



# Enhanced Oil Recovery Projects in Canada

Enhanced Oil Recovery with permanent CO<sub>2</sub> Sequestration, or storage, is a process where CO<sub>2</sub> is injected into deep reservoirs to improve oil production and is a technique already used in more than 100 US oil field operations.

**Below are just a few current EOR projects that are right here in our back yard.**

## Current EOR projects in Central Alberta

### Penn West (Joffre Viking sands)

The Joffre Viking flood shows CO<sub>2</sub>-based EOR can succeed in Alberta given the right reservoir characteristics and CO<sub>2</sub> cost.

Located northeast of Red Deer, the project buys CO<sub>2</sub> from a nearby petrochemical complex. Started as a pilot in the early 1980s, the Joffre Viking miscible flood is still active after three decades. The project, which Penn West acquired in 2001, is Canada's oldest operating CO<sub>2</sub> EOR scheme.

Primary production began in 1953, followed by water flooding in 1957.

The pool was abandoned in the mid-1960s after 42 per cent of the original oil in place was produced. A CO<sub>2</sub> flood began 20 years later.

After seven years of development and evaluation, a commercial CO<sub>2</sub> flood began with expected incremental recovery of 13 per cent. By 2003, after about two decades of continuous operation, the miscible flood had expanded to 13 patterns containing 33 per cent of the original oil in place. Simultaneous injection of water and CO<sub>2</sub> was found to be more effective than water-alternating-gas mode.

By 2003, tertiary oil production totalled 580,000 cubic metres—12 per cent of the original oil in place. The project had oil rates of 100 cubic metres a day from 32 producers in 13 patterns, and CO<sub>2</sub> injection was 265,000 cubic metres a day. The total CO<sub>2</sub> injected was 40 bcf, of which 16 bcf remained in the reservoir. (More current information wasn't available.)

A key economic indicator for a CO<sub>2</sub>-based EOR project is the amount of CO<sub>2</sub> that has to be injected to produce a barrel of oil. During the period reviewed,

the Joffre Viking project had an average gross utilization factor of 10.8 mcf of CO<sub>2</sub> per bbl of oil produced (ranging from 3.5 to 24.9 by individual pattern) and a net utilization factor of four mcf per bbl of oil (ranging from 1.7 to 9.9 by individual pattern). Net utilization includes only purchased CO<sub>2</sub> while gross utilization includes both purchased and recycled CO<sub>2</sub>.

The report said average CO<sub>2</sub> injection rates were about 20,000 cubic metres a day per well.

### Glencoe Resources (Chigwell Viking sands)

Glencoe Resources Ltd., a small privately held producer, operates the only other Alberta CO<sub>2</sub> EOR project ranked as commercial.

The Chigwell Viking pools are light-medium oil underpressured sandstone reservoirs at a depth of about 1,400 metres, similar to the Joffre Viking. Two pools with similar properties are being flooded with CO<sub>2</sub>—the Chigwell Viking E and I pools.

The E pool has been on a CO<sub>2</sub> flood scheme since 2007. Since the start of injection, the oil production rate increased to about 600 bbls a day.

The I pool was previously flooded with ethane, starting in 1999. At the start of ethane injection the oil rate went to almost 900 bbls a day, from about 125 bbls a day. CO<sub>2</sub> flooding began in around 2006. After the start of CO<sub>2</sub> injection, the oil rate went to about 570 bbls a day from about 125 bbls a day. But in both cases the peak rate was followed by a sharp decline, the report says. Straight CO<sub>2</sub> injection was switched to water-alternating-gas injection when CO<sub>2</sub> breakthrough occurred. Horizontal wells were introduced to address geological heterogeneities.



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## Current EOR projects in Canada

### Weyburn-Midale

About 2.8 Mt/a of CO<sub>2</sub> are captured at the Great Plains Synfuels Plant in the US State of North Dakota, a coal gasification plant that produces synthetic natural gas and various chemicals. The CO<sub>2</sub> is transported by pipeline 320 km across the international border into Saskatchewan, and injected into depleting oil fields where it is used for EOR. The IEA Greenhouse Gas Research and Development (R&D) Programme's Weyburn-Midale CO<sub>2</sub>

Monitoring and Storage Project was the first project to scientifically study and monitor the underground behavior of CO<sub>2</sub>. Canada's Petroleum Technologies Research Centre manages the monitoring effort. This effort is now in the second and final phase (2007-2011), of building the necessary framework to encourage global implementation of CO<sub>2</sub> geological storage. The project will produce a best-practices manual for carbon injection and storage.

