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Research Article

Beyond NIMBYism: towards an Integrated Framework for Understanding Public Perceptions of Wind Energy

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It is widely recognised that public acceptability often poses a barrier towards renewable energy development. This article reviews existing research on public perceptions of wind energy, where opposition is typically characterized by the NIMBY (not in my back yard) concept. The objectives of the article are to provide a critical assessment of past research and an integrated, multidimensional framework to guide future work. Six distinct strands of research are identified, summarized and critiqued: public support for switching from conventional energy sources to wind energy; aspects of turbines associated with negative perceptions; the impact of physical proximity to turbines; acceptance over time of wind farms; NIMBYism as an explanation for negative perceptions; and, finally, the impact of local involvement on perceptions. Research across these strands is characterized by opinion poll studies of general beliefs and case studies of perceptions of specific developments. In both cases, research is fragmented and has failed to adequately explain, rather than merely describe, perceptual processes. The article argues for more theoretically informed empirical research, grounded in social science concepts and methods. A multidimensional framework is proposed that goes beyond the NIMBY label and integrates previous findings with social and environmental psychological theory. Copyright © 2004 John Wiley & Sons, Ltd.

Introduction

With increasing concern amongst scientists and policy makers about the potentially catastrophic consequences of climate change (e.g. References 1 and 2), there has been a drive across many countries to increase the amount of energy generated from renewable resources (e.g. Reference 3). Since wind turbine technology has been more technically advanced in comparison with many other renewable energy technologies, and therefore most economically profitable, wind turbines, often deployed in arrays called wind farms, have been most often developed.[4] Focusing upon the UK, more than 1000 wind turbines have been developed to date,[5] and, in some cases, development has been marked by social controversy.[6]

Such controversy was recognized in the UK government's statement of energy policy[7] as being a barrier to the target of 60 per cent reductions in carbon emissions by 2050. Furthermore, it reflects the importance of researching and understanding processes of public perception and acceptance. Yet, with a small number of exceptions (e.g. References 8 and 9), social scientists, such as environmental psychologists, have rather over-

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looked renewable energy as a subject of empirical research. However, this criticism has to be set in the context of far greater funding being made available for researching technical, environmental and economic aspects of renewable energy technologies.[6] In this light, the principal aims of this article are to critically assess the outcomes of research to date and to suggest potential theoretical and methodological directions which can inform future attempts to account for public reactions to wind energy development.

The existing literature on public perceptions of a wide variety of renewable energy resources, including wind energy, has presented a striking divergence.[4,6] At a general level, there is strong public support, as evidenced by extensive international opinion polling since the 1970s (e.g. References 10 and 11). However, at the local level, there has been frequent controversy and public opposition across different technologies and social, economic and cultural contexts. For example, studies have identified conflict arising from geothermal energy development in Hawaii,[12] tidal energy development in the UK,[13] hydroelectric development in Australia,[14] waste incineration projects in France[4] and biomass development in the UK.[15] What differentiates controversy over renewable energy development such as wind farms from that over other energy resources such as fossil fuels and nuclear energy is the juxtaposition of high and stable levels of general public support with frequent local opposition to actual development, a phenomenon that has become known as the NIMBYism (not in my back yard) attitude.[16]

Public perception research on wind energy has chiefly been undertaken in developed countries such as the USA (e.g. Reference 17), Canada (e.g. Reference 18), the UK (e.g. Reference 19), Denmark (e.g. Reference 20, cited in Reference 21, and Reference 22, cited in Reference 23), Germany (e.g. Reference 24), Sweden (e.g. Reference 25) and the Netherlands (e.g. Reference 26). Most of this literature is empirical in nature, using quantitative survey tools, and 'barrier-oriented' in seeking to identify specific reasons for negative public attitudes to local development. Empirical studies have typically operationalized public perceptions in terms of self-reported evaluations of discrete aspects of turbines, with items focusing upon visual, acoustic, socio-economic, environmental and technical aspects. Two forms of methodology are commonly used: opinion poll research of public perceptions at the general level (e.g. Reference 20) and case studies of local people's perceptions of proposed or actual development (e.g. Reference 27). Overall, this body of research has largely been conducted without reference to any specific conceptual foundation, leading to a situation where the extant literature is rather incoherent and devoid of a sense of cumulative progress.

Reviewing the literature as a whole, it is apparent that the majority of empirical research studies have been guided by several key research questions.

1. What support exists amongst the public for a switch to wind energy from conventional resources?
2. What physical or environmental characteristics are linked to negative perceptions of wind farms?
3. Do those living closest to a wind farm have the most negative attitudes?
4. Do negative attitudes to a wind farm lessen over time?

Arising from these, this article addresses two further key questions.

5. Does NIMBYism explain wind farm opposition?
6. Does local involvement in wind farms increase local support?

Before critically assessing the research findings to these questions, it is important to note that the approach adopted by many wind energy researchers has been guided by a deterministic view of human psychology, which has shaped the sorts of research questions posed in the literature. For example, it has often been assumed that the physical proximity of a person's home to a wind farm will determine their psychological reaction to it—hence the body of work studying the 'physical proximity' hypothesis where researchers have set out to prove that those living closest to a wind farm have the most negative perceptions of it. In addition, it has been assumed that public opposition to wind turbines is motivated by negative perceptions of specific physical attributes of the turbines. Thus researchers have asked specific questions about turbine colour, size and orientation. This rationale has been criticized by recent research[23,28] arguing for greater recognition of the socially constructed nature of public perceptions.[29] Such authors argue for a focus not only upon technical or physical attributes of wind farms but also upon more symbolic, affective and socially constructed aspects. This includes

'how' wind farms are developed as much as 'what' is developed and how people come to make sense of the impact of an unfamiliar technology upon the places in which they live. This is most evident in the emerging literature on local involvement in wind energy development.

What Support Exists for a Switch to Wind Energy?

In terms of results, general opinion poll studies have indicated majority support for switching to wind energy development from conventional fuels in all countries studied (e.g. 79% in Canada,[18] 80% in the UK[30] and 82% in Denmark[20]). These are consistent with similar opinion poll results for renewable energy support (e.g. Reference 10) and indicate that support for renewable energy generally, and wind energy specifically, tends to be higher than that for further fossil fuel or nuclear energy development. Specific opinion poll studies of wind farm perceptions have also indicated majority support for wind energy development (e.g. References 27 and 30). Therefore the research has indicated high and stable levels of public support for renewable energy generally, and wind energy specifically, in comparison with other types of energy resources.

What Physical or Environmental Characteristics are Linked to Negative Perceptions of Wind Farms?

Research attempting to identify possible reasons for public opposition to wind farms has noted visual impacts and noise as the most frequently reported problems.[30] Visual impact problems refer to the negative evaluation of the impact of an array of turbines in a specific landscape context, whereas noise problems relate to negative evaluations of the noise made by rotating turbine blades. Other reported complaints include perceived unreliability,[31] high cost,[32] dangerous impact upon birds and wildlife (Reference 33, cited in Reference 30), perceived inefficiencies in comparison with coal-fired power stations,[32] suspicion of the motives of development organizations[24] and annoyance at idle turbines.[17]

In relation to size, there are consistent results suggesting that smaller wind farms are more positively perceived in comparison with larger-scale developments. In the UK, Lee *et al*.[8] referred to a 'favourability gradient' in noting a negative linear relationship between wind farm size and public support. Support was highest for wind farms with less than eight turbines. This finding has been replicated in several other countries. Research in Denmark[20] reported that clusters of two to eight turbines received more public support than both scattered single turbines and larger arrays. This finding was consistent across gender and age groups in this large-scale, representative Danish sample. In the Netherlands, Wolsink[34] reported that wind farm developments were less highly supported than stand-alone turbines in a review of 11 empirical studies. Finally, in Ireland,[35] research indicated a preference for smaller, clustered groups of turbines over larger-scale installations; for example, smaller numbers of large turbines were considered preferable to larger numbers of smaller turbines.

This consistent finding contrasts with the consensus in wind energy policy making that tends to favour large-scale (i.e. *both* larger turbines *and* in larger numbers) rather than smaller-scale development.[4,5] In so doing, the preference for larger-scale development reflects how energy policy makers have assimilated renewable energy development within a traditional approach of large-scale, centralized electricity supply infrastructure[36] or 'hard energy path'.[37] This approach was designed for the exploitation of fossil fuels and nuclear energy prioritizing economic and technical efficiencies, rather than the adoption of a people- or community-centred approach.[37]

Although visual impacts have consistently emerged as an issue of objection to wind farms, few research studies have examined visual perceptions by systematically comparing how turbines of different colour, shape or size are perceived. As a consequence of controversy, visual impact assessments are recommended by public institutions and are routinely carried out in wind farm planning applications as part of a wider environmental impact assessment process. These visual assessments represent the potential visibility of proposed turbines in the landscape, at different orientations or physical distances. That wind farms can be perceived to have a negative visual influence upon the landscape is reflected in language sometimes used to describe visual representations, using concepts such as 'zones of visual intrusion', 'visual burden' and 'visual impact' (e.g. Reference 38). The per-

ceived negativity of such language is apparent when contrasted with similar, if hypothetical, concepts focusing upon a 'zone of visual interest', 'visual improvement' or 'visual enhancement' caused by wind farms.

Negativity is also reflected in the research priorities of government agencies, for example UK research investigating the role of colour in *reducing* the visual impact of turbines (e.g. Reference 39). Within the planning process, visual assessments carried out by developers have an impact upon the conditions attached to planning consent by the local authority. The outcome of such assessments has been attempts to render wind farms 'invisible' in the landscape, reflecting the generally negative stance by policy makers at national and local levels to wind farm visual character mentioned above.

Existing empirical studies have indicated public support for turbines that are painted neutral colours and merge with the landscape (e.g. Reference 8). Although the computer-generated photomontages used in more recent visual assessments offer a novel methodological opportunity for social researchers to study public perceptions of turbines, few examples of such studies currently exist. One exception to this is a study carried out in Ireland[35] that used photomontages to study comparative perceptions of the visual impact of different forms of development and differently sized wind farms in different landscape contexts. Results, generated from a representative sample of 1200 Irish people, indicated that wind farms were more positively perceived than mobile phone masts, electricity pylons and fossil fuel power stations, but less positively than wooden poles carrying local electricity wires. Secondly, there was little indication that medium-sized wind farms (i.e. consisting of 15 turbines) were perceived to be more suitable for location in certain types of landscapes in comparison with others. Although urban/industrial and bogland landscapes were perceived as being less beautiful by respondents in comparison with coastal, upland and farmland landscapes, surprisingly, mean levels of support for wind farm development were virtually identical across all landscape types, indicating no preference for wind farms in any specific landscape context.

Furthermore, the study examined perceptions of differently sized farms in different landscapes. In upland and farmland landscapes, respondents perceived smaller-sized wind farms more favourably than larger-sized farms. Visual perceptions suggested a favourability gradient of a five-turbine wind farm (most positive), two clusters of 10 turbines (second most positive) and one wind farm of 25 turbines (least positive), echoing the other studies on preferred wind farm size summarized above. The preference for small numbers or clusters of turbines was further emphasized by responses to a question concerning turbine size and wind farm size. In an upland landscape a larger proportion (36%) of respondents preferred a small number of large turbines to a large number of smaller turbines (28%). A similar result was obtained for a 'fertile farmland' landscape (35% vs 25%), although it should be noted that the large proportion of respondents replying 'no preference' in both cases (30% and 31%) suggests widespread lack of awareness of these issues. Overall, the study is important in indicating in more detail the manner in which several variables interact to produce perceptions of visual impact—specifically turbine size, number and the specific landscape context in which they are situated.

Despite the predominant emphasis upon negative visual impacts of turbines in the literature, there is little evidence that wind turbines are universally perceived as ugly. Indeed, the literature includes several examples of positive evaluations of the visual character of wind turbines. For example, in one study an individual commented that 'I think they look beautiful; you know sometimes I think they're like sculptures'.[40] In quantitative studies, between 51% and 63% of respondents who could see a wind farm from their houses chose the word 'interesting' to describe the physical appearance of the turbines.[8,41]

Going beyond the physical characteristics of the wind farm, another factor affecting visual perceptions is the landscape or environmental context that the wind farm is sited upon. Wolsink[34] argued that many consider the development of wind turbines as an improvement in landscapes that are industrial or modern agricultural. However, such an observation must take account of the significant difference between 'objective' and 'subjective' landscape perceptions, as recent controversies in the UK have demonstrated. For example, even landscapes that have been objectively described as industrial have simultaneously been perceived as rare and distinctive by local people who oppose wind farm development (e.g. Reference 42). The landscape (or 'seascape') context is also clearly relevant in relation to how offshore wind farms are perceived and accepted.[43] With the growing number of proposed offshore developments and the assumption of many energy developers and policy makers that offshore wind farms are less likely to be socially controversial, emerging reports of

controversy regarding visual and environmental impacts[44] are a reminder of the limited degree of empirical research to date on perceptions of offshore wind farms[45] and the necessity for future work.[46] Together, such results point to the necessity for further research to better understand the complex, multidimensional nature of public perceptions of physical attributes of wind turbines in specific landscape contexts.

Understanding of the complexity of public perceptions has been aided by the more descriptive studies of wind farm perceptions that have tended to emerge from geographical researchers (e.g. References 47 and 48). Thayer and Hansen's[47] discussion of the perceived visual impacts of wind farms in rural areas in the USA contended that visual perceptions were based upon judgements of symbolic as well as instrumental or rational aspects of a specific wind farm (e.g. its size, colour, shape, etc.). They estimated that a person's evaluation of visual impact was based upon a combination of perceptions or judgements. These relate to the abstract sculptural nature of turbines (which perhaps accords with some of the more positive visual perceptions of wind turbines noted in the studies above), their perceived intrusiveness in that specific context and, finally, the degree to which turbines symbolized 'higher' concepts (both positive and negative). Such 'higher' concepts could include the degree to which turbines are associated with wider environmental concerns such as climate change and feelings of personal responsibility to address such problems. They concluded that evaluation of the visual impact of turbines in the landscape may be determined by the relative strength of each of these physical and symbolic aspects in judgement.

Unfortunately, few empirical studies have operationalized physical and symbolic dimensions to test such a hypothesis, and, of those that have (e.g. Reference 8), the relative significance of each aspect has not been assessed. Despite this, Lee *et al.*'s[8] study was useful in going beyond perceived physical characteristics to empirically analyse the symbolic dimension of wind farm perceptions. In an extensive study of seven UK wind farm locations with 1286 respondents, they noted that 62% of respondents agreed that wind turbines symbolized 'a sign of progress', whereas 15% agreed that they symbolized a 'harking back to the past' and 16% agreed that turbines represented a combination of both.

The association between positive perceptions of wind turbines and whether they are perceived to symbolize 'progressive' or 'historic' values is not clear-cut and requires further research attention. For example, in a recent study of public perceptions of renewable energy development in an English National Park,[40] small-scale hydroelectric developments were perceived in a highly positive manner when associated with the historic water mills found in many places in the park. Such perceptions illustrate how innovative energy technology can be perceived to 'fit' in a place by promoting a sense of continuity with the past. In a similar vein, communication strategies linking new wind farms or turbines with the concept of windmills may also serve to increase positive perceptions of 'fit' in locations where windmills existed in the past. This symbolic level of wind farm perception points to how different constructions of new development, when purposefully linked with aspects of place identification processes such as continuity with the past, can shape how wind farms are perceived.

Pasqualetti[48] observed that public perceptions of wind farms must be set in the context of normative expectations of electricity generation infrastructure. He argued that renewable energy development posed a moral difficulty for individuals, communities and societies since it is an energy form that, at present, cannot be stored or transported, but requires local development to exploit local resources. This is a quite different development pathway from the orthodox fuels used to generate electricity such as fossil fuels and uranium that can be transported great distances. As a result, conventional electricity generating power stations are embedded within a highly centralized, large-scale infrastructure that sites power stations at great spatial distances from centres of population.[36] Pasqualetti[48] claimed that the public, being accustomed to such spatial distance, faced a moral difficulty in accepting renewable energy development closer to their back yards rather than the conventional low-awareness, 'out of sight, out of mind' experience.

Do Those Living Closest to a Wind Farm Have the Most Negative Perceptions?

Empirical research has consistently investigated the 'proximity hypothesis' that those living closest to a wind farm will have the most negative perceptions of it. Such attempts have largely proved unsuccessful, although

there is some variability in the literature. For example, in Denmark, Anderson *et al*.[22] found no link between distance between residential location and the nearest turbine and negative public perceptions. In fact, this study found some evidence that those living closest (i.e. within 500 m) actually had more positive perceptions in comparison with individuals residing further away. In contrast, a US study of wind turbines in the Altamont Pass[17] found that people who lived closer to the area, and who were more familiar with it, liked it slightly less than people less familiar with it and living further away. In the UK, one study[41] concluded that being able to see turbines did not bother the majority of people and led in some cases to respondents expressing interest and pride in the wind farm. Similarly, a more recent study of three Scottish wind farms[49] found that those living closest to wind farms, and those who see wind farms most often, were more likely to mention positive aspects of the wind farm when asked, in comparison with those living further away.

The varied nature of the research evidence may be an indicator of wind turbine technical development. Earlier studies (e.g. References 8, 17 and 50) in the USA and the UK reported on wind turbine technology that has now been replaced with quieter designs, although clearly both objective and subjective perceptions must be accounted for. Beyond the specific issue of noise, recent research suggests that social influence processes and social networks (i.e. the opinions of significant others such as friends and family living in the local area) are important in determining public perceptions of wind farms.[28] This suggests that explanations of wind farm perceptions must go beyond purely physical parameters, such as proximate distance, turbine size and colour, to encompass 'social' distance measures affecting the personal salience of a wind farm and are likely to prove important in explaining negative wind farm perceptions.

Do Negative Perceptions of a Wind Farm Lessen over Time?

A small number of studies conducted in different countries have used longitudinal designs to track self-reported perceptions of wind farms across time, chiefly prior to development and for some period afterwards. These have generally noted that negative perceptions decline over time. For example, in the UK a study tracking 170 individuals living in Cornwall[31] indicated that negative perceptions of a local wind farm declined. The authors concluded that 'the results show, decisively, that any change of attitude from 1990 to 1992 is toward thinking that wind power is better' (p. 53). In the Netherlands, Wolsink[34] concluded similarly that approval increases following construction. Also in the Netherlands, Gipe[16] reported that a development by a Dutch wind developer led to lower levels of support in the planning and construction phases in comparison with both initial levels prior to planning and subsequent levels following construction. This led to his conclusion that the level of acceptance of wind energy in a local area declines with construction and rises afterwards (see Figure 1).

However, closer scrutiny of existing empirical evidence suggests that Gipe's[16] generalization is not always supported. For example, although Bishop and Proctor's[51] (cited in Reference 23) longitudinal study of public perceptions of three Welsh wind farms before and after construction indicated that approval improved from an average of 41% beforehand to 66% afterwards, this general increase masked a large degree of variability across the three sites. In two of the sites studied, the proportion of respondents with negative perceptions of development actually increased (e.g. in Llandinam from 12.1% to 22.7% and in Rhyd-y-Groes from 29.8% to 35.1%).

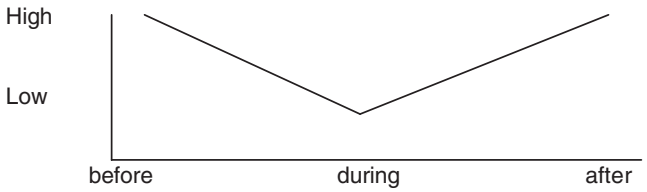

Figure 1. Level of acceptance of wind energy in a local area before, during and after construction of wind power plants[16]

The assumption that wind farms become more acceptable to the public with increased exposure over time implicates the degree of familiarity individuals have with wind turbines and farms. This leads to the general assumption that the more familiar a person is with wind farms, the more positively they are likely to support wind farm development. Research has indicated some support for this hypothesis, with respondents indicating previous experience of wind farms more likely to perceive new or proposed wind farms in a positive manner (e.g. Reference 35). However, it is unlikely that there will be a simple, linear relationship between experience and perception because of the numerous other influences that shape people's judgements and opinions. Future research is required to analyse the multidimensional and socially constructed nature of familiarity with wind farms and how familiarity shapes perceptions, unpacking issues of knowledge, prior experience and risk perceptions associated with the unknown.

In conclusion, the results indicate that the general assumption of negative public perception improving across time is unsupported by empirical evidence. The monitoring of perceptual change may need to be sensitive to whether one focuses primarily upon ratings of approval or ratings of disapproval—they may represent qualitatively different dimensions of evaluation. Finally, the variability in perceptual change across sites indicates that contextual influences, specific to development in specific locations, can play a more significant role in shaping public perceptions than has generally been acknowledged in the literature. This is expanded upon below.

Does NIMBYism Explain Opposition to Wind Farms?

Empirical wind farm research is often poorly grounded in existing social science theory; for example, studies rarely cite conceptual models used to generate hypotheses purporting to explain public perceptions of wind farms. The most frequently cited explanatory concept that has been used is the NIMBY concept. This has been used to refer to both public perceptions generally and more negative perceptions of wind farms specifically.[4,52] Although this concept has not been extensively subjected to empirical scrutiny across different national contexts, where it has, research has found only limited support for its validity.[23] As Wolsink[52] remarked, 'the validity of the NIMBY theory is questionable as the reasoning behind the theory is faulty' (p. 861). He pointed out that NIMBYism actually represented a constellation of different attitudinal positions to both wind energy policy and development and he was critical of NIMBY assumptions such as:

- decision making on facility siting is laborious;
- the project represents 'higher' interests than those of the local 'population';
- everyone is agreed on the usefulness of those facilities;
- everyone prefers not to have the facilities in their back yard;
- everyone prefers to have the facilities sited in someone else's back yard;
- the attitudes and opinions that go to make up the NIMBY phenomenon are static.

NIMBY perceptions of wind farms have been used as a means of describing the tension between general support for wind energy and local opposition to specific developments—that is a negative relation between general and local support for wind farms. They have also been used to describe active resistance to proposed developments. The validity of NIMBYism as a negative relation between general and local perceptions of wind energy would be demonstrated by studies indicating support for wind farms at regional or national level, but not locally in close proximity to respondents' place of residence. In contrast, most empirical studies have identified a positive relation, at least in terms of support—with those in favour locally also in favour of wind farm development nationally.[30] It is less clear from the empirical literature that those who are against wind farms in a locality are also against wind farms in other locations; consequently, it would be useful for future research to examine this hypothesis, perhaps by systematically collecting data about general wind energy support from individuals active in local opposition groups.

Where this issue has been explicitly addressed, empirical results have not supported the presumed prevalence of NIMBY views. For example, Hoepman[53] (cited in Reference 23) found that more people displayed a

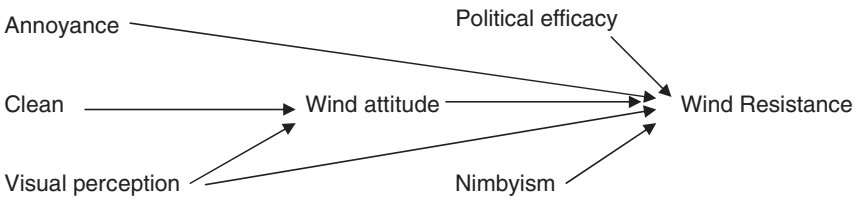

Figure 2. Wolsink's[26] model of causal factors determining wind farm resistance

preference for local development in contrast to regional development; 66% of respondents were willing to accept more wind turbines in their local community in comparison with 61% indicating support for more wind turbines in the region as a whole. Wolsink's[26,34,52] analyses of NIMBYism explore the structural, political and causal nature of NIMBY perceptions in greatest detail in the literature. In terms of structure, Wolsink[34] concluded that perceptions were made up of four distinct, specific 'attitudes'. These consist of a general attitude expressing support or opposition to wind energy, an attitude towards energy policy stimulating wind energy development and regulation of turbine siting, an attitude to wind energy specifically concerned with its proximity to the built environment and, finally, an attitude towards size of turbine development, contrasting scattered single turbines versus concentrated wind farms. By structuring general wind energy attitudes into specific perceptions, Wolsink was arguing for the multidimensionality of wind farm perception.

In a later empirical survey of three Dutch wind farm sites, Wolsink[26] reported similar conclusions to those previously identified by Hoepman.[53] Only 24% of respondents agreed that wind farms should be sited in other sites away from the locality. Wolsink applied causal modelling techniques to examine the determinants of anti-wind farm resistance behaviour (i.e. self-reported participation in activities such as signing a petition, writing a letter, attending a meeting, etc.). His statistical model is illustrated in Figure 2. The perceptual aspects included the NIMBY attitude, visual perceptions of the scenic value of turbines, their perceived interference with nature causing 'annoyance', the environmental 'clean' benefits of wind energy, political efficacy and, finally, general attitude towards a local wind farm. Variables measuring turbine reliability and electricity prices were not included in the final model because they were not statistically significant in explaining wind farm behaviour.

Although Wolsink[26] did not quote the estimated coefficients or total variance explained, he did contend that attitudes to a local wind farm were mainly explained by visual perceptions. Secondly, he concluded that resistance behaviours were directly explained by local factors rather than more general arguments in favour of wind energy (e.g. that wind energy is a 'clean' energy source). In particular, attitude to the local wind farm helped to explain 28% of the variance in resistance behaviour. In contrast, NIMBY beliefs added only 4% to the explained variance in the dependent variable. Wolsink[26] concluded that the data did not support the NIMBY hypothesis and that those opposed to wind energy locally were not in favour of wind farms anywhere.

Does Community Involvement Increase Local Support for Wind Farms?

This area of wind farm research has emerged most recently and reflects growing awareness amongst policy makers that the process of wind energy development, in addition to physical characteristics, is an important factor shaping public perception and the acceptability of wind farms. For example, the recent UK Energy White Paper[7] noted 'the value of community engagement' and 'providing local residents with a direct benefit from the renewables development' (p. 52). Research studies have focused upon political, economic and social-psychological aspects of local involvement, for example issues such as public participation in decision making, local shareholding and local perceptions of how the benefits of wind farms should be shared in the locality.

Studies of economic involvement in wind energy development have chiefly taken place in Denmark, where local co-operatives are more typical forms of development in comparison with other countries. This research

can be distinguished from economic research examining willingness to pay (e.g. Reference 54) and the economic value of wind farm environmental impacts (e.g. Reference 55) that does not focus upon issues of involvement. A recent study[19] targeted a specific sample of tourists in order to evaluate whether wind farm development was perceived to hinder local economic vitality. Such research did not identify negative economic consequences for wind farms upon the tourist industry, with most respondents unaware of the sites of current wind farms and 80% indicating an interest in visiting wind farm visitor centres. In a representative study of more than 1000 Danish citizens,[20] results indicated that although only 5% of respondents were share owners, 35% of respondents actually knew someone else who was and 43% expressed interest in becoming share owners. Daugarrd[21] concluded that more than one-third of people in Denmark are directly engaged in wind schemes or are familiar with other people engaged in such schemes.

The potential impact of share ownership upon public perceptions of wind farms was suggested in a study which revealed that 58% of households in the Sydthy region of Denmark owned one or more shares in a co-operatively owned wind turbine.[22] Examining links between share ownership and perceptions, the report found that people who own shares in a turbine are significantly more positive towards wind energy than people with no economic interest in wind turbines. Secondly, members of wind co-operatives are more willing to accept further turbines in their locality in comparison with non-members. Taken as a whole, the Danish studies suggest that economic involvement in wind energy development as shareholders can have a positive influence upon attitudes to wind farms, although these studies have not demonstrated causal relations between economic and psychological variables. Further research is required to do this by systematically comparing public acceptability in a context where shareholding was made available with one in which it was not.

The rather high levels of interest in shareholding in Denmark contrast with a survey of public opinion in Ireland[35] which noted that only 16% of respondents registered interest in wind farm investment. One potential reason for this lower figure is reflected in the statistic that 93% of Irish respondents were unaware of any opportunity to invest in wind farms. This lack of both awareness and interest suggests that the socio-cultural approach to wind farm development in Ireland was markedly different from that in Denmark, with the Irish approach less local or community-focused.

Political aspects of wind farm involvement have been studied in Denmark, Germany, the Netherlands and the UK. For example, Hoepman[53] reported that over 85% of respondents in a Dutch study wished to be informed of development plans for future wind farms in the locality, and 60% felt that this should be the responsibility of the local authority rather than local media. In Germany a recent study[24] also indicated some willingness on the part of the public to participate in wind farm development processes, with 49% expressing a positive attitude to attending public meetings, should such meetings occur. This links with a recent study of European public attitudes to energy resources[56] which indicated that a majority of respondents expressed a willingness to be involved in decision making about renewable energy development. However, few respondents expected such opinions to be taken into account by decision makers, reflecting the centralized context of energy decision making already mentioned.

An empirical study in South Wales[57] indicated high levels of public support for both economic and political aspects of local involvement in wind farm development. About 88% of respondents indicated that development of wind farms should be conducted in partnership with local people. Similarly, over 80% of respondents indicated that energy from wind farms should be used locally and that profits should be shared with local people. There was slightly less, although still majority (52%), support for the statement that wind farms should only be developed if owned by the local community. The fact that a large proportion of participants indicated 'not sure' to this statement (32%) suggests that the concept of local involvement in wind farm development was less familiar to the public in the UK, as was noted in Ireland[35] and in contrast to the situation in Denmark.

Collectively, these studies suggest that local involvement, in either economic or political terms, tends to have positive affects upon public perceptions of wind farms[58] and reflects growing interest in a 'soft energy path'[37] emphasizing 'community' aspects of renewable energy development. This is manifest in UK government programmes (e.g. the Countryside Agency's Community Renewables Initiative and the Energy Savings Trust's Community Action for Energy Programme) and studies of the potential impact of community-level schemes (e.g. Reference 59), which have suggested that community renewable schemes can form up to 10%

of UK renewable electricity supply by 2010. It is also similar to the sustainable livelihoods approach typically adopted in small-scale, off-grid renewable energy development in developing countries.[60]

The 'local participation' hypothesis was further explored by Devine-Wright *et al*.,[61] who noted that the typical development model in the UK, which is private sector led rather than community led, gave little control to local people. This was reflected in the poor quality of public consultations typically carried out by private sector developers and public sector institutions.[58] This assumption is supported by recent empirical research[49] indicating that less than 25% of respondents were aware of public consultation processes conducted by developers and local authorities in Scottish wind farm developments. Devine-Wright *et al*.[61] contended that negative perceptions of wind farms may be motivated not only by negative evaluations of visual impact but also by a sense of lack of control over development or land use planning processes, and dissatisfaction with these procedures. The authors hypothesized that development contexts featuring high and authentic levels of public participation were also likely to be associated with higher levels of planning success and lower levels of social conflict. Their analysis of secondary data from three UK wind farm case studies indicated a correlation between these three issues, whilst noting that community participation represented only one dimension of many contributing to planning outcomes.

A second study[28] explored the social-psychological context of wind farm perceptions by empirically examining social influences upon public perceptions of a proposed community-owned wind farm in the Amman Valley, South Wales. In an empirical study utilizing a random sample of 159 local people, perceptions of a local wind farm were analysed in relation to a range of social influence processes, including exposure to local media sources, the opinions of significant others such as friends and family, and the degree of personal involvement in public participatory processes. Results indicated that the opinions of respondents' friends was the single most important predictor of wind farm perceptions; that is, when positive perceptions of development were held by friends, they also tended to be held by respondents themselves.

Although little wind farm research has integrated environmental psychological theory and research on the concept of place (e.g. Reference 62) into analyses, the potential significance of place processes in shaping views of wind energy development was suggested in the study by the emergence of local place of residence (i.e. which of the local villages participants' resided in) as a significant predictor of wind farm perceptions. This stemmed from the fact that, in one of the local villages, people had joined together to set up a local action group to campaign against the development.[42] Residence in this location was significantly associated with negative perceptions of the wind farm, suggesting the relevance of place processes both in describing how local opinion is constructed and in predicting perceptions of the development. The study also indicated the importance of operationalizing place processes at the most appropriate scale, as a measure of place identity targeting the regional level did not emerge as a significant predictor, whereas a similar measure applied at the village level may have produced a different result. The author concluded that public perceptions of wind energy development were socially constructed and affected by a range of social influence processes, in this case primarily the opinions of friends and place of residence—factors that had not been taken into account in previous studies.

Conclusions

Existing research on public perceptions of wind energy has identified several distinct aspects of wind energy that shape public perceptions and can be characterized as 'independent variables' influencing how wind farms are perceived and accepted. These include physical, contextual, political, socio-economic, social, local and personal aspects and reflect the complex, multidimensional nature of forces shaping public perception (see Table I). It is difficult to identify the relative importance of each of these aspects or how each might act interdependently upon public perceptions, since little research has used empirical methods to systematically compare more than one aspect at a time. Such work would require the adoption of an interdisciplinary approach, as has recently been advocated.[63]

Aside from fragmentation, there are several deficiencies in the empirical literature. Firstly, in terms of content, there are several areas that require further research. For example, there is a lack of research focusing

Table I. A summary of factors identified in past research as affecting public perceptions of wind farms and renewable energy

Category	Aspect	Research examples
Physical	Turbine colour	References 8, 41 and 51
	Turbine size	
	Turbine acoustics	
	Farm size and shape	
Contextual	Proximity to turbines	References 35 and 50
	Landscape context	
Political and institutional	Energy policy support	References 26, 34, 52, 58 and 61
	Political self-efficacy	
	Institutional capacity	
	Public participation and consultation	
Socio-economic	Shareholding	References 22 and 35
Social and communicative	Social influence processes (media, social networks, trust)	References 28 and 58
Symbolic and ideological	Representations of wind turbines	References 40, 47 and 48
Local	Place and identity processes	Reference 9
	Local or community benefit and control	Reference 57
	NIMBYism	Reference 26
Personal	Previous experience and knowledge	Reference 35

upon public perceptions of wind farms in non-industrialized countries, perhaps seeking to make comparisons between how renewable energy is perceived in different socio-economic and socio-cultural contexts. Similarly, recent policy making and development of offshore large-scale wind farms (e.g. in the UK, Denmark and Ireland) have yet to be accompanied by empirical social research investigating the dynamics of public perceptions in such contexts. Furthermore, with moves to develop smaller-scale wind turbines and building integrated wind turbines in urban areas (e.g. Reference 64), there is a need to go beyond a predominantly rural, upland, wind farm-focused body of work.

Secondly, in terms of methodology, there has been an overemphasis upon a single type of research approach: the market research-oriented, case study design using a quantitative survey tool. Despite a plethora of empirical studies, there is a lack of valid and reliable quantitative methodological tools for operationalizing public perceptions of wind farms. With a few notable exceptions (e.g. Reference 26), probabilistic multivariate statistical tools (e.g. multiple regression and structural equation modelling) have not been used to explain variance in reaction to and support for wind energy development. Yet increased use of such tools would allow for a more sophisticated conceptual understanding of wind farm perceptions to emerge.

In addition, the use of alternative methodological tools may produce new insights. For example, quasi-experimental designs, perhaps using similar sorts of photomontages as used in the study of wind farms in Ireland,[35] can be used to investigate cognitive perceptions of wind farm aesthetics. This can serve to link literatures in cognitive and environmental psychology with descriptive work carried out on wind turbine aesthetics and design (e.g. References 65–67), serving to systematically unpick the complex interaction between discrete variables such as turbine colour and size, wind farm shape and size and, finally, landscape context. Qualitative methods could be applied to investigate how turbines are symbolically represented across divergent social groups, within and across communities, building upon the insights provided by geographical researchers (e.g. Reference 47). For example, studies could apply unconventional tools to explore the symbolic and affective dimension of wind farm perceptions, including the multiple sorting task (e.g. Reference 68), structured collages[69] or the content analysis of unconventional forms of data (e.g. anti-wind farm poetry or advertising images).

Thirdly, the 'public' or 'community' that is the focus of empirical research studies has often been conceived of in an oversimplistic and monolithic manner,[6] failing to take account of the role social identities, social rep-

resentations and social networks can play in creating heterogeneous attitudes to renewable energy developments.[28] For example, nested local social identities, structuring exposure to different social networks, can be important both in explaining how people come to hear about proposed wind farm developments and whom they trust, as well as the eventual perceptions that they choose to adopt. In addition, there is a need to assess how public perceptions of wind farms are affected by communities of interest[70] that lie outside of the local context but may affect how perceptions emerge. Such research could examine the role a new communication medium such as the internet plays as a social influence medium mobilizing both support for and opposition to wind farm developments, across localities, regions and countries (e.g. References 71 and 72).

Fourthly, in terms of theoretical aspects, the applied focus of the literature is associated with a marked absence of explanatory theoretical frameworks used to generate hypotheses and explain results. There is little sense of theory-driven applied research on wind farm perceptions. As a consequence, the literature has been more successful in *describing* perceptions of wind farms rather than providing substantive *explanations* of these. This is particularly a problem in cases where numerous empirical studies carried out in different regions or countries produce different findings, as has been the case with the proximity hypothesis. It is difficult to arrive at conclusions about the implications of such a body of research when underlying causes of psychological processes are not explored. Furthermore, the NIMBY concept that has been most frequently used to describe negative perceptions of wind farms has failed to receive empirical support, specifically in going beyond the study of perceptions to explain resistant behavioural responses (e.g. Reference 26). This lack of support has left a theoretical lacuna that needs to be filled.

Aside from the adoption of a more interdisciplinary frame for research, it may also be useful to ground wind farm perceptual research in existing social theory. Devine-Wright[73] has suggested the value of applying place theory (e.g. Reference 74) to the study of wind farm perceptions. In particular, the value of place theory in explaining negative symbolic, affective and political responses to wind farms could be helpful and complement the existing predominantly 'realist' approaches that focus upon physical attributes of turbines. Empirical research could investigate whether wind farm controversy arises because of perceived threats to local place identifications. From this perspective, the development of a wind farm could represent a form of place change that is perceived to conflict with identity principles of place-related continuity, distinctiveness, esteem and efficacy, building upon work linking place with identity process theory (e.g. Reference 75). In addition, such linkages could benefit place theory, which has tended to neglect issues of energy and other services that comprise the infrastructure of where people live, work and take leisure. Canter's[62] conceptual model of place was influential in orienting place researchers towards buildings and urban spaces, and the work that has followed has tended to neglect 'infrastructure' (e.g. energy, water, waste, etc.) in favour of 'superstructure' (e.g. the study of façade design, room layout, etc.).

Studies linking place and renewable energy are rare, but Vorkinn and Riese[9] have undertaken an empirical study of the comparative importance of place attachment processes in predicting perceptions of a proposed hydroelectric development in Norway. Results indicated that place attachment to the locally affected areas was a significant predictor of perceptions of the development and that place attachments at local and municipal levels were together more significant than socio-demographic variables in predicting the dependent variable (17% of explained variance vs 16%). In so doing, Vorkinn and Riese's[19] findings lend weight to the conclusion that the application of place theory to future studies of public perceptions of wind farms could offer a means of going beyond descriptive study to more sophisticated explanation of the social and psychological bases of wind farm perceptions.

In conclusion, it is apparent that the existing body of empirical research on perceptions of wind farms has been successful in addressing several key questions, although in a rather fragmented and atheoretical manner. Public perceptions have been investigated in numerous studies carried out in a range of different national and cultural contexts, at different scales of analysis. Collectively, they provide a basis for recognizing how public perceptions are shaped by a diverse range of technical, environmental, economic, social and psychological aspects. However, future research needs to evolve into a more coherent body of theory and results so as to be both less fragmentary and more grounded in established social science conceptual and methodological approaches.

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