Pathways Alliance

Carbon Capture and Storage: Safety

Carbon Capture and Storage (CCS) is a process used around the world to reduce industrial emissions of carbon dioxide (CO_2). Because Alberta was an early adopter of CCS, our province has a comprehensive regulatory framework in place governing this technology.

Canada has long benefitted from a strong energy sector that generates thousands of jobs and helps fund essential services, including health care, education and roads. But to keep these benefits for decades to come, we must continue raising the bar to protect the environment by reducing emissions and help our country achieve a sustainable future.

Pathways Alliance

Pathways Alliance is a collaboration between Canada's six largest oil sands companies. Together, they're working to reduce CO_2 emissions from oil sands operations to net zero by 2050. This ambitious goal will require several technologies and innovations. The cornerstone of the project is a proposed CCS network in Alberta that will eventually connect more than 20 CCS facilities in the Fort McMurray, Christina Lake and Cold Lake regions to a carbon storage hub near the Cold Lake region.

The proposed Pathways Alliance CCS network 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.

Canadian Natural

cenovus ENERGY

ConocoPhillips Canada

Imperial

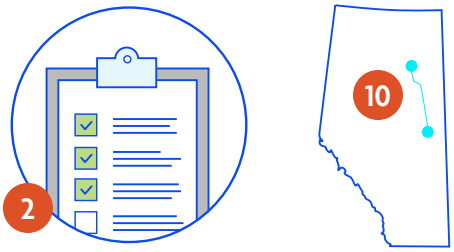
MEG Energy

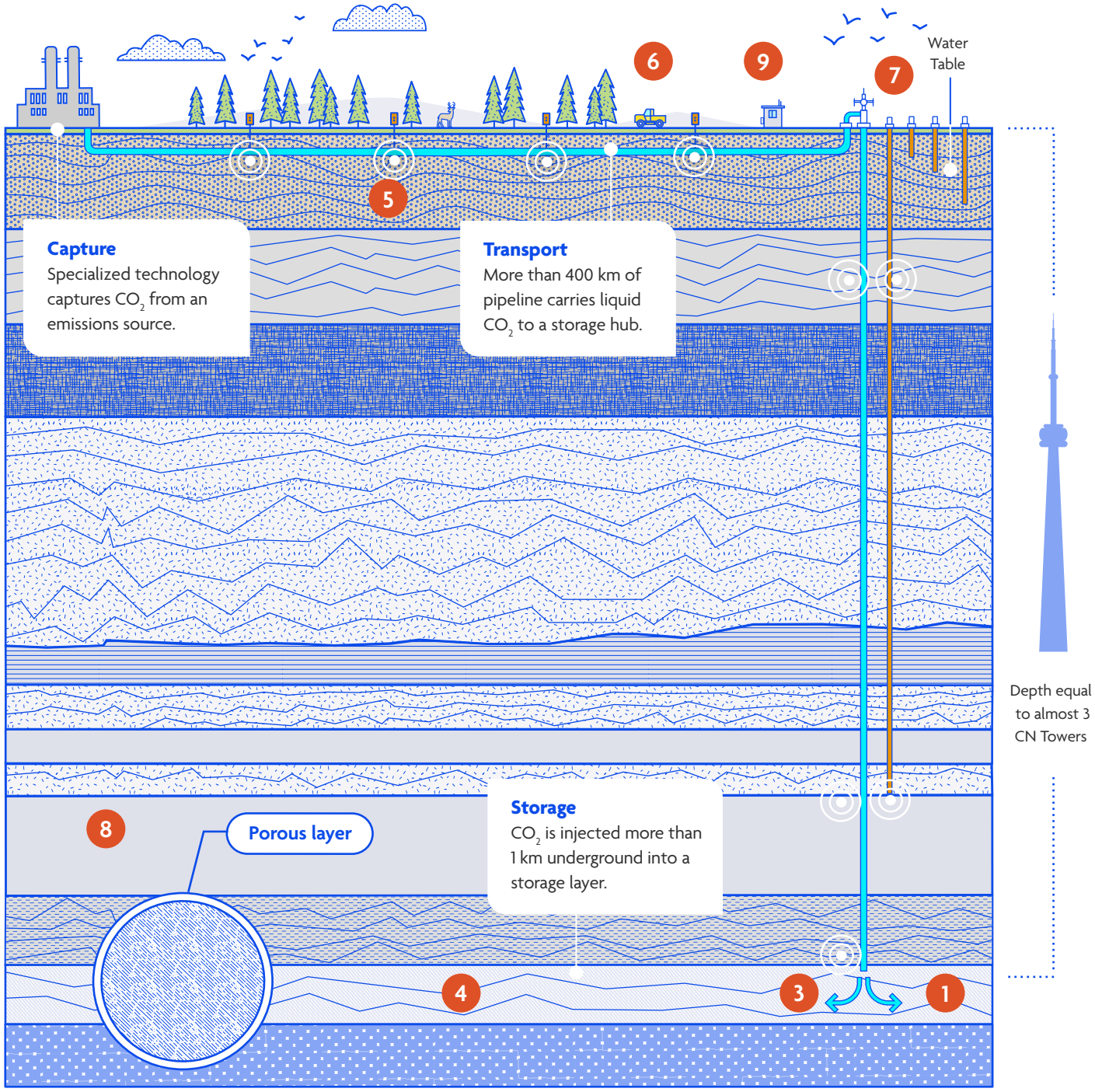
Suncor

Did you know?
Across the world, there are 30 operational CCS networks and over 150 more 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

When creating a CCS network, engineers and geologists must consider and solve for every possible safety scenario. This process begins at the planning stage and continues throughout the full life of the 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. That means every potential problem has a solution, as well as additional backup solutions.

1 **Suitable geological formation**
Alberta's Basal Cambrian Sandstone formation is ideal for 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 ensure the CCS storage site is 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 safe 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 and stays there permanently. Over time, stored CO_2 tends to become even less mobile.

Layer 2: Detection

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

5 **Autonomous leak detection**
Every 15 km along the underground pipeline, an advanced computer monitoring system watches for changes in pressure and temperature.

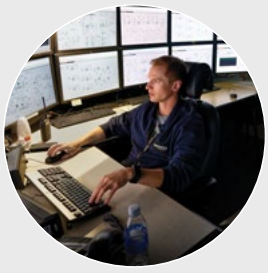
6 **Manual leak detection**
Human operators oversee the pipeline monitoring systems 24/7/365. Any change in pipeline pressure or temperature will alert the operator and isolate the affected section of pipe.

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 shows how it's distributed through the storage layer. It also monitors rock levels above the storage layer to confirm CO_2 isn't moving upward.

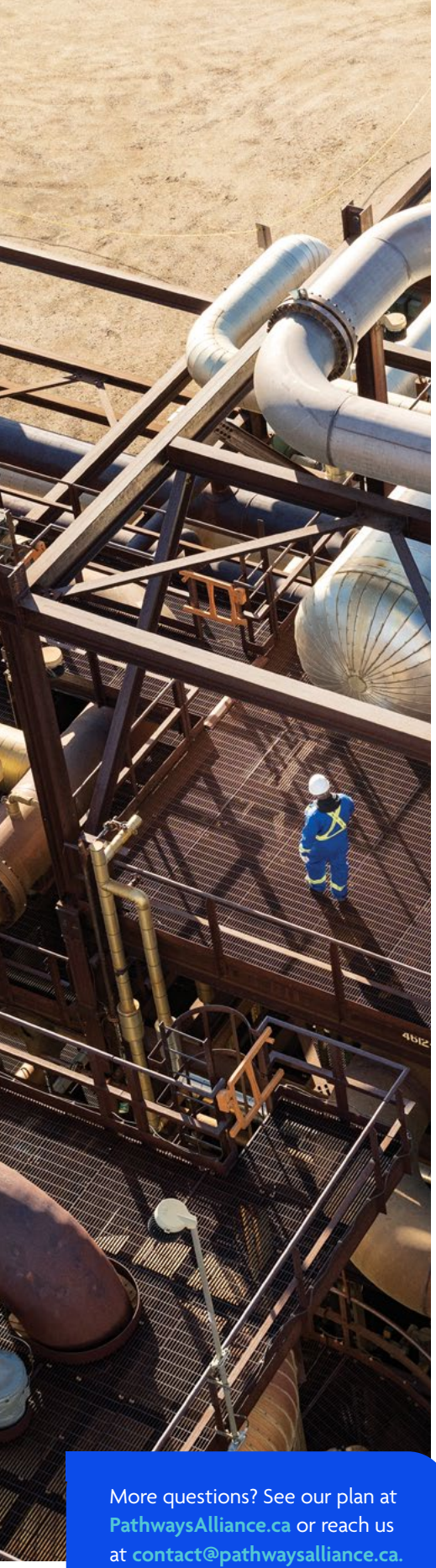
Layer 3: Response

The final layer of the safety system is response planning. It's essential to be prepared for any possibility. If an incident occurs, detailed response plans set out actions to mitigate its effects.



9 **Emergency shutdown procedures**
If pipeline monitoring systems sense changes in pressure or temperature, they trigger an immediate response. Isolation bars block off the affected section of pipe and stop the flow of CO_2, while alerting an on-the-ground operator.

10 **Community emergency response**
Emergency preparedness plans are developed in close cooperation with regional and local authorities. Residents of the region will be contacted directly when this plan is finalized.



More questions? See our plan at PathwaysAlliance.ca or 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 is naturally occurring in the atmosphere and 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 give us early warnings of any potential problems and if we identify an issue, emergency preparedness and response planning will be in place to ensure the public and environment are protected.

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 more than 1,000 metres below groundwater, separated by impermeable rock. If any CO_2 exited the storage layer, monitoring and seismic imaging would detect leaking CO_2 long before it could reach groundwater.

Did you know?

Pathways Alliance intends to file our formal regulatory application to the Alberta Energy Regulator in late 2023.