Geologic Carbon Storage

November 2024

The Ontario government is developing a new framework for commercial-scale carbon storage that should be in place by summer 2025. Capturing carbon dioxide (CO_2) and permanently storing it in geologic formations ("geologic carbon storage" or "carbon storage") could provide industries in Ontario with a critical tool for managing their emissions and help Ontario meet its emissions reduction targets.

Did you know?

According to the Global CCS Institute, the injection and storage of CO_2 "has been working safely and effectively for over 50 years" and "close to 300 million tonnes of CO_2 has been injected into storage formations underground." [1]

Figure 1: A carbon storage injection well in Alberta, Canada, courtesy of Carbon Management Canada.

Establishing a regulatory framework

Carbon storage is new to Ontario and we want to ensure the activity is undertaken safely and responsibly. That is why Ontario is taking a phased approach to creating a new framework for regulating this activity and created a roadmap detailing this phased approach.

Establishing a framework to regulate this activity would help ensure it is done responsibly, with measures in place to safeguard people and the environment. This will be key to realizing the potential benefits and managing the potential risks associated with geologic carbon storage, including minimizing the potential for leaks to the surface or drinking water sources, induced seismicity, or interactions with other resource activities.

What is carbon storage?

Large quantities of CO_2 are generated through industrial processes such as the production of cement, steel and fertilizer, from power generation, during oil and gas refining, and as a by-product of creating hydrogen from natural gas.

One way of reducing the impact of CO_2 emissions from these large emission sources is to take captured CO_2 that would have otherwise been emitted into the atmosphere and permanently store (sequester) it in deep underground rock formations (storage formations). This process is called 'geologic carbon storage, and is one tool being considered to manage Ontario's emissions.

Why is carbon storage necessary?

Geologic carbon storage is one necessary tool for economically achieving emissions targets and net-zero emissions, especially for carbon-intensive industries.

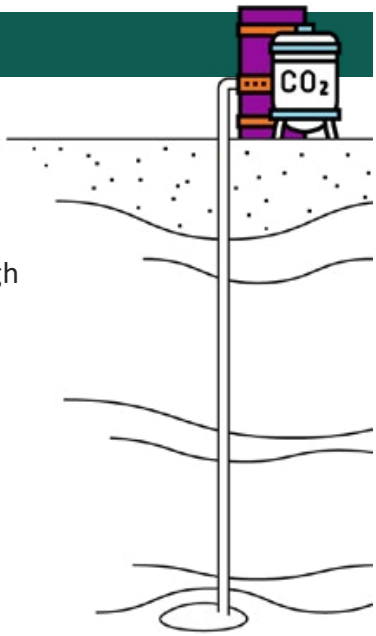
Geologic carbon storage could play an important role in supporting industry, encouraging sector innovation, helping industry manage emissions and meeting emissions targets. Development of commercial-scale carbon storage projects in Ontario could help:

- support emissions reduction and the production of low-carbon hydrogen
- support the transition to a low-carbon economy
- preserve high-value jobs, attract investment, and encourage innovation
- Ontario businesses take advantage of federal incentives for carbon storage

How is CO_2 stored?

Captured CO_2 emissions from industrial processes are injected into deep geologic formations through a storage well.

Detailed, site-specific studies need to be conducted to prove site suitability for geologic carbon storage.



Where could CO_2 be stored in Ontario?

Most projects in other jurisdictions have occurred in deep underground sedimentary rock formations, including:

- saline aquifers
- depleted oil and gas reservoirs

Previous research has suggested the most suitable storage formations in Ontario may be found beneath the beds of Lake Huron and Lake Erie and surrounding onshore areas. These areas also coincide with many of the province's largest point source emitters of CO_2.

Figure 2: Map illustrating the suitable storage formations in southwestern Ontario for carbon storage.

Depth is an important factor in geologic carbon storage. As depth increases below the surface, temperature and pressure increase. At depths greater than 800 metres (about 1.5 times the height of the CN Tower) temperature and pressure are high enough that CO_2 reaches a 'supercritical' state – it has the density of a liquid but flows like a gas – which allows the CO_2 to be stored efficiently [2].

Underground storage formation characteristics are also important. The following technical requirements are considered when determining if a formation is a good fit for geologic carbon storage:

- **Porosity**: the pore space in which the CO_2 can be stored.
- **Permeability**: the interconnectedness of the pore spaces that enables the injected CO_2 to flow throughout the formation.
- **Cap rock**: the presence of an impermeable barrier to flow around the formation to contain the CO_2 permanently

What happens to the CO_2 after it is injected?

After CO_2 is injected, it becomes trapped in underground pore space and sealed by rock layers above the storage formation which prevent the upward movement of CO_2. Injected CO_2 can also dissolve into saline water that is present in the storage formation or react with rocks and fluids to form solid carbonate minerals underground.

After injection activities end, wells are plugged, and the site is decommissioned and monitored to mitigate any potential safety risks to the public or the environment.

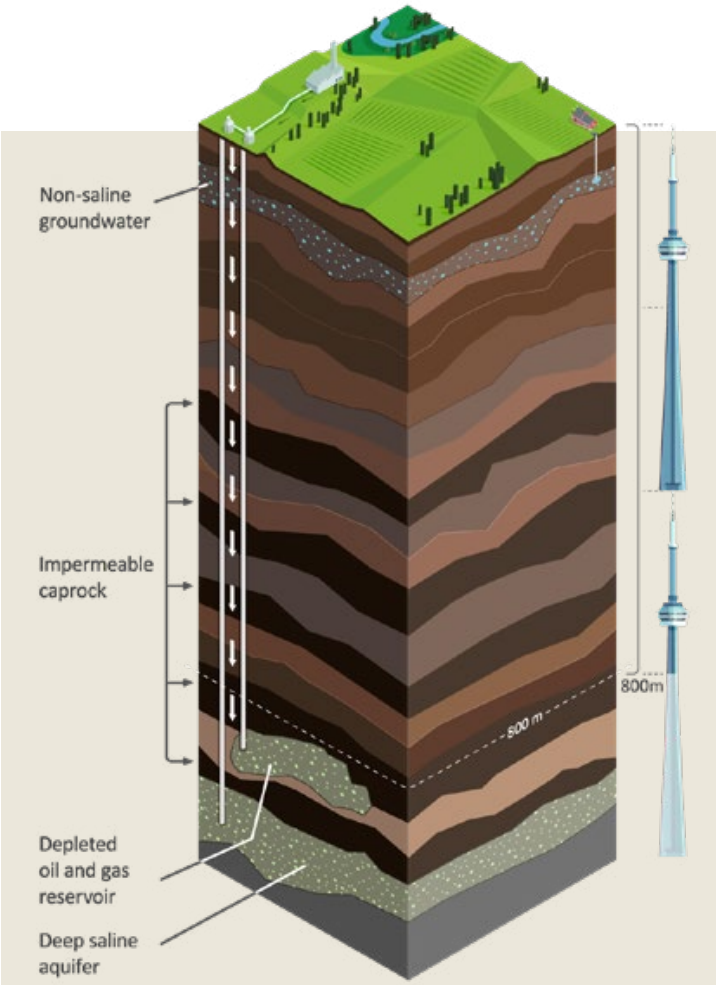


Figure 3: Schematic diagram of geologic carbon storage in a depleted oil and gas reservoir and a deep saline aquifer. This diagram is for illustrative purposes only. Objects shown are not drawn to scale.

Endnotes

1 Global Carbon Capture and Storage Institute Ltd. https://www.globalccsinstitute.com/ccs-101-storage/. Used under Creative Commons Attribution-Noncommercial-NoDerivatives 4.0 International Licence. © 2024 Global Carbon Capture and Storage Institute Ltd

2 Carter, T., Gunter, W., Lazorek, M., Craig, R. (2007). Geological Sequestration of Carbon Dioxide: A Technology Review and Analysis of Opportunities in Ontario. Climate Change Research Report CCRR-07. Ontario Ministry of Natural Resources. ISBN 978-1-4249-4557-3