Siting Community Wind Farms: An Investigation of NIMBY

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ABSTRACT

Wind energy is expanding rapidly in the United States as the nation's energy policy objectives increasingly focus on renewables. Public opinion polls show that a majority of Americans support wind energy development but actual wind farm projects often face intense local opposition. This dichotomy between general support for wind energy but opposition towards siting a project nearby is often attributed to the not-in-my-backyard (NIMBY) phenomenon. In this study we employ a discrete choice experiment to investigate public preferences for different characteristics of a local wind farm. We investigate NIMBY by first controlling for characteristics that might cause local opposition, such as seeing or hearing a wind farm from home, and then after considering these effects of a wind farm we examine whether people who favor wind energy display NIMBY resistance. Finally, we estimate compensation requirements for siting a wind farm within sight or sound of someone's home. Results show that people who somewhat favor wind energy do display NIMBY attitudes since they are predisposed to vote against local wind development even after controlling whether they would see and hear the wind farm from their homes. We do not detect NIMBY attitudes among people who strongly favor wind energy because they have a positive disposition towards local wind farms. Our results suggest that if an incentive program is in place from the onset of a wind development project it could offset NIMBY reactions to specific projects.

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1. Introduction

Energy policy in the United States has been increasingly focused on domestic renewable energy to mitigate the impact of fluctuating oil and gas prices, reduce carbon emissions, and increase the nation's energy independence. Interest in renewable energy grew after the oil shocks of the 1970s and U.S. energy policy since has had growing interest in domestic renewable energy production. This focus on renewable energy is evident in the U.S. Energy Policy Act of 2005 (H.R.6: 109th) and the current administration's Climate Action Plan (The White House 2013). The U.S. Energy Information Administration projects that electricity generation from renewables will account for 32% of the overall growth in electricity generation in the next 30 years (U.S. EIA 2012) and there is growing emphasis on updating and expanding the nation's electric grid to incorporate these new electricity sources (The White House 2013).

Wind is a renewable source of interest because it is the most developed and cost-competitive of renewable energy technologies (Herzog et al. 2001; Pernick et al. 2012). In fact, wind energy is the leading non-hydroelectric renewable electricity source in the U.S., accounting for about 4% of the nation's generated electricity mix (U.S. EIA 2012; U.S. EIA 2013). The U.S. Department of Energy released a goal to have wind energy supply 20% of the nation's electricity by the year 2030 (U.S. DOE 2008). From 2008 to 2012 the average annual growth rate of installed U.S. wind power capacity was 29% (AWEA 2012) and 35% percent of all new U.S. power generating capacity in the past five years has come from wind energy (AWEA 2013). As of 2012 there has been a total of 60,000 megawatts (MW) of wind power installed in the U.S.[1], enough to power about 15.5 million homes (ibid). With total U.S. wind resource potential amounting to 14,550 gigawatts (GW), there clearly is room for industry growth in the future (ibid).

Naturally, as more wind farms are installed to meet energy policy objectives more Americans will be impacted by this technology. Many specific wind farm projects in the U.S. have been confronted by significant local opposition. Probably the most notable example is the Cape Wind Project, a proposed offshore wind farm in the Nantucket Sound off Cape Cod in Massachusetts. The Cape Wind Project has encountered extensive delays and legal challenges from a group of local stakeholders called the "Alliance to Protect Nantucket Sound" (Cassidy 2013; Krasny 2010). The stalling or cancellation of wind farm projects in the U.S. is widespread,

[1] This statistic is for utility-scale wind power. Utility-scale wind is any project greater than 1 MW (see *Windustry*).

with other examples occurring in Pennsylvania, New York, Washington, Maine, Ohio, and Virginia (Hopey 2012; Mcallister 2009; Mulick 2007; Patrick County Board 2006; Redington/Black Nubble Wind 2012; Seffrin 2013; Virginia Business 2010); each of these projects faced some form of local resistance. What is surprising is that public opinion polls indicate that a majority of Americans support increased investment in wind energy production (Farhar 1996; Gallup Politics 2012; Leiserowitz et al. 2012). Wolsink (2007) provides a concise and accurate description of the situation: "public attitudes towards wind power are fundamentally different from attitudes toward wind farms".

This dichotomy between general support for wind energy but opposition to siting wind farms locally is often attributed to the not-in-my-backyard (NIMBY) phenomenon. Just a few vocal opponents can stall or cancel a wind energy project (Toke 2005); therefore, understanding and addressing NIMBY is important in meeting national renewable energy goals. In this study we employ a discrete choice experiment to investigate public preferences for different characteristics of a local wind farm. We investigate NIMBY by first controlling for characteristics that might cause local opposition, such as seeing or hearing a wind farm from home, and then after considering these effects of a wind farm we examine whether people who favor wind energy display NIMBY resistance. Finally, we estimate compensation requirements for siting a wind farm within sight or sound of someone's home.

2. Previous Research

Facility siting often faces the "volunteer's dilemma" in which the public benefits from a collective good only if an individual or subgroup incurs a personal cost (Diekmann 1985). There are certain facilities that historically have been deemed locally undesirable; some examples include waste and industrial facilities, fossil-fuel power plants, homeless shelters, mental institutions, and prisons (Cohen and Robbins 2011; Schively 2007). Wind energy adds an interesting dimension to the facility siting literature because even though it is a renewable energy source with generally positive environmental connotations it still faces the volunteer's dilemma: local residents must bear the localized negative externalities associated with wind farms while the benefits of wind energy, such as air pollution reduction and energy security, are felt outside of the affected locality (Devlin 2005). What all of these facilities, including wind farms, have in common is that although they are locally undesirable, most people accept that these facilities are necessary for modern society (Dear 1992). The public recognizes that wind energy has socially beneficial traits and this is likely the reason for such high general public support expressed in public opinion polls. But when wind energy is lauded by someone who then opposes siting a wind farm nearby, their attitude can be described as NIMBY.

The *Oxford English Dictionary* defines NIMBY as: "an attitude ascribed to persons who object to the siting of something they regard as detrimental or hazardous in their own neighborhood, *while by implication raising no such objections to similar developments elsewhere*[2]" (Nimby, n. 2013; emphasis added). In other words, NIMBY refers to when individuals or communities acknowledge that a facility is necessary, but exhibit protectionist attitudes when a facility is proposed in their neighborhood (Dear 1992). While NIMBY is often used to pejoratively describe selfish behavior, some researchers believe that NIMBY behavior is simply rational since these facilities may "generate noxious odors, visual intrusion, noise, traffic, perceived contamination, or some other limiting condition that alter a victim's lifestyle" (Edelstein 2004). Many researchers stress that the NIMBY label should not be used as a catchall phrase to describe local opposition, and a number of them use wind power to illustrate that there are other reasons for opposition other than personal utility (Bell et al. 2005; Burningham 2000; Devine-Wright 2005; Ek 2005; Kempton et al. 2005; Strazzera et al. 2012, Wolsink 1994, 2000, 2006, 2007). Bell et al. (2005) provides three possible explanations for the "social gap" between high public support for wind energy and local opposition against specific projects, one of these being a concern for personal utility or the "self-interest" NIMBY explanation. The authors explain that the NIMBY concept is "a very specific account of the social gap" in which an individual supports wind power in general but actively opposes a nearby development. According to Bell et al. (2005), more empirical studies are needed in order to determine the relevance of NIMBY in the context of wind energy.

2.1 Valuing Wind Farm Impacts

There is extensive literature on wind farm impacts that drive local opposition against siting a wind development in their community. Visual intrusion is the most commonly cited reason for opposition; other reasons include noise nuisances, negative impacts on birds and bats,

[2] We emphasize this latter part of the definition to clearly distinguish NIMBY from other types of opposition (see Wolsink 2007 page 1201).

displaced agricultural land, and diminished property values (Lynn 2011). Economic studies have sought to quantify these impacts using both revealed and stated preference techniques.

Revealed preference studies have used hedonic analysis to estimate the impact of wind farms on residential property values. Some of these studies find that closer proximity to wind farms can negatively affect house prices (Jordal-Jørgensen 1996; Heintzelman and Tuttle 2012; Hinman 2010; Termansen et al. 2012). Heintzelman and Tuttle (2012) state that landowners who are near wind developments but are not leasing their land to wind developers are incurring an externality cost and thus have "an economic case" that they should be compensated. Other hedonic studies find no effect of wind farms on property values (Hoen 2006; Hoen et al. 2009; Hoen et al. 2011; Sims et al. 2008) however the small sample sizes, sampling approach, and timing of these studies may have led to the finding of no significant impact (Heintzelement and Tuttle 2012). Indeed, Hoen et al. (2011) note that over half of the properties in their sample were sold over three years after construction and "effects that existed soon after the announcement or construction of the wind facilities might have faded over time". Hinman (2010) further investigates the temporal property-price effects of wind farms and finds that price effects vary during different stages of the development process. Her results show that the sale prices of homes located near a wind farm development decreased during the approval and construction phases of the project. Once the wind farm was in full operation, however, sale prices rebounded and even exceeded their pre-wind farm proposal prices. Although these hedonic studies did not set out to examine NIMBY specifically, their results provide important insights for analyzing the phenomenon. Particularly, they show that living in proximity to a wind farm can have a tangible negative impact in the form of reduced sale prices, but that these impacts can fade over time as residents become more accustomed to the turbines.

Other economic studies use stated-preference techniques to elicit preferences for wind energy development. These studies valuate the various impacts of wind power including impacts on flora and fauna, landscapes, air quality and carbon emissions, and jobs (Aravena et al. 2008; Fimereli et al. 2008; Meyerhoff et al. 2010; Alvarez-Farizo and Hanley 2002; Lutzeyer 2013). Preferences for different wind farm configurations and physical attributes have also been examined (Dimitropoulos and Kontoleon 2009; Ek 2002; Ladenburg and Dubgaard 2007; Meyerhoff et al. 2010). Valuing the aesthetic impacts of wind turbines has been a significant topic in the stated-preference literature. These studies find that people are willing to pay to mitigate the negative visual and noise impacts of wind turbines by locating wind farms offshore (Aravena et al. 2008; Ek 2002) and at increasing distances from the coast (Krueger et al. 2011; Ladenburg and Dubgaard 2007; Ladenburg and Dubgaard 2009; Landry et al. 2012; Lutzeyer 2013; Westerberg et al. 2013). People are also willing to pay to locate onshore wind farms further away from their homes. In addition, some studies show that people are willing to accept compensation to allow turbines to be sited within their viewshed (Groothuis et al. 2008; Preez et al. 2012; Strazzera et al. 2012). Each of these stated-preference studies provides important insight into the trade-offs people are willing to make between wind farm attributes and also how monetary payment can play a role in mitigating the aesthetic impacts of wind farms.

2.2 Investigating NIMBY

While NIMBY is frequently mentioned in academia and the media regarding wind farm opposition, few studies have examined the phenomenon empirically. Previous studies that do examine NIMBY empirically differ in their timing relative to the wind development process. This timing is crucial for evaluating NIMBY.

Three previous studies investigate NIMBY in relation to operating wind farms (Ek 2005; Ladenburg 2008; Swofford and Slattery 2010). All three studies reject the NIMBY hypothesis because they find that people living within view or in close proximity to an operating wind farm display minimal to no negative attitudes towards wind energy.

Three studies investigate NIMBY after a site had been identified for development or a project had been proposed (Jones and Eiser 2009; Koundouri et al. 2009; Wolsink 2000). These previous studies find weak or no evidence of NIMBY. Jones and Eiser (2009) find that attitudes towards wind energy in general are good predictors of attitudes towards local wind energy development; in other words, people who have negative attitudes towards wind energy are also negative towards local projects and this type of opposition is not NIMBY. Koundouri et al. (2009) also do not support the NIMBY hypothesis because they find that people living near a proposed wind development site value the construction of the local wind farm just as much as people not living near the site. Finally, Wolsink (2000) finds that NIMBY attitudes have a weak effect on resistance behavior against proposed wind farms, such as signing a petition, writing a letter, attending public meetings, or taking legal action.

One study explores NIMBY by considering attitudes during both the proposal and operation stages of a wind development project (Warren et al. 2005). This study finds that the NIMBY effect is prevalent to begin with but it weakens with time. The authors also observe an "inverse NIMBY" effect because their results show that people living near an operating wind farm have the highest level of support for wind energy.

Finally, two studies examine NIMBY using hypothetical wind farm scenarios (Groothuis et al. 2008; Navrud and Bråten 2007). Navrud and Bråten (2007) find that rural residents living near an existing wind farm value a switch from coal power to wind power less than urban residents not living near a wind farm and attribute this to the NIMBY phenomenon. Groothuis et al. (2008) find that individuals who agree that wind energy is "a clean energy source that should be pursued in the future" are more likely to vote in favor of a local wind farm proposal. They interpret this finding as a lessening of the NIMBY effect due to the positive impacts on air quality associated with wind energy. The authors find that acceptability of a local wind farm increases with increasing payment offers and conclude that compensation payments can help mitigate NIMBY in regards to the siting of wind farms.

There is considerable evidence that attitudes towards wind energy projects change during different stages of the development process (Bell et al. 2005; Dear 1977; Dear 1992; Gipe 1995; van der Horst 2007; Wolsink 1989; Wolsink 1994). Opposition towards local wind development grows during the planning phases of a project and is strongest during the construction phase. Once the project is in operation, however, local opposition weakens considerably as people become accustomed to the wind turbines. In fact, it has been shown that people living near a wind project have the highest level of support for the technology[3], i.e. the "inverse NIMBY" effect (Krohn and Damborg 1999; Pasqualetti 2001; Warren et al. 2005; Wolsink 1989). This variation in acceptance is not only expressed but also revealed in property values (Hinman 2010).

Most of the previous studies discussed above are ex-post analyses of NIMBY because they involve specific wind energy projects that had already begun the development process. All three studies that examine NIMBY in relation to operating wind farms reject the NIMBY hypothesis, yet this conclusion is based on the attitudes of respondents with a lot of previous

[3] Swofford and Slattery (2010) find the opposite, but only five months had passed between the commissioning of the wind project and the mailing of their questionnaire.

experience with the technology. Conclusions about NIMBY among the studies that were conducted after a wind project had been announced were also likely affected by respondents' reactions to the specific projects.

Examining NIMBY attitudes towards local wind development before people are confronted by an actual project is important in enhancing our understanding of the NIMBY phenomenon. This is particularly relevant in the context of U.S. wind energy because even though the industry is expanding, it still accounts for only 4% of the nation's total electricity mix and Americans have had relatively little experience with the technology (Smith and Klick 2007). Only two previous studies examine NIMBY using hypothetical wind farm scenarios. The results from Navrud and Bråten (2007), however, could be confounded by the traits that make rural residents different from urban residents, other than their attitudes towards wind energy. Groothuis et al. (2008) do not clearly define a respondent with NIMBY attitudes and thus it is unclear whether the compensation payments are for undesirable characteristics of the wind farm scenario in their study (siting turbines on mountain ridges) or for NIMBY resistance against a local wind farm.

Our research expands on the existing literature by investigating pre-development NIMBY effects and thus provides ex-ante insights on the nature of NIMBY attitudes before a wind farm is proposed. In addition, we utilize the discrete choice experiment technique which allows us to investigate NIMBY after controlling for wind farm characteristics that might cause local opposition, such as seeing or hearing a wind farm from home.

3. Study Design

3.1 Discrete Choice Experiments

Because there are currently no wind farms in our study region, we employ a discrete choice experiment (DCE) which is a nonmarket valuation approach that is appropriate when investigating scenarios that are hypothetical in nature. DCEs are founded on Lancaster's (1966) "new approach to consumer theory" in which consumers derive utility not directly from a good itself but from the "properties or characteristics" of the good. The DCE technique is valuable because the researcher can quantitatively measure the tradeoffs people make between different attributes of a good and it "provides a richer description of preferences than can be obtained by the valuation of single 'with versus without' scenarios" (Holmes and Adamowicz 2003). In a

DCE respondents are asked to choose among two or more alternatives which are differentiated by varying attributes and attribute levels. If one of the attributes included is a monetary cost or compensation payment then the researcher can estimate willingness-to-pay or willingness-to-accept measures, respectively, for a change in a given attribute (ibid).

3.2 Choice Experiment Scenario

In the current study we employ a DCE to analyze preferences for different attributes of an onshore community-owned wind farm on the Eastern Shore of Virginia. We use a community-owned wind farm scenario to try to alleviate any “us vs. them” reactions to an externally owned wind farm. It is well documented that wind farms are more accepted by a community if there is direct local involvement with the project (Devine-Wright 2005; Devlin 2005; Krohn and Damborg 1999; Warren and McFadyen 2010). A community-owned wind farm is a wind farm that is “locally owned and community members have a significant, direct financial stake in the project beyond land lease payments and tax revenue” (*Windustry*). In our DCE scenario, if a wind farm proposal is approved by voters then all electricity users in the community would be members of a cooperative that would share in ownership of the wind farm[4]. Some additional details about the wind farm included in the scenario were: the wind farm would be located on land in the respondent’s county of residence; the cooperative would hire an experienced wind-power company to construct and operate the wind farm; the location of the wind turbines would be selected to maximize electricity production, minimize negative impacts on wildlife, comply with safety and local zoning regulations, and respect the concerns of the local community; a wind turbine would not be placed any closer than 1,000 feet from any home or building where people work; one wind turbine would provide power for about 500 to 1,000 households; the cooperative would use a portion of the revenue from the sale of electricity to provide members with a discount on their electric bills.

3.3 Defining Attributes and Levels

The attributes and levels were chosen after a comprehensive literature review and discussions with wind industry professionals. We include attributes that represent physical

[4] Cooperatively-owned wind farms are common in Denmark, Germany and in Midwestern States of the U.S. (Devlin 2005; *Windustry*).

characteristics of the wind farm as well attributes that characterize visual and audible impacts of the wind farm on respondents' homes and daily lives. Finally, we include a monetary attribute in order to calculate compensation payments.

Wind farm size and turbine height are the two physical attributes of the community wind farm. The appropriate levels for these attributes were determined after consultation with wind energy developers. Wind farm size has six levels with one turbine being the smallest wind farm size and six turbines being the largest. Photo simulations were included in the questionnaire to help respondents visualize the different wind farm sizes[5]. Turbine height has two levels: 276 feet and 390 feet. The former level represents a common turbine height and the latter is a height that experts believe the industry is heading towards in the future. Respondents were provided a scaled diagram with a 276-foot turbine and a 390-foot turbine next to the Assateague Lighthouse, a popular and publicly accessible lighthouse on the Eastern Shore of Virginia. The attributes representing visual impacts of the wind farm are view from home and view during daily activities away from home (such as commuting to work, shopping, etc.). Each of these attributes has two levels: the wind farm would be seen or it would not. Noise level heard outside of home is the attribute that represents audible impacts of the wind farm. It includes three levels: the wind farm would not be heard, 30 dBA, and 45 dBA[6]. A table was included in the questionnaire with noise levels from different sources for reference. The noise sources included: normal breathing (10 dBA), a soft whisper (30 dBA), a library (40 dBA), and a refrigerator (50 dBA) (Center for Hearing and Communication 2013). The monetary attribute is a percentage discount on the respondents' electric bills. The levels for this attribute are 1%, 5%, 10%, 15% and 20%. These attribute levels were chosen after discussions with experts at *Windustry*. Having a discount on electric bills as our monetary attribute allows us to calculate compensation payments for changes in the non-monetary attributes. We chose a willingness-to-accept framework because the wind farm is community-owned and communities typically have property rights over local land (Dimitropoulos and Kontoleon 2009). Table 1 summarizes the attributes and attribute levels.

[5] Photo simulations were generated using the software WindPro (see http://www.emd.dk/windpro/frontpage).
[6] The symbol dBA signifies the A-weighted decibel which is used to approximate sound heard by the human ear (Acoustical Society of America 2013). In the questionnaire we used the term "decibels" instead of dBA for simplicity.

Table 1: Attributes and Levels

Attribute	Number of levels	Levels
Wind farm size	6	1 turbine 2 turbines 3 turbines 4 turbines 5 turbines 6 turbines
Turbine height	2	276 feet 390 feet
See wind farm from home	2	No Yes
Noise level heard from home	3	Do not hear 30 dBA 45 dBA
See wind farm daily activities	2	No Yes
Discount on electric bill	5	1% 5% 10% 15% 20%

3.4 Development and Design of the Questionnaire

We developed a mail questionnaire to implement our DCE. The first section of the questionnaire asked respondents about their opinions on energy development from varying sources (including wind). This section also gathered information on respondents' energy usage and their average monthly electric bills. The second section provided respondents with information about the community-owned wind farm and introduced the attributes. The third section contained the choice experiment where respondents were asked to vote for their most preferred wind farm option. The fourth section contained follow-up questions to gather information about what respondents considered when making their decisions. Finally, the fifth section collected demographic information. Two focus groups were conducted during the development of the questionnaire in order to verify that the questions were clear. We used feedback from the focus groups to further refine the questionnaire.

3.5 Experimental Design

The experimental design for our DCE was created using the software Ngene[7]. Using a full factorial design was not feasible given that we had six attributes with up to six levels; thus we opted to use a fractional factorial design. Prior coefficients were included in order to improve the efficiency of the design. Our DCE contains 48 unlabeled choice sets and each choice set has three alternatives: wind farm option A, wind farm option B, and an opt-out option (representing the status quo of no wind farm). Each respondent was presented with four separate choice sets. Please refer to Appendix B for further details on the experimental design and the choice sets.

3.6 Sample and Survey Implementation

Our study region is the Eastern Shore of Virginia. The Eastern Shore has a mostly level topography and the primary industry there is agriculture. We chose this region of Virginia because it is an area of the state with the best wind energy potential (U.S. DOE 2012). During the time this study was implemented there were no existing or proposed wind development projects in our study region. Our sample comes from the two counties that make up the Eastern Shore of Virginia: Accomack County and Northampton County.

The final postal survey was administered to 1,000 householders[8] at least 19 years of age in Accomack and Northampton Counties. A stratified random sample[9] of householders was obtained from a USPS Computerized Delivery Sequence File provided by Infogroup[10]. The mailings began in April 2013 with an introductory letter followed by the questionnaire. A follow-up reminder and additional copy of the survey was sent to non-respondents.

4. Model Development

4.1 Random Utility Theory

McFadden's (1973) theory of random utility maximization (RUM) links Lancaster's (1966) consumer theory with empirical models in order to model people's choices. The RUM theory can be applied in order to model respondents' choices as a function of attributes and

[7] Ngene is provided by Choice-Metrics (see http://www.choice-metrics.com/).
[8] The U.S. Census Bureau now uses the term "householder" instead of head of household.
[9] There are 13,798 households in Accomack County and 5,323 households in Northampton County. Population weights were applied for the analysis using Stata commands for survey data (see http://www.stata.com/help.cgi?svy).
[10] Infogroup is a data and marketing services company (see http://www.infogroup.com/).

attribute levels. The utility an individual receives from alternative *j* can be represented by the following utility function:

(1) $$U_j = V_j + \varepsilon_j$$

According to the RUM model, this utility function consists of a systematic component (V_j) and a random component (ε_j). The systematic component of utility can be written as:

(2) $$V_j = \beta \mathbf{x}$$

where x is a vector of the attributes in the DCE and socio-economic characteristics of the respondent and β is a vector of utility parameters which the researcher wishes to estimate. V_j is directly observable through individuals' choices in a DCE and is assumed to be equal across all individuals. The random component of utility is unobserved by the researcher and is assumed to characterize the idiosyncrasies of each individual (Louviere et al. 2000). Because ε_j is unobserved it "reflects researcher uncertainty about choice" (Holmes and Adamowicz 2003).

The RUM theory assumes that people make choices in order to maximize their utility and therefore an individual will choose alternative *j* over alternative *k* if:

(3) $$U_j > U_k \; \forall \, j \neq k$$

Combining $U_j = V_j + \varepsilon_j$ and $U_j > U_k$, the above equation can be re-written as:

(4) $$V_j + \varepsilon_j > V_k + \varepsilon_k \forall \, j \neq k \sim (V_j - V_k) > (\varepsilon_k - \varepsilon_j) \; \forall \, j \neq k$$

Because the random component of utility is unobserved, the *probability* that ($V_j - V_k$) is greater than ($\varepsilon_k - \varepsilon_j$) must be calculated. To calculate choice probabilities, assumptions must be made about the distribution of the random component. Oftentimes it is assumed that the random component has a Gumbel distribution[11] and is independently and identically distributed (IID). This distributional assumption makes the class of logit models appropriate to use for estimation.

4.2 The Conditional Logit Model

The conditional logit model can be used to model choice probability in which the choice among alternatives is a function of the attributes of the alternative and the characteristics of the individual making the choice (Hoffman and Duncan 1988). The probability that alternative *j* is chosen over all other alternatives *i* can be written as:

[11] Navrud and Bråten (2007) explain that "compared to the normal distribution, a Gumbel distribution has a flatter tail, and can therefore adapt to extreme values like especially strong preferences".

(5)
$$P_j = \sum_{i=1}^{I} exp(X_j\beta)/exp(X_i\beta)$$

where X_j represents the characteristics of the *j*th alternative and β are the utility parameters to be estimated. The conditional logit model has three assumptions: (1) respondents have homogeneous preferences, (2) choices satisfy the independence from irrelevant alternatives (IIA) assumption[12], and (3) errors have an equal scale parameter. The estimated parameters of the conditional logit model correspond to the marginal utility from each attribute. If a utility function is linear, then dividing the marginal utility corresponding to one attribute by the marginal utility corresponding to another attribute yields the marginal rate of substitution between the two attributes (i.e. the individual's willingness to trade-off between the two attributes) (Louviere et al. 2000). If one of the attributes is a monetary payment then the researcher can calculate an individual's marginal willingness-to-pay or willingness-to-accept compensation for a change in attribute levels; this is also known as the implicit price for each non-monetary attribute (Carson and Louviere 2011). Implicit prices can be calculated using the following equation:

(6)
$$\text{Implicit Price} = \left(\frac{\beta_{non-monetary\ attribute}}{\beta_{monetary\ attribute}}\right)$$

In our study a negative implicit price represents a discount on respondents' electric bills.

4.3 Model Specification

We utilize the conditional logit model to analyze data from our DCE. Our model specification for the main effects of the systematic component of utility for each alternative is:

(7)
$$V_j = \beta_{wfs2}(wfs2) + \beta_{wfs3}(wfs3) + \beta_{wfs4}(wfs4) + \beta_{wfs5}(wfs5) + \beta_{wfs6}(wfs6) + \beta_{height390}(height390) + \beta_{vhome}(vhome) + \beta_{noise30}(noise30) + \beta_{noise45}(noise45) + \beta_{vact}(vact) + \beta_{disc}(disc) + \beta_{asc}(ASC)$$

where *wfs2*, *wfs3*, *wfs3*, *wfs4*, *wfs5*and *wfs6* are dummy variables for number of turbines (one turbine is the omitted category), *height390* is a dummy variable for turbine height (276 feet is the omitted category), *vhome* is a dummy variable that equals 1 for see wind farm from home and equals 0 for do not see wind farm from home, *vact* is a dummy variable that equals 1 for see wind farm during daily activities away from home and equals 0 for do not see during daily

[12] The IIA assumption is that the choice probabilities are unaffected by the introduction or removal of other alternatives in the choice sets (Holmes and Adamowicz 2003; Navrud and Bråten 2007).

activities. The variables *noise30* and *noise45* are dummy variables for noise level from the wind farm heard outside of home; "do not hear" is the omitted category. *Disc* is the monthly discount on electric bills in dollars, calculated by multiplying the attribute level (which was defined as a percentage discount on the electric bill) by respondents' reported monthly electric bill. The alternative-specific constant (ASC) equals 1 for the two wind farm alternatives and equals 0 for the no wind farm alternative. The ASC represents factors other than the attributes included in the model that might make respondents vote in favor or against a local wind farm; if the coefficient on the ASC is significant, then a positive sign tells us that these factors cause respondents to vote in favor and a negative sign tells us these factors cause them to vote against. If the coefficient on the ASC is insignificant this indicates that the attributes in the model account for all of the factors that respondents consider when making their voting decisions. We will refer to the model specified in Equation 7 as the Base Model.

To investigate NIMBY we break-out the ASC based on respondents' heterogeneity in preferences towards wind energy:

(8) $$V_j = \beta_{wfs2}(wfs2) + \beta_{wfs3}(wfs3) + \beta_{wfs4}(wfs4) + \beta_{wfs5}(wfs5) + \beta_{wfs6}(wfs6) + \beta_{height390}(height390) + \beta_{vhome}(vhome) + \beta_{noise30}(noise30) + \beta_{noise45}(noise45) + \beta_{vact}(vact) + \beta_{disc}(disc) + \beta_{ascON}(ASC_{on}) + \beta_{ascSWFav}(ASC_{SWFav}) + \beta_{SFav}(ASC_{SFav})$$

where ASC_{SWFav} is an interaction term between the ASC and the respondent-specific variable *SWFav; SWFav* equals 1 if the respondent somewhat favors wind energy and equals 0 otherwise. ASC_{SFav} is an interaction term between the ASC and the respondent-specific variable *SFav*; *SFav* equals 1 if the respondent strongly favors wind energy and equals 0 otherwise. In this model the ASC_{ON} represents respondents who are opposed or neutral to wind energy, ASC_{SWFav} represents the difference between those who somewhat favor wind energy and those who are opposed or neutral, and ASC_{SFav} has a similar interpretation for those who strongly favor wind energy. The sign and significance of β_{ascON}, $\beta_{ascSWFav}$, and $\beta_{ascSFav}$ signify whether factors other than the attributes included in the model are causing respondents who oppose or are neutral to, somewhat favor, and strongly favor wind energy, respectively, to vote for or against a local wind farm. The model specified in Equation 8 will be referred to as the NIMBY Model.

4.4 Hypotheses Tests

Previous literature suggests that there is a visual and audible disamenity associated with wind farms. We test whether being able to see a wind farm from home has a negative effect on the probability of choosing a wind farm alternative:

A. H_0: $\beta_{vhome} = 0$ versus H_1: $\beta_{vhome} < 0$

If we reject H_0 in Hypothesis A this indicates that respondents are less likely to vote for a wind farm alternative that they would be able to see from their home. Next we test if hearing a wind farm from home has a negative effect on the probability of choosing a wind farm alternative. We test this for the 30 dBA noise level:

B. H_0: $\beta_{noise30} = 0$ versus H_1: $\beta_{noise30} < 0$

and the 45 dBA noise level:

C. H_0: $\beta_{noise45} = 0$ versus H_1: $\beta_{noise45} < 0$

Rejecting H_0 in Hypothesis B indicates that respondents are less likely to vote for a wind farm alternative that they would hear at a 30 dBA noise level from their home; rejecting H_0 in Hypothesis C has the same interpretation for the 45 dBA noise level.

We investigate NIMBY by testing whether respondents who somewhat favor or strongly favor wind energy are still predisposed to vote against a local wind farm after controlling for whether they would see or hear the wind farm from their homes. To operationalize, we first investigate the significance of $\beta_{ascSWFav}$ and $\beta_{ascSFav}$. If $\beta_{ascSWFav}$ or $\beta_{ascSFav}$ is insignificant this indicates that respondents who somewhat favor or strongly favor wind energy are no different in their voting decisions as respondents who are opposed or neutral to wind energy. If respondents who are opposed or neutral to wind energy are predisposed to vote against local wind farms, as might be expected, then β_{ascON} is negative and significant. Since those who somewhat or strongly favor wind energy do not have significantly different alternative specific coefficients, this is evidence of NIMBY among those who favor wind energy.

There is also evidence of NIMBY if either $\beta_{ascSWFav}$ or $\beta_{ascSFav}$ is significant and negative, and β_{ascON} is negative and significant. In this case respondents who somewhat favor or strongly favor wind energy are actually more negative towards local wind development than those who are opposed or neutral to the technology. Conversely, if $\beta_{ascSWFav}$ or $\beta_{ascSFav}$ is significant and positive, and β_{ascON} is negative and significant, we must take one step further to investigate the overall effect for respondents who somewhat favor or strongly favor wind energy:

D. H_0: $\beta_{ascON} + \beta_{asc,f} = 0$ versus H_1: $\beta_{ascON} + \beta_{asc,f} < 0$

where *f* represents respondents who either somewhat or strongly favor wind energy. If we can reject H_0 this is evidence of NIMBY.

Thus, we take negative and significant alternative specific constant effects as evidence of NIMBY among respondents who somewhat or strongly favor wind energy. That is, after controlling for the local effects of seeing and hearing a wind farm from their home, there are other factors that will cause these individuals who favor wind energy to not choose a wind energy project.

5. Results

Of the 1,000 surveys mailed out 303 were completed and returned. Taking into account the 147 surveys that were undeliverable, our final response rate was 36%. The summary of responses to each survey question can be found in Appendix A.

5.1 Attitudes towards Wind Energy

We asked respondents how strongly they favor or oppose increasing U.S. production of wind energy. A majority of respondents favor wind energy (see Table 2).

Table 2: Attitudes towards increasing U.S. production of wind energy

Strongly oppose	**Somewhat oppose**	**Undecided**	**Somewhat favor**	**Strongly favor**
3%	3%	8%	21%	58%

Note: A response to this question was missing for 7% of the respondents.

To gain insight into the potential determinants of attitudes towards wind energy we investigate how respondents' characteristics, previous experience with wind power, and perception of local wind farm impacts affect their attitudes towards wind energy. To do this we estimate an ordered logit model (see Table 3) where the dependent variable (*windattitude*) equals 1 if the respondent strongly opposes, somewhat opposes, or is undecided about wind energy[13],

[13] We combine strongly oppose, somewhat oppose, and undecided into one category because this group represents a small proportion of respondents.

equals 2 if the respondent somewhat favors wind energy, and equals 3 if the respondent strongly favors wind energy.

Our results indicate that respondents who have previously seen a wind farm in person are less likely to be in favor of wind energy than those who have never seen a wind farm. Having heard a wind farm in person has no effect. The three wind farm impact variables that are statistically significant are *agind*[14], *jobs*, and *air*. Respondents who believe that a wind farm would have a positive impact on job creation and air quality are more likely to favor wind energy. Although perceived negative impacts on scenic quality, property values, and birds are often cited as reasons that people oppose local wind farms, our results indicate that respondents who believe that a wind farm would cause these negative impacts are no less likely to be in favor of wind energy than those who believe there would be no impact. Whether or not a respondent was retired is the only respondent characteristic that affects attitudes towards wind energy; respondents who are retired are less likely to be in favor of wind energy than those who are not retired.

[14] The sign on *agind* is unexpected and difficult to interpret.

Table 3: Ordered Logit Model Results: Determinants of *windattitude*

Variable	Definition	Coefficient (Robust Std. Err.)
seen	Has seen a wind farm (1=Yes; 0=No)	−1.789** (0.690)
heard	Has heard a wind farm (1=Yes; 0=No)	0.214 (0.887)
ebill	Average monthly electric bill[a]	0.006 (0.005)
busown	Business owner (1=Yes; 0=No)	−0.065 (1.024)
agind	Impact on agricultural industry[b]	−1.13* (0.675)
tourism	Impact on tourism[b]	0.890 (0.623)
jobs	Impact on job creation[b]	1.682* (0.934)
air	Impact on air quality[b]	1.367* (0.736)
elec	Impact on electricity rates[b]	0.916 (1.023)
scenic	Impact on scenic beauty[b]	−0.354 (0.872)
property	Impact on property values[b]	0.023 (0.799)
birds	Impact on wild bird populations[b]	0.451 (0.673)
gender	1=Female; 0=Male	−0.187 (0.791)
income	Household income[a]	1.11e−06 (7.11e−06)
retired	1=Retired; 0=otherwise	−1.355* (0.719)
unemployed	1=Unemployed; 0=otherwise	−1.594 (1.463)
rural	1=Lives in rural area; 0=otherwise	0.089 (0.653)

Note: *** p<0.01; ** p<0.05; *p<0.1

[a] Values were response category midpoints

[b] Negative impact= −1; No impact=0; Positive impact=1

5.2 Conditional Logit Model Results

Estimation results for the Base Model can be found in Table 4. We tested to see if any of the wind farm size coefficients were equal and could not reject the null hypothesis that the coefficients on *wfs3*, *wfs4*, and *wfs5* were statistically identical (p>0.34). We therefore created the variable *wfs345* which equals 1 if wind farm size equals 3, 4, or 5 turbines and equals 0 otherwise. We also tested the hypothesis that the coefficients on *noise30* and *noise45* were statistically identical and could not reject the null hypothesis (p>0.25). Thus, we created the variable *noise* which equals 1 if the noise level is 30 dBA or 45 dBA and equals 0 if the wind farm could not be heard.

Table 4: Base Model Results

Variable	Coefficient (Robust Std. Err.)
wfs2	0.132 (0.161)
wfs3	0.529*** (0.164)
wfs4	0.324* (0.179)
wfs5	0.530*** (0.179)
wfs6	0.855*** (0.171)
height390	0.102 (0.117)
vhome	−0.280*** (0.091)
noise30	−0.259** (0.124)
noise45	−0.408*** (0.121)
vact	−0.030 (0.0845)
disc	0.053*** (0.008)
ASC	−0.290 (0.207)

Note: *** p<0.01; ** p<0.05; *p<0.1

Estimation results for the modified model (the Base Short Model in Table 5) show that respondents prefer the larger wind farms options, indicated by the positive and significant coefficients on *wfs345* and *wfs6*. The coefficient on *height390* is insignificant indicating that respondents are indifferent between the two turbine heights. Respondents are also indifferent to seeing a wind farm during their daily activities away from home. The coefficients on *vhome* and *noise* are both negative and significant indicating that respondents prefer not to see or hear a wind farm from home. As expected the coefficient on *disc* is positive and significant signifying that respondents prefer larger discounts on their electric bills.

Table 5: Base Short Model Results

Variable	**Coefficient (Robust Std. Error)**
wfs2	0.141 (0.161)
wfs345	0.461*** (0.146)
wfs6	0.854*** (0.170)
height390	0.098 (0.115)
vhome	−0.284*** (0.091)
noise	−0.332*** (0.105)
vact	−0.028 (0.085)
disc	0.052*** (0.008)
ASC	−0.281 0.207

Note: *** p<0.01; ** p<0.05; *p<0.1

5.2.1 NIMBY Model Results

Recall that the ASC represents factors other than model attributes that cause respondents to vote in favor or against a local wind farm. Thus, a positive or negative sign signifies respondents' predisposition to vote in favor or against, respectively, a local wind farm for considerations other than the attributes presented in the choice questions. Also recall that in the NIMBY Model (Table 6) the ASC_{ON} represents respondents who are opposed or neutral[15] to wind energy, ASC_{SWFav} represents the difference between those who somewhat favor wind energy and those who are opposed or neutral, and ASC_{SFav} represents the difference between those who strongly favor wind energy and those who are opposed or neutral. We see that the coefficient on the ASC_{ON} is negative and significant, which indicates that factors other than the

[15] Respondents who indicated that they are undecided about wind energy are described as being neutral.

attributes cause respondents who are neutral or opposed to wind energy to vote against a local wind farm.

NIMBY attitudes are ascribed to those respondents who say they favor wind energy development but vote against wind farms in their own community. We reject the null hypothesis for the one-sided test that $\beta_{ascSWFav}$ is negative. Therefore, since β_{ascON} is significant and negative we know that the net effect of $\beta_{ascON} + \beta_{ascSWFav}$ is negative. In fact, respondents who somewhat favor wind energy are more negative than those who are opposed or neutral. Thus, we detect NIMBY attitudes among respondents who somewhat favor wind energy because they are predisposed to vote against local wind development even after controlling whether they would see and hear the wind farm from their homes[16]. The coefficient on ASC_{SFav} is positive and significant, which indicates that respondents who strongly favor wind energy are less negative towards local wind development than those who are opposed or neutral. To know whether respondents who strongly favor wind energy display NIMBY attitudes we must determine if the net effect of $\beta_{ascON} + \beta_{ascSFav}$ is negative; we find that we cannot reject the null hypothesis for the one-sided test that the combined effect is negative. Further, upon reversing the hypothesis so that the alternative is that the combined effect is positive, we find that we can reject the null hypothesis of no effect. Therefore we conclude that respondents who strongly favor wind energy are positively disposed towards local wind farms and do not display NIMBY attitudes.

Since the alternative specific constants represent factors other than the modeled attributes that might make respondents vote in favor or against a wind farm, one is inclined to ask why those who somewhat favor wind energy might demonstrate a NIMBY attitude. These other factors might include an expected loss in property values, a concern for wildlife (e.g., bird deaths), or an anticipation of the deterioration in scenic beauty. Although results from our qualitative analysis indicated that these perceived negative impacts had no effect on respondents' favorability towards wind energy, it could be that when faced with the decision to vote for or against local wind development, respondents who somewhat favor wind energy prefer to avoid these localized impacts.

[16] We tested whether the coefficients on *vhome* and *noise* are equal for the Base Short Model and the NIMBY Model and fail to reject that the coefficients are statistically equal (p>0.72 and p>0.44, respectively). Thus, our conclusions about the effects of these attribute remain the same.

Table 6: NIMBY Model Results

Variable	**Coefficient (Robust Std. Error)**	**Implicit Prices**
wfs2	0.210 (0.160)	\$4
wfs345	0.539*** (0.158)	\$11
wfs6	0.862*** (0.178)	\$17
height390	0.114 (0.120)	\$2
vhome	−0.251*** (0.092)	−\$5
noise	−0.416*** (0.107)	−\$8
vact	0.004 (0.087)	\$0.08
disc	0.051*** (0.008)	---
ASC_{ON}	−1.189*** (0.281)	−\$23
ASC_{SWFav}	−0.203 (0.143)	−\$27
ASC_{SFav}	1.773*** (0.291)	\$11

Note: *** $p<0.01$; ** $p<0.05$; *$p<0.1$

5.2.2 Compensation Payments

Using the implicit prices reported in Table 6 we can calculate compensation requirements for different wind farm scenarios based on a respondent's attitude towards wind energy. A negative implicit price represents a compensation requirement to make an average respondent as well off as he or she was before the attribute change. For example take the case in which the smallest wind farm with one turbine can be seen and heard from the average respondent's home. If this respondent does *not* strongly favor wind energy she would require a \$36 (−\$5 − \$8 − \$23) monthly discount on her electric bill to accept this wind farm; if she strongly favors wind energy she would require a \$2 monthly discount (−\$5 − \$8 + \$11). Now consider if the largest wind farm with six turbines can be seen and heard from this respondent's home. If she does not strongly favor wind energy she would require a \$19 (\$17 − \$5 − \$8 − \$23) monthly discount on her electric bill to accept the wind farm; if she strongly favors wind energy she does not require compensation (\$17 − \$5 − \$8 + \$11). Putting these compensation payments into context, the average electric bill for respondents was $168 per month; therefore, for respondents who do not strongly favor wind energy the compensation requirement is 10% to 20% of their electric bill.

6. Discussion

Results from this study provide insight into public preferences for characteristics of a local wind farm. We find that that people prefer larger wind farm options (in this case three to six turbines), possibly because more turbines correspond to more green energy production. Previous research has shown that people prefer wind turbines to be located in small groups as opposed to being separately located or in large groups of ten to fifty turbines (Ek 2002); our results correspond with these previous findings. Additionally, we find that people are indifferent between the 276-foot turbine height and the 390-foot turbine height suggesting that this taller height will not affect utility. We also find that people are indifferent to seeing turbines during their daily activities, such as their commute to work or shopping, and this insight can be used for future planning.

Previous literature has found that people who live near wind farms have the highest support for wind energy. There were no existing wind farms in our study region and therefore none of our respondents lived near a wind farm at the time of our study. We found that respondents who had seen a wind farm in person were less likely to be in favor of wind energy; this suggests that casual exposure to wind farms is not enough to increase favorability towards wind energy technology.

Our results suggest that seeing or hearing a wind farm from home causes disutility. The question we ask is whether there is a residual NIMBY effect after controlling for these aesthetic disamenities. The NIMBY attitude is ascribed to people who support something but do not want to bear the negative impacts associated with it. Results from this study show that people who strongly favor wind energy have a positive disposition towards local wind farms and thus do not display NIMBY attitudes. It is possible that for people who strongly favor wind energy, the positive benefits of wind energy outweigh any negative impacts of a local wind farm. We do detect NIMBY attitudes among people who somewhat favor wind energy because they are predisposed to vote against local wind development even after controlling whether they would see and hear the wind farm from home.

Our results show that negative aesthetic effects of wind farms are potentially compensated by payments through reduction in electric bills. In addition, we find that a person's attitude towards wind energy affects how much compensation is required. On average, people who do not strongly favor wind energy will accept a 15% to 20% discount on their electric bill for seeing and hearing a wind farm from their home while those who strongly favor wind energy require minimal to no compensation; thus, respondents are not requiring large compensation payments that would cover or be in excess of their electric bills. Additionally, these compensation payments might not need to be in place forever since attitudes towards local wind farms have been found to become more positive as people become accustomed to the wind turbines.

Caution should be used when interpreting these results. A majority of our respondents strongly favored wind energy and did not display NIMBY attitudes towards a local wind farm. However, there is evidence that attitudes towards wind farms change during different stages of the wind development process and that attitudes are most negative during the planning and construction phases of a project. If people's attitudes change towards an actually proposed wind farm we might find NIMBY attitudes among those who strongly favor wind energy. In addition, we may find that compensation requirements might be greater for industrial-scale wind development. By doing an ex-ante analysis on NIMBY our study provides insights into the phenomenon that could not be inferred by studies who examine the phenomenon in an ex-post setting. Our results suggest that if an incentive program is in place from the onset of a wind development project it could offset NIMBY reactions to specific projects.

7. References

Acoustical Society of America, 2013. Classroom Acoustics. <http://acousticalsociety.org/>. Accessed 1 July 2013.

Alvarez-Farizo, B., Hanley, N., 2002. Using conjoint analysis to quantify public preferences over the environmental impacts of wind farms. An example from Spain. Energy Policy 30, 107–116.

American Wind Energy Association (AWEA), 2012. 2012 U.S. Wind Industry Annual Market Report Executive Summary. <http://awea.files.cms-plus.com/images/AWEA_USWindIndustryAnnualMarketReport2012_ExecutiveSummary%282%29.pdf>. Accessed 19 July 2013.

American Wind Energy Association (AWEA), 2013. Industry Statistics. <http://www.awea.org/Resources/industrystatistics.aspx?itemnumber=891&navItemNumber=620>. Accessed 21 July 2013.

Aravena, C., Martinsson, P., Scarpa, R., 2008. Does money talk? The effect of a monetary attribute on the marginal values in a choice experiment. Paper presented at the workshop Empirical Methods in Energy Economics. Zurich.

Bell, D., Gray, T., Haggett, C., 2005. The 'social gap' in wind farm siting decisions: explanations and policy responses. Environmental Politics 14, 460-477.

Burningham, K., 2000. Using the language of NIMBY: a topic for research not an activity for researchers. Local Environment 5, 55-67.

Carson, R.T., Louviere, J.J., 2011. A Common Nomenclature for Stated Preference Elicitation Approaches. Environmental and Resource Economics 49, 539-559.

Cassidy, P., 2013. Wind farm opponents sue Coast Guard. SouthCoast Today. <http://www.southcoasttoday.com/apps/pbcs.dll/article?AID=/20130713/NEWS/307130332>. Accessed 18 July 2013.

Center for Hearing and Communication, 2013. Common Environmental Noise Levels Factsheet. <http://www.chchearing.org/noise-center-home/facts-noise/common-environmental-noise-levels>. Accessed 1 July 2013.

Choice-Metrics, (2012). User Manual & Reference Guide Ngene 1.1.1

Cohen, N., Robbins, P., 2011. Green Cities: An A-to-Z Guide: NIMBY. Sage Knowledge, 342-345.

Dear, M., 1977. Spatial externalities and locational conflict. London Papers in Regional Science 7, 152-167.

Dear, M., 1992. Understanding and Overcoming the NIMBY Syndrome. Journal of the American Planning Association 58, 288-300.

Devine-Wright, P., 2005. Beyond NIMBYism: towards an integrated framework for understanding public perceptions of wind energy. Wind Energy 8, 125-139.

Devlin, E., 2005. Factors Affecting Public Acceptance of Wind Turbines in Sweden. Wind Engineering 29, 503-511.

Diekmann A., 1985. Volunteer's Dilemma. Journal of Conflict Resolution 29, 605-610.

Dimitropoulos, A., Kontoleon, A., 2009. Assessing the determinants of local acceptability of wind farm investment: a choice experiment in the Greek Aegean Islands. Energy Policy 37, 1842–1854.

Edelstein, M. R., 2004. Sustainable innovation and the siting dilemma: thoughts on the stigmatization of projects and proponents, good and bad. Journal of Risk Research 7, 233-250.

Ek, K., 2002. Valuing the environmental impacts of wind power: a choice experiment approach. Licentiate Thesis, Lulea University of Technology.

Ek, K., 2005. Public and private attitudes towards "green" electricity: the case of Swedish wind power. Energy Policy 33, 1677-1689.

Farhar, B.C., 1996. Energy and the Environment: The Public View. Renewable Energy Policy Project *REPP ISSUE BRIEF* No. 3, College Park, MD: University of Maryland College Park.

Fimereli, E., Mourato, S., Pearson, P., 2008. Measuring Preferences for Low-Carbon Energy Technologies in South-East England: The Case of Electricity Generation. ENVECON, London.

Gallup Politics, 2012. Americans Split on Energy vs. Environment Trade-Off. <http://www.gallup.com/poll/153404/Americans-Split-Energy-Environment-Trade-Off.aspx>. Accessed 1 April 2013.

Gipe P., 1995. Wind energy comes of age. Wiley, New York.

Groothuis, P.A., Groothuis, J.D., Whitehead, J.C., 2008. Green vs. green: measuring the compensation required to site electrical generation windmills in a viewshed. Energy Policy 36, 1545–1550.

Heintzelman, M.D., Tuttle, C. M., 2012. Values in the Wind: A Hedonic Analysis of Wind Power Facilities. Land Economics 88, 571-589.

Herzog, A. V., Lipman, T. E., Edwards, J. L., Kammen, D. M., 2001. Renewable energy: A viable choice. Environment 43, 8-20.

Hinman, J.L., 2010. Wind Farm Proximity and Property Values: A Pooled Hedonic Regression Analysis of Property Values in Central Illinois. Master's Thesis. Illinois State University.

Hoen, B., 2006. Impacts of Windmill Visibility on Property Values in Madison County, New York. Master's thesis. Bard Center for Environmental Policy, Bard College. Annandale-on-Hudson, New York.

Hoen, B., Wise, R., Cappers,P., Thayer, M., Sethi, G., 2009. The Impact of Wind Power Projects on Residential Property Values in the United States: A Multi-site Hedonic Analysis. Technical Report LBNL-2829E. Berkeley, CA:
Ernest Orlando Lawrence Berkeley National Laboratory, Environmental Energy Technologies Division.

Hoen, B., Wise, R., Capers, P., Thayer, M., Sethi, G., 2011. Wind Energy Facilities and Residential Properties: The Effect of Proximity and View on Sales Prices. Journal of Real Estate Research 33, 279-316.

Hoffman, S.D., Duncan, G.J., 1988. Multinomial and Conditional Logit Discrete-Choice Models in Demography. Demography 25, 415-427.

Holmes, T. P., Adamowicz, W.L., 2003. Attribute-based methods, in: Champ, P.A., Boyle, K.J., Brown, T.C. (Eds.), A primer on nonmarket valuation. Springer, Netherlands, pp. 171-219.

Hopey, D., 2012. Company cancels Shaffer Mountain wind power project. Pittsburgh Post-Gazette. <http://www.post-gazette.com/stories/local/region/company-cancels-shaffer-mountain-wind-power-project-640108/> Accessed 19 July 2013.

H.R. 6 (109th): Energy Policy Act of 2005. <http://www.gpo.gov/fdsys/pkg/BILLS-109hr6enr/pdf/BILLS-109hr6enr.pdf>. Accessed 1 July 2013.

Jones, R. C., Eiser, J.R., 2009. Identifying predictors of attitudes towards local onshore wind development with reference to an English case study. Energy Policy 37, 4604-4614.

Jordal-Jørgensen, J., 1996. Social Assessment of Wind Power: Visual Effect and Noise from Windmills-Quantifying and Valuation. Technical Report, AKF, Denmark.

Kempton, W., Firestone, J., Lilley, J., Rouleau, T., Whitaker, P., 2005. The Offshore Wind Power Debate: Views from Cape Cod. Coastal Management 33, 121-151.

Koundouri, P., Kountouris, Y., Remoundou, K., 2009. Valuing a wind farm construction: A contingent valuation study in Greece. Energy Policy 37, 1939-1944.

Krasny, R., 2010. Cape Wind, first U.S. offshore wind farm, approved. Reuters. <http://www.reuters.com/article/2010/04/28/us-usa-windfarm-idUSTRE63R42X20100428>. Accessed 18 July 2013.

Krohn, S., Damborg, S., 1999. On Public Attitudes Towards Wind Power. Renewable Energy 16, 954-960.

Krueger, A.D., Parsons, G.R., Firestone, J., 2011. Valuing the Visual Disamenity of Offshore Wind Power Projects at Varing Distances from the Shore: An Application on the Delaware Shoreline. Land Economics 87, 268-283.

Ladenburg, J., Dubgaard, A., 2007. Willingness to Pay for Reduced Visual Disamenities from Offshore Wind Farms in Denmark. Energy Policy 35, 4059–71.

Ladenburg, J., 2008. Attitudes towards on-land and offshore wind power development in Denmark; choice of development strategy. Renewable Energy 33, 111-118.

Ladenburg, J., Dubgaard, A., 2009. Preferences of Coastal Zone User Groups Regarding the Siting of Offshore Wind Farms. Ocean and Coastal Management 52, 233–42.

Lancaster, K.J., 1966. A New Approach to Consumer Theory. The Journal of Political Economy 74, 132-157.

Landry, C., Allen, T., Cherry, T., Whitehead, J., 2012. Wind turbines and coastal recreation demand. Resource and Energy Economics 34, 93-111.

Leiserowitz, A., Maibach, E., Roser-Renouf, C., Feinberg, G., Howe, P., 2012. Public Support for Climate and Energy Policies in September, 2012. Yale University and George Mason University. New Haven, CT: Yale Project on Climate Change Communication. <http://environment.yale.edu/climate-communication/files/Policy-Support-September-2012.pdf> Accessed 1 July 2013.

Louviere, J.J., Hensher, D.A., Swait, J.D., 2000. Stated Choice Methods: Analysis and Application. Cambridge University Press, Cambridge.

Lutzeyer, S., 2013. Essays in Offshore Wind Energy Development. Doctoral Dissertation. North Carolina State University.

Lynn, P.A., 2011. Onshore and Offshore Wind Energy: An Introduction. Wiley, Hoboken, NJ.

Mcallister, M., 2009. Hammon Group Takes on More Causes. Watertown Daily Times. <http://www.watertowndailytimes.com/article/20091203/NEWS05/312039949> Accessed 19 July 2013.

McFadden, D., 1973. Conditional Logit Analysis of Qualitative Choice Behavior, in Zarembka, P. (Ed.), Frontiers in Econometrics. Academic Press, New York.

Meyerhoff, J., Ohl, C., Hartje, V., 2010. Landscape externalities from onshore wind power. Energy Policy 38, 82-92.

Mulick, C., 2007. Saturday meeting to marshal Rattlesnake Mountain wind foes. National Wind Watch. <https://www.wind-watch.org/newsarchive/2007/11/01/saturday-meeting-to-marshal-rattlesnake-mountain-wind-foes/>. Accessed 19 July 2013.

Navrud, S., Bråten, K.G., 2007. Consumers' Preferences for Green and Brown Electricity: a Choice Modelling Approach. Revue d'économie politique 117, 795-811.

Nimby, n., 2013. Oxford University Press. <http://www.oed.com/;jsessionid=6AE44CF0450BCF5C30F8FF2B44FEBDCF?authRejection=true&url=%2Fview%2FEntry%2F245895%3FredirectedFrom%3Dnimby>. Accessed 1 May 2013.

Pasqualetti, M.J., 2001. Wind Energy Landscapes: Society and Technology in the California Desert. Society & Natural Resources: An International Journal 14, 689-699.

Patrick County Board of Supervisors, 2006. Work Session. <http://www.co.patrick.va.us/content/File/Minutes/approved_may_15_2006.pdf>. Accessed 1 May 2013.

Pernick, R., Wilder, C., Winnie, T., 2012. Clean Energy Trends 2012. < http://www.cleanedge.com/sites/default/files/CETrends2012_Final_Web.pdf>. Accessed 7 July 2013.

Preez, M., Menzies, G., Sale, M., Hosking, S., 2012. Measuring the indirect costs associated with the establishment of a wind farm: An application of the contingent valuation method. Journal of Energy in South Africa 21, 2-7.

Redington/Black Nubble Wind, 2012. Wind Energy-Visual Impacts and Public Perceptions. Macalester College. < http://www.macalester.edu/windvisual/redingtoninfo.html#sum>. Accessed 19 July 2013.

Schively, C., 2007. Understanding the NIMBY and LULU Phenomena: Reassessing Our Knowledge Base and Informing Future Research. Journal of Planning Literature 21, 255-266.

Seffrin, M., 2013. No wind turbines for Shelby, Auglaize counties. Sidney Daily News. <http://sidneydailynews.com/main.asp?SectionID=4&SubSectionID=345&ArticleID=260285> Accessed 19 July 2013.

Sims, S., Dent, P., Oskrochi, G. R., 2008. Modeling the Impact of Wind Farms on House Prices in the UK. International Journal of Strategic Property Management 12, 251–69.

Smith, E.R.A.N., Klick, H., 2007. Explaining NIMBY opposition to wind power. American Political Science Association Annual Meeting. Boston, MA. <http://www.polsci.ucsb.edu/faculty/smith/wind.pdf>. Accessed 3 April 2013.

Strazzera, E., Mura, M., Contru, D., 2012. Combining choice experiments with psychometric scales to assess the social acceptability of wind energy projects: A latent class approach. Energy Policy 48, 334-347.

Swofford, J., Slattery, M., 2010. Public attitudes of wind energy in Texas: Local communities in close proximity to wind farms and their effect on decision-making. Energy Policy 38, 2508-2519.

Termansen, M., Fonnesbech-Wulf, A. Fuglsang, M., Hasler, B., Ladenburg, J., Piil-Damm, A., Smart, J.C.R., 2012. Welfare effects of wind turbines in the landscape: A segmented market hedonic approach in Denmark. Paper presented at the 19th Annual Conference of the European Association of Environmental and Resource Economics (EAERE). Prague.

The White House, 2013. Develop and Secure America's Energy Resources. < http://www.whitehouse.gov/energy/securing-american-energy>. Accessed 7 July, 2013.

Toke, D., 2005. Explaining wind power planning outcomes: some findings from a study in England and Wales. Energy Policy 33, 1527-1539.

U.S. Department of Energy (DOE), 2008. 20% Wind Energy by 2030: Increasing Wind Energy's Contribution to U.S. Electricity Supply. <http://www.nrel.gov/docs/fy08osti/41869.pdf>. Accessed 1 April 2013.

U.S. Department of Energy (DOE), 2012. Virginia 80-Meter Wind Map and Wind Resource Potential. Wind Powering America. <http://www.windpoweringamerica.gov/wind_resource_maps.asp?stateab=va> Accessed 1 December 2012.

U.S. Energy Information Administration (EIA), 2012. Electric Power Monthly. <http://www.eia.gov/todayinenergy/detail.cfm?id=5350>. Accessed 19 April 2013.

U.S. Energy Information Administration (EIA), 2013. Electric Power Monthly. < http://www.eia.gov/electricity/monthly/pdf/epm.pdf>. Accessed 10 August 2013.

van der Horst, D., 2007. NIMBY or not? Exploring the relevance of location and the politics of voiced opinions in renewable energy controversies. Energy Policy 35, 2705-2714.

Virginia Business, 2010. Tazewell County vote a roadblock for wind farm plans. <http://www.virginiabusiness.com/index.php/news/article/tazewell-county-vote-a-roadblock-for-wind-farm-plans/>. Accessed 1 April 2013.

Warren, C.R., Lumsden, C.L., O-Dowd, S., Birnie, R.V., 2005. 'Green On Green': Public Perceptions of Wind Power in Scotland and Ireland. Journal of Environmental Planning and Management 48, 853-875.

Warren, C.R., McFadyen, M., 2010. Does community ownership affect public attitudes to wind energy? A case study from south-west Scotland. Land Use Policy 27, 204-213.

Westerberg, V., Jacobsen, J.B., Lifran, R., 2013. The case for offshore wind farms, artificial reefs and sustainable tourism in the French mediterranean. Tourism Management 34, 172-183.

Windustry. <http://www.windustry.org/>. Accessed 22 July 2013.

Wolsink, M., 1989. Attitudes and expectancies about wind turbines and wind farms. Wind Engineering 13, 196-206.

Wolsink, M., 1994. Entanglement of Interests and Motives: Assumptions behind the NIMBY-theory on Facility Siting. Urban Studies 31, 851-866.

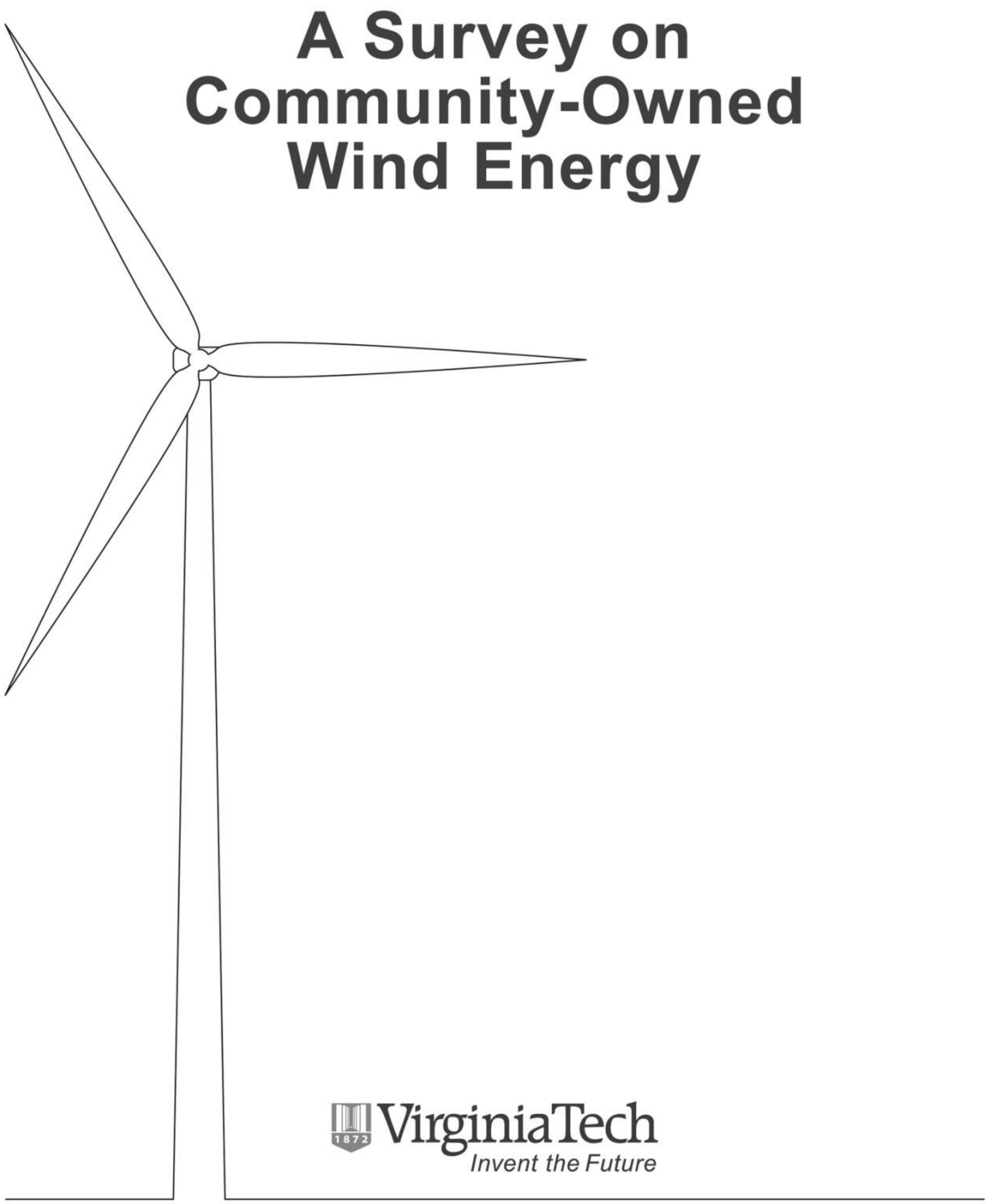
Wolsink, M., 2000. Wind power and the NIMBY-myth: institutional capacity and the limited significant of public support. Renewable Energy 21, 49-64.

Wolsink, M., 2006. Invalid Theory Impedes Our Understanding: A Critique on the Persistence of the Language of NIMBY. Transactions of the Institute of British Geographers 31, 85-91.

Wolsink, M., 2007. Wind power implementation: The nature of public attitudes: Equity and fairness instead of “backyard motives”. Renewable and Sustainable Energy Reviews 11, 1188-1207.

8. Appendices

Appendix A: Survey Instrument and Response Summaries



Introduction

The purpose of this survey is to learn what Northampton County residents think about a community-owned wind farm. A number of wind farms have been proposed for Virginia and neighboring states. The Eastern Shore is the area of Virginia with the greatest wind energy potential.

Terms Explained:

A "wind farm" is a group of wind turbines that capture wind energy to generate electricity.

A "wind turbine" is a special type of wind mill that produces electricity.

This survey will describe a possible community-owned wind farm in your county. A community-owned wind farm is **not currently proposed** in Northampton County, but we ask that you please answer all questions in this survey as if the wind farm were actually proposed. This information will help decision makers evaluate future wind farm proposals.

If a community-owned wind farm were approved by Northampton County voters:

A. All electricity users in Northampton County would be members of a cooperative that owns the wind farm.

B. The wind farm would be managed by the cooperative.

C. The wind farm would provide a local source of electricity that would be sold to power companies.

Section A: Energy Usage

In this section we would like to learn your opinions about energy development and to learn about your use of electricity.

1. How strongly do you favor or oppose increasing U.S. production of each of the following energy sources?
(*Circle **one** number for **each** energy source)*

Energy Source	Strongly oppose	Somewhat oppose	Undecided	Somewhat favor	Strongly favor	
Coal	1 19%	2 22%	3 17%	4 18%	5 16%	Missing 9%
Oil	1 11%	2 19%	3 16%	4 20%	5 23%	11%
Biomass (wood residues, straw)	1 8%	2 7%	3 38%	4 23%	5 14%	11%
Natural gas	1 5%	2 5%	3 14%	4 30%	5 39%	8%
Nuclear power	1 18%	2 12%	3 21%	4 21%	5 17%	11%
Solar energy	1 1%	2 4%	3 9%	4 19%	5 59%	8%
Wind energy	1 3%	2 3%	3 8%	4 21%	5 58%	7%

2. Have you done any of the following?
(*Circle **all** numbers that apply)* Missing: 2%

1 **Made an effort to turn lights off as soon as they are not being used**
Have done: 95% Have not done: 3%

2 **Made an effort to turn appliances off as soon as they are not being used**
Have done: 89% Have not done: 9%

3 **Bought an energy efficient appliance in the past 5 years**
Have done: 79% Have not done: 19%

4 **Used energy saving light bulbs**
Have done: 84% Have not done: 14%

5 **Purchased Renewable Energy Credits**
Have done: 3% Have not done: 94%

6 **Increased the insulation in your house**
Have done: 39% Have not done: 59%

7 **Replaced windows in your house**
Have done: 36% Have not done: 62%

8 **Other, please explain:** ______________________________
Have done: 19% Have not done: 79%

3. What was your average monthly electric bill in 2012?
(*Circle **one** number)* Missing: 3%

1 **Less than $50** 2%
2 **$50 - $75** 5%
3 **$76 - $100** 9%
4 **$101 - $125** 14%
5 **$126 - $175** 25%
6 **$176 - $200** 17%
7 **$201 - $250** 14%
8 **$251 - $300** 6%
9 **$301 - $350** 2%
10 **$351 - $400** 1%
11 **$401 and above** 2%
12 **Electric bills are included in my rent** 0%
13 **Do not know** 2%

4. Are you an owner or a co-owner of a business that is located in Northampton County?
(*Circle **one** number)* Missing: 4%

1 **Yes** 16%
2 **No** → Please SKIP to Section B on the next page 80%

5. What was the average monthly electric bill for your business in 2012?
(*Circle **one** number)* Missing: 5%

1 **Less than $200** 8%
2 **$200 - $400** 4%
3 **$401 - $600** 0.3%
4 **$601 - $800** 0.3%
5 **$801 - $1,000** 0%
6 **$1,001 - $1,200** 0.3%
7 **$1,201 - $1,400** 0%
8 **$1,401 - $1,600** 0%
9 **$1,601 - $1,800** 0%
10 **$1,801 - $2,000** 0.3%
11 **$2,001 and above** 0.7%
12 **Electric bills are included in my rent** 1%
13 **Do not know** 2%

Skipped: 79%

Section B: A Community-owned Wind Farm

We would like to know what you think about building a community-owned wind farm in Northampton County.

Suppose a community-owned wind farm is proposed for Northampton County. If the wind farm were approved by Northampton County voters, a cooperative would be formed to own and manage the wind farm. All electricity users in Northampton County would be members of this cooperative and would share in ownership of the wind farm.

Some important information about the wind farm:

- The wind farm would be located on land in Northampton County.
- Landowners who agree to have a wind turbine placed on their land would be paid an annual rental rate for the use of their land.
- The cooperative would hire an experienced wind-power company to construct and operate the wind farm.
- The location of the wind turbines would be selected to maximize electricity production, minimize negative impacts on wildlife, comply with safety and local zoning regulations, and respect the concerns of the local community.
- A wind turbine would not be placed any closer than 1,000 feet from any home or building where people work.
- There are about 5,300 households in Northampton County. One wind turbine would provide power for about 500 to 1,000 households.
- The cooperative would take out a loan to construct the wind farm.
- The cooperative would use part of the revenue from the sale of electricity to repay the construction loan and costs of operating the wind farm.
- The cooperative would use a portion of the revenue to provide members a discount on their electric bills.
- **There would be no costs to you for the construction and operation of the wind farm.**

The community-owned wind farm will have a number of important characteristics:

- Wind farm size in terms of the number of turbines
- Wind turbine height
- View of the turbines from your home
- Noise from the wind farm you could hear outside of your home
- View of the turbines during activities away from your home
- Discount on your electric bill

These characteristics are explained in more detail on the following pages.

6. Have you seen or heard a wind farm in person?
(*Circle **all** numbers that apply)* Missing: 1%

1 **Yes, seen** Yes: 48%; No: 51%
2 **Yes, heard** Yes: 20%; No: 79%
3 **No**

Now we are going to show you photo simulations of what a wind farm in Northampton County might look like. We have added a cow and fence in each of the scenes to provide context. We will ask you questions that relate to these photo simulations after you look at them.

No wind turbines

4 wind turbines

2 wind turbines

6 wind turbines

Wind farm size

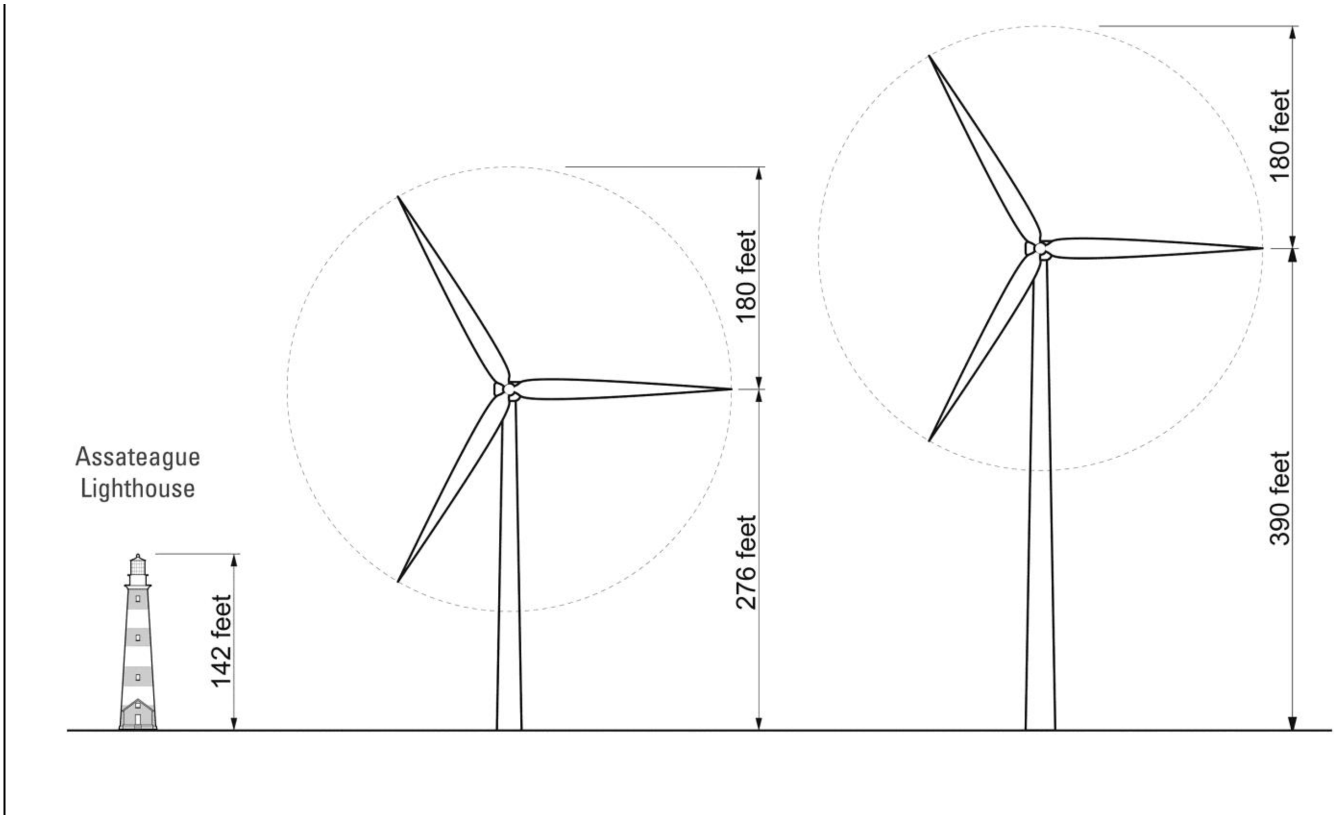
The wind farm could have as many as 6 turbines. The photo simulations on the previous pages show what a wind farm might look like in Northampton County with 2, 4 or 6 wind turbines. The first picture shows the scene with no wind turbines.

7. Did you expect the size of the wind farm to be larger or smaller?
(*Circle **one** number for **each** wind farm size)*

Wind farm size	Smaller	About what I expected	Larger	Do not know	Missing
2 turbines	1 4%	2 51%	3 21%	4 14%	11%
4 turbines	1 3%	2 51%	3 20%	4 14%	13%
6 turbines	1 3%	2 53%	3 20%	4 16%	8%

Wind Turbine Height

Two wind turbine heights would be considered. The turbines could be either 276 feet or 390 feet tall when measured from the ground to the top of the pole where the turbine blades are mounted. A 276-foot turbine is about the height of a 25-story building. These turbines can reach a height of 456 feet when the 180-foot blades are vertical to the ground. The 390-foot turbine is about the height of a 36-story building. These turbines can reach a height of 570 feet when the 180-foot blades are vertical to the ground. The diagram below shows two turbines next to the Assateague Lighthouse so you can compare their relative heights.



8. Are these wind turbines taller or shorter than you expected?
(*Circle **one** number for **each** turbine height)*

Turbine height	Shorter	About what I expected	Taller	Do not know	Missing
276 feet	1 6%	2 46%	3 36%	4 7%	6%
390 feet	1 1%	2 38%	3 48%	4 7%	7%

View of the turbines from your home

In the photo simulations you looked at previously the turbine blades are stationary, but when wind turbines are in operation their blades move. Each wind turbine would have a red aircraft warning light that blinks on and off at night. The warning lights would be on top of each turbine pole and would flash simultaneously every two seconds.

Depending on where the wind farm is located you might or might not see the turbines from your home.

9. If you own land suitable for a wind turbine, would you rent your land and allow a wind turbine to be constructed? Missing: 4%
(*Circle **one** number)*

   1 **Yes** 55%
   2 **No** 22%
   3 **It depends, please explain:** 20% ______________________________

10. Do you think any of your neighbors would rent their land and allow a wind turbine to be constructed on their land? Missing: 12%
(*Circle **one** number)*

   1 **Yes** 57%
   2 **No** 32%

Noise from the wind farm heard outside your home

Wind farms make noise. The noise is partly mechanical and partly the “whooshing” sound of the blades passing through the air. The noise level that you would hear **outside your home** depends on the distance between your home and the wind farm. The noise level will be less for wind farms that are located farther from your home and less for wind farms with fewer turbines. A Northampton County ordinance requires that noise from a wind farm does not exceed 55 decibels.

The table below is to help you compare the noise levels from a wind farm with other sources of noise:

Example	Approximate noise level
Normal breathing	**10 decibels**
Soft whisper	**30 decibels**
Library	**40 decibels**
Refrigerator	**50 decibels**

The loudest the wind farm would be for people who live or work near the wind farm ranges from the noise level of a soft whisper to the noise level of a typical refrigerator.

11. Did you think the noise from the wind farm would be quieter or louder? (*Circle **one** number*) Missing: 3%

    1 **Quieter** 15%
    2 **Louder** 44%
    3 **Do not know** 39%

View of the turbines during daily activities away from your home

Depending on where the wind farm is located you might see the turbines during daily activities such as commuting to and from work, shopping, participating in recreation activities and your other daily activities away from your home.

12. Would it concern you to see wind turbines during your daily activities away from home?
(*Circle **one** number)* Missing: 2%

1 **Yes** 12%
2 **No** 82%
3 **It depends, please explain:** 4% ______________________

Discount on your electric bill

The community-owned wind farm would provide a local source of electricity that would be sold to power companies. The cooperative would use a portion of the revenue from the sale of electricity to provide members a discount on their electric bills. If you rent your home or business location and do not pay an electric bill, please **assume** the discount is applied to your rent.

Suppose a household's average electric bill is $150 per month. If the wind farm discount is
10 percent, the household's monthly electric bill would decrease by $15 to $135 per month.

The discount would be a fixed percentage of your electric bill. Because electric bills vary from month to month with the amount of electricity used, the dollar amount of your discount will vary each month.

13. Would receiving a discount on your electric bill make you more likely to support the construction of a wind farm in Northampton County?
(*Circle **one** number)* Missing: 2%

1 **Yes, more likely** 73%
2 **No, not more likely** 18%
3 **It depends, please explain:** 6% ______________________

Section C: Your votes on wind farm designs

In the following questions we will ask you to vote on four wind farm designs. For each vote, you will be choosing between two alternative wind farm designs. For **each choice**, please vote as if the two wind farm designs are the only options available.

Suppose Northampton County had a referendum vote to choose one of the community-owned wind farms below.

Characteristics	**Wind Farm A**	**Wind Farm B**
Wind farm size	**4 turbines**	**5 turbines**
Wind turbine height	**390 feet**	**276 feet**
See the turbines from your home	**No**	**Yes**
Noise from the wind farm heard outside your home	**30 decibels**	**45 decibels**
See the turbines during your daily activities	**No**	**Yes**
Discount on your electric bill	**1%**	**1%**

14. **How would you vote?**
(*Circle **one** number)*

1 I would choose **Wind Farm A**
2 I would choose **Wind Farm B**
3 I would **not choose either** Wind Farm A or B

CQ 1

Suppose Northampton County had a referendum vote to choose one of the community-owned wind farms below.

Characteristics	**Wind Farm C**	**Wind Farm D**
Wind farm size	**5 turbines**	**1 turbine**
Wind turbine height	**276 feet**	**390 feet**
See the turbines from your home	**Yes**	**No**
Noise from the wind farm heard outside your home	**30 decibels**	**45 decibels**
See the turbines during your daily activities	**No**	**Yes**
Discount on your electric bill	**1%**	**1%**

15. **How would you vote?**
(*Circle* ***one*** *number)*

1 I would choose **Wind Farm C**
2 I would choose **Wind Farm D**
3 I would **not choose either** Wind Farm C or D

CQ 2

Suppose Northampton County had a referendum vote to choose one of the community-owned wind farms below.

	Wind Farm E	Wind Farm F
Wind farm size	**3 turbines**	**5 turbines**
Wind turbine height	**276 feet**	**390 feet**
See the turbines from your home	**Yes**	**No**
Noise from the wind farm heard outside your home	**45 decibels**	**Do not hear**
See the turbines during your daily activities	**No**	**Yes**
Discount on your electric bill	**10%**	**20%**

16. **How would you vote?**
(*Circle **one** number)*

1 I would choose **Wind Farm E**
2 I would choose **Wind Farm F**
3 I would **not choose either** Wind Farm E or F

CQ 3

Suppose Northampton County had a referendum vote to choose one of the community-owned wind farms below.

	Wind Farm G	**Wind Farm H**
Wind farm size	**5 turbines**	**6 turbines**
Wind turbine height	**276 feet**	**390 feet**
See the turbines from your home	**No**	**Yes**
Noise from the wind farm heard outside your home	**Do not hear**	**45 decibels**
See the turbines during your daily activities	**No**	**Yes**
Discount on your electric bill	**5%**	**20%**

17. **How would you vote?**
(*Circle* ***one*** *number)*

1 I would choose **Wind Farm G**
2 I would choose **Wind Farm H**
3 I would **not choose either** Wind Farm G or H

CQ 4

Section D: Understanding your votes

In this section we would like to learn what was important to you when you voted on the wind farms.

18. How frequently did you consider each of the characteristics when voting on the wind farms?
(*Circle **one** number for **each** characteristic)*

Characteristic	**Never**	**Rarely**	**Sometimes**	**Often**	**Always**	Missing
Wind farm size	1 17%	2 17%	3 24%	4 15%	5 19%	9%
Wind turbine height	1 17%	2 16%	3 21%	4 15%	5 21%	10%
See the turbines from your home	1 20%	2 19%	3 24%	4 13%	5 15%	9%
Noise from the wind farm heard outside your home	1 12%	2 17%	3 25%	4 15%	5 22%	9%
See the turbines during your daily activities	1 25%	2 27%	3 17%	4 10%	5 11%	10%
Discount on your electric bill	1 7%	2 7%	3 15%	4 16%	5 48%	9%

19. What is your general attitude toward wind power?
(*Circle **one** number)* Missing: 8%

1 **Very positive** 49%
2 **Positive** 27%
3 **Neutral** 9%
4 **Negative** 2%
5 **Very negative** 5%

20. How important is it to you that a wind farm in Northampton County is owned by members of your community?
(*Circle* ***one*** *number)* Missing: 5%

1 **Very important** 33%
2 **Important** 28%
3 **Moderately important** 17%
4 **Unimportant** 15%
5 **Very unimportant** 3%

21. Would you be interested in the following types of involvement in establishing a wind farm in Northampton County?
(*Circle* ***all*** *numbers that apply)* Missing: 5%

1 **Attend public meetings** Yes: 55%; No: 40%
2 **Participate in planning the wind farm** Yes: 30%; No: 66%
3 **Distributing information about the wind farm to your community**
Yes: 25%; No: 71%
4 **None**

22. If there were a community-owned wind farm in Northampton County, what impact do you think it would have on each of the following?
(*Circle* ***one*** *number for* ***each*** *characteristic)*

	Negative impact	No impact	Positive impact	Do not know	Missing
Agricultural industry	1 7%	2 48%	3 16%	4 22%	8%
Tourism	1 13%	2 46%	3 17%	4 16%	8%
Job creation	1 2%	2 17%	3 62%	4 11%	8%
Air quality	1 2%	2 48%	3 31%	4 13%	7%
Electricity rates	1 3%	2 6%	3 78%	4 8%	6%
Scenic beauty	1 34%	2 36%	3 10%	4 14%	7%
Property values	1 23%	2 26%	3 20%	4 25%	6%
Wild bird populations	1 31%	2 30%	3 4%	4 28%	8%
Climate change	1 3%	2 51%	3 20%	4 18%	9%
Other, please explain:					

Section E: Your characteristics

In this last section we ask you some questions that will help to compare your answers to those of other people. We stress that **all** your answers are **strictly confidential**.

23. Are you?
(*Circle* ***one*** *number)* Missing: 4%

1 **Male** 60%
2 **Female** 36%

24. In what year were you born?
(*Fill in the blank)* Missing: 5%

1 9 _ _
year

Mean	Median	Standard Deviation	Min	Max
1952	1950	14	1920	1990

25. How many people, **including yourself**, live in your household?
(*Fill in the blank)*

Number of adults: _________

Mean	Median	Standard Deviation	Min	Max
2	2	1	0	5

Number of children (18 years and younger): _________

Mean	Median	Standard Deviation	Min	Max
1	0	1	0	4

26. What is the highest level of education you have completed?
(*Circle **one** number)* Missing: 4%

1 **Less than 9th grade** 1%
2 **9th to 12th grade, no diploma** 5%
3 **High school graduate or equivalent** 12%
4 **Some college or education beyond high school** 28%
5 **Associate degree** 8%
6 **Bachelor degree** 20%
7 **Graduate or professional degree** 23%

27. Are you Hispanic or Latino?
(*Circle **one** number)* Missing: 7%

1 **Yes** 2%
2 **No** 91%

28. Which category most closely describes your racial identification?
(*Circle **one** number)* Missing: 8%

1 **White** 79%
2 **Black or African American** 10%
3 **American Indian or Alaska Native** 0%
4 **Asian** 0.33%
5 **Native Hawaiian or Other Pacific Islander** 0%
6 **Some Other Race** 1%
7 **Two or More Races** 2%

29. What is your current employment status?
(*Circle **one** number)* Missing: 5%

1 **Employed** 33%
2 **Self-employed** 14%
3 **Out of work and looking for work** 1%
4 **Out of work and not currently looking for work** 0%
5 **A homemaker** 2%
6 **A student** 1%
7 **Retired** 43%
8 **Unable to work** 1%

30. What was your household income from all sources before taxes in 2012?
(*Circle **one** number)* Missing: 14%

1 **Less than $10,000** 2%
2 **$10,000 to $14,999** 4%
3 **$15,000 to $24,999** 7%
4 **$25,000 to $34,999** 11%
5 **$35,000 to $49,999** 14%
6 **$50,000 to $74,999** 16%
7 **$75,000 to $99,999** 12%
8 **$100,000 to $149,999** 13%
9 **$150,000 to $199,999** 4%
10 **$200,000 or more** 4%

31. Do you currently own or rent your residence in Northampton County?
(*Circle **one** number)* Missing: 5%

1 **Own** 84%
2 **Rent** →Please SKIP to Question 33 11%

32. How many acres of land do you own?
(*Fill in the blank)* Missing: 8%

____**acres**

Mean	Median	Standard Deviation	Min	Max
12	1	41	0	400

33. Do you live in a rural area or in town?
(*Circle **one** number)* Missing: 5%

1 **Rural area** 65%
2 **Town** 30%

Thank you for completing the survey!
Your help in this effort is greatly appreciated.

If you have any additional comments, please write them in the box below:

Please return the survey in the postage-paid return envelope provided.

Block #; Version

Appendix B: Experimental Design and Choice Sets

Software: Ngene Version 1.1.1 (Build 305)
Comments:

- We used an efficient fractional factorial design which aims to generate parameter estimates with the smallest standard errors as possible (Choice-Metrics 2012).
- The D-efficiency measure was used to evaluate the statistical efficiency of each design.
- Prior values for *wfs* and *height* were adopted from coefficient estimates on the *WFS* and *HEIGHT* variables in Dimitropoulos and Kontoleon (2009).
- Prior values for *vhome* and *vactivites* were adopted from coefficient estimates on the *Distance* variable in Meyerhoff et al. (2010).
- Prior values for *noise* and *discount* were adopted from coefficient estimates on the *noise* and *price* variables in Ek (2002).

Ngene Syntax

Design
;alts = A, B, C
;rows = 48
;eff = (mnl,d)
;alg = swap(stop=noimprov(80 secs))
;model:
U(A) = b1[1] + b2.dummy[-.12|-.10|-.08|-.06|-.04]*wfs[6,5,4,3,2,1] + b3.dummy[-.478]
*height[390,276] + b4.dummy[2][-.261]*vhome[1,0] + b5.dummy[-.36|-.24]*noise[45,30,0] +
b6.dummy[2] [-.261]*vactivities[1,0] + b7[.09]*discount[1,5,10,15,20]/
U(B) = b1[1] + b2*wfs + b3*height + b4*viewhome + b5*noise + b6*viewact + b7*discount
$

Table 7: Choice Sets

Choice Set	wfs A	height A	vact A	noise A	vhome A	disc A	wfs B	height B	vact B	noise B	vhome B	disc B
1	4	390	0	30	0	1	5	276	1	45	1	1
2	5	276	0	30	1	1	1	390	1	45	0	1
3	3	276	0	45	1	10	5	390	1	0	0	20
4	5	276	0	0	0	5	6	390	1	45	1	20
5	4	276	1	45	1	20	2	390	0	0	0	10
6	2	276	0	0	0	10	4	390	1	30	1	20
7	2	276	1	45	1	15	1	390	0	30	0	5
8	4	390	1	0	0	10	6	276	0	30	1	15
9	2	276	1	45	0	10	5	390	0	0	1	15
10	4	276	1	0	0	5	1	390	0	30	1	20
11	3	390	1	30	1	20	1	276	0	0	0	5
12	5	276	0	0	1	5	4	276	1	45	0	20
13	1	276	1	45	0	15	2	390	0	0	1	10
14	1	390	1	0	1	15	6	276	0	30	0	15
15	5	390	1	0	0	10	2	276	0	45	1	15
16	1	390	0	45	1	5	2	276	1	0	0	1
17	1	390	0	45	1	1	6	276	1	30	0	1
18	5	276	0	45	0	10	1	390	1	0	1	10
19	1	390	1	30	0	20	4	276	0	45	1	10
20	6	276	1	0	1	15	2	390	0	45	0	15
21	1	276	0	30	0	5	6	390	1	0	1	15
22	6	390	1	0	0	15	2	276	0	30	1	5
23	3	390	0	45	0	10	1	276	1	0	1	15
24	4	390	0	30	1	20	3	276	1	45	0	10
25	6	276	0	45	0	5	2	390	1	0	1	5
26	5	390	1	0	1	15	1	276	0	30	0	5
27	2	390	1	0	1	15	5	276	0	45	0	10
28	2	276	0	0	0	5	3	390	1	30	1	20
29	3	276	1	30	1	1	5	390	0	45	0	1
30	4	390	0	45	0	1	3	276	1	30	1	1
31	4	390	0	45	1	20	5	276	1	30	0	10
32	5	390	1	30	1	20	6	276	0	0	0	5
33	1	276	0	30	1	5	3	390	1	45	0	20
34	2	390	0	30	0	15	1	276	1	0	1	10
35	4	390	0	0	0	15	2	276	1	45	1	10
36	3	276	1	30	0	5	4	390	0	0	1	15
37	3	390	0	45	1	20	4	276	1	30	0	5
38	1	390	1	45	0	20	4	276	0	30	1	5
39	3	276	0	0	1	1	6	390	1	45	0	5
40	5	276	1	30	1	10	3	390	0	0	0	15
41	6	276	1	45	1	1	3	390	0	30	0	1
42	2	390	1	30	0	10	3	276	0	0	1	10
43	6	276	0	0	1	5	5	390	1	45	0	20
44	6	390	1	30	0	1	5	390	0	45	1	1
45	3	276	1	0	0	10	6	390	0	30	1	20
46	6	390	0	30	0	1	4	276	1	45	1	1
47	2	276	1	30	1	20	3	390	0	0	0	5

Appendix C: IRB Approval Letters

VirginiaTech

Office of Research Compliance
Institutational Review Board
2000 Kraft Drive, Suite 2000 (0497)
Blacksburg, VA 24060
540/231-4606 Fax 540/231-0959
email irb@vt.edu
website http://www.irb.vt.edu

MEMORANDUM

DATE:	February 19, 2013
TO:	Kevin Boyle, Jessica Ann Boatwright
FROM:	Virginia Tech Institutional Review Board (FWA00000572, expires May 31, 2014)
PROTOCOL TITLE:	Community-owned Wind Energy
IRB NUMBER:	**13-054**

Effective February 19, 2013, the Virginia Tech Institution Review Board (IRB) Chair, David M Moore, approved the Amendment request for the above-mentioned research protocol.

This approval provides permission to begin the human subject activities outlined in the IRB-approved protocol and supporting documents.

Plans to deviate from the approved protocol and/or supporting documents must be submitted to the IRB as an amendment request and approved by the IRB prior to the implementation of any changes, regardless of how minor, except where necessary to eliminate apparent immediate hazards to the subjects. Report within 5 business days to the IRB any injuries or other unanticipated or adverse events involving risks or harms to human research subjects or others.

All investigators (listed above) are required to comply with the researcher requirements outlined at:

http://www.irb.vt.edu/pages/responsibilities.htm

(Please review responsibilities before the commencement of your research.)

PROTOCOL INFORMATION:

Approved As:	**Exempt, under 45 CFR 46.110 category(ies) 2**
Protocol Approval Date:	**January 22, 2013**
Protocol Expiration Date:	**N/A**
Continuing Review Due Date*:	**N/A**

*Date a Continuing Review application is due to the IRB office if human subject activities covered under this protocol, including data analysis, are to continue beyond the Protocol Expiration Date.

FEDERALLY FUNDED RESEARCH REQUIREMENTS:

Per federal regulations, 45 CFR 46.103(f), the IRB is required to compare all federally funded grant proposals/work statements to the IRB protocol(s) which cover the human research activities included in the proposal / work statement before funds are released. Note that this requirement does not apply to Exempt and Interim IRB protocols, or grants for which VT is not the primary awardee.

The table on the following page indicates whether grant proposals are related to this IRB protocol, and which of the listed proposals, if any, have been compared to this IRB protocol, if required.

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VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY
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Blacksburg, VA 24060
540/231-4606 Fax 540/231-0959
email irb@vt.edu
website http://www.irb.vt.edu

MEMORANDUM

DATE:	January 23, 2013
TO:	Kevin Boyle, Jessica Ann Boatwright
FROM:	Virginia Tech Institutional Review Board (FWA00000572, expires May 31, 2014)
PROTOCOL TITLE:	Community-owned Wind Energy
IRB NUMBER:	**13-054**

Effective January 22, 2013, the Virginia Tech Institution Review Board (IRB) Chair, David M Moore, approved the New Application request for the above-mentioned research protocol.

This approval provides permission to begin the human subject activities outlined in the IRB-approved protocol and supporting documents.

Plans to deviate from the approved protocol and/or supporting documents must be submitted to the IRB as an amendment request and approved by the IRB prior to the implementation of any changes, regardless of how minor, except where necessary to eliminate apparent immediate hazards to the subjects. Report within 5 business days to the IRB any injuries or other unanticipated or adverse events involving risks or harms to human research subjects or others.

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(Please review responsibilities before the commencement of your research.)

PROTOCOL INFORMATION:

Approved As:	**Exempt, under 45 CFR 46.110 category(ies) 2**
Protocol Approval Date:	**January 22, 2013**
Protocol Expiration Date:	**N/A**
Continuing Review Due Date*:	**N/A**

*Date a Continuing Review application is due to the IRB office if human subject activities covered under this protocol, including data analysis, are to continue beyond the Protocol Expiration Date.

FEDERALLY FUNDED RESEARCH REQUIREMENTS:

Per federal regulations, 45 CFR 46.103(f), the IRB is required to compare all federally funded grant proposals/work statements to the IRB protocol(s) which cover the human research activities included in the proposal / work statement before funds are released. Note that this requirement does not apply to Exempt and Interim IRB protocols, or grants for which VT is not the primary awardee.

The table on the following page indicates whether grant proposals are related to this IRB protocol, and which of the listed proposals, if any, have been compared to this IRB protocol, if required.

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Blacksburg, VA 24060
540/231-4606 Fax 540/231-0959
email irb@vt.edu
website http://www.irb.vt.edu

MEMORANDUM

DATE:	January 30, 2013
TO:	Kevin Boyle, Jessica Ann Boatwright
FROM:	Virginia Tech Institutional Review Board (FWA00000572, expires May 31, 2014)
PROTOCOL TITLE:	Community-owned Wind Energy
IRB NUMBER:	**13-054**

Effective January 30, 2013, the Virginia Tech Institution Review Board (IRB) Chair, David M Moore, approved the Amendment request for the above-mentioned research protocol.

This approval provides permission to begin the human subject activities outlined in the IRB-approved protocol and supporting documents.

Plans to deviate from the approved protocol and/or supporting documents must be submitted to the IRB as an amendment request and approved by the IRB prior to the implementation of any changes, regardless of how minor, except where necessary to eliminate apparent immediate hazards to the subjects. Report within 5 business days to the IRB any injuries or other unanticipated or adverse events involving risks or harms to human research subjects or others.

All investigators (listed above) are required to comply with the researcher requirements outlined at:

http://www.irb.vt.edu/pages/responsibilities.htm

(Please review responsibilities before the commencement of your research.)

PROTOCOL INFORMATION:

Approved As:	**Exempt, under 45 CFR 46.110 category(ies) 2**
Protocol Approval Date:	**January 22, 2013**
Protocol Expiration Date:	**N/A**
Continuing Review Due Date*:	**N/A**

*Date a Continuing Review application is due to the IRB office if human subject activities covered under this protocol, including data analysis, are to continue beyond the Protocol Expiration Date.

FEDERALLY FUNDED RESEARCH REQUIREMENTS:

Per federal regulations, 45 CFR 46.103(f), the IRB is required to compare all federally funded grant proposals/work statements to the IRB protocol(s) which cover the human research activities included in the proposal / work statement before funds are released. Note that this requirement does not apply to Exempt and Interim IRB protocols, or grants for which VT is not the primary awardee.

The table on the following page indicates whether grant proposals are related to this IRB protocol, and which of the listed proposals, if any, have been compared to this IRB protocol, if required.

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Blacksburg, VA 24060
540/231-4606 Fax 540/231-0959
email irb@vt.edu
website http://www.irb.vt.edu

MEMORANDUM

DATE:	March 19, 2013
TO:	Kevin Boyle, Jessica Ann Boatwright
FROM:	Virginia Tech Institutional Review Board (FWA00000572, expires May 31, 2014)
PROTOCOL TITLE:	Community-owned Wind Energy
IRB NUMBER:	**13-054**

Effective March 18, 2013, the Virginia Tech Institution Review Board (IRB) Chair, David M Moore, approved the Amendment request for the above-mentioned research protocol.

This approval provides permission to begin the human subject activities outlined in the IRB-approved protocol and supporting documents.

Plans to deviate from the approved protocol and/or supporting documents must be submitted to the IRB as an amendment request and approved by the IRB prior to the implementation of any changes, regardless of how minor, except where necessary to eliminate apparent immediate hazards to the subjects. Report within 5 business days to the IRB any injuries or other unanticipated or adverse events involving risks or harms to human research subjects or others.

All investigators (listed above) are required to comply with the researcher requirements outlined at:

http://www.irb.vt.edu/pages/responsibilities.htm

(Please review responsibilities before the commencement of your research.)

PROTOCOL INFORMATION:

Approved As:	**Exempt, under 45 CFR 46.110 category(ies) 2**
Protocol Approval Date:	**January 22, 2013**
Protocol Expiration Date:	**N/A**
Continuing Review Due Date*:	**N/A**

*Date a Continuing Review application is due to the IRB office if human subject activities covered under this protocol, including data analysis, are to continue beyond the Protocol Expiration Date.

FEDERALLY FUNDED RESEARCH REQUIREMENTS:

Per federal regulations, 45 CFR 46.103(f), the IRB is required to compare all federally funded grant proposals/work statements to the IRB protocol(s) which cover the human research activities included in the proposal / work statement before funds are released. Note that this requirement does not apply to Exempt and Interim IRB protocols, or grants for which VT is not the primary awardee.

The table on the following page indicates whether grant proposals are related to this IRB protocol, and which of the listed proposals, if any, have been compared to this IRB protocol, if required.

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