Carbon Capture Journal

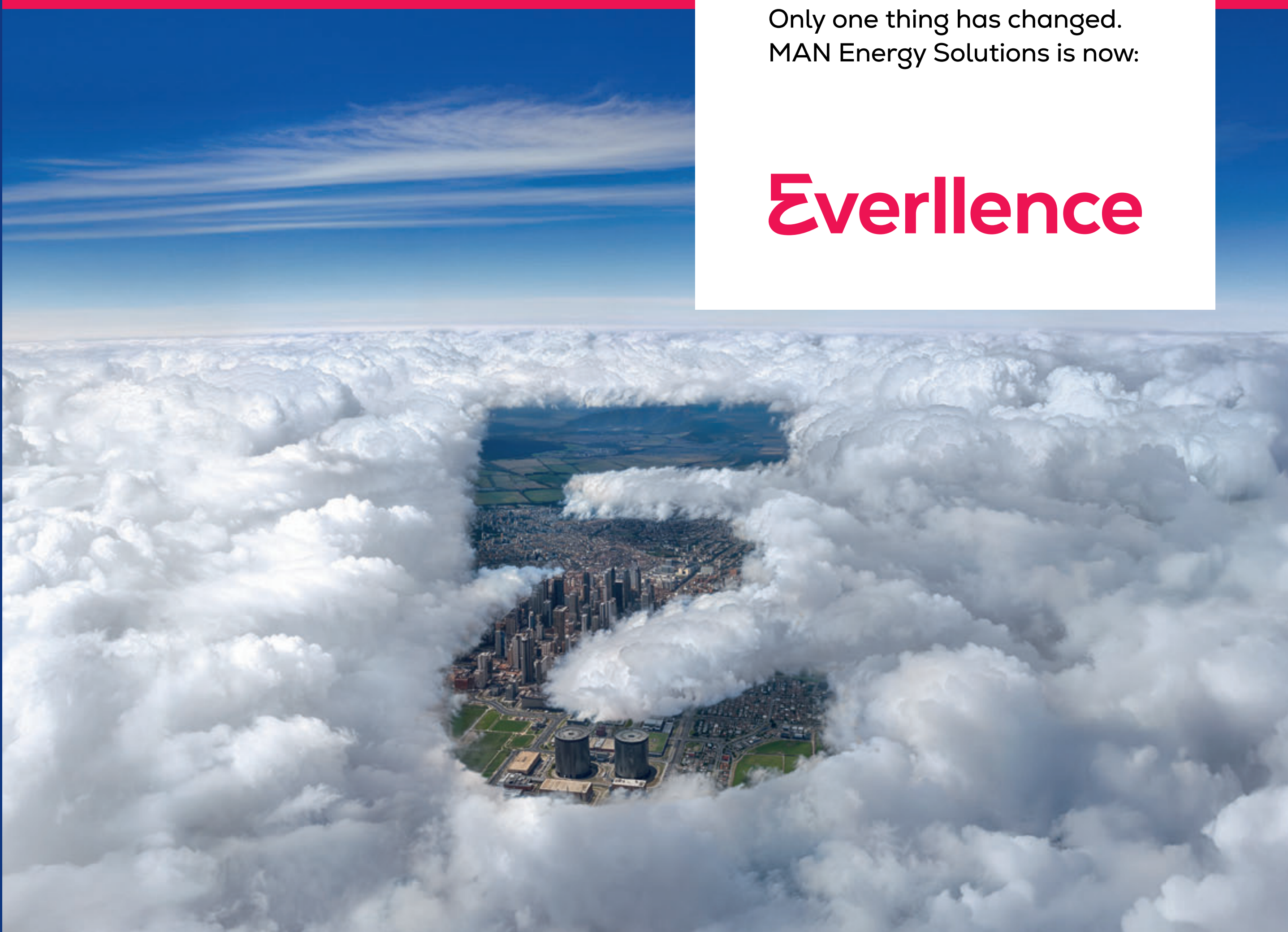
CCUS in Asia

KEPCO CO2 capture advances

Research and regulations in India

NTPC & Carbon Clean first methanol from captured CO2

Nov / Dec 2025 Issue 108



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Back cover: enfinium's Parc Adfer combined heat and power facility processes up to 232,000 tonnes of residual waste. A report from Beringa found that by combining the UK energy from waste sector with CCS, emissions can fall by over 70% and go carbon negative as early as 2035 in an accelerated deployment scenario, generating up to 10 million tonnes of carbon removals a year by 2040 (pg. 18)

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Leaders - CCUS in Asia

Projects and policy

Capture and utilisation

Transport and storage

KEPCO advances CO2 capture technologies for coal and LNG power

Korea Electric Power Corporation (KEPCO) and its power generation subsidiaries are aligning with government policies that phase down coal-fired power plants and replace them with gas-fired power plants. To support this transition, KEPCO has taken the lead in developing post-combustion CO2 capture (PCC) technologies. By Jeom-In Baek, JiHyun Lee, Jongmin Park. **www.kepco.co.kr**

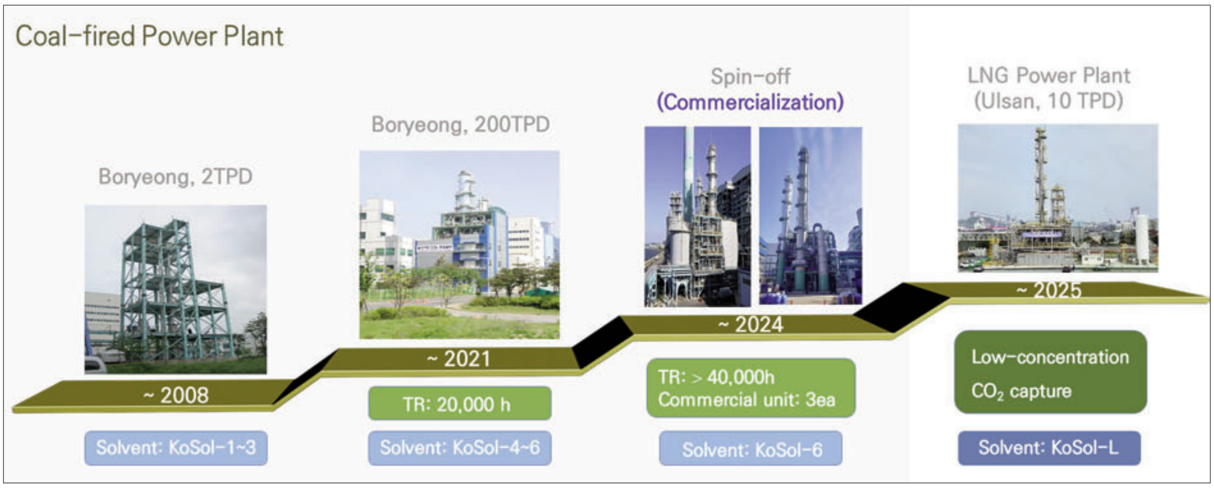

Figure 1 - KEPCO's CO2 capture technology development path

In response to the global climate crisis, Korea has pledged to achieve carbon neutrality by 2050 and is actively pursuing the development and demonstration of greenhouse gas reduction technologies.

According to the 2050 Carbon Neutrality Scenario announced in 2021, the Korean government expects CCUS technologies to contribute between 55 and 84.6 million tonnes of greenhouse gas reduction in 2050. Against this policy backdrop, KEPCO has developed a comprehensive post-combustion wet scrubbing CO2 capture technology platform that encompasses proprietary solvent design, process engineering, and demonstration projects.

This article summarises KEPCO's progress, focusing on its achievements in CO2 capture plants for coal and LNG power plants, industrial application, and its commercialisation roadmap.

Solvent Development and Technology Platform

Since the early 2000s, KEPCO Research Institute (KEPCO RI) has spearheaded R&D in CO2 capture. Through continuous study on absorbents, process design, and demonstration, KEPCO has built a complete technology development infrastructure. Central to this effort is the KoSol series of proprietary amine-based solvents, characterized by low heat duty for solvent regeneration and high CO2 capture capacity.

Validation has been carried out in collaboration with domestic and international partners. KEPCO's development pathway began with Korea's first 0.1 MW (2 TPD) capture pilot in 2002 and progressed to a 10 MW (200 TPD) demonstration plant at Boryeong coal power station in 2013, applying the low-energy KoSol solvent.

Successive KoSol solvents (KoSol-3, 4, 5, and 6) have been developed, capable of handling the demanding conditions of flue gases. At Boryeong coal fired power station, the 200TPD CO2 capture pilot plant achieved over 20,000 hours of continuous operation, maintaining ≥90% CO2 removal efficiency with solvent regeneration energy 2.3-2.5 GJ/tCO2 at the CO2 concentration of 13.5-15% in the flue gases. This represented Korea's first long-term PCC demonstration at such scale and confirmed the global competitiveness of KEPCO's technology.

Coal Power Plant CO2 Capture

The Boryeong 10 MW CO2 capture plant remains the largest coal-fired PCC installation in Korea. Loaded with KoSol-6 solvents, it consistently achieved high capture efficiency while operating under harsh conditions of the coal power plant.

This project provided essential data for scaling up and integrating capture into coal-based power generation, proving the feasibility of long-term stable operation at utility scale.

Through these results, KEPCO demonstrated that KoSol capture systems could reliably operate on coal flue gas, paving the way for further application and cross-sector expansion.

The project also played an important role for domestic capacity building, with KEPCO leading the development from design to long-term operation.

LNG Power Plant CO2 Capture

KEPCO expanded the PCC to LNG power generation, responding to Korea's policy of transitioning toward lower-carbon fuels. In 2021, the Ministry of Trade, Industry and Energy launched a national research project for CO2 capture in NGCC power plants, appointing KEPCO as the lead organization. KEPCO RI, together with five power generation subsidiaries.

KEPCO developed a new solvent tailored to low CO2 and high O2 flue gas environments typical of LNG combustion. Based on this solvent, a 10 TPD LNG PCC plant was designed in 2022 and installed at Ulsan Power Plant in October 2024. The plant was constructed by Hyundai Heavy Industries Power Systems as EPC contractor and operated by Korea East-West Power Company. The Ulsan capture facility is Korea's first and largest LNG PCC demonstration plant.

As of September 2025, the plant has achieved more than 1,500 hours of continuous operation, consistently delivering ≥90% capture efficiency, 99.9% CO2 purity, and solvent regeneration energy of 2.9–3.0 GJ/tCO2 at the CO2 concentration of 3.5-4.5 % in the flue gases. The facility is expected to capture more than 3,000 tonnes of CO2 annually, while providing critical operational data for scaling to commercial LNG capture projects.

This success marks an important expansion of PCC applicability, proving that the technology can be effectively deployed not only at coal-fired power plants but also at gas-fired power plants, thereby broadening the pathway for decarbonization in the Korean power sector.

Industrial Application and Technology Transfer

KEPCO's PCC technology has already been transferred to private industry and applied in commercial operations, contributing to the formation of Korea's CCUS ecosystem. Three commercial plants are currently operated with KEPCO's capture systems:

- Korea Midland Power (Boryeong, 2013): a 200 TPD capture plant supplying liquefied C2 for dry ice and industrial use.

- SGC Energy (Gunsan, 2023): a 300 TPD capture plant supplying liquefied CO2 for dry ice and industrial use.

- Kumho Petrochemical (Yeosu, 2024): a 220 TPD capture plant supplying liquefied CO2. These projects show that KEPCO's technologies go beyond emission reduction, enabling new business models and industrial synergies in CCUS.

Figure 2 - Ulsan post-combustion CO2 capture plant for NGCC

Future Directions

KEPCO continues to enhance its solvent performance and capture processes to further reduce energy consumption and improve overall efficiency. KEPCO is also developing modular capture plants for deployment at small and medium-sized industrial sites, broadening the reach of PCC technology.

In terms of commercialisation, KEPCO aims to supply full value-chain solutions, ranging from technology licensing to design, operation, and maintenance. Domestically, the initial focus will be on LNG and coal power plants, before expanding into steel, petrochemicals, and cement. Internationally, KEPCO is targeting markets in North America, the Middle East, and Southeast Asia, supplying capture systems for LNG and coal plants as well as for fertilizer and hydrogen production.

By integrating PCC with carbon utilization and storage, KEPCO intends to provide comprehensive CCUS solutions that will contribute meaningfully to both national and global decarbonization strategies.

Conclusion

KEPCO has built a strong track record in PCC technology, from developing its proprietary KoSol solvents to demonstrating capture at both coal and LNG power plants. The success of the Boryeong and Ulsan projects proves the reliability, scalability, and commercial viability of its solutions.

With technology transfer already underway and international expansion planned, KEPCO is set to contribute to advancing global carbon neutrality goals.

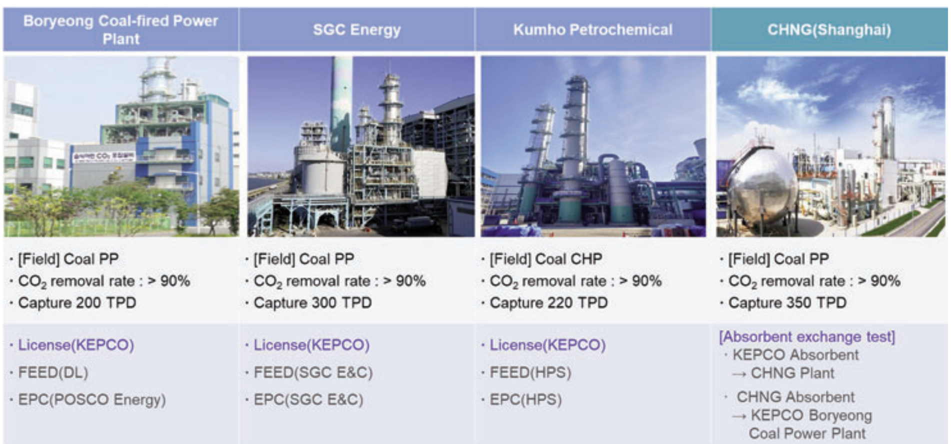

Figure 3 - KoSol CO2 capture plants in operation

Evolving CCUS research and regulations in India

India's path towards achieving net-zero emissions, committed by 2070, requires strategic actions in CCUS development. This article covers the current state of play and potential and looks at future initiatives to deploy the technology. By Dr (Mrs) Malti Goel*.

India's non-fossil fuel sources reached an installed capacity of 230 GW in June 2025, which is nearly 50% of total installed power capacity of 476 GW then; coal continues to have a major share (~60%) in total electricity generation.

To address coal based emissions, India began investment in the National Programme on CO2 Sequestration Research supported by the government of India with stakeholders' participation in early 2000s, thus providing a strong foundation for a holistic approach.

The main obstacles that hinder the large-scale implementation of CCUS are: high CO2 capture cost & energy penalty; lack of maturity of sub-system technologies; and missing-national regulatory frameworks. These factors have discouraged further investment in CCUS deployment, in contrast to renewable energy sources, which are getting a boost for a clean energy transition.

Advancements in CCUS technologies must get translated into measurable reductions in carbon emissions and policy frameworks and regulatory actions are vital. Technology trends in CCUS with policy priorities get alighned by integrating CCUS development into national energy frameworks.

National Institution for Transforming India (Niti) Aayog, a government policy think tank, has developed a comprehensive roadmap in 2022, aiming to expand CCUS capacity in India by giving a boost to R&D and investment. Collaboration among private and public industries for creation of hubs as business models is recommended to achieve commercialisation. The hubs can earn their revenue from industries that would require captured CO2 transport and management services.

Capitalising on economic and environmental opportunities, private sector companies such as Reliance Industries, Tata Steel, Jindal Steel and Dalmia Cement, among others have-come forward to commit to adoption of CCUS as part of their decarbonisation efforts.

The Prime Minister's Science, Technology & Innovation Advisory Council (PM-STIAC) at the highest level in India is committed to CCUS deployment and in a meeting in July 2024 said, "We must take a mission-mode approach to integrate CCUS into our industrial landscape." National Centres of Excellence at IIT Bombay and JNCASR, Bangalore are established with the third one coming up at NEERI, Nagpur.

Early this year a Wood Mackenzie assessment suggested development of a better carbon market to decrease the reliance on direct-government support to enhance the overall feasibility of CCUS projects in India. Projected to account for around 15% of the CCUS-capacity in the Asia Pacific region by 2050 in its base case would require investment equivalent to US4.3 billion dollars. India could potentially achieve a capture capacity of 123 million tonnes per annum (Mtpa) by then says the report.

On the policy front the Bureau of Energy Efficiency, with a mission to enable delivery mechanisms for energy efficiency services, has reflected CCUS in the national targets and included it in the scope of India's Carbon-Credit Trading Scheme in its paraphernalia.

Awareness and Capacity Building Workshop (ACBCCUS-2025)

The Climate Change Research Institute (CCRI) has been at the forefront of CCUS awareness and capacity building in India since its inception in 2009. In its ACBCCUS-2025 workshop on 'Recent Advances in CCUS Technology, Policy, and Regulations' in June 2025, insightful technical discussions, keynote lectures and interactive panel discussions on CCUS took place. Some highlights are covered as below.

A. Geologic Carbon Storage Potential in India

India's commitment to net-zero emissions underlines the importance of geologic carbon storage as a viable solution for sequestering industrial CO2 emissions on the ground. Studies conducted at IIT Bombay suggest significant potential for CO2 storage in various sedimentary basins across India. Key geological formations include hydrocarbon-bearing sandstones and marine shales. Opportunities exist for CO2 utilisation in enhanced oil recovery (EOR) techniques.

Detailed evaluations are needed to identify representative CO2 storage complexes with emphasis on multi-sector collaboration for scalable CCS technologies. The studies carried out suggest integrating experimental methodologies and geo-mechanical modeling during CO2 injection to improve risk assessments and project design to assess storage capacity and seal integrity.

B. Geologic Carbon Storage Implementation in India

Implementing geologic carbon storage in India is essential for sustainable industrial growth and energy security. Significant potential exists for CO2 storage in deep saline aquifers and coal seams with total estimated geologic storage capacity around 291 GtCO2. Investment of approximately $1–8 billion annually would be needed for CCUS infrastructure development; however identifying optimal storage sites near major CO2 sources would enhance cost-effectiveness.

CO2 storage can support deep decarbonisation efforts in hard-to-abate sectors by addressing technological readiness and regulatory frameworks being crucial for successful implementation.

President Climate Change Research Institute and Former Sc. 'G' and Emeritus Scientist, Govt. of India. The views expressed are personal.

C. Conversion of CO2 into Chemicals and Fuels

The chemical industry emitting 932 MtCO2 annually would require carbon as a feedstock, if fossil fuels resources are not there. CO2 conversion from biomass, waste plastics, and CO2 emissions are potential renewable carbon sources, and present a strategic opportunity for sustainable development. Only some portion of the biomass production is combusted, while the major portion is simply decomposed with sustainable harvesting principles needed.

Waste plastic recycling is inadequate to meet future carbon demands in the sector. The need arises for CO2 conversion into chemicals and fuels; however it requires significant energy inputs and materials. Emphasis on CO2 capture using bio-processes such as direct air capture (DAC) technology is vital. The cost of DAC is currently high but may decrease with technological advancements.

D. Single-Step Absorption and Isolation of CO2

Innovative methods for CO2 capture focus on simplifying the process through single-step absorption that captures CO2 and converts it into carbamates using amines. Various solvents, including green solvents, are explored for effective CO2 capture.

The process avoids multi-stage treatments and regeneration, enhancing efficiency. Some of the challenges being addressed at VIT, Chennai are solvent stability, carbamate solubility, and scale-up processes as efficient CO2 capture and utilization pathways.

E. Solar Integrated Carbon Capture and Sequestration

The integration of solar energy with carbon capture technologies can enhance overall efficiency and reduce energy penalties for CO2 reduction in coal-fired power plants. A pilot plant at RKDF University demonstrates capture of 45 kg/hr of CO2 with solar integration to reduce energy penalty for solvent regeneration.

The pilot plant has optimised energy balance for various utilization pathways including algal biofuel and hydrogen production from captured CO2. A feasibility study for retrofitting a 500 MW unit with a potential 30% CO2 capture rate is under preparation.

Contribute to "Handbook on CCUS"

We invite your contributions to the upcoming 'Handbook on CCUS' to be published by Springer Nature. If you are interested in contributing a chapter in the handbook, especially success stories of industrial scale projects and case studies, please contact:

Dr (Mrs) Malti Goel

Editor-in-Chief, Handbook on CCUS and President, Climate Change Research Institute on: maltigoel2008@gmail.com

F. NTPC's CO2 to Methanol Project

National Thermal Power Corporation (NTPC) has been taking new initiatives in carbon capture and utilisation by innovative solutions to demonstrate the potential in reducing CO2 emissions in line with NTPC aim to decarbonize its operations to achieve India's net-zero target by 2070. The 'CO2 to Methanol' project at NTPC Vindhyachal is a unique initiative in this regard. The project integrates green hydrogen with captured CO2 for methanol production. Lessons learned from the design and commissioning of the project will inform future initiatives. The project exemplifies the role of CCUS in achieving a just energy transition.

G. Decarbonising India's Power Sector through CO2 Storage

Geological storage of CO2 in deep unmineable coal seams offers a pathway for decarbonising India's coal-dependent power sector. Coal accounts for over 65% of India's electricity generation and for mitigating emissions from thermal power plants CO2 storage can be an option. Deep coal seams in regions like the Damodar Valley offer significant CO2 storage potential. The Jharia and East Bokaro coalfields exhibit favorable geological characteristics for CO2 sequestration.

CO2-Enhanced Coalbed Methane (CO2-ECBM) recovery can enhance economic viability. A just transition framework is essential to address socio-economic impacts on coal-dependent communities.

H. Modular Technology – Cyclone CC for Steel sector

Prioritisation of scalable, cost-efficient, and quick-to-implement solutions for decarbonisation in hard-to-abate sectors like steel, would define India's industrial green transition. A Modular Carbon Capture system is being adopted in collaboration with Carbon Clean Inc. at JSW Vijaynagar steel plant. The Cyclone CC is a rotating packed bed reactor, offering distinct advantages in size, energy efficiency, and modular application for scalability. With this JSW is the largest steel plant aiming to address commercialisation challenges of CCUS through strategic expansion.

I. Scaling CCUS in India: Business Models and Policy Enablers

The successful scaling of CCUS in India requires innovative business models and supportive policy frameworks to drive industrial decarbonization based on the premises that CCUS is essential for reducing emissions in hard-to-abate sectors like steel and cement. Business models should focus on hub-and-cluster approaches for cost-effective implementation of CCUS. Integration with the hydrogen economy can enhance competitiveness and circularity. Policy recommendations include carbon credit incentives, lifecycle carbon accounting, and de-risking mechanisms of CO2 stored. Development of a strategic roadmap is needed for national CCUS scale-up and institutional support.

J. Challenges and Opportunities in CCUS Deployment

The deployment of CCUS technologies in India faces several challenges due to high capital and operational costs for successful implementation that hinder CCUS deployment, which need to be addressed. The cost of capture and energy penalties associated with CO2 capture can also reduce overall power plant efficiency. Geological storage requires effective site selection for safe CO2 storage and its transport from capture to storage site, which is hampered by lack of integrated carbon management infrastructure. Policy and regulatory frameworks are inadequate to support CCUS deployment. These challenges are crucial for realizing CCUS's potential in climate mitigation.

The workshop with participation of 20+ stakeholders generated policy inputs and technical suggestions for cross-sectoral partnerships. A national mission led by the ministry of coal or any other central agency is recommended to coordinate efforts across various ministries. Establishing specific national targets for CCUS deployment and addressing concerns related to new technologies, including liability for transport and storage uncertainties should be given priority.

Key constraints in attaining commercialization of storage and utilisation, besides the cost of capture, are; (i) CO2 Storage – lack of geostratigraphic placement for cost optimisation (ii) CO2 Utilisation - lack of adaptability to use of renewable energy in place of conventional power for reducing energy penalty, and (iii) For both - missing legal / regulatory framework.

A new thrust by the government to the 'National Mission on CCUS' with estimated investment of INR 38,900 crores (~4.43 billion USD) to drive research, development and commercial deployment with phased roll-out is in the pipeline. About 50% share from private industry and multi-lateral institutions is anticipated. A policy push is expected from the Low Carbon Development Commission to coordinate with the multi-ministry efforts.

Further, in compliance of Carbon Credit Trading Scheme (CCTS) 2023, the government has already announced mandatory reduction of GHG emissions per unit of product beginning 2025-26 for four sectors. The country is all set to define emission targets for nine key sectors and begin carbon trading from 2026.

The upcoming Global Innovation Centre (GIC) in Navi Mumbai by the Carbon Clean Inc., a global leader in revolutionising carbon capture solutions, with world class carbon capture research facilities and carbon capture plants is a new hope. Knowledge sharing and timely action are two sides of the same coin for new technology deployment.

More information

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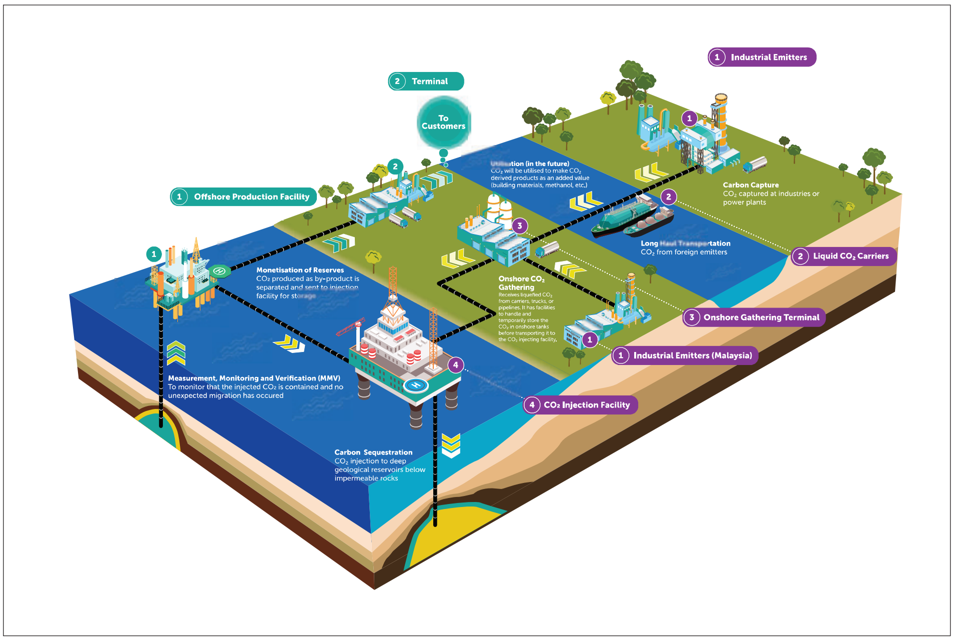
maltigoel2008@gmail.com

RINA Awarded FEED contract for PETRONAS CCS project in Malaysia

The contract is for the Southern Onshore Facilities of Malaysia's landmark CCS development and follows a successful pre-FEED executed in 2024.



The FEED contract will advance engineering for the Southern onshore CO2 receiving terminal in Peninsular Malaysia. The terminal is designed to receive CO2 from multiple domestic and international industrial emitters, which will subsequently be transported and injected into offshore geological storage.

Michele Budetta, Chief Executive Officer of RINA Consulting, said, "Securing the FEED phase underscores the trust placed in RINA's engineering depth and execution capability. We are proud to continue our collaboration with PETRONAS in advancing this strategic carbon management project."

"This phase introduces greater complexity and higher expectations, and we are committed to supporting the delivery of Malaysia's most strategic CCS infrastructure to date."

With a global team of over 6,600 specialists, advanced testing facilities and expertise in integrity assessments, RINA said it will provide support and guidance to the development of Malaysia's flagship CCS project, with a focus on safety, efficiency, and objectivity in technology selection and system design.

This project supports Malaysia's climate commitments and demonstrates the increasing readiness of Southeast Asia to implement large-scale, low-carbon infrastructure.

RINA's appointment to the FEED phase confirms its ability to support such strategic programmes and contribute to real-world decarbonisation.

More information

www.rina.org

NTPC produces first methanol from captured CO2 with Carbon Clean

India's largest power utility has reached a major milestone with CO2 captured from flue gas using Carbon Clean's CaptureX semi-modular technology used to produce the first drop of methanol.

NTPC's 500MW coal-fired power plant at Vindhyachal Super Thermal Power Station, in Madhya Pradesh, India has been demonstrating Carbon Clean's carbon capture technology

The project demonstrates that CO2 can be captured reliably at industrial scale and prepared for conversion into high-quality methanol. The project, executed by NTPC Energy Technology Research Alliance (NETRA), uses the licensed technology provided by Carbon Clean through its wholly owned Indian subsidiary, Carboncapture Technologies Pvt. Ltd.

The achievement advances India's ambition to become a global hub for CCUS, marks another milestone in Carbon Clean's portfolio by validating the robustness of its technology, and underscores NTPC's commitment to CCU and the viability of large-scale methanol production in India.

Designed to capture 20 tonnes of CO2 per day (TPD) directly from the power station's flue gas, the captured carbon dioxide will be catalytically hydrogenated using green hydrogen to produce methanol.

This will open new pathways for converting waste CO2 into a valuable chemical feedstock and sustainable fuel, further aligning with NTPC's decarbonisation strategy and long-term vision to create new business opportunities in the green economy.

This milestone comes as Carbon Clean participates in the UK Prime Minister's first major trade mission to India. The visit seeks to build on the momentum from the UK-India trade deal, signed in July. It underscores the growing collaboration between the UK and India in accelerating clean energy innovation, industrial decarbonisation and sustainable investment.

Aniruddha Sharma, Chair and CEO of Carbon Clean, said, "It's a privilege to be part of the Prime Minister's business delegation to India and to represent the UK's world-leading clean tech sector at such a pivotal moment for industrial decarbonisation."

"The partnership between the UK and India is crucial to scaling industrial decarbonisation, and the Vindhyachal project demonstrates how collaboration can turn ambition into action."

"Following the success of our initial 20 TPD CO2 capture project at NTPC Vindhyachal, our technology has been chosen for the subsequent 25 TPD CO2 capture project which will be used to produce ethanol at NTPC Simhadri."

"This selection strongly validates our system's robust performance under real industrial conditions and demonstrates customer confidence. These projects are key steps in showing how waste CO2 can be transformed into a valuable low-carbon product."

This progress follows the launch of Carbon Clean's Global Innovation Centre (GIC) in India three months ago, which will serve as one of their major international hubs to advance the next generation of carbon capture technologies.

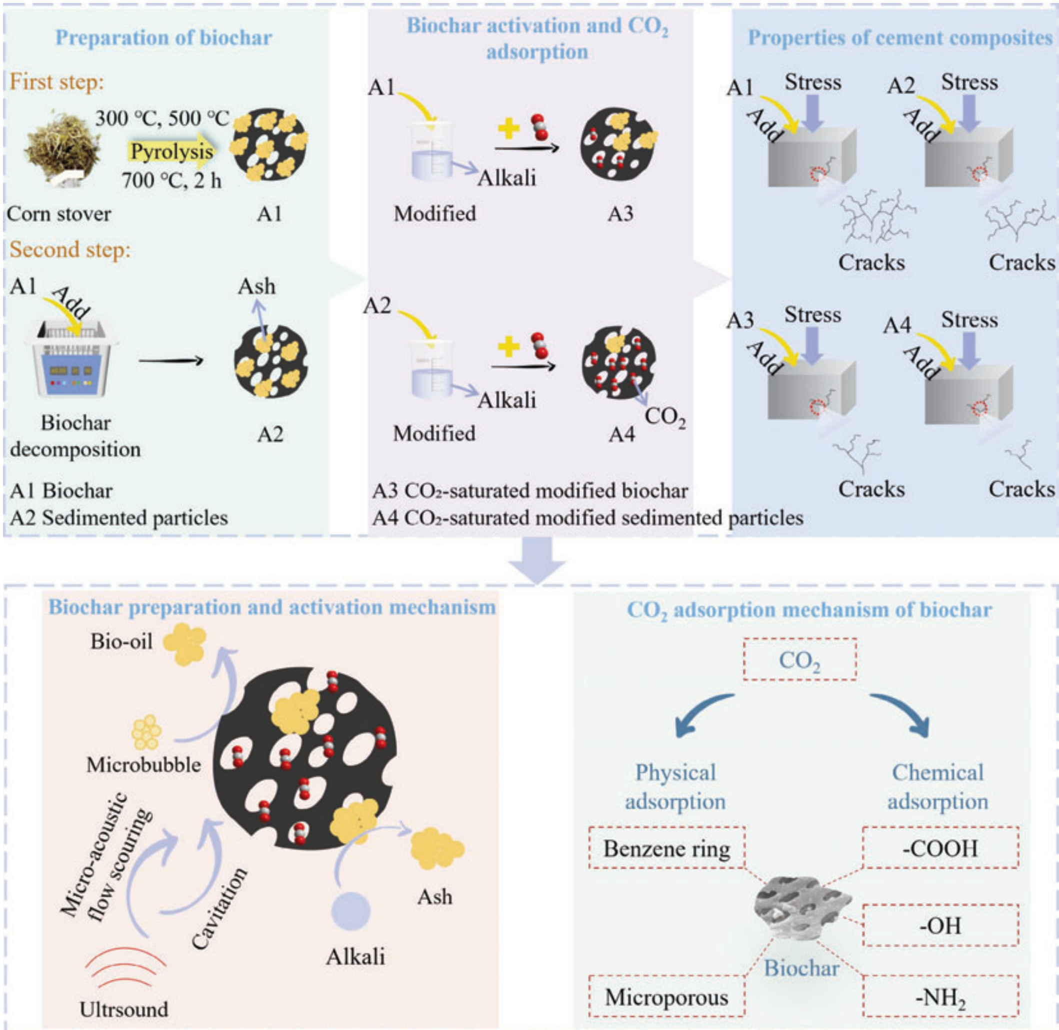
Carbon Clean said its modular carbon capture technology reduces site infrastructure needs, and its proprietary solvent, process equipment and heat integration systems deliver lower costs. Designed for flue gases with CO2 concentrations from 3% to 25% by volume, the system produces CO2 at over 99% purity.

More information

https://ntpc.co.in/vindhyachal
www.carbonclean.com

New biochar-enhanced cement could lock away more carbon dioxide

A research team from Hefei University of Technology, Zhejiang University, and South China University of Technology has discovered that adding specially treated biochar to cement can significantly improve its ability to capture and store carbon dioxide while strengthening the material itself.



Cement production is one of the world's largest sources of CO2 emissions. Finding cost-effective ways to store carbon directly in building materials could help reduce the industry's environmental footprint. In the new study, scientists explored how modifying biochar, a porous carbon-rich material made from plant waste, can make cement more sustainable.

The researchers produced biochar by heating corn straw at different temperatures and separated its main component, called sedimented particles. Both the original and separated biochar samples were treated with an alkali solution to enhance their structure and tested for CO2 adsorption. The team then mixed these biochars into cement at various proportions to evaluate their effects on strength and carbon capture.

The results revealed that the sedimented particles had a greater ability to trap CO2 than untreated biochar, and that alkali modification further improved this capacity by refining the material's microscopic pore structure. Biochar produced at 500 °C performed the best overall, combining strong adsorption ability with improved cement performance.

When added to cement, the CO2-saturated modified biochar made the material denser and stronger, particularly at a one percent replacement level. The study also showed that the biochar captures CO2 primarily through physical adsorption, which occurs quickly and efficiently under normal conditions.

In addition to enhancing mechanical strength, incorporating biochar reduced the total carbon footprint of the cement mixtures. The researchers concluded that the right combination of biochar type, treatment, and dosage can help transform ordinary cement into a carbon-storing material without compromising performance.

"This work provides new insight into using biochar as a sustainable additive that supports carbon neutrality in the construction sector," said lead author Binglin Guo. "By improving both strength and carbon sequestration, biochar-modified cement offers a practical step toward greener building materials."

Future studies could further investigate the applicability of different modified biochar saturated with CO2 at higher dosages. Additionally, comprehensive long-term durability evaluations, including resistance to environmental exposures, such as sulfate attack and chloride penetration, are crucial for fully assessing the practical applicability and benefits of biochar cement composites.

More information

www.maxapress.com/bchax
https://en.hfut.edu.cn
www.zju.edu.cn/english
www.scut.edu.cn/en

Asia news

JAPEX receives approval to drill two CO2 storage appraisal wells

www.japex.co.jp

JAPEX will commence exploratory drilling around November 2025 to advance the Tomakomai CCS Project offshore Japan.

Japan Petroleum Exploration Co., Ltd. (JAPEX) has received the license from the Minister of Economy, Trade and Industry to conduct exploratory drilling as the operator to confirm the existence of formations suitable for CO2 storage.

This exploratory drilling concerns the designation by the Minister of Economy, Trade and Industry in February of this year of a specific area off the coast of Tomakomai City, Hokkaido, pursuant to the Act on Carbon Dioxide Storage Business.

During the exploratory drilling, JAPEX plans to drill a total of two test wells using a drilling rig and based on the results intends to make a final investment decision within 2026 FY.

The Tomakomai CCS Project will separate and capture CO2 from Idemitsu Kosan Co., Ltd.'s Hokkaido refinery and Hokkaido Electric Power Co., Inc.'s Tomato Atsuma power station for injection and storage by JAPEX. Storage commencement is expected by 2030 according to the Japan Organization for Metals and Energy Security (JOGMEC) plan.

INPEX and Chubu expand study on Japan-Australia CCS value chain

www.inpex.com

The joint study focusses on the feasibility of establishing a CCS value chain involving the separation and capture of CO2 in Japan and its transportation from the Port of Nagoya in Aichi Prefecture to Australia for storage.

The new agreement is intended to further enhance the feasibility of the value chain and is based on positive preliminary findings of the joint study that the two companies initially announced in October 2024.

Under the new agreement, INPEX and Chubu Electric Power will continue to study key elements of the CCS value chain between the Port of Nagoya and Australia for CO2 storage. The study includes optimisation of CO2 transportation methods along the value chain such as loading in Japan, shipping and receiving in Australia.

The study will include an assessment of the legal and regulatory landscapes in Japan and Australia to understand the likely timeline for implementing the framework necessary to support the CCS value chain.

3D model of the plant – GE Vernova and YTL PowerSeraya aim to capture at least 90 percent of carbon dioxide emissions

ClassNK issues first guidance for membrane CO2 capture onboard vessels

www.classnk.or.jp

"Guidelines for Shipboard CO2 Capture and Storage Equipment (Version 2.0)", introduces onboard CO2 capture and storage equipment using the membrane separation method for the fist time.

The guidance can be used for the development, manufacturing, and safe installation of such equipment on ships.

In 2023, the Association published the "Guidelines for CO2 Capture and Storage Equipment on Ships (Version 1.0)," which describes the requirements for CO2 capture and storage equipment on board using the Amine Absorption Act.

The newly published version 2.0 stipulates the requirements to be considered when developing and installing the equipment on ships for CO2 capture and storage equipment using the membrane separation method, which requires less electricity for CO2 capture than the amine absorption method and does not require aqueous amine solution to be maintained.

Furthermore, by reorganising the basic functional requirements required for CO2 capture and storage equipment, ClassNK has extracted common requirements without relying on recovery technology, and summarises them as general requirements that should be applied regardless of the recovery technology method.

GE Vernova and YTL PowerSeraya PCC study in Singapore

www.gevernova.com
https://ytlpowerseraya.com.sg

The two companies are collaborating on a post-combustion CO2 capture (PCC) feasibility study to analyze the lowering of carbon emissions of YTLPS' H-Class Combined Cycle Gas Turbine (CCGT) plant on Jurong Island, Singapore.

Following the launch of a Power Sector CCS Grant Call by Singapore's Energy Market Authority (EMA) in October 2024, which invited the power industry to explore potential carbon capture solutions as part of Singapore's energy transition towards a low-carbon future, the EMA has selected five projects. Among these, YTLPS' Post-Combustion Carbon Capture Study proposal was successfully selected to receive co-funding.

"GE Vernova's first-of-its-kind carbon capture assessment in Singapore proposes significant enhancements aimed at improving the proposed carbon capture process and reducing its impact on the power plants' output, performance, and costs," said Ramesh Singaram, President & CEO of GE Vernova's Gas Power business in Asia Pacific region.

The Study is focused on retrofitting YTLPS' H-Class CCGT with technology capable of capturing at least 90 percent of the plant's carbon dioxide (CO2) emissions.

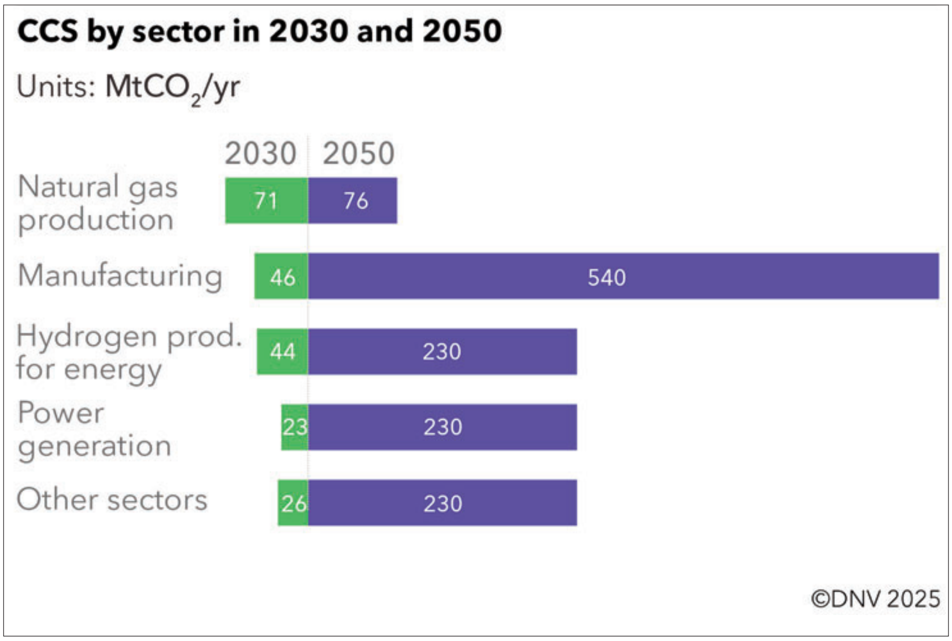
Charting the future of CCS through uncertain waters

Over the next five years, capture and storage capacity is expected to quadruple, heralding a major shift in how governments and industries view its role in the energy transition. By Jamie Burrows, Global Segment Lead CCUS, Energy Systems at DNV.

For all the vast amount of time, effort and money that has been ploughed into carbon capture and storage (CCS) over the years, it is yet to truly fulfil its promise. Attempts to perfect the efficacy and viability of the technology date back towards the millennium, but it has typically been considered a lower priority than renewables like wind and solar, as well as energy efficiency.

But patience is a virtue and the persistence that has been on show for decades is beginning to pay dividends. According to DNV's first Energy Transition Outlook CCS to 2050, the industry is at an inflection point.

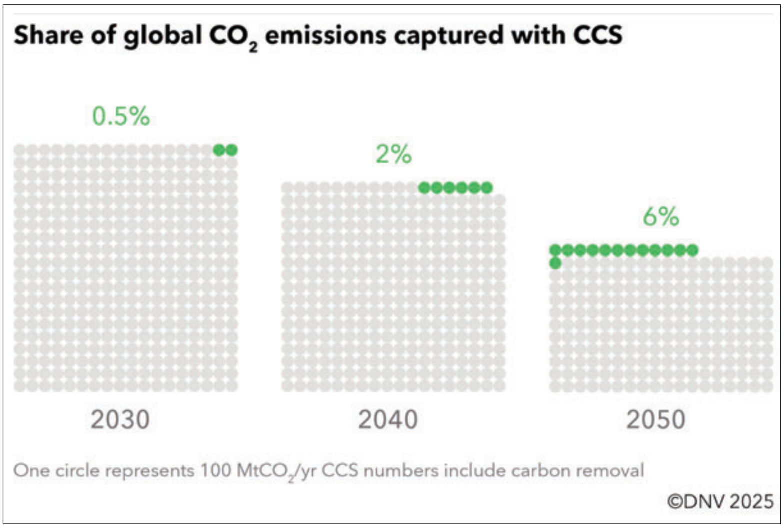
No longer limited to its traditional use in natural gas processing and enhanced oil recovery, CCS is starting to deliver on its promise as an essential tool for reducing emissions in hard-to-abate sectors, from cement and steel production to shipping and heavy industry.



Questions about its rollout remain though, not least will it scale up fast enough to store meaningful volumes of emissions and make the impact the planet needs to meet climate commitments. It is in today's high-emitting world where CCS is best applied. Even at 1.3 gigatonnes per year by 2050, CCS will only capture around 6% of global CO2 emissions, far short of what's required in most net zero aligned scenarios. The clock is ticking.

From fossil fuels to a net zero panacea

After 2030, the biggest growth in CCS will come from manufacturing, which by 2050 is projected to account for 41% of all annual CO2 captured.



In Europe, CCS will primarily serve cement and chemical production; in North America and the Middle East, hydrogen and ammonia will dominate the market; and in China, CCS will continue to be applied to coal power, albeit at a declining share.

fact, natural gas production, which today makes up a third of global CCS activity, will decline to just 6% of total captured volumes by 2050 as focus shifts toward broader industrial applications.

Maritime transport is another area for expansion, with onboard carbon capture systems, currently at early stages of development, expected to roll out from the 2040s onward, particularly in container shipping. This complements efforts to decarbonise shipping fuels and may provide an alternative where fuel-switching proves technically or commercially difficult.

While the technology is ready, regulations are catching up

Technologically, CCS is proven, advancing and will soon be established as cost trajectories trend downwards. But in our report we make clear that policy uncertainty remains the single largest barrier to scaling. Past project cancellations have more often been caused by regulatory matters and inconsistent incentives rather than technological hurdles.

Still, signs of improvement are emerging and in Europe carbon pricing, through the EU Emissions Trading System is providing a stronger business case for investment. The U.S. is driving deployment through measures like the 45Q tax credit, meanwhile voluntary carbon markets are beginning to support investment CCS related carbon removal technologies like Direct Air Capture (DAC) and BECCS.

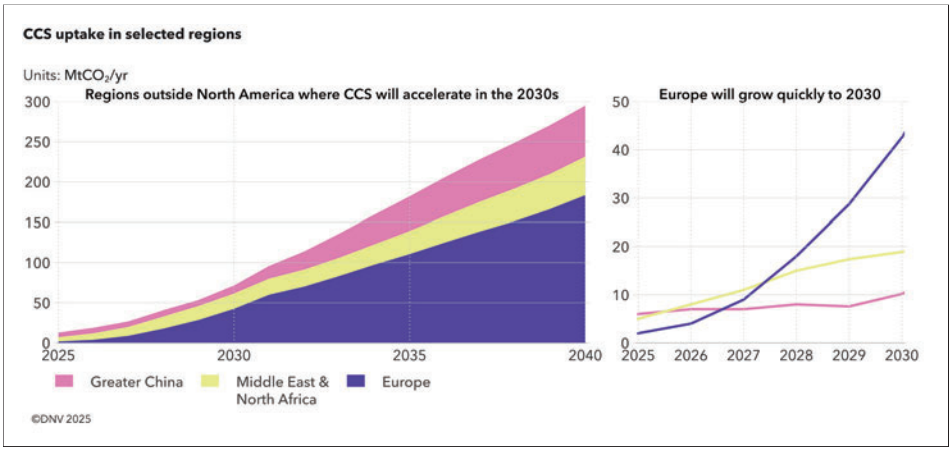
Yet even with positive signals, DNV warns that most sectors will only scale with strong mandates and meaningful price incentives. Without them, the market alone won't deliver CCS at the scale required.

Investment, innovation and economies of scale

DNV forecasts that cumulative investments in CCS will reach $80 billion over the next five years, and $700 billion by 2050. While that's a substantial commitment, it is still far below what is needed for most credible net zero aligned scenarios.

Fortunately, the economics of these capital-intensive projects are improving. As projects mature, average costs for capture, transport and storage are expected to decline by around 40% by 2050. Cost reductions are being driven by innovation in solvents and materials, modular plant design, process integration and economies of scale.

Modularisation is already reducing costs and timelines, particularly in amine-based capture systems, the most widely deployed approach. For industrial sites with limited footprint, modular capture units provide a scalable, replicable solution enabling them to participate in emerging CCS networks.



These networks, often referred to as CCS clusters, are already taking shape across Europe, North America and Asia. Projects are being developed that centralise transport and storage infrastructure, allowing multiple emitters to access shared pipelines or shipping routes and storage. These systems reduce costs and improve project viability, as well as reducing the risk that one project's delay or cancellation impacts the wider CCS value chain.

A global map of momentum

Deployment of CCS will not be evenly distributed and, in the short term, it will be North America and Europe that will lead the CCS build-out, leveraging existing infrastructure and favourable policy environments. Europe, with strong price signals, is expected to catch up with and eventually surpass North America in deployment scale.

By contrast, Asia, including China, Japan, and South Korea, will rely more heavily on CO2 shipping and cross-border storage arrangements, often transporting captured CO2 to countries with more mature storage capacity such as Australia, Indonesia or Malaysia.

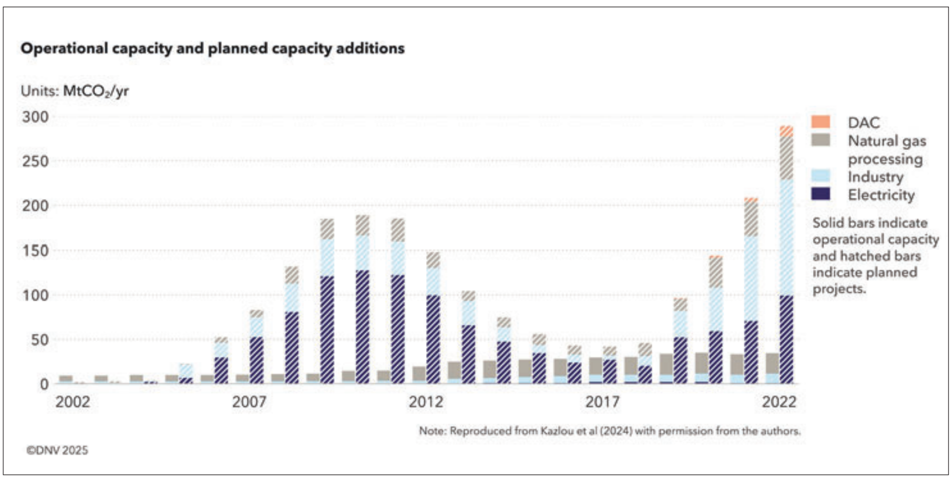
Our research also highlights emerging onboard carbon capture for shipping, which could offer a flexible pathway for maritime decarbonisation, especially where low-carbon fuels are unavailable or unaffordable.

A pivotal decade in which ambition must increase

The first steps in any emissions strategy should always be energy efficiency and renewable deployment. CCS alone won't solve climate change, but the world won't meet decarbonisation targets without its use. In sectors where emissions are unavoidable and where substitutions are not yet viable or are technically unfeasible, CCS may become the leading option for deep decarbonisation.

The technology is ready, investment is flowing, projects are breaking ground, and we are now permanently locking away emissions. The challenge ahead now is one of scale and urgency.

We forecast that CCS will scale rapidly and attract significant investment, but in any net-zero future, far greater deployment will be needed. It will be the next five years that will determine whether CCS can deliver on its promise as a key tool for emissions reduction and removal.



More information

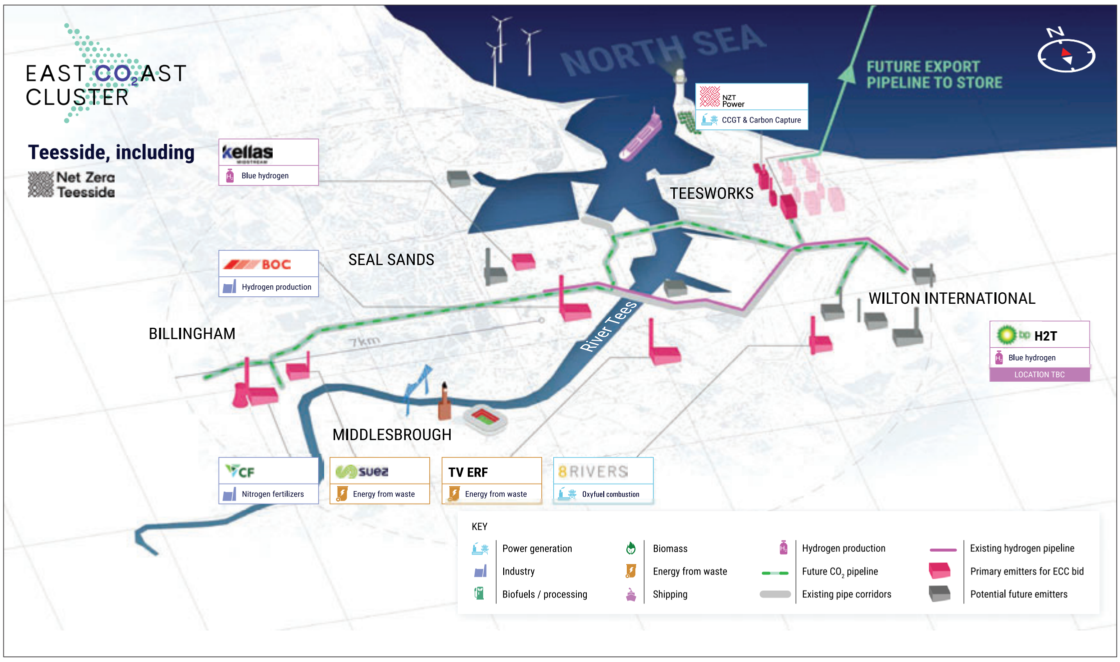
www.dnv.com/energy-transition

Well, well, well: Moving the UK from CCS concept to storage at scale

Carbon capture and storage is moving from concept to execution. For years, it has been positioned as a critical part of the UK's energy transition and broader energy and industrial strategy, but recent progress shows that we are steadily moving beyond ambition. By George Morrison, CEO, Aquaterra Energy.

The UK's Industrial Strategy, bolstered by announcements of planned funding for Projects Acorn and Viking, is sending a clear signal that CCS is a live industrial opportunity. The Northern Endurance Partnership's (NEP) forward momentum marks the first wave of real delivery.

With contracts awarded to major onshore and offshore contractors and the first CO2 storage wells now in development for the UK's East Coast Cluster, this is a shift that brings confidence for developers, engineers and the wider supply chain. I often say a project isn't really real until someone starts spending money on steel work, well now they are.



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Building Europe's CO2 storage hub

The UK has a stated ambition in its Industrial Strategy to become Europe's CO2 storage hub. Not just a leader in capturing and storing its own emissions, but the place where other countries send theirs. With nearly a third of Europe's CO2 storage capacity located offshore in the UK, the country is uniquely positioned to serve as a key player in the growing European carbon market.

Think of it like Sweden's renowned waste to energy system, where the country imports millions of tonnes of trash from neighbors and turns it into significant revenue, jobs and opportunity. Similarly, the UK could become the place where other nations send their CO2, generating a market which the CCS association projects could be worth £30bn by 2050. This would not only provide a decarbonisation solution but also create a valuable new industrial sector, positioning the UK as a leader globally generating valuable revenue streams and attracting and retaining talent.

There are several reasons to think the UK is uniquely well positioned to capitalise on this opportunity. One of those is its unrivalled understanding of its offshore geology and storage opportunities. Decades of mapping, modelling and extracting from offshore reservoirs mean the UK boasts the most extensive and comprehensively understood offshore geology in Europe, complete with proven wells, detailed pressure data and robust integrity records.

But geology is just the foundation. The UK's edge comes from industrial capability, supportive regulation, and offshore infrastructure. Few countries in Europe can rival our concentrated engineering expertise, directly applicable to CCS. Add the potential for repurposing of existing assets and decades of offshore coordination, and we have the places, ideas and people to lead.

The barriers we must break

Of course, building an industry of this scale is not straightforward. The first wave of CCS projects will face both technical and commercial hurdles, and it is important we remain realistic about what lies ahead. On the technical side, CCS will be built one well at a time, some new, some decades old and each with its own technical, permitting and safety challenges.

Success will depend on finding solutions that can be applied again and again across different sites, in the same way standardised approaches helped wind and oil and gas scale efficiently.

One important consideration for scaling offshore carbon storage is the re-entry and re-abandonment of legacy wells that intersect with potential storage sites. These wells were drilled and abandoned long before CO2 storage was considered, and unless they are safely re-entered and re-abandoned they risk becoming leakage pathways that could compromise future storage. Conventional methods such as drilling a relief well to intersect and seal an old well are slow, expensive and have no guarantee of success, particularly when ageing casings increase the risk of further damage during the process.

Fortunately, new approaches are emerging to meet this challenge. One is the Recoverable Abandonment Frame (RAF), now being deployed on the NEP project to enable safe re-entry and re-abandonment. The RAF overcomes the main limitations of conventional methods by allowing precise vertical well intervention, providing structural support and reducing the risk of damaging degraded casings. Because it is modular and reusable, it can be moved quickly between wells, cutting both time and cost. Innovations like this are essential to ensure legacy wells do not become barriers to large scale CO2 storage but are addressed safely and systematically.

This is one challenge where engineering has been able to get ahead, but there will be others. Being involved early means solving problems in real time and setting the standards, tools and methods others will follow. Progress also depends on the environment we operate in. The same pioneering projects that sharpen technical capability also expose the gaps in policy and planning that must be closed if CCS is to scale.

One of the clearest examples is ownership. It is likely that the economic interests tied up in legacy wells will not align neatly with those driving new CCS developments, creating uncertainty over access rights and long-term liability. A clear framework will be needed to reconcile these interests and give both groups confidence to move forward.

The North Sea is also becoming an increasingly congested space, with oil and gas, wind and CCS competing for the same space. These issues will not be solved on paper alone. Tackling them through real projects, backed by political commitment and clear regulatory frameworks, is how we set the standard for everything that follows.

Aquaterra Energy has analysed platform repurposing for CCS injection at Project Greensand

How CCS and decommissioning can work together

Decommissioning is one of the UK's largest offshore work scopes and among the most challenging. It is expensive, technically complex and increasingly difficult to deliver as supply chains feel the strain. In 2024 alone, operators spent a record £2.4 billion on decommissioning, yet the UK still has a backlog of more than 500 wells past their target dates, a figure that is expected to expand further.

CCS offers one way to help change that equation. By repurposing wells and infrastructure scheduled for decommissioning, short term costs can be turned into long term productive assets, delivering value for owners, governments and the UK's net zero ambitions.

At Denmark's Project Greensand, for example, Aquaterra Energy has been involved in analysing platform repurposing for CCS injection, a model that shows how existing assets can be given a second life, which could be adapted for the UK.

CCS and decommissioning can cross pollinate, sharing techniques and lessons learned to improve performance in both areas. The future may see CCS blurring the existing boundaries between development, intervention and decommissioning all happening and being essential parts of a single project. A tool or process refined for re-entering a well for CCS might also cut time or risk in a decommissioning campaign, and vice versa. By aligning plans and fostering this exchange, both sectors can benefit from a more resilient supply chain, steadier vessel utilisation and a strong workforce.

An industrial opportunity

CCS is no longer a far-off prospect, it's happening now, one well at a time. By tackling technical challenges in real projects, repurposing assets instead of retiring them, and applying decades of offshore engineering expertise, we can turn today's challenges into tomorrow's productive infrastructure.

If we get this right, the rewards go beyond emissions reduction. It's a chance to create a resilient supply chain, secure long-term employment for skilled teams, and deliver a return on the billions already invested in the North Sea. The same workforce and ingenuity that built our offshore industry can now shape its future, ensuring the UK not only meets its own net zero goals but becomes the place the world turns to for safe, scalable CO2 storage.

More information

https://aquaterraenergy.com

COSMIC (Costing Model for Integrated Carbon Capture and Storage) for hubs

COSMIC, developed by CO2CRC, has an easy-to-use Graphic User Interface (GUI) that provides options for various CO2 capture technologies, CO2 compression, and different modes of CO2 transport and being technology and product agnostic can provide independent advice when choosing suppliers.

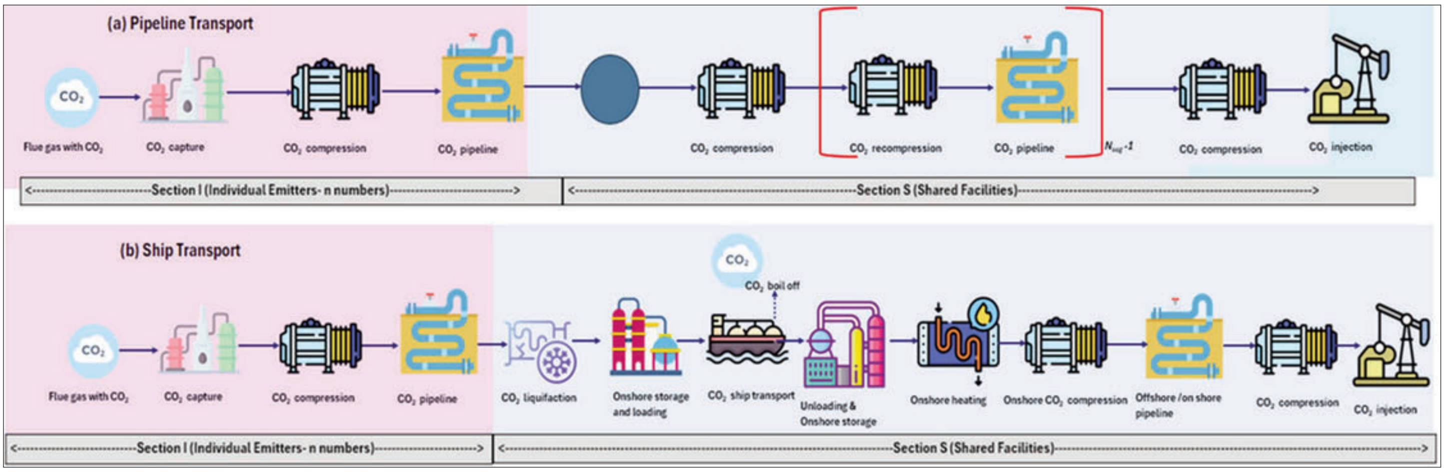


Figure 1 - Example schematic for Section I (individual facilities) and Section S (Shared Facilities)

The concept of clusters and hubs for CCS is gaining popularity due to benefits like lower costs, reduced liability, rapid scalability, and operational flexibility. A CCS hub gathers carbon dioxide from various emitters within an industrial cluster and transports it via shared infrastructure, facilitating decarbonisation across the power and industrial sectors.

Understanding costs (CAPEX & OPEX) is crucial for evaluating profitability and risks to decide on long term investment decision making.

CO2CRC has introduced COSMIC (Costing Method for Integrated CCS chain), a cost model that can optimises CCS Hub expenses using extensive data from various sources.

Benefits

COSMIC offers the following benefits to CCS operators:

• COSMIC estimates both CAPEX and OPEX across the CCS chain—from capture to storage—while distinguishing between individual and shared facility costs.

• COSMIC enables optimal siting of CO_2 collection points, minimising transport costs and ensuring fair cost distribution among emitters.

• COSMIC supports various capture technologies and CO_2 sources, including hard-to-abate sectors, power plants, and hydrogen production.

• COSMIC provides detailed economic analysis in multiple currencies, including incremental cash flows, profitability, and rate of return. Its modular design allows scalability from single-emitter CCS systems to complex hubs.

• COSMIC enhances strategic planning and investor confidence by delivering scenario-based cost forecasts and supporting Class 5 to Class 4 estimate accuracy, making it a powerful asset in accelerating decarbonization efforts through cost-effective, shared infrastructure solutions.

Technology description

COSMIC divides the whole CCS Hub into two sections, as shown in Figure 1.

Section I- Individual facilities

The individual facilities section has a CO2 capture process at the emitter's location, initial CO2 compression and the pipeline that takes captured CO2 to the CO2 gathering station.

Section S- Shared facilities

The shared facilities include a CO2 gathering station that collects CO2 from various emitters, along with compressors, pipelines, and shipping facilities transporting CO2 from the gathering station to the injection site. The injection facilities are located in the shared facilities section S, as shown in Figure 1

COSMIC calculates the costs of all components separately for Section I and Section S. COSMIC clearly demarcates the boundaries of shared and individual facilities. As shown in Figure 1, the cost of CO2 capture is under Section I, which also includes a CO2 compression stage and a relatively small transport section for transporting captured CO2 to the CO2 gathering station.

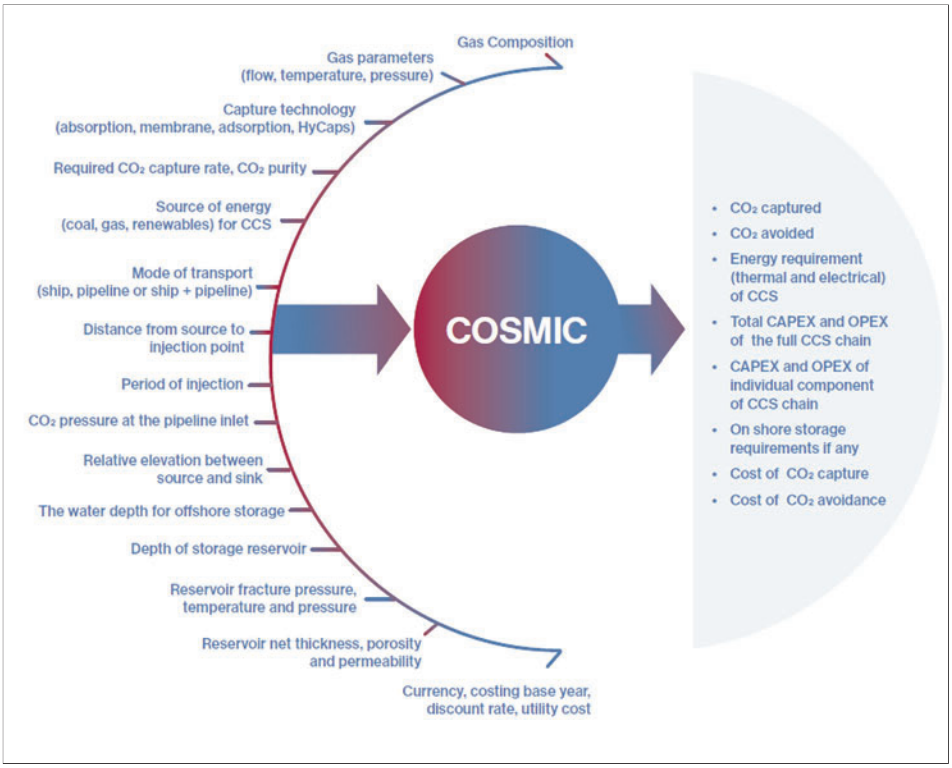
COSMIC plays a pivotal role in optimising the strategic placement of CO2 collection points by analysing the geographic locations of various greenhouse gas emitters in relation to designated storage sites. The primary objective of this optimization process is to identify a practical and efficient location for the CO2 collection point that minimizes the overall transportation costs incurred in Section I, which involves aggregating emissions from individual emitters.

To achieve this goal, the optimization model considers not just the distance between emitters and the collection point, but also the specific characteristics of each emitter, such as their size and output levels. However, it imposes a crucial condition during the optimization process: the transport costs for any given emitter must remain reasonably comparable to those of other emitters.

This condition is designed to prevent any single emitter from facing disproportionately high costs, ensuring that the burden of transport is shared equitably among all participating entities.

The approach adopted by COSMIC allows for the careful balancing of cost efficiency while also accommodating the diverse range of emitters involved. By not differentiating between large and small emitters in its calculations, COSMIC promotes a sense of fairness and inclusivity in the optimization process. This means that even smaller emitters can benefit from the overall efficiency gains achieved through economies of scale associated with the trunk pipeline used for transport.

Ultimately, the COSMIC optimisation strategy aims to facilitate a more sustainable and economically viable method for CO2 transport. By ensuring that costs are minimised and distributed evenly, the system empowers emitters to contribute to carbon reduction efforts while maintaining operational feasibility. This innovative approach enhances the effectiveness of CO2 management strategies and supports broader environmental goals by creating a systematic framework for reducing greenhouse gas emissions in a collaborative, cost-effective manner.



COSMIC calculates the cost of each component of the CCS chain and estimates the cost of CO2 capture, transport and storage separately

COSMIC uses mass and energy balances to determine the type and size of equipment required. Equipment costs are estimated using published/literature data, the CO2CRC costing database, scaling law and Lang factors. The model can also calculate the mass of CO2 captured and CO2 avoided. COSMIC requires a range of data as input to estimate the CAPEX, OPEX costs, profitability and rate of return.

The accuracy of the output depends on the quality of the input data. As a first go, a class 5 estimate can be obtained from COSMIC. This can be improved to a class 4 estimate (AACE, 2022) by having more accurate project-specific inputs.

As a rule of thumb, CO2 capture represents the largest expense in the CCS chain, making it a key focus of economic analysis. Most studies considered 10 US $/tonne for the cost of CO2 transport and storage (T&S) as assumed in the IPCC Fifth Assessment Report. Zero Emission Platform has estimated the technical cost of CO2 transport in the range of € 12-30/tonne.

As a result of advancements in CO2 capture technologies, process intensification and process integration, the cost of CO2 capture is expected to be below US $40/tonne; thus, it is important to consider the T&S cost more accurately as the capture cost decreases. In contrast, T&S costs are not expected to decrease significantly. Therefore, the contribution of T&S cost to total CCS cost is expected to increase.

As the CCS hub provides major savings in the cost of T&S, it is important to estimate the cost for the individual projects rather than assuming a fixed value. COSMIC calculates the cost of each component of the CCS chain and estimates the cost of CO2 capture, transport and storage separately.

Operating since 2003, CO2CRC is a global leader in CCUS research. CO2CRC collaborates with experts to manage interdisciplinary projects, has a strong international brand recognition, and has an excellent health and safety record. Additionally, CO2CRC develops next-generation low-emission technologies through innovative demonstrations.

More information

COSMIC is available from CO2Tech, a fully owned subsidiary of CO2CRC.

co2tech.com.au

www.co2crc.com.au

Proceedings of the IEAGHG's 8th CCS Cost Network 2025 Workshop

The aim of the workshop, held in Houston in March, was to explore and advance the understanding of real-world cost estimation across the CCS value chain, drawing on practical insights from ongoing projects, studies and deployment experiences.

The workshop also served as a forum to identify emerging cost drivers, share lessons learned, and discuss key enablers for reducing costs and de-risking investment in CCS.

Key takeaways from the workshop

While techno-economic analyses (TEAs) compare capture options under standardised assumptions, and provide indicative performance and cost estimates, they do not typically capture the localised impacts of "steel-in-the-ground" realities such as site constraints, permitting timelines, supply chains limitations, labour availability and integration with existing assets.

Direct cost comparisons between projects are not advisable, as cost estimates were developed using inconsistent methodologies and assumptions. Variations exist in the definition and treatment of capital and operating costs, including differences in tax structures, cost escalation methods, inclusion of owner's costs, insurance and other financial parameters. Furthermore, project costs are heavily influenced by a range of site-specific and design-dependent factors.

Offshore transport and storage (T&S) scenarios consistently exhibited the highest unit costs relative to onshore alternatives. Studies indicated that costs generally decrease with an increasing number of candidate storage sites, allowing for greater routing flexibility and more cost-optimised infrastructure development. Participants emphasised the urgent need for transparent, high-resolution cost data to guide strategic investment decisions in CO2 transport networks.

Costs for new-build, greenfield CO2 pipelines are highly sensitive to location-specific parameters including terrain, permitting complexity and stakeholder engagement. Installers are unable to provide firm cost estimates without a detailed understanding of these constraints, and routing alternatives can cause significant variation in capital costs.

Financing is one of the most significant cost drivers in CCS deployment, often representing up to 50% of the total levelised cost per tonne of CO2 captured and stored. Contributing factors include high capital intensity, inflationary pressures, interest rate volatility and the lack of long-term offtake agreements. These risks typically attract growth or structured equity investors, who demand higher returns. To reduce financial barriers and mobilise capital, targeted policy support – such as enhanced fiscal incentives for heavy industry, streamlined permitting, and robust regulatory frameworks – is essential.

Standardisation and replication of CCS system designs, especially for mature configurations such as gas boilers and natural gas combined cycle (NGCC) retrofits, could accelerate cost reductions and de-risk financing. This approach may yield faster gains in investor confidence and commercial viability than waiting for disruptive technology breakthroughs.

Current incentive mechanisms, which predominantly focus on capital cost support, tend to favour low-risk, commercially mature technologies. However, achieving broader cost reductions and enabling the future deployment of next-generation CCS systems will require phased and risk-tolerant investment in lower-TRL (technology readiness level) capture technologies.

Early-stage, collaborative "storage-ready" development significantly improves project bankability. Because secure storage access is critical to CCS viability, capture developers and T&S operators should jointly invest in early geological characterisation, risk assessment and permitting activities. Advancing preparatory work on Class VI wells and associated infrastructure can accelerate timelines, reduce uncertainty and improve access to financing.

Capture rates of ≥95% are technically and economically viable, particularly when supported by robust solvent management and optimised plant operation. However, pursuing 100% capture poses diminishing returns, with considerable cost and operational challenges. At these ultra-high capture levels, the majority of residual lifecycle emissions from NGCC+CCS systems stem from upstream methane leakage and gas supply emissions.

Integration of CCS into power plants requires careful selection of steam regeneration configurations. While steam extraction offers the highest thermodynamic efficiency, it imposes operational inflexibility and extended start-up times. In contrast, standalone CHP systems and auxiliary boilers offer improved flexibility and modularity, albeit at higher energy penalties and capital costs.

Government intervention remains the primary enabler of CCS deployment. Jurisdictions have employed a range of policy instruments – such as carbon pricing (taxes or markets), capital subsidies, operational incentives, and regulatory mandates – to stimulate investment. Long-term political alignment and consistent policy support are critical to sustaining deployment and scaling CCS as a viable decarbonisation pathway

Overall, the workshop underscored that scaling up CCS will require a pragmatic integration of commercially proven technologies, targeted innovation, and cohesive policy and financial frameworks. Success will hinge on early, cross-sector collaboration across the CCS value chain, improved transparency in cost and performance data, and the adoption of adaptive, site-specific project strategies.

These elements are critical to de-risking investments, optimising capital allocation, and establishing CCS as a reliable and scalable solution.

More information

https://ieaghg.org/publications-library

Defossilizing Industry: considerations for scaling-up CCU pathways

Carbon Capture and Utilisation could open up new markets, enhance industrial resilience and provide climate benefits – if given strong public sector support, clear demand signals and innovative finance models according to a report from the World Economic Forum.

The report in collaboration with Wood Mackenzie discusses the potential role that emerging CCU pathways could play in a sustainable industrial transition and focuses on the challenges faced by innovators and first movers.

Policies currently favour carbon CCS over utilisation, however as momentum builds behind industrial decarbonisation, CCU merits thorough, context-specific consideration. CCU offers the potential to "defossilise" carbon-reliant industries – but for it to become viable, it requires supportive policy frameworks, patient capital and close collaboration across stakeholder groups.

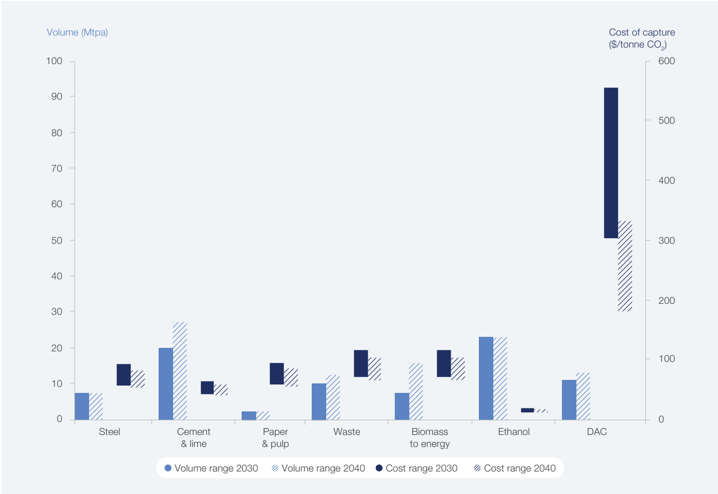
The report analyses three specific barriers to progress: fragmented and inconsistent policy frameworks that heavily favour sequestration over utilisation; the “valleys of death” that emerging CCU companies face, impacted by long development timelines, high capital requirements and immature business models that lack well-defined routes to revenue; and the role of cross-sectoral collaboration in scaling-up nascent CCU technologies within large, mature industrial complexes.

Conclusions

While pioneering activity driven by innovators, first movers and early incentives has built some momentum in recent years, CCU remains a nascent and evolving field. The absence of appropriate market frameworks means that CCU approaches have yet to find a significant role in industrial production. This may be explained by the diversity of contexts in which CCU could play a role, the complexity of integration into existing climate models, as well as the early-stage nature of many technologies involved.

Greater confidence in CCU outcomes will develop as technologies mature, though this can be accelerated through the standardization of life-cycle assessments to drive consensus on emissions potential.

Although CCU represents a different kind of challenge for policymakers, this paper’s findings highlight the central importance of the public sector in leading this activity. Ultimately it will be for policymakers to determine what role CCU should play in their transition strategies. If policymakers wish to incentivize CCU, these findings highlight the importance of a twin-track approach:



Current carbon capture capacity in development and cost estimates of global CCU-viable CO2 sources. Source: Wood Mackenzie Lens Carbon

– First, de-risking innovation and R&D can help drive performance improvements while enabling financiers and projects developers to become more familiar with CCU approaches.

– Second, creating supportive and predictable market environments can enable promising CCU approaches to become competitive against incumbent production routes.

At a company scale, the findings of the paper provide useful learnings for other first movers. In particular, the experience of start-ups and earlystage innovators in overcoming financing challenges and valleys of death can be valuable for informing market entry strategies and business planning for others in this space. However, it is equally clear that other corporate and financial stakeholders can also take concerted action to reduce friction for project developers, through establishing clear demand signals and innovative finance models.

An ongoing challenge will remain the sector’s ability to coordinate efforts and increase market familiarity with CCU technologies. In this, cross-sector alliances and shared infrastructure could reduce risks, aggregate demand and accelerate learning.

If CCU is incentivized it could open up new markets, enhance industrial resilience and provide climate benefits. Through deployment at increasing scale, the evidence base for policy can be expanded, industries can identify value opportunities and financiers can better assess potential investments.

“We invite stakeholders to engage in an open, evidence-based assessment of CCU, to ensure that future choices about its role are deliberate, informed and aligned with long-term climate and industrial goals,” concludes the report.

More information

www.weforum.org/publications

UK energy from waste sector can go carbon negative by 2035 with CCS

A report from Baringa, commissioned by enfinium, finds that the UK's EfW sector could be carbon negative by 2035 if CCS is deployed rapidly and generate up to 10 million tonnes of carbon removals annually by 2040.

The report titled, 'Realising the carbon-negative opportunity in the energy from waste sector' highlights that:

• By combining energy from waste with CCS, sometimes known as waste to energy with carbon capture and storage (WECCS), emissions can fall by over 70% by 2035 and go carbon negative as early as 2035 in an accelerated deployment scenario.

• WECCS roll-out could exceed the Climate Change Committee's energy from waste target for carbon removals, generating up to 10M tonnes of carbon removals a year by 2040.

• Overall UK power generation emissions will only become net-negative by 2040 if CCS is deployed in energy from waste. Without CCS, energy from waste fleet fossil emissions will remain above 7M tonnes of CO2 a year.

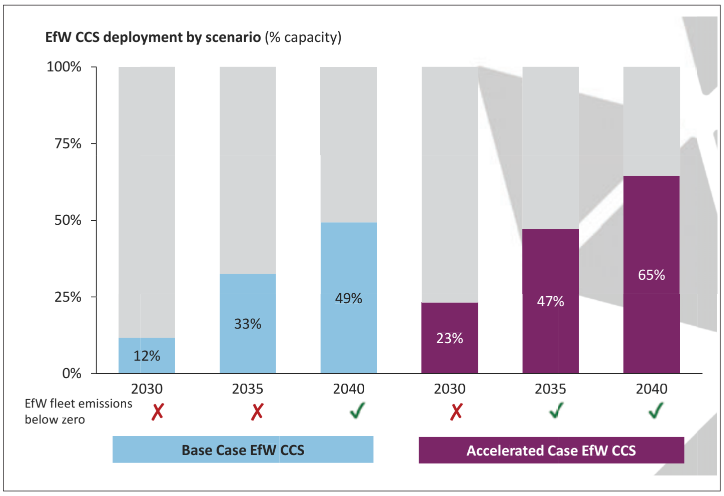
• Less than 50% of energy from waste facilities need CCS for the sector to go carbon negative by 2035.

To realise the carbon-negative opportunity in the EfW sector, the report identifies five policy actions including ending biogenic waste going to landfill, continued Government support for energy from waste CCS projects, inclusion of carbon removals in the UK Emissions Trading Scheme, and enabling non-pipeline transport such as shipping and rail.

Mike Maudsley, CEO of enfinium, said, "Baringa's report shines a light on how the UK can respond to the Climate Change Committee's call to accelerate carbon removals on the path to net zero."

"Even if recycling targets are met, the UK will still generate over 17 million tonnes of unrecyclable waste each year. Scaling up WECCS would turn that challenge into an opportunity, harnessing waste to remove carbon from the atmosphere and helping to realise the UK's journey to net zero."

Energy from waste can produce carbon removals, or 'negative emissions', because around 50% of the UK's unrecyclable waste consists of biogenic materials – such as food, plants and soiled paper – which have already absorbed CO2 from the atmosphere. Capturing and permanently storing this CO2 using CCS prevents it from being released, resulting in a net removal of carbon from the atmosphere.



To achieve EfW decarbonisation, a large proportion of the fleet will need CCS, with the net zero tipping point achieved when around half the fleet has it deployed. Source © Baringa Partners LLP 2025.

Government figures project that over 17 million tonnes of unrecyclable waste will continue to be produced each year into the 2040s. Without energy from waste facilities, this waste would go to landfill – which emits twice as many emissions as energy from waste, including methane, a potent greenhouse gas that has 80 times the climate warming effect of CO2. Emissions from the waste sector have fallen 66% since 1990 as growing volumes of biodegradable waste have been diverted from landfill.

The report comes as Dr Alan Whitehead CBE leads a government review into scaling engineered carbon removals. enfinium's response highlighted WECCS as a vital route to decarbonising unrecyclable waste and delivering large-scale carbon removals. EfW facilities already cut emissions by diverting waste from landfill and supporting a circular economy. Retrofitting them with CCS could enable carbon-negative baseload power and heat—offering a near-term, shovel-ready solution to strengthen energy resilience and meet UK climate goals.

The Climate Change Committee's Seventh Carbon Budget warned that work to roll out carbon removals in the UK must "accelerate now" if the UK is to achieve net zero – which requires over 35 million tonnes of carbon removals per year by 2050.

Chris Thackeray, Director and Global CCS Lead, Baringa, commented, "We're delighted to share our analysis on realising the carbon-negative opportunity in the energy from waste sector. By deploying carbon capture and storage technology at scale on energy from waste facilities, the sector could make a sizeable contribution to UK emissions reductions. Because of the carbon dioxide removal potential of the proportion of biogenic waste, it could be possible for the sector to be carbon negative by 2040."

More information

www.enfinium.co.uk

www.baringa.com

Report: EU carbon storage injection capacity targets face a significant shortfall

A Wood Mackenzie independent study commissioned by ExxonMobil, OMV Petrom, Shell and TotalEnergies assessed the feasibility of delivering the targets set out in Article 23 of the NZIA.

The EU's ambitious carbon storage targets, set in mid-2024 under the Net Zero Industry Act (NZIA), face a significant shortfall, with expected available injection capacity by 2030 falling well below the required 50 million tonnes per annum, according to new Wood Mackenzie analysis.

This independent study reveals widespread project delays and regulatory challenges are undermining Europe's CCS ambitions.

The study suggests the NZIA's 2030 target may need reassessment when the European Commission reviews progress in 2028, as originally planned under the legislation.

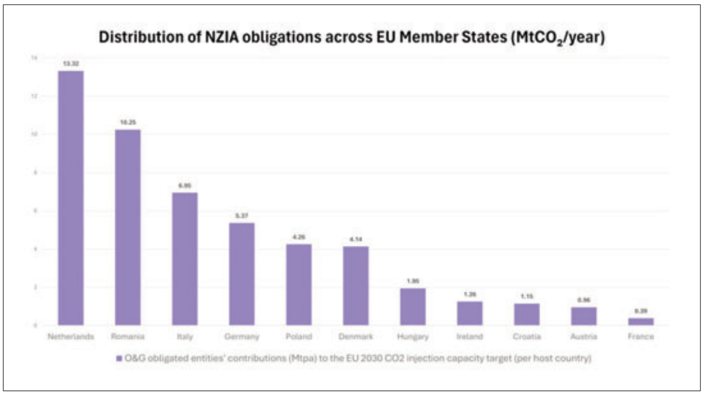
The assessment shows that the EU's CO2 injection capacity available by 2030, as assessed in October 2025, is projected to be around 28.5 million tonnes per annum - a shortfall of 21.5 mtpa against the NZIA target of 50 mtpa. The estimate falls further if projects without licences are discounted – regulatory issues being one of the key barriers to progress.

The analysis, commissioned by ExxonMobil, OMV Petrom, Shell and TotalEnergies but conducted independently by Wood Mackenzie, examined announced projects across the EU using the company's Lens Carbon database. Currently, no large-scale storage project operates in the EU: the small-scale projects operate today, and those that have taken final investment decisions already will deliver 2.9 million tonnes per annum by 2030.

"The EU's carbon storage ambitions are colliding with commercial and technical realities said," Jon Story, Vice President of Energy Consulting and Head of CCS Consulting at Wood Mackenzie. "With project delays averaging over 1.5 years and EU carbon prices still well below CCS costs/tonne for capture projects, we're seeing policy running ahead of market fundamentals and what the industry can deliver. The eight-year average development timeline from license award to operations means the window for meeting 2030 targets has essentially closed."

Eight-year development timeline creates bottleneck

European storage projects require approximately eight years from exploration/appraisal to operations, meaning projects needed exploration or appraisal licences by 2023 to meet the 2030 timeline. Only 15.6 million tonnes per annum of storage capacity was sufficiently advanced by 2023 to enable 2030 operations. This extended development period, combined with regulatory hurdles and legal challenges, means that accelerating projects to meet the 2030 deadline is not a realistic option.



Distribution of the contribution obligations to the Union CO2 injection capacity objective by 2030 (Source: Zero Emissions Platform)

Licensing lags behind ambition

The study reveals licensing has not kept pace with project development needs. Only Italy operates a pilot carbon storage project, while the Netherlands (one of Europe's most advanced jurisdictions for CCS) has awarded just two CO2 storage licences. Several projects, including Porthos and Aramis in the Netherlands, have experienced delays due to legal objections.

Economic challenges compound delays

EU Emissions Trading System (ETS) prices, averaging US$70 per tonne in 2024, remain below levelized CCS costs for all EU capture projects modelled by Wood Mackenzie. This economic reality, combined with bankability issues and price fluctuations, limits investment appetite. Many capture projects struggle economically due to insufficient incentives, creating a high risk of stranded assets.

The analysis shows many announced capture projects are in locations quite remote from proposed stores, necessitating expensive transport infrastructure that adds further cost and complexity to the value chain.

Projects encounter delays of over 1.5 years

Wood Mackenzie's research found most European CCS projects typically face delays averaging over 1.5 years, driven by technical, legal and commercial barriers. Even advanced projects like Liverpool Bay CCS in the UK and Porthos in the Netherlands have encountered significant setbacks despite government support.

Policy implications

The findings highlight the challenge of aligning policy ambition with technical and commercial reality. While the EU has established a supportive policy environment relative to other regions, limitations in individual incentive streams mean developers typically require multiple funding sources to advance projects.

More information

www.woodmac.com/lens/carbon

Normod Carbon secures Port of Grenaa exclusivity and offtake for €250m hub

The project is part of Normod's ambition to develop Northern Europe's largest network of CO2 hubs to aggregate over 20 mtpa for storage or utilisation of CO2.

Port of Grenaa, one of Denmark's largest commercial deepwater ports, will host a 10M tonne CO2 storage hub

Normod Carbon has secured exclusivity and customers for a phased development of approximately 10 million tonnes of CO2 intermediate storage capacity per annum (mtpa) at Port of Grenaa, Denmark. Operations are planned to start in 2029, with total investments of around EUR 250 million across Phase I and Phase II.

Aggregating volumes at intermediate storage hubs before transportation to dedicated on shore or onshore storage reservoirs typically reduces total CO2 transport and storage costs by over 25%, enabling more carbon capture projects to reach final investment decisions (FIDs) and supporting decarbonisation of hard-to-abate industries.

"Grenaa has the deepwater access, industrial zoning and scalability the CCUS industry needs," said Jan Lien, CEO of Normod Carbon. "Our agreement enables emitters to share cost-e icient infrastructure instead of building costly standalone solutions – accelerating deployment of carbon capture across the region."

Normod has signed Letters of Intent (LOIs) with three industrial emitters for 6.4 mtpa. While the LOIs already cover more than the phase I capacity at Grenaa, Normod continues to work on offtake and is in discussions with emitters representing ~35 mtpa of potential volumes across Northern Europe.

More than 80% of Normod's CO2 portfolio is bio-CCS, supported by durable carbon removal certificates (CDRs) trading at > EUR 200/t – over 3x the average ETS price YTD.

Phase I is a floating terminal planned to be operational in 2029. Phase II adds onshore tank capacity, targeted for 2030, subject to demand. FID for Phase I is targeted in Q1 2027, aligned with Normod's first customers' planned FIDs.

With more than 70 million tonnes per year of planned CO2 capture in Northern Europe by 2035, very few industrial regions currently have access to transport and storage. Normod aggregates volumes at its hubs before transporting them to permanent storage with larger ships – enabling shared logistics and lower costs. Port of Grenaa's deepwater location makes it an attractive gateway for license holders seeking a port to consolidate volumes before shipping them out on large carriers to FSIUs.

The company has secured access to permanent storage capacity and is currently in advanced dialogues with CO2 carrier/FSIU providers, additional permanent storage providers and other strategic ports to expand capacity across the value chain.

"By enabling large-scale CO2 handling, we are creating new opportunities for industry and ensuring our port plays a pivotal role in meeting climate goals," said Henrik Carstensen CEO of Port of Grenaa. "This partnership positions Grenaa as a key logistics hub in the green transition and supports new industrial activity in the region."

The Grenaa project qualifies for EU and local grant support, with its shared hub model ensuring cost efficiency and attractive returns.

"The Grenaa CO2 hub represents a major opportunity for the local community and Denmark as a whole," said Kasper Juncher Bjerregaard, Mayor of Norddjurs Municipality. "It will create skilled jobs, attract new industry to our region, and strengthen Denmark's role in delivering the climate transition. We are proud to support a project that combines business growth with real impact on global emissions."

Port of Grenaa is one of Denmark's largest commercial deepwater ports, strategically located on the Kattegat with deepwater access and modern facilities. The port supports the energy transition through activities in offshore wind, recycling and sustainable fuels.

More information

https://normodcarbon.com

Projects and policy news

Google supports first gas power plant with CCS

https://sustainability.google

www.broadwingenergy.com

In a first-of-its kind corporate agreement Google is supporting Broadwing Energy's gas power plant in Decatur, Illinois, which will capture and permanently store approximately 90% of its CO2 emissions.

By agreeing to buy most of the power it generates, Google is helping get this new, baseload power source built and connected to the regional grid that supports our data centers.

"We hope it will accelerate the path for CCS technology to become more accessible and affordable globally, helping to increase generating capacity while enabling emission reductions," said Michael Terrell, Head of Advanced Energy.

The Broadwing project is located at an industrial facility run by Archer Daniels Midland (ADM), which has nearly a decade of experience safely storing CO2 from ethanol production. A new gas power plant with over 400 MW of generating capacity will be built on site, substantially reducing coal use, and the CO2 it generates will be permanently stored in ADM's adjacent EPA-approved Class VI sequestration facilities.

Broadwing is the first project in a longer-term collaboration with project developer Low Carbon Infrastructure (LCI) to develop future CCS facilities in the U.S. and demonstrate how to deploy CCS projects for power generation at commercial scale.

Operational projects rise 54% despite global headwinds

www.globalccsinstitute.com

The Global CCS Institute's Global Status of CCS 2025 report underscored that while geopolitical uncertainties and inflationary pressures remain a challenge, CCS progress has a clear trajectory forward (see full summary in the next issue).

CCS has advanced strongly in 2025 despite global headwinds, with operational projects increasing 54% year-on-year as 27 new facilities came online in the past 12 months.

"A 54% rise in operating projects shows real, accelerating progress. CCS is now operating across a diverse array of sectors, proving its versatility and value to decarbonisation" said Jarad Daniels, CEO, Global CCS Institute. "To stay the course, we need durable policies, investable business models, and greater international collaboration."

The 2025 report shows:

• Operational projects have seen a 54% year-on-year increase, from 50 to 77

• 47 projects in construction, with a cumulative capture capacity of 44 Mtpa

• 610 projects in various stages of development

• Total CO2 capture capacity (operating and in development) has grown 23% to 513 million tonnes per annum (Mtpa)

• CCS continues to deploy in key industrial sectors such as cement, chemicals, and energy, where demand for low-carbon solutions is emerging alongside supportive policy. Staying the course to widespread CCS adoption will require bridging the gap between project growth and enabling conditions in policy, finance, and infrastructure.

Heidelberg's Padeswood facility will enable the production of evoZero carbon captured net zero cement for the construction industry in 2029

UK Government signs contracts to proceed two major CCS projects

www.padeswoodccs.co.uk

www.protos.co.uk

The UK's first carbon capture-enabled cement plant at Padeswood, developed by Heidelberg Materials UK, and one of the world's first full-scale carbon capture-enabled waste-to-energy facilities at Protos in Ellesmere Port, developed by Encyclis have reached FID.

Cement and waste-to-energy production are carbon-intensive and have no route to cut emissions without carbon capture. As the government moves towards net zero, Padeswood and Protos will deploy the latest technologies to remove 1.2 million tonnes of CO2 annually.

These are the first 2 anchor projects to join Eni's Liverpool Bay Transportation & Storage network, part of the HyNet carbon capture cluster which received approval in April. As a key pillar of the modern Industrial Strategy, the government further backed carbon capture in June's Spending Review with £9.4 billion over this Parliament.

Norway launches CCUS Innovation cluster

https://ccusnorway.no

The programme aims to strengthen Norwegian industry through innovation-driven collaboration, addressing challenges related to long-term growth, sustainability, and global competitiveness.

"CCUS Innovation will combine two of Norway's strongest CCUS communities into one powerful alliance – making it easier for international collaborators to access Norway's CCUS expertise and form strategic partnerships," said Francesco Finotti, Manager of the new CCUS Innovation cluster.

CCUS Innovation has been established through the Norwegian Innovation Clusters (NIC) programme – a government-funded initiative jointly run by Innovation Norway, SIVA, and the Research Council of Norway.

"CCUS Innovation will be a big step towards scaling up deployment-ready CCUS solutions by connecting technology developers, emitters, and investors across the full value chain," said Marton Vølstad, Head of Association, CCUS Norway.

Scientists transform plastic waste into efficient CO2 capture materials

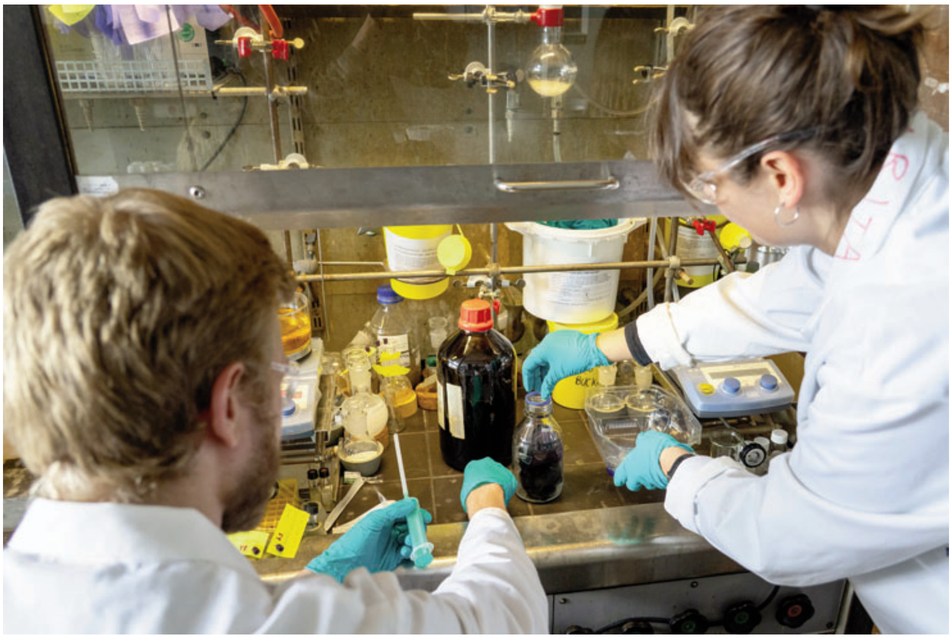
Researchers at the University of Copenhagen have developed a method where one man's trash really does become another man's "treasure", when decomposed PET plastic becomes the main ingredient in efficient and sustainable CO2 capture.

This is killing two birds with one stone as they address two of the world's biggest challenges: plastic pollution and the climate crisis.

As CO2 concentrations in the atmosphere keep rising regardless of years of political intentions to limit emissions, the world's oceans are drowning in plastics, which threatens marine environments and ecosystems.

The key global problems are often interconnected, and typically, the solution to one problem creates another one while the clock keeps ticking. But what if we could solve several problems at the same time?

We know the material from plastic bottles, textiles, and many other uses: PET plastic is one of the most widely used types of plastic in the world, but when it has served its purpose, it becomes a pressing global environmental issue. This is because it ends up in landfills in many parts of the world, where it breaks down into polluting microplastics that spread to the air, soil and groundwater. A large portion also end up in the oceans.



"The beauty of this method is that we solve a problem without creating a new one. By turning waste into a raw material that can actively reduce greenhouse gases, we make an environmental issue part of the solution to the climate crisis," says Margarita Poderyte. Photo: Max Emil Madsen

"The beauty of this method is that we solve a problem without creating a new one. By turning waste into a raw material that can actively reduce greenhouse gases, we make an environmental issue part of the solution to the climate crisis," said Margarita Poderyte from the Department of Chemistry at the University of Copenhagen, lead author of the research paper disclosing the invention.

The solution is a potential win-win on a global scale, where plastic waste not only does not end up in nature but also becomes an active player in climate mitigation.

Measured in weight, PET plastic constitutes over 60 percent of carbon, and the material has an inherent chemical and physical ability to maintain the structure.

This ability is enhanced by transforming the plastic by adding a quantity of ethylenediamine, a compound known for its ability to bind CO2.

The process breaks down the plastic from polymer to a monomer, giving the material a chemical composition that is very effective in pulling CO2 out of the air and binding it.

The material is called BAETA.

In industrial plants, the idea is to transmit the exhaust through BETA units, which will cleanse it of CO2. When the BAETA material is saturated, its efficiency decreases; however, CO2 can be released from the plastic through a heating process, restoring its efficiency.

The carbon released can then be stored underground or used in Power2X plants via CO2 utilization.

With the new chemical technology, researchers can transform PET plastic waste that is overlooked by recyclers into a primary resource in a new form of CO2 sorbent they have developed.

The process 'upcycles' it to a new material the researchers have named BAETA, which can absorb CO2 out of the atmosphere so efficiently that it easily compares with existing carbon capture technologies.

Sustainable, flexible and scalable

The BAETA material has a powdery structure that can be pelletized, and a chemically 'upgraded' surface, which enables it to very effectively bind and chemically capture CO2. Once saturated, CO2 can be released through a heating process allowing the CO2 to be concentrated, collected and stored or converted into a sustainable resource. In practice, the researchers expect the technology to be first installed on industrial plants with exhausts from chimneys passing through BAETA units to cleanse them of CO2.

The research paper is published in Science Advances journal, which describes the chemical process behind the invention. The process is gentle compared to existing technologies and, at the same time, well-suited for industrial scaling.

"The main ingredient is plastic waste that would otherwise have an unsustainable afterlife, and the synthesis we use, where the chemical transformation takes place, is gentler than other materials for CO2 capture because we can make the synthesis in ambient temperatures. It also has the advantage that the technology can be scaled up more easily," Margarita Poderyte said.

During the development process, the researchers encountered concerns that their technology could undermine efforts to recycle plastic, which has been heavily invested in. Fortunately, that is not the case, they say.

"In principle, we could use new plastic for our method, but our target is PET plastic that is difficult to recycle because of low quality, coloration or mixed sources – or that has decomposed to such a degree that it's no longer suitable for recycling. So, this will be a collaboration rather than competition with the efforts to recycle plastic," Margarita Poderyte said.

She is seconded by co-author and Associate Professor at the Department of Chemistry, Jiwoong Lee, who highlights the material's flexibility also.

BAETA vs. leading technologies

	Amine Scrubbing	BAETA	Lewatit	MOF (CALF-20)
Working conditions	flue gas, 40 °C	DAC/flue gas, 25-150 °C	DAC, 25 °C	flue gas, 25 °C
Binds a lot of CO_2	2-2.5 mmol/g	3.4 mmol/g	1.8 mmol/g	1.2 mmol/g
Low Energy Requirements	3.6-4.1 MJ/kg CO_2	1.6 MJ/kg CO_2	2.5-3.5 MJ/kg CO_2	1.2-1.5 MJ/kg CO_2
Stable and Durable	stable up to ~100 °C	stable up to ~250 °C	stable up to ~100–120 °C	stable up to ~300 °C
Affordable and Scalable	1.3 EUR/kg	1.8 EUR/kg	465 EUR/kg	29 EUR/kg
Abundant Availability of Resources	yes	yes	medium	no
Water Usage	yes	no	no	no

Comparison of the BAETA material. Figure: Margarita Poderyte

"One of the impressive things about this material is that it stays effective for a long time. And flexible. It works efficiently from normal room temperature up to about 150 degrees Celsius, making it very useful. With this kind of tolerance to high temperatures, the material can be used at the end of industrial plants where the exhausts are typically hot," Jiwoong Lee said.

With a potentially revolutionary idea, a proven method and an effective finished product, the researchers are now ready for the next step.

"We see great potential for this material, not just in the lab, but in real-life industrial carbon capture plants. The next big step is scaling up to produce the material in tonnes, and we're already working to attract investments and make our invention a financially sustainable business venture," Poderyte said.

The material BAETA is 'upcycled' from PET plastic through a chemical process. Photo: Max Emil Madsen, University of Copenhagen.

The technical challenges do not worry the researchers. Instead, the decisive challenge, they say, is to persuade decision-makers to make the necessary investments. If they succeed in that, the invention could ultimately lead to significant changes.

Large amounts of PET plastic accumulate in our oceans, damaging ecosystems and breaking down into microplastics, the consequences of which are yet unknown. That sort of plastic is very well suited for the technology.

"If we can get our hands on the highly decomposed PET plastic floating in the world's oceans, it will be a valuable resource for us as it's so well suited for upcycling with our method," Margarita Poderyte said.

The researchers hope that their invention can help to fundamentally change the way we see climate and environmental issues as separate problems.

"We're not talking about stand-alone issues, nor will the solutions be. Our material can create a very concrete economic incentive to cleanse the oceans of plastic," Jiwoong Lee said.

More information

www.ku.dk/english

Carbyon unveils world's fastest Direct Air Capture machine

Carbyon said the new unit demonstrates the technical viability of its approach and shows the potential for scalable and affordable carbon capture.

Carbyon GO represents a major step toward large-scale carbon removal, introducing the world's fastest DAC machine to date, said Carbyon, a Dutch startup. With only 1 kg of sorbent material, it capture 3 tons of CO2 per year, comparable to 150 trees.

Carbyon GO is the first of its kind: a compact, fast, and scalable Direct Air Capture machine. Using Carbyon's proprietary sorbent technology, Carbyon GO captures CO2 200 times faster than conventional solutions, achieving 90% CO2 saturation in just 100 seconds. This means CO2 capture is significantly faster and therefore more cost-effective than any technology demonstrated so far, the company said.

Unlike traditional large-scale systems, Carbyon's GO modular design allows for easier installation and scaling, opening up new possibilities for worldwide deployment in areas where sustainable energy is abundant. This compact and all-electric design allows for a new era of affordable, accessible, and scalable carbon capture solutions.

"Carbyon GO represents a giant leap forward but it is only the beginning," said the company. "It validates our design and highlights the potential of this technology at scale. While this first model has not yet been optimised for maximum efficiency or yield, it establishes a strong foundation for what comes next."

"Traditional direct air capture methods have proven too large, expensive, and complex to scale in a way that can make a meaningful impact. The industry requires a breakthrough technology that is scalable, affordable, and accessible. Carbyon GO delivers just that, and serves as a blueprint for the next generation of DAC technology."

Carbyon is now developing a next-generation machine, scheduled for presentation next year. Based on recent technological advances, it is expected to deliver 25 times more capacity within the same footprint, while reducing energy consumption significantly.

Carbyon GO at the companies test location at the High Tech Campus

The path to gigaton scale carbon capture

The machine design consists of a set of identical sorbent units that can be replicated and scaled. Carbyon envisions a future where mass production of these systems helps capture gigatons of CO2 annually. The company aims to have its large-scale production in place by 2032.

The potential of this breakthrough technology is further underscored by the growing Direct Air Capture market, which is expected to reach up to €1 trillion by 2050.

As DAC technology continues to improve and become more affordable over time, Carbyon is in a strong position to lead this fast-growing sector, creating both a cleaner future and new opportunities for carbon as a resource, whether through sustainable fuels, agriculture, or feedstock for building materials.

To achieve the global climate goals set for 2050, large-scale green carbon capture is essential to use for both carbon removal and carbon utilization.

"The future starts now," said Carbyon CEO Hans De Neve. "With Carbyon GO, we show that affordable and scalable Direct Air Capture is more than just an idea. We are making it a reality. This is only the first step toward a future where carbon capture at gigaton scale becomes achievable."

Carbyon is a spin-off from the applied research institute TNO and winner of the $1M Milestone Award of the XPRIZE Carbon Removal,

More information

www.carbyon.com

Prometheus Fuels cuts cost of carbon capture by more than 80%

At under $50 per ton, the DAC cost breakthrough unlocks carbon neutral fuels at fossil fuel prices, without relying on subsidies, biogenic carbon, or point-source emissions, the company said.

Prometheus Fuels says it has achieved the lowest-cost carbon capture in the world, reducing the cost of Direct Air Capture (DAC) by more than 80 percent compared to industry averages.

The achievement will be demonstrated in Prometheus' new 200-ton-per-year DAC system, currently under construction and scheduled for completion this year. The system captures CO2 directly from ambient air into water and feeds it into the company's patented Faraday Reactor for immediate conversion into fuel.

This streamlined approach bypasses traditional gas purification, compression, absorption and desorption, and costly infrastructure –dramatically reducing both energy use and capital requirements.

The announcement comes as policymakers, investors, and major emitters race to identify new carbon neutral power sources. With subsidy-driven approaches under pressure and most carbon capture technologies still too expensive to scale, Prometheus says its system offers a commercially ready, cost-competitive, new source of power – liquid fuels made from solar that can provide 24/7 carbon neutral electricity, propulsion, and heat anywhere in the world.

"Low-cost DAC unlocks the best solar locations, far away from point sources of CO2," said Rob McGinnis, founder and CEO of Prometheus.

"By developing a new low-cost DAC technology, along with our hydrocarbon electrolysis Faraday Reactor, we've brought carbon capture below $50 a ton and made truly affordable e-fuels possible for the first time."

Most DAC systems cost between $200 and $600 per ton of CO2 captured, making it virtually impossible to produce synthetic fuels that compete with fossil fuel prices. Prometheus' breakthrough slashes that cost by more than 80 percent, offering the first commercially viable model for scalable, carbon neutral fuel production.

Prometheus builds a 200-ton-per-year Direct Air Capture system at its California HQ, adding capacity to its currently operating 16-TPY system, the world's lowest-cost DAC technology at less than $50 per ton CO2

Unlike conventional e-fuel approaches that rely on smokestacks or bio-derived CO2, Prometheus' modular, off-grid system gives it full geographic and economic flexibility. By decoupling fuel production from traditional carbon sources, Prometheus can site its systems wherever renewable electricity is cheapest, and inexpensively transport liquid fuels anywhere in the world.

"This isn't just a scientific breakthrough, it's a whole new business model," added McGinnis.

"When you combine ultra-low-cost DAC with modular, off-grid electrochemical fuel production, you open up access to remote, off-grid solar – the cheapest source of energy on the planet – making it available anywhere in the world as a new low-cost source of 24/7, firm, dispatchable, carbon neutral power."

The company's DAC costs and fuel economics were independently validated by Ramboll, a global engineering firm, in a detailed techno-economic analysis of Prometheus' full production process.

Prometheus has operated the world's only commercial-scale DAC prototype for more than four years. That system is actively producing e-fuels at the company's Titan Forge Alpha pilot plant today.

The new modular 200-ton system builds on this proven platform to scale production and meet growing demand from sectors including AI power, factories, green steel, aviation, shipping, and cities, where this new source of carbon neutral power can stabilize the grid by fueling peaker and baseload plants.

More information

https://prometheusfuels.com

Capture & utilisation news

Deep Sky shows "bankability" of DAC with credit facility

www.deepskyclimate.com

Deep Sky has closed a bespoke credit facility for its flagship Deep Sky Alpha facility, located in Innisfail, Alberta, with Montreal-based Finalta Capital.

The $11M credit facility, specifically designed to finance Deep Sky's capital investments in CCUS, is a first of its kind in Canada.

"This landmark deal sends a clear signal: carbon removal is no longer a moonshot in Canada, it's a bankable industry," said Alex Petre, Deep Sky CEO. "By pioneering innovative debt financing, we're unlocking the capital needed to scale carbon removal and cement Canada's leadership in the global climate economy."

Deep Sky Alpha is the world's first cross-technology carbon removal facility, which captures and sequesters CO2 from the atmosphere and generates carbon removal credits. From breaking ground to operational in just 12 months, Alpha became the first direct air capture (DAC) facility in North America to sequester CO2 underground in August 2025. The commercial facility has already pre-sold all of its carbon removal credits.

KAUST innovation sustainably converts captured CO2 into industrial-grade ethylene

www.kaust.edu.sa

www.nature.com

Researchers at King Abdullah University of Science and Technology (KAUST) have developed a direct path to transforming greenhouse gas emissions into valuable chemical products.

Published in Nature Catalysis, the researchers outline a system for converting captured carbon dioxide into industrial-grade ethylene, a commodity chemical essential to plastics, textiles, and construction.

In addition to the environmental benefits, lead researcher Assistant Professor Xu Lu said key efficiencies in the system create an opportunity to turn the otherwise costly process of capturing CO2 into a profit.

"We designed and tested the system under realistic industrial conditions using captured, high-pressure CO2," he said. "Our results show captured carbon can be valorized into a valuable product with real economic potential."

An economic analysis shows the KAUST process can make ethylene at $1,240 per ton, which is about the same as today's market price. However, unlike standard ethylene production methods, which are energy- and carbon-intensive, the KAUST process uses CO2 and could operate on renewable electricity.

With system optimization, costs may fall further and turn carbon capture from a cost burden into a profit opportunity, as well as support Saudi Arabia's ambition of becoming a circular economy by 2060.

In June, a carbon capture pilot plant came online at Metsä Group's Rauma mill, where the company is testing the capture of pulp mill flue gases in cooperation with the technology company Andritz

Metsä and Andritz carbon capture pilot underway

www.metsagroup.com

www.andritz.com/group-en

As part of the pilot, Metsä Group will also investigate possibilities for a larger-scale demo plant for carbon capture at the Rauma mill site.

In June, a carbon capture pilot plant came online at Metsä Group's Rauma mill, where the company is testing the capture of pulp mill flue gases in cooperation with the technology company Andritz, the supplier of the pilot plant.

Carbon capture is an existing technology, but it has not previously been used for pulp mill flue gases. During the autumn of 2025, various operating models will be tested concerning aspects such as energy consumption and the amount of carbon captured. The pilot period will also provide information about the need for flue gas treatment and the quality of the end product.

"So far, the technology appears to be working well with the pulp mill's flue gases," said Kaija Pehu-Lehtonen, SVP Business Development and the Director of Metsä Group's carbon capture project.

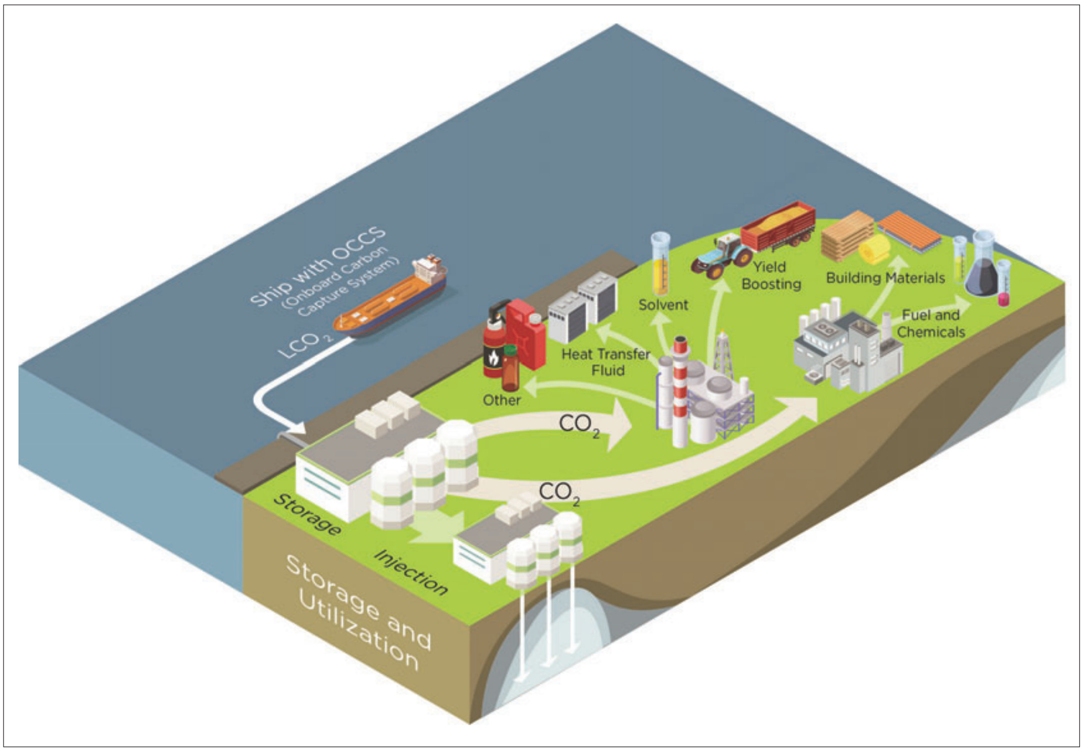
The annual capacity of a demo plant would be 30,000 to 100,000 tonnes of captured carbon dioxide. No decision has been made regarding the project or the demo plant's location. Implementing the project would require all technical and financial issues to be resolved. The larger-scale demo plant would have a capacity more than one hundred times that of the pilot plant, which can capture approximately one tonne of carbon dioxide per day.

Bio-based carbon dioxide is a virtually untapped pulp mill side stream. Carbon dioxide can be used as a raw material – for example, in the chemical and fuel industries – and it can serve as a replacement for fossil-based raw materials. Carbon capture does not increase wood use at the pulp mill, nor does it undermine production efficiency.

"Capture-related investments are large, and the market is underdeveloped, so we're proceeding gradually. In addition, the value chains from raw material to finished products are often new and complex, requiring close co-operation between the participants and an insight into industrial operations," said Pehu-Lehtonen

Creating the opportunity for onboard carbon capture in shipping

OCCS is being held back by lack of onshore infrastructure, policy support and regulatory uncertainty, writes Hamid Daiyan, Sustainability Manager, ABS.



An overview of the carbon value chain with a downstream focus

The maritime industry needs to develop a comprehensive program of pilot projects to fully assess the costs and benefits of onboard carbon capture and storage (OCCS) in reducing emissions. This process would benefit from stronger policy support to fund research and clarity around the place of OCCS in compliance with EU and IMO regulation.

For shipboard capture of carbon emissions, there is also a need for investment in shoreside receiving facilities, either as intermediate storage or as part of a wider industrial process.

Although significant progress has been made in evaluating OCCS for shipping, the process to date has been focussed on transposing land-based technology into a marine setting.

While its feasibility has been largely accepted, there remains a need to understand not just the chemistry of handling and treating flue gases but also the additional energy loads that required by OCCS.

More pilots are needed to judge the impact and of the technology in terms of effective capture rates and for that, only onboard trials can provide accurate and useful data for analysis.

This opportunity naturally falls to larger owners or those whose trading has a closer relationship to carbon capture, since they have the capacity and interest to provide vessels as test beds.

ABS has been involved in trials with shipowners examining the feasibility of OCCS on different vessel types, including containers, tankers, LCO2 carriers, LPG carriers and offshore support vessels. Some pilot projects are reportedly nearing the stage of investment decision, having undergone their preliminary assessments.

Technology and Regulation

Understand the risks involved in a new technology like OCCS is essential to its safe adoption. How to integrate highly technical systems into a vessel and operate them safety are critical to acceptance of the concept.

ABS has reviewed and provided approval for different technologies and vendors and has failed to find issues that would prevent the technology from being adopted.

The majority of pilots so far have focussed on the use of chemical absorption for OCCS as this approach is a more mature technology. The other options - cryogenic, membrane and calcium looping - each promise some potential, with feasibility studies and one pilot installation intended to confirm their suitability.

Given the cost and complexity in the development of OCCS, the over-arching need is for policy support in the form of funding to support the development and installation of multiple systems.

A streamlining of the funding application process would help shipping companies apply for funding from government bodies but an even bigger need is a clearer interpretation of the rules around carbon capture in maritime regulation.

The current uncertainty as to whether the EU will align its Fuel EU Maritime regulation with the newly agreed (but not yet adopted) IMO Greenhouse Gas Fuel Intensity (GFI) Indicator means the use of carbon capture is not codified as a form of compliance.

The one piece of regulation that does address OCCS is the EU Emissions Trading System (EU ETS) though it requires clarification on monitoring and verification of the amounts of captured carbon.

Moving Forward

To move the process forward, ABS has collaborated with various industry partners and explored integration across different vessel types. These studies assessed the efficacy, integration, and impact of OCCS on vessel performance.

Results showed that carbon capture does not pose significant stability or longitudinal strength issues. For example, LCO2 carriers maintained a good margin of intact and damage stability, even with the added weight of the capture system.

Capture rates ranging from 20% to 70% were achieved, depending on system configuration and operational parameters. The studies also highlighted key design considerations such as voyage duration, CO2 storage tank capacity, and the impact of additional system weight on available deadweight. These factors may necessitate adjustments to load line draft or hull design to maintain safe and efficient operations.

One of the main challenges identified was the presence of impurities in the captured CO2. Ensuring sufficient purity for downstream use in the CO2 value chain requires careful assessment of flue gas cleaning processes before capture.

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At present, capture of CO2 by ships involved in or adjacent to the carbon value chain – and therefore able to receive the CO2 in existing facilities – would present an operational advantage to carbon capture from conventional vessels.

Conclusions

The work conducted by ABS together with partners in shipowning and technology concludes that the take-up of OCCS is technically achievable in terms of safety.

While OCCS can be an option for both new and existing vessels, it might be particularly advantageous for addressing emissions challenges in the existing fleet. Despite the potential loss of cargo space onboard ship, the potential of OCCS is recognised for retrofit on ships that are unlikely to consider engine conversions or alternative fuels.

To the downside, carbon capture on either newbuilds or existing assets is costly and requires extra energy, increasing fuel consumption. Current international environmental regulations do not account directly for onboard carbon capture, though this may become clearer in future.

The costs associated with the installation and operation of OCCS technology can be high and the lack of ready infrastructure in ports to receive and handle captured CO2 is a major bottleneck.

Simultaneously exploiting the opportunity and addressing the challenges are key to the growth in OCCS in the shipping industry.

Probably the biggest step forward in the expansion of OCCS would be for more owners to engage in pilot projects that bring together technology providers with class to evaluate the different approaches and their results.

More information

www.eagle.org

GCMD report demonstrates feasibility of integrating maritime into CO2 value chain

The Global Centre for Maritime Decarbonisation (GCMD) published its report on Project CAPTURED, presenting findings from the world's first demonstration of a complete carbon value chain for onboard captured carbon dioxide.

The project successfully demonstrated the technical and operational feasibility of integrating maritime carbon capture into an industrial CO2 utilisation pathway.

Professor Lynn Loo, CEO of GCMD, said, "For OCCS to truly gain traction, what happens downstream is just as important as capturing CO2 onboard. Ships are floating assets that ply the world's oceans, which makes it vital to harmonise standards and regulations across ports and terminals so that offloading can be carried out safely and at scale."

"And to unlock economies of scale, maritime CO2 capture must be closely aligned with landside industrial end-use and demand."

Completed in China on 25 June 2025, the pilot involved Evergreen Marine Corp's Ever Top container vessel capturing CO2 using Shanghai Qiyao Environmental Technology Co., Ltd. (SMDERI-QET)'s Onboard Carbon Capture and Storage (OCCS) system.

The captured CO2 was then transferred ship-to-ship to Zhoushan Dejin Shipping Co., Ltd.'s (Dejin) Dejin 26, followed by a ship-to-truck transfer and subsequent overland transport to Baorong Environmental Co., Ltd. (Baorong).

At Baorong, the LCO2 was successfully utilised as feedstock, and together with steel slag, produced low-carbon calcium carbonate and post-carbonated slag.

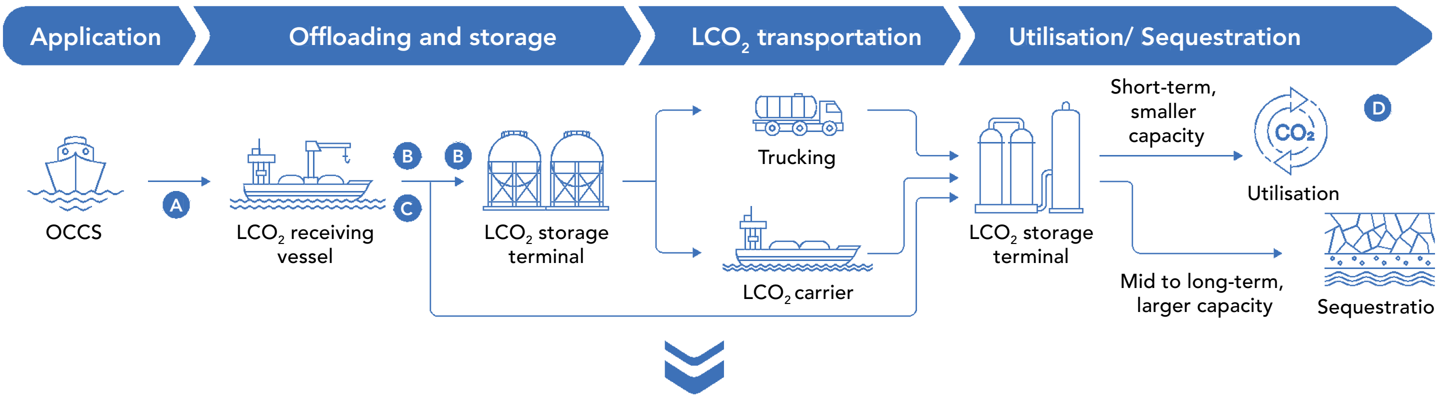
This is the first of a two-part series, with the second report to cover the life cycle assessment (LCA) of the carbon value chain. That analysis will quantify the greenhouse gas (GHG) impacts of the first maritime-to-industry CO2 utilisation pilot.

Demonstration of the world's first end-to-end carbon value chain for onboard captured CO2

Key highlights from the report

Project CAPTURED tracked the quality and quantity of the captured CO2 across the entire value chain through comprehensive sampling and analysis. At all custody transfer points, CO2 consistently exceeded 99.95 vol%, meeting the specifications of the downstream user. Of the 25.44 metric tonnes (MT) of captured CO2 offloaded from the Ever Top, 15.84 MT was delivered to the end-user.

The project also demonstrated safe and controlled operations, with no safety incidents during the trial. This outcome was achieved through a series of rigorous safety measures, including a hazard identification risk assessment covering all stages of LCO2 offloading, from vessel approach and mooring to transfer and disconnection.



	A	B	C	D
Challenges to address	Lack of established LCO_2 StS transfer	Gap in understanding if existing infrastructure can support pilot and the anticipated business-as-usual (BAU) scenarios	Lack of clarity in regulations around offloading of captured CO_2 from international vessels	Limited end-use options for captured CO_2; need to explore other usage and sequestration to scale OCCS
Industry next steps	Transfer can be done now as a no-regret move to de-risk offloading operations.	This can be mitigated in the short run, but scaling up needs further investment.	• Need advice from local regulators • Trial certification may be needed with external consultants	• Need to know end-users' require-ments • Further conversation is needed with owners of sequestra-tion facilities

Resolving challenges of post-captured CO2 from OCCS through pilots

The handling, transfer and transport of LCO2 followed procedures adapted from existing liquefied natural gas (LNG) and liquefied petroleum gas (LPG) transfer protocols.

Expanding the list of EU ETS end uses

Under the EU Emissions Trading System (EU ETS), only CO2 that is permanently fixed in products such as construction materials is recognised as "utilisation". At present, this covers carbonated aggregates, cement constituents, and products, such as concrete, bricks and tiles. This list does not include other products that also achieve permanent carbon fixation.

In this pilot, captured CO2 was mineralised into precipitated calcium carbonate (PCC)—a synthetic alternative to conventionally quarried fillers that offers higher purity and tighter control over particle size and morphology.

Although PCC can permanently bind CO2, it is only considered eligible under the EU ETS if used in construction materials. Other applications, such as its use as a functional filler in paper, plastics, and building materials, that demonstrate chemical permanence of carbon fixation, are not included.

As carbon capture technologies scale and the supply of captured CO2 increases, mineralisation pathways, like PCC, could offer additional pathways for carbon utilisation.

Expanding the EU ETS list of "eligible end-uses" to include other applications where carbon is also embedded in durable long-lived products could unlock new industrial demand, encourage investment, and accelerate the deployment of carbon capture and utilisation solutions onboard vessels and ashore.

Looking ahead

The successful scaling of the carbon value chain for onboard captured CO2 will hinge on several critical advancements identified by Project CAPTURED. One is to address the regulatory classification of captured CO2 as "hazardous cargo" from "hazardous waste" to enable lawful land transport and broad industrial utilisation.

Another focus area is streamlining transfer operations, including aligning tank capacities and transfer volumes as well as enhancing insulation of transfer equipment to reduce CO2 vaporisation, installing custody-transfer grade flow meters and inline gas analysers to monitor CO2 quality, and standardising safety protocols, including emergency shutdown interfaces and mooring configurations.

Improving commercial viability of the value chain is also crucial, which can be supported through the co-location of offloading and utilisation sites, fostering expanded industrial partnerships, and promoting CO2-derived product markets to increase the commercial drive for carbon capture.

More information

www.gcformd.org/our-publications/?report-id=8548

CO2 shipping – design, safety, and regulatory considerations

DNV has published a white paper exploring the key considerations in the design, construction, and operation of CO2 carriers and maritime CCS infrastructure for the emerging CO2 shipping fleet, as well as wider regulatory and market elements.

As the urgency for global decarbonisation intensifies, CCS is emerging as a cornerstone of climate strategy and is poised for rapid expansion. An estimated 210 million tonnes per annum of CO2 will be captured by 2030, with even steeper growth anticipated through 2040 and 2050. This surge must be matched by a corresponding scale-up in the CO2 carrier fleet.

CO2 shipping offers a flexible, long-range solution for transporting captured carbon across seas, playing a pivotal role in the global CO2 value chain. It enables delivery to final storage sites or reuse in industrial processes, bridging geographic gaps in CCS infrastructure.

However, this value chain remains in its early stages. The coming years will demand the construction of larger, cost-efficient, purpose-built vessels, alongside the development of supporting maritime infrastructure, including floating terminals and offshore units, to enable scalable, efficient CO2 transport.

While CO2 has been transported on board ships for many decades, mainly serving the food and beverage industry, this has been on smaller vessels with limited cargo capacities.

Taking this to a larger scale will involve a major expansion of the CO2 value chain, including the construction of a fleet of much larger, and specialized vessels, which will provide flexible transportation of CO2 globally. This will also be complemented by the development of wider maritime infrastructure, including floating terminals and floating offshore units.

Current status and future market

The global fleet of large-scale CO2 carriers is still at an early stage. By early 2025, two vessels dedicated for specific CCS projects have been delivered and gone into operation, with two more under construction. More vessels are expected to follow over the coming years.

Future LCO2 carriers are expected to fall into three main categories: short sea trading with vessels up to about 20k m3, offshore injection projects with vessels up to 50k m3 (also involving dedicated offshore units), and vessels for long-haul trades typically for the Asia-Pacific market transporting CO2 from Korea and Japan to permanent storage in countries like Malaysia, Indonesia, and Australia.

With the EU targeting an annual CO2 injection capacity of 50 million tonnes by 2030, and other countries like Korea and Japan also having ambitious targets for CCS, the need for CO2 carriers and supporting maritime infrastructure is expected to grow significantly in only a few years.

Looking forward, CCS capacity additions are projected to more than quadruple to 270 MtCO2/year over the next five years, with even stronger growth expected through to 2040 and 2050. This will need to be mirrored by growth in the CO2 carrier fleet.

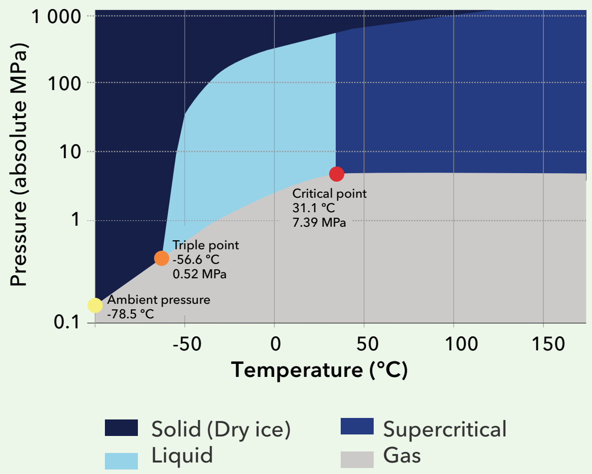
As this new fleet of CO2 carriers develops, it is crucial that the transport cost aligns and reinforces the economic case for CCS as a viable alternative to "business as usual" for emitters.

CO2 as cargo

The physical properties of CO2 differs from other liquefied gases transported at sea. Its density is higher than other commonly traded liquefied gases such as LPG and LNG.

FIGURE 1-1

Phase diagram of pure CO_2



Moreover, CO2 cannot exist in liquid form at atmospheric pressure. Pure CO2 has a triple point at 5.12 bara and -56.6°C, meaning it must be kept above this pressure and within a specific temperature range to remain in its liquid state. These factors create new challenges for the ship and cargo tanks, and need to be taken into consideration during design, construction, and operation.

While the relevant pressure and temperature are separately not extreme in any way, the combination poses challenges. In addition, the high weight of the cargo leads to high dynamic loads which create significant challenges in terms of fatigue.

CO2 from industrial emitters also contains different types of impurities, which can create a corrosive environment and influence the physical properties of CO2. A structured approach to manage the risks associated with the CO2 composition is a new but important element for this new shipping segment.

More information

www.dnv.com/maritime

First new round UK CCS appraisal well drilled at Bacton

The UK's carbon storage industry has reached an important milestone with the drilling of an appraisal well on the Hewett field, in the Southern North Sea, for the Bacton CCS project.

It is the first carbon storage appraisal well to be drilled on acreage licensed by the North Sea Transition Authority (NSTA) as part of the world's first large-scale carbon storage licensing round in 2023.

The appraisal well, operated by Eni, is an important step towards assessing the carbon storage potential of the UK continental shelf (UKCS). The basin has up to 78 gigatonnes of potential storage capacity in depleted reservoirs and saline aquifers, enough to sequester all the CO2 emitted in the UK since the industrial revolution.

The NSTA estimates that up to 100 stores may need to be appraised to identify the best candidates for storage and help the UK reach its net zero target by 2050.

Hewett, 18 miles off the Norfolk coast, was one of the UKCS's longest serving gas fields. Its original operator, Phillips, started production from the field in 1969, making Hewett only the third North Sea field to reach this stage, after West Sole and Leman. The field had produced 3.5 trillion cubic feet of gas by the time it permanently shut down in 2023.

Now Eni wants to give Hewett a new lease of life as a carbon store. It is thought to be capable of storing up to 10 million tonnes of CO2 per year emitted from the Bacton and wider Thames Estuary area, as well as potentially offering decarbonisation solutions for emitters across the European Union.

Eni contracted the Valaris 72 rig to drill the well – and work got under way in May 2025. Extensive data sampling was conducted, including cutting 270 ft of core and performing a nitrogen injection test, before plugging and abandoning it.

The data collected will inform the development plans for the Bacton CCS project by enabling the operator to build a fuller picture of the reservoir's post-production characteristics and conditions, including reservoir pressures, possible injection rates, wellbore integrity and leakage risk.

In time, the data will be made available on the NSTA's National Data Repository, helping to provide a richer data set to all operators looking to evaluate and derisk similar stores.

The NSTA awarded permits for the UK's first two carbon storage projects to the Northern Endurance Partnership in December 2024 and Liverpool Bay CCS, also operated by Eni, in April 2025. Together, they could store more than 200 million tonnes of CO2.

The Valaris 72 rig – the well on Hewett is the first to be consented as a dedicated carbon storage appraisal well via the Well Operations Notifications System

In May, the NSTA put out a call for nominations for potential carbon storage locations to encourage companies to focus on areas where they have already done some technical work, leading to higher quality applications and likely cutting time to project delivery.

The NSTA offered 21 licences in the UK's inaugural carbon storage licensing round, which concluded in September 2023. Licence CS008, which covers Hewett, is held by Bacton CCS Limited, a subsidiary of Eni CCUS Holding.

Andy Brooks, NSTA Director of New Ventures, said, "The carbon storage industry has entered an exciting period of delivery, with two multibillion-pound projects getting the go-ahead in the past year, unlocking thousands of supply chain jobs. Long-held ambitions for this industry, which is essential to the UK's energy transition, are rapidly becoming reality."

"The appraisal well on Hewett – the first to be drilled on acreage awarded by the NSTA as part of the world's first large-scale carbon storage licensing round – is yet another important milestone for the sector as it looks to assess further stores which should progress towards development. The NSTA continues to work with licensees to ensure that their plans are the right ones."

Offshore Energies UK welcomed the news, saying the UK is making significant strides on the path to becoming a global leader in carbon capture and storage. Enrique Cornejo, OEUK Head of Energy Policy said, "This Hewett appraisal well is a powerful signal of industry's commitment to invest in the UK's net zero future. It shows how our existing energy infrastructure and expertise are being repurposed to deliver climate solutions."

"But for commercial carbon capture and storage to succeed at scale, government must accelerate a clear route to market for projects like Bacton CCS which are outside the government's planned cluster sequencing process. The Hewett appraisal well is a tangible example of industry stepping up, and now it's time for policy to keep pace."

More information

www.eni.com/static/bactonthamesnetzero

www.nstauthority.co.uk

Transport and storage news

NZTC releases CCS Wells Technology Roadmap

www.netzerotc.com

The roadmap from the Net Zero Technology Centre in partnership with DNV serves as an industry resource to raise awareness of deployable technologies capable of addressing the challenges posed by CCS wells.

The UK North Sea offers substantial storage potential and there are currently twenty-seven CO2 appraisal and storage licences on the UK Continental Shelf (UKCS). The UK's oil and gas sector brings a strong foundation of well engineering expertise and innovation. Many of these technologies can be applied to CCS, but the CCS industry also faces unique challenges that require adaptation and, in some cases, entirely new solutions.

The CCS Wells Technology Roadmap provides clarity on where those challenges lie and which technologies are positioned to address them. Structured around key focus areas, the report profiles more than 60 emerging or existing technologies that are shaping the future of CCS wells. In addition, it highlights the current capabilities, uncovers technology gaps and identifies areas for future innovation.

Industry engagement played a central role in shaping the roadmap. Through workshops and interviews with operators and supply chain leaders, insights were gathered on successful deployments, technology limitations and future needs. This input directly informed the selection and assessment of technologies featured in the report.

AtmosClear selects ExxonMobil for CO2 transportation and storage

https://atmosclear.earth

ExxonMobil will provide CO2 transportation and storage services for the carbon removal project located at the Port of Greater Baton Rouge in Louisiana.

Up to 680,000 metric tons per annum of biogenic CO2 will be stored from AtmosClear's biomass energy with carbon capture (BECCS) facility, with the potential for additional volumes. The BECCS facility will generate clean energy from biomass while capturing the resulting CO2 emissions.

ExxonMobil's integrated system — including Class VI wells, existing pipelines, and advanced monitoring systems — will enable efficient, secure, and cost-effective CO2 transportation and storage and will provide CDR credits for Microsoft and other customers.

Fidelis Co-Founder and CEO, Dan Shapiro said, "We are excited to announce our carbon transport and storage agreement with ExxonMobil, a collaboration that enables large-scale carbon removal for AtmosClear.”

“ExxonMobil was selected for its extensive existing infrastructure, world-class safety culture, and proven operational excellence, making them the clear choice for AtmosClear's facility."

Tracerco deploys tracer technology in first US CCS project

https://tracerco.com

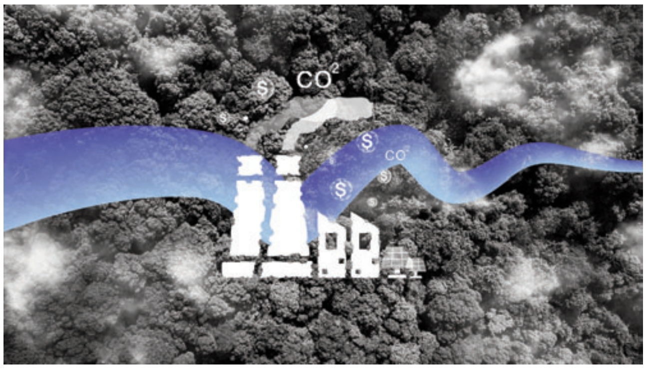
Its proprietary chemical tracer technology will be used in support of a US-based CCS project for the first time.

The project marks a significant expansion of Tracerco's carbon authentication capabilities, enabling the tracking, monitoring, and long-term independent verification of CO2 containment in CCS projects.

Tracers, alongside other complementary measurement, monitoring, and verification (MRV) technologies that are part of Tracerco's solutions portfolio, enable operators to tackle greenhouse gas emissions through the application of CCS, permitting safe and permanent underground CO2 storage.

Using its experience in the use of tracer technology in enhanced oil recovery (EOR), Tracerco has developed a family of unique chemical tracers that it said provide conclusive early warning of the presence of CO2 should it be detected by various detection methods.

Additionally, and due to its inherent application, tracer technology provides measurable evidence, crucial to quantifying any potential leaks.



Tracerco has developed a family of unique chemical tracers that it said provide conclusive early warning of the presence of CO2

Unlike other technologies, the tracers deliver leak detection down to parts-per-trillion sensitivity, map CO2 migration patterns through strategic sampling, and fingerprint the CO2 to distinguish between naturally occurring, recycled, and newly injected sources. This non-intrusive approach ensures continuous injection, without the need to disrupt operations, leading to greater and faster capture.

Babcock onboard CO2 capture system wins approval from Lloyd's

www.babcockinternational.com

IBabcock's LGE business has been awarded Approval in Principle (AiP) by Lloyd's Register (LR) for its onboard membrane-based carbon capture technology, ecoCPTR®.

ecoCPTR® integrates Aqualung's facilitated transport membrane CO2 capture technology with Babcock's ecoCO2® system, delivering a low-pressure, modular solution designed for installation on both newbuilds and retrofits.

Jose Navarro, LR's Global Gas Technology Director, said, “Lloyd's Register is pleased to award Approval in Principle to Babcock's ecoCPTR® system, recognising its potential to simplify onboard carbon capture through the integration of membrane capture and CO2 liquefaction technologies. This development underlines the importance of innovation in supporting shipowners with practical solutions to cut GHG emissions and to meet IMO net zero requirements.”

UK energy from waste sector could go carbon negative by 2035

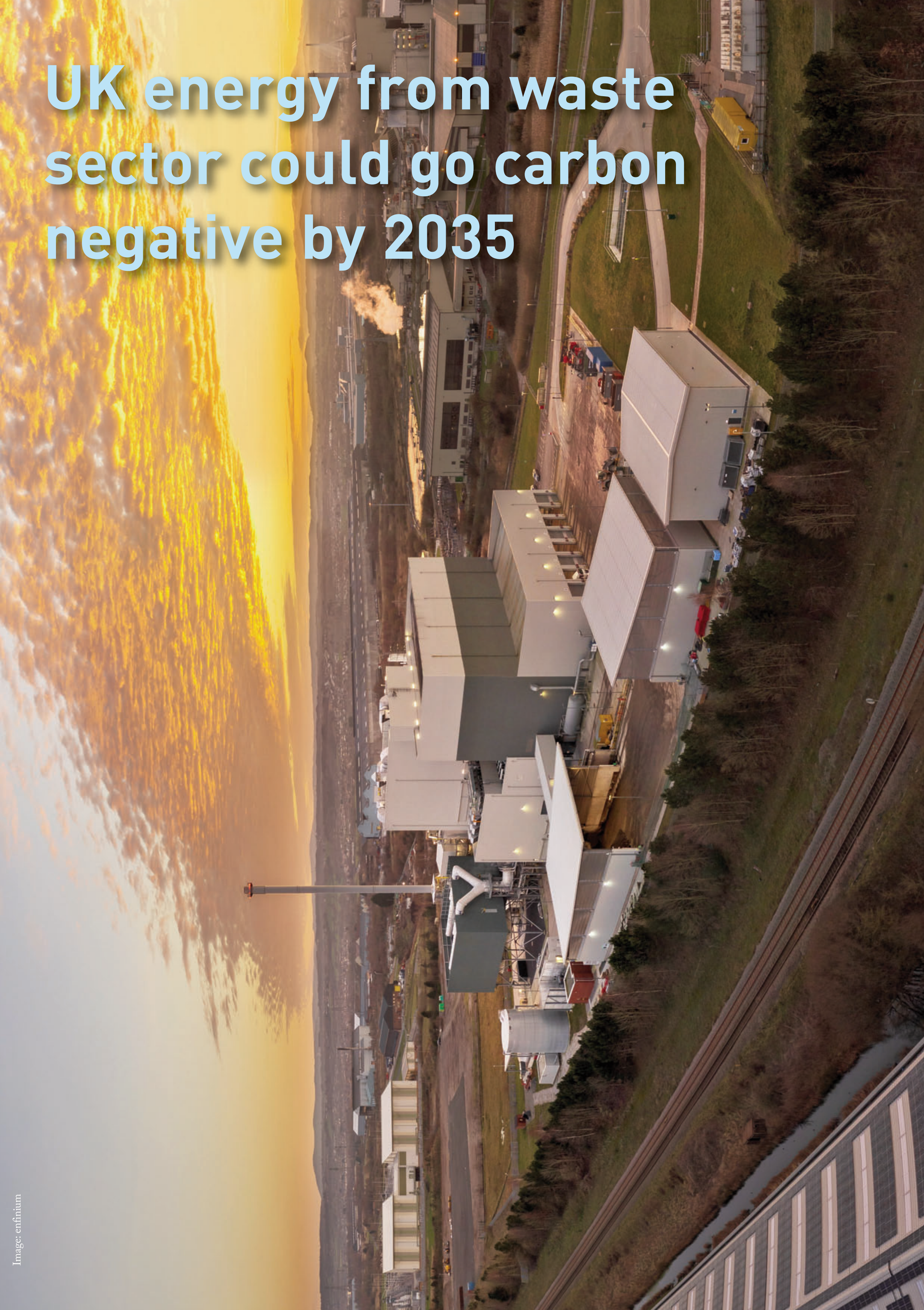


Image: enfinium