

THIRD EDITION

State of CCUS

Danish research and innovation driving
CCUS solutions to combat climate change



INNO-CCUS

Carbon capture,
utilisation and storage

About this publication:

This third edition of “Denmark: State of CCUS Research and Innovation” is developed and published by INNO-CCUS - one of four state-initiated mission-driven green research and innovation partnerships, supported by Innovation Fund Denmark.

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Reading Guide

This third edition provides an updated snapshot of the Danish carbon capture, utilisation and storage (CCUS) research and innovation landscape in 2026. It reflects an ambitious effort to gather and present the breadth of projects currently shaping the field across sectors and disciplines. The result is a shared view of the actors, technologies and approaches driving the development and deployment of CCUS in Denmark.

The projects presented in this publication are organised into three main value chains according to their primary contribution to CCUS:

- Carbon capture and storage (CCS)
- Carbon capture and utilisation (CCU)
- Carbon dioxide removal (CDR)

Each category is briefly introduced on the following pages and explored in greater detail in its respective section of the publication. The active projects are presented first, followed by a summary of completed projects for reference.

Following the research and innovation project sections, the publication features a dedicated section on implementation projects, highlighting initiatives focused on the practical deployment and scaling of CCUS technologies and solutions.

At the back of the publication, you will find an index listing all projects by title, partners, funding sources, focus areas and sectors.

If you have any questions about this publication or INNO-CCUS, would like to provide feedback or have a project featured in the next edition, please feel free to contact us at:

info@inno-ccus.dtu.dk

To complement this publication, we have developed a digital platform which allows users to explore projects interactively.





Contents

Building the CCUS we need	7
CCUS in Denmark 2026	11
National and regional initiatives	14
Project classification	16
Carbon capture and storage	18
Carbon capture and utilisation	83
Carbon dioxide removal	157
Implementation	189
List of abbreviations	203
Index	204



Building the CCUS we need

Since 2020, carbon capture, utilisation and storage (CCUS) has been a strategic priority in Denmark's green transition - and with good reason. Renewable energy, energy efficiency and electrification are central to reducing emissions, but they are not sufficient on their own. Reaching climate neutrality, and ultimately becoming climate negative by 2050, will also require us to address hard-to-abate industrial emissions and remove carbon dioxide from the atmosphere. CCUS is therefore an essential part of the green transition.

However, recognising the need for CCUS is one thing; making it work at the scale, pace and cost required is another. This is fundamentally a research and innovation challenge.

Across Denmark, researchers, companies and public-sector institutions are working to meet that challenge. INNO-CCUS is an important part of this broader effort, bringing together partners across sectors and disciplines to advance CCUS through research and innovation. Today, our portfolio comprises 42 research and innovation projects spanning the CCUS value chain.

But no single project, institution or partnership can provide all the answers. As the field grows and moves closer to implementation, so does the need to see the bigger picture: to understand how different efforts fit together, follow how the landscape is developing, share the knowledge they generate and create new connections across the field.

This is the idea behind State of CCUS. The publication brings Denmark's CCUS research and innovation activities together in one place, making the field more visible and accessible. In doing so, it becomes easier to navigate the landscape, identify connections and make better use of the knowledge already being generated.

Now in its third edition, State of CCUS covers 198 projects, 134 of which are currently active, spanning technologies, disciplines and stages of development. Thank you to everyone who shared their work and helped us make this edition as complete and accurate as possible.

Together, these contributions give us a clearer picture of where we stand - and a stronger foundation for building the CCUS we need.

Happy reading,

Jesper Sand Damtoft
Chairman of the Board

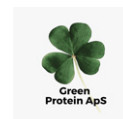
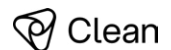
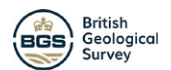
Karina Marie Søgaaard
Partnership Director

Scan the QR code
to learn more about
INNO-CCUS:



The INNO-CCUS partnership

The INNO-CCUS partnership comprises more than 140 partners across knowledge institutions, private companies, public companies, and organisations.





The INNO-CO2US Partnership is funded by:

Innovation Fund Denmark





Port of Esbjerg. Photo: Project Greensand.

CCUS in Denmark

2026

Denmark's CCUS landscape has developed remarkably fast over the past few years. What began with research, demonstration projects and the establishment of regulatory frameworks is increasingly moving towards implementation. Capture projects are advancing, storage sites are being developed, infrastructure is taking shape, and new carbon removal solutions are emerging. Reflecting this shift, this edition of State of CCUS expands its scope beyond research and innovation projects to include an overview of operational and planned CCUS facilities across Denmark.

At the same time, the past year has demonstrated just how complex the transition from technological readiness and political ambition to large-scale deployment can be. This became particularly evident in 2026, when Denmark's largest CCS tender reached its conclusion. Despite considerable initial interest, only two projects ultimately submitted final bids, with Aalborg Portland awarded the contract to capture and store 1.25 million tonnes of CO₂ annually. Meanwhile, Ørsted's Kalundborg CO₂ Hub experienced delays and did not meet its original target of beginning CO₂ capture in 2025. While the circumstances differ across projects, developments over the past year have highlighted the complexity of turning CCUS ambitions into operational projects.

This next phase of Danish CCUS is unlikely to be simple or linear. As projects move closer to implementation, practical, economic and system-level challenges become increasingly tangible. This further underlines the need for continued research and innovation – both to advance technologies and to address the challenges that emerge as they are applied at scale and integrated into functioning value chains.

The Danish CCUS research and innovation landscape

Against this backdrop, the research and innovation portfolio mapped in this edition of State of CCUS provides insight into how Denmark's CCUS research and innovation landscape is developing. The publication comprises 198 active and completed projects across CCS, CCU and CDR, covering a wide range of technologies and approaches at different stages of development.

Newer projects generally start at a higher Technology Readiness Level (TRL) than earlier projects and are expected to reach more advanced levels. Seen alongside the broader developments in Danish CCUS, this pattern is consistent with a growing part of the field moving towards demonstration and real-world application.

The composition of the portfolio shows where research and innovation activity is currently concentrated. CCU represents the largest of the three value chains in the portfolio, followed by CCS and CDR. Looking more closely at the specific activities within the projects, carbon conversion accounts for the largest share of both projects and budget, followed by point-source capture and geological storage. The publication uses the term 'focus areas' for these specific categories. Within carbon conversion, fuels account for a substantial share: 27 of the 63 total projects with conversion as their primary focus are associated with the fuels sector. Yet the majority fall outside fuels, showing that Danish research into carbon conversion extends well beyond fuel production. This breadth reflects a CCU research landscape in which multiple pathways for using captured carbon continue to be explored.

TABLE 1: Distribution of projects by main value chain, covering both active and completed projects

Main value chain	Number of projects	Accumulated budget
CCS	79	DKK 1,59 billion
CCU	86	DKK 2,33 billion
CDR	33	DKK 0,96 billion
Grand Total	198	DKK 4,87 billion

FIGURE 1: Distribution of projects by focus area, including both active and completed projects. Projects associated with multiple focus areas are counted in each relevant category and may therefore be represented more than once.

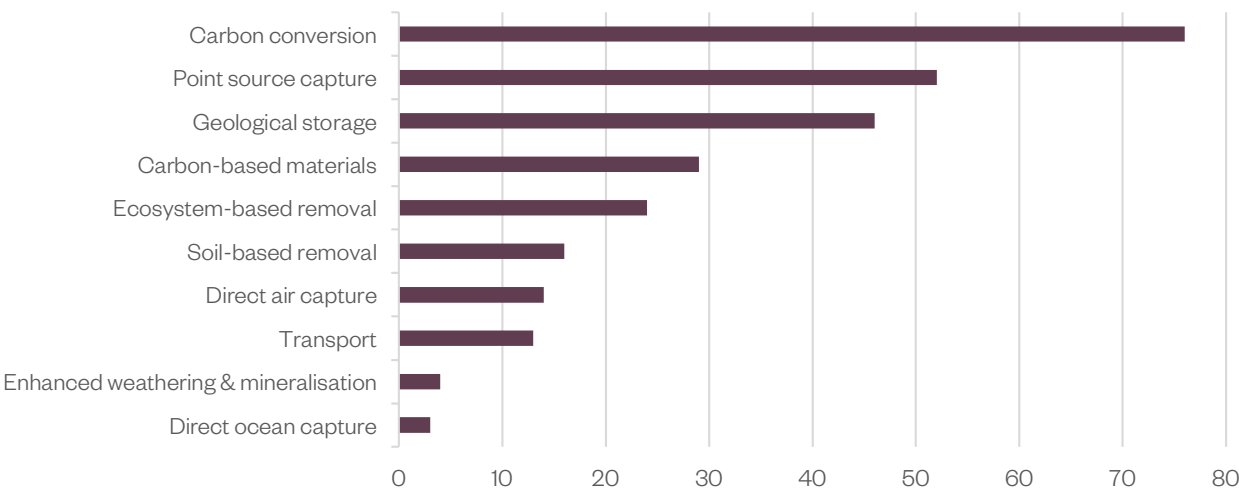
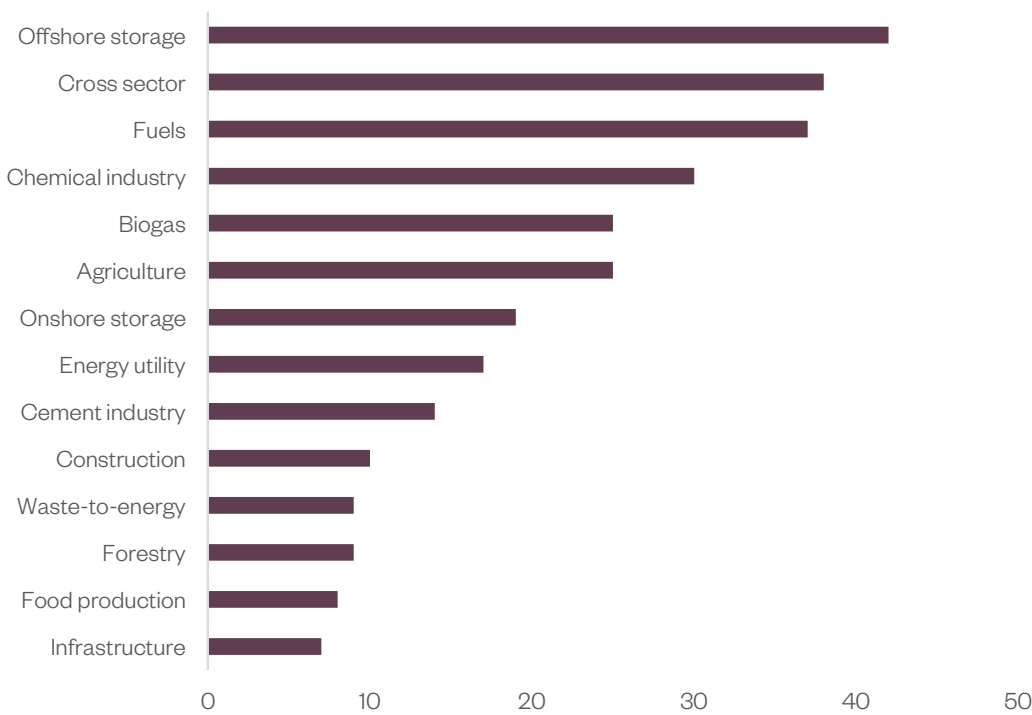


FIGURE 2: Distribution of projects by sector, including both active and completed projects. Projects associated with multiple sectors are counted in each relevant category and may therefore appear more than once.



While conversion illustrates the breadth of Danish CCU research, geological storage stands out on the CCS side of the portfolio. Storage is among the largest focus areas, with a clear offshore orientation: substantially more projects are related to offshore than onshore storage. This may partly reflect Denmark's long-standing experience with oil and gas activities in the North Sea. However, the emphasis is notable given that Denmark's geological storage potential extends beyond the North Sea. GEUS assesses the overall potential as equivalent to several centuries of Danish CO₂ emissions, with substantial potential also identified onshore.

Other parts of the CCS value chain show a different pattern. CO₂ transport is much less represented in the portfolio than capture and storage. Among the transport-related projects, however, several focus on infrastructure, business models and other system-level questions rather than on the transport technology itself. The transport projects thus illustrate that research and innovation needs extend beyond the technology itself to the wider conditions required to make CCUS value chains work in practice.

CDR, the smallest of the three value chains, presents a different picture, encompassing technologies at very different stages of development. Pyrolysis and biochar have established a relatively strong position in Denmark and are now moving towards industrial-scale deployment, backed by DKK 10.2 billion in public support for permanent carbon storage in biochar between 2027 and 2045. Research nevertheless continues on issues including permanence, agricultural impacts and climate accounting.

Other carbon removal approaches remain much less represented in the portfolio. Direct air capture and direct ocean capture account for only 17 projects, of which six have these technologies as their primary focus. While these technologies are still at an earlier stage of development, their representation is limited in light of the potential long-term role of permanent carbon removal. The contrast illustrates how research and innovation needs differ across the portfolio: some carbon removal approaches are beginning to confront the challenges of scaling and deployment, while others remain focused on technological development.

Taken together, the portfolio illustrates the different research and innovation needs across Danish CCUS. While some technologies are moving closer to deployment, bringing infrastructure, integration and business models to the fore, others still require further technological development to realise their longer-term potential. As CCUS matures, the role of research and innovation does not diminish – it evolves, from advancing technologies to addressing the practical and system-level challenges that determine whether they can ultimately succeed at scale.

National and regional initiatives

In addition to the many research projects and individual partners featured in this catalogue, several national and regional initiatives play a central role in shaping the Danish CCUS landscape. This section introduces five key organisations that help tie the ecosystem together. They coordinate efforts across sectors, support infrastructure and innovation, and work to ensure that Denmark's CCUS ambitions are backed by strong research environments, business models, and policy frameworks.

Use this overview to get a sense of how CCUS efforts are being structured at national and regional level - and where to look for coordination, collaboration, or strategic partnerships.

The Novo Nordisk Foundation CO₂ Research Center (CORC)



The Novo Nordisk Foundation CO₂ Research Center is a mission-oriented centre based at Aarhus University, with satellite institutions in Denmark, the US, and Europe. The centre develops novel science for CO₂ capture and conversion to enable sustainable alternatives to fossil carbon. By integrating chemical and life sciences with technical disciplines, CORC creates new, cross-disciplinary approaches for CO₂ management. Research areas include direct air capture, microbial and catalytic conversion, electrochemical reduction, and novel carbonate chemistries. These efforts are supported by advanced systems-level modelling and cutting-edge research infrastructure. CORC collaborates closely with industry, RTOs, and start-ups to ensure that scientific breakthroughs can inform and inspire future technologies. The centre aims to be among the world's top three science and technology hubs for CO₂-based climate solutions, while also supporting inclusive outreach and education to maximise long-term impact.

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INNO-CCUS



INNO-CCUS is one of Denmark's four mission-driven partnerships launched in 2022 to accelerate the green transition. The partnership promotes research and innovation in carbon capture, utilisation, and storage (CCUS), supporting technologies from early proof of concept to pilot scale. With over 120 partners from academia, industry, and the public sector, INNO-CCUS supports 42 projects spanning the full CCUS value chain. Its role is to bridge knowledge gaps, foster collaboration, and help scale promising technologies. Funded by Innovation Fund Denmark and the NextGenerationEU programme, INNO-CCUS works to make CCUS more efficient, scalable, and financially viable – contributing to Denmark's climate goals through applied research and cross-sector innovation.

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CO₂VISION

CO2Vision

CO2Vision is a regional lighthouse initiative based in North Jutland that aims to build a complete and future-ready CCUS ecosystem. With a foundation in research and strong regional partnerships, the initiative combines technology development, infrastructure planning, workforce training, and tailored business support. CO2Vision connects stakeholders across the value chain and helps translate knowledge into industrial capacity and green jobs. Activities include testing and demonstrating capture, transport, utilisation, and storage technologies – supported by green education and skills development. CO2Vision is part of Denmark's national lighthouse strategy and receives funding from the EU and the Danish Board of Business Development through the Just Transition Fund. The ambition is to position North Jutland as a leading European region for CCUS innovation and implementation.

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CCS Zealand

CCS Zealand is a regional collaboration in Eastern Denmark that aims to promote the large-scale implementation of CO₂ capture, transport, storage, and utilisation. The initiative serves as a forum for gathering, establishing, and sharing experiences across the CCUS value chain. It brings together 15 regional actors, including utility companies, businesses with an interest in CCUS, and the Novo Nordisk Foundation. The initiative supports regional efforts to establish carbon capture at major point sources, develop storage facilities, promote the use of surplus heat in district heating, and connect CO₂ sources, storage sites, and Power-to-X facilities via common infrastructure. CCS Zealand also works to reduce costs through shared learnings and to maintain a strong focus on safety to help secure public acceptance of CCUS.

Through strengthened regional collaboration, the initiative contributes to positioning Eastern Denmark as a key European hub for CO₂ management.

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The CCUS Alliance

The CCUS Alliance is a national business-focused partnership working to transform carbon capture and storage into a new Danish industrial and export success. Established by leading industry organisations, the alliance connects companies, researchers, and experts across the entire value chain – from capture and equipment production to transport, storage, and regulation. It supports members with market analysis, regulatory insight, and strategic dialogue, while also advocating for favourable policy frameworks and investment models. The alliance serves as a central forum for knowledge exchange and coordination, holding regular meetings and public events. By enabling cooperation and identifying opportunities, the CCUS Alliance aims to secure Denmark's role as a leader in the growing international CCUS industry.

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Project classification

Projects in this publication are classified at two levels: a main value chain and one or more focus areas. The main value chain indicates the project's primary contribution within CCUS, while the focus areas show the specific technologies, processes or approaches it addresses. Focus areas can apply across more than one value chain.

Main value chain



Carbon Capture and Storage (CCS)

CCS involves the capture of CO₂ from point sources, its transport and its permanent storage in geological formations. Denmark has significant geological potential for CO₂ storage, providing a strong foundation for developing CCS at scale. Realising this potential requires a reliable, integrated and scalable value chain connecting CO₂ sources with suitable storage sites. Research and innovation address challenges across this value chain, including capture technologies, CO₂ infrastructure, geological storage, reservoir characterisation, monitoring, infrastructure planning and governance.



Carbon Capture and Utilisation (CCU)

Carbon will remain an essential feedstock even as economies move towards climate neutrality. CCU offers a pathway to meet this continued demand with captured carbon, reducing reliance on virgin fossil carbon. Captured carbon can be converted into products ranging from chemicals and plastics to synthetic fuels. To fulfil this potential at scale, captured carbon must be converted efficiently and cost-effectively, integrated into industrial processes and supported by market and regulatory conditions that enable competitive and sustainable use.



Carbon Dioxide Removal (CDR)

CDR removes CO₂ directly from the atmosphere and stores it durably, creating net-negative emissions. It complements emissions reductions by helping to balance remaining emissions and support long-term climate goals. CDR includes both nature-based and engineered approaches, such as afforestation, soil carbon sequestration, biochar, enhanced weathering and direct air capture. Research is needed to advance these approaches towards credible and scalable climate solutions, with robust methods to measure and document their climate impact and long-term carbon storage.

Focus areas

Carbon conversion

Technological pathways that convert CO₂ into products such as chemicals, materials and fuels through biological, chemical or thermochemical processes. This focus area includes algae-based, enzymatic, electrochemical and catalytic routes, enabling the integration of captured biogenic and atmospheric carbon into industrial value chains.

Enhanced weathering & mineralisation

Carbon removal pathways based on the reaction of CO₂ with naturally occurring or engineered minerals to form stable carbonates. This focus area includes enhanced rock weathering and mineral carbonation and offers potential for permanent carbon storage with high durability, subject to scalability and environmental considerations

Carbon-based materials

Development of materials and products in which captured CO₂ replaces fossil carbon, including chemicals, polymers, and construction materials. This focus area supports the transition from fossil-based to carbon-based value chains and enables long-term storage of carbon in durable products where relevant.

Geological storage

Permanent storage of CO₂ in subsurface geological formations such as saline aquifers and depleted oil and gas reservoirs. Geological storage is a critical enabler for large-scale CCS and CDR, providing long-term containment and underpinning confidence in the integrity of carbon management systems.

Direct air capture

Technologies that capture CO₂ directly from ambient air using chemical or physical separation processes. DAC enables access to atmospheric carbon independent of emission sources and can support both carbon removal pathways (when combined with storage) and utilisation pathways based on non-fossil carbon feedstocks.

Point source capture

Technologies that capture CO₂ from concentrated emission sources such as industrial plants, waste incineration, energy production, and biogenic processes. Point source capture provides access to large volumes of CO₂ and can serve different roles in the value chain, including supply for geological storage, utilisation in industrial processes, and capture-based carbon removal when combined with storage.

Direct ocean capture

Technologies that extract CO₂ from seawater, leveraging the ocean's natural buffering of atmospheric carbon. Direct ocean capture can provide an alternative source of atmospheric carbon and may contribute to both utilisation pathways and carbon removal, subject to environmental safeguards and system integration.

Soil-based Removal

Practices and technologies that increase carbon storage in soils through biological processes and stable carbon forms. This includes soil carbon sequestration approaches and biochar, which can enhance long-term carbon storage while supporting soil health and agricultural resilience.

Ecosystem-based removal

Carbon removal through the restoration, management, or expansion of natural ecosystems such as forests, wetlands, and peatlands. These approaches leverage biological processes to remove CO₂ from the atmosphere and store it in biomass and soils, while delivering co-benefits for biodiversity and ecosystem services.

Transport

Infrastructure and logistics solutions for moving captured CO₂ between capture sites, utilisation facilities, and storage locations, including pipelines, shipping, and intermodal solutions. Reliable and scalable transport is essential for enabling integrated CCUS value chains and reducing system-wide investment risk.



Carbon capture and storage



Capturing and storing CO₂

Denmark has significant geological potential for CO₂ storage, corresponding to several centuries of Danish CO₂ emissions. This creates opportunities for large-scale storage and for the development of a CCS value chain that can handle CO₂ from multiple sources.

Realising this potential requires the transition from individual projects to reliable and integrated infrastructure. Storage sites need to be thoroughly characterised to understand their capacity, injectivity and long-term behaviour, while monitoring and risk assessment are essential to ensure safe and permanent storage. At the same time, capture and transport must become more efficient, flexible and cost-effective to connect different CO₂ sources with available storage capacity.

Research and innovation are therefore needed across the CCS value chain. Advances in capture technologies, reservoir modelling and monitoring must go hand in hand with infrastructure development and system integration. Clear regulatory frameworks, effective governance and coordination across the value chain are equally important for reducing uncertainty and creating the conditions for secure and scalable CCS deployment.

Alternative Capture Materials

Novel Compounds for Low-Energy CO₂ Capture

Objective

One of the primary limitations of conventional CO₂ capture technologies is the large energy penalty associated with regeneration processes. This project explores alternative capture compounds and processes that enable CO₂ release under low temperatures, significantly reducing the energy demand associated with regeneration.

The research expands the design space beyond conventional amine-based systems through multiple complementary approaches, including scalable and sustainable solid-state capture materials and humidity-responsive capture compounds. The ambition is to achieve high capture performance by utilising novel concepts: organic crystals, humidity swing, and entropy-driven processes, enabling lower-cost and more sustainable carbon capture processes.

Approach

The project investigates several classes of alternative capture materials designed to release CO₂ through the preparation of a library of organic molecules rationally designed based on structure-performance relationship. Material development is combined with experimental testing to evaluate capture performance, regeneration energy, stability, and suitability for different carbon capture applications. Promising results have been demonstrated across multiple material platforms, indicating the potential for efficient CO₂ capture and release under mild operating conditions. Current research focuses on understanding structure-performance relationships and identifying pathways towards practical implementation and scale-up.

Expected impact

The project will establish new pathways for low-energy and low-cost CO₂ capture based on alternative capture and regeneration mechanisms. Ongoing work focuses on understanding mechanisms and process design, including optimisation of capture capacity, mass transfer, cycling stability, and long-term material durability. Future efforts will validate performance in larger-scale continuous systems using real CO₂ sources and advance the most promising technologies towards pilot-scale demonstration. By achieving regeneration energies significantly below current industrial benchmarks and demonstrating stable long-term operation, the project aims to contribute to the development of more energy-efficient and economically viable carbon capture technologies.

Budget

DKK 38,800,000

Funding source

The Novo Nordisk Foundation CO₂ Research Center (CORC)

Partners

University of Copenhagen

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Timeline

2023 - 2028

TRL

2 → 5

Sectors

Cross sector

ASGREEN

Advanced Solvent with Green Regeneration by Electrochemical Energy and Nanotechnology

Objective

The project aims to develop an optimised, cost-effective electrochemical cell for carbon capture. The novel cell configuration should display improved capture efficiencies, make use of sustainable capture solvents, and provide a commercially pure CO₂ output. Finally, the project will develop an advanced thermodynamic model to predict experimental data within 5% uncertainty during 2025-2026.

Approach

Achieving a pure CO₂ stream is difficult with current cell designs, and high gas purity is crucial for repurposing CO₂. For this reason, the ASGREEN technology entails a rethinking of membrane configurations in the cells. The novel ASGREEN technology will be optimised through both laboratory scale tests and pilot tests. Solvent composition, membrane materials and configurations, and electrode materials will be analysed and optimised. In addition, long-term application of the ASGREEN set-up will be examined in pilot.

Expected impact

The ASGREEN technology can help create value for customers by eliminating their CO₂ emissions in a cost-effective manner. This will have economic implications for companies by reducing the amount of regulation-imposed emission taxes they have to pay. Additionally, the scalability of the technology will make it easy for especially small- to medium-sized CO₂ emitters to implement carbon capture.

Budget

DKK 12,344,512

Funding source

INNO-CCUS

Partners

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Timeline

2023 - 2026

TRL

3 → 5

Sectors

Cross sector

ASGREEN experimental setup at DTU.
Image provided by Technical University
of Denmark



BioNETzero

Integrated oxy-combustion solutions for flexible, bio-based combined heat and power: A negative emissions technology for a net-zero Europe

Objective

Integrated oxy-combustion solutions for flexible, bio-based combined heat and power: A negative emissions technology for a net-zero Europe Objective and hypothesis The project aims to advance biomass-based carbon capture by focusing on three oxy-combustion technologies:

- Oxy-MILD - Moderate or Intense Low-oxygen Dilution
- CLC - Chemical Looping Combustion
- Oxy-CFB - Oxy-fired Circulating Fluidised Bed

These will be tested experimentally and analysed through computational modelling. The project also includes the development of digital tools for full-scale CHP systems. In addition, it will assess the integration of different oxygen supply solutions and evaluate environmental, technical, economic, and social impacts. The goal is to identify viable pathways for using bio-based CHP as a negative emission technology.

Approach

The project approach is comprehensive, employing mixed methods including qualitative and quantitative research. A systematic process is designed to cover the full biomass residue-to-value chain - from mapping and characterising biomass feedstock sources to applying the three oxycombustion technologies, allowing inherent CO₂ capture. Advanced CFD models are validated through lab- and pilot-scale experiments, then scaled up using the digital platform. The showcase study method examines concepts in real-life contexts, addressing fuel flexibility, oxygen supply, CHP plant scales, and regional challenges in the transition from fossil fuels to bio-based resources.

Expected impact

Harnessing just 10% of Europe's accessible biomass residues for this project's solutions could unlock nearly 70 million dry tons of biomass resources. This, in turn, has the potential to remove approximately 90 million metric tons of CO₂ annually - equivalent to nearly 3.5% of Europe's total CO₂ emissions. The project is expected to strengthen Europe's scientific foundation, boost technological competitiveness and export potential in bioenergy, and reduce the cost while improving the technical performance and efficiency of bio-based CHP. In doing so, it contributes directly to the EU Green Deal.

Budget

DKK 29,834,960

Funding source

Horizon Europe

Partners

AGH University of Science and Technology, Air Liquide, CIUDEN, CSIC, Silesian University of Technology, SINTEF, Veolia Energia, Aalborg University

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Timeline

2024 - 2027

TRL

N/A

Sectors

Energy utility

BOMS

Borehole Monitoring Solutions for CO₂ storage wells

Objective

Several of the identified risks concerning CO₂ storage are related to the risk of CO₂ leakage in or near the well. In hydrocarbon fields, leaks have been recorded through the wellbore due to corrosion and mechanical failure of tubulars. This project concerns the monitoring that can be done inside and near onshore wells. It will consider the operational needs for monitoring and describe existing technology, such as well head monitoring (pressure, temperature, flow) and technology that could be improved or adapted for the continuous monitoring of the well.

Approach

The project will establish an overview of the existing monitoring technology and identify the most important gaps between existing technology and the operational and modelling need for data. Finally, the project will focus on the predictability of the reservoir model. A calibrated reservoir model is mandatory to interpret and predict responses from the reservoir in the injection - and post-injection periods.

Expected impact

Developing a good monitoring programme and suitable technologies is necessary for operating a CO₂-storage reservoir. This project is a key part of preparing for a CO₂ pilot in Stenlille, which has the potential to accelerate the implementation of full-scale CCS in Denmark by several years. The potential impact on climate is, therefore, significant. As CCS technology becomes large-scale, Denmark has a great potential for CO₂ import, and by accelerating this technology, this project has the potential to improve the economic and societal benefits of storage significantly. Resulting methods and technology will be particularly well suited to monitoring re-purposed wells, such as converted oil and gas wells.

Budget

DKK 3,582,605

Funding source

INNO-CCUS

Partners

BlueNord, Gas storage Denmark, Geological Survey of Denmark and Greenland (GEUS), Technical University of Denmark, Technion, Welltec

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Timeline

2022 - 2026

TRL

5 → 7

Sectors

Offshore storage

CARBONCHAINS

Emerging Carbon Value Chains in Denmark and the North Sea

Objective

The CarbonChains project aims to examine how emerging carbon management value chains -encompassing capture, transport, utilisation, and storage -are taking shape in Denmark and the broader North Sea region. The core hypothesis is that combining technological innovation with supportive socio-institutional frameworks can significantly accelerate the scale-up of CCS, CCU, and CDR solutions. By focusing on the interplay among sectors such as heavy industry, energy, and agriculture, the project posits that well-coordinated policy and governance efforts are essential to resolving 'chicken-and-egg' challenges - where supply and demand fail to align - and to establishing robust infrastructure for carbon management at scale.

Approach

Using socio-technical transition studies and innovation systems methodologies, the research team investigates cross-sector alliances, policy experiments, and market mechanisms that could spur carbon management innovation. This includes mapping actor networks, analysing missionoriented climate initiatives across heavy industry and agriculture, and examining how different carbon value chains interact - whether by sharing infrastructure or overlapping actors. By spotlighting potential synergies and conflicts, the project sheds light on the 'chicken-and-egg' issues that arise when multiple sectors converge, such as misaligned supply and demand or uncertain investment flows.

Expected impact

CarbonChains ultimately seeks to provide actionable insights for policymakers, industry stakeholders, and researchers aiming to broaden the adoption of carbon management solutions in line with urgent climate goals. The project will produce policy recommendations, stakeholder guidance, and frameworks for creating viable business models. In doing so, it underscores the pivotal role of cross-sector coordination and governance in overcoming barriers such as infrastructure bottlenecks, regulatory uncertainties, and market mismatches.

Budget

DKK 4,000,000

Funding source

Novo Nordisk Foundation

Partners

University of Copenhagen

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Timeline

2024 - 2028

TRL

N/A

Sectors

Cross sector

C•ASH

CO₂ mineralisation by volcanic ASH

Objective

The project aims to demonstrate that volcanic ash layers in the Danish subsurface can be used to permanently remove CO₂ from the atmosphere through natural mineralisation processes. This approach builds on well-known geochemical reactions where CO₂, when dissolved in water, reacts with silicate-rich minerals to form stable carbonate minerals. The hypothesis is that volcanic ash layers - rich in calcium, iron, and magnesium - can bind large amounts of CO₂ when exposed to CO₂-saturated water, offering a safe, low-cost alternative to conventional CO₂ storage.

Approach

Researchers will establish Denmark's first pilot plant for CO₂ mineralisation, in collaboration with a local biogas facility. CO₂ separated from the biogas production will be dissolved in water from the geological formation, creating a concentrated "sparkling water" solution. This will be injected into 200-300 metre-deep boreholes containing volcanic ash layers formed 56 million years ago. The ash, composed of microscopic particles with a high surface area and the right chemical composition, is expected to rapidly react with the CO₂ to form solid minerals. The site will include several wells for continuous monitoring of water chemistry and carbonate formation.

Expected impact

If successful, the project will validate a CO₂ storage method that is permanent, safe, and locally deployable. Mineralisation requires no pressurised CO₂ or deep storage infrastructure, and the approach has the potential to scale through multiple small plants with minimal land footprint. In Denmark alone, the ash deposits may be able to mineralise the equivalent of 40-50 years of national CO₂ emissions. Globally, the potential is even greater, with large volumes of volcanic material available. This project lays the groundwork for broader use of CO₂ mineralisation as part of Denmark's and the world's negative emissions strategy.

Budget

DKK 7,151,000

Funding source

Independent Research Fund Denmark, Novo Nordisk Foundation

Partners

Geological Survey of Denmark and Greenland (GEUS), Klimafonden Skive, Morsø Municipality, Rybjerg Biogas, Skive Municipality, Sunstones, Thisted Municipality, Aarhus University

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Timeline

2023 - 2027

TRL

3 → 7

Sectors

Onshore storage

Offshore storage

CAP-FLEX

CO₂ Capture in Cement Industry with Flexible Energy Sources

Objective

The CAP-FLEX project addresses the challenge of decarbonising cement production, which accounts for 8% of global CO₂ emissions, by advancing a novel, retrofittable technology for generating a concentrated CO₂ stream from limestone calcination. The technology builds on the FUELFLEX® Pyrolyzer platform developed by FLSmidth Cement, integrating electric heating and oxyfuel combustion for high-purity CO₂ production. The technology is designed for flexible, cost-effective integration into existing cement plants. Its dual capability of maximising alternative fuel use while enabling high-purity CO₂ capture supports the decarbonisation of cement production.

Approach

The project includes industrial data analysis, laboratory-scale validation, advanced process modelling and full-scale demonstration. Risk management, milestone tracking and project governance underpin the execution strategy.

Expected impact

The project could enable the capture of 60-90% of a cement plant's CO₂ emissions. If deployed across Denmark's cement sector, this corresponds to up to 2 Mt CO₂/year nationally and would support Denmark's 2030 and 2050 climate targets. In addition to direct emissions reductions, the project aims to deliver broader societal and economic benefits by supporting job creation, public acceptance of carbon capture, utilisation and storage (CCUS) and Denmark's position in green technologies.

Budget

DKK 21,740,231

Funding source

INNO-CCUS

Partners

Danish Technological Institute, Fuller Technologies Denmark, Mannok Cement Limited, Technical University of Denmark

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Timeline

2026 - 2026

TRL

3 → 6

Sectors

Cement industry

CapSim

Optimising carbon capture simulation through advanced modelling tools

Objective

The objective of CapSim is to develop accurate, robust software tools to be used in and with process simulators for standard and novel carbon capture processes. The project also explores how inaccuracies in process design can impact subsequent steps in carbon capture and storage.

Approach

The project aims to improve CO₂ capture simulation technology by focusing on two key areas:

- Improving the core multiphase reactive algorithm to enable us to handle complex reactions and multiphase equilibrium efficiently and robustly.
- Better integrate thermodynamics, kinetics, and transport phenomena into the simulation, emphasising their impact on simulation results.

CapSim tackles algorithmic and thermodynamic challenges associated with CO₂ capture simulation, using tools like Aspen Plus, Pro/II, CO₂SIM, and CAPCO₂. It seeks to overcome challenges related to acidic gases, speciation, reactions, and thermodynamics. CapSim is structured into four work packages: addressing algorithmic challenges, thermodynamic models, process uncertainties, and optimisation. The project utilises advanced algorithms like RAND and focuses on robustness, efficiency, and accuracy.

Expected impact

Capture simulation is the vehicle to bring various novel ideas to industrial scale implementation. Advancement of the key capture simulation technologies will enable quicker adoption of new solvents and a more reliable optimisation towards capture with lower energy consumption. Capture is the costliest step in CCS and the bottleneck for the whole chain.

Budget

DKK 12,591,900

Funding source

INNO-CCUS

Partners

Schlumberger, Technical University of Denmark, Aalborg University

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Timeline

2023 - 2027

TRL

3 → 6

Sectors

Cross sector

CAR2MA

Cross-Mission Carbon and Area Management

Objective

Despite ongoing research on carbon management and green fuels, unanswered questions persist regarding sustainable carbon management with the holistic integration across Denmark's four Innomissions for the green transition, including agriculture, forestry, energy, transport, industry, buildings, waste management and materials. These unmet needs have become even more pronounced with the political aim for Denmark to become carbon neutral by 2045 and carbon negative by 2050, as well as with the Green Tripartite Agreement. The aim of CAR2MA is to develop cross-cutting, society-wide system analysis methods, tools and models that enable holistic co-optimisation of land use and carbon management across all Innomission sectors.

Approach

The project combines technical and social sciences and humanities (SSH) methodologies. It integrates physical, agronomic, forestry and technical analyses with SSH methods in economics and local implementation strategies for energy clusters and land use. Moreover, it combines theoretical analysis from academia with applied implementation efforts from industry and local authorities.

Expected impact

The project will deliver a national cross-mission strategy and three local scenarios for carbon and land management. Expected outputs include:

- Potential quantities of additional agricultural and forest biomass that can be produced sustainably in Denmark under different scenarios.
- Optimised use of agricultural and forest biomass, integrating the allocation of carbon across forest and agricultural ecosystems, materials, energy products and permanent underground storage while supporting other policy objectives, particularly nitrate leaching and biodiversity.
- Technology scenarios for the best utilisation of biomass resources for materials, energy products and carbon storage through cascade utilisation at both the national level and across three local case areas.

Budget

DKK 13,800,000

Funding source

AgriFoodTure, INNO-COUS, MissionGreenFuels, Trace

Partners

Arla Foods, Dansk Skovforening, Erhvervshus Fyn, Klimafonden Skive, Landbrug og Fødevarer, PlanEnergi, Randers Kommune, Skive Municipality, Stiesdal SkyClean, The Novo Nordisk Foundation CO₂ Research Center (CORC), University of Copenhagen, University of Southern Denmark, Verdo, Vesthimmerland Municipality, Vestjyllands Andel, Viborg Kommune, Ørsted, Aalborg University, Aarhus University

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Timeline

2026 - 2028

TRL

5 → 8

Sectors

Agriculture

Biogas

Fuels

Energy utility

Forestry

Infrastructure

Cross sector

CarbonAdapt

The adaption of existing infrastructure for CO₂ storage in reservoirs

Objective

The aim of this project is to measure the corrosion effect of liquid or supercritical CO₂ in the presence of impurities and provide a mathematical model to predict this corrosion on existing and new infrastructure. The projects will examine possible CO₂ impurity monitoring systems, both sample-based (off-line or at-line) and in-line measurements and establish a relationship between the CO₂ impurities and material corrosion in the pipelines/wells and associated equipment.

Approach

The aim is pursued by applying an existing flow-loop facility at Welltec, specifically realised for corrosion testing in a liquid/supercritical CO₂ environment. This facility will simulate corrosion conditions like those expected in CO₂ transportation pipelines and injection wells. The lab facilities at AAU will be used to validate the different monitoring units in a controlled environment. Welltec's flow-loop facility will demonstrate the application in an industrial environment utilising the monitoring units after validation. The applicability of in-line measurement technologies, such as spectroscopic methods for monitoring CO₂ contaminants, will be investigated and validated against conventional analytical methods.

Expected impact

Since the transportation and injection of captured CO₂ is an essential part of any CCUS strategy, the project's impact is significant: If corrosion in the carbon storage system is left unchecked, the entire strategy of injecting CO₂ into the offshore reservoirs will result in excessive OPEX to such a degree that it may never be financially feasible. The project can contribute to Danish job creation as the addressed problem must be handled to ensure a safe and reliable injection of CO₂ in the existing offshore infrastructure. The learning in this project will be used to identify requirements for qualifying existing infrastructure for CO₂ injection in relation to carbon storage both on a technical as well as legislative level.

Budget

DKK 12,309,599

Funding source

INNO-CCUS

Partners

FORCE Technology, Gas storage Denmark, Rambøll, Welltec, Aalborg University

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Timeline

2022 - 2026

TRL

3 → 6

Sectors

Infrastructure

CarbonCuts

Import and permanent sequestering of CO₂ in Lolland, Denmark

Objective

Developing the value chain in the CCS sector demands insights and timing between all links in the chain. The aim of the project is to establish a permanent import facility for CO₂ in Rødby and to construct the necessary import infrastructure, including harbour terminal, intermediate storage, and pipelines connecting surface components.

Approach

The storage will be established in one of the geological structures identified as suitable for CO₂ storage by the Danish Energy Agency. The structure in Rødby consists of an underground saltwater reservoir covering a 10 x 20 km area near Rødby and Rødbyhavn. Regardless of the route through which the CO₂ arrives in Rødby, it is necessary to establish import and intermediate storage facilities to receive CO₂ in liquid form. To receive CO₂ via ship, CarbonCuts will investigate whether it is possible to establish barge storage as an alternative to the traditional land-based import and intermediate storage at the port. A barge storage is a flexible liquid intermediate storage comprising CO₂ tanks on a flat-bottomed barge, which can be placed either in the port or slightly offshore.

Expected impact

The goal is to develop a barge design at the 'Front End Engineering Design' (FEED) level, providing a high level of cost certainty, delivery time, and feasibility. As the project is developed as an onshore storage site, and the shipping distances within the Baltic Sea are relatively short, the estimated price for the CCS value chain is competitive, especially compared to offshore storage projects. CarbonCuts has received interest from several emitters in the Baltic Sea region where the above-stated elements, regarding onshore sites and short shipping distances, are regarded as valued qualities.

Budget

DKK 2,833,000

Funding source

BlueNord, Schneider Electric, Svanehøj, TGE Gas Engineering, Wartsila

Partners

BlueNord, Schneider Electric, Svanehøj, TGE Gas Engineering, Wartsila

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Timeline

2022 - 2030

TRL

9

Sectors

Offshore storage

CCUS-INFRASTRUCTURES

Strategic Planning of CCUS Infrastructure

Objective

The aim of the project is to investigate how national CO₂ and carbon capture, utilisation, and storage (CCUS) infrastructure is impacted and impacts different energy system transition pathways, including impacts on the carbon balance and economic efficiency. This means that geographical placements of CO₂ infrastructure such as pipes, storages, capture and utilisation units will be investigated in combination with geographical knowledge of the surrounding energy infrastructure.

Approach

To investigate CCUS infrastructure, the project will analyse the location aspects of the technologies. This includes both onshore and offshore infrastructure. This is included as it is highly relevant for optimising large-scale CO₂ storage, to understand the demand for carbon capture, as well as the potential infrastructural synergies between CCUS infrastructure and the energy infrastructure.

Expected impact

The project will contribute with the following results which create societal impact in terms of future implementation of CCUS infrastructures:

- This will include the placement of CCUS infrastructure based on location analyses considering costs for point sources, CO₂ transport, storage facilities, utilisation and synergies with the surrounding energy system.
- An assessment of different CCUS infrastructure configurations in combination with the surrounding energy infrastructure. This enables the project to identify the best solutions for CCUS implementation to achieve carbon neutrality and potentially a carbon negative society.

Budget

DKK 4,430,402

Funding source

INNO-CCUS

Partners

TotalEnergies, Ørsted, Aalborg University

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Timeline

2023 - 2027

TRL

N/A

Sectors

Infrastructure

CASPER

Cement cArbon Storage Pilot for Emission Reduction

Objective

The objective of the project is to evaluate the whole CCS value chain by demonstrating the full CO₂ capture and storage value chain from a cement plant.

Approach

The evaluation of the CCS value chain from a cement plant entail capturing CO₂ from Aalborg Portland. The project will capture and condition at least 20 tons of CO₂ from flue gas during a campaign in 2024. Additionally, the project will measure the quality of the CO₂ and compare it with existing standards relevant in 2024 and determine necessary post-capture processes needed in the full CCS value chain. Finally, the project will evaluate the effect on impurities on CO₂ transportation in a new 50 m-long CO₂ pipe test facility owned by Evida to prepare for CO₂ infrastructure that can be implemented in 2025.

Expected impact

The project will provide the first-ever evaluation of the CCS value chain from a cement plant and thereby introduce new knowledge to the sector.

Budget

DKK 14,637,071

Funding source

INNO-CCUS

Partners

Danish Gas Technology Centre, Danish Technological Institute, Evida, Gas Storage Denmark, Pentair, Technical University of Denmark, Aalborg Portland

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Timeline

2023 - 2026

TRL

4 → 7

Sectors

Cement industry

Installation of CO₂ capture facility at Aalborg Portland
Image provided by Technical University of Denmark



Cerberus

The CO₂ gate-keeper for intelligent and automated monitoring of geological CO₂ storage sites

Objective

The Cerberus project focuses on the intelligent monitoring of CO₂ stored in deep geological formations. It is an interdisciplinary initiative aimed at developing a cost-effective, fit-for-purpose, automated digital tool for continuous monitoring of containment and field-specific surveillance strategies. The project seeks to advance and validate THMC (Thermal-Hydrological-Mechanical-Chemical) simulation tools for CO₂ storage, improve petroelastic models, and develop a machine learning solution for monitoring CO₂ containment.

Approach

Nordsøfonden, TotalEnergies Cerberus aims to replace computation-intensive high-fidelity models with more efficient reduced order models (ROMs) using machine learning. These ROMs will address data and computation challenges, enabling real-time modelling of the subsurface while maintaining consistency with the original high-fidelity models and scenarios calibrated against real-world observations.

Expected impact

If successful, the developed toolkit will be integrated into future monitoring plans for large-scale CCS projects by field operators. It will address the critical need for a high-definition multiphysics model spanning from reservoir to surface, offering strong prediction capabilities and enabling low-cost analysis of monitoring datasets.

Budget

DKK 14,000,000

Funding source

Innovation Fund Denmark

Partners

Nordsøfonden, TotalEnergies

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Timeline

2024 - 2029

TRL

5 → 7

Sectors

Offshore storage

ChalkCO₂RE

Chalk-CO₂reactions at reservoir conditions

Objective

The aim of the project is to de-risk CO₂ storage in chalk reservoirs by quantifying the magnitude of dissolution/precipitation and predicting its sector-scale location in carbonate reservoirs during and after CO₂ injection. The project will establish a sector model which can be applied to chalk fields to predict dissolution/precipitation.

Approach

The project follows a new approach based on flooding and reactor experiments designed specifically to quantify dissolution/precipitation as a result of variable pressure, temperature, lithology, and brine chemistry. The project will determine effects on porosity, permeability and injectivity, coupled to a petrographic characterisation of lithological features induced by dissolution/precipitation. These results will be geochemically modelled on the core-scale to determine the conditions leading to dissolution/precipitation, allowing us to establish a sector-scale model identifying sites of potential dissolution/precipitation at varying injection conditions. Experiments will be based on reservoir core samples and analogues if necessary. Modelling will be performed on a conceptual model based on a well-described field in the North Sea.

Expected impact

The most important outcome of the project is to provide the fundamental knowledge necessary to decide to further progress the TRL of CO₂ storage in depleted chalk reservoirs. The project increases the potential for CO₂ injection as an integral part of abandonment strategies for operators in the North Sea and increases the potential for CO₂ import as a business model. In addition, the know-how created can be exported to other countries with hydrocarbon fields in chalk or other tight carbonates.

Budget

DKK 8,270,221

Funding source

INNO-CCUS

Partners

BlueNord, Nordsøfonden, Technical University of Denmark, TotalEnergies, Aarhus University

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Timeline

2022 - 2026

TRL

2 → 3

Sectors

Offshore storage

CO₂.0 Infrastructure

A new modular, safe and scalable CO₂ infrastructure

Objective

Denmark has set ambitious targets for reducing CO₂ emissions, which can only be achieved by implementing carbon capture and storage (CCS) at large scale.

It is not realistic to connect small and medium-sized emitters spread across Denmark with pipelines.

Some solutions rely on transporting CO₂ in liquid form under high pressure and cryogenic temperatures using specialised tank trucks and gas tankers. However, such trucks and ships exist only in very limited numbers, are extremely expensive, and it is not realistic to build new ones at the scale needed.

There are also several safety concerns associated with transporting CO₂ in liquid or gaseous form.

This combination makes large-scale CCS deployment unrealistic in the short and medium term, making it difficult to achieve climate targets.

Approach

CO₂.0 Infrastructure is a CO₂ transport solution based on CO₂ in solid form as dry ice at atmospheric pressure, designed from the outset to fit into existing container-based transport chains.

The innovation project is based on patented technology from DecarbonICE - a specially built insulated standard container and a re-liquefier that controls the conversion of CO₂ back into liquid or gaseous form according to end-user specifications. The pilot project demonstrates the transport of CO₂ in a specially built container, the conversion of dry ice back into liquid or gas, and the final use of CO₂ in the Project Greensand setup, with shipment from the Port of Esbjerg. It also includes a case study and a business case for implementation in several countries.

Expected impact

The market for CO₂ storage is expected to reach around 6 billion tons of CO₂ in 2050. Demand for CO₂ transport will therefore likely be high, requiring a CO₂ infrastructure on a scale that does not exist today. The CO₂.0 Infrastructure logistics system is modular, simple, and scalable, providing a competitive solution particularly for small and medium-sized emitters, while complementing pipeline infrastructure once it becomes available. The partners in the innovation project expect to have a commercial concept ready for the market in 2028.

Budget

DKK 18,207,794

Funding source

The Energy Technology Development and Demonstration Programme (EUDP)

Partners

Ancotrans, Cold Jet, DecarbonICE, Energy Cluster Denmark, Fremsyn, GreenGo Energy, KIRT X THOMSEN, Maersk Container Industry, Port of Esbjerg, Aarhus University

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Timeline

2026 - 2028

TRL

5 → 8

Sectors

Biogas

Fuels

Offshore storage

Onshore storage

CO₂flow

Experimental study and modelling of CO₂ propagation in geological storage

Objective

This project aims to enhance our understanding of CO₂ storage by developing standardised laboratory procedures for critical parameters like relative permeabilities and capillary pressure curves. The project seeks to shed light on the physical mechanisms governing CO₂ sequestration. Hypotheses include the feasibility of these procedures and their applicability in predicting CO₂ plume migration.

Approach

The project includes conducting CO₂-brine core flooding experiments using X-ray CT monitoring and acoustic two-phase separation on samples from the Stenlille gas storage site. Core-scale numerical simulations will help derive relative permeability and capillary pressure functions. Laboratory procedures for two-phase miscible flows will be established, and the domain of applicability for both methods identified. Additionally, analytical models for CO₂ plume migration will be developed based on these measurements.

Expected impact

CCUS is a critical element in achieving Denmark's target of a 70 % reduction in greenhouse gas emissions by 2030. The project is of particular importance for existing onshore gas storage sites, such as Stenlille, which has been used as natural gas storage for decades. According to the roadmap 'Mission CCUS-a roadmap for carbon capture, utilisation and storage', the questions on de-risking the reservoir will be answered to a great extent after completing this study. The results of this project will contribute to better estimates of the efforts needed to meet CO₂ emissions reduction targets, both for Denmark and globally. The main innovation within the project is related to developing a procedure at GEUS which is tailored towards experiments with supercritical CO₂ to be able to measure the flow functions (relative permeability parameters).

Budget

DKK 4,220,640

Funding source

INNO-CCUS

Partners

Gas storage Denmark, Geological Survey of Denmark and Greenland (GEUS), Technical University of Denmark, TotalEnergies

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Timeline

2023 - 2026

TRL

3 → 5

Sectors

Offshore storage

CO₂MAN

Low emission CO₂ capture solvent management

Objective

The CO₂MAN project seeks to advance CO₂ capture by developing an AI tool to screen over 1 billion solvent formulations. The tool will identify solvents with high CO₂ absorption, selectivity, low energy demand, environmental impact, etc. Top candidates will be validated at lab and pilot scales, aiming for over 25% efficiency gains and 15% cost cuts.

Approach

Solvent-based CO₂ capture has proven to be one of the only capture technologies that is scalable before 2030. However, current solvent technology still faces challenges such as high energy penalty, solvent degradation, and corrosiveness. If these challenges are not solved by 2030, there is a risk that the cost of CO₂ capture plants will remain too high. The aim of this project is to enhance an existing prediction tool with unique capabilities in pre-dicting solvent properties, to develop an artificial intelligence (AI) tool that will be used to screen more than 1 billion solvent formulations.

Expected impact

The developed tool will be the first to allow screening based on the overall efficiency and cost of full-scale CO₂ capture plants. Based on the predictions, the three most promising solvent candidates will be validated at lab scale and demonstrated at pilot scale at the Skærbækværket biomass combustion facility. The project expects the best-performing solvent to result in more than 25% improved capture plant efficiency, over 15% lower costs, and an improved corrosion and environmental profile compared to current state-of-the-art solvents.

Budget

DKK 13,897,000

Funding source

Energy Technology Development and Demonstration Programme (EUDP)

Partners

Hafnium Labs, Pentair, Technical University of Denmark, Ørsted

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Timeline

2025 - 2027

TRL

3 → 7

Sectors

Cross sector

CO₂Plus

Phase behavior of CO₂+X in CO₂ storage

Objective

Geological CO₂ storage involves complex phase behaviour of CO₂+X (X being either impurity in the injected CO₂ stream or the in-situ fluids that interact with CO₂). Detailed knowledge of this behaviour is crucial to many aspects of CO₂ storage. The aim of this project is to acquire systematic knowledge and develop the essential modelling approach for analysing the complex phase behaviour of CO₂+X in injection and storage.

Approach

The project will:

- Establish a comprehensive database for the phase behaviour of CO₂+X and make a systematic evaluation of the existing models.
- Measure the data for critically selected properties and conditions, particularly those directly related to the Danish storage sites.
- Develop a portfolio of models for the equilibrium and physical properties of CO₂+X, which can be used for accurate analysis of wellbore and near-wellbore phenomena related to injection and for reservoir-scale simulation analysis. The project will study non-cubic equations of state for high accuracy modelling of equilibrium and physical properties.
- Develop systematic methods to integrate the knowledge of CO₂+X into the simulation analysis of injection risks and storage issues.

Expected impact

Geological CO₂ storage will play a significant role in the green transition. It is, however, challenging in its scale and urgency. Even so, if implemented, it also presents significant opportunities for new businesses and secure jobs in the related areas. This systematic solution will help to de-risk the decision-making and implementation of CO₂ storage by improving the evaluation of injection risk, storage capacity, and storage safety. The ability to handle various complex phase behaviours also enables the potential utilisation of all types of reservoirs to maximise the storage potential.

Budget

DKK 8,270,000

Funding source

Innovation Fund Denmark

Partners

BlueNord, Gas storage Denmark, INEOS, Technical University of Denmark, TotalEnergies, Wintershall Dea

Contact

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Timeline

2023 - 2027

TRL

2 → 4

Sectors

Offshore storage

CO₂QMON

Developing a standardised system for CO₂ monitoring and quality assurance

Objective

The purpose of the project is to define and build a system for monitoring, quality assurance, management, and reporting of CO₂ produced for a shared pipeline infrastructure. The methodology is exemplified using CO₂ gas produced at a carbon capture plant, with a particular focus on quantities and quality. The goal is to develop a practical solution that can serve as a de facto standard and be demonstrated and documented throughout the project.

Approach

The project includes a review and description of the requirement specifications for CO₂ gas produced at individual carbon capture plants, along with the quality standards likely to be required for supplying a national infrastructure. Based on these specifications, suitable methods for analysing and monitoring impurities in the CO₂ gas will be recommended. In collaboration with Olicem, Thisted CHP Plant (KVVVT), and FORCE Technology, the project will demonstrate practical solutions for a monitoring system (metering skid) capable of determining the quantity and quality of the CO₂ produced. Identification of appropriate test facilities is also part of the project.

Expected impact

The project will develop and demonstrate a practical solution for automatic reporting of measurement data, including systems for ensuring data quality in accordance with applicable requirements. The intention is to create a system that can be used as a de facto standard. Testing and demonstration will be carried out using data from practical trials, followed by data comparison and preparation of the final project report and documentation. The project partners estimate that CO₂ data management and quality assurance could have a market potential of over DKK 200 million in Denmark alone. In addition, ongoing handling and auditing requirements are expected.

Budget

DKK 1,586,558

Funding source

CO₂Vision - REACT-EU

Partners

FORCE Technology, Kraftvarmefærk Thisted, Olicem, Aalborg Portland

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Timeline

2023 - 2026

TRL

N/A

Sectors

Infrastructure

CompReact

Compositional Simulation of Reactive Transport in CO₂ storage

Objective

CO₂ injection into geological formations triggers complex physical and chemical interactions at different time and length scales. These interactions are critical to the evaluation of subsurface capacities, operational risks, and storage safety. This project aims to develop a next-generation compositional CO₂ storage simulator with multiphase geochemical reactions. The simulator can be used in evaluating both the injection and the post-injection periods.

Approach

The project will develop the simulator using the novel RAND-based algorithms. The current multiphase geochemical equilibrium module will be extended by including kinetics and a database for relevant geochemical reactions. The module will be further improved with its code efficiency and reliability and integrated into an in-house compositional simulator for analysis of injection and storage problems at relatively short timescales. In collaboration with Stanford, the project will couple the simulator with the GEOSX simulator. The new GEOSX simulator will be applied to long time-scale post-injection simulations with coupled geomechanics.

Expected impact

The project will advance the simulation technology for geological CO₂ storage. Furthermore, the project directly contributes to the de-risking of CO₂ injection into different types of reservoirs, helping an early decision on the implementation of CO₂ storage. The post-injection analysis will build public confidence in the long-term safety of CO₂ storage, accelerating its implementation. The developed simulator will be disseminated as open-source code, thus benefiting the whole CCUS community. Industrial partners will benefit from the analysis of specific storage sites of their interest, helping decision-making on their investment in CO₂ storage.

Budget

DKK 10,703,600

Funding source

INNO-CCUS

Partners

BlueNord, INEOS, Stanford University, Technical University of Denmark, TotalEnergies

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Timeline

2023 - 2027

TRL

2 → 5

Sectors

Offshore storage

Onshore storage

Cooling Tower DAC

Evaluating Electrochemical Direct air capture Through System Modelling

Objective

Direct air capture (DAC) is a promising technology for removing CO₂ from the atmosphere, but widespread deployment remains limited by high capital costs, energy-intensive regeneration processes, and the need for dedicated air contactors. This project investigates a novel electrochemical Direct air capture (EDAC) concept that combines existing industrial cooling towers with electrochemical sorbent regeneration.

The ambition is to leverage existing cooling infrastructure for air contact and replace conventional thermal regeneration with electrochemical regeneration to reduce the cost and energy demand of Direct air capture.

Approach

The project aims to advance EDAC technology from concept validation towards pilot-scale demonstration. In the first stage, CO₂ is captured from ambient air into a liquid absorbent using a cooling tower as the air contactor. In the second stage, electrochemical processes are used to release concentrated CO₂ and regenerate the absorbent for reuse. Following construction of the pilot system, experimental studies will be conducted to optimise operating conditions and evaluate overall process performance. Process modelling, techno-economic assessment, and life-cycle analysis will be used to identify opportunities for further improvement and assess commercial potential.

Expected impact

The project will deliver a pilot-scale demonstration of an integrated electrochemical Direct air capture system. The resulting data will provide insight into the technical feasibility, energy requirements, and economic performance of coupling cooling tower infrastructure with electrochemical regeneration.

If successful, the technology could provide a pathway towards lower-cost DAC deployment by reducing both capital investment and operational energy demand. The project will also establish the knowledge and assessment framework needed to evaluate the potential for large-scale atmospheric CO₂ removal using existing industrial infrastructure.

Budget

DKK 5,000,000

Funding source

The Novo Nordisk Foundation CO₂ Research Center (CORC)

Partners

Aarhus University

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Timeline

2026 - 2028

TRL

1 → 4

Sectors

Cross sector

CORT

Carbon capture Open tests and Review of Technologies

Objective

This project will test and demonstrate solvents and process technologies for carbon capture at Aalborg Portland and Ørsted and find the best-suited solvents and processes for different carbon capture cases. The project will provide an overview and comparison of the different carbon capture processes that are available today.

Approach

The project takes advantage of the CO pilot system owned by DTU, which can be reconfigured for the project's purpose. Using the DTU-owned pilot, solvents (including proprietary solvents) can be tested and directly compared under different circumstances. For each solvent, a different optimal process configuration is expected, and the comparison is, therefore, not necessarily straightforward.

Expected impact

The optimised conditions found in this project will benefit all the solvents tested, and achieve lower energy consumption on amine-based CO₂-capture technology. The project will help CO₂ emitters choose the best-suited solution for emission reduction and may also result in more carbon capture installations in Denmark.

Budget

DKK 19,286,828

Funding source

INNO-CCUS

Partners

FORCE Technology, Pentair, Technical University of Denmark, Ørsted, Aalborg Portland, Aalborg University

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Timeline

2022 - 2026

TRL

3 → 7

Sectors

Cement industry

D-TRICS

Deep Triassic CO₂ storage potential

Objective

D-TRICS seeks to expand Denmark's geological CO₂ storage potential by investigating deeper-lying Triassic sandstone aquifers beneath the Gassum Formation. The central hypothesis is that these underexplored units (primarily the Lower and Middle Triassic Skagerrak Formation) offer significant, currently untapped storage capacity. By diversifying beyond the Gassum Formation, which is already targeted by most current CCS licences and used for geothermal energy, D-TRICS aims to reduce the risk of pressure-related conflicts and enable broader, more sustainable deployment of CCS technologies.

Approach

To test this hypothesis, D-TRICS will revise the legacy stratigraphic models that currently guide subsurface assessments. The project will generate new geological and biostratigraphic frameworks, map gross sandstone thicknesses, and construct detailed tectonic, structural, and depositional models. These will be integrated into reservoir simulations to evaluate the storage performance of deep Triassic units under different injection scenarios. A socio-ecological assessment framework will also be developed to ensure future CCS operations are technically sound, environmentally sustainable, and publicly acceptable. The project includes structured knowledge-sharing with stakeholders through annual workshops and open sharing of generated knowledge through scientific publications.

Expected impact

D-TRICS is expected to significantly improve the understanding of Denmark's deep subsurface and help greatly expanding national CO₂ storage capacity. The project will support current license operators by reducing geological uncertainty, aid in identifying new CCS acreage, and inform national planning to avoid reservoir interference with geothermal operations. Its outputs (geological models, reservoir simulations, stratigraphic charts, and policy recommendations) will be directly applicable to site development across Denmark, including regions near major emission sources in areas previously considered unsuitable storage. D-TRICS will contribute to achieving Denmark's 2050 climate goals and reinforce Denmark's position as a CCS leader in Northern Europe.

Budget

DKK 17,832,803

Funding source

INNO-CCUS

Partners

Bundesanstalt für Geowissenschaften und Rohstoffe, CarbonCuts, CASP, Equinor, Geological Survey of Denmark and Greenland (GEUS), Harbour Energy, Innargi, Gas storage Denmark, Sveriges Geologisk Undersøkelser, TotalEnergies Upstream Denmark, University of Oslo, Aalborg University

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Timeline

2026 - 2029

TRL

N/A

Sectors

Offshore storage

ENDES

Enzyme assisted desorption of CO₂ from aqueous solvents

Objective

Classical CO₂ scrubbing involves reactive absorption of CO₂ in alkaline aqueous solutions, e.g., carbonates or amines. The most energy-intensive step in the cyclic capture-release process is the desorption of pure CO₂ in the so-called stripper. This project investigates whether the stripping process can be made more efficient using enzymes. Our hypothesis is that accelerated desorption can lower energy requirements for the desorption of CO₂ from aqueous solvents.

Approach

We work with the discovery, engineering, and chemical modification of enzymes in an attempt to accelerate the desorption of CO₂ from aqueous solvents. We use both previously described enzymes and sequences found through bioinformatic searches in known genomes. Promising sequences are produced and purified in the lab and tested for their catalytic performance both in bulk aqueous solutions and gas-liquid mass transfer.

Expected impact

Quantitative measurements of enzyme-accelerated CO₂ desorption remain sparse and the project's first goal is to provide a reliable assessment of its potential. If this proves positive, our work builds a knowledge platform for the discovery and engineering of enzymes for this purpose. Ultimately, our work can identify specific enzymes or enzyme variants that are stable and active enough to be used in industrial scrubbing processes.

Budget

DKK 6,000,000

Funding source

The Novo Nordisk Foundation CO₂ Research Center (CORC)

Partners

Technical University of Denmark, University of Copenhagen

Contact

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Timeline

2022 - 2027

TRL

1 → 3

Sectors

Cross sector

EnviAmin

Evaluating the Environmental Impact of Amines Emitted by Carbon Capture

Objective

The leading carbon capture technology employs aqueous amine solutions to bind CO₂ directly from the flue gas of large sources. However, this results in amine emissions to the atmosphere. The atmospheric fate of these emitted amines is still not clearly understood.

Approach

The project proposes to investigate the atmospheric oxidation of amines emitted from carbon capture facilities through a combination of theoretical and experimental studies. The main focus will be on understanding the OH-initiated oxidation of these amines, using approaches developed in our previous work.

Expected impact

Understanding the atmospheric fate of emitted amines - together with emission monitoring - is essential for guiding the selection of amines used in carbon capture. This knowledge will support the development of an appropriate regulatory framework for carbon capture facilities.

Budget

DKK 3,163,212

Funding source

Independent Research Fund Denmark

Partners

University of Copenhagen

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Timeline

2025 - 2027

TRL

N/A

Sectors

Cross sector

Enzyme-accelerated Carbon Capture and Conversion

Enabling next-generation CO₂ technologies through biocatalysis

Objective

Carbon capture processes are often limited by the energy required for CO₂ absorption and particularly desorption. This collection of projects investigates whether enzymes can accelerate these processes, reducing energy consumption and improving overall process efficiency. The work explores the application of enzymes in carbon capture from flue gases, direct air capture (DAC), CO₂ mineralisation, and direct ocean capture systems.

The central concept is that naturally occurring and engineered enzymes can enhance CO₂ transfer and conversion rates under industrially relevant conditions, enabling more efficient capture processes while lowering operating costs and energy requirements.

Approach

The research combines enzyme discovery, engineering, and process development to identify biocatalysts capable of operating under varied system conditions. Particular focus is placed on understanding enzyme behaviour at gas-liquid and liquid-solid interfaces, where mass transfer often limits process performance. Systematic experimental studies are used to evaluate enzyme performance in both adsorption and desorption processes. Carbonic anhydrase has already been shown to enhance CO₂ absorption under mass-transfer-limited DAC conditions, enabling carbonate-based solvents to approach the kinetics of hydroxide systems while avoiding many of their associated energy and environmental challenges. An additional focus area is the use of carbonic anhydrase to accelerate rock weathering and other types of CO₂ mineralisation, which would provide an inexpensive and scalable approach to carbon capture and sequestration.

Expected impact

The project will improve understanding of how enzymes influence CO₂ capture and release processes, providing a scientific foundation for the development of enzyme-enhanced carbon capture and conversion technologies. Preliminary results indicate that micromolar enzyme concentrations can reduce desorption temperatures by approximately 20 °C, demonstrating the potential for significant energy savings. Future work focuses on developing thermostable carbonic anhydrases and maintaining high catalytic activity following enzyme immobilisation. The resulting knowledge and biocatalysts contribute to more energy-efficient carbon capture and conversion systems across flue gas, direct air capture, and direct ocean capture applications.

Budget

DKK 25,000,000

Funding source

The Novo Nordisk Foundation CO₂ Research Center (CORC)

Partners

Technical University of Denmark

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Timeline

2023 - 2028

TRL

2 → 5

Sectors

Cross sector

Green Twins

Data-driven digital twin platform to reduce CO₂ in industrial processes

Objective

Green Twins is a data-driven digital-twin platform aimed to virtually represent, optimise, and eventually control carbon capture in industrial processes and to minimise the associated energy cost. The project's emphasis is on digital-twin model development and the building of a digital-twin interface to handle data and perform control. For the duration of the project, one main (pre)industrial is envisioned: the digital twin of (defined parts of) the pilot plant for solvent-based capture of CO₂ from flue gas.

Approach

Three types of models are planned in the Green Twins project. The first model includes detailed computational fluid dynamics (CFD) models based on physical partial differential equations (PDEs). The second type of models include reduced, lumped models that simplify the detailed physical picture. The third type is full-scale plant models represented by flow diagrams in Matlab's Simulink (SimScape). These models use the above reduced models as physical inputs and can represent various virtual control scenarios. Once these controls are virtually executed, they will be put in the form of software executables to enable the driving of various active parts (pumps, valves) of the pilot plant.

Expected impact

The project is expected to inform operators of the plant - and of other carbon capture (industrial) units in the future - of the details of hidden dynamics of the carbon capture processes in the plant, enabling them to optimise CO₂ capture and related energy costs. In addition, the project creates new engineering jobs in the niche of green digital twins for CCUS. Finally, digital twins scale more easily than physical systems. Hence there is an opportunity for Denmark to export Green Twins rather than physical counterparts for carbon capture, with global impact.

Budget

DKK 10,820,342

Funding source

INNO-CCUS

Partners

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Timeline

2024 - 2026

TRL

3 → 7

Sectors

Cross sector

Hyper-CAP

Searching for new thermodynamic hydrate promoters to reduce the energy penalty of gas hydrate-based CO₂ capture technology

Objective

This project aims to develop an alternative carbon capture method using Gas Hydrate-Based CO₂ Capture (GHBCC) technology. The goal is to reduce the energy use of carbon capture by up to 50% compared to conventional methods. Unlike amine-based systems, GHBCC has the potential to reuse waste heat from flue gas, improving overall efficiency. To make this technology viable at scale, the project will explore ways to improve operating conditions through the use of chemical promoters. By overcoming current limitations, the research seeks to make GHBCC a more practical and cost-effective option for industrial carbon capture.

Approach

A major challenge in gas hydrate-based CO₂ capture is the high pressure typically required - around 100 bar - which limits its suitability for post-combustion use. Recent advancements have introduced chemical promoters that can reduce this pressure to 5-10 bar, improving process viability. This project focuses on finding a promoter that can lower the CO₂ capture pressure to below 5 bar while raising the operating temperature to 20-30°C. This would allow the process to make use of flue gas waste heat, reducing overall energy demand. A techno-economic assessment will also evaluate whether the process can be scaled up costeffectively for industrial applications.

Expected impact

If successful, the project will introduce a new promoter that allows CO₂ capture under milder conditions, significantly reducing energy requirements. It will also generate experimental data on hydrate formation under these conditions, providing a foundation for future studies on kinetics, reactor design, and process optimisation. By operating more efficiently and using available waste heat, GHBCC has the potential to become a cost-effective alternative to conventional capture technologies. The results will support continued development towards pilot-scale demonstration and contribute to broader decarbonisation efforts.

Budget

DKK 2,857,757

Funding source

The Novo Nordisk Foundation CO₂ Research Center (CORC)

Partners

Aarhus University

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Timeline

2023 - 2028

TRL

2 → 3

Sectors

Cross sector

ICaRUS

Integreret e-Kalcinering og CO₂-fangst ved brug af bæredygtig elektricitet.

Objective

The ICaRUS (Integrated e-Calcination and CO₂-Removal Utilizing Sustainable Electricity) project addresses the challenge of reducing CO₂ emissions from lime and cement production, which account for up to 8% of global CO₂ emissions. The project will build and demonstrate a 0.5 MW pilot system for electrified calcination with integrated CO₂ capture. The project aims to demonstrate an integrated process for electrified calcination with integrated CO₂ capture, replacing fossil-fuel combustion with renewable electricity.

Approach

The project includes engineering work on reactor and kiln design and will build and test a 0.5 MW pilot system between 2026 and 2028. The pilot system combines an e-UltraHeater, which provides high-temperature process heat, with a specially designed calciner (e-VerticalKiln). It aims to validate stable operation under industrial conditions, including temperatures above 1,200 °C, dust and cyclic loading. This proof of concept will confirm the technical feasibility of the solution and bring the technology significantly closer to deployment.

Expected impact

The process represents a radical innovation by electrifying a traditionally fossil fuel-based process while enabling the capture of pure CO₂ from the e-VerticalKiln. In addition, the e-UltraHeater enables direct integration with the electricity grid and dynamic operation to support the flexibility of renewable energy supply. Together, these technologies offer a solution with the potential to significantly reduce CO₂ emissions from one of the most difficult industrial sectors to decarbonise.

Budget

DKK 11,884,645

Funding source

The Energy Technology Development and Demonstration Programme (EUDP), Energy Cluster Denmark

Partners

ABB, Føns Transformers, Lhoist, Port of Aalborg, Aalborg University

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Timeline

2026 - 2028

TRL

4 → 6

Sectors

Cement industry

INNO-SALT

Innovative Strategies to Address Salt Precipitation in CO₂ storage

Objective

The injecting of large quantities of CO₂ into the subsurface can only be accomplished if the transmissivity of the near well environment does not severely degrade during the injection period. Due to the risk of salt clogging, one of the important phenomena to consider when supercritical CO₂ is injected through a high-saline aquifer is salt precipitation from the formation water. However, a lack of knowledge about the process renders unreliability the prediction of the phenomena, the interplay with fluid flow, the dependence on injection scenarios and the presence of impurities in the CO₂ stream unreliable. Therefore, this project aims to establish safe operational windows for the storage site operators, where injectivity is unhampered by the precipitation processes.

Approach

To establish safe operational windows, the project obtains real-time observations of the salt precipitation in experiments. This enables the definition of mechanistically sound, mathematical descriptions for how the processes unfold and finally simulate their impact during CCS for the Stenlille storage sites and injection scenarios, as well as the outcome of possible mitigation measures. The project leverages the experience of two highly esteemed laboratories: the DTU laboratory and the GEUS Core Analysis Laboratory.

Expected impact

By establishing safe operational windows, the project can advance CCS standardisation for formations in Stenlille and similar locations. This project's model deepens the understanding of salt precipitation's impact on injectivity. Its successful equipment and procedures could become industry standards for CO₂ storage optimisation. Finally, optimising onshore carbon storage facilities in Denmark expands storage capacity, which enables domestic and imported CO₂ storage as well as boosting the economy.

Budget

DKK 13,411,832

Funding source

INNO-CCUS

Partners

Gas storage Denmark, Geological Survey of Denmark and Greenland (GEUS), Technical University of Denmark

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Timeline

2023 - 2027

TRL

3 → 6-7

Sectors

Offshore storage

LegiRoad

LegiRoad

Objective

Despite Denmark's global leadership in green technologies, the deployment of Power-to-X (PtX), green fuels and carbon capture, utilisation and storage (CCUS) is slowed by fragmented governance, unclear liability rules, lengthy permitting and insufficient policy incentives. LegiRoad addresses these bottlenecks by mapping the policy landscape, identifying regulatory gaps and challenges, analysing regulatory impacts and co-creating regulatory innovations. The project aims to develop a co-created Policy Roadmap for Denmark.

Approach

The project takes a technological and social sciences approach coupling legal and critical pathways analyses with process innovation, co-creation workshops, and stakeholder engagement across the PtX and CCUS value chains (quadruple helix).

Expected impact

The project will deliver a co-created Policy Roadmap with actionable recommendations for national and municipal policymakers. The roadmap is intended to support earlier final investment decisions, faster deployment, strengthened competitiveness for Danish industry and stronger local support and societal acceptance. The Policy Roadmap complements the more technology-focused roadmaps of INNO-CCUS and MissionGreenFuels and supports Denmark's 2030 and 2050 climate targets, enhances societal readiness and strengthens Denmark's position as a frontrunner in green transition governance.

Budget

DKK 10,557,608

Funding source

Trace

Partners

Danish Institute of Fire and Security Technology (DBI), Danish Standards, FORCE Technology, Geological Survey of Denmark and Greenland (GEUS), Technical University of Denmark, University of Copenhagen

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Timeline

2026 - 2028

TRL

N/A

Sectors

Infrastructure

Offshore storage

Cross sector

Chemical industry

Construction

LOCASH

Local Carbon mineralisation in Volcanic Ash

Objective

A biogas facility with carbon capture is scheduled to begin operation in the Midtth Energy Zone in 2027. Based on geological and geophysical data, the area is also considered a suitable location for constructing Denmark's first major CO₂ mineralisation facility. LOCASH will investigate this potential and provide a comprehensive technological and societal foundation for a future mineralisation facility, demonstrating the potential of nature-inspired CO₂ mineralisation technology.

Approach

LOCASH will conduct test drilling up to 300 m to evaluate the geological potential for CO₂ mineralisation by analysing drill cores and performing pumping tests. The project will also prepare for a future CO₂ mineralisation facility through public surveys, stakeholder engagement, targeted communication with the public and authorities, local business development, and technological modelling and planning. LOCASH focuses on developing decentralised CO₂ storage for locally captured CO₂, eliminating the need for CO₂ liquefaction and transport while reducing associated costs and energy consumption.

Expected impact

LOCASH will help prepare the implementation of CO₂ mineralisation in Denmark by providing geological, technological and societal knowledge to support future deployment. Project outputs will include reports and scientific publications for the public, local and national authorities, including the Danish Energy Agency, and stakeholders across the Danish CCUS value chain. Through communication and public engagement, the project will increase awareness and understanding of CO₂ mineralisation. Together, these activities will help lay the groundwork for integrating small-to-medium-sized CO₂ capture with local CO₂ removal in Denmark.

Budget

DKK 15,123,370

Funding source

INNO-CCUS

Partners

Biogas Thy, Geological Survey of Denmark and Greenland (GEUS), Sunstones, The Carbon Removers, Thisted Municipality, Aarhus University

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Timeline

2026 - 2028

TRL

3 → 5

Sectors

Onshore storage

LoCo2

A journey from storage to seabed - impact of future large scale offshore CO₂ storage on the marine environment

Objective

The number of large-scale subsurface CO₂ storage sites is expected to increase considerably in the years to come. There will always be a risk (albeit small) of leakage from the underground stores to the seabed sediments. Other than CO₂, the leaking fluids may contain various impurities and accompanying formation fluids. Supported by VELUX FONDEN, project LoCo2 studies the (bio)chemical processes the leaking fluids go through in the leakage path and assesses the ecological effects of the fluids leaking to the seabed environment.

Approach

In combination with laboratory experiments, LoCo2 will utilise the previously generated data on the effects of CO₂ on life in seabed sediments to fill the gaps in the data. These will be used by a predictive tool that couples with Thermo-Hydro-bio-Chemical (THbC) models of the flow of contaminants from the storage reservoir through the overburden layers to the seabed sediments. The final predictive tools will be made freely available.

Expected impact

LoCo2 will be able to answer the following questions:

- What is the chemical composition of the fluids reaching the marine environment (that need to be monitored), considering (bio)chemical processes through the leakage path?
- What are the implications for monitoring methods?
- What is the fraction of leaked CO₂ retainable in the overburden?
- What are the likely impacts and their magnitude on life in the seabed in various possible leakage scenarios?

Budget

DKK 6,900,000

Funding source

Velux Fonden, Danish Offshore Technology Center

Partners

Danish Offshore Technology Center, Technical University of Denmark, TotalEnergies

Contact

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Timeline

2024 - 2028

TRL

2 → 5

Sectors

Offshore storage

LSICC

Large Scale Integration of Carbon Capture in Energy Systems

Objective

The aim of the project is to investigate the role of point source carbon capture and direct air carbon capture in the energy system. Point source capture of CO₂ plays an important role in both CCS and CCU, as it provides a higher concentration of CO₂ than is the case of direct air capture of CO₂. Additionally, the project will geographically locate the carbon capture units and how they relate to carbon point sources as well as district heating grids and electricity grids.

Approach

The technological performance of carbon capture will be considered in an energy system analysis. This will be supported by spatial analyses supporting the resource assessment and an assessment of economic impacts. By assessing scenarios for a decarbonised energy system in Denmark in 2045, these analyses will work with the potential of the technology by assessing the amount of CO₂ that can potentially be captured. Furthermore, the project will discuss the feasibility and compare the strategies of carbon capture through point source capture and direct air capture. Additionally, the analyses will work with an assessment of the demand for carbon, both for CCS and CCU.

Expected impact

The project will result in a strategy for carbon capture, highlighting the potential for the technology in terms of CO₂ but also in relation to CCS and CCU. The roadmap will be consolidated into recommendations for how carbon capture can efficiently be system integrated.

Budget

DKK 3,524,040

Funding source

INNO-CCUS

Partners

En2Save, Greenport North, Aalborg University

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Timeline

2022 - 2026

TRL

N/A

Sectors

Energy utility

MISSION-CCS

Material science innovation for accelerated, sustainable and safe implementation of carbon capture and storage

Objective

To adequately address CCS-related challenges and ensure safety and effectiveness around CCS-facilities, there is a need to develop capacity and capability of researchers and entrepreneurs. The aim of this project is to:

- Provide technical and professional training to foster world leading, industry ready experts, capable of delivering next generation solutions to CCS systems.
- Provide DCRs with subject-specific, inter-sectorial knowledge and innovation skills needed to accelerate the uptake of CCS technology.

Approach

The aims of the project will be achieved through a combination of extensive experimental research in leading international research centres and enriched mobility through secondments to industry partners at the forefront of CCS technology. Furthermore, wide-ranging workshops covering technical, professional, and transferrable skills will be held. The project will develop a comprehensive understanding of materials and solvent degradation mechanisms, new measurements, new test methods and innovative mitigation techniques. The outcomes will be exploited to increase the safety, sustainability, and cost-effectiveness of CCS. This will be conducted with strong industry input from industrial experts in every DCR supervisory team.

Expected impact

MISSION-CCS brings together high-quality professional development that reflects market requirements and helps address one of the key priorities in the EU Strategic Agenda 2019-2024. The project's aim is to develop new systems, approaches, and technologies for material degradation assessment in CCS combined with the exploration of innovative control strategies, and an appreciation of the associated techno-economics. This can pave the way in the application of material science in CCS to develop safe, optimum and sustainable performance for existing and future facilities, accelerating the CCS uptake, which is vital for a net-zero future.

Budget

DKK 21,849,000

Funding source

Horizon Europe

Partners

Alleima Tube, Baker Hughes Energy Transition LLC, Equinor, Global Solutions, Institute for Energy Technology, LBBC Baskerville, National Institute of Applied Sciences of Lyon, Norwegian University of Science and Technology, NPL Management, Oil and Gas Corrosion, Schlumberger Cambridge Research, Shell International, SINTEF, Technical University of Denmark, TotalEnergies, University of Leeds, Wood Group UK

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Timeline

2024 - 2028

TRL

N/A

Sectors

Cross sector

NEWCEMENT

CO₂ capture by oxyfuel combustion at cement plants

Objective

Oxy-fuel combustion, combustion in the presence of oxygen rather than atmospheric air, stands as a promising carbon capture technology to significantly reduce CO₂ emissions from cement production. However, further investigations and demonstration activities are required to mature the oxy-fuel cement process. Thus, the aim of the project is to

- Mature oxyfuel cement plant technology for full-scale testing.
- Develop an oxyfuel pilot calcination reactor.
- Create digitalisation technologies for CO₂ emission-free cement production.

Approach

In the first part of the project, the business viability of developments will be validated and benchmarked against competing solutions. In the second part, an oxyfuel pilot will be developed to analyse the gas stream to gauge CO₂ separation ease and purity. Additionally, it will be analysed, how temperature uniformity influences calcination in the oxyfuel process, and how fuel-to-oxygen ratio impact product quality. In the third part, the project focuses on process simulation to optimise the oxyfuel cement plant layout, including preheating integration. This includes studying the effects of high CO₂ levels on calcination, the influence of oxyfuel conditions on volatile elements, and CO₂ flue gas recirculation. Lastly, the effects of CCUS on the supply chain are analysed to ensure a cost-effective, net-zero carbon energy supply and cement production.

Expected impact

Cement is a significant global industry, accounting for approx. 8% of current global CO₂ emissions. By developing oxyfuel cement technology, the project has potential to contribute to large global CO₂ reductions. The project is expected to obtain a fully integrated pilot plant, process knowledge, new design tools and a technical layout, including techno-economic documentation. This information will pave the way for the first large-scale industrial unit and accelerate the decarbonisation of the cement sector. The technology may also provide a basis for the market possibility of upgrading CO₂ from cement plants to e.g., methanol.

Budget

DKK 11,363,590

Funding source

INNO-CCUS

Partners

Danish Technological Institute, FLSmidth, Lhoist, Technical University of Denmark

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Timeline

2022 - 2026

TRL

2 → 6

Sectors

Cement industry

OMGCCS

optimised Monitoring of Ground- and surface waters for CCS

Objective

High-quality and yet cost-effective monitoring of the ground- and surface water above Geological CO₂ storage is needed to lower long-term monitoring cost and mitigate the public concern for effects on ground- and surface water. This can be obtained by combining a) modelled leakage from the geological CO₂ storage with b) release rates of specific parameters from local geological formations in contact with CO₂ - in reactive transport models for the ground- and surface waters, to enable the optimisation of the monitoring network and the monitoring frequencies in monitoring wells and possibly volume integrating water supply wells and surface water. Further cost reductions and long-term monitoring consistency can be obtained by applying Machine Learning techniques.

Approach

A numerical model for CO₂ and brine leakage via faults and legacy wells is constructed. Kinetic models for parameters release from site sediments are derived from lab tests and upscaled through field tests. A detailed hydrostratigraphic model of the ground and surface water is set up for modelling reactive transport of the release parameters. Leakage from the CO₂ storage is introduced into the ground and surface water model at the modelled locations and with the calculated fluxes. The model results are then used to optimise the positioning of the monitoring network for cost and detection efficiency. Existing data, new monitoring data and model data with anomalies are used to train an ever-alert Machine Learning model for consistently flagging anomalies far into the future.

Expected impact

A methodology for cost-efficient long-term monitoring of ground- and surface water that could become a regulatory standard replacing the current imprecise requirements. Standard or not - a methodology that can be applied by consultancies enabling them to offer consistent, high quality, low cost, long-term monitoring operations.

Budget

DKK 7,502,380

Funding source

INNO-CCUS

Partners

Equinor, Geological Survey of Denmark and Greenland (GEUS)

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Timeline

2026 - 2029

TRL

3 → 6

Sectors

Offshore storage

OptiCap AI

Optimizing CO₂ capture from diverse sources with flexible AI-driven digital twin

Objective

Accurate process models are essential for optimising CO₂ capture processes, but existing models can be slow to calibrate and difficult to adapt to different capture technologies. OptiCap AI aims to develop the first open-architecture, physics-based digital twin for CO₂ capture. The digital twin uses artificial intelligence (AI) to calibrate the model with process data, enabling more efficient CO₂ capture. Combining rigorous first-principles models with physically constrained AI is expected to reduce energy use and the cost of CO₂ capture by 10-15%, while de-risking scale-up across emission sources and process concepts. By embedding dynamic simulation, uncertainty propagation and sensitivity analysis, the project will identify the parameters that have the greatest influence on cost and risk, supporting engineering and investment decisions.

Approach

OptiCap AI combines two complementary developments. First, it develops physically constrained AI calibration using grey-box parameters that honour mass and energy balances when fitting the digital twin to plant data, reducing months of manual tuning to hours. Second, it develops an open, high-fidelity digital twin in Julia/SciML, integrating Q-props electrolyte thermodynamics to accurately and efficiently model different solvents and flue gas compositions. Together, these developments address key bottlenecks in CO₂ capture modelling, including slow model calibration, limited solvent coverage and opaque black-box digital twins. The approach will be demonstrated across three real-world capture processes (power generation, biogas production and photo-electrochemical direct air capture (DAC)), as well as through a world-first process-level solvent screening demonstration and system analyses evaluating uncertainty and sensitivity for next-generation techno-economic and life-cycle assessments.

Expected impact

Expected impacts include 10-15% energy savings for post-combustion capture and biogas production. This could unlock approximately 1 Mt CO₂/year of additional economically viable capture from Denmark's estimated 10.5 Mt/year point-source potential. The project will also support de-risked scale-up, faster troubleshooting and modelling of novel solvents and process concepts, including photo-electrochemical DAC. An MIT-licensed Julia core will be released for public beta in 2029, allowing Danish emitters and engineering, procurement and construction (EPC) companies to test OptiCap AI.

Budget

DKK 11,948,115

Funding source

INNO-CCUS

Partners

BioCiro Group, Hafnium Labs, Stichting PDC Research Foundation, Technical University of Denmark

Contact

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Timeline

2026 - 2029

TRL

4 → 7

Sectors

Cross sector

Optimizing Europe's CO₂ transport

Optimizing Europe's CO₂ transport

Objective

The collaborative study by the Clean Air Task Force (CATF) and the Technical University of Denmark aims to model and optimise a cost-effective, multi-modal European CO₂ transport and storage network from 2028 to 2050. The project investigates how a coordinated, forward-looking pan-European infrastructure integrating pipelines with flexible transport modalities, such as rail, shipping, barges and trucks, can reduce the systemic costs of carbon capture and storage (CCS) compared with fragmented, reactive expansions. By incorporating advanced logistics and cross-border storage sites, the study aims to identify network bottlenecks and opportunities to improve the cost-efficiency and capacity of future European CCS infrastructure.

Approach

The project's methodology maps European industrial emitters against 50 gigatonnes of geological storage capacity using the Python-based PyCCSNet software. This data is integrated across distinct modelling phases that establish initial connectivity, assign multi-modal transport methods under real-world technical constraints, optimise flow sizes based on annual emissions and calculate energy consumption. To determine the most efficient network, the framework uses Pyomo to minimise network length via Mixed Integer Linear Programming (MILP) or minimise pipeline capital costs through Mixed Integer Nonlinear Programming (MINLP). Ultimately, this design simulates complex logistics and intermediate hubs to identify the lowest-cost infrastructure scale-up pathway under six deployment constraints.

Expected impact

The primary deliverables of the project will be a comprehensive report and an analytical slide deck mapping viable European network configurations and providing clear economic comparisons across all simulated scenarios. Beyond these immediate outputs, the study's broader impact lies in its potential to guide strategic infrastructure investments and policy decisions for European decarbonisation. By establishing priority infrastructure corridors and demonstrating the value of cross-border cooperation, the findings aim to de-risk future capital investments, connect hard-to-abate industries to optimal storage basins and accelerate the commercial, scalable deployment of CCS across the continent.

Budget

DKK 313,000

Funding source

Clean Air Task Force (CATF)

Partners

Clean Air Task Force, Simulcade

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Timeline

2026 - 2028

TRL

6 → 8

Sectors

Infrastructure

Offshore storage

Waste-to-energy

Cement industry

Chemical industry

Onshore storage

Cross sector

PAoCCUS

Public acceptance of CCUS

Objective

Practical deployment of CCUS rests on both acceptance and demand for the technologies and their associated products. Detailed information on consumers' willingness to accept and pay for CCUS technologies and products will help gear the green energy transition. The aim of the project is to investigate the factors deciding public acceptance and legitimacy in the placement of far-shore, near-shore and Onshore CCUS and related infrastructure.

Approach

Several approaches will be incorporated and triangulated to investigate public acceptance of carbon storage. Economic and behavioral research will be applied to understand the occurrence of conflict situations. Furthermore, the project will investigate the general public's perception of carbon storage and how this can be affected through targeted information. This project will build on surveys, focus group interviews, data collection, and the estimation of acceptance and preference relations for diverse types of CCUS technologies. The survey will use a CE/CVM to elicit the preference for the use and location of carbon storage facilities. Through case studies, the project will enhance the understanding of involvement processes to ensure legitimacy in decisions regarding carbon storage.

Expected impact

The project will contribute with a better understanding of how to secure public acceptance of carbon storage both in terms of choosing the right location, communicating effectively about risks and benefits and by outlining optimal processes for citizen involvement to ensure legitimacy. As public acceptance is a prerequisite for successful carbon storage projects in Denmark, the impact of this project is of immense importance to realise CO₂ emission reductions.

Budget

DKK 5,119,999

Funding source

INNO-CCUS

Partners

Copenhagen Business School, Technical University of Denmark, Aalborg University

Contact

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Timeline

2023 - 2026

TRL

N/A

Sectors

Cross sector

Plastics to Capture

Carbon capture by waste plastic upcycling

Objective

The continued accumulation of non-biodegradable plastics and textiles represents a major environmental challenge. At the same time, large-scale deployment of carbon capture technologies will require abundant and affordable sorbent materials. This project explores the conversion of waste plastics into high-performance CO₂ capture materials, creating value from existing plastic waste streams while potentially reducing the cost and resource demands of carbon capture.

The research focuses on developing chemical routes for transforming post-consumer plastics into functional CO₂ sorbents. In addition to evaluating capture performance and stability, the project examines whether waste-derived sorbents can provide a more resource-efficient and economically competitive alternative to conventionally manufactured capture materials.

Approach

The project investigates the catalytic transformation of diverse waste plastics, including polystyrene, polyethylene, polypropylene, polyethylene terephthalate (PET), acrylonitrile-based plastics, and rubber products, into functional CO₂ sorbents. Different conversion strategies are developed and optimised to account for the varying chemical structures of the waste streams.

Early work demonstrated successful conversion of polyacrylonitrile and PET-based plastics into high-performing sorbents, and this approach has since been expanded to mixed plastic, rubber, and textile waste streams. Current activities focus on improving synthesis routes, reducing catalyst and processing costs, and validating sorbent performance under realistic capture conditions.

Expected impact

The project will establish new pathways for converting widely available plastic waste into valuable carbon capture materials. Several waste-derived sorbents have already demonstrated high CO₂ uptake and stability, including materials with capacities of up to 15 wt% under ambient conditions. Future work will improve the durability and oxidative stability of waste-based sorbents while developing more efficient methods for processing capture materials for large-scale applications. By reducing material costs and advancing towards pilot-scale demonstration, the project aims to contribute to the development of low-cost carbon capture technologies while simultaneously supporting more circular use of plastic waste resources.

Budget

DKK 37,600,000

Funding source

The Novo Nordisk Foundation CO₂ Research Center (CORC)

Partners

University of Copenhagen, Aarhus University

Contact

Troels Skrydstrup, ts@chem.au.dk
& Jiwoong Lee, jiwoong.lee@chem.ku.dk

Timeline

2024 - 2028

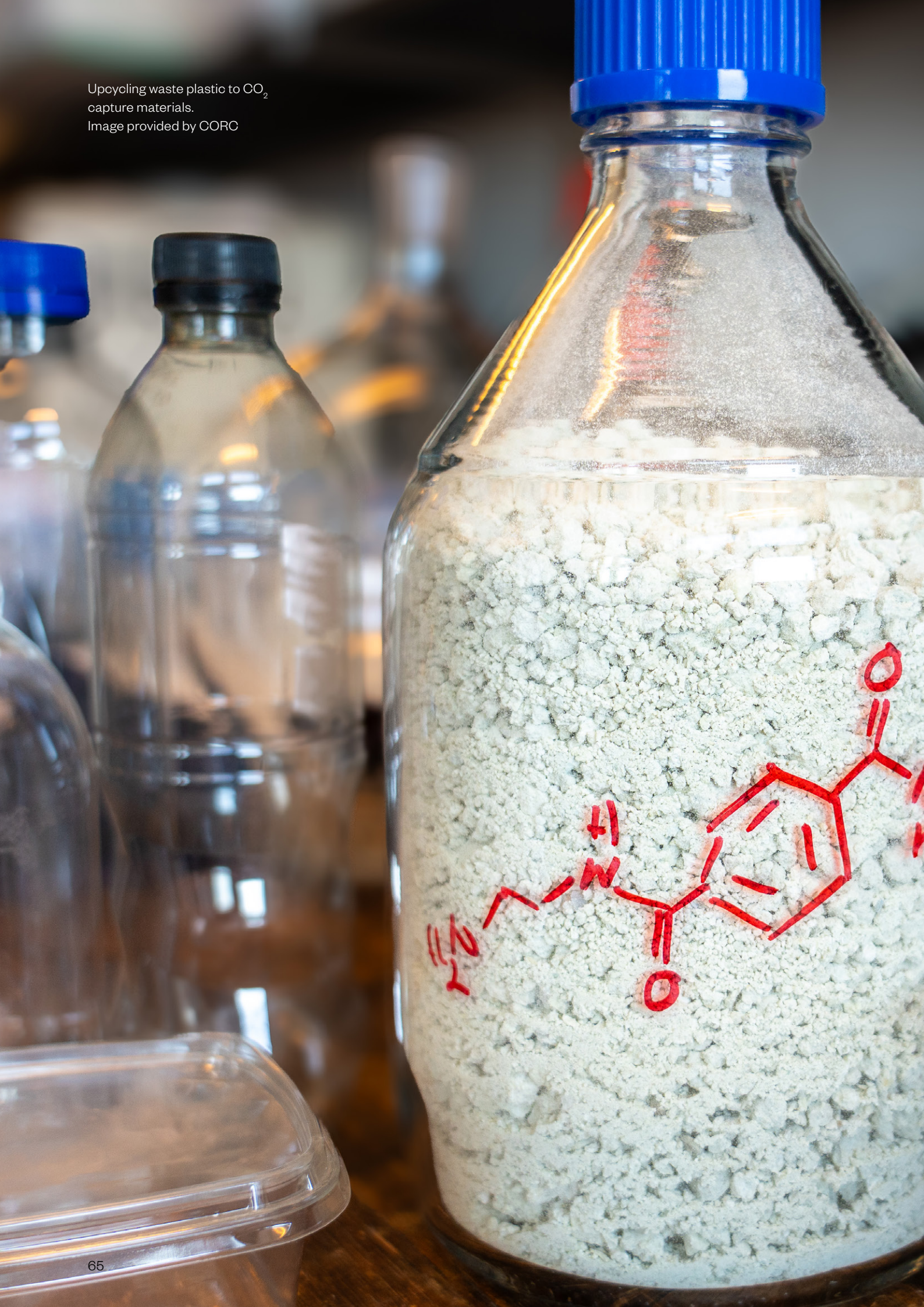
TRL

3 → 6

Sectors

Chemical industry

Upcycling waste plastic to CO₂
capture materials.
Image provided by CORC



PluriCarb

Transnational Carbon Governance: Legal Pluralism and Cross-Border CCS Regulation in the North Sea

Objective

PluriCarb addresses the growing problem of regulatory fragmentation and definitional inconsistency in cross-border carbon capture and storage (CCS) governance in the EU/EEA, particularly in the North Sea region. These inconsistencies undermine legal coherence, create uncertainty for policymakers and industry, and risk weakening the legitimacy and effectiveness of climate governance. The project's main objective is to analyse how overlapping regulatory frameworks such as the EU Emissions Trading System, Carbon Border Adjustment Mechanism, Net Zero Industry Act, and CCS Directive interact and conflict, and how actors navigate these complexities in practice. Combining comparative legal analysis, an original analytical framework, and empirical case studies enables PluriCarb to generate evidence-based recommendations to support more coherent, adaptive, and effective CCS governance across jurisdictions.

Approach

PluriCarb takes an integrated approach combining legal analysis with real-world insights from CCS projects. It brings together EU-level regulation, national implementation, and stakeholder perspectives to understand how cross-border governance works in practice. The project identifies where inconsistencies arise and how they are managed on the ground by linking legal texts with empirical evidence from key North Sea projects. The approach is designed to move beyond purely theoretical analysis and provide solutions that reflect the needs of regulators, industry actors, and other stakeholders working within complex regulatory environments.

Expected impact

Regulatory uncertainty is one of the main bottlenecks for scaling up cross-border CCS projects in Europe. Through clarifying how overlapping rules interact in practice, PluriCarb will help reduce legal ambiguity for regulators and industry. This contributes to more predictable and efficient project development, supporting the deployment of CCS infrastructure in the EU/EEA. The project will deliver concrete policy recommendations for EU institutions and national authorities, alongside accessible outputs such as policy briefs and stakeholder workshops. By improving regulatory coherence, PluriCarb aims to strengthen the reliability and legitimacy of CCS as a climate mitigation tool, helping to accelerate progress towards EU climate targets.

Budget

DKK 1,965,000

Funding source

Horizon Europe

Partners

University of Copenhagen

Contact

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Timeline

2026 - 2028

TRL

N/A

Sectors

Offshore storage

Onshore storage

SEAL

Seabed Environmental Analyzer for CO₂ and CH₄ Leakage

Objective

All CO₂ storage projects require monitoring to ensure containment in accordance with regulations. Notably, there is currently a lack of sensors capable of detecting CO₂ and CH₄ leaks in the water column in a cost-effective and reliable manner. Existing solutions are either too expensive or unsuitable for periodic deep-sea assessments. This project builds on the Danish Offshore Technology Centre's validated carbon dioxide and methane sensor to develop an autonomous, field-ready prototype capable of real-time data collection at up to 10 bar hydrostatic pressure. By integrating it with a seabed monitoring system, the project aims to enable efficient, periodic carbon dioxide and methane monitoring. The ability to measure CO₂ gives the sensor strong potential for future carbon storage site monitoring.

Approach

The project consists of four work packages: 1) Sensor manufacturing, 2) Hardware prototype design, 3) Software/data processing, 4) Offshore demonstration. The sensor will integrate with an ROV system, incorporating a single-board computer, quartz crystal microbalance electronics, and a pressure-rated enclosure. A fluidics system will ensure controlled water flow and a rapid response time. Initial testing will occur in a lab, followed by offshore pilot demonstrations to assess signal stability, the impact of seabed turbulence, and sensor integration with location, pressure, and temperature data.

Expected impact

The project will deliver a carbon dioxide and methane sensor system tested under offshore conditions and ready for market deployment. It will support cost-effective, periodic monitoring of decommissioned oil and gas fields, aligning with EU regulations. By enabling routine carbon dioxide and methane leak detection, the sensor developed in the project contributes to environmental protection and regulatory compliance. Additionally, by extending its application to carbon storage monitoring, the project positions its partners at the forefront of subsea gas monitoring technology.

Budget

DKK 8,200,000

Funding source

Energy Technology Development and Demonstration Programme (EUDP)

Partners

BlueNord, Danish Offshore Technology Center, Danish Technological Institute, Nordsøenheden, PoreSense I/S, Technical University of Denmark, Technical University of Denmark, TotalEnergies

Contact

Kristine Wille Hilstrøm, krihil@dtu.dk

Timeline

2025 - 2027

TRL

7

Sectors

Offshore storage

Project Greensand

Paving the way for mitigating climate change with CCS

Objective

The project aims to prove that depleted oil and gas reservoirs in the Danish North Sea can be utilised for safe, long-term carbon storage. The project is currently in the pilot phase where it is being developed, tested and demonstrated. The aim is to prove that Paleocene-Eocene sands in depleted oil and gas reservoirs in Danish North Sea can be utilised for long-term safe CO₂ storage and developing new ways to monitor offshore. The project also tests the effects of 'cyclic CO₂ injection' to emulate transport of CO₂ by ship and assess the suitability of storage sites with no access to pipeline.

Approach

Storage of CO₂ in depleted hydrocarbon reservoirs is a cost-effective option and can be implemented in 3-5 years. Project Greensand aims to provide the necessary insight for subsequent storage of up to 1,5 million tonnes of CO₂ per year in 2025/2026 in the Nini Field in Danish North Sea. By the year 2030 Project Greensand aim to safely capture and permanently store up to 8 million tonnes of CO₂ per year. With the event "First Carbon storage" Project Greensand Phase celebrated the worlds first cross-border offshore CO₂ storage intended to mitigate climate change. The Project Greensand consortium consists of 23 Danish and international partners who contribute with expertise from capture, transportation, storage, and monitoring of CO₂ in the subsoil. They have delivered the required technical documentation and reports to prepare for a CO₂ storage Site Permit Application by 2024.

Expected impact

The project has not only proved the technology's functionality but has also significantly boosted public acceptance of CCS. This was evident during the First Carbon storage event in Esbjerg on 8th March 2023, where His Royal Highness, Crown Prince Frederik of Denmark, officially initiated the success fully first storage of CO₂ in the North Sea alongside a video speech from the President of the European Commission, Ursula von der Leyen. The full-scale project will be initiated to allow storage in 2025/2026. The pilot will move the CO₂ storage in the Nini Field from its current TRL 5 to TRL 8 in 24 months. It is a challenging an ambitious timeline, but paramount for Denmark to meet the 2030 Climate Target, as well as the 50-54% midway target.

Budget

DKK 438,000,000

Funding source

The Energy Technology Development and Demonstration Programme (EUDP)

Partners

Aker Carbon Capture, Blue Water Shipping, Danish Hydraulic Institute, Danish Technological Institute, Dan-unity CO₂, Energy Cluster Denmark, Esvagt, Geelmuyden Kiese, Geological Survey of Denmark and Greenland (GEUS), INEOS, National Oceanography Centre, Noble, Rambøll, Resen Waves, Semco Maritime, Spotlight, Technical University of Denmark, TGS, University of Southampton, Welltec, Wind Power Lab, Wintershall Dea

Contact

Søren Reinhold Poulsen, soeren.reinhold.poulsen@ineos.com

Timeline

2022 - 2030

TRL

5 → 8

Sectors

Offshore storage



Depleted oil and gas reservoir in
the north sea being utilised for
CO₂ storage.
Photo: Project Greensand

Solution-space for CCU technologies

Identifying Viable Pathways for CO₂ capture and conversion in renewable energy systems

Objective

Many carbon capture and utilisation technologies demonstrate promising performance at laboratory scale, but their ultimate climate impact depends on interaction with broader energy, transport, and industrial systems. This collection of projects investigates the system-level conditions under which CO₂ capture and conversion technologies can contribute to decarbonisation.

Technology performance cannot be evaluated in isolation. Instead, cost, energy demand, resource availability, and infrastructure requirements must be considered simultaneously to identify where emerging technologies can deliver meaningful climate benefits.

Approach

The research combines high-resolution energy system modelling with scenario analysis of European decarbonisation pathways. Focus is placed on interactions between carbon capture technologies, renewable electricity generation, hydrogen infrastructure, biomass resources, and transport systems.

Expansion of the PyPSA-Eur modelling framework enables more detailed assessment of cost-optimal transition pathways and evaluation of how technology performance influences system-wide outcomes. By exploring multiple future scenarios, the work identifies the conditions under which different carbon capture, utilisation and storage (CCUS) become competitive and scalable.

Expected impact

The project will establish quantitative boundary conditions for the deployment of emerging carbon capture and utilisation (CCU) technologies. Modelling results reveal how variations in technology cost, efficiency, and resource requirements influence competitiveness within future low-carbon energy systems.

An important outcome is the identification of “feasibility spaces” that define the ranges of performance required for successful implementation. These results provide technology developers with quantitative targets for cost, energy efficiency, and deployment scale, helping to guide research and innovation towards solutions with the greatest potential for system-wide climate impact.

Budget

DKK 10,500,000

Funding source

The Novo Nordisk Foundation CO₂ Research Center (CORC)

Partners

Technical University of Denmark

Contact

Marta Victoria, mvipe@DTU.dk

Timeline

2023 - 2028

TRL

2 → 5

Sectors

Cross sector

Energy utility

SSCC

Small-Scale Carbon Capturing System for Decentralized CO₂ Point Sources

Objective

The project focuses on improving carbon capture solutions for small-scale, decentralised CO₂ sources - particularly those linked to agricultural biogas plants. It will demonstrate a fully integrated and automated carbon capture system in a real operational setting (TRL 7), capturing CO₂ from biogas combustion at the Greenfarm plant at Gråsten Agricultural School. The aim is to reduce CO₂ emissions and support the circular economy by enabling the conversion of biogenic CO₂ into e-fuels.

Approach

The project brings together partners covering the full carbon capture value chain—from technology development and testing, to real-world application and infrastructure support. The project's innovative strength lies in its pioneering approach to decentralise carbon capture technology for point source emissions, enabling decarbonisation of hard-to-abate sectors like agriculture. A decentralised approach also opens up opportunities for smaller players such as farmers to participate in the carbon credit market by offering a biogenic CO₂ solution that is integrated with their facility. To enable capture in small-scale post-combustion systems, the project will evaluate temperature swing adsorption (TSA) using metal-organic frameworks (MOFs) - a material known for its strong CO₂ uptake, easy regeneration, and operational stability.

Expected impact

Aligned with Danish energy policy objectives, this project Tags contributes to reducing dependence on fossil fuels and Point source capture supports the circular economy by enabling the sustainable reuse of biogenic CO₂. As a result, the project will deliver a CO₂ capture technology that is effective, energy-efficient, Process technology cost-competitive, scalable, regulation-compliant, and has minimal environmental impact.

Budget

DKK 28,858,558

Funding source

The Energy Technology Development and Demonstration Programme (EUDP), Green Labs DK programme (GLDK)

Partners

Center Completions, Esbjerg Havn, Greenfarm, SINEF, Technical University of Denmark, Welltec, Aalborg University

Contact

Lia Khasanova, lkhasanova@welltec.com

Timeline

2024 - 2026

TRL

4 → 7

Sectors

Biogas

THERMOCO2WELL

Risk assessment of the CO₂ injection well damage due to thermal stresses

Objective

CO₂ injection in the subsurface can experience intermittent behaviour during the well start-up/shut-in, due to fluctuations in CO₂ supply, or due to undesired events. The aim of the project is to tailor a numerical simulation model which will consider single- and multiphase mixtures of CO₂ and CO₂-rich mixtures in well configurations, including friction and heat transfer. To account for the induced thermal stresses in the cement and the reservoir, the model will be coupled to geomechanical simulators.

Approach

The first key milestone is to deliver a first version of a standalone software tool. This will allow for offline forecasts of the anticipated pressure and temperature profiles along the well, and the associated thermal stresses in the near-wellbore area. Based on iterations between the project team, the simulator will be loosely coupled with a geomechanical simulator. The planned functionality will include elaborate formulation of the geomechanical simulator, results of the calibration on the field data from Stenlille, and a GUI/web interface. Ultimately, the project will provide an assessment of the impact of thermal stresses on wellbore integrity, near-wellbore stability, and reservoir and caprock behaviour.

Expected impact

The project is addressing one of the key challenges of the CCUS Roadmap by INNO-CCUS, namely the maturation and de-risking of large potential storage sites. Choosing the right design of a well is key to mitigating some of the risks concerning well integrity. To be able to do this, it is necessary to know the environment around the well in detail. The results of this project are, therefore, crucial in the preparation for a CO₂-pilot in Stenlille, which has the potential to accelerate the implementation of full-scale CCS in Denmark. The methods and tools developed in this project can be generalised to usage for other storage sites. Therefore, this project has the potential to significantly improve the economic and societal benefits of storage.

Budget

DKK 3,021,940

Funding source

INNO-CCUS

Partners

Gas storage Denmark, Geological Survey of Denmark and Greenland (GEUS), Technical University of Denmark

Contact

Nikolai Adrianov, nia@geus.dk

Timeline

2023 - 2026

TRL

3 → 5

Sectors

Offshore storage

VALGREEN

VALidation of GREENhous gas emissions removal at gråsteN teglværk

Objective

Brick production is a hard-to-abate sector. From 2025, new buildings must emit far less CO₂ to comply with national climate regulations. Traditional brick production emits around 177 kg CO₂/ton, primarily due to natural gas firing, making compliance difficult without a fundamentally new approach. The VALGREEN project develops CO₂ capture technology tailored to brick production, enabling the production of low-emission bricks while advancing scalable, energy-efficient CO₂ capture solutions for hard-to-abate industries.

Approach

The VALGREEN project develops and demonstrates CO₂ capture technology designed specifically for brick production. The aim is to capture CO₂ directly from the brick kiln's exhaust without compromising the brick's well-known strength, durability or aesthetic value.

Expected impact

The project aims to produce bricks with close-to-zero emissions and a verified environmental profile (Environmental Product Declaration (EPD) below 10 kg CO₂/ton), while reducing the energy required for CO₂ capture to 1.95 GJ/ton through heat pumps, smart control and next-generation solvents. The project will also assess the overall economic and societal value of the solution. By creating value through a finished product rather than the captured CO₂ itself, the technology is intended to become an economically attractive solution for sustainable construction and be relevant for other hard-to-abate industries.

Budget

DKK 50,640,000

Funding source

The Energy Technology Development and Demonstration Programme (EUDP)

Partners

CYBERNETICA, FOROE Technology, Gråsten Tegl, Pentair, Ramboll, Technical University of Denmark, Topsoe

Contact

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Timeline

2025 - 2028

TRL

5 → 8

Sectors

Construction

Completed projects

4D observation - In-situ 4D observation of chalk modification during CO₂ injection

The project combines experiments and modelling at different scales to assess the feasibility of injecting CO₂ in chalk reservoirs from the Danish Underground Consortium Area in the North Sea. In doing so, the project aims to answer the following questions: a) Will dissolution occur during CO₂ injection in DUC sector chalk at reservoir conditions? b) Will this lead to the collapse of the pore network? c) What effect will it have on injectivity and storage capacity? d) Can substantial flow of CO₂-saturated brine occur in fracture networks driven by density differences, and with what consequences?

Budget: DKK 2,300,000

Funding sources: Danish Offshore Technology Center

Partners: Danish Offshore Technology Center, Geological Survey of Denmark and Greenland (GEUS), Technical University of Denmark

Contact: Hamid Nick, Charlotte N. Larsen, hamid@dtu.dk, clarsen@dtu.dk

Timeline: 2022 - 2024

TRL: 2 → 4

Focus area(s): Geological storage

CCCH2 - Combined carbon capture and hydrogen production

The project will develop a new carbon capture technology based on electrochemical regeneration of the solvent combined with hydrogen production. Key objectives include scaling up the technology from pilot scale to a demonstration scale of several hundred kg CO₂/h removal from flue gas. The project will demonstrate the reliability and robustness of the technology, making it ready for commercialisation. Upon successful demonstration, the technology will be matured for full-scale plant implementation.

Budget: DKK 33,640,000

Funding sources: CO2Vision - REACT-EU

Partners: Danish Gas Technology Centre, ESTECH, PureteQ, Technical University of Denmark, VandCenter Syd

Contact: Søren Gert Larsen, sgl@estech.dk

Timeline: 2022 - 2024

TRL: 8 →

Focus area(s): Point source capture

Cement durability - Experimental and numerical studies of microstructure and durability for cement

A significant number of wells are planned to be permanently plugged and abandoned in the upcoming decades and some of these wells will either be re-used for CO₂ injection or will be legacy wells for a CO₂ storage project. An important aspect of abandonment is ensuring long term well integrity after abandonment. The aim of this project is, therefore, to explore the key parameters that determine the durability and permeability of cement paste that is used as barrier material in a typical offshore well including the effect of stored CO₂.

Budget: DKK 4,700,000

Funding sources: Danish Offshore Technology Center

Partners: Danish Offshore Technology Center, Technical University of Denmark, Aarhus University

Contact: Wolfgang Kunther, Charlotte N. Larsen, wolku@dtu.dk, clarsen@dtu.dk

Timeline: 2021 - 2024

TRL: 3 → 4

Focus area(s): Geological storage

CeMetCorr / ML-CorrModel - Investigation of cement-metal barrier performance and machine learning based corrosion prediction model for CO₂ storage applications

When injecting CO₂ in an existing oil and gas reservoir the legacy wells are the main risks for future leakage. It is important to understand how the legacy well barriers will behave over time. The casing/cement interphase at the top of the reservoir will be exposed to the CO₂ and this project is looking into the potential degradation of the cement/metal interface under CO₂ storage conditions. In addition, a data driven machine learning based model will be built for CO₂ storage related corrosion prediction, based on empirical data. The model will include parameters such as material aspects and exposure condition variations in relation to CO₂ storage.

Budget: DKK 5,200,000

Funding sources: Danish Offshore Technology Center

Partners: Danish Offshore Technology Center, Technical University of Denmark, Aarhus University

Contact: Rajan Ambat, ram@mek.dtu.dk

Timeline: 2022 - 2024

TRL: 3 → 6

Focus area(s): Geological storage

CO₂ Corr - Investigation of corrosion issues and developing empirical prediction model

Non-producing oil and gas wells have great potential to be used as medium for CO₂ injection and storage. Large volume of CO₂ can be injected and stored in the depleted reservoirs. However, injection and storage of CO₂ in existing wells also introduce several challenges, such as the corrosion of the tubing. The objective of CO₂ Corr is to investigate these issues specifically in connection with the purpose of CO₂ injection and storage. Meanwhile the project will develop an empirical model for predicting the corrosion level based on sequence of operational parameters.

Budget: DKK 3,500,000

Funding sources: Danish Offshore Technology Center

Partners: Danish Offshore Technology Center, IKM Ocean Team, Technical University of Denmark

Contact: Rajan Ambat, ram@mek.dtu.dk

Timeline: 2021 - 2024

TRL: 2 → 5

Focus area(s): Geological storage

CO₂ injection in chalk - De-risking CO₂ injection and storage in chalk

CO₂ flooding in chalk under different in-situ conditions have been conducted to characterise the response of chalk to CO₂ injection under various reservoir conditions. The aim of this project is to understand the impact of CO₂ injection on the flow and geomechanical behaviour of chalk.

Budget: DKK 2,000,000

Funding sources: Danish Offshore Technology Center

Partners: Danish Offshore Technology Center

Contact: Hamid Nick, Charlotte N. Larsen, hamid@dtu.dk, clarsen@dtu.dk

Timeline: 2022 - 2024

TRL: 2 → 4

Focus area(s): Geological storage

CO₂ Seal Integrity - Shale as a barrier

The CO₂ Seal Integrity project aims at securing long-term well barrier seal integrity for CO₂ storage sites in North Sea Oilfields. The project investigates mechanisms to promote expansion of natural occurring clays/shales to create a lasting seal and prevent CO₂ leakage. Due to their low permeability, shales naturally provide a seal to the subsurface for the lifetime of the storage site and over geological time.

Budget: DKK 2,400,000

Funding sources: Danish Offshore Technology Center

Partners: Danish Offshore Technology Center, Technical University of Denmark

Contact: Irene Rocchi, Charlotte N. Larsen, ireroc@dtu.dk, clarsen@dtu.dk

Timeline: 2022 - 2024

TRL: 3 → 5

Focus area(s): Geological storage

CO₂ Impure - Effects of impurities on CO₂ storage in chalk reservoirs

This project focuses on CO₂ that contains varying degrees of impurities and how they affect storage scenarios. The aim of this project is to contribute to the de-risking of storage of impure CO₂ in chalk reservoirs. Furthermore, the project will identify the geochemical effects of high concentration impurities and limitations of low purity CO₂ sources on storage.

Budget: DKK 3,400,000

Funding sources: Danish Offshore Technology Center

Partners: Danish Offshore Technology Center

Contact: Hamid Nick, Charlotte N. Larsen, hamid@dtu.dk, clarsen@dtu.dk

Timeline: 2023 - 2024

TRL: 2 → 3

Focus area(s): Geological storage

CO₂ RESHC - Evaluation of residual hydrocarbons effect on CO₂ injectivity in depleted chalk reservoirs

The study examines the effect of residual hydrocarbons in non-flooded and water-flooded chalk reservoirs on supercritical (sc) CO₂ injectivity. This will be achieved through characterisation of the residual hydrocarbons in core and cuttings samples from the Maastrichtian chalk reservoir of the Halfdan and Dan chalk fields. The project will in detail investigate the distribution of residual oil fractions in the reservoir, and the effect of the residual hydrocarbons in non-flooded and water-flooded chalk reservoirs on scCO₂ injectivity. The project will help de-risk depleted oil field CO₂ storage sites.

Budget: DKK 4,288,530

Funding sources: INNO-CCUS

Partners: Geological Survey of Denmark and Greenland (GEUS), TotalEnergies, Aarhus University

Contact: Henrik Ingermann Petersen, hip@geus.dk

Timeline: 2022 - 2025

TRL: 3 → 5

Focus area(s): Geological storage

COLLATE - IKM CCUS test center

IKM Group have been designing, building, and utilising unique CO₂ processing equipment for more than 10 years and has been actively involved in CCUS development projects since 2019. The overall mission is to strengthen the upscaling, maturation, and commercialisation of CCUS on a global scale. Through partnerships and collaborations, IKM aims to bridge technical knowledge gaps, educate and train needed personnel, conduct risk assessments and much more.

Budget: DKK 20,110,000

Funding sources: Energy Technology Development and Demonstration Programme (EUDP)

Partners: DIN Forsyning Esbjerg, Technical University of Denmark

Contact: Benjamin Lorenzen, bel@oceanteam.eu

Timeline: 2022 - 2023

TRL: N/A →

Focus area(s): Point source capture

ConsenCUS - Carbon neutral clusters through electricity-based innovations in capture, utilisation and storage

The project's objective is to provide an industrial roadmap to a net-zero carbon future through carbon neutral clusters by way of electricity-based innovations in Capture, Utilisation and Storage. The project will demonstrate this concept by integrating a mobile demonstration unit at major cement, magnesia and oil refining installations.

Budget: DKK 104,000,000

Funding sources: Horizon Europe

Partners: British Geological Survey, Center for Research and Technology Hellas, Coval Energy, Danish Gas Technology Centre, Energinet, Energy Policy Group, European Centre of Excellence for Sustainable Water Technology, Geological Survey of Denmark and Greenland (GEUS), Grecian Magnesite, INEOS, New Energy Coalition, Oil and Gas Technology Center, OMV Petrom, Research Center for Carbon Solutions at Heriot-Watt University, Robert Gordon University, Stork/Fluor, Technical University of Denmark, University of Calgary, University of Groningen, Wetsus, Aalborg Portland

Contact: Philip Loldrup Fosbøl, plf@kt.dtu.dk

Timeline: 2021 - 2025

TRL: 2 → 6

Focus area(s): Point source capture

CORROPro - Corrosion protection for CO₂ storage facilities using nanofilament coatings

The project will test whether newly developed silica nanofilaments (SNF) can protect well pipes and reservoir sediments from corrosion by highly acidic liquid CO₂ solutions. This could potentially reduce corrosion inside of tubes and pipes but also the intricate hydromechanics within pumps, the inside of tanks and pipes. The project will help de-risk and reduce uncertainties with respect to the reuse of existing infrastructures for CO₂ storage.

Budget: DKK 1,917,762

Funding sources: INNO-CCUS

Partners: BlueNord, Nordsøfonden, Technical University of Denmark, TotalEnergies, Aarhus University

Contact: Tobias Weidner, weidner@chem.au.dk

Timeline: 2022 - 2024

TRL: 2 → 3

Focus area(s): Geological storage

CROSS - Cheap, reliable optical sensors for digital monitoring of CO₂ leakage undersea

The objective of this project is to design and test a cheap, reliable optical sensor (CROSS) for offshore CO₂ monitoring around a CO₂ storage site. The underlying challenge is to find an ideal dye chemical with no leaking, no bleaching, and good linking capability.

Budget: DKK 2,500,000

Funding sources: Aarhus University, Danish Offshore Technology Center, Unisense

Partners: Danish Offshore Technology Center, Unisense, Aarhus University

Contact: Mikkel Holmen Andersen, mha@unisense.com

Timeline: 2022 - 2024

TRL: 3 → 6

Focus area(s): Geological storage

CTS - CO₂ Transport - Flexible and cost-effective solutions for European offshore storage

The project's main objective is to demonstrate the techno- economic feasibility of using ships for transport and as injection vessels to ensure flexible and cost-effective solutions for European offshore storage. The project also aims to make further steps towards piloting the technology and increase CCUS awareness and acceptance in the selected regions among stakeholders.

Budget: DKK 3,460,000

Funding sources: The Energy Technology Development and Demonstration Programme (EUDP), The Clean Energy Transition Partnership

Partners: GeoEcoMar, Norce, Technical University of Denmark, University of Évora, WellPerform

Contact: Hamid Nick, hamid@dtu.dk

Timeline: 2023 - 2025

TRL: 5 → 6

Focus area(s): Geological storage

DemoBECCS - The potential and demonstration feasibility of bioenergy with carbon capture and storage

The experiences with BECCS from real large-scale projects are limited. Insufficient technical understanding of how biogenic CO₂ affects the CCS chain hinders the implementation of BECCS. This project aims to investigate the potential and feasibility of carrying out BECCS in both Denmark and China. The project mainly focuses on capturing CO₂ from biomass co-fired power plants and storing biogenic CO₂ in depleted oil reservoirs.

Budget: DKK 11,831,000

Funding sources: Innovation Fund Denmark

Partners: Aker Carbon Capture, Chongqing University, INEOS, Institute of Rock and Soil Mechanics at the Chinese Academy of Sciences, Shanghai Advanced Research Institute at the Chinese Academy of Sciences, SINOPEC, SINOPEC, Technical University of Denmark, University of Mining and Technology, Wintershall Dea

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Timeline: 2023 - 2025

TRL: 3 → 4

Focus area(s): Point source capture, Ecosystem-based removal

Effect of CO₂ injection - Effect of CO₂ injection on chalk properties - phase II

The project objective is to quantify effects on petrophysical, geochemical, rock mechanical and rock physical properties due to calcite dissolution from CO₂ injection and storage in Danish chalk reservoirs. This Phase II is designed to address uncertainties identified during Phase I with respect to suitability of CO₂ storage in Danish chalk reservoirs and potential showstoppers.

Budget: DKK 5,600,000

Funding sources: Danish Offshore Technology Center

Partners: Danish Offshore Technology Center, Geological Survey of Denmark and Greenland (GEUS), Technical University of Denmark

Contact: Frederik Ditlevsen, fpd@geo.dk

Timeline: 2022 - 2024

TRL: 3 → 4

Focus area(s): Geological storage

EnCO2age - A framework for energy and environmental assessment of a european carbon capture, transport, and storage network

CCS can have a positive environmental impact only if it is scaled up from megatonne-scale national projects to gigatonne scale cross-border networks. This project aims to assess the feasibility of large-scale European CCS by designing a capture and transport network that collects CO₂ from the flue gas of industrial emitters across Europe and stores it in selected offshore locations in the North Sea. The project considers the interplay between the boundaries and specification of the system, current technology, and geotechnical constraints to design a CCS network to minimise cost, energy demand, and environmental footprint.

Budget: DKK 1,700,000

Funding sources: Danish Offshore Technology Center

Partners: Danish Offshore Technology Center, Technical University of Denmark

Contact: Ali A. Eftekhari, Charlotte N. Larsen, alia@dtu.dk, clarsen@dtu.dk

Timeline: 2023 - 2024

TRL: 2 → 4

Focus area(s): Point source capture, Transport

FOS - Fiberoptic chemical sensing

The project aims to develop a seabed surveillance system for detecting CO₂ leaks using fiber optics. The goal is to identify and build robust chemical sensors based on fiber optic technology. Fiber optics offer the advantage of combining optical sensing with robust telemetry. Sensing can occur either through optical changes in the fiber's environment or through strain applied to the fiber. The project will explore the right combination of fiber types and sensing materials that produce detectable changes in response to CO₂ concentrations in the surrounding environment.

Budget: DKK 6,000,000

Funding sources: The Energy Technology Development and Demonstration Programme (EUDP)

Partners: BlueNord, Nordsøenheden, Technical University of Denmark, TotalEnergies

Contact: Simon Ivar Andersen, simand@dtu.dk

Timeline: 2022 - 2025

TRL: 1 → 4

Focus area(s): Geological storage

GRAF2X - Carbon Capture Membranes Enabled by Graphene

Small and medium-sized enterprises (SMEs) account for nearly 60% of global CO₂ emissions but are largely overlooked in current carbon capture strategies. Existing technologies like amine scrubbing are too costly, complex, and space-intensive for emitters under 100 tons CO₂ per day. This project aims to design and validate a compact, lowenergy membrane-based capture system designed for SMEs. With no toxic solvents, low energy needs, and a modular footprint, we hypothesise that this solution can provide a viable, scalable alternative - unlocking emissions reductions that conventional systems can't reach.

Budget: DKK 4,600,000

Funding sources: Villum Foundation

Partners: Technical University of Denmark

Contact: Abhay Shivayogimath, abshi@dtu.dk

Timeline: 2023 - 2025

TRL: 3 → 5

Focus area(s): Point source capture

HydraMOF - Hydrate-MOF synergy for improved performance in gas capture and storage

The objective of this project is to investigate and develop hydrate-based gas collection and storage on a basic level, aiming to improve the efficiency of this technology, which is currently underdeveloped. To achieve Denmark's ambitious climate goals, there is an urgent need to develop technologies that can collect and store greenhouse gases such as CO₂ and hydrogen. One technology that can be used for this purpose is hydrate technology.

Budget: DKK 1,880,000

Funding sources: Independent Research Fund Denmark

Partners: Technical University of Denmark

Contact: Jyoti Shanker Pandey, jyshp@kt.dtu.dk

Timeline: 2022 - 2024

TRL: 3 → 4-5

Focus area(s): Point source capture

Methane and CO₂ detection - Sensors for methane and CO₂ detection in water column

According to regulations all CO₂ storage projects need to have monitoring in place to ensure containment. However, there is a lack of sensors able to detect CO₂ and CH₄ leaks in the water column. Existing CO₂ sensors have slow response rates, limiting their use to stationary landers on the seabed. This project aims to develop sensors to fill this gap considering the complex interplay between CO₂, CH₄, and O₂ levels to reduce false positives.

Budget: DKK 4,000,000

Funding sources: Danish Offshore Technology Center

Partners: Danish Offshore Technology Center

Contact: Jonas Sundberg, Charlotte N. Larsen, jonsun@dtu.dk, clarsen@dtu.dk

Timeline: 2021 - 2024

TRL: 1 → 6

Focus area(s): Geological storage

MONICO - Monitoring Fugitive emissions

The implementation of CCUS technologies poses a new risk for unwanted CO₂ emissions within the new infrastructure. A main challenge relating geological storage is lack of an efficient monitoring system that can ensure environmentally safe storage and handling of CO₂. The project seeks to provide an efficient monitoring system to detect and quantify fugitive CO₂ emissions from surface infrastructure as well as subsurface geological storage sites. The aim is to provide a monitoring system that can lead to reduced leakage from an estimated 5% to below 1%.

Budget: DKK 6,754,649

Funding sources: INNO-CCUS

Partners: Danish Gas Technology Centre, Explicit, Gas storage Denmark, Aarhus University

Contact: Anna Zink Eikeland, aze@teknologisk.dk

Timeline: 2022 - 2025

TRL: 4 → 6-7

Focus area(s): Geological storage

Net Zero Arc - Net zero energy carbon capture at ARC

The objective of the project is to investigate how to best integrate carbon capture with waste incineration and whether it can be done in an energy-neutral manner, so the excess heat from the carbon capture process is utilised for district heating. The project, therefore, aims to construct, commission and operate a cost-effective demonstration-scale Carbon Capture (CC) unit at ARC.

Budget: DKK 62,600,000

Funding sources: The Energy Technology Development and Demonstration Programme (EUDP)

Partners: ARC (Amager Resource Center), Pentair, Rambøll, Technical University of Denmark

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Timeline: 2020 - 2024

TRL: N/A →

Focus area(s): Point source capture

Project Bifrost - Scalable CO₂ storage with potential to propel Denmark towards European CO₂ Hub

The aim of Project Bifrost is to unlock Denmark's Carbon, Capture and storage (CCS) potential in the Danish North Sea, by using existing offshore oil and gas infrastructure. The project leverages assets owned by DUC (Danish Underground Consortium) and Ørsted, repurposing depleted oil and gas fields and pipelines for CO₂ storage. The DUC is a joint venture comprising TotalEnergies, BlueNord, and Nordsøfonden. The project seeks to demonstrate the reusability of existing wells for CO₂ injection and storage, foster alternative CO₂ transportation options, and develop monitoring technologies.

Budget: DKK 157,000,000

Funding sources: Energy Technology Development and Demonstration Programme (EUDP)

Partners: Technical University of Denmark, TotalEnergies, Ørsted Salg & Service

Contact: David Nevicato, david.nevicato@totalenergies.com

Timeline: 2022 - 2024

TRL: 4-5 → 7

Focus area(s): Geological storage

SEABAS - Understanding the offshore environmental baseline prior to initiating a CO₂ injection project

The SEABAS project focus on understanding the offshore environmental baseline prior to initiating a CO₂ injection project. In another ongoing study (SEEP) a baseline is being created for Natural Hydrocarbon Seepage around offshore installations and the aim of SEABAS is to extend the SEEP study to potential leakage of CO₂. The hypothesis is, that an early indicator of CO₂ leakage from an existing oil and gas reservoir, will be increased methane in the sediments and water column. Generating baseline knowledge is key in order to understand a CO₂ storage project monitoring data and determine if a 'leakage signal' is originating from the storage reservoir or another source.

Budget: DKK 10,000,000

Funding sources: Danish Offshore Technology Center

Partners: Geological Survey of Denmark and Greenland (GEUS), Technical University of Denmark, Aarhus University

Contact: Charlotte N. Larsen, clarsen@dtu.dk

Timeline: 2021 - 2024

TRL: 1 → 5

Focus area(s): Geological storage

SHARP storage - Enhancing CO₂ storage safety and monitoring

storage of CO₂ in the subsurface is considered pivotal to reducing CO₂ emissions during the energy transition. The project SHARP storage aims at developing methods that will accelerate safe and cost-efficient CO₂ storage. The primary objective of the project is to improve the accuracy of subsurface CO₂ storage containment risk management. The project aims to achieve this by integrating observations and models related to subsurface stress, rock mechanical failure, and seismicity.

Budget: DKK 5,500,000

Funding sources: Energy Technology Development and Demonstration Programme (EUDP)

Partners: ASN Alcatel, bp, British Geological Survey, Equinor, Geological Survey of Denmark and Greenland (GEUS), Indian Institute of Technology Bombay, INEOS, NORSAR, Norwegian Geotechnical Institute, Norwegian University of Science and Technology, Risktec, Rockfield, Shell, Technical University Delft, University of Oxford, Wintershall Dea

Contact: Marie Keiding, mke@geus.dk

Timeline: 2021 - 2024

TRL: 1-3 → 5

Focus area(s): Geological storage

VALCCAP - Local value creation in carbon capture, storage and use: the development of cross-sectorial business set-ups and pathways

The main objective of the project is to understand how integrating CCUS pathways into a preexisting energy system can accelerate the green transition across different sectors. This includes bringing value to public-private partnerships by using local actors such as municipalities, companies, and citizens as a case. The aim of the project is, thereby, to co-create business set-ups and pathways with a high degree of local support and involvement.

Budget: DKK 3,357,080

Funding sources: INNO-CCUS

Partners: Thisted Municipality, Thy Mors Energy, University of Copenhagen, Aalborg University

Contact: Karl Sperling, karl@plan.aau.dk

Timeline: 2022 - 2025

TRL: N/A →

Focus area(s): Point source capture

WellCS - A multiphysics informed risk assessment framework for CO₂ leakage through wells

Depleted hydrocarbon reservoirs are considered a viable solution to the CO₂ storage challenge. Nevertheless, the leakage of CO₂ through wells is a concern in geological CO₂ storage. In this regard, whether the wells are properly sealed is a big concern, as CO₂ can react with and leak through the cement layer and back to the atmosphere. The aim of this project is to develop an assessment tool capable of assessing containment risk through wells.

Budget: DKK 1,500,000

Funding sources: Danish Offshore Technology Center

Partners: BetterWells, Danish Offshore Technology Center

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Timeline: 2023 - 2024

TRL: 3 → 5

Focus area(s): Geological storage

Aalborg I - Carbon capture from Aalborg Portland

The project is the first step in realising Aalborg Portland's vision of creating a flagship for CCUS in the industry. The project's objective is to analyse and model two different CO₂ capture technologies, with the aim of providing a decision-making basis for selecting the most cost-effective CO₂ capture technology for Aalborg Portland.

Budget: DKK 3,070,000

Funding sources: Energy Technology Development and Demonstration Programme (EUDP)

Partners: Aalborg CSP, Aalborg Portland, Aalborg University

Contact: Maria Kristiansen, mak@energycluster.dk

Timeline: 2022 - 2023

TRL: 3 → 4-5

Focus area(s): Geological storage

Carbon capture and utilisation



Utilising CO₂

Even as economies move towards climate neutrality, carbon will remain an important resource for producing many of the products and fuels society relies on. CCU offers an alternative source of carbon by capturing carbon and converting it into new products, reducing the need for carbon from fossil resources. These range from chemicals and plastics to synthetic fuels and can be integrated into a range of industrial value chains.

Turning captured carbon into a competitive feedstock, however, requires efficient conversion processes that can operate at industrial scale. The climate benefits also depend on factors such as the source of the carbon, the energy used for conversion and what the carbon is used for. Developing viable CCU pathways therefore requires attention to the entire value chain, from carbon supply and conversion to integration into industrial production and end use.

Research in this category develops and demonstrates new conversion technologies and products while addressing the conditions needed for wider deployment. This includes reducing energy use and conversion costs, improving process flexibility and integrating CCU into existing industrial and energy systems. Standards, credible climate accounting and supportive market and regulatory frameworks are also important for ensuring that carbon-based products can compete and deliver documented climate benefits.

Assessing DOC

CO₂ capture from seawater for production of green fuels

Objective

Direct Ocean Capture (DOC) has emerged as a promising approach for carbon dioxide removal, but its high investment cost and electricity demand remain major challenges for deployment at scale. This project investigates the integration of DOC systems with offshore energy islands, where abundant renewable electricity from offshore wind can be used to support carbon capture and utilisation.

The work explores how coupling DOC with offshore energy infrastructure can create synergies between renewable electricity generation, carbon capture, and synthetic fuel production, improving the overall economic viability of these technologies while supporting rapid decarbonisation.

Approach

The project combines techno-economic analysis with energy system assessment to evaluate the feasibility of integrating DOC into offshore energy islands. Experimental data on process performance, energy consumption, and operating costs are used to identify the key factors governing economic performance and scalability.

Focus is placed on understanding the interactions between offshore electricity generation, carbon capture, and synthetic methanol production. Preliminary results indicate that methanol produced through integrated DOC systems remains significantly more expensive than fossil-derived alternatives, highlighting the importance of identifying pathways for cost reduction.

Expected impact

The project will provide one of the first detailed assessments of Direct Ocean Capture integrated with offshore energy islands. The resulting analyses will identify the major technical and economic drivers influencing system performance and establish boundary conditions for future deployment. By quantifying the costs, energy requirements, and integration opportunities associated with offshore DOC, the project will support future development of carbon removal and carbon utilisation technologies. The results will help determine whether offshore energy islands can provide a viable platform for large-scale carbon capture and synthetic fuel production in future low-carbon energy systems.

Budget

DKK 2,600,000

Funding source

The Novo Nordisk Foundation CO₂ Research Center (CORC)

Partners

COWI, Technical University of Denmark, Aarhus University

Contact

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Timeline

2026 - 2028

TRL

N/A

Sectors

Fuels

BICCU

Bio-Integrated Carbon Capture & Utilisation for Improved System Efficiency

Objective

The energy required for regeneration remains a major challenge for conventional carbon capture processes. BICCU explores an integrated approach to carbon capture and utilisation in which CO₂ capture is directly coupled to biological conversion. Unlike conventional capture processes, which rely on energy-intensive thermal regeneration to release captured CO₂, this concept uses methanogenic microorganisms to facilitate CO₂ liberation and conversion into methane.

By integrating capture and conversion into a single process, the project aims to reduce the overall energy demand of carbon capture while producing methane as a renewable alternative to fossil-derived feedstocks.

Approach

The project investigates capture agents that are compatible with CO₂-utilising microorganisms and can support efficient biological conversion following capture. Because conventional capture solvents often exhibit limited biocompatibility, new capture agents are being evaluated to identify systems that balance capture performance with microbial activity.

Reactor configurations are being developed and optimised to improve CO₂ transfer, capture efficiency, and methane production rates. The combined study of capture agents and reactor design aims to establish the requirements for efficient integration of carbon capture and biomethanation.

Expected impact

The project will provide a mechanistic framework for selecting solvent-microbe combinations capable of achieving high-rate conversion of captured CO₂ to methane. This knowledge will support the development of integrated capture and conversion systems with lower energy requirements than conventional carbon capture processes. In addition, optimisation of reactor design and a techno-economic assessment of the complete BICCU process chain will identify the key technical and economic drivers influencing process performance. The resulting insights will help determine the viability of bio-integrated carbon capture and utilisation as a pathway towards more energy-efficient carbon management technologies.

Budget

DKK 21,300,000

Funding source

The Novo Nordisk Foundation CO₂ Research Center (CORC)

Partners

Aarhus University

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Timeline

2023 - 2028

TRL

2 → 5

Sectors

Energy utility

BIG

Biocatalyst interactions with gases

Objective

Reducing carbon emissions and developing alternative routes for fertiliser production are increasingly urgent challenges facing our world. This project aims to uncover new biology-based methods for CO₂ management and sustainable fertiliser production.

Approach

The project will fundamentally investigate enzyme-catalysed gas reactions involving carbon dioxide (CO₂) and nitrogen (N₂). The project team will develop insights on complementary enzyme-based approaches for transforming abundant CO₂ and N₂ gas molecules in Earth's atmosphere into small water-soluble compounds - bicarbonate, formate and ammonia. The transformation will improve gas molecule conversion efficiency, which will help advance greenhouse gas reduction technologies while creating useful precursors for cement, fuels, chemicals, and fertilisers.

Expected impact

Studying these life-essential bio catalysed gas reactions will lead to new innovations that contribute to global sustainability solutions. The five-year BIG Collaboration will prepare students for careers where they can make a significant impact on greenhouse gas emissions and support the bioeconomy. Carbon management is a rapidly growing field, creating a high demand for skilled scientists with experience advancing these technologies.

Budget

DKK 50,000,000

Funding source

Novo Nordisk Foundation

Partners

North Carolina State University, Technical University of Denmark

Contact

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Timeline

2022 - 2027

TRL

1 → 4

Sectors

Chemical industry

Bioreactor dynamics

Advancing gas fermentation bioreactor design via sensor integration and predictive modelling

Objective

Bioreactors are promising technologies for the capture and conversion of CO₂ into valuable products such as methane and acetate. Among these, biofilm-based packed-bed reactors have attracted increasing attention due to their ability to efficiently convert gaseous substrates, including CO₂ and hydrogen, using microbial communities. These reactors are still largely operated as "black boxes", with process monitoring typically limited to reactor inlet and outlet streams. However, emerging research has shown that strong chemical and biological gradients exist throughout the reactor, creating substantial heterogeneity that influences overall performance. The project investigates how these gradients affect CO₂ conversion and how they can be leveraged to improve reactor efficiency and productivity.

Approach

The project investigates heterogeneity in packed-bed bioreactors across multiple scales, from microscopic gradients at gas-liquid interfaces to larger-scale variations throughout the reactor. Advanced analytical methods, sensor technologies, and data-driven models will be developed to characterise these processes and identify the factors governing reactor performance.

By combining experimental studies with mechanistic modelling, the project aims to establish new approaches for monitoring, controlling, and optimising biological gas fermentation processes for CO₂ conversion.

Expected impact

The project will provide new insights into the biological and transport processes governing biofilm-based CO₂ conversion reactors. Understanding how reactor heterogeneity influences performance will support the design of more efficient systems to produce methane and acetate from captured CO₂.

In addition, the development of advanced sensing tools and predictive models will improve process monitoring and control and support bioreactor design. The resulting knowledge will broaden the applicability of biological gas fermentation technologies and support future scale-up of CO₂ conversion processes.

Budget

DKK 3,400,000

Funding source

The Novo Nordisk Foundation CO₂ Research Center (CORO)

Partners

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Timeline

2026 - 2028

TRL

3 → 5

Sectors

Chemical industry

BRIGHT Mission 1B

BRIGHT Mission 1B - bio-based production of commodity chemicals

Objective

Mission 1B is part of BRIGHT, the Novo Nordisk Foundation Biotechnology Research Institute for the Green Transition, which develops scalable biotechnology solutions for a bio-based economy. Mission 1B will establish a platform for producing large-volume commodity chemicals from sustainable CO₂-derived C1/C2 feedstocks and other compatible low-carbon inputs. The aim is to replace petrochemical routes with robust microbial cell factories producing drop-in bulk chemicals through biocatalytic and chemical catalytic approaches, resulting in scalable bioprocesses that can be deployed in Europe and other places in the world.

Approach

In the first four-year phase, the mission will combine feedstock and product mapping, providing a metabolic atlas of promising targets, including targets that increase the EU's resource base and secure access to a range of key chemicals. The mission will also develop engineering tools for unconventional mesophilic and thermophilic hosts, establish systems-level physiology and multi-omics, strain engineering for prioritised products and fermentation/downstream processing development guided by techno-economic analysis (TEA) and life cycle assessment (LCA). Initial product targets include bulk chemicals with combined markets exceeding 10 million tonnes per year, with the flexibility to add new targets identified through the metabolic atlas. The planned mission activities are collaborative and integrated.

Expected impact

A de-risked portfolio of CO₂-derived routes to commodity chemicals through TRL 3-4 integrated demonstrations and decision-ready TEA/LCA packages, enabling credible EU/global deployment of low-carbon production with 70-95% cradle-to-gate CO₂ reduction (for renewable CO₂/H₂ pathways powered by renewable electricity). Establish robust stage-gates with techno-economic viability across defined ranges for electricity price, H₂ cost and carbon price to progress the strongest routes towards TRL 5-6 pilot validation.

Budget

DKK 0

Funding source

Novo Nordisk Foundation

Partners

Again, Daka Denmark, Haldor Topsøe, Kassø e-methanol, LanzaTech, PYROCO₂, SINTEF, Stuttgart University, TU Delft, Unibio, Wageningen University and Research

Contact

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Timeline

2026 - 2032

TRL

3/4 → 5/6

Sectors

Chemical industry

CAPCO₂ - Algae

Capturing and valorisation of CO₂ through photobioreactors to drive the green transition

Objective

Currently, there are no real carbon capture and utilisation (CCU)-solutions or low-carbon technologies suitable for small and mid-sized companies. Therefore, there is an urgent need to develop new processes, technologies, mechanisms, and energy systems that are economically feasible and realistic for small and mid-size industries. The purpose of this project is to demonstrate that even smaller amounts of CO₂ from small-scale industrial sites can feasibly be transformed into algae-based biomass for further utilisation, as there is a large potential for high-quality low-carbon ingredients now and in the future.

Approach

The project intends to demonstrate how future biogas and fermentation clients of the ALGIECEL carbon capture as a service technology can valorise their CO₂ emissions to the benefit of the whole value chain. Within the project, the consortia-partners will thus set up a photobioreactor (PBR) in collaboration with NOVOZYMES, supplying their CO₂ into the photobioreactor. The algae-based broth will be directed into an up-concentration container, where the water will be separated, to demonstrate that it can be reused.

Expected impact

CAPCO₂ aims to demonstrate a breakthrough concept for CCU. The solution is highly modular and scalable, allowing cost neutrality (short-term) and profitability (long-term) to the clients implementing the technology. There is a great commercial opportunity for the solution based on:

- A market anchored in the reduction of greenhouse gas emissions
- A growing demand for sustainable bioproducts
- New methods
- CO₂ prices and the voluntary carbon market.

Budget

DKK 32,950,000

Funding source

The Energy Technology Development and Demonstration Programme (EUDP)

Partners

ALGIECEL, Knowledge Hub Zealand, Novozymes, P2CC (Power to Climate Change), Technical University of Denmark

Contact

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Timeline

2023 - 2026

TRL

4 → 8

Sectors

Cross sector

Biogas

CAPEX

The Pioneer Center for Accelerating P2X Materials Discovery (Aviation and Maritime X-Trail)

Objective

Electrofuels based on CO₂ and renewable electricity are essential to decarbonise hard-to-electrify sectors like shipping and aviation. This center aims to contribute by using CO₂ electrolysis to produce long-chain carbon compounds suitable for use in these sectors. CO₂ electrolysis typically yields a narrow distribution of short-chain products, while high-temperature Fischer-Tropsch synthesis generates longer chains but with broader distribution. The goal is to perform CO₂ electrolysis at high temperatures to achieve both chain length and product selectivity tailored to fuel applications.

Approach

The center brings together a broad range of expertise to achieve its goals. Computational chemists at DTU Physics will design the catalysts, while nanoparticle synthesis specialists at the University of Copenhagen will produce them. Electrode testing will also be conducted at DTU Physics. Pulsing and varying the potential is expected to be key to achieving stable, efficient conversion, and experts from Aalborg University will optimise the power electronics.

Expected impact

By merging CO₂ electrolysis and Fischer-Tropsch, the project expects to develop new catalysts and create new product distributions. As this is a low-TRL project, the primary impact will be understanding the science of the merging of these two fields. The goal will be to create electrolyzers that can then be up-taken by start-up incubators such as Villum P2X.

Budget

DKK 300,000,000

Funding source

Carlsberg Foundation, Danish National Research Foundation, Lundbeck Foundation, Ministry of Higher Education and Science in Denmark, Novo Nordisk Foundation, Villum Foundation

Partners

Stanford University, Technical University of Denmark, University of Copenhagen, University of Southern Denmark, Utrecht University, Aalborg University, Aarhus University

Contact

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Timeline

2023 - 2036

TRL

1 → 4

Sectors

Fuels

Carbon-4-LIFE

Next Generation Biomethane: Fully Circular and Carbon-Negative Renewable Energy with Soil Regeneration

Objective

Woody biowaste is an underutilised resource with significant potential for producing renewable energy and bio-based products. The Carbon-4-LIFE project demonstrates a next-generation, zero-waste biorefinery that transforms woody biowaste into high-value products through the integration of advanced technologies, including pyrolysis, syngas cleaning, biomethanation, anaerobic co-digestion of light pyrolysis condensate and valuable products for agronomic applications, such as soil amenders and peat substitutes.

Approach

The project integrates anaerobic digestion (AD), pyrolysis, syngas cleaning, biomethanation and anaerobic co-digestion of light pyrolysis condensate to maximise resource efficiency in the valorisation of heterogeneous feedstocks, including both fermentable and non-fermentable residual biomass. The concept converts woody biomass waste into biomethane, carbon dioxide (CO₂), biochar and circular bio-products for agriculture, while aiming to maximise resource efficiency and address biowaste management challenges.

Expected impact

The integrated approach aims to maximise utilisation of the carbon content in organic feedstocks, increasing biomass resource efficiency from 35.4% to 98.6% compared with the current state of the art. The project is expected to produce 20.4 kt/year of marketable products, including bio-LNG, liquefied CO₂, biochar-based soil amendments and peat substitutes. By combining renewable energy production with circular bio-products, the concept supports climate change mitigation and the transition towards a bio-based economy.

Budget

DKK 33,858,900

Funding source

EU

Partners

Andanatura Foundation for Sustainable Socioeconomic Development, Bioenergías de la Campiña, Cartago Ventures, Ellinikos Georgikos Organismos - Dimitra, GRDF, Magtel Operaciones, Riverse, TerraWatt, Veltis, Waste to Energy Advanced Solutions

Contact

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Timeline

2026 - 2029

TRL

N/A

Sectors

Biogas

Agriculture

Fuels

Chemical industry

Waste-to-energy

Carbonive

Bacterial CO₂ Capture To Produce Mineral Carbonates For Industrial Use

Objective

The project is developing an innovative bio-based technology specifically designed for point-source CO₂ capture in high-emission industries, offering a practical and efficient solution for reducing carbon emissions directly at their source. The overarching goal of this project is not only to significantly reduce CO₂ emissions but also to produce industrially relevant minerals (such as calcium carbonate) during the capture process that can be reintegrated into industrial applications, contributing to a circular economy and further enhancing the sustainability of the industries involved. This dual approach of emission reduction and resource recovery makes the technology a promising tool for a more sustainable future.

Approach

By mimicking coral reefs, which absorb CO₂ from seawater and combine it with calcium ions to form calcium carbonate used to build their skeletons, the project has developed a bacterial approach to capture industrial CO₂ emissions and convert them into stable mineral carbonates, suitable for use in industries such as cement production, steel manufacturing, and the paper and pulp industry. By capturing CO₂ and converting it to calcium carbonate using bacteria, the project provides a biosustainable way of not only utilising CO₂ as a waste gas but also connecting various waste streams of calcium ions to create calcium carbonate for reuse.

Expected impact

The goal of this project is to transition from a laboratory-scale process to a scalable platform capable of large-scale CO₂ precipitation, offering a tangible solution for significantly reducing industrial CO₂ emissions. By demonstrating the technology's effectiveness on a larger scale, we aim to demonstrate its viability for widespread industrial adoption. This progression is crucial to driving the broader implementation of the technology, enabling industries to make substantial strides toward sustainability and emissions reduction. Ultimately, this project seeks to lay the foundation for the large-scale application of this innovative solution, helping to mitigate the global impact of carbon emissions across various high-emission industries.

Budget

DKK 4,800,000

Funding source

Independent Research Fund Denmark, TotalEnergies

Partners

Technical University of Denmark, TotalEnergies

Contact

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Timeline

2022 - 2027

TRL

N/A

Sectors

Chemical industry

Catalyst stability studies

In Operando Characterisation of Catalyst Structure and Stability

Objective

Catalyst stability remains a major challenge for the large-scale implementation of CO₂ conversion technologies. Although many catalytic systems demonstrate promising activity and selectivity, performance often declines over time due to structural changes occurring during operation. Understanding these degradation processes is essential for the development of catalysts with longer operational lifetimes.

This project aims to establish a toolbox for atomic-scale characterisation of heterogeneous electrocatalysts and thermal catalysts under operating conditions. Direct observation of catalyst structure during operation has the potential to reveal the mechanisms responsible for deactivation and provide guidance for the design of more stable catalytic materials.

Approach

The project combines catalyst synthesis, structural characterisation, and performance evaluation to establish relationships between catalyst structure and long-term stability. Particular focus is placed on studying catalysts under realistic operating conditions, where many degradation processes occur.

The work begins with the development of a new in operando cell for electrochemical CO₂ conversion. The cell is designed to enable synchrotron-based characterisation, allowing researchers to observe changes in catalyst structure and composition while reactions are taking place. The resulting methodology will be applied to catalyst systems relevant for direct CO₂ conversion.

Expected impact

The project will provide new insights into the structural changes responsible for catalyst degradation under realistic operating conditions. By identifying the mechanisms that limit catalyst lifetime, the research will support the targeted development of more robust catalytic materials through improved synthesis and design strategies.

In addition, the project will establish broadly applicable characterisation methods for studying heterogeneous catalysts in operation. These tools will support future development of catalysts for CO₂ conversion and other energy-related applications, helping to accelerate the transition from laboratory-scale discoveries to durable industrial technologies.

Budget

DKK 5,000,000

Funding source

The Novo Nordisk Foundation CO₂ Research Center (CORC)

Partners

Aarhus University

Contact

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Timeline

2026 - 2028

TRL

1 → 2

Sectors

Chemical industry

CC and PtX

Optimal utilisation of surplus heat from Carbon Capture and PtX

Objective

This concept- and development-based project aims to investigate, map, model, develop, and analyse resource flows and synergies across the energy value chain related to Carbon Capture (CC) and Power-to-X (PtX). In particular, it explores how surplus heat from CC and PtX plants can be utilised in the most efficient way within the energy system, to maximise overall benefits - including the phase-out of fossil fuels and reduced resource consumption in energy production.

Approach

Surplus heat is expected to play a significant role in future energy systems, but its integration requires computational development, local collaboration, practical experience, and targeted solutions. Locally, Aalborg Utility is undergoing a major production transition due to the planned closure of the North Jutland Power Station in 2028, which currently provides approximately 60% of Aalborg's heat supply. Meanwhile, CIP plans to establish a new PtX facility for the production of green fuels. To support the PtX process, a new CC plant will be established at Nordværk in collaboration with CIP. Both the CC and PtX plants are expected to generate substantial amounts of surplus heat. The project will map and model the above processes and develop concept and system designs, as well as calculation models, to support the development of new technical solutions and improve competitiveness.

Expected impact

The project will explore how to integrate as much surplus heat as possible from CC and PtX into the energy system in the most effective way. Digital twins of the processes and their integration into the system will be developed. Calculation methods, models, and technology concepts (and/or configurations) for production and thermal storage will also be developed and tested in a real-life case at Aalborg Utility. These outcomes will support the development of new technical solutions that can later be commercialised and delivered by Aalborg CSP, and implemented in connection with CC, PtX, and energy supply systems.

Budget

DKK 2,670,185

Funding source

CO2Vision - REACT-EU

Partners

Aalborg CSP, Aalborg forsyning

Contact

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Timeline

2023 - 2026

TRL

N/A

Sectors

Fuels

CCCA

Unveiling CO₂ capture with catalytic activation

Objective

The aim of this project is to establish the scientific foundation for an integrated Carbon Capture and Utilisation system, where CO₂ capture and conversion are combined into a single process. Current CCU technologies typically treat CO₂ capture and utilisation as separate steps, resulting in increased energy consumption and reduced overall efficiency. The project hypothesises that CO₂ chemically bound within specially designed ionic liquids can be activated and directly converted into valuable chemicals. By investigating the fundamental mechanisms governing CO₂ binding and reactivity, the project seeks to identify how capture media can simultaneously facilitate catalytic conversion. This knowledge will provide the basis for developing next-generation integrated CCU technologies.

Approach

The project combines advanced experimental chemistry with theoretical modelling to investigate a novel CCU platform based on ionic liquids developed at DTU. Researchers will study the molecular interactions responsible for CO₂ capture and determine how chemical binding influences the subsequent catalytic transformation of CO₂.

The work will be conducted through a close collaboration between DTU Chemistry and international partners at the University of York and the University of Oslo. Experimental investigations will be complemented by advanced computational methods to provide detailed insight into reaction pathways, catalytic activation mechanisms, and system performance. Together, these approaches will generate a comprehensive understanding of integrated CO₂ capture and conversion processes.

Expected impact

The project is expected to deliver new fundamental knowledge of the mechanisms underlying integrated Carbon Capture and Utilisation technologies. By elucidating how CO₂ capture and catalytic conversion can be combined within a single system, the research may help overcome one of the key challenges limiting the commercial implementation of CCU.

In the longer term, the findings could support the development of more energy-efficient and economically viable CCU technologies, contributing to reduced greenhouse gas emissions and accelerating the green transition. The project will strengthen Denmark's position within green chemistry and sustainable energy research while creating a foundation for future industrial applications of integrated carbon management solutions.

Budget

DKK 6,330,671

Funding source

Independent Research Fund Denmark

Partners

Oslo University, Technical University of Denmark, York University

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Timeline

2026 - 2029

TRL

3 → 4

Sectors

Biogas

Cement industry

Agriculture

Waste-to-energy

CERNET

CERNET - biogenic gas carbon conversion into high added value chemicals and ingredients through a bio-based NETWORK

Objective

The main objective of CERNET is to improve the sustainability of bio-based processes by implementing innovative carbon capture and utilisation (CCU) systems that convert biogenic CO₂ and CH₄ into valuable chemicals and ingredients. The project aims to demonstrate four bio-based value chains, enhance resource efficiency, integrate renewable energy and support market uptake through business models and replication tools.

Approach

CERNET takes a joined-up approach to capturing and reusing carbon, connecting biological carbon sources with practical, real-world value chains. Rather than treating carbon capture as a standalone solution, CERNET embeds it directly into existing industrial processes. CO₂ and CH₄ emissions from bio-based industries are captured and converted into products such as organic acids, proteins and biopolymers using fermentation and catalytic technologies. This circular approach reduces reliance on fossil-based raw materials and opens up economically viable routes for carbon reuse. CERNET also incorporates life cycle assessments (LCAs), business models and scale-up strategies to support industrial implementation.

Expected impact

By converting biogenic CO₂ and CH₄ into valuable bio-based products, the project will demonstrate practical alternatives to fossil-based production. Four bio-based value chains will produce a range of high-value chemicals and ingredients, supported by industrial-scale demonstration. The project will also deliver sustainability assessments, business models and replication pathways to support wider deployment across different sectors. The project aims to support the transition towards a climate-neutral and circular European bioeconomy by demonstrating how biogenic carbon can be reused as a valuable resource.

Budget

DKK 56,000,000

Funding source

Circular Bio-based Europe Joint Undertaking (CBE JU)

Partners

ACEA Pinerolese Industriale, ACIES BIO Biotehnoške Raziskave in Razvoj, ADM Bazancourt, ADM Hamburg, ADM Razgrad, Biofertilizantes CH₄, Biometagás La Galera, BluEnergy Revolution, Bodega Matarromera, Centro de Investigación de Recursos y Consumos Energéticos, Draxis Research Ventures, ENCO, Environment Park, Food & Bio Cluster Denmark, Fundació Universitària Balmes, Fundación CARTIF, Kemijski Institut, Kiverdi Netherlands, Nuevas Tecnologías para el Desarrollo de Packaging y Productos Agroalimentarios con Componente Plástica, Procter & Gamble Services Company, STAM

Contact

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Timeline

2025 - 2029

TRL

4 → 7

Sectors

Biogas

Chemical industry

Food production

Agriculture

CHARBUILD

Biochar Integration in Building Materials: Enhancing Sustainability and Performance

Objective

This project aims to demonstrate the potential of using biochar as a component in building materials. Specifically, the goal is to explore the possibility of utilising biochar for carbon-sequestering in lightweight aggregate concrete (LWAC) elements and wood-based particle boards (WPBs) - without compromising material properties such as durability, strength, and fire resistance.

Approach

The influence of biochar variability in terms of chemical composition, particle size distribution, morphology, etc., will be investigated by parametric lab experiments. This includes the characterisation of various biochar products by chemical analysis and physical testing of the biochar in lab-scale samples of LWAC and WFBs. Furthermore, the project will carry out experiments with crushing, milling, and sieving of biochar to investigate the effect of such pre-processing techniques on the properties of the resulting building materials. Additionally, LCA analysis will be used as an important tool to assess the environmental impact that can be achieved from using biochar in LWAC elements and WFBs.

Expected impact

The use of biochar as a component in building materials has several positive impacts. It achieves benefits in terms of a significantly reduced CO₂ footprint of the building sector, saving natural resources as well as beneficial properties of the resulting materials, e.g., an inherent ability to reduce harmful volatile chemicals from the indoor climate of buildings. A substitution of 10-20% of the raw materials with biochar would create a new market demand of up to 6 Gt/year on an EU scale and thus improve the market condition for biochar producers, leveraging a faster growth in capacity, and thus, in the overall capacity to store CO₂ in biochar. Finally, this project will contribute towards bringing Denmark among the frontrunners in finding solutions to reduce CO₂ emissions from the building sector significantly.

Budget

DKK 5,813,150

Funding source

INNO-CCUS

Partners

AquaGreen, Danish Technological Institute, Kronospan, Leth Beton

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Timeline

2023 - 2026

TRL

4 → 6

Sectors

Construction



Experiments on implementing biochar in construction materials at the Danish Technological Institute.
Image provided by INNO-CCUS

CHARBLOCK

Biochar-enhanced Lightweight Clinker Blocks for Carbon-Negative Construction

Objective

The Danish construction sector accounts for approximately 10% of national CO₂ emissions, while increasingly stringent building regulations place greater emphasis on reducing embodied carbon. Conventional lightweight aggregate clinker blocks (LWCB) rely on lightweight aggregates, making it difficult to achieve significant reductions in their climate impact. CHARBLOCK aims to develop, document and demonstrate a carbon-negative LWCB by replacing lightweight aggregates with biochar. The project will identify the optimal biochar replacement rate and validate architectural applications.

Approach

The project combines laboratory research, industrial-scale production and architectural design. Different biochar types and pre-processing methods will be evaluated to identify the optimal mix design, followed by mechanical and fire-resistance testing. The most promising solution will be scaled to industrial production and demonstrated through digital and physical architectural applications. The project will also document material performance through a life cycle assessment (LCA), assess market uptake and support dissemination alongside project management.

Expected impact

CHARBLOCK will deliver a carbon-negative LWCB validated at industrial scale, supported by full material documentation, a life cycle assessment (LCA) and digital and physical demonstrators. If fully implemented in Denmark, the solution has the potential to reduce CO₂ emissions by up to 70,000 tonnes annually. The project strengthens Danish leadership in carbon-negative construction and creates new market opportunities for biochar producers and block manufacturers.

Budget

DKK 6,587,735

Funding source

INNO-CCUS

Partners

Cebra Architecture, CRH Products, Danish Technological Institute

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Timeline

2026 - 2028

TRL

4 → 7

Sectors

Construction

CO₂Nylon

CO₂ Electrolysis Integrated Adipic Acid Synthesis for Sustainable Nylon

Objective

Adipic acid is a key ingredient in the production of nylon, a commonly used polyester. Today, it is made from KA oil and nitric acid, which releases nitrous oxide as a by-product - a potent greenhouse gas. The CO₂ Nylon project aims to develop a more sustainable alternative by starting with butadiene (which can be made from biomass-based ethanol) and electrochemically reducing CO₂ onto it to produce adipic acid.

Approach

As CO₂ electrolysis is typically done in water, and butadiene is not soluble in water, we need to find the optimal solvent that will allow for both butadiene and CO₂ electrolysis to occur simultaneously. Additionally, we need to identify a catalyst that enables both butadiene and CO₂ intermediates to adsorb onto its surface, allowing them to react efficiently.

Expected impact

This should allow for a new method to produce adipic acid, which is produced at 2.5 million tonnes per year globally. The focus of this project will be to develop the catalyst for this reaction and identify the limiting parameters. From a broader perspective, this will help develop the knowledge base for electrifying the chemicals industry.

Budget

DKK 3,100,000

Funding source

Independent Research Fund Denmark

Partners

Technical University of Denmark

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Timeline

2024 - 2027

TRL

2 → 3

Sectors

Chemical industry

CO₂-to-Protein

A biological pathway from carbon to food-grade biomass protein

Objective

Meeting future protein demand while reducing the environmental footprint of food production is a growing global challenge. This project investigates a complete biological pathway for converting CO₂ and renewable energy into protein-rich microbial biomass, creating a direct link between carbon utilisation and food production.

The process consists of two biological stages: CO₂ is first converted into acetate, which is subsequently used as a feedstock for yeast growth. This approach has the potential to provide a scalable and resource-efficient route to protein production, reducing dependence on agricultural land while creating value from captured CO₂.

Approach

A pilot-scale CO₂-to-protein facility was constructed and commissioned in 2025 at the AU Viborg campus. The facility enables investigation of key integration challenges associated with linking acetate production and microbial protein synthesis at larger scales. Current research focuses on the concentration and recovery of acetate streams, where stable extraction has already been demonstrated at laboratory scale. Additional work investigates long-term membrane performance, energy efficiency, alternative microbial strains, and thermophilic operation to improve overall process integration and reduce energy demand.

Expected impact

The project will provide the knowledge required to reduce the technical and economic risks associated with electricity-driven CO₂-to-protein production. Through pilot-scale operation, researchers will evaluate system performance, integration strategies, and long-term process stability under realistic operating conditions.

The resulting insights will support the development of scalable biorefineries capable of producing vitamin-enriched microbial biomass from CO₂ and renewable energy. This approach has the potential to contribute to more sustainable food production systems by reducing pressure on agricultural land while creating valuable products from captured carbon.

Budget

DKK 70,800,000

Funding source

The Novo Nordisk Foundation CO₂ Research Center (CORC)

Partners

No partners

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Timeline

2023 - 2028

TRL

4 → 6

Sectors

Food production



Pilot scale CO₂-to-protein facility at AU
Viborg campus.
Image provided by CORC

CO₂Valorize

Valorisation of CO₂ for low carbon cement

Objective

This project is a doctoral education and postdoctoral training programme. The objective of this project is to contribute to the reduction of CO₂ emissions generated by cement production. The project proposes an innovative approach to drastically reduce CO₂ emissions by partly replacing the limestone content with supplementary cementitious materials, that are carbonated using captured CO₂. The project will set the scientific foundations to create fundamental knowledge on the mechanisms, reaction kinetics, physico-chemical subprocess and performance of the modified cement and demonstrate the feasibility of 50% CO₂ reduction per tonne of produced cement.

Approach

The project is driven by leading companies, representing important parts of the value chain, ensuring rapid adoption of results with the potential for commercialisation of new equipment, processes, and software. The project follows a structured approach combining complementary research for each individual project in the academic and industry sector. This is accompanied by a balanced mix of high-level scientific courses and transferable skills delivered by each partner locally and in dedicated training schools and workshops at network level. This way, each doctoral candidate builds up deep scientific expertise and interdisciplinary knowledge to deliver game-changing cleantech innovations during and after the project.

Expected impact

The project's results are expected to be transferred into first-of-its-kind engineering solutions to advance the next generation of cement processes aimed at mitigating climate change. Also, the project is impact driven and strives for portfolios of high-class joint publications in leading journals and patents.

Budget

DKK 14,429,000

Funding source

Horizon Europe

Partners

Cemmac AS, Helmholtz-Zentrum Dresden-Rossendorf, Karlsruhe Institute of Technology, Norwegian University of Science and Technology, Siemens Process Systems Engineering Limited, Technical University of Denmark, Technical University of Dresden, University of Padua

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Timeline

2022 - 2026

TRL

N/A

Sectors

Cement industry

CRONUS

Capture and reuse of biogenic gases for negative-emission - sustainable biofuels

Objective

The overall ambition of the CRONUS project is to significantly advance the current state of the art in biofuels production and the utilisation of biogenic effluent gases. CRONUS will introduce effective technologies with high-potential innovations (techno-economic feasible solutions), thus accelerating the green transition and associated transformation of our economy, industry, and society with a view to achieving climate neutrality in Europe by 2050.

Approach

The overall CRONUS project approach is built on insights from research on 'sustainability transitions' that analyse innovation within socio-technical systems. More specifically, CRONUS will deliver a unique platform of novel technologies suitable for easy integration into the existing biofuels production plants, able to upcycle dissimilar kinds of biogenic effluent gases to biofuels. These will be ready for distribution within installed grids and biochar as biogenic carbon sink. The establishment and activities of "Communities of Practice" will ensure the active involvement and engagement of key stakeholders in performing, demonstrating, and assessing the proposed technologies leading to the sustainability of biofuels value chain and active involvement of society.

Expected impact

The project aims to increase public acceptance and awareness of biofuel technologies, identifying and communicating their advantages to the general population. CRONUS seeks financing schemes to make its solutions more attractive and cost-effective, overcoming economic challenges and fostering sustainable biofuel transition. Through targeted policy briefs and active involvement of key policy actors, CRONUS aims to influence policy landscapes and secure political support for biofuel technologies at the local scale. The project's impact extends beyond technological advancements, as it strives to shape a sustainable energy landscape with the broad adoption of carbon-negative biofuels.

Budget

DKK 37,309,000

Funding source

Horizon Europe

Partners

Agricultural Research for Development, AlgEn, Autonomos University of Barcelona, BiotechPRO, Brunel University London, Cartif Technology Center, Hellenic Agricultural Organisation, Madisi, National Technical University of Athens, Novel Environmental Solutions, Technical University of Denmark, University of Padova, UT SMIDE

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Timeline

2022 - 2026

TRL

2 → 5

Sectors

Fuels

CSTO2NE

CSTO2NE - Biomimicry and carbon adsorbent eco-materials for a climate-neutral economy

Objective

The objective is to develop innovative solutions for recycling and valorising biowaste and industrial waste into new eco-engineered materials through industrial symbiosis waste co-utilisation, mineral carbonation, and biomimicry approach.

Approach

CSTO2NE aims to provide the European community with innovative solutions for recycling and valorising biowaste (biomass) and industrial waste into new eco-engineered materials through industrial symbiosis waste co-utilisation, mineral carbonation, and biomimicry approach; namely, nature-inspired solutions and technologies for improving carbon uptake and waste incorporation and design eco-engineered materials and, transference of the emergent technologies through eco-innovation business models.

Expected impact

CSTO2NE intends to

- promote international and interdisciplinary collaboration through research and innovation staff exchanges, leading to extended networks and opportunities;
- Enhanced networking and communication capacities with scientific peers, as well as with the general public that will increase the project's impact,
- foster a shared culture of open access research and co-creation, that welcomes and rewards creativity and entrepreneurship, inspired by the New European Bauhaus concept, fostering ideas into innovative prototypes and technologies for the eco-materials circular economy.

Budget

DKK 7,701,930

Funding source

Horizon Europe

Partners

Bioxegy, Brunel University London, Carbon8 Systems, Centro de Biotecnologia de Plantas da Beira Interior, Henan Polytechnic University, Phyona, Polytechnic University of Madrid, Silesian University of Technology, Technical University of Denmark, Universidade da Beira Interior, Universitat de Lleida

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Timeline

2022 - 2026

TRL

N/A

Sectors

Waste-to-energy

Construction

Cement industry

C-TECH

Carbon Transformation & Energy Control Hub

Objective

C-TECH aims to establish a modular test site for carbon capture, utilisation and storage (CCUS) in Esbjerg. The test site is intended to strengthen the development of green technologies, contribute to the education of future engineers within Power-to-X (PtX) and CCUS and create opportunities for future collaboration with industry on new solutions. The project thereby supports the green transition and regional business development.

Approach

The project is structured around eight main activities covering project management and coordination, permits and approvals, design and construction of the test site, procurement of systems and equipment, commissioning and testing, and demonstration of individual and integrated systems. The project also includes competence development for companies and students, supported by workshops, events and communication activities.

Expected impact

The project will deliver a modular CCUS test site that supports technology development, demonstration and collaboration between academia and industry. Public programmes and knowledge-sharing activities will increase access to the facility, with a particular focus on SMEs, while collaboration with students will strengthen competence development within CCUS and PtX. Together, these activities are expected to strengthen regional innovation, education and industry engagement.

Budget

DKK 27,835,453

Funding source

The Just Transition Fund (JTF)

Partners

Aalborg University

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Timeline

2025 - 2028

TRL

N/A

Sectors

Energy utility

Fuels

Biogas

Offshore storage

ECOMO

Electrobiocatalytic cascade for bulk reduction of CO₂ to CO coupled to fermentative production of high value diamine monomers

Objective

ECOMO is driven by the need for sustainable solutions to meet global material demand. The use of renewable energy, greenhouse gas CO₂ and nitrogen as starting materials for smart biotransformation steps is expected to play a game-changing role for the chemical industry in the coming years. The role of the Technical University of Denmark is within Innovation Gate 2 - acetate switch, investigating acetogenic biological transformation of CO with acetic acid as the target primary product. The objective is that the acetate switch will operate with a high specificity of more than 95% in a trickle-bed reactor (TBR), combining full conversion efficiencies of both CO and CO₂ with high production rates.

Approach

The objective of Innovation Gate 2, led by the Technical University of Denmark, will be accomplished through development of specialised and highly tolerant to CO microbial consortia for acetic acid production from CO as well as process development to promote high acetic acid selectivity and productivity. We will work with development of CO-tolerant, mesophilic and thermophilic microbial enrichments that will be kinetically characterised and used for the start-up of the trickle bed reactor (TBR) while in-situ acids extraction will be applied to optimise the process.

Expected impact

The ECOMO innovation chain includes all and specifically new steps of CO₂ capture and utilisation/storage and thus addresses disruptive and close to market solutions. ECOMO assembles around established technologies, thus bears an intrinsic high degree for implementation. ECOMO unites the worlds of sustainable CO₂ valorisation with the production of green monomers for established and new markets with a decreased or even negative CO₂ footprint.

Budget

DKK 28,140,000

Funding source

Horizon Europe

Partners

Centre National de la Recherche Scientifique, Eilenburger Elektrolyse und Umwelttechnik, Fraunhofer-Gesellschaft, Technical University of Denmark, Technical University of Munich

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Timeline

2023 - 2026

TRL

2 → 4

Sectors

Chemical industry

Electrocatalysts for CO₂ Conversion

Advancing Multi-Carbon Product Formation from CO₂

Objective

Electrochemical conversion of captured CO₂ offers a promising route to produce platform chemicals and fuels without relying on fossil carbon sources. This project aims to develop catalytic systems capable of selectively converting CO₂ into higher-value products, including multi-carbon compounds such as ethylene, while improving the efficiency of integrated carbon capture and conversion processes.

Catalyst selectivity and performance can be controlled through rational design of catalyst interfaces and active sites, enabling both efficient carbon-carbon coupling and alternative conversion pathways that reduce overall process energy requirements.

Approach

The project investigates catalyst architectures designed to promote the formation of multi-carbon products from CO₂. Research focuses on surface-modified copper catalysts and dual-atom catalyst systems, with particular emphasis on understanding how organic-inorganic interfaces influence catalytic performance and product selectivity.

Researchers are also exploring the direct electrochemical conversion of bicarbonate, eliminating the need for energy-intensive regeneration of CO₂ prior to conversion.

Experimental studies combine catalyst development with advances in electrolyzer design and mass-transfer control to understand how local pH, carbonate equilibria, and catalyst environment affect conversion performance.

Expected impact

The project will establish design principles for next-generation CO₂ conversion catalysts capable of producing energy-dense hydrocarbons and platform chemicals with improved efficiency and selectivity. The resulting structure-performance relationships will support the development of stable and tunable catalytic systems suitable for industrially relevant operating conditions.

For bicarbonate conversion, the project aims to demonstrate a viable alternative to conventional capture-and-release approaches by enabling direct conversion within carbon capture infrastructures. Together, these advances may contribute to more energy-efficient carbon utilisation pathways and strengthen the economic viability of electrochemical CO₂ conversion technologies.

Budget

DKK 32,600,000

Funding source

The Novo Nordisk Foundation CO₂ Research Center (CORC)

Partners

Aarhus University

Contact

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Timeline

2023 - 2028

TRL

2 → 5

Sectors

Chemical industry

Fuels

Enzyme-integrated electrochemical conversion

Integrating Carbon Capture and Syngas Production through Biocatalysis

Objective

The conversion of CO₂ into syngas provides a promising pathway for producing fuels and chemicals within established industrial value chains. This project combines carbon capture with electrochemical CO₂ conversion to create an integrated process that addresses mass-transfer limitations associated with conventional electrochemical processes.

By utilizing enzymes to increase the local concentration of electrochemically available CO₂, the project aims to improve electrochemical conversion performance. The approach has the potential to strengthen the integration of carbon capture and electrochemical utilisation while increasing process efficiencies.

Approach

The project investigates the use of modified thermostable enzymes within an integrated carbon capture and electrochemical conversion system. An enzyme-functionalized pH spacer is being developed to improve CO₂ availability at the electrode surface and facilitate efficient conversion of captured carbon into syngas.

Experimental studies are supported by Multiphysics modelling using COMSOL to evaluate transport phenomena, local pH conditions, and enzyme activity throughout the integrated process. These studies provide insight into how system design influences CO₂ availability and electrochemical performance.

Expected impact

The combined experimental and modelling approach will be used to evaluate how enzymes can improve the coupling between carbon capture and electrochemical conversion. In addition, the work will establish methodologies for enzyme immobilization within nanoparticle-based materials and evaluate their performance under operating conditions.

A key outcome will be the development of a laboratory-scale system for enzyme-assisted electrochemical conversion of CO₂ to syngas. The resulting modelling tools and enzyme-functionalized pH spacer technology may also support future development of integrated carbon capture and utilisation processes.

Budget

DKK 7,400,000

Funding source

The Novo Nordisk Foundation CO₂ Research Center (CORC)

Partners

Technical University of Denmark, Aarhus University

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Timeline

2025 - 2028

TRL

2 → 5

Sectors

Cross sector

eTecFuels3

Production of e-methanol in one-step by the phosphate process

Objective

The objective of this project is to develop a novel electrolysis technology, operating at 240-300°C, enabling the production of methanol from H₂O and CO₂ in a one-step process. This allows for the creation of cost-effective green methanol for use as fuel in shipping and other heavy transport.

Approach

The research project eTecFuels3 concerns an entirely new electrolysis technology that DTU Energy and the other partners have developed on a laboratory scale. In this process, electrolysis occurs at temperatures ranging from 240 to 300 degrees, the same temperatures typically used for the chemical synthesis of methanol and other simple organic products. DTU Energy has been collaborating with CO₂Techn and Blue World Technologies for several years on the phosphate electrolysis process, and with Elplatek on electrode materials and surface coatings. Moving forward in the project, Blue World Technologies, will contribute by conducting a techno-economic analysis of green methanol as a sustainable fuel.

Expected impact

From a Danish perspective, there is a need for technologies that can both utilize CO₂ emissions from industry and biomass and harvest electricity from wind power in the North Sea. This is essential for reducing CO₂ emissions through electrochemical conversion. Additionally, several sectors like shipping and heavy transport are unlikely to be directly electrified and will continue to rely on fuels in the future. The fact that the process can occur in a single step, rather than first splitting water into oxygen and hydrogen and then reacting hydrogen with CO₂ in a chemical reactor to produce methanol, potentially makes it more energy-efficient. If the project is successful, it could have a significant impact.

Budget

DKK 10,224,000

Funding source

Innovation Fund Denmark

Partners

Blue World Technologies, CO₂Techn, Elplatek, Mærsk, Technical University of Denmark

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Timeline

2023 - 2026

TRL

3 → 5

Sectors

Fuels

EXCEL

Extremely Cold CO₂ Electrolysis

Objective

Electrochemical conversion of CO₂ is a promising pathway for turning greenhouse gases into valuable chemicals and fuels. Yet, the fundamental mechanisms behind the reaction are still not fully understood—especially why different products form under seemingly similar conditions. CO₂ electrolysis is typically performed at room temperature or slightly elevated temperatures. However, this offers only a narrow window for understanding the reaction. The EXCELL project will analyse CO₂ electrolysis at temperatures as low as -100 °C. By generating data under conditions far from standard operating environments, we aim to gain insight into why the reaction behaves as it does.

Approach

We will place our standard electrolyser in a cryogenic freezer. This presents several challenges, as pumps and even electronic components can struggle to operate at such low temperatures. While water is typically used in CO₂ electrolysis, we will use a water-alcohol mixture to ensure a liquid-phase reactor is maintained at cryogenic temperatures.

Expected impact

This low-temperature dataset will provide computational chemists, machine learning experts and AI researchers with valuable input for developing fundamental models of CO₂ electrolysis. Given that room temperature electrolysis can produce up to 12 different products, cooling the system may help us better understand why these different products form and what determines product selectivity.

Budget

DKK 3,000,000

Funding source

Novo Nordisk Foundation

Partners

Technical University of Denmark

Contact

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Timeline

2024 - 2027

TRL

2

Sectors

Cross sector

FrontFuel

Pilot-scale demo of CO₂ to SAF process

Objective

This research project will design, test, and install the world's first demonstration plant that showcases the entire value chain to produce sustainable aviation fuel based on CO₂ and renewable energy. The green transformation of the aviation sector is today challenged by, among other things, immature technologies with high costs, lack of scalability, and high raw material costs. If society is to sustain the sector in the future, it requires net-zero solutions with liquid drop-in fuel sources available on a large scale.

Approach

Power-to-X has its justification in the hard-to-abate sectors, where it is difficult to convert away from fossil fuels. The aviation sector is a good example because jet fuel is the most energy-dense fuel we have and the most difficult to make synthetically. Aarhus University's research centre in Foulum, AU Viborg, will host the complete technology package for the production of CO₂-neutral jet fuel. The project will work with the technologies on an industrially relevant scale, where it can show that it works, and demonstrate a solid business case.

Expected impact

The project is an exciting step forward in the commercialisation of new technologies for the production of sustainable jet fuel and will make a significant contribution to decarbonising the aviation sector. It is expected that this will pave the way for the first commercial plants.

Budget

DKK 26,900,000

Funding source

The Danish Energy Agency, The Energy Technology Development and Demonstration Programme (EUDP)

Partners

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Timeline

2023 - 2026

TRL

5 → 7

Sectors

Fuels

Gate2GreenFuels

Demonstration and development of CO₂-based fuel technologies in a regional living lab setting

Objective

The Gate2GreenFuels project will further develop the test and demonstration platform CCU-Hub Aalborg at the Port of Aalborg, which in the long term will encompass the entire value chain for the use of CO₂ in the production of sustainable fuels (including methanol as a key component). Through testing and demonstration activities on and around the Gate2GreenFuels site at the Port of Aalborg, the project aims to lay the foundation for decision-making tools and roadmaps for CCU technologies. At the same time, the project will investigate how such technologies perform under local and regional conditions and within existing infrastructure. In this way, it will explore potential changes and connections to local communities, and how the technologies may create value for the actors involved.

Approach

Gate2GreenFuels will operate as a Living Lab, supporting industries that wish to demonstrate and test both existing and new technologies, while also serving as a platform for knowledge sharing and future competence building. Using a range of technologies, the project will ensure physical demonstrations as well as scenario development, creating a basis for effectively optimising and selecting technologies at scale - from both environmental and local perspectives.

Expected impact

By 2026, and with the implementation of the planned activities, the project aims to make a significant contribution to the development and potential final investment decision (FID) for European Energy's e-methanol plant at the Port of Aalborg. If realised, this could lead to substantial capital investments in renewable energy and methanol production in Aalborg and the wider North Jutland region. In addition, the project is expected to support continued testing and development related to methanol demonstration facilities at the site, as well as ongoing demonstration activities, commissioning, and the gradual establishment of methanol-related infrastructure. Finally, the test platform will contribute to competence development among employees in collaboration with knowledge and educational institutions.

Budget

DKK 7,901,735

Funding source

CO2Vision - REACT-EU

Partners

Blue World Technologies, Circle K, European Energy, Heatflow, Port of Aalborg, Aalborg CSP, Aalborg Portland, Aalborg University

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Timeline

2023 - 2026

TRL

N/A

Sectors

Fuels

GCO2M

GrassCO2mposites

Objective

GCO2M aims to use grassland biomass as the basis for future building materials. The underlying hypothesis is that grass-based materials can reduce carbon emissions by substituting conventional, energy-intensive materials while increasing carbon storage through long-lived building elements. The project aims to increase photosynthetically efficient and sustainably sourced biogenic materials in the built environment, increase the CO₂ sequestration potential of the available land area in Denmark and develop higher-value building materials with thermal and acoustic properties based on grass composite characteristics.

Approach

The project investigates and quantifies the carbon capture potential of different agromanagement systems for perennial and temporary grassland for green biorefineries and develops new processing methods combining protein extraction with fibre production. It also develops new lignin-based adhesives for grass-based fibres, including processing methods for chemically modifying cellulosic grass fibres for composites. Furthermore, the project investigates new analysis, design and fabrication methods for grass-lignin building composites with specified structural, thermal and acoustic properties and assesses the budgetary and socio-economic perspectives of replacing conventional building materials with grass-based alternatives, from farmer to consumer.

Expected impact

GCO2M is expected to deliver multiple environmental, societal and economic benefits, including:

- adding value to the emerging GBR business through higher-value PCF side streams
- creating large-scale carbon storage in the built environment
- creating new jobs in the agricultural and construction sectors
- reducing carbon emissions from the energy-intensive materials industry
- establishing profitable production of CO₂-friendly building materials.

Budget

DKK 19,001,800

Funding source

INNO-CCUS

Partners

Bollinger + Grohmann Engineers, Davidsen Pond Global, Green Protein, Klimafonden Skive, Royal Danish Academy, University of Copenhagen, Vandkunsten Architects, Vestjyllands Andel, We Build Denmark, Aarhus University

Contact

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Timeline

2026 - 2029

TRL

4 → 7

Sectors

Construction

HarWASTing

Valorisation of harvested agroforestry biomass waste as feedstock for value-added bio-based solutions as a green development pathway

Objective

The project aims to turn unused farm and forest waste into valuable green products. It focuses on building circular economy business models for rural areas. The main goal is to reuse pruning leftovers and bioethanol waste to create high-value items with zero waste left behind.

Approach

HarWASTing uses a combination of advanced heating and extraction processes. This includes hydrothermal carbonisation to create a carbon-rich substance called hydrochar. The project tests these methods in small pilot value chains across three European climates. It also uses an artificial intelligence (AI) forecasting tool to identify where waste is available and builds an online marketplace for the final products.

Expected impact

The main output will be hybrid wood panels made from hydrochar. These panels are designed for fire protection and blocking electromagnetic signals in buildings. The project will deliver three digital tools: a feedstock availability forecaster, a marketplace platform, and a digital passport to track item lifecycles. This will reduce waste and strengthen local economies.

Budget

DKK 41,602,300

Funding source

Horizon Europe

Partners

AIDIMME, Association for Rural Development Turia-Calderona, Association of Forest Municipalities of the Valencian Community, Brimatech Research, Eastern Transylvanian Association of Forest Owners and Administrators, F6S, Financiera Maderera, Foresa Technologies, Ingelia, Joutsenten Reitti, Spanish National Research Council, SRDC, Technical University of Denmark, Transilvania University of Braşov, Universitat Politècnica de València, VTT Technical Research Centre of Finland, Weif Agrotecnia

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Timeline

2025 - 2029

TRL

6 → 8

Sectors

Agriculture

Forestry

Construction

HEC

Data-Driven Development of High-Entropy Catalysts for CO₂ Utilisation

Objective

Developing efficient ways to convert CO₂ into useful products is key to making carbon utilisation more sustainable and economically viable. This project focuses on high-entropy oxide catalysts for the reverse water-gas shift (RWGS) reaction, which transforms CO₂ and H₂ into materials that can be used in industry. The hypothesis is that high-entropy oxide catalysts - particularly those containing first-row transition metals - can significantly improve the efficiency and selectivity of the RWGS reaction due to their unique structural properties, such as increased oxygen vacancies and metal disorder.

Approach

The project will implement a data-driven, high-throughput screening approach to optimise the synthesis of high-entropy oxide catalysts. Using Bayesian optimisation, the project will plan new experiments based on a probabilistic analysis of each incoming dataset, balancing exploration and exploitation to improve the catalyst composition and synthesis continuously. Additionally, thorough material Characterisation using techniques like XRD, XRF, XPS, and Raman spectroscopy will be conducted to understand the structure-activity relationship of the catalysts.

Expected impact

Expected impact/output To support more sustainable and cost-effective CO₂ utilisation, the project will develop highly efficient and selective high-entropy oxide catalysts for the RWGS reaction. The project will also advance the field of heterogeneous catalysis by providing new insights into the structure-activity relationship of high-entropy oxides, and the data-driven methodology developed could be applied to other catalytic processes.

Budget

DKK 3,167,604

Funding source

Independent Research Fund Denmark

Partners

Technical University of Denmark

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Timeline

2025 - 2028

TRL

2 → 3

Sectors

Chemical industry

MES-MODEL 2.0

Extending computational modelling of microbial electrosynthesis for accelerated technology development

Objective

Microbial electrosynthesis (MES) enables microorganisms to convert CO₂ and renewable electricity into valuable products such as acetate and methane. While the technology shows considerable promise as a route for carbon utilisation, engineering challenges remain before MES can be implemented at industrial scale.

This project aims to improve understanding of the physical, chemical and biological processes that govern MES performance. Mathematical modelling, combined with targeted experiments, can identify the factors limiting productivity and provide the predictive tools required for technology scale-up.

Approach

The project combines computational modelling with experimental validation to investigate key phenomena influencing microbial electrosynthesis performance. Current work focuses on incorporating microbial CO₂ utilisation kinetics into the modelling framework and improving understanding of the interactions between microorganisms and hydrogen gas bubbles formed during operation.

Experimental studies are conducted across multiple scales, with results used to calibrate and validate the models. The resulting knowledge will be integrated into the next generation of the modelling platform, MES-MODEL 2.0, enabling more accurate prediction of reactor performance under industrially relevant conditions.

Expected impact

The project will deliver a high-fidelity modelling framework capable of supporting the design and scale-up of microbial electrosynthesis technologies. Key outputs include experimentally validated parameters describing CO₂ utilisation kinetics in relevant acetogenic microorganisms, as well as improved understanding of microbe-gas interactions within MES systems.

By strengthening the predictive capability of MES-MODEL 2.0, the project will provide researchers and technology developers with tools for evaluating reactor designs, identifying performance limitations, and accelerating the development of scalable CO₂ conversion processes.

Budget

DKK 6,000,000

Funding source

The Novo Nordisk Foundation CO₂ Research Center (CORC)

Partners

Aarhus University

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Timeline

2025 - 2028

TRL

1 → 4

Sectors

Chemical industry

Chemical industry



Experimental setup on microbial
electrosynthesis
Image provided by CORC

IKKA-CCUS

Modular CO₂ Capture and Crystallisation via Ikaite

Objective

IKKA-CCUS aims to demonstrate a novel modular crystallisation process for carbon capture and utilisation (CCU) based on ikaite formation (CaCO₃ · 6 H₂O), inspired by natural processes in cold marine environments. The project is based on the hypothesis that a membrane-based system using seawater, carbonate chemistry and flue gas can efficiently precipitate ikaite and convert it into pure calcium carbonate, while achieving scalable, low-energy CO₂ capture.

Approach

The project will construct and operate a 2-3-container demonstration plant at an industrial coastal site in Denmark. CO₂ is first absorbed into alkaline seawater, altering the carbonate balance. The CO₂-enriched solution is then mixed with fresh, calcium-rich seawater across membrane surfaces, where ikaite precipitates and grows directly on the membrane. The system will be tested with raw, scrubbed and biogenic flue gas to evaluate performance across multiple sources. Analytical and optimisation activities will assess gas capture efficiency, water chemistry and mineral output. End-users from the paint and plastics sectors will validate the produced CaCO₃ solids. Finally, Topsoe and Valmet will develop a roadmap and simulate electrolysis integration for future industrial-scale plants.

Expected impact

The project will deliver proof of concept for ikaite-based CO₂ capture under real-world conditions, generate more than 1,000 kg of CaCO₃ for industrial validation and provide key datasets for environmental and techno-economic assessments. This will lay the foundation for scalable, decentralised CO₂ capture with integrated utilisation, aligned with Denmark's CCUS goals.

Budget

DKK 9,323,500

Funding source

INNO-CCUS

Partners

BRIPA, Ikkaton, Mettler-Toledo, PMH Plast, Topsoe, University of Copenhagen, University of Gothenburg, Valmet Oyj

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Timeline

2026 - 2029

TRL

4 → 6

Sectors

Cross sector

Methane electroconversion

Methane activation to methanol

Objective

This project takes a novel approach to addressing the pressing issue of methane emissions and their significant contribution to climate change. The project aims to develop novel hybrid catalysts to promote the electroconversion of methane to methanol to counteract methane accumulation in the atmosphere.

Approach

The primary strategy involves the development of innovative hybrid catalysts for the electroconversion of methane to methanol. This approach differs from traditional thermal catalytic methods, which have proven challenging due to the low reactivity of methane. The aim is to unlock the transformation of methane into a more manageable and usable liquid fuel, addressing methane emissions at their source within the energy sector.

Expected impact

The expected outcome of this project is to demonstrate the feasibility and scalability of electrocatalytic systems for the conversion of methane to methanol under ambient conditions. The project seeks to prove that this technology can be industrialised, offering a sustainable alternative to the environmentally harmful practices of flaring, and venting in the oil and gas supply chain. Successful development of efficient catalysts for methane conversion would significantly reduce methane emissions, mitigating their impact on climate change. This approach has the potential to revolutionise the energy industry by providing a more eco-friendly and easily transportable fuel source, thereby supporting the transition to clean energy.

Budget

DKK 7,400,000

Funding source

The Novo Nordisk Foundation CO₂ Research Center (CORO)

Partners

The Novo Nordisk Foundation CO₂ Research Center (CORO)

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Timeline

2022 - 2026

TRL

N/A

Sectors

Fuels

Mobile CU Reactor

Mobile Carbon utilisation Reactor

Objective

With the globally increasing rate of production and the growing demand for transport, CO₂ emissions are also rising exponentially. This has measurable and significant climate-related consequences, which is why reducing global CO₂ emissions is high on the political agenda. For many companies, both now and in the future, the cost of CO₂ disposal must be factored in to meet mandatory climate targets (carbon neutrality).

Approach

The objectives of this project are to:

- Finalise the full-scale design of the Carbon Capture (CC) reactor
- Design and implement an effective power supply system
- Develop and integrate a control system and data management platform for process optimisation
- Assemble all physical components
- Monitor, measure, and optimise the efficiency of the CC reactor

The design phase builds on Algicel's previous project (Q2 2022 - Q2 2023), which produced a scale model partly developed and manufactured by Roblight. The current aim is to complete the detailed technical package required for constructing the CC reactor, develop the control and 1 MW power supply systems, and deliver a full-scale demonstration unit.

Expected impact

Using a biological photosynthesis process driven by artificial light and CO₂, the Carbon Utilisation Reactor (CCU) - a so-called photobioreactor - produces algae-based oils and proteins, along with pure oxygen, while consuming significant amounts of CO₂. Surplus heat is the only by-product, and it can be fully utilised. The end products are high-value compounds, such as omega-3 oils and/or protein-rich biomass. This supports resource efficiency by enabling circular use of natural resources. The CU reactor is designed as a plug-and-play system that can be delivered in 40" containers for on-site deployment, with remote monitoring from central service centres in collaboration with local partners. This CO₂ capture and utilisation technology will enhance national competitiveness and position North Jutland as a hub for sustainable CO₂ solutions.

Budget

DKK 4,600,000

Funding source

CO2Vision - REACT-EU

Partners

Algicel, Danish Technological Institute, Roblight, Aalborg University

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Timeline

2023 - 2026

TRL

N/A

Sectors

Cross sector

Energy utility

Modelling CO₂-to-Protein

Digital Twins for optimisation of protein production

Objective

A pilot-scale bioprocess has been developed at the AU Viborg campus that converts CO₂ into edible protein through a two-stage biological process, an anaerobic gas-fermentation stage followed by an aerobic protein-production stage. While the technology has demonstrated technical feasibility, further optimisation is required before large-scale deployment becomes possible.

The aim is to develop digital twins of both the biological processes and the production system to support operation, optimisation, and future scale-up of the CO₂-to-Protein platform. By integrating multiple modelling approaches, the project aims to identify operational bottlenecks, predict system performance, and accelerate the development of commercially viable CO₂-to-protein production.

Approach

The project combines sensor data, process monitoring, and production management systems, together with mechanistic process models and Continuous Flow Dynamics (CFD) simulation output, to develop digital representations of the pilot facility. Initial work focuses on establishing a low-fidelity digital twin capable of describing key process behaviour, followed by development of higher-fidelity models for process optimisation and scale-up.

Data architecture is being developed to integrate information from the production management system and identify the variables most critical for process performance. The resulting models will be continuously validated against pilot-scale operation and used to evaluate optimisation opportunities.

Expected impact

The project will establish a digital framework for monitoring, analysing, and improving the CO₂-to-Protein pilot facility. By providing insight into process performance, energy consumption, and production costs, the digital twin will support more rapid technology development and reduce the risks associated with scale-up.

The developed tools will help identify optimal operating conditions and guide future process improvements, contributing to commercially viable CO₂-to-protein production systems, with the methodology building a foundation for digital process management of future industrial-scale facilities.

Budget

DKK 3,100,000

Funding source

The Novo Nordisk Foundation CO₂ Research Center (CORC)

Partners

University of Tübingen, Aarhus University

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Timeline

2026 - 2028

TRL

4 → 6

Sectors

Food production

PowerLBG

Development of power-to-gas technology for production of liquefied biogas for the transport sector

Objective

To support the decarbonisation of heavy transport and maximise the climate benefits of biogas, PowerLBG aims to develop a complete process chain for producing liquefied methane (e-LBG) from biogas and electricity-derived methane (e-methane). The project builds on the further development and industrial maturation of the InjectMe in situ biomethanation technology, which enables the biological conversion of CO₂ directly within biogas reactors, before the biogas leaves the system.

Approach

The project will develop a full process chain for producing liquefied biomethane and e-methane from biogas, by adding hydrogen produced through electrolysis. This includes research and development of in situ methanation at both pilot scale (30 m³) and full scale (10,000 m³), process modelling, and the development and testing of advanced sensor technology. PowerLBG builds on existing infrastructure at Aarhus University (Campus Viborg) and ongoing developments at GrønGas Hjørring.

Expected impact

The project will enable the following: 1. Production of green drop-in fuel for heavy transport sectors. 2. Direct production of LBG from biogas without need for prior separation, infrastructure, or transport of CO₂. 3. Design and evaluation of process chain for localised production of LBG at biogas plants without connection to the natural gas grid.

Budget

DKK 11,501,881

Funding source

MissionGreenFuels

Partners

GrønGas Hjørring, Landia, NxPAS, University of Queensland, Wärtsilä, Aarhus University

Contact

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Timeline

2024 - 2027

TRL

5 → 7

Sectors

Fuels



PowerLBG. Image provided
by project lead

PROFIT

Protein revolution: Obtain feed ingredients from wastes for green transition

Objective

Currently, food wastes and residues arising from agriculture, are either not properly utilised or only used for electricity, heat production or transport fuel. In the forthcoming future, both renewable electricity and heat can be produced more cheaply by other sustainable routes. Therefore, PROFIT proposes to convert CH_4 and CO_2 from biogas to a valuable product, namely feed in the form of SCP. The aim of the project is to develop an integrated technology for organic waste treatment.

Approach

The project will address three objectives:

- Technical: Electrochemical N and P recovery from digestate, and systems analysis of the proposed technology for the process.
- Social: By accepting to collaborate in the development and acceptance of PROFIT, the agricultural sector becomes part of the community. In this respect, PROFIT contributes to the social dimension of sustainability, since it provides new opportunities to the agricultural sector, namely its involvement in the co-creation of a product that benefits the economy and the environment.
- Economic: The sustainability and economic feasibility of PROFIT will be evaluated using life cycle, techno-economic assessment, and market penetration actions at each level of development.

Expected impact

PROFIT will provide the basis for policies and regulation to promote green transition and circular economy. PROFIT answers public concerns about green transition and provides a technical solution to support the public to have a greener lifestyle. Consequently, PROFIT will create social value as it will contribute to sustainable solutions, create new types of jobs, and promote Danish research institution and technology consultancy as pioneers in technology for green transition. The value proposition of the PROFIT project will derive from the sustainable supply of protein ingredients. During the project ongoing negotiations will be performed for the commercialisation of the product for target applications.

Budget

DKK 14,300,000

Funding source

Innovation Fund Denmark

Partners

ARC (Amager Resource Center), Copenhagen Municipality, Knowledge Hub Zealand, Roskilde University, Technical University of Denmark, Unibio

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Timeline

2023 - 2027

TRL

3 → 7

Sectors

Biogas

Food production

PROMISE

Products of Miscanthus - Multi purpose production and use of miscanthus for food, materials and negative emissions

Objective

Miscanthus is an effective carbon crop, but its increasing use raises questions about the balance between food production and carbon sequestration. PROMISE investigates whether the protein contained in miscanthus can be extracted while the remaining carbon fraction is used for long-term carbon storage in construction materials. The project investigates harvesting strategies and protein extraction, after which the remaining biomass undergoes hydrothermal carbonisation to facilitate drying and provide structural stability through polymerisation before being converted into biochar. The resulting material is being developed for use in carbon-based wall boards.

Approach

The project combines expertise from multiple disciplines, including crop harvesting strategies, maceration and protein extraction, hydrothermal carbonisation, pelletisation and high-temperature pyrolysis. PROMISE has demonstrated that combining these approaches produces a hard carbon material that can be shaped before pyrolysis into products such as bricks and wall panels.

Expected impact

The process has been demonstrated at laboratory scale and is currently being upscaled. Prototype carbon materials are undergoing material testing for use in construction materials. The project has demonstrated the production of biochar-only building products, eliminating the need for concrete or binders, as the carbon is fused through graphitisation chemistry.

Budget

DKK 9,795,444

Funding source

Green Development and Demonstration Programme (GUDP)

Partners

Ole Møller Helbæk, Roskilde University, Saint-Gobain Denmark, StrawTech, Technical University of Denmark, Aarhus University

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Timeline

2024 - 2027

TRL

3 → 4

Sectors

Agriculture

Construction

Cross sector

PYRAH2

PYrolytic Renewable Approach for Hydrogen and carbon production: Efficient Transformation of Biogenic Wastes into Hydrogen and High-Value Solid Carbon for New Industrial Value Chains

Objective

The PYRAH2 project aims to develop and demonstrate a renewable and sustainable pathway for the co-production of hydrogen and solid carbon from biogenic waste, contributing to the decarbonisation of hard-to-abate sectors. The project integrates gasification, biomethanation and pyrolysis technologies to establish an efficient and scalable process that valorises diverse waste streams. It also aims to improve the energy and economic performance of the system while maximising carbon valorisation for industrial applications.

Approach

PYRAH2 combines gasification, biomethanation and high-temperature methane pyrolysis in an integrated process for hydrogen and solid carbon production from residual biomass. Activities include engineering, construction, operation and testing of a near-industrial-scale demonstration plant (TRL 7) in an operational environment. The project will validate process integration, assess scalability and optimise system performance, targeting an energy consumption below 15 kWh/kgH₂, a hydrogen production rate of 30 kgH₂/h and a solid carbon yield exceeding 50% of the initial carbon content.

Expected impact

The project is expected to:

- Demonstrate a renewable pathway for the co-production of hydrogen and solid carbon from biogenic waste.
- Reduce greenhouse gas emissions by replacing fossil-based hydrogen production and utilising residual biomass, with preliminary studies estimating up to 783 tonnes of CO₂eq avoided per year.
- Improve resource efficiency through the valorisation of carbon by-products, including graphite and carbon black.
- Improve the economic performance of renewable hydrogen production, with a projected levelised cost of hydrogen (LCOH) below €3/kgH₂ by 2030.

Budget

DKK 59,472,656

Funding source

Horizon Europe

Partners

ArcelorMittal, AristEng, Cartago Ventures, Goodyear Tire & Rubber Company, HyChem Química Sustentável, Inveniam Group, Necta Bioenergy, Plenesys, Politecnico di Milano, Technical University of Denmark, TerraWatt, Waste to Energy

Contact

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Timeline

2026 - 2029

TRL

4 → 7

Sectors

Fuels

Waste-to-energy

Chemical industry

PyroCO₂

Demonstrating sustainable value creation from industrial CO₂ by its thermophilic microbial conversion into acetone

Objective

The PYROCO₂ project will demonstrate the scalability and economic viability of carbon capture and utilisation (CCU) to make climate-positive acetone, a platform chemical for many other chemicals, fuel additives, and materials.

Approach

The aim is to produce climate-positive acetone from industrial CO₂ and hydrogen derived from renewable electricity, as a platform for manufacturing chemicals and materials with a negative carbon footprint. The core of the technology is an energy-efficient thermophilic microbial bioprocess. The acetone produced by the PYROCO₂ process will be demonstrated as a platform for the catalytic synthesis of a range of chemicals, synthetic fuels, and recyclable polymer materials derived from CO₂.

Expected impact

The project aims to demonstrate the large-scale industrial feasibility of thermophilic microbial gas fermentation to produce acetone from CO₂ and renewable electricity as a platform for further chemo-catalytic upgrading into a range of other commodity chemicals and materials. The PYROCO₂ demonstrator plant will be located at an industrial cluster in Norway. From here, the PYROCO₂ project will represent a key driver for the emergence of CCU hubs across Europe. Besides the large-scale demonstration and full financial, regulatory, and environmental assessment of the PYROCO₂ technology, the project will explore public acceptance and market exploitation to further encourage the development of the CCU market.

Budget

DKK 332,000,000

Funding source

Horizon Europe

Partners

Again, Arkema France, Axelera, Bioprocess Technology, Chalmers University of Technology, CiaoTech, Ecoinnovazione, Firmenich, Herøya Industrial Park, Johnson Matthey, Karlsruhe Institute of Technology, French National Centre for Scientific Research, NextChem, Norce, Norner Research, Ranido, SCG Chemicals, SINTEF, Technical University of Denmark, Vestfold and Telemark County Council

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Timeline

2021 - 2027

TRL

4 → 7

Sectors

Chemical industry

PytoCCUS

Development and demonstration of an integrated solution in which pyrolysis is combined with CO₂ capture and liquefaction at an existing biogas plant.

Objective

Pyrolysis is a key technology for reducing greenhouse gas emissions in Danish agriculture, while also offering export opportunities and the potential to create new jobs in rural areas. The PytoCCUS project seeks to demonstrate how integrating pyrolysis with carbon capture, utilisation and storage (CCUS) technologies at a biogas plant can further enhance these benefits.

Approach

The PytoCCUS project develops and demonstrates an integrated solution in which pyrolysis is combined with CO₂ capture and liquefaction at an existing biogas plant in Vrå. The project brings together pyrolysis technology, CO₂ capture, energy-efficient heat integration and the use of biochar in a single integrated system.

Technologies are developed and tested to enable the capture of CO₂ from biogas upgrading and, in the longer term, from pyrolysis flue gases. At the same time, the project investigates how biochar from pyrolysis can be used within the biogas plant, for example to remove sulphur compounds, reduce odour emissions and improve methane production.

The system is designed as a modular solution that can be replicated and deployed at other biogas plants in Denmark and internationally.

Expected impact

The project is expected to demonstrate an energy-efficient and cost-competitive CCUS solution that significantly reduces CO₂ emissions from biogas plants. At the same time, it will strengthen value creation from biomass through improved carbon utilisation and support the development of new commercial applications for biochar.

Specifically, PytoCCUS is expected to:

- demonstrate an integrated CCUS value chain combining pyrolysis, biogas production and CO₂ capture
- provide documentation of climate impacts through life cycle assessments
- strengthen regional competences and employment opportunities

Budget

DKK 49,866,749

Funding source

The Just Transition Fund (JTF)

Partners

Agri Energy, Danish Technological Institute, Energy Cluster Denmark, Kliwen, Roskilde University, Soft & Teknik, Stiesdal SkyClean

Contact

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Timeline

2025 - 2028

TRL

2-6 → 7

Sectors

Agriculture

Biogas

PytoX

Advanced Pyrolysis Products

Objective

Pyrolysis of agricultural residues is considered a cost-competitive and scalable solution for producing carbon-negative biofuels. While Stiesdal SkyClean has matured the pyrolysis technology to produce safe and stable biochar, hot pyrolysis gas is not a commodity, limiting the large-scale deployment of the technology. The project aims to increase the value and utilisation of pyrolysis products by creating innovative applications for both pyrolysis gas and biochar.

Approach

The project seeks to develop biofuels for the industrial sector from the condensable bio-oil fraction of the pyrolysis gas and biomethane from the dry gas fraction using BioGasClean's biological methanation technology. In parallel, biochar-based products for building materials are developed in collaboration with Saint-Gobain Isover to expand the application possibilities of biochar.

Expected impact

The project will use Stiesdal's smaller wood-feedstock test facility at GreenLab Skive to inform the design of a larger future SkyClean plant. Skive provides a flexible, low-risk platform for testing new configurations, including BioGasClean's small-scale biological methanation unit, before scale-up.

The project is expected to demonstrate how pyrolysis gas and biochar can be upgraded into higher-value biofuels, biomethane and applications in building materials, while defining requirements for simulations, process flow diagrams and preliminary component sizing.

The project will deliver four outputs: a basic design for a larger plant, validated knowledge on upgrading residual gas and biochar, new biochar applications in building materials and an educational programme with Fredericia Maskinmesterskole to support recruitment and upskilling for future operation.

Budget

DKK 19,994,494

Funding source

The Just Transition Fund (JTF)

Partners

Fredericia College of Marine and Technical Engineering (FMS), Saint-Gobain, Stiesdal SkyClean, Technical University of Denmark

Contact

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Timeline

2025 - 2028

TRL

4 → 7

Sectors

Biogas

Fuels

Construction

ReCycle

Cost Efficient and Environmentally Friendly Green Transition by ReCycling of Bio-genic Carbon by combining Oxy-combustion and Power-to-X

Objective

A shortage of biogenic carbon is a key challenge for the green transition. The ReCycle project aims to provide a technology, infrastructure and operational strategy to recycle substantial amounts of biogenic carbon (~15 MtCO₂/year) at very low cost. This will save Denmark investments of more than €15 billion and operational costs of more than €2 billion annually, compared with the use of direct air capture (DAC) for the same purpose. The recycling of carbon is enabled by low-cost oxy-combustion carbon capture (<2 €/tonne), using surplus O₂ from Power-to-X (PtX).

Approach

The ReCycle project combines techno-economic modelling, experimental energy technology development and energy system analysis. It uses oxy-combustion carbon capture fuelled by surplus oxygen from Power-to-X (PtX) electrolysis to enable low-cost capture and recycling of biogenic CO₂ from biomass-fired combined heat and power (CHP) plants, particularly straw-fired systems. The project includes pilot-scale testing and control optimisation of straw-fired oxy-combustion at a demonstration CHP facility. Researchers will apply Balmorel-based energy system and gas infrastructure models to evaluate carbon recycling, seasonal energy storage, land use and socio-economic impacts under future Danish energy scenarios. The project also investigates reversible electrochemical technologies, grid-balancing capabilities and open-source modelling approaches to assess pathways for large-scale implementation and integration with renewable energy systems.

Expected impact

The ReCycle project is expected to deliver a scalable and cost-effective solution for recycling biogenic carbon, enabling up to 15 MtCO₂ per year of additional carbon availability for green fuels and other hard-to-abate sectors. By demonstrating low-cost oxy-combustion carbon capture and integrating biomass-fired CHP plants with Power-to-X (PtX) infrastructure, the project aims to reduce dependence on expensive direct air capture (DAC) and hydrogen-based seasonal storage. Expected impacts include lower costs for Denmark's green transition, improved energy security, enhanced grid stability through dispatchable renewable power generation and more efficient use of agricultural and forestry residues. The technology could be applied in biomass CHP plants, waste incineration facilities, carbon capture networks and future renewable fuel production systems.

Budget

DKK 18,452,921

Funding source

AgriFoodTure, INNO-CO₂US, MissionGreenFuels, Trace

Partners

Burmeister & Wain Energy APS (BWE), Danish Technological Institute, Technical University of Denmark, Topsoe, University of Copenhagen, Aarhus University

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Timeline

2026 - 2029

TRL

3 → 4

Sectors

Agriculture

Fuels

Energy utility

Forestry

Infrastructure

Cross sector

Onshore storage

Reformable

Biogas to Syngas

Objective

Reformable produces sustainable fuels and chemicals from biogas. One of the main technical challenges is to convert methane (CH_4) and carbon dioxide (CO_2), the two main components of biogas, into syngas (CO and H_2) without forming coke, which deactivates the catalyst. Reformable's solution is a new, patented technology that effectively removes the coke from the catalyst's surface, which results in high catalytic activity and stability.

Approach

The project will allow Reformable to optimise the catalytic process using a new dedicated and automated 16-parallel reactor setup equipped with state-of-the-art process control technology and online sample analysis. Furthermore, the project will focus on designing a future pilot plant.

Expected impact

In the short term, the project will allow Reformable to optimise and upscale a first pre-commercial prototype catalyst, which is needed for future pilot-scale testing using authentic biogas in the field. In the long term, Reformable aims to commercialize their technology, providing the catalysts and core process design needed to produce higher-value fuels and chemicals, such as methanol, ethanol, or sustainable aviation fuels from biogas.

Budget

DKK 4,600,000

Funding source

Villum Foundation

Partners

Technical University of Denmark

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Timeline

2025 - 2027

TRL

4 → 5

Sectors

Biogas

Fuels

ReFuel

Harnessing archaeal processes to capture carbon dioxide into alkanes as renewable fuels and energy storage agents

Objective

ReFuel investigates the feasibility of the microbial-mediated process, alkanogenesis, which is the proposed formation of higher alkanes mediated by Archaea. The vision is to harness alkanogenesis as a fundamental platform for the development of green, circular biotechnologies. ReFuel aims to explore the Archaeal alkane oxidation and tackle alkanogenesis by gaining a deeper understanding of the phylogenetic and functional diversity of alkane-oxidising Archaea.

Approach

Biological formation of higher alkanes is supported by physiology and isotope labelling experiments showing a backflux of CO₂ to alkanes, and by in situ geochemical studies showing the presence in gas reservoirs of alkanes depleted in ¹³C - an indication of biological origin. To meet the goals of the project, ReFuel will use a combination of microbial physiology experiments, stable isotope probing, single cell chemical imaging and metagenomics approaches. When demonstrated, alkanogenesis will offer an organismic explanation to sedimentary geochemical observations like natural gas micro-seepage or isotopically depleted gaseous alkanes.

Expected impact

The project expects to define an archaeal-mediated hydrocarbon cycle in anoxic sedimentary basins, and to expand our fundamental understanding of the metabolic potential of Archaea and their environmental function and impact. The project aims to develop green technologies that will produce renewable fuels (zero net CO₂ emissions). The target alkanes, like butane, have high energy density, are easily liquefied, stockpiled, and can drop-in directly in existing infrastructure.

Budget

DKK 24,992,842

Funding source

Novo Nordisk Foundation

Partners

Aarhus University

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Timeline

2023 - 2030

TRL

2 → 4

Sectors

Fuels

REUSE

Enzymatic CO₂ Capture in a Rotating Packed Bed and Electrocatalytic CO₂ Reduction to Useful Products

Objective

CO₂ capture is a key part of the green transition, but current technologies are often too complex, inefficient, or immature for large-scale use. The REUSE project addresses this challenge by advancing an integrated solution that captures CO₂ from biomass combustion and converts it into valuable products. The project will build an advanced CO₂ capture and utilisation solution by combining a biotechnological approach, where carbonic anhydrase (CA) is immobilised into cellulosic fibres in a rotating packed bed reactor (RPB), and advanced solvents to transform CO₂ into carbon monoxide or formic acid in a CO₂ reduction cell.

Approach

The project will build upon existing technologies and projects and converge these experiences into the development of an integrated system combining a biomass combustion unit, a rotating packed bed reactor, and a CO₂ reduction cell. Given the complexity of the process, a multi-disciplinary approach will be used to overcome limitations and optimise critical parts of the system, including the biomass combustion step, the rotating packed bed reactor, and enzyme-mediated CO₂ capture. Finally, the full system will be tested in a pilot plant to develop an appropriate model that captures the complexity of mass transfer and includes non-ideal thermodynamic modelling to assess overall performance.

Expected impact

REUSE's main contribution is the development of an integrated and efficient system that captures CO₂ from biomass combustion and converts it into formic acid. The system combines enzyme-based capture, a rotating packed bed reactor, and a CO₂ reduction unit, and will be demonstrated at technology readiness level 5. To improve integration between the system components, the project will consider ways to reduce flue gas variability and toxicity, such as using novel catalysts or blending different types of biomass. Immobilising the enzyme is expected to enhance its stability and absorption kinetics, enabling reuse. The development of a cost-effective supply of renewable energy carriers will further support circularity.

Budget

DKK 28,000,000

Funding source

Horizon Europe

Partners

Center for Research and Technology Hellas, Clean Energy Solutions, ETA Florence Renewable Energies, Manchester Metropolitan University, Newcastle University, Novonesis, TBW Research, University of Aveiro, University of Leicester, Y Squared

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Timeline

2024 - 2027

TRL

3 → 5

Sectors

Chemical industry

SEMPRE-BIO

Securing domestic production of cost-effective biomethane

Objective

In March 2022, the European Commission announced a target to produce 35 billion cubic metres of biomethane within the EU by 2030. Today, the EU produces 3 billion cubic metres of biomethane. Plans to scale up require the mobilisation of sustainable biomass feedstock. In this context, the aim of SEMPRES-BIO is to demonstrate novel and cost-effective biomethane production solutions and pathways.

Approach

The project will set up three European Biomethane Innovation Ecosystems (EBIEs), based in Adinkerke (Belgium), Baix Llobregat (Spain) and Bourges (France), which are representative of the different baseline situations for biomethane production across Europe. Those initial EBIEs will facilitate long-term replication by creating an active flow of information and resources for ideas to transform into reality. The project will build a process by which more innovators and entrepreneurs will be able to more quickly develop and launch solutions to solve problems related to the larger-scale and cheaper production of biomethane. This process will create new technical expertise, help diversify the technology portfolio, and will allow businesses to know their potential customers better. Additionally, the EBIEs will provide the means to create economic stability and resource sharing.

Expected impact

The value of the EBIEs lies in the access to resources for the start-ups and the flow of information for the ecosystem's stakeholders. This information flow will create more future investment opportunities for the right institutions to connect with the right ideas for their businesses and portfolios at the right time and for the right reasons.

Budget

DKK 74,076,000

Funding source

Horizon Europe

Partners

Aigües de Barcelona, Beta Technological Center, Biogas-e, CETAQUA, CRYO inox, Deutsches Biomasseforschungszentrum, Innolab, Inveniam Group, Naturgy, NV De Zwanebloem, ProPuls, SINTEF, Technical University of Denmark, TerraWatt, Transports Metropolitans de Barcelona, Universiteit Gent

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Timeline

2022 - 2026

TRL

7

Sectors

Biogas

SimCO₂CFuel

Simultaneous CO₂ Capture and Renewable Fuel Production by 4D Self-Electro-Promoted Catalyst Concept

Objective

SimCO₂CFuel aims to develop a compact and energy-efficient method for producing renewable methanol from CO₂, using only water and flue gas or atmospheric CO₂ as input. To achieve this, the project will develop a novel 4D self-electro-promoted catalyst concept that captures CO₂ from flue gas or ambient air and converts it into renewable methanol using water as a raw material in a compact, low-pressure process. This hybrid catalyst is designed to split water, filter and purify hydrogen, adsorb CO₂, and self-promote the hydrogenation reaction by increasing the catalyst's Fermi level using semiconductor materials.

Approach

The SimCO₂CFuel strategy focuses on the development of a hybrid 4D catalyst material that integrates thermoelectric and pyroelectric properties, facilitating the concurrent capture of CO₂ and the production of renewable methanol. A thermoelectric core, when exposed to temperature gradients, facilitates electron transfer, whereas a photoelectrochemical layer decomposes water into hydrogen and oxygen.

Expected impact

The successful development of the 4D catalyst will facilitate efficient, low-pressure CO₂ capture and conversion, leading to a reduction in energy consumption and costs compared to conventional methods. The technology offers the potential for scalable application across various CO₂ emitters, contributing to sustainability in line with the European Green Deal. The anticipated results will include a validated catalyst prototype, theoretical models, and experimental correlations, which will enhance catalyst design and establish a basis for future compact renewable fuel systems.

Budget

DKK 1,991,625

Funding source

Villum Foundation

Partners

Aalborg University

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Timeline

2023 - 2026

TRL

1 → 3

Sectors

Fuels

SOLARSPOON

Solar-driven synthesis of proteins and lipids via photoelectrochemistry of living organisms

Objective

The SOLARSPOON project addresses a critical bottleneck in global climate action and food security: the massive carbon and environmental footprint of traditional agriculture, which is heavily reliant on land, water and volatile supply chains. Current "Food from Air" alternatives rely on complex, multi-stage gas fermentation using green hydrogen, which suffers from severe energy conversion losses. SOLARSPOON will develop a first-of-its-kind, stand-alone bio-photoelectrochemical reactor. By establishing direct electron transfer from sunlight and captured carbon dioxide to specialised microbial consortia, the project aims to synthesise high-quality edible proteins and lipids with unmatched thermodynamic efficiency.

Approach

SOLARSPOON achieves direct solar-to-food conversion by combining advanced material science, electrochemistry and synthetic biology. The core technology centres on developing high-efficiency biophotoanodes, where proprietary microbial consortia are directly "wired" to an inorganic electrode surface. This electronic interface is enabled by designing and synthesising custom organic redox polymer hydrogels that facilitate ultra-fast extracellular electron transfer while physically immobilising the living cells. These biohybrid components are integrated into a single, modular, stand-alone bio-photoelectrochemical device prototype. Furthermore, the project utilises comprehensive life cycle sustainability assessment (LCSA) techniques to model land-use savings and overall environmental impact.

Expected impact

SOLARSPOON's primary outcome is a laboratory-validated, stand-alone prototype device proving the viability of direct solar-to-food conversion. By eliminating the need for fertile land and agricultural inputs, the technology yields a carbon-negative source of high-quality proteins and lipids, achieving a 99% reduction in land and water use compared with traditional livestock farming. It directly strengthens European Union strategic autonomy by bridging Europe's protein import gap and transforming captured carbon dioxide into a nutritional asset, accelerating the transition towards climate neutrality by 2050. In the B2B ingredient market, it offers sustainable, functional food additives for plant-based alternatives.

Budget

DKK 29,896,374

Funding source

Horizon Europe

Partners

Denmark University of Cambridge, Imperial College London, Solar Foods, Technical University of Denmark, Technical University of Munich

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Timeline

2025 - 2029

TRL

2 → 4

Sectors

Food production

SUMIT

SUstainable Microalgae protein production through InTegrated carbon-nutrient recovery

Objective

The SUMIT project addresses the critical EU protein dependency crisis alongside the environmental and financial burdens of the biogas sector, specifically the high costs of disposing of nutrient-rich digestate and the emissions of biogenic CO₂. Current systems lack integrated solutions to simultaneously tackle these waste management and carbon utilisation challenges. The project's main objective is to establish and demonstrate an integrated, circular technology platform (advancing from TRL 4 to TRL 6) that valorizes biogas CO₂ emissions and digestate nutrients to cultivate high-value, climate-adapted, non-GMO microalgae protein. This will create a scalable, land-efficient, and economically viable alternative protein source for Denmark and the EU.

Approach

SUMIT integrates biotechnology and process engineering by applying UV-based random mutagenesis to develop temperature-tolerant (15-40 °C) non-GMO microalgae strains. To sustain cultivation, Nordphos' three-stage pressure-distillation technology upcycles raw biogas digestate into a sterile, nutrient-rich growth medium, while direct pipeline systems feed biogenic CO₂ from upgrading units into the system. These streams are integrated into a 3,000 L vertical AlgaeNite photobioreactor system, automated by an AI cloud-based platform that dynamically manages pH, temperature, and gas sparging to optimise yields. Finally, the project validates this platform through on-site pilot-scale operations, supported by Techno-Economic and Life Cycle Assessments to evaluate commercial viability and proactive regulatory mapping for feed approval with Danish food authorities.

Expected impact

SUMIT will deliver a circular bioeconomy model that transforms biogas waste streams into high-value protein feed. Key outputs include climate-adapted microalgae strains, a validated pilot-scale platform (TRL 6), and a ≥90% clarified, sterile digestate nutrient medium. The project will achieve an annual protein yield of up to 30 t/ha, 30 times more land-efficient than soy, while capturing biogenic CO₂ with ≥75% efficiency. Economically, each typical biogas plant can save over 34 million DKK annually in digestate transport costs and generate 1-3 million DKK in new nutrient revenues. Ultimately, deploying just five installations will produce over 1,500 tons of sustainable protein and capture 6,000 tons of CO₂ annually, strengthening Danish food security, creating green jobs, and establishing a high-growth export market for the partner technologies.

Budget

DKK 15,288,503

Funding source

AgriFoodTure, INNO-COUS, MissionGreenFuels, Trace

Partners

Algaenite, Nordphos, Solrød Bioenergy/Bigadan

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Timeline

2026 - 2028

TRL

4 → 6

Sectors

Biogas

Food production

Waste-to-energy

SUSTEPS

Sustainable, Secure, and Competitive Energy Through Scaling Up Advanced Biofuel Generation

Objective

SUSTEPS aims to enhance the sustainable production of algae-based biofuels by addressing challenges and leveraging opportunities in the value chain. The project focuses on developing a cost-effective and eco-friendly bio-refinery concept. It efficiently produces biofuel from non-food microalgae by utilising CO₂ emissions from high-pollution sources and nutrients from wastewater. The goal is to minimise production costs, promote large-scale production, and contribute to a more sustainable biofuel industry.

Approach

Innovative customised biofuels targeting market standards will be produced using leading-edge catalysts while minimising waste streams and impurities. The production of biofuels using microalgae as a raw material and CO₂ as a feedstock holds significant potential for positive environmental impact. This process contributes to carbon capture by utilising flue gas, reducing greenhouse gas levels in the atmosphere. Microalgae's rapid growth and high lipid content make them an efficient biofuel feedstock, offering a renewable alternative to traditional fossil fuels. This can reduce overall carbon footprints, enhance energy security, and pave the way for a more sustainable and environmentally friendly energy future.

Expected impact

Disruptive renewable energy and renewable fuel technologies and systems to accelerate the replacement of fossil-based energy technologies. Reduced costs and improved efficiency of renewable energy and fuel technologies, their value chains and net zero greenhouse gas emissions by 2050. Better integration of renewable energy and renewable fuel-based solutions in energy consuming sectors. Strengthened European research and export opportunities Enhanced sustainability of renewable energy and renewable fuels value chains in line with the European Green Deal priorities. More effective market uptake of renewable energy and fuel technologies. Faster development of of CCUS as a CO₂ emissions mitigation option in industrial applications.

Budget

DKK 22,380,000

Funding source

Horizon Europe

Partners

ArditEC Association, Boğaziçi University, ErinN Innovation Limited, Federal University of Itajubá, Forschungszentrum Jülich, Institut de Recherches en Énergie Solaire et en Énergies Nouvelles, Ketjen Netherlands BV, Paul Scherrer Institute, Scientific and Technological Research Council of Turkey, University of Calgary, University of Southern Denmark

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Timeline

2023 - 2026

TRL

3 → 5

Sectors

Fuels

SynoProtein

Carbon capture from syngas to Single Cell Protein (SCP) and use as fish feed ingredient

Objective

The SynoProtein project aims to develop, mature, and demonstrate a novel carbon-negative process that enables high value creation of SCP from sawmill by-products through carbon capture and use (CCU). The project fits strongly with the mission of the CBE JU (Circular Bio-based Europe Joint Undertaking), which is to “advancing a competitive bioeconomy for a sustainable future”.

Approach

With this project, SynoProtein will demonstrate that 1.25 tons (t) of CO₂-e can be captured from syngas via CCU for each dry-ton sawmill by-products processed. The consortium has developed an innovative process for the vertical integration of by-products from sawmill industry, i.e., feedstocks comprising only residues (no sawlogs), and conversion into fish feed ingredients, i.e., single cell protein (SCP), along with the production of biochar for animal feed. The process can provide novel, sustainable protein sources, as opposed to conventional energy- and climate-intensive soybean and resource-limited wild fish protein production routes to meet future demands.

Expected impact

Overall, the project expects carbon capture of 200kt of CO₂-e from syngas annually within the process by 2033, recovering 160kt/year of forest residues and producing 120kt/year of fish/animal feed for industry, valued at €175m. This also represents 260 jobs created in EU and reduced 120kt per year imported feed ingredient from other continents. Compared to fish feed production from soybeans, the project is also expected to save carbon emission of 458kt CO₂-e, land use of 147km², and water use of 630,700m³ by 2033

Budget

DKK 44,967,000

Funding source

Horizon Europe

Partners

Bergene Holm AS, DECHEMA, Gesellschaft für Chemische Technik und Biotechnologie e.V., Nofima AS, Norwegian Institute for Sustainability Research (NORSUS), RISE Research Institutes of Sweden, SINTEF, Skretting Aquaculture Research Centre AS, Technical University of Denmark, WAI Environmental Solutions AS

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Timeline

2023 - 2028

TRL

4 → 6

Sectors

Food production

TOBIAS

The Methanol Generation from Biogas

Objective

Efficient conversion of biogas into methanol requires catalysts that minimise carbon buildup while maintaining high conversion efficiency and long operational lifetimes. The TOBIAS project aims to develop an innovative biogas reforming catalyst, demonstrate its performance in a pilot plant and produce 1,000 L of raw methanol to validate the catalyst's efficiency, stability and operational lifetime. The project will also prepare a technical report defining evaluation criteria for the optimal large-scale implementation of biogas-to-methanol conversion.

Approach

The TOBIAS project develops and optimises an advanced catalyst that reduces carbon buildup, enabling biogas reforming at lower temperatures while maintaining high conversion efficiency and syngas quality. By integrating the process in an electrified furnace powered by renewable energy, the project significantly lowers energy demand and CO₂ emissions.

Expected impact

The project is expected to deliver:

- Improved operational efficiency and reduced environmental impact through lower carbon buildup and reduced energy consumption.
- Demonstration of a cost-effective approach to greener syngas production as a pathway to methanol.
- A technical basis for the development of energy-efficient biogas-to-methanol plants.
- Opportunities for decentralised biogas utilisation through compact, easily deployable systems.
- A contribution to Denmark's ambitions for Power-to-X (PtX) and reduced dependence on fossil fuels.

Budget

DKK 8,520,000

Funding source

MissionGreenFuels

Partners

Elplatek, Shell, Technical University of Denmark

Contact

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Timeline

2025 - 2028

TRL

5 → 7

Sectors

Fuels

Biogas

UC-DC

Utilisation of carbon for decarbonisation project

Objective

This project will convert waste CO₂ and CO₂ captured directly from air into commodity chemicals for replacing petrochemicals, thus unlocking a sustainable and future-proof carbon source for decarbonising the chemical industry.

Approach

UC-DC will develop a CCU technology using bacteria for biological CO₂ capture. The technology will be able to convert the CO₂ into commodity chemicals which fit the existing chemical supply chain. To further expedite the potential applications of CCU, the project will demonstrate the conversion of the produced commodity chemicals into monomers for further polymerisation. This will provide valuable plastic pellets, demonstrating a value chain spanning from carbon capture to a final plastic material.

Expected impact

Combining environmental and socio-economic studies with technological advances, UC-DC will pave the way for a more sustainable, non-fossil-based chemical industry. This integration will bring value-creation for the consortium partners, enabling them to unlock a million-dollar market upon commercialisation 5 years following project completion. Part of this value will be realised immediately as the environmental, socio-economic, and technological advances will guide strategic choices of Again and Pond. The achieved results will be implemented at the UC-DC companies directly, thereby accelerating the global transition from petrochemicals to CCU-based chemicals.

Budget

DKK 10,562,523

Funding source

INNO-CCUS

Partners

Danish Technological Institute, Pond, SecondCircle, Technical University of Denmark

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Timeline

2023 - 2026

TRL

3 → 5-6

Sectors

Chemical industry

VALORGAS

Engineering a novel reactor system for enhanced valorisation of syngas and CO₂ to chemicals and fuels

Objective

As industry seeks to convert CO₂ and syngas into fuels and valuable chemicals using renewable electricity, new reactor technologies are needed to make the process more efficient and scalable. VALORGAS focuses on developing:

- A novel, compact reactor system that eliminates the need for an external water electrolysis unit while still securing enhanced mass transfer rates and productivities
- A model tailored to simulate the novel reactor type, which can be used for design purposes — i.e. to predict the optimal reactor size and dimensions for a given industrial scale of gas valorisation, as well as the best operating conditions for maximising productivity and carbon utilisation.

Approach

We will work on reactor design and construction, while simultaneously developing electroactive microbial enrichments to initiate the reactor process. The next step will be to measure the kinetics of the enriched microbial consortia and develop a model for the biological reactions in the novel reactor. This approach targets proof-of-concept for the reactor and the creation of a modelling tool that can be used to scale up the process.

Expected impact

Successful implementation of VALORGAS will pave the way for more cost-effective CO₂ valorisation using renewable electricity. The novel reactor and the methodology for Tags electroactive microbial enrichment can also be applied to syngas valorisation, and the system could accommodate Fuels electroactive strains and defined co-cultures. Similarly, the model will be tunable and adjustable for specific applications. PtX This adaptability maximises the potential impact of VALORGAS.

Budget

DKK 3,000,000

Funding source

The Novo Nordisk Foundation CO₂ Research Center (CORC)

Partners

Technical University of Denmark

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Timeline

2024 - 2027

TRL

2 → 4

Sectors

Fuels

Value4Farm

Sustainable renewable energy value chains for answering farmers' needs

Objective

The aim of Value4Farm is to increase on-farm renewable energy and bio/e-fuel production while preserving food production, soil health, soil carbon accumulation, and biodiversity, as well as reducing water and fertiliser use. The project focuses on several innovations to support more sustainable farming. These include developing better-adapted cropping systems for integrated, wind-sheltering agrivoltaics and combining food and bioenergy production through green biorefineries. It also aims to advance the concept of in situ power-to-methane and create a decision support tool to help farmers produce food, energy, and materials more sustainably.

Approach

The Danish platform of Value4Farm combines agrophotovoltaics, green biorefineries, anaerobic digestion, and biomethanation. Its aim is to maximise production of electricity, food, and feed, while ensuring an optimal supply of carbon for the production of bio- and electricity-based methane in a fully circular system. The project includes demonstration sites in Belgium, Italy and Denmark.

Expected impact

The continued deployment of renewable energy facilities based on wind and solar power will ultimately compete with access to arable land for food production. Value4Farm will explore how best to combine technologies for the production of green crops with electricity and bio/e-fuels through biogas-based Power-to-X. To this end, the project will develop new knowledge, technologies, and decision-support tools.

Budget

DKK 58,033,089

Funding source

Horizon Europe

Partners

Energy Institute Hrvoje Požar, Euroquality, Helmholtz Centre for Environmental Research – UFZ, Inagro, Institute of Soil Science and Plant Cultivation – State Research Institute, Italian Biogas and Gasification Consortium, Mitis, Orkidea samstarfsverkefni, REM Tec, Università Cattolica del Sacro Cuore, University of Reading, Wageningen University & Research, World Biogas Association, Aarhus University

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Timeline

2023 - 2027

TRL

N/A

Sectors

Agriculture

Vingegaard

The advanced electrochemical based carbon capture and green gas to methanol process demonstration

Objective

The project aims to demonstrate an innovative Power-to-X process that integrates electrochemical carbon capture with CO₂-based methanol synthesis at a wastewater treatment plant. The project will develop and validate a cost-effective and energy-efficient pathway for converting CO₂ emissions into green methanol. We expect that combining ESTECH's carbon capture technology, Elplatek's methanol synthesis expertise, and DTU's scientific support will enable a scalable and decentralized Power-to-X solution.

Approach

The project integrates electrochemical carbon capture with a modular methanol synthesis unit to create a cost-effective Power-to-X solution. ESTECH's advanced technology efficiently captures CO₂ from wastewater treatment plant flue gas, while Elplatek's containerised reactor converts CO₂ and H₂ into green methanol. DTU provides scientific and operational support to enhance efficiency, scalability, and automation, ensuring higher safety and reduced operational risks. Our approach focuses on a decentralised, containerised system that minimises energy consumption and operational costs.

Expected impact

The VINGEGAARD project will demonstrate that wastewater-derived CO₂ can be effectively utilised, reducing greenhouse gas emissions, while contributing to Denmark's green TRL: fuel transition. This will advance Power-to-X technology, enhancing Denmark's leadership in sustainable fuel solutions, 5 7 and contributing to climate goals. The project will create a scalable, modular system for decentralised green methanol production, fostering industrial collaboration and knowledge Tags transfer. End-user IKEA will evaluate the produced methanol for its applications, promoting sustainable supply chains and Fuels Point source capture reducing fossil fuel dependence.

Budget

DKK 26,113,701

Funding source

The Danish Energy Agency, The Energy Technology Development and Demonstration Programme (EUDP)

Partners

Elplatek, ESTECH, IKEA, Technical University of Denmark, VandCenter Syd

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Timeline

2025 - 2027

TRL

5 → 7

Sectors

Fuels

Waste plastics

CO₂ capture by waste plastics

Objective

Every year nearly 400 million tonnes of non-biodegradable materials, such as plastics and textiles, are produced. These materials generally have a short lifetime use, resulting in vast amounts of plastic waste accumulation. The ambition of the project is to expand plastic upcycling technologies to provide possible solutions for supporting household and community-level activities for carbon capture.

Approach

The project's research efforts are focused on the investigation of whether some of the most common and abundant plastic wastes can be upcycled into useful materials through simple and efficient chemical modifications for expediting the capture and sequestration of CO₂ directly from air or point sources.

Expected impact

The successful realisation of waste plastic for carbon removal provides an opportunity with economic benefits. The chemical industry will experience a boost in their production of highly useful platform and bulk chemicals from CO₂ through catalytic or biological processes. End-of-life plastics provide a unique opportunity for carbon capture, not only because their chemical modification to capturing agents can potentially be done in only a few chemical steps. More importantly, the tremendous quantities of such materials could allow for the goal of CO₂ sequestering at a gigaton scale to be potentially achievable.

Budget

DKK 20,000,000

Funding source

The Novo Nordisk Foundation CO₂ Research Center (CORC)

Partners

The Novo Nordisk Foundation CO₂ Research Center (CORC)

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Timeline

2023 - 2026

TRL

1 → 4

Sectors

Chemical industry

WOODCIRCLES

Integrated, circular, and digitally supported sustainable solutions for waste minimisation and carbon capture in buildings and the construction sector

Objective

This project addresses two challenges:

- How do we make better use of construction and demolition waste-wood from demolished buildings, and
- How do we design tomorrow's timber buildings so materials and components can be re-used in the future? Thus, the aim of this project is to significantly increase circular use of wood in construction, reducing waste generation and resource consumption through increased use and re-use of wood.

Approach

Based on identified needs and market potentials, the project will develop new value chains for upcycling of wood waste materials. Additionally, the project will develop optimised design-for-disassembly building system solutions, to significantly increase recycling rates of wood in construction. The project will prototype an 'Urban Sawmill' sorting and production facility, that can turn in-homogenous low value wood construction waste into a standardised homogenous baseline product. The project will integrate digital tools and solutions in all developments and create digital twins for the large-scale, real-life demonstrators. The WOODCIRCLES solutions will be demonstrated in three pilot European cities (Rotterdam, Tartu and Turin).

Expected impact

The construction sector is responsible for over 35% of the EU's total waste generation and about 50% of all extracted resources. Large scale circular use of wood could go a long way in ensuring the green transition of the construction industry. The goal of this project is to accelerate this transition.

Budget

DKK 66,099,000

Funding source

Horizon Europe

Partners

O11h Sustainable Construction, Amsterdam University of Applied Sciences, Comune di Torino, Danish Technological Institute, Easyscience, Enemærke & Petersen, EnviPark, Folkhem Trä, Fondazione ICONS, Fundacio ENT, Gemeente Rotterdam, Iren SPA, Rotho Blaas, Stora Enso Oyj, Tartu Linn, Trimble, University of Cambridge, Urbasofia, Waugh Thistleton Architects, Woodfiber

Contact

Anders Kjellow, awk@teknologisk.dk

Timeline

2023 - 2027

TRL

2 → 6

Sectors

Construction

WURTZ

The Power-to-X based Carbon Capture and Methanol Production for Wastewater Decarbonisation

Objective

Small- and medium-sized CO₂ emitters require scalable solutions to convert captured CO₂ into valuable products. The WURTZ project aims to develop a robust catalytic process for converting CO₂ and H₂ into green methanol that is tolerant to gas variations and impurities. The project will purify gases from the CAPPOW system, implement and operate a pilot system at VandCenter Syd and evaluate the quality of the produced methanol for use as a marine fuel.

Approach

The WURTZ project combines carbon capture, gas purification and methanol synthesis to demonstrate the first Power-to-X (PtX) methanol production system at a wastewater treatment plant. The project integrates the CAPPOW system with methanol production to convert captured CO₂ into green methanol. The integrated system will be demonstrated and operated under real flue gas conditions through collaboration between ESTECH, Elplatek, VandCenter Syd and the Technical University of Denmark

Expected impact

The project will demonstrate methanol production from CO₂ captured at a wastewater treatment plant and validate a compact CO₂ capture and conversion unit. It will evaluate the compatibility of the produced methanol with maritime fuel standards and demonstrate reliable operation under real flue gas conditions, including gas conditioning and catalyst performance. The modular approach is expected to provide a scalable solution for small- and medium-sized CO₂ emitters and support the conversion of CO₂ emissions into green methanol. Successful demonstration of the technology could strengthen Denmark's role in green fuel innovation.

Budget

DKK 16,300,000

Funding source

MissionGreenFuels

Partners

Elplatek, ESTECH, Technical University of Denmark, TORM, VandCenter Syd

Contact

Pantelis Bountzidis, pabou@kt.dtu.dk

Timeline

2025 - 2028

TRL

6 → 7

Sectors

Chemical industry

Waste-to-energy

Fuels

Completed projects

Acetate Consortium - CO₂ as a sustainable raw material in our future food production

Food insecurity is a rising global problem. A recent UN-led report shows that more than 250 million people faced severe hunger during 2022, which was an increase of 65 million compared to the year before. To counteract this development, this project aims to contribute to the establishment of a sustainable, safe, and stable food production that can feed a growing world population. The aim is to help fight the rising global problems with food insecurity and greenhouse-gas emissions from agriculture.

Budget: DKK 200,000,000

Funding sources: Novo Nordisk Foundation, Gates Foundation

Partners: Lectrolyst, The Novo Nordisk Foundation CO₂ Research Center (CORC), Novozymes, Topsoe, Washington University St Louis

Contact: Alfred Sporman, aspormann@corc.au.dk

Timeline: 2023 - 2025

TRL: 6

Focus area(s): Carbon conversion

ALGIECEL - CO₂ conversion to bio-based products using ALGIECEL's technology

The objective of this project is to demonstrate the feasibility of converting small amounts of CO₂ from industrial sites into valuable downstream B2B bio-based products. The hypothesis is that we can efficiently convert CO₂ into biomass and bio-oil, demonstrating that water and nutrients can be reused in the process. The aim is to collect CO₂ from Novozymes and utilise it in the ALGIECEL photobioreactor (PBR).

Budget: DKK 1,200,000

Funding sources: Innovation Fund Denmark

Partners: ALGIECEL, Knowledge Hub Zealand, Novozymes, P2CC (Power to Climate Change), Technical University of Denmark

Contact: Henrik Busch-Larsen, hbl@algiecel.com

Timeline: 2021 - 2023

TRL: N/A

Focus area(s): Carbon conversion

APPLAUSE - Apple Aarhus University Sustainable Energy

The project's aim is to develop technologies that enable a stable green power supply, even in scenarios dominated by power production from fluctuating renewables. To this end, the objective of the APPLAUSE project is to conduct research and technology development across multiple disciplines, combining specific aims within biogas, power-to-X, and energy system modelling, thereby coupling value streams of energy and carbon.

Budget: DKK 21,500,000

Funding sources: Apple Inc

Partners: Apple, Aarhus University

Contact: Michael Vedel Wegener Kofoed, Mvk@bce.au.dk

Timeline: 2016 - 2025

TRL: N/A

Focus area(s): Carbon conversion

BE Clean - Biogas electro clean

For power-to-x technologies, high-quality biogenic CO₂ is essential. The BE Clean project is developing a gas-cleaning technology to purify CO₂-rich biogas by removing impurities such as hydrogen sulfide (H₂S), which can interfere with catalytic CO₂ conversion even at parts-per-billion concentrations. The technology aims to reduce H₂S to below ppb levels and will be demonstrated for biogas purification. The project will also investigate the removal of other impurities.

Budget: DKK 23,000,000

Funding sources: The Energy Technology Development and Demonstration Programme (EUDP)

Partners: Danish Gas Technology Centre, Elplatek, Pentair, Technical University of Denmark

Contact: Philip Loldrup Fosbøl, plf@kt.dtu.dk

Timeline: 2020 - 2025

TRL: 6 → 7

Focus area(s): Carbon conversion,

BIFUNC - Bifunctional homogeneous catalytic CO₂ hydrogenation

For a method to efficiently facilitate classical carbon capture storage and utilisation, it must be excellent at both sorbing and desorbing the CO₂. This is inherently thermodynamically difficult to achieve. Thus, BIFUNC aims at skipping the storage element and developing an alternative route where the CO₂ is directly utilised subsequently to the capture step (CCU). The project hypothesises that a bifunctional homogeneous catalyst will realise this endeavour.

Budget: DKK 4,000,000

Funding sources: Villum Foundation

Partners: Technical University of Denmark

Contact: Martin Nielsen, marnie@kemi.dtu.dk

Timeline: 2023 - 2025

TRL: 1 →

Focus area(s): Carbon conversion

BioCO₂ - Biogas upgrading for high-purity CO₂ and natural gas distribution

The objective of this project is to develop and demonstrate a new, more energy-efficient way of upgrading biogas for the combined production of biomethane and bioCO₂. The aim is to improve the profitability for biogas producers by enabling them to sell not only methane to the natural gas grid, but also high-purity CO₂.

Budget: DKK 13,800,000

Funding sources: The Energy Technology Development and Demonstration Programme (EUDP)

Partners: Danish Gas Technology Centre, Pentair, Technical University of Denmark

Contact: Sebastian Nis Bay Villadsen, snbvi@kt.dtu.dk

Timeline: 2016 - 2023

TRL: 4 → 6

Focus area(s): Carbon conversion

Bio-hydrogen production - Decarbonisation of CO₂ storage platforms by bio-hydrogen production

The main objective of the project is to develop an efficient bio-hydrogen production system for a target field in the Danish North Sea. The project will thereby evaluate the applicability of in-situ bioproduction of hydrogen to reduce the environmental footprint of an existing platforms being re-utilised for CO₂ storage by using onsite hydrogen production as the source of energy for the injection process.

Budget: DKK 2,300,000

Funding sources: Danish Offshore Technology Center

Partners: Danish Offshore Technology Center, Technical University of Denmark

Contact: Hamid Nick, hamid@dtu.dk

Timeline: 2023 - 2024

TRL: 2 → 3

Focus area(s): Carbon conversion

BioReFuel - Biogas upgrading for high-purity CO₂ and natural gas distribution

The initial phase of the BioReFuel project developed a novel catalytic technology, which has been successfully tested and fine-tuned in lab-scale. The main objective of this project is to execute the second phase of the project, which includes constructing and testing a biogas-to-methanol demonstration unit.

Budget: DKK 17,000,000

Funding sources: Energy Technology Development and Demonstration Programme (EUDP)

Partners: Elplatek, Lemvig Biogas, Pentair, Technical University of Denmark, Unicat Catalyst Technologies

Contact: Philip Loldrup Fosbøl, plf@kt.dtu.dk

Timeline: 2020 - 2024

TRL: N/A →

Focus area(s): Carbon conversion

BioTechCCU - Biotechnology for converting CO₂ to platform chemicals

This project aims to build on the biomethanation platform as CO₂ capture and integrate it with the utilisation pathways. This will be done by developing biological technologies to produce platform and value-added chemicals. The project has three objectives for this integration:

- To develop biomethanation using Power-to-X for diverse CO₂ point sources and demonstrate at TRL4.
- To integrate acetic acid production at TRL4.
- To develop integrated fermentation of biomethane for bioplastics at TRL4.

Budget: DKK 5,128,000

Funding sources: INNO-CCUS

Partners: Danish Gas Technology Centre, Nature Energy, University of Southern Denmark, Aarhus University

Contact: Muhammad Tahir Ashraf, muta@igt.sdu.dk

Timeline: 2022 - 2024

TRL: 3 → 4

Focus area(s): Carbon-based materials, Point source capture

BUHPC - Development of climate-enhanced high-strength concrete for wind turbine foundations based on biochar from pyrolysis

Biochar is a by-product of pyrolysis and is typically used to improve soil quality in agricultural settings. Biochar from sources such as sludge from households may contain harmful substances and can therefore not be used unhindered. It is the objective of the project to incorporate biochar into ultra-high performance concrete (UHPC) - a particularly strong and durable type of concrete commonly used in demanding infrastructure applications. By doing so, potentially harmful substances will be encapsulated in UHPC and thereby stored safely even after later demolition of the UHPC material. At the same time, it is the objective to create a UHPC material with a lower environmental footprint by using biochar as a cement replacement and as a carbon capture medium.

Budget: DKK 3,876,000

Funding sources: The Energy Technology Development and Demonstration Programme (EUDP)

Partners: Springkilde Bio, Y-MatTec

Contact: Elo Yde, ey@ymattec.com

Timeline: 2024 - 2025

TRL: N/A →

Focus area(s): Carbon-based materials

CapCO₂ - Electrolysis - Capturing CO₂ for simultaneous chlorine and ethanol production using sea water and sustainable electricity

CO₂ electrolysis enables CO₂ utilisation, but the techno-economics of commercialisation remain challenging. In conventional systems, the anodic reaction typically produces low-value oxygen, while the chloro-alkali industry generates low-value hydrogen at the cathode. This project aims to develop a dual electrolyser that combines both processes, generating higher-value products at each electrode. Specifically, it focuses on converting CO₂ to ethanol or propanol at the cathode—both cleaning agents—and potassium chloride to chlorine (also a cleaning agent) and potassium hydroxide at the anode.

Budget: DKK 3,700,000

Funding sources: Innovation Fund Denmark, Ministry of Science and Technology of the People's Republic of China (MOST) - Bilateral Agreement project

Partners: Chinese Academy of Sciences, Fujian Institute of Research on the Structure of Matter, HADA Electrolyzers, HybridGreen Tech, Spectro Inlets, Technical University of Denmark, University of Geosciences

Contact: Brian Seger, brse@dtu.dk

Timeline: 2022 - 2025

TRL: 2 → 4

Focus area(s): Carbon conversion

CO₂ Hub - Hanstholm

Port of Hanstholm is aiming to become Europe's first CO₂-neutral fishing port. Thisted Cogeneration Plant also wishes to contribute to the climate goals. This project aims to prepare Thisted Cogeneration Plant and Port of Hanstholm to participate in future development driven by the following five elements: Implementation of the upcoming national CCUS strategy. PTX projects at Port of Hanstholm. Large-scale CO₂ storage in the seabed off Hanstholm. Expansion of CO₂ capture from biogas plants and an increased number of biogas plants in Denmark. Establishment of national infrastructure for hydrogen and CO₂.

Budget: DKK 4,940,000

Funding sources: CO2Vision - REACT-EU

Partners: Evida, FORCE Technology, Port of Hanstholm, Thisted Cogeneration Plant, Thisted Heat Supply, Thisted Municipality

Contact: Maria Kristiansen, mak@energycluster.dk

Timeline: 2022 - 2023

TRL: 3 → 4

Focus area(s): Carbon conversion

CO2Fix - Sustainability and permanent CO₂ removal: Using geocatalysts to mineralise CO₂ and convert waste to a valuable product

CO2Fix is based on the idea that biogenic molecules can act as catalysts to control mineral-water-gas reactivity. This paves a way for fast, permanent conversion of CO₂ to solid, locally, at the factory chimney with no safety risks associated with CO₂ transport and long-term monitoring at storage sites. Specifically, CO2Fix offers an end-of-life solution for large volumes of waste building materials, such as stone wool, that end in landfills each year.

Budget: DKK 26,097,301

Funding sources: Innovation Fund Denmark

Partners: ARGO (Roskilde Energitårnet), Ikast Betonvarefabrik, ROCKWOOL International, Technical University of Denmark

Contact: Susan Stipp, stipp@dtu.dk

Timeline: 2022 - 2025

TRL: 4 → 6

Focus area(s): Carbon conversion

CooCE - Harnessing potential of biological CO₂ capture for circular economy

The overall aim of the project is to accelerate the use of CCUS and revolutionise CO₂ capture and utilisation by closing carbon loops in a circular economy approach. The project therefore aims to develop and demonstrate a novel biotechnological platform in which CO₂ (from biogas or exhaust gasses) is converted into (a) upgraded biofuels for flexible on-site hybrid energy storage and (b) high market value platform chemicals, namely biosuccinic acid and polyhydroxyalkanoates, that form the building blocks of various biopolymers and bioproducts.

Budget: DKK 5,297,000

Funding sources: Horizon Europe, Energy Technology Development and Demonstration Programme (EUDP)

Partners: BTS Biogas, Euronewpack, Hellenic Agricultural Organisation, Imperial College London, Lemvig Biogas, Pond, Qlab Analytical Laboratory, Technical University of Denmark, University of Padua

Contact: Irini Angelidaki, iria@kt.dtu.dk

Timeline: 2021 - 2024

TRL: 6 →

Focus area(s): Carbon conversion

Flue-to-Fuel - Biomediated Conversion of Flue gas CO₂ to Biomethane

Flue-to-Fuel tackles a key challenge in the green transition by developing a low-energy pathway for CO₂ capture and direct conversion into e-methane using green hydrogen - with the potential to reduce emissions and supply renewable drop-in fuels. The Flue-to-Fuel (FtF) technology platform is based on a novel concept termed bio-integrated carbon capture and utilisation (BICCU), which allows CO₂ to be captured from low-concentration flue gases and then converted into biomethane. The goal of the project is to advance the FtF technology from lab scale to prototype test in a realistic environment, enabling capture and conversion of CO₂ from raw flue gas into e-methane.

Budget: DKK 4,475,800

Funding sources: Villum Foundation

Partners: Aarhus University

Contact: Michael Vedel Wegener Kofoed, Mvk@bce.au.dk

Timeline: 2023 - 2025

TRL: 3 → 5

Focus area(s): Carbon conversion, Point source capture

FRESH - Formate for renewable energy storage

The purpose of the FRESH project is to develop, operate and validate an integrated, cost-competitive process for conversion of CO₂ to potassium formate (PF) using an electrocatalytic process powered by renewable electricity. The project aims to develop, construct and operate a prototype for renewable energy storage technology that will convert green, carbon-neutral energy, water, and carbon dioxide into a renewable fuel used as an energy carrier for electricity production.

Budget: DKK 20,000,000

Funding sources: Horizon Europe

Partners: Coval Energy, Engie Laborelec, eRisk Group, Forschungszentrum Jülich, Hysytech, Technical University of Denmark, The Institute of Chemistry of OrganoMetallic Compounds (ICCOM)

Contact: Sebastian Nis Bay Villadsen, snbvi@kt.dtu.dk

Timeline: 2022 - 2025

TRL: 4 → 6

Focus area(s): Carbon conversion

InjectMe - Injection technology for H₂-mediated methane production

The purpose of InjectMe is to develop a cost-effective system for biogas methanation on a pilot scale. Additionally, the project will evaluate its application as a stand-alone or coupled with other PtX-technologies. The technology is based on methane production, using Landia's injector technology, which allows the utilisation of both the existing infrastructure and reactor biology present in already existing biogas plants.

Budget: DKK 12,160,000

Funding sources: The Danish Energy Agency, Energy Technology Development and Demonstration Programme (EUDP)

Partners: Landia, University of Queensland, Aarhus University

Contact: Thomas Lundgaard, Michael Kofoed, thomas.lundgaard@bce.au.dk, mvk@bce.au.dk

Timeline: 2021 - 2023

TRL: N/A →

Focus area(s): Carbon conversion

Let-them-stick - Increasing *Sporomusa ovata* cell numbers on cathodes

Microbial electrosynthesis is a novel biotechnological process for the conversion of excess renewable electricity and CO₂ into biofuels or other organic compounds, using electrons delivered by an electrode. This process relies on acetogenic bacteria, such as *Sporomusa ovata*. The microbial electrosynthesis production rates of the bacteria, however, are too low to enable the development beyond lab-scale. This project hypothesises that the production rate of microbial electrosynthesis can be improved by increasing the number of cells on the cathode.

Budget: DKK 2,935,000

Funding sources: Novo Nordisk Foundation

Partners: Aarhus University

Contact: Jo Philips, Klaus Koren, jo.philips@bce.au.dk, klaus.koren@bio.au.dk

Timeline: 2020 - 2024

TRL: 1 → 3

Focus area(s): Carbon conversion

Marine Renewable Hub - Establishing production facilities for bunkering 100% green fuels from Hirtshals Havn

Port of Hirtshals is working towards becoming Northern Jutland's regional centre for CO₂-neutral shipping by 2050 and has therefore established an independent development company - Greenport North. The initial project phase is focused on establishing production facilities for bunkering 100% green fuels from the port. Through the Nordic Transport Policy Network and the Trans-European Transport Network (TEN-T), Port of Hirtshals has the potential to become the crucial link between North Jutland producers of PTX fuels and maritime consumers.

Budget: DKK 76,220,000

Funding sources: CO2Vision - REACT-EU

Partners: Greenport North, Grøn Brint Hjørring, GrønGas Hjørring, Aalborg University

Contact: Hanne Skovby, has@greenportnorth.dk

Timeline: 2022 - 2023

TRL: 3 → 7

Focus area(s): Carbon conversion

MECOE - Mixed organic-aqueous Electrolytes for selective CO Electrolysis (ME-COE)

Reducing unwanted hydrogen formation is a key challenge in CO₂ and CO electrolysis, as it lowers efficiency and limits product yield. While water is needed to hydrogenate CO₂/CO, excess water can easily lead to hydrogen evolution. This project looks to operate CO₂/CO electrolysis in primarily non-aqueous solvents to reduce hydrogen evolution.

Budget: DKK 2,900,000

Funding sources: Independent Research Fund Denmark

Partners: Technical University of Denmark

Contact: Brian Seger, brse@dtu.dk

Timeline: 2023 - 2025

TRL: 2 →

Focus area(s): Carbon conversion

MES-MODEL - A mathematical model to improve microbial electrosynthesis

Microbial electrosynthesis (MES) reduces CO₂ with renewable electricity into valuable C2 chemicals (mainly acetate and ethanol) using acetogenic bacteria. The major open question is, however, how acetogenic bacteria acquire electrons from a cathode. It was recently hypothesised that microorganisms stimulate cathodic H₂ evolution by consuming H₂. This project aims to develop a mathematical model to describe the complex processes occurring at the cathode during MES.

Budget: DKK 2,878,000

Funding sources: Independent Research Fund Denmark

Partners: Aarhus University

Contact: Jo Philips, Jacopo Catalano, jcatalano@au.dk, jo.philips@bce.au.dk

Timeline: 2023 - 2025

TRL: 2 → 3

Focus area(s): Carbon conversion

METHARC - Wellbore hydrogen production with CCUS

Today, vast amounts of time, money, and energy are spent trying to recapture less than 100% of the carbon released into the atmosphere. However, as it is more efficient to capture it all at source, the project has patented a process and is developing wellbore hydrogen production technology in this form of a completion tool. The tool adapts the carbon production cycle to create replacement revenue sources while utilising, capturing and storing carbon as a part of the Metharc process.

Budget: DKK 750,000

Funding sources: Project partners

Partners: FORCE Technology

Contact: Stuart Gillick, info@metharc.com

Timeline: 2023 - 2024

TRL: 2 → 5

Focus area(s): Carbon conversion

Microbial electrosynthesis - Accelerating technology development of microbial electrosynthesis to convert CO₂ to natural gas (methane) at scale

Electromethanogenesis involves the production of methane from CO₂ and electricity using methanogenic microorganisms. This is a promising biotechnology because of its resilience to intermittent power supply and reliable long-term operation, as shown by lab studies. The goal of this project is to provide the necessary engineering optimisation of the laboratory-based insights and derive the engineering parameters necessary for testing electromethanogenesis at an industrial scale.

Budget: DKK 7,000,000

Funding sources: Novo Nordisk Foundation

Partners: The Novo Nordisk Foundation CO₂ Research Center (CORO), Stanford University, The Pennsylvania State University, Aarhus University

Contact: Jo Philips, Alfred Spormann, jo.philips@bce.au.dk, aspormann@corc.au.dk

Timeline: 2023 - 2025

TRL: 4 → 5

Focus area(s): Carbon conversion

NEOSUCCES - Upscaling and market introduction of simultaneous biogas upgrading and bio-succinic acid production

Biogas plants turn organic waste into biogas, primarily methane, through anaerobic digestion. Although quite promising, the process is still rather costly and inefficient, inhibiting more widespread implementation. The NEOSUCCESS project aims to utilise biogas plants and, at the same time, benefit the environment by creating a simple plug-and-play technology that enables the simultaneous production of biomethane and bio-succinic acid (BioSA).

Budget: DKK 18,220,000

Funding sources: Horizon Europe

Partners: AINIA, Aristotle University of Thessaloniki, BiotechPRO, Ingeniería Verificaciones Electromecánicas y Mantenimientos, Norvento Enerxía, Technical University of Denmark

Contact: Iriñi Angelidaki, iria@kt.dtu.dk

Timeline: 2020 - 2023

TRL: 9 →

Focus area(s): Carbon conversion

RD-BECCUS - Research and development platform for flexible BECCU/S

Available CCU technologies require year-round, constant operation to be commercially viable. The reality is, however, that an energy system is characterised by increasingly larger fluctuations. Thus, this project will investigate, design, and plan a research platform to enable the development of second-generation technologies for flexible carbon capture and utilisation/sequestration in combination with bioenergy (BECCU/S). In addition, the project will model both a full scale and pilot plant.

Budget: DKK 7,471,650

Funding sources: INNO-CCUS

Partners: Alexandra Institute, Ammongas, CO2Techn, Danish Technological Institute, Hafnium Labs, Technical University of Denmark, Verdo

Contact: Lars Schwarzer, lars@teknologisk.dk

Timeline: 2022 - 2024

TRL: 3 → 5

Focus area(s): Carbon conversion, Point source capture

WaveFuels I - A novel Power-to-X technology pathway

The project aims to design, test, optimise, and prepare for the demonstration of a novel technology - microwave cracking - at industrial scale. The goal is to advance the technology from TRL 6 to TRL 8 by converting biomass into biofuels and carbon storage products. Organic Fuel Technology's patented system enables a new Power-to-X pathway, where electricity is transformed into biofuels and stable carbon by generating a uniform electromagnetic field of a scale and intensity not previously achieved.

Budget: DKK 10,060,000

Funding sources: The Danish Energy Agency, The Energy Technology Development and Demonstration Programme (EUDP)

Partners: Biological and Chemical Engineering, Energy Cluster Denmark, Euromilling A/S, Organic Fuel Technology, Topsoe, Aarhus University

Contact: Jens Henrik Haahr, jhh@organicfuel.tech

Timeline: 2023 - 2025

TRL: 6 → 8

Focus area(s): Carbon-based materials



Carbon dioxide removal



Removing CO₂ from the atmosphere

CDR removes CO₂ from the atmosphere and stores it durably, creating net-negative emissions. It can complement emissions reductions by helping to balance remaining emissions and support long-term climate goals. CDR includes both nature-based and engineered approaches.

Nature-based approaches use biological processes to increase carbon uptake and storage in vegetation and soils, for example through afforestation, agroforestry and soil carbon sequestration. Engineered approaches use technological or geochemical processes to remove and store carbon, with direct air capture and enhanced weathering as examples. Biochar combines biological processes with the conversion of biomass into a stable, carbon-rich material. While these approaches work in different ways, they share key challenges related to scalability, storage duration and the ability to measure and verify their climate impact.

For CDR to become a credible component of climate strategies, promising approaches need to progress from individual demonstrations to solutions that can be applied at scale. This means not only improving and demonstrating the technologies and methods themselves, but also establishing how much additional carbon is removed and how securely it remains stored over time. Reliable measurement and verification are therefore essential. Together with robust carbon accounting, certification and governance, they can provide the confidence needed to integrate CDR into climate policy and long-term planning.

BIOCHSTA

Documentation of long-term carbon stability in biochar

Objective

Biochar is produced from residues and waste products from agriculture and waste sectors. Pyrolysis is used to produce biochar, a process where organic matter is heated to high temperatures in the absence of oxygen. This biological carbon dioxide removal (CDR) technique can potentially store large amounts of carbon. Currently, carbon stability in biochar is determined primarily from the elemental composition and other bulk parameters of the biochar and incubation experiments. However, this project hypothesises that it is more accurate to use well-documented methods from the field of geology. Thus, the aim of the project is to uniquely use geological state-of-the-art analysis techniques as a means of optimising the production of inert, non-degradable carbon for long-term stability in soil.

Approach

The proposed methodology stands on the shoulders of decades of in-depth geological knowledge of organic matter transformation, preservation and characterisation using organic petrographic, geochemical, and thermodynamic modelling techniques. A combination of acquired data and thermodynamic kinetic modelling will make it possible to standardise the optimal characteristics of the permanent biochar from a comparative study of the geologically preserved natural chars in carbonaceous rocks. Additionally, the project will conduct stakeholder meetings with farmers and carry out surveys among a representative sample of 2,000+ farmers. This will contribute to a virtual research gap by monitoring the willingness to apply biochar among farmers, and test how biochar familiarity, characteristics, and information support the readiness and willingness to adopt.

Expected impact

The result of this research has the potential to optimise biochar production to achieve the most stable carbon for long-term permanence in soil. Know-how of biochar formation technology and biochar permanence properties may have export potential, and provide a low-cost, reliable method to demonstrate long-term stability of biochar which could be a game-changer for the biochar industry. Also, biological carbon storage will likely have larger citizen acceptance if long-term stability can be demonstrated.

Budget

DKK 6,893,733

Funding source

INNO-CCUS

Partners

AquaGreen, European Biochar Industry Consortium (EBI), Geological Survey of Denmark and Greenland (GEUS), Landbo Nord, Mash Makes, Odsherreds Landboforening, Organic Fuel Technology, SLF, Stiesdal SkyClean, Technical University of Denmark, Østdansk Landboforening, Aarhus University

Contact

Henrik Ingermann Petersen, hip@geus.dk

Timeline

2024 - 2026

TRL

3 → 5

Sectors

Agriculture



BioStore

Biochars for soil carbon storage and sustainable agriculture

Objective

In a political agreement on climate change mitigation efforts in Danish agriculture, it was decided that production and use of biochar should contribute with a reduction of 2 million tons CO₂-eq in 2030. Successful implementation requires, however, a thorough assessment of the environmental impacts of the technology. The project's aim is to investigate effects of soil amendment with high doses of biochar produced by Danish companies on carbon stability and quality aspects of agroecosystem and groundwater, combined with supporting measures on legal issues and quantification of the full system climate effects.

Approach

The project includes producing a variety of biochars from relevant feedstock materials in Denmark, while monitoring emissions and keeping track of energy and mass balances. The project will assess biochar stability in long-term soil incubation studies using Danish soils with distinct characteristics. Given the increasing irregularity of rainfall patterns and the abundance of sandy soils in Denmark, the project will also focus on biochar effects on soil hydraulic properties and crop resilience towards drought stress. An experimental platform is established in the field to test effects on crop growth and environmental functions of soil and groundwater at high biochar application rates. All data generated will be used for a quantitative assessment to determine the potential impact of widespread production and use on Denmark's climate footprint. Finally, the work will contribute to defining biochar as a visible resource within legal and economic governance practices.

Expected impact

The project will help to pave the way for the large-scale implementation of the production and use of biochar from relevant Danish biomasses by key Danish technology providers, in particular by defining the biochar characteristics required for a successful implementation in the agricultural sector. This will affect both the growth of the Danish pyrolysis industry and connected companies and possibilities for technology export.

Budget

DKK 8,759,040

Funding source

INNO-CCUS

Partners

AquaGreen, Geological Survey of Denmark and Greenland (GEUS), Mash Makes, Roskilde University, SEGES, Stiesdal, Technical University of Denmark, University of Copenhagen, Aalborg University

Contact

Dorette Müller-Stöver, dsst@plen.ku.dk

Timeline

2022 - 2026

TRL

6 → 7

Sectors

Agriculture

CARMA-Green Fuels

Cross mission carbon management

Objective

The aim of this project is to further develop the existing theoretical understanding of the concept of sustainable biomass with GHG neutrality when applied with a holistic integration across sectors such as agriculture, forestry, and transport. Furthermore, the aim is to develop crosscutting society system analysis methodologies, tools, and models allowing for an overarching holistic co-optimisation of the carbon balance across these sectors.

Approach

The project unites essential partners from academia and industry and develops a management strategy for the use of biomass and biogenic carbon capture. The project will use inputs from three of the Danish Innomissions as well as state-of-the-art studies carried out by the project participants within the respective sectors of CCUS, Green Fuels, Agriculture, Forestry, and Materials.

Expected impact

The project will contribute with a broad range of results outlining the potential future development of sustainable use of biomass. These include:

- Potential quantities of additional agricultural and forest biomass that can be produced sustainably within Denmark under different scenario conditions.
- Optimised use of forest biomass, integrating temporal aspects of the allocation of carbon to the forest ecosystem, materials, energy products and permanent underground storage.
- Which other policies and ecosystem services can be supported by a transition of Danish agriculture and forestry facilitated by an integration with the energy, material, and carbon markets.
- Technology scenarios for the best utilisation of our biomass resources into various materials, energy products and carbon storage via cascade utilisation.

Budget

DKK 4,900,000

Funding source

MissionGreenFuels

Partners

Arla Foods, BioRefine Denmark, Mærsk, Mærsk-McKinney Møller Center for Zero Carbon Shipping, Nature Energy, The Novo Nordisk Foundation CO₂ Research Center (CORC), Stiesdal SkyClean, University of Copenhagen, University of Southern Denmark, Vestjyllands Andel, Ørsted, Aalborg University, Aarhus University

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Timeline

2023 - 2026

TRL

N/A

Sectors

Agriculture

CaSiCarbon

Potential for long-term CO₂ storage through enhanced weathering of Ca-silicate minerals and materials

Objective

The objective of the project is to assess whether calcium-rich silicate minerals can act as a sink for atmospheric CO₂. Thermodynamic models suggest that calcium-rich plagioclase (anorthite) dissolves at rates similar to magnesium-rich olivine - a mineral already proven effective in enhanced rock weathering. The study is motivated by growing interest in anorthite mining in Southwest Greenland, which produces calcium-rich materials such as finely crushed anorthite - ideal for this purpose. These materials could provide an abundant source for CO₂ offsetting strategies.

Approach

The project will test the ideal parameters for when calcium-rich anorthosites (made up of more than 90% plagioclase) dissolve, causing chemical changes in pore water that result in the safe storage of CO₂. This will be done through experiments where initial conditions such as reaction temperature, pH, and CO₂ concentration will vary, favouring conditions that can be applied in nature or in industry. The experiments will also examine the effect of possible secondary mineral formation and reaction time as factors that might influence the overall efficiency of long-term CO₂ storage. The anorthosites used are sourced from the Fiskensæset Anorthosite Complex in Southwest Greenland, which is dominated by calcium-rich plagioclase. The results can therefore be used to evaluate the Fiskensæset Anorthosites as a resource and as a means for CO₂ storage under conditions relevant for potential use in nature.

Expected impact

The outcome of this project will demonstrate the potential use of calcium silicate minerals as an enhanced, nature-based solution for CO₂ capture and storage. The conditions used in the experiments will allow for future estimates of the CO₂ capture capacity of calcium-rich anorthosites under scenarios relevant for specific industrial or nature-based applications. The results may also encourage the use of readily available mineral resources and mining waste in strategies to mitigate CO₂ emissions.

Budget

DKK 2,879,480

Funding source

Independent Research Fund Denmark

Partners

University of Copenhagen

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Timeline

2023 - 2026

TRL

N/A

Sectors

Cross sector

C-Farming

Carbon Farming Alliance

Objective

Through innovative teaching and acquisitive learning, C-Farming aims to holistically upscale green, digital, net-positive, entrepreneurial, transversal and resilience skills among farmers, students, and educators for accelerating the adoption of carbon farming across Europe and beyond.

Approach

The project's main approach combines co-design and participatory co-creation with experts and focus groups, innovative learning methods, train-the-trainer activities, Universal Design for Learning, the Impact+ methodology and the Plan-Do-Check-Act (PDCA) quality cycle. The project also uses a range of digital learning tools and platforms to support implementation.

The work begins with curriculum and content design, followed by capacity-building activities, pilot training programmes, work-based learning, the establishment of Learning & Business Incubators, transnational meetings, Info Days, a final conference and dissemination activities.

Expected impact

C-Farming will create lasting individual, organisational, and societal impact by first and foremost increasing the knowledge of different learning groups (academic and non-academic) on the carbon cycle in the context of agriculture and the opportunity for carbon credits, as well as enhancing carbon farming competencies and future-oriented skills across the agricultural ecosystem, supporting sustainable growth, innovation, employability, and resilience.

The training programmes, digital learning ecosystem, virtual farm, ESCO skills package, and Learning & Business Incubators can all be directly applied by farmers, agribusinesses, vocational education and training (VET)/ university educators and policymakers across Europe to acquire knowledge, upskill agricultural practitioners, integrate carbon farming into formal curricula, certify micro-credentials, and support the green and the digital transition of the agricultural sector.

Budget

DKK 14,200,000

Funding source

Erasmus+

Partners

ACQUIN, Biotechnical Centre Naklo, Confagricoltura, COSVITEC, EIT Food, ELGO-DIMITRA, European Conservation Agriculture Federation, Institute for Bio-Economy and Agri-Technology, Institute of Soil Science and Plant Cultivation – State Research Institute, LAND, LODR, PI4SD, READLAB, University of Ljubljana, Aarhus University

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Timeline

2025 - 2028

TRL

7 → 9

Sectors

Agriculture

DACBattery

Integration of Direct air capture and Hydrogen Batteries

Objective

The DAC-Battery project aims to develop and demonstrate an integrated system that captures atmospheric CO₂ while simultaneously providing grid-balancing services through hydrogen production, storage and consumption. The project is based on the hypothesis that combining a novel, passive, membrane-assisted Direct air capture (DAC) system with a reversible alkaline fuel cell/electrolyser (H-Battery) can significantly reduce the levelised cost of CO₂ capture to USD 250/tonne, well below current DAC costs. This dual-functional system is expected to close the price gap between sellers and buyers in carbon credit markets, enabling large-scale deployment of DAC.

Approach

The project involves the development and integration of two core innovations: a passive, membrane-based DAC unit and the H-Battery. The DAC unit will be scaled from a TRL 3 prototype to a TRL 5 pilot system. The H-Battery will be scaled from TRL 2 to a 2 kW TRL 4 stack capable of switching between electrolysis mode - regenerating the DAC sorbent and producing hydrogen - and fuel cell mode - generating electricity from stored hydrogen. These components will be integrated and tested for compatibility, performance and durability, with system-level modelling conducted using EnergyPRO to simulate real-world operation under Danish energy market conditions. The project also includes techno-economic analysis, policy evaluation and stakeholder engagement to support market readiness and alignment with national climate goals.

Expected impact

The DAC-Battery project is expected to deliver a TRL 5 prototype that integrates CO₂ capture with hydrogen-based energy storage, targeting a CO₂ capture cost of USD 250/tonne. It will enable flexible grid services, support renewable energy integration and contribute to Denmark's 2045 climate neutrality goals. The system offers a scalable, economically viable solution for carbon removal and energy storage, with strong commercialisation and job creation potential.

Budget

DKK 8,501,046

Funding source

INNO-CCUS

Partners

Concito, ECA Engineering, EMD International, R&R Consult, ShipTown, Aalborg University

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Timeline

2026 - 2028

TRL

3 → 5

Sectors

Energy utility

DACkbone

A Modular, Low-Energy Electro-DAC Pilot to Anchor Denmark's CCUS Backbone

Objective

Reducing the cost and energy consumption of Direct air capture (DAC) remains a key challenge for large-scale carbon removal. The project is based on the hypothesis that fully electric, membrane-based DAC can deliver certified negative emissions faster and with far less energy than conventional thermal based systems.

Approach

The project will build and operate Denmark's first electro-DAC pilot at the Technical University of Denmark (DTU). In 2026, a modular pilot system will be commissioned using RepAir's membrane stack. The project will optimise porous electrodes to reduce energy consumption and enable flexible operation using surplus wind power. Continuous gas analysis and reservoir modelling will assess storage compatibility with Stenlille, Hashøj and Greensand, while energy system modelling will evaluate the integration of DAC, flexible operation and CO₂ network layouts under future Danish energy system conditions. Pilot results will be translated into national cost curves and siting maps, supported by citizen panels to secure social licence.

Expected impact

By 2028, the project aims to deliver:

- a TRL 7 electro-DAC plant operating for more than 4,000 hours, accelerating the InnoMission roadmap
- Denmark's first high-resolution performance dataset for DAC under Nordic weather conditions
- verified CO₂ purity dossiers and a monitoring, reporting and verification (MRV) template aligned with the European Union Carbon Removal Certification Framework
- an open-source cost model for upscaling
- a public engagement playbook and policy brief to support regulatory pathways :

The pilot aims to achieve more than 99% net-removal efficiency, and pave the way for at least 0.5 Mt CO₂ removal per year in Denmark by 2035. The modular, factory-built approach also creates green jobs and provides an exportable solution for hard-to-abate emissions worldwide.

Budget

DKK 24,150,662

Funding source

INNO-CCUS

Partners

By Nature, CO2Laborate, Geological Survey of Denmark and Greenland (GEUS), RepAir DAC LTD, Technical University of Denmark

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Timeline

2026 - 2029

TRL

3-5 → 5-7

Sectors

Cross sector

Dall Pyrolysis

Simple pyrolysis using fluid bed teknologi

Objective

Large amounts of biogas fibres are currently an under-utilised resource in Denmark, and biogas plants need heat for gas upgrading. The purpose of this project is to design, build and demonstrate pyrolysis technology capable of converting biogas fibres into high-quality biochar, process heat and district heat. A 10 MW demonstration plant will be built at Thorsø Biogas Plant.

Approach

The pyrolysis plant is based on the low-temperature circulating fluidised bed (LT-CFB) technology, also known as Pyroneer. The process will be optimised to use biogas fibres and produce carbon-rich biochar and process heat for biogas upgrading. The pyrolysis process will be integrated with dewatering and drying of biogas digestate and the utilisation of low-temperature heat for district heating. The process has already been tested on biogas fibres and has produced high-quality biochar with high nutrient content and insignificant levels of contaminants.

Expected impact

The project will demonstrate the Dall Pyrolysis technology at a 10 MW scale, supporting its further development and commercial deployment. By utilising the unused heating value in biogas digestate, the process can produce high-quality biochar while supplying process heat for biogas upgrading and district heating, improving resource utilisation at biogas plants.

Budget

DKK 99,000,000

Funding source

The Energy Technology Development and Demonstration Programme (EUDP)

Partners

Renegas, Technical University of Denmark

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Timeline

2026 - 2029

TRL

6 → 8

Sectors

Biogas

FENIX

New life for biowaste as a sustainable soil improver

Objective

Bio-waste can contribute significantly to a more circular economy, delivering valuable soil-improving material and fertiliser, as well as biogas, a source of renewable energy. Biochar helps regenerate soils by enhancing water-holding capacity, nutrient uptake, soil fertility and acts as a carbon sink. Project FENIX aims to develop a soil improvement product that combines:

- Biochar produced from the pyrolysis and heat treatment of park and garden pruning waste.
- Digestate from a biogas production plant that uses supermarket food waste as organic biomass.

Approach

FENIX will demonstrate the agronomic benefits (soil fertility, water-holding capacity, nutrient uptake and stimulating microbial activity) and economic returns of its soil improver in field tests in three countries in Southern Europe, facilitating the adoption by farmers and cooperatives.

Expected impact

The products developed by FENIX will create an incentive for bio-waste valorisation, significantly reducing bio-waste for landfill, and improving nutrient recovery from bio-waste for soil improvers production, through the valorisation of anaerobic digestion and pyrolysis by-products. The project will also demonstrate the environmental, health and safety performance of soil improvers from bio-waste and related production operations, including improved testing methods throughout the entire life cycle, guided by partner EAS (Eurofins Agroscience Services Regulatory). In the long term, FENIX's ambition is to contribute to the recovery of abandoned poor soils for agriculture, increasing the EU's soil quality and water retention capacity while also contributing to climate change mitigation, secure and independent energy supply, and sustainable bio-waste management.

Budget

DKK 24,270,000

Funding source

CO2Vision - REACT-EU

Partners

C.I.R.A.D, Cartago Ventures, Ellinkikos Goergokos Organismos, Eurofins Agroscience Services Regulatory, Inrae Transfert, Institut National de Recherche pour L'Agriculture, Technical University of Denmark, TerraWatt

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Timeline

2023 - 2027

TRL

8

Sectors

Agriculture

Fluid Bed Pyrolysis

Large-scale fluid bed pyrolysis

Objective

The main purpose of the project is to develop, build and demonstrate the performance of a highly energy-efficient pyrolysis technology, that can convert agricultural waste and sewage sludge into high-quality carbon rich biofertiliser and district/process heat. Furthermore, a comprehensive engineering design study for an add-on syngas upgrading unit will be completed. This will enable the conversion of the resulting syngas into liquid or gaseous fuels for transportation and for integration with Power-to-X plants.

Approach

The pyrolysis plant will be based on the Low Temperature - Circulating Fluidised Bed technology invented 25 years ago. The process is very fuel flexible, and the plant will be designed to process both wet resources, such as biogas fibres and sewage sludge, as well as dry agricultural waste. The process has been tested on straw, biogas fibres and other fuels, with good results. Studies of the produced biofertiliser have shown, that it can meet requirements for distribution on farmland and growth tests have shown good plant response. The biofertiliser contains carbon and nutrients, that can enrich farmland and reduce greenhouse gas emissions.

Expected impact

There is a strict target for reduction of CO₂ emissions from the agricultural sector in Denmark by 2030 and beyond. Pyrolysis plants producing carbon rich biofertiliser from agricultural waste products will be CO₂ negative and contribute to national and global CO₂ emission neutrality. The preliminary market survey shows a large market for a large-scale pyrolysis technology solution for wet waste products. This project will enable the development and maturation needed to be able to offer the technology on commercial terms to future customers in the Northern hemisphere.

Budget

DKK 208,000,000

Funding source

The Danish Energy Agency's Pyrolysis Pool

Partners

Dall Energy, DIN Forsyning Esbjerg, Technical University of Denmark

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Timeline

2022 - 2026

TRL

4 → 8

Sectors

Agriculture

FUTUREFOR-DK

Predicting the climate change mitigation potential of new forest landscapes in Denmark

Objective

The project aims to predict the climate change mitigation potential of existing and newly established forests in Denmark and identify the most effective afforestation strategies to support the country's goal of reaching net-zero greenhouse gas emissions by 2045. It will evaluate how tree species, soil conditions, previous agricultural land use, climate change, and forest management influence carbon sequestration, greenhouse gas emissions, and nitrogen retention. The project seeks to determine what kinds of forests to plant, where to plant them, and how to manage them to achieve the greatest climate and environmental benefits.

Approach

The project combines field measurements, data collection and assessment of long-term forest monitoring data, and advanced ecosystem modelling. FUTUREFOR-DK will compile existing data from Danish forest trials and monitoring networks, while also conducting new experiments to measure soil greenhouse gas emissions and nitrogen cycling. These observations will be used to calibrate and validate the LandscapeDNDC model, a process-based biogeochemical model capable of simulating carbon and nitrogen dynamics in forests. The model will then be applied to assess the growth of existing forests and predict the performance of future forests under different climate scenarios and afforestation strategies. Scenarios will compare business-as-usual management, economically focused plantations, ecological approaches, and climate-resilient forest designs to evaluate their long-term environmental outcomes.

Expected impact

The project will generate detailed predictions of how and to what extent existing and newly established forests across Denmark can contribute to climate change mitigation and environmental sustainability throughout the 21st century. It will provide evidence-based recommendations on which tree species should be planted, where they should be planted, and how forests may be managed. These insights will support policymakers, land managers, and local stakeholders in designing more effective afforestation programs and advancing Denmark's Green Transition. By helping to create forests that are both climate-resilient and environmentally beneficial, the project will contribute to national climate targets, improved water quality, healthier ecosystems, and a more sustainable landscape for future generations.

Budget

DKK 7,187,817

Funding source

Independent Research Fund Denmark

Partners

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Timeline

2026 - 2031

TRL

4 → 8

Sectors

Forestry

Agriculture

ICEFIELD

Unfreezing Climate Action: Scaling Enhanced Rock Weathering on Danish Croplands Using Greenlandic Rock Flour

Objective

This project will demonstrate the potential of Greenlandic rock flour to deliver permanent carbon dioxide removal (CDR) and reduce greenhouse gas emissions at scale on Danish croplands through Enhanced Rock Weathering (ERW). It aims to establish the first Danish reference values for CDR through ERW and to develop and validate an adapted Monitoring, Reporting and Verification (MRV) protocol to support integration into carbon markets and policy frameworks. The project also assesses the attitudes of farmers, stakeholders and the public towards ERW to support its wider adoption.

Approach

Over three years, pilot trials will generate data to establish reference values for CDR and greenhouse gas (GHG) emission reductions, develop robust MRV schemes, and improve ERW models for Danish sandy soils. The pilots will represent the first full-scale field deployment of ERW in Denmark. Alongside the technical work, the project will engage stakeholders to improve societal readiness and support wider implementation.

Expected impact

The project will provide the evidence base needed to assess the potential of Enhanced Rock Weathering (ERW) in Denmark and support its future deployment. Expected outcomes include peer-reviewed publications establishing the first Danish reference values for Greenlandic rock flour-based ERW, a validated Monitoring, Reporting and Verification (MRV) protocol, and new knowledge on public acceptance.

Budget

DKK 15,707,439

Funding source

INNO-CCUS

Partners

Agrolab, Clean Cluster, Rock Flour Company, University of Copenhagen, ZeroEx, Aarhus University

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Timeline

2026 - 2029

TRL

4 → 7

Sectors

Agriculture

INNO4EST

Innovative forests for curbing climate change while integrating biodiversity, nutrient retention, and recreation

Objective

Objective and hypothesis Sustainably managed forests have a potential for carbon sequestration and storage while integrating biodiversity, nutrient retention and recreation. Establishing new forests with increased attention to multifunctional services enhances their future value while still curbing climate change. The overall aim of INNO4EST is to provide and demonstrate sustainable afforestation and provide transparent and reliable methods for documentation of effects for the 4 ecosystem services in new and existing forests.

Approach

The INNO4EST project will be organised in three work packages.

- WP 1 will address the 4 ecosystem services and provide the scientific foundation for species selection, impact assessment and selection of indicators. The tasks will in addition to literature reviews draw upon data from afforestation in Denmark.
- WP 2 will have focus on the establishment of new forests while implementing the documentation methods and developing the reporting tools.
- WP 3 will be a dissemination of the projects results and increase the impact of the project through workshops and publications. All stakeholders are invited to participate and contribute to the development of the end products: scientific/technical results, new forests, the input data, expected outcome and more.

Expected impact

The project will in general increase the transparency and hence the willingness to invest in afforestation, for companies and individuals. Landowners and investors, private as well as public, will benefit from the knowledge for decisions on afforestation and from the needed documentation methods for the outcome. Knowledge can further be compiled for improve decision support system, given more funding for this development.

Budget

DKK 12,176,971

Funding source

INNO-CCUS

Partners

Agency for Data Supply and Infrastructure, De Danske Skovdyrkerforeninger, Det Danske Hedeselskab, DHI, Gubra, HedeDanmark, Klimaskovfonden, KW-Plan, NaturlIT, Samsø Municipality, Skovkortet.dk, The Danish Environmental Protection Agency, The Danish Nature Agency, University of Copenhagen, Aarhus University

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Timeline

2022 - 2026

TRL

4 → 7

Sectors

Forestry

MARVIC

Developing and testing a framework for the design of harmonised, context-specific monitoring, reporting and verification (MRV) systems for soil Carbon and greenhouse gas balances by Agricultural activities

Objective

MARVIC aims to support climate action in agriculture by creating a reliable monitoring, reporting and verification (MRV) framework for measuring how farming practices affect carbon storage and greenhouse gas emissions in soil and woody vegetation. The project will develop and test a harmonised, context-specific MRV system to assess changes in carbon stocks and emissions from agricultural soils and woody biomass. The main ambition is to offer scheme developers across Europe a standard approach for designing robust monitoring systems that:

- Comply with upcoming European rules for certifying carbon removal
- Balance accuracy with cost-effectiveness
- Consider risks related to carbon loss due to changing land use or natural events such as extreme weather or climate shifts

Approach

The framework will be developed for four key land-use types:

- Arable land with mineral soils
- Permanent grasslands with mineral soils
- Managed peatlands
- Areas with woody crops or agroforestry systems

Expected impact

The framework will support different levels of detail and precision depending on the purpose of the climate initiative—whether related to agricultural policy or the voluntary carbon market. It will be flexible enough to adapt to local conditions, data availability and infrastructure, while also being manageable for landowners in terms of cost and paperwork. An important feature of the MARVIC framework is that it will be open and freely available. This allows researchers and practitioners across Europe to update and improve the system over time as new evidence emerges - from field trials, scientific studies, or advances in data technology and automation.

Budget

DKK 6,819,549

Funding source

Horizon Europe

Partners

Agroscope, Agrosolutions, CSIC, Czech University of Life Sciences Prague, Eesti University of Life Sciences, Finnish Meteorological Institute, Fisheries and Food (ILVO), Flanders Research Institute for Agriculture, Food and Environment, INRAE - French National Research Institute for Agriculture, SAE Innova, Teagasc - Agriculture and Food Development Authority, Università Cattolica del Sacro Cuore, University of Copenhagen, University of Teramo, Universität Freiburg, Wageningen University and Research, Aarhus University

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Timeline

2023 - 2027

TRL

N/A

Sectors

Agriculture

MycoForest

Stimulating forest carbon uptake and storage by mycorrhizal inoculation

Objective

Major afforestation on agricultural land is being implemented in Denmark, offering significant potential for carbon capture and storage (CCS). However, the microbiome of agricultural soils may limit forest growth and thereby the CCS potential. MycoForest is based on the hypothesis that inoculating afforestation sites with forest-adapted mycorrhizal fungi can increase the CCS potential by 10-20%. The project will investigate the short- and long-term potential for increasing carbon uptake and storage in different Danish contexts (soil, tree species, soil amendments, mycorrhizal strains and climate), ensure the practical feasibility of combining mycorrhizal inoculation with other soil amendments and provide economic feasibility scenarios, carbon documentation and stakeholder and policy outreach.

Approach

MycoForest will combine laboratory and greenhouse experiments to identify key factors influencing mycorrhizal inoculation with full-scale afforestation experiments at three sites in Denmark. The project will document and upscale the effects of mycorrhizal inoculation on carbon uptake and storage and provide a long-term assessment. Practical and economic feasibility studies involving key stakeholders will also be conducted.

Expected impact

MycoForest will deliver methodologies and documentation for increasing carbon uptake and storage through inoculation with mycorrhizal fungi and other soil amendments in afforestation. The project will also deliver an implementation plan, including guidelines for inoculation methods and modified afforestation practices that facilitate mycorrhizal use. In addition, it will assess economic feasibility and regulatory requirements for carbon documentation and provide stakeholder, policy and communication activities to support future implementation.

Budget

DKK 12,775,690

Funding source

INNO-CCUS

Partners

Bureau Veritas, Copenhagen Business School, Dansk Skovforening, Hedeselskabet, Hjorthede Planteskole, Klimaskovfonden, Novonesis, Oath Inc, PFA Pension, Stiesdal SkyClean, University of Copenhagen

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Timeline

2026 - 2030

TRL

3 → 7

Sectors

Forestry

Agriculture



MitiChar

Mitigation of climate impacts from plant production with biochar from straw and biogas digestates

Objective

The aim of MitiChar is to explore the potential of biochar to mitigate climate impacts of plant production. Agricultural plant production emits large amounts of N₂O, a greenhouse gas 300 times stronger than CO₂. MitiChar aims to identify mechanisms that allow biochar to reduce N₂O emissions and optimise them. Furthermore, the ability of biochar to store carbon and improve soil physical properties will be examined. MitiChar will also investigate barriers to biochar implementation.

Approach

Biochar pellets will be produced from straw and biogas digestates at various temperatures and their energy balance calculated. Through field experiments, the project will test the biochar's stability, effects on soil physical properties and ability to reduce N₂O emissions. Barriers to wider biochar implementation and incentive structures will also be analysed through farmer surveys and an analysis of legislation and regulations.

Expected impact

The project will produce knowledge about biochar production, process optimisation, N₂O-reducing properties, barriers to implementation and incentives for widespread use. The project has potential to create an export market for pyrolysis units and knowhow on logistics, trade, use and application of biochar. A rough estimate is that full-scale implementation of biochar from straw and biogas digestate could reduce greenhouse gas emissions from Danish agriculture by 38%. It should be possible to implement 30% of this potential by 2030.

Budget

DKK 6,850,000

Funding source

AgriFoodTure

Partners

HedeDanmark, Stiesdal, University of Copenhagen, Aarhus University

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Timeline

2022 - 2026

TRL

5 → 9

Sectors

Agriculture

NNF-BECCS

BECCS as a tool to achieve net-negative GHG emissions in Europe

Objective

Bioenergy with carbon capture and storage (BECCS) offers a potentially low-cost carbon dioxide removal solution and has reached a relatively high level of technological maturity. While the use of biomass for heat and electricity production is well established in several European countries, no BECCS facilities currently operate at commercial scale. As biogenic carbon is a limited resource and biomass production is closely linked to land use, there is a need for a better understanding of the carbon dynamics between ecosystems and the surrounding techno-economic systems.

Approach

The project will

- Analyse the potential for BECCS in Europe as a CDR instrument based on current point sources of biogenic CO₂.
- Integrate recent developments in BECCS into a Europe-wide energy system model to develop an integrated systems analysis of the carbon dynamics of current and future BECCS deployment within the European Union (EU) and assess potential climate benefits.
- Link the energy system model with a land-use model to analyse ecosystem-techno-economic system interactions regarding carbon storage and carbon use.
- Comprehensively analyse the magnitude and risks of land-use change resulting from widespread BECCS deployment in Europe to meet climate goals.

Expected impact

The project will provide the scientific basis for societal prioritisation of resources to support climate change mitigation through:

- Scientifically robust data and insights to support evidence-based decision-making regarding the integration of carbon capture and storage (CCS) technologies into the European Union's climate action strategies.
- Contributions to systems analysis and carbon dioxide removal research through prospective case studies of BECCS.
- Quantitative assessments of the potential for negative emissions through BECCS and its contribution to climate targets in the European Union.
- A full-system approach to analysing the climate effects of carbon dioxide removal (CDR).

Budget

DKK 4,800,000

Funding source

Novo Nordisk Foundation

Partners

No partners

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Timeline

2025 - 2029

TRL

N/A

Sectors

Agriculture

Energy utility

Offshore storage

Onshore storage

PytoN

Full-scale pyrolysis at the next level

Objective

Pyrolysis has significant potential to reduce greenhouse gas emissions while producing biochar for long-term carbon storage. Following the demonstration of a full-scale pyrolysis plant in Vrå, there is a need to further improve the efficiency, cost-effectiveness and operational maturity of the technology to support wider deployment. The PytoN project aims to advance and optimise Stiesdal's SkyClean pyrolysis technology and build the competences needed for future implementation in Denmark.

Approach

PytoN continues and accelerates the development of Stiesdal's SkyClean pyrolysis technology, which has been demonstrated at the first full-scale plant in Vrå, inaugurated in 2024. The facility utilises agricultural residues to produce green energy and biochar for carbon storage. The project focuses on further developing plant components and optimising performance to reduce operating costs and improve efficiency. In parallel, chemical and environmental validation of biochar for application on agricultural fields is carried out.

In addition, a training programme for pyrolysis operators is being developed, alongside the establishment of Danish certification competences for biogas companies, pyrolysis subcontractors and agricultural consultants.

Expected impact

The project is expected to result in a new and improved design of the Stiesdal SkyClean plant and its components, thereby supporting the deployment of pyrolysis technology and the establishment of future pyrolysis plants in Denmark. Expected outputs include the advancement of key components from TRL 7 towards TRL 8, increased efficiency and capacity, advanced control and regulation systems, feasibility assessments for new pyrolysis plants, and a new vocational training course programme for pyrolysis operators

Budget

DKK 42,460,909

Funding source

The Just Transition Fund (JTF)

Partners

Agri Energy, AMU Nordjylland, Energy Cluster Denmark, Food & Bio Cluster Denmark, FORCE Technology, Stiesdal SkyClean, Technical University of Denmark

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Timeline

2025 - 2028

TRL

7 → 7-8

Sectors

Agriculture

Onshore storage

Stiesdal's SkyClean full scale pyrolysis facility in Vrå
Image provided by Energy Cluster Denmark



REFOREST

Agroforestry at the forefront of farming sustainability in multifunctional landscapes in Europe

Objective

The primary mission of the project is to foster innovation, knowledge exchange and provide novel solutions to empower farmers in Europe and associated countries to deliver to multiple objectives: food production, carbon capture, and biodiversity. To achieve this, the project focuses on agroforestry - an integrated land use system that combines trees and agriculture. Agroforestry enables continued food production while improving environmental sustainability and supporting a range of ecosystem services. The project addresses key barriers to wider adoption of agroforestry, such as limited knowledge, uncertainty around economic impacts for farms, and unclear policy frameworks.

Approach

Reforest will employ a cocreation and multi-actor approach as our fundamental research method to place agroforestry systems in the right balance of farm productivity, socioeconomic viability and sustainability. The project will make use of existing knowledge and data, apply agroforestry living labs based on previous projects, and establish a stakeholder and actor engagement platform to enable knowledge transfer, training and innovation.

Expected impact

This project will prioritise enhancing knowledge exchange and transfer, enabling the integration of carbon and biodiversity finance in farm business models, and by proposing targeted policy interventions to overcome barriers to agroforestry expansion.

Budget

DKK 24,873,387

Funding source

Horizon Europe

Partners

Czech University of Life Sciences Prague, Euro-Mediterranean Economists Association, Europroject Ltd., FarmTree BV, German Association for Agroforestry (DEFAF), INAGRO, Philipps University of Marburg, Polish National Agroforestry Association, Progressive Farming Trust Ltd LBG, Trakia University, University of Bonn, University of Copenhagen, University of Reading, University of Sopron

Contact

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Timeline

2022 - 2026

TRL

N/A

Sectors

Agriculture

RenByLand

Demonstrating circular bioeconomy through integrated biomass processing on Mors

Objective

The vision of the RenByLand project is to establish a combination of technologies that can collectively handle and create value from local waste and residual biomass on the island of Mors. RenByLand is a demonstration project in circular bioeconomy. Technologically, the project is built around a drying technology based on superheated steam. This technology offers a clear energy and, consequently, economic advantage compared to traditional hot-air drying, as 85% of the energy used can be recycled for process or district heating.

Approach

The aim of the mini-lighthouse is to carry out a feasibility study to assess the technological viability of the RenByLand vision and circular bioeconomy, by exploiting sector coupling and synergy effects within the overall project. The long-term goal is to establish an integrated drying and pyrolysis plant capable of processing various types of waste and residual biomass, including sewage sludge, organic household waste, and slurry fibres from biogas plants. The process will generate surplus heat from drying, as well as oil, gas and biochar from pyrolysis. Additionally, a scrubber will be installed to purify ammonium sulphate from the drying water, which can, for example, be used to increase the fertiliser value of the biochar before it is applied to agricultural land.

Expected impact

In addition to enabling CO₂ storage, the project contributes to emission reductions in the energy and agricultural sectors through:

- Displacement of fossil fuels
- Reduction of methane and nitrous oxide emissions from slurry
- Conversion to grass production by establishing a market outlet for clover grass for feed products

Budget

DKK 2,250,625

Funding source

CO2Vision - REACT-EU

Partners

Burhøjgaard, Danish Technological Institute, Filtenborg, GRAINAS, Morsø Municipality, Morsø Spildevand, Nordendahl Landbrug v. Niels Holger Nordendal Nielsen, Sdr. Herreds Kraftvarmeværk

Contact

Alex Søgaaard Moreno, asm@aalborg.dk

Timeline

2023 - 2026

TRL

N/A

Sectors

Waste-to-energy

Restore

Biochar addition during peatland rewetting to restore soil carbon and mitigate greenhouse gas emissions and nutrient leaching

Objective

Drained peatlands are major sources of greenhouse gas emissions. Rewetting is a key climate measure, and Denmark aims to restore 1,000 km² of peatlands by 2030 to reduce emissions by 2.6 million tonnes of CO₂ equivalents per year. However, rewetting can also increase methane emissions and may raise CO₂ and nitrous oxide emissions due to changes in water levels and organic matter input. Phosphorus leaching may also threaten water quality, creating challenges for large-scale rewetting. RESTORE explores biochar as a potential solution to reduce emissions and nutrient loss in rewetted peat soils. The project investigates biochar's effects on emissions, soil microbiology, and nutrient dynamics. Key hypotheses focus on whether biochar can reduce emissions, how its sorption and redox properties contribute, and whether results can be scaled to real-world conditions as part of a sustainable rewetting strategy.

Approach

RESTORE will test these hypotheses across three research activities:

- Lab experiments will assess how biochar affects greenhouse gas emissions, carbon and nutrient dynamics in peat soils under Danish soil and climate conditions.
- Microbiome studies will examine how biochar influences microbial communities, especially those involved in emissions and nutrient cycling, and how these changes relate to the lab results.
- Outdoor experiments will verify lab findings in a year-long field experiment under real environmental conditions and different management strategies.

Expected impact

RESTORE will generate the first detailed insights into how biochar affects greenhouse gas emissions, nutrient cycles, and microbial communities in rewetted peat soils. The project aims to demonstrate that biochar can reduce emissions, prevent nutrient loss, and enhance carbon storage - helping Denmark reach its peatland rewetting goals for 2030. If successful, RESTORE could pave the way for full-scale field implementation and inspire broader adoption internationally.

Budget

DKK 3,168,000

Funding source

Independent Research Fund Denmark

Partners

GFZ Helmholtz Centre for Geosciences, SEGES, Stiesdal, University of Copenhagen

Contact

Dominique Tobler, dominique.tobler@plen.ku.dk

Timeline

2025 - 2028

TRL

N/A

Sectors

Forestry

SIMPLY

Supporting implementation of pyrolysis via constructive alignment of climate impact assessment methods, goals, frameworks, and incentives

Objective

The project aims to support and accelerate the deployment of Danish biomass pyrolysis and contribute to Denmark's climate goals. In particular, it supports the ambition to achieve 2 million tonnes of annual CO₂e reductions from pyrolysis by 2030 as part of the green transition of the agricultural sector.

Approach

The project is designed to support the realisation of political PyCCS/BCR climate goals by:

- Mapping and characterising the relevant resource base, value chains and market opportunities for deploying Danish biomass pyrolysis at sufficient scale.
- Analysing barriers, bottlenecks and drivers related to planning, constructing and operating Danish pyrolysis plants in different configurations and context.
- Identifying potentials to accelerate planning and deployment procedures based on historical experience with bio-energy technology and the current political landscape.
- Determining the climate- and environmental impact potentials of Danish biomass pyrolysis and securing constructive alignment between impacts and representation in various accounting and certification schemes.
- Analysing key stakeholder incentives in relevant biochar-production-and-use value chain configurations and increasing awareness and knowledge among key stakeholder groups.

Expected impact

Societal impacts are obtained through the acceleration of deployment. Substantial impacts are related to avoiding direct GHG emissions, production of bioenergy and from soil effects. Economic impacts that can be highlighted include revenue from energy, climate impact, and benefits in the agricultural sector as well as the development of new value chains for a more circular and more bio-based economy. Also, large-scale deployment of pyrolysis in Denmark could potentially create up to 12,000 jobs. Finally, The Danish pyrolysis industry will benefit from the project as pyrolysis impact potentials are qualified by independent research institutions and barriers and bottlenecks are identified and addressed. The success of the project increases the possibility of making Denmark a leading exporter of pyrolysis technology.

Budget

DKK 8,263,190

Funding source

INNO-CCUS

Partners

Central Denmark Region, CLEAN, Ringkøbing-Skjern Kommune, Roskilde University, Stiesdal SkyClean

Contact

Tobias Pape Thomsen, tpapet@ruc.dk

Timeline

2023 - 2026

TRL

N/A

Sectors

Agriculture

TIMBERHAUS

Climate-smart, circular, and sustainable solutions for use of wood in the construction sector

Objective

To support the implementation of the EU Forest strategy and enhance the contribution of the forest-based sector to climate change mitigation, TIMBERHAUS pursues the following overarching objectives:

- Catalyse the green transition of the construction sector by making it more renewable and circular.
- To create a stronger link between the European forest sector and construction sector by matching the needs of the construction sector with available biomass in the forests.
- Create new value chains for currently underused wood types and species to maximise the climate mitigation potential of the forest sector.
- Identify and address barriers to scaling up wood construction in Europe.

Approach

TIMBERHAUS will develop machine-learning-based wood processing technologies and prototype construction products using underutilised wood resources. Circular multi-storey building concepts will be demonstrated as digital pilots with European cities, incorporating local design traditions and health and well-being considerations. The project will also assess the quantitative limits and opportunities of wood as a resource and develop a robust, cost-efficient methodology for quantifying the carbon removal benefits of wood construction products and other building materials. Finally, local and EU-level decarbonisation strategies, roadmaps for mainstreaming multi-storey wood buildings, and policy recommendations will be developed.

Expected impact

The construction sector is responsible for 40% of carbon emissions, 50% of extracted materials, and 35% of waste. EU policies highlight wood and renewable materials as key to decarbonising the sector. Despite their climate benefits, wood materials are still underused. TIMBERHAUS aims to boost wood use in construction by developing sustainable value chains and business models for under-utilised wood species and recycled biomass. This will support European competitiveness, sustainability, and self-sufficiency. By encouraging better forest management, TIMBERHAUS can enhance forest protection, attract investment in wood processing, and create rural jobs.

Budget

DKK 65,000,000

Funding source

Horizon Europe

Partners

Bauhaus der Erde, Built by Nature, City of Baia Mare, City of Berlin, City of Siena, Climate-KIC, Danish Technological Institute, Demos Helsinki, EMPA, ETH Zürich, F. Junkers Industrier, Icons, Maderas Gamiz, Metabolic Institute, Pfeifer Holding, Tegel Projekt, University of Copenhagen, Urbasofia, Waugh Thistleton Architects

Contact

Anders Kjellow, awk@dti.dk

Timeline

2024 - 2028

TRL

3 → 6

Sectors

Forestry

Wavefuels II

A novel Power-to-X technology pathway

Objective

Building on the design and development work carried out in WaveFuels I, this project aims to demonstrate microwave cracking at full industrial scale. By constructing and operating a facility that converts dewatered wastewater sludge into bio-oil and biochar, the project will support the technology's progression towards TRL 8 and lay the groundwork for future commercial deployment.

Approach

WaveFuels II comprises the construction and demonstration of a full-scale plant for converting dewatered wastewater sludge into biooil and biochar. The plant will include an integrated system for biomass reception and handling, drying, microwave cracking in specially designed reactors, condensation of gas-oil into oil, and storage of the resulting biochar. In parallel, the end products (oil and char) will be analysed, and methods for optimising post-treatment of the oil will be identified.

Expected impact

The first full-scale microwave processing plant for sewage sludge will be commissioned by mid-2025. Industrial symbiosis solutions will enable the use of surplus heat from nearby green energy facilities. The plant will be optimised and demonstrated, running 24/7 for 27 days per month, processing over 900 tons of sludge (240 tons dry matter) and producing at least 50 tons of bio-oil monthly. The full value chain for handling, upgrading, and utilising bio-oil and biochar will be demonstrated and validated, with short- and medium-term off-taker agreements secured. Upstream and downstream technologies will be verified to support serial production and commercial roll-out.

Budget

DKK 52,320,000

Funding source

The Danish Energy Agency, The Energy Technology Development and Demonstration Programme (EUDP)

Partners

Energy Cluster Denmark, Euromilling A/S, Organic Fuel Technology, Topsoe, Aarhus University

Contact

Jens Henrik Haahr, jhh@organicfuel.tech

Timeline

2024 - 2029

TRL

6 → 8

Sectors

Waste-to-energy

Fuels

Completed projects

Biogas and Pyrolysis - Development of synergy between biogas and pyrolysis = Doubling of gas extraction from agricultural residues

At a biogas plant, biomass is converted into gas that can be used for heating. In the biogas reactor, approximately 35% of the energy content from sources like straw is utilised. The rest remains untapped in the biomass that is returned to the fields. By integrating pyrolysis into the biogas plant, it is possible to achieve an improvement in energy utilisation in a much more flexible and efficient form compared to today's standards.

Budget: DKK 25,406,000

Funding source: Green Development and Demonstration Programme (GUDP)

Partners: Frichs Pyrolysis, University of Southern Denmark, Vrejlev Energy

Contact: Søren Bruun, sbr@frichs.com

Timeline: 2023 - 2025

TRL: 5 → 8

Focus area(s): Soil-based removal

BlueOFS - A mission to maximise C storage in Danish marine ecosystems

This project will identify the carbon capture/storage capacity potential in Odense Fjord, based on mitigative actions taking place both in the fjord and in its catchment area. This project is a pilot study for national upscaling. In addition, the project will outline diverse possible scenarios to optimise the use of nature-based solutions to increase carbon capture/storage capacity catchment-fjord system. The overall aim of the present project is to create a Danish blue carbon capture roadmap, quantifying the carbon balances, as well as other positive environmental side effects generated when using native nature-based solutions (NBS).

Budget: DKK 4,508,465

Funding source: INNO-COUS

Partners: Danish Hydraulic Institute, University of Southern Denmark

Contact: Paula Canal-Vergés, canal@biology.sdu.dk

Timeline: 2022 - 2025

TRL: 2 → 6

Focus area(s): Ecosystem-based removal

eDAC - Large scale integration of DAC in Energy Systems

This project's aim is to provide guidelines for stakeholders across the entire value chain, covering both technology and SSH aspects. This includes the development of an extension to state-of-the-art energy system analysis (EnergyPlan), enabling the assessment of DAC-PtX system performance in existing energy systems. Collectively, the project will assess technology, economy, business models, and regulatory issues for DAC deployment, consolidated into recommendations for how DAC can efficiently be system integrated.

Budget: DKK 4,400,000

Funding source: INNO-COUS

Partners: COWI, EuroWind, Port of Aalborg, Aalborg University

Contact: Thomas Helmer Pedersen, thp@energy.aau.dk

Timeline: 2022 - 2025

TRL: 4 → 5

Focus area(s): Direct air capture

Flash pyrolysis - Development of a system for gas-borne flash pyrolysis

The project's purpose is to develop a full-scale flash pyrolysis plant with a capacity of 15 tonnes of biomass per day. Frichs Pyrolysis has been working on developing pyrolysis plants for an extended period. Prior to this project, Frichs Pyrolysis received a patent for a pyrolysis method that not only produces biochar but also an excess of gas that can be utilised for energy production.

Budget: DKK 30,605,000

Funding source: The Danish Energy Agency's Pyrolysis Pool

Partners: Frichs Pyrolysis, Lisbjerggaard, Lykkesmeden, Springkilde Bio, University of Southern Denmark

Contact: Søren Bruun, sbr@frichs.com

Timeline: 2022 - 2024

TRL: 5 → 8

Focus area(s): Ecosystem-based removal

Future forests - Trees for the future forests

This project addresses how to support high adaptive potential of trees that can grow well in the uncertain future climate. The long-term health and fitness of our future forest trees are challenged by the predicted increasing temperatures, heavier and more frequent climate extremes. On the other hand, global warming could also lead to increased productivity if the trees can utilize longer growing seasons. This project studies how to select, improve or prepare the trees for the future forests.

Budget: DKK 5,900,000
Funding source: Villum Foundation
Partners: University of Copenhagen
Contact: Erik Dahl Kjær, edk@ign.ku.dk
Timeline: -
TRL: N/A
Focus area(s): Ecosystem-based removal

PETREA - Oaks in green transition

This project will examine the two types of oak trees in Northern Europe, called *Quercus robur* and *Quercus petraea*. The two species have overlapping genetic distributions where they are known to hybridise. *Q. robur* is the colder tolerant of the two, and after the last glaciation most likely facilitated *Q. petraea*'s northward spread towards colder environments. However, with increased frequency of dry summers, it may be *Q. robur* that can get an adaptive advantage by introgression with *Q. petraea*.

Budget: DKK 2,875,000
Funding source: Independent Research Fund Denmark
Partners: University of Copenhagen
Contact: Erik Dahl Kjær, edk@ign.ku.dk
Timeline: 2022 - 2025
TRL: N/A
Focus area(s): Ecosystem-based removal

SkyClean 2MW - Combining biofuel production with CO₂ capture and storage

The SkyClean technology combines biofuel production with CO₂ capture and storage. The core of SkyClean is a pyrolysis process, where organic waste from agriculture and forestry is converted into biochar, gas, and oil through heating at high temperatures in the absence of oxygen. The goal of this project is to advance and de-risk the SkyClean technology sufficiently, to make a final investment decision regarding the first full-scale plant.

Budget: DKK 36,440,000
Funding source: The Energy Technology Development and Demonstration Programme (EUDP)
Partners: Danish Gas Technology Centre, Energy Cluster Denmark, Stiesdal SkyClean, Technical University of Denmark, Topsoe, Ørsted Bioenergy & Thermal Power
Contact: Jesper Ahrenfeldt, jah@stiesdal.com
Timeline: 2021 - 2024
TRL: 3 → 7
Focus area(s): Ecosystem-based removal

SkyClean Scale-Up - Upscaling a pyrolysis plant to industrial and commercial scale

The core of the project is the pyrolysis technology itself and the upscaling of a pyrolysis plant to industrial and commercial scale. The SkyClean Scale-up project focuses on both the production of biochar, which captures CO₂ from the air, and the production of advanced biofuels. The project has three main objectives: 1) Mature the SkyClean technology, 2) document CO₂ storage, environmental, and fertilisation effects, 3) develop the surrounding value chains.

Budget: DKK 200,582,000
Funding source: The Danish Energy Agency's Pyrolysis Pool
Partners: AEA (Active Energy Systems), Agri Energy, Energy Cluster Denmark, Food & Bio Cluster Denmark, KK Wind Solutions, Roskilde University, SEGES, Stiesdal SkyClean, Technical University of Denmark, Topsoe, University of Copenhagen, Vestjyllands Andel, Aarhus University
Contact: Jesper Ahrenfeldt, jah@stiesdal.com
Timeline: 2022 - 2025
TRL: 6 → 8
Focus area(s): Soil-based removal

Vesthimmerland - Agricultural innovation, CO₂ storage, and utilisation

This project aims to establish a test and demonstration facility for biomass separation, with a focus on creating the optimal foundation for CO₂ storage and utilisation. Today, it is considered a prerequisite to present a comprehensive business model for a full-scale plant that includes all value streams. The technology around the pyrolysis plant is already undergoing testing. However, crucial knowledge is lacking regarding value creation in the preceding process leading up to the actual pyrolysis process.

Budget: DKK 1,639,000
Funding source: CO2Vision - REACT-EU
Partners: Lundsby Biogas, Vesthimmerland Biogas, Vesthimmerland Municipality
Contact: Maria Kristiansen, mak@energycluster.dk
Timeline: 2022 - 2023
TRL: 7 → 8
Focus area(s): Ecosystem-based removal

Implementation



Implementing CCUS

Carbon capture, utilisation and storage (CCUS) in Denmark is rapidly moving from research and demonstration to real-world implementation. Across the country, projects are being developed that establish the infrastructure, capture facilities, utilisation pathways, and storage sites needed to build a complete carbon management ecosystem.

Several facilities are already operating or under construction, demonstrating how CCUS can be integrated into industries such as energy production, cement manufacturing, waste management, biogas, and agriculture. At the same time, a growing pipeline of planned projects is advancing through feasibility studies, permitting processes, engineering design, and investment planning. Together, these initiatives illustrate the breadth of Denmark's emerging CCUS value chain and the increasing maturity of the sector.

The projects presented in this section provide an overview of both implemented facilities and known projects that have reached advanced planning stages. While not all planned projects have reached final investment decision, they represent significant commitments by companies, utilities, infrastructure developers, and public stakeholders to establish the foundations of a future Danish CCUS industry. Seen collectively, these projects highlight a notable shift in Denmark's CCUS journey: from developing technologies to deploying them at scale. They demonstrate how capture facilities, transport hubs, storage reservoirs, utilisation facilities, and biomass-based carbon removal solutions are being connected into integrated value chains capable of delivering substantial emissions reductions and carbon removals in the years ahead.

Hubs

FACILITIES



Port of Hirtshals - Greenport Scandinavia

Greenport Scandinavia is a CCUS hub being developed at the Port of Hirtshals to enable large-scale transport, intermediate storage, and export of CO₂ from multiple emitters across Northern Europe. The hub integrates infrastructure for receiving CO₂ by ship, truck, or pipeline, conditioning and temporary storage, and onward transport to offshore or onshore geological storage sites. By connecting cross-border CO₂ flows with storage capacity in Denmark, the project establishes a key gateway for building commercial carbon management value chains.

Status: Under construction

Investment milestone: 2023

Operation start: 2026

Operator: the Greenport Scandinavia consortium

Capacity: 0.5 -> 3 MtCO₂/year (2029) -> 15 MtCO₂/year (early 2030s)

CO₂ Source: Multiple

CO₂ Destination: Offshore storage



Port of Kalundborg - Ørsted Kalundborg Hub

The Kalundborg CO₂ hub is a central infrastructure facility for handling, temporary storage, and shipment of captured CO₂ from multiple sources. At the hub, CO₂ is received, conditioned, and exported by ship to offshore storage sites in the North Sea for permanent sequestration. By providing shared transport and logistics infrastructure, the hub enables efficient integration of carbon capture across different emitters and supports the scaling of CCS solutions.

Status: Operating

Investment milestone: 2023

Operation start: 2026

Operator: Ørsted

Capacity: 0,43 million tCO₂

CO₂ Source: Biomass

CO₂ Destination: Offshore storage



Port of Esbjerg - Greensand Future

Greensand Future is a full carbon capture and storage (CCS) value chain centred on offshore CO₂ storage in the Danish North Sea. The project integrates CO₂ transport by ship, intermediate handling infrastructure, and injection into geological formations beneath the seabed, enabling permanent storage of captured CO₂. It represents one of the first industrial-scale CCS systems in Europe and demonstrates how cross-border CO₂ flows can be connected to large-scale offshore storage capacity.

Status: Operating

Investment milestone: 2024

Operation start: 2026

Operator: INEOS

Capacity: 400,000 tCO₂ -> 4–8 million tCO₂

CO₂ Source: Multiple

CO₂ Destination: Offshore storage

EXPECTED FACILITIES

Port of Aalborg - Norne Carbon Storage Hub - Planning

The Norne hub is a large-scale CO₂ reception and transportation network in Denmark, designed to receive CO₂ from both domestic and international emitters via ship and pipeline and transport it to permanent geological storage sites. The project has completed FEED studies and environmental assessments, is developing infrastructure at the Port of Aalborg, and is designed for a capacity exceeding 15 million tonnes of CO₂ per year. Shortly before the release of this publication, Norne withdrew from the project.



CO₂ carrier. Photo: Project Greensand.

Point source capture

FACILITIES



Asnæs CHP plant

At Ørsted's Asnæs Power Station in Kalundborg, a carbon capture and storage (CCS) facility is being established to capture CO₂ from biomass-based heat and power production. The CO₂ is separated from flue gas using amine-based technology, then purified and liquefied for transport and permanent storage underground. The project is integrated with nearby CO₂ handling and shipping infrastructure in Kalundborg, supporting the development of shared CCS logistics and large-scale decarbonisation.

Status: Under construction

Investment milestone: 2023

Operation start: 2026

Operator: Ørsted

Capacity: 0,28 million tCO₂

CO₂ Source: Biomass (wood chips)

CO₂ Destination: Offshore storage (Northern Lighs)



Avedøre CHP plant

At Ørsted's Avedøre Power Station in Greater Copenhagen, a carbon capture facility is being established to capture CO₂ from straw-based heat and power production. The CO₂ is separated from flue gas using amine-based technology, then prepared for transport to central handling infrastructure in Kalundborg for further processing and permanent storage. The project supports the integration of CCS across multiple sites and contributes to reducing emissions from biomass-based energy generation.

Status: Under construction

Investment milestone: 2023

Operation start: 2026

Operator: Ørsted

Capacity: 0,15 million tCO₂

CO₂ Source: Biomass (agricultural waste)

CO₂ Destination: Offshore storage (Northern Lighs)



BioCirc Vesthimmerland - BioCirc Carbon Capture and Storage (CCS) project

At BioCirc's Vesthimmerland biogas facility, a bioenergy with carbon capture and storage (BECCS) solution is being implemented to capture biogenic CO₂ generated during biomethane production. The CO₂ is captured, purified, and liquefied on-site, then transported to coastal infrastructure for shipment and permanent storage in geological formations in the North Sea. The project forms part of a fully integrated CCS value chain and enables negative emissions by combining renewable biogas production with carbon removal.

Status: Operating

Investment milestone: 2025

Operation start: 2026

Operator: BioCirc

Capacity: 32.500 tCO₂

CO₂ Source: Biogas

CO₂ Destination: Offshore storage (Nini West)



Kalundborg Bioenergi

At Bigadan's biogas facility in Kalundborg, a carbon capture and storage (CCS) solution is being implemented to capture biogenic CO₂ from biomethane production. The CO₂ is separated during the upgrading process, liquefied on-site, and transported for permanent storage in geological formations in the North Sea. The project establishes a fully integrated CCS value chain for biogas and enables negative emissions by combining renewable energy production with carbon removal.

Status: Operating

Investment milestone: 2024

Operation start: 2026

Operator: Bigadan

Capacity: 27.000 t CO₂

CO₂ Source: Biogas

CO₂ Destination: Offshore storage (Nini West)



Aalborg Portland - ACCSION

ACCSION is a carbon capture and storage (CCS) project led by Aalborg Portland in collaboration with Air Liquide, aimed at enabling CO₂-neutral cement production. The project establishes a fully integrated value chain for capturing, transporting, and storing CO₂ emissions from cement manufacturing, using advanced cryogenic technology to efficiently capture CO₂ from multiple production streams. It represents a significant step toward decarbonizing the cement industry and supports both national and European climate goals.

Status: Pre-construction

Investment milestone: 2024

Operation start: 2030

Operator: Aalborg Portland, Air Liquide

Capacity: 1,42 million tCO₂

CO₂ Source: Cement, biomass

CO₂ Destination: Onshore storage

EXPECTED FACILITIES

AffaldPlus Næstved - AffaldPlus Carbon Capture - Feasibility

AffaldPlus CCS, Næstved is a planned full-scale carbon capture project at AffaldPlus' waste-to-energy facility, designed to capture and permanently store up to 150,000 tonnes of CO₂ annually from residual waste incineration. Developed by a consortium comprising AffaldPlus, European Energy, Ammongas and CarbonCuts, the project was one of 10 projects prequalified for Denmark's national CCS funding tender but did not submit a final bid.

Amager Bakke - ARC Carbon Capture Programme - Pre Front End Engineering Design (Pre-FEED)

This programme is ARC's long-term initiative to establish large-scale carbon capture at the Amager Bakke waste-to-energy facility. Building on a demonstration plant commissioned in 2023, ARC is pursuing both permanent storage and CO₂ utilisation pathways, including concrete mineralization, industrial gas use and future PtX applications, with an ultimate capture potential of approximately 500,000 tCO₂ per year. A commercial project, CopenCapture, was developed to capture up to 400,000 tonnes of CO₂ annually and was prequalified for Denmark's national CCS funding tender, but did not submit a final bid.

Amager CHP plant - HOFOR BECCS - Pre-FEED

HOFOR BECCS (Amagerværket), Copenhagen is a large-scale BECCS project being developed at HOFOR's biomass-fired Amagerværket CHP plant, one of Denmark's largest sources of biogenic CO₂. The project aims to capture and permanently store hundreds of thousands of tonnes of biogenic CO₂ annually, generating verified carbon removals while supporting Copenhagen's ambition to become climate-positive. The project was one of 10 projects prequalified for Denmark's national CCS funding tender but did not submit a final bid.

BioCirc Favrskov, Vinkel, Haderslev, Grønhøj - BioCirc Carbon Capture and Storage (CCS) project - Pre-FEED

BioCirc BECCS Portfolio comprises carbon capture projects at the Favrskov, Vinkel, Haderslev and Grønhøj biogas facilities, where biogenic CO₂ will be captured, liquefied, transported and permanently stored in the Danish North Sea. The projects form part of BioCirc's NECCS-supported CCS programme and contribute to a combined portfolio targeting up to 1 million tCO₂ of permanent storage; however, the projects remain in the planning and development phase

Nordværk - FjordPtX - Permitting

Nordværk CO₂ Capture is part of FjordPtX, a planned carbon capture facility at Nordværk's waste-to-energy plant in Aalborg, developed by Copenhagen Infrastructure Partners. The facility is designed to capture approximately 330,000 tonnes of CO₂ annually from waste incineration for use as feedstock in the adjacent FjordPtX e-fuel production plant, supporting the production of sustainable aviation fuel (eSAF). The project has entered the environmental permitting process and forms an integrated part of one of Denmark's largest Power-to-X developments.

Roskilde CHP - ARGO Carbon Capture - FEED complete

ARGO Carbon Capture, Roskilde is a planned carbon capture facility at ARGO's waste-to-energy plant in Roskilde, designed to capture up to 350,000 tonnes of CO₂ annually from residual waste incineration. The project has advanced through feasibility and FEED phases, was one of 10 projects prequalified for Denmark's national CCS funding tender, but did not submit a final bid.

Sindal Biogas - Sindal Biogas Carbon Capture Project - Pre-FEED

Sindal Biogas CCS, Hjørring is a biogenic CO₂ capture project integrated with the expansion of the Sindal Biogas facility, which will process up to 500,000 tonnes of biomass annually. The project aims to capture and utilize or permanently store up to 50,000 tCO₂ per year, supporting the development of Denmark's emerging BECCS value chain

Vestforbrændingen Glostrup - Gaia Carbon Capture - FEED complete

Gaia CCS (Vestforbrænding), Glostrup is a large-scale carbon capture project at Denmark's largest waste-to-energy facility, designed to capture up to 500,000 tonnes of CO₂ annually for permanent geological storage. The project has completed FEED studies, obtained environmental approval, secured a long-term carbon removal offtake agreement, and was one of 10 projects prequalified for Denmark's national CCS funding tender but did not submit a final bid.

Pyrolysis

FACILITIES



Fårevejle Pyrolyseanlæg

At Odsherred Forsyning's wastewater treatment plant in Fårevejle, a pyrolysis facility has been implemented to convert sewage sludge into biochar through

high-temperature treatment in an oxygen-free environment. The process reduces sludge volumes while destroying pollutants such as microplastics and pharmaceutical residues, and produces a stable carbon-rich biochar that can be reused. The facility demonstrates an integrated approach to waste treatment and carbon sequestration within the wastewater sector. [tv2east.dk], [stateofgreen.com]

Status: Operating

Investment milestone: 2020

Operation start: 2022

Operator: Odsherred Forsyning (Aquagreen)

Capacity: 3.500 tCO₂e

CO₂ Source: Sewage sludge

CO₂ Destination: Soil



Harboøre Renseanlæg

At the wastewater treatment plant in Harboøre, a second-generation pyrolysis facility has been implemented to treat sewage sludge and convert it into biochar.

The process heats sludge in an oxygen-free environment, reducing its volume while stabilising contaminants such as PFAS and microplastics. In addition to producing biochar, the facility generates energy that can be reused on-site, demonstrating a circular solution for waste treatment and carbon sequestration.

Status: Operating

Investment milestone: 2023

Operation start: 2025

Operator: Lemvig Vand (Aquagreen)

Capacity: 1.000 tCO₂ (350 t biochar)

CO₂ Source: Sewage sludge

CO₂ Destination: Soil



Kastrup Strandpark renseanlæg

At Tårnby Forsyning's wastewater treatment facility, a pyrolysis plant is being constructed to convert sewage sludge into biochar through high-temperature treatment in an

oxygen-free environment. The process reduces sludge volumes, destroys contaminants such as PFAS, and produces a stable carbon-rich biochar, while also generating energy for reuse. The facility is part of Tårnby Forsyning's strategy to achieve energy-neutral operations and demonstrates the integration of carbon removal and resource recovery in the wastewater sector.

Status: Operating

Investment milestone: 2023

Operation start: 2025

Operator: Tårnby Forsyning (Aquagreen)

Capacity: 5.000 tCO₂e

CO₂ Source: Sewage sludge

CO₂ Destination: Soil

Vrå - Stiesdal SkyClean



At Agri Energy's biogas facility in Vrå, a large-scale pyrolysis plant is being established to convert agricultural residues such as straw, manure, and digestate into biochar and bioenergy. The process heats biomass in an oxygen-free environment, producing a stable carbon-rich biochar for long-term carbon storage while generating gas and heat for local energy supply. The project integrates biogas production with pyrolysis to increase carbon utilisation and enables negative emissions in the agricultural sector.

Status: Operating

Investment milestone: 2022

Operation start: 2024

Operator: Stiesdal

Capacity: 28.000 tCO₂e

CO₂ Source: Biogas digestate

CO₂ Destination: Soil



Stiesdal pyrolysis facility
Image courtesy of Energy Cluster Denmark

Storage sites

FACILITIES



Nini West - Greensand Future

The Nini West field is an offshore geological CO₂ storage site located in the Danish sector of the North Sea, where depleted oil reservoir formations are repurposed for permanent carbon storage. As part of the Greensand project, CO₂ is transported by ship, injected into the subsurface, and stored in porous rock formations sealed by impermeable cap rock layers. The site represents one of the first operational offshore CO₂ storage locations in the EU and plays a central role in enabling large-scale CCS in Denmark.

Status: Operating

Investment milestone: 2024

Operation start: 2026

Operator: INEOS E&P, Harbour Energy, Nordsøfonden

Capacity: 0,4 million tCO₂ -> 8 million tCO₂ in 2030

CO₂ Source: Multiple

CO₂ Destination: Offshore storage

EXPECTED FACILITIES

Dangy, Harald & Inez - Project Bifrost - Exploration

Bifrost CO₂ Storage (Dangy, Harald & Inez) is an offshore CO₂ storage project in the Danish North Sea being developed by TotalEnergies and its partners to establish large-scale geological storage capacity for Danish and European industrial emitters. The project comprises three storage licences covering saline aquifers and depleted gas fields, with the newly awarded Inez licence alone estimated to have a potential storage capacity of up to 10 million tCO₂ per year and currently progressing through exploration and appraisal activities, including subsurface studies and drilling.

Havnsø - Exploration

CO₂ Storage Kalundborg (Havnsø Reservoir) is an onshore CO₂ storage project being developed by Equinor, Ørsted and Nordsøfonden to evaluate the Havnsø geological structure in western Zealand for large-scale permanent CO₂ storage. The project is currently in the exploration and appraisal phase, with seismic surveys, subsurface investigations, and reservoir evaluations underway to assess a potential storage capacity of up to 12 million tCO₂ per year.

Randers/Hobro - Project Greenstore - Exploration

Project Greenstore (Randers–Hobro) is an onshore CO₂ storage project being developed by Harbour Energy, INEOS Energy and Nordsøfonden to evaluate the geological formations between Randers and Hobro for permanent CO₂ storage. The project is currently in the exploration and appraisal phase, with extensive seismic surveys and drilling activities planned to assess a potential storage capacity of up to 5 million tCO₂ per year.

Rødby - Project Ruby - Exploration

Project Ruby, Rødby (Lolland) is a proposed onshore CO₂ storage project being developed by CarbonCuts and Nordsøfonden to assess the suitability of the Rødby geological structure for large-scale permanent CO₂ storage. The project is currently in the exploration and appraisal phase, with geological investigations ongoing and no public Final Investment Decision (FID) announced; a potential investment decision is expected after completion of subsurface studies and permitting activities.

Thorning - Project Norne - Exploration

Thorning CO₂ Storage is an onshore CO₂ storage project being developed by Norne Thorning Storage and Nordsøfonden to evaluate the Thorning geological structure in central Jutland for safe and permanent CO₂ storage. The project is currently in the exploration and appraisal phase, with aerial surveys, 3D seismic campaigns, and exploration wells planned to assess the suitability of the reservoir and support the development of a future storage site before 2030. Shortly before the release of this publication, Norne withdrew from the project.



Harald offshore platform, Project Bifrost.
Photo: TotalEnergies.

Utilisation

FACILITIES



Glansager

At Shell's biogas facility in Glansager on Als, a Power-to-X plant developed by Andel integrates electrolysis and biological methanation to convert renewable electricity and CO₂ into green methane (e-methane). Hydrogen produced from electrolysis is combined with CO₂ from biogas upgrading to form additional methane, increasing overall gas output and reducing CO₂ emissions. The project demonstrates a circular carbon utilisation pathway, where CO₂ is recycled into renewable gas for energy applications.

Status: Operating

Investment milestone: 2022

Operation start: 2023

Operator: Shell Biogas, Andel

Capacity: 12.000 m³ eNG/day

CO₂ Source: Biogas

CO₂ Destination: E-methane



Horsens

At Bigadan's Horsens Bioenergy facility, a carbon capture and utilisation (CCU) system captures CO₂ from biogas production and upgrades it to liquid bio-CO₂ for industrial use. The captured CO₂ is purified and liquefied, enabling efficient transport and use as a refrigerant in transport systems, as well as a feedstock for fuels and greenhouse applications. The project demonstrates how biogenic CO₂ can be valorised into commercial products, replacing fossil-based alternatives.

Status: Operating

Investment milestone:

Operation start: 2023

Operator: Bigadan

Capacity: 26.280 tCO₂

CO₂ Source: Biogas

CO₂ Destination: Refrigerants



Kassø - Kassø E-methanol Facility

At the Kassø facility in Southern Denmark, a large-scale e-methanol plant developed by European Energy converts renewable electricity, water, and biogenic CO₂ into green methanol. Using electrolysis to produce hydrogen and combining it with captured CO₂, the plant produces a synthetic fuel and chemical feedstock for sectors such as shipping, aviation, and plastics. The project demonstrates an integrated carbon utilisation pathway, enabling the use of CO₂ as a resource for producing low-carbon fuels and materials.

Status: Operating

Investment milestone: 2022

Operation start: 2025

Operator: European Energy

Capacity: 42.000 t e-methanol

CO₂ Source: Biogas (agricultural waste)

CO₂ Destination: E-methanol (fuels & plastic)

EXPECTED FACILITIES

ARC - ARC–Carbonaide CO₂ Mineralization - Pilot plant

ARC–Carbonaide CO₂ Mineralization is a carbon utilisation and storage demonstration project in which biogenic CO₂ captured at ARC's Amager Bakke facility is transported to Finland and permanently mineralized in concrete products using Carbonaide's technology. Operating at demonstration scale with 40–100 tCO₂ per year, the project validates a complete value chain from CO₂ capture and liquefaction to permanent storage in construction materials and the generation of verified carbon removals.

Energist Esbjerg - Energist CCS - Feasibility

Energist CCS, Esbjerg is a planned carbon capture project at Energist's waste-to-energy facility in Esbjerg, designed to capture more than 200,000 tCO₂ per year and transport the CO₂ via pipeline to a future terminal at the Port of Esbjerg for liquefaction and offshore storage. The project was one of 10 projects prequalified for Denmark's national CCS funding tender, but did not submit a final bid.

Fredericia Refinery - Crossbridge CCS - Pre-feasibility

Pre-feasibility study for producing liquid e-fuels through the combination of green hydrogen from the HySynergy electrolyser and captured CO₂ from the Crossbridge refinery. The study evaluated pathways for methanol, aviation fuels, and other low-carbon transport fuels

Port of Vordingborg - Green2x - Pilot plant

Green2x, Vordingborg is a large-scale biomethane and biofuel project based on agricultural straw feedstock, targeting production of more than 170 million Nm³ of biomethane annually and generating approximately 350,000 tCO₂ per year of biogenic CO₂. The project is currently in development and pilot demonstration, with the captured CO₂ intended primarily as feedstock for methanol and other low-carbon fuels.

Vordingborg - Project Endor - FEED complete

Project ENDOR (Arcadia eFuels), Vordingborg is a large-scale Power-to-X and CCU project that will combine renewable hydrogen with up to 300,000 tCO₂ per year of captured biogenic CO₂ to produce approximately 80,000 tonnes of eSAF and e-fuels annually. The project has completed FEED, obtained its environmental permit, secured EU Innovation Fund support, and is progressing toward construction as one of the world's first commercial-scale eSAF facilities.

Aalborg Forsyning - FjordPtX - Pre-FEED

FjordPtX, Aalborg is a large-scale Power-to-X and CCU project that will combine green hydrogen with approximately 330,000 tCO₂ per year captured from Nordværk's waste-to-energy plant to produce up to 90,000 tonnes of eSAF annually. The project has completed its pre-FEED phase and is progressing toward FEED, with construction targeted from 2027 and production expected around 2030.

List of abbreviations

Short form	Full term	Short form	Full term
AD	Anaerobic Digestion	THMC	Thermal-Hydrological-Mechanical-Chemical
BECCS	Bioenergy with Carbon Capture and Storage	TRL	Technology Readiness Level
BIOCCU	Bio-Integrated Carbon Capture & Utilisation	TSA	Temperature Swing Adsorption
CA	Carbonic Anhydrase	UHPC	Ultra-High Performance Concrete
CC	Carbon Capture	UPO	Unspecific Peroxygenases
CCS	Carbon Capture and Storage		
CCU	Carbon Capture and Utilisation		
CCUS	Carbon Capture, Utilisation and Storage		
CDR	Carbon Dioxide Removal		
OETP	Clean Energy Transition Partnership		
CHP	Combined Heat and Power		
CLO	Chemical Looping Combustion		
DAC	Direct Air Capture		
DOC	Direct Ocean Capture		
EDAC	Electrochemical Direct Air Capture		
ERW	Enhanced Rock Weathering		
FEED	Front End Engineering Design		
H ₂ S	Hydrogen Sulfide		
HTC	Hydrothermal Carbonisation		
LCA	Life Cycle Assessment		
LWAC	Lightweight Aggregate Concrete		
LWCB	Lightweight Aggregate Clinker Blocks		
MES	Microbial Electrosynthesis		
MOF	Metal-Organic Framework		
MRV	Monitoring, Reporting and Verification		
NBS	Nature-Based Solutions		
Oxy-CFB	Oxy-fired Circulating Fluidised Bed		
Oxy-MILD	Moderate or Intense Low-oxygen Dilution		
PBR	Photobioreactor		
PF	Potassium Formate		
PPO	Polyphenol Oxidases		
PtX / P2X	Power-to-X		
ROM	Reduced Order Model		
ROV	Remotely Operated Vehicle		
RWGS	Reverse Water-Gas Shift		
SOP	Single Cell Protein		
TEA	Techno-Economic Analysis		
TEN-T	Trans-European Transport Network		
THbC	Thermo-Hydro-bio-Chemical		

Projects

Akronym

4D observation 74
 Acetate Consortium 150
 ALGIECEL 150
 Alternative Capture Materials 21
 APPLAUSE 150
 ASGREEN 22
 Assessing DOC 85
 BE Clean 150
 BICCU 86
 BIFUNC 151
 BIG 87
 BIOCHSTA 159
 BioCO₂ 151
 Biogas and Pyrolysis 186
 Bio-hydrogen production 151
 BioNETzero 24
 Bioreactor dynamics 88
 BioReFuel 151
 BioStore 161
 BioTechCCU 151
 BlueOFS 186
 BOMS 25
 BRIGHT Mission 1B 89
 BUHPC 152
 CAPCO₂ - Algae 90
 CapCO₂ 152
 CAPeX 91
 CAP-FLEX 28
 CapSim 29
 CAR2MA 30
 Carbon-4-LIFE 92
 CarbonAdapt 31
 CARBONCHAINS 26
 CarbonCuts 32
 Carbonive 93
 CARMA-Green Fuels 162
 C•ASH 27
 CaSiCarbon 163
 CASPER 34
 Catalyst stability studies 94
 CC and PtX 95
 CCCA 96
 CCCH₂ 74
 CCUS-INFRASTRUCTURES 33
 Cement durability 74
 CeMetCorr / ML-CorrModel 74
 Cerberus 36
 CERNET 97
 C-Farming 164

Akronym

ChalkCO₂RE 37
 CHARBLOCK 100
 CHARBUILD 98
 CO₂-O Infrastructure 38
 CO₂Corr 75
 CO₂Fix 152
 CO₂flow 39
 CO₂Hub Hanstholm 152
 CO₂Impure 75
 CO₂injection in chalk 75
 CO₂MAN 40
 CO₂Nylon 101
 CO₂Plus 41
 CO₂QMON 42
 CO₂RESHC 75
 CO₂Seal Integrity 75
 CO₂-to-Protein 102
 CO₂Valorize 104
 COLLATE 76
 CompReact 43
 ConsenCUS 76
 CooCE 153
 Cooling Tower DAC 44
 CORROPro 76
 CORT 45
 CRONUS 105
 CROSS 76
 CSTO₂NE 106
 C-TECH 107
 CTS - CO₂ Transport 77
 DACBattery 165
 DACKbone 166
 Dall Pyrolysis 167
 DemoBECCS 77
 D-TRIOS 46
 ECOMO 108
 eDAC 186
 Effect of CO₂ injection 77
 Electrocatalysts for CO₂ Conversion 109
 EnCO₂age 77
 ENDES 47
 EnviAmin 48
 Enzyme-accelerated Carbon Capture and Conversion 49
 Enzyme-integrated electrochemical conversion 110
 eTecFuels3 111
 EXCOEL 112
 FENIX 168
 Flash pyrolysis 186
 Flue-to-Fuel 153

Akronym

Fluid Bed Pyrolysis 169
FOS - Fiberoptic chemical sensing 78
FRESH 153
FrontFuel 113
FUTUREFOR-DK 170
Future forests 187
Gate2GreenFuels 114
GCO2M 115
GRAF2X 78
Green Twins 50
HarWASTing 116
HEC 117
HydraMOF 78
Hyper-CAP 51
ICaRUS 52
ICEFIELD 171
IKKA-CCUS 120
InjectMe 153
INNO4EST 172
INNO-SALT 53
LegiRoad 54
Let-them-stick 154
LOCASH 55
LoCo2 56
LSICC 57
Marine Renewable Hub 154
MARVIC 173
MECOE 154
MES-MODEL 2.0 118
MES-MODEL 154
Methane and CO₂ detection 78
Methane electroconversion 121
METHARC 154
Microbial electrosynthesis 155
MISSION-CCS 58
MitiChar 176
Mobile CU Reactor 122
Modelling CO₂-to-Protein 123
MONICO 174
NEOSUCCES 155
Net Zero Arc 79
NEWCEMENT 59
NNF-BECCS 177
OMGCCS 60
OptiCap AI 61
Optimizing Europe's CO₂ transport 62
PAoCCUS 63
PETREA 187
Plastics to Capture 64

Akronym

PluriCarb 66
PowerLBG 124
PROFIT 126
Project Bifrost 79
Project Greensand 68
PROMISE 127
PYRAH2 128
PyroCO2 129
PytoCCUS 130
PytoN 178
PytoX 131
RD-BECCUS 155
ReCycle 132
REFOREST 180
Reformable 133
ReFuel 134
RenByLand 181
Restore 182
REUSE 135
SEABAS 79
SEAL 67
SEMPRE-BIO 136
SHARP storage 80
SimCO2CFuel 137
SIMPLY 183
SkyClean 2MW 187
SkyClean Scale-Up 187
SOLARSPoon 138
Solution-space for CCU technologies 70
SSCC 71
SUMIT 139
SUSTEPS 140
SynoProtein 141
THERMOCO2WELL 72
TIMBERHAUS 184
TOBIAS 142
UC-DC 143
VALCCAP 80
VALGREEN 73
VALORGAS 144
Value4Farm 145
Vesthimmerland 187
Vingegaard 146
Waste plastics 147
WaveFuels I 155
Wavefuels II 185
WellCS 80
WOODCIRCLES 148
WURTZ 149
Aalborg I 80

Project partners

Partner	Page	Partner	Page
011h Sustainable Construction	148	Algaenite	139
Aalborg CSP	80, 95, 114	AlgEn	105
Aalborg forsyning	95	ALGIEOEL	90, 150
Aalborg Portland	34, 42, 45, 76, 80, 114	Algiecel	122
Aalborg University	22, 24, 29, 30, 31, 33, 45, 46, 52, 57, 63, 71, 80, 91, 107, 114, 122, 137, 154, 161, 162, 165, 186	Alleima Tube	58
Aarhus University	27, 30, 37, 38, 44, 51, 55, 64, 74, 75, 76, 79, 85, 86, 88, 91, 94, 109, 110, 113, 115, 118, 123, 124, 127, 132, 134, 145, 150, 151, 153, 154, 155, 159, 162, 164, 170, 171, 172, 173, 176, 185, 187	Ammongas	155
ABB	52	Amsterdam University of Applied Sciences	148
AOEA Pinerolese Industriale	97	AMU Nordjylland	178
AOIES BIO Biotehnološke Raziskave in Razvoj	97	Ancotrans	38
AOQUIN	164	Andanatura Foundation for Sustainable Socioeconomic Development	92
ADM Bazancourt	97	Apple	150
ADM Hamburg	97	AquaGreen	98, 159, 161
ADM Razgrad	97	ARC (Amager Resource Center)	79, 126
AEA (Active Energy Systems)	187	ArcelorMittal	128
Again	89, 129	ArditEO Association	140
Agency for Data Supply and Infrastructure	172	ARGO (Roskilde Energitårnet)	152
AGH University of Science and Technology	24	AristEng	128
Agri Energy	130, 178, 187	Aristotle University of Thessaloniki	155
Agricultural Research for Development	105	Arkema France	129
Agrolab	171	Arla Foods	30, 162
Agroscope	173	ASN Alcatel	80
Agrosolutions	173	Association for Rural Development Turia-Calderona	116
AIDIMME	116	Association of Forest Municipalities of the Valencian Community	116
Aigües de Barcelona	136	Autonomos University of Barcelona	105
AINIA	155	Axelera	129
Air Liquide	24	Baker Hughes Energy Transition LLC	58
Aker Carbon Capture	68, 77	Bauhaus der Erde	184
Alexandra Institute	50, 155	Bergene Holm AS	141
		Beta Technological Center	136
		BetterWells	80
		BioCirc Group	61
		Bioenergías de la Campiña	92
		Biofertilizantes CH ₄	97

Partner	Page	Partner	Page
Biogas Thy	55	Centro de Investigación de Recursos y Consumos Energéticos	97
Biogas-e	136	CETAQUA	136
Biological and Chemical Engineering	155	Chalmers University of Technology	129
Biometagás La Galera	97	Chinese Academy of Sciences	152
Bioprocess Technology	129	Chongqing University	77
BioRefine Denmark	162	CiaoTech	129
Biotechnical Centre Naklo	164	Circle K	114
BiotechPRO	105, 155	City of Baia Mare	184
Bioxegy	106	City of Berlin	184
Blue Water Shipping	68	City of Siena	184
Blue World Technologies	111, 114	CIUDEN	24
BluEnergy Revolution	97	CLEAN	183
BlueNord	25, 32, 37, 41, 43, 67, 76, 78	Clean Air Task Force	62
Bodega Matarromera	97	Clean Cluster	171
Bollinger + Grohmann Engineers	115	Clean Energy Solutions	135
Boğaziçi University	140	Climate-KIC	184
bp	80	CO2Laborate	166
Brimatech Research	116	CO2Techn	111, 155
BRIPA	120	Cold Jet	38
British Geological Survey	76, 80	Comune di Torino	148
Brunel University London	105, 106	Concito	165
BTS Biogas	153	Confagricoltura	164
Built by Nature	184	Copenhagen Business School	63, 174
Bundesanstalt für Geowissenschaften und Rohstoffe	46	Copenhagen Municipality	126
Bureau Veritas	174	COSVITEC	164
Burhøjgaard	181	Coval Energy	76, 153
Burmeister & Wain Energy APS (BWE)	132	COWI	85, 186
By Nature	166	CRH Products	100
C.I.R.A.D	168	CRYO inox	136
Carbon8 Systems	106	CSIC	24, 173
CarbonCuts	46	CYBERNETICA	73
Cartago Ventures	92, 128, 168	Czech University of Life Sciences Prague	173, 180
Cartif Technology Center	105	Daka Denmark	89
CASP	46	Dall Energy	169
Cebra Architecture	100	Dan-unity CO ₂	68
Cemmac AS	104	Danfoss	50
Center Completions	71	Danish Gas Technology Centre	34, 74, 76, 79, 150, 151, 187
Center for Research and Technology Hellas	76, 135	Danish Hydraulic Institute	68, 186
Central Denmark Region	183	Danish Institute of Fire and Security Technology (DBI)	54
Centre National de la Recherche Scientifique	108	Danish Offshore Technology Center	56, 67, 74, 75, 76, 77, 78, 80, 151
Centro de Biotecnologia de Plantas da Beira Interior	106	Danish Standards	54
		Danish Technological Institute	28, 34, 50, 59, 67, 68, 98, 100, 122, 130, 132, 143, 148, 155, 181, 184

Partner	Page	Partner	
Dansk Skovforening	30, 174	Esvagt	68
Davidsen Pond Global	115	ETA Florence Renewable	135
De Danske	172	Energies	
Skovdyrkerforeninger		ETH Zürich	184
DecarbonICE	38	Euro-Mediterranean	180
DEOHEMA	141	Economists Association	
Demos Helsinki	184	Eurofins Agrosience Services	168
Denmark University of	138	Regulatory	
Cambridge		Euromilling A/S	155, 185
Det Danske Hedeselskab	172	Euronewpack	153
Deutsches	136	European Biochar Industry	159
Biomasseforschungszentrum		Consortium (EBI)	
DHI	172	European Centre of Excellence	76
DIN Forsyning Esbjerg	76, 169	for Sustainable Water	
Draxis Research Ventures	97	Technology	
Eastern Transylvanian	116	European Conservation	164
Association of Forest Owners		Agriculture Federation	
and Administrators		European Energy	114
Easyscience	148	Europroject Ltd.	180
EOA Engineering	165	Euroquality	145
Ecoinnovazione	129	EuroWind	186
Eesti University of Life Sciences	173	Evida	34, 152
Eilenburger Elektrolyse und	108	Explicit	79
Umwelttechnik		F. Junkers Industrier	184
EIT Food	164	F6S	116
ELGO-DIMITRA	164	FarmTree BV	180
Ellinikos Georgikos Organismos	92	Federal University of Itajubá	140
- Dimitra		Filtenborg	181
Ellinkikos Goergokos	168	Financiera Maderera	116
Organismos		Finnish Meteorological Institute	173
Elplatek	111, 142, 146, 149, 150, 151	Firmenich	129
EMD International	165	Fisheries and Food (ILVO)	173
EMPA	184	Flanders Research Institute for	173
En2Save	57	Agriculture	
ENCO	97	FLSmidth	59
Enemærke & Petersen	148	Folkhem Trä	148
Energinet	76	Fondazione ICONS	148
Energy Cluster Denmark	38, 68, 130, 155, 178, 185, 187	Food & Bio Cluster Denmark	97, 178, 187
Energy Institute Hrvoje Požar	145	Food and Environment	173
Energy Policy Group	76	FORCE Technology	31, 42, 45, 50, 54, 73, 152, 154, 178
Engie Laborelec	153	Foresa Technologies	116
EnviPark	148	Forschungszentrum Jülich	140, 153
Environment Park	97	Fraunhofer-Gesellschaft	108
Equinor	46, 58, 60, 80	Fredericia College of Marine	131
Erhvervshus Fyn	30	and Technical Engineering	
ErinN Innovation Limited	140	(FMS)	
eRisk Group	153	Fremsyn	38
Esbjerg Havn	71	French National Centre for	129
ESTECH	22, 74, 146, 149	Scientific Research	
		Frichs Pyrolysis	186

Partner	Page	Partner	Page
Fujian Institute of Research on the Structure of Matter	152	Herøya Industrial Park	129
Fuller Technologies Denmark	28	Hjorthede Planteskole	174
Fundacio ENT	148	HybridGreen Tech	152
Fundació Universit�ria Balmes	97	HyChem Qu�mica Sustent�vel	128
Fundaci�n CARTIF	97	Hysytech	153
F�ns Transformers	52	Icons	184
Gas storage Denmark	25, 31, 39, 41, 46, 53, 72, 79	Ikast Betonvarefabrik	152
Gas Storage Denmark	34	IKEA	146
Geelmuyden Kiese	68	Ikkaton	120
Gemeente Rotterdam	148	IKM Ocean Team	75
GeoEcoMar	77	Imperial College London	138, 153
Geological Survey of Denmark and Greenland (GEUS)	25, 27, 39, 46, 53, 54, 55, 60, 68, 72, 74, 75, 76, 77, 79, 80, 159, 161, 166	INAGRO	180
German Association for Agroforestry (DEFAF)	180	Inagro	145
Gesellschaft f�r Chemische Technik und Biotechnologie e.V.	141	Indian Institute of Technology Bombay	80
GFZ Helmholtz Centre for Geosciences	182	INEOS	41, 43, 68, 76, 77, 80
Global Solutions	58	Ingelia	116
Goodyear Tire & Rubber Company	128	Ingenier�a Verificaciones Electromec�nicas y Mantenimientos	155
GRAINAS	181	Innargi	46
GRDF	92	Innolab	136
Grecian Magnesite	76	INRAE - French National Research Institute for Agriculture	173
Green Protein	115	Inrae Transfert	168
Greenfarm	71	Institut de Recherches en �nergie Solaire et en �nergies Nouvelles	140
GreenGo Energy	38	Institut National de Recherche pour L'Agriculture	168
Greenport North	57, 154	Institute for Bio-Economy and Agri-Technology	164
Gr�sten Tegl	73	Institute for Energy Technology	58
Gr�n Brint H�rring	154	Institute of Rock and Soil Mechanics at the Chinese Academy of Sciences	77
Gr�nGas H�rring	124, 154	Institute of Soil Science and Plant Cultivation – State Research Institute	145, 164
Gubra	172	Inveniam Group	128, 136
HADA Electrolyzers	152	Iren SPA	148
Hafnium Labs	40, 61, 155	Italian Biogas and Gasification Consortium	145
Haldor Tops�e	89	Johnson Matthey	129
Harbour Energy	46	Joutsenten Reitti	116
Heatflow	114	Karlsruhe Institute of Technology	104, 129, 170
HedeDanmark	172, 176	Kass� e-methanol	89
Hedeselskabet	174	Kemijski Institut	97
Hellenic Agricultural Organisation	105, 153	Ketjen Netherlands BV	140
Helmholtz Centre for Environmental Research – UFZ	145	KIRT X THOMSEN	38
Helmholtz-Zentrum Dresden-Rossendorf	104		
Henan Polytechnic University	106		

Partner	Page	Partner	
Kiverdi Netherlands	97	NextChem	129
KK Wind Solutions	187	No partners	102, 177
Klimafonden Skive	27, 30, 115	Noble	68
Klimaskovfonden	172, 174	Nofima AS	141
Kliwen	130	Norce	77, 129
Knowledge Hub Zealand	90, 126, 150	Nordendahl Landbrug v. Niels Holger Nordendal Nielsen	181
Kraftvarmeværk Thisted	42	Nordphos	139
Kronospan	98	Nordsøenheden	67, 78
KW-Plan	172	Nordsøfonden	36, 37, 76
LAND	164	Norner Research	129
Landbo Nord	159	NORSAR	80
Landbrug og Fødevarer	30	North Carolina State University	87
Landia	124, 153	Norvento Enerxía	155
LanzaTech	89	Norwegian Geotechnical Institute	80
LBBC Baskerville	58	Norwegian Institute for Sustainability Research (NORSUS)	141
Lectrolyst	150	Norwegian University of Science and Technology	58, 80, 104
Lemvig Biogas	151, 153	Novel Environmental Solutions	105
Leth Beton	98	Novonesis	135, 174
Lhoist	52, 59	Novozymes	90, 150
Lisbjerregaard	186	NPL Management	58
LODR	164	Nuevas Tecnologías para el Desarrollo de Packaging y Productos Agroalimentarios con Componente Plástica	97
Lundsby Biogas	187	NV De Zwanebloem	136
Lykkesmeden	186	NxPAS	124
Maderas Gamiz	184	Oath Inc	174
Madisi	105	Odsherreds Landboforening	159
Maersk Container Industry	38	Oil and Gas Corrosion	58
Magtel Operaciones	92	Oil and Gas Technology Center	76
Manchester Metropolitan University	135	Ole Møller Helbæk	127
Mannok Cement Limited	28	Olicem	42
Mash Makes	159, 161	OMV Petrom	76
Metabolic Institute	184	Organic Fuel Technology	155, 159, 185
Mettler-Toledo	120	Orkidea samstarfsverkefni	145
Mitis	145	Oslo University	96
Morsø Municipality	27, 181	P2CC (Power to Climate Change)	90, 150
Morsø Spildevand	181	Paul Scherrer Institute	140
Mærsk	111, 162	Pentair	34, 40, 45, 73, 79, 150, 151
Mærsk-McKinney Møller Center for Zero Carbon Shipping	162	PFA Pension	174
National Institute of Applied Sciences of Lyon	58	Pfeifer Holding	184
National Oceanography Centre	68	Philipps University of Marburg	180
National Technical University of Athens	105	Phyona	106
Nature Energy	151, 162	PI4SD	164
Naturgy	136		
NaturIT	172		
Necta Bioenergy	128		
New Energy Coalition	76		
Newcastle University	135		

Partner	Page	Partner	Page
PlanEnergi	30	Saint-Gobain Denmark	127
Plenesys	128	Samsø Municipality	172
PMH Plast	120	Sasol	113
Polish National Agroforestry Association	180	SCG Chemicals	129
Politecnico di Milano	128	Schlumberger	29
Polytechnic University of Madrid	106	Schlumberger Cambridge Research	58
Pond	143, 153	Schneider Electric	32
PoreSense I/S	67	Scientific and Technological Research Council of Turkey	140
Port of Aalborg	52, 114, 186	Sdr. Herreds Kraftvarmeværk	181
Port of Esbjerg	38	SecondCircle	143
Port of Hanstholm	152	SEGES	161, 182, 187
Procter & Gamble Services Company	97	Semco Maritime	68
Progressive Farming Trust Ltd LBG	180	Shanghai Advanced Research Institute at the Chinese Academy of Sciences	77
ProPuls	136	Shell	80, 142
PureteQ	74	Shell International	58
PYROCO2	89	ShipTown	165
Qlab Analytical Laboratory	153	Siemens Process Systems Engineering Limited	104
R&R Consult	165	Silesian University of Technology	24, 106
Ramboll	73	Simulkade	62
Rambøll	31, 68, 79	SINEF	71
Randers Kommune	30	SINOPEC	77
Ranido	129	SINTEF	24, 58, 89, 129, 136, 141
READLAB	164	Skive Municipality	27, 30
REM Tec	145	Skovkortet.dk	172
Renegas	167	Skretting Aquaculture Research Centre AS	141
RepAir DAC LTD	166	SLF	159
Research Center for Carbon Solutions at Heriot-Watt University	76	Soft & Teknik	130
Resen Waves	68	Solar Foods	138
Ringkøbing-Skjern Kommune	183	Solrød Bioenergy/Bigadan	139
RISE Research Institutes of Sweden	141	Spanish National Research Council	116
Risktec	80	Spectro Inlets	152
Riverse	92	Spotlight	68
Robert Gordon University	76	Springkilde Bio	152, 186
Roblight	122	SRDC	116
Rock Flour Company	171	STAM	97
Rockfield	80	Stanford University	43, 91, 155
ROCKWOOL International	152	Stichting PDC Research Foundation	61
Roskilde University	126, 127, 130, 161, 183, 187	Stiesdal	161, 176, 182
Rotho Blaas	148	Stiesdal SkyClean	30, 130, 131, 159, 162, 174, 178, 183, 187
Royal Danish Academy	115	Stora Enso Oyj	148
Rybjerg Biogas	27		
SAE Innova	173		
Saint-Gobain	131		

Partner	Page	Partner	
Stork/Fluor	76	TotalEnergies	33, 36, 37, 39, 41, 43, 56, 58, 67, 75, 76, 78, 79, 93
StrawTech	127	TotalEnergies Upstream Denmark	46
Stuttgart University	89	Trakia University	180
Sunstones	27, 55	Transilvania University of Braşov	116
Svanehøj	32	Transports Metropolitans de Barcelona	136
Sveriges Geologisk Undersøkelser	46	Trimble	148
Tartu Linn	148	TU Delft	89
TBW Research	135	Unibio	89, 126
Teagasc - Agriculture and Food Development Authority	173	Unicat Catalyst Technologies	151
Technical University Delft	80	Unisense	76
Technical University of Denmark	22, 25, 28, 29, 34, 37, 39, 40, 41, 43, 45, 47, 49, 50, 53, 54, 56, 58, 59, 61, 63, 67, 68, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 85, 87, 90, 91, 93, 96, 101, 104, 105, 106, 108, 110, 111, 112, 116, 117, 126, 127, 128, 129, 131, 132, 133, 136, 138, 141, 142, 143, 144, 146, 149, 150, 151, 152, 153, 154, 155, 159, 161, 166, 167, 168, 169, 178, 187	Universidade da Beira Interior	106
Technical University of Dresden	104	Universitat de Lleida	106
Technical University of Munich	108, 138	Universitat Politècnica de València	116
Technion	25	Universiteit Gent	136
Tegel Projekt	184	University of Aveiro	135
TerraWatt	92, 128, 136, 168	University of Bonn	180
TGE Gas Engineering	32	University of Calgary	76, 140
TGS	68	University of Cambridge	148
The Carbon Removers	55	University of Copenhagen	21, 26, 30, 47, 48, 54, 64, 66, 80, 91, 115, 120, 132, 161, 162, 163, 170, 171, 172, 173, 174, 176, 180, 182, 184, 187
The Danish Environmental Protection Agency	172	University of Geosciences	152
The Danish Nature Agency	172	University of Gothenburg	120
The Institute of Chemistry of OrganoMetallic Compounds (ICCOM)	153	University of Groningen	76
The Novo Nordisk Foundation	30, 121, 147, 150, 155, 162	University of Leeds	58
CO ₂ Research Center (CORC)	162	University of Leicester	135
The Pennsylvania State University	155	University of Ljubljana	164
Thisted Cogeneration Plant	152	University of Mining and Technology	77
Thisted Heat Supply	152	University of Oslo	46
Thisted Municipality	27, 55, 80, 152	University of Oxford	80
Thy Mors Energy	80	University of Padova	105
Topsoe	73, 113, 120, 132, 150, 155, 185, 187	University of Padua	104, 153
TORM	149	University of Queensland	124, 153
		University of Reading	145, 180
		University of Sopron	180
		University of Southampton	68
		University of Southern Denmark	30, 91, 140, 151, 162, 186
		University of Teramo	173
		University of Tübingen	123
		University of Évora	77
		Università Cattolica del Sacro Cuore	145, 173

Partner	Page
Universität Freiburg	173
Urbasofia	148, 184
UT SMIDE	105
Utrecht University	91
Valmet Oyj	120
VandCenter Syd	74, 146, 149
Vandkunsten Architects	115
Veltis	92
Veolia Energia	24
Verdo	30, 155
Vestfold and Telemark County Council	129
Vesthimmerland Biogas	187
Vesthimmerland Municipality	30, 187
Vestjyllands Andel	30, 115, 162, 187
Viborg Kommune	30
Vrejlev Energy	186
VTT Technical Research Centre of Finland	116
Wageningen University & Research	145
Wageningen University and Research	89, 173
WAI Environmental Solutions AS	141
Wartsila	32
Washington University St Louis	150
Waste to Energy	128
Waste to Energy Advanced Solutions	92
Wagh Thistleton Architects	148, 184
We Build Denmark	115
Weif Agrotecnia	116
WellPerform	77
Welltec	25, 31, 68, 71
Wetsus	76
Wind Power Lab	68
Wintershall Dea	41, 68, 77, 80
Wood Group UK	58
Woodfiber	148
World Biogas Association	145
Wärtsilä	124
Y Squared	135
Y-MatTec	152
York University	96
ZeroEx	171
Ørsted	30, 33, 40, 45, 162
Ørsted Bioenergy & Thermal Power	187
Ørsted Salg & Service	79
Østdansk Landboforening	159

Funding sources

Project title		Project title	
AgriFoodTure	30, 132, 139, 176	INNO-CCUS	22, 25, 28, 29, 30, 31, 33, 34, 37, 39, 43, 45, 46, 50, 53, 55, 57, 59, 60, 61, 63, 72, 75, 76, 79, 80, 98, 100, 115, 120, 132, 139, 143, 151, 155, 159, 161, 165, 166, 171, 172, 174, 183, 186
Apple Inc	150	Innovation Fund Denmark	36, 41, 77, 111, 126, 150, 152
Carlsberg Foundation	91	Lundbeck Foundation	91
Circular Bio-based Europe Joint Undertaking (CBE JU)	97	Ministry of Higher Education and Science in Denmark	91
Clean Air Task Force (CATF)	62	Ministry of Science and Technology of the People's Republic of China (MOST) - Bilateral Agreement project	152
CO2Vision - REACT-EU	42, 74, 95, 114, 122, 152, 154, 168, 181, 187	MissionGreenFuels	30, 124, 132, 139, 142, 149, 162
Danish National Research Foundation	91	Novo Nordisk Foundation	26, 27, 87, 89, 91, 112, 134, 150, 154, 155, 177
Danish Offshore Technology Center	56, 74, 75, 76, 77, 78, 79, 80, 151	The Clean Energy Transition Partnership	77
Energy Cluster Denmark	52	The Danish Energy Agency	113, 146, 153, 155, 185
Energy Technology Development and Demonstration Programme (EUDP)	40, 67, 76, 79, 80, 151, 153	The Danish Energy Agency's Pyrolysis Pool	169, 186, 187
Erasmus+	164	The Energy Technology Development and Demonstration Programme (EUDP)	38, 52, 68, 71, 73, 77, 78, 79, 90, 113, 146, 150, 151, 152, 155, 167, 185, 187
EU	92	The Just Transition Fund (JTF)	107, 130, 131, 178
Gates Foundation	150	The Novo Nordisk Foundation CO ₂ Research Center (CORC)	21, 44, 47, 49, 51, 64, 70, 85, 86, 88, 94, 102, 109, 110, 118, 121, 123, 144, 147
Green Development and Demonstration Programme (GUDP)	127, 186	Trace	30, 54, 132, 139
Green Labs DK programme (GLDK)	71	Velux Fonden	56
Horizon Europe	24, 58, 66, 76, 104, 105, 106, 108, 116, 128, 129, 135, 136, 138, 140, 141, 145, 148, 153, 155, 173, 180, 184	Villum Foundation	78, 91, 133, 137, 151, 153, 187
Independent Research Fund Denmark	27, 48, 78, 93, 96, 101, 117, 154, 163, 170, 182, 187		

Sectors

Secor	Page
Agriculture	30, 92, 96, 97, 116, 127, 130, 132, 145, 159, 161, 162, 164, 168, 169, 170, 171, 173, 174, 176, 177, 178, 180, 183, 187
Biogas	30, 38, 71, 90, 92, 96, 97, 107, 126, 130, 131, 133, 136, 139, 142, 151, 152, 153, 154, 155, 167, 186, 187
Cement industry	28, 34, 45, 52, 59, 62, 76, 78, 80, 96, 104, 106, 152
Chemical industry	54, 62, 64, 87, 88, 89, 92, 93, 94, 97, 101, 108, 109, 117, 118, 128, 129, 135, 143, 147, 149, 150, 151, 152, 153, 154, 155
Construction	54, 73, 98, 100, 106, 115, 116, 127, 131, 148
Cross sector	21, 22, 26, 29, 30, 40, 44, 47, 48, 49, 50, 51, 54, 58, 61, 62, 63, 70, 74, 76, 77, 78, 90, 110, 112, 120, 122, 127, 132, 150, 151, 154, 163, 166, 186, 187
Energy utility	24, 30, 57, 70, 77, 79, 80, 86, 107, 122, 132, 153, 155, 165, 177, 186
Food production	97, 102, 123, 126, 138, 139, 141, 150
Forestry	30, 116, 132, 170, 172, 174, 182, 184, 187
Fuels	30, 38, 85, 91, 92, 95, 105, 107, 109, 111, 113, 114, 121, 124, 128, 131, 132, 133, 134, 137, 140, 142, 144, 146, 149, 151, 152, 153, 154, 155, 185, 186
Infrastructure	30, 31, 33, 42, 54, 62, 132
Off-shore storage	25, 27, 32, 36, 37, 38, 39, 41, 43, 46, 53, 54, 56, 60, 62, 66, 67, 68, 72, 74, 75, 76, 77, 78, 79, 80, 107, 151, 177, 186
On-shore storage	27, 38, 43, 55, 62, 66, 75, 76, 77, 78, 79, 80, 132, 177, 178
Waste-to-energy	62, 92, 96, 106, 128, 139, 149, 181, 185

Focus areas

Focus area	Page
Carbon conversion	26, 30, 38, 49, 54, 70, 85, 86, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 101, 102, 105, 107, 108, 109, 110, 111, 112, 113, 114, 117, 118, 120, 121, 122, 123, 124, 128, 129, 131, 132, 133, 134, 136, 137, 139, 140, 142, 143, 144, 145, 146, 149, 150, 151, 152, 153, 154, 155, 164
Carbon-based materials	30, 49, 87, 97, 98, 100, 102, 104, 106, 109, 115, 116, 123, 126, 127, 128, 131, 135, 138, 139, 141, 143, 147, 148, 151, 152, 155, 167, 180
Direct air capture	21, 26, 30, 44, 49, 57, 61, 64, 70, 96, 107, 165, 166, 186
Direct ocean capture	49, 85, 107
Ecosystem-based removal	24, 30, 49, 71, 77, 97, 106, 162, 163, 170, 171, 172, 173, 174, 177, 180, 182, 184, 185, 186, 187
Enhanced weathering & mineralisation	27, 49, 55, 171
Geological storage	25, 26, 27, 30, 31, 32, 33, 36, 37, 39, 41, 43, 46, 49, 53, 54, 55, 56, 60, 62, 63, 66, 67, 68, 72, 74, 75, 76, 77, 78, 79, 80, 177
Point source capture	21, 22, 24, 26, 28, 29, 30, 33, 34, 40, 45, 47, 48, 49, 50, 51, 52, 57, 58, 59, 61, 62, 64, 70, 71, 73, 74, 76, 77, 78, 79, 80, 86, 93, 95, 96, 97, 107, 120, 132, 135, 139, 142, 151, 153, 155, 167, 177
Soil-based removal	49, 130, 159, 161, 164, 168, 169, 171, 173, 174, 176, 178, 181, 183, 186, 187
Transport	26, 30, 33, 34, 38, 42, 49, 62, 63, 66, 70, 77, 107

