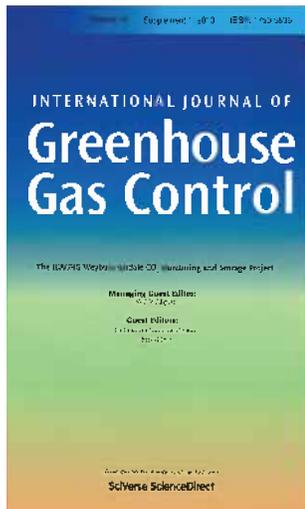


# PTRC Impacts



CO<sub>2</sub> pipeline arriving at the Weyburn plant.



Cover of Weyburn results from the IJGGC.



## IEAGHG WEYBURN-MIDALE CO<sub>2</sub> MONITORING AND STORAGE PROJECT

This 15-year, \$80 million field study to measure, monitor and verify the CO<sub>2</sub> being injected as part of CO<sub>2</sub>-enhanced oil recovery at the Weyburn and Midale oil fields in southern Saskatchewan provided the confirmation of safety and storage monitoring that validated the ongoing operation of these fields.

PTRC's research into areas such as wellbore integrity, soil-gas and ground water monitoring, 4D seismic imaging, modeling and history matching of data contributed towards the oil field operators maintaining efficient and safe operations.

PTRC has become a world-leader in developing measurement, monitoring and verification plans for oil field operators thinking of injecting CO<sub>2</sub> and other solvents for enhanced oil recovery.

The Weyburn-Midale research led to over 300 peer-reviewed articles by researchers from around the world, the publication of a Best Practices Manual offering guidance for storage and utilization of CO<sub>2</sub> in depleted oil reservoirs, and a special supplement of technical papers in the International Journal of Greenhouse Gas Control (IJGGC).

The results from Weyburn-Midale continue to inform other CO<sub>2</sub> storage and CO<sub>2</sub>-EOR projects worldwide.

Incremental oil production at the Weyburn and Midale oilfields will eventually surpass 220 million additional barrels of oil. The chart below demonstrates the economic impact of that increased recovery, which would not have been possible without PTRC-funded research confirming the safety of CO<sub>2</sub> storage. The figures below do not include the impact of jobs created, both direct and indirect, and taxes paid to different levels of government.

	WEYBURN FIELD	MIDALE FIELD
<b>Original oil in place</b>	1.4 billion barrels	515 million barrels
<b>Oil recovery (pre-CO<sub>2</sub>-EOR)</b>	370 million barrels	154 million barrels
<b>Projected CO<sub>2</sub>-EOR</b>	+155 million barrels	+67 million barrels
<b>Increase in Recovery Rate</b>	26% to 38%	30% to 43%
<b>Projected CO<sub>2</sub> stored</b>	35+ million tonnes (gross) 28+ million tonnes (net)	10+ million tonnes (gross) 8.5+ million tonnes (net)
<b>Economic Value of Oil (\$60/bbl)</b>	\$9.3 Billion	\$4 billion
<b>Estimated Royalties to Province</b>	\$1.86 Billion	\$800 Million



The physical model at the Saskatchewan Research Council's Energy Division remains a key tool for modeling oil reservoirs.



Husky's Edam JIVE pilot led to further field application of solvent injection.

### JOINT IMPLEMENTATION OF VAPOUR EXTRACTION (JIVE) DEMONSTRATION PROJECT

This four-year, \$40 Million initiative involved three separate solvent vapour extraction field trials near Lloydminster involving Husky, CNRL and Nexen. The field demonstrations were supplemented with well-defined laboratory studies arranged by PTRC through the Saskatchewan Research Council that included scaled and mechanistic physical modeling and numerical simulations using real field data. The impacts of temperature, pressures and solvent concentrations were all studied.

All operations in the JIVE field trials experienced an increase in oil production, and Husky's field achieved high solvent recovery with the oil. The field trials were environmentally important for the heavy oil industry because solvent extraction uses less steam and heat, resulting in fewer greenhouse gas emissions during recovery.

JIVE informed Husky's decision to move forward with its solvent injection pilots at its Edam and Mervin fields, and the CO<sub>2</sub>-injection demonstrations at Lashburn and Pikes Peak South. Construction jobs for these projects surpassed 500 over three years, and dozens of permanent operational positions were created. 1.8 million barrels of incremental oil were produced in the first two years of Pikes Peak pilot operations, with accompanying royalties to governments realized from these operations.

### THE LARGEST FIELD LABORATORY IN THE WORLD FOR STUDYING CO<sub>2</sub> STORAGE AND OTHER ASPECTS OF THE DEEP SUBSURFACE

PTRC continues to move research to the field with the Aquistore CO<sub>2</sub> monitoring and storage research site. Aquistore consists of injection and observation wells – drilled to 3400 metres and rigged with extensive monitoring equipment – and numerous other monitoring technologies such as a 650-geophone permanent seismic array, DAS and DTS fibre-optic lines, tiltmeters, GPS and other monitoring equipment.

The field location is being used not just to measure the CO<sub>2</sub> being injected into a deep brine and sandstone formation, but by mining and oil/gas companies to test various technologies and their abilities to image the subsurface. Aquistore will be continuing its measurement and monitoring program over several years as CO<sub>2</sub> totals increase underground, and the extensive database of collected results will have a global impact on the development of carbon capture and storage regulations.



Injection well at Aquistore.



Aquistore field location as seen from above, with geophone array indicated.

