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ENTEC

Energy Transition Expertise Centre

Summary report of the results of the Open Public Consultation Industrial Carbon Management

Report - Open Public Consultation Industrial Carbon Management

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Content

List of abbreviations

Abbreviation	Full term
BECCS	Bioenergy and Carbon Capture and Storage
CCS	Carbon Capture and Storage
CCU	Carbon Capture and Utilisation
CCUS	Carbon Capture Utilization and/or Storage
CHP	Combined Heat and Power
CO_2	Carbon Dioxide
CR	Carbon Removals
DACCS	Direct Air Carbon Capture and Storage
EC	European Commission
EU	European Union
EU ETS	European Union's Emissions Trading System
ESR	Effort Sharing Regulation
ICR	Industrial Carbon Removals
ICM	Industrial Carbon Management
IEA	International Energy Agency
IMO	International Maritime Organization
IPCC	Intergovernmental Panel on Climate Change
IRA	Inflation Reduction Act
LCA	Life Cycle Analysis
LTS	Long Term Strategy
LULUCF	Land Use, Land Use Change and Forestry
NECPs	National Energy and Climate Plans
NZIA	Net-Zero Industry Act
OPC	Open Public Consultation
P	Part
Q	Question
R&D	Research & Development
RFNBO	Renewable Fuels of Non-Biological Origin
SME	Small and Medium Enterprises
US (USA)	United States (United States of America)
WtE	Waste to Energy

1 Analytical approach

1.1 Introduction

This report provides an analysis of the responses received to the Open Public Consultation (OPC) on 'Industrial Carbon Management', organised in the context of the European Commission's communication on an EU strategy for establishing an industrial carbon management market by 2030 (EU Strategy), which is due for publication by Q1 of 2024.

The EU Strategy will outline how such technologies can best contribute to the objective of reaching climate-neutrality for the EU by 2050 and set a strategic vision for industrial carbon management in the EU. The OPC aimed to gather insights from stakeholders on various Carbon Capture and Storage (CCS), Carbon Capture and Utilization (CCU) and Industrial Carbon Removal (ICRs)-related issues regarding a comprehensive EU approach to Industrial Carbon Management, including specific policy recommendations, within the context of the EU Strategy.

The report is structured based on four main themes around which the questionnaire responses have been grouped. These are:

- Relevance of CCS, CCU and/or Industrial Carbon Removals for the EU climate goals,
- Role of the European Commission in relation to CCS, CCU and/or Industrial Carbon Removals,
- Main challenges and policy options to address them, and
- Any other topics.

In addition to the analysis of the OPC responses (OPC survey) which are analysed in chapter 2, this report also provides a summary of the written feedback and documents supplied as attachments to the "call for evidence" under the OPC summarised under chapter 3.

1.2 Target group, timing and structure of the OPC

All interested citizens and stakeholders were invited to respond to the OPC. To facilitate this, it was possible to contribute to the survey in any of the 23 EU languages. The consultation was **open for twelve weeks from June 8th to August 31st, 2023**.

The OPC consisted of a questionnaire of up to 29 questions (varying depending on the stakeholder type) uploaded to the EUSurvey platform[1]. The questionnaire was split into two sections: a general section consisting of five multiple-choice or multiple-answer questions (i.e. multiple-choice questions where multiple answers were possible) and a section for experts that included multiple-choice, multiple-answer, as well as an open 'other' field to be filled in optionally by the respondent as an add-on to some of the multiple-choice questions. The final question was an open-ended question.[2] Respondents were not obliged to respond to both parts – they could choose to fill in only the general part.

The report is structured based on the four main topics outlined above; however, the questions that correspond to each topic are scattered throughout the questionnaire. Thus, in Table 1 an overview of how the questions in the OPC survey correspond with the main topics is provided. The first

[1] https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/13848-Industrial-carbon-management-carbon-capture-utilisation-and-storage-deployment_en

[2] A question that is designed to encourage a full, meaningful answer using the subject's own knowledge.

column identifies the topics, while the second column identifies the questions in the OPC which fall under a specific topic.

Table 1: Organisation of OPC questions per topic

Topic	Relevant Questions in Questionnaire
1. Relevance of CCS, CCU and/or Industrial Carbon Removals for the EU climate goals	Part 2: Q1. Q2. Q3. Q4. Q7. Q16. Q17. Q18. Q19. Q20. Q21. Q22.
2. Role of the European Commission in relation to CCS, CCU and/or Industrial Carbon Removals	Part 1: Q4. Q5. Part 2: Q8. Q24. Q25. Q26. Q27. Q28.
3. Main challenges and policy options to address them	Part 2: Q5. Q9. Q10. Q11. Q12. Q13. Q14. Q15. Q23
4. Any other topic	Part 1: Q1. Q2. Q3 Part 2: Q6. Q29.

1.3 Method of analysis

The full dataset resulting from the OPC contains the results from **280 responses**[3] to the questionnaire. The results were quantitatively analysed. For each question, the number of respondents (*n*) is indicated as (*n=x*). The number of respondents is also expressed as a percentage of the total. In some cases, these percentages do not add up to 100% given that the numbers have been rounded to the nearest whole number.

Respondents could add any further information or suggestions they wished in an open question at the end of the survey: question Q29 "Is there anything else you want to share with us that we have not (sufficiently) addressed in previous questions?'' **143 responses** were submitted to this question. Out of the 13 languages used by respondents in total, five were used in the open responses. A machine translation[4] of responses in languages other than English was therefore a necessary preliminary step before the analysis. Due to the relatively low frequency of open responses, a qualitative approach was taken to review the open responses. All responses were read by one staff member and the key points are summarised in this report.

Finally, respondents could submit additional written feedback and/or relevant files or position papers as attachments to the OPC under the 'call for evidence'. A total of **209 responses** were submitted. Not all responses included attachments, in total **152 attachments** were received; however 5 attachments were not available for download on the website so **147 attachments** were analysed. The analysis of the submitted feedback was done qualitatively. All submitted comments were divided among 4 staff members, who read through each submission and filed it an excel database noting key themes. Similarly, all papers were read in full and the summarised in an excel database. A common understanding of key themes and concepts was sought to come up with the key points based on the submissions. The excel database is available upon request by the Client. The results of the analysis are presented in chapter 3.

[3] Note that on the OPC website 278 submissions are reported. The aggregated, raw data provided to in the excel format by the EC contains 280 submissions, two of these submissions did not reply to any of the questions in the OPC. We have however decided to still account for their response in the analysis.

[4] DeepL was used for machine translation.

2 Results

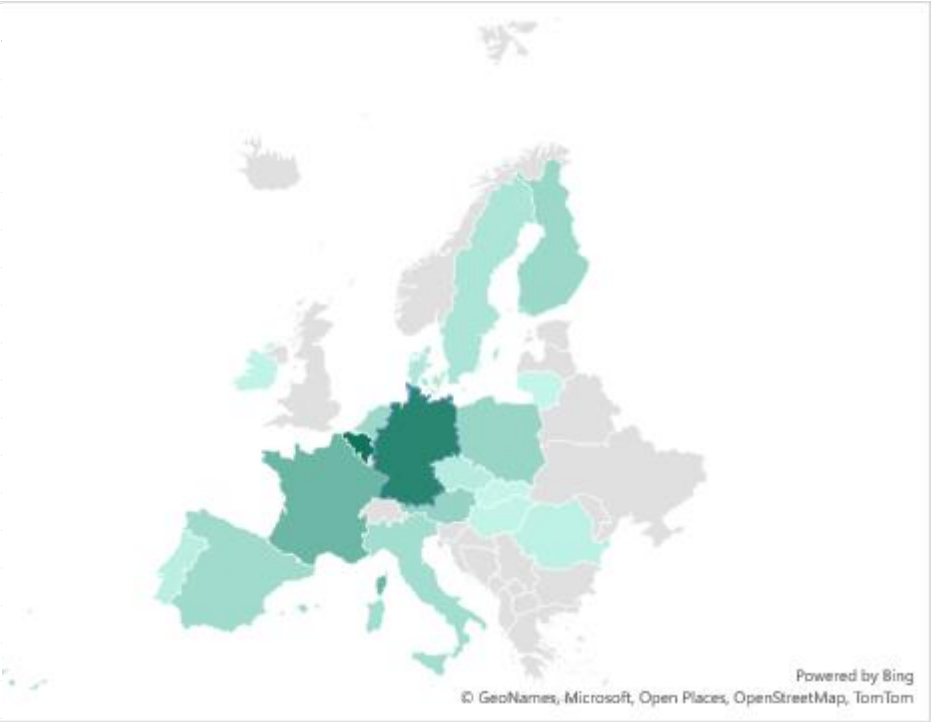
2.1 Profile of respondents

2.1.1 Country of origin

Figure 1 shows the distribution of EU respondents based on their country of origin. The largest group of respondents (54) comes from Belgium. Additionally, about 15% of all responses came from outside the EU-27, most of them (15) from Norway. The rest comes from the UK (13), US (6), Switzerland (2), Mexico (2), Japan (2) and Canada (1). The heavy overrepresentation of Belgium among the respondents' country of origin can be a result of interested stakeholders' concentration and presence in Brussels.

Figure 1: The distribution of respondents across the EU

Member state	Nr. of respondents
Belgium	54
Germany	47
France	27
Austria	15
Poland	14
Finland	13
Netherlands	13
Spain	12
Italy	11
Sweden	8
Denmark	7
Czechia	5
Portugal	4
Romania	3
Hungary	2
Ireland	2
Lithuania	1
Slovakia	1



2.1.2 Type of stakeholder and field of activity or interest

In total, 280 people provided responses to this OPC. The distribution of respondents based on different stakeholder categories is shown on Figure 2 below. The large majority – almost three quarters – of responses came from business, either directly from companies (119 responses) or through business associations (84 responses).

Figure 2: Number of respondents per stakeholder category

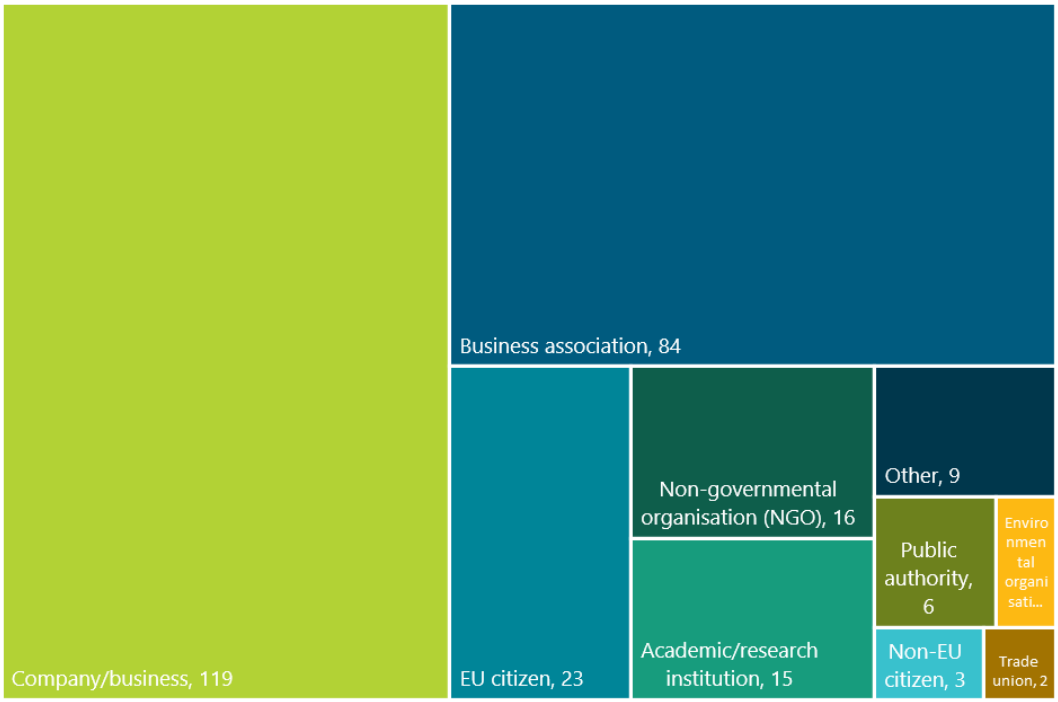


Figure 3 below shows the distribution of respondents based on the size of organisation they represent. 254 respondents disclosed this information, out of which 119 responses came from large organisations (with 250 or more employees), 32 from mid-size (50 to 249 employees), 60 from small (10 to 49 employees) and 43 from micro (1 to 9) organisations. 26 respondents provided no response on this.

Figure 3: The number of respondents per size of organisation represented

2.1.3 [P1, Q1-Q3] Interest in or familiarity with Industrial Carbon Management

The vast majority of respondents (275 out of 280) reported to be familiar with the CCS technology. Only 2 respondents claimed to have heard of it but not being familiar with it. The distribution is very similar in the case of the CCU technology – 273 respondents claim to be familiar with it, 4 respondents heard of it but don't know what it is. 270 of the respondents reported to be familiar with industrial carbon removal technologies, while 7 heard of them but are not familiar with them. 2 respondents provided no answer regarding either of the 3 technologies, and 1 respondent did

not hear of any of these technologies. Based on this, it can be concluded that the vast majority of respondents feel very familiar with all three of the technologies, with very little variation in the responses. Table 2 below summarises these results.

Table 2: Respondents familiarity with the different technologies

Technology	Never heard of it	Doesn't really know what it is	Knows exactly what it is
CCS	1	2	275
CCU	1	4	273
ICR	1	7	270

2.2 Relevance of CCS, CCU and/or Industrial Carbon Removals for the EU climate goals

In the following section the results to the questions related to the **relevance** of CCS, CCU and ICRs for the attainment of the EU climate goals, as perceived by the respondents of the OPC, are summarised.

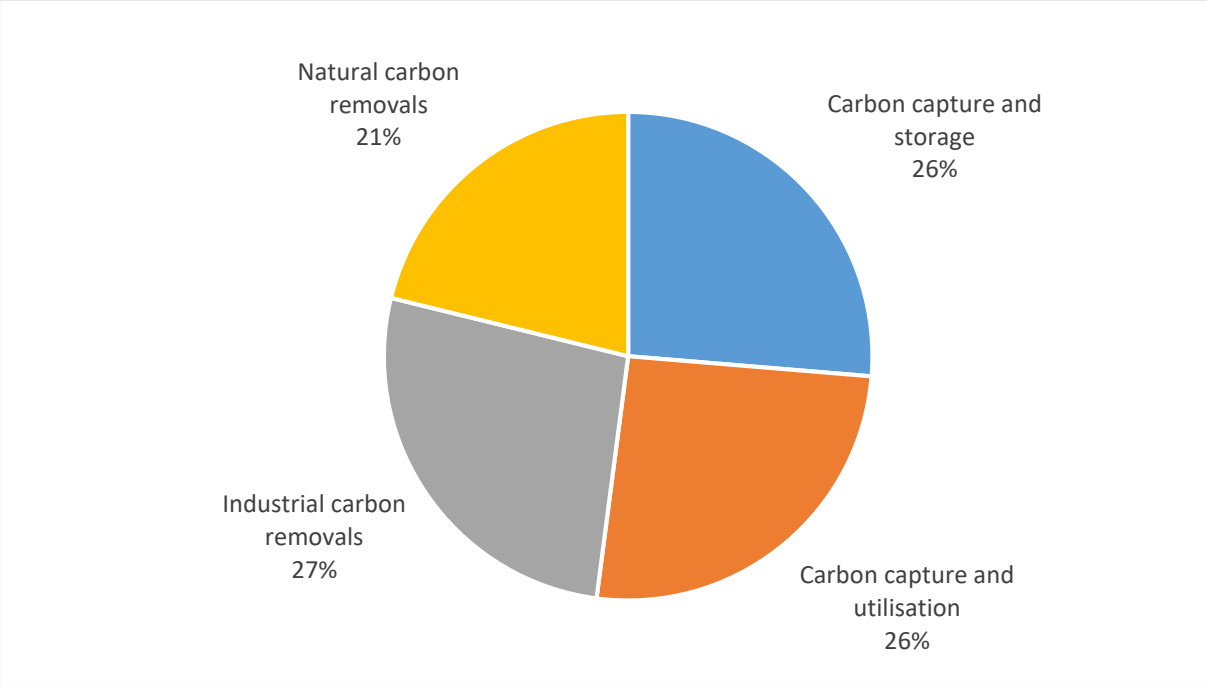
2.2.1 [P2, Q1] Considering the sixth assessment report of the Intergovernmental Panel on Climate Change (IPCC) and the European energy and climate objectives do you think that the EU should do more to facilitate deployment of: (multiple answers possible)

Regarding their opinion on the relevance of different technologies in achieving the EU's climate goals, the respondents were presented with four technological options:

- Carbon capture and storage (CCS)
- Carbon capture and utilisation (CCU)
- Industrial carbon removal (ICR)
- Natural carbon removal (NCR)

Figure 4 below shows the responses received to the question which of the above technologies should be promoted by the EU, with multiple answers being possible. The results are almost evenly split between the presented options with no respondents thinking that the EU should not promote any of the technologies, and a small share (less than 1%) providing no answer to the question. Almost half of the respondents (136) indicated their preference for all four of the given technologies at the same time, including 4 responses that also included the contradictory 'neither' option.

Figure 4: Distribution of respondents' answer to which technology the EU should do more to facilitate the deployment of



Under the open text box to the same question, a very large share of the respondents also stressed the necessity to employ all four options in addition to efforts in avoiding CO_2 emissions (deployment of renewables and energy savings), the options being complementary to each other, having their own specific focus and benefit. Overall, they called for a strict and clear regulatory framework integrating avoidance and removal option and enabling of an accelerated scaling-up of these technologies. Frequent arguments for facilitating the deployment of CCS, CCU, ICR and NCR could be summarised as:

- Cost-efficiency in specific applications, e.g. in hard to abate industries, or industries that need CO_2 as feedstock.
- Potential options to remove excess CO_2 (of historic emissions) from the atmosphere.
- Combination of climate and recycling targets.
- Using a technology neutral approach.
- The EU becoming the front-runner of these technologies.
- No disruption of the energy system and economic growth.
- Synergies in setting up regulations, institutions and infrastructures.

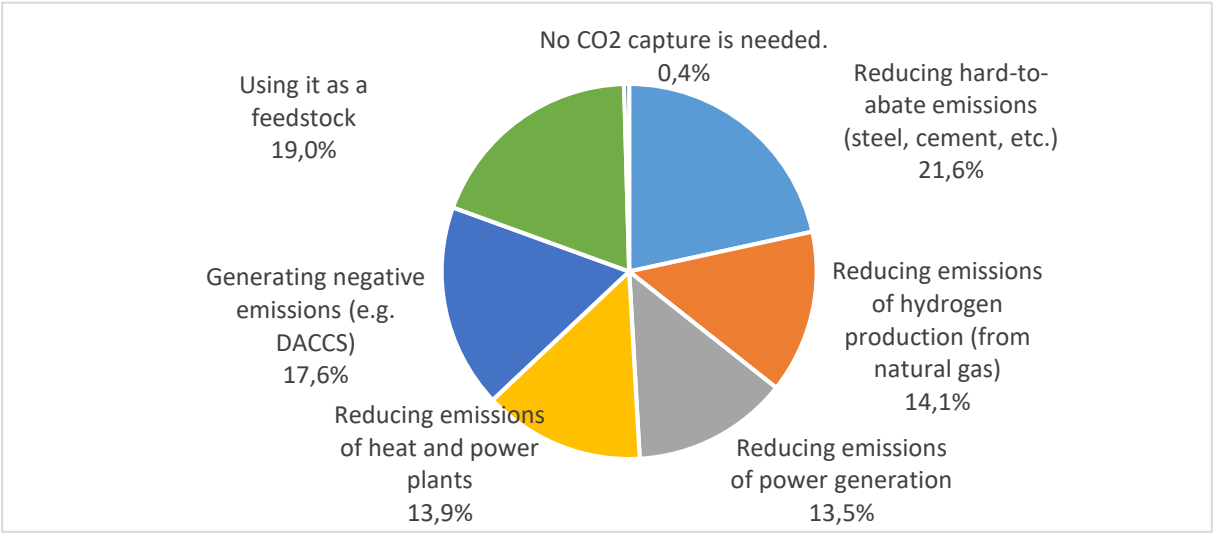
Common counter-arguments against prioritising or exclusively relying on these options revolve around their associated high costs and energy consumption and the reduced incentive to phase out fossil fuels when carbon storage options are available. Reasons for not using CCS are uncertainty about the permanence of storage and sequestration, limited (secure) storage capacities and high costs and energy input. Some respondents consider CCU as market driven economic activity and call for a respective regulatory framework but not for policy support, since it is an established practice in some sectors where carbon is needed as feedstock (could replace fossil-based carbon). Others consider its energy intensity as too high and its (potential) CO_2 storage too temporal in order to consider it a general mitigation option while it might be climate neutral when the utilised carbon is sourced from biomass. ICR is one of few solutions to remove excess carbon from the

atmosphere, but it is expensive and very energy intensive if captured from the atmosphere. In contrast, NCR is less expensive, but doubts exist about the available natural capacity, its permanence of CO_2 storage and quick or sufficient effectiveness.

2.2.2 [P2, Q2] Why should CO_2 capture in Europe be applied? (multiple answers possible)

On the motivation as to why carbon capture should be applied in Europe, the respondents' distribution is presented below, in Figure 5. Generally, respondents show a rather even distribution across the presented 6 major themes: to reduce emissions from hard-to-abate sectors (21.6%); to use CO_2 as feedstock for production (19.0%); to generate negative emission (17.6%); to reduce emissions from the production of hydrogen (14.1%); to reduce carbon emissions from power generation (13.5%); to reduce emissions from heat and power plants (13.9%). A small percentage of respondents (0.4%) indicated that no carbon capture is necessary in their opinion, while only 0.1% indicated to have no opinion on the matter. With multiple choices possible, and therefore without incentives to prioritise, there seems to be little difference between the support for the provided options - but a slight, relative majority of the respondents (21.6%) emphasised the technologies' importance in the hard-to-abate sectors.

Figure 5: Distribution of respondents' answer to the motivation why carbon capture should be applied



Through the open text box of this question, some stakeholders expressed their **general concerns** regarding CCUS by emphasizing that it should only be employed when emissions are inevitable and no other opportunities for direct demand reduction, efficiency improvements or options for electrification are available. However, there are various reasons raised for capturing CO_2 in Europe. A fundamental statement is the **time pressure**, i.e. the urgency of the situation: achieving climate neutrality by 2050 requires accelerated decarbonization across all sectors, and CCS is seen as a necessary component to meet this goal. In certain sectors, the potential for cost-effective CO_2 reduction has already been exhausted, and there are **no alternative processes** available to mitigate emissions. CCS presents a viable and economically sound option for decarbonisation in many sectors due to its **scalability**, relatively short planning and construction timelines compared to the installation of entirely new processes and plants, and its ability to complement existing facilities, allowing them to continue production.

Many stakeholders advocated for a **market-oriented approach**, where they can pursue the most cost-efficient decarbonization strategy for each application area without being hindered by regulatory barriers. Additionally, applying CCS aligns with the commitment of the industry to environmental stewardship, helping to maintain competitiveness in environmental protection matters and contributing to economic growth and employment.

Regarding the specific applications of CCUS, stakeholders highlighted the following aspects:

- CCS is especially relevant for the **hard-to-abate** industrial sectors. In a few production areas, CCS is the only option for decarbonisation. In others it is essential for their cost-efficiency and overall competitiveness (survival). Some industries have already made investments in CCUS projects (pilots or demonstrations). Given the high integration and long lifetimes of these hard-to-decarbonize industries, neglecting CCS options would result in significant and far-reaching economic consequences.
- In the realm of natural gas-based **hydrogen production**, CCS is regarded as an important, but mostly temporary solution. It allows for adjustments in production processes, ultimately paving the way for renewable based hydrogen in the long term.
- In the context of heat and power generation, CCS provides **'low-carbon' flexibility** in supply, particularly in the absence of readily available hydrogen. Combined Heat and Power (CHP) is considered as a vital component in the energy system due to its high efficiency and when paired with CCS, it contributes to the decarbonisation of district heating. In addition, the use of CCS in waste-to-energy plants (WtE) not only captures emitted CO_2 but can also remove CO_2 provided it is of biogenetic origin.
- Consequently, WtE (biogenetic part) represents another avenue for generating **negative emissions**. Some respondents view negative emissions based on BECCS or WtE as more certain, viable and cost-efficient, while others stress the importance of DACCS, albeit acknowledging that capturing emissions at point sources is more efficient in their view.
- CCU is helpful for replacing fossil-based carbon which will remain a necessary feedstock for industries such as the chemical (organic) industry. Thus, CCU offers the possibility to establish a recycling process that efficiently uses 'waste-CO_2' based on a cascading principle. Finally, CCU is an important part of the Renewable Fuels of Non-Biological Origin (RFNBO) strategies.

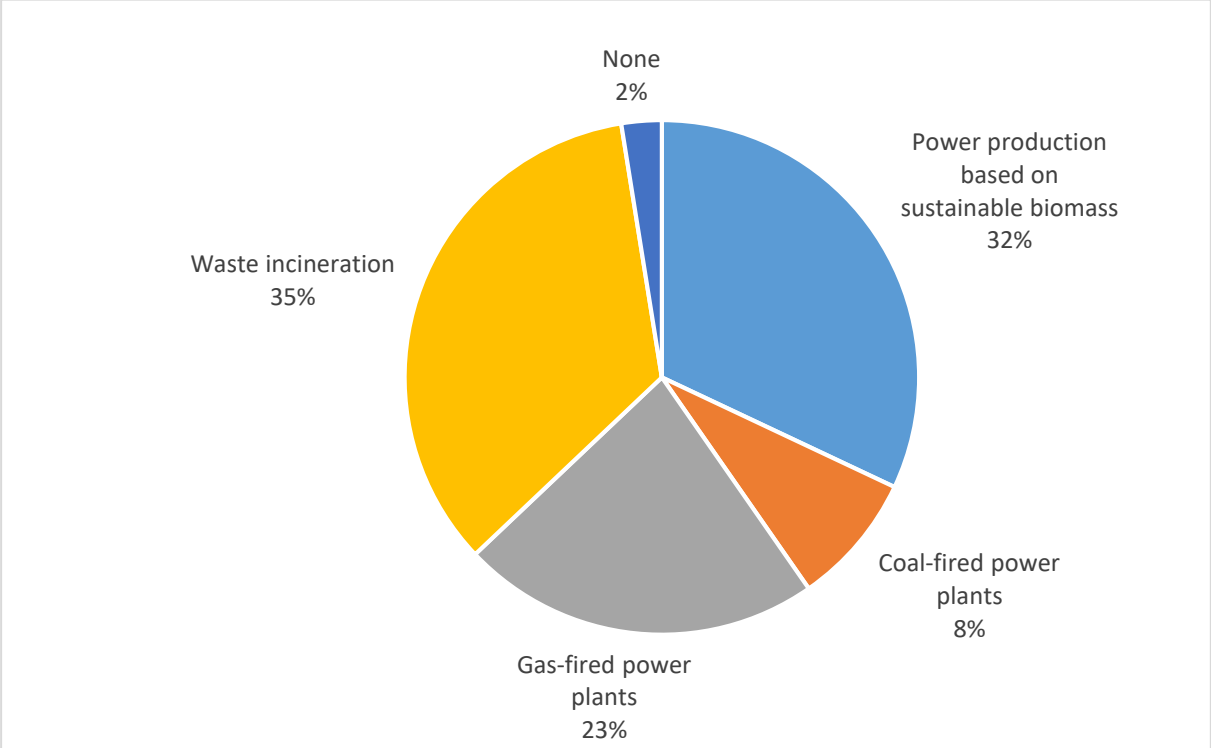
2.2.3 [P2, Q3] Which power generation technology with added CCS should play a role in a decarbonised EU power market? (multiple answers possible)

The next question inquired about the respondents' opinion on which (fossil) power generation technologies should (continue to) play a role in the EU – provided that it can and will be coupled with CCS. The questionnaire presented them with four options:

- Power production based on sustainable biomass
- Coal-fired power plants
- Gas-fired power plants
- Waste incineration

Figure 6 shows the distribution of answers between these technologies, with multiple answers per respondent possible. A rather large number, 12.5% of the respondents (35 people) indicated to have no opinion on the matter. More than 9% (26 people) indicated support for all four of the listed technologies. The answers are, again, almost equally split between the two most 'popular' technologies; biomass and waste incineration (32% and 35%), while natural gas also has some considerable support (23%), and 8% of the respondents even considering coal power plants to be acceptable when combined with CCS. Only 2% rejected all the provided options.

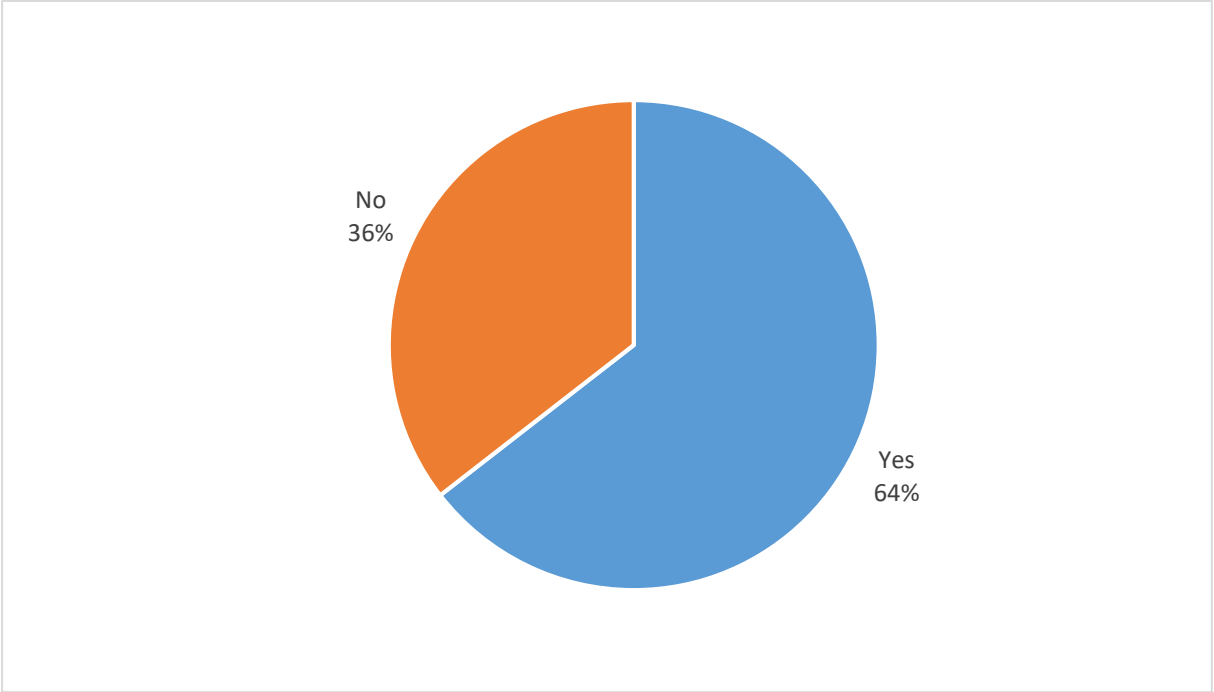
Figure 6: The share of responses regarding which power generation technologies with CCS should play a role in a decarbonized EU power market



2.2.4 [P2, Q4] In line with the objectives of the EU circular economy and the cascading principle, should it be mandatory to equip large-scale installations where municipal household waste is incinerated to provide heating and electricity (or both) with CO2 capture?

Figure 7 below shows the distribution of responses regarding an obligation to equip household-waste incinerators with CO_2 capture. Almost two thirdsof the respondents who provided an answer supported an obligation like this, while only 36% outright opposed it. The respondents of the survey seemed to be overall unsure, however, with 40% of all respondents providing no answer to this specific question.

Figure 7: Respondents' views on whether it should be mandatory to equip large-scale installations where municipal household waste is incinerated to provide heating and electricity (or both) with CO2 capture

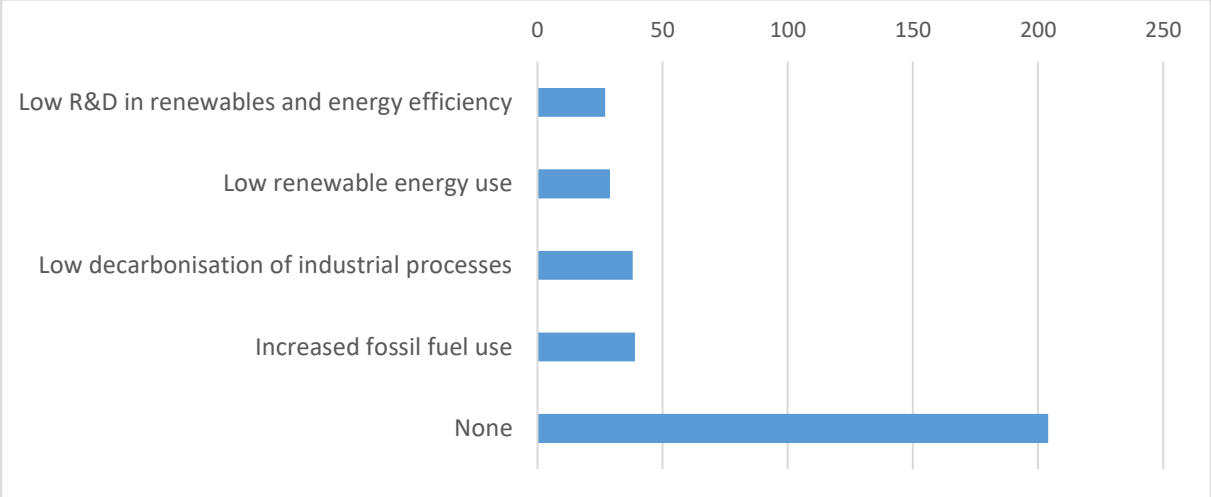


2.2.5 [P2, Q7] Do you expect the deployment of CCS, CCU or Industrial Carbon Removals to have any of the following negative effects? (multiple answers possible)

Figure 8 below shows the respondents 'views on the provided options regarding the adverse effects that could follow the deployment of CCS/CCU/ICR technologies. Overall, large majority of the respondents (204) expects **none** of the provided negative effects from the deployment of CCS, CCU or ICR technologies. Among those concerned, stimulating new investments in fossil fuels and discouraging investments in decarbonised industrial processes are the two most voted options with an almost even split (with 39 and 38 respondents expressing concern, respectively). These are followed by concerns regarding discouraging investment in renewables and in R&D for energy efficiency technologies.

Based on this, it can be concluded that the respondents of the consultation are not particularly concerned by the possible negative side-effects of the deployment of these technologies.

Figure 8: Respondents' views regarding the expected negative effects from the deployment of CCS, CCU and Industrial Carbon Removals



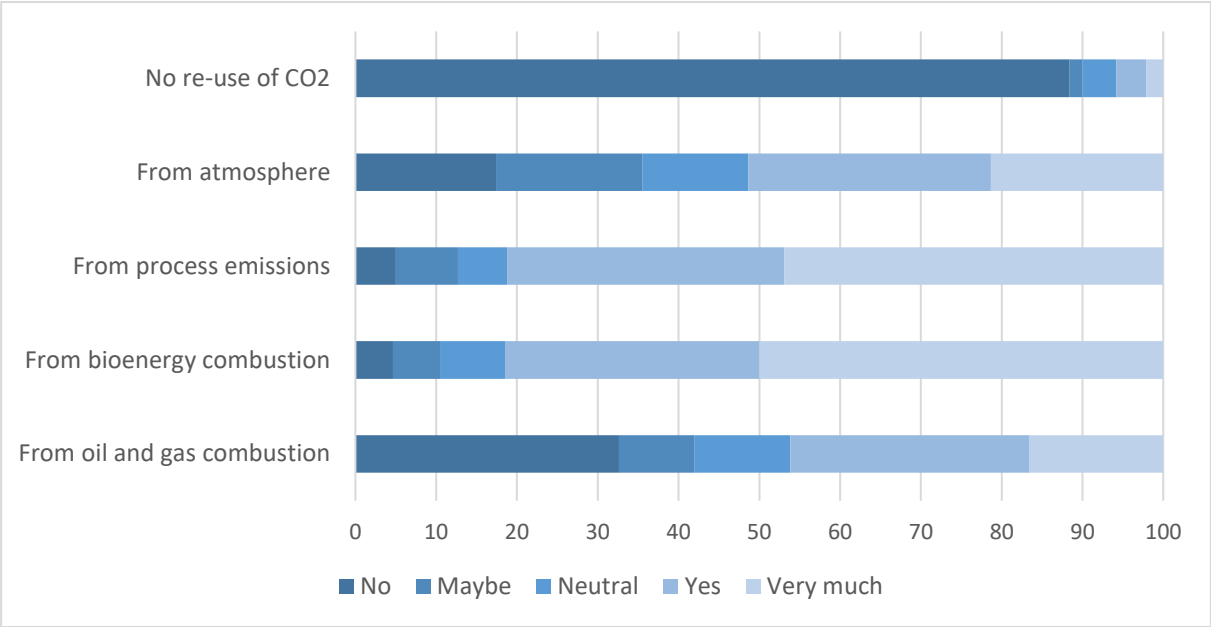
2.2.6 [P2, Q16] Carbon as feedstock: Captured CO_2 could play a role as a new feedstock for industry replacing the fossil carbon inputs from current production (e.g. for chemicals/plastics). If this is overall good for the climate depends on the source of the carbon, how long the carbon is contained in the products and the overall energy penalty. From which sources do you think this CO_2 could best be captured? (please rank your answers)

Figure 9 below shows the respondents' views regarding different options for the utilisation of captured CO_2. A majority of respondents (51%) is in favour of the use of captured CO_2 from the atmosphere, responding either "Yes" (30%) or "Very much" (21%), while only 17% of the respondents outright oppose it. A vast majority of respondents (81%) also supports the reuse of captured CO_2 from industrial processes, with 47% answering "Very much" and 34% "Yes". Similar figured show support for the reuse of CO_2 from bioenergy combustion (81%), with 50% answering "Very much" and 31% "Yes". Finally, 47% of the respondents support the reuse of captured CO_2 from oil and gas combustion, while 33% oppose it.

Overall, a remarkable majority of respondents rejected the option to avoid the re-use of CO_2 altogether, while the most supported sources for CO_2 capture were process emissions and bioenergy combustion with identical support. The respondents' preference list is as follows:

1) From bioenergy combustion
2) From process emissions
3) From atmosphere
4) From oil and gas combustion
5) No re-use of CO_2

Figure 9: Respondents' support for the utilisation of captured CO_2



When queried about providing illustrations of 'other applications', a significant portion of the respondents stressed the significance of securely binding CO_2 in products over the long term. In this context they listed mineral carbonation (magnesium or calcium carbonate), and biochar, conversion of CO_2 into carbon or storing carbon from pyrolysis in the soil. Regarding the use of CO_2 in the production of chemicals, respondents have suggested applications such as fertilizers, protein, textiles, alcohols and ethylene products. As for synthetic fuels, recommendations include ammonia, methanol or RFNBO in general. In the agricultural and food industry, in addition to applications in horticulture and beverages, the cultivation of algae was brought into consideration. Further suggestions include using CO_2 in liquid form, in new unspecified industrial materials or pharmaceutical products or for renewable steel production.

In general, a significant number of individuals emphasised the significance of utilising CO_2 derived from biogenic sources in CCU to attain, at the very least, climate neutrality in CO_2 utilisation. Likewise, many expressed a reluctance towards establishing a hierarchy of application options dictated by the European Commission. Instead, they argued that the driving factors should be the effectiveness, economic efficiency, and suitability of the applications themselves.

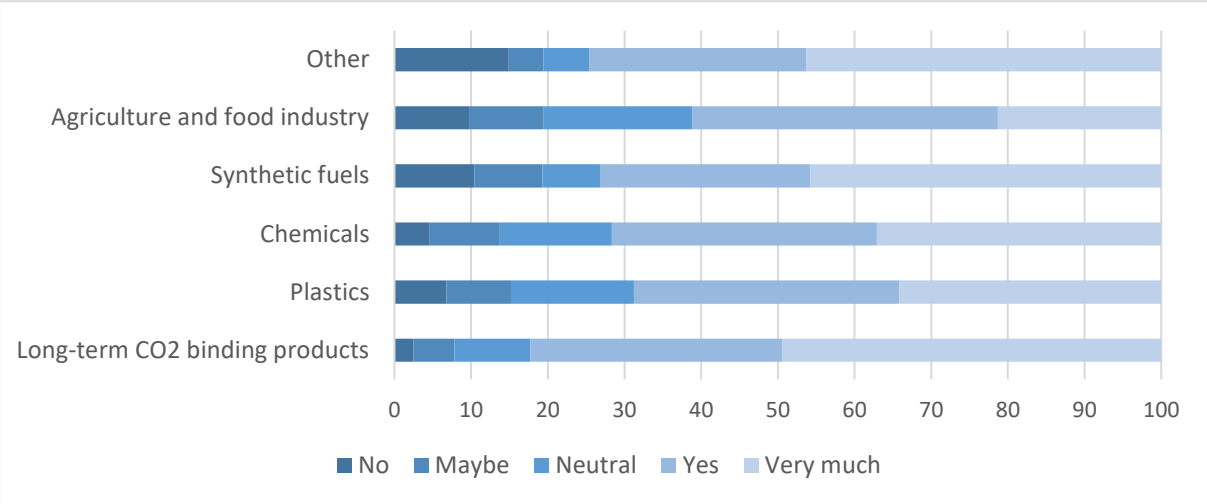
2.2.7 [P2, Q17] Which applications of CO_2 utilisation should the Communication support as priority and why? (please rank your answers)

Figure 10 shows the views of the respondents on which applications of CO_2 utilisation should be given priority in the Communication. The option ranked the highest by the respondents is long-term binding of CO_2 in products, with 82% supporting this application, followed by non-specified 'Other' options (74%), production of synthetic fuels (73%), and production of chemicals (72%). Agriculture and food industry receives the lowest ranking, but still with 61% of respondents identifying it as priority application.

Overall, long-term CO_2 binding was a clear preference among the respondents with regards to priority support, with plastic, chemicals, synthetic fuels and 'other' options following with more or

less equal support, and support for agricultural applications of CO_2 falling somewhat – but not significantly – behind.

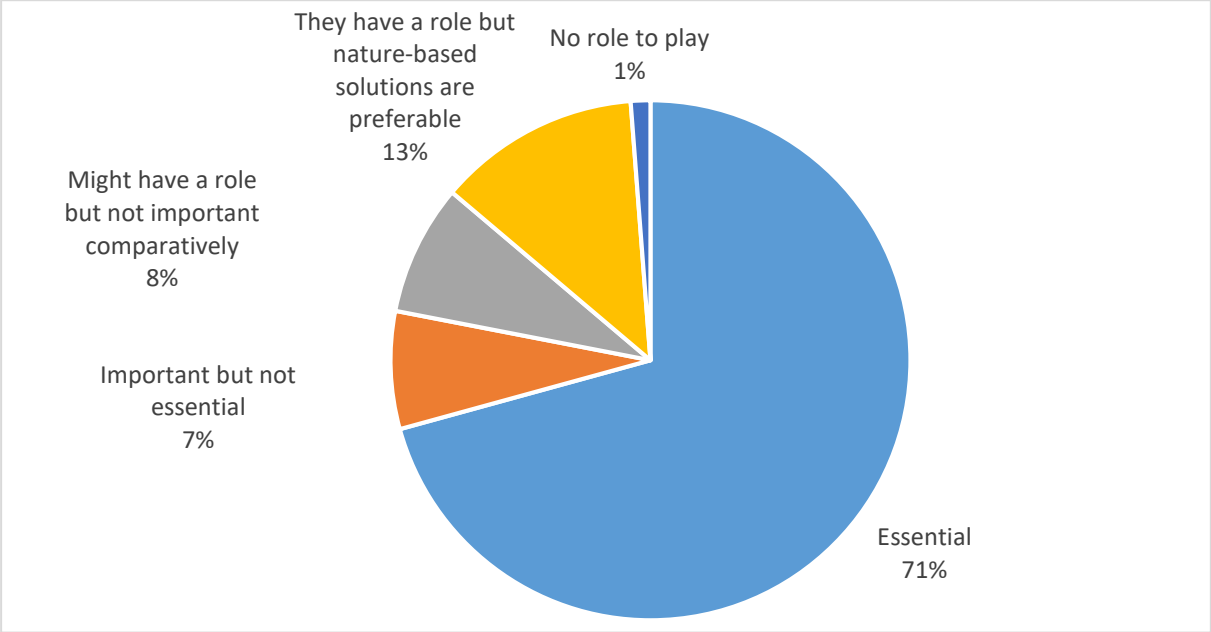
Figure 10: Respondents' views regarding which applications of CO2 utilisation should be supported as priority by the Communication



2.2.8 [P2, Q18] A consensus has emerged in the scientific community on the importance of removing carbon from the atmosphere to meet the objectives of the Paris Agreement: Carbon removals are required first to neutralize hard-to-abate emissions that with current technologies cannot be captured or avoided to reach net-zero GHG emissions and then to clean up the atmosphere and bring the CO2 to concentrations compatible with 1.5°C or even 2°C objectives. How would you describe the role that industrial solutions have to play to capture CO_2 from the atmosphere, or biogenic sources, transport and store it, in order to achieve the goals of the Paris Agreement and the objectives of the EU Climate Law?

Figure 11 shows the respondents' views regarding the role of industrial solutions in capturing CO_2. Among those, who expressed any opinion on this question, the clear majority of respondents (71%) see industrial solutions as **essential** to remove carbon at the scale needed. Of the other views, 13% see a more prominent role to be played by nature-based solutions, while 8% see a more important role to be played by other technologies. 7% see the role of industrial solutions as important but not essential. 5% of respondents has no opinion on the issue, while 1% does not think that industrial solutions have a role to play.

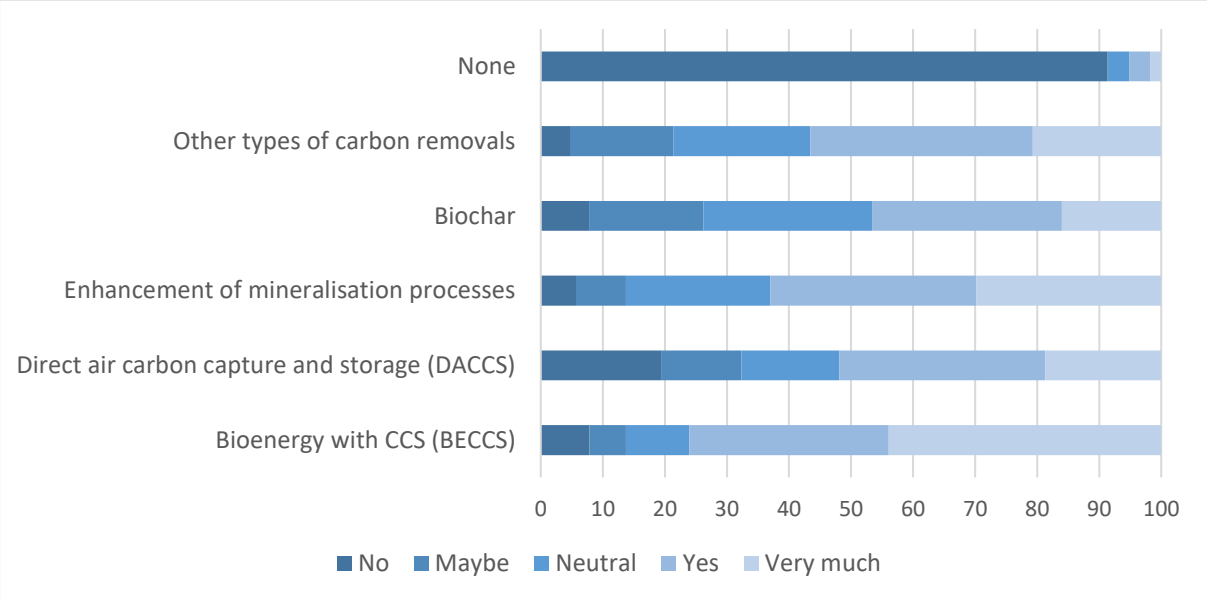
Figure 11: Respondents' views regarding the role that industrial solutions have to play to capture CO2 from the atmosphere, or biogenic sources, transport and store it, in order to achieve the goals of the Paris Agreement and the objectives of the EU Climate Law



2.2.9 [P2, Q19] Which type of Industrial Carbon Removal should be prioritized: (please rank your answers)

Figure 12 shows the respondents' ranking of the priority options for Industrial Carbon Removal technologies. The highest-ranked option is BECCS, being supported by 76% of the respondents (44% answering 'Very much' and 32% 'Yes'), followed by enhancement of mineralisation processes (63%) and DACCS (62%). Almost the totality of respondents (91%) rejects the statement where no option should be given priority. DACCS is the options receiving the highest opposition, with 20% of the respondents answering "No". Biochar receives the lowest support, with 47% of the respondents ranking it as a priority.

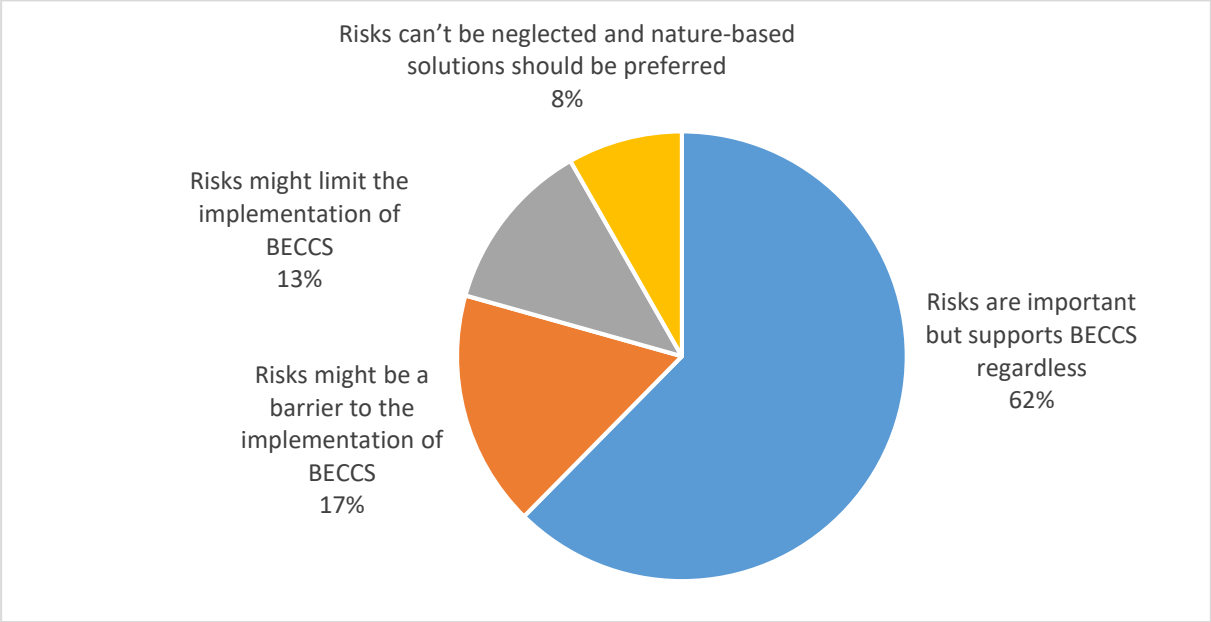
Figure 12: Respondents' views regarding which type of Industrial Carbon Removal should be prioritized



2.2.10 [P2, Q20] Some stakeholders have voiced their concerns on the potential environmental risks of the use of BECCS and its high costs. Do you think that these risks outweigh the climate benefits?

Figure 13 shows the respondents' views regarding the risks and costs of BECCS. Among those who expressed an opinion in this question, 62% said that while those risks are needed to be addressed, they should not hamper the deployment of BECCS. On the other hand, 17% of respondents think that the risks might influence the promotion of BECCS, while 13% think that these risks might have a role to play in the decision on whether to promote BECCS. A significant portion of the respondents (22%) did not provide an answer to this specific question, however.

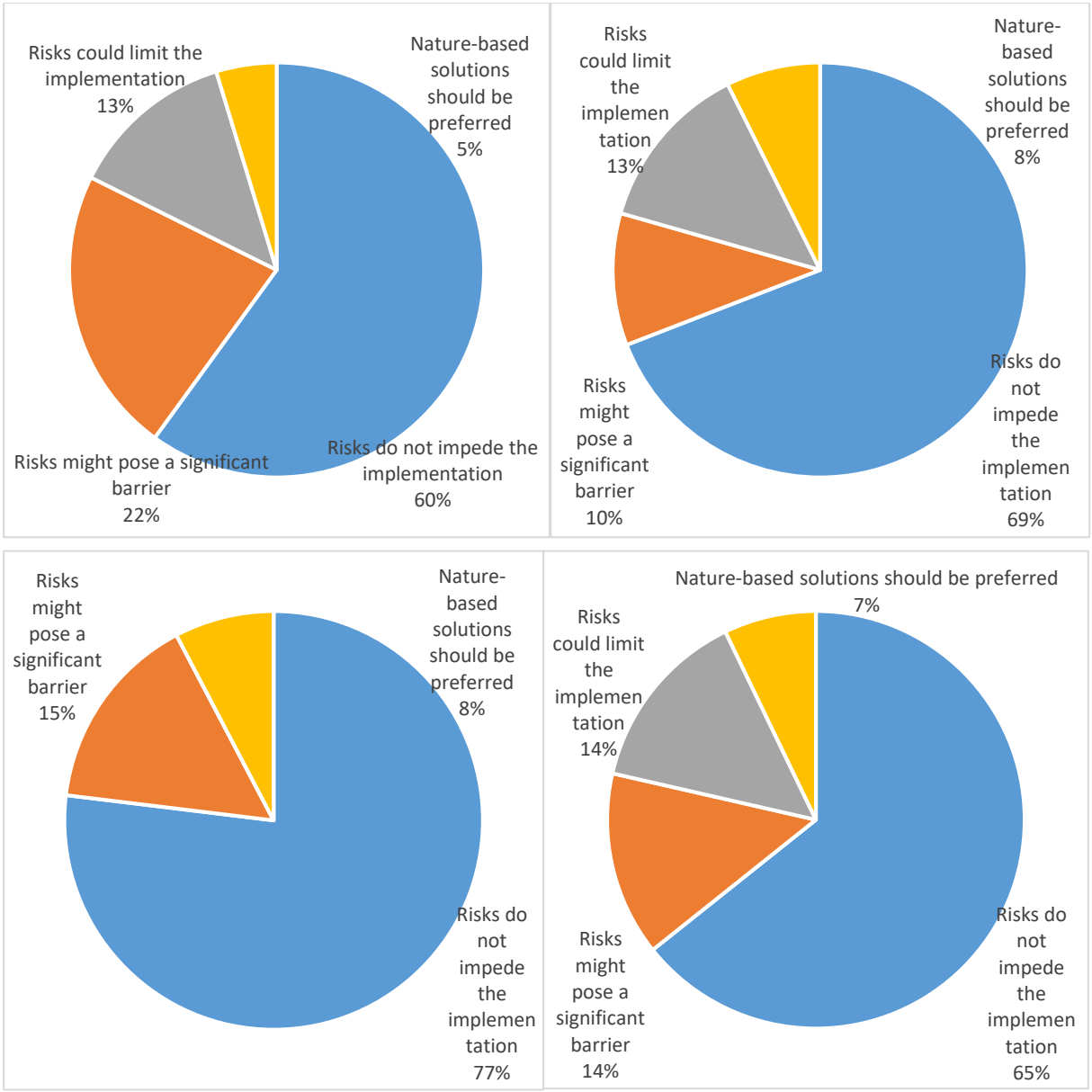
Figure 13: Respondents' views regarding the potential environmental risks of BECCS



When looking at the different types of stakeholders' responses to this question, small variability can be detected among different stakeholder groups. Most notably, academics/research institutions seem to be somewhat more optimistic regarding the environmental drawbacks of BECCS compared to the businesses, business associations and NGOs. In none of the four groups the opinion that these risks could/should limit its implementation was dominant but in each group it represented between 13 and 15% of the overall responses. Businesses had the largest share of views (22%) that 'risks might be a barrier to the implementation of BECCS' out of the four groups.

Figure 14: Difference in opinion by subgroups regarding environmental risks of BECCS

upper left: businesses, upper right: business associations, bottom left: academics, bottom right: NGOs



2.2.11 [P2, Q21] What are the main barriers to the development of Industrial Carbon Removals? (please rank your answers)

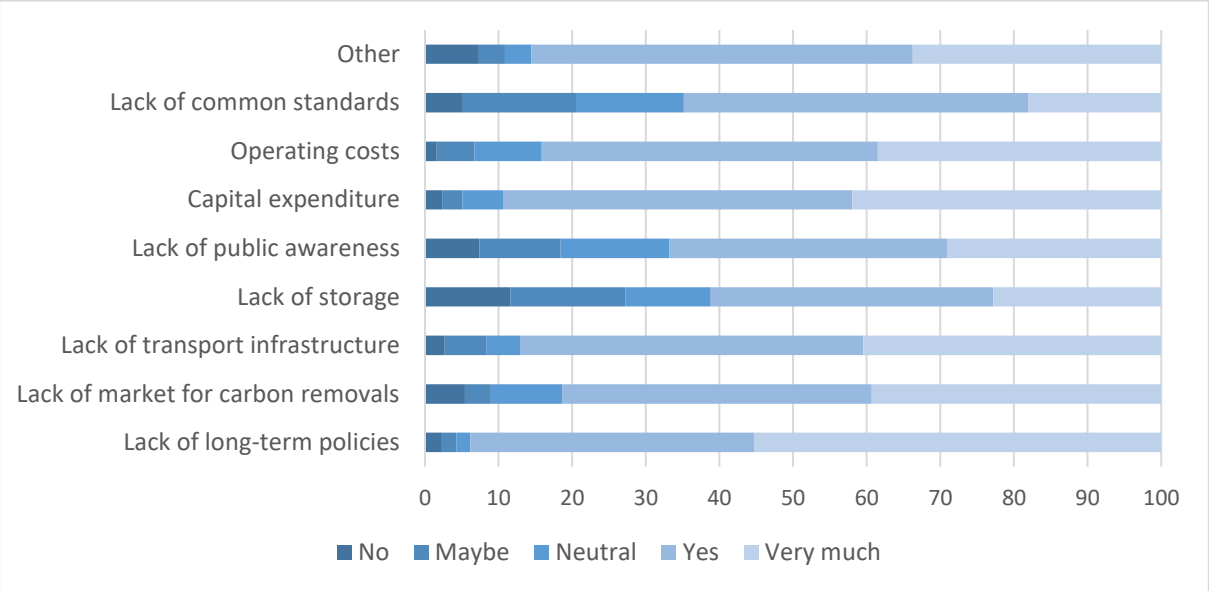
Figure 15 shows the respondents' views on the barriers to the development of industrial carbon removals. The highest-ranked barrier by respondents is the lack of long-term policies on carbon removals - this being the view of 94% of the respondents. This is followed by the high capital costs (89%), the lack of CO_2 transport infrastructure (87%), and high operating costs (84%).

Overall, the results show that most respondents recognise **all given options** as potential barriers to the development of industrial carbon removals with the lack of long-term policies being a front-runner, closely followed by capital expenditure. The respondents ranked the lack of storage to be the least important barrier.

The complete ranking based on respondents' opinion is as follows:

1) Lack of long-term policies
2) Capital expenditure
3) Lack of transport infrastructure
4) Operating costs
5) Other
6) Lack of market for carbon removals
7) Lack of public awareness
8) Lack of common standards
9) Lack of storage

Figure 15: Respondents' views regarding the main barriers to the development of Industrial Carbon Removals



2.2.12 [P2, Q22] Which type of policies should support the development and deployment of industrial carbon removals? (please rank your answers)

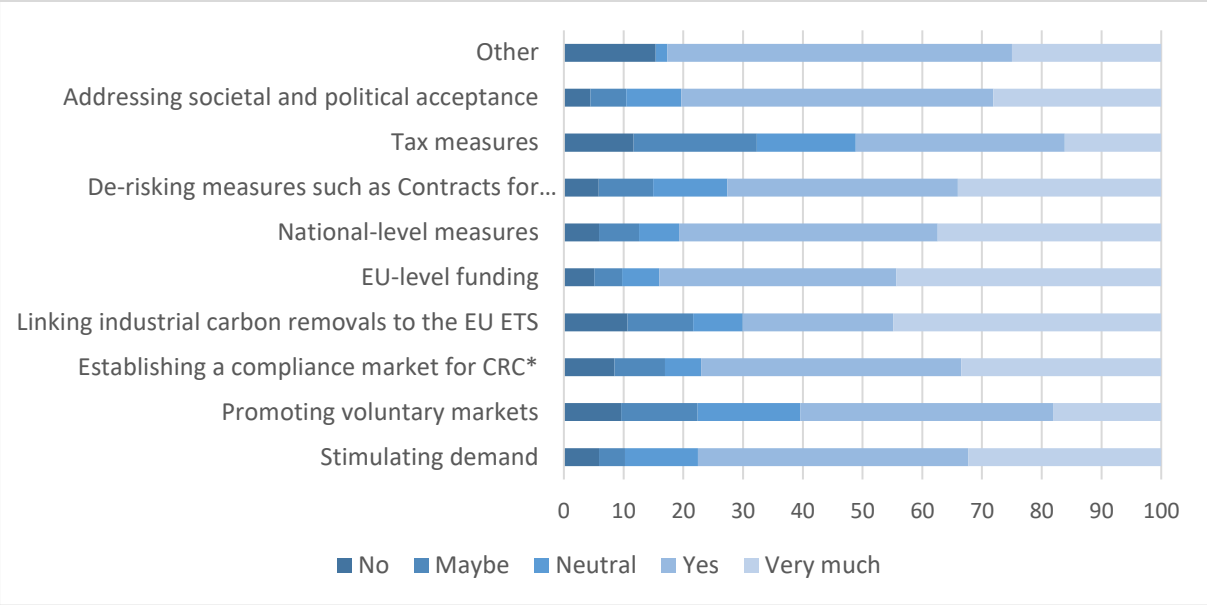
Figure 16 shows the respondents' views regarding the policies that should support the development and deployment of ICR. The highest-ranked policy type is EU-level funding options, supported by 84% (40% "Yes" and 44% "Very much") of the respondents. This is followed by policies that address societal and political acceptance and national-level support measures, both supported by 80% of the respondents.

Overall, responses show that all policy options are acknowledged as relevant to promote the development of industrial carbon removals, pointing at the need for a diverse policy mix to achieve this objective. The exact ranking based on respondents' opinion is as follows:

1) EU-level funding
2) Other
3) National-level measures
4) Addressing societal and political acceptance
5) Stimulating demand

6) Establishing a compliance market for CRC
7) De-risking measures such as Contracts for Difference
8) Linking ICR to the EU ETS
9) Promoting voluntary markets
10) Tax measures

Figure 16: Respondents' views regarding which type of policies should support the development and deployment of industrial carbon removals



*CRC stands for Carbon Removal Certificates

In addition to the policies outlined in the questionnaire, there are several other aspects that stakeholders wish the Commission to consider based on the open-text submissions to this question. These are:

- Encouraging private-public partnerships (PPP) for advancing research and implementation of CO_2 removal technologies.
- Providing financial support for research, development, and innovation in CO_2 removal technologies to reduce both initial capital and ongoing operational costs.
- Implementing direct government procurement at the EU or national level to support and encourage removal efforts.
- Enforcing penalties for biogenic CO_2 emissions to discourage environmentally pointless practices.
- Providing a proper regulatory framework and open market for cross-border transportation of CO_2
- Introducing a carbon take-back obligation, similar to Denmark's approach, to improve carbon management.
- Including measures applied in the framework of the Inflation Reduction Act (IRA) of the United States to foster economic activities and growth.
- Developing appropriate and adaptable trade policies that align with and account for decarbonisation and removal goals in the EU.

In a broader sense, stakeholders advocate for a transparent and ambitious approach to decarbonisation and removal objectives to achieve certainty regarding CO_2 pricing, long-term policy stability, and certainty in investments. Furthermore, stakeholders emphasize the importance of clear and

stringent definitions and standards related to CO_2 removals, life-cycle analyses, certificates, biogenic origins, and storage quality.

Overall, stakeholders see a need for a **comprehensive regulatory framework** that integrates emissions and removals of CO_2, along with well-defined procedures, rules and standards to facilitate participation in both the removal and emission markets.

2.3 Role of the European Commission in relation to CCS, CCU and/or Industrial Carbon Removals

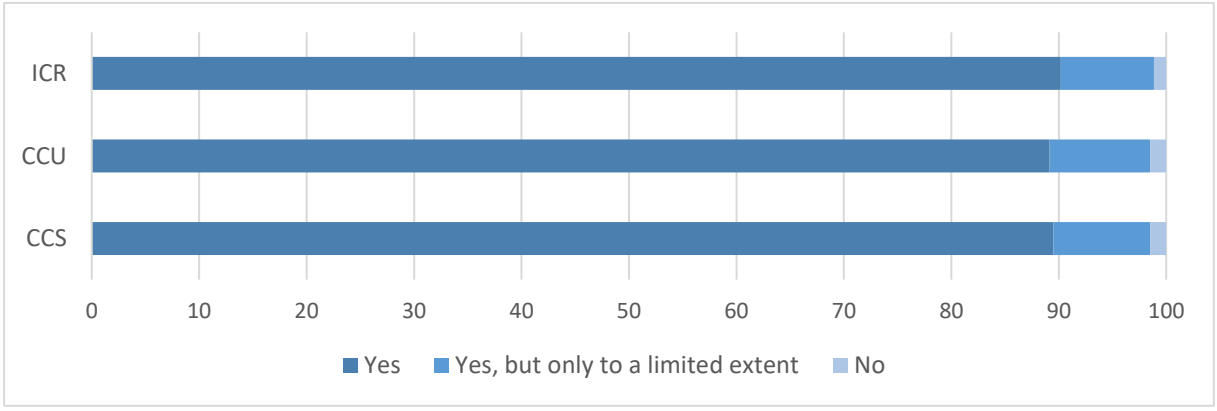
In this section the questions pertaining to the role that the EC should play in relation to supporting CCS, CCU and/or ICR, according to the views of the respondents are presented.

2.3.1 [P1, Q4] Do you think that the European Commission should: i) Do more to communicate the advantages and risks of CCS; ii) Do more to communicate the advantages and risks of CCU; iii) Do more to communicate the advantages and risks of Industrial Carbon Removals

Figure 17 shows the respondents' views regarding the Commission's role in communicating the advantages and risks of CCS, CCU and Industrial Carbon removals. Nearly all respondents see a role for the Commission in communicating the advantages and risks for all technologies (90%), while 9% indicate that is should do so to a limited extent. Only 1% of the respondents advised against such role for the Commission.

The values were consistent across the technologies, showing limited variability and an overall consensus in favour of a more robust effort on the part of the EC in communicating the advantages of all these technologies.

Figure 17: Respondents' views regarding the role of the European Commission on the communication of advantages and risks of CCS, CCU and Industrial Carbon Removals

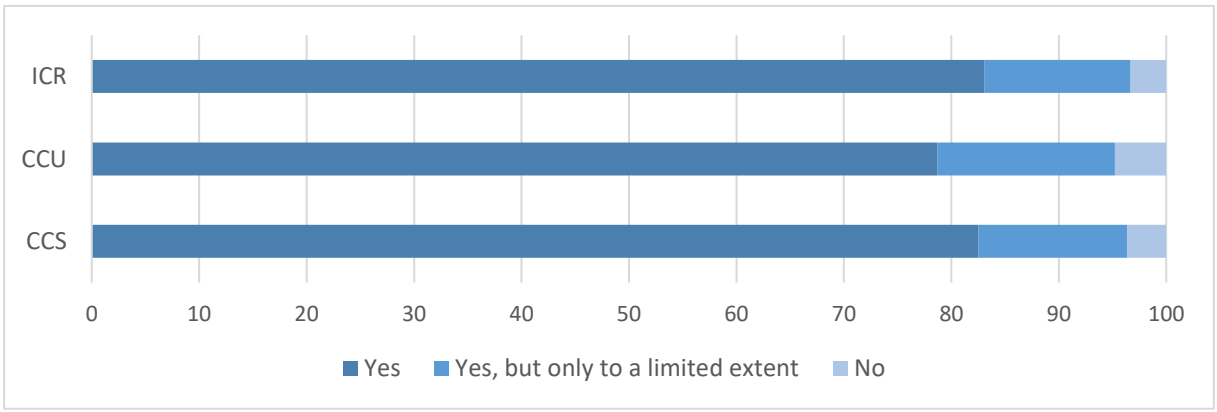


2.3.2 [P1, Q5] Do you think that the European Commission should: i) Support the deployment of CCS; ii) Support the deployment of CCU; iii) Support the deployment of Industrial Carbon Removals

Figure 18 shows the respondents' views regarding the support of the Commission to the deployment of CCS, CCU and ICR. A vast majority of respondents believes that the Commission should support all three technologies, with nearly equal results for all three.

Overall, there is a small variety regarding the technologies, with the overwhelming majority being in favour of all three, CCU being the least supported option by the respondents just slightly behind the other two.

Figure 18: Respondents' views regarding the role of the Commission in supporting the deployment of CCS, CCU and Industrial Carbon Removals



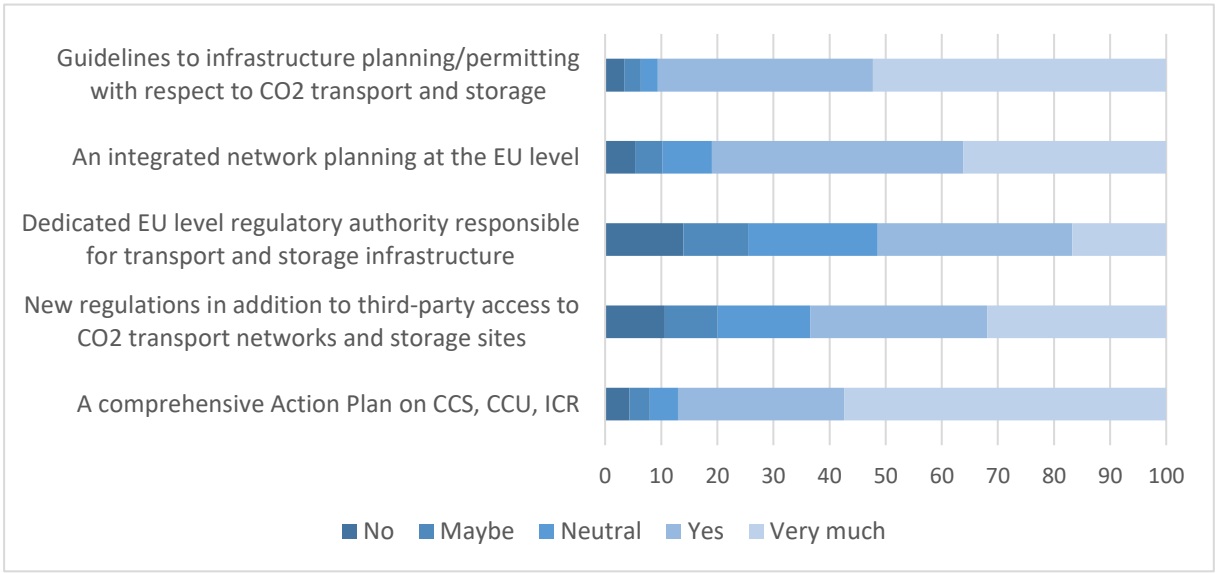
2.3.3 [P2, Q8] At the EU level, do you think we need the following: (please rank your answers)

Figure 19 shows the respondents' views regarding the ranking of different options for EU-level initiatives. Of these, the highest-ranked one is 'guidelines for infrastructure planning and permitting', receiving support of 90% of the respondents, followed by 'a comprehensive Action Plan on CCS, CCU and Industrial Carbon Removals' with 87%. The option receiving the lowest support is 'the establishment of an EU regulatory authority'.

Overall, each presented option enjoys the support of the majority of respondents, the exact ranking being as follows:

1) Guidelines to infrastructure planning with respect to CO2 transport and storage
2) Comprehensive Action Plan on CCS, CCU, ICR
3) Integrated network planning on EU-level
4) New regulations in addition to third party access to CO2 transport and storage sites
5) Dedicated EU-level regulatory authority for the transport and storage infrastructure

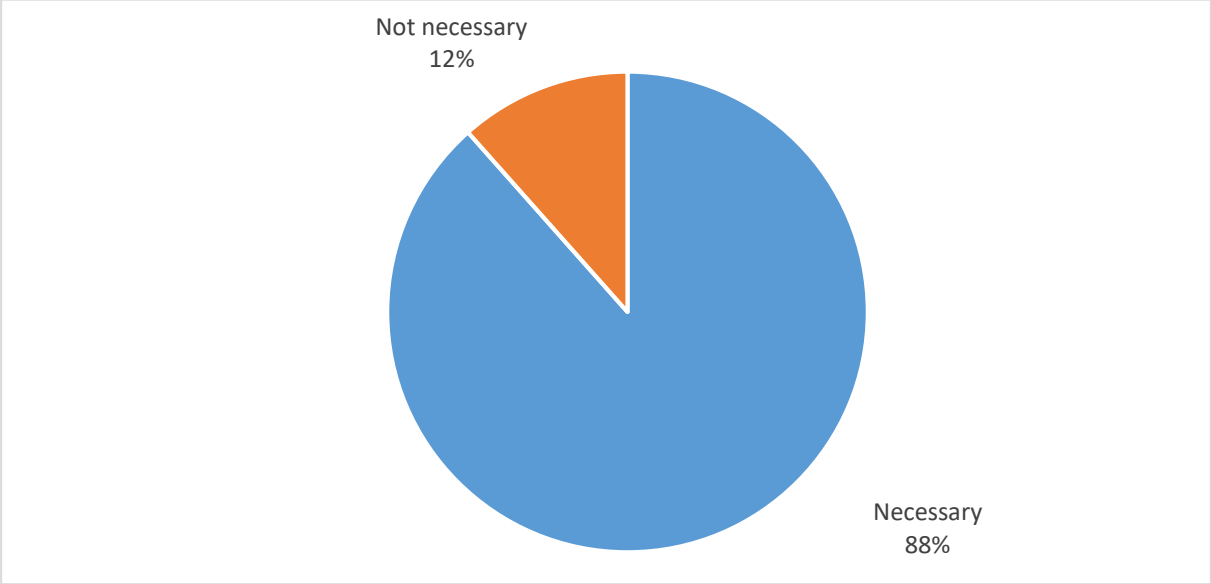
Figure 19: Respondents' ranking of proposed options



2.3.4 [P2, Q24] In some sectors like hydrogen or biomethane, industrial initiatives (like European Clean Hydrogen Alliance) have been created to advance the technology development and speed up project deployment. Such initiatives foresee a close co-operation of business and the European Commission. Do you think that such an initiative is needed for Industrial CCS, CCU and Carbon Removals?

Figure 20 shows the respondents' views on the need for an industrial initiative at EU level to increase collaboration between industry and the Commission on CCS, CCU and Industrial Carbon Removals. A vast majority of respondents who provided an answer support this initiative (88%), while 12% reject it. About 20% of all respondents, however, provided no answer/expressed no opinion to this question.

Figure 20: Respondents' views on the need for a EU industrial initiative on CCS, CCU and Carbon Removals



Stakeholders who agreed on the necessity of an industrial initiative focusing on CCS, CCU (CCUS), and Carbon Removals (CR) were invited to specify potential goals for such an endeavour. The suggested objectives encompass a broad spectrum of aspects, including addressing market and regulatory concerns related to CCUS and CR applications, assuming a representative role for the initiative, fostering partnerships and networking for the exchange of ideas, as well as sharing comprehensive and in-depth information and insights on the subject matter.

Moreover, the proposed goals extend to the development of technologies, the implementation of strategic initiatives, and a coordinating function concerning the planning, execution of projects, and the procurement of necessary supplies. A comprehensive list of these suggested objectives is provided in the following Table 3.

Table 3: Suggested objectives of an initiative

Market

- scaling-up and implementation of a CR (voluntary) market
- call for long-term CO_2 removal and utilisation targets and commitments
- create a European level playing field facilitating a European market
- identification of barriers to implementation of CCUS, CR
- de-risk and foster investments in, and demand for CCUS, CR

Regulation

- creation of instruments and (regulatory) framework for CCUS, CR
- development and implementation of certification, standards
- elaborate a liability management
- suggest and support establishment of EU or national funding schemes
- one forum for CCUS/CR, one single voice
- improve awareness for benefits and challenges of CCUS, CR

- act as reliable partner/representative of the CCUS, CR industry for the EU

Partnering

- participation of industry in policy discussion, give policy recommendations
- organise dialogues between stakeholders in politics, industry and science
- networking among businesses, politics, experts, project developers, NGOs
- facilitate business partnerships and international cooperation
- exchange on project ideas, concerns, opportunities

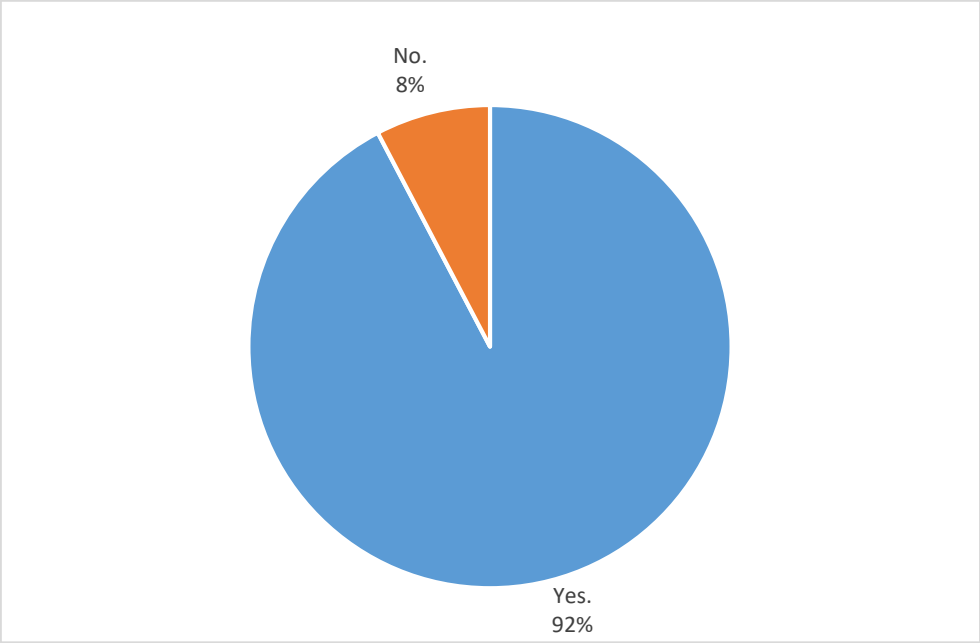
Information

- education and engagement of broader stakeholder community
- provide inputs to studies/reports of the EC and EP
- information on funding opportunities at EU and national level
- knowledge sharing, promoting best practices, exchange of experiences
- evaluate and suggest funding mechanisms
- assess potential benefits, costs, impacts of CCUS and CR options, express concerns
- set up a research agenda for CCUS and CR technologies
- accelerate technology development and CCUS, CR deployment
- implement industrial carbon management strategy
- promote application of CCUS and CR
- elaborate a CO_2 circular economy
- ensure third party access to infrastructure (transport, storage)
- coordinate infrastructure projects, or value chains, and finance
- organise or coordinate auctions or tenders of projects
- establish a Carbon Removal Purchase Facility guaranteeing a price for CR
- act as a one-stop shop for industries in CCUS, CR business
- coordinate joint procurements to catalyse market

2.3.5 [P2, Q25] Is it desirable to create international coalitions for developing cross-border CO_2 transport infrastructure and storage infrastructure?

Figure 21 shows the respondents' views regarding the creation of international coalitions for developing cross-border CO_2 infrastructure. A vast majority of respondents who provided a clear answer supports this (92%), while only 8% rejects it. 12% of all respondents refused to answer the question, or had no opinion about it.

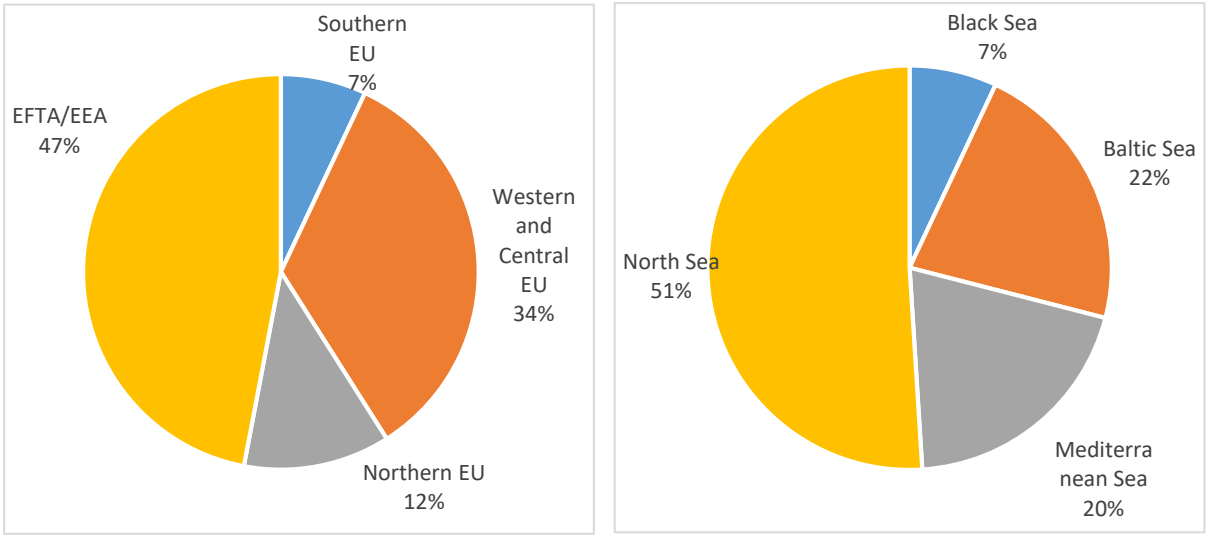
Figure 21: Respondents' support for international coalitions for CO2 cross-border infrastructure



Cross-border infrastructure agreements (or coalitions) are needed between countries that have large clusters with high industrial activity, therefore demand for CCS, and countries that have sufficiently large and secure storage options – be it offshore or onshore. The most relevant regions or countries for coalitions for CO_2 cross-border infrastructure, according to written submissions from respondents, are:

- From a global perspective, the EU followed by the UK are considered as most relevant for cross-border coalitions.
- Within Europe, coalitions are expected to be needed with EEA or EFTA countries, especially with the UK and Norway, and Western and Central European countries such as Germany, Netherlands, Belgium and Ukraine.
- Regarding sea regions, the North Sea is mentioned the most, followed by the Baltic and Mediterranean Sea.

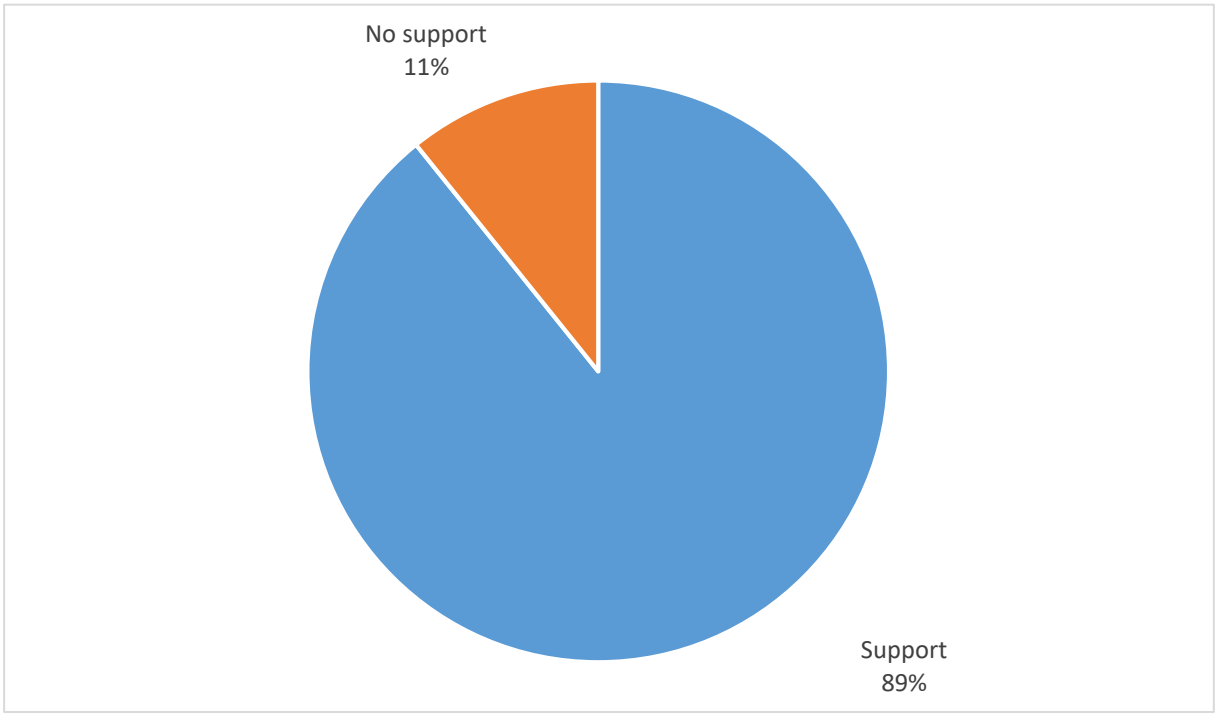
Figure 22: Respondents' suggested regions or countries for coalitions of CO_2 cross-border infrastructure



2.3.6 [P2, Q26] Is it desirable that the European Commission contributes to the deployment of CCS, CCU and Industrial Carbon Removals globally?

Figure 23 shows the respondents' views regarding the role of the Commission in the global deployment of CCS, CCU and ICR. The vast majority of respondents, who expressed a clear opinion, supports this role for the Commission (89%), while 11% rejects it. Additionally, 12% of all respondents have no opinion, while 5% provided no response.

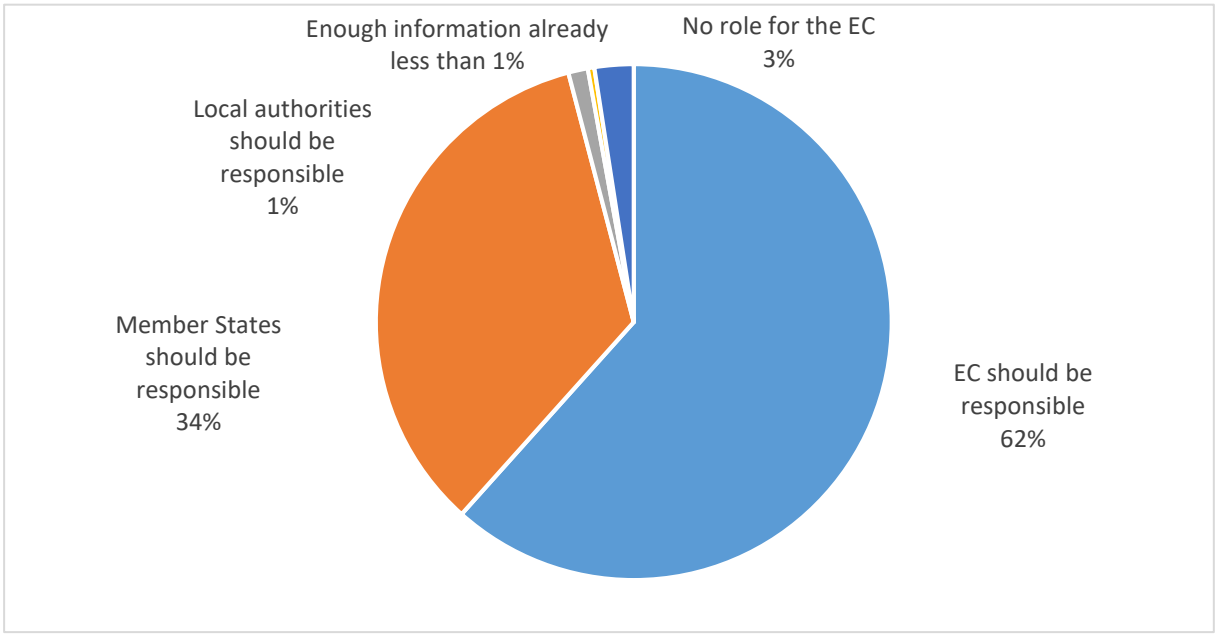
Figure 23: Respondents' views regarding the role of the European Commission in global deployment of CCS, CCU and Industrial Carbon Removals



2.3.7 [P2, Q27] Do you think the European Commission should take a role in improving the quantity and quality of public information available on the three topics: industrial CCS, CCU and Carbon Removals?

Figure 24 shows the respondents' view on the role of the Commission in providing better and more information on industrial CCS, CCU and Carbon Removals. The majority of respondents who provided an answer (62%) supports a centralised information system, while 34% supports this role in coordination with Member States. 3% of the respondents do not see the need for this role. 6% of all respondents had no opinion or refused to answer this question.

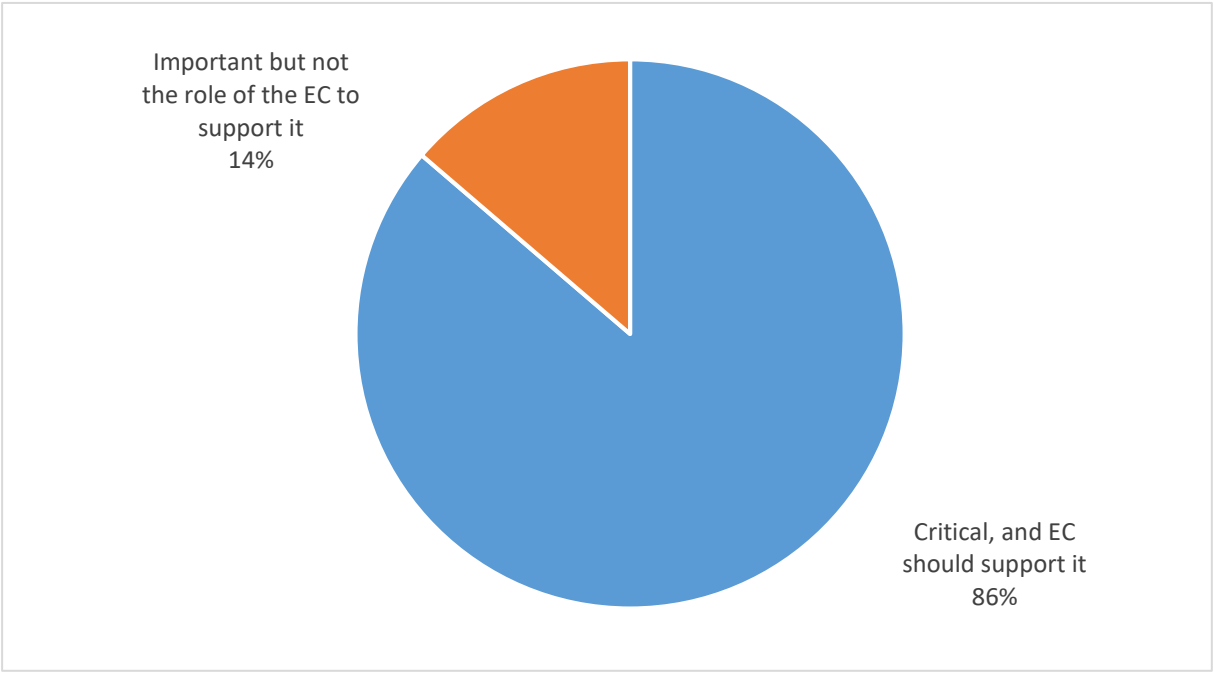
Figure 24: Respondents' views on the Commission's role in improving quantity and quality of information on industrial CCS, CCU and Carbon Removals



2.3.8 [P2, Q28] Do you think the European Commission should take a role in support of societal engagement and participation for the three topics: industrial CCS, CCU and Carbon Removals?

Figure 25 shows the respondents' views regarding the role of the Commission in supporting societal engagement on industrial CCS, CCU and ICR. A majority of respondents (who expressed a clear opinion on this question) supports this role for the EC, while 14% believe that this should not be taken up by the Commission but 19% of all respondents again provided no answer to this question.

Figure 25: Respondents' views on the role of the European Commission in improving the quantity and quality of public information available on the three topics: industrial CCS, CCU and Carbon Removals



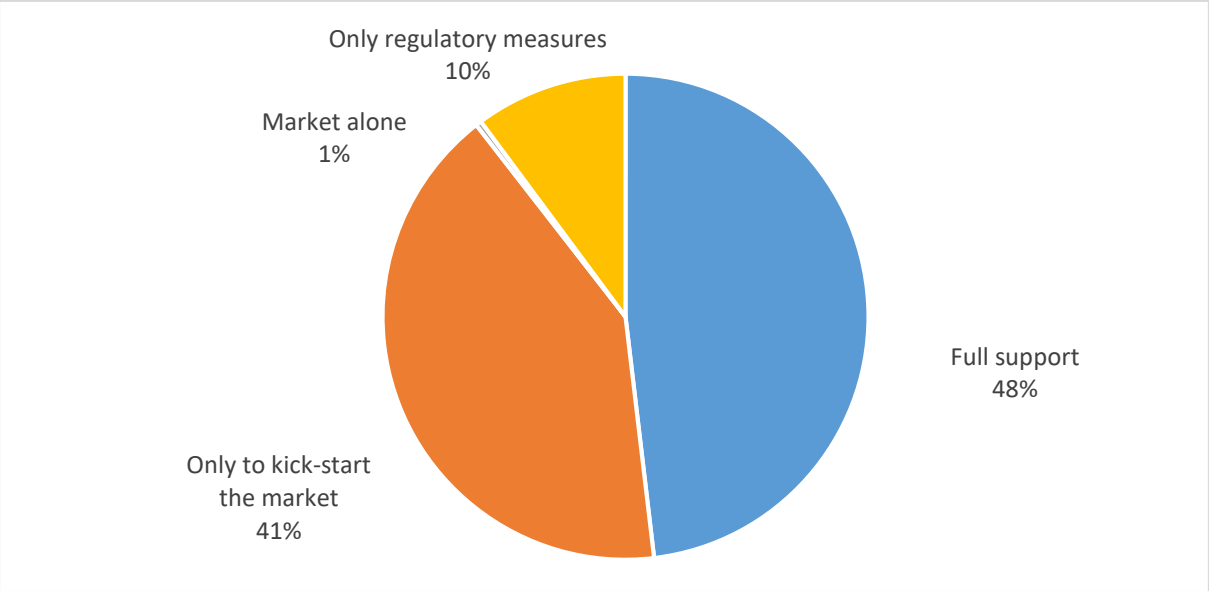
2.4 Main challenges and policy options to address them

In this section the answers to questions related to key challenges for the deployment of CCS, CCU and ICR are presented. The section is made up of eight questions in which stakeholders were asked to provide their views on barriers and policy options to address them.

2.4.1 [P2, Q5] In order to transport captured CO_2 emissions to areas where they can be safely and permanently stored underground or used in products, new infrastructure is needed. Are public funds necessary to stimulate the deployment of such infrastructure to facilitate emitting industries to transport their CO_2 for permanent storage or sustainable use?

Figure 26 shows the respondents' views regarding the need for public funding to storage infrastructure. A majority of respondents expressing any opinion on this topic supports this (48%), while 41% only for a limited period of time for the market to develop. 10% of the respondents reject the need for public funds, in favour of other regulatory measures. 2% of the respondents have no opinion on this, while 3% provided no response.

Figure 26: Respondents' views on whether public funds necessary to stimulate the deployment of such infrastructure to facilitate emitting industries to transport their CO2 for permanent storage or sustainable use



2.4.2 [P2,Q9] Who do you think should finance investment in the CO_2 transport infrastructure?

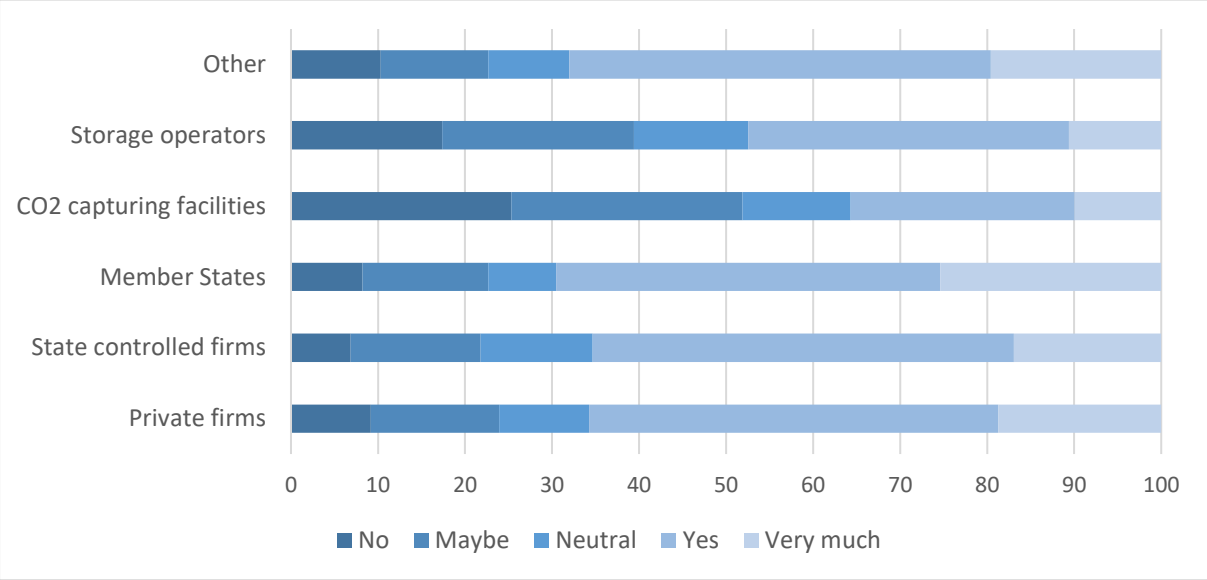
Figure 27 shows the respondents views regarding the source of funding to infrastructure investment. Member States receive the highest support by respondents (71%), followed by unspecified 'Other', and private or state controlled energy infrastructure companies. The actors receiving the lowest support are CO_2 storage operators.

Overall, the responses reveal a preference for either direct or indirect public funding (through state controlled firms), or private funding through companies. Majority of respondents did not deem it to be the storage operators' and rejected the capturing facilities' responsibility in financing the needed CO_2 transport infrastructure.

The answers show the respondents' priority list to be:

1) Member States
2) Other
3) Private firms
4) State controlled firms
5) Storage operators
6) CO_2 capturing facilities

Figure 27: Respondents' ranking of proposed options regarding who should finance investment in CO_2 transport infrastructure



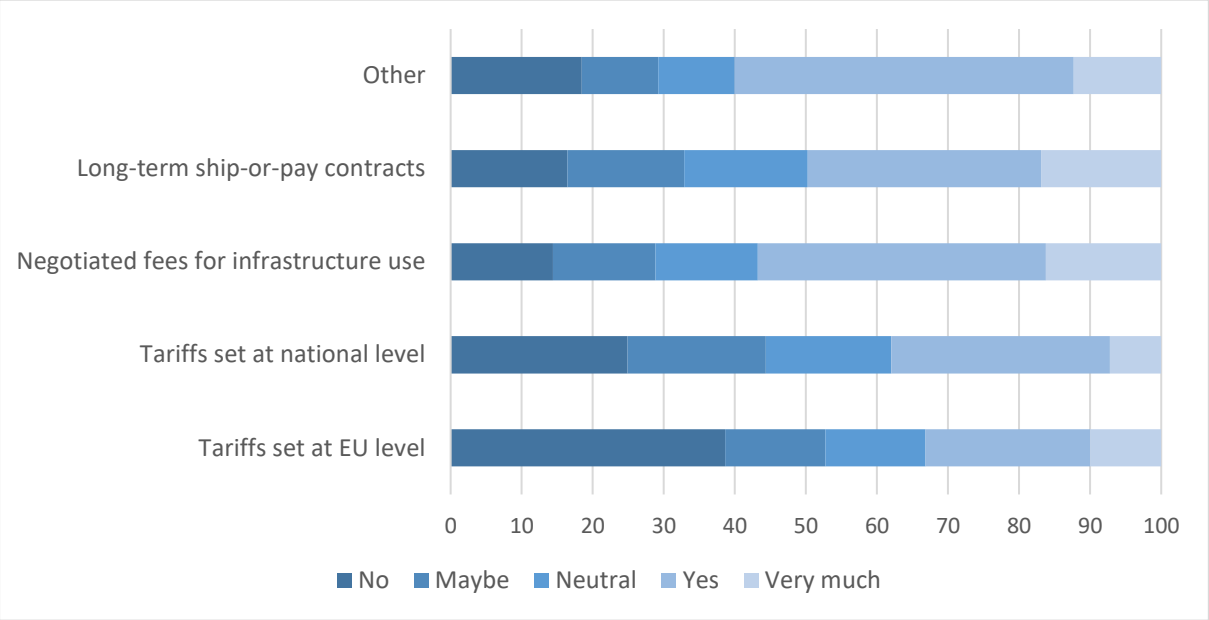
2.4.3 [P2, Q10] How should investment in the CO_2 transport infrastructure be recovered? (please rank your answers)

Figure 28 shows the respondents' views regarding the recovery of investment into CO_2 transport infrastructure. The highest support is given to the "Other" unspecified option (60%), followed by negotiated fees for infrastructure use (57%). The lowest support is received by tariffs set at EU-level, with 39% of respondents opposing this option.

Overall, the responses suggest a preference for little state (or EU) intervention in tariff setting. The respondents' preferences, starting with the most preferred option:

1) Other
2) Negotiated fees for infrastructure use
3) Long-term ship-or-pay contracts
4) Tariffs set at national level
5) Tariffs set at EU level

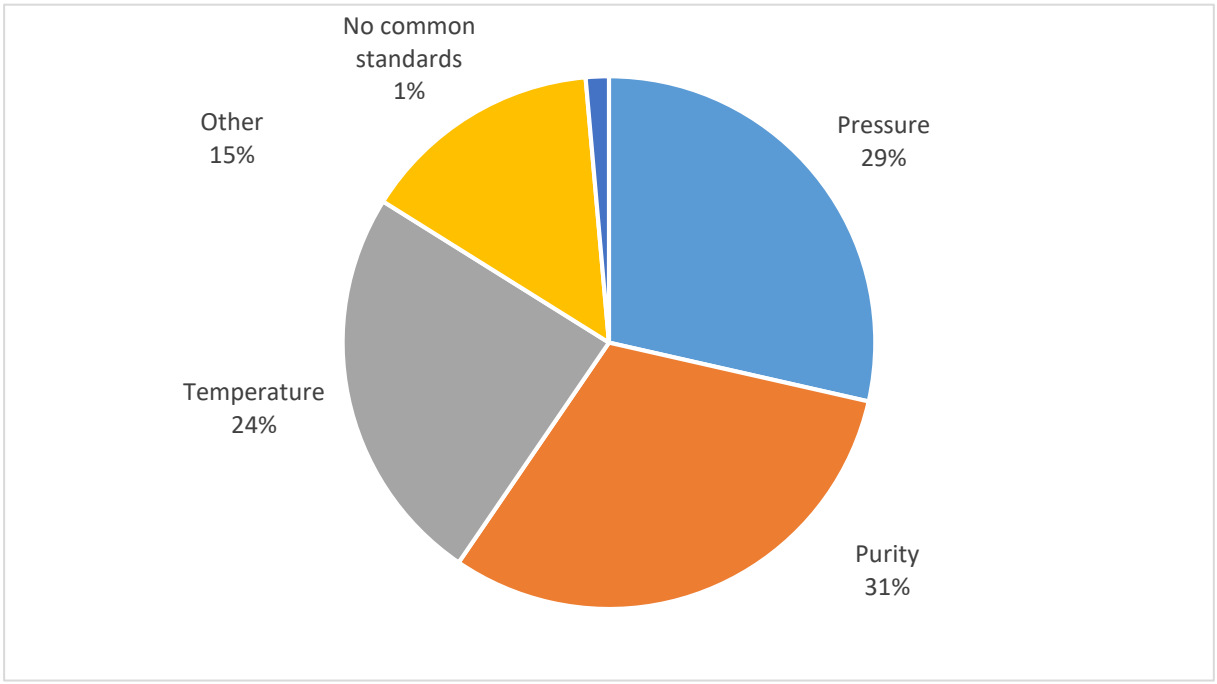
Figure 28: Respondents' ranking of proposed options on how investment in the CO_2 transport infrastructure should be recovered



2.4.4 [P2, Q11] If you think common CO_2 standards are needed in the EU to ensure compatibility of EU-wide CO_2 transport infrastructure, which elements should be considered? (multiple answers possible)

Figure 29 shows the respondents' views on the elements to be included within a EU-wide CO_2 standardisation. Purity (31%), pressure (29%) and temperature (24%) are identified as the most favoured elements to be covered by EU standardisation. The unspecified "Other" was selected by 15% of the respondents who had an opinion on this question, while 8% provided no response and 1% opposed EU-level standardisation efforts.

Figure 29: Respondents' view on which elements to be considered in EU standardisation of EU-wide CO2 transport infrastructure



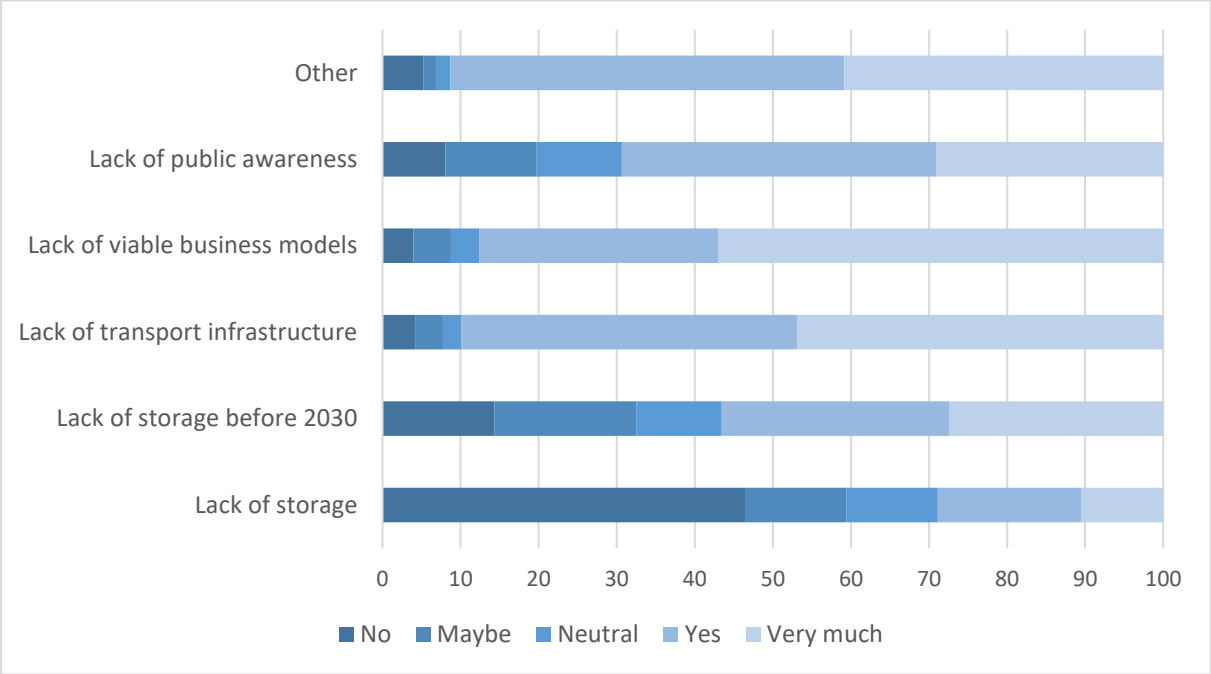
2.4.5 [P2, Q12] What are the main barriers for CCS development? (please rank your answers)

Figure 30 shows the opinion of respondents regarding the main barriers for CCS development. The least limiting factor by far, according to the survey, is the lack of geological storage capacity – 46% of respondents of the option that this is not a main barrier to CCS development, a further 14% does not think that lack of geological storage capacity available by 2030 is a major barrier. Respondents see a lack of viable business models as the most important barrier (57%) followed by lack of transport infrastructure (47%) and other barriers (41%).

The main barriers according to the respondents:<

1) Other
2) Lack of transport infrastructure
3) Lack of viable business models
4) Lack of public awareness
5) Lack of storage before 2030
6) Lack of storage (long-term)

Figure 30: Respondent's opinion on the limiting factors of CCS development



In addressing this open question, stakeholders highlight the absence of viable business cases as a significant barrier to the widespread adoption of CCS applications. However, several underlying factors ultimately contribute to making CCS economically not feasible.

One frequently mentioned issue is coordination failure, often referred to as the chicken-egg dilemma. In this context, it means that investments in CCS technology and infrastructure must occur simultaneously to avoid the risk of economic failure and stranded assets.

Secondly, public opinion and acceptance of CCS, particularly for onshore sites, remain low. This lack of support is often rooted in a poor understanding of how the technology functions and the perceived risks to society. Concerns about accidents further influence public sentiment. Therefore, there is a pressing need for education, information dissemination, and societal debates to address these misconceptions.

Thirdly, due to the low societal acceptance, legal and regulatory frameworks have not been appropriately adjusted in many regions. Some countries still prohibit CCS, and standards for CO2 quality, transport regulations, international trade agreements, liability rules for storage and transport, certification schemes, monitoring protocols, and streamlined permitting processes are often missing. Moreover, there is a lack of an effective regulatory market framework to ensure fair competition and market access. Additionally, CCS as a means of achieving negative emissions should be integrated into the EU emission reduction systems, and access to the EU ETS (Emissions Trading System) should be extended to SMEs.

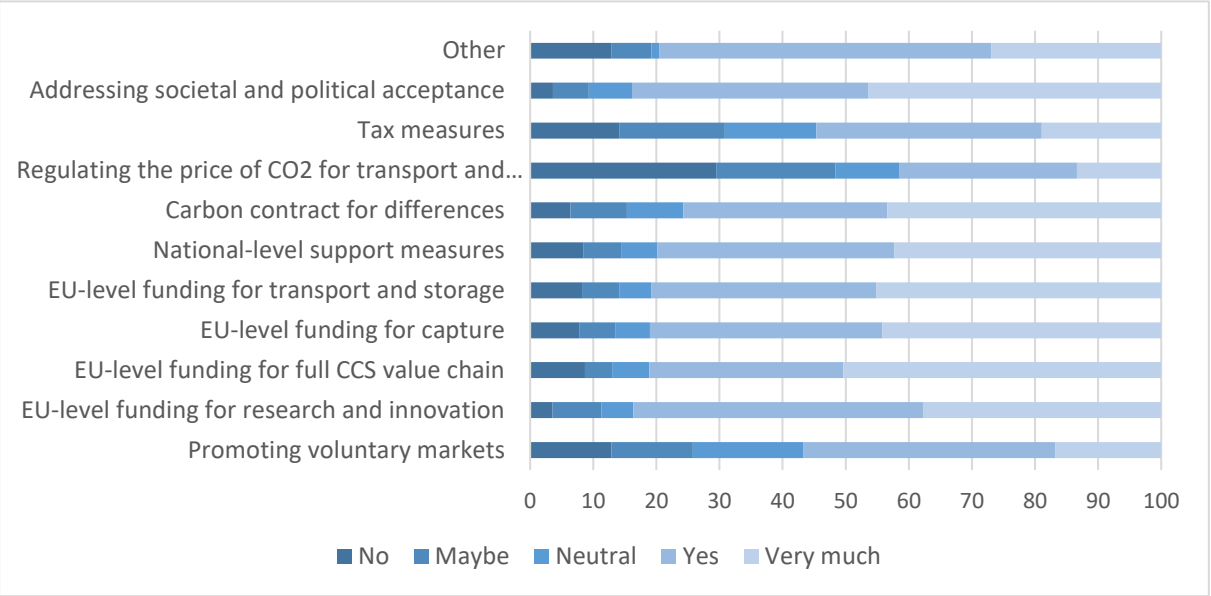
Fourth, from an economic standpoint, the high initial investments and operational expenses, coupled with unclear or unstable revenue streams, create significant uncertainty and risks for CCS projects. This is exacerbated by the lack of financial support or the presence of scattered and inconsistent support schemes, as well as the uncertainty surrounding CO2 price developments and the absence of robust demand policies. Furthermore, the exploration risks associated with storage facilities remain high and present another strong barrier.

Lastly, technological barriers persist, as CCS technologies have not yet proven their scalability or achieved full technological readiness. Additionally, incomplete and unreliable supply chains, coupled with a shortage of experienced personnel, further contribute to the array of challenges facing CCS implementation.

2.4.6 [P2, Q13] Which type of policies should support the development and deployment of CCS?

Figure 31 below shows the acceptance of the different proposed policy measures. The most rejected option within the group of respondents to this survey is 'the regulation of the price of CO_2 for transport and storage' (29% against), followed by 'tax measures' (14%) and 'the promotion of voluntary markets' (13%). The most supported policy is the promotion of 'EU funding for the full CCS value chain' (50% very much in favour and 31% in favour). Other polices with large support were EU-level funding for transport and storage (45% very supportive, 36% supportive), EU-level funding for capture (44% very supportive, 37% supportive), addressing societal and political acceptance (46% very, 38% supportive), national level support measures (42% very, 38% supportive)) and carbon contracts for difference *43% very, 32% supportive).

Figure 31: Respondents' views regarding the type of policies to support the development and deployment of CCS



Stakeholders have put forth additional policy recommendations to bolster the advancement and deployment of CCS, encompassing various aspects across the entire value chain, spanning from CO_2 capture and transportation to storage. Collectively, these recommendations underscore the need for a comprehensive policy framework that can transform CCS into a viable business case. This framework should encompass ambitious and reliable emission reduction and/or removal targets, robust backing for CCUS during the market introduction phase, integration of CCUS into the National Energy and Climate Plans (NECPs) and long-term climate strategies, a blend of policies that create synergies and complementary effects, as well as the assurance of planning and investment stability.

Specific suggestions are clustered around support policies, regulatory measures, collaborative partnerships, implementation strategies, market issues, transparency and funding for infrastructure to mitigate capital expenses, particularly during the initial scaling-up phase. Nevertheless, support for

research and development of technologies, pilot projects, and demonstration initiatives remains still crucial. Support mechanisms should also be tailored to accommodate small and medium-sized enterprises (SMEs). To discourage the use of fossil fuels, a proposal for a "fossil fuels sales fee" has been put forward. Additionally, in cases where CO_2 storage facilities are not readily accessible when required, there is a suggestion to introduce a public risk insurance to offset the substantial costs associated with the subsequent purchase of CO_2 certificates. Another suggestion involves extending the tax credit framework (as in the United States) to encompass all types of carbon oxides, not just CO_2.

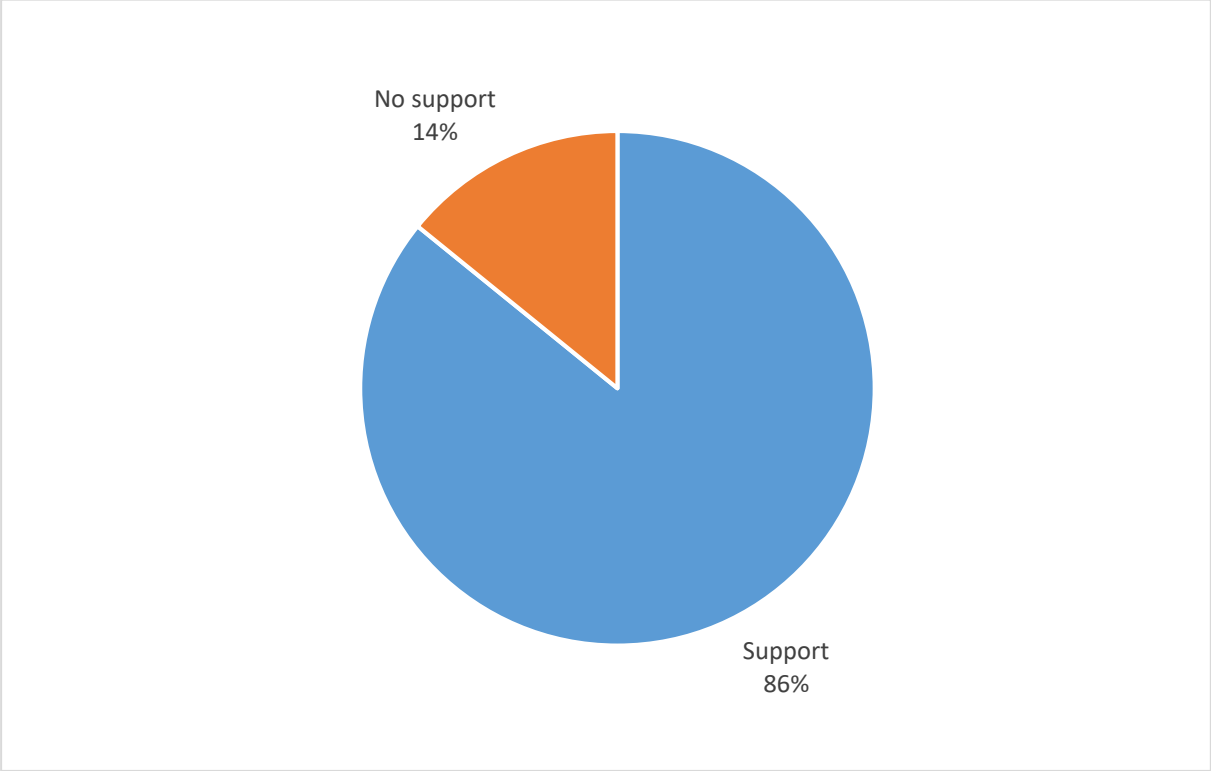
Regarding regulatory matters, concerns have been raised regarding the existence of natural monopolies and the absence of competition in the transportation and storage sectors. Stakeholders advocate for third-party access regulations and a market-driven approach to ensure healthy competition. This entails also establishing clear purity standards for CO_2, harmonized cross-border transportation regulations, and multilateral export agreements. Overall, stakeholders emphasize the need for compatible EU and non-EU Emission Trading Systems (ETS) or Carbon Removal (CR) regimes to facilitate cross-border CO_2 transport to third countries. To streamline the planning and execution of infrastructure projects, appropriate spatial planning policies and the reduction of administrative burdens are deemed crucial. Stakeholders have also called for the establishment of a certification system for BECCS and other CR options, along with a clear definition of biogenetic sources to encompass all CR types within a unified trading system. Several stakeholders advocate for a free and competitive market with open negotiations between market participants and tender processes for storage facilities. While the carbon price is expected to allocate and incentivize investments, stakeholders recognize the possibility of market failures and therefore suggest the implementation of a minimum carbon price to mitigate uncertainty and stimulate investments.

Beyond support and regulations, additional actions could involve promoting industry partnerships through collaborative ventures, implementing CO_2 product labeling to inform consumers about the carbon content of products, capacity building to enhance the skills of staff and authorities to control standards and certifications, and empowering multilateral financial institutions to attract capital.

2.4.7 [P2, Q14] Do you consider that the Commission should define storage availability targets as part of the climate targets for 2040 and 2050?

Figure 32 below details the responses to the question on whether the Commission should define storage availability targets as part of the EU's climate goals. 86% of the respondents who had a strong opinion agreed that the Commission should define these targets, whereas only 14% disagreed. Worth noting, however, that additionally 22% of the respondents either had no opinion or gave no answer to the question.

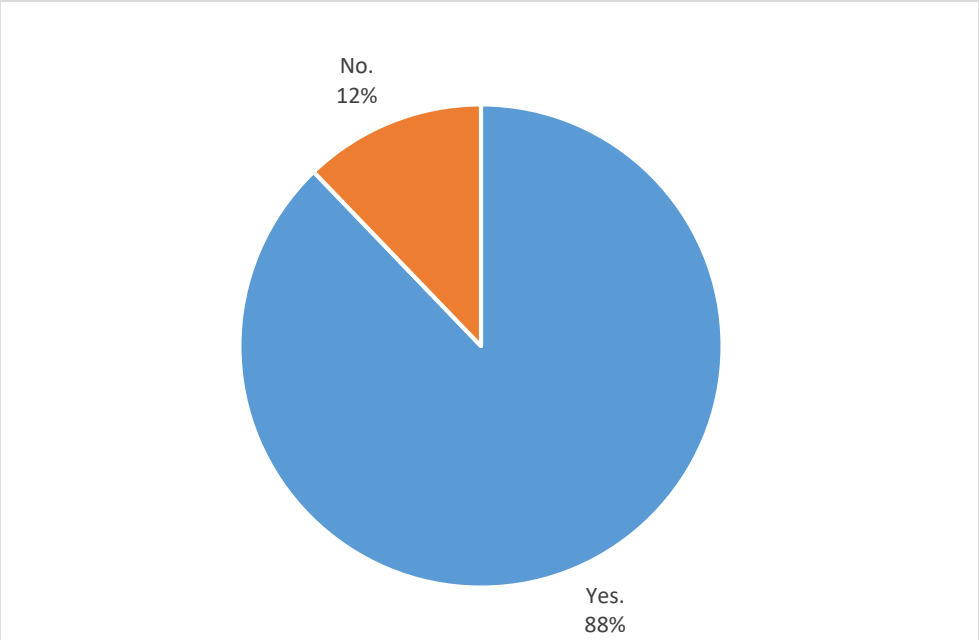
Figure 32: The distribution of respondents who agree/disagree with the Commission setting storage targets



2.4.8 [P2, Q15] In order to speed up storage site permitting, should governments be obliged to provide pre-competitive exploration and assessment of CO2 storage facilities? (as described in the IEA report: Exploring Clean Energy pathways - The role of CO2 storage)?

Figure 33 below shows that a large majority of respondents who expressed an opinion regarding this question supports a government obligation to provide pre-competitive exploration and assessment of CO_2 storage facilities – it is worth noting, however, that a significant portion, 30% of all respondents, did not answer this question.

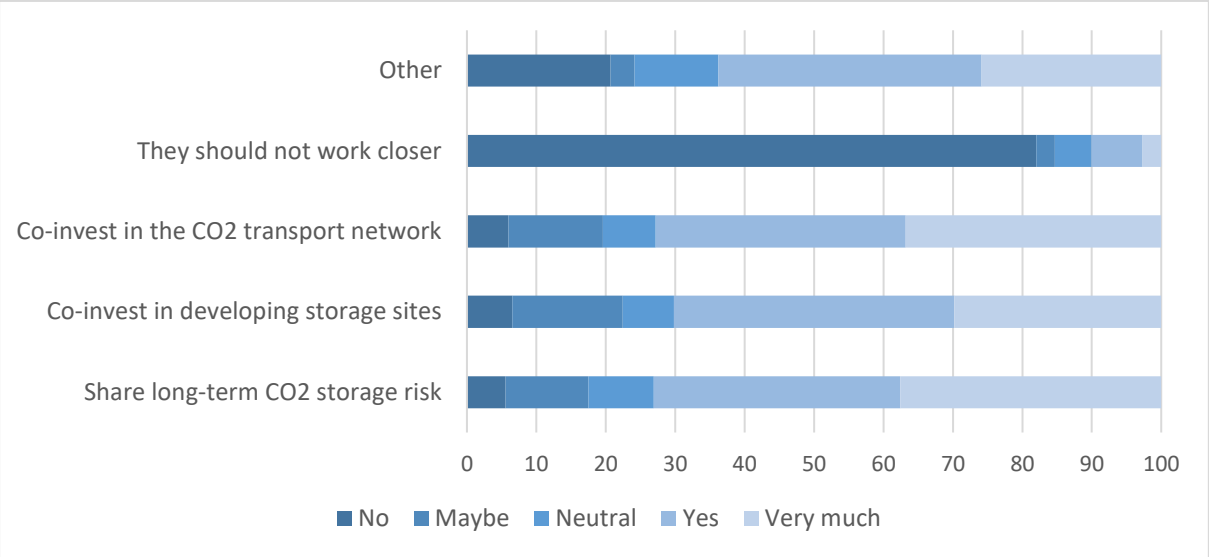
Figure 33: The distribution of respondents' who support or oppose the idea of government obligation to provide pre-competitive exploration assessment of CO_2 facilities



2.4.9 [P2, Q23] Where could private investors and governments work closer together to better stimulate deployment of technologies covered above: (please rank your answers)

Figure 34 below shows the responses to the question regarding which areas for cooperation between private investors and governments are most desirable. The majority of respondents believe that there should be some sort of collaboration as 82% rejected the option of 'they should not work closer'. 'Co-invest in CO_2 transport infrastructure', 'co-invest in developing storage sites' and 'share longer CO_2 storage risk' received a very similar distribution of responses with the majority supporting cooperation in these areas as well as in 'others'.

Figure 34: Responses to the question on where could private investors and governments work closer to support deployment of CCS, CCU and/or Industrial Carbon Removals



Based on the answers to the 'open text' part of the question, several stakeholders do not envision the government as a co-investor; instead, they propose that governments participate in co-funding various aspects along the value chain, encompassing activities such as research and development (R&D), pre-permitting exploration, interconnectors, hubs, terminals, and storage. Co-funding would involve fiscal measures, subsidies, and grants, while guarantees would serve as risk-mitigation instruments to enhance investment certainty.

Moreover, stakeholders emphasize that collaboration extends into regulatory measures, with stakeholders suggesting that governments play a role in ensuring the market functions effectively. This includes granting market access, such as third-party access, and preventing price distortions resulting from market failures. Additionally, stakeholders advocate for the removal of regulatory or market barriers. Furthermore, stakeholders stress the need for robust legal cooperation to collectively formulate a suitable framework for CCUS projects.

Another recommendation involves public procurement, where the government takes the lead as a first mover to demonstrate the feasibility of projects. Additionally, streamlining approval and permitting processes is identified as a key area for collaboration -or improvement-, with the aim of reducing administrative resources and expenses.

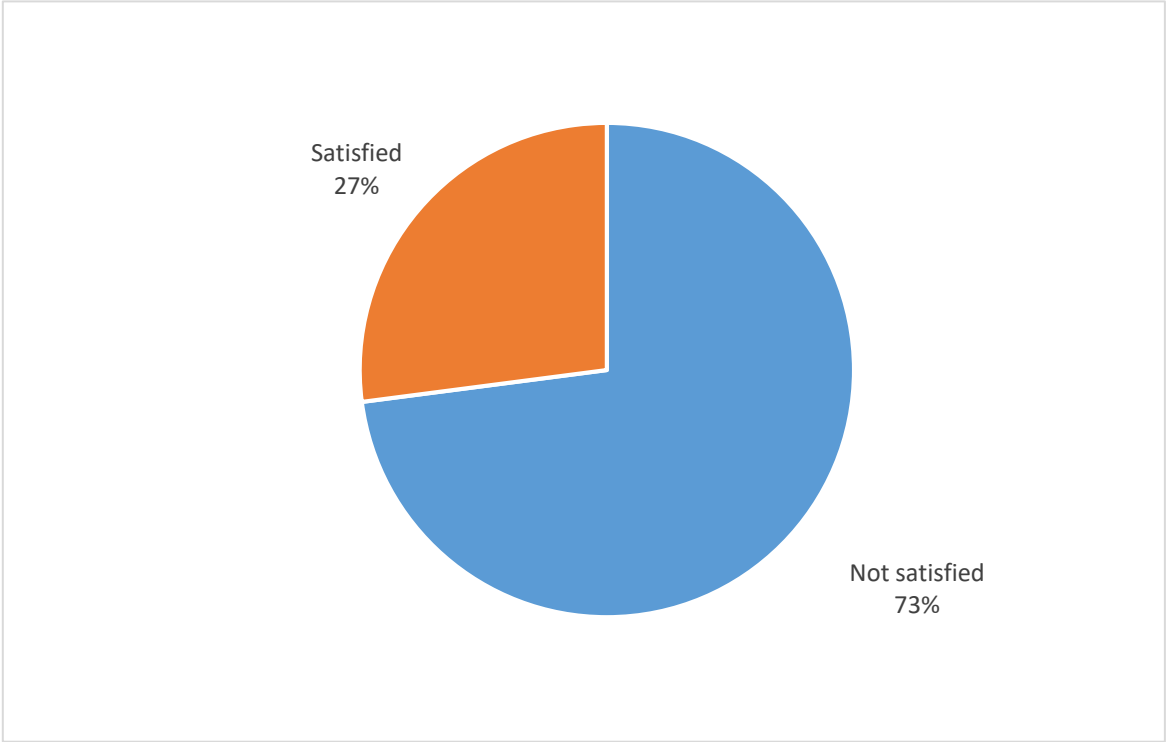
2.5 Other topics

Only a couple of the questions did not fall clearly under one of the three themes above. The question below related to stakeholder involvement in the development of the National Energy and Climate plans. Finally, the last question of the survey was an open question allowing respondents to provide additional information beyond the questions analysed in this report. We provide a summary of the major themes and topics submitted below.

2.5.1 [P2, Q6] The Commission has encouraged Member States to include in their updated National Energy and Climate Plans (NECP) actions enabling capture and permanent storage of CO_2 in accordance with Directive 2009/31/EC. Are you satisfied with the way stakeholders are involved in the NECPs in identifying hard-to-abate emissions and developing decarbonisation roadmaps with assigned roles to CCS, CCU and carbon removals?

Figure 35 below shows the respondents' satisfaction with the involvement of stakeholders in the identification of hard-to-abate sectors and decarbonisation roadmaps of the NECPs involving CCS, CCU and carbon removal technologies. Only 27% of respondents who expressed a clear opinion were satisfied with the stakeholder engagement in these matters, whereas 73% were not satisfied. Also worth noting that a very large portion of the respondents – 39% altogether – expressed no opinion or decided not to answer the question.

Figure 35: Respondents' satisfaction with stakeholder engagement



2.5.2 [P2, Q29] Is there anything else you want to share with us that we have not (sufficiently) addressed in previous questions?

Replies from stakeholders regarding additional concerns or messages cover various aspects along the value chain, spanning from research and development (R&D) to policy implementation. In the realm of R&D, stakeholders emphasize the necessity for financial backing to support research, development, and innovation across all technologies and applications of CCS, CCU and CR, including those at lower technology readiness levels. One proposed approach to achieve this is reallocating

more financial resources from the EU Emissions Trading System (ETS) to the Innovation Fund while also adjusting application criteria.
Given that the exploration of storage sites necessitates substantial investments, spans over extended timeframes, and involves significant risks of sunk costs, stakeholders recommend that the EU or national governments provide support or actively engage in these endeavors.

Regarding site exploration, they advocate for the inclusion of Central and Eastern European countries, such as Ukraine. Furthermore, they express their support for completing the storage mapping initiative at the EU level and granting open access to data concerning potential storage sites. In this context, concerns have been raised regarding the disparities among EU Member States in terms of access conditions to onshore or offshore storage sites.
In general, the coordination of infrastructure planning and development is a crucial issue because projects involving carbon capture, transportation, and storage need to be developed in tandem. This implies that infrastructure development serves as a prerequisite not only for installations but also for further innovation and the advancement of CO_2 capture technologies. While there is a strong need for harmonized standards related to purity, market regulations, and liability for each type of infrastructure and technology separately - transportation and storage - premature regulation might risk limiting the cost-efficient use and development of specific modes and technologies.

Regarding the range of CCUS and CR technologies, there are varied opinions among stakeholders. Some advocate for technology-neutral support and promotion, emphasizing that each technology comes with its own set of benefits and risks. Conversely, others express specific priorities, such as a preference for CCS or CCU in certain sectors, like the maritime sector for CCU. In this context, they underscore the potential of technologies with a low technology readiness level, such as CO_2 mineralization as a removal option.

The increased utilization of biogenic raw materials, including Combined Heat and Power (CHP) and Waste-to-Energy (WtE) plants, enhances the significance of CCU. This is because it replaces fossil-fuel-based CO_2 feedstock and has a climate impact that is considered neutral since emissions from the end-of-life (CCU) do not affect emission balances and are ideally captured again at the end of life. When stored as biogenic CO_2 in end-products (CCUS), it contributes to negative emissions without requiring additional storage infrastructure. To account for this potential contribution, a Guarantee of Origin system is proposed.
Other stakeholders have no specific preferences regarding biogenic or CO_2 from hard-to-abate industries, or they support CCU only if the released CO_2 is permanently stored. Some stakeholders emphasize the importance of the cascading principle, of which BECCS is seen as an integrated part. According to some stakeholders, the questionnaire's presentation of risks and benefits related to BECCS has been biased, as each of the CCS technology encompasses distinct risks and benefits.

Several stakeholders have highlighted the unique case of Waste-to-Energy (WtE) plants. WtE facilities serve the purpose of managing residual waste that cannot be prevented or recycled. While ensuring efficient waste management, WtE facilities recycle the energy contained in residual waste through the simultaneous production of electricity and heat. Consequently, the fossil CO_2 emissions arising from WtE plants are considered inherent to the process. The functional unit of measurement for a WtE plant is typically the tonne of waste treated, and imposing additional financial burdens on such facilities may deter the recycling of energy content and result in the retention of CO_2 within the waste. This underscores the argument that WtE should not be directly listed or compared with other power generation technologies like coal or gas-fired power plants.
Furthermore, the capture of CO_2 emissions originating from biogenic sources could be regarded as a form of CO_2 removal. Any capturing and reusing of CO_2 (CCUS) represents substantial costs,

which should be offset by market prices established through a robust market mechanism for negative emissions.

In general, the majority of stakeholders support a market-oriented development approach for CCUS and CR, particularly when the market and competition are functioning well, and projects are economically viable. Consequently, they advocate for measures to address disadvantages faced by land-locked industries, a strong support of infrastructure investments due to coordination challenges and the public good nature of such endeavors, financial assistance during the ramp-up phase to mitigate high uncertainties and risks, as well as initial support for startups and projects.

To prevent distortions in competition arising from natural monopolies in transportation and storage, stakeholders emphasize the importance of regulations that ensure appropriate market access and third-party access but no price regulation.
To maintain transparency regarding costs and prices, they propose the establishment of an information platform that provides data on various CO_2 certificate prices and costs associated with different CO_2 reduction, CCS, CCU, or CR options. Such a platform could also take on the role of coordinating activities in capture, transport, and storage infrastructure, potentially becoming a key component of the industrial carbon management strategy mentioned. Another aspect of this strategy could involve the development of an agreement for cross-border CO_2 transport or export, which would create a large storage market outside the EU. Lastly, a suggestion is made to include objectives for CO_2 transport in the Net-Zero Industry Act.

While the questionnaire has already sought input on potential policies and regulations supporting the development of CCUS or CR, stakeholders have reiterated certain key points. They have placed particular emphasis on:

- **Awareness, Education, and Communication**: Stakeholders stress the importance of raising awareness, providing education, disseminating information, and involving civil society in discussions. They emphasize the need to communicate with local communities regarding the costs, risks, and benefits of storage options.
- **Networking and Dialogue**: Many respondents highlight the value of networking and fostering dialogues across sectors, involving various stakeholders and experts from politics, industry, and science to facilitate the sharing of knowledge and experiences.
- **Streamlining Administrative Processes**: The streamlining of administrative, licensing, permitting, or approval processes has been a key concern for many stakeholders.
- **Price Signals**: Some respondents call for clear price signals to kick-start CCS, CCU and CR, although not all stakeholders advocate for mandatory storage targets. They propose that high CO_2 prices within the EU should be supported by appropriate import tariffs on non-CO_2 priced products.
- **Investment Certainty**: Stakeholders express a paramount concern for investment certainty, which could be enhanced through long-term, clear, and stable support mechanisms, including the de-risking of projects through stable revenue streams (e.g., Contract for Difference, or CCfD) and addressing investment gaps. Strong policy commitment is seen as crucial.
- **Specific Regulatory Suggestions**: Stakeholders provide specific regulatory recommendations, including: i) Standardization of mass balancing, life cycle assessment of CO_2 (including upstream CO_2-footprints), monitoring, and accounting of CO2 in both ETS and non-ETS sectors. They suggest avoiding premature mandates for standards on activities that are in the early stages of technical and commercial development, such as purity standards for CO_2 in transport and storage. ii) Streamlining and adapting regulations for repurposing existing infrastructure, including hydrocarbons licensing directives and CO2 storage directives, as well as extending hydrocarbons production permits to CO2 storage and addressing liability for decommissioning of repurposed CCS facilities. iii) Ensuring regulatory coherence with existing climate policies,

such as the EU ETS, LULUCF, ESR, and CCUS strategy. iv) Proposing changes to the EU ETS Directive, Annex I, to cover the entire CCS/CCU value chain, including transport and storage, to account for potential emissions leakages, avoid double counting of emissions, and include CO_2 transport for CCU purposes. v) Recognizing the uniqueness of each technology and project in legislation, allowing flexibility in project evaluation and approval to ensure the most efficient projects are realized. vi) Avoiding price regulation in transport and storage activities while ensuring fair competition. vii) Establishing a booking, trading, or claiming system for CO_2 certificates.

These reiterated points reflect the diverse perspectives and detailed recommendations provided by stakeholders in support of CCS, CCU and/or CR development.

Specific aspects of discussion revolved around the definition of "hard-to-abate" sectors. Stakeholders emphasized the need for this definition to incorporate a time component and be closely linked to the application of CCS. Further, the formation of CO_2 in processes should be distinguished from the term CO_2 emissions.

In a broader context, several stakeholders reiterated that the utilization of carbon removals should be viewed as a complementary measure to achieve net-zero greenhouse gas emissions, rather than a substitute for efforts to phase out fossil fuels. While carbon removals are essential for meeting the EU's climate targets, priority should be given to the deployment of renewable energies, energy efficiency improvements, electrification, and the development of green hydrogen. Stakeholders highlighted risks associated with CCS, CCU and/or CR such as maintaining dependence on fossil fuels, sunk costs, environmental concerns, but also benefits such as the EU's technology leadership and contributions to a flexible energy system.

3 Call for evidence – Submissions to the OPC

In addition to the OPC questionnaire, stakeholders could also submit written statements and attach position papers, or other documents. In total, 209 stakeholder statements were submitted. 152 of those statements were complemented with additional attachments of which 147 were analysed. The remaining 57 stakeholders submitted statements without any further attachments. The majority of submissions (182) were in English; however 17 respondents answered in German, 4 in French and 6 in other languages (Italian, Polish, Slovak, Swedish, Flemish and Finnish). Submissions in languages other than English were machine translated.

The section 3.1 below contains a short analysis of the respondents' profile, since the OPC survey and call for evidence submissions were independent from each other. In the section 3.2 the analysis of the content of the submissions (statements and attachments) is summarised at the thematic level.

3.1 Profile of respondents

Figure 36 shows the distribution of respondents based on their country of origin. Like in the case of the OPC questionnaire, the largest number of respondents were from Belgium (37). The second largest country of origin was Germany (32), followed by the Netherlands (20), Finland (15) and Denmark (14).

Non-EU submissions (not shown in figure) came from Canada (1), Mexico (1), Norway (10), Switzerland (2), UK (11), US (6), Jordan (1), Scotland (1) and UAE (1).

Figure 36: Distribution of respondents by country of origin

Member state	Nr. of respondents
Austria	2
Belgium	37
Czechia	1
Denmark	14
Finland	15
France	13
Germany	32
Greece	1
Ireland	4
Italy	13
Latvia	1
Netherlands	20
Poland	9
Slovakia	1
Spain	4
Sweden	8

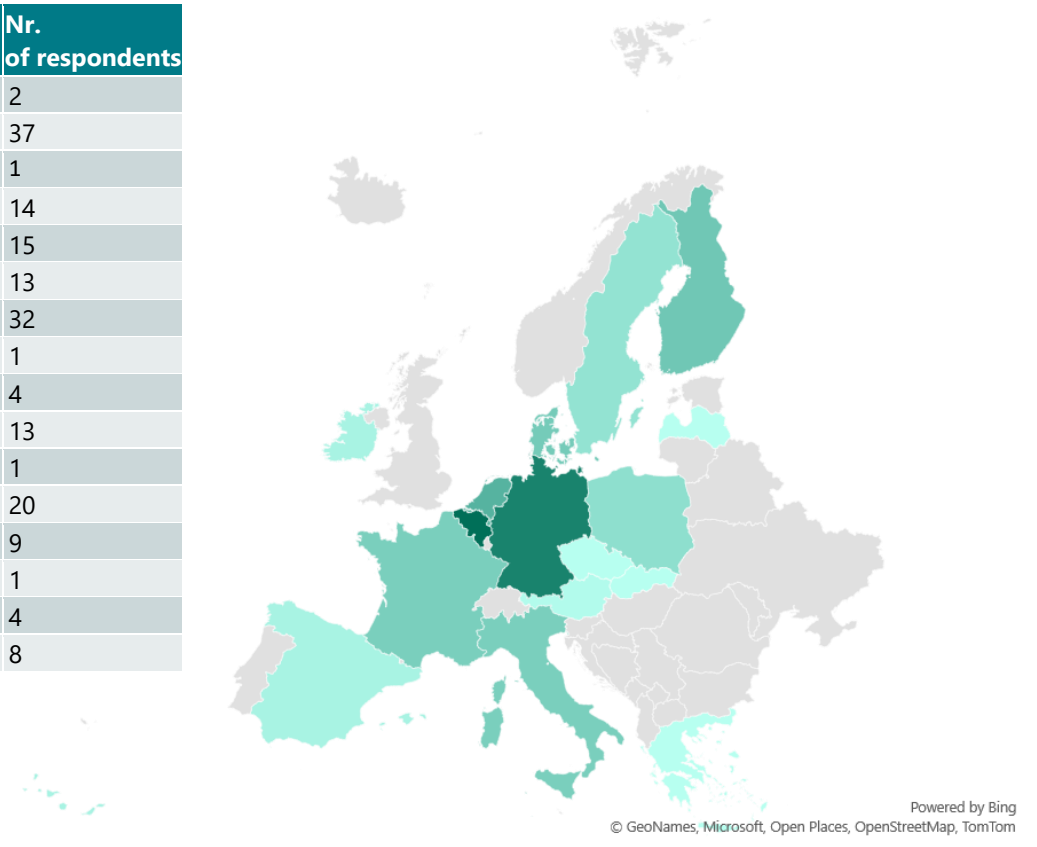
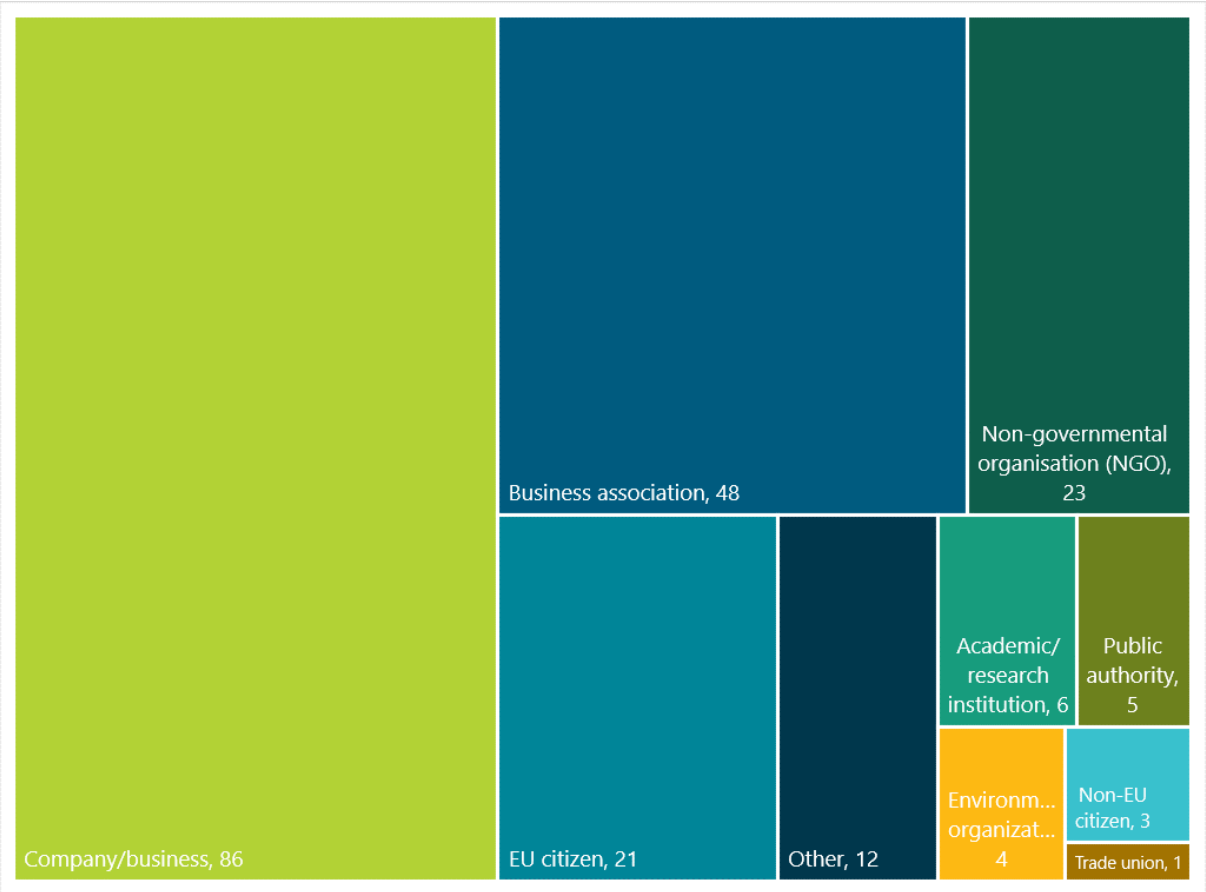


Figure 37 shows the different stakeholder groups that submitted feedback. Like for the OPC survey, the majority of stakeholders represented companies/businesses (86) or business associations (48). NGOs (23) and EU citizens (21) were also often represented. Fewer submissions came from Academic Institutions (6), public authorities (5), environmental organizations (4), non-EU citizens (3) and trade unions (1). Twelve submissions self-identified under 'others'.

Figure 37: The number of respondents by types of organisation



When applicable, the respondents were asked about the size of their organisation. As seen in Figure 38 the largest group (70) of respondents came from Large (250 or more employees))

organizations, the second largest (47) from small (10 to 49 employees), followed by (33) micro (1 to 9 employees) and (32) medium (50 to 249 employees) organisations.

Figure 38: The number of participants by the size of organisation

3.2 Summary of Key Points from the Call for Evidence

Key messages

Overall, there is a **general acknowledgement that CCS is necessary to achieve net-zero emissions by 2050**, in particular for the hard-to-abate sectors. Industrial Carbon Removals are also seen as a needed option to address residual emissions. A few respondents (mostly NGOs), however, were explicit that **carbon removal technology development should not be placed above general climate change mitigation** – fossil power and bioenergy production should not be incentivised.

Most find that **a balanced approach between technologies is needed**, although a few submissions were particularly cautious regarding the use of BECCS due to sustainability issues and limited applicability.

There is a **clear need for a robust policy framework, at both the EU and Member State level**, with **clear definitions** of CCS, CCU and (I)CDR. There is also a need for clarity around what is considered permanent storage of CO_2 particularly for CCU.

Regarding CO_2 transport, many found that **coordination of the (pipeline) network at the EU level is necessary**. Some also stressed that all transport modes should be recognised.

In general, **the submitted opinions were in support of the milestone targets towards 2050**. Some were supportive of an EU-level carbon removals target.

The **need for a market for permanent carbon removals** was mentioned a number of times. Some submissions stated that the negative emissions should be included in the ETS, with ETS carbon removals also counting as negative emissions.

Companies stressed the need for financial support, particularly to reduce risks by developers. However, mostly NGOs, stressed that carbon removal technologies are a waste of public money.

For international cooperation, a number of submissions mentioned the need for EU/Member States to ratify the amendment(s) to the London Protocol.

3.3 Relevance of CCS, CCU and/or Industrial Carbon Removals for the EU climate goals

The vast majority of submissions acknowledge the need for CCS to achieve net-zero emissions by 2050. Also, **the majority of submissions acknowledge that carbon removals CDRs including industrial options (ICDRs) will be needed to address residual emissions** in hard to abate sectors. To support their position on the role of CCS, CCU and/or ICRs several submissions reference the IPCC[5], the IEA[6], the European Scientific Advisory Board on Climate Change[7], and the Commission's own analyses of possible EU pathways to climate neutrality[8] to support their positions.

However, there were also a number of responses that expressed **concerns that CCS and CDR diverts attention and resources from much needed investments into other (technical) mitigation options, reduction of consumption and the development of a circular carbon economy**. While not all of those submissions completely oppose the use of CCS, those that see a role for CCS point out explicitly that CCS should only be allowed as last option, where mitigation is not possible.

The opinions on the **role of CCU in achieving climate targets is more contested.** Many respondents point out that depending on the CCU pathway the CO_2 can be stored for a short period or longer one. As such LCA **evaluation on a case-by-case basis** is need, as argued by some stakeholders. In addition, a few stakeholders asked for an **assessment of the contribution of different CCU applications to Europe's climate policy objectives**. However, others stressed that CO_2 can be used as feedstock in many industries and that should not be forgotten; there is the circular economy aspect that should be considered. Some of those respondents explicitly see a priority for CCU over CCS in those cases.

A few papers are particularly cautious regarding the use of BECCS either due to **sustainability issues with biomass** or because so far, the application of BECCS is very limited. On the other hand, a couple of stakeholders were unhappy with sustainability of biomass being singled out as a concern in the survey, arguing other technologies have other sustainability issues.

In terms of volume of papers that focused on specific technologies, most discussed was CCS, second most discussed was CCU, stressing the importance of including CCU in the Strategy, while industrial carbon removals (BECCS and DACCS) were mentioned the least. Most find that **a balanced approach between technologies is needed**. Some statements point to making more use of the natural sinks instead of using the industrial carbon removal options.

Generally and at a high level, there are opposing views expressed in the submitted papers. This contradiction is mostly between businesses and non-governmental organizations. Some (mostly businesses) view carbon capture and carbon removal (in all its forms) as necessary for the transition of industry and power sector. At the same time others (mostly NGOs) believe that CCUS, and particularly CCS, should definitely not be used for the power sector, as a number of other alternatives exist, that are much more deployment ready. The overarching view here is that industrial carbon management should be done in a way that does not inadvertently incentivize more fossil power and bioenergy production – mitigation should be prioritised.

[5] IPPC (2022): Climate Change 2022: Mitigation of Climate Change – Working Group III Contribution to the AR6.

[6] IEA (2021): Net Zero by 2050 – A Roadmap for the Global Energy Sector.

[7] ESABCC (2023): Scientific advice for the determination of an EU-wide 2040 climate target and a greenhouse gas budget for 2030–2050.

[8] European Commission (2018): In-depth analysis in support of the Commission Communication COM(2018) 733.

3.4 Role of the European Commission in relation to CCS, CCU and/or Industrial Carbon Removals

The majority of responses agree that the European Commission has a role to play in supporting the deployment of CCS, CCU and ICR technologies and infrastructure. A couple of papers stressed that while European coordination is needed, this should be done in a decentralized way to give Member States flexibility and not to hinder 'front runners'.

Two overarching areas in which a role for the EU is generally seen as necessary are:

i) overseeing the development of a coherent and overarching EU regulatory framework, and
ii) coordination support for the development of Pan-European infrastructure for CO_2 transport and storage.

On the **regulatory front**, a large number of submissions emphasize the current lack of a robust policy framework (i.e., guidelines, incentives, safeguards) along the value chain and a role for the EU in addressing this issue. A call for clear definitions on CCS, CCU and (I)CDRs was repeated many times by stakeholders. Specifically, **uncertainty remains around the definitions of CCU and (Industrial) CDR**. There should be clarity around what is considered permanent carbon storage under CCU – the industry related to minerals expressed, that they would like to see the integration of mineralisation into the framework. Furthermore, several papers mentioned that a future framework should specify which activities constitute emission reductions and which carbon removal. It is important to understand, and appropriately reflect in law and policy, that the **nature and climate impact of carbon removals and emission reductions are not equal**.

Clarity around regulation at **both EU and Member State level** would be much needed, where the European Commission could also provide guidelines to MS on the carbon regulation, to ensure a coherent approach. For example, a number of papers call for an **inclusion of CCS/negative emission uptake in the National Energy and Climate Plans (NECPs) and/or Long Term Strategies (LTS)** or other Member State or EU strategies. Legal and policy frameworks should be developed in a **timely manner**.

A few papers proposed the creation of a **European alliance for industrial carbon management**. They argue that such an Alliance could help strengthen cross-border cooperation between CO_2 emitters and transport and storage operators in different European countries. It could also support national policy makers on relevant actions and good practices to develop the market.

3.5 Main challenges and policy options to address these

The majority of stakeholders find that there are still important barriers that need to be addressed for the large-scale deployment of CCS, CCU and ICDRs.

Among the regulatory barriers the issues mentioned were: **need for a coherent framework and need for clear definitions**. These two issues were highlighted as requisites to give better legal certainty to businesses. Other points mentioned several times were:

Businesses expressed the need for EU to **clarify how the carbon capture market will function**.

A number of industry players stressed the need for **consistent and timely permitting** across the entire value chain.

Some companies find the **current storage target (under the NZIA) for 2030 insufficient**; however, in general the papers that mentioned milestone targets were in favour of them. A few papers mentioned that they would also like to see interim **targets for 2040 and 2050**. There is some support for an EU-level carbon removals target. In addition to storage targets, some stakeholders

expressed that it would be desirable to develop a strategic plan for making available large-scale storage basins across Europe. To this end, **development of an EU CO_2 storage atlas** would be helpful.

The topic of **market for permanent carbon removals** was mentioned a number of times; some papers suggested creating a market for negative emissions (most of the time linking this to the existing emissions trading scheme in the EU). A number of papers stressed the interaction with carbon removals and the EU ETS. A number of them stated that within the EU ETS carbon removals (either CCS or CCU) should count as negative emissions. Some others even suggested that within the EU ETS operators should be given allowances for negative emissions. Other papers however, address the fact that under current EU ETS legislation CCU can lead to a **double-counting** of emissions and call for changes in the legislation to solve that issue.

Many respondents highlight the need for **viable business models** along the whole value chain in the future. For kick-starting the market and in the current absence of those business cases a majority of the papers (particularly from companies) stressed the **need for financial support**. NGOs on the other hand expressed that so far, the investments into CCS technology have not paid off and thus such large sums of money should be diverted to more proven technologies. Some mentioned that a well-functioning regulatory framework would include support **mechanisms to reduce risks by developers**. NGOs stressed that the regulatory framework should not put citizens in a position where Member States are in the end responsible for the injected CO_2 (and thus minimising the applicability of "polluter pays").

Instruments mentioned that could support the development of a marker include **Carbon Contracts for Difference**, as well as continued support from the **Innovation Fund**. Other ideas included using **product standards and purchase targets** to grow demand for near-zero carbon products and exploring the use of producer responsibility measures as a long-term regulatory driver. **Public procurement** was also mentioned as an important lever. **State aid** exceptions were mentioned by only a few papers. A few papers also mentioned the creation of a **CO_2 Removals Bank** (akin to the Europea Hydrogen Bank). A number of papers stressed that funding efforts should be synchronized. The papers also included a number of references to the IRA in the US where a tax credit tied to the amount of CO_2 captured was put forward.

Regarding **CO_2 transport** networks, many find that coordination of the (pipeline) network at the EU level is necessary. In addition, a number of submitted papers stressed that **all transport modes (beyond pipelines) should be recognised** within the Strategy. The TEN-E, TEN-T and Connecting Europe Facility (CEF) were mentioned as examples where the role of flexible transport modes should be more clearly defined. Further, several respondents stressed the need **to ensure that investments in transport infrastructure are 'future proofed'**, i.e. with a view for future, larger CO_2 volumes. A few stakeholders mentioned that the EU should provide funding and regulatory support to promote the build-out of appropriately sized infrastructure. This also means that clear rules to **ensure interoperability** are needed. Ensuring third party access to the infrastructure was also mentioned as an important element in the view of a number of respondents.

This is very closely tied to the expressed need for improved legal and policy frameworks for cross-border CO_2 transport – a number of papers submitted stressed that import and export of CO_2 within and to regions outside the EEA needs to be allowed.

A few papers mention **lack of public perception or potential challenges around social acceptance** and some of them point to the need for raising awareness. A few suggest that a dedicated awareness campaign is developed by the European Commission. The importance of ensuring access to developing the necessary **skills, education and advisory services** as well as **cross-sectoral partnerships** were highlighted in a few papers.

3.6 Other topics

On **international cooperation**, a number of the papers mentioned the need for the EU/Member States to ratify the amendment(s) to the **London Protocol**. Member States party to the London convention should ratify the addition to Article 6, make a declaration of provisional application to the IMO and start talks with possible partner countries to regulate conditions provided for in Article 6 in bilateral agreements. A few respondents called on the European Commission to make swift progress in its dialogue with the government of the United Kingdom on cross-border transport of CO_2.

4 Stakeholder Workshop: Presentation of the results of the open public consultation on industrial carbon management

Brussels, the Madou Tower Auditorium, Place Madou 1, 1210 - Saint-Josse-Ten-Noode and online (Webex), 6th October 2023

4.1 Introduction

In this workshop, the Commission together with the Consultants hired, presented the results of the Open Public Consultation (OPC) on Industrial Carbon Management (ICM) including the results of the survey and the feedback submitted under the 'call for evidence'. The OPC survey and 'call for evidence' were open from early June to end of August 2023. The workshop is part of the public consultation activities.

The objective of the OPC is to allow stakeholders to share their views and provide feedback on the technological options to capture CO_2 emissions before they can reach the atmosphere. To transport them, store, or use them in a carbon management value chain. The objective of the workshop was to present the results received so far, and to give participants an opportunity to provide further inputs to the consultation.

The feedback received will serve as important input for the European Commission (EC) in the development of an EU strategy for establishing an industrial carbon management market by 2030 (EU Strategy), which will include how these technologies can best contribute to the objective of reaching climate neutrality for the EU by 2050 and set a strategic vision for industrial carbon management in the EU.

171 stakeholders registered for in-person participants and there were 489 online participants.

This full agenda of the technical workshop is provided below.

Table 4: Workshop Agenda

Time (CEST)	Activity	Who
14:00-14:15	**Welcome and presentation of agenda**	*Moderator (Hans Bolscher, Trinomics)*
14:15-14:45	**What we expected from Industrial Carbon Management Strategy OPC**	*DG ENER, Edith Hofer*
14:45-16:00	**Presentation of OPC results** • Relevance of CCS, CCU and/or Industrial Carbon Removals for the EU climate goals • Role of the European Commission in relation to CCS, CCU and/or Industrial Carbon Removals • Main challenges and policy options to address them	*Barbara Breitschopf, Fraunhofer*
16:00-16:45	**Q&A and feedback from participants**	*Moderator (Hans Bolscher, Trinomics)*
16:45-17:00	**Closing remarks**	*DG CLIMA, Daniel Kitscha*

4.2 Event Minutes

Edith Hofer (DG ENER) gave introductory remarks on preliminary reflections on the results of the OPC, expressing her and the EC's satisfaction with the broad participation to the survey. It was highlighted that this involvement in the OPC reflects an increasing recognition for the need of industrial carbon management technologies on the path towards carbon neutrality. A major barrier to the full development and deployment of these technologies is seen in the lack of a regulatory environment for the infrastructure. The very large participation in the OPC serves as a further motivation for the development of such regulatory framework. Finally, Edith invited the workshop's participants to partake in the CCUS Forum taking place in Aalborg, Denmark, on 27-28 November 2023.

4.3 Q&A

Following the presentation by Barbara Breitschopf (Fraunhofer) on the results of the OPC, a Q&A session from the audience, online and in person, was moderated by Hans Bolscher (Trinomics). The main questions posed to the audience were grouped under three themes: i) regarding the necessity of this regulatory framework; ii) the main barriers to its effective implementation, iii) what the role of the Commission is. However, given that the responses did not always follow the themes, below they have been organized by the key topics raised by the stakeholders.

4.3.1 Need for a swift ICM strategy that maintains technology neutrality

Stakeholders generally agreed that ICM technologies are really needed, as shown in the Intergovernmental Panel on Climate Change (IPCC) report(s). However, an environmental NGO emphasized that while an important and necessary element in global carbon neutrality, the efforts in developing a framework for industrial carbon removals should not substitute measures to reduce emissions. One stakeholder also mentioned that, in his/her opinion, to date, there is no knowledge nor evidence that CCS is a realistic climate solution in the quantities and timeframe needed.

Participants also emphasized that time is needed to build up necessary investment and that industry needs a **clear framework with a time horizon**. Liability is a key aspect to address through regulation. There were several comments regarding the need for a rapid development of the EC Strategy. Furthermore, one stakeholder remarked that the strategy should focus on net-zero in 2050 and beyond. Given that the EU climate law aims for net negative Greenhouse Gas (GHG) emissions after 2050 the industrial carbon strategy should also take this aim into account by building infrastructure and incentives that facilitate the net negative emissions target beyond 2050.

One stakeholder said that in his/her opinion, what seems little emphasized in the presented feedback was: 1) the importance of a standardized reporting/classification framework, (e.g. like UNFC-2019), to monitor progress and maturation of CCUS projects in relation to targets set, and 2) stimulating accessibility of reliable information in the public domain which is needed to assess viability of projects and prospects for CCUS.

Several comments about **keeping a technology neutral approach** were also voiced. One participant asked whether the ICM Strategy will be agnostics as to which technology can contribute to CO_2 reduction & removal. For example, it appears that opinions differ on merits of BECCS vs DACCS where this could be partly due to current perceptions rather than future outlook. There was a question about how the EC will ensure a balance between not only CCS, CCU and ICR but also methods within ICR, namely in the storage and transportation infrastructure.

4.3.2 Carbon Dioxide Transport

A number of stakeholders agreed that the EU should support the **development of a Pan-European infrastructure to transport CO_2**. Stakeholders emphasised that it is needed to take into consideration multimodal transport solutions as key driver for market ramp-up of CCS and CCU. There was a question on how the Commission will ensure the establishment of a Single Market for the multimodal transport of CO_2 across borders without having to endure a patchwork of bilateral agreements between Member States. The stakeholder mentioned that the Commission needs to secure the ratification of the London Protocol.

A workshop participant mentioned that the transport and storage of CO_2 are particularly challenging for CDR companies operating across borders, especially those outside the EU and that the administrative burden can often (especially for SMEs) be substantial and costly.

4.3.3 Carbon Dioxide Storage: Geography and targets

Concerns were voiced about the fact that CCS infrastructure in Europe is developing largely around the North Sea. An ICM framework needs to ensure that industries in other regions of Europe are connected, otherwise this could bear negative consequences for regions with no access to the North Sea CO_2 storage. One participant mentioned that we need two types of CCUS hubs: large scale hubs and territorial hubs for industries which cannot afford economically to send CO_2 to northern Europe. Another comment was about the need for small-scale CCS chain at regional scale

with optimized transport solutions because monitoring of storage sites is less costly in case of small onshore sites than big sites offshore.

A stakeholder voiced the concern that the EU is underestimating having enough storage ready in time. Another stakeholder requested that the target of permanently storing at least 5 million tonnes of CO_2 from the atmosphere using technological solutions by 2030 is reviewed and raised to consider the actual potential of the technology. He/she argued that bolder targets would give a clear signal to the industry that the EU is serious in its ambition to utilize CCUS as a part of its climate change mitigation strategy. According to this view, this would consequently enhance the establishment of an overall EU level carbon removal target that incorporates all types of carbon capture. This would greatly benefit the development and commercial deployment of carbon capture technologies.

The concept of Carbon Capture and intermediate Storage (CCiS) was introduced by one stakeholder. The participant mentioned that CCiS is very necessary for land-locked countries with only small possibilities for long term sequestration in reservoirs; CCiS is also very needed to provide future constant feedstock flows for H_2 and CO_2 for synthetic chemical production processes. The stakeholder wanted to know how this will be valuated in the Strategy.

A clarification on the long term stewardship focused on permanent storage and handing over the responsibility from business to national government should be included in the Strategy according to one stakeholder. Another participant thought that all potential CO_2 storage projects should be communicated to the EC and that the EC could help in giving technical advice for these projects.

There was also a remark regarding the long term CO_2 storage solutions other than CCS. For example, by developing a certification framework for solid carbon from pyrolysis (which can be produced from either methane or biomethane).

4.3.4 Business case and financial incentives

A stakeholder noted that currently there is no business case for CCS and other ICM technologies in the EU. In contrast to the EU, the US provides the right regulatory environment and incentives. There was a comment that the EU should learn from other jurisdictions beyond Europe. A participant asked for a comparison with other jurisdictions outside of EU, and mentioned that many of them include **simplicity, predictability and a de-risking approaches**. Further, the EU should either provide financial incentives or set obligations. Another stakeholder wrote that there are a lot of financial uncertainty for companies and asked whether the EC will evaluate the necessary financial incentives (e.g., through subsidies and funds) to support this sector.

Stakeholders mentioned that a timely deployment for CCU/CCS/ICR technologies will require significant investment decisions in the years to come, and a **robust European industrial policy** is very much needed. Despite the array of existing EU funding tools such as the Innovation Fund, InvestEU, Horizon Europe, and CEF, there is an urgent need for a **more coordinated approach to streamline funding** specifically aimed at cleantech manufacturing. A question was asked about whether the Commission plans to significantly increase the level of EU funding available to boost ICM technologies.

A stakeholder commented that the EC should consider the role of the 'polluter pays principle' in climate mitigation.

Waste Sector

A number of stakeholders had comments related to the Waste Sector. The Waste Sector faces the problem that it has both biogenic and fossil carbon in the stacks. The sector needs CCS to be able

to contribute to the climate goals. There is a need to be able to allocate the biogenic carbon as removals, and allocate the fossil part as reduction, regardless of if the carbon is stored or used. Also in relation to the waste sector, stakeholders wanted to know how will the EC ensure the ICM Strategy will not undermine other policies focused on reducing waste generation and cautioned about putting CCS on incinerators as many of them should be eventually phased out. One organization was particularly concerned about CCS in the context of waste incineration and the **technology lock-in effects** that CCS is likely to have in this context. If at all, only emissions that cannot be abated at source should be targeted end-of-pipe, captured, and permanently stored. However, through circular practices, almost all emissions linked to waste incineration can be avoided.

Another stakeholder pointed out that the amount of waste globally, especially from plastic, is unfortunately increasing. If and when plastics are recycled and/or biogenic, Waste-to Energy CCS can be part of the circle as CCU. He/She argued that it is very much a no-regret option to put CCS/CCU on Waste-to-Energy facilities.

There was a question regarding CDRs in the waste sector. The stakeholder asked how will carbon removals from waste-to-energy be addressed in the Strategy, and whether are there diverging views on the role of waste-to-energy among DG Climate Action, DG Energy and DG Environment.

Further, there was a concern that Waste-to-Energy CCS might be dependent on both the ETS-system (avoiding cost for fossil emissions) as well as CDR's (income from negative emissions or from CCU). The concerned stakeholder asked whether the Strategy would consider the linking of these two system or whether it would rather develop the systems simultaneously.

4.3.5 BECCS and DACCS

Regarding BECCS, stakeholders mentioned that the majority of the biomass burned in the EU comes directly from forests. Burning forest biomass is not carbon neutral over policy-relevant timeframes, and therefore BECCS with forest biomass cannot deliver "negative" emissions. The IPCC has stated that BECCS with forest biomass could increase emissions over decades. The EC should take this into consideration and ensure that it is not 'putting the cart before the horse in promoting BECCS without taking the science into account'. Another stakeholder mentioned that the biomass that is presently consumed in the EU often causes significant air pollution, in particular, particulate matter with its very negative health effects. This is not compatible with one of the Green Deal objectives, namely a zero pollution society. Can all/most existing biomass use, or at least the strictly sustainable part of it, gradually be rediverted to clean CCUS?

One stakeholder requested to please highlight the need of Direct Air Capture. CCS and CCU will not be enough to clean the atmosphere according to this view. He/she also mentioned that carbon removals have a viable business case and cited the example of converting part of CO_2 into e-methanol and storing another part with a CO_2 cost below 50 EUR/ton.

Furthermore, a stakeholder pointed out that, carbon removals are key to offset residual emissions but according to IPCC 6th assessment report "carbon cycle response is asymmetric for pulse emissions or removals, which means that CO_2 emissions would be more effective at raising atmospheric CO_2 than CO_2 removals are at lowering atmospheric CO_2". This must be considered in the methodologies for accounting and inventorying emissions.

4.3.6 Role of EC and Member States

Stakeholder pointed out that it is important to make sure that the EU strategy will overall be consistent with the MS strategies. There was a question on how the Commission will ensure the establishment of a Single Market for the multimodal transport of CO_2 across borders without having to

resort to bilateral agreements between MS. A participant mentioned that the EC should not only monitor CCS but also work for ensuring the development of infrastructure in an efficient and integrated way.

There was a question on how will the EC **assist MS to evaluate permitting request for storage sites**? Many of MS authorities prefer to refuse the permit for storage than to take a deep evaluation of risks and benefits. A participant asked if technical support from the EC in the evaluation of permitting issues can be expected and whether the European Commission would look to address these issues and work towards harmonising the rules across Member States? Another stakeholder highlighted that the EU should play a role in supporting harmonisation [of rules] across Member States.

4.3.7 Role of different Industrial Carbon Management technologies in the ICM Strategy

Stakeholders were interested in how it can be ensured that the strategy will be balanced equally between CCS, CCU and CDR - addressing both challenges and barriers for all technologies. A question on how CO_2 emission avoidance will be included and whether this will be coupled with EU ETS came up.

A participant of the workshop stated that a regulatory framework supporting CCS and CCU is needed and that for his/her organization it is key that CCS and CCU (as well as e-fuels) are both implemented together. The market conditions should allow this to happen. CCU is an important element of the cement sector. A stakeholder mentioned that due to the currently limited [regulatory] framework, some CCU projects that were planned did not 'take off the ground'.

For one of the companies in the workshop, the use of CO_2 as feedstock for production has the highest and longer lasting priority. It can be used for fuels but more critically for materials. In their view, acknowledging carbon from the source and not just end of pipe will allow higher climate mitigation ambition but also provide the much needed carbon feedstock for the European industry.

4.3.8 Barriers to ICM deployment

For companies that are first movers, CO_2 is readily available but the hurdles come from different time horizons between emitters and storage operators. Emitters have different investment conditions. For capture projects it is important to have certainty in permitting for advancing as fast as possible. Issue related to storage capacity are on a longer time-scale. Various sources of storge data, that are not accessible by everyone. There is a need to coordinate storage research.

A participant mentioned that a very simple framework should be established at EU level for accompanying deployment of CCU, CCS or CR. Considering all the questions, trying to respond to everyone will make the regulation too complex. There should be a high level regulation and in addition detailed approach per value chains. It is also necessary to accompany the Strategy with relevant tools and ensure swift deployment.

A stakeholder stressed that in his/her opinion all types of obstacles can be overcome by a public-private cooperation, for example, in the case of Denmark's CCS efforts. Close work between the Commission and industry is desirable.

Capacity building for permitting is very important and needs to be improved. There is a need for build-up of personal resources at the level of administration. There was a question on whether the Commission would consider tendering for educating skilled professionals to get permitting faster done.

4.3.9 Other topics

One stakeholder mentioned that the strategy should also include 'non-traditional' CCUS technology, to ensure a stronger impact of decarbonization. Another asked how Enhanced Oli Recovery (EOR) and CCS in combination are addressed in the Strategy if at all.

There was a call for investment in clean manufacturing.

A stakeholder stated that industry, technology and investment in the lands of indigenous peoples have the big negative impact on indigenous peoples' living conditions because the food system, resilience relative to their values, economic conditions etc are also affected. He/she wanted to know how will these issues be addressed.

4.3.10 Closing remarks

Daniel Kitscha (DG CLIMA) provided closing remarks, welcoming the large participation to the OPC, which shows a strong interest in the matter, as well as a high-level knowledge shared by the community. He particularly stressed the high representation SMEs, pointing at an interest in these solutions that is not limited to large industrial players only. Nevertheless, it was highlighted that participants to the OPC showed a clear over-representation of businesses and industries. Therefore the results are likely not fully reflecting the views on these technologies that the broader EU population holds and also point to the need to foster more public dialogues with citizens at Member State and regional levels.

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