INDUSTRY

TRENDS
CCUS

CCUS Reaches a Turning Point

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By endorsing the goal "*to achieve a balance between anthropogenic emissions by sources and removals by sinks of GHGs in the second half of the century*", the Paris Agreement made States and non-state actors adopt the concept of carbon neutrality and to engage with the idea of "negative emissions". In this way, not only has the issue of offsetting emissions grown in importance, but also, to a lesser extent, that of capturing carbon for its geological storage or use (Carbon Capture, Utilisation and Storage – CCUS). Currently, most international reference scenarios regarding carbon neutrality (IEA, IPCC) include CCUS technologies to varying degrees, but in view of the past and current difficulties in implementing them, uncertainties remain as to whether they can be rolled out at the scales envisaged.

DATA OVERVIEW

An unprecedented boom in investment driven by the oil and gas sector

CCUS technologies are aimed at capturing CO_2 from industrial smoke or smoke from fossil-fuelled power plants and transporting it to a storage point in order to permanently sequester it in deep geological strata, or to reuse it (for the production of crude oil, fizzy drinks, synthetic fuels, greenhouses or building materials).[1] At the end of 2020, there were 26 CCUS projects in operation in the world.[2] Together, they capture the equivalent of 40 million tonnes of CO_2 ($MtCO_2$) per year with different processes of capture (post-combustion, oxy-combustion, pre-combustion), transport (trucks, boats, pipelines), storage and use — these processes themselves having varying degrees of technical maturity and economic viability. Currently, the main use of captured CO_2 is Enhanced Oil Recovery (EOR) in wells that have become unproductive: of the 26 projects in operation worldwide, 20 are financed through EOR (**fig. 1**).[2]

Several countries have recently issued or revised roadmaps for decarbonising their economies, that include CCUS technologies. These include Australia, Canada, China, the Netherlands, Norway, the United Kingdom and the United States of America.[3] To these, we must add countries that have made CCUS an instrument of their Nationally Determined Contributions (NDCs) to reduce climate change after 2020 under the Paris Agreement: Bahrain, Egypt, Iran, Iraq, Malawi, Mongolia, Saudi Arabia, South Africa and the United Arab Emirates. For example, after a period of inactivity, the United Kingdom published a roadmap in 2018 entitled Clean Growth Strategy aiming to make it a world leader in CCUS technologies. There could also be a large-scale relaunch of R&D based on CCUS in the EU via the Innovation Fund program (2020-2030), in order to stimulate the roll-out of new projects in decarbonisation. In the USA, several programs have recently been set up to help get this type of technology off the ground. For example, in 2016 the Carbon SAFE initiative was launched aiming to develop geological storage sites with a capacity of over 50 $MtCO_2$ and, in 2018, the 45Q tax credit, having been in place since 2009 but with problems in its application, was extended. This mechanism enables companies launching CCUS projects to obtain, under certain conditions, a \$30/t tax credit when CO_2 is captured for EOR and \$50/t when it is captured for geological storage.

This strategic context thus favours the launch of new projects at an industrial scale. According to figures provided by the IEA, between 2017 and 2020 more than 30 CCUS projects were announced worldwide.[4] If all the announced projects were to be implemented, storage capacities could go from 40 $MtCO_2$/year to 130$MtCO_2$/year. Between early 2020 and May 2021, a total of \$12 billion in investments in CCUS projects were announced by governments and industry.[5] In 2020, effective investments in CCUS took off to reach \$3 billion (up by 212% from 2019), mainly thanks to a few flagship projects devoted to heavy industries and driven by oil and gas companies.[6]

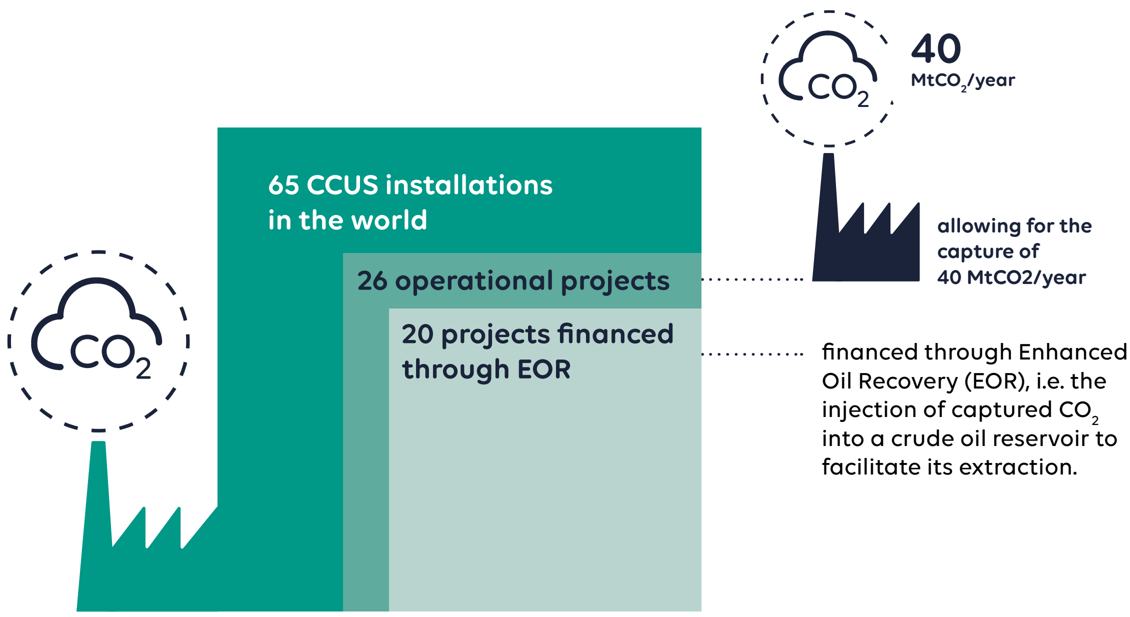
Among the recent projects in Europe, we can cite the Northern Lights project in Norway, combining the creation of transport infrastructure with carbon storage. It is driven by Equinor, Shell and TotalEnergies, a partnership resulting from a public consultation launched by the Norwegian Government, with the objective of storing 0.8 to 1 $MtCO_2$/year during the first phases of development, and then increasing this to 5 $MtCO_2$/year by receiving CO_2 from different European sources.[7] The project was supported by the Norwegian government, which injected \$1.8 billion into it in 2020 to tie the Longship project in with it, a project that captures emissions from a cement plant and a waste incinerator (**see Case Studies**).

In Great Britain, the oil giants BP, ENI, Equinor, Shell and Total have formed a consortium to finance Net Zero Teesside, a

FIGURE 1

CURRENT STATUS OF CCUS PROJECTS UNDER DEVELOPMENT AND IN OPERATION

Source: Global CCS Institute, 2020



project which aims to decarbonise the Teesside industrial valley and its numerous chemical industries. Further south, Equinor, the steel company British Steel and ten or so other partners are joining forces in the Zero Carbon Humber initiative to decarbonise the Humber industrial basin using hydrogen and CCUS.

The Netherlands has also included CCUS in several strategy documents (a specific roadmap in 2018 and the national climate plan in 2019) and relaunched a hub project in the port of Rotterdam (the Porthos project) for the capture and storage of 2 to 5 $MtCO_2$/ year.

In France, the 3D project, launched in 2019 in Dunkirk, brings together manufacturers such as Axens, TotalEnergies, ArcelorMittal and the French Institute of Petroleum and New Energies (IFPEN, *Institut Français du Pétrole et des Energies Nouvelles*), with several objectives: to demonstrate the efficiency of the capture technology developed by Axens/IFPEN, to prepare the deployment of CCUS on the ArcelorMittal steel site in order to capture 0.5 to 1 $MtCO_2$/year, and to study the feasibility of a CO_2 collection hub in the Dunkirk region (mainly to store CO_2 under the North Sea).[8]

Outside Europe, North America takes up the mantle as a CCUS leader, since 80% of capture capacity is in the USA, with a dozen sites in operation, and approximately double this if we count the development phase projects that have been announced. China, partly trailing behind up to now, with only one CCUS operation on a commercial scale (CNPC Jiling capturing 0.6 $MtCO_2$/year), has announced two new projects in this domain. However, outside the EU, operations launched between 2015 and 2020 are still relying heavily on EOR to remain economically viable. The IEA believes, nonetheless, that the future projects will be less dependent on this type of outlet.[4]

All in all, CCUS was placed third as a low-carbon expenditure item in the oil and gas sector in 2020 (**see Energy sector**). Of the 66 CCUS projects already in operation or planned in Europe in the coming decade, more than 50% are financed by oil and gas companies that are members of IOGP, the International Oil and Gas Producers association.[9]

This rekindled interest in CCUS, driven largely by oil and gas companies, comes after years of effort by stakeholders to get CCUS recognised as a fully-fledged solution in the transition to a low carbon economy. However, its actual roll-out at a large scale is still far off.

THE OBSERVATORY'S LENS

From 1990 to today: the long battle of CCUS to become recognised as a viable, legitimate and feasible decarbonisation solution.

From the 1990s to the mid-2010s: the pilot projects... and the initial difficulties

The first intended CO_2 capture projects with the aim of combating climate change, or to meet a carbon requirement (taxation, emission quotas), date back to the 1990s. In Norway, Statoil (now Equinor), forced by carbon taxation on its offshore crude oil exploitation, began injecting CO_2 at Sleipner in 1996. This was the first industrial-scale carbon storage project in Europe and, because it was the first, it went hand in hand with R&D programmes to meet the technical and safety challenges posed by this new activity. Almost at the same time, in Hawaii, an international project involving North American, Norwegian and Japanese teams was launched, but strong local opposition, supported by the NGO Greenpeace, led to its abandonment in 2001.[10]

With the first data collected at Sleipner, demonstrating the feasibility of geological storage, CCUS technologies were garnering interest on a global scale in the early 2000s, and there was even a Special Report of the Intergovernmental Panel on Climate Change (IPCC) on this question in 2005.[11] This report explored the potential use of CCUS technologies on the basis that fossil fuels would continue to play a large part in the global energy mix for decades to come and that the necessary changes in behaviour and means of production would be difficult to achieve. The figures proposed were therefore very ambitious: CCUS could trap 20 to 40% of global emissions (including 30 to 60% of emissions linked to energy production and 30 to 40% of those from industry) and could account for 15 to 55% of global mitigation activities in 2100, necessitating the rapid deployment of thousands of capture systems.

A few years later, the development of CCUS technologies was the subject of other experiments, mainly in North America and Europe, however taking different trajectories.

On the European continent, at the beginning of the 2010s, the EU was seeking to stimulate CCUS demonstration projects through various mechanisms, principally by setting up a reserve fund (New Entrant Reserve or NER 300) corresponding to 300 million quotas of CO_2 emissions issued through the Emission Trading System (ETS)[a], i.e. the equivalent of 4.5 to 9 billion euros for a CO_2 price ranging from 15 to 30 euros per tonne in order to finance projects fighting global warming. This strategy was relatively ambitious since it provided for the establishment of a dozen industrial-scale demonstration projects by 2015. However, for a number of observers it was a failure since in the end no CCUS project was funded by the NER 300, and other nationally launched projects in this domain also ran into a number of difficulties.[12] In France, for example, the few demonstration projects on an industrial scale launched at that time were all abandoned: this is the case, for example, of the ULCOS (Ultra Low Carbon Dioxide Steelmaking) project for capture on an ArcelorMittal blast furnace in Florange and its storage in saline aquifers near Verdun. However, a smaller-scale experiment with a complete CO_2 capture, transport and storage chain was carried out by Total (now TotalEnergies) in Lacq between 2010 and 2013, which finally enabled storage of 51,000 tCO_2.[13] In the neighbouring European countries, the Barendrecht and ROAD projects in the Netherlands and the Altmark project in Germany also had to be abandoned. In the United Kingdom, a strong supporter of CCUS from the outset, a government program to support industrial projects involving Shell (Peterhead) and the White Rose consortium (Drax) was discontinued in 2015. This was the second withdrawal on the part of the British government in this domain since 2010.

Several factors can explain this failure of the CCUS sector's deployment in the EU in the first half of the 2010s. One of them concerns economics: because of successive decreases in carbon prices in the ETS, these projects suffered from profitability problems, and it was more viable to buy carbon credits than to invest in these technologies. Furthermore, this period was marked by an unexpected growth in renewable energies, which gradually became the preferred solution of the public authorities in terms of decarbonisation.[14] To this was added a lack of political support[15] as well as local opposition (a factor often cited to explain project failures in the Netherlands and Germany) because of the various risks posed by CCUS (such as of leaks, or even induced seismicity), but also because of the energy transition model they underpin by maintaining a large share of fossil fuels in the energy mix and competing with renewables and other solutions based behavioural changes.[16]

On the European continent, only Norway continued to invest in CCUS with a second industrial project undertaken in Snøhvit in 2010 with a storage capacity of 0.7 $MtCO_2$/year operated by Statoil (now Equinor). CCUS was developed in this country thanks to a high carbon tax (in any case higher than that of the EU), but also due to strong political will: carbon storage, in Norway, is referred to as the national "mission to the Moon".[17] Thanks to this project and the one at Sleipner, the country currently stores 1.7 $MtCO_2$/year and is the only European country with industrial CCUS projects in operation.

In North America, the deployment of CCUS has had more success, in particular because a number of projects are associated with EOR, which makes them economically profitable. Nevertheless, this practice poses problems in terms of carbon footprints since the oil thus obtained, once consumed, releases more CO_2 into the atmosphere than the amount of CO_2 injected

a The CO_2 emissions trading system in the EU and European Free Trade Association (EFTA) countries set up in 2005, covering around 40% of European emissions.

into the reservoir and stored[b]. The problem is accentuated when the CO_2 used is of natural and not anthropogenic origin, which is the case in 70% of the EOR projects currently underway in the USA[4]: as the CO_2 is not removed from the atmosphere or industrial smoke, but is produced, amongst other things, to stimulate oil production, the carbon footprint is therefore even more negative. For these reasons, but also because it enables the use of fossil fuels to be extended, EOR, even if it pursues a final storage goal which is achieved relatively quickly, is considered a "taboo" in the EU.[18]

One of the flagships North American EOR projects in early 2010s (and still today) was the Weyburn-Midale project in Canada. Considered at the outset as an industrial project for oil production stimulated by CO_2 injection, it then gave rise to a research project on geological carbon storage (the IEA-GHG Weyburn-Midale CO_2 Monitoring and Storage research project from 2005 to 2012, then SaskCO_2USER from 2013 to 2015). Since 2014, a part of the CO_2 has come from the smoke of the Boundary Dam coal-fired power station in the Saskatchewan province. This CCUS chain enables the capture of 1 $MtCO_2$/year. The Weyburn-Midale project is also known for the controversy over suspected leaks, investigations having subsequently proven that the CO_2 present at the surface was of natural origin.[19]

Moreover, in North America, industrial and commercial CCUS projects have had more political support than in Europe. Accordingly, projects developed there in the 2000s and early 2010s benefited from different public funding mechanisms. For example, the Quest project (carried out by Shell) received grants from the Alberta Government (CA$740 million) and the Canadian federal government (CA$120 million) for carbon capture and storage connected with the transformation of tar sands and hydrogen in Edmonton (with a capture capacity of 1.2 $MtCO_2$/year, i.e., 30% of the site's emissions). Furthermore, in the United States, some projects have benefited from research and development funds, the U.S. Department of Energy (DOE) offering such funding for CCUS since 1997. However, this has not prevented certain projects from running into serious difficulties: this was the case of FutureGen 2.0 (in Illinois), a project to capture and store CO_2 from smoke from a coal-fired power station which, after many assembly problems and several suspension phases, was definitively abandoned in 2016 after losing its federal funding for not having implemented the scheduled work in the time allotted by the DOE.[20]

Elsewhere in the world, there were relatively few initiatives until mid-2010s: for example, the EOR projects of the Petrobras group in Brazil (3 $MtCO_2$/year) and Uthmaniyah in Saudi Arabia (0.8 $MtCO_2$/year), which are still going on.

The end of the 2010s: a rekindling of interest

At the end of the 2010s, the IEA and the Global CCS Institute, the main association for CCUS related manufacturers, discussed reviving CCUS, and fine tuned emission reduction scenarios focusing on a revival of the sector at a global scale. In the IEA's so-called "Sustainable Development" Scenario which models reaching carbon neutrality in 2070, 9.5 $GtCO_2$/year would have to be captured and stored, and 0.9 $GtCO_2$/year captured and used: 40% would be captured from the energy sector (mainly Bioenergy, Coal, Gas), 25% from heavy industry, 30% from fuel supply (hydrogen and biofuels) and 7% from direct air capture (DAC).[4]

In its new scenario for achieving carbon neutrality objectives in 2050, the IEA was even more ambitious and estimated that CCUS could capture 7.6 $GtCO_2$/year by 2050 (5.6 $GtCO_2$/year in the "sustainable development" scenario), with a similar distribution (**fig. 2**).[5] The EU would have to take a leadership role in this domain, alongside the USA and China: the IEA encourages it to invest heavily in CCUS and Negative Emission Technologies (NETs), using the recovery plans as an opportunity not to be missed. For the IEA, therefore, CCUS projects are vital for achieving carbon neutrality within a reasonable timeline. To support its line of argument, it produces scenarios with a small share of this type of technology in decarbonisation efforts,[21] which show that an energy transition without CCUS would be more expensive and take longer because it would require big investment in disruptive technologies that have not yet been developed.

Furthermore, CCUS is also regaining a certain legitimacy thanks to the IPCC's special "1.5°C" report, which includes these technologies and the NETs in three of the four major categories of scenarios considered.[22] Some advocates of these technologies have seen it as the ultimate proof of their inevitability, since the IPCC scenarios generally serve as a global benchmark for the implementation of climate policies.

In addition to these scenarios promoting CCUS, other factors are also causing renewed interest in these technologies. The first are political, since State commitments to achieve "carbon neutrality" have flourished since the signing of the Paris Agreements, commitments which have revived the discussion about technologies that can complement "natural" means of carbon sequestration.

The other factors are economic: in addition to the rise in the price of carbon, which could make CCUS operations more profitable (increase from €25/t in January 2020 to over €50/t in summer 2021 on the European carbon market), the oil and gas sector sees new economic opportunity in the development of this sector as their know-how could be invaluable, especially on the transport and storage side.

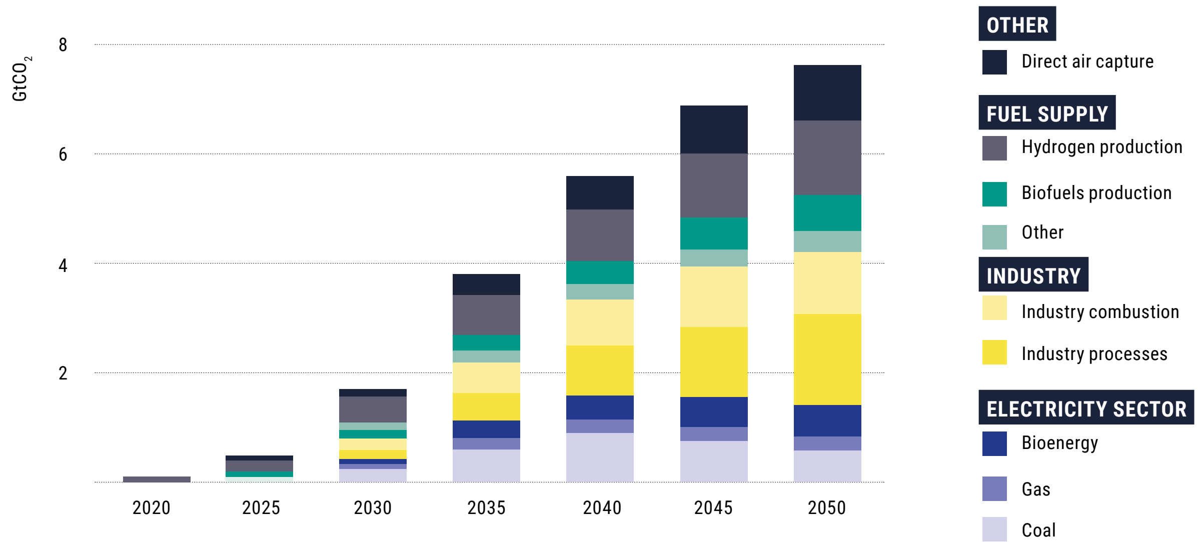
In society, perceptions of CCUS seem to have changed, although it is still largely overlooked by the general public

b Farret (2017) estimates that one tonne of CO_2 makes it possible to recover on average 0.25 tonnes of oil which, when burned, will produce around 2 tonnes of CO_2.

FIGURE 2

CO_2 CAPTURE BY SOURCE IN THE INTERNATIONAL ENERGY AGENCY'S (IEA) "NET ZERO BY 2050" SCENARIO

Source: IEA, 2021.



and the political class. Its principal advocates have changed their discourse to make it more acceptable and legitimate in the energy transition scenarios envisaged. In the beginning of the 2000s and 2010s, it was presented as useful for the "greening" of energy production based on conventional fossil fuels (particularly coal), which led to its rejection by a large number of players wishing to get out of fossils. Today, however they place emphasis on its potential in terms of reducing the "incompressible" emissions from heavy industry, i.e., after integrating decarbonised energy sources and optimising production processes.[23] In fact, three industrial sectors (cement, steel and chemicals) alone account for 65% of industrial GHG emissions, using only 1% of renewable energy in their processes.[24] Their decarbonisation might appear unattainable without disruptive technologies like CCUS or hydrogen (**see Hydrogen trend**).

According to their proponents, CCUS technologies could enable preventing the relocation of industries that have failed to complete decarbonisation, thereby becoming a group of technologies that could save jobs nationally and reduce dependence on exported industrial production.[25] The association with NETs also contributes to this operation of upgrading CCUS, since their development could pave the way for other processes that could remove carbon from the atmosphere and help stick to the 1.5°C objective (with the possibility of deploying more NETs if needed).[26]

Finally, the theoretical roll-out of uses for captured carbon other than EOR (say in building materials[27] or plastic objects[28]) echoes the concerns about material recycling and waste matters.[14] However, these new outlets for CCUS may also raise new concerns. As to its uses, as previously mentioned in case of EOR, uncertainties remain about the final carbon footprint, due to the CO_2 not being permanently sequestered and returning to the atmosphere in most cases in the more or less short term – say, at the end of the life-cycle of the manufactured product. As for NETs, there are many uncertainties about the possibility of actually implementing them, and also about their social and environmental sustainability. For example, Bioenergy with Carbon Capture and Storage (BECCS), which requires significant agricultural extension and intensification in order to produce the biomass that will be used in the power plants, raises issues of competition for space with other forms of land use (agricultural production, natural vegetation), pressures on biodiversity and also pollution.[29]

For the IEA, the next ten years will be crucial for rolling-out CCUS and NETs. It considers the proliferation of industrial and R&D projects as one of the means of lowering costs and demonstrating the relevance of these technologies to achieve the climate targets set.[4] But is upscaling in this way to reach 1.6 $GtCO_2$ captured in 2030 and 7.6 $GtCO_2$ in 2050 really feasible?

The beginning of the 2020s: significant obstacles to the large-scale roll-out of CCUS remain

The answer to this question is far from simple, even for a staunch proponent of CCUS like the IEA. On the one hand, it believes that rolling out these technologies in an exponential way is possible, citing the example of flue gas desulfurisation techniques in thermal power plants which has grown dramatically in 30 years (1972-2012). On the other hand, it is aware of the fragility of the current economic situation: the economic crisis of 2008 put the brakes on the first wave of CCUS projects, and it is possible that the one resulting from the Covid-19 pandemic could have the same consequences.[4] For example, the Petra Nova project, a recent US showcase of CCUS, also based on EOR, was put on hold because of the fall in oil prices in 2020. Some analysts, such as R. Farret, see CO_2 capture for EOR as a springboard for developing CCUS technologies since it could lead to their technical improvement, lower cost and the general public becoming more familiar with this type of technology.[12] Recent IEA recommendations on stopping further exploration of oil fields by 2025[30] and the announcements of certain governments in the same vein may indeed favour a multiplication of CCUS systems for EOR purposes, to extend the life of existing oil wells. However, the likely fall in oil prices in the coming years may also have the opposite effect.

Another factor of uncertainty relates to the social and political support for this type of technology. From a social point of view, CCUS and NETs remain largely unknown to the general public. They arouse much less interest and cause less controversy than nuclear or renewable energies.[31] However, these are technologies that generate concern over the risks – industrial, leakage or induced seismicity.[32] Furthermore, their assimilation with geoengineering technologies,[33] which are subject to a certain amount of mistrust, and the fact that they are presented as solutions that serve only industrial and oil and gas lobbies does not make their acceptance by the general public any easier.[34]

In the political arena, some authors describe CCUS as "orphan technologies" (in other words, they have neither strong supporters nor or strong opponents).[17] In general, up to now, the political class has had little time for debates about CCUS, apart from a few specific nations such as the USA, Canada or Norway, countries with a strong tradition of exploration of geological resources on their territory. As there are quite a lot of uncertainties about these technologies (how they are received by society, the environmental risks, whether there are real climate benefits), taking a stance on this topic may be dangerous for a politician.

In the big environmental NGOs, such as those making up the "green lobby" in Brussels (the "Green 10")[c], support is also far from strong. Greenpeace is the only one to have campaigned against CCUS during the first wave of projects, because it was associated with the idea of maintaining a large share of fossil fuels in the global energy mix.[35] Today, its position seems to have changed: it is not against marginal use of these technologies once all other possible decarbonisation options have been exhausted.[36] This position is also held by the Climate Action Network, even though one of its recent notes tries to warn of the danger of having too much faith in NETs.[37, 38] For the moment, these NGOs are focusing their attention on questions that attract broader engagement, such as the climate commitments of certain States or economic actors and keeping fossil fuels in the future energy mix, which may lead to them making the odd criticism of CCUS technologies, but it is not their main target.[39] This may be linked to its status as a "bridge technology", with CCUS sometimes being put forward as an interim solution in order to ensure the transition from the current phase, which is heavily dependent on fossil fuels, to the desired phase, that of an economy globally fuelled by renewable energy.

Advocates of CCUS, therefore, still need to find convincing arguments, which is not easy given that promises of economic development, jobs or technological competition no longer allow for easier acceptance of industrial projects.[40] The IEA and certain analysts wish, for example, to abolish the distinction between "natural" and "technological" carbon sinks in order to facilitate public support as well as that of the political class, and to avoid criticism of "techno-fixes" (technological solutions to problems created in part by technological development itself).[41] Another trend that we are currently seeing emerge is the emphasis on the role that CCUS could play in the production of carbon-free hydrogen (or "blue hydrogen"), an energy source that has a rather positive aura (**see Hydrogen Trend**).

Last but not the least, the main question remains the feasibility of this type of technology. For its advocates CCUS poses no particular problems. On paper, geological storage opportunities broadly cover our needs. For example, the IEA estimates that the North Sea can store 80 years' worth of current emissions from the EU.[42] For the industrial sector, geological storage is a simple procedure and one that is completely achievable, given that if they can extract crude oil from a reservoir, then they can store CO_2 in it.[43]

However, when it comes to the localisation of CCUS, in other words, concretising its implementation in one or more given areas, there are many uncertainties and difficulties to be overcome. In France, ADEME, the public agency for ecological transition, published a document seeking to precisely determine where it would be possible to capture and store carbon on the French mainland territory. Taking geographical (distance between emitter/well), economic (cost and profitability of the various links in the chain depending on the volumes emitted, transported and stored) and social (low acceptability of onshore storage) constraints into account, it concluded that the roll-out of CCUS should be limited to three areas (Dunkirk, Le Havre and Lacq), and invited manufacturers located outside these areas to consider other decarbonisation processes.[44] The initial assumptions made by ADEME have been criticised by some players in the sector, considering that the costs may fall and that other transport solutions (reuse of existing gas pipelines) and other storage solutions (for example in the Mediterranean) could be envisaged in the more or less short term, with major investments from private stakeholders and public authorities.[45]

Another problem is the extent of the work and the expenditure necessary for CCUS deployment to transition to the scales envisaged in certain IEA or IPCC scenarios. For CO_2 transport, for example, there are few figures and projections available. In Europe, a 2011 modelling carried out for the European Economic Area and based on a scenario forecasting the capture of 1.39 $GtCO_2$/year by 2050, estimates that 18,728 km of pipeline would be necessary for transporting and storing CO_2 if this is configured optimally (cost/distance between emitters and sinks). These facilities would represent a cumulative investment of 28 billion euros up to that date.[46] However, the target of the Net Zero By 2050 scenario (7.6 $GtCO_2$/year in 2050) is 5.4 times higher than the assumption in this scenario. This quantity of pipeline seems far from negligible, and yet it is

c This designation refers to the following NGOs: Greenpeace Europe, CEE Bankwatch, Birdlife International, Climate Action Network Europe, WWF Europe, Naturfriends International, European Environmental Bureau, Health and Environmental Alliance, Friends of the Earth Europe, Transport and Environment.

still low compared to the networks used in Europe for natural gas (200,000 km in 2005[47]). Based on the observation that this has already been implemented for crude oil production, the deployment of several thousand kilometres of pipeline for CO_2 remains a plausible hypothesis. However, the existing networks have been developed because the products conveyed had real economic value and represented potential benefits for manufacturers or operators, which is not the case with captured carbon, since for the moment it is still mainly a constraint (apart from its use for EOR).

It remains to be seen, therefore, whether public authorities and the private sector will agree to finance all of this work.

KEY TAKEAWAYS

Since 2015, there has been a resurgence of interest in CCUS and conditions once again appear favourable for its deployment. But due to a number of uncertainties of an economic (viability of CCUS), technical (safety during the various stages of the production chain) and strategic (the relative share of CCUS in decarbonisation strategies) nature, private actors and public authorities are still hesitant to embark on industrial-scale projects or infrastructure financing. Currently, although CCUS is increasingly presented as relevant for certain business sectors (such as for reducing emissions from heavy industries) and certain applications (especially for NET deployment), it is still considered by political actors as a secondary solution or a back-up solution if the other decarbonisation mechanisms fail. At a social level, it is not the subject of lively debate and continues to be largely ignored outside certain specific spheres (NGOs, bodies specialising in the energy transition) or during attempts to implement local projects. Few political, institutional and regional players have thrown their weight behind it. For these reasons, large-scale deployment at least of the order of a gigatonne per year from 2030 as envisaged by the IEA or in certain IPCC scenarios, is unlikely.

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