SCCS Briefing

What is carbon capture and storage?

Carbon capture and storage – or CCS – is a set of technologies that tackles emissions of carbon dioxide (CO_2) at source to prevent increased atmospheric concentration of the gas, which causes climate change. It is being used at a number of sites across the world.

CCS allows industries to reduce their emissions: it prevents CO_2 emitted by industrial processes (including burning fossil fuels to generate heat or electricity) reaching the atmosphere. This means that industries which would otherwise have high emissions can continue to operate without affecting efforts by countries to meet climate change targets.

The CCS process has three distinct parts: capture, transport and storage. In some industries, a pure stream of CO_2 is a by-product of the process and needs little additional treatment. However, in most processes, CO_2 is mixed with other gases when emitted and must be separated out before capture. Once captured, cleaned and compressed, the CO_2 is transported to a geological storage site to be permanently stored deep below ground.

Capture and separation

There are different ways to capture CO_2 depending on the situation. The technology most appropriate for one project may not suit another. The two main options currently used are:

- **Chemical absorption**
  A liquid solvent reacts with the CO_2 in a stream of gases (flue gases), separating it from the mix. Heat is then used to recover the CO_2 from the solvent.

- **Physical absorption**
  A liquid solvent selectively absorbs the CO_2, without a chemical reaction taking place, separating it from the rest of the gases. A change of pressure is then used to release the CO_2 from the solvent.

Capture technologies are constantly emerging and developing to help reduce the cost and energy required. The following have not yet been used on an industrial scale but may be available in future:

- **Adsorption**
  CO_2 is separated by attaching itself to the surface of certain solid materials.

- **Membrane technologies**
  Gases pass across a membrane from an area of higher to lower pressure. Certain membranes allow CO_2 to pass through faster than other gases in the stream.

- **Cryogenic separation**
  CO_2 is separated from other gases by cooling and condensation.

All of these technologies need energy to provide heating or cooling, or to create changes in pressure. In general, the higher the concentration of CO_2 in the flue gases, the less energy is needed and the more efficient the capture process is. It is therefore generally most effective on point sources of CO_2, such as manufacturing sites or power stations.

However, this is not to say that CO_2 can only be captured in these situations: techniques are being developed to remove CO_2 directly from the air, but these currently use a lot more energy per tonne of CO_2 captured.

Transport

Captured CO_2 is most commonly transported to a storage site by pipeline, but it can also be transported by road, rail or ship if smaller volumes are involved. The UK has a number of onshore and offshore pipelines that are currently used to transport gas from the North Sea: these could be repurposed to transport CO_2 in the opposite direction, from onshore sources to offshore storage sites.

Storage

The main option for securely storing CO_2 is geological storage, which allows the CO_2 in liquid form to be stored for tens of thousands of years, or longer, in rocks deep below the Earth's surface. Ideal storage sites have layers of rock that are highly permeable and highly porous so that CO_2 can move through the rock and fill the pore spaces within it. These storage sites are at least 800 metres below ground, and above them are several layers of impermeable rock ("cap rock"), which prevent the CO_2 returning to the surface. In the UK, only offshore geological storage sites are considered. We are fortunate that, unlike many other countries, our geology is well-suited to CO_2 storage.

Once injected into the storage site, the CO_2 moves upward through the permeable rock until it reaches the cap rock and can go no further. Over time, the store becomes more secure. In the early stages, CO_2 is physically kept in place by being trapped within the pore spaces of rock and sealed by layers of cap rock. Eventually, the CO_2 dissolves in the water held within the rocks, becoming denser and less mobile until it forms new rock.

Depleted oil and gas fields have the necessary porosity and permeability, as do saline aquifers, which hold salt water in their pores. In Scotland, where we have both types of store beneath the North Sea, geological storage is the most obvious choice.

Our history of oil and gas exploration means that we have a detailed understanding of this geology and how well-suited it is to storage; it is estimated to have the capacity to store several decades' worth of the European Union's CO_2 emissions and offers the potential for a new North Sea industry.

For more information visit www.sccs.org.uk or contact us on info@sccs.org.uk