



The ACCSEPT project:

Stakeholder Perceptions of CO₂ Capture and Storage in Europe: Results from the EU-funded ACCSEPT Survey

Deliverable D3.1 from ACCSEPT – Main Report

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Jason Anderson, Kathy Draxlbauer, Heleen de Conick, Heleen
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European
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for Climate Change Research



April 2007

Stakeholder Perceptions of CO₂ Capture and Storage in Europe: Results from the EU-funded ACCSEPT Survey

MAIN REPORT

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Introduction

Between August and December 2006 a survey was undertaken to elicit stakeholder opinions regarding the role of CO₂ capture and storage (CCS) in Europe's energy future. The survey was delivered to 2619 individuals or organizations by post or email in the EU25 member states¹. We also sent questionnaires to selected respondents in accession or candidate-status EU countries (Croatia, Romania, Bulgaria, Macedonia and Turkey)² and to a number of non-EU European nations (Norway, Switzerland and Serbia).

Respondents had the choice of completing the questionnaire in paper form from a choice of 17 languages³, or electronically in English via the World Wide Web. One objective of the survey was to survey a wide range of stakeholders, i.e. not just those involved directly in the development or implementation of CCS technology (tier 1 stakeholders), but also those with a more general role or interest in energy policy, climate change and decision-making (tier 2 stakeholders). For this reason just over half of the individuals sent the questionnaire (1341) were elected members of parliament in all the EU25 countries (with the exception of Malta, Cyprus, Greece and the Czech Republic).

A short fact sheet on the key facts surrounding CCS was provided in the paper mailing along with the questionnaire to ensure that all respondents had a common baseline of information available to them whilst responding (though of course there is no guarantee that the respondents all read the information note). We also arranged for the information sheet to be translated into the 17 different languages and these were sent to the appropriate respondents. The English language version of the fact sheet was available on the website. Copies of the English-language version of the questionnaire and fact sheet are provided at the end of this report.

As of 11th October 2006, 464 responses had been received, a response rate of approximately 18%.⁴ However, because only 20 parliamentarians (1.5% of all those contacted) had responded as of 11/10/06, a more realistic measure of the response rate is to exclude the parliamentarians from the sample. If this is done then the response rate is 444/1278 or approximately 35%. This is a reasonable response rate to achieve for a questionnaire delivered remotely. The initial survey was distributed in mid-August. Two email reminders were issued, one on 4th September, and the other on 28th September. In October it was decided to pursue two further strategies were employed to improve the response rate.

¹ The EU25 are: Austria, Belgium, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Netherlands, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, UK. No respondents were identified in two of the EU 25: Malta and Cyprus.

² Bulgaria and Romania joined the EU on 1st January 2007.

³ Languages in which the questionnaire is available: English, German, French, Italian, Spanish, Portuguese, Czech, Lithuanian, Polish, Dutch, Swedish, Norwegian, Finnish, Danish, Estonian, Slovenian and Greek.

⁴ It should be noted that some respondents were not included in the initial database, because some respondents passed on the questionnaire to their other contacts. For instance, the questionnaire was distributed to members of an industry association concerned with development of CCS. In addition, the web-version of the questionnaire was accessible to any one who knew of its existence. Hence the 'real' response rate is some what lower than the percentages quoted here. The key issue is really what percentage of the target population has been included in the survey. This is very difficult to estimate since it differs for each stakeholder group in each country and there is no reliable way of identifying what is the appropriate population of potential respondents.

1. A postcard was sent to all the parliamentarians in our database to request their assistance in completing the questionnaire. This strategy was not successful, with only a few additional responses from parliamentarians.

2. It was decided that selective telephoning would be necessary to increase the response rate from certain sectors and countries. In November and December 2006 individuals were contacted by phone and encouraged to complete the survey. This strategy was only partially successful and it was decided in January that it was not worth devoting additional resources to improving the response rate. It was decided, instead, that following up with telephone and/or face-to-face interviews with key respondents would be a more useful way of accessing the opinions of under-represented groups. This report only documents responses to the written survey.

The final number of respondents as of 19th December 2006 was 511. The majority of the new respondents appear to have completed the survey online independently of our efforts to elicit additional responses as set out in (1) and (2) above. This is 40% of the sample excluding the parliamentarians.

Statistical Analysis

Where appropriate, statistical analysis has been undertaken within SPSS to compare the means between countries, stakeholder groups and other categorizations of the countries (e.g. into regional blocs, by GDP per capita, fossil fuel production and national population). The independent T-Test has been used for this purpose and where the two-tailed significance is 0.05 or below the difference has been assumed to be significant (i.e. there remains a 5% chance that any significant difference in the means arises by chance). Bivariate correlations using the Pearson test have also been employed to examine whether different variables are correlated at the 0.05 and 0.01 significance levels. Where no statistical tests of the difference between means or correlations are mentioned in the report, this is generally because no significant differences or correlations between variables have been detected.

Note that where expressing percentages, we have generally referred to the ‘valid percent’, i.e. excluding the missing respondents from the sample. Both the percent and valid percent are provided in the Annex of Tables.

We have provided the figures referred to in the text within this document. All the Tables referred to are available in a separate Annex of Tables.

Respondents by Stakeholder Group

Seven categories of stakeholder were identified and a second level classification of these stakeholders was also undertaken. The breakdown of respondents from the first- and second-level classification is shown in Figures 1 and 2 and Tables 1 and 2. s: energy sector 141; chemicals sector 6; transport sector 2; government. The largest single group is research / academia, followed by the energy industry and government officials. NGOs and parliamentarians and other industrial sectors are poorly represented in absolute terms, but because they form a smaller population of respondents in the first place, they may still be reasonably well represented in relative terms. The actual numbers of respondents is: energy sector 141; chemicals sector 6; transport sector 2; government 68; NGOs 26; academics & researchers 172; and parliamentarians 21. 75 respondents did not specify their occupation or else did not fit into the above categories.

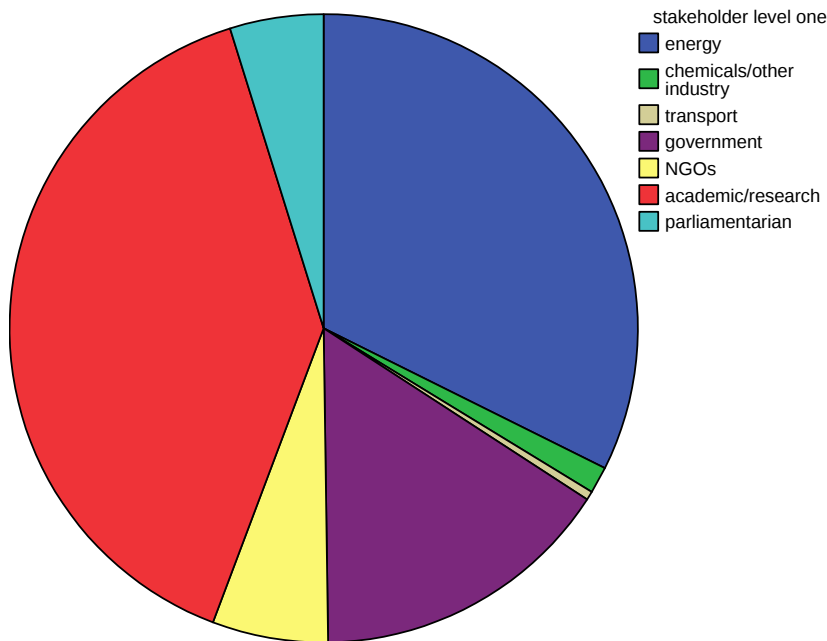


Figure 1: Breakdown of Major Stakeholders (Level 1)

The more detailed breakdown by stakeholder group (level 2) is shown in Figure 2. The most well represented groups are electricity generation, power plant designers, oil and gas, ‘other’ energy, national geological surveys, engineering, earth sciences, and socio-economic research. Poorly represented are other industrial sectors, coal sector, parliamentarians, government officials (with exception of geological surveys) and NGOs. The pattern of responses suggests that we were only partly successful in attracting a response from tier 2 stakeholders; which constituted approximately 25% of the respondents (those spending less than 10% of their work time on CCS). This probably reflects the extent to which CCS is still widely regarded as a technical and scientific issue, which tier 2 stakeholders do not feel confident in addressing, or simply do not have an interest in as of yet. Figure 3 (table 3) shows that the sample is largely composed of people who spend most of their working time on energy issues. As shown in Figure 4 (table 4), however, only about 1/3rd of the sample are working

more than 50% of their time on CCS, and hence could be termed CCS specialists. Nearly half of the sample spend less than one-third of their time on CCS.

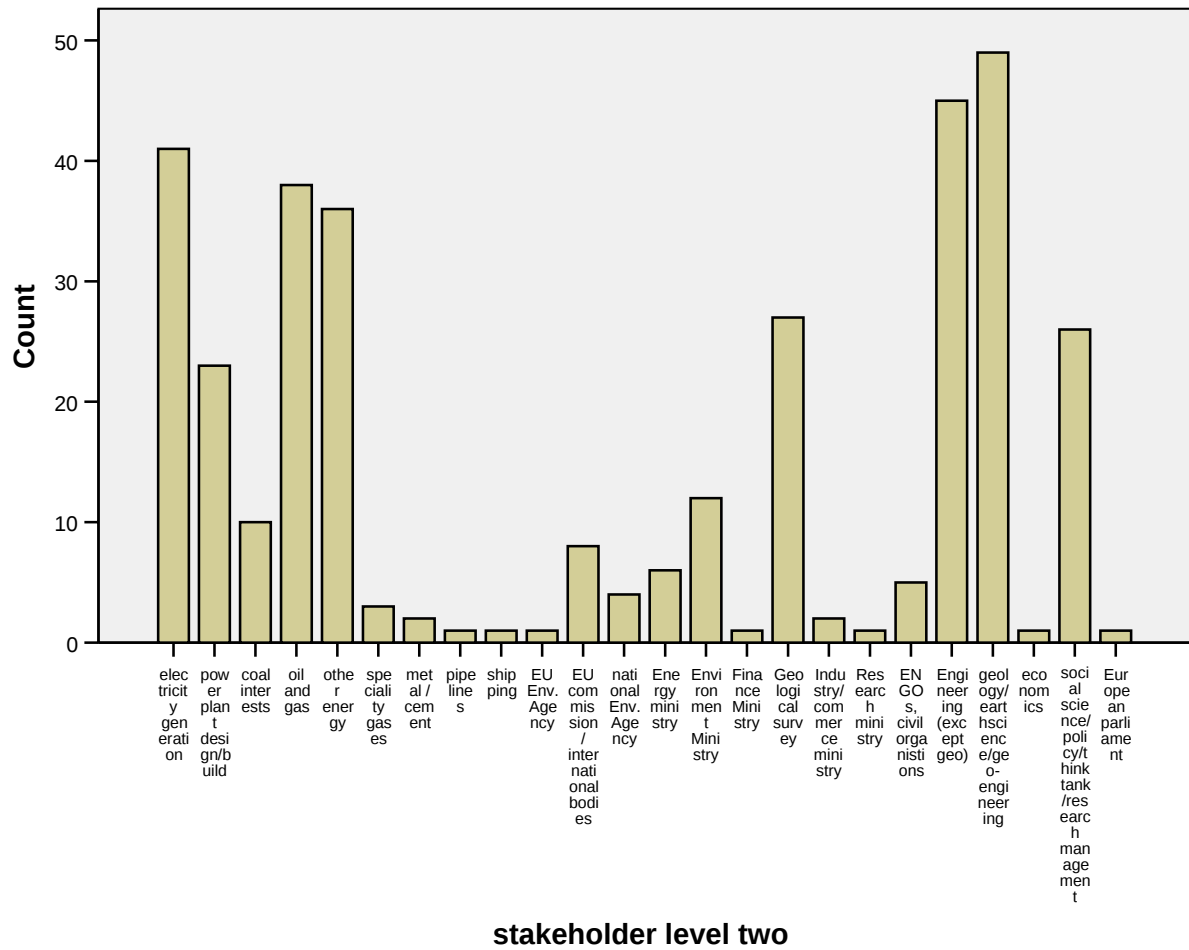


Figure 2: Breakdown of Stakeholders (Level 2)

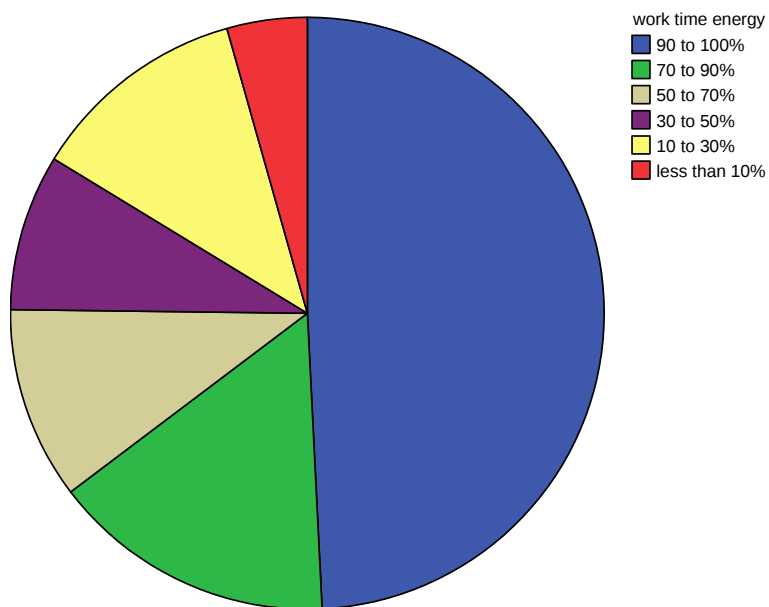


Figure 3: Amount of working time (expressed as a percentage) spent on energy issues (question 4)

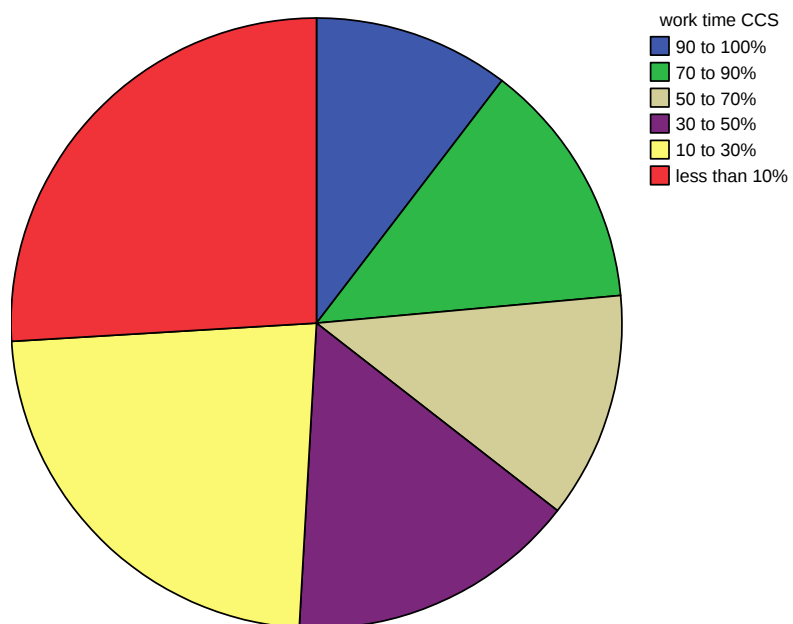


Figure 4: Amount of working time (expressed as a percentage) spent on CCS (question 5)

Respondents by Country

One-fifth of the respondents (20%) were from one country, the UK (see figure 5, table 5). The other largest responses were from Germany (11%), Netherlands (9%), France (6%), Italy (6%), Norway (5%), Denmark (5%), Spain (5%), Belgium (4%), Finland (3%) and Sweden (3%). The highest per capita responses received were (in descending order) from: Norway, Estonia, Denmark, Slovenia, Finland and the Netherlands. The lowest per capita responses were received from Hungary, Greece, Italy, Poland, Spain and France. The countries around the North Sea – Denmark, Norway, Sweden, Netherlands, UK and Germany – have been most engaged in CCS over the past decade through major EU and national R&D programmes. Thus, pre-existing involvement and interest in CCS had a large influence upon the responses by country. It is also likely that the composition of the research team had an influence on the level of responses obtained. A German, French, Italian or Spanish partner might have helped in obtaining more responses from those countries.

To analyze difference in responses across countries we selected several countries for individual analysis based upon the absolute number of responses and the population size. We selected two large countries - the UK (at 1.7 respondent per million population) and Germany (0.67 respondent per million); three medium-sized countries - Sweden, Belgium (both at 1.9 respondents per million) and the Netherlands (2.9 respondents per million); and three small countries – Denmark, Norway (both at 4.6 respondents per million) and Finland (2.9 respondents per million). Whilst France, Italy and Spain all had reasonable numbers of respondents (30, 29 and 25 respectively) it was decided that these numbers were too small relative to population size to be at all representative of the target stakeholder community for these countries to be selected for more detailed analysis. In the case of Slovenia and Estonia, which had a high number of respondents per million head of population (at 4 and 4.5 respectively) it was decided that the absolute number of respondents (8 and 6 respectively) was simply too small to justify selection of these countries for more detailed analysis.

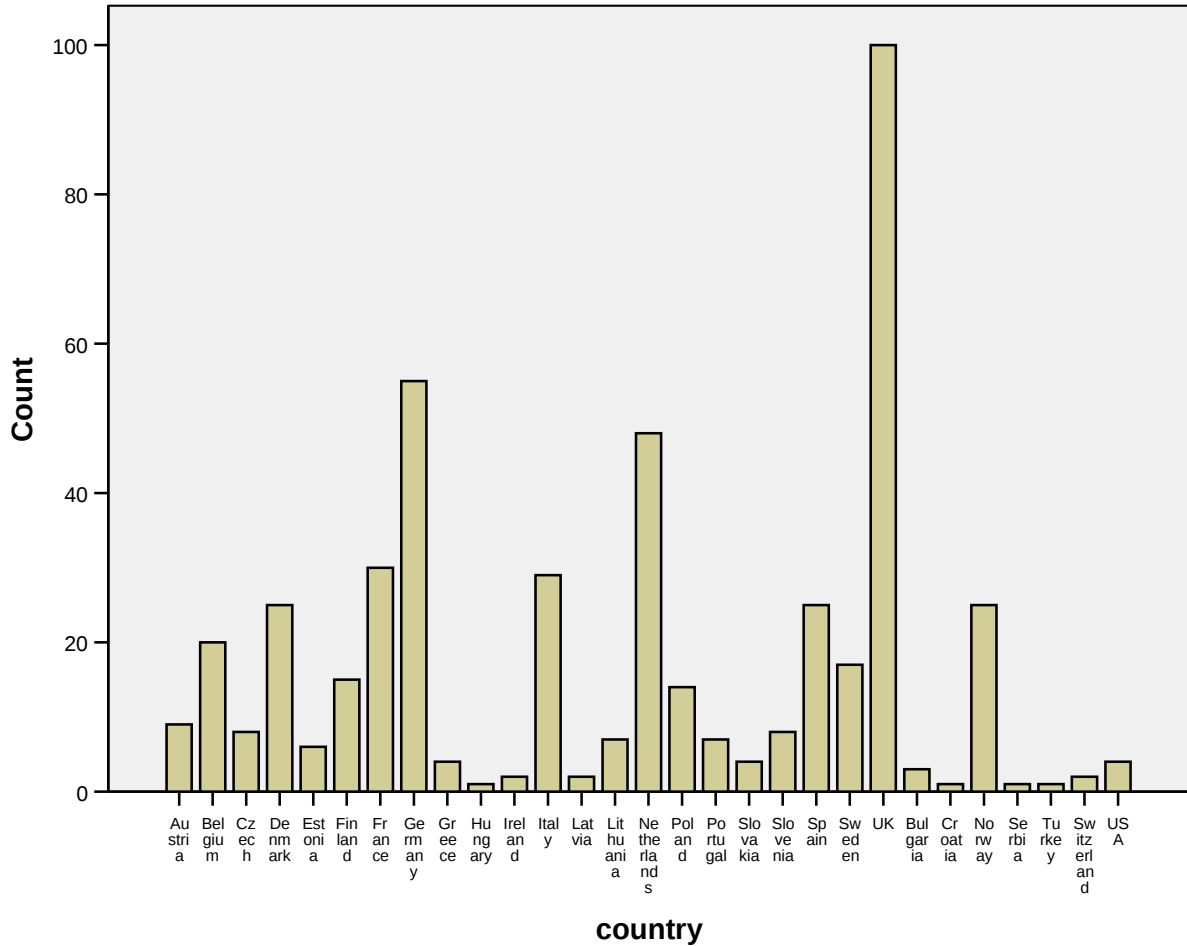


Figure 5: Respondents by Country

Organisational Positions on CCS (questions 6 and 7)

47% of the respondents reported that their organization was 'very positive' towards CCS and a further 24% indicated a 'slightly positive' organizational position (see figure 6, table 6). Only 6% of the sample indicated a 'slightly negative' or 'very negative' posture towards CCS. The majority of the respondents therefore work for organizations which adopt a positive stance towards CCS.

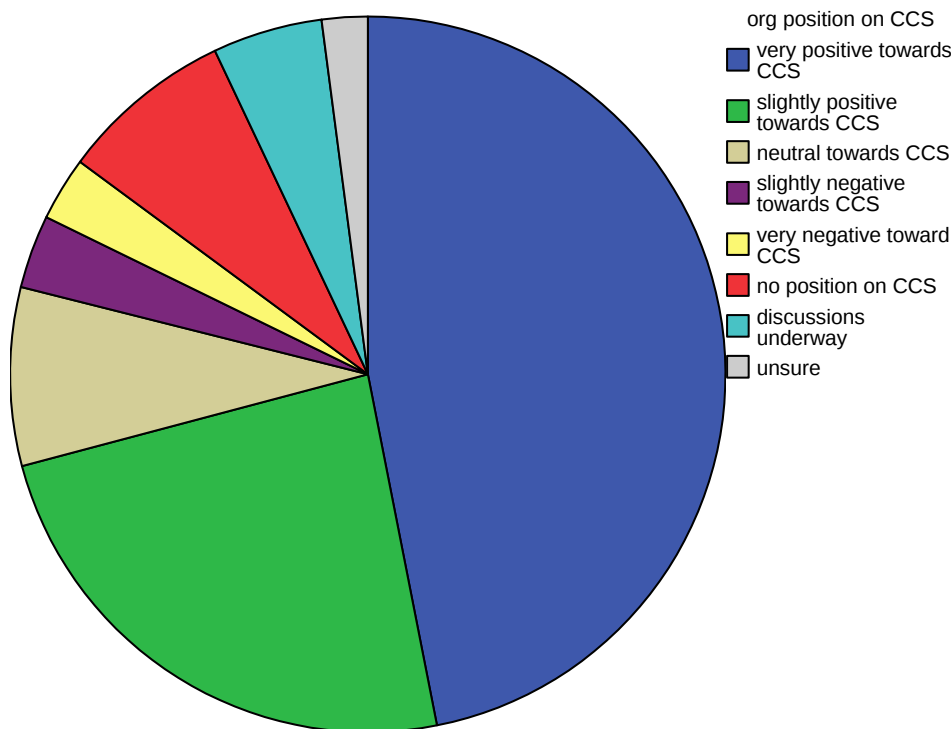


Figure 6: Organisational Position on CCS (Question 6)

The respondents were asked for the reason for their organisation's position on CCS. The overall responses are provided in Figure 7 (table 6). It can be seen that the most frequent reasons given for adoption of an organisational position are: potential to continue use of fossil fuels, potential magnitude of CO₂ emission reductions, business opportunities, potential for rapid cuts in CO₂ emissions, energy security and environmental risks.⁵

We split the sample in to two in order to explore whether there was a difference between the reasons given by the 'slightly negative / very negative' group, and those given by the 'slightly positive / very positive' group. Figure 10 shows the reasons given by the respondents who stated that their organizations had a slightly or very negative stance towards CCS. The most frequent concern of the respondents from the more 'sceptical' organizations is that CCS will discourage investment in other options, e.g. renewables; the other frequently mentioned concerns are: the environmental risks (which we interpret as meaning the risks of CO₂ seepage and its impacts, see footnote 4), high costs, regulatory and legal uncertainty,

⁵ It seems not unreasonable to assume here that the respondents are referring to the environmental risks arising from *not* abating CO₂ emissions. The way that we asked the question does not permit us to know how the respondents have interpreted 'environmental risks'. In retrospect it would have been better to have specified the nature of the environmental risks, e.g. climate change risks arising from not abating CO₂ emissions or the risks arising from the leakage from CO₂ which has been stored in underground reservoirs.

continuation of the use of fossil fuels⁶ and the availability of more effective CO₂ mitigation options

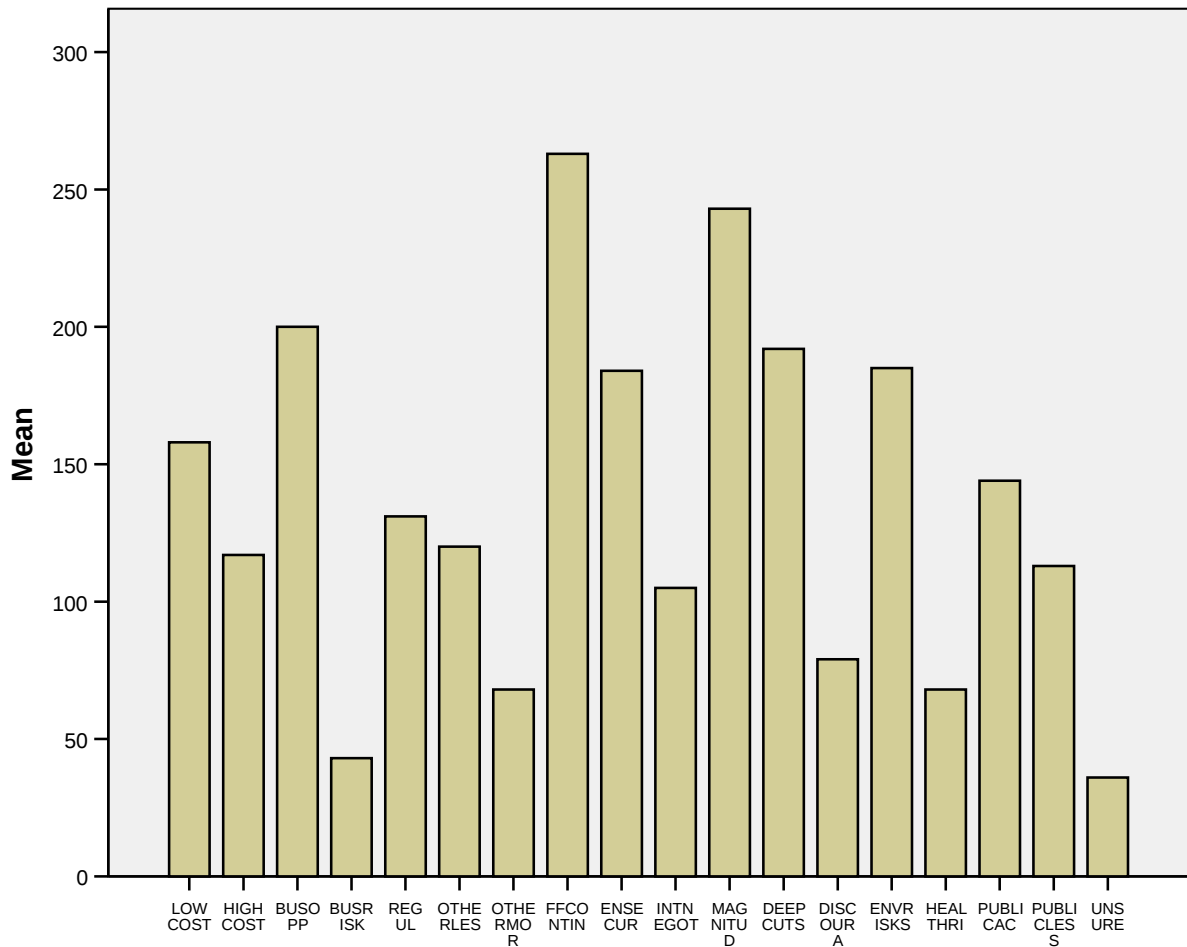


Figure 7: Reasons for the organizational position on CCS (question 7)

LOWCOST: relatively low-cost of CCS as a climate change mitigation option

HIGHCOST: relatively high-cost of CCS as a climate change mitigation option

BUSOPP: business opportunity

BUSRISK: business risk

REGUL: regulatory and legal uncertainty

OTHERLES: other available measures for mitigating climate change are less effective

OTHERMOR: other available measures for mitigating climate change are more effective

FFCONTIN: CCS would allow continued use of fossil fuels

ENSECUR: CCS helps to improve energy security

⁶ Note that there is some ambiguity regarding the response that ‘CCS would allow continued use of fossil fuels’. Whilst we assume that this was regarded as a positive dimension of CCS by most respondents, it could also be interpreted as a negative aspect of CCS by those who are of the opinion that the main imperative of the move towards sustainable energy is to reduce dependency upon fossil fuels as rapidly as possible. This might explain why this response is relatively frequent amongst respondents from organisations which are more sceptical of CCS.

INTNEGOT: CCS is important in international negotiations
 MAGNITUD: The potential magnitude of CO₂ emission reductions from CCS
 DEEPCUTS: The potential for CCS to make deep and rapid cuts in CO₂ emissions
 DISCOURA: CCS could discourage other climate change mitigation measures such as renewables
 ENVRISKS: risks to the environment
 HEALTHRI: health risks
 PUBLICAC: public likely to accept CCS more readily than other low-carbon options
 PUBLICLESS: public less likely to accept CCS than other low-carbon options
 UNSURE: unsure

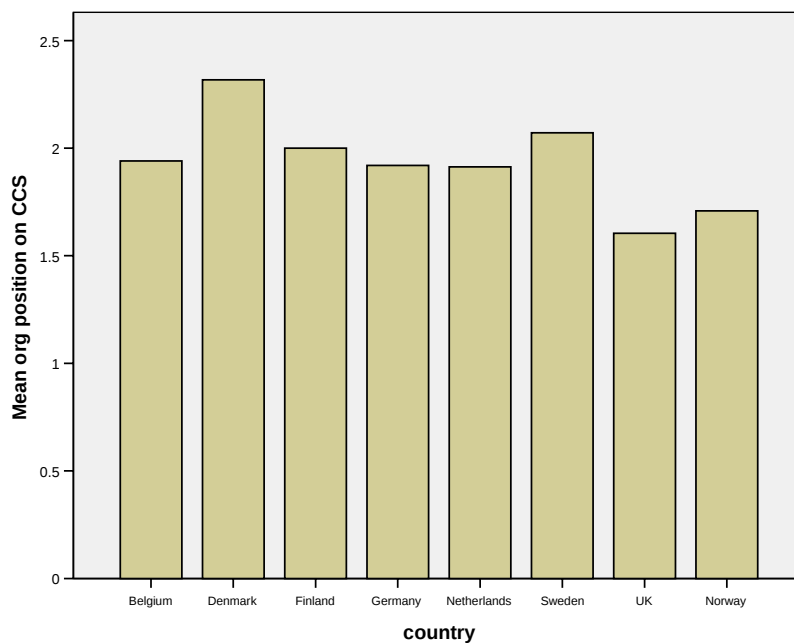


Figure 8: Perceived organisational position on CCS (question 6) by country (1 'very positive towards CCS', 2 'slightly positive towards CCS' and 3 'neutral towards CCS')

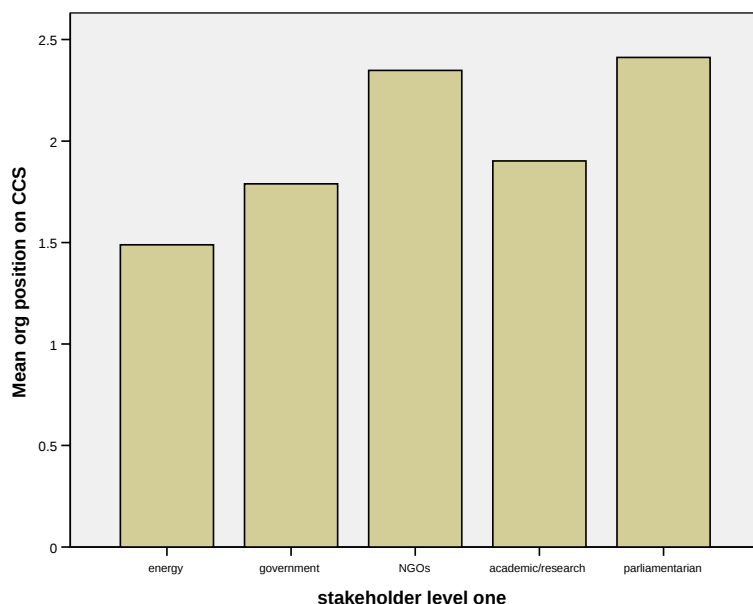


Figure 9: Perceived organisational position on CCS (question 6) by stakeholders (1 'very positive towards CCS', 2 'slightly positive towards CCS' and 3 'neutral towards CCS')

Requirement for CCS to Achieve Deep CO₂ Emission Reductions in Home Country, EU and Globally (question 8)

A large percentage of respondents believe that CCS is definitely or probably necessary to achieve deep cuts in emissions. The extent to which CCS is regarded as necessary tends to increase with scale, i.e. from own country to EU level to globally. British, Norwegian and Dutch respondents show the greatest enthusiasm for CCS and relatively little scepticism (no significant difference in the means for own country).

At the EU scale, there is a statistically significant difference between those countries most in favour - UK, Norway, Netherlands and Sweden and those less favourably disposed – Belgium, Denmark, Sweden and Germany.

Although German, Belgian and Danish respondents show greater scepticism regarding the role of CCS at the national, EU and global scales, even in those countries, an overwhelming majority of respondents supports the use of CCS. Least convinced of the need for CCS are the Finnish and Swedish respondents. The difference between the UK, which is the most persuaded of the use of CCS at the global scale, and Sweden & Finland is statistically significant.

The energy, government and academic stakeholders constitute a distinctive group which tends to support CCS, with a minority of 10% or so stating that CCS would only be necessary 'if other options fail to live up to current expectations'. The level of support by these stakeholder groups for CCS increases from their own country, to the EU and global scales.

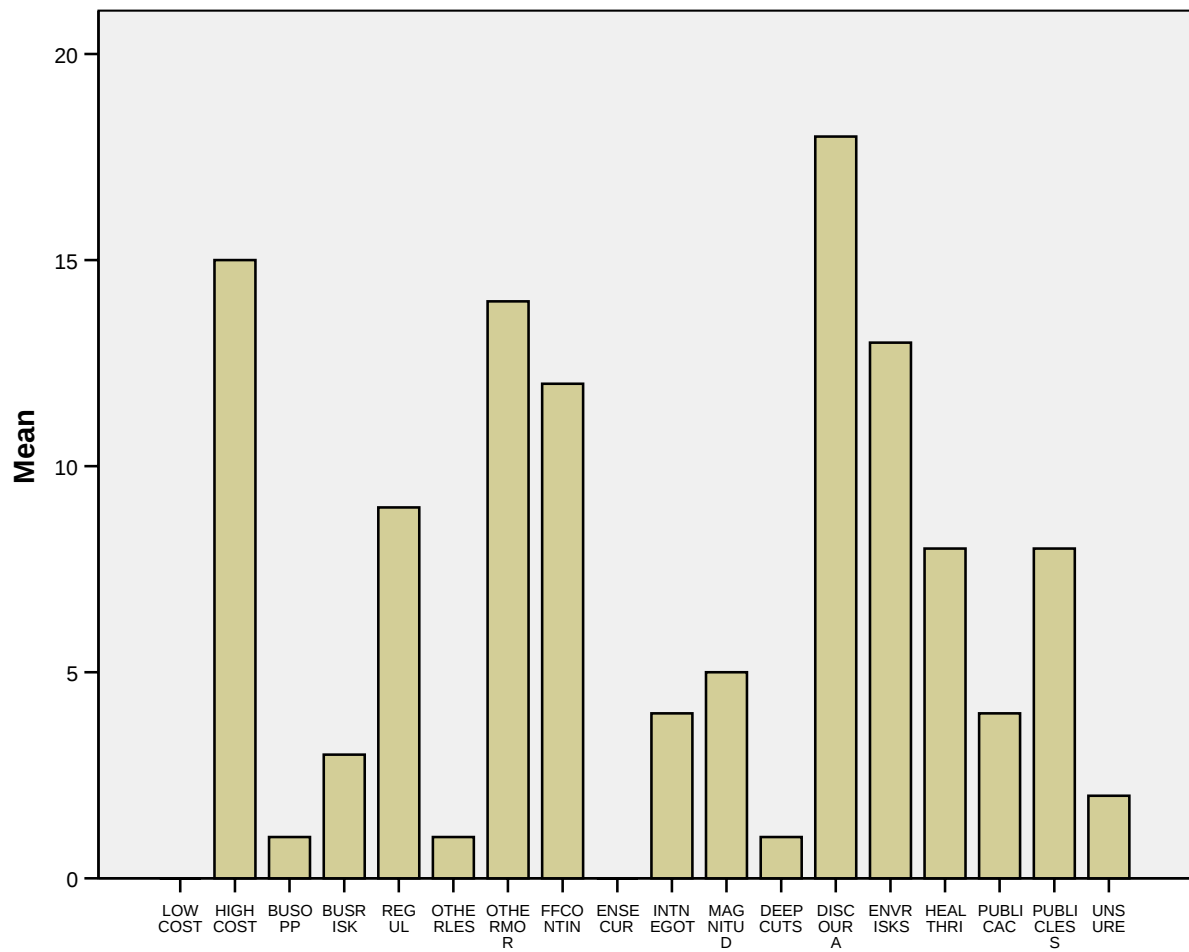


Figure 10: Reasons for organizational position given by those organizations with slightly or very negative stance (question 7)

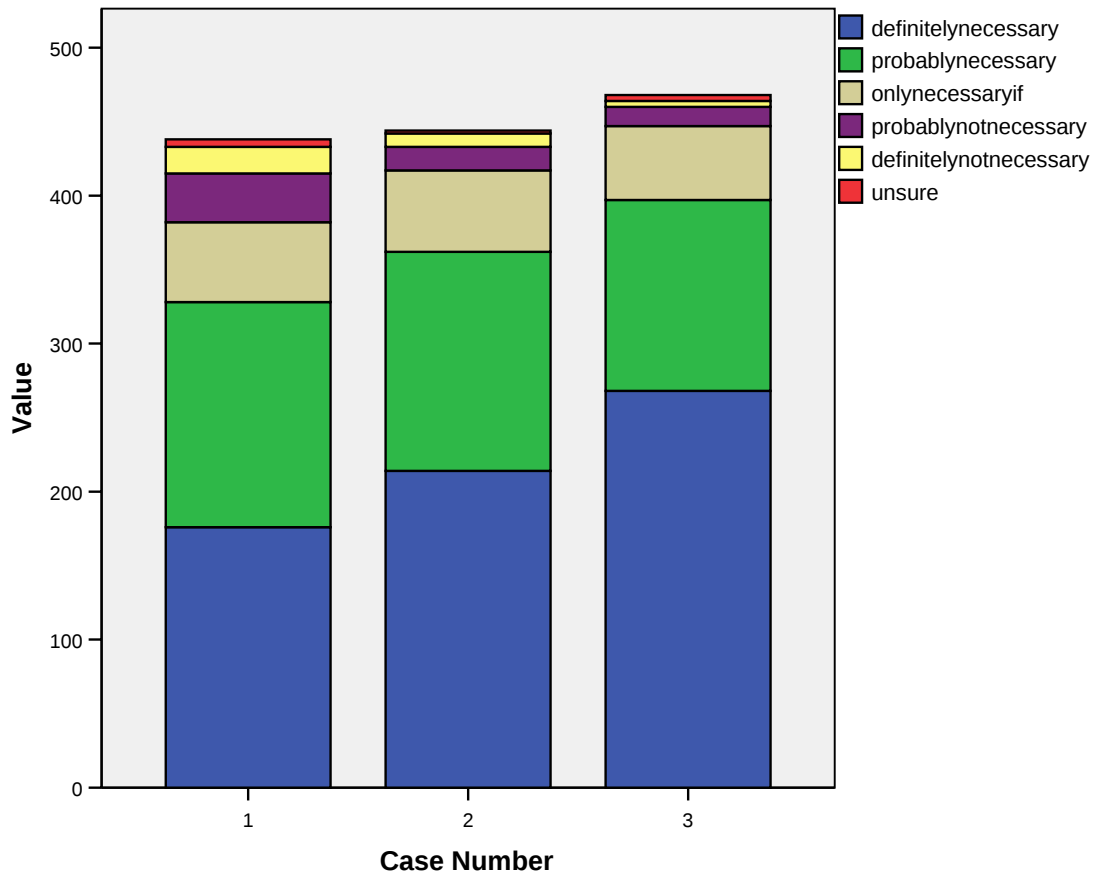


Figure 11: Requirement for CCS to meet deep CO₂ cuts in host country (1), EU (2) and globally (3) (question 8)

The NGOs are more sceptical of the role of CCS at the national scale, tending to more frequently choose the ‘only necessary if...’, ‘probably not necessary’ or ‘definitely not necessary’ options. The NGOs seem to be most sceptical of the role of CCS at the EU scale, where the most common response was: ‘probably not necessary’. For the global scale, the most common response was ‘only necessary if’. NGOs, unlike the other stakeholder groups, do not show a stronger preference for CCS at higher scales (EU and globally), possibly reflecting scepticism about CCS becoming a ‘technology fix’ for climate change around the world.

The parliamentary respondents are largely in favour of CCS, though there is again a tendency towards more scepticism, though not as pronounced as that of the NGOs. The combined result for NGOs and parliamentarians is shown in Figure 12, from which it can be seen that there is much less enthusiasm for CCS, and this is especially pronounced at the national scale; resistance to CCS as a solution decreases from national to EU to global scales. (The differences between NGOs & parliamentarians on the one hand and government, academics and energy sector are statistically significant for ‘own country’, EU and global scales). It must be pointed out that the sample size for the NGO and parliamentary respondents may limit the validity of the above findings.

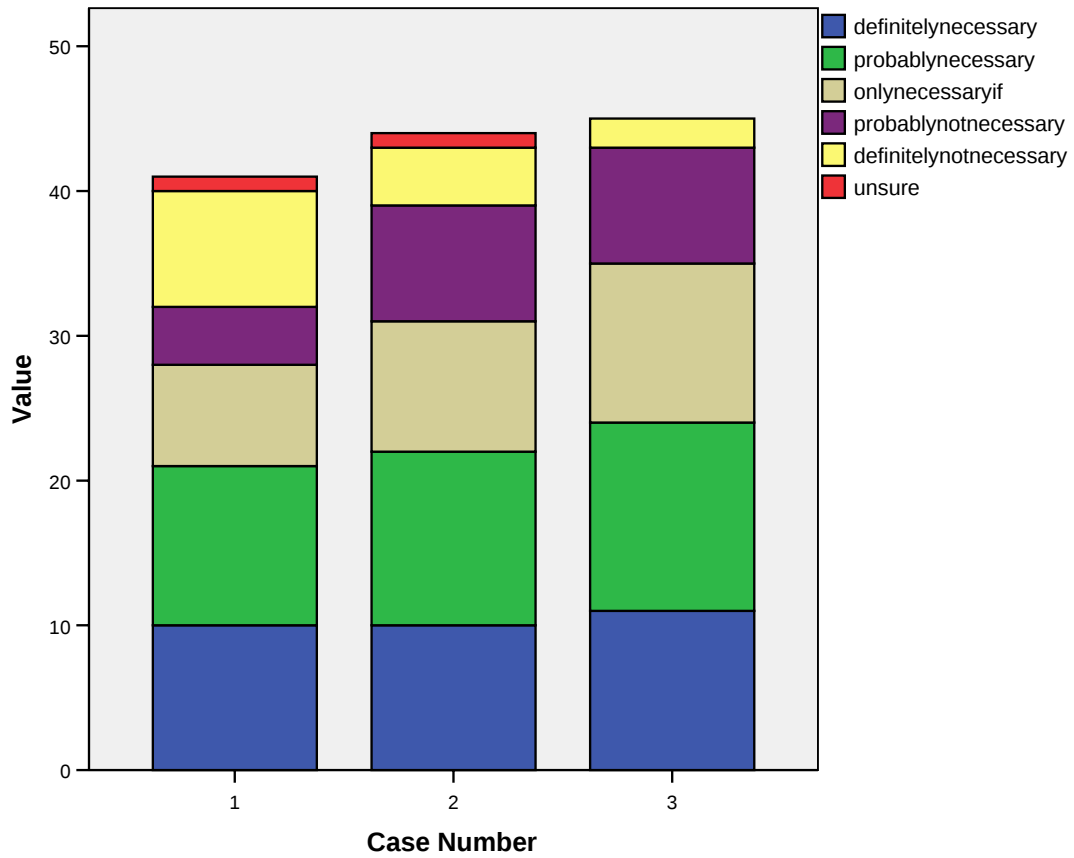


Figure 12: Requirement for CCS to meet deep CO₂ cuts in host country (1), EU (2) and globally (3) as perceived by NGOs and Parliamentarians (question 8)

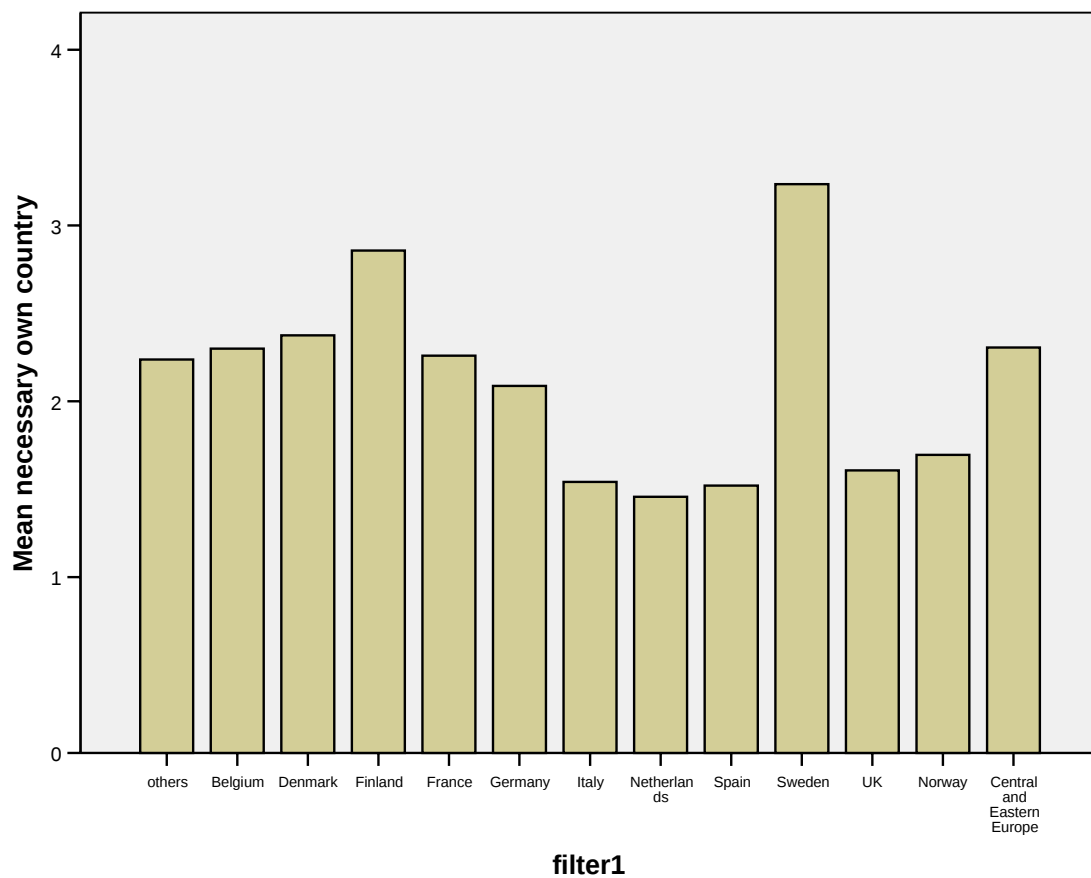


Figure 13: Perceived need for CCS in own country by country (where 1 is 'definitely necessary', 2 'probably necessary', 3 'only necessary if other options fail to live up to current expectations' and 4 'probably not necessary')

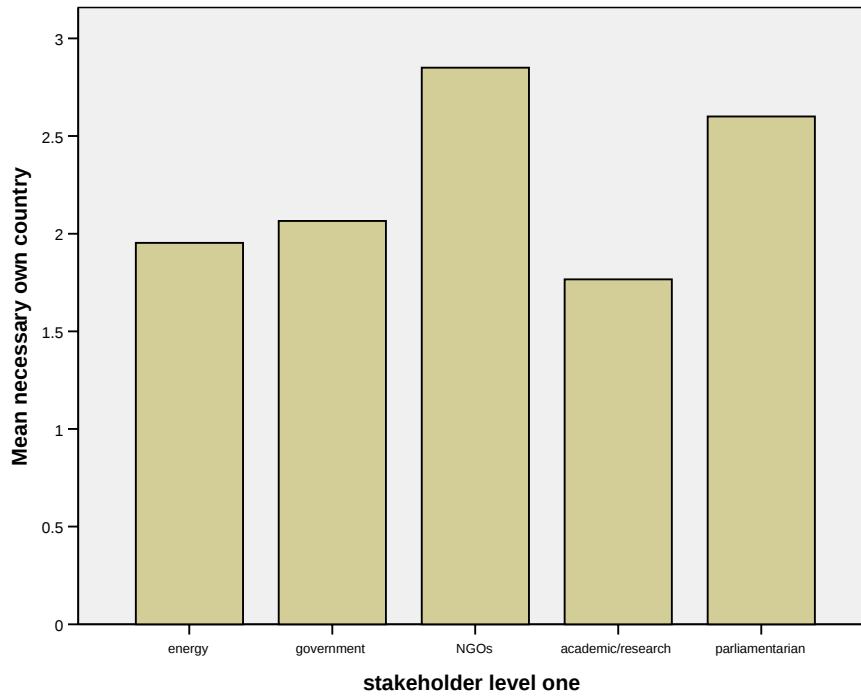


Figure 14: Perceived need for CCS in own country by stakeholder group (where 1 is ‘definitely necessary’, 2 ‘probably necessary’, 3 ‘only necessary if other options fail to live up to current expectations’ and 4 ‘probably not necessary’)

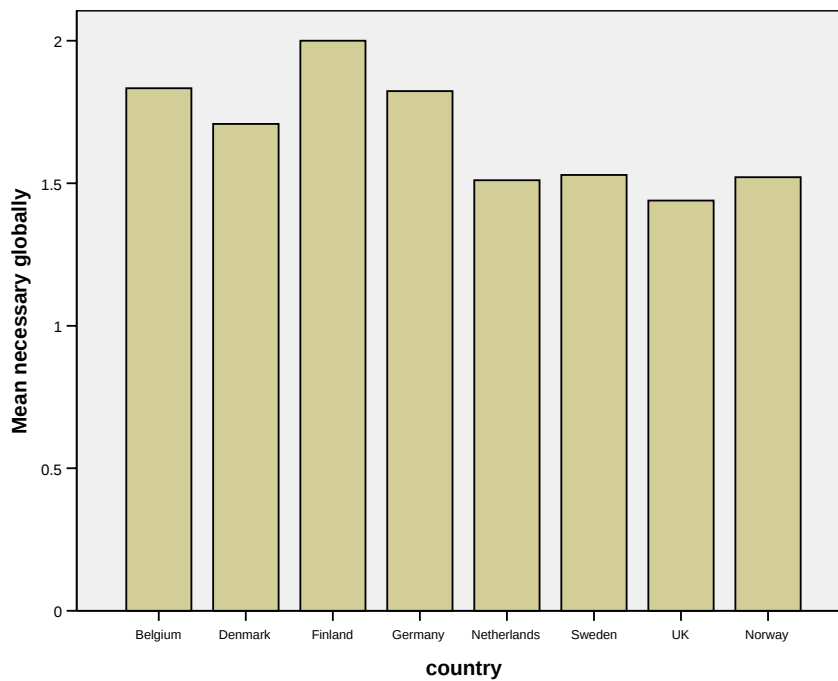


Figure 15: Perceived need for CCS at the global scale by country (where 1 is ‘definitely necessary’, 2 ‘probably necessary’, 3 ‘only necessary if other options fail to live up to current expectations’ and 4 ‘probably not necessary’)

Role of CCS in the National Climate Change Debate (questions 9 and 10)

It can be seen from Figure 16 (table 15) that CCS is perceived to play a very large, large or moderate role in the current national climate change debate (57%), with a sizeable percentage (37%) stating that CCS has a small or very small role.

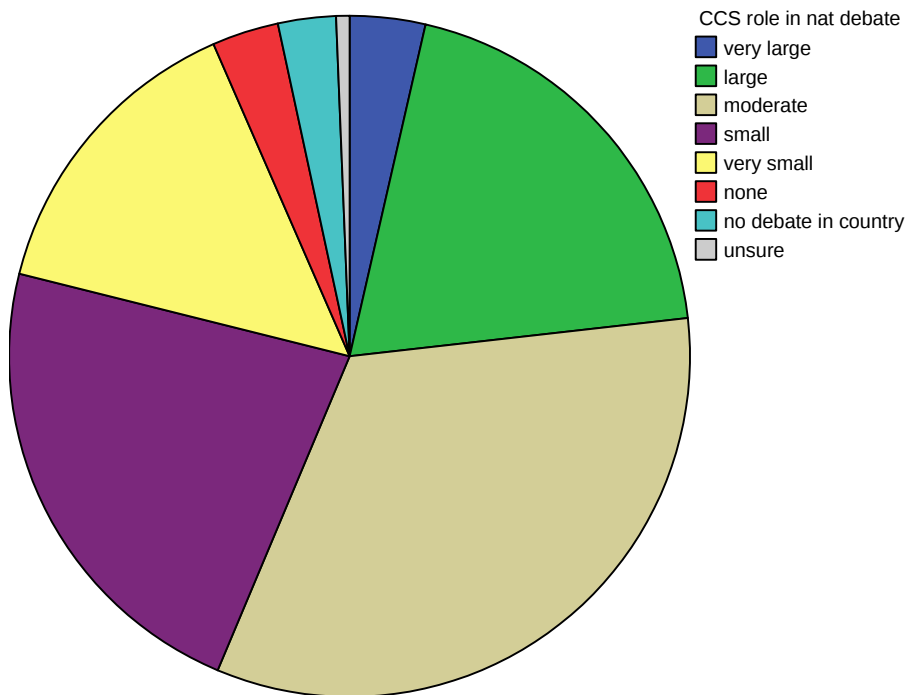


Figure 16: The role of CCS in the current national climate change debate in home country (question 9)

Broken down by country, the greatest role for CCS is identified in Norway (see figure 17), followed by the Netherlands, UK (figure 18), Germany and Denmark (figure 19) (in descending order). Statistically, four distinct groups emerge: Norway perceiving the largest role for CCS, followed by the Netherlands, then by the UK plus Germany, with Denmark, Sweden and Finland identifying the smallest role for CCS in the current national debate.

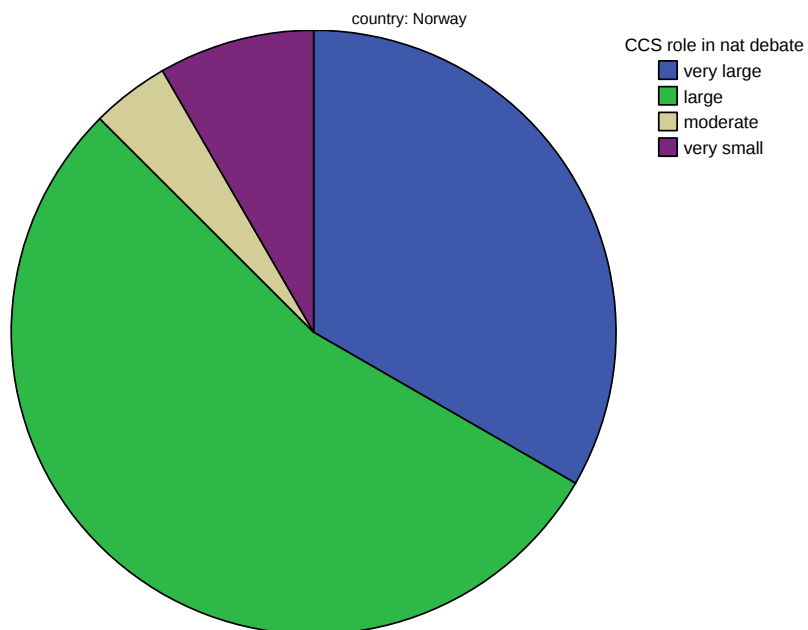


Figure 17: The role of CCS in the current national climate change debate in Norway (question 9)

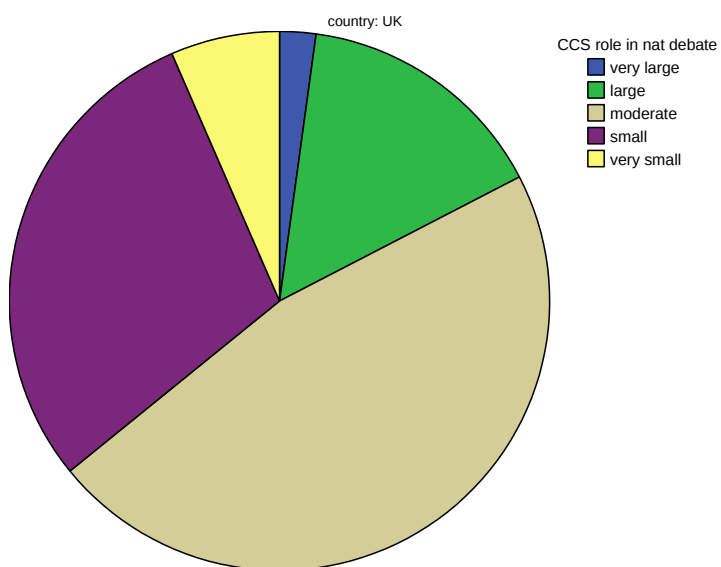


Figure 18: The role of CCS in the current national climate change debate in the UK (question 9)

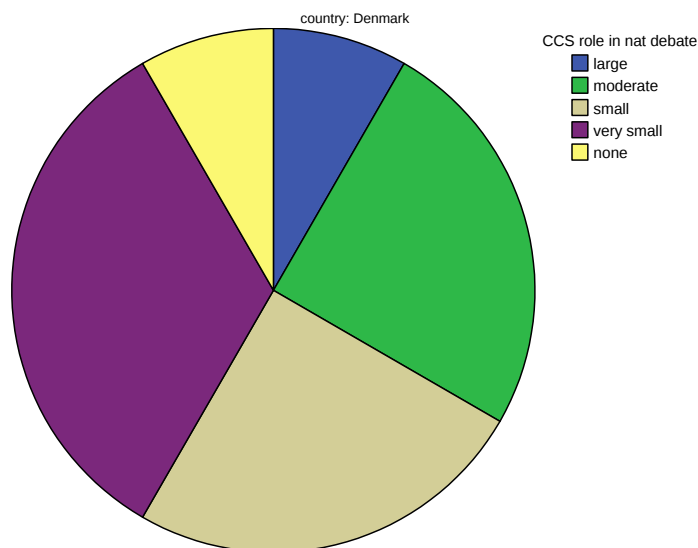


Figure 19: The role of CCS in the current national climate change debate in Denmark (question 9)

When asked whether the role of CCS is increasing or decreasing (question 10), the most common response was that it is increasing, slightly or substantially (see figure 20, table 8).

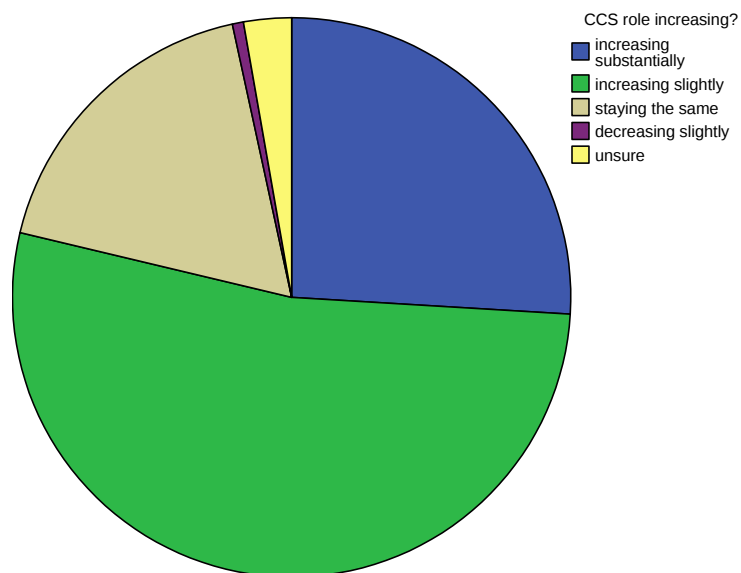


Figure 20: The changing role of CCS in the national climate change debate in home country (question 10)

A larger percentage of respondents than the average (24%) considered that the role of CCS in the national climate change debate was increasingly substantially in Norway (figure 21) and Germany (both 44%), Netherlands (42%) and the UK (36%), all countries where active

CCS initiatives and debates are now underway. Three groups are statistically distinct: the UK where the greatest increase in the role of CCS was identified, followed by all other countries except for Denmark (where there was the least increase in the role of CCS in the national climate change debate).

Table 9 provides descriptive statistics (mean and standard deviation) for the full sample with respect to questions 6, 8, 9 and 10. Table 10 provides provides the same information broken down by stakeholder group and Table 11 broken down by country.

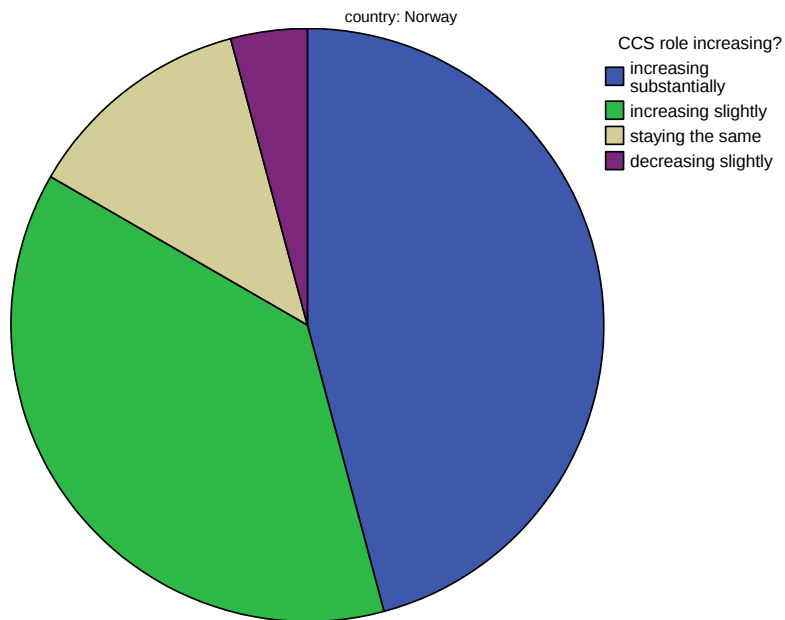


Figure 21: The changing role of CCs in the national climate change debate in Norway (question 10)

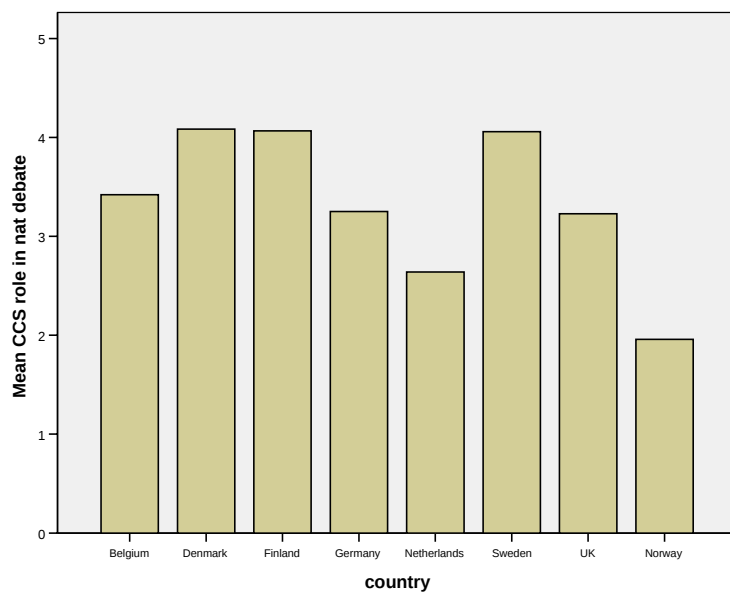
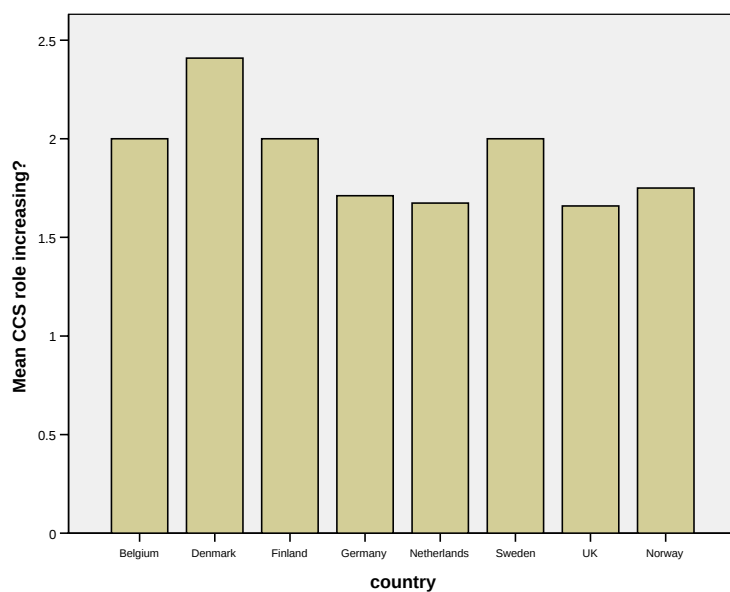


Figure 22: Perceived role of CCS in the national climate change debate by country (where 1 is ‘very large’, 2 ‘large’, 3 ‘moderate’, 4 ‘small’, 5 ‘very small’)

Figure 23 (below): Perceived extent to which the role of CCS in the national climate change debate is changing by country (where 1 is ‘very large’, 2 ‘large’, 3 ‘moderate’, 4 ‘small’, 5 ‘very small’)



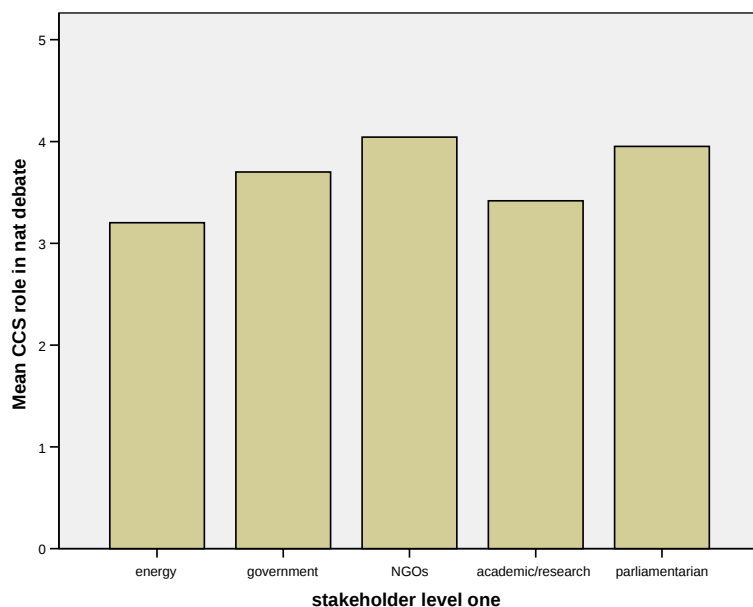


Figure 24: Perceived role of CCS in the national climate change debate by stakeholder group (where 1 is ‘very large’, 2 ‘large’, 3 ‘moderate’, 4 ‘small’, 5 ‘very small’)

The Enabling Context for CCS in Home Country (question 11)

The relative importance of different factors in helping to explain the current and future development of CCS technology in the respondents’ own country is shown in Figure 25.

In general it can be seen from Figure 25 that most of the factors are regarded as important in enabling the development of CCS in the respondents’ own country. The most important factors identified are availability of suitable geological storage sites (item 10 in figure 25) and price of carbon under the EU ETS (1), followed closely by reduction in costs of CO₂ capture (6), development of the research and technological basis for CCS (8), a post-Kyoto phase with tighter national emission reduction requirements (14), development of legal and regulatory basis for CCS (17) and public perceptions of CCS (19). Items 11, 13, 3, 4, 5, 15, 16 and 18 are all in the moderately important category. The least important factors identified are: availability of venture capital (2), development of the H₂ economy (7) and availability of domestic supplies of coal (9). There is, however, more uncertainty attached to evaluation of the importance of the availability of venture capital and development of the H₂ economy (and also for the eligibility of CCS in the CDM) than for the other factors (though only 10% or less of respondents replied ‘unsure’). Other factors regarded as relatively less important are: concerns about energy security (3), need to replace aging power plant (4), opportunities for EOR/EGR (5) and negotiating positions of the US, or of China & India (15 & 16). Note, however, that only two factors - the development of the H₂ economy (7) and availability of domestic coal (9) - are regarded overall as not important / not at all important.

Note that due to a mistake in the web version of the questionnaire, option 12 was excluded, hence the low overall response rate. We have excluded this option from the discussion. Table 12 provides the mean and standard deviations for question 11 (full sample), whilst Table 13 provides the same information broken down by stakeholder groups and Table 14 broken down by country.

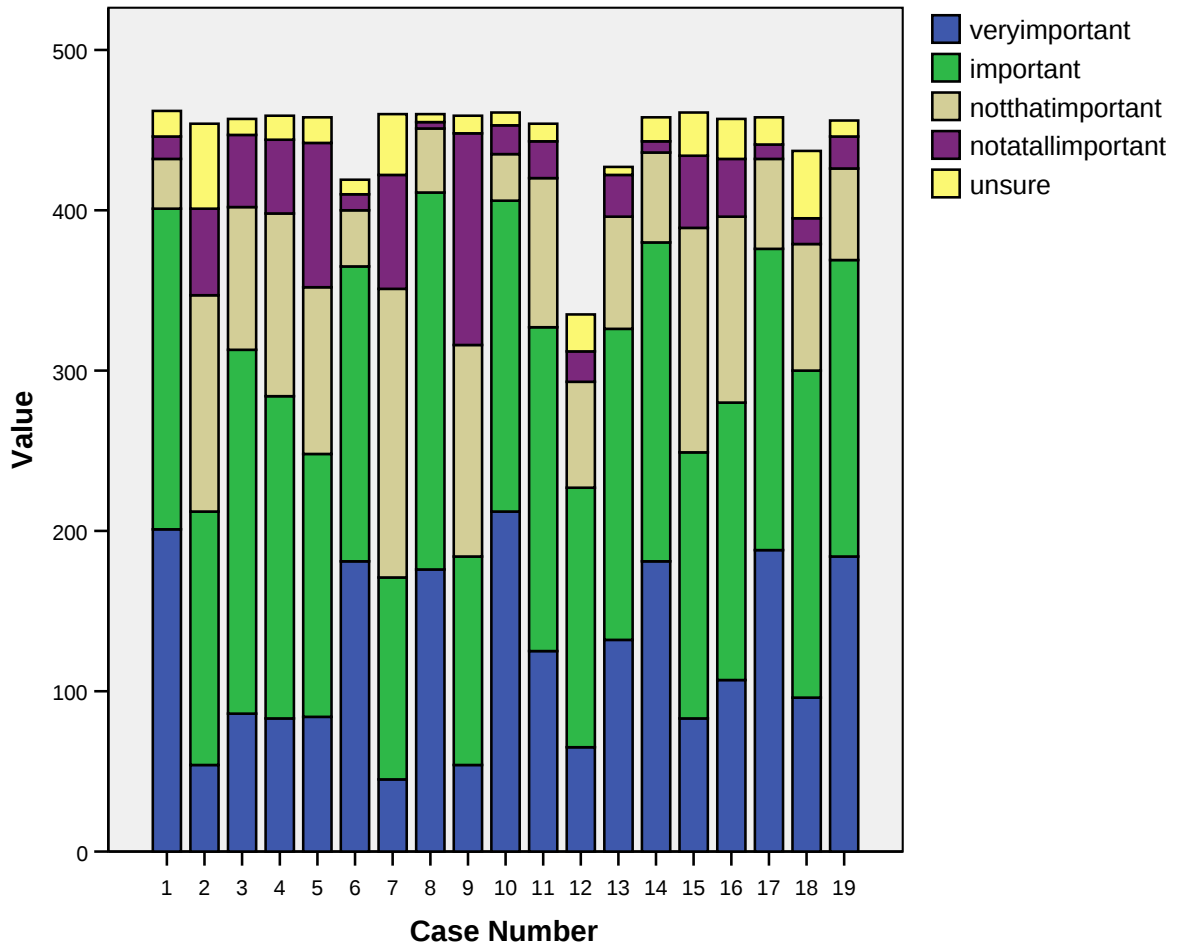


Figure 25: Relative importance of different enabling factors and incentives for CCS (question 11)

- 1: price of carbon under the EU Emissions Trading Scheme
- 2: availability of venture capital
- 3: concerns about energy security
- 4: need to replace aging power plant
- 5: opportunities for Enhanced Oil / Gas Recovery with CO₂
- 6: reduction in costs of CO₂ capture
- 7: development of the H₂ economy
- 8: development of the research and technological based for CCS

- 9: availability of domestic supplies of coal
- 10: availability of suitable geological storage sites
- 11: development of other zero- or low-carbon energy generation technologies
- 12: existence of relevant skills base
- 13: Kyoto Protocol commitments
- 14: a post-Kyoto phase with tighter national emission reduction requirements
- 15: negotiating stance and policy of the USA
- 16: negotiating stance and policy of China and India
- 17: development of legal and regulatory basis for CCS (including accounting, monitoring and liability)
- 18: eligibility of CCS for the Clean Development Mechanism (CDM) and / or Joint Implementation
- 19: public perceptions of CCS

Whilst the most important factors identified here reflect the wider discussion in the CCS community, more surprising is the relative lack of importance attached to energy security concerns, availability of domestic coal and opportunities for EOR/EGR.

Breaking down the responses by country, it appears that the perceived importance of domestic coal supplies as a factor influencing CCS development is higher in the UK, Spain, Poland and Germany than it is in the Netherlands, Denmark, France and Norway, possibly reflecting the greater availability of domestic coal supplies in the former countries. (The percentage of respondents indicating that domestic coal supplies are an important or very important factor in influencing the development of CCS are as follows: UK 47%, Germany 55%, Poland 86%, Spain 72%, Denmark 8%, Netherlands 21%, France 20%, Norway 20%; the average response of the sample is 40%). In statistical terms, the UK and Germany are significantly different from Sweden, Norway, Denmark, Netherlands and Finland.

Likewise there is quite a marked variation in the perceived importance of Enhanced Oil and Gas Recovery. 82-3% of respondents in Norway, Denmark and the UK – all nations with gas and / or oil supplies – thought that opportunities for EOR/EGR were important or very important for CCS development; 54% of respondents in the Netherlands (where there is opportunity for EGR) also responded in this way, whilst the value for France was 43% and 32% for Germany (both countries without significant oil or gas supplies). (The average response of the sample is 54%). Particularly striking is the Norwegian response, where 2/3rds of the sample regarded EOR/EGR as a ‘very important’ enabling factor (as compared to 30% of UK respondents). In statistical terms, four groups of countries emerge: Norway most strongly perceives EOR as a very important enabling factor, followed by the UK and Denmark, then intermediate countries (Belgium and Netherlands) and finally those that do not tend to regard EOR as that important an enabling factor for CCS (Sweden, Finland and Germany).

Breaking down the responses by stakeholder group, an interesting difference emerges regarding opinion on the importance of public perceptions in influencing development of CCS. Whilst 80-90% of energy, government and academic stakeholders rate public perceptions as ‘important’ or ‘very important’, this figure drops to 50% for NGOs. 36% of NGOs consider that public perceptions are ‘not that important’ or ‘not at all important’ to development of CCS, whilst 30% of parliamentarians also share this view. This compares to

8 to 18% of government, energy and academic stakeholders who regard public perceptions as either 'not that important' or 'not at all important'. (Statistically there are two groups – NGOs and parliamentarians who are less convinced that public perceptions are an important influencing factor, and energy, government and academics who regard them as more important). Our interpretation of this finding is that NGOs are sometimes sceptical about the role that public perceptions will have in the decision-making of governments and companies. This interpretation is consistent with previous empirical research on stakeholder perceptions of CCS⁷. Hence, the response of the NGOs is not that public opinions are not important, but that in real-world decision making, it will not assume that large a significance in the development of CCS.

NGOs also adopt a distinct line on a number of other factors. E.g. factor 18, eligibility of CCS for the CDM. Energy, academic, government and parliamentary stakeholders all regard this as important or very important (60-80%). NGOs respondents are split with 41% of the sample regarding it as important / very important, and 50% who think it is not important or not at all important. The NGO response may reflect skepticism about the use of the CDM to meet the Kyoto Protocol targets of the EU Member States. NGOs have tended to prefer Member States to meet CO₂ emission reduction through domestic policies and measures.

Energy stakeholders perceive the role of EOR/EGR in the development of CCS as more important than other categories of stakeholders, though not by a massive margin (36% of energy stakeholders still regarding EOR/EGR as not that important / not at all important, as compared to 45-50% for other stakeholder groups) (though the difference is still statistically significant). When we break down energy stakeholders further (to level 2), we find that only 30% in the oil and gas sector to not believe EOR/EGR is important. Not surprisingly, the oil and gas sector stakeholders are most persuaded of the importance of EOR/EGR as an enabling factor for CCS (their response being statistically significant compared to electricity generators and coal sector).

⁷ Shackley, S. and McLachlan, C. (2006), 'Trade-offs in assessing different energy futures: A regional multi-criteria assessment of the role of carbon dioxide capture and storage', *Environmental Science and Policy*, 9(4): 376-391.

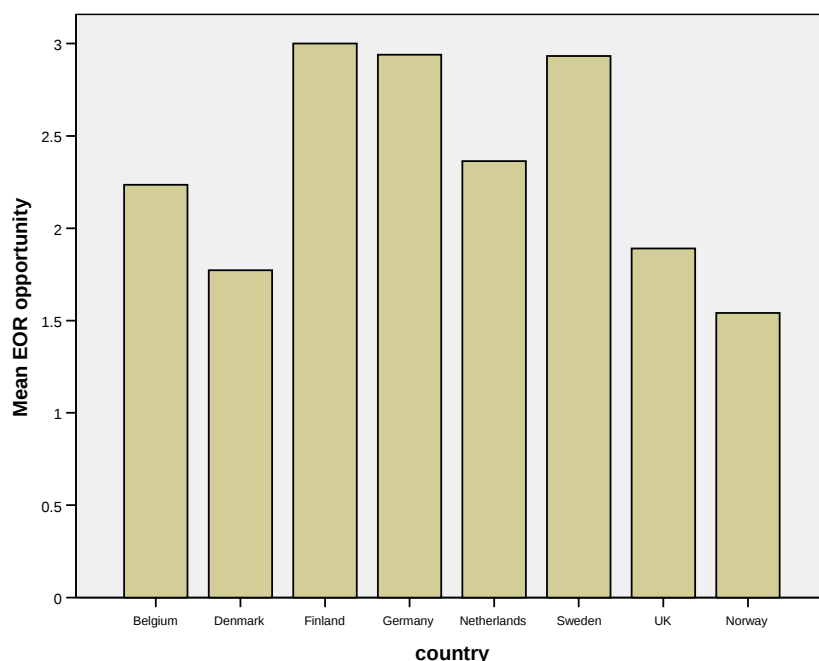


Figure 26: Importance of Enhanced Oil Recovery as an enabling factor for CCS by country (question 11) (where 1 is ‘very important’, 2 ‘important’, 3 ‘not that important’ and 4 ‘not at all important’)

Energy stakeholders also regard the development of other low- and zero-carbon energy technologies (LZCTs) a less important a factor in influencing the development of CCS than other stakeholders (statistically significant except compared to Parliamentarians, who are closer to the energy stakeholder perspective). Government, NGOs, academics and parliamentarians all regard the development of other LZCTs as an important or very important factor in influencing the development of CCS (75 to 90% of respondents). Whilst 60% of energy stakeholders also regard LZCTs as important/very important, 37% also regard them as not important/not at all important (compared to 5 to 24% for other stakeholder groups). It is possible that the response of energy stakeholders may reflect a perception that renewables and other potential LZCTs will not advance as rapidly as advocates of these particular technologies tend to claim; however as yet we do not have any independent evidence to support this conjecture.

Parliamentarians tend to regard the hydrogen economy as more important in the development of CCS than other stakeholders (at 60% compared to 25 to 43% for other stakeholder groups). (The difference is only statistically significant between parliamentarians and energy stakeholders, however). Parliamentarians also tended to regard the need to replace ageing power plant as a more important factor influencing the development of CCS (74% responses indicating that it is important / very important) than other stakeholders (57-62% indicating important/very important) (though the difference is not statistically significant).

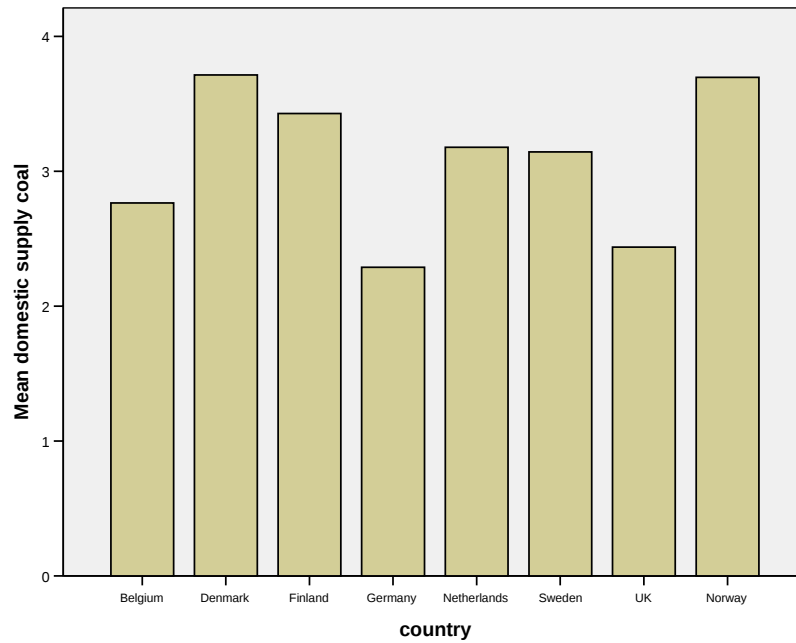


Figure 27: Importance of availability of domestic supplies of coal as an enabling factor for CCS by country (question 11) (where 1 is 'very important', 2 'important', 3 'not that important' and 4 'not at all important')

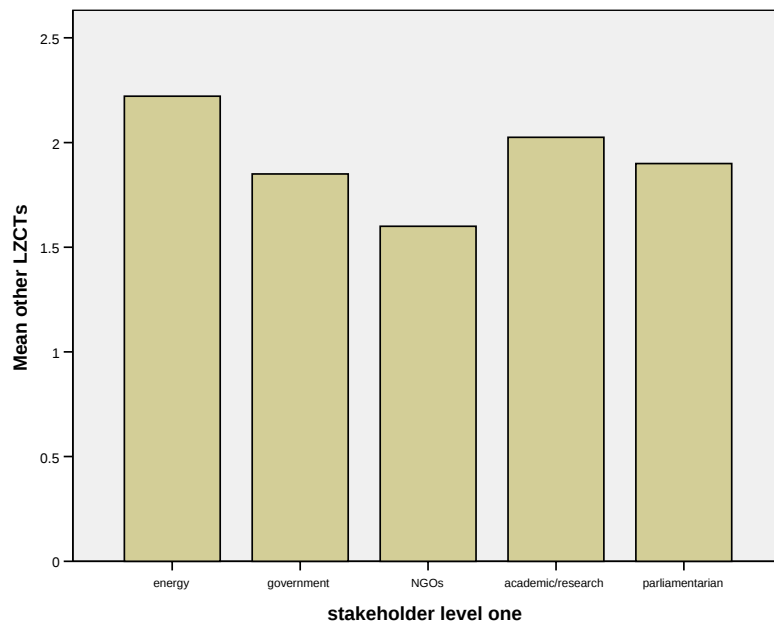


Figure 28: Importance of development of other low- and zero-carbon energy technologies as an enabling factor for CCS by stakeholder group (question 11) (where 1 is 'very important', 2 'important', 3 'not that important' and 4 'not at all important')

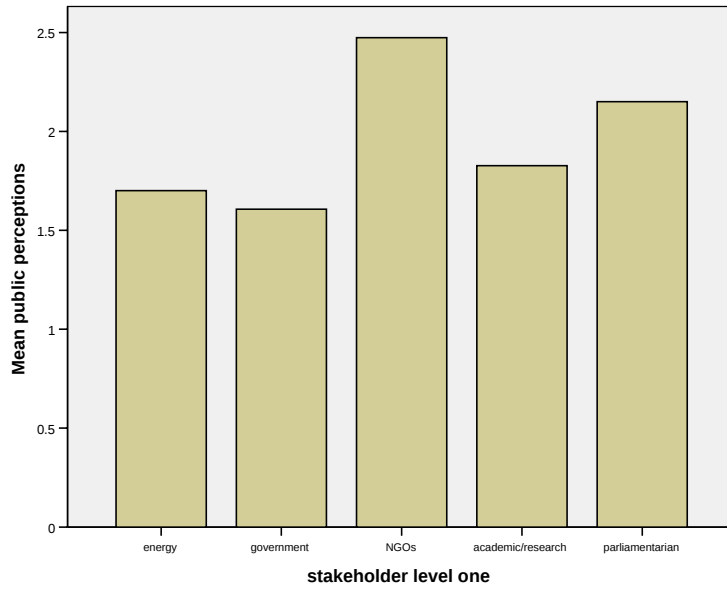


Figure 29: Importance of public perceptions as an enabling factor for CCS by stakeholder group (question 11) (where 1 is ‘very important’, 2 ‘important’, 3 ‘not that important’ and 4 ‘not at all important’)

Should CCS Receive Similar Subsidies to Renewable Energy Development? (question 12)

It can be seen from Figure 30 (table 15) that half of the respondents think that incentives for CCS should either be set at the same level as those for renewables (39%) or that higher incentives should be applied (11%). By contrast, 33% of respondents consider that incentives should be lower than those for renewables and 12% felt that incentives for CCS were not needed at all.

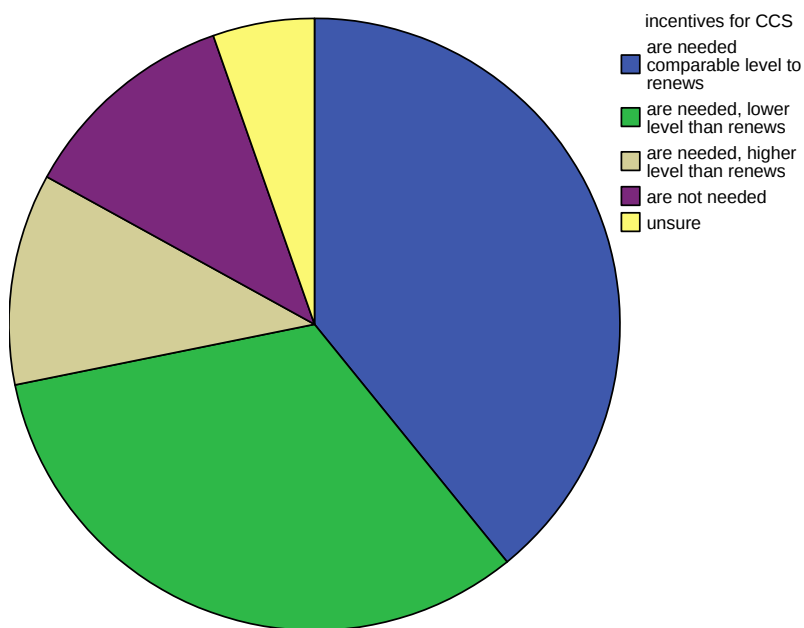


Figure 30: Provision of incentives for CCS compared to those for renewables (question 12)

There is quite a strong difference of opinion amongst stakeholders regarding the appropriate level of incentives for CCS. Whereas energy, government and academic stakeholders tend to regard incentives as necessary, and at a level either comparable to those for renewables, or at a lower level, NGOs (figure 31) and parliamentarians were generally more cautious, with 52% and 38% respectively doubtful that incentives are needed at all, although 40% and 48% of each group are still in favour of incentives comparable to, or set at a lower level, than those for renewables. (Support for incentives at a lower level than for renewables was 22% for NGOS and 33% for parliamentarians. 9 to 10% of NGO and parliamentarians respondents supported incentives for CCS at a higher level than those for renewables). In other words, opinion amongst NGOs is fairly evenly split between those who favour incentives for CCS and those who do not, whilst parliamentarians are somewhat more in favour of incentives.

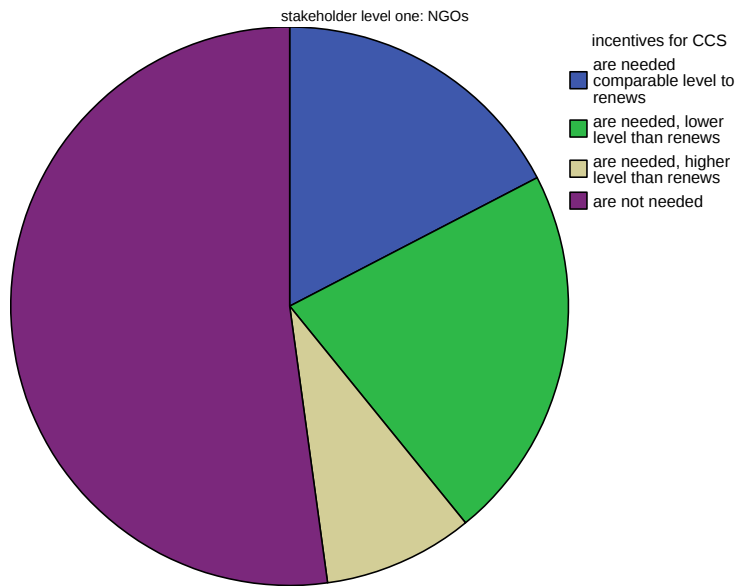


Figure 31: Provision of incentives for CCS compared to those for renewables (question 12), response of NGOs

Energy, government and academic stakeholders tended to show similar responses to this question. 11% of academic and government, and 8% of energy stakeholders, believed that incentives for CCS should be higher than those for renewables, and 34-38% (energy, academic) and 25% (government) of respondents considered that incentives should be set at a lower level than for renewables. (Statistically NGOs and parliamentarians form a distinct group from government, academics and energy sector respondents).

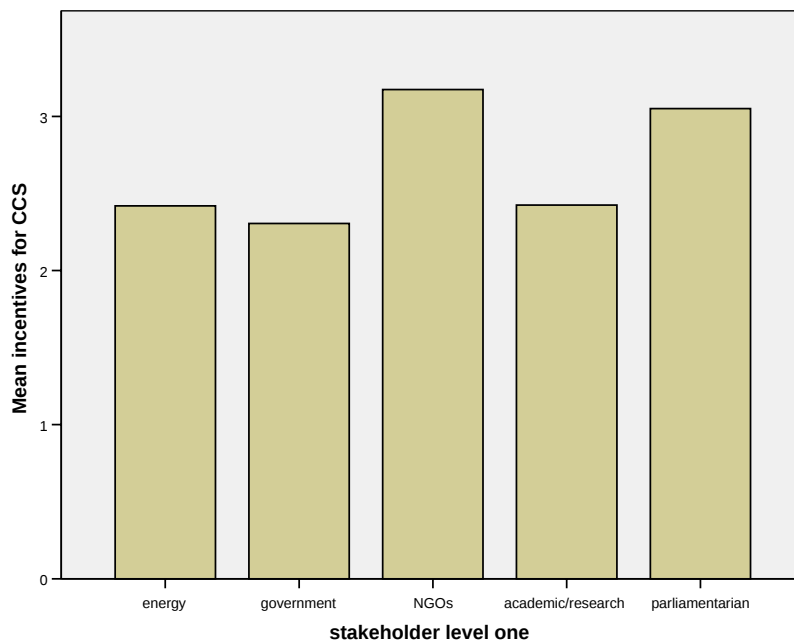


Figure 32: Provision of incentives for CCS by stakeholder group (where 1 is the view that incentives 'are needed, but at a higher level than for renewables', 2 'are needed at a level

comparable to renewables’, 3 ‘are needed, but at a lower level than for renewables’ and 4 ‘are not needed’)

Compared to the sample as a whole, a slightly larger proportion of German and Dutch respondents supported incentives for CCS higher than those for renewables (14% and 13% respectively, compared to 11% for full sample). A higher proportion of German respondents also thought that there should be no incentives for CCS, however (22% compared to 12% for full sample), a view also shared by Norwegian respondents (17%). Meanwhile, fewer Dutch and British respondents thought that there should be no incentives (4% and 6% respectively, compared to 12% for full sample). Danish, Dutch and British respondents appear to favour a more generous incentives structure for CCS than the average respondent. The German respondents look to be more divided in their opinions. Some what unexpectedly Norwegian respondents are less supportive of more generous incentives for CCS than might have been anticipated given the prominence of CCS in energy and climate policy in Norway, though 46% still wish to see incentives for CCS set at a comparable level as those for renewables. The only statistically significant differences are between Sweden (least supportive of generous incentives for CCS) and the UK and Netherlands (most supportive of generous incentives).

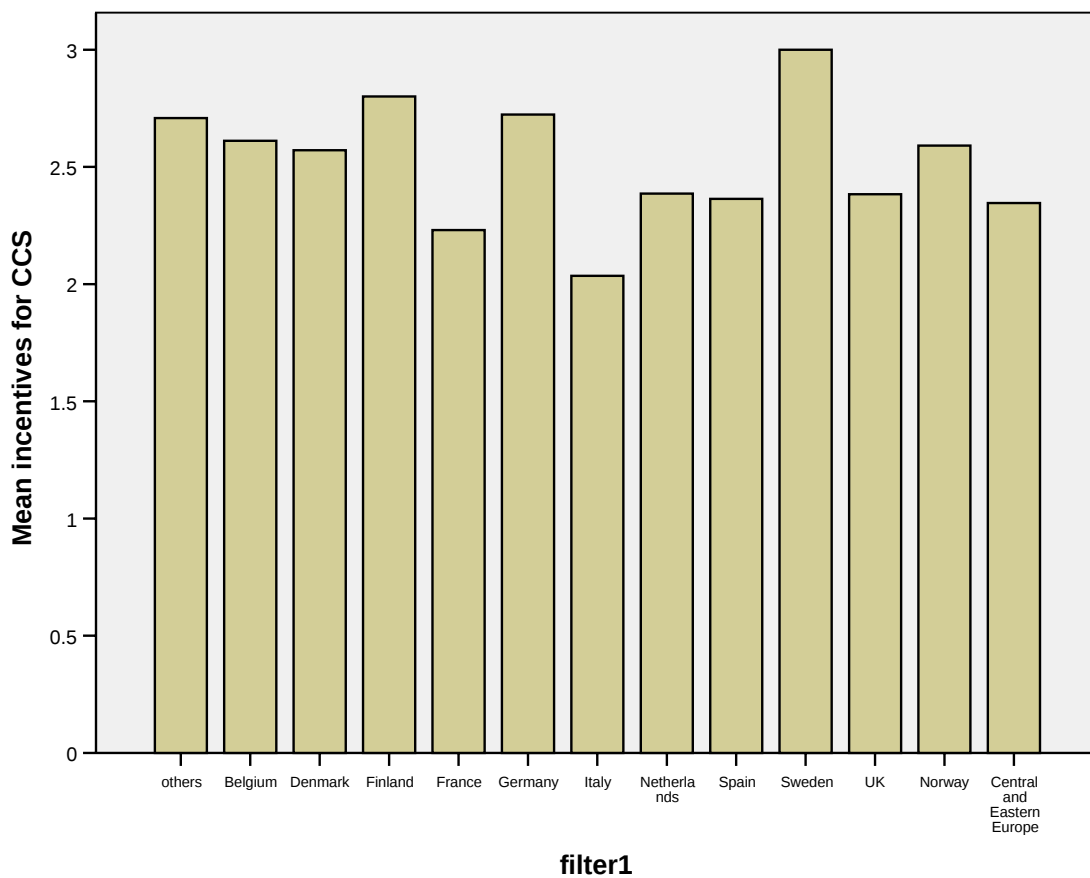


Figure 33: Provision of incentives for CCS by country (where 1 is the view that incentives ‘are needed, but at a higher level than for renewables’, 2 ‘are needed at a level comparable to renewables’, 3 ‘are needed, but at a lower level than for renewables’ and 4 ‘are not needed’)

What are the most Appropriate Incentives for CCS Development in Home Country? (question 13)

Figure 20 illustrates that there is positive support for all of the seven options.

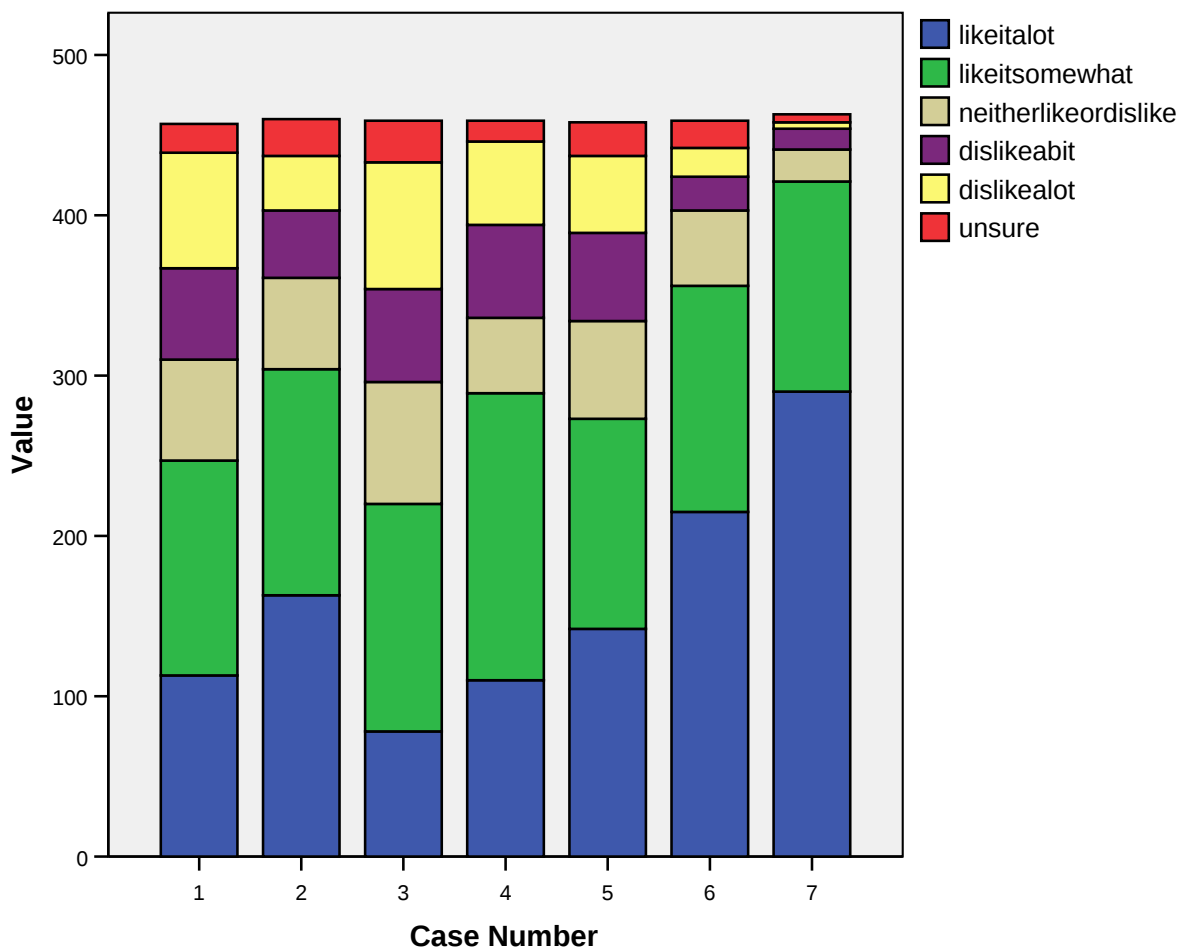


Figure 34: Preference for different incentive options for CCS (question 13)

- 1: a requirement for electricity generators to supply a given % of zero- or low-carbon electricity through CCS
- 2: a requirement for electricity generators to supply a given % of zero- or low-carbon electricity (all sources)
- 3: a guaranteed feed-in price for electricity produced by CCS
- 4: a capital subsidy scheme to support construction of CCS plant

- 5: an economy-wide carbon tax
- 6: an early commitment to extend the EU ETS beyond 2012 with tighter emission caps
- 7: support for research, development and demonstration projects

By far the most popular option is for RD&D to be pursued, at over 90% of respondents in favour. This is followed by early commitment to extend the EU ETS with tighter emissions caps (77% in favour, 8% against). The third most popular option is a requirement for electricity generators to supply a given % of zero- or low-carbon electricity, but without specifying the source of the electricity (i.e. it could be from CCS but also from renewables, or nuclear). The three options of a requirement for electricity generators to supply a given % of zero- or low-carbon electricity through CCS specifically, an economy-wide carbon tax and a capital subsidy scheme to support construction of CCS plant all receive a similar level of support. The least popular option is a guaranteed feed-in price for electricity produced by CCS (3), but even in this case those in favour ('like it a lot' or 'like it somewhat') outnumber those against ('dislike a bit' or 'dislike a lot') (48% versus 30%) (though this question elicits the largest number of 'neither like/dislike' responses at 17%). (See Table 16 for the mean and standard deviations (SDs) for the full sample).

When broken down by country, there are some large differences but the small sample sizes make any detailed analysis problematic. German stakeholders tend to be some what more skeptical than the average respondent about the following options: an EU-wide carbon tax, capital subsidy, a guaranteed feed-in price and a requirement to generate low-carbon electricity through CCS. Renewable generation in Germany has been fostered through use of a guaranteed feed-in price but in recent years there has been something of a 'backlash' against the rapid expansion of wind energy in Germany which such feed-in tariffs has encouraged [refs] and it may be that this 'backlash' has made stakeholders wary of relying upon such policy instruments in future. Danish stakeholders are more unsupportive than the average respondent of a requirement for CCS generation.

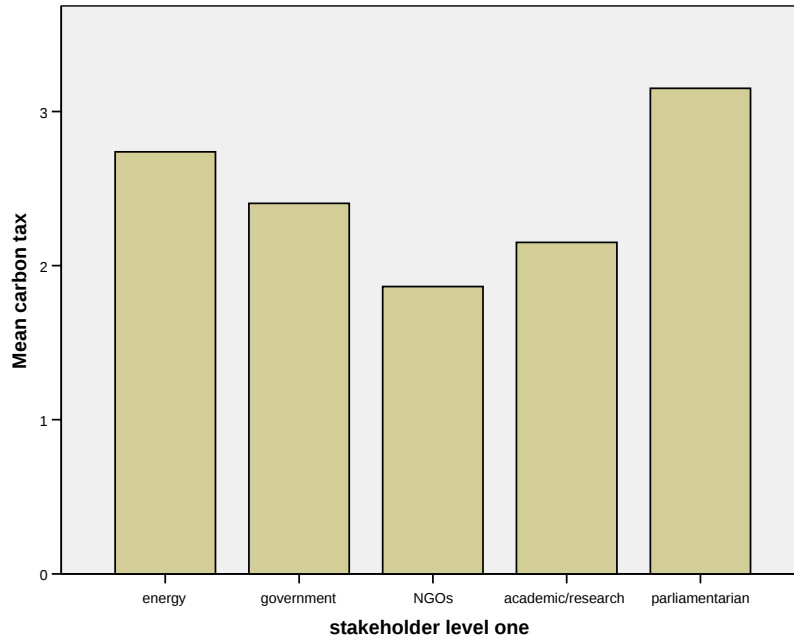


Figure 35: Preference for a carbon tax as an incentive mechanism (question 13, part 5) by stakeholder group (where 1 refers to 'like it a lot', 2 'like it somewhat', 3 'neither like nor dislike' and 4 'dislike a bit')

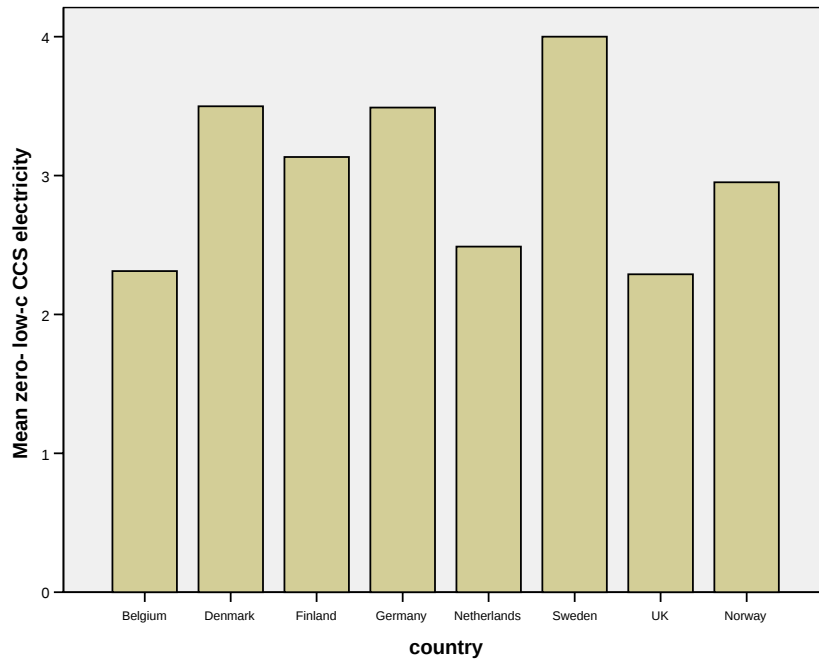


Figure 36: Preference for a CCS electricity requirement as an incentive mechanism (question 13, part 1) by country (where 1 refers to 'like it a lot', 2 'like it somewhat', 3 'neither like nor dislike', 4 'dislike a bit' and 5 'dislike a lot')

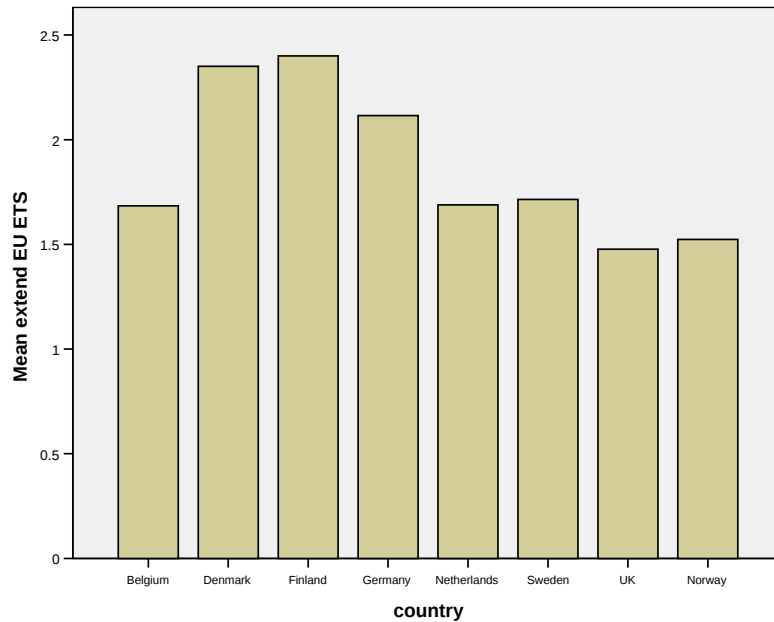


Figure 37: Preference for an early commitment to extend the EU ETS beyond 2012 as an incentive mechanism (question 13, part 6) by stakeholder group (where 1 refers to ‘like it a lot’, 2 ‘like it somewhat’, 3 ‘neither like nor dislike’ and 4 ‘dislike a bit’)

Statistically two groups emerge with respect to requirement for CCS electricity generation (question 13, part 1): the UK, Netherlands and Belgium (most in favour), Germany, Denmark, Finland and Sweden (some what negative to quite negative) (see Table 18 for the means and standard deviations). A rather similar pattern emerges for a requirement for low-carbon electricity generation (question 13, part 2), with Sweden some what negative and the UK, Belgium and Netherlands some what in favour and the other countries in between. The UK and Netherlands are also significantly different from Sweden and Germany regarding a guaranteed feed-in price (question 13, part 3), with other countries such as Belgium and Norway adopting an intermediate position.

Sweden is notably less enthusiastic about provision of an economy-wide carbon tax (question 13, part 5) than other countries (statistically significant differences emerging with UK and Denmark). Denmark and Finland are relatively less enthusiastic about an early extension of the EU ETS (question 13, part 6) (statistically significant differences emerging with the UK, Norway and Netherlands). There are no significant differences between countries regarding the desirability of supporting Research, Development and Demonstration (question 13, part 7) as an incentive mechanism.

When analysed in terms of stakeholder groups, it is found that there is a sizeable minority of energy sector, government, NGO and research stakeholders who are sceptical of the requirement for generators to use CCS; by allowing the generator the choice of selecting zero- or low-carbon electricity from other sources, the objection seems to a large extent to be overcome. There are substantial minorities against set feed-in tariffs for CCS amongst

bNGOs and parliamentarians. NGOs, and a minority of parliamentarians, are also skeptical of capital subsidy schemes. Energy stakeholders are, overall, in favour of an economy-wide carbon tax, but there is a sizeable minority against, as there is also amongst parliamentarians. All stakeholder groups appear to support an early commitment to extend the EU ETS with tighter emission caps. We suspect that the negative reaction of NGOs and some parliamentarians to capital subsidy schemes, feed-in tariffs for CCS, and requirements for CCS electricity generation reflect a concern that companies will be able to make unjustified profits from such CCS-incentives.

Statistically, there are no significant differences between stakeholders with respect to the desirability of a requirement for CCS electricity (question 13, part 1). In the case of a zero- or low-carbon electricity requirement (question 13, part 2), the opinion of energy stakeholders is statistically distinct from that of government and academics. It is interesting to observe that the energy sector stakeholders are less persuaded of this mechanism than might have been anticipated, for reasons that are not yet known. There are two groups with respect to guaranteed feed-in price and support through capital subsidy (question 13, parts 3 and 4 respectively): government and academics (who are ambivalent) and NGOs and parliamentarians (who are some what against). In the case of an economy-wide carbon tax (question 13, part 5) parliamentarians and energy stakeholders hold a statistically significant position from NGOs (who are more in favour). Following the same pattern, the response to a proposed early commitment to extend the EU ETS (question 13, part 6) results in two significant groupings: NGOs who are most in favour, and energy & parliamentarians who are less enthusiastic. Even though all stakeholders are strongly supportive of CCS RD&D (question 13, part 7), the strongest support arises from energy, government and academic stakeholders, with NGOs and parliamentarians not quite so enthusiastic. (See Table 17 for the means and SDs).

Scale at which Incentives and Regulation should be Applied (questions 14 and 15)

Respondents some what favoured having a common price for CO₂ across the EU25 under the EU ETS but then allowing national governments to introduce additional incentives (50% in favour) (figure 38, table 19). There was also substantial support for having a common incentives structure across the whole EU25 (without any additional national incentives), however (36%). All stakeholder groups supported both these options, though the common price for CO₂ plus national incentives received a higher score for all groups except NGOs (50% for common incentives, 36% for common CO₂ price).

Government stakeholders were the most in favour of the common CO₂ price + national incentives option. Very few supported phasing out the EU ETS and passing over full responsibility to member states: 8% of energy stakeholders, 1.5% of government officials, 8% of academics and 0% of NGOs. The one group where there was some minority support for phasing out the EU ETS was amongst parliamentarians (20% of respondees). There is greater uncertainty regarding the appropriate scale for CCS incentives on the part of parliamentarian and NGO respondents (13-15%) compared to the other stakeholder groups (3-7%).

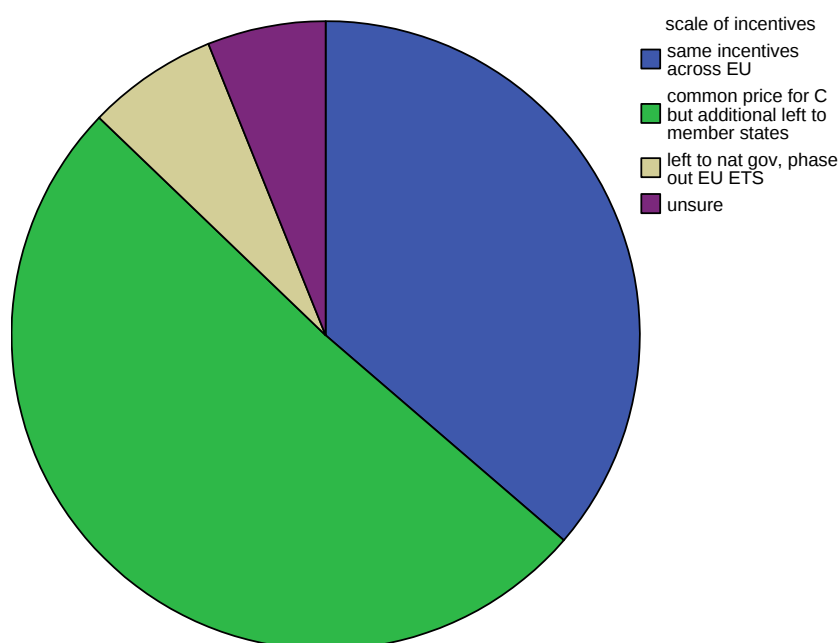


Figure 38: Scale at which incentives for CCS should be applied within the EU (question 14)

There was greater support for common incentives across the EU25 (without additional national incentives) from respondents from Poland, Belgium and Sweden. Respondents from the following countries preferred a common CO₂ price with additional national incentives: UK, Denmark, Germany, Italy and the Netherlands. Note, however, that in all cases there was substantial support for both of the two major options, and little support for phasing out the EU ETS and reverting entirely to national programmes (between 0 and 10% supports this option in the above countries).

Regarding regulation of CCS, the most popular option is that this be achieved through internationally agreed set of standards (43%), followed by EU wide standardization but national implementation (32%) (see Figure 39, table 20). Least popular is a system of information sharing (8%). Regulation through an agency of the EU commission is also not popular (12%).

When broken-down by country, there are some differences. The Dutch respondents were the least enthusiastic regarding regulation by an EU Commission agency (2%), whilst the Italian and Spanish respondents were quite enthusiastic regarding this idea (30% and 26% respectively). The Dutch and Spanish stakeholders were more enthusiastic than others concerning EU wide standardization with national implementation (c. 50%), whereas the notion of an internationally agreed set of standards received less support in those two countries than in most others (c. 20%). The Norwegian respondents, on the other hand, were distinctly unenamoured by the prospect of EU wide standardization – with only 8% of respondents in favour – no doubt because Norway is not part of the EU hence might find it difficult to influence the standards-setting process. Furthermore, the Norwegian government would have no particular reason to adopt the EU standards in any case.

Norwegian stakeholders much preferred international standards (at 67%). An even higher percentage of Swedish stakeholders favoured the adoption of international standards (75%). The option of ‘information sharing’ also received 20% of the responses from Norwegians and Dutch respondents.

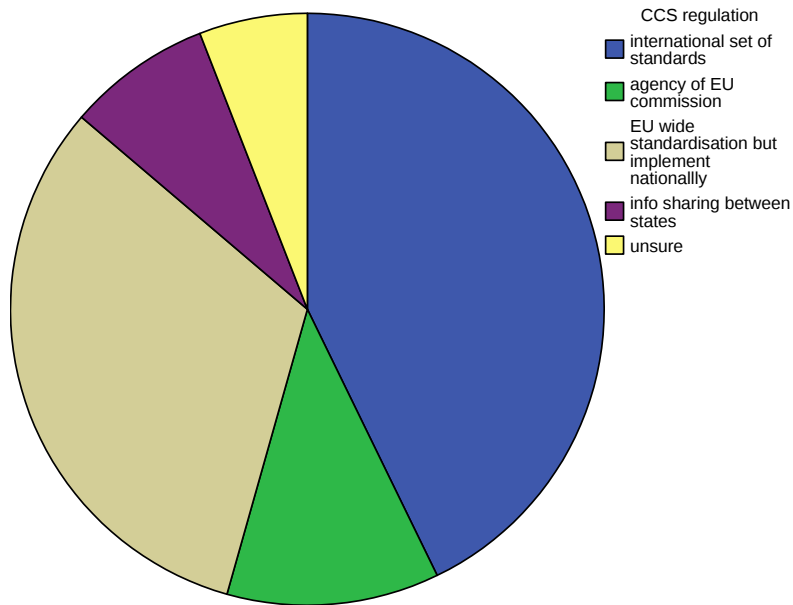


Figure 39: Who should regulate CCS within the EU? (question 15)

When broken-down by stakeholder group, energy, academic and government stakeholders all respond rather similarly, and broadly in line with the overall sample response shown in Figure 39. Parliamentarians are also broadly the same, though they seem some what more skeptical of an agency of the EU Commission becoming the regulator (this option only receiving 5% of the responses). The NGO respondents stand out in that they seem skeptical of EU wide harmonization with national implementation (9% of responses), and favour an EU Commission agency more than other stakeholder groups (17% of responses). NGO respondents are the most enthusiastic of all groups about an international set of standards being developed (57%) (see figure 40). Therefore, the NGO stakeholders seem suspicious of the most common regulatory mechanism being used in the EU to regulate CCS, i.e. a directive which establishes the broad framework and principles, but the detail of which implementation is in the hands of national governments. This may reflect NGOs concern that environmental regulation across the EU25 has been too lax in the past. Note, however, the relatively large number of ‘unsure’ responses from NGO respondents.

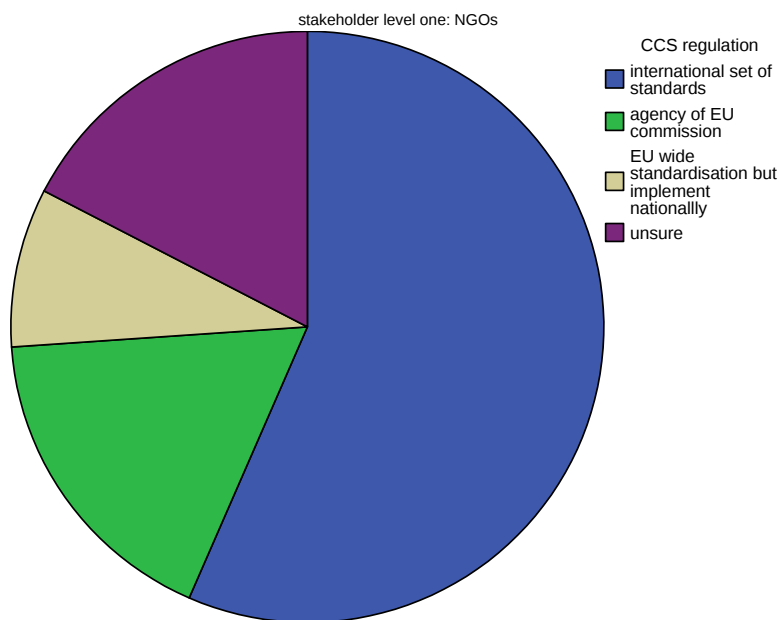


Figure 40: Who should regulate CCS within the EU? (question 15): NGO respondents

The Potential Risks of CCS (question 16)

Figure 41 compares stakeholders' perceptions of the main environmental, health and safety risks arising from CCS. It can be seen that the sample as a whole did not consider that the risks of CCS are particularly large. The most common response is 'minimal risk'. 'Very serious' risk never appears as a prominent response for the sample as a whole. Those issues which are identified as most high risk are: additional fossil fuel use for energy penalty (item 1 in figure 20), human health and safety and environmental damage from onshore CO₂ storage (5 & 6) and environmental damage from offshore CO₂ storage (8). The lowest levels of perceived risk are associated with accidents arising from inclusion of CO₂ capture at power stations (2) and human health and safety risks from offshore CO₂ storage site leakage (7). (Table 25 provides the means and SDs for the full sample).

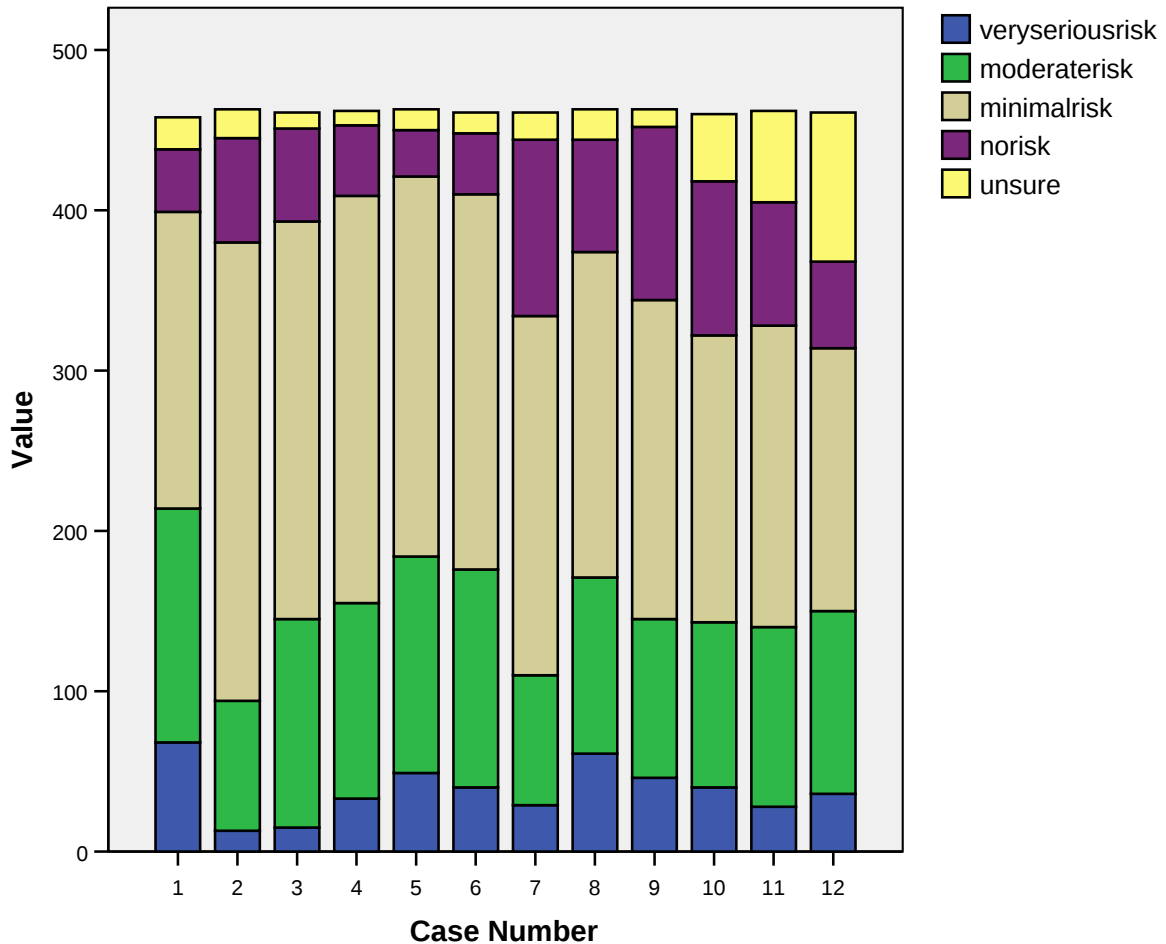


Figure 41: The potential risks to health, safety and environment arising from CCS (question 16)

- 1: impacts arising from additional extraction of fossil fuels to compensate for the energy penalty associated with CO₂ capture
- 2: accidents arising from inclusion of CO₂ capture at power stations
- 3: impacts of new CO₂ pipeline network on landscape and environment
- 4: human health and safety risks from leakage from CO₂ pipelines
- 5: human health and safety risks from **onshore** CO₂ storage site leakage
- 6: local environmental damage from **onshore** CO₂ storage site leakage
- 7: human health and safety risks from **offshore** CO₂ storage site leakage
- 8: local environmental damage from **offshore** CO₂ storage site leakage
- 9: global climate impacts from CO₂ storage site leakage
- 10: global climate impacts due to additional greenhouse gas emissions resulting from enhanced hydrocarbon recovery
- 11: impacts of CO₂ storage upon drinking water reservoirs
- 12: impacts of CO₂ storage upon micro-organisms within the storage site

Stakeholder Differences

NGO respondents are far more concerned about the additional extraction of fossil fuels to compensate for the energy penalty associated with CO₂ capture (figure 42), with 52% of respondents identifying this as a ‘very serious risk’, a concern shared to some extent by Parliamentary stakeholders at 30%, but compared to only 5% for energy sector, 10% for academics and 16% for government respondents (table 21). (The NGO response is significantly different from that of energy, government and academics, but not parliamentarians). All stakeholder groups do regard the additional use of fossil fuels as, at least, a moderate to minimal risk. The contrast between energy and NGO respondents is illustrated in Figures 42 (NGOs) and 43 (energy stakeholders).

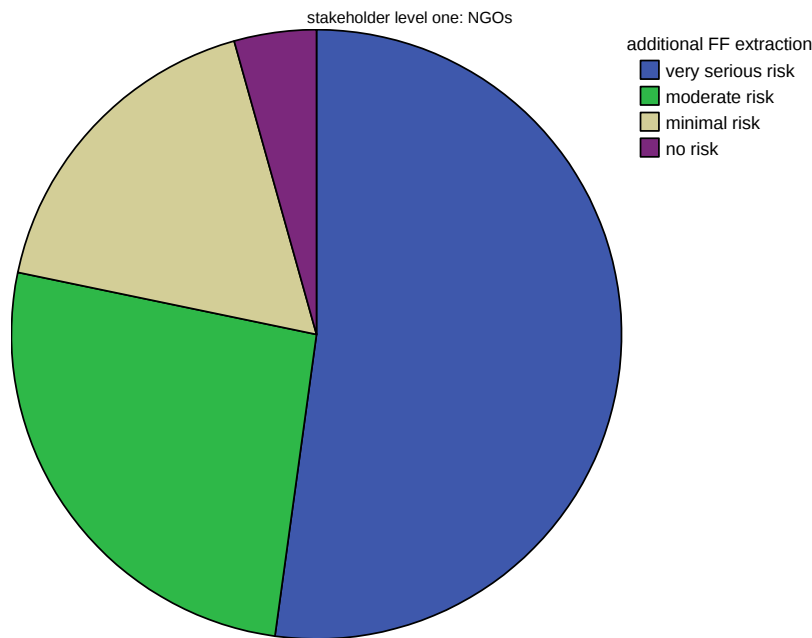


Figure 42: Opinion of NGO stakeholders regarding impacts arising from additional extraction of fossil fuels to compensate for the energy penalty associated with CO₂ capture (question 16, part 1)

Responses to many of the parts of question 16 follow a similar pattern, with the NGO and Parliamentary respondents tending to perceive the risks as higher (either ‘very serious risk’ or ‘moderate risk’) than energy, government and academic stakeholders. Statistically significant differences between the responses of NGOs and other stakeholders (excluding parliamentarians) emerge: for accidents arising from CO₂ capture at power stations (question 16, part 2), impacts of new CO₂ pipelines on the environment (question 16, part 3), human health and safety risks from CO₂ leakage from pipelines (question 16, part 4) (excepting government), from onshore storage site leakage (question 16, part 5), local

environmental damage from onshore CO₂ leakage (question 16, part 6), local environmental damage from offshore leakage of CO₂ (question 16, part 8), global climate impacts from CO₂ leakage (question 16, part 9), additional CO₂ emissions arising from enhanced hydrocarbon recovery (question 16, part 10), impacts of CO₂ storage upon drinking water reservoirs (question 16, part 11) and impacts of CO₂ storage upon micro-organisms (question 16, part 12).

Responses to question 16(vii) regarding human health and safety risks from **offshore** CO₂ storage site leakage are interesting because the difference in response between energy stakeholders and NGOs are less pronounced for this question than for the others. There are no statistically significant differences in the responses of different stakeholders to this question. 7% of energy stakeholders perceive this risk as being 'very serious' as compared to 9% of NGO respondents, 3% government officials, 5% of academics and 5% of Parliamentarians (table 22). The overall response of energy stakeholders to question 16(vii) is surprisingly similar to that of the NGOs, and places more emphasis upon the risks than the response of government or academic stakeholders. It is possible that the perceived risks of offshore health and safety reflect the experience of the oil and gas industry in working offshore. To test this idea, stakeholders were broken-down to the second level classification. What we found, however, is that oil and gas respondents did not regard the health & safety risks from offshore CO₂ storage sites to be very serious, only 3% of respondents giving this response. More respondents from the electricity generating sub-group appeared to regard these risks as very serious, at 16% of respondents. However, there was no statistical difference between the electricity generators (or power plant designers/builders) and oil and gas sub-groups of energy stakeholders with respect to perceptions of the health and safety risks arising from offshore CO₂ storage sites. There was a statistically significant difference between coal and oil and gas sub-groups with respect to this potential risk, though relatively few respondents from the coal sub-group. It would be interesting to follow-up with such stakeholders why they rate the risks to health & safety from offshore CO₂ storage as highly as do NGO respondents.

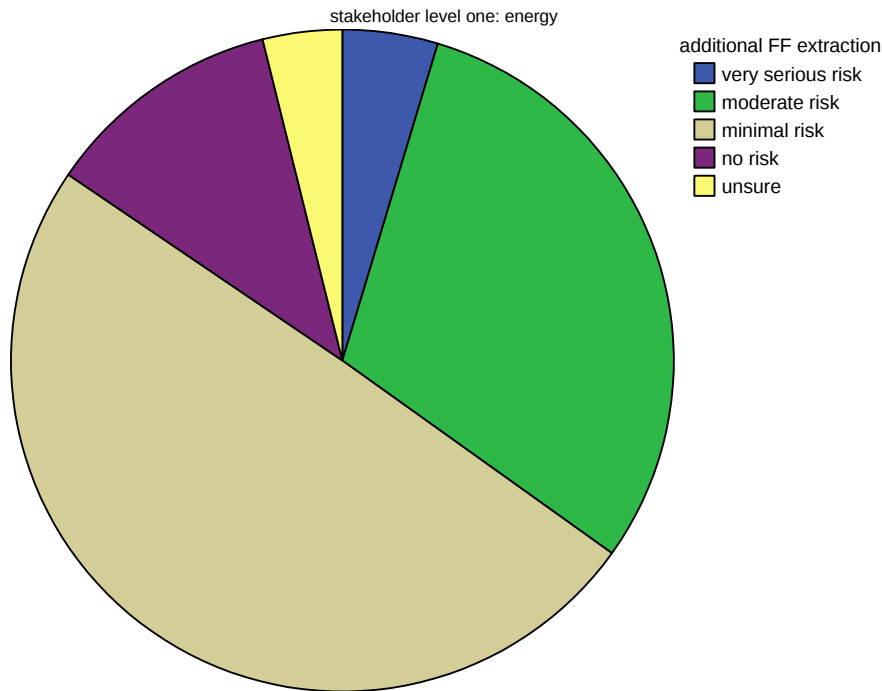


Figure 43: Opinion of energy industry stakeholders regarding impacts arising from additional extraction of fossil fuels to compensate for the energy penalty associated with CO₂ capture (question 16, part 1)

There is a marked difference in response by stakeholders concerning the potential risks of global climate impacts from CO₂ storage site leakage (question 16, part 9) (table 23). Energy stakeholders are fairly relaxed about these potential risks (3% very serious, 13% moderate), whilst NGOs are much more concerned (35% very serious, 26% moderate) (see figures 46 and 47), as are Parliamentarians (24% serious, 29% moderate). Academics are relatively unconcerned (6% serious, 27% moderate), whilst government officials are somewhat more concerned (14% serious, 17% moderate). (The differences between NGOs and energy, government and academics are significant, whilst those between parliamentarians and energy and academic stakeholders are also significant, but not that difference with government stakeholders). (Table 26 provides the means and SDs for the stakeholder groups).

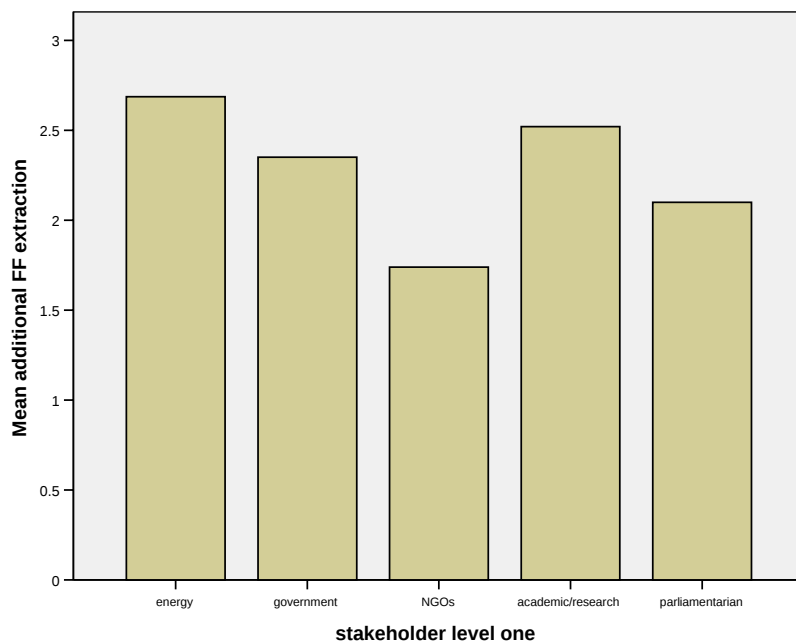


Figure 44: Potential risks of CCS arising from energy penalty (question 16, part 1) (where 1 refers to ‘very serious risk’, 2 ‘moderate risk’, 3 ‘minimal risk’, 4 ‘no risk’)

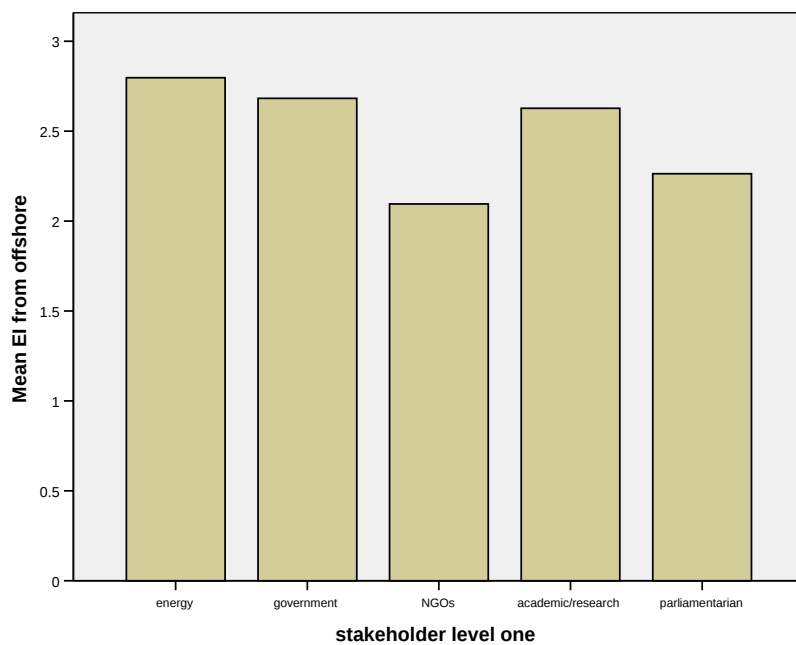


Figure 45: Potential risks of CCS arising from environmental impacts arising from offshore storage site leakage (question 16, part 8) (where 1 refers to ‘very serious risk’, 2 ‘moderate risk’, 3 ‘minimal risk’, 4 ‘no risk’)

There is also a striking difference in perceptions of the risks arising from global climate impacts due to additional greenhouse gas emissions resulting from enhanced hydrocarbon recovery (question 16, part 10) (table 24). NGOs are most concerned (39% very serious, 17% moderate) (figure 49), followed by Parliamentarians (10% very serious, 43% moderate). Least concerned is the energy sector (5% very serious, 20% moderate) (figure 48) and academics (4% very serious, 24% moderate). Government respondents' are moderately concerned (13% very serious, 19% moderate) (table 15). (As with part 9, the differences between the NGO respondents and government, academic and energy stakeholders are all significant. The differences between parliament and energy and academic stakeholders are significant, but not those with government stakeholders).

Responses to question 16 part 11 (impacts of CO₂ storage upon drinking water reservoirs) and part 12 (impacts of CO₂ storage upon micro-organisms within the storage site) reveal a higher level of expressed uncertainty on the part of the stakeholders that for the other questions (see figure 41). Whilst the 'unsure' response for most parts of question 16 was typically 2-10% for different stakeholder groups, that for parts 11 and 12 was in the realm of 15 to 20%. This reflects the relatively little research that has been conducted on these particular issues and the lack of a good understanding of the potential risks.

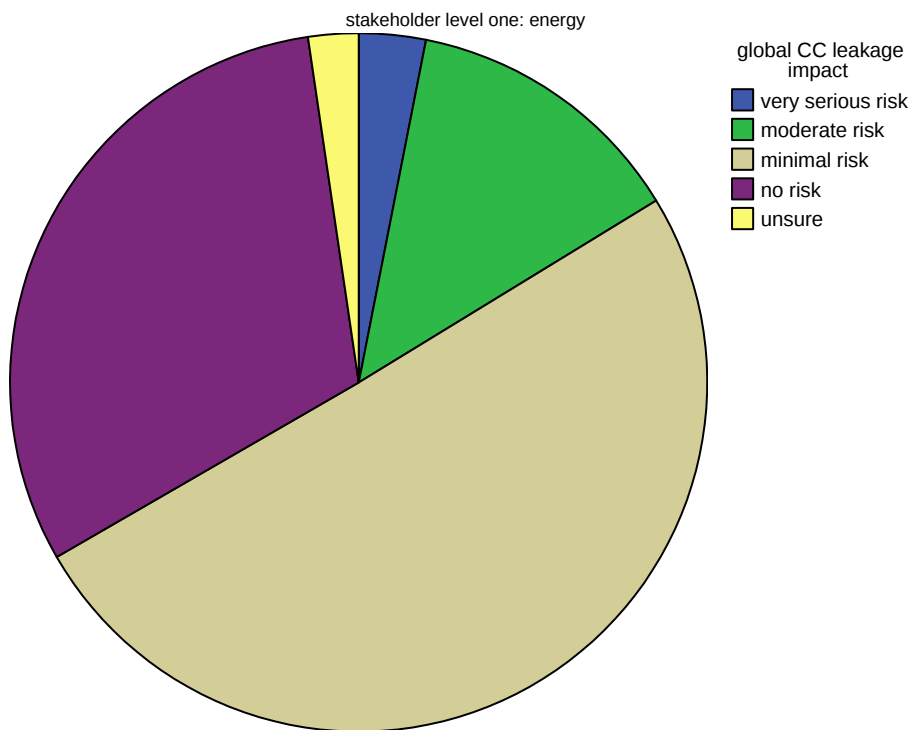


Figure 46: Opinion of energy stakeholders regarding global climate impacts from CO₂ storage site leakage (question 16, part 9)

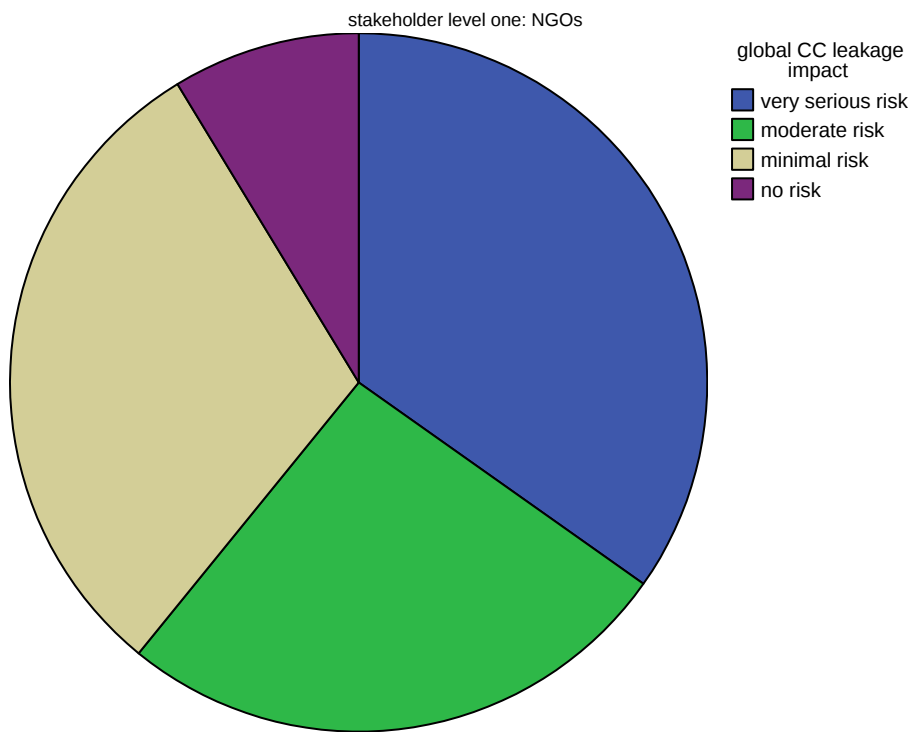


Figure 47: Opinion of NGO stakeholders regarding global climate impacts from CO₂ storage site leakage (question 16, part 9)

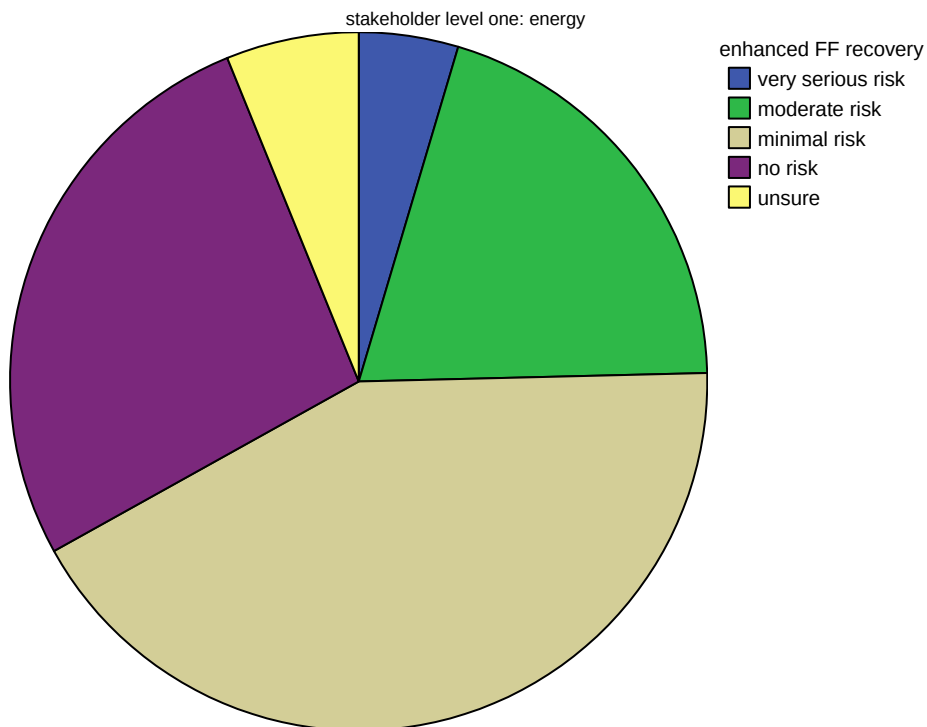


Figure 48: Opinion of energy stakeholders regarding global climate impacts due to additional greenhouse gas emissions resulting from enhanced hydrocarbon recovery (question 16, part 10).

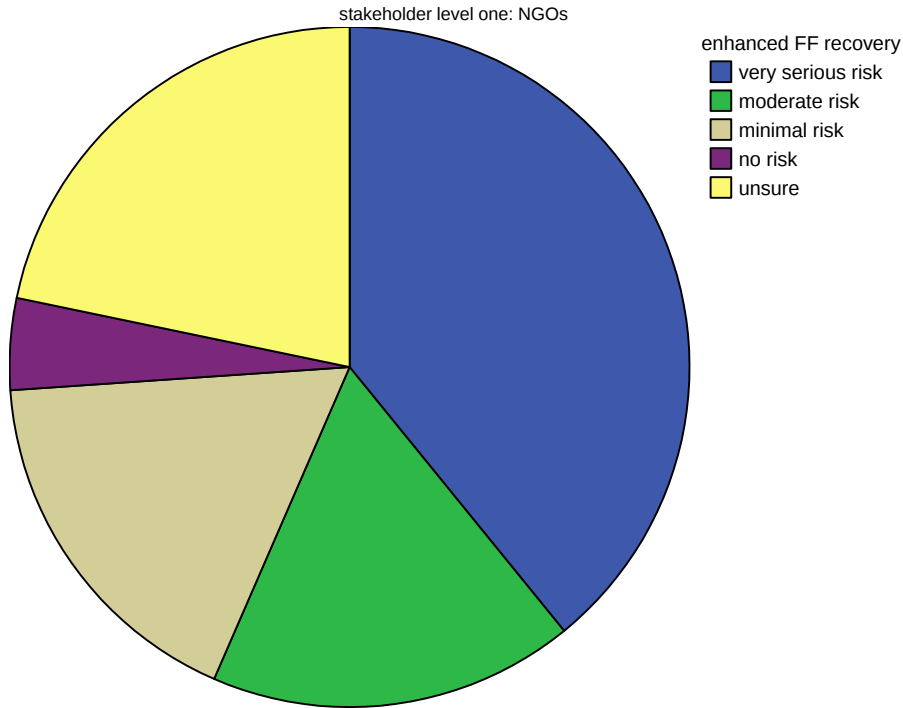


Figure 49: Opinion of NGO stakeholders regarding global climate impacts due to additional greenhouse gas emissions resulting from enhanced hydrocarbon recovery (question 16, part 10).

National Differences

UK, Spanish, Italian and Norwegian stakeholders are generally less concerned about the risks arising from additional use of fossil fuels because of the energy penalty (question 16, part 1) than the average respondent. Hence, 3% and 9% of British and Norwegian respondents respectively thought that this was a very serious risk, compared to 15% for the sample as a whole; in contrast Danish stakeholders regarded this risk as ‘very serious’ more frequently than the average, at 30%. There was a smaller percentage of respondents from Britain and Norway signifying ‘moderate risk’ and a higher percentage than the average signifying ‘minimal risk’ (59% and 55% respectively, compared to 40% indicating this response for the sample as a whole). The differences between the Netherlands, Germany and Finland (all relatively more concerned about this risk) and the UK are statistically significant. (Table 27 provides the means and SDs for the eight countries examined in detail).

Regarding the risk of accidents arising from inclusion of CO₂ capture at power stations (Question 16, part 2), German and Italian respondents are somewhat less concerned, whilst Danish respondents are somewhat more concerned about these risks compared to the average respondent (though none of these differences are statistically significant). The German and Italian respondents are less concerned about the risks of CO₂ pipelines on the landscape and environment (Question 16, part 3) than the average respondent (though once

again there are no statistically significant differences). German, British, Italian and Norwegian respondents tend to regard the risks to human health and safety arising from leakage from CO₂ pipelines (Question 16, part 4) as some what lower than the average respondent. (The difference between Norway and Denmark & Sweden is statistically significant as is that between the UK and Sweden). The British, Italian and Norwegian respondents tend to regard the risks to human health and safety arising from leakage from onshore CO₂ storage (Question 16, part 5) as some what lower than the average respondent (though only slightly) (no statistically significant differences). Norwegian respondents also tend to regard the environmental risks arising from onshore CO₂ leakage (Question 16, part 6) as some what lower than the average respondent (but there no statistically significant differences). The Danish and Norwegian respondents tend to regard the risks arising to human health and safety from offshore CO₂ storage (Question 16, part 7) as some what lower than the average respondent. (The Danish and Norwegian response is statistically distinct from the Swedish, who are relatively more concerned by this risk).

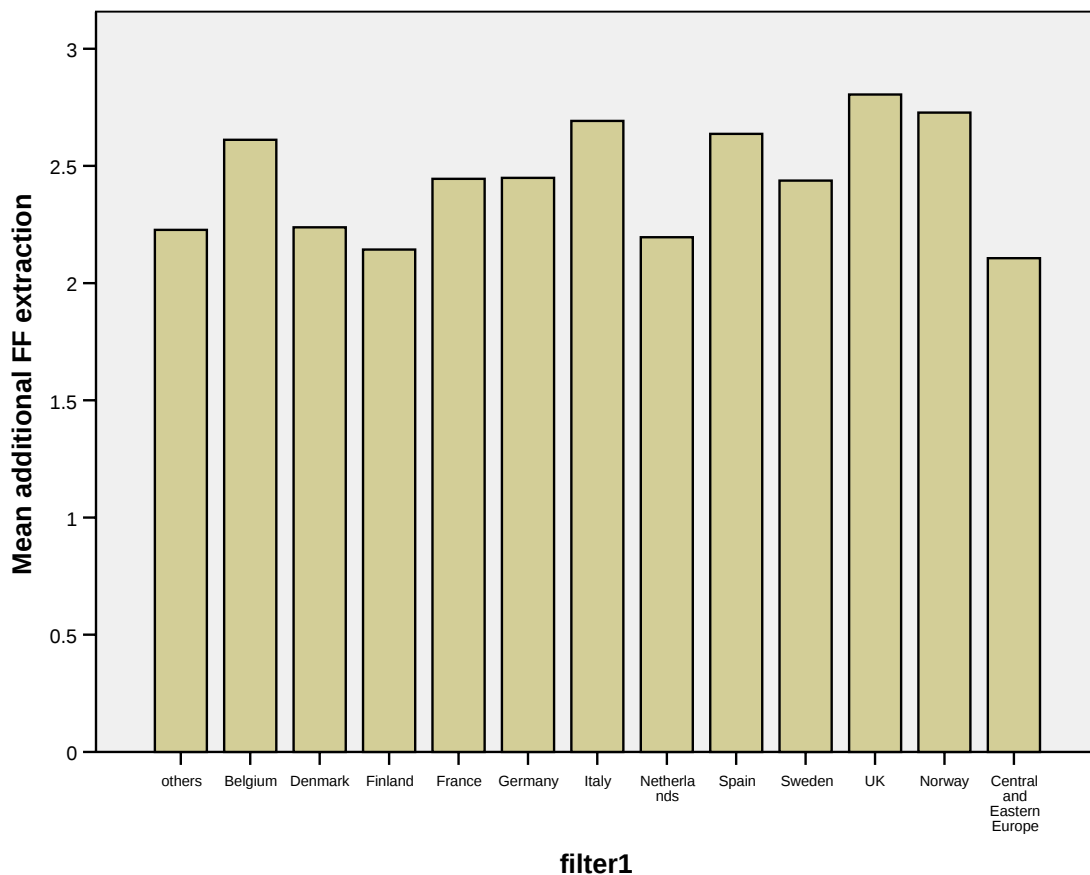


Figure 50: Potential risks of CCS arising from energy penalty by country (question 16, part 1) (where 1 refers to ‘very serious risk’, 2 ‘moderate risk’, 3 ‘minimal risk’, 4 ‘no risk’)

Regarding the environmental risks arising from the leakage of offshore CO₂ (Question 16, part 8), respondents from Denmark, Italy, Norway and the Netherlands regarded these as some what lower than the average respondent. The Finish respondents are the most concerned about this risk and the difference between them and the Dutch and Norwegian respondents is statistically significant, as is the difference between Danish and German (more cautious) respondents. The Italian respondents were less concerned about the global climate impacts from CO₂ storage site leakage risks (question 16, part 9) than the average respondent, whilst the Finish respondents were the most concerned about this risk (statistically significant difference when compared to the Netherlands, though not other countries). Likewise the Italian response for global climate impacts due to additional greenhouse gas emissions resulting from enhanced hydrocarbon recovery (question 16, part 10) and for impacts of CO₂ storage upon drinking water reservoirs (question 16, part 11) (though no statistical differences emerged between the other countries with respect to parts 10 and 11). No appreciable or statistically significant differences were observed with respect to national differences for question 16, part 12 (impacts of CO₂ storage upon micro-organisms within the storage site).

Impact of Investment in CCS upon other Low- & Zero- Carbon Energy Options and upon Energy Efficiency and Limiting Energy Demand (questions 17 & 18)

The sample is split between those who regard CCS as having a negative impact upon other LZCT development (15% significant negative, 29% minor negative) and those who do not consider that there will any negative impact (35%) or who see it as a potentially positive impact (16%) (Figure 51, table 28). (Table 42 shows the means and SDs for questions 17 & 18).

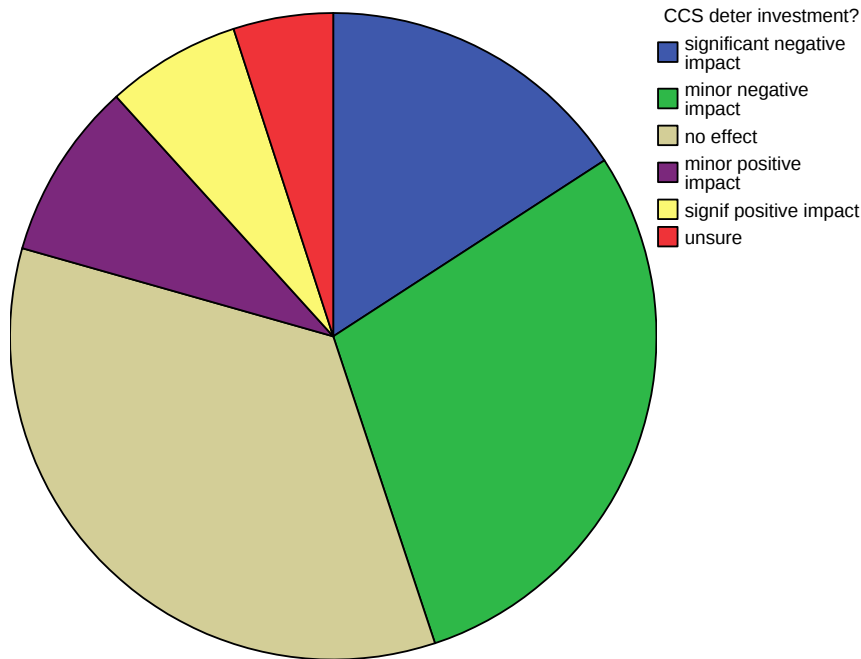


Figure 51: Impact of investment in CCS upon development of other zero- and low-carbon energy generation options (question 17)

Broken down by stakeholder group, the NGOs stand out as most concerned about the impact of CCS upon investment in other LZCTs (see figure 52, table 29) (65% significant negative impact, 22% minor negative impact, 9% no impact, 4% positive impact). By contrast, energy stakeholders are much less concerned (5% significant negative impact, 33% minor negative impact, 40% no impact, 18% positive impact) (figure 53). The response of government officials (figure 54), academics and parliamentarians is broadly similar to that of energy stakeholders (table 29), though with a somewhat higher percentage of respondents expressing the view that the impact could be a significant negative one (12-14%). The NGO response is statistically distinct from that of the other stakeholder groups (which are not themselves distinct statistically). (Table 43 shows the means and SDs with respect to questions 17 & 18).

Broken down by country, the differences between Denmark, Germany, Netherlands, UK, Norway and France are not large. Germany and Norway have the highest proportion of respondents who feel that CCS investment will have a significant negative impact on investment in other LZCTs (20%, 21% respectively) followed by Italy (19%) and Denmark (17%), the other countries being at 9-11%. Only the difference between the UK and Germany is statistically significant. (Table 44 shows the means and SDs with respect to questions 17 & 18).

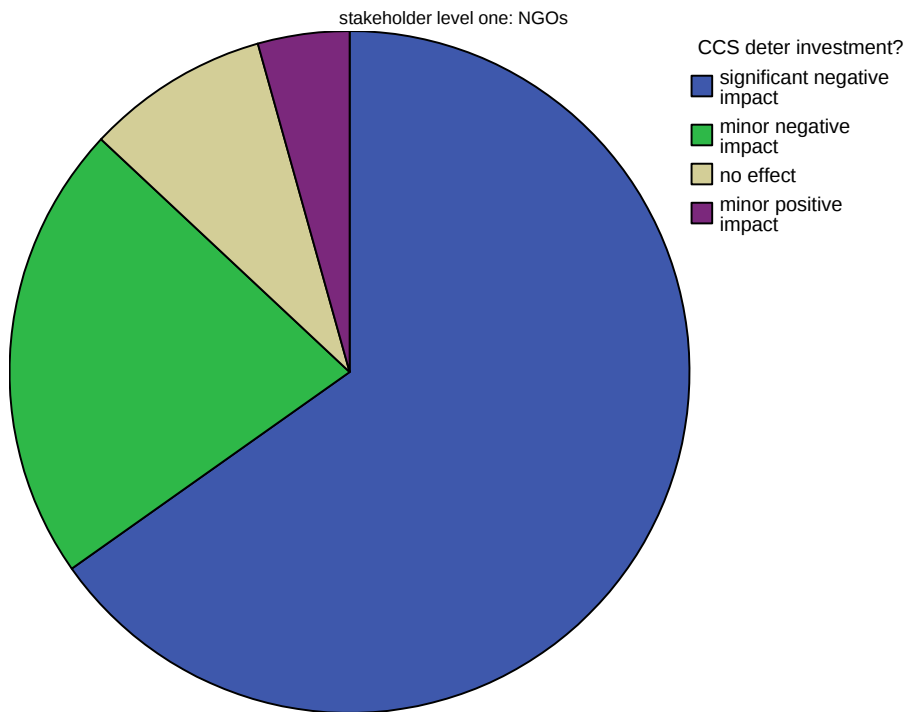


Figure 52: NGO perceptions of the impact of CCS investment upon development of other Low- and Zero-Carbon energy generation options (question 17)

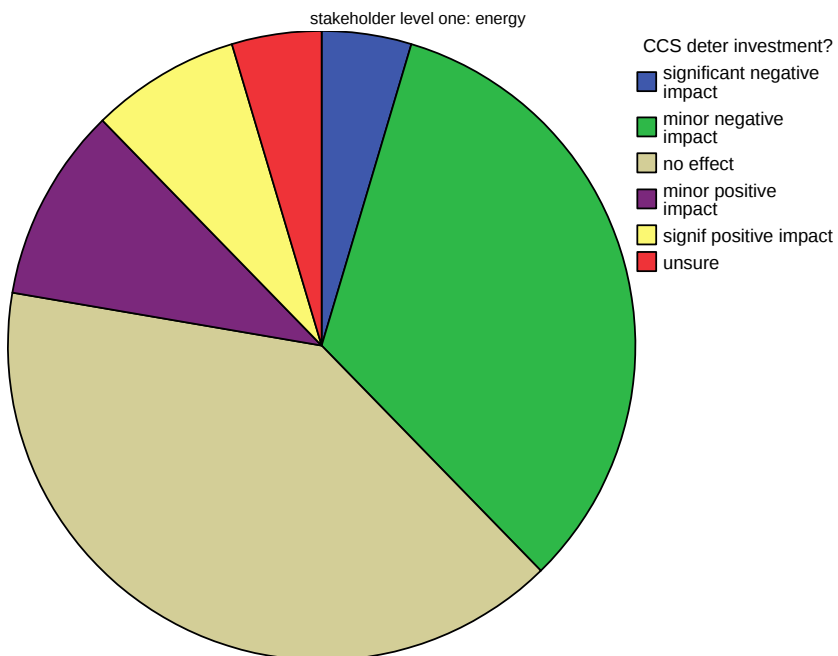


Figure 53: Energy sector perceptions of the impact of CCS investment upon development of other Low- and Zero-Carbon energy generation options (question 17)

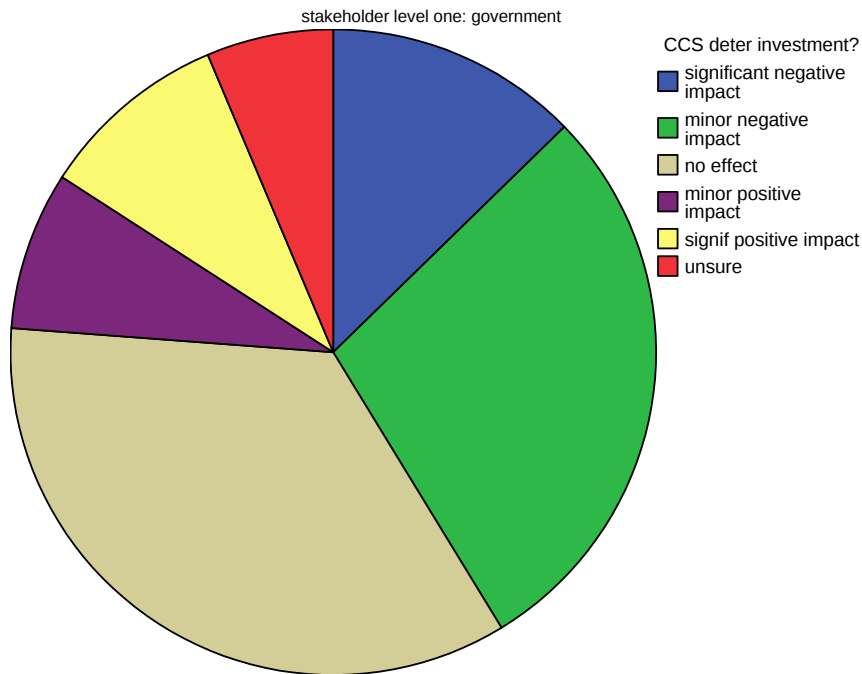


Figure 54: Government perceptions of the impact of CCS investment upon development of other Low- and Zero-Carbon energy generation options (question 17)

Meanwhile, France and Italy have the highest proportion of respondents who think that investment in CCS could have a minor or significant positive impact on development of other LZCTs (25% and 19% respectively). It would be interesting to explore why these stakeholders think that investment in CCS could positively effect development of other LZCTs.

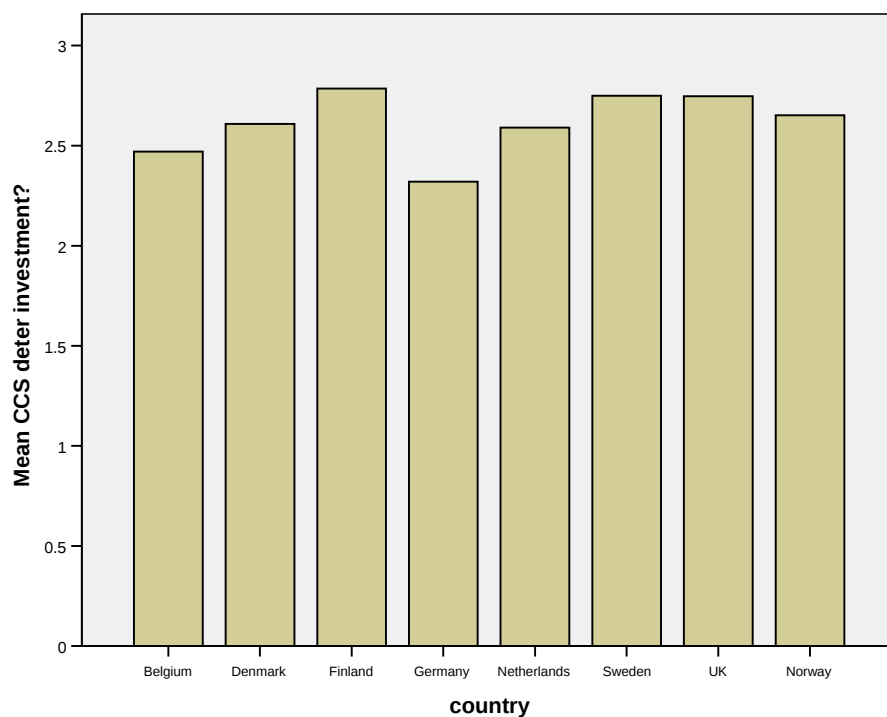


Figure 55: Perceptions of whether CCS will deter investment in low- and zero-carbon energy technologies (question 17) by country (where 1 refers to ‘a significant negative impact’, 2 a ‘minor negative impact’, 3 ‘no effect’, 4 a ‘minor positive impact’)

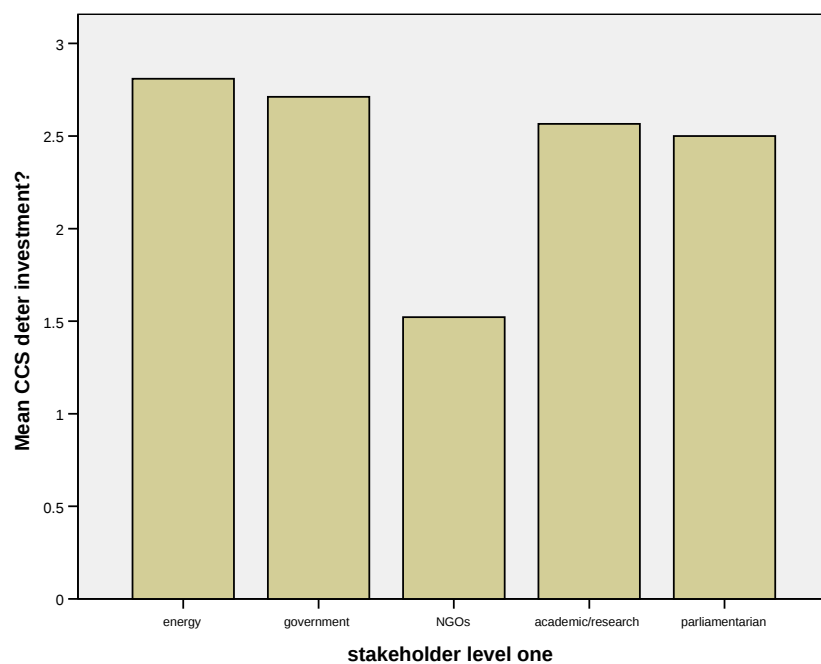


Figure 56: Perceptions of whether CCS will deter investment in low- and zero-carbon energy technologies (question 17) by stakeholder group (where 1 refers to ‘a significant negative impact’, 2 a ‘minor negative impact’, 3 ‘no effect’, 4 a ‘minor positive impact’)

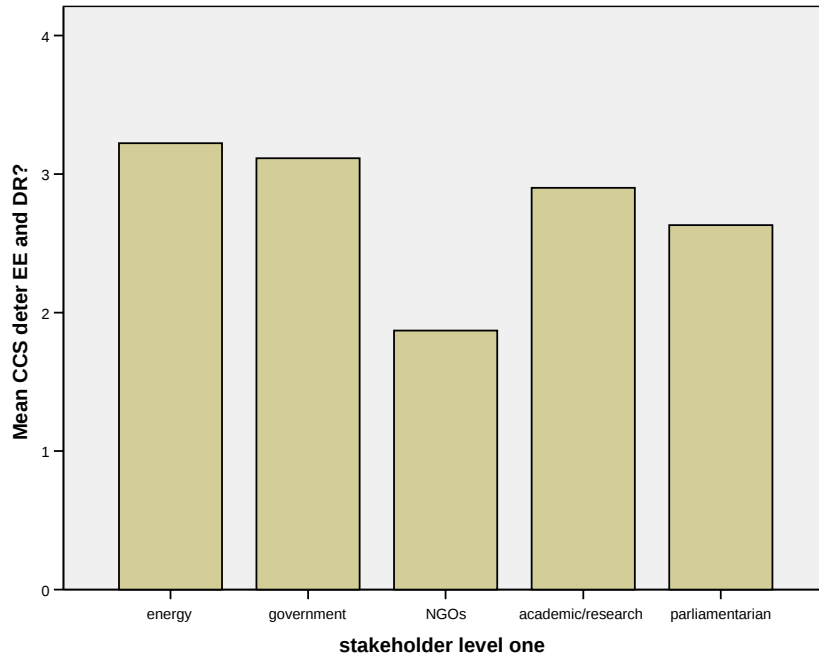


Figure 57: Perceptions of whether CCS will deter investment in energy efficiency and energy demand reduction efforts (question 18) by stakeholder group (where 1 refers to ‘a significant negative impact’, 2 a ‘minor negative impact’, 3 ‘no effect’, 4 a ‘minor positive impact’)

Turning to the impact of investment in CCS upon effort devoted to improving energy efficiency and reducing energy demand, the overall response (see figure 58, table 30) was not dissimilar from the response to question 17. The major difference is that the sample thought that there would be some what fewer minor negative impacts arising from CCS development upon energy efficiency measures than for development of LZCTs (22% compared to 29%). Furthermore, more positive impacts upon energy efficiency / demand reduction were anticipated from CCS development than for LZCT development (29% compared to 16%). It is possible that this positive effect arises from the increased use of energy in CCS, hence focusing efforts upon improving efficiency as much as possible.

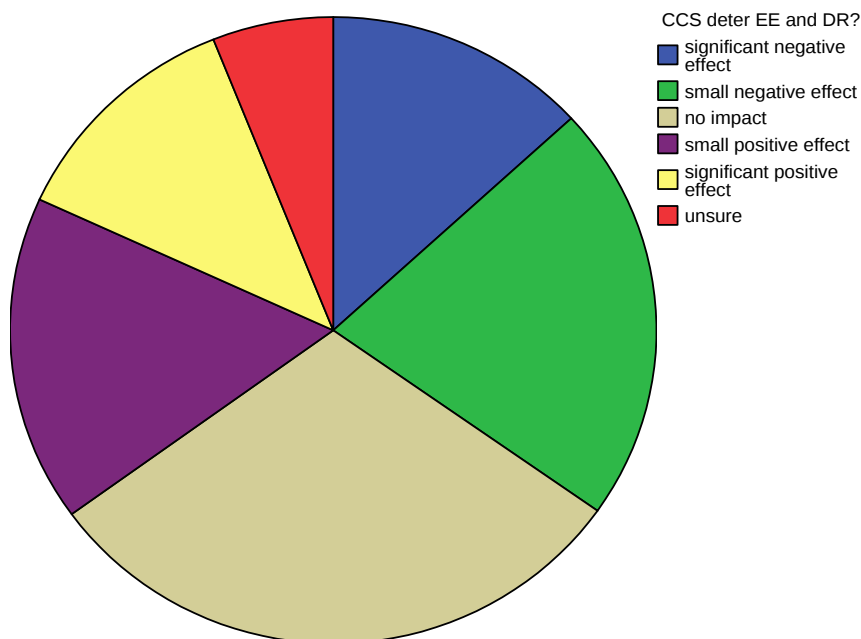


Figure 58: Perceptions of the impact of CCS investment upon effort spent on improving energy efficiency and reducing energy demand (question 18)

Broken down by country, Denmark stands out as somewhat unusual in the extent to which there is large percentage (26%) who think that there will be a significant negative impact upon energy efficiency measures, but also a large percentage (also 26%) who think that there will be a significant positive impact. The reason for this bipolar response, or whether it is an anomaly arising from the small sample size, is currently unknown. Only small percentages of the British, Dutch and German respondents consider that there will be significant positive benefits for energy efficiency (4-8%, compared to an average frequency at 12%), though a small positive effect is acknowledged by 16-26% of the respondents in those countries (compared to an average frequency of 17%). The difference between Germany – more concerned about this risk – and the UK and Sweden, is statistically significant. Respondents from Spain, France and Italy are all somewhat less concerned about the effects of CCS upon energy efficiency / demand reduction than the average respondent in the sample.

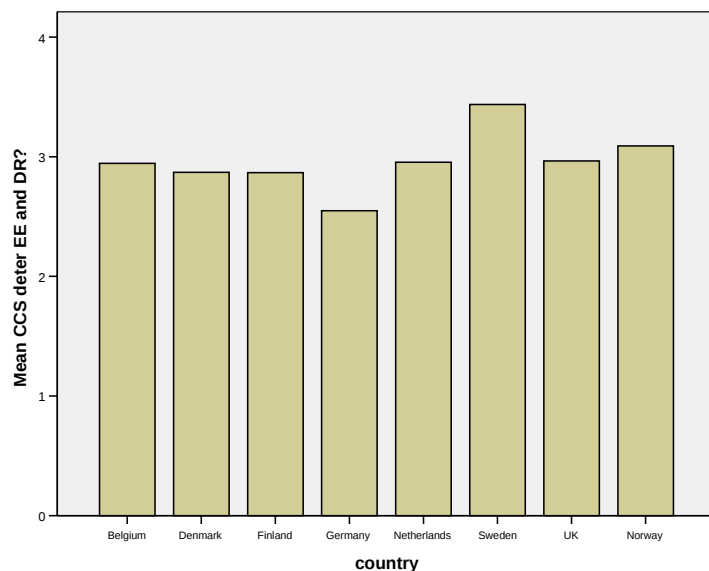


Figure 59: Perceptions of whether CCS will deter investment in energy efficiency and energy demand reduction efforts (question 18) by country (where 1 refers to ‘a significant negative impact’, 2 a ‘minor negative impact’, 3 ‘no effect’, 4 a ‘minor positive impact’)

Turning to stakeholder responses, NGOs are firmly of the view that there will be significant negative impacts on energy efficiency / demand reduction arising from CCS investment (57% of the sample) (figure 60, table 31). All other stakeholder groups have a much lower percentage for this response (between 7% for energy sector and 15% for parliamentary). (The difference between the NGO response and that of other stakeholders is statistically significant). The energy and government stakeholders were the most positive about the effects of CCS investment on encouraging energy efficiency (37-39%), whilst NGOs were the most skeptical (13%, all for ‘small positive effect’). Academics and parliamentarians were somewhere in between, with 26% and 19% of the sample respectively regarding there to be a positive impact upon energy efficiency from CCS investment. (There is a statistically significant difference between the response of energy and parliamentary stakeholders).

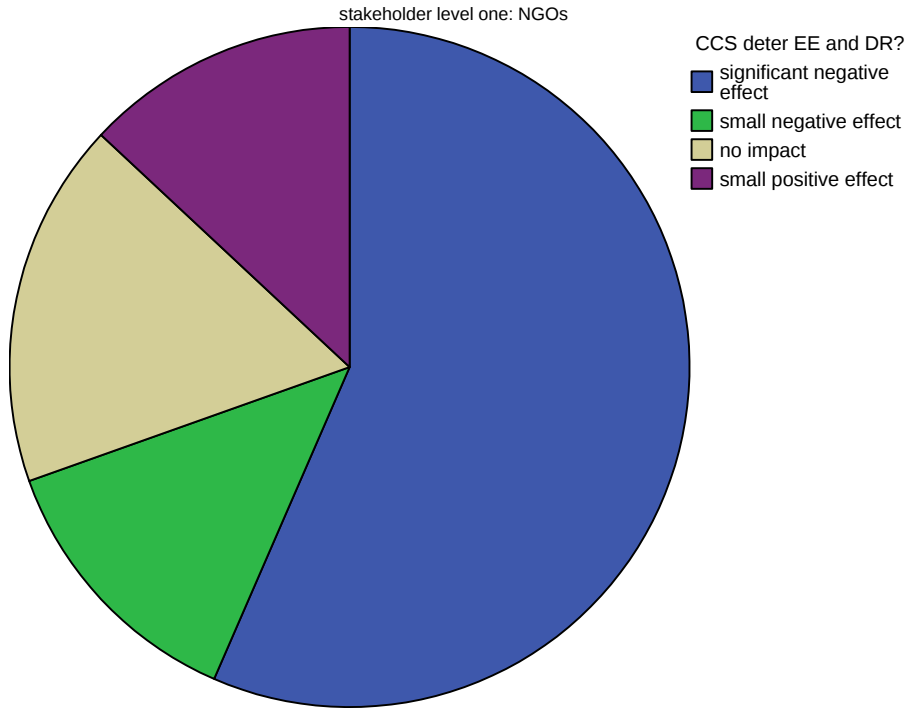


Figure 60: Perceptions of the impact of CCS investment upon effort spent on improving energy efficiency and reducing energy demand: NGO respondents (question 18)

The Effects of CCS upon Development of Decentralized Power Generation Systems (question 19)

14% of the sample perceives a very negative impact arising from CCS for decentralised generation (DG), whilst a further 33% thinks that there might a slightly negative effect (47% in total for a negative impact) (figure 61, tables 32 and 42). A further 24% of the sample perceived there to be no effect, whilst about 10% thought there could be a slightly or very positive impact. Hence, whilst the majority of stakeholders do not regard CCS development as much of a threat to the development of renewables (question 17) or of energy efficiency/energy demand reduction measures (question 18), a much larger number of stakeholders (if not quite a majority) do consider that CCS will deter development of DG energy systems.

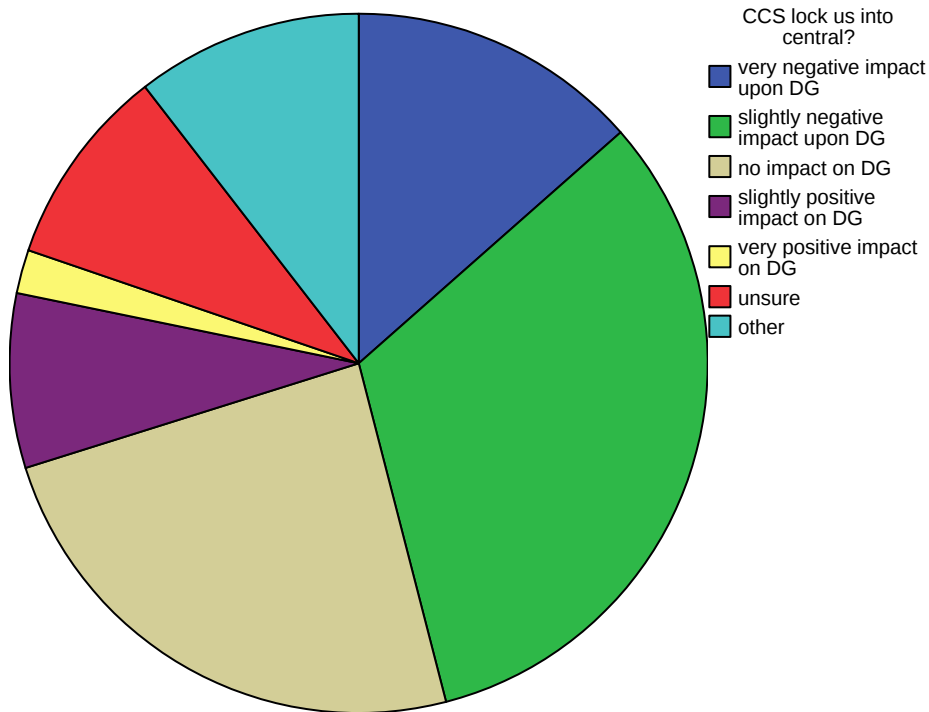


Figure 61: Stakeholder perceptions of the effect of CCS upon development of a decentralized power generation system (in particular from renewable sources) over the next 20 to 40 years (question 19)

Energy (figure 62), government and academic stakeholders (figure 63) do not perceive there to be a very negative impact of CCS upon DG (7%, 9% and 14% respectively) in contrast to NGOs (44%) and parliamentarians (29%) (Tables 33 & 42). (The difference between the NGO response and that of energy, government and academic stakeholders is statistically significant, but not that with the parliamentary stakeholders). All stakeholders do, however, consider that there will be a slightly negative impact of CCS upon DG (34% for energy, 46% government, 32% academics). Only a small number of stakeholders identify any potentially positive impact from CCS upon DG systems (between 0 and 10% for both slightly and very positive).

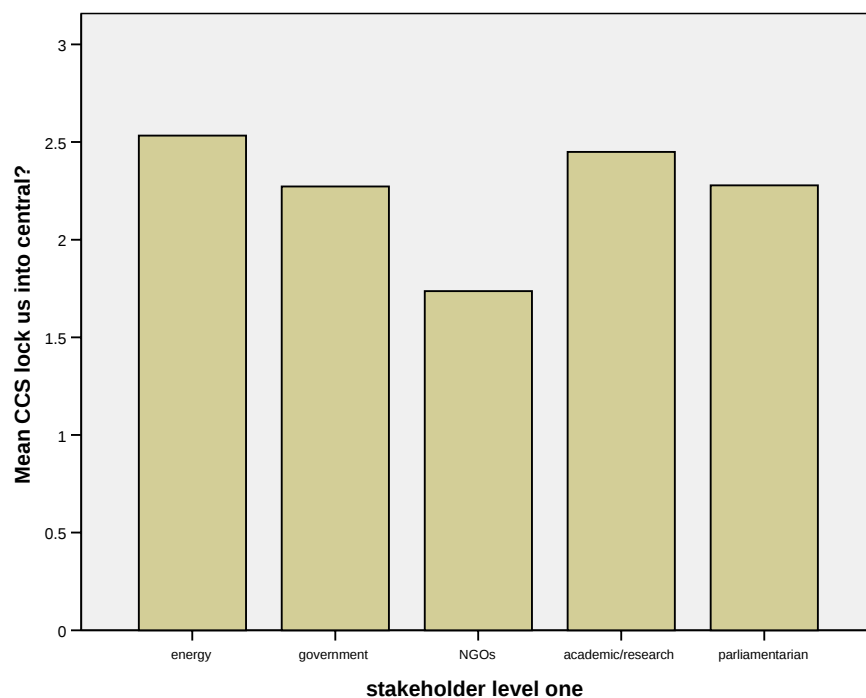


Figure 62: Perceptions of the effect of CCS upon development of a decentralized power generation system (in particular from renewable sources) over the next 20 to 40 years (question 19) by stakeholder group (where 1 means ‘a very negative impact’, 2 ‘a slightly negative impact’, 3 ‘no impact’ and 4 ‘a slightly positive impact’)

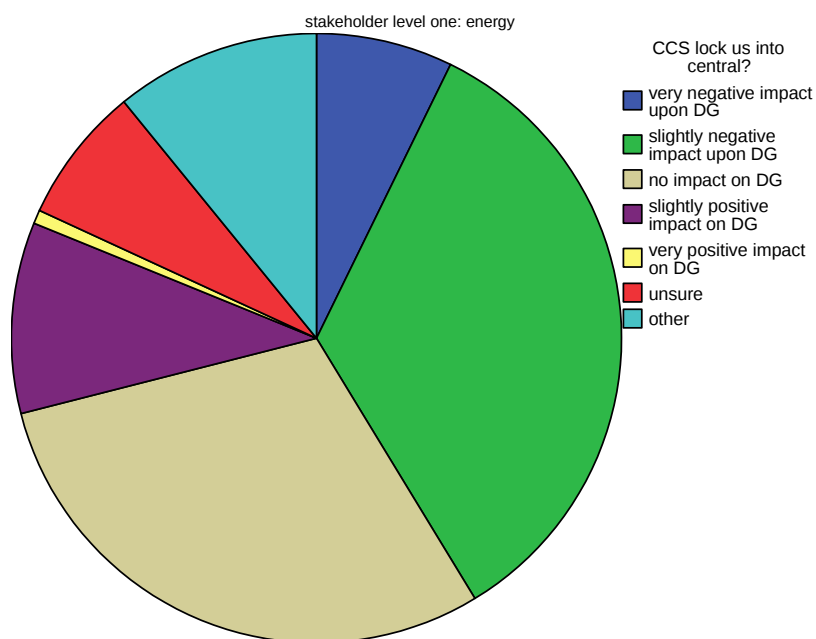


Figure 62: Energy respondent perceptions of the effect of CCS upon development of a decentralized power generation system (in particular from renewable sources) over the next 20 to 40 years (question 19)

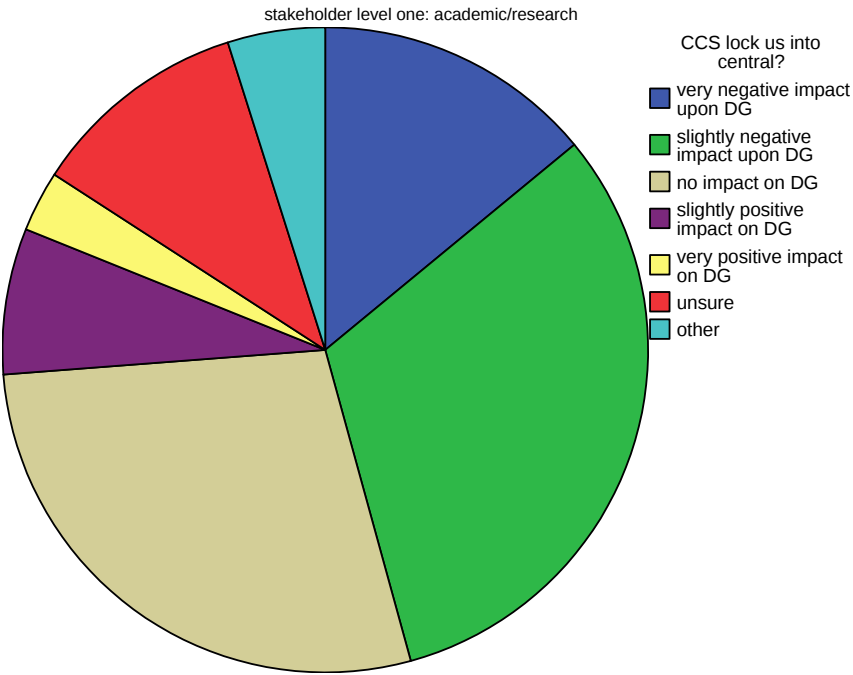


Figure 63: Academic / research respondent perceptions of the effect of CCS upon development of a decentralized power generation system (in particular from renewable sources) over the next 20 to 40 years (question 19)

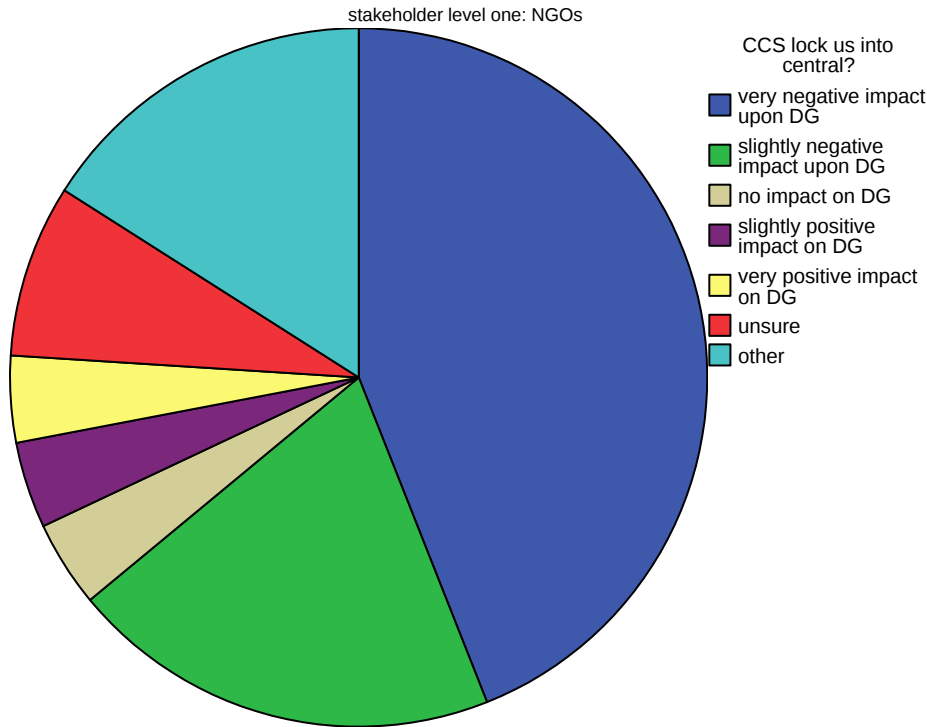


Figure 64: NGO respondents perceptions of the effect of CCS upon development of a decentralized power generation system (in particular from renewable sources) over the next 20 to 40 years (question 19)

The responses of stakeholders in Denmark, Germany, Netherlands, Norway and the UK are largely similar (no statistically significant differences) (table 44). The only really interesting difference is the number of Norwegian respondents who thought that CCS could have a slightly positive effect upon DG systems (24%). This contrasts with an 8% frequency response for the sample as a whole. It is not know why Norwegian respondents thought that CCS could stimulate DG generation and this is an issue which could be explored in future stakeholder interaction. German, Swedish and Danish respondents were also some what more negative about the effects of CCS upon DG, 25% of Danish, 19% of Swedish and 20% of German respondents stating the view that CCS could have a ‘very negative impact’ upon DG (compared to 14% frequency for the sample as a whole).

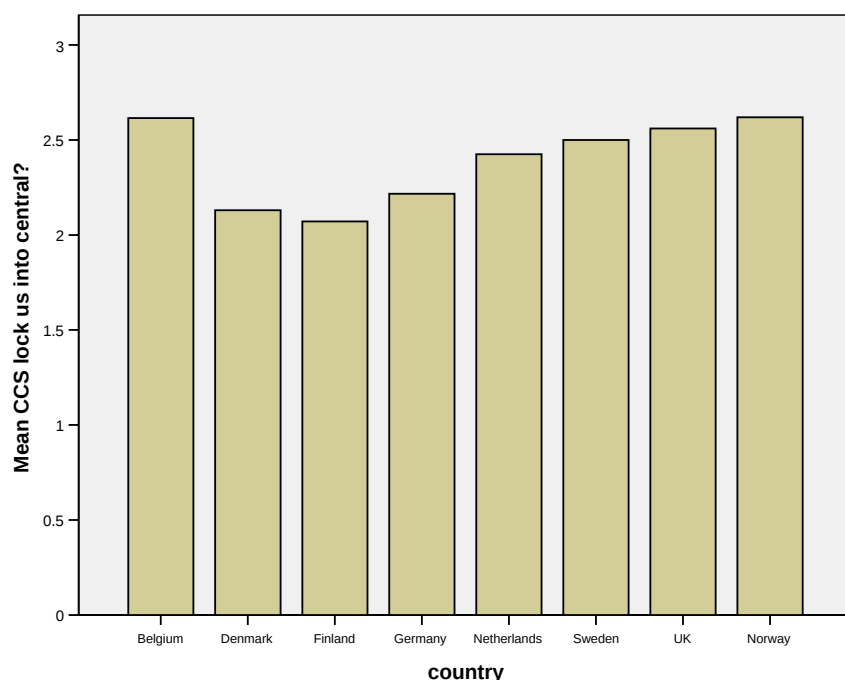


Figure 65: Perceptions of the effect of CCS upon development of a decentralized power generation system (in particular from renewable sources) over the next 20 to 40 years (question 19) by country (where 1 means ‘a very negative impact’, 2 ‘a slightly negative impact’, 3 ‘no impact’ and 4 ‘a slightly positive impact’)

The Impacts of CCS upon Energy Security (question 20)

Coal with CCS

The most common response to the issue of the impact of CCS with coal-powered generation upon energy security is that there will be no impact (28%) (see figure 66, tables 34 & 42). 22% of the sample thought that coal with CCS would result in more imports from stable countries, whilst 22% thought imports from unstable countries would reduce. 12% of respondents stated that reliance on imports from unstable countries would increase so reducing energy security. Overall, however, 44% of respondents thought that use of coal with CCS would increase energy security in the EU. Note, that 15% of the sample was unsure, a relatively high level compared to most questions in the survey.

There was no real difference between responses on the basis of country (no statistically significant differences). More NGO respondents consider that coal with CCS is more likely to reduce energy security (29% of respondents) (figure 67, tables 35 & 43) and Parliamentarians are also concerned about this (20%) (compared with a frequency of 12% for the whole sample) although there is still a large number of respondents each group who consider that energy security will be improved (33% and 30% respectively) (compared to a frequency of 44% for the whole sample). The energy and government stakeholders (figure 68, table 35) are much less concerned about a reduction in energy security with coal CCS

(6% for energy and 3% for government respondents). Statistically, the stakeholders fall into two distinct groups: energy and government (least concerned) and NGOs, academics and parliamentarians (more concerned).

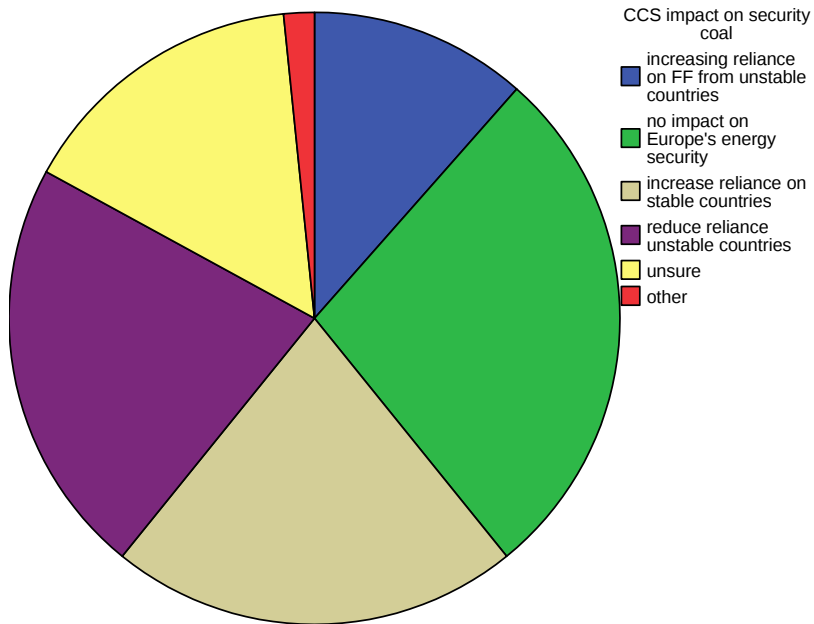


Figure 66: Stakeholder perceptions of the effect of using coal with CCS upon energy security in the EU (question 20, part 1)

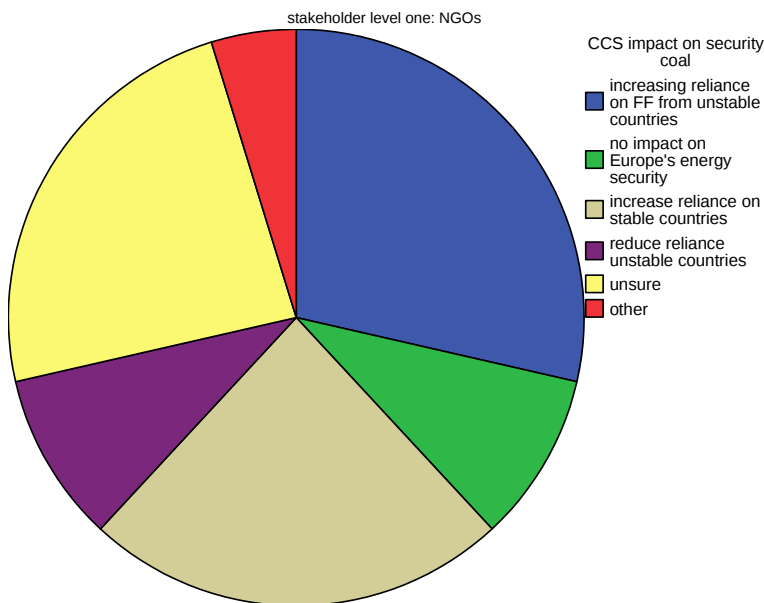


Figure 67: NGO respondents perceptions of the effect of using coal with CCS upon energy security in the EU (question 20, part 1)

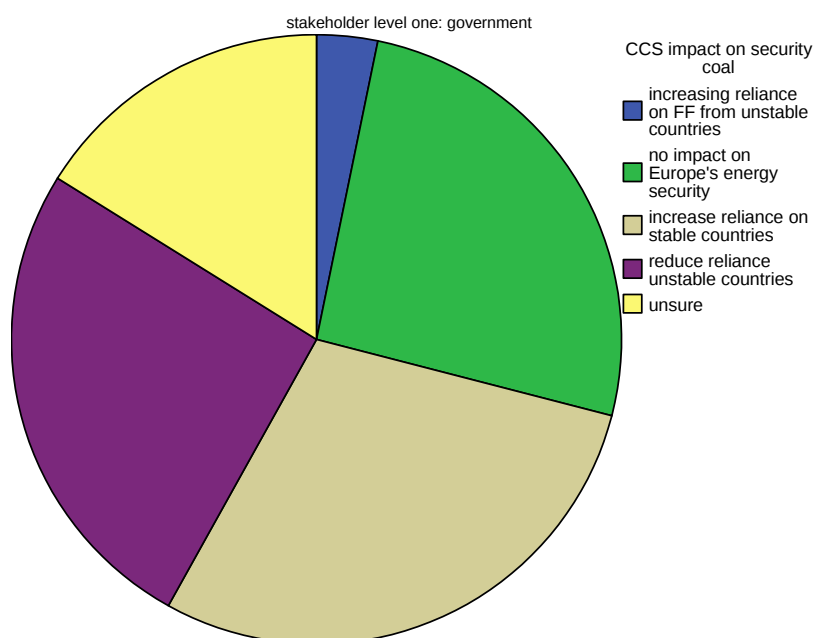


Figure 68: Government respondents perceptions of the effect of using coal with CCS upon energy security in the EU (question 20, part 1)

Gas with CCS

The stakeholder sample perceived that there were much greater risks for energy security in the EU arising from natural gas electricity generation with CCS than for coal with CCS (see figure 69, tables 36 & 43). 37% thought that using gas with CCS would increase reliance on unstable countries and thereby reduce energy security (cf. 12% for coal with CCS). Only about 18% thought that gas with CCS would actually improve energy security (cf. 44% for coal with CCS).

NGOs and parliamentarians (figure 70, table 37) are the stakeholder groups most concerned about the use of natural gas with CCS reducing energy security (48% and 53% compared to 35-37% for the other stakeholders), although the difference is not statistically significant. The response to this question is therefore strikingly different from responses to other questions concerning the potential risks of CCS in that NGOs do not emerge as notably more concerned, suggesting that the risks of reduced energy security through use of more natural gas in the EU is a very real concern for all stakeholders.

In terms of national diversity, the Norwegian respondents were least concerned about gas with CCS reducing energy security (27% compared to 37% for the whole sample and 48% for Denmark, 47% for Germany and 42% for Netherlands). This may be related to Norway's large domestic supplies of natural gas. Belgium also stands out as less concerned

than other countries on this issue and is significantly different from, e.g., Sweden (though not from any of the other countries examined, all of which are very similar).

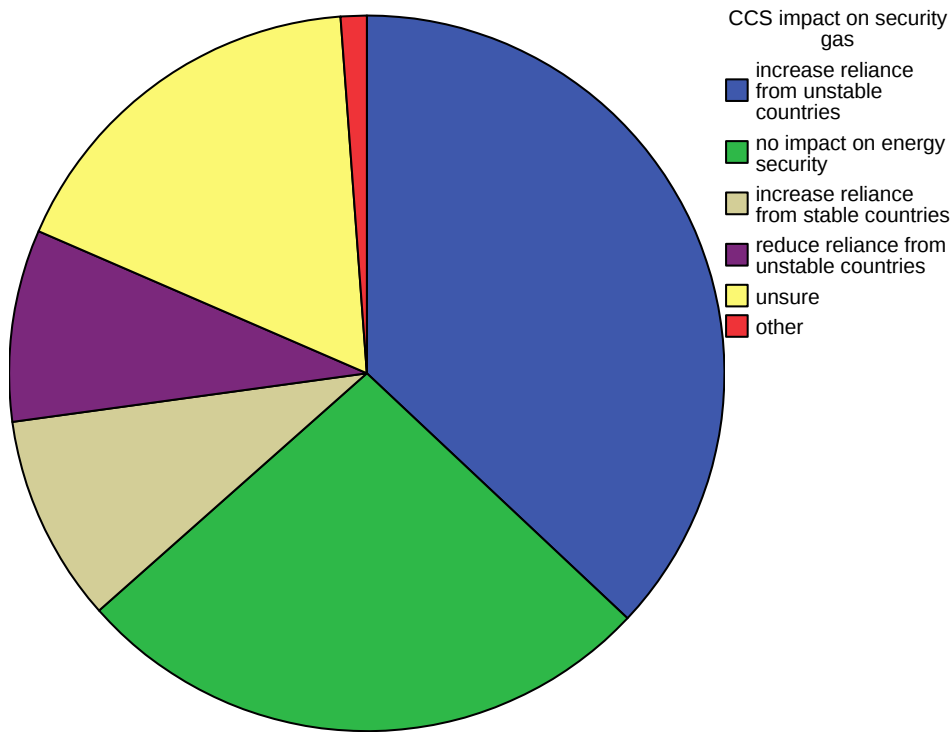


Figure 69: Stakeholder perceptions of the effect of using gas with CCS upon energy security in the EU (question 20, part 2)

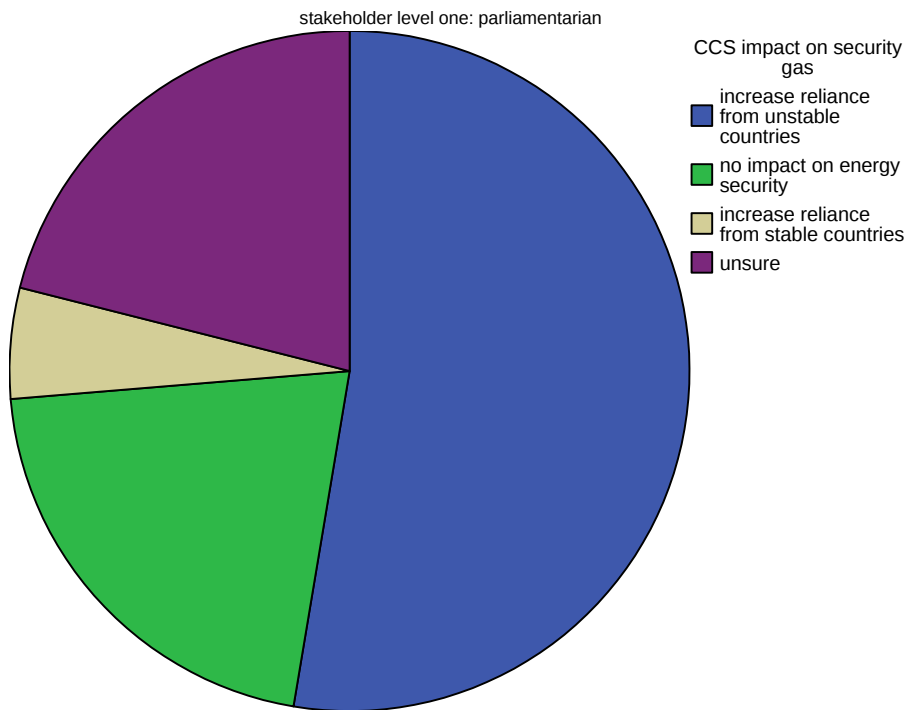


Figure 70: Parliamentarian perceptions of the effect of using natural gas with CCS upon energy security in the EU (question 20, part 2)

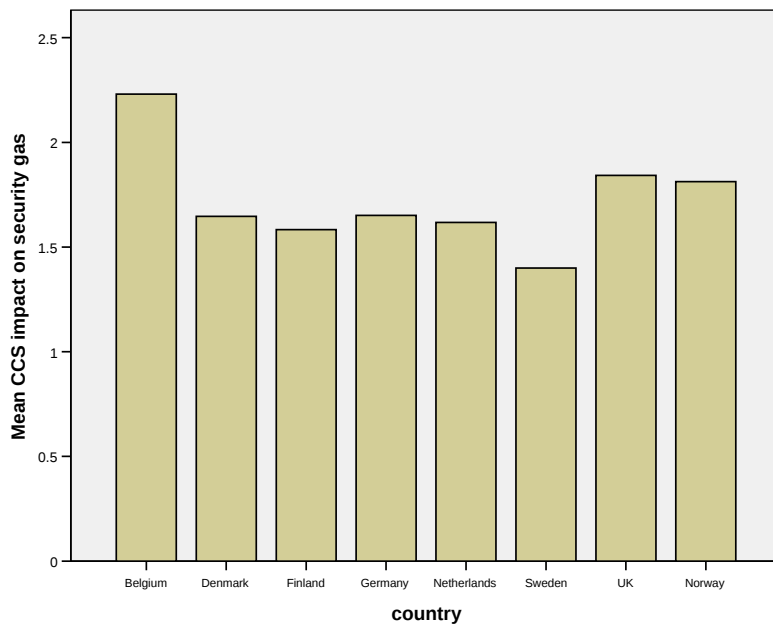


Figure 71: Impacts of natural gas with CCS upon energy security in the EU by country (where 1 means 'reduces energy security', 2 'no impact', 3 'increases energy security')

Public Perceptions of CCS in Home Country and in the EU (question 21)

Home Country

The most common response is that the public in home countries will ‘moderately support’ CCS (34%), followed by ‘neutral’ (30%) (figure 72, tables 38 & 42). Only 4% of respondents thought that the public would be strongly opposed to CCS, whilst 19% would be moderately opposed, and only 5% thought that the public would be strongly supportive. Hence, on balance the respondents regarded public support for CCS as greater than public opposition (40% versus 25%).

There are very marked variations between countries regarding opinions on public perceptions. The response of Norwegian stakeholders is shown in Figure 73. It is perceived that the Norwegian public will strongly support CCS (48%) with a further 39% moderately supportive. Only 4% of respondents thought that there be moderate opposition to CCS, and no respondent thought there would be strong opposition. There is a statistically significant difference between the response of Norwegian respondents and those of the other countries (see Table 44 for the mean and SD values).

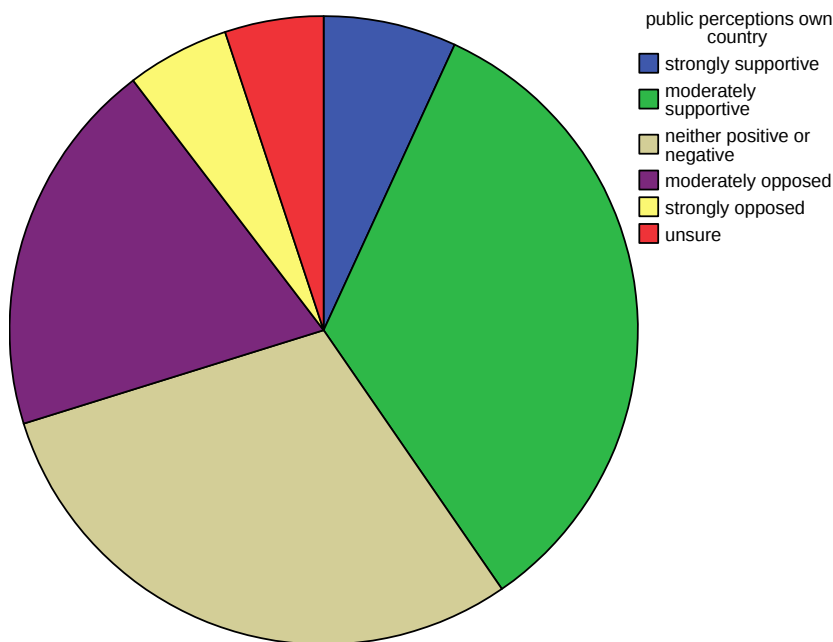


Figure 72: Respondents' opinion of public perceptions of CCS in own country (question 21, part 1)

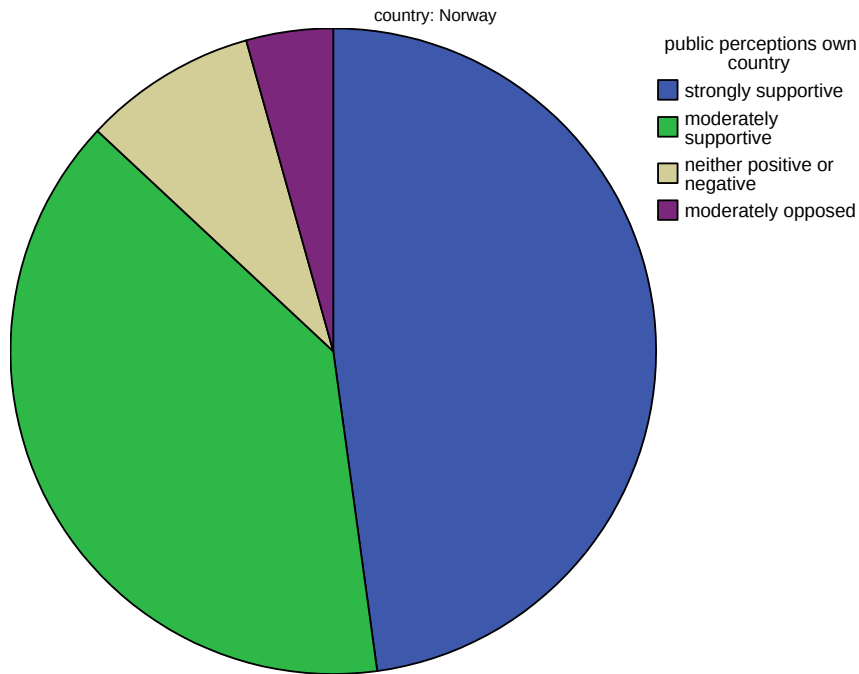


Figure 73: Norwegian respondents' opinion of public perceptions of CCS in own country (question 21, part 1)

Respondents in the UK (figure 74) and the Netherlands (figure 77) also expected little opposition (roughly 10%, of which only 1-2% expected strong opposition).

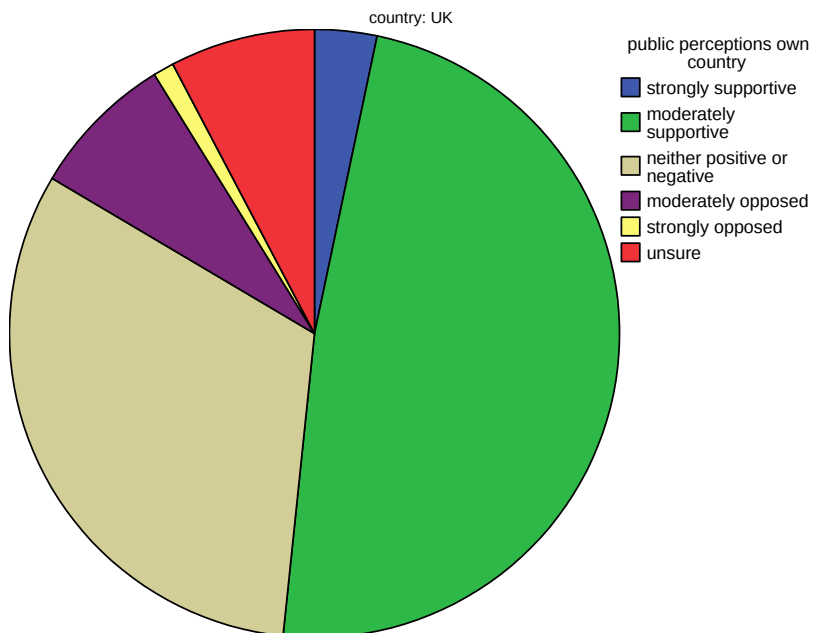


Figure 74: UK respondents' opinion of public perceptions of CCS in own country (question 21, part 1)

Respondents from Denmark (figure 75) and Germany (figure 76) were most likely to express the view that there would be greater public opposition to CCS in their countries than average: 35% and 31% would be moderately opposed respectively (compared with a frequency of 19% for the whole sample) with a further 9% and 4% strongly opposed. 11% of Dutch stakeholders believe that the public will be strongly supportive, whilst another 46% will be moderately supportive (see figure 77). In statistical terms, the UK is significantly different from Sweden, Denmark and Germany (but not from the Netherlands, which is itself distinct from the Swedish response). The reasons why there is such a large difference in how respondents' perceive the reaction of the public to CCS in their own country is not known, and would be an interesting future research question. Why are Norwegian, Dutch and British stakeholders so much more confident that CCS will receive a largely positive reception in their countries compared to stakeholders from other countries?

NGOs and Parliamentarians are the least convinced that the public will be supportive of CCS, none selecting the 'strongly supportive' option (figure 78, tables 39 & 44). What is curious, however, is that NGOs and Parliamentarians do not think that there will be that much public opposition to CCS. Their characterisation of moderate and strong opposition to CCS by the public is similar to the estimates made by the other stakeholder groups. Meanwhile, both parliamentarians and NGOs consider more than other stakeholder groups that the public will be, on balance, 'neither positive nor negative' about CCS (48% and 41% respectively, compared to 23% for energy and 24% for governmental stakeholders). NGO respondents do consider, however, that a larger percentage of the public will be either moderately or strongly opposed to CCS than will be moderately or strongly supportive (18% versus 32%). This contrasts with energy stakeholders, who think that 46% of the public will be strongly or moderately supportive compared to 29% who will be strongly or moderately opposed to CCS. (The only statistically significant difference is that between the response of NGOs and academics).

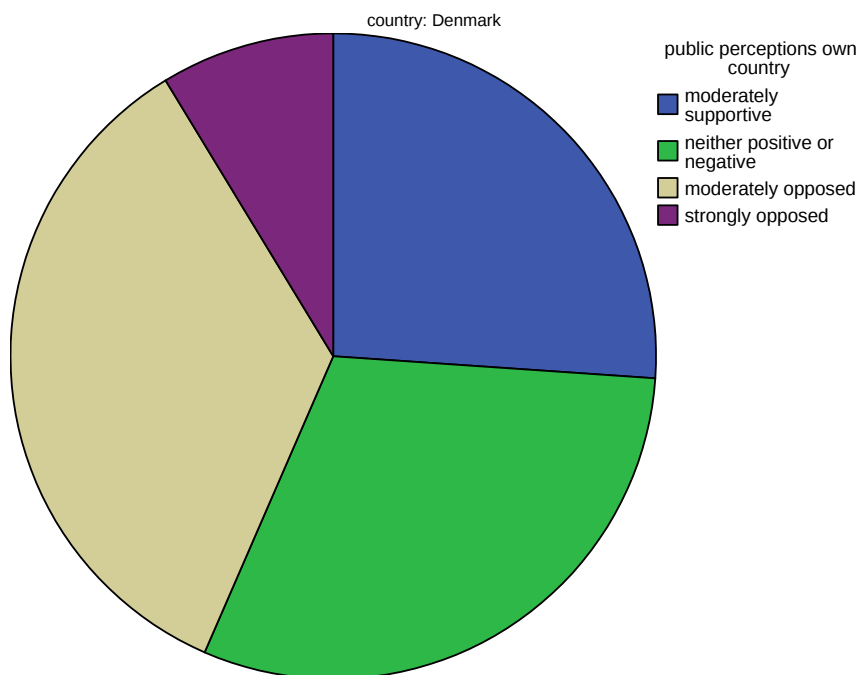


Figure 75: Danish respondents' opinion of public perceptions of CCS in own country (question 21, part 1)

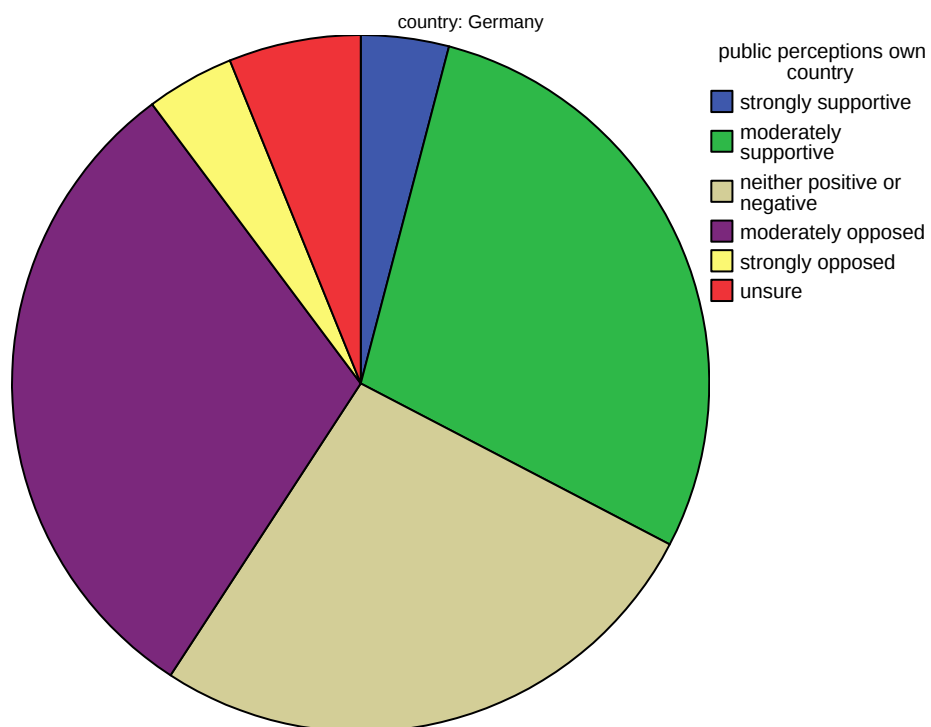


Figure 76: German respondents' opinion of public perceptions of CCS in own country (question 21, part 1)

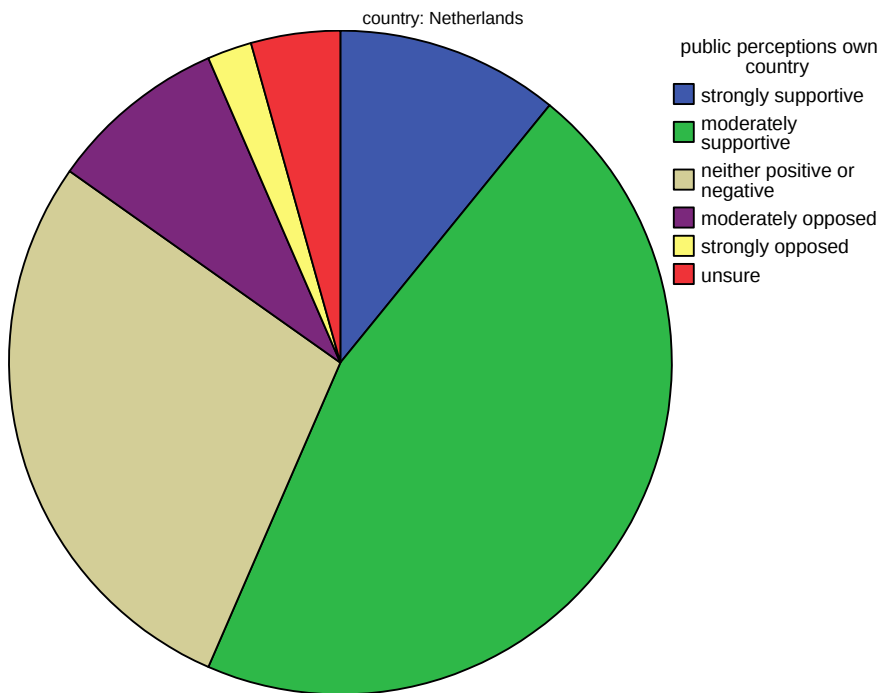


Figure 77: Dutch respondents' opinion of public perceptions of CCS in own country (question 21, part 1)

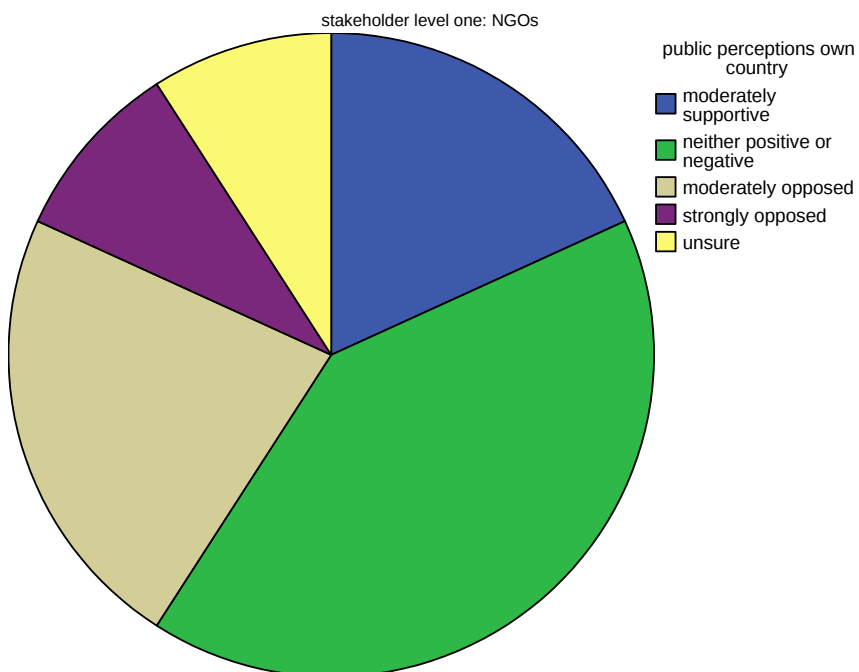


Figure 78: NGO respondents' opinion of public perceptions of CCS in own country (question 21, part 1)

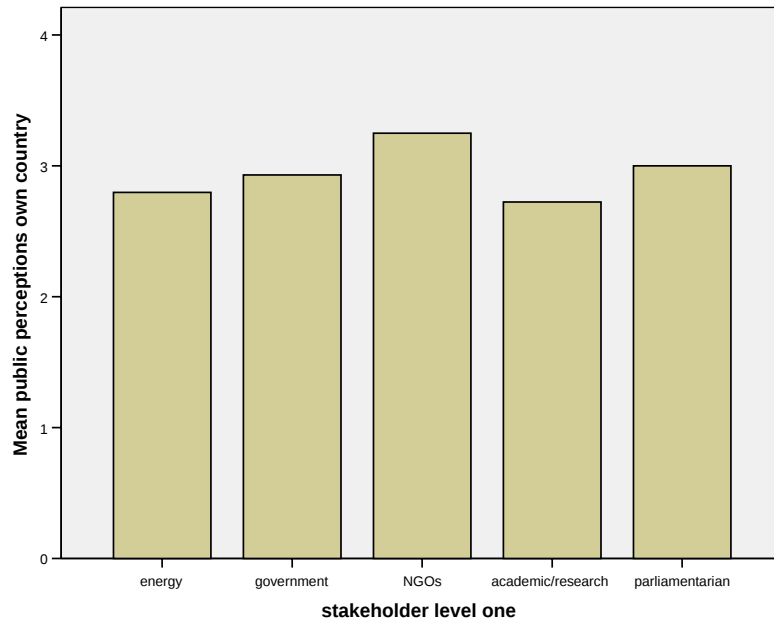


Figure 79: Opinion on public perceptions of CCS in own country by stakeholder group (where 1 means 'strongly supportive', 2 'moderately supportive', 3 'neither positive nor negative', 4 'moderately opposed' and 5 'strongly opposed')

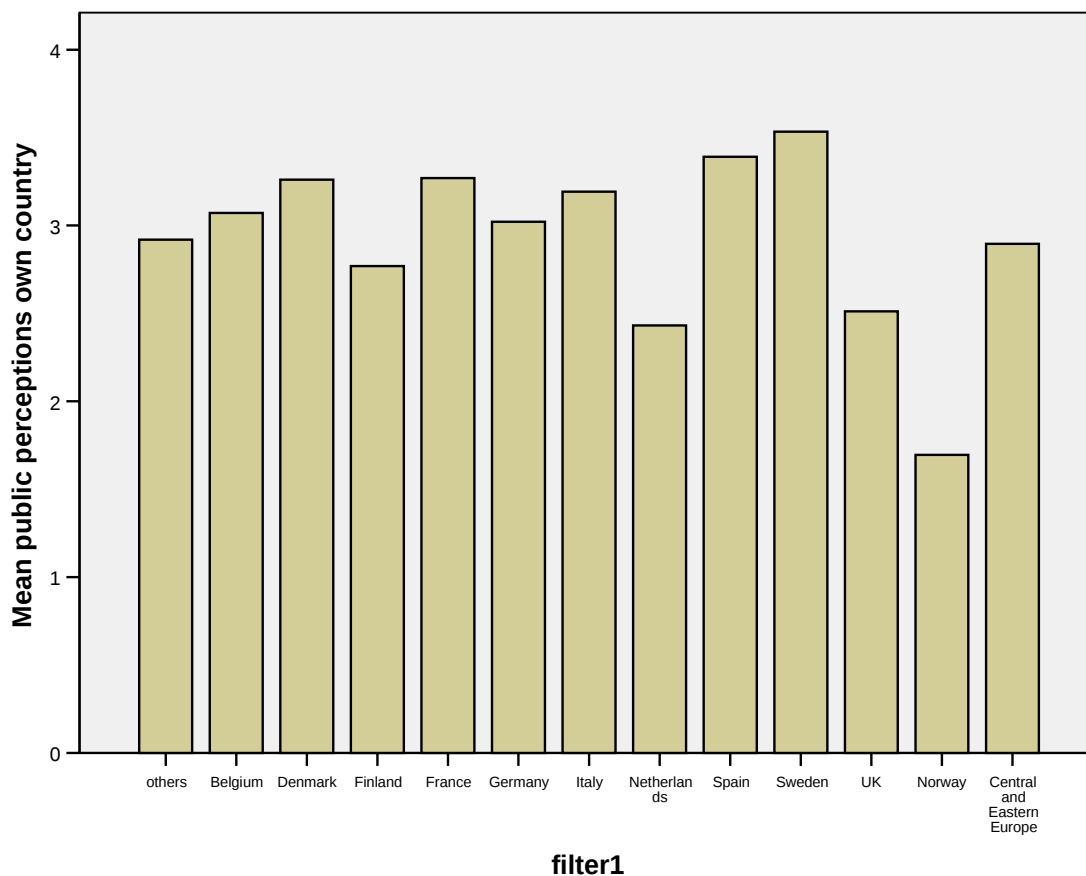


Figure 80: Opinion on public perceptions of CCS in own country by country (where 1 means ‘strongly supportive’, 2 ‘moderately supportive’, 3 ‘neither positive nor negative’, 4 ‘moderately opposed’ and 5 ‘strongly opposed’)

EU Scale

The stakeholders generally believed that CCS would be more strongly supported by the public at the EU level than in their home country (see figure 81, tables 40 & 42). A higher percentage of respondents thought that CCS would be strongly (12%) or moderately supported (36%), and relatively few believed the public would be moderately (13%) or strongly (1%) opposed. Hence, the expectation of support (48%) easily outweighed expected opposition (14%) (compared to perceived support in home country of 40% versus 25% against).

None of the groups except for parliamentarians thought that there would be any strong public opposition to CCS at the EU scale (figure 82, tables 41 & 43). A large minority of NGO respondents thought that the public would neither like nor dislike CCS (38% compared to only 23-28% for other groups except parliamentarians). 62% of parliamentarians thought that there would be moderate public support for CCS at the EU scale (whereas only 24% believed there would be moderate public support in their home

countries). Why there are these differences between the responses at the EU and national scales is not known. (The only statistically significant difference is that between energy and academic stakeholders, the later more confident of public support for CCS within the EU). (The only statistically significant difference is that between energy and academic stakeholders, the later more confident of public support for CCS within the EU).

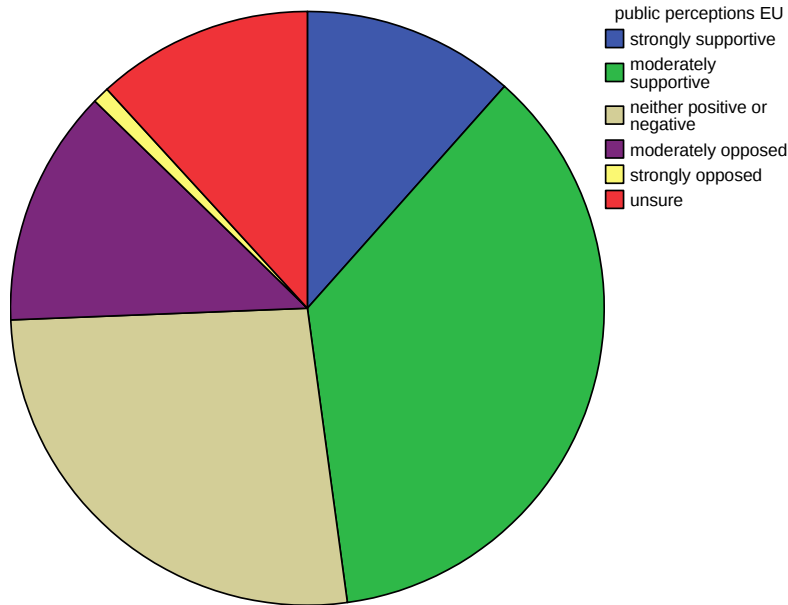


Figure 81: Respondents' opinion of public perceptions of CCS in the EU (question 21, part 2)

The respondents from Denmark, Germany, Netherlands, UK and Norway tend to give rather similar responses for the EU scale. The Danish respondents are slightly more sceptical that CCS will be supported by the public in the EU, and the British respondents are slightly more optimistic about public support for CCS in the EU, but none of the results are statistically significant.

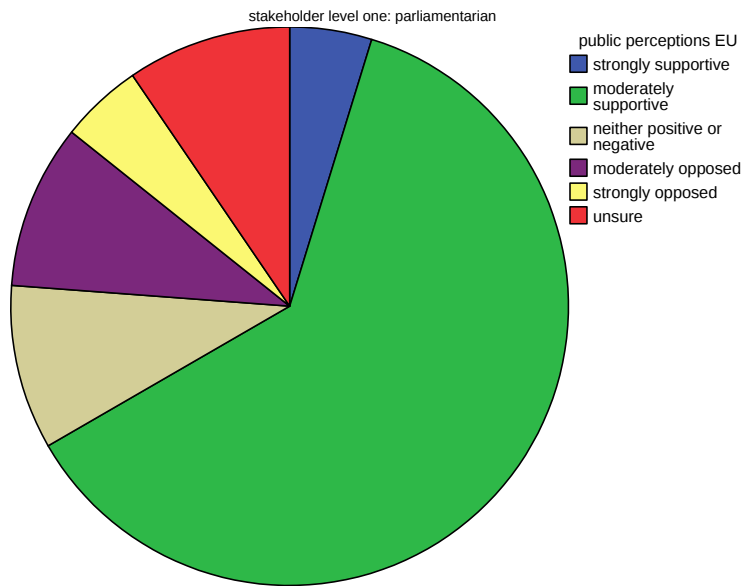


Figure 82: Parliamentarians' views on public perceptions of CCS in the EU (question 21, part 2)

Factors which will Influence Public Perceptions of CCS in Home Country (question 22)

It can be seen from figure 83 that there is rather little difference in opinion regarding which factors will influence public perceptions of CCS. The most significant factor is the 'views of major opinion formers', followed by the 'perceived urgency of responding to climate change'. When examined by country (figure 84), the differences are not striking. Norwegian respondents saw the local siting issues and (to a lesser extent) security of storage as less important, whereas the urgency of responding to climate change was regarded as more important, relative to other respondents. The impact upon electricity prices was slightly more important in the UK and Norway than in the other countries. Likewise, differences in the response of stakeholder groups are not striking (see figure 85). Slightly more parliamentary and NGO stakeholders consider that the views of major opinion formers are a key factor in influencing public opinion compared to the other stakeholder groups. Parliamentarians regarded local siting issues as slightly more important. In none of the cases, however, were differences statistically significant.

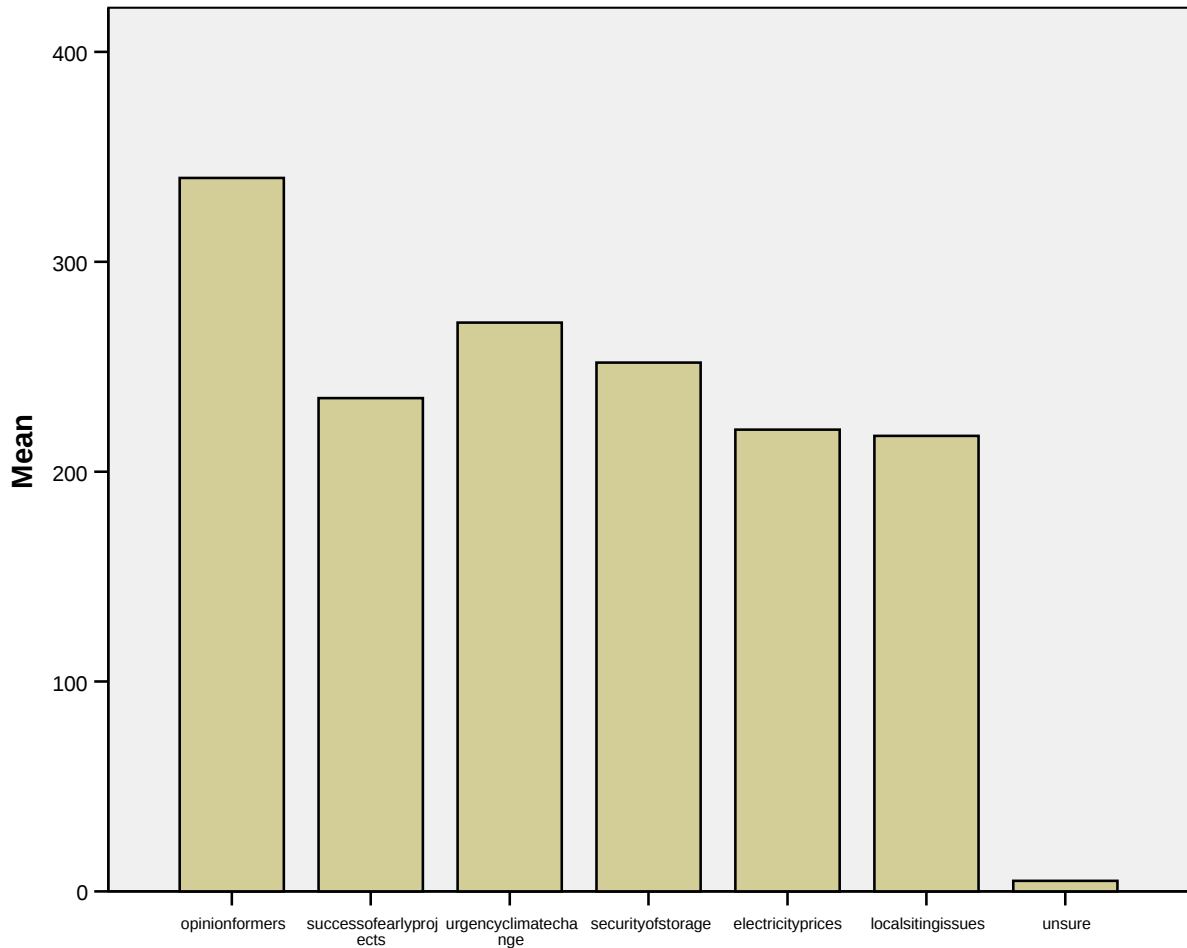


Figure 83: Respondent's perceptions of what factors are most likely to influence public perceptions regarding CCS in home country

opinionformers: the views of major opinion formers, e.g. the media, politicians and NGOs

successofearlyprojects: success or failure of early projects

urgencyclimatechange: the perceived urgency of responding to climate change

securityofstorage: evidence of the security of storage

electricityprices: impact on electricity prices

localsitingissues: local siting issues involving the public which lives close to CCS developments (infrastructure and storage sites)

unsure

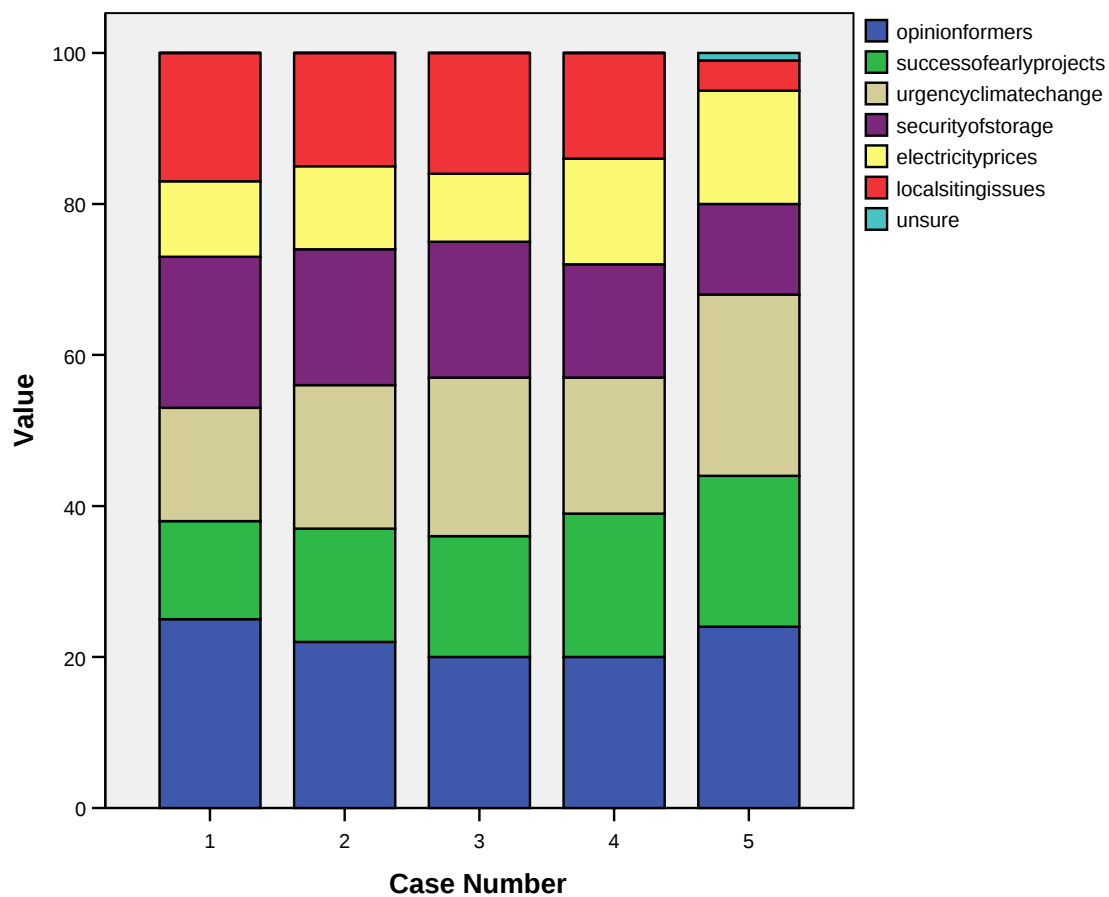


Figure 84: Respondent's perceptions of what factors are most likely to influence public perceptions regarding CCS in (1) Denmark, (2) Germany, (3) Netherlands, (4) UK, and (5) Norway shown as percentages

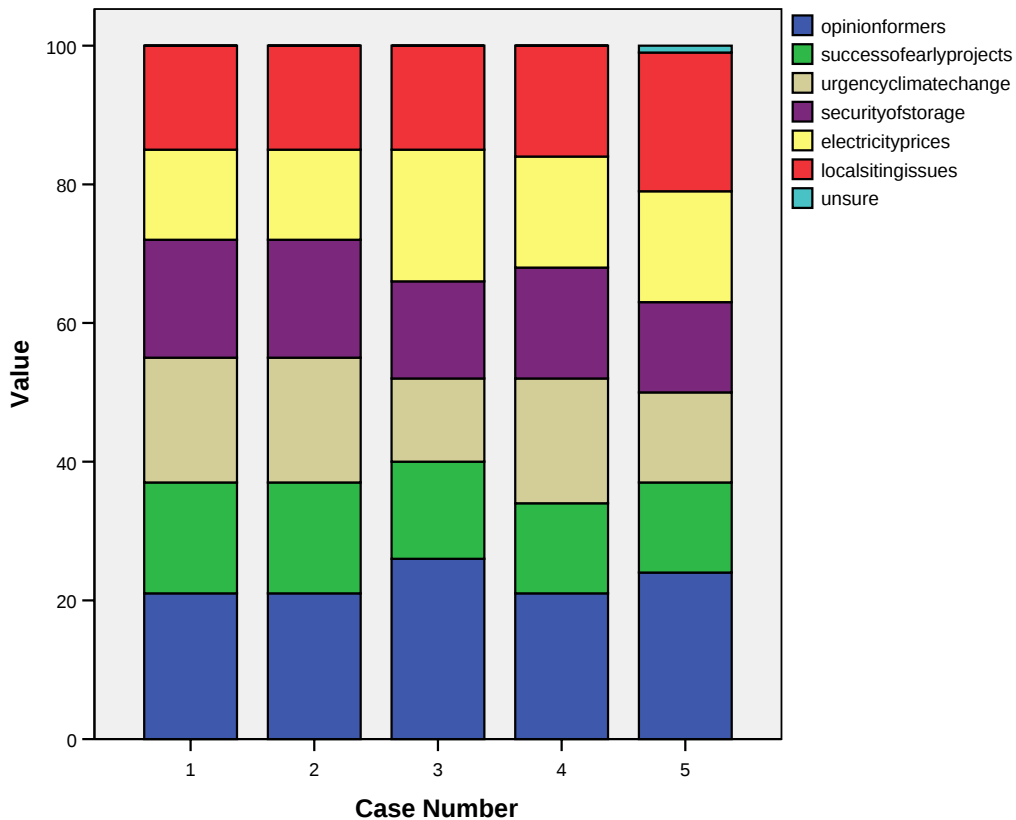


Figure 85: Different stakeholder perceptions of what factors are most likely to influence public perceptions regarding CCS: (1) energy industry, (2) government, (3) NGOs, (4) academics, and (5) parliamentarians shown as percentages

Correlations between Variables

Perceived Need for CCS (question 8)

The correlation between belief in the need for CCS in one's own country (question 8, part 1) and the role of CCS in the national climate change debate (question 9) is shown in Figure 86. Proportionally more respondents who identify CCS as being less necessary also tend to regard it as less important in the national climate change debate. Figure 87 shows the correlation between the role of CCS in the national climate change debate (question 9) and whether that role is increasing or decreasing. Those who believe that CCS has a more important role to play already also tend to see an increasing role for CCS in the national climate change debate. By contrast, those who do not see CCS as being such an important part of the debate do not tend to see its role much increasing. Finally, those who see CCS as more important nationally also tend to see its role as increasing in the national debate.

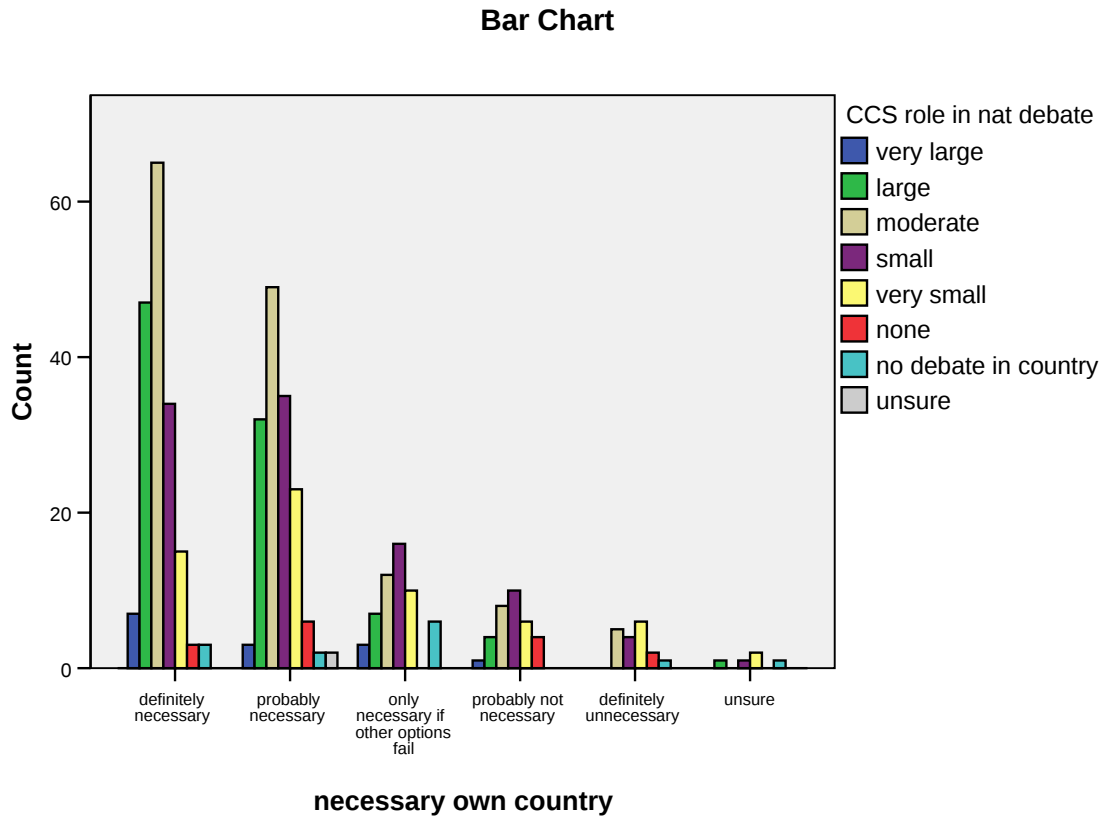


Figure 86: Correlation between the necessity of CCS in own country (question 8, part 1) and the role of CCS in the national climate change debate (question 9) (correlation 0.255, significant at p value of 0.01)

Enabling Context for CCS (question 11)

Figure 88 shows the correlation between the necessity of CCS in one's own country (question 8, part 1) and the importance of price of carbon under the EU Emissions trading scheme (EUETS) as an enabling factor (question 11, part 1). Those who believe that CCS is necessary also tend to see the price of carbon as an important or very important enabling factor. A similar pattern exists with respect to the correlation between necessity for CCS and the reduction in costs of CO₂ capture as an enabling factor and also with the importance of public perceptions (figures not shown). Figure 89 correlates necessity of CCS in own country with opportunities for CCS EOR. Here opinion is more spread and many who regard CCS as definitely or probably necessary do not necessarily regard EOR as an important enabling factor. Opinion is even more mixed with regards to the importance of domestic supplies of coal as an enabling factor for CCS (figure 90). Many who support CCS do not regard domestic supplies of coal as being an important enabling factor at all. Respondents who regard CCS as being probably not necessary or only necessary if other

options do not deliver, may still believe that establishment of a legal and regulatory framework for CCS is important / very important (figure 91).

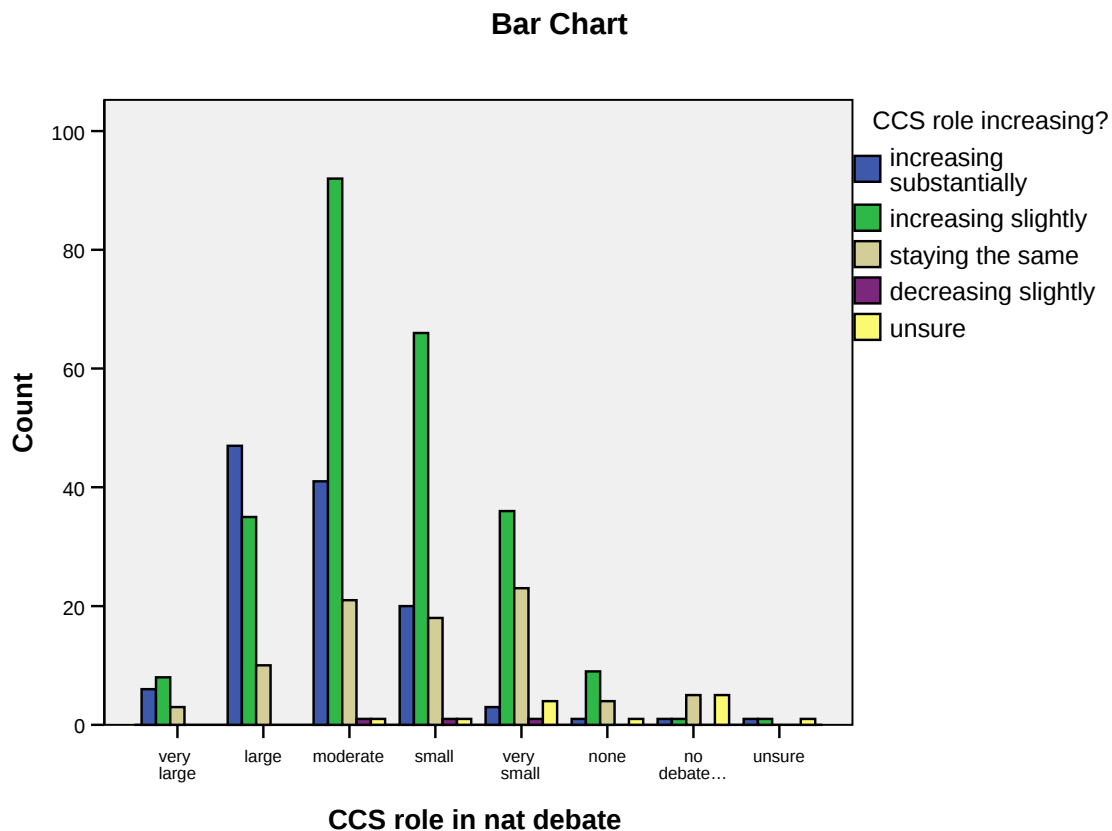


Figure 87: Correlation between the role of CCS in the national climate change debate (question 9) and the changing role of CCS in the national climate change debate (question 10) (correlation 0.322, significant at p value of 0.01)

Financial Incentives for CCS (question 13)

Correlation between organisational position on CCS (question 6) and the need for incentives (question 12) is shown in Figure 92. It can be seen that most people from an organization which strongly supports CCS believe that incentives should be set an equivalent level as for renewables, though there is a substantial fraction which considers that incentives should be lower. Those from organizations which are slightly positive are more in favour of incentives set a lower level than for renewables. An essentially similar pattern is witnessed if the correction is made between the perceived need for CCS in own county (question 8, part 1) and incentives (Figure 93). In this case, it is noticeable that those who are least convinced of the need for CCS also do not see the case for giving CCS any incentives. In general, therefore, there is a reasonably clear correlation between support for CCS and incentives that are at least at an equivalent level to renewables.

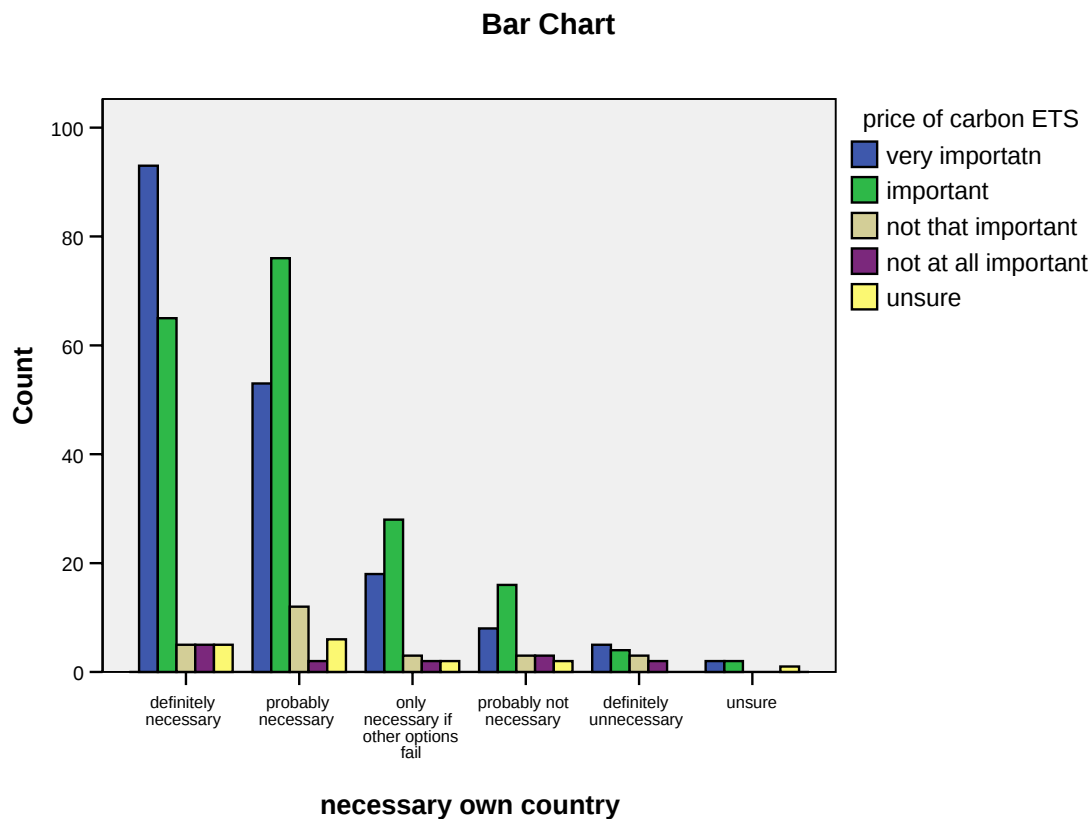


Figure 88: Correlation between the necessity of CCS in own country (question 8, part 1) and the importance of price of carbon under the EU Emissions trading scheme (EUETS) as an enabling factor (question 11, part 1) (correlation 0.220, significant at p value of 0.01)

Figures 94-99 correlate the necessity of CCS in own country with a range of possible incentive mechanisms for CCS. It can be seen that there is a strong correlation between necessity of CCS and support for RD&D and for early extension and tightening of the EU Emissions Trading Scheme. The majority response from those respondents who were somewhat more skeptical of CCS ('only necessary if other options fail', 'probably not necessary' and even 'definitely unnecessary') was in favour of support for RD&D on CCS and on extending the EU ETS (figures 98 and 99). Clearly the EU ETS benefits many other zero- and low-carbon technologies in addition to CCS, so could well be supported by CCS skeptics. It is interesting to note that skepticism regarding the role of CCS does not preclude support for RD&D. The most mixed (least correlated) response was for a guaranteed feed-in price for CCS electricity, where there was quite a lot of opposition from those who were CCS supporters (figure 96). The proposition of an economy-wide carbon tax was *not* correlated with perceived need for CCS in own country, the only one of the incentive mechanisms which was not positively correlated. A carbon tax was not popular with many CCS supporters, whilst it did attract support from many of those more sceptical about CCS,

no doubt because of its other perceived benefits in moving away from carbon-intensive energy consumption (figure 97). A requirement for CCS electricity was also controversial with CCS

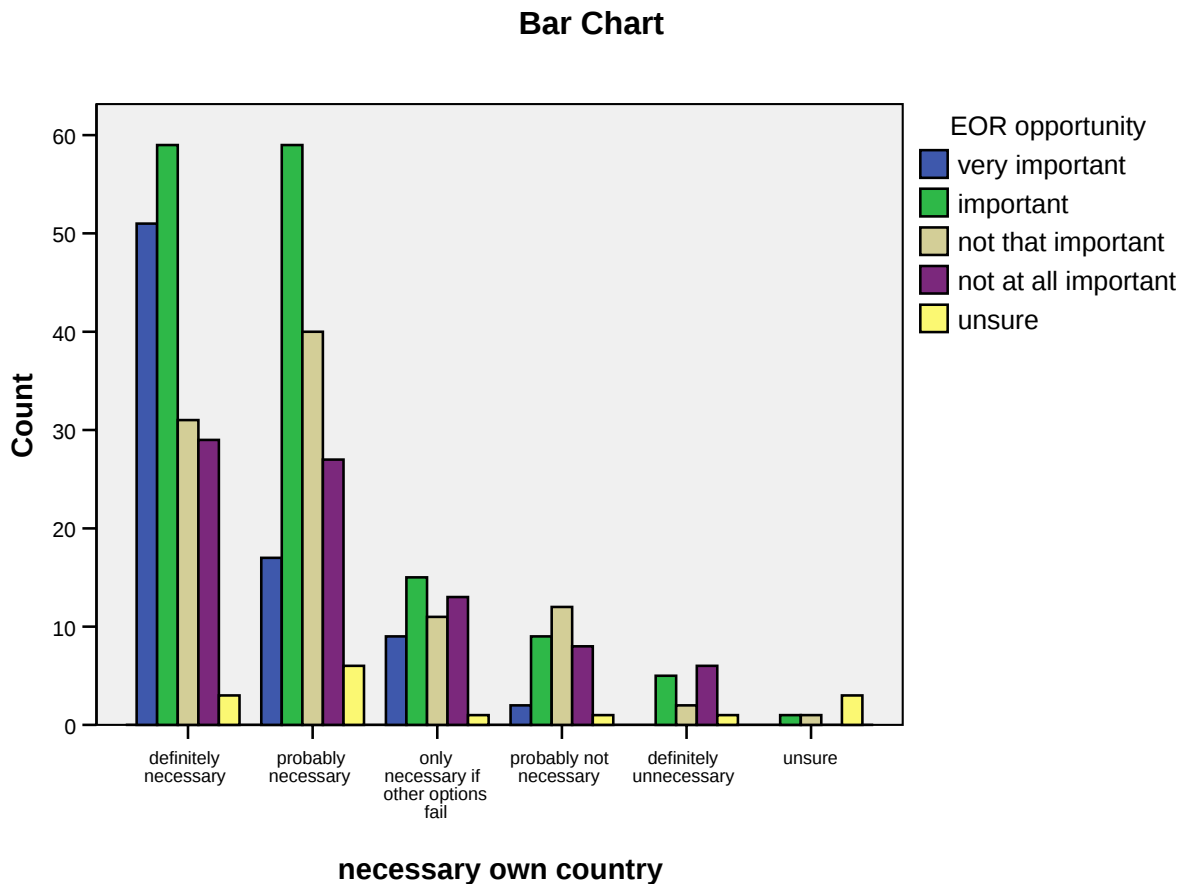


Figure 89: Correlation between the necessity of CCS in own country (question 8, part 1) and opportunities for enhanced oil or gas recovery with CO₂ (question 11, part 5) (correlation 0.212, significant at p value of 0.01)

supporters though generally disliked by CCS skeptics, presumably because it would by definition guarantee a role for CCS (figure 94). More strongly correlated was the proposed requirement for zero- or low-carbon electricity, without specifying the source (figure 95), which would act as an incentive for other technologies apart from CCS (renewables, etc.).

Regulation (question 15)

Both CCS supporters and CCS skeptics tend to support the same regulatory mechanisms, namely an international sets of standards or an EU wide-standardisation of rules with national implementation (figure 100).

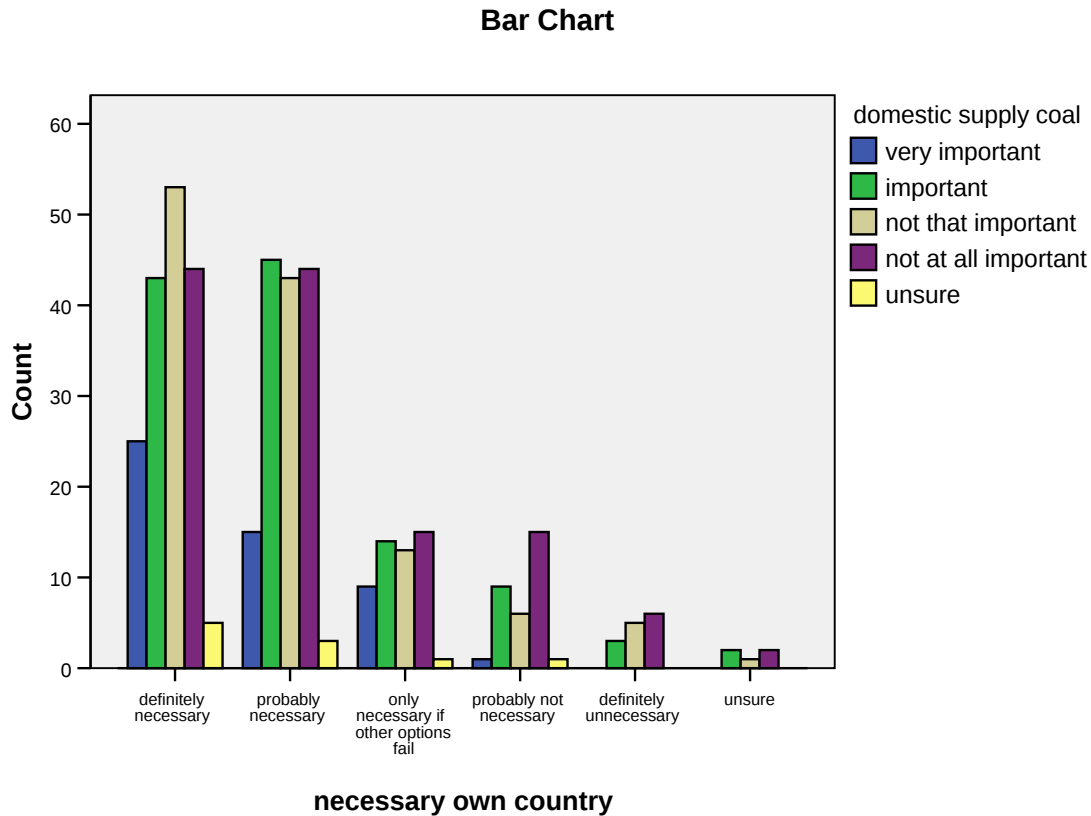


Figure 90: Correlation between the necessity of CCS in own country (question 8, part 1) and availability of domestic supplies of coal (question 11, part 9) (correlation 0.106, significant at p value of 0.05)

The Potential Risks of CCS (question 16)

Figures 101-104 show the correlation between the perceived necessity of CCS in the respondents' own country and perceptions of the potential risks of CCS. Figure 101 shows that CCS supporters tend not to regard the risks of global climate impacts arising from CO₂ leakage as being large, most frequently characterizing these risks as minimal or no risk. (Hence the two variables are negatively correlated). By contrast those some what more skeptical of CCS are more likely to characterize the risks as very serious or moderately serious. For example, a majority of respondents who regarded CCS as 'definitely unnecessary' thought that the climate risks arising from CO₂ leakage were 'very serious'. A similar pattern emerges in evaluation of the risks of additional fossil fuel extraction arising from the CCS energy penalty (figure 102). An essentially similar pattern also occurs with respect to the health and safety and environmental risks arising from onshore and offshore CO₂ storage site leakage (figures 103 & 104).

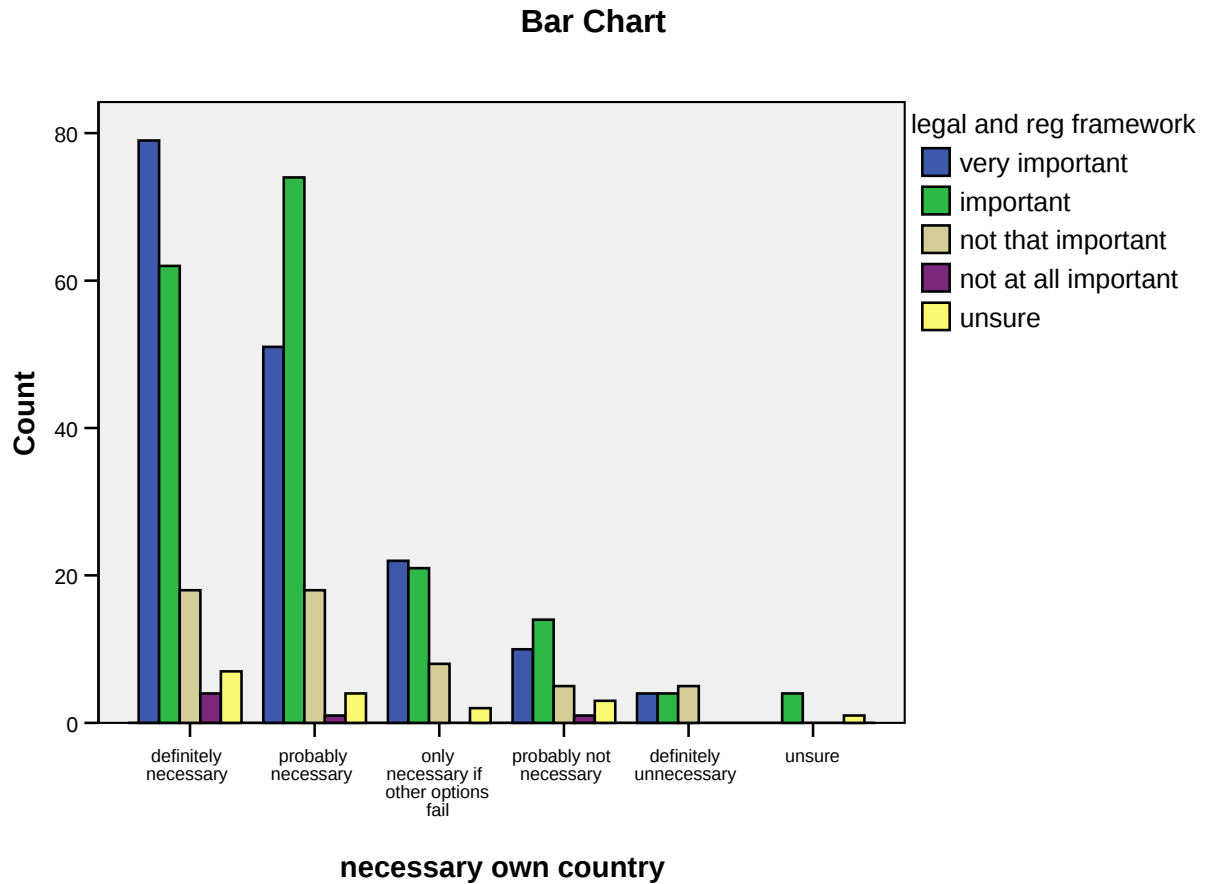


Figure 91: Correlation between the necessity of CCS in own country (question 8, part 1) and development of a legal and regulatory basis for CCS (question 11, part 17) (correlation 0.112, significant at p value of 0.05)

The Effects of CCS Investment upon Investment in Other Zero- and Low-Carbon Energy Technologies and upon Investment in Energy Efficiency and Demand Reduction (questions 17 and 18)

CCS supporters tend to regard CCS investment as having ‘no effect’ or a ‘minor negative impact’ upon investment in other zero- and low-carbon energy technologies (figure 105). The strongest supporters for CCS (‘definitely necessary’) tend not to regard investment in CCS as deterring investment in other low-carbon technologies, whilst moderate CCS supporters (‘moderately necessary’) and those more skeptical (‘only necessary if ...’, ‘probably not necessary’) perceive there to be more significant negative impacts. For example, for respondents who responded ‘only necessary if other options fail’ and ‘definitely unnecessary’ the ‘significant negative impact’ of CCS investment upon other low-carbon technologies was the most frequent response (figure 105).

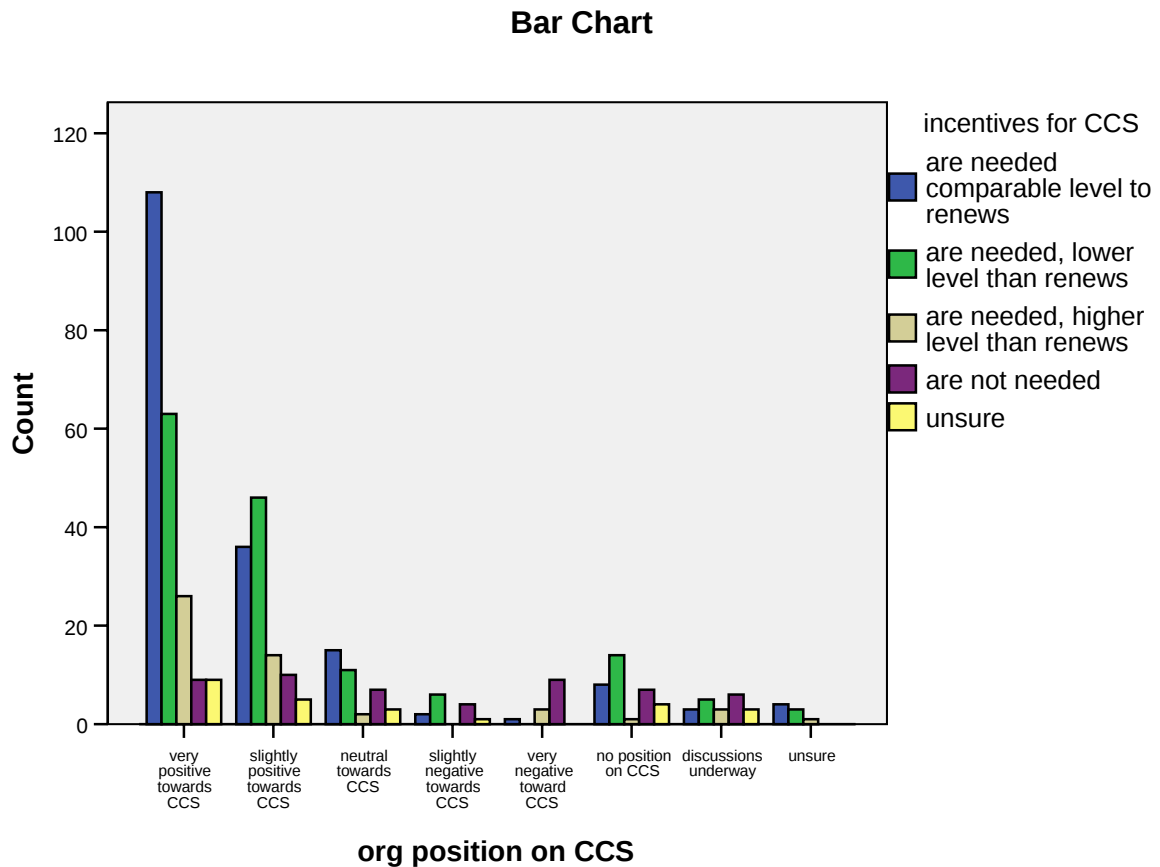


Figure 92: Correlation between organizational position on CCS (question 6) and opinion on the need for incentives for CCS (question 12) (correlation 0.302, significant at p value of 0.01)

A generally similar pattern was obtained regarding the impact of investment in CCS upon investment in energy efficiency and energy demand reduction measures (figure 106). The main difference is that a larger proportion of respondents perceived there to be benefits for energy efficiency / demand reduction arising from investment in CCS, with the exception of respondents who regarded CCS as ‘definitely unnecessary’. Those more skeptical of CCS (‘only necessary if’, ‘definitely unnecessary’) were again more likely to perceive there to be negative impacts associated with investment in CCS upon investment in energy efficiency and demand reduction (‘significant negative impact’ being the most frequent response). There is a reasonable degree of consensus amongst supporters of CCS (‘definitely necessary’, ‘probably necessary’) regarding the impacts of CCS upon investment in other low- and zero-carbon energy technologies, whilst there is more disagreement within these groups regarding the impacts of CCS upon energy efficiency and demand reduction. Hence, there is a negative correlation in the cases of both impacts upon investment in other zero- and low-carbon energy options and investment in energy efficiency / energy demand reduction.

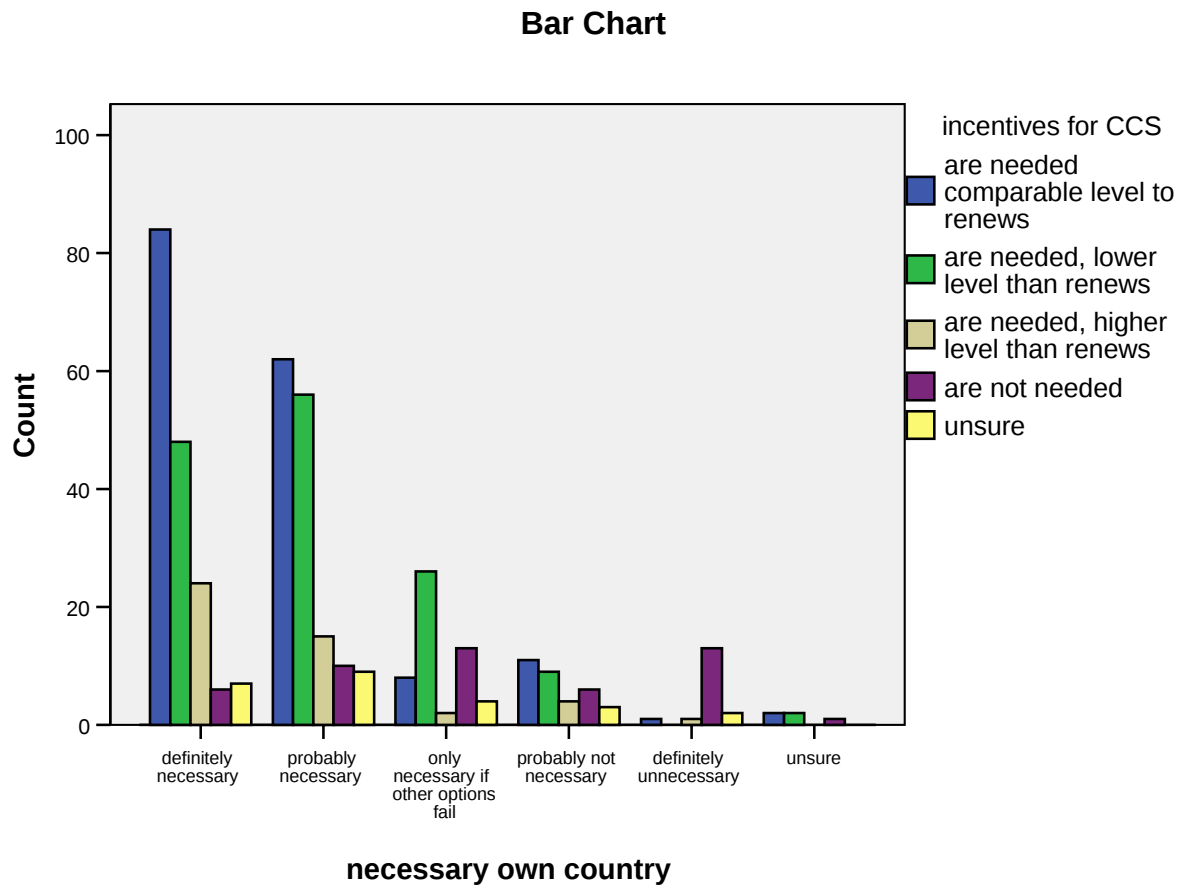


Figure 93: Correlation between perceived need for CCS in own country (question 8, part 1) and opinion on the need for incentives for CCS (question 12) (correlation 0.348, significant at p value of 0.01)

Impact of CCS upon moves towards Decentralised Power Generation Systems (question 19)

Opinion is fairly mixed regarding the impact of CCS upon decentralization across the supporters and sceptics of CCS (i.e. moderate level of negative correlation). A 'slightly negative impact' arising from CCS upon moves towards decentralization was the most frequent response for those who regarded CCS as 'definitely necessary', 'probably necessary', 'only necessary if' and 'probably not necessary'. Those who regarded CCS as 'definitely unnecessary' responded overwhelmingly that CCS would have a 'very negative impact' upon moves towards decentralization. There is a reasonable degree of consensus amongst supporters of CCS regarding the impacts of CCS upon decentralization.

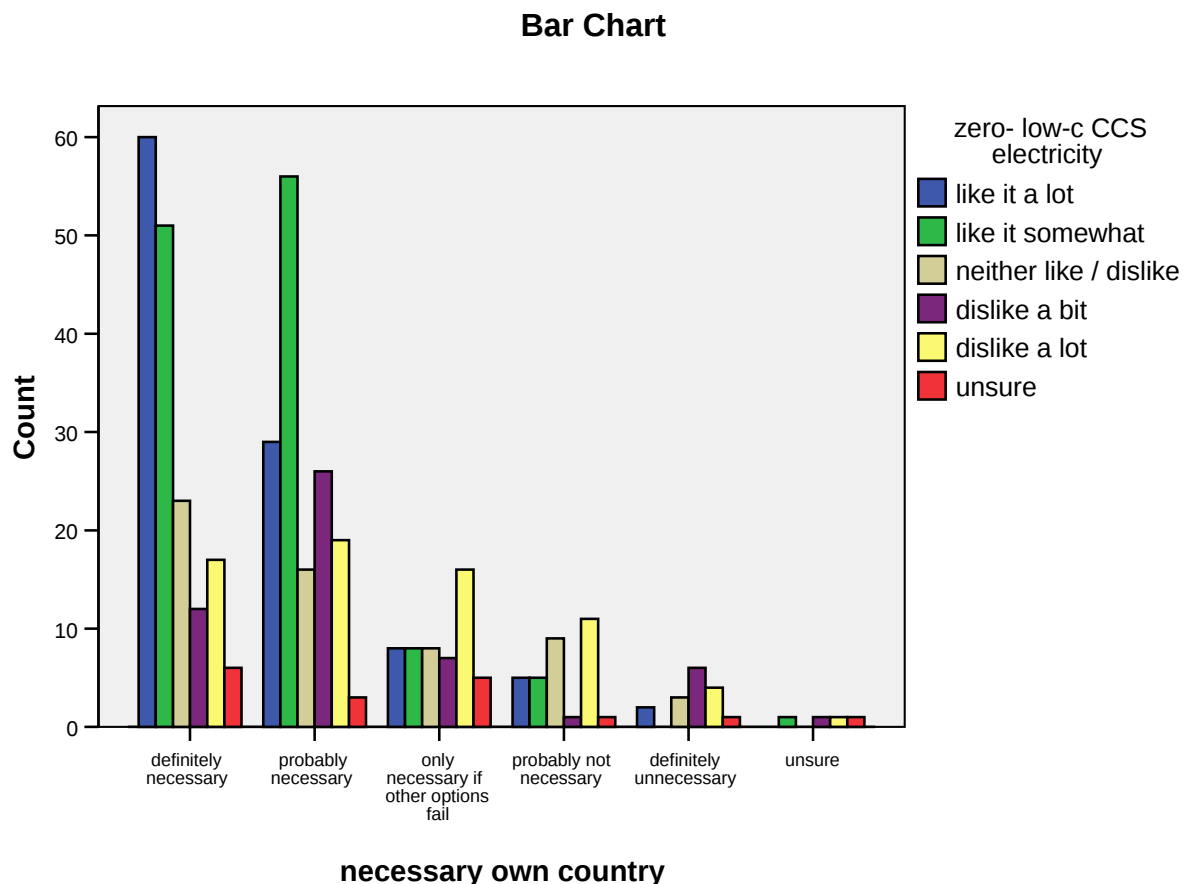


Figure 94: Correlation between perceived need for CCS in own country (question 8, part 1) and a requirement for electricity generators to supply a given % of zero- or low-carbon electricity through use of CCS as an incentive mechanism (question 13, part 1) (correlation 0.297, significant at p value of 0.01)

The Impact of CCS Development upon Energy Security in the EU (question 20)

Figure 108 shows the correlation between the perceived need for CCS in own country (question 8, part 1) and the effects upon energy security in the EU arising from use of CCS with coal (question 20, part 1). It can be seen that amongst supporters of CCS, it is generally regarded that CCS with coal will have no impact on energy security or will actually improve energy security. Only amongst those most opposed to CCS ('definitely unnecessary') is the perception that use of CCS (coal) will decrease energy security the most frequent response.

In the case of CCS with gas (question 20, part 2) (figure 109), opinion is more mixed amongst both advocates and sceptics of CCS. Hence, for those respondents who consider that CCS is 'definitely' or 'probably necessary', there are nearly equal numbers of respondents for the view that CCS (gas) will reduce energy security or will have no impact. For those more skeptical of CCS ('only necessary if', 'probably not necessary', 'definitely

unnecessary’) the most frequent response is that CCS (gas) will reduce energy security in the EU, though there is a range of other responses. In summary, whilst there is a reasonable consensus amongst CCS advocates that CCS with coal will have no impact upon energy security in the EU, there is much less agreement amongst CCS advocates regarding the impact of CCS with gas upon energy security (both variables are negatively correlated with perceived need for CCS). Meanwhile there is less consensus from CCS sceptics concerning the impact of CCS with coal upon energy security in the EU, whilst there is a reasonable consensus amongst CCS sceptics that CCS with gas will decrease energy security in the EU.

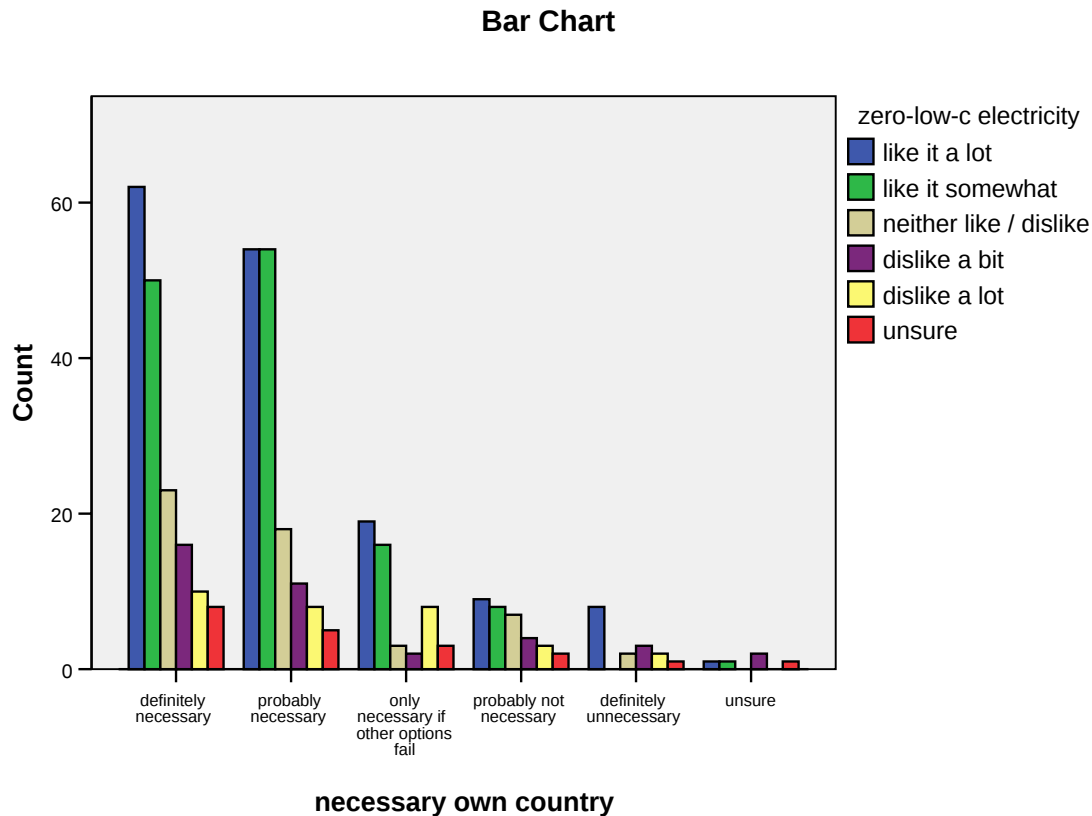


Figure 95: Correlation between perceived need for CCS in own country (question 8, part 1) and a requirement for electricity generators to supply a given % of zero- or low-carbon electricity (all sources) as an incentive mechanism (question 13, part 2) (correlation 0.297, significant at p value of 0.01)

The Perceived Public Acceptability of CCS (question 21)

Figure 110 shows the correlation between perceived need for CCS in own country (question 8, part 1) and perceived public perceptions of CCS in own country (question 21, part 1). Amongst advocates of CCS (‘definitely’, ‘probably necessary’) the most frequent response is that the public will be ‘moderately supportive’, though a substantial proportion of respondents also believe that opinion will be neither positive or negative or (to a lesser

extent) moderately opposed. Amongst CCS skeptics, there is a more mixed response and it is more commonly regarded that public opinion will be some what negative or ‘neither positive or negative’. The two variables are positively correlated.

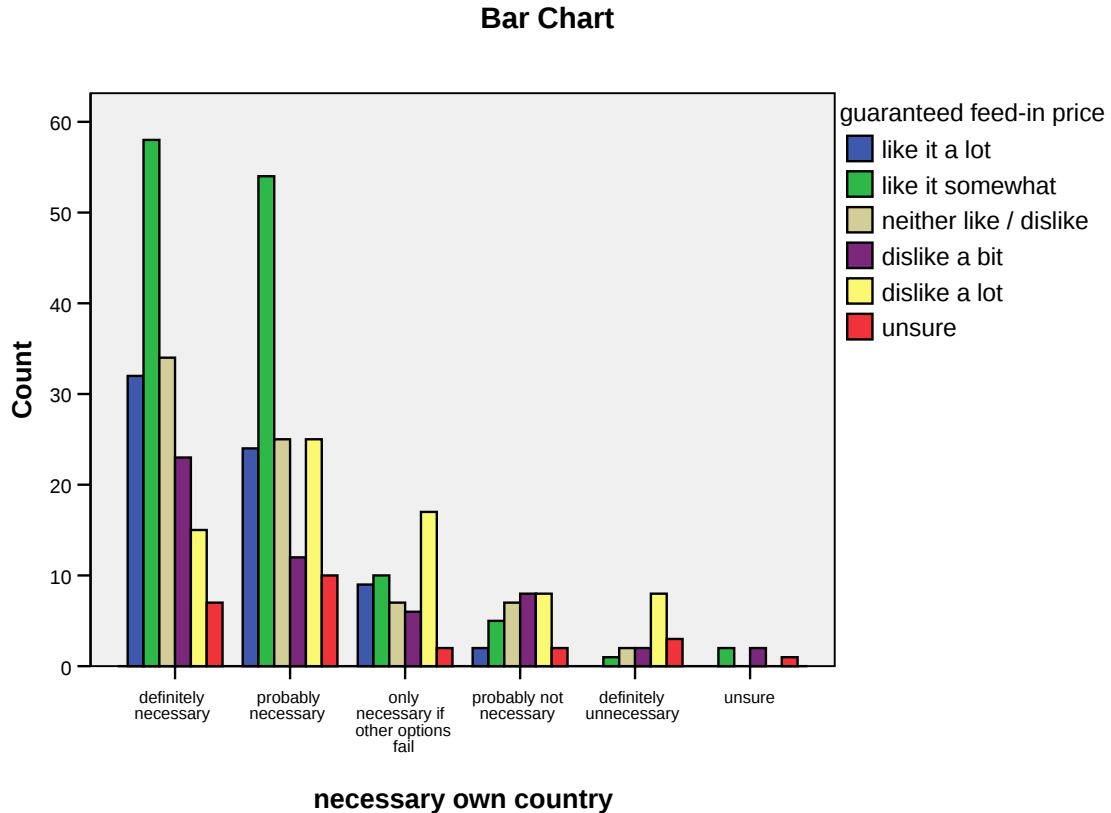


Figure 96: Correlation between perceived need for CCS in own country (question 8, part 1) and a guaranteed feed-in price as an incentive mechanism (question 13, part 3) (correlation 0.290, significant at p value of 0.01)

Correlations with Work Time Spent on Energy and on CCS Specifically

Figure 111 is a correlation between work time spent on energy (question 4) and the necessity of CCS in own country (question 8, part 1). It can be seen that those respondents who spent 90-100% of their time on energy (by far the majority) also tend to regard CCS as more necessary than those respondents who spend less than 90% of their work time on energy issues. However, irrespective of the percentage of time spent on energy there is a majority of respondents who consider that CCS is ‘probably’ or ‘definitely necessary’. Therefore it does not appear to be the case that the amount of work time spent on energy issues has a large impact upon the perceived necessity for CCS in own country. The two variables are not significantly correlated. In the case of work time spent on energy and necessity of CCS at the global scale (question 8, part 3) (figure 112), there is a moderate positive correlation. This

may reflect the general tendency for respondents to regard CCS as more important at the global scale than within their own country.

Turning to the correlation between work time spent specifically on CCS (question 4) and the perceived necessity of CCS in own country (question 8, part 1) (figure 113), there is a moderate positive correlation. The most common response of those working more than 30% of their time on CCS is that CCS is 'definitely necessary', whilst for those working less than 30% of their time on CCS, 'probably necessary' is the most frequent response. Hence those working less on CCS are some what less inclined to see CCS as definitely necessary. Furthermore, the proportion of respondents who consider that CCS is 'probably not necessary' grows as the respondent spends less time working on CCS. This relationship makes sense since one would expect those working more on CCS to have a some what more favourable opinion on the necessity of CCS in their own country.

Analysis of some of the correlations between work time spent on CCS and other variables indicates that there is a possible difference in response from those respondents who spend less than 50% of their time on CCS and those who spend over 50% of time on CCS. To explore this further, we split the respondents into those who work less than 50% time on CCS and those who work more than 50% time on CCS. We then re-ran the correlations with each of these two groups. When this was done with respect to perceived need for CCS in own country, it was found that there was no significant correlation with work time on CCS for that part of the sample which worked over 50% of time on CCS (-0.016, not significant). On the other hand, the correlation was significant for those working under 50% of time on CCS (0.318, significant at p value of 0.01). Hence, those spending a majority of their time on CCS do not perceive a greater need for CCS in their own country depending on the amount of work time spent on CCS. This negates the idea that as the respondents spend more work time on CCS they will tend to become more favourably inclined towards CCS as necessary in their own country. On the other hand, this is the case for that portion of respondents who spend less than 50% of time on CCS. I.e. for those less involved in CCS (meaning less than 50% of work time devoted to CCS), there is a tendency for greater involvement with CCS to correlate with greater support for CCS in their own country.

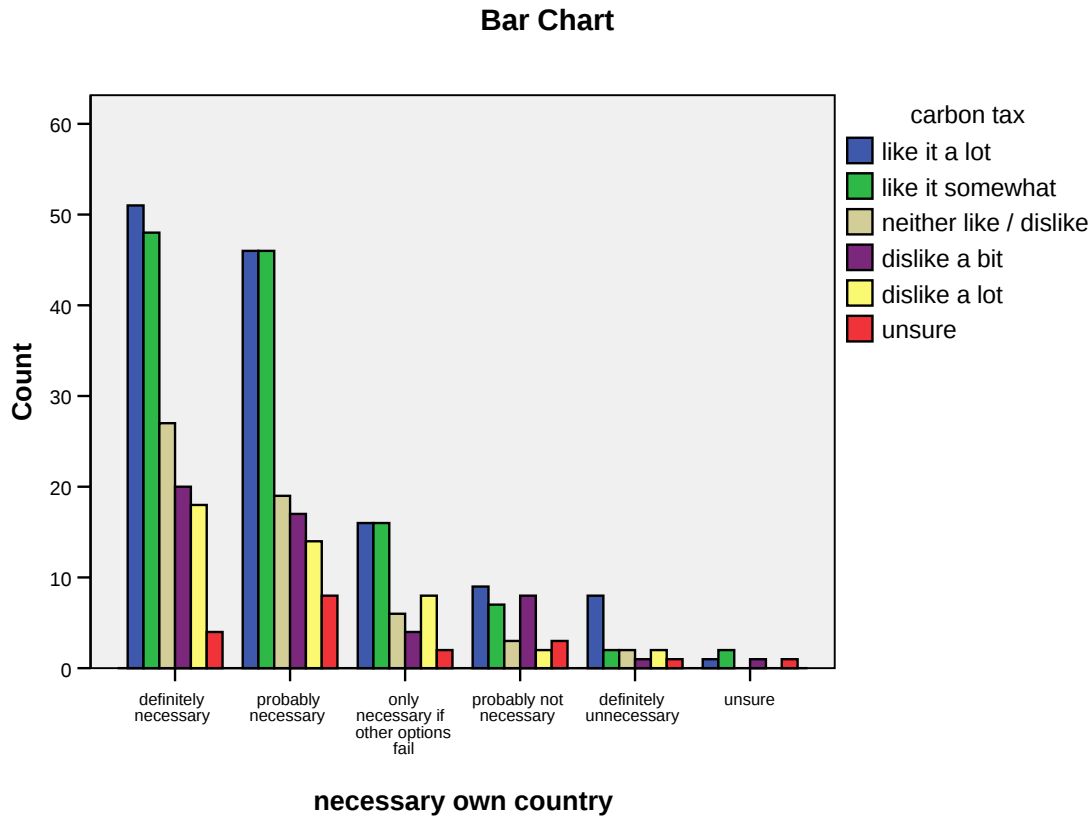


Figure 97: Correlation between perceived need for CCS in own country (question 8, part 1) and an economy-wide carbon tax as an incentive mechanism (question 13, part 6) (correlation -0.01, not significant)

Hence, the proportion of respondents who consider that CCS is only necessary if other options fail to live up to expectations increases with reduction in time spent on CCS as follows: 3% (30-50% time spent on CCS), to 12% (10-30% time) to 24% (less than 10% time). Likewise for those who regard CCS as ‘probably not necessary’: 3% (30-50% time spent on CCS), to 7% (10-30% time) to 13% (less than 10% time); and for those who regard CCS as ‘definitely unnecessary’: 3% (30-50% time spent on CCS), to 7% (10-30% time) to 7% (less than 10% time).

A somewhat different pattern is observed with respect to the correlation between work time spent on CCS and the necessity for CCS globally (figure 114), though there is a similar level of moderate positive correlation. In this case, the most frequent response irrespective of time spent on CCS is that CCS is ‘definitely necessary’. The proportion of respondents who regard CCS as ‘probably necessary’, ‘only necessary if other options fail’ and ‘probably not necessary’ all increase as we go from 30-50% of work time on CCS to 10-30% and less than 10%. In summary, it appears that perception of the necessity or otherwise of CCS is moderately correlated with the amount of work time spent on CCS. Splitting the respondents into ‘over 50% time on CCS’ and ‘under 50% time on CCS’ groups, it was

found that there was no significant correlation with the ‘over 50%’ group (0.078), but that it was significant for the ‘under 50%’ group (0.318, significant at p value of 0.01).

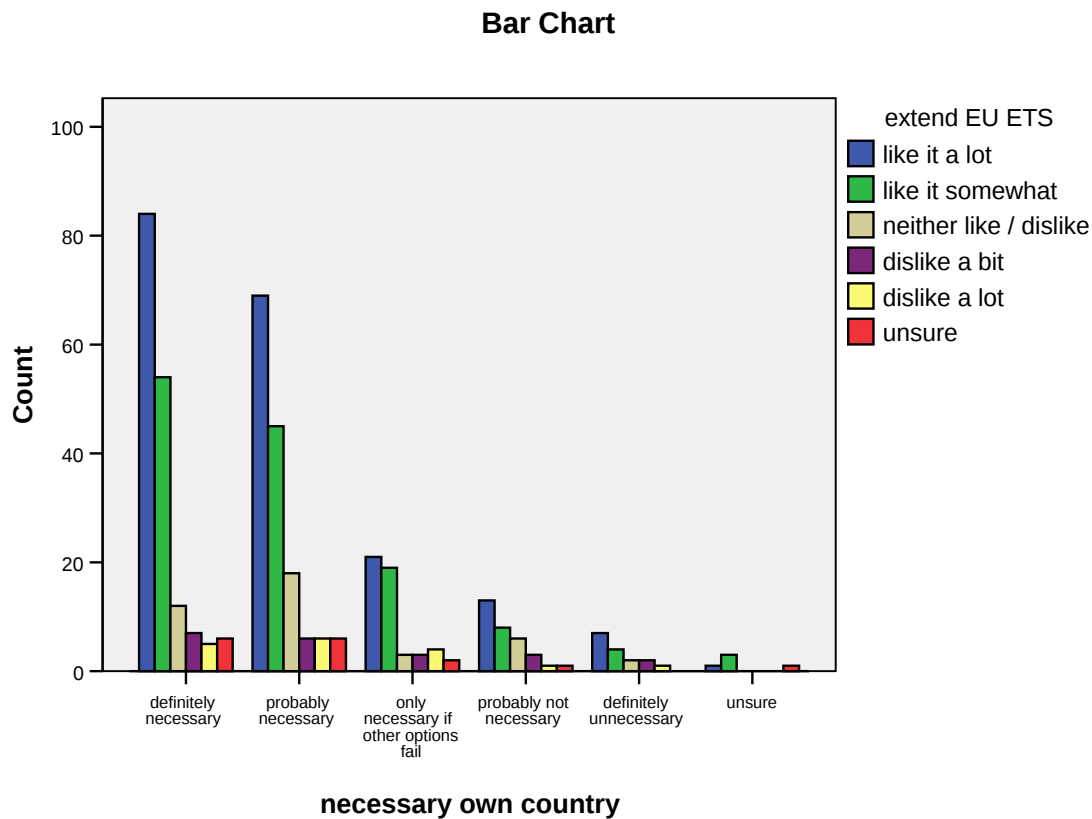


Figure 98: Correlation between perceived need for CCS in own country (question 8, part 1) and an early commitment to extend the EU Emissions Trading Scheme beyond 2012 with tighter emission caps as an incentive mechanism (question 13, part six) (correlation 0.112, significant at p value of 0.05)

Correlation between work spent on energy and the provision of incentives for CCS is shown in Figure 115. In this case there is *no* significant correlation between the two variables. It can be seen that opinion on incentives is reasonably mixed across those who spend different proportions of their time on energy. In terms of their preferences for financial incentives for CCS there is not a large difference in the proportions of respondents working predominantly (90-100% of their time) on energy compared to respondents working 10-30% of their time on energy, as shown in table 45. Therefore there does not seem to be any clear relationship in preference for incentives and working in the energy industry. Does such a relationship hold for those working specifically on CCS however?

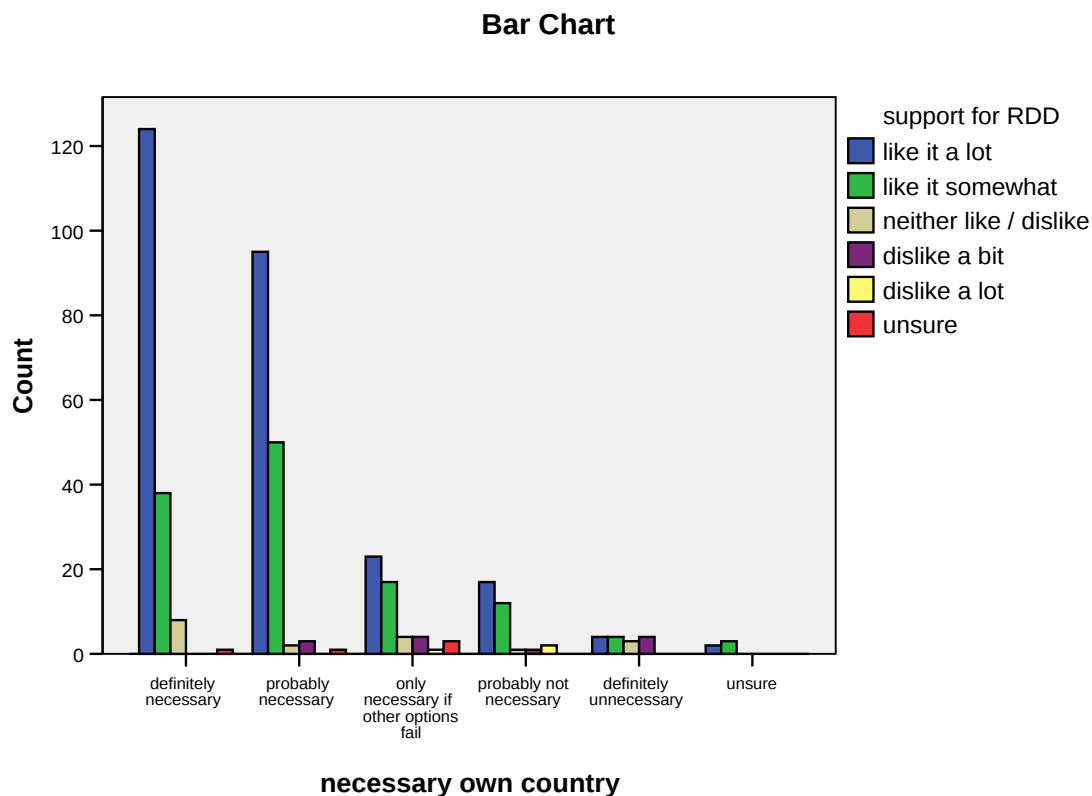


Figure 99: Correlation between perceived need for CCS in own country (question 8, part 1) and support for Research, Development and Demonstration projects as an incentive mechanism (question 13, part six) (correlation 0.311, significant at p value of 0.01)

Figure 116 shows the relationship between preference for financial incentives for CCS and the amount of work time spent on CCS. As can be seen, there is again a fairly mixed response and a weak positive correlation between the two variables. Table 46 shows the proportions of respondents for the six work time categories (90-100%, 70-90%, 50-70%, 30-50% 10-30% and less than 10%). There is some tendency for an increase in the frequency of 'not needed' response when work time spent on CCS is below 50% and there is in addition a slight decrease in frequency for the setting incentives at a comparable level to that for renewables response for this group. There is no significant correlation between the 'over 50%' work time on CCS and provision of incentives variable (-0.072), but there is between the 'under 50%' work time on CCS (0.123, significant at p value of 0.05) and provision of incentives. Hence those most involved in CCS work do not tend to favour generous incentives for CCS proportionate to their work time on CCS, whereas those who are less intimately involved in CCS do tend to support generous incentives more in proportion to their work time on CCS.

Hence, it is only partially correct to state that those respondents who spend more time working on CCS perceive the need for more generous financial incentives for CCS. I.e. the

CCS ‘community’ has not responded in a way that would be expected were they to respond solely out of self-interest. That part of the CCS community most closely involved in CCS appears to be rather ‘neutral’, and this may reflect their greater knowledge of the challenges that face CCS and uncertainties which need to be addressed before it could be implemented on a large scale.

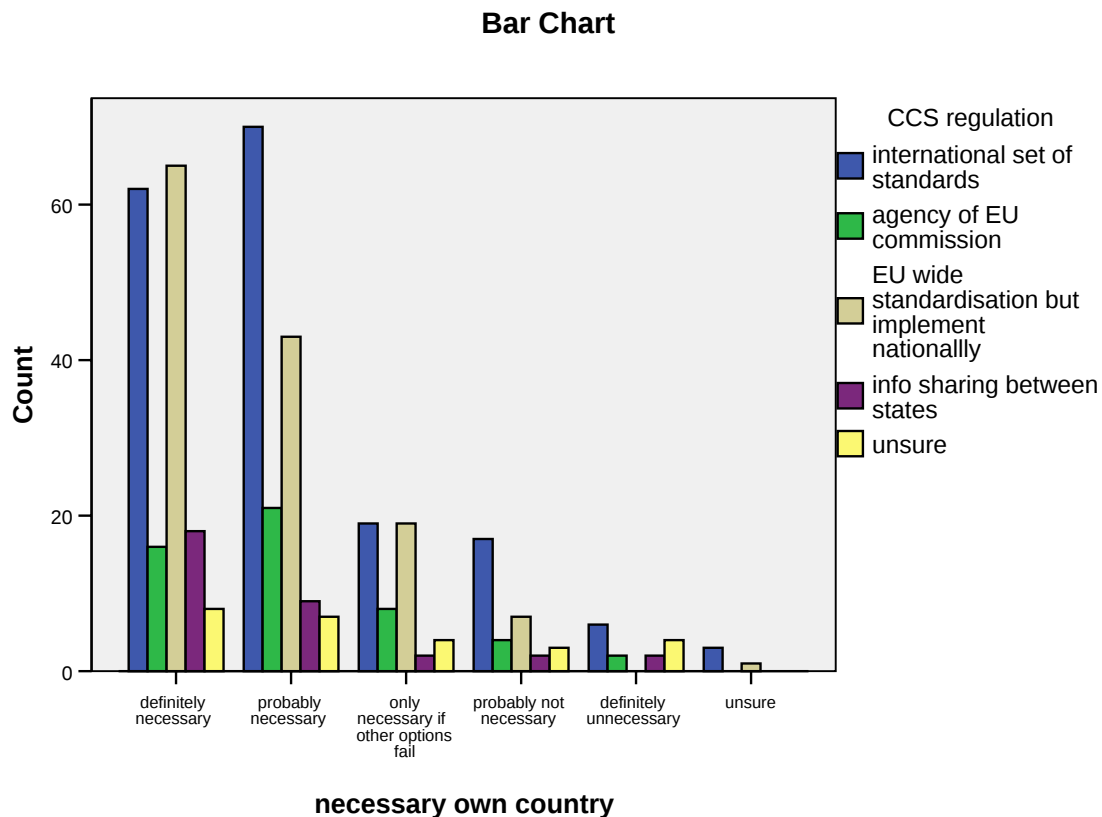


Figure 100: Correlation between perceived need for CCS in own country (question 8, part 1) and the mechanism by which CCS should be regulated (question 15)

Turning to the question of incentive mechanisms, figure 117 shows the correlation between the work time spent on energy and the requirement for generation of zero- or low-carbon electricity from CCS. There is no significant correlation (-0.085), i.e. those who spend more of their time working on energy do not have a markedly stronger or weaker preference for this particular incentive mechanism. If advocates of CCS were motivated primarily to promote CCS, then one would expect them to express a strong preference for an incentive mechanism such as the requirement for CCS generation or a feed-in mechanism geared specifically at CCS. Figure 118, which correlates a requirement for zero- or low-carbon electricity from CCS with work time spent on CCS, suggests that those most involved in CCS do not disproportionately support this incentive mechanism (0.070, no significant correlation).

A similar pattern is shown in the correlation of work time on energy and guaranteed feed-in price for CCS (figure 119) (-0.085, not significant) and work time on CCS and guaranteed feed-in price (figure 120) (-0.070, not significant). There is no clear correlation between work time on either energy or CCS and support for a guaranteed feed-in price. The hypothesis that those most involved in CCS will act in a self-interested fashion to promote the incentivisation of the technology does not appear to be supported. If the test is repeated with the 'over 50%' and 'under 50%' time on CCS groups, it is found that there is a weak correlation (0.133, significant at p value of 0.05) between support for a CCS electricity generation requirement (question 13, part 1) and work time on CCS for the 'under 50%' group, but not for the '50% group'. There was no significant correlation for either group with respect to a guaranteed feed-in price mechanism (question 13, part 3), probably reflecting the relative unpopularity of this policy option.

Bar Chart

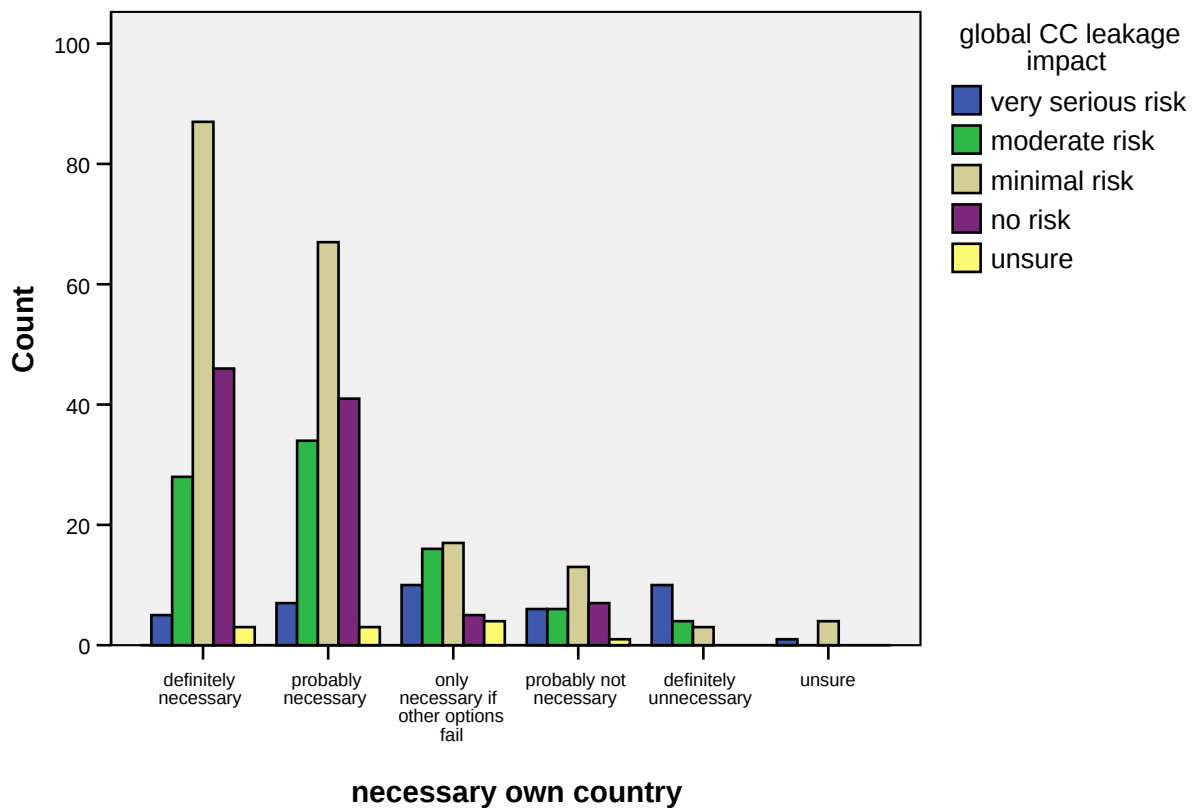


Figure 101: Correlation between perceived need for CCS in own country (question 8, part 1) and global climate impacts from CO₂ storage site leakage (question 16, part 9) (correlation -0.311, significant at p value of 0.01)

Figure 121 shows the correlation between time spent on energy (question 4) and the risks arising from additional fossil fuel extraction due to the energy penalty associated with CCS (question 16, part 1). There is a weak negative correlation (-0.128, significant at p value of 0.01), i.e. a weak tendency for those who spend more work time on energy to regard the potential risks as lower. When the same correlation is performed but this time with work time on CCS (figure 122) there is again a weak negative correlation (-0.203, significant at p value of 0.01). However, it is interesting to observe that in the case of those respondents working less than 50% of their time on CCS, there is an increase in the proportion of respondents who regard this as a 'very serious risk'. Hence, whilst those most involved in CCS do not appear to discount the risks of additional fossil fuel extraction compared to the sample as a whole, those least involved in CCS do regard this risk as more serious than does the average respondent. Although there is no significant correlation between the 'over 50%' work time on CCS group and the perception of risk (-0.067), there is for the 'over 50%' CCS work time group (-0.188, significant at p value of 0.01).

A similar pattern emerges with respect to the global environmental risks arising from the leakage of CO₂ from storage site (figures 123 & 124). Both % work time on energy and % work time on CCS weakly correlate negatively with potential risks for climate change arising from CO₂ leakage (-0.123 and -0.214, both significant at p value of 0.01). For those working less than 50% of their time on CCS, the frequency of the 'moderate' and 'very serious risk' responses increases. This is a significant correlation (-0.140, significant at p value of 0.05) (no significant correlation with respect to the 'over 50%' work time on CCS group).

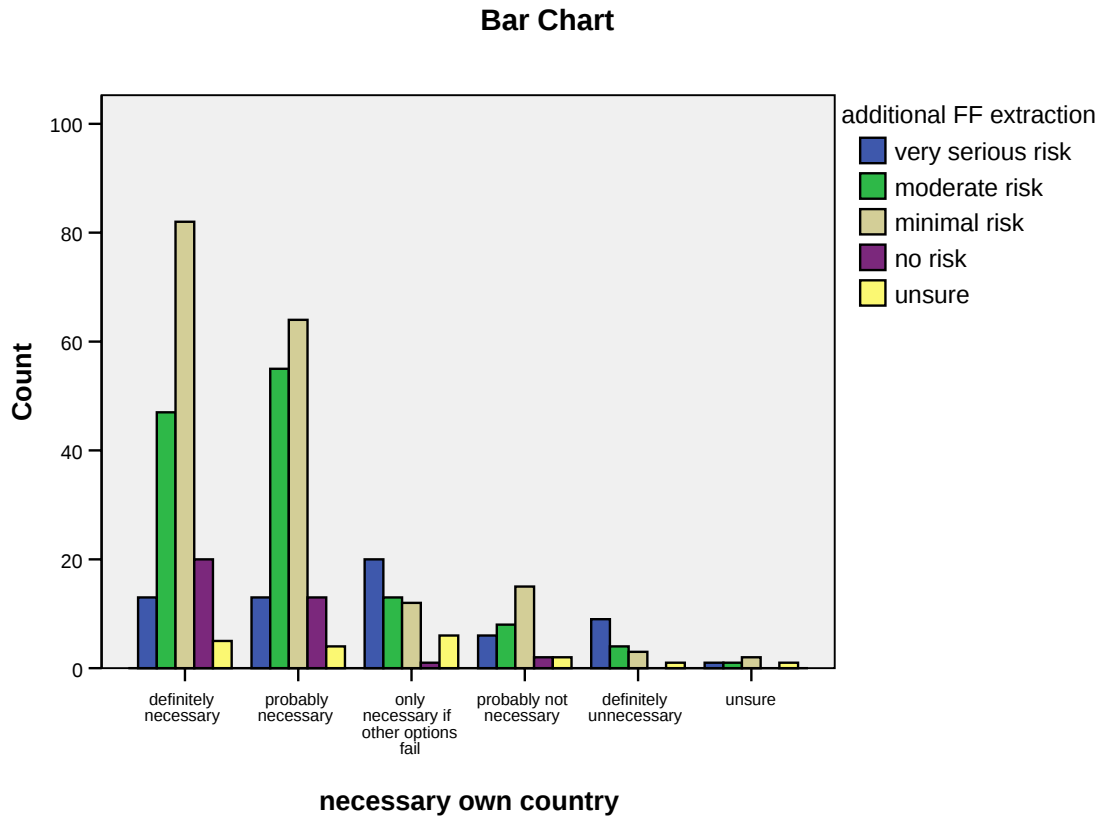


Figure 102: Correlation between perceived need for CCS in own country (question 8, part 1) and impacts arising from additional extraction of fossil fuels to compensate for the energy penalty associated with CO₂ capture (question 16, part 1) (correlation -0.279, significant at p value of 0.01)

Figure 125 shows the correlation between work time spent on energy and opinion regarding whether investment in CCS will deter investment in other low- and zero-carbon energy generating technologies (LZCTs). There is no significant correlation between the two variables (-0.062). Figure 126 shows that there is a weak negative correlation with work time spent on CCS and whether investment in other LZCTs will be deterred (-0.220, significant at p value of 0.01). I.e. there is a tendency for those who spend more of their time working on CCS to be less concerned about the impact of more investment in CCS upon investment in other LZCTs. If we regarded those who work on CCS to be entirely self-interested in promoting the technology, we might have expected those spending 50 to 100% of their time on CCS to be less concerned about the impacts of CCS investment upon development of other LZCTs. Figure 126 suggests that there is no clear pattern, although there is an increase in frequency of 'significant negative impact' and 'minor negative impact' as the respondent devotes less time to CCS. This was confirmed statistically as there was no significant correlation between the 'over 50%' work time on CCS group (0.013), whereas there was with respect to the 'under 50%' work time on CCS group (-0.119, significant at p value of 0.05). The changes are expressed as percentages in Table 47.

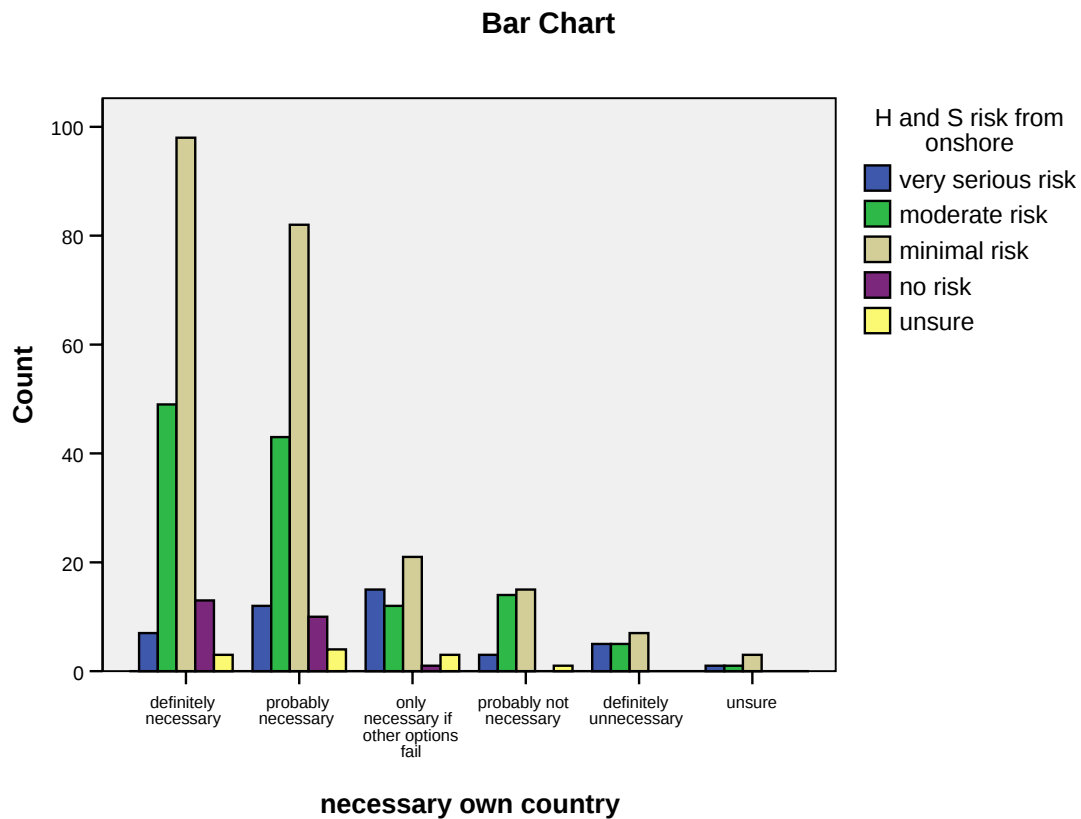


Figure 103: Correlation between perceived need for CCS in own country (question 8, part 1) and health and safety risks from onshore CO₂ storage site leakage (question 16, part 5) (correlation -0.227, significant at p value of 0.01)

The figures in table 47 show that the proportion of respondents who regarded investment in CCS as potentially having a ‘very negative impact’ upon investment in other LZCTs increased when the work time spent on CCS dropped to below 50%. The average frequency for respondents spending more than 50% of work time on CCS was 5%. However, it rose to 13% for 30-50% time, 24% for 10-30% time and 25% for less than 10% time. The changes in the other variables are less obvious. This result provides some evidence that those working most extensively on CCS are less inclined to regard CCS as having ‘very negative impacts’ on investment in other LZCTs. However such respondents are not less likely than others in the sample to view CCS as having fewer minor negative impacts upon such investment. What might be more interesting is that those who spend least time on CCS (between 0 and 50%) are more prone to regard investment in CCS as detrimental to investment in other LZCTs. A generally similar pattern is observed for the relationship between work time on energy and CCS and the impacts of investment in CCS upon investment in energy efficiency and energy demand reduction.

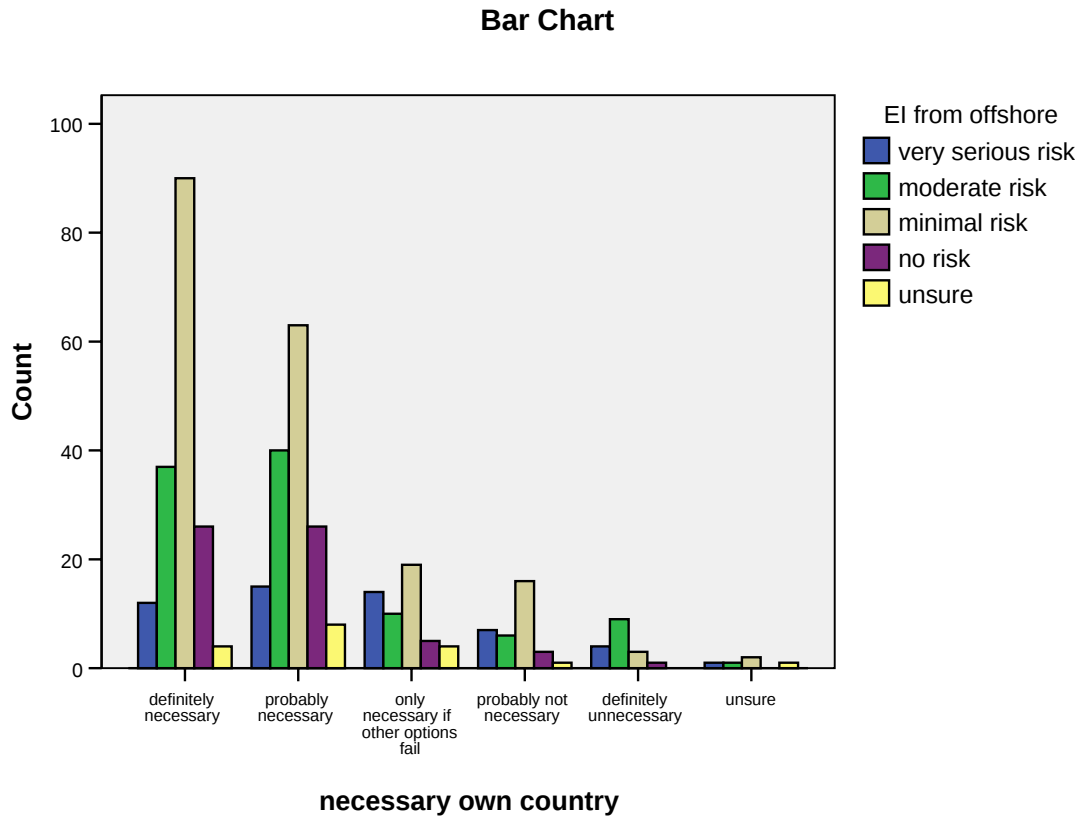


Figure 104: Correlation between perceived need for CCS in own country (question 8, part 1) and local environmental damage from offshore CO₂ storage site leakage (question 16, part 8) (correlation -0.203, significant at p value of 0.01)

It can be seen in Table 48 that those who spend most of their work time on CCS do not perceive the impacts of CCS upon distributed generation more or less negatively than respondents who spend less time on CCS. Hence, it appears that those working on CCS do not attempt to dismiss the potential negative consequences of CCS for the development of distributed generation energy systems.

Figure 127 shows the correlation between work time spent on energy and opinion on whether adoption of CCS might make us more dependent upon a centralized power generation system (question 19). No significant correlation was identified (-0.095). Correlation of this variable with work time spent on CCS shows a weakly negative correlation (-0.166, significant at a p value of 0.01). I.e. there was a slight tendency for those who worked more on CCS to regard the risks to decentralization from CCS adoption to be lower. The correlation was not significant, however, for either the 'over 50%' or for the 'under 50%' time on CCS groups.

Correlation between Organisational Position on CCS (question 6) and Perceived Need for CCS in Own Country (question 8, part 1)

Figure 129 shows that there is a strong correlation between the respondent's perception of their own organisation's position on CCS and their own perception of the need for CCS in their own country. 60% of those working in organizations with a 'very positive' position on CCS thought that CCS is 'definitely necessary' in their own country, a further 29% thought it was 'probably necessary', whilst 7% thought it was either 'probably not necessary' or 'definitely unnecessary'. 28% of those working in organizations which are 'slightly positive toward CCS' thought that CCS is 'definitely necessary' in their own country, a further 47% thought it was 'probably necessary', whilst 7% thought it was either 'probably not necessary' or 'definitely unnecessary'. Of those 26 respondents working in organizations which are either 'slightly' or 'very negative towards CCS', 20% considered that CCS is either 'definitely' or 'probably necessary', whilst 23% thought that CCS is 'probably not necessary' and a further 35% that CCS is 'definitely not necessary'. However the small sample limits the reliability of these figures. Nevertheless, the strong correlation suggests that most respondents' own opinions were in tandem with their organizational view points.

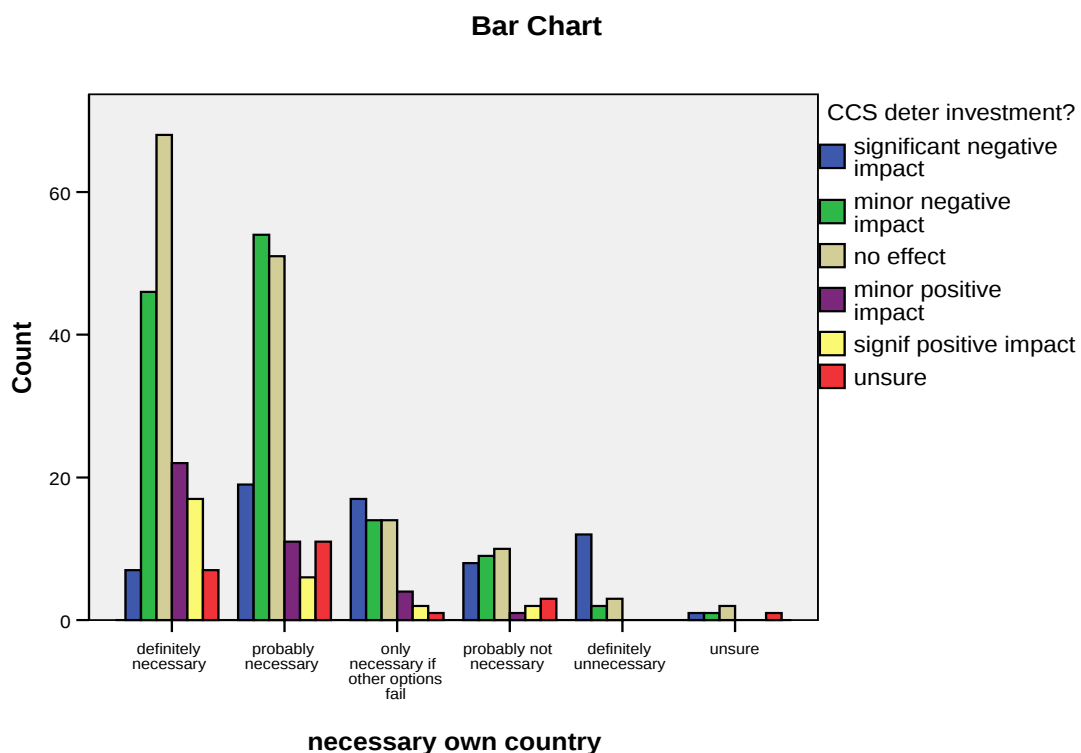


Figure 105: Correlation between perceived need for CCS in own country (question 8, part 1) and the effect of investment in CCS upon other zero- and low-carbon electricity and energy generation options in own country (question 17) (correlation -0.325, significant at p value of 0.01)

Analysis by Groupings of Countries

The countries included in the survey were grouped into four categories: North Western Europe (263 respondents), Southern Europe (66 respondents), Central and Eastern Europe (63 respondents) and Scandinavia (81 respondents). Because the sample is so dominated by respondents from North Western Europe, it is difficult to draw any strong conclusions from this regional-level analysis.

Table 49 shows the perceived need for CCS in own country (question 8, part 1). North West (NWE) and Southern Europe (SE) show similar results, whilst Central and Eastern Europe (CEE) and Scandinavia (Scan) are also similar, the latter less enthusiastic than the former on the need for CCS (the difference between the two groups is statistically significant).

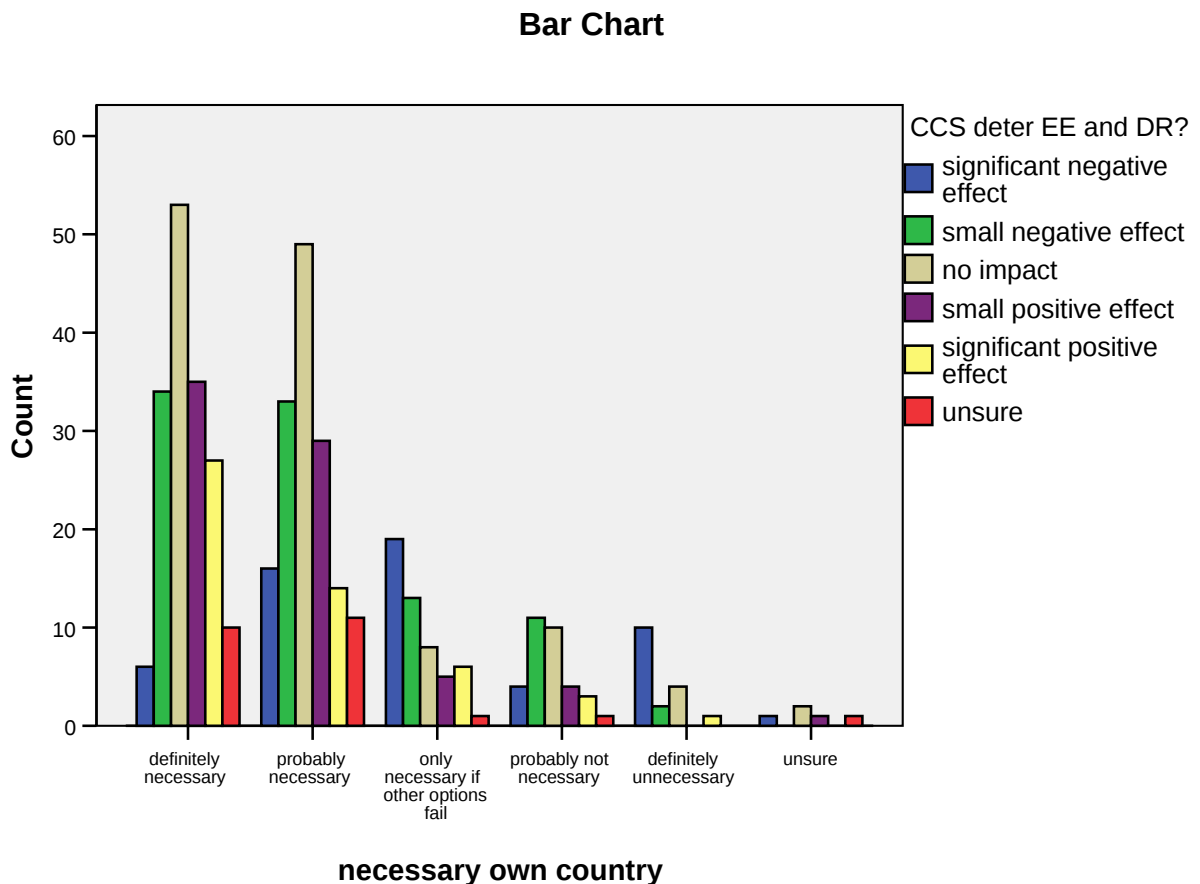


Figure 106: Correlation between perceived need for CCS in own country (question 8, part 1) and the effect of investment in CCS upon improving energy efficiency and reducing energy demand in own country (question 18) (correlation -0.288, significant at p value of 0.01)

We know that in the case of Scandinavia, these responses conceal quite significant variation, with Norwegian respondents more favourably inclined towards CCS than is the average Scandinavian respondent. The difference between NW / Southern Europe and Central and Eastern Europe / Scandinavia is less marked when respondents were asked about the perceived need for CCS at the EU scale. (There are no statistically significant differences between the four groupings of countries with respect to the necessity for CCS at the EU and global scales).

Table 50 shows the frequency of response in terms of the role of CCS in the national climate change debate broken down by large-scale regions. It can be seen that for NWE, SE and Scan the role of CCS appears to be very large to moderate (50-60% of responses). In CEE, however, the equivalent percentage is only 24% of responses. Meanwhile the percentage of respondents in NWE, SE and Scan who perceived the role of CCS as being 'small' or 'very small' was between 32 and 40%, whilst this proportion increased to 56% for CEE. CEE is also distinctive in that 14% of respondents thought that there is 'no climate change debate' in my country', compared to 0-2% for the other three regions. (CEE is statistically distinct from the other three regions).

Bar Chart

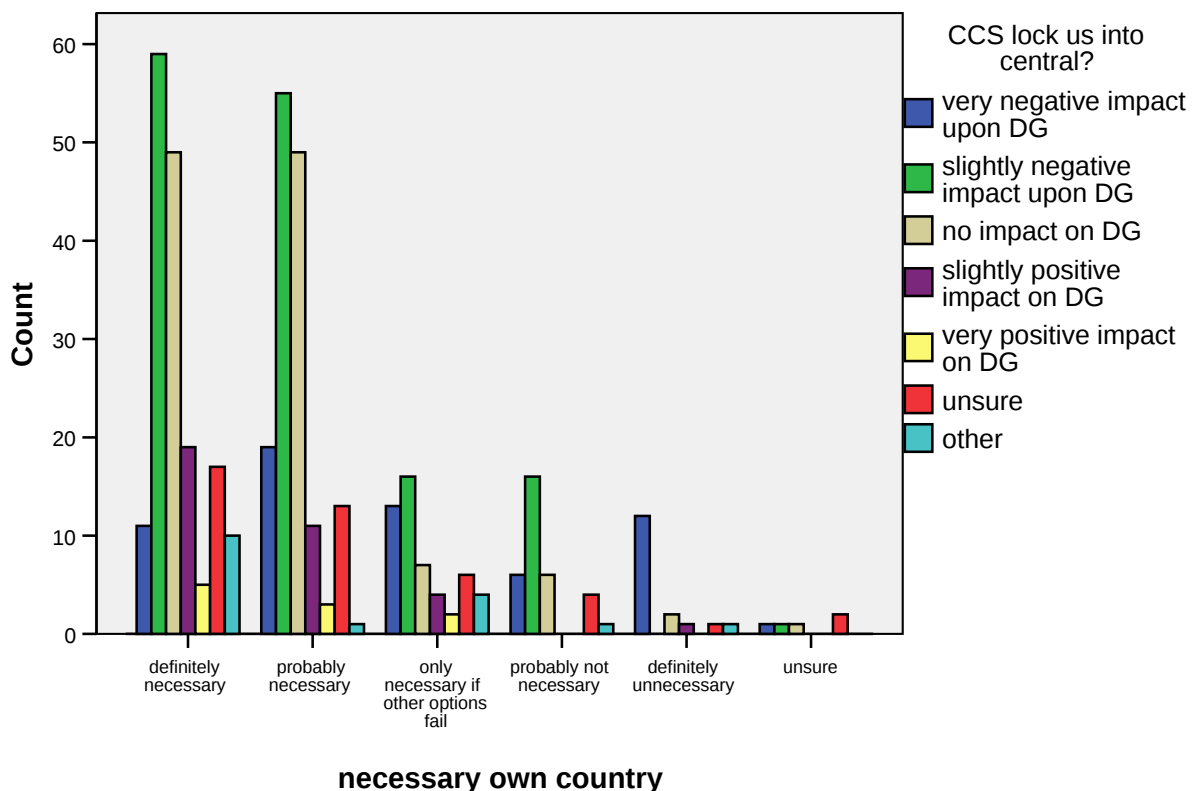


Figure 107: Correlation between perceived need for CCS in own country (question 8, part 1) and perceptions regarding whether use of CCS might make us more dependent upon a centralised power generation system (question 19) (correlation -0.279, significant at p value of 0.01)

A correlation between the role of CCS in national climate change debate in own country and the perceived need for CCS in own country is shown for NWE (figure 130), CEE (figure 131) and Scan (figure 132). Figure 130 shows that there was no significant correlation (0.053): a third of those respondents from NW Europe who regarded CCS as 'definitely necessary' or 'probably necessary' also considered that the role of CCS in the national debate was 'moderate' or 'small'. This does not necessarily imply that those respondents also thought that the role of CCS in the national climate change debate should be greater since we did not ask this question. In CEE (figure 131) there is moderate significant correlation between the necessity of CCS and role of CCS in national debate. Scan (figure 132) illustrates a relatively strong correlation, but also an interesting divergence of opinion. Those who regard CCS as 'definitely' necessary' also tend to regard the role of CCS in the national debate as 'very large' (27%) or 'large' (41%), with 14% responding 'small', 'very small' or 'none'. Those who regard CCS as 'only necessary if', 'probably not necessary' or 'definitely unnecessary', on the other hand, tend to regard the role of CCS in the national debate as 'small', 'very small' or 'none' (74% of respondents). 10% of those more skeptical of CCS regarded the role of CCS in the national debate as 'very large' or 'large'. The respondents who responded 'probably necessary' also do not conform to this; in this case 42% responded that the role of CCS in the national climate change debate was 'very large' or 'large', and 50% that it was 'small', 'very small' or had no role.

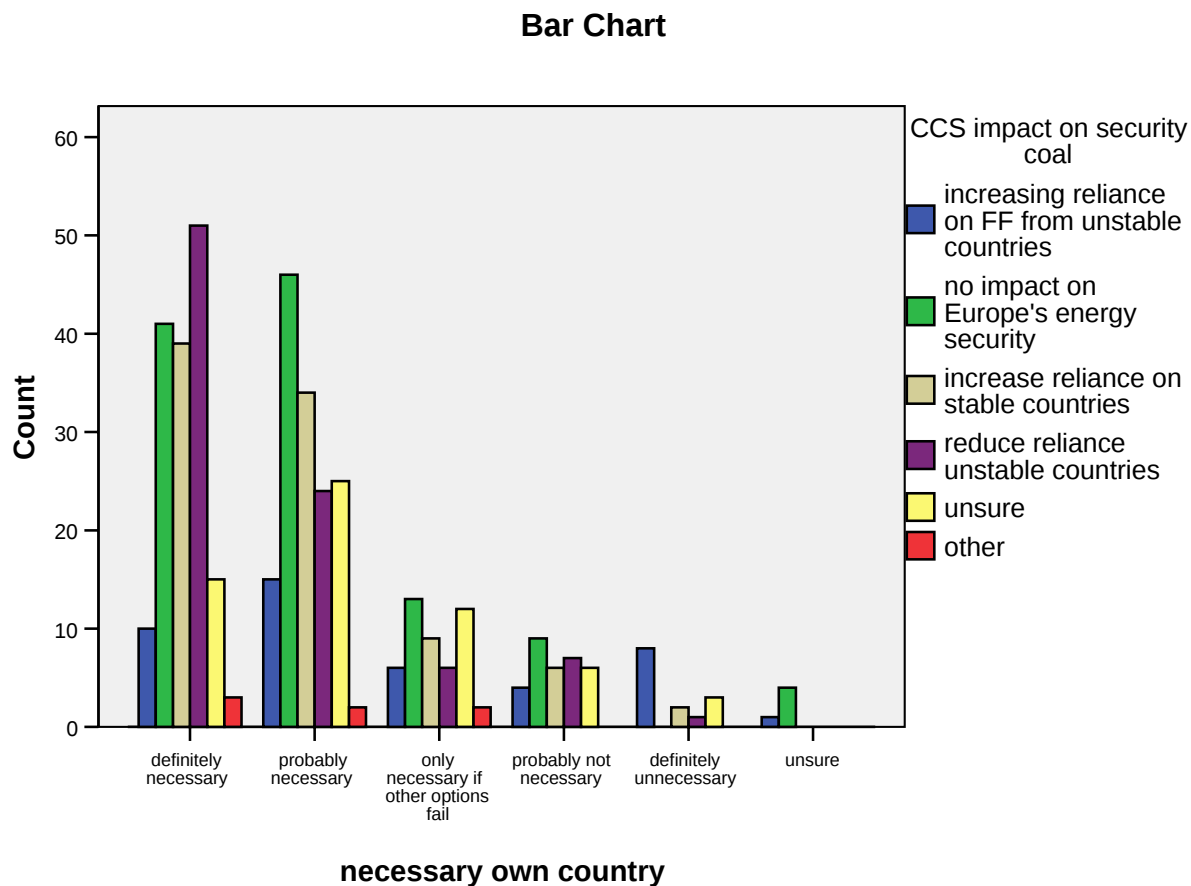


Figure 108: Correlation between the perceived need for CCS in own country (question 8, part 1) and perceptions of whether use of CCS with coal could result in less energy security in the EU (question 20, part 1) (correlation -0.242, significant at p value of 0.01)

The explanation for this interesting distribution appears to be that the Scan group includes Norway that is very CCS positive and where there is strong consensus that CCS has a large role in the national climate change debate, but also Finland, Denmark and Sweden where there is much less consensus either on the desirability of CCS or on the importance of CCS in the national climate change debate. Hence, the result is something of an artefact of combining countries together which have quite different internal positions and debates on CCS. (Examination of the correlations of the two variables in individual countries confirms that this is the case).

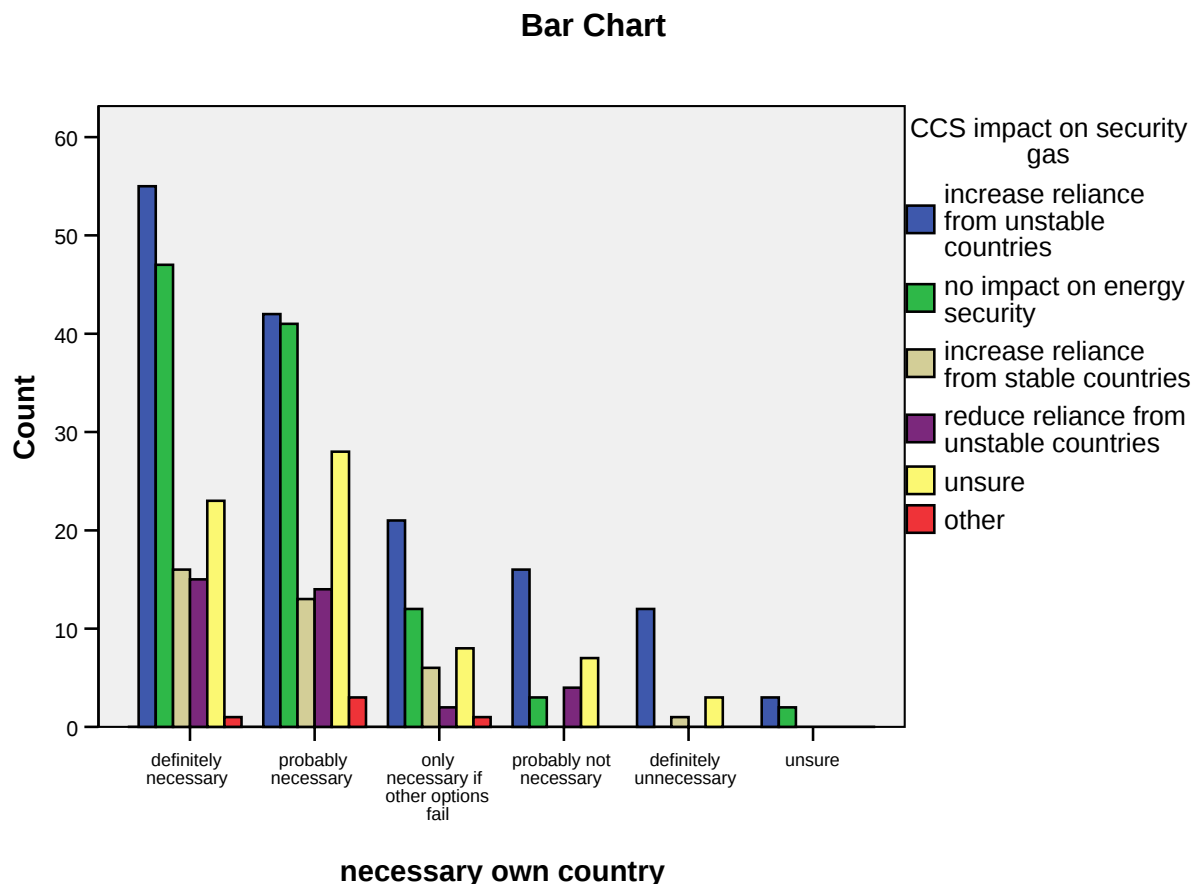


Figure 109: Correlation between the perceived need for CCS in own country (question 8, part 1) and perceptions of whether use of CCS with gas could result in less energy security in the EU (question 20, part 2) (correlation -0.165, significant at p value of 0.01)

Turning to incentive mechanisms, each of the four regions tend to respond in a similar way to the question about the provision of financial incentives (question 12). However, there are differences with respect to which incentives are preferred (question 13). For example, a CCS requirement for electricity generators is popular in SE (73%) and also gets strong support in NWE and CEE (55-56%), but only 32% in Scan (Table 51). Dislike of this mechanism in Scan reaches 39%, compared to 15% in SE, 22% in SE and 30% in NWE. (Statistically there are three distinct groups, SE, NWE & CEE and Scan, in descending order of support for the CCS electricity requirement). There are no statistically significant differences between the four regions regarding the desirability of a low- or zero-carbon electricity generation requirement.

The feed-in price mechanism is also least liked in Scan, followed by NWE, CEE and SE. (There are three statistically significant groups: SE & CEE, NWE and Scan). There are no statistical differences between the four regions with respect to a capital subsidy scheme or an economy-wide carbon tax. In the case of an early commitment to extend the EU ETS

beyond 2012 with tighter emission caps, NWE stands out here as the region with the strongest support for this mechanism (and the difference between NWE and the other regions is statistically significant).

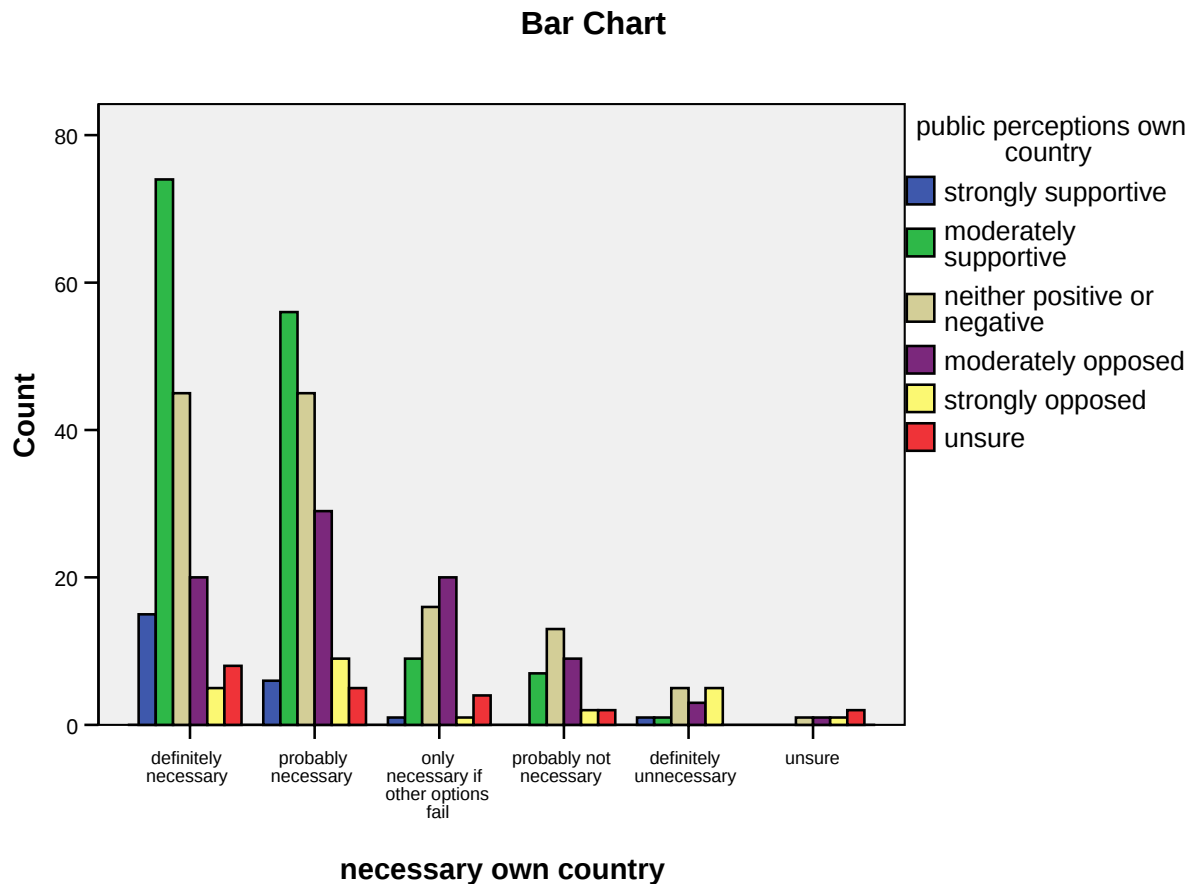


Figure 110: Correlation between the perceived need for CCS in own country (question 8, part 1) and anticipated public perceptions of CCS in own country (question 21, part 1) (correlation 0.294, significant at p value of 0.01)

Respondents in CEE and Scan tended to prefer the adoption of common incentives across the EU25 (question 14) relative to NWE and SE, whilst the latter were some what more enthusiastic about a common price for CO₂ through the EU ETS plus additional national incentives. Scan was most enthusiastic about regulation through adoption of an internationally agreed set of standards (question 15), closely followed by CEE. Regulation through EU standardisation was popular in both NWE and SE, and a dedicated agency of the EU Commission was reasonably popular in SE.

Turning to the potential risks of CCS (question 16) an interesting trend emerged in the case of respondents from CEE. For each of the 12 parts of the question, respondents from CEE

identified greater potential risks than did respondents from NWE, SE and Scan. In a few instances, higher risk perceptions also emerged for Scan, e.g. for the global impacts arising from leaks of CO₂ from storage sites (part 9). It appears, therefore, that risk perceptions of CCS are greater in CEE than in other parts of Europe and it is an interesting question why this should be the case. (Statistically, there are significant differences between CEE and: NWE & SE (16, parts 1, 2, 6); NWE (16, parts 3, 4), NWE & Scan (16, parts 7, 8) and SEE (16, part 10), NEW, SE & Scan (16, part 11) and no significant differences (16, parts 5, 9, 12).

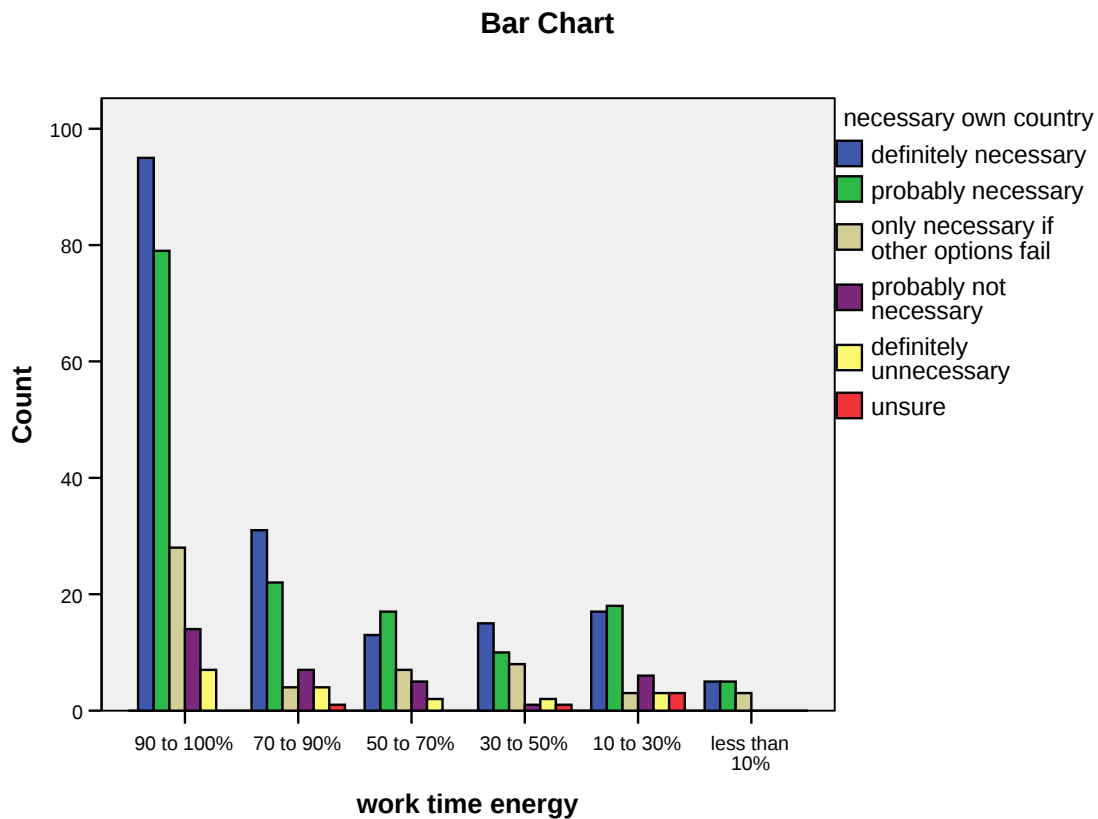


Figure 111: Correlation between the perceived need for CCS in own country (question 8, part 1) and work time spent on energy (question 4) (correlation 0.06, not significant)

No differences between the four regions were observed with respect to the potential impacts of CCS upon investment in other zero- and low-carbon energy generation technologies (question 17) or upon efforts to improve energy efficiency and reduce energy demand (question 18) or upon energy security in the EU arising from use of CCS with natural gas (question 20, part 2) (no differences in statistical significance). Respondents in Scan and CEE were some what more likely than those in NWE or SE to express the view that CCS would make us more dependent upon a centralized power generation system (question 19), though the differences are not statistically significant. Scan respondents tended to see CCS

with coal as improving energy security in the EU more frequently than respondents from the other three European regions (question 20, part 1), whilst CEE were more inclined to regard it as reducing energy security (statistically significant difference compared to NWE). When it comes to perceptions of public opinion regarding CCS in own country (question 21, part 1), respondents from SE considered that opposition would be more likely than those from the other regions (44% compared to 21-24% for the other regions) (statistically significant difference from SE and NWE). Meanwhile respondents from Scan were more likely to regard the public as ‘strongly supportive’ (15%) compared to 5% for the other regions. In the case of public perceptions of CCS at the EU scale (question 21, part 2), the main difference is that respondents from CEE considered that there would be more ‘moderate’ support for CCS than did the other respondents from the other three regions.

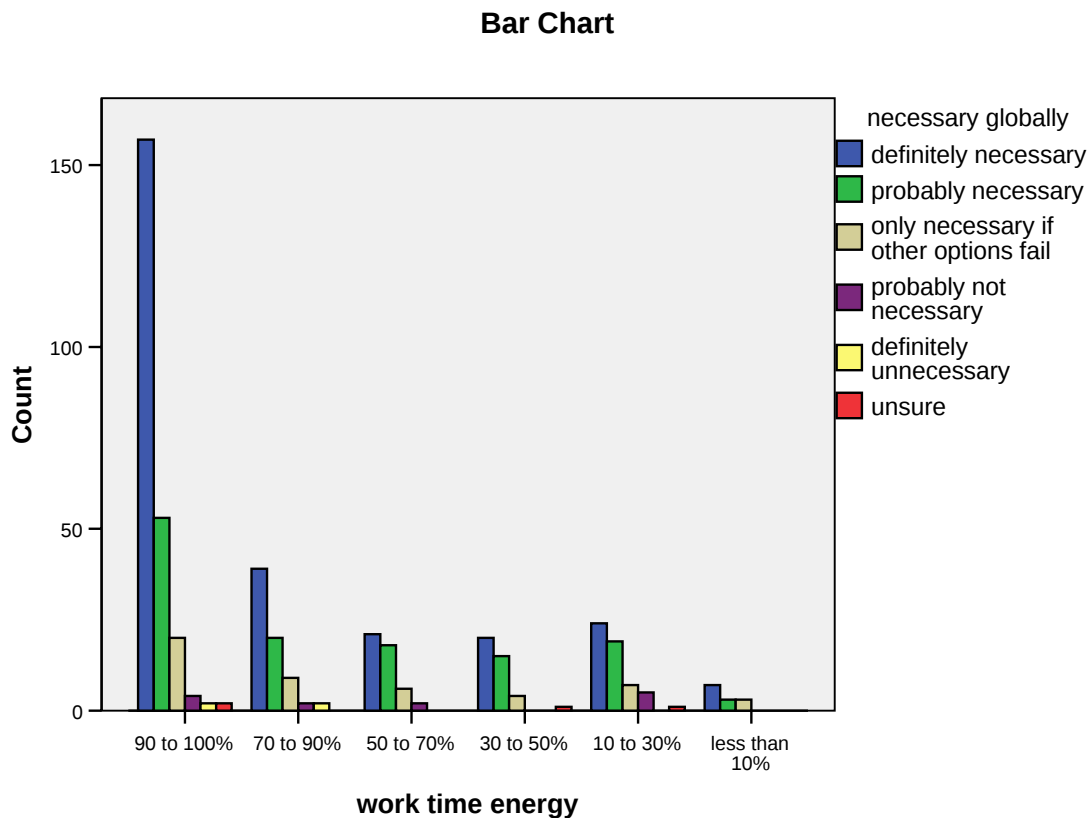


Figure 112: Correlation between the perceived need for CCS globally (question 8, part 3) and work time spent on energy (question 4) (correlation 0.138, significant at p value of 0.01)

Analysis by Size of Countries

The sample was split into three categories according to the size of the country: large (>45 million), medium (8 – 45 million) and small (<8 million). 243 respondents (48%) are from large countries, 132 from medium-sized (26%) and 98 from small countries (19%). In general it was found that there were not clear distinctions in perceptions of CCS according to country size. The few exceptions to this are described below. There were fewer respondents from small countries than in large and medium-sized countries who were working on CCS as a part of their work (from 30 to 70% of their time) and hence more from small countries who worked on CCS for less than 10% of their time. More large country respondents were from organizations that had a ‘very positive’ position on CCS (question 6) compared to medium-sized and small countries (statistically significant). The perceived need for CCS in own country (question 8, part 1) was also stronger in large countries (statistically significant). With respect to the importance of different enabling factors in question 11, it was found that respondents from small countries tended to regard the following as less important than respondents from large and medium-sized countries: the price of carbon under the Emissions Trading Scheme (question 11, part 1); concerns about energy security (question 11, part 3); the need to replace ageing power plant (question 11, part 4); and reduction in costs of CO₂ capture. Meanwhile the following factors were more important for respondents from large countries compared to medium-sized and small countries: availability of domestic supplies of coal (question 11, part 9); and availability of suitable geological storage sites (question 11, part 10). (In statistical terms, large countries were significantly different from small countries with respect to question 11, parts 1, 3, 4, 9, 11 and 17). Most frequently the large countries regard the item as a more important enabling factor than the small countries.

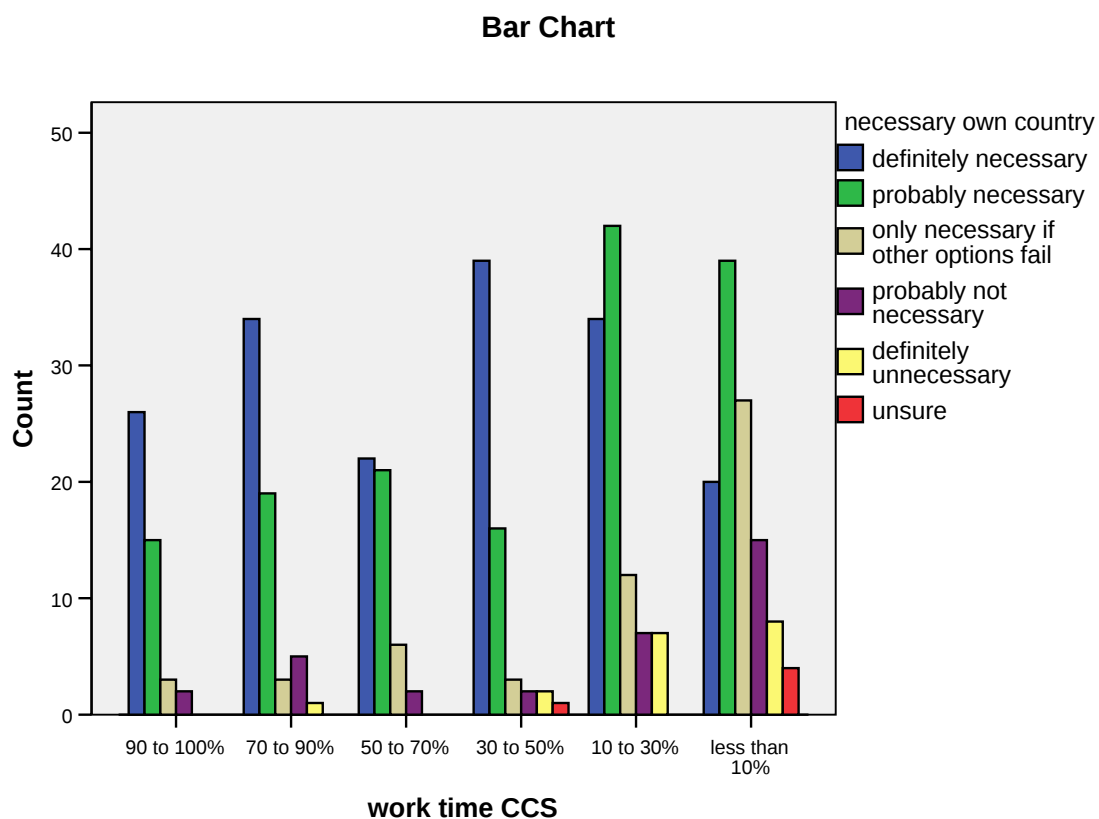


Figure 113: Correlation between the perceived need for CCS in own country (question 8, part 1) and work time spent on CCS (question 5) (correlation 0.297, significant at p value of 0.01)

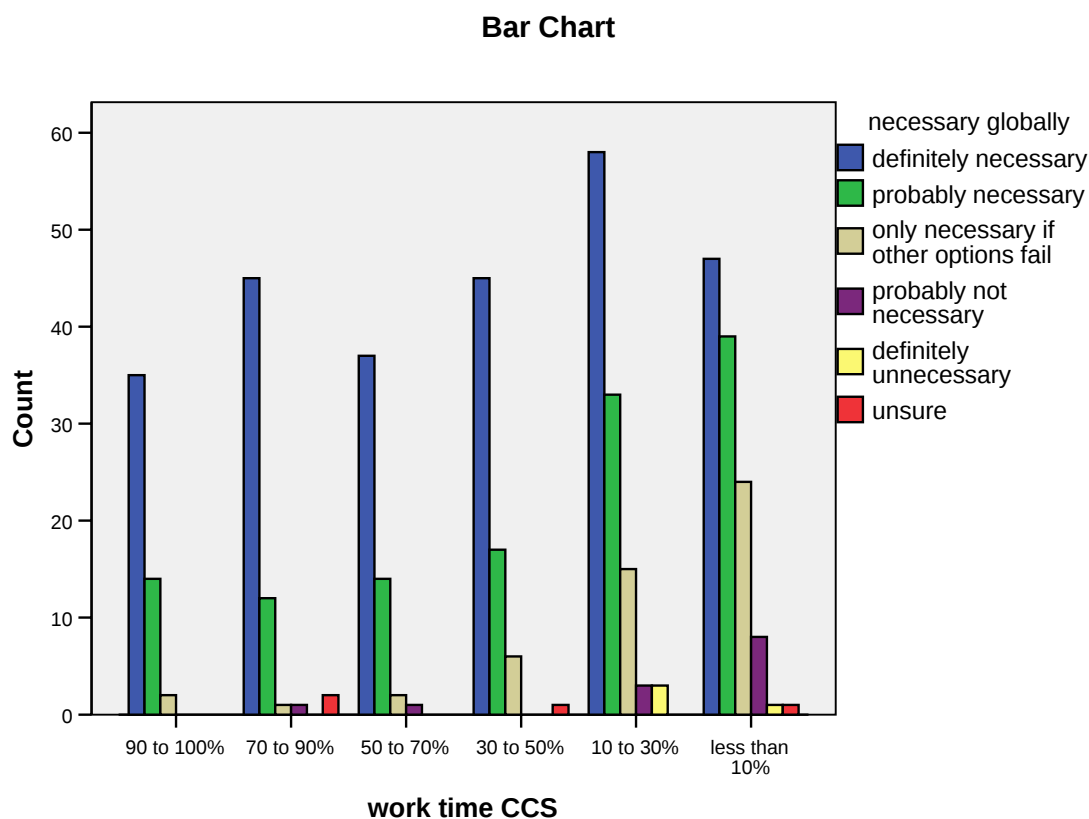


Figure 114: Correlation between the perceived need for CCS globally (question 8, part 3) and work time spent on CCS (question 5) (correlation 0.283, significant at p value of 0.01)

Analysis by GDP per Capita of Countries

We also split up the data into four categories depending upon the GDP per capita at current prices (not PPP values) (in US Dollars, 2006). The four categories are:

Low:	< \$19,000	56 (11%) of respondents
Medium-Low:	\$19,000-29,000	36 (7%) of respondents
Medium-High	\$29,001-39,000	114 (22%) of respondents
High	>\$39,001	267 (52%) of respondents

Low Countries: Latvia, Lithuania, Slovakia, Estonia, Hungary, Slovenia, Czech, Poland, Bulgaria, Estonia, Slovenia

Medium-Low countries: Portugal, Greece, Spain

Medium-High countries: France, Italy, Germany

High countries: UK, Belgium, Sweden, Finland, Norway, Switzerland, Netherlands, Denmark

Given that the average GDP per capita in the EU is \$28,100 in 2006, it is clear that our sample is overly-represented by respondents from richer countries. Our sample includes other countries which are not in the EU but which have higher GDP per capita than the EU average (e.g. Norway and Switzerland).

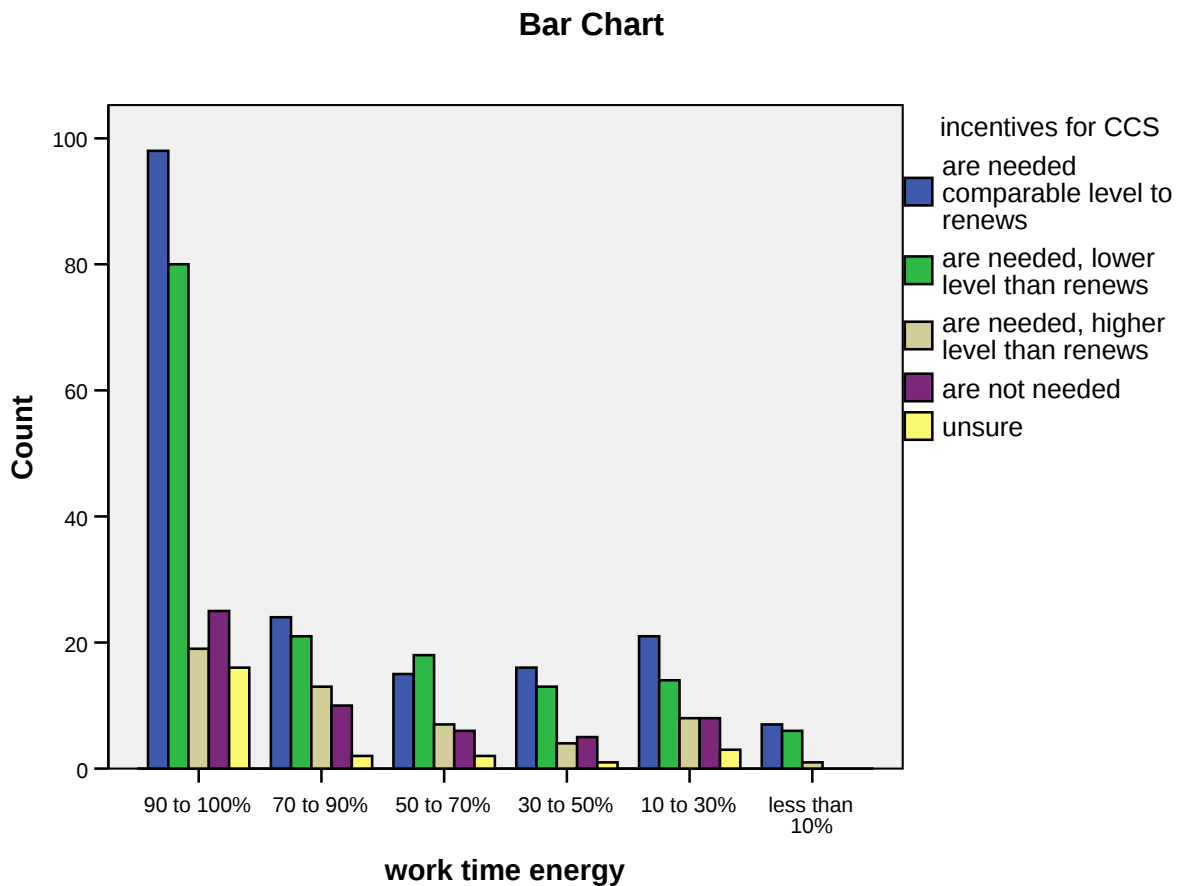


Figure 115: Correlation between work time spent on energy (question 4) and the provision of incentives to encourage CCS (question 12) (correlation -0.026, not significant)

The main differences between these four GDP per capita groups are discussed qualitatively below. The comments made with respect to a particular group are made relative to the other groups unless otherwise specified. The low group respondents generally spent less time on energy (question 4). The high group spent more time (70-100%) on CCS specifically (question 5). The frequency of the 90-100% work time on CCS response decreased as we

went from the high to the low groups, whilst the less than 10% work time on CCS increased. Fewer of the low group's respondents were working for organizations which were 'very positive towards CCS' (question 6); but the 'slightly positive towards CCS' response was more frequent. A smaller proportion of the low group thought that CCS was 'definitely necessary' in own country, in the EU and globally (question 8, parts 1-3). A larger proportion of the medium-low group thought that CCS was 'probably not necessary' in own country (question 8, part 1).

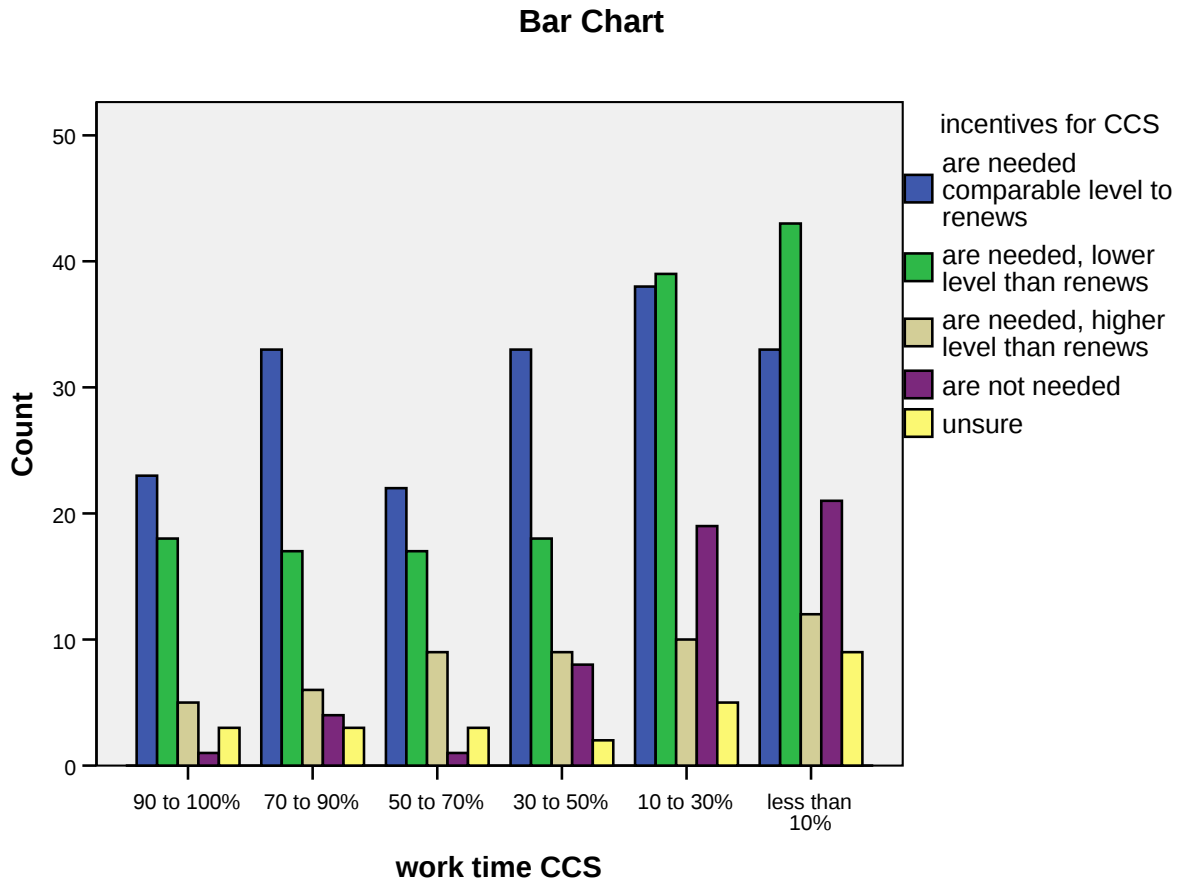


Figure 116: Correlation between work time spent on CCS (question 5) and the provision of incentives to encourage CCS (question 12) (correlation 0.180, significant at p value of 0.01)

Turning to the role of CCS in the current national climate change debate in own country (question 9), there was a higher frequency for the 'very large' response by the high group, whilst the low group responded 'none', 'very small' and 'there is no climate change debate in my country' more frequently. Respondents tended to regard the role of CCS as increasing in the national climate change debate (question 10) as we go from the low to the high group. Turning to those issues which are important enabling factors for the further development of CCS (question 11), the frequency of the 'very important' response was lower for the low group with respect to the following: price of carbon under the EU ETS (question 11, part 1),

availability of venture capital (question 11, part 2), and a post-Kyoto phase with tighter national emission reduction requirements (question 11, part 14). Meanwhile, the frequency of the ‘very important’ response was higher for the high group with respect to opportunities for Enhanced Oil/Gas Recovery with CO₂ (question 11, part 5). The high group more frequently regarded the availability of domestic supplies of coal (question 11, part 9) as ‘not at all important’, whilst the medium-low group regarded coal supplies more frequently as ‘very important’. (The low and medium low group are significantly different from the medium-high and high groups with respect to availability of domestic coal. The low group regards the extension of the EU ETS as less important than the other groups (statistically significant). The high group also respond more frequently that the development of a legal and regulatory basis for CCS is ‘very important’.

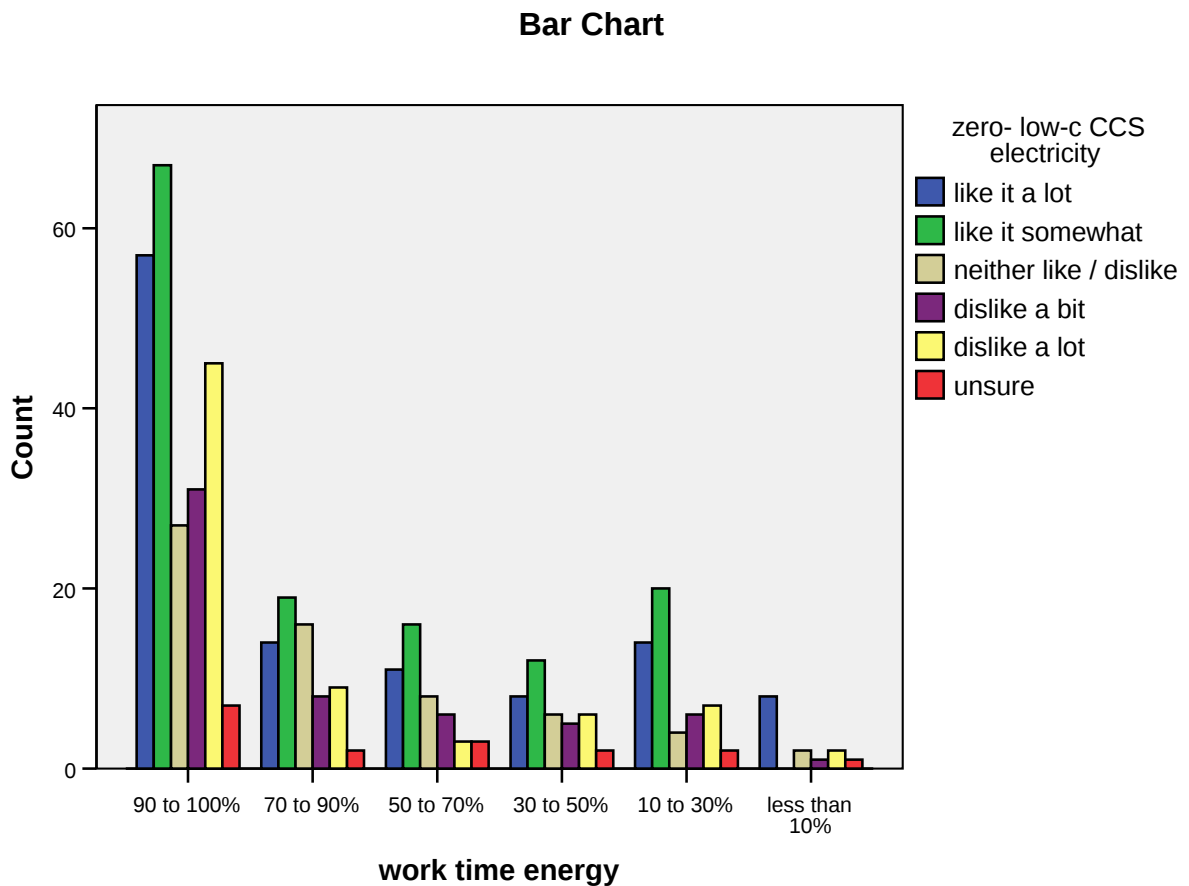


Figure 117: Correlation between work time spent on energy (question 4) and a requirement for low- or zero-carbon electricity generation from CCS as an incentive mechanism (question 13, part 1) (correlation -0.085, not significant)

On the issue of incentives (question 13), there was a higher frequency of the ‘like it a lot’ response amongst the high group for the early commitment to extend the EU ETS beyond 2012 with tighter emission caps (part 6); this option was less liked by the low group

respondents. The low group respondents also tended to prefer that the same incentives should be applied across the EU (question 14), and were less enthusiastic about the idea of a common price for CO₂ through the ETS plus additional national incentives.

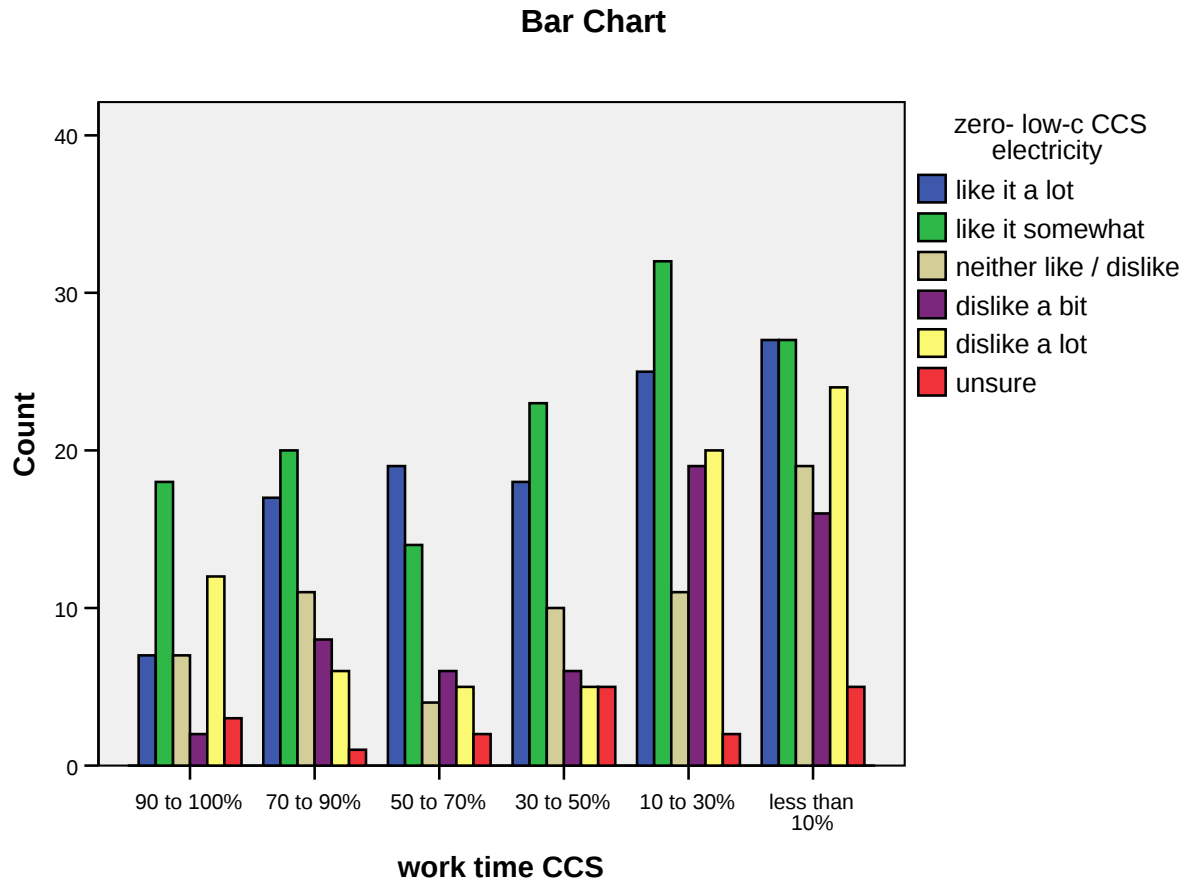


Figure 118: Correlation between work time spent on CCS (question 5) and a requirement for low- or zero-carbon electricity generation from CCS as an incentive mechanism (question 13, part 1) (correlation 0.070, not significant)

Differences also emerged between the four groups with respect to the perceived risks of CCS (question 16). For a number of the potential risks identified, the low group respondents more frequently identified them as ‘very serious risk’ and/or ‘moderate risk’. This is the case for: impacts of new CO₂ pipeline network on landscape and environment (part 3); human health and safety risks from leakage from CO₂ pipelines (part 4); local environmental damage from onshore CO₂ storage site leakage (part 6); and impacts of CO₂ storage upon micro-organisms within the storage site (part 12). Meanwhile, respondents from the high group responded *less* frequently that a number of risks were ‘very serious’: local environmental damage from offshore CO₂ storage site leakage (part 8); global climate impacts due to additional greenhouse gas emissions resulting from enhanced hydrocarbon recovery (part 10); and impacts of CO₂ upon drinking water reservoirs (part 11).

Respondents from the low group tended more frequently to regard the impacts of CCS upon development of distributed generation energy systems (question 19) as ‘very negative’; and to regard energy security in the EU decreasing as a consequence of CCS with coal (compared to the other groups) (question 20, part 1). Finally, the low group considered that the public would be less ‘moderately opposed’ to CCS whilst the high group thought that there would be less strong opposition, but more moderate opposition (compared to the other groups).

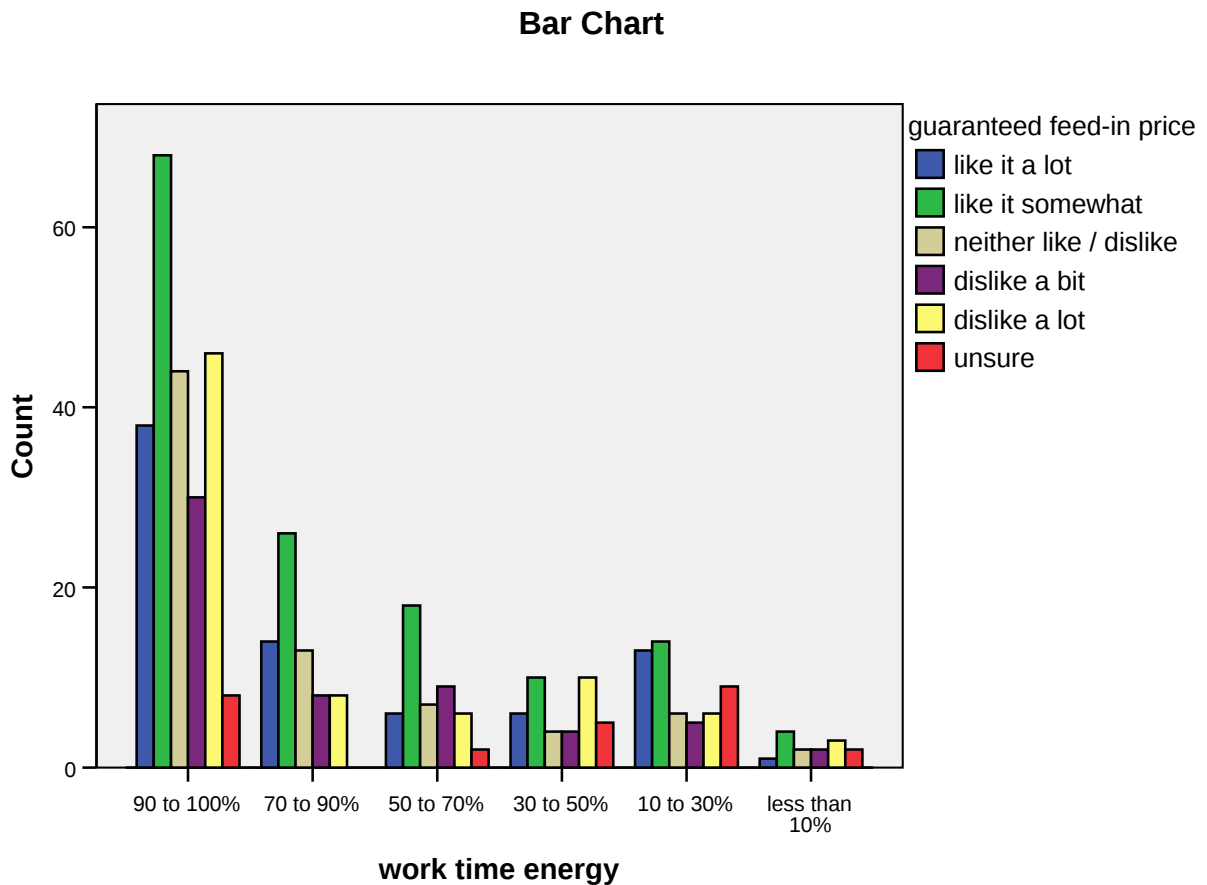


Figure 119: Correlation between work time spent on energy (question 4) and a guaranteed feed-in price for CCS as an incentive mechanism (question 13, part 1) (correlation -0.085, not significant)

Analysis by Fossil Fuel Status of the Country

We next split the countries into four groups:

1. Coal = those countries with a coal mining industry (about 4 million tones per year); 68 respondents (13%)

Czech Republic, Greece, Hungary, Poland, Slovakia, Slovenia, Spain, Bulgaria

2. Oil and gas = those countries with an active gas and / or oil industry; 133 respondents (26%)

Denmark, Estonia, Italy, Netherlands, Norway

3. Coal, oil and gas: those countries with both gas and oil industries and coal industry; 159 respondents (31%)

UK, Germany

4. None: no significant oil, gas or coal industries; 113 respondents (22%)

Bar Chart

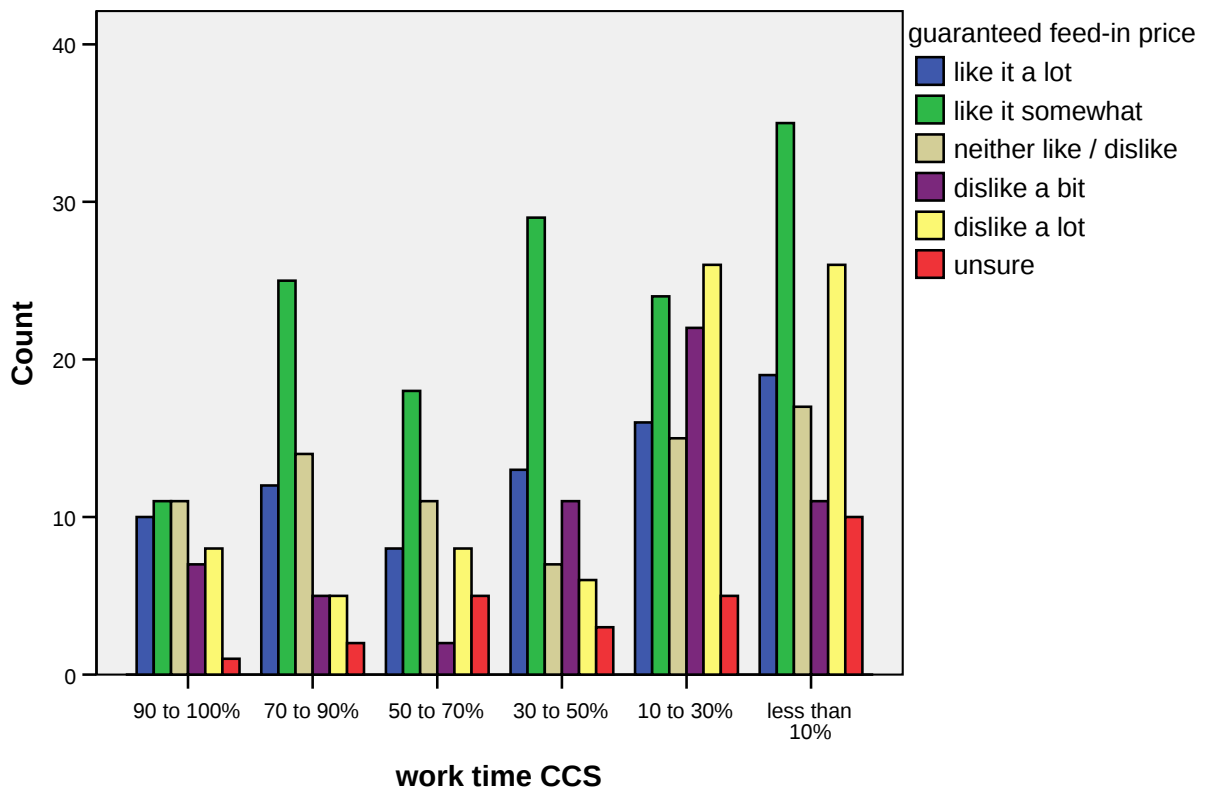


Figure 120: Correlation between work time spent on CCS (question 5) and a guaranteed feed-in price for CCS as an incentive mechanism (question 13, part 3) (correlation 0.070, not significant)

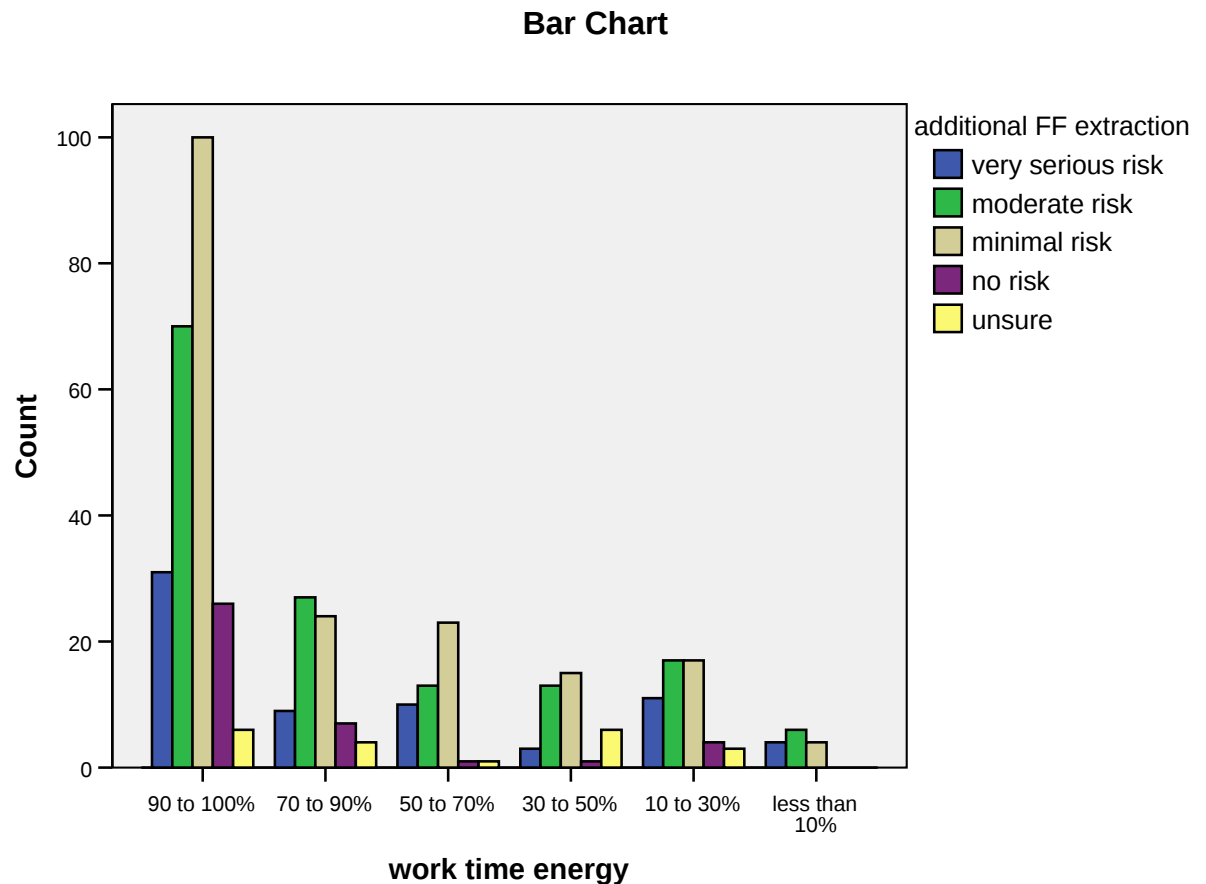


Figure 121: Correlation between work time spent on energy (question 4) and impacts arising from additional extraction of fossil fuels to compensate for the energy penalty associated with CO₂ capture (question 16, part 1) (correlation -0.128, significant at p value of 0.01)

Below we describe qualitatively the key differences which emerged on comparing these four groups. The oil and gas group had a higher proportion of respondents working more time on CCS than the other groups (question 5). The 'no fossil fuel' group had a higher proportion of organizations where discussions were underway on CCS (question 6). The 'no fossil fuel' group also showed a distinctive position on the perceived role of CCS in own country (question 8, part 1), with the proportion of 'definitely necessary' responses at about half of that given by the other three groups. (Statistically, the 'no ff' group is significantly different from the other groups). When the question is asked at the EU and global scales (question 8, parts 2 and 3), however, the response of all four groups is fairly similar (no significant differences). This makes good sense, since there are fewer opportunities for CCS

in countries without fossil fuel reserves and it does not imply opposition to CCS *per se*, as the response at the EU and global scales suggests.

The non fossil fuel group regarded CCS to have the largest role in the national climate change debate of all four groups. This is a somewhat surprising result since one would have imagined that CCS would have the greatest role in countries with oil, gas and coal. (However, statistically the coal, oil & gas and 'no ff' groups are significantly different from the coal, oil & gas group).

Respondents from coal, oil and gas countries regarded the role of CCS in the national climate change debate (question 10) to be increasing the most. Turning to the enabling factors for CCS development, the oil & gas and 'coal, oil and gas' groups regarded Enhanced Oil and Gas Recovery (question 11, part 5) as more important than the coal and no fossil fuels groups (this difference is statistically significant). The coal, oil and gas group were most skeptical of the importance of the hydrogen economy (question 11, part 7); again this is somewhat counter-intuitive, since one might have hypothesised a connection between the H₂ economy and CCS. (The coal, oil & gas and no fossil fuels groups are significantly different from the 'coal, oil and gas' group).

Bar Chart

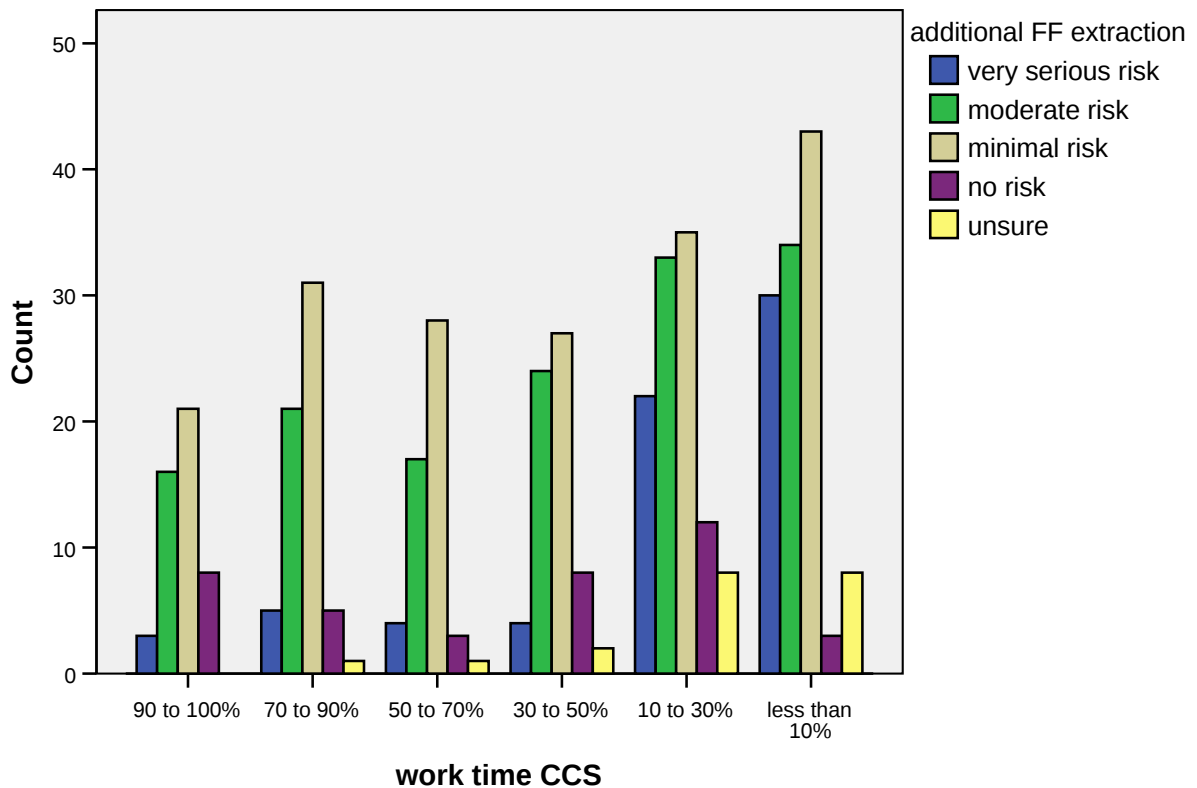


Figure 122: Correlation between work time spent on CCS (question 5) and impacts arising from additional extraction of fossil fuels to compensate for the energy penalty associated with CO₂ capture (question 16, part 1) (correlation -0.203, significant at p value of 0.01)

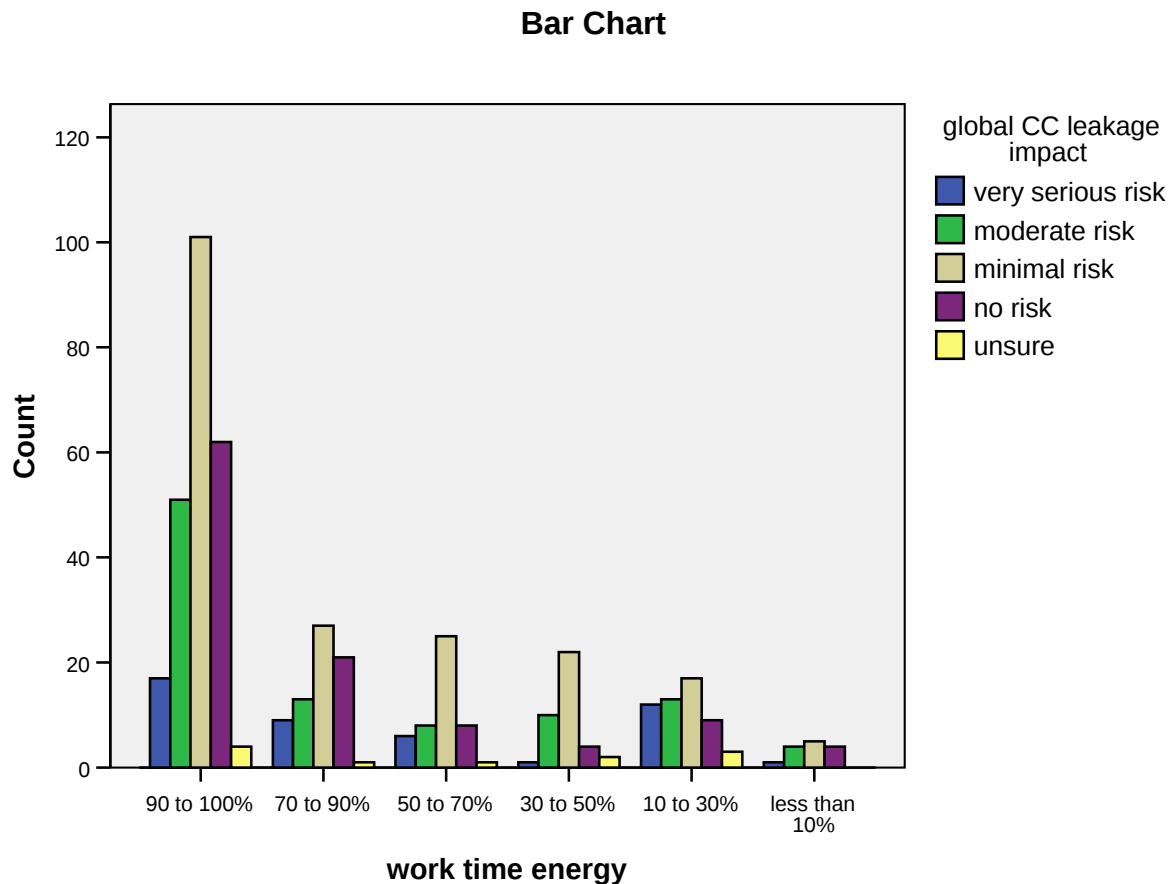


Figure 123: Correlation between work time spent on energy (question 4) and global climate impacts arising from CO₂ storage leakage (question 16, part 9) (correlation -0.123, significant at p value of 0.01)

The frequency of the 'not at all important' response is higher for the oil and gas group with respect to the 'availability of domestic supplies of coal' (question 11, part 9) than for the other groups. (Statistically, the oil & gas and no fossil fuels groups are significantly different from the coal and 'coal, oil and gas' groups). The oil and gas group does not regard the adoption of CCS as being tightly coupled to domestic coal supplies. Both the coal, oil & gas and oil & gas groups regarded availability of suitable geological storage sites (question 11, part 10) as 'very important' more frequently than the other groups. (Statistically, the oil & gas and 'no fossil fuels' groups are significantly different from coal, oil & gas, the latter regarding the availability of geological storage sites as more important). The 'no fossil fuels' group regarded development of other low- and zero- carbon energy generation technologies

(question 11, part 11) as ‘very important’ more frequently than the other groups. The development of a legal and regulatory basis for CCS (question 11, part 17) was identified as ‘very important’ more frequently for the coal, oil & gas and ‘no fossil fuels’ group.

The eligibility of CCS for the CDM (question 11, part 18) was regarded as ‘very important’ more frequently by the ‘no fossil fuels’ groups (possibly because respondents from such countries are less focused upon CCS opportunities in their own country). There were no major differences between the four groups with respect to financial incentives, so suggesting that respondents from countries with oil, gas and coal reserves are not simply supporting generous incentives for CCS.

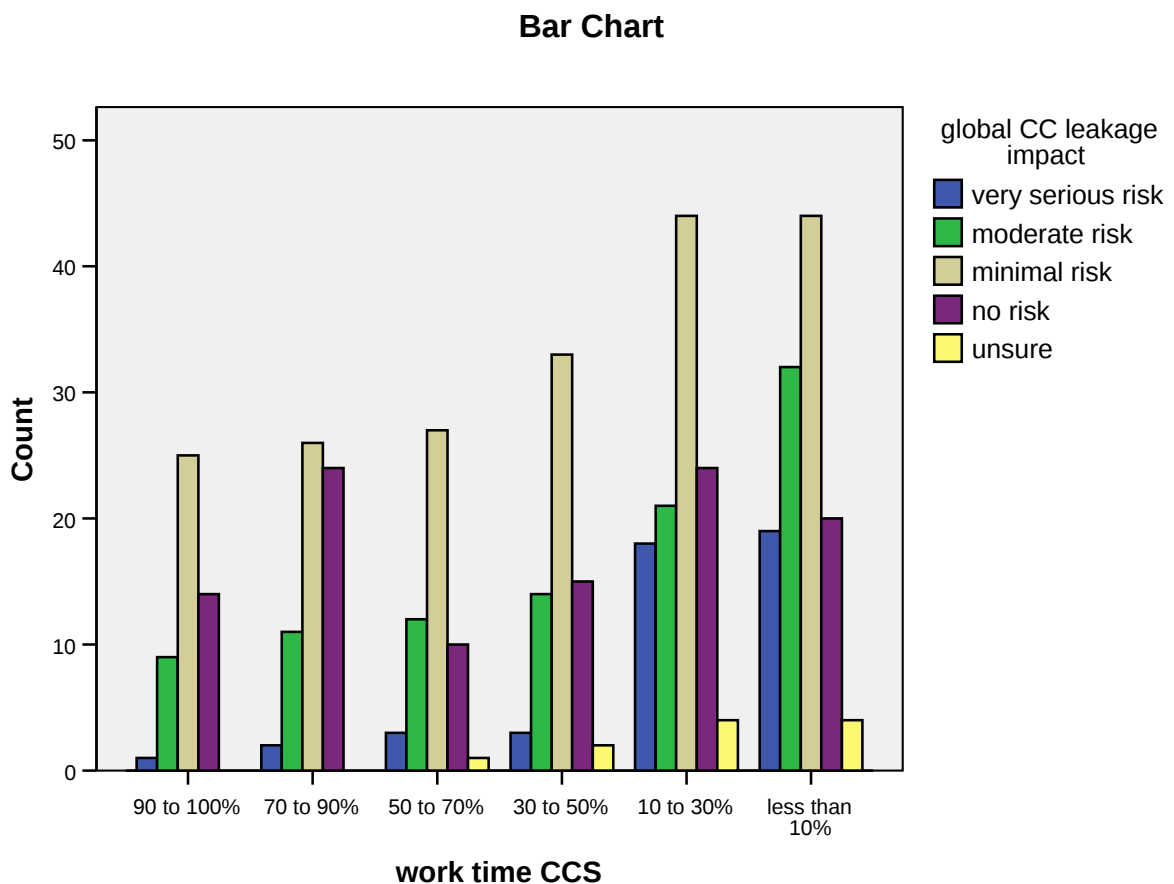


Figure 124: Correlation between work time spent on CCS (question 5) and global climate impacts arising from CO₂ storage leakage (question 16, part 9) (correlation -0.214, significant at p value of 0.01)

Turning to support for particular financial incentive options, there were no real differences between the groups with respect to a ‘CCS’ requirement for generators or a ‘zero-carbon’ or ‘low-carbon’ generation requirement (question 13, parts 1 and 2). The coal, oil & group was

less favourably inclined towards a guaranteed feed-in price (question 13, part 3). The coal group was less supportive (fewer 'like it a lot' responses) of an early commitment to extend the EU ETS beyond 2012 with tighter emission caps (question 13, part 6). (Under the EU ETS coal-based electricity generation has suffered relative to gas-powered CCGT, which may help explain the lower level of support for this option from respondents in the coal group). Relative to the other groups, the coal group also preferred incentives to be applied across the EU25 rather than relying upon a common price for CO₂ under the EU ETS plus additional national incentives (question 14).

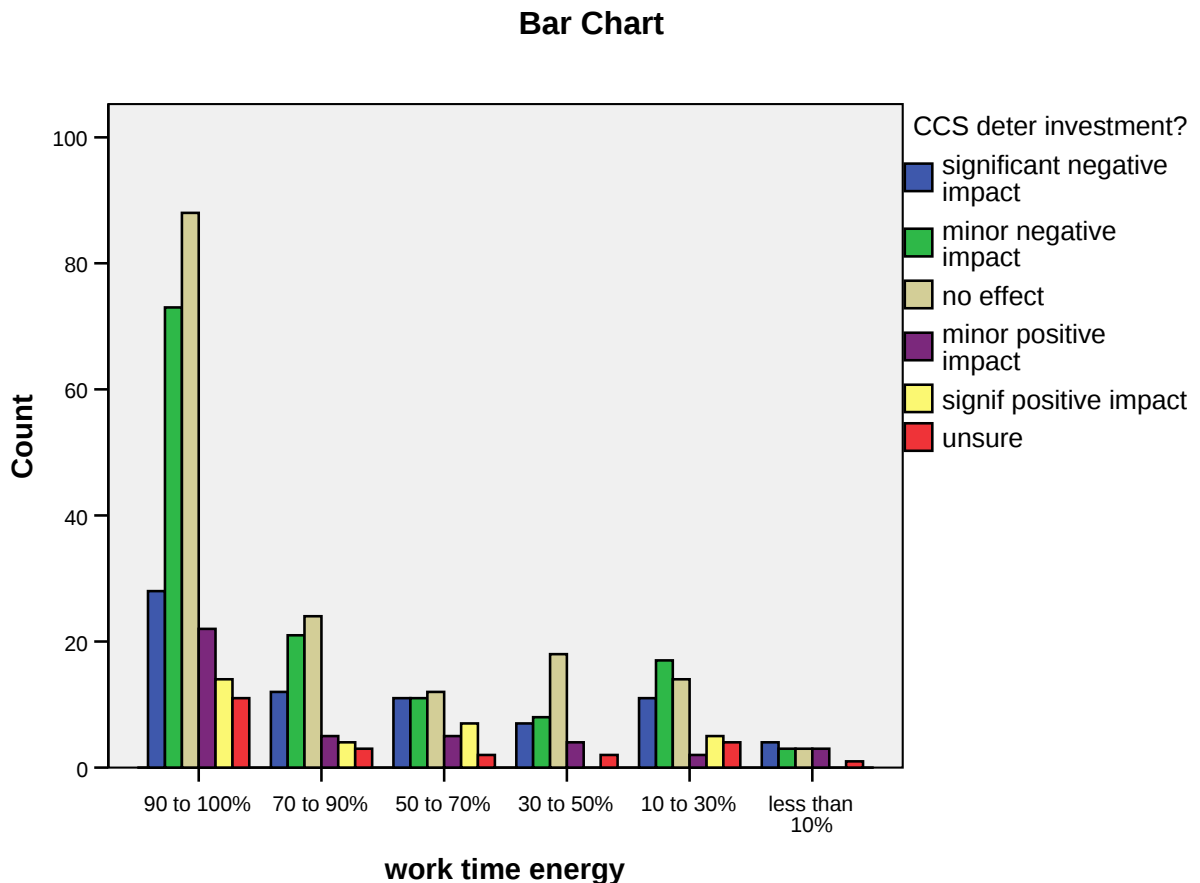


Figure 125: Correlation between work time spent on energy (question 4) and opinion on whether investment in CCS will deter investment in other zero- and low-carbon energy generation technologies (question 17) (correlation -0.062, not significant)

Turning to risk perceptions (question 16), the coal, oil & gas group had a lower frequency of response for 'very serious risk' with respect to: impacts arising from additional extraction of fossil fuels to compensate for the CCS energy penalty (part 1) than other groups. The coal, oil & gas group and the oil & gas groups rated the following risks as lower (fewer 'very serious risk' responses from respondents) than the other groups: human health and safety risks from leakage from CO₂ pipelines (part 4); human health and safety risks from onshore

CO₂ storage site leakage (part 5); local environmental damages from onshore CO₂ storage site leakage (part 6); the global climate impacts due to additional greenhouse gas emissions resulting from enhanced hydrocarbon recovery (part 10); and impacts of CO₂ storage upon drinking water reservoirs (part 11). The oil and gas industry is the main industry with experience in constructing and operating pipelines and it is therefore understandable that it might express a greater level of confidence in the safety of CO₂ pipelines than other groups. It is interesting that the differences did not emerge with respect to the impacts of leakage from offshore CO₂ storage sites.

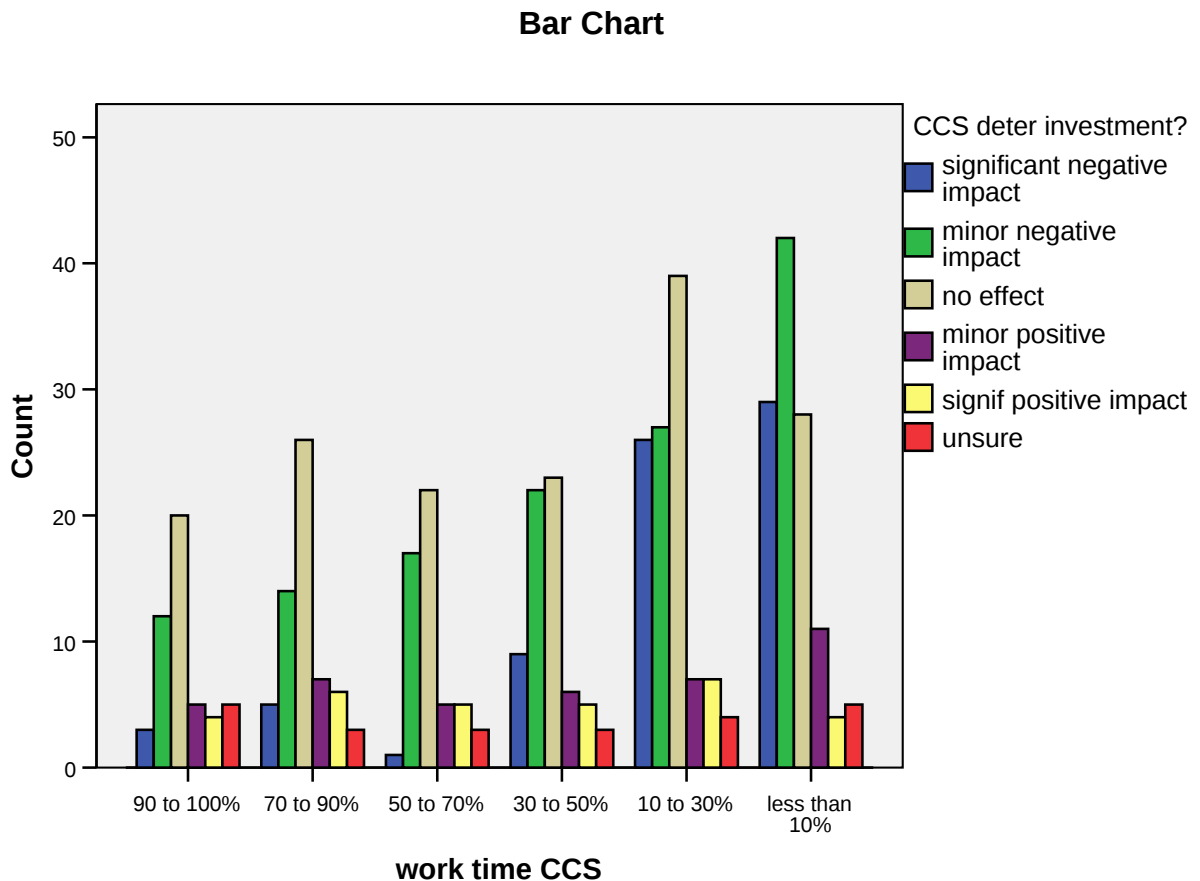


Figure 126: Correlation between work time spent on CCS (question 5) and opinion on whether investment in CCS will deter investment in other zero- and low-carbon energy generation technologies (question 17) (correlation -0.220, significant at p value of 0.01)

The ‘no fossil fuels’ group responded slightly more frequently that the global climate impacts arising from CO₂ storage site leakage would be a ‘very serious risk’ (question 16, part 9). No real differences emerged between the four groups with respect to whether CCS would deter investment in other zero- and low-carbon energy generation technologies (question 17), or on energy efficiency / energy demand reduction (question 18). Small difference arose with respect to the impacts of CCS upon moves to decentralization (question 19). The coal group

responded more frequently that CCS would have a ‘very negative impact’ upon decentralization than did the ‘no fossil fuel’ group.

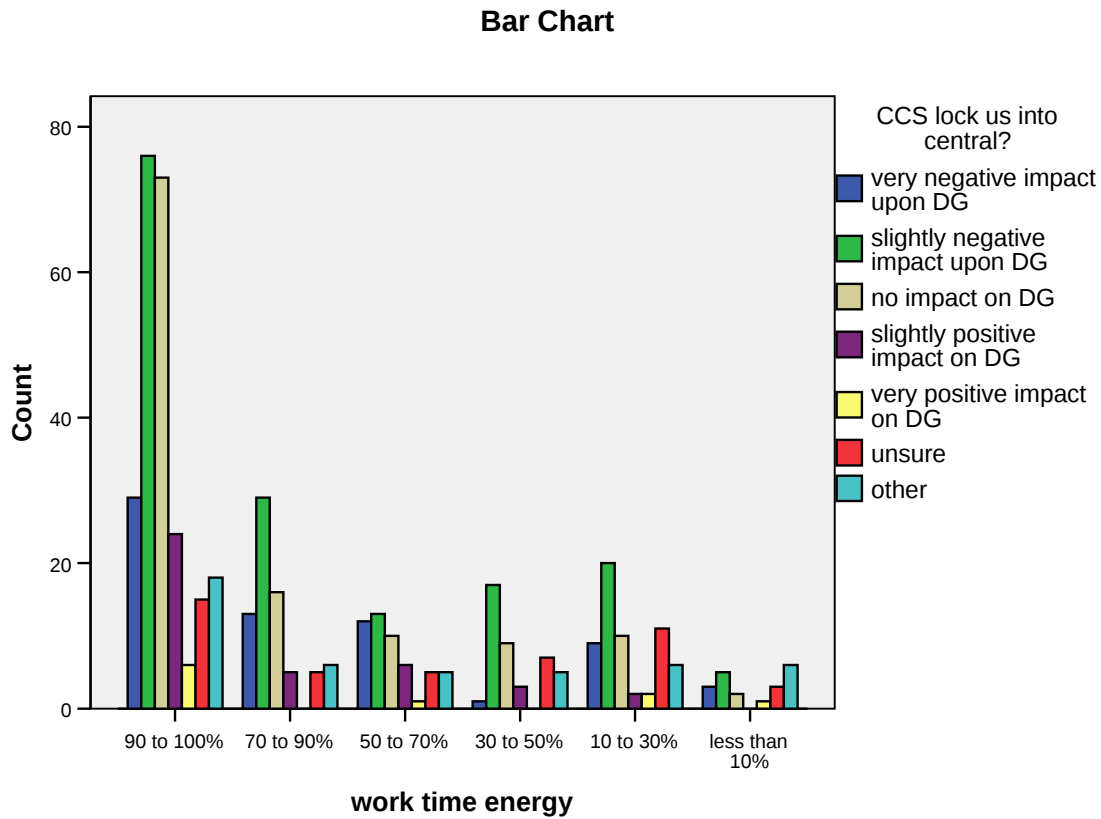


Figure 127: Correlation between work time spent on energy (question 4) and opinion on whether CCS might make us more dependent upon a centralized power generation system (question 19) (correlation -0.095, not significant)

The non-fossil fuel group also thought that CCS with coal would result in an increasing reliance upon fossil fuels imports from unstable countries compared to other groups, though opinion was similar across all four groups with respect to the impact of CCS with gas upon energy security. The non fossil fuel and coal groups tended to regard public opinion of CCS in own country (question 21, part 1) as more likely to be ‘neither positive nor negative’ and less likely to be ‘strongly’ or ‘moderately’ supportive than in coal, oil & gas and oil & gas groups. There was no appreciable difference in responses across the four groups regarding public opinion of CCS in the EU.

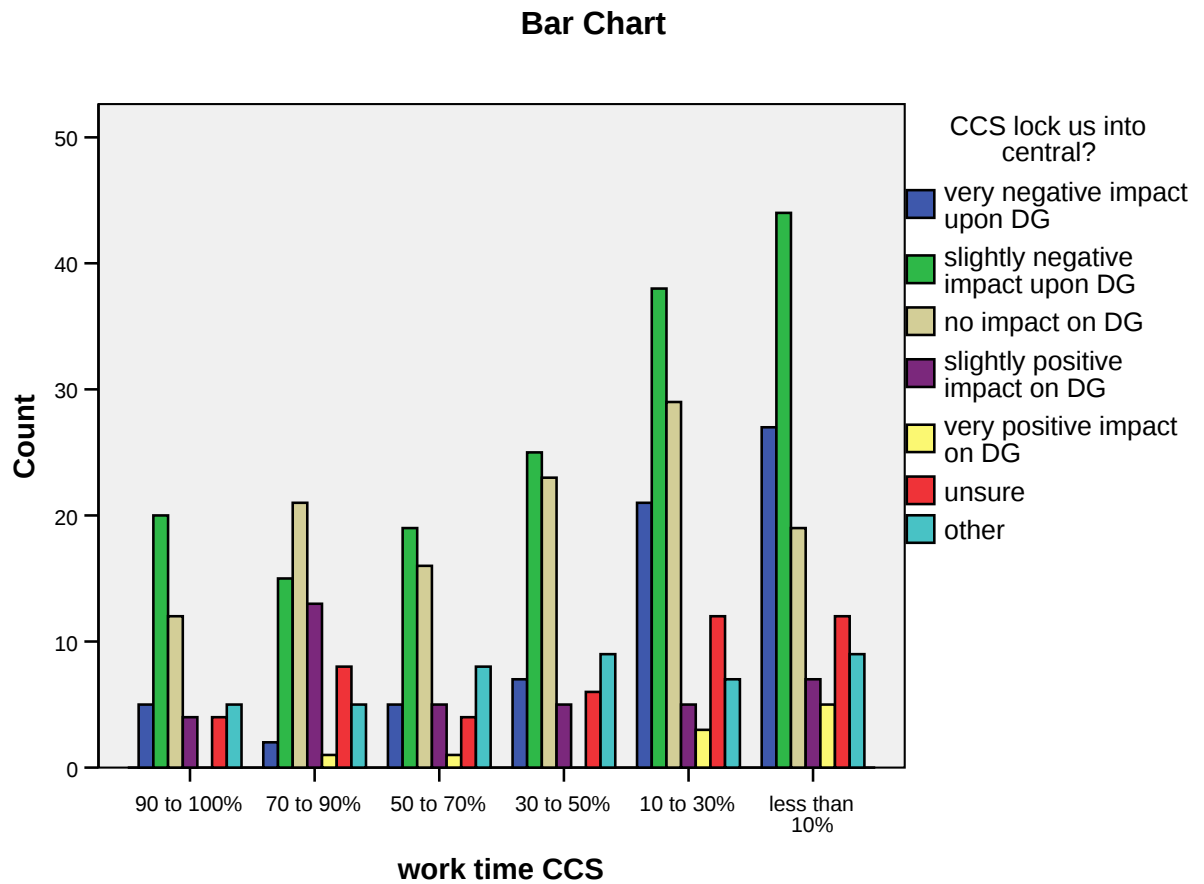


Figure 128: Correlation between work time spent on CCS (question 5) and opinion on whether CCS might make us more dependent upon a centralized power generation system (question 19) (correlation -0.166, significant at p value of 0.01)

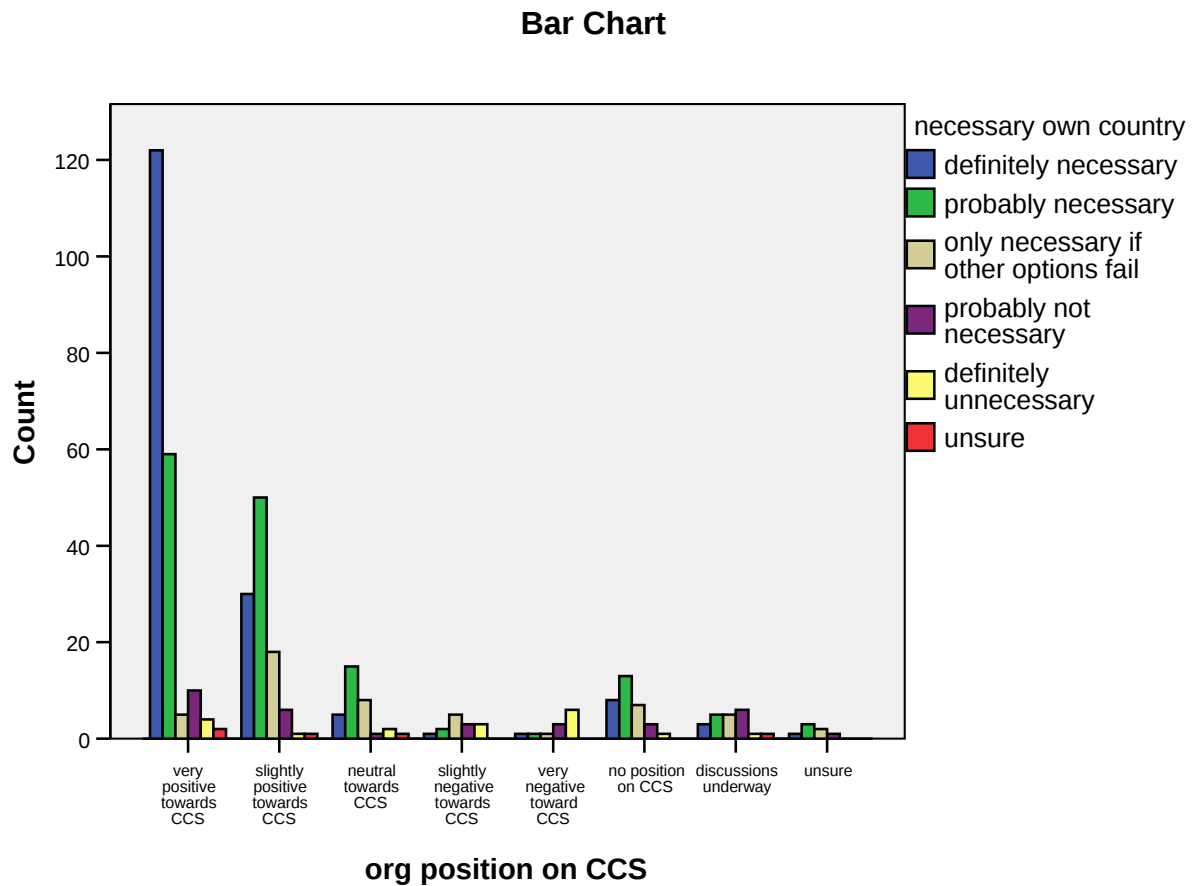


Figure 129: Correlation between organization position on CCS (question 6) and the perceived need for CCS in own country (question 8, part 1) (correlation 0.479, significant at p value of 0.01)

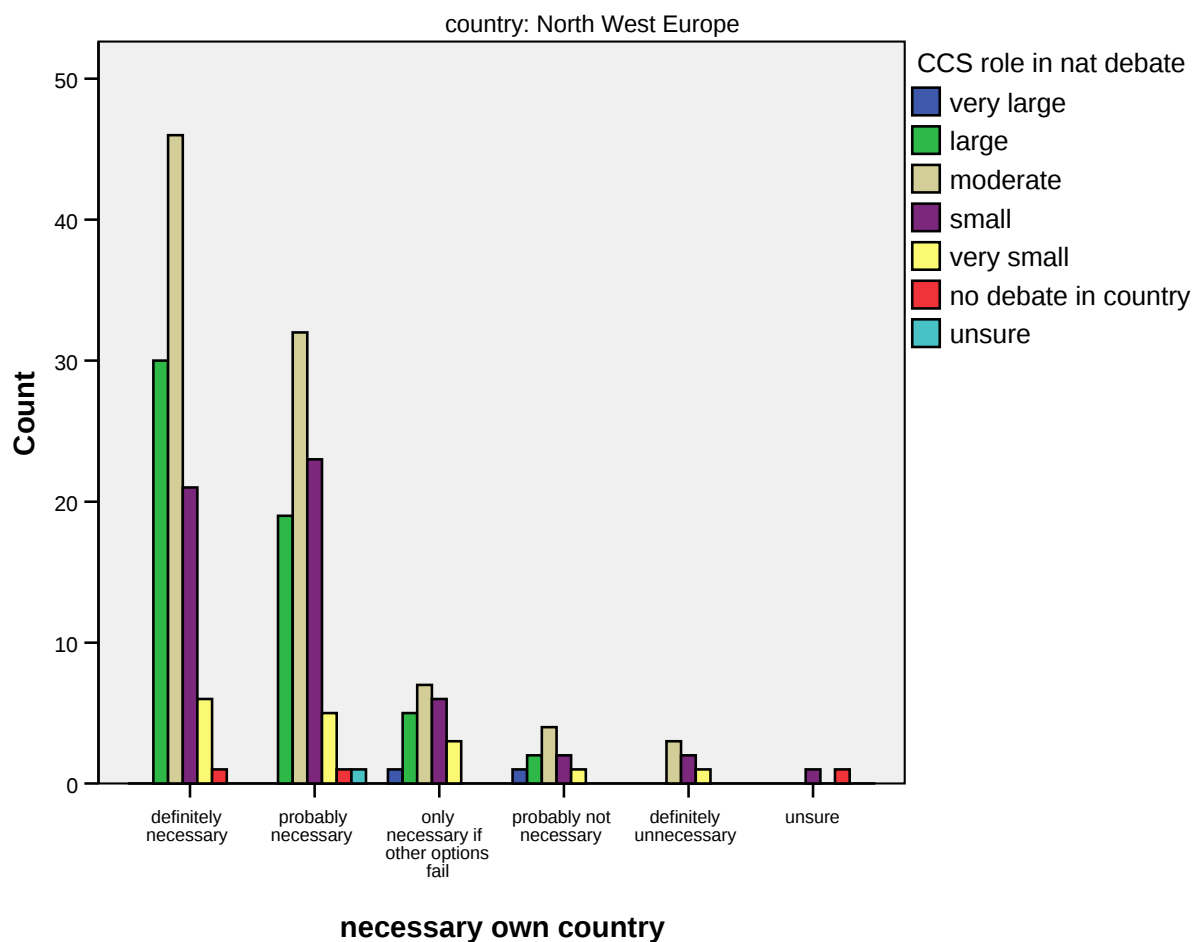


Figure 130: Cross-correlation between need for the perceived need for CCS in own country (question 8, part 1) and perceived role of CCS in national climate change debate (question 9) for North West Europe (correlation 0.053, not significant)

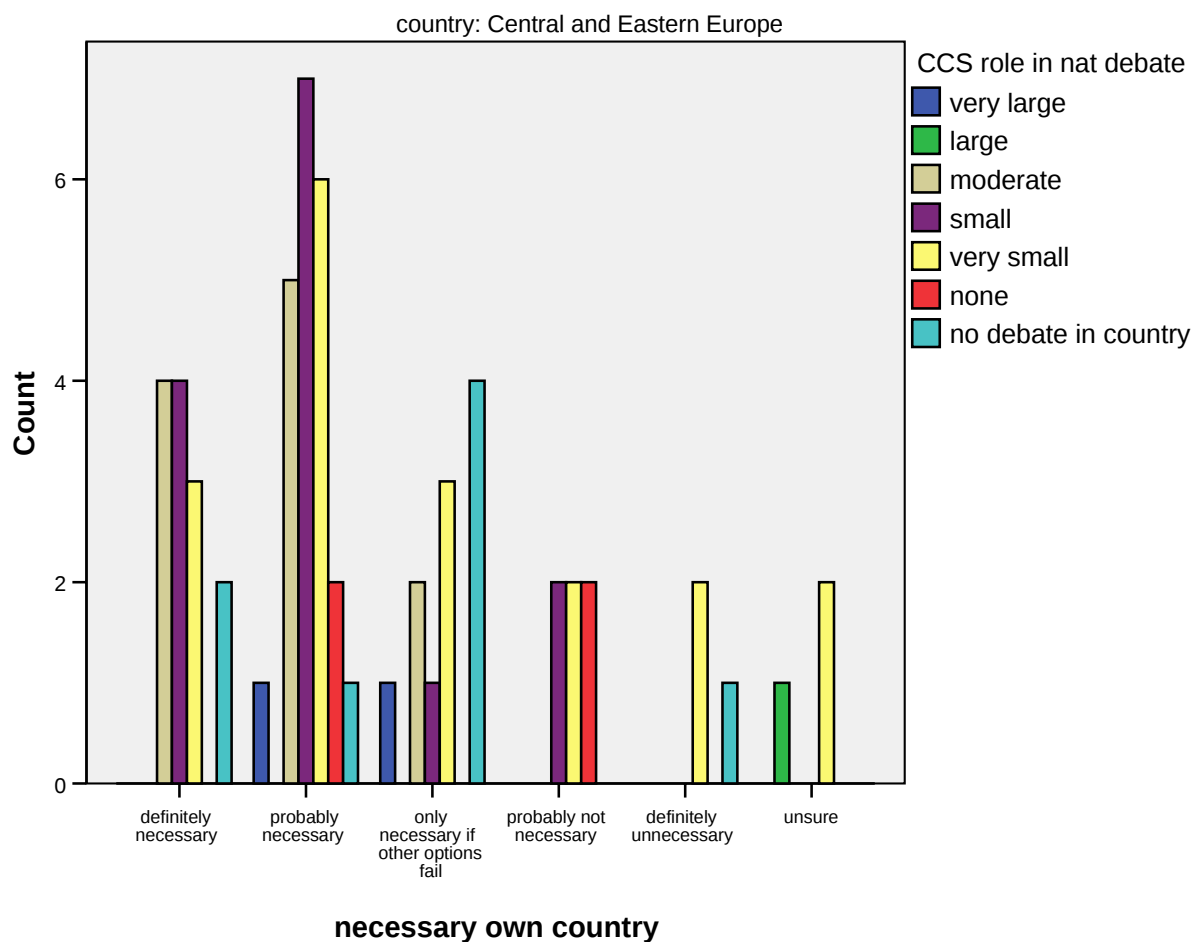


Figure 131: Cross-correlation between need for the perceived need for CCS in own country (question 8, part 1) and perceived role of CCS in national climate change debate (question 9) for Central and Eastern Europe (correlation 0.301, significant at p value of 0.05)

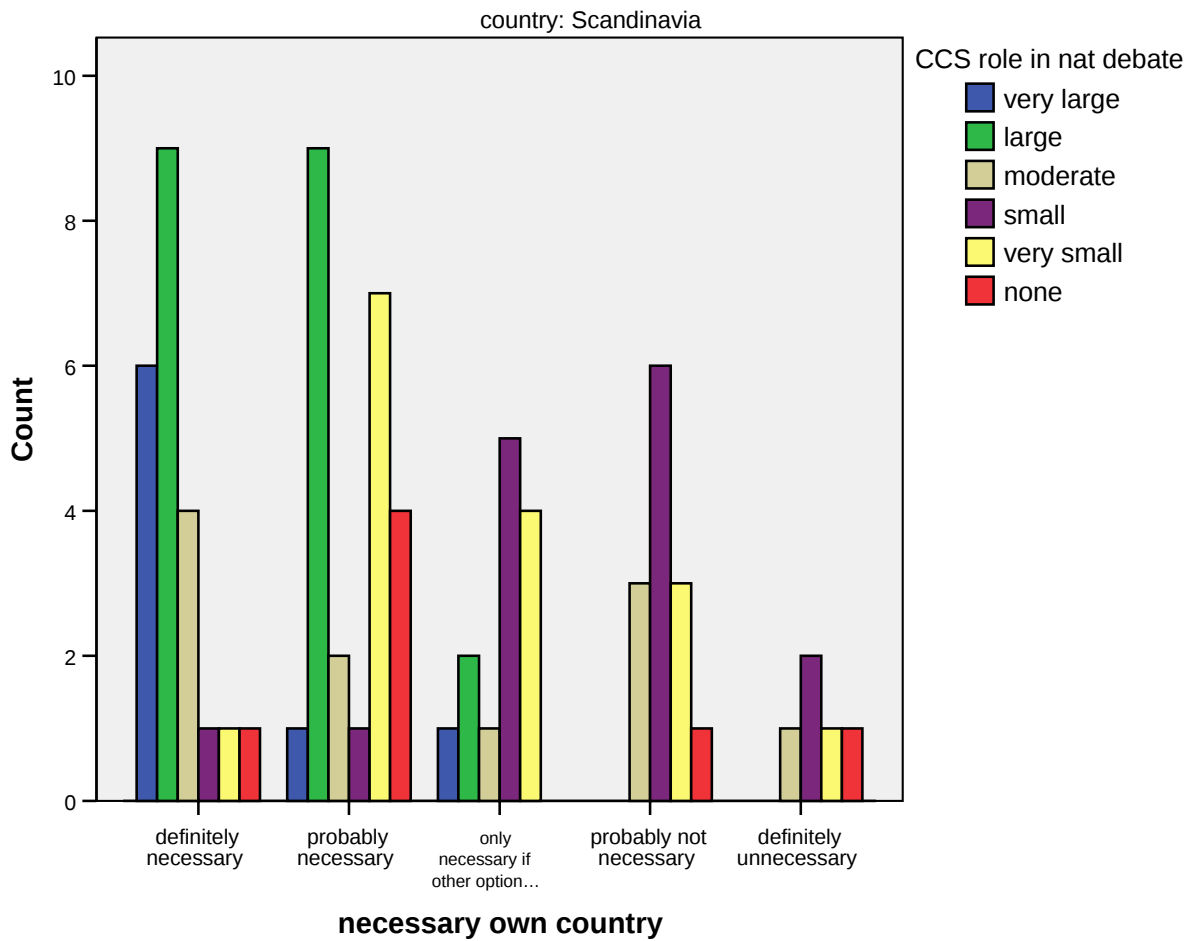


Figure 132: Cross-correlation between need for the perceived need for CCS in own country (question 8, part 1) and perceived role of CCS in national climate change debate (question 9) for Scandinavia (correlation 0.434, significant at p value of 0.01)

Limitations of the Survey

The survey has a number of limitations.

- 1) The number of respondents in most countries is too small to allow meaningful analysis of differences in perceptions between most of the EU25 countries (see figure 5). With larger samples it would be possible to undertake more detailed analysis of national variations and to explore underlying reasons for these differences.
- 2) The number of respondents in different stakeholder groups is unevenly spread (see figure 2). In particular, there was a lack of response from NGOs, non-energy industry, government officials (with exception of geological surveys) and parliamentarians. With a more even response across stakeholder groups and countries, it would be possible to have more confidence in the findings that are

presented here. Clearly, there is a much smaller population of NGOs than of energy sector respondents, so we would not anticipate equal numbers.

Conclusions

The overwhelming response of stakeholders in this survey was mildly to strongly positive towards CCS. This and all the results must be interpreted in the context of the sample, which is largely made up of professionals working in the energy sector and research, most of whom have at least some CCS component to their work. Hence, three-quarters of the organizations for which the respondents work adopt a positive attitude towards CCS. The perceptions collected in the survey largely reflect and confirm this positive outlook towards CCS.

Where the sample is split into stakeholder groups, we find that NGOs and, to a lesser extent, parliamentary stakeholders have quite different perceptions of CCS than the energy industry, governmental or academic stakeholders. NGOs are much less enthusiastic regarding CCS, more concerned about the potential risks to the environment, health and safety arising from CCS, consider that investment in CCS will deter investment in other low- and zero-carbon energy technologies and in energy efficiency and demand reduction measures and will inhibit the move towards a more decentralized power generation system. In summary, many NGOs are skeptical as to the future role of CCS in creating a sustainable energy system. We can term this a **'critical observer'** position. Parliamentary respondents are not as skeptical as NGOs and are more ambivalent or neutral regarding the potential role and impacts of CCS; their opinions tend to be in between those of the energy, research and government stakeholders, on the one hand, and the NGOs, on the other.

Likewise, we have also identified some interesting differences across the countries surveyed. To be more confident that these differences are meaningful, and not anomalous, it would be desirable to increase the sample sizes. In the current report only eight countries have been compared due to small sample sizes. If larger number of respondents were obtained across the range of countries, then it would be possible to extend the comparison of country-level responses. It would also be possible to test the relationships between responses at the national level and other characteristics of those countries. It might also be possible to cluster countries in terms of their response patterns. This has only been possible to a limited extent in the current report.

The opinions of stakeholders in different countries tend to reflect the different state of play on CCS in those countries. Hence, Norway and, to a lesser extent, the UK and Netherlands, tend to show a more pro-active and engaged response. There is generally more optimism in these countries that CCS will be deployed without major impediments, that it is a 'good thing' with manageable risks and that the public will not object. These three countries stand out as being those in which CCS is probably furthest developed and most widely debated within the climate change and energy communities. Norway is a major oil and gas producing nation, the UK also produces oil and gas and retains a coal mining industry, and the Netherlands is a major producer of natural gas. All three also border the North Sea, which is a large potential repository for millions of tons of CO₂. This means that all three countries

enjoy major opportunities for CO₂ storage in onshore and / or offshore sites and also have oil and gas industries which are capable of taking advantage of CCS, i.e. their industries have the skills and human resources necessary for implementation of CCS. A further important factor to note is that Norway, UK and Netherlands have strong domestic commitments to take action on climate change. The economic conditions in the three countries is also promising, with Norway one of the wealthiest countries in the world, and the UK and Netherlands both having experienced reasonably healthy economic growth over the past decade. We can term the position of energy, research and government stakeholders in these countries one of **‘developer optimism’**.

Respondents from most other countries were more ambivalent in their opinions, sometimes more positive regarding CCS but also often ‘neutral’ or slightly negative. For example, there was a noticeable streak of scepticism in other Scandinavian countries (Sweden, Finland, Denmark), Germany and Belgium regarding aspects of CCS such as the potential risks, impacts on development of other low-carbon technologies and so forth.

By dividing the sample into four regions (North West Europe, Southern Europe, Central and Eastern Europe and Scandinavia) we were able to identify significant differences between opinion on CCS in Central & Eastern Europe and in other parts of Europe. There was less enthusiasm for CCS and greater concern about the potential risks and potential adverse impacts of CCS from respondents in Central & Eastern Europe. To some extent, the perception of greater risks could be an indication of lack of knowledge, since the CCS debate is much less advanced in Central & Eastern Europe than in most other regions. It is some what difficult to understand why academics, government officials and energy sector respondents from Central and Eastern Europe should regard the risks of CCS as being greater than do the same types of stakeholder in other parts of Europe and lack of knowledge and familiarity could certainly be one explanation.

The Central & Eastern European countries are also those which appear in the Low GDP per capita group (<\$19K), with the exception of Austria. Many of these countries have been suffering from relatively high unemployment and have required extensive structural economic reforms. What is more, most of these countries have already met their Kyoto emission targets, due to economic restructuring since 1990. Measured against their Kyoto targets, the current state of emissions reductions are as follows: Czech Republic (reduction of -25% against a target of -8%), Estonia (-50% against a target of -8%), Hungary (-32% against a target of -6%), Latvia (-58% against a target of -8%), Poland (-32% against a target of -6%) and Slovakia (-30% against a target of -8%).⁸ There is, therefore, no need for CCS (or indeed any other low-carbon technologies) to meet current Kyoto targets in Central and Eastern European countries. Given this combination of circumstances, it is understandable that CCS does not currently feature as a major option for Central and Eastern European countries.

It is also interesting to note that CCS does not appear as a more important option for some other EU countries which are struggling to meet their targets adopted as part of the so-called ‘EU bubble’ target.. Member states that are currently furthest from their Kyoto targets include: Austria (16% increase in emissions since 1990 relative to target of -13%), Denmark

⁸ Data provided by the European Environmental Agency, 2006.

(-2% relative to -21%), Finland (+14% relative to target of 0%), Ireland (+23% relative to target of +13%), Portugal (+41% relative to target of +27%), Italy (+12% relative to target of -6.5%) and Spain (+48% relative to +15%).⁹ On the other hand, there may, of course, be other reasons why certain countries find CCS appropriate or desirable (e.g. availability of geological storage sites, characteristics of the power sector, presence of oil, gas or coal industries, domestic priority placed on taking action on global climate change, and so on). In any case, CCS is an option which will be employed for emissions reductions not to any extent in the Kyoto reporting period, but post-Kyoto. Hence, interest in CCS from countries that are currently more or less on track to meet their Kyoto targets such as Germany, Sweden and the UK reflects the need for much larger CO₂ reductions in those countries in the post-Kyoto commitment period.

The responses of some respondents reflected the particular resources available in their country. For example, we tended to find that countries with domestic supplies of coal regarded this as a more important factor enabling the development of CCS than countries without their own coal supplies. Likewise, oil and gas producers tended to regard Enhanced Oil and Gas Recovery as a more important enabling factor for CCS than countries without their own oil and gas reserves. These responses may be explained in part by greater awareness and knowledge, but there may also be an element of 'self-interest' involved, i.e. the perception that the particular country (or industry or sector in that country) will stand to gain from implementation of CCS as a carbon mitigation option on an equal footing to other options such as renewables.

We find weak to moderate evidence that those more in favour of CCS tend to regard specific risks and impacts of CCS more benignly. However, it is not possible to know the direction of causality. It may be that the benign perception of risks and impacts of CCS is what results in the respondent's overall perception that CCS is required as a carbon mitigation option (rather than the causality being the other way around). There are almost certainly other factors contributing to the respondent's perceptions and opinions which have not been analyzed in the survey. One interesting finding was that the general trend tended to break down for those respondents who spent more than 50% of their time on CCS. One might therefore conclude that those most involved in CCS research are probably not unduly biased in favour of CCS, or 'self-serving' in presenting CCS in a more attractive light than respondents who are less involved in working on CCS. This could reflect the greater knowledge of uncertainties, risks and challenges facing implementation of CCS on the part of those who are most actively involved in CCS issues, whether as researchers, developers, government officials or NGOs.

Further Research Questions Arising from the Survey

Some of the interesting questions which have arisen from this report are listed below.

- Why do stakeholders not regard energy security as being a particularly important enabling factor for CCS development in their home country? (question 11)

⁹ Data provided by the European Environmental Agency, 2006.

- Why do stakeholders not regard EOR / EGR as being a particularly important enabling factor for CCS development in their home country? (question 11)
- Why do NGOs think that public perceptions are less important to development of CCS than do energy and government stakeholders? (question 11)
- Why are NGOs some what sceptical of the use of CCS within the CDM? (question 11)
- Why do energy industry stakeholders think that the development of LZCTs are less important to development of CCS than other stakeholder groups? (question 11).
- What explains the different national stances taken on the issue of incentives for CCS (question 12)? For example, why do Danish, Dutch and British respondents prefer a more generous approach to CCS, compared to more divided responses in Germany and Norway.
- Why are Danish and German respondents so sceptical about guaranteed feed-in price tariffs for CCS? (question 13)
- What explains the different national stances taken on the issue of incentives? E.g. Norway, Poland, Sweden and Spain prefer EU-wide incentives, whereas UK, Denmark, Germany and Netherlands prefer common EU price for CO₂ plus national incentives (question 13)
- Why are the Norwegian respondents so opposed to regulation through EU-wide standardization? (question 15)
- Why are NGOs opposed to regulation through EU harmonization with national implementation?
- What are NGO respondents main concerns about enhanced hydrocarbon recovery using CO₂? (question 16)
- Why do energy industry, government and some academic stakeholders consider that CCS development will assist the development of Low- and Zero-Carbon Energy Technologies (LZCTs)? (question 17).
- Why do energy industry, government and some academic stakeholders consider that CCS development will assist in the achievement of energy efficiency and energy demand reduction? (question 17).
- Why do some UK respondents consider that CCS could stimulate decentralized energy systems? (question 19)

- Why do Norwegian, Danish and British respondents show less concern regarding the potential for natural gas with CCS to reduce energy security than most other respondents? Why do some stakeholders from these countries think that gas with CCS will actually enhance energy security? (question 20).
- Why are Norwegian, Dutch and British stakeholders so much more confident that CCS will receive a largely positive public reception in their countries compared to stakeholders from other countries? (question 21)
- Why do NGO and parliamentary stakeholder groups consider that the public will neither be positive nor negative regarding CCS development? (question 21)
- Why do stakeholders generally believe that CCS will be more strongly supported by the public at the scale of the EU rather than in their home country? (question 21)

The Role of Carbon Dioxide Capture and Storage in Europe's Energy Future

A questionnaire to support research commissioned by DG Research of the European Commission.

All information provided will be treated with the strictest confidence and only reported in aggregate. Please contact Simon Shackley (simon.shackley@mbs.ac.uk) if you have any further questions related to the ACCSEPT project.

Part A: About You and Your Organisation

In this section we ask some questions about your occupation and the organisation for which you work.

Question 1: What is your name?

Question 2: What organisation do you work for?

Question 3: What is your job title?

Question 4: How much of your working time (expressed as a percentage) is spent on average on issues directly or indirectly concerned with energy?

- | | |
|---------------|-----------------------|
| 90 to 100% | ☐ |
| 70 to 90% | ☐ |
| 50 to 70% | ☐ |
| 30 to 50% | ☐ |
| 10 to 30% | ☐ |
| less than 10% | ☐ |

Question 5: How much of your working time (expressed as a percentage) is spent on average on issues directly concerned with CO₂ capture and storage (CCS)?

- 90 to 100% ☐
- 70 to 90% ☐
- 50 to 70% ☐
- 30 to 50% ☐
- 10 to 30% ☐
- less than 10% ☐

Question 6: If your organisation has a position on CCS, which of the following best describes it?

Please mark the statement that comes closest to your opinion. (Only one alternative should be marked)

- Very positive toward CCS ☐
- Slightly positive toward CCS ☐
- Neutral toward CCS ☐
- Slightly negative toward CCS ☐
- Very negative toward CCS ☐
- No position on CCS ☐
- Discussions underway ☐
- Unsure ☐

Question 7: Which of the following do you consider to be the major reason(s) for your organisation's position on CCS?

Please mark all concerns that you consider applicable, i.e. more than one term may be marked.

Economic considerations

- Relatively low-cost of CCS as a climate change mitigation measure ☐
- Relatively high-cost of CCS as a climate change mitigation measure ☐
- Business opportunity ☐
- Business risk ☐
- Regulatory and legal uncertainty ☐
- Other (please write in the space below) ☐

Question 7 continues onto the next page

Policy and strategic considerations

- Other available measures for mitigating climate change are less effective ☐
- Other available measures for mitigating climate change are more effective ☐
- CCS would allow continued use of fossil fuels ☐
- CCS helps to improve energy security ☐
- CCS is important in international negotiations ☐
- The potential magnitude of CO₂ emission reductions from CCS ☐
- The potential for CCS to make deep and rapid cuts in CO₂ emissions ☐
- CCS could discourage other climate change mitigation measures such as renewables ☐
- Other (please write in the space at the bottom of the page) ☐

Social and environmental considerations

- Risk to the environment ☐
- Risk to human health ☐
- Public likely to accept CCS more readily than other low-carbon options ☐
- Public less likely to accept CCS than other low-carbon options ☐
- Other (please write in the space below) ☐

- Unsure ☐

Continue to Part B on the next page

Part B: The Contribution of CCS in Meeting Europe's Future Energy Requirements

Here we are interested in your opinion of the extent to which CCS might help address the challenges facing the energy future in your own country and in the EU as a whole, assuming that appreciable cuts in carbon dioxide emissions will be required.

Question 8: Is wide-scale implementation of CCS required to achieve deep reductions in CO₂ emissions between now and 2050 in your own country, the EU and at the global scale?

Please mark the statement that comes closest to your opinion. (Only one alternative should be marked for each column)

The implementation of CCS is:	Your country	EU	Globally
Definitely necessary	☐	☐	☐
Probably necessary	☐	☐	☐
Only necessary if other options fail to live up to current expectations	☐	☐	☐
Probably not necessary	☐	☐	☐
Definitely unnecessary	☐	☐	☐
Unsure	☐	☐	☐

Question 9: How would you characterise the role that CCS plays in the current national climate change debate in your country?

Please mark the option that comes closest to your opinion. (Only one alternative should be marked)

Very large	☐
Large	☐
Moderate	☐
Small	☐
Very small	☐
None	☐
There is no national climate change debate in my country	☐
Unsure	☐

Question 10: Do you believe that the role of CCS is increasing or decreasing in the national climate change debate in your country?

Please mark the option that comes closest to your opinion. (Only one alternative should be marked)

- | | |
|--------------------------|-----------------------|
| Increasing substantially | ☐ |
| Increasing slightly | ☐ |
| Staying the same | ☐ |
| Decreasing slightly | ☐ |
| Decreasing substantially | ☐ |
| Unsure | ☐ |

Part C: The Enabling Context for CCS and Incentive Regimes

In this section we ask for your opinion of the different factors that are influencing the development of CCS (positively or negatively) within your own country and in the EU. We then enquire about the appropriateness of different incentives mechanisms and schemes.

Question 11: How important are the following factors in helping to explain the current and future development of CCS technology in your country? Please indicate your response for each factor. (Question 11 continues on to the next page).

Factor	Very important	Important	Not that important	Not at all important	Unsure
The price of carbon under the EU Emissions Trading Scheme (EU ETS)	☐	☐	☐	☐	☐
Availability of venture capital	☐	☐	☐	☐	☐
Concerns about energy security	☐	☐	☐	☐	☐
The need to replace ageing power plant	☐	☐	☐	☐	☐
Opportunities for Enhanced Oil / Gas Recovery with CO ₂	☐	☐	☐	☐	☐
Reduction in costs of CO ₂ capture	☐	☐	☐	☐	☐
Development of the hydrogen economy	☐	☐	☐	☐	☐

Factor	Very important	Important	Not that important	Not at all important	Unsure
Development of the research and technological base for CCS	☐	☐	☐	☐	☐
Availability of domestic supplies of coal	☐	☐	☐	☐	☐
Availability of suitable geological storage sites	☐	☐	☐	☐	☐
Development of other zero- or low-carbon energy generation technologies	☐	☐	☐	☐	☐
Existence of relevant skills base	☐	☐	☐	☐	☐
Kyoto Protocol commitments	☐	☐	☐	☐	☐
A post-Kyoto phase with tighter national emission reduction requirements	☐	☐	☐	☐	☐
Negotiating stance and policy of the USA	☐	☐	☐	☐	☐
Negotiating stance and policy of China and India	☐	☐	☐	☐	☐
Development of legal and regulatory basis for CCS (including accounting, monitoring and liability)	☐	☐	☐	☐	☐
Eligibility of CCS for the Clean Development Mechanism (CDM) and/or Joint Implementation	☐	☐	☐	☐	☐
Public perceptions of CCS	☐	☐	☐	☐	☐

Question 12: What is your view on providing financial incentives for CCS, similar to those used in some countries to support renewable energy?

Please mark the statement that comes closest to your opinion. (Only one alternative should be marked).

Incentives for CCS:

- Are needed at a level comparable to renewables ☐
- Are needed, but at a lower level than for renewables ☐
- Are needed, but at a higher level than for renewables ☐
- Are not needed ☐
- Unsure ☐

Question 13: If a policy for supporting CCS was to be agreed in your country, what is your opinion of the following mechanisms for providing incentives to companies? (Further information on the mechanisms is provided in the Fact Sheet).

Please indicate your response to each of the incentive options

Incentive options for promoting CCS	Like it a lot	Like it somewhat	Neither like or dislike	Dislike a bit	Dislike a lot	unsure
A requirement for electricity generators to supply a given % of zero- or low-carbon electricity through use of CCS	☐	☐	☐	☐	☐	☐
A requirement for electricity generators to supply a given % of zero- or low-carbon electricity (all sources)	☐	☐	☐	☐	☐	☐
A guaranteed feed-in price for electricity produced by CCS	☐	☐	☐	☐	☐	☐
A capital subsidy scheme to support construction of CCS plant	☐	☐	☐	☐	☐	☐
An economy-wide carbon tax	☐	☐	☐	☐	☐	☐
An early commitment to extend the EU ETS beyond 2012 with tighter emission caps	☐	☐	☐	☐	☐	☐
Support for Research, Development and Demonstration projects	☐	☐	☐	☐	☐	☐

Question 14: How important is it that any incentives scheme is made applicable at the EU scale rather than applying only within different national jurisdictions?

Please mark the statement that comes closest to your opinion. (Only one alternative should be marked)

- The same incentives should be applied across all EU25 ☐
- A common price for CO₂ across the EU25 through the EU ETS but then additional incentives are left to national governments ☐
- Incentives should be left to national governments, with phasing out of the EU Emissions Trading Scheme beyond 2012 ☐
- Unsure ☐

Question 15: How do you think CCS should be regulated?

Please mark the statement that comes closest to your opinion. (Only one alternative should be marked).

- Through an internationally agreed set of standards ☐
- Through an agency of the EU Commission ☐
- EU wide standardisation of standards but implemented nationally ☐
- Information sharing between member states but governed by each state's regulatory system ☐
- Unsure ☐

Continue to Part D on the next page

Part D: The Potential Risks of CCS

In this section we are interested in your opinion of the potential risks to the environment, health and safety arising from CCS, in addition to the possible effects of CCS upon the development of other low-carbon energy options.

Question 16: In your opinion which of the following potential risks to health, safety and environment arising from CCS is of most importance?

Please indicate your response to each of the potential risks listed below.

Potential risks arising from CCS	Very serious risk	Moderate risk	Minimal risk	No risk	unsure
impacts arising from additional extraction of fossil fuels to compensate for the energy penalty associated with CO ₂ capture	☐	☐	☐	☐	☐
accidents arising from inclusion of CO ₂ capture at power stations	☐	☐	☐	☐	☐
impacts of new CO ₂ pipeline network on landscape and environment	☐	☐	☐	☐	☐
human health and safety risks from leakage from CO ₂ pipelines	☐	☐	☐	☐	☐
human health and safety risks from onshore CO ₂ storage site leakage	☐	☐	☐	☐	☐
local environmental damage from onshore CO ₂ storage site leakage	☐	☐	☐	☐	☐
human health and safety risks from offshore CO ₂ storage site leakage	☐	☐	☐	☐	☐
local environmental damage from offshore CO ₂ storage site leakage	☐	☐	☐	☐	☐
global climate impacts from CO ₂ storage site leakage	☐	☐	☐	☐	☐
global climate impacts due to additional greenhouse gas emissions resulting from enhanced hydrocarbon recovery	☐	☐	☐	☐	☐
impacts of CO ₂ storage upon drinking water reservoirs	☐	☐	☐	☐	☐
impacts of CO ₂ storage upon micro-organisms within the storage site	☐	☐	☐	☐	☐

Question 17: In your opinion will investment in CCS deter investment in other zero- and low-carbon electricity and energy generation options (e.g. renewable energy) in your own country?

Please mark the statement that comes closest to your opinion. (Only one alternative should be marked)

Investment in CCS is likely to:

- have a significant negative impact upon investment in other zero- /low-carbon energy technologies ☐
- have a minor negative impact upon investment in other zero-/low carbon energy technologies ☐
- have no effect (provided that CCS is not given special treatment) ☐
- have a minor positive impact upon investment in other zero-/low-carbon energy technologies ☐
- have a significant positive impact upon investment in other zero- /low-carbon energy technologies ☐
- Unsure ☐

Question 18: In your opinion will investment in CCS reduce effort spent on improving energy efficiency and on reducing energy demand in your own country?

Please mark the statement that comes closest to your opinion. (Only one alternative should be marked)

Investment in CCS is likely to:

- have a significant negative effect upon energy efficiency / demand reduction ☐
- have a small negative effect upon energy efficiency / demand reduction ☐
- have no impact on energy efficiency / demand reduction ☐
- have a small positive effect upon energy efficiency / demand reduction ☐
- have a significant positive effect upon energy efficiency / demand reduction ☐
- Unsure ☐

Question 19: Use of CCS might make us more dependent upon a centralised power generation system. What is your opinion of CCS and its impact on decentralised power generation over the next 20 to 40 years, in particular that from renewable sources?

Please mark the statement that comes closest to your opinion. (Only one alternative should be marked)

CCS as a centralised form of energy generation will:

- have a very negative impact upon decentralised power generation ☐
- have a slightly negative impact upon decentralised power generation ☐
- have no impact on decentralised power generation ☐
- have a slightly positive impact upon decentralised power generation ☐
- have a very positive impact upon decentralised power generation ☐
- unsure ☐
- other (please write in the space below)

Question 20: Greater use of fossil fuels could increase the European Union's dependence upon (non-EU) coal- and gas-exporting countries which are politically unstable and decrease the reliability of the fuel supply chain. Since CCS allows use of fossil fuels alongside appreciable cuts in CO₂ emissions could extensive use of CCS therefore result in less energy security?

Please mark the statement that comes closest to your opinion. (Only one alternative should be marked for each column)

The use of CCS will:

- | | Coal with
CCS | Gas with
CCS |
|--|--------------------------|-------------------------|
| increase reliance upon fossil fuel imports from unstable countries
reducing Europe's energy security | ☐ | ☐ |
| have no impact upon Europe's energy security | ☐ | ☐ |
| increase reliance upon fossil fuel imports from stable countries,
improving Europe's energy security | ☐ | ☐ |
| reduce reliance upon fossil fuel imports from unstable countries,
improving Europe's energy security | ☐ | ☐ |
| unsure | ☐ | ☐ |
| other (please write in the space below) | ☐ | ☐ |

Question 21: What is your opinion of potential public perceptions regarding CCS, both in relation to the EU and to your own country?

Please mark the statement that comes closest to your opinion. (Only one alternative should be marked for each column)

The public reaction to CCS will be:	Your country	EU
strongly supportive	☐	☐
moderately supportive	☐	☐
on balance, neither positive nor negative	☐	☐
moderately opposed	☐	☐
strongly opposed	☐	☐
unsure	☐	☐

Please
include any
additional
response
here

Question 22: Which factors do you think are most likely to influence public perceptions regarding CCS in your country?

Please mark all those statements that you agree with.

- the views of major opinion formers, e.g. the media, politicians and NGOs ☐
- success or failure of early projects ☐
- the perceived urgency of responding to climate change ☐
- evidence of the security of storage ☐
- impact on electricity prices ☐
- local siting issues involving the public which lives close to CCS developments (infrastructure and storage sites) ☐
- unsure ☐

The End

Fact sheet on Carbon Dioxide Capture and Storage (CCS)

Below we present a summary of key issues related to CCS. For more detailed information please see the Special Report on *Carbon Dioxide Capture and Storage* produced by the Intergovernmental Panel on Climate Change (IPCC) in 2005. The Summary (in French, Spanish and Russian in addition to English) and the full report (in English) are available at the following site:

http://arch.rivm.nl/env/int/ipcc/pages_media/SRCCS-final/IPCCSpecialReportonCarbondioxideCaptureandStorage.htm

or by following links at: www.ipcc.ch

Policy Context

The European Community and its Member States are signatories to the United Nations Framework Convention on Climate Change (UNFCCC). A key aim of the treaty (Article 2) is: “stabilisation of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system”. The EU Council of Ministers has agreed that a mean 2°C rise in global temperature represents the limit which should not be exceeded. The Council has stated that, in line with that limit, reductions in developed country greenhouse gas emissions of between 15 and 30% below 1990 levels will likely be required by 2020, while the Environment Council noted the probable need for a global reduction of up to 50% in greenhouse gas emissions by 2050.

The European Community and its Member States have also ratified the Kyoto Protocol under the UNFCCC, requiring reductions in greenhouse gas emissions in the period 2008-2012. As one mechanism for meeting this target, the EU Emissions Trading Scheme (EU ETS) was established in 2005 for thousands of installations in Europe, for instance steel factories, refineries, and power plants larger than 20 Megawatts in size. The EU ETS covers about 45% of all EU CO₂ emissions (the other 55% of emissions are from other industrial sectors, transport and households). The second phase of the EU ETS will run from 2008-2012, concurrent with the ‘first commitment period’ of the Kyoto Protocol, and the system is designed to continue beyond 2012.

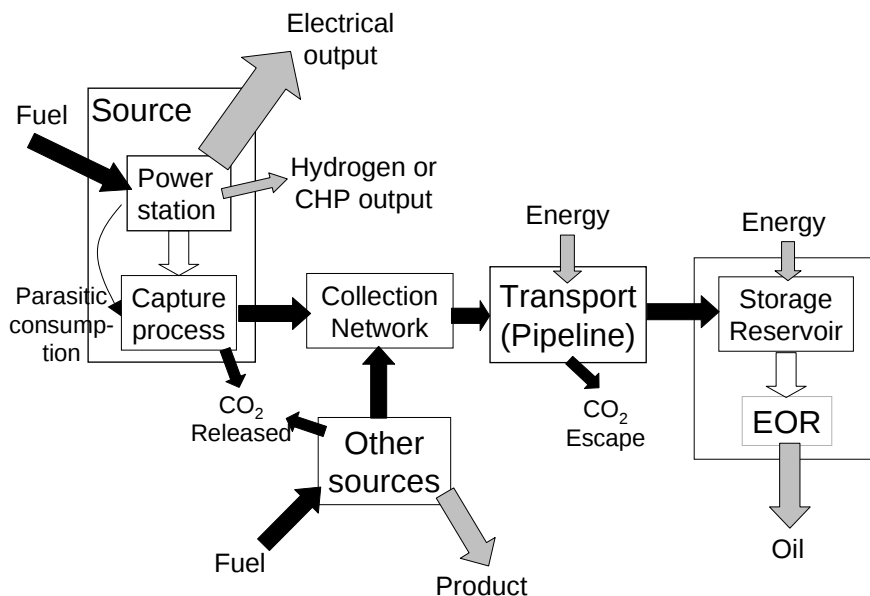
Overview of Concepts and Technologies behind CCS

CO₂ capture and storage or CCS is the removal of carbon dioxide from the emissions arising from power plants or from other large ‘point sources’ of CO₂ such as cement works or steel plants. The CO₂ is then compressed and transported as a liquid for storage in a suitable geological structure. Figure 1 shows the CCS process, whilst Figure 2 on the final page is a pictorial representation.

CCS can, in theory, be applied to all processes using fossil fuels (coal, gas and oil) and biomass. It can therefore be said to permit the continued use of fossil fuels whilst still limiting CO₂ emissions into the atmosphere. CCS is most often discussed in combination with coal. The amount of carbon contained in known coal reserves far exceeds the quantity which can be safely released into the atmosphere if dangerous levels of climate change are to be avoided. In addition to generating electricity from coal, liquid fuels such as hydrogen can be created from coal. Such

coal-derived fuels could be used not only in transportation but also in meeting domestic heating and cooling demands. Because their manufacture from fossil fuels is energy-intensive, however, such new fuels would end up contributing to human-induced climate change unless CCS is employed.

Figure 1: The Carbon Dioxide Capture and Storage Process



There are four major possible storage sites for the captured CO₂: i) depleted oil and gas reservoirs; ii) still operational oil and gas fields with the CO₂ being used for enhanced oil (or gas) recovery; iii) saline formations, which are porous rocks that currently contain very salty water; and iv) unmineable coal beds, in which the CO₂ attaches via a chemical reaction to the coal's surface. The first three types of storage can be located onshore or offshore. Coal beds are more commonly onshore.

The capacity of potential reservoirs globally is not known with any degree of accuracy but is likely to be sufficient to allow CCS to play a major role in reducing CO₂ emissions in many countries. For example, in the UK the storage sites examined in detail have a large enough capacity that they can store all of the CO₂ arising from electricity generation (at present levels) for at least the next 50 years. For Norway and the Netherlands, similar numbers have been published.

Much work is underway on assessing the risks arising from potential leakage of CO₂ from the geological storage sites. Such risks are site-specific and detailed risk assessment on a site-by-site basis will be necessary. Natural gas and CO₂ have remained trapped in geological formations for millions of years, so there are good reasons for believing that storage sites can be chosen that would hold CO₂ for the very long timescales required for climate change mitigation purposes. Questions remain regarding the integrity of existing borehole seals and more research will be

required to better understand the risks. An appropriate regulatory regime will include site-specific requirements for monitoring during and probably also following injection. Very minor leakage might be tolerated both in terms of local environmental impacts and global climate change impacts, but this depends on the careful assessment of risks to human health and safety and ecosystems arising from leakage from sites.

Costs

It is nearly always more expensive to use CCS than to allow the CO₂ to escape to the atmosphere. This is because the capture of the CO₂ requires a large installation and uses up energy – a so-called ‘energy penalty’ – for the separation and compression of the CO₂. The only reason to implement most applications of CCS therefore is to reduce CO₂ emissions to limit climate change. The capture installation can remove 85 to 95% of the CO₂ from the flue gas. Taking into account the energy penalty of 10 - 40%, which varies greatly depending upon the CO₂ capture method, the power plant design and age and other local conditions, the CO₂ reduction drops to 80 to 90% per unit of output. A summary of the costs of CCS is provided in Table 1. Expressed as the cost of avoiding a tonne of CO₂ emissions, the additional costs for most of these CCS technologies are in the same order of magnitude as many renewables and new nuclear build. The cost of electricity with CCS would increase by approximately 2 to 3 cents per kWh. Depending on the price paid by the end-consumer, this represents an increase in price of between 20 and 80%.

Table 1: Range of total costs for CO₂ capture, transport and geological storage based on current technology for new power plants (in € 2002)

Power plant with capture and storage	Pulverised coal power plant	Natural gas combined cycle plant	Integrated coal gasification combined cycle plant
Cost of electricity <i>without</i> CCS per MWh (in €)	43-52	31-50	41-61
Cost of electricity per MWh <i>with</i> CCS (in €)	63-99	43-77	55-91
Electricity cost increase per MWh (in €)	19-47	12-29	10-32
% increase in costs with CCS	43-91%	37-85%	21-78%
Cost per tonne CO ₂ avoided (in €)	30-71	38-91	14-53

Source: adapted from Table 8.3a, page 347, IPCC (2005)

Incentives

Because electricity generation with CCS always costs more than equivalent generation without it CCS will only take place if there are specific financial incentives. The one exception to this is where cheap CO₂ capture can be combined with Enhanced Oil Recovery, though this is likely to be limited to a relatively few locations. Furthermore many companies will require financial incentives which take account of the relatively high business risk associated with the implementation of CCS due to, e.g., technological, market and policy uncertainties. The EU Emissions Trading Scheme is one such incentive scheme but the price it gives for a tonne of CO₂ abatement (between 10 and 30 euros per tonne CO₂) is lower than the (current) real cost of CCS per tonne of CO₂ especially when there is no guarantee that those prices will be as high over the entire lifetime of the CCS project. Hence some further incentive is likely to be required. The following incentive mechanisms have been proposed.

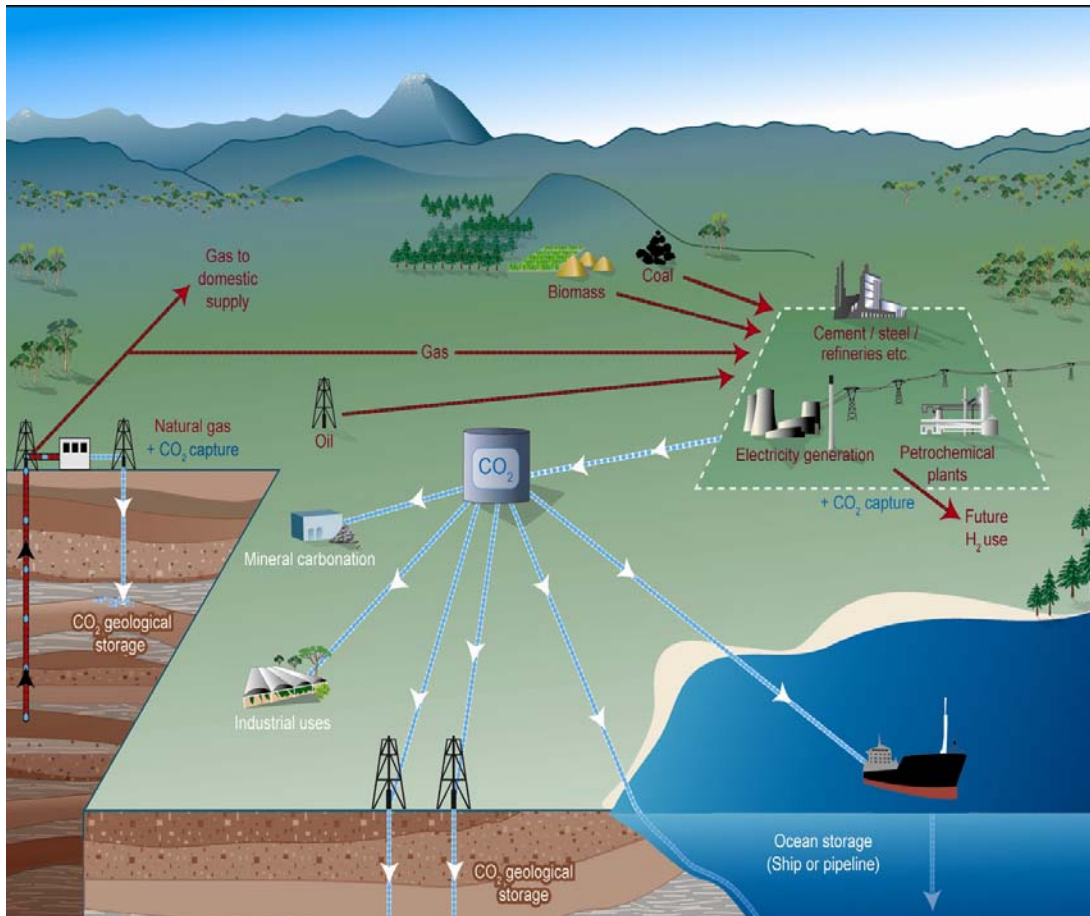
- a) A subsidy scheme whereby producers of electricity using CCS are provided with the additional cost of CCS from public finances (e.g. through a guaranteed feed-in tariff for electricity generated with CCS which reflects the real costs of implementing CCS).
- b) A requirement or obligation scheme whereby electricity producers are required to produce a certain proportion of their electricity using CCS (comparable to Renewable Portfolio Standards or a Renewables Obligation) or a similar requirement, but without specifying the low- or zero-carbon electricity source.
- c) A capital subsidy support scheme, whereby public finance is used to subsidise the initial capital costs of a CCS project.
- d) An economy-wide carbon tax, whereby end-users of carbon-based fuels and electricity pay a tax per unit of CO₂ emitted. This would mean that domestic, commercial and industrial users of gas, electricity and petroleum-derived fuels would pay a tax based upon the carbon content of the fuel so providing an incentive for the development of low- or zero-carbon sources of energy such as CCS.
- e) An extension of the EU Emissions Trading Scheme with tighter emission caps: the EU ETS could be extended beyond 2012 and tighter national emissions quotas could be negotiated, so pushing up the permit price of a tonne of CO₂. The EU ETS could also be extended to all energy users, not just medium- to large- energy producers.
- f) Public support for Research, Development and Demonstration projects.

Legal Issues

The London Convention regulates the dumping of wastes at sea. OSPAR is a regional treaty for the North East Atlantic and similar to the London Convention. Dumping is defined widely to include any deliberate disposal or storage at sea of wastes or other matter. No dumping of wastes is permitted except for those listed and CO₂ is not presently included on the list. Exceptions are permitted such as placement of wastes rather than disposal and disposal related to seabed mineral exploitation. Amendment of the London Convention and OSPAR treaties is probably necessary before CO₂ storage in saline aquifers and oil and gas fields can take place offshore and this could take several years, especially as little is known about the impact of leaks of CO₂ into the marine environment. Clarification and modification of the legal framework will be necessary before CCS can become an established carbon abatement technology. Companies are unlikely to initiate major investments in CCS technology where there are potential conflicts with the

provisions of the London and OSPAR Conventions. A process is now underway to modify the London Convention and a proposed amendment is to add CO₂ to the annex so allowing it to be dumped provided: that it is stored in sub-seabed formations (not in the water column); that it is overwhelmingly CO₂ and does not contain additional wastes.

Figure 2: Pictorial Representation of CO₂ Capture and Storage



Source: IPCC Special Report on *Carbon Dioxide Capture and Storage*

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