Gas Processing Association Canada

Setting New Directions – Facing New Challenges

Alberta Saline Aquifer Project & CO_2 Slurry Pipeline

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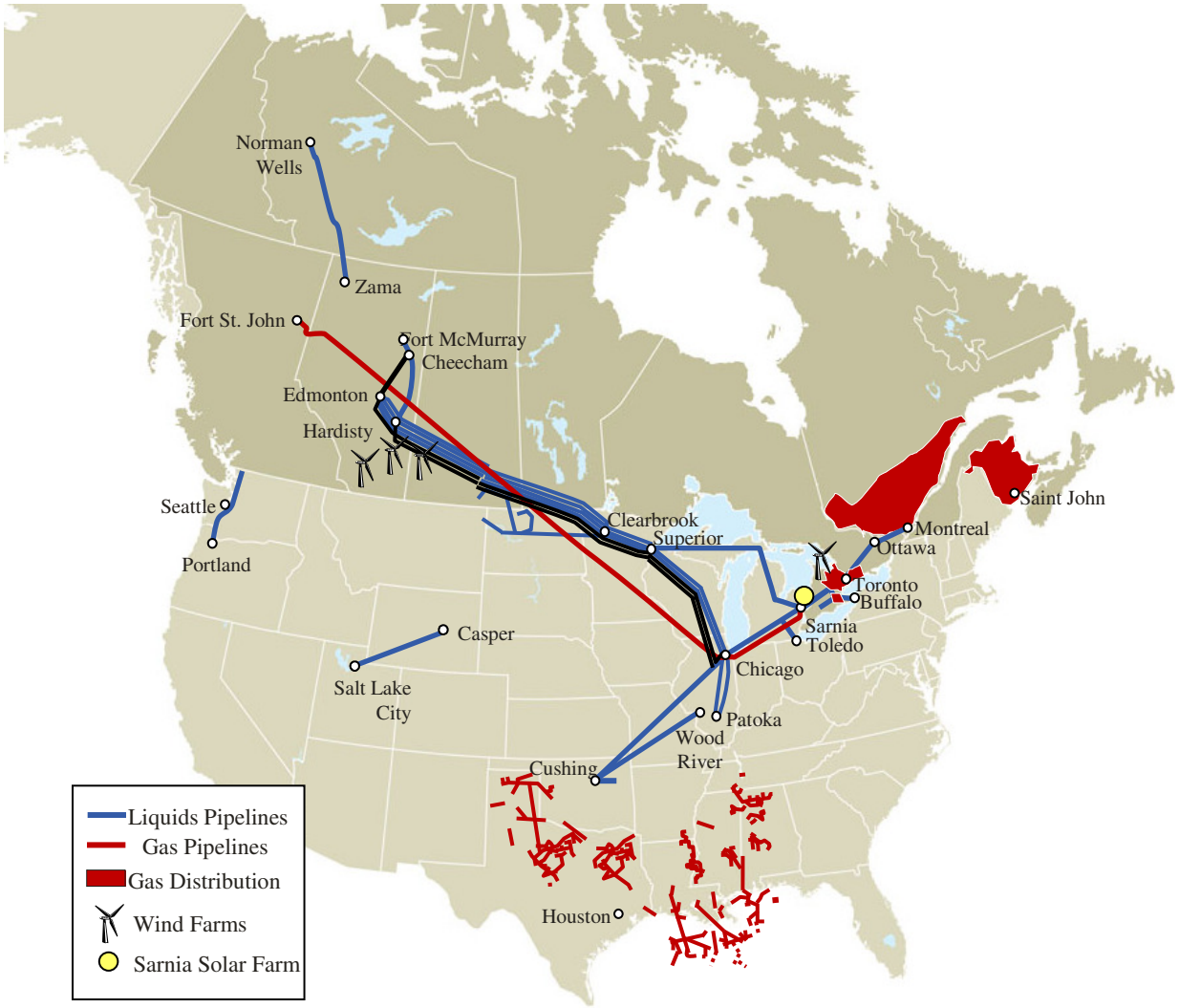
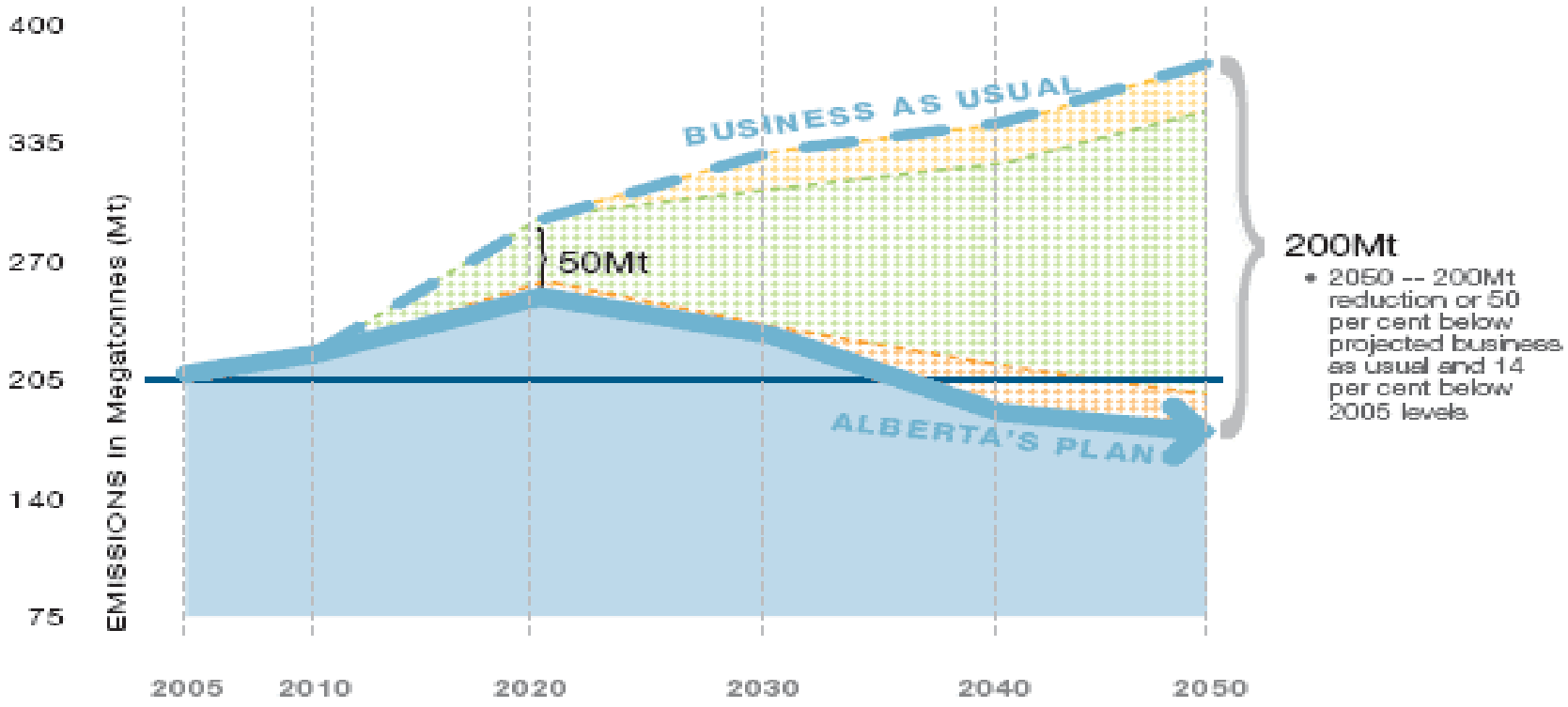
Enbridge Overview



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

- World's longest liquids pipeline system – 2 MMB/D
- Canada's largest natural gas distribution system – 5 BCF/D
- Oil and Gas cavern storage
- Wind power projects, stationary fuel cells, CCS
- $15 billion assets
- 6,000 employees

Alberta CO_2 Reduction Plan



CONSERVATION & ENERGY EFFICIENCY	24Mt
CARBON CAPTURE & STORAGE	139Mt
GREENING ENERGY PRODUCTION	37Mt
TOTAL =	200Mt

= **2.4 MM B/D of liquid CO_2**

Addressing CO_2 Emissions

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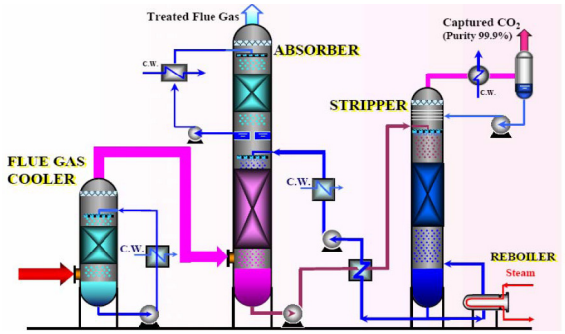
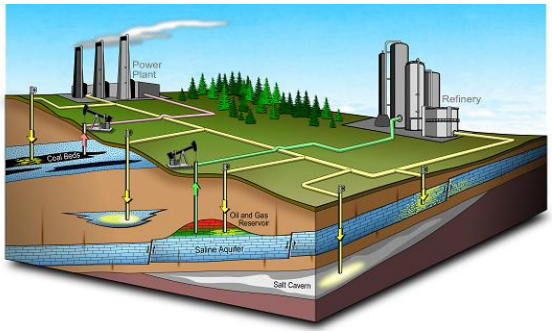
- **Capture**
  - Pre combustion
  - Post combustion
  - Refinery Process



- **Transportation**
  - Truck
  - Rail
  - Pipeline

- **Sequestration**
  - Enhanced oil recovery
  - Depleted reservoirs
  - Coal seams
  - Deep saline aquifers



The ASAP Consortium
(Alberta Saline Aquifer Project)

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38 Participants

AERI

ATCO GROUP

ATHABASCA OIL SANDS CORP.

bp

CMG COMPUTER MODELLING GROUP LTD.

Canadian Natural

ConocoPhillips

Chevron

devon

ENBRIDGE

ENCANA

EPCOR

GreatPoint ENERGY

HATCH energy

TTI Terralog Technologies Inc

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Shell

Saitt POLYTECHNIC

Swan Hills Synfuels

StatoilHydro

sojitz

teckcominco

TransCanada
In business to deliver

TOTAL

TOKYO GAS

UTS

WorleyParsons
resources & energy

The ASAP Vision

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Accelerate CO_2 Capture and Sequestration Infrastructure

1. Identify the top deep saline aquifer sequestration sites and anticipated pipeline routes to EOR projects
2. Establish design and cost for a large-scale sequestration project
3. Build and operate a large-scale pilot that leads to commercial scale sequestration of sufficient volume to address environmental targets

ASAP Phases

1. **Design: Completed April 2009**
   - **Identify 6 prospective sites**
   - **Design and cost sequestration pilot**
   - **Propose regulatory template**

2. **Pilot: 2009 – 2015**
   - **Construct & operate demonstration pilot**
     - 1,000 – 3,000 tonnes/day

3. **Commercial: 2015 & Beyond**
   - **Expand to commercial operation**
     - 10,000 – 20,000 tonnes/day

Deep Saline Aquifer Sequestration

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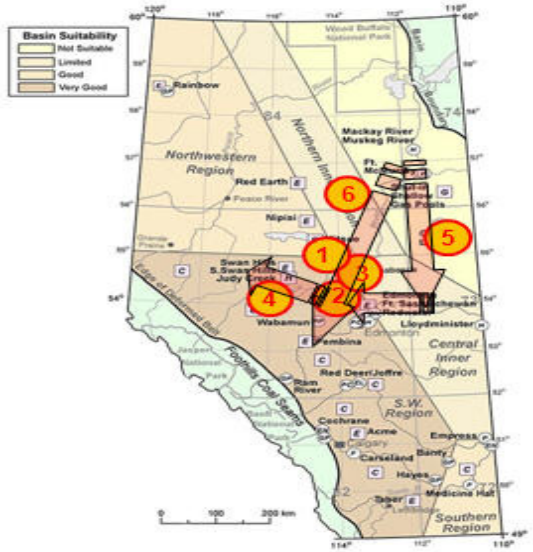
- **Numerous Alberta locations**
  - Identified through 50 years of hydrocarbon exploration
  - 6 sites identified by ASAP
- **Abundant capacity**
  - 10 x EOR requirements
  - All of Canada's emissions for 800 years



- **Transferable Experience**

Sleipner and Snohvit

North Sea

In Salah

Algerian Desert

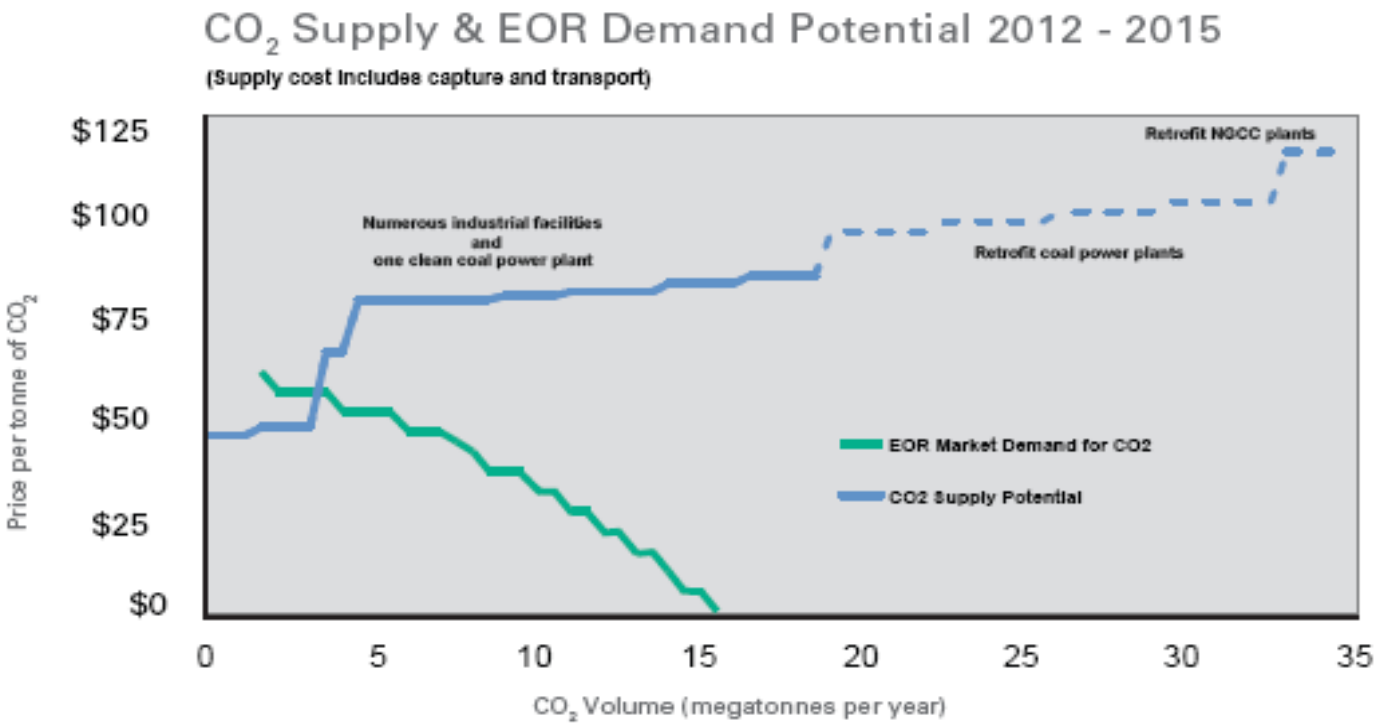
Saline Aquifer Storage Issues

- **Pore Space Ownership**
  - Acid gas model
  - New crown leases
- **Long-Term Liability**
  - Industry during operation
  - Crown thereafter
- **Public**
  - Safety
  - Effectiveness
- **Cost**

	$ per tonne of CO_2
Capture	$25 - $45
Transport	$20 - $36
Storage	$15 - $19
Total	$60 – $100 / tonne

Economic Challenge for CO_2 Pipelines (ICO_2N Report)

- CO_2 capture will increase
- CO_2 EOR for demand will drop



Useful Work for CO_2

- **Food product and commercial applications**
  - carbonated beverages
  - refrigerants, fire extinguishers
- **Enhanced oil recovery**
  - miscible flood reduces oil viscosity
  - fracture fluid
- **Slurry agent to transport solids via pipeline**

Enbridge CO_2 Slurry Pipeline Concept

- Use CO_2 pipeline constructed for environmental purposes to transport other salable products
- Move products such as sulphur, coke and limestone from Fort McMurray to local markets and railheads
- Potential to make the CO_2 transportation more economically attractive as well as environmentally beneficial

CO_2 Slurry Pipeline Visualization

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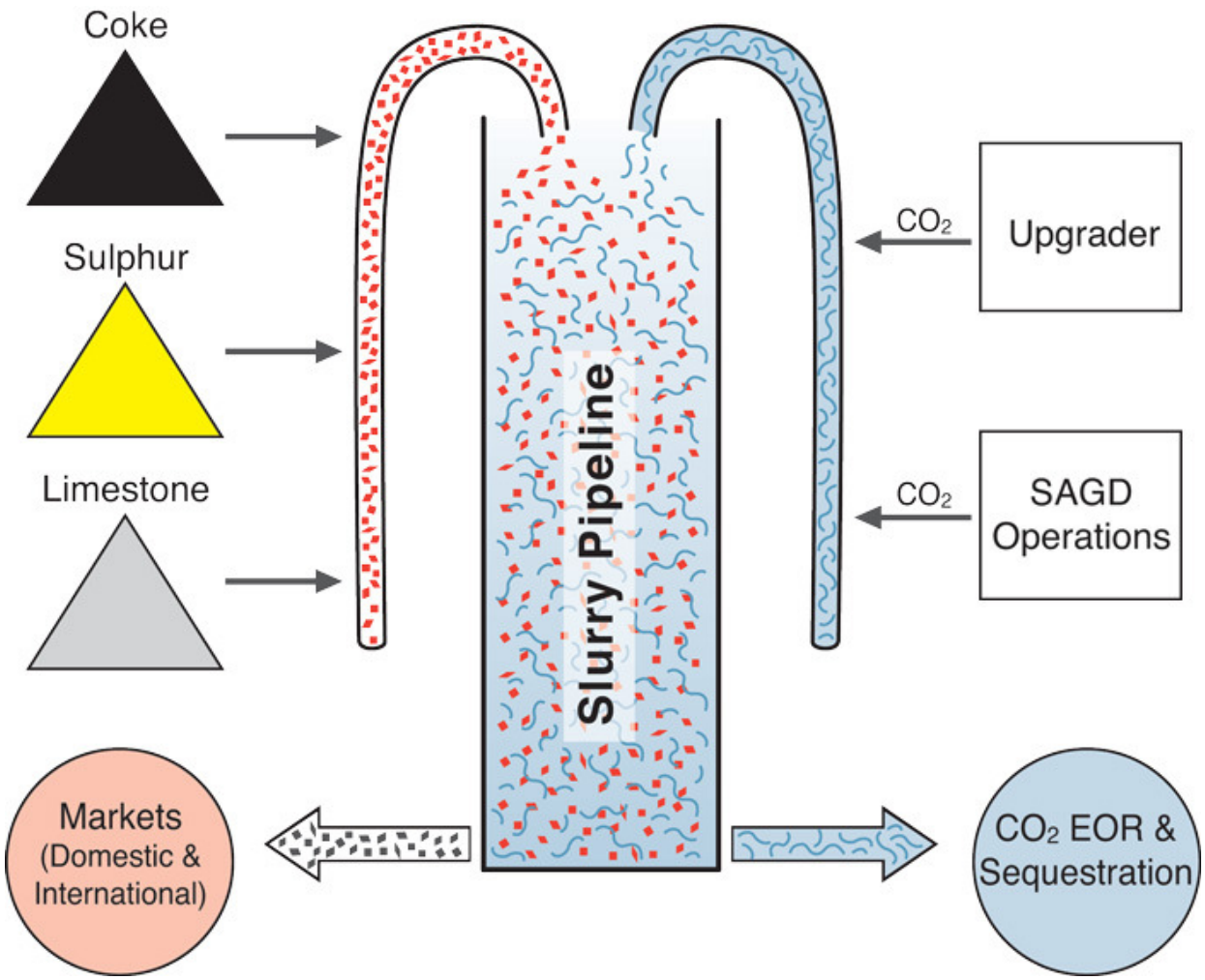

CO_2 Slurry Pipeline Basics

- A slurry pipeline uses flowing liquid (typically water) to carry entrained solids in the pipeline
- CO_2 at pressure in a pipeline flows as a liquid
- Extensive research and flow loop experiments have shown that liquid CO_2 is a more efficient carrier fluid than water
  - Less abrasive than with water -- pipeline life 2 to 3 times that with water
  - 85% coal in CO_2 slurry vs. 50% by weight with water
  - Cheaper to de-slurry (solids are delivered dry)

CO_2 Slurry Pipeline Markets

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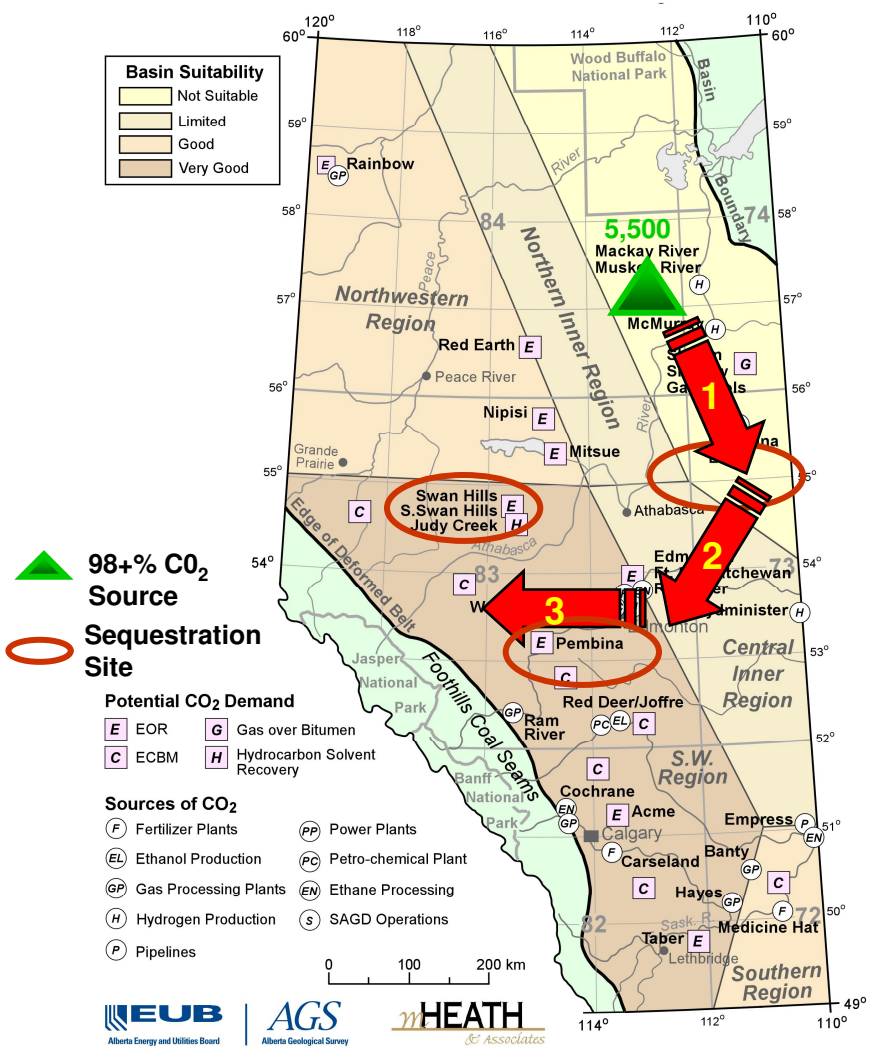
1. Deliver petcoke to SAGD operations and displace natural gas for steam operation
2. Petcoke to Ft. Saskatchewan to provide hydrogen for refineries and upgraders from coke gasifiers
3. Deliver petcoke/sulphur and limestone to rail junctions to access world markets



Conclusions

- Alberta will need carbon capture and sequestration to meet emissions targets
- EOR demand for CO_2 will soon be less than CO_2 supply
- Deep saline aquifers can accommodate foreseeable CO_2 values
- Significant deep saline issues including cost must be addressed
- A CO_2 slurry pipeline could create “useful work” and reduce the cost of CCS