Alberta Carbon Capture and Storage (CCS) Landowner Information Guide

Prepared by:
The International CCS Knowledge Centre

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About the Knowledge Centre

The International CCS Knowledge Centre is a non-profit organization dedicated to sharing the lessons learned from building and operating large-scale carbon capture and storage (CCS) projects as a critical means of managing greenhouse gas emissions and achieving the world's ambitious climate goals. We provide independent, expert advisory services for CCS projects across heavy-emitting industries based on our team's unique experience developing the world's first fully integrated post-combustion CCS facility on a coal-fired power plant, SaskPower's Boundary Dam Unit 3 (BD3) CCS Facility.

About GLJ

This document was prepared with the assistance of GLJ:

GLJ has been a trusted independent technical advisor supporting the global energy industry since 1972. Our team of over 100 engineers, geoscientists, analysts and sustainability practitioners have performed highly complex evaluations across more than 70 countries and serve over 200 energy clients annually. GLJ has supported clients in the development and operation of CO2 Enhanced Oil Recovery (EOR) schemes, gas storage reservoirs and acid gas injection schemes for over 30 years. This has laid a strong foundation for evaluating CCS projects in support of industrial decarbonization, where GLJ has delivered over 30 projects in the last 3 years for CCS developments across Western Canada, the U.S.A., the U.K., Europe and beyond. The GLJ suite of CCS services include site screening, risk assessment, geological and geomechanical modelling, dynamic simulation modelling, economic modelling, monitoring plans and storage capacity certification, as well as support for FEED studies, project development plans and operations.

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Indigenous Land Acknowledgment

We acknowledge that we are on the traditional territories of the many First Nations, Métis and Inuit peoples who have cared for these lands for generations. In Alberta, we specifically recognize the territories of Treaty 6, Treaty 7, and Treaty 8. We honor and respect the histories, languages and cultures of all Indigenous peoples who have contributed to shaping this province.

As we strive for a sustainable future, we are committed to reducing carbon emissions and protecting the environment, inspired by the traditional knowledge and stewardship practices of Indigenous communities. May we move forward in the spirit of reconciliation, collaboration and environmental responsibility.

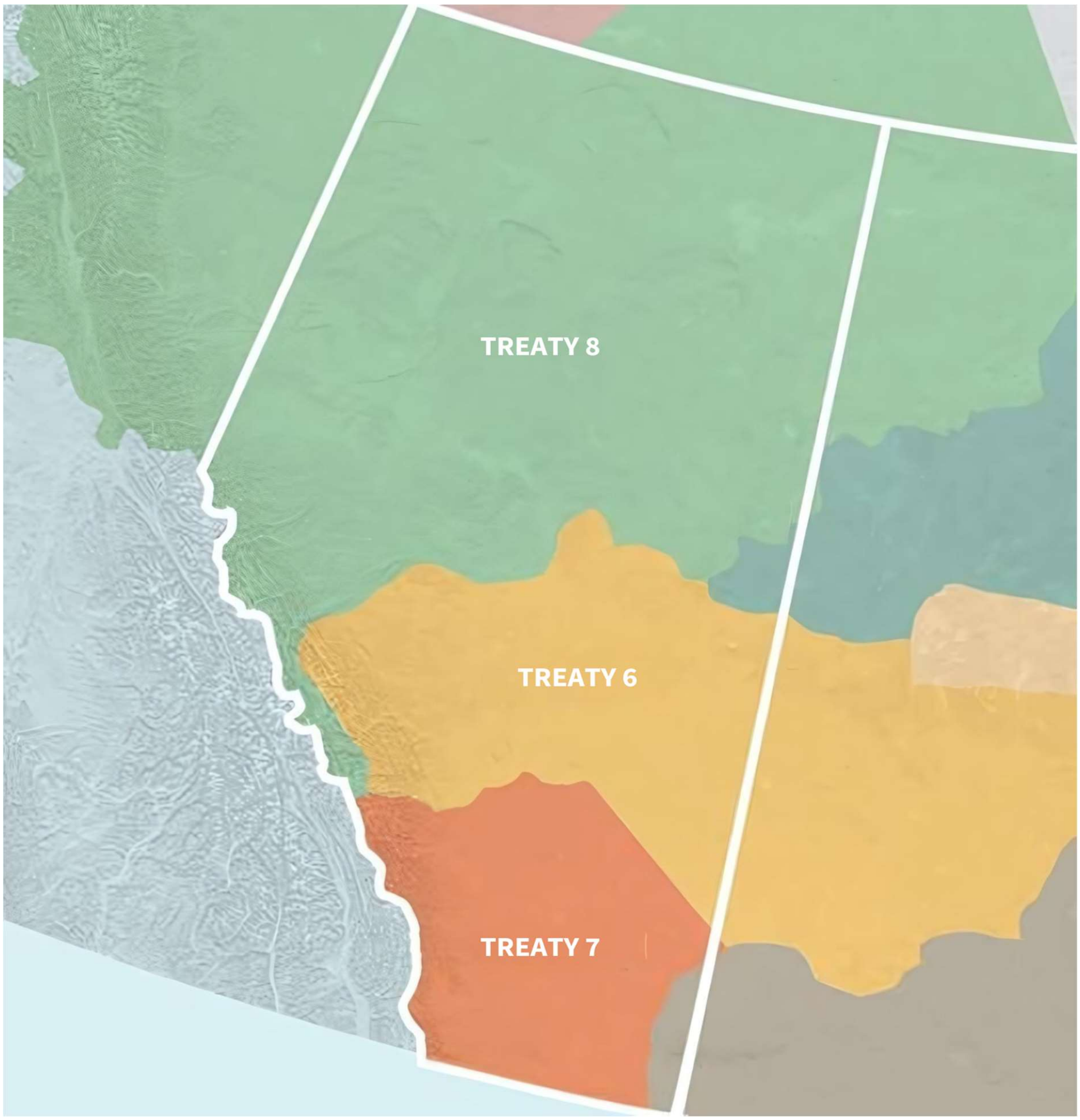
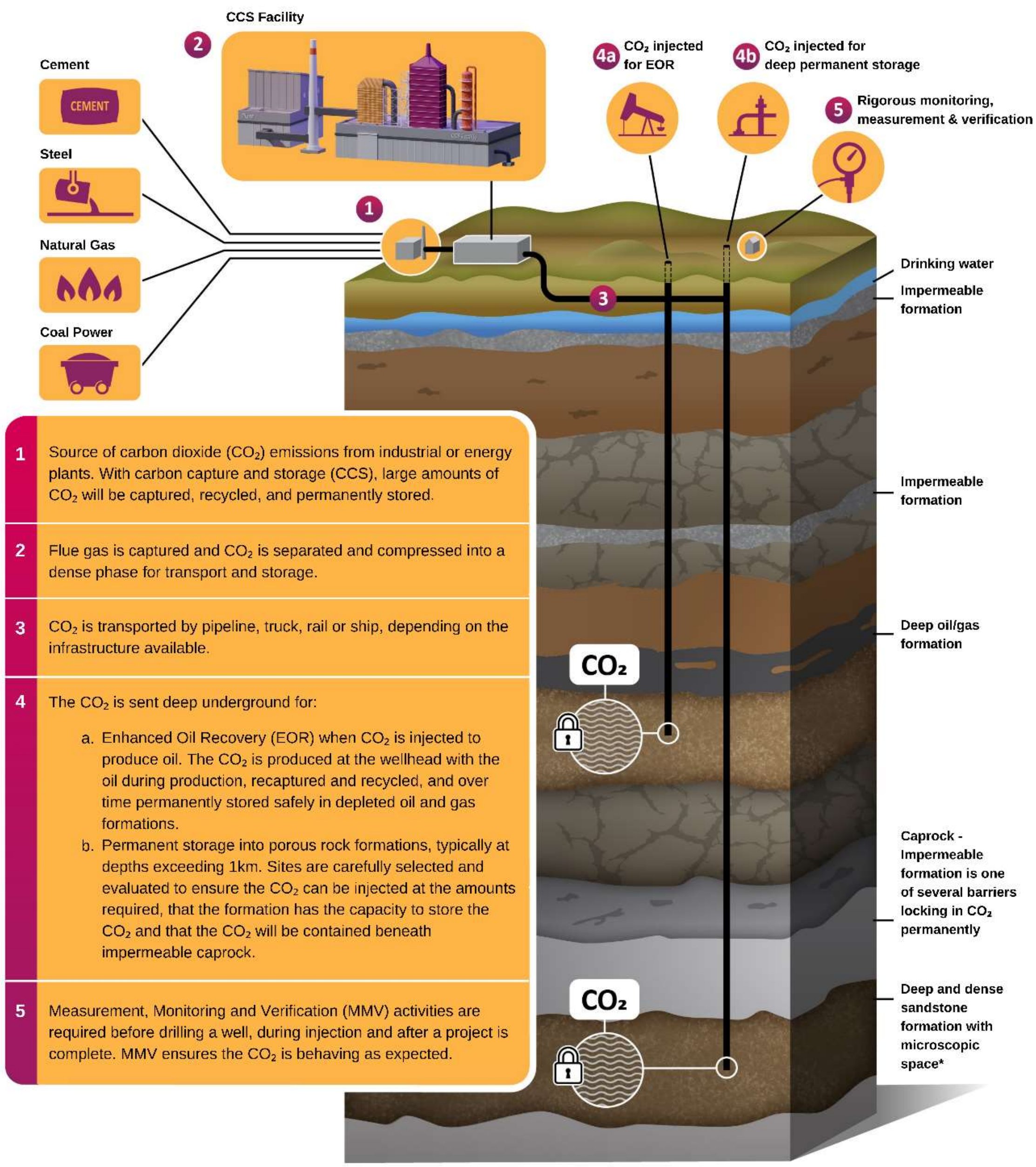


Table of Contents

What is CCS / CCUS?

Carbon Capture and Storage (CCS) is also referred to as carbon capture, utilization and storage (CCUS), and is a suite of technologies that play an important role in meeting global climate goals. CCS involves capturing carbon emissions from industrial processes, like power generation, or facilities that use either fossil fuels or biomass for fuel. Then, the CO_2 that isn't being used on-site is compressed and transported to be used in a range of applications in the case of CCUS, or injected into deep geological formations which trap the CO_2 for permanent storage in the case of CCS. While the CCS and CCUS are different, the terms are often used interchangeably.



*The deep sandstone formation has microscopic spaces between its individual sand grains, or porosity, which allows it to hold high salinity water – that is 10 times more salty than the ocean. Due to the presence of this very salty brine, geologists refer to this type of formation as a saline aquifer.

Carbon Cycle

Carbon dioxide or CO_2 is an essential component for life. Our atmosphere contains 0.04% CO_2 which is absorbed by plants through photosynthesis, producing oxygen and organic compounds.

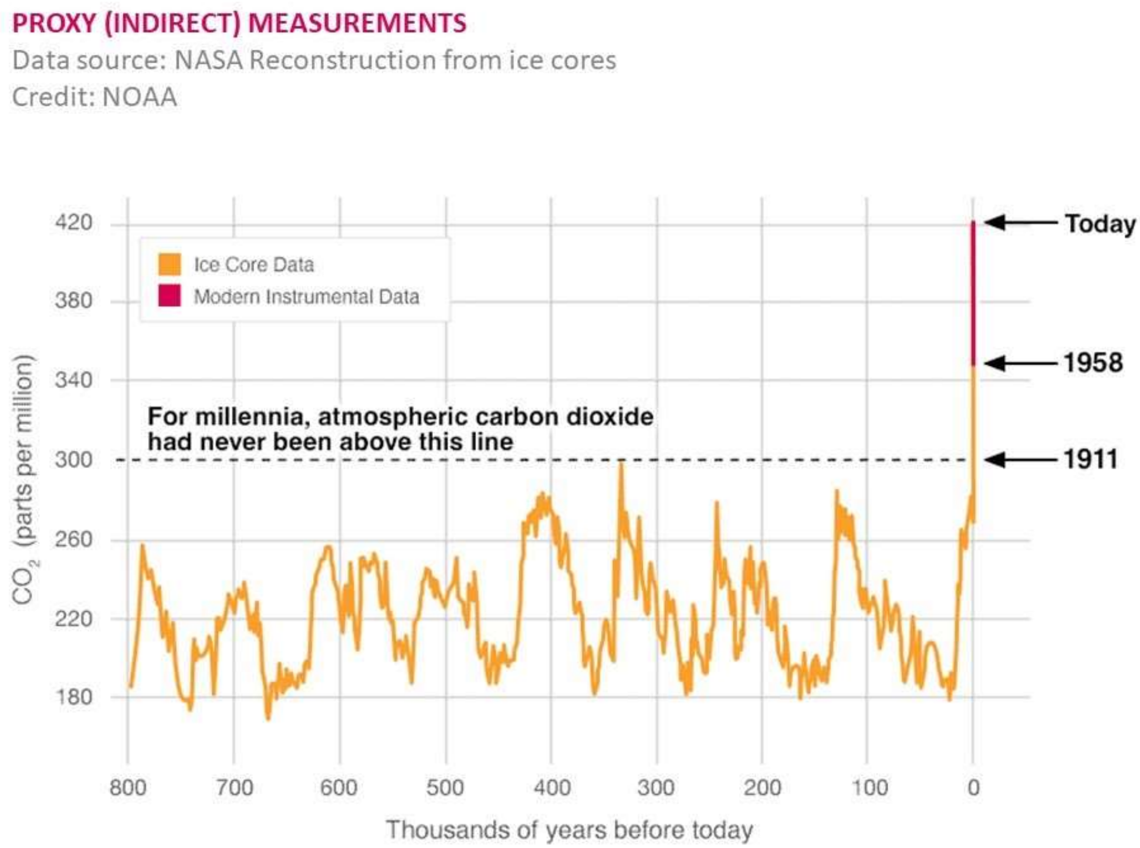
The carbon cycle is a fundamental process that describes the movement of carbon through various mechanisms on Earth. The carbon cycle includes these key components and processes:

- **Atmosphere**: Carbon exists in the atmosphere primarily as carbon dioxide (CO_2). It plays a significant role in regulating Earth's climate through the greenhouse effect.
- **Photosynthesis**: Plants, algae, and certain bacteria absorb CO_2 from the atmosphere and convert it into organic matter using sunlight through photosynthesis. This process sequesters carbon from the atmosphere and stores it in plant biomass.
- **Respiration**: Both plants and animals release CO_2 back into the atmosphere through respiration. When organisms consume organic matter for energy, carbon is returned to the atmosphere as CO_2.
- **Decomposition**: When plants and animals die, decomposers like bacteria and fungi break down their organic matter. This decomposition process releases CO_2 and methane (CH_4) back into the atmosphere or soil.
- **Ocean Uptake**: Oceans absorb a large amount of atmospheric CO_2. Some of it dissolves directly into the water, while marine organisms, like phytoplankton, also take up CO_2 for photosynthesis. The oceans act as a significant carbon sink.
- **Fossil Fuels**: Over millions of years, organic matter buried under sediments can transform into fossil fuels (coal, oil, natural gas). When these fuels are extracted and burned for energy, they release stored carbon back into the atmosphere as CO_2.
- **Weathering and Volcanic Activity**: Carbon in rocks can be released back into the atmosphere through weathering and volcanic eruptions, completing the cycle. The weathering of rocks also contributes to the long-term carbon cycle by transferring carbon to the oceans.
- **Human Activities**: Human activities, such as deforestation, land-use changes and burning fossil fuels, have significantly altered the natural carbon cycle. These activities increase the concentration of CO_2 and other greenhouse gases in the atmosphere, contributing to climate change.

Although there have been fluctuations of CO_2 in the atmosphere throughout history, these processes have worked together to maintain a balance of carbon between the atmosphere, land, oceans and organisms. This is how the carbon cycle maintains CO_2 levels, impacts the climate, supports life through the production of energy in ecosystems and maintains the acidity of oceans. Understanding and managing the carbon cycle is key to addressing global environmental challenges like climate change.

Over the past 150 years, human activities have disrupted the natural balance of CO_2 in the atmosphere, which can be determined by measuring the composition of the air trapped in ice cores from Antarctica. The disruption primarily stems from industrial processes and deforestation, which have added a surplus of CO_2 to the environment. One promising solution to mitigate this issue is CCS. CCS allows for the reduction of CO_2 emissions from industrial sources, allowing decarbonization without deindustrialization.

The following is a graph showing the CO_2 levels increasing since the early 1900s.



Is CO_2 hazardous?

Carbon dioxide (CO_2) is a colourless, odourless gas that's essential for life on Earth. It's a heat-trapping gas, also known as a greenhouse gas, and consists of one carbon atom bonded to two oxygen atoms. CO_2 is in the air we breathe and the carbonated beverages we drink. CO_2 is non-flammable and non-explosive, making it suitable for use in fire extinguishers. However, it can be hazardous to people if it's present in high concentrations, especially in confined spaces because it has a higher density than oxygen and displaces it. Exposure to CO_2 in high concentrations can cause shortness of breath, dizziness and confusion, headaches, increased heart rate and blood pressure, and possibly be life-threatening.

Due to these potentially adverse health impacts, safety regulations are in place for CO_2 capture, transport and storage operations to protect people. Regulations include monitoring CO_2 levels to ensure they remain within safe limits, systems for detecting leaks and ventilation systems to prevent any accumulation in enclosed spaces. Workers also wear personal protective equipment, such as respirators and CO_2 detectors, and are trained to recognize symptoms of CO_2 exposure and follow emergency protocols in case of an accidental release.

How is CCS regulated in Alberta?

The capture, transport and storage of CO_2 are managed through legislation, regulations and policies. Existing legislation addresses the underground ownership, management and liability for CCS projects, while regulations and policies address project applications and ongoing operations, ensuring compliance with environmental and safety standards.

The Government of Canada sets the strategy for emissions reductions, and each province and territory forms policies to reduce their greenhouse gasses. The strategies and policies have been continually adapted to encourage reduced emissions and to drive clean growth.

The Alberta Government implemented the Regulatory Framework Assessment (RFA) process in 2011 to ensure the right regulations were in place before full-scale CCS projects were operational. The RFA reviewed the CCS regulations and best practices around the world and specifically reviewed the technical, environmental, safety, monitoring and closure requirements. The process took over a year to complete and resulted in Alberta having one of the most advanced CCS regulatory frameworks in the world. Alberta was the first jurisdiction in Canada with an established regulatory and risk management framework for permanent storage of CO_2 and pore space management. Alberta's experience and understanding of the subsurface has led to the province being a global leader in CCS.

The Government of Alberta is responsible for the development of policies and regulations to enable CCS projects in the province. Alberta Energy and Minerals works with industry and other relevant ministries to develop a pathway for implementing carbon-reducing technologies and credits to achieve carbon neutrality by 2050. The ministry grants CCS project proponents the right to carry out evaluation activities, such as drilling wells, and conducting seismic surveys, to help develop CCS projects. Such regulations ensure sufficient due diligence of project proponents in evaluating, testing, building, operating and eventually closing CCS projects.

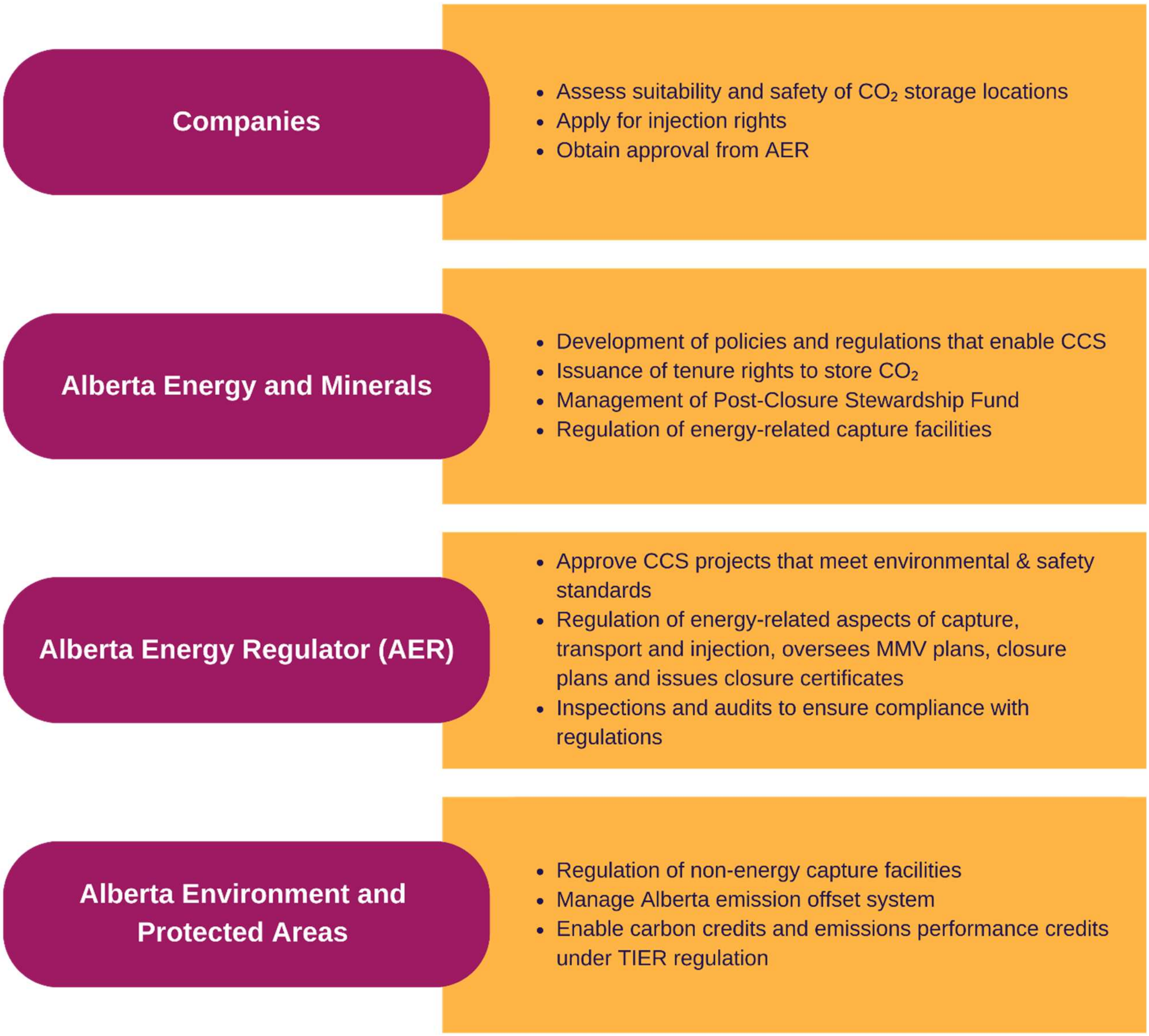
Companies requesting carbon storage must complete several steps before CO_2 can be sequestered:

- Capture facilities for energy activity are regulated by Alberta Energy and Minerals, while capture facilities for non-energy activities are regulated by Alberta Environment and Protected Areas.
- Storage locations are assessed for their suitability and safety and once a company demonstrates that they are able to provide safe and permanent storage, they can apply to Alberta Energy and Minerals for the right to inject CO_2.
- Companies then must obtain approvals from the Alberta Energy Regulator (AER). The AER ensures that CCS projects meet high environmental and safety standards at every step, regulating all energy-related aspects of CO_2 capture, transport and injection, and overseeing measurement, monitoring and verification (MMV) plans, closure plans and closure certificates. The AER regularly conducts inspections and audits to make sure companies are complying with the regulations.
- Companies transporting CO_2 must adhere to standard practices to ensure safe and efficient transport. This includes designing, constructing and maintaining pipelines according to stringent regulatory requirements set by the AER. If transporting CO_2 in trucks, there are regulations set by the Ministry of Transportation and Economic Corridors. These practices are essential for the safe and efficient movement of CO_2 from capture sites to storage locations. Compliance with

these standards ensures that the infrastructure meets high safety and environmental protection criteria.

- Finally, Alberta Environment and Protected Areas manages the Alberta Emission Offset System and enables the generation of carbon credits, and under the Technology Innovation and Emissions Reduction (TIER) Regulation enables the generation of emissions performance credits – a major incentive for industry to reduce greenhouse gas (GHG) emissions.

ALBERTA CCS REGULATORY FRAMEWORK



Once a company is approved to store CO_2, they must follow the AER's directives on the requirements for facilities and pipelines that handle CO_2, for the design, monitoring and reporting of injection wells, for the subsurface processes, and for ongoing testing and reporting.

How do companies safely store CO_2?

Carbon dioxide can be safely stored like other compressed gases such as propane and oxygen, in tanks above ground, however, in order to permanently store the volumes required, underground storage sites are used. Storage sites are carefully selected to ensure the underground geological formations can safely and permanently store the CO_2. CO_2 is injected deep underground, often at depths greater than 1,000 m – these formations are similar to the rocks that held oil and gas underground for millions of years. Rocks suitable for CO_2 storage are porous and permeable – meaning there are little holes that have the capacity to store the CO_2 – and these little holes are connected so the CO_2 can flow into the formation. Above the storage formation must be an extensive cap rock – or a barrier – to help ensure the CO_2 is contained permanently. And over time the CO_2 mineralizes and is permanently stored in the formation. A company must conduct ongoing monitoring activities to verify the effective containment of the stored CO_2.

Once a storage site is selected, a company conducts a thorough risk assessment which is reviewed by the AER. A risk assessment is used to identify, analyze, and evaluate potential hazards associated with a particular activity or project. In the context of CCS, a risk assessment usually includes several key steps:

- Identifying possible hazards.
- Analyzing the likelihood and impact of hazards.
- Evaluating which risks need action.
- Developing strategies to reduce or manage risks.
- Implementing monitoring strategies.
- Regularly reviewing and updating the assessment as needed.

How does a CCS project start?

Developing a CCS project in Alberta begins with site selection and feasibility studies. The initial phase involves identifying suitable geological formations, such as saline aquifers or depleted oil and gas reservoirs, that can securely store CO_2. Economic feasibility is analyzed to ensure the project is cost-effective, considering capture, transport, and storage expenses. Additionally, a thorough risk assessment is conducted to evaluate potential hazards, such as seismic activity and environmental impacts.

Environmental Impact Assessments (EIAs) follow, if required by the Alberta Energy Regulator (AER). These assessments detail the potential environmental impacts of the project. Public consultation is a crucial part of this process, engaging local communities and stakeholders to address concerns and gather input.

The next step is obtaining regulatory approval. Companies must submit applications to the AER and other relevant authorities, seeking approval for their projects. This stage involves securing the necessary permits and licenses for drilling, CO_2 injection and infrastructure construction.

Once approvals are secured, construction begins. This includes developing infrastructure such as pipelines for CO_2 transport from capture sites to storage sites. The time required for pipeline construction varies depending on the project's complexity and the distance to the storage site.

Concurrently, the storage site, often referred to as a well pad, is developed. The well pad serves as the operational base for storage activities and includes injection wells and observation wells, for both deep and groundwater monitoring. The size of the well pad can vary based on the project's scale and geological considerations.

At the storage site, injection wells are drilled and equipped to inject CO_2 into the geological formation. Observation wells monitor CO_2 migration and ensure environmental safety. Continuous monitoring systems are implemented to track CO_2 levels, pressure and potential leaks, ensuring the integrity of the storage site. Regular maintenance is conducted to keep the infrastructure in optimal condition.

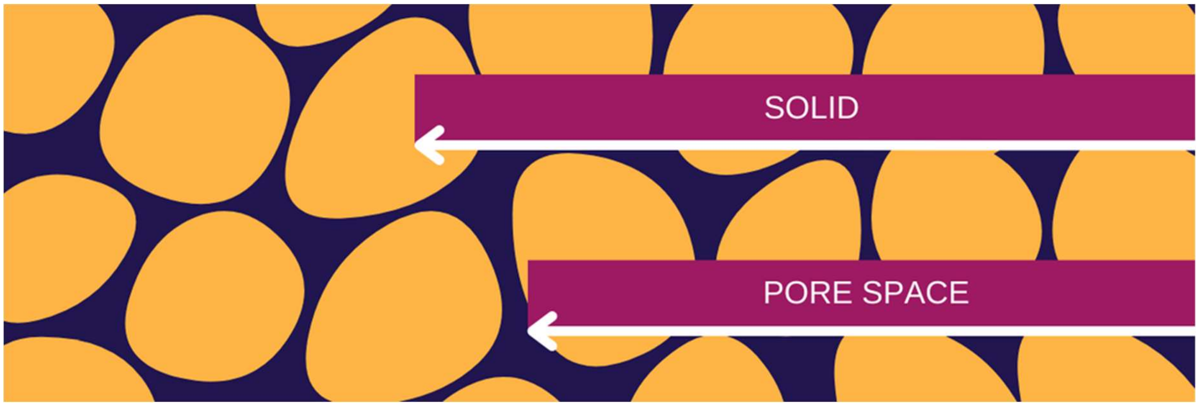
As part of Alberta’s climate strategy, the Alberta government aims to have significant CCS capacity operational by 2030. This aligns with the federal government's Investment Tax Credit (ITC), designed to incentivize CCS projects. The ambitious timeline emphasizes the importance of efficient project management and strict regulatory compliance. Projects must meet stringent environmental and safety standards while advancing towards a lower-carbon future. Economic incentives from federal and provincial governments help reduce costs and encourage investment in CCS technologies.

What are the right rocks for safe CCS?

When considering the underground storage of CO_2, certain geological formations are better equipped to securely contain the CO_2 and prevent it from leaking to the surface. These formations have porous and permeable rocks with tiny, interconnected spaces that trap CO_2 called pore space. Above these storage rocks, there are cap rocks, like shale, anhydrite, and halite, which act as barriers to stop CO_2 from escaping. Cap rocks are natural seals that sit on top of the storage rocks, while shale’s low permeability prevents fluids from moving through it. Non-porous rocks like anhydrite and halite also help keep the CO_2 in place. Combining these types of storage rocks and sealing layers is essential for safely and securely storing CO_2 underground for the long term. Alberta’s Western Canadian Sedimentary Basin has tremendous storage potential with the right geology to support the CCS industry.

What is pore space and why is it important?

Pore space is the empty space between the particles of sand and sediment or the space within and between the rocks found deep underground (see image below). Pore space refers to the subsurface space where CO_2 can be stored. Pore space can be filled with water, oil, natural gas, or, in the context of CCS, captured CO_2. Once injected, CO_2 can move between the particles and fill the space.



In Alberta, the government owns the rights to pore space and has an inventory of suitable space for storage. Sometimes the pore space that is suitable for CCS could also include useful minerals, so companies looking to store CO_2 or extract minerals apply for the rights to the space from the Government of Alberta.

How is CO_2 transported to storage locations?

Captured CO_2 must be transported to sites where it can be injected for permanent storage. This is done via rail, truck or pipeline, and each method has specific advantages and considerations.

Rail Transport:

- **Method:** CO_2 is often transported in pressurized tanks designed for railcars.
- **Advantages:**
    - Efficient for long-distance transport, especially across regions with established railways.
    - Can handle large volumes of CO_2, making it suitable for industrial-scale transport.
    - Relatively safe and secure, with stringent regulations and safety protocols in place.
- **Considerations:**
    - Initial infrastructure costs for loading and unloading at rail terminals can be significant.
    - Dependence on rail schedules and availability can affect planning logistics.

Truck Transport:

- **Method:** CO_2 is transported in specialized tank trucks.
- **Advantages:**
    - Flexibility in reaching locations not served by pipelines or railways, including remote areas.
    - Well-suited for smaller volumes of CO_2 or where immediate delivery is required.
    - Can be cost-effective for shorter distances.
- **Considerations:**
    - Higher transportation costs per unit compared to rail or pipeline over long distances.
    - Truck fleets require more frequent refilling and maintenance.
    - Safety considerations for handling pressurized CO_2 during loading, transport and unloading.

Pipeline Transport:

- **Method:** CO_2 is transported in specially designed piplines. CO_2 may be in either gas or supercritical state, depending on pressure and temperature conditions.
- **Advantages:**
    - Continuous, reliable transport over long distances with minimal energy consumption.
    - Economical for large volumes of CO_2 transport, particularly for industrial applications and large-scale CCS projects.
    - Lower environmental impact compared to trucks or rail in terms of emissions and land use.
- **Considerations:**
    - High initial capital investment for pipeline construction.
    - Regulatory and permitting challenges due to safety and environmental concerns.
    - Limited flexibility compared to trucks or rail in terms of reaching specific locations.

Operating CO_2 pipelines

Alberta is a world-leader in the pipeline transport of CO_2. The Alberta Carbon Trunk Line (ACTL) is the world's largest capture to storage project. The ACTL is a 240 km pipeline transporting captured CO_2 from Sturgeon Refinery and Nutrien's Redwater fertilizer plant to depleted oil reservoirs for injection. The pipeline can move up to 14.6 million tonnes of CO_2 per year.

Regulations are in place to ensure safe operations and environmental protection. Pipelines must be designed, constructed, operated and maintained according to the requirements established by the Canadian Standards Association. Pipeline operators may be handling CO_2 from multiple sources, captured with different techniques, which may lead to varied compositions. The operator determines the minimum necessary composition requirements of CO_2 and then monitors for the specified requirement.

Monitoring is required throughout operations, and an emergency response plan must be in place to address any potential incidents. Monitoring systems include measuring the volume of CO_2 being transported and continuously checking for pressure or temperature changes, which may indicate an issue. As well, pipeline operators are responsible for regular inspections and maintenance to ensure ongoing reliability and safety.

What is MMV?

A Measurement, Monitoring and Verification (MMV) plan is a multi-step framework designed to ensure the safety and effectiveness of CCS operations. MMV plans must be submitted to the AER as part of a CCS project approval process and are reviewed periodically to ensure the storage site is performing as expected. An MMV plan includes the following:

- **Site Characterization**: Seismic assessments of the geological formation where CO_2 is planned to be stored are completed to ensure its suitability. This involves evaluating factors like rock permeability, porosity, and sealing integrity. It also involves collecting baseline data.
- **Risk Assessment**: Risk assessments are integral for every part of a CCS project. This includes analyzing potential leakage pathways and assessing the potential impacts on groundwater and surface ecosystems.
- **Modelling**: Advanced modelling techniques are used to simulate CO_2 behaviour and to predict its long-term storage performance. These models help assess storage capacity, predict CO_2 plume migration, and evaluate the effectiveness of storage strategies. Throughout the life of the storage operations, the model will be updated and refined.
- **Measurement**: This involves accurately measuring the amount of CO_2 captured, transported, and stored using specific techniques and instrumentation.
- **Monitoring**: Using surface and downhole technologies and expertise, storage sites continuously monitor the CO_2 behaviour to detect any abnormalities. This includes measuring pressure, temperature, and CO_2 movement within the storage reservoir.
- **Verification and Reporting**: Independent verification and reporting mechanisms are established to confirm that CO_2 storage sites comply with regulatory requirements and safety standards. This involves periodic site inspections, data analysis, and reporting to regulatory authorities and interested parties.
- **Emergency Response Plan**: A predefined strategy is set in place for addressing any emergencies or unexpected events related to CO_2 storage sites. This includes protocols for immediate action, communication with authorities, and steps to mitigate any adverse effects of an emergency.

By completing a thorough risk analysis and implementing these MMV measures, a baseline is established early in the project and ongoing monitoring data is used so site operators can ensure that CO_2 is being safely and permanently stored.

Seismic imaging and its role in CCS

Seismic imaging directs a sound source into the ground to evaluate and detect subsurface conditions. Seismic imaging surveys typically use specialized vehicles that deploy seismic energy like vibrations and recording equipment to help assess the characteristics beneath the surface to ensure safe and effective project execution before the start of a CCS project. Time-lapse seismic imaging is also used to monitor and track the CO_2 plume in the formation over time.

Seismic surveys can be conducted in various locations. These surveys are common in areas where oil and gas exploration or CCS storage projects are being conducted.

Seismic acquisition is likely to occur during the early evaluation stages of a project as the target storage site is being evaluated and de-risked. Seismic surveys will then occur regularly throughout the project as data is integrated into ongoing MMV activities.

Can seismic surveys happen on my property?

Seismic surveys can be conducted on private property, but there are specific steps and conditions to follow. The landowner must first give permission for the survey, meaning a company must obtain a land access agreement. The company must provide advanced notice, explaining the timing, nature, and areas affected by the survey. The survey must comply with provincial and legislative regulations, including environmental protection and noise limits. Additionally, the company must ensure the survey is safe and minimizes disruption and environmental impact, protecting wildlife and water sources.

What if the CO_2 migrates?

CO_2 is found in the air we breathe and the carbonated beverages we drink. It's non-flammable and non-explosive, however, in high concentrations CO_2 in the air can pose a hazard to people. If CO_2 migrates from its expected storage location, laterally or upwardly, analysis needs to be performed to determine the cause and next steps. If the CO_2 migrates upwards through a well or a fault line, it could have negative impacts on ecosystems. Leaked CO_2 has the potential to alter soil pH, potentially impacting vegetation, and the potential to effect water sources. To mitigate these risks and detect a leak as soon as possible, comprehensive MMV plans and early detection measures are essential. In Alberta, because of the required site characterization and ongoing MMV, unmitigated migration is unlikely. Well-designed storage sites with effective seals and barriers help prevent upward migration, while emergency response plans should also be in place and communicated to local responders to address any incidents in a timely fashion. Steps can then be taken to address the CO_2 migration.

Will CCS affect groundwater?

Sites are carefully selected based on their geological formations, like deep saline aquifers and impermeable cap rocks, which help to contain the CO_2. Regular monitoring of these storage sites is also crucial, as it allows for early detection of any leaks by checking pressure changes, CO_2 movement, and groundwater composition. CCS projects must follow strict regulations, including thorough risk assessments and safety protocols, to protect groundwater and the environment. If the CO_2 avoided detection and migrated upwards from a storage site and through the cap rock into the groundwater, it likely would pass through the water and bubble to the surface. There is a small chance that it could eventually increase the acidity of the water if the CO_2 entered the water at a high pressure, remained trapped and was adsorbed.

Will CCS impact soil?

To prevent CO_2 from interacting with the soil, it's crucial to choose secure geological storage sites and continuously monitor them to detect any potential upward migration early. Underground CO_2 storage sites are typically over 1,000 m deep and have a cap rock barrier that has low permeability to minimize the risk of CO_2 upward migration. If CO_2 migrates upwards and through the cap rock, it has the potential to affect the soil. CO_2 could react with minerals in the soil, changing its composition and affecting how plants and microbes live and grow. These changes can disrupt important soil processes like nutrient cycling and decomposition.

How will I know if there's going to be a CCS project near my property?

If there's going to be a CCS project near your property, you may receive notifications or information through various channels. Operators often engage in public consultation processes to inform nearby residents and gather feedback, which can involve community meetings, informational materials, and online surveys. Regulatory authorities will issue public notices and announcements about the project, allowing people to review and comment on the plans. Your local government or municipal authorities will also provide information about upcoming CCS projects through public meetings, newsletters, or official communications channels. Lastly, local news outlets or industry publications will likely report on proposed CCS projects, providing information on project location, scope, and potential impacts. Common rules and regulations include:

- **Environmental Impact Assessment**: CCS projects may be required to complete environmental impact assessments to evaluate potential impacts on air quality, water resources, ecosystems, and human health.
- **Permitting and Licensing**: Operators must obtain permits and licenses from regulatory authorities before beginning any CCS activities. This includes approvals for CO_2 injection, site construction, and operation.
- **Safety Standards**: Projects must follow safety guidelines to protect workers, nearby communities, and the environment, including risk assessments and emergency response plans.
- **Public Consultation**: Operators may engage in public consultation processes to inform the public and gather input on project plans, potential impacts, and mitigation measures. This is the best opportunity for a landowner to learn more about CCS operations in their area. Operators will share their project details including plans, timing and potential impact.
- **Monitoring and Reporting**: CCS projects must track and report CO_2 storage performance to ensure regulatory compliance and address any issues posed to the facility.

What are the differences between surface and subsurface rights?

There is a distinction between surface rights and subsurface rights.

Surface Rights:

- Surface rights refer to the rights of the land and everything on its surface. This includes buildings, vegetation, and any other improvements made to the land.
- Surface owners have the right to use the land for residential, agricultural, commercial, and other purposes.
- Surface ownership does not automatically include the rights to the minerals, resources or pore space located beneath the surface.

Subsurface Rights:

- Subsurface rights refer to the ownership of the minerals, resources and pore space found below the surface.
- Subsurface rights include pore space or mineral rights and can be owned separately from the surface rights. This means one party can own the land while another party owns the rights to the minerals and pore space beneath it.

In Alberta, the province owns 81% of all the region's subsurface resources and all pore space is considered as property of the Crown (or the Government of Alberta), with the exception of pore space owned by the federal government. This federal pore space includes the rights owned by the government on behalf of First Nations and the National Parks. For CO_2 sequestration, subsurface rights agreements include evaluation permits and sequestration leases. After the subsurface rights are obtained by a company, they must acquire surface rights to access the land. This process is different if the land is private or public. On private land, there needs to be an agreement in place between the company and the landowner. On public land, a surface lease must be obtained.

What happens when the CO_2 storage site ends their operations?

Once a CCS site's storage capacity is reached or the CO_2 has been securely stored and monitored for the required time, the site moves to closure. CCS operations typically last at least a couple of decades. Once the injection has stopped, the site undergoes a transition period to implement post-closure monitoring activities determined by the closure plan to ensure the long-term stability of the stored CO_2. In Alberta, the requirements are that MMV continues for at least a period of 10 years. Monitoring at this stage involves inspections and assessments of the site's integrity, including the sealing of injection wells and ongoing monitoring of groundwater, and surface ecosystems. In Alberta, closure reporting is required annually, and once the closure plan is complete, the company applies for a closure certificate. Post-closure monitoring and maintenance continues.

Who is responsible when a site is closed?

When a company finishes putting CO_2 safely underground, the liability for the CCS site transitions from the operator to the Government of Alberta. This transition occurs when the site meets all regulatory closure criteria, including successful CO_2 injection and monitoring, sealing of injection wells, and implementation of post-closure monitoring plans. Once these requirements are met and regulatory approvals are obtained, the province assumes responsibility for the long-term liability of the site. This ensures that ongoing monitoring and maintenance activities are carried out to prevent any potential environmental or safety risks associated with the stored CO_2 over the site's operational lifespan. The cost of long-term monitoring is to be fully funded by the operator through contributions to the government's Post-Closure Stewardship Fund throughout the project's lifespan. This ensures that the government and taxpayers are not financially responsible for this transition; instead, it is managed entirely by the site's operators.

Overcoming CCS risks

If we want to tap into CCS to help achieve Canada's net-zero goals, we need to find ways to overcome and mitigate all potential risks. CCS will undoubtedly require careful management and engagement with landowners and other stakeholders. The potential impacts can be considered and addressed with proper CCS management, preparation and risk mitigation strategies, including:

- Commitment to long-term monitoring for the length of carbon capture and storage tenure, including continual monitoring of CO_2 on-site as well as in pipelines.
- Development of robust risk mitigation strategies and procedures.
- Employing responsible site regulation and planning by conducting an environmental assessment, as well as adhering to all legislation currently applicable to CCS strategies.
- Utilizing technology within the injection process such as underground sensors to oversee the safe storage of CO_2.
- Partnering and consulting with experienced operators that are well-versed with the process of underground storage.

Despite its potential risks, CCS is an important solution for industries to reduce CO_2 emissions and is a vital part of Alberta's strategy to reach net-zero by 2050.