GLOBAL CCS INSTITUTE

CCS PROJECTS IN ACTION

Carbon capture and storage (CCS) technologies can be applied to a range of power and industrial emission sources. CCS is currently in a pre-commercial stage for many of these applications, such as power, and in pilot stage for several others, including iron, steel, and cement. For some industries, such as natural gas processing, CCS is already operating at full commercial scale.

INDUSTRIAL APPLICATIONS

CCS in industrial applications refers to capture, transport, (utilisation) and storage of carbon dioxide (CO_2) that would otherwise be emitted from commercial facilities outside the power sector. Unlike power sector CO_2 emissions, which are generated by combustion of fossil fuels, industrial CO_2 can result from combustion, pre-combustion processing, chemical reactions integral to the formation of a final product (process emissions), or a combination of these sources.

According to the International Energy Agency's (IEA) *Energy Technology Perspectives* (2012), around 45 per cent (or 55 gigatonnes) of the total CO_2 captured between 2015 and 2050 will be in industrial applications. Further, industrial applications will account for an increasing share of CCS deployment over time.

There are two main reasons for this. First, for many industrial processes, CCS is often the only technology that can provide substantial reductions in CO_2 emissions.

Second, these production processes often lend themselves to relatively low-cost capture opportunities—remembering that capture can contribute up to 85 per cent of the total cost of a CCS solution—due to either:

- high CO_2 purity of the emissions stream in industries such as ammonia and fertiliser production, and/or
- the already embedded cost of capture in making the product market-ready, for example in natural gas processing and liquid natural gas facilities.

Several important industrial sectors are suitable for CCS applications, including:

- **natural gas processing**
  many sources of natural gas contain high levels of CO_2 that must be removed before the gas is sold
- **food and drink**
  CO_2 is used primarily for the carbonation of drinks, although the brewing industry generates substantial volumes of CO_2 from the fermentation processes that convert sugars to alcohol
- **pulp and paper**
  CO_2 is generated from fossil fuel and/or biomass combustion for high temperature chemical pulping, mechanical pulping, onsite electricity production and drying
- **refining**
  includes petroleum for transport fuels, which generates CO_2 from the production of heat, hydrogen and power
- **chemicals**
  includes the manufacture of ammonia, methanol and olefins, which rely on fossil fuel feedstocks (process emissions)
- **cement**
  CO_2 is generated from the calcination of lime (process emissions), which also relies on fossil fuels
- **iron and steel**
  generates CO_2 due to the dominance of coal as a reducing agent and a fuel, as well as the process emissions that cannot be avoided
- **non-ferrous metals**
  includes the manufacture of aluminium, which not only generates the majority of its CO_2 from the production of electricity imported to power the electrolysis process (combustion emissions), but also from the reduction of alumina with carbon (process emissions)
- **biofuels** (see overleaf).

The IEA estimates that the greenhouse gas emissions from these sectors alone currently represent about 22 per cent of total global CO_2 emissions.

BIOFUELS

Bio-energy with CCS (BECCS) is the combination of biomass processing (esterification, digestion, fermentation or gasification) and/or combustion with CCS.

A double dividend of a BECCS solution is that it can often lead to negative emissions—that is, removal of emissions from the atmosphere. This results from the dual processes of bio sequestration, where atmospheric CO_2 is captured and stored in biomass as plants grow, and geological sequestration, which involves capturing the CO_2 emissions from combusted bio-energy feedstock and permanently storing them deep underground in geological formations.

CCS IN THE POWER SECTOR

CCS is essential for the near-decarbonisation of fossil fuel-based power generation, including coal and gas, if the scale of mitigation required over the medium to long term is to be achieved.

The IEA estimates that CO_2 capture from power generation will represent about 55 per cent of the global deployment of CCS between 2015 and 2050. Indeed, the IEA suggests the power sector must rapidly adopt CCS over the next three decades and that nearly all fossil fuel-based power plants must use CCS by 2040.

COMMON CCS COMPONENTS

The technologies used to capture CO_2 from industrial and bio-energy applications have important elements in common with pre-combustion, post-combustion and oxyfuel capture technologies in the power sector. Further, the technologies that can safely transport and permanently inject and store the captured CO_2 from industrial, power and BECCS applications are identical.

This provides a significant opportunity to share knowledge and experience gleaned from CCS demonstration projects, regardless of the applications, and scope options to reduce deployment costs over time.

CURRENT STATUS OF CCS PROJECTS

Worldwide, 16 large-scale integrated CCS projects[1] are considered active—that is, they are already operating or have secured a positive financial decision to proceed to construction. Of these, 12 per cent are in the power sector and 88 per cent are in industrial applications:

- 57 per cent in natural gas processing
- 14 per cent in fertiliser production
- 14 per cent in hydrogen production
- 7 per cent in ethanol production, and
- 7 per cent in synthetic natural gas production.

1 A large-scale integrated project is defined as capturing at least 800,000 tonnes of CO_2 annually for a coal-based power plant; or at least 400,000 tonnes of CO_2 annually for other emission-intensive industrial facilities (including natural gas-based power generation).

FOR MORE INFORMATION

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