Attitudes towards Carbon Capture and Storage in Norway

Anders Berg-Hansen

Master's Thesis

Department of Psychology

Norwegian University of Science and Technology

April 2011

PREFACE

Studying a topic of current interest feels very rewarding. Social science will be increasingly important for facing future challenges of climate change, and I am happy for all I have learnt through working with this thesis.

There are several persons I would like to thank. First of all, thanks to Gassnova for providing me the financial support that made it possible to carry out a broad public survey. Special thanks to my advisor Mons Bendixen for helpful support and suggestions. Thank you, Carl Erik Leitao, for reading my thesis and giving me valuable feedback. I would also like to thank Sturle Danielsen Tvedt at NTNU and Hans Torvatn at Sintef for being cooperative when I developed my questionnaire.

Finally, I would like to thank my friends and my family. My classmates at HOK-07 deserve special recognition – they made my time in Trondheim the most memorable of my life. And of course, thank you Sara for supporting me through two years of hard work, stress, anger, frustration… and good times!

Anders Berg-Hansen

ABSTRACT

This study presents the results of a 2010 Internet survey conducted on 999 Norwegian citizens aiming to investigate and explain the main determinants of public attitudes towards carbon dioxide capture and storage (CCS), a technology considered crucial for mitigating adverse consequences of global climate change. The results confirmed the main hypothesis, in line with previous research based on risk psychology and the risk-benefit model: Attitudes towards CCS were positively related to benefit perceptions and negatively related to risk perceptions, but this study found benefit perception to be a stronger predictor of attitudes than risk perception. Clear relationships were also found between attitudes towards CCS and other predictor variables. Perception of CCS as an interference with nature was negatively related to attitudes, while general trust in science and technology, a concept labeled epistemic trust, was positively related to attitudes towards CCS. Based on the results, epistemic trust seemingly was a more important predictor than social trust. Climate change concern did not directly predict CCS attitudes, but mediation analysis revealed an indirect relationship through benefit perception. Ecological concern, as measured by The New Ecological Paradigm Scale, was not a significant predictor of attitudes towards CCS and neither were knowledge of environmental issues, climate change or the CCS technology. Knowledge was, however, negatively related to risk perception. The results and future implications are discussed.

CONTENTS

BACKGROUND

Global climate change

According to the Fourth Assessment Report of the United Nations initiated Intergovernmental Panel on Climate Change (IPCC), "most of the observed increase in globally averaged temperatures since the mid-twentieth century is very likely due to the observed increase in anthropogenic greenhouse gas concentrations" (IPCC, 2007, p. 39). The report states that global emissions of greenhouse gases due to human activities have grown since pre-industrial times with an increase of 70% between 1970 and 2004. Increasing concentrations of greenhouse gases in the atmosphere are expected to cause significant changes in global climate systems. These changes will bring along adverse effects on the natural and human systems through sea level rise, more frequent and more intense extreme weather events and negative impacts on the health status of millions of people (IPCC, 2007). Extended analysis of observation data show that significant changes in physical and biological systems are already occurring on all continents and in most oceans (Rosenzweig et al., 2008). The Stern Review, one of the most widely cited reports on the issue, concludes that avoiding the worst impacts of climate change still is attainable and that "the benefits of strong, early action considerably outweigh the costs" (Stern et al., 2006).

Carbon capture and storage

The growing certainty of climate science has caused governments worldwide to look for solutions to mitigate unwanted consequences of climate change through reducing emissions of greenhouse gases. As carbon dioxide (CO_2) is regarded the most important anthropogenic greenhouse gas (IPCC, 2007), one proposed option is capturing and storing CO_2 underground, a technology known as carbon dioxide capture and storage (CCS). The IPCC Special Report on CCS predicts this technology to be able to contribute to 15-55% of the cumulative CO_2 mitigation effort worldwide within this century (Metz, Davidson, De Coninck, Loos, & Meyer, 2005). In most future scenarios CCS is considered a critical part of the range of actions and technologies needed for reducing greenhouse gas emissions (International Energy Agency [IEA], 2010; McKinsey & Company, 2008; Metz et al., 2005; Stern et al., 2006). Nevertheless, public acceptance is recognized as one of the main challenges for the future adoption of CCS (Ashworth, Boughen, Mayhew, & Millar, 2010; Gibbins & Chalmers, 2008; Organisation for Economic Co-operation and Development [OECD]/IEA, 2007).

Opposition against CCS. Public protests against CCS are already taking place. In the Dutch town of Barendrecht, even the local city council objected plans for CO_2 storage in the area (Slavin & Jha, 2009). Royal Dutch Shell, the world's largest oil company, had plans to store 300,000 tons of CO_2 annually in a depleted gas reservoir, 1,800 meters below Barendrecht. The plans were recently cancelled due to lack of public support ("Dutch drop plan", 2010). In Germany citizens have established a protest group to stop the energy company Vattenfall's plans to store CO_2 from a coal power plant in the Brandenburg region (CO_2 Endlager Stoppen, 2010). The protesters argue that the potential risks of CO_2 storage are not properly understood nor fully investigated. They fear interferences with geological formations, contamination of drinking water and loss of land value. American citizens have started a local opposition group against CO_2 storage in Greenville, Ohio, while also developing a website to gather CCS protesters worldwide to form a global movement against the technology (Citizens Against CO_2 Sequestration, 2010).

In 1999, a multinational research group, including the Norwegian Research Council, were about to start a project for testing CO_2 storage in the deep ocean near Hawaii. In this variant of the technology, captured CO_2 is directly injected into the ocean at great depth, where most of the liquid is expected to remain isolated from the atmosphere for centuries (Metz et al., 2005). After the plans were revealed in a local newspaper article, a few individuals organized in an effort to stop the project (De Figueiredo, Reiner, & Herzog, 2003). Their motivation was based on environmental concerns, "not-in-my-backyard" concerns as well as a distrust of scientists due to past scientific experiments in the area. Because of the public opposition, the experiment eventually was discontinued. Lack of perceived benefits combined with many potential risks was seen as a major obstacle for Hawaiians to accept the test. A few years later, the research group wanted to do the same ocean storage experiment in the Norwegian Sea outside Kristiansund (Tjernshaugen, 2007). Even though there were no local protests, the experiment was not carried out. During the summer of 2002 activists aboard the Greenpeace ship Rainbow Warrior anchored in Oslo drawing media attention to protest the CO_2 experiment. They succeeded, as then Minister of the Environment in Norway, Børge Brende, put the project to a stop.

Norway and CCS. Currently, numerous demonstration projects on CO_2 capture and geological CO_2 storage are being planned worldwide, but so far only a small number of plants have been put in large-scale commercial operation (National Energy Technology Laboratory, 2010). Two of these are located in Norway and operated by the Norwegian state-owned energy company Statoil. The world's first large-scale CCS project with the intention of

reducing greenhouse gases was Statoil's CO_2 capture project from the natural gas production at the Sleipner platform, started in 1996. Since then, Statoil has been storing one million tonnes of CO_2 every year in the Utsira formation, a porous layer of sand rock filled with salt water, under the North Sea (Statoil, 2009; Torp & Gale, 2004). Another operating CCS plant is the natural gas facility Snøhvit, located outside Hammerfest in Northern Norway. A third storage site in Algeria, the In-Salah Gas Storage Project, is co-operated by Statoil. The state-owned oil company is furthermore responsible for the construction of a full-scale CO_2 capture facility at Mongstad in Hordaland. The company Naturkraft, owned by Statoil and Statkraft, is planning CO_2 capture from Norway's largest gas power plant at Kårstø in Rogaland (Naturkraft, 2010).

To sum up, Norway is at the forefront of technological development of CCS. And political support is also in place: Through a multi party compromise agreement the Norwegian parliament has passed goals of making Norway "carbon-neutral" by 2030 and to reduce Norway's CO_2 emissions with 30% by 2020 (Regjeringen, 2008). In this agreement CCS is pointed out as a key ingredient in Norway's climate change mitigation efforts. But for moving from a few local demonstration projects to global implementation, public support is needed.

THEORY

The CCS technology

Before discussing how the public perceive this technology, a basic understanding of the technical principles is needed. Easily explained, CCS is a three-step process of capturing, transporting and storing CO_2 gas with the aim of retaining it from the atmosphere. The technology is intended for large point sources of CO_2 emission, including fossil fuel energy facilities, major CO_2-emitting industries and natural gas production (Metz et al., 2005). Relevant fossil fuel energy facilities are especially coal and gas power plants. Injection of CO_2 into subsurface geological formations has also been used in enhanced oil recovery for a long time. The first step of CCS is capturing CO_2 from the flue gases of energy production or industry facilities. Today's available technology captures about 85-95% of the CO_2 processed in a power or industry plant. When captured, the CO_2 is compressed into high density, to a supercritical fluid (a liquid-like density between gas and fluid), and transported by pipelines or ships to storage locations. Suitable storage locations include depleted oil and gas reservoirs and deep saline formations (underground layers of permeable reservoir rock, such as sandstones, that are saturated with very salty water). At depths below 800 meters, CO_2 will be prevented from migrating to the surface by various physical and geochemical trapping mechanisms, most importantly by a well-sealed cap rock over the storage reservoir. As long as the site is carefully selected, CO_2 can remain trapped for millions of years, as evidenced by oil and gas fields (Metz et al., 2005).

Technical risks. Some potential health risks to humans are associated with the CCS process. Currently, the leading technology for CO_2 capture is through the use of amines. Researchers have recently looked into possible health effects from amines and degradation products of amines in the capture process (Låg, Andreassen, Instanes, & Lindeman, 2009). Evaluations suggest that while amines themselves are not dangerous, some of the degradation products may pose a hazard to humans. One group of degradation products, so-called nitrosamines, is pointed out as carcinogenic (capable of causing cancer). Nitrosamines are a large and diverse family of synthetic and naturally occurring compounds. Even though they are suspected to be human carcinogens, direct causal associations have not yet been found. Data on health effects of the specific degradation products are still sparse and this issue will need further study. Besides, there are different types of capture technologies, other than the amine method. Details of the different technologies, however, are beyond the scope of this thesis (for a full review, see Metz et al., 2005).

CO_2 is an essential substance in the atmosphere and required for photosynthesis to happen in nature. Still, an uncontrolled CO_2 leakage may create a dangerous situation, and a sudden and large release of CO_2 would pose an immediate threat to human life and health (Metz et al., 2005). While the normal atmospheric concentration of CO_2 is 0.037%, for most people exposure of up to 0.5-1.5% CO_2 for an hour or more will do no harm. From 7-10% concentration CO_2 can lead to unconsciousness, asphyxiation and death. Thus, local high CO_2 concentrations in the air could harm animals or humans. Such scenarios would be especially dangerous if CO_2 were to be released in lowland areas, because CO_2 is heavier than air and will float downwards. Any transportation of liquid or gas can cause leakage, i.e. emissions of CO_2 in the air. The chance for this to happen is very small since such pipelines have been routinely used for many years and will be subject to monitoring. Thousands of kilometers of CO_2 pipelines already exist throughout the world, and according to the IPCC Special Report on CCS, accident numbers are very low and comparable to those for oil and natural gas pipelines (Metz et al., 2005). Norway already has a number of existing oil and gas pipelines.

CO_2 might also leak from a storage site. Concern for leakage has been a main problem for achieving public acceptance in other countries (CO_2 Endlager Stoppen, 2010; Slavin & Jha, 2009; Citizens Against CO_2 Sequestration, 2010; De Figueiredo et al., 2003). Furthermore, CO_2 injection could cause a built-up pressure which eventually could trigger small seismic events. Still, the risks of CO_2 storage, when properly managed, are comparable to the risks of current activities such as natural gas storage. Besides, with offshore storage human risks are minimized as compared to onshore storage (Metz et al., 2005). Experts now consider the risks of CO_2 storage to be acceptable: "Observations from engineered and natural analogues as well as models suggest that the fraction retained in appropriately selected and managed geological reservoirs is very likely to exceed 99% over 100 years and is likely to exceed 99% over 1,000 years" (Metz et al., 2005, p. 14). In IPCC terminology 'likely' refers to a probability between 66 and 90% and 'very likely' is a probability between 90 and 99%.

If CO_2 were to leak from a geological reservoir this could also have environmental impacts. CO_2 leakage to seawater will have consequences like water acidification, which in turn could affect the structure and diversity of coastal sediment communities (Widdicombe et al., 2009). However, in a recent simulation series of the North West European continental shelf (the area where Statoil's Sleipner is operating) only the most extreme leakage scenarios tested were capable of producing environmental consequences beyond the locality of a leak event (Blackford et al., 2009). Some possibility of leakage notwithstanding, most scientists regard CCS safer than carrying on with today's levels of global CO_2 emissions. In any

scenario, the environmental repercussions of *not* capturing and storing CO_2 are expected to be greater than those created by potential leaks, because of the anticipated negative consequences of human contribution to the greenhouse effect (Blackford et al., 2009; IPCC, 2007; Widdicombe et al., 2009). A study using an actuarial approach compared expected fatalities from global implementation of CCS with fatalities from climate change occurring if CCS is not implemented (Ha-Duong & Loisel, 2010). The conclusion of this study is that realization of CCS is likely to save thousands of lives until 2050, the date recognized by the United Nations to which a 50% greenhouse gas reduction below 1990 levels is needed. Even though not fully certain on the risks and the necessity of CCS, science seems to point in the direction that CCS is an important part of the total effort needed to combat global climate change. Nevertheless, the way people perceive risks and technologies do not always mirror objective reality.

Social cognition and attitude formation

In their theoretical model for attitudes and social judgment, Chen and Chaiken (1999) separate between two basic modes of human information processing: systematic and heuristic. Analyzing and considering a wide amount of judgment-relevant information is called systematic processing. Judgments made this way are responses to actual information. This type of processing requires both cognitive ability and capacity. Heuristic processing, on the other hand, is fast and makes minimal cognitive demands. This is because heuristic processing activates pre-learned judgmental rules, known as heuristics. The assumption that "expert statements can be trusted" is an example of such a judgment-relevant cue that can guide people's decision making. Activation of heuristics, however, requires that they are stored in memory and can be retrieved and used whenever needed. Underlying the heuristic-systematic model is the assumption that human cognition is guided by a principle of sufficiency. The model asserts that "perceivers attempt to strike a balance between minimizing cognitive effort on the one hand and satisfying their motivational concerns on the other" (Chen and Chaiken, 1999, p. 74). Based on a judgmental continuum the model states that people will exert cognitive effort until the gap between their actual confidence and desired confidence (sufficiency threshold) is closed. When heuristic processing is sufficient – and heuristic cues are available, accessible and applicable – perceivers are not motivated to engage in systematic processing. If heuristic processing fails, effortful systematic processing is more likely to occur.

The heuristic-systematic model is closely linked to other dual-model theories of social cognition, particularly the elaboration-likelihood model (Petty & Cacioppo, 1986). The latter model, however, does not permit the co-occurrence of systematic (central) and heuristic (peripheral) processing. The present study will build on the additivity hypothesis: the assumption that people in some situations may use both systematic and heuristic processing, that is, they analyze information as well as rely on cues like trust (Chen & Chaiken, 1999).

Risk perception

Risk is defined as "the probability of a particular adverse event occurring during a stated period of time" (Breakwell, 2007, p. 2). This definition is split into two dimensions: probability and effect. While probability has to do with the likelihood of a specific negative event resulted by exposure to a hazard, effect refers to the (numerically estimated) extent of the harm caused by the adverse event. Breakwell (2007) propose that risk, as a social psychological construct, should be studied in a framework spanning from the intra-psychic individual level to the societal structural level. The psychometric paradigm of risk perception, making the foundation for the present study, has a focus on intra-psychic processes but also aims to study how these are influenced by "a wide array of psychological, social, institutional and cultural factors" (Slovic, 2000, p. xxiii). A typical method of studying risk perception under the psychometric paradigm is by the use of self-report inventories, where people are simply asked to respond to a fixed set of questions (Breakwell, 2007). Often cited as originators of this paradigm, Slovic, Fischhoff and Lichtenstein (1982) stress that in all situations, no matter the amount of statistical data at hand, some human judgment is always needed when making decisions and judging probabilities. Despite being valid in many circumstances, these human judgments are often biased.

Heuristics and biases. Research on judgment biases leads us to the work of Tversky and Kahneman (1982), who demonstrated that people rely on a limited number of rules when assessing probabilities of uncertain events. These rules are called heuristics, and they will often lead to cognitive biases or fallacies. This explanation of the term heuristic pretty much fits into the mentioned heuristic-systematic model of Chen and Chaiken (1999) and other dual-process theories (Kahneman & Frederick, 2002). Heuristics has the function of reducing complexity in uncertain situations. Thus, people make use of these heuristics in risky situations (Slovic et al., 1982). The availability heuristic is said to have special relevance for risk perception. People make use of this rule when they judge an event as likely or frequent because an instance of the event is easily recalled or imagined. The availability heuristic is

often very helpful to humans, because frequently occurring events are generally easier to recall and imagine than rare events. However, availability is not always a useful cue for estimating probabilities. As an example, if you watched the movie Jaws last night you are more likely to misperceive (overrate) the probability of a shark attack on humans (Slovic et al., 1982). If a leakage from an operating CO_2 storage site were to happen right now, people would, according to the availability heuristic, overestimate the risk for such an event to happen again, because this event is easily available.

Risk acceptability. Studies on laypeople's risk perception often try to determine to which degree a risk is acceptable to people (Breakwell, 2007). Knowledge of the extent to which citizens accept or reject a risk, such as the implementation of a new technology, is crucial in modern democracies. Acceptability is normally tied to perceptions of risks and benefits: Higher perceived benefit and lower perceived risk, will lead to more acceptance for a hazard. Furthermore, Alhakami and Slovic (1994) demonstrated the inverse relationship between these concepts: An activity or object rated high in risk tends to be rated low in benefit, and vice versa.

The psychometric paradigm. Through factor analysis, Slovic et al. (1982) reduced a list of 18 risk characteristics down to three factors: dread, familiarity and number of people exposed. A risk rated high on the dread dimension would be uncontrollable, have a catastrophic potential, and its consequences would be fatal. Dread also refers to risks posed to future generations, risks that are not easily reduced, and risks that are involuntary. The familiarity dimension includes observability, knowledge, immediacy of consequences and novelty of the risk. In the psychometric paradigm of risk perception, hazards can be placed in a two-dimensional space where the end of one axis represents unknown risk (familiarity), and the other dread risk. Nuclear power is commonly understood to score high on both factors, while day-to-day activities such as riding a bicycle are low on both dimensions. Hazards rated low on both unknown risk and dread risk, are more willingly accepted by the public. The third factor, number of people exposed, are considered relatively independent of the others (Slovic et al., 1982). In the case of CCS, Singleton, Herzog and Ansolabehere (2009) compared the risks of the technology to those of other hazards through a theoretical psychometric analysis. The authors based their analysis on literature review and qualitative assessment, not on public perception surveys (which is a more common basis for such analyses). They postulate that CCS has more of the characteristics "new risk" and "risks unknown to science" than for example radioactive waste. Moreover, CCS is rated lower or on level with radioactive waste on twelve risk characteristics. CCS was also compared to other hazards and was predicted to

have less perceived risk than nuclear technologies, but could be perceived more risky than fossil fuels, coal burning pollution, and other broadly accepted technological hazards.

Awareness and knowledge

So far, about 30 studies of attitudes towards CCS have been conducted around the world (Ashworth et al., 2010). Most of these are questionnaire surveys, and the general finding is that the public has low awareness and knowledge of CCS (Ashworth, Pisarski, & Littleboy, 2006; De Best-Waldhober, Daamen, & Faaij, 2009; Duan, 2010; Ha-Duong, Nadai, & Campos, 2009; Huijts, Midden, & Meijnders, 2007; Miller, Summerville, Buys, & Bell, 2007; Reiner et al., 2006; Sharp, Jaccard, & Keith, 2009; Tokushige, Akimoto, & Tomoda, 2007; Wallquist, Visschers, & Siegrist, 2010). In a 2003 survey, Reiner et al. (2006) measured public attitudes towards CCS in the United States, the United Kingdom, Japan and Sweden. The samples, sizes ranging from 742 to 1205 respondents, were drawn from internet-based panels (U.S. and U.K.), randomly selected households (Sweden) and through a multi-stage stratified sampling method in two cities (Japan). Only a minority of the respondents had ever heard or read about CCS, from 22% of the Japanese respondents to merely 4% of the American sample. Respondents, especially the Americans, also had difficulty associating CCS with the environmental problem it is meant to address, implying little knowledge of this technology. A 2006 follow-up study in the U.S. indicated that awareness and knowledge of CCS were still low, with only 5% of respondents reporting that they had ever heard of the technology (Curry, Ansolabehere, & Herzog, 2007). Climate change is often mixed up with ozone layer depletion and other environmental problems (i.e. Leiserowitz, 2007). Confirming this confusion, Curry et al. (2007) found that there was no consensus among respondents when asked to identify what environmental problem CCS was meant to address, even within the small group who claimed to be familiar with the technology. However, results from the follow-up study showed a significant increase in public concern for global warming and willingness to pay for global warming mitigation, from 2003 to 2006.

In an Australian research project, random samples of 900 citizens were drawn from the Queensland region (Ashworth et al., 2006). The study measured knowledge of and opinions towards climate change and various energy technologies. From 70.7% to 72.5% of the respondents did not know that CCS has a potential role in reducing greenhouse gas emissions. A number of open ended responses further demonstrated lack of knowledge about CCS. In another Australian survey, Miller et al. (2007) revealed that the majority of the respondents

(1273 Australian adults, not representative of the population) lack knowledge about CCS: Only 18% had heard about CCS prior to the study.

Even in Canada, a country hosting one of the world's few existing CCS demonstration projects, awareness and knowledge is low: Only 10.5% of the Canadian population had heard about CCS (Sharp et al., 2009). In Alberta and Saskatchewan, two provinces pushing on CCS development in Canada, 15.4% reported to have heard of CCS. However, when asked to identify what environmental problem CCS was meant to address, only 5.6% and 6.2% of the sample, respectively, was able to provide the correct answer (climate change). A larger part of the respondents thought the technology was a solution for the hole in the ozone layer.

The results of a focus group series in Spain, conducted in 2007 and 2008, confirmed that CCS is widely unknown among laypeople (Oltra, Sala, Solà, Di Masso, & Rowe, 2010). Participants could eventually engage in discussion about CCS after receiving extensive explanation about the technology. Offering brief information, such as a diagram, was not sufficient for the participants to understand the concept.

In a survey on a representative sample of the French population, 34% of the respondents reported that they had heard of CO_2 storage (Ha-Duong et al., 2009). An open-ended follow-up question, however, revealed that only about 6% of the respondents were able to offer a correct definition of the technology.

Norwegians, on the other hand, seem to be more familiar with CCS compared to citizens in other countries. Through the FENCO-ERA research project, surveys were conducted during the winter of 2009-2010 in six European countries: Germany, the U.K., Greece, the Netherlands, Romania and Norway. The Norwegian survey, administered by SINTEF, was replicated twice: in November 2009 and in January 2010. In the January survey 62.6% of the respondents reported to have heard of CCS (Pietzner et al., 2010). (Data from the November survey is as yet unpublished but will be briefly presented in the Results section of this paper.) Importantly, the Norwegian numbers are not all comparable to other results as different surveys give somewhat different questions and response alternatives. The results can still be compared to the other countries participating in the FENCO-ERA project; Germany (38.0%), the U.K. (38.1%), Greece (23.5%), the Netherlands (50.0%), and Romania (24.3%). Clearly, the awareness rate is highest among Norwegians. Interestingly, a comparison of the general public in Norway with a sample from the Rogaland region (hosting the Kårstø plant and being very familiar with oil and gas exploration) showed almost no difference in attitudes towards CCS, and only small differences in risk and benefit perception (Terwel et al., 2009).

Information experiments. Some earlier studies have also experimentally measured how information can affect attitudes of the respondents. Half of the U.S. and U.K. samples in the Reiner et al. (2006) study were provided with information, and results showed that this information led to increased support of CCS from 6% to 16% and 1% to 10%, respectively. The mentioned French survey also employed a similar information experiment (Ha-Duong et al., 2009). Respondents in this study, interviewed face-to-face, were provided with information at two points in the questionnaire. Before they answered any questions, they read information presenting the principle of CCS technology, rather positively framed. They were then asked about their approval or opposition to CCS. Later on in the questionnaire, they were provided with more information, focusing more specifically on the risks and potential adverse consequences of CCS, before a final approval rating. Approval rates dropped from 59% being positive before the risk information, to 38% after.

Results from the FENCO-ERA project showed that the Norwegian survey respondents apparently were not very much influenced from reading positively or negatively skewed information about CCS (Pietzner et al., 2010). The respondents were placed in one of four experimental conditions where they received positive or negative information about CCS. In the two positive conditions, half of the participants were told the oil company Shell was the source of information while the other half was not provided with a specific source. In the negative conditions, half of the participants were told the environmental group Greenpeace was source of information while the other half had no information source cited. Only in the positive information conditions the attitude-change scores differed significantly from zero (in a positive direction), and the mean absolute change was a mere .33 and .38 on a 1-7 response scale. Attitude change furthermore did not depend on information source for the Norwegian respondents.

Non-attitudes. Even though only a minority in some countries reports to be familiar with CCS, most of them still offer their opinion of the technology. A study in the Netherlands found CCS to be unknown by most of the public: 76% indicated they knew nothing or very little about CCS, but the majority, 61%, was happy with only a little information to base their opinion on (Huijts et al., 2007). Another Dutch survey demonstrated that public opinions of CCS are unstable and can easily be changed within minutes (De Best-Waldhober et al., 2009). Such uninformed opinions are known as non-attitudes, a term originating from Converse (1970). Converse argued that the majority of the public does not have preexisting opinions on most issues and therefore responses to survey questions lack stability. This has led some to put forward that traditional surveys are not an appropriate research methodology to

investigate public opinions of CCS (Malone, Bradbury, & Dooley, 2009; Malone, Dooley, & Bradbury, 2010). Instead, these researchers suggest that the public should be involved in other ways, e.g. through citizen panels or special types of questionnaires containing very comprehensive information that forces them to build attitudes (Price & Neijens, 1997; Price & Neijens, 1998). They recommend not simply measuring attitudes at present time, but instead trying to predict, or even influence, future attitudes. However, the intent of this thesis is not to influence the public but to establish some initial insight into the present Norwegian situation. Furthermore, studies suggest the Norwegian public has a much larger awareness and knowledge of CCS than other populations (Pietzner et al., 2010). Norwegian respondents also did not change their attitude as much as other respondents in the information experiment conducted as part of the FENCO-ERA survey.

Even if attitudes are unstable, they still represent "the voice of the people" which is fundamentally what modern democracies base their decisions on (Berg, 2009). Instead of focusing on stability of attitudes within one questionnaire, what is more interesting is the stability of attitudes over time. Attitudes may vary considerably within one sample but may still be stable in the population when measured over a prolonged time period. Although the present study is not longitudinal, results from three large-sample surveys at different points in time, as will be presented in the Results section, will be valuable when making assumptions of the population's attitude.

Attitudes towards CCS

Overall, public samples seem to be neither very negative nor very positive when asked about attitudes towards CCS (e.g. Ashworth et al., 2006; De Best-Waldhober et al., 2009; Duan, 2010; Ha-Duong et al., 2009; Huijts et al., 2007; Miller et al., 2007; Reiner et al., 2006; Sharp et al., 2009; Tokushige et al., 2007). As described in the previous section, providing information to respondents can affect their opinions. Another general finding is that CCS is less popular than renewable energy technologies like wind and solar power.

Comparison of energy technologies. Reiner et al. (2006) asked respondents from the U.S., the U.K., Japan and Sweden to rate their preference for CCS and other energy technologies. The respondents had a similar view on technology preferences, with solar energy and energy-efficient appliances and cars being viewed favorably by at least 80-90%. About 40-50% of the respondents stated that they were not sure about whether or not they wanted to use CCS as a measure to combat global warming. Those who had an opinion were about evenly split between positive and negative attitudes. Similarly, a U.S. study found solar,

hydro and wind power to be more popular (Palmgren, Morgan, Bruine de Bruin, & Keith, 2004). This study involved 126 convenience sampled individuals from the Pittsburgh area, and the respondents were provided with basic background information before the survey. A new study from the Pittsburgh area asked 60 participants to rank ten energy technology options and seven low-carbon energy portfolios aimed at reducing greenhouse gas emissions (Fleishman, Bruine de Bruin, & Morgan, 2010). Participants read information materials before answering questionnaires. Energy efficiency, defined as cutting electricity use, was clearly the most preferred technology option, followed by nuclear energy, a specific type of coal power plant technology with CCS and wind energy. The most favored portfolio also included these technologies.

Respondents in a Canadian study, using both focus groups and the survey approach, were slightly in favor of CCS (Sharp et al., 2009). More than half of the survey sample would include CCS in a strategy for combating climate change. Energy efficiency and renewable energy were however more popular solutions than CCS.

Shackley, McLachlan and Gough (2004) held two citizen panels in the U.K. in 2002 and 2003. Without any information, participants were at first neutral or slightly skeptical towards CCS, but after being informed people were generally slightly supportive. Acceptance, however, depended upon CCS being seen as part of a wider strategy for cutting greenhouse gases. The researchers did a survey based on the findings from the citizen panels. Of a convenience sample of 212 persons, about half of the respondents answered that they did not know (25%) or were neutral (23%) to the concept of CCS. In an open-ended question of what negative effects they could imagine coming from CCS, the most frequent answer was leakage (49%), followed by effects on ecosystems (31%). When getting more information about the technology more respondents changed their opinions to being more positive (50%) than to being more negative (16%).

Norwegian attitudes towards CCS. Only one study has so far mapped public attitudes towards CCS in Norway, the earlier mentioned FENCO-ERA survey (Pietzner et al., 2010). In the results from the January 2010 survey, 10.5% of the respondents were strongly in favor of a CCS demonstration plant, while 6.1% would strongly reject such a proposal. 34.8% were neutral. The Norwegian responses were quite similar to those of Germany, the U.K. and the Netherlands. The mean attitude rating of proposed plans for a CCS plant was just above the middle/neutral point. Norwegians rated the associated risks of CCS lower than other respondents, but they also rated the benefits lower (Reiner et al., 2010). Norwegians had the

lowest risk-to-benefit-ratio of the six national samples, suggesting they judged the benefits to outweigh the risks.

Shortcomings of previous studies. To a large extent, published articles on attitudes towards CCS have focused on descriptive statistics. Most of them are done as part of applied research projects, often commissioned by national energy departments or agencies, or energy companies. The consequence is that a majority of the studies are limited to socio-demographic variables, while dismissing risk perception theory and more thorough analyses. A few studies try to determine factors influencing attitudes (e.g. Huijts et al., 2007; Tokushige et al., 2007). Yet these studies are not using samples representative of their populations. While Huijts et al. (2007) handed out their questionnaire to 103 citizens in two selected Dutch towns Tokushige et al. (2007) sampled Japanese university students. Hopefully, the present study will shed some more light on what factors shapes attitudes towards CCS. Wallquist et al. (2010) did a survey on a representative sample of the Swiss population but did not focus on attitudes but on the determinants of risk and benefit perception.

Risk and benefit perceptions. As described by Alhakami and Slovic (1994) there is an inverse relationship between risk perceptions and benefit perceptions, and these concepts furthermore predict approval of or attitude towards a technology. Tokushige et al. (2007) put five factors through a covariance structure analysis. They found risk and benefit perceptions to be directly related to attitude towards CCS, while three other variables were indirectly related to attitude. These three variables – trust and perceptions of human interference with the environment (one each for CO2 storage and global warming, respectively) – were mediated by risk and benefit perceptions. The results showed that benefit perception influenced acceptance most strongly, but risk perception also had a significant influence on attitude.

Huijts (2003) also found risk and benefit perceptions to be important predictors of attitude towards CCS. She suggested a model, similar to that of Tokushige et al. (2007), where risk and benefit perceptions mediates factors like trust and affect. The FENCO-ERA research project confirmed a similar model: perceptions of risks and benefits are inversely related, and they both influence acceptance of CCS (Pietzner et al., 2010). Other factors, e.g. trust, have an impact on risk and benefit perceptions. Similar models have been found statistically significant in domains such as gene technology (Siegrist, 2000).

CCS is not a sustainable technology, and Wallquist et al. (2010) found unsustainability ("socioeconomic concerns") to be a strong predictor of both risk and benefit perceptions.

Perceptions of storage mechanisms, fear of leakage and overpressurization were other significant factors.

Social trust and epistemic trust

When estimating the risks and benefits of CCS, trust in others may be used as a heuristic for reducing cognitive load. Several studies have found trust to be positively correlated with acceptance of hazards like nuclear waste repositories (Kunreuther, Easterling, Desvousges, & Slovic, 1990), gene technology (Siegrist, 2000) and mobile phone base stations (Siegrist, Earle, Gutscher, & Keller, 2005). Likewise, distrust in risk management is believed to be an important factor in the opposite direction, namely in reducing public acceptance or creating controversy about whether a hazard should be tolerated (e.g. Slovic, Flynn, & Layman, 1991; Poortinga & Pidgeon, 2004). There is a convincing amount of research pointing in the direction of trust being an influential variable in explaining attitudes towards new technologies.

Siegrist and Cvetkovich (2000), furthermore, found trust to be a more important predictor of perceived risks and benefits when individuals themselves lacked knowledge about the hazard. This makes sense, as people who do not have sufficient knowledge about a new technology or a potential risk may have to rely on information from authorities managing the hazard. It may very well be the case with CCS. As mentioned, surveys from several countries have shown the public to have very low awareness and knowledge of CCS (for a review, see Ashworth et al., 2009). Trust in responsible actors, therefore, may play an important role in predicting public acceptance of the technology.

Social trust. By a very popular definition, trust is described as "a psychological state comprising the intention to accept vulnerability based upon positive expectations of the intentions or behavior of another" (Rousseau, Sitkin, Burt, & Camerer, 1998, p. 395). Although this definition stem from organizational psychology it is meant to be cross-disciplinary and can be adopted in risk perception research (Earle, 2010). According to Rousseau et al. (1998) trust can be relational or calculus-based. While the first form can be affective and based on emotions, the latter is purely rational. Building on this definition, Siegrist, Earle and Gutscher (2003) split the concept into trust and confidence[1]. While trust is based on value similarity, confidence is based on performance. That is, if you perceive an authority to share values that you see fundamental to yourself, you will have more trust in that

[1] Such a distinction is also ascribed to Luhmann (1988, in Siegrist et al., 2003).

authority. Confidence is the belief that certain future events will occur as expected, based on perceived past performance. Trust is relational, confidence is calculative (Earle, 2010). While trust builds on social relations and indicates good intentions, confidence rests on past performance or constraints on future behavior. Several studies have explored the antecedents of trust, like value similarity and past performance, general trust and general confidence (for a review, see Earle, 2010) but the present study will focus exclusively on the consequences of trust. To sum up, trust is more intention-based, whereas confidence is more based on ability or competence (Earle, 2010).

In the field of CCS, some studies have documented the relationship between trust and risk perceptions or acceptance. Bradbury et al. (2009) conducted a series of focus groups and interviews with citizens from five very distinct cultural and geographic U.S. regions. Trust in authority and concerns about the fairness of CCS implementation procedures were the most strongly expressed concerns among the citizens. Lack of trust in the government and/or the private sector was a pervasive issue in several of the communities studied. A focus group study in Spain also concluded that acceptance of CCS will be dependent on a high level of trust in safety management (Oltra et al., 2010). A British focus group study found all participants to be suspicious of the motivations of large oil companies in advocating CCS (Gough, Taylor & Shackley, 2002). With this in mind, the focus groups expressed concerns that CCS was a strategy devised to allow the industrialized world continue current economic and industrial policies.

Similarly, Huijts et al. (2007) found trust in professional actors to be an important variable in predicting public acceptance. The participants in this study were 103 citizens living near two potential CO_2 storage sites (onshore) in the Netherlands. Through a questionnaire survey on these citizens, environmental non-governmental organizations (NGOs) were found to be the most trusted key actor involved in CCS development. The Dutch government was less trusted than NGOs but more trusted than the industry. The study furthermore found perceived competence and intentions of these actors to be of particular importance to the acceptance of CCS. Of the three actors, trust in the government had the strongest influence on overall feeling of trust.

Tokushige et al. (2007), as mentioned, found five factors to effectively predict acceptance of CCS: trust, perceptions of risk and benefit, and two types of perceptions of interference with the environment. The trust factor influenced acceptance through risk and benefit perceptions, in accordance with the psychometric risk model. Trust, in this model, had a direct negative impact on risk perception and a direct positive impact on benefit perception.

Epistemic trust and unknown risks. The kind of trust discussed so far is known as social trust. Sjöberg (2001), however, argues that social trust may not be as important as disbelief in science and the belief that there are unknown effects of technology. People may think there are many unidentified risks and outcomes of emerging technologies that even experts cannot predict. Such a belief, named epistemic trust, may explain more variance in risk perception than social trust: Even if people have social trust in risk management authorities they may still worry about the risks. Sjöberg and Herber (2008) tested this hypothesis with a survey on random samples of citizens from two Swedish towns (N = 888). They found that trust in science and technology per se was more important than social trust in explaining risk perceptions, attitudes and voting intentions. This concept may be essential in explaining perceptions of risk and benefit, as well as predicting acceptance of novel technologies. People could well be doubting scientists' claim that CO_2 will remain safely stored in reservoirs for thousands of years, and they may as well worry about the health risks related to the CO_2 capture process.

So far, epistemic trust has not been explicitly studied in relation with CCS. However, previous findings indicate this may be important. Bradbury et al. (2009), through their interviews and focus groups with U.S. citizens, discovered that some communities worried that expert knowledge in the face of unknown technological risks would be deficient. This finding was evident among Californian citizens who have a history with oil and gas industry and environmental problems. As mentioned, Singleton et al. (2009) did a psychometric analysis of CCS and conclude that it has more of the characteristics "new risk" and "risks unknown to science" than for example radioactive waste. Because such attributes seem to be important dimensions of people's initial perception this thesis will be the first to look into epistemic trust as a predictor of attitudes towards CCS.

Concern for environment and climate change

While onshore CO_2 storage normally is closer to the places people live and so is associated with some risks to humans offshore storage unquestionably involves less human risks (Metz et al., 2005). As human risks are less important (they should be in Norway, because of the offshore siting) other risks may become more salient. For example, environmental risks associated with the technology may be an important motive for rejecting the technology or for taking up a more negative attitude against it. This should make environmental concern a more central factor in predicting Norwegians' attitudes towards CCS.

The new ecological paradigm. One of the most widely employed measures of environmental orientation is the New Environmental Paradigm Scale (Dunlap & Van Liere, 1978, in Oskamp & Schultz, 2005). This instrument was first developed more than thirty years ago but a revised version, labeled the New Ecological Paradigm (NEP), was introduced more recently (Dunlap, Van Liere, Mertig, & Jones, 2000). The new scale was designed to better capture growing environmental issues like global warming. As Dunlap et al. (2000) notes, "environmental problems have generally tended to become more geographically dispersed, less directly observable, and more ambiguous in origin" (p. 426). The scale was developed through a broad literature review and has been given criterion validity by demonstrating clearly distinguished responses from the general public and known environmentalists (known-group validity), and by significant relationships with certain behaviors and behavioral intentions (predictive validity). Theorists do not fully agree on whether the NEP scale measures attitudes, values, beliefs or endorsement of a fundamental paradigm. According to the founders, the NEP items primarily tap "primitive beliefs" about the nature of the earth and humanity's relationship with it. These beliefs are thought to influence a wide range of beliefs and attitudes concerning more specific environmental issues (Dunlap et al., 2000).

The revised scale consists of 15 statements about the relationship between humans and the environment which are to be rated in agreement on Likert scales (for example: "Humans have the right to modify the natural environment to suit their needs"). The NEP scale is intended to tap five hypothesized facets of an ecological worldview (see Appendix A for all items): the reality of limits to growth, anti-anthropocentrism, the fragility of nature's balance, rejection of exemptionalism, and the possibility of an ecocrisis.

Schultz (2001) places NEP in the value-basis theory for environmental attitudes. The value-basis theory separates three clusters of environmental values: egoistic, altruistic and biospheric (Oskamp & Schultz, 2005). Egoistic values include self-oriented goals and a focus on oneself (e.g. social power, wealth); altruistic values imply concern for other people (e.g. family, friends, humanity in general); biospheric values involve concern for all living things (animals, plants). In his study, Schultz (2001) found a pro-ecological worldview (high scores on the NEP scale) to be correlated with biospheric values. People with high scores on the NEP scale, thus, are prone to be more concerned about nature and animals.

While high perceived environmental risks from CCS may lead to rejection of the technology, environmental or ecological concern (as measured by NEP) should correlate negatively with acceptance of CCS. On the other hand, a pro-ecological worldview could also

be related to more positive attitudes towards CSS. After all, CCS is meant to tackle climate change, commonly regarded the most serious environmental problem of our time (IPCC, 2007). Dunlap et al. (2000) claim that the revised NEP measure is designed to capture concerns about global warming. A parallel between NEP and climate change perceptions are nevertheless unclear. Surprisingly, hardly any studies have looked into the correlation between the NEP scale and perceptions of global warming and climate change, even though the NEP scale is among the most frequently used instruments for assessing environmental orientation. In one study, Bord, O'Connor and Fisher (2000) used a truncated version of the 1978 NEP scale – containing only six items – to measure relationships between NEP and several variables, one of them perceptions of global warming. Perception of societal risk from global warming was positively correlated with NEP scores, as was perception of personal risk, though not as strongly. Pro-NEPs then, seem to be more concerned about climate change. The author is not aware of any published studies utilizing the revised NEP scale in relation with climate change perceptions, which will make the present study the first to investigate such a relationship.

Two American studies have investigated the relationship between NEP and attitudes towards CCS. Respondents in one survey answered the 15 questions in the NEP measure and rated their perceptions of CCS (Palmgren et al., 2004). Results showed significant negative correlations between NEP ratings and ratings of two different CCS technologies. That is, pro-NEPs were more negative towards CCS. The second study to measure this also suggested weak to moderate negative correlations between mean NEP ratings and ratings of CCS (Fleishman et al., 2010). Participants were asked to rank ten energy technologies and seven low-carbon energy portfolios (a set of emission-reducing technologies). Wind energy was clearly favored among pro-environmentalists. However, a negative correlation was found between the mean NEP ratings and a portfolio that included CCS but no wind energy. Two surveys have found opposition to CCS to be stronger among ecologists, defined by a question forcing respondents to rank the importance of economic development against protecting the environment (Ha-Duong et al., 2009; Duan, 2010).

Climate change perceptions. If the public sees considerable perceived benefits in climate change mitigation it is more likely that they will accept implementation of CCS (Oltra et al., 2010; Sharp, 2009). However, public understanding of global climate change has been shown to suffer from basic misconceptions since research on this topic began (Bord, Fisher, & O'Connor, 1998; Bostrom, Morgan, Fischhoff, & Read, 1994; Read, Bostrom, Morgan, Fischhoff, & Smuts, 1994). Public awareness and concern for global warming have changed

over time; the public is getting growingly more aware of climate change (Leiserowitz, 2007; Lorenzoni & Pidgeon, 2006). But even with mounting concern many still confuse the issue with other environmental problems, like depletion of the ozone layer (Bord et al., 1998; Leiserowitz, 2007). Moreover, Sterman and Sweeney (2007) experimentally demonstrated that even highly educated adults misunderstand the principle of greenhouse gas accumulation in the atmosphere. The reality is pretty straight-forward: While the current rate of global emissions is about twice the rate of removal, concentrations will continue to rise even if emissions fall. Only when emissions equal removal, concentrations will stabilize. Still, participants in the experiment believed atmospheric concentrations of greenhouse gases could be stabilized while emissions into the atmosphere continuously exceeded removal. According to Sterman and Sweeney, this is analogous with assuming a bathtub filled faster than it drains will never overflow. Such an erroneous assumption violates fundamental physical principles but leads people to support wait-and-see policies on climate change, the authors claim.

As there are fundamental misconceptions among the public, those who fully understand the risks of climate change presumably should be more concerned and hence more willing to accept CCS. Bord et al. (2000) found real knowledge about climate change to be a powerful predictor of willingness to take action against climate change. Knowledge fits well into the familiarity dimension of the psychometric paradigm of risk perception (Slovic et al., 1982). Higher knowledge about a hazard should lead to decreased perceived risks, and hence, more positive attitudes towards the risk object.

Perceptions of interference with nature

People's concept of what is natural and what is unnatural can be related to their acceptance or rejection of technologies: Sjöberg (2000b) found that risk perception is to a large extent predicted by what people find as being tampering with nature. When a new technology (or any other risk object) is being seen as unnatural, it is consequently being perceived as more risky and is hence less likely to be accepted. The perception of interference with nature is related to a sense of immorality. This 'tampering with nature' factor was found to play an important role in a study of a public sample and a sample of politicians from Sweden. Especially, 'tampering with nature' explained a large part of the variance in attitude towards a nuclear waste repository in Sweden. Focus group participants in a U.K. study recognized nuclear waste, in addition to genetically modified food, as a possible analogue to CO_2 storage (Gough et al., 2002). This indicates that there may be parallels between nuclear waste repositories and CO_2 storage in risk perception research.

Palmgren et al. (2004) presented participants with a list of 13 reasons for favoring or opposing CCS technology. They were asked to indicate their agreement with each reason. Of all the items in the list, an item concerning the 'tampering with nature' dimension was the one with the highest negative correlation with attitudes towards CCS. This indicates that people who perceive CCS as tampering with nature are more likely to reject this technology.

Tokushige et al. (2007) went deeper into the concept of 'interference with nature'. They asked participants in their survey to rate their agreement with three statements regarding their perception of CCS being a human interference with nature (e.g. "Do you think that CO_2 geological storage interferes with nature's laws?"). As hypothesized, the perception of CCS as an interference with nature was negatively influencing acceptance of the technology. Such a perception influenced acceptance directly as well as through risk perception. Also, perceptions of global warming as an interference with nature influenced acceptance positively through benefit perception.

Media effects

The availability heuristic leads us to believe that what people see or hear in the news can make certain information easier accessible for further processing (judgment and decision). Indeed, media coverage of life-threatening events is found to correlate with perceptions of risk (Combs & Slovic, 1979, in Slovic et al., 1982). A review of research on media influence and risk perception also gives credibility to the availability heuristic; the amount of media coverage is a fundamental way for media to affect people's risk perception (Af Wåhlberg & Sjöberg, 2000). More information gives a stronger effect. Another study found support for the cultivation theory, indicating that television viewing cultivates scientific reservation, promoting a more negative perception of science and technology (Nisbet et al., 2002). In contrast, general newspaper reading was related to fewer reservations regarding science and technology.

Pietzner et al. (2010) discuss that their Dutch and Norwegian respondents are more aware of CCS technology compared to respondents from other nations, because of higher media coverage in these countries. They also argue that media preference is a key factor in determining acceptance of new technologies. In-depth interviews from the U.K. reveal that key actors involved in the development of CCS, such as the government, scientific communities and business representatives, actively use the media for reaching out with their messages (Mander, Wood, & Gough, 2009). The media is also an important route through which people will learn about CCS. Obviously, the majority of the public do not get their

information from meeting in person with government officials or industry representatives. It seems likely that most people will have their first encounter with CCS through media sources, like newspapers or TV.

An American media analysis concluded CCS had been portrayed favorable to neutral in the U.S. (Bradbury & Dooley, 2004). There is no media analysis of CCS coverage in Norwegian media. Still, a quick database search proves that CCS has been considerably discussed in Norway, mainly in relation with "Norway's moon landing", a rhetorical expression of CCS development used by Prime Minister Jens Stoltenberg in his 2007 new year's speech (Statsministerens kontor, 2007). Since then more than 6000 articles have been written in Norwegian newspapers on the topic[2]. The topic has been even more widely debated during the spring of 2010, when it became known that the government is postponing the CCS project at Mongstad (Randen & Brekke, 2010).

Several survey experiments have demonstrated that respondents may change their attitude towards CCS after reading negatively or positively framed information about the technology (e.g. Reiner et al., 2006; Ha-Duong et al., 2009). Sharp et al. (2009) let half of the respondents in a Canadian survey read a negative newspaper article about CCS while the other half read a positive article. Respondents who read the negatively framed article shifted from showing slight support to slight opposition to CCS. Conversely, those who read positively framed articles became more enthusiastic about the technology. Even if such an experiment simplifies the interaction between the public and the media, it seems likely that media messages to a certain degree will shape perceptions of risks and benefits of CCS.

Other factors

Socio-demographic variables. In their French survey Ha-Duong et al. (2009) found several socio-demographic variables to be significantly correlated to approval of CCS, some of them well-known in risk perception research: Men were more supportive than women, and respondents with higher education and higher income were more supportive than others. Similarly, Miller et al. (2007) found women to be less accepting of CCS and more concerned about safety, risk and effectiveness than men. These gender difference mirrors previous risk perception research (Slovic, 1999).

[2] Search conducted in the Retriever media database on September 16, 2010. Search term: ("co2-rensing" OR "co2-håndtering" OR "co2-fangst" OR "fangst og lagring av co2" OR "karbonfangst" OR "co2-lagring").

"Not in my back yard". Most opposition against CCS so far has been performed by local citizens protesting CO_2 storage in their neighborhood (Citizens Against CO_2 Sequestration, 2010; CO_2 Endlager Stoppen, 2010; Slavin & Jha, 2009). Such opposition is well-known from nuclear waste disposal issues and is often explained by a so-called "not-in-my-back-yard" (NIMBY) effect (e.g. Marks & Von Winterfeldt, 1984). Respondents in a Dutch study demonstrated a NIMBY effect, as they had slightly positive attitudes to CCS in general but were slightly negative towards storing CO_2 in their own area (Huijts et al., 2007). These Dutch respondents were living in towns placed on top of a potential storage site and so were faced with having CO_2 stored in their neighborhood. An Australian survey also demonstrated the NIMBY effect for CO_2 storage (Miller et al., 2007). These findings might suggest a NIMBY phenomenon, but a different explanation might be that people simply do not find residential areas suitable for storage. Still, the NIMBY effect is not thought to be important in Norway, again because CO_2 storage will be located in the sea.

Willingness to pay. Solving the climate crisis does not come free. Common for most solutions to global warming, including both CCS and renewable energy, is the condition of rising energy prices. Some studies have investigated the possible influence of increasing electricity bills on the perception of different technologies or on the willingness to address climate change (Curry, 2004; Palmgren et al., 2004; Reiner et al., 2006). These studies commonly show that an individual's willingness to pay increases when he or she is concerned about global warming and the environment. Furthermore, support for mitigation actions fall when people are faced with rising electricity bills. In 2003, 24% of Americans were not willing to pay $5 more on their monthly electricity bill to "solve global warming" (Curry, 2004). Results from a Dutch study, on the other hand, found that energy prices was not a very important factor in predicting people's evaluation of energy policy options (De Best-Waldhober et al., 2009). 18 to 25% of the respondents even stated that the personal costs of technologies were unimportant.

The importance of costs and potential increased electricity prices are beyond the scope of this study. First of all, only a small number of power plants in Norway need CO_2 reducing technology as most of the electricity production are made up of carbon-neutral hydropower (Statistics Norway [SSB], 2009). The cost of implementing CCS to industrial facilities will be entirely decided by political decisions on the carbon tax system (Tjernshaugen, 2007). As far as the author knows, no precise estimate of what "solving the climate crisis" will cost Norwegian citizens exists to this date. Moreover, it is unclear if cost of electricity actually is

an important factor in predicting respondents' evaluation of energy technologies (de Best-Waldhober et al., 2009).

Affect. Affect is by many regarded an important factor in predicting risk perception (Slovic, Finucane, Peters, & McGregor, 2007). However, Midden and Huijts (2009), investigating affect and attitudes towards CCS, found that this applies most strongly to situations of high self-relevance (i.e. living in close proximity to a CO_2 storage site). They found that the role of affect was less important for the perception of CCS in general than for the perception of CCS in citizens' local area. When respondents were asked to rate positive and negative emotions on 7-point scales the mean scores were between 1 and 2, suggesting that CCS did not evoke very strong feelings among respondents (at least as measured by self-report). Given the fact that these respondents lived on top of a potential CO_2 storage site, and that the question was framed to specifically ask for feelings evoked for storage in their neighborhood, one should expect feelings among Norwegian respondents, who are not faced with CO_2 storage in their near proximity, to be even lower. Affect may very well play a role in shaping attitudes towards CCS, but it will not be explicitly measured in the present survey. Still, it is recognized that emotions as a heuristic can influence attitudes, as explained by models of attitude formation, and that attitudes have an embedded affective component (Eagly & Chaiken, 1993; Oskamp & Schultz, 2005). Another way to look at it is to say that measures of social trust, like those included in the present study, is one sort of affective response (Lee, Scheufele, & Lewenstein, 2005).

The political situation in Norway

Broad topics such as climate change and energy production should not be studied without understanding the societal context and implications. In Norway CCS as an option for energy production may not be as important as the opportunities for reducing CO_2 emissions from industrial sources. The Norwegian mainland (excluding the offshore production facilities for oil and gas) has only two operating gas power plants (Tjernshaugen, 2007). Coal energy is not produced in Norway (except a very small plant on Svalbard). In most other European countries coal and gas are the major sources of energy. While in these countries CCS could be implemented on the current electricity production system and hence greatly reduce CO_2 emissions, there is no need for emission reductions for the current Norwegian electricity production system as this is made up by 98-99% CO_2-free hydropower (SSB, 2009). Still, gas power plants with CCS could be feasible options for implementing low-emission energy production in the Norwegian oil and gas sector (Tjernshaugen, 2007). For Norway, CO_2

storage could even become a new, highly profitable business. Many European countries lack Norway's vast coast line and maritime zones, and offshore storage is generally viewed as more desirable than onshore storage due to risks of leakage in near proximity to inhabited areas (Huijts et al., 2007). The calculated potential storage capacity in Norway is quite tremendous: If half of the saline aquifer capacity is used, the Norwegian continental shelf alone has a theoretical capacity of storing 67 years of total CO_2 emissions from all European Union countries (Torvanger, Rypdal, & Kallbekken, 2005).

Stakeholder attitudes. In addition to studying public perceptions, some research has been done on measuring the attitudes of stakeholders involved in CCS development. Through the EU funded ACCSEPT project a total of 511 European stakeholders, chosen from industry, government, environmental non-governmental organizations (NGOs), researchers and academicians and parliamentarians, participated in a survey on perceptions of CCS (Shackley et al., 2007). The respondents represented 25 EU nations and 8 non-EU nations, including Norway. The results showed that Norwegian experts, which constituted 5% of the total sample, were among the most positive and least skeptical of CCS technology. Compared to respondents from other countries, Norwegian respondents considered CCS to play a significant larger role in the national debate. About eight out of ten Norwegians stated that CCS currently plays a "large" or "very large" role in the national debate, none perceiving the role of CCS to be "very small". About the same amount of Norwegians reported that the role of CCS is increasing slightly or substantially. Two thirds of the Norwegian respondents thought the opportunities of enhanced oil and gas recovery was very important for future CCS development. This differed from the perceptions of the other stakeholders.

Interestingly, Norwegian environmental NGOs have taken a somewhat different position to CCS than NGOs in other countries. A number of international environmental NGOs are opposing the use of CCS, particularly Greenpeace, labeling the technology as unproven, risky, expensive, energy-wasting etc. (Greenpeace, 2008). Conversely, major Norwegian NGOs (e.g. Bellona, Zero) are very positive towards the technology. This has led to a stronger political support for CCS in Norway compared to other countries (Tjernshaugen, forthcoming). Environmental NGOs arguably have a significant influence on public perceptions towards CCS as they normally are more trusted than both industry and government sources (Huijts, 2007; Stephens & Verma, 2006).

Attitudes or perceptions?

Although perceptions and attitudes are used interchangeably in the studies discussed in the previous sections, their theoretical definitions do not precisely overlap. There are no doubt perceptions and attitudes are related notions, but a distinction between the two needs to be made. According to Eagly and Chaiken (1993) an "attitude is a psychological tendency that is expressed by evaluating a particular entity with some degree of favor or disfavor" (p. 1). Attitudes are often theoretically organized in a tripartite or three-component model: they are a product of cognitive, affective and behavioral processes, and they are leading to cognitive, affective and behavioral responses. A latent process viewpoint holds that these three aspects are unobservable intervening variables (Oskamp & Schultz, 2005).

Perception, on the contrary, is described as "the reception and organization of sensory information" (Oskamp & Schultz, 2005, p. 19). It is the first stage of social cognition. A perception, obviously, has to do with receiving information and to make something out of it. This way, one would consider perceptions as preceding attitudes, or influencing attitude formation. At the same time, prior attitudes can affect perceptions, as evidenced by experiments demonstrating biased assimilation and attitude polarization (e.g. Lord, Ross, & Lepper, 1979). Oskamp and Schultz (2005) make an additional division between attitudes and opinions. They regard opinions as equivalent to beliefs, which implies opinions are narrower than attitudes, and more often cognitive.

In the present study, when referring to former research, attitudes, perceptions and opinions are sometimes used as referring to the same concept, in order to keep with the researchers' original language. Still, all the studies mentioned in the previous are essentially discussing what people think about CCS and how they evaluate CCS. When discussing the results of the present study, however, attitudes will be used when referring to people's evaluation of CCS, while perception will be used in relation to risk and benefit.

The present study

To this date, only one study (still unpublished) has been done to investigate attitudes towards CCS in Norway: the Norwegian part of the FENCO-ERA project (Pietzner et al., 2010). This study, collecting data through two surveys in November 2009 and January 2010, was however still unpublished when this thesis was printed. The present study will use parts of this questionnaire to make results comparable to the results of the FENCO-ERA surveys, offering a third measure of Norwegian attitudes. The results from the present study will add to data

from the two previous Norwegian surveys to produce almost comparable data from one country at three different points in time.

Research questions. The main research question posed in this thesis is: What are the main determinants of attitudes towards CCS? This implies scrutinizing what factors, from the ones chosen in this study, are the most influential in predicting attitudes towards CCS. Secondly, measuring knowledge about environmental issues, climate change and CCS will be a goal of the present study. Instead of measuring subjective knowledge, the study will focus on a well-prepared set of knowledge questions to discover respondents' actual knowledge. Thirdly, the thesis will briefly address the question: How do attitudes towards CCS in Norway vary over time? Information experiments have established that lay people in many countries possess little knowledge about CCS and show unstable attitudes towards the technology. Equally important, this study will see if attitudes may be more stable over time. As this is not a longitudinal panel survey, the question cannot be given a certain answer, but a comparison with the two Norwegian surveys from November 2009 and January 2010 will shed some light on the issue.

Conceptual model. The study is based on the basic risk-benefit model. Perceptions of risks and benefits are expected to directly influence attitudes towards CCS, in line with previous research (e.g. Huijts et al., 2007; Tokushige et al., 2007). A set of other variables are thought to influence perceptions of risks and benefits, such that risk/benefit act as mediating or moderating variables on attitude towards CCS. At the same time, factors are expected to have a direct influence on attitude towards CCS, making them relate both directly and indirectly to this variable, as shown by Huijts et al. (2007) and Tokushige et al. (2007).

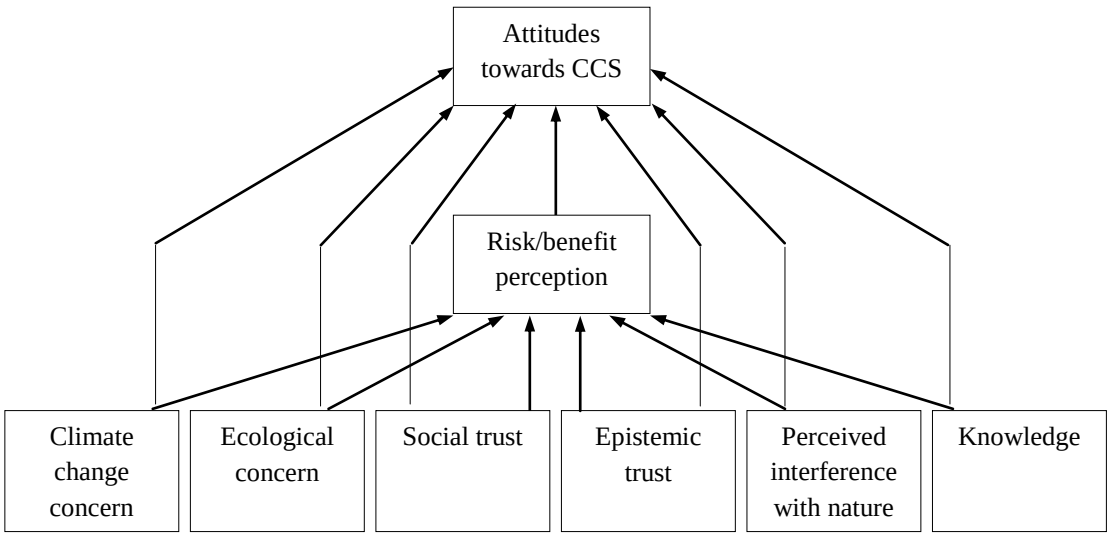

Figure 1. Simplified conceptual model for formation of attitudes towards CCS.

Hypotheses. An amount of research has confirmed the basic assumption of the psychometric risk paradigm; perceptions of risks and benefits influence acceptance of new technologies, including CCS (Huijts et al., 2007; Tokushige et al., 2007). The present study will try to find out if this consistent finding can be replicated in the context of CCS in Norway.

1. People have a more positive attitude towards CCS when they perceive risks as lower and benefits as higher.

As described in the previous sections, it is assumed that people with a higher concern for climate change will be more willing to accept mitigation measures. Risks to humans will not be as critical in Norway, planning to store CO_2 far away from people, as in some other countries. Therefore, climate change concern should be a significant contributor to predict attitudes towards CCS, presumably in a positive direction. Environmental or ecological concern may be a different story. From the previous discussion on the NEP scale two possible predictions can be made: 1) Norwegian pro-ecologists may perceive CCS positively, as part of a solution to fight global climate change, or 2) they may see the technology as posing a threat to the local nature and environment (i.e. through leakage) and hence adopt a negative stance. A third option is that the NEP factor will be eliminated by other factors and will not have a significant influence on overall attitude towards CCS. Based on the two existing studies of NEP and CCS, however, it seems sensible to hypothesize a negative relationship between ecological concern and attitudes towards CCS (Palmgren et al., 2004; Fleishman et al., 2010).

2. People have a more positive attitude towards CCS when they are more concerned about climate change and less concerned about ecology (as measured by NEP).

People may perceive the whole process of CCS as going against nature. Viewing a technology as tampering with nature may lead to higher risk perception and lower attitude ratings (Sjöberg, 2000b). Previous research indicates citizens may indeed have such perceptions of CCS (Palmgren et al., 2004; Tokushige et al., 2007). This leads to a similar hypothesis for the present study:

3. People have a higher risk perception and a more negative attitude towards CCS when they perceive the technology as an interference with nature.

Earlier studies have looked at social trust in key actors on the CCS domain, but none have looked into the epistemic trust construct. Even scientists will agree that there may be unknown effects of CCS, and, naturally, the public may as well believe that some aspects of CCS are not yet fully understood. Based on findings from studies of nuclear waste (Sjöberg, 2001; Sjöberg & Herber, 2008), a reasonable prediction for this study is that epistemic trust will explain variance over and above that of social trust.

4. Epistemic trust will be a more important predictor of attitudes towards CCS than social trust.

Research has shown knowledge to have a significant relationship with attitudes towards CCS (Huijts, 2003). Knowledge is a fundamental part of the familiarity dimension in the psychometric risk paradigm (Slovic et al., 1982). Having more knowledge normally leads to lower risk perception. Huijts (2003) found that Dutch citizens, who rated themselves higher on knowledge within technology, physics, chemistry, etc., had a more negative attitude towards CCS. However, those rating themselves higher on knowledge about CCS were more positive towards the technology. Huijts recommends exploring this relationship measuring objective knowledge. Huijts' measure was based on subjective knowledge. In this study, the objective knowledge of respondents will be measured. It seems likely that Norwegians with more knowledge about the seriousness of climate change and environmental problems will be more supporting of implementing CCS in the context of offshore CO_2 storage.

5. People have a lower risk perception and a more positive attitude towards CCS when they have more knowledge about the environment, climate change and CCS.

Tokushige et al. (2007) and Huijts et al. (2007) found that perceptions of risks and benefits had a mediating effect on various variables, such as trust and perception of interference with nature. Similar models have been established on attitudes towards gene modified products, which is also a novel technology (Siegrist, 2000). An initial hypothesis for the present study should use these models as a starting point.

6. Perceptions of risks and benefits will mediate the influence of climate change concern, ecological concern, social and epistemic trust, knowledge and perceived interference with nature, on attitude towards CCS.

In addition to variables included in these six hypotheses, a set of other factors will be studied as potential predictors of attitudes towards CCS, but these are of secondary importance for this study. Media use, a concept thought to be related to risk perception, will also be measured (Gough et al., 2002; Sharp et al., 2009). It may be assumed that people, who more frequently consume media, will have higher knowledge of the issue and lower risk perception. There are several competing theories about mass media's influence on public perceptions, like the cultivation theory and the quantity of coverage hypothesis (Gerbner & Gross, 1976; Mazur, 1975). This study will not try to verify or falsify such broad and extensive theories but instead recognizes that media consumption will have some effect on perceptions of risks and benefits. Hence, the study will try to demonstrate this effect in the context of CCS.

Furthermore, basic socio-demographic data, such as gender, age, education, income, political preference and place of residence, will be recorded. Women are repeatedly shown to have higher risk perception than men, and, hence, they will possibly be more negative towards CCS. There is no specific hypothesis concerning age of the respondents. Highly educated people are thought to be more knowledgeable and more supportive of CCS than less educated people, in line with previous research (Ha-Duong et al., 2007). Likewise, people with higher income are thought to be more supportive of CCS compared to those with lower income.

METHODS

Background

The methodology of the present study also builds mainly on the surveys conducted in Norway by SINTEF as part of the multinational FENCO-ERA research project (Pietzner et al., 2010). Social scientists from SINTEF, Wuppertal Institute and the University of Cambridge developed the questionnaire in cooperation with technical experts at the Institute for Energy Research, Forschungszentrum Jülich. Focus groups were conducted before conducting the survey (Terwel et al., 2009). For the present study, some parts of the questionnaire were excluded, while at the same time, some new sections were added by the author, primarily to explore a few new explanatory variables and to include more risk psychology theory to the questionnaire. While parts of the questionnaire are exact duplicates of the SINTEF questionnaire, about one third of the questions in the final questionnaire are added by the author.

This survey was funded by Gassnova, the advisory and consultative body on CCS for the Norwegian Ministry of Petroleum and Energy. The author contacted Gassnova and had a meeting with two representatives in June 2009 in order to present the planned thesis and to arrange for funding of a professional polling firm to conduct the survey. The sample and recruitment of respondents will be discussed in further detail below. Representatives of SINTEF were furthermore contacted by the author to establish a collaborative agreement on exchange of data from this survey and from the two done by SINTEF. The author had a meeting with SINTEF in May 2010.

Respondents

Recruitment. Recruitment of respondents was arranged by YouGov, a professional polling firm specializing in online research. YouGov holds a web panel of more than 30,000 Norwegian citizens. Panel members are recruited by telephone, print ads, targeted campaigns via websites, and by specialist recruitment agencies to contact specific groups for ensuring an appropriate demographic balance (YouGov, 2010). In total YouGov lists 16 different recruitment channels. Panel members were invited to the survey by a URL link sent to them by e-mail. Such e-mails are sent out routinely to all panel members. When a respondent chose to follow the link he/she was randomly directed to one of many ongoing surveys. Survey participation was access limited through this invitation-only procedure and was further controlled through e-mail identifiers and passwords to prevent respondents from passing the

survey along to others. Respondents received an incentive of about 1 krone per minute for completing the survey.

Pilot testing. The questionnaire was pilot tested on 15 individuals before it was handed out to the main sample. Pilot testers spent about 15-20 minutes to complete the questionnaire and this was regarded an acceptable length in order to ensure participation among the general public. Some minor adjustments were made in agreement with feedbacks from these preliminary tests, particularly the wording was slightly altered on some questions to make the text easier to read and understand for respondents. Since large parts of the questionnaire were similar to the FENCO-ERA survey, it basically was "tested" on thousands of respondents: SINTEF conducted two web surveys on national representative samples of the Norwegian public (N = 2000), and the same questionnaire was used in five other European countries. In total, the FENCO-ERA questionnaire has been completed by more than 7000 persons.

Survey respondents. The survey was conducted in June 2010 and data collection was closed when the number of full responses reached about 1000. Citizens ranging from 18 to 75 years old were selected. This age group constitutes about 70.5% of the entire population in Norway, according to national statistics (SSB, 2010). A total of 1179 persons responded to the e-mail invitation and were directed to the questionnaire. 177 did not complete the full questionnaire and three respondents were deleted for reporting their age outside the chosen age stratum. Still, it is impossible and irrelevant to report response rates for surveys of this kind. Such numbers are of course not comparable to response rates of traditional postal surveys since YouGov panel members have agreed to regularly participate in surveys beforehand. The final sample included in the analyses consists of 999 persons.

Representativeness. The sample is about equally distributed between men (N = 501, 50.2%) and women (N = 498, 49.8%) but compared to the Norwegian public the sample is somewhat younger (see Table 1). 58.2% of the respondents are between 18 and 44 years old while 52.2% of the population lies in this age group. Samples skewed in direction of the younger part of the population are not uncommon in online surveys (Kaplowitz, Hadlock, & Levine, 2004). However, a smaller part of the sample (6.7%) lies in the age group 18-24 compared to the population (12.7%).

Table 1

Distribution of respondents and population by age and gender

Age	**Percent of sample**			**Percent of population**		
	Men	*Women*	*Total*	*Men*	*Women*	*Total*
18-24	2.2	4.5	6.7	6.5	6.2	12.7
25-34	13.2	12.5	25.7	9.3	9.0	18.3
35-44	12.1	13.7	25.8	10.9	10.3	21.2
45-54	9.2	9.0	18.2	9.8	9.3	19.1
55-64	8.3	7.8	16.1	8.7	8.5	17.2
65-75	5.1	2.3	7.4	5.6	6.0	11.6
Total	50.1	49.8	100.0	50.8	49.3	100.0

Note. Sample values are percentages of respondents; $N = 999$. Population figures are based on the Norwegian population, 18-75 years old, from SSB (2010).

The sample does not differ much from the population in terms of geographical distribution (see Table 2). Compared to the Norwegian population (18-75 years old) a larger part of the sample (23.3% as against 18.7%) lives in Eastern Norway, while a slightly smaller percentage of the sample (21.4% as against 25.6%) comes from Western Norway. Other regions are fairly close to the population.

Table 2

Distribution of respondents and population by geographic regions

Region	**Sample**	**Population**
Oslo and Akershus	25.7	23.6
Østfold, Hedmark, Oppland, Buskerud	23.3	18.7
Vestfold, Telemark, Aust-Agder, Vest-Agder	11.6	13.9
Rogaland, Hordaland, Sogn og Fjordane, Møre og Romsdal	21.4	25.6
Sør-Trøndelag, Nord-Trøndelag, Nordland, Troms, Finnmark	17.9	18.2
Total	100.0	100.0

Note. Values are percentages of respondents; $N = 999$.

Overall, the distribution of respondents by political preference looks quite similar to that of the population (Table 3). Compared to statistics from the 2009 general election in Norway, a slightly smaller part of the respondents voted for the Labour Party (Arbeiderpartiet) and the Centre Party (Senterpartiet). A noticeable larger part of the respondents voted for the

Socialistic Left Party (SV), and the Liberal Party (Venstre) also made up a larger part of the sample compared to the population. Note that the Socialistic Left Party and the Liberal Party are generally known to be "green" political parties, so the sample may be skewed against being more pro-environmental than the general population. That may be of importance for a study with an environmental topic.

The second and third most popular parties, the Progress Party (Fremskrittspartiet) and the Conservative Party (Høyre), had fairly comparable percentages of voters in the sample and the population. These numbers are yet difficult to compare because 23.6% of those entitled to vote did not participate in the 2009 Norwegian general election (Stortinget, 2009), while, in contrast, only 8.3% of the survey respondents reported they did not vote in the last general election. There are several explanations for why people do not vote in an election, and it is not surprising that there is higher voter participation among members of a public opinion panel than in the general population.

Table 3

Distribution of respondents and population by political affiliation

Region	**Percent of sample**	**Percent of population**
The Labour Party (Ap)	30.5	35.4
The Progress Party (Frp)	22.1	22.9
The Conservative Party (H)	19.8	17.2
The Christian Democratic Party (KrF)	3.5	5.5
The Centre Party (Sp)	3.2	6.2
The Socialistic Left Party (SV)	11.5	6.2
The Liberal Party (V)	5.3	3.9
The Red Party (R)	2.4	1.3
Other parties	1.8	1.2
Total	100.0	100.0

Note. Values are percentages of respondents; $N = 837$. 7.9% ($N = 79$) of the respondents refrained from answering the question. Population data is adapted from "*Stortingets nettsted, Valgstatistikk*," by Stortinget, 2010, retrieved from http://www.stortinget.no/no/Stortinget-og-demokratiet/Valg-og-konstituering/Valgstatistikk

Table 4 shows that the largest share of respondents lies in the '200,000-499,999 NOK/year' income group. The percentage of respondents in this group is quite similar to the population. On the whole, the sample is nonetheless skewed towards the higher income groups compared to the population: About twice as large part of the population compared to the sample belongs

to the lowest income group. Almost twice as large part of the sample compared to the population report their income within the second highest group.

Table 4

Distribution of respondents and population by income groups

Income group	Percent of sample	Percent of population
Below 200,000 NOK/year	14.1	30.2
200,000-499,999 NOK/year	56.1	53.2
500,000-999,999 NOK/year	26.3	14.1
Above 1,000,000 NOK/year	3.5	2.4
Total	100.0	100.0

Note. Values are percentages of respondents; $N = 834$. 16.5% ($N = 165$) of the respondents refrained from answering the question. Population data is adapted from "*Statistikkbanken*," by SSB, 2010, retrieved from http://statbank.ssb.no/statistikkbanken

Results from the present study cannot be described as fully generalizable to the Norwegian population. The main reason for this is YouGov's sampling method; with panel members recruited through e.g. advertisements, each citizen in Norway does not have an equal chance of being selected, as is the principle of true random sampling (Howell, 2010). Several sample characteristics are similar to the Norwegian population by means of gender distribution, political preference and geographical distribution, as was described in the previous sections.

Questionnaire and measurements

A total of 100 items are included in the questionnaire (attached in Appendix B). Some questions were not included in the analysis and will not be thoroughly described here. As far as possible, only well-known, previously validated measures were selected for the questionnaire. Questions and response alternatives from the FENCO-ERA studies were as far as possible left unchanged. The bulk of questions used a 7-point Likert-type response scale where only the anchor points were labeled. Furthermore, the sequence of questions is also mostly equal to the FENCO-ERA questionnaire to ensure that the results are comparable to the greatest extent. Most of the questions added by this author are placed towards the end of the questionnaire.

Socio-demographics. Gender and age are the two first items of the questionnaire. Other socio-demographic items, i.e. education, political affiliation, income and place of residence, are placed in the end of the questionnaire. Measurement of respondents' education

was based on a standard scale offered by the Norwegian Social Science Data Services ([NSD], K. Svarva, personal communication, March 15, 2010). Political affiliation and income were measured by scales from Statistics Norway (B. Glesne, personal communication, April 28, 2010). While age and income were used as continuous variables, education and political affiliation was dummy-coded before being included in regression analysis (described in the Results section).

Media use. Next, respondents were asked how often they read newspapers (both print and online) and how often they watch news on television (response alternatives: 'Every day', '5-6 days a week', '3-4 days a week', '1-2 days a week', 'Less often', 'Never'). These scales were developed in cooperation with Associate Professor of Media Sociology at NTNU, Toril Aalberg (personal communication, April 23, 2010).

Social trust. Two question scales, each with four items, measured social trust. Each item were to be rated on 1-7 scales. The questions were developed by Huijts et al. (2007), and they measured competence-based trust and intension-based trust, respectively. Respondents were asked to express how much they trusted the most important actors involved in development of CCS. Equal to the study of Huijts et al. (2007) respondents were asked to rate their trust in the government, the industry and environmental NGOs. In addition, the present study included a measure of trust towards scientists, as they too can be actively involved in public outreach activities (Reiner, 2008). This was an important inclusion as there had been massive debate about the credibility of climate science during the last year.

The first question asked 'How much confidence do you have in these parties' competence to make decisions about carbon capture and storage?' while the second question asked 'To what extent do you think it is the different parties' intention to take the interests of citizens and environment into account?' The four items on the first question were included in a 'trust in competence' index, with a Cronbach's alpha of .67, while the four items on the second question were added up to a 'trust in intentions' index with an alpha of .71. Cronbach's alpha is a measure of internal consistency, which according to Kline (2000) should ideally lie around .9 and never drop below .7. If the index contains a small number of items the alpha value is more vulnerable, especially within small samples. Lower alpha values are common in indexes built up of less than ten items. This also applies to measuring of psychological constructs (Field, 2005). The trust objects were presented in randomized order for minimizing response-order effects, a systematic bias among survey respondents to select response alternatives based on the order these are presented to them (Krosnick, 1999).

Knowledge. Three subscales, each containing six items, measured knowledge of 1) general environmental issues and science, 2) activities contributing to CO_2 build-up (climate change), and 3) CCS. All knowledge questions were equal to the FENCO-ERA survey. The first scale had statements such as 'We are currently in a warm period between ice ages' with respondents forced to answer 'True' or 'False'. The second question asked 'There is a growing concern about increasing levels of carbon dioxide in the atmosphere. How do the following activities contribute to these levels?' This question had six items: 'Cars (motoring)', 'Coal burning power plants', 'Nuclear power plants', 'Windmills / wind turbines', 'Planting trees', 'Factories (e.g. steelworks)'. Responses were demanded in one of three categories: 'Increases carbon dioxide', 'No impact' or 'Decreases carbon dioxide'. To tap respondents' knowledge of CCS the third scale asked which of a list of environmental concerns this technology can help reduce: 'Toxic waste', 'Ozone depletion', 'Global warming', 'Acid rain', 'Smog' and 'Water pollution'. This scale had three response alternatives: 'Can reduce', 'Does not reduce' or 'Don't know'. All knowledge items were listed in random order.

The three subscales were each made into an index while all 18 items added to one global knowledge index. Indexes were calculated from the amount of correct responses on each question. On the third knowledge question, 'Don't know' responses were computed as incorrect. Some items had more than one correct answer, e.g. installation of windmills has no direct impact on CO_2 levels but when chosen as an alternative to other modes of energy production it will reduce CO_2 emissions, i.e. both 'No impact' and 'Decreases carbon dioxide' were coded as correct.

Awareness. One question explored self-reported awareness of CCS: 'Have you heard about carbon capture and storage (also known as carbon capture and sequestration)?' There were three possible choices to this question: 'No, never heard', 'A little bit' and 'Yes, quite a bit'.

Attitudes towards CCS. Questions on attitude towards CCS were framed in three different ways. An initial question asked respondents which of five technologies they would prefer if they were to create a plan to tackle global warming. The five technologies were CCS, energy-efficient appliances, nuclear power, solar power, and wind power, and respondents were to rank these on a 1-7 scale, ('Definitely not use' - 'Definitely use'). At this point, respondents had not been informed about the CCS technology. Directly following this question, a second question read: 'CCS technologies capture carbon dioxide from power plant exhaust and store it in underground reservoirs. If our government decided to proceed with a plant to test the applicability of this technology would you be supportive of such a proposal?'

Response categories went from '1 Strongly oppose' to '7 Strongly supportive'. It should be noted that this was the first piece of information about CCS in the questionnaire, and so it may be what some of the respondents base their view on. The third rating of attitude towards CCS was three questions asking about respondents' view of a chosen locality for CCS, namely Kårstø in Rogaland (selected because this is the most relevant planned demonstration plant in Norway). The items tapped attitudes towards capture, transport and storage of CO_2. These three questions were part of a larger risk/benefit section to be described shortly. Five questions in total made up a global attitude index with an alpha of .86.

Risks and benefits. For the risk and benefit sections, qualitatively assessed information about capture, transport and storage was presented to respondents. These short texts (about 100-140 words in length) were developed by technical experts from Leiden University, British Geological Survey, Forschungszentrum Jülich, CEARTH and GeoEcoMar. A professional translation agency made the texts available in Norwegian. In Norway, SINTEF further added a few sentences describing the specific plans of the Norwegian government for CO_2 capture at the Kårstø natural gas plant in Rogaland and transport to the Utsira sandstone formation in the North Sea, where CO_2 is planned to be stored. The three different information pieces (capture, transport, storage), with accompanying questions, were presented in randomized order. All questions specified the risk target (either personal or societal risk), as recommended by risk perception researchers (Sjöberg, 2003). Each section further contained two questions on perceived risk (personal and societal), two questions on perceived benefit (personal and societal) and one question asking respondents for their overall attitude towards the presented CCS plans. Questions on risks and benefits were randomized for each section. The scores on the six risk items (capture, transport, storage; personal and societal) were aggregated into one single index. This global risk index had an alpha of .91 and a mean inter-item correlation of .62. Similarly, a global benefit index was made of the six benefit items, with an alpha of .92 and a mean inter-item correlation of .66. The three attitude questions made up an index with a total of five items that was described in the previous section.

Epistemic trust. Sjöberg and Herber's (2008) measure of epistemic trust was translated from English into Norwegian by the author. The original three questions concerned nuclear fuel, so they had to be modified to the topic of CCS. They were all rated on 1-7 Likert scales. Cronbach's alpha for the index with these three items were .85 with a mean inter-item correlation of .67.

Perceived interference with nature. Three items measured perception of CCS as an interference with nature. These were adapted from Tokushige et al. (2007) but were modified from a question-type format into statements to which the respondents had to agree/disagree. All items were measured on 1-7 Likert scales. The 'interference with nature' index had an alpha of .55. According to Kline (2000) internal consistency reliability should generally never drop below .7. The item-total statistics shows that by deleting the third item the alpha improves to an acceptable .79. Therefore, this index was made up of only the two first items.

Concern for climate change. To get a sense of how respondents view the threat of climate change one question aimed to measure their perception of this problem. Four statements (plus an 'Unsure' category) regarding the seriousness of climate change were given, and respondents could agree with only one of these statements. Response alternatives were scaled such that agreement with the first statement indicated higher concern than agreement with the second statement and so on. This question was adopted from Reiner et al. (2006).

Ecological concern. Following the climate change question was the NEP scale. The scale used in this questionnaire was the revised version developed by Dunlap, Van Liere, Mertig and Jones (2000). The items were translated into Norwegian by Professor Arne Vikan at the Norwegian University of Science and Technology (Vikan, Camino, Biaggio & Nordvik, 2007). Eight of the items were worded in a pro-NEP direction, so that agreement with the statement indicated a pro-ecological worldview. Seven of the statements were worded in an anti-NEP direction, and these were reverse-coded before analysis.

The creators have hypothesized five underlying facets but NEP is usually treated as a one-dimensional scale of environmentalism (Dunlap et al., 2000). Cronbach's alpha for the full NEP scale was .83, which is acceptable based on the widely used criterion of .7 (Kline, 2000). The corrected item-total correlations were moderately strong for all items, except item 6 ('The earth has plenty of natural resources if we just learn to develop them') with a value of only .08. The alpha would slightly increase if this item were removed. All other variables have item-total correlations ranging from .34 to .60. The correlation matrix showed item 6 also had very low correlations with the other items, three being insignificant while the highest correlation was a mere .21. All other variables had at least three correlations above .3. In a cross-cultural study, Schultz & Zelezny (1999) also found item 6 to detract on the NEP scale, with internal consistency improving when this item was removed.

The dimensionality of the NEP scale is not entirely clear. Dunlap et al. (2000) recommend treating NEP scores as a single measure of ecological attitudes, as long as no

substantively meaningful dimensions emerge through factor analysis. When running an exploratory factor analysis, four factors emerged. The analysis showed that all items load significantly on the first unrotated factor except for item 6. Because item 6 did not load on this one factor, and because of this item's very low correlations and item-total correlation, it was excluded from the analysis. The full NEP index was then made up of 14 items. Cronbach's alpha for the full scale was improved to .84 and deletion of any item would reduce internal consistency. The mean inter-item correlation was .27 and all items had item-total correlations above .31.

A new exploratory factor analysis of the 14 items resulted in three factors and showed that all items had loadings on the first unrotated factor ranging from .37 to .75. Stevens (1992, in Field, 2005) recommends that factor loadings greater than .162 can be considered significant for a sample size of 1000. Still, Kaiser's criterion suggests we should keep all factors with Eigenvalues above 1, in this case three factors. These factors had Eigenvalues of 4.6 (explaining 32.9% of the variance), 2.1 (15.2% variance) and 1.1 (8.2% variance), respectively. Dunlap et al. (2000) developed the revised NEP scale to tap five hypothesized facets of an ecological worldview: the reality of limits to growth (items 1, 6, 11), anti-anthropocentrism (2, 7, 12), the fragility of nature's balance (3, 8, 13), rejection of exemptionalism (4, 9, 14) and the possibility of an ecocrisis (5, 10, 15). With direct oblimin rotation the first rotated factor contained eight items: two of the 'limits to growth' items (1, 11), two of the 'fragility of nature's balance' items (3, 13), two of the 'ecocrisis' items (5, 15), one anti-anthropocentrism item (7), and one 'rejection of exemptionalism' item (9). The second rotated factor contained two 'anti-anthropocentrism' items (2, 12), two 'rejection of exemptionalism' items (4, 14), and one 'fragility of nature's balance' item (8). Only one item (10) loaded most strongly on the third factor. This factor structure was not considered meaningful in relation to the hypothesized theory. Orthogonal rotation was also performed but did neither produce any meaningful factor structure[3]. It was therefore decided to use all 14 items in one single index for further analysis.

Cortina (1993, in Field, 2005) warns against using alpha scores of more than .7 as a measure of unidimensionality. He claims that one can easily get a large alpha value when the

[3] With varimax rotation the first rotated factor contains the two items from the 'limits to growth' facet (only two items remain in this facet after Item 6 was excluded), one item from the 'fragility of balance' facet and two items from the ecocrisis facet. The second rotated factor contains two items from the anti-anthropocentrism facet, two items from the 'rejection of exemptionalism' facet, one item from the 'fragility of balance' facet and one item from the ecocrisis facet. The third factor in the rotated solution contains one item from the 'fragility of balance' facet, one item from the anti-anthropocentrism facet and one item from the 'rejection of exemptionalism' facet.

scale is made up of more than 12 items. The three emerging factors did nevertheless not reveal any theoretical meaning according to the five hypothesized facets indicated by Dunlap et al. (2000). Because emerging factors was not theoretically meaningful and because former literature recommends so, it was decided to treat NEP as a single index in the preceding analyses.

Items not analysed. Some questions in the questionnaire were not included in the analysis. For instance, there were a few questions about preferred energy sources. These are to be scrutinized in later research projects and will not be analyzed in this thesis. One question asked respondents about their preference of media channels to obtain information about new energy technologies. There were also a third measure of trust; trust in information sources. This question was taken from the FENCO-ERA survey and is equal to the one used in Eurobarometer surveys on energy technologies (European Commission, 2007).

Statistical analyses

For using parametric tests data must meet certain assumptions (Field, 2005). Normal distribution of the scores was measured by studying values of skewness and kurtosis. Overall, these numbers were considered to be acceptable and normal distribution was generally met. Confidence intervals of 95% were used in all statistical analyses. The statistical analysis software SPSS 17 was used for running statistical tests.

Principal component analysis. In order to discover if a set of items can be split into several underlying constructs principal component analysis, also called exploratory factor analysis, was used (Kline, 2000). Principal component analysis searched for underlying facets in the NEP scale, to understand the structure of that set of variables. Normally, scientists use factor rotation to improve interpretation. Oblique rotation is the preferred method when there are theoretical grounds for believing that factors might correlate, which they very often do in psychological research (Field, 2005). Orthogonal rotation may, however, be run as a second choice if oblique rotation produces no theoretically meaningful results.

T-tests. To test for differences between groups, like men and women, independent samples t-test was used. This statistical test compares the difference between the means of two samples to the difference we would expect by chance (Field, 2005). The independent samples t-test was used to check for gender differences in various variables as well as to compare results from this study with results from the two FENCO-ERA surveys. Levene's test was used to control for variance homogeneity, since t-tests assume equal variances. In large samples, however, small differences can produce a significant Levene's test. Therefore,

variance ratio was checked in cases where Levene's test reported unequal variances. Variance ratio is the variance of the group with the biggest variance divided by the variance of the group with the smallest variance (Field, 2005).

Variance analysis. One-way independent ANOVA (analysis of variance) is a statistical test that compares several means, when those means have come from different groups of people or when the independent variable has several levels (Field, 2005). In this study, ANOVA was used to see if people with different self-reported awareness of CCS differed in attitude towards CCS. The test was also used to see if different levels of climate change concern were related to different ratings of attitude. While ANOVA simply tells whether there are differences between the group means, it does not report where the differences between groups lie. So, either planned contrasts or post-hoc procedures can be applied to find out which groups differ. Post-hoc tests are more conservative than planned contrasts and involve a higher risk of making Type II errors. Planned contrasts is the recommended method in cases where the researcher has a priori predictions about the data (Field, 2005). When there is no specific hypothesis in advance, a post-hoc procedure is more suitable. Some post-hoc tests, like Bonferroni and Tukey, are powerful but should not be used when group sizes differ (Field, 2005). Gabriel's pairwise test procedure is a good alternative when sample sizes are unequal. When population variances differ, the Games-Howell test is better. In this study, post-hoc procedures are chosen for tests with no specific hypotheses, while planned contrasts is chosen for tests with a priori predictions.

Regression analysis. With multiple regression analysis, one can predict levels of the dependent variable from the levels of several independent variables (Field, 2005). This study used a multiple linear regression analysis with hierarchical entry of variables (blockwise forced entry). This method is regularly used for testing theoretical models or for testing mediator and moderator effects. Hierarchical regression is usually chosen when the researcher has past work to build hypotheses on, and the general rule is to first enter known predictors and control variables into the model (Field, 2005). When adding new blocks into the regression model, one can detect changes in coefficient values and in overall explained variance of the model.

Three regression analyses were run; to find out what variables predict attitude, risk perception and benefit perception. Socio-demographic variables were entered into the first block as control variables. A general rule is to include known predictors first (Field, 2005). Therefore, the second block contained the risk and benefit variables. The third block included variables thought to influence attitude (or risk and benefit perception).

When performing regression analysis, multicollinearity may pose a problem: Very strong correlations between two or more predictors in a regression model may increase the standard errors of the beta values, limit the size of explained variance (*R*) and it may make it more difficult to assess the importance of predictors (Field, 2005). The variance inflation factor (VIF) and tolerance values are typically used to detect multicollinearity. There are different opinions on the interpretation of these numbers, but for this study a tolerance value of less than .2 and a VIF of 5 and above will be considered indications of a multicollinearity problem.

Mediation analysis. A mediator is a variable that accounts for (some of) the relation between the predictor and the outcome variable (Baron & Kenny, 1986). The Sobel test is a statistical procedure for measuring such effects. A criterion for the Sobel test is that all variables included in the analysis are significantly correlated. Figure 2 explains the mediation design.

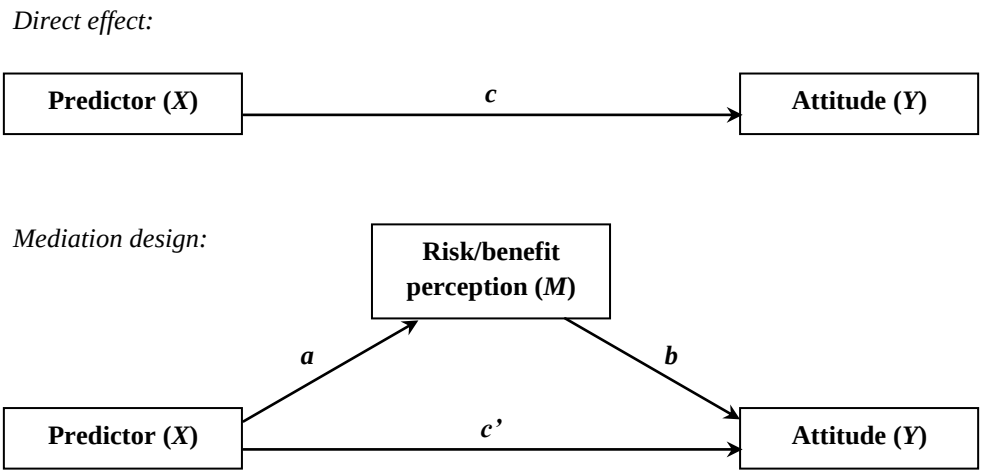

Figure 2. Top: Illustration of a direct effect. Bottom: Illustration of a mediation design. From "SPSS and SAS procedures for estimating indirect effects in simple mediation models," by K. J. Preacher & A. F. Hayes, 2004, *Behavior Research Methods, Instruments, & Computers, 36*, p. 718.

The Sobel test addresses whether or not the total effect of the predictor (*X*) on the outcome variable (*Y*) is significantly reduced upon the addition of a mediator (*M*) to the model (Preacher & Hayes, 2004). In Figure 2, *a* represents the effect of the independent variable on the mediator, and *b* is the effect of the mediator on the dependent variable when the independent variable is controlled for. The total effect of the predictor on the outcome variable is a regular cause-effect relationship with no mediator, represented in Figure 2 by *c* in the top illustration. The direct effect of the predictor on the outcome variable, controlling for the mediator, is represented by *c'* in the bottom part of the figure. An indirect effect would be

indicated by *ab* in Figure 2. Note that even though the relationships between variables are described as effects in this explanation, the survey design of the present study of course prohibits any conclusions about cause and effect (Howell, 2010). They should be seen as relationships. In the analysis to follow, an SPSS macro was used to test the indirect effect using the Sobel test (Preacher & Hayes, 2004).

Ethics and anonymity

The study was reported to and approved by the Norwegian Social Science Data Services (NSD). NSD's approval letter is attached in Appendix C. As participation is anonymous and data collection was administered by YouGov personal data from this survey was unavailable to the author. Respondents are simply marked with a number in the data set. According to NSD's definitions, a person is identified when combining his/her survey responses makes it possible to come down to three or fewer individuals. With a sample of 999 this is impossible with no other personal information than age, gender, place of residence (county), income and education.

RESULTS

Descriptive statistics

Attitudes towards CCS. The mean value on the global attitude index (based on five questionnaire items, 1-7 scales) is 4.09 (*SD* = 1.24). On the initial question about preference of technologies to tackle global warming, the mean for CCS is 4.02 (*SD* = 1.72), almost right at the middle. Respondents rank the other technologies in this order: solar power (*M* = 6.24, *SD* = 1.23), wind power (*M* = 6.05, *SD* = 1.36), energy-efficient appliances (*M* = 5.85, *SD* = 1.39), and nuclear power (*M* = 3.19, *SD* = 1.96). Accordingly, only nuclear power is rated below CCS, while the other technologies are seen as more desirable to include in a plan to combat global warming. The next question, about agreement to a hypothetical CCS test plant, has a mean of 4.25 (*SD* = 1.64) on a scale where 1 stands for 'Strongly oppose' and 7 is 'Strongly supportive'. Attitudes towards specific plans in Norway vary for capture (*M* = 4.18, *SD* = 1.38), transport (*M* = 3.91, *SD* = 1.40), and storage (*M* = 4.09, *SD* = 1.55) of CO_2.

Perceptions of risk and benefit. Values on the global risk index show that respondents in general report low perceived risk, with a mean of 3.05 (*SD* = 1.18). The mean for the global benefit perception index is 3.94 (*SD* = 1.27). Mean personal risk perception is 2.84 (*SD* = 1.24) and mean societal risk perception is 3.26 (*SD* = 1.23). Mean personal benefit perception is 3.71 (*SD* = 1.33) and mean societal benefit perception is 4.17 (*SD* = 1.32). Table 5 shows a full chart of all scores on the risk and benefit perception items.

Table 5

Perception of risks and benefits

Item	**Mean**	***SD***
Capture, personal risk	2.80	1.39
Capture, societal risk	3.14	1.38
Capture, personal benefit	3.78	1.53
Capture, societal benefit	4.30	1.48
Transport, personal risk	2.89	1.43
Transport, societal risk	3.38	1.44
Transport, personal benefit	3.60	1.48
Transport, societal benefit	4.03	1.42
Storage, personal risk	2.84	1.46
Storage, societal risk	3.26	1.46
Storage, personal benefit	3.74	1.55
Storage, societal benefit	4.18	1.54

Knowledge. The global knowledge index, containing all 18 knowledge questions, has a mean of 11.63 (*SD* = 2.94) correct answers. Hence, the average respondent has about two thirds of the answers correct. Each of the three knowledge indexes had six questions, such that a respondent could have a minimum of zero and a maximum of six correct answers. General knowledge on environmental issues and science has a mean score of 4.19 (*SD* = 1.16) correct answers, knowledge on activities contributing to CO_2 build-up has a mean of 5.29 (*SD* = 1.02), and knowledge of CCS has a mean of 2.16 (*SD* = 1.84) correct answers.

About 40 % of the respondents believe the greenhouse effect is caused by a hole in the earth's atmosphere, an erroneous statement (Table 6). About two thirds of the respondents also picked the wrong answer on statements about whether we are living in a warm period between ice ages and whether most of the energy used to produce electricity from fossil fuels is lost. Respondents show high knowledge on CO_2-increasing activities and causes of climate change: 86.5% of the respondents have five or six correct answers on this index. The question about whether or not nuclear power plants increases or decreases CO_2 in the atmosphere is the only question creating some confusion among respondents (Table 7). Otherwise, around 90 % have all answers correct.

The CCS index listed six environmental problems and asked which of these could be solved by CCS. Global warming is the single environmental problem CCS can reduce. 63.9% of the respondents have this correct (see Table 8). Still, a large part of the respondents also believe CCS can reduce smog (50.8%), ozone depletion (46.8%) and acid rain (42.4%). Sizable groups (from 25.3% to 32.2%) report 'Don't know' on these questions. Of all respondents, 5.2% have all six items correct on the CCS knowledge scale, namely recognizing that the unique aim of CCS is to reduce global warming, while indicating that the five other options (e.g. 'to reduce toxic waste') is incorrect.

Table 6

Knowledge of general environmental issues

Statement	**True**	**False**
'We are currently in a warm period between ice ages'	*64.9*	35.1
'Roughly two-thirds of the energy used to produce electricity from fossil fuels is lost'	*66.1*	33.9
'The greenhouse effect is caused by a hole in the earth's atmosphere'	39.3	*60.7*
'Every time we use coal or oil or gas, we contribute to the greenhouse effect'	*87.5*	12.5
'Oil and gas reservoirs are typically found 100 meters below the surface'	37.5	*62.5*
'Oxygen is the main component of the smoke emitted from a smokestack or tailpipe'	22.5	*77.5*

Note. Values are percentages of respondents in each category; $N = 999$. Correct answers in italics. Question: 'To the best of your knowledge, please mark whether each statement below is true or false.'

Table 7

Knowledge of CO_2 build-up

Activity	**Increases**	**No impact**	**Decreases**
Cars (motoring)	*91.8*	6.8	1.4
Coal burning power plants	*91.2*	6.1	2.7
Nuclear power plants	32.9	*56.0*	*2.7*
Windmills / wind turbines	1.7	*67.3*	*31.0*
Planting trees	3.7	8.0	*88.3*
Factories (e.g. steel mills)	*91.9*	6.3	1.8

Note. Values are percentages of respondents in each category; $N = 999$. Correct answers in italics. Question: 'There is a growing concern about increasing levels of carbon dioxide in the atmosphere. How do the following activities contribute to these levels?'

Table 8

Knowledge of CCS

Environmental problem	**Can reduce**	**Does not reduce**	**Don't know**
Toxic waste	23.5	*44.9*	31.5
Ozone depletion	46.8	*23.7*	29.4
Global warming	*63.9*	10.8	25.3
Acid rain	42.4	*26.2*	31.3
Smog	50.8	*22.1*	27.1
Water pollution	33.1	*34.6*	32.2

Note. Values are percentages of respondents in each category; N = 999. Correct answers in italics. Question: 'Carbon capture and storage can reduce which of the following environmental concerns?'

Awareness. On the single awareness question 70.7% of the respondents report to have heard of CCS: 51.1% answer 'A little' while 19.6% say 'Yes, quite a bit'. 29.3% of the respondents answer 'No, never heard'.

Concern for climate change. Respondents were asked a single question about their concern for anthropogenic climate change: 'Based on what you know about climate change (additional greenhouse effect caused by humans), which of the following statements comes closest to your opinion?' Of all respondents, 32.6% agrees with the first statement: 'Climate change has been established as a serious problem and immediate action is necessary'. 35.1% of the respondents agrees with the second statement: 'There is enough evidence that climate change is taking place and some action should be taken'. In other words, 67.7% of the sample believes human-induced climate change is a real problem and agrees that action should be taken to mitigate it. The third statement, 'We do not know enough about climate change and more research is necessary before we take any actions', gains agreement from 19.4% of the respondents, while 6.6% agrees with the fourth statement: 'Concern about climate change is unwarranted'. Another 6.2% are unsure or have no opinion.

Social trust. All social trust items were scaled such that 1 represented no trust and 7 represented full trust. Overall, scientists were the most trusted actor (M = 4.69, SD = 1.28) and environmental NGOs were rated second highest (M = 4.45, SD = 1.52). Industry and energy companies were the least trusted actor (M = 3.27, SD = 1.27), while the government were given slightly higher trust ratings (M = 3.52, SD = 1.43). 'Trust in intentions' (M = 4.09, SD = 1.14) was slightly higher than 'trust in competence' (M = 3.87, SD = 1.06).

Epistemic trust. Three items measuring the 'epistemic trust' concept had mean ratings lower than the mid value on the 1-7 scale: Question 1, 'How well do you think science know

the risk associated with CCS?', had a mean rating of 3.72 (*SD* = 1.46), question 2, 'To what extent do you consider the technical and scientific questions about CCS to be solved?', had a mean rating of 3.23 (*SD* = 1.27), while question 3, 'To what extent is current scientific knowledge sufficient for implementing CCS?', had a mean rating of 3.65 (*SD* = 1.34). The epistemic trust index had a mean rating of 3.53 (*SD* = 1.20).

Perception of interference with nature. The respondents' perception of CCS as an interference with nature was also rated slightly lower than the mid value: Statement 1, 'From the viewpoint of environmental protection, humans should not start with CCS', had a mean rating of 3.50 (*SD* = 1.61), while statement 2, 'CCS interferes with nature's laws', had a mean rating of 3.73 (*SD* = 1.65). As mentioned in the Methods section, the third item was deleted from the scale. The 'perception of interference' index, made up of the two first items, had a mean of 3.61 (*SD* = 1.48).

NEP. The mean rating of the global NEP index was 4.87 (*SD* = .83). On an aggregated level, the sample leaned towards having a pro-ecological worldview. Table 9 shows all mean values on the specific NEP items.

Table 9

Mean scores on the NEP items

Item	Mean	*SD*
1. We are approaching the limit of the number of people the earth can support.	4.73	1.67
2. Humans have the right to modify the natural environment to suit their needs.	2.90	1.47
3. When humans interfere with nature it often produces disastrous consequences.	4.78	1.46
4. Human ingenuity will ensure that we do not make the earth unlivable.	3.40	1.52
5. Humans are severely abusing the environment.	5.21	1.53
6. The earth has plenty of natural resources if we just learn to develop them.[a]	4.37	1.70
7. Plants and animals have as much right as humans to exist.	5.63	1.54
8. The balance of nature is strong enough to cope with the impacts of modern industrial nations.	2.94	1.44
9. Despite our special abilities humans are still subject to the laws of nature.	5.64	1.34
10. The so-called 'ecological crisis' facing humankind has been greatly exaggerated.	3.46	1.70
11. The earth is like a spaceship with only limited room and resources.	4.47	1.59
12. Humans were meant to rule over the rest of nature.	2.80	1.61
13. The balance of nature is very delicate and easily upset.	5.03	1.49
14. Humans will eventually learn enough about how nature works to be able to control it.	3.25	1.56
15. If things continue on their present course, we will soon experience a major ecological catastrophe.	4.68	1.60

Note. Mean scores before rotation of negatively worded items. 1-7 scale.

a This item was excluded from the analysis

Bivariate statistics

Demographics. The results show quite clear gender differences: men's mean attitude rating (M = 4.31, SD = 1.35) is higher than women's (M = 3.87, SD = 1.08). An independent t-test concludes this difference is significant, $t(952.19) = 5.76$, $p < .001$, while only representing a small effect $r = .18$. Perceived risk is higher for women (M = 3.33, SD = 1.07) than for men (M = 2.77, SD = 1.22), also a significant difference, $t(981.73) = -7.76$, $p < .001$, $r = .24$. There was no significant difference between men's perceived benefits and women's, $t(965.10) = 1.50$, $p > .05$.

Education. A common way to define education is to say that everything above high school (videregående skole) is higher education while high school or below is defined as lower education (SSB, 2006). The low education group (N = 340) had a mean attitude rating

of 3.92, and the high education group (N = 659) had an attitude rating of 4.18. This difference was significant, $t(997) = -3.09$, $p < .01$. It was decided to use this dummy coded education variable in further analysis.

Bivariate correlations. Table 10 shows that all variables are significantly correlated to attitude on at least a .05-level (even though correlation with the NEP index is very weak). The highest correlation is between attitude and benefit perception ($r = .779$, $p < .001$). As expected, there is also a high correlation between the two social trust concepts ($r = .706$, $p < .001$). Risk perception and benefit perception are negatively correlated, in line with expectations ($r = -.149$, $p < .001$).

NEP was not significantly correlated to risk perception and perceived interference with nature, and knowledge is not significantly correlated to trust in competence and epistemic trust. Otherwise, there are significant correlations between all variables but seemingly none so strong that they would be a problem for regression analysis. All bivariate correlations with attitude towards CCS are in the direction predicted by the hypotheses except the NEP variable. Climate change concern, social trust, epistemic trust and knowledge are positively correlated to attitude towards CCS, while perceived interference with nature is negatively correlated. Epistemic trust has a higher correlation than the two social trust variables.

Table 10

Correlations between variables

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1 Attitude	1									
2 Risk perc.	-.338***	1								
3 Benefit perc.	.779***	-.149***	1							
4 Climate ch. conc.	.229***	-.097**	.227***	1						
5 Knowledge	.199***	-.351***	.086**	.126***	1					
6 NEP	.070*	-.016	.095**	.363***	.204***	1				
7 Trust competence	.410***	-.095**	.419***	-.346***	.059	.143***	1			
8 Trust intentions	.379***	-.100**	.411***	-.339***	.095**	.165***	.706***	1		
9 Epistemic trust	.578***	-.197***	.584***	.108***	.051	-.113***	.389***	.332***	1	
10 Interfer. nature	-.544***	.394***	-.445***	-.147***	-.225***	.041	-.142***	-.158***	-.374***	1

* $p < .05$, ** $p < .01$, *** $p < .001$

Multivariate statistics

Political affiliation. Political affiliation was tested as a factor of attitude through an ANOVA. There was a significant between-group difference, $F(10, 988) = 3.45$, $p < .001$. Gabriel's post-hoc procedure revealed that the only significant differences were between the group of respondents that refrained from saying what party they voted, and those who voted Ap, H and SV. The Labour Party (Ap), the Conservative Party (H), the Socialistic Left Party (SV) and the Liberal Party (V) were the most positive towards CCS (see Appendix D). The Progress Party (Frp), the Christian Democratic Party (KrF) and the Red Party (R) were the most negative.

However, these differences are difficult to interpret as they seem to be unrelated to the parties' actual opinion on CCS, gas power and/or the Kårstø power plant. There are different opinions on the use of natural gas power in Norway but support for CCS cut across the left/right axis, with an exception being made for the Progress Party (Tjernshaugen, forthcoming). The Progress Party is against the CO_2 capture project at Kårstø (Frp, 2009). Voters of the Christian Democratic Party and the Red Party came out as the two most skeptical groups, but according to these parties' political programmes they are very positive to implementing CCS in Norway (KrF, 2009; Rødt, 2009). For political affiliation to be included in a regression analysis, the variable should be dummy coded, as it is a categorical variable (Field, 2005). Based on these attitude ratings it is difficult to find any meaningful ways to code this variable. Still, to check for any influence of political affiliation it is important to include this factor in the regression analysis. It was therefore decided to code a dummy variable separating between pro-CCS parties and anti-CCS parties. All groups with a mean attitude over the mid value (4) were regarded pro-CCS (Ap, H, Sp, SV, V, 'Other parties'), while those groups having a mean attitude below the mid value were regarded anti-CCS parties (Frp, KrF, R, 'Did not vote').

Income. A one-way ANOVA revealed there was a significant difference of mean rating of attitude towards CCS between income groups, $F(6, 992) = 3.56$, $p < .01$. According to Gabriel's post-hoc procedure[4], the lowest income group differed significantly from the '350,000-499,999' income group and the '500,000-699,999' group. Appendix D shows the mean attitude rating for each income group. It was decided to keep income as a continuous variable in the following regression analyses.

[4] Because of unequal sample sizes the data was also tested with the Hochberg GT2 test. With this test the difference between the low income group and the '500,000-699,999' group was barely insignificant.

Awareness. Respondents with the lowest self-reported awareness have a lower attitude rating ($M = 3.69$, $SD = 1.06$) than respondents reporting to have heard a little bit about CCS ($M = 4.16$, $SD = 1.29$), while those with the highest self-reported awareness have the highest attitude rating ($M = 4.59$, $SD = 1.53$). A one-way ANOVA was carried out to see if these differences were significant. Homogeneity of variance was explored with Levene's test and was found to be significant, $F(2, 996) = 23.50$, $p < .001$, which means that the variances are significantly different and one of the assumptions of ANOVA is violated (Field, 2005). Looking instead at Welch's F, there is a significant effect of self-reported awareness on attitude, $F(2, 464.62) = 30.09$, $p < .001$. Furthermore, there is a significant linear trend, $F(1, 996) = 59.96$, $p < .001$, indicating that the more aware of CCS respondents are, the more positive attitude they have towards it.

Climate change concern. A one-way ANOVA was conducted to explore the possible relationship between climate change concern and attitude towards CCS. As explained in the Methods section, the four statements ('No opinion' respondents were coded as missing data) were scaled such that the first statement represented the highest concern and the fourth statement represented the least concern. There was a significant linear trend, $F(1, 933) = 62.92$, $p < .001$, indicating that as the concern for climate change increased, attitude towards CCS increased proportionately[5]. There was also a significant quadratic relationship, $F(1, 933) = 7.50$, $p < .01$. Planned contrasts furthermore revealed that the two groups who deemed action to combat climate change necessary (statements 1 and 2) had significantly more positive attitudes towards CCS than the two groups who did not see action necessary (statements 3 and 4), $t(123.20) = 6.84$, $p < .001$ (one-tailed). Planned contrasts also revealed a significant difference between those agreeing with statement 3 and those agreeing with statement 4, $t(89.63) = 3.02$, $p < .01$ (one-tailed), but no significant difference between the two high-concern groups, statement 1 and 2, $t(653.37) = 1.30$, $p > .05$ (one-tailed).

Attitude towards CCS. To test the hypotheses, three linear multiple regression analyses were run. One analysis was carried out with attitude towards CCS as dependent variable. Hierarchical blockwise regression was used, a method in which known predictors should be entered first in order of their importance (Field, 2005). Demographical variables (gender, age, education, political affiliation, income) were entered into the first block, to control for the effect of such factors in the model. Education was dummy-coded into high and low education levels, while age and income were used as continuous variables. The second block contained

[5] Levene's test was significant, so all values are reported from the 'Equal variances not assumed' column

risk perception and benefit perception. Other important predictors were included in the third block: concern for climate change, knowledge, ecological concern, social trust, epistemic trust, perception of interference with nature. Based on the results from the ANOVA (see previous section), concern for climate change was dummy-coded into high and low concern. All variables were entered with the forced entry method, as recommended when there is past theoretical research to base the model on (Field, 2005). Results can be seen in Table 11.

R^2 is a measure of the proportion of variance in the dependent variable explained by the regression model, while adjusted R^2 (labeled $R_{adj}{}^2$) is the proportion of variance that would be accounted for if the model were derived from the target population (Field, 2005). Compared to R^2, the adjusted R^2 is a less biased estimate of the squared population coefficient (Howell, 2010). Both values are reported in the tables but the values referred to in the text and discussion is the adjusted R^2.

Clearly, Table 11 shows that the addition of risk perception and benefit perception had the most dramatic effect on the results. While demographics alone explain a mere 5.2% of the variance, adding risk perception and benefit perception increased explained variance of the model to 67.2%. This number increased to 70.7% when the third block was included. Of all the predictors, the following came out significant in the regression analysis: gender, age, risk perception, benefit perception, trust in competence, epistemic trust, and perception of interference with nature.

The Durbin-Watson test gave a value of 1.99, which indicates that the residuals are relatively independent. The highest VIF value was 2.15, which should be unproblematic according to Myers' (1990, in Field, 2005) criterion. The lowest tolerance value is .47.

Table 11

Hierarchical regression analysis on predictors of attitudes towards CCS

	Block 1			**Block 2**			**Block 3**		
	B	**SE**	**Beta**	**B**	**SE**	**Beta**	**B**	**SE**	**Beta**
Gender	-.392	.080	-.158***	-.212	.048	-.085***	-.179	.048	-.072***
Age	.004	.003	.039	.004	.002	.048*	.006	.002	.063***
Education	.135	.087	.051	.087	.051	.033	.055	.049	.021
Political affiliation	.376	0.84	.147***	.018	.050	.007	-.036	.048	-.014
Income	-.004	.022	.006	-.003	.013	-.005	-.003	.012	-.005
Risk perception				-.219	.021	-.205***	-.141	.022	-.132***
Benefit perception				.720	.019	.740***	.562	.024	.578***
Conc. for climate ch.							.097	.057	.035
Knowledge							.015	.009	.034
NEP							.018	.030	.012
Trust competence							.104	.031	.087***
Trust intentions							-.016	.028	-.014
Epistemic trust							.108	.024	.103***
Perc. interfer. nature							-.139	.019	-.165***
R^2	.057			.674			.712		
R_{adj}^2	.052			.672			.707		
R^2 change	.057			.617			.038		
F change	11.288***			878.953***			17.251***		

* $p < .05$, ** $p < .01$, *** $p < .001$

Table 12 shows that demographic variables explain 9.5% of the variance in risk perception, while benefit perception add 2.1% of explained variance to the model. With all other predictor variables included (Block 3) the model explains 30.5% of the variance in risk perception. Gender, age, benefit perception, knowledge, epistemic trust, perceived interference with nature and newspaper consumption were significant predictors of risk perception.

With a Durbin-Watson value of 2.00 it is very likely that the residuals are uncorrelated. The highest VIF value was 2.15 and the lowest tolerance value was .47.

Table 12

Hierarchical regression analysis on predictors of risk perception

	Block 1			**Block 2**			**Block 3**		
	B	**SE**	**Beta**	**B**	**SE**	**Beta**	**B**	**SE**	**Beta**
Gender	.564	.073	.242***	.553	.072	.238***	.292	.072	.125***
Age	-.005	.003	-.057	-.005	.003	-.062*	-.006	.003	-.065*
Education	-.186	.080	-.075*	-.185	.079	-.074*	-.067	.073	-.027
Political affiliation	-.351	.077	-.146***	-.299	.077	-.124***	-.140	.073	-.058
Income	.022	.020	.035	.024	.019	.038	.020	.018	.032
Benefit perception				-.135	.028	-.148***	.060	.036	.066**
Conc. for climate ch.							-.076	.086	-.029
Knowledge							-.084	.013	-.208***
NEP							.025	.045	.018
Trust competence							-.012	.046	-.011
Trust intentions							-.032	.042	-.031
Epistemic trust							-.085	.036	-.086*
Perc. interfer. nature							.230	.027	.292***
Media use (newsp.)							-.099	.036	-.083**
Media use (TV)							.044	.027	.051
R^2	.100			.121			.265		
R_{adj}^2	.095			.116			.253		
R^2 change	.100			.021			.144		
F change	20.686***			22.554***			20.015***		

* $p < .05$, ** $p < .01$, *** $p < .001$

Table 13 shows that demographic variables explain very little or none of the variance in benefit perception. Even with risk perception added, explained variance does not increase very much. The R_{adj}^2 grows to 48.2% when all other predictor variables are accounted for (Block 3). Six of the predictor variables in Block 3 have significant beta coefficients, indicating that they do contribute to explaining variance in the dependent variable, benefit perception.

The Durbin-Watson test gave a value of 1.94, which indicates that the residuals are relatively independent. The highest VIF value in the analysis was 2.13 (for the 'trust in competence' variable) while the lowest tolerance value was .47 (for the same variable).

Table 13

Hierarchical regression analysis on predictors of benefit perception

	Block 1			**Block 2**			**Block 3**		
	B	**SE**	**Beta**	**B**	**SE**	**Beta**	**B**	**SE**	**Beta**
Gender	-.078	.084	-.031	.021	.085	.008	.008	.067	.003
Age	-.003	.003	-.028	-.004	.003	-.037	-.001	.003	-.015
Education	.011	.091	.004	-.022	.090	-.008	-.042	.068	-.015
Political affiliation	.390	.088	.148***	.328	.088	.124***	.055	.067	.021
Income	.017	.023	.025	.021	.022	.030	.022	.017	.033
Risk perception				-.176	.037	-.160***	.051	.030	.046
Conc. for climate ch.							.091	.079	.032
Knowledge							-.010	.012	-.022
NEP							.178	.041	.116***
Trust competence							.138	.042	.113***
Trust intentions							.151	.039	.132***
Epistemic trust							.426	.030	.396***
Perc. interfer. nature							-.250	.024	-.289***
Media use (newsp.)							.019	.033	.015
Media use (TV)							.067	.025	.071**
R^2	.024			.047			.482		
R_{adj}^2	.019			.041			.473		
R^2 change	.024			.023			.435		
F change	4.540***			22.554***			85.901***		

* $p < .05$, ** $p < .01$, *** $p < .001$

Mediator effects

Hypothesis 5 states that risk perception and benefit perception will mediate the effect of the predictor variables on attitude towards CCS. As discussed in the Methods section, a mediator is a variable that accounts for (some of) the relation between the predictor and the outcome

variable (Baron & Kenny, 1986). A criterion is that all variables should be significantly correlated to be included in the mediation analysis. Baron and Kenny (1986) do not give an exact minimum size for these correlations but emphasize that it is critical to investigate the absolute size of relationships, not just their significance. As shown in Table 8, most variables were significantly related. Some correlations are significant but very small, so for this study it was decided to only include variables with correlations above .1 in the mediation analyses.

Separate mediation tests were carried out with risk perception and benefit perception, respectively, as mediator variables. Only trust in intentions, epistemic trust, perceived interference with nature and knowledge had significant correlations above .1 with both attitude and risk perception. Climate change concern, trust in competence, trust in intentions, epistemic trust and perceived interference with nature were the only variables correlated (above .1) with both attitude and benefit perception. Even though all z-values were statistically significant, most of these indirect effects are very small and may not be very important (Table 14). The results will be further discussed in the Discussion section.

Table 14

Effect of predictor variables on attitude with risk perception as mediator

	Total effect	**Direct effect**	**Mediation**	**SE**	**Z**
Trust in intentions	.412***	.379***	.033	.011	3.043**
Epistemic trust	.599***	.551***	.048	.009	5.214***
Perceived interference with nature	-.457***	-.408***	-.049	.010	-4.807***
Knowledge	.084***	.039**	.045	.006	7.463***

* $p < .05$, ** $p < .01$, *** $p < .001$

Note. Unstandardized coefficients. Standard errors (SE) and z-scores relate to the mediations (indirect effects).

Table 15 shows results with benefit perception as mediator. The results revealed that concern for climate change, the social trust variables, epistemic trust and perceived interference with nature have significant relationships with attitude through benefit perception. Note that trust in intentions and climate change concern did not have a significant beta value in the regression analysis on attitude towards CCS (Table 11).

Table 15

Effect of predictor variables on attitude with benefit perception as mediator

	Total effect	**Direct effect**	**Mediation**	**SE**	**Z**
Concern for climate change	.635***	.151**	.484	.069	6.993***
Trust in competence	.481***	.119***	.362	.027	13.396***
Trust in intentions	.412***	.077**	.335	.026	13.164***
Epistemic trust	.599***	.194***	.405	.023	17.673***
Perceived interference with nature	-.457***	-.207***	-.250	.018	-14.102***

* $p < .05$, ** $p < .01$, *** $p < .001$

Note. Unstandardized coefficients. Standard errors (SE) and z-scores relate to the mediations (indirect effects).

Validity checks

As shown in the Methods section, there are a few differences between with the present sample and the Norwegian population. A comparison between this sample and the Norwegian samples of the FENCO-ERA surveys shows that the age distribution is quite similar. The June sample has somewhat fewer respondents in the 18-24 age group, but the biggest difference is between the November and January samples. The June sample furthermore has a slightly larger share of its respondents lying between 25 and 44 years old, compared to the November and January samples. The three samples are also quite similar in geographical distribution. The June sample has fewer respondents from Southern Norway and Western Norway, but the differences are not serious. All three samples were equally distributed between men and women. The FENCO-ERA surveys did not collect information on income and political affiliation. A full comparison of the demographic variables is included in the Appendix E.

Table 16 presents mean attitudes, risk perceptions and benefit perceptions of the three surveys; in November 2009, January 2010 and June 2010. A big caution should be taken regarding the fact that these surveys are done on different samples, so this cannot be thought of as a longitudinal study.

Table 16

Comparison of samples

Variable	**Nov. 2009**	***SD***	**Jan. 2010**	***SD***	**Jun. 2010**	***SD***
Awareness	50,3 %	-	62.6 %	-	70.7 %	-
Knowledge environ. issues	4.13	1.12	4.09	1.21	4.19	1.16
Knowledge CO_2 build-up	5.30	.93	5.40	.93	5.29	1.02
Knowledge CCS	1.76	1.79	1.95	1.84	2.16	1.84
Knowledge index	11.20	2.70	11.43	2.94	11.63	2.94
Risk perception capture	2.87	1.33	2.80	1.29	2.84	1.24
Risk perception transport	2.99	1.30	2.87	1.31	3.26	1.23
Risk perception storage	2.87	1.33	2.75	1.30	3.05	1.38
Risk perception index	2.91	1.19	2.81	1.18	3.05	1.18
Benefit perception capture	4.10	1.34	4.13	1.32	3.71	1.33
Benefit perception transport	3.89	1.33	3.89	1.29	4.17	1.32
Benefit perception storage	3.86	1.38	3.86	1.38	3.96	1.47
Benefit perception index	3.95	1.25	3.96	1.21	3.94	1.27
Acceptance specific	4.08	1.30	4.13	1.27	4.06	1.29
Attitude index	4.06	1.27	4.20	1.28	4.09	1.24

The results are surprisingly similar, bearing in mind that these are three different samples at three different points in time. Mean attitude rating varied with a mere .14 while risk perception had a maximum difference of .24. Benefit perception was practically similar between the three samples. Knowledge of environmental issues and CO_2 build-up seems to be largely unchanged across the samples. One possible trend is that knowledge of CCS has increased from 1.76 (November 2009) to 1.95 (January 2010) to 2.16 (June 2010). Likewise, awareness of CCS increased across the same time span from 50.3 % to 62.6 % to 70.7 %.

While comparability between these samples obviously is questionable, the data is presented here mainly as indication of sample representativeness and information about trends or changes in attitudes.

Validity. Discriminative validity can be proven if a scale adequately differentiates between groups that should differ based on theoretical reasons or previous research (Grendstad, 1999). Gender differences are widely known in risk psychology[6], and perceived

[6] Specifically, American studies have found white males to stand out from other subgroups (Slovic, 1999). Gender differences are also found to vary cross-nationally (Boholm, 1998).

risk is generally found to be higher among women than men (Boholm, 1998; Sjöberg & Herber, 2008; Slovic, 1999). This persistent finding is replicated in the current study. Several gender differences are found in the sample, as shown in Table 17. Higher environmental concern among women than men is also a replication of earlier research, and can be seen as a sign of validity (Davidson & Freudenburg, 1996; O'Connor, Bord, & Fisher, 1999). Men also recorded a higher level of epistemic trust than women, that is, they have more trust in science and technology, in line with previous research (Slovic, 1999). Mean ratings on the NEP scale is also significantly different between men and women, with women being more ecologically concerned than men. Grendstad (1998) produced the same result in his study of NEP on a Norwegian public sample.

Table 17

Mean scores and t-tests on gender differences in index variables

	Men	**SD**	**Women**	**SD**	***df***	***T***	**Effect size**
Attitude	4.31	1.35	3.87	1.08	952.19	5.76***	.18
Risk perception	2.77	1.22	3.33	1.07	981.73	-7.76***	.24
Benefit perception	4.00	1.38	3.88	1.15	965.10	1.50	.05
Trust competence	3.79	1.09	3.96	1.01	992.155	-2.51*	.08
Trust intentions	3.99	1.21	4.19	1.06	981.777	-2.88**	.09
Epistemic trust	3.68	1.27	3.39	1.11	981.08	3.83***	.12
NEP	4.76	.85	4.98	.79	997	-4.31***	.14
Knowledge[a]	12.47	2.93	10.79	2.69	990.79	9.44***	.29
Perc. of interference	3.36	1.53	3.87	1.38	988.23	-5.55***	.17

*** $p < .001$

a Mean number of correct answers on 0-18 scale.

Another sign of validity is that those voting traditional "green" parties, like the Liberal Party (V) and the Socialistic Left Party (SV), are among the most positive towards CCS, on average. Voters of the Liberal Party had a mean rating of 4.24 on attitude towards CCS, while voters of the Socialistic Left Party had a mean rating of 4.28, the highest of all parties in the present survey (see Appendix D).

DISCUSSION

The goal of this thesis has been to look into the present public attitudes towards CCS in Norway, as well as to investigate what factors are most important in determining attitude towards CCS. Furthermore, the thesis wanted to investigate what factors affect perceptions of risks and benefits from CCS, and how these relate to attitudes. People's knowledge about CCS and climate issues has also been studied. Lastly, a brief comparison was made between the present study and previous studies. To test a set of hypotheses, various statistical analyses, mainly multiple regression analyses, were performed on a dataset comprising responses from 999 Norwegian persons. This section starts with a brief summary of the main findings, followed by a more thorough discussion of the results.

Main findings

The regression analysis on attitude (Table 11) had pretty good explanatory power, indicating that the model can predict variance in attitude towards CCS pretty well. Most of this variance seemed to be explained by only one variable: benefit perception. However, risk perception was also a significant predictor of attitude towards CCS. The results from this regression analysis showed that people have a more positive attitude towards CCS when they perceive benefits as higher and risks as lower and thus supported Hypothesis 1. Results from the regression analyses furthermore showed that perceived interference with nature influenced attitude towards CCS. When people perceive CCS as an interference with nature, they are less likely to support the technology, in line with Hypothesis 3. Hypothesis 4 was also supported by the data. Epistemic trust had a significant beta coefficient in the regression model, indicating that respondents showing more epistemic trust are more likely to support CCS. Based on the results, epistemic trust seemed to be a more important predictor than social trust.

Risk perception and benefit perception acted as mediators for some of the predictor variables. Risk perception was shown to mediate the influence of trust in intentions, epistemic trust, knowledge, and perceived interference with nature. The indirect effects were significant but very small. Benefit perception acted as a mediator for climate change concern, trust in competence, trust in intentions, epistemic trust and perceived interference with nature. Hypothesis 6 was though partly confirmed.

Some variables were shown to be insignificant. Concern for climate change did not correlate positively with attitude towards CCS in the regression model, as predicted, and there was no linear negative relationship between the NEP scale and attitude ratings. Hypothesis 2

was therefore not supported. According to Hypothesis 5, having more knowledge about environmental problems, climate change and CCS would be related to being more positive towards CCS. This hypothesis was not supported.

Other findings

Several factors, previously shown to be significant in explaining attitude were included in the model. Some socio-demographic variables were included in the analysis. Of these, gender and age came out as significant. Reading Table 11, one can see that women are less accepting of CCS than men. As age increases, respondents get more positive towards CCS. Respondents' level of education, political affiliation and income did not significantly affect their attitude.

Predictors of perceived risks and benefits. Some variables may be important predictors of risk and benefit perception, even if they do not directly influence attitude, therefore two regression analyses were run with perceived risk and benefit as dependent variables. The regression model on benefit perception (Table 13) had quite high explanatory power, while a similar model could not explain risk perception that well (Table 12). There are obviously independent variables, as yet undiscovered, that could explain people's perceptions of risks or drawbacks with CCS. Knowledge had a quite clear negative influence on risk perception, suggesting that people with more knowledge about environmental issues, CO_2 emission problems and CCS are less concerned about the risks of CCS. Knowledge did not, however, influence perception of benefits in the regression model. Concern for climate change was insignificant on both risk and benefit perception, while ecological concern, as measured by the NEP scale, had only very weak bivariate correlations with perceived risks and benefits. The NEP variable did significantly predict benefit perception in a positive direction but it was not a significant predictor of perceived risks in the regression model.

Previous research has found social trust to influence benefit perception positively and risk perception negatively (Huijts et al., 2007; Tokushige et al., 2009). While social trust did not have any significant influence on risk perception in the regression model, both trust dimensions did influence benefit perception positively. Epistemic trust influenced risk perception negatively and benefit perception positively, both beta values being statistically significant in the regression analyses. Epistemic trust seemed to have a stronger influence on benefit perception than on risk perception. Of all predictor variables epistemic trust had the highest regression coefficient on benefit perception. Furthermore, people perceive benefits as higher and risks as lower when they perceive CCS as less interfering with nature. This factor had a strong relationship with both risk perception and benefit perception. Thus, perceived

interference with nature seems to be an important reason for forming a negative attitude towards CCS. Finally, media consumption was thought to have an impact on perceptions of risks and benefits (Mander et al., 2009; Pietzner et al., 2010; Slovic et al., 1982). For analyzing the data, this hypothesis had to separate between different types of media consumption: reading newspaper and watching television. The regression analyses showed that high consumption of newspapers led to lower perceived risk. Reading newspapers did not have a significant beta value on benefit perception, though. People's frequency of watching TV apparently influenced their risk benefit perception positively.

In the following sections, the findings will be given a more thorough discussion.

Risk and benefit perceptions

As mentioned, Hypothesis 1 was confirmed by the data: People have a more positive attitude towards CCS when they perceive risks as lower and benefits as higher. This confirms previous research on CCS (Huijts et al., 2007; Tokushige et al., 2009) as well as a number of studies on other risk objects like oil, coal, gas and wind power, and gene technology (e.g. Siegrist, 2000; Sjöberg, 1999).

The inverse risk-benefit relationship. Underlying the first hypothesis is the assumption that there is an inverse relationship between perceived risks and perceived benefits. Table 10 shows a negative bivariate correlation between perceived risk and perceived benefit, and this correlation is again demonstrated in the regression analysis shown in Table 11. The mean rating of perceived risks is lower than the mean rating of perceived benefits. According to Alhakami & Slovic (1994), the presence of a negative correlation between perceived risks and benefits plus an absolute distance between their mean ratings, are satisfactory for concluding that there is an inverse relationship between those variables. Thus, these results back up the assertion of an inverse relationship between risk perception and benefit perception.

Still, the multiple regression analyses with risk and benefit perception as outcome variables, complicate the picture (Table 12 and 13). Risk perception and benefit perception was interestingly found to be positively correlated when the other predictor variables were included in the model. In both regression analyses, risk perception and benefit perception, respectively, had a negative coefficient before other predictor variables were added (Block 2) but a positive coefficient after all other variables were included (Block 3). Such a pattern could point to a possible interaction effect between risk/benefit perception and some other variable. There could also be other explanations to this finding, such as a possible suppression effect (Cohen, Cohen, West, & Aiken, 2003). Suppression indicates that "the relationship

between the independent or causal variables is hiding or suppressing their real relationships with Y, which could be larger or possibly of opposite sign were they not correlated". If there was a suppression effect in one of the analyses, one of the other predictor variables, except risk/benefit perception, would be acting as a suppressor. It is however hard to find out what variable(s) this could be based on the analyses reported here. Importantly, the size of these relationships is relatively small and only the effect of benefit perception on risk perception (Table 12), not the effect of risk perception on benefit perception (Table 13), is statistically significant. According to Cohen et al. (2003), modest suppression effects are more common in complex models and in analyses of aggregate data.

Perceived benefits stood for most of the variance in the attitude model. There is obviously a diverse set of reasons for the high correlation between benefit perception and attitude towards CCS, and even though the benefit variable has a high beta value in the regression model the mediation analysis reveals that other variables have important indirect effects on attitude. Benefit perception functioned as a mediator for several of the predictor variables, including climate change concern, trust in competence, trust in intentions, epistemic trust and perceived interference with nature.

Support for Hypothesis 1 indicates that people have a more positive attitude towards CCS when they perceive benefits as higher and risks as lower. But considering the very low ratings of perceived risk found in this survey, one may ask if risk perception is among the most relevant factors to predict attitudes towards CCS in Norway. As discussed in the Theory section, risks to humans will be reduced in Norway compared to many other countries because CO_2 is to be stored offshore, not onshore. As the human risks are not overwhelming other factors become more important.

Concern for the environment and climate change

Hypothesis 2 is not supported. Other factors than climate change concern and ecological concern are important for predicting the variance in attitude towards CCS. Still, there is a bivariate correlation between attitude and climate change concern, and there is an indirect effect through benefit perception of this variable on attitude towards CCS. NEP did have a significant positive relationship with benefit perception.

The NEP scale has been validated through several studies, showing construct validity in confirming NEP to be negatively correlated to age, and positively related to education and political liberalism (for a full list of validation studies, see Dunlap et al., 2000). NEP has been given criterion validity in displaying differences between groups of the general public and

groups of known environmentalists (Grendstad, 1999; Dunlap et al., 2000) and predictive validity in explaining environmental behavior or intentions (Cordano, Welcomer, & Scherer, 2003; Schultz & Zelezny, 1999).

Table 10 shows that NEP correlates moderately strong (.36) with concern for climate change. This finding is in line with survey results reported by Bord et al. (2000). In their study, NEP correlated moderately strong (.46) with perception of global warming as a societal risk. For predicting attitudes towards CCS and risk perception of CCS, the NEP scale seems almost useless when treated as a one-dimensional unit. One interpretation of the findings is that pro-ecological people are concerned about climate change but are not convinced that storing CO_2 is the way to go for solving the problem. NGOs, such as Greenpeace, are heavily protesting adoption of the technology (Greenpeace, 2008). After all, CCS is not considered a sustainable way of producing energy but is proposed as a bridging technology to prevent the global average temperature from rising more than two degrees Celsius, while waiting for waiting for more renewable energy production to be implemented (Gough et al., 2002).

The lack of correlation between the NEP factor and attitudes towards CCS is in conflict with earlier studies. Findings from two American studies suggest that NEP is negatively correlated to attitude towards CCS (Fleishman et al., 2010; Palmgren et al., 2004). In these studies, however, CCS is presented as a technology primarily applicable for coal energy. In Norway, including the present study, CCS has been presented in relation with natural gas production and primarily as an initiative to fight climate change. Hence, one reason for the negative correlation in the U.S. studies may be the generally negative public perception of coal compared to other energy options (Reiner et al., 2006).

NEP showed low correlations with attitudes towards CCS. This could be because NEP represents more a global value or general belief than a specific attitude, and values are probably conceptually further apart from CCS than attitudes (Ajzen, 1991; Ajzen, 2005). Dunlap et al. (2000) assert that the NEP scale measures primitive beliefs about the nature of the earth and humanity's relationship with it, and that these beliefs influence attitudes towards specific environmental issues. According to Ajzen (2005) there is generally little consistency between concepts measured at different levels, like global values and specific behaviors. Such a theory can to some degree explain the low correlation between people's general worldview (NEP) and the specific evaluative measure on capture, transport and storage of CO2 at the Kårstø facility in Western Norway.

The natural-unnatural dimension

The third hypothesis was confirmed: Respondents had a higher risk perception and a more negative attitude towards CCS when they perceived the technology as an interference with nature. Based on the strength of beta values, perceived interference with nature was the second most important predictor of attitude in the regression model. From the results we can deduce that perceiving CCS as an interference with nature is an important reason for rejecting the technology. The finding verifies Sjöberg's (2000) extended psychometric model, where the 'tampering with nature' factor plays a more important role. In the present study, this variable actually was more important than perceived risk, commonly regarded an essential predictor of acceptance (Breakwell, 2007). Risk perception in this survey was operationalized as risks to humans, separating between personal risks and societal risks. Interference with nature was not only a predictor of attitude; it was also a very influential variable in explaining risk and benefit perception. Possibly, the results prove the idea that perceived environmental or natural risk is of greater importance for Norwegians because human risks from CCS are in fact minimal with operation planned offshore, e.g. in the North Sea. Instead of being worried that CO_2 leakage could harm or injure people, a higher concern may be that of the risks to the natural environment.

On the other hand, ecological concern (NEP) and climate change concern did not come out as very important variables in the model, although NEP was a statistically significant predictor of benefit perception. The results may be interpreted in an alternative way: Those being negative towards CCS may see the whole operation of CCS as immoral. Sjöberg (2002) notes that some people view technology as having a destructive relationship with nature. In two studies Sjöberg (2000b) found 'tampering with nature' to be a very important contributor to variance in risk perception and attitude towards a nuclear waste repository, as well as risk perception of a potential nuclear disaster.

However, past research, which this questionnaire was based on, used only three items when measuring this factor (Tokushige et al., 2007). It was mentioned in the Methods section that the third item was deleted in order to increase index reliability. The third item stated: "Implementation of CCS is an example of human domination over nature". This is different from the two first statements in that it is not clearly negative. In comparison, the two first statements were explicitly framed in a negative way: "[…] human beings should avoid stepping into the field of CCS" and "CCS interferes with nature's laws". This may have been one reason for the low correlations between the third variable and the two first variables.

The whole process of CCS explained to lay people can understandably be perceived very unnatural: Humans are inventing a very advanced technology to capture a gas through a chemical procedure for injecting the gas into the earth.

Social trust and epistemic trust

Sometimes people, even though fully trusting scientists, simply do not believe that science has the final answer (Sjöberg, 2001; Sjöberg & Herber, 2008). In their study of public perceptions towards CCS in Japan, Tokushige et al. (2007) asked respondents 'To what extent do you think the risks of CO_2 geological storage are known to science?' This single variable, however, did not produce any significant differences in the levels of regression coefficients between observed variables and the latent variable 'risk perception'.

Arguably, the results in this study suggest that epistemic trust is a more important predictor of attitude towards CCS than social trust, in line with Hypothesis 4. Only trust in competence was significantly related to attitudes towards CCS and the epistemic trust variable had a slightly stronger beta in the regression analysis than this variable. Drawing on earlier research, the results are not surprising. When epistemic trust is also accounted for in a regression model, the effect of social trust is expected to diminish (Sjöberg, 2001; Sjöberg & Herber, 2008).

There may be alternative explanations as well. Because people are not very knowledgeable about CCS, they may have been motivated to go through systematic processing when asked to give their opinion on it (Chen & Chaiken, 1999). The information offered in the survey may have been enough to base an effortful analysis on. When analyzing and considering all relevant information, social trust in actors like the government and the industry is not that important.

A possible limitation of the present study is that the social trust concept was not fragmented into several trust objects. For example, trust in industry could be more important than trust in government, if a respondent perceives the industry to be the most central actor in implementing CCS. Such a distinction might have given different results.

We may also try to explain the strong correlation with epistemic trust the same way we explained the lack of correlation with the NEP variable. The NEP scale may have been conceptually further apart from attitudes than epistemic trust and perceived interference with nature, which are among the most important predictors of attitudes towards CCS and perceived risks and benefits from CCS. The questionnaire items tapping these two concepts are more specific and closer to the CCS concept than for example the questions about social

trust. While the social trust questions ask about the actors, the questions about epistemic trust and perceived interference with nature ask specifically about CCS. It is not unlikely that the correlations may have been inflated for this reason.

Awareness and knowledge

Contrary to Huijts' (2003) finding, the analysis did not find knowledge to play a major role in explaining attitude towards CCS. In the regression analysis, when other variables were accounted for, knowledge was outplayed as a contributing factor. Still, the variable is not totally insignificant. The positive bivariate correlation (.199) implies there is a relationship between what people know about CCS and related topics, and how much they appreciate the technology. While knowledge did not influence attitude towards CCS directly, the clear relationship between knowledge and risk perception also implies the knowledge variable is of some importance. The negative bivariate relationship (-.351) suggests that the more knowledge a person have about CCS and related topics, the lower he or she perceives the risks from the technology. Wallquist et al. (2010) also found knowledge of CO_2 to decrease risk perception. However, they also found knowledge to decrease benefit perception. In the present study, knowledge is not a significant predictor of benefit perception.

Knowledge is also negatively related to perceived interference with nature. People with more knowledge presumably do not think CCS interferes with nature as much as people with less knowledge. One can reason that those rating high risks and high interference with nature, base such beliefs on other grounds than their objective knowledge. Again, attitudes are made up from cognitive, affective and behavioral processes (Oskamp & Schultz, 2005). When people with less knowledge judge the risks and the natural interference of CCS, they may base their judgments more on affective processes than on cognitive processes. Moreover, according to Chen and Chaiken's (1999) attitude model, there is a systematic way and a heuristic way of processing information. Judgments made through systematic processing are responses to actual information, while heuristic processing entails using pre-learnt rules or cues for building an attitude. People with solid knowledge of environmental problems, climate change and the CCS technology may comprehend the information offered in the questionnaire (both the short information pieces and the "hidden" information underlying all questions) differently than those with less knowledge. With previous knowledge, one should have formed an attitude already, while with less knowledge (or no knowledge at all) one should be more prone to base an attitude on heuristics.

As mentioned, knowledge was found to be an important predictor of risk perception in negative direction. This is in line with the assumptions of the psychometric paradigm (Slovic et al., 1982). Familiarity, one of two dimensions in the earliest theory of psychometric risk perception, includes knowledge, in addition to observability, immediacy of consequences and novelty of the risk. Applying this theory to the current public debate about the Mongstad facility, doubts and uncertainty made about CCS technology can make people perceive that the risks are unknown to science and hence increase their risk perception of CCS.

Awareness. An awareness of more than 70% is remarkable in an international context. In a 2003 survey of a representative sample of the Swedish population, 15% of the respondents had heard of CCS. Only 5% of U.S. citizens had heard about CCS, according to a 2006 survey (Curry et al., 2007). These questions were framed similarly but had only two response alternatives (yes/no), so the numbers are not directly comparable. Questions in the FENCO-ERA survey, however, were identical to the present survey. In the survey conducted in January 2010, about six months before this survey, 62.6% of the Norwegians said to have heard about CCS, the highest share of the participating countries. Greek respondents had the lowest rate of familiarity (23.5%) while the Netherlands (50%) had the second highest, after Norway. Romania, the U.K and Germany placed somewhere in between. The high awareness of CCS in Norway arguably is due to a very potent political debate about the issue. As mentioned, the technology has been high on the climate policy agenda in Norway since the Prime Minister established development of CCS as an area of commitment in his 2007 new year's speech. There might also be a reason for the presumed slight increase in awareness from January to June 2010. During April and May the disputed Mongstad project was postponed, a government decision that was covered widely in the media and then led to a month-long national debate in Norway (Randen & Brekke, 2010). This discussion was still alive in Norwegian news media when the survey was conducted and may have led to increased awareness among survey participants. The political debate may also have affected public attitudes towards the technology, but such assumptions cannot be proven by this study.

Comparing the results of the true-false knowledge questions, the three Norwegian samples differed very little. Still, there is a notable linear increase in knowledge of CCS from November to January, and from January to June. Likewise there was a significant increase in public awareness of CCS, across the time span November-January-June. There was a lot of media attention to climate change in the aftermath of the Copenhagen climate summit in December 2009, and there was even more focus on CCS in Norwegian media from April to June 2010, caused by the disputed delay of the Mongstad CCS plant. It is tempting to say that

the public has been educated on CCS through extensive political debate and wide media coverage during the last year, although one cannot reach such conclusions from the present data.

While more than 70% of the sample reported to have heard of CCS, only about 5% achieve a full score on the CCS knowledge index. This means there is a large gap between awareness and knowledge; having heard about CCS obviously does not mean one knows the details of the technology. This makes sense, as CCS is a novel technology, still in its development phase. CCS may be something you have heard of but do not know what is. There is also a gap between what respondents "claim" to know and what they really know. On each of the knowledge questions about 25-32% of the respondents chose the 'Don't know' (DK) option, while a large part, about 11-51%, instead made an incorrect answer. The intention of offering a DK option available in the questionnaire is of course to give those who do not know the answer a chance to select this option. Still, a sizable share of the sample did not know the answer but apparently did not choose the DK option. An explanation for this gap may be that there are misconceptions about CCS, climate change and environmental problems among the public. For example, a common misunderstanding among the public is that climate change is directly related to depletion of the ozone layer (Bostrom et al., 1994; Read et al., 1994; Reiner et al., 2006; Bord et al., 1998). This incorrect belief is again demonstrated in the present study. Substantial parts of the respondents seemingly also think climate change is caused by smog and acid rain. For gaining public acceptance for climate change mitigating technologies, such as CCS, educating the public seems vital.

There might as well be methodological explanations for the quite large portion of incorrect answers. A well-known phenomenon in survey research is satisficing, i.e. when respondents "do just enough to satisfy the survey request, but no more" (Krosnick, 2000, p. 4). To answer questions in an optimal way, respondents have to go through quite demanding cognitive efforts. They must interpret the question, they must search their memories for relevant information, they must integrate the information into a judgment, and finally, they must translate the judgment into a response by selecting one alternative (Krosnick, 1999). Sometimes respondents skip one or more of these steps to spend less energy rather than making the effort to generate optimal answers. This may have been the case with these knowledge questions, maybe leading some respondents to choose a random answer. Satisficing is more likely to occur with difficult tasks. As CCS and climate change is complex topics, it is not unlikely that respondents just answered randomly instead of thinking thoroughly through each question. However, the fact that a considerable part of the

respondents neglected the DK option and instead chose an incorrect alternative makes this methodological explanation less likely. Choosing the DK option is a common way of satisficing (Krosnick, 1999). If one would get through the questionnaire as fast as possible with making minimal cognitive effort, one would probably find it easier to select all available DK options.

Public understanding of CCS is low, with only 5 % of the present sample correctly identifying the aims of the technology. Still, it is too early to draw conclusions about whether or not perceptions of this technology suffer from faulty judgments or cognitive biases that are present in public risk perceptions on other fields (Slovic et al., 1982). What is clear is that the public demonstrates serious misconceptions about climate change. This is evident from past research and it was confirmed again in the present study. Such misconceptions probably transfer onto perceptions of CCS because understanding of CCS is based on understanding of climate change. When people confuse climate change and ozone layer depletion they also develop incorrect knowledge about what CCS can do and what it cannot do.

Of the three environmental topics, the respondents show highest knowledge on activities contributing to CO_2 build up, but the mean number of correct answers on general environmental issues is also above middle. As expected, precise knowledge about CCS is low among respondents. A large part correctly identify global warming as the environmental problem CCS is meant to address but many also believes CCS can be the solution to other problems, like ozone layer depletion and acid rain.

Risk and benefit perception as mediators

It was expected that risk perception and benefit perception would act as mediators for other predictor variables, a hypothesis that was confirmed for several variables and gave support to previous research (e.g. Huijts et al., 2007; Tokushige et al., 2007; Siegrist, 2000). Risk perception significantly mediated the relationship between attitudes towards CCS and four variables (trust in intentions, epistemic trust, knowledge, and perceived interference with nature). These indirect effects were very small, however. Even though the finding was statistically significant, one should be careful in drawing any conclusions. With an indirect effect of a mere .033 (for the ‘risk perception’ - ‘trust in intentions’ relationship) the mediator apparently did not affect the relationship much at all, such that there is no strong evidence for a single, dominant mediator (Baron & Kenny, 1986). None of the indirect effects through risk perception were above .5 and probably do not explain important mediator effects. Preacher and Hayes (2004) note that a Type II error is likely to occur when employing large samples

because even small regression weights may remain statistically significant. This might have been the case in this analysis.

Benefit perception acted as a mediator for climate change concern, trust in competence, trust in intentions, epistemic trust and perceived interference with nature. Trust in intentions and climate change concern came out insignificant in the regression model on attitude towards CCS, but the mediation analysis revealed that both had significant indirect relationships through benefit perception. As we can see, climate change concern had the highest mediation effect of all tested variables. Logically, people being highly concerned about climate change and eager to take actions against it, will see considerable benefits from employing a technology that can prevent CO_2 from further speeding up the climate problem. Likewise, benefit perception acted as a mediator between trust in intentions and attitudes towards CCS. The subjects of trust, relevant CCS actors and stakeholders in Norway, are positive towards the technology. Therefore, the more you trust the intentions of the actors, the more you will perceive characteristics of CCS as benefits. Having high trust in science and technology cohere with having positive attitudes towards CCS, but part of this relationship is mediated by benefit perception. Trust in competence and perceived interference with nature also produced strong and significant indirect effects. The mediation analysis seemingly explained important relationships between the variables.

Methodological issues

Validity and reliability. The questionnaire was to a large extent based on the questionnaire used in the European FENCO-ERA studies (Pietzner et al., 2010). It had therefore been tested extensively: SINTEF conducted two web surveys on national representative samples of the Norwegian public (N = 2000), and the same questionnaire was used in five other European countries. In total, more than 7000 persons had completed it. Supplying respondents with information is critical in survey context, because the information easily can be biased and influence the responses (Bradburn & Sudman, 1988, in Malone et al. 2010). To limit such biases, the information pieces offered in the present survey were developed by technical experts from different universities, cross-checking each other. The texts were made available in Norwegian by a professional translation agency and finally proofed by social scientists at SINTEF and the author. All in all, the results are not likely to be an effect of provision of biased information.

Furthermore, the units of measure had good reliability, indicated by high internal consistency. Most of the indexes satisfied Kline's (2000) principle. The study used validated

question scales, such as the NEP scale, the climate change concern scale, the knowledge scales, the trust scales, and the attitude scales.

Representativeness. Selection of panel members from the YouGov panel data base was based on the probability sampling method. Still, the fact that respondents have volunteered to join YouGov's web panel makes it a nonprobability sample of Norwegian Internet users. Based on Couper's (2000) review of web survey methodologies YouGov's method is an example of a "volunteer opt-in web panel". A main critique of this method is that the panel is a self-selected sample of volunteers. Still, this does not necessarily lead to results of less quality. Malhotra and Krosnick (2007) compared findings about voters and elections from the American National Election Study, face-to-face interviews from national probability area samples, with Internet data collection from nonprobability samples of volunteer respondents. In the 2004 presidential election, the nonprobability Internet data, collected by YouGov, was closer to the actual outcome, while in the 2000 election the probability interview data was closer to the outcome.

Could it be that the results were affected by respondents receiving a monetary incentive (1 krone per minute) for completing the survey? Research on the topic has typically found response rates to increase along with incentives while there is no apparent decrease in quality of answers provided. One mail survey experiment found larger monetary incentives to produce higher quality data through a greater degree of effort expended in completing the questionnaires (James & Bolstein, 1990). Respondents with higher incentives provided a larger number of short answers and comments, and wrote more words than those with lower incentives or no incentives. A similar experiment, comparing web surveys, found no difference in nonresponse patterns between a web survey with no incentives and a web survey paying a $2 incentive to participants after completion of the questionnaire (Bosnjak & Tuten, 2003).

Coverage error is another threat to online surveys (Couper, 2000). The last ten years have nevertheless seen a remarkable increase in Internet coverage, with 86 % of Norwegian households connected to the Internet today (according to 2009 data, SSB, 2010). Nevertheless, no certain claims can be made that the sample of the present study is fully representative of the Norwegian population and hence no certain generalizations should be inferred to the Norwegian public from these results. Still, the survey may provide a valuable insight into Norwegian attitudes towards CCS and environmental questions. Apart from the slightly skewed age distribution towards the younger and a higher relative response from Eastern Norway than Western Norway there are no major demographic differences between

this sample and the Norwegian population (see Table 1, 2, 3, 4). Most importantly however, even though demographic distribution is not entirely accurate, statistical analyses of the data shows interesting findings of correlations and regressions between different explanatory variables. These results are important for predicting future attitudes towards CCS and perceptions of risks and benefits of this technology.

Non-attitudes. Some have argued against the use of traditional surveys in researching public attitudes towards CCS (Malone et al., 2009; Malone et al., 2010). Their main critique is that lack of knowledge is a barrier to conducting valid surveys. They may have a point in other countries, considering that awareness of CCS in certain places has been as low as 4 % (Reiner et al., 2006). Some studies have tried to overcome the pseudo-opinion challenge by investing more time and resources in testing and revising the information provided to respondents (De Best-Waldhober et al., 2009; Fleishman et al., 2010). These studies do, however, not explain current attitudes, but instead try to predict future or potential attitudes in the public. Fleishman et al. (2010) note that as their study is done in a controlled setting the results do not guarantee the same outcome in the society. They also point to the fact that uninformed members of the public probably will be exposed to persuasion attempts from advocates. The same reservation is made in the mentioned experimental study, emphasizing that the results "do not necessarily reflect present public support for a policy" (De Best-Waldhober et al., 2009, p. 325).

Malone et al. (2010) go on to claim that filter questions or a 'don't know' (DK) option should be included in every situation where the respondents are likely to lack sufficient information. On most of the questions in the present survey there was no DK category. For example, there were deliberately no DK categories on the two first knowledge scales, and one may assert that a substantial amount of the respondents are likely to make a guess when they do not know the answer. This may create a large portion of non-substantive answers or "noise". However, the DK category was excluded because of known systematic differences between humans' propensity to guess, a tendency influenced by personality and cognitive skills, among other factors (Krosnick et al., 2002; Mondak, 2001). Propensity to guess is considered a personal response style, permitting people with equal knowledge to receive different score, a source of error which no doubt will reduce the survey's validity (Cronbach, 1946, in Mondak, 2001). In studies of factual questions, inclusion or exclusion of a DK option mostly does not result in substantive changes in response distribution (Poe, Seeman, McLaughlin, Mehl, & Dietz, 1988). Still, a DK option was included on the CCS questions because knowledge of this issue was expected to be severely lower than of the other issues.

Neither on other questions, e.g. the attitude items, were there DK options in the present survey. According to Krosnick (1999) "people who select 'no opinion' responses have characteristics suggesting that they are least likely to have formed real opinions" (p. 557). Krosnick (1999) states that "offering a no opinion option does not increase the reliability of data obtained" (p. 558). In a series of questionnaire experiments, Schuman and Presser (1996) found that filtering questions typically does not alter substantive opinions, and when it does, the effect is usually small. They also concluded that non-attitudes are in fact not random, and there are systematic differences between people who choose DK options and people who avoid DK options. The meaning of an attitude object is a product of both knowledge about the specific object and more general dispositions evoked by other aspects of the question. Therefore, to some degree, all answers are meaningful, not random "noise" (Schuman & Presser, 1996).

Pseudo-opinions, or non-attitudes, may represent a problem in other countries where the level of awareness of CCS is low. In the present sample, however, more than 70 % reported they were aware of the technology, a very high number compared to all other countries and all previous surveys in on this topic (Ashworth et al., 2009). Malone et al. (2010) claim that "opinions are dynamic, changing as conditions change and as people relate differently to different topics" (p. 420). Such unstable pseudo-opinions are shown in experimental studies (De Best-Waldhober et al., 2009). However, comparing the results of this study (June 2010) with results from the FENCO-ERA surveys conducted in November 2009 and January 2010, attitude ratings come out remarkably stable. This is despite of a series of significant events between the points in time at which the surveys were held; the elevated debate and raised concern for climate change in the months before the Copenhagen summit in December 2009, the failure of an outcome from the Copenhagen summit, the unusually cold temperatures during winter of 2010 leading more people to doubt global warming, and, in Norway, the broad debate about the Mongstad CCS project during the spring of 2010. Such events certainly change the conditions for perceiving and understanding a new technology that aims to curb climate change. The evidence presented in the present study, showing highly stable attitudes over a seven-month period, teaches us that opinion instability at one point in time is maybe not such an important barrier for conducting valid attitude surveys, even regarding complex topics such as CCS. While people may demonstrate unstable opinions in a closed experimental setting, such variations will probably not be significant across the public as a whole. Very simplified, while in a controlled experimental setting one may "inject"

information into a person's brain, in real life one can never be sure what kind of information reaches a certain individual or how that individual will perceive and interpret it.

Response scales. The questionnaire employed in the present survey had only anchor points labeled on the 7-point Likert scales. Some claim that labeling all response alternatives rather than only the anchor points can improve reliability and validity (Krosnick, 1999). Others have found no differences in responses to Likert-scales with all points labeled compared to scales with only the end points labeled (Landrum, 1999). This type of response scale was however chosen by the FENCO-ERA project partners, and because it was of critical importance to ensure comparability with this study, the author tried to avoid any significant changes in question wording or format. Therefore it was chosen to stick with the same response format. As YouGov panel members are skilled survey participants one might also suggest they are familiar with responding to all types of Likert scales and hence would have less trouble with placing their opinion on a numbered scale.

Media. Studies have shown that public acceptance of CCS is dependent on whether the technology is presented as part of a broad solution to climate change (Shackley et al., 2004). This broad portfolio of solutions should also include renewable energy and energy efficiency policies. To a large extent the public rely on the media to inform them about these issues. However, Af Wåhlberg and Sjöberg (2000) note that one of the major shortcomings of the media is that they often present facts outside their contexts. If this is also the case for the media's presentation of CCS, it implies a greater difficulty for the public to acknowledge that CCS is a part of a broad greenhouse gas mitigation package.

Survey methods. Another question is if all parts of the public will ever be fully informed. Knowledge of CCS will probably never be evenly distributed in the public. How, if so, can we predict what parts of the public will be educated on the topic of CCS, and what kind of information will influence their attitudes? A major accident within one of the early demonstration projects could possibly influence public attitudes in a negative direction more than any public outreach activities could have a positive influence. Anyway, do all parts of the public take informed decisions in societal and political questions in all situations? Probably not. A large portion of the public will never have more than superficial knowledge of CCS. This is an attribute of the increasingly complex democracies we live in. As the majority of us are not engineers, physicists or technical experts we do not fully understand the science behind the cars we drive or the facilities that produce our electricity. Neither do we fully understand global climate change or technologies that capture CO_2 and store it underground.

Still, collecting data through public surveys gives a good view of the current attitudes towards a specific topic, based on current levels of awareness and knowledge.

CONCLUSIONS

CCS is an exciting subject of study for risk researchers. Confronted with the technology we need to consider two kinds of risks. On one hand, capturing, transporting and storing CO_2 around the world could pose risk to humans and nature if not properly managed. On the other hand, avoiding CCS will pose a major risk to humans and nature because it will become difficult, if not impossible, to reduce or stop climate change. Accordingly, it seems hard for the public to establish strong attitudes in either direction, and most of the respondents in the present survey seemed to take an almost neutral stance. For authorities it may be difficult to raise public enthusiasm for a non-sustainable technology like CCS.

Suggestions for future studies

Interestingly, the NEP scale was not a significant predictor of attitudes towards CCS. One explanation may be that the scale is not suitably adapted to capture the dividing gap between concern for nature and ecology, and concern for greenhouse gas emissions and climate change. As global climate change becomes more inevitable we will see more conflicts between conservationists arguing for protecting land and authorities being forced to use more land for building renewable energy. There will be disagreements over sacrificing land for windmills and solar power production, and there will be new debates about nuclear power, a carbon-neutral technology. CCS is in the middle of this conflict. Storing CO_2 under the ocean bed and risking harm to marine life is completely against the principles of traditional conservationists. In an increasingly complex landscape, future research should look for new ways to measure conservationism, environmentalism and climate change concern.

The affect heuristic has traditionally been measured by self-reports. New studies have suggested that this construct may be equivalent to implicit attitudes, and that it can successfully be measured indirectly, with an implicit association test (Spence & Townsend, 2008). Such tests have for example been shown to correlate with explicit measures of nuclear risk perception (Dohle, Keller & Siegrist, in press). Implicit association tests could be a useful complement to data derived from traditional explicit measures, such as self-reports (Siegrist, Keller, & Cousin, 2006).

Qualitative methods should not be forgotten. For obtaining more depth knowledge of the attitudes of Norwegian citizens, qualitative interviews or focus groups could provide valuable insight into attitudes towards CCS and related topics. Even though focus groups already have been conducted in Norway (Terwel et al., 2009), more qualitative research may

produce more knowledge on underlying cognitive structures explaining people's attitudes towards CCS.

Concluding remarks

This study presents several new findings of theoretical relevance for risk psychology and of practical relevance for decision makers in energy and environment policy. First of all, the Norwegians asked in this study are not clearly positive or negative towards CCS. Attitudes towards CCS in Norway are best described as neutral. This means there is still a scope for communicating about CCS and for moving attitudes in either direction. This opportunity should be used with care and responsibility as public support for technologies like CCS may be crucial for combating global climate change.

For influencing public attitudes towards the technology, one should distinctly promote all benefits of CCS, as benefit perceptions stands out as the most important predictor of attitudes. But there are also other significant variables. The present study was the first to look into the concept of epistemic trust in relation with CCS. People's general trust in science and technology, epistemic trust, was confirmed to be an important predictor of attitudes, and perhaps even more important than people's social trust in actors responsible for implementing the technology. Another variable, perception of CCS as an interference with nature, had not been investigated before either. The results indicate that this variable correlates negatively with both risk perception and attitudes towards CCS. Finding natural analogues and portraying the CCS process as natural should make it easier for people to accept it. Concern for climate change and willingness to take action against it, is another key variable, that is linked to a higher benefit perception of CCS and, hence, a more positive attitude. Obviously, before they will see the benefits of CCS the public needs to believe there are good reasons to act against climate change.

Put together, the results provide valuable guidance for risk researchers and policy makers. While the answers are far from complete, they shed light on society's response to a new technology and they add new knowledge to the growing theoretical field of risk psychology.

REFERENCES

Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes, 50*, 179-211.

Ajzen, I. (2005). *Attitudes, personality and behavior* (2nd ed.). New York, NY: McGraw-Hill.

Alhakami, A. S., & Slovic, P. (1994). A psychological study of the inverse relationship between perceived risk and perceived benefit. *Risk Analysis, 14*, 1085-1096.

Ashworth, P., Boughen, N., Mayhew, M., & Millar, F. (2010). From research to action: Now we have to move on CCS communication. *International Journal of Greenhouse Gas Control, 4*, 426-433.

Ashworth, P., Pisarski, A., & Littleboy, A. (2006). *Social and economic integration report: Understanding and incorporating stakeholder perspectives to low emission technologies in Queensland* (Final report). Pullenvale, Qld., Australia: Centre for Low Emission Technology.

Baron, R. M., & Kenny, D. A. (1986). The moderator-mediator variable distinction in social psychological research: conceptual, strategic, and statistical considerations. *Journal of Personality and Social Psychology, 51*(6), 1173-1182.

Berg, O. T. (2009). Demokrati. In *Store norske leksikon*. Retrieved 16.09.2010 from http://snl.no/demokrati

Blackford, J., Jones, N., Proctor, R., Holt, J., Widdicombe, S., Lowe, D., & Rees, A. (2009). An initial assessment of the potential environmental impact of CO_2 escape from marine carbon capture and storage systems. *Proceedings of the Institution of Mechanical Engineers, Part A: Journal of Power and Energy, 223*(3), 269-280.

Bord, R. J., Fisher, A., & O'Connor, R. E. (1998). Public perceptions of global warming: United States and international perspectives. *Climate Research, 11*, 75-84.

Bostrom, A., Morgan, M. G., Fischhoff, B., & Read, D. (1994). What do people know about global climate change? 1. Mental models. *Risk Analysis, 14*, 959-970.

Bradbury, J., & Dooley, J. (2004). *Who's talking? What are the issues? The media's portrayal of carbon dioxide capture and sequestration in the United States.* Global Energy Technology Strategy Program Working Paper 2004-12. College Park, MD: Joint Global Change Research Institute.

Bradbury, J., Ray, I., Peterson, T., Wade, S., Wong-Parodi, G., & Feldpausch, A. (2009). The role of social factors in shaping public perceptions of CCS: Results of multi-state focus group interviews in the U.S. *Energy Procedia, 1*, 4665-4672.

Breakwell, G. M. (2007). *The psychology of risk.* Cambridge, UK: Cambridge University Press.

Chen, S., & Chaiken, S. (1999). The heuristic-systematic model in its broader context. In S. Chaiken & Y. Trope (Eds.), *Dual-process theories in social psychology* (pp. 73-96). New York, NY: Guilford Press.

Citizens Against CO_2 Sequestration (2010). *Citizens Against CO_2 Sequestration.* Retrieved from http://citizensagainstco2sequestration.blogspot.com/

CO_2 Endlager Stoppen (2010). *Bürgerinitiative CO_2 Endlager Stoppen.* Retrieved from http://www.co2-endlager-stoppen.de/

Cohen, J., Cohen, P., West, S. G., & Aiken, L. S. (2003). *Applied multiple regression/correlation analysis for the behavioral sciences* (3rd ed.). Mahwah, NJ: Lawrence Erlbaum Associates.

Converse, P. E. (1970). Attitudes and non-attitudes: Continuation of a dialogue. In E. R. Tufte (Eds.), *The quantitative analysis of social problems* (pp. 168-189). Reading, MA: Addison-Wesley.

Cordano, M., Welcomer, S. A., & Scherer, R. F. (2003). An analysis of the predictive validity of the new ecological paradigm scale. *The Journal of Environmental Education, 34*(3), 22-28.

Couper, M. P. (2000). Web surveys. A review of issues and approaches. *Public Opinion Quarterly, 64,* 464-494.

Curry, T. E., Ansolabehere, S., & Herzog, H. (2007). *A survey of public attitudes towards climate change and climate change mitigation technologies in the United States: Analyses of 2006 results.* Retrieved from the MIT Carbon Capture and Sequestration Technologies Program website: http://sequestration.mit.edu/pdf/LFEE_2007_01_WP.pdf

De Best-Waldhober, M., Daamen, D., & Faaij, A. (2009). Informed and uninformed public opinions on CO_2 capture and storage technologies in the Netherlands. *International Journal of Greenhouse Control, 3,* 322-332.

De Figueiredo, M. A., Reiner, D. M., & Herzog, H. J. (2003). *Ocean carbon sequestration: A case study in public and institutional perceptions.* Paper presented at GHGT-6, the 6th International Conference on Greenhouse Gas Control Technologies. Retrieved from http://sequestration.mit.edu/pdf/ghgt6_paper_134.pdf

Duan, H. (2010). The public perspective of carbon capture and storage for CO_2 emission reductions in China. *Energy Policy, 38,* 5281-5289.

Dunlap, R. E., Van Liere, K. D., Mertig, A. G., & Emmet Jones, R. (2000). Measuring endorsement of the new ecological paradigm: A revised NEP scale. *Journal of Social Issues, 56,* 425-442.

Dutch drop plan to store carbon dioxide under town (2010, November 4). *Associated Press.* Retrieved from http://finance.yahoo.com/news/Dutch-drop-plan-to-store-apf-760162900.html?x=0&.v=3

Eagly, A. H., & Chaiken, S. (1993). *The psychology of attitudes.* Fort Worth, TX: Harcourt Brace Jovanovich.

Earle, T. (2010). Trust in risk management: A model-based review of empirical research. *Risk Analysis, 30,* 541-574.

European Commission (2007). *Energy technologies: knowledge, perception, measures.* Retrieved from ec.europa.eu/public_opinion/archives/ebs/ebs_262_en.pdf

Fleishman, L. A., Bruine de Bruin, W., & Morgan, M. G. (2010). Informed public preferences for electricity portfolios with CCS and other low-carbon technologies. *Risk Analysis, 30,* 1399-1410.

Frewer, L. J., Scholderer, J., & Bredahl, L. (2003). Communicating about the risks and benefits of genetically modified foods: the mediating role of trust. *Risk Analysis, 23,* 1117-1133.

Frp (2009). *CO_2-begravelse på Kårstø.* Retrieved from http://www.frp.no/CO2-begravelse+p%C3%A5+K%C3%A5rst%C3%B8.d25-TgZnG2y.ips

Gerbner, G., & Gross, L. (1976). Living with television: the violence profile. *Journal of Communication, 26,* 173-199.

Gibbins, J., & Chalmers, H. (2008). Carbon capture and storage. *Energy Policy, 36,* 4317-4322.

Gough, C., Taylor, I., & Shackley, S. (2002). Burying carbon under the sea: An initial exploration of public opinions. *Energy & Environment, 13,* 883-900.

Greenpeace (2008). *False hope: Why carbon capture and storage won't save the climate.* Retrieved from http://www.greenpeace.org/international/Global/international/planet-2/report/2008/5/false-hope.pdf

Grendstad, G. (1999). The new ecological paradigm scale: Examination and scale analysis. *Environmental Politics, 8*(4), 194-205.

Ha-Duong, M., & Loisel, R. (2010). *Expected fatalities for one wedge of CCS mitigation: Actuarial risk assessment of carbon capture and storage at the global scale in 2050*

(Working paper 21-2010). Nogent-sur-Marne, France: Centre International de Recherches sur l'Environnement et le Développement.

Ha-Duong, M., Nadaï, A., & Campos, A. S. (2009). A survey on the public perception of CCS in France. *Energy Procedia, 1*, 4757-4764.

Howell, D. C. (2010). *Statistical methods for psychology* (7th ed.). Belmont, CA: Wadsworth.

Huijts, N. M. A., Midden, C. J. H., & Meijnders, A. L. (2007). Social acceptance of carbon dioxide storage. *Energy Policy, 35*, 2780-2789.

International Energy Agency (2010). *Energy Technology Perspectives 2010: Scenarios and strategies to 2050* [Executive summary]. Paris, France: International Energy Agency.

Intergovernmental Panel on Climate Change (2007). *Climate change 2007: Synthesis report.* Geneva, Switzerland: IPCC.

Kaplowitz, M. D., Hadlock, T. D., & Levine, R. (2004). A comparison of web and mail survey response rates. *Public Opinion Quarterly, 68*(1), 94-101.

Kline, P. (2000). *Handbook of psychological testing* (2nd ed.). London, UK: Routledge.

Krosnick, J. A. (1999). Survey research. *Annual Review of Psychology, 50*, 537-567.

Krosnick, J. A. (2000). The threat of satisficing in surveys: The shortcuts respondents take in answering questions. *Survey Methods Newsletter, 20*(1), 4-8.

Krosnick, J. A., Holbrook, A. L., Berent, M. K., Carson, R. T., Hanemann, W. M., Kopp, R. J. … Conaway, M. (2002). The impact of "no opinion" response options on data quality. Non-attitude reduction or an invitation to satisfice? *Public Opinion Quarterly, 66*, 371-403.

Kunreuther, H., Easterling, D., Desvousges, W., & Slovic, P. (1990). Public attitudes toward siting a high-level nuclear waste repository in Nevada. *Risk Analysis, 10*, 469-484.

Landrum, R. E. (1999). Scaling issues in faculty evaluations. *Psychological Reports, 84*, 178-180.

Leiserowitz, A. (2007). *International public opinion, perception, and understanding of climate change.* Retrieved from the United Nations Development Program website: http://hdr.undp.org/en/reports/global/hdr2007-2008/papers/leiserowitz_anthony6.pdf

Lord, C. G., Ross, L., & Lepper, M. R. (1979). Biased assimilation and attitude polarization: The effects of prior theories on subsequently considered evidence. *Journal of Personality and Social Psychology, 37*, 2098-2109.

Lorenzoni, I., & Pidgeon. N. F. (2006). Public views on climate change: European and USA perspectives. *Climatic Change, 77*, 73-95.

Låg, M., Andreassen, Å., Instanes, C., & Lindeman, B. (2009). *Health effects of different amines and possible degradation products relevant for CO_2 capture* (Report 2009:3). Retrieved from http://www.fhi.no/dokumenter/de810a615a.pdf

Malhotra, N., & Krosnick, J. A. (2007). The effect of survey mode and sampling on inferences about political attitudes and behavior: comparing the 2000 and 2004 ANES to internet surveys with nonprobability samples. *Political Analysis, 15*, 286-323.

Malone, E. L., Bradbury, J. A., & Dooley, J. J. (2009). Keeping CCS stakeholder involvement in perspective. *Energy Procedia, 1*, 4789-4794.

Malone, E. L., Dooley, J. J., & Bradbury, J. A. (2010). Moving from misinformation derived from public attitude surveys on carbon dioxide capture and storage towards realistic stakeholder involvement. *International Journal of Greenhouse Gas Control, 4*, 419-425.

Mander, S., Wood, R., & Gough, C. (2009). Exploring the media framing of carbon capture and storage and its influence on public perceptions. *IOP Conference Series: Earth and Environmental Science, 6*(53), 1-2.

Marks, G., & Von Winterfeldt, D. (1984). "Not in my back yard": Influence of motivational concerns on judgments about a risky technology. *Journal of Applied Psychology, 69*, 408-415.

Mazur, A. (1975). Opposition to technical innovation. *Minerva, 15*, 58-81.

McKinsey & Company (2008). *Carbon capture and storage: Assessing the economics.* Retrieved from http://www.mckinsey.com/clientservice/ccsi/pdf/ccs_assessing_the_economics.pdf

Metz, B., Davidson, O., De Coninck, H., Loos, M., & Meyer, L. (2005). *IPCC special report on carbon capture and storage.* Cambridge, UK: Cambridge University Press.

Miller, E., Summerville, J., Buys, L., & Bell, L. (2007). Initial public perceptions of carbon geosequestration: Implications for engagement and environmental risk communication strategies. *International Journal of Global Environmental Issues, 8*, 147-164.

Mondak, J. J. (2001). Developing valid knowledge scales. *American Journal of Political Science, 45*(1), 224-238.

National Energy Technology Laboratory (2010). *Carbon Capture and Storage Database.* Retrieved June 16, 2010, from http://www.netl.doe.gov/technologies/carbon_seq/database/index.html

Naturkraft (2010). *Naturkraft – Gasskraftverket på Kårstø.* Retrieved from http://www.naturkraft.no/

Neijens, P. (2004). Coping with the nonattitudes phenomenon: A survey research approach. In W. E. Saris & P. M. Sniderman (Eds.), *Studies in public opinion: Attitudes, nonattitudes, measurement error, and change* (pp. 295-313). Princeton, NJ: Princeton University Press.

O'Connor, R. E., Bord, R. J., & Fisher, A. (1999). Risk perceptions, general environmental beliefs, and willingness to address climate change. *Risk Analysis, 19*, 461-471.

Organisation for Economic Co-operation and Development / International Energy Agency (2007). *Legal aspects of storing CO_2.* Paris, France: International Energy Agency.

Oskamp, S., & Schultz, P. W. (2005). *Attitudes and opinions* (3rd ed.). Mahwah, NJ: Erlbaum.

Oltra, C., Sala, R., Solà, R., Di Masso, M., & Rowe, G. (2010). Lay perceptions of carbon capture and storage technology. *International Journal of Greenhouse Gas Control, 4*, 698-706.

Palmgren, C. M., Morgan, M. G., Bruine de Bruin, W., & Keith, D. W. (2004). Initial public perceptions of deep geological and oceanic disposal of carbon dioxide. *Environmental Science & Technology*, *38*(24), 6441-6450.

Petty, R. E., & Cacioppo, J. T. (1986). The elaboration likelihood model of persuasion. In L. Berkowitz (Ed.), *Advances in experimental social psychology* (Vol. 19, pp. 123-205). New York: Academic Press.

Pietzner, K., Schumann, D., Tvedt, S. D., Torvatn, H. Y., Næss, R., Reiner, D., ... Ziogou, F. (2010). *Scrutinizing the impact of CCS communication on the general and local public. Results of the representative national surveys of public awareness, knowledge and opinions concerning CCS* (Report of the FENCO-ERA research project).

Poe, G. S., Seeman, I., McLaughlin, J., Mehl, E., & Dietz, M. (1988). "Don't know" boxes in factual questions in a mail questionnaire. Effects on level and quality of response. *Public Opinion Quarterly, 52*, 212-222.

Poortinga, W., & Pidgeon, N. F. (2004). Trust, the asymmetry principle, and the role of prior beliefs. *Risk Analysis, 24*, 1475-1486.

Preacher, K. J., & Hayes, A. F. (2004). SPSS and SAP procedures for estimating indirect effects in simple mediation models. *Behavior Research Methods, Instruments, & Computers, 36*(4), 717-731.

Price, V. & Neijens, P. (1997). Opinion quality in public opinion research. *International Journal of Public Opinion Research, 9*, 336-360.

Price, V., & Neijens, P. (1998). Deliberative polls: Toward improved measures of "informed" public opinion? *International Journal of Public Opinion Research, 10*, 145-75.

Randen, A., & Brekke, A. (2010, May 1). Månelandingen på Mongstad utsettes. *NRK.* Retrieved from http://www.nrk.no/

Read, D., Bostrom, A., Morgan, M. G., Fischhoff, B., & Smuts, T. (1994). What do people know about global climate change? 2. Survey studies of educated laypeople. *Risk Analysis, 14,* 971-982.

Regjeringen (2008). *Avtale om klimameldingen.* Retrieved from http://www.regjeringen.no/Upload/MD/Vedlegg/Klima/avtale_klimameldingen.pdf

Reiner, D. (2008). *A looming rhetorical gap: A survey of public communications activities for carbon dioxide capture and storage technologies* (Working paper 0801). Cambridge, UK: Electricity Policy Research Group, University of Cambridge.

Reiner, D., Curry, T., de Figueiredo, M., Herzog, H., Ansolabehere, S., Itaoka, K., … Odenberger, M. (2006). American exceptionalism? Similarities and differences in national attitudes toward energy policy and global warming. *Environmental Science & Technology, 40,* 2093-2098.

Reiner, D. M., Pietzner, K., Schumann, D., Tvedt, S. D., Torvatn, H. Y., Daamen, D., ... Watt, R. (2010). *Results of regional surveys of public awareness and opinions regarding CO_2 capture, transport and storage project proposals* (Project report of the FENCO-ERA research project: Scrutinizing the impact of CCS communication on the general and local public). Cambridge, UK: University of Cambridge.

Rosenzweig, C., Karoly, D., Vicarelli, M., Neofotis, P., Wu, Q., Casassa, G., … Imeson, A. (2008). Attributing physical and biological impacts to anthropogenic climate change. *Nature, 453,* 353-357.

Rousseau, D. M., Sitkin, S. B., Burt, R. S., & Camerer, C. (1998). Not so different after all: a cross-discipline view of trust. *Academy of Management Review, 23,* 393-404.

Schwarz, N., Groves, R. M., & Schuman, H. (1998). Survey methods. In D. T. Gilbert, S. T. Fiske, & G. Lindzey (Eds.), *The handbook of social psychology* (4th ed., Vol. 1, pp. 143-179). Boston, MA: McGraw-Hill.

Shackley, S., McLachlan, C., & Gough, C. (2004). *The public perceptions of carbon capture and storage* (Working paper 44). Manchester, UK: Tyndall Centre for Climate Change Research.

Shackley, S., Waterman, H., Godfroij, P., Reiner, D., Anderson, J., Draxlbauer, K., … Flagstad, O. (2007). *Stakeholder perceptions of CO_2 capture and storage in Europe: Results from the EU-funded ACCSEPT survey* (Main report). Retrieved from http://www.accsept.org/outputs/main_survey_report.pdf

Sharp, J., Jaccard, M. K., & Keith, D. W. (2009). Anticipating public attitudes toward underground CO_2 storage. *International Journal of Greenhouse Gas Control, 3*, 641-651.

Siegrist, M. (2000). The influence of trust and perceptions of risks and benefits on the acceptance of gene technology. *Risk Analysis, 20*, 195-203.

Siegrist, M., & Cvetkovich, G. (2000). Perception of hazards: the role of social trust and knowledge. *Risk Analysis, 20*, 713-719.

Siegrist, M., Earle, T. C., & Gutscher, H. (2003). Test of a trust and confidence model in the applied context of electromagnetic (EMF) field risks. *Risk Analysis, 23*, 705-716.

Siegrist, M., Earle, T. C., Gutscher, H., & Keller, C. (2005). Perception of mobile phone and base station risks. *Risk Analysis, 25*, 1253-1264.

Singleton, G., Herzog, H., & Ansolabehere, S. (2009). Public risk perspectives on the geological storage of carbon dioxide. *International Journal of Greenhouse Gas Control, 3*, 100-107.

Sjöberg, L. (1999). Risk perception in Western Europe. *Ambio, 28*, 543-549.

Sjöberg, L. (2000a). Factors in risk perception. *Risk Analysis, 20*, 1-11.

Sjöberg, L. (2000b). Perceived risk and tampering with nature. *Journal of Risk Research, 3*, 353-367.

Sjöberg, L. (2001). Limits of knowledge and the limited importance of trust. *Risk Analysis, 21*, 189-198.

Sjöberg, L. (2002). Attitudes toward technology and risk: Going beyond what is immediately given. *Policy Sciences, 35*, 379-400.

Sjöberg, L. (2003). The different dynamics of personal and general risk. *Risk Management: An International Journal, 5*, 19-34.

Sjöberg, L., & Herber, M. W. (2008). Too much trust in (social) trust? The importance of epistemic concerns and perceived antagonism. *International Journal of Global Environmental Issues, 8*(1/2), 30-44.

Slavin, T., & Jha, A. (2009, July 29). Not under our backyard, say Germans, in blow to CO_2 plans. *The Guardian.* Retrieved from http://www.guardian.co.uk/

Slovic, P. (1999). Trust, emotions, sex, politics, and science: Surveying the risk-assessment battlefield. *Risk Analysis, 19*, 689-701.

Slovic, P. (2000). *The perception of risk.* London, UK: Earthscan.

Slovic, P., Finucane, M. L., Peters, E., & MacGregor, D. G. (2007). The affect heuristic. *European Journal of Operational Research, 177*, 1333-1352.

Slovic, P., Fischhoff, B., & Lichtenstein, S. (1982). Facts versus fears: Understanding perceived risk. In D. Kahneman, P. Slovic, & A. Tversky (Eds.), *Judgment under uncertainty: Heuristics and biases* (pp. 463-489). Cambridge, UK: Cambridge University Press.

Slovic, P., Flynn, J. H., & Layman, M. (1991). Perceived risk, trust, and the politics of nuclear waste. *Science, 254*, 1603-1607.

Statistics Norway (2006). *Nye definisjoner av utdanningsnivåer.* Retrieved from http://www.ssb.no/magasinet/slik_lever_vi/art-2006-09-14-01.html

Statistics Norway (2009). *Produksjon, import, eksport og forbruk av elektrisk kraft. 1950, 1955 og 1960-2007.* Retrieved from http://www.ssb.no/elektrisitetaar/tab-2009-05-28-11.html

Statistics Norway (2010). *Statistikkbanken.* Retrieved from http://statbank.ssb.no/statistikkbanken

Statoil (2009). *Statoil.* Retrieved from http://www.statoil.com/

Statsministerens kontor (2007). *Statsministerens nyttårstale 2007.* Retrieved from http://www.regjeringen.no/nb/dep/smk/aktuelt/taler_og_artikler/statsministeren/statsminister_jens_stoltenberg/2007-4/statsministerens-nyttarstale-2007.html?id=440349

Stephens, J. C., & Verma, P. (2006, May). *The role of environmental advocacy groups in the advancement of carbon capture and storage (CCS).* Paper presented at the Fifth Annual Conference on Carbon Capture & Sequestration. Retrieved from http://www.netl.doe.gov/publications/proceedings/06/carbon-seq/Tech%20Session%20001.pdf

Stern, N., Peters, S., Bakhshi, V., Bowen, A., Cameron, C., Catovsky, S., … Zenghelis, D. (2006). *The economics of climate change: The Stern review.* Cambridge, UK: Cambridge University Press.

Terwel, B. W., Ter Mors, E., Daamen, D. D. L., Reiner, D. M., Schumann, D., Anghel, S., ... Ziogou, F. (2009). *Scrutinizing the impact of CCS communication on opinion quality. An experimental comparison between Focus Group Discussions versus Information-Choice Questionnaires (ICQs): Results from cross-national analyses* (Final report of the FENCO-ERA research project).

Tjernshaugen, A. (2007). *Gasskraft. Tjue års klimakamp.* Oslo: Pax Forlag.

Tjernshaugen, A. (forthcoming). The growth of political support for CO_2 capture and storage in Norway. *Environmental Politics.*

Torp, T. A., & Gale, J. (2004). Demonstrating storage of CO_2 in geological reservoirs: The Sleipner and SACS Projects. *Energy, 29*, 1361-1369.

Torvanger, A., Rypdal, K., & Kallbekken, S. (2005). Geological CO_2 storage as a climate change mitigation option. *Mitigation and Adaptation Strategies for Global Change, 10*, 693-715.

Tokushige, K., Akimoto, K., & Tomoda T. (2007). Public perceptions on the acceptance of geological storage of carbon dioxide and information influencing the acceptance. *International Journal of Greenhouse Gas Control, 1*, 101-112.

Tversky, A., & Kahneman, D. (1982). Judgment under uncertainty: Heuristics and biases. In D. Kahneman, P. Slovic, & A. Tversky (Eds.), *Judgment under uncertainty: Heuristics and biases* (pp. 3-20). Cambridge, UK: Cambridge University Press.

Vikan, A., Camino, C., Biaggio, A., & Nordvik, H. (2007). Endorsement of the new ecological paradigm: A comparison of two Brazilian samples and one Norwegian sample. *Environment and Behavior, 39*(2), 217-228.

Widdicombe, S., Dashfield, S. L., McNeill, C. L., Needham, H. R., Beesley, A., McEvoy, A., … Berge, J. R. (2009). Effects of CO_2 induced seawater acidification on infaunal diversity and sediment nutrient fluxes. *Marine Ecology Progress Series, 379*, 59–75.

YouGov (2010). *Panel methodology.* Retrieved from http://yougov.no/Aboutus/PanelMethodology.aspx

APPENDIX

A. The New Ecological Paradigm (NEP) Scale with underlying facets.

B. Questionnaire with all items (Norwegian).

C. Approval letter from the Norwegian Social Science Data Services (NSD).

D. Table 18: Attitude towards CCS as a function of political affiliation.

Table 19: Attitude towards CCS as a function of income.

E. Table 20: Age distribution, comparison between samples.

Table 21: Distribution by geographic regions, comparison between samples.

Appendix A

The New Ecological Paradigm (NEP) Scale with underlying facets

A. The reality of limits to growth

We are approaching the limit of the number of people the earth can support.

The earth has plenty of natural resources if we just learn to develop them.

The earth is like a spaceship with only limited room and resources.

B. Anti-anthropocentrism

Humans have the right to modify the natural environment to suit their needs.

Plants and animals have as much right as humans to exist.

Humans were meant to rule over the rest of nature.

C. The fragility of nature's balance

When humans interfere with nature it often produces disastrous consequences.

The balance of nature is strong enough to cope with the impacts of modern industrial nations.

The balance of nature is very delicate and easily upset.

D. Rejection of exemptionalism

Human ingenuity will ensure that we do not make the earth unlivable.

Despite our special abilities humans are still subject to the laws of nature.

Humans will eventually learn enough about how nature works to be able to control it.

E. The possibility of an eco-crisis

Humans are severely abusing the environment.

The so-called 'ecological crisis' facing humankind has been greatly exaggerated.

If things continue on their present course, we will soon experience a major ecological catastrophe.

Appendix B

SPØRREUNDERSØKELSE OM CO2-HÅNDTERING

Takk for at du tar deg tid til å svare på vår undersøkelse om miljø, klima og energi. Undersøkelsen utføres av YouGov på vegne av Norges teknisk-naturvitenskapelige universitet (NTNU). Deltagelse i undersøkelsen er frivillig og du kan trekke deg når som helst underveis. Alle opplysninger du oppgir, anonymiseres og vil behandles konfidensielt.

Svarene vil brukes i et forskningprosjekt på nordmenns holdninger til miljø, klima og energi. Vi setter stor pris på din deltagelse. Studien er meldt til Personvernombudet for forskning, Norsk samfunnsvitenskapelig datatjeneste.

Ansvarlig for prosjektet er masterstudent Anders Berg-Hansen og førsteamanuensis Mons Bendixen. Har du spørsmål om forskningsprosjektet, send en e-post til andebe@stud.ntnu.no eller mons.bendixen@svt.ntnu.no.

1.0 Kjønn, alder

Q 1.1: Er du mann eller kvinne? (Tillat kun ett svar.)
Mann □
Kvinne □

Q 1.2: Hvilket år ble du født? (Utfyllingsboks, krev fire siffer.)

2.0 Energikilder

Q 2.1: På en skala fra 1-7 vennligst marker i hvilken grad du er for eller imot bruken av disse forskjellige kildene til elektrisitet og/eller oppvarming i Norge. (Energikilder fra (a) til (g) i randomisert rekkefølge. Tillat kun ett svar per linje. Krev svar på hver linje.)

Energikilde	1 Mot	2	3	4	5	6	7 For
(a) Solenergi	□	□	□	□	□	□	□
(b) Vindkraft	□	□	□	□	□	□	□
(c) Hydroelektrisk energi	□	□	□	□	□	□	□
(d) Biomasseenergi (eks. pelletsovner)	□	□	□	□	□	□	□
(e) Kull	□	□	□	□	□	□	□
(f) Naturgass	□	□	□	□	□	□	□
(g) Kjernekraft	□	□	□	□	□	□	□

3.0 Mediepreferanser/mediebruk

Q 3.1: På en skala fra 1-7 vennligst marker for hver av de følgende kanalene sannsynligheten for at du vil bruke kanalen for å få informasjon om nye energiteknologier. (Mediekanaler fra (a) til (g) i randomisert rekkefølge. Tillat kun ett svar per linje. Krev svar på hver linje.)

Mediekanal	**1 Svært usannsynlig**	**2**	**3**	**4**	**5**	**6**	**7 Svært sannsynlig**
(a) Aviser	□	□	□	□	□	□	□
(b) Tidsskrifter	□	□	□	□	□	□	□
(c) Vitenskapelige eller faglige publikasjoner	□	□	□	□	□	□	□
(d) Fjernsyn	□	□	□	□	□	□	□
(e) Radio	□	□	□	□	□	□	□
(f) Nettaviser	□	□	□	□	□	□	□
(g) Sosiale medier (Facebook, Youtube o.l.), blogger, wikis	□	□	□	□	□	□	□

Q 3.2: Hvor ofte leser du aviser (nett eller papir)? (Tillat kun ett svar.)

Hver dag □
5-6 dager i uken □
3-4 dager i uken □
1-2 dager i uken □
Sjeldnere □
Aldri □

Q 3.3: Hvor ofte ser du nyheter på fjernsyn? (Tillat kun ett svar.)

Hver dag □
5-6 dager i uken □
3-4 dager i uken □
1-2 dager i uken □
Sjeldnere □
Aldri □

4.0 Tillit (informasjon)

Q 4.1: I hvilken grad stoler du på informasjon om energirelaterte spørsmål fra hver av de følgende kildene? (Kilder fra (a) til (i) i randomisert rekkefølge. 7-trinns vurderingsskala: "1 Ikke i det hele tatt" - "7 Fullstendig". Tillat kun ett svar per linje. Krev svar på hver linje.)

Kilder	1 Ikke i det hele tatt	2	3	4	5	6	7 Fullstendig
(a) Landets regjering	□	□	□	□	□	□	□
(b) Regionale/lokale styresmakter	□	□	□	□	□	□	□
(c) Den europeiske union	□	□	□	□	□	□	□
(d) Elektrisitets-, gass- og andre energiselskaper	□	□	□	□	□	□	□
(e) Forskere	□	□	□	□	□	□	□
(f) Journalister	□	□	□	□	□	□	□
(g) Politiske partier	□	□	□	□	□	□	□
(h) Miljøvernorganisasjoner	□	□	□	□	□	□	□
(i) Forbrukerorganisasjoner	□	□	□	□	□	□	□

5.0 Kunnskap

Q 5.1: Vennligst marker etter beste evne hvorvidt den enkelte påstand under er sann eller usann. (Spørsmål fra (a) til (f) i randomisert rekkefølge. 2 alternativer: "1 Sant", "2 Usant". Tillat kun ett svar per linje. Krev svar på hver linje.)

Påstand	Sant	Usant
(a) 'Vi befinner oss nå i en varm periode mellom istider'	□	□
(b) 'Omtrent to-tredjedeler av energien vi bruker for å produsere elektrisitet fra fossilt brennstoff blir borte'	□	□
(c) 'Drivhuseffekten er forårsaket av et hull i jordens atmosfære'	□	□
(d) 'Hver gang vi bruker kull, olje eller gass, bidrar vi til drivhuseffekten'	□	□
(e) 'Olje- og gassreservoarer finnes som regel 100 meter under overflaten'	□	□
(f) 'Oksygen er hovedkomponenten i røyken som slippes ut fra en fabrikkpipe eller et eksosrør'	□	□

Q 5.2: Det er økende bekymring for stadig høyere nivåer av karbondioksid i atmosfæren. På hvilken måte bidrar følgende aktiviteter til disse nivåene? (Aktiviteter fra (a) til (f) i randomisert rekkefølge, 3 alternativer: "1 Øker", "2 Ingen innvirkning", "3 Reduserer". Tillat kun ett svar per linje. Krev svar på hver linje.)

Aktivitet	Øker karbondioksid	Ingen innvirkning	Reduserer karbondioksid
(a) Biler (bilisme)	□	□	□
(b) Kullkraftverk	□	□	□
(c) Kjernekraftverk	□	□	□
(d) Vindmøller/vindturbiner	□	□	□
(e) Planting av trær	□	□	□
(f) Fabrikker (f.eks. stålverk)	□	□	□

Q 5.3: Har du hørt om "Fangst og lagring av karbon" (også kjent som "CO_2-håndtering")? (3 alternativer: "1 Nei, aldri hørt om" "2 Litt" "3 Ja, ganske mye". Tillat kun ett svar.)

Nei, aldri hørt om □
Litt □
Ja, ganske mye □

Q 5.4: "Fangst og lagring av karbon" eller "CO_2-håndtering" kan redusere hvilke av følgende miljøproblemer? (Miljøproblemer fra (a) til (f) i tilfeldig rekkefølge, 3 alternativer: "1 Kan redusere", "2 Reduserer ikke", "3 Vet ikke". Tillat kun ett svar per linje. Krev svar på hver linje.)

Problemer	Kan redusere	Reduserer ikke	Vet ikke
(a) Giftig avfall	□	□	□
(b) Uttynning av ozonlaget	□	□	□
(c) Global oppvarming	□	□	□
(d) Sur nedbør	□	□	□
(e) Smog	□	□	□
(f) Forurensing av vann	□	□	□

6.0 Holdning (teknologi)

Q 6.1: Følgende teknologier er foreslått for å takle den globale oppvarmingen. Hvis du fikk ansvar for å lage en plan for å takle den globale oppvarmingen, hvilke av de følgende teknologiene ville du bruke? (Teknologier fra (a) til (e) i randomisert rekkefølge, 7-trinns vurderingsskala: "1 Absolutt ikke bruke" - "7 Absolutt bruke". Tillat kun ett svar per linje. Krev svar på hver linje.)

Teknologier	1 Absolutt ikke bruke	2	3	4	5	6	7 Absolutt bruke
(a) Fangst og lagring av karbon: Fange karbondioksid fra utslipp fra kraftverk og lagre det i underjordiske reservoarer.	□	□	□	□	□	□	□
(b) Energieffektive apparater: Produsere apparater som bruker mindre energi for å gjøre samme jobb.	□	□	□	□	□	□	□
(c) Kjernekraft: Produsere energi fra en kjernereaksjon.	□	□	□	□	□	□	□
(d) Solenergi: Bruke energi fra solen til oppvarming eller produksjon av elektrisitet.	□	□	□	□	□	□	□
(e) Vindkraft: Produsere elektrisitet fra vind, vanligvis i en vindturbin.	□	□	□	□	□	□	□

Q 6.2: CCS-teknologiene fanger karbondioksid fra utslipp fra kraftverk og lagrer det i underjordiske reservoarer. Hvis regjeringen bestemmer seg for å sette i gang et anlegg for å teste anvendbarheten av denne teknologien, ville du støtte et slikt forslag? (7-trinns vurderingsskala: "1 Sterkt imot" - "7 Sterkt for". Tillat kun ett svar.)

1 Sterkt imot	□
2	□
3	□
4	□
5	□
6	□
7 Sterkt for	□

7.0 Tillit (aktører)

Q 7.1: Regjeringen, energiselskaper, miljøvernorganisasjoner og forskere er involvert i prosessen med å utvikle CCS-teknologiene. Hvor mye tillit har du til disse partenes kompetanse til å ta gode beslutninger om fangst og lagring av karbon? (Kilder fra (a) til (d) i randomisert rekkefølge. 7-trinns vurderingsskala: "1 Ingen tillit" - "7 Full tillit". Tillat kun ett svar per linje. Krev svar på hver linje.)

	1 Ingen tillit	**2**	**3**	**4**	**5**	**6**	**7 Full tillit**
(a) Regjeringen	□	□	□	□	□	□	□
(b) Industrien	□	□	□	□	□	□	□
(c) Miljøorganisasjoner	□	□	□	□	□	□	□
(d) Forskere	□	□	□	□	□	□	□

Q 7.2: I hvilken grad tror du det er de ulike partenes intensjon å ta interessene til innbyggerne og miljøet i betraktning?

	1 I svært liten grad	**2**	**3**	**4**	**5**	**6**	**7 I svært stor grad**
(a) Regjeringen	□	□	□	□	□	□	□
(b) Industrien	□	□	□	□	□	□	□
(c) Miljøorganisasjoner	□	□	□	□	□	□	□
(d) Forskere	□	□	□	□	□	□	□

RISIKO/GEVINST/AKSEPT

Nå vil vi først presentere deg for informasjon om de tre trinnene som er involvert i CCS-prosessen, det vil si fangst, transport og lagring. Deretter vil vi spørre deg om ditt syn på disse.

Presenter temaene Fangst, Transport, Lagring (inkludert informasjon og spørsmål) i randomisert rekkefølge. Randomisér presentasjonen av Risiko og Gevinst slik at halvparten av respondentene først får presentert spørsmål om Risiko og den andre halvparten først får presentert spørsmål om Gevinst.

8.0 Risiko
9.0 Gevinst
10.0 Aksept

Informasjon - Fangst

Når man forbrenner kull og naturgass for å få energi, genereres CO_2. I kraftverk med CCS kan CO_2 fanges ved bruk av forskjellige teknikker. Det er ingen stor generell helsefare knyttet til selve CO_2-fangsten. Det viktigste miljøproblemet er at fangstprosessen medfører en "energibot" som krever omtrent 25% mer energi for samme energiproduksjon. Ved innføring av fangstteknologier ved et kraftverk, vil CO_2-utslippene fra kraftverket reduseres med omtrent 90%.

Det mest aktuelle forslaget for fangst av CO_2 er planlagt for gasskraftverket på Kårstø i Rogaland. Forutsatt at utbygging går som planlagt, vil anlegget levere 420 MW strøm, tilsvarende nesten tre Alta-kraftverk, basert på renset drift innen 2012.

8.1 Risiko - Fangst

Q 8.1.1: I hvilken grad tror du denne planen utgjør en risiko for deg og din familie? (7-trinns vurderingsskala: "1 Svært lav" - "7 Svært høy". Tillat kun ett svar.)

1 Svært lav □
2 □
3 □
4 □
5 □
6 □
7 Svært høy □

Q 8.1.2: I hvilken grad tror du denne planen utgjør en risiko for samfunnet generelt? (7-trinns vurderingsskala: "1 Svært lav" - "7 Svært høy". Tillat kun ett svar.)

1 Svært lav □
2 □
3 □
4 □
5 □
6 □
7 Svært høy □

9.1 Gevinst - Fangst

Q 9.1.1: I hvilken grad tror du denne planen kan gi gevinst for deg og din familie? (7-trinns vurderingsskala: "1 Svært lav" - "7 Svært høy". Tillat kun ett svar.)

1 Svært lav □
2 □
3 □
4 □
5 □
6 □
7 Svært høy □

Q 9.1.2: I hvilken grad tror du denne planen kan gi gevinst for samfunnet generelt? (7-trinns vurderingsskala: "1 Svært lav" - "7 Svært høy". Tillat kun ett svar.)

1 Svært lav □
2 □
3 □
4 □
5 □
6 □
7 Svært høy □

10.1 Aksept - Fangst

Q 10.1.1: Alt i alt hva er ditt syn på denne fangstlokaliteten? (7-trinns vurderingsskala: "1 Svært negativ" - "7 Svært positiv". Tillat kun ett svar.)

1 Svært negativ □
2 □
3 □
4 □
5 □
6 □
7 Svært positiv □

Informasjon - Transport

Etter å ha fanget opp CO_2-gassen, kan den transporteres til aktuelle lagringssteder. Enhver transport av væske eller gass kan føre til lekkasje, dvs. utslipp av CO_2 i luften. Den viktigste helsefaren er knyttet til oppsamling av CO_2 i lavereliggende områder som for eksempel kjellere, siden høye konsentrasjoner av CO_2 kan føre til kvelning. Sjansen for at dette skal skje er svært liten siden rørene har vært i rutinemessig bruk i mange år og vil være underlagt overvåking. Sammenlignet med andre alternativer for transport av CO_2, som lastebiler eller skip, er rør den mest kostnadseffektive løsningen for transport av større mengder.

Det mest aktuelle forslaget for CCS i Norge vil innebære transport av fanget CO_2 i en distanse på 200 km over havbunnen. Den undersjøiske gassledningen er planlagt fra Kårstø i Rogaland over Stord-bassenget til Utsira-formasjonen i nærheten av Sleipner-feltet, sør-vest i Nordsjøen.

8.2 Risiko - Transport

Q 8.2.1: I hvilken grad tror du denne planen utgjør en risiko for deg og din familie? (7-trinns vurderingsskala: "1 Svært lav" - "7 Svært høy". Tillat kun ett svar.)
(1 = Svært lav, 7 = Svært høy)

Q 8.2.2: I hvilken grad tror du denne planen utgjør en risiko for samfunnet generelt? (7-trinns vurderingsskala: "1 Svært lav" - "7 Svært høy". Tillat kun ett svar.)
(1 = Svært lav, 7 = Svært høy")

9.2 Gevinst - Transport

Q 9.2.1: I hvilken grad tror du dette forslaget vil være en fordel for deg og din familie? (7-trinns vurderingsskala: "1 Svært lav" - "7 Svært høy". Tillat kun ett svar.)
(1= Svært lav, 7 = Svært høy)

Q 9.2.2: I hvilken grad tror du dette forslaget vil være en fordel for samfunnet generelt? (7-trinns vurderingsskala: "1 Svært lav" - "7 Svært høy". Tillat kun ett svar.)
(1 = Svært lav, 7 = Svært høy)

10.2 Aksept - Transport

Q 10.2.1: Alt i alt hva er ditt syn på transport av CO_2 gjennom dette området? (7-trinns vurderingsskala: "1 Svært negativ" - "7 Svært positiv". Tillat kun ett svar.)
(1 = Svært negativ, 7 = Svært positiv)

Informasjon - Lagring

CO_2 kan lagres på lagringssteder som for eksempel olje- eller gassfelt, dype kullag og såkalte 'saltholdige akvifere', som er dype bergartsformasjoner som fungerer som svamper fylt med saltvann. Det viktigste helsespørsmålet ville være knyttet til lekkasje fra lagringsstedene selv om både overvåknings- og verifiseringssystemer vil være på plass for å oppdage eventuelle lekkasjer. Den lagrede CO_2-gassen kan lekke ut, men mengdene vil sannsynligvis være ekstremt små. Vi kan i Norge unngå en betydelig del av våre CO_2-utslipp ved å injisere CO_2 på slike lagringssteder.

Det mest aktuelle forslaget for å lagre CO_2 i Norge vil være Utsira-formasjonen som er et oljereservoar som er ferdig utvunnet sør-vest i Nordsjøen i nærheten av Sleipner-feltet. Lagringsstedet ligger mer enn 1000 meter under havbunnen.

8.3 Risiko - Lagring

Q 8.3.1: I hvilken grad tror du denne planen utgjør en risiko for deg og din familie? (7-trinns vurderingsskala: "1 Svært lav" - "7 Svært høy". Tillat kun ett svar.)
(1 = Svært lav, 7 = Svært høy)

Q 8.3.2: I hvilken grad tror du denne planen utgjør en risiko for samfunnet generelt? (7-trinns vurderingsskala: "1 Svært lav" - "7 Svært høy". Tillat kun ett svar.)
(1 = Svært lav, 7 = Svært høy).

9.3 Gevinst - Lagring

Q 9.3.1: I hvilken grad tror du denne planen kan gi gevinst for deg og din familie? (7-trinns vurderingsskala: "1 Svært lav" - "7 Svært høy". Tillat kun ett svar.)
(1= Svært lav, 7 = Svært høy)

Q 9.3.2: I hvilken grad tror du denne planen kan gi gevinst for samfunnet generelt? (7-trinns vurderingsskala: "1 Svært lav" - "7 Svært høy". Tillat kun ett svar.)
(1 = Svært lav, 7 = Svært høy)

10.3 Aksept - Lagring

Q 10.3.1: Alt i alt hva er ditt syn på lagring av karbondioksid på dette stedet? (7-trinns vurderingsskala: "1 Svært negativ" - "7 Svært positiv". Tillat kun ett svar.)
(1 = Svært negativ, 7 = Svært positiv)

11.0 Tillit (epistemisk)

Q 11.1: Hvor godt tror du vitenskapen kjenner til risiko knyttet til CO_2-håndtering? (7-trinns vurderingsskala: "1 Svært dårlig" - "7 Svært godt". Tillat kun ett svar.)

1 Svært dårlig □
2 □
3 □
4 □
5 □
6 □
7 Svært godt □

Q 11.2: I hvilken grad mener du de tekniske og vitenskapelige spørsmål om CO_2-håndtering er løst?
(7-trinns vurderingsskala: "1 I svært liten grad" - "7 I svært stor grad". Tillat kun ett svar.)

1 I svært liten grad	□
2	□
3	□
4	□
5	□
6	□
7 I svært stor grad	□

Q 11.3: I hvilken grad er dagens vitenskapelige kunnskap tilstrekkelig for å igangsette CO_2-håndtering?
(7-trinns vurderingsskala: "1 I svært liten grad" - "7 I svært stor grad". Tillat kun ett svar.)

1 I svært liten grad	□
2	□
3	□
4	□
5	□
6	□
7 I svært stor grad	□

12.0 Holdning (klima/miljø/natur)

Q 12.1: Her er tre utsagn om CO_2-håndtering og menneskenes forhold til naturen. Vennligst ta stilling til følgende: (Påstander fra (a) til (c) i randomisert rekkefølge, 7-trinns vurderingsskala: "1 Sterkt uenig" - "7 Sterkt enig". Tillat kun ett svar per linje. Krev svar på hver linje.)

	1 "Sterkt uenig"	**2**	**3**	**4**	**5**	**6**	**7 "Sterkt enig"**
(a) 'Sett fra et miljøvernperspektiv, burde vi mennesker unngå å starte med CO_2-håndtering.'	□	□	□	□	□	□	□
(b) 'CO_2-håndtering forstyrrer naturens lover.'	□	□	□	□	□	□	□
(c) 'Realisering av CO_2-håndtering er et eksempel på menneskenes herredømme over naturen, som er feil.'	□	□	□	□	□	□	□

Q 12.2: Basert på hva du vet om klimaendringer (økt drivhuseffekt forårsaket av mennesker), hvilken av følgende påstander stemmer best overens med din mening? (Tillat kun ett svar.)

'Klimaendringer er et reelt problem, og øyeblikkelige tiltak må iverksettes'	□
'Det finnes tilstrekkelig bevis for at klimaendringer pågår, og noen tiltak bør derfor settes i gang'	□
'Vi har ikke nok kunnskap om klimaendringer og mer forskning er nødvendig før vi iverksetter tiltak'	□
'Det er ingen grunn til bekymring for klimaendringer'	□
Usikker / Ingen mening	□

Q 12.3: De neste utsagnene dreier seg om ditt syn på natur og miljø. Vennligst ta stilling til følgende:
(Utsagn fra (a) til (o) i randomisert rekkefølge. 7-trinns vurderingsskala: "1 Sterkt uenig" - "7 Sterkt enig". Tillat kun ett svar per linje. Krev svar på hver linje.)

	1 "Sterkt uenig"	**2**	**3**	**4**	**5**	**6**	**7 "Sterkt enig"**
(a) 'Vi nærmer oss grensen for det antall mennesker som jorda kan brødfø.'	□	□	□	□	□	□	□
(b) 'Menneskene har rett til å forandre naturmiljøet for å imøtekomme deres behov.'	□	□	□	□	□	□	□
(c) 'Når mennesker griper inn i naturen, får det ofte katastrofale følger.'	□	□	□	□	□	□	□
(d) 'Menneskenes dyktighet og klokskap vil sikre at det ikke blir ulevelig på jorda.'	□	□	□	□	□	□	□
(e) 'Menneskene misbruker miljøet i alvorlig grad.'	□	□	□	□	□	□	□
(f) 'Jorda har overflod av naturressurser, bare vi lærer å gjøre oss nytte av dem.'	□	□	□	□	□	□	□
(g) 'Planter og dyr har like stor rett som oss mennesker til å eksistere.'	□	□	□	□	□	□	□
(h) 'Naturens balanse er stabil nok til å motstå påvirkningene fra moderne industriland.'	□	□	□	□	□	□	□
(i) 'Til tross for våre spesielle evner er vi mennesker fremdeles underlagt naturens lover.'	□	□	□	□	□	□	□
(j) 'Den såkalte "økologiske krisen" som menneskeheten står overfor har blitt sterkt overdrevet.'	□	□	□	□	□	□	□
(k) 'Jorda er som et romskip som har meget begrenset plass og ressurser.'	□	□	□	□	□	□	□
(l) 'Det er meningen at menneskeheten skal herske over resten av naturen.'	□	□	□	□	□	□	□
(m) 'Naturens balanse er ømfintlig og svært lett å forstyrre.'	□	□	□	□	□	□	□
(n) 'Menneskene vil til slutt finne ut nok om naturen slik at de vil være i stand til å kontrollere den.'	□	□	□	□	□	□	□
(o) 'Hvis ting fortsetter på sin nåværende kurs, vil vi snart få oppleve en større økologisk katastrofe.'	□	□	□	□	□	□	□

13.0 Utdanning

Q 13.1: Hva er din høyeste fullførte utdanning? (Tillat kun ett svar.)

Grunnskole	□
Noe videregående skole	□
Fullført videregående skole	□
Noe høyskole eller teknisk fagskole	□
Fullført 3-årig høyskole eller universitet	□
Påbegynt mastergrad eller tilsvarende	□
Fullført mastergrad eller tilsvarende, eller høyere (f.eks. doktorgrad)	□

14.0 Politisk preferanse

Q 14.1: Hvilket parti stemte du ved siste stortingsvalg? (Tillat kun ett svar.)

Arbeiderpartiet (Ap)	□
Fremskrittspartiet (Frp)	□
Høyre (H)	□
Kristelig Folkeparti (KrF)	□
Rødt (R)	□
Senterpartiet (Sp)	□
Sosialistisk Venstreparti (SV)	□
Venstre (V)	□
Annet parti	□
Stemte ikke	□
Vil ikke oppgi parti	□

15.0 Inntekt

Q 15.1: Hvor stor omtrent er din egen samlede brutto årsinntekt (før skatt og fradrag)? (Tillat kun ett svar.)

1 Under 200.000	□
2 200-349.999	□
3 350-499.999	□
4 500-699.999	□
5 700.000-999.999	□
6 1.000.000 eller mer	□
7 Vet ikke / Vil ikke oppgi inntekt	□

16.0 Kommentarer

Q 16.1: Har du noen kommentarer til denne undersøkelsen? (Åpent felt.)

Tusen takk for at du deltok!

Appendix C

Norsk samfunnsvitenskapelig datatjeneste AS
NORWEGIAN SOCIAL SCIENCE DATA SERVICES

Harald Hårfagres gate 29
N-5007 Bergen
Norway
Tel: +47-55 58 21 17
Fax: +47-55 58 96 50
nsd@nsd.uib.no
www.nsd.uib.no
Org.nr. 985 321 884

Mons Bendixen
Psykologisk institutt
NTNU
Dragvoll
7491 TRONDHEIM

Vår dato: 21.06.2010 Vår ref: 24409 / 2 / KH Deres dato: Deres ref:

KVITTERING PÅ MELDING OM BEHANDLING AV PERSONOPPLYSNINGER

Vi viser til melding om behandling av personopplysninger, mottatt 12.05.2010. All nødvendig informasjon om prosjektet forelå i sin helhet 21.06.2010. Meldingen gjelder prosjektet:

24409	*Publikums holdninger til CO2-håndtering*
Behandlingsansvarlig	*NTNU, ved institusjonens øverste leder*
Daglig ansvarlig	*Mons Bendixen*
Student	*Anders Berg-Hansen*

Personvernombudet har vurdert prosjektet og finner at behandlingen av personopplysninger er meldepliktig i henhold til personopplysningsloven § 31. Behandlingen tilfredsstiller kravene i personopplysningsloven.

Personvernombudets vurdering forutsetter at prosjektet gjennomføres i tråd med opplysningene gitt i meldeskjemaet, korrespondanse med ombudet, vedlagte prosjektvurdering - kommentarer samt personopplysningsloven/-helseregisterloven med forskrifter. Behandlingen av personopplysninger kan settes i gang.

Det gjøres oppmerksom på at det skal gis ny melding dersom behandlingen endres i forhold til de opplysninger som ligger til grunn for personvernombudets vurdering. Endringsmeldinger gis via et eget skjema, http://www.nsd.uib.no/personvern/forsk_stud/skjema.html. Det skal også gis melding etter tre år dersom prosjektet fortsatt pågår. Meldinger skal skje skriftlig til ombudet.

Personvernombudet har lagt ut opplysninger om prosjektet i en offentlig database, http://www.nsd.uib.no/personvern/prosjektoversikt.jsp.

Personvernombudet vil ved prosjektets avslutning, 01.10.2010, rette en henvendelse angående status for behandlingen av personopplysninger.

Vennlig hilsen

Atle Alvheim

Kjersti Håvardstun

Kontaktperson: Kjersti Håvardstun tlf: 55 58 29 53
Vedlegg: Prosjektvurdering
Kopi: Anders Berg-Hansen, Sofies gate 29, 0168 OSLO

Personvernombudet for forskning

Prosjektvurdering - Kommentar

24409

Personvernombudet forutsetter at det inngås en databehandleravtale mellom prosjektleder og YouGov Norway AS, jf. personopplysningsloven § 15.

Ombudet forutsetter at det tilføyes i informasjonen til utvalget når opplysningene anonymiseres (måned og år).

Prosjektslutt er 01.10.2010. Datamaterialet anonymiseres ved at verken direkte eller indirekte personidentifiserbare opplysninger fremgår. YouGov sletter sine logger og koblingsnøkkelen.

Appendix D

Table 18

Attitude towards CCS as a function of political affiliation

Political party	**Mean**	***SD***
The Labour Party (Ap)	4.26	1.23
The Progress Party (Frp)	3.93	1.30
The Conservative Party (H)	4.29	1.22
The Christian Democratic Party (KrF)	3.82	1.24
The Red Party (R)	3.80	1.37
The Centre Party (Sp)	4.04	1.21
The Socialistic Left Party (SV)	4.28	1.19
The Liberal Party (V)	4.24	1.27
Other parties	4.25	1.06
Did not vote	3.87	1.13
Refrained from answering	3.58	1.13

Table 19

Attitude towards CCS as a function of income

Income group	**Mean**	***SD***
Below 200,000 NOK/year	3.77	1.30
200,000-349,999 NOK/year	4.05	1.24
350,000-499,999 NOK/year	4.17	1.23
500,000-699,999 NOK/year	4.33	1.16
700,000-999,999 NOK/year	4.20	1.12
Above 1,000,000 NOK/year	4.43	1.69
Don’t know / Refrain from answering	3.90	1.20

Appendix E

Table 20

Age distribution in samples

Age	November 2009	January 2010	June 2010
18-24	13.8	9.9	6.7
25-34	21.4	19.9	25.7
35-44	21.2	20.2	25.8
45-54	21.9	22.7	18.2
55-64	19.4	23.1	16.1
65-75	2.4	4.2	7.4
Total	100.0	100.0	100.0

Note. Values are percentages of respondents; $N = 999$.

Table 21

Distribution of respondents by geographic regions

Region	Nov. 2009	Jan. 2010	Jun. 2010
Oslo and Akershus	22.4	20.0	25.7
Eastern Norway	20.1	21.8	23.3
Southern Norway	14.0	14.0	11.6
Western Norway	24.7	24.9	21.4
Mid Norway and Northern Norway	18.9	19.3	17.9
Total	100.0	100.0	100.0

Note. Values are percentages of respondents; $N = 999$.