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Title:

Public Attitudes to Windfarms – How Opinions Change Over Time

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Abstract

While independently-conductedd polls suggest significant support for wind power among the general public in the United Kingdom, the debate is often dominated by active and vocal critics. This is particularly apparent when wind farms apply for planning permission. Many studies have gathered opinions of wind power at a single point in time but very few 'before and after' studies exist. The aim of the study was to determine whether the pre-construction opinions held by communities local to a windfarm change after an extended period following commissioning. Residents of St. Newlyn East, Cornwall, were questioned to assess how their opinions of Carland Cross windfarm changed between 1991 and 2006. Negative opinions generally improved with 70% today believing the windfarm has no negative impacts on the economy, society or environment. Greater improvements occurred for the positive impacts with only 22% today believing no benefits have transpired. Statistically significant changes in opinion were observed for the windfarm's visual attractiveness and the energy security it provides. To ensure planning applications are not unnecessarily declined, planning committees should assign greater weighting to the benefits of windfarms, reduce the influence of public objections and offer education so that considered opinions can be formed.

Keywords

Attitudes, Renewable Energy, Planning

Introduction

In response to the threats of global climate change and national energy security, the UK government has proposed that 10% of electricity generation by 2010 will be derived from renewable sources, rising to 20% by 2020 (DTI, 2003). In the recent past this has seen the development of onshore wind power to meet these targets (Strachan and Lal, 2004). This approach has been controversial due to the negative environmental and socio-economic impacts perceived to be created by windfarms.

Environmental Concerns

Windfarms occupy large land areas, a common reason for public objection, but the footprint of the wind turbines is between 1 - 2% of the total site area (Friends of the Earth, 2002) leaving the land between the towers available for agricultural or recreational use. Furthermore, sites can easily be returned to their original state upon decommissioning unlike the infrastructure required for a large hydro, nuclear or fossil fuelled plant.

Visual intrusion is often the most important environmental issue (Daniels *et al.* 2001; Middleton, 2003) that arises from wind turbines and power transmission lines being constructed in the open, upland landscapes required for effective wind generation. Of course, this is highly subjective and will rely on psychological and sociological factors,

such as a person's knowledge of the technology or exposure to particular media reports (Boyle, 2004). Two further aspects of visual intrusion from wind turbines are sun glint and sun flicker which can annoy residents and become a blinding hazard to drivers. Sun glint occurs when the sun's rays are intermittently reflected from the turbine rotors while sun flicker refers to the intermittent shadow cast when the rays of the sun are viewed through a turning turbine.

Visual intrusion from wind farms can be perceived to affect tourism, especially within economies that rely on tourism as a primary income. However, studies in Wales and Scotland found contradictory responses; a proportion of visitors reported that a windfarm would put them off visiting a location while others suggested a windfarm could actually be used as a tourist destination to bring more visitors into an area (NFO System Three, 2002; NFO System Three, 2003).

Wind turbines produce noise, due to the mechanics and aerodynamic turbulence of the blades, which is a common objection to wind power even in remote locations. Boyle (2004) mentions that there is currently no legislation on the noise emissions of wind turbines in the UK but Sørensen (1995) reminds the reader that the annoyance of the aerodynamic noise will depend up on its tone, intermittency and the sensitivity of individuals under certain circumstances, such as sleeping. Careful turbine siting can minimise immission levels at near-by dwellings.

The RSPB have reported that the number of breeding pairs of white-tailed eagles on the Smola islands, Norway, have fallen from 19 to one since a wind farm was constructed (Anon. 2006) suggesting windfarms can impact bird populations. However, Ross (2006) mentioned that during the first two years of operation of the Novar windfarm, Scotland, only two grouse and one kestrel were killed despite the wind farm being located in eagle territory and on a migration route for geese. While bird strikes are frequent, the threat posed to bird life appears to be highly dependent upon site-specific parameters.

Problems arise with television signal interference (Dabis and Chignell, 1999). The reflection of the signal off of the turbine blades causes a cyclic ghosting of the picture that matches the frequency of turbine rotation, but this can be overcome through various technological fixes.

Voltage fluctuations, due to sudden wind speed variation, propagates electrical flicker (Vilar *et al.* 2006) which can cause problems for consumers in the form of changes in the illumination intensity of incandescent light bulbs (Larsson and Poumaréde, 1999). Voltage regulation technologies can mitigate electrical flicker and it is virtually unheard of with state-of-the-art, variable speed wind turbines (Zhe Chen, 2005).

Planning Process

It isn't simply environmental concerns that have restricted wind power development in the UK. Exposed, remote, high ground provides the greatest opportunity for the exploitation of wind power, which is often environmentally sensitive. One of the main reasons for windfarms in the UK encountering difficulties in gaining planning permission from local authorities is that the approval of these large structures in upland areas is a reversal of land use policy (ETSU, 1994) in areas that have historically been protected from development because of their natural beauty and value (Hedger, 1995). Additionally, there is little interaction between national energy and local land use planning policies, which has given rise to local authorities adopting different policies on renewable energy development and interpreting the objectives and intentions of national strategies in dissimilar ways (Birnie *et al.* 1999).

The planning process is often perceived to be a set of rules aimed at preventing development rather than making sure good development goes ahead and communities frequently feel detached from the process (Price, 2004). Community ventures, which ensure continual participation and consultation with local people and the reinvestment of profits into the local area, are a way to ensure wind farm development will be rapid enough to meet government targets. This can be demonstrated by the Danish experience where, despite Denmark having stricter planning controls than the UK (Toke, 2002),

deployment of wind power has been very successful due to 75% of wind power capacity being privately owned by individuals or wind power co-operatives (Wilson, 2003).

More recently, windfarm planning applications in the UK have had greater success at being approved than at the end of the 20th century (Table 1), possibly due to heightened concern over climate change and a growing acceptance of windfarms by the public as the technology matures. Toke (2005) suggests one reason for this apparent weakening in the planning process may be because the government departments that deal with national parks and countryside protection were separated after the 2001 election.

In an attempt to integrate national energy policy into local planning decisions 'Planning Policy Statement 22: Renewable Energy' was published in 2004. It advocates the setting of regional targets for renewable energy installation through Regional Spatial Strategies and raises awareness of the environmental and socio economic impacts that are likely to arise. It aims to allow Development Control Committees to make more favourable decisions for renewable energy by ensuring the environmental and economic benefits of renewable energy developments are well understood and prepared for in the decision making process.

Public Attitudes

With decisions on wind farm planning being made by elected local councillors, public concern over wind farms can be responsible for projects' planning applications being turned down. This restricts the government's ability to meet renewable energy generating capacity and carbon emission targets.

There has been much public opposition to windfarm developments in the UK but this would appear to be from a vocal minority as various studies have found overwhelming support for wind farm construction (e.g. Anon, 2005a; MORI, 2004). The BWEA (2005) report that, constantly, over the past 15 years, between 70 and 80% of residents living near windfarms are in favour of wind power both in principle and practice, which is consistent with a review of public attitude surveys by Krohn and Damborg (1999). If support is so high for windfarms in the UK then why between 1999 and 2002 did only 25% of contracted wind power gain planning approval, with the most frequent objection being the adverse visual impact of the windfarm on the landscape (Toke, 2002).

The 'not in my backyard' (Nimby) syndrome is one of the main reasons for the disparity between the outcomes of public attitude surveys and the granting of planning consent in the UK. A Swedish study found no significant difference between the opinions of the public living local to a windfarm and the public who have little contact with them (Ek, 2005). This suggests that institutional factors in the UK are responsible for Nimbyism,

such as a suspicion of the person or company that wants to construct the windfarm or a disagreement with the general planning process. It is possible that the culmination of residents' fears of windfarms may be unfounded once the windfarm has been constructed. If this is the case, up to 5170 MW of wind power capacity, three times the total installed wind power capacity of the UK (BWEA, 2006), may have unnecessarily been declined planning consent.

Few studies have attempted to determine how the opinion of the public changes between having a windfarm proposed in their locality and after having lived with the structures. In 1990, residents of Delabole, Cornwall, were questioned on their opinions of a proposed windfarm near the village and were questioned again in 1992 six months after commissioning. It found that residents were more accepting of wind power after having lived with the development for 6 months; only 14% of respondents were not concerned about noise intrusion before the windfarm was constructed, but this rose to 80% after 6 months (DTI and Exeter Enterprises, 1994). Later, Bishop and Proctor (1994 *cited in* Damborg, 2003) in a report for BBC Wales performed a 'before and after' survey of three windfarms in Wales. It was found that both before and after construction more residents were in support of the development than opposed it, with 66% of the population supporting the windfarms after construction, while only 41.1% supported them before. More recently, a study on public attitudes of four operational windfarms in Scotland (Dudleston, 2000) found that 40% of residents expected to be negatively affected by a local windfarm but in fact only 9% experienced any problems.

The studies by DTI and Exeter Enterprises (1994) and Bishop and Proctor (1994 *cited in* Damborg, 2003) were performed when wind power was in its infancy in the UK when the population may have been very concerned over the change this alien technology may have brought. This study will identify how public opinion has changed over the 14 years that residents have been living with a windfarm in Cornwall; the longest period of any study of this type. Consequently, the aim of this study was to determine whether the opinions held by communities local to a windfarm proposal before construction begins are maintained as they learn to live with a completed windfarm in their environment.

Study Location

Cornwall is home to the first windfarm in the UK, Delabole (Freris, 1992), and currently has eight windfarms in total, commissioned between 1991 and 2004 (Yes2Wind, 2006). There has thus been a considerable opportunity for residents to form their true opinions of windfarms.

The 15 turbine windfarm constructed in 1992 with a 6MW generating capacity at Carland Cross was chosen as the location for this study (Figure 1) due to its proximity to a reasonably-sized population and its offering of a more rural location over other Cornish windfarms. The windfarm's 30m high turbines are constructed upon the highest hill in the area at an altitude of 149m and are surrounded by sparsely vegetated moorland and downland. The village of St. Newlyn East, 2¹/₄km from Carland Cross, with a population of 1230 (CCC, 2000) was used for questioning as the windfarm can be seen from the village across the Lappa Valley (Figure 2).

Methodology

There were two main objectives for the methodology. The first was to obtain the opinions of the Carland Cross windfarm from the residents before the windfarm was constructed, and secondly, the opinions of residents today after having lived with the development for 14 years.

To obtain residents' opinions of the windfarm at the time the development was proposed a door-to-door questionnaire was prepared, which was used to verbally interview residents who had lived in St. Newlyn East since before the construction of the Carland Cross windfarm. To overcome the possible reluctance of residents to admit that their attitudes towards the windfarm had changed, it was proposed that the questionnaire results would be compared with media reports from the early 1990s. However, very few opinions of residents were found in the press for this purpose.

A separate section of the questionnaire was designed to decipher the current opinion of the windfarm held by the same sample of residents. It was decided to use the same sample of residents for both the 'before' and 'after' questioning to avoid the likely occurrence of demographic disparities had two separate samples been used.

The questionnaire was designed to make the comparison of residents' opinions between the pre-construction stage and today as simple as possible. This involved using a majority

of closed questions to allow a quantitative analysis. However, an important aspect of the questionnaire design was that respondents were not prompted with specific impacts that the windfarm may have had on their lives, but simply asked to disclose, without the provision of examples, the impacts they recalled being concerned about at the planning stage and the impacts they experience today. After the impacts had been disclosed the respondents were asked to rank their concern about a negative impact on a scale of 1 to 5 where 1 was 'very slightly concerned' and 5 was 'very greatly concerned' and to rank the importance of positive impacts where 1 was 'very slightly important' and 5 was 'very greatly important'.

As the study needed to question residents who had lived in St. Newlyn East since before the windfarm was proposed, a simple random sampling method was employed. A systematic sampling method could have omitted these residents. Under the time and resource constraints of this study a sample of 100 was aimed for. At the 95% significance level this produced a maximum sampling error of 9.4%. Despite this being relatively high, the results are still acceptable as long as the reader is aware of the study limitations.

Results

Sample Characteristics

The final sample size was 100 after two full days of questioning and a visit to every house in the village in June 2006. Gender distribution was fairly consistent with that of the village with 43% of the sample being male, leaving 57% as female. The gender distribution of the population of the Newlyn and Goonhavern Ward, in which St. Newlyn East appears, is 51% female and 49% male (National Statistics, 2001). The age group distribution of the sample varied by a maximum of 9% from that of the ward population (Figure 3).

Attitudes Towards Wind Power

84% of the sample suggested wind power should be included in the UK's energy portfolio while 16% were either undecided or believed wind power should not be advocated further as an energy source for the UK. The overwhelming reason given for this was that wind power does not produce enough electricity to make a significant contribution to UK demand and so many windfarms would be required.

Changes in General Opinion

74% generally approved of the Carland Cross windfarm proposal in 1991, before construction, but 14% objected. In 2006, after having lived with the windfarm for 14 years, support for the windfarm had increased to 82%. The majority of the increased support is derived from the population that was undecided over their opinion in 1991. 6% still object to the windfarm's presence.

Changes in Opinion of the Negative Impacts

Figure 4 shows how the general concerns of residents changed between 1991 and 2006. The percentage of respondents who believed noise and visual intrusion would create a negative impact upon the environment before the windfarm was constructed reduced from 23% to 15% and 19% to 15% respectively. Concerns over radio interference and impact upon wildlife also reduced. These changes caused the percentage of the sample that perceived that there would be no negative impacts upon the local environment, society or economy to increase from 64% in 1991 to 70% in 2006. Electrical flicker appeared to be considered more of an issue after the construction of Carland Cross than at the planning stage.

10% of the sample thought that the visual intrusion of the wind turbines was worse after the farm was constructed than they had predicted. 8%, however, thought that the visual

impact was less intrusive. 82% of the respondents did not change their opinion. Similarly, 75% of the sample did not change their opinion about the nuisance that noise from Carland Cross caused them. 11% believed that the nuisance was worse than they had expected while 14% thought that the noise levels were lower than they had previously predicted (Figure 5).

95% did not change their opinion regarding the threat they believed Carland Cross windfarm poses to wildlife and only 1% reduced their concern, by a magnitude of 2, of the perceived interference of radio and television signals caused by windfarms.

6% believed the problem of electrical flicker was greater in 2006 than they had predicted before the windfarm was commissioned. Of this 6%, two thirds considered the problem to have increased by only an order of 1, but the remaining third thought the problem had increased by an order of 3.

After Anderson-Darling tests for normality, Mann-Whitney tests were run for each negative impact to identify any significant differences between the opinions of the residents in 1991 and 2006. No significant differences were identified at the 95% confidence level.

Changes in Opinion of the Positive Impacts

In 1991, 59% thought that the windfarm would bring no positive environmental, social or economic impact to St. Newlyn East but this figure dropped to 22% over the 14 years to 2006 (Figure 6). Since 1991, the proportion of respondents who found the windfarm visually attractive increased from 6% to 40%. After construction certain positive impacts of the windfarm emerged that none of the respondents had considered whilst Carland Cross was in the planning process. These were: The usefulness of the windfarm as a navigational aid, which one respondent ranked as 'very greatly important'; and the pleasure gained by 7% of the sample in watching the phenomenon of sun flicker and sun glint. The fact that windfarms provide a secure form of energy for the UK had risen in popularity from 6% in 1991 to 41% today. 5% of respondents hoped that Carland Cross would provide cheaper, local electricity but these failed to materialise over the past 14 years.

58% of the respondents did not change their opinion regarding the attractiveness of wind turbines. 38% found the Carland Cross windfarm more attractive after it was constructed than they thought they would before it was constructed. Only 4% found the structure less visually appealing in 2006 than 1991. 41% of the sample believed that the energy security and independence that the deployment of wind power provides to the UK had become more important since 1991, despite living with a windfarm on their immediate doorstep. While 2% believed the importance of energy security had declined over the past 14 years,

9% did not believe energy security was important at all in 1991 but responded with 'very greatly important' in 2006 (Figure 7).

The fact that wind power provides a source of 'green', renewable energy became more important in the opinion of 16% of the residents of St. Newlyn East during the past 14 years. 3% of the respondents thought that the 'green' energy aspect of windfarms had become less important since 1991; two thirds of these had replied with 'very greatly important' in 1991 but had since decided it was no longer a positive impact of windfarms. 81% did not change their opinion.

5% thought that the windfarm has had a more positive impact on tourism over the past 14 years than they had thought it would in 1991. 93% of the respondents left their opinion unchanged.

7% of the sample found they had a more a positive attitude toward sun flicker and glint once they had lived with the windfarm in comparison to their opinion while the windfarm was being planned. 6% improved their opinion by more than an order of 3.

After Anderson-Darling tests for normality, significant differences in opinion were identified at the 95% confidence interval for the visual attractiveness of the windfarm and for the secure source of energy that wind power provides to the UK.

Discussion

Attitudes Towards Wind Power

84% of the sample was quite happy to see wind power as one of the renewable sources of energy that will be exploited further in the future. The presence of Carland Cross windfarm has therefore not appeared to have given the residents of St. Newlyn East a negative opinion of wind power. These findings corroborate a study by TNS (2003) which found that 82% of residents living within 5km of a windfarm were in favour of further wind power exploitation. However, 10% of the respondents suggested that wind power should not be exploited further, the most common reason quoted being that windfarms fail to generate enough electricity to justify their existence and that entire landscapes would have to be covered in turbines to meet demand.

Changes in General Opinion

Considering the negative press and apparent opposition new windfarm developments in Cornwall have received it is surprising to learn that 74% of the sample approved of the Carland Cross windfarm development when it was being planned. Many residents revealed that they were very remotely involved in the planning process and admitted that their approval of the scheme was largely based on the fact that they didn't know what to

expect but that it was exciting to be at the heart of the development of a new technology; the first windfarm in the UK, at Delabole, Cornwall, had opened only months earlier.

Today, 82% of the sample is in support of the windfarm but, interestingly, the proportion of residents who are against the development fell by only two percentage points to 12% between 1991 and 2006. The increase in support has appeared from a change in opinion of the residents who were undecided in 1991 for the reasons that either the negative impacts associated with windfarms were not as great as they had previously thought, or that they believe the benefits provided by a windfarm have become more relevant over the past 14 years.

Changes in Opinion of the Windfarm Impacts

There were no considerable differences between the opinion of the sample population regarding negative impacts of Carland Cross when the windfarm was proposed in 1991 and their opinion in 2006 after having lived with the structure for 14 years. 64% of the population were not concerned about any negative impacts when the windfarm was in the planning stage compared to 70% today. However, before construction 59% had not believed any positive impact would emerge from the windfarm but after construction only 22% could not identify a positive impact. This is a clear message that local councillors and members of planning committees should take note of the opinions of the wider community rather than the vocal minority.

It is often the case that the primary objection to windfarm developments is the visual degradation of the landscape as found in a study by Warren *et al.* (2005) in Ireland in which 89% of respondents were concerned about visual intrusion. The findings of this study, however, have shown that the greatest concern of the residents of St. Newlyn East before the windfarm was constructed was noise intrusion; visual intrusion was the second greatest concern but at a very much lower level than in Warren's study, at only 19%. This significantly lower response could be because the windfarms used in Warren's study were commissioned around the millennium by which time the public had greater experience of windfarms.

A statistically significant change in opinion was observed between 1991 and 2006 in the proportion of residents who found the windfarm visually attractive, from 6% to 40%, with a modal change of opinion of 2 but 6% changing their opinion by an order of as much as 4 or 5. A similarly high acceptance of the visual impact of windfarms was discovered by MORI (2004) in Devon with 28% of residents saying they found the structures attractive. An almost seven-fold increase in the proportion of the population finding the windfarm attractive in this study, and similarly high rates of acceptance in other studies, should be taken into account by planning authorities when considering refusing planning consent on the grounds of visual intrusion.

The proportion of local residents who anticipate noise as a negative impact from a proposed windfarm varies between studies from 12% (Dudleston, 2000) to 59% (Warren *et al.* 2005). 23% of the sample in this study believed they were concerned about the potential noise that would be created by Carland Cross. In contradiction to many residents, it was disclosed by a few respondents that the village had been given the opportunity to visit Delabole windfarm to hear for themselves just how noisy the turbines were. This is similar to Warren *et al.*'s (2005) study in which only 5% of the sample was aware of the public consultation meetings. The proportion of respondents who still find noise a problem today had dropped to 15%. Interestingly, one respondent told of how she couldn't sit outside on a summer's evening, while her neighbour questioned whether she'd ever heard the turbines at all. This supports Wolsink's (2000) theory that often people aren't protesting against the windfarm itself, but at a more subconscious level against the planning process, the individual or the developer that put it there. More people improved their opinion of the noise produced by Carland Cross after its construction than those who believed the noise worsened, and by a higher order, showing that opposition to windfarms can arise through the irrational exaggeration of fears.

This study has found that the public's knowledge of certain windfarm issues can lead to unfounded negative attitudes towards their construction. For example, 1% of the sample was adamant in 2006 that their poor television reception was due to the windfarm. However, they described a 'snowy' picture rather than the cyclic ghosting of a television picture that the rotation of a wind turbine is said to cause. A similar situation arose with

the issue of electrical flicker. Today, 7% say their lights occasionally flicker and blame this on the windfarm. The overwhelming majority of the sample, 93%, had not experienced any electrical flicker in the past 14 years since Carland Cross was constructed, suggesting that the village does not suffer from this problem. It is therefore likely that the 'flicker' experienced by some residents is caused by electrical devices within their own homes as well as switching activity on the distribution system. Finally, one elderly respondent blamed the increased wind speed in the area on the construction of the windfarm. These negative attitudes have most likely materialised through residents misunderstanding what they have read in the media. If opinions of this type are allowed to develop, the deployment of wind power could be severely restricted and government targets for electricity generated from renewable sources will take longer to meet. Public information campaigns are therefore required from sources that the public trust so that residents can make informed decisions regarding the possible impacts of proposed and existing windfarm installations. The recent brochure *Wind Power in the UK* published by the UK Sustainable Development Commission (2005) is one such example.

In addition to considerate turbine positioning and technical fixes this study indicates that future windfarm proposals should not be restricted on the grounds of the public's opinion of sun flicker and glint and electrical intermittency. Only 1% of the sample found these phenomena to be an issue both before and after construction. Indeed 7% of the respondents told of how they enjoy watching the sun glinting off the blades and that sun flicker can make for very beautiful sunsets.

It is surprising for a region of the UK that has tourism as a key economic sector (Lang, 2004) that only 1% of residents were concerned about the impact of Carland Cross on local tourism and only 2% could see its potential for developing tourism in the area. Intriguingly, the number of people who believed the windfarm to have had a negative impact on local tourism increased, as did the proportion of people who thought the windfarm's influence on tourism was positive. One respondent had experience of the National Trust in Cornwall and had witnessed some German tourists leave a property with the comment "what's the point of preserving a building that has a hideous building in the background?" Of course this opinion is based upon the subjectivity of whether the onlooker finds a windfarm attractive. Some respondents who believed the windfarm has had a positive impact on tourism quoted the Gaia centre at Delabole as an example without realising that the centre recently closed due to lack of visitors. The impact of a windfarm on tourism in its local area will depend on many factors, one of which will be the reason why tourists come to the area. One person suggested that the interior of Cornwall is a "boring" landscape and that tourists come to Cornwall for the coastline; therefore, windfarms inland won't affect tourism at all.

'Green' power was the greatest perceived positive impact of Carland Cross in 1991, with 21% of respondents believing this factor of wind power to be important. This figure increased by 7% to 28% in 2006, with a modal change in opinion of 3, most likely due to the growing prominence of environmental issues within politics and the media over the

past 14 years, highlighted by 16% of the sample ranking their opinion as of 'very great importance'. This figure is considerably lower than the 85% of the Devon, Cornwall and Orkney respondents questioned by Varley *et al.* (1989) that believed the clean energy provided by wind turbines was of a 'great advantage'. This disparity suggests that, despite climate change having risen to the top of the UK political agenda, in a display of Nimbyism the provision of carbon neutral electricity from wind power is less significant than its visual impact to people living adjacent to windfarms. This supports Wolsink's (2007) comment that attitudes towards wind power bear little relation to attitudes towards windfarms.

The growing concern regarding national energy security produced a statistically significant change in opinion between 1991 and 2006, with a modal change of 3, of the energy independence that windfarms provide. The requirement for secure forms of energy will only gain precedence in the future as fossil fuel resources dwindle.

Implications for Planning Authorities

Dudleston (2000) and Brauholtz (2003) found significant improvements between the 'before and after' opinions of Scottish residents but the data in this study has shown that for the majority of negative and positive impacts there is no statistically significant change in opinion. This is most likely because the technology was new to the UK in the early

1990s and so, as the residents have admitted, they hadn't really an idea of what to expect whereas the Scottish residents had had a decade to build their fears. Nonetheless, the general picture painted by this study is of an improvement in opinion of both the negative and positive impacts after construction. The implication of this for planning committees is that the opinion of residents during the consultation stage will most likely improve after construction. The visual intrusion of a windfarm is the most frequently quoted objection to a windfarm development and yet this study has found that a statistically significant change occurred in the proportion of residents that found the windfarm attractive, while the number of residents who found the windfarm visually intrusive declined. It should be suggested that planners therefore reduce the weighting of local residents' opinion of the predicted visual intrusion of a windfarm within the decision making process.

It may be the case that only the residents who object to windfarms attend the planning meetings to make their opinion heard and so this negative bias is a result of the silence of those residents who are in favour of the development. Perhaps the public consultation methods used by the planning system should be redesigned so that more informed planning decisions can be made by encouraging a greater cross section of the community to air their views, rather than just those in opposition. The added cost of this should be compared to the cost of not meeting carbon emission reduction targets or the financial impact of unchecked climate change.

Considerations for Future Studies

A limitation of this study is the age of the windfarm. The 400kW turbines that are installed at Carland Cross have rotor diameters of 39m. In comparison to the current technology this is very small as a modern 5MW turbine will have a rotor diameter of 135m, over four times as large, which will have a much greater visual and noise impact. However, some of the residents of St. Newlyn East commented that they didn't know about some of the impacts of wind power due to the immaturity of the technology in the UK in 1991. This will have suppressed the magnitude of residents' opinions of the positive and negative impacts of the windfarm before construction as the Nimby syndrome would not have had a knowledge base on which to develop. This could suggest that even greater changes in opinion than those found in this study may occur in residents living adjacent to more contemporary windfarms.

A logical progression from this study would therefore be to question residents living in the vicinity of a more modern windfarm to identify whether the results of this study can be effectively applied to planning applications for windfarms utilising current technology.

Conclusion

Changes in Opinion

This study has shown that the majority, 64%, of the residents of St. Newlyn East were not concerned about the construction of Carland Cross windfarm and its possible negative impact upon the economy, society or environment of the village. However, the opinions of the small proportion of residents who had fears generally improved after its commissioning between 1991 and 2006. Additionally, a large proportion of residents, 59%, had not considered that the windfarm would have any positive impacts on the village before its construction but this proportion had fallen to 22% by 2006 with some residents changing their opinion by orders of 5. Statistically significant changes in opinion occurred for the visual attractiveness of the wind turbines and for the secure form of energy that wind power provides.

Recommendations from this Study

Between 1999 and 2002 planning applications for 75% of UK contracted wind power capacity was declined mainly on the grounds of visual intrusion (Toke, 2002). The statistically significant change in opinion regarding the visual attractiveness of wind turbines found in this study may imply that up to three times the total installed wind capacity (5170 MW; BWEA, 2006), may have unnecessarily been declined planning

consent due to the exaggerated fears of local residents and the prominence of negative opinions from the media. This will have had a considerable impact on the ability for government carbon emission and renewable energy targets to be met.

The implications of this study for planning authorities are therefore two-fold. The first is that the objections voiced over a windfarm proposal will be stronger than the objections after construction and so the degree to which the public's objections should determine the planning outcome ought to be reduced in weight to represent predicted post-construction objections, while the positive impacts should be given greater consideration. Obviously, opinions will change by varying amounts between locations but as further studies of this type are conducted in the future an average improvement in opinion could be calculated and applied to pre-construction public objections as a weighted statistic. Secondly, planning authorities need to ensure that the general opinion of the development received from the local residents actually represents that of the whole community, rather than that of just those residents who have a reason to object or were able to attend the public meetings. This may involve the implementation of a doorstep survey, postal questionnaire or an on-line consultation exercise. This will cost both time and money but the cost of this should be compared to the cost of not meeting carbon emission reduction targets or the financial impact of unchecked climate change in the region, as highlighted by the recent Stern Review (Stern, 2006).

Additionally, the implication of this study for windfarm developers and national government is that local populations need to be informed of the likely impacts so that myths held by society, such as the creation of windier weather by windfarms, can be eradicated. This practice will reduce the proportion of residents responding in a negative manner toward windfarm proposals and increase the proportion that will be expecting a windfarm to produce positive impacts.

The advent of Planning Policy Statement 22 (ODPM, 2004) will encourage local authorities to grant planning permission for renewable energy installations based on the knowledge that an enhanced understanding of the environmental and socio-economic impacts to be expected will have enabled effective mitigation actions to be implemented. This will increase the weight of the environmental benefits of wind power in the decision making process, which is one of the recommendations from the findings of this study, and integrate local planning policy with national energy policy. In the near future windfarm developers should therefore find it less difficult to obtain planning permission.

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Tables

Year	Refused	Approved
1999	12	7
2000	9	9
2001	7	4
2002	3	14
Up to 09/2003	3	7

Table 1: Onshore wind power planning history in England and Wales after appeal. Planning has become more favourable in recent years. Source: Toke (2005)

Figure Captions

Figure 1: Location map of St. Newlyn East and the Carland Cross windfarm. The area is both sparsely vegetated and populated. Source: Traced from Edina Digimap (2006)

Figure 2: Carland Cross windfarm viewed from St. Newlyn East. Many residents can see the turbines from their property. Source: Author's collection.

Figure 3: Frequency distribution of the age of respondents in the survey sample compared to that of the Newlyn and Goonhavern Ward. The distribution of the sample varied by a maximum of 9% from that of the ward population. Source: (National Statistics, 2001a)

Figure 4: Change in residents' concerns over the negative impacts of the windfarm between 1991 and 2006. Noise and visual intrusion were not considered as great a problem after the windfarm was constructed and more people believed the windfarm had no perceived impact after commissioning than before.

Figure 5: Change in opinion of the sample regarding the visual and noise intrusion caused by Carland Cross windfarm between 1991 and 2006. 82% and 75% of the sample did not change their opinions on these issues respectively.

Figure 6: Change in the perceived positive impacts of the windfarm in 1991 compared to the actual positive impacts over the past 14 years. Once constructed, 40% of the sample believed the windfarm was attractive and only 22% of the respondents believed the windfarm had brought no positive impacts.

Figure 7: Change in opinion of the sample regarding the visual attractiveness of the windfarm and energy security provided by Carland Cross between 1991 and 2006. 38% believed the windfarm was more attractive after 14 years of operation than they had originally expected it to be and only 57% didn't change their opinion regarding energy security.

Figure 1

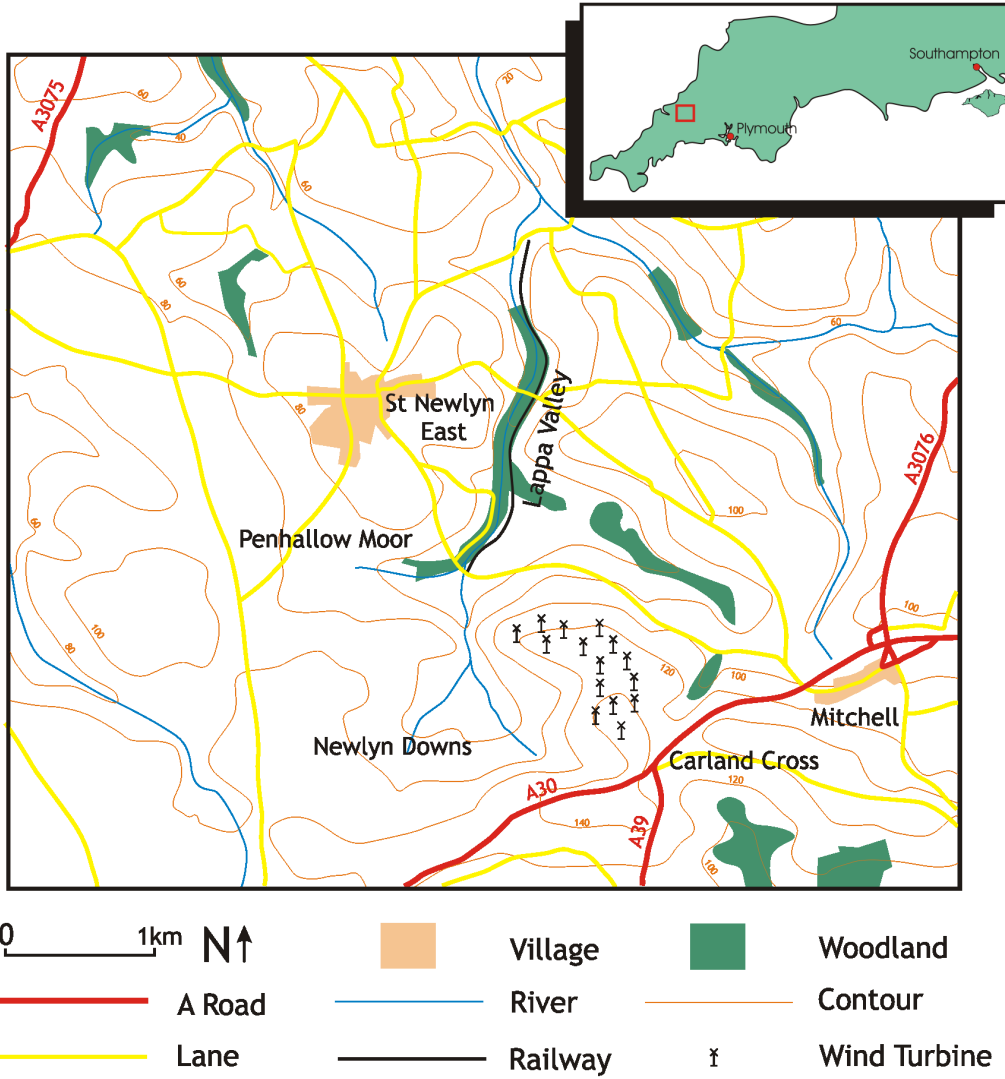


Figure 2



Figure 3

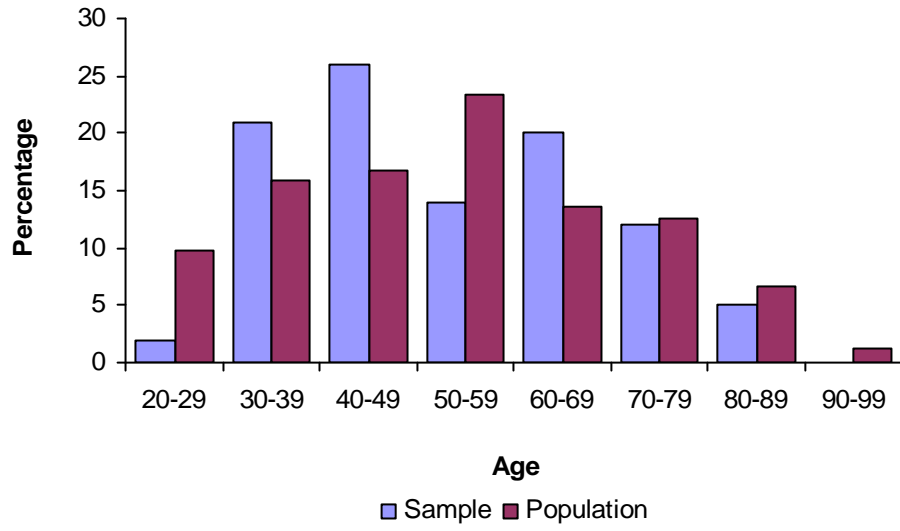


Figure 4

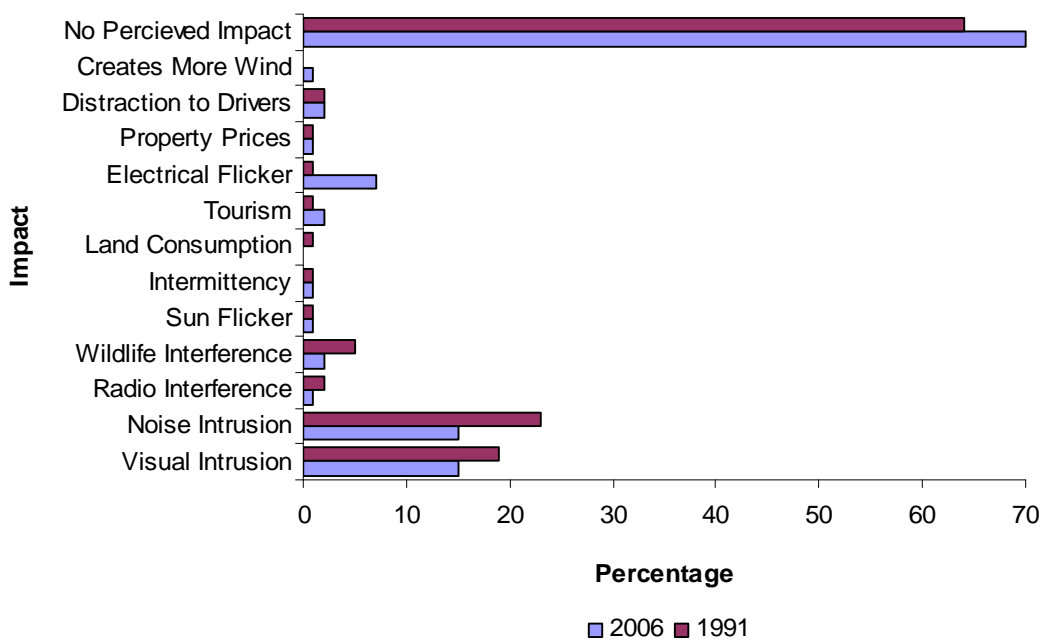


Figure 5

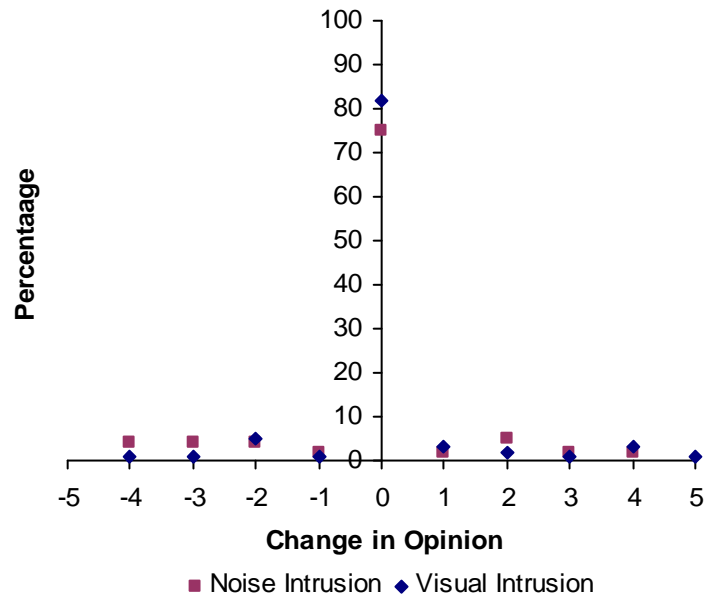


Figure 6

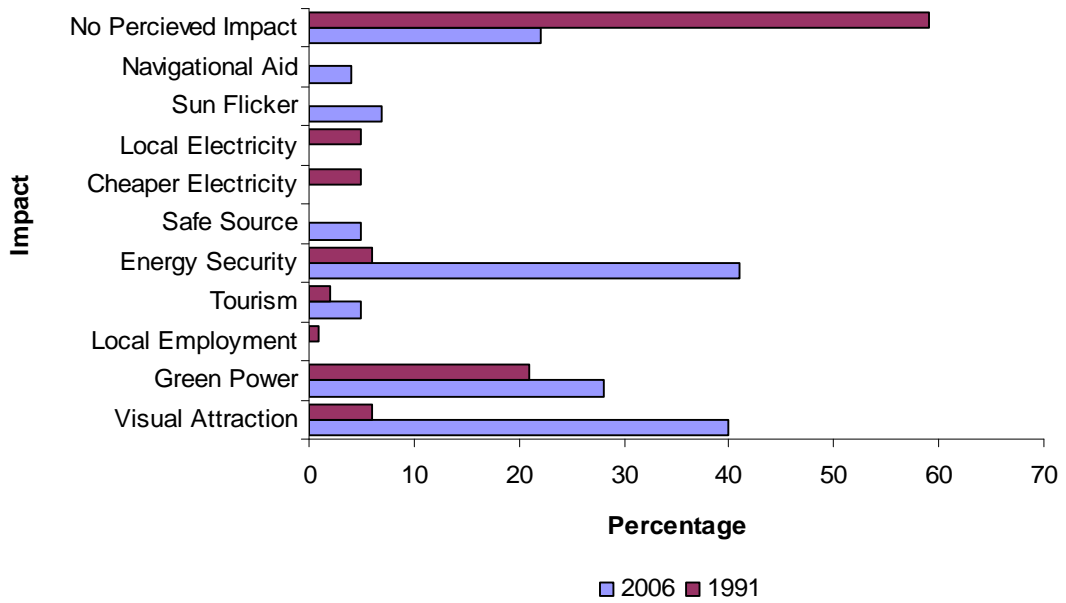


Figure 7

