Future Financial Liability for Greenhouse Gas Emissions from Hydro-Québec's *Centrale du Suroît*

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by

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Contents

[1] For more information about the Pembina Institute, see http://www.pembina.org.

1. Background

Hydro-Québec is proposing to build and operate a combined-cycle gas turbine (CCGT) electricity generation facility, the *centrale du Suroît* (CdS). The purpose of this paper is to assess the future financial liability that can plausibly be expected to accrue to Hydro-Québec for greenhouse gas (GHG) emissions from the CdS throughout the facility's expected operational life. This assessment is made in the context of

- international action to address climate change;
- the government of Canada's participation in such international action; and
- the government of Québec's climate change policy.

GHG emissions from the CdS, when it is in full operation, are estimated to be 334 tonnes of carbon dioxide equivalent (CO_2e) per gigawatt-hour (GWh),[2] or 2.25 megatonnes (Mt) CO_2e per year.[3,4] No technology is currently available to reduce or capture these emissions.[5] Assuming, for the sake of simplicity, that the electricity production of the CdS will remain constant, we therefore conclude for the purpose of this paper that the annual emissions of the CdS will also remain constant throughout the facility's operational life. The CdS is expected to be in full operation by about the beginning of 2008,[6] and has a planned operational life of "at least" 25

[2] Ministère de l'Environnement du Québec (December 2003), *Rapport d'analyse environnementale, Centrale à cycle combiné du Suroît par Hydro-Québec à Beauharnois*, dossier 3211-12-073, Sommaire exécutif.

[3] *Ibid.*, p. 6.

[4] Emissions could be somewhat higher depending on the technology ultimately chosen. See Hydro-Québec (2004a), *Réponses d'Hydro-Québec Production à la demande de renseignements no. 1 de la Régie au producteur en date du 5 mars 2004*, demande R-3526-2004, HQP-3, Document 1, p. 3. However, to be conservative, we will use the figure of 2.25 Mt.

[5] *Ibid.* In theory, capture and underground storage of CO_2 from thermal electricity generation facilities such as the CdS could become viable at some point during the facility's life. This is, however, highly speculative and would involve significant additional financial cost.

[6] Ministère de l'Environnement du Québec, *op. cit.*, p. 4.

years.[7] For the purpose of this paper we will assume that the CdS will operate for precisely 25 years, until the end of 2032.

2. International action to address climate change

Major Canadian sources of GHGs, notably large industrial facilities such as the CdS, face regulatory constraints on their GHG emissions beginning no later than 2008. These constraints, while of uncertain severity, are likely to become increasingly severe over the period 2013–2032. As discussed in section 3, this will most likely translate directly into an increasing financial liability for facilities such as the CdS.

This trend of constraints on GHG emissions has three key long-term root causes, as follows.

Scientific concern. National governments, in partnership with the scientific community, formed the Intergovernmental Panel on Climate Change (IPCC) to advise them on the scientific basis, actual and likely impacts, and means of adapating to and mitigating, global climate change caused by GHG emissions from human activities. The formal reports of the IPCC since 1990 show that the accumulating body of scientific evidence is resulting in increasing confidence that GHG emissions from human activities have become a dominant driver of global climate change; and that this change, allowed to proceed unchecked, will have profound global impacts.[8] Review of the scholarly scientific literature[9] and public statements by numerous national science academies[10] indicate that the vast majority of professional climate scientists concur with the IPCC position.

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[7] Hydro-Québec (2004b), *Réponses d'Hydro-Québec à la demande de renseignements no.1 du GRAME*, demande R-3526-2004, HQ-3, Document GRAME, p. 48.

[8] The IPCC's latest (third) full *Assessment Report*, which includes *Summaries for Policymakers*, is available at http://www.ipcc.ch.

[9] See, for example, Environment Canada (2003), *2001 in Review, An Assessment of New Research Developments Relevant to the Science of Climate Change* (CO_2/Climate Report Summer 2003 Issue), available at http://www.msc-smc.ec.gc.ca/saib/climate/climat_e.cfm.

[10] See, for example, Royal Society (May 18, 2001), *Royal Society backs international call for action on climate change* (media release), available at http://www.royalsoc.ac.uk/templates/press/releasedetails.cfm?file=318.txt.

Global consensus for action. 187 countries,[11] including Canada and the US, have now ratified the United Nations Framework Convention on Climate Change (UNFCCC), which entered into legal force in March 1994. The Convention states that its "ultimate objective" is "to achieve... stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system."[12] The IPCC has shown that to stabilize GHG *concentrations* in the atmosphere at any level, it will be necessary to reduce global GHG *emissions* from human activities to a small fraction of their current level; and that the longer it takes to achieve those reductions, the higher the level at which GHG concentrations will stabilize.[13,14] The higher the stabilization level, the larger the likely environmental impacts.

Legally binding instruments. National governments have recognized the need for legally binding instruments to achieve the objective of the UNFCCC by negotiating, in December 1997, the first such instrument: the Kyoto Protocol to the UNFCCC sets GHG emission targets for the period 2008–2012 for industrialized countries including Canada. Canada ratified the protocol in December 2002, thereby accepting its target of reducing its GHG emissions, net of credits for "sinks" and international emissions trades, to 6% below the 1990 level during 2008–2012. The protocol now only requires ratification by Russia to enter into legal force. Given that the Kyoto Protocol currently sets emissions targets only up to 2012, while falling very far short of the UNFCCC's objective of stabilizing GHG concentrations, a series of amendments to the protocol or successor treaties, setting increasingly demanding emissions targets, will be needed over several decades post-2012 to implement the UNFCCC.

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[11] See http://unfccc.int/resource/conv/ratlist.pdf.

[12] See http://unfccc.int/resource/docs/convkp/conveng.pdf.

[13] IPCC (2001), *Climate Change 2001: Synthesis Report*, p. 90. Available at http://www.ipcc.ch/pub/syreng.htm.

[14] IPCC (2001), *Climate Change 2001 – The Scientific Basis*, Technical Summary, p. 75–76. Available at http://www.ipcc.ch/pub/wg1TARtechsum.pdf.

3. GHG emissions pricing

3.1 Regulatory use of emissions pricing for controlling industrial GHG emissions

It was noted in section 2 that major Canadian sources of GHGs, notably large industrial facilities such as the CdS, will be subject to regulatory constraints on their GHG emissions beginning no later than 2008. As elaborated in section 3.3, the government of Canada intends to implement these constraints largely through the use of emissions pricing.

3.1.1 International developments

Governments throughout the industrialized world have settled on emissions pricing, implemented through emissions trading systems, as the method of choice to control GHG emissions from large industrial facilities. Emissions trading systems set emissions targets or provide emissions quotas that can be met by combining on-site emission reductions with purchases of freely tradeable emissions rights (variously referred to as permits, allowances, credits or offsets). The emissions trading markets thereby created put a price on the emission of each tonne of CO_2e, representing a financial liability for the emitters that are required to participate.

The Kyoto Protocol itself sets targets for individual countries' emissions, but allows those targets to be met via three international emissions trading mechanisms, thereby creating an international emissions trading market. Within countries, governments can similarly set GHG emissions targets for individual industrial emitters, but allow those targets to be met through domestic emissions trading (DET) in emissions rights. The United Kingdom has already implemented a broad DET system, while Denmark has implemented a pilot system for the electricity sector.[15] European Union member state governments have now agreed on the implementation of an EU-

[15] R. Rosenzweig, M. Varilek and J. Jannsen (2002), *The Emerging International Greenhouse Gas Market*, Pew Center on Global Climate Change, p. 57–58. Available at http://www.pewclimate.org/global-warming-in-depth/all_reports/international_greenhouse_gas_/index.cfm.

wide DET system that will constrain the emissions of a broad set of industrial facilities, including thermal[16] electricity generation, to begin in 2005.[17]

3.1.2 Developments in the US

The US has made more use of regulated emissions trading systems (mainly for pollutants other than GHGs) than any other country. The largest and best-known example, operating since 1995, is the Acid Rain Program which constrains sulphur dioxide emissions from thermal electricity generating units nationwide.[18] While the current US federal administration has chosen not to participate in the Kyoto Protocol, the states of Oregon,[19] Massachusetts[20] and New Hampshire[21] have regulated/legislated emissions trading systems that constrain CO_2 emissions from their thermal electricity sectors (beginning in 1997, 2004 and 2006 respectively). In 2003, the governors of Connecticut, Delaware, Massachusetts, New Hampshire, New Jersey, New York, Maine, Rhode Island and Vermont (with Maryland and Pennsylvania also participating as observers) formed the Regional Greenhouse Gas Initiative to develop a regional CO_2 emission trading system for the electricity generation sector, with the aim of completing the program design by April 2005.[22]

There is also now in Congress strong interest in and support for constraining GHG emissions, and for GHG emissions pricing in particular. The numbers of climate change-related legislative proposals introduced increased from seven in the 105th Congress (1997–1998), to 25 in the 106th Congress (1999–2000), to over 80 in the 107th Congress (2001–2002), to nearly 70 in

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[16] In this paper, "thermal" is used to mean "fossil fuelled".

[17] See http://europa.eu.int/comm/environment/climat/emission.htm.

[18] A. Ellerman, P. Joskow and D. Harrison (2003), *Emissions Trading in the US: Experience, Lessons and Considerations for Greenhouse Gases*, Pew Center on Global Climate Change, p. 11–20. Available at http://www.pewclimate.org/global-warming-in-depth/all_reports/emissions_trading/index.cfm.

[19] See http://www.energy.state.or.us/siting/co2std.htm, http://www.leg.state.or.us/ors/469.html.

[20] See http://www.mass.gov/dep/bwp/daqc/files/regs/729final.doc.

[21] See http://www.gencourt.state.nh.us/legislation/2002/hb0284.html.

[22] Pew Center on Global Climate Change (2004), *Climate Change Activities in the U.S.: 2004 Update*, p. 10–11. Available at http://www.pewclimate.org/what_s_being_done/us_activities_2004.cfm.

2003, the first year of the 108th Congress (2003–2004).[23] Several of these have been bills to constrain CO_2 emissions from electricity generation facilities, accompanied by emissions trading provisions. Between January and August 2003, four such bills were introduced.[24] Of these, the most significant was the bipartisan bill (S.139, S.Amdt.2028) introduced in January 2003 by the prominent senators McCain and Lieberman. The bill would establish a broad DET system capping the six GHGs covered by the Kyoto Protocol and emitted by the electricity generation, transportation, industrial, and commercial sectors (representing 85% of total US emissions) at their 2000 level after 2010. This is a very significant constraint, given that total US emissions are projected to be 16–21% higher in 2010 than in 2000.[25] The bill was defeated fairly narrowly by 55 votes to 43 in the Senate in October 2003.[26] However, more than half of the current 100 senators have voted at one time or another for proposals to cap CO_2 emissions from the electricity sector.[27] In March 2004, a version of the McCain-Lieberman bill was introduced by representatives Gilchrest (Republican) and Olver (Democrat) in the House of Representatives.[28]

3.1.3 Views in the investment community

All these activities demonstrate clearly that regulatory use of emissions pricing is firmly entrenched at the international, national and sub-national levels as governments' method of choice to control industrial GHG emissions. In light of the three long-term causes of contraints on GHG emissions identified in section 2, this can be expected to remain the case for decades to come.

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[23] *Ibid.*, p. 4.

[24] See http://www.pewclimate.org/what_s_being_done/in_the_congress/108th.cfm#GHG_Reduction and http://www.pewclimate.org/what_s_being_done/in_the_congress/108th.cfm#Power_Plants.

[25] US Department of State (2002), *US Climate Action Report 2002*, p. 73. Available at http://unfccc.int/resource/natcom/nctable.html. The figure is 16% for gross emissions and 21% for emissions net of carbon sequestration.

[26] Pew Center on Global Climate Change, *op. cit.*, p. 5.

[27] Annie Petsonk, Environment Defense (2004), personal communication.

[28] See http://www.pewclimate.org/_policy_analyses_g_o.cfm.

Indeed, the planned or implemented regulatory actions described above are now leading to a recognition within the investment community that GHG emissions pricing, and climate change more generally, represent serious emerging financial liabilities for companies. For example, Innovest Strategic Value Advisors, an investment research and advisory firm based in New York City, warns that: "Investors failing to take account of climate change and carbon finance issues in their asset allocation and equity valuations may be exposed to significant risks which, if left unattended, will have serious investment repercussions over the course of time."[29] With specific reference to electricity generation, Innovest states: "Given the current GHG regulatory environment, we believe that the inclusion of carbon shadow prices into liquidity, valuation and balance sheet calculations is a prudent step towards managing carbon risks. The corollary of this is that asset pricing may be significantly affected by carbon risk premiums."[30] Another recent report commissioned by the United Kingdom's third largest pension fund recommended that: "Institutional investors should request that sell-side brokers comment on a company's relative exposure to climate related risks (environmental, product-related and policy-related) and the management's capabilities and positioning on climate change."[31]

Concern in the investment community about financial liability for GHG emissions is now quite broad-based. In November 2003, a group of 87 institutional investors with assets of over $US9 trillion under management wrote to the 500 largest quoted companies in the world by market capitalisation, asking for the disclosure of information concerning their GHG emissions. The investors expressed their desire "to improve our understanding of possible material impacts on investment value driven by climate change related to *taxation and regulation*, technological innovations, shifts in consumer attitude and demand, [and] changes in weather patterns" (our emphasis).[32] One of the questions posed was "Have you considered scenarios involving

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[29] Innovest Strategic Value Advisors (2003), *Carbon Disclosure Project 2003*, p.2. Available at http://www.cdproject.net.

[30] *Ibid.*, p. 47–48.

[31] M. Mansley and A. Dlugolecki (2001), *Climate Change – a Risk Management Challenge for Institutional Investors*, Universities Superannuation Scheme, p. 41. Available at http://www.usshq.co.uk/downloads/pdf/climate_change_paper.pdf.

[32] See http://www.cdproject.net.

reductions in GHG emissions *beyond existing national, regional and international targets*? If yes please detail these scenarios, and your estimated costs or savings associated with each one. If no, are you planning on doing so, and if so when?" (our emphasis).[33]

3.2 Voluntary use of emissions pricing

There is also now broad recognition in the business community, especially among large companies in the electricity and oil and gas sectors, that GHG emissions pricing is a long-term reality for them. Companies have recognized this and sought to manage the future financial liability it creates by voluntarily adopting the following three forms of GHG emissions pricing in advance of government action to introduce regulated DET systems.

Four of Canada's largest GHG-emitting companies – three of them thermal electricity producers – namely Ontario Power Generation, Transalta, Epcor Utilities and Suncor, have made **GHG offset purchases** in the hundreds or thousands of kilotonnes CO_2e (offsets are emission reductions physically realized outside a company's own operations).[34] Globally, the total volume of GHG offsets traded has risen from 13 Mt CO_2e in 2001, to 29 Mt in 2002, to over 70 Mt in the first ten months of 2003.[35] In 2001, more than half of this volume consisted of emission reductions with no value for regulatory compliance purposes, but in 2003, 93% of the volume consisted of reductions expected to be valid for compliance with the Kyoto Protocol.[36] (Even in the latter case, these purchases are voluntary in the sense of emitters preparing for a future regulatory regime.)

Many companies now explicitly **build GHG pricing into investment planning** processes, even for projects in countries whose emissions are not constrained by the Kyoto Protocol, to reflect

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[33] *Ibid.*

[34] M. Bramley (2002), *The Case for Kyoto: The Failure of Voluntary Corporate Action,* Pembina Institute and David Suzuki Foundation, p. 6. Available at http://www.pembina.org/publications_item.asp?id=140.

[35] F. Lecocq and K. Capoor (2003), *State and Trends of the Carbon Market 2003*, PCF*plus* Research, World Bank, p. 10–11. Available at http://carbonfinance.org/docs/StateandTrendsofCarbonMarket2003.pdf.

[36] *Ibid.*

the likelihood that GHG pricing resulting from future DET systems will nonetheless affect the economics of their projects. Among the pioneers in this area are Shell,[37] ChevronTexaco[38] and BG[39] (formerly British Gas).

BP and Shell operated full-scale **internal GHG emissions trading systems** during 1999–2001 and 2000–2002 respectively to help meet corporate GHG targets and provide real financial incentives to business units to secure emission reductions.[40] In BP's system, covering operations worldwide, 2.7 Mt CO_2e were traded in 2000 at an average price of $US7.60 per tonne. Shell's system covered facilities accounting for one third of global corporate emissions, including operations in Canada.[41]

3.2.1 Hydro-Québec's view of future GHG pricing for the CdS

Hydro-Québec has been asked to provide details of its view of future GHG pricing as applied to the CdS, differentiating the Kyoto commitment period 2008–2012 and the period post-2012.[42] However, the answers all refer to a document[43] that restricts its discussion of GHG pricing almost exclusively to 2008–2012. Hydro-Québec's description of expected GHG pricing as applied to the CdS for 2008–2012 appears to be a fair representation of the government of Canada's current thinking regarding its "Large Final Emitters" system, described below in section 3.3. But regarding the period post-2012, Hydro-Québec states only that it is difficult to predict conditions in that period, and that it expects the CdS to be "well positioned" in light of its

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[37] D. Austin and A. Sauer (2002), *Changing Oil: Emerging environmental risks and shareholder value in the oil and gas industry*, World Resources Institute, p. 13. Available at http://climate.wri.org/pubs_description.cfm?PubID=3719.

[38] M. Mansley (2003), *Sleeping Tiger, Hidden Liabilities: Amid growing risk and industry movement on climate change, ExxonMobil falls farther behind*, Claros Consulting, p. 5. Available at http://www.ceres.org/newsroom/press/exxon.htm.

[39] Innovest Strategic Value Advisors, *op. cit.*, p. 57.

[40] Pew Center on Global Climate Change, *op. cit.*, p. 47–48.

[41] R. Rosenzweig, M. Varilek and J. Jannsen (2002), *op. cit*, p. 52.

[42] Hydro-Québec (2004b), *op. cit.,* p. 31–33, 50–51.

[43] Hydro-Québec (2004a), *op. cit.,* p. 5–7, 33–40.

"very low emissions intensity for a thermal facility" (our translations). It does not appear that Hydro-Québec has considered any explicit GHG emissions pricing scenarios in its evaluation of the CdS for the latter 20 of the 25 years of the facility's minimum operational life. This is equivalent to assuming no GHG pricing at all between 2013 and 2032 – an assumption that we consider to be unrealistic in the context of the likely outlook described below in section 3.4. It also runs counter to the suggestion by institutional investors, cited in section 3.1.3, to consider "scenarios involving reductions in GHG emissions beyond existing national, regional and international targets".

3.3 The Kyoto Protocol commitment period: 2008–2012

The *Climate Change Plan for Canada*, the government of Canada's November 2002 plan for implementation of the Kyoto Protocol, stated that industrial facilities emitting large amounts of GHGs per unit of production, including thermal electricity generation facilities such as the CdS, would be subject to a "covenants and emissions trading system."[44] Natural Resources Canada has since undertaken considerable work, outlined in some 20 discussion papers,[45] to elaborate the details of this system, now known as the "Large Final Emitters" (LFE) policy or system. It can be summarized as follows:

- New federal legislation will empower the government to set, by regulation, GHG emissions targets for industrial facilities. The government is currently preparing drafting instructions for this legislation. It is also engaged in detailed discussions with sectoral associations, individual companies and, in the case of thermal electricity, with provincial governments, as to the precise levels of the targets. The regulated targets can be expected to be accompanied by stiff penalties for non-compliance. The government is seeking to set all targets in terms of emissions intensity (emissions per unit of production). The targets are to add up to a total reduction in annual emissions of 55 Mt CO_2e compared to the projected business-as-usual

[44] Government of Canada (2002), *Climate Change Plan for Canada*, available at http://www.climatechange.gc.ca/plan_for_canada/plan.

[45] See http://www.nrcan-rncan.gc.ca/lfeg-ggef/English/papers_en.htm.

level in 2010. Targets will apply to the years 2008–2012. It is unlikely that they would apply to earlier years, but they could potentially apply to later years in addition to 2008–2012.

- Facility owners will be able to combine four different ways of meeting their targets:
  - by reducing emissions from their own facilities;
  - by purchasing government-certified offset credits granted to projects that reduce emissions from sources not covered by the LFE system;
  - by purchasing emissions permits/credits from outside Canada, available through the international emissions trading mechanisms of the Kyoto Protocol; and
  - by purchasing emissions permits from companies over-achieving their targets, who will earn emissions permits in respect of the amount by which targets are exceeded.

- The government will make available special non-tradeable emissions permits at a price of $15[46] per tonne CO_2e to insure industry against the risk that the market price of emissions units (domestic credits or permits and foreign emissions units) rises above $15 per tonne.[47]

There is some uncertainty regarding the implementation of the LFE system in the eventuality that Russia fails to ratify the Kyoto Protocol and that the latter therefore fails to enter into force. However, it is worth noting that the current government of Canada, in its Throne Speech of February 2, 2004, clearly stated it would "respect its commitments to the Kyoto accord" without any reference to a need for international entry into force.[48] In light of the discussion in sections 2 (long-term international causes of contraints on GHG emissions) and 3.1.2 (moves in the US to constrain GHG emissions), it seems likely that a future federal government would pursue

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[46] All $ figures in this document are Canadian dollars unless otherwise stated.

[47] This commitment was not made in the *Climate Change Plan for Canada*. It was made in a Natural Resources Canada news release and accompanying ministerial letter to the Canadian Association of Petroleum Producers, dated December 18, 2002, and available at http://www.nrcan-rncan.gc.ca/media/newsreleases/2002/2002147_e.htm. Natural Resources Canada recently published a discussion paper, available at http://www.nrcan-rncan.gc.ca/lfeg-ggef/English/price_assurance_en.pdf, proposing a mechanism for operationalizing the commitment.

[48] See http://www.pm.gc.ca/eng/sft-ddt.asp.

implementation of the LFE system, although perhaps in a weakened form, even if it decided not to respect its Kyoto commitments.

3.3.1 The target for the CdS

The LFE system is a form of DET system linked to the international emissions trading market, putting a price on GHG emissions capped at $15 per tonne CO_2e. The government of Canada has recently published its thinking on the emissions intensity targets that the system will set for electricity generation facilities. The level of these targets will determine the financial liability accruing to the CdS during 2008–2012. The government is considering the four following options:[49]

- 370 tonnes CO_2e / GWh for new thermal facilities and thermal facilities 35 years old or older (with all other thermal facilities facing no constraints);
- 558 tonnes CO_2e / GWh for all thermal facilities;
- 455 tonnes CO_2e / GWh for all thermal facilities (in this option, the target is lower to allow for issuance of emissions permits to zero-emission facilities, such as hydro and wind);
- targets that vary by province, including about 260 tonnes CO_2e / GWh for thermal facilities in Québec.

For the first option, although it is not clear what threshold date would be used to distinguish new and existing facilities, the CdS seems almost certain to be designated a new facility. None of the options makes any distinction between coal-, oil- and gas-fired facilities. On this point there seems to be a reasonable degree of consensus among governments and industry, and the government of Canada's thinking seems unlikely to change.

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[49] Natural Resources Canada (2003), *Allocation of Greenhouse Gas Emission Reductions in the Electricity Sector*, presentation to federal/provincial/territorial meeting, Toronto, November 20, 2003. Available at http://www.nrcan-rncan.gc.ca/lfeg-ggef/English/pres1-031120_en.pdf and http://www.nrcan-rncan.gc.ca/lfeg-ggef/English/supplement1-031120_en.pdf.

All four options are designed to achieve the same result – a reduction of 15% in the GHG emissions intensity of the Canadian thermal electricity generation sector compared to the projected business-as-usual level in 2010. The government is seeking this 15% reduction because the 55 Mt CO_2e of reductions from the overall LFE system represent 15% of the 359 Mt[50] of projected business-as-usual emissions in 2010 from emission sources to be covered by the system. However, the government of Canada will come under pressure to set targets for thermal electricity generation facilities adding up to an emissions reduction significantly more than 15% below business-as-usual, for two reasons:

- The *Climate Change Plan for Canada* commits to implement programs to reduce the emissions intensity of the thermal electricity generation sector *beyond* the 55 Mt from the LFE system, implying that the intensity targets set for the sector will need to add the effects of these programs to the sector's share of the 55 Mt. For example, the *Plan* seeks to obtain 4.5 Mt of emission reductions from demonstration of "clean coal" technology.
- According to analytical work conducted for federal and provincial governments,[51] the electricity sector alone possesses opportunities to reduce annual GHG emissions by 45 Mt CO_2e at a marginal cost of less than $10 per tonne CO_2e. About 70% of these reductions are associated with efficiency improvements or fuel switching within the thermal electricity sector and could therefore be captured by the LFE system. Other industry sectors with fewer lost-cost emission reduction opportunities can argue, with good reason, that targets should be adjusted accordingly.

In order to assess the financial liability accruing to the CdS from the LFE system during 2008–2012, it is necessary to take into account not only emissions intensity targets but also likely prices of emissions permits/credits per tonne CO_2e. While the government of Canada has committed to cap the price at $15 per tonne CO_2e, the *Climate Change Plan for Canada* reports economic modelling studies predicting international prices in the range of $1–30, but with a large majority of studies in the range of $6–10. The *Plan* quotes $10 per tonne as a "most likely"

[50] Mike Beale, Environment Canada (2002), personal communication.

[51] M.K. Jaccard and Associates (2002), *Construction and Analysis of Sectoral, Regional and National Cost Curves of GHG Abatement for Canada*, report for the Cost Curves Working Group, Analysis and Modelling Group, National Climate Change Process.

international price. The government of the Netherlands and the World Bank's Prototype Carbon Fund – the largest buyers to date of international emission credits expected to be valid for compliance with the Kyoto Protocol[52] – have made most of their purchases in the range of 3–5 Euros (about $5–8) per tonne.[53] However, prices of such credits have recently been trading as high as 10 Euros (about $16) per tonne "for sellers with a very good credit rating and contracts that pose little risk to the buyer".[54]

3.3.2 Participation by Québec in the LFE system

The previous government of Québec supported the concept and participated in the development of a Canadian DET system for GHGs.[55] The policy of the present government is still represented by the previous government's *Plan d'action québécois 2000–2002 sur les changements climatiques*.[56] The *Plan*[57] included establishment of a pilot GHG emission reduction trading program, a program to raise awareness about the Kyoto Protocol's emissions trading mechanisms, and modification of the *Loi sur la qualité de l'environnement* to give the government authority to implement a GHG emissions trading system.

Beyond supporting the concept of a Canadian DET system, Québec governments have consistently supported Canada's participation in the Kyoto Protocol and the UNFCCC. The present government of Québec speaks of a February 2003 Parliamentary Commission having

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[52] F. Lecocq and K. Capoor, *op. cit.,* p. 12.

[53] Joint Implementation Network (October 2003), *Joint Implementation Quarterly* vol. 9 no. 3, p. 1. Available at http://www.northsea.nl/jiq.

[54] Evolution Markets (March 2004), *Greenhouse Gas Markets, Monthly Market Update*, p. 1.

[55] For example, the previous government of Québec participated in the Tradeable Permits Working Group under the National Climate Change Process and in the Greenhouse Gas Emission Reduction Trading Pilot. It also "subscribed, in general terms, to the idea of implementing a Canadian DET system as proposed in the federal plan" (our translation). See Ministère de l'Environnement du Québec (2003), *Contexte et orientations du gouvernement du Québec pour la mise en oeuvre du Protocole de Kyoto au Québec*, document de référence aux fins des audiences générales de la commission parlementaire sur les transports et l'environnement, p. 33. Available at http://www.menv.gouv.qc.ca/publications/2003/ENV20030022.htm.

[56] Ministère de l'Environnement du Québec, *op. cit.*, p. 6.

[57] See http://www.menv.gouv.qc.ca/changements/plan_action.

"confirmed Québec's intentions to reducing its emissions to 6% below the 1990 level" (i.e., in line with Canada's Kyoto Protocol target) (our translation).[58] There is discontent in Québec regarding the general approach to target setting in the federal LFE system, because of its generosity to high-growth sectors with rapidly rising emissions, notably oil and gas and thermal electricity itself. But taking all these factors into account, it does not appear likely that a government of Québec will strongly object to the setting of targets for thermal electricity generation facilities in the general vicinity of those outlined in section 3.3.1. In any case, the government of Canada believes strongly that it has the constitutional authority to regulate such targets throughout Canada, although it has also expressed a willingness to consider "equivalency agreements" under which the targets would be applied through equivalent provincial legislation.[59]

Discussion of the implications of sections 3.3.1–3.3.2 for Hydro-Québec's financial liability for GHG emissions from the CdS will be pursued in section 4.

3.4 Emissions allocations and prices during 2013–2032

Four-fifths of the minimum expected life of the CdS extends beyond the Kyoto Protocol commitment period of 2008–2012. As noted in section 2, given that the Kyoto Protocol falls very far short of the UNFCCC's objective of stabilizing atmospheric GHG concentrations, a series of amendments to the protocol or successor treaties, setting increasingly demanding national emissions targets, will be needed over several decades post-2012 to implement the UNFCCC. This scenario can be considered likely in view of the strength of the scientific basis for human-induced climate change, its acceptance by governments and most stakeholders, and the existing political commitments that have been made by governments.

These commitments are now beginning to go beyond the UNFCCC and the Kyoto Protocol:

[58] Ministère de l'Environnement du Québec, *op. cit.*, p. 6.

[59] See http://www.nrcan-rncan.gc.ca/lfeg-ggef/English/equiv_agreement_en.pdf.

- The government of the United Kingdom recently published an *Energy White Paper* that sets the goal of cutting the UK's CO_2 emissions to 60% below the 1990 level by 2050.[60] The paper was accompanied by a detailed scientific argument,[61] based on the work of the IPCC and the UK's Royal Commission on Environmental Pollution, making the case for this 60% reduction target.
- The government of Sweden has established the objective of reducing Sweden's per-capita GHG emissions to 43% below the current level by 2050.[62]
- The European Union has adopted a target of stabilizing GHG concentrations at 550 ppm, which will require global GHG emissions to decrease by 60–80% relative to current levels by 2100.[63]
- The German Advisory Council on Climate Change (WBGU), an independent scientific advisory body to the German government, has recommended that the CO_2 concentration be stabilized below 450 parts per million (ppm). "This will only be possible if global energy-related CO_2 emissions can be reduced by about 45–60% from 1990 levels… industrialized countries must reduce their greenhouse gas emissions by at least 20% by 2020."[64]
- The international Climate Action Network has argued, also on the basis of IPCC science, that meeting the objective of the UNFCCC requires an 80% reduction in industrialized countries' GHG emissions below 1990 levels by 2050.[65]

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[60] See http://www.dti.gov.uk/energy/whitepaper.

[61] Department for Environment, Food and Rural Affairs (2003), *The scientific case for setting a long-term emission reduction target*. Available at http://www.defra.gov.uk/environment/climatechange/ewpscience.

[62] Swedish Ministry of the Environment (2001), *The Swedish Climate Strategy*, Summary Gov. Bill 2001/02:55, p. 15. Available at http://www.miljo.regeringen.se/english/public.htm.

[63] Swedish Environmental Protection Agency (2002), *Kyoto and Beyond: Issues and Options in the Global Response to Climate Change*, p. 13, 19. Available at http://www.internat.naturvardsverket.se/documents/issues/climate/report/Kyoto.pdf.

[64] German Advisory Council on Global Change (2003), *Climate Protection Strategies for the 21st Century: Kyoto and beyond*, p.2. Available at http://www.wbgu.de/wbgu_sn2003_engl.html.

[65] Climate Action Network (2002), *Preventing Dangerous Climate Change*, p. 11. Available at http://www.climatenetwork.org/pages/publications.html.

Deep emission reductions of this order are even finding support among some of the world's largest industrial GHG emitters. The CEO of BP, the major oil company, said recently that "we've come to the judgement that to avoid serious impact upon societies or the environment it is necessary to stabilise atmospheric concentrations of greenhouse gases at around 500–550 parts per million"; and that "stabilisation in the range 500–550 ppm is possible, and with care could be achieved without disrupting economic growth".[66] Shell has also put forward scenarios that allow the atmospheric GHG concentration to stabilize below 550 ppm.[67] As noted above, stabilization at this level will require global GHG emissions to decrease by 60–80% relative to current levels by 2100.

Increasingly demanding national emissions targets during the decades post-2012, combined with emissions pricing, implemented through DET systems, as governments' method of choice to control GHG emissions from large industrial facilities (see section 3.1), will likely translate into two main consequences with direct implications for the financial liability of industrial GHG emitters. These are discussed in sections 3.4.1 and 3.4.2.

3.4.1 Falling allocations

Emissions targets in DET systems are implemented in the form of free allocations of emissions rights. For example, for 2008–2012, the targets set by Canada's LFE system will be operationalized as free allocations of emissions permits to industrial emitters. As national GHG emissions targets decrease, post-2012, the allocations of emissions rights that governments are willing to pass on at no cost to industrial emitters in their countries will correspondingly fall.

A second reason why free allocation of emission rights to industrial emitters will likely fall is that free allocation of emission rights can be viewed as the opposite of the polluter-pays principle

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[66] *Climate Change*, speech by Lord Browne to the Institutional Investors Group, London, November 26, 2003. Available at http://www.bp.com/genericarticle.do?categoryId=98&contentId=2015334.

[67] *Prudence pays – practical steps to bridge conflicting views on climate change*, speech by Sir Philip Watts at Rice University, Houston, March 12, 2003. Available at http://www.shell.com/static/media-en/downloads/speeches/pw_rice120303.pdf.

(according to which all emission rights would have to be paid for, i.e. a zero free allocation of emission rights). The government of Canada has subscribed to two justifications for providing exemptions to the polluter-pays principle, i.e. free allocation of GHG emissions rights to industrial emitters in a DET system: (i) preventing capital losses associated with the imposition of GHG constraints on capital stock existing prior to the introduction of the system; and (ii) protecting the competitiveness of Canadian facilities that compete with facilities in countries where there is no regulatory use of GHG emissions pricing.[68] The first justification will fade away post-2012 as capital stock turns over. With regard to thermal electricity facilities, the second justification can also be expected to recede if, post-2012, the strong scientific case for action (see section 2), the views of future US administrations and the significant state-level and congressional moves in the US (see section 3.1.2) towards GHG emissions pricing all combine to bring the US to participate in international legally binding instruments to constrain GHG emissions, or to implement comparable domestic contraints unilaterally.

Thirdly, governments are already interested in the concept of auctioning off a portion of available GHG emissions rights, as evidenced by the provision for an element of auctioning in the EU DET system.[69] Auctioning emissions rights provides revenue that governments can deploy to further accelerate the pace of GHG emission reductions in the economy. As the role of auctioning increases, so the free allocation of emission rights to emitters falls.

3.4.2 Rising GHG prices

A second likely consequence of increasingly demanding national emissions targets during the decades post-2012 are increasingly higher GHG prices. The future evolution of GHG prices depends on the interaction of two factors: the severity of international constraints on GHG

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[68] Tradeable Permits Working Group (2000), *Using Tradeable Emissions Permits to Help Achieve Domestic Greenhouse Gas Objectives*, National Climate Change Process, p. 42. Available at http://www.nccp.ca/NCCP/national_process/issues/tradable_e.html#options. While this report was the work of a multistakeholder group including government of Canada officials, it was a good representation of government views at the time.

[69] See See http://europa.eu.int/comm/environment/climat/emission.htm.

emissions; and progress in lowering the costs of low-emission technologies. It would appear to be a good bet that constraints on GHG emissions close to those cited at the beginning of section 3.4 (60–80% reductions by 2050–2100) will outpace technological progress, leading to increasingly higher GHG prices. For example, the IPCC recently stated that: "Stabilization of atmospheric CO_2 concentration at levels below about 600 ppm is only possible with reductions in carbon intensity and/or energy intensity greater than have been achieved historically... The historically recorded annual rates of improvement of global energy intensity (1 to 1.5% per year) would have to be increased and maintained over long time frames to achieve stabilization of CO_2 concentrations at about 600 ppm or below. Carbon intensity (carbon per unit energy produced) reduction rates would eventually have to change by even more (e.g., up to 1.5% per year (the historical baseline is 0.3 to 0.4% per year))."[70]

Further evidence for increasingly higher GHG prices is provided by economic modelling studies reviewed by the IPCC, suggesting that substantial (e.g. 25%) emissions reductions in industrialized countries imply mid-range GHG prices of about $US 200 per tonne of carbon, i.e. about $80 (Canadian) per tonne CO_2.[71] The German Advisory Council on Climate Change study cited above also projects GHG prices approaching $US 200 per tonne of carbon by 2030 in scenarios consistent with the Council's objectives for stabilizing atmospheric GHG concentrations.[72]

There is some evidence of political tolerance (i.e. by governments) of GHG prices substantially higher than the $15/tonne CO_2e price cap that will be in place in Canada during 2008–2012:

- prices in the United Kingdom's GHG DET system temporarily rose above £12 (about $28) per tonne CO_2 in September 2002;[73]
- the *Climate Change Plan for Canada* envisages the possibility that the international GHG price could be as high as $50 per tonne CO_2e during 2008–2012, while presenting

[70] IPCC (2001), *Climate Change 2001: Synthesis Report*, p. 93. Available at http://www.ipcc.ch/pub/syreng.htm.

[71] IPCC (2001), *Climate Change 2001: Mitigation*, section 8.2.2.1.1. Available at http://www.grida.no/climate/ipcc_tar/wg3/327.htm.

[72] German Advisory Council on Global Change, *op. cit.,* p. 43.

[73] Innovest Strategic Value Advisors, *op. cit.*, p. 29.

economic modelling results showing only relatively modest macroeconomic impacts at that price;[74]

- prior to the US withdrawal from the Kyoto Protocol in 2001, the government of Canada was planning for the international GHG price during 2008–2012 to be in the range of $24–58 per tonne CO_2e.[75]

4. Potential financial liability to Hydro-Québec

It is important to be clear that when comparing the financial liability for GHG emissions of the CdS and other competing options for managing electricity supply and demand, the liability should be evaluated for each option alone. Hydro-Québec, in discussing the financial liability for the GHG emissions of the CdS, seems to suggest that possible financial benefits from the low/zero GHG emissions level of its hydro and wind facilities be included in this evaluation.[76] This would be equivalent to arguing that low-emission facilities should subsidize, in emissions terms, high-emission facilities. It is not generally considered sound business practice to include in the financial analysis of a company's new business projects their ongoing subsidization by the company's other activities.

There are too many policy uncertainties to calculate the precise financial liability to Hydro-Québec for GHG emissions from the CdS. However, we can propose some plausible scenarios for future GHG emissions allocations and prices and calculate the financial liability that they would represent to Hydro-Québec. In light of the evidence and analysis presented in sections 2–3, we stress that the following scenarios should be considered to be roughly mid-range: there are plausible scenarios that represent both a somewhat greater and a somewhat lesser financial liability to Hydro-Québec.

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[74] Government of Canada, *op. cit.*, p. 63–64.

[75] Analysis and Modelling Group (2000), *An Assessment of the Economic and Environment Implications for Canada of the Kyoto Protocol*, National Climate Change Process, p. 19–20. Available at http://www.nccp.ca/NCCP/national_process/issues/analysis_e.html#final.

[76] Hydro-Québec (2004a), *op. cit.*, p. 7.

4.1 Scenarios

We have used the following scenarios:

Years	Scenario 1		Scenario 2		Scenario 3	
	Free emission rights allocated (% of actual emissions)	Price per tonne CO_2e ($)	Free emission rights allocated (% of actual emissions)	Price per tonne CO_2e ($)	Free emission rights allocated (% of actual emissions)	Price per tonne CO_2e ($)
2008–2012	111	10	111	15	111	10
2013–2017	50	30	50	50	80	30
2018–2022	25	50	25	80	50	50
2023–2032	0	80	0	100	50	80

4.1.1 Scenario 1

In this scenario, we assume that the first option in section 3.3.1 will be chosen for targets for thermal electricity facilities under the LFE system for 2008–2012: 370 tonnes CO_2e / GWh for new facilities. This represents 111% of the actual emissions of the CdS (334 tonnes/GWh). This option appears quite likely, as it avoids providing a large surplus of emissions permits to CCGT facilities, and is reasonably consistent with positions taken by the government of Alberta and the electricity industry. It is also conservatively assumed that the government of Canada's expectation of $10 per tonne CO_2e as a "most likely" international price (section 3.3.1) is borne out. However, as will be seen in section 4.2, the assumptions made for 2008–2012 have little bearing on the financial liability over the full life of the CdS.

Post-2012, the GHG price is assumed to rise initially to $30 per tonne, then $50, still well within the range of prices that have already been envisaged for 2008–2012 (see section 3.4.2), but the free allocation of emission rights is assumed to fall to 50% of actual emissions, then 25%, in light of the reasons discussed in section 3.4.1. From 2023 onwards, there is assumed to be no free allocation of emission rights, while the GHG price is assumed to rise to $80 per tonne, a price in line with the expectations reported in section 3.4.2.

4.1.2 Scenarios 2 and 3

Scenarios 2 and 3 are variations on scenario 1. In Scenario 2, the free allocation of emission rights is unchanged from scenario 1, but the GHG price rises more quickly and higher. During 2008–2012, this means that the GHG price would reach the government of Canada's maximum level of $15 (see section 3.3.1). Post-2012, the GHG price jumps to $50 per tonne, still within the range of prices that have already been envisaged for 2008–2012 (see section 3.4.2), then to $80 and finally to $100, reflecting the eventuality that a tough international regime of GHG constraints coincides with slower progress in lowering the costs of low-emission technologies.

In Scenario 3, GHG prices are unchanged from scenario 1, but the free allocation of emission rights is more generous, initially falling to 80% of actual emissions, and then remaining at 50% for the remainder of the life of the CdS. This would reflect an Alberta-style approach (Alberta's climate change action plan, presented as an "alternative" to the Kyoto Protocol, requires the province's GHG emissions intensity to fall to 50% below the 1990 level by 2020).

4.2 Results

4.2.1 Liability to Hydro-Québec

The financial liability to Hydro-Québec from the three scenarios has been calculated and is summarized in the following table. The liabilities per kilowatt-hour (kWh) have been calculated assuming annual production of 6737 GWh, a number consistent with those reproduced in section 1. The present value figures have been calculated using a discount rate of 8%, a rate commonly used in electricity sector analysis.

Years	Liabilities	Scenario 1	Scenario 2	Scenario 3
2008–2012	$million/year	-2.5	-3.7	-2.5
	¢/kWh	-0.037	-0.055	-0.037
2013–2017	$million/year	34	56	14
	¢/kWh	0.50	0.83	0.20
2018–2022	$million/year	84	135	56
	¢/kWh	1.3	2.0	0.83
2023–2032	$million/year	180	225	90
	¢/kWh	2.7	3.3	1.3
Full life (2008–2032)	$million present value in 2008	668	933	347

These results show the GHG emissions from the CdS initially representing a small financial benefit to Hydro-Québec during the Kyoto Protocol commitment period (2008–2012). But they also show that financial liability for GHG emissions could plausibly grow rapidly to quite high levels post-2012. That liability could be between $90 million and $225 million per year, or between 1.3 and 3.3 ¢/kWh, during the final 10 years of the facility's life. In all three scenarios those final 10 years account for over half of the present value of financial liability over the full facility life, which ranges from $347 million to $933 million.

Overall, these results underline the critical importance of considering explicit GHG emissions pricing scenarios post-2012 – something that Hydro-Québec does not appear to have done (see section 3.2.1).

4.2.2 Impact on a comparison of options for managing electricity supply and demand

It is beyond the scope of this paper to undertake a comparison of options for managing electricity supply and demand in Québec with and without the CdS. However, the results presented above clearly indicate that the financial liability from GHG emissions pricing is an important factor that should be included in any such comparison, which would normally include zero-emission

generation as well as demand side management options. The comparison would need to take into account not only the financial liability for GHG emissions from the CdS, but also the prospects of governments implementing, during the life of the CdS, the following policies to support zero-emission electricity generation facilities and demand side management activities:

- provision of tradeable GHG permits or credits to such facilities/activities;[77]
- provision of direct financial incentives to such facilities/activities;[78]
- quotas for renewable electricity production (renewable portfolio standards) or for consumer demand reduction.

4.3 Liability to governments

It can of course be debated whether or not the CdS would face free allocations of emission rights within the range of scenarios 1–3 above. It is possible, for example, that governments would want to "grandfather" the generous free allocations that characterize the facility's early years well into the latter years of its life. *It is important to note that this possibility would not remove the financial liability calculated above.* Instead, if Canada remained bound by the kinds of constraints on national GHG emissions that we have argued are likely (section 3.4), then that liability would have to be transferred to governments (i.e., taxpayers), consumers or else to other economic sectors.

A transfer of burgeoning financial liability for thermal electricity generation in Québec from Hydro-Québec to all taxpayers/consumers, or to other business sectors, could represent a political challenge. It is questionable whether governments would be willing to shoulder indefinitely the bulk of the financial responsibility for the GHG emissions from thermal electricity generation, thereby, in effect, significantly subsidizing it.

[77] This is the topic of a recent discussion paper by Natural Resources Canada, available at http://www.nrcan-rncan.gc.ca/lfeg-ggef/English/papers_en.htm.

[78] For example, the federal Wind Power Production Incentive.

5. Summary of key points

- Major Canadian sources of GHGs, notably large industrial facilities such as the *Centrale du Suroît* (CdS), face regulatory constraints on their greenhouse gas (GHG) emissions beginning no later than 2008, and likely becoming increasingly severe post-2012. Governments are expected to impose these constraints through emissions pricing, implemented through emissions trading systems, most likely translating directly into an increasing financial liability for facilities such as the CdS.
- There are too many policy uncertainties to calculate the precise financial liability to Hydro-Québec for GHG emissions from the CdS. However, we have proposed three plausible, roughly mid-range scenarios and calculated the financial liability that they would represent. Our results show the GHG emissions from the CdS initially representing a small financial benefit during the Kyoto Protocol commitment period (2008–2012). But they also show that financial liability for GHG emissions could plausibly grow rapidly to quite high levels post-2012. That liability could be between $90 million and $225 million per year, or between 1.3 and 3.3 ¢/kWh, during the final 10 years of the facility's minimum 25-year life. The present value of financial liability over the full facility life ranges, in our scenarios, from $347 million to $933 million (using an 8% discount rate).
- **These results underline the critical importance of considering explicit GHG emissions pricing scenarios post-2012 in any comparison of options for managing electricity supply and demand in Québec with and without the CdS.** However, it does not appear that Hydro-Québec has considered any explicit GHG emissions pricing scenarios post-2012 in its evaluation of the CdS.
- When comparing the financial liability for GHG emissions of the CdS and other competing options, the liability should be evaluated for each option alone. Hydro-Québec seems to suggest that possible financial benefits from the low/zero GHG emissions level of its hydro and wind facilities be included in this evaluation. This would be equivalent to arguing that low-emission facilities should subsidize, in emissions terms, high-emission facilities. It is not generally considered sound business practice to include in the financial analysis of a company's new business projects their ongoing subsidization by the company's other activities.