CCUS SET-PLAN

zep zero emissions platform

PUBLIC PERCEPTION

KEY ENABLERS AND HURDLES FOR CCS AND CCU PROJECTS

JUNE 2024

6 INSIGHTS FOR ACHIEVING POSITIVE PUBLIC PERCEPTION

1 | RAISING PUBLIC AWARENESS

Public understanding of CCS technologies, their environmental, social and economic benefits, and their critical role in climate mitigation is primordial to improve perception.

Lack of awareness leads to a lack of societal readiness. Some studies show public perception improves when there is readily information available.

2 | LOCAL COMMUNITY FACTORS

Perception of risks and benefits vary based on socio-demographic factors, and their experience with industrial projects. Understanding the specific context in which the project takes place is important to tailor communication and engagement strategies to address specific concerns and interests of different demographic groups.

3 | TRUST AND TRANSPARENCY

Trust is cultivated through transparent communication about the project's objectives, processes and outcomes. Involving credible, unbiased experts to share facts and address misconceptions contributes to the project's legitimacy. Addressing potential risks and sharing the measures taken to mitigate them also reinforce trust.

4 | COMMUNITY ENGAGEMENT

Engaging local communities from the start of CCS projects is crucial. Regular meetings, feedback sessions, and participatory decision-making help ensure understanding and support.

Perceived benefits, such as job creation, community investments, and improved infrastructure also impact community support.

5 | METHODS AND CHANNELS OF COMMUNICATION

Methods and channels of communication require careful consideration. Experiences from CCS projects show success in engaging with community at a local level, such as coffee shops, town halls and other community spaces.

Open, two-way dialogue is also essential, recognising that opposition is an inherent part of any public discourse.

6 | RESEARCH AND KNOWLEDGE SHARING

Ongoing research into public perceptions of CCS/CCU and the development of effective engagement strategies are crucial for projects.

Publishing findings from these research efforts and sharing lessons learned from past projects can guide future projects and improve their chances of success.

ENABLERS FOR CCS/CCU PROJECTS

TRUST AND CREDIBILITY Establishing trust in CCS projects and their developers is fundamental for gaining public and stakeholder support. This trust is cultivated through transparent communication about the project's objectives, processes, and outcomes. Involving credible, unbiased experts such as scientists and industry specialists to share facts and debunk misconceptions about CCS technology contribute to the project's legitimacy. Demonstrating accountability and openness in addressing potential risks and sharing the measures taken to mitigate them also reinforces this trust.

PUBLIC AWARENESS Public understanding of CCS technologies, their environmental, social, and economic benefits, and their critical role in climate mitigation is paramount. Educational campaigns that explain the science behind CCS, its importance in reducing greenhouse gas emissions, and its contribution to achieving national and global climate targets can significantly enhance public knowledge. These efforts can be supported through various mediums, including social media, workshops, informational brochures, and interactive platforms.

COMMUNITY ENGAGEMENT Engaging local communities from the inception of CCS projects ensures that their concerns are heard and addressed, and the benefits of the projects are clearly communicated. This engagement includes regular meetings, feedback sessions, and participatory decision-making processes. Ensuring communities understand how the project impacts them positively, through local job creation, environmental protection, and sustainable development, fosters support and cooperation.

DEMONSTRATION OF BENEFITS Clearly showcasing the environmental benefits, such as reduced carbon emissions, and economic advantages, including job creation and energy security, is crucial. Success stories and case studies from existing CCS projects can be powerful tools in illustrating these benefits. Highlighting the role of CCS in supporting local economies and contributing to global climate goals makes the technology more relatable and acceptable to the public.

RESEARCH AND KNOWLEDGE SHARING Ongoing research into public perceptions of CCS and the development of effective engagement strategies are vital. Initiatives such as the Zero Emissions Platform's Projects Network play a crucial role in facilitating the exchange of knowledge and best practices among CCS stakeholders. Publishing findings from these research efforts and sharing lessons learned from past projects can guide future initiatives and improve their chances of success.

HURDLES FOR CCS/CCU PROJECTS

LACK OF AWARENESS The general public's limited understanding and knowledge of CCS technologies pose a significant barrier to their acceptance and support. Overcoming this hurdle requires targeted educational initiatives to raise awareness and improve understanding of CCS's role in mitigating climate change.

NEGATIVE PUBLIC PERCEPTION Overcoming negative perceptions of CCS, often rooted in past industrial experiences, NIMBYism, and misinformation is challenging. Addressing these concerns through transparent communication, engagement with local communities, and correction of misinformation is essential for changing public attitudes.

SOCIO-DEMOGRAPHIC FACTORS The public's response to CCS projects can vary widely depending on socio-demographic factors such as age, gender, and locality. Tailoring communication and engagement strategies to address the specific concerns and interests of different demographic groups can help in building broader support for CCS projects.

DISTRUST IN PROJECT DEVELOPERS Public scepticism towards the motives behind corporations and governments involved in CCS projects can hinder their acceptance. Building trust requires demonstrating a genuine commitment to environmental protection and community benefits, beyond mere regulatory compliance or profit motives.

NEGATIVE COVERAGE The way media presents CCS projects can significantly influence public perception. Negative coverage can lead to heightened fears and opposition, while positive coverage can improve perception and support. Engaging with the media to provide accurate information and highlight the benefits of CCS is crucial in shaping a more supportive public narrative.

Support stakeholders on Carbon Capture Utilisation and Storage of ETIP ZEP and IWG9

This is a Horizon Europe project (Coordination and Support Action) funded by the European Union for 3 years (from 1 July 2022 until 30 June 2025).

Project summary

Support Stakeholders on Carbon Capture Utilisation and Storage of ETIP ZEP and IWG9.

The overarching goal of this project is to bring together and further develop a strong inclusive network of CCUS stakeholders – effectively interconnecting and coordinating the activities of CCUS European Technology Innovation Platforms (ETIP ZEP) and the CCUS SET Plan Implementation Plan Working Group (IWG9) – to support the development and implementation of the SET Plan.

Supporting the alignment and efficient coordination of stakeholders – including industry, researchers, public authorities, civil society – in order to accelerate the delivery of the CCUS research and innovation (R&I) activities and to progress the emerging policy priorities at EU and national level for the implementation of CCUS, will be crucial over the coming years for Europe to reach the ambitious climate targets for 2030 and 2050.

This will be achieved by efficiently aligning and coordinating the activities of ETIP ZEP and the IWG9 in a joint work programme; establishing networks and other fora to enable the stakeholders to collaborate and coordinate effectively, pooling expertise, experience and resources to address common challenges; engaging also with other programmes and external stakeholders; facilitating engagement and creating greater interaction and cohesion between the different CCUS activities; supporting the CCUS community to develop clear strategies and recommendations; accompanied by a strong continuous programme for outreach, dissemination and communication.

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1. INTRODUCTION

Understanding public perception is crucial for the success of any carbon capture and storage (CCS) and carbon capture and utilisation (CCU) project. As Europe aims to meet its climate goals, the deployment of large-scale CCS projects becomes essential for the decarbonisation of industries. However, beyond securing necessary incentives and funding, these projects hinge on support from public authorities, impacted communities, and the broader public. Raising awareness and overcoming public opposition are key challenges and must be addressed to advance CCS efforts.

The CCUS Forum Working Group on Public Perception of CCUS[1] was set up to contribute to the development of an EU Industrial Carbon Management Strategy. This was achieved by analysing and communicating how public perception of CCS and CCU and engagement with these technologies emerges, and what role they play in delivering CCS and CCU in the EU. The European Commission's Industrial Carbon Management Communication, published in February 2024, acknowledges the CCUS Forum's concerns and outlines a proposal to "work with Member States and industry to increase knowledge, awareness and public debate on industrial carbon management"[2].

The CCUS Forum[3] and other key studies from the CCUS Projects Network[4], IMPACTS9[5], the GATEWAY project[6], the Global CCS Institute[7], the Clean Air Task Force[8], and Bellona[9] have demonstrated how public perception plays a crucial role in the deployment of CCS projects across Europe. Building on this wealth of information, this report highlights six key considerations for positive public engagement with CCS. These considerations are complemented by case studies examining the strategies of CCS and CCU deployment in

Heidelberg Materials cement plant located close to a residential area in Brevik, Norway, where CO2 will be captured, transported and stored on the Norwegian continental shelf.

Denmark, Norway, the Netherlands, Spain, France, and Poland, highlighting valuable insights into effective ways to enhance public perception, as well as barriers to avoid. However, it is important to note that different European countries have varying approaches towards CCS and CCU due to their geological location, political interests, and long-term energy objectives. Therefore, there is no universal solution to increase CCS and CCU awareness[4]. Nevertheless, with the right policies and communication strategies, it is possible to create a positive public perception of CCS/CCU and achieve the goal of reducing emissions in hard-to-abate sectors.

1.1 Summary of the report

Building on six key considerations from the CCUS Forum Working Group on Public Perception of CCUS[10], this report underscores the importance of positive public perception as a fundamental element in the strategy of project developers. It highlights the primary challenge of a widespread lack of awareness about CCS, compounded by various socio-demographic factors and the level of trust in project developers. The report emphasises that the community's perception of a project is largely dependent on the perceived benefits, making community involvement and tailored communication strategies crucial. Moreover, it notes the persistent issue of general unawareness that complicates predicting and managing public responses, thereby identifying a need for further research to improve methodologies and support CCS project developers.

The report details six key considerations for positive public engagement with CCS:

1. **Awareness and knowledge**
2. **Understanding the socio-demographic factors**
3. **Trust in the messenger and the project**
4. **Local involvement and empowerment of communities**
5. **Methods and channels of communication**
6. **Research on public perception**

To illustrate these considerations, the report outlines six case studies from Denmark, Norway, the Netherlands, Spain, France, and Poland, each offering unique insights based on their different levels of experience with CCS projects, outcomes, and evolving situations. Through these case studies, the report analyses how public perception of CCS is shaped by the six considerations, providing a nuanced understanding of the dynamics at play in fostering public support for CCS projects.

The case studies demonstrate that the countries that take into account these six considerations, or parts of them, are more likely to succeed than those who do not. The countries and CCS projects that took a combination of these considerations on board proved to lead to a more effective and faster deployment of CCS technologies. Based on the case studies and preceding works, the report concludes that the enablers for CCS and CCU projects include (1)

trust and credibility, (2) public awareness, (3) community engagement, (4) demonstration of benefits, and (5) research and knowledge sharing. The hurdles facing CCS and CCU projects include (1) lack of awareness, (2) negative public perception, (3) socio-demographic factors, (4) distrust in project developers, and (5) negative coverage.

1.2 Objectives of the report

This report serves as a synthesis of the extensive body of literature on public perception related to the capture, transport, and storage of CO2 along with insights from various project reports and discussions from the 2023 CCUS Forum[11]. It compacts this wealth of information into six key considerations, with the goal of effectively disseminating these insights to stakeholders involved in CCS projects. These considerations are crafted to guide project developers, policymakers, and other stakeholders in managing public perception as a potential enabler for the implementation of CCS projects.

The objectives of the report are multifaceted:

- The report aims to underscore the significance of public perception in the success of CCS projects. It posits public perception as a double-edged sword that can act as either a strong enabler or a significant barrier to the deployment of CCS technologies. By doing so, it emphasises the necessity of understanding and strategically managing public perception.
- Recognising the gap in public awareness about CCS, the report aims to highlight that research is needed to strengthen our comprehension of how the public reacts to CCS when provided with information.
- The report seeks to facilitate discussions among stakeholders about the relevance of public perception for CCS project development and deployment.

In essence, the report is designed to be a resource that not only highlights the importance of public perception in the CCS domain but also provides actionable insights and strategies for effectively managing this critical aspect. The report can be used by the CCUS SET Plan Implementation Plan Working Group (IWG9) to support the development and implementation of the SET Plan and align research and innovation activities between stakeholders. Through its objectives, the report aims to contribute significantly to the advancement of CCS/CCU projects by leveraging public perception as a key factor in their successful implementation and acceptance.

1.3 Target audience

This report targets industrial carbon management stakeholders, placing a strong emphasis on project developers, the research community, and EU and national policymakers, demonstrating its relevance to those directly involved in the planning, approval, and implementation of CCS projects. It also extends its reach to industries, NGOs, and trade unions.

2. KEY CONSIDERATIONS

There are many considerations which can affect public perception and achieve public support for CCS/CCU projects. This report assesses 6 key considerations which can have a posititve impact on public perception if considered carefully in stakeholder strategies.

2.1 Awareness and knowledge

Large-scale development and deployment of CCS will not only require economic investment, political willingness, and technological progress but also increased public awareness. A strong public awareness and knowledge of CCS is fundamental to speeding up the development and deployment of projects. There is already a significant amount of research on public perception of CCS that has contributed to a better understanding of the current level of awareness in Europe[12] [13]. These studies reflect the increased levels of interest towards this technology, both from academia and civil society.

Measuring public perception is crucial during the initial stages of a project's development process. This knowledge helps to gain a better understanding of the levels of public awareness and support among local communities. A lack of public awareness can hinder the project's effectiveness and development speed. Alternatively, communities that have experienced industrial projects of similar size and investment are more likely to understand the necessity and accept the project[14]. As society learns more about CCS technology and its role in reducing emissions, the public perception towards it will also become more positive.

When analysing the public perception of CCS, it is important to compare it with the perception towards other decarbonisation solutions to achieve net-zero emissions by 2050. This understanding could help stakeholders and society realise the significance of capturing and storing CO2 to reduce emissions in hard-to-abate sectors. The lack of CCS awareness leads to a lack of societal readiness. Therefore, it is crucial to create trust through clear and consistent collaboration and communication around technologies including their risks, benefits, costs, and realities[8]. In essence, public perception increases when there is clear and accessible information available on the topic in question.

2.2 Understanding factors in local communities

Public perception is relative to several socio-demographic factors (i.e. gender, age, profession, level of education, etc.) which need to be taken into consideration during stakeholder engagement. Generally, people tend to be less supportive of industrial projects when these are located in close proximity to their homes. However, this support can increase when people gain a better understanding of the potential benefits that these projects can bring to the area.

While it may be difficult to fully understand the reasons behind local opposition, having a good understanding of the specific context in which the project will be set up is crucial to

ensuring its viability and public acceptance.

How people perceive risks and benefits can vary greatly based on several factors including:

- The specific phase in the CCS/CCU process (i.e. capture, transport, utilisation, or storage)
- The origin of the source of carbon
- The differentiation between offshore and onshore deployment of CO2 storage

According to research, CCU is viewed more positively than CCS because people prefer to reuse CO2 rather than simply storing it[15]. Hubs that combine CCS with bioenergy are generally preferred over those that use shale gas, underground coal gasification, or heavy industries[16]. Furthermore, people tend to prefer CCS combined with bioenergy and heavy industry over coal-fired power plants (CFPP)[17].

It's worth considering the location of CCS projects when analysing their public perception and acceptance. Data shows that offshore projects tend to be more accepted because they are perceived as having less negative impact on local communities[18]. This phenomenon, commonly known as the NIMBY (Not In My Backyard) effect, is observed in all industrial projects, including in the clean energy sector.

Further research will be needed to address the knowledge gap surrounding public perception and other socio-demographic factors.

2.3 Trust in the messenger and the project

It is essential to consider the trustworthiness of the communicators since it affects the effectiveness of the message and the cooperation level[19]. The audience will consider the perceived goals of the communicator, hence, unbiased experts, such as scientists, are more likely to influence public perception as they are generally perceived as trustworthy communicators[20]. Moreover, local messengers are usually considered more reliable and could lend credibility to a project[21 22].

CCS public perception and awareness research acknowledges the existence of risks and benefits attributed to the technologies and their deployment. These risks and benefits, and how they are communicated, play a crucial role in shaping society's perception of CCS, as well as how these projects will impact their local communities. Furthermore, it is important to emphasise that CCS is not perceived as a tool to prolong fossil fuel usage, and to highlight successful CCS projects to build trust and legitimacy for these technologies amidst the urgency of the climate crisis[23]. An increase in publicly available information on CCS projects will lead to a better understanding of the role and benefits of CCS in achieving climate goals[24].

Public perception is influenced by the perceived trustworthiness of stakeholders, as well as their role in policy-making. It is important to consider the reliability of stakeholders as information sources during the decision-making process of CCS policy. If there is an increase in trust towards CCS stakeholders, it will lead to more positive public support for CCS. Public

understanding of the role that stakeholders play in policy-making has a significant impact on policy support. Therefore, trust in institutional decision-makers who will implement the regulations for CCS projects is usually seen as the most significant factor in determining risk and benefit perceptions[25].

It is important to give all stakeholders, including citizens, organisations, and institutions, the opportunity to participate in discussions on CCS. Effective community engagement is crucial for establishing trust between project developers and local communities, necessitating the incorporation of community concerns into decision-making processes. This fosters an environment of transparency and allows for the creation of beneficial outcomes for both parties. This will help build trust, share information, and create opportunities for dialogue.

2.4 Local involvement and empowerment of communities

Local-level participation in the early phases of projects has proven to contribute positively to the public perception of CCS. A notable drawback of the Barendrecht project (see case study: the Netherlands) was the lack of early-phase community engagement in the preparation of the project. Among a range of benefits, engaging with communities plays a crucial role in raising awareness about CCS. This level of engagement may contribute to bringing transparency to the project, which in turn helps foster trust in the project developers.

Community support or opposition to a project often hinges on the perceived benefits it brings[26]. These benefits include direct economic gains like job opportunities, community investments, and the enhancement of local infrastructure, goods, and services. Additionally, indirect economic impacts can also be significant. The mutual benefit between the local community and the project depends on how the community gains from the project. For example, job creation is advantageous when the necessary skills are available locally. In the context of CCS, the capture site is typically viewed as offering more benefits compared to the storage site, which often raises safety concerns.

2.5 Methods and channels of communication

Engaging with the public, community, and decision-makers requires careful consideration of the methods and channels of communication used. This involves selecting appropriate messaging, visuals, and dissemination pathways, along with tailoring the language to suit the audience. These elements must align with the specific objectives of the outreach, ensuring that the methods and channels used are optimal for the intended purpose. For example, social media technologies can be effective in raising awareness about CCS among specific target groups[27].

Experiences from various CCS projects highlight the success of engaging with communities at a local level. Meetings with stakeholders in informal settings such as coffee shops, town halls, and other community spaces have demonstrated the significance of not just what is

communicated, but also where and how the engagement occurs. This local-level approach emphasises the importance of the communication method in the overall success of the project[28].

Open, two-way dialogue is also essential, recognising that opposition is an inherent part of any public discourse. Transparent and honest conversations about risks and safety measures with stakeholders are fundamental. This approach not only addresses concerns and questions but also plays a pivotal role in building trust. Lastly, the choice of the interlocutor, as raised above, is an important consideration to have in an outreach strategy. Building partnerships with trusted CCS advocates is important to consider for building supportive narratives.

2.6 Research on public perception

Numerous studies[29] [30] [31] exist on the public perceptions of CCS, providing a foundation to understand and address the challenges linked to stakeholder management and CCS project development. However, a significant issue is the general lack of public awareness surrounding these technologies, which complicates efforts to accurately understand public perceptions of CCS. To overcome this, there is a need for more research that evaluates public perceptions after individuals are presented with relevant information.

One promising approach is the use of citizen jury panels. Such methods can offer insights into how public perceptions of CCS change when people are better informed. Additionally, this approach provides an opportunity to test and refine strategies for fostering positive public attitudes towards CCS. By employing such methods, it becomes possible to develop more effective mechanisms for managing and integrating public perceptions in CCS projects.

More social science research could help to overcome the NIMBY effect, which is caused by the social perception of risk, perceived inequity, and the process of attribution of causes[32]. It is a form of self-defence when the quality of life or well-being of an individual or community is perceived to be at risk. Therefore, further social science research can offer several insights and strategies to address the NIMBY effect by understanding community dynamics, improving communication and engagement, mitigating risks and negative impacts, and building coalitions and partnerships to promote inclusive and sustainable development.

3. CASE STUDIES

The following case studies highlight the efforts of six European countries to implement CCS projects. These countries have experienced different outcomes, largely due to various factors that have impacted public perception. It is important to note that there is no universal solution to improve public perception, and each CCS project should be evaluated on a case-by-case basis. However, valuable insights can be obtained from the lessons learned in these case studies, which can be useful when developing new CCS projects.

3.1 Denmark

Located in the North Sea, Denmark holds a significant potential to become a leading hub for CO2 storage. Yet, unlike its Norwegian neighbour, Denmark's recognition of CCS/CCU only materialised in 2020 with the publication of its Climate Agreement for Energy and Industry[33], making it possible for CO2 to be stored in Denmark. This acknowledgement marked the beginning of Denmark's successful journey in CCS, highlighted by significant projects like the Greensand project and the Ørsted Kalundborg Hub. The success of these initiatives relies on strong political backing, acknowledging CCS as a vital strategy for achieving the nation's climate goals as outlined in its national Climate Law. However, even though there is a strong consensus among government officials in favour of CCS, this does not automatically guarantee public backing for the technology. Public awareness remains underdeveloped, with a 2021 poll showing that 36% of Danes did not have an opinion on the storage of CO2 close to their home[34].

Avedøre Power Station part of the Kalundborg Hub project, located in Greater Copenhagen

A study pooling the opinions of around 1,500 Danes on low-carbon technologies and their support of net-zero technologies shows CCS ranked at the bottom, above nuclear, in terms of public support[35]. Most respondents did not indicate a negative view of the technology but only supported onshore/offshore CCS to "some degree", suggesting a lack of opinion. Moreover, the level of acceptance tends to vary based on the geographical location and the distance of the project pointing towards potential NIMBY concerns. While respondents were provided with an explanation of CCS, the lack of awareness made it difficult to evaluate acceptance of the technology.

Offshore CO2 storage projects in Denmark have faced little opposition to date. However, since Denmark has opened up onshore storage sites, CCS has been framed in a negative way in the media, with environmental organisations voicing concerns about the government's strategy and the potential risks it will have on nature and people[36]. Negative framing of CCS in the media can have a detrimental impact on the deployment of these projects. A recent study[37] tested Danish public perception on CCS, by exposing them to positive and negative media framing and surveying the framing effect. Findings showed positive framing of CCS improved the perception of the technology, whereas negative framing deteriorated it. Interestingly, the study showed that "prior knowledge of CCS" had a limited framing effect.

A successful project management strategy for CCS must include efforts to increase public awareness. Engaging in stakeholder dialogues, offering clear and transparent information, and addressing concerns about safety and environmental impacts are critical steps. These actions can not only improve awareness but also establish trust between the community and the developers of projects that impact them. Additionally, this case study also demonstrates the necessity to develop research on public perception and improve our understanding of the factors influencing acceptance or resistance. This understanding can enable developers and policymakers to tailor their stakeholder strategy and fostering inclusive and informed dialogue which can significantly enhance the feasibility and societal support for CCS projects and ensure their successful implementation and long-term sustainability.

3.2 Norway

Norway is the only European country which actively operates offshore CO2 storage sites, namely Sleipner which has been operating since 1996 and Snøhvit, launched in 2008. As part of its Longship project[38], the Norwegian government aims to capture and store CO2 from hard-to-abate industries based in Norway in addition to offering transport and storage solutions. The Northern Lights CO2 transport and storage facilities, set to be operational in 2024, are the first of their kind, offering open access for CO2 storage[39]. While some European countries grapple with public and political opposition to CCS, Norway has already stored 20Mt of CO2 over the last three decades. This achievement is partly attributed to the country's political culture, characterised by high levels of trust and a supportive narrative towards CCS.

Local residents of Øygaarden visit the Northern Lights JV facility during an open-day.

The PERCCSEPTIONS[40] project in Norway operating between 2019 and 2021, studied the perception of the Norwegian public towards CCS. The overall picture of the study supports Norwegians' positive attitudes towards CCS, with around 60% to 70% being positive towards the technology. The study compares Norwegian perceptions to Germany, where less than half (<40%) of the respondents were aware of the technology and held positive perceptions of CCS. In Norway, the general awareness of the technology is significantly higher, with only 15% of Norwegians declaring never having heard of CCS technology.

Norwegian public perception of CCS stands apart from Germany's due to the positive representation of the technology in public and political debates. The narrative surrounding CCS in Norway highlights the technology's potential to contribute to lowering the country's emissions. In contrast, the public debate on CCS in Germany, though less present, has traditionally lacked support from political parties and environmental actors.

An interesting finding from the PERCCSEPTIONS study shows that Norwegians' perception of CCS varies on factors such as the origin of the CO2. Whereas 81% of Norwegians support storing CO2 emissions emitted within the country, the support falls to 40% when the CO2 originates from another country[41]. While more research is needed into the factors influencing public perception, the study concludes it is important to raise awareness about the role of CCS in reducing CO2 emissions. For instance, the authors argue better communication is needed to explain how public-funded CO2 storage studies and projects only become worthwhile if it leads to CO2 imports from other countries.

3.3 The Netherlands

In contrast to Norway, CCS projects in the Netherlands initially faced difficulties. The Barendrecht project, launched in 2007, was met with opposition due to inadequate consideration of local concerns before its announcement[42]. After the project was approved, a public hearing raised safety concerns relating to potential negative impacts on human health and the environment as the plan proposed to store CO2 beneath the suburbs of Barendrecht[43]. Additionally, reports of earthquakes caused by natural gas production from subsurface reservoirs in Groningen further contributed to the negative public perception of CCS. Consequently, the project was halted, and further studies were requested before it was eventually cancelled in 2010. This is a clear example that without broad support from society, such projects are unlikely to be completed.

Another Dutch CCS project, ROAD, launched in 2010, was a large-scale, integrated project consisting of a gas pipeline transporting CO2 to two offshore natural gas fields located in the North Sea[44]. ROAD received less negative attention than Barendrecht due to it being an offshore project, however, its plan to capture carbon from a CFPP was not popular among the public[45]. Studies have shown that acceptance of CCS is more implicit than explicit, and it appears that offshore CCS projects will not attract as much negative attention as onshore projects[46]. However, it is important to note that a lack of active resistance to offshore CCS does not equate to active support and the potential effects of societal attitudes remain uncertain.

During the Barendrecht and ROAD projects, only 10.4% of the Dutch population was aware of CCS technology[47]. However, by 2013 this number had increased to 84% due to the high media attention around these two projects[48]. As a result of their failure, the Dutch population became more aware of the topic of CCS. This may explain why, Porthos, a joint venture launched in 2023, has experienced a higher level of public acceptance than the previous projects. The Porthos project combines CO2 capture from clusters of industrial installations with shared infrastructure in the Port of Rotterdam[49]. The offshore nature of the project combined with an increased public awareness, could be why it has been more widely accepted than its predecessors[50].

Building on the experience of the Barendrecht and ROAD projects, Porthos adeptly navigated the complex landscape of stakeholder engagement, securing political backing at EU, national, and local levels. Additionally, securing the endorsement of civil society played a pivotal role in the project's success. In particular, the support from environmental NGOs was instrumental in launching Porthos. Despite some initial opposition[51], Porthos has been widely recognised for its exemplary stakeholder management practices, presenting a compelling success story with valuable insights for future endeavours.

Porthos shared the following “lessons learned” on public perception at the Projects Network in Rotterdam in early 2024:

- “Actively engage with stakeholders from the start”;
- “Invest time in key stakeholders in the public arena (government, NGOs, local government)”;
- “Be honest and transparent”;
- “Use CCS in the correct context, meaning that it is about industrial decarbonisation/ energy transition and not about CCS only”;
- “Have a long-term communication plan”;
- “Acknowledge the counterarguments, critics concerns need to be addressed”; and
- “Cooperate/coordinate communication with the clients/emitters”.

First drilling under the seawall of the Porthos CO2 Transport and Storage project at the Port of Rotterdam after taking final investment decision in October 2023.

Greenpeace activists protest in front of the Castor gas storage project halted in 2013 due to seismic activity linked to gas injection.

© Pablo Blazquez / Greenpeace

3.4 Spain

The Castor project, launched in 2012 off the coast of Castellón, was Spain's largest artificial deposit of natural gas[52]. However, Castor's activity has been suspended since 2013, when seismic movements were detected during the gas filling phase. It was later confirmed that the earthquakes were directly caused by injecting gas into the silo. The error has been attributed to insufficient monitoring, as a better understanding of what was happening could have prevented the earthquakes[53]. Nevertheless, the damage in trust had already been done.

There are currently no CCS projects in Spain, however, there are two CCU projects which can be attributed to the fact that CCU technologies have received more support among the Spanish population than CCS[54]. The lower acceptance of CCS could be explained by the fact that the Spanish public still remembers the catastrophic failure of the Castor project, which cost €4.7 billion and remains controversial[55].

Another reason for the low levels of CCS support, linked to the bad memories of Castor, is Spain's lack of a clear CCS policy framework. Spain's energy transition strategies do not align with the more ambitious EU plans, making it unlikely that CCS technologies will be implemented in the near future[56]. It seems that policy-makers are hesitant to address the issue of CCS, possibly due to fear of repeating past mistakes and losing public support.

The support for CCS differs depending on how much risk and benefit society sees in its implementation. This perception affects the level of trust placed in stakeholders and their involvement in policy-making[57]. Studies indicate that storage and transportation are the stages that worry the public the most[58]. Specifically, CO2 storage is considered the least accepted stage, largely due to the potential risks associated with leakage and increased seismic activity near the storage facility, which the Spanish public experienced first-hand.

3. 5 France

The PYCASSO cross-border project[59], launched in 2021 and supported by the Avenia Cluster, aims to decarbonise industrial emitters on either side of the French-Spanish border. This initiative involves transporting CO2 to be stored in onshore geological formations in the North of the Pyrenees, with plans to utilise a portion of the captured CO2 in various applications, such as methane and methanol production. The project plans to take FID in 2027 and to store 2Mtpa by 2030 and 7Mtpa by 2035[60]. The initiative is rooted in an early CO2 storage pilot project conducted by Total in the depleted gas field of Rousse, situated near the French city of Pau. Between 2010 and 2013, approximately 51kt of CO2 originating from a nearby gas processing facility was successfully injected into the site, garnering overall positive support from the local community[61].

The PYCASSO project encompasses a wide geographical area and involves diverse stakeholders, including local communities, elected representatives, and industry partners. Despite some political opposition regarding potential job threats, the project has received general acceptance due to hydrocarbon producers' longstanding presence in the Pau region and the community's familiarity with heavy industry[62]. Furthermore, project partners have emphasised their intent to retain the number of jobs in the area[63].

Public communication efforts have been limited thus far as the project partners as still gathering preliminary data before sharing this with the public[64]. However, the project is organising a public consultation, in collaboration with the French Commission Nationale du Débat Public, to be carried out over the course of two years. The consultation is set to be run locally, involving local actors, and is intended to demonstrate the safety of the project, resilience to local industry, economic benefits, and create transparency[65].

As the PYCASSO project is still in the early stages of development, the success of public perception efforts remains to be evaluated as the project progresses. Moving forward, it will be essential to engage with the local community transparently, addressing concerns and providing accurate information about CCS technologies. By involving stakeholders from the outset and utilising trustworthy communication channels, the PYCASSO project aims to build trust and foster support within the community while promoting economic and environmental benefits. Ongoing assessment and dialogue will be critical to ensuring the project's success and mitigating potential challenges.

3.6 Poland

Despite its large industrial fleet that cannot fully decarbonise without the application of CCS, Poland currently lacks a comprehensive political strategy and regulatory framework for CCS. A few CCS initiatives are in development, but overall, the country's approach to CCS is still underdeveloped.

This situation is reflected in the public's awareness of CCS, particularly in regions like Upper

Silesia in Southern Poland, which is characterised by a high concentration of coal workers. A case study by PilotSTRATEGY revealed that only around 10% of respondents in the region were familiar with CCS[66]. This lack of awareness underscores the need for a more robust narrative around CCS in Poland, especially in areas where it could potentially have a significant impact.

The PilotSTRATEGY findings also highlighted diverse opinions about CCS. Some individuals saw it positively, recognising its potential for economic benefits, such as job creation, fostering stakeholder cooperation, and attracting future investments. However, others were concerned about its capacity to generate significant employment, viewing it as offering limited opportunities. Additionally, concerns were voiced about CCS potentially affecting the region's attractiveness, with potential negative impacts on tourism, agriculture, and the environment, along with safety issues. Some respondents also worried that CCS might extend reliance on coal, rather than advancing with alternatives such as renewable energy.

This case study illustrates that the lack of public awareness makes it difficult to evaluate public perceptions of CCS technology. Raising awareness is essential to improve public perception and highlight the potential benefits of CCS projects for the community. This approach could contribute significantly to developing a more informed and supportive public perception towards CCS in Poland.

3.7 Summary of case studies

To summarise, the case studies of CCS projects in European countries showcase the diverse outcomes influenced by public perception. Denmark's successful CCS initiatives underscore the importance of political backing and proactive engagement with stakeholders to address concerns and build trust. Norway's positive experience with offshore CCS projects highlights the significance of supportive political narratives and effective communication strategies in shaping public attitudes. Conversely, the Netherlands' challenges with onshore CCS projects demonstrate the necessity of early stakeholder engagement and transparent communication to mitigate opposition and ensure project success. Spain's experience with the Castor project underscores the impact of past failures and the importance of policy alignment and public trust in shaping CCS implementation. France's historical industry presence means there is a general acceptance, nonetheless the project needs to focus on transparent engagement and accurate communication with the local community to avoid misinformation and ensure success. Finally, Poland's evolving CCS landscape underscores the need for comprehensive strategies and increased public awareness to foster informed decision-making and community support. Overall, these case studies provide valuable insights into the complexities of implementing CCS projects and emphasise the importance of tailored approaches to address unique socio-political contexts and public perceptions.

4. KEY ENABLERS AND HURDLES FOR CCS/CCU PROJECTS

Based on the above case studies and preceding studies, as summarised throughout this report, the following are considered key enabler and hurdles for CCS/CCU projects.

4.1 Enablers for CCS/CCU Projects

TRUST AND CREDIBILITY Establishing trust in CCS projects and their developers is fundamental for gaining public and stakeholder support. This trust is cultivated through transparent communication about the project's objectives, processes, and outcomes. Involving credible, unbiased experts such as scientists and industry specialists to share facts and debunk misconceptions about CCS technology contribute to the project's legitimacy. Demonstrating accountability and openness in addressing potential risks and sharing the measures taken to mitigate them also reinforces this trust.

PUBLIC AWARENESS Public understanding of CCS technologies, their environmental, social, and economic benefits, and their critical role in climate mitigation is paramount. Educational campaigns that explain the science behind CCS, its importance in reducing greenhouse gas emissions, and its contribution to achieving national and global climate targets can significantly enhance public knowledge. These efforts can be supported through various mediums, including social media, workshops, informational brochures, and interactive platforms.

COMMUNITY ENGAGEMENT Engaging local communities from the inception of CCS projects ensures that their concerns are heard and addressed, and the benefits of the projects are clearly communicated. This engagement includes regular meetings, feedback sessions, and participatory decision-making processes. Ensuring communities understand how the project impacts them positively, through local job creation, environmental protection, and sustainable development, fosters support and cooperation.

DEMONSTRATION OF BENEFITS Clearly showcasing the environmental benefits, such as reduced carbon emissions, and economic advantages, including job creation and energy security, is crucial. Success stories and case studies from existing CCS projects can be powerful tools in illustrating these benefits. Highlighting the role of CCS in supporting local economies and contributing to global climate goals makes the technology more relatable and acceptable to the public.

RESEARCH AND KNOWLEDGE SHARING Ongoing research into public perceptions of CCS and the development of effective engagement strategies are vital. Initiatives such as the Zero Emissions Platform's Projects Network play a crucial role in facilitating the exchange of knowledge and best practices among CCS stakeholders. Publishing findings from these research efforts and sharing lessons learned from past projects can guide future initiatives and improve their chances of success.

4.2 Hurdles for CCS/CCU Projects

LACK OF AWARENESS The general public's limited understanding and knowledge of CCS technologies pose a significant barrier to their acceptance and support. Overcoming this hurdle requires targeted educational initiatives to raise awareness and improve understanding of CCS's role in mitigating climate change.

NEGATIVE PUBLIC PERCEPTION Overcoming negative perceptions of CCS, often rooted in past industrial experiences, NIMBYism, and misinformation is challenging. Addressing these concerns through transparent communication, engagement with local communities, and correction of misinformation is essential for changing public attitudes.

SOCIO-DEMOGRAPHIC FACTORS The public's response to CCS projects can vary widely depending on socio-demographic factors such as age, gender, and locality. Tailoring communication and engagement strategies to address the specific concerns and interests of different demographic groups can help in building broader support for CCS projects.

DISTRUST IN PROJECT DEVELOPERS Public scepticism towards the motives behind corporations and governments involved in CCS projects can hinder their acceptance. Building trust requires demonstrating a genuine commitment to environmental protection and community benefits, beyond mere regulatory compliance or profit motives.

NEGATIVE COVERAGE The way media presents CCS projects can significantly influence public perception. Negative coverage can lead to heightened fears and opposition, while positive coverage can improve perception and support. Engaging with the media to provide accurate information and highlight the benefits of CCS is crucial in shaping a more supportive public narrative.

Addressing these hurdles requires a multifaceted approach that includes enhancing public awareness, building trust through transparency and engagement, demonstrating the tangible benefits of CCS, and providing clear and supportive policy frameworks. By leveraging the identified enablers and effectively navigating the challenges, stakeholders can foster a more favourable environment for the successful deployment of CCS projects.

Greenpeace activists protest against the CO2 storage law of 2011 in front of the Federal Council in Berlin.

5. ZEP'S CONTRIBUTION TO BUILDING A POSITIVE PUBLIC PERCEPTION OF CCS

The Zero Emissions Platform (ZEP) is a collaborative platform for stakeholders working on CCS and CCU, which receives partial funding from an EU grant and sponsorships from some of its members. ZEP's membership comprises a diverse group including industry representatives, researchers, emitters, technology providers, trade unions, and environmental NGOs. This wide-ranging membership ensures a balanced view of the role of CCS/CCU in achieving the EU's net-zero objectives.

ZEP conducts open and transparent quarterly meetings through its Advisory Council. These meetings serve as a gathering for members, EU, and national policymakers, as well as the wider community to discuss and present CCS/CCU projects and strategies. Additionally, ZEP organises committees for stakeholders to facilitate the sharing of information on policy and technological developments in CCS.

Furthermore, ZEP plays a significant role in raising CCS awareness through various events, including an annual conference. This conference, offered free of charge, is designed to promote dialogue on CCS at the EU policy level, between policymakers, academia, and the CCS and CCU community. In addition, ZEP actively shapes public discourse on CCS and CCU through the publication of reports and position papers. These publications, which are available on ZEP's website, provide valuable insights and contribute to the broader understanding and acceptance of CCS and CCU technologies. Furthermore, the IWG9 monitors the progress of CCS and CCU related research and innovation activities as set out under the European Strategic Energy Technology Plan[67].

ZEP Advisory Council meeting, gathering the industrial carbon management community to share knowledge and discuss project developments.

6. CONCLUSION

In conclusion, addressing public perception and acceptance of CCS projects requires a multifaceted approach based on several key considerations. Firstly, increasing awareness and knowledge about CCS among the public is paramount, as it lays the groundwork for acceptance and support. Socio-demographic factors play a significant role in shaping public perception, highlighting the need for tailored engagement strategies. Trust in both the messenger and the project itself is crucial, necessitating transparent communication and involvement of local communities from the project's inception. Effective communication methods and channels, including social media and local engagement, can facilitate meaningful dialogue and address concerns. Moreover, ongoing research on public perception offers valuable insights for refining strategies to foster positive attitudes towards CCS. Ultimately, building trust, transparency, and inclusivity are essential for the successful implementation of CCS projects and mitigating the NIMBY effect. The six case studies demonstrate how adopting these key considerations can positively impact a CCS project. Whilst there is no universal solution for gaining public acceptance and positive perceptions for CCS/CCU, they provide valuable insights and emphasise the importance of tailored approaches to address country specific contexts and public perceptions.

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