



UNIVERSITY OF LEEDS

This is a repository copy of *Perceptions of wind energy projects in two coastal Massachusetts communities*.

White Rose Research Online URL for this paper:
<http://eprints.whiterose.ac.uk/126660/>

Version: Accepted Version

Article:

Lamy, J, Azevedo, IML, Bruine de Bruin, W orcid.org/0000-0002-1601-789X et al. (1 more author) (2017) Perceptions of wind energy projects in two coastal Massachusetts communities. *The Electricity Journal*, 30 (7). pp. 31-42. ISSN 1040-6190

<https://doi.org/10.1016/j.tej.2017.07.003>

© 2017 Elsevier Inc. This manuscript version is made available under the CC-BY-NC-ND 4.0 license <http://creativecommons.org/licenses/by-nc-nd/4.0/>.

Reuse

Items deposited in White Rose Research Online are protected by copyright, with all rights reserved unless indicated otherwise. They may be downloaded and/or printed for private study, or other acts as permitted by national copyright laws. The publisher or other rights holders may allow further reproduction and re-use of the full text version. This is indicated by the licence information on the White Rose Research Online record for the item.

Takedown

If you consider content in White Rose Research Online to be in breach of UK law, please notify us by emailing eprints@whiterose.ac.uk including the URL of the record and the reason for the withdrawal request.



eprints@whiterose.ac.uk
<https://eprints.whiterose.ac.uk/>

Perceptions of wind energy projects in two coastal Massachusetts communities

Manuscript accepted for publication in The Electricity Journal

Julian Lamy¹, Inês M. L. Azevedo¹, Wändi Bruine de Bruin^{1,2}, M. Granger Morgan¹

1. Department of Engineering and Public Policy, Carnegie Mellon University
2. Center for Decision Research, University of Leeds

Julian V. Lamy, PhD (**corresponding author**),
Research Associate
Department of Engineering and Public Policy
Carnegie Mellon University
5000 Forbes Ave., Pittsburgh, PA 15213
Email: jlamy@andrew.cmu.edu
Phone: +1 (202) 257 8377

Inês L. Azevedo,
Associate Professor
Department of Engineering and Public Policy
Carnegie Mellon University
5000 Forbes Ave., Pittsburgh, PA 15213
Email: iazevedo@cmu.edu
Phone: +1 (412) 268 3754

Wändi Bruine de Bruin
Professor
Centre for Decision Research and Leeds University Business School
University of Leeds
G48 Maurice Keyworth Building, Leeds LS2 9JT, UK
Email: w.bruinedebruin@leeds.ac.uk
Phone: +44 (0)113 343 8839

M. Granger Morgan
Hamerschlag University Professor of Engineering
Engineering and Public Policy
5000 Forbes Ave., Pittsburgh, PA 15213
Email: granger.morgan@andrew.cmu.edu
Phone: +1 (412) 268-2672

Abstract

We study the perceptions of wind projects using 15 semi-structured interviews of residents in two neighboring coastal Massachusetts communities, one which recently installed an onshore wind project.

We identify the specific characteristics that drive perceptions about the existing project as well as hypothetical new onshore or offshore projects. We find that economic benefits and visual aspects of the project were most important to participants, followed by noise, environmental benefits, hazard to wildlife, and safety concerns.

Keywords: wind energy, project development, public perception, semi-structured interviews

Perceptions of wind energy projects in two coastal Massachusetts communities

1. Introduction

Wind energy will contribute to decarbonizing the United States (U.S.) electricity system. Many states have already set ambitious goals in the form of Renewable Portfolio Standards (RPS) that require minimum levels of electricity demand be met from renewable resources like wind [1]. The EPA Clean Power Plan and other Federal climate change policies may further encourage the adoption of renewable energy [2]. Overall, there is strong general public approval of wind projects across the U.S., with 70% of Americans agreeing that more emphasis should be placed on producing domestic energy from wind resources [3]. However, support from communities where projects are located may be different. Past work has shown a disconnect between general support for wind power, and opposition in some communities where projects are located [4-6]. This phenomenon is often referred to as not-in-my-backyard, or NIMBY. However, as many studies [6] have pointed out, NIMBY may be too superficial an explanation since opposition often focuses on more specific project characteristics such as visual changes to the landscape, noise from the project, wildlife impacts, or perceived inefficiencies of the technology.

This challenge is of particular concern in Massachusetts, which has committed to building 2,000 megawatts (MW) of wind capacity by 2020 [7] relative to only 100 MW installed today [8]. Thus, the state will face substantial growth in the number of wind projects in the near-term, including both onshore and offshore locations, a characteristic that has been shown to affect public perception [9, 10]. Offshore projects in Massachusetts have already provoked significant controversy. Cape Wind, a 130 turbine offshore wind project proposed in Nantucket Sound, recently failed to gain public approval due, in part, to local opposition [11].

In this paper, we used 15 semi-structured interviews to identify positive and negative perceptions of wind projects within two neighboring coastal communities in Massachusetts, for existing wind projects, as well

as potential new onshore and offshore locations. We selected our sample from the coastal city of Gloucester, Massachusetts, which recently built three onshore wind turbines, and the neighboring town of Rockport, which is 5 miles away. These communities share demographics that are similar to other coastal regions of Massachusetts (Essex, Plymouth, and Barnstable counties, see Appendix 1) that will soon be faced with new development of onshore and offshore wind farms. A sample of 15 is sufficient to identify the most commonly held beliefs in a population [12]. Our goal was to identify what people believe, so as to inform future follow-up surveys with larger samples, which can then be used to assess how many hold each of the identified beliefs.

2. Methods

2.1. Sample: We conducted 15 semi-structured interviews with residents of Massachusetts' city of Gloucester and town of Rockport, aiming to reflect the communities' diversity of experiences with wind projects. We used door-to-door recruitment to reach participants living near the existing turbines, during the month of September 2015. The rest of the participants were recruited using posted advertisements at local stores and restaurants during the month of August 2015. Table 1 shows that our sample's demographics were diverse in location, age, income, gender, and education. However, all participants identified with non-conservative political views (either Independent or Democrat), which is representative of political views within coastal Massachusetts communities (see Appendix 1 for more information).

Table 1: Diversity of participants (15 total).

| Demographic | Range | # Participants |
|-----------------------|----------------------|----------------|
| Location | Rockport | 4 |
| | Gloucester | 2 |
| | <1 mile from project | 9 |
| Age | < 25 years | 3 |
| | 24-44 years | 2 |
| | 45-64 years | 7 |
| | > 65 years | 3 |
| Income | < \$35k | 3 |
| | \$35-50k | 2 |
| | \$50-100 k | 3 |
| | >\$100k | 4 |
| | NA | 3 |
| Gender | F | 7 |
| | M | 8 |
| Highest Education | High school | 6 |
| | Associates | 2 |
| | Bachelors or Masters | 7 |
| Political Affiliation | Democrat | 8 |
| | Independent | 6 |
| | Republican | 0 |
| | NA | 1 |

2.2. Procedure: Each interview lasted 30-60 minutes, and was audio recorded. Each participant was provided the incentive of a \$25 Amazon gift card. Each interview consisted of open-ended questions, a ranking exercise, and a discrete choice task, as explained below. The full interview protocol is presented in Appendix 2.

Open-ended Interview Questions:

We conducted semi-structured interviews that were based on the mental models interview approach developed by Morgan et al. [13], where a “mental model” is the set of beliefs relevant to people’s decisions about a specific topic. The interviewer opened with open-ended questions (i.e. “Tell me about the existing wind project in your community”), and then followed up with clarifying questions (i.e., “Can you explain further?”, “Anything else?”, “What other important aspects can you think of?”).

To identify positive and negative perceptions about wind projects, participants were also asked open-ended questions about their perceptions of the existing wind project in Gloucester. In addition, we asked

about three hypothetical new projects in their community, within 1 mile of their home, within 5 miles from their home, and offshore. Throughout the interviews, we maintained a list of the project characteristics that were introduced by each participant.

Ranking Exercise:

After completing the open-ended questions, participants were asked to confirm the list of characteristics we recorded. Subsequently, participants ranked each of the listed characteristics in terms of their perceived importance.

Discrete Choice Task:

In a simple discrete-choice task, we first showed maps of a new three-turbine wind project to be built in one of four locations: (i) as an expansion of the existing wind project in Gloucester; (ii) a new onshore project at the Rockport transfer station (recycling center/ dump); (iii) an offshore project 2 miles from Gloucester's shore; or (iv) an offshore project 2 miles from Rockport's shore. Projects located farther from shore have been shown to be more acceptable to coastal communities [14], [15], and are more amenable to larger scale projects. However, we chose 2 miles from shore for its visual similarity to the existing onshore wind project near Gloucester, which is clearly visible in many neighborhoods.

Furthermore, we selected only 3 turbines in our study since this is the size of the existing project in Gloucester, and is the average size of existing onshore wind projects in Massachusetts [8]. Although future development of offshore wind will likely consist of many more turbines that are farther from shore¹, near-term projects are likely to be small and close to shore. For example, the first offshore wind

¹ In the United Kingdom (which has over 5,000 MW of offshore wind capacity), the average number of turbines per offshore wind project is about 60 and the average distance from shore is about 6 miles [16]

project in the U.S., built in 2016 and located off Block Island in Rhode Island, consists of only 5 turbines and is 3.8 miles from shore [17].

Figure 1 presents the maps participants received. For each map, we asked participants to identify the proposed wind project location to confirm their understanding, and asked them to comment on the proposed project. We also showed a picture of an offshore project 2 miles from shore in the United Kingdom (see Appendix 3) and asked them to assume that the proposed offshore project (presented in Figure 1) would look similar. This was important since, at the time of the interviews, no offshore projects existed in the United States. Visual displays have been shown to improve the accuracy of learning a participant's perceptions about projects [18]. We explained that each of the new onshore projects we presented would look like the existing one in Gloucester. All participants confirmed that they saw the existing project in Gloucester every day.

Lastly, we asked participants to choose one of the four locations they liked most, and to rank locations based on their preferences. In both cases, they were asked to explain their underlying reasoning. At the end of the interview, each participant reported demographic information.

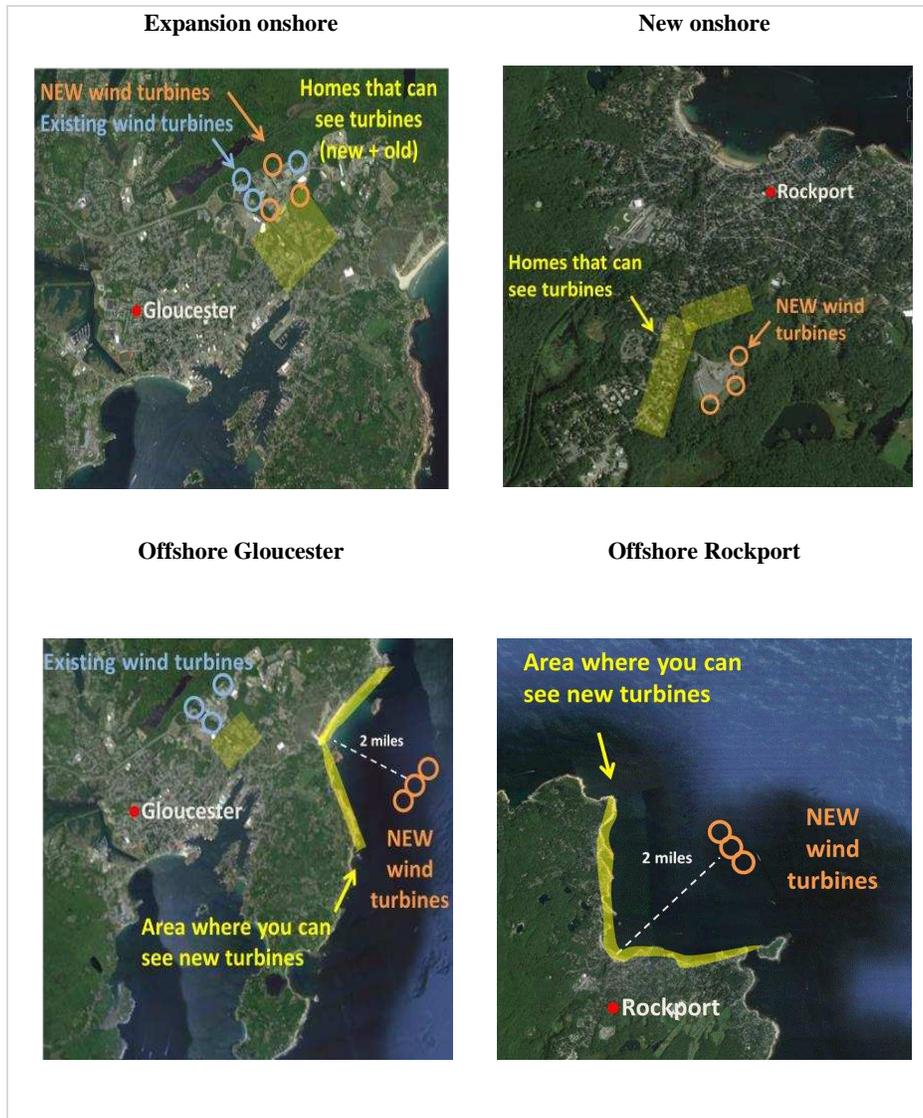


Figure 1: Screenshot of maps shown to participants in the discrete choice task.

2.3. Coding: After each interview, we coded the specific characteristics discussed for the existing and hypothetical projects. We then categorized these specific characteristics into general categories. In total, we identified 16 categories (across 55 specific characteristics), including: visual impact, benefits from renewable energy, economics, personal experience with wind projects, specific site location, community identity, impact to the local environment, noise, proximity to homes, wildlife impacts, the process of how wind projects are built, size, safety, construction, concerns about impacts to the local fishing industry, and references to the Cape Wind project. For each, we identified whether they were referred to

as positive or negative. Appendix 4 shows all specific characteristics identified, their mapping to general categories, and example quotes.²

3. Results and Discussion

Project characteristics identified during open-ended interview questions: In Table 2 we present the general categories of characteristics (henceforth referred to as “characteristics”) identified across participants for the existing three-turbine wind project in Gloucester as well as for a hypothetical new project within varying distances from their home. Table 2 also shows both the number of participants who mentioned the characteristics, as well as a positive to negative ratio (i.e. “P/N ratio”) of whether the characteristics was mentioned in a positive or negative context. A P/N ratio of 1 indicates that the characteristic was thought to be positive by all participants, whereas a P/N ratio of 0 indicates unanimous negative views across participants. For participants who referred to a characteristic as positive in some statements but negatively in others, we classified their responses as overall positive if the number of positive statements were greater than negative ones (and vice versa). Table 2 also shows (in the last row) whether participants made more positive or negative statements about the project. If a participant had more positive than negative statements, then we labeled the participant as “generally positive”. We find that 12 of 15 participants had generally positive statements about both the existing wind project and a new project within 5 miles of their home. This number drops to 8 of 15 for a project within 1 mile of their home, and to only 5 for an offshore project. Also, when asked about wind energy in general at the beginning of the interview, 9 of 15 participants mentioned the Cape Wind project in a negative context.

² For example, we coded the following as a positive characteristic about ‘visual impact’: “I don’t consider them an eye sore... I think they are surprisingly pretty”

Similarly, we coded the following as a negative characteristic about ‘visual impact’: “There is a price to be paid for [a new wind project] in a place of great natural beauty. Is the price too steep? ... I don’t know.”

Table 2: Number of participants mentioning a general project characteristic during interviews about the existing project and a hypothetical new project within different *distances from the participant’s home*.

| Characteristics* | Existing Wind Project | | Hypothetical New Wind Projects | | | | | |
|---|-----------------------|-------------|--------------------------------|-----------|-----------------|-----------|-----------------|-----------|
| | # | P/N Ratio** | 5 Miles | | <1 Mile | | Offshore | |
| | | | # | P/N Ratio | # | P/N Ratio | # | P/N Ratio |
| Visual impact | 15 | 0.5 | 6 | 0.6 | 12 ^Δ | 0.4 | 11 ^Δ | 0.2 |
| Climate change / renewable | 13 | 1 | - | - | 1 | 1 | 3 | 1 |
| Economics | 13 | 0.7 | 3 | 0.5 | 9 | 0.8 | 6 ^Δ | 0.3 |
| Personal experience with wind | 6 | 0.8 | - | - | 1 | 1 | - | - |
| Specific Site | 6 | 0.75 | 2 | 1 | 2 ^Δ | 0 | - | - |
| Community identity | 5 | 1 | 1 ^Δ | 0 | 1 ^Δ | 0 | 3 ^Δ | 0.3 |
| Local environment | - | - | - | - | - | - | 5 ^Δ | 0 |
| Noise and flicker effects | 11 ^Δ | 0.4 | - | - | 11 ^Δ | 0 | - | - |
| Wildlife | 7 ^Δ | 0.2 | 1 ^Δ | 0 | 2 ^Δ | 0 | 8 ^Δ | 0 |
| Proximity | 7 ^Δ | 0.2 | 5 ^Δ | 0.3 | 3 ^Δ | 0 | - | - |
| Process / communication | 6 ^Δ | 0 | - | - | 3 ^Δ | 0 | - | - |
| Size (number of turbines) | 4 ^Δ | 0 | 1 ^Δ | 0 | 2 ^Δ | 0 | - | - |
| Safety / hazard | 3 ^Δ | 0.3 | 1 ^Δ | 0 | 3 ^Δ | 0 | 6 ^Δ | 0.2 |
| Construction | 2 ^Δ | - | - | - | 2 ^Δ | 0 | 1 ^Δ | 0 |
| Fishing | - | - | - | - | - | - | 6 ^Δ | 0.2 |
| # participants making generally positive statements | | 12 | | 12 | | 8 | | 5 |

*Characteristics were coded into these 16 categories presented in this table based on the mapping in Appendix 4

**P/N ratio is the ratio between positive and negative statements regarding the characteristic. A value of 1 means that all participants mentioned the characteristic in a positive context. A value of 0 = all participants mentioned the characteristic in a negative context. The ratio excludes when the context was not clearly positive or negative.

^Δ P/N ratios < 0.5

For the existing wind project, visual appearance was the only characteristic mentioned by all participants.

Participants were split on whether the visual appearance was something they liked or not, with 7 participants mentioning it positively, and 7 negatively. Participants provided very similar responses for a new project within 5 miles of their home, which is about the maximum distance that any resident in the two communities lives from the existing project. Visual aspect had a slightly negative perception when located within a mile of someone’s home (PN ratio of 0.4). Similarly, the P/N ratio for the visual aspect is lowest (0.2) for the hypothetical offshore project. Only 2 of the 11 participants mentioned it positively.

Thirteen participants mentioned the economic aspects of the existing wind project, most of them positively (PN ratio 0.7). This is likely because of local community involvement with project economics.

One of the turbines is owned by the city and is used to offset energy costs at municipal buildings, such as public schools, while the other 2 are owned by a local engineering company [19]. Similarly, for the project within 1 mile of their home, participants reiterated the economic benefits that they expect the city to receive from the project. Some participants made a distinction regarding economics to the community versus economics to individuals. For example, one participant said that: “if Gloucester was going to benefit and my taxes were going to go down, or they were going to get my... road paved, I’m all for putting more turbines up.” This statement refers to both community (Gloucester) and personal benefits (reduced taxes and a better road). Another participant asked: “are they going to ... push the [economic benefits] back to the residents that ... are closest [to the project]?”, which refers to personal benefits.

Community identity and the specific site location were mostly regarded positively for the existing project (with P/N ratios of 1 and 0.75 respectively), but less often for new projects (P/N ratio of 0 to 0.3). Only two characteristics were discussed positively across all projects: those were climate change/renewable energy benefits of the project and prior experience with wind energy. For example, one participant said, “my experience with [the existing project] has been positive ... [the turbines] are in my backyard and it’s OK.”

Impacts to the local environment was identified by 5 participants in connection with the offshore wind project, always in a negative context. For example, one participant was concerned about how the project might “affect how the tide comes in”, and another mentioned their concern about “pollution from the project [such as] wind mill rust or oil.”

Eleven participants mentioned noise and flicker effects for the existing project (P/N ratio of 0.4). Surprisingly, most negative statements were from participants living far from the existing project. Only 2 of the 9 participants living within 1 mile of the existing project had overall negative statements about noise and flicker effects, and 3 of the 9 had positive statements, such as how the effects are likely minimal and often exaggerated. Concerns about noise and flicker were stronger when discussing a hypothetical

new project – 11 participants expressed strong concerns about the potential noise impacts if the project was sited within a mile of their home. Even those who live within 1 mile of the existing project, and who were not concerned about noise from it, wanted to know more about potential noise impacts from new projects.

Proximity to a project was mentioned frequently in connection with the existing wind project, mostly in a negative context (P/N ratio of 0.2). Seven participants said that their opinion of the existing project would likely change if they lived closer to it. For example, one participant said: “if they were sitting in my backyard, I might feel differently.” Regarding a new project 5 miles away, one participant explained that they would “like [the project] better if it was along the horizon rather than right outside [their home].” Five participants made similar claims. Similarly, proximity was mentioned as a negative characteristic by 3 participants for projects within 1 mile of their home. As one participant noted, “maybe I couldn't do anything about [a project built within a mile of me], or maybe I would move away.”

Process/communication was mentioned as a negative characteristic of the existing project. Six participants expressed anger at the lack of communication about the project’s construction and their surprise when it was eventually built. Safety was also a concern to some participants.

Wildlife was another concern. Seven participants expressed concerns about the impact to birds from the existing project; however, two of these participants argued that these impacts are likely well managed and that birds adapt to the project over time (overall P/N ratio of 0.4). For example, one participant said that “birds aren’t stupid, they learn to go around it.” Participants who discussed wildlife impacts for future projects did so in a negative content. Eight participants raised concerns about wildlife for offshore projects, not only regarding impact to birds, but also impact to marine life. For example, one participant explained that he/she wouldn’t want offshore turbines “disrupting either the sand, or the fishes, or [other sea life].” However, even though presented in a negative context, most concerns were raised as questions about the potential impact, not as belief statements. There was also concern about the fishing and boating

industry in Gloucester, which is a historic fishing town. There has been a recent effort by the National Oceanographic Atmospheric Association to limit the amount of fishing due to environmental concerns about depleting fish stocks. This has strained the local economy and frustrated many locals [20].

Therefore, 6 participants mentioned their concern about how offshore turbines might interfere with fishing, further straining an already struggling local industry (P/N ratio of 0.2). Lastly, regarding the existing project, the number of turbines (mentioned by 4 participants), and temporary construction from the project (mentioned by 2 participants) were brought up always in a negative context.

Results from ranking exercise of project characteristics: The height of each bar in Figure 2 represents the number of participants who mentioned a characteristic, and the different shading shows the ranking as 1st (most important) 2nd, 3rd, or lower (less important). Figure 2 only shows characteristics that ranked in the top three for any participant.

Economic benefit from the project (to participants and their community) was consistently ranked highly – four participants ranked it as most important, another four ranked it as 2nd most important, and three others ranked it as 3rd. This was a common theme during interviews, for participants who spoke about wind projects in a positive context as well as those who spoke about them in a negative context. Similar to past work (Wolsink [6] and Devine-Wright [21]), we find that participants were also strongly influenced by visual impact, which ranked top three most important for seven participants. Noise, wildlife impacts, and concerns about addressing climate change / increasing the amount of renewable energy also ranked highly among participants. For a few participants, safety of the project was also listed as one of the most important characteristics.

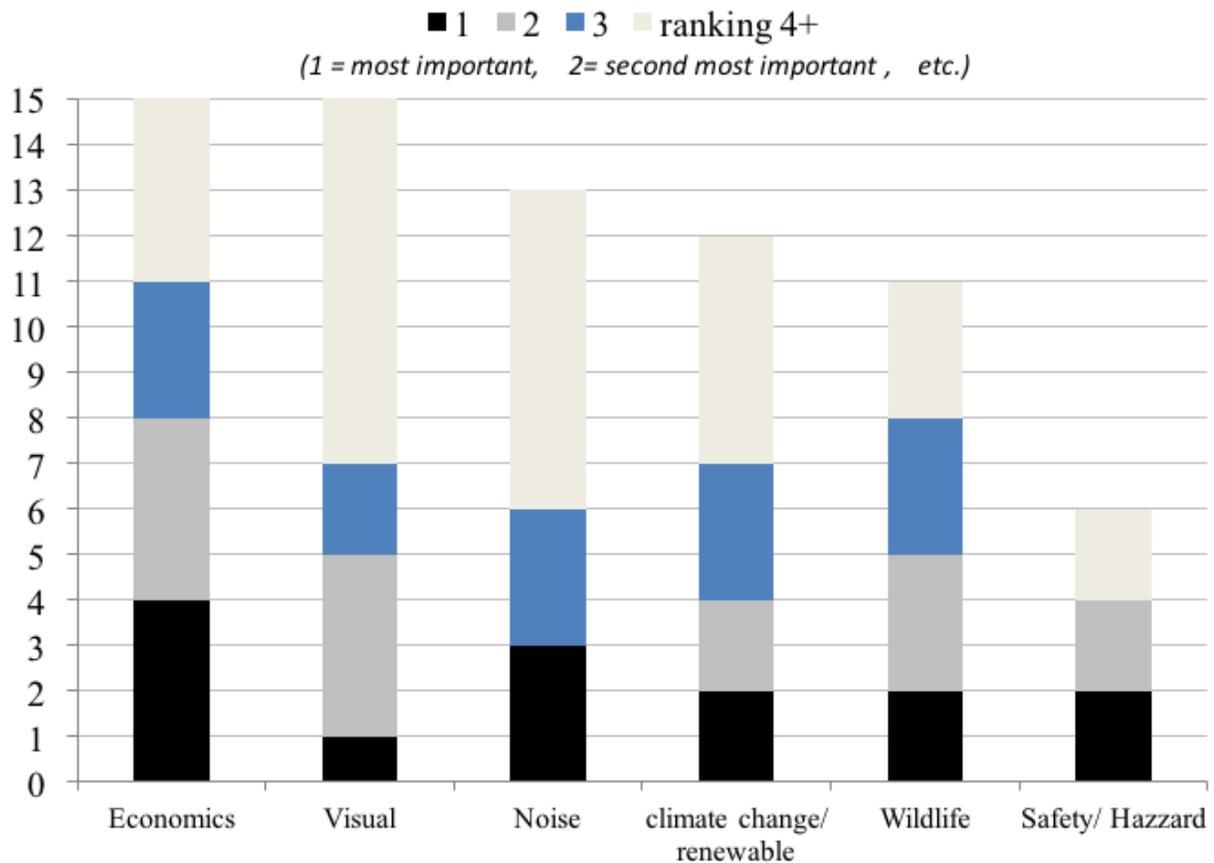


Figure 2: Ranking of most important project characteristics to interviewed participants.

Discrete choice task: When presented with the prospect of a new three turbine project in their community, 8 interview participants selected to expand on the existing project in Gloucester (see Table 3). Six of these participants liked this option because wind turbines “are already there” and the community is “accustomed to seeing them already.” We label this reasoning as ‘experience with wind energy’ since it implies that experience with wind energy will limit the perceived cost relative to the other options. Two other participants chose this option because they preferred to keep economic benefits nearby in Gloucester, rather than having them go to Rockport (labeled as ‘economics’). However, not all participants liked this option. One participant ranked this option last, claiming that the project would look “too cluttered,” and feared that noise impacts would increase with more turbines (labeled as ‘visual/noise’).

Seven participants preferred the option to build a new project in Rockport at the transfer station instead. The most common justification was that the Rockport project would be “out of the way” and located “far enough away from people’s houses” in their opinion, as opposed to in Gloucester, which is more populated and already has a project (labeled as ‘proximity’). Another participant liked the option in Rockport because “there is a strong possibility that [the new turbines] could provide all electricity for Rockport, it's not a big town,” suggesting that Rockport would benefit most from a new project in the area (labeled as ‘economics’). One other participant liked the idea of siting the project at the transfer station because since it’s where the community “transfers energy, [and] ... recycles”. We labeled this as ‘specific site,’ which implies a perception about the specific site itself. Another participant stated for similar reasons that they didn’t like the site (bottom choice), since they think it “looks so weird putting it in a dump”, and said they’d “rather have it in the industrial park” (near Gloucester’s existing wind project). Lastly, one participant thought the project would take away from the “old charm aspect to Rockport” and would be less of an effect in Gloucester, “which is a bit more urban in the downtown area.” We labeled this reasoning as ‘community identity’.

Additionally, not one participant selected an offshore project option as their top choice. In fact, 12 of the 15 participants selected the offshore project as the choice they least preferred, mainly due to the visual impact, which was mentioned by 11 participants. As one of these participants explains, the ocean landscape is considered “sacred” in the community and is “part of [their] legacy,” which evoked strong negative emotions about the prospect of an offshore project (labeled as ‘visual / community identity’). This is consistent with findings by Kempton et al. [22], who conducted semi-structured interviews of Cape Cod residents about the Cape Wind offshore project . One participant also expressed concerns about the additional cost of an offshore project, which would therefore not yield as many financial benefits to the community as an onshore project (labeled as ‘economics’).

Table 3: Results from choice task. The numbers represent the number of participants that preferred each of the alternatives (“expansion onshore”, “new onshore” or “offshore”) provided.

| | Expansion Onshore | New onshore | Offshore* |
|--|---|--|---|
| |  |  |  |
| Top Choice | 8 | 7 | 0 |
| Reason | Experience with wind energy (6) Economics (2) | Proximity to homes (5) Economics (1) Site specific (1) | |
| Bottom Choice | 1 | 2 | 12 |
| Reason | Visual / Noise (1) | Community Identity (1) Specific site (1) | Visual / Community Identify (11) Economics (1) |
| * During interviews, we included a fourth option for an offshore project in Rockport. In this figure we present results for both offshore projects combined since participants viewed the two project opinions as almost identical | | | |

4. Conclusions

We examined the perceptions of local wind projects held by 15 residents of two coastal Massachusetts communities who live near an existing wind project. Through a combination of open-ended questions, a ranking exercise of project characteristics, and a choice task, we identified the key project characteristics that shaped their perceptions for an existing wind project as well as several hypothetical new projects in their community. We find that the most important characteristics to our sample were economic benefits, visual impact, noise, climate change / renewable energy benefits, and safety concerns. Most of these characteristics can be addressed through responsible project development. For example, noise impacts and safety concerns can be managed by locating the project within a reasonable distance from homes. Efforts are currently being made in Massachusetts to identify appropriate distance through the MassDEP Wind Turbine Noise Technical Advisory Group [23]. Also, climate change and renewable energy benefits are

unlikely to vary by project within a community. However, economic benefits and visual impacts do vary by project, and therefore deserve careful attention from project developers and policymakers when siting new wind projects. Furthermore, our sample showed strong negative reactions to the prospect of an offshore project relative to an onshore one, mainly due to changes to ocean landscape, which several participants described as “sacred”. We also find evidence that our respondents prefer to avoid having a project close to people’s homes. In future work, discrete choice surveys could be used to identify preferences for new project locations at varying distances from a participant’s home, while controlling for other project characteristics. Our study provides the necessary roadmap for deciding which characteristics to include in such surveys.

Our results suggest that project economics for existing and future projects should be clearly communicated to local communities. Several of our participants didn’t know that the city of Gloucester benefits from the existing wind project through reduced energy costs. A simple solution could be to periodically include information on residential energy bills about the project’s contributions to the city. This would likely improve the perception of the project, even for those who dislike how it looks. The communication of the benefits may be further complicated in that each project and community may have specific arrangements on how the economic benefits are distributed. For example, Newburyport Massachusetts has a single wind turbine, owned by a local woodworking company, that doesn’t share economic benefits with the city, but still makes a distinguishable mark on the landscape as the only wind project in the area [24]. Other projects not only benefit the local government, but also local residents directly: for example, the Block Island offshore wind project off the coast of Rhode Island is expected to lower household energy bills in the local community by up to 40% [17]. Since economic benefits is a critical component in shaping opinions of wind energy, future work should explore how to best communicate these benefits to local communities.

5. Acknowledgement

This work was funded by the U.S. Environmental Protection Agency (EPA) through the EPA STAR Graduate Student Fellowship Award (FP-91763701-0). Funding was also provided by the Center for Climate and Energy Decision Making (CEDM) through a cooperative agreement between the National Science Foundation and Carnegie Mellon University (SES-0949710 and SES-1463492). None of the funding agencies formally reviewed this paper. Findings and recommendations are the sole responsibility of the authors and do not necessarily represent the views of the sponsors. Further, none of the funding agencies endorse any products or commercial services mentioned in this work.

6. References

- [1] DSIRE, “Database of State Incentives for Renewables & Efficiency (DSIRE),” Mar-2015. [Online]. Available: http://dsireusa.org/incentives/incentive.cfm?Incentive_Code=IL04R&re=0&ee=0.
- [2] EPA, “Clean Power Plan,” U.S. Environmental Protection Agency, Aug-2016. .
- [3] Gallop, “Gallop Historical Trends - Energy.” 2016.
- [4] P. Devine-Wright, “Beyond NIMBYism: towards an integrated framework for understanding public perceptions of wind energy,” *Wind Energy*, vol. 8, no. 2, pp. 125–139, Apr. 2005.
- [5] D. Van der Horst, “NIMBY or not? Exploring the relevance of location and the politics of voiced opinions in renewable energy siting controversies,” *Energy Policy*, vol. 35, no. 5, pp. 2705–2714, May 2007.
- [6] M. Wolsink, “Wind power and the NIMBY-myth: institutional capacity and the limited significance of public support,” *Renew. Energy*, vol. 21, no. 1, pp. 49–64, Sep. 2000.
- [7] “Massachusetts State Website for Wind Energy,” Energy and Environmental Affairs, Commonwealth of Massachusetts, 29-Jul-2015.
- [8] U.S. Geological Survey, “Wind Turbine Interactive Web Map,” Mar-2015. [Online]. Available: <http://eerscmap.usgs.gov/windfarm/>.
- [9] K. Ek and L. Persson, “Wind farms — Where and how to place them? A choice experiment approach to measure consumer preferences for characteristics of wind farm establishments in Sweden,” *Ecol. Econ.*, vol. 105, pp. 193–203, Sep. 2014.
- [10] J. Ladenburg, “Attitudes towards on-land and offshore wind power development in Denmark; choice of development strategy,” *Renew. Energy*, vol. 33, no. 1, pp. 111–118, Jan. 2008.
- [11] E. McNamara, “What really toppled Cape Wind’s plans for Nantucket Sound,” *The Boston Globe*, 30-Jan-2015.
- [12] W. Bruine de Bruin and A. Bostrom, “Assessing what to address in science communication,” *Proc. Natl. Acad. Sci.*, vol. 110, no. Supplement_3, pp. 14062–14068, Aug. 2013.
- [13] G. Morgan, B. Fischhoff, A. Bostrom, and C. J. Atman, *Risk Communication: A Mental Models Approach*. Cambridge University Press, 2001.
- [14] A. D. Krueger, G. R. Parsons, and J. Firestone, “Valuing the Visual Disamenity of Offshore Wind Projects at Varying Distances from the Shore.” *Land Economics* 87 (2): 268–283, May-2011.

- [15] J. Ladenburg and A. Dubgaard, "Willingness to pay for reduced visual disamenities from offshore wind farms in Denmark," *Energy Policy*, vol. 35, no. 8, pp. 4059–4071, Aug. 2007.
- [16] 4C Offshore, "Global Offshore Wind Farm Database," 10-Mar-2017. [Online]. Available: <http://www.4coffshore.com/windfarms/>. [Accessed: 10-Mar-2017].
- [17] "Block Island Wind Farm," Aug-2016. [Online]. Available: <http://dwwind.com/project/block-island-wind-farm/>.
- [18] I. D. Bishop, "Visualization for Participation: The Advantages of Real-Time?" Wichmann Verlag, 2005.
- [19] S. A. Rosenberg, "Three wind turbines push Gloucester to renewable energy forefront," *The Boston Globe*, 06-Jan-2013.
- [20] J. Elias, "Fishing Industry At Risk Of Disappearing In New England," CBS Boston, 25-Nov-2013.
- [21] P. Devine-Wright, "Beyond NIMBYism: towards an integrated framework for understanding public perceptions of wind energy," *Wind Energy*, vol. 8, no. 2, pp. 125–139, Apr. 2005.
- [22] W. Kempton, J. Firestone, J. Lilley, T. Rouleau, and P. Whitaker, "The Offshore Wind Power Debate: Views from Cape Cod," *Coast. Manag.*, vol. 33, pp. 119–145, 2005.
- [23] "MassDEP Wind Turbine Noise Technical Advisory Group," Aug-2016. [Online]. Available: <http://www.mass.gov/eea/agencies/massdep/news/advisory-committees/wntag.html>.
- [24] G. Swart, "City airs wind turbine concerns," *WickedLocal.com*, 05-Mar-2010.
- [25] DOE, "Wind Vision: A New Era for Wind Power in the United States," U.S. Department of Energy, DOE/GO-102015-4557, Apr. 2015.
- [26] U.S. Census Bureau, "U.S. Census QuickFacts table," 08-Jul-2016. [Online]. Available: <http://www.census.gov/quickfacts/table/>.
- [27] "State Election Enrollment Statistics." Commonwealth of Massachusetts, 17-Oct-2012.

7. Appendices

Appendix 1: Demographics in the region of interest

Table A1: Demographics for coastal Gloucester and Rockport, and coastal Massachusetts counties.

| | | Gloucester | Rockport | Essex County | Plymouth County | Barnstable County |
|---------------------|-------------|------------|----------|--------------|-----------------|-------------------|
| Population | | 28,789 | 6,952 | 743,175 | 494,915 | 215,888 |
| Age | <18 | 19% | 17% | 23% | 24% | 17% |
| | 18-65 | 63% | 60% | 63% | 62% | 58% |
| | >65 | 18% | 23% | 14% | 14% | 25% |
| Gender | Female | 54% | 52% | 52% | 51% | 52% |
| Median Income | | \$60,229 | \$70,288 | \$68,776 | \$75,816 | \$61,597 |
| Education | B.A. earned | 33% | 50% | 37% | 34% | 40% |
| Registered Party | Democrat | 29% | 25% | 33% | 29% | 26% |
| | Republican | 10% | 10% | 12% | 14% | 16% |
| | Independent | 61% | 64% | 55% | 58% | 57% |
| Source: [26] , [27] | | | | | | |

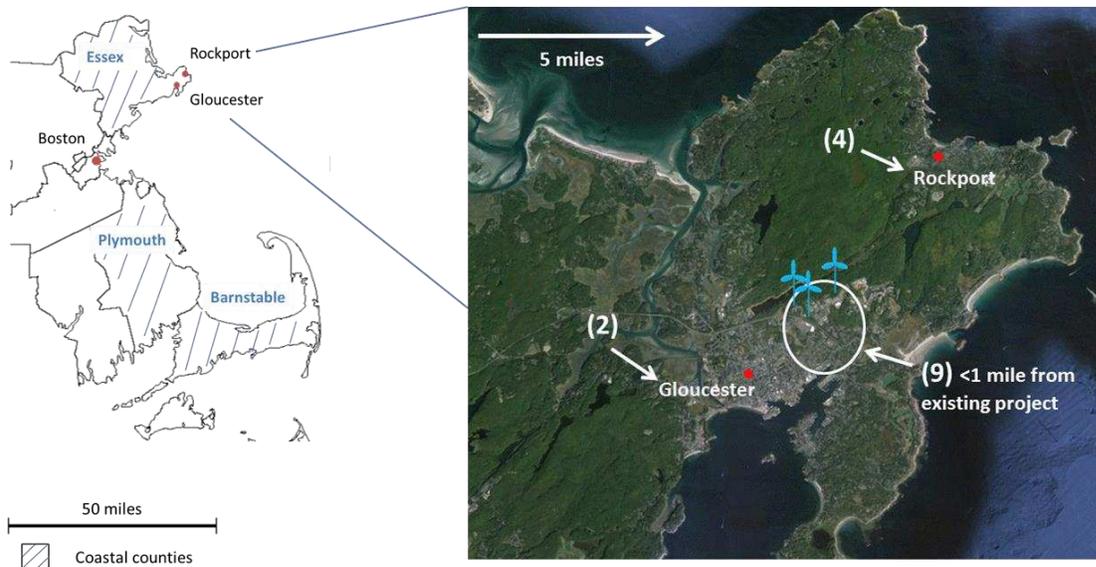


Figure A1: Left: Massachusetts Coast. Right: General location where the 15 interview participants live in Gloucester and Rockport

Appendix 2: Interview protocol

Part I: Introduction

I am a doctoral student at Carnegie Mellon University, and grew up around here. I’m currently working on a study on energy that’s part of my doctoral work. My work is funded by Carnegie Mellon University and by a fellowship by the Environmental Protection Agency.

I’ll first ask you to tell me what you know about wind projects in your region. All the questions I’ll ask you are meant to stimulate a discussion. Sometimes, I may repeat questions just so I can make sure I understand everything you say. Please don’t worry about whether your answers are right or not, just tell me everything that comes to mind. At the end of these questions, I’ll then ask you to take a very short survey that asks you to choose between several alternatives. Lastly, I’ll provide you with a short demographic form to fill out.

The interview will take between 30 and 60 minutes. I'll cut it off at the 1 hour mark in case it goes over; however, if you'd like to continue and finish, it's up to you.

I will not include any directly identifiable information about you in any results or publications. Also, please do not discuss identifiable and sensitive information about third parties. I will be recording the conversation so that I can then summarize the results from our interview. I may want to use a short portion of any audio recording for illustrative reasons in presentations and publications of this work for scientific or educational purposes. In such cases, your name will NOT appear, nor any identifiable information.

- First, do you have any questions about this research?
- Do you agree to participate in the study?
- Do you allow me to audio record?
- Lastly, do you give permission to use portions of the audio recording for scientific / educational purposes?

OK, shall we begin?

Part II: Open-ended interview questions

1. Are you aware of any existing wind projects in your area?

2. Tell me about what you know about these wind projects
 - a. Anything else?
 - b. Are there other things you can think about related to these wind projects?
 - c. What sort of information, if any, did you get about this project when it was being considered?
 - d. Did you generally support the project?

3. Are there any specific aspects related to having these wind installations nearby that you feel very **POSITIVELY** about?
 - a. You mentioned _____. Tell me more.
 - b. Anything else related to _____ that you feel is important for us to talk about?
 - c. Anything else?

4. Are there any specific aspects related to these existing wind installations nearby that you feel very **NEGATIVELY** about?
 - a. You mentioned _____. Tell me a bit more about that.
 - b. Anything else related to _____ that you feel is important for us to talk about?
 - c. Anything else?

5. Are there other existing wind installations in the region that you are aware of, but that are not as near your house as the ones you just told me about?
 - a. How do you feel about those?
 - b. Overall, would you support having those projects built?
 - c. You mentioned _____. Any other projects nearby that you are aware of?

(Go over questions a and b again for these new projects if the participant mentions any)

6. Imagine that there is a **NEW** wind project that would be built **1 mile** from your house. What are positive aspects related to such a project in your view?
 - a. You mentioned _____. Tell me more.
 - b. You also talked about _____. Can you tell me more about that?
 - c. Anything else?

7. What are some of the negative aspects related to such a project in your view?
 - d. You mentioned _____. Tell me more.
 - e. You also talked about _____. Can you tell me more about that?
 - f. Anything else?

8. Overall, would you support having this project within **1 mile** of your home?

9. Now imagine that there is a **NEW** wind project that would be built **5 miles** from your house. How about you feel about the project?

10. Now imagine that there is a **NEW** wind project that would be built offshore (like at sea, let's say 2 miles from the shore in ____insert town name____). How would you feel about the project?

11. Of all the characteristics you mentioned about the existing and hypothetical projects that we talked about (within 1 mile, 5 miles away, and offshore) can you please rank the characteristics that are most important to you?
 - a. For example, you mentioned _____.
[Write each down and show them]
 - b. How would you rank these?

Part III: Discrete choice exercise

A page with pictures/maps will be printed and shown to the participant (see Figure 1 in the main text for the maps shown).

1. The figures below show four options for wind projects that could be built in your area. Please describe to me your thoughts about these different options.
2. Tell me about these pictures, what do you see?
3. Do you know where that location is? Please explain further?
4. Where do you live in relation to the map?
5. Is this picture confusing at all, or do you understand it fine?

Here's an example of what an offshore project would look like if built. (see Appendix 3 for picture)

6. Which of these options do you prefer?
7. Why?
8. What other considerations come to your mind?

RANKING: if you had to rank them, which one is best? Please rank them in order of best to worst. Why?

Part IV: Demographic form

A. Which statement describes your housing situation?

| | |
|-------------------|--------------------------|
| I own this house | <input type="checkbox"/> |
| I rent this house | <input type="checkbox"/> |
| Neither | <input type="checkbox"/> |

B. What is the approximate value of this house?

| | |
|-----------------------|--------------------------|
| Less than \$100,000 | <input type="checkbox"/> |
| \$100,000 – \$199,999 | <input type="checkbox"/> |
| \$200,000 – \$299,999 | <input type="checkbox"/> |
| \$300,000 – \$399,999 | <input type="checkbox"/> |
| \$400,000 – \$499,999 | <input type="checkbox"/> |
| More than \$500,000 | <input type="checkbox"/> |

C. How many people live in your household? _____

D. What is your occupation? _____

E. Household income range?

| | |
|------------------------|--------------------------|
| Less than \$35,000 | <input type="checkbox"/> |
| \$35,000-\$49,999 | <input type="checkbox"/> |
| \$50,000-\$74,999 | <input type="checkbox"/> |
| \$75,000-99,999 | <input type="checkbox"/> |
| \$100,000-\$150,000 | <input type="checkbox"/> |
| Greater than \$150,000 | <input type="checkbox"/> |

F. What is the highest level of education you achieved?

| | |
|-------------------------------------|--------------------------|
| High school graduate | <input type="checkbox"/> |
| Some college no degree | <input type="checkbox"/> |
| Associate's degree, occupational | <input type="checkbox"/> |
| Associate's degree, academic | <input type="checkbox"/> |
| Bachelor's degree | <input type="checkbox"/> |
| Master's degree | <input type="checkbox"/> |
| Professional degree | <input type="checkbox"/> |
| Doctoral degree | <input type="checkbox"/> |

G. How old are you?

| | |
|-------------------|--------------------------|
| 18 to 24 years | <input type="checkbox"/> |
| 25 to 44 years | <input type="checkbox"/> |
| 45 to 64 years | <input type="checkbox"/> |
| 65 years and over | <input type="checkbox"/> |

H. What political party do you affiliate with?

| | |
|-------------------------|--------------------------|
| Democrat | <input type="checkbox"/> |
| Republican | <input type="checkbox"/> |
| Independent | <input type="checkbox"/> |
| No affiliation | <input type="checkbox"/> |
| Other (please specify): | |
| _____ | |

I. How active are you in politics?

| | |
|--|--------------------------|
| Very Active: attend political meetings regularly | <input type="checkbox"/> |
| Active: attend political meetings on occasion | <input type="checkbox"/> |
| Not Active: don't attend political meetings | <input type="checkbox"/> |

Appendix 3: Offshore image presented during the choice task



Figure A2: Example view of offshore wind project that is ~2 miles from shore in Great Yarmouth, England (Scroby Sands Wind Farm)

Appendix 4: Project characteristic mapping

Table A2: Project characteristics coded across all interviews, with example quotes.

| General characteristic | Specific characteristic | Example quote |
|----------------------------|---|---|
| Visual impact | visual impact | There is a price to be paid for [a new wind project] in a place of great natural beauty. Is the price too steep? ... I don't know. |
| | landscape | It depends on placement. We like to go in the woods hiking so I wouldn't want it to be in the place we normally go hiking, and wreck that natural landscape. |
| | ocean view | The ocean view ... It's our legacy, and I wouldn't want to have it spoiled anymore. |
| | Orientation | I think [the expansion project would be] too much in a little area |
| | Spinning | Some of [the existing turbines] don't run, other days they run, I don't know exactly how they work. |
| Climate change / renewable | energy problems | I understand that we need to find more of a creative long-term solution to solve our energy problems. |
| | oil independence | I'm glad we're pursuing non-diesel energy sources. |
| | reduced pollution | To me, [the existing wind project] is a positive... I know that we need to find a new energy, we can't go back to the old energy which was burning coal...with all these emissions, we'd be going blind, driving in the fog. |
| | renewable | I think the attempt to use a renewable clean energy resource is 1 commendable and 2 absolutely necessary |
| | energy produced | The wider range it could provide power for, the better. |
| Economics | economics | I think I'd probably also ask what [the new wind project] is used to power for, because I have wondered that... or if it went straight to a power company, that would be great, and then got distributed to everyone, and lowered bills. |
| | | I think [the existing wind project] is a great idea, it helps the town, which doesn't have a lot of money. |
| | | If [a new wind project] is going to save the city money, sure. And then where is that money savings going? I'd like to know, I don't know. I haven't seen anything produced on [the existing project]. Because, for example, if you noticed the road driving up here, it isn't very good. |
| | intermittent energy | energy generated by wind turbines must be stored, it must be used immediately. |
| | little maintenance | there is no maintenance, I would imagine it would be low. |
| | longevity | I guess I would like to know the longevity of it? What's the maintenance schedule? |
| | property value | I think that all the lawyers who live in east Gloucester would be at arms, because I think [the offshore project option] would devalue their property. |
| | tourism | I think seeing wind turbines offshore might detract tourists. |
| | existing project | My experience with [the existing project] has been positive ... [the turbines] are in my backyard and it's OK. |
| | accustomed to project | [Expanding on the existing project] would probably work out well. The people aren't going to disagree with it too much because they are already there. |
| | I would probably lean more towards the Gloucester option [since] people ... are really used to seeing them. | |

| | | |
|--------------------------|-----------------------|--|
| | trust | What kind of trust was built from the [existing project]? Would they be using the same contractors [for the new project]? Using someone new? They will have to prove their trustworthiness if it's someone new. |
| Specific site | specific site | Well certainly the dump is not one of the most visually compelling places, which is good for a wind project. |
| | land use | I think about the land that has to be cleared for [a new wind project], and all of the other things that have to happen. |
| | location | [I'd want to know of the] location [of a new project] to make sure it wasn't in a historical area, or area that was not receptive to modern technology. |
| | populated area | The location [of the existing project] is not populated, there aren't any houses around there...it's not even in a residential area or anything like that. It isn't even an area that could potentially become a residential area. |
| Community identity | community identity | I think [the existing wind project] distinguishes Gloucester from other towns. |
| | community | our 5 year old grandson is in love with [the existing wind project]...every time he comes, we have to go stand at the base of the wind mill and look at up them. |
| | concerns for neighbor | How do my neighbors feel about it? Will it create controversy or rift in the community? |
| | future technology | My understanding is that [the existing project] was basically a test for wind turbine [technology]... and then the idea was to go far offshore where the wind was stronger and steadier. |
| | inspiration | I'm an artist so I'm not coming from the same place as other people might... [an offshore project would be] in my field of vision, in my field of inspiration ... it would be more of a hot button for me [compared to an onshore project]. |
| Local environment | environment | What effect will [a new wind project] have on the environment? |
| | ocean | I just think that the oceans are so fragile right now because of all the plastics, offshore drilling, I really don't like having one more thing [like an offshore wind project] affect it. |
| Noise and flicker effect | noise | I'd ask about the noise [regarding a new wind project within 1 mile of my home], because I don't know what it's like to live next to one. |
| | ocean noise | One of my favorite things about where I live is that I sleep to the sound of the ocean. I think I would be sad if the wind mills would be louder than the ocean. |
| | flicker effect | I've heard about the flicker effect, and people's nervous system is affected if the sun is in a particular position or whatever so that concerns me... I don't know any low level or any kind of direct injury I'm having from it now that I'm living in Gloucester. |
| Wildlife | wildlife | Is it displacing a whole bunch of animals, or generally messing with the overall ecosystem? |
| | bird deaths | They said it was going to kill birds ... so I got my [binoculars] and watched them ... I haven't seen one bird dead yet! |
| | bat deaths | There are some data about wind farms in the Berkshires, and elsewhere, killing large numbers of bats. And bats are having big problems in a number of realms, which would be on the negative side of the ledger with any wind project. |
| | marine life | I'd be more concerned with the offshore project because of the other impacts, like to the ocean life. |
| Proximity | NIMBY/ proximity | If [the new wind turbines] were sitting in my backyard, I might feel differently. |
| | | Because [turbines are 5 miles away], they wouldn't be as much of an immediate concern for me. |

| | | |
|---------------------------|--------------------------------|---|
| | | I'd probably like it a little better if [the project] was something along the horizon rather than being right outside [my home]. |
| | | That would be fine, [putting a new project in Rockport and not in Gloucester], I mean that really doesn't affect me. |
| | | Well I don't live [near the existing project], so I'm sure that the people that see it every day don't see it as pretty as I do. |
| Process / communication | communication | Is [the new wind project] something that someone is trying to shove down our throats? Or is there ability to negotiate and really get true reasonable conversation about it based on facts, based on realities ... who's benefiting, what's going on behind the scenes? |
| | compromise | [Accepting a new wind project in our community] is not a case of surrender, it's a case of an armistice; an agreement - you get this, we get that. It's not a war. |
| | expansion | [Regarding the prospect of a three turbine project within a mile of my home], I would probably want to know if they were planning on expanding, making more. |
| | regret | Now that we have [the existing wind project], there doesn't seem to be recourse for what we do now. |
| | utility | I'm all for other sources of energy, solar... wind farms... stuff like that. Anything to get away from the oil, you know...and national grid (local utility). |
| | Who builds the project? | What's the history of these things? Are they using a reputable manufacturer? Did they do a study? |
| Size / number of turbines | number of turbines | I'd be all for [a new project within 1 mile of me], as long as there wouldn't be 20 more wind turbines to crowd out the sky. If it was a few more, I'd be totally all for it. |
| | size of turbines | How tall would they be? Comparable in height to what Gloucester has? |
| Safety / hazard | safety | Are the blades going to come tearing off? |
| | driving distraction | when you're driving through the highway, and then all of a sudden there are these three huge wind mills, you know they are a bit of a distraction on the road |
| | health | What is coming off of those things? Is it radiation? ... There's got to be something coming off of it. We don't know much about it, but maybe 50 years from now people will say that "you know those wind mills, well those cause cancer" or something wrong with your hearing, the closer you are to them. |
| | endurance with extreme weather | I'd be concerned with [offshore turbines] breaking away... the ocean is always in motion, especially with hurricanes... that would be my main concern. |
| | landmark | I'm able to know where I am in relation to the [existing] wind turbines, which I think is good. |
| | navigation | [an offshore project] would be cute, but you'd have to have a good light house so that ships wouldn't bump into them. |
| Construction | construction | How long would it take to finish putting everything up, and any kind of inconveniences like traffic rerouting?... How long would it take to complete? |
| Fishing | fishing/ fishermen | This is a very fishing dependent community... if you put them on the water, and you start running lines in the water, and you impact the fish population,... you're going to have a ton of really angry people. |
| Cape Wind | Cape Wind | It was quite an ambitious project, a controversial project, a huge-scale project, that never came to fruition... ultimately the whole thing crashed... I can't imagine what the people in Cape Cod were thinking. |

