Pathways Alliance

Carbon capture and storage: safety

Carbon capture and storage (CCS) is a process used around the world, including here in Canada. Alberta in particular has experience and expertise in the safe construction and operation of large-scale CCS projects.

The proposed Pathways Alliance CCS network and pipeline will have a multi-layered safety system based on decades of technical experience and scientific research. This system will be assessed and approved by the Alberta Energy Regulator (AER), and will follow this organization's Measure, Monitor and Verification (MMV) principles. It will also follow world-leading regulations set out by the Canadian Standards Association.

Pathways Alliance

We're Canada's largest oil sands companies, working together to provide the energy the world needs while advancing environmental innovation. Our country has long benefitted from a strong energy sector that supports Canada's high standard of living. The sector creates thousands of jobs and generates critical revenue for governments that helps fund essential services, including health care, education and roads.

To ensure our industry can keep providing these benefits for decades to come, Pathways Alliance is focused on advancing environmental innovation and projects, including CCS. We've proposed a CCS network and pipeline that, when operational, would have the capacity to transport captured CO_2 from multiple CCS facilities to a hub in the Cold Lake area of Alberta for permanent underground storage.

Canadian Natural

cenovus ENERGY

ConocoPhillips Canada

Imperial

MEG Energy

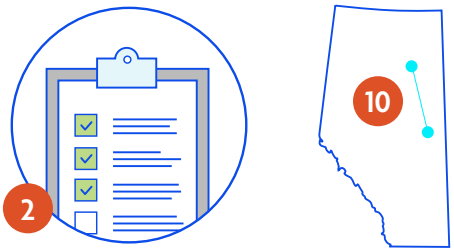
Suncor

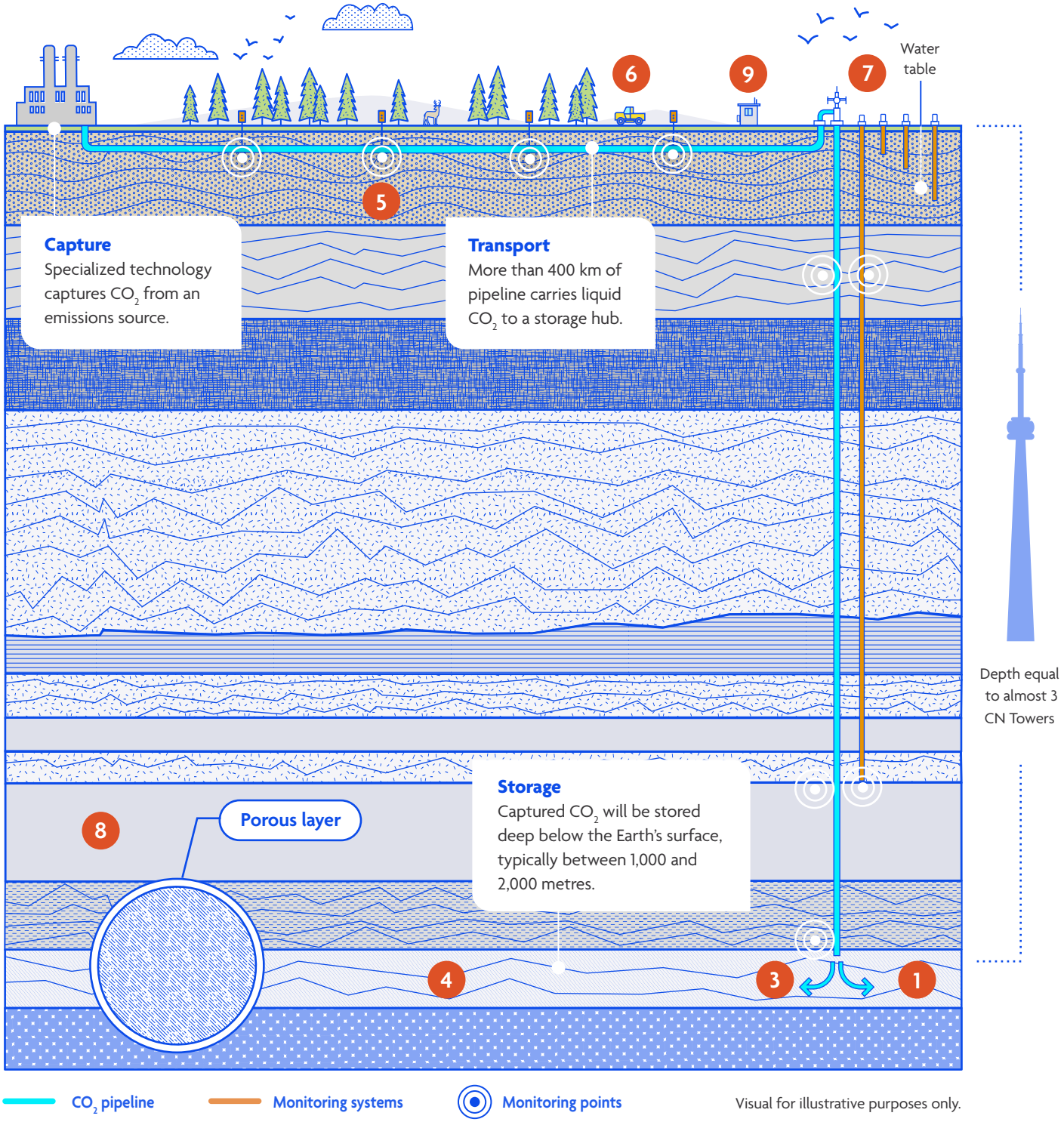
Did you know?

According to the Global CCS Institute's 2023 report, there are more than 40 carbon capture and storage projects in operation, 26 under construction and 325 in development. Alberta is home to two established, incident-free CCS networks. Quest Carbon Capture and Storage has been operational since 2015, and the 240-km Alberta Carbon Trunk Line began transporting CO_2 in 2020.

A multi-layered safety system

Safety considerations are built into each stage of the process when building a CCS network.





Visual for illustrative purposes only.

Layer 1: Prevention

The first layer of the safety system is identifying and preventing risk. Risk management begins at the design stage and continues through construction and operations. Engineers and other experts must build multiple safety measures into these plans.

1. **Suitable geological formation**
   Alberta's Basal Cambrian Sandstone formation is well suited to CO_2 storage. It has a deep, porous layer that can contain CO_2 underneath many layers of impermeable rock that act as natural seals.

2. **Monitoring, Measurement and Verification (MMV) plans**
   These detailed plans are designed so that the CCS storage site can be built, operated and eventually closed down safely. MMV plans must be evaluated and approved by the Alberta Energy Regulator.

3. **Safe injection pressure**
   During the project planning stage, geologists and engineers determine an injection pressure level. It must be suitable for the storage layer and the sealing rock layers, and it must meet regulatory standards.

4. **Permanent CO_2 storage**
   CO_2 is stored as a liquid, which is less mobile than gas. It enters the tiny pore spaces in the sandstone storage layer.

Layer 2: Detection

The second layer in the safety system is careful and constant monitoring. The proposed CO_2 transportation network and storage hub will have multiple monitoring points. This technology is placed along the underground transportation pipeline, at the CO_2 injection site and down to the storage hub. Any unusual activity triggers an immediate alert.

5. **Autonomous leak detection**
   An advanced computer monitoring system, set at regular intervals along the underground pipeline, watches for changes in pressure and temperature.

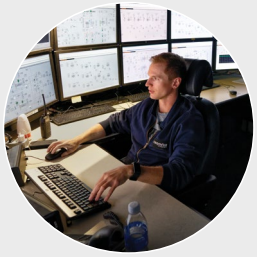
6. **Manual leak detection**
   Human operators oversee the pipeline monitoring systems 24/7/365. Any change in pipeline pressure or temperature will alert the operator and isolate the affected section of pipe.

7. **Managing pressure in the hub**
   The proposed storage hub is connected to multiple injection wells with real-time pressure monitoring. This helps distribute and track injection pressure in the storage space.

8. **Seismic imaging**
   Once CO_2 is underground, seismic imaging will show how it's distributed through the storage layer. It also monitors geological formations above the storage layer to confirm CO_2 is remaining in place and not moving upward.

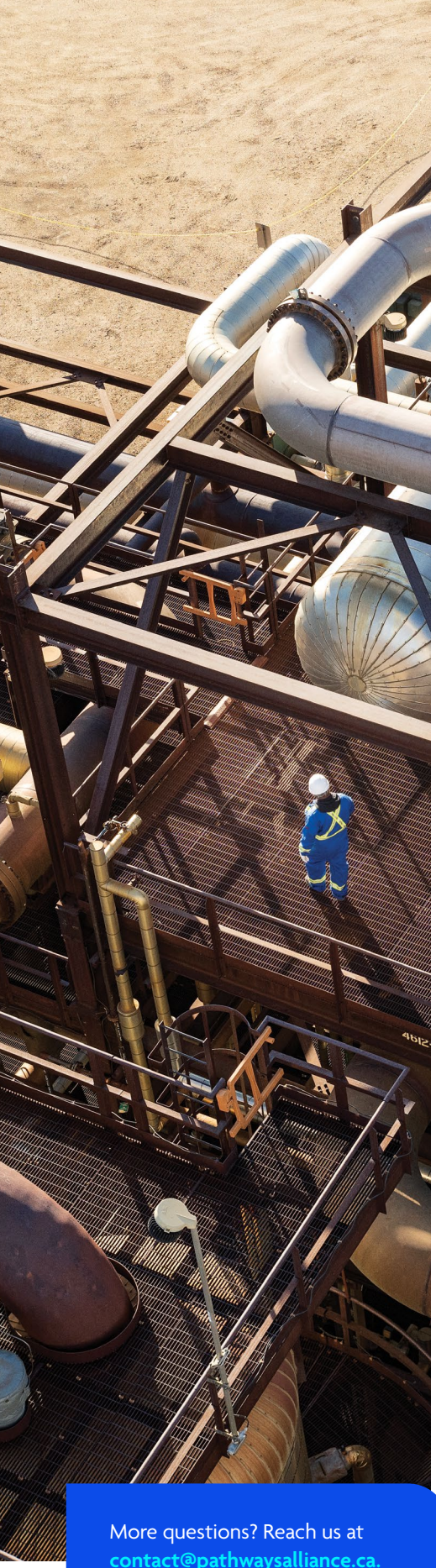
Layer 3: Response

The final layer of the safety system is response planning, because preparation is essential. If an incident occurs, detailed response plans regulated by the AER set out actions to mitigate its effects.



9. **Emergency shutdown procedures**
   If pipeline monitoring systems sense changes in pressure, they trigger an automated response. Valves turn off the affected section of pipe and stop the flow of CO_2 while alerting a 24/7 control centre.

10. **Community emergency response**
    Emergency preparedness plans are developed following provincial and federal regulations and Occupational Health & Safety standards. Plans are submitted to regulators for approval and are tested through mock exercises with local and regional participation, including regulators.



More questions? Reach us at contact@pathwaysalliance.ca.

FAQs

Many people have questions about the impact and safety of carbon storage. Because this technology has been in operation for decades, its effects are well researched and documented.

What's CO_2?

Carbon dioxide, or CO_2, is a colourless, odourless gas that's produced when animals (including humans) breathe, or when carbon-containing materials (including fossil fuels) are burned. CO_2 occurs naturally in the atmosphere and is essential to the photosynthesis process that sustains plant life. But it can accumulate in the air and trap heat near the Earth's surface (the "greenhouse effect"), which is why it's the focus of global efforts to reduce emissions.

How is CO_2 captured?

Capture technologies are fitted to a large emissions source, which diverts the CO_2 before it reaches the atmosphere. The CO_2 is pressurized and turned into liquid form, which can flow through the pipeline network to the storage facility. Then the liquefied CO_2 is stored deep underground.

How likely is a pipeline leak?

There are more than 2,500 km of CO_2 pipelines in North America, including a cross-border line between North Dakota and Saskatchewan. This line has been in operation since 2000, transporting more than 40 million tonnes of CO_2 without incident.

In 2020, there was a CO_2 pipeline leak in Mississippi. The incident was the result of the location—the pipeline was in an area vulnerable to landslides. The proposed Pathways Alliance pipeline will be built along a stable corridor primarily following existing rights-of-way. Direct and remote monitoring will be in place to help give us early warnings of any potential problems, and if we identify an issue, emergency preparedness and response planning will be established to help protect the public and environment.

What is stored underground? Gas or liquid?

CO_2 is transported and stored as a liquid. This liquid fits into tiny spaces in the sandstone storage layer. This layer is constantly monitored to make sure the liquid doesn't move into the surrounding rock. The surrounding rock is dense and solid, with no spaces for the CO_2 to enter. Around 10% of the stored CO_2 dissolves in the salty water in the storage layer. Some stored CO_2 reacts with the sandstone and becomes a solid mineral, which doesn't move at all.

Could stored CO_2 affect my drinking water?

The CO_2 storage reservoir is typically between 1,000 and 2,000 metres below groundwater, separated by impermeable rock. If any CO_2 exits the storage layer, the monitoring and seismic imaging are set up to detect leaking CO_2 long before it can reach groundwater.

Did you know?

On behalf of Pathways Alliance, Canadian Natural began filing the regulatory applications to the Alberta Energy Regulator in 2024. These applications are seeking approvals for Pathways' proposed CO_2 transportation network and storage hub.