Update on the IEA GHG Weyburn-Midale CO$_2$ Monitoring and Storage Project and PTRC’s New Aquistore Project

Steve Whittaker, Ph.D., P. Geol.
Senior Project Manager
Petroleum Technology Research Centre
Regina, Saskatchewan

Carbon Sequestration Leadership Forum
November 16, 2008
Washington, D.C.
IEA GHG Weyburn – Midale CO₂ Monitoring & Storage Project

“The Weyburn-Midale Project will provide policymakers, the energy industry and the general public with reliable information about industrial carbon sequestration and enhanced oil recovery.”

- Samuel Bodman, Secretary of Energy, USA
Review: Weyburn-Midale CO$_2$ Storage Project

The world’s largest full-scale, field study of CO$_2$ storage associated with commercial EOR operations

- $80$ million project
- Currently in Final Phase, ending 2011
- 12 million tonnes of CO$_2$ injected to-date
  - 10 million Weyburn
  - 2 million Midale
- 40 million tonnes stored by 2035
- > 20,000 incremental bbl/day
Where is the CO₂ from? Where is it stored?

Geoscience Framework Study Area
100,000 km³

SASKATCHEWAN

Weyburn

Williston Basin

Project Area

200 km

4 km

200 km

N

Courtesy © Geological Survey of Canada
Phase One Results

Geological “container” at Weyburn is effective:
- Primary carbonate and secondary shale seals are highly competent
- Hydraulic separation between adjacent aquifers

Initial results indicate over 98% of the initial CO$_2$ in place will remain stored for hundreds of years:
- Further work is required
- Develop risk management practices
**Update: Final Phase (2005-2011) Objectives**

**Best Practices Manual**
- Guide all aspects of future CO₂ EOR-Storage projects
- Ensure integration across Technical and Policy Research

**Technical Components**
- Site Characterization
- Monitoring and Verification
- Wellbore Integrity
- Performance Assessment

**Policy Components**
- Regulatory Issues
- Public Communication and Outreach
- Fiscal Policy Issues
Weyburn & Midale Fields
## Review: Weyburn & Midale Statistics

<table>
<thead>
<tr>
<th></th>
<th>Weyburn (EnCana)</th>
<th>Midale (Apache)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Field Size</strong></td>
<td>70 square miles</td>
<td>40 square miles</td>
</tr>
<tr>
<td><strong>Original oil in place</strong></td>
<td>1.4 billion barrels</td>
<td>515 million barrels</td>
</tr>
<tr>
<td><strong>Oil recovery</strong>&lt;br&gt;(pre-CO₂-EOR)</td>
<td>370 millions barrels</td>
<td>154 million barrels</td>
</tr>
<tr>
<td><strong>Projected CO₂ IOR</strong></td>
<td>155 million barrels</td>
<td>67 million barrels</td>
</tr>
<tr>
<td><strong>Projected CO₂ stored</strong>&lt;br&gt;(gross)</td>
<td>30+ million tonnes</td>
<td>10+ million tonnes</td>
</tr>
<tr>
<td></td>
<td>26+ million tonnes (net)</td>
<td>8.5+ million tonnes (net)</td>
</tr>
</tbody>
</table>

*equivalent to removing more than 8 million cars off the road for a year*
Final Phase Technical Program

- Currently about 33 tasks that have been reviewed and initiated under the four major Technical Themes
  - Geological Integrity
  - Wellbore Integrity
  - Monitoring
    - Geophysical
    - Geochemical
  - Risk Assessment

Synchrotron analyses of pore spaces and mineralogy in Midale Vuggy

- As project progresses additional data requirements and tasks may be identified.
- PRISM meeting in December
Geological architecture of system
Geocellular model
- lithology
- hydrogeological characteristics
- Faults
- Well bores

Can be tailored for different RA methods and scenario analyses
Tracking CO₂ Movement: Seismic Surveys (Baseline to 2002)- Phase 1
Monitoring continued in Phase 2

EnCana Corporation; Geological Survey of Canada
Theme 3: Storage Monitoring Methods

Forward Tuned Stochastic Modeling

- Improved Site Characterization and Storage Prediction through Stochastic Inversion of Time-Lapse Geophysical and Geochemical Data.
- Develop and Demonstrate a new stochastic modeling technique that will improve site characterization and dependant predictions of CO₂ storage performance at Weyburn.
- Utilizes 4D seismic reflection and fluid chemistry data collected during Phase I and the Final Phase.
- This work represents a truly novel and broadly integrative research, which is widely applicable.
Additional Projects

Three large Field-Based Demonstration Tasks

1. Monitoring / Observation well 1.8M
2. Well Integrity Field Testing Program 1.3M
3. Permanent Seismic Sparse Array 1.5M

Smart Well Technology
- Drill dedicated well
- Geophones
- Pressure sensors
- Temperature sensors
- Fluid Recovery System
- Downhole pH measurement
Final Phase: Partners to Date

Industry Sponsors

- Apache
- EnCana
- Chevron
- OMV Austria
- Saudi Aramco
- SaskPower
- Schlumberger
- Shell
- DGC
- Nexen

$40 Million

Government Sponsors

- Natural Resources Canada
- United States Dept. of Energy-National Energy Technology Lab
- IEA GHG R&D Programme
- Saskatchewan Ministry of Energy and Resources
- Alberta Energy Research Institute
- RITE (Research Institute of Innovative Technology for the Earth – Japan)

Research Organizations

- Alberta Research Council (ARC)
- Canadian Light Source – Synchrotron
- ECOMatters (ECOM)
- Geological Survey of Canada (GSC)
- Permedia Group
- Saskatchewan Research Council (SRC)
- Canada Capital Energy Corp.
- T.L. Watson & Associates
- University of Regina (U of R)
- University of Sask. (U of S)
- University of Alberta (U of A)
- University of Calgary (U of C)
- URS Canada Inc.
- Saskatchewan Geological Survey
- Fugro Seismic Imaging
- Lawrence Livermore National Laboratories
- Bluewave Resources
- University of Bristol UK
- IEA GHG R&D Programme
Deep Saline Aquifer Project
AQUISTORE Project

- 5 year, $100 million project, July 2008 to July 2013.

- 500 tonnes/day of CO₂ captured from Consumers’ Co-operative Refineries Limited.

- Transported by pipeline from upgrader to injection site.

- CO₂ injected into a suitable deep saline aquifer.

- Comprehensive Measurement, Monitoring and Verification Program.
AQUISTORE: Work Plan

Task 1 Site Selection
Task 2 Geological and Hydrogeological Detailed Site Characterization
Task 3 Seismic Monitoring and Site Characterization
Task 4 Groundwater Sampling and Analysis
Task 5 Fluid Sampling and Analysis
Task 6 Aquifer Mineralogy
Task 7 Monitoring Wells
Task 8 Reactive Transport Numerical Simulations
Task 9 Risk Assessment and Risk Management Framework
Task 10 Commercialization/ Economic Analysis
Project Partners

Aquistore is a joint collaborative research project between governments and industry.

• **100 million dollar project**
  • SDTC (5 million in funding announced, July 2008)
  • ecoETI (application submitted)
  • Saskatchewan Ministry of Environment (5 million in funding, November 2008)
  • SaskEnergy (MOU)
  • Canadian Co-op Refinery Limited (MOU)
  • Schlumberger (MOU)
  • Enbridge (MOU)
  • Additional sponsors being sought
Objectives

• Demonstrate CO₂ deep saline aquifer storage is a safe, workable solution for emissions reductions.

• Develop a transportable, integrated suite of technologies for carbon storage in a saline aquifer.

• Establish an environment for creating:
  • linkages between financial institutions developing domestic trading schemes;
  • regulators designing an appropriate regulatory environment
  • Industrial commercialization, and
  • public acceptance
AQUISTORE: Conclusions

Leading Canadian project in terms of:

- Large CO$_2$ point source confirmed
- Experienced and integrated research team engaged
- Comprehensive, single phase work program defined
- Experienced pipeline, compression and well operators
- Feasibility evaluation complete
- Seed funding approved
Thank You