Carbon Capture Journal

CCUS in EMEA

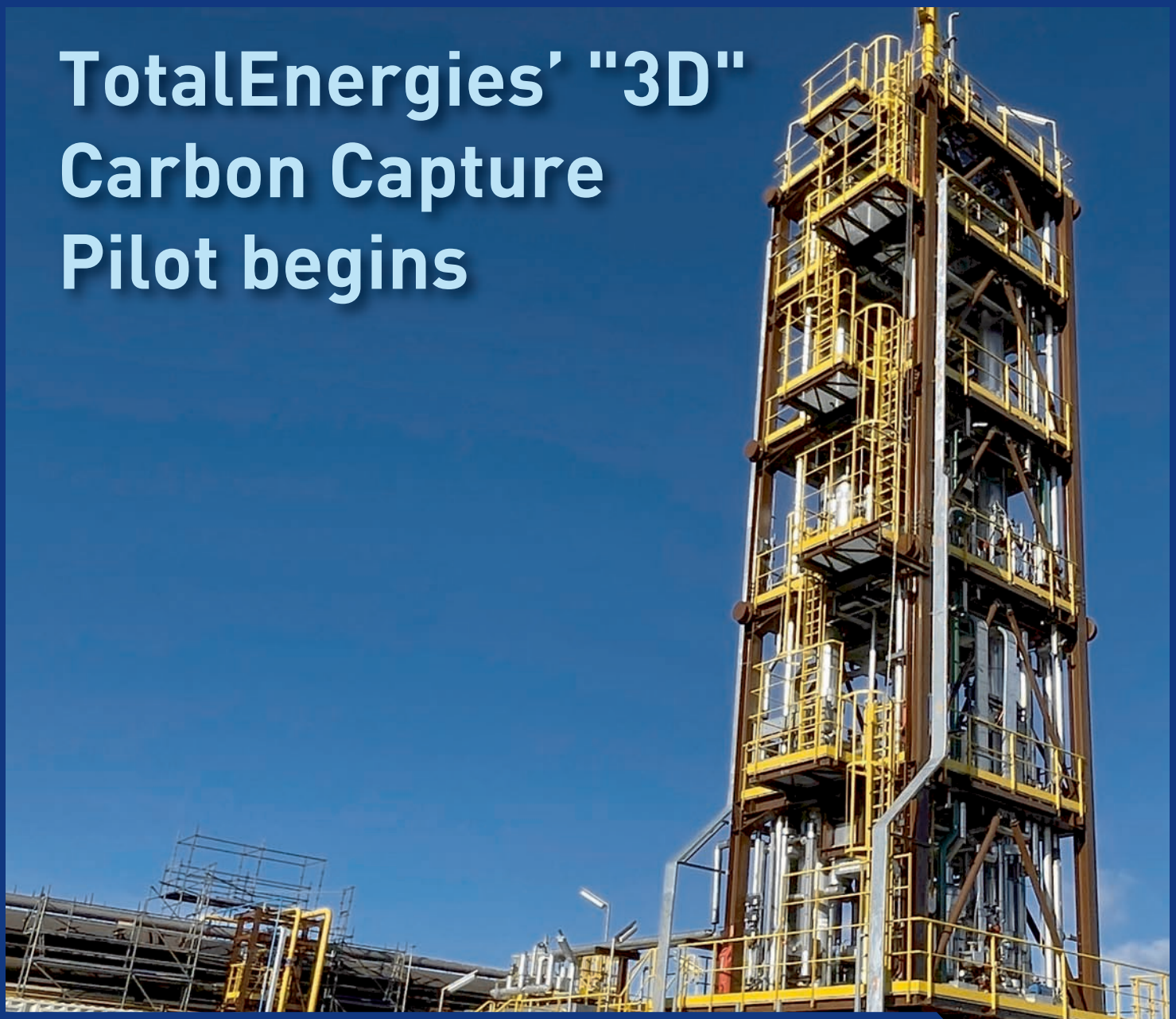
EU awards over €1bn

Mix of all low carbon tech could save EU €80bn

1000km CO2 transport network in Germany

May / June 2022 Issue 87

TotalEnergies' "3D" Carbon Capture Pilot begins



Carbon removals needed to limit global warming to 1.5°C

CCSA: UK needs to start planning next set of projects past 2030

Treated plastic waste particles good at grabbing carbon dioxide

Peel NRE reveals plans for CO2 network at Protos in Cheshire UK

Carbon removals needed to limit global warming to 1.5°C

The Energy Transitions Commission (ETC) report describes how carbon dioxide removals (CDR) alongside rapid and deep global decarbonisation can give the world a 50/50 chance of limiting global warming to 1.5°C.

The report confirms that all sectors of the economy can and must decarbonise by mid-century with big emission reductions in the 2020s. Cutting coal use by half and ending 70% of deforestation by 2030 are particularly important priorities. But even given the fastest feasible path of emissions reductions, the world will need at least 70 to 220 Gt of carbon removals between now and 2050 to limit cumulative net emissions to a level compatible with globally agreed climate objectives.

These removals could be achieved via a combination of Natural Climate Solutions (such as reforestation and improved soil management), Engineered solutions (for instance using direct air capture of CO2) and hybrid solutions (such as Bioenergy plus carbon capture and storage). NCS solutions will dominate in the early years but carry measurement and permanent risks which must be carefully managed; Engineered solutions are currently far more expensive, but costs can and must be reduced over time.

A feasible scenario suggests that from close to zero today, removals could reach 3.5 Gt per annum by 2030 and could deliver around 165 Gt of cumulative sequestration over the next 30 years.

A portfolio approach to CDR

No single CDR solution can be deployed in significant enough volumes to deliver the emissions removals required, and each entails different costs and risks. A portfolio approach is therefore required, with solutions playing vital and complementary roles.

Initially the bulk of investment must be focused on reforestation and delivering other NCS, alongside early scale-up support for engineered and hybrid solutions. In the 2030s and 2040s the portfolio is likely to shift towards hybrid and engineered solutions as these newer technologies scale, bringing down costs and increasing availability.

Closing the Gap

Removals will only occur if someone pays for them. A massive ramp up of financial support from both governments and corporates is needed to scale removals in the coming decades. Currently funding for emissions removal is very limited, less than $10 billion per year, with the voluntary carbon markets delivering just 10 megatons (Mt) per year of emissions removals. This is equivalent to less than 0.1% of global emissions.

"Unless we develop carbon dioxide removals rapidly and on large scale – closing the gap in both ambition and funding between today's minimal level and what we need – it will be impossible to limit global warming to 1.5°C. It's not either or – deep decarbonisation or carbon dioxide removals. Both are essential, rapidly and at scale, if we are to avoid enormous harm to people across the world," urged Adair Turner, Chair, Energy Transitions Commission.

Supporting c. 3.5 Gt/ year of removals in 2030 could require annual payments of over $200 billion / year. Over the next three decades sequestering 165 Gt could require payments of around $15 trillion, equivalent to around 0.25% of projected global GDP over this period. In contrast required investment in clean power is around 1.5% of GDP over the same period.

Government and Corporate Action

Voluntary carbon markets will play an important role in scaling up CDR but even under ambitious projections are only likely to meet 1/3 of 2030 volume required. Further action will be required with governments supporting via market creation (e.g., emissions trading schemes), via direct finance and purchase of removals, and by redirecting agricultural subsidies and funding of nature restoration.

In turn corporates should support by meeting their obligations in compliance markets (e.g., EU Emissions Trading Scheme). In addition, high ambition corporates should choose to commit to 1.5°C degree aligned science-based pathways to reduce emissions, with any remaining emissions fully neutralized via carbon credits. Crucially, the type of carbon credits corporates purchase should shift away from today's focus on emissions reductions, towards removals.

Working together government and corporates can create the enabling conditions for CDR. Specifically, building supporting infrastructure (e.g., renewable power, CCSU), accelerating innovation (e.g. enhanced weathering), and delivering training in areas such as improved land management practices. In addition, risk should be managed by governments and regulators investing in monitoring and verification technologies, and standardising best-practices.

"In addition to rapid and deep decarbonisation, governments and corporates must work together, starting now, to scale-up an ambitious and diverse portfolio of CDR solutions. As we look ahead to COP27, this is vital to delivering on commitments made in Glasgow and keeping 1.5°C alive," said Nigel Topping, UK High Level Climate Action Champion

The Mind the Gap: How Carbon Dioxide Removals Must Complement Deep Decarbonisation to Keep 1.5°C Alive report constitutes a collective view of the Energy Transitions Commission. Members of the ETC endorse the general thrust of the arguments made in this report but should not be taken as agreeing with every finding or recommendation. The institutions with which the Commissioners are affiliated have not been asked to formally endorse the report.

More information

Read the report:

www.energy-transitions.org

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Front cover: ArcelorMittal's steelmaking site in Dunkirk. The phases of building TotalEnergies' "3D" carbon capture pilot pilot and connecting it to the plant have now been completed, and the unit is ready for start-up (pg. 11)

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Leaders - CCUS in EMEA

Projects and policy

Capture and utilisation

Transport and storage

EU awards over €1 billion to projects for the climate transition

The Commission signed grant agreements of €1.1 billion with seven large-scale projects via the EU Innovation Fund, funded by revenues from the EU's Emissions Trading System (ETS).

These projects aim to reduce emissions by over 76 Mt of CO2eq during the first ten years of operation. The seven projects are deploying innovative low-carbon technologies at industrial scale, covering key sectors such as hydrogen, steel, chemicals, cement, solar energy, biofuels, and carbon capture and storage.

"With the Innovation Fund, the European Commission is granting €1.1 billion to empower innovative, forward-thinking businesses that develop cutting-edge technologies and drive the climate transition in their respective fields," said Executive Vice-President for the European Green Deal, Frans Timmermans.

"This is a smart investment into the decarbonisation and resilience of our economy; it boosts European industry's position as global leaders in clean tech, creates local jobs, and helps to accelerate our green transition."

BASF's Verbund site in Antwerp. Due to its prime location in the Port of Antwerp with direct sea access, CCS is an attractive solution to reduce CO2 emissions from production processes on an industrial scale within a relatively short timeframe. Image: BASF

Projects in brief

Kairos@C: Located in the Port of Antwerp (Belgium), the Kairos@C project aims to create the first and largest cross-border carbon capture and storage value chain to capture, liquefy, ship, and permanently store CO2. Kairos@C will enable the deployment of several pioneering technologies that together have the potential to avoid the emission into the atmosphere of 14 Mt of CO2eq over its first ten years of operation.

Kairos@C will be jointly developed by Air Liquide and BASF at its Antwerp chemical site. By avoiding 14.2 million tons of CO2 over the first 10 years of operation, it will significantly contribute to the EU's goal of becoming climate neutral by 2050.

Besides combining CO2 capture, liquefaction, transportation and storage on a large scale in the North Sea, the project includes several innovative technologies. Notably, for capturing the CO2 from production plants, Air Liquide will use its patented Cryocap™ technology and, for drying the CO2, BASF will apply its Sorbead® solution. The project is planned to be operational in 2025.

Kairos@C is paving the way for the next phases of carbon abatement in the port of Antwerp. The project will also be connected to shared CO2 transport and export infrastructures, including a first-of-its-kind CO2 liquefaction and export terminal, which will be built under the framework of "Antwerp@C", a consortium that aims to halve CO2 emissions in the Port of Antwerp by 2030. Air Liquide and BASF are founding members of Antwerp@C.

BECCS at Stockholm: Located in Stockholm (Sweden), this project aims to create a full-scale Bio-Energy Carbon Capture and Storage (BECCS) facility at the existing heat and power biomass plant in Stockholm. Combining CO2 capture with heat recovery the project will avoid 7.83 Mt of CO2eq emissions during its first ten years of operation. This is more than the entire amount of greenhouse gas emissions from public sector electricity and heat production in Sweden in 2018.

At its research facility, which opened in 2019, Stockholm Exergi has been able to demonstrate the extent of the project's innovation with very high levels of energy efficiency and sustainability. Tests show that it has been possible to capture almost 90 per cent of the biogenic carbon dioxide at high energy efficiency levels due to extensive heat recovery and reuse towards Stockholm's district heating network.

To secure financing of the BECCS facility, Stockholm Exergi said it believes that three main financing streams are needed, with the support from the EU Innovation Fund being one of them. The other two sources are the

Swedish state – through a so-called reverse auction, the details of which are due to be decided in 2022 – and income from the sale of so-called Carbon Removal Certificates (CRC) on the voluntary carbon market.

Hybrit Demonstration: Located in Oxelösund and Gällivare (Sweden), the Hydrogen Breakthrough Ironmaking Technology Demonstration project (Hybrit Demonstration) aims to revolutionise the European iron and steel industry. It will replace fossil-based technologies with climate-neutral alternatives such as green hydrogen production and use.

The project has the potential to avoid the emission of 14.3 Mt of CO2eq over its first ten years of operation. Moreover, it will use a technology associated with major climate benefits for the steel production sector.

Ecoplanta: Located in El Morell (Spain), this project will deliver a first-of-a-kind commercial plant for the European market, using waste that would otherwise end up in landfills. The plant will produce 237 kt/y of methanol, and thereby recover 70% of the carbon present in non-recyclable materials. The project will avoid the emission of 3.4 Mt of CO2eq over its first ten years of operation.

K6 Program: Located in Lumbres (France), the K6 Program aims to produce the first carbon-neutral cement in Europe, becoming a representative project for the cement industry worldwide and supporting the clean energy transition of a hard-to-abate sector.

The project will deploy a first-of-a-kind industrial-scale combination of an airtight kiln and cryogenic carbon capture technology with CO2 storage in the North Sea site that otherwise would be emitted to the atmosphere. This will result in the avoidance of 8.1 Mt of CO2eq emissions over its first ten years of operation.

Air Liquide and EQIOM are joining forces in a project named "K6" with the aim to transform EQIOM's Lumbres plant into one of the first carbon-neutral cement plants in Europe

Stockholm Exergi plans to build Europe's first large-scale negative emissions plant, when complete, the BECCS plant will capture 800,000 tonnes of biogenic carbon dioxide every year

Once purified and liquefied, the CO2 captured at the Lumbres Plant would be transported via shipping to permanent storage sites currently under development below the North Sea or would be used in building materials.

The implementation of this project in close proximity to the port of Dunkirk would also contribute to the development of a new carbon capture and storage ecosystem in Europe.

The K6 project is a key step for the development of the Dunkirk D'Artagnan PCI (Project of a Common Interest), which aims to create a multi-modal CO2 export hub from Dunkirk industrial basin and its broader area.

SHARC: Located at the Porvoo refinery (Finland), the Sustainable Hydrogen and Recovery of Carbon project (SHARC) will reduce greenhouse gas emissions by moving away from the production of fossil-fuel based hydrogen towards both renewable hydrogen production (through the introduction of electrolysis) and hydrogen production by applying carbon capture technology.

In the first ten years of operation, the SHARC project will avoid the emission of more than 4 Mt of CO2eq.

Background

Funded by revenues from the auction of emission allowances from the EU's ETS, the Innovation Fund aims to create the right financial incentives for companies and public authorities to invest now in the next generation of low-carbon technologies and give EU companies a first-mover advantage to become global technology leaders.

The Innovation Fund is currently sourced from 450 million allowances from the existing ETS in 2021-30. Under the European Commission's Fit for 55 proposals, it would be topped up with 50 million allowances from the revised ETS and 150 million allowances from the new system covering emissions from road transport and buildings. In addition, allowances which would otherwise be allocated for free to industry sectors covered by the Carbon Border Adjustment Mechanism would be auctioned and added to the Innovation Fund.

More information

kairosatc.eu

beccs.se

www.eqiom.com

Mix of all low carbon tech could save EU €80bn compared to renewables alone

Modelling commissioned by Carbon-Free Europe shows the European Union's most feasible, cost-effective pathway to net-zero by 2050 must bring all available low-carbon technologies online.

The analysis reinforces that the chances of reaching emissions goals for individual countries and the EU increase as more clean technology and fuel options, such as carbon capture, direct air capture, hydrogen, and nuclear power, are included as viable mitigation options. Increased optionality reduces risk and makes it more likely that clean energy will be costeffective and net-zero goals can actually be achieved.

The optimal energy mix to achieve these goals would require the EU to make the investments and scale infrastructure to generate 20% of its electricity from nuclear, 18% from offshore wind, 27% from onshore wind, and 27% from solar, and 8% other resources like biomass, geothermal, and hydro by 2050. Pursuing a 100% renewable energy strategy would cost the EU at least €80 billion more a year by 2050 and require the EU to quadruple its electricity generation compared to a tripling in other net-zero pathways.

Decarbonisation changes the map of energy in Europe as the nature of energy resource endowments change. Whereas prior energy advantages included access to oil, natural gas, and coal resources, now resource advantages include: access to high quality renewable resources, biomass availability, geologic advantages for CO2 sequestration and hydrogen storage, and an acceptance of nuclear technology.

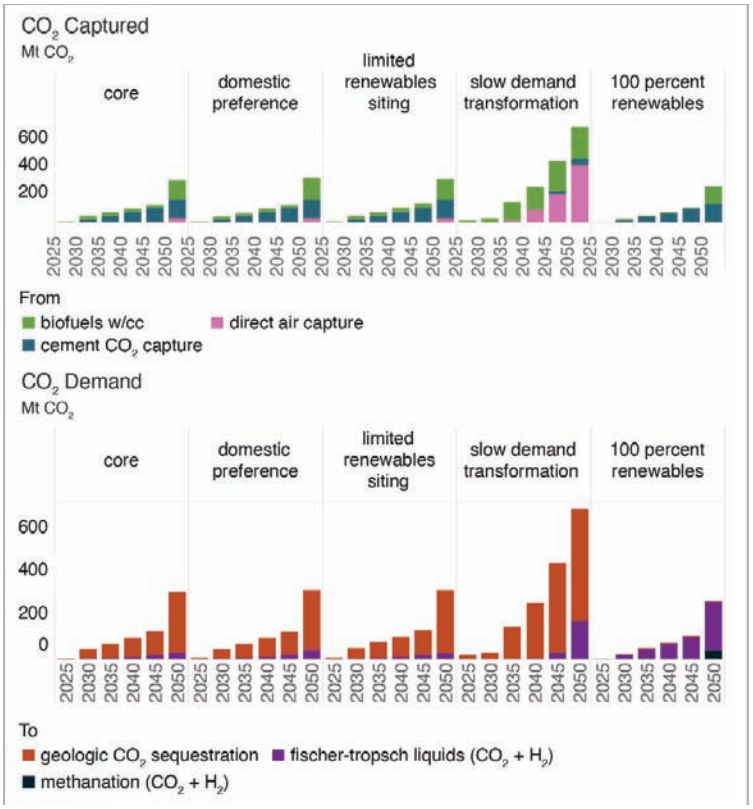
Using every low- and zerocarbon resource to get to net-zero would also help the EU insulate itself from persistently high natural gas prices and significantly increase its energy sovereignty.

Risk assessment is an important framework to use when evaluating long-term energy plans. Required costs as well as pace and scale of infrastructure transformation are two of the largest risks to the feasibility of net-zero pathways.

In industry, the report found that around 50% of the industrial sector can be decarbonised by electrifying process heat, and the remaining industrial emissions would be eliminated using a combination of clean hydrogen and carbon capture.

Clean hydrogen would develop as an entirely new industry, becoming the backbone of decarbonising industry, freight, shipping, and aviation.

Carbon capture would be required in all net-zero pathways in order to decarbonise cement and create negative emissions with bioenergy with carbon capture and storage (BECCS) and direct air capture (DAC), although it would not be required in the power sector.



In net-zero pathways, Europe captures carbon dioxide from biofuels, cement production, and direct air capture (top). This captured CO2 is then either sequestered in geologic formations or used to produce fischer-tropsch liquids or methane (bottom)

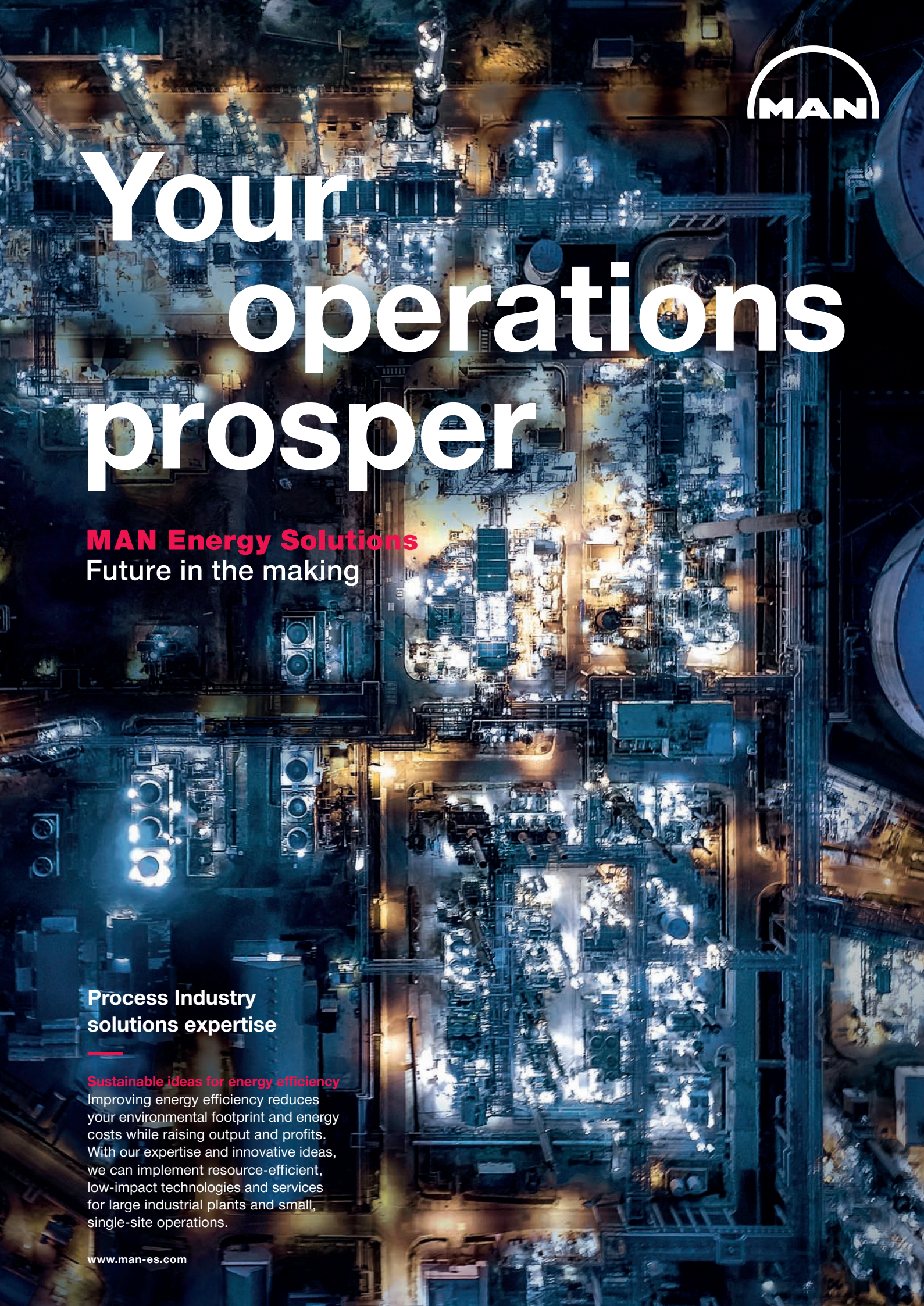
Captured carbon is either used to produce synthetic fuels (e-fuels) or stored underground to offset a small amount of continued fossil use (see figure). The balance of these approaches depends on additional policy constraints on fossil energy (i.e. 100% renewables), fossil fuel prices, the cost of hydrogen (as a feedstock for e-fuels), and the cost of geologic storage.

"To develop a robust, long-term strategy to reach climate neutrality, keeping multiple pathways open to reach Europe's climate goals is essential for each region to tailor the transition to their economic needs," said Lee Beck, International Director, Carbon Capture at Clean Air Task Force (CATF).

"Technology optionality means that we need to focus on volumes rather than colors for low-carbon hydrogen supply, and on commercializing carbon capture and storage technologies for harder-to-abate sectors as soon as possible."

More information

www.carbonfreeeurope.org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International team wins €3.4M to advance ship-based carbon capture

The EverLoNG project involving science and industry has been awarded €3.4 million from an EU climate action fund to accelerate the uptake of ship-based carbon capture (SBCC) by international shipping companies.

The project led by TNO will demonstrate SBCC on board two LNG-fuelled ships, owned and operated by project partners TotalEnergies and Heerema Marine Contractors, with results aimed at moving the technology closer to market readiness.

EverLoNG project coordinator, Marco Linders of TNO, said, "Funding from the ACT3 programme will enable us to conduct studies aimed at making commercial ship-based carbon capture a reality."

"Our demonstration campaigns will optimise SBCC technology and we will also consider how best to integrate it into existing ship and port infrastructure. We'll also carry out detailed life cycle assessments and techno-economic analysis, which will be essential information for maritime sector companies. International collaboration is a big part of EverLoNG and our consortium is fully committed to supporting the shipping industry's decarbonisation goals."

As well as the SBCC trials, the 16 project partners from five countries – Germany, the Netherlands, Norway, the UK and the USA – will conduct studies to support the development of full-chain CCUS networks, connecting SBCC with CO2 transport links, geological CO2 storage and markets for CO2 use. These studies will identify and help solve any technical barriers to the implementation of SBCC as well as lower the costs associated with the technology.

The project consortium includes ship classification societies – Lloyd's Register, Bureau Veritas and DNV – who will evaluate how SBCC fits within existing regulatory frameworks for shipping.

Combined activities by EverLoNG partners will support the ambitious target of advancing SBCC as a cost-competitive decarbonisation option on the market by 2025, with a marginal abatement cost – the cost of reducing environmental impact – of between €75 and €100 per tonne of CO2 equivalent and a CO2 capture rate of up to 90%.

The maritime sector aims to reduce CO2 emissions from international shipping by at least 50% by 2050. SBCC is one option being considered as a low-cost, short-term approach to decarbonising the sector, compared to zero-emission fuels, such as ammonia and hydrogen.

Philip Llewellyn, Carbon Capture, Utilisation and Storage Program Manager, TotalEnergies, said, "As part of our climate ambition to achieve net zero emissions by 2050, together with society, the decarbonisation of our maritime activity is an important challenge."

"Ship-based carbon capture is a promising short-term solution as it could be installed on the current fleet of ships. In addition, the potential application of such a technology onboard future CO2 carriers, as in the Northern Lights project, in which TotalEnergies is a partner, could bring high-potential synergies."

The project will be organised into separate work packages.

WP1 : Demonstrating ship-based carbon capture

Ten tonnes of CO2 will be captured on board TotalEnergies' LNG carrier, during a 3000-hour test campaign, providing data on environmental emissions and the impact of motion on capture rates, capture solvent behaviour and degradation. A second campaign of around 500 hours of CO2 capture operations on board Heerema's Sleipnir will allow comparison of the system performance on both ships to provide further insights.

WP2 : Ship-based carbon capture in the full CCUS chain

The CO2 Shipping Interoperability Industry Group (CSIIG) aims to connect at least five European ports, where CO2 shipping already occurs, with developing CCUS projects where it is expected to play a key role.

WP3 : Impact of SBCC on ship infrastructure

EverLoNG supports the deployment of SBCC on board all types of LNG-fuelled ships – from bulk carriers and dredgers to ferries and cruise ship

WP4 : Environmental impact & techno-economic aspects

Life Cycle Assessment (LCA) considers the full chain of ship-based carbon capture (SBCC) for both EverLoNG ships, including the fate of the captured CO2 once offloaded, transported and geologically stored or utilised. Results will be benchmarked against operation without SBCC.

WP5 : Regulatory frameworks

Regulatory frameworks must be in place before SBCC can be deployed at full scale. The project will bring together technology developers and three major class societies – namely, Bureau Veritas Norway AS, Lloyds Register and DNV – to ensure the technology's design is in line with current safety regulations.

WP6 : Dissemination & knowledge sharing

Sharing information and results generated by EverLoNG are key to their uptake by stakeholders, which include the international shipping community, workforces, connected industries, policymakers, national and international governments with responsibility for climate targets, and the wider public.

More information

everlongccus.eu

ZEP information factsheet

Directive on the geological storage of carbon dioxide

Experience in developing CO2 storage

Permanent CO2 storage projects in the North Sea play a key role in Europe's climate change mitigation efforts. But the success of these projects relies on clear guidance that provides operators with regulatory certainty.

50+ MARKET-READY CCS PROJECTS ***are planned today in Europe.***

These projects will play a key role in decarbonising a wide range of sectors and activities. Their growing number attests to the emergence of a strong geological CO2 storage community in Europe. The lessons learned by these forerunners could inform policy and drive decarbonisation forward.

These past experiences will be crucial to consider as the EU updates its Guidance Documents for the Directive on the geological storage of CO2. Further details are provided in the report.

*Clear communication on the functional requirements for **effective CO2 storage** is key to promote best practices in this ever-growing sector.*

Key recommendations

1/ Provide guidance on depleted hydrocarbon reservoirs, as well as in deep saline formations.
This will help avert a competent authority from 'over-interpreting' the Guidance Documents for application to depleted hydrocarbon fields.

2/ Avoid incresing or further detailing the requirements in the Guidance Documents.
This will speed up deployment and maintain the positive momentum we see today within the CO2 storage community.

3/ Engage early and often with CCS projects, enhance cooperation among stakeholders, and provide communication.
This will promote knowledge-sharing, while reducing regulatory and legal uncertainties.

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This report is the outcome of extensive and inclusive stakeholder consultation within the Zero Emissions Platform, a European Technology and Innovation Platform.
Click here to learn more about how ZEP functions.

Click to read the report

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TEN-T: multimodal transport of CO2 to storage key to Europe's decarbonisation

The current proposal from the European Commission misses a great opportunity by not including support for multiple modalities transporting CO2 to permanent storage, says Bellona.

The European Commission published its proposal for the ongoing revision of the Trans-European transport network (TEN-T) on the 16th of December 2021. The TEN-T proposal clearly identifies the need to take into account possible synergies with other networks, such as the TEN-E Regulation, in its Article 5 point (f).

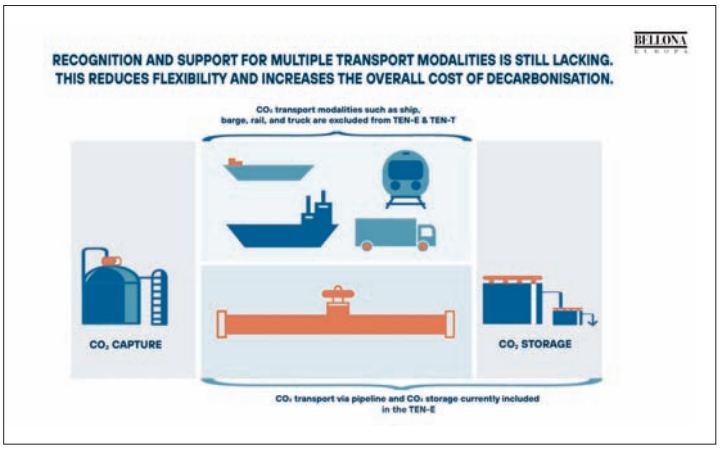
While it is still not certain where the ongoing revision of the TEN-E Regulation will land, the current proposal includes CO2 storage and transport via pipeline as eligible for Project of Common Interest (PCI) status. Eligibility for PCI status not only sends an important market signal, it can come with both administrative and financial support mechanisms depending on the scope.

Multiple transport modalities for CO2 such as ship, barge, truck and rail are not included as eligible for PCI status in the TEN-E. This sends a negative market signal which fails to reduce investor risks – a much-needed step to enable the private market and encourage first-movers.

Several planned projects for carbon capture and storage already rely on multiple modalities for part of their CO2's transportation to storage. Such mobile modalities for transport are particularly important in the initial phase of market development, given the higher degree of flexibility associated with mobile assets as opposed to immobile pipelines. Multiple transport modalities are also key to enable equitable access across Europe – including for countries with no access to storage themselves.

Bellona Europa, together with Clean Air Task Force (CATF), has throughout 2021 led the campaign #TenETuesday, focusing on the need for recognition of CO2 storage and multiple transport modalities in the TEN-E Regulation. They now continue these efforts by launching an updated campaign #TenTTuesday – focusing specifically on ensuring recognition of multiple transport modalities in the TEN-T Regulation as it has not been included in the TEN-E.

"We cannot risk this vital infrastructure falling in between two chairs, and will therefore in the coming months seek to highlight challenges facing multiple transport modalities as part of a European CO2 network, as well as opportunities. The TEN-T is one such opportunity," said Bellona.



Not only will recognition under the TEN-T optimize possible synergies with other networks such as TEN-E as outlined in Article 5 (f), it will contribute both direct and indirectly to decarbonizing the transport sector. Carbon capture and storage play a vital role in the production of low-carbon hydrogen – and is key to kick-start a market for hydrogen-derived fuels such as ammonia for sector such as marine and shipping.

Carbon capture and storage also enables industry to decarbonize at a quicker pace, reducing its reliance on renewables – freeing up low-carbon power for other applications including electrification in the transport sector.

Nearly all EU net-zero by 2050 scenarios rely on large-scale carbon capture, and storage. It is therefore important that the European Union contributes in every way possible to kick-start market development. Important steps in the right direction have been taken for CO2 storage in the TEN- E Regulation (pending final approval), as well as by recognition of multiple transport modalities' role in both the proposed revision of the EU ETS and the EU Sustainable Finance Taxonomy.

Not following through by including important recognition and support in the TEN-T Regulation for multiple transport modalities, in particular when it connects to the CO2 infrastructure category and PCIs projects already included in the TEN-E Regulation, is therefore a potential lost opportunity Europe simply cannot afford on the path to net-zero by 2050.

It is therefore our strong recommendation that the European Commission's proposal for the TEN-T Regulation is amended to include the below, in particular as it relates to optimize for synergies with the TEN-E Regulation as set out in Article 5 (f) by:

- Reduce perceived investor risks in the private market by granting PCI status to multiple modalities transporting CO2 to storage
- Enable rapid market development by administrative, permit granting and public consultations support mechanisms granted to PCI projects
- Contribute to actual project deployment by funding support offered by CEF to PCIs

Bellona and CATF ran an event as part of the #TenETuesday campaign which can be viewed online.

More information

www.bellona.org

OGE and TES combine to develop 1000km CO2 transport network

OGE and Tree Energy Solutions, which recently announced a green energy hub for importing green gas into Wilhemshaven, Germany, have entered a strategic partnership for a CO2 pipeline network.

OGE, one of Europe's leading transmission system operators, is planning to build a pipeline network to enable the transport of CO2 and to enable the reuse of CO2 in a green circular closed-loop system to transport green hydrogen. The network will at start be 1,000 km long and will enable a transport volume of around 18 million tons of CO2 a year.

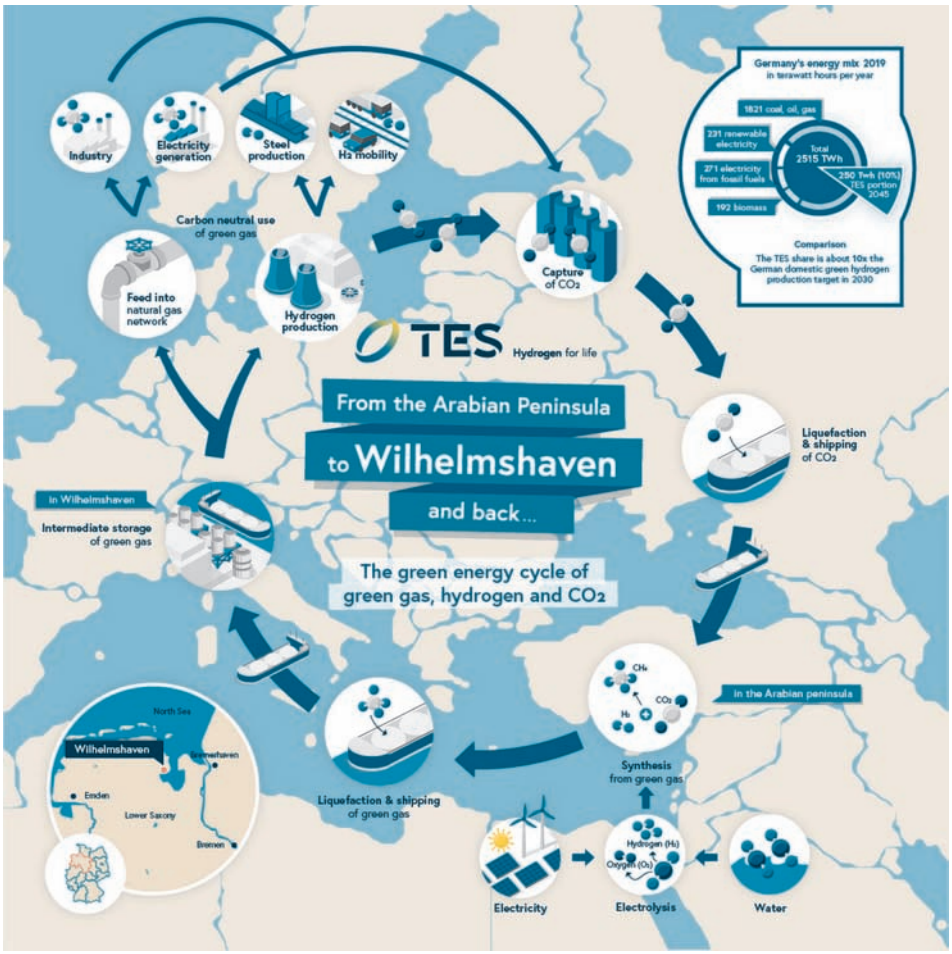
The pipeline network, starting from the green gas import terminal to be built by TES in Wilhelmshaven, will integrate important industrial, power and mobility locations around Germany. The commissioning of the first part of the network is expected from 2028.

"To achieve our climate targets, we must invest in renewable energies and above all hydrogen but also offer a solution to industries in Germany that need to capture and utilize their CO2 emissions," Dr Jörg Bergmann, CEO of OGE, says. "This requires a CO2 infrastructure. We will offer these to all interested parties openly and at standardised conditions."

OGE and TES are in conversation with German steel producers, cement/ lime producers, power plant operators and chemical plant operators to transport CO2 via the new pipeline back to the future Wilhelmshaven green energy hub. Right from the start, the transport network will be equally open to other market participants.

"The CO2 pipeline network supports the closed-loop circularity strategy, ensuring that CO2 can be kept within the TES cycle and GHG emissions are avoided," Paul van Poecke, Founder and Managing Director at TES, says. "Via this project, the CO2 will be captured and re-used in a circular closed-loop system as a carrier to transport green hydrogen or as a resource in other industries."

The carbon cycle strategy will significantly accelerate the energy transition in Germany and help the industry, power and mobility, sectors to achieve their decarbonization targets. This requires a Germany- wide CO2 strategy and corresponding instruments.



TES Green Cycle

TES also recently announced the acceleration of its announced plans to develop the German port of Wilhelmshaven into a world-scale hub for importing Green Gas. The fast-tracking will provide for alternative energy security for Germany and Europe whilst accelerating the growth of Green Gas imports over time.

With Green Hydrogen at its core, the Wilhelmshaven green gas terminal is sustainable, carbon-neutral, and transitional, meeting the German's government short term and long term energy requirements.

TES Green hydrogen will be primarily produced using solar, wind and hydro power in countries with abundant renewable energy sources, after which CO2 will be added to make green CH4 which will be used as the 'energy carrier'. This will then be transported to Wilhelmshaven utilizing a specially constructed fleet of ships. At Wilhelmshaven, the green CH4 can be converted back into green hydrogen, with the resulting CO2 being captured and returned to the producing countries by ship in a continuous closed-loop system, this way we guarantee that the CO2 never leaves the cycle and we avoid GHG emissions.

More information

www.co2-netz.de

tes-h2.com

Toward 2030: new pathways to CO2 capture

CARMOF, MEMBER and MOF4AIR are three European-funded projects geared to demonstrate innovative CO2 capture technologies in real industrial conditions. Promising new material solutions are under development for the next generation of CCUS technologies that are expected to reach the markets in the next few years.

The CARMOF project group has come together under the umbrella of the Horizon Results Booster programme (HRB) of the European Commission to jointly collaborate on addressing common goals toward the 2050 targets of reducing CO2 emissions in energy-intensive companies.

The cost and energy requirements of CO2 capture must be further reduced to make it more attractive as an emissions reduction pathway. To meet the European climate objectives for 2030, more operational CCUS projects at commercial scale are needed in a short timeframe. Commercial technological solutions exist and will need to be deployed. However, technological development is essential to reduce the cost and energy requirements of CCUS and make it more attractive as an emissions reduction pathway.

A policy brief aims at formulating recommendations that are deemed essential for the development of CCUS solutions in Europe, to ensure CCUS can play its role in the reduction of CO2 emissions by carbon intensive industries.

Recommendation 1: Include provisions for key technological advancements in the future roadmap for CO2 capture technology

Technological advancements are needed for process intensification, modularisation, and cost-effective, upscalable materials as they can reduce the cost and energy demand of the CO2 capture process by process intensification.

Technology development and the identification of suitable capture technologies for a specific industrial application should be guided by considerations of accessibility to clean and sustainable energy sources and the potential for heat integration at the plant site.

In addition, large-scale and long-term demonstration of the developed technologies is needed to go to the market. Policymakers can promote these needed advancements by including support for them in future calls on the European research roadmap.

Recommendation 2: Provide investment incentives to increase the manufacturing readiness levels of the CCUS industry

Manufacturing readiness and producibility are as important to the successful development of a system as the technologies intended for the system. Therefore, support for the improvement of manufacturing readiness levels should be provided together with the technology advancement to facilitate the supply chain development for the replication at large scale of the successful technology and the go-to-market strategy.

Recommendation 3: Provide financial support for the formation of industrial CCUS clusters

National, local and EU government financial support is currently being given (e.g., Northern Lights project, Porthos) but government-backed loans and grants for developing shared CO2 transport, storage and/or (local) CO2 utilisation infrastructure are currently insufficient to promote industrial clustering and fill the cost-revenue gap to address the full scale of the global challenge (e.g., the EU Innovation Fund is oversubscribed by a factor of 20 times).

Recommendation 4: Support CCUS through regulatory and strategic policy

The adjustment of the regulatory context will be important to frame the development of CCUS technologies and infrastructures in the coming years, and remove barriers to the important role CCUS can play in CO2 emissions mitigation. In particular, a European strategy and policy for carbon capture, transport, storage and utilisation is needed that coordinates with regions and member-state strategies and policies.

This involves incentives for the proactive development of strategic CO2 transport and storage infrastructure solutions, including highways, railways, pipelines, and shipping infrastructure. In addition, regulatory instruments such as incentives to promote the use of captured CO2 for new products, carbon taxes on direct CO2 emissions as well as taxes taking into account the carbon footprint of a product throughout its lifetime should be further implemented to make CCUS more competitive.

Recommendation 5: Boost the social acceptance of CCUS technologies

Overcoming negative perceptions of CCUS technologies in local societies is crucial to develop CCUS solutions4. Public engagement should be fostered through various instruments such as public consultations, formation of local groups interacting with authorities, and financing for public awareness-raising activities such as site tours, websites, and media releases. Public debate forums should be provided for discussion of the European Strategy for CCUS, both at national levels and then at local levels.

Technical and safety specifications (e.g. environmental and hazard studies) should be financed ahead of CCUS projects to foster acceptance and trust. Local communities should be invited to participate in the technical specification of, e.g., storage sites, in order to engage them in issues of critical interest to them such as leakage and environmental impact.

More information

www.carmof.eu

www.member-co2.com

www.mof4air.eu

EMEA news

LEILAC 2 project to proceed at HeidelbergCement's plant

www.project-leilac.eu

By 2025, the facility aims to capture 20% of the cement plant's carbon emissions, corresponding to around 100,000 tonnes of CO2 annually.

The LEILAC 2 (Low Emissions Intensity Lime And Cement) carbon capture project has successfully passed its Financial Investment Decision milestone, confirming that the project can now enter the implementation phase. Together with the Australian technology company Calix and a European consortium, HeidelbergCement will proceed to build a demonstration facility integrated into HeidelbergCement's plant in Hanover, Germany. The installation will be capable of capturing 20% of the cement plant's CO2 emissions, corresponding to around 100,000 tonnes of CO2 per year.

"LEILAC 2 is one of several carbon capture projects we are currently pursuing at HeidelbergCement," says Dr. Dominik von Achten, Chairman of the Managing Board: "We are very pleased to advance this key technology at industrial scale at our plant in Hanover, Germany. The location is ideally suited for further utilisation and/or transport to offshore storage of the captured CO2." The company targets CO2 reductions of up to 10 million tonnes with several CCUS projects already underway by 2030.

As part of the prior LEILAC 1 project, a CO2 capture pilot installation with a capture capacity of 25,000 tonnes of CO2 per year had been developed at HeidelbergCement's Lixhe plant in Belgium. With LEILAC 2, an installation around four times as large will be operated in Hanover. The project now enters the detailed design phase through 2022, followed by procurement and construction of the plant itself.

Construction is expected in 2023, dependent on flag points over the coming months. The project scope for LEILAC 2 also includes a thorough analysis of the potential destination of the captured CO2, either for utilisation purposes or for safe geological offshore storage.

With the patented LEILAC technology, the CO2 released during cement production can be captured in a highly pure form via a separate waste gas stream and used in other processes. As minimal additional energy is needed and no chemicals are required, this happens in an especially cost-efficient way. The technology can also be retrofitted in a modular form at any scale and use any fuel or energy source, including biomass, hydrogen, or electricity – providing a 'future proof' solution.

TotalEnergies begins "3D" Carbon Capture Pilot

www.totalenergies.com

The "3D" industrial pilot to demonstrate an innovative process for capturing CO2 from industrial activities is now running at ArcelorMittal's Dunkirk site.

With support from the European Union's Horizon 2020 Research and Innovation program, the project aims to validate replicable technical solutions for carbon capture. The "3D" project, a collaboration by a consortium including TotalEnergies, ArcelorMittal, Axens and IFP Energies Nouvelles (IFPEN), is a major step towards decarbonizing industries that are highly emissive of CO2, such as steelmaking.

The challenge for carbon capture researchers is making the processes more competitive and less energy intensive. This industrial pilot should allow the performance of the DMX™ carbon capture process developed in IFPEN's labs over the last ten years to be verified.

The project was launched in May 2019, and the building of the demonstrator began in 2020 under Axens' supervision. Last December, the pilot's main modules, including a 22 meter tower, were delivered and assembled at ArcelorMittal's site in Dunkirk. The phases of building the pilot and connecting it to the plant have now been completed, and the unit is ready for start-up.

This demonstration, which is scheduled to last for 12 to 18 months, is the final stage before the technology's full-scale deployment.

The carbon capture facility will process steelmaking gases: it will demonstrate the effectiveness of the carbon capture process by separating the CO2 from other gases. During the demonstration stage, it will capture 0.5 tons of CO2 an hour, i.e. more than 4,000 tons a year.

World Cement Association call for action in MENA region on decarbonisation

www.worldcementassociation.org

The World Cement Association is calling on cement companies in the Middle East and North Africa (MENA) to take action, as the world's attention is set on decarbonisation efforts in the region in light of upcoming COP27.

COP27 is to be held in Sharm-el-Sheikh, Egypt and 2023's COP28 in Abu Dhabi, UAE. All eyes are on the commitments and actions of the region's oil and gas sector; however, cement manufacturing in MENA is also significant, making up around 15% of the world's total production.

The first steps are being made, with the UAE, India, UK, Canada and Germany launching the Industry Deep Decarbonisation Initiative at COP26 in 2021. Nevertheless, there has been limited progress to date across the MENA region on decisive emissions reductions, with many pledges insufficient to reach a warming limit of 2°C. Only the UAE and Saudi Arabia have made net zero pledges of 2050 and 2060 respectively, according to the Climate Action Tracker.

WCA sees this as an opportunity for cement producers across MENA to take the lead and embark on their decarbonisation journeys today, which will both contribute to emissions reductions and save on operational costs, including energy and fuel. Indeed, consulting group and WCA member A3 & Co., based in Dubai, UAE, estimates that there is potential for companies in the region to reduce their CO2 footprint by as much as 30% with no investment required.

"There has been a lot of discussion in Europe and North America about decarbonisation roadmaps for the cement industry and good work has been done to start on this journey. However, 90% of the world's cement is produced and used in developing countries; to impact overall industry emissions we must include these stakeholders. Cement companies in the Middle East have some low hanging fruit to take advantage of, which will lower costs at the same time as reducing CO2 emissions. At WCA we have a number of programmes that can help them realise this opportunity," CEO of WCA, Ian Riley stated.

CCS in the latest IPCC report "Mitigation of Climate Change"

In a Brief for the Global CCS Insitute, Noora Al Amer, Senior International Climate Policy Advisor takes a look at the Intergovernmental Panel on Climate Change Working Group III (WG3) Report. The message of the report is clear she says: the time for action is now.

WG3 is the chapter directly related to CCS, where the Global CCS Institute has correspondingly participated in the submissions of two rounds of comments in the process of the report's writing, says Ms Al Amer.

To echo the IPCC, the next few years are critical, she says. The message of the report is clear: the time for action is now. Global GHG emissions need to peak between 2020 or at the latest before 2025 to limit warming to 1.5°C, and this will require major transitions in the energy sector.

To limit warming to 1.5°C with no or limited overshoot involves rapid, deep and largely immediate GHG emission reductions in all sectors. Compared to the Special Report on 1.5°C, WG3 brings to the table the assessment of near term (to 2030) future pathways to join medium term (up to 2050) and long term (to 2100) timescales.

This sets the stage for urgent mitigation action needed this decade, for which CCS is one of the main deep decarbonisation options. Correspondingly, CCS is included in almost all of the mitigation pathways to limit warming to 1.5°C.

Reducing emissions across the full Energy sector requires major transformation, where the transition to fossil fuels with CCS is now more necessary than ever. Current fossil fuel infrastructure will need to be either retired early, used less, or retrofitted with CCS to contribute to aligning future CO2 emissions from the power sector. The report clarifies that CCS will allow fossil fuels to be used longer, thereby considerably reducing the potential for stranded infrastructure assets.

The mitigation potential in the Industrial sector differs depending on the subsector and the availability of CCS, where the largest potential reductions are found to be in the manufacture of cement and steel. Similar to energy, asset stranding also features as a looming risk in these industries, where blast furnaces and cement factories without CCS could face stranding under strong climate policy. For many existing cement and steel plants, the lowest cost, fastest and largest potential for abatement path is shown to be through retrofitting CCS.

In a growing world with growing needs, a conscious and comprehensive technological approach that includes CCS will enable us to deliver the action required to strengthen the global response to climate change needed today, she concludes.

Key Takeaways from the Report

- Carbon capture and storage is an option to reduce emissions from large-scale fossil-based energy and industry sources, provided geological storage is available
- The technical geological CO2 storage capacity exceeds the CO2 storage requirements through 2100 to limit global warming to 1.5°C, although regional availability could be a limiting factor
- If geological storage sites are appropriately selected and managed, CO2 can be permanently isolated from the atmosphere
- CO2 capture and subsurface injection is a mature technology for gas processing and enhanced oil recovery
- Compared to the oil and gas sector, CCS is less mature in the power sector as well as cement and chemical production, where it is a critical mitigation option
- Current global rates of CCS deployment are far below those in modelled pathways to limit global warming to 1.5°C or 2°C
- CCS implementation currently faces technological, economic, institutional and ecological-environmental and socio-cultural barriers
- Policy instruments, greater public support and technological innovations could reduce barriers to CCS deployment
- Government policy instruments for CCS include financial instruments such as emission certification and trading, legally enforced emission restraints, and carbon pricing
- When CO2 is captured directly from the atmosphere through Direct Air Carbon Capture and Storage (DACCS) or from Bioenergy with Carbon Capture and Storage (BECCS), CCS provides the storage component of these carbon dioxide removal (CDR) methods
- While the future of hydrogen (H2) is still uncertain, CCS may kick-start the H2 economy, through fossil fuels reforming with CCS "blue"sources.

More information

Read the full report:

www.globalccsinstitute.com

Wide array of governments include carbon management in climate commitments

New analysis from Clean Air Task Force (CATF) finds that both developed and developing countries plan to use advanced low-emission energy and climate technologies like carbon management, hydrogen, and nuclear energy to meet their climate goals.

The finding underscores the importance of increasing funding and advancing research, government support, and international collaboration to commercialize these technologies quickly, says the report.

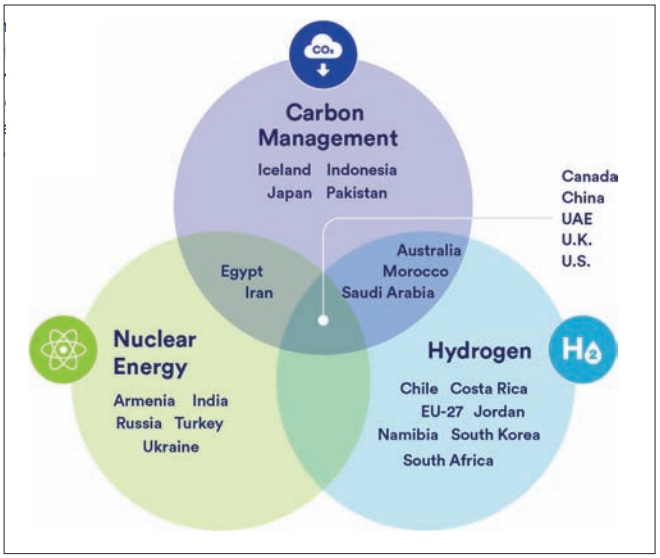
"There is growing consensus around the world that full decarbonization will require an expanded suite of critical carbon-free technologies," said Stacey Davis, Climate, Technology, and Innovation Policy Director at CATF. "This new analysis from CATF shows a significant appetite for advanced climate solutions, and should serve as a demand signal for institutions funding decarbonization efforts around the world."

The report, "NDC Assessment: How Do Advanced Low-Emission Energy and Climate Technologies Factor into Nationally Determined Contributions?", summarizes the results of CATF's review of 42 Nationally Determined Contributions (NDCs). It documents which countries and governments plan to rely on carbon management technologies like carbon capture, utilization, storage and direct air capture, zero-carbon fuels like hydrogen and ammonia produced using low-carbon methods, and nuclear energy to reach their goals under the Paris Agreement.

The assessment shows that there is substantial interest in nearly every region of the world to deploy and prove out advanced low-emission energy and carbon management technologies in different contexts and for different applications. Canada, China, UAE, the UK and the U.S. all plan to use all three technology areas as part of their climate plans.

"Each country is unique in terms of its economy, its geopolitical positioning, its geology, its climate, and its stage in the decarbonization process, and each will chart its own course to net-zero emissions. It's noteworthy, however, how much each of these assessed NDCs have in common."

"With each of these countries planning to rely on some form of advanced low-emission energy and climate technology, and with the IPCC and IEA acknowledging the importance of these technologies to a net-zero future, there should be no doubt as to the imperative of investing globally in research, demonstration, and development to ensure we can commercialize and rapidly deploy these solutions at scale."



Venn diagram showing national interest in carbon management, zero-carbon fuels (e.g., hydrogen) produced using low-carbon methods, and/or nuclear energy technologies

Under the Paris Agreement, each participating country agrees to prepare, communicate, and maintain successive nationally determined contributions that it intends to achieve — representing its highest possible ambition reflecting common but differentiated responsibilities and capabilities and considering national circumstances.

Of the 42 NDCs included in the assessment, 14 include the use of carbon capture, utilization and storage: Australia, Canada, China, Egypt, Iceland, Indonesia, Iran, Japan, Morocco, Pakistan, Saudi Arabia, United Arab Emirates (UAE), United Kingdom (U.K.), U.S.

Many of these countries may anticipate using carbon capture, utilization and storage to manage carbon emissions from ongoing use of fossil energy production or power generation, but only Pakistan, UAE and the U.S. allude to such applications.

Some countries expect to use carbon management in concert with hydrogen production (Australia, Saudi Arabia, U.K., U.S.). Canada, China, Iceland, Indonesia, Morocco and the U.S. will use carbon management to prevent industrial and/or industrial process emissions. Moreover, Saudi Arabia is developing carbon capture, utilization and storage hubs aiming to support a circular carbon economy across its industrial sectors, and UAE is expanding on existing industrial applications.

Canada (British Colombia) and Iceland are looking at carbon management to advance net-negative emissions. Only Saudi Arabia makes explicit mention of direct air capture in its NDC, though others like Australia may highlight the technology in documentation referenced in their NDCs.

More information

Read the full report:

www.catf.us

UK "needs to plan post 2030" - CCSA

The UK needs to start thinking about the next set of carbon capture and storage projects beyond 2030 because it takes so long to plan them, particularly storage sites. The Carbon Capture and Storage Association (CCSA) shared its modelling and thinking in a webinar. By Karl Jeffery.

The UK carbon capture and storage industry is working towards the UK government's goal, set in October 2021, to store 20-30m tonnes CO2 a year by 2030. But the government also set a goal to store 'at least' 50m tonnes CO2 a year by 2035 – and it is time to start working on projects now, said Ruth Herbert, CEO of CCSA, speaking at a webinar on March 29.

CCSA has consulted with its members and put together a delivery plan, aiming for between 50m and 70m tonnes a year CO2 storage by 2035.

It analysed the projects currently under development, to see what they could store by 2035. Then it explored what would additionally need to happen, and when, to achieve this 2035 goal.

The analysis found that the current pipeline of UK projects can "just about" meet the 2035 target, but only if there is no attrition (projects being cancelled). So, unless further projects are started now, there may be something of a scramble in the 2030s to achieve the 2035 goal.

There were estimates that 70m tonnes a year CO2 storage was possible by 2035, but only if sufficient storage capacity is licensed, the investment framework is there, and the capture and transport network can expand.

In terms of CO2 sources, CCSA expects that there will be much gas power generation with CCS attached, generating low carbon electricity, which could then be used to decarbonise other areas of energy use.

There could be a demand from companies outside the UK for CO2 storage sites, with CO2 being delivered by tanker. This could start in the "early to late 2020s," she said.

All the building blocks need to be in place at the right time, including the investment framework, the delivery of CCS clusters, and infrastructure for capture, transport and storage. There may also need to be more technology development, she said.

"We need to be thinking about what the long term framework is, get the business model right" - Ruth Herbert, CEO of the Carbon Capture and Storage Association

Storage

Ms Herbert says she has been asked "a million times" if the UK has enough storage space, and her answer is, "we've got lots of storage potential, but it takes time to get it ready."

The currently licensed storage space will run out, if CCS is deployed at the recommended build out rate. But it can take 6-8 years to get a permit for another storage site, including all the necessary geological studies, and going through a process with the regulator.

There are more storage sites in the pipeline, but which are not yet licensed. "We need to get cracking with those now," she said.

Developing storage sites is similar in many ways to oil and gas exploration, in that people need to identify sites and work out how to connect them to a market.

A difference is that the 'market' for CCS is people who have CO2 which needs storing, not people who want to buy hydrocarbons.

Other hurdles and drivers

There are many other hurdles to overcome in getting projects underway, such as local planning requirements, and it is important that these are well understood, including by the national government.

To keep investors engaged, Ms Herbert suggested that a steady schedule of government contract allocation rounds would be useful, as was seen in the offshore wind sector. "Government must provide certainty on frequency and volume of future contract awards for future capture, transport and storage projects," she said. And "we want to know when the next cluster is coming forward."

"No-one is asking for 100 per cent guarantees, they are just asking to understand the odds, the volumes to be allocated and when. I think that is fundamentally the most important thing."

Other actions which may help CCS move faster include getting consensus on the UK's strengths, in terms of product and skill areas,

so they should be prioritised for investment; setting policy and regulation to incentivise UK content; accelerating people's entry into the CCS workforce; accelerating permitting and construction of infrastructure; and establishing a strategy to support national, cluster and project level communications, she said.

Questions

Alex Cunningham, chair of the UK government All-Party Parliamentary Group for CCUS and Labour MP for Stockton North, County Durham (NE England), asked Ms Herbert, "how ambitious do you think we have a right to be?"

"That's a very good question, she replied." I think overall - the net zero target for 2050 itself is an ambitious one, that is going to require a combination of technologies. The more ambitious we can be in CCUS the more we will be able to deliver."

Ms Herbert was asked if the UK should follow EU Storage Directive rules for CO2 storage, which may help it win business to store CO2 from Europe. She replied that the UK had been involved in drafting the EU Storage Directive, as an EU member at the time.

"The EU Directive is what we thought, in the UK, was the right way to do it. [After Brexit] we transposed it into the UK. At the moment we're totally aligned. I think it's quite useful to be aligned."

One audience member asked about what should happen with CCS beyond 2035, perhaps moving the CCS industry to being more market driven rather than government funding driven.

"We need to start those conversations now [about] what drives commercial investment," she replied. "We need to be thinking about what that long term framework is, get the business model right. It has been quite difficult getting [people] to talk about that."

Ms Herbert was asked if she envisages a future where all the output of the North Sea oil and gas operators is decarbonised, such as by converting their gas into hydrogen with carbon stored. All the clusters have some kind of hydrogen network associated with them, she replied. "I definitely see that's the way."

Although for power generation, it is not yet clear whether it is better to reform gas to make hydrogen with CCS and burn the hydrogen in a power station or burn gas in a power station with CCS downstream.

"I think we need all these technologies, whether it's a CO2 pipeline or a hydrogen pipeline," she said.

Ms Herbert was asked how CO2 emitters based inland could capture their CO2, if it is hard to connect them to a pipeline. She replied that the CO2 could be transported by road, rail or barge. "I think there's quite a lot of work to do that.".

Mr Cunningham, the MP for Stockton, noted that in the past coal was sent by barge from coalfields in the North of England to power generation sites in London; now we may see CO2 sent by barge from power generation in London to storage sites in the North.

More information

You can view the video and slides:

www.ccsassociation.org

UK Government invests £375m in CCUS and hydrogen

It includes £240 million to support the production of hydrogen, £2.5 million to develop next-generation nuclear technology and a further £5 million towards research into carbon capture.

This follows the announcement of the 'British energy security strategy' which sets out how Great Britain will accelerate the deployment of wind, new nuclear, solar and hydrogen, whilst supporting the production of domestic oil and gas in the nearer term – which could see 95% of electricity by 2030 being low carbon.

The Carbon Capture and Storage Association (CCSA) welcomed the strategy, which it said reaffirmed the Government's commitment to delivering 4 CCUS clusters by 2030 and set out new commitments to accelerate deployment of low-carbon energy sources – to deliver a decarbonised electricity system by 2030, including 10GW of low carbon hydrogen.

The new support includes £5 million for accelerating Carbon Capture and Storage Technologies under the ACT 3 scheme. ACT 3 is an international initiative between 14 countries worldwide including the UK, aimed at accelerating CCUS technologies through funding research and innovation projects and the funding will support the commercialisation of the technology so that companies in the UK can invest in it.

In addition to these investments the Government is also publishing a Hydrogen Investor Roadmap and a CCUS Investor Roadmap, which summarises the current engagement of government and industry, outlining further opportunities to deliver CCUS and drive investment.

The response to a consultation on a Low Carbon Hydrogen Standard, with the intention of setting a maximum threshold for greenhouse gas emissions allowed in the production process for hydrogen to be considered low carbon under the Net Zero Hydrogen Fund and hydrogen business model will also be published.

Olivia Powis, Head of UK Office at the CCSA, said, "The Energy Strategy emphasises the key role that CCUS and hydrogen will play in delivering a net zero electricity system and Government has responded by doubling their hydrogen target to 10GW. With up to 5GW of this being provided by blue hydrogen, it is clear that CCUS is central to decarbonising the energy sector. As the IPCC concluded in their report this week; if we are to meet Paris Agreement goals and avoid stranded energy assets, CCUS is crucial."

Report sets priorities for UK CCUS supply chain

Urgent action is needed to increase UK content in the emerging carbon capture sector, according to a new report published by the Nuclear AMRC.

The new CCUS supply chain intervention strategy was published on behalf of the CCUS Council, the government-backed group for engaging and steering the UK's carbon capture, usage and storage (CCUS) sector.

The report, led by the Nuclear AMRC as part of the High Value Manufacturing Catapult, concludes that there is a significant opportunity to increase UK manufactured content in the CCUS sector, contributing to economic growth and creating export opportunities while helping to achieve the UK's transition to net zero greenhouse gas emissions. It draws on existing market research, and adds new analysis on the UK manufacturing supply chain's capability and readiness to support this rapidly growing market.

With targeted development, UK manufacturers can supply all parts of a carbon capture plant. However, the UK needs to act quickly to establish its capability, competence and capacity in domestic projects if the national supply chain is to drive down costs and compete in the much larger global market.

To ensure the supply chain is ready to support CCUS deployment to meet government targets for 2035 and beyond, the report recommends the establishment of a Fit For CCUS (F4CCUS) programme. Based on the Nuclear AMRC's established Fit For Nuclear and Fit For Offshore Renewables programmes, F4CCUS would strategically develop existing manufacturing businesses to match to CCUS sector requirements.

"If we are to exploit domestic and international opportunities, we must act now to ensure the UK supply chain is fit and ready to deliver for the national developments," said Andrew Storer, CEO of the Nuclear AMRC. "We really hope the results can inspire a coherent overall approach to CCUS supply chain initiatives, ensuring the UK delivers CCUS to help achieve net zero and provide significant economic impact in key regions in the UK. Therefore, we recommend launching the F4CCUS programme to enable the UK supply chain to seize the opportunity."

Priority actions

The recommendations for specific interventions during 2022 to develop the manufacturing supply chain for CCUS are:

- Strategic sector engagement to develop close working relationships with CCUS developers and main manufacturing contracting organisations. This will support new product introduction and supply chain readiness activities associated with UK manufactured content.
- Assisting and advising effective demand-based supply chain engagement and associated procurement strategies in the manufacturing sector.
- Identification of wider CCUS plant, system and component requirements to enable more comprehensive readiness assessments of UK manufacturing supply chain capability and capacity.
- In-depth assessment of HVM Catapult supplier and supply chain development tools, creating a one-stop shop for industry support. This includes CCUS-focused supplier development activities through the proposed Fit For CCUS programme and SCRL assessment.
- Deployment of standardised approaches and capability tool sets for information intelligence management, already available through HVM Catapult and partner networks.

The report is the first key output of the CCUS Council's supply chain working group, chaired by Dame Judith Hackett.

"This report clearly shows the scale of opportunity for UK manufacturing in the supply chain for CCUS, but if we are to make the most of it we must act quickly to raise awareness and build capability and capacity," Hackett commented. "We need clear signals from Government to create confidence and this can be done by backing the proposal to establish a Fit For CCUS programme."

Energy and Climate Change Minister Greg Hands said: "I welcome this report which outlines the opportunities presented by CCUS technologies for supply chain companies, creating economic growth and export potential, while helping achieve the UK's commitment to net zero."

James Smith CBE, co-chair of the CCUS Council, said: "We need an ambitious vision for a low carbon industrial revolution, creating tens of thousands of skilled, satisfying and well-paid jobs throughout the UK. Time is of the essence to grasp this unique chance to be world leaders in crucial low carbon technologies."

Ruth Herbert, CEO of the CCSA trade association, said: "We are entering a critical period for CCUS deployment and the recommendations in today's report build on the CCSA's report Supply Chain Excellence for CCUS, setting out further details on how the UK can maximise the significant economic opportunities that a strong CCUS industry represents.

"The UK has unique advantages, skills and expertise – in both CCUS and hydrogen – and as the first CCUS clusters move ahead, there is not a moment to lose if the UK supply chain is to capture its share of this vital net-zero industry."

More information

namrc.co.uk

www.ccsassociation.org

Urgent scale up of negative emissions markets needed to meet Paris pledges

In its report, Delivering the 'Net' in Net Zero, the Coalition For Negative Emissions calls for action to develop and scale a robust carbon removals market.

There is a clear consensus around the need to develop a global CO2 'negative emissions' (NE) industry that delivers permanent carbon removals to balance emissions from hard-to-abate industries, stabilise global CO2 levels, and address historic emissions, says the report.

Recent forecasts from the Intergovernmental Panel on Climate Change (IPCC), which cast doubt on our ability to remain within the Paris target of 1.5 degrees global warming, add to the urgency to develop the negative emissions market as one of the few ways we can stay within those climate ambitions when coupled with robust emissions reduction programmes. In recent forecasts, the IPCC state that engineered removals of CO2 may need to range from 3,500 to 16,000 metric tons of carbon dioxide equivalent (MtCO2e) a year by 2050.

At either end of that envelope, negative emissions need to scale up significantly, and that process needs to start now. Technologies to deliver negative emissions do exist, and their costs will fall materially through investment, scale, and R&D. But currently, the biggest barriers to deploying engineered removals are commercial and financial, where we lack the business models, agreed standards, regulations, and demand from confident purchasers or governments to underpin a nascent market.

Despite these constraints, it is encouraging to see the UK Government supporting the negative emissions industry by enabling CO2 transport and storage networks; funding early innovation projects; developing the bioenergy with carbon capture and storage (BECCS) business model; exploring the inclusion of negative emissions in the UK emissions trading scheme (ETS); contributing to the monitoring, reporting and verification of greenhouse gas (GHG) removals; and developing the Voluntary Carbon Market initiative, which are all discussed in the report. In addition, several governments and regional partnerships have signalled their long-term support for negative emissions, including:

- The UK Government's ambition to deploying at least 5 million tonnes per annum (mpta) of engineered removals by 2030.

- The European Union's ambition to deploy at least 5 mtpa of negative emissions by 2030.

In the report, the Coalition outlines:

1. The urgent need to accelerate a robust negative emissions market;

2. Three pillars of support required, i.e., voluntary, regulated and government-supported markets;

3. Challenges to scale the negative emissions markets; and

4. The role of the Coalition in navigating global initiatives, regulations, and standards, and providing industry insight.

About the Coalition

The Coalition for Negative Emissions (CNE) is a growing industry body of negative emissions project developers, potential CO2 capturers, companies who may look to purchase negative emissions to mitigate their emissions, and companies critical to the supply chain, as well as other industry supporters who are aligned with the aim of accelerating the development of a negative emissions market.

The coalition members commonly agree:

1. All businesses must have a clear plan to reduce carbon emissions and decarbonise their operations.

2. To stay within the Paris Agreement target of less than 1.5 degrees of global warming will require not only huge reductions in emissions in the next decade, but also substantial negative emissions which deliver permanent carbon removals for areas that are prohibitively expensive or impossible to decarbonise quickly.

3. Investing in negative emissions will allow visionary companies to become either carbon neutral or net negative within the next decade and allow companies with impossible-to-reduce emissions to become carbon neutral.

4. Private sector participation in negative emissions markets will help provide the funding to ramp up the infrastructure needed to deliver permanent carbon removals.

5. Companies have a crucial role to play in meeting carbon targets: the more companies that invest in negative emissions to achieve their Net Zero targets early and proactively, the greater the likelihood we have of staying within 1.5 degrees.

6. Investors need the confidence that carbon removals are high quality, verifiable, permanent, and additional.

7. Robust standards and business models are needed to underpin this developing market.

More information

Read the full report:

coalitionfornegativeemissions.org

CCS service spending to total more than $50 billion globally by 2025

Service sector spending on CCS developments is set to quadruple from 2022 to 2025, with cumulative global expenditure over the next three years topping $50 billion, according to Rystad Energy research.

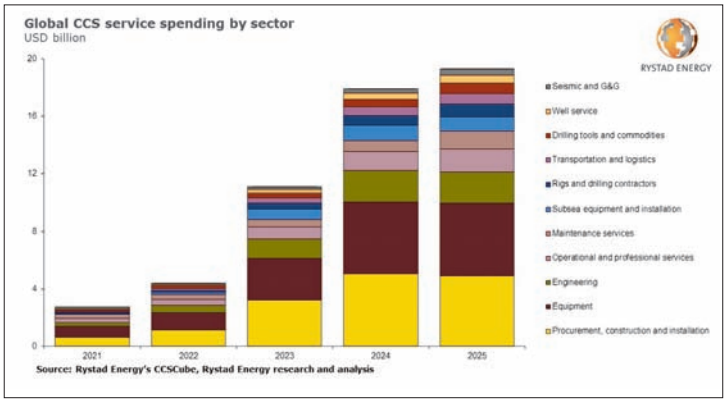
Total spending for announced commercial projects in 2022 is projected to hit $4.4 billion, up from $2.8 billion last year. Outlay is then expected to nearly triple in 2023, topping $11 billion for the year. Projections show 2024 and 2025 will see an additional $18 billion and $19 billion, respectively, bringing the projected total to $52 billion by the middle of the decade. These totals only include announced projects, assuming all projects move ahead as planned, and do not account for pilot or demonstration-only developments.

The cash will be spent on a broad range of services related to the installation of the capture unit, transportation of the carbon dioxide and storage. Europe and North America will drive spending, with 63 out of the 84 announced commercial CCS projects expected to start operations by 2025 situated in these two regions.

"CCS technology is viewed as a fundamental component of the societal decarbonization required for a successful energy transition. Although the technology dates back to the 1970s, the number of CCS project announcements has surged in the last two years, and service sector spending is expected to go through the roof in the coming years as a result," says Lein Mann Hansen, Rystad Energy senior analyst.

There are 56 commercial CCS projects already in operation globally, capable of capturing up to 41 million tonnes per annum (tpa) of CO2 across various industries. Based on already announced projects, nearly 140 CCS plants could be operational by 2025, capturing at least 150 million tpa of CO2 if all projects move ahead as scheduled. These projects are currently in various stages of development, including feasibility, concept and construction.

Almost two-thirds of the total service spending will go towards equipping the facility with the CO2 capture component and maintaining operations. Engineering, procurement, construction and installation (EPCI) costs will be the primary driver of spending, contributing about $35 billion to the $55 billion total by 2025. Annual EPCI spending will hit $12 billion in 2025, a more than 300% increase from the $2.8 billion projected for this year.



Transportation – which follows capture of the CO2 – will require service purchases worth $8.5 billion through 2025. CO2 can be commercially transported in gas and liquid form to the storage area using pipelines, trucks and ships. Within each project and depending on the transport distance and location of the target storage location, the mode of transportation can vary. Pipelines are widely used to transport CO2, and there are 51 operational onshore pipelines, 38 of which are located in North America.

Onshore storage is currently the dominant mode of storage since it is cheaper and less complex. However, there will be an uptick in the number of offshore storage sites driven by Europe, including the Netherlands and the UK, in the coming years. There are five operational offshore pipelines, but the number could increase to 50 once the under-construction and planned projects with an offshore storage site become operational.

Additional capital will, therefore, be required to lay the necessary subsea pipelines to transport the CO2 to the storage site. This will lead to growth in the subsea pipeline, shipping and offshore installation segment in the coming years. Trucks can be used to transport small amounts of CO2 and have the flexibility to collect from and deliver to several locations. Trucks are widely used in countries such as China.

The third and final step in most cases is storage. The process starts with identifying the potential storage location and is followed by drilling wells for injection and monitoring purposes, with associated drilling tools and oil country tubular goods (OCTG) then required. The storage process will incur at least $9 billion in service purchases through 2025.

The majority of these new additions will stem from Europe and North America, which account for 85% of the service purchases expected through 2025. The European market will account for more than 50% of the purchases despite having almost the same number of projects in the pipeline as North America. This is because many of the new upcoming projects in Europe will store CO2 offshore. Offshore storage is more expensive as it requires, for example, laying subsea pipelines for transport using pipelaying vessels, offshore rigs operating at higher rates to drill injection wells, and is coupled with higher labor rates in the region.

The growth in Europe is fueled by high European Union Emissions Trading System (EU ETS) prices along with favorable carbon policies and support for CCS projects. The North American CCS landscape is continuing to gain momentum with multiple projects announced in the US and Canada, driven by national incentives and funds supporting the technology.

More information

www.rystadenergy.com

IEEFA: widespread adoption of CCUS in South East Asia unlikely

CCUS is increasingly attracting attention in South East Asia, however in the absence of the right drivers, its prospect in the region remains questionable.

With very little carbon emissions' valuations, public funding support, and market drivers to support CCUS development, widespread CCUS adoption in South East Asia remains unlikely in the near future according to IEEFA's latest report, "Carbon Capture in the Southeast Asian Market Context: Sorting out the Myths and Realities in Cost-Sensitive Markets."

"CCUS can be viable when placed under a certain operational context, such as a high carbon price environment with a strict emissions regulation, but the same technology could be far from ready in more cost-sensitive markets with lax emissions control," says IEEFA Energy Finance Analyst Putra Adhiguna, author of the report.

CCUS costs range widely from sub-US$50 to more than US$100 per tonne of captured carbon dioxide (CO2). There is no dodging the big question that CCUS costs need to be reconciled, as someone in the value chain will need to internalize the costs, Adhiguna adds.

"With the exception of Singapore, a carbon price is largely non-existent in the South East Asian market, yet CCUS essentially represents a 'tax' to continue emitting carbon," says Adhiguna.

Reality check: CCUS for processing gas, not power generation

Adhiguna outlines three CCUS applications, which currently dominate the discussions in South East Asia: gas processing, industries/product based CCUS for hydrogen and ammonia exports, as well as potential future usage in the power sector. Current global CCUS capacity is around 40 million tonnes per annum (MTPA) of CO2 captured. In more than 70% of existing CCUS facilities, the captured CO2 is utilized to help increase oil and gas production.

Three quarters of the CCUS project pipeline in South East Asia is to capture excess CO2 from the processing of gas as they are produced from the ground.

The uniqueness of CCUS is its ability to be retrofitted into existing power and industrial assets. Nevertheless, "While the public may be captivated by the imagination of coal or gas power with little-to-no emissions, current plans are traveling in a different direction," says Adhiguna.

More than 60% of the current CCUS capacity deployed globally is applied for gas processing, not for power generation. In fact, only one commercial power generation CCUS is operating in the world at present, one for coal and none for gas. Gas processing CCUS has been applied since the 1970s and costs much less than power generation CCUS.

"The recent uptick in South East Asia's CCUS discussions is largely a form of catching up on the past trend, potentially anticipating possible changes in market attitudes towards CO2-rich gas," Adhiguna observes.

Be mindful of the burgeoning price tag: who is paying?

In the case of CCUS for power, Adhiguna finds that the often-cited claims of a continual cost decline of CCUS for power could muddle understanding, as they are largely based on studies. The indefinite closure of the United States' sole power generation CCUS project in 2021 due to economic reasons after only three years in operation further raises questions.

The line between technical and commercial readiness of CCUS in power should not be blurred, especially when most existing projects have been scaffolded by significant public funding.

"The United States has spent at least US$1.1bn of public funds to support power and industrial CCUS, but none of its eight power projects is online today," says Adhiguna.

The European Union has spent at least €424m, with 'intended progress not achieved', as stated by the European Court of Auditors. Most South East Asian governments are unlikely to afford such a prominent role to backstop CCUS developments.

Testing CCUS in large power plants has proven costly, with US$1bn cost to retrofit a 240MW coal power plant in 2017. With the high cost, a different maturity pathway for CCUS should be expected.

"In comparison, it is arguably easier to learn from and incrementally improve a US$3-4m wind turbine, than a demonstration project costing hundreds of millions of dollars," says Adhiguna.

The three potential leaders for CCUS in Asia — China, Japan, and South Korea still have a lot of catching up to do. How CCUS plays out in these countries is important, especially given the United States' rapid departure from coal, and potentially along with it, its attention to coal power CCUS, a large part of the power mix in South East Asia.

Adhiguna also advises to carefully assess the full cost of CCUS as its operation consumes significant amounts of energy, of which associated emissions need to be considered. Measuring the cost of carbon dioxide captured is insufficient, as the cost of carbon dioxide avoided needs to be the measure. These are especially important in South East Asia, with fairly lax emissions standards and the predominance of subcritical coal power plants.

Everyone wants CCUS to be viable, but drawing a clear line is necessary on what it could and could not offer in cost-sensitive markets.

More information

Download the full report at:

ieefa.org

Achieving American leadership in the CCTS Supply Chain

A report from the U.S. Department of Energy finds that developing CCS poses no significant supply chain risk and can support the U.S. government in achieving its net-zero goals.

The Carbon Capture, Transport, and Storage Supply Chain Deep Dive Assessment finds that CCS provides a near-term pathway to rapidly reduce the impacts of existing, difficult-to-decarbonize, emissions-intensive infrastructure and processes, while zero-carbon alternative solutions mature.

CCS also poses a low supply chain risk, due to the required infrastructure relying on large amounts of common and readily available raw materials (such as steel, cement, and ammonia).

Opportunities

CCS presents considerable opportunities in the following areas:

• Growth in the American Economy and Workforce: The growth of the CCS market could help produce between 390,000 and 1.8 million good-paying union jobs in various industries, including in fossil energy communities affected by the transition to a net-zero economy.

These employment opportunities will include the fields of raw materials (steel and cement, among others); engineering and design (the design of carbon capture, pipelines, injection sites, and supervisory control and data acquisition), construction (retrofitting, pipeline development, injection sites, and trucking), and operation and maintenance (O&M).

The report states that these employment opportunities will follow the value chain of CCS, largely in the Midwest, Appalachian, and Southern states for the construction and subsequent O&M of capture sites, pipeline sites, and storage sites.

• Development of Diverse Supply Chains: The United States remains a leader in CCS development and deployment, and CCS infrastructure can be supplied in large part by American-made components. There are also opportunities to develop diversified supply chains with U.S. allies and partners that play to the strengths of each country.

• Technological Innovations for CO2 Use and Capture Technologies: There are several opportunities for research and innovation in the CCS space, such as leveraging captured CO2 for use in applications like chemicals, plastics, and novel materials. This would add new revenue streams to the carbon capture industry alongside existing 45Q tax credit incentives and restoring depleted oil and gas reservoirs for reuse.

Long-Term Use

Decarbonization efforts are rapidly evolving, potentially putting large capital investments into CCS infrastructure at risk of stranding or under-utilization. However, there are multiple long-term use cases, particularly for investment into transportation and storage:

• Continued CCS: There may be future conditions where zero-carbon alternatives are technically impossible or impractical. A built-out CCS network would allow infrastructure and processes to continue while addressing emissions.

• Direct Air Capture and Storage (DACS): CCS infrastructure also enables a long-term solution for continuing to remove CO2 from the atmosphere by enabling the CO2 transport and storage infrastructure needed for DACS. DACS will be easier to implement regionally if the CCS infrastructure is available for use.

• Other Pipeline Uses: Researchers are investigating opportunities to leverage CO2 pipelines to transport other fluids, including hydrogen. Additional research is required in the areas of hydrogen compression technology and large-scale pipeline conversion, especially when converting pipelines originally intended to transport CO2.

Policy Next Steps

To advance the growth and development of the CCS industry, policy recommendations and next steps are included in the report, "America's Strategy to Secure the Supply Chain for a Robust Clean Energy Transition". A high-level summary is included below.

• Accelerate early development of CCS infrastructure. Provide research, development, and demonstration to address technical challenges and costs of carbon capture, storage, and transport.

• Enable CCS market growth. Incentivize CO2 infrastructure projects (pipelines and storage), including providing investment and permitting support.

• Incentivize domestic manufacturing of materials and equipment for the midstream by prioritizing and/or requiring materials to be produced domestically.

More information

Download the full document and the corresponding other documents that are part of the DOE response to the supply chain executive order at:

www.energy.gov/policy/supplychains

Projects and policy news

px Group's Saltend Chemicals Park to host CO2 store for Future Biogas

www.futurebiogas.com
www.pxlimited.com

Carbon neutral CO2 will be transported to Saltend for short term storage then shipped to Norway's 'Northern Lights' project for permanent CO2 storage under the North Sea

Future Biogas' storage facility at px Group's Saltend Chemical Park will temporarily store liquid CO2 from anaerobic digestion plants before transport to the Northern Lights project for permanent storage

In an investment worth tens of millions of pounds, a storage facility for the temporary storage of liquid CO2 will be constructed by Future Biogas by the end of 2024 on a dedicated site at Saltend, comprising up to 32 CO2 storage tanks.

Future Biogas's carbon negative process uses energy crops from a regenerative farming system as feedstock for its Anaerobic Digestion (AD) plants. Biomethane produced from the AD plant is then fed into the National Gas Grid and the byproduct, carbon neutral CO2, will be transported to Saltend for short term storage and shipping to Norway's 'Northern Lights' project for permanent CO2 storage under the North Sea.

Geoff Holmes, CEO of px Group, said, "Today marks another significant milestone at Saltend with this major investment from Future Biogas, a company that itself is investing in this and other projects with a negative carbon footprint and quickening the country's journey to Net Zero."

Future Biogas' storage facility will facilitate the temporary storage of 200,000 tonnes of liquified CO2 annually by mid-2025, and up to 400,000 tonnes of CO2 by the end of 2028. The CO2 is a by-product of Anaerobic Digestion plants and will be captured and liquified at the facilities operated by Future Biogas.

As part of the development, px Group will be involved in the design, construction, operation and maintenance of the infrastructure at the Park, and potentially the CO2 storage facility itself. The development now goes into FEED (Front End Engineering Design) stage.

px Group says that Saltend, a Top Tier COMAH site, was chosen for its expertise in handling complex, high-hazard materials and its quality record on safety - a sentiment echoed by Future Biogas.

Future Biogas said that Saltend's leading role in UK decarbonisation, and its strategic goal of attracting key players in sustainable energy supply chains, was critical to it choosing Saltend. Saltend was recently selected as the site for a world-scale Hydrogen plant - the flagship project of the Zero Carbon Humber decarbonisation initiative that recently secured major Government funding.

How does the process work?

Future Biogas will transport liquified CO2 that it captures from its Anaerobic Digestion (AD) and Bio-Energy sites across the UK via trucks to Saltend.

Saltend's facilities will temporarily store the liquid CO2 in the built-to-specification tanks.

From the tanks, the liquid CO2 will be transported via Saltend's jetty onto specially designed vessels for transportation to the Northern Lights Carbon Capture and Underground Storage project (CCUS) which is supported by the Norwegian Government and is currently under construction.

How is the process carbon negative?

The Anaerobic Digestion facilities use energy crops from a regenerative farming system with negative carbon at its core.

The products from the AD process are dealt with in two ways. The biomethane is fed directly into the National Gas Grid's network for domestic and commercial use, and the CO2 by-product is captured, liquified and transported to Saltend (in this case) for storage, transportation, and geological sequestration.

The process removes CO2 from the atmosphere without releasing further CO2, making it carbon negative.

Tech companies commit $1bn to carbon removal technologies

frontierclimate.com

Meta has joined Stripe, Alphabet, Shopify and McKinsey Sustainability in collectively committing an initial $925 million to accelerate the development of technological carbon removal.

To avoid the worst effects of climate change, we must focus not only on reducing carbon emissions, but also removing carbon dioxide already present in the environment, said Meta. The partnership is launching Frontier — an advanced market commitment (AMC) to accelerate the development of carbon removal technologies. An AMC signals to researchers, entrepreneurs and investors that there is strong demand for their product.

Collectively, the companies have committed an initial $925 million to purchase carbon removal tons from companies building promising new solutions over the next nine years. Purchasing carbon removal tons involves investing in projects that remove greenhouse

gas emissions from the atmosphere. Meta said it has committed to reaching net zero emissions across its value chain by 2030.

"We believe that by collaborating to find technologies with the greatest long-term carbon removal potential and helping them scale, we can help accelerate the solutions needed to meet global climate goals," said Meta. "Collaboration with globally renowned organizations — nonprofits, businesses and civil society — is an essential part of our sustainability strategy and is key to making a difference."

The AMC model was successfully piloted a decade ago to accelerate the development of vaccines for low-income countries. This is the first time the model is being applied to carbon removal at scale, and these technologies are in the earlier stages of development. They are currently expensive, untested at scale and new to carbon markets. The first steps will be to:

• Work to support the development of new monitoring and verification methods

• Set new standards for climate justice and social and environmental outcomes in technological removal

India's first industrial scale capture design and feasibility study completed

www.dasturenergy.com

Dastur has completed a techno-economic feasibility of the Indian Oil Corporation Limited's (IOCL) CCUS project at the 13.7 mtpa Koyali refinery in Gujarat, India.

The project, as designed, provides IOCL with a technically and economically viable solution for capturing up to almost 0.7 mtpa (million tonnes per annum) of carbon dioxide from its Steam Methane Reforming (SMR) based Hydrogen Generation Units (HGU) at a very competitive cost structure.

The captured CO2 will be primarily used at the Oil and Natural Gas Commission's (ONGC) Gandhar oilfields for enhanced oil recovery (EOR) from its maturing oil wells. A part of the captured CO2 is also expected to be liquefied and purified to 99.9% for supply to food and beverage sector consumers.

Shri S.S.V. Ramakumar, Director (R & D) and Board member of IOCL, said, "The project and Dastur's work provide a blueprint for IOCL and ONGC to pursue the ambitious goal of combining industrial-scale carbon capture with CO2 EOR in India. Dastur and its partners evaluated different CO2 sources and carbon capture technologies from multiple vendors to engineer a techno-economically feasible solution that we can implement within the constraints and challenges of a large and complex operating refinery. The novel use of advanced gas processing to provide an extremely competitive cost of carbon capture bodes well for the future success of the project."

The carbon capture solution designed by Dastur would allow IOCL to substantially decarbonize its HGU operations and support IOCL's strategy of producing clean hydrogen. The project also supports the Government of India's mandate of decarbonizing the oil & gas sector. With carbon accounting likely to become a reality in developing carbon markets, this carbon capture project can be expected to provide a competitive advantage to IOCL in the form of carbon credits in the international markets.

The carbon capture system designed by Dastur provides IOCL with an integrated solution across the carbon value chain, enabling industrial-scale carbon capture and storage. The project brings together Dastur Energy's capabilities in the areas of energy engineering, gas processing, carbon capture technologies, energy supply chains and economics; Air Liquide's carbon capture technology offerings; the University of Texas at Austin's Bureau of Economic Geology's (BEG) experience in research and development in EOR; and India based M. N. Dastur & Co. (P) Ltd.'s engineering and capital project delivery capabilities.

The project was funded by a grant from the United States Trade and Development Agency (USTDA).

XPRIZE awards further milestone payments

xprize.org/carbonremoval

15 teams from nine countries have taken home $1M Milestone awards in next stage of $100M XPRIZE Carbon Removal competition to innovate and scale solutions to fight climate change.

In celebration of Earth Day, 15 teams have been designated as milestone winners in the $100M XPRIZE Carbon Removal competition. Each of the 15 milestone winning teams has been awarded $1M to recognize their efforts to date and support their continued work to scale solutions. The overall winners will be awarded $80M in 2025.

The XPRIZE Carbon Removal competition was launched to encourage carbon removal innovators to work on tackling the biggest threat facing humanity: fighting climate change and rebalancing Earth's carbon cycle. This $100M competition, funded by Elon Musk and the Musk Foundation, is the largest incentive prize in history and the XPRIZE Carbon Removal teams represent the largest collection of innovators working on carbon removal. Unlike previous prizes, every team is still eligible to compete and win the grand prize.

The teams are pursuing a mix of known solutions and new approaches to carbon removal: ecosystem restoration, biochar, agricultural solutions, organic and inorganic ocean solutions, mineralization of mine tailings and naturally occurring minerals, direct air capture with geologic sequestration, agroforestry, soil carbon and more.

Any solution is eligible to compete so long as it actually works, achieves net negative emissions, sequesters carbon dioxide durably over at least 100 years, and shows a sustainable path to ultimately achieving gigatonne scale.

Crucially, the XPRIZE is not an ideas competition; it is an execution and demonstration competition. The submission process was extremely demanding by design, with a field of 1,133 teams narrowed to 287 teams meeting the eligibility criteria for the milestone awards. 70 expert reviewers screened and ranked the inbound proposals for scientific validity, and selected the top 60 teams.

The competition now completely resets before the remaining $80M prize purse is awarded in 2025. Any team is eligible to win, whether they participated in this Milestone Round or not. Registration is open for any team interested in joining the competition to compete for the Grand Prizes. Registration closes on December 1, 2023.

To win the Grand Prize, teams must demonstrate a working solution at a scale of at least 1,000 tonnes removed per year, model their costs at a scale of 1 million tonnes per year, and show a pathway to achieving a scale of gigatonnes per year in future, as validated by a third party. The Grand Prize winner and runners up will be announced on Earth Day 2025.

Treated plastic waste good at grabbing carbon dioxide

A Rice University lab has turned hard-to-process plastic into particles that act as an effective carbon capture sorbent. These particles can be used to remove CO2 from flue gas streams.

Rice chemist James Tour and co-lead authors Rice alumnus Wala Algozeeb, graduate student Paul Savas and postdoctoral researcher Zhe Yuan reported in the American Chemical Society journal ACS Nano that heating plastic waste in the presence of potassium acetate produced particles with nanometer-scale pores that trap carbon dioxide molecules.

"Point sources of CO2 emissions like power plant exhaust stacks can be fitted with this waste-plastic-derived material to remove enormous amounts of CO2 that would normally fill the atmosphere," Tour said. "It is a great way to have one problem, plastic waste, address another problem, CO2 emissions."

Pores in this micron-scale particle, the result of pyrolyzing in the presence of potassium acetate, are able to sequester carbon dioxide from streams of flue gas. Rice University scientists say the process could be a win-win for a pair of pressing environmental problems. (Credit: Tour Group/Rice University)

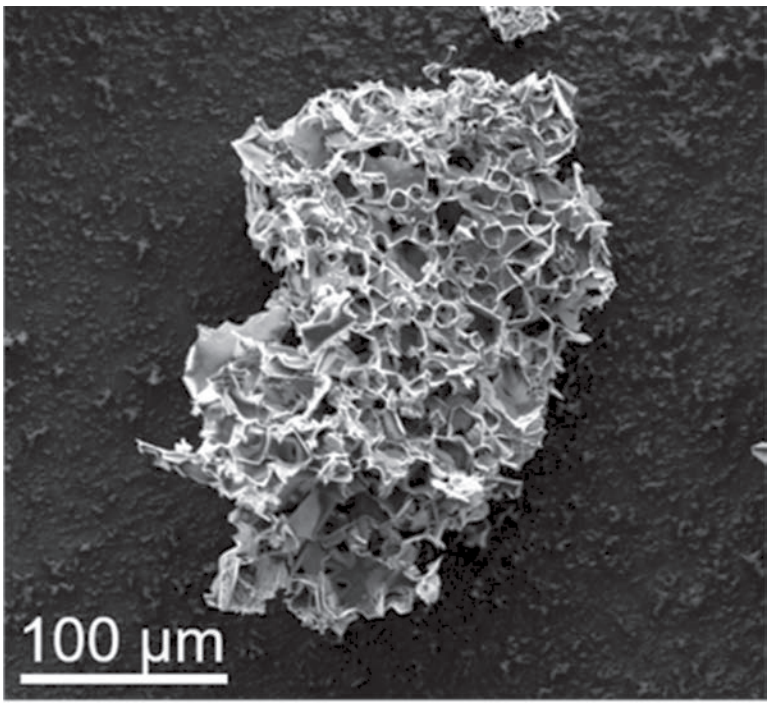
Pores in this micron-scale particle, the result of pyrolyzing in the presence of potassium acetate, are able to sequester carbon dioxide from streams of flue gas.Courtesy of the Tour Group

A current process to pyrolyze plastic known as chemical recycling produces oils, gases and waxes, but the carbon byproduct is nearly useless, he said. However, pyrolyzing plastic in the presence of potassium acetate produces porous particles able to hold up to 18% of their own weight in CO2 at room temperature.

In addition, while typical chemical recycling doesn't work for polymer wastes with low fixed carbon content in order to generate CO2 sorbent, including polypropylene and high- and low-density polyethylene, the main constituents in municipal waste, those plastics work especially well for capturing CO2 when treated with potassium acetate.

The lab estimates the cost of carbon dioxide capture from a point source like post-combustion flue gas would be $21 a ton, far less expensive than the energy-intensive, amine-based process in common use to pull carbon dioxide from natural gas feeds, which costs $80-$160 a ton.

Like amine-based materials, the sorbent can be reused. Heating it to about 75 degrees Celsius (167 degrees Fahrenheit) releases trapped carbon dioxide from the pores, regenerating about 90% of the material's binding sites.



Pores in this micron-scale particle, the result of pyrolyzing in the presence of potassium acetate, are able to sequester carbon dioxide from streams of flue as.

Image courtesy of the Tour Group

Because it cycles at 75 degrees Celsius, polyvinyl chloride vessels are sufficient to replace the expensive metal vessels that are normally required. The researchers noted the sorbent is expected to have a longer lifetime than liquid amines, cutting downtime due to corrosion and sludge formation.

To make the material, waste plastic is turned into powder, mixed with potassium acetate and heated at 600 C (1,112 F) for 45 minutes to optimize the pores, most of which are about 0.7 nanometers wide. Higher temperatures led to wider pores. The process also produces a wax byproduct that can be recycled into detergents or lubricants, the researchers said.

Co-authors of the paper are Rice alumnus Zhe Wang and research scientist Carter Kittrell, and graduate student Jacklyn Hall and Praveen Bollini, an assistant professor of chemical and biomolecular engineering, both of the University of Houston. Tour is the T.T. and W.F. Chao Chair in Chemistry as well as a professor of materials science and nanoengineering.

The Department of Energy (DE-F0031794) and Saudi Aramco supported the research.

More information

www.jmtour.com

New polymer membrane improves efficiency of CO2 capture

Researchers at NC State University have developed a new membrane technology that allows for more efficient removal of carbon dioxide from mixed gases, such as emissions from power plants. The technology could be developed through an industry partnership and broadened to other applications.

"To demonstrate the capability of our new membranes, we looked at mixtures of CO2 and nitrogen, because CO2/nitrogen dioxide mixtures are particularly relevant in the context of reducing greenhouse gas emissions from power plants," says Rich Spontak, co-corresponding author of a paper on the work.

"And we've demonstrated that we can vastly improve the selectivity of membranes to remove CO2 while retaining relatively high CO2 permeability."

"We also looked at mixtures of CO2 and methane, which is important to the natural gas industry," says Spontak, who is a Distinguished Professor of Chemical and Biomolecular Engineering and Professor of Materials Science & Engineering at North Carolina State University.

"In addition, these CO2-filtering membranes can be used in any situation in which one needs to remove CO2 from mixed gases – whether it's a biomedical application or scrubbing CO2 from the air in a submarine."

Membranes are an attractive technology for removing CO2 from mixed gases because they do not take up much physical space, they can be made in a wide variety of sizes, and they can be easily replaced.

The other technology that is often used for CO2 removal is chemical absorption, which involves bubbling mixed gases through a column that contains a liquid amine – which removes CO2 from the gas. However, absorption technologies have a significantly larger footprint, and liquid amines tend to be toxic and corrosive.

These membrane filters work by allowing CO2 to pass through the membrane more quickly than the other constituents in the mixed gas. As a result, the gas passing out the other side of the membrane has a higher proportion of CO2 than the gas entering the membrane. By capturing the gas passing out of the membrane, you capture more of the CO2 than you do of the other constituent gases.

A longstanding challenge for such membranes has been a trade-off between permeability and selectivity. The higher the permeability, the more quickly you can move gas through the membrane. But when permeability goes up, selectivity goes down – meaning that nitrogen, or other constituents, also pass through the membrane quickly – reducing the ratio of CO2 to other gases in the mixture. In other words, when selectivity goes down you capture relatively less CO2.

The research team, from the U.S. and Norway, addressed this problem by growing chemically active polymer chains that are both hydrophilic and CO2-philic on the surface of existing membranes. This increases CO2 selectivity and causes relatively little reduction in permeability.

"In short, with little change in permeability, we've demonstrated that we can increase selectivity by as much as about 150 times," says Marius Sandru, co-corresponding author of the paper and senior research scientist at SINTEF Industry, an independent research organization in Norway. "So we're capturing much more CO2, relative to the other species in gas mixtures."

Another challenge facing membrane CO2 filters has been cost. The more effective previous membrane technologies were, the more expensive they tended to be.

"Because we wanted to create a technology that is commercially viable, our technology started with membranes that are already in widespread use," says Spontak. "We then engineered the surface of these membranes to improve selectivity. And while this does increase the cost, we think the modified membranes will still be cost effective."

"Our next steps are to see the extent to which the techniques we developed here could be applied to other polymers to get comparable, or even superior, results; and to upscale the nanofabrication process," Sandru says. "Honestly, even though the results here have been nothing short of exciting, we haven't tried to optimize this modification process yet. Our paper reports proof-of-concept results."

The researchers are also interested in exploring other applications, such as whether the new membrane technology could be used in biomedical ventilator devices or filtration devices in the aquaculture sector.

The researchers say they are open to working with industry partners in exploring any of these questions or opportunities to help mitigate global climate change and improve device function.

The paper, "An Integrated Materials Approach to Ultrapermeable and Ultraselective CO2 Polymer Membranes," is published in the journal Science.

The paper was co-authored by Wade Ingram, a former Ph.D. student at NC State; Eugenia Sandru and Per Stenstad of SINTEF Industry; and Jing Deng and Liyuan Deng of the Norwegian University of Science & Technology.

The work was done with support from the Research Council of Norway; UEFSCDI Romania; the National Science Foundation, under grant number ECCS-2025064; and Kraton Corporation.

More information

news.ncsu.edu

DOI: 10.1126/science.abj9351

Copper-silver-gold nanostructure gives carbon capture a boost

Chemists at Tsinghua University have developed a nano-scale structure that combines copper, gold and silver to work as a superior catalyst.

A study describing the process appeared in the journal Nano Research on Mar. 15.

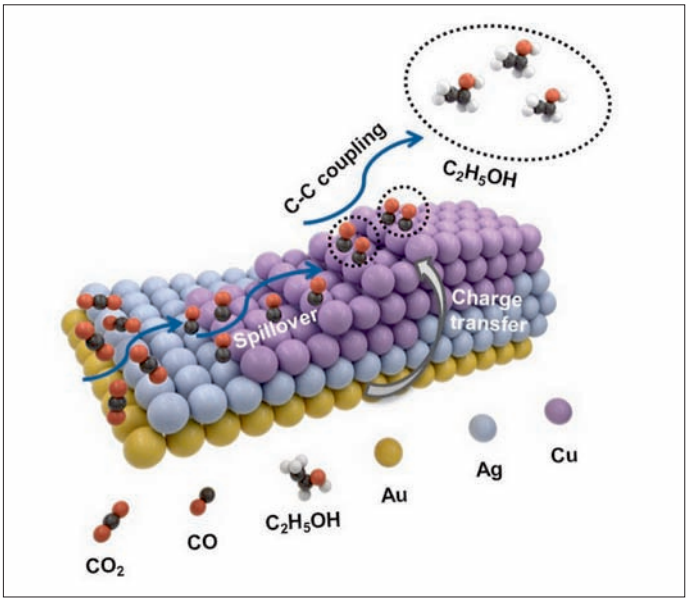
In the face of the climate change challenge, policy makers have in recent years increasingly focused on carbon capture and utilization (CCU), where CO2 is drawn down from the atmosphere and then used as a feedstock for industrial chemicals (such as carbon monoxide, formic acid, ethylene, and ethanol) or for the production of carbon neutral synthetic fuels (especially useful for hard-to-electrify transport sectors such as long haul aviation and shipping). So long as the latter process is powered by clean electricity, it also offers a way to store renewable energy over the long term - the holy grail of overcoming the intermittency of energy options such as wind and solar power.

One possible means of doing all this is via a chemical reaction called the electrochemical CO2 reduction reaction (eCO2RR, or simply ECR). This uses electricity to power the conversion of the gas into other usable substances by separating CO2's carbon atoms from its oxygen atoms. Water can also provide hydrogen "donors" in some varieties of ECR whereby the carbon atoms are combined with hydrogen to produce various species of hydrocarbons or alcohols.

Key to ECR is using the right catalyst, or chemical substance whose structure and charge enables it to kick off or speed up a chemical reaction. Various different metals have been used as catalysts depending on which end product is desired. Catalysts employing just one type of metal include tin to produce formic acid, silver for carbon monoxide (CO), and copper for methane, ethylene or ethanol.

However, the performance of the process can be limited when ECR competes with the tendency of hydrogen atoms within the electrochemical splitting of water to pair up with themselves instead of joining up with the carbon atoms. This competition can lead to production (or "selection") of a different chemical end product than the one desired. As a result, chemists have long been on the hunt for catalysts with high "selectivity".

Recently, instead of just using a single metal as a catalyst, researchers have turned to the use of heterostructures that incorporate two distinct materials whose combined properties produce different or superior outcomes to either of the individual materials on their own.



Proposed possible mechanism for the electrochemical CO2RR on (a) Au@Ag NRs and (b,c) asymmetric AuAgCu NSs.

Image: Nano Research

Some of the heterostructures that have been tested for ECR include combining silver and palladium in a branchlike formation (AgPd "nanodentrites"), and various other combinations of two metals in sandwich-like, tube-like, pyramidal and other shapes. Researchers have enjoyed considerable success with bimetallic heterostructures that include copper—which is very good at converting CO2 into products that use two carbon atoms. These bimetallic heterostructures include silver-copper (AgCu), zinc-copper (ZnCu), and gold-copper (AuCu), with the latter enjoying particular selectivity success for methane, C2 and carbon monoxide.

"We thought if two metals were producing good results, then perhaps three metals would be even better," said Zhicheng Zhang, a nanochemist with Tianjin University and co-author of the study.

So the researchers constructed a trimetallic nanostructure that combined gold, silver and copper and was asymmetric in form. The shape and precise ratio of the three metals can be altered via a growth method involving multiple steps. Specifically, gold "nanopyramids" are first synthesized and used as "seeds" for subsequent growth of various trimetallic structures involving different ratios of the three metals.

They found as a result of the unique form of their heterostructure design and by altering the ratios of these three metals, they could carefully tune the selectivity toward different C2-based products. Production of ethanol (C2H6O) in particular was maximized by using a heterostructure with the feeding ratio involving one atom each of gold and silver combined with five copper atoms.

The work sets out a promising strategy for development of other trimetallic nanomaterials within ECR development.

More information

www.tsinghua.edu.cn

Capture and utilisation news

'World first' pilot project producing gasoline from CO2 hydrogenation

english.cas.cn

The demonstration device for 1,000 tons/year production of gasoline from CO2 hydrogenation located in Zoucheng Industrial Park completed its trial operation.

The project was jointly developed by the Dalian Institute of Chemical Physics (DICP) of the Chinese Academy of Sciences (CAS) and Zhuhai Futian Energy Technology Co., Ltd.

Hydrogenation of CO2 into liquid fuels and chemicals can not only realize the resource utilization of CO2, but also facilitate the storage and transportation of renewable energy.

However, the activation and selective conversion of CO2 are challenging. A technology that can selectively produce value-added hydrocarbon fuels with high energy density will provide a new route for promoting clean and low-carbon energy revolution.

The technology of carbon dioxide hydrogenation to gasoline was proposed by Sun Jian, GE Qingjie and WEI Jian from DICP in 2017, with a paper published in Nature Communications.

The demonstration device has been completed in Zoucheng Industrial Park, in 2020. In October 2021, the device passed the continuous 72-hour on-site assessment organized by China Petroleum and Chemical Industry Federation (CPCIF).

It could realize both CO2 and H2 conversion of 95%, gasoline selectivity of 85% in all carbon-based products, with reduced consumption of the raw material of CO2 and H2.

It produced clean and green gasoline product with octane number more than 90 conforming to the Chinese national VI standard, accompanied by low energy consumption of the whole process.

"This technology marks a new stage of CO2 resource utilization technology in the world, and provides a new strategy for realizing the goal of carbon neutral," said Prof. Sun.

The world's first demonstration device for 1,000 tons/year production of gasoline from carbon dioxide hydrogenation has completed its trial operation and technology assessment on March 4. Image: DICP

Woodside partners with ReCarbon and LanzaTech

www.woodside.com.au

Woodside, ReCarbon and LanzaTech are investigating the viability of a proposed Carbon Capture and Utilisation (CCU) pilot facility in Perth, Western Australia.

The proposed pilot facility would recycle greenhouse gases such as carbon dioxide and methane into value-added ethanol using ReCarbon and Lanzatech's technologies. The ReCarbon technology would convert carbon dioxide and methane into synthesis gas, with the LanzaTech technology fermenting the synthesis gas into ethanol.

Traditionally, ethanol manufacture relies on land and water use for source crops, such as corn. CCU reduces the reliance on these natural resources. Woodside believes CCU is an emerging field with growing demand from existing and potential customers seeking alternative solutions for lower carbon.

The project is now in the front-end engineering design phase. Woodside CEO Meg O'Neill described CCU as an exciting addition to the portfolio as it looked at carbon as an opportunity and resource, not just a challenge. "What's notable about CCU is the wider co-benefits. Some end products have a further decarbonisation benefit. Products such as ethanol can be used as raw materials in the chemical manufacturing industry."

"We also see a potential role for the technology in helping to abate some of our Scope 1 and 2 emissions," she said.

Australia's Clean Energy Regulator is currently leading a co-design process to develop a carbon capture use and storage method under the Emissions Reduction Fund. ReCarbon Founder and CEO Dr. Jay Kim welcomed the collaboration. "The global energy and fuel sector is experiencing unprecedented transition. We are grateful to be selected as a leading technology solution to transform greenhouse gases into decarbonised products."

"Woodside is moving decisively by establishing real projects with its CCU initiative, and ReCarbon is proud to play our part," he said.

LanzaTech CEO Dr. Jennifer Holmgren noted the scale of the opportunity. "Waste carbon can be transformed into critical resources like ethanol without adding CO2 to the atmosphere. Together with Woodside and ReCarbon, we can create an opportunity to reuse greenhouse gases for meaningful applications," she said.

Nuada ready to deliver step-change for cost-effective carbon capture

www.moftechnologies.com/nuad

Belfast-based MOF Technologies says it will revolutionise the world of carbon capture following the development of a new modular system that can reduce capture costs to as low as £13 per tonne of CO2.

The Nuada system, which has been developed by MOF Technologies, represents a step-change for commercial carbon capture due its ability to cut associated energy costs – often seen as the biggest barrier to implementation at scale – by up to 80% when compared to other systems.

The ultra-efficient system is driven by mature vacuum pressure swing adsorption technology coupled with a MOF-based filter that has been specifically designed to capture and remove CO2 at source.

MOFs, or metal-organic frameworks, are highly engineered filters that use bespoke chemistry to target, capture and remove specific gases like CO2.

It is this selectivity combined with an ability to regenerate with minimal energy input that sets Nuada apart from established amine solvent-based systems, which can require up to 3.4GJ per tonne of CO2 removed.

Dr Conor Hamill, Co-CEO at MOF Technologies, commented, "The main draw for carbon capture is its feasibility in providing businesses in hard-to-abate sectors with a practical means to cut carbon while also maintaining a level of output needed for growth. The cripplingly high energy requirements of amine solvent treatment have proved to be a sizeable and, for many organisations, prohibitive barrier to the implementation of carbon capture technologies.

"However, thanks to a technical breakthrough along with greater awareness at board and policy level of the need to rapidly decarbonise, Nuada is set to help industry achieve these goals and will positively disrupt the carbon capture industry. Unlike traditional approaches, the modular system can be easily connected to a facility's waste gas line without extensive redesign or installation work. The units can be scaled according to demand, giving businesses a non-invasive and far more cost-effective means of carbon capture."

Following successful prototyping, MOF Technologies is currently building an in-field pilot plant.

Dr Hamill concluded, "The launch of the Nuada system is a game-changing moment for carbon capture. The energy savings make the cost of each project far more enticing for investors, while also allowing businesses to continue production without falling foul of emissions targets. While the exact route to net zero may still be up for debate, credible carbon capture systems will be central to any realistic plan."

Mitsubishi and Tokuyama to test CO2 capture at cement plant in Japan

www.mhi.com

Mitsubishi Heavy Industries Engineering has signed an MoU with Tokuyama Corporation on the implementation of a CO2 capture demonstration testing program at their cement plant.

Tokuyama's Nanyo Plant will host a mobile CO2 capture test unit provided by MHIENG

Photo provided by Tokuyama Corp.

Demonstration in a cement plant operated by Tokuyama Corp., one of Japan's leading chemicals/cement manufacturers, will examine the technology's applicability. The program will contribute to the early realization of carbon neutrality in cement and other industrial fields and develop solutions to issues impacting their decarbonization.

A mobile CO2 capture test unit manufactured by MHIENG is being installed at Tokuyama's existing cement plant in Shunan, Yamaguchi Prefecture, where Tokuyama is based. Flue gas from cement kiln, which contains CO2 and other components would be introduced to the mobile unit for the demonstration test.

MHIENG will evaluate its performance and study optimum technology and design suited for cement application. These insights will enable MHIENG to realize CO2 capture in the cement industry, and will also contribute to achieving the industry's decarbonization goals.

MHIENG's CO2 capture technology has already been successfully used in commercial applications at chemical and coal fired power plants, and MHIENG has many experiences of conducting demonstration tests for industrial fields such as in biomass-fueled power plants and waste-to-energy plants. With this first demonstration test in a cement plant, MHIENG will acquire profounder expertise and knowledge of its technology, which will realize stable and continuous CO2 capture with optimized process.

Besides cement production, Tokuyama is also known for various products in the areas of chemical, life science and the environment. Tokuyama is very proactive in promoting the development of products and technologies that solve the issues the society faces, such as global warming. The demonstration test agreed under this MOU is part of Tokuyama's commitment to implement specific measures to enable a carbon-neutral society.

MHI Group said it is currently strengthening its position in the energy transition, and development of a CO2 ecosystem is central to those initiatives.

"MHIENG will continue to contribute toward reducing greenhouse gas emissions on a global scale by promoting broad adoption of high-performance CO2 capture technology worldwide.

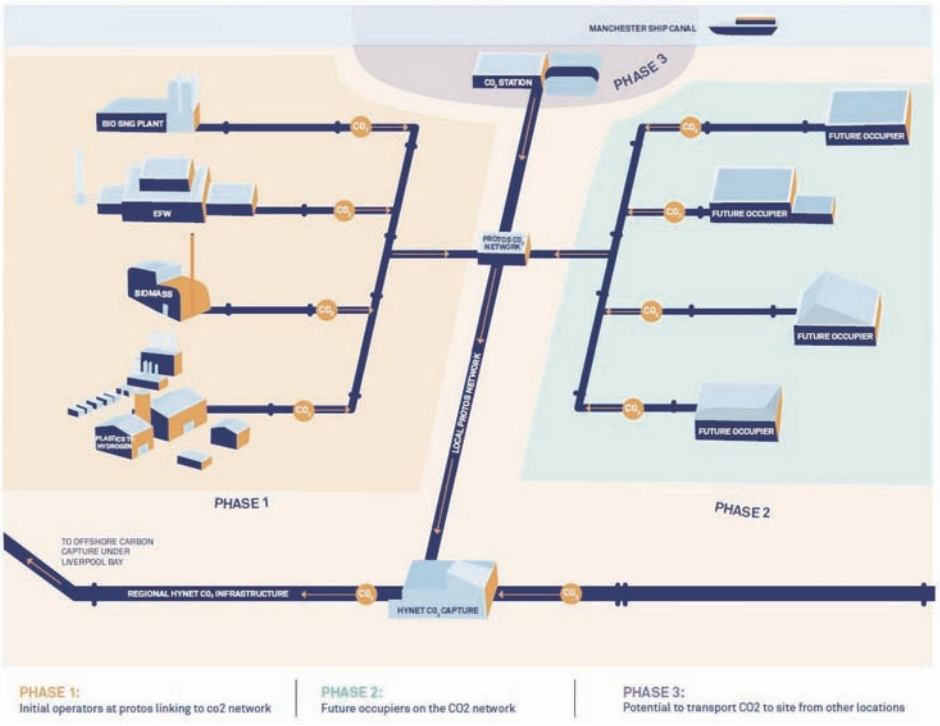
Peel NRE reveals plans for CO2 network at Protos in Cheshire UK

Peel NRE has set out plans for a network of CO2 pipelines that could capture 800,000 tonnes of CO2 emissions each year for the HyNet North West partnership.

The Protos CO2 network would create a carbon-capture ready destination, setting the blueprint for net zero energy clusters in the UK and beyond. The network would connect to the regional CO2 pipeline being developed as part of HyNet North West.

It is part of a cohesive plan for the North West to become one of the first regions to deliver a carbon capture cluster and reach net zero – by storing greenhouse gases in offshore depleted gas fields beneath Liverpool Bay. It follows the Government selecting the North West as a Track 1 CCUS cluster to begin decarbonising industry with the backing of a £1billion infrastructure fund.

The Protos network, which could be operational by 2025, would be initially concentrated on energy generators at Protos, with scope to expand to capture emissions from additional generators and businesses in the industrial corridor between Ellesmere Port and Runcorn and beyond. The project would capture some 800,000 tonnes of carbon dioxide a year– with future phases increasing capacity to over 1.2 million tonnes.



The proposed network would capture 800,000 tonnes of carbon dioxide a year, with future phases increasing capacity to over 1.2 million tonnes

Peel NRE has commenced work to outline how creating strategic CO2 hubs at a local level will avoid the need for costly and complex individual connections to the regional carbon capture pipeline. It will create a carbon-capture ready destination for businesses looking to become net zero.

It will also explore the future potential of bringing liquified CO2 - including via the Manchester Ship Canal and rail - from other operations in the North West and neighbouring regions, that are not able to connect to the planned regional carbon capture pipelines.

It follows further commitment to ramp up hydrogen production and invest in carbon capture in the Energy Security Strategy, recently published by the Government.

Jane Gaston, Protos Development Director at Peel NRE, part of Peel L&P, said, "Protos has been a real draw for energy generators and innovators. Our vision has always been to underpin the circular economy – making the best use of our resources to power the region. In turn, we've unlocked hundreds of millions of pounds of investment into the North West. The CO2 network is the next major step on our journey to create a destination for low carbon energy and support the transition to net zero."

"With the region becoming one of the UK's leading carbon capture clusters, there's a real opportunity to generate net zero energy by linking existing facilities to the complementary regional carbon capture pipelines being planned as part of HyNet. The Protos CO2 network would set a blueprint for how local CO2 hubs at key locations can be a game-changer for decarbonisation, making carbon capture available to a much wider pool of industries."

"The network would make Protos one of the North West's first carbon-capture ready destinations, meaning businesses wanting to locate to the region would have the option of connecting to a local CO2 network. Our objective has been to support industry with shared infrastructure, such as local power grids. Applying this to carbon capture makes absolute sense when you consider the scale of the challenge to cut emissions and target dates."

Protos is currently home to Bioenergy Infrastructure Group's 21.5MW operational biomass facility, with construction underway at Covanta's 49MW Energy Recovery Facility. Further planned facilities including the UK's first Plastic-to-Hydrogen facility, using Powerhouse Energy technology, and Protos Biofuels Ltd's waste-based BioSNG plant.

More information

www.protos.co.uk

Transport and storage news

DNV approves KNCC for high pressure LCO2 transport concept

www.kn-cc.com

DNV has awarded approval in principle (AIP) to Knutsen NYK Carbon Carriers (KNCC) for its PCO2 tank system for the transportation of liquefied CO2 (LCO2).

KNCC is a new joint venture company established by the Knutsen Group and the NYK Group to provide CO2 transportation and storage solutions.

Ship transport of CO2 for commercial use is currently carried out via small ships at medium pressure. For the expansion of the CCS value chain larger ships will be required to maximise transportation efficiency. The KNCC PCO2 concept aims to tackle the scaling challenge by transporting liquefied CO2 at high (35-45 bar) pressure and temperatures in the range of 0-10°C.

The PCO2 concept is based on a cylinder type CO2 containment system applying principles used in compressed natural gas (CNG) transportation. The CO2 is stored in bundles of vertically stacked small-diameter pressure cylinders, rather than large cylindrical tanks.

"The close cooperation with DNV, representing world class expertise in the area of marine transportation of liquefied CO2 has been both constructive and valuable, and KNCC is now prepared to take the next step with the PCO2 technology into this emerging shipping segment" said Anders Lepsøe, CEO of KNCC. "Further, our ability to form an integral part of the CCS value chain and by that contributing to reach global climate goals is essential both to our owners and KNCC."

By focusing on the transport of liquid CO2 under high pressure at roughly ambient temperatures, the PCO2 concept looks to significantly scale potential transport volumes compared to existing solutions. The concept aims to maintain a relatively uniform product across the LCO2 transport chain, in terms of pressure, temperature and state, from capture through transport, to offshore injection.

An Approval in Principle (AiP) is an independent assessment of a concept within an agreed framework, confirming that the design is feasible, and no significant obstacles exist to prevent the concept from being realized.

DNV has approved a liquefied CO2 carrier with bow loading system (Image courtesy of KNCC)

ExxonMobil begins design studies for South East Australia carbon capture hub

www.exxonmobil.com

The company is undertaking early front-end engineering design studies (pre-FEED) to determine the potential for carbon capture and storage in the Gippsland Basin.

The South East Australia carbon capture and storage (SEA CCS) hub would initially use existing infrastructure to store CO2 in the depleted Bream field off the coast of Gippsland, Victoria.

The company is in active discussions with local industries which may be interested in accessing the SEA CCS hub to reduce emissions from their operations.

The project is designed to capture up to 2 million metric tons of CO2 per year. If technical and business feasibility is confirmed, the SEA CCS hub could be operational by 2025.

"Collaboration with other industries is an important step to unlock future carbon capture and storage opportunities for Australia, with the potential for large-scale reductions in the highest emitting industrial sectors," said Joe Blommaert, president of ExxonMobil Low Carbon Solutions.

"Sound government policies will accelerate the deployment of key technologies required to support society's ambition for a net-zero future."

Equinor awarded the Smeaheia and Polaris CO2 licenses

www.equinor.com

The company has been awarded the operatorships for the development of the CO2 storage sites at Smeaheia in the North Sea and Polaris in the Barents Sea.

The two licenses are important building blocks for developing the Norwegian continental shelf into a leading province for CO2 storage in Europe.

In its application, Equinor has submitted plans to develop the CO2 storage capacity in Smeaheia at 20 million tonnes annually, which entails a sharp increase in the capacity to store CO2 on a commercial basis on the Norwegian continental shelf.

Northern Lights, the CO2 storage facility in the Longship project, has a planned injection capacity of 1.5 million tonnes a year in Phase 1 available from 2024 with plans to develop the capacity to 5-6 million tonnes a year from around 2026.

Through these two projects, Equinor aims to contribute to CO2 reductions equivalent to half of Norway's annual emissions. Equinor has ambitions to develop further storage licenses in the North Sea in the coming years with the aim of building a common, pipeline-based infrastructure that can contribute to substantial cost reductions for the CCS value chains.

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