IN BRIEF

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Clean Coal?

INTRODUCTION

Coal is often written off as the fuel of the 19th century. Although it is an abundant and cheap source of energy and the fuel of choice in many rapidly industrializing countries such as China and India, it has been falling out of favour in North America and most of Europe due to environmental considerations. Stricter environmental regulations have consistently encouraged the shift from coal to natural gas for power generation and other industrial processes.

In recent years, the substantial increase in the price of natural gas and volatility in global energy markets have renewed interest in coal. Governments and industry, notably in the United States, are investing in the development of so-called "clean coal" technologies. The U.S. government is spearheading FutureGen, a US$1-billion research initiative to design, build and operate a nearly emissions-free, coal-fired electricity and hydrogen production plant by 2012. For its part, the Government of Canada has financed the development of a Canadian Clean Coal Technology Roadmap and is considering tangible investments in clean coal technologies through the Partnership Fund announced in Budget 2005. This paper explores the factors behind the renewed interest in coal, describes some of the key clean coal technology (CCT) and examines the outlook for the deployment of CCT.

WHY COAL? WHY NOW?

The International Energy Agency (IEA) anticipates that worldwide demand for coal will grow at a rate of 1.4% per annum in the coming decades. Coal's share of worldwide primary energy demand will thus continue to hover around 25%.(1) It is expected that about two-thirds of the increase in demand for coal will come from China and India alone. These two countries have large coal resources which they are using to generate electricity. China, in particular, is building coal-fired power plants at an astounding rate – it is expected that hundreds of them will be built in the coming decades.(2) The IEA estimates that China and India will account for nearly half of total world coal demand by 2030, up from 40% in 2003. The environmental consequences of this reliance on coal could be severe unless new technologies are successfully deployed to minimize emissions. This situation presents potentially valuable export opportunities for those countries with market-leading CCT.

The United States is a front-runner in clean coal research and development. The U.S. interest in coal stems in part from concerns about energy security in the face of increasing energy demand. North America is endowed with enormous coal reserves. Coal therefore presents few geopolitical risks. The National Energy Board calculates that coal accounts for about 90% of the United States' and Canada's combined hydrocarbon reserves.(3) At current production rates, it is estimated that coal reserves in these two countries could last about 235 years. This compares very favourably to reserves-to-production ratios of 9.6 years for natural gas and 11.8 for oil.(4)

The rapid run-up in the price of natural gas is further stimulating interest in coal for power generation, both in the United States and in provinces such as Alberta and Saskatchewan. The price gap between gas and coal has widened considerably in recent years. Natural gas is now nearly five times more expensive than coal per unit of energy, making coal increasingly attractive from a price perspective.(5)

While coal is relatively inexpensive, it is also the dirtiest fossil fuel. The combustion of coal releases significant amounts of carbon dioxide (CO_2), sulphur oxides (SO_X), nitrogen oxides (NO_X), particulate matter (PM), and other pollutants and greenhouse gases. While most environmentalists strongly decry

the use of coal, the sheer vastness of the resource nevertheless makes it hard to dismiss out of hand. The relevant question is whether it is possible to successfully develop and deploy technology to effectively harness the energy content of coal while minimizing harmful emissions.

CLEAN COAL TECHNOLOGY

Clean coal technology is a catch-all term to describe the various technologies that can be deployed to *reduce* the environmental impacts associated with the use of coal. There are no technologies in existence today that can *eliminate* emissions from coal.(6)

The introduction of environmental regulations in industrialized countries in the 1970s precipitated the widespread adoption of technologies to reduce emissions of pollutants such as SO_2 and NO_X from coal-fired power plants. The use of advanced burners, filters and scrubbers to control emissions is now commonplace, and such technologies continue to be improved upon. Today, renewed concerns about air pollution and climate change are precipitating further advances in technologies to improve efficiencies and reduce emissions from coal-fired power plants.

Such advanced technologies are now being introduced in Canada. In March 2005, EPCOR unveiled a 450-megawatt supercritical coal-fired power plant, the first of its kind in Canada. The unit is located outside of Edmonton. The higher temperatures and steam pressures in supercritical boilers translate into a more efficient and less emissions-intensive process for generating electricity from coal combustion. Such boilers can also be retrofitted to existing coal-fired units.

Coal gasification is, in the view of many, even more promising, and is increasingly touted as a "bridge technology" to a cleaner energy future. By making coal, steam and air or pure oxygen react at high temperature and pressure, a synthesis gas (syngas) can be created. This syngas can be stripped of most pollutants and then, through what is know as a combined cycle process, it is combusted in a gas turbine to produce electricity. The waste heat is used to produce additional electricity in a steam turbine, thus improving the efficiency of the process. A plant incorporating a coal gasifier and a combined cycle unit is referred to as an integrated gasification combined cycle (IGCC) plant. Synthesis gas, which is hydrogen-rich, can also be processed for use in fuel cell applications or to create chemical feedstocks. A plant capable of generating electricity, hydrogen and other gases is referred to as a "polygeneration" facility.

PROSPECTS FOR CLEAN COAL TECHNOLOGY

While some technologies such as supercritical boilers have a proven track record, much research and development is needed before emerging technologies such as coal gasification and polygeneration can become commercially viable. The widespread deployment of these technologies in the near term is unlikely. Nonetheless, high natural gas prices in industrialized countries and surging energy demand in rapidly industrializing countries provide an important impetus for moving forward with the development of CCT.

The term CCT will, however, remain somewhat of a misnomer until the carbon dioxide emissions associated with the use of coal can be successfully captured and permanently sequestered by pumping them underground. Only then could coal realistically re-emerge as a fuel of choice in countries that have pledged to reduce their greenhouse gas emissions.

Considerable emphasis is now being put on carbon capture and storage (CCS) as a climate change mitigation tool. Pilot projects such as one in Weyburn, Saskatchewan, have shown that CCS is technically feasible and that it can also, under the right conditions, be cost-effective. What remains to be seen is whether CCS is practicable on a scale that could support a climate-friendly coal renewal.

Saskatchewan and Alberta, with their massive coal deposits, potential CO_2 storage sites and burgeoning industrial sector, are prime candidates for the deployment of CCT (including CCS). *Canada's Clean Coal Technology Roadmap* illustrates how rising natural gas prices are causing oil sands operators in particular to explore alternative fuel sources. Natural gas is currently used in the oil sands industry to generate electricity, to generate steam for bitumen extraction and to generate hydrogen for heavy oil upgrading. In the future, the electricity, steam and hydrogen needs of the industry could conceivably be met through the deployment of CCT using indigenous coal resources.(7) CO_2 emissions could be captured and used to maintain pressure in aging oil and gas reservoirs, thus improving their productivity while removing carbon dioxide from the atmosphere.

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(1) International Energy Agency, *World Energy Outlook*, 2005.

(2) U.K. Department of Trade and Industry, Cleaner Fossil Fuels Programme, *IEA-China Power Plant Project*, http://www.iea.org/textbase/work/2004/coal/KeithBurnard.pdf.

(3) National Energy Board, *Canada's Energy Future: Scenarios for Supply and Demand to 2025*, 2003. The calculations exclude oil sands and oil shale.

(4) British Petroleum, *BP Statistical Review of World Energy*, 2005. The oil reserves-to-production ratio calculated by BP includes only the portion of the oil sands that is under active development.

(5) Energy Information Administration, *Electric Power Monthly*, November 2005. Figures cited are for the average price paid for coal and natural gas by U.S. electricity generators.

(6) As with other fuels, it is also important to consider the full life-cycle of coal. Coal mining, for example, is typically far from environmentally benign.

(7) Natural Resources Canada, CANMET Energy Technology Centre, *Canada's Clean Coal Technology Roadmap*, 2005, http://www.cleancoaltrm.gc.ca. The challenge in Canada is to develop clean coal technology that is compatible with the use of indigenous coal, namely, low-rank coals (sub-bituminous and lignite).