Backgrounder
July 24, 2001

Best Available Pollution Control Technologies for Coal Combustion

The Alberta government recently revised its air pollution emission standards for coal-fired power plants. As in most jurisdictions, these standards reflect an explicit or implicit understanding between government and industry about the type of control technology that any new facilities will use to meet the standards.

The revised Alberta standards are more stringent than in the past. However, even with these new standards, any new facility will result in an absolute increase in air emissions[1], many of which are harmful to human health or the environment. In a very real way, such pollution represents a direct transfer of costs from the shareholders of a corporation to society as a whole. While society does benefit from the ongoing provision of reliable, fairly-priced electricity it is only prudent to ensure that the control technologies being proposed are the best available. This is particularly important given that (a) the industry is poised to massively increase coal-fired electricity generation in Alberta, and (b) substantial levels of pollutants are already being emitted into Alberta's atmosphere by coal plants, the petroleum and other industries, and the transportation sector.

The Pembina Institute previously demonstrated that Alberta's new standards are more lax than other jurisdictions[2]. The Institute recently assessed the range of technology options available for coal-fired plants[3], concluding that although Alberta's new standards are lower, they are already outdated and not nearly as stringent as standards in other jurisdictions. It is clearly possible to get much lower emissions using current, commercially available technology but, unlike the U.S., Alberta does not require the use of the best available control technologies (BACT).

The following table shows the range of combustion control technologies available and their relative environmental merits.

Base Processes Environmental Performance	Subcritical Pulverized Coal Combustion (PCC)	Super-critical PCC	Atmospheric Fluidized Bed Combustion (AFBC)	Pressurized Fluidized Bed Combustion (PFBC)	Integrated Gasification Combined Cycle (IGCC)	Natural Gas Combined Cycle (NGCC)	Natural Gas Combined Heat and Power
Efficiency	33%	38-43%	36%	42%	45%	52%	~60%
CO_2 (kg/MWh)	1000	870-770	920	790	735	400	350
Sulphur Removal Standard	Alberta: 180 ng/J U.S.: 260 ng/J, 70-90% SO_2 removal and BACT						
SO_2 (ng/J) - no FGD	229	221	30	14	~zero	~zero	~zero
SO_2 (ng/J) - with FGD	< 70	< 60	Not Required	Not Required	Not Required	Not Required	Not Required
NO_x Removal Standard	Alberta: 125 ng/J U.S.: 65 ng/J						
NO_x (ng/J) - no SCR and w/ LNB	86-125	86-125	43	< 86	31-56	18	18
NO_x (ng/J) - with SCR and LNB	43-62	43-62	SCR not required	SCR probably not required	SCR probably not required	SCR probably not required	SCR probably not required
Particulate Matter Standard	Alberta: 13 ng/J U.S.: 13 ng/J						
PM (ng/J) - no	46	42	~42	Better than PCC	~zero	~zero	~zero

ESP/Baghouse				but not as good as IGCC			
ESP/Baghouse	Requires baghouse or ESP. Baghouse more efficient and less prone to upsets.	Requires baghouse or ESP. Baghouse more efficient and less prone to upsets.	Requires baghouse or ESP. Baghouse more efficient and less prone to upsets.	Requires baghouse or ESP. Baghouse more efficient and less prone to upsets.	Not required	Not required	Not required
Mercury	Depends on coal source	Depends on coal source	Depends on coal source	Better than PCC but not as good as IGCC	Little or no air borne mercury	Little or no air borne mercury	Little or no air borne mercury

* A more detailed table in the Appendix to this backgrounder explains the derivation of all figures in this table.

kg/MWh = kilograms per megawatt hour
ng/J = nanograms/joule of heat input.
BACT - best available control technology
CO_2 - carbon dioxide
ESP - electrostatic precipitator
FGD - flue gas desulphurization
LNB - low NO_x burners
NO_x - nitrogen oxides
PM - particulate matter
SCR - selective catalytic reduction
SO_2 - sulphur dioxide

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[1] The pollutants of most concern are nitrogen oxides, sulphur dioxide, greenhouse gases (primarily carbon dioxide and methane), particulate matter and heavy metals (such as mercury).
[2] "New standards position Alberta as a pollution haven for coal-fired plants," news release, June 18, 2001.
[3] See Appendix to this news release: A Comparison of Combustion Technologies for Electricity Generation; or download the 12-page Appendix as a pdf file (95 KB)

It is important to note that none of the technologies listed in the table represents "clean" or "zero-emission" coal. Under the most optimistic scenario the so-called "zero-emission" coal technologies are probably 15 or 20 years away from being economically viable. Even if technically feasible, the costs of such technologies could be prohibitive.

For electricity generation that requires the burning of fossil fuels, high-efficiency natural gas combined cycle (NGCC) generation clearly has the lowest environmental and health costs. No coal-fired technologies, by themselves, can reduce emissions to the level of NGCC generation. The technology that comes closest to meeting emission levels achieved with NGCC is one that first turns the coal into a gas, then burns the gas to generate electricity, using integrated gasification combined cycle (IGCC) technology. Coal gasification is a well-tried process. Several plants in the U.S. and Europe already use gasified coal to generate electricity. While early IGCC plants relied on some government assistance, there is growing interest in this technology. The Pembina Institute estimates that the overall levelized cost of electricity using

IGCC is competitive with using natural gas and is within 10 to 20% of the most economic generation options available today. As well as emitting the least pollution of any current coal-fired technology, it is somewhat easier to capture carbon dioxide from an IGCC plant than from one using other processes and thus easier to reduce the greenhouse gas impact.

An important consideration in reducing emissions is to burn the coal as efficiently as possible. As the table shows, a conventional coal-fired plant is about 33% efficient, while a supercritical plant can have an efficiency of 38-43%. The IGCC process can achieve efficiencies as high as 45%. The supercritical plant planned by EPCOR for Genesee 3 will operate at 38.7% efficiency and be slightly more efficient than a conventional plant. TransAlta expects its planned Keephills facility to operate at 37.9% efficiency. In addition to cleaner-burning technologies, a number of "add-on" pollution control devices can further cut emissions from conventional coal-generation processes. Sulphur dioxide emissions can be greatly reduced by using various flue gas desulphurization (FGD) processes, while nitrogen oxides can be cut with selective catalytic reduction (SCR). A baghouse or electrostatic precipitator (ESP) reduces emissions of particulate matter and also captures some mercury and other heavy metals.

A new conventional power plant being developed by Two Elk Power Generation in Wyoming, for example, will use a lime spray dryer FGD process to remove sulphur, SCR to lower nitrogen oxides and a baghouse. Sulphur dioxide and nitrogen oxide emissions from the Two Elk facility will be less than half what is allowed under new Alberta standards and particulate matter emissions will be about two-thirds of those permitted in Alberta. It should be noted that a plant's size and method of operation, as well as the equipment used, also affect the emissions. Like the Wyoming plant, EPCOR plans to use a lime spray dryer for the desulphurization process at its proposed Genesee 3 plant, but the plant's emissions of sulphur dioxide are projected to be about twice those from the Wyoming facility.

It is possible to attain the Alberta standards by only using a low-efficiency subcritical boiler, with low NO_x burners, moderately efficient flue gas desulphurization and a baghouse (or ESP) to reduce particulate matter. Yet, despite the significant environmental and human health improvements, there is no requirement to use selective catalytic reduction to cut nitrogen emissions or to optimize the use of flue gas desulphurization technology in Alberta. This province clearly did not adopt the Best Available Control Technology approach in designing the latest environmental standards, and the companies proposing to construct new coal facilities are not utilizing these cleaner, commercially viable coal technologies.

Meanwhile, a range of proven, cost-effective technologies is available to meet Alberta's growing demand for electricity-namely energy efficiency, renewable energy and high efficiency natural gas. As discussed in the Pembina Institute's report "A Smart Electricity Policy for Alberta," development of a modest portion of Alberta's unused potential for energy efficiency and renewables could displace the need to develop any new coal generation.[4]

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[4]"A Smart Electricity Policy for Alberta," Pembina Institute, February 2001 (see www.pembina.org).