Report on survey among residents: Results and implications for decision procedure and communication campaign

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Executive summary

This report presents the results of the first study on public knowledge and awareness of CCS in general, public trust in CCS stakeholders, and initial public perceptions of CCS activities planned for the Northern Netherlands. Because the location for CO_2 storage in this region is not yet known, it was not possible to administer a survey to people living near such a planned storage location and ask them about their perceptions of these plans in the context of other local issues. Therefore, we administered a traditional survey to a representative sample of the Dutch general public ($N = 1109$) and to an additional broad sample of people living in the Northern Netherlands ($N = 349$) to examine levels of public knowledge and awareness of CCS, trust in CCS stakeholders, and *initial* public attitudes toward CCS activities planned for the Northern Netherlands. Such initial public attitudes are proven to be highly unstable because they are based only on the very little amount of information people had at their disposal when they were asked about their opinions, which is why a traditional survey is not particularly suited to assess public opinions on CCS. However, the survey is suited to examine public knowledge and awareness, and public trust in stakeholders. The results of this survey show that public knowledge and awareness of CCS is quite low; 50% of the respondents indicated to have never heard of CCS, and only 2.6% of the entire representative sample is able to correctly indicate both which environmental problem CCS aims to address and which environmental problems CCS does *not* address (for more details on public knowledge and awareness, see Sections 1 and 2). Second, the results show that on average, both people living in the Northern Netherlands and people living in the other Dutch provinces trust knowledge institutions most (with a mean score of $M = 5.09$ on a 7-point scale ranging from 1 = *no trust at all* to 7 = *very much trust* for the Northern sample and $M = 5.04$ for the other Dutch provinces), followed by environmental NGOs ($M_{\text{northern}} = 4.50$ versus $M_{\text{other provinces}} = 4.62$), while government bodies ($M_{\text{northern}} = 4.30$ versus $M_{\text{other provinces}} = 4.20$) and companies ($M_{\text{northern}} = 4.36$ versus $M_{\text{other provinces}} = 4.15$) are trusted least. With regard to specific companies, people living in the Northern Netherlands tend to be relatively trusting the companies involved in CCS activities in the Northern Netherlands (e.g., Essent, Gasunie, NAM, NUON) with mean trust scores varying between $M = 4.69$ and $M = 4.96$, although RWE is trusted less ($M = 4.08$). Also, while trust in environmental NGOs on average is quite high, people living in the Northern Netherlands are particularly trusting WWF ($M = 5.26$; for more details on public trust in specific CCS stakeholders, see Section 3). Finally, the results indicate that initial public attitudes toward CCS (i.e., toward CCS in general and toward CCS activities planned for the Northern Netherlands) are, on average, neither extremely negative nor extremely positive (mean score around 4 on a 7-point scale). People living in the Northern Netherlands seem a bit more negative about CO_2 transport and storage (but not about CO_2 capture) in this region as compared to people living in the other Dutch provinces (for more details on initial public attitudes, see Sections 4 and 5). All in all, this study is a relevant first step for future research and

interventions within WP5.1 and provides support for the proposed procedure how to introduce a CCS project in a local community and how to communicate on this project. Within WP5.1 subsequent surveys will repeatedly be conducted once the actual CO_2 storage location is known.

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AD-03	CATO-2 Program Plan	CATO2-WP0.A-D03	2009.09.17

Abbreviations

WP	Work Package

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Report on survey among residents: Results and implications for decision procedure and communication campaign

Introduction

This report describes the results of the first study on public perceptions of CCS activities planned for the Northern Netherlands that has been conducted as part of CATO-2 WP5.1. Among other things, in this work package we will monitor (shifts in) knowledge levels and perceptions of planned CCS activities in local communities—people residing in the direct vicinity of a planned CCS activity. Monitoring will be done by means of carefully designed repeated surveys to monitor the local public's perceptions of CCS compared to other issues in the local community. However, we are only able to develop and administer such a questionnaire once the actual CO_2 storage location is known.

Unfortunately, to date, there has not yet been decided on the specific location for CO_2 storage in the Northern Netherlands. However, if a CCS demonstration project is subsidized by the EU and the Dutch government, storage of CO_2 will probably be in an onshore depleted gas fields in the Northern Netherlands (i.e., somewhere in Friesland, Groningen, or Drenthe). Given this situation, it is not yet possible for us to examine the local public's perceptions of specific CCS activities planned for that region. However, it is possible to conduct a traditional survey to assess public understanding of CCS in general and public trust in CCS stakeholders, and to examine initial public attitudes toward CCS activities planned for the Northern region—described in general terms based on what is already known.

In this report, we present the results of a survey among both a representative sample of the Dutch general public (N = 1109) and a broad sample of residents of the Northern Netherlands (i.e., people living in the provinces of Friesland, Groningen, and Drenthe; N = 349). This first survey provides a baseline for subsequent studies once the actual storage location is known. The report first describes the aims and background of the study, after which we present the results. These results cover public understanding of CCS in general, public trust in CCS stakeholders, initial attitudes toward CCS among the general public, and initial attitudes toward CCS activities planned for the Northern Netherlands (and we examine whether these initial attitudes differ for the Northern regional sample and the sample of people living in the other Dutch provinces). Finally, the implications of the study are discussed.

Aims and background of the study

The main aims of this first study were to examine

1. levels of public knowledge and awareness of sources of CO_2, the percentage of members of the general public indicating to know about CCS, and the degree to which people are able to correctly indicate the environmental problem CCS aims to address
2. current levels of public trust in CCS stakeholders (i.e., companies, environmental NGOs, government bodies, and research institutions)

In addition, we aimed to assess

3. initial public attitudes toward CCS among members of the general public
4. initial public attitudes toward CCS activities—capture, transport, and storage—planned for the Northern Netherlands. For the latter purpose, we compared initial attitudes reported by residents of that region to those reported by people living in the other Dutch provinces.

We will briefly provide the rationale for each of these aims, before we describe the main results.

1. Previous research has consistently found that public knowledge and awareness of CCS is limited or non-existent (e.g., De-Best-Waldhober, Daamen, & Faaij, 2006, 2009). Yet, with increased media exposure concerning plans for CO_2 storage in depleted natural gas fields below Barendrecht, public knowledge and awareness of CCS may have increased. There is a demand for ongoing monitoring of awareness and knowledge of CCS because the results of such monitoring have implications for future communications about CCS. For example, if public knowledge about the sources of CO_2 remains low, people need to be educated on the subject so they understand that conventional fossil fuel-fired power plants emit CO_2. Similarly, if people do not know that CCS contributes to the reduction of global warming by preventing that CO_2 is released into the atmosphere, they need to be taught about this as well. As such, this survey aims to assess knowledge about sources of CO_2 as well as the environmental concern CCS aims to address among a representative sample of the general public.
2. The second aim of the survey was to collect data on current levels of public trust in the different CCS stakeholders. CATO-1 research has shown the importance of public trust in CCS stakeholders. Members of the general public are more willing to rely on the judgments of organizations that they think are trustworthy. As such, they use their trust in stakeholders to decide whether to accept or oppose CCS (Terwel, Harinck, Ellemers, & Daamen, 2009a; Terwel, Harinck, Ellemers, & Daamen, in press). Moreover, the perceived quality of CCS information provided

by a stakeholder depends on whether or not people perceive this stakeholder to be trustworthy (Ter Mors, 2008). Finally, CATO-1 research showed that a coalition of parties with different interests to provide CCS information is seen as credible and likely to supply high-quality information (Ter Mors, 2008).

Based on these CATO-1 findings, in WP5.1 we propose to instigate public trust by implementing a procedure in which multiple stakeholders and scientists collaborate in a local 'Stakeholders and Scientists Committee (SSC) to develop a knowledge base consisting of high-quality information relevant to local CCS activities. That is to say, the SSC acquires information on all relevant aspects and consequences of local CCS activities. Eventually, the SSC should reach consensus about the qualities of the information (i.e., that the information is valid, balanced, relevant and comprehensible). Note that the information will be *factual* and does not include opinions of specific stakeholders. Such a procedure is not only expected to instigate public trust in the process, but also to instigate trust among stakeholders. Once ready, the knowledge base will consist of credible and high-quality information and can be presented to the local public (as the basis for a local information-on-demand campaign).

The procedure for developing the knowledge base will (generally) involve the following steps. First, at the storage location, the relevant stakeholders will be identified. Then, different stakeholders and scientists will be invited to participate in the SSC with the aim to gather information on all aspects and consequences of local CCS activities. In the end, different parties with different interests will participate in the SSC, including companies, scientists and other experts in the field (from TNO, Ecofys, UU, and UL), environmental NGOs, regional government, and local opinion leaders who are not active in the political arena. The participating of environmental NGOs is crucial). Each member of the SSC may add new aspects and consequences for which he or she wants expert information. Independent experts from Ecofys, UU and TNO who participate in the SSC collect this information by reviewing literature and talking to other experts in the field. Next, the SSC checks whether the information provided by experts is indeed valid, balanced, and relevant. Once all relevant information is acquired, it will be made comprehensible for laypeople and checked on accuracy again. We expect that this procedure will instigate trust in the decision process and that the public will recognize that the information is credible and of high quality. Hence, the knowledge base will be a valuable tool for communications near local CCS activities.

The current public trust assessment identifies current levels of trust in different CCS stakeholders operating in the Northern Netherlands. Based on this assessment (and future assessments at the actual storage location once the location is known), an informed decision will be made with respect to the specific parties to invite to participate in the SSC. While public trust in specific CCS stakeholders

has already been examined in CATO-1 research, this previous research (1) was not conducted among a representative sample of the general public, (2) did not include all current CCS organizations (e.g., DSM was not included), and (3) did not allow for comparisons between geographic regions. The latter is important with an eye on CCS activities planned for the Northern Netherlands and the proposed introduction procedure (as described above), because it is relevant to determine whether people in the Northern Netherlands report higher (or lower) levels of trust in specific stakeholders. After all, this may have implications for communications by stakeholders in the near future. Therefore, in the analyses we compare the regional sample with the national sample.

3. CATO-1 has addressed informed public opinions by means of Information-Choice Questionnaires (ICQs; De Best-Waldhober et al., 2006, 2009; De Best-Waldhober, Daamen, Hendriks, de Visser, Ramírez Ramírez, & Faaij, 2008; also see Neijens, 1987). In these studies, people were thoroughly informed about the consequences of CCS before stating their overall opinion. Compared to traditional surveys, ICQs have the advantage that these are better suited to predict future levels of public acceptance (i.e., once the general public is well-educated on the subject). That is, informed public opinions are more stable as compared to uninformed public opinions.

   In the current study, we focus on 'initial public opinions' rather than informed public opinions. Initial opinions are opinions reported by people without being thoroughly informed on the issue. On the one hand, initial public opinions may be very unstable. After all, they are reported by people who have very little knowledge so that they are probably subject to misconceptions and are based on general associations people have (including trust, see above). Future communications about CCS can be expected to heavily influence initial public opinions (while this would be less true for informed opinions reported in an ICQ). Yet, with respect to public acceptance of CCS, the best we can do at this moment is to examine initial public attitudes by means of a traditional survey. Important in this regard is to provide respondents with a context when asking them about their initial attitudes toward CCS. In the current survey we provide such a context by asking people about CCS in the context of other energy technologies they are more familiar with (e.g., solar and wind energy). Finally, although initial attitudes as reported in traditional surveys may well be transitory, it should be noted that a traditional questionnaire *is a* valid instrument to assess public knowledge on CCS and awareness of CCS (see the first aim formulated above).
4. It is relevant to study initial public attitudes on CCS activities such as those planned for the Northern Netherlands. For example, how people initially respond to CCS plans may determine which communication steps are required in the near future. In the survey, we have briefly described CCS activities planned for the Northern Netherlands in terms of capture, transport and storage, and we ask

people about their initial opinions accordingly. We were particularly interested in local residents' initial attitudes on CCS activities planned for the Northern region. As such, we conducted the survey among a sample of people living in one of the Northern provinces (Friesland, Groningen, or Drenthe) and compared their views to those of people living in the other Dutch provinces.

Method and Results

TNS-NIPO, a professional polling firm, collected the data for the study in the last two weeks of October 2009. Respondents were randomly drawn from the massive panel (about 200000 people) of respondents that TNS-NIPO has at its disposal. TNS-NIPO invests a lot of effort and money to keep this panel representative and to avoid selective withdrawal of respondents. The procedure followed by TNS-NIPO resulted in a sample representative for the Dutch general public, not only representative on variables such as sex, age, and education, but also on background variables such as socioeconomic status, living area, etc. Respondents were invited to complete the computer-assisted survey at their home. In the survey the order of questions was randomized when order effects could be expected. [1]

The representative sample (N = 1109) consisted of 544 males (49.1%) and 565 females, of all ages between 18 and 86. Concerning highest level of education completed, most respondents (33.9%) had completed MBO education, 20.1% had completed HBO education or WO candidacy, 18.0% had completed LBO-VMBO education, 8.7% had completed MAVO education (or some type of education comparable to the MAVO level), 8.5% had completed a WO master or doctoral education, 6.4% had completed HAVO or VWO education, 4.1% did not receive education or completed elementary school only, and 0.2% did not know or did not want to say. All the Dutch provinces were represented as expected. These distributions are representative for the Dutch population and compare well with previous representative surveys done on CCS (De Best-Waldhober et al, 2006, 2008).

In addition to the representative sample, TNS-NIPO administered the survey to a regional sample of people living in the three Northern provinces (N = 349). This sample again was drawn from the massive panel of respondents that TNS-NIPO has at its disposal, and consisted of 181 males (51.9%) and 168 females, of all ages between 18 and 88. Concerning education received, most respondents (36.4%) had completed MBO education, 23.2% had completed HBO education or WO candidacy, 14.0% had

[1] Parts of the data were collected in the context of an international FENCO-ERA project, titled "Scrutinizing the impact of CCS communication on the general and local public". However, the present report also contains unique data which were not part of this FENCO-ERA project (e.g., all results on trust in organizations)

completed LBO-VMBO education, 9.5% had completed a WO master or doctoral education, 7.7% had completed MAVO education (or some type of education comparable to the MAVO level), 4.6% had completed HAVO or VWO education, 4.3% did not receive education or completed elementary school only, and 0.3% did not know or did not want to say. All the Northern provinces (i.e., Friesland, Groningen, and Drenthe) were represented in this sample as expected.

We considered the possible influence of two relevant background variables on the main outcome variables, namely (1) highest level of education completed, and (2) geographic region (i.e., the Northern Netherlands versus the other Dutch provinces). For analyzing purposes, a variable for highest level of education completed was created by dividing respondents in three groups: low education (LO, LBO, VMBO, MAVO), medium education (MBO) and higher education (HAVO, VWO, HBO, WO). We expected that education level would be a determinant of knowledge and awareness, with highly educated people being more knowledgeable and aware than less educated people. Concerning the influence of geographic region on the dependent variables, we compared the responses of people living in the Northern Netherlands with responses of people living in the other Dutch provinces, but only if comparisons were considered relevant (which is the case with regard to the results on current levels of public trust in CCS stakeholders and initial public attitudes on CCS activities in the Northern region). Otherwise, we solely focused on the results for the representative sample.

1. Knowledge on sources of CO_2

Analyses performed on the national representative sample - N = 1109

We asked people the following question to assess their knowledge on sources of CO_2:

> "There is a growing concern about the ever-increasing CO_2 concentrations in the atmosphere. Please indicate for each of the following issues [car use/coal-fired power plants/nuclear power plants/windmills wind turbines/planting trees/steel factory] how it contributes to CO_2 concentrations in the atmosphere"

Respondents had to choose one of three possible answers, either (1) the issue increases CO_2 levels; (2) the issue has no effect on CO_2 levels; or (3) the issue decreases CO_2 levels.

Results indicated that most people were quite accurately aware of how each these issues contribute to CO_2 levels in the atmosphere. For example, concerning car use, 92.9% of all respondents indicated that car use increases CO_2 levels in the atmosphere. Only a very small minority indicated that car use had no impact (4.4%) or decreased CO_2 concentrations (2.7%). We observed a similar pattern of results for coal-fired power plants (90.0% correct) and steel factories (94.0% correct). About half the sample

indicated that nuclear power plants (49.8%) and windmills (51.7%) had no impact on CO_2 levels in the atmosphere. 46.4% of the respondents erroneously thought that wind turbines decrease CO_2 levels in the atmosphere. Finally, 91.0% indicated that planting trees decreases CO_2 concentrations. Table 1.1 provides an overview of the percentages. Given that respondents had a 1/3 chance to indicate the correct answer in the case of no prior knowledge on sources of CO_2 at all, we can conclude that the general public is quite accurately aware of sources of CO_2.

Table 1.1. Public understanding of how activities contribute to CO_2 levels.

	Increases CO_2	No impact	Decreases CO_2
Car use	92.9%	4.4%	2.7%
Coal-fired power plants	90.0%	6.6%	3.4%
Steel factories	94.0%	2.7%	3.2%
Nuclear power plants	31.0%	49.8%	19.2%
Windmills/Wind turbines	1.9%	51.7%	46.4%
Planting trees	2.9%	6.1%	91.0%

Note. $N = 1109$

To further illustrate this point, additional analyses showed that 86.0% of the respondents were able to correctly identify *all three* prominent sources of CO_2 (i.e., car use, coal-fired power plants, and steel factories), while 66.2% of the sample correctly indicated that *none* of the other three issues (i.e., nuclear power plants, windmills and planting threes) would lead to an increase in CO_2 levels. Taken together, 59.3% of the respondents were able to indicate both (a) that car use, coal-fired power plants and steel factories lead to an increase in CO_2 levels, and (b) that nuclear power plants, windmills, and planting trees do not lead to an increase of CO_2 concentrations in the atmosphere. As expected, such combined knowledge of sources of CO_2 was higher for highly educated respondents (69.3%) than for respondents with medium (56.6%) or low (51.3%) education.

2. (Self-reported) Knowledge on CCS

Analyses performed on the national representative sample - N = 1109

2.1. Knowledge about CCS

We further asked respondents to indicate whether they know about carbon dioxide (CO_2) capture and storage (CCS). They could either indicate (1) to have never heard about it, (2) to know only a little bit about it, or (3) to know quite a lot about it.

Responses on this question showed that half of the Dutch general public indicated to have never heard about CO_2 capture and storage (50.0%). This percentage was lower as the level of respondents' education increased. That is, the majority of lowly educated people (59.8%) indicated to have never heard of CCS, while this percentage was lower for medium educated respondents (50.8%) and highly educated respondents (40.7%).

Also indicative of the low levels of knowledge on CCS was that only 5.5% of the respondents indicated to know quite a lot about CCS. Again, this percentage was somewhat higher for highly educated respondents (9.8%) than for respondents with medium education (4.5%) or lower education (1.7%). Overall, irrespective of education levels, the percentage of respondents that claimed to know quite a lot about CCS can be considered low, though.

2.2. Public understanding of the environmental concern CCS aims to address

Furthermore, we assessed people's ideas about the environmental concern CO_2 capture and storage aims to address by asking

> "CO_2 capture and storage can reduce which of the following environmental concerns [toxic waste/ozone depletion/global warming/acid rain/smog/water pollution]?"

For each environmental concern, respondents had to choose one of three possible answers, either (1) can reduce, (2) does not reduce, or (3) I do not know.

Results show that whereas people's knowledge about the sources of CO_2 is considerable, their knowledge about the environmental concern that CCS aims to address is rather limited. At first glance, one could say that most people are aware that CCS reduces global warming, considering that 55.8% did in fact indicate this (versus 13.5% who indicated that CCS does not reduce global warming and another 30.7% who indicated not to know). Nevertheless, such a conclusion would be premature. After all, because respondents had the opportunity to indicate not to know the answer, those who did choose to provide an answer had a ½ chance of making the correct guess. So, people did only slightly better than chance.

Even more important though, while only 55.8% correctly indicated that CCS reduces global warming, at the same time a considerable number of people indicated that CCS reduces smog (55.9%), ozone depletion (54.9%), acid rain (47.1%), water pollution (26.7%) and toxic waste (18.4%). Table 2.1 provides an overview of the percentages. As such, it seems that people thought about CCS as a one-size-fits-all solution to a broad range of environmental issues. In fact, only 2.6% of all respondents indicated the reduction of global warming as the unique aim of CCS. These results indicate that knowledge about CCS among members of the general public is quite poor.

Table 2.1. Public understanding of the environmental concern CCS aims to address.

	CCS can reduce	CCS does not reduce	I do not know
Global warming	55.8%	13.5%	30.7%
Smog	55.9%	14.6%	29.5%
Ozone depletion	54.9%	15.3%	29.8%
Acid rain	47.1%	18.2%	34.7%
Water pollution	26.7%	37.5%	35.8%
Toxic waste	18.4%	44.8%	36.8%

Note. $N = 1109$

Further analyses revealed that awareness that CCS aims to reduce global warming was higher for respondents who had indicated before to know a little (72.8%) or quite a lot (77.0%) about CCS compared to respondents who had indicated to have never heard of the technology (38.4%). Important to note, however, the group of respondents with at least some self-reported knowledge about CCS *in particular* believed that CCS also reduces other environmental concerns such as ozone depletion (68.8%), smog (68.2%), and acid rain (59.7%). As such, it seems that knowledge about the aims of CCS is poor even among members of the general public who indicate to know a little or quite a lot about the technology.

Finally, we examined possible education effects on public understanding of the environmental concern CCS aims to address. Indeed, we found that respondents with high education were somewhat better able to correctly indicate that CCS reduces global warming (65.5%) than respondents with medium education (53.7%) or lower education (47.5%). Important to note, irrespective of education level, respondents did still only slightly better (or worse) than chance, taking into consideration a ½ chance of making the correct guess. The percentage of respondents that was able to indicate the reduction of global warming as the unique aim of CCS did not depend on respondent education and was low (2.6%), as mentioned above.

2.3. Other indications for lack of relevant knowledge

We further presented respondents with several statements to measure their knowledge of issues related to global warming and CCS. For each of these statements, respondents indicated whether the statement was true (1) of false (2). A remarkable finding relevant for (communication about) CCS was that 62.4% of the respondents indicated to believe that oil and gas reservoirs are typically found 100 meters below the surface. This misperception was widely-held and did not depend on the level of education

received. This again illustrates that the general public lacks the basic knowledge to judge CCS and its consequence on its merits.

3. Public trust in CCS stakeholders

Analyses performed on the regional sample for the Northern Netherlands (N = 458) and the sample consisting of people living in the other Dutch provinces (N = 1000) separately

The second main aim of the survey was to assess current levels of public trust in specific CCS stakeholders. Respondents had to indicate the extent to which they trusted each of the CCS stakeholders with regard to issues relating to energy. The answering scale ranged from 1 = *not at all* to 7 = *very much*. The order of presentation varied to control for possible order effects. A person who did not know an organization could indicate this by stating that he or she did not know the organization. In that case, this person did not give a trust rating for the specific organization and proceeded with the next organization. As a result, per stakeholder, mean trust ratings were calculated based only on those people who indicated to know the organization in question. Accordingly, levels of public trust as reported below are based on more cases when the organization is well-known as compared to rather unknown. First, we report public trust in stakeholders clustered by type of organization (i.e., companies, environmental NGOs, government bodies, and research institutions). Then, we report the levels of public trust for each individual stakeholder (and we provide the number of cases on which the trust score is based). Each time, we report trust levels for the Northern Netherlands and the other Dutch provinces separately.

3.1. Public trust in CCS stakeholders clustered by type of organization

Figure 3.1 provides the means for the types of CCS stakeholders for people living in the Northern Netherlands and people living in the other Dutch provinces separately. It shows that in both samples people placed most trust in research institutions (around 5 on the 7-point scale), followed by environmental NGOs (just over 4.5 on the 7-point scale). Both companies and governmental organizations were trusted less. Note that these mean scores are not weighted averages in that, for example, a mean trust score for a well-known company (e.g., Shell) is given equal weight to the mean trust score for a less well-known company (e.g. SEQ) in calculating the average trust score for the cluster of companies.

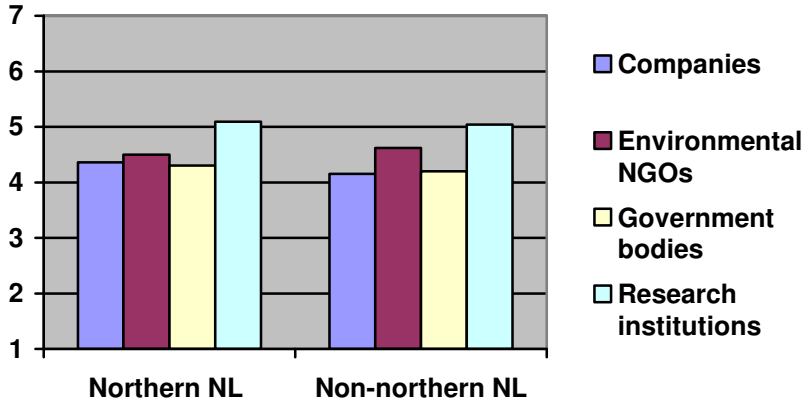

Figure 3.1. Means for public trust in CCS stakeholders clustered by type of organization. Answers were given on 7-point scales ranging from 1 = *not at all* to 7 = *very much*.

3.2. Public trust in specific organizations

Table 3.1 provides the means for public trust in companies. The most trusted companies are Essent, Gasunie, NAM and Nuon. It seems that people in the Northern Netherlands trust these organizations even more than people in the other Dutch provinces. Each of these organizations is also very well-known. SEQ, on the other hand, is not well-known and those who indicated to know the organization (i.e., those who refrained from indicating not to know the organization) did not place much trust in it. RWE is also relatively unknown and average trust lies around the midpoint of the 7-point scale.

Table 3.1. Means for public trust in companies.

Trust in companies	Northern NL (N = 458)	Non-Northern NL (N = 1000)
AkzoNobel	4.31 (N = 429)	4.18 (N = 924)
Corus	4.16 (N = 367)	3.94 (N = 782)
DSM	4.26 (N = 392)	4.14 (N = 873)
E-ON	4.05 (N = 315)	3.99 (N = 721)
Essent	4.96 (N = 454)	4.49 (N = 948)
Gasunie	4.84 (N = 450)	4.48 (N = 926)
NAM	4.69 (N = 436)	4.30 (N = 798)
Nuon	4.74 (N = 447)	4.54 (N = 956)
RWE	4.08 (N = 309)	3.98 (N = 640)
SEQ	3.52 (N = 111)	3.43 (N = 220)
Shell	4.31 (N = 452)	4.18 (N = 975)

Note. Answers were given on 7-point scales ranging from 1 = *not at all* to 7 = *very much*.

Table 3.2 provides the means for public trust in environmental NGOs. On average, public trust in environmental NGOs is higher than public trust in companies, but this is not the case for all NGOs. The most trusted and most well-known NGO is the World Wildlife Foundation, WWF (in Dutch: Wereld Natuur Fonds – WNF).

Table 3.2. Means for public trust in environmental NGOs.

Trust in environmental NGOs	Northern NL (N = 458)	Non-Northern NL (N = 1000)
Greenpeace	4.57 (N = 457)	4.71 (N = 988)
Milieudefensie	4.15 (N = 426)	4.31 (N = 926)
Stichting Natuur en Milieu (SNM)	4.47 (N = 346)	4.62 (N = 730)
Uw provinciale Milieufederatie	4.16 (N = 333)	4.19 (N = 632)
Wereld Natuur Fonds (WNF)	5.14 (N = 457)	5.26 (N = 994)

Note. Answers were given on 7-point scales ranging from 1 = *not at all* to 7 = *very much*.

Table 3.3 provides the means for public trust in government bodies. On average, public trust in these organizations is just above the midpoint of the 7-point scale. There are no apparent differences between trust in municipal, provincial, and national governments.

Table 3.3. Means for public trust in government bodies

Trust in government bodies	Northern NL (N = 458)	Non-Northern NL (N = 1000)
Municipal government	4.29 (N = 452)	4.20 (N = 979)
Provincial government	4.35 (N = 449)	4.17 (N = 974)
National government	4.27 (N = 454)	4.23 (N = 986)

Note. Answers were given on 7-point scales ranging from 1 = *not at all* to 7 = *very much*.

Table 3.4 provides the means for public trust in research institutions. On average, these are the organizations the public trusts most. There are differences in trust between the research institutions, however. Both TNO and universities are highly trusted and rather well-known. ECN is less well-known. Ecofys is trusted least of the research institutions and also is the least well-known.

Table 3.4. Means for public trust in research institutions

Trust in research institutions	Northern NL (N = 458)	Non-Northern NL (N = 1000)
ECN	4.80 (N = 163)	4.84 (N = 353)
Ecofys	4.39 (N = 82)	4.28 (N = 172)
TNO	5.72 (N = 433)	5.66 (N = 940)
Universities	5.44 (N = 407)	5.37 (N = 879)

Note. Answers were given on 7-point scales ranging from 1 = *not at all* to 7 = *very much*.

4. Initial attitudes toward CCS

Analyses performed on the national representative sample - N = 1109

4.1. Initial attitudes toward CCS (and other energy technologies)

This study also assessed *initial* public perceptions on CCS. Respondents were only given a very brief description of what CCS involves (i.e., "CO_2 capture and storage: Capturing CO_2 from power plants exhaust and storing it in underground reservoirs") before stating their opinion about the favorability of CCS implementation to address global warming. Because it is important to examine initial public attitudes toward CCS in relation to other energy technologies, we asked them to indicate their opinion about other energy technologies as well. People were asked

> "The following technologies are proposed to address global warming. If you were responsible for designing a plan to address global warming, which of the following technologies would you use [CO_2 capture and storage: Capturing CO_2 from power plants exhaust and storing it in underground reservoirs/Energy efficient appliances: Producing appliances that use less energy to accomplish the same tasks/Nuclear energy: Producing energy from a nuclear reaction/Solar energy: Using the energy from the sun for heating or electricity production/Wind energy: Producing electricity from the wind, traditionally in a wind mill]?"

Responses were given on a 7-point scale ranging from 1 = *definitely not use* to 7 = *definitely use*.

Results show that on average people were not very inclined to use CCS to address global warming ($M = 4.20$, $SD = 1.61$). Looking at the distribution of response categories, we see that 15.0% of the sample indicated that they would not use CCS as a means to address global warming (i.e., those people with a score of 1 or 2 on this variable), while 20.9% indicated that they would use it (i.e., those people with a score of 6 or 7 on this variable). The large majority (64.1% - those with a score of 3, 4 or 5 on this variable) were less convinced about whether or not they would use CCS to address global warming.

In relation to the other energy technologies, people preferred CCS ($M = 4.20$, $SD = 1.61$) somewhat over nuclear ($M = 3.70$, $SD = 1.92$), but they indicated much greater willingness to use solar energy ($M = 6.39$, $SD = 1.03$), wind energy ($M = 6.21$, $SD = 1.16$), and energy efficiency ($M = 6.04$, $SD = 1.17$) (see Figure 4.1).

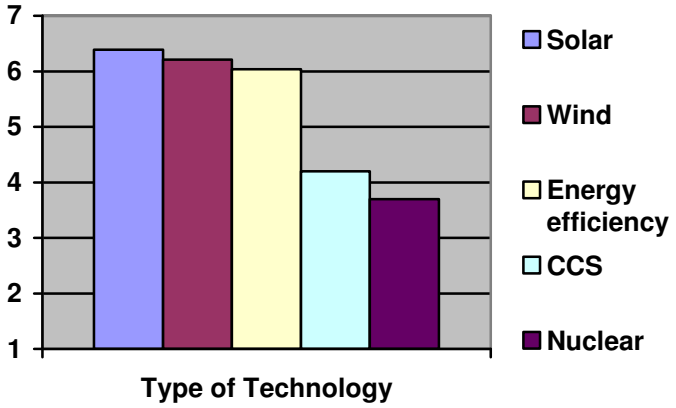

Figure 4.1. Evaluations of CCS in comparison to other energy technologies. Answers were given on 7-point scales ranging from 1 = *definitely not use* to 7 = *definitely use*.

4.2. Support for a test of CCS in practice

We further assessed people's initial attitudes toward a test of CCS in practice. We asked

> "If our government decided to proceed with a plant to test the applicability of the technology, would you be supportive of such a proposal?"

Responses were given on a 7-point scale ranging from 1 = *strongly opposed* to 7 = *strongly supportive*.

Results on this measure were consistent with the results reported earlier in that on average members of the general public were neither strongly opposed nor strongly supportive of CCS (M = 4.31, SD = 1.53). Looking at the distribution of response categories, we see that 14.5% of the sample indicated that they were opposed to a test of CCS in practice (i.e., those people with a score of 1 or 2 on this variable), while 23.2% would be supportive of such a test (i.e., those people with a score of 6 or 7 on this variable). The majority (62.3%) is less convinced about whether or not they would support a test of CCS in practice though (i.e., scores of 3, 4, or 5).

5. Initial attitudes toward capture, transport and storage in the Northern Netherlands: Comparing initial attitudes of people in the Northern region with people living in the other provinces.

Analyses performed on the regional sample for the Northern Netherlands (N = 458) and the sample consisting of people living in the other Dutch provinces (N = 1000) separately

After having asked about their initial attitudes towards CCS in general, we also asked people about their initial attitudes toward each of the three elements of the CCS chain (i.e., capture, transport, storage) with regard to planned CCS activities in the Northern Netherlands. As already noted in the introduction section, there has not yet been decided on the actual CCS storage location. Nevertheless, we were able to paint a general picture of planned CCS activities in the Northern Netherlands based on what is known (i.e., that CO_2 capture will likely take place at the Eemshaven, that it will be transported through pipelines to an onshore storage location, most likely a depleted natural gas field). This setup offers a chance to see how attitudes toward capture, transport, and storage compare to one another, and whether there are differences between the judgments of people living in the Northern Netherlands and people living in the other Dutch provinces. In addition, we aimed to examine whether potential differences between the two samples with regard to initial attitudes toward the specific elements of CCS could be explained by people's risk perceptions. All in all, this study on initial public perceptions of CCS in the Northern Netherlands is a first step of examining the local public's perceptions of CCS.

For each element of the CCS chain, respondents read a brief description of what it involves and how it is planned to take place in the Northern Netherlands. After each piece of information, people were asked to indicate their views on that particular element in the CCS chain. For example, with regard to CO_2 storage, people read

> "CO_2 can be stored in storage sites like depleted oil or natural gas fields, deep coal layers, and so-called 'saline aquifers', which are deep rock formations that are like sponges of rock filled with salt water. The major public concern would be for leakage from storage sites, although there would be a monitoring and verification system in place designed to detect any leaks. The stored CO_2 might leak away, but the quantities are likely to be extremely small. The Netherlands can avoid a substantive amount of its CO_2 emissions by injecting CO_2 in such storage sites.
> One leading suggestion for storing CO_2 in the Netherlands would be to store it in yet to be defined depleted natural gas fields in the provinces of Groningen, Friesland, or Drenthe. These storage sites are at a depth of more than 1000 meters below the surface.

Then, they were asked "All in all, what is your opinion on the plan to store CO_2 in a depleted natural gas field in Groningen, Friesland, or Drenthe?" (answers were given on a 7-point scale ranging from 1 = *very negative* to 7 = *very positive*). Moreover, to examine whether differences in initial public attitudes between people living in the Northern Netherlands and people living in the other Dutch provinces (if they occurred) were due to perceptions of the risks associated with the CCS activity, we asked respondents about the extent to which they thought the CCS plans would entail risks to themselves and their family's. Similar questions were posed for views on capture and views on transport after people had read the general description of capture and transport respectively.

5.1. Initial attitudes toward capture

We performed frequency analysis to examine the percentages of people who were negative, positive or indecisive about the plan to capture CO_2 in the Eemshaven. This was done for the Northern sample (covering the provinces of Friesland, Groningen, and Drenthe) and the non-Northern sample (covering the other Dutch provinces) separately. Moreover, we performed analyses of variance (ANOVA) to compare whether initial views on capture differed between the two samples.

Results for initial attitudes on capture showed that the majority of both samples were indecisive (i.e., people with a score of 3, 4 or 5 on this variable) about the favorability of CO_2 capture in this area (64.6% for the Northern Netherlands versus 72.0% for the other Dutch provinces). Just over 10% indicated to be rather negative about it (i.e., people with a score of 1 or 2 on this variable). Overall, people were slightly positive about the plans for CO_2 capture in the Northern Netherlands (M = 4.30, SD = 1.35), regardless of whether they lived in one of the three Northern provinces (M = 4.33, SD = 1.48) or in one of the other Dutch provinces (M = 4.30, SD = 1.29). The difference between the means of the two samples was not statistically significant, $F(1, 1456) = 0.16$, $p = .691$. For an overview of the results for initial public attitudes on capture see Table 5.1.

Table 5.1. Initial attitudes toward *capture*.

Capture	Northern NL (N = 458)	Non-Northern NL (N = 1000)
Negative	13.1%	10.2%
Neither negative nor positive	64.6%	72.0%
Positive	22.2%	17.8%
Overall mean	4.33	4.30

Note. Answers were given on 7-point scales ranging from 1 = *very negative* to 7 = *very positive*.

5.2. Initial attitudes toward transport

Similar analyses were performed to examine whether people were negative, positive or indecisive about the plan to transport CO_2 from the Eemshaven to the storage location somewhere in Friesland, Groningen, and Drenthe. Compared to initial public attitudes towards capture, public views on transport were a bit different. That is, a considerable number of people living in the Northern Netherlands were rather negative about CO_2 transport through this region (22.7%), while 14.8% was quite positive. By contrast, of the people living in the other Dutch provinces, a smaller percentage was negative about CO_2 transport through the Northern region (15.3%) and a comparable number of people were rather positive (14.3%). Again, the majority of both samples were indecisive.

Additional analysis of variance was conducted to compare whether views on CO_2 transport differed between the two samples, which appeared to be the case, $F(1, 1456) = 6.66$, $p < .01$. Overall, the Northern sample ($M = 3.82$, $SD = 1.59$) was somewhat more negative than the non-Northern sample ($M = 4.03$, $SD = 1.38$). For an overview of the results for public views on transport see Table 5.2.

Next, we examined whether this difference in initial public opinions concerning CO_2 transport between the two samples could be due to perceptions of the risk associated with CO_2 transport in the region. Therefore, we conducted mediation analysis following the stepwise procedure proposed by Baron and Kenny (1986). We found that the direct effect of geographic region (i.e., Northern Netherlands versus the other Dutch provinces) on initial attitudes toward CO_2 transport in the Northern region ($\beta = .07$, $p < .01$) dropped to nonsignificance after including the proposed mediator, perceived risk, in the analysis ($\beta = -.03$, $p = .319$). A Sobel test (Sobel, 1982) revealed that the indirect was significant ($z = -8.29$, $p < .001$), indicating mediation. These results suggest that people living in the Northern Netherlands were more negative about CO_2 transport than people living in the other Dutch provinces because the former perceived more risks for themselves and their family's compared to the latter.

Table 5.2. Initial attitudes toward *transport*

Transport	Northern NL (N = 458)	Non-Northern NL (N = 1000)
Negative	22.7%	15.3%
Neither negative nor positive	62.4%	70.4%
Positive	14.8%	14.3%
Overall mean	3.82	4.03

Note. Answers were given on 7-point scales ranging from 1 = *very negative* to 7 = *very positive*.

5.3. Initial attitudes toward storage

To analyze initial public attitudes toward the plans for CO_2 storage, the final element in the CCS chain, in the Northern Netherlands we used similar statistical techniques and obtained roughly similar results as for CO_2 storage. Again, a considerable number of people in the Northern region (24.5%) were rather negative about CO_2 storage in the area, while another 16.4% was positive. In the other provinces, the percentage of people that was negative about CO_2 storage in the Northern Netherlands was lower (13.4%) and a comparable percentage was quite positive (17.1%). As was the case for CO_2 capture and transport, the majority of both samples were neither negative nor positive about the plan.

Analysis of variance further showed that on average people living in the Northern Netherlands (M = 3.82, SD = 1.66) were indeed more negative about CO_2 storage plans than people living in the other provinces (M = 4.14, SD = 1.42), $F(1, 1456) = 14.25$, $p < .001$. For an overview of the results for public views on storage see Table 5.3.

Again, as for CO_2 transport, we examined whether the difference in initial public opinions on CO_2 storage between the two samples could be due to perceptions of the risk associated with CO_2 storage somewhere in the Northern region. We conducted mediation analysis and found that the direct effect of geographic region (i.e., Northern Netherlands versus the other Dutch provinces) on initial attitudes toward CO_2 storage in the Northern region ($\beta = .10$, $p < .001$) dropped to nonsignificance ($\beta = .00$, $p = .925$) after including perceived risk, the proposed mediator, in the analysis. A Sobel test confirmed that the indirect effect was significant ($z = -8.10$, $p < .001$), indicating mediation. These results suggest that people living in the Northern Netherlands were more negative about CO_2 storage than people living in the other Dutch provinces because the former perceived more risks for themselves and their family's compared to the latter.

Table 5.3. Initial attitudes toward *storage*

Storage	Northern NL (N = 458)	Non-Northern NL (N = 1000)
Negative	24.5%	13.4%
Neither negative nor positive	59.2%	69.5%
Positive	16.4%	17.1%
Overall mean	3.82	4.14

Note. Answers were given on 7-point scales ranging from 1 = *very negative* to 7 = *very positive*.

Summarizing the results for each of the elements in the CCS chain (see Figure 5.1), it seems that people are (on average) slightly positive about CO_2 capture but they are a bit more worried about CO_2 transport and storage. This is particularly true for people who live in the region through which CO_2 transport will take place or where it will be stored. However, it should be noted that because the exact storage location (and, as a result, the exact pipeline route) is yet to be defined, these results do not allow for conclusions about whether distance to CCS activity will play a role. Drawing such conclusions requires research at actual storage sites once these are known (research that will be carried out in WP5.1 at a later stage).

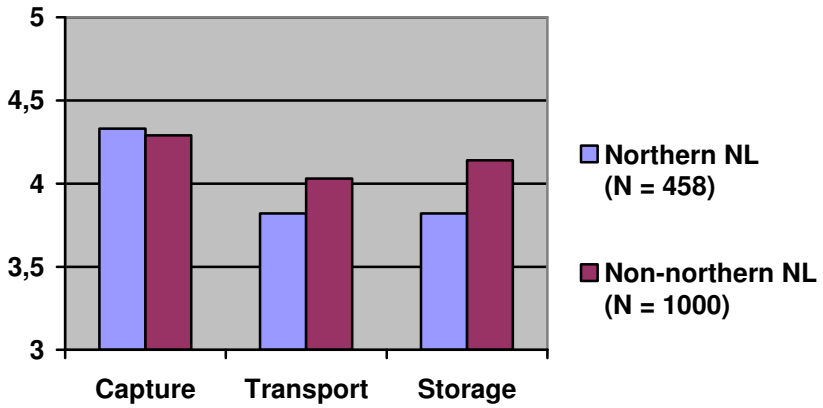

Figure 5.1. Summary of public views on capture, transport, and storage of CO_2. Answers were given on 7-point scales ranging from 1 = *very negative* to 7 = *very positive*.

Discussion

The main aim of the survey was to assess levels of public knowledge and awareness of sources of CO_2, the percentage of members of the general public indicating to know about CCS, and the degree to which people were able to correctly indicate the environmental problem CCS aims to address. Concerning sources of CO_2, the results show that the general public is quite accurately aware that for instance car use and coal-fired power plants contribute to CO_2 concentrations in the atmosphere. However, most people indicate to have never heard about CCS. These results resemble the findings from a study conducted by de Best-Waldhober and colleagues in 2004 (De Best-Waldhober et al., 2006), which found that 76.1% of the general public had never heard of CCS (in the current study, this was 50%) and 20.2% indicated to know just a bit about it (in the current study, this was 44.5%). The number of people that stated to know a lot about it

was low in both the 2004 questionnaire (3.7%) and the current survey (5.5%). As such, the current survey clearly indicates that, regardless of increased media coverage about CCS as a result of the Barendrecht situation, public knowledge and awareness of CCS remains low.

Moreover, this study shows that most people are not able to correctly indicate which environmental concern CCS means to address and which it does not. Most people assume that CCS provides a solution to a range of environmental issues, not just global warming. In fact, only 2.6% of the entire representative sample correctly indicated CCS aims to reduce global warming while at the same time correctly indicating that it does not address other environmental problems such as ozone depletion or acid rain. This finding again is in line with results reported by de Best-Waldhober and colleagues (2006), which for instance showed that among people who were not provided with relevant background information about CCS, less than 50% indicated that CO_2 does not contribute to the greenhouse effect if it is stored underground. Public knowledge about the aim of CCS could well be even lower in reality as compared to what the current results suggest. That is, we asked people which environmental concern CCS would address, thereby hinting at the fact that CCS in fact aims to address an environmental concern (and not another concern, e.g., unemployment). Perhaps people also are likely to indicate that CCS would address a list of other (non-environmental) concerns when presented with such concerns.

The implication of our findings is that there is a need to educate people on the purpose and necessity of CCS. It should be noted, however, that the current study only assessed public knowledge of two elements (i.e., sources of CO_2 and the environmental concern CCS aims to address) in the entire chain of "the energy production by means of fossil fuels" to "CCS implementation". It did not cover other relevant aspects. Hence, a much more elaborate knowledge test is necessary, testing public knowledge about all elements in the CCS chain, starting with questions about how energy is produced, followed by knowledge questions about the emission of CO_2, about the properties of CO_2, the link between CO_2 and global warming, consequences of global warming, and then finally about CO_2 reduction by means of CCS. Such an elaborate knowledge test could identify those aspects of the chain for which public knowledge is lacking and that may cause people to completely miss the point of CCS or hold false beliefs based on which they eventually may decide to accept or oppose CCS implementation. Once knowledge gaps are identified, there may well be solid grounds to start educating people on the issues identified before informing them about the purpose and necessity of CCS. Therefore, identifying knowledge gaps and widely shared misconceptions is important and this will be systematically done in WP5.3.

For now, at least the results concerning knowledge and awareness imply that future communications should not assume existing knowledge about CCS among members of the general public. This also holds true for the development of the 'knowledge base' as proposed in WP5.1, which could serve as a source of information for people who are interested to learn more about planned CCS activities. That is, to date,

members of the general public are unfamiliar with CCS and have only little clue which environmental issue it aims to address (i.e., they at best assume CCS provides a solution to a range of environmental issues). Because the knowledge base is intended to contain valid, balanced, relevant, and comprehensible information, it should be made clear that CCS aims to contribute to the reduction of global warming, but will have no effects on, for instance, ozone depletion.

Given the fact that public understanding is rather limited, the question is whether and how communications about CCS should take place. Among the main things to keep in mind is that communications can only be successful if information stems from sources that are trusted by the general public. The main concern would be that parties who are not trusted by the general public provide information to the public, because CATO-1 research has shown that people may well doubt the quality of the information provided, even if this information would be accurate (Ter Mors, 2008). In fact, when people distrust a certain organization they may even run counter to the position advocated by this organization (Ter Mors, 2008; Terwel et al., 2009a).

However, a coalition of parties with different interests to provide CCS information is seen as credible and likely to supply high-quality information (Ter Mors, 2008). This is why in WP5.1 we propose to install a local 'Stakeholders and Scientists Committee (SSC)' consisting of different parties including companies, scientists and other experts in the field (from TNO, Ecofys, UU, and UL), environmental NGOs, regional government, and local opinion leaders who are not active in the political arena. For a more elaborate description of this procedure, see page 9 of this document.

If awareness and knowledge about CCS is low (and this study provides an indication that it is), it is proposed that collaboration between these CCS stakeholders to develop a knowledge base containing CCS information and an information-on-demand campaign would be the best communication strategy. People who want to learn about the specifics of the CCS plan are invited to consult the knowledge base. It is expected though that many people are not particularly motivated to reach an informed opinion and will simply rely on the fact that multiple parties with different interests are involved in the introduction procedure (and accordingly perceive it to be credible) and leave it with that.

The current results with respect to public trust in specific stakeholders support our reasoning that it is crucial to involve environmental NGOs in the introduction procedure. One of the most trusted NGOs is the WWF, so involvement of this specific party may be important for the overall credibility of the introduction procedure. Moreover, the fact that research institutions are involved should also enhance the perceived credibility of this procedure because these parties (e.g., TNO, universities) are highly trusted as well. This is important, because in the introduction procedure research institutions are the parties that need to provide scientifically sound answers to questions raised by the other parties involved (e.g., local opinion leaders who are not active in the political arena, environmental NGOs, regional government bodies). In short, the decision procedure

proposed in WP5.1 will instigate trust due to collaborating parties and is expected to be the basis for a site-specific information-on-demand campaign.

It should be noted, however, that while this study provides initial evidence about which organizations are trusted and which are not (note that virtually none of the parties was extremely distrusted), it does not show why differential trust occurs. CATO-1 research has shown that differences in trust between NGOs and industry do not so much have to do with different levels of perceived organizational competence (e.g., expertise on the issue), but rather with perceived organizational motives (Terwel, Harinck, Ellemers, & Daamen, 2009b). Moreover, the trust questions in this survey assessed trust in CCS stakeholders, but people were asked about their trust in each of the organizations with regard to issues relating to energy, not specifically with regard to a particular CCS demonstration project. Although this trust measure provides a relevant first indication and replicates previous work on trust (Terwel et al., 2009b), future research is needed to examine (1) the local public's trust in (local) CCS organizations with regard to CCS (rather than "energy issues" as in the present study) once the actual storage location is known and (2) the origins of public trust (e.g., perceived expertise, salient value similarity).

The current results do suggest that organizations that are not so well-known are generally found less trustworthy than well-known organizations, even if the organizations are from the same type. For example, only few people indicated to know Ecofys and trust in this organization was on average only just above the midpoint (i.e., 4) of the 7-point scale, while almost everybody indicated to know TNO and trust in this organization was close to 6 on the 7-point scale. Along this line, the NAM is well-known in the Northern Netherlands and reasonably known in the other Dutch provinces and the results indeed show that on average people place more trust in the NAM if they live in the Northern Netherlands.In fact, companies involved in capture (e.g., Essent/RWE.Nuon), transprt (e.g., Gasunie), and storage (e.g., NAM) in the Northern Netherlands were rather well-known and trusted by people living in the Northern region. While the same principle applies to NGOs—WWF is better known and also trusted more than provincial environmental federations—this does not necessarily imply that WWF is a more prominent candidate to be included in the Stakeholders and Scientists Committee, however. That is, if people start to realize that provincial environmental federations are representing a large range of local environmental groups, perhaps they consider it very important that the provincial environmental federation is included. Also, trust in provincial environmental federations itself could prove to be higher than in the present survey when assessed in the context of an actual local CO_2 storage site.

The survey further shows that if people are very briefly explained what CCS involves, most of them are neither extremely negative nor extremely positive about it. On average, people indicated to prefer CCS over nuclear, but sustainable energy sources and energy efficiency were seen as more favorable. Concerning public views on planned CCS activities in the Northern Netherlands, people who live in that region are more negative

about CO_2 transport and storage (not about capture) than people who live in any of the other Dutch provinces. Yet, it is important to emphasize that these were initial attitudes, reported by people who were confronted with planned CCS activities for the first time in their lives, while information about these activities was presented in rather general terms. These opinions are highly unstable and not so much relevant to predict future levels of acceptance of CCS at a specific location. However, this study is a first step to examine public perceptions and knowledge in the local community. Carefully designed questionnaires will be administered once the location of CCS in the Northern Netherlands is known in order to study these issues in more detail and in the context of other local issues.

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