



The Importance of Coal



2007 CAMPUT Conference

April 30, 2007

Allen Wright, Executive Director & CEO

The Coal Association of Canada

Overview

- **Worldwide Energy From Coal**
- **The Reality of Electricity Supply**
- **Technology: The Key to using Coal Better**
- **Why Clean Coal**





'This is Coal's Century...'

Lord Oxburg

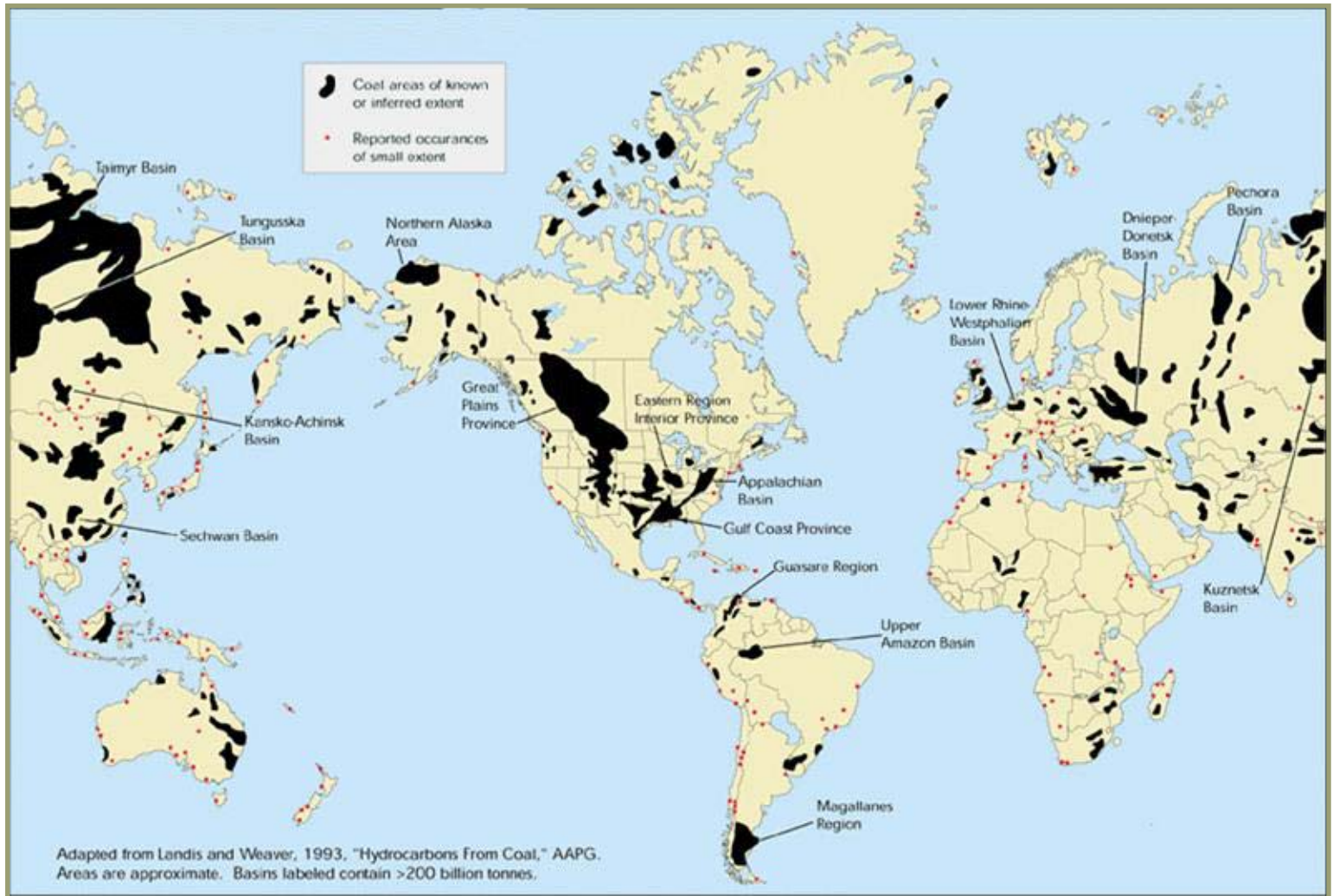
The Carbon Capture and Storage Association - 2007

Worldwide Energy From Coal

- 26% of the world's primary energy
- 39% of all electricity
- 1.6 B w/o electricity – coal a solution
- Widely dispersed around the globe
- Distribution varies notably from that of oil and gas
 - United States – 26% - *'Saudi Arabia of Coal'*
 - Former Soviet Union – 23%
 - China and India – 22%
 - None in the Middle East
- Global reserves of 980 billion tonnes
 - 3 times the amount of oil on an energy basis



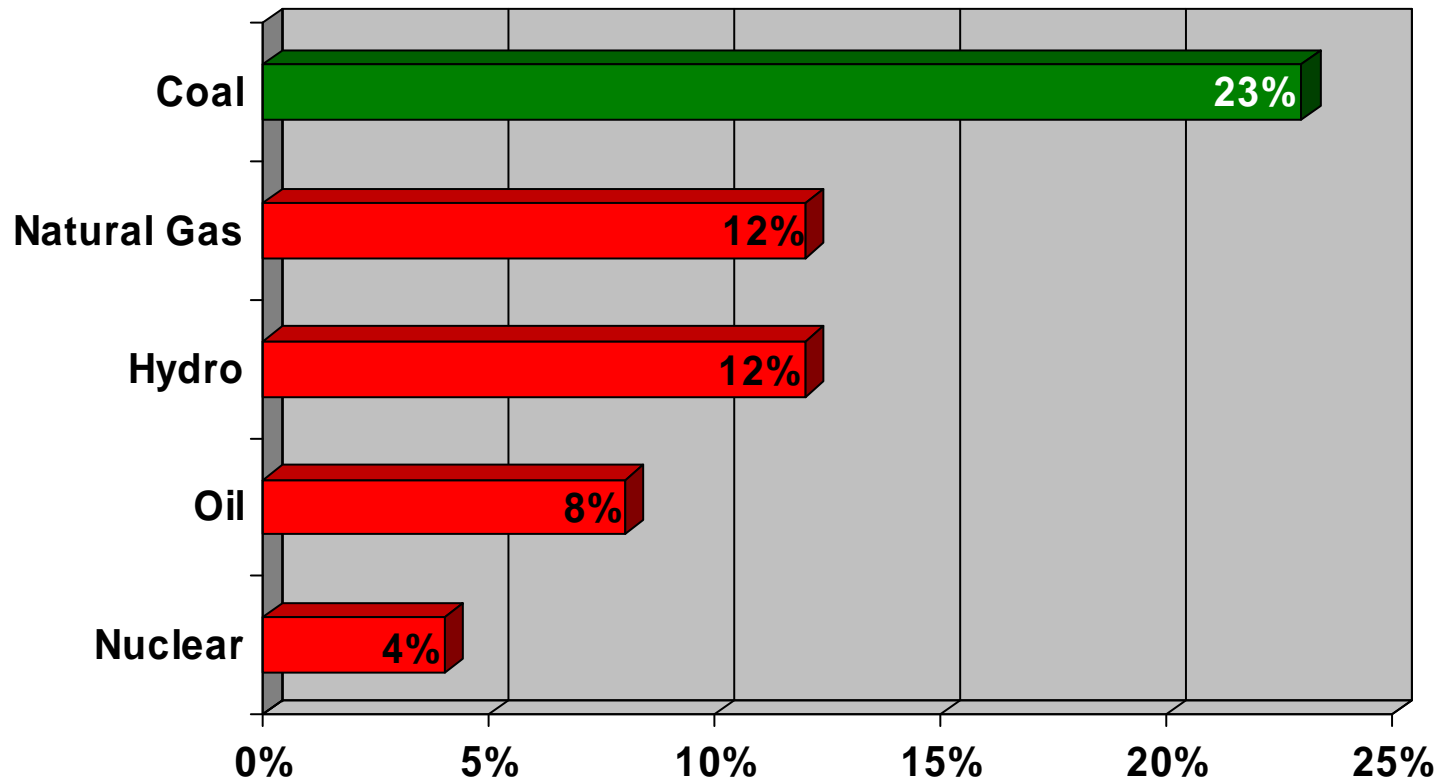
Global Coal Distribution



Source: Norwest Corp.

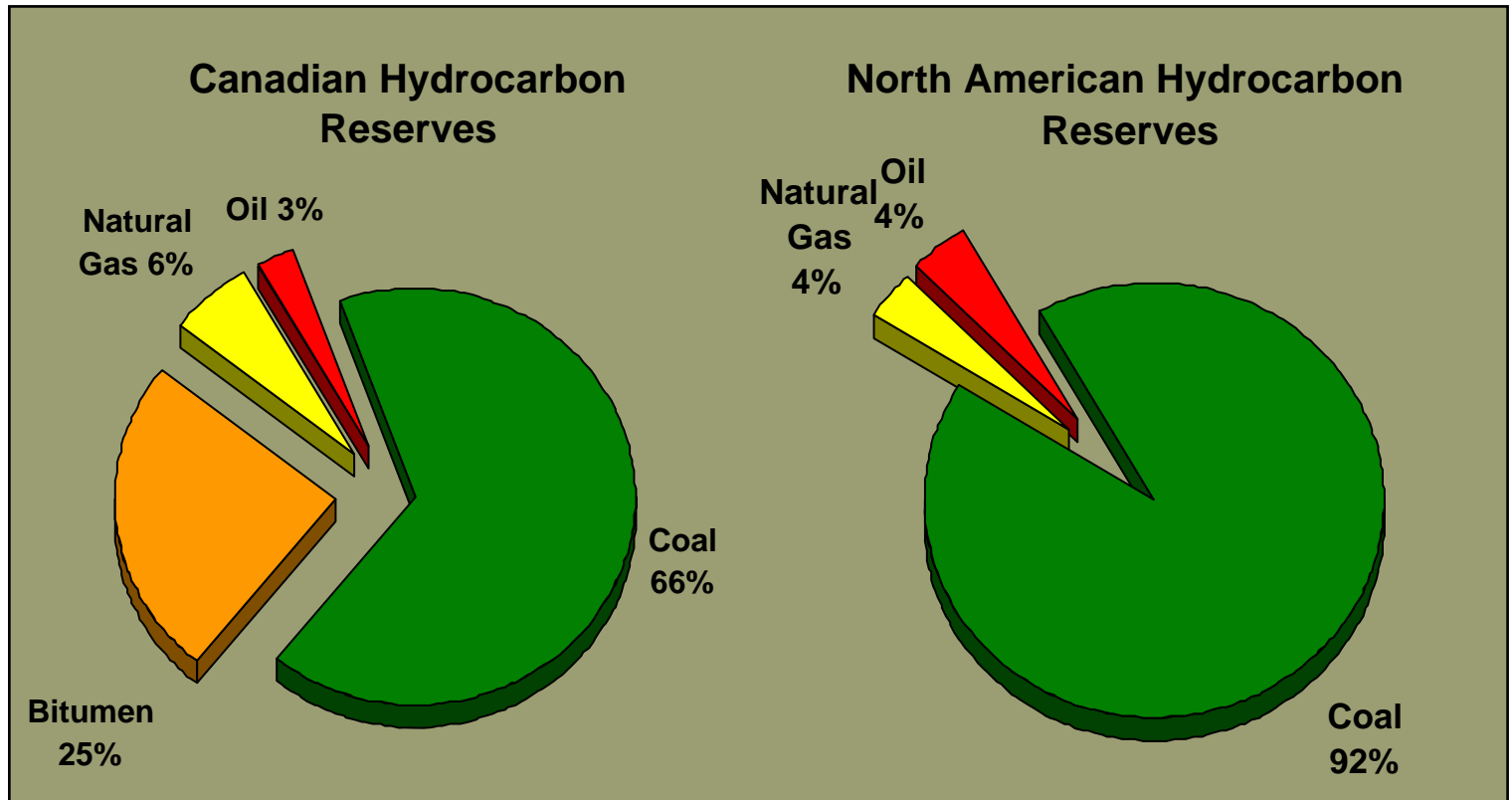
Global Coal Use Increased by 1 Billion Tonnes from 2001 – 2005

% Increase in Global Energy Consumption



Source: BP Statistical Review of World Energy, 2006 edition

North American Energy Supply



- Canada has over 224 years of proven coal reserves at current production rates
- Advantageous cost structure
 - **Western Canadian Coal: \$1.00 GJ**
 - **Ontario Coal Imports: \$2.00 GJ**
 - **Natural Gas: 2006: \$6.00 to \$14.00 /GJ - very volatile**

The Reality of Electricity Supply

- Demand increases at about 2.8% per year
 - More rapidly than overall energy use
- Total world production in 2003 was 16,000 TWh
 - 10,000 TWh was from conventional thermal (mostly coal)
- Large potential growth in production
 - An additional 1,500 TWh by 2010
- 250 new coal-fired units worldwide by 2010
 - One per week
- Clearly there is a need for high performance conventional coal-fired technology as well as conversion technologies



Energy Realities will Drive Equipment Selection

- Alternatives to coal are very costly
- Existing North American gas plants sit idle while utilities contemplate new coal capacity
- Retrofit technology is available for most non-compliant plants
 - Some older coal units will be closed
- Remarkable developments in conversion technologies will occur;
 - Prudence will dictate that IGCC and PFBC be backed up by known and proven technology
- A combination of all options will drive the industry
 - In the beginning weighted toward conventional
 - Later the weighting will shift to new technology
- Security of supply is at the forefront of energy policy



Trends in Europe and Asia

- High energy prices and environmental regulations promote
 - Efficiency
 - New technology
- Germany, Spain, Sweden, Denmark, Japan, Korea and Australia have built industry leading plants:
 - PC and ACFB units in Supercritical and Ultra Supercritical steam conditions
 - District heating for increased efficiency
 - Co-firing with alternative fuels
 - CCS a key focus for Europeans
- Some coal-to-gas conversion technologies have been demonstrated in Europe but the workhorse is still the Rankine Cycle*
- China & India planned coal plants with emissions profile many times Kyoto signatories



Meeting Energy Demand – Its About:

- Balancing cost and emissions
- Orderly transformation to a lower emission future
- An energy mix – conventional coal, cleaner and clean coal
- Conservation and efficiency are key elements
 - Need to consider District Heat, CHP and Integrated Energy Systems
- Governments can guide orderly transition over longer period
- Industry can lead
- Need to invest in technological solutions



Technology: The Key to Using Coal Better



What is “Clean Coal Technology”?

Innovative new technologies designed to extract and utilize coal in a more efficient and cost effective manner while reducing the environmental impact of these activities.

Clean Coal Technology Roadmap 2005



Potential CCT Pathways



Combustion	Gasification
<p>Pulverized Coal</p> <ul style="list-style-type: none"> • Sub-critical steam cycles • Supercritical steam cycles • Ultra-supercritical steam cycles <p>Fluidized Bed Combustion</p> <ul style="list-style-type: none"> • Atmospheric Combustion • Pressurized Combustion 	<p>Integrated Gasification Combined Cycle (IGCC)</p> <ul style="list-style-type: none"> • Entrained Flow Gasifier • Fluidized Bed Gasifier • Moving Bed Gasifier <p>Pre-combustion Capture Fuel Cells Integrated Energy/Chemical Plexes</p>
<p>Ultra Clean Coal Oxy-fuel Combustion Cogeneration and Combined Heat and Power Post Combustion Carbon Capture CO₂ Transportation and Storage</p>	

Conventional Coal?

- There is still a place for conventional coal technology
- Methodologies will be specific in each case
 - Economics
 - Environmental regulations
 - Coal type available
 - End use
- Coal will continue to be a major component of the worldwide energy industry due to its abundance, availability and affordability



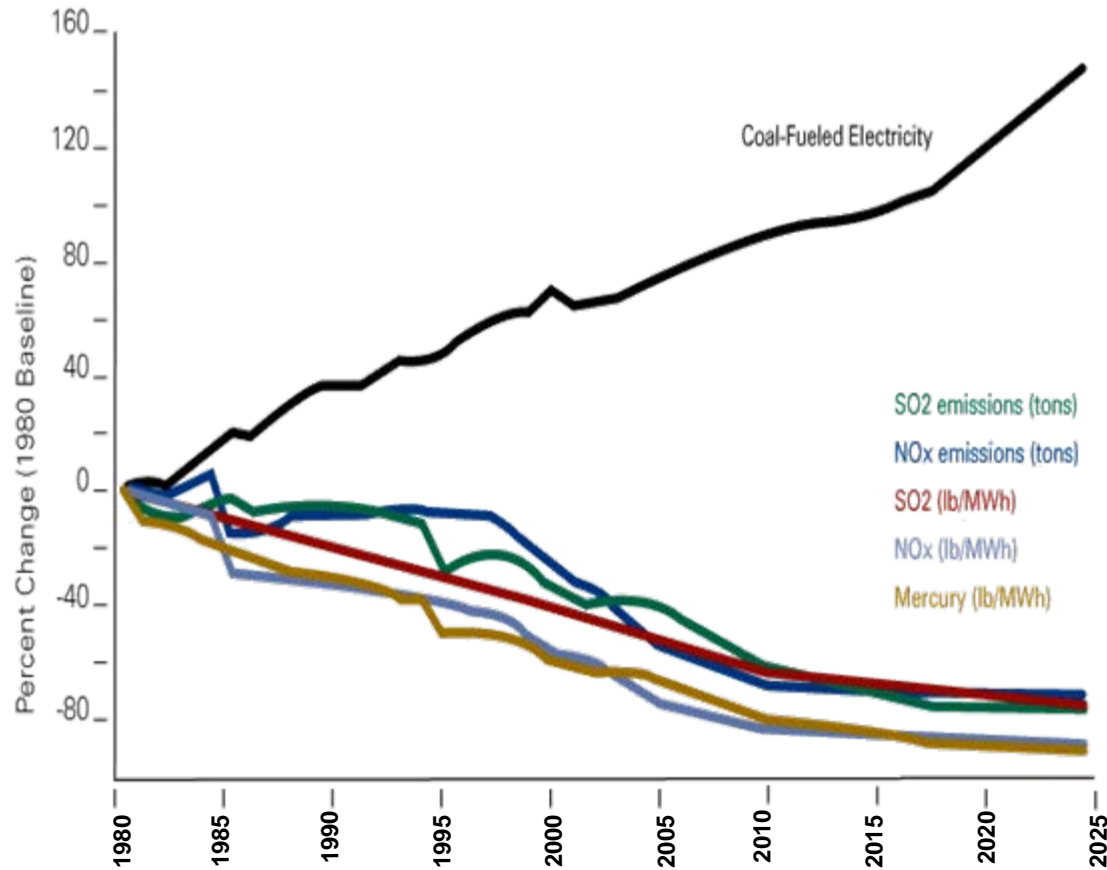
Clean Coal Technology: The International Experience

- Variety of CCT in commercial use around the world
 - SC, USC, FBC, IGCC
 - Japan, Netherlands, Germany, Spain, Korea
 - Initial use in North America (G3 burner, Wabash, IN)
- Maximize value of coal resource
- Better technology rather than simply shut down coal use
- Taking a long-term view of sustainability
 - Environmental, social and economic sustainability



Coal Use Grows While the Environment Improves

Change in Coal-Fueled Electricity and Emissions



Source: U.S. Environmental Protection Agency, IEA Annual Energy Outlook 2005.

Supercritical Coal Plants in Canada

Genesee 3

- Canada's most advanced coal-fired generation unit
- Dramatic reduction in emissions
 - 18% reduction in CO₂ below Alberta average
 - 99.9% reduction in particulate matter; 77% SO₂; 54%NO_x

Keephills 3 – Supercritical

- 450 MW - Q1 2001 - \$1.6 billion
 - 76% reduction in So_x; 68% No_x; 72% Hg
 - 24% reduction in CO₂



Carbon Capture and Storage (CCS)

➤ IPCC Special Report CSS (2005)

- Potential for 2,000 Gt CO₂ geological storage
- Ocean storage could add thousands Gts to this
- Power plants with CCS could reduce CO₂ emissions by 80-90% net
- Majority of CCS technologies either economically feasible under specific conditions or part of a mature market now
- Potential leakage:
 - likely < 1% over 100 years;
 - very likely <1% over 1,000 years

➤ Geological Sequestration

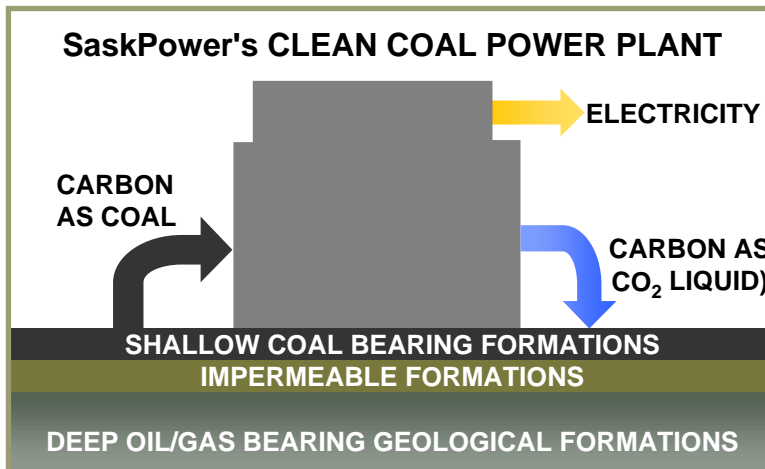
- EOR/ECBM – i.e. Weyburn Saskatchewan
- Deep Saline Aquifers



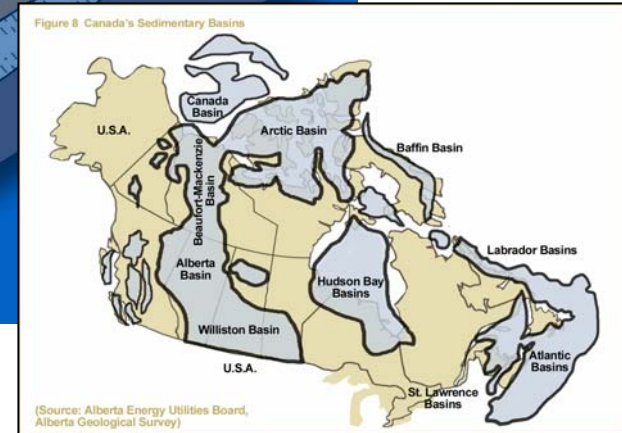
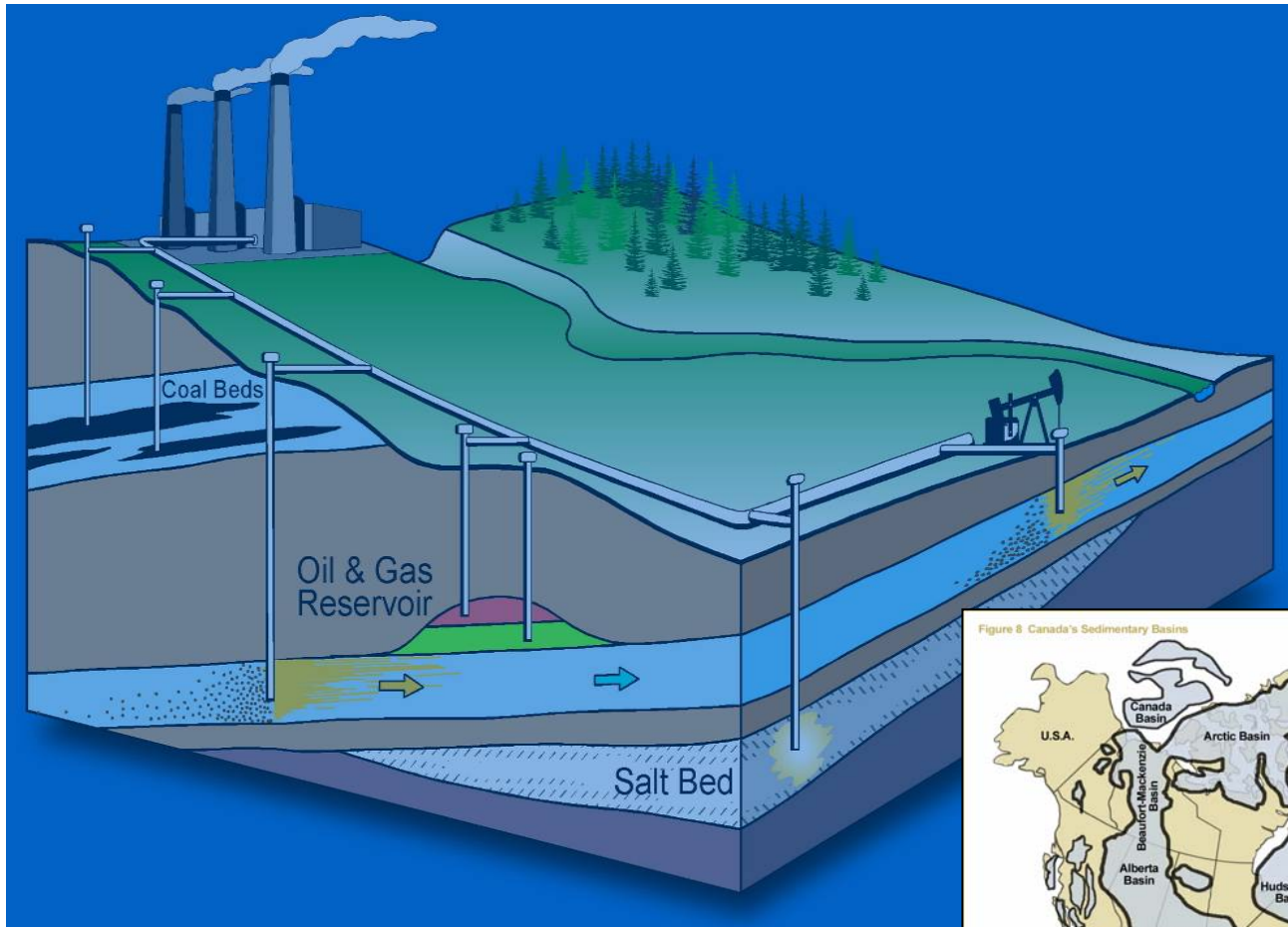
Clean Coal Opportunity: The SaskPower Project

World's first "Near Zero Emissions" pulverized coal power plant based on oxy-fuel technology

- 300 MWe net; 450 MW Gross
- Capturing 90%+ of CO₂
- 3 MT/y CO₂ for sequestration or EOR Sale
- 1.6 MT/y emission reduction
- Fast tracked for in service 2011/ 2012: decision mid 2007



Geological Sequestration of CO₂



CCS – Issues

- Serious need for pipeline infrastructure
- Many new regulatory issues
 - Permanence (not leak out) – *IPCC Report*
 - Ground Water Flows
 - Impermeable cap rocks
- Who covers costs – value of EOR cover cost & transport
- Availability of appropriate geological structures
- Probable role for public/private partnerships
- Some NGO's skeptical



Gasification as a Future Technology

- Interest in gasification as a future technology is increasing significantly
- What has changed?
 - Traditional fuel costs are increasing
 - Domestic fuel security and fuel price stability
 - CO2 concerns and reduction of future risk
 - US third wave emission reductions for power plants including mercury
 - U.S. Energy policy initiatives
 - Paradigm shift of IGCC suppliers



Coal Conversion Technologies

- Coal can be converted to a form of synthesis gas that has features similar to natural gas
 - Four major suppliers of Gasification Technology
 - Conversion technologies have existed for many years
 - Current gas prices support the capital expenditures
- Synthesis Gas can be used for:
 - Replacement of Natural Gas in industry
 - Conversion to Hydrogen for Bitumen upgrading
 - Feedstock to chemical production
 - Combined Cycle power production
- All emissions are eliminated in the process
- Pure CO₂ is a by-product



Gasification in the World

- 117 Operating Plants
 - 285 Gasifiers
 - Capacity ~ 45,000 MWth
- Feedstocks
 - Coal 49%, Petroleum Residue 36%
- Products
 - Chemicals 37%, Liquids 36%, Power 19%
- Growth Forecast
 - 5% annual



Sherritt's Dodds-Roundhill Project

- First commercial coal gasification project in Canada
- Produce hydrogen synthetic oil upgrading
- Coal price is stable, natural gas price is volatile
- Byproduct CO₂ to be used for EOR
- No current supply of commercial quantities
 - Hydrogen
 - Carbon Dioxide



ENMAX Coal to Gas Project

- Size – 1200 MW
- Gasification Technology – BATEA off the shelf
- Cost - \$1.5 – \$2.5 Billion
- Timing – Phase 1 Target 3 Yrs
- Produce 50% less CO₂ than current coal plants
- Potential to meet 2/3 of Calgary's electricity needs
- Firm up southern transmission grid – allow more wind



Constraints on Adopting Clean Coal

- Sterilization of existing infrastructure
- 25% premium on capital compared to existing technology
- Preclusive environmental policy
- Market for power, heat, hydrogen, syngas and CO₂
- Infrastructure such as CO₂ or hydrogen pipelines



Why Clean Coal?



- Lowest Cost source of power generation
 - Competitive solution even with increased technology cost
- Available
 - India & China have little option
 - pressure to develop oil sands
- Secure supply
 - Hundred of years vs. decades for oil and gas
 - Lowers dependence on imports
- Limits need to purchase offshore credits
- Encourages development of domestic technology

Why Clean Coal?

- Coal gasification makes hydrogen a commodity
- Preserves existing social infrastructure and jobs
- Fully compatible with development of renewables (i.e. wind)
- Conservation & energy efficiency are key elements
- Timeliness
 - Technology solutions within next 5 years
 - GHG reductions by 2020 and near zero emissions by 2050



Thank You



See us at www.coal.ca

