HAL
open science

# A survey on the public perception of CCS in France

Minh Ha-Duong, Ana Sofia Campos, Alain Nadaï

## To cite this version:

Minh Ha-Duong, Ana Sofia Campos, Alain Nadaï. A survey on the public perception of CCS in France. 2007. hal-00866557

**HAL Id: hal-00866557**

**https://hal.science/hal-00866557v1**

Preprint submitted on 30 Sep 2013

**HAL** is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

DOCUMENTS DE TRAVAIL / WORKING PAPERS

No 08-2008

# A survey on the public perception of CCS in France

Minh Ha-Duong
Ana Sofia Campos
Alain Nadai

DÉCEMBRE 2007

**C.I.R.E.D.**
**Centre International de Recherches sur l'Environnement et le Développement**
UMR 8568 CNRS / EHESS / ENPC / ENGREF
/ CIRAD / Météo France
**45 bis, avenue de la Belle Gabrielle**
**F-94736 Nogent sur Marne CEDEX**
Tel : (33) 1 43 94 73 73 / Fax : (33) 1 43 94 73 70
www.centre-cired.fr

***Résumé***

Une enquête d'opinion et de sensibilisation sur la capture et le stockage de carbone a été menée sur un échantillon représentatif de français âgés de 15 ans et plus. Environ 6% des répondants ont été capables de donner une définition satisfaisante de cette technologie. La question clé relative à 'l'approbation ou l'opposition à' l'utilisation de la CCS en France a été posée deux fois, d'abord à la suite d'une présentation de la technologie, puis après l'exposé de potentielles conséquences défavorables. Les taux d'approbation, 59% et 38%, montrent qu'il n'existe pas de rejet *a priori* de cette technologie, mais la confiance du public nécessite d'être construite. L'échantillon a été dédoublé pour tester un effet sémantique : en interrogeant la première moitié sur le `Stockage' ('Storage' en anglais), et la seconde sur la `Sequestration'. La manipulation du vocabulaire n'a pas d'effet statistiquement significatif sur le niveau d'approbation. Le 'stockage' fait davantage sens mais ne communique pas l'idée d'un contrôle permanent.

*Mots-clés* : Capture et tockage du Carbone, opinion publique.

*Keywords* : Carbon capture and storage, public opinion.

# A survey on the public perception of CCS in France*

Minh Ha-Duong† Alain Nadaï‡ Ana Sofía Campos§

December 21, 2007

**Abstract**

An awareness and opinion survey on Carbon Capture and Storage was conducted on a representative sample of French aged 15 years and above. About 6% of respondents were able to provide a satisfying definition of the technology. The key question about 'approval of or opposition to' the use of CCS in France was asked twice, first after presenting the technology, then after exposing the potential adverse consequences. Approval rates, 59% and 38%, show that there is no a priori rejection of the technology, but public trust needs to be build. The sample was split in two to test for a semantic effect: questioning one half about 'Stockage' (English: storage), the other about 'Sequestration'. Manipulating the vocabulary had no statistically significant effect on approval rates. Stockage is more meaningful, but does not convey the idea of permanent monitoring.

## 1 Introduction

A survey on awareness and 'approval of or opposition to' the use of Carbon Capture and Storage in France was conducted to explore the variability of opinion to two key factors: information and semantics. To this end, the survey was designed as a split-sample, before/after experiment.

In order to examine the effect of information, we asked about approval of / opposition to CCS twice: first after offering a short presentation on the technology focusing on global warming mitigation; second after explaining its potential adverse consequences. A lower approval could be expected the second time, which was the case but only shows that public opinion is not anchored. The main result is that there is no a priori rejection of the technology, but public trust needs to be build.

*Work funded by ADEME as part of the METSTOR project during its pilot phase, then by ANR as part of the SOCECO2 project. Industrial participants in the SOCECO2 and METSTOR research projects have an economic interest in the perception of CCS. Neither the funding agencies nor the industrial participants had a role in the design and conduct of this study. With the usual disclaimer that any mistakes' responsibility remain with the authors, we gratefully thank Gilles Mardon, Gabriela Pfeifle (INERIS), Nathalie Etchart-Vincent, Alain Nadai and the partners of the SOCECO2 research project for their useful contributions. At the TNS Sofres institute, Guénaëlle Gault led the study.

†Chargé de recherche, CIRED, CNRS. Mail to haduong@centre-cired.fr.

‡Researcher, CIRED.

§Doctoral student, INERIS and CIRED.

The semantic effect was analyzed by splitting the sample in two: one half was talked about 'Storage' (literally in French: stockage), the other half about 'Sequestration' (also: sequestration). We found no statistically significant difference in approval rates between the two terms, but respondents found the former term clearer.

In addition to these two core issues, respondents were asked about their awareness of various $CO_2$ mitigation technologies. Questions were designed so as to be comparable with the existing literature on the subject, within the limits of such an inter-cultural exercise. While the sample was aware of several $CO_2$ mitigation technologies, less than a third of the respondents had heard about $CO_2$ sequestration /storage, making this technology one of the less well known.

The outline is as follows. Section 2 presents the method. Section 3 presents results on awareness. Section 4 and 5 present results on approval, before and after the additional information focused on CCS risks. Section 6 examines the effect of semantics. Section 7 discusses the policy implications. Annex 1 describes the sample demographics, annex 2 shows the results of the survey.

# 2 Method

TNS-Sofres, a large reputable survey institute in France, conducted the survey. Respondents were interviewed face to face at home by the TNS-Sofres network of surveyors using a computer-assisted system. The study was done on April 11–12th, 2007, between the two rounds of the French presidential election. Environment was an important issue in the campaign, but CCS was almost not mentioned. For example, it is absent from Nicolas Hulot's Ecological Pact, which played a central role in the public debates at that time.

The questionnaire was developed iteratively starting with a pilot survey described by Ha-Duong and Mardon [2007], itself inspired in part by the work of Palmgren et al. [2004]. After rewriting to consider recent research findings, budget constraints and technical specifications, the questionnaire was further refined with two rounds of pre-testing with workers in the authors' campus. The survey institute helped to simplify and shorten further the final version.

For each individual, three groups of data were collected. Twelve questions specifically related to CCS were asked, as shown Annex 2. They were followed by eleven questions addressing the social and demographic characteristics of the respondent. Six additional variables describing the respondent's neighborhood were looked up in a national database.

As Daamen [2006] discusses it, one cannot expect respondents to know about the subject matter in this kind of survey. A key methodological issue is then to inform as well as question. Answers should not be interpreted as signs of an already existing opinion but as quick responses to a stimulus, a new idea for most respondents. Designing interviews as a two-staged process (before/after information) and structuring the survey as a split-sample (storage /sequestration) allowed us to focus on relative response and analyze the effects of information and semantics.

The sample of 1076 individuals aged 15 and above was selected by the Institute. Representativity of the metropolitan French population (in both subsamples) was achieved by using the quota method on sex, age, head of household

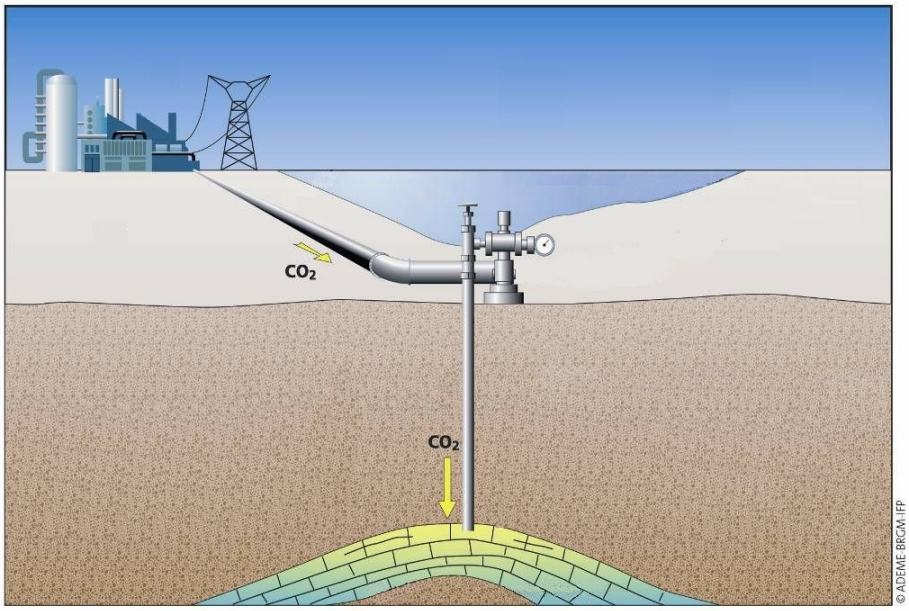


Figure 1: Diagram used to help explain CCS in the SOCECO2 survey. Simplified from BRGM/IFP/ADEME original, with permission.

profession/social category and through stratification on the region and the type of urban area. The sample is described in Annex 1.

The surveyors explained CCS using both a simple textual description of the technology and a graphical description. The text, see Box 2, was shown and read aloud by the surveyor. The diagram, see Figure 1, originally provided by BRGM (France) was simplified by erasing confusing elements such as text legends, chimney fumes, boat transportation and alternative storage types.

Most questions were multiple-choices, with a 'no opinion' option available. Questions numbers 4 and 12 were open-ended. Question 4 asked for a CCS definition. Answers, when given, were encoded as 'Correct' (the respondent redefined 'geological storage' using his or her own words), 'Vague' (essentially not wrong, even if remotely related), or 'Wrong'. Question 12 asked about 'Which questions would you like to ask experts'. A list of topics of interest was determined from the answers, which were then encoded according to that list.

The summary results for the first 12 questions are displayed in Annex 2. They are also available electronically from the TNS-SOFRES website. The complete dataset is available on CIRED website [Ha-Duong and Campos, 2007] and as an electronic supplement to this manuscript.

Statistical results exposed in sections 3, 4 and 5 below are taken from the summary tables and cross analysis tables provided by the survey institute. In addition to discussing the aggregate results, we comment on subgroups which deviate from the mean answer at a 95% confidence level. We used the following elementary tests, with the R statistical computing environment [R Development Core Team, 2007] for deriving results on the effect of semantics. Answers to questions 3, 4, 6, 11 are given on an ordered but not numerical scale. The

*Here is a text presenting the principle of $CO_2$ geological [sequestration — storage]. We will read it together before going on with the questionaire.*
$CO_2$, also called carbonic gas, is found naturally in the earth's atmosphere. Plants require it to growth and to produce the oxygen in the air we breathe. However, when there is too much $CO_2$, temperatures rise on the surface of the earth. Today there is 30% more $CO_2$ in the atmosphere than 100 years ago, this is mostly due to energy production (burning coal, oil and natural gas).
This increase in $CO_2$ is the main cause of climate change which might have important consequences for the environment and human health. To fight against climate change, we must therefore reduce $CO_2$ emissions. To do so, some political and technical measures should be considered. Among them, one solution has already been experimented in North America, Norway and Algeria. It consists in capturing the $CO_2$ and injecting it deep into the underground instead of letting it go away in the atmosphere. This method is called geological $CO_2$ [sequestration — storage]. The principle already exists in nature since there are a lot of natural underground reservoirs, which have kept $CO_2$ there for thousands of years.

**Box 1:** Translation of the text used to explain CCS in the SOCECO2 survey. [sequestration — storage] is a placeholder for either 'stockage' or 'séquestration'.

*Here is a second text about the consequences of geological [sequestration — storage]. We will read it together.*
The goal of geological [sequestration — storage] is to postpone and limit the effects of climate change. Notwithstanding the difficulties involved in finding appropriate underground locations, scientists question themselves about:

- Leakages by which $CO_2$ might go back into the atmosphere and cause environmental damages.
- Sudden leakages that might impact on human and animal health.
- Increasing the pressure underground could cause gentle ground motion that might damage buildings.
- The possibility that $CO_2$, a weak acid, contaminates underground rocks and pollutes water.

These effects are not well known yet, this is the reason why:

- Long term permanent monitoring of [sequestration — storage] sites is planned.
- If problems developped, there are solutions to take back most of the $CO_2$ injected underground.

**Box 2:** Translation of the text used to expose respondents to CCS risks in the SOCECO2 survey.

Wilcoxon rank sum test with continuity correction was used to compare the answers between the two subsamples: 'stockage' and 'sequestration'. Answers to questions 7 and 8 are categorical (yes/no), so we tested if the difference between the two subsamples were significant using the Chi-squared test of the contingency table.

# 3 Awareness of climate mitigation technologies

(Questions 1, 2, 3, 4, 12 and 13)

Let us first examine basic results and how they are affected by the socio-demographic characteristics of the respondents.

The first two questions focused on the interest of the respondent on climate change. On question 1, most respondents (79%) recognized the seriousness of climate change and said that actions should be undertaken.

Subsamples significantly more likely to support action against climate change include: respondents 18–34 years old, civil servants, higher-education graduates and those living in the Paris area. The older, retired respondents, those with lower education and those living in villages with less than 2000 inhabitants were less supportive.

These results are confirmed by the answers to question 12, which was the open ended question enquiring about what respondents would like to ask if faced with climate change experts. A substantial minority (9%) of answers demonstrate skepticism about the reality of the climate change issues. Yet, most answers related to issues of mitigation (22%), impacts (21%), technologies (11%) and actors (6%). This confirms that, broadly, the French public is aware of and interested in the climate change issue.

Question 2 was about the balance between the Environment and the Economy. Again, a large majority of the sample (78%) tilted towards the former. Replies correlate strongly with the previous answer and the population was more or less divided along the same lines. The subsamples of educated, intellectuals, left-wing, richer, organic-consuming and Parisians respondents inclined relatively more towards the environment. Subsamples comprising older, retired, less educated respondents, or those living in rural areas, or in the Center of France, gave relatively more attention to the economy.

Question 3 examined awareness of various energy technologies, mostly following the list used by Reiner et al. [2006]. As Table 1 shows it, nearly everybody declared having already heard about solar energy, nuclear power, wind power, biofuels and energy efficient appliances. Hybrid engine vehicles and hydrogen vehicles are also well known, albeit to a lesser extent. Less than half of the sample declared being aware of carbon sequestration by forests and of energy from biomass. Geological $CO_2$ storage or sequestration is clearly a technology most people have never heard about.

Compared to international results (see Table 1) our findings reveal a rather high level of awareness on climate change mitigation options among the French public (or a higher self-confidence bias in France). Note however that the wording is critical: the 60% of respondents not having heard of 'biomass energy' probably do know what a fireplace is for.

| Technology | % of respondents having ever heard about it | |
|---|---|---|
| | This survey | Other countries |
| Solar energy | 99 | ∼73 |
| Nuclear energy | 97 | ∼38–85 |
| Wind energy | 97 | 34–87 |
| Biofuels | 93 | N/A |
| Energy saving appliances | 90 | 40–68 |
| Hybrid engine vehicles | 80 | ∼85 |
| Hydrogen vehicles | 71 | 26–48 |
| Forest carbon sequestration | 48 | 2–38 |
| Biomass energy | 40 | 10–54 |
| $CO_2$ storage | 34 | 4–22 |
| $CO_2$ sequestration | 27 | 4–22 |
| Iron ocean fertilization | 16 | ∼3 |

Table 1: Awareness of energy technologies relevant for climate change mitigation (SOCECO2 survey question 3). Data for other countries from Reiner et al. [2006], Reiner [2007].

Respondents were asked again to compare technologies at the end of the survey. Question 13 proposed them to select, among the same list as in question 3, the three most efficient technological choices to fight climate warming. We used the scientifically simplistic expression 'climate warming' because we assumed it was clearer than both 'climate change' and 'global warming'. Despite asking the question at the end of the questionnaire, CCS remained next to the least efficient technology. It was selected in their top 3 by only 5% of the respondents. Oceans fertilization by iron remained last with 3%.

Results demonstrate that the most heard-about technologies are not necessarily seen as the most efficient: 'planting trees and preserving forests to absorb $CO_2$ in the atmosphere' ranked first on question 13 (57% of respondents selected it) but 'carbon sequestration in forests' ranked eighth on the awareness question 3. Conversely, nuclear energy ranked second on question 3, but seventh on question 13.

Question 4 asked respondents to describe the geologic storage/sequestration of $CO_2$, using their own words. At that stage, the technology had not been presented by the interviewer. The majority of respondents (72%) declined to answer, which is consistent with the result of question 3 since they have never heard about it. Other answers were categorized as exact/vague or wrong. Any reply conveying the idea that $CO_2$ was being put underground was classified as exact: 6% of respondents offered a correct definition, while 8% demonstrated a vague idea. The 14% erroneous replies mostly confused $CO_2$ sequestration / storage with carbon sequestration in forests.

The subsamples of civil servants, better educated, politically involved, richer respondents or those with an intellectual or executive occupation provided significantly better definitions. With respect to gender, more males offered an answer (only 63% of no replies), but more provided a wrong definition (19% versus 14% in the full sample). Females were less numerous to give an answer (81%), less numerous to get it wrong (10%), and also less numerous to get it right (3%).

These results are not directly comparable with the previous surveys in other countries, which tried to assess knowledge about CCS by asking 'Which environmental issues CCS helps to solve'. However, we believed that such a formulation was very problematic as it compounded respondents' ignorance about CCS with their ignorance about other environmental issues. For example, Conseil [2005] reports that 15 to 25% of French citizens explain global warming by something like the sun-rays falling through the hole in the ozone layer.

# 4 The debate on CCS

(Questions 9 and 10)

Basic information on the principles and the role of CCS in reducing $CO_2$ emissions were provided as shown in Box 1 and Illustration 1. We then asked question 9 about support of / opposition to the use of CCS in France, using a 4-point scale in order to purposely force an informative answer.

A majority of respondents (59%) were positive, 48% being rather supportive and 11% strongly supportive. The rate of approval was significantly higher among respondents aged 15–17 (73%), respondents living in the North of France (69%), those identifying politically at the right (66%) and those working in the trade sector (71%). Rate of approval was significantly lower in the subsample of respondents with elementary education only (51%) and those living alone (48%).

Less than a quarter (21%) were opposed to the use of CCS in France: 14% rather opposed, 7% strongly opposed. Opposition was significantly higher than average among respondents with middle-scale professions (32%), and lower than average among those identifying politically at the right (15%).

The non-response rate was 20%. It was significantly higher among the respondents aged 62 and older (32%), with elementary education only (30%), living alone (28%), retired (27%), in Paris area (27%) or in communities with lots of social housing (25%). It was significantly lower for respondents in the trade sector (7%), those living in the North of France (10%), in a family of four (12%), high-school-only graduates (12%).

After two questions on semantics, discussed below in section 6, we presented information on the potential consequences of CCS, see Box 2. The word 'Risk' was purposefully avoided as we believed it would strongly bias the results. Given the scientific uncertainties and the need for simplicity, we did not present any quantification of the effects or of their likelyhood. Remediation measures were presented.

Question 9 tested how respondents reacted to this shortlist of potentially negative consequences of CCS. The no-reply rate was rather low (10%). Most respondents (63%) considered that more research was needed.

A small minority (9%) already considered that uncertainties could be controlled enough so as to ensure a good security. This point of view was significantly more frequent among organic product consumers (20%), inhabitants of the North of France (16%), executives (16%) and higher-educated people (13%). It was significantly less frequent among respondents aged 18–24

A larger minority (18%) answered that the uncertainties are too large and that this technology should not be used. Nearly a third (29%) of those who

believed that concerns about climate change are not justified pointed out that CCS should not be used. In short, skepticism on the climate change issue tends to imply opposition to CCS. This intuitive result was already apparent in the pilot survey and in the previous literature, see for example Itaoka et al. (2004). However, there are subsamples in which this a priori rejection of the technology is less frequent. They include executives (7%), parliamentary right sympathizers (13%), families of 5 or more (11%), incomes above 3.000 euros (10%) and Parisians (10%).

Question 10 was a choice between two propositions. Proposition one framed CCS positively, stating that it allows us to benefit from the existing coal and oil reserves. Proposition two depicted CCS as a moral hazard, stating that it potentially discourages the development of renewables energy technologies. The response rate was lower than at question 9, with 21% of no-opinion. This is not surprising since the question was more complicated. But as a way to focus the respondent's attention on the main CCS pros and cons, we felt that asking this question was probably more efficient than an academic standalone explanation.

Only an 18% minority balances towards the idea that CCS is a good transition technology. This rate was significantly higher among teen-agers (32%), respondents living in the North of France (30%), consumers of organic goods (29%), and those living in an area with low unemployment. It was lower (9%) among young adults aged 18–24.

Most respondents (61%) rather inclined towards the idea that 'CCS could be an excuse to avoid changing the way we produce energy'. Dispersion between subsamples is larger than for other questions. The use of CCS tended to be seen as an ecological alibi particularly by members of consumer groups (84%), ecologists (77%), adults 18 to 49 years old (77% of the 18–24 age class, 69% of the 25–34 and 70% of the 35–49), respondents with high levels of income (75%) and highly graduated (72%), executives middle-managers and employees (72%). The older, retired or elementary education only subsamples were significantly less likely to support this point of view and much more likely to have no opinion.

This confirms the salience of the moral hazard. In a survey context, Itaoka et al. [2004] has shown that it is a significant factor influencing public opinion on CCS. This aspect is also important in NGOs' discourse, for example Moussally [2007], speaking for the Climate Action Network France, argued that financial public support should be used to promote energy efficiency rather than CCS.

# 5 Ex ante / ex post approval or opposition to CCS

(Questions 6 and 11)

At this stage, question 11 repeated the text of question 6 on approval of or opposition to the use of CCS in France. Compared to the initial reactions when the principle of the CCS was presented, lower approval rates could be expected and have been found.

On the whole, the approval rate was 38%, down from 59% in question 6. As previously, it was significantly higher (50%) among respondents aged 15–17 and those identifying politically at the right (47%). It was also significantly higher among executives and intellectuals (48%), and non working persons in the

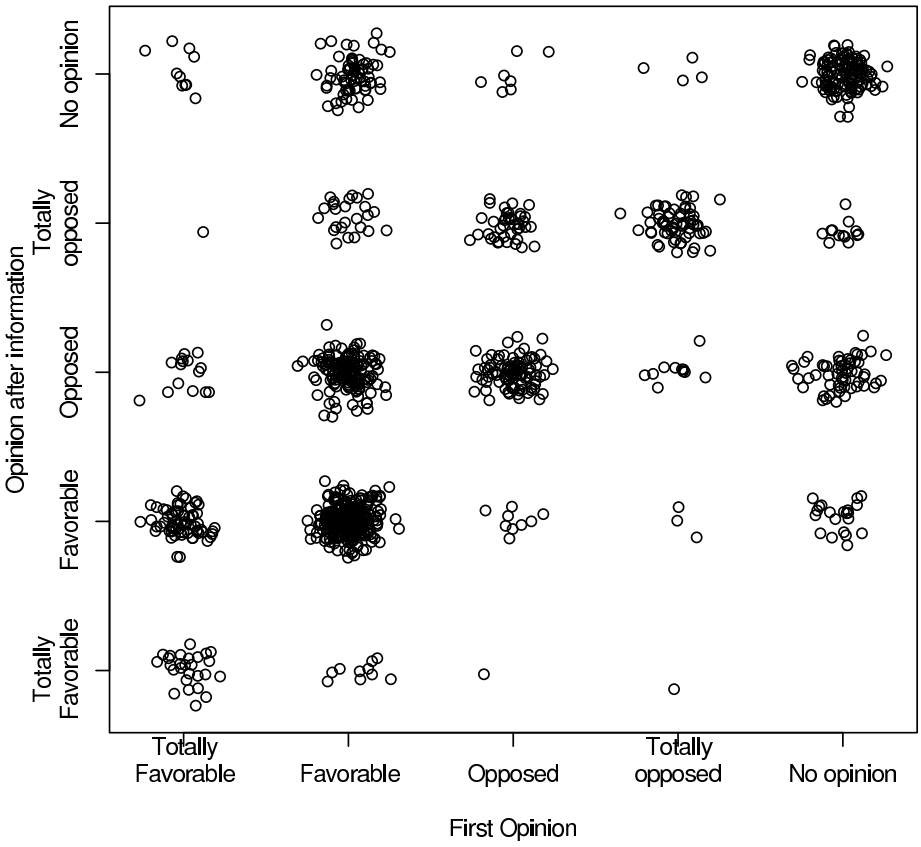


Figure 2: Initial and revised degree of approval on CCS.

highest income bracket considered (50%). The rate of approval was significantly lower in the 35–49 years age range (31%), for ecologists (26%) and respondent without a political preference (31%).

The opposition rate was at 42%, compared to 21% in question 6. Opposition was stronger among ecologists (60%), lower income respondents (55%), workers (54%) employees (52%), respondents aged between 35 and 49 years old (53%). Opposition rates were lower in Paris (33%) and in urban areas with low unemployment (33%), as well as for respondents identifying politically at the right (34%) and non-working persons in the highest income bracket (24%).

The rate of no-reply was comparable for questions 6 and 11, about 20%. Respondents retired, aged over 65 or living in two-persons households were relatively more likely to give no answer (30, 34 and 26%, respectively), and less likely to oppose CCS (32, 33 and 34%).

Illustration 2 displays the 1076 individual responses (contingency table) to questions 6 and 11. Most points lie on the diagonal. They represent people who did not change opinion (or absence of). Points above the diagonal represent people who have decreased approval (or moved to 'no opinion' if they lie on the first row). A large fraction (29%) of the sample initially favorable to the use of CCS in France switched views and showed opposition ex post. There has been much less change in the other direction, towards a more favorable view.

The large variation between the answers to questions 6 and 11 shows that opinions are not firmly anchored. Approval rates decline when the respondent's attention is focused on the uncertain local consequences rather than on the global climate benefits.

# 6 Semantics: Storage vs. Sequestration

Annex 2 result tables break down answers according to the use of 'stockage' (storage) or 'sequestration'. Question 7 and 8 made it clear to the respondents that we were interested in the semantics, even if the questionnaire did not ask for a straight comparison between the two words.

First, does the degree of approval change with the word used to describe the technology? The pilot survey found that the word 'sequestration' tended to arouse higher rates of approval. In this survey when basic information was provided the approval rate for 'sequestration' was 60%, against 58% only for 'storage' (question 6). The difference was even larger at the end of the questionnaire: 40% versus 35% for the 'storage' half of the sample (question 11). The balance tilted in the same direction.

But the difference between the two halves of the sample was not statistically significant. On question 6 (ex ante opinion), approval rates differed by only 2%. The hypothesis that 'the semantics has no effect' easily passes the two-sided Wilcoxon rank sum test ($p = 0.2004$[1]). On question 11 (ex post opinion), we tested the one-sided hypothesis that approval rates in the half-sample with 'sequestration' was larger than in the half-sample with 'storage'. Here again, $p = 0.1376$ is large so that the hypothesis does not hold. We conclude that statistically, the semantics does not influence significantly the respondent's degree of approval.

Considering the effect of the semantics elsewhere in the questionnaire, storage appears clearer than sequestration. Answers to question 3 (awareness) shows that people were more aware of storage than sequestration. The difference is statistically significant (Wilcoxon rank sum test with continuity correction, one sided, $p = 0.0386$.) Moreover, question 4 (open ended, CCS definition) shows that people were able to provide a better description of the technology when it was called carbon storage than carbon sequestration (Wilcoxon rank sum test with continuity correction, one sided, $p = 0.0796$.) Since that question had a lot of no replies, 72%, we conducted the same test in the subsample that provided a definition. The difference here is even more statistically significant ($p = 0.0006$). This is congruent with the result from question 7, where more people faced with 'stockage' considered that the name of the technology helped to understand what CCS is about (62% versus 48% in the 'sequestration' subsample). The difference is significant (Chi-squared test for independence between the semantic and the reply to question 7, $p < 10^{-5}$).

[1] Reminder on statistical testing: $p = 0.2004$ means that assuming that the two subsamples come from the same distribution, there is a 20 percent probability that the difference will be as large as observed or larger, just by chance. Thus, it cannot be ruled out with confidence that the distributions differ. This is for one way to measure the difference between distributions. Although it is possible to conduct many other statistical tests using other ways to measure difference, there is no reason to report them because if they are testing the same thing on the same data, the results will be qualitatively the same.

| **6. About CCS (initially):** | Favor | Oppose | No opinion | |
|---|---|---|---|---|
| Men | 66% | 22% | 16% | |
| Women | 56% | 21% | 23% | |
| **11. About CCS (finally):** | Favor | Oppose | No opinion | |
| Men | 41% | 42% | 17% | |
| Women | 34% | 43% | 23% | |
| **9. Uncertainties are:** | Manageable | Worrying | Excessive | No opinion |
| Men | 12% | 62% | 17% | 9% |
| Women | 7% | 63% | 18% | 12% |

Table 2: Gender effects in SOCECO2 survey. We asked opinion about CCS on question 6 after a short presentation of the technology and once again in question 11 after a short presentation of the uncertainties. Question 9 asks about the perception of these uncertainties. Column 'Favor' shows the sum of 'Completely favorable' and 'Rather favorable'. Column 'Oppose' shows the sum of 'Completely opposed' and 'Rather opposed'.

On Question 8, more people faced with 'stockage' considered that the name of the technology gave a good image of it (44% versus 33% in the 'sequestration' subsample). Here again the difference is significant (Chi-squared $p = 0.000197$). This contradicts the survey result, that sequestration arose higher rates of approval (questions 6 and 11, although this result is not statistically significant). Either the public is not a reliable assessor of its own opinion, or although we intended 'a good image' to mean *favorable*, most respondents interpreted it as *clear*.

# 7 Discussion

In this section, we compare the SOCECO2 survey findings with previously published results. We successively discuss socio-demographic predictors and the effect of information.

Miller et al. [2007] found that the Australian public lacked knowledge about CCS but was willing to engage and learn about this technology. Compared to men, women were less accepting of CCS and more concerned about safety, risk and effectiveness. Those with a higher education were more aware of the greenhouse gas debate and supportive of CCS, whilst younger Australians were more trusting that information providers 'told the truth' about CCS.

In the SOCECO2 survey, gender and the opinion on CCS are significantly not independent (Chi-squared test, $p = 0.011$ for question 6, $p = 0.037$ for question 11.) Results shown table 2 show that women tend to be less accepting than men, as in the Australian survey. This does not mean that women are more opposed but that they more frequently abstain from giving an opinion. As with the Australian survey, women tend to be more concerned about uncertainties.

Education level and age are also very much correlated. We found that aged or retired respondents as well as respondents holding no or an elementary degree tended more often to abstain from giving an opinion. Accordingly, they are less often supportive of the technology, but also less often opposed to it.

With respect to other factors, occupation and income are influential. Respondents holding executive positions or intellectual jobs were more frequently

supportive of the technology than those in other job categories. This is also true for respondents in the highest income bracket. This holds for both ex-ante and ex-post opinions (questions 6 and 11), even the deviation is not always significant at a 95% confidence level. Finally, we consistently found that respondents in the North of France tended to deviate significantly from the average (better awareness, more favorable to CCS, more inclined to perceive it as a good transition). One interesting assumption that could be made, but was not explored in this survey, would be to relate this deviation to the (past) importance of mining activity in this region.

Considering that the difference between questions 6 and 11 arises only because respondents have been informed about the technology might suggest that acceptability decreases when information increases. Yet, this would implicitly reduce information to a quantitative asset, neglecting that its content (quality) as well as the type of situation in which it is provided are decisive. In other words, our results do not mean that withholding information might increase the acceptability of CCS projects. On the contrary, many reasons suggest that transparency is necessary in project development. We will only explore a few of them in what follows before discussing our result as regards to the impact of information.

Our survey has approached CCS as a generic technology. As in the case of other technologies, such as wind power for instance, the acceptance of local projects might be very different than that of the generic technology [Bell et al., 2005]. At the local level, NIMBY concerns, environmental justice, planning procedures and specific features of the local project can drive opposition to or approval of it. In the case studied by de Figueiredo et al. [2002], the storage experiment was planned off shore, into the deep ocean, but sovereignty of native populations became an issue. That case clearly showed that being late to reach out to the public can be fatal to a planned storage experiment.

Information is not the only factor influencing people's opinion. Huijts et al. [2007] has shown that trust in professional actors is particularly important. NGO's were found to be trusted most and industry least by the general public. Trust was found to depend on perceived competence and intentions. However, perceived intentions were more important than perceived competence when it came to trusting industrial actors.

As Bourdieu [1973] explained, questionnaire-based surveys create very artificial communication situations. In reality, people form opinions by dialogue. Actual opinions are diverse, volatile, history and situation-dependent. 'Public opinion' is a statistical social construct, as is the half male, half female 'average individual'. A known bias is that when answering a questionnaire, people tend to pay more attention to what they have heard last. Accordingly, answers to question 11 are influenced by risk considerations and oriented towards a negative view of CCS. For these reasons, the average answer to question 11, that is a rate of approval at 38%, is not a better approximation of a pre-existing 'public opinion' than the average answer to question 6, a rate of 59%. These two values might only be interpreted as a range, which can be compared to other ranges obtained in other surveys that ask similar 'approval of/opposition to' questions.

The difference in information between questions 6 and 11 is not only quantitative, but also qualitative: we initially exposed the necessity of CCS, then the risks associated with it. To some extent our approach to the formulation

of information was driven by a technical and precautionary acception of 'objectivity', implicitly believing that informing about risks might contribute to objectivity. The shift from 59% to 38% can be read as the effect of a technical / precautionary approach to information provision.

The scientific literature about the effect of information provision on CCS approval is ambiguous. Palmgren et al. [2004] found that interviewees' initial dislike for geological and oceanic carbon sequestration relative to other carbon management options seemed to increase with the provision of more detailed information. On the contrary, Itaoka et al. [2004] found that the more information respondents obtained about CCS, the more likely they were to support those storage options except for the onshore geological storage. In a similar way, Shackley et al. [2005] reported that in the absence of information, the majority of people either do not have any opinion about carbon storage or are somewhat sceptical about it. Once (even limited) information is provided as to its role in reducing $CO_2$ emissions, opinion shifts considerably towards a slight support for the concept.

The two surveys reported by Curry et al. [2007, VIII] also showed a significant impact of information. Respondents in the United States were asked to choose one energy technology to address global warming. Half of the sample received no information and the other half received information about the various technologies, such as: their costs, their efficiency in reducing emissions $CO_2$ and their current share in electricity production. Informed respondents more frequently chose CCS than uninformed respondents, at the expense of renewable energies. But these findings can hardly be compared with those from our study, because qualitatively different information was presented. In the study of Curry et al, the information provided was strictly focused on relative costs aspects. It included much less information on the principle of CCS and its risks than the SOCECO2 survey. Thus, respondents who selected CCS among other technological choices did so based on a differently incomplete information package.

# 8 Concluding remarks

Carbon capture and storage can only be accepted if one recognizes that climate change is a serious issue and that reducing $CO_2$ emissions is a necessary answer. Our survey shows that climate change is largely recognized by the French public as a serious problem calling for action. Overall, the sample said that the environment/economy balance tilts toward the former term. Yet, several alternative sources of energy remain unknown and the request for information is real, in particular about the causes of climate change and the solutions to be brought.

This depicts a general background in which the idea of carbon capture and storage could potentially fit positively. However, this technology is not known by the large majority of the French public. Only about a third of the population declared having heard about it and only one in twenty respondents were able describe its principle correctly.

How the public learns / might learn about CCS appears to be a significant stake. The rate of approval was insignificantly higher when the word 'sequestration' was used to describe the technology, compared to the same description using the word 'storage'. But the word 'storage' appeared clearer than the

word 'sequestration', even if it does not convey the idea of monitoring and irreversibility. There seem to be a general agreement in France to use the 'stockage' word.

Overall, this study reveals that French public is not strictly opposed to carbon capture and storage, but rather suspicious than supportive. Support is conditional at best, its level depends critically on technical risks and the political use of this technology.

# References


D. Bell, T. Gray, and C. Haggett. The 'Social gap' in wind farm siting decisions : explanation and policy response. *Environmental Politics*, 14(4): 460–477, 2005. doi: 10.1080/09644010500175833.

Pierre Bourdieu. L'opinion publique n'existe pas. *Les Temps modernes*, 318: 1295–1309, 1973. Republished in Questions de Sociologie (1984), ed. Minuit.

RCB Conseil. Les représentations sociales de l'effet de serre (6e vague d'enquête). Technical report, ADEME, 2005. URL `http://www.ademe.fr/etudes/Socio/Effet_de_serre.htm`.

Thomas E. Curry, Stephen Ansolabehere, and Howard Herzog. A survey of public attitudes towards climate change and climate change mitigation technologies in the united states: Analyses of 2006 results. Technical Report LFEE 2007-01 WP, Laboratory for Energy and the Environment, Massachusetts Institute of Technology, 77 Massachusetts Avenue, Cambridge, MA 02139-4307, April 2007. URL `http://sequestration.mit.edu/bibliography/`.

Dancker Daamen. Pseudo-opinions on CCS technologies. In NTNU [2006]. URL `http://www.ghgt8.no/`.

M. A. de Figueiredo, D. M. Reiner, and H. J. Herzog. Ocean Carbon Sequestration: A case study in public and institutional perceptions. In Yoichi Kaya, Kanji Ohyama, John Gale, and Yutaka Suzuki, editors, *GHGT-6: Sixth International Conference on Greenhouse gas control technologies*, Kyoto, Japan, September 30–October 4 2002. Elsevier. URL `http://sequestration.mit.edu/pdf/ghgt6_paper_134.pdf`.

Minh Ha-Duong and Ana Sofía Campos. The SOCECO2 survey dataset, 2007. URL `http://www.centre-cired.fr/forum/article515.html`.

Minh Ha-Duong and Gilles Mardon. Enquête pilote sur la perception de la technologie "capture et séquestration du $CO_2$" en france. Technical Report NA/PN 003, CIRED, June 2007. URL `http://www.centre-cired.fr/`.

Nicole M. A. Huijts, Cees J. H. Midden, and Anneloes L. Meijnders. Social acceptance of carbon dioxide storage. *Energy policy*, 35:278–2789, 2007. doi: 10.1016/j.enpol.2006.12.007.

Kenshi Itaoka, Aya Saito, and Makoto Akai. Public acceptance of CO2 capture and storage technology: a survey of public opinion to explore influential factors. In John Wright et al., editors, *GHGT-7: Seventh International Confer-*

*ence on Greenhouse gas control technologies*, Vancouver, Canada, September 5–9 2004. URL `http://uregina.ca/ghgt7/PDF/papers/peer/093.pdf`.

E. Miller, L. Bell, and L. Buys. Public understanding of carbon sequestration in australia: Socio-demographic predictors of knowledge, engagement and trust. *Australian Journal of Emerging Technologies and Society*, 5(1):15–33, 2007.

Jean-Pierre Moussally. Le CSC : une technologie providentielle ? le point de vue du RAC-F. In *Discussions sur l'Acceptabilité Sociale de la Capture et du Stockage du CO2 en France. Actes d'une Journée de travail entre les ONG, les industriels, les institutions officielles et le monde académique.*, Nogent sur Marne, April 27 2007. CIRED et APESA. URL `http://www.centre-cired.fr/forum/article498.html`.

NTNU, editor. *GHGT-8: Eighth International Conference on Greenhouse gas control technologies*, Trondheim, Norway, 19–22 June 2006. The Gas Technology Center NTNU-SINTEF. URL `http://www.ghgt8.no/`.

Claire Palmgren, Wändi Bruine de Bruin, David W. Keith, and M. Granger Morgan. Initial public perceptions of deep geological and oceanic disposal of carbon dioxide. *Environmental Science and Technology*, 38(24):6441–6450, 2004.

R Development Core Team. *R: A Language and Environment for Statistical Computing*. R Foundation for Statistical Computing, Vienna, Austria, 2007. URL `http://www.R-project.org`. ISBN 3-900051-07-0.

David Reiner, Tom Curry, Mark de Figueiredo, Howard Herzog, Steven Ansolabehere, Kenshi Itaoka, Makoto Akai, Filip Johnsson, and Mikael Odenberger. An international comparison of public attitudes towards carbon capture and storage technologies. In NTNU [2006]. URL `http://www.ghgt8.no/`.

David M. Reiner. Overview of public acceptance of CCS. In *Overcoming Barriers to CCS Deployment Workshop*, Paris, 27 mar 2007. CSLF. URL `http://www.cslforum.org/mar272007.htm`.

Simon Shackley, Carly McLachlan, and Clair Gough. The public perception of carbon dioxide capture and storage in the uk: results from focus groups and a survey. *Climate Policy*, 4(4):377–398, 2005. URL `http://www.tyndall.ac.uk/publications/working_papers/wp44_summary.shtml`. See also Tyndall Centre for Climate Change Research, jan. 2004 Working Paper 44.

# Annex 1: Sample description

**Sex**

| M | F |
|---|---|
| 506 | 570 |

**Age**

| 15–17 | 18–24 | 25–34 | 35–49 | 50–64 | 65+ |
|---|---|---|---|---|---|
| 60 | 106 | 153 | 286 | 253 | 218 |

**Occupation of the house head**

| Business, craftman | Manager, intellectual | Intermediate | Employee | Blue collar | Inactive, retired | NA |
|---|---|---|---|---|---|---|
| 43 | 116 | 154 | 133 | 238 | 380 | 12 |

**Respondent's occupation**

| Business, craftman | Manager, intellectual | Intermediate | Employee | Blue collar | Inactive, retired | NA |
|---|---|---|---|---|---|---|
| 31 | 76 | 112 | 193 | 140 | 516 | 8 |

**Education level**

| Elementary | Middle school | High school | College+ | NA |
|---|---|---|---|---|
| 237 | 368 | 163 | 290 | 18 |

**Household size**

| 1 | 2 | 3 | 4 | 5+ | NA |
|---|---|---|---|---|---|
| 193 | 379 | 165 | 201 | 136 | 2 |

**Number of children under 15 at home**

| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|
| 693 | 162 | 151 | 54 | 9 | 3 | 3 | 1 |

**Political affiliation**

| Left | Green | Parliementary right | Extreme right | None |
|---|---|---|---|---|
| 388 | 73 | 310 | 49 | 256 |

**Employment status**

| Self employed | Public sector | Private sector | Unemployed | Retired | Other | NA |
|---|---|---|---|---|---|---|
| 61 | 149 | 278 | 77 | 312 | 197 | 2 |

**Income category (euros per month)**

| | | | | | |
|---|---|---|---|---|---|
| Active | ≤1.200 | 1.201–1.500 | 1.501–2.300 | 2.301–3.000 | over 3000 |
| | 90 | 77 | 128 | 141 | 145 |
| Inactive | ≤800 | 801–1200 | 1201–1500 | 1501–2300 | over 2300 |
| | 54 | 53 | 44 | 60 | 80 |
| NA | | | | | |
| 204 | | | | | |

**Sector of activity**

| Industry | Building | Trade | Transports | Services | NA |
|---|---|---|---|---|---|
| 137 | 42 | 110 | 50 | 365 | 372 |

**Agglomeration size**

| < 2k | 2–20k | 20–100k | >100k | Paris area |
|---|---|---|---|---|
| 289 | 197 | 133 | 318 | 139 |

**Neighborhood type**

| Urban center | Suburban | Country | Isolated rural | NA |
|---|---|---|---|---|
| 553 | 192 | 155 | 116 | 60 |

**City unemployment rate**

| very small | small | large | very large |
|---|---|---|---|
| 197 | 193 | 274 | 412 |

**Density of social housing in city**

| Very small | small | large | very large |
|---|---|---|---|
| 429 | 153 | 101 | 393 |

**Density of worker's households in city**

| very small | small | large | very large |
|---|---|---|---|
| 179 | 141 | 261 | 495 |

**Region of France**

| Nord | Ouest | Sud-ouest | Sud-est | Centre | Est | Paris |
|---|---|---|---|---|---|---|
| 116 | 191 | 141 | 218 | 129 | 118 | 163 |

# Annex 2: Questionnaire results

**Question 1** *Which of the following opinion is close to yours?*

| | |
|---|---|
| There is no doubt as to the seriouness of climate change and an immediate answer is required | 45 |
| There is enough evidence behind the reality of climate change and action should be taken | 34 |
| We do not have enough knowledge about climate change, more research is required before decinding anything | 14 |
| Worries abotu ckimate change are not grounded | 4 |
| No opinion | 3 |
| | 100% |

**Question 2** *As a general matter, how do you rank the protection of the environnement as compared to economic development?*

| | |
|---|---|
| The protection of the environnement should have the pripority even if it is to the expense of economic development | 28 |
| Economy is as important as the environnement, but we should give a priority to the protection of the environment | 50 |
| Economic development is as important as the environnement, but we should give a priority to economic development | 15 |
| Economic development should have the pripority even if it is to the expense of the protection of the environnement | 2 |
| No opinion | 5 |
| | 100% |

**Question 3** *For each of the following technologies, could you tell me if you have heard about it?*

| | Yes and you know what it is about | Yes but you don't know what it is about | No | No opinion |
|---|---|---|---|---|
| Solar energy | 91 | 8 | 1 | 0 |
| Nuclear energy | 84 | 13 | 3 | 0 |
| Wind energy | 89 | 8 | 3 | 0 |
| bio fuels | 77 | 16 | 7 | 0 |
| Energy saving household appliances | 76 | 14 | 10 | 0 |
| Hybrid combustion vehicules | 62 | 18 | 19 | 1 |
| Hydrogen vehicules | 47 | 24 | 28 | 1 |
| Carbon sequestration in forests | 27 | 21 | 51 | 1 |
| Nanotechnologies | 23 | 20 | 56 | 1 |
| Biomass energy | 19 | 21 | 59 | 1 |
| $CO_2$ geological storage | 12 | 22 | 65 | 1 |
| $CO_2$ geological sequestration | 11 | 16 | 72 | 1 |
| Sea fertilisation with iron | 5 | 11 | 83 | 1 |

**Question 4** *According to you, what is $CO_2$ geological sequestration / storage?*

| Base: | Full sample | Sequestration | Storage |
|---|---|---|---|
| Exact answer | 6 | 4 | 8 |
| Vague answer | 8 | 9 | 7 |
| Wrong answer | 14 | 17 | 11 |
| No opinion | 72 | 70 | 74 |
| | 100% | 100% | 100% |

**Question 5** *There was no Question 5. Figure 1 and box 1 were shown at this point.*

**Question 6** *Yourself, would you be a priori completely favorable, rather favorable, rather opposed or completely opposed to the use of $CO_2$ geological sequestration / storage in France?*

| Base: | Full sample | Sequestration | Storage |
|---|---|---|---|
| Completely favorable | 11 | 13 | 10 |
| Rather favorable | 48 | 47 | 48 |
| Rather opposed | 14 | 12 | 16 |
| Completely opposed | 7 | 7 | 7 |
| No opinion | 20 | 21 | 19 |
| | 100% | 100% | 100% |

**Question 7** *And would you say that the term sequester / store:*

| | Sequester | Store |
|---|---|---|
| Helps rather well to understand what it is about | 48 | 62 |
| Does not really help to understand what it is about | 46 | 31 |
| No opinion | 6 | 7 |
| | 100% | 100% |

**Question 8** *And would you say that the term sequester / store:*

| | Sequester | Store |
|---|---|---|
| Give a rather positive image of what it is | 33 | 44 |
| Give a rather negative image of what it is | 54 | 42 |
| No opinion | 13 | 14 |
| | 100% | 100% |

**Question 9** *Concerning the possible effects of sequestration / storage, which of the following sentences is the closest to your opinion?*

| Base: | Full sample | Sequestration | Storage |
|---|---|---|---|
| Uncertainties can be mastered so as to make it safe | 9 | 10 | 8 |
| Uncertainties are worrying, we need mroe research before going ahead | 63 | 65 | 61 |
| Uncertainties are too big, we should not use this technology | 18 | 15 | 20 |
| No opinion | 10 | 10 | 11 |
| | 100% | 100% | 100% |

**Question 10** *Personally, which of the following opinions is closer to what you think?*

| Base: | Full sample | Sequestration | Storage |
|---|---|---|---|
| Geological sequestration/storage will allow us to keep on consuming our coal and oil reserve ... | 18 | 19 | 18 |
| Geological sequestration/storage might be an excuse for keeping our ways of producing energy unchanged | 61 | 61 | 61 |
| No opinion | 21 | 20 | 21 |
| | 100% | 100% | 100% |

**Question 11** *Finally, are you completely favorable, rather favorable, rather opposed or completely opposed to the use of $CO_2$ geological sequestration / storage in France?*

| Base: | Full sample | Sequestration | Storage |
|---|---|---|---|
| Completely favorable | 4 | 4 | 3 |
| Rather favorable | 34 | 36 | 32 |
| Rather opposed | 29 | 27 | 32 |
| Completely opposed | 13 | 13 | 13 |
| No opinion | 20 | 20 | 20 |
| | 100% | 100% | 100% |

**Question 12** *And if you weer faced with experts in climate change, which are all the questions you would like to ask them?*

| | |
|---|---|
| What are the causes of climate change | 3 |
| What are the solutions to climate change | 14 |
| What can we do at an individual level / which simple things | 3 |
| How can we make people aware of it | 1 |
| why didn't we do something before | 1 |
| *Total fight against climate change* | *22* |
| What are the alternatives / alternative technologies | 4 |
| What is the efficiency of biofuels | 0 |
| What is the ecological impact of nuclear energy | 0 |
| Clarification about the risks associated with $CO_2$ geological sequestration / storage | 7 |
| *Total alternative / alternative technologies* | *11* |
| What are the dangers/consequences/risks | 11 |
| Aren't we alreasy at a point of no return/ is it not too late, already unavoidable | 4 |
| Deadline/ when will the consequences of climate become perceptible | 6 |
| How long before the point of no return | 0 |
| *Total impact of climate change* | *21* |
| Is climate change as dramatic as experts says it | 3 |
| Is it true/ are the surveys reliable | 4 |
| Isn't climate change a ntural phenomenon | 2 |
| *Total veracity of climate change* | *9* |
| Will contries collaborate /how to get them cooperate /why did'nt they all sign the Kyoto protocol | 4 |
| What can we do against polluting industries | 2 |
| *Total actors of climate change* | *6* |
| Others | 5 |
| Not relevant | 5 |
| No opinion | 26 |

Total is greater than 100, respondents could give several answers.

**Question 13** *According to you, what woud be the three most efficient actions to fight climate change?*

| | |
|---|---|
| Planting trees and preserve forest so as to absorb $CO_2$ from the atmosphere | 57 |
| Generate solar electricity | 53 |
| Produce cars which consume less energy for the distance | 48 |
| Produce appliances which consume less energy for the same service | 41 |
| Produce electricity from wind, with wind turbines | 37 |
| Produce electricity from wood, agricultural wastes or energy crops | 23 |
| Produce nuclear energy | 10 |
| Get the $CO_2$ back to sequester/ store it underground | 5 |
| Add iron to the sea so as to increase $CO_2$ absorption by plancton | 3 |
| No opinion | 3 |

Total is greater than 100, respondents could give up to three answers.