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## Capitalizing on Multidimensionality in Survey Instruments to Ensure Delivery of Relevant Extension Programming

### Abstract

At a time when resources are dwindling, Extension must capitalize on the potential of multidimensionality in survey instruments. A research project on wind energy development in Ohio involved a survey instrument that assessed the attitudes and opinions of community members, thereby meeting the needs of local stakeholders. However, responses to a set of peripheral questions on the survey also revealed gaps in community members' knowledge related to wind energy development. This article addresses data resulting from the three peripheral survey questions, the data analysis methods that yielded background for future Extension programming, and the importance of using a survey instrument to achieve multiple goals.

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## Introduction

Wind energy development in the United States has grown significantly over the last decade. According to the U.S. Department of Energy, installed wind capacity in the United States increased from 6,723 MW in 2004 to 65,879 MW in 2014 (U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, 2015). Despite the aggressive development of wind farms and their contribution to the generation of clean renewable electricity, wind energy development also is associated with notable concerns, including those related to intermittent generation, grid integration, ecological impacts, and local siting considerations. According to Warren, Lumsden, O'Dowd, and Birnie (2005), "The continued development of wind energy will depend not only on economics but also on public acceptance" (p. 857). Furthermore, Bidwell (2013) suggested, "If the actual effects of wind energy drive public opinion, it stands to reason that one's proximity to a wind farm would be an important factor affecting public opinion" (p. 191). Although researchers have studied the connection between opinion toward wind energy development and distance one lives from a development site, results from such studies have varied.

Extension has a history of engaging local communities, assessing local dynamics, and developing programs grounded in research to address critical community issues. According to Guy and Rogers (1999), "Efforts to gather information about residents' opinions, behaviors, and attitudes are worth the time and energy of Extension, elected officials, and volunteers because they help identify activities and practices important in sustaining communities" ("Social Sustainability," para. 7). Although many surveys have been conducted to

identify attitudes and opinions of community residents living close to wind farms, assessment of knowledge gaps that exist among people who have not formed attitudes and opinions prior to development is often overlooked. In addition, perhaps as important as determining residents' attitudes and opinions on a topic is evaluating the accuracy of the knowledge underlying those attitudes and opinions.

At a time when resources are dwindling, Extension must capitalize on the potential of multidimensionality in survey instruments. A research project on wind energy development in Ohio involved a survey instrument for assessing community members' attitudes and opinions in response to local stakeholders' requests for information. The survey also was used for identifying critical gaps in residents' knowledge. This article summarizes research results related to three peripheral survey questions designed to measure residents' knowledge, as evidenced by their perceptions of benefits and concerns related to wind energy development. The article also describes how the data were analyzed to inform future Extension programming and stresses the importance of achieving multiple goals with one survey instrument.

## Purpose and Objectives

The primary purpose of the research project was to identify local attitudes and opinions toward renewable energy, with a specific focus on wind farms and associated perceived benefits and challenges. The study was conducted in partnership with university, community, and industry stakeholders interested in assessing the attitudes and opinions of community residents toward wind energy development. Specifically, project funding originated from multiple stakeholders, including Ohio State University (OSU) Extension, the OSU School of Environment and Natural Resources, the OSU Social Responsibility Initiative, the Board of Commissioners of Wyandot County, Ohio, the Wyandot County Regional Planning Commission, and EDF Renewable Energy. To protect the integrity of the study and maintain transparency, those involved developed and signed a document that outlined the ground rules for working together. The document was included in the final study report, which is available at [www.go.osu.edu/wyandotwind](http://www.go.osu.edu/wyandotwind).

A multidimensional questionnaire enabled the research team, of which I was a member, to generate empirical measures of energy and environmental issues from residents in Wyandot County, Ohio. The questionnaire focused on two core objectives:

1. *Primary objective.* Determine Wyandot County residents' opinions, attitudes, and behaviors regarding emerging and potentially contentious energy and environmental issues in the community, with a specific focus on wind energy development.
2. *Secondary objective.* Conduct a local needs assessment for wind energy education by identifying the most critical local issues and evaluating community members' knowledge of wind energy development benefits and concerns.

The primary objective results were summarized in the *Journal of Extension* article "Residents' Perceptions Toward Utility-Scale Wind Farm Development" ([www.joe.org/joe/2015december/rb2.php](http://www.joe.org/joe/2015december/rb2.php)). This article focuses specifically on the secondary objective, addressing the results of the needs assessment questions and implications for Extension related to the methodology used.

## Methodology

In 2013, faculty and staff from OSU Extension and the OSU School of Environment and Natural Resources

and a graduate research assistant created an 11-page, 45-item questionnaire for examining attitudes, opinions, and knowledge related to energy and the environment, with a focus on wind energy development. The study population consisted of homeowners from eight zip code areas in Wyandot County, Ohio. At the time of the survey, a wind developer was actively leasing property in the area for a proposed wind farm project. The development zone of the proposed 100-MW wind farm was in one of the eight zip code areas, allowing for "a consideration of differences between residents located in the development zone and those located elsewhere in the area" (Campbell & Romich, 2015, "Purpose and Objectives," para. 1).

The target population for the study included households in Wyandot County, Ohio. The sample frame was purchased from a private vendor and included a total of 7,127 households. The 700 households comprising the study sample were selected and stratified according to zip code for the purpose of distinguishing between residents living in the proposed wind energy development zone and those living in other parts of the county. We contacted each household up to five times, providing a presurvey notification letter, the initial survey, a reminder postcard, a replacement survey, and a final reminder postcard. After excluding surveys that were undeliverable (83) and recipients who refused to participate (14), we determined the contactable sample to be 603 households. Surveys were collected from 160 households, yielding a 26% response rate. Comparing the total sample frame to the completed sample size, we can be 95% confident that an estimate from the sample survey is within a margin of error of  $\pm 10$  percentage points of the true population value (Dillman, Smyth, & Christian, 2014). The sample size also varied slightly from question to question due to skipped questions and incomplete responses on multiple-response items.

Three items on the 45-item questionnaire were included for the purpose of determining relevant educational needs among Extension clientele (Figure 1). The first of these items was a multiple-choice single-response question concerning respondents' overarching opinion of whether the benefits outweigh the concerns or the concerns outweigh the benefits with regard to wind energy development. Two additional, multiple-response questions asked respondents to consider potential impacts associated with wind energy development and select the three most important benefits and the three most important concerns. In our analysis of the two multiple-response questions, we calculated the total frequency of responses for each option and did not consider various combinations of responses. According to Santos (2000), "an obvious advantage to this approach is its simplicity, which makes for easy discussion and interpretation of results" ("Methodology," para. 4).

**Figure 1.**  
Survey Questions

## Question 1

**Overall, do you feel the benefits outweigh the concerns or do the concerns outweigh the benefits of wind energy development? (Circle the appropriate response)**

- a. Potential benefits of windmills outweigh the possible concerns
- b. Possible concerns outweigh the potential benefits
- c. Unsure

## Question 2

**Please rank the three most important benefits associated with wind energy development. (Rank 1-3 and use each number only once)**

- a. Low cost of energy generated
- b. No emission of greenhouse gases
- c. No water usage to produce energy
- d. Creates construction jobs
- e. Creates permanent jobs on site
- f. Generates economic activity in the community
- g. Source of income for landowners
- h. Source of local tax revenue
- i. Represents an alternative source of energy
- j. Reduces dependence on foreign energy sources
- k. Mitigate climate change

## Question 3

**Please rank the three most important concerns associated with wind energy development. (Rank 1-3 and use each number only once)**

- a. Noise from wind turbines
- b. Impact on the view / appearance of the landscape
- c. Potential impact on birds and bats
- d. The potential for damaging local roads during construction period
- e. Impact of windmills on nearby residential property values
- f. Integrating wind's intermittent power generation into the electric grid system
- g. Potential for "shadow flicker" from wind turbine blades
- h. Loss of farmland production due to land dedicated to windmill infrastructure
- i. Cost of power generated by wind farms
- j. Potential for ice particles to be thrown from windmill blades
- k. Potential interference with radar signals caused by windmills
- l. Windmills interfering with aerial spraying of crops

The results were imported into the IBM SPSS statistics package version 17 for a descriptive statistical analysis that included frequency, rank, percentage, and cross tabulation tables. The statistical significance was calculated through use of chi-square analysis and benchmarked with a  $p$  value of  $<.05$  indicating statistical significance.

## Results and Discussion

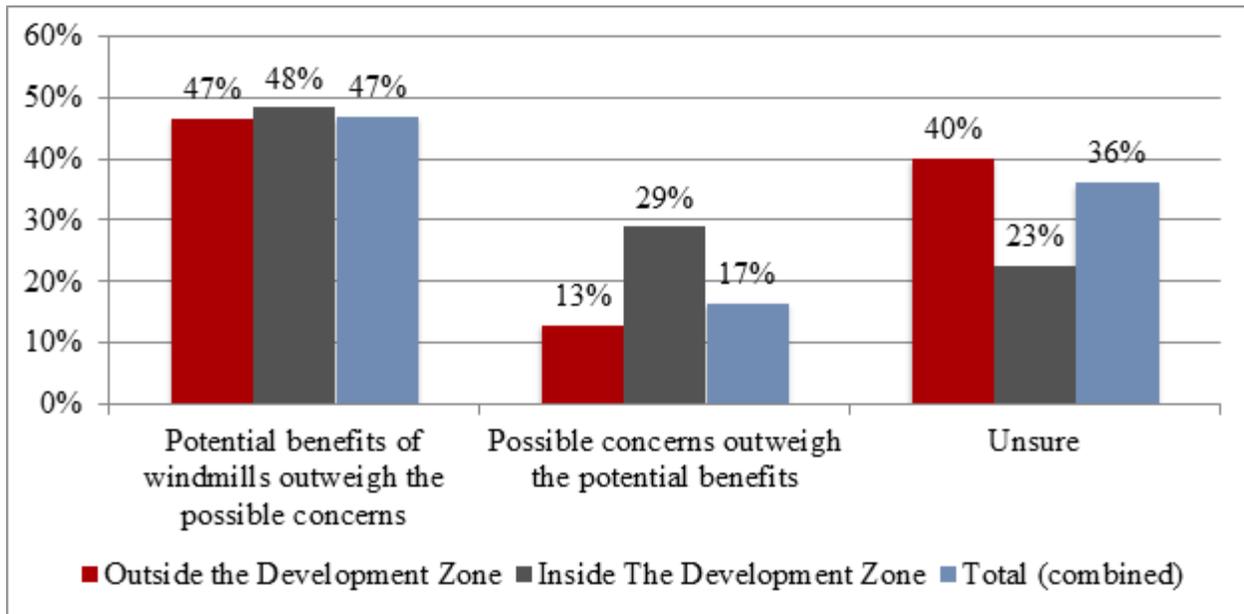
### Opinions Toward Wind Energy Development

The association between geographic location and overarching opinion toward wind energy development was slightly above the level of significance ( $p = .057$ ). In general, respondents living inside the development zone were more likely than those living outside the zone to feel that the concerns of wind energy

development outweigh the benefits (Figure 2). Another important observation concerning the association of geographic location to overarching opinion is that respondents living outside the proposed development zone were more likely than those living in the zone to be unsure about whether the benefits outweigh the concerns or vice versa (Figure 2).

**Figure 2.**

Respondent Opinions Regarding Whether Benefits Outweigh Concerns or Concerns Outweigh Benefits with Regard to Wind Energy Development



Because the data suggested that more than a third (36%) of the respondents were unsure of how they felt about wind energy development and, thus, were still formulating their opinions, we wanted to consider any differences between the subsets when assessing the frequencies of benefits and concerns selected as most important. Consequently, we conducted a cross-tabulation analysis between the respondents' opinions toward wind energy development (benefits outweigh concerns, concerns outweigh benefits, unsure) and the frequencies of benefits and concerns selected as most important (see Tables 1 and 2).

## Associations Between Opinions Toward and Perceived Benefits of Wind Energy Development

Respondents' overarching opinions toward wind energy development were significantly associated ( $p = .009$ ) with their perceptions of the most important benefits of wind energy development. In general, respondents who were unsure whether benefits of wind energy development outweigh concerns or vice versa and those who felt that benefits do outweigh concerns were very similar with regard to their selections of the most important benefits (Table 1). For both subsets, the same four benefits were the most frequently selected: "reduces dependence on foreign energy sources," "low cost of energy generated," "no emission of greenhouse gases," and "represents an alternative source of energy." These benefits tend to relate more closely to global environmental and social impacts than to local interests and impacts. Conversely, the subset of respondents who felt that concerns outweigh benefits preferred, in general, options more closely related to local impacts, such as "generates economic activity in the community," "source of local tax revenue," and "creates construction jobs."

**Table 1.**

## Associations Between Opinions Toward and Perceived Benefits of Wind Energy Development

Benefit associated with wind energy development	Benefits outweigh concerns		Concerns outweigh benefits		Unsure		Total	
	<i>f</i>	%	<i>f</i>	%	<i>f</i>	%	<i>f</i>	%
	Reduces dependence on foreign energy sources	31	19.3%	8	17.4%	27	21.4%	66
Low cost of energy generated	27	16.8%	3	6.5%	22	17.5%	52	15.6%
No emission of greenhouse gases	29	18.0%	3	6.5%	15	11.9%	47	14.1%
Represents an alternative source of energy	23	14.3%	5	10.9%	19	15.1%	47	14.1%
Generates economic activity in the community	10	6.2%	5	10.9%	8	6.3%	23	6.9%
Source of income for landowners	7	4.3%	5	10.9%	9	7.1%	21	6.3%
Creates permanent jobs on site	7	4.3%	4	8.7%	7	5.6%	18	5.4%
Source of local tax revenue	7	4.3%	5	10.9%	6	4.8%	18	5.4%
Mitigate climate change	11	6.8%	1	2.2%	4	3.2%	16	4.8%
No water usage to produce energy	8	5.0%	1	2.2%	6	4.8%	15	4.5%
Creates construction jobs	1	0.6%	6	13.0%	3	2.4%	10	3.0%

The results shown in Table 1 also suggest the existence of a knowledge gap with respect to the local benefits of large-scale wind projects and the need for future Extension programming focused on wind energy taxation in Ohio. Combined, only 5.4% of respondents identified "source of local tax revenue" as a most important benefit of wind energy development. Our research team felt that this percentage was low considering that at the time, large-scale wind projects in Ohio were required to make annual service payments of \$6,000 to \$9,000 per megawatt to local county government (Ohio Revised Code 5727.75). For example, in 2013, the

304-MW Blue Creek Wind Farm was the largest real estate taxpayer in Van Wert County, Ohio, contributing \$2,070,000 in annual real estate taxes (Van Wert County Treasurer's Office, n.d.)

## Associations Between Opinions Toward and Concerns About Wind Energy Development

Respondents' overarching opinions toward wind energy development were not significantly associated ( $p = .484$ ) with their perceptions of the most important concerns related to wind energy development. In general, there was consistency among the three subsets of respondents regarding their respective selections of most important concerns (Table 2). For the three groups combined, the four concerns most frequently selected were "cost of power generated by wind farms," "loss of farmland production due to land dedicated to windmill infrastructure," "impact of windmills on nearby residential property values," and "noise from wind turbines."

**Table 2.**

Associations Between Opinions Toward and Concerns About Wind Energy Development

Concern associated with wind energy development	Benefits outweigh concerns		Concerns outweigh benefits		Unsure		Total	
	<i>f</i>	%	<i>f</i>	%	<i>f</i>	%	<i>f</i>	%
	Cost of power generated by wind farms	24	15.4%	11	20.4%	21	18.4%	56
Loss of farmland production due to land dedicated to windmill infrastructure	27	17.3%	10	18.5%	17	14.9%	54	16.7%
Impact of windmills on nearby residential property values	20	12.8%	7	13.0%	18	15.8%	45	13.9%
Noise from wind turbines	14	9.0%	6	11.1%	19	16.7%	39	12.0%
Integrating wind's intermittent power generation into the electric grid system	21	13.5%	4	7.4%	11	9.6%	36	11.1%
Impact on the view/appearance of the landscape	10	6.4%	9	16.7%	7	6.1%	26	8.0%
Potential impact on birds and bats	9	5.8%	2	3.7%	6	5.3%	17	5.2%
Potential for damaging	9	5.8%	0	0.0%	4	3.5%	13	4.0%

local roads during  
construction period

Potential interference with radar signals caused by windmills	7	4.5%	1	1.9%	4	3.5%	12	3.7%
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Windmills interfering with aerial spraying of crops	4	2.6%	3	5.6%	3	2.6%	10	3.1%
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Potential for "shadow flicker" from wind turbine blades	6	3.8%	1	1.9%	2	1.8%	9	2.8%
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Potential for ice particles to be thrown from windmill blades	5	3.2%	0	0%	2	1.8%	7	2.2%
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The results shown in Table 2 suggest a potential need for education relating to land-use conversion and impacts of wind energy development. Loss of farmland production was identified as a top concern; however, studies have suggested that permanent land-use conversion from wind energy development is minimal in comparison to total project area. For example, in a 2009 study by the National Renewable Energy Laboratory, researchers assessed 161 large wind projects (greater than 20 MW) and estimated that the total project area for such projects is roughly 84 ac/MW but that the total direct impact of land that is temporarily or permanently disturbed is less than 3% of the total project area (2.47 ac/MW) (Denholm, Hand, Jackson, & Ong, 2009).

## Implications

The topic of large-scale energy development is often emotionally charged and controversial, having the potential to divide a community. During the development process, community leaders and residents are in need of research-based information to help them accurately evaluate the full range of impacts to the community. The economic, social, and environmental dynamics of each community are unique; therefore, localized data should be used to assess the community and inform future educational programs.

Extension is uniquely positioned to provide communities with localized data by engaging them in survey research that can assess existing opinions and, at the same time, identify future educational needs. When Extension personnel conduct local needs assessments to inform program development, learners must be integrally involved in determining content (Kluchinski, 2012). As stewards of the community, local Extension professionals can design surveys to capture multiple types of data and then analyze and interpret data to pinpoint how the data apply to the issue at hand. As Skelly, Hill, and Singletary (2014) stated, "Demographic constructs typically exist within the data that can provide a much more detailed picture of target clientele. Cluster analysis allows for that detailed picture to become clearer and subsequent programs tailored and more effective" ("Conclusions and Recommendations," para. 2). To plan for more customized programming, we clustered and examined results of the study described here on the basis of conceptual differences in opinions toward wind energy development.

Although the results from our study are localized, they also contribute to a growing discussion concerning

community acceptance of large-scale renewable energy projects. However, with regard to overall relevance for Extension professionals, perhaps there is more to gain by considering our process than our results. First, we attended to limited resources by designing a survey instrument that would pull double duty as a gauge of public opinion and an assessment of educational needs. Second, we leveraged traditional strengths of the Extension system, including the willingness to address controversial issues, engage a community, and conduct research to inform timely and relevant educational programs. Large-scale renewable energy projects are often accompanied by conversation and debate, much of it ill-informed. Engaging community interests in local survey research and the discussion of research findings enables Extension to serve as a trusted source to inform a controversial discussion.

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