

WHAT IS CCS?

Carbon capture and storage (CCS), also referred to as carbon capture and sequestration, is an integrated suite of technologies that can prevent large quantities of the greenhouse gas carbon dioxide (CO₂) from being released into the atmosphere.

As the name implies, CO₂ is captured – typically from large industrial processes – before it is emitted into the atmosphere. Captured CO₂ is then transported to a carefully selected and secure storage site, where it is injected deep into a rock formation for permanent storage.

Because CCS can achieve significant emission reductions, it is considered a key option within the portfolio of approaches required to reduce emissions.

There are three major stages involved in this technology:

- 1 Capture – the separation of CO₂ from other gases produced at large industrial process facilities such as coal and natural gas power plants, steel mills and cement plants.
- 2 Transport – once separated, the CO₂ is compressed and transported, usually via pipelines, to a suitable site for geological storage.
- 3 Storage – CO₂ is injected into deep underground rock formations, often at depths of one kilometre or more.

WHY DO WE NEED CCS?

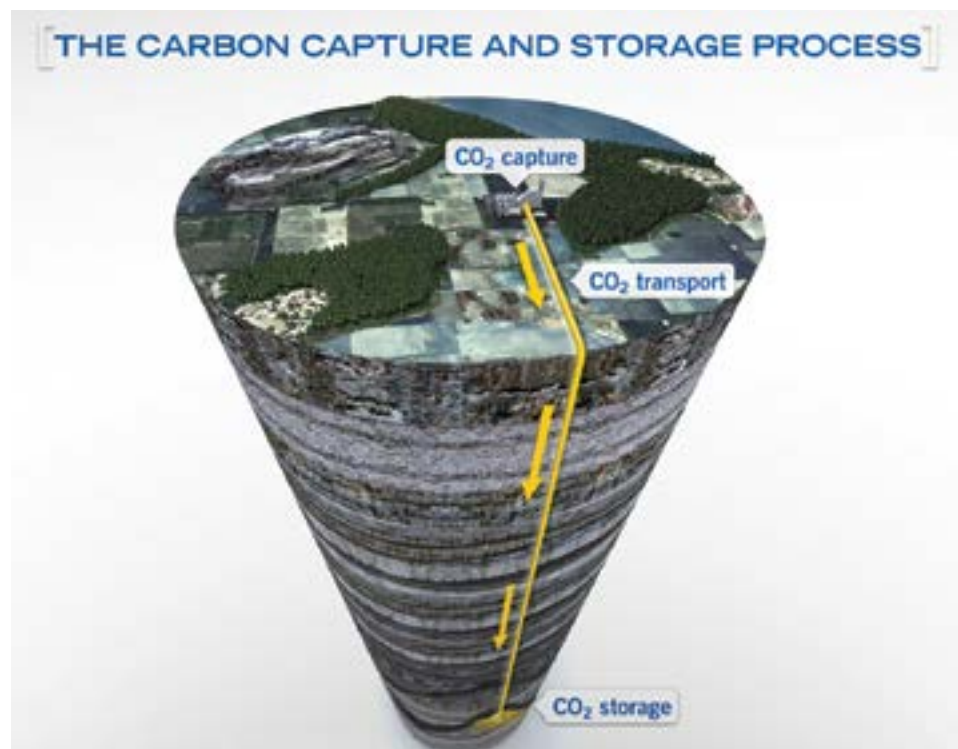
The amount of CO₂ in the atmosphere is increasing and the temperature of the Earth is rising. To avoid dangerous climate change, the global average temperature rise must be capped at 2°C relative to pre-industrial times. To achieve this, we need a very significant scale of CO₂ mitigation.

CCS can contribute around 13% of total energy-related CO₂ reductions by 2050, compared to a 'do nothing' approach (2015, IEA, Energy Technology Perspectives).

Around 40% of CO₂ emissions come from the power sector. Another 25% come from large-scale industrial processes such as iron and steel production, cement making, chemicals and refining.

Demand for fossil fuels is likely to remain strong, especially in developing countries, where a significant percentage of the population currently has no access to electricity.

CCS is a viable option – in some cases, it is the only viable option – for significantly reducing emissions from such large-scale emission sources.



CAPTURING CO₂

Carbon dioxide can be separated from a carbon emission source either before or after it has been combusted (burnt) to produce energy or other products, such as cement and steel.

There are three ways to capture CO₂ that can be applied to the power sector:

- pre-combustion technology
- post-combustion technology
- oxyfuel combustion.

TRANSPORTING CO₂

Once separated from other elements of the flue gas (gas exiting via a chimney or 'flue'), the CO₂ is compressed to make it easier to transport.

Today, CO₂ is already transported most often by pipeline, but also by ship and road tanker, primarily for use in the oil industry where CO₂ is injected into mature fields to enhance oil recovery, as well as for use in the food and beverage industry. However, the scale of transportation required for widespread deployment of CCS is far more significant than present levels.

STORING CO₂

At a suitable geological storage site, the CO₂ is injected into deep underground rock formations, often at depths of one kilometre or more. The CO₂ moves slowly through the porous rock, filling the tiny spaces known as 'pore space'.

Possible storage sites include depleted oil or gas fields, rocks containing unpotable saline water formations or incidental storage during enhanced oil recovery (EOR). These sites generally have an impermeable trap, also called a 'seal-rock', above them. The seal and other geological features prevent the CO₂ from migrating to the surface. Such sites have been demonstrated to securely contain fluids and gases for millions of years.

Once injected, a range of technologies is used to monitor movement of the CO₂ underground. Monitoring, reporting and verifying processes are important to ensure that the CO₂ is safely and permanently stored.

The Intergovernmental Panel on Climate Change (IPCC) estimates the world's potential storage capacity at two trillion tonnes, although there could be a "much larger potential" (2005, IPCC Special Report).

WHAT CAN BE DONE WITH CAPTURED CO₂?

Generally speaking, there are three possibilities:

- 1 The CO₂ can be stored securely in deep underground geological formations.
- 2 It can be used as a value-added commodity. This can result in a portion of the CO₂ being permanently stored – for example, in concrete that has been cured using CO₂ or in plastic materials derived from biomass that uses CO₂ as one of the ingredients.
- 3 The CO₂ can be converted into biomass. This can be achieved, for example, through algae farming using CO₂ as a feedstock. The harvested algae can then be processed into bio-fuels that take the place of non-biological carbon sources.

CCS TODAY

CCS projects have been operating successfully across the world since the mid-1990s. Significant projects include:

- The world's first large-scale CCS project in the power sector commenced operation in October 2014 at the Boundary Dam power station in Saskatchewan, Canada. Two additional large-scale CCS projects in the power sector – at the Kemper County Energy Facility in Mississippi and the Petra Nova Carbon Capture Project in Texas – are planned to come into operation in 2016.
- The Sleipner and Snøhvit CO₂ storage projects in Norway have stored just under 20 million tonnes of CO₂ into offshore deep saline formations.
- Great Plains Synfuels Weyburn-Midale. Since 2000, about 3 million tonnes of CO₂ a year has been captured from a synthetic natural gas plant at Great Plains in the US, and transported for EOR operations at the Weyburn-Midale oilfields, in Canada.

As of 2015, there were 22 large-scale integrated CCS projects in operation or under construction.

FOR MORE INFORMATION

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