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Porthos: CO_2 storage under the North Sea

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Sustainability: Carbon capture as key component

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CCS/CCU

A market on the verge of a breakthrough

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CCS-/CCU-TECHNOLOGY

A MARKET ON THE VERGE OF A BREAKTHROUGH

Carbon Capture and Storage (CCS) is rapidly becoming a crucial transition technology to achieve the goal of a climate-neutral industry. Even more fascinating, however, is the idea of putting the captured CO_2 emissions to use (CCU – Carbon Capture and Utilization), especially for the manufacture of products or energy. What opportunities does CCS or CCU technology offer? And what are the current challenges? Massimo Pardocchi and René de Schutter from Bilfinger provide some insights.

CCS and CCU solutions are now being discussed very frequently in the industry. What is the current status of the discussion?

Massimo Pardocchi: First of all, the discussion about carbon capture and storage or utilization has become much more objective and rational. The focus today is much more on technical than on political issues. This has been helped in particular by the numerous research and pilot projects that have demonstrated the diverse possibilities of this new approach. It is also clear that more and more CCU solutions are coming to the fore. An increasing number of projects are thus addressing the question of how the captured emissions can be transported, stored or put to use, for example as a raw material for the production of alternative fuels in combination with hydrogen.

> “The focus today is much more on technical than on political issues.”
>
> MASSIMO PARDOCCHI, GLOBAL DEVELOPMENT DIRECTOR AND LEAD CCUS BUSINESS DEVELOPMENT AT BILFINGER SE

In which industries is the interest in CCS and CCU solutions strongest? From where do you receive the most inquiries?

René de Schutter: The greatest demand is undoubtedly in those industries where the highest levels of CO_2 emissions also occur. These are primarily the cement, steel and chemical industries. However, as more and more countries have defined net-zero targets, interest is also growing in other sectors. Many companies have set ambitious climate targets and now recognize CCS/CCU technology as one of several building blocks to achieve these targets. This can be seen, for example, in the waste-to-energy sector: Here, high demand can be observed right now, especially for medium-sized plants.

In which countries is the CCS/CCU technology primarily being promoted?

René de Schutter: Those countries that have significantly developed CCS/CCU technology and are still decisively pushing it forward are the countries bordering the North Sea – first and foremost Norway, the Netherlands and the United Kingdom. Central to this is the idea of linking industrial port areas with offshore depleted gas fields that can be used to store the captured CO_2. However, increasing interest can also be seen in neighboring countries, particularly Germany, Denmark and Switzerland. And in the USA, too, carbon capture has recently been pushed.

Massimo Pardocchi is Global Development Director and Lead CCUS Business Development at Bilfinger SE

René de Schutter is Business Development Manager Energy Transition at Bilfinger Tebodin

Here, corresponding projects are currently being set up around the Gulf of Mexico in particular.

What are the biggest challenges in implementing and realizing the projects?

Massimo Pardocchi: The biggest bottleneck for the development and implementation of CCS/CCU projects is the lack of an integrated and efficient CO_2 transport infrastructure. As long as this is lacking, only comparatively small or regionally limited projects can be developed. Therefore, work is currently being done in particular on projects in which several emitters cooperate in industrial hubs and share the costs of building the necessary infrastructure. Many more CCS/CCU projects could quickly emerge in industry, but most interested parties lack a clear and viable business case. And this can only emerge if governments create the necessary framework conditions, especially in the form of appropriate infrastructure, a long-term policy and reliable tax rates.

How do you think the market will develop in the next years or decades?

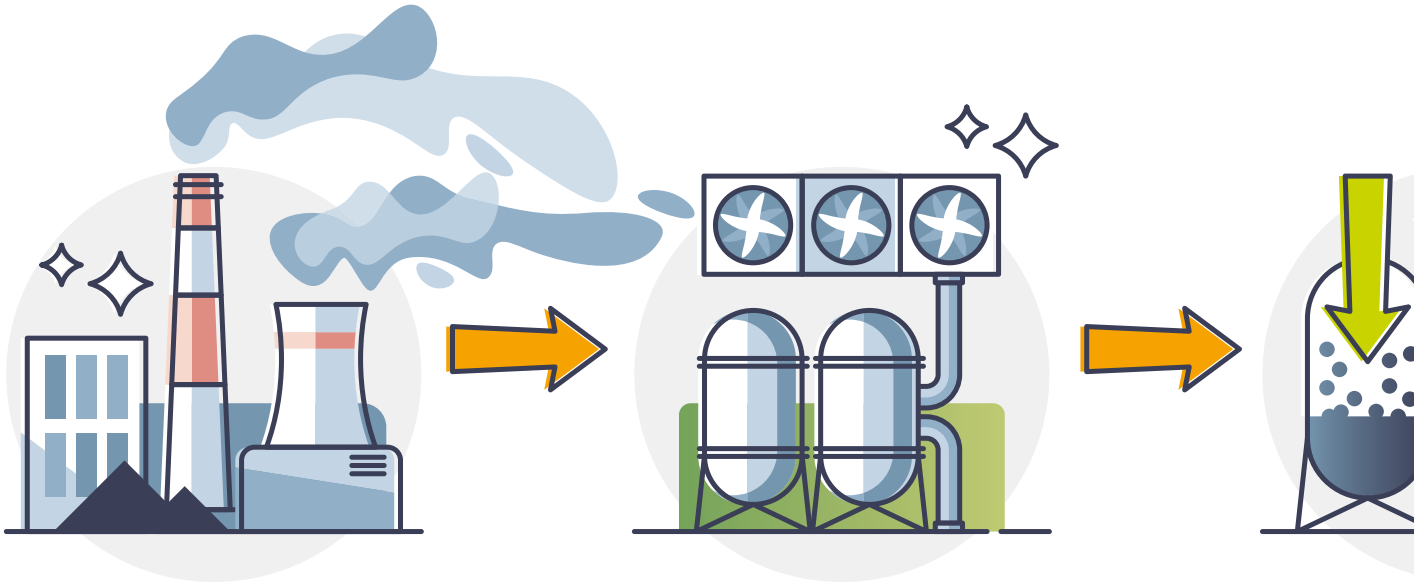
René de Schutter: The market will undoubtedly develop very dynamically. In recent years, we have seen several technical breakthroughs: In principle, the capture and transport of CO_2 no longer pose any major challenges from a technological point of view.

> “The market will undoubtedly develop very dynamically.”
>
> RENÉ DE SCHUTTER, BUSINESS DEVELOPMENT MANAGER ENERGY TRANSITION AT BILFINGER TEBODIN

As soon as the aforementioned infrastructure has been established and we have developed new and further ways of storing and, above all, using CO_2, CCS/CCU technology will be used to a significant extent worldwide. It was therefore important for us to be represented in this market at an early stage and to help shape its development.

How does Bilfinger support the development and implementation of CCS/CCU projects?

Massimo Pardocchi: Bilfinger has already been active in the field of carbon dioxide capture for over 20 years. Especially in the design phase, Bilfinger has contributed its know-how to numerous projects. In recent years, we have continuously expanded our range of services and are now offering design and build solutions which can support several industries such as cement or waste to achieve their decarbonization goals.



STUDY

NEARLY 200 COMMERCIAL CCS PROJECTS WORLDWIDE

The number of CCS projects around the world is increasing substantially, and the pace of growth is expected to accelerate even further. This is because CCS technology is being promoted in an increasing number of countries. These are the findings of the Global CCS Institute's most recent market analysis.

Interest in CCS technology has picked up around the globe. The Global CCS Institute, a climate think tank, lists a total of 196 commercial CCS plants in its "Global Status of CCS 2022" study. Of that number, 30 projects are already in operation, 11 are under construction and 153 are under development. 61 new facilities have been added to the project pipeline in 2022. Overall, this has brought the carbon capture capacity of all CCS plants under development to 244 million metric tons per year (MTPA). This represents an impressive 44 percent increase in the past 12 months.

The Global CCS Institute's CEO Jarad Daniels expects the pace of growth in CCS project development and implementation to increase further as countries and companies work to achieve their climate commitments. "The latest, most credible scientific analysis from organizations including the Intergovernmental Panel on Climate Change (IPCC) and the International Energy Agency (IEA), highlights that reaching our climate goals is practically impossible without CCS," says Daniels. "Many essential industries like cement and chemical production have no other viable path for deep decarbonization other than CCS."

CCS IS BECOMING INCREASINGLY COMPETITIVE

As CCS continues to scale-up, we are also seeing savings in cost and efficiency of deployment. "Thanks in part to strengthening government policies around the

Key results of the "Global Status of CCS 2022" study:

- In 2022, there are 30 commercially operating CCS facilities, 11 facilities in construction and 153 in various stages of development.
- The capture capacity of CCS projects in the project pipeline is 244 million tons per annum (MTPA) – an increase from 169 MTPA in 2021.
- In the USA, taxes on CCS projects have been reduced. Initial analyses suggest that this could lead to a 13-fold increase in CCS deployment by 2030.
- Canada continues to pursue CCS as part of broader decarbonization, with the 2022 federal budget including a CCUS tax credit and a CCUS strategy currently under development.
- In Europe, the Danish Government has committed €5 billion for CCS over 10 years, the Dutch Government has more than doubled the SDE++ program since its launch to €13 billion. Several countries in Europe, including Poland, Bulgaria, and Finland, are entering the CCS market for the first time due to the EU Innovation Fund's subsidy program.
- In the Asia Pacific region, Thailand announced its first CCS project, China's first million tonne project commenced operations and Australia saw new project announcements in Victoria and Western Australia as well as notable progress in the Northern Territory.

world, CCS is increasingly commercially competitive across the entire value chain, from capture technologies through to storage", explains Daniels. "We anticipate even more strategic partnerships and collaboration driving deployment, particularly through CCS networks."

Despite the growing importance of CCS, Daniels believes global efforts to reduce emissions remain insufficient: "Government policy must be met with private capital to unlock the full potential of CCS and limit global warming to 1.5 degrees to avoid the most catastrophic impacts of climate change. Though CCS deployment is scaling rapidly, we need to see an increase by at least a factor of 100 if we are to achieve the Paris climate goals."

THE GLOBAL CCS INSTITUTE

The Global CCS Institute is an international think tank whose mission is to accelerate the deployment of CCS technology. The institute's international membership includes governments, global corporations, private companies, research bodies and non-governmental organizations. With a team of professionals working with and on behalf of the its members, the Global CCS Institute drives the sharing expertise, building capacity and providing advice and support. The institute is headquartered in Melbourne. The institute also has offices in Washington, Brussels, Beijing, London, Tokyo and Abu Dhabi.

Jarad Daniels, CEO, Global CCS Institute

PROJECT PORTHOS

CO_2-STORAGE UNDER THE NORTH SEA

Work on the implementation of one of the world's most ambitious carbon capture and storage (CCS) projects is currently underway at the port of Rotterdam. The objective of the project is to compress roughly 2.5 million metric tons of CO_2 per year and store it in empty gas fields beneath the North Sea. The project has a considerable signal effect for other carbon capture and storage projects throughout Europe.

Preliminary preparations have been completed, but the final investment decision has yet to be made: a unique carbon capture and storage project will be implemented in the port of Rotterdam. The name of the project is "Porthos", the abbreviation for "Port of Rotterdam CO_2 Transport Hub and Offshore Storage". The infrastructure that will be built by Porthos will ensure that around 2.5 million tons of CO_2 generated in the Rotterdam port area will be compressed and stored every year from 2025/2026.

The port of Rotterdam is ideally suited for this ambitious project. This assessment is based on the fact that around 14 percent of all CO_2 emissions in the Netherlands are generated in the vicinity of the port. Porthos should succeed in reducing these emissions by approximately 10 percent. There are also empty gas fields in the North Sea around 20 kilometers from the port where the CO_2 can be stored.

STORAGE BELOW THE SEABED

Specifically, the transport and storage of the emissions by the project's initiators, EBN (Energie Beheer Nederland), Gasunie and the Port of Rotterdam Authority, is planned as follows: The CO_2 will be supplied by Air Liquide, Air Products, ExxonMobil and Shell.

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> From a strategic perspective, our involvement in the Porthos project is extremely important for us."
>
> THOMAS SCHULZ, GROUP CEO OF BILFINGER

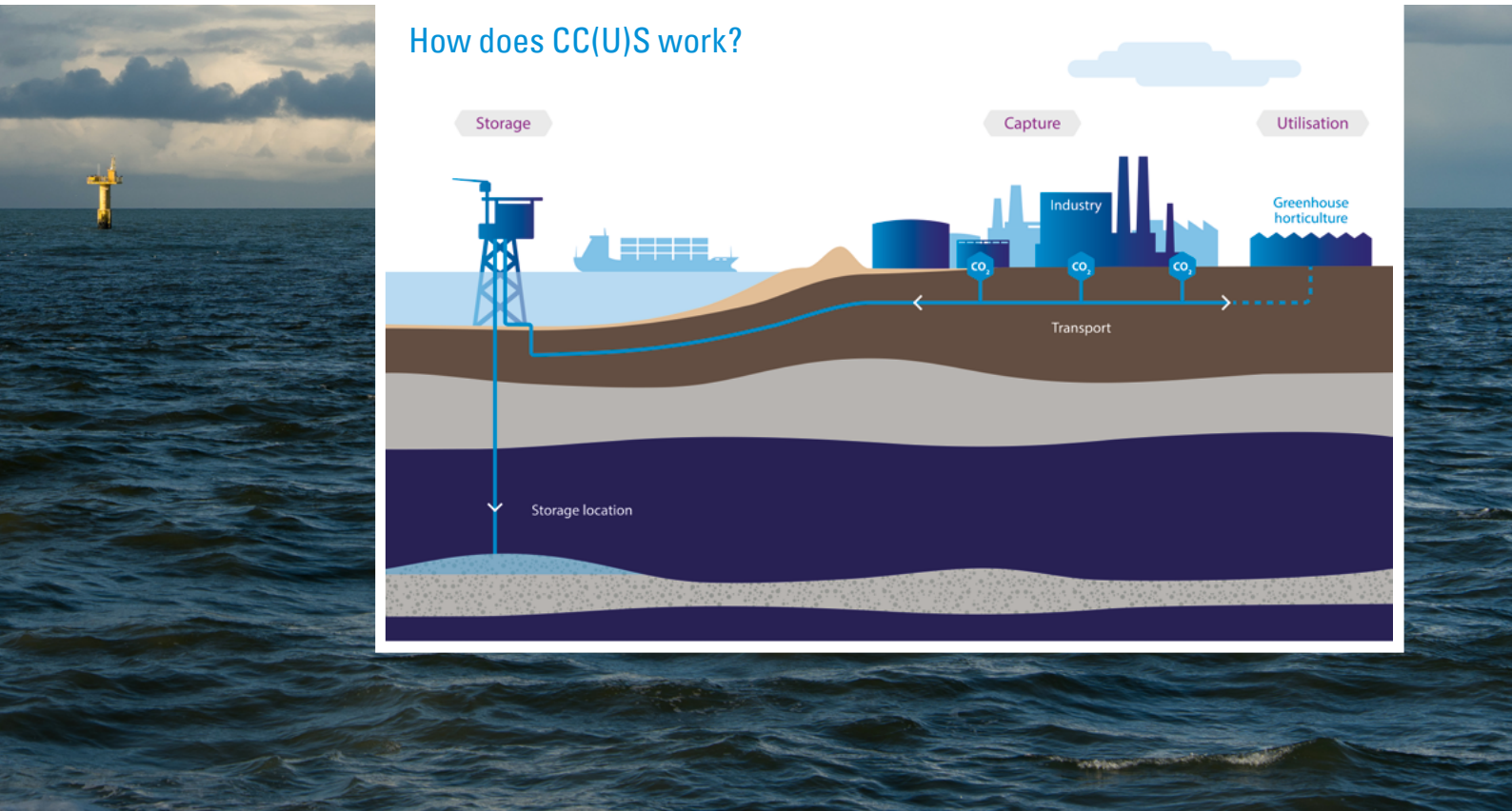
These companies will capture it at their industrial facilities near Rotterdam and feed it into a pipeline that runs through the port of Rotterdam. The CO_2 will then be routed through a compressor station into an offshore pipeline below the seabed and transported to a platform in the North Sea about 20 kilometers offshore. From this platform, the CO_2 will be pumped into empty gas fields located in a closed reservoir more than three kilometers below the North Sea bed.

"In September 2022, final storage permits were granted for the storage of CO_2 in empty gas fields under the North Sea", says Myrna Fraters, communications advisor at Porthos. "This makes fields P18-2 and P18-4 the first fields in the Netherlands in which CO_2 can be permanently stored. An important milestone for Porthos!" It is expected, however, that the realization of the project will be delayed by several months. As is common with projects of this magnitude and the use of innovative technologies, there are still legal issues to be clarified and these are currently being investigated thoroughly.

YEARS OF PREPARATION

Construction of the necessary infrastructure will begin as soon as the final investment decision has been made. The European Union has already recognized Porthos as a project of common interest and has granted funding of €102 million. According to current plans, the infrastructure is scheduled to go into operation in 2025/2026 at which point the capture and storage of CO_2 will begin.

A number of companies have been involved in the development of the planned infrastructure and Bilfinger is one of them. The company has been delivering support services for two years, including the preparation of a process simulation study, detailed planning for buildings at the compressor station and engineering of piping systems. "From a strategic perspective, our involvement in the Porthos project is extremely important for us. We can once again demonstrate that our services from a single source generate a high degree of added value across the entire value chain", says Thomas Schulz, Group CEO of Bilfinger.



How does CC(U)S work?

FEASIBILITY STUDY

CO_2 CAPTURE AS KEY COMPONENT OF SUSTAINABILITY STRATEGY

RHI Magnesita, the world market leader in refractories, has ambitious sustainability targets. Among them is a 15 percent reduction of CO_2 emissions by 2025. To achieve this goal, the company also relies on the capture and utilization of carbon dioxides – and devotes considerable effort and resources to testing new technologies within the framework of new partnerships.

To reach the goal of net zero emissions, companies in energy-intensive industries in particular must undertake a number of different measures. Such is the case with RHI Magnesita, the world's leading supplier of high-grade refractory products, systems and services. The company offers more than 120,000 products for the steel, cement, lime, non-ferrous metals, glass, energy, environmental and chemical industries. What really sets these products apart is the fact that they remain stable even under the most adverse conditions and at temperatures of 1,200 degrees Celsius, protecting firing and furnace systems from thermal, mechanical and chemical stress.

The manufacture of refractory products, however, is extremely energy-intensive and results in substantial CO_2 emissions. "One of our top five corporate priorities is to strive for net zero emissions", says Andreas Drescher, Project Manager Carbon Reduction at RHI Magnesita. "That's why we have adopted a variety of measures – more recycling, improving energy efficiency, switching fuels as well as the use of green electricity."

TESTING NEW CCU TECHNOLOGIES

But Drescher is confident that conventional measures alone will not help RHI Magnesita get to net zero. This is because almost half of the carbon dioxide emissions are released during the processing of minerals. "For this reason, we will be investing €50 million in new technologies for the capture and utilization of CO_2 emissions between now and 2025. In cooperation with leading research institutes and industrial partners, we are conducting industrial testing with these technologies and expect these efforts to deliver cru-

> “The options developed by Bilfinger have been essential in helping us take the next steps forward and identifying the solutions that are best for us.”
>
> ANDREAS DRESCHER, PROJECT MANAGER CARBON REDUCTION AT RHI MAGNESITA

cial progress and insights that will bring us closer to our climate targets”, says Drescher.

Initially, RHI Magnesita intends to reduce its emissions from Scopes 1, 2 and 3 (raw materials) by 15 percent before the end of 2025. For this purpose, the company has been measuring its CO_2 emissions for several years and has already made encouraging headway in the three year period from 2018 to 2021. At the same time, partnerships have been developed with universities, research institutes, companies and industry platforms to identify opportunities to capture and utilize the CO_2 generated during production.

FEASIBILITY STUDY ILLUSTRATES SCENARIOS

RHI Magnesita also approached Bilfinger about the project. The task was to prepare a feasibility study as well as a draft concept for a CO_2 separation plant to be used in a production facility for the processing of magnesite. Bilfinger’s experts developed several scenarios as part of this study, identifying solutions for how the captured CO_2 could be purified, liquefied and stored in a cryogenic storage facility for safe transport by truck or rail. This involved the development of a number of options that are made possible by a combination of different technologies.

“The options developed by Bilfinger have been essential in helping us take the next steps forward and identifying the solutions that are best for us”, Drescher explains. “The approaches we are now pursuing are extremely promising in terms of being able to continue to significantly reduce our Scope 1 emissions in the years ahead and taking a big step toward net zero.”

PILOT PLANT

REVERSING THE IMPACT OF CO_2 EMISSIONS

The extraction and burning of coal is one of the largest causes of greenhouse gases in the world. Lapwing Estate, a British food and farming company, is currently developing a concept that reverses this process – and converts CO_2 emissions back into solid carbon. The concept is known as “Reverse Coal”.

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Peatlands throughout the world are being drained in order to grow food. This process generates greenhouse gas emissions of between 25 and 35 metric tons of CO_2 per hectare per year. This corresponds to around five percent of total global anthropogenic CO_2 emissions. Lapwing Estate, a British food and farming company in Nottinghamshire, has focused considerable efforts on solving this problem in recent years. The company has developed a concept that captures and removes significant amounts of carbon and produces food with a measurable positive environmental and social impact.

THE SOLUTION CONSISTS OF FOUR CORE SYSTEMS:

1 Carbon abatement & capture

In order to stop current landscape emissions from degraded peat, the land needs be restored. This is achieved through careful land management and raising of the water table. This prevents further oxidation of the peat and allows the peat to slowly rebuild. Willow coppice, which uses nature's own carbon capture technique of photosynthesis, is planted on the rewet lowland peat.

2 Carbon processing

Biomass is rotationally harvested and chipped from the field. Once dried, the woodchips are fed into a high temperature pyrolysis plant which breaks down the biomass through thermal decomposition. This produces biochar, heat and electricity.

3 Carbon storage

Biochar is buried underground to ensure long-term, easily verifiable carbon sequestration (reverse coal).

4 Controlled environment agriculture

The heat and power generated from the pyrolysis plant will be used to power controlled environment agriculture for more sustainable food production and provide greater food security.

The concept developed by Lapwing Estate was successfully verified in a feasibility study. The next step will now be to set up a pilot plant. Bilfinger UK is providing support in the areas of technical planning, procurement and installation. Academic support for the project is provided by the University of Lincoln and the UK Centre for Ecology and Hydrology. The project is funded by BEIS, the UK Department for Business, Energy and Industrial Strategy within the scope of Phase 2 of the Direct Capture of Air and Other Greenhouse Gases program.

> "Bilfinger UK are excited to be part of Lapwing Estate's innovative CO_2 reduction project and delivering the carbon processing plant design, supply and installation. We see this as a positive opportunity for the future of Bilfinger UK and the environment."
>
> SANDY BONNER, EXECUTIVE PRESIDENT FOR BILFINGER UK

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