local development company with input from community stakeholders (13.6). Citizens unwilling to accept strongly prefer governance under a committee composed of community members (25.9). The involvement of the local authority or private developer in the management of funds is not preferred by either group. The literature proposes that this could point to mistrust in these actors or processes which exclude communities from decision-making (Aitken, 2010; Jørgensen, 2020; Siamanta, 2019; Walker et al., 2015), or an appreciation for benefits that are managed by locals, for locals (Bristow et al., 2012; Kerr et al., 2017).

Reflecting on the greater relative importance of these issues to citizens *conditionally* willing to accept developments, the following subsection examines these trade-offs in greater detail.

4.3. Preferences of conditional and strong supporters

This subsection focuses on the preferences of citizens conditionally willing to developments to examine differences in how public

acceptance is more/less contingent on the specific characteristics of onshore wind farms. Following on from Section 4.2, Figs. 2–4 contrast the relative preferences of 'strong supporters' (who were willing to accept all preferred wind farm developments) and 'conditional supporters' (who were willing to accept some, but not all, of their preferred wind farms in their community).

Fig. 2 contrasts the strength of preferences of strong supporters (shown in dark bars) which can be compared to conditional supporters (light bars). The relative height indicates preference for a feature of a wind farm compared to the average (at zero), bounded by a 95% confidence interval. From this illustration, conditional supporters showed greater preference for wind farms located outside of the community (i.e. 3–10 km) or which were not visible from the home than for strong supporters. Further to this, conditional supporters showed a greater preference for the compensation of near-neighbour households than strong supporters. In contrast to conditional supporters, strong supporters demonstrate a greater preference for a larger allocation of financial benefits to community projects. Both groups reveal equivalent preference for opportunities for citizens living within 10 km to invest in the development.

Taken together, these findings suggest that wind farms which offer local financial benefits in the form of near-neighbour compensation and investment opportunities for citizens closest to a wind farm are considered more acceptable in principle. This effect is particularly evident in conditional supporters, who show greater preference for reduced visual impact and wind farms located further from their residence. Some studies have proposed that the preference for collective benefits is linked to communitarian values (García et al., 2016; Strazzera et al., 2012; Vuichard et al., 2022). Building on this research, we also connect the preference for collective community benefits to a stronger level of support for wind projects, which might imply supporters view wind energy development as an opportunity for local development.

Trade-offs between different types of wind farm developer which positively influenced respondents' choices are shown in Fig. 3. Owing to economies of scale, local forms of ownership are associated with greater electricity production costs as shown on the lower axis (0%, 20% and 30% added cost). Dark bars show the average relative preferences of strong supporters and light bars correspond to conditional supporters, each bounded by a 95% confidence interval.

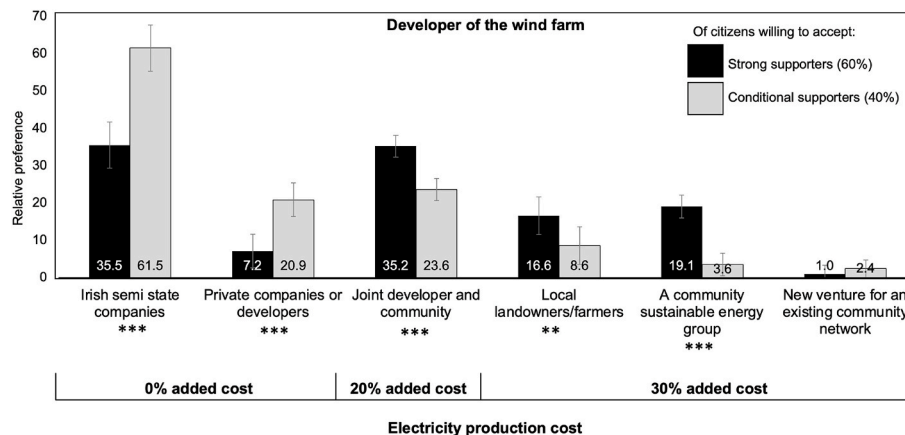


Fig. 3. Relative preferences (i.e. part-worth utilities) for different types of developer associated with 0%, 20% or 30% added cost of electricity production, contrasted between strong supporters and conditional supporters. Positive values show increasing preference for a feature of a wind farm compared to the average (at zero). **Note:** Bounded lines show 95% confidence intervals. T-test * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

Conditional supporters show stronger preference for semi-state and private developers, though to a lesser extent than strong supporters. In contrast, strong supporters demonstrate similar preference for wind farm developments owned by semi-state companies than for joint ventures co-developed between a professional developer and the community. The joint production of electricity is a relatively novel practice, but has been described as a distributionally ‘fair share’ of wind farm financial benefits, since it necessitates the exchange of property rights and determines benefit based on generated income (Kerr et al., 2017). Similarly, the procedural and distributive benefits of citizen participation in wind farm ownership appears to be most pertinent to strong supporters, who are more influenced in their choices towards 100% local ownership of wind farms.

Fig. 4 shows the trade-offs between different modes of engagement and governance of community benefit funds for strong supporters (dark bars) and conditional supporters (light bars).

In the first instance, strong supporters prefer one-on-one engagement with a community liaison officer. Alongside this, conditional supporters also show preference for town hall meetings including the wider community. While this finding might suggest less supportive groups find strength in numbers, this is also consistent with a view that interactions outside the institutions and politics of formal decision-making are important for the acceptance of renewable energy technologies (Batel, 2018). Knudsen et al. (2015) found that quality of information is a prerequisite for constructive engagement between developers and communities and that large meetings with wide community representation can fulfil this need, at least initially. Dwyer and Bidwell (2019) proposed that informal engagement, often facilitated through community liaison representatives known to local residents, is more effective in trust-building than formal engagement over the long-term. Our findings support both views, that formal engagement and informal interactions matter for perceived fairness at different stages of development. During the construction phase, both groups prefer that a community liaison officer be available to address local concerns.

Here we also build on the understanding that citizen involvement in the governance of the community benefit fund wind farm supports process fairness (see Table 3). Fig. 4 shows that conditional supporters prefer community benefit funds administrated by a committee composed of community members. Nevertheless, the results also suggest

both groups are willing to accept the involvement of local development companies. This might represent trust in established networks of local development organizations and/or an appreciation for the involvement of community-based expert intermediaries (Bristow et al., 2012).

Together, these findings highlight that citizen participation in decision-making supports local acceptance at different stages of development. This is especially pronounced in conditional supporters, whose preferences point to a procedural role for widely-representative forms of engagement and control of decisions on community benefit funds by a committee composed of community members.

5. Conclusion and policy recommendations

This paper examines a choice experiment of 1014 Irish citizens. It finds that financial benefits, especially near-neighbour compensation, and processes which facilitate citizen participation throughout the siting, construction and operation of a wind farm development are more likely to contribute to the public acceptance of a proposed development. The paper focuses on (1) the importance of different features of onshore wind development to citizens willing and unwilling to accept wind farms, and (2) how citizens with a greater/weaker level of support make trade-offs between citizen participation and financial benefits.

5.1. Key findings

We find that 87% of the representative public were willing to accept one or more proposed developments, subject to various procedural and distributive conditions for during siting, construction, and operation.

The findings illustrate that citizen participation in deciding *how* to spend financial benefits on local initiatives is more conducive to fairness than the issue of *who* benefits from a shared fund, whether in the form of compensation for near-neighbours or local initiatives. Of the former, we find a general preference for governance of community benefit funds by a committee composed of community members, and in the second instance, administration under a local development company with community input. Of the latter, we build on existing evidence (e.g. García et al., 2016; Knauf, 2022) to illustrate that citizens prefer financial benefit arrangements which prioritise the compensation of near-neighbour households from a shared community benefit fund. This

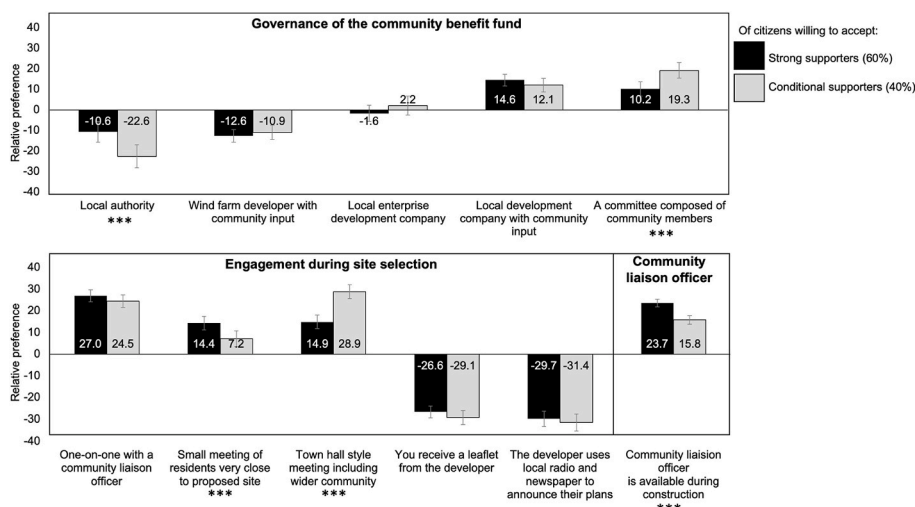


Fig. 4. Relative preferences (i.e. part-worth utilities) for different modes of engagement during siting and construction, and different governance structures of a shared community benefit fund, contrasted between strong supporters and conditional supporters. Positive values show increasing preference for a feature of a wind farm compared to the average (at zero).

Note: Bounded lines show 95% confidence intervals. T-test * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

effect is stronger for citizens unwilling to accept, who place greater importance on visual impact and proximity. We also find that most citizens prefer wind farms which offer an opportunity for those living closest (i.e. within 10 km) to invest in the project.

Citizen participation in the wind farm itself is important for willingness to accept. Procedural characteristics of wind farm developments, including the developer of the wind farm and modes of engagement during siting and construction appear to be more important than the distribution of financial benefits, particularly for citizens willing to accept. Conditional supporters and citizens unwilling to accept prefer town hall meetings. However, overall, we also note a preference for one-on-one engagement during wind farm site selection and construction.

Alongside general preferences for projects owned by semi-state companies in contrast to private developers, we also found (particularly for strong supporters) that local (co-)ownership is associated with willingness to accept even where this is associated with a 20–30% higher electricity production cost. We conclude that supporters perceive local (co-)ownership as important for distributive and procedural justice.

5.2. Policy implications

Policies for the provision of financial benefits from wind farms should consider proximity. Our findings support the provision of community benefit funds including compensation for near-neighbour households, as well as citizen investment opportunities. In Ireland, community benefit contributions will represent a substantial transfer of wealth to local communities (DECC, 2021) and therefore have material potential to support grassroots local development. This is a key consideration for the local acceptance of wind farms (Munday et al., 2011). Policies which endorse community committees (rather than local authorities or developers) as primary decision-making bodies and which allow flexibility for local representatives to consult with local development companies or expert intermediaries could facilitate capacity-building at a local level.

Further to this, developers' engagement strategies should commence early on during the planning process. Involving communities early during site selection and ensuring that a community liaison officer is available to meet with residents throughout construction are conducive to better acceptance of a project and offer an opportunity to address the concerns of citizens less supportive of projects (e.g. proximity; visual impact). At minimum, our results suggest one-on-one consultation and town hall meetings are necessary to engage these groups. This does not guarantee genuine opportunities for stakeholder input. Developers should provide regular formal and informal opportunities for citizens to meet in person with a single key contact person. For instance, efforts to advertise small meetings for those near to a proposed development and large meetings for the wider community could be complemented with house visits or pop-up stands facilitated by a community liaison officer.

Lastly, the results foreground the importance of the developer of the wind farm. Private developers will likely be required to go to greater lengths to build a relationship with a community than local or semi-state owners. They could consider joint ventures and co-investment as an opportunity to bring communities onboard a project. It has also been said that the co-production of renewable energy which prioritises citizen involvement supports justice and is critical for social acceptance (Wolsink, 2018a). Therefore, within the context of increasingly competitive energy auctions and challenges for energy security, policy should recognise that citizens lack economies of scale, and establish a formal role for citizen (co-)owners in local energy transitions.

5.3. Limitations and future research

This study has limitations which inform future research. In the absence of a revealed dataset containing representative information on local preferences for financial benefits and citizen participation in wind farms, the conjoint approach is subject to the same constraints as other stated preference methods and is limited in its interpretation to the questions presented at the time of study.

We have assessed the perceptions of a particular set of key attributes for the representative public. Social acceptance, being a process, warrants consideration at different scales. It would be interesting for future research to hone in on the direction of the relationships presented in this paper through, for instance, interviews with community participants and beneficiaries of standardised financial benefit schemes, or by replicating the study with communities at different stages of the development process. While some countries (e.g. Germany) have an established history of citizen investment into wind farms, research into the processes, outcomes and acceptance of these schemes in regions unfamiliar with citizen involvement in energy projects would be interesting. Further, understanding how and why citizens' preferences for financial benefits and local participation change with proximity to, experience of, and involvement in, wind farms are valuable avenues for future research on this topic.

CRedit authorship contribution statement

Julia le Maitre: Conceptualization, Methodology, Software, Validation, Formal analysis, Data curation, Investigation, Writing – original draft, Writing – review & editing, Visualization, Data curation. **Geraldine Ryan:** Conceptualization, Writing – review & editing, Supervision, Funding acquisition, Investigation, Data curation. **Bernadette Power:** Conceptualization, Writing – review & editing, Supervision, Funding acquisition, Investigation, Data curation. **Ellen O'Connor:** Conceptualization, Investigation, Data curation.

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.

Data availability

The data that has been used is confidential.

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Appendix

Introduction to the survey

A In this interactive section we would like to find out how you feel about different wind farm - public interactions and if different combinations would make you more amenable to having a wind farm in your neighbourhood. Please read the explanations for the different wind farm attributes that will be presented and select your preferred option (i.e. Wind Farm A or Wind Farm B) in the eight choices which follow. You will be given the chance to say if the preferred option would actually be acceptable or not.



Fig. A1. Introductory text prefacing the choice experiment (A: top)
Images of wind farms in different Irish contexts as shown at the start of the survey (B: bottom, courtesy of Sustainable Energy Authority Ireland)

Segmentation and subgroup characteristics

Table A1

Area characteristics of respondents (un)willing to accept wind farm development(s) in the conjoint experiment

Characteristics	Unwilling to accept any wind farm development (13%)	Willing to accept a wind farm with at least one set of features (87%)	Total (%)
Age (***)			
18–24	3.7%	11.9%	10.8%
25–34	8.8%	19.9%	18.4%
35–44	13.2%	21.8%	20.6%
45–54	25.7%	16.4%	17.7%
55–64	24.3%	13.0%	14.5%
65 and older	24.3%	17.1%	18.1%
Gender (**)			
Male	40.4%	50.2%	48.9%
Female	59.6%	49.8%	51.1%
Region (***)			

(continued on next page)

Table A1 (continued)

Characteristics	Unwilling to accept any wind farm development (13%)	Willing to accept a wind farm with at least one set of features (87%)	Total (%)
Border	14.7	9.6	10.3
Dublin	8.1	19.1	17.7
Mid-East	5.9	12.0	11.1
Midlands	11.8	7.0	7.6
Mid-West	11.8	12.1	12.0
South-East	8.1	11.4	11.0
South-West	28.7	17.4	18.9
West	11.0	11.5	11.4
Distance to nearest large wind turbine (**)			
Within 1 km	2.9%	7.2%	6.6%
2–3 km	6.6%	8.2%	8.0%
4–10 km	16.9%	26.5%	25.3%
11–50 km	39.7%	33.3%	34.1%
Unaware of a wind farm within 50 km	33.8%	24.8%	26.0%
Population characteristics (**)			
Rural Area (pop. under 1500)	47.1%	34.4%	36.1%
Small town (pop. 1500–5000)	16.2%	21.9%	21.1%
Mid-sized town (pop. 5000–50,000)	21.3%	23.2%	23.0%
A city (pop. over 50,000)	15.4%	20.5%	19.8%
Years in current community (***)			
Under 1 year	1.5%	4.2%	3.9%
1–5 years	8.8%	20.3%	18.7%
6–10 years	9.6%	14.6%	13.9%
11–20 years	27.2%	24.2%	24.6%
Over 20 years	35.3%	24.6%	26.0%
Always lived here	17.7%	12.2%	12.9%
Total (%)	100%	100%	100%
Total (n)	136	878	1014

Pearson Chi²: *p < 0.1; **p < 0.05; ***p < 0.001.

Table A2

Crosstabulation of subgroups by dual-response.

Respondent dual-response choices over 8 choice options:	Unwilling to accept any wind farm development (13%)	Willing to accept a wind farm with at least one set of features (87%)
<u>Conditional supporters</u>	0	350
‘likely to accept’ a wind farm with at least one set of features AND ‘unlikely to accept a wind farm with at least one set of features’		
(Subgroup):	(0)	(30)
‘very likely to accept’ a wind farm with at least one set of features AND ‘very unlikely to accept’ a wind farm with at least one set of features		
(Subgroup – remainder)	(0)	(320)
Stance varied:		
‘unlikely to accept’ AND ‘very/somewhat likely to accept’ OR ‘likely to accept’ AND ‘very/somewhat unlikely to accept’		
<u>Strong supporters</u>	0	528
‘likely to accept’ ALL preferred wind farms		
(Subgroup - enthusiasts):	(0)	(113)
‘very likely to accept’ ALL preferred wind farms		
(Subgroup – moderately supportive):	(0)	(209)
‘somewhat likely to accept’ ALL preferred wind farms		
(Subgroup – remainder)	(0)	(206)
Stance varied: ‘very likely to accept’ and ‘somewhat likely to accept’		
<u>Unwilling to accept</u>	136	0
‘unlikely to accept’ ALL preferred wind farms in the experiment		
(Subgroup - opponents)	(52)	(0)
‘very unlikely to accept’ ALL preferred wind farms in the experiment		
(Subgroup – moderately opposed)	(55)	(0)
‘somewhat unlikely to accept’ ALL preferred wind farms in the experiment		
(Subgroup – remainder)	(29)	(0)
Stance varied: ‘very unlikely to accept’ and ‘somewhat unlikely to accept’		
Total	136	878

Representative model

Table A3

Relative importance of attributes showing standard deviation (SD) and 95% confidence intervals (CI)

Relative importance of attributes	Willing to accept a wind farm with at least one set of features (%)				Unwilling to accept any wind farm development (%)				Full representative sample (%)			
	mean	SD	[95% CI] ^a		mean	SD	[95% CI]		mean	SD	[95% CI]	
Developer (accounting for Electricity production cost)	21.8	6.4	21.4	22.3	19.7	6.0	18.7	20.7	21.6	6.4	21.2	22.0
Distance to the wind farm	20.1	10.8	19.3	20.8	27.2	11.2	25.3	29.1	21.0	11.1	20.3	21.7
Governance of community benefit fund	14.5	5.5	14.2	14.9	11.8	4.6	11.0	12.6	14.2	5.5	13.8	14.5
Engagement during site selection	13.3	4.9	12.9	13.6	12.4	4.3	11.7	13.2	13.2	4.8	12.9	13.5
Opportunity for citizens to invest	8.7	4.6	8.4	9.0	7.7	4.0	7.0	8.3	8.6	4.6	8.3	8.8
Sharing of community benefit fund	8.2	4.4	7.9	8.5	6.7	3.5	6.1	7.3	8.0	4.3	7.7	8.2
Visual impact	7.5	5.4	7.1	7.9	9.3	5.4	8.4	10.2	7.7	5.4	7.4	8.1
Community liaison officer	5.9	4.0	5.7	6.2	5.3	3.5	4.7	5.8	5.8	4.0	5.6	6.1

^a 95% CI: Confidence intervals for each attribute level calculated by two-tailed *t*-test using the standard error (SE) and mean relative importance: 95% CI_{U/L} = (relative importance) ± 1.96 (SE).

Table A4

Consensus of coefficients estimated by Hierarchical Bayes and classic frequentist multinomial logit (n = 1014)

Attribute	Level	Hierarchical Bayes model ^a			Classic model ^b	
		β	SD	[95% CI] ^c	β	
Distance to the wind farm	Outside immediate community (3–10 km)	68.6	64.2	64.7	72.6	0.4***
	Close to community (2–3 km)	22.6	36.5	20.4	24.8	0.1***
	Close to community (radius of 1–2 km)	−23.4	32.8	−25.4	−21.4	−0.1***
	Near neighbour (within 1 km radius)	−67.8	64.8	−71.8	−63.9	−0.4***
Visual impact	Wind turbines visible	−17.9	33.4	−19.9	−15.8	−0.1***
	Wind turbines not visible	17.9	33.4	15.8	19.9	0.1***
Engagement during site selection	One-on-one with a community liaison officer	26.2	29.8	24.3	28.0	0.1***
	Small meeting of residents very close to proposed site	10.6	35.2	8.5	12.8	0.1**
	Town hall style meeting including the wider community	22.7	34.2	20.6	24.8	0.1***
	You receive a leaflet from the developer	−28.7	30.5	−30.6	−26.8	−0.2***
Community liaison officer	The developer uses local radio and newspaper to announce their plans	−30.8	38.5	−33.2	−28.5	−0.2***
	Available during construction	20.4	19.6	19.2	21.6	0.1***
	Not available during construction	−20.4	19.6	−21.6	−19.2	−0.1***
	Governance of community benefit fund	Local authority	−17.2	55.6	−20.6	−13.7
Wind farm developer with community input		−11.5	33.9	−13.6	−9.4	0.0
Local enterprise development company		0.5	44.1	−2.2	3.2	0.0
Local development company with community input		12.7	31.6	10.7	14.6	0.1*
Sharing of community benefit fund	A committee composed of community members	15.5	37.6	13.2	17.8	0.1**
	Community projects: €130,000 p.a. and Near-neighbours: €50,000 p.a.	−17.5	30.5	−19.4	−15.7	−0.1***
	Community projects: €100,000 p.a. and Near-neighbours: €80,000 p.a.	7.1	24.4	5.6	8.6	0.0
	Community projects: €80,000 p.a. and Near-neighbours: €100,000 p.a.	10.5	29.4	8.7	12.3	0.2***
Opportunity for citizens to invest	Residents within 10 km	17.0	27.9	15.3	18.7	0.1***
	Residents anywhere within Ireland	1.9	29.0	0.1	3.7	0.0
	There is no opportunity to invest	−18.9	32.0	−20.9	−16.9	−0.1***
Developer (No added cost)	Irish semi state companies	49.7	66.5	45.6	53.8	0.3***
	Private companies or developers	13.6	49.9	10.5	16.7	0.1
(20% added cost)	Joint developer and community	28.9	31.7	26.9	30.8	0.2***
(30% added cost)	Local landowners/farmers	12.1	55.9	8.7	15.5	0.0
	A community sustainable energy group	11.5	33.1	9.4	13.5	0.1**
	New venture for an existing community network	1.8	26.4	0.1	3.4	0.0
	Local landowners/farmers	−41.7	44.4	−44.4	−38.9	−0.2***
(50% added cost)	A community sustainable energy group	−28.3	49.0	−31.3	−25.3	−0.1***
	An existing community network group	−47.6	34.8	−49.7	−45.4	−0.3***
Dual response	Given your selection above, how likely is it that you would accept such a wind farm in your community?	448.5	389.9	424.5	472.5	1.9***

^a Expressed in zero-centered differences: Hierarchical Bayes multinomial logit was used to obtain respondents' part-worth utilities (part-strength preferences), which were rescaled to allow for comparison as zero-centered differences ranging between −100 and 100. Positive values indicate preference for an attribute level.

^b Unscaled part-worth utilities: A classic (frequentist) multinomial logit is shown for the aggregate model highlighting respondents' part-worth utilities (part-strength preferences) as unscaled logit estimates. A two-tailed *t*-test shows significance, **p* < 0.1; ***p* < 0.05; ****p* < 0.01.

^c 95% CI: Confidence intervals for each attribute level were calculated by two-tailed *t*-test using the standard error (SE) and mean zero-centered part-worth utilities: 95% CI_{U/L} = (zero-centered part-worth utility) ± 1.96 (SE).

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