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IN BRIEF

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The Economics of Carbon Capture and Storage

INTRODUCTION

Carbon capture and storage (CCS), sometimes referred to as carbon capture and sequestration, is emerging as a promising potential greenhouse gas mitigation option in certain circumstances. Studies are under way to determine its potential in terms of both cost and effectiveness. Put simply, CCS entails the separation of carbon dioxide (CO_2) from flue gases or off-gases originating from large stationary sources such as coal-fired power plants or hydrogen production plants. The CO_2 is then transported, typically by pipeline, to a storage site where it is injected into a suitable geological formation such as a deep saline aquifer for long-term isolation.(1)

Various projections and scenarios by organizations such as the International Energy Agency (IEA) and the U.S. Department of Energy suggest that fossil fuels will continue to be the world's dominant source of energy in the coming decades.(2) CCS technology, if it proves economically practicable on a large enough scale, could play a useful role in ensuring that the world's continued reliance on fossil fuels does not further contribute to the accumulation of CO_2 in the atmosphere.

The "decarbonization" of fossil fuels is an appealing scenario for many Canadian companies involved in energy-intensive industries such as the oil sands, and indeed for Canada as a whole given its status as both a large producer and consumer of fossil fuels, and as a signatory to the Kyoto Protocol.

Of course, from a purely financial perspective, capturing and storing carbon is worth the expense only if avoided emissions have value. It follows that CCS systems are not likely to be deployed on a large scale in the absence of explicit policy directives that put limits, and hence a price tag, on greenhouse gas emissions.

COST OUTLOOK

As yet, few fully integrated industrial carbon capture and storage projects are currently in operation; but interest is growing, both in Canada and abroad. In the fall of 2005, the Intergovernmental Panel on Climate Change (IPCC) released an exhaustive special report on CCS which, amongst other things, modelled the cost and economic potential of CCS, based in part on early commercial experiences with all the major components of CCS.(3) The report shows that approximately 90% of total CCS costs relate to the capture of CO_2, a process that requires additional energy: about 10-40% more in the case of new coal- or gas-fired power plants that incorporate carbon capture technology, and considerably more in the case of older power plants that are retrofitted to capture CO_2. The costs of transport and storage are less onerous in comparison, and can be minimized by achieving economies of scale and/or by siting emitting plants close to potential storage sites such as oil and gas reservoirs.

Overall, it is estimated that capturing, transporting and storing the CO_2 from a new gas- or coal-fired power plant would increase the cost of electricity generated by that plant by between 37% and 91%. This translates into a CO_2 mitigation cost of US$30-91/tonne, making CCS a comparatively high-cost method for mitigating carbon emissions, at least for the time being. The IPCC report warns that because there is "relatively little commercial experience with configuring all of these components into fully integrated CCS systems at the kinds of scales which would likely characterize their future deployment," these cost estimates are highly uncertain.

The report nevertheless suggests that carbon capture and storage can be "economically feasible under specific conditions." This may be the case, for example, if CO_2 is captured from low-cost sources, such as gas processing or ammonia plants, and used towards a productive end, such as enhancing oil recovery at a nearby oil field.

A CASE STUDY IN ENHANCED OIL RECOVERY – THE WEYBURN OIL FIELD

Carbon dioxide can have economic value in certain applications. Notably, it can be used to enhance oil recovery in mature reservoirs.(4) Injecting CO_2 under high pressure in oil reservoirs can help push some of the oil that has been left behind toward producing wells, thereby increasing recovery rates while at the same time sequestering carbon. Enhanced oil recovery (EOR) is appealing when oil prices are high, as they have been in recent years. Such a price environment in turn increases the value of CO_2 and can therefore considerably improve the economics of CCS.

In October 2000, EnCana Corporation began injecting carbon dioxide in the Weyburn oil field in southeast Saskatchewan to enhance recovery beyond what could be achieved with more conventional water flooding.(5) The CO_2, in this case a by-product of a coal gasification plant in North Dakota, is transported to the injection site via a specially built 320-km pipeline. Approximately 20 million tonnes of CO_2 is likely to be injected into the reservoir over the project's life, making this Canada's largest industrial greenhouse gas sequestration project to date. EnCana anticipates that CO_2 injection will improve the oil recovery rate in the project area by about 50%, resulting in incremental production of 130 million barrels over the next 30 years. Field tests conducted as part of the ongoing IEA GHG Weyburn CO_2 Monitoring and Storage Project, funded in part by the Government of Canada, have shown that the Weyburn oil field is suited to long-term geological storage of CO_2.

CONCLUSION

Initial research suggests that Canada has considerable geological storage potential, including in mature oil fields throughout the Western Canada Sedimentary Basin and in the deep coal beds underlying much of Alberta and parts of British Columbia that harbour large volumes of trapped methane gas.(6) Carbon capture and storage could play a part in reconciling the seemingly dissonant goals of promoting the development of Canada's vast hydrocarbon resources and meeting Canada's carbon emission reduction commitment under the Kyoto Protocol.

The costs of CCS systems, currently an important obstacle to their widespread deployment, are expected to fall over time as the technology improves and as more experience is gained in commercial applications around the world. Whether CCS transcends its niche applications and emerges as an economically viable tool for mitigating carbon emissions on a large scale depends to a significant extent on the stringency of the limits that may be placed on greenhouse gas emissions in the coming years.

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(1) For a more technical exposition of carbon capture and storage, see Tim Williams, *Carbon Capture and Storage: Technology, Capacity and Limitations*, PRB05-89E, Parliamentary Information and Research Service, Library of Parliament, Ottawa, 10 March 2006.

(2) See, for example, International Energy Agency, *World Energy Outlook 2005*, Paris, 2005.

(3) Intergovernmental Panel on Climate Change, *IPCC Special Report on Carbon Dioxide Capture and Storage*, 2005.

(4) Carbon dioxide can also be used to enhance gas recovery, including methane from coal (coal bed methane). Enhanced coal bed methane recovery is particularly appealing given the size of the resource, but the technology is still at the demonstration stage.

(5) For more information on the project, see http://www.encana.com/operations/upstream/ca_weyburn.html.

(6) Natural Resources Canada, Canadian CO_2 Capture & Storage Technology Network, *Summary of Canadian CO_2 Capture and Storage Technology Initiatives*, http://www.nrcan.gc.ca/es/etb/cetc/combustion/co2network/pdfs/cccstn_brochure_nov2004_text.pdf.