Fraunhofer Institute Systems and Innovation Research

SIXTH FRAMEWORK PROGRAMME

Professional and public acceptance for carbon capture and storage activities

Report in the framework of the DYNAMIS project

Towards Hydrogen and Electricity Production with Carbon Dioxide Capture and Storage

ISI Working Paper

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Karlsruhe, February 2009

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Executive Summary

Objectives

Work package 6.4 of the DYNAMIS project "Towards Hydrogen and Electricity Production with Carbon Dioxide Capture and Storage" aimed at identifying preconditions which have to be fulfilled in order to guarantee the broad public acceptance and the support of relevant stakeholders for carbon capture and storage. As a first step, the state of the art of existing findings on public acceptance was evaluated. In a second step, surveys with experts – participants in CCS conferences and representatives of stakeholder groups – were carried out on an international level and in Germany. They covered attitudes of experts towards CCS, their perceptions of public opinion, their own assessment of benefits and risks as well as technical, economic and research aspects of CCS, and general attitudes towards energy options. The next step aimed at regional aspects: in-depth interviews with representatives of stakeholder groups were carried out in selected countries – Bulgaria, UK, and Germany. Finally, outreach strategies were elaborated to overcome the barriers to the acceptance of CCS based on the results of the previous working steps. The recommendation should address critical thematic issues for CO_2 transport and storage as well as procedural issues that can add to a successful communication with stakeholders and the broad public.

Methodological approach

Only in a few countries empirical studies on CCS acceptance were found. The were evaluated with regard to methodologies and main findings on crucial topics for CCS, such as information level in the broad public, arguments for and against CCS, positive and negative associations, perceived risks and benefits, and suggestions for information measures.

As the information level in the public turned out to be very low, own surveys concentrated on the acceptance of CCS amongst professionals and opinion makers. During the project three CCS conferences were used to conduct a written survey with the participants: the conference "Greenhouse Gas Control Technologies" (GHGT-8) in Trondheim in June 2006, "G8 Clean Coal Conference" in Leipzig in June 2007 and the "First French-German Symposium on Geological Storage of CO_2" in Potsdam in June 2007. The detailed questionnaire included attitudes towards CCS, aspects of risks, positive or negative implications, organisational issues connected to the implementation of CCS, public acceptance and visibility, technical, economic and research aspects, but also general attitudes towards environmental issues, climate change challenge and solutions for the problems.

The partner institutions in the respective countries were responsible for the in-depth interviews of stakeholders in Bulgaria, UK, and Germany. They were carried out face-to-face or by telephone based on an interview guideline covering the topics of the written surveys in more detail.

For the outreach strategies an analysis was made of the communication process in general, how messages are communicated to certain target groups, and the necessary steps in developing a communication strategy. The communication research includes a broad spectrum of concepts and theories which are relevant for a successful campaign regardless of the concrete issue involved. This knowledge was combined with the specific framework conditions of CCS resulting from the literature review and the interviews. The opportunities and risks of various elements of communication were analysed in order to achieve acceptance of CCS by the general public.

Results of the literature review

There are not many empirical studies of social acceptance of CCS, and they were made in only very few countries, mainly The Netherlands, UK, Australia, Japan, USA, and Canada. Most of them were carried out since 2000and focus on the empirical investigation of general awareness of CCS issues in the public, attitudes and influencing factors on public opinion. Generally authors emphasise the important role of public perceptions for the implementation of the technology. Social acceptance includes acceptance by the broad public as well as by stakeholders.

Existing studies of lay people's perception showed the low level of knowledge and understanding of CCS issues and of the relation to the climate change problem. Within a choice of alternative technologies renewable energies and improved energy efficiency are always strongly preferred to CCS. From a methodological point of view most studies recognised that there is need for providing information to the respondents in order to assure that statements to this issue make sense at all.

Acceptance of CCS depends on various factors: e.g. the belief in global warming as a serious problem and in CCS as an important CO_2 mitigation option and a bridge technology, and the level of information about risks. An important result of some studies was a general acceptance of the CO_2 storage as long as the storage site is not in the own neighbourhood – a phenomenon known as NIMBY effect (Not In My Back Yard). Experiments showed that another influencing factor is the perception of the source of information about CCS, mainly its trustworthiness and competence or the communicator. Without any information neutral or negative views of CCS prevailed, neutral information led to more positive views. If CCS is compared to other options, most respondents prefer by far renewable energies and improved energy efficiency or at least vote for a mix of measures.

A final step in the literature review was to learn from experiences with other technologies, e.g. natural gas storage, hydrogen, or nuclear energy. The storage of natural gas is a technology which in principle can also be affected by leakages or accidents. The difference is that the objective of the storage is to use the gas later and not to provide a final disposal. Natural gas storage is not an issue of general awareness in the public. If there are objections, they occur only on a restricted regional level. There is also little awareness of the hydrogen issue in the public. Hydrogen-based energy technologies exist more or less in the form of prototypes or in laboratories and include a complex

technological system; therefore they are subject to various, often contradictory, conjectures. Sometimes in press reports the question occurs whether opposition from environmental groups or the broad public can emerge referring to a comparison of CO_2 storages to nuclear waste disposals, mainly due to the long-term aspect of storage and its risk potential as a burden for many future generations. The broad public however is not enough informed about technical details, and the attitudes pro or contra nuclear energy are more of a general nature. Usually psychologically motivated objections of the public are very resistant to change. This means for CCS, that it is important to avoid highly emotional debates on CCS at the time being when the broad public is not yet informed on this technology. A neutral view should be offered and arguments should keep to the facts. Main communicators should be scientists, environmental groups and consumer organisations because they are in the public's confidence and able to provide trusted information.

Findings from the written survey of conference participants

The surveys showed that most experts have a positive or neutral view of CCS. Influencing factors are nationality (Participants from UK, Norway, USA and countries outside Europe have the most positive, participants from France and Germany the most negative own view of CCS), professional background and general attitudes towards energy and environment as well as the perception of benefits and risks. However they are sceptical with regard to public acceptance of CCS. This view can be explained by lack of information in the broad public. In addition, a considerable number of experts assume that the public perceives high risks of the CCS technology.

The experts classify the level of knowledge in the broad public as very low. The discussion of CCS issues in the media is by far not considered sufficient. However the communication activities undertaken by stakeholders neither are intensive. Often experts themselves do not yet have a decided opinion or they do not see an urgent need for communication of such topics at the moment.

As far as arguments or especially risk communication is concerned, communication strategies should

- avoid to establish a contradiction between the development of the CCS technology and the further promotion of renewable energies or energy efficiency – both highly accepted options of a sustainable energy supply
- rather support the idea of CCS as a "bridging" technology only relevant until renewable energies are fully profitable
- clarify the actual risks of CCS, for example compared to natural gas, and avoid that risks will be identified by the public with risks of nuclear waste disposal
- avoid an extremely optimistic view of the role of CCS and its benefits
- rather offer an open and neutral information and discussion about CCS.

Another important barrier for the implementation of CCS obviously is the economic feasibility of the technology. The experts interviewed have considerable doubts about the profitability. This is also considered the most important barrier for the implementation of CCS, even slightly more important than public acceptance.

Findings from in-depth interviews with stakeholders in Bulgaria, UK and Germany

The attitudes of multipliers towards CCS have a strong influence on the communication of CCS and public acceptance. NGOs, consumer organisations, churches, and partially trade unions are organisations which enjoy a high confidence in environmental issues. These organisations mostly represent a critical or even negative attitude towards CCS. They are expected to make use of their role and communicate their position broadly and intensively. Scientists and experts are also regarded as trustworthy for the public, politicians only to a smaller degree, and industry is generally perceived as biased. Political parties mainly influence the public opinion making by defining the legal framework for CO_2 sequestration, transport, and storage as well as the role of CCS in the energy and climate policy. Many multipliers wish an open debate between the different positions. In this framework the role of scientists and experts is seen as a factual contribution to the discussion.

The attitudes of multipliers towards CCS show a wide spectrum of opinions pro and contra CCS from a technical and economic point of view. Pro arguments for CCS are climate change mitigation and partially the need for use of coal worldwide, but all agree that CCS is only a bridging technology. Main arguments against CCS are risks of long-term CO_2 storage and impediments for an energy supply strategy based on decentralised options, such as renewable energies, cogeneration, and energy efficiency. All agree that the public awareness of CCS still is very low. Most of the respondents expect problems of public acceptance of CCS as soon as commercial CO_2 storage sites will be implemented. Early, transparent, and unbiased information of the public is regarded as necessary. All groups, either with positive, negative or neutral positions, should contribute to the discussion. NGOs, consumer organisations, and churches are highly trusted institutions, but mostly characterised by a negative view of CCS. Scientists and experts have a leading role for information about facts.

In Bulgaria almost all respondents found CCS reasonable and globally essential. The public's willingness to pay for environmental energy technologies has been found very low. The reason is may be coming from the fact that all major Bulgarian thermal power plants have introduced massive and costly SO_2 emission reduction facilities recently and this caused significant electricity price increases. Most of the respondents consider CCS technology ready for implementation, but there is a lot of uncertainty about carbon storage potential in Bulgaria. Most of the people hope that CO_2 can be stored locally. Bulgarian public has a general positive attitude towards nuclear power generation. This is one reason why some respondents regard nuclear power as a real alternative to CCS. The lack of a relevant legal basis has been found as an obstacle for fast CCS implementation in most of the interviews. One of the clearest results from this survey is the

lack of an official CCS attitude and internal discussion in all respondents' organisations. It is important that this situation will be changed through short-term activities. Another weak point is the declared very low level of awareness and information on CCS in the public in this country. Significant lack of information and news in the media about CCS is indicated in almost all interviews. Nevertheless, most of the respondents have found that the public's opinion about CCS is rather in favour. The others think that this opinion is not formed yet. The news about CCS in the media has been found insufficient, but neutral. As a result, more broad and active information about CCS is reasonable. Most of the respondents think that all aspects of CCS deserve intensive discussion. CCS risks have to be discussed in an open manner without hidden facts and shortages. Most of the respondents are convinced that the public has to be informed as early as possible about any upcoming CCS project. To summarise the results: the CCS technology could be well accepted in Bulgaria but intensive preliminary informative work and discussions are needed.

In UK it was difficult to find persons who were willing to participate in the interviews. Most of the respondents stated that maturity and profitability of CCS are not yet given, at least not at full commercial scale. CCS is regarded as essential for a transition period as long as coal is needed in the energy mix. Climate and pollution is the principle focus, and CCS is indispensable alongside to the development of renewable energies as well as energy efficiency improvements and demand management. In the public CCS is not well known or understood. The views of the role of the media vary among the respondents, some regard the publications as biased, some as balanced, but all agree that there should be more information about CCS, even if the public interest would be limited also in the future.

In Germany, all respondents do not regard CO_2 storage as technically mature. Sequestration is regarded by some of them as feasible. However they still see problems and need for further development, at least with regard to the loss of efficiency of power production, technical optimisation, and cost reduction. Correspondingly the profitability is not yet given for most of the respondents. Profitability depends on many factors, such as the price of CO_2 certificates, the price for electricity produced from other fuels, the loss of efficiency of "clean" power production, and the development of prices of natural resources in general. In addition, transport demand – mainly the infrastructure of pipelines – and lacking acceptance were mentioned as factors which rise costs. Only a few respondents regard CCS as absolutely essential, some other said that it is reasonable from a global point of view with regard to the climate change problem and the necessity to use coal in the future, at least in China and other countries, but don't have an enthusiastic positive attitude. For some other persons the climate problems are so urgent that it would be too late for CCS when it will be commercially available.

One aspect is especially relevant for Germany: Due to the necessary modernisation or replacement of the existing power stations within the next years a basic decision has to be taken whether CCS will be introduced. This decision is made at a time when there are not yet well-founded results of a broad application of the technology according to most persons interviewed. Especially the risks of the long-term CO_2 storage will not be

tested enough by 2020. Thus a course will be set for an energy supply structure based on coal which can only be used with CCS for climate reasons without knowing whether the technology is viable. The large majority of the respondents agreed that there is further need for research of CO_2 storage and that there is urgent need for the development of a legal framework for CCS including responsibilities for decision making, approval procedures, and liabilities in case of failures.

The public awareness of CCS is generally considered to be very low at the time being. However many respondents expect a strong opposition of the public, environmental groups, etc. against CCS, especially CO_2 storage sites, in the future. The media coverage of the CCS issue mostly is regarded as unbiased. Most of the respondents hold the opinion that the public should be more informed about CCS, according to the majority this should be done as soon as possible. Others would start with information when demonstrations projects take place. For the communication almost all suggested a transparent, unbiased, and open discussion of facts, also of risks. One should neither stir up unreasonable hopes, nor unjustified fears. Withhold of risks, e.g. of long-term CO_2 storage, would cause more opposition than an open communication. In order to avoid polarisation it should be clarified that risks of CCS cannot be compared to those of nuclear energy, rather CO_2 storage should be compared to natural gas storage. It is important not to establish a contradiction between CCS and the promotion of renewable energies and energy efficiency.

To summarise the findings of the in-depth interviews: Most of the multipliers expect problems of public acceptance of CCS, not at the time being, but as soon as first commercially operated CO_2 storage sites will be started up. It is expected there will be a more emotional than factual discussion, mainly of those directly concerned, e.g. in CO_2 storage regions.

In all groups pro arguments for CCS are climate change mitigation and partially the need for use of coal worldwide, e.g. in China and India, and CCS is necessary if an increased use of renewable energies and improved energy efficiency are not sufficient for climate reasons. All agree that CCS is only a bridging technology. Main arguments against CCS are risks of long-term CO2 storage and impediments for an energy supply strategy based on decentralised options, such as renewable energies, cogeneration, and energy efficiency.

For the communication of CCS issues chances and limits of the technology should be discussed. Scientists and experts have a leading role. Most of the multipliers regard early, transparent, and unbiased information of the public as necessary. All groups, either with positive, negative or neutral positions, should contribute to the discussion.

More research and development is needed mainly on the long-term CO_2 storage, but also in the field of sequestration, especially with regard to loss of efficiency and cost. Also transport is partially considered to be high cost factor. Altogether CCS is by far not yet regarded as profitable, partially not as technically mature. It has to be taken into account whether CCS will come too late for combating climate change when it is devel-

oped to be used at large-scale. Most important is that CCS will be communicated as only one additional option complementary to renewable energies and energy efficiency.

Conclusions for an outreach strategy

According to experts' opinion lacking public acceptance can be a severe obstacle for the implementation of CCS. The perception of risks, the belief in the necessity and usefulness of CCS, real facts, and the published opposition or support of societal groups play an important role for the development of public attitudes towards CCS.

Level of information: There is a broad consensus that the level of information in the public is very low. It is expected that a higher level of information has a positive effect on the acceptance of CCS whereas a low awareness and understanding causes fears and opposition.

Benefits of CCS: The most important factor for acceptance is perceived benefits of the technology. First of all the benefit of CCS is its role for climate change mitigation. This role depends on the geographical reference: whereas it might not be relevant for individual countries, e.g. in Europe, it might be necessary and acceptable in a global view and for countries with a coal-based energy-mix and increasing energy need. Another aspect is the diversification of energy sources and security of supply, also in Europe. Finally employment is a relevant issue; if it is shown that CCS helps to ensure employment, this will promote the acceptance of CCS. Opposition against CCS can be alleviated by clarifying that it is a bridging technology to have time to develop renewable energies until they can provide large parts of the energy supply.

Obstacles for acceptance: Some factors can influence the acceptance of CCS negatively. As CCS causes additional energy consumption and additional costs (lower power plant efficiency due to CO_2 capture, transport and storage needed) it is expected that electricity prices will increase which certainly affects acceptance even if there are many other reasons for increasing electricity prices. The main reason for a negative image of CCS is the perception of risks, especially in regions where CO_2 storage projects are planned. A general problem is the publics' concern that the support for CCS results in a decreasing support for renewable energies which are a top ranking solution for the climate change problem in the public's view.

Multipliers have a large influence on public opinion, especially NGOs which are considered to be a credible information source in environmental issues. Some of them are no pronounced opponents of CCS, they rather attach conditions to the implementation, e.g. international rules, absolute priority of renewable energies and efficient use of energy over CCS, or extensive controlling measures to avoid risks. Consumer organisations, trade unions, churches, etc. can also have influence, but in general they do not yet have a firm attitude. The second important group is experts in science and research who are also considered to be trustworthy when presenting fact and discussion pros and cons in an open manner. Media, such as newspapers and TV play an important role in the early stage of awareness of a new technology. According to existent studies the media

present a relatively balanced view of CCS so far. An effective legal framework is a precondition for public acceptance of CCS. Until now no regulations exist for the management of risks, approval procedures, or decision making processes with public participation.

For communication strategies for an increased acceptance of CCS the following recommendations were made: Although important questions are still open, such as long-term CO_2 storage and the legal framework, the public should be informed early. Chances and risks should be communicated in an open manner in order to create trust in the communicator. It is expected that the low level of information will lead to doubts about CCS and lacking acceptance in the broad public.

Above all people living in regions with upcoming projects should be informed very early and in a comprehensive way. Personal communication should be offered in these cases. Also other interested groups should have the possibility to get informed in detail, representatives of organisations, journalists, multipliers and opinion leaders as well as people in the broad public. This means that the content and form of the information should be oriented by target groups according to their level of information and their needs.

The public is mainly interested in unbiased and trustworthy information. Therefore it should be based on facts and come from different sources. Each communicator is characterised by a certain attitude towards technologies such as CCS. A governmental CCS campaign should try to get different groups involved, for example with individual statements, public expert discussions, etc.

Important messages with a CCS information campaigns should include aspects such as the role of CCS in energy supply and climate protection, impact on society, legal issues concerning decision-making, control of risks, liabilities, etc. Unsolved risks should be communicated clearly in order to prevent from unnecessary and exaggerated fears, negative associations, e.g. to nuclear energy, or the contradiction to the further development of renewable energies. The main opposition is expected with regard to CO_2 storage, at least in regions with upcoming projects. Concerning CO_2 capture negative attitudes will not concentrate on this technology but rather on the construction of more coal-fired power plants. Therefore an explanation of the need for a continuing use of coal should be given.

Mainly facts are needed to convince the public. Therefore demonstration projects should be carried out showing the amount of potential risks and how they can be controlled, which regulatory framework is necessary, etc. These projects are an opportunity to test also the steps of communication mentioned above. Within the communication all relevant stakeholder groups should be included. A feedback process should be provided and an evaluation of the communication measures in order to respond to the needs and concerns of the public.

Part A: EU-wide mapping report of existing findings on public perception and acceptance of CCS Objectives

1 Objectives

Work package 6.4 "Professional and public acceptance of carbon capture and storage activities" aims at identifying preconditions which have to be fulfilled in order to guarantee the broad public acceptance of and the support of relevant stakeholders for carbon capture and storage. As a first step, up-to-date findings on public acceptance were evaluated. Since 2000, a number of surveys have been carried out in different countries which focus on the empirical investigation of the general awareness of CCS issues among the general public, on attitudes and on influencing factors on public opinion.

The evaluation of existing literature is seen as a necessary background step before empirical investigations within the project. It is also needed for recommendations of accompanying activities to the implementation of potential storage sites in selected areas, e. g. arguments, information campaigns, motivation of stakeholders, as well as for the identification of critical areas which could be barriers to the acceptance of CCS, e. g. the perception of technical risks, negative ecological impacts, etc.

The general assumption was that the general public is not yet aware of CCS issues. There have only been a few reports in the mass media which are more or less neutral towards CCS technologies and have not affected public opinion so far. This is expected to change as soon as concrete sites are discussed or selected for CO_2 storage and field experiments are carried out. In the past, the implementation of other large-scale technologies showed that broad opposition occurred first in the regions affected, e. g. regarding nuclear disposal, large power stations, etc.

Another assumption was that people are not sufficiently informed about CCS technologies, so that they are not able to correctly assess the drawbacks and benefits. In such a case, attitudes tend to be largely influenced by other factors, such as actors or communication sources and by general feelings towards technology.

The scope of studies in this report is not restricted to the European Union, because findings from Australia, Japan, Canada or the US are also relevant. Other interesting studies are currently in the process of being published and will also be evaluated. The report will be completed by the end of phase 1 of the project. Finally, experiences from the introduction of other energy technologies will also be included.

2 Overview of empirical studies of CCS acceptance

Empirical studies on CCS acceptance were only found in a few countries. In Europe, studies are known from the Netherlands, Sweden and the UK. Various methodological approaches were taken, ranging from discussions in small groups to written surveys with a large number of respondents. There are examples of studies based on the percep-

tions of the broader public as well as on stakeholder or expert evaluations. Table 2.1 gives an overview of the studies.

Table 2.1: Surveys of public acceptance of CCS

Country	Type of survey	Sample	Date	Source
Australia	telephone interviews	900 respondents 35 key persons and citizens	2005	Ashworth et al. 2006
Canada	focus groups and internet-based national survey	1,972 respondents 2 group discussions	2004/05	Sharp et al. 2006
Japan	written questionnaire	267 + 423 students	2003, 2005	Tokushige et al. 2006, Itaoka et al. 2006
Japan	experiment	25 students	2003	Uno et al. 2004
Japan	written questionnaire group discussions	60 students 34 students or laypersons	2003	Uno et al. 2004
Netherlands	face-to-face explorative interviews	112 residents in areas with natural gas storage	2003	De Conninck/ Huijts 2004
Netherlands	(written) “information-choice questionnaire” “traditional” questionnaire	995 respondents 327 + 300 respondents	2004	De Best-Waldhober/ Daamen 2006
Netherlands	experiment	78 students from Leiden University		Terwel et al. 2006
Netherlands	interviews and workshop	stakeholders		Van Alphen et al. 2006
UK	face-to-face interviews	212 persons at Liverpool airport and 2 discussion groups	2002/03	Shakley et al. 2004
UK	group discussions	2 panels (10 students and 9 citizens)	2001	Gough et al. 2001
US	qualitative interviews and written questionnaire	18 + 126 respondents in Pittsburgh, area	2003	Palmgren et al. 2004
US	internet-based survey	1,236 respondents nationwide	2006	Ansolabehere et al. 2006
EU	EU-wide survey: written questionnaire	results not yet available	2006	Flagstad et al. 2006
UK, US, Can, NZ, Australia	screening of print media	36 media analysed over 312 days	2006	Mander/Gough 2006
	International comparison			Reiner et al. 2006
Japan	written questionnaire	1,006 respondents (sample in Tokyo and Sapporo)	2003	Itaoka et al. 2004
UK	internet-based survey	1,056 respondents (national sample)	2003	Curry et al. 2005
US	internet-based survey	1,205 respondents	2003	Curry et al. 2004
Sweden	written questionnaire	742 respondents (sample)	2003	Johnsson 2006

2.1 Europe

2.1.1 The Netherlands

The Energy Research Center of the Netherlands (De Conninck/ Huijts 2004) carried out an *inquiry into public perception of CCS in the region around Alkmaar* in the northwest of the Netherlands located above a gas storage field. In 2003, 112 inhabitants were interviewed personally; 84 % of them were aware of the gas storage, in particular as in the past this had caused some small earthquakes underground. They first received some information about climate change, CCS technology, the possibility of storage in the region and potential risks. Finally they were informed about the view of industrial, governmental and environmental actors.

The study revealed that the respondents had a very low level of information. It was assumed that their opinions mainly followed those of the most trusted institutions, the NGOs, than of other actors such as government or industry, but the results were ambiguous. In general, the attitudes towards CCS were slightly positive, but more negative than positive associations with CCS were reported. Potential risks were rated higher than benefits for society and even higher for the respondents personally. Above all, a clear NIMBY feeling was identified (Not In My Back Yard): the respondents were negative about CO_2 storage in their neighbourhood.

A study of the Center for Energy and Environmental Studies at the University of Leiden (De Best-Waldhober/Daamen 2006) applied a special method in order to obtain useful answers in a situation where respondents had a low information level: an "*information-choice questionnaire*". The respondents (995) were asked to rate six different options of CCS with regard to their potential to reduce CO_2 emissions and fulfil national goals. They were informed about the background of these options, their role and the consequences. Their task was to rate each of these consequences on a scale between "big advantage" and "big disadvantage". On this basis, each option could be identified as preferred or unacceptable. Between 12 and 24 % ranked the various options positively, whereas only 4 to 6 % ranked them negatively.

For comparison, two smaller groups (327 and 300 respondents, respectively) received a "traditional" questionnaire concerning evaluation of the global warming problem, CCS in general and the six CCS options with the same wording, but without any kind of information or description of the consequences of the options. Most of the respondents stated that they had never heard of the specific technologies mentioned. After some minutes the first group received a little bit of information, but the second group were given no information (they performed an unrelated task in the meantime). Both groups were then asked again to evaluate the options and it was observed that the opinions had changed significantly. The first group judged the options slightly more positively, the second group slightly more negatively.

The authors conclude that uninformed respondents produce unstable, "pseudo" opinions and recommend the use of the information-choice questionnaire method. However it has to be stated that the options presented as well as the consequences to be evaluated were extremely complex for laypersons and that this method presupposes really "neutral" information and explanation. The authors plan to extend their studies and completely cover other energy options, too, e. g. renewables, nuclear energy, etc. in addition to CCS options.

At the University of Leiden, an *experiment* was carried out with 78 students (Terwel et al. 2006). The participants were allocated to four groups in which two conditions varied: the source of communication was either NGOs or industry, and the issues communicated were either environmental or economic arguments in favour of CCS. Finally, participants answered a questionnaire about their trust in the organisations, perceived honesty, competence, and concern for public interests. The hypothesis was that trust in organisations is higher after the provision of arguments that are congruent with the attributed motive than after the provision of incongruent arguments. The results did indeed point in this direction, but were not significant. Perceived honesty accounted for different levels of trust. The authors assume that perceived competence is a further relevant factor. This was the starting point for another study (ter Moers et al. 2006). In an experiment, 100 students from Leiden University were allocated to four groups with low/high expertise and low/high trustworthiness of communicators. The results show that the characteristics of communicators influence quality perception and acceptance of a message, but that the influence is lower when communicator characteristics are incongruent. This implies that proponents – or opponents – of CCS should be perceived positively with regard to multiple characteristics, e. g. seen as both competent and trustworthy, in order to be convincing.

The Department of Innovation Studies at the University of Utrecht carried out *interviews and a workshop with stakeholders* (van Alphen et al. 2006). Considering the low information level of CCS among the public, this approach was selected because it is argued that stakeholders are involved in the implementation of a technology, but also represent organisations which influence public opinion, e. g. via mass media. The persons surveyed were selected in line with these criteria. They come from government, industry (associations), and environmental NGOs. Two lots of issues were covered: firstly, general attitudes regarding CCS and its role in combating climate change and, secondly, opinions about conditions which have to be fulfilled for its broad implementation. In a further step, stakeholders were invited to a workshop based on a computer system where participants can vote or present ideas simultaneously in order to encourage an open discussion. The advantage of this method was that stakeholders were put in contact with each other and could outline a consensus.

The core consensus of the stakeholders was positive towards CCS. They agreed that climate change represents a serious problem which has to be addressed by all possible measures: energy efficiency improvements, deployment of sustainable energy sources and also CCS. CCS is seen as a temporary way to quickly and easily achieve large CO_2

reductions. They also emphasised that the climate problem is a global one and requires a global approach.

For environmental NGOs, CCS is a necessary technology but not the first choice. Priority is given to energy efficiency and renewable energies. The energy industry pointed out that CCS causes additional costs and lowers the overall efficiency of plants. In addition, it considers the technology not yet sufficiently developed to be used on a large scale. The position of representatives from governmental institutions reflects the above mentioned core consensus of the whole group of respondents. They argued that they support the technology when it is safe, but want to leave the decision for implementation to the market.

The stakeholders widely agreed on the conditions for CCS implementation: above all safety, but also temporality for several decades only, simplicity, financial stimuli, cooperation between different sectors and acceptance by the broad public. Suggestions were made, such as the initiation of pilot projects, regulations and standard setting for site selection, operation and monitoring, inclusion of CCS in the emissions trading system and effective communication to the public.

2.1.2 United Kingdom

In 2001, the Tyndall Centre of the Manchester School of Management surveyed a *small sample of laypersons* about CCS issues (Gough et al. 2001). The method of group discussion was chosen because it allows discussion with mutual stimulation and a very detailed understanding of attitudes and underlying motives. One of the groups consisted of engineering students, but none from environmental sciences. The discussion in this group was much more lively and advanced, whereas the second group had difficulties understanding the issues. No participant in either group had previous knowledge of CCS.

The authors found limited opposition to CCS in both groups. The potential fear of risks was partially compensated by climate benefits. It was accepted as a “bridging” technology. Objections were made regarding the safety of storage, costs, and the binding of resources required to develop alternatives. Nuclear waste disposal was used as an analogy because of the long-term perspective, safety and monitoring aspects. With regard to potential storage solutions, ocean disposal was completely rejected. Geological storage appeared safer with its “visible” physical barrier. For future communication strategies of CCS it is important to note that the groups expressed general scepticism towards the motives of the energy industry. CCS activities are more likely to be accepted if the energy industry also demonstrates its support for renewable energies and energy efficiency. The participants were also convinced that the mass media, which reflects the attitudes of both proponents and opponents of CCS, will have a large influence on opinions.

Another Tyndall Centre study was based on 212 *face-to-face interviews with travellers at Liverpool Airport* in 2003, and continued group discussions in 2002–2003. Both sur-

veys focused on associations with the unknown issue of CCS, attitude changes resulting from the information provided, influence of socio-demographic variables and basic beliefs, and potential factors or measures to make CCS more or less acceptable to the public.

There were two discussion groups, one in Manchester and one in York. They varied in socio-demographic variables: a female group with administrative and secretarial occupations and a male group with managers and self-employed persons. Both groups participated in five sessions and were given expert presentations within the sessions. The respondents in the airport survey were also briefly informed about the impacts, costs, risks and perspectives of CCS.

The results can be summarised as follows. In their first contacts with the issue, most people had a negative or neutral view of CCS rather than a positive one, or claimed ignorance. After receiving a small amount of information on the purpose of CCS, the majority supported it as an important CO_2 mitigation option. Compared to renewable energy or energy efficiency, support for CCS was always much smaller, but higher than for nuclear energy and increasing energy bills. Concerning socio-demographic variables, the results did not show significant variations by gender, age or socio-economic status. Prerequisites of CCS acceptance were: recognition of climate change as a serious problem and an understanding of the high quantity of CO_2 to be reduced. The group discussions revealed that there was little knowledge about the contribution of various options to this objective. The general view was that all options for CO_2 reduction should be developed simultaneously. More certainty about the long-term risks of CCS and its use as a "bridging" technology would help to increase its acceptability by the public. Other factors would be: an appropriate regulation strategy involving all parties, government, NGOs and industry, and a transparent and open decision-making process.

As mass communication plays a relevant role for public opinion, the Tyndall Centre completed its study with an *analysis of mass media*. Articles on CCS in print media were analysed in five English-speaking countries: UK, US, Canada, New Zealand and Australia (Mander/Gough 2006). The authors consider mass media such as newspapers and TV to be more important than other channels such as the Internet, informal networks or the specialist press. One factor of influence is the position of articles, e. g. on the front page or elsewhere with minor visibility, another factor is the type of presentation chosen, the wording, interpretation, embedding into stories, etc. ("amplification") in order to attract people's attention. The authors analysed the wording, the description of risks, and the information source of the journalists. Statements on CCS were compared to statements on other climate change mitigation technologies such as renewable energies or nuclear power. The review took place between autumn 2005 and spring 2006. Nation-wide print media, mainly daily newspapers and some weekly newspapers and magazines were analysed. This involved a daily search for relevant key words; summarized information on the articles found was recorded in a database.

Considerable differences were found between the countries involved. Greatest attention was given to nuclear power except in the US where CCS was more often mentioned. In

the UK and Australia there was a very large number of articles on nuclear power, much larger than on other items (CCS, renewables, coal without CCS). In sum, 53 articles were collected in the UK, 30 in Australia, 16 in the US, 7 in Canada and only 2 in New Zealand. The large majority of articles presented a positive (42 %) or neutral (32 %) view of CCS. Articles with mixed views (19 %) or a negative view (6 %) formed a minority. Australia had the largest number of negative articles (23 %). The articles were strongly related to current events, such as the discussion about phasing out nuclear power, construction of new power plants, impending electricity shortfalls or the announcement of the intention to build a hydrogen plant with CCS (California). The most frequently raised negative aspects were costs, safety and leakage issues, efficiency of the technology, doubts about the available storage capacity, and the additional energy consumption required for capture. Generally, there was no polarised debate on CCS, but rather neutral and informative reporting. A key message was that there is an urgent need for a legislative framework for CCS implementation.

2.1.3 EU-wide research

The ongoing *EU project ACCSEPT* (Acceptance of CO_2 Capture, Storage, Economics, Policy and Technology) aims at assessing public acceptance of CCS in Europe and addressing gaps in socio-economic studies. A strong relation is assumed between social acceptance and regulations for CCS as well as risk management and public trust in actors in this field. The project started in 2006. A stakeholder workshop has already been held and a written survey of social acceptance has been carried out. The results are not yet available. The interview package included relatively detailed information on the background of the project, CO_2 reduction commitments, CCS concepts and processes, costs, financial support programmes, and legal issues. The target group comprises experts and stakeholders; the questionnaire was sent in the respective national language. The main issues were attitudes towards CCS, political, strategic, social and environmental arguments, the contribution of CCS to climate change mitigation, frame conditions, support measures, regulation issues, potential risks, and the role of public acceptance in CCS deployment.

2.2 Other countries

2.2.1 Australia

In Australia, a broad, *quantitative, nation-wide survey* was carried out. In addition, *in-depth discussions with stakeholders* were held in regional workshops in Queensland (Ashworth et al. 2006). The methodology used for the workshops was a “participatory action research”. The regions selected for recruiting the participants – one group with local decision-makers or other key actors and one with citizens – were located close to coal mines or power plants. They met in two sessions; in-between they were given information and could actively seek more information. The information was given by a multi-stakeholder advisory group with diverse, but overall balanced opinions on CCS.

Climate change was perceived as a serious problem in the workshops and the need for government action was emphasized. The main relevant measures suggested were: improved energy efficiency, education and behavioural changes as well as activities on the part of the energy industry and manufacturers of energy-consuming goods. The participants were asked to identify issues on which they would like to receive more information. The most important issue was CCS with 74 %, followed by climate change with 55 % and biomass with 50 %. Specific CCS fields in which participants felt particularly uninformed were transport, leakages from pipelines and storages, capture processes, risk of terrorism, worst cases, impact of hazards, types of storage and impacts of each type, threat for water systems, and the safety of geological storages in case of earthquakes. As a result of the workshops, the researchers observed a considerable change in priorities for technologies. Above all, there was greater acceptance for biomass, CCS, and coal (without CCS) than at the beginning. The medium preferences for solar energy and natural gas and the strong opposition to nuclear power remained stable. A detailed analysis showed that changes came from those who were at first unsure about their preferences and were then strongly influenced by the information received which was classified as accurate, balanced and credible.

The broad survey showed (cited by Coninck et al. 2006) that 70 % of the respondents were not able to explain what CCS means. Others provided reasonable answers such as "storing gas underground" or "storing gas in barrels". 80 % were not aware of the efforts made by the coal industry to reduce greenhouse gas emissions. The authors also found a lack of knowledge about other issues related to energy supply and climate change. The conclusion was that the more accurate information people have, the more likely they are to accept new technologies.

2.2.2 Japan

An *experimental study* was conducted within the framework of a field demonstration of CO_2 aquifer sequestration in 2003 (Uno et al. 2004a). 25 students from a private girl's high school participated in six two-hour lessons on technologies "to save the earth". They were asked to collect more information on their own initiative and exchange opinions within the class. At the beginning they were already familiar with environmental issues, but not with CCS.

To start with, participants suggested solutions such as introducing policies and regulations, improving education and raising consciousness or changing individual lifestyles. However invited experts told them how difficult it is to achieve adequate results with these measures and introduced the topic of CCS among others. At the end of the experiment, mainly affirmative descriptions of the technology were given with regard to CCS, followed by neutral attitudes or minor reservations ("if it is not harmful", "if it is cheap and efficient", "if CO_2 can be reused"). Only two students associated CCS with negative implications for the environment, high costs, unknown availability of storage sites or long-term aspects, but they also expected further technological development and solutions for these problems. The results underline the relevance of adequate information and of a forum to exchange information and opinions.

In the same region, a *survey and group discussions* were carried out (Uno et al. 2004b). Most students had already learned about environmental issues, but their concern increased with the level of additional information. The awareness and knowledge of the laypersons were relatively low, especially on CCS. Students' trust of mass media information was relatively high, whereas older people were often not able to judge whether the information is correct, or even felt the media were dishonest. One reason was the use of many technical terms and a complex language. The participants had many open questions concerning CCS; the most important were linked to leakages, local effects, and reasons for the use of this technology. Most participants agreed with further development of the technology and experiments, or said it was too early to make a decision because of the lack of knowledge. However, the majority (45 %) did not agree with the implementation of CCS in the neighbourhood, or agreed with reservation (17 %); only 7 % agreed. Acceptance was slightly higher with regard to implementation in a distant area, but the highest percentage said that they were undecided (40 %). Additional information helped to deepen understanding and improved the level of acceptance, but did not completely remove anxiety concerning CCS.

The authors concluded that in-depth group discussions were an important element complementing the quantitative survey because the respondents are not yet familiar with CCS. The qualitative methods can also reveal the background of attitudes.

A *broad survey* was carried out in Tokyo and Sapporo in 2003 (Itaoka et al. 2004) with 1006 respondents. Two different questionnaires were developed: one with limited information on CCS and the other with extensive additional information. Compared to other CO_2 reduction technologies, CCS was relatively unknown. The main information sources were TV and newspapers. Four main factors were found which influence public views about CCS: opinions on risks and leakages, effectiveness of CCS, responsibility for CO_2 mitigation, and use of fossil fuel. 82 % of the respondents accepted CCS in general, at least under certain conditions, whereas 18 % reported fundamental opposition. Specific types of storage (offshore, onshore, lake, dilution) however were less accepted. The provision of extensive information could reduce fundamental opposition – depending on the type of information. For example, information on maintaining the use of fossil fuels increased acceptance, but information about the responsibility for CO_2 mitigation had no influence. With regard to the types of storage, only the acceptance of onshore geological storage was not changed by additional information.

In 2003 and 2005, *two surveys with students* (267 and 423 respondents) were made to analyse the public acceptance of CO_2 geological storage (Tokushige et al. 2006). More than 60 % of the respondents had little knowledge about CCS, but 85 % said that they pay attention to global warming issues. The results showed that acceptance is strongly influenced by the perception of the benefits. After having received information on benefits and on natural analogies, e. g. natural CO_2 accumulations, the perception of risks decreased and acceptance increased. In the second survey the respondents were provided with additional information about field demonstrations of CO_2 geological storage. This study also revealed four factors: risk perception, benefit perception, sense of environmental values, and trust. A path analysis showed (Itaoka et al. 2006) that the percep-

tion of the effectiveness of CCS is most influential for public acceptance; this means that CCS is seen as a realistic option to reduce CO_2 and that its reduction potential is substantial. The authors consider the dissemination of these arguments a key issue for the communication to the public.

2.2.3 United States and Canada

In 2003, two studies were conducted in Pittsburg based on a "*mental model method*" in order to examine public acceptance of oceanic and geological CCS (Palmgren et al. 2004). The first study used a semi-structured questionnaire, the second study was a closed-ended survey based on a written questionnaire, which aimed at testing the prevalence of beliefs identified in the first study. In both studies, information was provided to the respondents. The first study consisted of 18 face-to-face interviews. The researchers found the sample sufficient for the introduction of new concepts like CCS.

One of the results was that the respondents had a neutral view of CCS. Geological disposal was preferred to ocean disposal; after the provision of information, opposition to both options increased. A further question covered the willingness-to-pay if electricity companies achieved a 50 % CO_2 reduction. Compared to other options such as various renewable energies, natural gas, energy efficiency and even nuclear power, CCS received the lowest acceptance. Additional information only resulted in a slight shift in rankings.

A similar methodological design was used in a Canadian study in 2004/2005 (Sharp et al. 2006). *Focus groups* were run in order to understand the concerns and attitudes towards CCS, and a *representative Canadian survey* was used to test the findings. A strong majority of Canadians are aware of the climate change problem and the need for action, but other national issues were considered more important. CCS is seen as a bridging technology until other long-term solutions can be developed. Risks were considered more important than benefits. The respondents were most concerned about unknown future impacts, contamination of groundwater, leakages and harm to plants and animals. They clearly preferred renewable energy and energy efficiency and emphasised the need for a combined approach, but they did prefer CCS to nuclear power and conventional oil-, gas- and coal-fired power plants. Measures to improve the image of CCS could include more information, government involvement (not only the energy industry) and NGOs, strong regulations and monitoring. No clear determinants of acceptance or opposition could be identified except the perceived seriousness of the climate change problem.

In 2003, Curry et al. (2004) conducted a *survey in the US* with 1205 respondents. This was an Internet-based public opinion survey on a broad range of energy and environmental issues, including CCS. A large majority of respondents were not able to correctly report the objective of CCS (address global warming), about 70 % didn't know, 16 to 29 % thought that CCS can reduce toxic waste, acid rain, ozone depletion, water pollution or smog. Even persons who had already heard of CCS (4 %) were no more likely to answer correctly, but they did not say as frequently that they didn't know. The

authors conclude from the study that early successes or failures, which lead to greater public awareness, will have a large impact on public perception of CCS. With regard to general energy and environmental issues, the study revealed that environment is not a pressing concern of the public and, among environmental issues, global warming is not the most important one. Most respondents supported investments in renewable energies, but acceptance decreased when they received information about the costs. Many were uncertain about what is causing global climate change and therefore how to address it.

In 2006, the *same survey design* was replicated with a different sample population so that a direct comparison of answers was possible (Ansolabehere et al. 2006). National policies did not change between 2003 and 2006, but there was a public discussion of this issue. In the 2006 survey, the majority of respondents recognised global warming as a problem and in a list of ten environmental problems global warming was the most important issue for 30 % compared to only 10 % in 2003. 28 % agreed that immediate action is necessary compared to 17 % in 2003. Also the willingness-to-pay for remedies was much higher than in 2003. However CCS was still generally unknown and there was only a slight increase in the understanding of its role to combat global warming. The technology preferences of climate change mitigation were still mainly renewable energies and improved energy efficiency, but more respondents considered CCS and nuclear power to be possible technologies than was the case in the 2003 survey.

In 2005, the US Department of Energy collected *public comments* on the environmental impacts of its Carbon Sequestration Program. It organised eight meetings in various regions. CCS was presented as a permanent solution for CO_2 reduction, as a safe technology, which allows the existing energy infrastructure to be maintained. No description of the results has been found so far.

2.3 International comparison study

Reiner et al. (2006) conducted public opinion surveys in the US, the UK, Sweden and Japan. Topics were the awareness of and preferences for various energy technologies, knowledge of the relationship between energy technologies and environmental impacts, views on research and development priorities, and judgements of political measures to combat global warming. The wording in the survey was as similar as possible in the countries involved.

The results verified former findings about a low to very low knowledge level and understanding of CCS compared with other energy technologies (wind, nuclear, hydrogen, bioenergy, and energy efficiency, carbon sequestration – defined as planting trees). About 70 % in the UK and almost 80 % in the US were not able to judge the problem to be solved by CCS or carbon sequestration, whereas this holds true for only 20 to 30 % in Sweden and Japan. The acceptance of solar energy, energy efficiency and wind energy was much higher in all countries than the acceptance of nuclear energy and CCS. Bioenergy was ranked in the middle. In case of CCS, 40–50 % of respondents in the

countries involved were not sure whether they would accept CCS or not, a much larger figure than for all the other technologies.

In addition, the influence of information was tested by distinguishing two groups in the UK and US surveys of which one received additional information, e. g. that renewable energy is more expensive than other energy sources, or that nuclear energy does not produce CO_2. The results were different in the US and the UK: the support for renewable energies decreased slightly in the UK and by half in the US. The acceptance of CCS increased considerably - in the US from 6 to 16 % ("would definitely use") and in the UK from 1 up to 10 %.

3 Experiences from other technological fields

One of the objectives of WP 6.4 is to learn from experiences with the acceptance of other technologies in order to prevent avoidable opposition to CCS. Public acceptance is strongly influenced by risk perception and may be partially "irrational", i.e. does not take into account the actual or scientifically founded risk. This phenomenon can also be interpreted as the difference between scientific and "social" rationality. The perception of risks is embedded in social and psychological contexts (Slovic 2000). Another fact is that there is often no consensus on the level of risks associated with technologies which are being controversially discussed among different groups of experts or stakeholders. If there is relatively low public awareness of a technology, the supporting and opposing arguments of experts concerning risks can have a strong influence on forming public attitudes.

Possibly comparable technological fields include natural gas storage, hydrogen, nuclear and wind energy. The nuclear discussion but also wind energy shows the high influence of environmental groups on public opinion.

3.1 Natural gas storage

Natural gas storage is a technology which in principle can also be affected by leakages or accidents. The difference is that the storage objective is a later use of the gas and not to provide a final disposal. The acceptance of natural gas storage is relatively high; there is no strong tendency to opposition which would result in complete abandonment of a storage site, but only in delays in installation. Natural gas storage is not an issue of which the public are generally aware. If there are objections, these occur only on a restricted regional level. A review in Germany showed that some opposition occurred in the past in the case of three projects. In two of these cases – one was a tourist area – the storage was finally implemented with some delay and operated without trouble, whereas in the third case – in an inhabited region in Berlin – an explosion took place, which triggered vehement opposition, but which was not a long-term serious obstacle to further use of the site. Coninck et al. (2006) mention other analogies for CCS acceptance, e. g. liquid petroleum gas storage and the Underground Injection Control Program in the US because of similarities in the regulatory framework.

3.2 Hydrogen

In the past, hydrogen was used as an industrial gas, but a future hydrogen economy foresees a much broader application at the level of private individuals as well. Sometimes the issue of public acceptance is discussed, but there is a relatively weak analogy. In the case of CCS storage sites, inhabitants of the respective region are affected by potential risks without experiencing direct benefits from the technology. In the case of hydrogen, however, individuals actually get to use an advanced technology, a clean and possibly relatively cheap fuel – arguments which go a long way to promote the acceptance of this energy source. According to a study of Flynn et al. (2006), the analysis of risk perception in the case of hydrogen energy shows that there is still little awareness of this issue among the public. Since hydrogen-based energy technologies mostly exist as prototypes or in laboratories and include a complex technological system, they are subject to various, often contradictory, conjectures. Even experts have difficulties assessing the benefits and risks due to limited knowledge of safety aspects and the effects on health and the environment. Evidence of public acceptance is still rare, but all the available studies show a positive assessment of hydrogen-powered transportation (Altmann et al. 2004). However, many people are still undecided and need more information – the same situation as in the case of CCS.

3.3 Nuclear energy

There is a wide consensus among experts that the risks caused by nuclear energy use are not comparable to those potentially caused by CCS. Basically, CO_2 capture does not have a hazard potential like a nuclear plant. However, in press reports, the question is sometimes raised whether opposition from environmental groups or the general public may emerge from comparing CO_2 storages to nuclear waste disposals, mainly due to the long-term aspect of storage and its risk potential as a burden for future generations. In the public opinion, nuclear energy is perceived as a system including generation, transport and storage sites – unlike CCS – where the discussion concentrates on storage Therefore it is worthwhile reflecting on the development of acceptance of and opposition to nuclear power.

Nuclear energy use has always been a highly controversial issue since the 1950s. On the one hand, large benefits were communicated with respect to the unlimited availability of cheap energy as a precondition for economic growth. Laypersons felt threatened because of the association with nuclear weapons. NGOs communicated warnings about the use of nuclear energy because of its risks and long-term impacts. Severe opposition occurred to selected sites for power plants and storage facilities. Ultimately, today, nuclear power is still the least accepted energy technology in Europe compared with others (Table 3.1).

Table 3.1: Acceptance of energy sources in EU-25

Are you in favour or opposed to the use of these different sources of energy in your country?	In favour
• Solar energy	80 %
• Wind energy	71 %
• Hydroelectric energy	65 %
• Ocean energy (tidal, wave, marine current)	60 %
• Biomass (wood, plants, biogas)	55 %
• Gas	42 %
• Oil	27 %
• Coal	26 %
• Nuclear energy	20 %

Source: EU Commission 2006

The general public, however, is not sufficiently informed about technical details, and the attitudes pro or contra nuclear energy are more general in nature. Usually psychologically motivated objections are very resistant to change. The Eurobarometer surveys also reveal that the acceptance of nuclear energy varies with emerging events and changing values in society. Thus public opinion was influenced by a shift from technology-orientation and belief in economic progress towards environmental concerns, by the nuclear accidents of Harrisburg and Chernobyl, by strongly rising energy prices, etc. Perceived risks also vary with general attitudes. A higher acceptance of nuclear energy may result from the current climate change discussion.

Conclusions can be derived as follows: It is important to avoid highly emotional debates on CCS for the time being while the wider public is not yet informed about this technology. A neutral view should be offered and arguments should stick to the facts. The main communicators should be scientists, environmental groups and consumer organisations because they enjoy public confidence (EU Commission 2006) and are able to transmit trusted information.

3.4 Wind energy

Wind energy usually enjoys a high degree of acceptance among experts and the general public. The Eurobarometer and other surveys show that the public strongly favour wind energy and the use of renewable energies in general (European Commission 2007). Opposition is almost non-existent (3 %). Despite this fact, some locations for wind plants are still discussed controversially. The main arguments against wind plants are the negative perception of its effect on the appearance of the environment, noise and potential damages to birds. This affects emotional issues, for example landscape views and recreation, but also economic aspects, e. g. tourism. From this point of view, CCS technology is not comparable to wind energy because a clean coal plant does not look

much different to a conventional one. However the issue of accident risks with a wind plant – which is of minor importance for onshore plants – may play a substantial role in the case of offshore plants, e. g. shipping accidents (Byzio et al. 2005). Similar to nuclear accidents, the threat is less due to the frequency of events than to the potential amount of damage.

Another important conclusion from how wind energy is perceived is the dilemma of NGOs with an environmental background when judging this type of energy generation: On the one hand, the desirability of wind as a renewable energy complies with their core concern, i. e. climate protection and sustainability and, on the other hand, conflicts emerge from wind plants' negative effects such as potential threats to flora and fauna. This can result in strong confrontation.

4 Conclusions for empirical research on social acceptance

There are not many empirical studies of social acceptance of CCS, and those that exist were done in only a very few countries. Generally, authors emphasise the important role of public perception for the implementation of the technology. Social acceptance includes acceptance by the broader public as well as by stakeholders.

Table 4.1: Relevant categories for CCS acceptance

Category	**Specification**
Information	General awareness Knowledge Sources of information
Communication	Communication channels Type of communication (personal, mass media, campaigns, etc.) Transparency Content of news reporting (balanced, trustworthy, informative, etc.)
Interest	General interest in policy, public affairs, technology, environment, etc.
Trust	Trust in sources of information: decision-makers, experts, industry, NGOs, etc.
Perceived benefits	Climate change mitigation Secure energy supply
Perceived risks	Risks for health or environment because of hazards, leakages, transport Burden for future generations Unspecific dread
Costs	Cheap energy supply Social costs of CCS
General attitudes	Values and beliefs: towards technology, the environment, social aspects, Economic issues Influence of socio-demographic background
Legal framework	Regulations on storage site selection Participation in decision-making Operation, monitoring Responsibility, liability

Existing studies of laypersons revealed the low level of knowledge and understanding of CCS issues and how they relate to the climate change problem. Given a choice of alternative technologies, renewable energies and improved energy efficiency are always strongly preferred to CCS. From a methodological point of view, most studies recognised the need to provide information to respondents in order to ensure that statements on this issue make sense. The findings regarding changes in attitudes are controversial and need further research. It can be assumed that some answers are still "artificial". In sum, the relevant categories for CCS acceptance can be classified as follows (Table 4.1):

In the DYNAMIS project, the researchers concentrate first on stakeholders, e. g. experts, because they are considered to be influencing agents for public opinion. Relevant issues were compiled from the aspects in Table 4.1 for the elaboration of questions. Questionnaires available from the studies reviewed proved helpful. Later, in the second phase of the project, another approach will be used to explore "realistic" attitudes: surveys of stakeholders in selected countries or areas which give an overview of the attitudes and perceptions of various social groups.

Part B: Professionals' acceptance of CCS

1 Objectives

Following the review of existing literature on CCS acceptance and an evaluation of surveys in different countries own surveys were carried out organised by the Fraunhofer project team. It was originally planned to determine public acceptance of CCS in selected potential storage sites. However, because the corresponding work package had not yet been completed, more general samples were chosen.

The review of the existing literature was used as a background for the development of questionnaires and interview guidelines. The main relevant aspects were identified with regard to public acceptance and influencing factors. The analysis confirmed the underlying assumption of the work package that CO_2 capture and storage as a way of mitigating climate change is new to the wider public and that general knowledge about the technology is very low. At this early stage – as another hypothesis says – the communications of experts and societal multipliers play an important role. It was expected that, at present, it is more useful to include experts and multipliers who are already informed about CCS or have the necessary preconditions to understand the issue, than to survey the general public among which the issue is not internalized enough for people to be able to answer such questions. It was therefore decided to first explore the attitudes of representatives of experts and multiplier groups.

The results of the interviews will contribute to findings on

- the attitudes of experts and multipliers towards the new technology,
- interrelations with other attitudes towards energy and climate issues,
- influencing factors of attitudes,
- aspects of factual discussion, e.g. on types of storage, costs or R&D activities,
- perceived benefits and risks, as well as potential barriers to CCS,
- public acceptance.

This will help to avoid unnecessary fears and to identify critical areas which could lead to public opposition to CCS. It should result in suggestions for arguments, information campaigns, the motivation of stakeholders, adequate communication channels, etc.

2 Methodology

In the proposal it was planned to explore the acceptance of CCS among professionals and opinion makers in European regions where promising storage options are estimated. As it became clear that the selection of adequate areas will take longer than expected, two different approaches were then used: surveys of participants at relevant international conferences on CCS issues and detailed interviews with representatives of relevant stakeholders.

2.1 Written survey of conference participants

Since the beginning of the project there have been three CCS conferences where the project team at Fraunhofer ISI had the opportunity to survey the participants: the biennial "Greenhouse Gas Control Technologies" (GHGT-8) conference in Trondheim in June 2006, "G8 Clean Coal Conference" in Leipzig in June 2007 and the "First French-German Symposium on Geological Storage of CO_2" in Potsdam in June 2007. Participants at these events can be regarded as experts or at least as well-informed persons. The questionnaires were detailed and concentrated on attitudes towards CCS, aspects of risks, positive or negative implications, organisational issues connected to the implementation of CCS, public acceptance and visibility, technical, economic and research aspects, but also general attitudes towards environmental issues, climate change challenge and solutions for the problems.

The questionnaire was based on the results of the literature review (see deliverable 6.4.1) as well as the experiences and know-how of the project team at Fraunhofer ISI. The draft was discussed with all members of WP 6.4.

2.2 Statistical overview of the respondents of the survey

Altogether, 171 questionnaires were available for evaluation. The questionnaires were sent back to the project team as shown:

- GHGT-8 in Trondheim 103
- G8 Clean Coal Conference in Leipzig 26
- French-German Symposium in Potsdam 42

With regard to the professional background of the respondents, a broad spectrum was found:

- National governmental institution 13 %
- Regional or local government 1 %
- Research institute 23 %
- University 24 %
- NGO 1 %
- Geo-technologies 2 %
- Utility 8 %
- Oil or gas company 12 %
- Equipment manufacturer 4 %
- Service provider 2 %
- Planning, engineering 5 %
- Others 3 %

Industrial representatives were the largest group in Leipzig (64 %), whereas Potsdam was dominated by researchers (60 %). GHGT-8 had about 50 % researchers and 35 %

industrial participants. In the following analyses, these categories are summarised as follows: government (24 respondents), research (79), and industry (55). The professions of six remaining persons are too heterogeneous to be classified; some of them, but not all, are representatives of NGOs. Seven respondents gave no information about their profession.

The respondents were from many different countries, or had a wide range of nationalities. As expected, the range of nationalities was largest at the Trondheim conference; German (38 %) and French participants (45 %) dominated the Symposium in Potsdam. In Leipzig, 46 % of the participants were Germans. For all three events together, the distribution is as follows:

• Germany	37	22 %
• France	28	17 %
• Norway	14	8 %
• Netherlands	9	5 %
• United Kingdom	9	5 %
• Other European	27	16 %
• USA	19	11 %
• Canada	7	4 %
• Australia	6	4 %
• Japan	5	3 %
• Other countries	5	3 %

The participants who stated their age (162) can be subdivided into the following age groups:

• younger than 35 years	36	21 %
• between 35 and 50	72	42 %
• older than 50 years	54	32 %

These numbers allow cross tables subdivided into groups of persons according to these characteristics.

2.3 Interviews with stakeholders in Germany

Germany is a country where the consciousness about environmental concerns is traditionally relatively high and related issues are often broadly and controversially discussed. However this is not yet the case with CCS. This topic is not yet familiar. It was therefore decided to first conduct in-depth interviews – personally or by telephone – with relatively well-informed persons representing the following social groups: research, political parties and decision makers, experts in governmental committees, industrial associations, representatives of the energy industry and NGOs such as consumer associations, unions, renewable energy associations or religious communities. 15 interviews were carried out, more are planned.

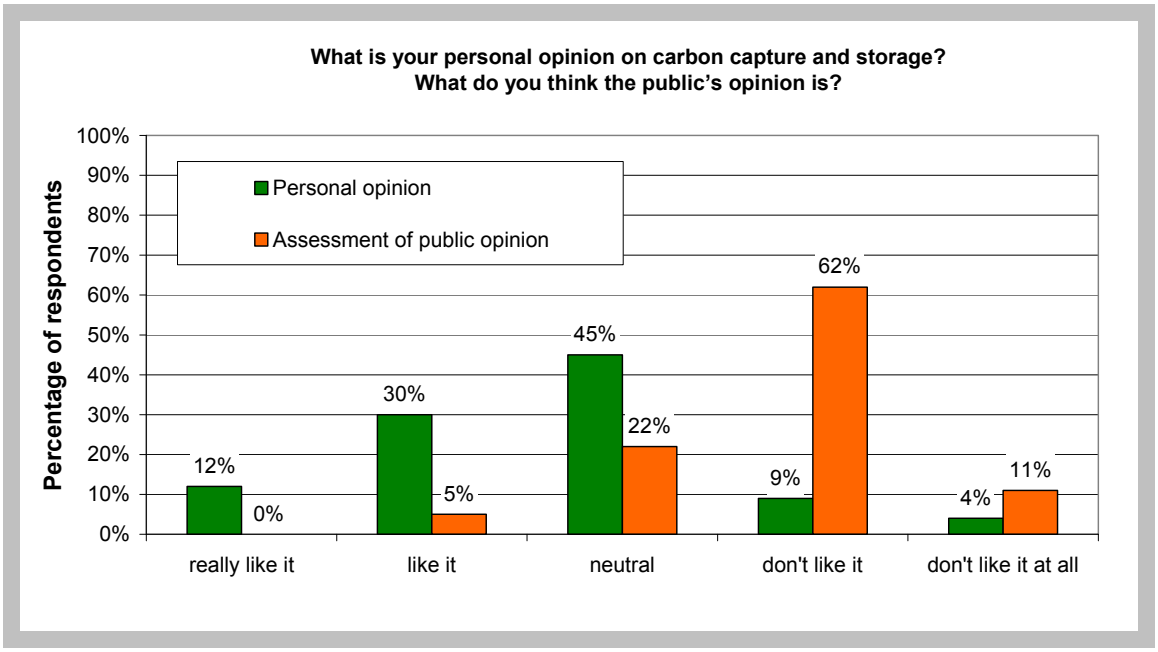
The interviews were based on a detailed questionnaire covering technical and economic aspects of CCS (need for CCS, profitability, role within an energy mix, etc.), attitudes towards CCS, perceived benefits and risks, potential storage sites in Germany or abroad, security of transport, issues of responsibility, liability, approval, etc. A second part deals with the discussion within the organisation, official statements, communication channels to the public, influence on public opinion, and finally the perceived public attitudes, discussions, arguments, obstacles to acceptance, and suggestions for further communication strategies.

3 Results of the surveys with conference participants

3.1 Basic attitudes towards CCS

One of the noteworthy results of the survey was that, in contrast to the mainly positive or at least neutral, personal attitudes towards CCS, the experts attributed a negative perception to the general public (Figure 3.1). 42 % "really like" or "like" CCS personally, but only 5 % expect the public to like it. 13 % of the experts "don't like it", but 73 % assume that the public shares this attitude.

Figure 3.1: Own attitude towards CCS and perception of public attitude



Different professional groups among the respondents had slightly different attitudes and perceptions (Figure 3.2). Government representatives had a more positive personal opinion of CCS, but a less positive perception of the public opinion than the average. The representatives of industrial companies or associations participating in the GHGT-8 conference were much more positive towards CCS than participants in the conferences in Germany (Figure 3.3). Among the participants at the GHGT-8 conference, persons

with a job in industry had the most positive opinion of CCS. Concerning the assessment of public opinion, there were only small variations between industrial representatives at the three conferences.

Personal opinion is closely related to how public attitude is perceived: if the personal opinion is more positive, the public attitude is also perceived as more positive. This holds true for all conferences and all professional groups. 98 % of the respondents classify the public opinion as being more negative than their own.

Figure 3.2: Attitudes and professional background

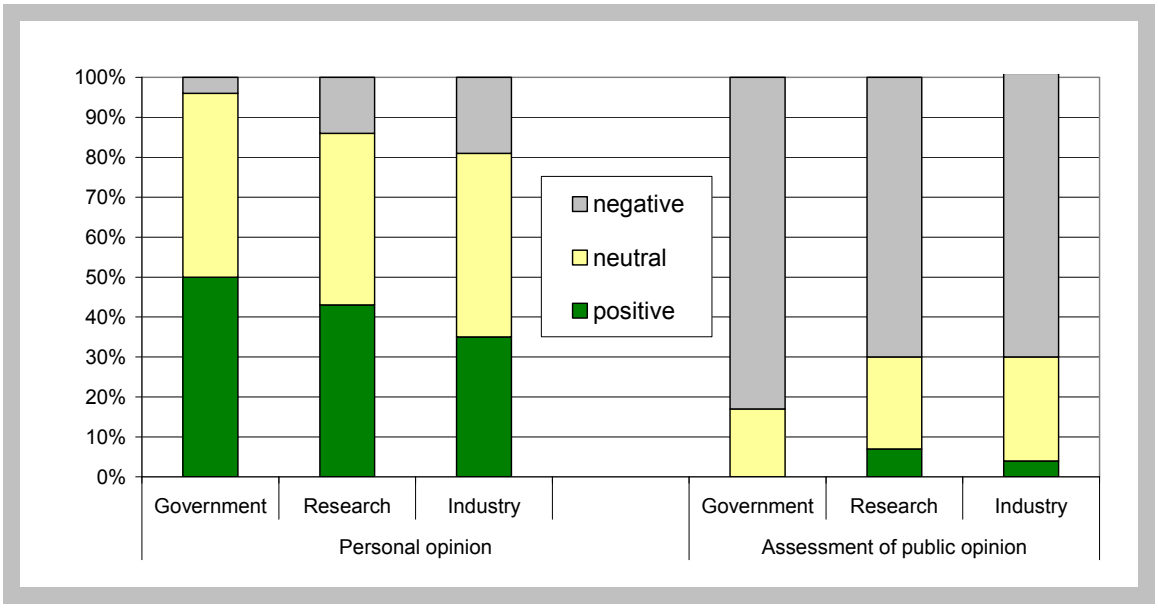
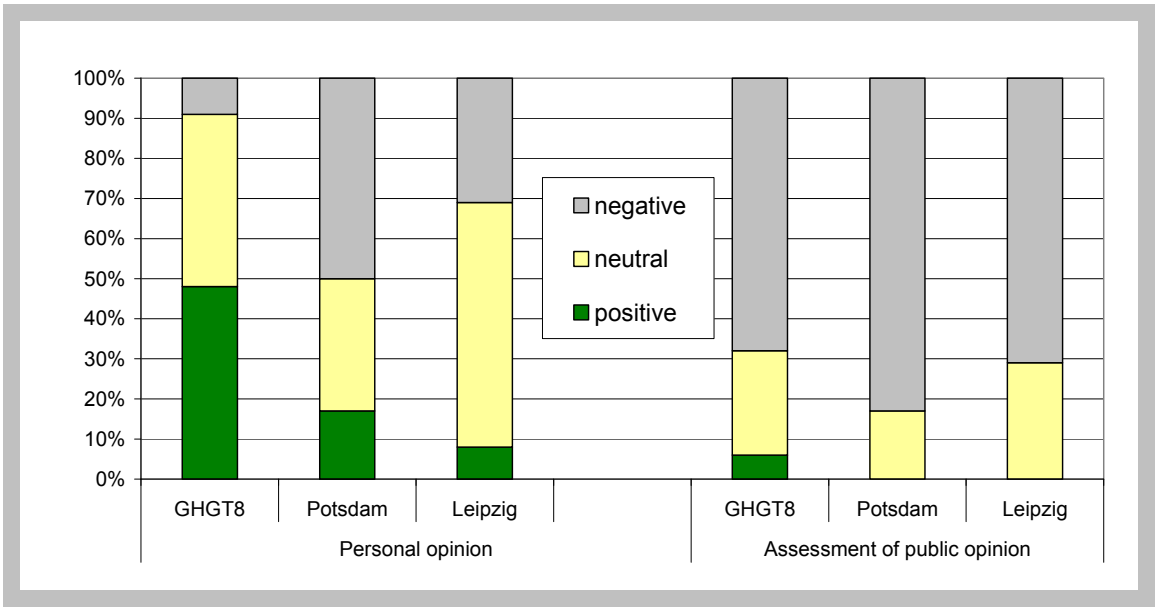


Figure 3.3: Differences between the attitudes of industrial participants



The personal opinion on CCS shows substantial variations between different nations (Figure 3.4). Participants from the UK, Norway, the US and countries outside Europe have the most positive views, participants from France and Germany the most negative views of CCS. However the assessments of public opinion show quite a different picture (Figure 3.5). French respondents have by far the most positive impression of public attitudes. In contrast, Germans have the most negative view.

Figure 3.4: Nationality and attitudes towards CCS

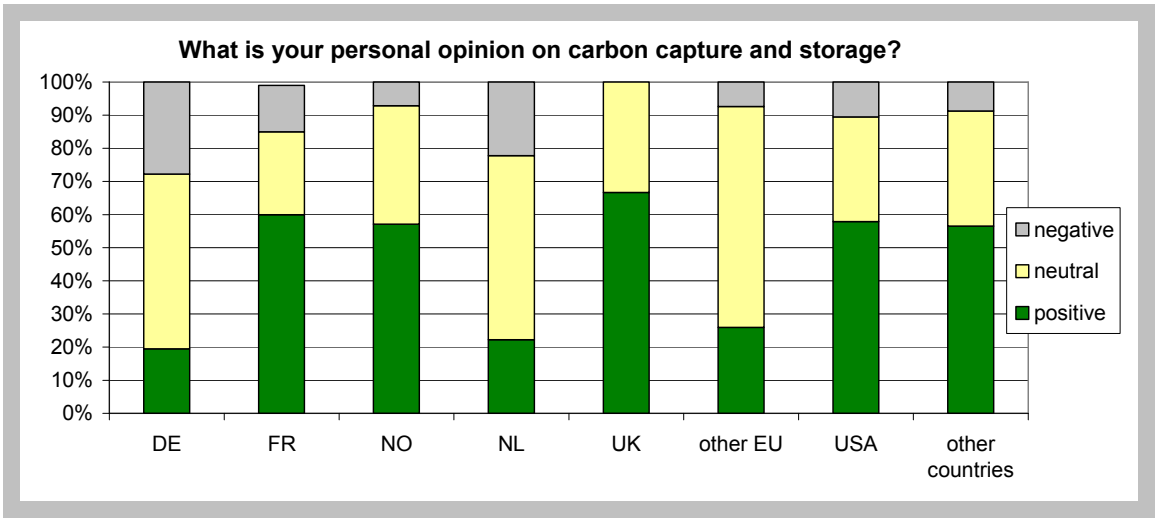
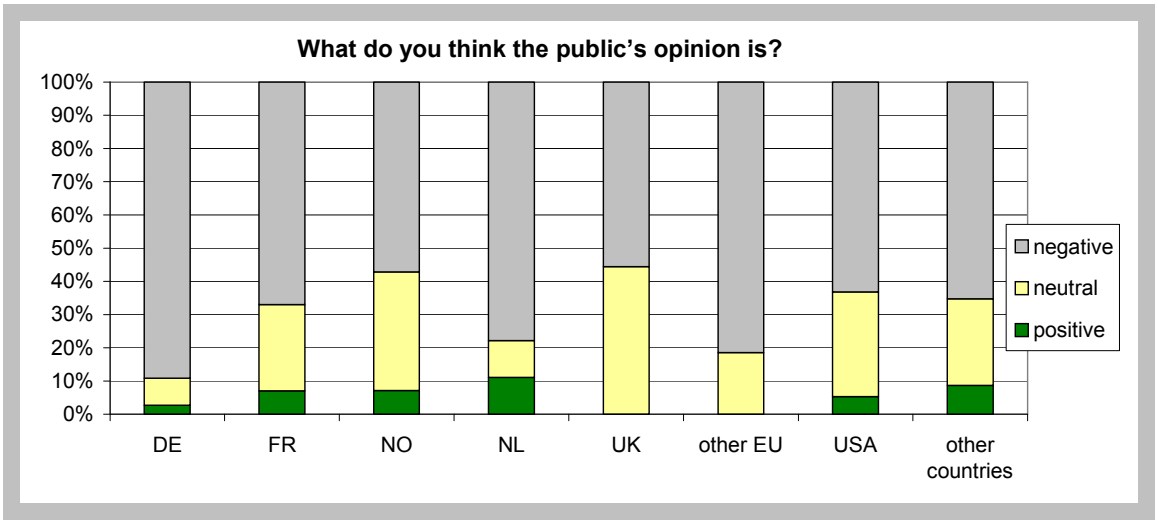


Figure 3.5: Nationality and assessment of public opinion of CCS



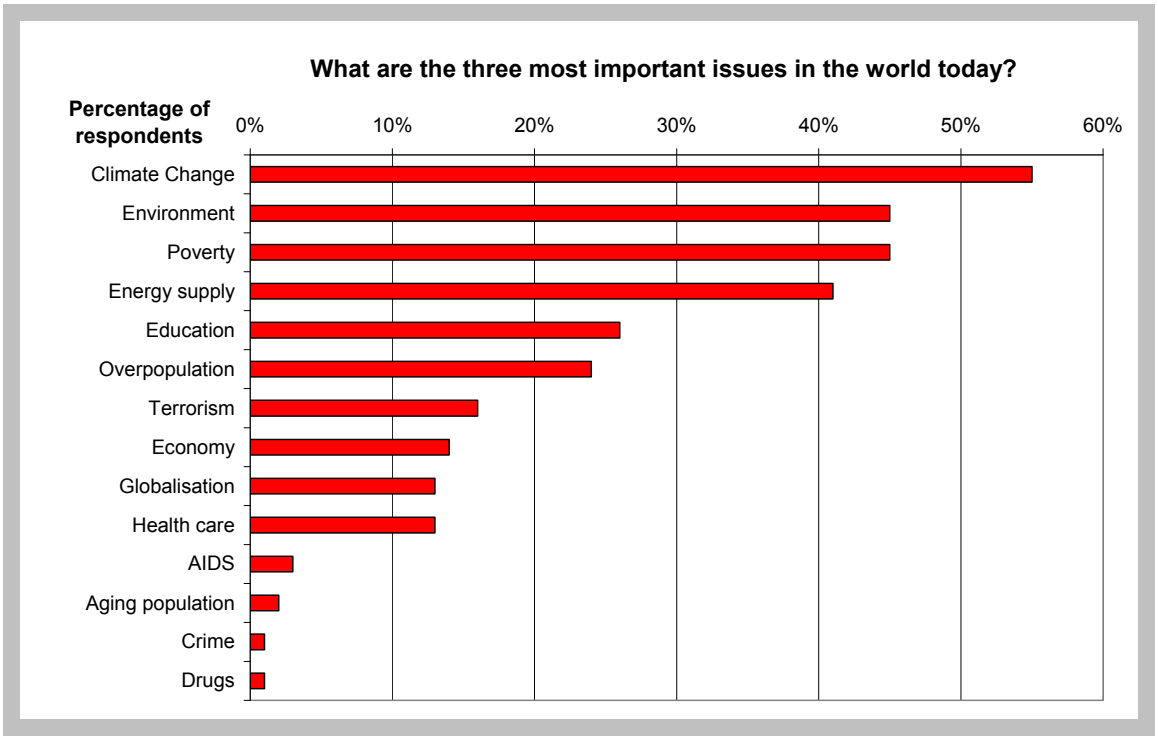
Other personal characteristics also have a significant influence on attitude towards CCS:

- There are less favourable attitudes with increasing age.
- Female respondents have more positive views than males.

- The higher the respondents assess their own degree of knowledge of CCS, the less likely they are to classify their attitude as neutral: there are more positive but also a few more negative views.
- The earlier they first heard about CCS, the more positive their attitudes.
- The assessment of public opinion is only marginally influenced by such factors.

Several questions were compiled to cover the personal relevance of topics such as climate change, energy saving, etc. as well as the role of CCS for climate change mitigation and sustainability. 3 of 14 issues had to be identified as the most important ones currently in the world (Figure 3.6). By far the four most frequently mentioned issues were climate change (55 %), environment (45 %), poverty (45 %) and energy supply (41 %). Less important were drugs (1 %), crime (1 %), aging population (2 %) and AIDS (3 %).

Figure 3.6: Most important issues currently perceived in the world



A more specific question was asked with regard to environmental issues (Figure 3.7); the respondents could select three out of seven environmental problems. Global warming had the highest percentage (86 %), followed by the destruction of eco-systems (71 %) and water pollution (68 %). Air pollution (35 %), toxic waste (20 %), ozone depletion (16 %), and noise (2 %) were less important.

Another question aimed to identify the most important ways of guaranteeing a secure and sustainable energy supply in the long run, this also required the selection of the three most important from among 10 different issues (Figure 3.8). Use of renewable

energies (64 %), energy-saving behaviour (53 %), CCS (43 %) and energy-saving investments (42 %) were mentioned most frequently (Figure 8). Carbon sequestration, such as reforestation (4 %), and extension of large hydropower (2 %) were regarded as hardly relevant.

Figure 3.7: Most important environmental issues

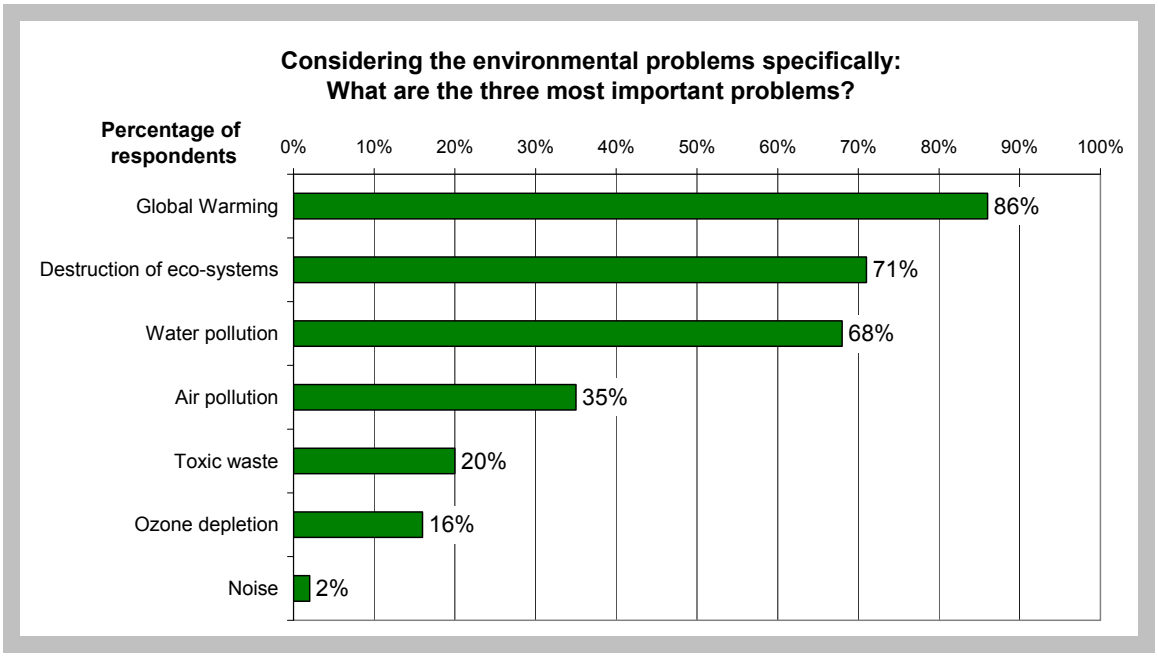
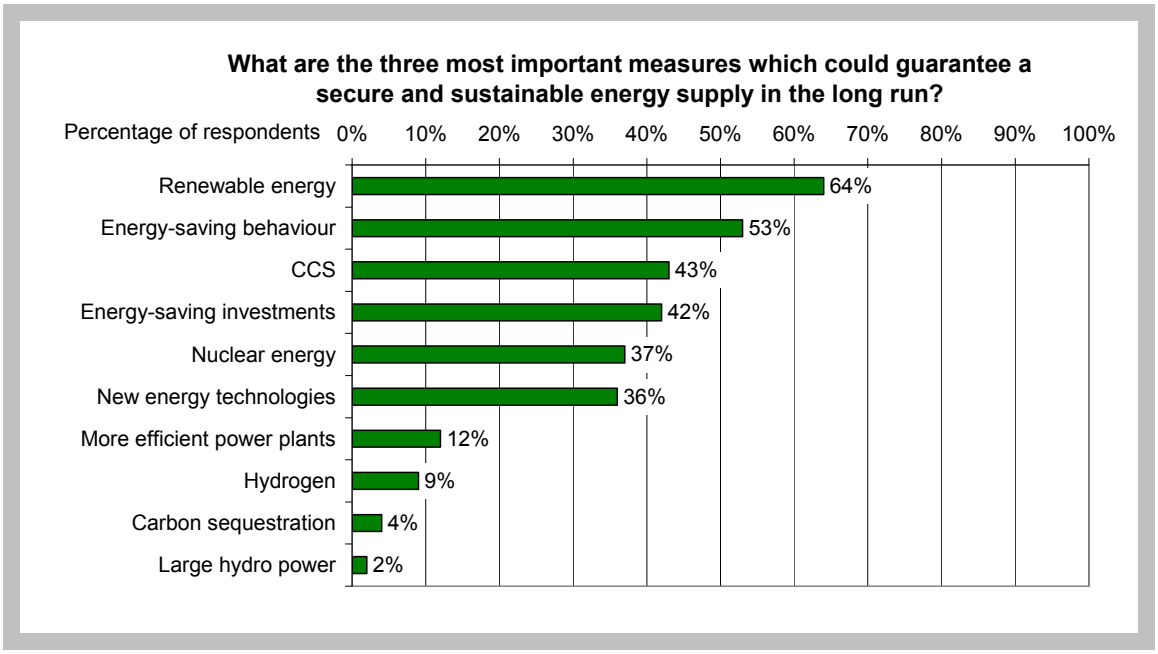
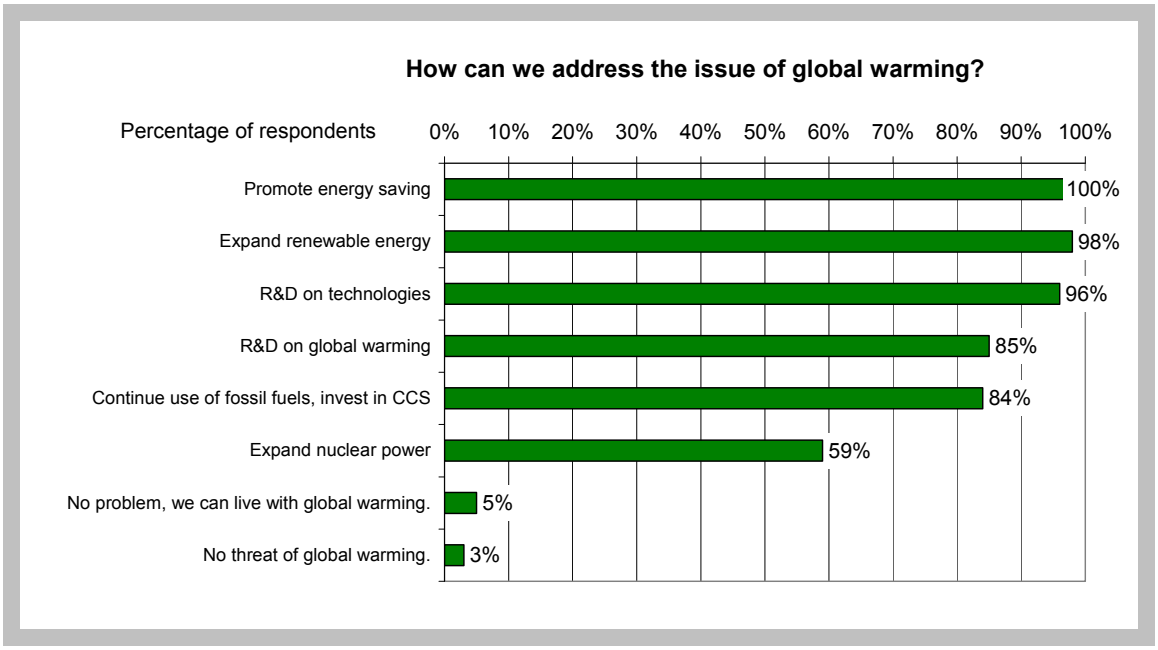


Figure 3.8: Energy options to guarantee sustainable energy supply



A corresponding question asked the participants to answer a statement concerning measures to combat global warming with yes or no (Figure 3.9). Two statements were added to this question: "There is no problem because we can live with global warming" and "There is no threat of global warming". Almost nobody agreed with these statements, whereas all agreed with the need to promote energy saving, almost all recommended an increased use of renewable energy sources and more R&D of suitable technologies in order to solve the problem. 84 % of respondents recommended continuing the use of fossil fuels and investing in CCS and 59 % still recommended expanding nuclear power.

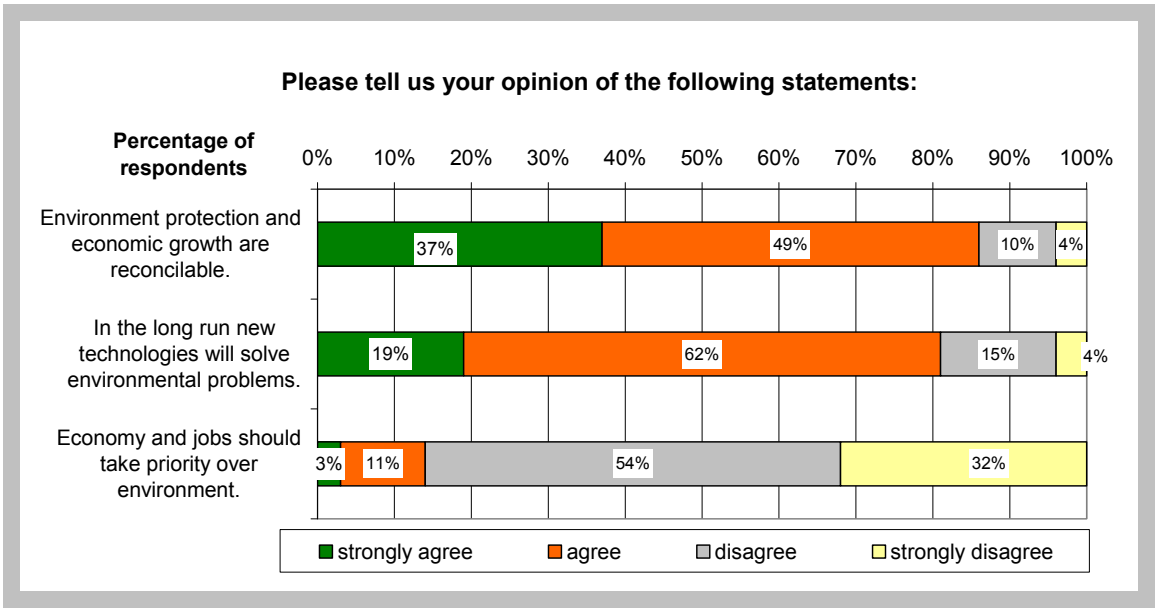
Figure 3.9: How to solve the problem of global warming



Only a few respondents agreed that CCS is the only solution to combat climate change (7 %), even fewer said that "it is not worth making the effort with CCS because there are not sufficient fossil fuel resources left" (5 %). However, more than 26 % believe that "The contribution of CCS to emission reduction is overestimated".

Some general attitudes were also addressed (Figure 3.10). The majority of the respondents argue that "in the long run new technologies will solve environmental problems" (81 %). Even more agreed that "Environment protection and economic growth are reconcilable" (86 %), whereas the statement "Economy and jobs should take priority over environment" was shared by only a few (14 %).

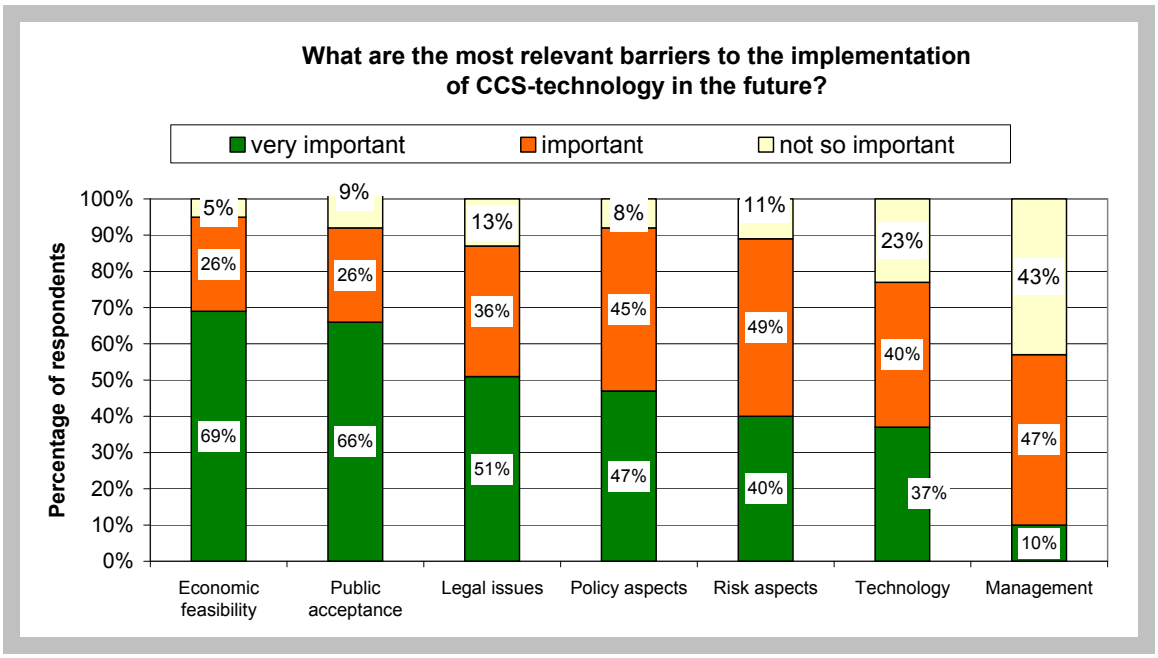
Figure 3.10: General attitudes on environment and technology



3.2 Opinions about CCS implementation

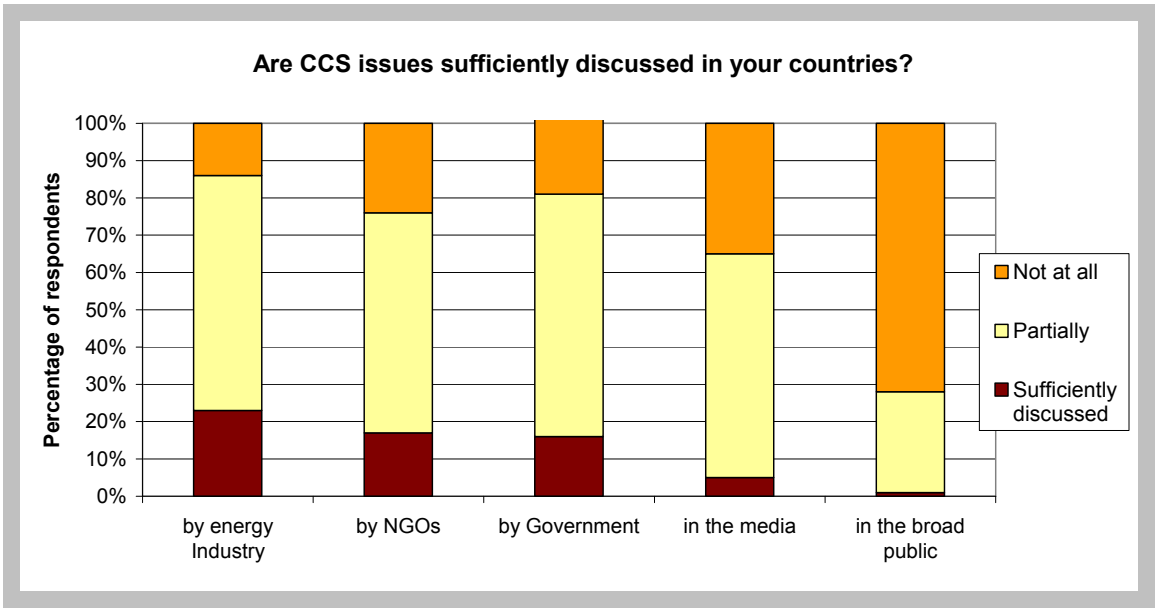
The respondents mentioned economic feasibility and financing, followed by public acceptance as important barriers to the implementation of CCS (Figure 3.11). Management, risk aspects and technology are considered less important. The classification of risks will be described in the following chapter in more detail.

Figure 3.11: Opinions on barriers to the implementation of CCS



Problems with the public acceptance of CCS may be caused by the fact that knowledge has not yet been broadly disseminated and that there are no or only a few public discussions of this topic. CCS is not being discussed, especially in the press and even more among the general public. The respondents perceived the discussion as follows (Figure 3.12):

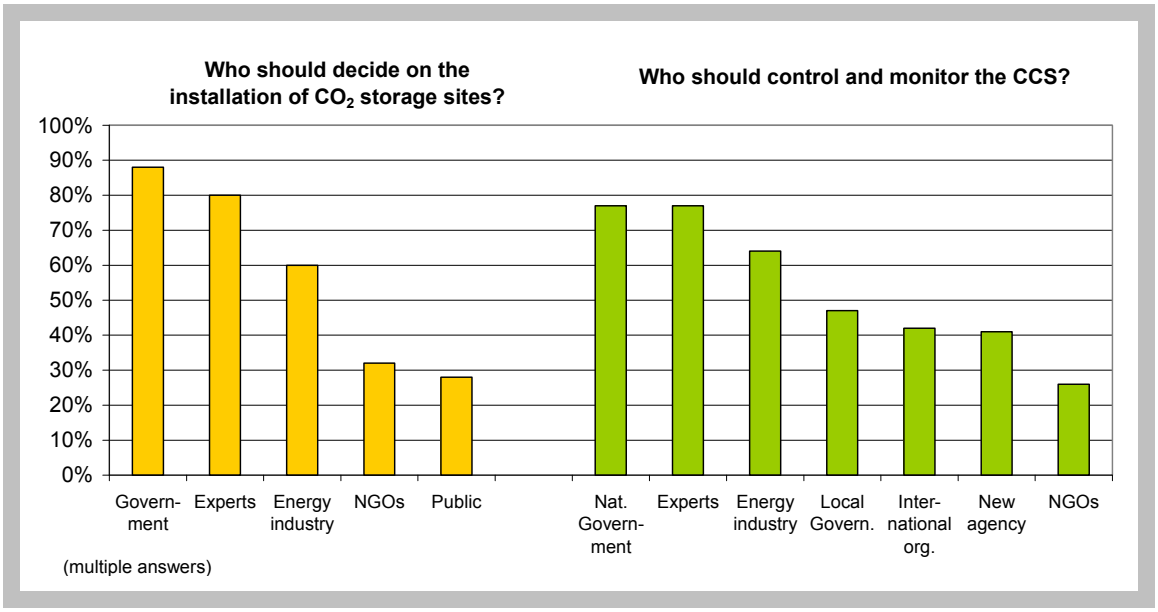
Figure 3.12: Discussion of CCS issues by actors, in the media and in the broad public



The majority of the respondents perceived the discussion to be positive in the government (61 %) and the energy industry (70 %), neutral in the press (68 %) and the general public (80 %), but the view is mixed with regard to NGOs (21 % positive, 45 % neutral, 34 % negative). The result concerning the public runs counter to the above mentioned perception of the public opinion on CCS: 80 % perceive the public discussion as neutral and 10 % each as positive and as negative, whereas in the other question, the large majority said that people "don't like it".

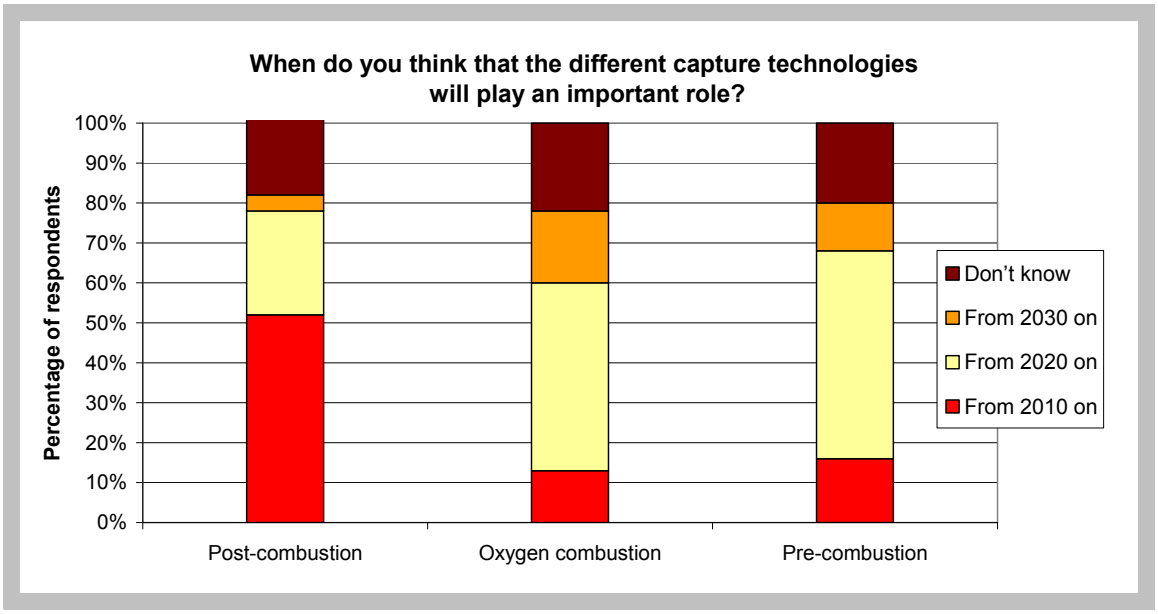
With regard to the future implementation of CCS technology, the conference participants were asked "Who should decide on the installation of carbon dioxide storage sites?" and "Who should control and monitor the CCS?" (Figure 3.13). A large majority of the respondents stated that the government should decide (88 %); 80 % attribute the responsibility to experts and 60 % to the energy industry. Only 32 % mentioned NGOs here and 28 % agreed that the public should decide, e.g. in a referendum. The attitudes towards institutions for CCS control and monitoring were similar. In this question national and local government were separated, and local government received less support. Additional institutions asked for in this question were international organisations (42 %) and "a new Government Agency" (41 %).

Figure 3.13: Preferred decision and control authorities for CCS



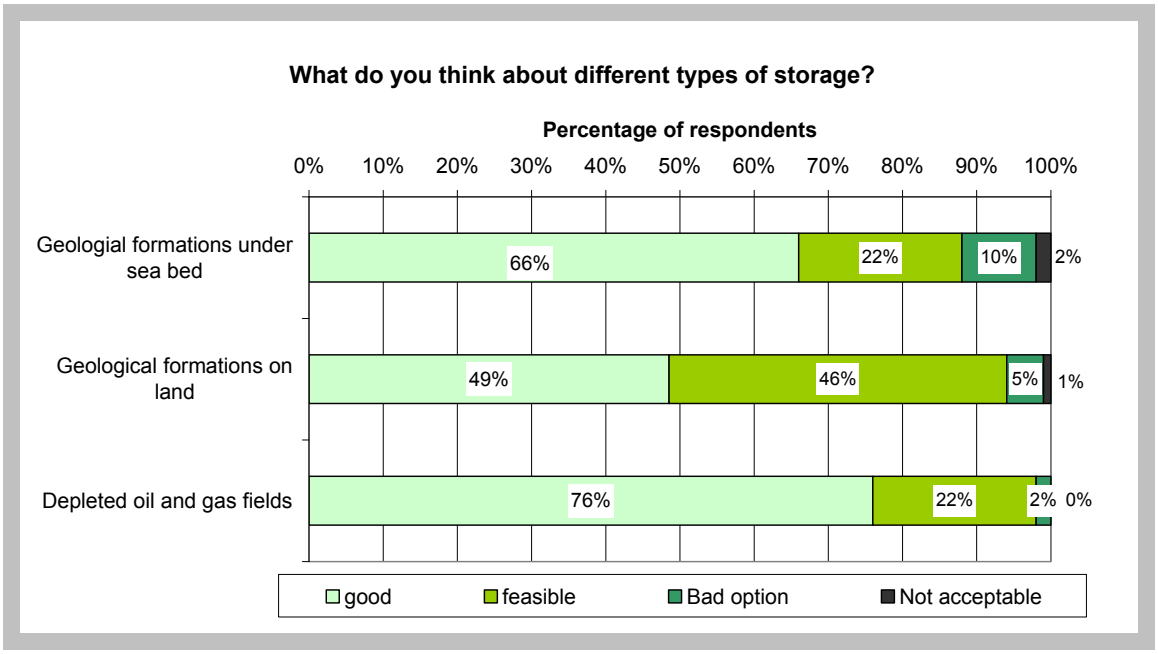
CCS is not only seen as an interim solution. 36 % of the respondents believe CCS will play a role in emission reduction for more than 80 years, 47 % mention a period between 30 und 80 years and only 13 % a maximum of 30 years. Furthermore, the respondents were asked to assess from which year different capture technologies will play an important role. For the majority, post-combustion technology will be relevant first (Figure 3.14).

Figure 3.14: Time perspective for different CCS technologies



Preferred types of storage are depleted oil and gas fields. However, most of the respondents regard all types of storage as a "good option" or at least "feasible" (Figure 3.15).

Figure 3.15: Preferences with regard to CO_2 storage options



The type of fuel for which CCS will be important is obviously coal (94 % "very important"), but to a certain extent also gas (26 % "very important", 52 % "important") and oil (31 % "very important", 35 % "important"). Biomass was not considered as relevant (8 % "very important", 30 % "important").

Another question referred to feelings about the cost of CO_2 capture and storage. 46 % said that CCS will be profitable if the cost can be reduced below 20 Euro per ton of CO_2. 31 % said more than 20 Euro and for 6 % it is principally impossible to achieve profitability. 17 % were not able to answer this question. The average of all respondents was 21.50 Euro.

45 % of the respondents agreed that "the hydrogen economy is a driver for CCS".

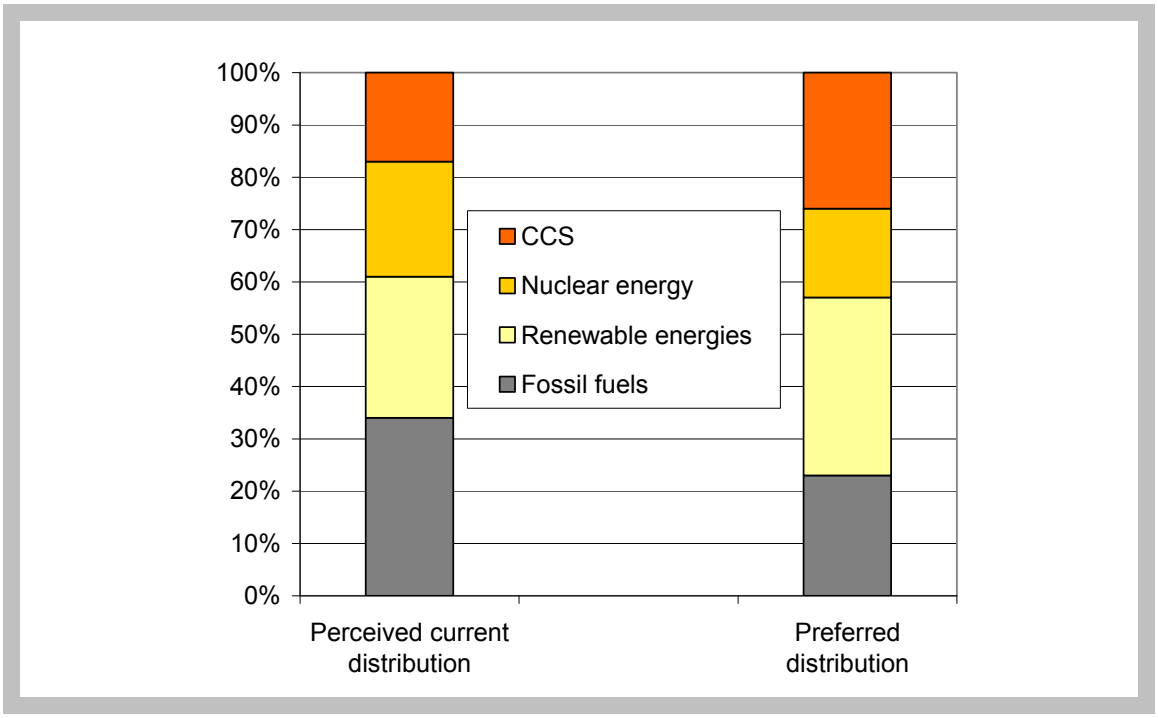
3.3 Opinions on R&D efforts for CCS

The majority of respondents (54 %) regard the worldwide R&D resources for CCS as being "too low", for 43 % they are "adequate", for 3 % "too high". Among researchers, the percentage choosing "too low" is significantly above average.

In addition, the participants were asked about the actual and desired distribution of R&D resources for CCS compared to those for energy sources such as fossil fuels, nuclear energy and renewable energies. The result was a broad range of answers, par-

tially caused by the fact that some respondents focused on R&D in their own country and not on worldwide R&D efforts. The average values are shown in Figure 3.16. This means that the percentage spent on fossil fuels and nuclear energy should decrease in favour of R&D on CCS and renewable energies. 37 % did not give percentages for current distribution and 32 % not for preferred distribution.

Figure 3.16: Perception of the current R&D resources and preferred distribution



Finally, the conference participants should state the countries they perceive as being most active in different fields of CCS: capture, transport and storage. In all three fields, Norway and the United States were mentioned most. With regard to CO_2 capture, Norway (25 %), USA (19 %) and Germany (16 %) are significantly ahead, followed by the UK, Japan, Australia, Canada, and France. The highest activity with regard to transport is assigned to the US (46 %), followed by Norway, Canada, and the UK. A leading function is attributed to Norway (52 %) in storage, followed at a large distance by the US, Canada, the UK, Germany, and Australia. Other countries were mentioned by only a very few. Among the answers there are large variations by the nationality of the respondents, demonstrated by some examples (Table 3.1).

Table 3.1: Perception of leading countries in CCS

		Respondents' nationality			
		DE	FR	NO	US
		%			
Capture:	DE	30	21	0	0
	FR	3	0	7	0
	NO	19	11	43	26
	US	16	14	29	32
Storage:	DE	8	0	0	0
	FR	3	7	0	0
	NO	43	39	79	63
	US	16	4	7	26

This picture is also reflected by the next question asking what respondents think about the activity in their own country of residence (identical to their nationality except for a few cases). The estimation of their own country's role was only evaluated for countries with six or more respondents (Table 3.2). 73 % of Norwegians said that their country is leading, whereas only 25 % of Americans did the same.

Table 3.2: Judgement of the role of the respondent's own country

	• Number of Respondents	• Own country is		
		• leading	• active	• not active
Germany	37	9 %	82 %	9 %
France	28	–	86 %	14 %
USA	19	25 %	55 %	23 %
Norway	14	73 %	27 %	–
The Netherlands	9	–	86 %	14 %
UK	9	–	77 %	23 %
Canada	7	17 %	67 %	16 %
Australia	6	14 %	86 %	–

3.4 Assessment of benefits from CCS

When assessing the role of CCS for their own country, a large majority said that CCS means opportunities to export technology (31 % "very important", 45 % "important"). 55 % think it is very important and 26 % think it is important that CCS "allows use of fossil fuels for electricity production". There are no significant variations between nationalities.

More advantages and possible benefits were included (Table 3.3). The majority agreed with these, except for the statement that CCS is cheaper than other options.

Table 3.3: Advantages and possible benefits from CCS

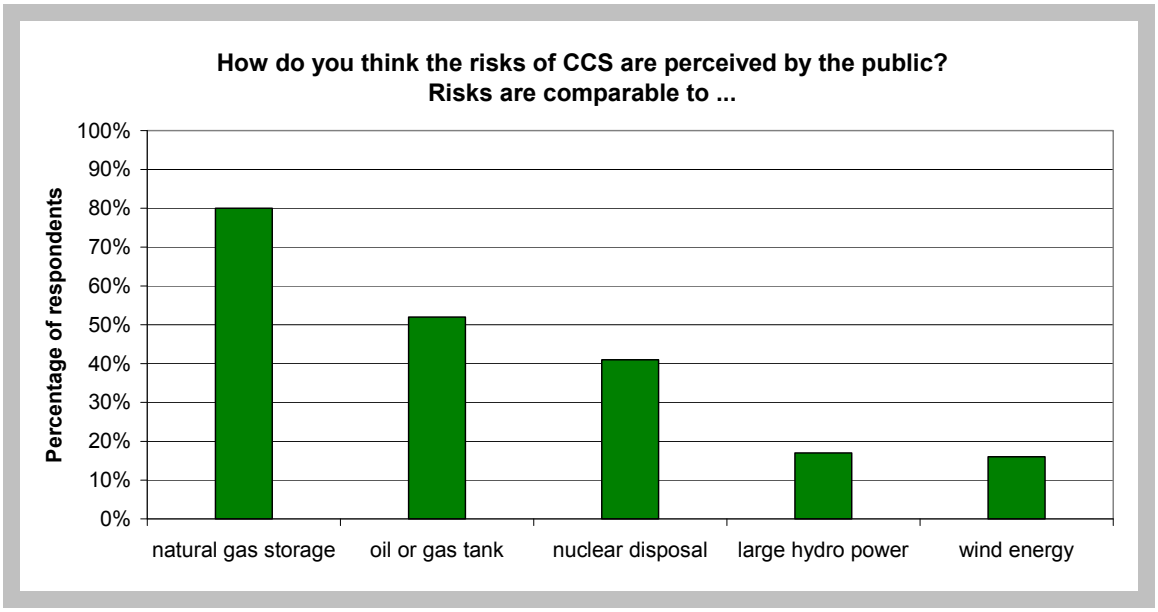
	Percentage of respondents
Carbon dioxide can be used for oil extraction.	94 %
CCS allows time to develop other energy sources.	86 %
CCS gives national industries opportunities to exploit know-how.	77 %
CCS creates jobs.	71 %
CCS is cheaper than other options.	38 %

3.5 Risk perception and assessment

The acceptance of CCS by the general public will largely depend on risk perception. The participants were asked about their personal opinion and their perception of the public opinion on this issue.

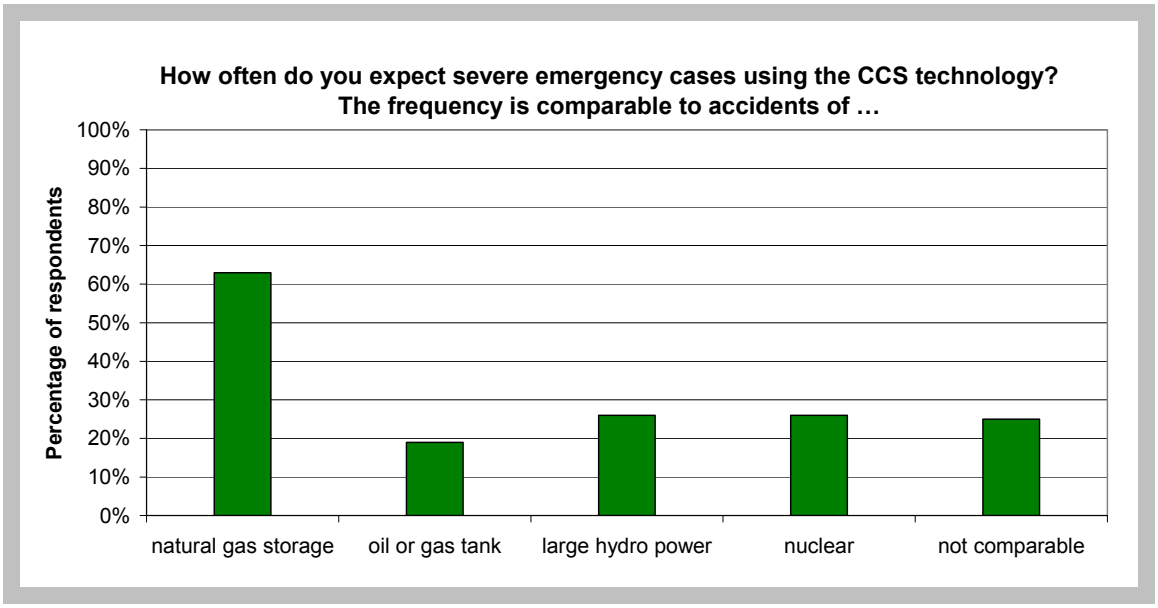
In order to measure the experts' assessment of public opinion, they were asked to state how they believe people compare the risks of CCS with the risks of other energy supply options. According to the experts, the public compare the risks of CCS mainly to the risks associated with underground natural gas storages and pipelines (80 %). 41 % believe that the public compares them to the risks of nuclear disposal sites. 52 % said that people compare it to oil or gas tanks, 17 % to large hydropower plants and 16 % to wind energy plants (Figure 3.17).

Figure 3.17: Perceived public opinion on risks of CCS compared to other risks



The respondents were also asked for an assessment of how often they expect severe emergencies from using CCS technology in comparison with the frequency of other potential emergencies. The highest number of responses were given for underground natural gas storage and pipeline explosions (63 %). 26 % compared CCS to large hydro-power (bursting of a dam), 19 % to oil or gas tank explosions, and 26 % to nuclear accidents. 25 % of the respondents could not compare it to any of the risks mentioned. The answers to this question are shown in Figure 18. In another question, 74 % of the respondents point out that the existence of natural CO_2 reservoirs proves that safe storage is feasible.

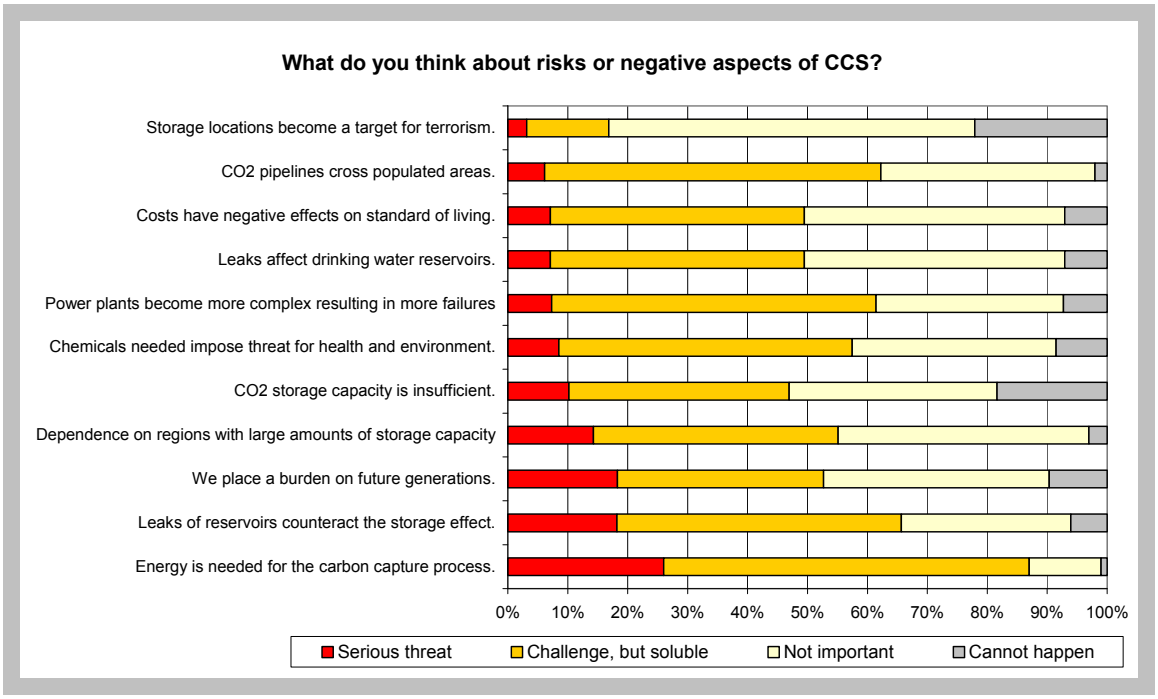
Figure 3.18: Respondents' opinion about CCS emergencies compared to other risks



In addition some statements covered personal attitudes towards the risks of CCS. It is obvious that terrorism or insufficient storage capacity are not seen as serious risks, whereas the additional energy needed for the carbon capture process is seen as a serious threat to the technology (26 %) or at least a major challenge (61 %) (Figure 3.19).

Not explicit risks, but some problems are perceived. 55 % of the respondents said that poor countries have no access to expensive CCS technology. 48 % assume that CCS diverts attention from energy saving, 33 % that CCS increases Europe's dependence on fossil fuels. The majority agreed with the statement that other environmental energy supply problems remain unsolved (68 %), and even more with the statement that CCS will favour large-scale centralised installations (77 %). In order to avoid risks, 33 % recommend the establishment of storage sites in uninhabited regions of the world.

Figure 3.19: Assessment of problems and risks of CCS



4 Results of stakeholder interviews

All those interviewed had doubts about the present technical maturity of CCS, especially with respect to transport and storage. Some even stated a need for research and development for CO_2 capture with respect to a lower efficiency of power stations and profitability. Many respondents assume that CCS will never be profitable and will at least result in higher electricity production costs. Prices of emission certificates, development of alternative energy sources and raw material prices were mentioned as the most important factors of influence on profitability. It was also said that the potential lack of acceptance by the broad public could lead to higher costs of CCS. Some respondents assume that CCS technology will be commercially available in 2020; others expect a broader implementation only in 20 or 30 years time. With respect to transport, the respondents do not perceive large problems except for the cost of infrastructure.

A controversial issue was the necessity of CCS. Only a few respondents said that they regard CCS to be essential in order to achieve climate protection targets in Germany. Others emphasized that CCS allows a long-term use of coal, including lignite, so that Germany can go on using domestic energy sources and thus increase the security of its energy supply. However, if the broad application of CCS only starts in 2020, this is regarded as being too late to combat climate change. Therefore almost all respondents argued that the further development of renewable energy sources, energy efficiency policies and increased combined heat and power production can help to mitigate the

climate problem earlier and may make CCS unnecessary at least in Germany, in the opinion of some, even in a worldwide perspective.

Another perceived problem was the burden for future generations concerning the climate problem, but at the same time it was clear for the respondents that the problem of storing CO_2 cannot be compared to the discussion about the storage of nuclear waste.

CCS is seen as a technology which promotes the centralisation of the energy supply. More decentralised solutions would be socially desirable because they offer opportunities for individual responsibility and influence. This is regarded as an important strategy concerning general attitudes in Germany.

Only a few respondents communicated that CCS is an important and recommendable solution, and of these some see it only as a bridging technology. Another small group communicates fundamental objections or a strict rejection of CCS. For others, the issue has no priority, so there is no action at the moment.

All the respondents describe the public's knowledge of CCS as very low or non-existent. As a result, a public opinion about it does not yet exist. However they assume that acceptance problems will occur wherever the technology is implemented, i.e. a storage site is selected for commercial use. There was a controversial discussion about whether an enforced communication strategy on CCS should be promoted at the moment, but if communication takes place, an objective, realistic and transparent description of the benefits and risks is considered important, neither too optimistic nor too pessimistic. It was recommended not to withhold risks if they exist; this could be worse for CCS implementation than an open discussion. Neutral communication channels, mainly NGOs, possibly inspire more confidence in the public than other actors. Communication of CCS should avoid polarisation, a comparison with the issue of nuclear energy, or conflict with the promotion of renewable energies.

An additional analysis was made in the region of Ketzin in North-East Germany where a research project with small-scale CO_2 storage is being implemented. It turned out that inhabitants of the region have only little interest in the project. This can be concluded from the fact that only a few of them participated in hearings organised by the local government.

5 Conclusions

The surveys showed that most experts have a positive or neutral view of CCS. Influencing factors are nationality, professional background and general attitudes towards energy and environment as well as the perception of benefits and risks. However they are sceptical with regard to public acceptance of CCS because of the lack of information among the public. In addition, a considerable number of experts assumes that the public perceives high risks of CCS technology. The experts classify the level of knowledge in the general public as very low. The discussion of CCS issues in the media is considered far from being sufficient.

However, the communication activities undertaken by stakeholders are not intensive either. Often the experts themselves do not yet have a definite opinion, or they do not see an urgent need to communicate such topics at the moment.

As far as arguments or especially risk communication is concerned, communication strategies should:

- avoid establishing a contradiction between the development of CCS technology and the further promotion of renewable energies or energy efficiency – both highly accepted options for sustainable energy supply;
- instead support the idea of CCS as a "bridging" technology, only relevant until renewable energies are fully profitable;
- clarify the actual risks of CCS, for example compared to natural gas, and avoid risks being identified by the public as similar to nuclear waste disposal;
- avoid an extremely optimistic view of the role of CCS and its benefits,
- instead provide open and neutral information and discussions about CCS.

Another important barrier to the implementation of CCS is obviously the economic feasibility of the technology. The experts interviewed have considerable doubts about its profitability. This is also considered the most important barrier to the implementation of CCS, even slightly more important than public acceptance of the technology.

Part C: assessment of CCS acceptance on a regional level

1 Objectives

The development of opinions of the unknown technology and possibly the emergence of opposition against it will be strongly influenced by the occurrence of problems during the realisation of projects, but also by stakeholder and media interventions. It is very difficult to anticipate such influences in general and to investigate them. The project therefore evaluated existing information on general attitudes and beliefs as a relevant background in selected countries of special importance for the topic. Main research questions were:

- Will there be sufficient public acceptance for CO_2 storage at favourable sites?
- What conditions will probably have to be fulfilled by CO_2 storage projects to earn sufficient acceptance in the public?
- What measures have to been taken in order to inform the stakeholders and the public with the objective to develop a favourable climate towards CCS?

The objective of task 6.4.4 in particular was to develop guidelines for an outreach strategy for a CO_2 storage activity connected to a demonstration plant. Based on the findings from the previous work in Task 6.4.1 to Task 6.4.3 and from other sub-projects, guidelines for an outreach strategy were be elaborated addressing critical thematic issues for CO_2 transport and storage as well as procedural issues that can add to a successful communication with stakeholders.

2 Methodology

Based on the evaluation of existing literature and the survey of professionals as participants of conferences detailed interviews with opinion makers were carried out. Respondents were stakeholders in three selected European regions: UK, Bulgaria, and Germany. They represent the following organisations, which usually have a certain influence on the public opinion and information strategies:

- Energy industry
- Government
- Science
- Trade associations
- NGOs
- Churches
- Embassy

The interviews were carried out either personally or by telephone with a detailed interview guideline. A few persons could not be contacted directly and they filled in the questionnaire themselves. The questions covered the following topics:

- Maturity, profitability, and role of CCS
- Security, risk, and liability aspects
- Attitudes and activities of the organisation
- Discussion of the CCS topic in the public and suggestions for information strategies

UK, Bulgaria, and Germany were selected because institutions from these countries participated in WP 6.4. In UK Especially in UK it was difficult to find persons who were willing to participate in the interviews. In Bulgaria it was difficult to find persons except in research organisations and energy industry who were informed enough to answer the questions. Finally interviews were carried out with 11 respondents in UK, 14 in Bulgaria, and 24 in Germany.

3 Results

3.1 Bulgaria

3.1.1 Background: Bulgarian Energy Sector – current status

Although Bulgaria is not very rich in natural fuels such as coal, oil and gas, it has very a well developed energy sector, which is of crucial importance for the Balkans and the whole South Eastern Europe. The production of electricity is 38 billion kWh (as of 2006). In production per capita, the country is in fourth place in Central and Eastern Europe. Bulgaria has a very large nuclear power plant at Kozloduy with six reactors, out of which only two are online currently (four reactors were taken off-line in 2003 and in 2006 respectively under intensive EU pressure), with a combined capacity of 3,760 MW. They covered about 45 % of the country's energy demand in the past. A second power plant is currently under construction at Belene site with € 1 billion already invested there. It will consist of two reactors of 1,000 MW each and will cost the government another € 2–4 billion.

Bulgaria has extensive deposits of coal, but these are mostly lignite. The reserves of lignite coal are estimated to 4.5 billion tons. They are located in the Maritsa East Coal Basin. As a result all major Bulgarian thermal power stations with a total capacity of more than 2600 MW are located within this region. A new 670 MW power plant is under construction in this region too. Another new 500 to 600 MW lignite fired power plant project is under consideration.

Until recently **CO_2 emissions in Bulgaria** have been relatively low due to two factors: large share of nuclear power generation and huge and long lasting economy depression in nineties of the last century. Nowadays, the situation is definitely different. The nuclear power share declines while coal fired power generation increase year after year along with strong and regular economic growth. As a result Bulgarian carbon emissions have marked a significant increase in 2007. At the same time Bulgarian allowable CO_2

emissions have been cut by the European Commission. Bulgaria wants to renegotiate its 2008–2012 carbon dioxide emissions quota set by the European Commission and may challenge it in court. Under these circumstances German giant RWE has decided to launch new lignite fired power plant project with CCS. Bulgarian Economy and Energy Minister declared to investors coming from USA and UK that the every new TPS has to be based on CCS.

CCS topic is very new for this country. There are very few people that are familiar with this technology. As a result the people taking part in this survey have been gathered mainly from the energy industry and the leading Bulgarian Universities.

3.1.2 Science

There are six respondents from Universities. Another respondent is a representative of an NGO, but it is a scientific federation; therefore his answers are included in this section. With regard to **maturity and profitability** of CCS all respondents said that CCS is mature at least in small scale. However most of them said that it is not profitable without subsidies and until a CO_2 market exists. Except one respondent all experts agree that CCS is a reasonable technology and globally essential because of climate concerns. It creates jobs and allows further use of coal instead of constructing new nuclear power plants. Coal is considered to be a very important energy source in Bulgaria. It can be substituted by renewable energies only for a very small part. Therefore CCS is of critical importance for the further development of the country. This view is closely connected to the assessment of the security of CO_2 storage. The majority of respondents regard the long-term storage in deep geological formations in non-seismic areas as secure. This has been proved by the presence of natural gas storage in Bulgaria. Comprehensive preliminary geological analyses are needed in advance. As a positive example the experiences with the Sleipner field in Norway were mentioned. Two experts stated that it is not secure due to potential leakages, e.g. caused by a natural cataclysm. According the experts good geological conditions and sufficient sites are available in Bulgaria, so that there is no need for exports, Bulgaria could even import CO_2. As a main problem was mentioned that the favourable sites – under the sea and in depleted natural gas fields – are in Northern Bulgaria whereas the large power stations are located in Southern Bulgaria. All respondents agree in the opinion that the transport of CO_2 is secure – similar to the natural gas pipelines.

They also agree that the decision on the installation of storage sites should be made by the Government, assisted by experts of geology. A firm legal base has to be created. One respondent suggested to lay down the issue in the national constitution. The responsibility for the long-term liability in the case of leakages is seen with the energy industry for a period of at least 60 years.

An **official position** of the organisation towards CCS is either not yet defined or positive. Only in few organisations there are controversial discussions among colleagues about the CCS issue. All available, mainly scientific sources of information are used including own research results in one case. Two of the universities communicate their

positive view of CCS very often through press releases and scientific publications, others refer to the communication of their personal attitudes in discussions with colleagues outside of the own institution and in lectures to students. In so far they regard their influence on opinion making as high because they teach young people and future engineers.

All respondents agree that **public awareness** of CCS is very low. Due to this lack of information about CCS the majority assumes that a public opinion is not yet formed, but that the tendency will be positive. The experts regard the publications in the media as insufficient, partly also biased and not competent. They agreed on the demand for more broad information on the CCS subject in all available communication channels and media, such as brochures, events, press articles, internet, lessons, and public discussions. All aspects of CCS should be discussed, mainly the location of storage sites, risks, and energy costs. Risks should be communicated in an open manner by experts with arguments and knowledge and compared to other industrial technologies. One respondent said that a suitable point in time for broad information would be demonstration projects in the starting phase. The others agreed that the information should be given as early as possible. Extensive popular campaigns and public discussion with experts will lead to an unbiased view of CCS. The majority of respondents recommend social research on CCS acceptance issues. The general willingness of the public to pay for environmental energy technologies like CCS is regarded very low because of lack of information and the poverty of large parts of the population in Bulgaria.

3.1.3 Politics

There is only one respondent from a Ministry in the survey in Bulgaria. He regards the CCS as **technically mature**. However power plants with CCS are not competitive compared to the power plants without CCS, but in the future this situation can be changed especially when CO_2 emission reduction is going to be obligatory. CCS has to be considered being indisputable, at the beginning this technology will be exercised in some developed countries. In Bulgaria case, CCS introduction will be delayed not only due to financial reasons but also due to leak of appropriate storage capacities. Good alternatives to CCS are NPPs and HPPs. CO_2 can be stored with low risks in deep geological formations which are not seismic. Unlike the representatives of universities the respondent regards the storage conditions in Bulgaria as unfavourable, at best this could be in north western parts of the country. Transport is also regarded as technically secure. CO_2 storage sites location should be a subject of geological studies, not of administrative procedure. The legal issues are not clear yet, but this is true not only for Bulgaria. The long-term liability has to be shared.

The respondent describes the **official position** of the organisation as positive towards CCS. There is not internal discussion on this topic. The main source of information is local and international workshops. The position is communicated by press releases, reports, events, and the internet, but mainly for experts at the stage being.

The **public awareness** is regarded as very low, CCS is only known at the expert level; experts have a "pro" consent in principle. The media should provide more information for the broad public concentrating on location of storage sites and energy costs. NGOs and citizens' initiatives are regarded as the most influencing actors for the public opinion making. Risks have to be communicated in open manner as soon as demonstration projects have started.

3.1.4 Energy industry

Four interviews with energy supply companies and two interviews with trade associations of energy industries were carried out. Concerning **maturity, profitability, and role of CCS** they have different opinions. Four of them said that the technology is mature. For one of the respondents there is not enough practical application yet, for another one the CO_2 storage on the long run is not yet solved. The majority regards CCS as non profitable. It is not efficient enough and large investments are needed. The others said that it depends on the country where it is used or that is would be profitable as soon as it would be broadly applied worldwide, e.g. if power plants are obliged to capture CO_2. All agree that CCS is reasonable and essential for climate protection. It has to be developed further in order to become economically viable and implemented as soon as possible. Some pointed out that "rich countries" should put the technology forward, whereas Bulgaria has not enough funds although it is especially dependent on benefits of CCS due to its coal dominated energy sector.

Except one respondent all agree that CO_2 storage is secure. This is proved by natural CO_2 reservoirs, but two of them said that there still is need for technological development. There are different opinions concerning potential storage sites and the security of the transport. The majority said that there are not enough options in Bulgaria or the potential sites have not yet been analysed enough. Four experts said that the transport is secure, the others still see a need for further research and development. Decision on storage sites should be made either by the Government or upon international agreement. Propositions by technical experts should also be considered. Half of the respondents said that the energy industry should be responsible for the long-term liability for potential leakage risks. The others see it as a duty of the Government.

The **official attitude** towards CCS of the organisations represented is positive. There are no different opinions within the organisations or no or rare discussions. A communication of the official attitude does not (yet) take place. The influence on opinion making is regarded low.

The level of **public awareness** of CCS is regarded as very low or even "zero". Therefore a public attitude does not exist yet, however three experts expect a rather favourable attitude, as soon as the public will be informed or advised enough. All agree that there should be more broad information about CCS communicated by a bundle of channels, such as brochures, press media, internet, events, and public debates of experts. For the majority of the respondents this has to be done as early as possible. As most important topics for the public discussion are mentioned the location of the storage sites, cli-

mate change issues, risks of CCS, energy costs and the further use of stored CO_2. Potential communicators with influence on public opinion making are consumer organisations, NGOs, Government, local authorities, scientific institutions, labour unions, mass media, and industry. Risks of CCS have to be communicated in an open and circumspect manner. All pros and cons have to be discussed unbiased. Serious research and development and the practical demonstration, that risks can be controlled, can help to convince the public.

3.1.5 Summary of the CCS public acceptance survey in Bulgaria

Almost all respondents find CCS reasonable and globally essential. Only one person (although Technical College Director) has a firm negative attitude.

The public's willingness to pay for environmental energy technologies has been found very low. The reason is may be coming from the fact that all major Bulgarian thermal power plants have introduced massive and costly SO_2 emission reduction facilities recently and this caused significant electricity price increases.

Most of the respondents have found CCS technology ready for implementation. There is a lot of uncertainty about carbon storage potential in Bulgaria. Most of the people hope that CO_2 can be stored locally.

Bulgarian public has a general positive attitude towards nuclear power generation. This is one reason why some respondents regard nuclear power as a real alternative to CCS.

The lack of a relevant legal basis has been found as an obstacle for fast CCS implementation in most of the interviews.

One of the clearest results from this survey is the lack of an official CCS attitude and internal discussion in all respondents' organisations. It is important that this situation will be changed through short-term activities.
Another weak point is the declared very low level of awareness and information on CCS in the public in this country. Significant lack of information and news in the media about CCS is indicated in almost all interviews.

Nevertheless, most of the respondents have found that the public's opinion about CCS is rather in favour. The rest think that this opinion is not formed yet. The news about CCS in the media has been found insufficient and neutral. As a result, more broad and active information about CCS is reasonable. Most of the people think that all aspects of CCS deserve intensive discussion. CCS risks have to be discussed in an open manner without hidden facts and shortages. Most of the respondents are convinced that the public has to be informed as early as possible about any upcoming CCS project.

The main result of the survey is that CCS technology could be well accepted in Bulgaria but intensive preliminary informative work and discussions are needed.

3.2 UK

3.2.1 Background: The Energy Sector in the UK – current status

The Department of Business Enterprise and Regulatory Reform (DBERR), previously DTI (Department of trade and industry), oversee the regulation of the energy sector. DBERR's role is to help ensure business success by raising productivity in order to keep the UK competitive both in the UK and by encouraging foreign investment to the UK (DBERR 2008). The Energy Group from DBERR was separated into a separate body in October 2008; the Department of Energy and Climate Change (DECC).

The DTI 2007 white paper, 'meeting the energy challenge' (DTI 2007a), outlines aspects of the current UK energy supply and climate change policies. Security of supply and tackling climate change represent two key aspects of UK energy policy.

Currently, about 90 % of the UK's energy needs are met by oil, gas and coal. Although it is anticipated that renewables and other low carbon technologies will play an increasing role in the UK energy mix over the longer term, fossil fuels will continue to provide the predominant source of energy for decades to come: by 2020, fossil fuels are still expected to supply the great majority of UK energy needs (DTI, 2007a). However, although significant North Sea oil and gas reserves remain, they are declining, and, imports are likely to play an increasingly important role. The UK became a net importer of gas in 2004 and by 2010, gas imports could be meeting a third or more of the UK's total annual gas demand, rising to around 80 % by 2020. The UK is also already a net importer of oil, and by 2020 imports could be meeting up to around 75 % of the UK's coal demand. Decrease of indigenous resources of oil and gas and increasing importance of imported fuels could potentially result in higher and more volatile energy prices, and greater vulnerability to overseas disruptions of energy supply. The Government are, however, confident that their policies and the market will ensure reliable supplies of these fuels at competitive prices to both industry and domestic consumers. In terms of future energy supply, companies will be encouraged to invest in large-scale energy investments including a wide range of low carbon emissions to help retain a diverse energy mix.

The Government has concerns over security of energy supply, particularly relating to gas supplies and has implemented a series of programmes to address the growing reliance on imports. Improvements have been made to compressors on the existing Zeebrugge interconnector, and the major new Langeled South pipeline from Norway (Ormen Lange field) has been constructed and, in the southern North Sea, an interconnector pipeline from Bacton to Balgzand (Groningen, Holland). However, applications to develop import and gas storage facilities in suitable areas are subject to numerous planning regulations and consent processes that lead to major delays in the delivery of important gas supply infrastructure (DTI 2003, 2006b&c, 2007b).

The need for increased gas supply infrastructure and a regulatory environment to allow such infrastructure to be delivered to the market in a timely fashion was set out by the Government in the (DTI 2003). This was re-iterated in two further Government papers: 'The Energy Challenge: Energy Review Report' of July 2006 (DTI 2006b) and 'Meeting the Energy Challenge: A White Paper On Energy' of May 2007 (DTI 2007a).

Overall trend of UK oil production shows an increase from 1970 to a maximum of approximately 137000 thousand tonnes in 1999. Production has then slowly declined to the present day (57000 thousand tonnes for 2007). Oil imports gradually increased (Dukes 2008a). Over the last 12 years, coal production has decreased from 53000 thousand tonnes/year to 17000 thousand tonnes per year. Import and export quantities have remained relatively stable over this period with an average annual value of around 32000 and 760 thousand tonnes per year respectively (ET 2008). Overall trend of gas production (natural gas and colliery methane) increased from 1970 to a maximum of 1261000 GWh in 2000 and then slowly decreased to 839000 GWh in 2007. Gas exports began in 1992, reached a maximum in 2003 (177000 GWh) (DUKES 2008b).

Electricity production remained fairly constant from 2003-2007 averaging around 394000 GWh a year (DUKES 2008c). Imported electricity increased slightly over this time period. Average demand for electricity over the period 2003-2007 was approximately 401000 GWh.

The Stern Report (Stern 2006) estimates the annual cost of not tackling climate change to be at least 5% of GDP each year, with poorer economies suffering higher costs. This report also estimates the cost of stabilising greenhouse gases in the atmosphere at between 450 and 550 ppm of carbon dioxide equivalent to be around 1 % of GDP in 2050 (Stern 2006). The most recent report by the IPCC details predictions that climate change will bring severe consequences including flooding, sea-level rise leading population displacement and increased pressure on water resources.

The UK considers there to be 5 essential factors to establishing an international framework to tackle climate change from 2012 onwards (DEFRA 2008);

1. Shared vision of the long-term goal for stabilising greenhouse gas emissions to provide a framework for international efforts and offer more certainty to business for future investment

2. Establishing a global carbon price to simulate investment by the private sector in clean technology and energy efficiency including the carbon pricing and emissions trading scheme. Emissions trading could result in significant transfer of resources to developing countries through innovative mechanisms such as the Clean Development Mechanism (CDM).

3. International cooperation on technology and energy efficiency to stimulate and accelerate research and deployment of low carbon technologies and overcome barriers to cost-effective action to reduce demand for energy.

4. Incentives for sustainable forestry management that reflect the value of avoiding deforestation; and
5. Support for developing countries to adapt to the unavoidable impacts of climate change.

UK energy policy also supports the European Commission's proposals to save 20 % of the EU's energy through energy efficiency in the industrial, commercial, public and domestic sectors by 2020. Government measures including those set out in the white paper (DTI 2007a), aim to cut carbon emissions by more than a quarter compared to 1990 levels, as well as making significant cuts in gas consumption. Cost of climate change to the UK will include direct costs such as storm damage, implementing defences (e.g. coastal defences), loss of valuable low-lying land and population displacement

Incentives are already offered to energy intensive businesses to save energy and reduce emissions, for example through Climate Change Agreements (which currently run until 2013) and through the EU-emissions trading scheme (EU-ETS). Efforts are being made to minimise the regulatory burden to business is kept to a minimum. A review of the regulatory framework including EU-ETS, Climate Change Agreements, and domestic trading mechanisms such as the proposed Carbon Reduction Commitment in response to the report by the Better Regulation Commission; Regulating to Mitigate Climate Change (BRC 2007).

3.2.2 Science

As there is only one answer, these results are not representative. With regard to **maturity, profitability, and role of CCS** it was stated that the CCS technology is considered quite simple, and its implementation is only a financial issue. It could be important in the energy mix, but priority is given to nuclear energy. However the specific question of security of CO_2 storage shows that the respondent perceives a need of further development to avoid leakages in depleted oil fields and saline aquifers. Capacities in both reservoirs are available in many places in UK. Security of transport is regarded as a question of cost. Government should have the long-term liability for potential leakage risks in storage sites and transport.

The **official position** of the institution (University, geoscience) is generally positive towards CCS, but all options are taken into consideration.

The **public awareness** of CCS is regarded low. News about CCS in the media are evaluated being neutral and unbiased. The topic which is discussed mostly is cost. The respondent is no convinced whether more information is needed than given at present. Information should take place when the population is concerned concretely, e.g. about transportation network and what actions are taken to prevent local leakages. Concepts are necessary to convince the public if CCS causes additional costs of energy.

3.2.3 Politics

Two persons participated in the survey, one of them is more and the other less familiar with the CCS technology. **Maturity and profitability** of CCS are not yet given, but regarding costs the consumer has to pay for energy, and renewable energies for example are also expensive. CCS is considered necessary in the energy mix; renewable energies cannot substitute fossil fuels completely, and increasing global warming has to be avoided. Therefore CCS should be fitted to all fossil fuel power plants irrespective of economic arguments. Storage is quite secure; risks of continuing CO_2 emissions are greater than those of storage. Oil and gas fields are recommended as storage sites. Transport cannot be completely secure. Government or energy agencies should decide on CCS implementation.

In the **public** CCS is not well known or understood. Carbon sequestration is difficult to understand for the broad public, but its role for responding to climate challenge would carry support in principle. People should be informed more although there are doubts whether there is interest in the technology. The information should concentrate on safety and hazard risks, justification for the selection and development of storage sites, costs for CCS compared to costs of climate change, who will pay the costs, and issues of responsibility. Risks should be communicated on a comparative basis. Demonstration projects can create confidence. The public concerned should always be informed before CCS is implemented. Communicators and multipliers should be informed in more detail in order to understand the technology. Information should take place as soon as possible. Social research is useful to assess public attitudes. Generally there is an increasing acceptance in the public to pay for more environmentally sound approaches in the supply of energy.

3.2.4 Energy industry

The evaluation of the survey of energy industries is based on seven respondents. Except one of them they all stated that the **maturity** of the CCS technology is not yet given, at least not at full commercial scale. Outstanding issues include the development of efficient techniques for stripping CO_2 from flue gas, construction of a CO_2 distribution network, definition of regulatory frameworks, establishment of monitoring techniques, monitoring possible leakages, cost, obtaining planning permission for all the processes involved, availability of suitable storage locations, long term monitoring of storage locations, public's perception of CCS, and insufficient support of the Government. CCS is considered not to be profitable today.

CCS is regarded as **essential for a transition** period as long as coal is needed in the energy mix. Climate and pollution is the principle focus, and CCS is indispensable alongside to the development of renewable energies as well as energy efficiency improvements and demand management. The storage of CO_2 is considered to be secure provided that further research will be done and risks assessments undertaken in each site planned. It has to be taken into account that natural storage sites are stable for geologi-

cal time periods. The experts agreed that sufficient storage options are available in the UK whether onshore or offshore, e.g. in saline aquifers, gas or oil reservoirs. Transport costs have to be taken into account in the case of offshore storage. The transport is also regarded as relatively secure; risks are seen, but they appear to be manageable in an acceptable way given sufficient investment and appropriate control measures.

There are different opinions with regard to **decision making** on storage sites and long-term **liability**: decision should be made either by Government, industry, or geologists. However the respondents agree that a clear regulatory framework is needed. The responsibility for long-term liability is allocated to Government by most of the respondents, one respondent said that it is the duty of the plant operator, and two respondents stated that this still is an unsolved issue and a big discussion in CCS circles.
The general **attitude** of industries towards CCS – if there is an official one – is positive. It is regarded as technically viable and offers large opportunities for the UK in addressing climate change and future commercial use. Mostly the attitude is also communicated to the public, either by participation in EU, governmental, or trade bodies, published papers, expert seminars, or other channels. However the influence on opinion making is considered to be relatively low, except by one respondent who regards his organisation as leading in CCS.

All respondents regard the **public awareness** of CCS as very low. The broad public is not enough informed about the issues and therefore not interested. The small percentage of those who are informed either sees CCS as a solution for climate warming, either rejects it because of practical difficulties in the implementation. One respondent mentioned a favourable public opinion in the case of a demonstration project (maintaining jobs, offshore location). The views of the role of the media vary among the respondents, some regard the publications as biased, some as balanced, but all agree that there should be more information. Up to now, issues such as onshore storage sites, costs, risks, long-term liability, benefit for climate change, negative impact on energy cost, or local opposition. NGOs, academia, and the media are regarded as most influencing on public opinion. Scientific organisations can provide the most balanced information whereas media and NGOs tend to stir up fears. Therefore a mixture of communication channels should be used, also Government and industry has an important role in communicating CCS issues. Risks of CCS should be communicated in an open and honest manner, compared to risks of other technologies – which are considered to be equal or more severe, also in order to avoid that long-term liabilities are regarded in a similar way to the nuclear waste issue. Information should take place as early as possible allowing an informed debate. More demonstration projects are necessary.

3.2.5 Church

The respondent did not engage in CCS issues before, but well enough informed to answer most of the questions. In his view CCS is **not mature enough**, but demonstration projects such as Sleipner show that the technology can be done. It is not yet profitable, additional energy is needed for the storage underground. In European scale CCS is considered to be necessary because the use of fossil fuels cannot be abandoned. Storage

options are sandstone or limestone, but this should be carefully analysed, especially regarding the long-term aspects. Also transport options need further research; lessons should be learnt from oil and gas industry. Politicians should decide on the implementation of CCS, having scientists and economists as consultants. The long-term liability lies with the industry which carries out the storage, but government has also some responsibility.

Besides the general support for environmentally friendly technologies there is **no official position** of the organisation towards CCS. The role of the church is to be informed and to give moral-ethical input "how to use the planet". However the influence on technological development and its use is low.

The **public awareness** of CCS is considered very low. The public has not enough knowledge to have a certain opinion. The respondent did not perceive yet news about CCS in the mass media except in the internet which is not accessible for everyone. He stated that more information is needed to reach a broad audience. The information should take place as soon as possible. Risks should be communicated honestly. Social research is needed to learn how to make the communication efficiently. Generally, a growing acceptance is seen for the need of cleaner energy and change of lifestyle, and the public might be willing to pay for a cleaner energy.

3.3 Germany

3.3.1 Background: The German Energy Sector – current status

Efficiency objectives together with supply security and environmental compatibility are central aspects of energy policy in Germany. The Federal Ministry of Economy and Technology (BMWi) is responsible for the implementation and the Federal Ministry for Environment, Nature Conservation and Nuclear Safety (BMU) for fundamental environmental policy issues as well as climate protection, environment and energy and safety of nuclear facilities and nuclear supply and disposal. Energy research is a cross-sectoral task, e.g., institutional funding of energy research including basic research and efficient energy conversion, renewable energies sources (RES) and nuclear energy by the Federal Ministry of Education and Research BMBF together with BMWi and project-based funding on RES by BMU.

Since 1990 primary energy production sharply decreased mainly due to reduced extractions of hard coal in West Germany and limitation of lignite mining in Eastern Germany. By 2018 it is planned to phase out hard coal subsidies. The primary energy net import rate published by BMWi (2008) was 71 % in 2007 compared to 57 % in 1990. Import dependency was near 97 % for oil, 83 % for natural gas, 67 % for hard coal and 100 % for uranium (note: nuclear energy often is considered as a domestic source). Thus, domestic energy production is mainly based on lignite and increasingly by renewable energy sources promoted by the Renewables Law (EEG) and the Market Incentives Programme.

Primary as well as final energy consumption showed a decrease in the period from 1990 to 2007 (–6 % or –9 % respectively; AGEB 2008). In the German energy mix oil is still representing nearly 34 % of primary supply, gas 22 % and coal 26 % (of which hard coal 14.2 % and lignite 11.5 %). Furthermore, the 2007 share of nuclear energy is 11 % and renewable energy sources represent 6.7 % (AGEB, BMU 2008).

Mainly due to modernisation effects in Eastern Germany and realization of climate protection measures GHG emissions decreased in the past. An integrated Energy and Climate Programme was elaborated. The National Energy Efficiency Action Plan documents the elements of the EU Directive on Energy End-Use and Energy Services (ESD). By 2007, Germany has already fulfilled a large part of its obligation of European climate policy burden-sharing under the Kyoto Protocol (Bundesregierung 2008: GHG reduction by 20.7 % compared to the 21 % target against the 1990 level). The EU Emission Trading Scheme is a driver for additional emission reductions in the future.

On the other hand, electricity consumption increased by more than 12 % from 551 TWh to 619 TWh if net losses and internal use are considered as well. Gross electrictity production including feed-in of third parties into the public grid increased from 550 TWh to 632 TWh in the same period (export surplus 2007: 14 TWh). Compared to the 1990s the change in production structure was in favour of natural gas (from a 6.5 % share to 11.6 %) and renewable energy sources (from 3.2 % in 1991 to 14 % in 2007, original target for 2010: 12.5 %). The shares of lignite (25 %, 1990: 31 % using inland deposits), hard coal (22 %; 1990: 26 %, more and more based on imports) and nuclear energy (22 %, 1990: 28 %) continuously became less important (AGEB 2008).

Following elections in 1998 German Federal Government (Social Democratic Party and Green Party coalition) made an agreement with energy utilities to phase out nuclear power. In April 2002, this agreement was implemented by an amendment to the Atomic Energy Act giving a limited lifetime generation allowance (i.e. closure of all nuclear plants by about 2022). The 2005 coalition agreement by Christian Democrats and Social Democrats emphasizes that the parties involved disagree on the further use of nuclear energy but agree on the need to solve the problem of radioactive waste disposal. Future political parameters (time frame after elections in 2009) are to amend the agreement with the utilities (e.g. prolongation of commercial electricity generation) or to confirm the phase-out law.

The public debate on future electricity supply mix (especially base load supply) is very controversial in Germany. Most important aspects are the future role of nuclear energy, additional need of coal-fired power plants and the management of fluctuating renewable energies (BMWi 2008). A recent scenario sponsored by BMU (Nitsch 2008) shows the long-term possibilities to phase-out nuclear energy and yet to limit CO_2 emissions. Key measures outlined are intensified promotion of renewable energies together with boosted efficiency improvements in order to meet the national and EU climate protection targets. In 2007, the federal government implemented an "Integrated Energy and

Climate Programme" aiming at a 30 % share of renewable energies in total energy supply in 2020.

Besides replacing nuclear power German actors in energy policy are faced with the need to also replace a large part of the fossil fueled power station capacity in the next decades. For this time span studies on future electricity demand expect a further increase. The public debate is focused on a potential gap in electricity generation for 2020 (ETP ZEP).

In view of these boundary conditions vigorous discussions about the mitigation option CCS as bridging technology are under way. Recently published studies by Greenpeace and McKinsey & Company assessing CCS show contrasting results.

Within the scope of R&D the so-called COORETEC initiative by BMWi (CO_2 Reduction Technologies) explores the potential of new technologies (long-term goal: zero emission plants). In addition, actors in the programme "Geotechnologien" are analysing the potential formations for storing CO_2 in Germany (Jülich Research Centre).

The development of CCS is a priority research field and a key element of the Integrated Energy and Climate Programme in order to confirm the technical, environmental and economic feasibility (Decision of the German Cabinet on August 23rd/24th 2007 at Meseburg). Measures include development of a suitable legal framework and construction of demonstration power stations in Germany (see also actual industrial and utility activities such as Vattenfall in East Germany and participation of German institutions in international programmes). The federal government aims at the inclusion of the CCS in the EU Emissions Trading Scheme and at incorporation into the post-Kyoto regime. BMWi and BMU are developing a detailed roadmap for CO_2 capture. For storage BMBF (Federal Ministry of Education and Research) and BMU are responsible partners.

3.3.2 Science

Two experts were interviewed. **Maturity, profitability and role of CCS:** They regard CCS as by far not mature concerning CO_2 sequestration (at least the problem of additional energy needed), but also transport to some degree (corrosion of pipes). Storage is regarded as secure in depleted oil and gas fields, and in saline aquifers, but not in oceans. A risk lies in the available capacities. Costs of CCS will make the use of coal so expensive that renewable energies will become competitive. One expert said the coal would not have a future if external costs of use of coal were reflected by the price. The other one said that for the next 50 years coal is indispensable, and therefore CCS is necessary as a bridging technology. Countries where energy supply is mostly based on coal cannot be prevented from using it. Transport of CO_2 is regarded as secure as the transport of oil and gas, at best it is a question of costs.

An **official attitude** towards CCS of the organisations represented does not exist. One of the respondents said that he tries in expert or public discussions to communicate rea-

sonable arguments pro CCS whereas the other side mostly emphasises rather emotional points of view.

Both respondents regard **public awareness** of CCS as very low. One respondent argues that people are not very interested in how the energy supply will be in the future because energy industry will communicate supporting arguments whereas the opposition, such as NGOs etc., does not have enough funds for a broad communication. The other respondent expects more opposition because of a generally negative attitude towards coal and large power plants and the emotional arguments of opponents which lead to polarisation. Both plead for more information. This should be given now or when demonstration projects start and should be neutral and factual. Risks should be mentioned, together with solutions how to control them.

3.3.3 Politics

Interviews with representatives of the largest parties in Germany were carried out. (Due to large differences in the attitudes, the respondent of the "Green" Party is included in Chapter 3.3.6.) **Maturity, profitability, and role of CCS:** The respondents said that CO_2 sequestration is feasible, but storage is mot mature. There are still technical problems to be solved, and the legal framework is not yet developed. CCS is not yet regarded as profitable. The profitability depends on the development of CO_2 prices, emission trading, prices of other energy sources, and the loss of power production efficiency. The respondents agree that there is need for CCS for combating climate change, at least for a transition period until renewable energies can play a leading role. Germany or the EU could do without CCS, but worldwide the use of coal for power production will increase for many years, e.g. in China. The future role of coal will depend on the development of CCS. If it will not become mature, coal has to be substituted by other fuels. The respondents did not want to commit themselves concerning the security of CO_2 storage and rather relay on engineers and geologists who say whether CCS is a realistic perspective. Natural gas storages were mentioned for comparison. There were no clear views concerning transport. Generally, the legal framework has to be developed and decided politically.

The **official attitude** of the organisations is either slightly positive – for a transition period – or not yet settled. They agree that there should be a clear political decision which sets a framework for the further development of energy sources as soon as the feasibility of CCS is proved and the main problems solved. The worldwide role of CCS has to be defined and its role in the energy mix. One respondent said with regard to potential burdens for future generations that small leakages of CO_2 storages or pipelines will not create many problems as far as CO_2 emitting fuels will not be used any more in future.

Public awareness of the CCS issue is regarded as low. The concept mostly known could be "clean coal". People are much more informed about renewable energies which are broadly accepted and regarded as solution for all energy problems. Public acceptance of CCS depends on regional aspects: coal is more accepted in coal mining regions,

CCS will find little acceptance in CO_2 storage regions. One respondent expects opposition if certain opinion leaders tend to communicate emotional arguments against CCS. Two respondents argue that CCS is not yet a topic for public discussion because many aspects are still unsolved. The other respondent regards early, unbiased information as very important in order to avoid that fears will be stirred up unnecessarily (in Germany more relevant than in other countries) or false hopes occur. NGOs are trusted most as communicators; they should also be informed and convinced of CCS as a temporary solution.

3.3.4 Energy industry and associations

One energy supplier and five associations in the energy sector were interviewed. Concerning **maturity, profitability, and role of CCS** they agree that the CCS technology is not yet mature in a large scale application. There still is a high need for research and development. Transport will cause minor problems, sequestration should be further developed to become more efficient and decrease specific costs, and practical experiences with CO_2 storage are necessary. The experts expect a commercial use of CCS by 2020 or later. The respondents also agree that the CCS technology is not profitable at the time being and not competitive to conventional power production from fossil fuels. The investment costs in power plants and costs for transport and storage are regarded as too high and current CO_2 prices too low. Main obstacles for profitability are efficiency losses in the power production and additional energy demand for sequestration. As one factor for the reduction of operational costs was mentioned, that new power plants should be constructed close to storage sites.

In principle CCS is regarded as a reasonable technology, which is globally essential to combat climate change, however not yet at the time being, but only, when the large-scale availability is proved, the additional energy demand for the process reduced, appropriate storage sites identified and public acceptance given. In the meantime conventional power plants should be made more efficient. Furthermore CCS is considered to be a bridging solution, about 2020 until 2050, especially for countries being strongly dependent on energy supply with coal. The potential for creating or maintaining employment should be carefully analysed and compared to other options such as increased use of renewable energies. Generally, energy supply should be based on a well-balanced mix of energy sources; as long as coal is an indispensable component CCS plays an important role.

Three experts said that CO_2 storage is secure, e.g. relying on an IPCC report, if certain rules are obeyed. The other experts are more sceptical and see a large need for further research in this area. At least depleted national gas reservoirs are regarded as relatively secure. In any case, risks cannot be compared to those caused by nuclear waste disposal. As appropriate storage sites in Germany the North Sea, depleted gas and oil reservoirs, and saline aquifers were mentioned. Coal and salt mines as well as ocean storage were excluded generally. The experts do not agree in the opinion whether CO_2 should be exported or not if not enough storage sites can be found in Germany or if there is public

opposition. The transport of CO_2 is mainly compared to the transport of oil or gas and insofar regarded as relatively secure. The main problem is high cost of transport.

For the approval of the implementation of storage sites almost all respondents suggest that this should be done according to the existing mining law in Germany. This law should therefore be further developed. However in the case of storage under sea ground international agreements are needed. The long-term liability is sees as a still unsolved problem. Mainly the responsibilities are allocated to the state if storage sites are approved.

The official attitude of the associations interviewed towards CCS is positive and with one exception also communicated to the public or at least to experts and multipliers. CCS is described as one option among others. The further development of renewable energies, energy efficiency, and combined heat and power production is of equal importance. In part of the organisations there is an internal discussion about the attitudes towards CCS concerning the relevance of energy options, e.g. compared to nuclear energy. Sources of information are mainly research organisations and reports, which are regarded as very trustworthy. The own influence of the organisations on opinion making is considered to be medium.

All respondents regard **public awareness** of CCS as very low. The said that the public attitudes towards CCS are either not yet specified due to a lack of information or slightly negative due to opposition by NGOs, the negative image of coal, associations to nuclear waste disposal, and the NIMBY effect in the discussion of CO_2 storage. News about CCS in the media are regarded as more or less neutral, but only few articles can be found. In order to avoid negative attitudes towards CCS in the broad public more information is needed to increase the transparency. This information should be balanced, realistic, and based on facts. It should contain benefits and risks, needs and options, comparisons to other energy technologies, and should not claim that CCS is a universal solution for a secure energy supply and the climate warming problem. The legal framework has to be defined and published.

Practical experiences in demonstration projects have a large impact on public acceptance. Besides the mass media, NGOs, consumer organisations, churches, citizen initiatives, and labour unions have a higher position in the public's confidence than politicians and a much higher position than industry. All respondents agree that risks have to be communicated in an open and transparent manner. It has to be avoided that the public compares CO_2 storage to nuclear waste disposal and CCS as a obstacle for the further development of renewable energies. The information of the public has to be done as early as possible. The majority of respondents do not regard broad acceptance surveys as reasonable at the time being because the level of information is too low. Information strategies have to be developed first and demonstration projects carried out.

3.3.5 Churches

Two representatives of churches were interviewed. With regard to **maturity, profitability and role** both said that CCS is by far not yet enough developed for large scale application and is by far not profitable. They are convinced that the promotion of CCS impedes the development of decentralised solutions with renewable energies and cogeneration. The availability of CCS in 2020 is too late to combat climate change. For this reason CCS is not regarded as a reasonable technology and should not play a role in the energy mix. Even with regard to countries which are based on coal like China it is argued that industrialised countries should demonstrate that energy efficiency improvements and renewable energies can help to achieve economic development and prosperity without CO_2 emissions. If CCS would be mature it could be used as bridging technology, but CO_2 is considered to be not secure enough and not accepted by the public. One of the respondents even compares the CO_2 storage to nuclear waste disposal with regard to the shift of the problem to future generations. Offshore underground storage is disapproved, the capacities of depleted gas storages and salt mines are regarded as insufficient for the expected amount of CO_2 worldwide. Another problem is the need for transport of CO_2 because potential storage sites are far from existent power plants. The respondents assume that the CCS technology can not be implemented due to public opposition.

The organisations represented did not communicate yet an **official attitude** about CCS, but they plan to do it. A general argument is that energy efficiency improvement has priority and energy consumption should not create a burden for future generations, e.g. with CO_2 storage sites. In the other hand, the church sees itself as a neutral institution, which offers opportunities for information and open discussions in the public. As far as CCS is an ethical topic the church is regarded as an important voice in the public discussion.

The **public awareness** is considered to be low. Also the topic is seldom dealt with in the media. Therefore a decided public opinion does not yet exist. More – neutral – information including potential risks should be given as soon as possible in order to promote a reasonable discussion without creating vague expectations in the technology or unnecessary fears. The highest influence in opinion-making is seen with NGOs, mainly environmental organisations, churches, and (critical) scientists. There should be more information about ongoing CCS projects, which can bring the most realistic view of the technology. However it cannot offer results concerning the long-term storage risks.

3.3.6 Consumer association, renewable energy association, trade association, and “green” politics

The opinion of representatives of a consumer organisation, a renewable energy association, a trade association, and a “green” politician are quite similar, therefore they were summarised in the following description. They also see a lack of **maturity and profit-**

ability of CCS. Whereas the CO_2 sequestration is technically feasible, main problems are the unsolved risks of CO_2 storage and the loss of efficiency in power plants. The development of CCS to maturity will take time and competing technologies will become profitable in the meantime. CCS is too expensive as a bridging technology. Rather renewable energies and energy efficiency should be developed further. Therefore the respondents do not assume that CCS will play an important role, even in China where CCS would raise the price of coal drastically, so that China would also relay on more energy efficiency and alternative sources. The representative of the trade association pointed out that political decisions concerning the CO_2 emission certificates play an important role for the profitability of CCS and the competitiveness of other energy sources than coal. The respondents said that it is not yet possible to judge the risks of long-term CO_2 storage. It is not clear whether there are sufficient potential sites for more than 30–40 years, and the representative of the renewable energy association mentioned a conflict with geothermal energy use. Depleted gas field could be used in Northern Germany, but they are far away from most of the power plants. The transport in pipelines is regarded as secure but too expensive. The respondents completely agree in the allocation of the responsibility for long-term liability to the operators of CCS technologies.

With regard to the communication of an **official attitude** of the organisations the representative of the renewable energy association reports a decided opposition to CCS – and also to new large power plants – due to its risks and the contradiction to decentralised solutions and the further development of renewable energies. The trade union would prefer energy solution without CCS as long as a secure CO_2 storage is not guaranteed. The organisation communicates information and attitudes regularly to works councils, e.g. on the basis of a specified study committed. The consumer association has a clear position towards the future energy supply strategy mainly consisting of energy efficiency, cogeneration and renewable energies. Therefore there is no need for CCS. Its influence on public opinion making normally is large. One of their strategy is to convince the consumers to be more active in energy conservation.

The **public awareness** of CCS is considered to be low, although the topic is present in the media. However CO_2 free power plants are judged positively, but this is regarded as misleading concept. The respondents expect broad opposition to CCS in future, at least when storage sites will be identified and developed. The representative of the trade union mentioned that there is already a clear opposition to large conventional coal-fired power plants. Generally all agree that there should be more information of the public. It should be unbiased and mention existing risks and problems. The representative of the consumer organisation claims more political promotion for a broad diversification of the energy supply.

3.3.7 NGOs

All NGOs were contacted who active in climate or environmental issues. They had already published official attitudes of their organisation towards the CCS-technology before in various media.

A common position between these organisations exists with regard to three issues:

- Refusal of CO_2 storage in oceans
- Renewable energies and efficient use of energy have absolute priority over CCS.
- No general campaigns are planned against CCS at the time being.

A smaller part of the NGOs reject CCS completely for reasons such as the followings:

- CCS is an end-of-pipe technology which reinforces the problems of use of fossil fuels.
- CCS causes additional energy consumption, underestimated risks of storage, and high costs.

Others complain the "misleading" concept of CO_2 free coal-fired power plants. One of the NGOs has no decided opinion against CCS, it rather tries to prevent the construction of new coal-fired power plants.

Some NGOs support CCS under certain essential conditions, such as:

- Introduction of an independent international controlling body of CO_2 storage
- Implementation of international rules for handling CO_2 storage
- Public funds for CCS may not diminish funds for renewable energy and energy saving
- Only countries with CO_2 limits are allowed to count CCS in emission trading, no eligibility of CCS in CDM
- Storage sites must be secure over thousands of years
- Storage in disused oil and gas fields only, not in oceans, coal fields, salt mines
- Export of the CCS technology to developing countries only if a secure application has been demonstrated in industrialised countries
- Open questions have to be settled with regard to quantity and quality of the potentials storage sites and the actual contribution of CCS to emission reduction

An important argument of the supporters is that CCS is a bridging technology for the time span while other, more efficient climate mitigation technologies will be developed, especially if high growth rates in the use of renewable energies and energy efficiency improvements cannot be achieved as fast as necessary. In addition, it is expected that large industrial and developing countries will not stop using their domestic fossil fuel resources. However broad scepticism remains that an intensive promotion of CCS impedes the transition to a "renewable energy era". Another severe argument is potential risks of CO_2 storage and transport on the long run.

NGOs usually consider their influence on public opinion relatively high, especially with regard to environmental and health aspects. Except some local activities no public cam-

paigns are planned at the moment. None of the NGOs would be willing to participate in a common platform of information on CCS together with governmental authorities or energy industries.

3.3.8 Local experiences with a demonstration project

In order to analyse aspects of acceptance of a group of persons who are already concerned by CCS in Germany, experiences of the CO_2 storage projects "CO_2 sink", funded by the EU and coordinated by the Geo Research Centre Potsdam, were evaluated. They show that the inhabitants of the region of Ketzin have a relatively low interest in the project. Some hearings were organised by the local government, but only few people participated. Most questions referred to issues such as necessity of CCS, personal benefits and risks. There was also no reaction by local NGOs. The local public opposed against the transport of CO_2 by trucks for emission and noise reasons. This was a larger problem than the storage itself.

The researchers and industries involved in the project try to communicate the real facts in a balanced way. Playing down risks stirs up more opposition. Clear metering results and demonstration of control mechanisms of potential CO_2 leakages can help to reassure the public. Scientists should explain how the pore storage works that CO_2 cannot explode (there was an explosion of an underground gas storage in the former DDR 40 years ago and people still remember this hazard).

It can be assumed that the local attitudes in this region are not representative for a commercial large scale CCS storage site. Only 60,000 tons of CO_2 will be stored and the storage will be evacuated and dismantled after the end of the project.

3.3.9 Summary of the survey in Germany

All respondents do not regard CCS as technically mature as far as CO_2 storage is concerned. Sequestration is regarded by some of them as feasible. However they still see problems and need for further development, at least with regard to the loss of efficiency of power production, technical optimisation, and cost reduction. Correspondingly the profitability is not yet given for most of the respondents. Profitability depends on many factors, such as the price of CO_2 certificates, the price for electricity produced from other fuels, the loss of efficiency of "clean" power production, and the development of prices of natural resources in general. In addition, transport demand – mainly the infrastructure of pipelines – and lacking acceptance were mentioned as factors which rise costs. Transport risks were compared to those of oil and gas and. Most respondents agreed that engineers can get them under control.

Parts of the respondents assume that CCS will be available on commercial scale from 2020 on, others assume that this will be 2030 or later. Only a few respondents regard CCS as absolutely essential, some other said that it is reasonable from a global point of view with regard to the climate change problem and the necessity to use coal in the

future, at least in China and other countries, but don't have an enthusiastic positive attitude. For some other persons the climate problems are so urgent that it would be too late for CCS when it will be commercially available. Another group of persons has a disapproving attitude towards CCS in general, mainly because of risks of CO_2 storage and a negative impact on the development of renewable energies. Both groups which are not in favour of CCS argue that alternatives should be strengthened, above all improved energy efficiency in energy consumption and power production, increased cogeneration, and use of renewable energies. This would not cause a further burden for future generations. As disadvantages of CCS was also mentioned the enduring dependence on coal and a centralised power supply structure. A more decentralised development path would share the responsibilities for the future.

One aspect is especially relevant for Germany: Due to the necessary modernisation or replacement of the existing power stations within the next years a basic decision has to be taken whether CCS will be introduced. This decision is made at a time when there are not yet well-founded results of a broad application of the technology according to most persons interviewed. Especially the risks of the long-term CO_2 storage will not be tested enough by 2020. Thus a course will be set for an energy supply structure based on coal which can only be used with CCS for climate reasons without knowing whether the technology is viable. The large majority of the respondents agreed that there is further need for research of CO_2 storage and that there is urgent need for the development of a legal framework for CCS including responsibilities for decision making, approval procedures, and liabilities in case of failures.

About one third of the respondents said that their organisation regards CCS as a reasonable option during a transition period and communicates this position officially. For other organisations CCS has no priority at the moment and an official position is not yet settled. Others have fundamental doubts about the technology and disapprove it.

The public awareness of CCS is generally considered to be very low at the time being. However many respondents expect a strong opposition of the public, environmental groups, etc. against CCS, especially CO_2 storage sites, in the future. The media coverage of the CCS issue mostly is regarded as unbiased. Most of the respondents hold the opinion that the public should be more informed about CCS, according to the majority this should be done as soon as possible. Others would start with information when demonstrations projects take place. For the communication almost all suggested a transparent, unbiased, and open discussion of facts, also of risks. One should neither stir up unreasonable hopes, nor unjustified fears. Withhold of risks, e.g. of long-term CO_2 storage, would cause more opposition than an open communication. In order to avoid polarisation it should be clarified that risks of CCS cannot be compared to those of nuclear energy, rather CO_2 storage should be compared to natural gas storage. It is important not to establish a contradiction between CCS and the promotion of renewable energies and energy efficiency.

4 Conclusions

The attitudes of multipliers towards CCS have a strong influence on the communication of CCS and public acceptance. NGOs, consumer organisations, churches, and partially trade unions are organisations which enjoy a high confidence in environmental issues. These organisations mostly represent a critical or even negative attitude towards CCS. They are expected to make use of their role and communicate their position broadly and intensively. Scientists and experts are also regarded as trustworthy for the public, politicians only to a smaller degree, and industry is generally perceived as biased. Political parties mainly influence the public opinion making by defining the legal framework for CO_2 sequestration, transport, and storage as well as the role of CCS in the energy and climate policy. Many multipliers wish an open debate between the different positions. In this framework the role of scientists and experts is seen as a factual contribution to the discussion.

Most of the multipliers expect problems of public acceptance of CCS, not at the time being, but as soon as first commercially operated CO_2 storage sites will be started up. It is expected there will be a more emotional than factual discussion, mainly of those directly concerned, e.g. in CO_2 storage regions.

In all groups pro arguments for CCS are climate change mitigation and partially the need for use of coal worldwide, e.g. in China and India, and CCS is necessary if an increased use of renewable energies and improved energy efficiency are not sufficient for climate reasons. All agree that CCS is only a bridging technology. Main arguments against CCS are risks of long-term CO_2 storage and impediments for an energy supply strategy based on decentralised options, such as renewable energies, cogeneration, and energy efficiency.

For the communication of CCS issues chances and limits of the technology should be discussed. Scientists and experts have a leading role. Most of the multipliers regard early, transparent, and unbiased information of the public as necessary. All groups, either with positive, negative or neutral positions, should contribute to the discussion.

More research and development is needed mainly on the long-term CO_2 storage, but also in the field of sequestration, especially with regard to loss of efficiency and cost. Also transport is partially considered to be high cost factor. Altogether CCS is by far not yet regarded as profitable, partially not as technically mature. It has to be taken into account whether CCS will come too late for combating climate change when it is developed to be used at large-scale. Most important is that CCS will be communicated as only one additional option complementary to renewable energies and energy efficiency.

Part D: Outreach strategies for CCS activities

1 Objectives

The objective of this part in particular was to develop guidelines for an outreach strategy for a CO_2 storage activity connected to a demonstration plant. Based on the findings from the previous work and from other sub-projects, guidelines for an outreach strategy were elaborated which address critical thematic issues for CO_2 transport and storage as well as procedural issues that can contribute to successful communication with stakeholders.

The guidelines for an outreach strategy are based on literature reviews, conference surveys, and in-depth interviews with representatives of stakeholder groups in selected countries.

Besides the technical, economic, and legal challenges, public acceptance is regarded as a key issue in the implementation of CCS. In the near future, political decisions have to be made about the worldwide role of coal within the energy mix. Under the assumption that CCS is indispensable, at least for a transition period for climate reasons until fossil fuels can be substituted by renewable energies and until energy efficiency is able to be further developed, public communication options are described in the following report. In order to design an information strategy, relevant influencing factors were taken into account such as technology characteristics, actor groups, and public campaign options.

2 Methodology

All findings of the working steps in the Work Package 6.4 “Professional and public acceptance for carbon capture and storage” were used for the development of an outreach strategy:

- results of the literature review
- survey of conference participants
- interviews with stakeholders in Bulgaria, the UK, and Germany

In addition, the strategy is based on communication theory. An analysis was made of the communication process in general, how messages are communicated to certain target groups, and the necessary steps in developing a communication strategy. The communication research includes a broad spectrum of concepts and theories which are relevant for a successful campaign regardless of the concrete issue involved. This knowledge was combined with the specific framework conditions of CCS resulting from the literature review and the empirical social research.

The opportunities and risks of various elements of communication were analysed. In order to achieve acceptance of CCS by the general public, the following questions have to be answered:

- Which target groups have to be included in the information campaign?
- Who are the relevant opinion leaders and multipliers?
- What are the exact objectives of the communication?
- How should a campaign be designed?
- Which communication channels and media should be used?
- When should the public be informed about what?
- How can unbiased, factual information be ensured?
- What are the costs of information campaigns?
- How can the impact of communication strategies be measured and evaluated?

The results of innovation research form another basis for the communication strategy. CCS is defined as an innovation system, i.e. a network of institutions which contribute to the development and dissemination of new technologies.

3 Results

3.1 Findings from communication research

A communication formula was established by Lasswell in 1948: Who communicates what to whom by which channel with which impact? Today communication is seen more as an interactive dialogue. Not only intentional communication has an impact but also "non-communication", which is an important aspect for attitudes towards CCS. The main elements of communication comprise the source, the recipient, and the communication channel. The goal of communication is achieved when the recipient records and stores the message. Interferences can influence the reception, e.g. selective perception, selective interpretation according to existing attitudes, or a selective memory. Messages should be simple, clear, straightforward, and interesting and should be repeated often. If the target groups think about the messages often, the content will be stored long-term. The more the message coincides with existing attitudes, the more successful the communication.

Feedback from the recipient is needed in order to optimise the communication flow. Feedback can be organised either using surveys or – as a modern option – internet platforms.

A very important influencing factor is the trustworthiness of the information source or the communicator, especially when an issue is unfamiliar to the recipient, complicated, difficult to understand, and possibly linked with negative associations. For the general public these are all true for CCS.

Some important steps have to be taken for an efficient communication process:

- Target groups and their relation to the communication issues have to be defined. The broad public can be split up into groups, e.g. according to demographic (structural, lifestyle), psychological (attitudes, motivation, involvement, affectedness), or sociological characteristics (culture, values, roles, opinion leaders).
- The objectives of the communication have to be defined. They should be precise, transparent, coherent and clearly understandable for the recipients. Inconsistent objectives can render the message useless. The objectives may refer to the cognitive (rational understanding), affective (emotional), and conative (behavioural) level. The process of influence functions as follows: attention – interest – desire – action.
- The design of the message plays a leading role: the content and obvious intention of the message, logic of arguments, use of symbols, type of communicator, interaction of communicator and recipient. A general decision has to be taken whether the message should be more rational or more emotional. Rational messages must inform about the characteristics of a "product" such as its quality, benefits, performance, profitability, etc., especially when it is an innovative product which needs explaining. At this stage, unbiased information is important. Emotional messages are relevant if the characteristics of a product are well known to differentiate it from competing products. An emotional message is not appropriate for CCS for the time being.
- The communication can either be one-dimensional, i.e. containing arguments only in the intended direction, or can include pro and contra arguments. Findings from studies showed that the latter version is more suitable for issues which are basically controversial or disapproved, and for an audience with a higher educational or information level.
- Trustworthy communicators have to be identified. They should be recognized as experts, especially when the communicated issue is a matter of facts. Messages from trustworthy sources are regarded by the recipients as more valid and have greater influence than those from questionable sources.
- Messages should not be too far from the recipients' prevalent attitudes. Otherwise there will be even more opposition towards the communicated facts or values. On the other hand, if a change of attitude is intended, the message has to be slightly different from the existing one otherwise no attention will be paid to it. This means that a change of attitude or behaviour can only be achieved in a sequence of small steps.
- Recipients are especially interested in a message when they are personally affected. They may be more critical and not easy to convince, but if they do change their attitude, this change is then more stable. Persons with low involvement will change their mind more often according to dominant pro or contra arguments.
- Personal communication is the most efficient communication channel. It enables the communicator to adjust the message to the recipient individually, communicator and recipient are in direct contact, the recipient receives feedback, and a dialogue is possible. However personal communication cannot be managed on a large scale. In the

case of mass communication, the audience consists of relatively isolated, anonymous, heterogeneous recipients. Extensive research has revealed that the information flow and the influencing process take place in two steps: Ideas flow from the mass media to opinion leaders and from them to the broader population. Opinion leaders exist in all social groups, are more informed and interested, more active and communicative, and regarded as trustworthy. The communication between an opinion leader and the final recipient is often a personal one and has therefore more influence than mass communication alone.

Due to the fact that a large number of actors are involved in the innovation system CCS and that new facts may emerge, an adaptive strategy of communication has to be developed.

3.2 Current situation of acceptance of CCS

3.2.1 Actors in the innovation system CCS

With respect to the communication of CCS issues, the following actors are important:

- Government and politicians: they are relevant as decision makers and can decide about a general framework for the implementation of CCS, either promoting or rejecting it.
- Actors in industry, e.g. producers of CCS technologies and suppliers. These have a large business interest in the implementation of CCS and hold a corresponding position. On the other hand, producers involved in renewable energies also have to be mentioned. These may represent an opposing position if they see a conflict between CCS and the promotion of renewable energies. Other industrial actors are also significant: especially power supply companies and the coal industry.
- Experts in research institutions have an influence on opinion making because they stand for factual information. At the same time these institutions may benefit from receiving public and private funds for research in the field of CCS.
- Journalists can also influence the public opinion.
- NGOs, consumer organisations, trade associations and churches are important multipliers due to their good reputation as trustworthy communicators.

Thus a variety of influencing actors, interests and attitudes are involved which have to be taken into account when designing a CCS communication strategy.

3.2.2 Prevalent attitudes

A literature review revealed that there are not many empirical studies of the social acceptance of CCS, and that those available were made in only a very few countries. Generally, authors tend to emphasise the important role of public attitude for the

implementation of the technology. Social acceptance includes acceptance by the broad public as well as by stakeholders.

Existing studies of lay people's perception show the low level of knowledge and understanding of CCS issues and of their relation to the climate change problem. Within a choice of alternative technologies, renewable energies and improved energy efficiency are always strongly preferred to CCS. A clear NIMBY (Not-In-My-Back-Yard) effect was found: people were negative about CO_2 storage in their neighbourhood. Another finding was that respondents changed their opinion in a positive direction after receiving more detailed information.

From a methodological point of view most studies recognised that there is a need to provide information in order to ensure that statements about this issue make sense at all. The finding that respondents change attitude is controversial and requires further research. It can be assumed that some answers are still "artificial".

Surveys of experts (conference participants) within the framework of the DYNAMIS project showed that most experts have a positive or neutral view of CCS. Influencing factors are nationality, professional background and general attitudes towards energy and environment as well as the perception of benefits and risks. However they are sceptical with regard to public acceptance of CCS. This view can be explained by the lack of information of the general public. In addition, a considerable number of experts assume that the public perceives high risks associated with CCS technology. The experts classify the public's level of knowledge as very low. The discussion of CCS issues in the media is considered very insufficient.

However, so far the communication activities undertaken by stakeholders have not been very intensive. Often the experts themselves do not yet have a decided opinion or they do not see an urgent need to communicate such topics at present.

As far as arguments or especially risk communication is concerned, communication strategies should:

- avoid establishing opposition between the development of CCS technology and the further promotion of renewable energies or energy efficiency – both well accepted options of a sustainable energy supply;
- support the idea of CCS as a "bridging" technology, only relevant until renewable energies are fully profitable;
- clarify the actual risks of CCS, for example compared with natural gas, and avoid the risks being identified by the public with the risks associated with nuclear waste disposal;
- avoid an extremely optimistic view of the role of CCS and its benefits; and
- provide information and initiate a discussion about CCS which is open and neutral.

Another important barrier to the implementation of CCS is obviously the economic feasibility of the technology. The experts interviewed have considerable doubts about its profitability. This is also considered the most important barrier to CCS, even slightly more important than public acceptance.

The respondents, who were mainly from research (51 %), industry (32 %), and government (17 %), mentioned four issues most frequently as "most important in the world today": climate change, environment, poverty, and energy supply (Figure 3.1). In their opinion, the most important measures to combat climate change and guarantee a long-term sustainable energy supply are the use of renewable energies followed by energy saving (see Part B). However CCS is in third place.

Whereas the experts themselves have mainly positive or at least neutral attitudes towards CCS, they attributed a negative attitude towards this topic to the general public. Thus public acceptance was mentioned as the most relevant barrier to the implementation of CCS besides economic feasibility and financing.

The experts said that knowledge is not yet broadly disseminated and that there are no or few public discussions of this issue. Above all, in the press and even more so among the general public, CCS is not yet being sufficiently discussed (Figure 3.5):

In the experts' opinion, the public compare the risks of CCS mainly to the risks connected with underground natural gas storage and pipelines. However, about 40 % believe that the public compares them to the risks of nuclear disposal sites (Figure 3.6).

Interviews with stakeholders in Bulgaria, the UK and Germany showed that NGOs, consumer organisations, churches, and some trade unions – organisations which enjoy a high level of confidence in environmental issues – tend to have a critical or even negative attitude towards CCS. They are expected to make use of their role and communicate their position broadly and intensively. Scientists and experts are also regarded as trustworthy by the public, politicians only to a smaller degree, and industry is generally perceived as biased. Political parties mainly influence public opinion by defining the legal framework for CO_2 capture, transport, and storage as well as the role of CCS in the energy and climate policy. Many multipliers would like an open debate between the different positions. In this framework, the role of scientists and experts is seen as contributing facts to the discussion.

Most of the multipliers expect problems with the public acceptance of CCS, not necessarily immediately, but as soon as the first commercially operated CO_2 storage sites exist. It is expected that the discussion will be more emotional than factual, mainly among those directly concerned, e.g. in CO_2 storage regions.

In all groups, the arguments in favour of CCS include climate change mitigation and partially the global need for coal use, e.g. in China and India, and that CCS is necessary if an increased use of renewable energies and improved energy efficiency are not sufficient for climate reasons. All agree that CCS is only a bridging technology. The main

arguments against CCS are the risks of long-term CO_2 storage and that CCS impedes an energy supply strategy based on decentralised options, such as renewable energies, cogeneration, and energy efficiency.
When communicating CCS issues, both the opportunities and limits of the technology should be discussed. Scientists and experts play a leading role here. Most of the multipliers regard it necessary to inform the public in a timely, transparent, and unbiased way. All groups, whether from positive, negative or neutral standpoints, should contribute to the discussion.

More research and development is needed mainly on long-term CO_2 storage, but also in the field of capture, especially with regard to the loss of efficiency and costs. Transport is also considered to be a high cost factor. Overall, CCS is regarded as being not yet profitable, and, partially, not yet technically mature. It has to be taken into account whether the large-scale use of CCS will come too late to combat climate change. Most important is that CCS should be communicated as only an additional option, complementary to renewable energies and energy efficiency.

3.2.3 Risks and chances with regard to influencing factors

The efficiency of communication intended to convince people that CCS is a reasonable technology is influenced by the development of certain situational factors. Some are more in favour of acceptance of CCS; others create barriers to it in the public's perception. A profile of risks and chances was elaborated on the basis of findings from the project. The factors are related mainly to three areas: society, environment, and economy (Figure 3.1).

The communication strategy has to take these factors into account. Chances have to be exploited, and risks have to be addressed. The CO_2 problem and climate change will play a crucial role for CCS. If the reduction of CO_2 emissions retains its leading role in climate policy, CCS will have a good chance of being accepted by the broad public.

3.3 Strategies for information campaigns about CCS

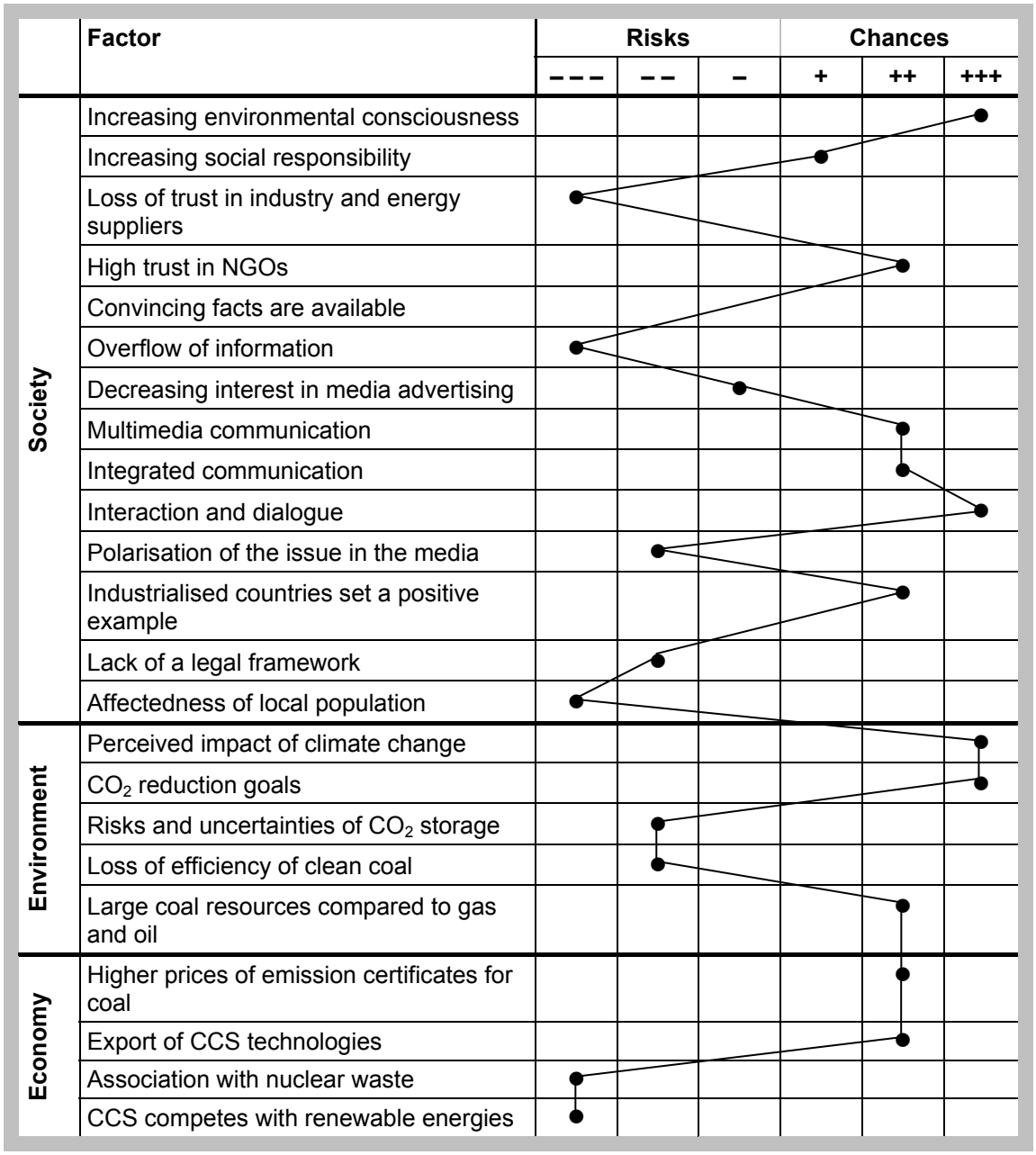
In the following generally valid findings from communication research will be combined with specific requirements for communication about CCS technology resulting from the literature review and the surveys in the framework of the project.

3.3.1 When should the public be informed about CCS?

Due to the low level of knowledge of CCS among the general public, now would be a good opportunity to provide information and convincing arguments and mould opinion in the direction of positive attitudes towards CCS. However, at present, there are still gaps in the existing knowledge, a need for more research (e.g. on the ecological impact of long-term CO_2 storage) and open questions with regard to the legal framework. It is

therefore not possible to provide all the necessary information at the moment. These uncertainties should be disclosed within the framework of an information campaign. By openly communicating these issues, the message will become more convincing and the communicator will be accorded a greater degree of trust. It is not advisable to wait with the campaign because it is not clear when the missing information will be available.

Figure 3.1: Chance-risk profile of situational factors for CCS communication



3.3.2 Which target groups should be informed?

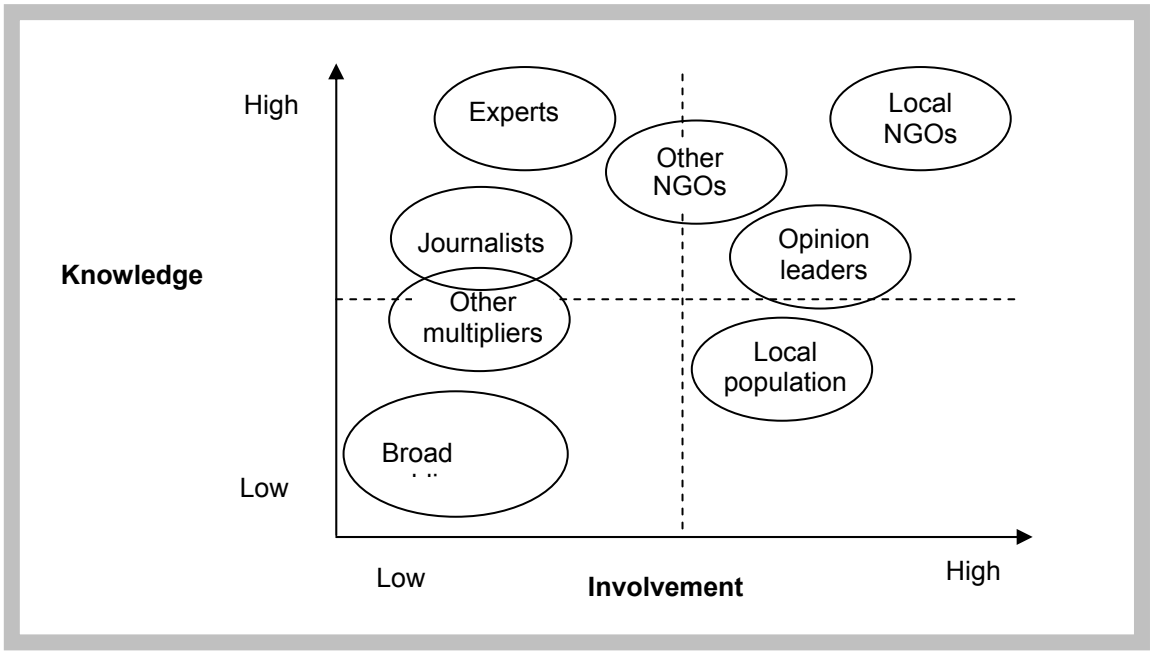
Everyone interested in CCS should have the chance to receive factual and neutral information, not only the broad public but also multipliers from all stakeholder groups because they are important players in opinion making and have a strong influence on the wider acceptance of a topic.

For a communication strategy to be successful, it is very important to identify and define the target groups and their characteristics. This determines the type of communication – its core messages, content, and design – and the type of communication media. The public's attention should be gained through an information campaign. Public communication is open to all recipients and communication channels. It has a large influence on public opinion and ultimately also on political decisions.

It is reasonable to split the target groups up in the case of CCS since the results of the analyses show that the NIMBY effect (Not-In-My-Back-Yard) plays a significant role. People who live near to upcoming projects of CCS technologies (power plants, pipelines, storage sites) should be informed especially early. At the latest, when a concrete implementation is planned, the people concerned should be aware of what is going on. The best option in this case is personal communication. Representatives of utilities, government, etc. could organise an event, e.g. a forum, which enables those concerned to make up their minds on the technology, benefits, risks, etc. This is a basic prerequisite for acceptance. When people are personally concerned, this has a larger influence on CCS acceptance than personal or social characteristics. It can be assumed that these groups also communicate among themselves or may even organise themselves, e.g. in opposition to a planned project. This has to be taken into account in the communication strategy.

People can also be generally concerned about CCS for environmental reasons or worries about risks for future generations. Influencing factors such as an interest in climate change mitigation, social commitment, or environmental consciousness create a greater degree of involvement than in the case of other target groups. These people will be more interested in acquiring knowledge about CCS technology, they want a greater depth of understanding, actively search for more information and more detailed information. The design, content and transmission of the information therefore depend on the level of knowledge of the recipients. The main relevant stakeholder groups were classified according to both categories – involvement and level of information – as shown in Figure 3.1.

Figure 3.1: Relevant societal groups for CCS communication



Involvement and the level of information cannot be quantified at present. As the level of information in generally low in the public sphere and the technology is quite complex, only a qualitative assessment can be made. It is based on the explorative interviews with representatives of stakeholder groups and surveys of experts. The large majority of them said that the CCS issue is not discussed at all among the general public.

In Figure 3.8, NGOs mean organisations which are engaged in climate and environmental activities. They have a very large influence on the acceptance of CCS. Therefore they form a special target group for information and communication, because they already have a high level of knowledge and often a general opposition to large-scale technologies. “Local NGOs” are NGOs which are active where the local population is concerned, e.g. in the case of a planned CO_2 storage site. “Other multipliers” are interest groups, trade associations or organisations in the area of consumer protection, social welfare, education, or human rights. They can also influence public acceptance of CCS. Professional “communicators” constitute a special type of multipliers, e.g. journalists and teachers, politicians, or other persons with a public function.

NGOs and other multipliers are generally important communicators of information. They influence attitudes, images, opinions, and the behaviour of the public with or without intention. Multipliers are recognised as trustworthy because they are perceived as being independent. They are very active in obtaining information and wish to be informed as early as possible about a new development. Their knowledge and interest with regard to technological issues is mostly more general than detailed.

Another influential group are opinion leaders. They are often specialised with regard to certain issues and are very active recipients of mass media communication. Due to their

frequent contact to the media and their communicative behaviour, they take a lead role in information and opinion making. They forward their knowledge to their social groups. This information is often biased, i.e. influenced by the attitudes of the opinion leaders. Their influence depends on their trustworthiness and their social status in their group. However for an information campaign about CCS it is very difficult to identify opinion leaders. With regard to socio-demographic characteristics, they are very similar to their group. If possible, it is very useful to identify them in order to integrate them into the information and communication strategy. In a regional context, e.g. information for people directly affected by CCS technologies, opinion leaders can be more easily identified, e.g. in the framework of monitoring research. According to Figure 3.8, this group of personally concerned people is characterised by a higher level of knowledge, because it can be assumed that the community, environmental groups, other multipliers, mass media, or opinion leaders have already provided prior information before beginning concrete activities. Whether the local population perceives and absorbs the information provided depends on personal attitudes such as interest in environmental or climate issues, risk perception, etc.

Besides this relatively small sub-population, there is the larger public who is not yet concerned about or aware of CCS. Due to the fact that CCS is not often featured in the media, public opinion has not yet settled. This broad target group cannot yet be divided with regard to different levels of information and involvement. However, in order to address groups in society as appropriately as possible, the classical target group-based design of communication can be used. Characteristics of such groups include, for example, socio-demographic (age, income, use of media, etc.), social-psychological (attitudes, group affiliation, lifestyles, etc.), or geographical attributes (regions with or without relevance of coal and lignite production, power stations, potential CO_2 storage sites, etc.). If these characteristics are taken into account, communication will be more targeted and more efficient.

3.3.3 Who should the communicators be?

With regard to energy and climate issues, the general public has a high degree of confidence in NGOs and scientists. Environmental NGOs are probably considered the most trustworthy and believable in communicating information about energy technologies. However, it is important to note that if they accept or even cooperate in solutions which are considered non-sustainable and therefore not desirable by many NGOs, they risk forfeiting their trustworthiness in the public eye. For many NGOs, the CCS technologies in particular represent a balancing act between making a desired contribution to climate protection on the one hand and additional local problems on the other.

The general public want balanced information, where possible communicated by a neutral arbitrator. It would definitely be difficult for the public to form a well-founded opinion based on scattered information delivered by different sides - which is the case today for many topics. Who is suitable to play the role of such an arbitrator is not a trivial question. Individual, well-known personalities with high social standing are conceivable as are scientific institutions with good reputations who could manage to

initiate a dialogue with all the relevant stakeholders. Attributes such as competence, social status, trustworthiness and the professional background of the communicator are decisive for acceptance.

In Germany, companies from the energy sector and plant engineering launched an attempt in the "Information Centre for Climate-Friendly Coal-Fired Power Plants" to provide information about CCS based on a broader platform and involving different actors (e.g. scientists) which is meant to be both comprehensive and neutral in nature. Critics are doubtful about this claim, especially on account of the selected structure and sponsorship of the centre. In particular, there is no participation of critical groups (above all NGOs). From the viewpoint of the supporters of CCS, it would be helpful if at least individual NGOs were constructively involved in the process of identifying locations once the basic decision in favour of CCS has been made. However, it is doubtful to what extent NGOs could play such a role without endangering the support of their base.

It should be assumed that the characteristics (above all the trustworthiness) of the main persons reporting on CCS have a significant influence on the acceptance of CCS. For this reason an analysis is made in the following of who could play the role of communicator for CCS within the scope of a public information campaign and what characteristics the communicator should have.

Since the innovation system CCS consists of a multitude of actors, several groups are possible communicators. These are distinguished by different attributes such as e.g. competence, social status, professional background and credibility, which are ultimately responsible for the extent to which the public perceive them as trustworthy. Although the technical competence of industry and primarily energy supply companies concerning CCS is relatively high, they struggle with credibility problems because of the low level of trust people have in them. As different surveys have shown, trust in industry as a communicator is low since people claim it is mainly concerned with its own advantages.

NGOs, in contrast, enjoy a relatively high degree of confidence among the general population and have additional technical competence in CCS, but above all in environmental and climate protection issues. Since NGOs thus seem particularly credible communicators especially with regard to CCS, the public sector should try to integrate them into the communication process. Government environmental protection authorities themselves enjoy a medium level of confidence. Since they are often said to follow a concrete political objective, the credibility of government environmental authorities is also lower than that of NGOs. Further, there is a wider gap between the general public and government institutions. By orienting arguments more on the benefits to the recipients and through a more intensive dialogue, this gap could be lessened and the credibility of government environmental authorities raised as a communicator for CCS.

Research institutes, scientists and experts are also accorded a high degree of trust since they are expected to represent higher social or ecological interests. Government institu-

tions should therefore try to integrate such experts alongside NGOs in the communication process. Especially scientific institutions or individual renowned scientists could play the role of a neutral arbitrator in communicating information. If a dialogue involving all the stakeholders is initiated, the foundation of a balanced information supply could be created.

Leaving the social perspective behind, the credibility factors of the communicator vary depending on which part of society is involved. While among social groups with "high involvement" such as, e.g. the group of experts, the technical competence of the communicator is of high relevance, in other parts of society with "low involvement" such as, e.g. the general public, the broad masses, the popularity and general liking felt for the communicator influences his credibility. If famous personalities are used in low involvement areas, it is sufficient if they are well liked from the viewpoint of the target persons. In high involvement areas, in contrast, if famous persons are to function as communicators, they should have a certain degree of competence or at least have a certain connection to the subject communicated. The impact that competence has can thus only be judged by taking the recipients into account. Emphasizing your own, very high level of competence only seems to be recommended when facing experts since otherwise the audience do not receive the message or are unable to understand it. It therefore seems advantageous if the transmitter has a slightly higher competence than his audience.

The credibility of the communicator becomes more important the lower the information processing capacity and the connection of the target persons to the subject. The higher the involvement of the target persons, the lower the significance of the informant's characteristics and the more important the form of the message becomes.

3.3.4 What content should be communicated?

Technical and legal issues are almost completely missing from the current reports in the media as are the possible consequences at the level of society which would result from using the technology. This is where targeted information campaigns must be implemented. The global role which CCS could play in the future and its connection to the subject of climate change are not yet being handled in the media. These topics represent gaps in the present reporting on CCS and could be covered to a greater extent in the future by information campaigns in order to report in full on CCS.

The EU Directive proposed by the Commission on the geological storage of CCS (EU, 2008) will have a stabilizing effect on public perception of the issues if the population is sufficiently aware of it. Solutions are being suggested for the major criticisms from the viewpoint of the laws on waste and water. Other aspects such as liability issues are still missing. Clear lines of communication are necessary in this respect as well.

A decisive task of conveying information will be to organise an open and fair discussion between all the relevant stakeholders. The corresponding structures have to be created for this, whose sponsorship is transparent and whose autonomy is clearly documented.

Designing an information campaign requires special strategic and integrated measures. How the content is presented represents the actual positioning of the topic in the public eye. An integrated communication plan offers the chance to minimise the risks of information overload in today's media society. With regard to the communication of CCS, a main focus is on content integration. The coordination of the topics in an information campaign for CCS should concentrate predominantly on clear main messages, core arguments and slogans. Alongside standardized communication elements, this should also involve a specific content design suited to the various public sub-groups.

In order to provide a brief overview of the possible differences, specific content design is listed based on the example of two sub-groups. The group of "residents" has high involvement with the subject, the "broad mass" group, in contrast, displays low involvement. There are also large differences in the number of people participating. For example, a sub-group “residents” may consist of the residents of a region, whereas the sub-group “broad mass” may cover all the rest of the population. Resulting from this are different demands for designing the contents of group-specific communication which are described in the following.

The sub-group "residents" already show a certain interest in communication because they are personally affected. They are looking for information on CCS, some actively, some more passively in order to find out what they should expect. A more rational message is therefore more suitable to meet their need for information. Also the fact that the subject to be communicated is an innovative product which requires greater explanation indicates that a more rational message design is appropriate here. The message should contain factual and objective information about the technology in order to create a transparent broad information base. To avoid overwhelming the recipients, however, they should not be inundated with information. Attention should be paid to communicating key information to start with in a manner suited to the sub-group involved.

If the sub-group of residents are in a very rural area with a generally lower level of education, the message should focus on environmental and risk aspects and use a simple and clear method of presentation. In addition, the sub-group could be informed for instance that CO_2 is a commonplace, colourless, odourless gas, whose handling is tried and tested to a large extent and that it is used to produce drinks, as dry ice, as a fire extinguisher, a fertiliser, and a refrigerant or in dry cleaning.

Emotional aspects should not be ignored completely when planning the communication with interested target persons since these usually have a stronger influence on attitudes. An emotional address may make sense in order to strengthen and extend the existing readiness for information. However, the message and the emotional address must form a unified whole otherwise this may cause opinion changes counter to the communication objectives.

If, in contrast, the sub-group "broad mass" is regarded, which has no interest in information about CCS to start with, the emotional packaging of the message becomes much

more important. If low involvement is present, it is necessary to capture people's attention using design elements of communication since this attention is not expected based solely on the message itself. The attempt should be made to awaken the interest of the target persons by using suitable motives in order to generate a certain personal concern so that they want to get involved. Predominantly emotional processes are triggered in this way although at the same time more or less strong cognitive processes also result from the target persons automatically concentrating on the message. If the emotional aspects match the values and attitudes of the target persons, frequent repetition of the message can foster acceptance of the topic. Again, it should be ensured that creative, attention-grabbing elements are directly connected to the central message. If this is not the case, there is the danger that attention might be diverted away from the main message and that the real message is quickly forgotten.

Climate change and its impacts are stimuli which can be used to awaken the interest of the sub-group "broad mass" in the topic of CCS. The more incident-related (gimmicky), more surprising, more graphical and more vivid the campaign message, the greater the chance it will be noticed in the mass media. In view of the layman's language necessary in the public sphere, the subject of CCS should be presented as simply and as symbolically as possible in the initial phase of communication since the larger the target group, the simpler the message should be designed.

For both sub-groups it can be concluded that it is necessary to grade the message contents with different depths of information for the different levels of the communication strategy. Differentiated and many-layered arguments are only suitable if it is certain that the target group has an interest in and a certain prior knowledge of the topic. Playing on peoples' fears is problematic as is the use of humorous elements since their effect is not clearly predictable. They should definitely be tested beforehand within the scope of information about demonstration installations. It should be concluded that argumentative content is significant for persons with high involvement, whereas frequent repetition of the message and its permanent presence in the media is more relevant for groups with low involvement.

Table 3.1 summarises the results of the content design of the message. This includes both core messages which are to be used for all groups as well as specific messages for the sub-groups covered.

3.3.5 How should the public be informed about CCS?

Communicating possible risks in good time and in a targeted way is one way to put topics with strongly negative associations back onto a footing based on facts. Communicating the risks is best suited to addressing those affected by CCS technologies on location (local level).

It is generally important to assign more significance to the subject of communication in the future so that the level of information in the population is raised to a level on which opinion forming can take place. This is a must for achieving acceptance of an issue.

Table 3.1: Elements of CCS communication

Core messages
• Communication of the concept "clean power production"
• CCS as a bridging technology
• Description of the role of CCS for climate change mitigation and in a global context
• Open and transparent communication of risks in small steps
• Existing legal framework conditions
• Role of CCS compared to renewable energies (no competing situation)
• Benefits and disadvantages: secure energy supply, loss of efficiency of power production
• Special emphasis on environmental issues and aspects of risk
Specific messages
• Rational arguments (cognitive aspects)
• Emotional elements (affective aspects)
• Behavioural requirements (conative aspects)
• Experiences in the (secure) handling with CO_2
• Impacts of climate change
• CCS allows use of domestic coal (less imports, secure supply, employment)
• Large coal resources worldwide
• Increase of energy prices due to CCS
• Increasing prices of CO_2 certificates
• Industrialised countries set a positive example
• Export of CCS technologies to developing or transition countries
Issues of design
• Messages which are easy to understand, use of symbols
• Presentation of facts
• Repeated, frequent messages, presence in the media
• Emotional appeals to stir up the interest in climate protection
• Complexity of information adapted to target group
• Potential compensation for the local population especially concerned

In order to be able to address as many groups of the broader population as possible (e.g. interested lay persons, those affected) as well as on the level of multipliers (media,

associations and others), an information campaign should tailor or structure the information on CCS to specific target groups.

Although classical communication research clearly argues in favour of presenting an explicit conclusion when designing the message, this approach should be challenged. In the case of CCS it can be assumed that, independent of the sub-group involved, this is a complex technology, the facts of which can only be partially known to the target persons. If the whole of society is regarded, it could be assumed that an explicit description would be successful. Indicators in the case of CCS which also support an explicit message design include a complex starting point, relative unfamiliarity, issues which do not necessarily affect individuals directly and high credibility on the part of the communicator. However, the explicit confirmation that CCS technology can make an efficient, effective and safe contribution to climate protection will not necessarily produce acceptance among the target audience. Certain target persons will want to make their own minds up and draw their own conclusions so that a too sharply defined conclusion may actually limit acceptance of the technology. Above all, however, the fact that CCS is so far still a future option and that its development in the power station and storage area is still in the testing and development phase mean that no premature conclusions should be communicated in advance. If the credibility of the communicator drops, the target persons may even be encouraged to act counter to the communication objective of CCS acceptance. Energy supply companies who are active in this area of communication should be aware of this problem and avoid making explicit conclusions if possible.

The question of whether a one-sided or two-sided argument is more effective in an information campaign depends on the attitudes of the target persons to begin with and the expected standpoints within the process of opinion forming. It can be assumed that, in the case of CCS, opinions in the population will be strongly differentiated. This is supported by the opinions already formed within NGOs. While Germanwatch and WWF are positive about CO_2 separation and storage, Greenpeace, BUND, NABU and Robin Wood reject them. The viewpoints range from strong to medium rejection through to limited and clear agreement. As a result there are no clearly recognisable positions which can be transferred to forming public opinion. In this context it is essential when communicating CCS to present arguments for both sides. This will include persons in the communication who have a different standpoint to that of the message. Especially because CCS technology is a controversial topic and because of the many advantages and drawbacks which are associated with it at the moment, there is a good chance that the general public will have a basic attitude of opposition. Government institutions should therefore try to present two-sided arguments right from the start in order to raise the credibility of their communication and reduce the points in which they are open to attack. An effective message has to be structured like this in order to create the preconditions for acceptance. The recipients should be prepared for relatively intensive information processing however and certain requirements have to be met with regard to the use of the communication instruments. Media advertising alone is not sufficient for two-sided communication, public relations work and personal communication, for example in the form of lectures, represent possibilities for effective, two-sided communication on CCS.

Finally, it should be questioned how the various arguments should be ordered. According to Kotler, the communicator of two-sided arguments should present the counter arguments first if the target audience could be opposed to the topic to start with. In this way, the audience is disarmed and the strongest "pro" arguments can be placed at the end. This could well be the case concerning communication about CCS, since the target persons are likely to be sceptical to start with because of the novelty, unfamiliarity, complexity and existing risks of the technology. However, this could also result in the recipients being unnerved right from the start and seeing CCS as automatically hazardous. Since this problem is beset by contradictions, no general statements can be made here. An exact order of the arguments in the dynamic innovation system CCS is only manageable or planable to a limited extent because of its diversity and complexity. It is much more important for a CCS information campaign to communicate the core messages using two-sided arguments without drawing conclusions in advance.

Various design elements can be used to make the communication expressive. Communication instruments and means can be linked with each other using design principles in an "integrated communication" in order to convey a uniform appearance with regard to the main communication objectives. Such design principles for a CCS information campaign could comprise, for example, logos based on formal guidelines, slogans or the standardised use of style, tone and choice of words. They try to generate attention and achieve memory and recognition effects.

Tonality is another component of style. This is the style of addressing the target persons from the viewpoint of the communicator. Since the topic of CCS should be presented to as many sub-groups as possible, it is necessary to adapt the tonality to the specific target-group being addressed. Communicating with the sub-group of experts, for example, requires a form of address which is detailed, strongly scientific and to some extent perhaps even provocative in order to persuade the experts to act. Addressing the sub-group "residents", on the other hand, should be done on a par with them in an informative and sympathetic way, without 'talking down' to them.

The visual design features core images to illustrate the communication object; these illustrations are meant to be particularly memorable. Obviously, it is very difficult to visualise a technology. This is why individual aspects of CO_2 capture and storage should be illustrated in a highly simplified way, or be symbolically represented in connection with environmental and climate aspects. The visual side and other design principles such as reduction, repetition, addition and emotionalisation are the main means to achieve a strong media and public response in the broad public sphere.

3.3.6 Which communication channels should be used?

When selecting a communication channel, the main possibilities consist of personal communication or mass communication. A CCS information campaign should adjust the choice of communication channel to the previously defined sub-groups as well as the desired communication objectives. To start with, it should be considered which features and functions the various sub-groups have.

The “middle public sphere” or public assembly shows a higher degree of organisation and has the objective of initiating social topics. Participants in this public sphere such as for example persons within a certain regional setting or members of an environmental organisation are mainly characterised by similar interests, attitudes and values concerning specific topics. Topics considered relevant are taken up and the attempt made to bring these to the attention of the wider, mass media-based public sphere.

In contrast, the “mass media-based public sphere” disseminates public issues and has the objective to provide information to the general population. Despite this, the mass media is a highly selective communication system which can in no way present all the relevant facts and evaluations to society. Journalists select topics according to criteria and codes, in which the orientation to social elites from politics and the economy is clearly visible. The chances for individual participants to access this system are therefore slight since power, prestige, money and knowledge represent important barriers to breaking into the mass media-based public sphere.

In the case of CCS, the communication is directed at a mass audience – the "broad mass" of the population - as well as at seven other specific target audiences who can be grouped based on shared characteristics. Addressing the broad masses is not a direct target of the communication planning for CCS. Instead the CCS information campaign is primarily intended to raise the subject's familiarity which might potentially result in it automatically becoming a topic of conversation among ordinary people.

In order to inform the public sphere about CCS and to make the subject known, a communication strategy for CCS should address the mass media first of all since this can be assumed to have the highest level of information dissemination. It is true that information can be spread relatively quickly with the help of the mass media, but there are few opportunities for target persons to participate and the information is highly selected. This may lead to target persons not being able to receive and interpret the information properly. In addition, there are no feedback channels in place which would reveal incorrect interpretation on the part of the target persons. Despite these drawbacks, mass communication is essential to achieve broad publicity and familiarity at more or less acceptable cost and to lay the foundations for the commercial use of CCS. In general, the aim is to ensure that the term CCS is already known to the public before concrete projects are planned. This could then lower the risk perception of those affected on location since they would know that CCS is not something completely novel but has already been tested elsewhere. However, at present the developments seem to be heading in a different direction, which is why the government should try to introduce appropriate measures as quickly as possible.

Because of the drawbacks of mass communication, this should be supported by interpersonal channels, networks and organisations so as to be able to reach specific target audiences or public assemblies in a more targeted way. Interpersonal contact, i.e. the interpersonal relations between communication partners, can take place on two levels: either public authorities communicate directly with the target persons (personal com-

munication), or opinion formers exert influence on target persons within the mass communication.

The complexity of CCS technology or, for example, the fact that more coal would be used in power stations with low CO_2 emissions could represent factors which are inconsistent to recipients' prior attitudes. It may also occur that the recipients do not understand the sender's information and contact opinion leaders to obtain additional information and evaluations. The initiative for personal communication on the second level may originate from the followers as well as from opinion leaders, who often seek advice themselves from professionals such as, e.g. scientists, experts or members of environmental organisations. These groups usually represent the sources from which the mass media themselves draw their information. Opinion leaders and experts mould the information and decision processes of both individuals and groups with their opinions, knowledge, prejudices, image and competence. If the communicator manages to reach opinion leaders and experts, the influence brought to bear on the mass media can be reinforced by their credibility and trustworthiness.

In order to continue to reinforce interpersonal relations and the influence on the target persons, in a third stage, the communicator should initiate personal contact with specific sub-groups. The communicator directs such personal communication at a homogenous and limited audience, for example within a round of discussions between residents, NGOs, energy supply companies and government authorities. Such personal contacts seem less constructed and the communication is more flexible than mass communication. A direct dialogue is possible so that feedback can take place and misunderstandings and discrepancies can be cleared up as quickly as possible. However, because of the high efforts and costs involved, personal communication should be directed in a highly targeted manner at specific sub-groups, above all at those where strong opposition is expected. Through the personal contact, the recipients or discussion partners might come to trust the communicator more than the impersonal communicators of the mass media.

It can be concluded with regard to the choice of communication channel that mass communication has high priority above all in the first phases of communication about CCS, in which publicity should be increased, attention captured, information spread and knowledge transmitted. Personal communication, in contrast, is of greater significance in order to achieve the communication objectives of the acceptance of CCS and the storing of permanent attitudes. Incorporating opinion leaders is necessary throughout the entire communication process since they hold a relevant position in all the communication phases. However, because the different sub-groups are at different levels and different phases of the communication process, the use of mass communication, personal communication and other communication instruments should always depend on the respective group being addressed.

3.4 Communication mix for the information about CCS

The available mix of communication instruments for CCS differs clearly in their respective advantages and weak points. A communication strategy has to match the functional use and timing of the instruments as closely as possible in order to achieve synergy effects via "integrated communication". It is particularly important that the information communicated on the topic is consistent. The messages from different energy supply companies or different authorities and research institutions should therefore work using the same information. For simplicity's sake, the instruments used are not listed in a target group-specific way to start with, but within the scope of communicating with the whole population. Determining the mix is done along defined communication phases and objectives. For the whole of the population, reaching the stage of "remembering the message" should be targeted, for individual sub-groups serving as multipliers, the stages "decision" and "action" are also relevant.

As can be seen from the situation analysis, the interaction between communicator and sub-groups is highly significant. In contrast to advertising, in public relations, the communicating organisations are in a dialogue with the corresponding sub-groups. Moreover, the credibility of and confidence in the message is raised due to the mostly objective reporting by independent third parties (journalists). The strategic and long-term significance of public relations within an information campaign on CCS results in it being able to assume a leadership function in communication about CCS. Public relations should therefore be the main instrument along all the previously defined stages and objectives of communication. In order to avoid polarisation in the media, balanced and neutral reporting should be aimed at, which is focused to start with on the core messages.

Positioning the message in the editorial part of print media is very important right from the first phase of communication. Of all the media forms, newspapers play a special role because of their topicality, speed of disseminating information and credibility. Since the use of print media results in a greater knowledge acquisition, they are particularly relevant for people acquiring an understanding of the message. Apart from the possible route via print media, public relations can also access other written and audiovisual communication channels such as business reports, for example, image brochures or customer magazines. In this way unfiltered information can be passed on to target groups. The production of radio and TV programmes (promotional spots or video clips) as a form of editorial address is important mainly in the first two phases of communication in order to get the attention of the target persons. If those targeted show interest in the problem and have developed a certain desire for information, they can then be supplied with additional material. Online media such as, for example, a specially designed homepage or an Internet platform on the subject of CCS are suitable primarily because of the possibilities for individual information, constant updating and interactiveness. Another important field of action of public relations is the communication surrounding special events. Directly addressing sub-groups, for example, in panel discussions, raises the probability of acceptance since communication partners are able to participate in a direct exchange and have the chance to resolve any discrepancies.

The impacts of communication can be reinforced by complementary connections between the instruments. Media advertising could have such a supportive function in CCS communication.

3.5 Characteristics and impact of various media

Mass communication is tied to the mass media since these are the means used to spread messages. The mass media has numerous functions, of which the information function and publicity are the most important in the context of communication about CCS. Other functions include helping to form opinion, criticism and control, selection and topicalising certain subjects, education and entertainment. To what extent which type of mass media is used to spread communication messages is based, on the one hand, on the media habits of the previously defined sub-group being targeted and, on the other hand, on the defined communication objectives and instruments used.

Print media represent a large group of the mass media which can be further subdivided into the advertising forms of newspapers, specialist journals and popular magazines. Although communication based on dialogue and experience is being ever more significant, press campaigns and media relations still play an important role. The messages placed in print media have a relatively high acceptance among media users. Print media are seen by the public as being neutral and objective authorities and enjoy much greater credibility compared with advertising. While recipients turn to television primarily to satisfy their need for entertainment, the need for information is usually behind them turning to the press. Furthermore, it seems that much greater knowledge acquisition results from using print media than from using electronic media.

The main features of **newspapers** are publicity (general accessibility), topicality, a wide range of subjects, regular appearance, speed, information and credibility. According to Schenk, the hypothesis was able to be corroborated that respondents who are actively engaged in looking for information believe newspapers to be more credible than passive users. Daily or weekly newspapers guarantee a mainly rational delivery of facts and arguments. Daily newspapers provide the opportunity to differentiate content on a regional basis since, depending on the target groups, articles can be placed in regional as well as supra-regional papers. As an information medium with a wide reach, they hold strong positions in both local markets and the national media market. For example, 80% of all Germans over 14 read a daily paper every day and this has not changed much over recent years in spite of the increasing offer of media channels. Advertisements in newspapers play an important role since the trustworthiness of the editorial parts affects the credibility of the adverts as well. Daily papers are therefore particularly suited to communicating information about products in need of explanation. However, the learning success in newspapers is only short-lived even if information is absorbed in a stimulating way. Communication messages in newspapers are perceived by readers to be particularly informative because they have close ties to this medium and a correspondingly high acceptance of advertisements. Whether the readers actually notice the adverts depends on their design, size and colour.

Magazines share similar characteristics with newspapers: topicality, regular appearance, readily accessible to the public and the dissemination of knowledge from many different fields. Since magazines are very varied, their distinctive features also vary widely. Popular magazines are directed at a very broad public which are connected by their shared interest in a particular subject independent of profession, social status, political or religious affiliations. Contents are predominantly directed at current affairs, but also include easily comprehensible information and entertainment. Facts and arguments are thus transmitted in a rational and/or emotional way. Magazines can reinforce the degree of familiarity of a topic and support opinion forming in global subject areas. Moreover, they can target readers with detailed information who are themselves opinion leaders in important communicative groups.

Popular magazines can contain either adverts or informative articles about the object to be communicated. Advertisements can convey more extensive messages - argumentative verbal statements for instance - although it should be taken into account that a relatively short attention span must be assumed for adverts (on average between 2 and 5 seconds). This is why advertisements should generally be designed to transmit a simple message which can be processed at a glance. Additional information can be supplied later or via other media, e.g. the Internet. The headline plays a central role for articles because this has to capture the attention of the targeted readers and stimulate their need for information so that they are prepared to read longer texts.

Specialist journals are aimed at specific groups of professionals or otherwise definable groups. Their use can be compared with that of popular magazines although overall a greater interest or involvement of the readers can be assumed. Despite this, an information overload of adverts and articles should be avoided in specialist journals as well and instead their readers should be motivated to acquire more information.

Outdoor media in the form of **posters, advertising spaces, signs** and public and private transport represent a smaller group of the mass media. These are used exclusively by the communication instrument of media advertising and comprise short-term, current and supportive advertising possibilities outside closed rooms. Poster advertising is particularly suited to transmitting simple and clear messages, mostly in picture form. The message is received immediately and without deliberate intent on the part of the recipient; the contact with the medium is practically unavoidable for people. Posters are especially appropriate for younger target groups and reach people in cities with populations over 500,000 in a better than average way.

Within this study, the group of electronic media focuses on the advertising media of television, radio and Internet. Television and radio, in particular, transmit emotional impressions and capture people's attention using audiovisual presentations. According to Schenk, the emotional impressions produced by radio and television are retained longer than the knowledge transmitted by these media. Television has the greatest impact on perception since readers and viewers are more closely bound to the medium than listeners. Television should direct attention to certain events and topics which will

then need a greater depth of information, for example, via print media or personal communication.

The components which make **television** effective are above all its topicality, realism, entertainment, credibility and information. Television can present rational and emotional sequences of events, demonstrations and arguments. Television is often used to build up an image, but this is actually a medium with a rather passive take-up of information which results in a relatively superficial influencing of the viewer. In addition, television is subject to the danger of zapping, even when it is intensively used, so that repeating messages is assigned a high importance. By carefully selecting the right programme and the right broadcasting time, certain target groups can be addressed and television advertising can be timetabled throughout the day although high viewing losses will still occur.

Unlike print media, but also television, **radio** is a medium which is often used in the background or alongside another activity so that the chances of the listener's attention being diverted are relatively high. Radio's influence is only very short-lived and its messages are forgotten very quickly. However, radio can quickly reactivate already learned messages which were acquired via other media. In this way a relatively rapid penetration of a target group is possible which can lead to very fast familiarisation with a topic and it is primarily suited to communicating messages which are very topical.

The **Internet** is mentioned last, although this is actually a media form from the multimedia domain. Online media are made up of a combination of digitally-based text, images and tone. As a result, in general, all different types of content are possible which were previously offered separately in the traditional print and TV domains. Alongside multimedia-based presentation, online media also offer new communication possibilities with the user, the opportunities for individual information, constant updating and interactiveness. While the interactiveness of television and radio is still relatively weak, the Internet offers a multitude of participation possibilities in the form of discussion platforms, web logs or newsgroups. Above all, these represent opportunities for public assembly, to exchange experiences and to participate in opinion forming. The rapid spread of online media has not resulted in classical media use being ousted, but rather to a growth in the total time spent using media. However, false information on the Internet represents a danger which is apparent in the slightly weaker and more inconsistent image of the Internet in comparison to conventional media.

Communication impacts can be reinforced by complementary connections between the various communication instruments. **Media advertising** could have such a supportive function in communicating CCS. It has to be integrated into and coordinated with the other communication instruments, especially with regard to timing and topics. In order to achieve interdependencies between the impacts of media advertising and public relations, both instruments should be used in parallel, especially in the first two communication phases. With the help of media advertising, besides purely factual information about the communication object, emotional messages can also be transmitted which capture people's interest and attention and help to build up a succinct image. In this way,

target persons have greater exposure to the communication messages so that they develop a need for more information and react to other communication measures. Because advertising is usually seen as an instrument for the targeted communication of a particular organisation, however, its credibility is limited since the advertising messages are perceived as the means for the organisation placing the ads to assert its own self-interests. This effect is reinforced by the one-sided communication of the mass media because recipients have less confidence in the impersonal communicators of these media. For these reasons, communicators should compensate for these effects by directing the message in an extremely targeted way at existing interests and needs of the respective target groups.

In addition, media advertising is battling with the problem of an increasing information overload of the recipients. The simplification and symbolisation of advertising messages therefore represents a major challenge when designing the advert contents related to CCS. Above all, adverts should be designed to concentrate on the core arguments of the technology. To reinforce PR measures, placing ads in daily newspapers is particularly suitable since the credibility of the editorial sections affects the credibility of the advertising as well. Adverts in magazines are also suited to raising the familiarity of a topic because, depending on the specialist journal involved, a more interested readership can be addressed by designing the message in a more argumentative way. Since opinion leaders are usually interested readers of popular or specialist magazines, there is also a chance of reaching them more directly through advertisements. The adverts in print media are especially important in the third phase of communication to motivate target persons to occupy themselves more intensively with the topic of CCS (e.g. read editorial reports on CCS). In addition, informative advertising should be offered to a greater extent on the internet so that target persons are able to satisfy their need for information. In contrast, poster advertising is less suitable as a communication strategy on CCS since, on the one hand, it is difficult to symbolise the technology and, on the other, its impacts are only very short-lived.

Television spots are important within the scope of the long-term impact of communication. Audiovisual images are able to capture people's attention, especially to start with, and in addition are remembered for a long time due to their emotional appeal. To do so, the television spot has to try to overcome the indifference generally reserved for advertisements and possibly also the fact that audiences are actually occupied with something else. The factual style is less important for television spots than communicating the message in an appropriate way by concentrating on a single idea per TV spot. Different ideas can be covered by producing several spots which are formally integrated and which can be aired in succession at different times. Conditional connections between the types of advertising could be produced with the help of radio, although the impact of radio presupposes the use of television spots since radio advertising is usually used in addition to these in order to reactivate already received information. As well as the use of television adverts in the first two communication phases, their use once acceptance has been achieved could also be relevant since they address the targeted persons on an emotional level once the message has already been processed on a cognitive level. Emotional appeals in television adverts are one way of doing this.

Personal communication is another important communication instrument within the scope of an information campaign for CCS. However, personal communication can only have a noticeable effect after society has already acquired a certain level of information. There are therefore contextual factors which exist between personal communication and the other two communication instruments.

4 Conclusions

According to experts' opinion lacking public acceptance can be a severe obstacle for the implementation of CCS. The perception of risks, the belief in the necessity and usefulness of CCS, real facts, and the published opposition or support of societal groups play an important role for the development of public attitudes towards CCS.

Level of information

There is a broad consensus that the level of information in the public is very low. It is expected that a higher level of information has a positive effect on the acceptance of CCS whereas a low awareness and understanding causes fears and opposition.

Benefits of CCS

The most important factor for acceptance is perceived benefits of the technology. First of all the benefit of CCS is its role for climate change mitigation. This role depends on the geographical reference: whereas it might not be relevant for individual countries, e.g. in Europe, it might be necessary and acceptable in a global view and for countries with a coal-based energy-mix and increasing energy need. Another aspect is the diversification of energy sources and security of supply, also in Europe. Finally employment is a relevant issue; if it is shown that CCS helps to ensure employment, this will promote the acceptance of CCS. Opposition against CCS can be alleviated by clarifying that it is a bridging technology to have time to develop renewable energies until they can provide large parts of the energy supply.

Obstacles for acceptance

Some factors can influence the acceptance of CCS negatively. As CCS causes additional energy consumption and additional costs (lower power plant efficiency due to CO_2 capture, transport and storage needed) it is expected that electricity prices will increase which certainly affects acceptance even if there are many other reasons for increasing electricity prices. The main reason for a negative image of CCS is the perception of risks, especially in regions where CO_2 storage projects are planned. A general problem is the publics' concern that the support for CCS results in a decreasing support for renewable energies which are a top ranking solution for the climate change problem in the public's view.

Multipliers have a large influence on public opinion, especially NGOs which are considered to be a credible information source in environmental issues. Some of them are no pronounced opponents of CCS, they rather attach conditions to the implementation,

e.g. international rules, absolute priority of renewable energies and efficient use of energy over CCS, or extensive controlling measures to avoid risks. Consumer organisations, trade unions, churches, etc. can also have influence, but in general they do not yet have a firm attitude. The second important group is experts in science and research who are also considered to be trustworthy when presenting fact and discussion pros and cons in an open manner.

Media, such as newspapers and TV play an important role in the early stage of awareness of a new technology. According to existent studies the media present a relatively balanced view of CCS so far (Mander & Gough 2006; Fischedick et al. 2008).

An effective legal framework is a precondition for public acceptance of CCS. Until now no regulations exist for the management of risks, approval procedures, or decision making processes with public participation.

Communication strategies for an increased acceptance of CCS

Components of a communication strategy are the content itself, but also the communicator and the form of communication.

Although important questions are still open, such as long-term CO_2 storage and the legal framework, the public should be informed early. Chances and risks should be communicated in an open manner in order to create trust in the communicator. It is expected that the low level of information will lead to doubts about CCS and lacking acceptance in the broad public.

Above all people living in regions with upcoming projects should be informed very early and in a comprehensive way. Personal communication should be offered in these cases. Also other interested groups should have the possibility to get informed in detail, representatives of organisations, journalists, multipliers and opinion leaders as well as people in the broad public. This means that the content and form of the information should be oriented by target groups according to their level of information and their needs.

The public is mainly interested in unbiased and trustworthy information. Therefore it should be based on facts and come from different sources. Each communicator is characterised by a certain attitude towards technologies such as CCS. A governmental CCS campaign should try to get different groups involved, for example with individual statements, public expert discussions, etc.

Important messages with a CCS information campaigns should include aspects such as the role of CCS in energy supply and climate protection, impact on society, legal issues concerning decision-making, control of risks, liabilities, etc. Unsolved risks should be communicated clearly in order to prevent from unnecessary and exaggerated fears, negative associations, e.g. to nuclear energy, or the contradiction to the further development of renewable energies. The main opposition is expected with regard to CO_2

storage, at least in regions with upcoming projects. Concerning CO_2 capture negative attitudes will not concentrate on this technology but rather on the construction of more coal-fired power plants. Therefore an explanation of the need for a continuing use of coal should be given.

Finally, according to the International Association for Public Participation five steps of communication can be identified for the communication of CCS describing an increasing level of public impact (Logan et. al. 2007):

Table 4-1: Steps of public information and participation

	Information	Consultation	Involvement	Collaboration	Empowering
Goal	To provide balanced and factual information	To obtain public feedback	To discuss with the public about its concerns (e.g. at local level)	To find common solutions	To include the public in the decision making process
Promise to the public	We will keep you informed	We listen to your concerns	We work with you	We include your concerns in formulation solutions	We will implement what you decide
Tools	Information materials, website, press conferences, contributions on TV, TV and radio spots, advertisements	Surveys, public events, focus groups, public houses, expert and stakeholder discussions	Workshops, deliberate polling	Citizen advisory committee, consensus building, participatory decision making	Citizen juries, ballots, delegated decisions

Mainly facts are needed to convince the public. Therefore demonstration projects should be carried out showing the amount of potential risks and how they can be controlled, which regulatory framework is necessary, etc. These projects are an opportunity to test also the steps of communication mentioned above. Within the communication all relevant stakeholder groups should be included. A feedback process should be provided and an evaluation of the communication measures in order to respond to the needs and concerns of the public.

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