Carbon Capture and Storage

Frequently Asked Questions

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How does Carbon Capture and Storage work?

Carbon Capture and Storage (CCS) involves the capture of carbon dioxide (CO_2) that is emitted from sources such as power stations and industrial processes. It is then transported to a suitable site for safe, long-term storage deep underground.

The first step is the capture of CO_2 before it is emitted into the atmosphere. Once the gas is captured, it is separated into many different elements. For instance, coal fired power stations emit a large amount of nitrogen gas (the main constituent of air) along with carbon dioxide and traces of other compounds.

There is no sense (environmentally or economically) in storing nitrogen gas underground, so this is released into the atmosphere at the time in which the gases are separated.

The CO_2 is then compressed and transported to the injection site. It may be transported by a pipeline or by train. The gas is injected into geological formations at least 800 metres underground to keep it in a dense, fluid state.

The stored gases are then monitored to ensure they are behaving as predicted.

No adverse health, safety, or environmental effects have resulted from CCS operations of this kind.

Why do we need Carbon Capture and Storage?

Australia is one of the largest per capita emitters of greenhouse gas (GHG) emissions in the world. This is due to our:

- a continued reliance on coal for electricity production
- emission intensive industries such as aluminium manufacturing
- extensive road transport networks and
- coal being one of our major exports.

Not only do we need to reduce our emissions, but importantly we need to demonstrate that the use of coal can be associated with low carbon emissions.

The effective use of CCS technologies will help us reduce GHG emissions and reduce the impact of mining and coal-fired electricity generation.

China, for example, recognises the need to reduce GHG emissions and is introducing clean coal technologies and renewable energy sources at a scale unseen anywhere else in the world.
Capturing and safely storing CO_2 will significantly contribute to our move to a low emissions future. Leading scientists and international authorities such as the Intergovernmental Panel on Climate Change (IPCC) have identified CCS as having the potential to safely and effectively reduce GHG emissions.

Why not replace coal with renewable forms of energy?

While we are moving to more renewable forms of electricity generation, we still have a reliance on coal as a major electricity source and this is unlikely to change in the short and medium term. This is especially the case globally. Within NSW, coal-fired generators still account for approximately 80% of electricity generation.
With energy demands forecast to significantly increase, particularly in developing economies,[1] coal will likely continue to be a major contributor to global electricity production. As we transition towards more renewable forms of electricity, we must also ensure we do so practically, keeping the price of electricity affordable to all, and ensure we have a constant and stable supply.
CCS does not replace the need to increase energy efficiency or develop renewable energy technologies. Rather, CCS is part of a portfolio approach to addressing the issue of GHG emissions. While we continue to rely on fossil fuels for energy production, CCS has a valuable role to play during the transition to a low carbon economy.

Is Carbon Capture and Storage safe?

CCS is a well-established commercialised technology. An estimated minimum of 220 million tonnes of CO_2 has securely been injected into the sub-surface since the early 1970s. With this comes a

[1] https://www.eia.gov/outlooks/aeo/pdf/0383(2017).pdf

strong body of research developed over many decades, backed by years of industry experience, that clearly demonstrates that carbon dioxide can be stored safely and securely deep underground.

For well-selected, designed and managed geological storage sites, experts estimate that 99% or more of the injected CO_2 will be retained for 1000 years [2].

Leakage of CO_2 from a well-chosen storage site is highly unlikely. The CO_2 is sealed in the underground reservoir by the rock structure. These sealing rocks have held gas securely in reservoirs for millions of years.

Once injection activities are complete, the well that is used to inject the CO_2 is sealed with concrete to prevent leakage. However, if leakage did occur it would be a very slow process. CO_2 migrating upwards through the ground would become trapped in porous rock layers beneath one or many impermeable layers of rock, rather than reach the Earth's surface.

Critics argue that CO_2 storage is unproven, however CCS is not a new or untested technology. The reality is that each year, tens of millions of tonnes of CO_2 are transported and injected into deep rocks as part of petroleum, natural gas, fertiliser and synthetic gas production operations. Therefore, a great deal is known about the behaviour of CO_2 in pipelines and in rocks. We also know how to monitor stored CO_2 to ensure it does not leak or pose any danger.

A similar technology, known as enhanced oil recovery has been in use for over 40 years in the oil and gas industries. Permanent storage of carbon dioxide has been used in the following countries, all without incident:

- Sleipner, Norway since 1996
- Weyburn, Canada since 2000
- Salah, Algeria since 2004

In Victoria, the Cooperative Research Centre for Greenhouse Gas Technologies (CO2CRC's) highly successful Otway Project has demonstrated the safe and secure geological storage of tens of thousands of tonnes of CO_2 under Australian conditions.

[2] https://www.ipcc.ch/pdf/special-reports/srccs/srccs_wholereport.pdf

What are the costs – is Carbon Capture and Storage viable in NSW?

While CCS applications have been used in the oil and gas industry for many decades, the technology may not be considered commercially viable in the electricity generation sector. The technology is, however, currently being demonstrated around the world with the aim of gaining knowledge on how to lower the associated costs. As with the introduction of any new technology, costs will fall as more plants are built.

Storage costs are associated with the geological characteristics of individual sites and will depend on the storage reservoir's ability to contain an amount of carbon dioxide. Transport costs are related to distance and pipeline capacity. For the electricity industry, it is likely that the capture component of CCS will be the most costly part of the process. This cost will fall as innovation delivers costs savings and demand increases.

Due to storage reservoirs in NSW being relatively unexplored, it is a priority for NSW to identify potential storage sites suitable for storing greenhouse gases. As such, the NSW Government is coordinating the NSW CO_2 Storage Assessment Program aimed at identifying deep geological sites throughout NSW that may be suitable for the safe and secure storage of carbon dioxide.

How do we know that the stored gases won't leak?

The Special Report on Carbon Dioxide Capture and Storage by the Intergovernmental Panel on Climate Change[3] found that where underground storage sites are appropriately selected and managed, it is likely that 99% or more of the carbon dioxide (CO_2) gas will be retained for 1000 years. Stored gas will eventually react with the rocks and saline aquifers in the storage area to form carbonates. This results in their permanent storage underground.

[3] https://www.ipcc.ch/pdf/special-reports/srccs/srccs_wholereport.pdf

These findings are based on scientific understanding of gas storage from petroleum geology and from modelling of existing CO_2 injection sites.

There is an extremely low risk of gradual or slow greenhouse gas leakage from underground storage. Less than 1% of stored gas may leak, and then only as far as the next strata of rock above the storage reservoir. This is still deep underground, not at the surface or into the atmosphere.

The risk of leakage can be minimised through the identification of appropriate sites, by careful site assessment and appropriate risk analysis.

What happens to the carbon gas once it is injected?

Once carbon dioxide (CO_2) has been compressed, it is injected deep underground, at depths of greater than 800 metres. It is stored in geological formations with characteristics that will trap large volumes of gas and not allow it to escape. The characteristics include tiny microscopic spaces within the rock, generally filled with salty water.

The injected gas goes through several stages. First, because it is more buoyant than the water, it rises to the top of the underground geological formation. It is then trapped there by the impermeable cap rock. Cap rocks have trapped oil, gas, and carbon dioxide underground naturally for millions of years.

The CO_2 then starts dissolving into the salty water, and becomes heavier than the water, causing it to sink to the bottom of the formation. It is then trapped there indefinitely.

Finally, the dissolved CO_2 reacts chemically with the rocks to produce minerals. This process effectively turns the CO_2 into rock thereby providing permanent storage over time.

What safeguards are in place to guard against risks to public safety and the environment?

Ensuring the safety and health of the community and protection of the environment is paramount to any CCS activity. And analysing and managing risk is a crucial element of a CCS project.

In Australia, CCS projects must comply with relevant laws and strict regulatory requirements that include the long-term monitoring of the stored carbon dioxide (CO_2). NSW, through the Council of

Australian Governments (COAG) and Ministerial Council on Mineral and Petroleum Resources, is party to the *Carbon Dioxide Capture and Geological Storage Regulatory Guiding Principles*.
The guiding principles take into account the:

- COAG agreed principles relating to Ecologically Sustainable Development
- Intergovernmental Agreement on the Environment
- Principles of Good Regulation
- relevant COAG agreed Occupational Health and Safety Principles.

The guiding principles also facilitate a nationally consistent approach to the application of CCS in respect to:

- assessment and approvals processes
- access and property rights
- transportation issues, monitoring and verification
- liability and post-closure responsibilities and financial issues

Currently Australia is collaborating with countries form around the world to develop CCS Standards under the banner of the International Standards Organisation.

What are the health risks associated with exposure to carbon dioxide?

Carbon dioxide (CO_2) is a natural part of air and soils. It naturally leaks from springs, water bores, caves, and is expelled during volcanic activity. Humans and animals expel CO_2 with every breath as they then inhale oxygen. Plants synthesise it to produce oxygen.
However, CO_2 can be a hazard if it accumulates in a low-lying, confined or poorly ventilated spaces, or if there is a significant cloud release. For instance, a sudden leak of CO_2 from a capture installation or pipeline could pose a potential hazard to workers or others in the vicinity. That said, the risk of this arising is no greater than the risk that exists for any industrial installation or pipeline, and may be much lower because CO_2 is inert. Not only is CO_2 not flammable or explosive, the probability of a sudden large leakage of the gas is extremely low.
The International Panel on Climate Change has found that, if a CO_2 storage site is selected and managed appropriately, 99% or more of the injected gas will be retained for 1000 years, with leakage only into the next rock formation (not to the surface). The NSW Government has a high degree of

confidence that, with high standards of site selection and management, underground storage represents a negligible risk to human and environmental safety.

Where can I find out more?

- Visit CCS Fact Sheet
- Visit Resources and Geoscience Website – Coal Innovation NSW
- Contact the Coal Innovation NSW team on:
  Email: ccs.info@industry.nsw.gov.au
  Phone: (02) 9934 0800