

Public Understanding of and Support for Wind Power

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Wind power has been identified as the most cost-efficient form of alternative energy. We regularly read news stories about wind power and see newspaper advertisements urging the public to support wind power. Yet, because large-scale wind power is relatively new, we do not know how much people understand about it or what they think about it.

National public opinion about wind power has been studied, but only superficially. The survey questions used to gauge public opinion about wind power are broad, and often combine wind power with solar power. Moreover, few surveys ask more than one or two questions about wind power.

We analyze the results of a national internet survey conducted in 2008, which was designed to study public opinion about wind power. We present evidence that the public's understanding of wind power is relatively poor. We show what positive and negative characteristics of wind power the public regards as important. We develop a model to explain public support for expanding wind power, and we discuss the implications for the future of the wind power industry.

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Wind power is generally recognized as the form of alternative energy with the greatest potential. Studies predict that it can provide at least 20 percent of our electricity needs within the next 10 to 15 years, and possibly more in later years. Although wind power is still more expensive than electricity generated from fossil fuels, it is the most cost-effective source of alternative energy and its costs are declining (Kempton et al. 2007; Smil 2003). Moreover, the American public seems to embrace wind energy, typically giving it 70 to 80 percent support in public opinion polls (e.g., Gallup 2009). By most accounts, wind power seems to have a great future.

Despite the general public support for wind power, proposals for specific wind farms are often opposed by people living near the site of the proposed developments. In some cases, even environmental groups resist wind farms. Observers usually characterize this opposition as a *Nimby* ("not in my backyard") response. Wind farm opponents argue that wind turbines cause too much noise, decrease property values, harm birds and other wildlife, and "spoil the scenery" (Krohn and Damborg 1998; Walker 1995). The best known case of public opposition to a proposed wind farm is the resistance to the Cape Wind Project, which would be built on Horseshoe Shoals in Nantucket Sound, a few miles off Cape Cod, Massachusetts. Senator Edward Kennedy (D-Mass.) and Robert F. Kennedy, Jr., a senior attorney for the National Resources Defense Council, have forged an alliance with the Massachusetts Audubon Society, the Humane Society of the United States, the International Fund for Animal Welfare, and residents living in the Cape Cod area to resist the project (Kempton et al. 2005; Kennedy 2005; Lydersen 2006; Onion 2004).

Cape Wind is not an isolated case. Many proposals for land-based wind farms have also met organized opposition (Applebome 2007; Bosley and Bosley 1988, 1990; Convarrubias 2005; Pasqualetti 2001; Podger 2007; Powers 2005; Voyles 2009; Wilson 2007; Wolsink 2000; Wolverson 2007). Summarizing recent wind power studies, Devine-Wright (2005: 125) observed, "It is widely recognized that public acceptability often poses a barrier towards renewable energy development." Public attitudes toward wind power, therefore, are important to the expansion of the wind power industry.

In this paper, we use a national internet survey to investigate how much the public knows about wind power, how much the public supports wind power, and what characteristics of wind power the public regards as important.

Wind Power: A New Issue

A starting point for researchers seeking to understand the public's attitudes toward wind power is the fact that wind power is relatively new to most Americans. In some form, wind power has been with us for the nation's entire history, but as a means of large-scale electricity production, it dates back just over a decade, and it has only recently received much media attention. The news coverage of wind power in the *New York Times* over the last decade illustrates this point. In the late 1990s, wind power received only a handful of stories each year, but by 2008, readers saw almost one story a week on average (see figure 1). The growth of media coverage of wind power paralleled the growth of the industry. As the industry grew, more Americans could see wind farms

across the country. Still, the industry is new, and fifty news stories over the course of a year is not a strong basis for learning about a new issue.

[Figure 1 here]

One of the best established findings from decades of public opinion research is that the public is not well informed about most issues (Althaus 2003; Delli Carpini and Keeter 1996; Page and Shapiro 1996, 1999; Smith 1989). Most people have some knowledge about most issues, but relatively few people are truly well informed about any topic. A 2007 PEW study provides a good set of examples. According to the study, 76 percent of the public knew that the Democrats held a majority in the House of Representatives, 69 percent of the public could recall that Dick Cheney was Vice President, 66 could recall the name of their state's governor, 49 percent knew that Nancy Pelosi was the Speaker of the House of Representatives, and 37 percent knew that U.S. Supreme Court Chief Justice John Roberts is considered a conservative. Only ten percent of the survey's respondents could answer at least 20 of the 23 questions asking for basic facts about politics (PEW Research Center for the People and the Press 2007).

Because wind power is a new issue, and because the public typically has limited knowledge about even prominent, long-standing issues, we should expect that the public is poorly informed about wind power. Or to put it in context, we should expect the public to know less about wind power than, say, about an issue like nuclear power, which has been the subject of a great deal of attention and controversy for decades.

In addition, because wind power is new and not yet associated either major political party or an ideological camp, we should expect the public not to have well-developed partisan or ideological opinions about it. This expectation contrasts with findings about conventional sources of energy that have been the focus of political debate for decades. People's opinions about nuclear power, coal, and oil drilling either offshore or in the Arctic National Wildlife Refuge are strongly influenced by their party identifications and ideological views. Republicans and conservatives favor all these energy sources, while Democrats and conservatives oppose them (Michaud et al. 2008; Smith 2002).

In contrast to conventional energy sources, wind energy has been embraced (with varying degrees of enthusiasm) by both parties. In the 2004 and 2008 presidential campaigns, both the Democratic and Republican party platforms supported wind power (Democratic National Committee 2004, 2008; Republican National Committee 2004, 2008). In 2008, Barack Obama and John McCain spoke in favor of wind power. Although Obama advocated wind power far more forcefully than did McCain and some questions were raised about McCain's commitment to wind power, nothing that McCain said turned wind power into a partisan issue (Robertson 2008; Stein 2008). As a result, we should not expect to see the partisan and ideological divides in support for wind power that we see on conventional energy sources. These differences of opinion may develop over time, but we have not seen them yet.

Data

To examine public opinion about wind power, we used data from an internet survey conducted by the UC Santa Barbara Survey Research Center using a sample purchased from Survey Sampling International. The survey of 610 American adults was conducted June 18-23, 2008. Internet samples, of course, are not as representative of their target populations as telephone or face-to-face samples are (Berrens et al 2003; Malhotra and Krosnick 2007). Our sample is no exception. We can, however, say is that it is roughly representative. Our sample over-represents whites and under-represents blacks and Hispanics. In addition, it over-represents college graduates.¹ The age and gender differences between our sample and U.S. Census data, however, are trivial. Despite the fact that our sample is only roughly representative, we believe that it provides a good basis for describing public opinion toward wind power.

Public Knowledge about Wind Power

We begin our look at the data with an examination of how much people know about wind power. Our survey included following four knowledge questions about wind power (with the correct answers in bold font):

- Do you happen to know how much pollution wind turbines produce in comparison with fossil fuel power plants? [Answers: more pollution; the same amount of pollution; **less pollution**]
- Thinking about the financial cost of energy production, is the electricity produced by wind turbines cheaper, the same, or more expensive than electricity produced by other means such coal-fired power plants? [Answers: cheaper; the same; **more expensive**]
- In every wind turbine location, regardless of weather and climate, do wind turbines produce a steady stream of electricity? [Answers: yes; **no**]
- We hear people speak about “alternative energy” these days. When people talk about alternative energy, do they consider wind power to be one type of alternative energy? [Answers: **yes**; no]

The results, shown in table 1, initially suggest that the public is well-informed. Eighty-seven percent of our respondents know that wind turbines emit less pollution than fossil fuel power plants, which is a key argument in their favor. Yet only 18 percent realize that electricity generated from the wind is currently more expensive than power generated from coal-fired power plants. Because of the importance that many people assign to the price of electricity, which we discuss later in this paper, increasing knowledge about this aspect of wind power may reduce its popularity. A majority of our respondents know that turbines do not produce a steady flow of electricity despite changes in the weather.

¹ Our sample is 88% white, 4% black, and 6% Hispanic; the Census reports 81% white, 12% black, and 16% Hispanic. In our sample, 96% graduated from high school and 32% graduated from college. The Census reports that only 86% graduated from high school and only 28% graduated from college.

Finally, 80 percent of our sample correctly identified wind power as a type of alternative energy. Collectively, these four results suggest a public that is fairly well informed.

[Table 1 about here]

Further analysis of these data, however, indicate that the public is actually not well informed. The correlations among these four items, shown in table 2, are quite low, ranging from $-.09$ to $.21$. Three of the correlations are actually negative, indicating that respondents who get one answer right are likely to get the other answer wrong. Only two of the correlations are both positive and statistically significant. This pattern suggests that we are looking at a group of almost unrelated bits of stray information, rather than four items which reflect a single characteristic, knowledge about wind power.

[Table 2 about here]

To explore the relationships among these four knowledge questions further, we performed a principal components analysis. If the four items fit together so that we could use them to build a knowledge index, we would expect to see a single factor with high factor loadings. The results, shown in table 3, indicate something quite different. We find two factors with only modest factor loadings. The first factor seems to reflect positive beliefs about wind power, whether true or not. The two positive coefficients are for knowing that wind power does not pollute and that it is one type of alternative energy. The two negative coefficients are for incorrectly believing that wind power is not more expensive than fossil-fuel power and that wind turbines produce a steady stream of electricity regardless of weather. All of these things are positive characteristics of wind power, or would be if they were true. The second factor looks more like a conventional knowledge index. All of the loadings are positive, although two are fairly low. The inference we draw from these results is that many of our respondents answered the questions by guessing. If they liked wind power, they guessed that its characteristics were all positive—that is, they gave two correct and two incorrect answers in the pattern that we see in factor 1. This finding suggests a poorly informed public.

[Table 3 about here]

Finally, we note that if we were to combine these four items into an additive knowledge index, it would have a Cronbach's alpha of 0.10 , a level of reliability that is so low that the scale would be worthless.

The conclusion we draw from these data is that even though the items seem to have face validity, they do not reflect an underlying characteristic that we might call knowledge about wind power. To the contrary, the items seem to reflect wishful guessing by people who like wind energy, rather than real knowledge. The evidence suggests that the public is in the early stages of learning about wind power and still does not know very much.

To put these numbers in perspective, we can report the results of a five-item political knowledge index that was asked in the same survey. The questions were recommended by Delli Carpini and Keeter (1996), and they constitute what is probably the most

thoroughly tested and widely used political knowledge index in current use.² A principal component analysis of these items yielded a single factor with loadings ranging from 0.64 to 0.76. The Cronbach's alpha for the resulting scale was 0.74. These results are quite similar to those in the original Delli Carpini and Keeter study. From these data, we infer that the failure of the knowledge items to fit together coherently was not caused by the sample or the internet survey method; rather, it was caused by the public's confusion about wind power.

Public Support for Wind Power

We now turn to an examination of the sources of public support for wind power. We will explore the question in two ways. First, we will seek to discover what advantages and disadvantages of wind power people regard as important. Second, we will seek to discover why people favor or oppose wind power using both our series of questions about the advantages and disadvantages of wind power and additional questions about our respondents' background characteristics.

Our survey included a series of eleven questions asking people how important they thought various wind energy characteristics were. The list of characteristics was developed based on our review of wind farm siting controversies. That is, the items on our list were all offered as reasons why a wind farm should or should not be built. The response options were very important, somewhat important, not too important, and not important at all. The statements were:

- Producing more energy from wind reduces the amount of energy we need to import from foreign sources
- Wind farms increase tourism in local communities
- Wind turbines release no greenhouse gases, such as carbon dioxide, and help us fight global warming
- Wind power projects are a symbol of local, state and federal commitment to renewable energy
- Wind turbines release no air pollution, such as mercury, unlike other energy sources such as coal

² The questions are: (1) Do you happen to know what job or political office is now held by Dick Cheney? (2) Whose responsibility is it to determine if a law is constitutional or not . . . is it the president, the Congress, or the Supreme Court? (3) How much of a majority is required for the U.S. Senate and House to override a presidential veto? (4) Do you happen to know which party has the most members in the House of Representatives right now? (5) Would you say that one of the parties is more conservative than the other at the national level? Which party is more conservative?

- Wind turbine blades kill thousands of migratory birds and harm wildlife while they produce electricity
- Wind turbines are noisy, which bothers the people who live near them
- Wind power projects often include government giveaways of public lands to private wind farm developers
- Some people believe that wind turbines are ugly and spoil the scenery
- Wind turbines may lower local property values, harming local homeowners
- Wind energy is still more expensive than electricity produced by other sources such as coal

Most respondents saw the advantages of wind power as being more important than the disadvantages (see figure 2). Between 64 and 81 percent of the respondents saw four of the advantages as very important. Increasing tourism was the only advantage that a majority of respondents did not see as important. In contrast, the most important disadvantage of wind power according to our respondents is that “wind power is more expensive than electricity produced by other sources such as coal.” However, only 31 percent held such a view. Our respondents saw the other disadvantages as being even less important.

[Figure 2 about here]

To develop a better understanding of the sources of support for wind power, we estimated a set of regression equations using two different measures of support. Our survey opened with a series of questions about support for seven different types of energy production, including wind power. The order of questions in the list was randomized so that wind power did not stand out. This is typical for questions about energy policy. The specific question was:

We would like to begin by asking you a series of questions about different sources of energy we can develop in the United States to meet our future needs. How strongly do you favor increasing U.S. production of each of the following energy sources? Oil, natural gas, coal, wind power, solar power, nuclear power plants, hydroelectric power dams. [Answers: Strongly favor, somewhat favor, undecided, somewhat oppose, strongly oppose]

Following the opening sequence of questions, respondents were asked four knowledge questions about wind power and then asked about the advantages and disadvantages of wind power. (These are the questions discussed earlier on in this paper.) Finally, respondents were asked to reconsider their opinions about wind power:

Now that you have had a chance to consider some of the advantages and disadvantages of wind power, we would like to ask you to rethink your opinion on wind power. How strongly do you favor increasing U.S. production of wind power?

This series of questions gives us two measures of support for wind power—an initial measure before respondents are peppered with questions about the topic, and a later question posed after they have been thinking about various aspects of the issue.

Our purpose in asking the question about wind power twice was to see how opinions changed when respondents considered the issue more carefully. Our series of knowledge and positive-negative characteristic questions brought up aspects of wind power that respondents might not have thought about when they answered the first question. We regard the responses to the second question, therefore, as being the products of more deliberative thought. We should add that we also believe that the answers to the second wind power support question may be more representative of communities in which wind farms have been proposed or built and in which the local news media have covered wind power more frequently than the national media have. Consequently, we believe that the two wind power support questions both merit examination. (We address the issue of how individual respondents changed their opinions from the first to the second wind power support question and the topic of *nimbyism* in a separate paper [Smith and Klick 2008]).

As figure 3 shows, support for wind power fell significantly after respondents answered our series of questions. Seventy-three percent expressed strong support when the question was first asked, but only 53 percent said they strongly supported wind power after the questions about knowledge, advantages, and disadvantages. Although the combined percentage of respondents who said they supported wind energy strongly or somewhat was still high, at 84 percent, these data indicate that people's opinions can change when they consider more facts about wind power.

[Figure 3 about here]

Multivariate Analysis. In our first pair of regression equations, we used our questions about the advantages and disadvantages of wind power to explain support for increasing production of energy from wind farms. The results are presented in table 4.³ In the model explaining initial support, four coefficients have statistically significant effects, all in the expected direction. As the importance of the facts that wind energy reduces imported energy, emits no greenhouse gases, and is a symbol of renewable energy increases, support for producing more wind power increases. On the opposite side, as the importance of the fact that wind turbines are noisy increases, support for wind energy falls. In the model explaining support after respondents answered our series of wind power questions, the results change in critical ways. That wind power reduces the need

³ Because only four of our respondents did not answer one or more of the questions used in the regression models in table 4, we use listwise deletion of missing data. The regression models presented in table 5 were estimated using multiple imputation of missing data (Rubin 1987, 1996) because of missing data among the demographic questions. The results of models using listwise deletion are substantively the same as the results in table 5.

to import energy and that it is a symbol of renewable energy remain significant causes of support. However, concern over greenhouse gases and noise are replaced by concerns over three other aspects of wind power, one of which is positive and the other two negative. In our second equation, the fact that wind turbines emit no pollution raises support for wind power. Concerns about the expense of wind power and its effects on property values both cause support for wind energy to decline.

[Table 4 about here]

Our interpretation of these findings is that people gave quick, probably superficial responses to the initial wind power question, but they give more thoughtful responses to the later question because it follows a series of questions that bring up positive and negative characteristics of wind power. In more concrete terms, we suspect that our respondents' high level of initial support was reduced because our questions pointed out that wind power is more expensive than power from other sources and that wind farms might affect property values. These concerns reduced the initial concerns with greenhouse gases and noise.

We also note that the explanatory power of the equation explaining the initial wind power support question was greater than that of the second wind power support question. That is, the adjusted R^2 for the first equation was 0.38, but the R^2 for the second equation was 0.25. Calling the respondents' attention to various characteristics of wind power made their responses less predictable.

To gain further insights into people's attitudes toward wind power, we estimated two more regression equations, shown in table 5, in which we added a set of demographic and identity variables. (See the appendix for details on coding.) All of these variables have been used in previous studies to explain attitudes on environmental issues (Dunlap and Van Liere 1978; Guber 2003; Jones and Dunlap 1992; Michaud et al. 2008; Smith 2002).

[Table 5 about here]

The addition of the demographic and identity variables had no effect on the coefficients for the importance of the various advantages and disadvantages of wind power. The numbers changed slightly, but the changes were trivial.

Few of the new variables had significant impacts on support for wind power. In the model explaining responses to the initial question, older respondents were more likely to favor wind power. Race also had an effect. Blacks were less likely than whites (the omitted baseline category) to support wind power, while Asians were more likely. People who said they were Christians, but not evangelical were also more likely to favor wind power. In the model explaining the later question, age no longer has an effect, but a gender gap appeared, with women being less likely to support wind power. The effects of being black or Asian dropped out, but people who said checked the "other" race category were more supportive of wind power than whites. There were also some other small effects of borderline significance.

A key finding in table 5 is that party identification had no effect at all, and ideology only had an effect of borderline significance ($p < .09$) in the second question. These regression coefficients match the simple correlation coefficients among the items. Party identification is not related to either of the two wind support questions ($R = -.04$, n.s. for both relationships) and ideology is not related to the initial wind question ($R = -.02$, n.s.) and is only weakly related to the second ($R = -.11$, $p < .02$).

These results are in sharp contrast to the results from previous studies of other, established environmental issues. Party identification and ideology are well known causes of environmental opinions. Democrats and liberals typically favor environmental positions, while Republicans and conservatives generally oppose them (Dunlap and Van Liere 1978; Guber 2003; Jones and Dunlap 1992; Michaud et al. 2008; Smith 2002).

Discussion

The picture that emerges from our data is one of a public that is still working out what it thinks about wind energy. The public's current view of wind power is very positive. However, two considerations raise the possibility that the public's strong support for wind energy may fade away.

First, the public's understanding of the issues is relatively weak. The pattern of responses we received to our knowledge questions seemed to reflect wishful guessing. People who supported wind energy said that all of its characteristics were positive, even though in two cases that was not true. Perhaps more worrisome, only 18 percent of our respondents knew that electricity generated from wind farms is more expensive than electricity generated from conventional sources such as coal-fired power plants. When the public learns that not all aspects of wind power are positive, their support may decline.

Second, the public is receiving positive messages about wind energy from both major political parties. This presumably explains why we are not finding partisan or ideological differences in support for wind energy, which are typical for conventional energy sources. If some major political leaders began to oppose wind energy on the grounds of its cost or other characteristics, we may see attitudes toward wind power become more partisan and ideological, which would cause support for wind power to decline.

Public support for wind energy is critical for the growth of the wind industry. Without public support, Congress may deny the industry the subsidies it requires during its startup years. Without public support in communities across the country, the industry's ability to build wind farms where it needs them may be hindered. How the public's views about wind power will change in the future remains to be seen.

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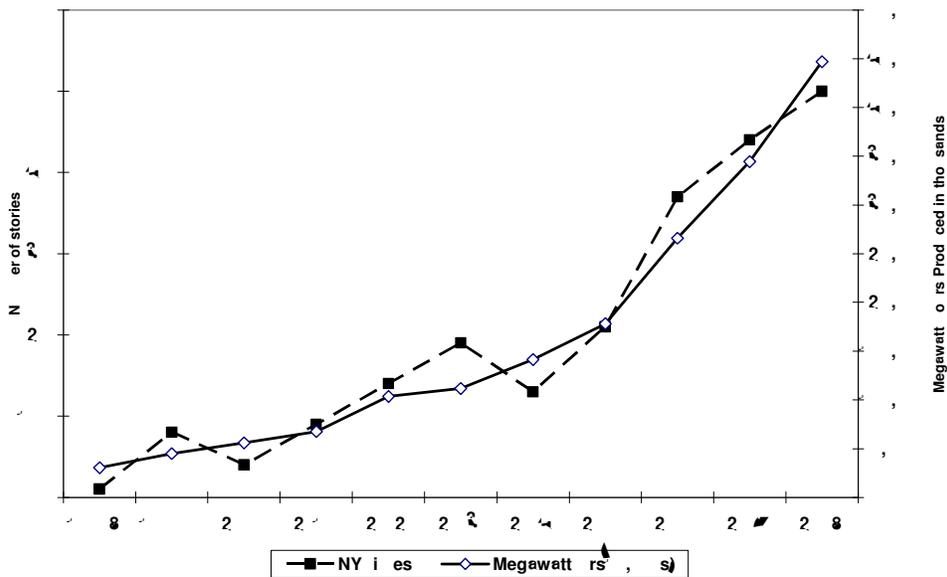
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Figure 1. The Growth of Wind Power and Media Coverage of Wind Power



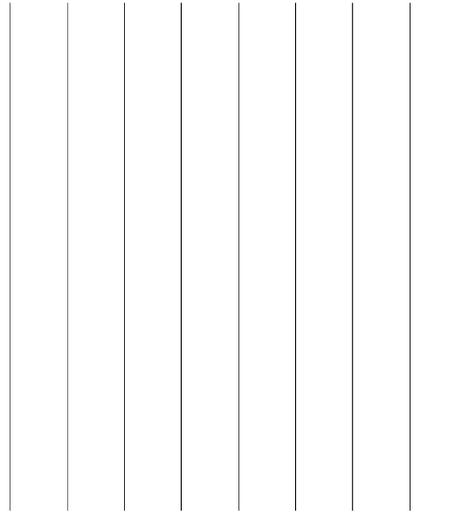


Figure 2: Support for Wind Power, Pre- and Post-treatment

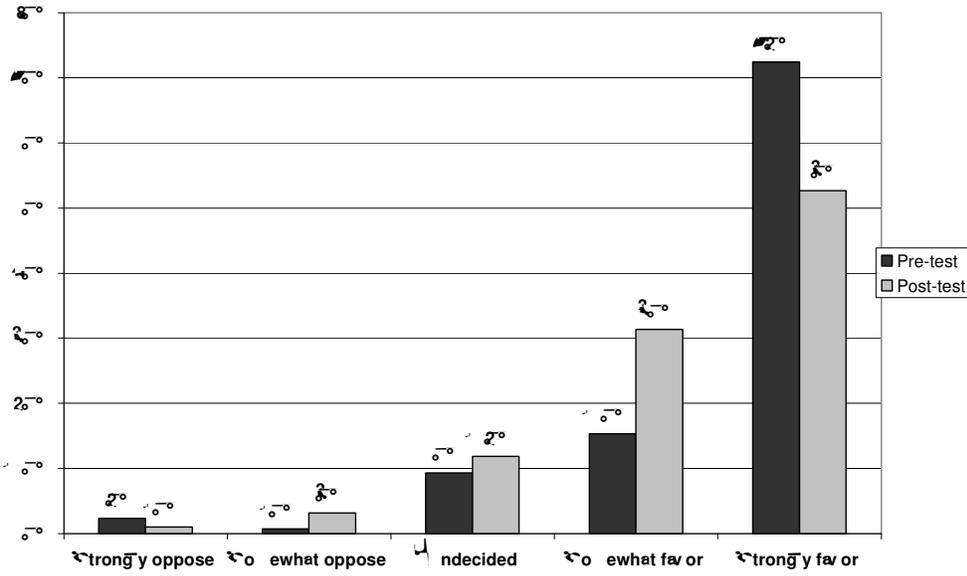


Table 1: Knowledge about Wind Power

	Percent Correct	
	Count	Percentage
Wind turbines pollute less	87	60.1
Wind electricity costs more	18	59.8
Electricity from wind is not stable	59	60.0
Wind is alternative energy	80	59.6

Table 2: Pearson Correlations among Knowledge Questions

	Position Low	Price High	Steady Flow
	Wind electricity costs more	-0.1*	
Electricity from wind is not stable	0.04	0.16**	
Wind is alternative energy	0.21**	-0.06	-0.08*

**p < .001
 * p < .05
 Minimum n = 593
 Note: Items scored 1=correct; 0=incorrect

a-2. Principal Component Analysis of independent Questions

	Factor	Factor2
ind turbines pōtēss	0.60	0.56
ind electricity costs ore	-0.56	0.44
Electricity Tow is not staē	-0.42	0.70
ind is āternatīve energy	0.67	0.32
Eigen vā e	1.30	1.09
Varān	596	

a-4. Regression Models Estimating Support for Wind Power

	Initial Question		Later Question	
		se		se
<i>Wind turbines:</i>				
Red ce i ported energy	2 ***	0.07	2 ***	0.07
Increase to ris	-0.01	0.03	-0.01	0.03
E it no greenho se gas	0.2 ***	0.07	0.07	0.07
Varān of renewāes	0.05 ***	0.05	0.08 **	0.06
E it no pōtion	0.04	0.08	0.02 **	0.09
T irds	-0.06	0.04	-0.03	0.04
Noisy	-0.04 ***	0.04	-0.06	0.05
Gov t giv eaways	0.03	0.04	0.02	0.04
Varān, spōt scenery	-0.06	0.04	-0.03	0.04
Lower property vā es	-0.02	0.04	-0.02 ***	0.04
More e pensīve	0.02	0.04	-0.02 ***	0.04
Constant	0.23 ***	0.23	0.26 ***	0.26
Adjusted R-square	0.38		0.25	
Sample n	606		606	

* p < .10; ** p < .05; *** p < .01

Table 1. Regression Models Estimating Support for Wind Power

	Initial Question		Later Question	
Wind turbines:		s.e.		s.e.
Red ceiling on energy	2.2***	0.07	2.2***	0.07
Increase to risk	.01	0.04	.01	0.04
Eliminate greenhouse gas	2.8***	0.07	.07	0.07
Quantity of renewables	1.8***	0.05	1.8***	0.06
Eliminate production	.05	0.08	2.2**	0.09
Tires	-.06	0.04	-.01	0.04
Noisy	-.1**	0.04	-.08	0.05
Go to highways	.01	0.04	.02	0.04
Ugly, spoils scenery	-.1**	0.04	-.05	0.04
Lower property values	-.0	0.04	-.2***	0.04
More expensive	.05	0.04	-.4***	0.04
Age	-.4**	0.02	0.01	0.02
Education	0.01	0.02	.3*	0.02
Female	-0.08	0.06	-.2***	0.07
Black	-.2***	0.14	0.03	0.15
Asian	2*	0.15	-0.02	0.17
Other Race	0.26	0.2	1.2**	0.20
Hispanic	-0.11	0.15	0.08	0.15
Evangelical	-0.10	0.13	0.22	0.14
Christian	2**	0.1	0.01	0.11
Catholic	0.04	0.08	-.4*	0.08
Jewish	-10	0.19	0.21	0.18
Atheist	0.04	0.09	0.05	0.09
Knowledge index	0.03	0.02	-0.02	0.02
Ideology (conservative)	0.01	0.04	-.1*	0.05
Party (Dem/Rep/Other)	-0.01	0.02	0.02	0.02
Constant	0.31	0.31	1.7	0.30
Adjusted R-square	0.39		0.29	
Sample n	610		610	

* p < .10; ** p < .05; *** p < .01

Deleted: ¶