

INNO-CCUS

# Navigating Denmark's CCUS Ecosystem

Evaluating Knowledge Sharing and Collaboration Mechanisms for the Emerging CO<sub>2</sub> Capture and Storage Industry in Denmark

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**About this report:**

*This report presents findings from a summer research project undertaken with INNO-CCUS and the Danish Energy Agency. The project explores how knowledge about onshore carbon capture and storage (CCS) is communicated and applied in Denmark across regulation, research, and industry. It is only intended as a learning opportunity for the author and to provide an outside perspective into the priorities of INNO-CCUS.*

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**INNO-CCUS**  
Carbon capture,  
utilisation, and storage



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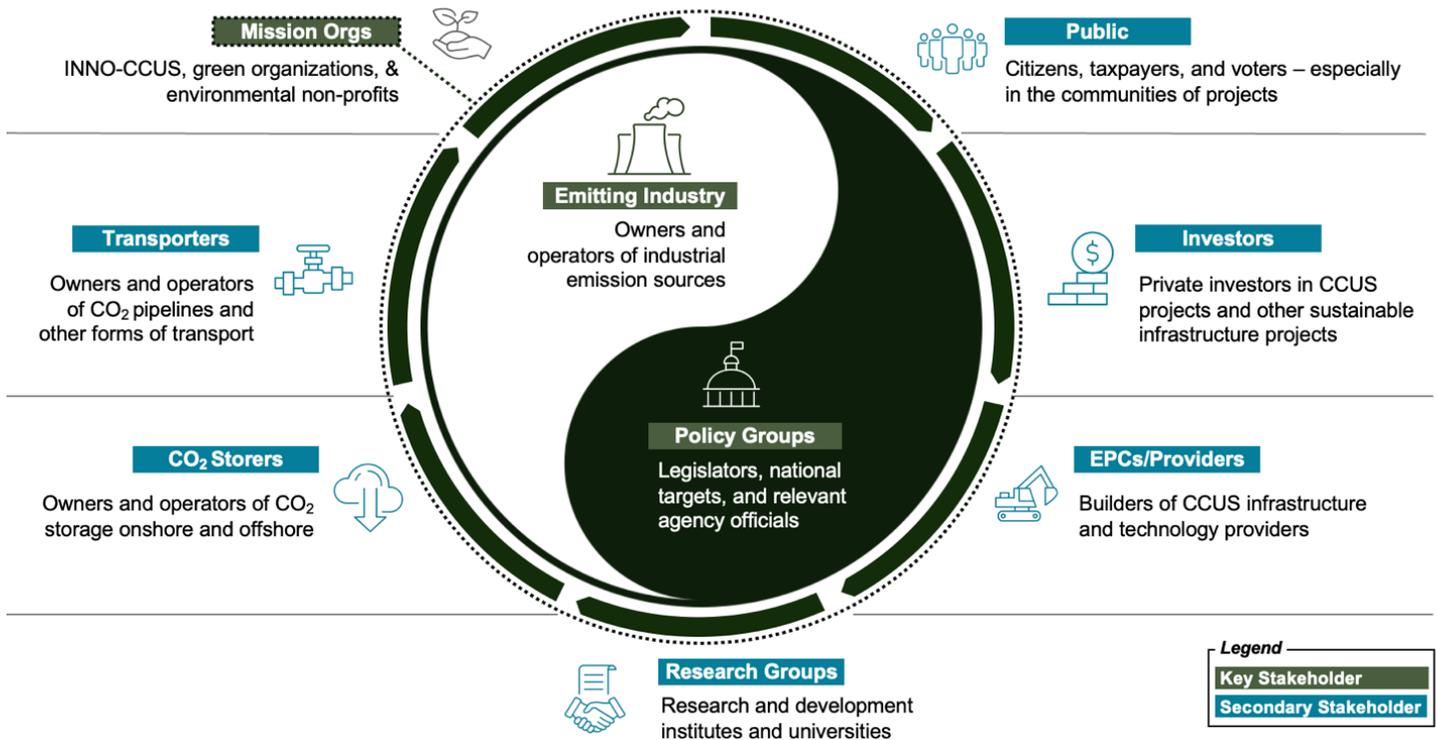
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# 1 Introduction

This report presents a synopsis of a summer research project undertaken with INNO-CCUS and the Danish Energy Agency as part of my graduate studies at Stanford University. The project explores how knowledge about carbon capture and storage (CCS) – with an emphasis on onshore storage – is communicated and applied in practice across regulation, research, and industry in Denmark. Especially in an emerging industry, understanding the flow of information is important – it dictates everything from how the latest research and innovation impacts industry and policy to how communities are informed.

The first step is to understand the ecosystem. The different players make up the space – with a variety of incentives and motivations. I developed the following mental model of the emerging Danish CCS ecosystem:

## The Danish CCUS Ecosystem



At the center is a balance of industry and regulation in a constant balance. A push and pull. Thankfully though, there is overall alignment at a people-level on the long-term direction of industrial operations to be as sustainable and circular as possible. Surrounding, and supporting, these two central stakeholders is the rest of the complex ecosystem – from transporters (pipeline, shipping, rail, etc.), storage, research, technology providers, investors, and the communities. For Denmark, this ecosystem is brought together by certain mission organizations, including INNO-CCUS, which play a crucial role in helping bring

people together, align goals and incentives, and share knowledge/contacts when possible. The Danish CCS ecosystem, while it can feel small in nature at times, is still complex – the mission organizations can be your guide.

For Denmark, this ecosystem and industry foundation has essentially been built in the last five years. Until 2020, CO<sub>2</sub> storage was prohibited under Danish law. In just a few short years since that ban was lifted, Denmark has developed a national CCS strategy, issued its first offshore and onshore storage licenses, and launched large-scale funding tenders for capture and storage. This pace of progress sets Denmark apart as one of the most ambitious and fast-moving CCS front-runners in Europe and the world.

The rapid emergence of CCS in Denmark provides a remarkable backdrop for this work. It was a beautiful learning opportunity to attempt to understand the emerging industry by navigating the ecosystem with desktop research and stakeholder interviews. The sections that follow provide an overview of the project scope and methodology, highlights of key themes and findings that showcase Denmark's distinctive approach to CCS and conclude with recommendations for how INNO-CCUS can continue strengthening knowledge-sharing and collaboration across the ecosystem.

While it is important to consider outside perspectives, such as this, it is also important to acknowledge the fine work that been completed to get the ecosystem to the place that it is today. It is, nothing short of remarkable. From here, it is more about prioritizing and adapting as the industry transitions into a state of execution, complimenting the perpetual research and innovation work that be the groundwork for future development.

## 2 Project overview

This project was designed to explore how Denmark is building the foundations of a carbon capture, utilization, and storage (CCUS) industry, with a particular focus on knowledge flows and collaboration mechanisms. While the introduction outlined the broader context and Denmark's rapid progress in establishing CCS, this section provides a closer look at the scope of the project, the methodology applied, and the core research materials reviewed. Together, these elements frame the findings and recommendations that follow.

### 2.1 Project description

**Description:**

This project analyzes how knowledge about onshore CCS is communicated and applied in practice across regulation, research, and industry in Denmark. It will map existing collaboration mechanisms and knowledge channels between authorities, companies, and research environments to assess their effectiveness. The project will examine how far the latest knowledge reaches and identify barriers that may hinder the rapid and effective implementation of regulatory and innovation initiatives. Based on international experiences and Danish case studies, the project will propose concrete improvements to enhance collaboration and increase the impact of existing initiatives in CCS.

**Expected Results:**

- Overview of current ecosystem and collaboration opportunities
- Analysis of how effectively knowledge flows between research, industry, and regulatory actors
- Identification of barriers and potential areas for improvement
- Policy recommendations or adjustments to existing collaboration structures

**Relevance to Stakeholders:**

- *Danish Energy Agency*: Supports work on CO<sub>2</sub> storage regulation and the implementation of policy initiatives
- *INNO-CCUS*: Ensures that research and innovation reach the appropriate actors and have maximum impact

**Methods:**

- Document analysis of relevant strategies, regulations, and existing cooperation agreements
- Qualitative interviews with key stakeholders from the Danish Energy Agency, INNO-CCUS, industry, and research institutions
- Comparison with international best practices and norms in the U.S.

## 2.2 Methodology

The project was carried out through a combination of desktop research, stakeholder interviews, and comparative synthesis, ensuring breadth and depth of insight.



The first phase consisted of a comprehensive desktop review of the emerging Danish CCUS industry. This included close study of official strategies, policy documents, and legal frameworks, as well as the founding documents of INNO-CCUS and the other *Inno-Missions*. To broaden the perspective, I also reviewed international CCS case studies, particularly from Norway, the United Kingdom, and the Netherlands, which provided useful benchmarks.

The second phase involved nearly two dozen semi-structured interviews with stakeholders across the entire CCUS value chain. These conversations brought together perspectives from project developers, infrastructure operators, regulators, researchers, and NGOs. They were invaluable in revealing how strategies and policies are applied in practice, as well as in highlighting the incentives, priorities, and cultures that shape Denmark's approach to CCS.

Finally, the third phase of the methodology synthesized the findings from both the desktop research and interviews and compared them against my prior knowledge of CCS projects and processes. They are aggregated into two categories: first, five overall themes and key findings, and second, three areas INNO-CCUS can address to help stay in front of key risks for the industry and the organization.

## 2.3 Background readings and research

The background phase of the project was informed by a wide set of documents and sources that contextualized Denmark's emerging CCUS industry. They included National Strategies and Policy Documents, Innovation and Research Frameworks, Project-Level Reports, and International Comparisons. Here is a non-exhaustive list of some helpful reference material:

**Danish Government:** [Green Solution of the Future, 2020](#), [Denmark's Climate Status and Outlook](#), [General reading and research](#)

**INNO-CCUS:** [Danish CCUS Roadmap 2024](#), [National Project Overview: State of CCUS](#), [Initial CCUS Roadmap, 2022](#), [Initial INNO-CCUS Mission Direction, 2022](#)

**Next Generation EU:** [General reading and research -- EU map](#), [INNO-CCUS funding](#)

**Innovation Fund Denmark:** [Inno-Mission Guidance](#), [Launch press release for INNO-CCUS](#), [Impact Frameworks, 2024](#), [General reading and research](#)

**Mapping of Danish CCUS Projects:** [Online map of CCUS projects in Denmark](#)

### 3 Key Findings: Denmark's distinctive approach

Through a combination of desktop research and nearly two dozen stakeholder interviews, several themes emerged that illustrate Denmark's distinctive approach to developing a CCUS industry. These findings highlight not only the structures and policies shaping the sector, but also the cultural and institutional dynamics that underpin its momentum. Together, they reveal a country advancing CCS with remarkable speed, while navigating the tensions and uncertainties inherent in building an entirely new industry. The five themes outlined below capture the essence of Denmark's experience to date and provide context for the recommendations to INNO-CCUS that follow.

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**3.1: Denmark has a highly collaborative ecosystem unlocking system benefits**
- 

**3.2: Aligned motivations across the ecosystem, but unequal financial risks**
- 

**3.3: Policy pushes and pulls - this will be crucial with upcoming 2030 key dates**
- 

**3.4: There is a culture of trust and support that is critical at the community level**
- 

**3.5: With shared infrastructure and timelines, shared knowledge is also beneficial**

#### 3.1 A collaborative ecosystem unlocking system benefits

A defining feature of Denmark's CCUS sector is the degree of collaboration between government, industry, and research institutions. This was witnessed first-hand by an overall openness of key stakeholders from throughout the entire value-chain, lending their time and wisdom. From the beginning, Denmark has sought to structure CCS development as a national mission rather than a collection of isolated projects. INNO-CCUS plays a central role in this ecosystem, convening diverse stakeholders and ensuring that research insights are not confined to academic circles but actively inform policy and industrial practice. This integrated approach stands in contrast to more fragmented models in other countries, where innovation often occurs in silos and coordination is left to the market.

Stakeholders consistently noted that this collaborative culture accelerates progress by creating system-level benefits. Especially for CCUS, system-level benefits are critical as it opens the door for new solutions and business model designs. The collaborative nature of the Danish CCS ecosystem enables shortened learning curves and reduced duplication of effort. While at times, some areas may seem redundant, this allows for multiple points of entry for any new technology or company to play a role in Denmark's CCUS journey. The willingness to tie research, industrial projects, and regulatory design together has allowed Denmark to capture efficiencies that are rare in this field.

### **3.2 Aligned motivations, but not necessarily the risks**

There is broad consensus across Danish stakeholders that CCS is indispensable for reaching the national climate targets by 2030 and climate neutrality by 2045. This alignment of motivation is impressive in its own right, especially given that CCS was prohibited by law as recently as 2020.

That said, agreement on the destination does not mean that risks are evenly shared along the way, this is evident in the ongoing Danish CCS Tender. Capture developers, from the emitting industry stakeholder group, often face the steepest uncertainties and thus financial risks: securing long-term contracts, managing supply chain delays, and shouldering reputational risks if projects stall. Many of the upcoming CCS projects will be, in some regards, a first-of-a-kind project – at best, they are one of the earlier of these types of technology deployments. There is a history of overconfidence when it comes to budget and timelines for early projects such as these, and the developer holds much of that risk. It is only natural that this risk is included in any Final Investment Decision (FID) made by these companies and their Boards, further complicating the path from idea to execution.

### **3.3 The push and pull of the industry, and approaching key dates**

Denmark's CCS industry is being shaped by a constant push-and-pull dynamic. On one side, government policy is pulling the sector forward through funding programs like the CCUS Fund, NECCS Fund, and the newly launched CCS Fund, which provide long-term contracts and financial certainty. These tenders lower investor risk and ensure that first-mover projects, can advance with more confidence. On the other side, industry actors are pushing to deliver against tight timelines, knowing that the 2030 climate targets require projects to move from planning to operation at an unprecedented pace.

This urgency creates both opportunities and challenges. Stakeholders expressed both optimism and concern: optimism that Denmark's policy clarity provides a strong framework for scaling CCS, but concern that the pressure of key milestones could create bottlenecks if permitting, logistics, or supply chains falter. Over these next few years, as progress is

observed on critical projects, the ability of relevant organization to continue with this push and pull dynamic will be critical to make sure targets are met on time and in budget.

### **3.4 The importance of local community trust and support**

Perhaps the most consistently emphasized theme across interviews was the importance of community trust, especially for onshore storage. While offshore projects have advanced with relatively little public opposition, the awarding of Denmark's first onshore licenses in 2024 has brought CCS into local contexts where residents expect to be engaged directly. Trust in Danish institutions is generally high, but stakeholders warned that this trust should not be taken for granted in the face of new technologies and subsurface activity.

Building and maintaining trust will require transparent communication, credible monitoring frameworks, and genuine opportunities for citizens to voice concerns and influence decisions. It is also important to understand that general national trends are not necessarily representative of local communities, especially when it may mean operations in their area. For some, the additional vehicle traffic and potential for noise/dust may be enough of a reason to begin voicing disapproval – this could, at a minimum, risk delays to projects in order to work with the communities to make sure questions are answered and address concerns. Unlike many industrial activities, there is inherently a shared incentive challenge where the community benefits little from CCS projects outside some employment opportunities. It is important to involve local community members and, with time, examine ways to propose Community Benefit Plans.

### **3.5 Shared infrastructure and risks mean shared knowledge**

The final theme from the desktop and stakeholder research is that CCS is fundamentally a shared endeavor. CCS in Denmark is no different. Capture facilities will depend on transport networks; ideally pipelines and shipping routes that will feed into common storage hubs; and monitoring responsibilities will crosscut institutions. Because no single actor controls the whole chain, risks and benefits are inherently distributed. This leads to the complex web of stakeholders across the entire industry.

This interdependence makes knowledge-sharing not just desirable, but essential. Denmark has already shown leadership here by investing in shared-use facilities which are designed as a gateway for regional European markets and is exploring open-access principles for pipelines. Interviewees repeatedly emphasized that openly sharing lessons – whether in permitting, technical design, or community engagement – can save time, money, and reputational capital across the system. However, at the same time, knowledge can at times be an advantage held by certain companies which will help differentiate them from others in a period of competition, such as the ongoing Danish CCS Tender. While the culture of sharing and connection is strong, there is still a natural element of competition and business

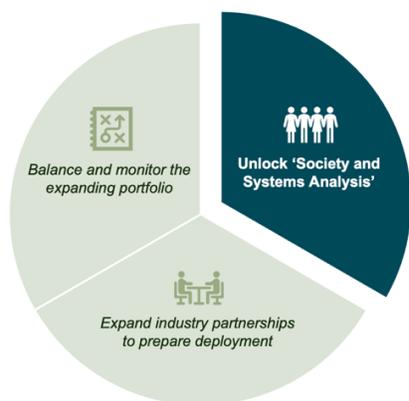
strategy. It begs the question of how much financial and operational risk is shared across the value chain and who acts first to begin one component of the value chain while other critical elements are still in the planning and evaluation stage.

Taken together, these five themes highlight both the remarkable strengths and the critical challenges of Denmark's CCUS journey. A collaborative ecosystem, clear policy direction, and a culture of knowledge-sharing have enabled Denmark to move from prohibition to international leadership in just a few years. At the same time, the uneven distribution of risks, the urgency of approaching deadlines, and the importance of community trust underscore the complexity of scaling CCS responsibly. The following section translates these findings into concrete recommendations for INNO-CCUS, with a particular focus on addressing key risks and bottlenecks identified through this research.

## 4 INNO-CCUS recommendations based on key risks

The findings outlined in the previous section highlight both Denmark’s unique strengths and the challenges it must navigate as CCUS scales up. INNO-CCUS, as a central hub for research, innovation, and collaboration, is well-positioned to address many of these issues by adapting its portfolio and engagement strategies. The following recommendations focus on three areas where INNO-CCUS can expand its influence and increase its value to the broader ecosystem.

### 4.1 Unlocking ‘Society and Systems Analysis’ workstream value



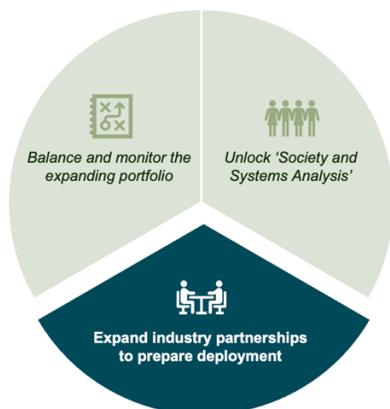
Local support, especially for onshore storage, will be decisive for ensuring that projects remain on schedule and maintain legitimacy. Interviews underscored how critical community trust and acceptance will be in determining whether onshore exploration licenses evolve into timely operational projects. INNO-CCUS already has a dedicated *Society and Systems Analysis* workstream that is designed to address these dynamics, yet stakeholders noted that this stream has been comparatively undersubscribed.

By maximizing the value of this workstream, INNO-CCUS could play a direct role in helping Denmark navigate one of the greatest risks to CCUS deployment timelines. Adjustments such as altering funding requirements to encourage more project proposals in this area, or directly establishing interest groups to stimulate demand, would ensure that social dimensions of CCS receive research and understanding. Doing so would not only strengthen local trust but also reduce the risk of costly delays.

*Example methods: alter funding requirements to prioritize proposals in the Society and Systems Analysis track or establish a standing “community and CCS” project interest group.*

### 4.2 Expand industry partnerships to prepare technology deployment

The scope of industry partnerships within INNO-CCUS has been broad and inclusive, drawing in project developers, technology providers, and research institutions. However, one critical stakeholder group has so far been left on the sidelines: project investors from the broader capital markets. As CCS projects advance from lower Technology Readiness



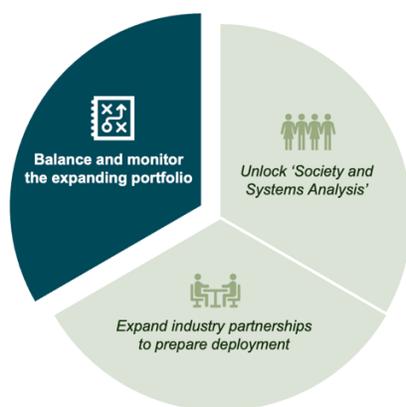
Levels (TRLs) toward commercial deployment, the role of finance becomes increasingly central, especially with Denmark’s overall strategy of relaying upon the market to find efficient solutions and development opportunities.

By bringing capital market actors into the INNO-CCUS network early, the partnership can prepare projects for commercial viability and reduce the financing gap that often arises between demonstration and scale-up. Establishing relationships with infrastructure funds, green investors, and major financing institutions will help align

expectations, reduce transaction friction, and improve the bankability of future CCS clusters. Investors also bring additional experiences, expertise, and skills that can be value additive for the community or partners already build by INNO-CCUS.

*Example methods: invite Copenhagen Infrastructure Partners to join the INNO-CCUS network as an industry partner, offering expertise in financing large-scale infrastructure and renewable projects.*

### 4.3 Balance and monitor the expanding INNO-CCUS portfolio



As INNO-CCUS expands its portfolio from around 30 projects to more than 50, it will become increasingly important to maintain a clear overview of how these initiatives contribute to the mission. Without this structured monitoring, there is a risk of portfolio imbalance, with certain themes overrepresented and others underexplored. It is also a critical step in ensuring mission alignment. Moreover, as policymakers look to INNO-CCUS for insights, the ability to track and demonstrate impact will be critical (impact measurement at a research level is an inherent challenge within itself).

Developing a systematic monitoring framework that categorizes projects by sub-themes (at least a level below the capture, transport, storage, utilization, and social systems) and tracks measurable outcomes would create real value. Such a system would allow INNO-CCUS to identify trends, respond to gaps, and communicate results more effectively to stakeholders. This would also aid in assessing whether knowledge-sharing across the portfolio is improving over time, thereby reinforcing one of Denmark’s distinctive strengths.

*Example methods: implement a portfolio monitoring system that tracks projects by sub-theme and impact metrics, helping to balance the mission and evaluate cumulative progress (easier said than done, but it is important given requests from Innovation Fund Denmark).*

Together, these recommendations position INNO-CCUS to not only strengthen its existing role as a hub for research and innovation but also to expand its influence in shaping how CCS unfolds in Denmark. By unlocking the full value of social analysis, integrating financial partners, and improving portfolio oversight, INNO-CCUS can help ensure that Denmark continues to lead in developing a responsible, collaborative, and effective CCUS industry. The final section reflects on this progress and offers concluding remarks.

It is important to take a moment to pause and reflect on the quality of job INNO-CCUS has done in the last few years. In general, the research and stakeholder engagement process brought forward praise for INNO-CCUS – they have acted extraordinarily well in their dual role: a funding source for essential research and innovation, and a community builder helping advance the entire ecosystem. This is not an easy feat. These recommendations, more than anything, highlight the need to adapt as INNO-CCUS grows and so too does their portfolio. Additionally, INNO-CCUS must constantly reflect on how their mission-driven organization can continue playing a primary role as large-scale CCS projects get brought into operation and the Danish CCS industry begins to emerge at scale.

## 5 Closing Comments

I want to express my gratitude to the many individuals and organizations who made this project possible. Nearly two dozen stakeholders across the CCUS value chain shared their time, insights, and expertise with me – conversations that were invaluable in shaping my understanding of Denmark's emerging CCS ecosystem. Their openness and willingness to engage not only enriched the research but also made this an especially memorable experience. With extra gratitude, I turn to the teams at INNO-CCUS and the Danish Energy Agency for welcoming me, providing resources, and for all the cake.

Coming to Denmark as an American with a background in petroleum engineering, I was struck by the speed and decisiveness with which the country has embraced CCS. At times, progress to me often feels incremental, marked by fragmented policies and uneven coordination across jurisdictions. By contrast, Denmark has moved from prohibition to the current landscape in less than five years, underpinned by long-term policy, state participation, and a strong culture of collaboration. Observing this momentum firsthand has been both inspiring and instructive. The next five years, marking the transition into large-scale technology deployment, is in good hands.

I leave this project optimistic about Denmark's trajectory. Challenges remain – as they always will, especially during the emergence of a new industry – but the foundation laid to date is, simply put, impressive. INNO-CCUS, in particular, stands out as a central node connecting research, industry, and regulation, while also helping prepare the next generation of CCUS leaders through its engagement with students and researchers.

The pace of progress to date suggests that Denmark is well on its way to becoming a leader in demonstrating how carbon capture and storage can be deployed responsibly, collaboratively, and at scale. I will continue to follow Denmark's unfolding CCUS journey with eagerness and optimism. The lessons from this summer will stay with me as I return to my studies and future work, and I look forward to seeing how the Danish model can inform the global transition to a low-carbon future.

In Appreciation,



**Carson Muscat**

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