

# An international comparison of public attitudes towards carbon capture and storage technologies

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## Abstract

We offer a comparative study of public attitudes in the United States, United Kingdom, Sweden and Japan towards key questions of energy and the environment, with particular emphasis on attitudes towards carbon capture and storage (CCS). We find low levels of awareness, recognition or understanding of CCS and mixed views of how CCS might fit within a broader portfolio of energy technologies or as part of a national climate change policy. The results are a first effort to elicit public views and will need to be extended to other key countries and repeated at regular intervals.

**Keywords:** Public acceptance, carbon capture & storage

## Introduction

Public acceptability is widely recognized as an important element in determining the eventual fate of new technologies and carbon capture and storage (CCS) should not be an exception. Understanding of public attitudes on global warming in general and preferences and knowledge on technologies and systems to mitigate anthropogenic emissions of greenhouse gases is important as basis for decision makers developing strategies for communication with the public. However, to date, empirical studies on public acceptability remain sparse. There are a number of general studies on public awareness and attitudes towards energy and climate issues. On CCS in particular, focus group studies have been conducted to test the response of participants to information and provide a more detailed reaction to CCS. There have also recently been a number of studies that begin to offer more representative samples of public attitudes in a number of different countries. However, there are no studies comparing differences between countries in a more systematic way that include CCS.

We have recently published the results of a comparison of four public opinion surveys in the US, UK, Sweden and Japan on the question of public perceptions of global warming and energy technologies [1]. Here, we expand on that analysis, and focus on the results of those surveys as applied to CCS.

## **Previous Surveys of Lay Public Perceptions**

We begin by reviewing some recent work on public perceptions with regard to CCS conducted in both smaller settings and on representative samples. Focus group and small local surveys in the UK, US and the Netherlands have found mixed results. A Tyndall Centre study based on focus groups and 212 face-to-face interviews conducted in a UK airport found moderate support for the concept of CCS as a component in the government's long-term policy target [2]. Compared with other mitigation options, renewable energy and energy efficiency were more strongly preferred, but CCS was much preferred to nuclear power or higher energy bills. In the US, a local convenience sample of 126 individuals in the Pittsburgh area found that provision of more information led the survey respondents to actually adopt a more negative view towards CCS (described as disposal) and CCS was rated lowest of all mitigation options [3]. A Dutch study of 112 residents living in an area located above a gas field that had experienced two small earthquakes, were slightly positive about CCS in general terms, but neutral to negative about storage in the immediate vicinity of their neighborhood. Respondents thought that the risks and drawbacks were somewhat larger than the benefits to the environment and society [4].

Recent public opinion studies on CCS in Australia, Canada and the Netherlands that are meant to be representative of national or regional populations, have all found generally low levels of awareness, and a mixed or neutral to slightly positive view of CCS as a mitigation option. A survey of 900 respondents in the Brisbane/Queensland area showed just over 70% of respondents were unable to provide a correct answer to an open-ended question asking for a definition of carbon capture and storage. Nevertheless, Queensland residents were, on average, favorably inclined toward CCS when it was described, although they were much more supportive of solar and wind power, but strongly opposed to introducing nuclear power. Surveys of "informed preferences" in the Netherlands for six possible CCS options found that, on average, the informed respondents rated all six options as "adequate" (just over 6 on a scale of 1-10) [5]. Depending on the CCS option, 12% to 24% ranked the technology very positively (ranked 8, 9 or 10) and only 4% to 6% ranked the technology options negatively (ranked 1, 2 or 3). Finally, an internet-based survey of just under 2000 Canadians found that knowledge of CCS (described as 'geological disposal of carbon dioxide' or GDC) was low – even those claiming to have heard of the technology were unable to correctly identify the environmental problem it was meant to address [6]. The technology was perceived as having a net positive environmental impact, and believed to be less risky than conventional oil and gas operations, or nuclear or coal-fired power. More than half of respondents would likely use GDC (CCS) as part of a climate change strategy, although GDC was much less popular than energy efficiency or renewable energy.

In summary, it is no surprise that CCS is not well known among the public. Success or failure of the first projects may therefore have an important impact on public acceptance -- communicating with the public in a transparent manner in the course of these first projects may thus play a critical role.

## **Survey Results**

In public opinion surveys we conducted in the US, UK, Sweden and Japan, respondents were asked to describe their awareness of various energy technologies and tested on their understanding of the relationship between energy generation technologies and environmental impacts. The polls solicited views on research and development priorities, beliefs regarding both the desired and likely national approaches to tackling global warming, and energy technology preferences. Emphasis was put on

posing the same questions across all four surveys, although translation and national context led to some inevitable differences. Details of the four surveys can be found in Table 1.

The first clear result of the surveys is that there are low to very low levels of awareness regarding CCS technologies and in some countries, even those expressing familiarity do not appear to understand what problem CCS is meant to address. As seen in Table 2, “carbon capture and storage” and “carbon sequestration” both received the lowest recognition across a range of technologies. The term carbon sequestration is also problematic and generated even lower recognition in all countries except for Japan. Given the bias against admitting ignorance, these figures should be treated as upper bounds.

Table 1 Characteristics of public opinion surveys in US, UK, Japan and Sweden

Country	Method of Distribution	Sample Size & Response Rate	Female/ Male Ratio	Average Age
Sweden	Printed version of the questionnaire was sent to a sample of the Swedish population aged 18-65 [7].	742 of 1500 (49 %)	44/56	43
US	Internet poll distributed by Knowledge Networks, which has recruited an online research panel designed to be representative of the entire U.S. population. A random sample was drawn of panel members over 18 years of age [8]	1205 of 1710 (70 %)	52/48	46 (median)
UK	Internet poll distributed by YouGov, an online polling company that maintains a panel of 46,000 UK electors, recruited via non-political websites. Results are weighted based on demographic information provided by the panellists [9].	1056 of 2640 (40 %)	52/48	40-49
Japan	A multi-stage stratified sampling method from the Basic Resident Register was used to choose people who were 20 years of age or older in Tokyo and Sapporo. Surveyors visited people and asked them to participate in the survey. If they agreed, surveyors left a printed questionnaire [10].	1006 of 1 574 (64 %)	51/49	47

Table 2 Responses to: “Have you heard of or read about any of the following in the past year?” (Japanese respondents were also asked if they “know to some extent” these technologies)

Technology	UK	US	Sweden	Japan (heard or read)	Japan (know to some extent)
Wind energy	69%	50%	83%	44%	52%
More efficient appliances	40%	49%	68%	45%	38%
Nuclear energy	39%	54%	87%	41%	54%
Hydrogen cars	26%	48%	46%	45%	33%
Bioenergy/biomass	10%	10%	54%	34%	18%
Carbon capture and storage	5%	4%	15%	22%	9%
Carbon sequestration	2%	3%	8%	38%	52%

Asked to associate CCS with a particular environmental problem, US respondents (even those few that claimed to have heard or read of CCS) were unable to distinguish between the problems listed, whereas in the UK, Sweden, and Japan two to three times as many people associated CCS with reducing global warming compared with toxic waste. However, there was confusion with other air pollution problems. Although respondents in those countries recognized global warming as the leading problem, many also listed other air pollution problems such as ozone depletion and smog (see Figure 1).

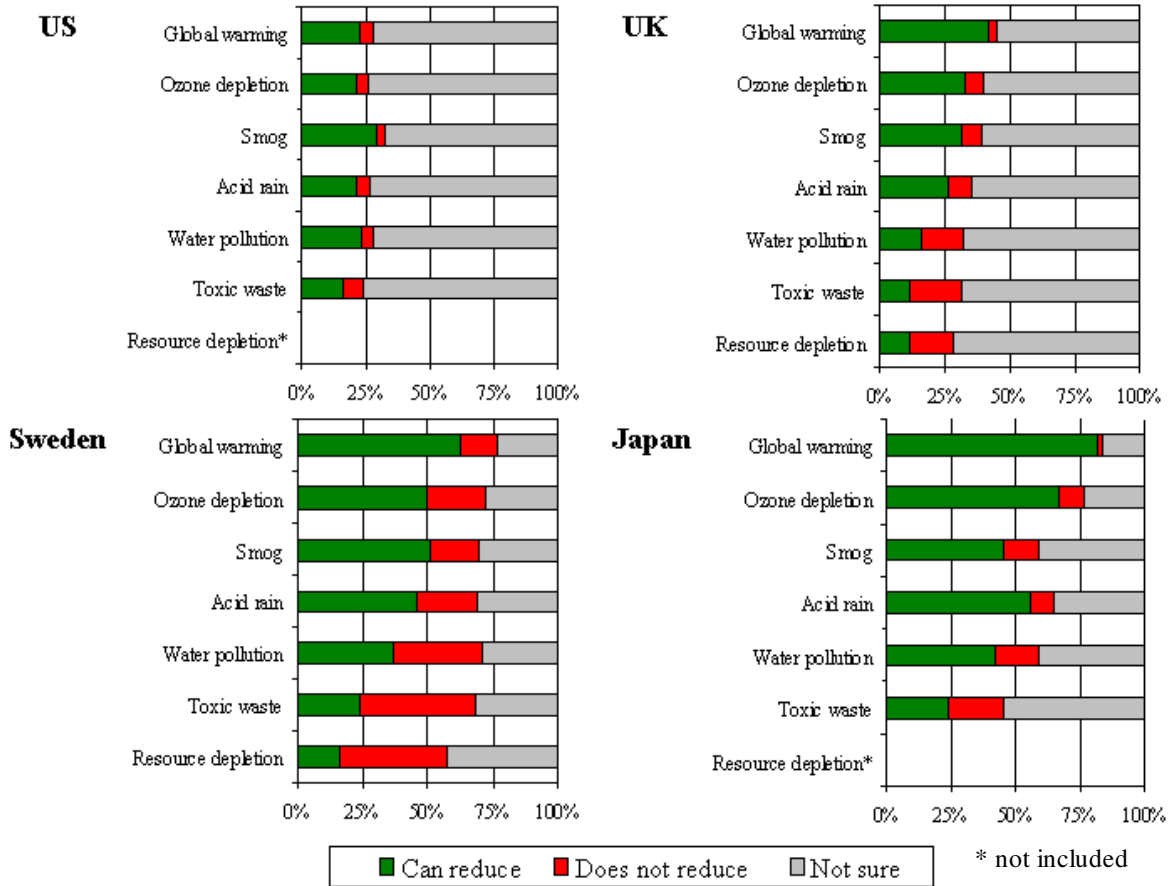


Figure 1 Responses to: “Please select if ‘carbon sequestration’ or “carbon capture and storage” can reduce each of the following environmental concerns.”

The four countries displayed similar energy technology preferences (see Figure 2). Solar energy, energy-efficient appliances and energy efficient cars all were viewed favorably by 80-90%, with virtually no one expressing negative views. Wind energy, carbon sequestration (defined here as planting trees), and biomass/bioenergy, all were viewed favorably by clear majorities and relatively few answered “definitely do not use”, but in each case a notable minority (generally in the 5-15% range) displayed at least some skepticism towards using the technology. Finally, views of nuclear energy and CCS were split. Compared with CCS, there was a slightly stronger bias in favor of “definitely not use” in case of nuclear power and notably larger numbers (in the range of 40-50%) that were “not sure” of whether to use CCS or not. Not surprisingly, given the low levels of awareness, the high levels of those not expressing a clear preference for CCS means that there is still considerable potential for the image of CCS to be shaped by key actors and the outcomes of the first projects.

With more information on costs and emissions, both nuclear and CCS improve at the expense of renewables, but even then, support for renewables remain strong. Unlike focus group studies, public opinion surveys offer a relatively limited scope for examining how information affects opinions. In the UK and US surveys, half of the respondents were given additional information on costs (i.e., costs of renewables are substantially higher than competing technologies) and environmental impacts (e.g., nuclear power does not produce CO<sub>2</sub>) as a means of testing the strong opinions in favor of renewables.

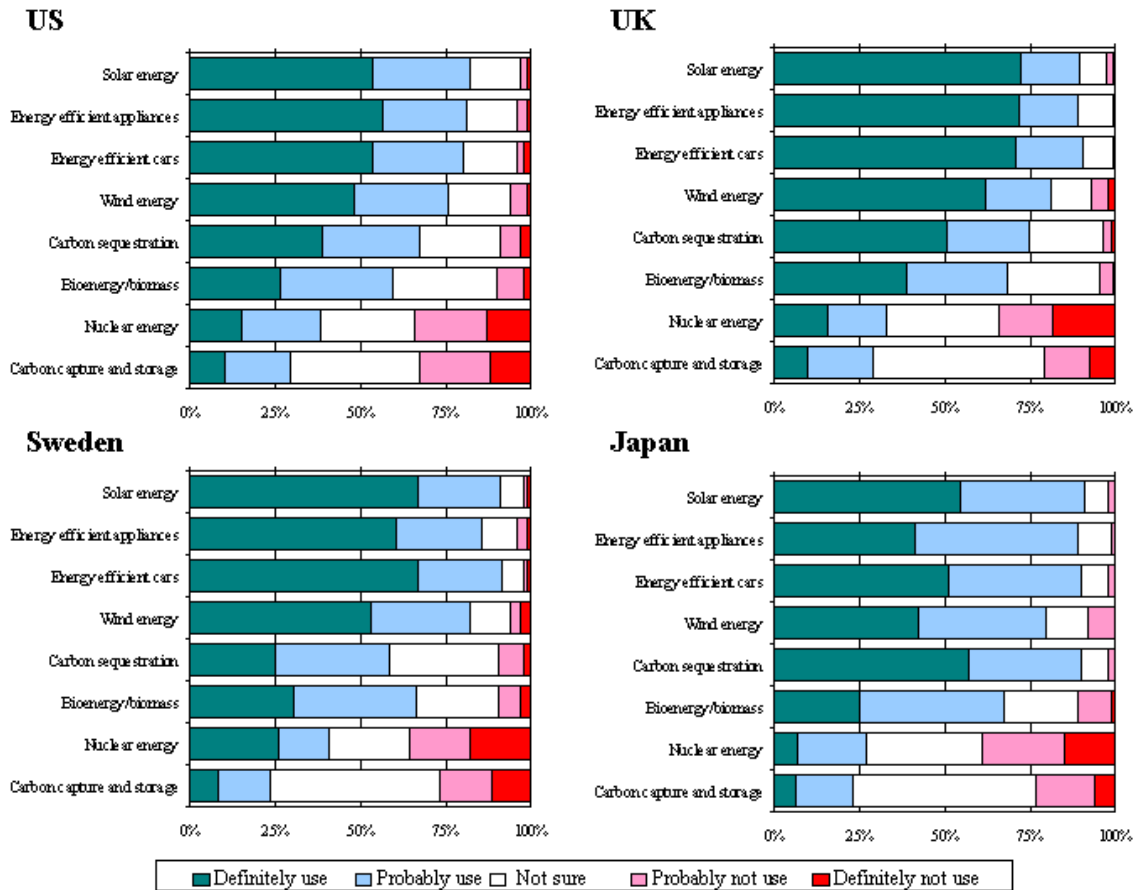


Figure 2 Responses to: “The following technologies have been proposed to address global warming. If you were responsible for designing a plan to address global warming, which of the following technologies would you use?”

Support for increasing renewables decreased from 46% to 40% in the UK and 49% to 25% in the US. In the UK, support for expanding nuclear power doubled (from 9% to 18%) and support for CCS went from 1% to 10%, while in the US, those figures increased from 7% to 11% and 6 to 16% respectively. Some would argue, therefore, that education will improve the willingness of the public to consider nuclear or carbon capture, but one might equally acknowledge the strength of support for renewables even amongst a group where these persistent misperceptions were corrected.

Another challenge for CCS, and indeed any other climate-friendly technology, is that greener electricity will lead to higher electricity prices for consumers. Unfortunately, widespread approval for taking action on climate change or in support of renewables does not mean that the public will support spending more on their electric bill. A recent Eurobarometer study found that over half of European citizens were unwilling to pay anything additional for renewable sources of energy [11]. Asked how much they would pay on top of their existing electric bill to “solve global warming”, 14% of

respondents in Japan, 24% in the US, 22% in Britain, and 43% in Sweden refused to pay *anything* extra (although Swedes do already pay the highest electric bills as a fraction of income). Less than 10% in each survey expressed a willingness to pay more than the equivalent of \$50 per month. More generally, there was remarkable similarity in the willingness to pay across countries. Answers may well differ depending on whether willingness to pay is linked to their electric bill or is asked more generally.

## Next steps

Given the low levels of awareness found in the surveys, and the rapid growth in interest in the area of CCS by governments, firms, and even the media and non-governmental groups, one obvious next step is to repeat the surveys at regular intervals to begin to understand how the public's views with respect to CCS and how CCS fits into a portfolio of options might be changing over time.

With respect to the existing datasets, further analysis still needs to be done to relate the answers describing technology preferences to the questions that test respondent knowledge (such as the type of environmental problem addressed by CCS). Does better understanding of a technology necessarily lead to support for a technology? We also will seek to explore the determinants of willingness to pay by investigating the role played by key demographic variables and results of other survey questions.

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