CAPTURE

CCS EXPLAINED SERIES

GLOBAL CCS INSTITUTE

Carbon Capture and Storage (CCS) refers to a suite of technologies that capture and store the greenhouse gas carbon dioxide (CO_2), so that it does not reach the atmosphere and contribute to climate change.

CO_2 CAPTURE

Capture is the first stage of the CCS process, involving separating CO_2 from emissions produced by industrial processes or from fossil fuel-based power generation. This type of capture is known as **'point source capture'**.

Industrial processes such as cement, steel, pulp and paper, chemicals and natural gas processing account for around 34%[1] of global energy-related CO_2 emissions. In some cases, CO_2 emissions are a by-product of these processes rather than the result of burning fossil fuels in the production process. For some industrial processes (such as cement manufacturing and blast furnace steel making) CCS is one of the only technological options that can help secure deep emissions reductions now.

CO_2 can also be **removed** from the air during **Carbon Dioxide Removal (CDR)**, enabling the removal of historical emissions from the atmosphere.

CO_2 CAPTURE APPLICATIONS

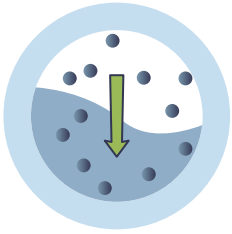
Some of the first CCS facilities are in natural gas processing, as well as fertiliser, ethanol, chemical and hydrogen production. However, in the last decade, applications of CCS have broadened and now include coal-fired power generation, ironmaking, low-carbon hydrogen production and direct air capture and storage.

The first commercial CCS application in cement production is operational in China, and similar applications in gas power generation and waste-to-energy are under development.

Brevik CCS facility in Brevik, Norway. Image courtesy of SLB Capturi.

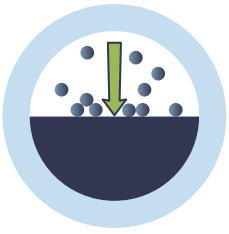
TECHNOLOGIES USED DURING CO_2 CAPTURE

CO_2 capture uses several broad classes of technologies.



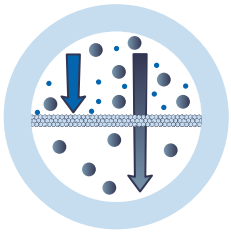
ABSORPTION BY LIQUID SOLVENTS

Gaseous CO_2 dissolves into a liquid solvent - the absorbent - forming a solution.



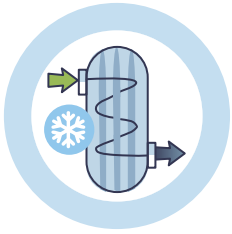
ADSORPTION ONTO THE SURFACE OF SOLID SORBENTS

Can be a physical or chemical process in which CO_2 molecules bind to the surface of a solid adsorbent.



SEPARATION USING MEMBRANES THAT ACT LIKE MOLECULAR SIEVES

A barrier or medium, called a membrane, allows for the selective separation of CO_2 from a gas stream.



CRYOGENIC SEPARATION

Cooling is used to condense CO_2 from a gas stream, distilling it to a liquid, or transforming it into a solid.

Other capture processes include chemical processes such as chemical looping - but these are not as commercially common at present.

[1] www.ipcc.ch/report/ar6/wg3/downloads/report/IPCC_AR6_WGIII_FullReport.pdf

POINT SOURCE CAPTURE METHODS

A variety of capture methods, including membranes, have been developed for different applications. Three effective CO_2 capture methods for power generation are shown below.

PRE-COMBUSTION

Involves the separation of CO_2 from flue gases **before fuel combustion** in industrial processes or facilities. This method converts fuel into a gaseous mixture **(syngas)** of hydrogen and CO_2. The CO_2 is compressed for transport and storage, while the hydrogen is separated and can be burnt for energy without producing any CO_2.

Advantages: Hydrogen produced can be either stored or used for different applications.

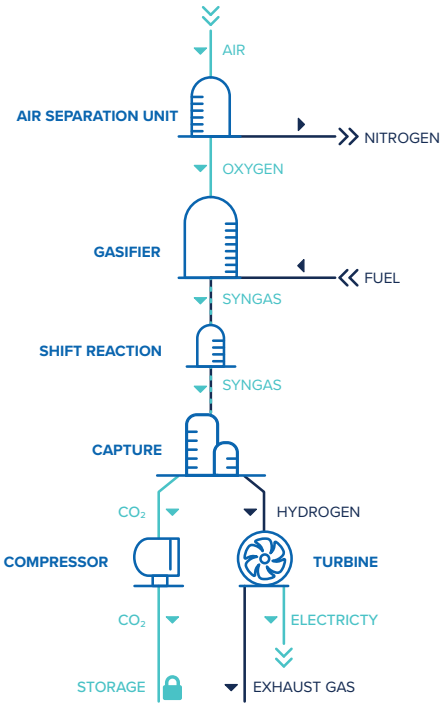
POST-COMBUSTION

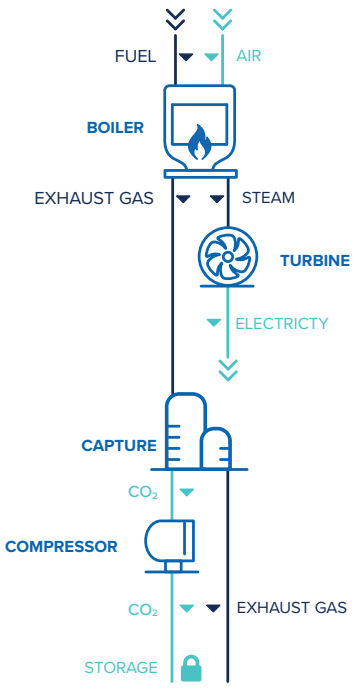
Involves the separation of CO_2 from flue gases emitted **after fuel combustion** in industrial facilities. This method separates CO_2 from combustion exhaust gases using a liquid solvent or other separation methods. In an absorption-based approach, once absorbed by the solvent, the CO_2 is released by heating to form a CO_2 stream, which can be compressed for transport and storage.

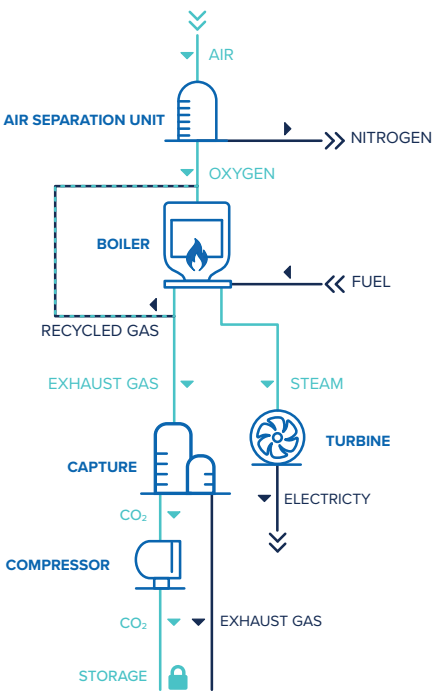
Advantages: This technology can be retrofitted to existing power stations not yet ready for decommissioning.

OXYFUEL COMBUSTION

Involves separating the CO_2 by combusting fuel in the presence of nearly pure oxygen rather than air. This produces exhaust gas that is mainly water vapour and CO_2 that can be easily separated to produce a CO_2 stream that can be compressed for transport and storage.







CCS technologies can capture well over 90% of CO_2 emissions from industries where they are applied – CO_2 that would otherwise have been released into the atmosphere.

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