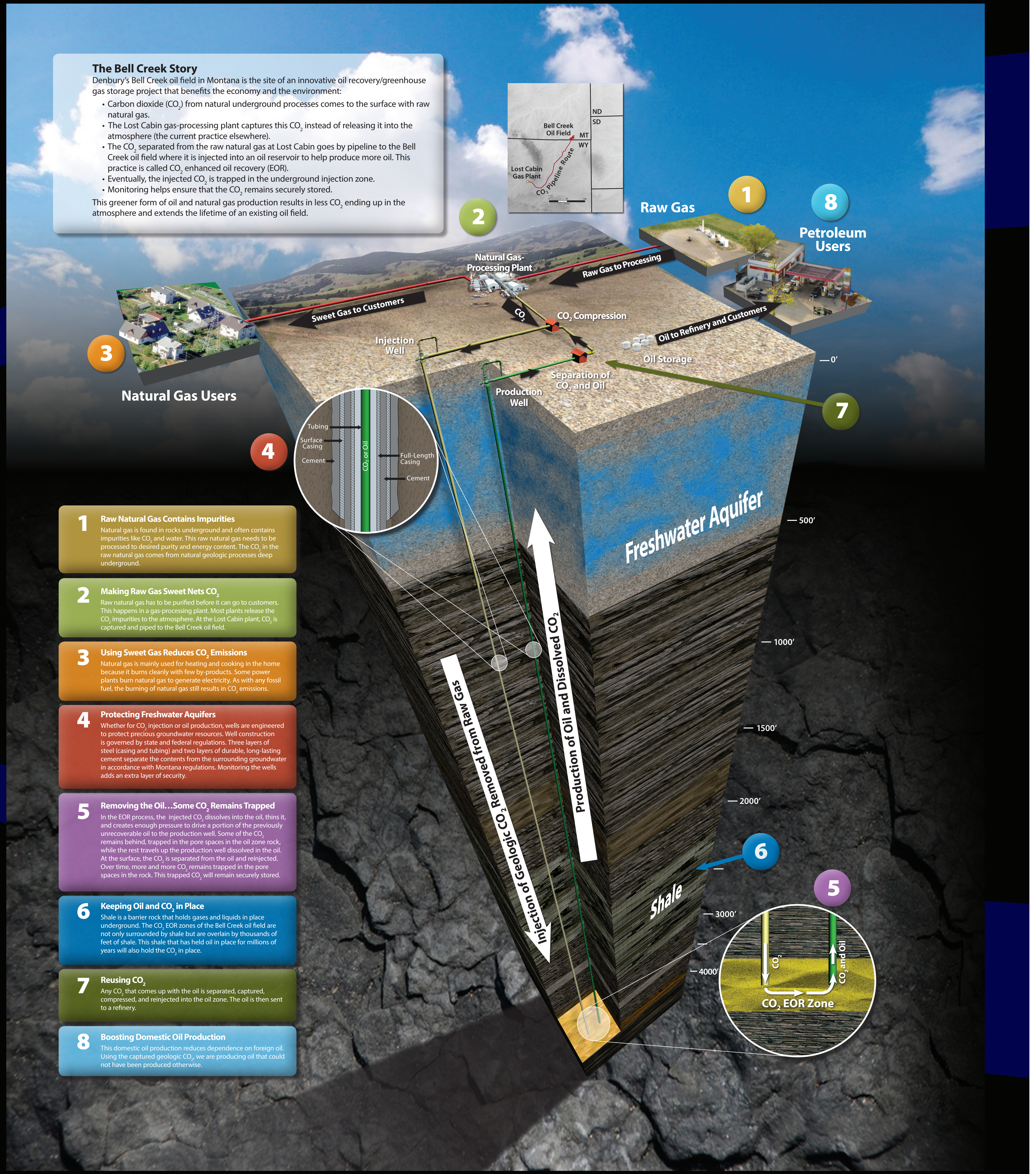
PCOR PARTNERSHIP PHASE III

Bell Creek


Bell Creek Oil Field
ND
SD
MT
WY
Lost Cabin Gas Plant
CO_2 Pipeline Route
Raw Gas
1
8
Petroleum Users
2
Natural Gas-Processing Plant
Raw Gas to Processing
Sweet Gas to Customers
CO_2
CO_2 Compression
Oil to Refinery and Customers
Injection Well
Oil Storage
3
Natural Gas Users
Production Well
Separation of CO_2 and Oil
— 0′
7
4
Tubing
Surface Casing
Cement
CO_2 or Oil
Full-Length Casing
Cement
Freshwater Aquifer
— 500′
— 1000′
— 1500′
— 2000′
— 3000′
— 4000′
Injection of Geologic CO_2 Removed from Raw Gas
Production of Oil and Dissolved CO_2
6
5
Shale
CO_2
CO_2 and Oil
CO_2 EOR Zone

The Bell Creek Story

Denbury's Bell Creek oil field in Montana is the site of an innovative oil recovery/greenhouse gas storage project that benefits the economy and the environment:

- Carbon dioxide (CO_2) from natural underground processes comes to the surface with raw natural gas.
- The Lost Cabin gas-processing plant captures this CO_2 instead of releasing it into the atmosphere (the current practice elsewhere).
- The CO_2 separated from the raw natural gas at Lost Cabin goes by pipeline to the Bell Creek oil field where it is injected into an oil reservoir to help produce more oil. This practice is called CO_2 enhanced oil recovery (EOR).
- Eventually, the injected CO_2 is trapped in the underground injection zone.
- Monitoring helps ensure that the CO_2 remains securely stored.

This greener form of oil and natural gas production results in less CO_2 ending up in the atmosphere and extends the lifetime of an existing oil field.

1 Raw Natural Gas Contains Impurities
Natural gas is found in rocks underground and often contains impurities like CO_2 and water. This raw natural gas needs to be processed to desired purity and energy content. The CO_2 in the raw natural gas comes from natural geologic processes deep underground.

2 Making Raw Gas Sweet Nets CO_2
Raw natural gas has to be purified before it can go to customers. This happens in a gas-processing plant. Most plants release the CO_2 impurities to the atmosphere. At the Lost Cabin plant, CO_2 is captured and piped to the Bell Creek oil field.

3 Using Sweet Gas Reduces CO_2 Emissions
Natural gas is mainly used for heating and cooking in the home because it burns cleanly with few by-products. Some power plants burn natural gas to generate electricity. As with any fossil fuel, the burning of natural gas still results in CO_2 emissions.

4 Protecting Freshwater Aquifers
Whether for CO_2 injection or oil production, wells are engineered to protect precious groundwater resources. Well construction is governed by state and federal regulations. Three layers of steel (casing and tubing) and two layers of durable, long-lasting cement separate the contents from the surrounding groundwater in accordance with Montana regulations. Monitoring the wells adds an extra layer of security.

5 Removing the Oil…Some CO_2 Remains Trapped
In the EOR process, the injected CO_2 dissolves into the oil, thins it, and creates enough pressure to drive a portion of the previously unrecoverable oil to the production well. Some of the CO_2 remains behind, trapped in the pore spaces in the oil zone rock, while the rest travels up the production well dissolved in the oil. At the surface, the CO_2 is separated from the oil and reinjected. Over time, more and more CO_2 remains trapped in the pore spaces in the rock. This trapped CO_2 will remain securely stored.

6 Keeping Oil and CO_2 in Place
Shale is a barrier rock that holds gases and liquids in place underground. The CO_2 EOR zones of the Bell Creek oil field are not only surrounded by shale but are overlain by thousands of feet of shale. This shale that has held oil in place for millions of years will also hold the CO_2 in place.

7 Reusing CO_2
Any CO_2 that comes up with the oil is separated, captured, compressed, and reinjected into the oil zone. The oil is then sent to a refinery.

8 Boosting Domestic Oil Production
This domestic oil production reduces dependence on foreign oil. Using the captured geologic CO_2, we are producing oil that could not have been produced otherwise.

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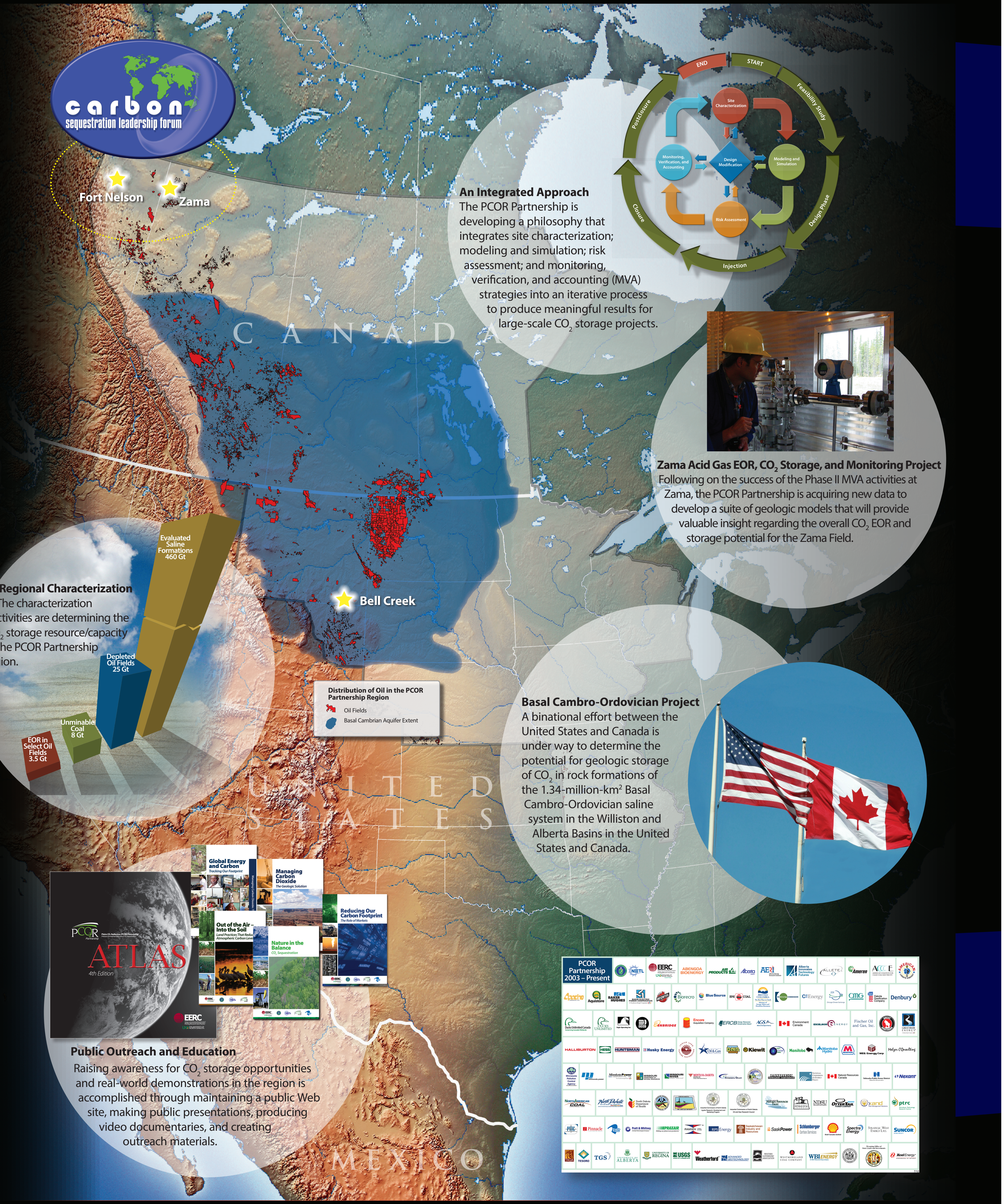
Regional Activities


carbon sequestration leadership forum
Fort Nelson
Zama
CANADA
Bell Creek
UNITED STATES
MEXICO
END
START
Feasibility Study
Design Phase
Injection
Closure
Postclosure
Site Characterization
Modeling and Simulation
Design Modification
Risk Assessment
Monitoring, Verification, and Accounting
Evaluated Saline Formations 460 Gt
Depleted Oil Fields 25 Gt
Unminable Coal 8 Gt
EOR in Select Oil Fields 3.5 Gt
Distribution of Oil in the PCOR Partnership Region
Oil Fields
Basal Cambrian Aquifer Extent
PCOR Partnership
ATLAS
4th Edition
EERC
Global Energy and Carbon
Tracking Our Footprint
Managing Carbon Dioxide
The Geologic Solution
Out of the Air – Into the Soil
Land Practices That Reduce Atmospheric Carbon Levels
Nature in the Balance
CO_2 Sequestration
Reducing Our Carbon Footprint
The Role of Markets
PCOR Partnership 2003 – Present

An Integrated Approach

The PCOR Partnership is developing a philosophy that integrates site characterization; modeling and simulation; risk assessment; and monitoring, verification, and accounting (MVA) strategies into an iterative process to produce meaningful results for large-scale CO_2 storage projects.

Zama Acid Gas EOR, CO_2 Storage, and Monitoring Project

Following on the success of the Phase II MVA activities at Zama, the PCOR Partnership is acquiring new data to develop a suite of geologic models that will provide valuable insight regarding the overall CO_2 EOR and storage potential for the Zama Field.

Regional Characterization

The characterization activities are determining the CO_2 storage resource/capacity in the PCOR Partnership region.

Basal Cambro-Ordovician Project

A binational effort between the United States and Canada is under way to determine the potential for geologic storage of CO_2 in rock formations of the 1.34-million-km^2 Basal Cambro-Ordovician saline system in the Williston and Alberta Basins in the United States and Canada.

Public Outreach and Education

Raising awareness for CO_2 storage opportunities and real-world demonstrations in the region is accomplished through maintaining a public Web site, making public presentations, producing video documentaries, and creating outreach materials.

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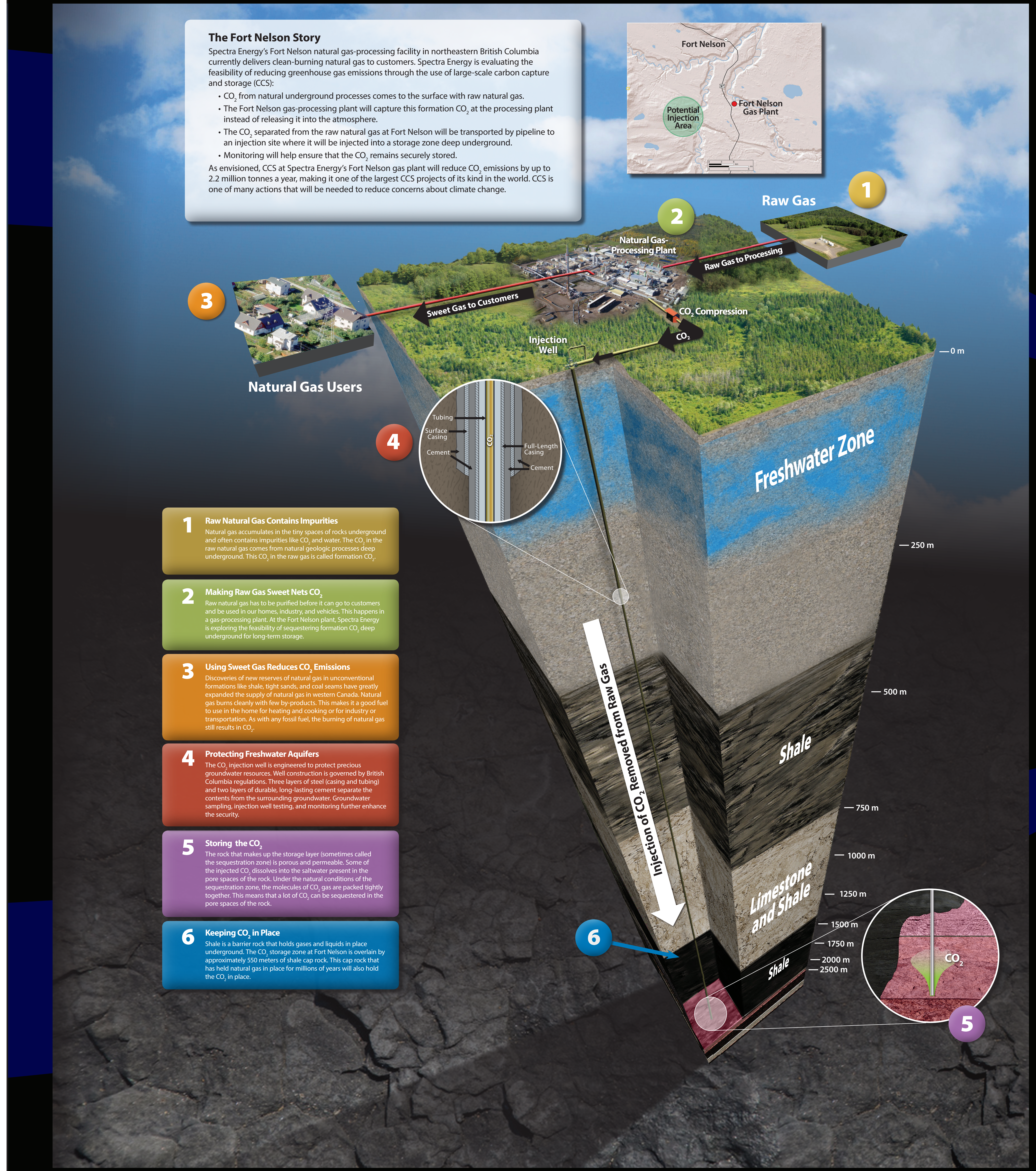
Fort Nelson


Fort Nelson
Potential Injection Area
Fort Nelson Gas Plant
Raw Gas
1
2
Natural Gas-Processing Plant
Raw Gas to Processing
Sweet Gas to Customers
CO_2 Compression
CO_2
3
Injection Well
Natural Gas Users
— 0 m
4
Tubing
Surface Casing
Cement
CO_2
Full-Length Casing
Cement
Freshwater Zone
— 250 m
— 500 m
Shale
— 750 m
— 1000 m
Limestone and Shale
— 1250 m
— 1500 m
— 1750 m
— 2000 m
— 2500 m
Shale
Injection of CO_2 Removed from Raw Gas
6
CO_2
5

The Fort Nelson Story

Spectra Energy's Fort Nelson natural gas-processing facility in northeastern British Columbia currently delivers clean-burning natural gas to customers. Spectra Energy is evaluating the feasibility of reducing greenhouse gas emissions through the use of large-scale carbon capture and storage (CCS):

- CO_2 from natural underground processes comes to the surface with raw natural gas.
- The Fort Nelson gas-processing plant will capture this formation CO_2 at the processing plant instead of releasing it into the atmosphere.
- The CO_2 separated from the raw natural gas at Fort Nelson will be transported by pipeline to an injection site where it will be injected into a storage zone deep underground.
- Monitoring will help ensure that the CO_2 remains securely stored.

As envisioned, CCS at Spectra Energy's Fort Nelson gas plant will reduce CO_2 emissions by up to 2.2 million tonnes a year, making it one of the largest CCS projects of its kind in the world. CCS is one of many actions that will be needed to reduce concerns about climate change.

1 Raw Natural Gas Contains Impurities
Natural gas accumulates in the tiny spaces of rocks underground and often contains impurities like CO_2 and water. The CO_2 in the raw natural gas comes from natural geologic processes deep underground. This CO_2 in the raw gas is called formation CO_2.

2 Making Raw Gas Sweet Nets CO_2
Raw natural gas has to be purified before it can go to customers and be used in our homes, industry, and vehicles. This happens in a gas-processing plant. At the Fort Nelson plant, Spectra Energy is exploring the feasibility of sequestering formation CO_2 deep underground for long-term storage.

3 Using Sweet Gas Reduces CO_2 Emissions
Discoveries of new reserves of natural gas in unconventional formations like shale, tight sands, and coal seams have greatly expanded the supply of natural gas in western Canada. Natural gas burns cleanly with few by-products. This makes it a good fuel to use in the home for heating and cooking or for industry or transportation. As with any fossil fuel, the burning of natural gas still results in CO_2.

4 Protecting Freshwater Aquifers
The CO_2 injection well is engineered to protect precious groundwater resources. Well construction is governed by British Columbia regulations. Three layers of steel (casing and tubing) and two layers of durable, long-lasting cement separate the contents from the surrounding groundwater. Groundwater sampling, injection well testing, and monitoring further enhance the security.

5 Storing the CO_2
The rock that makes up the storage layer (sometimes called the sequestration zone) is porous and permeable. Some of the injected CO_2 dissolves into the saltwater present in the pore spaces of the rock. Under the natural conditions of the sequestration zone, the molecules of CO_2 gas are packed tightly together. This means that a lot of CO_2 can be sequestered in the pore spaces of the rock.

6 Keeping CO_2 in Place
Shale is a barrier rock that holds gases and liquids in place underground. The CO_2 storage zone at Fort Nelson is overlain by approximately 550 meters of shale cap rock. This cap rock that has held natural gas in place for millions of years will also hold the CO_2 in place.

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