Carbon Capture & Storage:
The Hidden Risks for the EU and Canada

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Carbon capture and storage (CCS) technology has been garnering much attention (especially during the run up to the COP-15 Summit in Copenhagen) and a significant amount of government investment as part of various government stimulus packages. Theoretically, the technology would allow power stations (as well as industrial emitters) to capture carbon dioxide from whatever fuel source they were using. Once captured, the CO_2 could be transported to and stored in underground geological formations. The deceivingly simple proposition presents intriguing possibilities to policymakers and industry leaders alike. There are many hurdles which must be overcome before the technology can be implemented on a commercial scale, however. Most agree that the technology is at best a medium-term solution that will not be commercially viable before 2020. Moreover, several negative externalities need to be addressed. For instance, there are concerns about the safety of long-term storage of CO_2 underground. The allure of CCS has overshadowed the risks and as a result the EU and Canada are faced with a dilemma. By overemphasizing CCS through inflated funding schemes, instead of concentrating on proven renewable energy and energy efficiency technologies, the EU is further limiting itself as a normative leader. At the same time, Canada is perpetuating

the view that federal environmental policy is being held hostage by interests linked to the exploitation of Canada's vast natural resources, particularly the Alberta tar-sands.

The European Union has positioned itself as a leader in the effort to combat climate change. The reasons for this vary. There are certainly economic advantages associated with the role. Past EU directives have inspired innovation among European firms, which has positioned them very fortuitously in a changing global economy. Another reason, frequently trumpeted by European leaders (and the topic of this paper) has to do with norms; more specifically the normative character of the EU. The EU sees itself as a normative actor in many areas; one of which is sustainable development.[1] So there are perhaps economic and normative interests which have driven the European Union to strive for a leadership position in the international climate change régime. The EU's motivations are not the subject of this paper, however. This paper asks whether particular EU policies associated with climate change efforts (i.e. CCS) have the capacity to damage the normative image that is important to the EU achieving its goals in other areas.

Canada, while today not a normative actor or global environmental leader on par with the European Union, has an opportunity, thanks to its abundance of renewable natural resources and its geographic proximity to the United States, to act as a good practices

[1] Some, including myself, have argued that the EU is, at best, a limited normative actor in the area of sustainable development, because of the inherit duality of EU interests in correspondence to the inherit duality of sustainable development. That is, the normative agenda of the Union is attracted to sustainable themes, while the economic interests of the Union are drawn to development. Unfortunately, there is often conflict.

model for its southern neighbor in particular and the world in general. There was once a time when Canada was seen as a leader on environmental issues. The 1987 Montréal Protocol, which effectively banned ozone-depleting CFCs, signaled the beginning of an era of environmental activism at the Federal-level in Canada. That era saw the setting of emissions goals that would have capped Canadian CO_2 at 1990 levels by 2000 and the introduction of several energy-efficiency standards. Unfortunately, that era did not last and Canada found itself neglecting ecological responsibilities in order to compete in the global marketplace. Today, because Canada's economy was relatively well-positioned for the global financial downturn, Canada is at a crossroads with unprecedented opportunities to change course and become a valuable example to other countries. Unfortunately, Carbon Capture and Storage may be an indication of a sustained path of environmental negligence, but this time under the guise of sustainability.

1.0 A Closer Look at the Panacea

There are many uncertainties surrounding CCS. The technology is in some ways nascent, while in other ways quite developed. As a result, the economics of implementation are uncertain. Currently all of the capture technologies include hefty efficiency penalties and the risks associated with transport and storage are unclear, while the potential harm is great. Overall the process has the potential for massive costs savings, but also the potential for hugely detrimental externalities.

1.1 The Technology

Carbon capture and storage should actually be viewed as three separate processes; capture, transport and storage. Each process currently faces obstacles that must be overcome before wide-scale commercial implementation can be achieved. Carbon capture is the main stumbling block at the moment, because it is the most technologically complex. As the name implies, the technology involves the separation and capture of carbon dioxide from a fuel source. This can be done before, after or during combustion and is subsequently referred to pre-, post- or oxyfuel-combustion.

The first, pre-combustion capture technology involves gasifying the fuel source, then separating the gas into carbon dioxide (CO_2) and hydrogen (H_2). The CO_2 is compressed for transport while the hydrogen is burned for energy (emitting only water vapor). A form of pre-combustion capture called Natural Gas Combined Cycle (NGCC) has been used at the Sleipner West gas platform by the Norwegian state oil firm, Statoil, since 1996. It is one of only three small-scale capture facilities that operates commercially.[2] Researchers at the Energy Research Centre of the Netherlands estimate that this process incurs an 8-10% efficiency penalty.[3] Still this penalty is relatively low compared with other CCS technologies. A major drawback is that this technology cannot be retrofitted to current facilities like post-combustion technologies. Post-combustion, as the title suggests, involves removing CO_2 from exhaust gases after

[2] Hetland 2009, p. 39.

[3] Jansen 2008, slide 9.

fuel combustion (coal, natural gas, oil or biomass). The most common way to do this is by using a chemical sorbent to strip the CO_2 from the other gases. This is the most promising of the three capture methods discussed here because it is already used to produce CO_2 for commercial purposes (on a very small scale) and it offers the possibility of retrofitting existing power stations or industrial emitters. For this reason, post-combustion CCS has garnered the most attention outside of the scientific and policy communities. The third method, known as oxyfuel-combustion, is the newest and involves a seemingly simple process of burning coal with pure oxygen. The result of which is pure CO_2 which can then be compressed and stored. The simplicity of the process is complicated by the rather substantial reduction in efficiency -- a result of the energy-intensive process needed to produce pure oxygen.[4] As with post-combustion, oxyfuel can be retrofitted on current plants and the somewhat reduced energy penalty (compared to post-combustion) may mean that this technology will soon surpass the others.

The technology needed to transport carbon dioxide from the capture facility to the sequestration site is more or less in place today. The large quantities of CO_2 that would need to be transported rule out truck, train and barge options and leave only pipeline transport.[5] There are a number of CO_2 pipelines operating today -- most owned and operated by petroleum firms for use in enhanced oil recovery (EOR). Of course, more pipelines would need to be constructed, which does not pose a problem technologically,

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[4] Höök 2007; Jansen 2008, slide 8.

[5] S.I. Plasynski *et al.* 2009, p.130; IEA 2009, p. 30.

but rights-of-passage disputes may hinder construction in some areas.[6] Globally, the IEA predicts that 70,000 to 120,000 km of pipelines will need to be constructed by 2030.[7]

Long-term storage of CO_2 underground presents uncertainties, but some experience exists again within the petroleum industry in reference to EOR and similar technologies. In general, experts point to oil and gas reservoirs, unminable coal beds and saline formations as potential storage sites.[8] More studies are needed to determine the long-term viability of subterranean CO_2 storage including improved CO_2 seismic modeling and monitoring techniques to enhance the ability to predict the fate of CO_2 in the subsurface and a greater understanding of leakage.[9] Finally, more needs to be learned of the global storage capacity. Little is currently known apart from rough estimates, which make investment and cost projections difficult.

1.2 The Unknowns: Economics, Risks and Externalities

There is a general deficit of information available concerning the actual costs and risks associated with CCS technologies. The unanswered questions concern the safe, socially compatible as well as ecologically and economic sound applications of CCS.[10]

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[6] S.I. Plasynski *et al*. 2009, p.130.

[7] IEA 2009, p.30.

[8] Myer 2008, p. 368.

[9] IEA 2009, p.33.

[10] Viebahn 2007.

For instance, many believe that the economics behind the technology are flawed -- in particular those surrounding global storage capacity and the cost of subterranean storage. An EU-funded study noted six areas where information gaps and uncertainties could lead to inaccurate cost estimates. First, much of the body of literature on CCS cites a small number of engineering-cost studies, which gives a false sense of creditability to the nascent technology. Second, most studies assume pre-2005 fuel and material prices, which hides potentially large cost discrepancies. Third, much of the current literature is based on a small number of publicly funded research projects and does not reflect private research which is (in many cases) proprietary. Fourth, in many countries (Canada for example), the policy framework needed to govern the deployment of CCS does not exist or is underdeveloped. Therefore, the cost of adhering to the regulations of any one policy framework cannot be included in a cost estimate. Nuclear power offers an analogous example in which increased regulatory stringency and more safety requirements led to more complex designs and higher costs.[11] Fifth, the number of experts working on CCS has increased from a couple of hundred three to four years ago to around one to two thousand today. Along with the enormous increase in inherent advocates for CCS has come an artificial optimism for the technology. Finally and perhaps significantly, the risks associated with the technology have been understated and as a result the costs associated with those risks has been underestimated.[12]

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[11] Hansson 2009, p. 2275.

[12] Anderson *et al*. 2007, p. 9-10.

The risks associated with transporting to and storing large amounts of CO_2 underground -- especially underneath the seabed -- are substantial at present. While concerns over possible seismic activity as a result of CO_2 injection are very real and should not be ignored, leakage and the side-effects are perhaps the most pressing considerations. At least one study outlines the possible ways in which leakage could occur during transport, injection and storage,[13] but many cite the need for more study. The amount of CO_2 that would need to be transported and stored is very sizable and would increase if the technology ever becomes viable. To take an example from the United States, 1.5bn tons of CO_2 are produced from coal-fired power plants per year. If that amount of CO_2 were transported for sequestration it would equal three times the amount of natural gas transported through the US gas pipeline system.[14] Each meter added between the source of the CO_2 emissions and the site of sequestration increases the risk of leakage. Once sequestered, the risk of leakage continues. As noted, possible types of storage sites include sub-seabed, deep saline formations, depleted oil and gas reservoirs, coal seams and terrestrial installations.[15] Risk varies depending on storage site, but most experts admit that a leakage of 2% per year is expected and potential for long-term storage of CO_2 in underground repositories is still highly uncertain.[16] Experts have noted that there is a distinct lack of research concerning the effects of CO_2 leakage into dwellings and into groundwater supplies. This is troubling because as a potential asphyxiant, elevated subsurface CO_2 levels could have lethal effects on plants and

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[13] Mace 2007, p. 255.

[14] Katzer 2007, p. ix.

[15] Herzog 2004, p.4.

[16] Schellnhuber 2009, p.41.

subsoil animals and the contamination of groundwater could result in increased occurrences of lead.[17] Research has shown that elevated concentrations of ambient CO_2 could be harm plants, animals as well as humans.[18]

While the economics behind CCS may soon shift and make the technology financially practical, all of the technologies collectively known as carbon capture and storage include negative externalities, which will almost certainly be more difficult to overcome. For instance, if CCS were successfully implemented, extraction of coal and other fossil fuels will inevitably increase. Increased coal extraction would bring with it well-known negative side-effects such as increased coal sludge production and increased water use.[19] Water is already scarce in parts of Canada and the EU during times of peak generation. In parts of the developing world where we expect to see emissions dramatically increase in the coming years and where water is already hard to come by, the increased water demand needed for CCS could have potentially negative sociopolitical effects. There is also the potential for completely new emissions from the chemical scrubbers used in the post-combustion capture process.[20] Beyond the negative externalities associated with the CCS process and continued fossil fuel extraction, perhaps the most damaging externality is the tragic irony that CCS is detracting funds from other low- or zero-carbon technologies. This is happening in four ways: the diversion of research and development funding, the diversion of government

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[17] Stenhouse *et al.* 2009, p.1901; Mace 2007, p. 255.

[18] Metz 2005, p. 13.

[19] Anderson *et al.*, p. 14.

[20] *ibid.*

incentives, the diversion of private sector investments and the diversion of attention by government and policy makers. Of these, government funds and attention are arguably the most important. The EU and Canada are shifting huge sums of stimulus and other monies meant for sustainable energy and climate change solutions into carbon capture and storage.

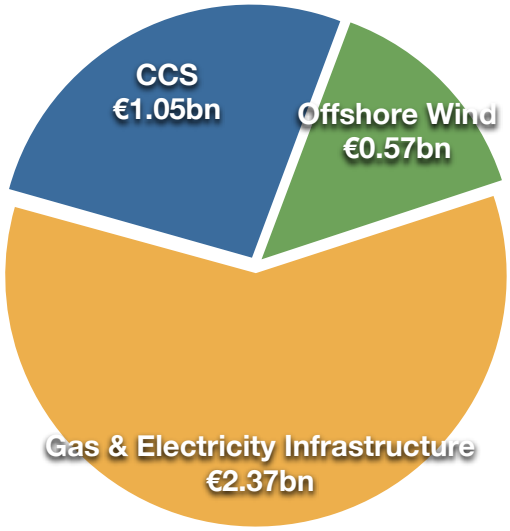
2.0 The EU and Canada: Enthusiastic Advocates of CCS

The European Union, in March 2009, announced that it would spend €1.05bn on CCS development as part of its economic stimulus package. In addition, according to a Commission Non-Paper, the revised Emissions Trading Scheme directive sets aside a significant portion of the €9bn New Entrants Fund for CCS research.[21] Finally the EU has recently announced that as part of the Strategic Energy Technology (SET)-Plan research initiative, CCS will receive €13bn over the next 10 years.[22] Presumably much of this money will go towards building 12 demonstration sites the EU wants by 2015. The Canadian Federal government, while not providing as much money, is earmarking a higher percentage of funds than the EU.

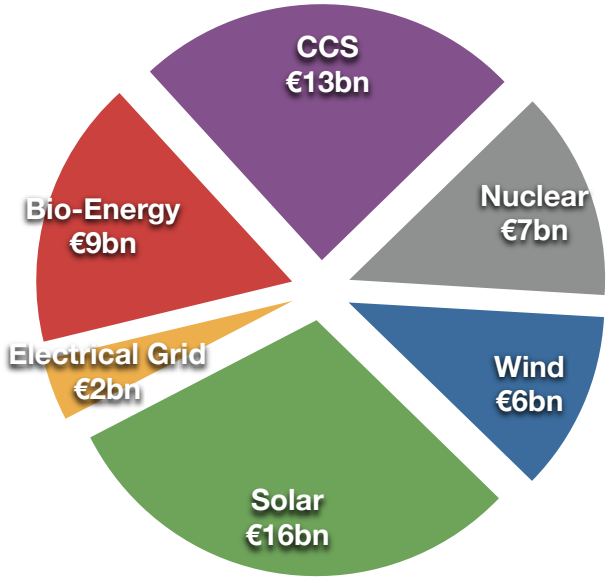
[21] The New Entrants Fund is 300m EUAs, which the European Parliament estimates at €9bn. EurActiv 2009.

[22] European Commission 2009, p. 6 ¶ 4.

European Energy Programme for Recovery

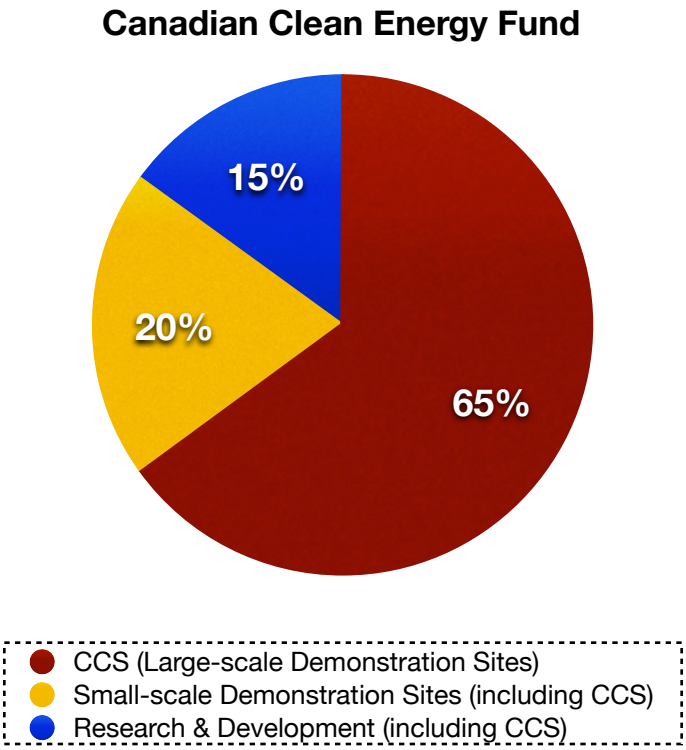


SET-Plan



Source: European Commission

In May, the Canadian government announced a C$1bn Clean Energy Fund, the majority of which (C$650mn) is reserved exclusively for large-scale CCS demonstration projects. Another C$200mn is slated for small-scale demonstration projects that utilize 'renewable and alternative energy technologies'; a category that surprisingly includes carbon capture and storage. The remaining C$200mn is designated for research and development, which again includes CCS-related schemes. In the end, a small percentage of the fund will actually go towards sustainable energy solutions such as solar, tidal or wind energy technologies. It is this point, which is the most important when discussing CCS funding. The amounts of funding are more or less trivial -- it is the amount of CCS funding relative to other renewable or sustainable energy funding that is the issue.



Source: Natural Resources Canada

Favoring CCS over renewables when earmarking public funds brings up questions of fairness and responsibility. Canada and the EU take different approaches to funding CCS with public money, but in the end all funds are public. Canadian federal CCS funds are generated through taxation, thus placing the bill to develop CCS directly on the taxpayer. This shifts the burden for reducing emissions (at least partially) from the polluter. Taxpayers, of course, produce the demand for the energy and products that require the production of emissions, but they are generally disconnected from the production process, thus it would be more difficult for them to inspire innovation via their demand. The emitters, on the other hand, would respond very quickly if the funding burden were concentrated on them. In the end, higher emissions standards and less government funding would be more effective at stimulating innovation and reducing emissions. The Clean Energy Fund seems to be less of an attempt to spur the

production of clean energy and more of an industrial subsidy. This fact becomes more apparent If one considers that of the C$1bn Clean Energy Fund, the C$200mn that will not be spent directly on CCS demonstration sites will be set aside for research and development which critics have argued will go towards mitigating the effects of tar-sands oil production. Ironically, tar-sands oil production would almost certainly expand with the successful introduction of CCS. A recent survey by Environmental Defense demonstrates that a majority of Canadians want tar-sands oil production cut, with only 29% stating that production should be increased.[23] If the poll reflects reality, Canadian taxpayers are paying to modernize, expand and cleanup an industry which they believe should be shrinking. Oil companies are actually favorably positioned to make money from storing CO_2 produced by stationary emitters who do not possess their own sequestration sites like exhausted natural gas and oil reservoirs.[24] In Canada, the taxpayer is being positioned to pay to develop a technology that is poised to sustain not the environment but firms that are exploiting it.

In the European Union, much of the funding for CCS development is slated to come from 300 allowance credits generated by the Emissions Trading Scheme -- a market-based scheme where polluters buy emission permits. The value of the credits is constantly changing because it is set by the market, but the EU expects the plan to push between €7-9bn towards CCS. Since the ETS revenue comes from emitters, the plan is in line with the so-called 'polluter pays' principle, which has guided European

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[23] Environmental Defence Canada 2009.

[24] Wong-Parodi *et al.* 2008, p. 5.

environmental legislation for nearly thirty years. While the emitters may pass the costs on to the consumers, the taxpayers are not being billed directly as in Canada. Still some question whether the plan is also in keeping with an initial promise that funds generated by the ETS would be reinvested in sustainable energy technologies. The questionable sustainability credentials of CCS are obvious, as is the unequal allocation of funds. Meanwhile, voices arguing that it is not at all sustainable to store vast amounts of a potentially unstable substance underground for future generations are growing louder in the EU and people are starting to ask how this seemingly oxymoronic situation arose in which sustainability funding is being used to subsidize the fossil fuel industry; an industry that needs public money less than most.[25] The ethical shortcomings of these plans are obvious, but why does it matter? Beyond the fact that these plans cannot be called economically or ecologically responsible and perhaps have not met normal safety benchmarks, they pose additional threats to the international and domestic integrity of both the EU and Canada.

3.0 The Consequences

The disproportionate funding models adopted by Canada and, to a lesser but still pronounced degree, by the European Union have the potential to reduce the creditability of each party in several ways. First, as outlined above the economic, ecological and social risks associated with CCS technology are many and if any of those risks are realized, it would result in an enormous loss of face for Canada and the

[25] Vormedal 2008.

EU. Second, the public costs could be substantial (both financial and in the form of negative externalities), and if the extent of the lobbying effort on the part of the petroleum industry is revealed to the public, further image degradation may occur. Finally and most importantly, the overemphasis on such a risky technology may lead to failure to achieve emissions goals on time or at all.

3.1 What the European Union could lose

In recent years the European Union has described itself as a normative leader throughout the world -- promoting such norms as rule of law, democracy and sustainable development, but at least with sustainable development the EU's normative actorness has been limited. Before discussing how the promotion of carbon capture and storage could further limit the normative character of the EU, it is necessary to provide a short background on Europe's normative identity.

François Duchêne's 1973 discourse on the European Community as a civilian power is regarded by most as the beginning of the discussion of Europe as a different kind of power.[26] Duchêne describes the EC's rise in status in terms of promoting its stated social values (equality, justice and tolerance) through civilian (i.e. nonmilitary) means. He thought the EC could develop as the first great actor in a new balance of power based not on military might but a civilian, perhaps economic, power. He envisioned the EC '...as a civilian group of countries long on economic power and relatively short on

[26] Duchêne 1973, p. 1.

armed force."[27] Duchêne imagined the EC as an additional power to the dual hegemony of the time. The debate of a civilian Europe continued throughout the nineteen-eighties and -nineties, and indeed there are many strong arguments today for a primarily economic power imitating from Europe.[28] Though, as constructivist theory began to gain ground in European Studies and International Relations, scholars started to argue that Europe was not exclusively an economic power but was instead guided, in at least some policy areas, by ideas. Then, in 2002, Ian Manners wrote an influential paper which shifted the debate away from civilian power Europe to normative power Europe.[29]

Manners argued, like others before him, that Europe was indeed a different sort of international power; a power based on ideas (an *idée force* to quote Duchêne), a normative power. Yet even the idea of normative power or actorness emanating from Europe was not completely new. After all, the decolonization policies of many European countries immediately following World War II were seen as part of a normative agenda.[30] Carr, Galtung, and even Duchêne to a lesser extent briefly discussed the idea in reference to the then European Community in the sixties and seventies, but it was Manners who started the current discourse.[31] Where the others (Carr and Galtung respectively) imagined normative power Europe as having the ability to dictate opinion or ideology internationally, Manners argued that normative power meant the ability to

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[27] Duchêne 1973, p. 19.

[28] Smith 2005, p. 2.

[29] Manners 2002.

[30] Finnemore 2005, p. 887.

[31] Carr 1981, Duchêne 1973, Galtung 1973.

shape others' perceptions of 'normal.'[32] Manners' conceptualization of a normative power departed from the idea of a civilian power where he considered the older concept centered on a 'Westphalian' state-system and the focus on rational interest as the primary motivation behind external policy.[33] In his new conceptualization, he outlined nine norms which the European Union seeks to promote internationally and argues that it promotes them through normative means.[34] Of these norms, we are most concerned with sustainable development, because it is sustainable development funding which is being made available to CCS. The most common definition of the term sustainable development comes from the Brundtland Commission report of 1983, which stated that sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs.'[35] It was formally included as an EU objective in the Treaty of Amsterdam[36], a document which also stipulated that environmental protection requirements be considered in all EU policies and activities.[37]

In the EU, when policies are of a mixed nature, particularly when they involve trade issues, they have had a tendency to quickly become watered-down because of a perceived conflict of interests. The conflict between economic interests and

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[32] Manners 2002, p. 240.

[33] Scheipers 2007, p. 436.

[34] Manners 2008, p. 46.

[35] Bruntland 1987.

[36] Treaty on European Union, Art. 2.

[37] Treaty on European Union, Art. 6.

environmental interests greatly compromises the EU's credibility when promoting sustainable development internationally. CCS is a prime example of a mixed policy area (energy/environment) in which the EU has trouble projecting a coherent message. The international audience looks suspiciously upon the European Union, when it is perceived to be promoting it's narrow self-interest. As a result, the European Union is, in terms of sustainable development, a limited normative leader. CCS can only limit it further.

3.2 Canada's Missed Opportunities

Admittedly, Canada may have less creditability to lose than the EU. While Canada was seen during the late 1980s/early 1990s as first-mover and even innovator vis-à-vis development of an international climate change régime[38], it has not been seen as a force since it became part of the so-called JUSCANZ (Japan, United States, Canada, Australia and New Zealand) group of laggards during the Kyoto negotiations. That is, since the mid-1990s environmental policies in general and climate change policy in particular have taken a backseat to the trade liberalization policies that have preoccupied most of the world.[39]

At the May 2009, EU-Canada Summit in Prague, the two parties agreed to cooperate on Carbon Capture and Storage (CCS), bioenergy along with distributed generation and

[38] S. Andresen 2002, p. 45.

[39] Warner 2009, p. 99.

smart electricity networks.[40] Still, Canada is missing out on an exceptional opportunity to further strengthen its ties with Europe, by conspicuously omitting renewable energy research as an area of cooperation. Moreover, Canada is well positioned, geographically, to act as a model for the United States. So what alternative paths could the European Union and Canada take that would most effectively lead to emissions reductions, yet still result in economic growth?

4.0 Conclusion

The main alternative to the current situation is fairly straightforward. There should be a realignment of funding priorities away from an over-dependence of CCS and towards renewable energy sources and the updating of infrastructure such as power-grids to better accommodate renewable energy sources. Current EU funding (as part of the SET-Plan and the European Energy Programme for Recovery) assigns quite a substantial amount to modernizing the grid which should be increased. Enormous sums of stimulus and other monies should be directed towards proven first- (hydro, bioenergy, geothermal) and second-generation (solar heating and cooling, solar photovoltaic and wind) renewable energy technologies that can be deployed today at relatively low costs. Additional monies should be directed towards third-generation renewables such as concentrated solar, tidal and enhanced geothermal systems along with CCS.

[40] Canada-EU Summit Declaration - May 6, 2009 from http://www.canadainternational.gc.ca/eu-ue/bilateral_relations_bilaterales/2009_05_06_statement-declaration.aspx?lang=eng.

Carbon Capture and Storage technologies should continue to be developed, but not as a panacea. Rather the technology should be developed in conjunction with biofuels as potential negative emissions solution. That is, in the distant future, after much of the energy sector has been decarbonized, CO_2 could be captured from biofuels, essentially resulting in negative emissions since the flora used to produce the biofuel originally removed CO_2 from the atmosphere. One particular area that deserves more public funding is offshore wind energy (OWE). The technology presents enormous possibilities for generating energy, especially in Europe. In fact Peter Vis, an advisor to EU Energy Commissioner Piebalgs, stated in a recent interview that offshore wind was judged to be the biggest contributor to achieving the EU's target of producing 20% of its power by way of renewables by 2020.[41] If more money were invested in equipment needed to install the turbines and in training workers to do the job, current costs would be reduced dramatically.

In the end, both Europe and Canada are well positioned to decarbonize their economies and still achieve positive growth. If they cooperate on lowering the cost of renewable energy sources they would create jobs and reduce emissions. Carbon Capture and Storage development needs to continue, but should be removed from the portfolio of tools to mitigate climate change until it is proven to be a viable technology. It simply cannot be relied upon to deliver the emissions reductions the world needs.

[41] EurActiv 'EU at odds over priorities for "green stimulus"'

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