KAIROS Policy Briefing Paper

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No. 21 November 2009

The Costs and Risks of Carbon Capture and Storage

By John Dillon

Carbon Capture and Storage (CCS) is a technology for trapping carbon dioxide (CO_2) emissions and storing them underground before they escape into the atmosphere. The Canadian government wants CCS to be a major part of Canada's efforts to reduce greenhouse gas (GHG) emissions. This briefing paper examines some major questions concerning how much CCS will cost, what risks it will entail and its adequacy as a method for mitigating climate change. It warns that investing in CCS cannot be a substitute for adopting serious conservation, efficiency and renewable energy measures.

Federal and Alberta Government Support for CCS

The Prime Minister's Office says that "Canada has the potential to store underground as much as 600 million tonnes of carbon dioxide a year, an amount equivalent to roughly three-quarters of Canada's current annual greenhouse gas emissions."[1] While this claim may be theoretically correct with respect to *ultimate* storage capacity, at best only half of all CO_2 emissions could ever be captured since they originate at dispersed sites such as automobile tailpipes, aircraft engines and wellheads. Implicit in the PMO's comparison between ultimate storage potential and current emissions is the assumption that total emissions will continue to grow.

The biggest obstacle to the rapid deployment of CCS is its cost, although there are also questions about its long-term commercial viability and risks as will be discussed below. The industries that could benefit from the deployment of CCS expect governments to shoulder most of the costs, certainly in the near-term development stage and perhaps also in the long-term should the technology prove to be viable.

KAIROS' study *Pumped Up: How Canada subsidizes fossil fuels at the expense of green alternatives*, describes how energy-related expenditures announced in the 2006 and 2007 federal budgets overwhelmingly favour the oil and gas industry. The 2009 budget continues the same pattern with the announcement of a $1 billion Clean Energy Fund from which $650 million will be dedicated to large-scale CCS research and demonstration projects and only $200 million will be available for small-scale, renewable energy technologies.

The government of Alberta says it will meet 70% of its 2050 GHG reduction target through CCS. Accordingly, Alberta has set aside $2 billion to subsidize CCS experiments that it hopes will achieve five million tonnes in annual GHG reductions by 2015.Yet, in April of this year nine of the biggest tar sands operators including Suncor, Syncrude and Conoco Phillips, said they were no longer interested in tapping into the provincial fund due to the high costs of CCS.[2]

Two of the three Alberta subsidies announced so far involve capturing emissions from upgraders at tar sands operations. These subsidies for CCS complement another huge subsidy for the tar sands – an Accelerated Capital Cost Allowance that will allow tar sands operators to defer $1.5 billion in taxes over the period 2007-2011.

As United Nations Secretary General, Ban Ki-moon, told the World Business Summit on Climate Change: "Continuing to pour trillions of dollars into fossil-fuel subsidies is like investing in sub-prime real estate. Our carbon-based infrastructure is like a toxic asset that threatens the portfolio of global goods, from public health to food security."[3]

CCS Costs Both High And Uncertain

Among the various options for constraining GHG emissions, CCS is much more costly than investments in energy conservation and efficiency measures or the development of renewable sources of energy such as wind power.

A powerful lobby group, the Integrated CO_2 Network (ICO_2N) composed of 17 of Canada's largest energy producers, is pressing Edmonton and Ottawa to offer subsidies for CCS. The group representing such giants as Imperial Oil, Canadian Natural Resources, and electricity producer TransAlta, wants government assistance to build a CCS transportation and storage network. The ICO_2N initially estimated the costs of CCS at between $25 and $85 per tonne of avoided emissions. Later they increased their estimate to $85-$120 a tonne for existing chemical and fertilizer plants and $160-$250 a tonne for capturing carbon dioxide from flue stacks.[4]

A report from the Alberta Carbon Capture and Storage Development Council, composed of persons from academia, industry and federal and provincial governments and chaired by a former Syncrude president, said that CCS in Alberta would cost at least $70 and perhaps more than $150 per tonne of CO_2 sequestered. This is considerably more than the $15 per tonne payment into a technology fund that Alberta currently charges petroleum producers that fail to meet emission intensity reduction targets.

Globally there are widely varying estimates of the probable costs of CCS ranging from an IPCC estimate between US$14 and US$91 a tonne to an International Energy Agency estimate that early CCS demonstration projects for coal-fired electricity generators would capture and store carbon for US$60-75 per tonne of CO_2 abated.[5]

A 2008 study by McKinsey consultants put the cost of early demonstration projects at €60-90 (US$85-$127) per tonne.[6] A more recent study released in July of 2009 suggests that the initial costs of CCS could be in the range of US$120 to US$180 per tonne.[7]

Commercial Viability?

The IEA says the price of CCS might drop to between US$50-60 a tonne in 2030 when CCS is expected to become commercially viable. Similarly the McKinsey study expects technological improvements will cut costs in half by 2030 when they expect investments in CCS to become self-sustaining.

The supposition that CCS will become commercially viable is based on two types of scenarios. One scenario assumes that corporations can sell the CO_2 they extract for use in enhanced oil recovery (EOR). EOR involves the injection of CO_2 into depleting oil reservoirs to flush out more of the remaining oil. The Alberta Carbon Capture and Storage Development Council projects that if oil prices are above US$75 a barrel, EOR could increase Alberta's recoverable reserves of conventional oil by 50%.

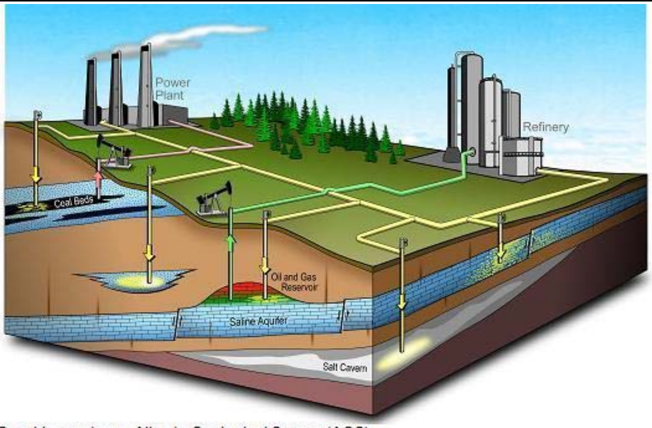
The second scenario would occur if its costs were less than what corporations would have to pay for purchasing emission credits under a cap and trade system or in carbon taxes. The McKinsey study assumes commercial viability by 2030 on the grounds that various financial institutions expect carbon prices to be between €30-48 a tonne by 2030. In the fall of 2009 CO_2 is priced at around €14 (US$21) a tonne on European markets.

None of the assumptions behind these cost and price projections are certain. While storage in depleted oil and gas wells is promising, McKinsey says storage in saline aquifers has been less researched and is less understood. Moreover, the need to transport CO_2 over long distances through pipelines would add significantly to costs.

Projections of future CO_2 prices are even more uncertain particularly as governments move towards cap and trade schemes under which carbon prices are determined by market forces rather than fixed through carbon taxes or fines. If carbon prices don't rise high enough to make CO_2 capture commercially viable, corporations would expect governments to continue subsidizing CCS beyond the demonstration stage.

While the Alberta Carbon Capture and Storage Development Council expresses confidence that CCS will be commercially viable through selling CO_2 for enhanced oil recovery, it also says that additional federal and provincial subsidies worth up to $3 billion a year will be needed between 2015 and 2025 to help bring down the costs of the technology.

But there is a limit to how much governments will dole out in subsidies for fear of a backlash from voters. In 2008 the US Department of Energy cancelled its FutureGen demonstration project after the initial cost estimate doubled. Similarly, a demonstration project planned for Saskatchewan was shelved in 2007 due to soaring costs.



Graphic courtesy - Alberta Geological Survey (AGS)
Rather than being emitted into the air by a power plant or a refinery, CO2 is separated from other emissions, dehydrated, compressed and transported by pipeline (yellow) where it can be injected into geological formations to help increase production from coals beds or oil and gas reservoirs. Or it can be injected one to two kilometers deep into porous rock formations where it is sealed and monitored by experts to ensure there is no leakage or impact on public safety or the environment.

Source: Government of Alberta
http://www.energy.alberta.ca/Initiatives/1438.asp

CCS in the Tar Sands
While CCS may be technically feasible for GHG emission abatement from electricity generating plants and for the cement, iron and steel and chemical industries, its application to the tar sands will be limited due to the dispersed nature of their extraction facilities. Yet the tar sands are the fastest growing source of GHG emissions in Canada. Under current expansion plans the portion of total Canadian CO_2 emissions coming from the tar sands will grow from 5% in 2008 to 16% by 2020.

Conoco Phillips investigated using CCS at its dispersed Steam Assisted Gravity Drainage (SAGD) projects and found capturing, transporting and storing CO_2 would cost $200 a tonne. The Alberta Carbon Capture and Storage Development Council estimates the cost of extracting CO_2 from similar *in situ* tar sands operations at over $250 a tonne.

CCS is more cost effective at tar sands upgrader plants that extract hydrogen from natural gas for use in breaking apart bitumen molecules to create synthetic oil. This process creates a separate stream of easily captured CO_2. However, there would be extra costs for compressing and transporting the CO_2. Shell claims that using CCS at its upgrader would "trim 25% from the carbon footprint of its entire oil sands mining and upgrading operation."[8]

The Integrated CO_2 Network estimates the costs of using CCS at new and existing steam methane reforming plants to make hydrogen for upgraders is $120-$$160 a tonne. How quickly the industry moves towards adding CCS capacity to upgraders will depend on what happens to the price of carbon. Currently it is cheaper for companies to pay $15 per tonne into Alberta's Technology Fund than to capture CO_2.

Capturing CO_2 also consumes energy
Capturing CO_2 at a power plant consumes energy, as does its compression and transportation to a storage site. Carbon capture itself will use up from 25% to 40% of the output from a new coal-fired power station. Retrofitting existing power plants would involve a larger efficiency penalty, estimated at between 43-77%.

Thus new plants with CCS will need to be at least a third bigger than conventional ones in order to generate the same net amount of power and also consume at least a third more fuel. "In addition, there is the extra expense of building the capture plant and the injection pipelines. If the storage site is far from the power plant, yet more energy will be needed to move the carbon dioxide."[9]

According to a study by Mark Jacobson, an engineering professor at Stanford University, new coal-fired plants fitted with CCS capability will emit 60 to 110 times more carbon and air pollution than wind turbines.[10] Jacobson also points out that CCS has no impact on the emissions associated with the mining and transportation of coal or the exhaust of other pollutants.

CCS and Liability
There are a number of risks associated with storing CO_2 in depleted oil fields. The natural seal of a reservoir could be fractured by drilling for oil or by the increased pressure exerted by the injection of CO_2. Long forgotten boreholes for oil extraction could serve as leakage points. New cement mixes will be needed to fully seal boreholes for thousands of years as standard Portland cement is known to slowly disintegrate when in contact with CO_2.

A large CO_2 leak would be disastrous for humans and animals as well as damaging the climate. In 1986 around a million tonnes of CO_2 from an active volcano bubbled up from the bottom of Lake Nyos, in Cameroon. Since the invisible gas is denser than air, it formed a ground-hugging blanket that asphyxiated some 1,800 people, 3,000 cattle and countless other creatures in a death zone that extended for 19 kilometers.[11] This tragedy has raised concerns about what could happen if large concentrations of CO_2 were released by an event such as an earthquake. Accordingly, CO_2 pipelines would have to be carefully routed to avoid low-lying areas.

Who monitors CO_2 containment or takes responsibility if CO_2 leaks out of a storage cavern? Legal responsibility among jurisdictions has yet to be established. CCS advocates generally assume that governments will take charge of reservoirs, along with all the monitoring costs and legal liabilities. This attitude resembles the posture of private companies in the nuclear industry that expect the public to assume long-term liabilities for disposal and storage of radioactive wastes. In the case of the cancelled FutureGen experimental CCS project in the US, Congress "agreed to insure the proposed plant and to indemnify the firms behind it from all lawsuits arising from leaks."[12] Other legal questions remain to be settled such as rules governing ownership of storage repositories and the allocation of carbon credits.

CCS cannot deliver on time to avert climate chaos. Scientists say GHG emissions must peak by 2015 and decline thereafter if we are to avert catastrophic climate change. Under even the most optimistic scenarios a significant level of carbon capture would not occur until well past 2015.

A Massachusetts Institute of Technology study estimates that the first commercial CCS power plants won't be on stream until 2030 at the earliest. It would then take another 20 years before a significant portion of the world's existing power plants would be retired at normal replacement rates. Thus it would not be until 2050 before CCS could make a significant contribution to reducing emissions.

The Canada-Alberta ecoENERGY Carbon Capture and Storage Task Force says that Canada could potentially capture and bury as much as **one-third to one-half** of our GHG emissions by 2050. **But** in order to avert catastrophic climate change emissions must peak by 2015 and **not** in 2050. An analysis of the Task Force report shows how it envisions only a very small five megatonne (Mt) reduction by 2015.[13] Five Mt is equivalent to just 0.7% of 2007 Canadian emissions.

According to University of Manitoba energy researcher Vaclav Smil attempting to establish CCS on a global level would be a mammoth undertaking comparable to duplicating the entire infrastructure of the global oil industry: "Smil calculates that if just 10% of global CO_2 emissions were to be sequestered, this would mean burying annually [more] CO_2 … than the annual volume of oil extracted globally. … Noting that the oil industry's infrastructure and capacity has been put in place over a century, Smil concludes that 'such a technical feat could not be accomplished within a single generation."[14]

Conclusion

The Canadian government is promoting CCA as a technology that will safely bury our greenhouse gas emissions while expanding the extractions and export of fossil fuels, especially from the tar sands. The evidence presented above argues that this is a very risky proposition. It is troubling that so much government money is being dedicated to this one still unproven technology. If the Canadian government wants to get serious about tackling climate change, then it should make massive investments in energy efficiency, conservation, renewable energy, and a carbon-free transportation infrastructure.

John Dillon is the Economic Justice Program Coordinator for KAIROS. He may be reached by email at jdillon@kairoscanada.org

KAIROS: Canadian Ecumenical Justice Initiatives unites eleven churches and religious institutions in work for social justice in Canada and around the globe.

Endnotes

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