FACT SHEET

GLOBAL CCS INSTITUTE

SECURE GEOLOGIC STORAGE OF CO_2

Storing carbon dioxide (CO_2) emissions produced by human activity underground helps address climate change by keeping this greenhouse gas out of the atmosphere.

This is not a new or emerging technology – it is happening now. In fact, there are numerous geological systems that naturally contain CO_2 and have stored it for millennia. As well, the oil and gas industry has used CO_2 for decades for enhanced oil recovery (EOR).

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.

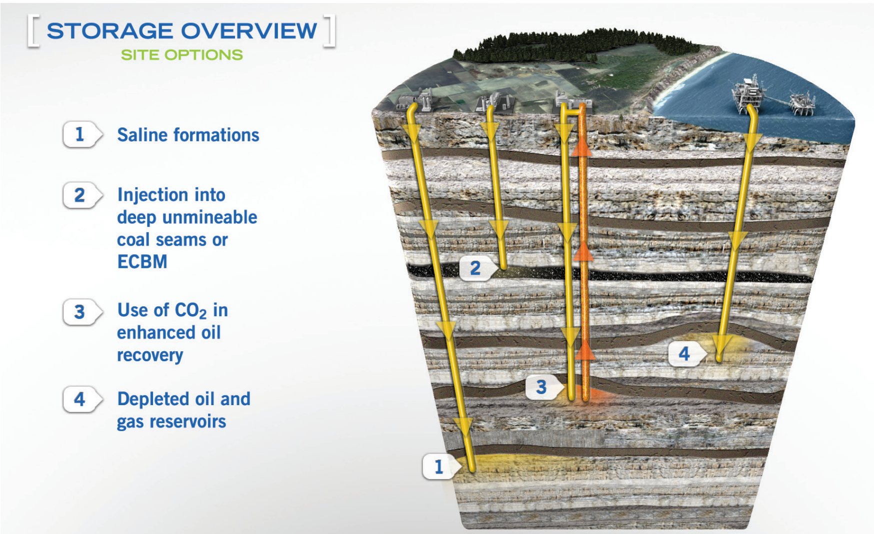
Fortunately, there are many locations globally that have formations with these characteristics; most are in vast geological features called sedimentary basins. Almost all oil and gas production is associated with sedimentary basins, and the types of geologic formations that trap oil and gas (and also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

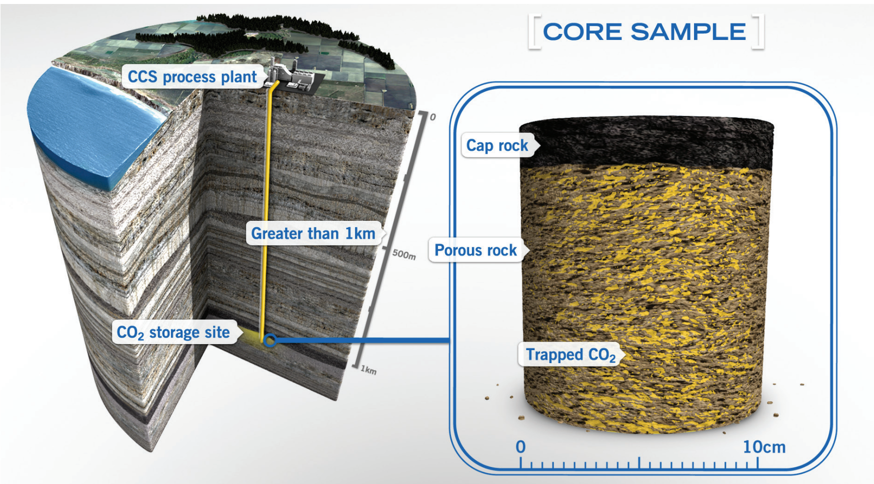
HOW DOES GEOLOGICAL STORAGE OF CO_2 WORK?

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.





It is the natural geologic characteristics, the ones that resulted in oil and gas being trapped for millions of years before they were discovered, that make secure geological storage of CO_2 such a viable option for greenhouse gas mitigation. Many coal deposits are also associated with sedimentary basins, so coal-fired power plants, which are a significant source of CO_2 emissions, can sometimes be co-located near storage sites. In other instances, and for other industries, suitable storage locations may be considerable distances away.

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

1 Deep saline formations refer to any saline water-bearing 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 Coal-bed methane, in which CO_2 is injected into coal-beds to exchange CO_2 with methane. CO_2 binds to the coal and is stored permanently. Currently, this type of storage is in the research phase, with no operational projects.

3 EOR, which involves injecting CO_2 to increase oil production from mature oil fields.

4 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 projects 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 capacity 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 reservoir, 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.

IS UNDERGROUND STORAGE OF CO_2 SAFE?

Industrial-scale, pilot, and research-scale storage projects inject several millions of tonnes of CO_2 annually into deep saline formations, demonstrating that injection is safe and effective. EOR projects, where CO_2 storage occurs incidentally, have been operating safely for decades.

This has been validated by the work of intergovernmental and industry partnerships, research programs, and stakeholder networks. No significant safety, health or environmental impacts have been documented from existing CCS projects, whilst the EOR industry has an excellent safety record over four decades of operation'

HOW DO WE KNOW THAT IT WORKS?

The oil and natural gas industry has more than 40 years' experience of injecting almost one billion tonnes of CO_2 into geologic reservoirs to increase oil production. This is called CO_2-EOR. The CO_2 is usually injected into the reservoir under pressure in a liquid or dense phase, which allows it to mix with the oil and make the oil flow more easily, ultimately producing more oil. The CO_2-oil mixture is brought to the surface, where the CO_2 separates from the oil, and is recaptured for re-injection. Through this recycling process, virtually all the CO_2 used will eventually remain in the reservoir indefinitely at the end of the oil field's life (called incidental storage). Large quantities of CO_2 can be stored underground – safely, securely, and for a very long time.

HOW MUCH CO_2 CAN BE STORED UNDERGROUND?

The United Nations Intergovernmental Panel on Climate Change (IPCC) estimates the world's potential capacity at two trillion tonnes, although it may possess 'much larger potential' (IPCC, 2005, Special Report on Carbon Dioxide Capture and Storage: Summary for Policymakers).

More recent and focused studies in North America, Europe, Australia, and elsewhere have shown that in many regions there is centuries' worth of CO_2 geological storage potential in saline formations and oil and gas reservoirs. The proximity of CO_2 sources and suitable geological storage sites will vary according to a number of factors; many regions and sources will have a variety of convenient storage options, whilst others may need to invest in more significant transport systems. In some regions, limited storage options may restrict the potential for CCS deployment'

The selection and characterisation of individual storage sites is one of the most expensive components in the early stages of a CCS project, but it must be considered early. Storage is also one of the most closely scrutinised aspects of CCS by the public.