

# Carbon capture and storage (CCS)

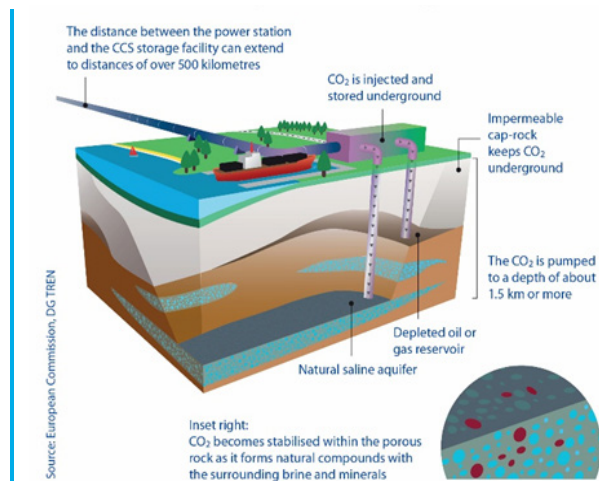


**The transition to a low carbon world requires a transformation in the way we manufacture iron and steel. There is no single solution to CO<sub>2</sub> free steelmaking, and a broad portfolio of technological options is required, to be deployed alone, or in combination as local circumstances permit. This series of fact sheets describes and explores the status of a number of key technologies and issues.**

## What is CCS?

Carbon capture and storage (CCS) describes a suite of technologies that capture waste CO<sub>2</sub>, usually from large point sources, transport it to a storage site, and deposit it where it will not enter the atmosphere.

Stored CO<sub>2</sub> is injected into an underground geological formation; this could be a depleted oil and gas reservoir or other suitable geological formation. CO<sub>2</sub> can also be injected into mature oil fields, driving out additional oil from the rock before being permanently stored. This is known as enhanced oil recovery (EOR) and is a form of carbon capture use and storage (CCUS).



Carbon Capture and Storage (CCS) - Source EU, DG TREN

## CCS deployment now

There are currently 21 large scale CCS plants operating globally. All but 6 of these are in North America and the overwhelming majority (16/21) use captured CO<sub>2</sub> in EOR operations. Ten of the CCS plants are attached to natural gas processing plants, 2 are in the power sector, and the remaining 7 are scattered across the chemicals, hydrogen, fertiliser and steel sectors.

## CCS in the steel industry

### Potential approaches

CCS could potentially be applied to all major point sources in the steel sector. Past studies have tended to focus on the blast furnace as the major point source of CO<sub>2</sub> on a conventional integrated steel plant, either using retrofitted CO<sub>2</sub> capture technology or by developing a new type of blast furnace. The European ULCOS programme represents a good example of the latter – proposing a radical new top gas recycling blast furnace design. CCS has not yet been applied to blast furnace steelmaking.

Direct reduction plants can offer an easier route to CCS, as some plants incorporate CO<sub>2</sub> separation into their designs and emit a concentrated stream of CO<sub>2</sub> during normal operation. In these plants additional carbon capture equipment is not required.

Carbon capture can potentially be retrofitted to conventional DRI facilities.

Innovative coal-based smelt reduction plants such as the HISARNA process piloted at Tata Steel in the Netherlands are capable of producing a concentrated stream of CO<sub>2</sub>, negating the need for CO<sub>2</sub> capture technology.

### State of on the ground development

- The DRI unit at Emirates Steel in Abu Dhabi is currently the only operational CCS plant in the iron and steel sector. This plant is capable of capturing 800kt of CO<sub>2</sub> per year, which is compressed, dehydrated and then pumped through 50 km of pipeline to be injected into a mature onshore oil field for EOR operations. The design of the DRI unit meant that a 90% CO<sub>2</sub> waste stream was emitted during normal operations, so an additional capture step was not required.
- A similar plant in Venezuela emits a waste stream close to 100% CO<sub>2</sub>, but the captured CO<sub>2</sub> is currently vented to atmosphere.
- CO<sub>2</sub> is captured for use (see CCUS factsheet) from Ternium DRI facilities in Mexico.
- Carbon capture on the blast furnace have been studied in a number of research projects – these include the Japanese 'COURSE 50' project, the EU ULCOS programme and current projects in Germany (ROGESA, Sairstahl) and Sweden (STEPWISE).
- A Front End Engineering Design study is currently being undertaken by ArcelorMittal looking to design a carbon capture system capable of capturing 50-70% of CO<sub>2</sub> emissions from blast furnace gas.
- Tata Steel is involved in the Athos project, with the aim of developing a CO<sub>2</sub> transport and storage network in the Dutch North Sea Canal area to enable the utilisation and storage of large volumes of CO<sub>2</sub>.
- ArcelorMittal is working with the Northern Lights consortium. This project could potentially see CO<sub>2</sub> derived from steelmaking in Belgium and France shipped to Norway for geological storage.

### Challenges

#### Scale up

Under the IEA's core 'Sustainable Development Scenario' (SDS), by 2070 about 75% of all the CO<sub>2</sub> produced globally in iron and steel is captured. For this to happen, an average of 14 steel plants operating with CO<sub>2</sub> capture need to be built every year from 2030 to 2070<sup>1</sup>, amounting to over 15Gt of CO<sub>2</sub> being captured cumulatively by 2070. Currently installed CCS capacity accounts for 0.0007GT/year, so the scale up challenges are considerable.

#### Infrastructure

One of the challenges that faces CCS is how to transport significant volumes of compressed CO<sub>2</sub> from point sources to sites established for large-scale storage, especially offshore. Pipelines are one solution, but their viability depends on access to land, the volume to be transported and if the CO<sub>2</sub> comes from a variety of dispersed sources. The other option is to use dedicated sea tankers that can deliver CO<sub>2</sub> from one or more ports, either directly to an offshore storage site, or an intermediate shore-based facility connected via pipeline to the storage site.

### Public acceptance

CCS is not universally embraced, and public perception and acceptance remain a bottleneck for its broad deployment. Many environmental NGOs dismiss CCS as high risk, unproven and fundamentally unnecessary.

Local communities have also rejected CCS, citing concerns around safety and impact on property value, though this varies by region. In many areas with a history of exploiting the subsurface (e.g. Saudi Arabia, Texas) community concern is low, however, in Europe development CO<sub>2</sub> storage is now exclusively offshore.

Evidence suggests that community concerns can be managed but with significant effort on the part of the project proponents.

### Costs

The IEA found that innovative process routes (including CCS on the blast furnace, smelt reduction and gas-based DRI) can be expected to cost 10-50% more than conventional technology within a given regional context, noting this cost increase significantly exceeds profit margins from steelmaking today.

### Regulatory issues

As an emerging technology, CCS regulation is still under development. For example, there is currently no framework in the EU to quantify and verify the CO<sub>2</sub> stored, and globally, there are still a lot of jurisdictions with little or no CCUS framework.

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<sup>1</sup> IEA ETP