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CCUS technologies: an important component in climate action?

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To curb global climate change, governments and companies are setting increasingly ambitious targets to cut their emissions to “net zero” in the coming years. Capturing carbon dioxide from production processes and the environment, as well as its long-term storage, play an important role in the underlying strategies Technologies that are not yet in widespread use today are also being considered in these efforts. The focus is on CCUS.

CCUS: an array of technologies

CCUS – *carbon capture, utilisation and storage* refers to a wide range of different technologies that can be used to directly reduce emissions in key sectors. In addition, CO_2 is also considered a raw material. CCUS specifically covers the following areas of application:

1. Carbon **capture** from thermal power plants or from industrial processes. CO_2 can also be removed directly from the atmosphere.

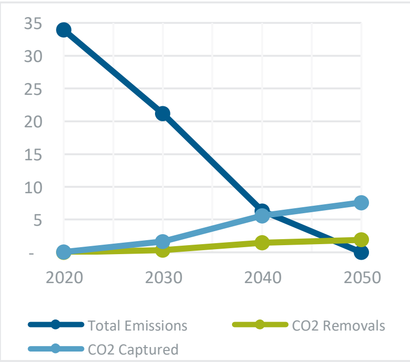
2. The **use** of captured carbon for a variety of downstream products such as the production of synthetic fuels.

3. The long-term **storage** of carbon dioxide in underground geological reservoirs.

The challenges in the individual areas, however, are enormous. For example, **capturing** emissions at power plants goes hand in hand with an increase in fuel consumption of up to 30%. The annual demand for CO_2 for **utilisation** is around 230 megatonnes (Mt); the largest consumer is the fertiliser industry with around 125Mt of CO_2 annually. On the **storage** side, however, it is still uncertain what the global storage capacity is from a technical standpoint. In theory, it is estimated at 8,000–55,000 gigatonnes (Gt), but with considerable regional differences. In addition, suitable storage sites and sources of carbon dioxide are often physically separated, which is why end-to-end transport concepts are needed.

Potential for climate action

Carbon capture and storage plays a central role in the International Energy Agency’s (IEA) roadmap “Net Zero by 2050”. The IEA assumes that CCUS can and must significantly reduce energy and industry-related CO_2 emissions.



Forecast of CO_2 reduction potential
Source: IEA (2021) in Gt CO_2 per year

In the short to medium term, the greatest potential for reduction continues to be found in the increased expansion of renewable energy and energy efficiency. But even if climate-friendly technologies are scaled up to a massive extent, CCUS will be indispensable to radically reduce global emissions.

According to the IEA, capacities must be created by 2050 to remove a total of around 9.5Gt of CO_2 annually from the atmosphere or industrial processes. This is almost equivalent to the annual CO_2 emissions of China. Around 0.04Gt of CO_2 is currently captured and stored per year by the 21 CCUS facilities in operation worldwide. In comparison: in Germany alone, around 0.74Gt of harmful greenhouse gases were emitted in 2020. The reduction potential associated with CCUS will therefore have to be an essential pillar in national and international mitigation strategies. This also affects a large number of developing countries and emerging economies, which continue to show strong growth in demand for energy.

General conditions and outlook

To date, there is hardly any economically viable use of CCUS. Virtually every operating facility needs public support, e.g. in the form of capital or operating subsidies. The cost structures vary greatly depending on the area of application, which is why only approximate values can be provided; the cost of capturing one tonne of CO_2 in the power plant sector is currently estimated to be approx. USD 60. Capture from industrial processes is usually associated with higher costs and ranges between 60–190USD/tCO2.

However, the general technical and economic conditions for CCUS have evolved in recent years. With the worldwide increase in facilities and new research activities, further cost reductions can therefore be expected. Apart from the reduction of capital costs, the increase in efficiency and the physical proximity between carbon source and storage location, the design of national and international carbon pricing regimes is particularly crucial for the further development of profitability.

At the same time, there is a need for widespread political and social acceptance of the technologies. This still raises a number of questions, particularly with regard to long-term storage.■

Note: This paper reflects the opinion of the authors and does not necessarily represent the position of KfW.