CCPC Phase I Executive Summary

Summary Report on the Phase I Feasibility Studies
conducted by the
Canadian Clean Power Coalition

May 2004

Acknowledgements

The Canadian Clean Power Coalition wishes to acknowledge the financial contributions made by Natural Resources Canada, Alberta Energy Research Institute and Saskatchewan Industry and Resources to the Phase I studies.

Introduction

The Canadian Clean Power Coalition (CCPC) represents electricity generators and coal suppliers of over 90% of Canada's coal-fired power generation. The participants of the CCPC have been concerned about the level of greenhouse gas emissions resulting from the operation of their plants. As the challenge of potential climate change impacts became clear, coal and coal fired electricity producers began to evaluate strategies for net emission reduction.

A number of the participants held a series of discussions throughout 2000 and 2001 to identify a joint course of action to ensure that coal and coal fired electricity would continue to have a place in Canada's energy supply future, alongside both other conventional fuels and non-conventional renewable supplies. These discussions expanded and culminated in the formation of the CCPC, an association and formal agreement.

The CCPC Participation Agreement was signed in mid 2001 among ATCO Power Canada Ltd., EPCOR Utilities Inc., Luscar Limited, Nova Scotia Power Inc., Ontario Power Generation Inc., Saskatchewan Power Corporation, and TransAlta Utilities Corporation, with the concept of a private-public partnership to develop technology to meet the stated goals. Phase I of the project commenced in September 2001. Subsequently, the governments of Alberta, Saskatchewan, and Canada subscribed to support the CCPC. In addition, the participation of EPRI (Electric Power Research Institute of Palo Alto, CA) and IEA (International Energy Agency) was solicited and secured.

The CCPC established a goal to develop projects to demonstrate technology at a commercial utility scale for retrofit to existing plants, or for use in new coal fired power plants, that would allow all emissions, including CO_2, to be controlled to meet all foreseeable new regulatory requirements. The emissions target was to allow a coal-fired plant to be as clean as a modern natural gas fired gas turbine plant. The goal was to do this while maintaining overall efficiency at or above current levels, maintaining costs competitive with other generation technologies and enabling the CO_2 to be captured.

Phase I of the project comprised the Conceptual Engineering and Feasibility Studies, undertaken from mid 2001 to early 2004. The objective of the conceptual engineering and feasibility studies was to determine the most appropriate technologies for demonstration. Implementation plans, preliminary designs and cost estimates were developed for those technologies, recognizing the geographical variability of coal: western lignite and sub-bituminous coals, and eastern bituminous coals.

The fundamental principle underlying the goals of the CCPC was to identify a process that would produce electricity from coal in some fashion and that would also provide a relatively pure stream of CO_2 that could be captured, further processed as necessary, and subsequently used or stored.

Work Packages

Table 1 summarizes the work packages that were used to complete the Phase I effort. The CCPC requested potential contractors to submit proposals on the various work packages. These proposals were evaluated by the CCPC and contracts were awarded to carry out the work.

Table 1: WORK PACKAGE DESCRIPTIONS

Number	Description	Contractor	Completion Date
WP1	Pre-screening study	SFA Pacific	December 2001
WP2	Amine scrubbing and oxyfuel evaluation	Fluor Canada	July 2003
WP3	Gasification technologies evaluation	Fluor Canada	July 2003
WP4	Retrofit emissions control except CO_2	Neill & Gunter	December 2002
WP5a	CO_2 utilization and storage options in western Canada	SNC Lavalin	August 2003
WP5b	CO2 sequestration opportunities in Nova Scotia coal seams	Geological Survey of Canada	March 2004
WP6	Phase I final report	CRI Consulting	February 2004

Results

The main results of the feasibility studies are summarized in Table 2. Much detailed analysis has been conducted in order to develop these data.

Table 2: TECHNICAL AND ECONOMIC COMPARISON OF CO_2 ABATEMENT TECHNOLOGIES

Fuel		Bituminous	Sub-bituminous	Lignite	Lignite	Lignite
Technology		Gasification	Gasification	Gasification	Amine	Oxyfuel
COE (90%CF)	$/MWhr	**107**	**97**	**131**	**116**	**152**
Cost	millions $	1,330	1,490	1,590	1,370	2,310
CO_2 Emitted	Tonne/MWhr	0.116	0.111	0.182	0.060	0.145
CO_2 Captured	%	86	89	86	95	90
CO_2 Avoided	Tonne/MWhr	0.65	0.74	0.71	0.82	0.74
Cost CO_2 Avoided*	$/tonne	47	52	88	57	112
Capacity	MW gross	594	629	555	454	629
Economic Capacity	MW net	445	437	361	311	373
Net Heat Rate	KJ/kWhr	11,410	13,810	13,240	12,530	14,880
Unit Cost	$/kW net	3,000	3,400	4,400	4,400	6,200

*Note to Table 2. Cost of CO_2 avoided is defined as the increase in cost of electricity in $/MWhr (evaluated case minus selected base case) divided by the decrease in tonnes of CO_2 emitted per $MWhr_{net}$ (selected base case minus evaluated case).

Conclusions and Next Steps

The learnings from Phase I were:

- This was the first study to assess all three available technologies for CO_2 capture.
- Emissions from coal can be reduced to levels equivalent to natural gas power generation.
- The cost of electricity (COE) with CO_2 capture was 50% higher than current rates, but lower than prior studies.
- Gasification ranked first and amine scrubbing next, even with non-optimized processes.
- The Western Canada Sedimentary Basin has vast storage capacity for CO_2.

The set of conclusions that the CCPC has adopted as a result of the work of Phase I are itemized below.

- Gasification is still not mature technology for power plant applications. Significant work remains to be undertaken to make this a competitive technology, although it is probably the most likely platform for the future if limits on CO_2 emissions are applied. Similarly, oxyfuel is not yet a mature technology. Amine scrubbing would appear to be relatively mature, one of the lowest cost alternatives, and ready to apply to power plant applications for capturing CO_2. Initiatives are required:
    - To explore and develop gasification for low ranked coals to make it more reliable and cost effective, and
    - To answer scale up questions regarding amine scrubbing.
- A demonstration project will require a substantial effort from industry and government if it is to proceed and to succeed. Government participation will be required to ensure that such a project can be financed, to ensure that the necessary permitting is provided, and to provide significant funding.

Detailed studies of IGCC plants will be conducted in Phase II prior to making commitments for demonstration projects. The studies should include considerations of polygeneration of power, hydrogen, and steam at Saskatchewan (lignite-fueled) and Alberta (sub-bituminous-fueled) sites, where business cases might be built based on partnerships with nearby oil refineries and other industries. Those refineries could supply low-cost petroleum coke for fuel blending and potentially could utilize the polygenerated hydrogen and steam. An IGCC plant designed for co-production of hydrogen is inherently ready for the addition of CO_2 capture equipment. Phase II will optimize the technologies to lower costs further and develop the right business case for the demonstration plant. It appears that a CO_2 capture project is most likely to be a greenfield project because CO_2 capture technologies are not sufficiently attractive on a retrofit project.

In summary, power generators using coal-fired generation see an array of new emissions regulations approaching in the next few years. There is an urgent need to understand and evaluate the ability for advanced combustion and emissions control technologies to mitigate the environmental impact of coal-derived power generation before committing the significant capital investment necessary to construct the necessary plant. The Canadian Clean Power Coalition is one such response. The participants anticipate that the results of the studies will make a significant contribution to the understanding of the control of air emissions, including CO_2, from the generation of power from coal.