Alberta's First Saline Aquifer Carbon Dioxide Sequestration Demonstration

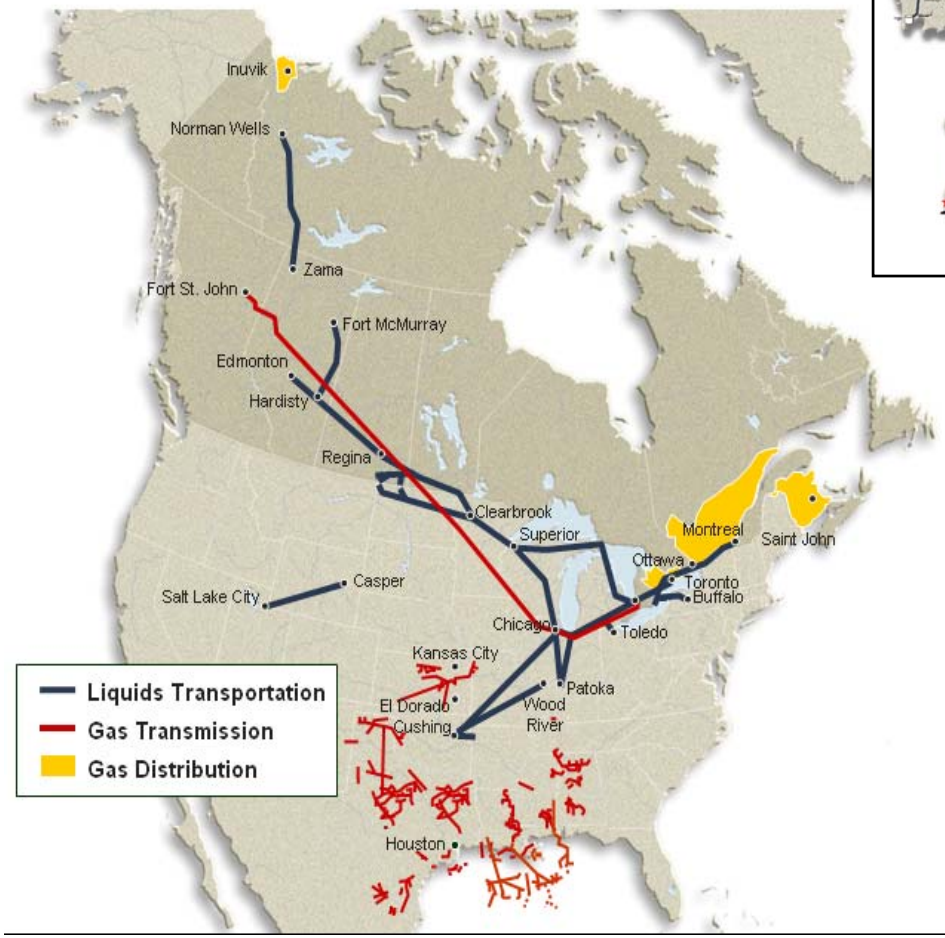
Enbridge, EPCOR, PTAC

Technology Information Session

Calgary, Alberta

November 27, 2007

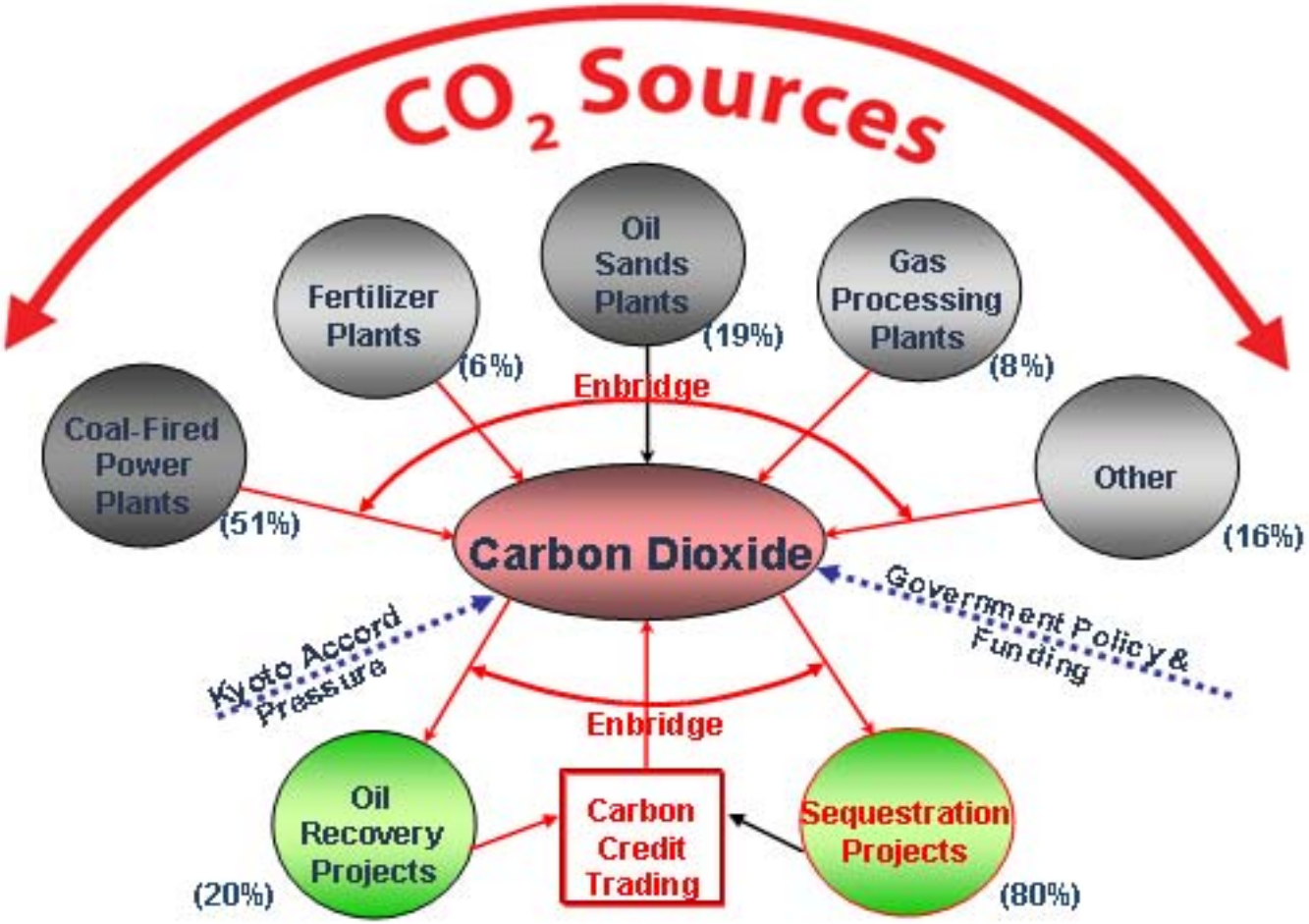
Enbridge Overview



Enbridge Inc. is a leader in energy transportation and distribution in North America and internationally:

- Owns and operates the world's longest crude oil and products pipeline system
- Owns and operates Canada's largest natural gas distribution company
- Interest in 80,000 km of pipelines
- Delivers 2 MM BPD of liquids
- Handles 5 BCF/D of gas
- Wind power capacity of 225 MW
- Employs 5000 people

CO_2 Mind Map


CO2 Sources
Fertilizer Plants
(6%)
Oil Sands Plants
(19%)
Gas Processing Plants
(8%)
Coal-Fired Power Plants
(51%)
Enbridge
Other
(16%)
Carbon Dioxide
Kyoto Accord Pressure
Government Policy & Funding
Enbridge
Oil Recovery Projects
(20%)
Carbon Credit Trading
Sequestration Projects
(80%)

Government Policy Drivers

- **Federal:**
  - **Tory Green plan announced on April 26, 2007**
    - **Overall GHG reduction targets of 20% by 2020**
    - **Industry GHG intensity reduction targets of 26% by 2015**
    - **Domestic emission trading and technology fund**
  - **$156 million committed to Alberta carbon sequestration**
  - **Possibility of a carbon tax**

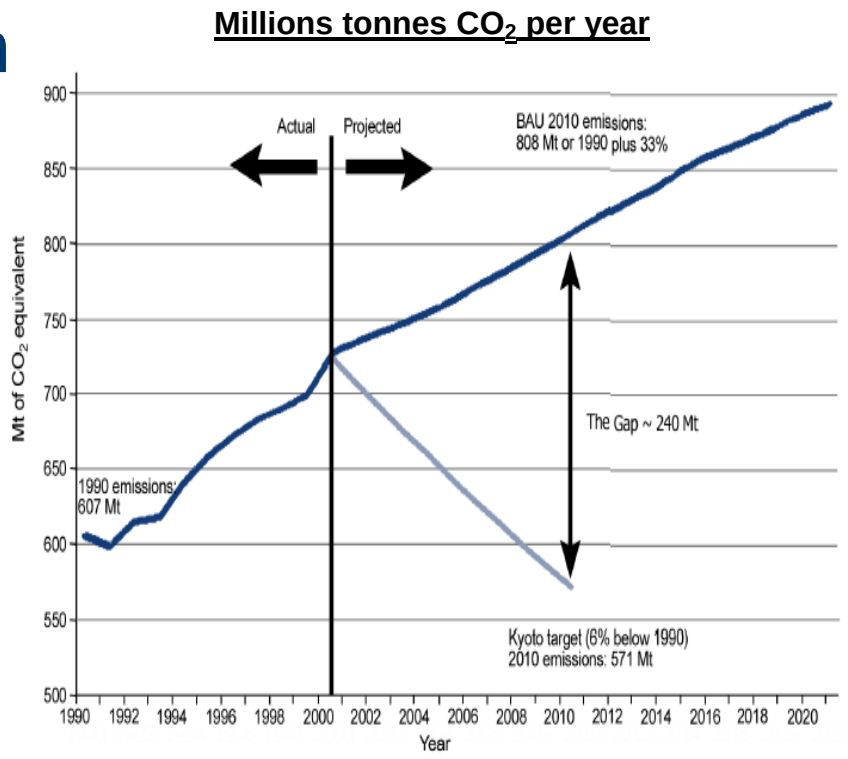
- **Alberta:**
  - **Bill 3**
    - **Facilities emitting 100,000 tonnes of CO_2/yr. - must reduce by 12% beginning July 2007**
    - **Three ways to reduce CO_2**
      - **Lower emissions**
      - **Pay $15/tonne to technology fund**
      - **Purchase Alberta derived offsets**

Canadian Government Task Force

- **Alberta/Federal Carbon Capture and Storage Task Force**
  - **Blueprint for implementing large-scale Carbon Capture and Storage**
  - **Chaired by Steve Snyder (TransAlta)**
  - **Recommendations expected around year-end**

Need For CO_2 Sequestration

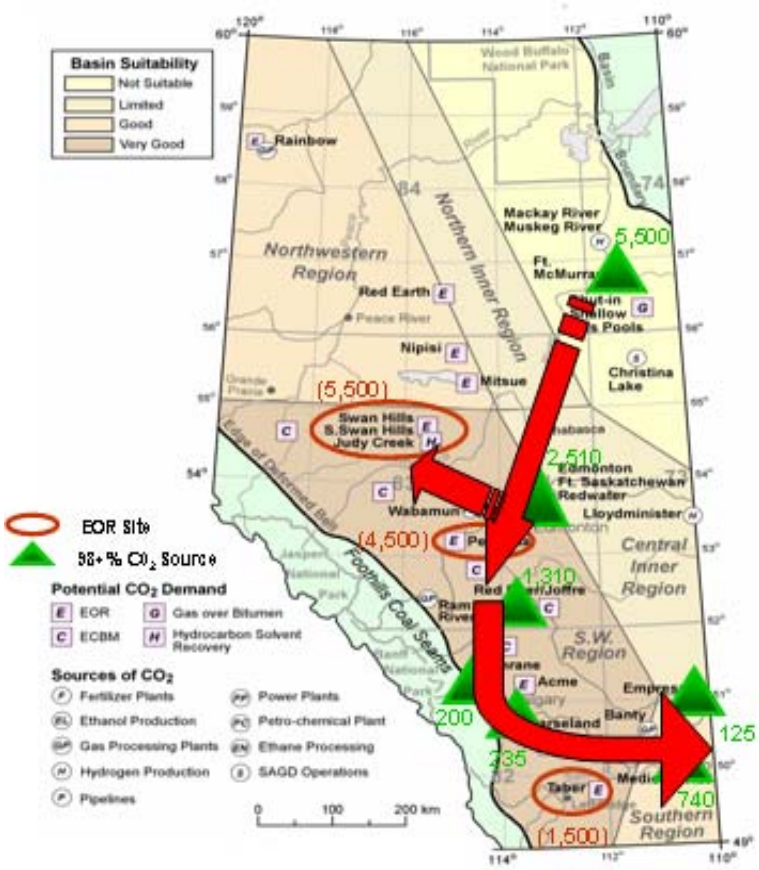
- CO_2 volume reductions will likely be much larger than EOR requirements
- Sequestration will be necessary to meet Government targets
- Repository for EOR CO_2 surplus



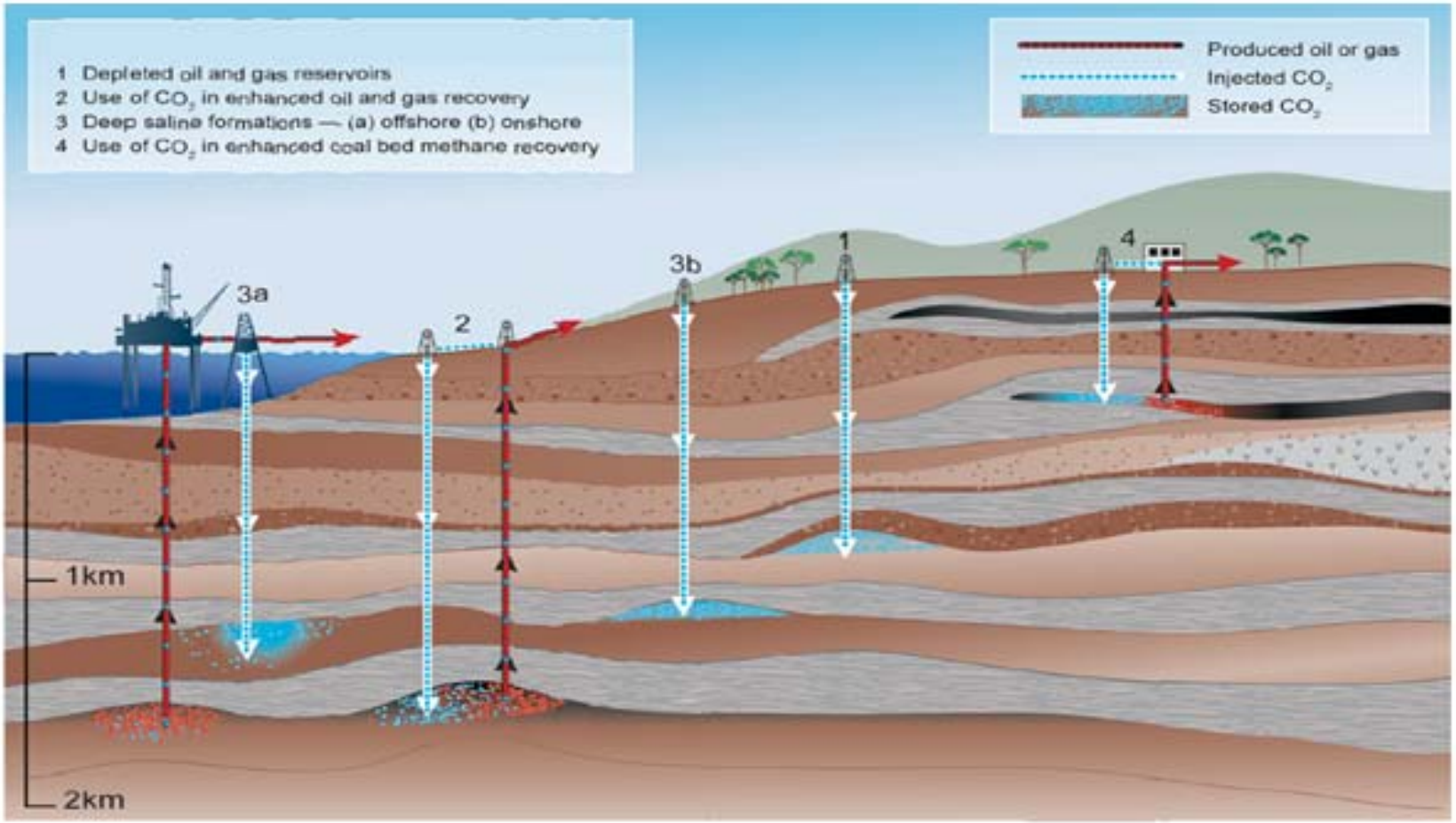
Current Barriers Limiting CO_2 Capture, Transport & Sequestration

ENBRIDGE

- Regulatory clarity
- Lack of CO_2 pipeline delivery
- Timing of expansion of EOR to commercial projects
- Timing of clean coal power plant and upgrader startups
- Uncertainty of large-scale CO_2 storage opportunities



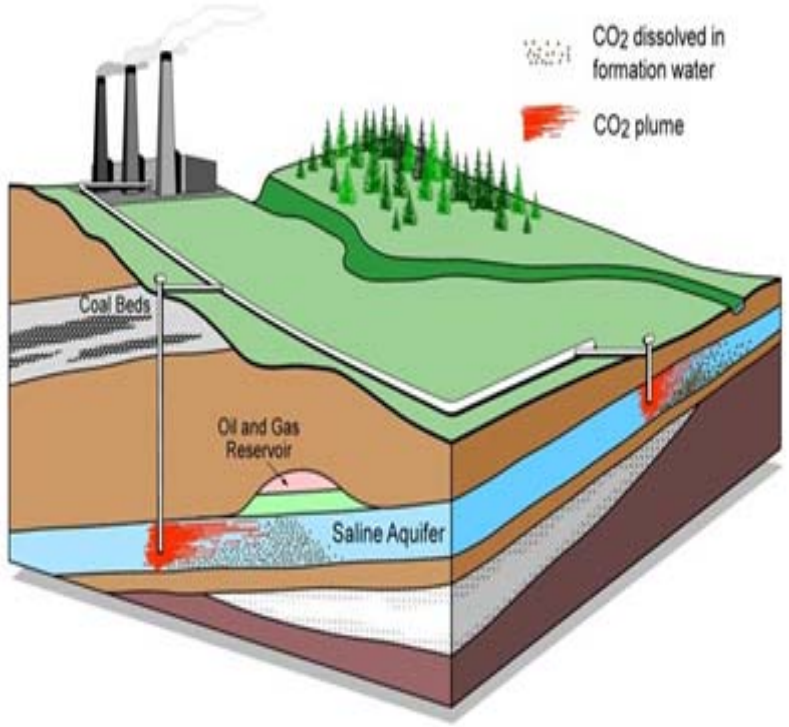
Sequestration Types



Source: IPCC, 2005)

Why Saline Aquifer CO_2 Sequestration?

- **Massive CO_2 storage potential**
- **Can provide early start on CO_2 collection and infrastructure**
- **No existing oil and gas operations**
  - **No interference with existing production**
  - **Reduces reservoir integrity issues with pre-existing wells**
- **Safe, reliable, measurable**

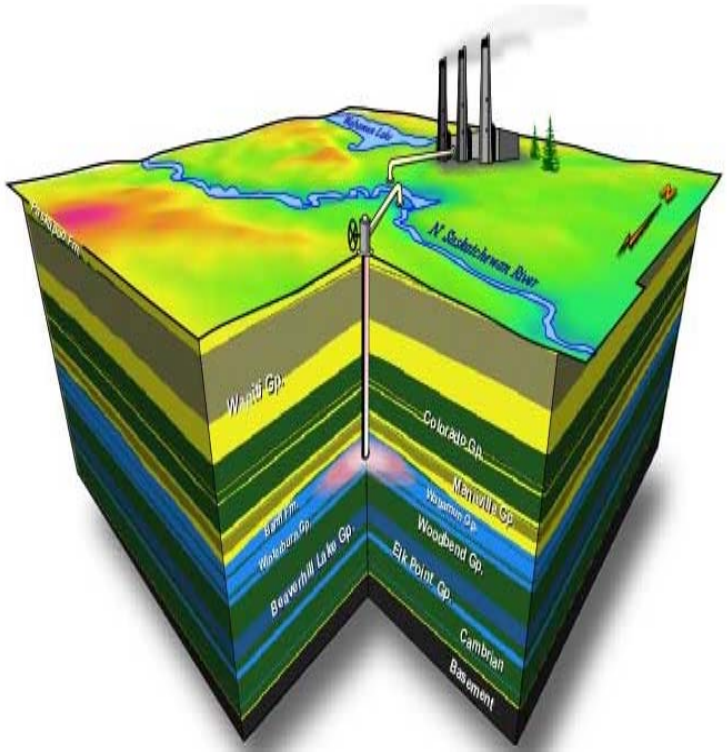


World Wide CO_2 Saline Aquifer Sequestration Pilots

Saskatchewan:	**Petroleum Technology Research Centre and Enbridge have applied for Federal funds for a demonstration pilot**
Norway:	**Sleipner, 1996, 3000 tonnes/day**
Japan:	**Nagoaka, 2002, 40 tonnes/day**
Algeria:	**In Salah, 2004, 4000 tonnes/day (depleted hydrocarbon)**
Texas, USA:	**Frio, 2004, 170 tonnes/day (short-term)**
Australia:	**Otway, 2005, 160 tonnes/day**
Germany:	**Ketzin, 2006, 100 tonnes/day**
Norway:	**Snohvit, 2006, 2000 tonnes/day**

Sequestration Issues

1. **Pore space ownership**
   - Oil and Gas (ie: Acid Gas Model)
   - Water owners (ie: Crown)
   - Surface owners
2. **Permits/studies/approvals**
   - Environmental impact statement
   - Health and safety
   - Impact of existing well bores
3. **Legal liability of sequestration**
4. **First Nations and public consultations**



Wabamun Sequestration AGS Source

Project Vision

Accelerate CO_2 Capture and Sequestration Infrastructure

1. Locate sequestration sites along anticipated pipeline routes to EOR projects
2. Collect CO_2 from existing (and future) emissions locations
3. Develop capability to simultaneously provide CO_2 to EOR projects and sequester excess CO_2 in saline aquifers

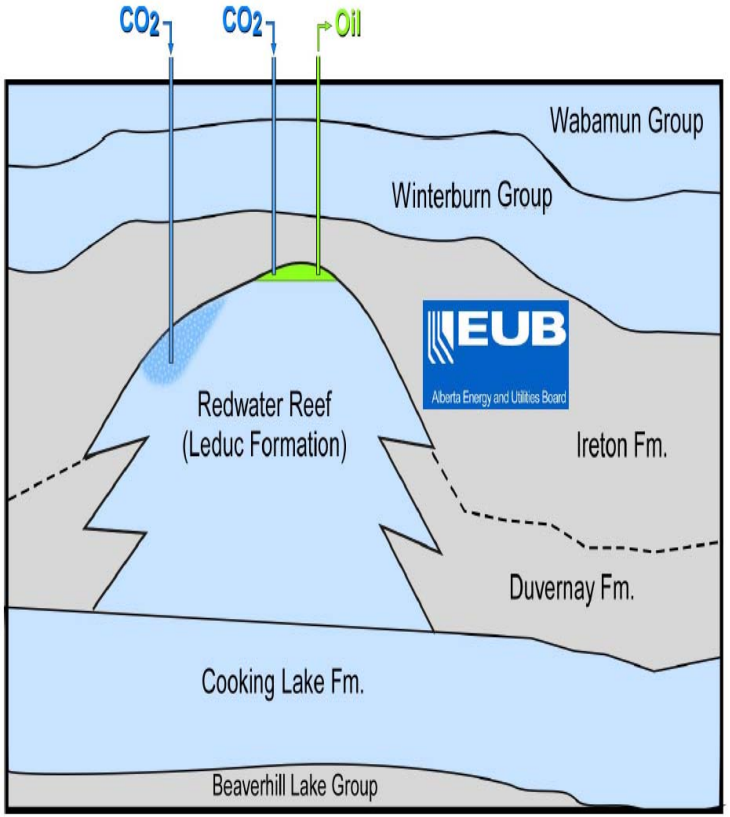
Need For Multi-Party Study

1. Many stakeholders and parties
2. Developing a major long-term industry
3. Available funds are limited
4. Need cooperative plan that accelerates development
5. Economics are thin: thus need integrated support infrastructure development

Australia Otway Saline Aquifer CO_2 Sequestration

Alberta Energy Research Institute (AERI) Invitation for Carbon Capture & Storage Proposals

- **In July 2007, AERI invited Expressions of Interest for carbon storage demonstration initiatives**
- **ARC Resources has announced its application and described the basis for the sequestration of CO_2 into the Redwater Reef/Cooking Lake formation**
- **Alignment of the AERI and PTAC project is being discussed**



Multi-Phase Project Description

Phase 1: 2008, $750,000 (Participants $15-20k/ea. Federal & Provincial)

- Identify 3 specific saline aquifer locations
- Design and cost (± 30%) a sequestration demonstration including CO_2 compression and transportation
- Prepare preliminary application for saline lease/permit and approval for demonstration pilot

Phase 2: 2009/12, $30 - 50MM (Technology Funds, Participants, Western Economic Dev., Federal & Provincial)

- Construct & operate demonstration pilot (1000 - 3000 tonnes/day)

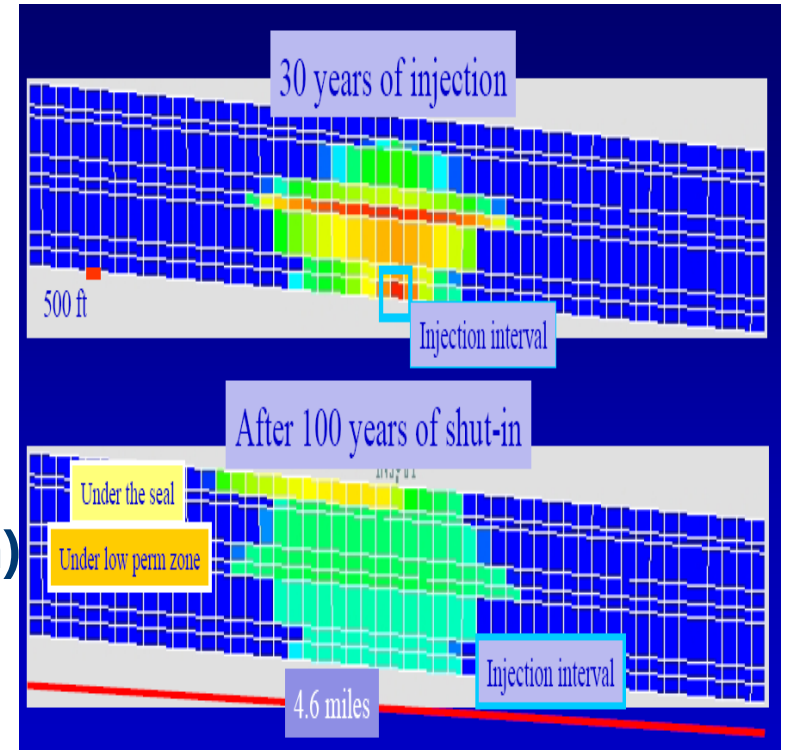
Phase 3: 2013, $100 - 200MM (Operators for commercial return)

- Expand to commercial operation

Saline Aquifer Sequestration Performance and Measurements

Establish Pilot to Clarify

- Regulation and ownership template
- Injection pressure (injectivity)
- Absorption rates (capacity)
- Migration patterns (containment)
- Costs (economics)
- Operational issues (resource protection)
- MMV (measure, monitor, verify) and numerical simulation



Illinois State Geological Survey Source

Project Governance

- **Management Committee (Decisions)**
  - Industry representatives
  - Government representatives
- **Technical Committee (Advice & Direction)**
  - Participant representatives
- **Implementation Team**
  - Project consultants and participants' staff

Proposed Implementation Project Team*

- Alberta Research Council (Alberta Geologic Survey)
- Norwest Corporation
- University of Alberta
- University of Calgary
- Monitoring team from Weyburn EOR project
- Vikor Energy
- EERC (Energy & Environment Research Center)
- Project participants

** Subject to project funding and participant direction – contracts with team have not yet been put in place. Others will be included as required.*

Why Join This Project?

Emitters:	**Prepare for CO_2 sales and respond to pressure to reduce CO_2 emissions**
Flooders:	**Accelerate CO_2 capture and infrastructure development on route to EOR projects**
Sequesterers:	**Early clarification of legal & regulatory regime**
Government Funders:	**Broad-based industry led project with world class expertise**
Cheapest Alternative:	**Industry cost share and efficient use of Government support**
Public Credibility:	**Combination of diverse interests with a broad-based agenda**

Next Step to Launch Project

Interested parties wanting to decide on Phase 1 financial participation are invited to:

A private meeting to provide more information:

Enbridge Office 425 – 1St Street SW

18th Floor

9:30 am Thursday, December 6, 2007

Indicate attendance at the meeting by:

- **returning the interest form today or,**
- **contacting richard.luhning@enbridge.com (403.231.5909)**

Thank You

Questions?

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