Sixth Annual Conference on Carbon Capture & Sequestration

Session 4-E: CCS Outside the U.S.

An Overview of Carbon Capture & Storage Research Demonstration and Field Piloting Activities in Alberta

Surindar Singh, Eddy Isaacs, Duke du Plessis

May 7-10, 2007 • Sheraton Station Square • Pittsburgh, Pennsylvania

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Alberta Energy Research Institute
(*Technology arm of the Alberta Government)*

Mission: Enhance the development of clean energy resources through research, technology and innovation.

Mandate:

- Leadership: Position Alberta for the future in energy
- Service: Coordinate R&D across departments
- Investment: Invest in technology and innovation

Strategy:

- Partnerships & International collaboration

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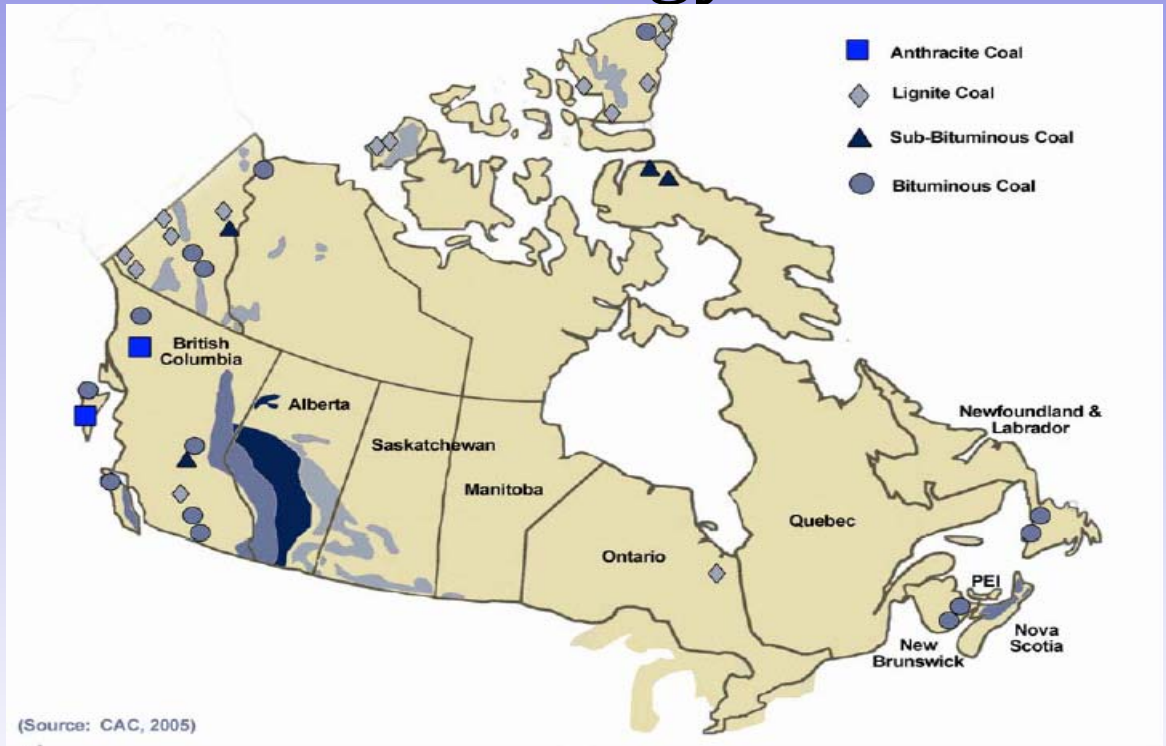
Alberta's Energy Reserves



	Oil	Gas	Bitumen	Coal	CBM
	Million m^3	Million m^3	Million m^3	Mill tonnes	Million m^3
Remaining Reserves	291	1,211	27,810	34,000	>3,600
Annual Production	44	141	100	34	
Life Index, Years	7	9	580	1000	

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Size of Oil Reserves

Alberta's oil reserves contribute to 16% of total global reserves, 2nd Only to Saudi Arabia

Reserves (2005 - AEUB)
(Billion Barrels)

	Oil Sands	Conv.
In Place	1,694	65
Remaining Est.	175	2
Rem. Ult. Pot'l	315	20

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Key Messages

- It is our sandbox –you are welcome to play!
- Alberta is the largest supplier of oil and gas to the United States – and we could do more!
- Clean coal-fired power generation possible
- More CO_2 has been stored geologically in Alberta - & longer - than anywhere else
- Leading in CCS expertise and initiatives

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Canadian Imperative

- National Roundtable on the Environment and Economy (GHG Reduction Wedges)
  - "Oil and gas sector: Canada's growing role as a major energy exporter is compatible with deep GHG emissions, but only if carbon capture and sequestration (CCS) is perfected .
  - Electricity generation: To reduce GHG emissions by 60 per cent, the electricity sector will need to be transformed; clean coal technology involving CCS plays an important role; this study assumes that all coal-fired generation in Alberta, will use CCS by 2050."

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CCS 1989 "Watershed"

- E.J. Wiggins, W.J. Yurko, "*The Greenhouse Effect and the Alberta Fossil Fuels Industry*"
  - Listed 6 options, including CCS (EOR/Depleted Reservoirs, Salt Caverns); high cost penalty
- Alberta's first Acid Gas Injection project – based on new sulphur flaring regulations
  - >3 million tonnes sequestered
- Unintended consequences (gas 'bubble' and deregulation) – cheap, plentiful LPG for EOR

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The "Journey"

- 362,265 oil & gas wells drilled
- Generic CO_2-EOR screening studies - identified best EOR sites
- **What's needed?**
  - Site-specific, simulation-based EOR economics
  - Deep saline aquifer geology
  - Incentive-to-inject (market, policy, sustainability)

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Applied R&D

- University of Calgary
  - Integrated GeoStorage Simulator, Downhole Seismic, Gas Hydrates Storage, Reservoir Modelling
- University of Alberta
  - Well Integrity, Geomechanics
- Alberta Research Council
  - Geochemical Modelling, CO2 EOR Modelling, Acid Gas Injection, Enhanced Coal Bed Methane Field Pilot (China)

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CO_2 Capture

- 100 Large Final Emitters – power, oilsands
- Current Initiatives:
  - Site-specific Front End Engineering Design study for IGCC-With-Carbon-Capture
  - Centralized facility for high-quality CO_2
  - Coal, Coke and Asphaltene-Residue gasification
- **What's needed?**
  - How much high-to-medium quality CO_2 is available – now and in the future?

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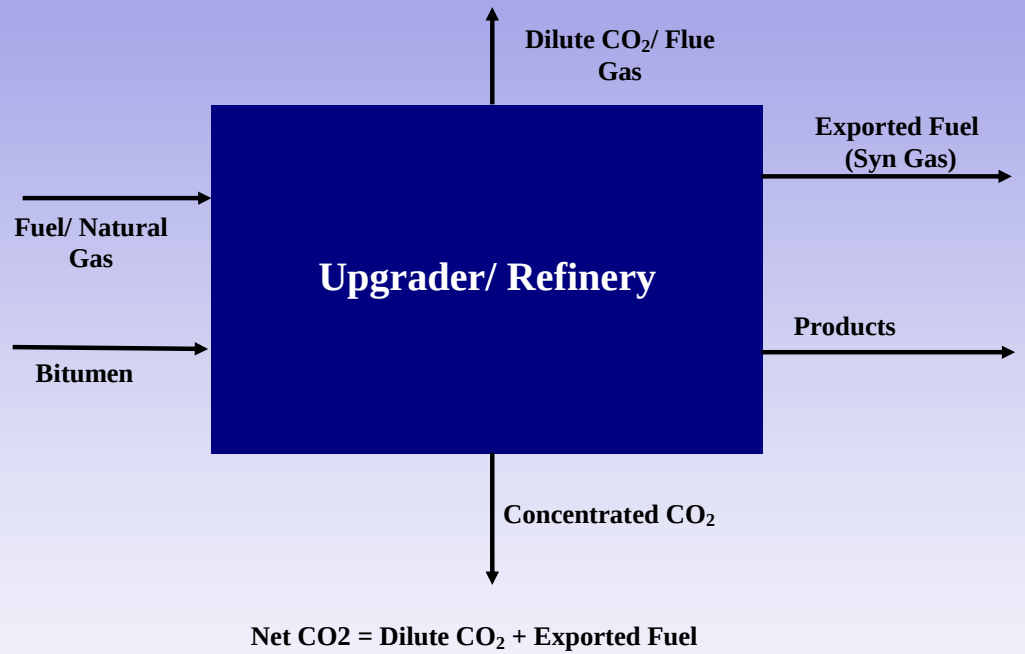
Types of CO_2 Emissions



Total CO_2 emitted = Concentrated CO_2 + Dilute CO_2

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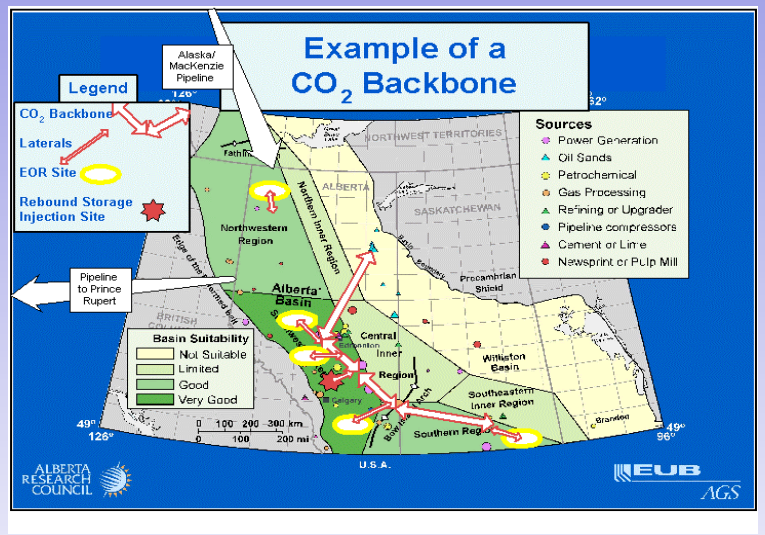
CO_2 Transportation

- Large-scale?
  - Link LFEs to EOR Sites
  - $1.5 Billion Oversized Pipeline
  - Government-funded
  - Common Carrier
  - Long-term Horizon
  - Who goes first?



- Or Incremental?
  - Build Hub around Industrial Heartland (Fort Saskatchewan)
  - Three Phases – (I) Central Alberta EOR; (II) Oil Sands; (III) Southern Alberta
  - Pipelines are "just another service"
  - Partnership with LFEs, EOR operators and service companies

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Enhanced Hydrocarbon Recovery

- Commercial – Penn West (Joffre)
  - Pure CO_2 from petrochemical plant
- CO_2 EOR Royalty Credit Program
  - Penn West (Pembina Cardium) - MMV, with Alberta Universities
  - Apache (Zama) - MMV, with PCOR/North Dakota U
  - Devon (Swan Hills)
  - Anadarko (Enchant)
- Other CO_2 Floods
  - ARC Resources (Red Water)

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Enhanced Hydrocarbon Recovery

- CO_2 Enhanced Coal Bed Methane Recovery
  - Suncor – Drayton Valley (Sequester CO2 in coal seams, displace natural gas)
- Solvent-Assisted Gravity Drainage
  - DOVAP VAPEX field pilot
- **What's Needed?**
  - Successful pilots
  - Site-specific tech-econ studies
  - Infrastructure (CO_2 sources), Expertise
  - Incentives or Penalties

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Lessons from Joffre (1983-2005)

- Simultaneous CO_2 - water injection (0.8:1)
- CO2 price < $2/MCF; or use HC solvents
- Incremental oil: 12% (produced); 25% (projected)
- CO_2 injected now contains 20% recycled HC's
- CO_2 Utilization

  (10.8 MCF/bbl) – GROSS

  (4.0 MCF/bbl) - NET

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Non-EOR Geological Storage

- Potential Sites:
  - Husky (Provost) –Acid Gas Injection Facilities
  - Sherrit (Coal Gasification) – 10,000 TPD CO_2 emissions
  - Industrial Heartland (Bitumen Upgraders) - Increase CO_2 emissions five-fold, to 30 million tonnes/year by 2015
  - Opti-Nexen (Long Lake) Asphaltene Residue Gasification
- **What's Needed?**
  - Suitable sites near LFE; detailed geology
  - Successful field pilot
  - Effective Metering, Measurement & Verification

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Key Obstacles

- Cost of capture from low-quality CO_2 sources
- No market pull for large-scale sequestration
- Who invests first – LFE or EOR?
- Lack of regulatory framework
- Ownership and long-term legal liability
- Lack of infrastructure, expertise

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Examples of Alberta Incentives

Innovative Energy Technology Program (Royalty Credit)	$200 Mil
Energy Innovation Fund	$200 Mil
Next-Generation Hydrocarbon Upgrading, Including CO_2 Capture	$100 Mill

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Policy Framework

Alberta Regulations	Federal Framework
• Effective July 1, 2007 • 12% intensity-based reductions, applied to 2003-2005 baseline • Technology Investment credit @ $15/t for life of program • Offset credits limited to Alberta	• Effective Jan 1, 2010? • 18% intensity-based reductions, increasing 2% p.a. to 26% by 2015 • Technology Investment credit @ $15/t (2010-2012), $20/t from 2013, index to GDP; phase out in 8 years • Offset credits limited to Canada • Credits for early-action (1992-2006) • Clean Development Mechanism – for 10% of national target

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Conclusions

- 50+ Acid Gas Injection sites
- ~10 CO_2-EHR and non-EHR initiatives
- Front-End Engineering Design – Power
- More gasification projects
- Leading-edge MMV expertise
- Government incentives – policy & monetary
- CCS recognized as a key initiative to reduce GHG emissions in Alberta

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