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Do concerns about wind farms blow over with time? Residents' acceptance over phases of project development and proximity

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ABSTRACT

Social acceptance is a key issue for the continued expansion of onshore wind energy. Wind energy development targets increasingly rely on the assumption that residents' concerns related to new wind farms dissipate over time. The persistence of resistance to new wind farms has motivated efforts to investigate this effect. The 'U-curve' hypothesis proposes that acceptance is likely to decrease when residents are confronted with the planning of a wind farm in their neighbourhood, but that acceptance may later recover during construction and operation. In this study, relevant research is reviewed, discussed, and applied using a largescale experimental survey focused on residents living within 10 km of an existing wind farm in Ireland (n = 1109). It uses two indicators of how people experience wind farms to investigate willingness to accept further developments. The indicators include the proximity of existing wind farms and their development phase (i.e., planning, construction or operation). The findings show that experience is an important determinant of acceptance, as are an awareness of low-carbon energy initiatives and sense of community spirit. The study examines residents' expectations for participatory fairness and local benefits. Expected adverse impacts on local tourism or potential for discord within the community influence the acceptance for further development. Acceptance is also determined by trust in sources of information, including a designated community liaison officer. The concerns of residents living within the nearest 2 km radius of a wind farm and at the earliest and most uncertain phases of project planning can be crucial issues for acceptance.

1. Introduction

Living close to a wind farm is expected to become an increasingly common experience for non-urban communities in regions with high wind potential [1,2]. Wind energy has established itself as a pre-eminent technology in the transition to renewable energy sources and its accelerated development is anticipated to add 570 GW worldwide by 2027 [3,4]. Therefore, a critical assumption for expanding onshore wind capacity is that local residents will become accustomed to wind farm developments as they continue to be developed near residential areas [2, 5]. However, evidence of whether and how acceptance of wind farms progresses during implementation has been limited to date [5]. The operational lifetime of a wind farm provides evident national benefits in the form of affordable renewable electricity without producing greenhouse gas emissions [6]. Nonetheless, the social impacts of wind farms disproportionately affect the immediate surrounds of the project. These impacts persist until project decommissioning or, increasingly, repowering [7,8]. Acceptance for local energy transitions is therefore shaped over the lifetime of renewable energy infrastructure. This relationship can be described as a U-shaped curve, which hypothesises that residents' attitudes towards wind farms are likely to be less favourable during the planning phase of development but may gradually become more favourable once a wind farm enters into operation [9]. Understanding this process calls for deeper investigation as to how the process of acceptance is affected by prior experience [10]. The dynamics of social acceptance of renewable energy has become a high-priority research focus [11,12] and the topic of a recent special issue [13]. To contribute towards closing this gap, the paper investigates how willingness to accept further wind farm development progresses over different phases of project development for residents living within 2 km, 2–5 km or 5–10 km of a wind farm. It investigates how this process is influenced by the individual-specific trade-offs associated with wind farm proposals. It also profiles respondents whose acceptance varies with prior involvement with renewables, trust in information about a

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new wind farm proposal, and attitudes towards onshore wind-generated electricity.

It has been suggested that residents grow accustomed to wind farms during the development process and that this contributes to acceptance, whether due to the realisation of local benefits of wind farms [14] or with first-hand experience (rather than the expectation) of wind farm impacts [15]. Various studies have highlighted prior experience of renewable energy as an important consideration for the local acceptance of new developments [1,2,5,8,14,15]. Survey methods are helpful to investigate the relationship between wind energy development and local attitudes relevant to planning for wind farm implementation which considers local concerns [2]. An important inclusion in such methods is to consider variables for residents' "experience" of wind farm developments within the local setting using a Euclidian proximity measure, such as the distance and/or view of the turbines from their residence ([2] p.3). However, the relationship between prior experience of wind farm developments and local attitudes has an important temporal dimension [5,8,12].

In the short term, the tendency to preserve the status quo when confronted with an uncertain imagined future for an environment can heighten initial resistance to a wind farm development [16,17] and prior attitudes might never return to the same level [7,18]. It is essential that these possible outcomes be better understood and incorporated into planning and policy. However, research into how social responses towards renewable energy change over time is scarce, owing to conceptual challenges [19] as well as imperfect empirical assessment methodologies [20]. There has been a significant interdisciplinary effort to understand how familiarity, knowledge and experiences of nearby wind farms affect the acceptance of wind energy [2,15,21,22,23,24]. This paper makes headway towards this objective and uses two indicators of residents' experiences of wind energy to investigate whether and how acceptance develops with greater/longer-term exposure to wind farm developments. It considers residents' experiences of wind farms owing to exposure to existing projects over (i) the temporal phases of project development (planning, construction and operation); and (ii) by residents' proximity to the wind farm (within 2 km, 2–5 km or 5–10 km). These effects on local acceptance are investigated under the research question, "*Do residents who live nearer to wind farms, or with a longer exposure to wind farms, have stronger acceptance for further development in their community?*" Addressing this question contributes to a fuller understanding of residents' responses towards renewable energy development in the community. Across wind-rich areas, it is becoming more urgent to understand stakeholders' prevailing concerns if the energy transition is to go forward equitably and at the necessary pace [25,26].

Renewable energy developments affect diverse interests [27]. Acceptance is moderated by experience and knowledge of renewable energy innovation which has an ostensibly different influence on stakeholders' perception of risks, costs, benefits and impression of fairness during the phases of the development process [21]. Long-term attitudes can be shaped by residents' perception of the distributive and procedural justice of wind farm developments throughout planning, construction and operation [5,25,21]. For example, residents may place importance on the socioeconomic or environmental outcomes for communities neighbouring a wind farm [7]. Their expectations for fairness can be affected by their underlying trust in information sources about the development and the actors involved in its implementation [28,29]. Therefore, information, involvement, and stakeholders' desired outcomes have been identified as key concerns for the local acceptance of renewable energy technologies [11,30]. This study aims to identify segments of respondents who might benefit from common interventions during the development process based on individual-specific concerns, priorities and attitudes towards wind development. A latent class approach is used to examine the factors affecting wind farm neighbours' willingness to accept further wind development in the community. Therefore, the paper also addresses the following question: "*To what extent do community/individual circumstances, attitudes, and awareness of renewable energy influence wind farm neighbours' willingness to accept further development in the area?*" Characterising how experiences of renewable energy, perceived costs/benefits and personal norms determine willingness to accept accelerated onshore wind is essential for the shift towards sustainable electricity use. Policy is increasingly called upon to recognise that stakeholder confidence, awareness and involvement can act as "social catalysts" or "soft barriers" for/against the diffusion of renewables [31,32].

To our knowledge, this paper is the first largescale choice experiment examining the relationship between residents' acceptance for further wind development and their experience of wind energy implementation temporally, across each phase of wind farm development, with sampling based on geographic proximity to the wind farm. The paper investigates the acceptance of Irish citizens living within 10 km of a wind farm and examines their preferences for further wind energy developments located in the community. Ireland is an illustrative case/site to study the experience of communities near to wind farms on account of its vast onshore wind potential [33], small and rural population, and the increasing pressure on its onshore wind farm planning system [34]. This adds to comparable studies which have been conducted at a national scale (e.g., Refs. [35,36–39]), but which do not study respondents' experience of wind farms within their area of residence. It also identifies and characterises unobserved latent factors that shape the conditional acceptance of onshore wind farm development at the individual level [40]. This research contributes towards Sustainable Development Goals 7, 11 and 13 relating to fair infrastructure development processes in renewable energy for climate action. Section 2 provides an overview of the theory concerning wind farm neighbours' experiences and attitudes towards wind farm developments. Section 3 details the methodology. Section 4 contains the results and discussion. Section 5 presents implications for policy and future research.

2. Theory

Society's increasing reliance on wind electricity will continue to require the deployment of numerous wind farms across predominantly rural areas [41–43][59]. This implies that residents in these areas are more likely to encounter and become accustomed to onshore wind farms through their daily activities in a way not seen for dispatchable energy sources which supply electricity to the centralised system from large-scale power plants. However, research to investigate whether prior experience of wind farms leads to greater tolerance or support for further development has been limited [5]. There is a growing body of evidence which highlights the planning phase as a crucial point for social acceptance [5,7,29,9,44,45]. During planning, hesitancy to accept uncertain changes from the status quo [5,46] can manifest as resistance towards wind energy developments or fear about the impacts of a proposed project [1,5,11,9]. However, equally important for the energy transition is the nature of acceptance beyond this point, and the ways in which residents continue to interact with, and respond to, onshore wind energy developments [5,23,47]. Acceptance is characterised by dynamic interactions between society and technology which ultimately shape the perception of the justice of new developments [9,48,49]. However, residents may feel alienated by shortcomings in the distribution of benefits between developers from outside the community and local inhabitants [5,7],42,50 or if the participation and representation of

Table 1
Empirical research into the effects of experience on the local acceptance of onshore wind farms.

Study	Measure of experience	Interval	Location (Commercial operation date)	Project scale (Total capacity)	Sample	Explanatory factors	Effect on local acceptance
Warren *et al.* (2005)	Proximity Pre-/post-construction	0–5 km, 5–10 km, 10–20 km	Scottish Borders: Dun Law, Scotland (2000) Black Hill, Scotland (1999) South-West Ireland: Currabwee, (2000) Milane Hill (2000) Beenageeha (2000) Tuarsillagh (2000)	26 turbines, 42 m (17.2 MW) 22 turbines, 50 m (22 MW) 8 turbines, 60 m (4.8 MW) 9 turbines, 47 m (5.94 MW) 6 turbines, 47 m (3.96 MW) 23 turbines, 50 m (15.8 MW)	Scottish Borders (115) South-West Ireland (240)	Visual factors, local benefits, tourism, noise annoyance, intrinsic value, siting preferences, attitude towards first/second wind farm proposal	+
Wolsink (2007)	Pre-planning, concrete planning stage and post-construction	16 years (16 public survey occasions)	Multiple locations	Multiple projects and locations	1733 Wadden Vereniging environmental protection survey respondents (pre-planning: 499; concrete planning stage: 554; post-construction: 680)	Perceptions of visual changes to the landscape, processes for citizen involvement during the planning/siting negotiation and development process	+
Eltham *et al.* (2008)	Pre-/post-construction	14 years (recalled opinion)	St Newland East village within 2.25 km of Carland Cross, Cornwall, UK (1992)	15 turbines, 30 m (6 MW)	100 (semi-structured interviews)	Visual factors, noise annoyance, technical or contextual disruption, tourism impacts, environmental benefits, financial benefits	+
Swofford and Slattery (2010)	Proximity	0–5 km, 5–10 km, 10–20 km	Wolf Ridge Wind Farm, Cooke County, Texas, US (2008)	75 turbines, 80 m (112.5 MW)	200 surveys (8 <5 km; 106 5–10 km; 86 10–20 km)	Visual impact, noise annoyance, property value-loss, reliability, necessity/cost of reducing fossil fuel use, global environmental benefits, areas where wind farms are visible	–
Baxter *et al.* (2013)	Proximity	Comparative case-control survey within 15 km	Cases: Melancthon I (2006) and II (2008), Ontario, Canada. Control: West Perth, Ontario, Canada (no turbines)	Melancthon I: 45 turbines (67.5 MW) Malancthon II: 88 turbines (132 MW)	300 surveys within 15 km	Self-assessed knowledge and preferences for renewable energy, visual factors, health impacts, biodiversity impacts, economic impacts, siting process, community conflict, opposition to existing infrastructure	+
Meyerhoff (2013)	Proximity	Local/global autocorrelation within a distance band of 6 km	Westsachsen, Saxony, Germany	Multiple projects	353 telephonic interviews	Local/global autocorrelation within a distance band of 6 km, Size of wind farms, maximum height of turbines, minimum distance to residential areas, monthly surcharge to electricity bill, effect on red kite bird population	+
Rijnsoever *et al.* (2015)	Pre-/post-Fukushima nuclear accident	2 years (unpaired sample)	Households across the Utrecht province, Netherlands	Multiple survey locations	916 (2010) and 1448 (2012) hand-delivered surveys	Un/labelled energy source, security of supply, spatial impact, amount of effort, price per kilowatt hour, long-term problems	–
Motosu and Maruyama (2016)	Proximity	0–1 km/1–2 km/2–3 km	Within 3 km of X Wind Farm, Japan	Confidential project	298 paper surveys	Global environmental benefits, energy security, local benefits, creation of a local image, creation of a new landscape, tourism, noise annoyance, shadow flicker, light obstruction, sources of information about the wind farm, trust in the developer, developer responses to concerns	–
Petrova *et al.* (2016)	Proximity	0.25–0.5 mi, 0.5–0.75 mi, 0.75–1 km	Hull Wind I (2001) and Wind II (2006), Plymouth County, Massachusetts, USA Kingston wind turbines (2011–2012), Plymouth County, Massachusetts, USA Falmouth Wind I and II (2010), Barnstable County, USA	Hull Wind I: 1 turbine (660 kW), Hull Wind II: 1 turbine (1.8 MW) Kingston: 3 private turbines (6 MW), transport authority (100 kW), 1 municipal turbine (2 MW) Falmouth Wind I: 1	345, 350 and 356 surveys collected within each town respectively	Visual/landscape factors, noise annoyance, environmental concern, socioeconomic benefits, procedural aspects (VESPA)	+/-

(*continued on next page*)

Table 1 (*continued*)

Study	Measure of experience	Interval	Location (Commercial operation date)	Project scale (Total capacity)	Sample	Explanatory factors	Effect on local acceptance
				turbine (1.25 MW), Falmouth Wind II: 1 turbine (1.25 MW)			
Wilson and Dyke (2016)	Pre-/post-construction	5 years (recalled opinion)	Within 3 km radius of Roskrow Barton, Cornwall, UK (2008)	2 turbines, 70 m (1.7 MW)	58 key stakeholders (semi-structured interviews)	Place attachment, visual impact, noise annoyance, environmental impacts, changes to local area, traffic congestion during construction, property value-loss	+/-
Hoen *et al.* (2019)	Proximity	<0.8 km, 0.8–1.6 km, 1.6–4.8 km, 4.8–8 km	Within 8 km of a wind turbine, US	Multiple projects	1705 (online survey)	Auditory and visual sensory perception, perceived planning process fairness, demographic characteristics, environmental concern	+
Mills *et al.* (2019)	Post-construction	2 years (individually repeated survey)	Michigan 1, Michigan (2008) Harvest, Michigan (2008/2012) Sigel, Michigan (2012) Stoney Corners, Michigan (2008/2010)	46 turbines, 119 m 65 turbines, 121/145 m 40 turbines, 150 m 29 turbines, 126/146 m	520 landowners (online surveys) 149/172/126/73	Visual impact, noise annoyance, local benefits, biodiversity impacts, procedural justice, health impacts, perceived changes in local weather, property value-loss	+/-
Windemer, (2023)	End-of-life	25 years (recalled opinion)	Within 3.5 km of St Breock, Cornwall (1994) and Kirkby Moor, Lake District National Park (1993) UK	12 turbines, 42.4 m; repowering application refused 11 turbines, 53.5 m, repowering in 2015 received wide support, for 5 turbines, 100 m	Kirkby Moor: 128 (12.5 MW) St Breock: 74 (18 MW)	Awareness of 25-year planning consent, community involvement in the planning process, local benefits, place attachments, environmental concern	+/-

residents in decisions affecting the community are perceived to be undemocratic [5,7,25,29,51]. This section provides an overview of relevant empirical research investigating the ways in which residents "get used to" wind farms [5].

Table 1 provides an overview of thirteen studies which have considered how stakeholders' level of experience of onshore wind farm development affects local acceptance. One strand of research gives greater emphasis to stakeholders' temporal exposure to wind farms as a measure and aims to understand whether there are activities at specific phases of the wind farm development process which are most salient for local support. Another strand focuses on proximity to wind farms and aims to explore which conditions of new developments are most conducive to the acceptance of wind farms sited within the community. The table's chronological ordering reflects the evolution of research into the diffusion of wind energy technology over the past two decades. This research progression has been reviewed in detail by Batel [52], Ferraro and Ellis [53], and Rand and Hoen [54].

The table highlights identified factors that affect nearby stakeholders' attitudes towards nearby wind farms. These studies show that prior experience of wind farm developments can, but does not necessarily, enhance acceptance among local residents. The findings indicate that acceptance can increase over time if the development and operation of a wind farm is felt to be necessary and is consistent with stakeholders' expectations for distributive and procedural fairness [29,22,51,55]. Research into these effects temporally, proximally, and in conjunction with community/individual circumstances are discussed next in turn.

2.1. *Temporal experiences of wind energy*

In a landmark paper, Wolsink [9] observes that the acceptance of a wind farm by the community develops over the phases of a wind farm's development. The process is illustrated as following a U-shaped trajectory which describes that the first announcement of a wind farm proposal prompts residents to interrogate the acceptability of a development which can weaken supportiveness during planning, however acceptance can recover over time once the wind farm becomes operational [9]. Wilson and Dyke [23] perform a similar investigation at Roskrow Barton wind farm at Cornwall, United Kingdom, to contrast post-construction opinions towards the 'controversial' project with recalled attitudes before construction. It concludes that residents' attitudes reflect complex individual 'acceptance curves' based on specific areas of concern. While initial concerns may dissipate over the lifetime of a project, this does not imply a highly positive outlook towards the development [23].

Research suggests the negative expectations of residents are more likely to be overestimated when there is limited information about a project, but that with first-hand exposure to nearby wind farms, they may come to view the project more favourably [5,46]. This cannot be assumed however; those who are annoyed by the proximity-dependent impacts of wind farms are also more likely to view the planning process as unfair to local residents [29]. A study of a Cornish wind farm finds that while residents express greater appreciation of a wind farms' visual characteristics or environmental benefits after fourteen years, there is insufficient evidence to conclude that the initially strong level of support for the wind farm varies over time [51]. This points to the complexity of societal adaptation to wind energy implementation, including throughout the post-installation processes for local involvement in the project [29,50]. For example, Mills *et al.* [29] and Windemer [50] note that initial perceptions of a wind farm have longer-term implications for the tolerance of wind farms throughout the operational or extended project lifetime, which is connected to stakeholders' satisfaction with the earliest processes of planning. These studies also find that the acceptance of wind energy developments reflects an evaluation of the trade-offs for local residents, and the anticipated fairness of the distribution of costs and benefits between actors involved in the project [29,50]. Similarly, a study of a Japanese wind farm development notes that a lack of opposition towards a wind farm does not imply support for the project, and may reflect resignation [28]. Reflecting on the lack of impetus to engage local residents beyond the statutory requirements for planning consent and the associated risks for future developments, the paper calls for greater efforts to represent 'unvoiced opinions' and to inform and include 'silent' stakeholders throughout a wind farm's planning, construction and operation [28].

2.2. Proximal experiences of wind energy

Evidence shows some respondents never grow accustomed to a nearby development and that proximity has at least some effect on individual attitudes [56]. Drawing on evidence collected across three suburban wind farms in Massachusetts, United States, Petrova [7] provides a framework to characterise local concerns towards specific wind farm development proposals (namely VESPA: Visual/landscape, Environmental, Socioeconomic and Procedural Aspects). Sources of local concern, such as visual impact, are often specific to the siting context with the potential to affect emotional attachments to the pre-existing character of the landscape [7,57]. Wind farm implementation therefore has the potential to disrupt the identarian values local residents ascribe to their 'backyard' [7,22,57]. NIMBY (Not in my backyard) explanations for resistance to wind farms lack compelling evidence to support that place protectionism is motivated by self-interest over the collective good [9,58,56].[1] Although many environmental and visual concerns about wind farms are related to proximity, residents' participation rights, access to information and trust in developers are key issues for acceptance throughout a project [7]. The study proposes a participatory 'ENUF' framework and encourages developers to 'Engage', 'Never use NIMBY', 'Understand' and 'Facilitate' local concerns [7].

Warren *et al.* [22] provided the first investigation into the relationship between proximity and acceptance, covering multiple projects in the early or operational phases of development across South-West Ireland and the Scottish Border. The study describes an 'inverse NIMBY' effect finding those nearest to wind farms tend to be the most supportive, concluding that their positive attitudes towards wind farms developed in the locality are engendered through positive experiences of prior wind farm implementation (p.872) [22]. The study describes resistance to wind farm developments as a NIABY (Not in anybody's backyard) rejection of wind development as a matter of principle that is reinforced by the perceived risks and/or impacts of the project for the local community [22]. Research highlights that proximity-dependent environmental impacts are a genuine source of local concern towards the siting or scale of wind farm developments. The proximity of a wind farm determines the reasonable zone of impact with a decay effect over increasing distance [59]. However, uncertainty and (mis)information about possible impacts can also reach stakeholders who live much further away [15]. Environmental arguments have been utilised by both opponents and supporters of wind energy ('green on green' debates), with the former's concerns focused on the potential impact on local flora/fauna and residents and the latter's on global environmental benefits of clean energy use [22]. Over time, this has mainstreamed the use of protective technologies and the stringency of impact assessments to mitigate repercussions and identify sources of local concern [7].

2.3. Disentangling experience and acceptance

Several studies have integrated multiple factors across numerous projects to capture contextual trends in local wind energy acceptance owing to proximity and temporal exposure to wind farm developments as well as community/individual circumstances, attitudes, or involvement in renewable energy (e.g., Refs. [7,55,58,60,61]. In a choice experiment setting, Meyerhoff [60] combines latent class and spatial proximity to examine preferences for a 'constrained' or 'status quo' wind farm development programme in Germany. The findings reveal similar geographical clusters to show the opponents of wind farm proposals are more likely to live greater distances from existing wind farms and are willing to pay more on average for the siting of turbines further away [60]. Another experimental study compared Dutch citizens' attitudes and knowledge of wind energy before and after the Fukushima nuclear accident of 2011 and applied a latent class model to examine preference heterogeneity towards renewable energy development programmes. Despite the rapid deceleration of nuclear energy observed in the wake of the accident, the study suggests that individual preferences remain temporally stable, with changes observed within specific segments rather than on aggregate [61]. Hoen *et al.* [55] is an example of a national study with sampling based on geographic criteria and provides evidence of two parallel phenomena in a survey of United States households within 8 km of a wind farm. First, the paper proposes that attitudes which become more positive over the long-term operation of a wind farm can be partly attributed to Tiebout sorting [55].[2] Second, controlling for demographic differences and reported visual/auditory impact, the paper also reports that residents closer to wind turbines generally have more positive attitudes towards wind energy infrastructure [55].

Noting these potential social costs, policy increasingly highlights the importance of perceived fairness in the outcomes of wind energy development. Within this context, financial benefit-sharing mechanisms have gained prominence and tend to focus on residents who live closest to a wind farm [7,23,58]. Incentives can take the form of community benefit funds for spending on collective initiatives, structured compensation schemes, or in-kind funding from developers for projects such as infrastructure upgrades, which can provide genuine local benefit [28,29,51]. However, research also shows that compensation has a shorter-term impact on the acceptance of landowners than local involvement and representation in the development process [29], and furthermore that the strength of the compensation effect is halved when comparing payments towards households not hosting a wind farm on their property with those that do [55]. In some instances, analysts report that the introduction of financial incentives can contribute to conflict within the community depending on who stands to gain from the operation of a wind farm [29,58].

Research into the relationship between experience and the local acceptance of wind farms presents an argument to encourage citizen participation throughout project development, beginning before the formal process of preparing a planning application with the first stages of stakeholder consultation and public engagement during site selection [48,54]. Perceived procedural fairness has been shown to reinforce respondents' appreciation for the local benefits of the wind farms, whereas perceived unfairness during the wind farm consultation process has been linked to greater perception of adverse impacts [29,44,45]. Involving community stakeholders in wind farms also serves a normative rationale to address local concerns and support justice throughout the planning, construction, and operation of a wind farm [5]. Inclusive processes imply a default position which is more conducive to local acceptance than so-called 'decide-announce-defend' siting approaches [9,58]. Communication and information-sharing can help to recognise the underlying institutional and social grievances of a silent majority [28]. Furthermore, stakeholder engagement opens alternative routes for citizens to influence decision-making rather than through legal opposition, which is said to represent the interests of a vocal but active and

[1] NIMBY explanations for local resistance towards energy infrastructure grew from social challenges associated with nuclear facility siting in the 1970s–1980s. Research suggests its use in the context of renewable energy development is inappropriate [57,107,130].

[2] Tiebout sorting describes the self-selection of individuals supportive of wind energy into an area hosting wind turbines, and the movement of non-supporters out of the area.

organised minority [51].

Residents' concerns and priorities for wind farm developments determine under which conditions, and to what extent, they perceive a wind farm proposal in the community to be fair. This study investigates residents' willingness to accept wind farms within a choice experiment based on conditions which have been identified as important for distributive and procedural fairness [62]. The study aims to characterise to what extent the phase of a wind farm's development and/or proximity affects residents' preferences, expectations and acceptance.

3. Methods

3.1. Sample and survey structure

There are approximately 2200 turbines across 300 wind farms representing 4.3 GW onshore wind capacity in Ireland distributed as shown in Fig. 1. In Ireland, almost all wind farms are owned and operated by private or semi-state companies [63,64].[3] Onshore renewable energy auctions aim to add 14,000 GWh by 2025 compared with 10,729 GWh in 2020, and the first and second rounds in 2020 and 2022 respectively added a further 33 wind farms, amounting to 893 MW [65,66].

Against this background, a novel survey instrument was designed to investigate wind farm neighbours' concerns for further onshore wind development. Data were collected through an online survey conducted in two stages over May–July 2021 and July–August 2022. The survey was administered by a market research company. It focused on residents living near to existing wind farms at the planning, construction, or operation phase and asked respondents about their attitudes towards another (new) wind farm located near to their home. The survey screened respondents on the basis of their age, gender, and region to identify a suitable sample living with 10 km of a wind farm as summarised in Table 2 (n = 1109). This radius defines an area of interest that is in keeping with earlier surveys of wind farm neighbours [55,22].

The survey instrument was structured into sections to elicit information from respondents to examine each of the variables shown in Table 3. The questions were designed to capture information on a four-point Likert scale as to respondents' trust in information sources regarding wind farms and their attitudes towards onshore wind energy as a national electricity resource. The survey instrument collected demographic information about respondents, their households, communities, and nearby wind farms. Respondents were asked to provide information about the distance to their nearest wind farm and its phase of project development at the time of the survey.[4] The survey also contained a choice experiment that modelled respondents' willingness to accept a hypothetical wind farm proposed for development in their community.

The choice experiment method elicits stated preference information from respondents. The method is increasingly applied to policy research [73–76] to investigate complex environmental preferences in instances where there is a lack of information concerning choice behaviours in the real market setting [77], as in the case of wind energy [74,35,78]. Choice experiments rely on the principle that preferences are based on the specific attributes of goods [79]. Using this information to elicit trade-offs between different attributes in combination presents respondents with many opportunities to express their environmental preferences, resulting in deep sampling of preferences across choice tasks [77,80].

In this study, this was achieved by defining a set of key attributes and

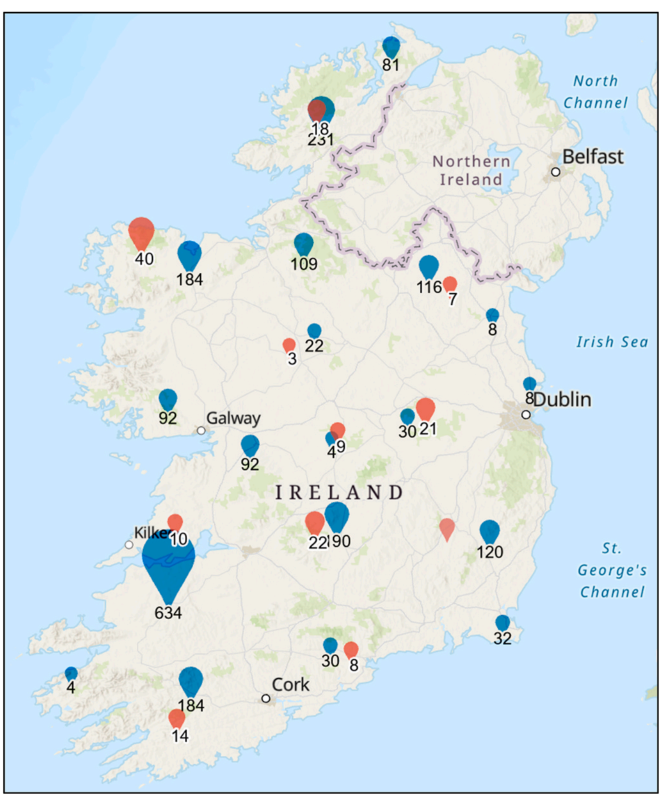

Fig. 1. Distribution of operating (blue) and planned (red) wind turbines (Data courtesy of SEAI, 2022).

Table 2
Demographic characteristics of the sample.

	Within 10 km of a wind farm (n=1109)	National census[a]	Difference
Gender			
Male	44 %	49 %	(-5 %)
Female	56 %	51 %	(+5 %)
Age			
18–24	20 %	11 %	(+9 %)
25–34	27 %	18 %	(+9 %)
35–44	19 %	21 %	(+2 %)
45–54	14 %	18 %	(-4 %)
55–64	10 %	14 %	(-4 %)
65+	10 %	18 %	(-8 %)
NUTS 3 Region [b]			
Border	11 %	8 %	(+3 %)
Dublin	18 %	28 %	(-10 %)
Mid-East	11 %	15 %	(-4 %)
Midlands	7 %	6 %	(+1 %)
Mid-West	13 %	10 %	(+3 %)
South-East	11 %	9 %	(+2 %)
South-West	18 %	14 %	(+4 %)
West	10 %	10 %	(0 %)

[a] Statistics reported as per 2022 national census data available from the Central Statistics Office, cso.ie. Values may not sum to 100 % due to rounding error.

[b] Nomenclature of territorial units for statistics. Dublin intentionally undersampled as there are only a few turbines within 10 km of the city.

[3] The details of connected and contracted wind farms can be viewed at the Irish Wind Atlas, gis.seai.ie/wind/.

[4] Distances to nearest wind farms were also examined at the level of the postal routing key system using geographic coordinates. Straight-line responses were screened out of the sample.

Table 3
Questions presented to respondents to examine variable effects.

Variable	Question as presented to respondents	Anticipated effect on acceptance	Relevant research
Experience:			
Distance to the nearest wind farm	(1) within 2 km, (2) 2–5 km, (3) 5–10 km	Increasing with proximity	Hoen *et al.* [55] Warren *et al.* [22]
Phase of wind farm development	(1) Planning, (2) Construction, (3) Operation	Increasing post-construction	Wolsink [9] Hoen *et al.* [55]
Awareness of renewable energy initiatives (agree/disagree)	(1) Is there a Sustainable Energy Community (SEC) in your area? (2) Has your household ever availed of a SEAI Home Energy grant? (3) Do you have investments/shares in wind energy? (4) Would you be willing to get involved in a community wind farm development? (5) I would like to purchase exclusively renewable 'green' electricity.	Increasing with prior involvement	Bauwens and Devine-Wright [14] Sirr *et al.* [67]
We are interested in your opinion on wind energy as an electricity resource for Ireland. Please indicate whether you agree or disagree with the following statements (agree/disagree/don't know)	(1) Wind energy in Ireland is a clean renewable energy source. (2) Wind energy is key to achieving Ireland's carbon reduction commitments. (3) Unreliable because the wind does not always blow. (4) Does more environmental harm than good. (5) Wind farm developments can negatively impact tourism. (6) There is a role for both onshore and offshore wind energy. (7) Wind farm developments should be moved offshore. (8) Wind energy has the potential to create jobs. (9) Wind farms bring discord into communities.	Increasing with agreement with perceived environmental/local benefits	Devine-Wright and Howes [57] Growth and Vogt [68] Mills *et al.* [29] Petrova [7] Slattery *et al.* [69] Swofford and Slattery [56]
How likely are you to trust the following sources of information regarding the proposed wind farm? (very unlikely/unlikely/likely/very likely)	(1) A website run by the developer (2) A website run by an anti-wind farm segment (3) Local paper (4) Local radio (5) An elected representative such as a councillor or TD (6) Social media such as Twitter and Facebook (7) Community liaison officer from the wind farm developer (8) An information pack from the wind farm developer (9) A neighbour who probably knows more about these things	Increasing with greater trust in developer-supplied information	Borch *et al.* [70] Devine-Wright and Howes [57] Firestone *et al.* [71] Motosu and Maruyama [28] Petrova [7]
Controlling variables	(1) Gender, (2) Home ownership, (3) Land ownership, (4) Age, (5) Education, (6) Household income, (7) Tenure within the community, (8) Rural/urban area, (9) Community spirit	Contextual preferences moderate willingness to accept	Hoen *et al.* [55] Hyland and Bertsch [72] Roddis *et al.* [40] Devine-Wright and Howes [57]

Table 4
Attributes and levels included in the choice experiment.

Attribute	Description as presented to respondents	Levels (trade-offs)	Relevant research
Distance to the wind farm	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 radius)	Bauwens and Devine-Wright [14] Brennan *et al.* [33] Hoen *et al.* [55] Peri *et al.* [59,84]
Visual impact	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	Devine-Wright [85] Hallan and González [1] Strazzera *et al.* [74]
Engagement during site selection	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 segment of people living very close to the proposed site (3) Town hall style meeting that includes the wider community (4) Receive a leaflet from the developer (5) The developer uses local radio and newspaper to announce their plans	Bidwell [86] Langer *et al.* [87] Walker and Baxter [88]
Community liaison officer [a]	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	Brennan *et al.*[33] Dywer and Bidwell [83] Firestone *et al.* [71]
Governance of the community benefit fund [b]	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	Bristow et al. [89] Devine-Wright and Sherry-Brennan [90] Kerr *et al.* [82]
Sharing of the community benefit fund	Sharing of the €180,000 annual community benefit fund between community projects for the common good and personal payments to neighbours within 2 km	(1) €130,000 p.a. to community projects and €50,000 p.a. shared between neighbours (2) €100,000 p.a. to community projects and €80,000 p.a. shared between neighbours (3) €80,000 p.a. to community projects and €100,000 p.a. shared between neighbours	Brennan *et al.* [33] García *et al.* [91] Vuichard *et al.* [92]
Opportunity for citizens to invest [c]	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	Curtin *et al.* [93] Sirr *et al.* [67] Lienhoop *et al.* [39] Jørgensen *et al.*[94] Walker and Baxter [88]
Developer [d]	The wind farm developer offering the investment (Commercial wind farms can produce electricity at a lower cost than either a community-led development or a joint developer/community development)	Community ownership (30 %/50 % extra cost): (1) Local landowners/farmers (2) A community sustainable energy (3) A new venture for an existing community network group Community (co-)ownership (20 % extra cost): (4) Joint developer and community venture Private/state ownership: (5) Irish semi-state companies (6) Private companies or developers	Baxter *et al.* [25] Goedkoop and Devine-Wright [95] Philpott and Windemer [96] Slee, [97] Warren and McFadyen [98]

[a] The Code of Practice for Wind Energy Development in Ireland provides guidelines for community engagement including the appointment of a community liaison officer, which is required for new wind farms developed after 2020 [99].

[b] The Irish national government recommends that the administration of community benefit funding is carried out by a committee of five to fourteen people including the developer and an administrator, with decision-making carried out by a panel of community representatives [81].

[c] There is discussion about mechanisms to encourage Irish citizens to invest into onshore wind farms. The first auction rounds included preferential categories for community-led renewable energy projects [99].

[d] Ireland's first two onshore renewable energy auctions contain a preferential capacity category for community bids, provided at least one member is part of a Sustainable Energy Community registered with the state agency for renewable energy [99]. Based on the average strike-price of successful projects awarded under the first onshore renewable energy auction [65], the *Developer* attribute was coupled to an attribute describing the *cost of electricity production* as shown. Levels of increase (20 %, 30 %, 50 %) were designed in consultation with policymakers and industry. Incompatible levels were not presented in combination.

Table 5
Goodness-of-fit measures for latent class solutions.

Segments	Log-likelihood	Percent Certainty[a]	Chi-Square	Relative Chi-Square[b]	AIC	CAIC[c]	BIC[c]
1	−10975.08	3.40	772.02	29.69	22002.15	22218.46	22192.46
2	−9610.73	15.41	3500.71	66.05	19327.46	19768.40	19715.40
3	−9315.59	18.00	4090.99	51.14	18791.19	19456.75	19376.75
4	−9248.90	18.59	4224.37	39.48	18711.80	19601.99	19494.99
5	−9208.46	18.95	4305.25	32.13	18684.92	19799.74	19665.74

[a] Percent certainty produces a goodness-of-fit measure analogous McFadden's pseudo-R^2 by using the geometric mean of the model likelihood.
[b] Relative Chi-Square applies a penalty for each added segment, and is twice the log-likelihood of the current model and twice the log-likelihood of the null model, divided by the number of parameters.
[c] Consistent Akaike Information Criterion is a common method to determine the number of segments and is similar to the Bayesian Information Criterion (BIC) by adjusting the log likelihood for the number of classes, choice tasks and independent parameters estimated for each class.

levels for the local acceptance of a wind farm at the planning, construction and operation phases of development based on the existing research as shown in Table 4 [62]. The attributes included in the analysis are based on existing mechanisms aimed at promoting distributive and procedural justice at different phases of wind farm development [62]. For example, local financial benefits associated with wind farm developments are increasingly formalised in Ireland [81] and are generally paid on an annual basis by professional developers into a community benefit fund or trust shared between, and governed by, residents living within the locality [82,50]. Another approach recommends that developers employ a community liaison officer to act as a single point of contact with the community, with the aim of better mediating and addressing residents' concerns about the wind farm [83,62]. The levels of each attribute were used to define a set of individual-specific wind farm proposals comprising one level of each attribute in a randomised fashion. Maintaining even sampling balance, respondents were presented with a set of choice tasks representing a proposal for the development of a wind farm within the community. This required respondents to make a series of eight trade-offs between two different wind farm proposals. Willingness to accept each development was incorporated into the choice experiment using a dual-response task that appeared after each choice to ask respondents whether they would accept their preferred wind farm if it were proposed for development within their community.[5] The sampling depth over attributes associated with each phase of wind farm development allows for measurement relative to respondents' willingness to accept. This is modelled against the dual-response task which represents preferences for the status quo.

3.2. Latent class segmentation

Stemming from consumer demand theory [79] and utility maximisation theory [100], the choice experiment methodology assumes that with some degree of natural variability, individuals (i) will consider wind farm proposals based on their defining characteristics (j) and choose the proposal which provides the greatest personal satisfaction (economic utility). The indirect total utility associated with wind farm development (U_{ij}) can be expressed under a model with a vector of estimable part-worth utility coefficients (β_j) describing the wind farm attributes (X_{ij}), such that the probability function $Pr(ij)$, is given by:

$$Pr(ij) = \frac{exp(U_{ij})}{\Sigma\, exp(U_{ik})} = \frac{exp(\beta_j X_{ij})}{\Sigma\, \exp(\beta_j X_{ik})} \forall j \neq k \tag{1}$$

It is advantageous to understand why individuals' utilities share similarities, however this often depends on unobserved characteristics which are difficult to predict *a priori* [73]. Following similar approaches [26,60,74–76], this paper uses a latent class utility model to assign respondents with similar willingness to accept to segments according to their behaviour within the choice experiment. This assumes the probability of respondent choices depends on h_{LC}, the prior probability of latent class membership, and $Pr(ij|LC)$, the conditional probability of a choice given that the class membership effects of individuals with similar latent preferences, expressed as follows [74,77]:

$$Pr(ij) = \Sigma h_{LC}\, Pr(ij|LC) \tag{2}$$

Following Tabi *et al.* [75], the latent class model defines segment membership and part-worth utility estimates. Part worth utilities, $\beta_{j|LC}$, are calculated at the individual-specific level using hierarchical Bayes estimation.[6] The aggregate model obtained a good fit with a percent certainty of 0.603 and root likelihood of 0.668. The latent class procedure was replicated five times from random starting points for up to five-class solutions under Sawtooth Software's default settings. Table 5 indicates that the three-class model was selected as the most parsimonious model, given trade-offs between goodness-of-fit measures (relative chi-square and percent certainty) and over-parameterisation as detected by the Consistent Akaike Info Criterion [75]. Maximum average segment membership is high, 93.7 %. The first latent class contains 397 respondents (35 %) who in aggregate accepted 66.3 % (SE = 8.4 %) of the wind farm proposals they encountered within the choice experiment. The second latent class contains 144 respondents (13 %) who accepted just 4.4 % (SE = 0.7 %) of wind farm proposals within the choice experiment. The third latent class contains 587 respondents (52 %) who accepted almost every proposal within the choice experiment (99.3 %, SE = 1.1 %).

3.3. Analysis and profiling

Willingness to accept was investigated using a randomised first-choice method. Randomised first-choice considers trade-offs between each level of each attribute and extends the simple total utility methods and simulates naturally imperfect choice behaviour by incorporating variability into the error term [73,101]. It predicts the share of preference between the status quo (i.e., no further wind development) and the

[5] The dual-response option allowed respondents to indicate after each choice whether they would take this option if it was presented to them in reality.

[6] Hierarchical Bayes regression is a multilevel approach that advantageously separates meaningful differences in individual preferences from random variance. The estimation method iteratively converges on an individual's specific utility function by borrowing information from other respondents. It is advantageous to combine the strengths of the latent class procedure, (i.e., to identify discrete differences in preferences between segments), with hierarchical Bayes estimation, (i.e., to converge on the mean part-worth utility for each segment to provide individual-specific parameters free from the independence of irrelevant alternatives (IIA) assumption) [100].

wind farm development conditions characterised in Table 2 [100]. A preferred 'best-case' combination of wind farm characteristics was included which maximises respondent utility.[7] Willingness to accept was compared across all attribute levels, *ceteris paribus*. This examined the influence of specific development conditions on acceptance including the best-case combination as well as the option not to accept a wind farm development under any circumstances. Latent classes' preferences between attributes were expressed as a relative importance measure captured by the range of individual-specific utilities for an attribute of interest over all attributes.

To profile each latent class, the factors affecting willingness to accept further wind energy development in the community, were profiled under a multinomial probit approach.[8] The results were checked for robustness.[9] Table 6 contains the descriptive statistics of each variable (experience over project phase/proximity; prior un/involvement in renewable energy; attitudes towards onshore wind electricity; mis/trust in information sources) across the full sample and for each latent class. Variables with multiple levels each sum to 100 % by attribute down each column, notwithstanding rounding error. Corresponding chi-square goodness-of-fit measures indicate that there are significant bivariate differences between the three latent classes.[10]

4. Results and discussion

This section investigates whether residents living near to a wind farm have similar attitudes towards additional wind energy developments proposed in the community based on their prior experience and the conditions of the proposal. First, Fig. 2 illustrates specific trends in willingness to accept and adds to existing research examining prior experience [2,55,102] over the phase of development and the proximity to the wind farm. Second, Fig. 3 and Table 7 summarise the wind farm preferences of three latent class segments identified using individual-specific information collected within the choice experiment. These are applied in Table 8 which profiles each segment to identify the key considerations for acceptance.

4.1. Proximity, phase of development and acceptance

This section investigates the specific effects of prior experience owing to proximal or temporal exposure to existing wind farms on residents' willingness to accept a new wind farm proposed for development in the community. Fig. 2 compares the share of preferences for a 'best-case' wind farm proposal which is predicted to maximise utility with preferences for the status quo. The figure contrasts residents living near a wind farm at the planning, construction or operation phase of development. It also compares between those living 2 km, 2–5 km, and 5–10 km away from an existing wind farm.[11]

The results of Fig. 2 highlight that considering the proximity between residential areas and wind farms (within 2 km) and the earliest phases of a wind farm's development is critical for acceptance. Specifically, Fig. 2A shows in light bars that on average willingness to accept wind farm developments in the community is stronger for residents at the construction or operation phase of development than in the planning phase. This trend is significant at the $p < 0.01$ level as indicated by asterisks. Similarly, the dark bars in Fig. 2B show that residents living 2–10 km from a wind turbine have similar willingness to accept. However, respondents living within 2 km are less willing to accept further wind farm development compared to those living further away ($p < 0.05$). The grey bars indicate that more residents at the planning phase and within 2 km are likely to prefer maintaining the status quo and forgo further wind farm development than the rest of the sample.

Earlier research has proposed that the significant shift in attitudes at the earliest phase of planning are a function of the responsive interest to the announcement of a wind farm and speculation about the possible future impacts of such a development [9]. The uncertainty of a long-term proposal requires communities to collectively and separately interpret, evaluate, and act on information communicated through local media and the developer [57,85]. This suggests uncertainty is likely to be strongest for individuals within the immediate vicinity of a wind farm [84]. Other papers identify a stronger relationship between proximity and acceptance, whether reinforcing [e.g., Ref. [55]] or counteractive [e.g., Ref. [33]]. Elsewhere, spatial analysis reports a non-linear trend, remarking that regions with the greatest concentration of onshore energy infrastructure (e.g., rural Scotland) and also the least concentration (e.g., city of London) show comparatively low levels of support for further energy development [40].

In order to examine the relationships between acceptance and residents' experience owing to the proximity and phase of existing wind farms, a latent class and profiling procedure was performed as detailed in Subsections 4.2 and 4.3 respectively.

4.2. Latent class preferences

A latent class model for residents' preferences for additional wind farm developments in their community identified three segments whose level of supportiveness for additional implementation showed clear distinctions (unwillingness to accept; strong willingness to accept; and a segment expressing moderate willingness to accept). The choices made by each segment indicate the preferred conditions for a wind farm development in the community. Table 7 and Fig. 3 highlight key differences between the preferences of each segment. Table 7 reports the relative importance of attributes. This provides an overview of the features which most strongly influenced respondents' choices. Fig. 3 compares respondents' preferences based on the conditions of each wind farm proposal. It represents willingness to accept as a share of preference comparing each condition against the average 'best-case' wind farm and the option to refuse further wind development (i.e., opt out).[12]

Approximately 13 % of respondents are unwilling to accept wind farm developments under any circumstances. Unwillingness to accept wind farm development is reflected as a near-zero share of preference

[7] Individual-specific part-worth utilities are provided in Appendix Table A1. From these, a randomised first choice procedure predicts on average 79.8 % (SE = 0.8 %) would be willing to accept such a wind farm proposal.

[8] Multinomial probit regression suitably accommodates random preference heterogeneity, substitution, and error correlation. Dummy variables test the hypotheses that willingness to accept further wind development within the community is enhanced by experience owing to the phase a wind farm development (β_1), proximity to a wind farm (β_2), controls for sociodemographic context and awareness of renewable energy initiatives (β_3), un/certainty as to the role of onshore wind energy as a source of national electricity (β_4), and mis/trust in information sources concerning wind developments (β_5) (Table 3). Constrained model 1 : $LC_i = \beta_0 + \beta_1(\text{Phase}_i) + \beta_2(\text{Proximity}_i) + \Sigma\beta_3(\text{Controls}_i) + \varepsilon_i$ Full model 2 : $LC_i = \beta_0 + \beta_1(\text{Phase}_i) + \beta_2(\text{Proximity}_i) + \Sigma\beta_3(\text{Controls}_i) + \Sigma\beta_4(\text{Attitudes}_i) + \Sigma\beta_5(\text{Information}_i) + \varepsilon_i$.

[9] The interaction term (Phase)*(Proximity) was included as an additional regressor in models 1 and 2 (see Footnote 7) to assess whether the joint temporal and spatial effect has a significant influence on segment membership. It was found to be insignificant. The significance, magnitude, and direction of other coefficients in models 1 and 2 did not change. Results are available from the authors.

[10] Correlation matrices for each variable are provided in the Appendix, Fig. A1.

[11] Further contrasts between the average frequency of acceptance over time for wind farm neighbours living within the immediate radius of a wind farm (within 2 km) or further away (up to 10 km) are provided in the Appendix. This approximates the underlying propensity of each segment of wind farm neighbours to accept a wind farm.

[12] The 'best-case' wind farm uses the individual-specific total utility. Individual-specific utilities are provided in the Appendix, Table 1.

Table 6
Descriptive statistics for the full sample and each latent class.

	Unwillingness to accept (13 %)	Moderate willingness to accept (35 %)	Strong willingness to accept (52 %)	*Total (100 %)*	p-value[a]
Wind farm characteristics					
Distance to the wind farm					0.001
Within 2 km	28 %	15 %	14 %	16 %	
2–5 km	33 %	38 %	42 %	39 %	
5–10 km	39 %	47 %	45 %	45 %	
Phase of wind farm development					0.000
Planning	35 %	27 %	15 %	22 %	
Construction	6 %	15 %	9 %	11 %	
Operation	60 %	58 %	76 %	68 %	
Individual characteristics					
Gender (Female)	62 %	59 %	52 %	56 %	0.035
Homeowner[b]	87 %	70 %	75 %	74 %	0.000
Landowner	38 %	38 %	38 %	38 %	0.986
Age					0.000
18-34	19 %	55 %	49 %	47 %	
35-54	38 %	31 %	33 %	33 %	
55+	42 %	14 %	18 %	20 %	
Education [c]					0.149
Primary level, junior cycle (NFQ 1–3)	7 %	11 %	14 %	12 %	
School leaving certificate (NFQ 4–5)	24 %	25 %	25 %	25 %	
Third level and higher education (NFQ 6–10)	69 %	64 %	61 %	63 %	
Employment status					0.000
Working full-time	48 %	55 %	57 %	55 %	
Working part-time	10 %	20 %	18 %	17 %	
Not currently working[d]	24 %	20 %	16 %	18 %	
Retired	18 %	6 %	10 %	9 %	
Household characteristics					
Annual household income					0.177
€23,348 or under	25 %	23 %	21 %	22 %	
€23,400 - 62,348	51 %	45 %	44 %	45 %	
€62,400 or over	24 %	32 %	35 %	32 %	
Number of people in household					0.001
1 person	21 %	11 %	12 %	13 %	
2 people	43 %	44 %	37 %	40 %	
3+ people	36 %	45 %	51 %	47 %	
Community characteristics					
Time living in current community					0.000
Under 1 year	3 %	6 %	3 %	4 %	
1–10 years	20 %	37 %	40 %	37 %	
11–20 years	21 %	24 %	20 %	22 %	
Over 20 years	56 %	33 %	36 %	38 %	
Rural/Urban area					0.000
Rural Area (population under 1500)	71 %	40 %	40 %	44 %	
Small town (population between 1500 and 5000)	17 %	27 %	26 %	25 %	
Mid-sized town (population between 5000 and 50,000)	9 %	30 %	26 %	25 %	
A city (population greater than 50,000)	3 %	3 %	7 %	5 %	
Awareness of renewable energy initiatives (yes, %)					
Know of a sustainable energy community in the area	9 %	30 %	36 %	30 %	0.000
Availed of a home energy grant	19 %	25 %	31 %	28 %	0.008
Investments/shares in wind energy	3 %	18 %	20 %	17 %	0.000
Willing to get involved in a community wind farm	8 %	29 %	33 %	29 %	0.000
Would like to purchase exclusively green electricity	49 %	60 %	69 %	63 %	0.000
Strong community spirit in the community	81 %	86 %	90 %	87 %	0.023
Opinions concerning wind electricity (agree, %)					
A clean renewable energy source	62 %	89 %	89 %	86 %	0.000
Key to achieving carbon reduction commitments	42 %	77 %	83 %	75 %	0.000
Unreliable because the wind does not always blow	38 %	30 %	29 %	31 %	0.094
Does more environmental harm than good	40 %	20 %	21 %	23 %	0.000
Wind farm developments can negatively impact tourism	65 %	37 %	25 %	34 %	0.000
There is a role for both onshore and offshore wind energy	47 %	78 %	85 %	78 %	0.000
Wind farm developments should be moved offshore	65 %	44 %	37 %	43 %	0.000
Wind energy has the potential to create jobs	50 %	78 %	81 %	76 %	0.000
Wind farms bring discord into communities	81 %	47 %	41 %	48 %	0.000
(Very) likely to trust sources of information (%):					
Website run by the developer	20 %	54 %	69 %	57 %	0.000
Website run by an anti-wind farm segment	42 %	34 %	38 %	37 %	0.121
Local paper	56 %	61 %	71 %	65 %	0.000
Local radio	55 %	60 %	73 %	66 %	0.000
Elected representative such as councillor/TD	32 %	49 %	62 %	53 %	0.000
Social media such as Twitter and Facebook	18 %	38 %	45 %	39 %	0.000
Community liaison officer from the wind farm developer	28 %	58 %	76 %	64 %	0.000
Information pack provided by the developer	26 %	62 %	75 %	64 %	0.000
A neighbour who probably knows more about these things	43 %	48 %	55 %	51 %	0.013

Note: Categories sum down each column. For brevity 'agree', '(very) likely' and 'yes' statements are reported excluding negative/neutral responses. Due to rounding errors, totals may not add to exactly 100 %.

[a] Two-tailed Chi-square goodness of fit, corresponding to *p < 0.1, **p < 0.05, ***p < 0.01.

[b] Owned outright or with Mortgage/Loan.

[c] National Framework of Qualifications is a 10-level system. NFQ levels 1–5 apply to education up to the end of formal schooling. NFQ levels 6–10 apply to higher academic education, including the higher-doctoral level. Details can be viewed at nfq-qqi.com.

[d] Unemployed, Student, Homemaker, or Unable to work due to health reasons.

for wind development in the area, irrespective of the conditions of the project (left dotted line, Fig. 3). The relative importance measures shown in Table 7 indicate that these resident's choices are strongly influenced by the proximity and visual impact attributes and less so by the developer of the wind farm than the rest of the sample.

In contrast, 52 % of residents are strongly willing to accept additional wind farm implementation in the community. However, they perceive a higher relative importance concerning the developer of a wind farm compared to individuals who are unwilling to accept wind farm developments (Table 7, fifth column). Fig. 3 (further right curve) shows that compared to other forms of ownership, residents who are strongly willing to accept prefer wind farms owned by local sustainable energy community and local (co-)ownership opportunities, such as providing opportunities for citizens living within 10 km of a wind farm to invest into the project. This suggests that the residents who are most willing to accept wind farms in the area value opportunities for community involvement and ownership of future wind farms [25,103–105]. For these residents, engagement during site selection is also amongst the most important wind farm attributes (Table 7) and in-person community engagement has an influence on willingness to accept across all phases of development – during siting (i.e., one-on-one, small, and town hall gatherings), construction (i.e., via a community liaison officer) and operation (i.e., administration of community benefit funding under a committee of community representatives). These identified conditions for support contribute to research which increasingly recognises the role of participatory justice in determining wind farm acceptance [25,33,9,35,105].

A third segment containing 35 % of respondents show moderate willingness to accept (middle curve, Fig. 3; middle column, Table 7). As described elsewhere, this segment revealed a 'midpoint stance' towards further onshore wind farm development which might suggest uncertainty [14], ambivalence [61,35] or qualified support for wind development [18]. While generally individuals have similar preferences for wind development, this segment's choices reflect a greater preference for near-neighbour benefit contributions and wind farms which are further away or not visible. This finding suggests that individuals with moderate preferences take into consideration their understanding of the 'cost-benefit ratio' of wind farm proposals [21]. The results reflect the

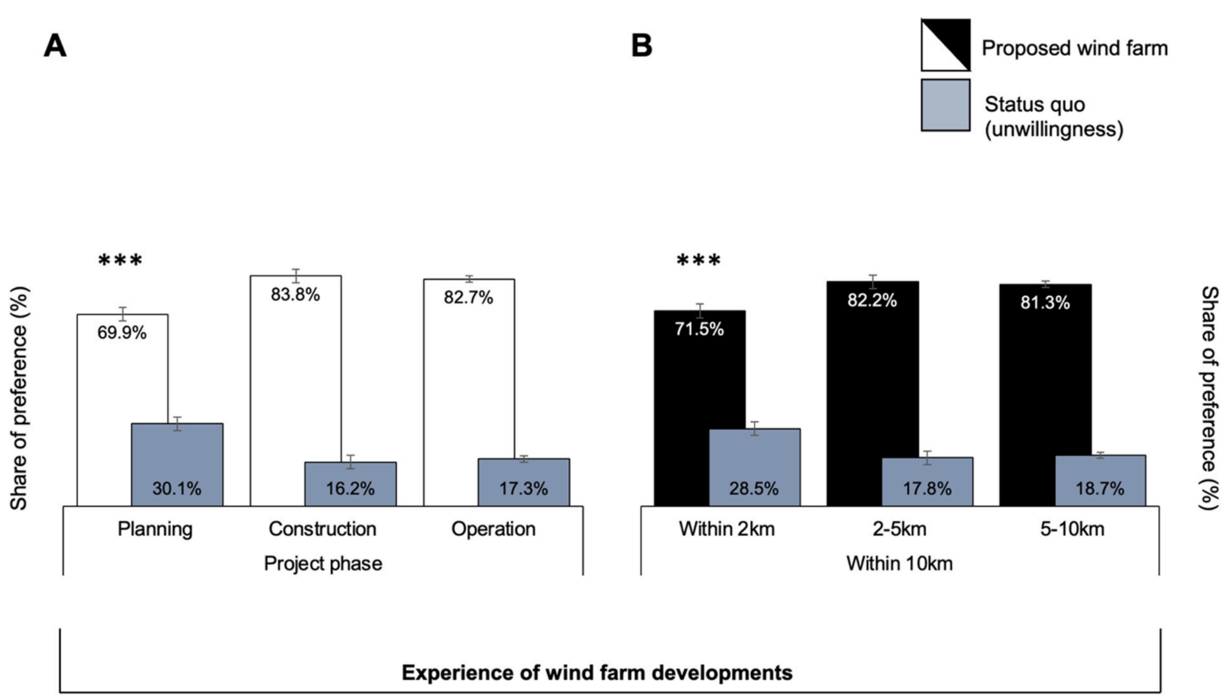

Fig. 2. Share of preference for a 'best-case' combination of wind development features and the status quo (A) over phase of project development; and (B) over proximity to the wind farm.

Note: Non-overlap of 95 % confidence intervals indicates significance demonstrated by *** for p < 0.01. A randomised first-choice procedure was used to define a wind farm scenario based on maximised total utility.

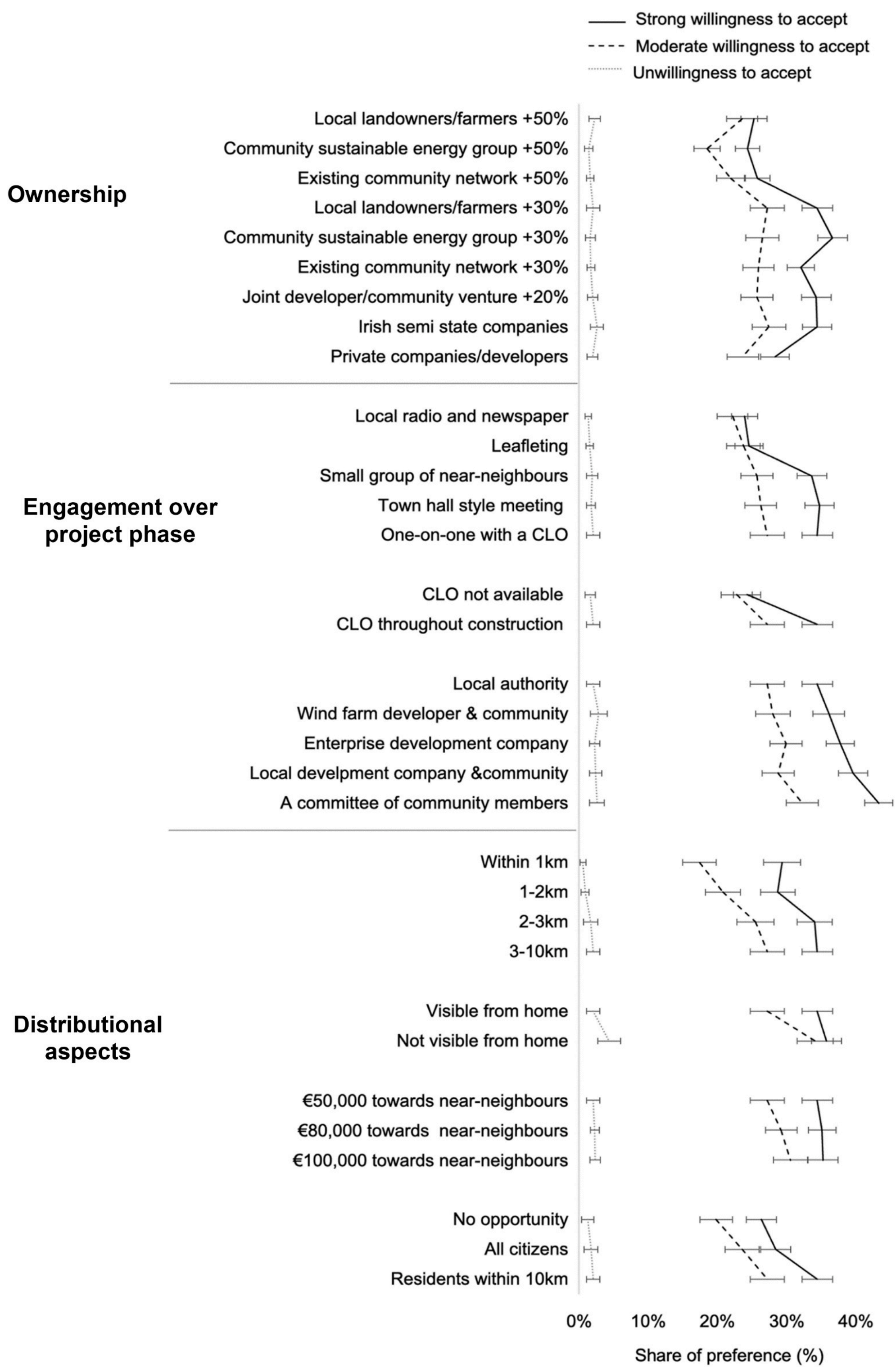

Fig. 3. Share of preference for different wind farm development conditions contrasted between three latent classes
Note: Bounded lines show 95 % confidence intervals. Non-overlap indicates significance of difference. Share of preference for attribute levels calculated by randomised first-choice versus a 'best-case' wind farm and the option for no further wind development.

Table 7
Relative importance of attributes to three latent class segments.

	Attribute	Unwillingness to accept *(13 %)*		Moderate willingness to accept *(35 %)*		Strong willingness to accept *(52 %)*		Total (100 %)
		RI	SE	RI[a]	SE[b]	RI	SE	'Best-case' preferred level of the attribute
Ownership	Developer	14.2 %	0.4 %	17.3 %	0.3 %	17.2 %	0.2 %	A community sustainable energy segment (30 % extra electricity production cost)
	Engagement during site selection	11.5 %	0.4 %	14.3 %	0.3 %	15.8 %	0.2 %	One-on-one with a community liaison officer
Engagement over project phase	Community liaison officer during construction	5.3 %	0.4 %	6.2 %	0.2 %	8.0 %	0.2 %	Yes
	Governance of the community benefit fund	11.9 %	0.4 %	14.1 %	0.2 %	13.9 %	0.2 %	A committee composed of community members
Distributional aspects	Distance to the wind farm	27.7 %	1.0 %	19.4 %	0.5 %	17.4 %	0.4 %	Over 3 km but under 10 km
	Visual impact (view from home)	9.0 %	0.5 %	7.4 %	0.3 %	6.6 %	0.2 %	No
	Sharing of the community benefit fund	9.5 %	0.4 %	9.7 %	0.2 %	9.8 %	0.2 %	If they live close to the wind farm (within 10 km)
	Opportunity for citizens to invest	10.7 %	0.4 %	11.6 %	0.3 %	11.3 %	0.2 %	€100,000 p.a. to community projects and €80,000 p.a. shared between neighbours

[a] Relative importance, RI (%): averaged individual utility range within each attribute as % of the total range of all attributes.
[b] Standard error of the mean (SE): a measure of sample heterogeneity equal to standard deviation over the square-root of sample size.

preferences of residents with some experience of existing wind farms, supporting that community benefit-sharing can help to recognise the potential local impacts of wind farms [8,23,82] and tend to be viewed as a favourable opportunity for communities in the area [33,58,82,106].

4.3. Factors affecting willingness to accept

This section jointly examines various factors affecting respondents' acceptance for additional wind farm development in their community. Table 8 shows the results of the multinomial probit models. Model 1 is 'constrained' to include only controlling sociodemographic variables and experience variables. Model 2 is 'full' and additionally examines the effect of attitudes towards onshore wind energy and trust in information sources as well as the sociodemographic and experience variables. The direction and significance of the relationships in comparison are of interest, holding all else constant. These are reported alongside the standard error. The Wald chi-square statistic increases between Model 1 and Model 2 showing an improvement in the predictive power with the inclusion of all variables.

First addressing each of the variables of interest, the models demonstrate that residents strongly willing to accept wind farm development in their community are significantly more likely to live within 10 km of a wind farm which is currently in operation (i.e., 76 %, Table 6) than a wind farm which is currently in its planning phase (15 %). A greater proportion of residents with weaker preferences for wind farm development are at earlier phases of project development than strongly supportive respondents (Table 6). This indicates that the planning phase is likely to be an important time to address local concerns [107,53,62,45]. Furthermore, Model 1 in Table 8 also suggests that residents are more likely to be willing to accept projects that are 2–10 km away from their home rather than within a 2 km 'near--neighbour zone' of possible impact [33]. However, proximity is not a significant factor when all potentially relevant variables are considered in the full model (in Model 2). It is worth noting that the dataset reflects the Irish context, where there are more operating wind farms than in construction phases of development as well as comparatively fewer households within 2 km than 2–10 km of a wind farm. For the large majority of nearby residents, the results would suggest sited wind farms become increasingly viewed as commonplace features over their operational lifetime [1,10,14].

Awareness of local renewable energy initiatives also has an influence on willingness to accept wind farms. Model 1 shows that respondents who are strongly willing to accept wind farm development are more likely to be aware of a sustainable energy community in the area, have a strong sense of community spirit, and express a desire to purchase exclusively 'green' electricity, unlike respondents unwilling to accept. The models provide evidence to suggest respondents moderately willing to accept are on average more willing to get involved in a community-owned wind farm initiative. Previous research has similarly described non-members of energy cooperatives as being more indifferent or uncertain towards renewable energy than members [14]. This highlights a growing understanding that acceptance is affected by local culture and social norms which influence the perceived "fit" between a wind farm development and the community [11,21,108].

Wind farm neighbours generally agree with economic and environmental arguments for wind energy, such as job creation (76 % agreement), clean energy (86 %) and carbon reduction (75 %) as reported in Table 6. Table 8 further illustrates that these viewpoints seem to have greater resonance with individuals willing to accept wind energy developments [69]. For instance, Model 2 shows that respondents who are supportive of wind electricity as a national resource are similarly likely to be willing to accept wind farms developments in the community, and vice versa. Those who are unwilling to accept wind energy are more likely to express that wind farms can cause discord in communities, offer limited local job creation, and are non-essential for reducing greenhouse gas emissions. Concerns relating to intra-community conflict, local economic benefits and environmental impact have been identified as issues for fairness that are important to both supporters and opponents of wind energy [9,58]. These findings suggest that greater sensitivity towards potential risks, rather than benefits, is associated with lower willingness to accept additional wind farms in the community. Another noticeable difference between segments concerns local tourism. Whereas residents who are strongly willing to accept appear unconvinced of the potential for negative impacts on tourism, those moderately or unwilling to accept generally agree that there could be adverse effects. These findings are consistent with what has been described as

Table 8
Average marginal effects for factors affecting willingness to accept wind farm development.

	Model 1: 'Constrained'						*Model 2: 'Full'*					
	Unwillingness to accept (13 %)		Moderate willingness to accept (35 %)		Strong willingness to accept (52 %)		Unwillingness to accept (13 %)		Moderate willingness to accept (35 %)		Strong willingness to accept (52 %)	
	AME[a]	SE[b]	AME	SE	AME	SE	AME	SE	AME	SE	AME	SE
Distance to the wind farm (ref. within 2 km)												
2–5 km	−0.06*	0.03	−0.02	0.04	0.08*	0.04	0.01	0.02	−0.04	0.04	0.03	0.04
5–10 km	−0.06**	0.03	−0.02	0.04	0.08*	0.04	0.02	0.02	−0.03	0.04	0.01	0.04
Phase of wind farm (ref. Pre-/planning)												
Construction	−0.07*	0.04	0.01	0.06	0.07	0.06	−0.03	0.03	0.02	0.06	0.01	0.05
Operation	−0.07**	0.03	−0.15***	0.04	0.21***	0.04	−0.02	0.02	−0.14***	0.04	0.16***	0.04
Awareness of renewable energy initiatives (yes, %)												
Know of a sustainable energy community in the area	−0.05*	0.03	−0.03	0.04	0.08*	0.04	−0.03	0.02	−0.01	0.04	0.04	0.04
Availed of a home energy grant	0.00	0.02	−0.05	0.04	0.05	0.04	0.01	0.02	−0.05	0.04	0.04	0.03
Investments/shares in wind energy	−0.04	0.04	0.05	0.05	−0.01	0.05	−0.04	0.04	0.06	0.05	−0.02	0.05
Willing to get involved in a community wind farm	−0.07***	0.03	0.06*	0.04	0.01	0.04	−0.06**	0.02	0.06*	0.03	−0.01	0.03
Would like to purchase exclusively 'green' electricity	−0.07***	0.02	−0.04	0.03	0.11***	0.03	−0.02	0.02	−0.02	0.03	0.05	0.03
Strong community spirit in the community	−0.02	0.03	−0.06	0.04	0.08**	0.04	−0.02	0.02	−0.05	0.04	0.07*	0.04
Individual characteristics												
Female (ref. male)	0.00	0.02	0.02	0.03	−0.02	0.03	0.03	0.02	0.02	0.03	−0.05*	0.03
Homeowner[a]	0.03	0.03	−0.03	0.04	0.00	0.04	0.02	0.02	−0.05	0.04	0.03	0.03
Landowner	0.02	0.02	0.00	0.03	−0.02	0.03	0.00	0.02	−0.01	0.03	0.01	0.03
Age (ref.18-34) rowhead												
35–54	0.06***	0.02	−0.07**	0.03	0.01	0.04	0.01	0.02	−0.06*	0.03	0.05	0.03
55+	0.14***	0.04	−0.09*	0.05	−0.05	0.05	0.07**	0.03	−0.08*	0.05	0.01	0.05
Education (ref. Primary, intermediate, junior certificate)												
Secondary, leaving certificate	0.00	0.03	0.02	0.05	−0.02	0.05	0.03	0.03	0.03	0.05	−0.06	0.05
Third level and higher	0.03	0.03	0.03	0.05	−0.06	0.05	0.05**	0.02	0.04	0.05	−0.09*	0.05
Employment status (ref. Working full-time)												
Working part-time	−0.05**	0.02	0.03	0.04	0.02	0.04	−0.03*	0.02	0.04	0.04	0.00	0.04
Retired	−0.03	0.03	−0.06	0.06	0.09	0.06	−0.02	0.03	−0.07	0.06	0.09	0.06
Not currently working[b]	0.04	0.03	0.02	0.04	−0.07	0.04	0.01	0.02	0.02	0.04	−0.03	0.04
Annual household income (ref. €23,348 or under)												
€23,400 - 62,348	0.01	0.03	0.00	0.04	−0.01	0.04	−0.01	0.02	0.01	0.04	0.00	0.04
€62,400 or over	−0.03	0.03	−0.01	0.04	0.03	0.05	−0.03	0.03	−0.01	0.04	0.04	0.04
Number of people in household (ref. 1 person)												
2 people	−0.06*	0.03	0.08*	0.05	−0.02	0.05	−0.02	0.02	0.08*	0.05	−0.06	0.04
3+ people	−0.06*	0.03	0.02	0.05	0.04	0.05	−0.01	0.03	0.02	0.05	0.00	0.05
Time living in current community (ref. under 1 year)												
1–10 years	−0.03	0.05	−0.09	0.08	0.12	0.08	−0.03	0.05	−0.07	0.07	0.10	0.07
11–20 years	−0.01	0.06	−0.04	0.08	0.06	0.08	−0.03	0.05	−0.03	0.08	0.07	0.07
Over 20 years	0.00	0.06	−0.09	0.08	0.09	0.08	−0.02	0.05	−0.07	0.08	0.09	0.07
Rural/Urban area (ref. Rural area)												
Small town (population between 1500 and 5000)	−0.04	0.03	0.00	0.04	0.04	0.04	−0.03	0.02	0.00	0.04	0.03	0.04
Mid-sized town (population between 5000 and 50,000)	−0.09***	0.02	0.04	0.04	0.05	0.04	−0.05**	0.02	0.03	0.04	0.03	0.04
A city (population greater than 50,000)	−0.06	0.05	−0.07	0.07	0.13*	0.07	−0.06	0.04	−0.04	0.07	0.10	0.07
Opinions concerning wind electricity (agree, %)												
A clean renewable energy source							−0.04*	0.02	0.00	0.05	0.04	0.05
Key to achieving carbon reduction commitments							−0.04**	0.02	0.01	0.04	0.03	0.04
Unreliable because the wind does not always blow							−0.04*	0.02	0.00	0.04	0.04	0.04
Does more environmental harm than good							0.03	0.02	−0.06	0.04	0.03	0.04
Wind farm developments can negatively impact tourism							0.03*	0.02	0.08**	0.03	−0.11***	0.03
There is a role for both onshore and offshore wind energy							−0.07***	0.02	−0.04	0.04	0.11***	0.04
Wind farm developments should be moved offshore							0.01	0.02	0.03	0.03	−0.04	0.03
Wind energy has the potential to create jobs							−0.03*	0.02	0.02	0.04	0.02	0.04
Wind farms bring discord into communities							0.05***	0.02	−0.01	0.03	−0.04	0.03

(*continued on next page*)

Table 8 (*continued*)

	Model 1: 'Constrained'						*Model 2: 'Full'*					
	Unwillingness to accept (13 %)		Moderate willingness to accept (35 %)		Strong willingness to accept (52 %)		Unwillingness to accept (13 %)		Moderate willingness to accept (35 %)		Strong willingness to accept (52 %)	
	AME[a]	SE[b]	AME	SE	AME	SE	AME	SE	AME	SE	AME	SE
(Very) likely to trust sources of information (%)												
Website run by the developer							−0.04**	0.02	−0.03	0.04	0.07**	0.03
Website run by an anti-wind farm segment							0.02	0.02	−0.01	0.03	−0.01	0.03
Local paper							0.04*	0.02	−0.01	0.04	−0.04	0.03
Local radio							0.01	0.02	−0.06*	0.04	0.05	0.03
Elected representative such as councillor/TD							−0.01	0.02	−0.04	0.03	0.05	0.03
Social media such as Twitter and Facebook							−0.03	0.02	−0.02	0.03	0.04	0.03
Community liaison officer from the wind farm developer							−0.05**	0.02	−0.06	0.04	0.10***	0.03
Information pack provided by the developer							−0.02	0.02	0.02	0.04	0.01	0.04
A neighbour who probably knows more about these things							0.01	0.02	0.01	0.03	−0.02	0.03
Wald Chi^2 (df)	211.63 (60)						332.12 (96)					
n	1109						1109					

[a] Average marginal effects (AME) for factor levels is the discrete change from the base level, significance applies to raw coefficients.
[b] Standard error of the mean (SE): a measure of sample heterogeneity equal to standard deviation over the square-root of sample size.

"wind caution" towards commercial development at a local scale, and a preference to address national energy issues differently [109]. For instance, residents unwilling to accept are less likely to agree there is a role for onshore and offshore wind energy. Despite this, residents unwilling to accept generally perceive wind farms as being reliable. Respondents who have doubts regarding the fairness of cost-benefit trade-offs of wind development, particularly with respect to local interests and industries, are generally less willing to accept wind energy development in the community [7,69].

Moreover, residents' degree of trust in sources of information about a new wind farm has a bearing on their acceptance for further development in the community. Residents have different propensities to trust information circulated through the local media. This may be because controversial projects tend to attract greater focus from local stakeholders [50], social media [70] and the mainstream press [22]. For example, respondents unwilling to accept additional wind farms in the community are more likely to trust information circulated within local newspaper coverage whereas respondents with moderate preferences perceive local radio as less trustworthy on average. Notably, Model 2 shows that residents who trust information provided by a developer's website or community liaison officer are more likely to have a strong willingness to accept. Conversely, on average residents who are unwilling to accept additional development in the area are significantly less trusting of these sources of information. This comparison underlines that acceptance is affected by the quality and openness of relationships between different stakeholders involved in the development and operation of a project. Research indicates it is not conducive to relationship-building if wind farm neighbours only learn about projects after they are complete [28], which reinforces the importance and challenges for mediators such as community liaison officers to establish their legitimacy in the consultation process [83].

Finally, Models 1 and 2 show that several controlling sociodemographic variables correlate with acceptance for wind farms proposed within 10 km. It is not well understood precisely how sociodemographic context shapes the acceptance of onshore wind energy, and there is conflicting evidence as to the significance of variables such as gender, income and level of educational attainment [54]. These results show that male respondents living in areas which have a higher population are more likely to be supportive of further wind development in the community. Comparatively, residents who are unwilling to accept further wind development in their community are more likely to be female, to live in rural areas, and to have a third-level education. Residents with a 'moderate' stance towards further wind development are more likely to belong to a two-person household, to be working part-time and to be younger than 35 years old. It is worth noting that respondents who are unwilling to accept further implementation in the area also tend to be older on average, representing double as many 55+ years-olds than the full sample (42 %, Table 6). These findings are consistent with technology acceptance theory [110] and empirical research [40,111] which suggest that age is an important factor in how people perceive the usefulness of innovation and that experience and knowledge have direct and indirect effects on the acceptance of sustainable energy technologies [21]. It has similarly been said that younger generations have a different perception of environmental change and land use arising from 'shifting baseline syndrome' [24] and are more likely to view increased renewable energy development as normal and acceptable [40,112].

In summary, together these results reveal that the majority of residents living within 10 km of an existing wind farm are generally supportive of further onshore wind development in the community but emphasise the ongoing participation and benefit of local stakeholders throughout planning, construction and operation. Hesitancy towards wind farm development can be viewed as part of a natural reaction to change, such that the process of acceptance takes longer for some than for others [17,113]. Nevertheless, the findings support that acceptance generally increases with experience of operating wind farms. Factors including trust in information, participation with renewable energy and personal values differentially shape this process. Previous studies have revealed a close relationship between participatory justice and community acceptance for wind energy developments [25,27,54]. As the leader of the stakeholder engagement process, the wind farm developer is the focal point for a series of relationships which can collectively reinforce or undermine the legitimacy of a commercial wind farm [83].

Discourses concerning wind energy development cover a variety of motivations for and against further development, for instance a desire to anticipate unforeseen local impacts, as well capturing scepticism or enthusiasm about the potential of wind energy, or the incentives and motivations of actors such as developers [18,114]. Early research named community resistance to the visual impact of wind farms on the natural landscape as a primary impediment to the diffusion of wind energy, second only to economic feasibility constraints [115]. However, a more nuanced picture is emerging. It suggests residents' acceptance for the continued expansion of wind energy is interrogated according to the perceived benefits and impacts of wind energy developments, which have different scales (visible 'local' impacts to provide abstract 'global' benefits) and change over the long-term (since the benefits of both local wind farms and the global energy transition accrue by degrees and over decades) [22]. Within this context, the results suggest that favourable attitudes towards the development of further wind farms in the local community are reinforced through prior experiences which corroborate with residents' expectations for equity and justice, for instance with the realisation of benefits for the community and environment [58]. The findings also suggest that citizen participation in wind farms is a persistent and significant issue affecting the perceived legitimacy of further development [14,25,9]. Procedural issues such as the information about the wind farm, the extent of residents' involvement in the project and the relationships between stakeholders shape the acceptance of wind farms over their lifetime. Though many residents express support for additional wind farms, a comparatively smaller, but still important, proportion living near existing wind farms are not willing to accept further development in the community. This contributes to the research which recognises local concerns about the suitability and fit of new projects within the community as lasting issues for future implementation [41,57,108,46]. The findings provide lessons to support fairness which is particularly relevant at the earliest phases of wind farm development when there is greater likelihood for uncertainty and resistance to change [9,85]. The following section concludes with specific recommendations for policy, practice and future research.

5. Conclusion

Local acceptance of renewable energy developments by residents living nearby is a focal point for the decarbonisation of the electricity sector as reiterated by policy [106,116,117], the wind industry [118, 119] and the international press [120,121]. An enhanced understanding of how activities associated with different phases of nearby wind farm development affect residents' acceptance is a crucial consideration for further wind energy deployment [5,48]. This is especially important considering that global renewable capacity targets have increased by 85 % over the last five years and are projected to continue to accelerate within the context of the European energy crisis [4]. Alongside new developments, more than a quarter of the earliest wind farms are approaching the end of their operational phase and many are anticipated to pursue planning applications to extend their operational permits [50,122].

This paper investigates the relationship between wind farm neighbours' level of experience with wind farms and their acceptance for further development in the community. The analysis gives specific focus to wind farm neighbours who have experience of living within 10 km of a wind farm at the planning, construction or operation phase of development. Using a choice experiment which provided 1109 Irish residents with specific proposals for additional wind farm developments in the community, it identifies three latent classes of residents exhibiting distinctly different levels of acceptance. It investigates to what extent willingness to accept is determined by temporal and proximal experiences of wind farms, accounting for awareness and involvement in renewable energy, as well as persistent personal factors such as general sentiments towards onshore wind-generated electricity and trust in information sources concerning wind farm proposals. There is a strong relationship between willingness to accept and awareness of local renewable energy initiatives, trust in information sources, and the perceived fairness of local benefits. These findings guide recommendations for policies concerning wind farm development processes.

5.1. Key findings: Evolution of perceptions and responses

The key findings provide evidence in support of the hypothesis that prior experience with wind farms is linked to greater acceptance for further development in the area [14,15,54]. Residents who live near an operating wind farm [9], or who live beyond the 2 km 'near-neighbour zone' of likely impact [15,84] are on average more supportive of additional wind farm developments in the community.

Of residents living within 10 km of a wind farm, more than half show strong willingness to accept additional wind farm developments in the community. Residents who are willing to accept perceive community engagement across planning, construction and operation to have a high relative importance. Building on earlier research, the paper finds that acceptance for a nearby project relates to residents' appraisal of the collective socioeconomic and environmental benefits of wind electricity in general, as well as more specific preferences for the development of a proposed wind farm in the area [21,29,109]. For example, 13 % of residents are unwilling to accept a proposed wind farm, give greater emphasis to the perceived costs of development, and are generally less convinced of potential benefits [21]. These residents are older on average and are more sensitive to proximity and visual attributes of specific wind farm development proposals as well as socially or environmentally contentious aspects wind energy, such as the perceived negative impact on tourism [18].

Additionally, two key factors differentiate strong support from weaker attitudes towards wind farms proposed in a community. Firstly, prior awareness or involvement in local energy initiatives such as sustainable energy communities, a sense of community spirit and a desire use 'green' electricity contribute to willingness to accept. Secondly, trust in sources of information about a project, particularly a developer's website or community liaison officer, is strongly related to acceptance. This contributes towards a growing body of work that grassroots energy initiatives and local relationships can spark a supportive collective interest in renewable energy in comparison to groups who have no prior experience of renewable energy and are less likely to engage with information provided about a project or developer [14,28,123]. Together these findings have implications for policy supports and the topic warrants further investigation.

5.2. Recommendations for policy and future research

It is in the interests of effective wind projects that developers and policymakers recognise that uncertainty, partiality and resistance are reasonable responses towards wind farm development proposals [52]. Even as wind energy establishes itself as a viable source of wind electricity, social buy-in to new projects is not guaranteed, and it is to be expected that acceptance within the nearest vicinity of a wind farm is weaker at the earliest and most uncertain phases of project development [9,23]. Surveyed wind farm neighbours place high importance on engagement and local participation throughout planning, construction and operation. The longer-term acceptance of a project depends on trust in information provided by a developer at time when a new wind farm is proposed for development. This supports frameworks which recommend that developers should aim to engage, understand and address local residents' concerns as a starting point for fair development procedures [7].

Since the earliest wind farm proposals, there have been numerous calls for sensitivity to local interests during siting and for deeper levels of citizen influence on the decision-making process [57,107]. Nevertheless, evidence suggests that the impacts of wind farms, whether expected or experienced, can be an important aspect of residents' acceptance [11]. Perceived impacts are affective issues and can exacerbate uncertainty during planning [124] and extend well beyond a wind farm's perceptible impact [15,84]. Critically for developers, the first point contact with local residents can determine longer-lasting attitudes towards the wind farm [28]. The energy transition increasingly requires efforts to build working relationships between renewable energy developers and local stakeholders, often over a longer time frame and in a more deliberative fashion than once-off compensation and communication campaigns [125]. For example, this study finds community liaison officers can provide an important intermediary role, however it is not guaranteed that they will be trusted by members of the community. The results also suggest that it is valuable for developers to communicate a proposed development across multiple channels, including local radio, and to undertake in-person consultation. This can help to gather feedback at the early stages of planning and to encourage the representation of diverse stakeholder interests and credible information-sharing during decision-making.

Supportive attitudes towards further wind farm development are linked to strong preferences for community-owned wind farms and citizen investment opportunities. Therefore, it is in the interests of a just energy transition to develop enabling frameworks for community participation in renewable energy initiatives. This can support social capital through familiarisation [14], experience- and knowledge-building [123,89] and help foster psychological ownership of a local energy transition [98].

Considering the cross-sectional nature of this research, there is interesting scope to build upon these findings and deepen investigation into the longitudinal nature of wind farm acceptance over time. Future research efforts could conduct repeated focus groups supplemented by a repeat survey at later points in time. Transition management strategies could be tailored to engage local communities during siting, construction and operation with deeper investigation into the effects of 'learning-by-doing' [126] and local culture [108]. A valuable area of ongoing research aims to contextualise stakeholder concerns, for instance the site-specific effects of wind farm implementation on local tourism [74,127,128]. Similarly, an important area of research takes into consideration the proximity-dependent impacts experienced by residents (such as noise emissions [15] or visibility [24]) and aims to investigate to what extent these affect respondents' acceptance of wind farms. Studies of specific wind farm locations including topographical context could also provide further insight into the relationship between proximity, timing of development, and acceptance. For example, there is evidence to suggest with appropriate regulation to minimise impacts, the planning process has primary importance for wind energy acceptance [11]. There is also a need to focus on jurisdictions with pressing concerns for electricity supply, security or affordability to understand the differing local requirements for, and perceptions of, renewable energy infrastructure [129].

CRediT authorship contribution statement

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

1 Latent class	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37
2 Gender	1.00																																				
3 Age	-0.05	1.00																																			
4 Education	0.10	-0.02	1.00																																		
5 Employment	-0.11	0.51	-0.06	1.00																																	
6 Homeowner	-0.07	0.22	0.00	0.17	1.00																																
7 Landowner	-0.09	-0.14	-0.08	-0.08	0.25	1.00																															
8 Household size	0.02	-0.25	-0.06	-0.23	0.03	0.07	1.00																														
9 Income	-0.09	-0.07	0.17	-0.12	0.22	0.12	0.20	1.00																													
10 Years in community	0.06	0.21	0.02	0.17	0.22	-0.04	0.06	0.01	1.00																												
11 Rural/Urban	-0.06	-0.11	0.01	-0.02	-0.16	-0.16	0.02	0.01	-0.09	1.00																											
12 NUTS3	0.01	0.08	0.07	0.01	-0.02	-0.08	-0.03	-0.02	-0.04	-0.03	1.00																										
13 Proximity	0.05	0.20	0.08	0.13	-0.09	-0.26	0.00	-0.04	0.08	0.22	0.04	1.00																									
14 Project phase	0.00	0.27	0.02	0.15	-0.06	-0.25	0.03	-0.10	0.03	0.19	0.04	0.77	1.00																								
15 Attitude: Unreliable	-0.16	-0.09	-0.09	-0.02	0.09	0.21	0.05	-0.02	-0.07	0.01	-0.05	-0.22	-0.19	1.00																							
16 Attitude: Clean	0.08	0.01	0.07	0.04	-0.06	-0.12	0.00	0.00	-0.01	0.05	0.07	0.16	0.08	-0.26	1.00																						
17 Attitude: Harm	-0.13	-0.12	-0.10	-0.07	0.05	0.18	0.04	-0.03	-0.04	-0.01	-0.11	-0.22	-0.17	0.43	-0.32	1.00																					
18 Attitude: Commitments	-0.04	-0.01	0.06	0.02	-0.02	-0.05	-0.01	0.03	-0.03	0.06	0.04	0.06	0.03	-0.15	0.39	-0.17	1.00																				
19 Attitude: Tourism	-0.10	-0.03	-0.01	0.00	0.11	0.17	0.01	0.00	-0.01	-0.05	-0.02	-0.15	-0.13	0.35	-0.18	0.37	-0.23	1.00																			
20 Attitude: Jobs	0.04	-0.01	0.09	0.00	-0.03	-0.06	-0.01	0.05	0.00	0.04	0.02	0.08	0.03	-0.13	0.34	-0.16	0.32	-0.18	1.00																		
21 Attitude: Discord	-0.06	0.13	0.01	0.06	0.18	0.10	-0.07	0.03	0.07	-0.10	-0.03	-0.10	-0.10	0.22	-0.10	0.22	-0.08	0.36	-0.10	1.00																	
22 Attitude: Offshore	-0.12	0.05	-0.06	0.08	0.14	0.14	-0.01	0.01	0.01	-0.10	-0.02	-0.09	-0.07	0.24	-0.11	0.25	-0.08	0.33	-0.07	0.23	1.00																
23 Attitude: On/offshore	0.01	0.00	0.09	0.05	-0.03	-0.09	-0.02	0.07	0.00	0.01	0.03	0.04	0.00	-0.10	0.31	-0.14	0.34	-0.14	0.29	-0.06	-0.13	1.00															
24 Green electricity	-0.03	0.05	0.04	0.04	0.04	0.04	0.02	0.04	-0.02	-0.01	0.00	-0.07	-0.07	-0.09	0.13	-0.10	0.19	-0.11	0.08	-0.03	-0.01	0.12	1.00														
25 Availed of grant	-0.10	-0.06	-0.09	0.01	0.17	0.18	0.05	0.05	-0.03	0.04	-0.08	-0.14	-0.10	0.15	-0.03	0.13	0.05	0.06	-0.01	0.08	0.06	-0.02	0.12	1.00													
26 Investments / shares	-0.17	-0.27	-0.14	-0.10	0.06	0.29	0.12	0.04	-0.14	0.09	-0.07	-0.24	-0.17	0.23	-0.06	0.26	0.05	0.12	-0.01	0.03	0.08	-0.03	0.07	0.32	1.00												
27 Local WF involvement	-0.13	-0.02	-0.03	0.01	0.00	0.07	0.11	0.00	-0.11	0.14	-0.01	0.08	0.17	0.04	0.04	0.00	0.08	-0.03	0.03	-0.03	0.00	0.05	0.24	0.21	0.23	1.00											
28 SEC in area	-0.14	-0.29	-0.10	-0.15	0.02	0.24	0.08	0.06	-0.17	0.09	-0.07	-0.28	-0.20	0.20	-0.09	0.18	0.05	0.08	-0.03	0.02	0.05	-0.02	0.07	0.31	0.47	0.22	1.00										
29 Info: online (dev.)	0.06	-0.20	-0.02	-0.16	-0.10	0.06	0.08	0.00	-0.11	0.05	0.03	-0.04	-0.05	0.02	0.11	0.02	0.17	-0.12	0.12	-0.17	-0.11	0.15	0.11	0.05	0.13	0.08	0.16	1.00									
30 Info: online (anti.)	-0.06	-0.09	-0.09	-0.09	0.00	0.10	0.06	-0.06	-0.11	0.03	0.02	-0.14	-0.08	0.23	-0.11	0.24	-0.02	0.15	-0.11	0.08	0.13	-0.10	-0.02	0.13	0.24	0.08	0.26	0.14	1.00								
31 Info: newspaper	-0.02	0.01	0.00	0.01	-0.01	-0.06	0.01	-0.02	0.00	0.08	0.03	0.07	0.06	-0.01	0.12	-0.04	0.12	-0.03	0.11	-0.04	-0.02	0.15	0.09	0.02	-0.01	0.09	0.02	0.26	0.12	1.00							
32 Info: radio	-0.01	0.01	0.01	0.00	-0.02	-0.07	-0.02	-0.01	-0.03	0.06	0.02	0.07	0.07	-0.02	0.14	-0.06	0.12	-0.07	0.14	-0.07	-0.01	0.12	0.09	0.02	0.01	0.08	0.00	0.23	0.11	0.62	1.00						
33 Info: elected rep	-0.02	-0.15	-0.01	-0.07	-0.04	0.03	0.12	0.02	-0.07	0.06	0.00	-0.04	-0.02	0.04	0.07	0.03	0.12	-0.05	0.06	-0.08	-0.04	0.08	0.08	0.07	0.13	0.10	0.14	0.34	0.24	0.29	0.29	1.00					
34 Info: Social media	-0.04	-0.26	-0.07	-0.16	-0.10	0.08	0.11	-0.04	-0.16	0.08	-0.03	-0.12	-0.11	0.17	-0.05	0.18	0.05	0.04	0.01	-0.05	0.05	0.01	-0.02	0.10	0.25	0.05	0.25	0.29	0.35	0.19	0.18	0.31	1.00				
35 Info: CLO	0.07	-0.10	-0.02	-0.06	-0.07	-0.03	0.08	-0.01	-0.03	0.08	0.00	0.07	0.05	-0.09	0.14	-0.06	0.20	-0.20	0.15	-0.15	-0.13	0.17	0.12	0.04	0.04	0.10	0.08	0.46	0.07	0.29	0.27	0.30	0.20	1.00			
36 Info: leaflet	0.03	-0.12	-0.01	-0.05	-0.07	-0.02	0.06	-0.02	-0.05	0.06	0.01	0.05	0.04	-0.05	0.18	-0.11	0.21	-0.18	0.15	-0.18	-0.13	0.16	0.15	0.02	0.07	0.12	0.10	0.54	0.07	0.24	0.25	0.29	0.22	0.59	1.00		
37 Info: neighbour	-0.10	-0.04	-0.10	-0.02	-0.04	0.03	0.03	-0.02	-0.05	0.06	-0.02	-0.04	0.00	0.15	-0.01	0.10	0.08	0.03	-0.01	0.02	0.07	-0.03	0.02	0.09	0.14	0.06	0.16	0.13	0.28	0.24	0.25	0.26	0.35	0.16	0.16	1.00	

Appendix Fig. A1. Spearman's rank correlation matrix of variables with Bonferroni adjustment

Appendix Table A1
Part-worth utilities and standard error (SE) of the aggregate model

Attributes	Levels (trade-offs)	Part-worth utility	SE
Distance to the wind farm	Outside immediate community (3–10 km)	0.66	0.03
	Close to community (2–3 km)	0.34	0.01
	Close to community (1–2 km)	−0.26	0.01
	Near neighbour (within 1 km radius)	−0.74	0.03
Visual impact	Yes	−0.16	0.01
	No	0.16	0.01
Engagement during site selection	One-on-one with a community liaison officer	0.23	0.02
	Meeting of a small group of people living very close to the proposed site	0.16	0.01
	Town hall style meeting that includes the wider community	0.23	0.02
	You receive a leaflet from the developer	−0.32	0.02
	The developer uses local radio and newspaper	−0.30	0.01
Community liaison officer	Yes	0.27	0.01
	No	−0.27	0.01
Governance of the community benefit fund	Local authority	−0.23	0.01
	Wind farm developer with community input	−0.14	0.02
	Local enterprise development company	0.04	0.02
	Local development company with community input	0.05	0.02
	A committee composed of community members	0.29	0.01
Sharing of the community benefit fund	€130,000 to community projects and €50,000 to near-neighbours	−0.13	0.02
	€100,000 to community projects and €80,000 to near-neighbours	0.07	0.01
	€80,000 to community projects and €100,000 to near-neighbours	0.05	0.01
Opportunity for citizens to invest	Citizens must live close to the windfarm (within a radius of 10 km)	0.40	0.01
	Citizens can live anywhere in Ireland	−0.04	0.01
	There is no opportunity to invest	−0.36	0.01
Developer	Local landowners/farmers (30 % added cost)	0.19	0.01
	Local landowners/farmers (50 % added cost)	−0.18	0.02
	A community sustainable energy group (30 % added cost}	0.22	0.01
	A community sustainable energy group (50 % added cost)	−0.39	0.01
	A new venture for an existing community network group (30 % added cost)	0.13	0.01
	A new venture for an existing community network group (50 % added cost)	−0.20	0.02
	Joint developer/community (20 % added cost)	0.15	0.01
	Irish semi state companies	0.21	0.02
	Private companies/developers	−0.14	0.02
Status quo	Dual-response	−1.86	0.13

Note: Within an attribute, more strongly positive coefficients indicate increasing preference compared to the mean (zero), while more negative coefficients mean that these features of wind development tended to have comparatively less influence on respondents' preferences.

Appendix Table A2
Average acceptance of a wind farm for segments at different phases of development and proximities

Proximity [a]	Phase of development	Average frequency of acceptance (%)	SE	[95 % CI]	Proportion of wind farm neighbours within 10 km (n = 1109)
Within 2 km***	(Pre-planning)	47.5 %	5.9 %	[35.9 %; 59.2 %]	4.5 %
	Construction	63.5 %	8.6 %	[46.5 %; 80.6 %]	1.1 %
	Operation	75.0 %	3.2 %	[68.6 %; 81.4 %]	0.5 %
2-5 km**	(Pre-planning)	68.1 %	4.0 %	[60.2 %; 75.9 %]	7.2 %
	Construction	79.0 %	3.8 %	[71.5 %; 86.4 %]	3.9 %
	Operation	80.8 %	1.7 %	[77.4 %; 84.2 %]	28.0 %
5-10 km	(Pre-planning)	70.8 %	3.0 %	[64.9 %; 76.7 %]	10.1 %
	Construction	81.9 %	3.1 %	[75.8 %; 87.9 %]	5.5 %
	Operation	76.8 %	1.8 %	[73.3 %; 80.4 %]	29.0 %

[a] Within-segment significance H(2): *$p < 0.1$, **$p < 0.05$, ***$p < 0.01$.

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