Integrating electricity sectors in Canada: Good for the environment and for the economy

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March 2012

THE FEDERAL IDEA
A Quebec Think Tank on Federalism

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INTRODUCTION

In July 2011, the foundation for a collaborative action plan by Canadian provinces on energy was built at the annual conference of the energy and mines ministers in Canada, in Kananaskis, Alberta. This draft Canadian energy strategy has particular support from the Western provinces, who recently committed themselves to promoting the idea at the federal level as part of their New West Partnership, bringing together British Columbia, Alberta and Saskatchewan. Many other groups financed by energy industry associations (essentially the oil and natural gas sectors) are also promoting a Canadian energy policy: the Energy Policy Institute of Canada, the Energy Framework Initiative, and the members of the Winnipeg Consensus are indeed very active in the promotion of such a harmonization of the various provincial energy regulatory regimes.

Paradoxically, in the electricity sector, where regulatory regimes are more divergent from one province to another than in the hydrocarbon sectors, the players are far less motivated to press for increased integration of infrastructures, commercial practices and legislation. The best illustration of the current issues in the electricity sector is probably the strained relationship between Québec and Newfoundland and Labrador regarding the Lower Churchill hydroelectric development: regulatory and business disputes over access to Québec's transmission lines, controversy over loan guarantees offered by the federal government for a provincial project, and a contamination of relations on other matters, such as the development of the Old Harry oil deposit in the Gulf of St. Lawrence. The electricity sector is very important, not only because all other economic and social activities are directly dependent on devices that use electricity (far more than for oil and natural gas), but also because electricity is a source of a major competitive advantage for Canada (in the aluminum, mines, and pulp and paper industries, among others). Also, with its 14% share of Canada's greenhouse gas (GHG) emissions, electricity production is the second largest GHG source after the transportation sector (27%).

Thus, if the Canadian provinces wish to give themselves the greatest chance of to develop their economy by avoiding heavy and unnecessary investments in energy infrastructure, and to minimize the environmental impact of this sector, they have no other choice but to talk about a shared platform on which they can transform and integrate their electricity markets.Obviously , such a project faces major obstacles. The potential economic, environmental and even social benefits are so great, however, that grounds for agreement should be sought. This document is intended to show why a plan for collaboration and integration of the electricity sectors in Canada, and even North America, is not only desirable, but necessary. The first part looks at the benefits and the various models of integration of the electricity sector, with illustrations drawn from various international initiatives. The main challenge of integration is also identified: access to hydraulic resources, which should be open to all, without geographic discrimination. This is followed by a description of the main projects, either completed or aborted, for interprovincial collaboration and integration in the electricity sector, showing not only that there is a solid base on which to build, but also that the benefits of integration have already been studied on various occasions. Finally, drawing from the lessons of the theoretical and historical sections, a series of approaches are proposed to achieve success in moving towards an integrated structure for the Canadian electricity markets.

1 INTEGRATING ELECTRICITY SECTORS – A GLOBAL PERSPECTIVE

Integration players and international examples

On the international scene, the integration of electricity sectors has been pursued by many organizations over the past decade. The UN has published many reports on the subject (see in particular UNECA, 2004, and UN, 2006), as have the World Bank (ESMAP, 2010), the World Energy Council (WEC, 2010), the Organization of American States (OAS, 2007) and even the Commission for Environmental Cooperation (CEC, 2002), which is a North American organization established in 1994 along with the North American Free Trade Agreement (NAFTA). Companies such as Hydro-Québec have also promoted electricity integration through the Global Sustainable Electricity Partnership, which in 2000 published a guide on regional cooperation and integration in the energy sector (E7, 2000). In Canada, the Canadian Electricity Association (CEA, 2007), the Canadian Academy of Engineering (CAE, 2009) and think-tanks like the C.D. Howe Institute (Pierce et al., 2006) all favour greater integration in the electricity sector.

Despite several examples of pan-Canadian cooperation (described in the next section), no initiative can compare with the most significant international experiences. The Nordic countries (Norway, Sweden, Finland and Denmark) have, since 1996, built a common market in electricity, within which these four sovereign countries have voluntarily harmonized their laws structuring the electricity sector. This has brought a convergence of infrastructure and commercial practices. The European Union has also proceeded with an integration of the various electricity markets of its members since 1996, but its legalistic approach, with various directives issued in 1996, 2003 and 2009 establishing common rules for the internal electricity market, barely attains the goal of a real common market between member countries. In the United States, the PJM interconnection (bringing Pennsylvania and New Jersey together since 1927) joins today 14 Mid-Atlantic States and offers an integrated platform for electricity trade and management . In the rest of the world, many international initiatives have taken place in Latin America: the interconnection project of six Central American countries (Sistema de Interconexión Eléctrica de los Países de América Central, SEIPAC), in the Andean community (Peru, Colombia, Ecuador, Bolivia, Venezuela) and in Mercosur. Various groups of African and Asian countries have also undertaken ambitious integration processes in their electrical sectors.

Expected benefits

Various types of benefits are generally expected in these integration initiatives: technical benefits, which can translate into economic as well as environmental and social benefits. The following list summarizes these potential technical benefits, as discussed in the literature (CEC, 2002; UN, 2006; and ESMAP, 2010).

1. **Improving reliability and pooling reserves.** With access to the production facilities of its neighbours, each region gains access to much greater resources to meet the demand in the case of an accident on its territory. This increases reliability and reduces the need for local reserves of production capacity.
2. **Reduced investment in generating capacity.** Thanks to this pooling, each region can avoid costs of adding further capacity in its own.
3. **Improving load factors and increasing demand diversity.** Greater geographic reach often provides a more diverse demand, where peak periods do not coincide. This helps to avoid operating generating plants only for peak periods, and it uses the generator fleet in a more constant and efficient manner.
4. **Economies of scale in new construction.** With guaranteed access to a much larger market, larger generating stations can be installed, gaining economies of scale.
5. **Diversity of generation mix and supply security.** With more types of generation producing electricity, over a larger territory, the system is less exposed to events that affect a particular source of energy (low rainfall, lack of fuel, etc.). This increases the overall security of the integrated system.
6. **Economic exchange.** With a more diversified generating fleet and production costs, it is possible to use less costly technologies, situated in other regions, to meet various energy needs. It becomes possible to use lower cost, but distant, energy resources if equivalent local resources are not available. This reduces the overall operating costs of the system.
7. **Environmental dispatch and new plant siting.** With a larger territory in which to choose the location of generation facilities, the best sites can be chosen (for example, areas with less fragile ecosystems or zones with the most favourable winds for wind power).
8. **Better coordination of maintenance schedules.** Greater flexibility and reduced impact can be obtained with a more extensive production fleet.

All of these technical benefits translate into greater economic efficiency, by reducing overall investments and production costs. Also, greater competition between the players in different regions can bring greater efficiency and innovations that are beneficial for the entire society.

In a more concrete manner, Box 1 illustrates the reduction of energy needs when two regions are integrated, compared to the situation where they plan and operate independently. This example relies on the gains enumerated above in points 2 (reduced investment in generating capacity) and 6 (economic exchange), but requires an adjustment of heating systems.

Box 1
Gains from integration in meeting energy needs

Hydraulic force is converted into electricity with high efficiency, without loss of heat. This electricity can therefore be used for various electric devices or for heating, as is often the case in Québec. If no more hydroelectric potential is available, as in Ontario, natural gas is often chosen as an energy source for generating electricity. Natural gas can be transformed into electricity with an efficiency of about 54% (in combined cycle generation) or it can be transformed into heat, with an efficiency of 85% (intermediate energy-efficiency boilers).

Rather than using hydroelectricity for heating, it would be more efficient overall to use it to avoid producing electricity from natural gas, to eliminate this less efficient use (at 54%) and use natural gas where it is more efficient, for heating (85%). In this way, as the table illustrates, an integrated approach can meet the same overall needs in electricity and heating with a 13.5% lower utilization of primary energy.

		Needs of thermal region A		Needs of thermal region B		Needs of integrated regions A+B	
		Electricity 1	Heating 1	Electricity 1	Heating 1	Electricity 2	Heating 2
Energy source	**Hydro**	X	X	1	1	2	X
	Natural gas*	1.86	1.18	X	X	X	2.35
	Sub-total	3.03		2		4.35	
	Total	5.03				4.35 **(-13.5%)**	

*With an efficiency of 54%, 1.86 units of natural gas are required to obtain a unit of electricity (1.86 X 54% = 1), while 1.18 units of natural gas are required to produce a unit of heat (1.18 X 85% = 1).

Evidently, greater energy efficiency in satisfying needs is also a source of reduction in energy consumption. This approach should be promoted in all cases as well.

Of course, integration involves some costs that must be taken into account: the cost of interconnections between the region, and also those of coordination and harmonization of practices. These can represent a major initial investment. The redistribution of certain benefits also represents a major obstacle – not because of additional costs, but because certain groups would lose (for example, the loss of privileged access to low cost electricity).

The models

Historically, when different regions have been connected by transmission lines, they have traded electricity. These trades have remained marginal, however: integrated into long-term planning, offering little operational flexibility, and above all leaving intact the respective regulations of the parties involved. This is called “shallow integration”, as opposed to “deep integration”, where not only is infrastructure shared, but also similar market conditions and regulation. Four levels of integration can thus be identified, as presented in Table 1. These levels represent increasing integration, and form a perfect continuum.

Table 1 Four levels of integration (inspired by UNECA, 2004)				
	1 **Physical interconnection**	**2** **Loose power pool**	**3** **Tight power pool**	**4** **Competitive electricity market**
Planning	Independent but with information exchange	Independent but with certain common projects	Common	Left to market forces (under the monitoring of regulators)
System operation	Synchronization of activities	Coordination of production	Centralized planning	Independent network operator
Basis for electricity trades	Firm long term or emergency contracts	Benefit sharing	Benefit sharing	Competitive market
Sources of cost reduction	Economies of scale	+ reliability and reserves	+ minimization of total production costs	+ competition
Price	Set in a distinct manner	Set in a distinct manner but directly influenced	Set in a common process	Freely set by the marketplace
Regulation	Independent	Independent	Common	Common

Physical interconnection leaves the different regions very independent in regulatory and commercial terms. Integration exists only through certain physical links and with very structured trades. A Canadian example is the 5,150 megawatt (MW) interconnection between Labrador and Québec, which allows Hydro-Québec to receive annually about 30 terawatt hours[1] (TWh) of energy without the two provinces having any interaction beyond the contract that deals with this transfer. This contract is discussed further below. In a loose power pool, there is more coordination in both planning and production, with some efforts to share resources, but each region keeps its own regulatory institutions and commercial practices. It is only in a tight power pool that integration goes beyond physical links and limited, structured, trades. In this case, there are converging or similar regulations, and similar commercial practices. Finally, in a competitive electricity market, the characteristics of a common energy pool are found, but with greater emphasis placed on market forces. Regulation is reduced in favour of competition. The physical, regulatory and commercial infrastructures converge between the regions.

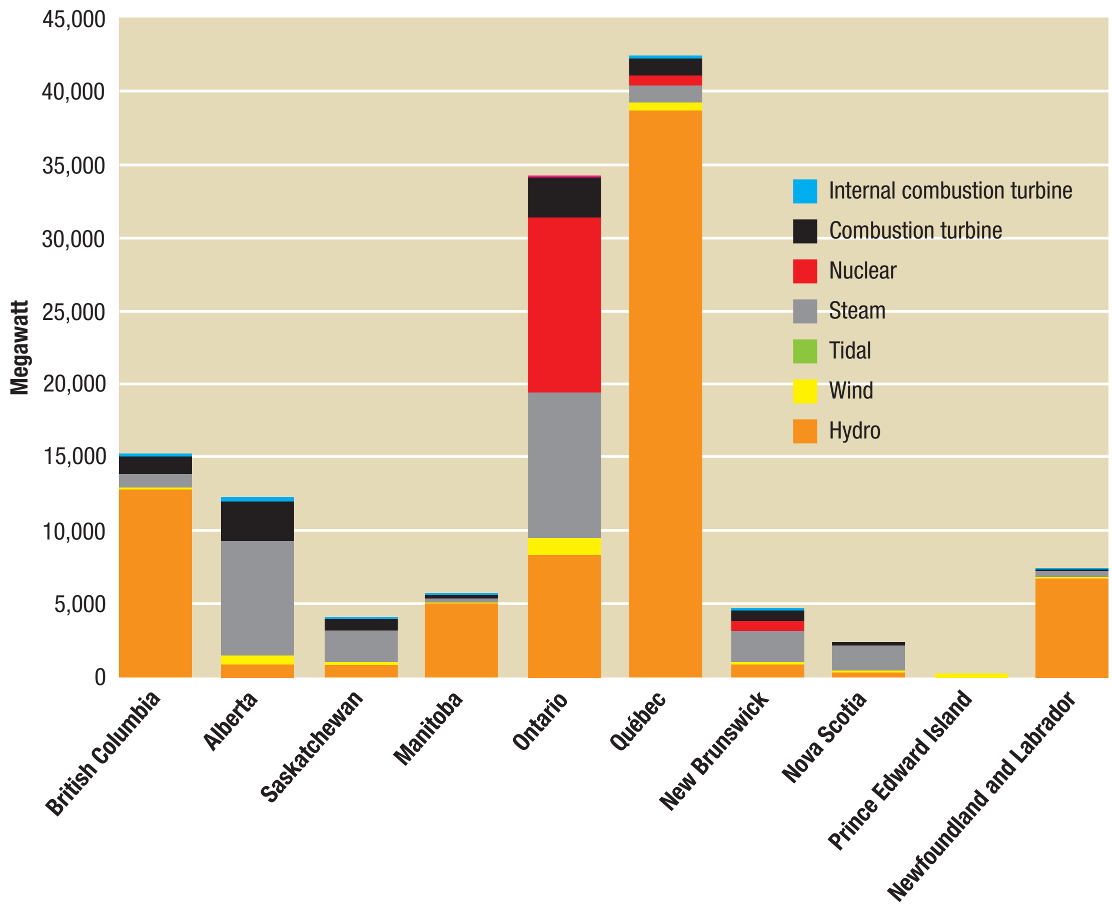
While some North American regions have adopted quite advanced levels of integration (3 or 4), such as the Southern Power Pool (with member companies from 9 American states: Arkansas, Kansas, Louisiana, Mississippi, Missouri, Nebraska, New Mexico, Oklahoma and Texas) and the PJM interconnection, most American states and all of the Canadian provinces operate their electricity sectors independently, at integration levels equivalent to that of physical interconnection, or occasionally that of a loose electricity pool. While this does not prevent companies from being active in competitive electricity markets beyond their borders (Hydro Québec, Manitoba Hydro or BC Hydro are active, for example, in the open markets of New York, Ontario, or Alberta), the prices, internal regulation and infrastructures are established independently, which does not allow for the majority of the benefits described above.

1. 1 terawatt hour = 1 billion kilowatt hours (kWh). The average consumption of a Canadian household was around 12,000 kWh for the year 2009 and around 18,500 kWh in Québec. Québec's imports of electricity from Newfoundland and Labrador (around 30 TWh per year) therefore supply the electricity needs of 45% of Québec households.

The electricity sectors in Canada

As shown in Figure 1, electricity production capacity in Canada is dominated by hydroelectricity in four provinces (British Columbia, Manitoba, Québec, and Newfoundland and Labrador). The other provinces have had to install steam thermal power (using coal), nuclear power, or combustion turbines (most often using natural gas). These are the three types of technologies which dominate the production of electricity in the six other provinces (Alberta, Saskatchewan, Ontario, New Brunswick, Nova Scotia and Prince Edward Island).

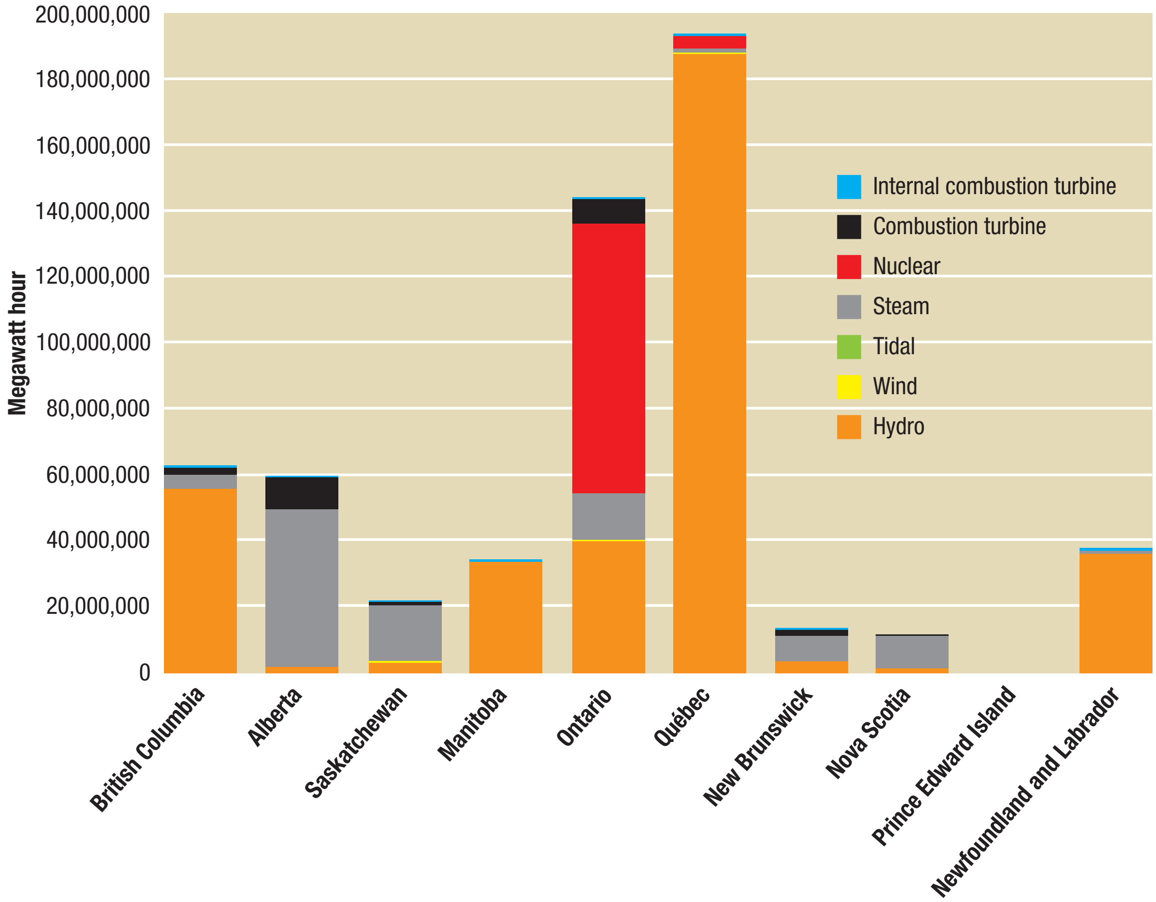
Figure 1
Electricity production capacity by province and by type of production in 2009 (MW)
(Statistics Canada, 2012a)



Note that internal combustion turbines (most often using diesel) are used in isolated regions or as emergency generators (for example, in hospitals), and that wind and tidal capacity exist in some provinces.

The production of electricity is largely determined by the available resources. Figure 2 illustrates this. However, it should be noted that because of their low cost, hydroelectric, nuclear, and steam turbines (using coal) represent a greater proportion of total production than their respective share of total capacity. Hence, while Québec's hydraulic capacity represents 91% of total capacity, hydraulic production accounts for 97% of total production. Similarly, in Alberta, coal thermal generation produces 81% of the electricity while it represents only 63% of total capacity. This is explained by the fact that these power stations operate more often, while other power stations are left inactive more often.

Figure 2
Production of electricity by province and by type of production in 2009 (MWh)
(Statistics Canada, 2012b)



These provincial differences and the divergent regulations and rates lead to major variations in the levels of electricity prices and consumption (see particularly Pineau, 2009 for more details). For example, while 77% of Québec households use electricity as their principal source of energy for heating, this is so for only 19% of Ontario households, which mainly use natural gas (NRCan, 2010). Québec households living in houses use twice as much electricity as equivalent Ontario households, and those in apartments use 1.3 times more. As explained in Box 1, this type of use of electrical energy is inefficient, because heating with natural gas is more efficient than the production of electricity from natural gas. However, with a limited hydraulic and nuclear production capacity and a wish to reduce its use of coal, Ontario has increasingly turned to natural gas to produce electricity.

Beyond sub-optimal choices of energy sources for certain applications, provincial planning of electricity sectors leads to production inefficiencies in the choice of technologies (type 3 and 7 on the list of expected benefits). Thus, to satisfy a peak demand which comes only rarely, Québec relies on steam generators (operating on diesel fuel) and combustion turbines, which are very seldom used (13.2% and 1.9% of the time in 2009, as indicated by lines D and F of Table 2), while the norm in other provinces is much higher. If Québec could count on better access to production in neighbouring jurisdictions, maintaining this production capacity (more than 2,000 MW, or 5% of Québec's total capacity) could be avoided.

In the case of wind power, the provincial choices are even more aberrant: wind generators have been installed in regions where they produce power less than 10% of the time (Alberta, Ontario, Québec, Prince Edward Island; see Line B of Table 2), while in Saskatchewan and Nova Scotia the load factors (percentage of utilization of capacity) are 38.5% and 18.3%. Given that the installation costs for wind power are similar from one region to another their profitability is directly affected by their production level. The optimal sites within a province may be inefficient from a larger perspective. Without any doubt, it would have been preferable to install all of Canada's wind generators in Saskatchewan, where they are four times more productive than in Québec and where, above all, such production replaces electricity produced from coal. In Québec, wind power substitutes essentially for hydroelectricity, providing very little environmental advantage.

Table 2
Load factors for available capacity, by type of production and by province (%), 2009
(based on data from Statistics Canada 2012a and 2012b)

		B-C	AB	SK	MB	ON	QC	NB	NS	IPE	TL
A	Hydro	49.5	19.7	39.5	76.0	54.6	55.3	39.1	30.4		60.8
B	Wind	0.0	1.0	38.5		4.5	8.2		18.3	9.0	0.0
C	Tidal								92.4		
D	Steam	53.7	70.9	86.8	11.6	15.9	13.2	43.2	67.4	0.1	21.9
E	Nuclear					77.8	60.8	-0.7			
F	Combustion turbine	19.0	38.4	18.0	0.4	33.0	1.9	26.7	16.3	0.0	72.6
G	Internal combustion	16.0	3.1	1.4	14.8	1.7	24.5	16.1			12.6

The great disparities in the utilization of different types of production capacity, as illustrated in Table 2, show the redundancy of investments in production capacity, leading to under-utilization of equipment. While transmission lines must be in place to allow consumers to access power produced by wind generators, this constraint is not insurmountable. First, interprovincial transmission lines are not being used to their full capacity, as shown in Pineau and Lefebvre (2009). Furthermore, investments in new transmission lines as well as demand management programs, displacing or reducing consumption, could overcome the bottlenecks that limit transmission from production to consumption sites.

The priority for the Canadian approach: open access to hydroelectricity

The main problem that Canada faces in its electricity sector relates to its unequal distribution of hydraulic resources between the provinces, as described above. Even though Canada is the third largest hydroelectricity producer in the world (after China and Brazil), which allows it to produce 60% of its electrical energy with low GHG[2] emissions and low costs (2.14¢/kWh in Québec in 2010), the Canadian electricity sector is still responsible for more than 14% of Canadian GHG emissions. Also the price of electricity is more than 50% higher in Calgary, Toronto, Ottawa and Halifax than in Vancouver, Winnipeg or Montréal. By comparison, even with oil production and refineries more unevenly spread across Canada, and with very different provincial taxation rates, the price of gasoline does not vary much between the provinces. The greatest difference between regions with the highest prices and those with the lowest is only around 30%.

2. Considering the full life cycle of hydroelectricity production, GHG emissions are not zero. Dam construction and the flooding of territory are both notable sources of GHG emissions. But emissions are still low compared to all of the other technologies that use fossil fuels, and comparable or lower than wind generation (Lee et al., 2012).

The weak integration across Canada (at levels 1-2, see Table 1) has therefore given provinces that benefit from lots of hydroelectricity compared to their population (British Colombia, Manitoba, Québec), the ability to meet their needs with this source of energy, while pricing it based on their average cost of production – leading to low prices. However, these low prices make it more difficult to improve energy efficiency in order to reduce local consumption. They also encourage the use of electricity for applications such as heating, for which other sources of energy are more efficient overall (see Box 1).

The other provinces (Alberta, Saskatchewan, Ontario and the Maritime provinces) lack access to hydroelectricity, and have had to develop more onerous and polluting production capacity (coal, natural gas) or more complex (such as Ontario`s nuclear energy). The lack of integration (physical, regulatory, and commercial) translates into non-realized opportunities for technical, economic and environmental benefits. This obviously has social consequences: a greater financial burden and a lowering of the bar of acceptability for redundant projects.

To correct this situation, to move to a level 3 or 4 integration, requires essentially one thing: that a province's hydroelectricity is not reserved for provincial needs, at a rate based on the average cost of production. It rather should be shared, as with other energy sources (oil and natural gas) and other consumer goods, according to economic criteria. In other words, discrimination between consumers based on their province of residence must stop, to allow production companies to sell to the highest bidder.

Concretely, this means opening up the electricity "heritage pools" of the provinces to all potential buyers, including those of neighbouring provinces. By this very fact, progress towards a common and more integrated system would be possible, because there would immediately be a greater uniformity of access to resources and more similar challenges in planning infrastructure.

Before detailing approaches to greater integration, in the next section, it would be useful to review the current situation of pan-Canadian cooperation in electricity, and the interprovincial projects that are being or have been considered. This review shows that a solid basis for collaboration already exists and that the benefits of integration have already been studied and are known.

2 A FRUITFUL PAN-CANADIAN COLLABORATION IN ELECTRICITY

The basis for integration

While the Canadian constitution confers the management of natural resources (including hydroelectricity) to the provinces, there are numerous pan-Canadian and federal institutions in the electricity sector. Furthermore, regional non-governmental organizations are active in the electricity sector. Also, many Canadian provinces comply with American regulations. Therefore, a solid base exists upon which greater integration could be built.

The main Canadian institutions in the electricity sector are the following:

- **Agreement on internal trade.** This agreement is intended to reduce commercial barriers in 11 specific sectors, including energy (Chapter 12). In particular, the agreement seeks to harmonize the treatment of energy-related goods and services. Negotiations regarding the energy sector have been under way since 1995, without any text yet being adopted for this sector. Since the goal is to permit access to markets and a non-discriminatory treatment of energy goods and services, this agreement could offer a path to integration of electricity sectors that would give all Canadians access to provincial sources of hydroelectricity.
- **National Energy Board.** An independent federal organization created in 1959 to regulate the international and interprovincial aspects of the oil, gas, and electricity sectors. It grants electricity export permits, for example. In the United States, the equivalent organization (the Federal Energy Regulatory Commission, FERC) has much greater powers, notably regarding the opening of electricity markets to competition. It is FERC that forces the states – and Canadian provinces that wish to sell to the United States – to allow the use of the transmission lines of one state or province by all, and not just by companies that are active on the territory of that state or province.
- **Natural Resources Canada.** The energy division of this department is responsible for Canadian energy policy and is directly involved in the search for and implementation of solutions for energy efficiency and renewable energy. Its three CanmetENERGY research centres (in Québec, Ontario and Alberta) bring together more than 450 scientists working on the production and use of energy.
- **Atomic Energy of Canada Limited (AECL).** Even after the sale of the CANDU division (nuclear reactors) to SNC Lavalin in October 2011, AECL remains a Canadian research organization in nuclear technology, which shows Canada's capacity to develop a technology used in three provinces (Ontario, Québec, New Brunswick).
- **Sustainable Development Technology Canada (SDTC).** Since its creation in 2001 by the federal government, this non-profit foundation has received $590 million to finance and support "the development and demonstration of clean technologies which provide solutions to issues of climate change, clean air, water quality and soil," essentially in energy production and use. The 223 projects it has supported have been carried out in 10 provinces.
- **Environment Canada.** With its mandate to coordinate environmental policies and programs on behalf of the federal government, this department could play an integrating role in the electricity sector if national constraints on GHG emissions are established.

Non-governmental organizations:

- **CAMPUT** (Canada's Energy and Utility Regulators). This non-profit organization brings together provincial regulators in the energy sector. Through its annual conference and other activities it offers an unparalleled platform for exchanges among regulators.
- **Professional associations.** The industry players are used to developing various common projects and consulting each other through several professional associations (notably the Canadian Electricity Association, the Canadian Hydropower Association, and Smart Grid Canada).
- **North American Electric Reliability Corporation** (NERC). This organization has a mission to ensure the reliability of the North American electricity network. All of the network operators must send information to this organization, and planning for regional needs is carried out to ensure the reliability of the electricity system. This organization does not, however, have any particular means of acting directly in the various states and provinces that report to it.
- **North American Transmission Forum.** This forum promotes best practices in the operation of transmission systems.

This selection of governmental and non-governmental institutions provides an illustration of the domains in which collaboration already occurs. Many of these organizations could testify to the benefits of a common approach – benefits that their very existence explains – and could thus facilitate a greater integration of electricity markets.

Integration projects

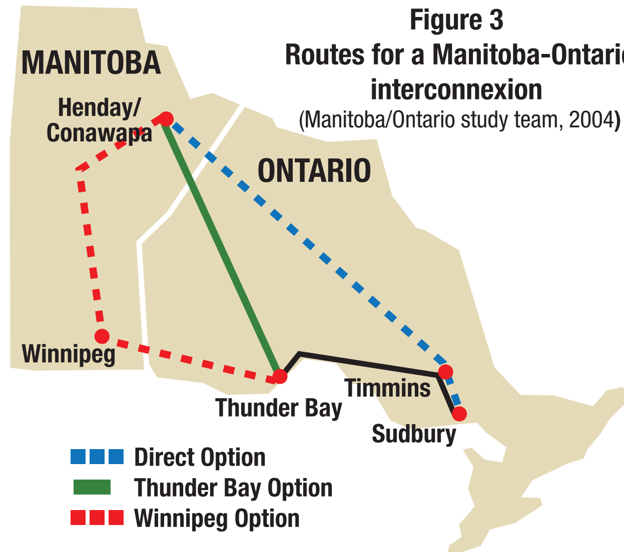
The advantages of integration in the electricity sector can be seen through the analysis of various projects, which often have been abandoned for political reasons. Several of these projects are presented below to describe the opportunities for integration.

The 2003 Clean Energy Transfer Initiative (CETI) between Manitoba and Ontario

Undeveloped hydroelectric resources in Manitoba were studied in terms of meeting Ontario's needs in the CETI initiative of 2003. This initiative has been abandoned since that time due to a series of obstacles that arose: negotiations with First Nations for rights of way, uncertainty about financing from the federal government, uncertainty over the value of GHG emissions that would be avoided, the complexity of interprovincial relations and intra-provincial electoral dynamics.

More than 5,000 MW of power could be developed in this way to add to or replace part of Ontario's production capacity (which includes notably 11,000 MW of nuclear energy and 4,500 MW of thermal coal generators, out of a total of nearly 35,000 MW. Figure 3 illustrates the different routes envisaged for a 1,800 MW capacity transmission line. Current interconnection capacity between these provinces is only 300 MW.

Figure 3
Routes for a Manitoba-Ontario interconnexion
(Manitoba/Ontario study team, 2004)



In 2009, Ontario instead adopted the Green Energy Act, which included only provincial measures. Ontario's Long-Term Energy Plan, related to this Act, projects investments between 2010 and 2030 of some $33 billion in nuclear, $14 billion in wind power and $9 billion in solar power, all within Ontario. It does not attempt to compare the costs of supply from Manitoba or Québec (Ontario, 2010). From an electoral point of view, these strictly provincial investments can direclty be connected to job creation, which is the type of message politicians like to send, despite the potential extra costs of such choices.

Québec and Newfoundland and Labrador: The 1969 Churchill Falls project and the 1998 Lower Churchill-La Romaine project

In 1952 the government of Newfoundland and Labrador ceded mineral and energy development rights to a private British company, Brinco, in the hopes that this company would develop the economic potential of these resources in the province[3]. Brinco did not proceed with such development, however, but rather created a new company, the Churchill Falls (Labrador) Corporation (CFLCo), which preferred to associate with Hydro-Québec to raise the capital required for the development of this 5,429 MW of production capacity. A contract was signed in 1969 between CFLCo and Hydro-Québec, giving the latter access to nearly all of the production from Churchill Falls. Full-capacity production began in 1972. This contract, which goes to 2041, allows Hydro-Québec to purchase the annual production of the generating station (about 30 TWh) at 0.25426¢/kWh until 2016, then at a price of 0.2¢/kWh until 2041. Given that the resale price of energy to Québec consumers is around 3¢/kWh (before costs of transmission, distribution and customer service), it is evident that this supply is extremely profitable for Hydro-Québec, which enjoys an annual profit from it of about $825 million. Hydro-Québec is also a shareholder of CFLCo (34.2%), while the other shareholder is Nalcor Energy, a Newfoundland and Labrador Crown Corporation. . Note that the province of Newfoundland and Labrador, disappointed by the Brinco's management, bought back its share of CFLCo in 1974, in an effort to regain control of the energy development of its territory.

In 1974, thejoint development with Hydro-Québec of two sites downstream of the Churchill Falls dam had already been studied: the Gull Island and Muskrat Falls projects, also known as the Lower Churchill projects. Given the unfairness of the profit sharing between the two provinces, this joint project was delayed by Newfoundland and Labrador. It was re-launched at the end of the 1990s when the Premiers of Québec (Lucien Bouchard) and of

3. See Froschauer (1999) for more detail on the history of the development of the hydroelectric potential of the Churchill River.

Newfoundland and Labrador (Brian Tobin) signed an agreement to develop these sites. Compensation for the historic inequity would have been provided, and the terms of the new contract would have been good for both partners[4]. To optimize the production at the two generation stations, 50% of the flow of the La Romaine River would have been diverted to the north, to join the Churchill River. A new transmission line would have been built in Québec (connecting the plants to the network already in place) to export the greater part of the production to the United States. A transmission line to the Island of Newfoundland would also have been built to ensure its supply. Figure 4 illustrates the routes that were considered. The federal government would have assumed part of the financing costs for the transmission line connecting Labrador to the Island of Newfoundland.

Figure 4
Proposed transmission lines for the Lower Churchill joint project (NL, 1998)

However, bad relations with Native communities, particularly the Innu, and the low price for natural gas during this period[5] put an end to this cooperative project. It is noteworthy to stress that the bitterness felt by Newfoundlanders regarding the 1969 contract with Hydro-Québec could be overcome.

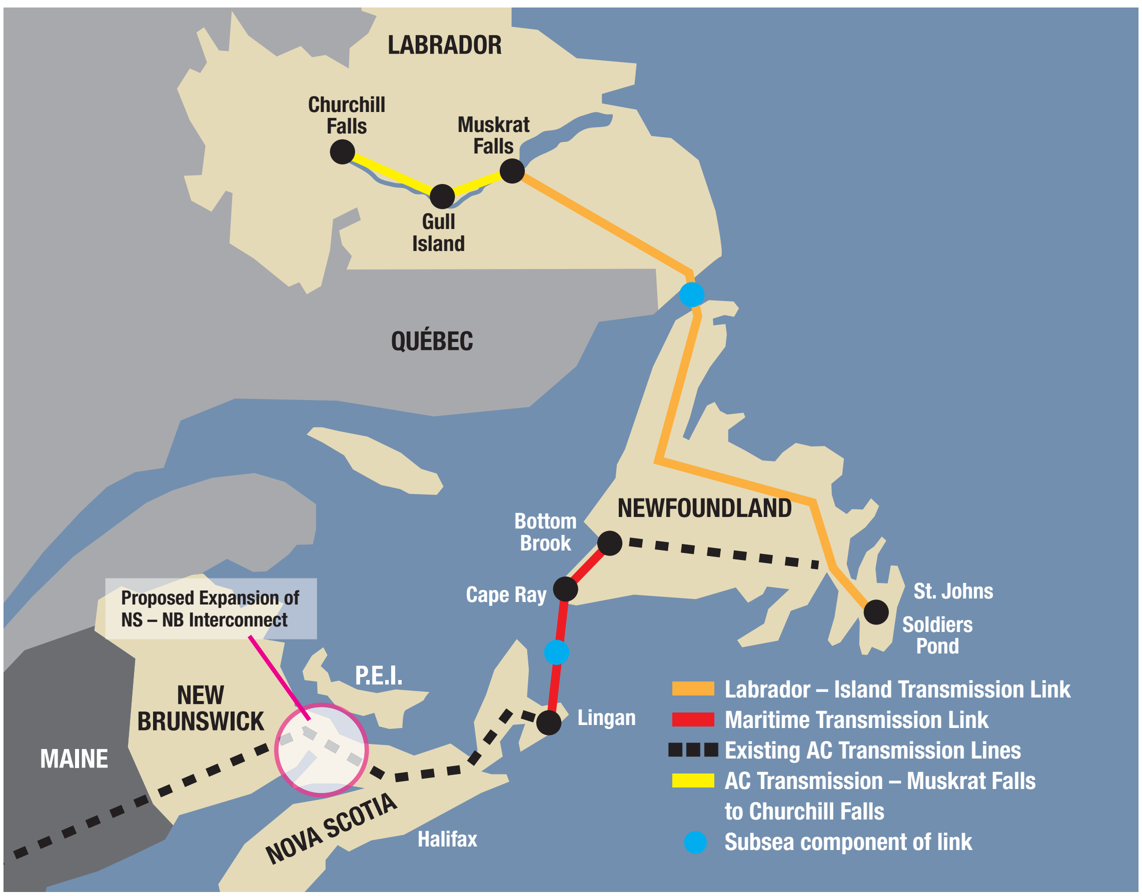
4. Newfoundland and Labrador would have received by 2041 some $2.6 billion in compensation for the 1969 contract, and Hydro-Québec would have guaranteed a minimum rate of 4.7¢/kWh for Newfoundland and Labrador (Clugston, 1998)

5. 5 The price of natural gas is a key factor for the viability of hydroelectricity exports because it is the cost of production of gas-powered generating stations that in large part determines the price of electricity in the American markets to which the electricity is exported.

The Lower Churchill development… 10 years later

In 2007, Newfoundland and Labrador set up a multi-sectorial energy company, Nalcor Energy, which is owned by the provincial government. It is responsible for development in the hydroelectric and oil and natural gas sectors, and also has a share of existing projects such as the Churchill Falls power plant. In 2009, it re-launched on its own study of the Muskrat Falls (824 MW) and Gull Island (2,250 MW) projects on the Churchill River in Labrador. Given the absence of collaboration with Hydro-Québec and the difficulty of accessing export markets, the more modest Muskrat Falls project alone was considered first. Its production would be exported to the Island of Newfoundland, Nova Scotia and the United States by terrestrial and ocean lines to the east (Figure 5). The construction cost of the Muskrat Falls station is an estimated $2.9 billion, plus another $3.3 billion for the Labrador-Island of Newfoundland and Newfoundland-Nova Scotia transmission lines. The total cost would therefore be $6.2 billion.

Figure 5
Route of the proposed transmission lines for the Lower Churchill projects (NL, 2010)



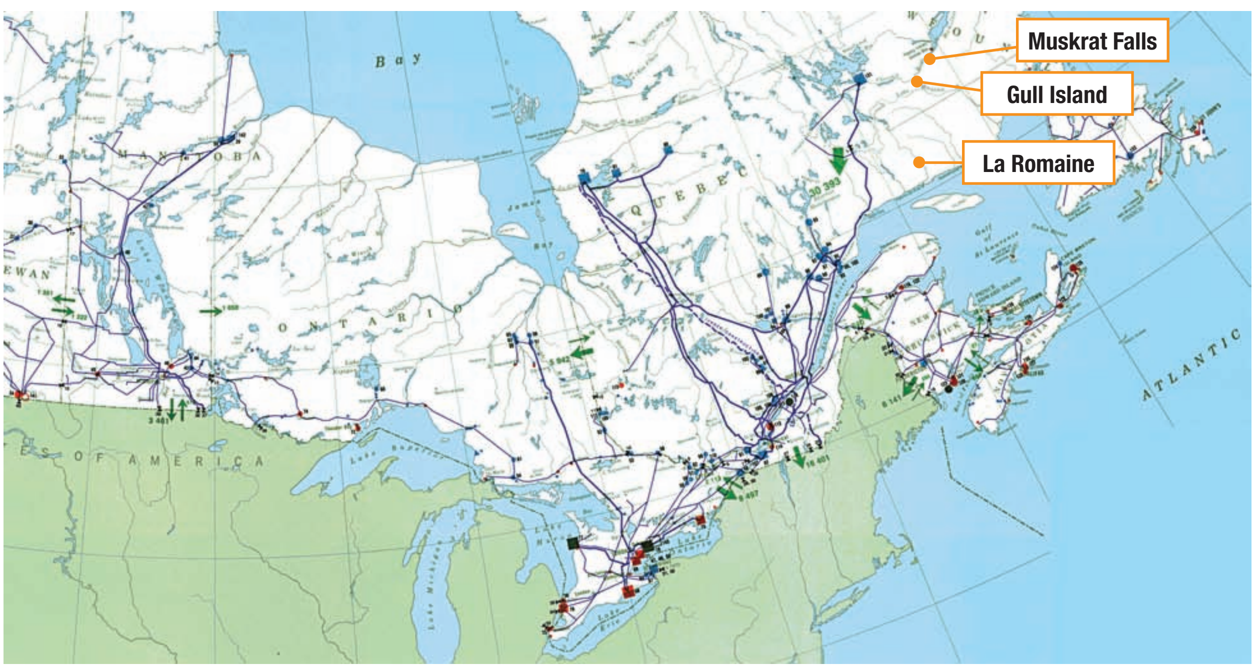
By comparison, Hydro-Québec's La Romaine project (1,550 MW) was also developed independently starting in 2004, following the rupture of the 1998 agreement between Québec and Newfoundland and Labrador. It represents a total investment of $8 billion, including transmission, which is about 25% more than the Muskrat Falls development cost for nearly twice the production capacity. It is clear that, given the proximity of the two projects (see Figures 4, 5 or 6), the La Romaine project is much more interesting in economic terms. Above all, the construction of transmission lines to avoid Québec makes no sense economically – a fact which is particularly evident from the initial 1998 project to connect the Lower Churchill stations to the Québec network. A transmission line through Québec can be done for a lower cost than a longer terrestrial and marine line through the Island of Newfoundland and Nova Scotia. However, the absence of a common structure for planning and political incentives to collaborate means that such projects can co-exist separately.

Furthermore, a loan guarantee by the federal government, evaluated by Nalcor Energy as a 2% reduction in the interest rates for financing the project, would reduce annual costs by $124 million – the equivalent of more than 2¢/kWh. This specific initiative of the federal government was denounced by Québec and does not fit in with a global approach to energy and the environment. On the contrary, it stimulates piecemeal energy choices that make no sense in financial or energy terms, while poisoning interprovincial relations.

Québec's interconnections with its neighbours

As Figure 6 shows, Québec is well interconnected with its neighbours, notably to be able to import and export when market conditions in nearby regions make these trades interesting. The enormous energy storage capacity in Hydro-Québec's reservoirs (170 TWh, nearly the annual consumption of Québec), allows it to purchase energy when it is less expensive and resell when the price rises.

Figure 6
Networks in Eastern Canada (EMRCan, 1988)



This economic advantage is beneficial for all, except from an environmental point of view when the low-cost energy imported by Hydro-Québec comes from coal-burning generating stations. Furthermore, since the electricity sold in Québec is at low cost and the internal consumption is consequently higher, the neighbouring jurisdictions need to build thermal stations that would be useless in an integrated system. The total cost of the current system is thus much greater than it should be.

Integration with its neighbours is so beneficial to Québec that interconnection capacity with Ontario was increased by about 600 MW in 2010, to take advantage of trade and increase the reliability of supply.

Québec is not the only province to pursue this strategy: British Columbia and Manitoba have also developed major interconnections with the United States (with greater capacity than their interconnections with their Canadian neighbours), so that they can export their electricity at prices that are more interesting than their provincial regulation will allow.

The abandoned Hydro-Québec project to purchase NB Power

In October 2009, the premiers of Québec (Jean Charest) and New Brunswick (Shawn Graham) announced a Canadian first: the purchase of a Crown corporation (NB Power) by another (Hydro-Québec). The transaction would have allowed the unification of the two neighbouring systems, and both would have obtained a range of benefits. Nearly all of the expected gains from integration (presented above) would have been achieved. In particular, the important use of coal and oil, on which New Brunswick depends (more than 60% in 2009) would have progressively declined, to be replaced by less costly supply from Québec. Hydro-Québec would have been able to sell its production at a better price, while offering New Brunswick a rate freeze for residential and commercial consumers and a rate reduction for industrial consumers (under the terms of the agreement). To these economic advantages would be added the environmental advantage of reducing GHG emissions, given the decreasing use of fossil fuels for electricity production.

Unfortunately, in March 2010 the same two premiers announced the cancellation of this transaction. While the official reason for Québec's withdrawal was the discovery of assets with less value and greater risk than originally foreseen, the announcement of the sale of NB Power to Hydro-Québec had set off a major political crisis in New Brunswick. The people of the province had the impression that they would lose control of a key sector of their economy, and subject themselves to another province with greater demographic and economic clout. In the face of this internal political crisis and despite the advantages of integration, which were badly communicated, the two provincial governments cancelled the sale.

3 IS THERE AFUTURE FOR COOPERATION IN THE ELECTRICITY SECTOR?

As indicated in the introduction, many groups currently promote a Canadian energy policy. Furthermore, in the electricity sector, the expected benefits from integration are recognized internationally, and several Canadian initiatives have already been undertaken to develop joint projects. Despite a seemingly favorable context , however, very few forces in the electricity sector are active to develop a pan-Canadian integration, or even a greater interprovincial integration that would achieve some of the expected benefits. In an economy with financial constraints and major environmental challenges, a greater cooperation in the electricity sector is one of the most efficient path to achieve both financial savings and environmental gains.

There are three major obstacles to this cooperation:

1. The structure of political and electoral incentives in the provinces and the federal government.
2. The redistribution of the gains from a partial or complete integration.
3. The lack of recognition of the environmental benefits flowing from integration.

Obstacle 1: Political and electoral incentives against integration

The sharing of powers between the provinces and the federal government has allowed provinces to shape their energy sector, particularly electricity, in a very specific manner. In almost all of the provinces the provincial electricity companies are important provincial symbols that operate on the basis of universal access and with a significant social element. For example, electrification is assured for the entire territory (at the cost of the collectivity), and electricity service is cut only in cases of repeated failure to pay.

For provincial politicians, changing the status quo in favour of a pan-Canadian approach (or interprovincial cooperation) represents a double risk: on the one hand, provincial voters could badly perceive the “loss” of powers to the benefit of another government; on the other hand, there is a perceived threat to an essential service, because of possible changes in rates or mode of operation. It is therefore very delicate for politicians to develop joint projects, since they represent a change from the status quo which is often badly perceived by voters.

Since many energy projects are presented to the population as job creation projects, if these jobs are not located in the province using the energy this argument loses credibility. This explains why Ontario went ahead with its Green Energy Act, and why the provinces invest in local wind generation, rather than reserving it for places where it would be more productive (see the wind generation discussion in relation to Figure 2).

Furthermore, integration efforts are perceived as an intrusion into provincial jurisdiction. The best known example of this, the National Energy Program, was created by the Liberal government of Pierre Trudeau in 1980 and abandoned in 1984 by the Progressive Conservative government of Brian Mulroney. It was so badly received in the Western provinces that politicians fear to use the words “national” and “energy” in the same sentence.
Since the benefits of an integrated approach would appear only in the longer term, beyond the period of an electoral mandate, while the transition costs and the projects would be visible in the short term, the political calculation is quickly done. To work for integration, even partial, is problematic. Shawn Graham, the former Premier of New Brunswick, is the most recent premier to have paid an electoral price for an integration project, however beneficial it may be for the economy and the environment.

Obstacle 2: The problem of redistributing gains

With integration, as shown in an extreme way by the Churchill power project and the 1969 contract with Hydro-Québec, a distribution of the gains must be done. It is difficult to change the initial distribution once it is done, when those who benefit from it evidently do not wish to lose from such a change. Hence, it is difficult for Québec to revisit a contract which is excessively advantageous to it.

In the current situation of hydroelectricity in Canada, it is the consumers in the hydraulic provinces (BC, MB, QC, NL) who benefit directly from this resource, since it is exclusive to them and sold at the average production price, which is relatively low. With greater integration, economic principles would lead to electricity trades being done on market principles, with a price that could only be higher for these consumers. In effect, buyers ready to pay more (but less than what they pay for their current electricity production from fossil fuels or non-hydraulic renewables) would have access to this hydroelectricity and would compete with "local" consumers. Current consumers of hydroelectricity (industrial as well as commercial or residential) are thus understandably reluctant to let go of this exclusive access at favourable prices.

Pressure from consumers, many of them also voters, makes the political challenge even greater. On the other hand, in the "thermal" provinces (AB, SK, ON, NB, NS, and PEI), while consumers would benefit from greater integration of the electricity sector, the current producers would be losers: competition from less costly hydroelectricity production would inevitably cost them market share; the viability of some of their less efficient generating stations would be compromised. Thus, paradoxically, it is the provinces with the most liberalized internal markets (Alberta and Ontario) which have the producers least able to compete with producers from more regulated provinces such as BC Hydro, Manitoba Hydro and Hydro-Québec, who have extremely favourable cost structures and operational flexibility thanks to their storage capacity.

Thus, there are groups of consumers and producers who would have something to lose from integration, and who would press to maintain the status quo. The hydroelectricity companies which could benefit the most (BC Hydro, Manitoba Hydro and Hydro-Québec) are for their part likely to remain silent on the subject, since their owners (provincial government) do not wish to experience a consumers' backlash.

Obstacle 3: Lack of recognition of environmental benefits

While the economic gains from integration would be sufficient to justify greater integration, the environmental gains flowing from better coordination of electricity systems across Canada are also significant. However, in the absence of constraints on GHG emissions, these gains are not taken into account by any of the players. What is worse is that hydroelectricity export, replacing thermal production from fossil fuels allows a reduction of emissions in the importing province, but does not count in the emissions inventory of the exporting province. If, on the contrary, this hydroelectricity is used for heating to replace natural gas or oil, local GHG emissions are in fact reduced. This creates a situation where, in terms of GHG emissions, a province like Québec has an interest in promoting the use of electricity for heating; however this is globally inefficient in terms of energy and economics: it brings greater GHG emissions regionally, since the neighbouring provinces must turn to natural gas (or coal or oil) to produce their electricity.

With national and international constraints on GHG emissions, the economic incentives would better align with best practices. The relative environmental value of hydroelectricity would be recognized and this would become a further competitive advantage that would stimulate the use of best practices.

Approaches to success

These three obstacles were the direct cause of the failure of CETI (between Manitoba and Ontario) and the integration of the Québec and New Brunswick systems. They add to the historic problem of relations between Québec and Newfoundland and Labrador. However, some approaches to success can be identified, providing hope of overcoming these obstacles.

Awareness and information. The magnitude of the economic and environmental gains should be better documented and communicated, making the point that in electricity it is possible to become collectively richer while reducing GHG emissions. Too often, the struggle against climate change presupposes that emission reduction represents an extra cost; but in this particular case, exactly the reverse is true.

Redistribution and compensation. Residential consumers in hydraulic provinces, who would lose their access to low prices under a regime of greater integration, should be financially compensated during such a transition to a more coherent market-based rate regime. This compensation, necessary to make their support for change economically rational, would not be problematic from a financial point of view. In fact, the supplementary profits realized by the producing companies (both through exports and in the internal markets) would be greater than the increase in individual costs. The greater efficiency of the new system would therefore allow for complete compensation of consumers, while still bringing greater profit to production companies. Evidently, complete compensation might not needed, given that environmental and social sensitivities might lead consumers to accept some of the cost.

Similarly, compensation could be envisaged for production companies that have invested in production capacity that is viable in a non-integrated system, but non-competitive in an integrated system.

Model of the Canada Health Act. The health sector is a field of provincial jurisdiction where harmonization has been achieved between the provinces thanks to the Canada Health Act. This model shows that it is possible, in Canada, to respect provincial jurisdiction while having harmonization emanating from the federal government. Just as the provincial health systems must respect common conditions of public administration, comprehensiveness, universality, portability, and accessibility, a common framwork could be established regarding water fees for hydropwer, access to hydraulic resources, operation of transmission networks (to ensure fair and transparent access), the operation of markets, and the standards for distribution and service.

Such an initiative, somewhat similar to the Regional Transmission Organizations promoted by FERC in the United States (and abandoned in 2005 due to the same obstacles to integration as those mentioned above) should take place in a context where information and compensation would be put forward to help overcome the obstacles.

Agreement on Internal Trade. While negotiations have continued since 1995, the completion of the energy chapter can be used as an engine to close this period of commercial incoherence between the provinces and ensure that Canada has coherent internal energy regulation . This already existing negotiating platform should therefore be used precisely for the purposes for which it was conceived. It is only by finalizing certain parts, such as energy, that the governments can focus on other equally pressing matters. It is a bit surreal that negotiations have stretched out over more than 15 years without really progressing, as they have in the case of energy.

The integration of electricity sectors between Canadian provinces can be done without constitutional change, and without having to create new pan-Canadian structures. The essential prerequisite is to harmonize rate and trade principles between the provinces, to permit greater coherence in the planning and construction of electricity infrastructure. The main change to be accomplished, as identified above, is to put an end to the regulatory silos in which provincial hydroelectricity is confined. These protect local consumers, to the detriment of economic and environmental efficiency.

Relations between Québec and Newfoundland and Labrador

In the particular case of Lower Churchill, Québec should proactively divulge the terms and conditions that would make it possible to develop the Gull Island and Muskrat Falls generating stations with transmission through Québec, to clearly establish that the proposal of transmission lines through Nova Scotia is economically inferior. Such an approach would be a gesture of good will on the part of Québec, and would support Hydro-Québec's export strategy by presenting it as a company that is ready to cooperate. This could also open the way to bilateral agreements with Ontario and the Maritime provinces, to establish the bases for mutually beneficial contracts for electricity supply. With such agreements, the viability of Hydro-Québec's new projects would be less questioned (as it was for La Romaine, for example), since the exports would be less exposed to market price fluctuations .

In Ontario and the other Maritime provinces, the cost of electricity supply is constantly increasing because of green energy objectives (Ontario), delays in rebuilding the Pointe Lepreau nuclear station (New Brunswick) and purchases of coal and oil for electricity production. Consumers in these regions might therefore by very receptive to this possibility, and politicians could obtain electoral support though agreements that lower the price of electricity.

A return to a joint development between Québec and Newfoundland and Labrador, inspired by the 1998 agreement between Lucien Bouchard and Brian Tobin, would be extremely beneficial for other situations. For example, it would lead to a less conflictual management of the development of the Old Harry oil deposit, situated on the marine boundary between the two provinces. Since it appears that the personalities of the premiers play a big role in this type of negotiation[6], a rapid change in approach should not be ruled out.

6. Danny Williams, the Premier of Newfoundland and Labrador from 2003 to 2010, was known for his antagonistic positions towards the federal government and Québec, which made it difficult, if not impossible, to make any progress on the Lower Churchill. While his successor, Kathy Dunderdale, was very involved in the recent Lower Churchill project, she does not adopt the hard line of Danny Williams. A recommencement of discussions could more likely be contemplated with her.

CONCLUSION

A strong integration movement is leading electricity markets towards a more uniform organization that allows for greater trading and efficiency gains. International organizations are documenting and promoting this type of integration, which is underway in certain parts of the world, notably in Europe and Latin America. However, in North America, apart from some regions that are historically integrated (for example the PJM zone in the Mid-Atlantic States), most provinces and states refuse to consider increased integration of their electricity sectors. This opposition carries a high opportunity cost: it sacrifices major economic and environmental gains. In particular, the development of thermal generating stations (using fossil fuels) is necessary in some regions because the hydroelectricity in nearby regions is not accessible for regulatory reasons. The Canadian provinces that have lots of hydraulic resources have decided to sell their hydroelectricity at a preferential rate to local consumers, rather than optimize sales by offering the energyto all, on non-discriminatory terms. The piecemeal organization of North American electricity sectors, Canadian in particular, has meant many lost opportunities for joint projects: between Manitoba and Ontario (the Clean Energy Transfer Initiative of 2003), between Québec and Newfoundland and Labrador (joint development of the Lower Churchill in 1998) or between Québec and New Brunswick (integration of the New Brunswick system into that of Hydro-Québec). All of these examples of integration initiatives have failed not because of low economic or environmental gains, but because of unfavourable political conditions.

The absence of a common electricity platform opened the way to aberrant projects, such as investments in wind energy in regions which are not suitable for it, or the proposed high cost marine transmission lines for the latest Lower Churchill project (exporting its electricity to Newfoundland and Nova Scotia), when far less costly alternatives exist (through Québec).

The three main obstacles to greater integration of electricity markets are (1) existing political structures, which do not offer any political incentive for cooperation; (2) the redistribution of the benefits, which would create losers who naturally oppose such change; and (3) the lack of recognition of the environmental gains, which is not doing justice to the many advantages of integration. There are many possible approaches to success, however. First, better documentation and distribution of information on benefits that could be obtained through integration would help to mobilize more players. Next, financial compensation should be envisaged for the “losers” from integration, to help them change their position. Finally, the existing structures for pan-Canadian cooperation in fields of provincial jurisdiction should be used as examples: the Canada Health Act could thus serve as a model for integrating principles to be shared by all provinces, facilitating trade and joint projects. The Agreement on Internal Trade, a negotiation platform created in 1995, dealing with the energy sector, could be the springboard for launching an integration effort without the need to create new structures.

The economic and environmental challenges leave less and less room to ignore still unexploited sources of productivity. Integrating electricity sectors, by changing their current structure, could generate greater collective wealth, while reducing its environmental impacts – particularly by reducing GHG emissions. It would be a shame if Canadian provinces, with Québec a leader, continue to deprive themselves of this opportunity.

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