New Electricity Technology

Paul Clark
Director, Fuel Supply
TransAlta Utilities Corporation

ASRA Retreat
June 7, 2002 – Ft. McMurray

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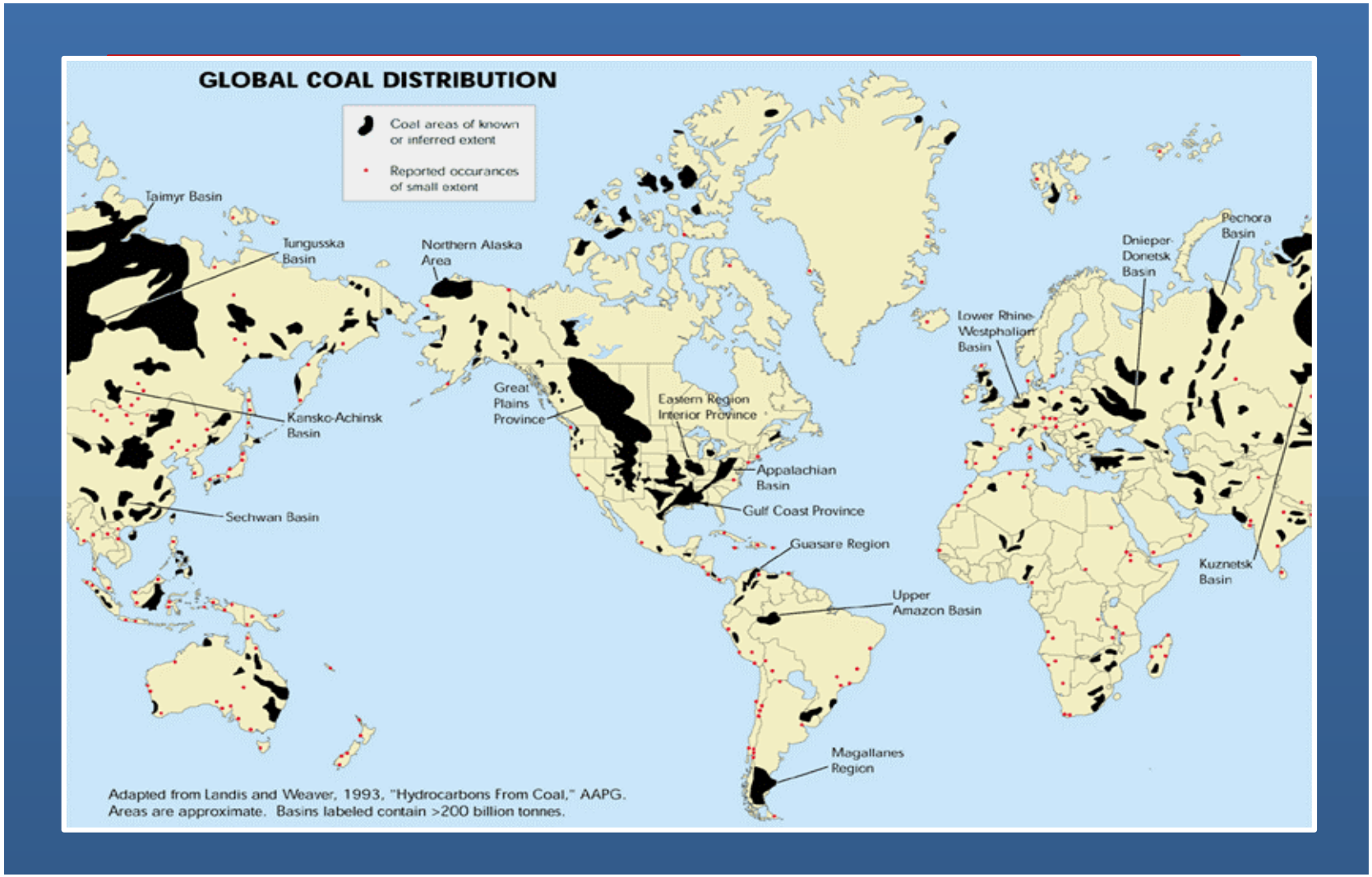
Global Coal Distribution



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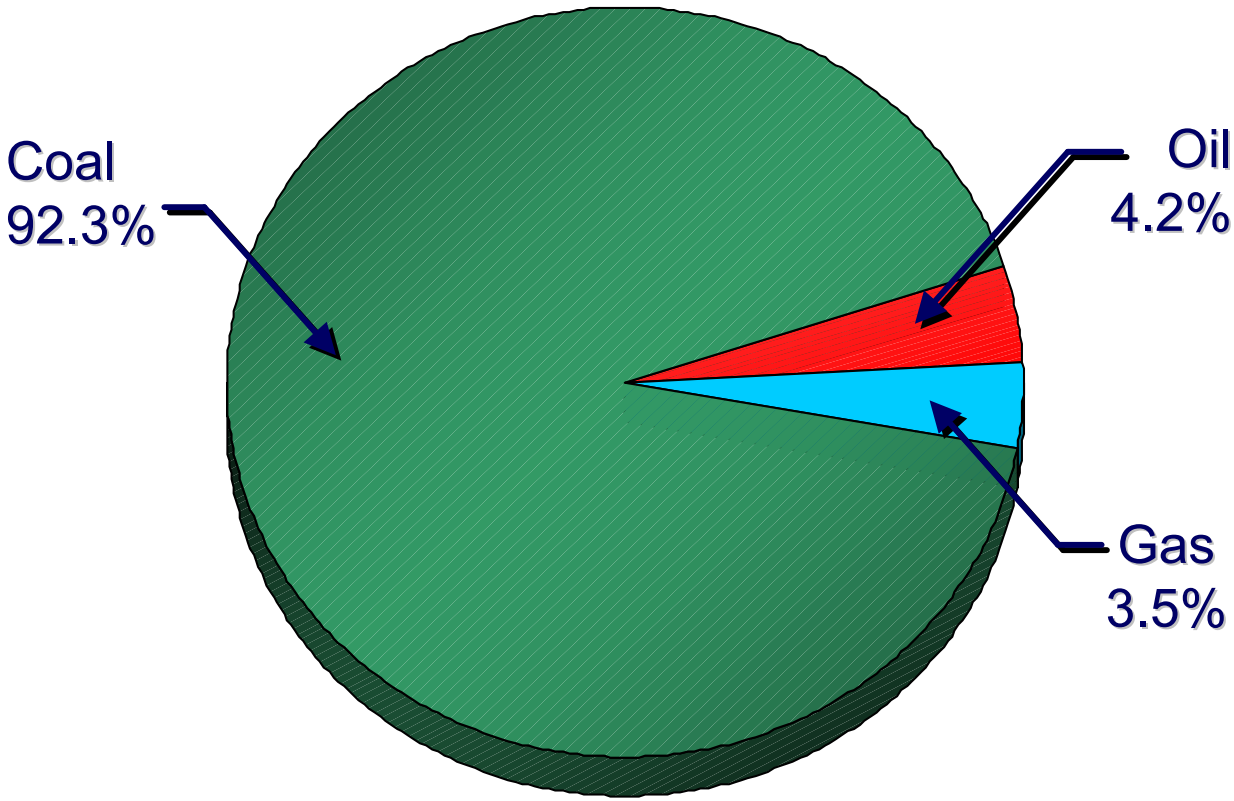
North American Hydrocarbon Reserves



Source: Energy Information Administration; U.S. Crude oil, Natural Gas Liquids Reserves, 1999 Annual Report National Energy Board (Canada) http://www.coal.ca/coalstat01.html

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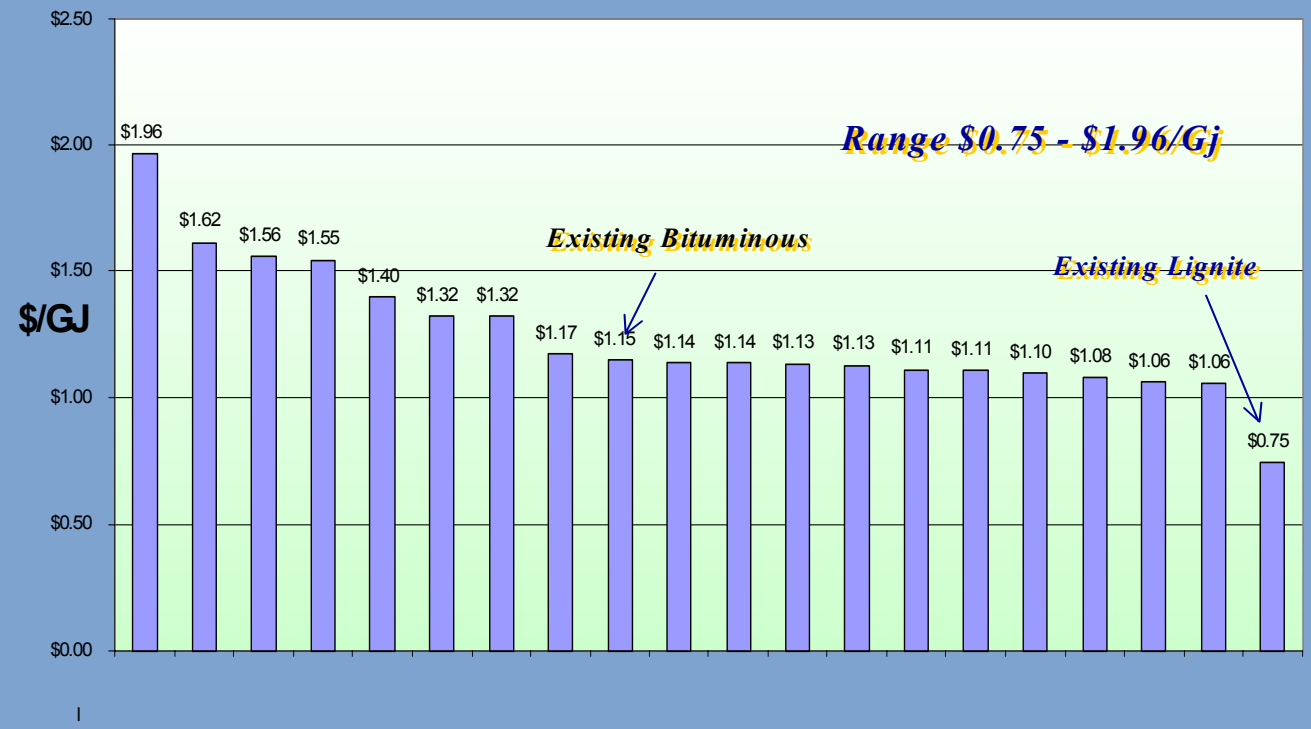
Alberta Mine-gate Sub-bituminous Coal Prices – Prospective/Undeveloped



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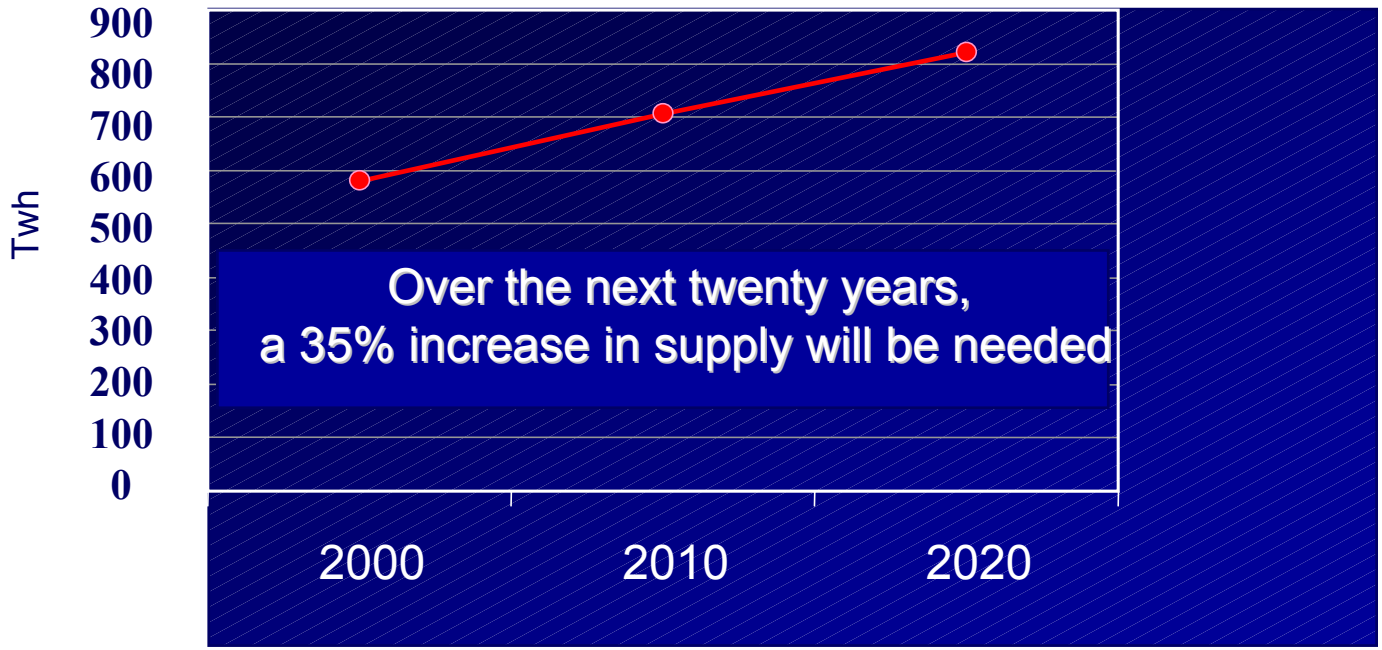
Canadian New Supply Requirements



- 30 775-MW CANDU nuclear units, or
- Two and a half La Grande hydro complexes, or
- 7 Nanticoke (or 15 Sundance) coal-fired plants, or
- 635 50MW gas turbines, or
- 40,000 1.5-MW wind turbines

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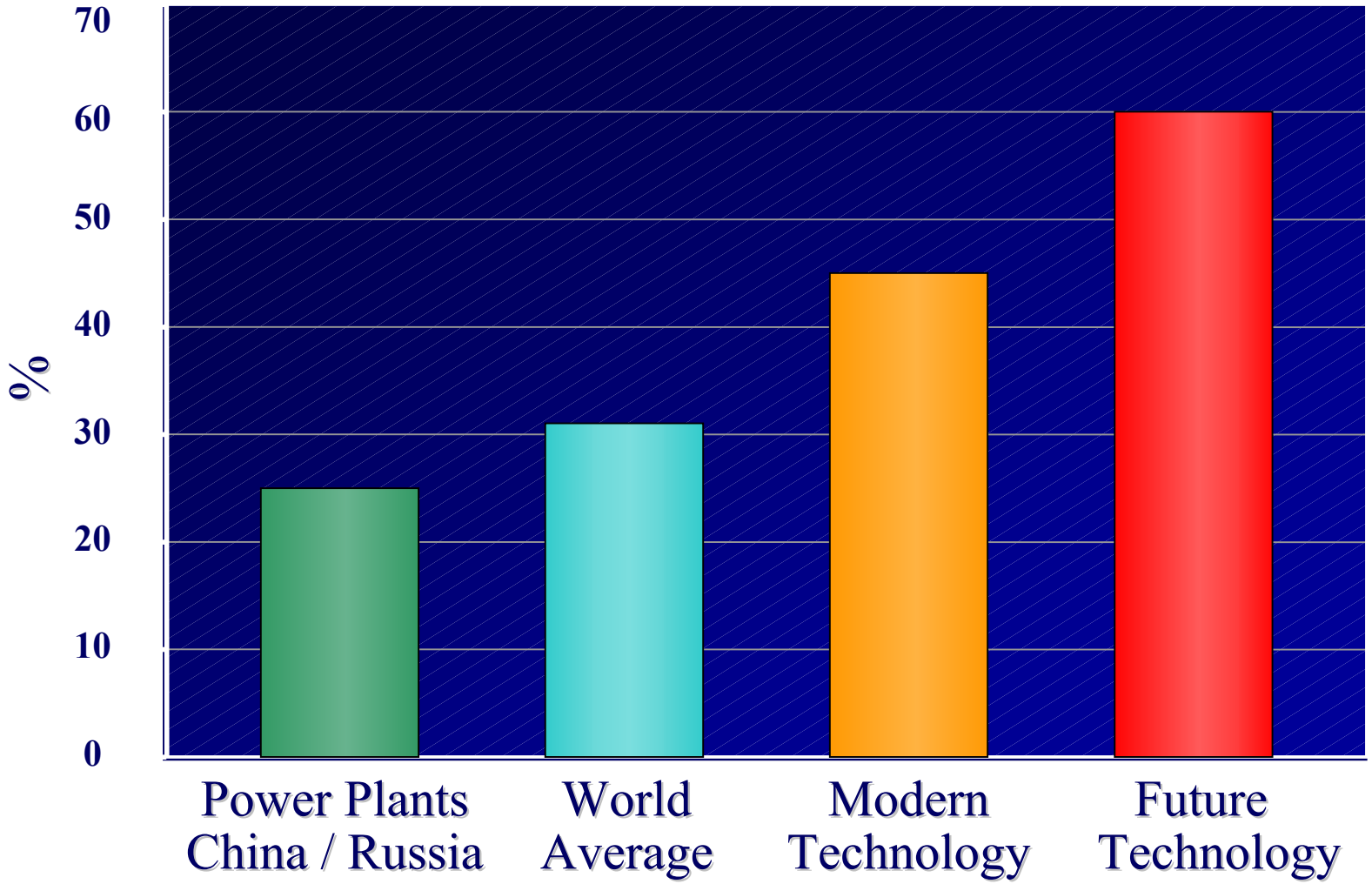
Efficiency of Coal Power Plants



Source: Future Technologies: US Department of Energy (DOE/EIA), Vision 21

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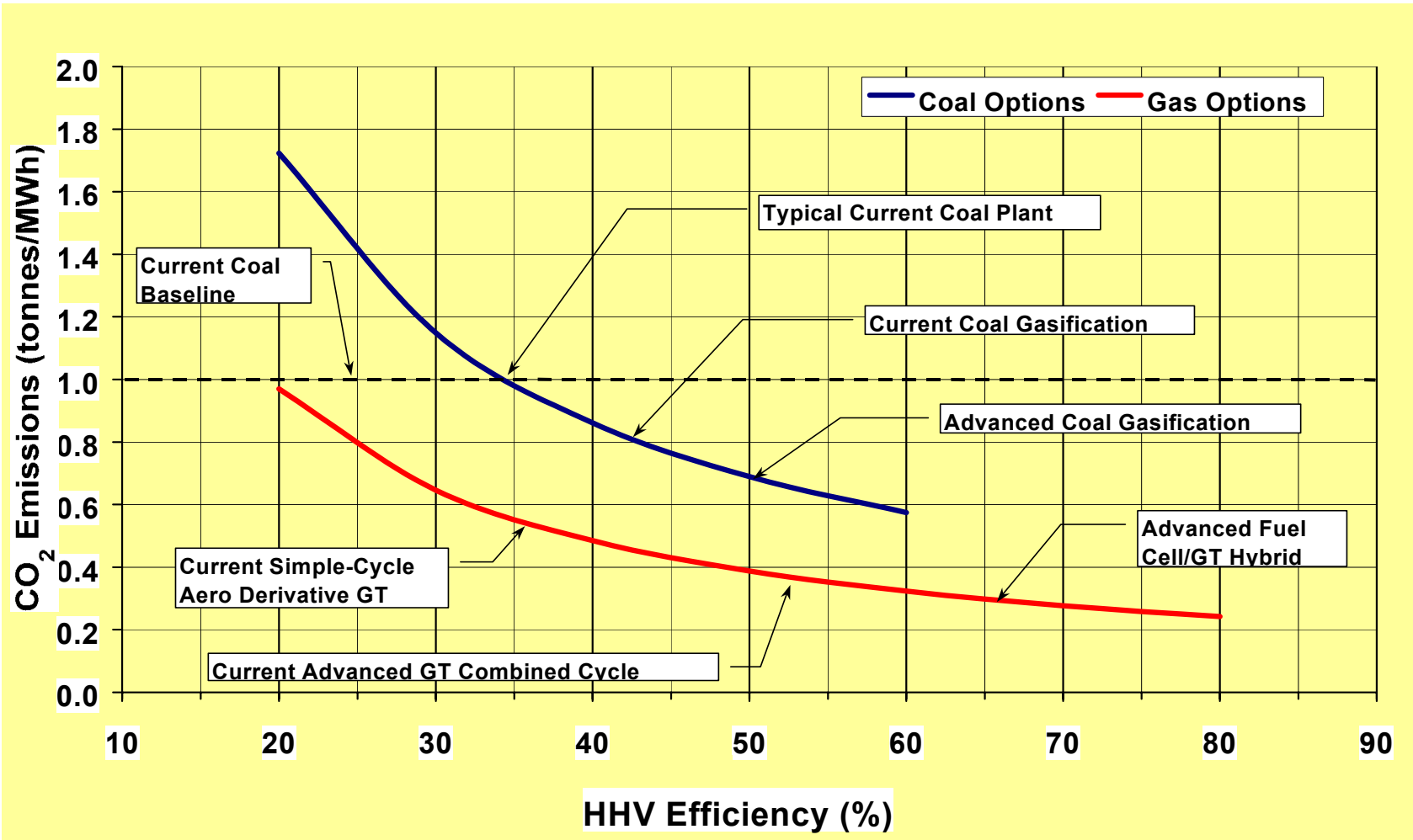
IMPACT OF EFFICIENCY ON CARBON DIOXIDE EMISSIONS



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CO_2 Extraction Cost Projections

ITEM	IGCC	PC	NGCC
Percent Reduction in CO_2 Emissions	90	90	90
Costs of Capture, $US/ton CO_2 Avoided	14.8	30	48.2
CO2 Removed, tpd	8145	8525	3105
Net Plant Efficiency, %	37	28.9	43.3
Energy Penalty, Percent of Output	4.9	28.7	19.2

IGCC: Integrated gasification Combined Cycle **PC:** Pulverized Coal **NGCC:** Natural Gas Combined Cycle
Source: Evaluation of Innovative Fossil Cycles Incorporating CO_2 Removal, DeLallo et al, Gasification Technologies Conference, San Francisco, Oct., 2000.

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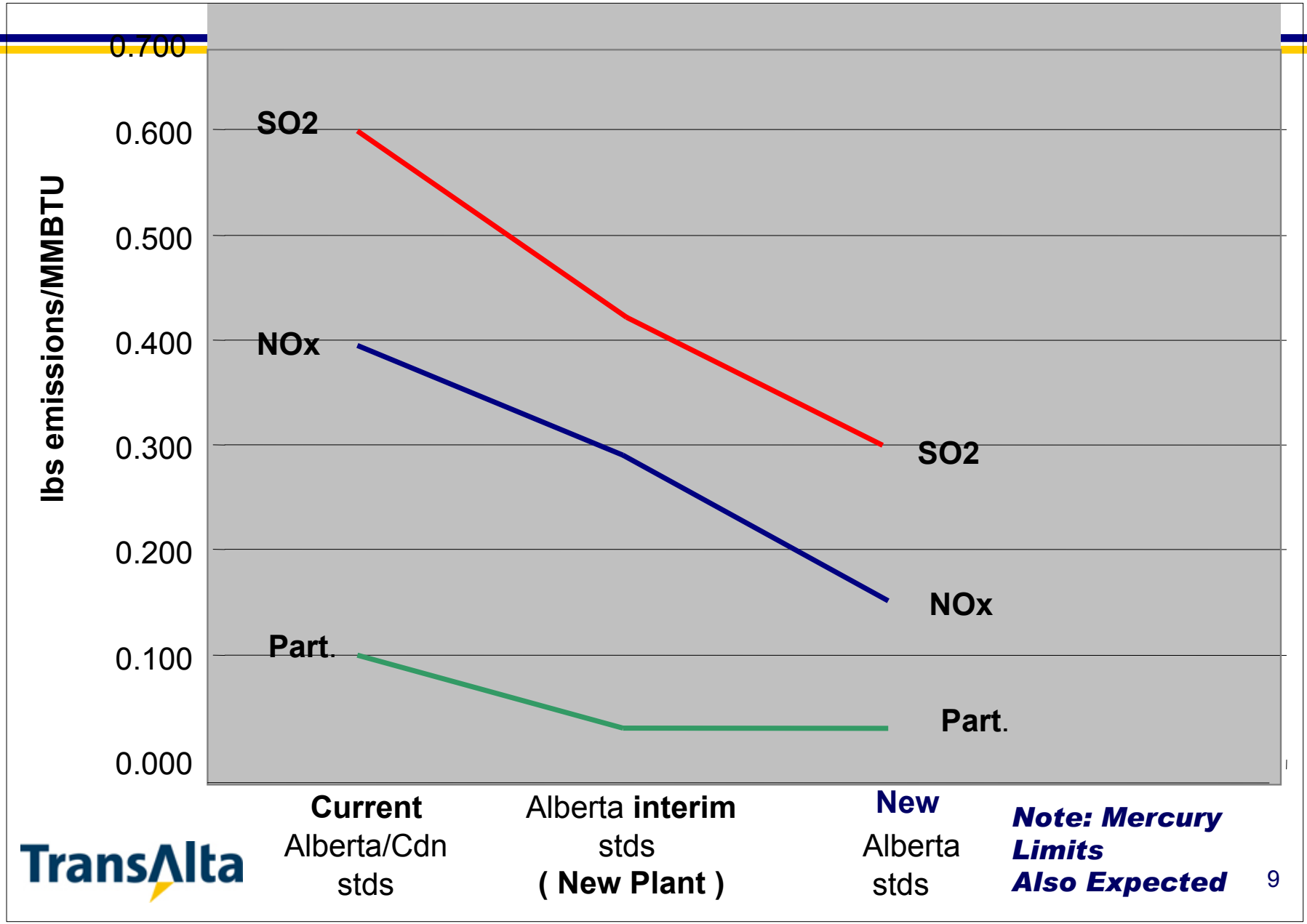
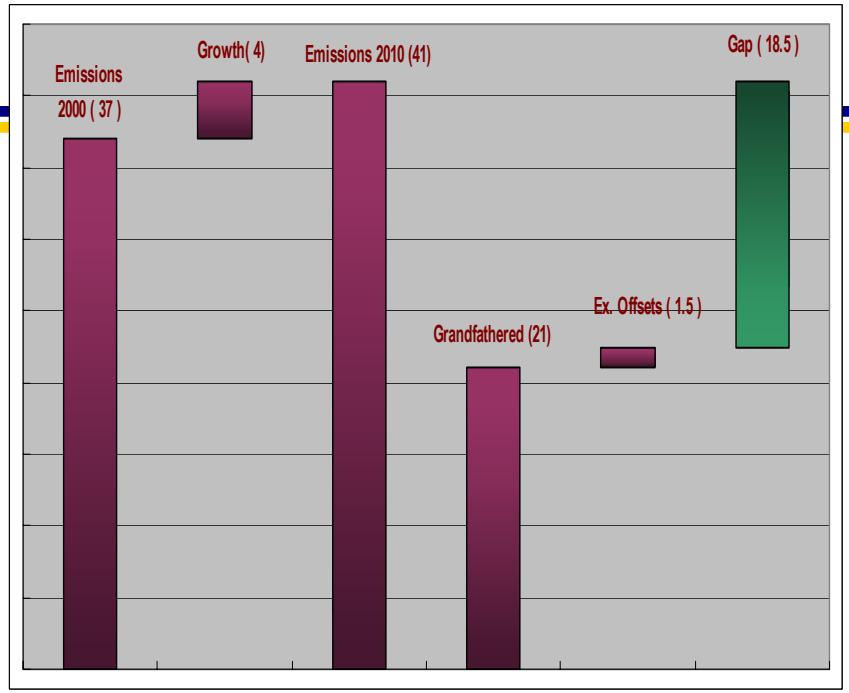
Post 2005… Expected ***So2 / NOx / Part.*** Emission Reduction Obligations under Anticipated Regulation



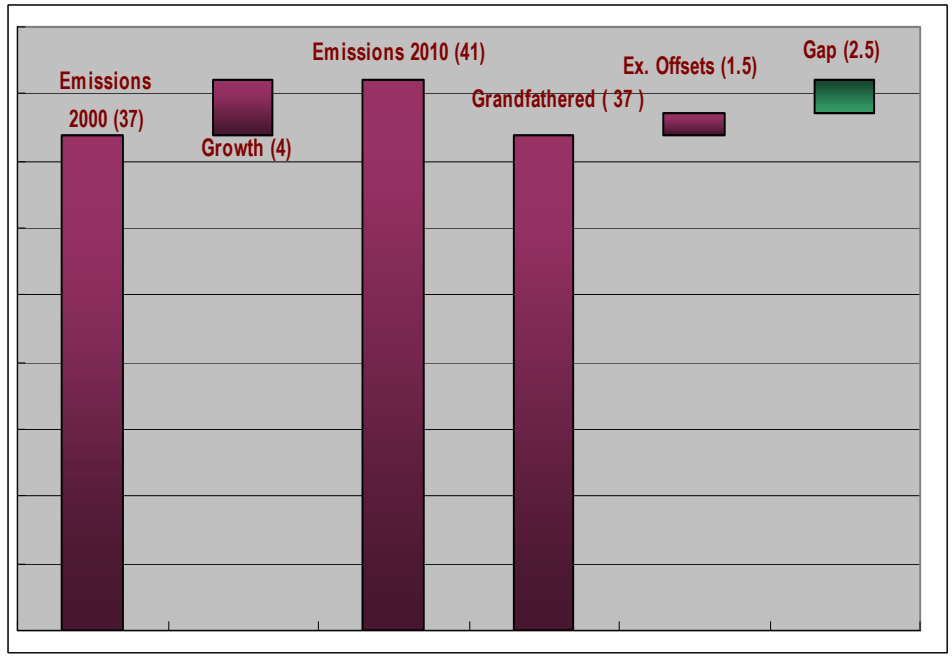
Note: Mercury Limits Also Expected

2010… Expected GHG Emission Reduction Obligations Under Anticipated Regs in Canada and the USA



← Kyoto Model (Canada, US States)
Cost to close gap= $ 5.00 per MWHr
(2010 $)

Efficiency Model (US Fed / Alberta) →
Cost to close gap = $ 0.80 per MWHr
(2010 $)



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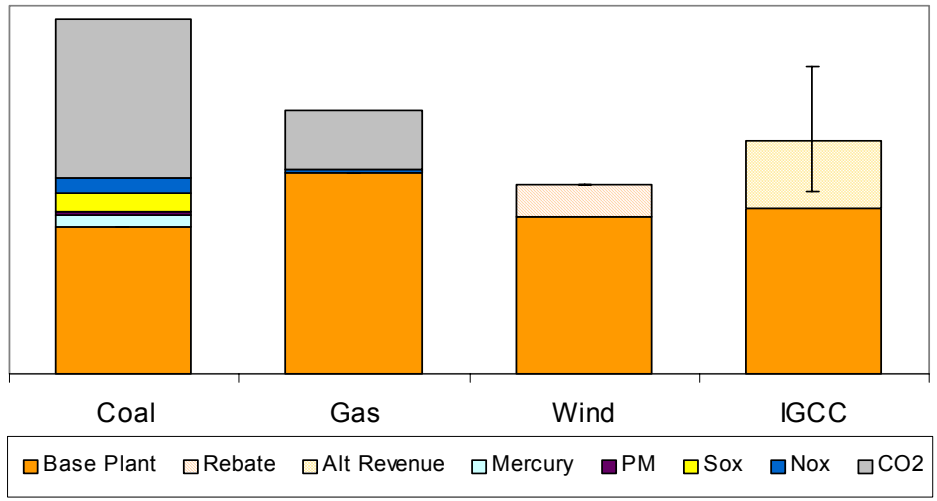
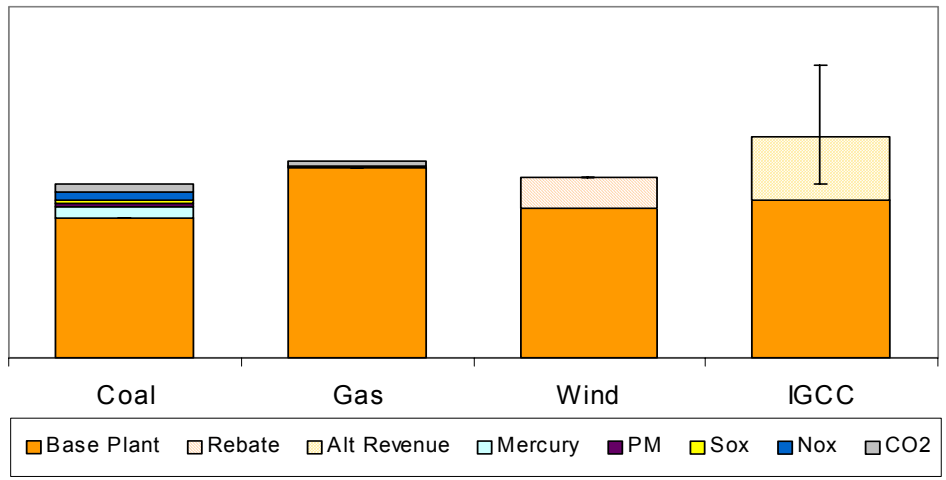
Environment Technology and Trading

- Many different options
  - Portfolio design
  - End of pipe technology
  - New technology
  - Offsets and trading
- Co-benefits not as big as you might think
- Integrated approach avoids trade-offs
- Clear targets, flexibility and choice are critical

Portfolio Options with Best Available Control Technology
Canadian $ / MWh



Portfolio Options with Trading
Canadian $ / MWh



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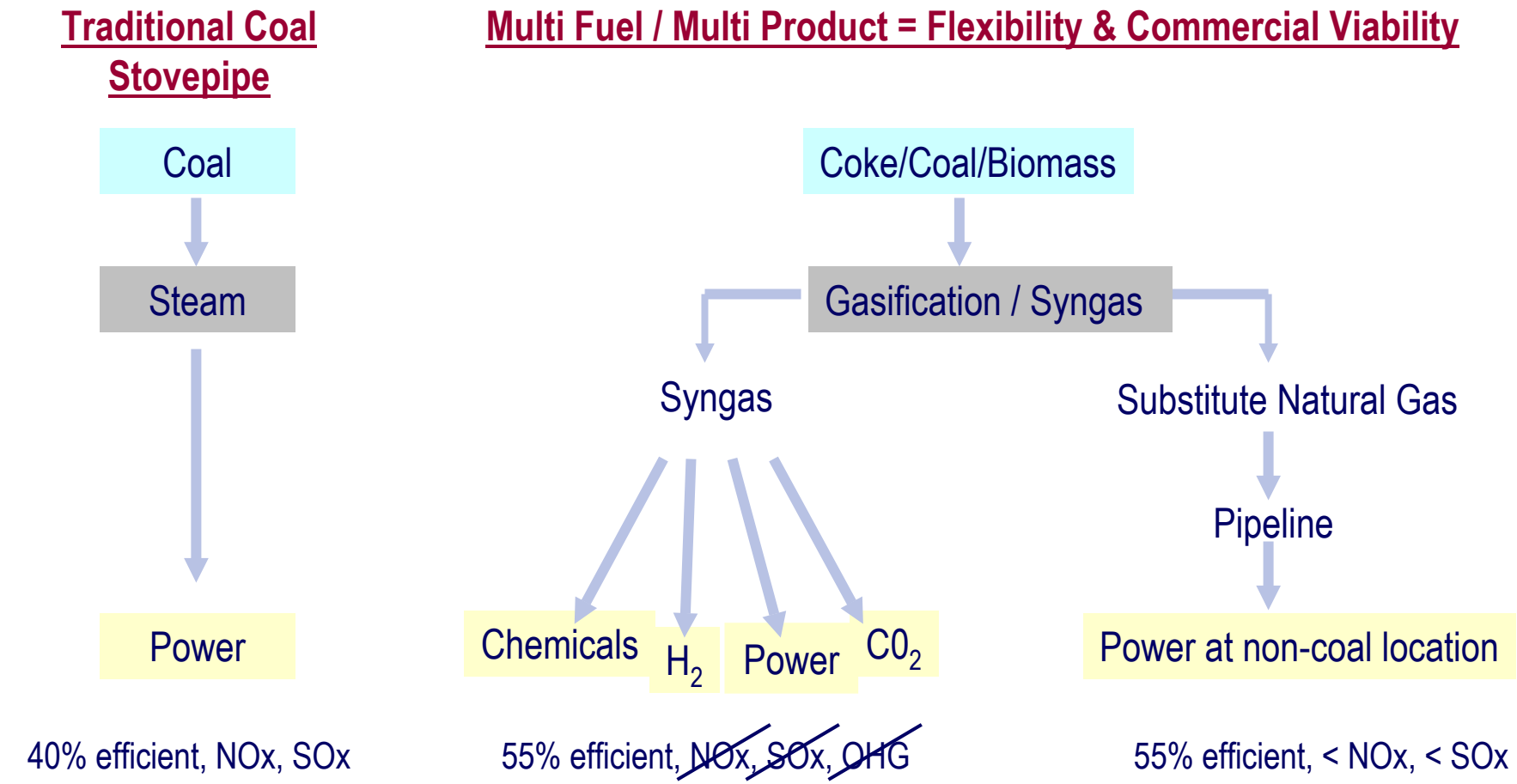
Gasification – Emission Solutions & Economic Plants



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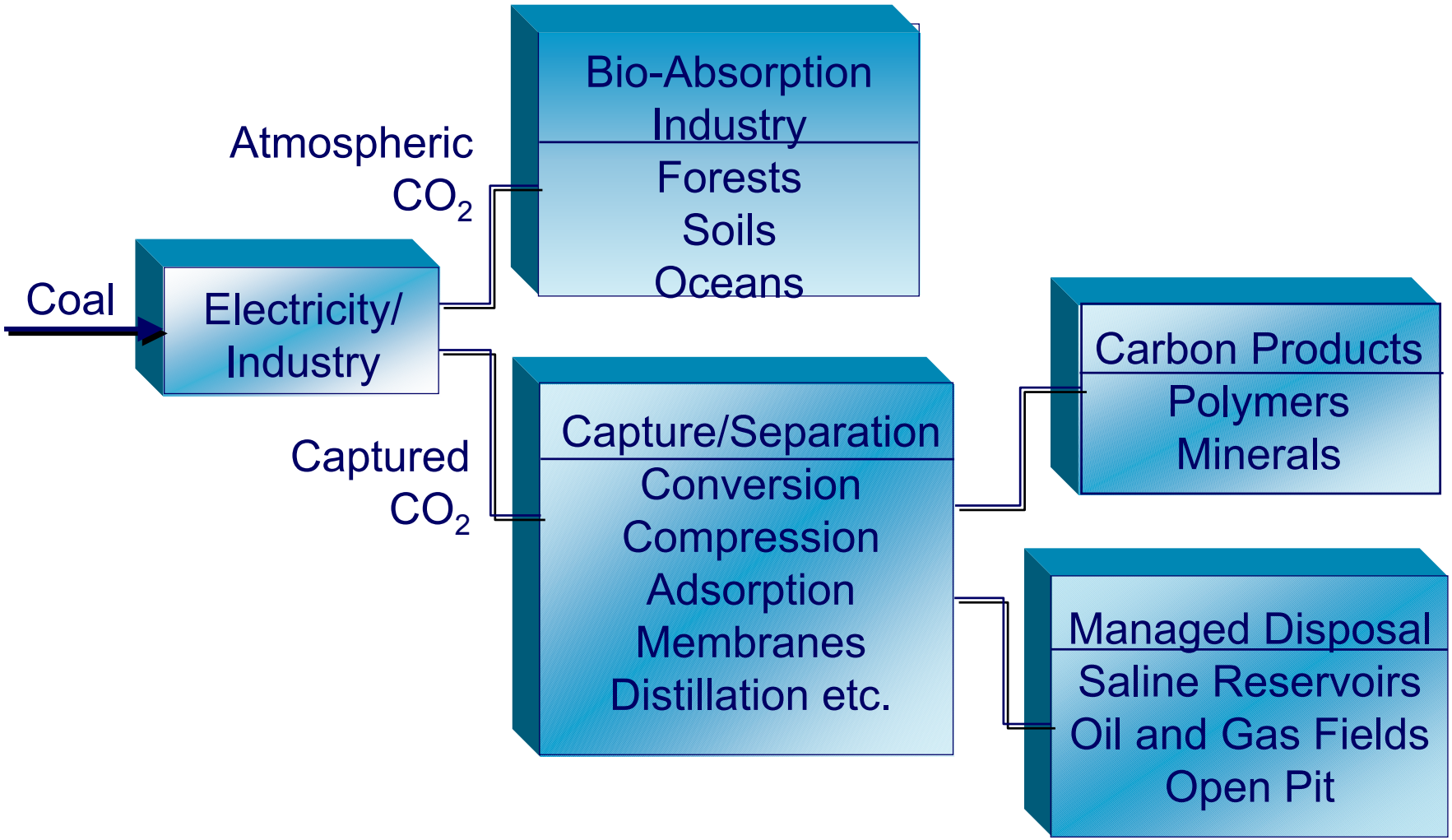
Carbon Sequestration



Source: US Department of Energy (DOE), Technology Road Map for Carbon Capture and Sequestration, February 1999.

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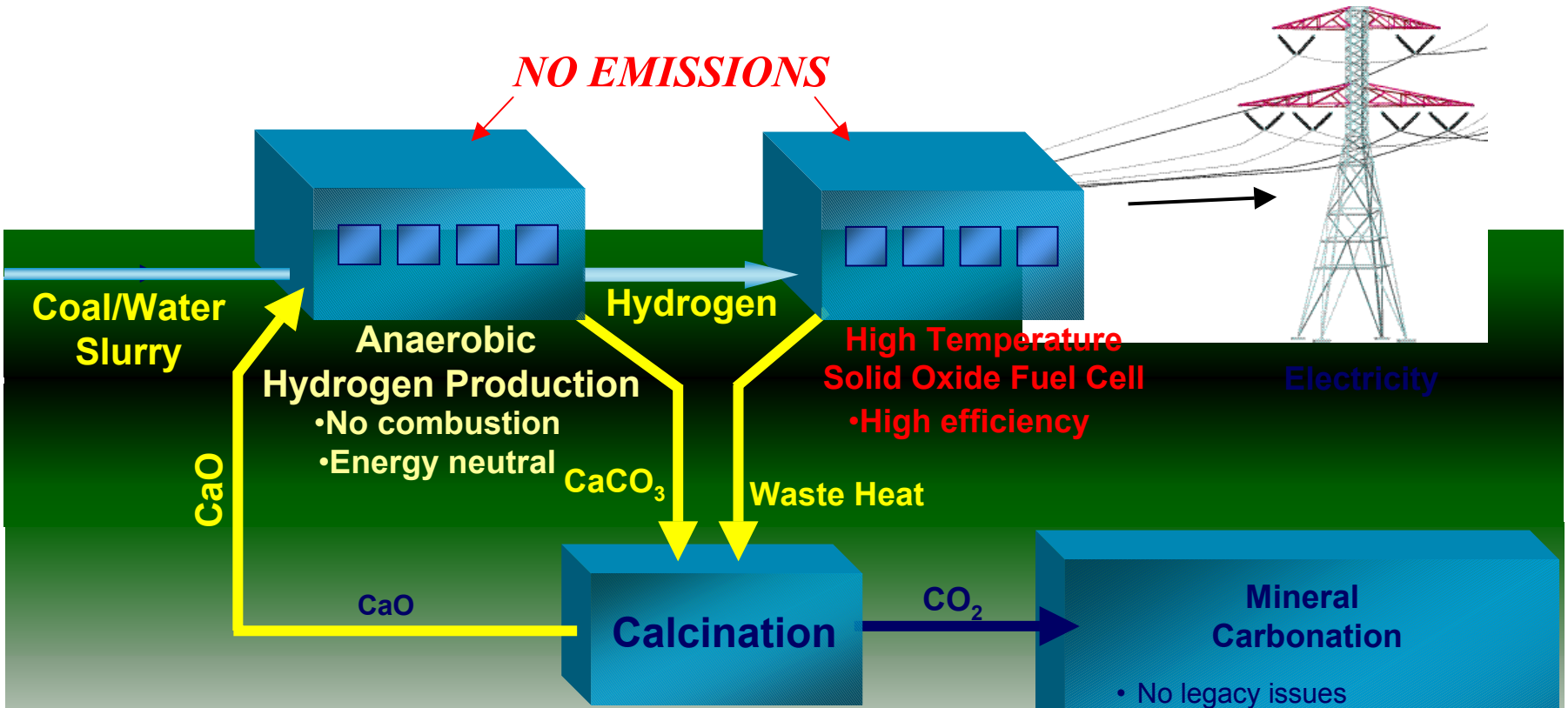
The Zero Emission Coal Concept



Coal to electricity with extremely high efficiency

- Waste heat from fuel cell fully recycled
- 50% less CO_2 even without disposal
- Capture all emission products

Source: Los Alamos National Laboratory

Optimizing Alberta's Coal Resource

- Integrated Development Concept
  - Electricity Supply
  - Cement
  - Agriculture
  - Co-generation
  - Heavy Oil
  - Enhanced Oil Recovery
  - Enhanced Coal Bed Methane
  - Synfuels
  - Hydrogen

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Benefits for Integrating Coal Energy

- Lower input costs for
  - Electricity
  - Steam
  - Industrial Fuel
  - Agricultural Processing
- Expands resources
  - Gas for Export
  - Synthetic Oil
  - Enables the Hydrogen Economy

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Electricity Supply for North America

- Transmission Issues
  - Long Lead Times
  - Siting
  - Low Return on Investment
  - Who Pays

Potential lost opportunity for provincial/interprovincial and North American trade

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What are the Drivers for Distributed Generation?

MARKET	REGULATED	DEREGULATED MARKETS
Customer Choice	✓ kWhs ✓ CHP (large) ✓ Own standby ✓ Own UPS	✓ kWhs ✓ Power quality ✓ Power reliability ✓ Waste fuel management ✓ Emission reductions ✓ CHP (small) ✓ Standby service ✓ Grid support
Technology	Internal combustion engine for standby, large gas turbines, coal	Internal combustion engines, micro-turbines, fuel cells, solar, wind turbines

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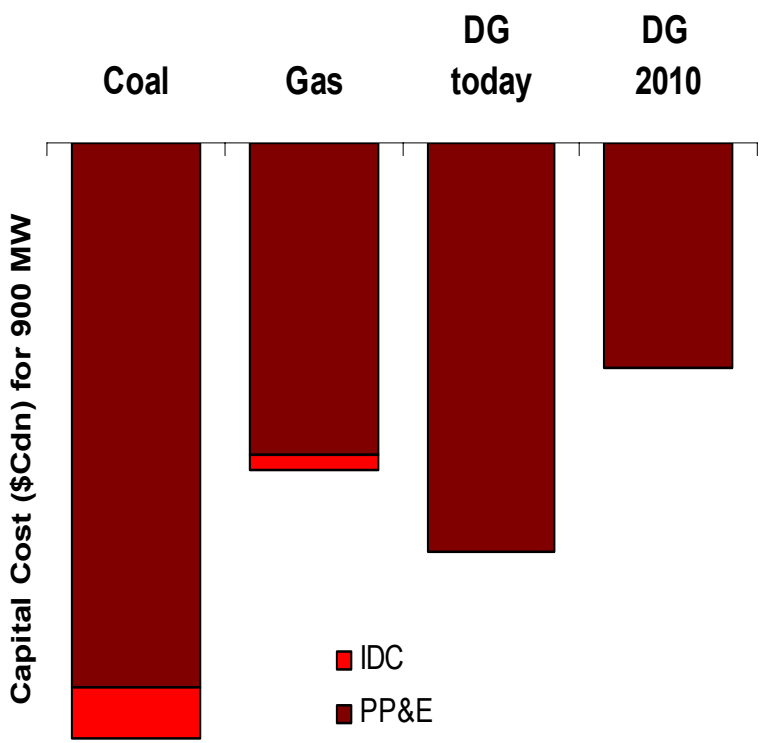
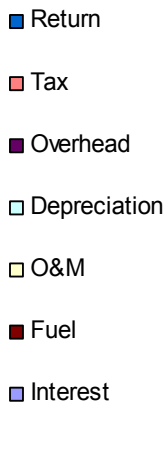
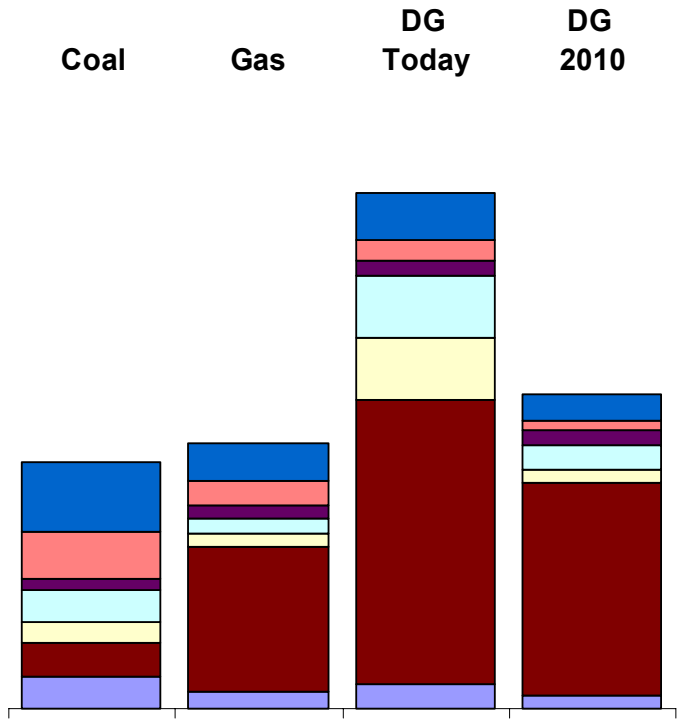
What does Distributed Generation Cost?







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How Costs Will Improve

- Capital Cost Improvements
  - Power Electronics
  - Systems Labour
  - Recuperator
  - Engine and Alternator
  - Package and BOP
  - Boiler
- Operating Cost Improvements
  - Scale of Operations
  - Simplification of Design
  - Solving Compressor Problems
  - Predictive Maintenance Capability
  - Increased Digitization of the Engine/Grid Interface

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Photovoltaics

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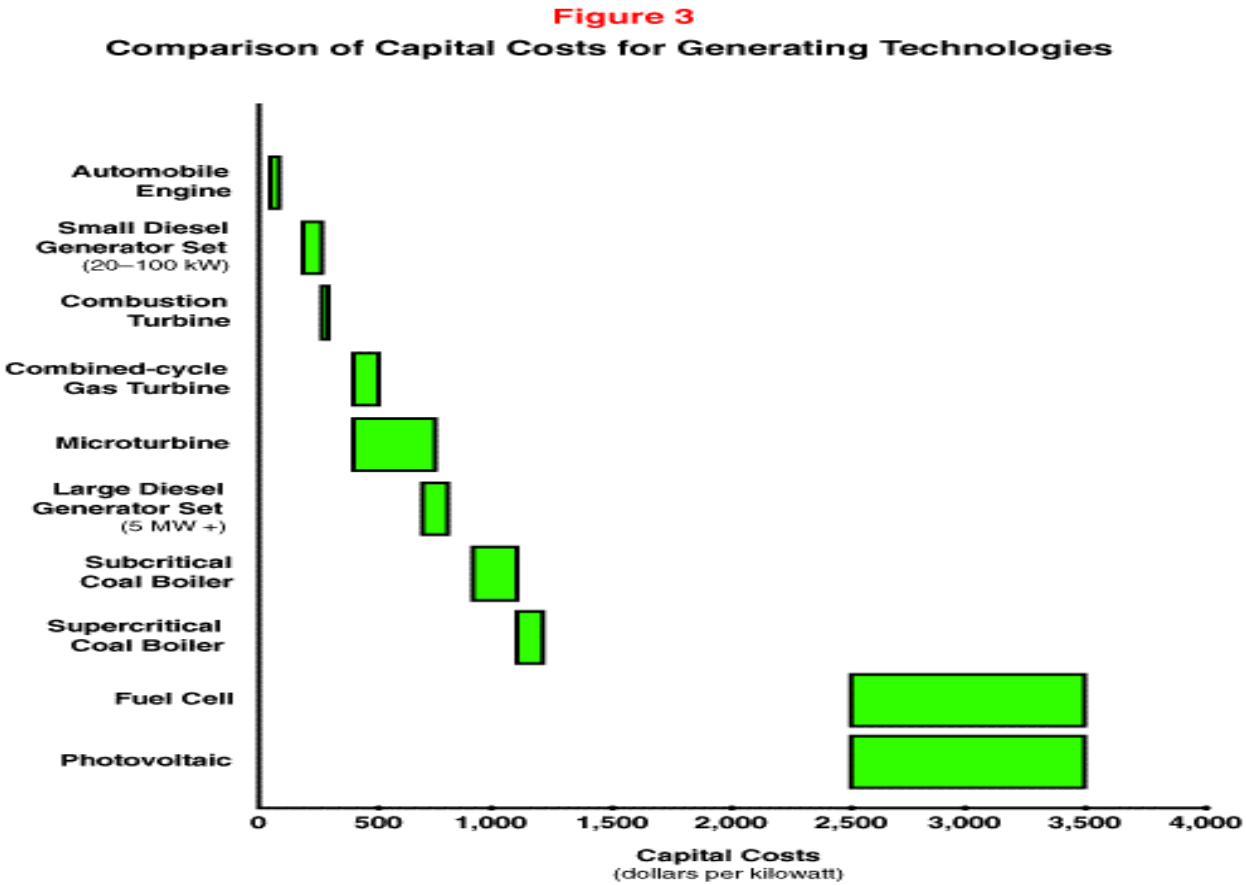
Fuel Cells and Solar are out for few years

Recips and turbines competitive now



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Key Messages

Distributed Generation

- Distributed generation is still 5 -10 years out.
- Business model for DG is not well understood
  - Scaling down will not work
- Everyone is following technology developments
  - Technology is the least of our worries
- Entrepreneurial teams will create a competitive advantage
  - Today – no one has a competitive edge

Coal Resources

- Alberta needs a vision of coal as an abundant, competitively priced and clean input into a fully integrated energy, resource development and industrial production matrix.
- Key industries, Alberta and Canada, need to convene a task force to identify opportunities and develop work plans to realize synergies.

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