FACT SHEET

GEOLOGICAL STORAGE OF CO_2: SAFE, PERMANENT, AND ABUNDANT

Storing carbon dioxide (CO_2) emissions produced by a wide variety of industries keeps this greenhouse gas out of the atmosphere.

The injection and storage of CO_2 has been working safely and effectively for 45 years. In fact, With abundant underground storage resources at our disposal, storage remains the easiest and most logical CO_2 mitigation solution.

There are many similar geological systems throughout the world that are capable of retaining centuries' worth of CO_2 captured from industrial processes. Although geologic storage of gases occurs naturally and has been used safely by industry for many decades, it remains a challenge to describe this process to the public.

Fortunately, there are many locations globally that have formations with these characteristics; most are in vast geological features called sedimentary basins. Almost all oil and gas production is associated with sedimentary basins, and the types of geologic formations that trap oil and gas (and also naturally occurring CO_2) are similar to those that make good CO_2 storage reservoirs.

HOW DOES GEOLOGICAL STORAGE OF CO_2 WORK?

Geological storage involves injecting CO_2 captured from industrial processes into rock formations deep underground, thereby permanently removing it from the atmosphere.

Typically, the following geologic characteristics are associated with effective storage sites:

- rock formations have enough millimetre-sized voids, or pores, to provide the capacity to store the CO_2
- pores in the rock are sufficiently connected, a feature called permeability, to accept the amount of CO_2 at the rate it is injected, allowing the CO_2 to move and spread out within the formation
- an extensive cap rock or barrier at the top of the formation to contain the CO_2 permanently.

Figure 1: Storage Overview

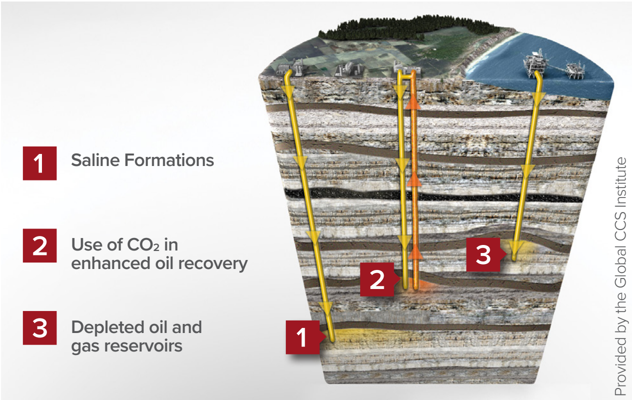
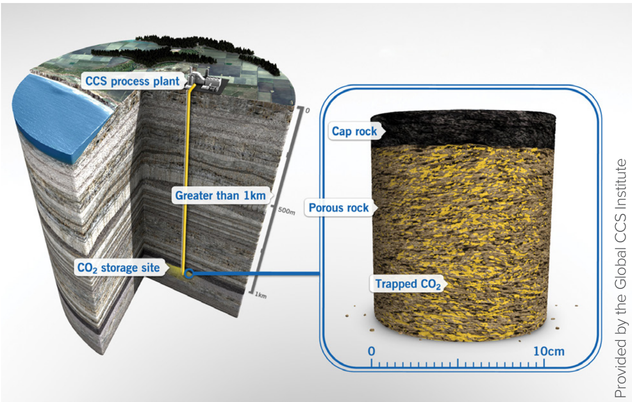


Figure 2: Core Sample



The storage overview figure shows the different types of storage options available.

1. Deep saline formations refer to any saline waterbearing formation (the water can range from slightly brackish to many times the concentration of seawater, but is usually non-potable). The saline formation is sealed by a caprock for permanent storage.
2. EOR, which involves injecting CO_2 to increase oil production from mature oil fields.
3. Depleted oil or gas fields that are no longer economic for oil or gas production, but have established trapping and storage characteristics.

HOW IS CO_2 INJECTED UNDERGROUND AND WHY DOES IT STAY THERE?

Once captured, the CO_2 is compressed into a fluid almost as dense as water and pumped down through a well into a porous geological formation. The pores in underground formations are initially filled with a fluid – either oil, gas, or salty water. Whilst a majority of existing CCS facilities utilise storage associated with EOR, future deployment of CCS will increasingly require storage in deep saline aquifers, which have wider geographical distribution and larger theoretical storage resources in comparison to oil and gas reservoirs. Because injected CO_2 is slightly more buoyant than the salty water that co-exists within the storage formation, a portion of the CO_2 will migrate to the top of the formation and become structurally trapped beneath the impermeable cap rock that acts as a seal. In most natural systems, there are numerous barriers between the reservoir and the surface.

Some of the trapped CO_2 will slowly start to dissolve into the saline water and become trapped indefinitely (called solution trapping); another portion may become trapped in tiny pore spaces (referred to as residual trapping). The ultimate trapping process involves dissolved CO_2 reacting with the reservoir rocks to form a new mineral. This process, called mineral trapping, may be relatively quick or very slow, but it effectively locks the CO_2 into a solid mineral permanently.

HOW MUCH CO_2 CAN BE STORED UNDERGROUND?

Many people assume that one of the biggest challenges impeding the acceleration of CCS facilities is limited underground CO_2 storage resources.

The reality is, there is more underground storage resource than is actually needed to meet climate targets.

In fact, a large proportion of the world's key CO_2 storage locations have now been vigorously assessed and almost every high-emitting nation has demonstrated substantial underground storage resources. As an example, there is between 2,000 and 20,000 billion tonnes of storage resources in North America alone. Countries including China, Canada, Norway, Australia, US and the UK all boast significant storage availability, and other countries such as Japan, India, Brazil and South Africa have also proven their storage capability.

HOW DO WE KNOW THAT IT WORKS?

Over 200 million tonnes of anthropogenic CO_2 has been successfully injected underground. Accumulated experience of CO_2 injection worldwide over several decades has proven there are no technical barriers preventing the implementation of storage. Over 40 sites have or are presently safely and securely injecting man-made CO_2 underground, mainly for EOR or explicitly for dedicated geological storage. Additional experience is also gained from industrial analogues such as waste water or natural-gas storage.

A variety of monitoring technologies have been successfully deployed, demonstrating our ability to measure, monitor and verify injected CO_2 in the subsurface. Monitoring of a CO_2 storage site occurs over its entire lifecycle from pre-injection to operations to post-injection; it enables the progress of CO_2 injection to be measured and provides assurance that storage is developing as expected. Operational and research experience over several decades demonstrates that injected CO_2 can be monitored to confirm its containment.

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