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A Survey of Public Attitudes towards Climate Change and Climate Change Mitigation Technologies in the United States: Analyses of 2006 Results

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Executive Summary

In 2006, MIT sponsored a survey of the U.S. public to measure attitudes toward and understanding of climate change and climate change mitigation technologies. The survey was a nearly identical follow-up to one sponsored by MIT in the U.S. in 2003 and sponsored by collaborators in the United Kingdom, Sweden, and Japan in the intervening years.

This paper presents the results of our analyses of changes in U.S. public opinion from 2003 to 2006 and correlations between demographic information and responses to questions. We found that a sizable majority recognized global warming as a problem in 2006, and the willingness to pay for remedies increased 50 percent from 2003 to 2006. Further, we found that willingness to pay to solve global warming increased with concern about global warming.

We did not find strong correlations between political affiliation and willingness to pay to solve global warming. However, we found that a more conservative ideology correlated with a lower willingness to pay in 2006. We found that a greater percentage of Democrats ranked global warming as their top environmental concern than did Republicans, and that Democrats were more supportive of immediate action to address global warming.

The potential for regional differences is often a part of the global warming debate. In 2006, region of the country was not a significant indicator of concern about global warming or willingness to pay. In both 2003 and 2006, we found a weak correlation between living in the Northeast and support for more immediate action to address global warming.

We did not find a change in understanding of the underlying causes of global warming or the technologies to address global warming from 2003 to 2006. However, we found that this type of knowledge increased willingness to pay to address global warming in the 2006 survey.

I. Introduction

Any attempt by industry or government to address greenhouse gas emissions and global warming will require public understanding or recognition of the problem and willingness to bear the costs of remedies. With that in mind, MIT has instituted a cross-national survey research program with partners in the United Kingdom, Sweden, and Japan. The program is aimed at tracking public understanding of this problem and support for and opposition to policies that may be required in order to lessen emissions.

We conducted the first of these surveys in 2003 in the United States. It showed a relatively low level of public recognition of the problem and low willingness to bear costs of a remedy. Collaborators replicated that survey in the United Kingdom, Sweden, and Japan. Across all four nations, we found varying degrees of acceptance of the problem and varying beliefs about what national government would do. We did find a unified response in one critical aspect – willingness to pay. In no country was the median person willing to pay 10 percent more a month on electricity bills in order to lower carbon emissions (Reiner et al. 2006).

In September 2006, we replicated the 2003 U.S. survey using the same survey design and questionnaire we administered three years ago. We released the results of the 2006 survey at the Carbon Sequestration Initiative Forum on October 31, 2006. The results are available in Appendix B of this paper and are available for download with a press release from MIT's Carbon Capture & Sequestration Technologies website.[1] Additional information on energy-related surveys at MIT is available from the Public Opinion Research Training Lab.[2]

While little changed in U.S. federal policies concerning global warming from 2003 to 2006, there was considerable public discussion of the problem. Comparing the 2003 results with the 2006 results suggests a real change in public attitudes in two key respects:

- A sizable majority now recognizes global warming as a problem; and
- the willingness to pay for remedies has risen 50 percent.

However, as the American public increased its recognition of global warming as a problem and increased its willingness to pay to address that problem, awareness of the portfolio of solutions to that problem appears unchanged. Recognition of the technologies to address global warming and understanding of the sources of carbon dioxide did not change over the three years.

This paper explores the data collected from the September 2006 survey, looking for relationships that enhance our understanding of public opinion and looking for trends to inform the development of future surveys. In this paper, we highlight changes in public

[1] http://sequestration.mit.edu
[2] http://web.mit.edu/polisci/portl/

opinion from 2003 to 2006 and explore correlations between demographic information and responses to questions.

Appendix C includes details of some of the multiple regression analyses performed during this review. We used multiple regression to analyze the simultaneous impact of a number of independent variables (demographic characteristics or responses to questions) on responses to particular questions. For example, we used multiple regression to look at the impact of a number of demographic variables on willingness to pay to solve global warming. By doing this, we were able to conclude that as concern over global warming increases, willingness to pay also increases. Further, this trend exists while controlling for age, income, geographic location, political ideology, and other demographic variables.

When discussing the regressions in the text, we only discuss the significant variables (i.e., those that impact the dependent variable). For details on the other independent variables, see Appendix C.

After briefly summarizing the survey methodology, this paper includes analyses of the survey responses. It builds from demographic information and general questions about the environment and global warming to questions that measure willingness to pay to solve global warming, support for a carbon dioxide tax, and the impact of information on technology choice.

II. Survey Methodology

MIT and Knowledge Networks first conducted the survey from September 24 to October 13, 2003 using an Internet-based survey instrument. MIT and Knowledge Networks repeated the survey using the same survey instrument but a different sample population from September 8 to September 25, 2006. Both surveys used a national sample representative of the general population of the United States. Knowledge Networks drew the samples from a membership panel they maintain, and provided free hardware and Internet access to households that needed it (40 percent of respondents).

To correct for known deviations from the general population, Knowledge Networks develops sample weights. The data included in this report are appropriately weighted.

In 2003, 1,205 out of 1,710 panelists completed the survey, a 70 percent response rate. In 2006, 1,236 out of 1,596 panelists completed the survey, a 77 percent response rate. Both surveys had a margin of error of +/- 3 percent.

In 2006, 48 percent of respondents were male, 22 percent were over the age of 60, 26 percent had at least a Bachelor's degree, and 10 percent had a household income of $100,000 or greater. Appendix A includes additional demographic information.

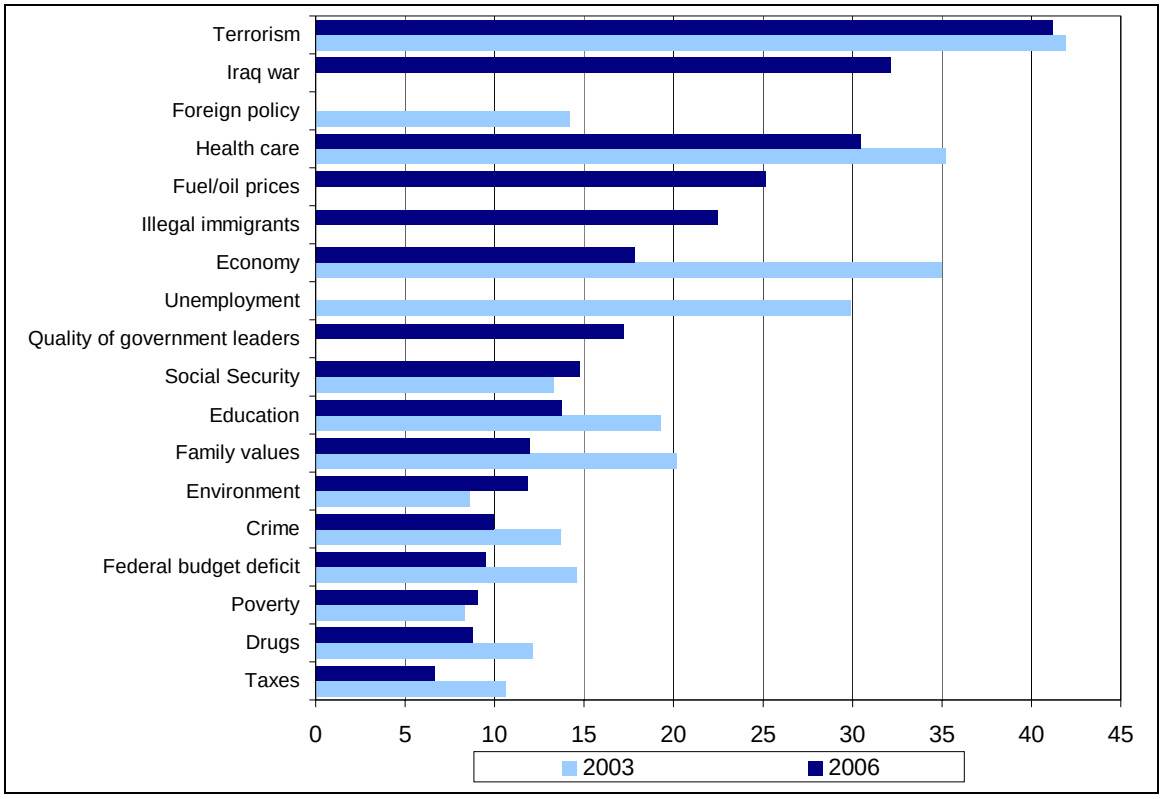
For a full discussion of the 2003 survey, including demographic information, see Curry 2004.

III. Public Attitudes Toward Environmental Issues

To measure the relative importance of the environment to other national issues, we asked participants to choose the three most important issues from a list of 22. Eighteen of the issues were consistent between surveys with four issues (foreign policy, stock market, unemployment, and welfare) specific to the 2003 survey and four issues (quality of government leaders, illegal immigrants, fuel/oil prices, and Iraq war) specific to the 2006 survey.

Figure 1 summarizes the responses. Throughout this paper, the lighter colored bars represent the 2003 responses. Note that Figure 1 does not include issues receiving support from five percent or less of the respondents.

Figure 1. Most Important Problems Facing the U.S.
(Percent choosing issue in the top three)



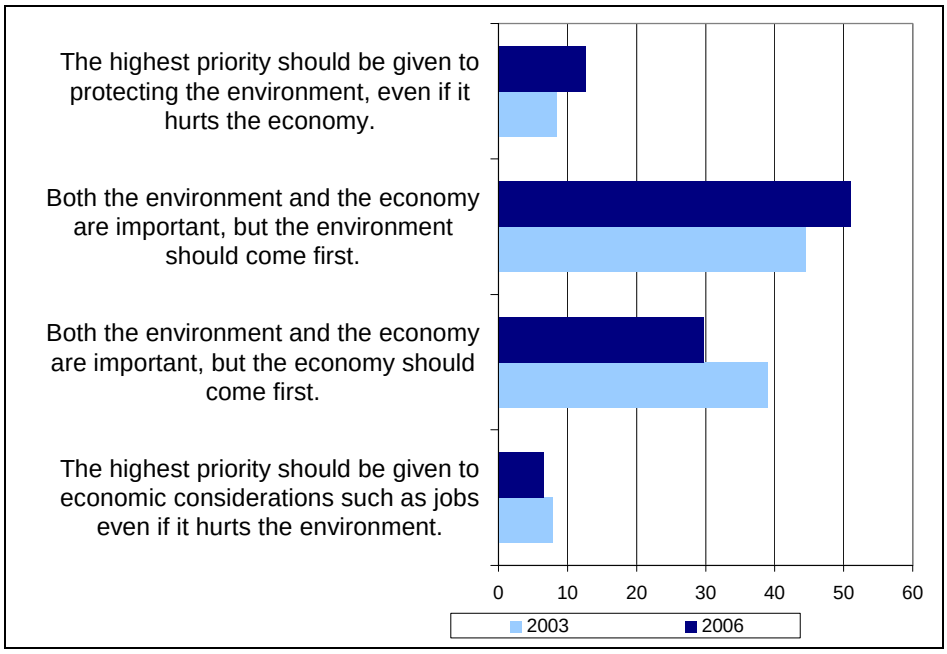
The American public's top concern in both 2003 and 2006 was terrorism, followed in 2006 by concern about the war in Iraq. Concern about the environment grew between 2003 and 2006 but it continued to rank in the middle of the 22 issues. It ranked 13 in 2003 and 11 in 2006.

Environmental issues are often framed as being a tradeoff between the economy and the environment. Looking at Figure 1, it appears the economy holds an edge on the environment. In both surveys, a greater percentage of Americans ranked the economy among the top three problems facing the U.S. than ranked the environment among the top

three problems. The economy remained a higher concern in 2006 even though the percentage choosing the economy dropped by half from 2003 to 2006.

However, when asked directly about tradeoffs between the economy and the environment, 64 percent of respondents prioritized the environment in 2006 and 53 percent prioritized the environment in 2003. Figure 2 summarizes the responses.

Figure 2. Tradeoffs Between the Economy and the Environment (Percent choosing each response)



The growth in preference for the environment came in the middle with a nine-percentage point drop in preference for this statement:

> "Both the environment and the economy are important, but the economy should come first."

And a six-percentage point increase in those choosing this statement:

> "Both the environment and the economy are important, but the environment should come first."

Our analysis of the data suggests that ranking the environment as one of the top three issues facing the U.S. does not correlate with preference for the environment over the economy in the tradeoff question. In 2006, however, there was a correlation between identifying with a more conservative ideology and a preference for the economy.[3] In both 2003 and 2006, there was a correlation between those identifying with the Republican Party and a preference for the economy.

[3] Ideological information was not collected in 2003.

To explore the relative importance of environmental issues, we asked participants to choose the two most important environmental problems from a list of ten environmental problems. Between 2003 and 2006, there was a dramatic shift in public concern about global warming. The percent of the American public ranking global warming as the top environmental problem tripled over the last three years.

In 2003, global warming ranked sixth on a list of ten environmental problems. In 2006, global warming was the number one environmental concern. More than one in three chose global warming as the nation's top environmental priority from a list of ten key environmental problems. In 2003, about 10 percent of the public felt that global warming was the primary environmental problem facing the country. It lagged behind water pollution, destruction of ecosystems, toxic waste, overpopulation, and ozone depletion. Table 1 summarizes the results.

Table 1. Most Important Environmental Problem Facing the United States

Environmental Problem	2003			2006		
	Top Problem	Second Problem	Total	Top Problem	Second Problem	Total
Global warming	11%	10%	21%	34%	15%	49%
Destruction of ecosystems	16%	15%	31%	13%	19%	32%
Water pollution	17%	22%	39%	12%	14%	25%
Overpopulation	15%	8%	24%	13%	10%	23%
Toxic Waste	14%	17%	30%	10%	13%	22%
Ozone depletion	11%	11%	22%	7%	15%	22%
Urban sprawl	8%	8%	16%	7%	7%	13%
Smog	5%	6%	11%	3%	4%	7%
Endangered species	2%	2%	4%	1%	2%	3%
Acid rain	1%	1%	1%	0%	2%	2%

Concern over global warming grew in both political parties, although about twice as many Democrats as Republicans ranked global warming as the top concern in both 2003 and 2006 as shown in Table 2.

Table 2. Percent Ranking Global Warming as the Top Environmental Concern by Party

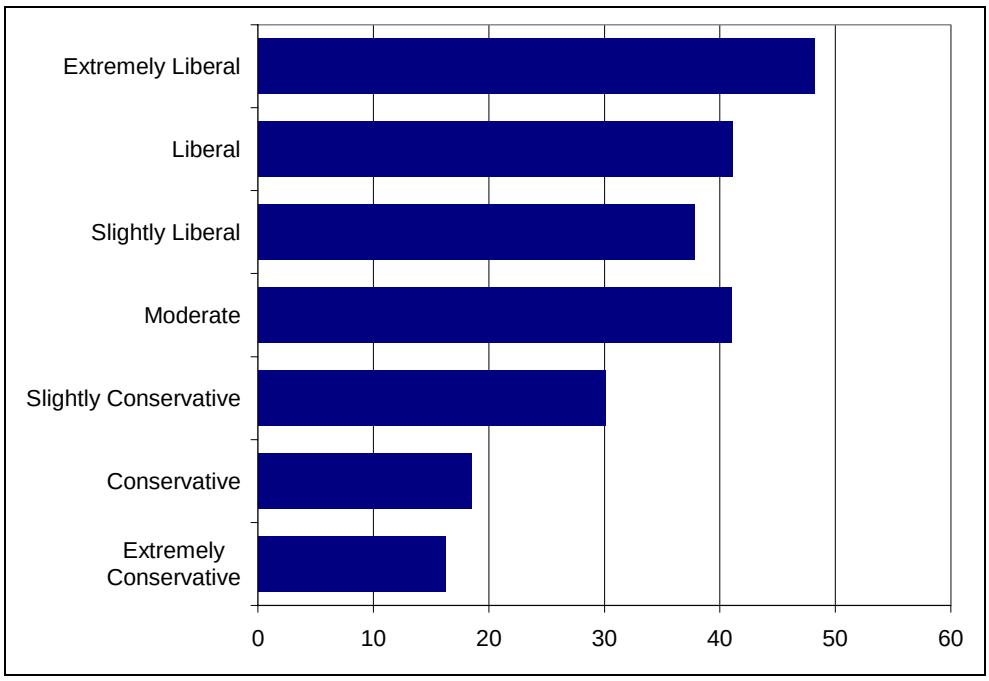
Party	2003	2006
Democrats	14% (n=391)	43% (n=450)
Republicans	6% (n=305)	22% (n=287)
Other	13% (n=484)	33% (n=475)

Unlike the 2003 survey, the 2006 survey included information about ideology. As shown in Figure 3, those who identified themselves as liberal were more likely to rank global warming as one of the top two environmental concerns as opposed to those who

identified themselves as more conservative. Of importance for the developing political debate, those who identified themselves a moderate were in closer agreement with the liberal faction than the conservative faction about the importance of global warming.

Concern about global warming is sometimes framed as a regional debate as well as a political debate. However, we found that regional differences were not significant after we controlled for ideology.

Figure 3. Percent Ranking Global Warming as the Top Environmental Concern by Ideology

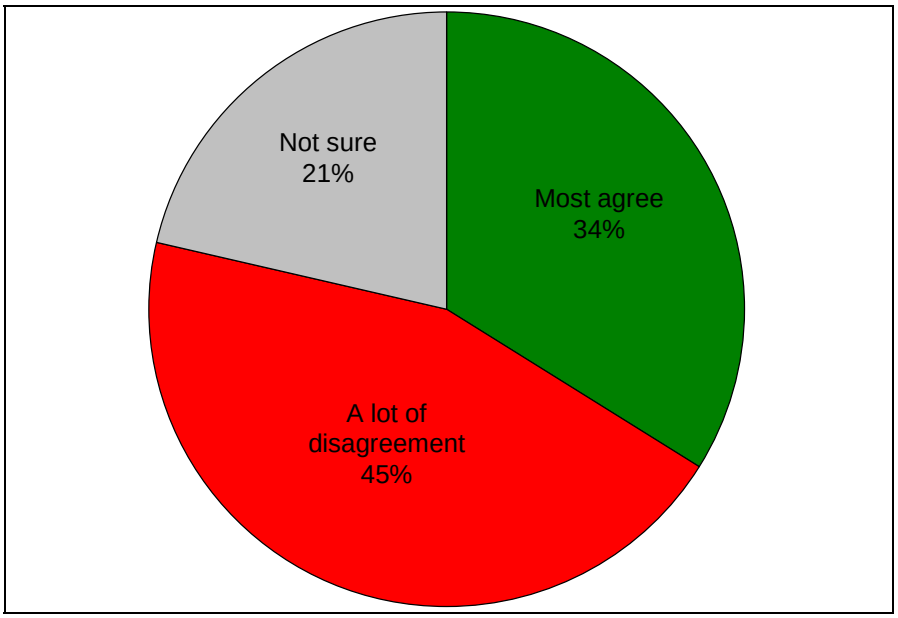


IV. Public Understanding of Global Warming

To get a clearer picture of public understanding of global warming, we added a question to the 2006 survey asking for views on the degree of scientific consensus about global warming.

As shown in Figure 4, 45 percent of respondents chose "a lot of disagreement" to characterize whether most scientists agree with one another about global warming.

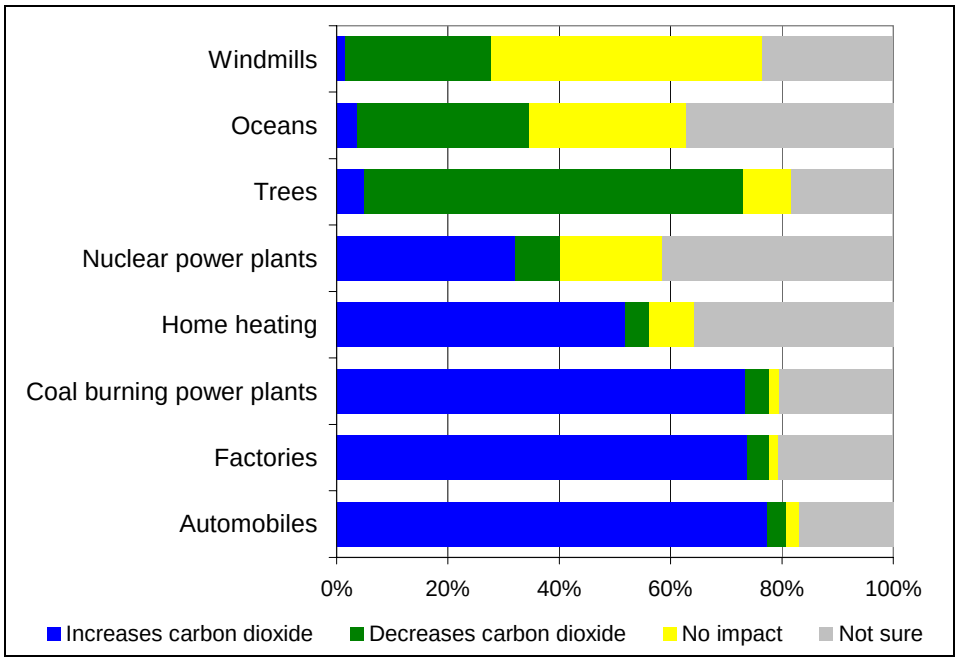
Figure 4. Characterization of the Level of Scientific Agreement About Global Warming



Regression A in Appendix C examines the influence of demographic variables on the belief that most scientists agree. Four variables correlated with belief in scientific agreement: political party affiliation, frequency of religious service attendance, knowledge about sources of sinks of carbon dioxide, and having heard of global warming-related technologies. Those more strongly affiliated with the Democratic Party; those who attend religious services less frequently; those who better understood sources and sink of carbon dioxide (based on responses to the question discussed below); and those who have heard or read about more global warming-related technologies (based on responses to a question discussed in Section V) were more likely to believe scientists agree about global warming.

To probe public understanding of the science behind global warming, we provided a list of technologies and natural resources and asked the public which emitted carbon, absorbed carbon, or were relatively neutral. Figure 5 lists the technologies and resources with the responses for 2006. The responses in 2003 were very similar to 2006.

Figure 5. Opinion about the Impact of Technologies or Resources on Carbon Dioxide (2006 responses)



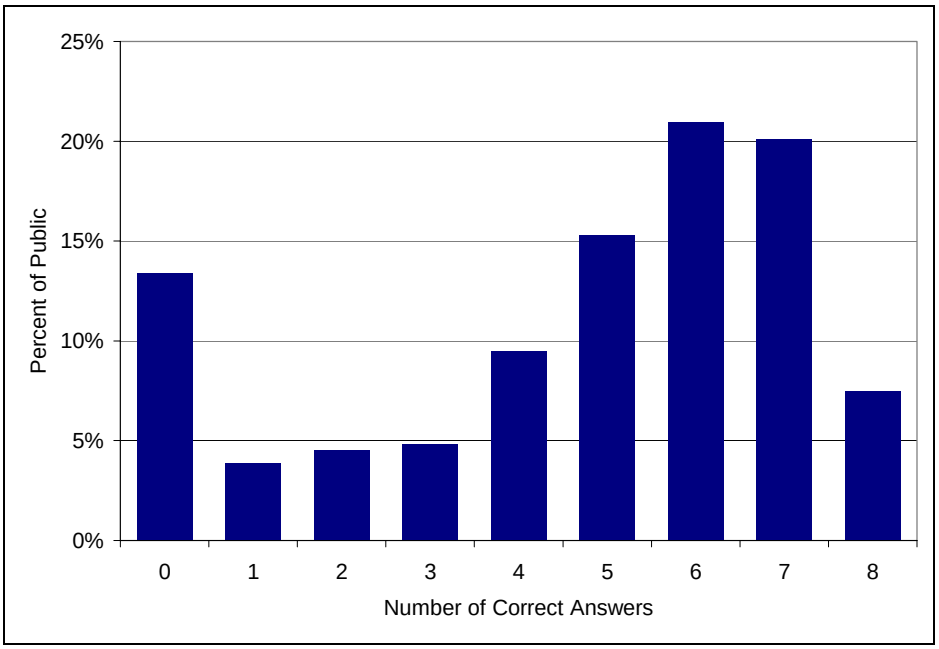
In 2006, as in 2003, the public generally understood that automobiles, coal burning power plants, and factories are sources of CO2. They were less certain about home heating being a source of CO_2. Notably, the public was uncertain about nuclear power plants and oceans.

In both 2003 and 2006, the average respondent answered just over half of the questions correctly. The number of correct answers provides a crude marker of knowledge about CO_2 (or pollution) sources. The analysis of willingness to pay discussed later in this document finds that the number of correct responses correlated with an increased willingness to pay to solve global warming in 2006 and a marginal increased willingness to pay in 2003. As discussed above, more correct responses correlated with an increased belief that scientists agree about global warming.

Figure 6 shows the distribution of the number of correct answers in 2006. Note that the "zero" column includes those who answered they were not sure for all technologies (a response of "not sure" is technically correct but was marked incorrect for this analysis because it suggests an uncertainty about sources of carbon dioxide – the metric of interest).

The mean number of correct answers in 2006 (4.7) was almost identical to the mean number of correct answers in 2003 (4.6), suggesting no change in understanding of sources and sinks of CO_2.

Figure 6. Distribution of Correct Answer to the 2006 Survey

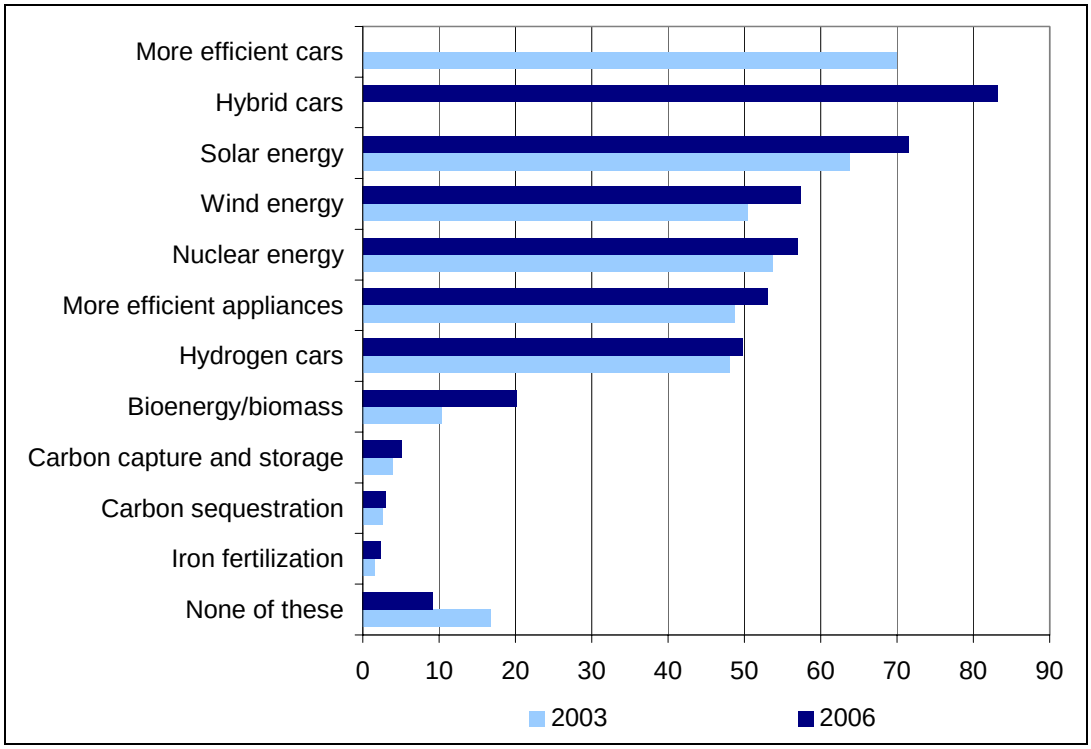


One of the potential biases of this question is that respondents may associate CO_2 with a general notion of pollution. The respondents may not know what CO_2 is (and that it is different from other forms of pollution) or may not make the connection between CO_2 and global climate change. It is possible that the public was responding to a general idea of air pollution when saying that automobiles, factories, and coal burning power plants increase the amount of carbon dioxide. For a full discussion of this question, see Curry 2004.

V. Public Understanding of Carbon Dioxide Capture and Storage

A key area of interest for the MIT Carbon Sequestration Initiative is public awareness of the technologies to address global warming. We are particularly interested in public awareness and understanding of carbon dioxide capture and storage (CCS). To that end, the survey included questions asking whether participants had heard or read about a list of energy and environmental technologies in the year prior to the survey. Figure 7 lists the technologies along with the percent of the public that has heard of each technology.

Figure 7. Percent Who Have Heard of or Read about Technologies in the Past Year



Importantly for MIT's research interests in this area, almost no one had heard of CCS or carbon sequestration. Even biofuels were relatively unknown, though their salience rose. Ten percent of the public reported hearing about such fuels in 2003 compared to 20 percent in 2006. More than fifty percent of the public reported that they had heard about hybrid cars, renewable technologies (solar and wind energy), nuclear power, and more efficient appliances in 2006.

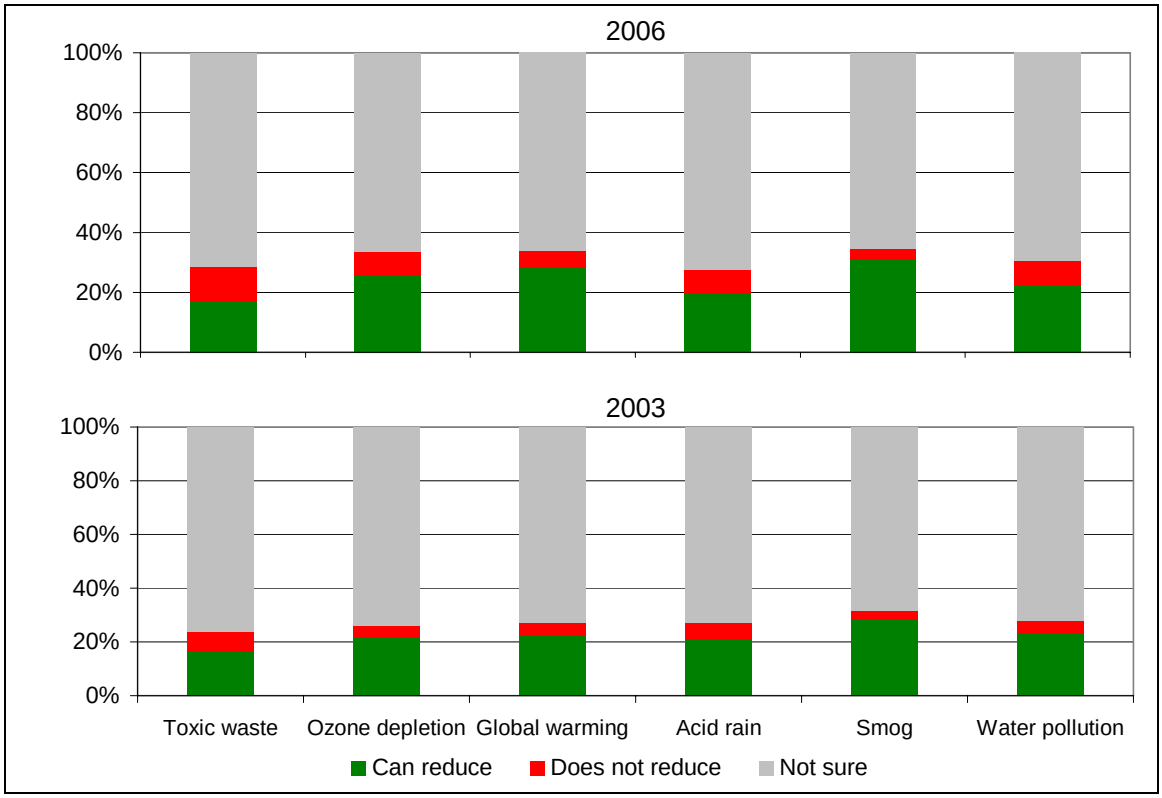
The percentage of the American public who reported hearing of none of the ten technologies in 2006 was about half of what it was in 2003. However, the 2006 survey included "hybrid cars" in place of "more efficient cars" and more respondents had heard of hybrid cars in 2006 than any technology in the 2003 list.

To explore knowledge of CCS, we asked respondents to identify the environmental problem that CCS addressed. As expected, given that four percent reporting hearing of CCS in 2003 and 5 percent reported hearing of CCS in 2006, a majority (60 percent) of

respondents reported that they were "not sure" across all the environmental problems. Given the lack of familiarity with CCS, one could argue that the number of respondents selecting "not sure" across all of the responses should have been higher.

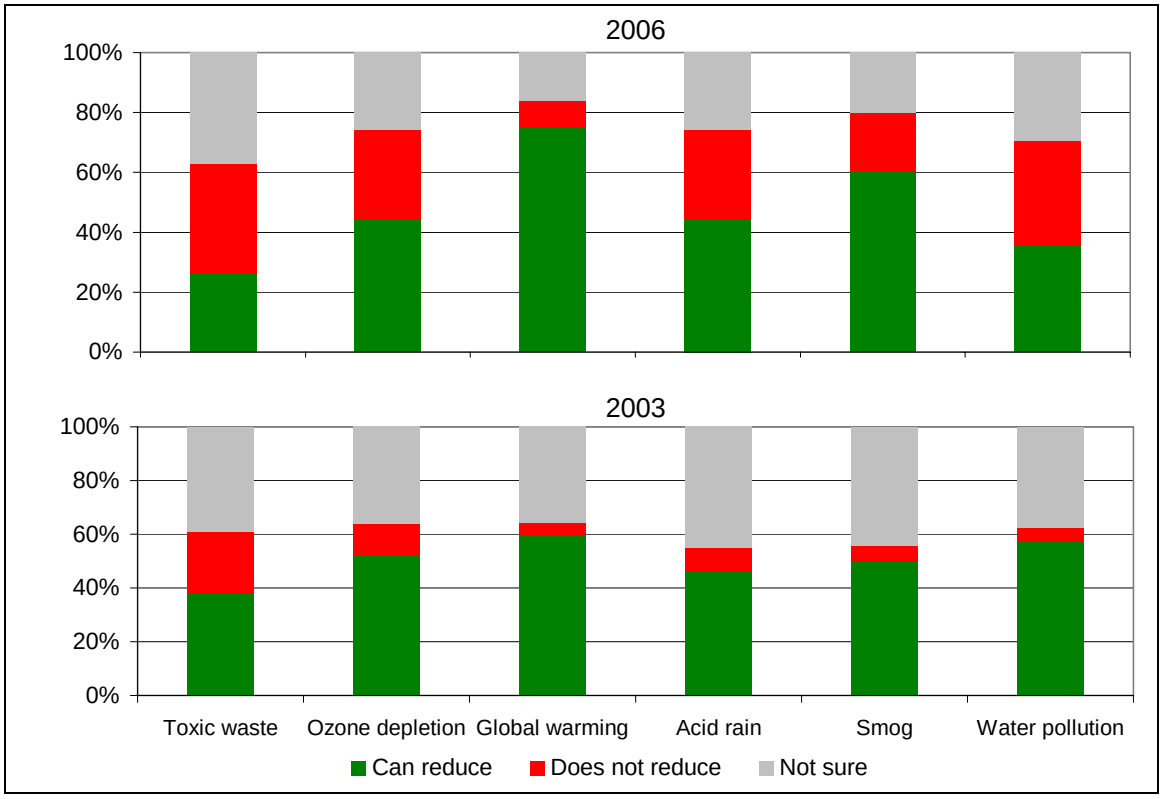
Figure 8 shows the results for 2003 and 2006. No public consensus emerged on the environmental problem CCS is intended to address.

Figure 8. Identification of the Environmental Problem CCS Addresses



Looking only at the group who reported hearing of CCS or carbon sequestration, it appears that understanding of what environmental problem the technology addresses is trending towards global warming. Figure 9 shows the responses for the group that reported hearing of CCS or carbon sequestration. Note that the sample size for the numbers in Figure 9 was very low (n=58 in 2003 and n=73 in 2006) and the margin of error is high. We will continue to track this group in future surveys.

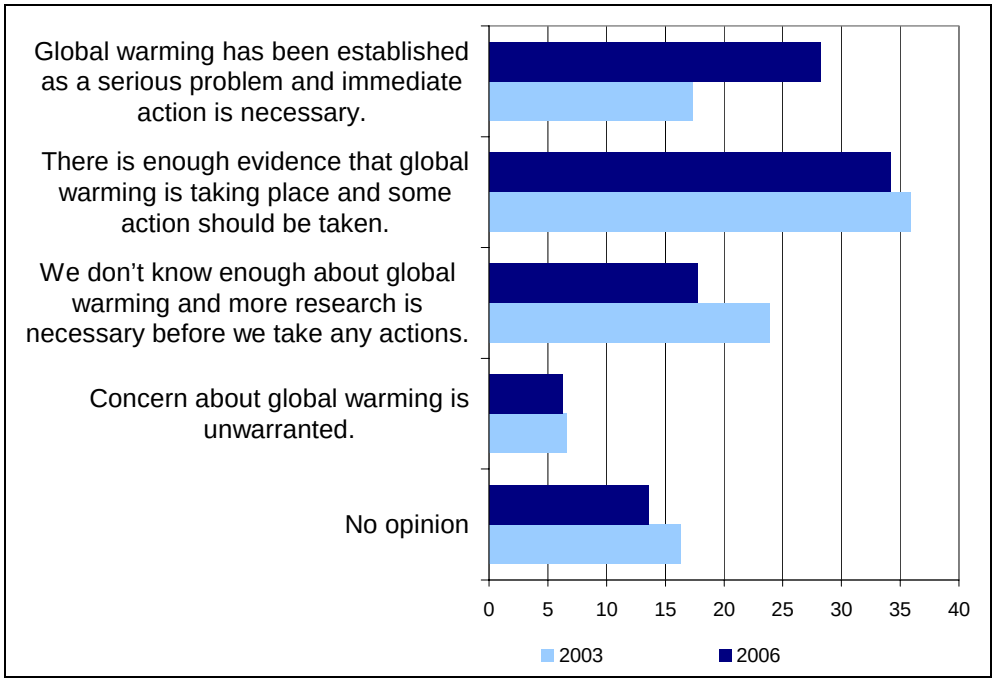
Figure 9. Identification of the Environmental Problem CCS Addresses by Those Who Reported Hearing of the Technology



VI. Public Support for Action to Address Climate Change

A number of questions in the survey explore the public's appetite for action to address global warming. The 2006 survey shows that a majority of the American public feel that scientific evidence warrants action. In 2003, barely 50 percent of the respondents agreed that the scientific evidence was sufficiently strong to warrant some action, and 17 percent of Americans agreed that global warming required immediate action. In 2006, 61 percent agreed that there is enough evidence that we should act, and 28 percent characterized it as a scientific fact that demands immediate action. Figure 10 summarizes the results.

Figure 10. Opinions about the Speed of Action to Address Global Warming (Percent agreeing with each response)



Note that percent of the public agreeing with the statement, "Concern about global warming is unwarranted," did not change from 2003 to 2006 (about 6.5 percent).

Regressions B and C in Appendix C show correlations between variables and support for action to address global warming in 2003 and 2006, respectively. In both 2003 and 2006, ranking global warming as one of the top environmental problems correlated with an increased desire for action. Additionally, those who favored the environment to the economy were more likely to want immediate action.

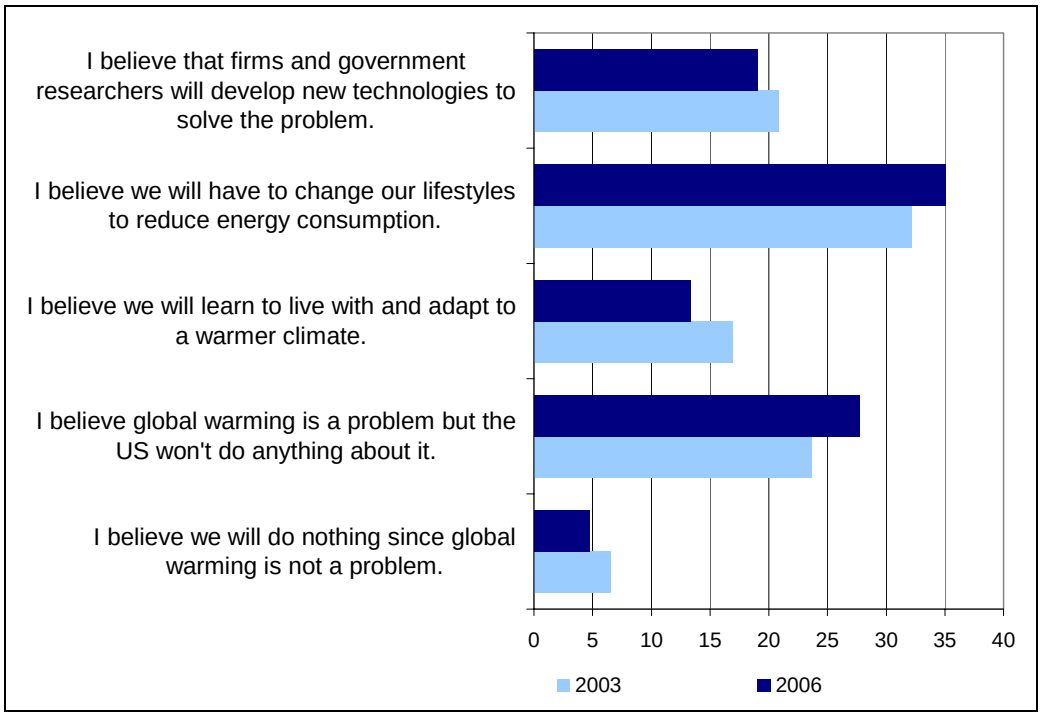
Regional differences appeared to have some impact on the desired speed of action. In both 2003 and 2006, people in the northeast appeared to be slightly more in favor of more immediate action as compared to people in other regions of the country. Differences in attendance at religious services also seemed to impact desired speed of action. Those who attended religious services more frequently had a negative correlation with action. This relationship was stronger in 2006 than it was in 2003. There was also an apparent

negative correlation between male respondents and a desire to take action to address global warming.

In the 2006 survey, where we had data on ideology and detailed information on party preference, there appears to be a correlation between supporting action on global warming and both being more liberal and identifying with the Democratic Party. In the 2003 survey, identifying with the Democratic Party correlated with an increased support for action. In the 2006, there was a correlation between wanting action and believing there is a scientific consensus on global warming.

In both versions of the survey, we asked the public what the U.S. is likely to do about global warming – assuming global warming is a problem. As shown in Figure 11, there was an increase in the cynical response "global warming is a problem but the U.S. won't do anything about it" and in the response that "we will have to change our lifestyles." But, the shifts in opinion about what we will do to address global warming were not as dramatic as the growth in opinion about the need for action.

Figure 11. What the U.S. Will Do to Address Global Warming (Percent agreeing with each response)



VII. Public Willingness to Pay to Address Global Warming

Every serious policy study of global warming agrees that either a cap and trade system or a carbon tax is the optimal way to address the problem. Such taxes may either be explicit in the form of excise taxes on electricity and transportation and heating fuels, or the taxes may be implicit, as would occur with regulations on carbon emissions (Poterba 1990; Goulder 1995; Bovenberg and Goulder 1996, 2000). Recent public policy studies suggest that a tax in the range of $30 per ton of carbon is necessary to reduce U.S. carbon emissions significantly and to reduce worldwide emissions of greenhouse gases (MIT Coal Study 2007).

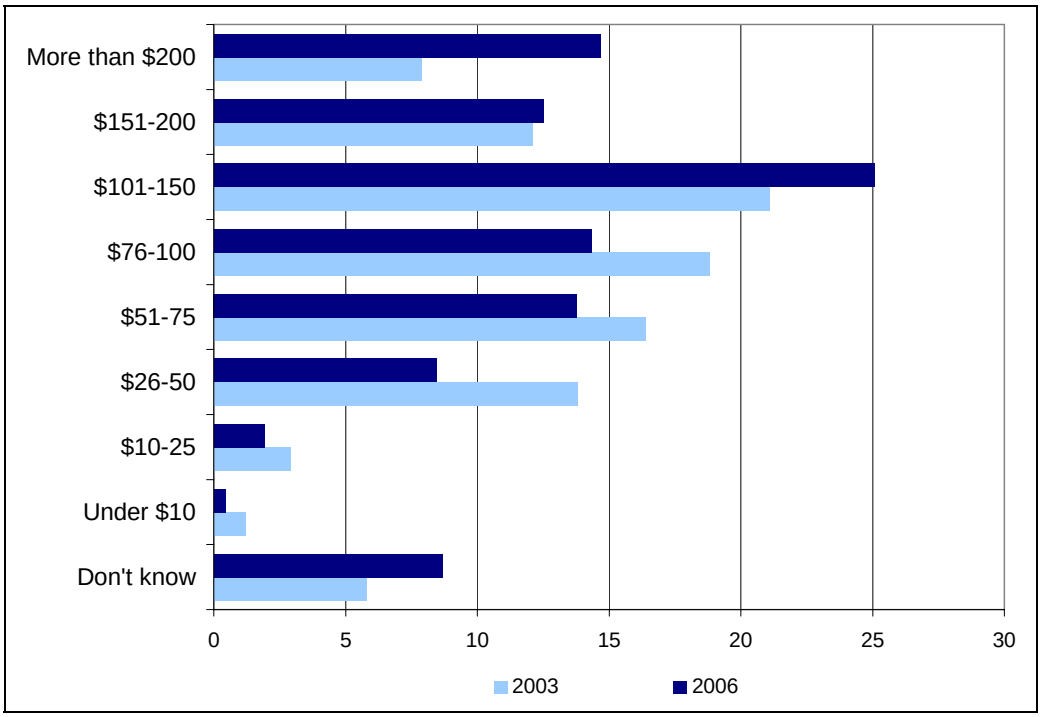
The practical difficulties with such a tax lie in public acceptance. Our surveys of the US, the UK, Japan, and Sweden in 2003 show a low willingness to pay higher electricity bills in order to "solve global warming" (Reiner et al. 2006). A majority of people would be unwilling to spend more that $10 more per month on electricity bills (a 10 percent increase or less) to address problems of climate change. Public resistance to tax increases has led many policy analysts to seek more subtle ways of introducing regulatory controls, such as cap and trade systems, but analysis shows these to be less efficient than an outright tax increase.

The 2006 survey included a striking change in the willingness of the American public to pay to remedy this problem. In 2003, the median respondent was willing to pay approximately $10 more per month on their electricity bill, and the average amount that the public was willing to pay came to just $14 more per month.

Three years later, the willingness to pay grew 50 percent. We asked the same question in 2006 as we did in 2003. The median respondent stated that he or she would be willing to pay $14 more per month, and the average amount that the sample was willing to pay came to $21. This is a remarkable increase, and suggests that there has been a substantial change in the public's willingness to address this problem.

We asked about willingness to pay in the context of monthly electricity bills. Before asking about willingness to pay, we asked participants about the previous month's electric bill. Figure 12 summarizes the reported monthly electric bills.

Figure 12. Reported Electric Bills for September 2003 and September 2006 (Percent choosing each response)

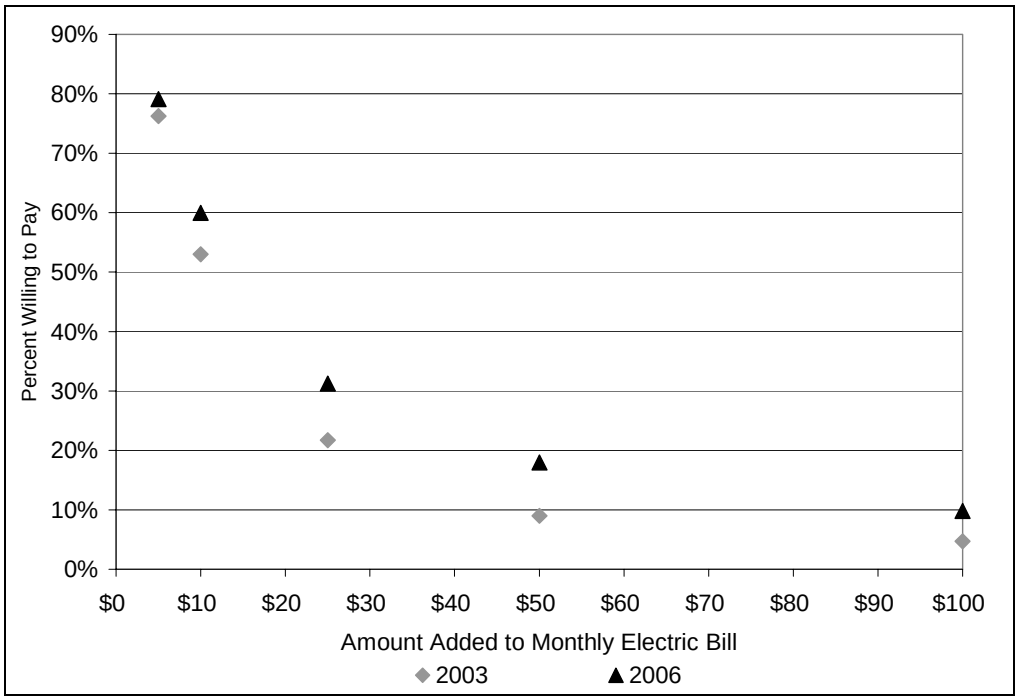


As expected, the amount paid on the monthly electric bill increased between 2003 and 2006. The reported monthly electric bills averaged $106 in 2003 and $125 in 2006, an 18 percent increase. According to the Energy Information Administration, the average residential retail price of electricity in September 2003 was 8.90 cents per kilowatt-hour (EIA 2003). It jumped to 10.94 cents per kilowatt-hour by September 2006, a 24 percent increase (EIA 2006). In 2003, the average monthly residential bill in the United States was $78.84 (EIA 2007a). The average monthly electricity bill was $88.60 in 2005, the most recent year for which national data is available (EIA 2007b). The 2006 data will not be available until late 2007 but it is expected to be significantly higher than 2003 and 2005.

After establishing the monthly electric bill, we asked about willingness to pay extra on the electric bill to "solve" global warming. We offered a series of values that would be added to the monthly electric bill, starting with $5. If the respondent answered yes to $5, the dollar value increased to $10. A second yes response increased the dollar value to $25, followed by $50, and $100.

Figure 13 shows the responses to the willingness to pay question in 2003 and 2006. Each point corresponds to the percent of respondents who agreed to that price.

Figure 13. Willingness to Pay to "Solve" Global Warming



The number of people willing to pay $5 did not increase significantly between 2003 and 2006 (from 76 percent to 79 percent). However, the number willing to pay $50 and $100 per month doubled from 2003 to 2006 (from nine to 18 percent at $50 and from five to ten percent at $100). Overall, the average willingness to pay increased by 50 percent. Not only is the public more concerned about global warming, it is also willing to pay more to address it.

There are caveats to our willingness to pay estimate. The question is abstract and does not define global warming or provide information about the potential impacts of global warming. It measures the respondent's expressed willingness to pay to solve his or her personal definition of global warming. When faced with an actual increase in his or her monthly electric bill, a respondent may not be willing to pay as much as he or she expressed in the survey.[4]

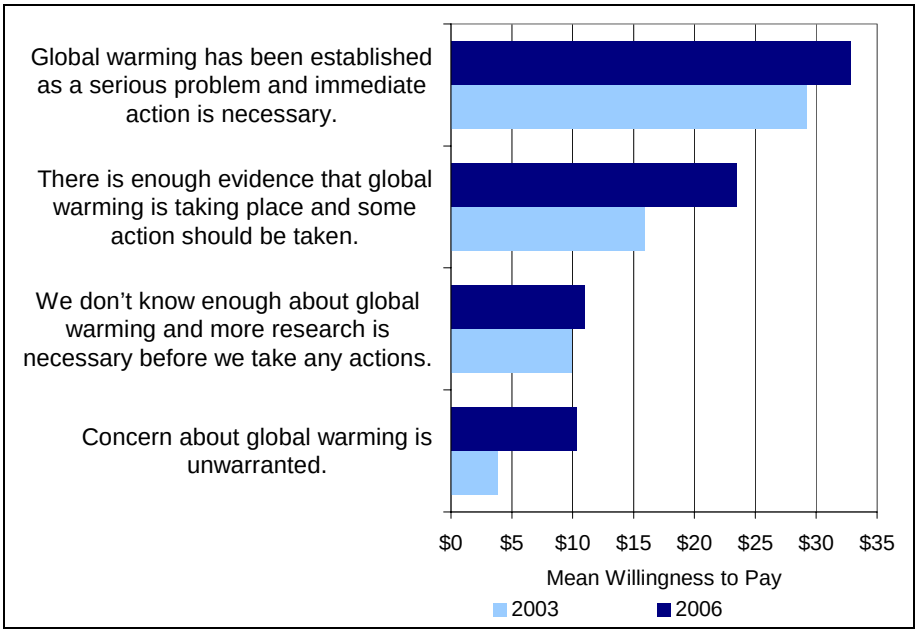
Despite its limitations, expressed willing to pay is a useful metric for comparing the relative attitudes of different groups of individuals toward bearing a cost for this environmental problem. Regressions D and E in Appendix C explore the relationship of a number of the variables to willingness to pay in 2003 and 2006, respectively.

One variable that correlates with willingness to pay in 2006 but not in 2003 is the monthly electric bill. As the reported electric bill increased in 2006, the willingness to pay to solve global warming also increased.

[4] See Curry 2004 for a detailed discussion of limitations of the willingness to pay question.

Support for action to address global warming (Figure 10 in Section VI) correlated with willingness to pay in both 2003 and 2006. Figure 14 shows that as support for action increased (moving from the bottom to the top of the figure), the mean willingness to pay increased.

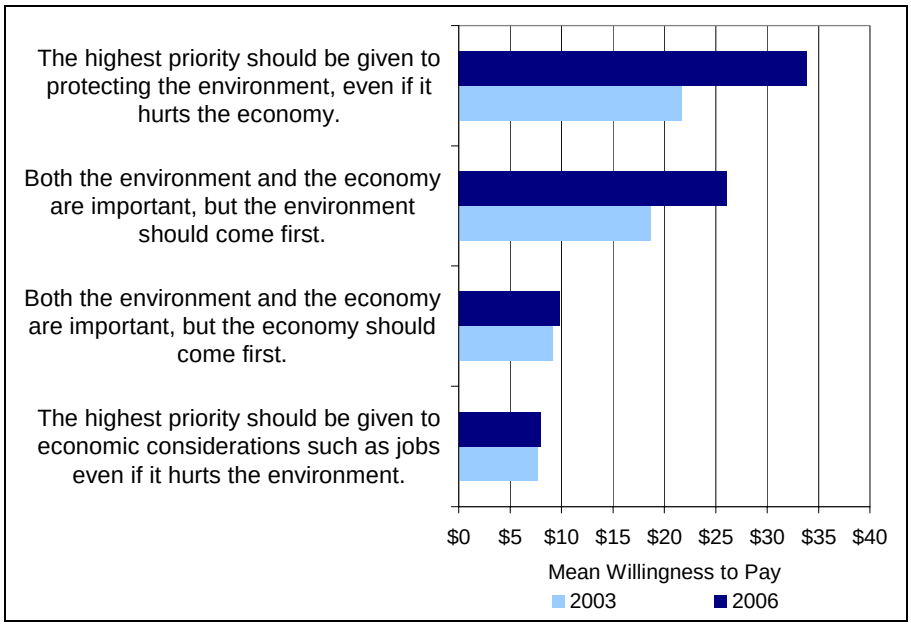
Figure 14. Impact of Concern about Global Warming on Willingness to Pay to Solve Global Warming



Remarkably, in 2006, even those who said concern about global warming was unwarranted were willing, on average, to pay $10 more a month on their electric bill. In 2003, none of those respondents were willing to pay $50 or $100. In 2006, 4 of those respondents said they were willing to pay $100 (another 4 said they were willing to pay $50) driving up the average willingness to pay. The 95 percent confidence interval of the willingness to pay for those who said concern about global warming was unwarranted was $5 to $15 in 2006.

Support for the environment over the economy also correlated with willingness to pay to solve global warming. Figure 15 shows that as preference for the environment increased, willingness to pay to solve global warming increased. Figure 15 shows a significant increase in willingness to pay from 2003 to 2006 among those who prioritize the environment and no change among those prioritize the economy.

Figure 15. Impact of Environment and Economy Tradeoffs on Willingness to Pay to Solve Global Warming



Despite correlations between the preferences listed in Figure 15 and party affiliation (discussed in Section III), there was no correlation between party affiliation and willingness to pay. However, in 2006 there was a correlation between ideology and willingness to pay. As ideology became more conservative, willingness to pay declined. These data were not available in 2003.

In 2003, there was a correlation between people residing the Midwest and a lower willingness to pay (as compared to people from other parts of the country). Over the three years between the surveys, this difference has disappeared. In 2006, regional differences did not have a significant impact on willingness to pay.

In 2003, there was also a correlation between less frequent religious service attendance and an increased willingness to pay to solve global warming. In 2006, this relationship appears to have weakened if not reversed.

In addition to asking about the willingness to pay extra on monthly electric bills, the 2006 survey included a question about the willingness to pay a revenue-neutral tax. The language used to describe the tax is in included in the box below.

Tax Proposal

One way to reduce greenhouse gases is to tax emissions. This would increase the price for gasoline, heating oil, and electricity. Such taxes would reduce use of oil and coal and make it easier to introduce new technologies, such as solar and wind power.

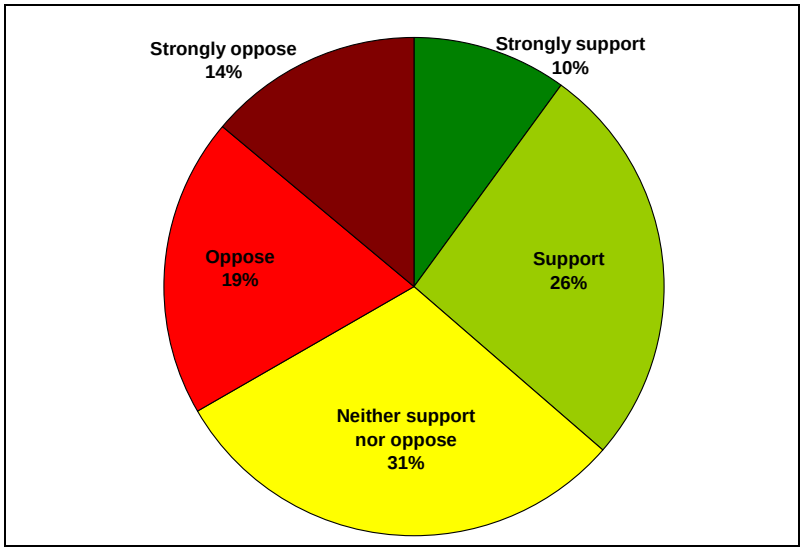
A proposal currently before Congress would keep the amount paid in taxes by the typical family the same, but the plan would shift taxes from being placed on income to being placed on emissions. This proposal would:

- Cut the income tax of a typical family by $1000
- Increase the amount the typical family pays for electricity by $25 per month
- Increase the price of gasoline by 60¢ per gallon
- Decrease greenhouse gas emissions by 50%

Would you oppose or support this proposal?

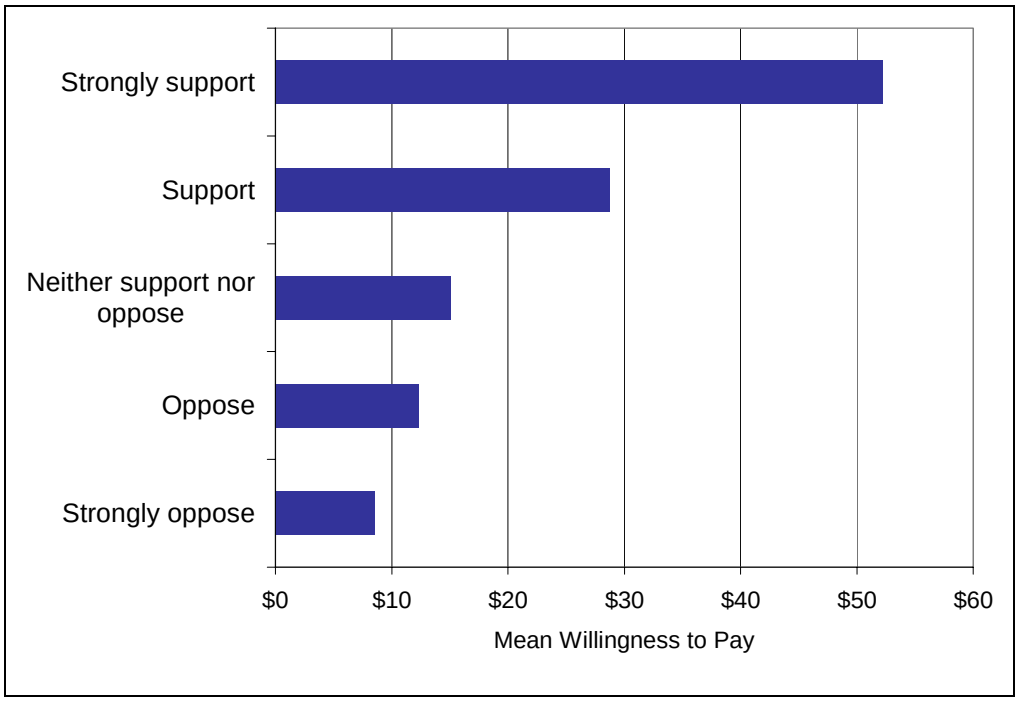
Responses to the tax proposal were mixed. As shown in Figure 16, public opinion on the carbon tax proposal was evenly divided with just over a third supporting it, about a third opposing it, and just under a third neither supporting nor opposing it. More respondents strongly opposed the plan than strongly supported the plan.

Figure 16. Responses to the Tax Proposal



The tax question provides an internal validation of the willingness to pay question. As shown in Figure 17, stronger support for the tax corresponds to a higher willingness to pay. Those who support or strongly support the tax were willing to pay more than $25 per month (the level suggested by the tax question) even without the offer of a reduction in their income tax.

Figure 17. Relationship of Support for the Tax Proposal and Willingness to Pay to Solve Global Warming

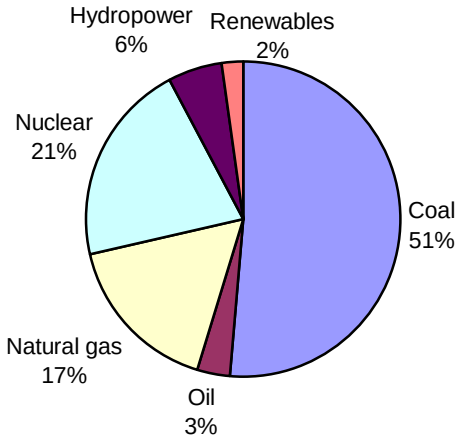


VIII. Impact of Information

The survey included an experiment to test the effect of price and production information on public preference for methods to address the issue of global warming as it relates to electricity production. The question gave respondents seven choices for addressing global warming and asked them to choose the one that they preferred. In both surveys, about half of the survey participants received no information and about half of the survey participants received the information shown in the box below.[5]

Information Provided to Half of Respondents

The following chart shows our reliance on fossil fuels (coal, oil and natural gas) for producing electricity.



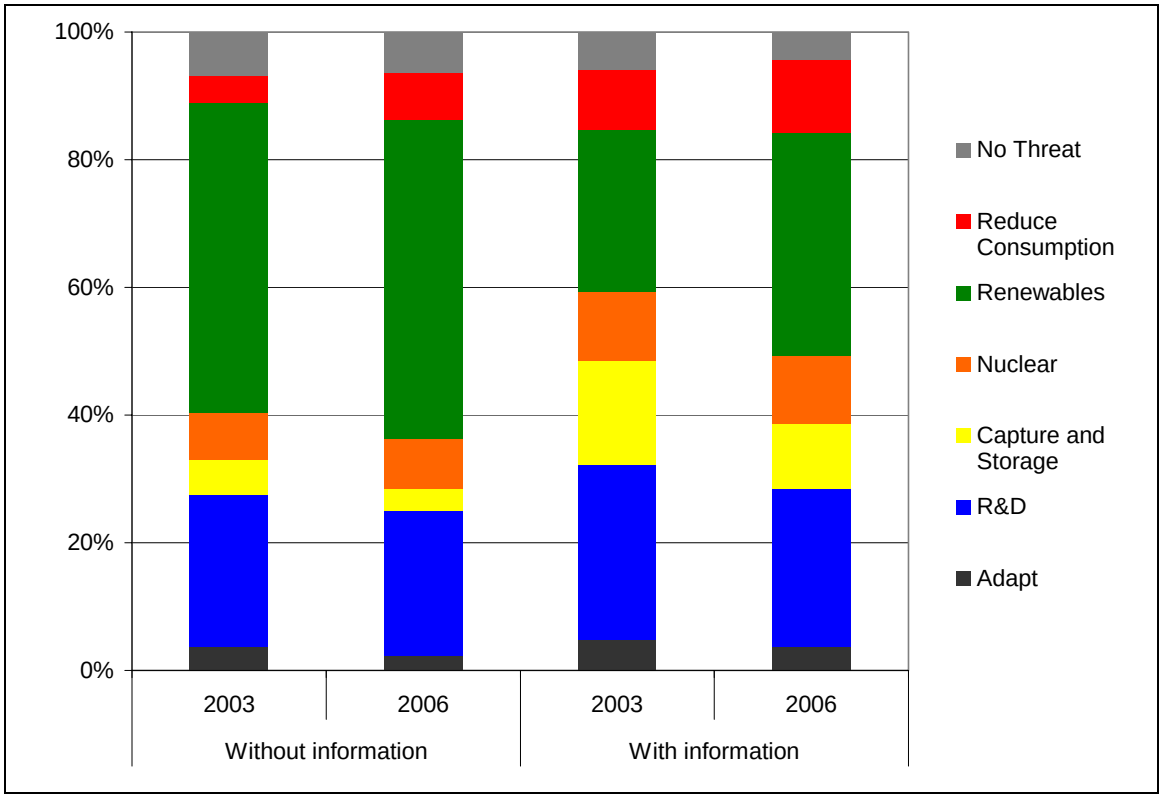
Based on published studies, we can summarize electricity production costs as follows:

- Using coal and natural gas, the typical family pays $1,200 per year for electricity.
- Using all nuclear power would emit no carbon dioxide and would increase electricity costs for families to $2,400 per year.
- Using capture and storage of carbon dioxide along with coal and natural gas would reduce carbon dioxide emissions by 90% and would increase electricity costs to $2,400 per year.
- Using renewables (solar and wind power) would emit no carbon dioxide and would increase electricity costs to $4,000 per year.

[5] We derived the electricity production data shown in the box from electricity net generation data compiled by the Energy Information Agency (EIA) data for 2002 (EIA 2003a). The price information was not meant to be exact, but was meant to clearly portray relative costs between the technologies. Round numbers were used to gather information on whether the public maintained their support for renewable energy in the face of higher prices. It should be noted that on a regional or local level, there are economically competitive sources of renewable energy (wind turbines, hydropower, etc.) that could be cheaper than the costs shown in the figure.

Figure 18 summarizes public opinion with and without information. Carbon capture and storage had more support in 2003 compared to 2006 (six percent in 2003 compared to three percent in 2006 without information and 16 and ten percent with information).

Figure 18. Impact of Information on Technology Preferences



In both 2003 and 2006, about half of respondents chose renewable electricity without information about electricity sources or costs. With information, the number choosing renewables decreased (to 25 percent in 2003 and 35 percent in 2006). The continued support for renewables occurred even though the public was told it would face higher monthly electricity prices. In both 2003 and 2006, there was no clear preferred alternative to renewables after we provided the information.

In 2006, those who chose renewables expressed a mean willingness to pay of $28 extra per month in electricity bills which was significantly higher than the mean willingness to pay of those who did not choose renewables ($18). However, it was significantly less than the average $233 monthly increase suggested in the information for a switch to 100 percent renewable energy. In 2003, the difference in willingness to pay between these two groups was not significant.

IX. Conclusions

The American public is significantly more concerned about global warming than it was just three years ago. This increased concern runs through the survey from the ranking of global warming as the top environmental concern to a 50 percent increase in willingness to pay to solve global warming.

The increase in willingness to pay to solve global warming came despite the fact that the 2006 survey was conducted during the fall of 2006 when energy prices were significantly higher than they were in 2003. In fact, analysis of the 2006 survey suggests that higher electric bills correlated with a higher willingness to pay – even when controlling for income.

Those who were concerned about global warming were willing to pay more to address the problem. As support for action to address global warming grew, willingness to pay to solve global warming grew, even as we controlled for political affiliations and other demographic variables.

Renewable energy sources continue to garner strong support from the public. Over a third of the public supports the use of renewables even after learning that their monthly electric bill will increase by over $230 per month. There are some signs of disconnect, however, as the group favoring renewables said, on average, that they were willing to pay $28 extra per month on their electric bill.

Despite the increased concern over global warming, the 2006 survey did not show a marked increase in concern for the environment relative to other pressing issues. While global warming shot to the top of environmental issues, the environment continued to rank in the middle of the pack of issues facing the U.S. The relative importance of the environment to other issues supports recent initiatives that connect global warming to issues of security.

In the debate about global warming, political affiliation and geographic location are often considered. In 2006, we did not find strong correlations between political affiliation or geographic location and willingness to pay to solve global warming. However, we did find that a greater percentage of Democrats rank global warming as their top environmental concern than do Republicans, and that Democrats are more supportive of immediate action to address global warming.

Regional differences are of particular interest to those researching climate change technologies. Large-scale technologies will have to be sited throughout the country and public opinion is an important part of the process. We looked for differences in opinion by region of the country (Northeast, Midwest, West, and South) and found that in 2006, when we controlled for other variables (particularly political ideology), there was no difference in public willingness to pay or in public concern about global warming. In 2003, living in the Midwest correlated with a slightly lower willingness to pay to solve global warming compared to other parts of the country. This correlation did not appear to

be significant in 2006. We did find that residence in the Northeast correlated with support for more immediate action to address global warming.

The 2006 survey did not show an increased understanding of sources of carbon dioxide or an increased awareness of the technologies available to address global warming. This suggests that the public continues to misunderstand – or are simply unaware of – some of the issues underlying action on global warming. It is unclear what this means for the long run. It is possible that knowledge about solutions will grow as the problem continues to make news. On the other hand, the lack of knowledge could become a barrier to implementing solutions, especially if the public looks for a quick fix to global warming.

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Appendix A: 2006 Demographic Information

Ideology	
Extremely Liberal	4%
Liberal	14%
Slightly Liberal	11%
Moderate	39%
Slightly Conservative	12%
Conservative	17%
Extremely Conservative	4%

Gender	
Male	48%
Female	52%

Age Categories	
18-29	22%
30-44	28%
45-59	28%
Over 60	22%

Education	
Less that high school	14%
High school	32%
Some college	27%
Bachelor's or higher	26%

Region	
Northeast	19%
Midwest	22%
South	36%
West	23%

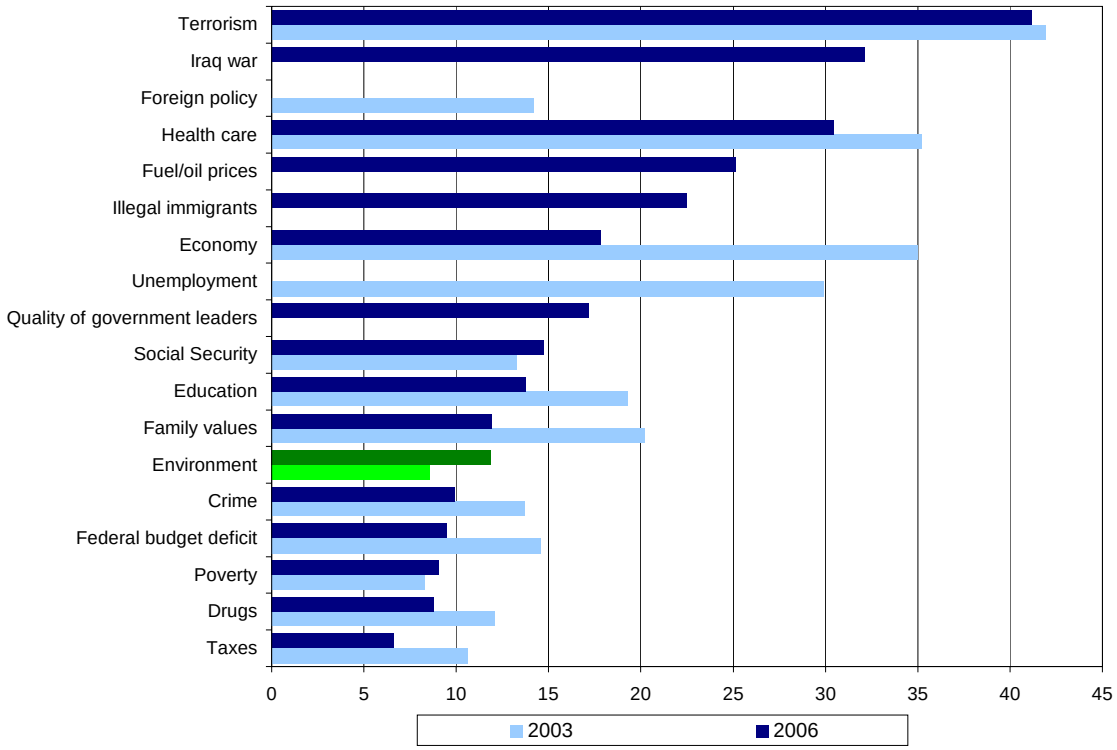
Household income	Percent
less than $5,000	3%
$5,000 to $7,499	3%
$7,500 to $9,999	4%
$10,000 to $12,499	3%
$12,500 to $14,999	4%
$15,000 to $19,999	5%
$20,000 to $24,999	7%
$25,000 to $29,999	7%
$30,000 to $34,999	7%
$35,000 to $39,999	8%
$40,000 to $49,999	10%
$50,000 to $59,999	8%
$60,000 to $74,999	9%
$75,000 to $84,999	7%
$85,000 to $99,999	5%
$100,000 to $124,999	5%
$125,000 to 149,999	2%
$150,000 to $174,999	1%
$175,000 or more	2%

Party Affiliation	
Strong Republican	13%
Not Strong Republican	10%
Leans Republican	14%
Undecided/Other	7%
Leans Democrat	20%
Not Strong Democrat	17%
Strong Democrat	19%

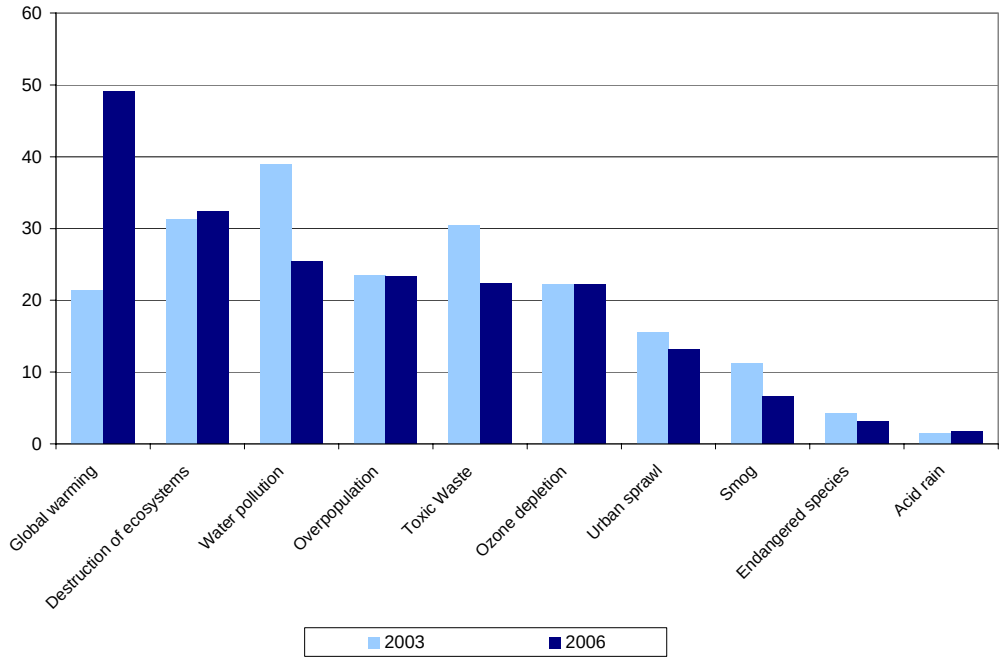
Frequency of Attendence at Religious Services	
> Once a week	10%
Once a week	20%
Once or twice a month	9%
Few times a year	22%
Once a year or less	15%
Never	24%

Appendix B: Survey Results

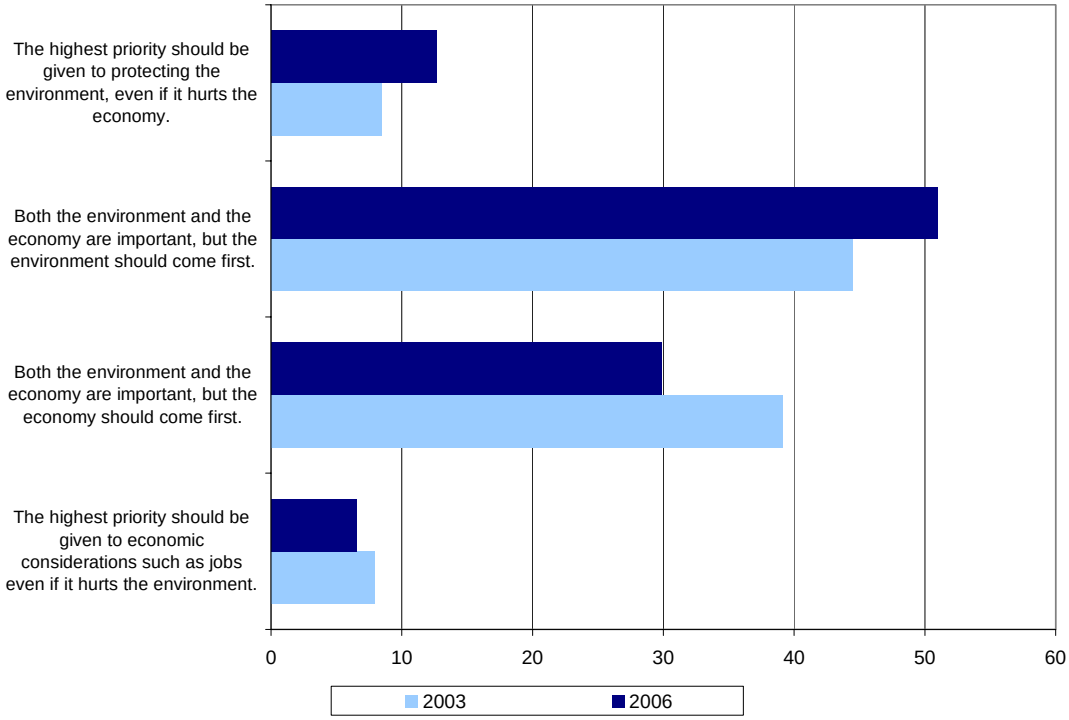
Question 1: *Consider the following issues. What are the three most important issues facing the US today?* [2006 survey included Iraq war, Fuel/oil prices, Illegal immigrants, and Quality of government leaders and did not include Unemployment, Foreign policy, Welfare, and Stock Market. Note the graphic does not include issues with less than five percent support.]



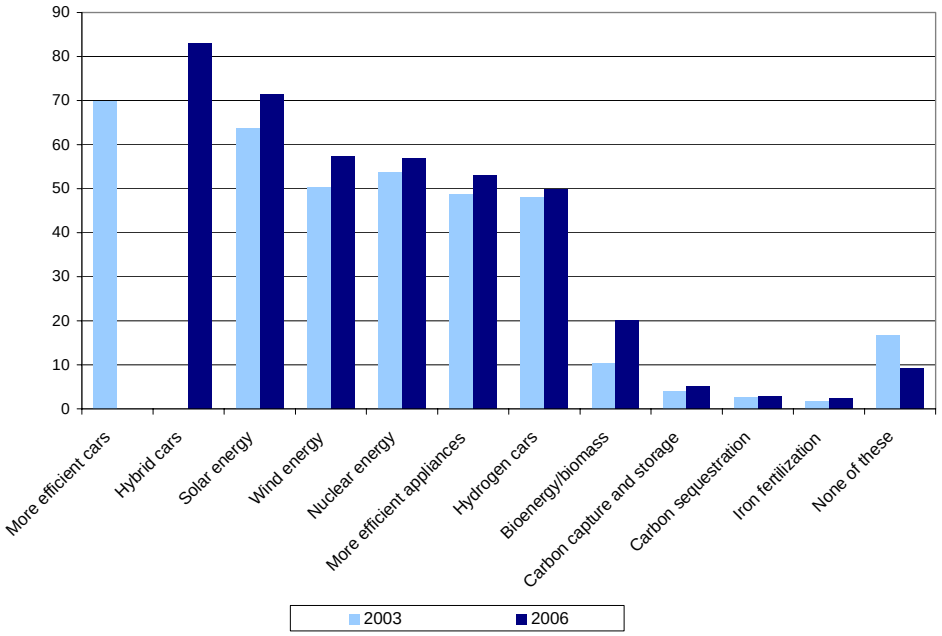
Question 2: *Consider the following environmental problems. Which is the most important problem facing the US today?* [Asked to select the top two, in order]



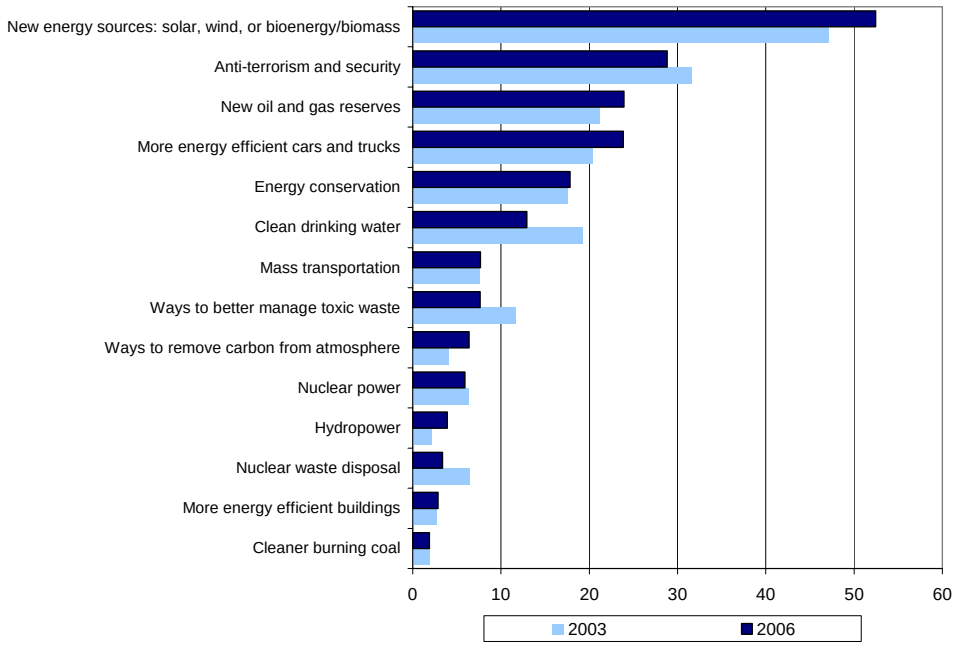
Question 3: *Many environmental issues involve difficult trade-offs with the economy. Which of the following statements best describes your view?*



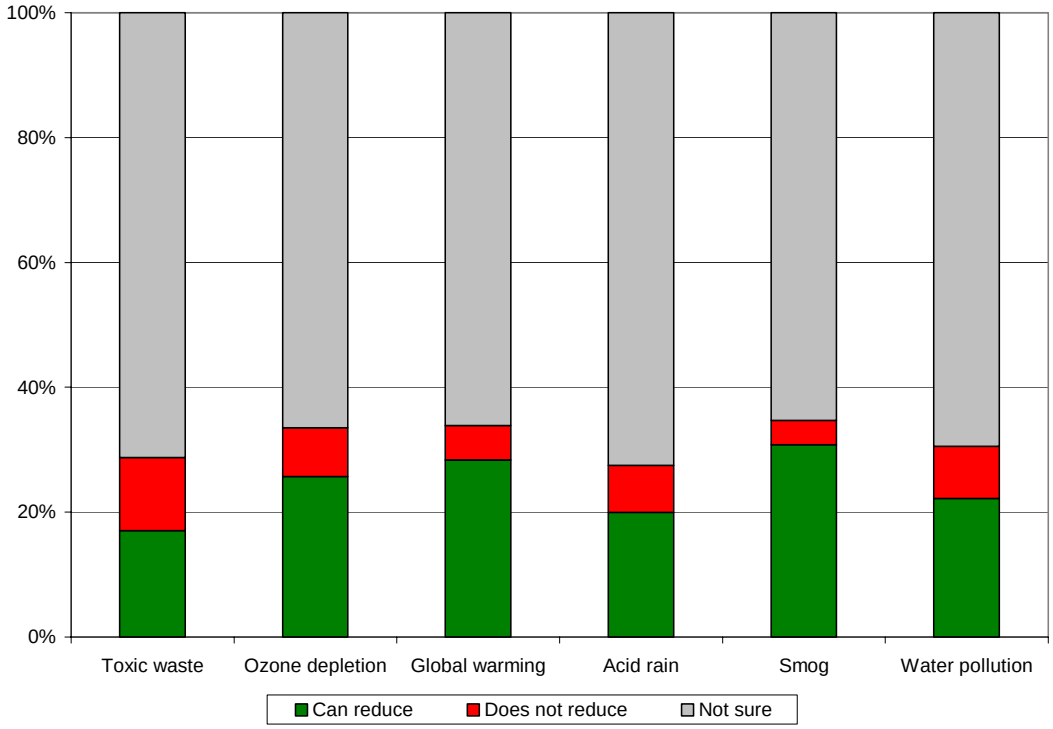
Question 4: *Have you heard of or read about any of the following in the past year? Check all that apply.* [2006 survey included Hybrid cars in place of More efficient cars.]



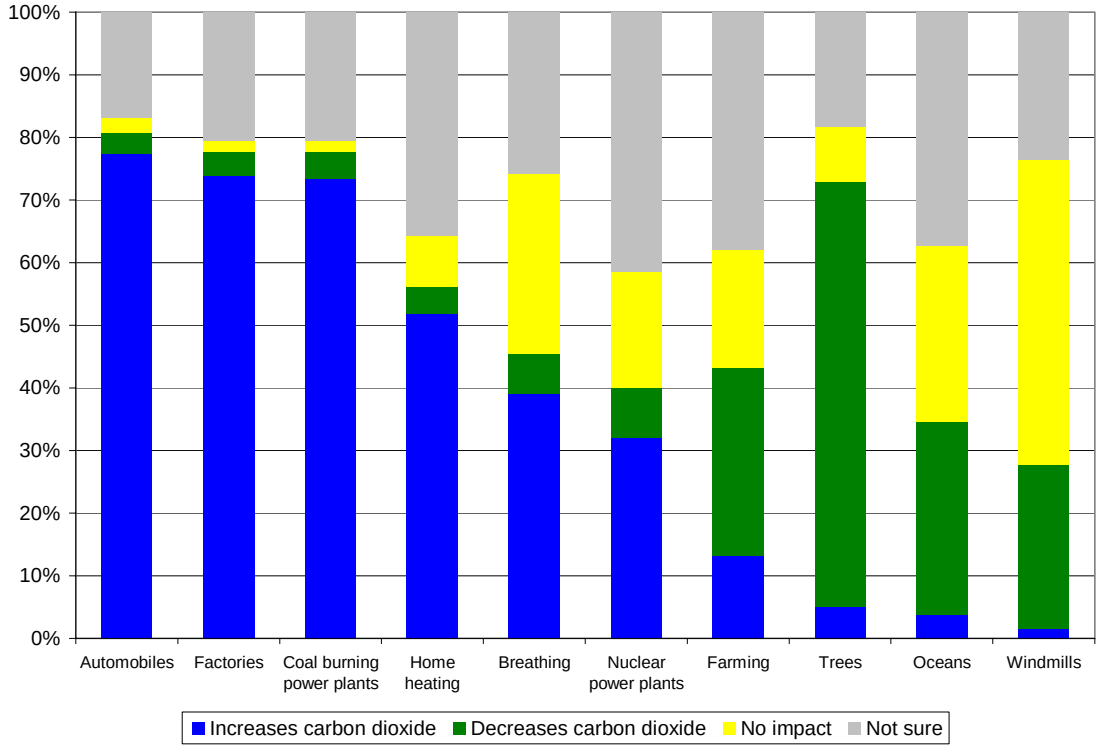
Question 5: *If the US Department of Energy has $10 billion to spend, which do you think should be the top priority?* [Asked to select the top two, in order]



Question 6: *Please select if "carbon sequestration" or "carbon capture and storage" can reduce each of the following environmental concerns.* [Only 2006 responses shown here.]



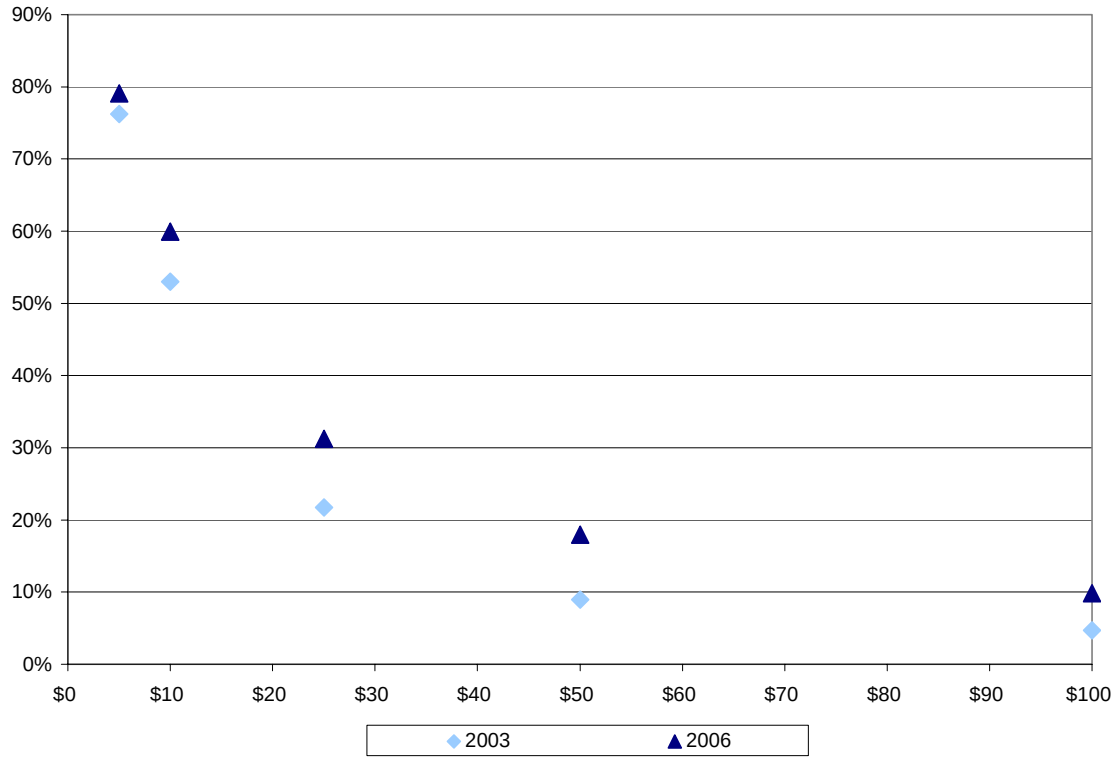
Question 7: *There is a growing concern about increasing levels of carbon dioxide in the atmosphere. How do you think the following contribute to these levels?* [Only 2006 responses shown here.]



Question 8: *How much was your electric bill last month?*

Amount	9-10/03	9/06
Under $10	1	0
$10-25	3	2
$26-50	14	8
$51-75	16	14
$76-100	19	14
$101-150	21	25
$151-200	12	13
More than $200	8	15
Don't know	6	9

Question 9: *If it solved global warming, would you be willing to pay [dollar value] more per month on your electricity bill?* (Dollar value started at $5, if a respondent chose "yes" it increased to $10 then $25, $50, and $100.)

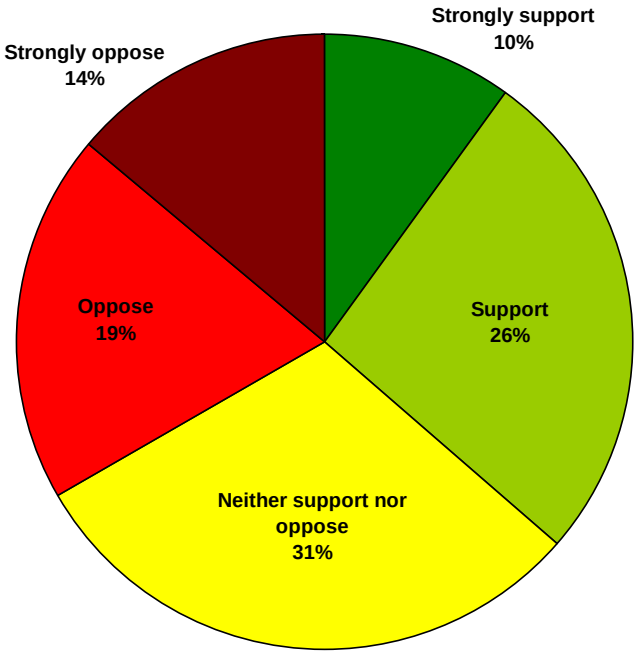


Question X: *One way to reduce greenhouse gases is to tax emissions. This would increase the price for gasoline, heating oil, and electricity. Such taxes would reduce use of oil and coal and make it easier to introduce new technologies, such as solar and wind power.*

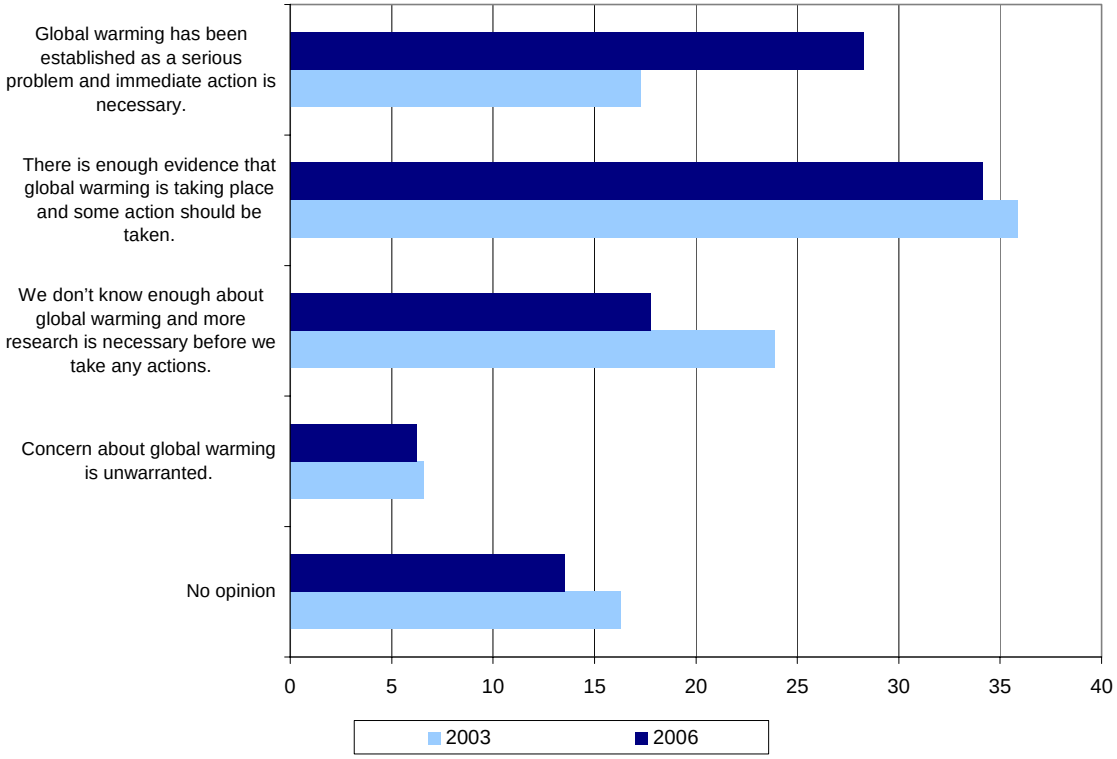
A proposal currently before Congress would keep the amount paid in taxes by the typical family the same, but the plan would shift taxes from being placed on income to being placed on emissions. This proposal would:

- *Cut the income tax of a typical family by $1000*
- *Increase the amount the typical family pays for electricity by $25 per month*
- *Increase the price of gasoline by 60¢ per gallon*
- *Decrease greenhouse gas emissions by 50%*

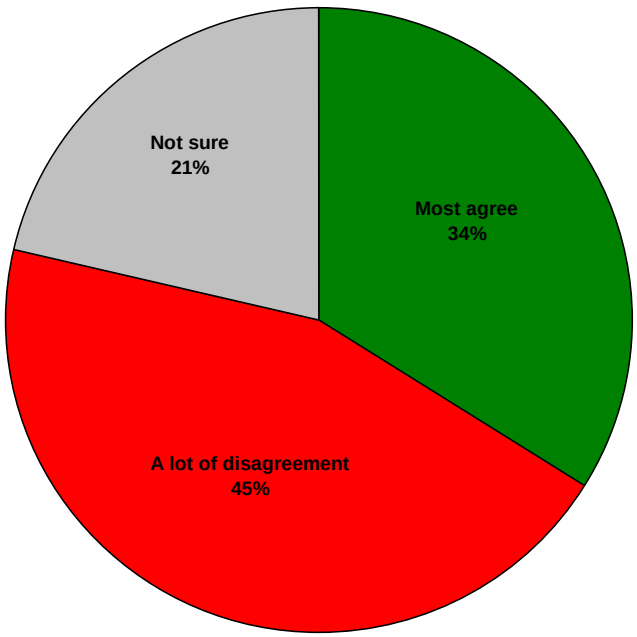
Would you oppose or support this proposal? [Only included in 2006 survey.]



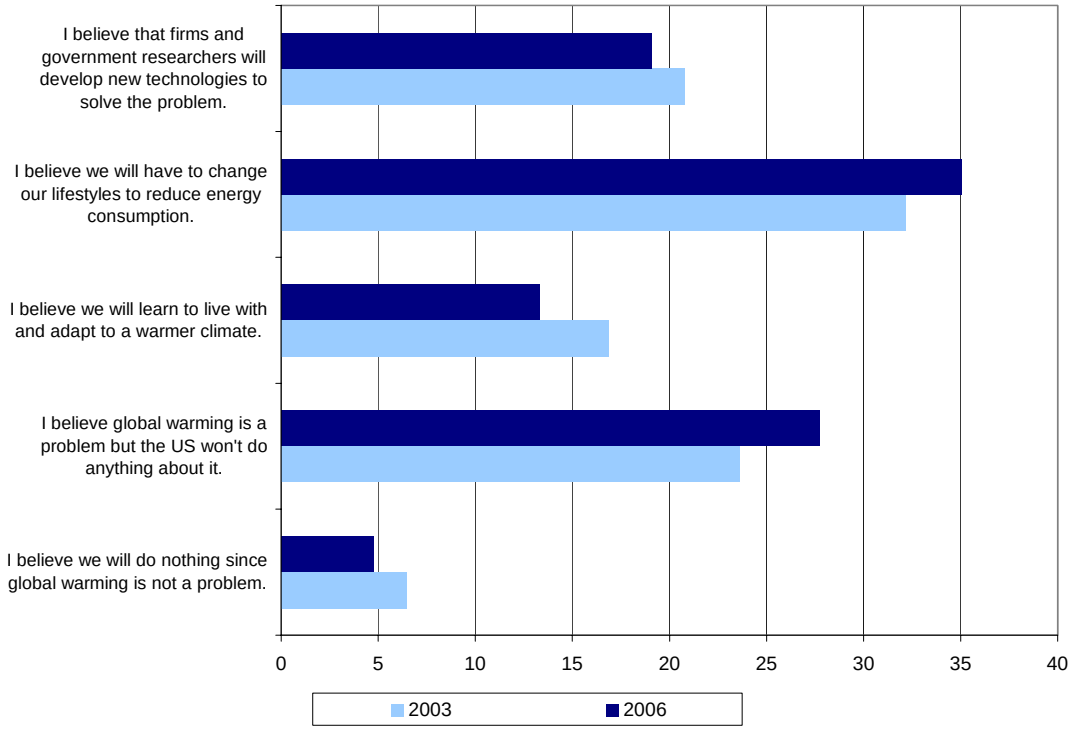
Question 10: *From what you know about global warming, which of following statements comes closest to your opinion?*



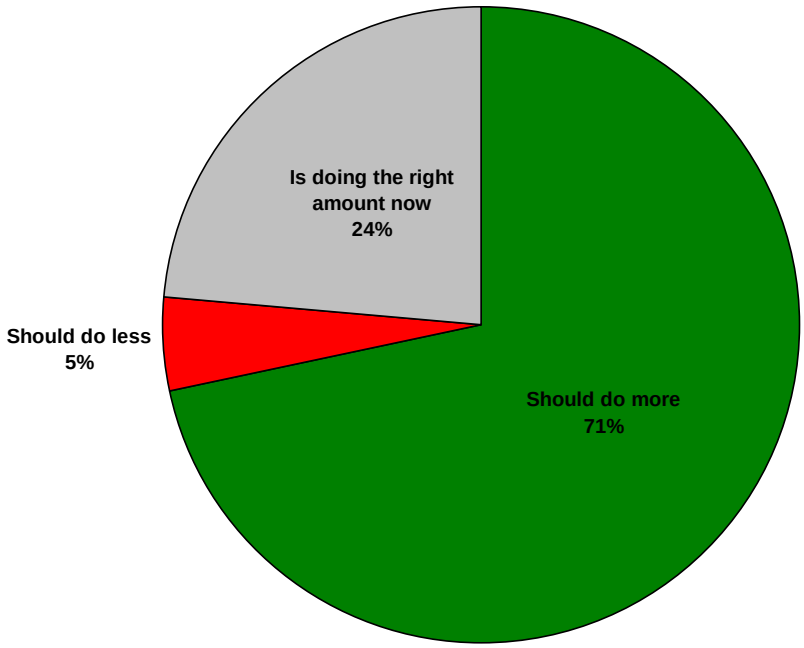
Question 10a: *Do you think most scientists agree with one another about global warming, or do you think there is a lot of disagreement?* [Only included in 2006 survey.]



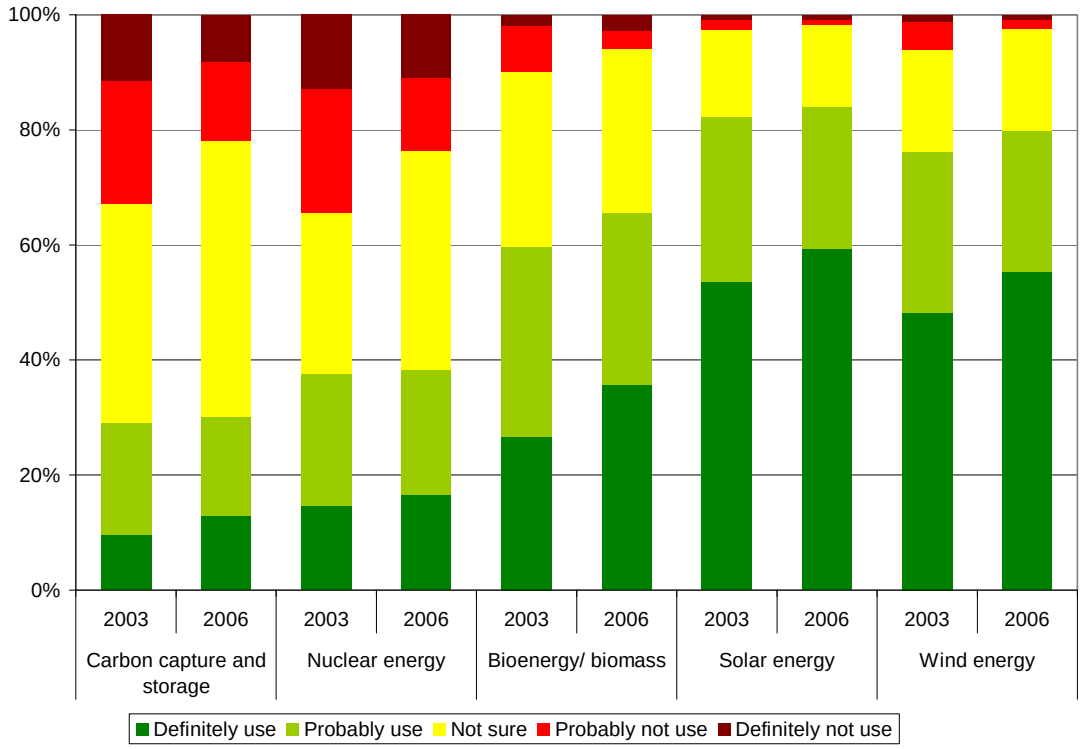
Question 11: *Assuming that global warming is a problem, what do you think the US is likely to do about it?*

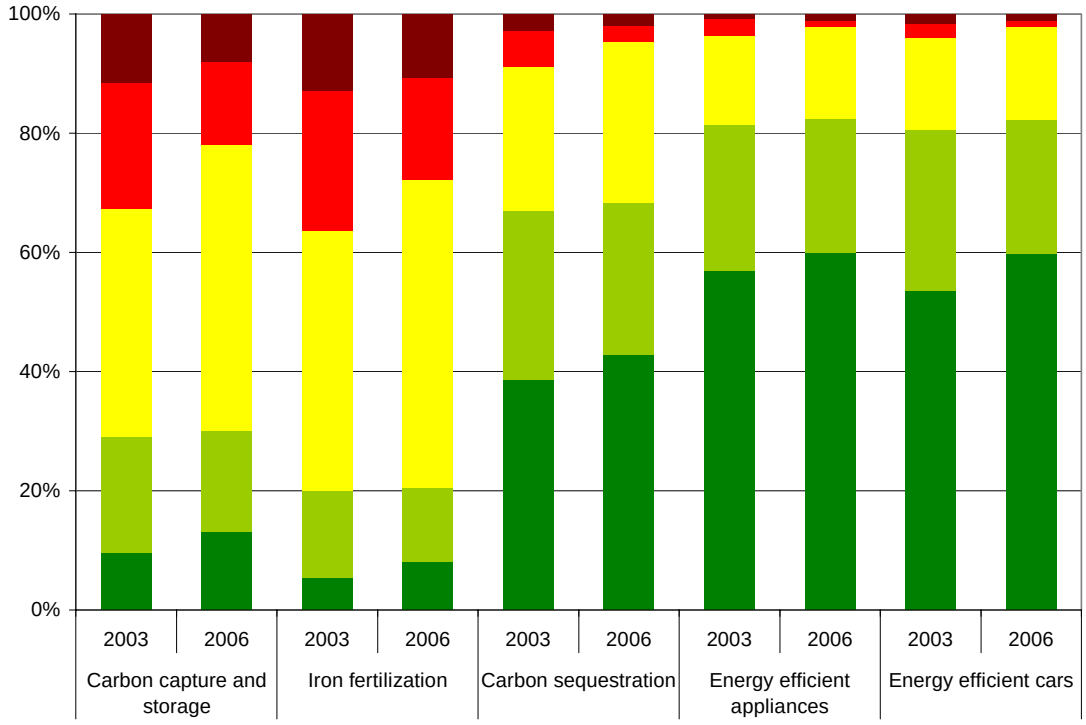


Question 12a: *Do you think the federal government should do more to try to deal with global warming?* [Only included in 2006 survey.]

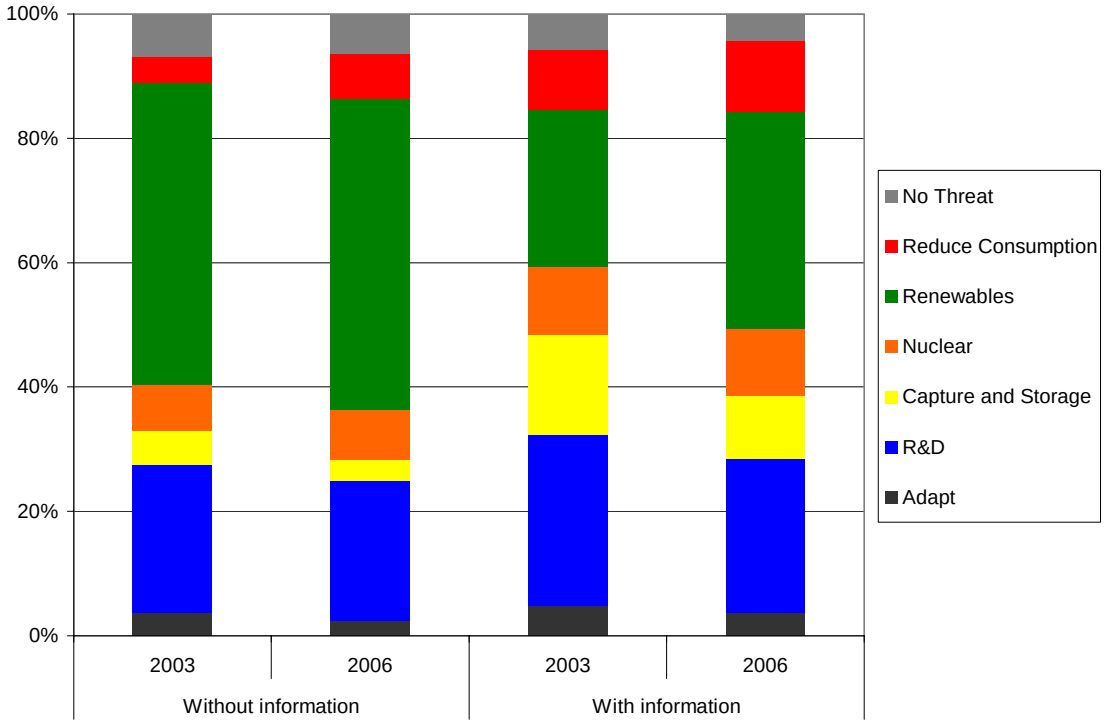


Question 13: *The following technologies have been proposed to address global warming. If you were responsible for designing a plan to address global warming, which of the following technologies would you use?* [The question included definitions not included here.]





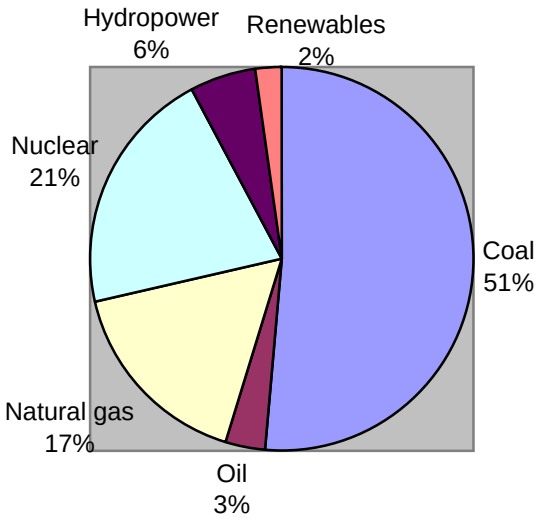
Question 14: *How can we best address the issue of global warming?* In the survey, we provided half of the sample with information on cost and current use and provided half of the sample with no additional information. The next page includes the information.



Information for Question 14:

Now we would like to present some facts on electricity production and prices.

The following chart shows our reliance on fossil fuels (coal, oil and natural gas) for producing electricity.



Based on published studies, we can summarize electricity production costs as follows:

- Using coal and natural gas, the typical family pays $1,200 per year for electricity.
- Using all nuclear power would emit no carbon dioxide and would increase electricity costs for families to $2,400 per year.
- Using carbon capture and storage along with coal and natural gas would reduce carbon dioxide emissions by 90% and would also increase electricity costs to $2,400 per year.
- Using renewables (solar and wind power) would increase annual electricity costs to $4,000.

Question 15: *Do you believe that we have a responsibility to look out for the interests of future generations, even if it means making ourselves worse off?*

Response	**9-10/03**	**906**
Yes	87	84
No	13	16

Question 16: *We currently assist other nations through foreign aid and charitable donations, do you think we should increase that assistance, let it stay the same, decrease our assistance or remove it entirely?*

Response	**9-10/03**	**9/06**
Increase	6	10
Stay the same	35	35
Decrease	48	43
Remove it entirely	12	12

Question 17: *How do you heat your home?*

Heat Source	**9-10/03**	**9/06**
Oil	9	8
Electricity	31	34
Natural Gas	50	44
Wood	3	3
No Heating	2	2
Don't know	2	4
Other	4	5

Appendix C: Regression Analyses

As discussed in the Introduction, we used multiple regression to analyze the impact of independent variables (demographic characteristics or responses) on responses to various questions. For example, when looking at the impact of concern about global warming on willingness to pay to solve global warming, multiple regression provided us with a tool that could look at that impact while controlling for other variables (e.g., age, income, geographic location, concern about the economy, etc.). The regressions shown below include the significant independent variables (t>2), insignificant independent variables are listed in the footnotes.

Key to Variables

bus_1to4 – Preference in tradeoff between environment and economy (Question 3), responses coded from 1 to 4 with 4 with 4 signaling preference for the economy.

dem – Democrat.

ebill – Amount paid on monthly electric bill responses coded from 1 to 8 with 1 equaling responses of <$10 and 8 equaling responses of >$200 (Question 8).

gotit – Number of correct answers about sources and sinks of CO_2 (Question 7).

gw_1to4 – Opinion about what should be done to address global warming (Question 10), responses coded from 1 to 4 with 4 with 4 being "concern about global warming is unwarranted."

heard – Number of technologies heard of or read about in the previous year (Question 4).

iep_globwarm – Ranked global warming as the first or second most pressing environmental problem (Question 2).

male – Male.

midwest – Live in the Midwest, compared to regions not in regression.

mip_enviro – Ranked environment as the most important problem facing the U.S. (Question 1).

mip_economy – Ranked the economy as the most important problem facing the U.S. (Question 1).

northeast – Live in the Northeast, compared to regions not in regression.

not_relig – Frequency of attendance at religious services (divided into six categories from more than once a week (1) to never (6)).

ppage – Age.

ppeducat – Education level.

ppgender – Gender.

ppincimp – Household income.

rep – Republican.

sci_agree – Believe most scientists agree about global warming.

use – Number of technologies responded would "probably use" or "definitely use," (Question 13).

west – Live in the West, compared to regions not in regression.

willing_a – Willingness to pay to solve global warming (Question 9).

xideo – Ideology (divided in seven categories from extremely liberal (1) to extremely conservative (7)).

xparty7 – Party affiliation (divided in seven categories from strongly Republican (1) to strongly Democrat (7)).

Regression A: Responses to Question about Scientific Agreement (2006)[6]

```
Positive t values indicate belief in scientific agreement.

      Source |       SS       df       MS              Number of obs =    1225
-------------+------------------------------           F(  5,  1219) =   32.37
       Model |  32.2179684     5  6.44359369           Prob > F      =  0.0000
    Residual |  242.652996  1219  .199059061           R-squared     =  0.1172
-------------+------------------------------           Adj R-squared =  0.1136
       Total |  274.870964  1224  .224567781           Root MSE      =  .44616

------------------------------------------------------------------------------
   sci_agree |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       heard |   .0315443   .0062159     5.07   0.000     .0193493    .0437393
       gotit |   .0202123    .005038     4.01   0.000     .0103282    .0300963
       ppage |   .0021564   .0007909     2.73   0.006     .0006048     .003708
       xideo |  -.0644891    .008694    -7.42   0.000     -.081546   -.0474322
   not_relig |   .0190907     .00783     2.44   0.015     .0037289    .0344524
       _cons |   .1868159   .0673431     2.77   0.006     .0546946    .3189372
------------------------------------------------------------------------------
```

Regression B: Responses to Speed of Action to Address Global Warming (2003)[7]

```
Negative t values indicate a desire for faster action on global warming.

      Source |       SS       df       MS              Number of obs =     890
-------------+------------------------------           F(  7,   882) =   32.33
       Model |  134.434136     7  19.2048766           Prob > F      =  0.0000
    Residual |  523.934445   882  .594029983           R-squared     =  0.2042
-------------+------------------------------           Adj R-squared =  0.1979
       Total |  658.368581   889  .740572082           Root MSE      =  .77073

------------------------------------------------------------------------------
     gw_1to4 |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
iep_globwarm |  -.4784507   .0625968    -7.64   0.000    -.6013068   -.3555946
    bus_1to4 |   .3368084   .0352007     9.57   0.000     .2677216    .4058952
         use |  -.0504815   .0116122    -4.35   0.000    -.0732722   -.0276908
   northeast |  -.1538248   .0669678    -2.30   0.022    -.2852596     -.02239
```

[6] Independent variables that were not significant based on results not shown here: northeast, midwest, west, ppeducate, ppgender.

[7] Independent variables that were not significant based on results not shown here: mip_enviro, mip_economy, heard, ebill, willing_a, ppeducat, ppage.

```
        male |   .1886968    .052684     3.58   0.000     .0852961    .2920976
         dem |  -.1729702    .055718    -3.10   0.002    -.2823255   -.0636149
   not_relig |  -.0389283   .0163802    -2.38   0.018     -.071077   -.0067795
       _cons |   1.961432   .1331771    14.73   0.000     1.700051    2.222813
------------------------------------------------------------------------------
```

Regression C: Responses to Speed of Action to Address Global Warming (2006)[8]

Negative t values indicate a desire for faster action on global warming. The first regression includes the same variables as in Regression B; the second includes a more detailed variable for party affiliation that is only available for the 2006 data.

```
      Source |       SS       df       MS              Number of obs =    1036
-------------+------------------------------           F(  7,  1028) =   72.61
       Model |  280.914703     7  40.1306718           Prob > F      =  0.0000
    Residual |   568.15057  1028  .552675652           R-squared     =  0.3309
-------------+------------------------------           Adj R-squared =  0.3263
       Total |  849.065273  1035   .82035292           Root MSE      =  .74342

------------------------------------------------------------------------------
     gw_1to4 |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
iep_globwarm |  -.5801798    .047464   -12.22   0.000    -.6733173   -.4870423
    bus_1to4 |   .3511061   .0326273    10.76   0.000     .2870825    .4151298
         use |  -.0811167   .0109519    -7.41   0.000    -.1026074    -.059626
   northeast |  -.1261912   .0583732    -2.16   0.031    -.2407355   -.0116469
        male |   .1683036   .0472694     3.56   0.000     .0755481    .2610592
         dem |  -.2084605   .0490383    -4.25   0.000    -.3046871   -.1122338
   not_relig |  -.0759436   .0141967    -5.35   0.000    -.1038013   -.0480859
       _cons |   2.310646   .1313592    17.59   0.000     2.052883    2.568409
------------------------------------------------------------------------------


      Source |       SS       df       MS              Number of obs =    1036
-------------+------------------------------           F(  9,  1026) =   77.24
       Model |  342.941394     9  38.1045993           Prob > F      =  0.0000
    Residual |  506.123879  1026  .493298127           R-squared     =  0.4039
-------------+------------------------------           Adj R-squared =  0.3987
       Total |  849.065273  1035   .82035292           Root MSE      =  .70235

------------------------------------------------------------------------------
     gw_1to4 |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   sci_agree |  -.4231057    .049428    -8.56   0.000    -.5200973   -.3261142
iep_globwarm |  -.4401819   .0465483    -9.46   0.000    -.5315227   -.3488411
    bus_1to4 |    .290725   .0313615     9.27   0.000      .229185    .3522651
         use |  -.0613823   .0106159    -5.78   0.000    -.0822138   -.0405509
   northeast |  -.1461359   .0574669    -2.54   0.011    -.2589021   -.0333697
        west |  -.1104728   .0545784    -2.02   0.043    -.2175708   -.0033747
        male |     .14986   .0446149     3.36   0.001     .0623131    .2374068
     xparty7 |  -.0777371   .0113623    -6.84   0.000     -.100033   -.0554411
   not_relig |  -.0530952   .0136008    -3.90   0.000    -.0797837   -.0264066
       _cons |   2.635132   .1329136    19.83   0.000     2.374318    2.895945
------------------------------------------------------------------------------
```

[8] Independent variables that were not significant based on results not shown here: mip_enviro, mip_economy, heard, ebill, willing_a, midwest, ppeducat, ppage.

Regression D: Willingness to Pay to Solve Global Warming (2003)[9]

Negative t values indicate a lower willingness to pay.

```
      Source |       SS       df       MS              Number of obs =     894
-------------+------------------------------           F(  8,   885) =   32.58
       Model |  319.199721     8  39.8999651           Prob > F      =  0.0000
    Residual |  1083.77051   885  1.22459945           R-squared     =  0.2275
-------------+------------------------------           Adj R-squared =  0.2205
       Total |  1402.97023   893  1.57107529           Root MSE      =  1.1066

------------------------------------------------------------------------------
ln_willing_a |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     gw_1to4 |  -.5456822   .0459645   -11.87   0.000    -.6358943   -.4554701
    bus_1to4 |  -.2090099   .0528985    -3.95   0.000     -.312831   -.1051887
       gotit |   .0286771   .0140447     2.04   0.041     .0011123    .0562419
       ebill |  -.0252391   .0235435    -1.07   0.284    -.0714468    .0209685
     midwest |  -.3259173   .0888558    -3.67   0.000    -.5003099   -.1515247
   not_relig |   .0507969   .0234534     2.17   0.031     .0047661    .0968277
         dem |   .1074235   .0806703     1.33   0.183     -.050904     .265751
    ppincimp |   .0141751      .0096     1.48   0.140    -.0046663    .0330166
       _cons |    3.41137   .2497585    13.66   0.000     2.921182    3.901559
------------------------------------------------------------------------------
```

Regression E: Willingness to Pay to Solve Global Warming (2006)[10]

Negative t values indicate a lower willingness to pay. The first regression includes the same variables as in Regression D; the second includes variables for belief in scientific agreement and political ideology that are only available for the 2006 data.

```
      Source |       SS       df       MS              Number of obs =    1016
-------------+------------------------------           F(  8,  1007) =   47.76
       Model |  533.206457     8  66.6508072           Prob > F      =  0.0000
    Residual |  1405.43815  1007  1.39566847           R-squared     =  0.2750
-------------+------------------------------           Adj R-squared =  0.2693
       Total |  1938.64461  1015  1.90999469           Root MSE      =  1.1814

------------------------------------------------------------------------------
ln_willing_a |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     gw_1to4 |  -.5081931   .0461408   -11.01   0.000    -.5987362     -.41765
    bus_1to4 |  -.3974531   .0552891    -7.19   0.000    -.5059482   -.2889579
       gotit |   .0502499   .0142204     3.53   0.000      .022345    .0781549
       ebill |   .0748511   .0229679     3.26   0.001     .0297807    .1199215
     midwest |   .1218079   .0905886     1.34   0.179    -.0559562    .2995719
   not_relig |  -.0340353   .0227361    -1.50   0.135    -.0786508    .0105802
         dem |   .0683593   .0789815     0.87   0.387    -.0866278    .2233464
    ppincimp |   .0579788   .0092711     6.25   0.000     .0397859    .0761718
       _cons |   2.957209   .2513086    11.77   0.000      2.46406    3.450357
------------------------------------------------------------------------------
```

[9] Independent variables that were not significant based on results not shown here: mip_enviro, mip_economy, iep_globwarm, heard, ebill, use, northeast, west, ppeducat, ppage, ppgender, rep.

[10] Independent variables that were not significant based on results not shown here: mip_enviro, mip_economy, iep_globwarm, heard, ebill, use, northeast, west, ppeducat, ppage, ppgender, rep.

```
      Source |       SS       df       MS              Number of obs =    1016
-------------+------------------------------           F( 10,  1005) =   42.31
       Model |  574.398715    10  57.4398715           Prob > F      =  0.0000
    Residual |   1364.2459  1005   1.3574586           R-squared     =  0.2963
-------------+------------------------------           Adj R-squared =  0.2893
       Total |  1938.64461  1015  1.90999469           Root MSE      =  1.1651

------------------------------------------------------------------------------
ln_willing_a |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     gw_1to4 |  -.3997972   .0495989    -8.06   0.000    -.4971265   -.3024679
    bus_1to4 |  -.3607636   .0549663    -6.56   0.000    -.4686254   -.2529018
       gotit |   .0462022    .014074     3.28   0.001     .0185844    .0738199
       ebill |   .0783742   .0226628     3.46   0.001     .0339022    .1228461
     midwest |   .1008666   .0897305     1.12   0.261     -.075214    .2769472
   not_relig |  -.0552203   .0232652    -2.37   0.018    -.1008742   -.0095664
         dem |  -.0408448   .0826422    -0.49   0.621    -.2030158    .1213263
    ppincimp |   .0579653   .0091657     6.32   0.000     .0399792    .0759514
       xideo |  -.0905008   .0289819    -3.12   0.002    -.1473727   -.0336289
   sci_agree |   .3690184   .0846126     4.36   0.000     .2029807     .535056
       _cons |   3.014976    .279237    10.80   0.000     2.467021     3.56293
------------------------------------------------------------------------------
```