PTRL – U.S. Collaboration on EOR and Tight Oil Research

Dan MacLean
CEO, President
Petroleum Technology Research Centre
May 23, 2018

Williston Basin Petroleum Conference, Bismarck North Dakota
PETROLEUM TECHNOLOGY RESEARCH CENTRE

• Not-for-profit founded in 1998 by Governments of Canada and Saskatchewan

• Collaborative partnership with industry, government and research organizations

• Research associated with CO₂ management:
  • IEAGHG Weyburn –Midale CO₂ Monitoring & Storage Project
  • Aquistore

• EOR
  • Heavy Oil Research Network (HORNET)
  • Tight/Light oil research

• PTRC is Canada’s Representative on the IEAEOR Committee
CORE AREAS OF RESEARCH & MMV

- Weyburn CO₂ EOR
- Aquistore: CO₂ Storage (Boundary Dam Estevan)
- Heavy Oil
- Tight / Light Oil: Viewfield, Viking, Shaunavon, Williston Basin
Commercial EOR operations in Weyburn and Midale oilfields utilise anthropogenic CO₂

200 MM bbls Incremental Oil
Over 39 Mt of CO₂ stored since 2000 (30 Weyburn, 9 Midale)

PTRC used these sites to study technical aspects of CO₂ geological storage
### IEAGHG Weyburn-Midale Research Impact

$81$ MM Total Funded MMV & Research

<table>
<thead>
<tr>
<th>Organization</th>
<th>$MM$</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>NRCAN</td>
<td>15.2</td>
<td>37%</td>
</tr>
<tr>
<td>USDOE</td>
<td>13.9</td>
<td>34%</td>
</tr>
<tr>
<td>Sask Gov't</td>
<td>3.8</td>
<td>9%</td>
</tr>
<tr>
<td>Alta Gov't</td>
<td>1.1</td>
<td>3%</td>
</tr>
<tr>
<td>Industry</td>
<td>7.0</td>
<td>17%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>41.0</strong></td>
<td></td>
</tr>
</tbody>
</table>

$40.0$ MM Cash Investment in Research

Industry & Researcher In-Kind Contribution

+250 Referred Publications
### IEAGHG Weyburn-Midale Project Partnerships

#### INDUSTRY SPONSORS
- Apache
- EnCana (Cenovus)
- Chevron
- OMV Austria
- Saudi Aramco
- SaskPower
- Schlumberger
- Shell
- Dakota Gasification Company
- Nexen

10 Industry Sponsors

#### GOVERNMENT FUNDERS
- NRCan (Government of Canada)
- US DOE (NETL)
- IEAGHG R&D Programme
- Alberta Energy Research Institute
- Saskatchewan Ministry of Energy & Resources
- RITE (Research Institute of Innovative Technology for the Earth – Japan)

6 Government Funders

#### RESEARCH PARTNERS
- Alberta Research Council (now AITF)
- Canadian Light Source
- Geological Survey of Canada
- British Geological Survey
- Saskatchewan Geological Survey
- Saskatchewan Research Council
- U of Regina
- U of Saskatchewan
- U of Alberta
- U of Calgary
- Carleton U
- U of Bristol
- U of California Irvine
- URS Canada Inc.
- Permedia Group
- Fugro Seismic Imaging
- Lawrence Livermore National Lab
- Bluewave Resources
- Schlumberger-Doll Research
- TL Watson and Associates
- ECOMatters

21 Research Partners
16 Years of CO$_2$-EOR Research

Weyburn-Midale

2000 to 2014

Extension of Weyburn 2014 - 2016

2009 to Present
BOUNDARY DAM: COAL FIRED POWER GENERATION PLANT
Carbon Capture and Storage System

- Carbon Capture Capacity
  - 3500 Tonnes/day

- Contract to Cenovus
  - Up to 3000 Tonnes/day

- Aquistore Injection Capacity (1 vertical Injector)
  - 2100 Tonnes/day

Capture Plant Approved: April 2011
Commissioned: Oct 2014
First CO2 into Aquistore: April 2015
1. Passive Seismic Monitoring
2. 4D Seismic with Permanent Array
3. Crosswell Seismic Profile
4. Downhole Fluid Recovery System
5. Time Lapsed Borehole Gravity Measurement
6. Accurately Controlled, Routinely Operated Signal System (ACROSS)
7. Pulsed Neutron Decay & Cross-Dipole Sonic Logging
8. Magnetotelluric & Controlled Electromagnetic Source
9. Coupled Reservoir Modelling / Seismic Simulation
10. Inherent Tracers
11. Groundwater & Soil Gas
12. InSAR & GPS
13. Tiltmeters
14. Vertical Seismic Profile Using Distributed Acoustic Sensing & Geophones
USA
1. Illinois State Geological Survey (Decatur Project)
2. Plains CO₂ Reduction Partnership (PCOR)
3. Midwest Geological Sequestration Consortium

UK
4. University of Edinburgh

Australia
5. Global Carbon Capture and Storage Institute
6. Commonwealth Scientific and Industrial Research Organisation (CSIRO)
7. CO₂CRC (Australia)
8. Australian National Low Emissions Coal Research & Development (ANLEC R&D)

South Africa
8. South African National Energy Development Institute (SANEDI)
9. South African Centre for Carbon Capture and Storage (SACCCS)
Over 26 Research Partnerships in 9 Different Countries

For updates and news, follow us on Twitter: @PTRC_SK
Enhanced heavy oil recovery research has been ongoing at PTRC since 1999.
HEAVY OIL RESEARCHERS

$77 MM Funded So Far

1. SRC
2. U of Regina
3. U of Saskatchewan
4. U of Alberta
5. U of Calgary
6. PermInc
7. Canadian Light Source: Synchrotron
Partner with Operating Companies
TIGHT-LIGHT OIL RESEARCH CAPABILITIES

CT SCANNER

$1.2 MM Investment

Installed March, 2018

• Located at PTRC building
• Operated by SRC
• Rock and core analysis at the microporous level
• Aquistore Research:
  – Continued research in CO₂ storage and monitoring
  – Collaboration with US research organizations such as EERC, Lawrence Berkley Labs, US DOE and others
  – Support CO₂ storage initiatives as:
    • Reliable means of storing CO₂
    • Effective means of reducing GHG emissions

• Heavy Oil Research (HORNET)
  – Support research to improve heavy oil recovery from 10% to 20%+

• Tight Light Research
  – Support research for tight/light oil EOR recovery
  – Support field trials/pilots of new EOR schemes
“5 over 5”

To initiate & coordinate oil and gas research with cumulative unrisked potential to deliver 5 B BBLS of incremental oil reserves over the next 5 yrs

(2018 to 2023)
Thanks for your attention

Questions?

Dan MacLean
dan.maclean@ptrc.ca

https://ptrc.ca

Twitter: @ptrc_sk
CO₂ Source: Great Plains Synfuel Plant

- 250 mmscfd CO₂ by-product of coal (lignite) gasification
  - approx. 8000 tonnes/day suitable for EOR
- CO₂ purity 95% (less than 2% H₂S)
- 180 mi pipeline (14 in & 12 in) built & operated by Great Plains
**AQUISTORE (CO₂ STORAGE): 2009 TO PRESENT**

- Integrated CO₂-EOR and CO₂ Storage CCUS Projects
- CO₂ sourced from carbon capture at SaskPower Boundary Dam coal fired power generator
- CO₂ sold to Weyburn for EOR and/or injected into Aquistore