Canadian Clean Power Coalition: Clean Coal Technologies & Future Projects

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Presentation Outline

- Canadian Clean Power Coalition (CCPC) Overview
- Technology Overview
- Phase II Results
- Demonstration Projects
- Concluding Comments

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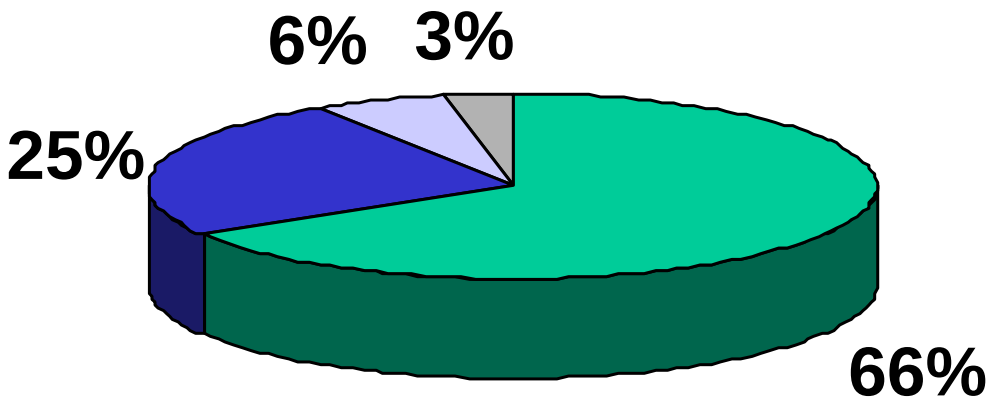
Canada's Fossil Fuel Energy Reserves



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Who we are

- Formed in 2000
- An association of Canadian and U.S. coal and coal-fired electricity producers, government agencies and research organizations
- Participants include:
    - Basin Electric Power Cooperative (North Dakota)
    - EPCOR Utilities Inc.
    - Electric Power Research Institute (EPRI)
    - Nova Scotia Power Inc.
    - Sherritt International
    - Saskatchewan Power Corporation
    - TransAlta Corporation
    - Natural Resources Canada
    - Alberta Energy Research Institute
    - Saskatchewan Industry and Resources

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Our Mandate

- The CCPC believes that coal, along with a diverse mix of fuels like hydro, natural gas, wind, solar and nuclear, will play an important role in meeting the energy needs of the future.
- The CCPC's mandate is to research, develop and facilitate the demonstration of commercially viable near-zero emission power technology.
- Our objective is to demonstrate that coal-fired electricity generation can effectively address environmental issues - **including CO_2** – and move us forward to a cleaner energy future.

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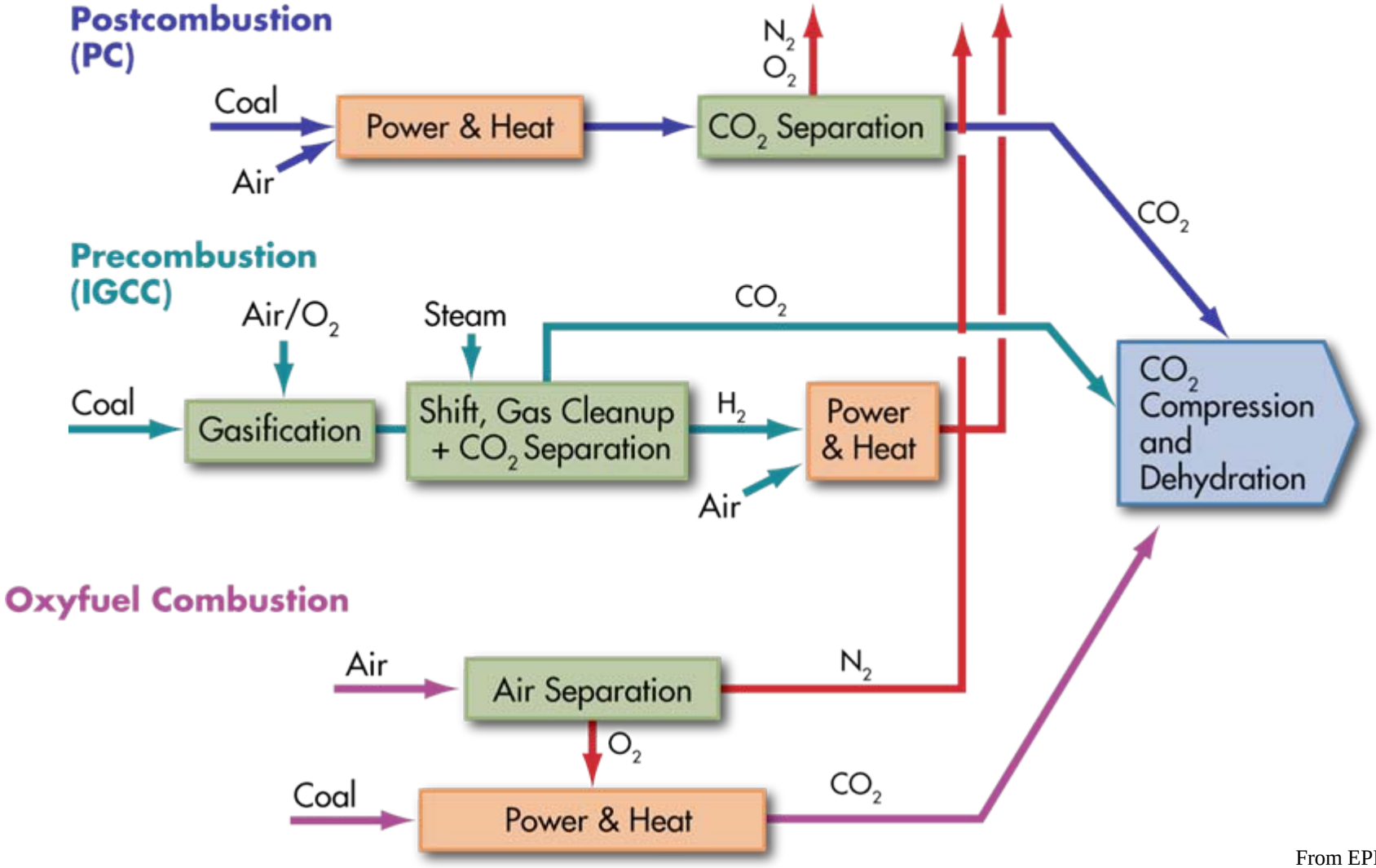
CO_2 Capture in Coal Power Systems



From EPRI

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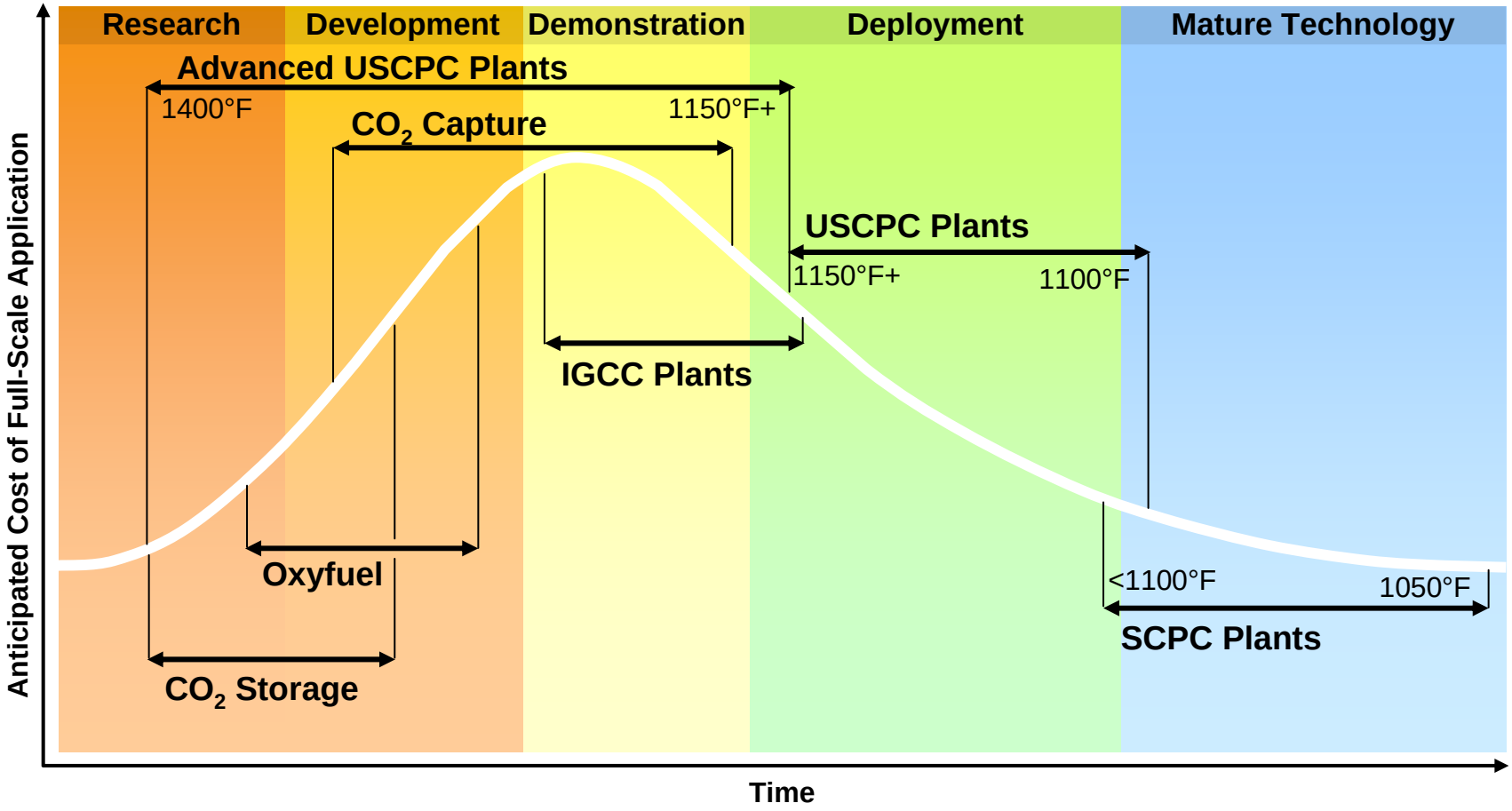
New Technology Deployment Curve for Coal



Not All Technologies at the Same Level of Maturity.

From EPRI

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General Context Statements

- These costs (except bituminous coals) are developed for the western Canada market; sub-bituminous is in AB and lignite is in SK
- These are feasibility level studies; costs are ± 35%, Q4 2007 dollars and for 2013 in-service date. The level of effort for these studies was $1.5 million for the IGCC cases and $1.5 million for the pulverized coal cases (amine scrubbing and oxyfuel)
- Recent experience has shown that costs given by suppliers will increase when one moves from a budget estimate to a contractual quote
- When comparing capital cost estimates, it is important to know what is included and, more importantly, what is not included!
  - Total Capital Requirement (TCR) is 30% to 40% higher than Total Plant Cost (TPC)
  - Other issues impacting reported costs are capital charge rates, capacity factors and plant size (larger plants have economies of scale)

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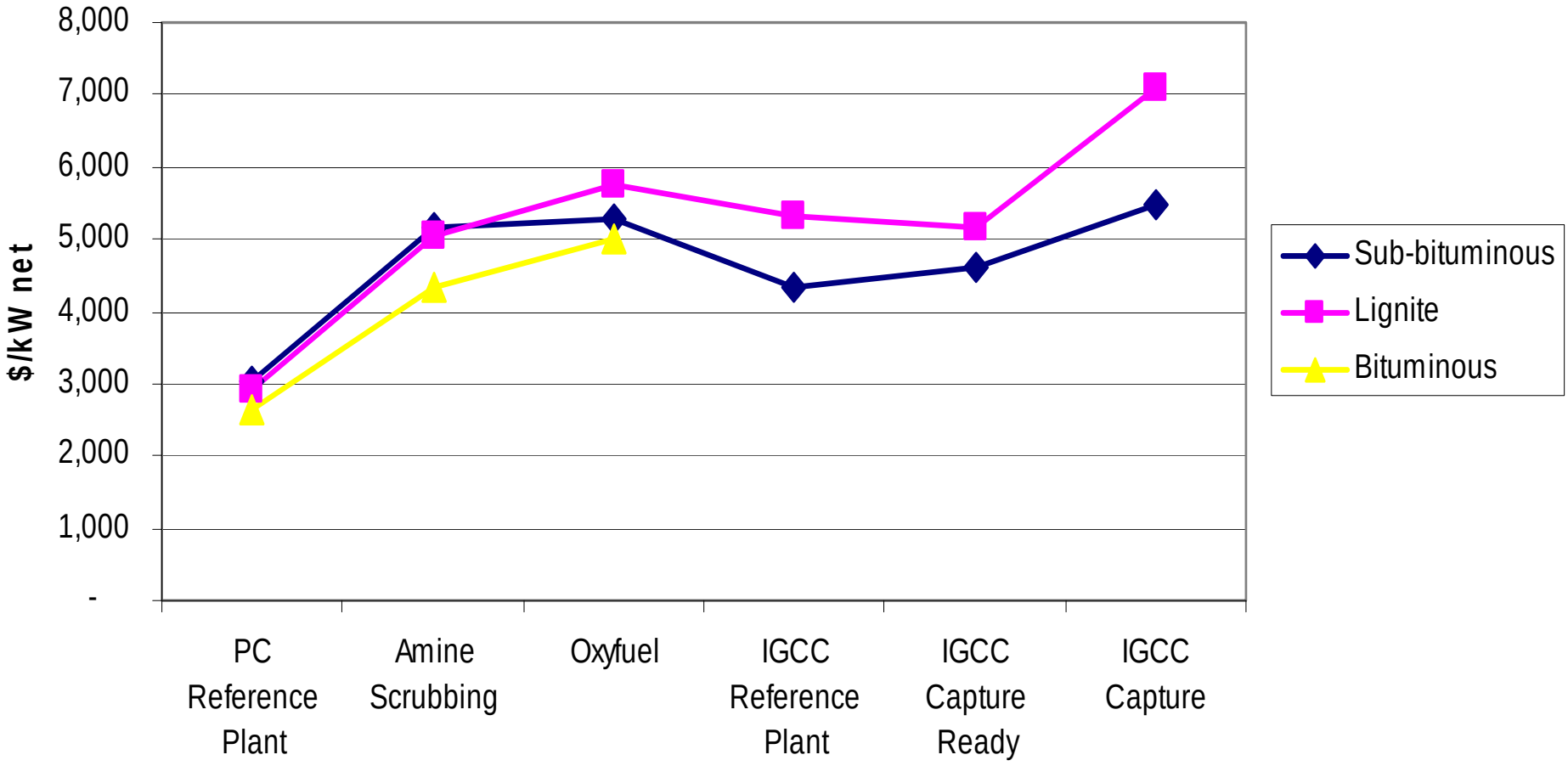
CCPC Phase II Unit Cost Comparisons (TPC)



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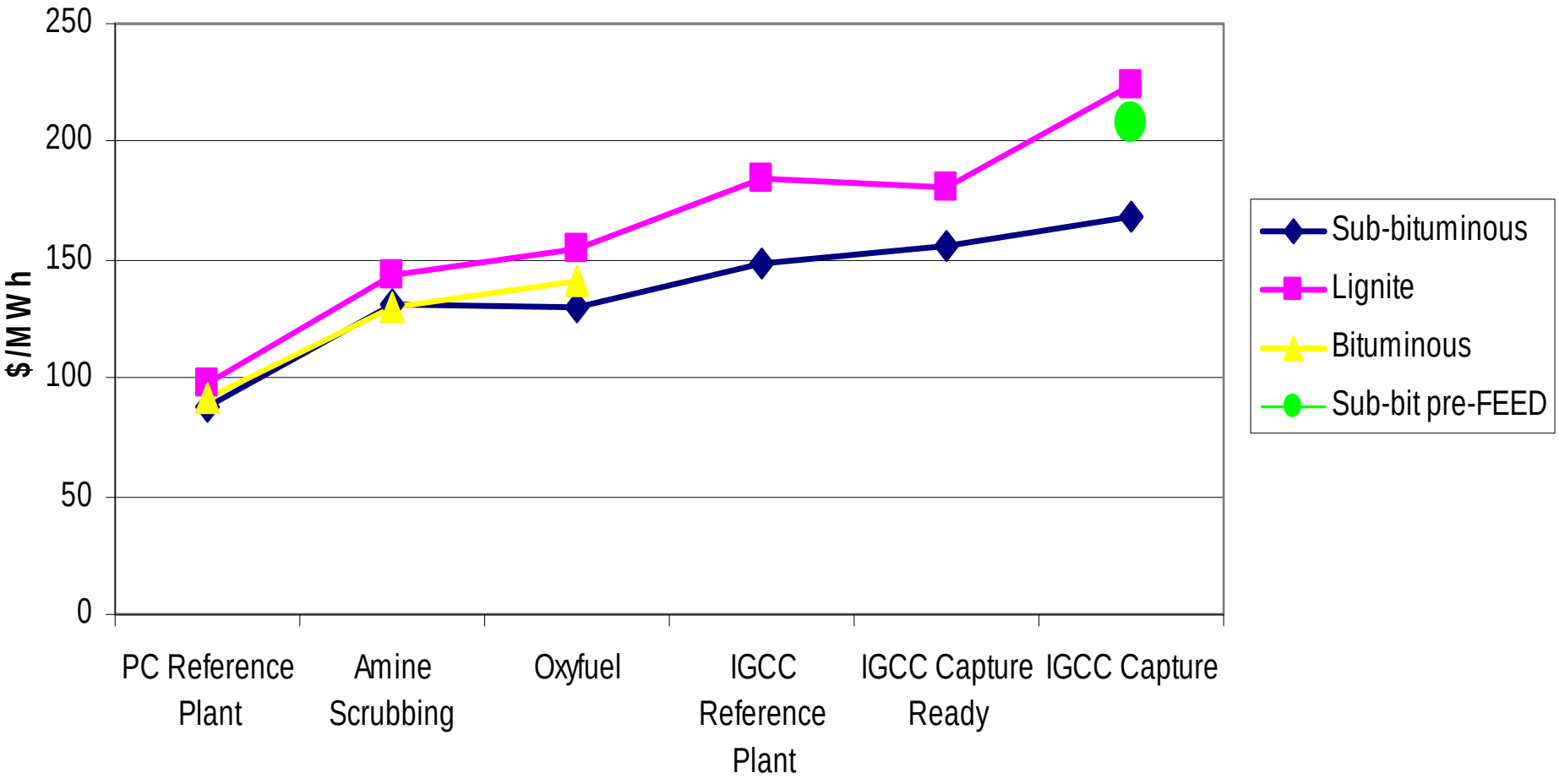
CCPC Phase II COE Comparisons



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Cost of Electricity (COE)

- As expected, PC plants without CO_2 capture have the lowest COE
- Cost increase to move to CO_2 Capture are higher for PC plants than for IGCC plants (again as expected)
- However, IGCC costs are higher across the board – this was unexpected
  - The COE for the sub-bit pre-FEED IGCC is higher than the COE for IGCC (sub-bit) case in this study because the cost estimates are for two different technologies. The technology in this study had the promise of much lower oxygen consumption, therefore lower cost. It was also a next generation technology but development work has ceased. Hence, the level of engineering to support cost estimating was not there yet.
  - IGCC costs are related to fuel quality
  - These costs are for low rank coals, therefore expected to be higher than numbers for eastern bituminous coals

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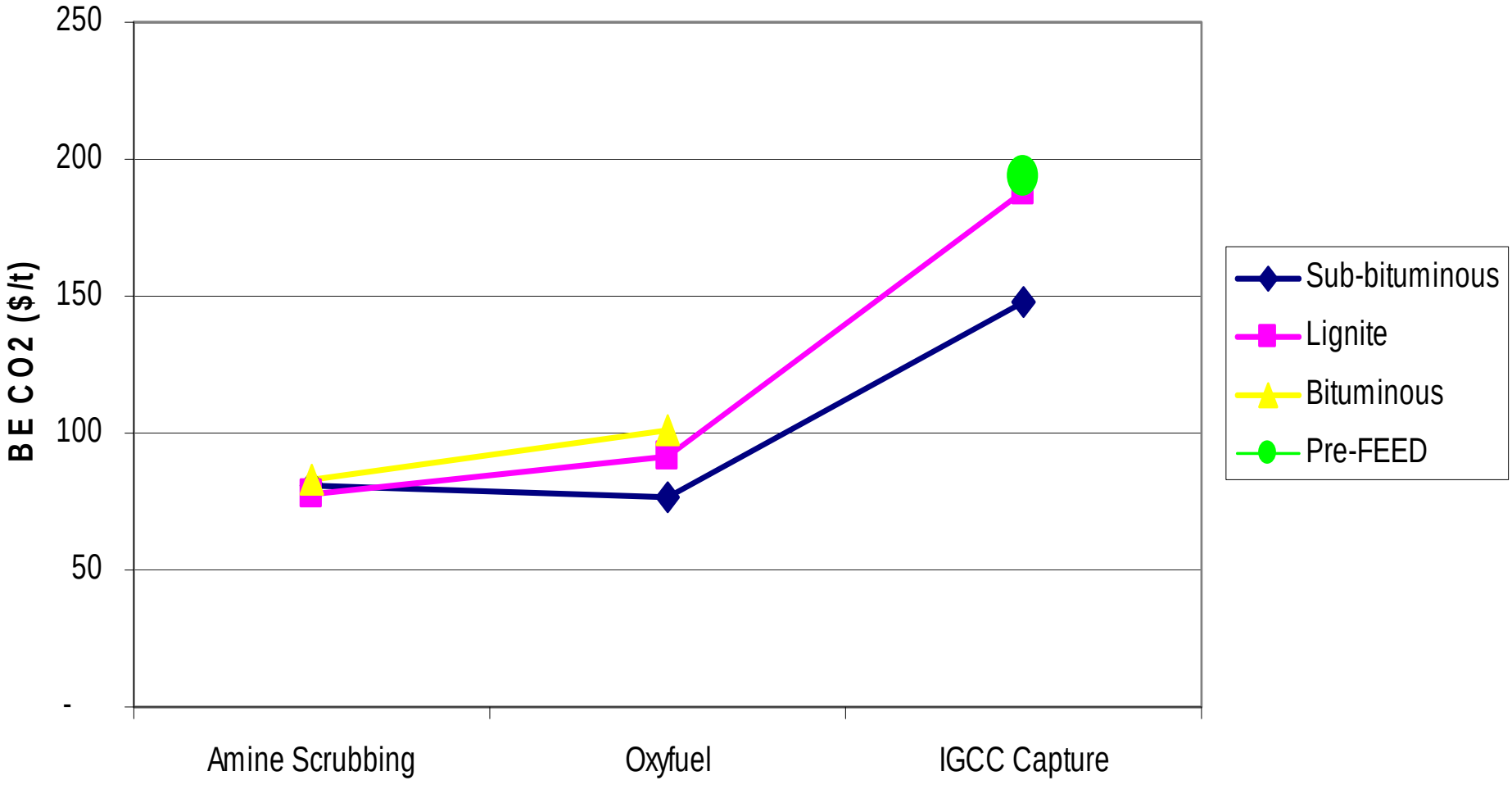
CCPC Phase II CO2 Cost Comparisons



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Break-even (BE) Costs for CO_2

- This is similar to avoided cost calculation, but not identical
- CO_2 costs must approach $75 per tonne before one would install CO_2 capture equipment

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Progress toward a cleaner energy future

- There are a number of projects currently in development that support our mandate, including;
  - SaskPower's integrated clean coal/carbon capture and sequestration demonstration project at the Boundary Dam Power Station in Estevan, Saskatchewan
  - EPCOR's Front End Engineering and Design (FEED) project to determine the feasibility of developing a commercial-scale coal-fueled gasification power plant.
  - TransAlta's large scale carbon dioxide capture and storage facility incorporating a chilled ammonia process.
  - Sherritt – Dodds-Roundhill gasification project to produce hydrogen
  - Basin Electric's pilot test to capture emissions of CO_2 from a conventional coal-based power plant that could be expanded to a demonstration project at the Antelope Valley Station and includes EOR.

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SaskPower

- Post combustion retrofit at Boundary Dam #3 (rebuild of a 35 year old 150 MW unit)
- Mine mouth plant using lignite coal
- In service by 2013
- Will capture 1 million tonnes per year of CO_2
- The capture technology will be selected at the end of 2009
- Capital cost of $1 billion for SaskPower, plus estimated $400 million by oil companies
- Project has received $240 million from Federal government

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SaskPower

- SK – Montana project
- Capture CO2 in SK and store in Montana
- MOU signed with business plan to be developed by August 2009

EPCOR (1)

- EPCOR is conducting a Front End Engineering Design (FEED) for an Integrated Gasification Combined Cycle (IGCC) plant at its Genesee site southwest of Edmonton
- Mine mouth plant using sub-bituminous coal
- In service by 2015
- Will capture 1.2 million tonnes per year of CO_2
- They have selected the Siemens gasification technology
- EPCOR has submitted a proposal to the $2 billion Alberta fund

EPCOR (2)

- EPCOR proposes to build a 150 MW_{net} coal-fired plant with post-combustion designed to capture CO_2 emissions on conventional power plants.
- Mine mouth plant using sub-bituminous coal
- In service by 2015
- Will capture 1 million tonnes per year of CO_2
- EPCOR has submitted a proposal to the $2 billion Alberta fund

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TransAlta

- TransAlta proposes to retrofit a “chilled ammonia” capture system on one of its generating units in the Wabamun area west of Edmonton
- Mine mouth plant using sub-bituminous coal
- In service by 2015
- Will capture 1 million tonnes per year of CO_2
- TransAlta has submitted a proposal to the $2 billion Alberta fund

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Basin Electric

- Basin Electric proposes to retrofit the Powerspan capture technology on one of its generating units at its Antelope Valley station in North Dakota
- Mine mouth plant using lignite coal
- In service by late 2012 or early 2013
- Will capture 1 million tonnes per year of CO_2
- Powerspan is operating their pilot plant in Ohio working toward reaching design conditions. Once these are met, the six month FEED study will begin.
- After completion of FEED and final decision, Powerspan believes the CO_2 capture process will be operational in 36 months.

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Nova Scotia

- Nova Scotia has received $5 million in federal funding to assess geological storage options for CO_2
- A slipstream CO_2 capture pilot plant will be required to capture enough CO_2 to conduct a storage test

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Sherritt International

- Sherritt proposes to build a gasification plant to produce hydrogen and other products southeast of Edmonton
- Mine mouth plant using sub-bituminous coal
- In service by 2015
- Will capture 1 million tonnes per year of CO_2
- Capital cost of $1.5 billion
- Sherritt has submitted a proposal to the $2 billion Alberta fund

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ATCO Power

- ATCO Power proposes a fully integrated carbon capture, transportation and storage project which has then technical capability to utilize different kinds of fuels to produce clean electricity
- Mine mouth plant using sub-bituminous coal
- In service by 2015
- Will capture 1 million tonnes per year of CO2
- ATCO Power has submitted a proposal to the $2 billion Alberta fund

Concluding Comments (1 of 2)

- There is no one “silver bullet” for clean coal technologies. The coal used and site specifics all impact the technology choice for any given project.
- Supercritical pulverized coal (SCPC) with amine scrubbing cost estimates have the smallest error band.
- Oxyfuel combustion cost estimates have the largest error band. More experimental results are required to enable a significant comparison with post combustion capture
- There are considerable development activities aimed at improved solvents for post combustion capture (e.g. chilled ammonia). Since both post combustion capture and oxyfuel combustion are both subjects of considerable development activity the economic comparison will doubtless continue to exhibit considerable uncertainty for many years to come.

Concluding Comments (2 of 2)

- The gasification technology used in this study for the sub-bituminous IGCC is conjectural and is not being developed. Thus, no significant conclusion can be made from this case regarding the use of IGCC for the sub-bituminous coal. There are other gasification technologies commercially available for both bituminous and sub-bituminous coals.
- At this stage in its development the gasification technology used for the IGCC lignite case does not appear likely to be competitive with SCPC post combustion capture. Additional improvements in gasifier size and in less energy intensive and expensive coal drying are needed.

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CCPC Phase III Plans

- Budget ~ $7 million
- Assessing Technology Improvements
  - Coal cleaning
  - Retrofit options
- Evaluating New or Emerging Technologies
  - Advanced gasification technologies
  - Novel solvent technologies

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Canada's Recent GHG Activities

- Canadian government wants to be in step with U.S. approach
- Intensity based targets are gone – now looking at cap & trade system
- Regulations for the electricity sector by 2012 to 2015
- Target is a 20% reduction from 2006 levels by 2020
- On June 12, 2009 the federal government issued an offset protocol for comment

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Thank you!