Enabling the decarbonisation of fossil fuel based power sector through CCS

The application of CCS to industrial sectors is expected to deliver an overall 14% of the required emission reduction by 2050. Two key challenges in the short term are geological storage and the application of CCS to industrial sectors other than power. Apart from the overview of the state of the art of CCS R&D in Europe, it is worth stressing the economic potential, options and challenges for this technology to contribute to the decarbonisation of the energy system.

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Introduction

Since CCS can achieve significant CO_2 emission reductions, it is considered a key option within the portfolio of approaches required to reduce greenhouse gas emissions. CCS technology involves three major steps [1].
Capture: separation of CO_2 from other gases produced at large industrial process facilities, such as coal and natural gas power plants, oil and gas plants, steel mills, cement plants, etc. Transport: once separated, $CO_2$is compressed and transported via pipelines, trucks, ships or other methods to a site suitable for geological storage.
Storage: CO_2 is injected into deep underground rock formations, often one kilometer deep or more.

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Enabling CCS means providing governments, regulators, policymakers, communicators and others interested in CCS with resources to help different entities and stakeholders to act into the deploying. The

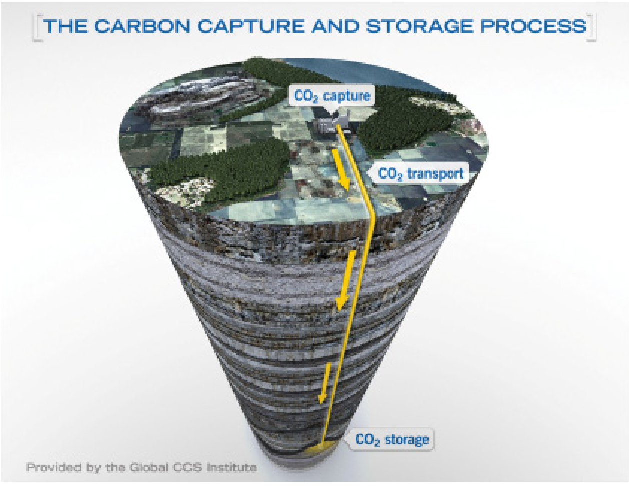

FIGURE 1 The CCS technology chain
Source: GCCSI

International Energy Agency showed that in scenarios that do not consider this option the total cost to halve CO_2 emissions levels would increase by 70%. Therefore CCS can play its part, ensuring an affordable energy supply at reduced costs.

The state of ongoing activities

Despite considerable efforts to take the lead on CCS development, apart from Sleipner and Snohvit projects that deal with natural gas sweetening, in the EU none of full-size demonstration projects are still running, and even the most promising EU projects are facing major delays. When the planning of CCS demonstration projects started in 2008, companies and, actually, legislators and regulators were expecting a further rise in certificate prices in the near future, being soundly optimistic on the assumption that the savings in CO_2 certificates will be able to compensate for the additional costs of CCS after the demonstration phase, thus opening a business perspective for this technology. Certificate prices of 25 €/t-CO_2 had been a common assumption, and went into the economic calculations of the project proponents. Since then, certificate prices have dramatically fallen, and now languish at a price of around 5 €/t-CO_2, thus making the operational costs of the CCS chain more expensive than the potential savings. Without additional European or national support, the demanding CCS demo program of the EU, having at least 5-6 demo projects running, will fail [2].

Challenges and opportunities

The recession in Europe, along with a significant increase in renewable electricity production triggered by subsidies, has undermined the EU Emission Trading System (ETS). Cleaning up power plants or industrial installations by CCS will require additional investments for equipment and will increase the operational costs of the plants. Support schemes such as the European EEPR program and the NER-300 support for CCS demonstration projects are not sufficient to make the project work. Additional national support by capital grants and/or feed-in tariffs will most likely be necessary to bring demo projects to a positive investment decision. The cost for adding CCS at demonstration plant scale of 250 MWel will typically be in the range of 500-1000 million euro.

The EU CCS Directive provided the legal framework for the storage of CO_2 in the EU. However, to be applicable in the different Member States (MS), the EU directive needs to be transposed. Fortunately most MS, with demonstration projects under way, had transposed it into national law but with some delays. In addition, project developers are facing the challenge that there remain significant uncertainties regarding the liabilities and the handover processes and requirements once the CO_2 storage phase has been completed.

Renewable energy has the highest support rate in general even if all large scale infrastructure projects are heavily debated. A key challenge with all infrastructure projects is that advantages and disadvantages for any individual need be balanced with the advantages and disadvantages for society. Carbon capture and storage, as a new technology, has still to explain and prove its merits to the public, requiring the testing and application of the technology at demo scale. All this has caused severe delays for demo projects planning to store CO_2 onshore. There is still a strong belief in the general public that the electricity supply can be completely shifted to fluctuating renewable energy and therefore CCS might not be necessary. However people tend to ignore that electricity from renewables together with the necessary reinforced grids and energy storage will be more costly than allowing CCS in the electricity mix.

The European industry has to compete internationally, and significantly higher electricity prices will reduce the competitiveness of industry, which is the key driver for economic growth and jobs in Europe.

In the CCS technology development significant progress has already been made, bringing down the energy penalty from 17% point to values of around 8% points. It is expected that significant further learning effects can be realized, based on the experience from demo projects and further R&D. Conventional natural-gas-fired power plants are likely to be a serious competitor to coal CCS in the short to medium term, providing large emission reduction opportunities by shifting fuel from existing coal power plants to new highly efficient gas-fired combined cycles. Such development can be

a barrier for early deployment of CCS and could result in the delay CCS commercialization [3].
The introduction of carbon sequestration technologies will result in the increase in a number of costs. Specifically: increased capital costs for each plant to be equipped with carbon separation/capture; additional capital costs for CO_2 transport and storage; increased fixed operational costs and increased variable costs; additional operating costs for CO_2 transport and storage. There is currently no clear difference between any of the three CO_2 capture technologies (post, pre-combustion or oxy-fuel), that could be competitive once successfully demonstrated.
Several analyses show that investment costs are the main factor influencing total costs. The associated European Unit Allowances (EUA) break-even cost corresponds to a price of 34 €/t-CO_2, and 90 €/t-CO_2 for gas. At an EUA price of 35 €/t-CO_2, coal-fired CCS power plants are therefore close to becoming commercially viable.

Conclusions

Enabling policies are required in the intermediate period – once the technology is commercially proven, but before the EUA price increases sufficiently to allow full commercial operation. The goal is to make new-built power plants with CCS more attractive to investors than those without, and with a secure environment for long-term investment.
All recent studies and roadmaps have proven the importance of CCS, even if not fully recognized by the public at large. It is therefore important to ensure that CCS can keep its momentum to deliver from 2020 onwards. Therefore, at least 2 or 3 demonstration projects have to be realized in Europe during this very decade.

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references & notes

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