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Power Connections: Canadian Electricity Trade and Foreign Policy

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About the Author

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At the outset of his career in 1970, Dr. Goodman became a consulting geologist with Bondar-Clegg and Company, later assuming the position of corporate vice-president, business development. In 1974, he worked in various departments of the federal government, as a technical expert in mineral and metal commodities, where he led Canadian delegations to international organizations such as the United Nations and the Organisation for Economic Co-operation and Development. In 1980, Dr. Goodman became a senior manager with Crows Nest Resources Limited, specializing in international coal marketing. He joined Shell Canada Limited in 1984 and served in a variety of senior management positions in resources marketing, corporate strategy, and business development. In 1984, Dr. Goodman formed a consulting organization, Kernow Consulting Corporation, which continues to provide expertise in business trends analysis to a wide range of global corporations and governments.

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Executive Summary

This paper examines potential net benefits of an integrated approach to electricity exports and Canadian foreign policy. Its primary focus is on how such integration could help enhance development of electricity exports to the United States. Spinoffs could also support a broader global role for Canadian expertise in the provision of value-added opportunities in electricity services and clean electricity technology development.

Canada is a major energy producer and exporter of most forms of energy including electricity. In 2008, total electricity exports to the United States were 55.7 terawatt hours (TWh) valued at $3.8 billion.[1] The vision of a growing role for Canadian electricity exports is driven by two key recent elements of US energy policy: the goal of enhanced energy security and the desire for a strong role for clean energy. Unlike Canada's, the US electricity sector is heavily dependent on carbon-intensive coal for about half of its electricity production. For the United States this provides energy security but not clean energy. On the other hand, three-quarters of Canada's electricity production is defined as clean energy, mostly in the form of hydro power, wind, and nuclear energy. Canada has the resource base to support growth in Canadian exports of electricity to the United States as well as to market its clean energy credentials globally through the development of new technology and value-adding electricity services.

Increasing electricity trade brings strong economic advantages to Canada, including economic growth, an improved international trade balance, job creation, enhanced regional development, development of carbon offsets, and better flexibility and reliability of the electrical system. Regional development implications can be especially beneficial, as projects such as hydro power and wind developments often occur in areas that have poor economic prospects. Major benefits could also accrue to the aboriginal population.

Foreign policy can play a helpful role in promoting both electricity exports to the United States and an expanded service industry with global reach, particularly in the strong growth economies of China and India. Industries cannot capitalize on this opportunity without support. The Canadian federal government could play a catalyzing role by creating a framework for secure, clean electricity exports to the United States. Foreign policy forms a critical platform upon which to build long-term business for the Canadian power industry that will also bring gains for Canadian citizens.

Advancement of the concept of Canada as a clean, secure energy supplier could be achieved through the establishment of a formal mechanism to discuss North American energy trade: a Canada-US Energy Trade Council. The focus of this new initiative would be on energy security, foreign policy, and expanded energy trade, including all forms of energy, not just electricity. Secure energy has a different connotation than clean energy alone, because oil and natural gas exports are also critical to both the health of the Canadian economy and energy security for US consumers.

An ad hoc approach to electricity exports will likely preclude our successful capture of the full range of economic opportunities; implementation of a more formal mechanism coordinated at the federal level is more likely to achieve this objective. The Canadian federal government should take on a leadership role but work closely with the provinces, as they are the owners of the resources. The proposed council would comprise members appointed by the prime minister of Canada and the president of the United States, including executive-level representatives of the regulatory agencies in energy, environment, and economic development. It would also involve active participation by provinces and states where key decisions are made on fuel choice and technology.

Projects that result in positive federal-provincial relations rather than conflicts are always welcome in a country with high levels of decentralized decision-making. Electricity exports certainly fall into this category, given that most provinces across Canada have the potential to become net exporters of clean electricity. Indeed, expansion of the electricity grid for exports could also lead to the development of a more integrated domestic grid, which could help all regions.

1 In this paper, dollars are Canadian unless specified otherwise.

Résumé

Ce document examine les avantages nets qui pourraient découler d'une approche intégrant les exportations d'électricité et la politique étrangère du Canada. Il vise en premier lieu à établir comment une telle intégration permettrait de développer nos exportations d'électricité vers les États-Unis, un développement dont les retombées pourraient favoriser à l'échelle mondiale l'expertise canadienne en matière de services d'électricité à valeur ajoutée et de développement de technologies d'énergie électrique propre.

Le Canada produit et exporte en grande quantité la plupart des formes d'énergie, électricité comprise. En 2008 seulement, ses exportations d'électricité vers les États-Unis ont totalisé 55,7 terawatts-heures (TWh) évalués à 3,8 milliards de dollars. Cette ambition d'accroître les exportations canadiennes d'électricité est motivée par deux nouveaux objectifs clés de la politique énergétique américaine : une sécurité énergétique renforcée et un rôle accru en matière d'énergies propres. Contrairement à celui du Canada, le secteur américain de l'électricité repose en grande partie sur le charbon à forte intensité carbonique, qui compte pour environ la moitié de sa production d'électricité. Cette production assure la sécurité énergétique des États-Unis mais aucune énergie propre. En revanche, les trois quarts de l'électricité produite par le Canada entrent dans la catégorie des énergies propres, essentiellement sous les trois formes de l'énergie hydroélectrique, éolienne et nucléaire. Le Canada possède donc les ressources nécessaires pour soutenir la croissance de ses exportations d'électricité vers les États-Unis, mais aussi pour commercialiser mondialement ses capacités en énergies propres grâce au développement de nouvelles technologies et de services électriques à valeur ajoutée.

L'essor du commerce de l'électricité procurerait au Canada de solides avantages en termes de croissance économique, de balance commerciale internationale, de développement régional, de compensations en fixation de carbone ainsi que de souplesse et de fiabilité du système d'électricité. Les retombées liées au développement régional sont particulièrement prometteuses puisque les projets d'énergie hydroélectrique et éolienne sont souvent conçus dans des régions à faible perspective économique. La population autochtone pourrait notamment en tirer d'importants avantages.

La politique étrangère peut jouer un rôle utile pour promouvoir nos exportations d'électricité vers les États-Unis mais aussi pour stimuler l'expansion d'une industrie de service de portée mondiale, surtout auprès d'économies à forte croissance comme l'Inde et la Chine. Mais sans appui, l'industrie ne peut mettre à profit cette opportunité. Ottawa doit donc jouer un rôle catalyseur en élaborant un cadre assurant l'exportation d'énergie propre et garantie aux États-Unis. Et la politique étrangère est une plate-forme indispensable sur laquelle bâtir à long terme la prospérité d'une industrie énergétique dont les retombées profiteront à l'ensemble des Canadiens.

La mise en valeur du Canada en tant que fournisseur d'énergie propre et garantie pourrait reposer sur un mécanisme officiel de dialogue sur le commerce nord-américain d'énergie, à savoir un Conseil du commerce énergétique Canada–États-Unis. Les travaux de ce nouvel organisme privilégieraient la sécurité énergétique, la politique étrangère et l'expansion du commerce de tous les produits énergétiques, et non seulement de l'électricité. L'énergie garantie a une connotation différente de la simple énergie propre, puisque les exportations de pétrole et de gaz naturel sont cruciales à la fois pour la santé économique du Canada et la sécurité énergétique des consommateurs américains.

Il va de soi qu'une approche improvisée amoindrirait notre capacité de saisir la totalité de ces opportunités économiques. D'où l'importance d'un mécanisme plus officiel coordonné au niveau fédéral. Tout en collaborant étroitement avec les provinces, qui sont propriétaires des ressources, le gouvernement canadien doit à cet égard jouer un rôle dirigeant. Le Conseil proposé se composerait ainsi de membres nommés par le premier ministre du Canada et le président des États-Unis, parmi lesquels des représentants de haut niveau des organismes de réglementation des secteurs de l'énergie, de l'environnement et du développement économique. Il solliciterait aussi la participation active des provinces et des États, où sont prises les grandes décisions en matière de carburants et de technologies.

Tous les projets qui favorisent les relations fédérales-provinciales au lieu de susciter des conflits sont les bienvenus dans un pays dont les processus décisionnels sont très décentralisés. Or les exportations d'électricité entrent clairement dans cette catégorie de projets, puisque la plupart des provinces canadiennes sont potentiellement exportatrices nettes d'électricité propre. C'est pourquoi l'expansion du réseau d'électricité aux fins d'exportation pourrait stimuler le développement d'un réseau national mieux intégré qui profiterait à toutes les régions canadiennes.

Setting the Stage

Canada is a trading nation and exports are critical to Canada's economic health. In 2008, Canadian's total exports were $562 billion, or over one-third of Canada's gross domestic product.[2] Energy accounted for about 22 percent of total Canadian exports.

Canada is a significant energy producer and exporter in a global context. In 2008, we ranked second in global exports of uranium,[3] second in natural gas, fourth in electricity, sixth in oil, and eighth in coal.[4]

This paper argues that electricity trade between Canada and the United States has been very beneficial for both countries, especially by enhancing flexibility and reliability of electricity supply. For the United States it specifically offers a source of secure, competitive clean electricity. For Canada the economic attributes are clear: growing wealth and prosperity, important contributions to our balance of trade, job creation, the development of carbon offsets, the provision of value-added services, and positive impacts for regional development, including aboriginal communities.

This paper will focus specifically on electricity trade issues with the United States. With a renewed focus on energy security and clean energy under the new US administration, there is significant economic opportunity for an increasing role for Canadian electricity exports in the US power industry.

The success of this vision of electricity trade hinges on the ability to satisfy US energy security and clean energy requirements while meeting Canadian economic and societal objectives for energy exports that work for all regions of the country. The energy model would accommodate a slate of energy exports including oil sands and natural gas as well as the subject of this paper, electricity exports. The role of federal government policy should be to develop an energy strategy that is compatible with regional cohesion rather than regional division.

The opportunity for increasing electricity exports can be a model in this respect as it could be done in most regions of the country. Foreign policy is a critical dimension of increasing energy exports to the United States. As a result there is merit in creating a joint forum for discussion and resolution of the complex array of energy trade issues between the two countries. One of the major recommendations of this paper is the establishment of a Canada-US Energy Trade Council to facilitate cross-border discussions aimed at issue resolution.

Canada's energy resource endowment gives us a classical comparative advantage. In tapping the full range of opportunities at hand, however, it is important that a strategy based on expanding energy development incorporate more than the traditional role of Canadians as hewers of wood and drawers of water. In reality, resource exploitation has long moved beyond this basic level. Many forms of resource exploitation now incorporate high levels of advanced technology and expertise such as seismic processing of oil and gas, oil upgrading technologies, renewable energy development, nuclear power development, and smart-grid power systems.

The primary focus of this paper is the opportunity for increasing Canadian electricity exports to the United States. But beyond the physical exports of electricity there are also a range of more knowledge-intensive services that can be leveraged. These include our expertise in complex project management and implementation, engineering design, smart-grid technology, smart regulatory systems, and the research and development of a range of clean energy technologies including renewable energy. Together, these fields could provide a foundation for Canada to expand its global presence as an energy knowledge cluster. Leverage of these knowledge-intensive activities is a vital platform for future sustainable economic growth in Canada.

2 Statistics Canada, *National Income*.
3 World Nuclear Association, "Canadian Exports, 2008."
4 Central Intelligence Agency, *World Factbook 2008*.

In 2008, Canada's total electricity production reached 602 TWh,[5] and total electricity trade with the United States was valued at $5.13 billion. Canadian exports to the United States were 55.7 TWh, valued at $3.8 billion, at an average price of $64.91 per megawatt hour (MWh).[6] Canada also imported 23.5 TWh of electricity from the United States, valued at $1.33 billion, at an average price of $56.59 per MWh.

A number of core issues and unique opportunities for Canada are emerging in this evolving energy environment. This paper addresses some of the following key questions pertaining to opportunities for increased electricity exports. Do Canadian electricity exports enhance development of electricity for domestic consumption and add value for Canadian society as a whole? Does Canada have the potential to become a much larger electricity exporter? Are increasing electricity exports compatible with increasing concerns about sustainability? What are the spinoff benefits of such trade in terms of value-adding opportunities and technology development, in particular those with more global reach? How can foreign policy assist in providing a framework to achieve these ends?

The paper will first review the evolution of the North American power industry as a backdrop to the recent focus on clean electricity, which is driven by increasing global concern about greenhouse gas emissions and their links to global warming. This will lead to a discussion of the opportunities for Canada to increase electricity exports to the United States as well as potentially leveraging the development of more knowledge-intensive activities in the clean power business on a wider global basis. The paper will then consider the role of foreign policy in facilitating an expanding electricity export business and make recommendations on how this can be achieved.

The North American Power Industry: Industry Structure and Public Policy

Six major challenges now confront the electric power industry in North America, especially in the United States:

- aging infrastructure for generation, transmission, and distribution
- strong moves toward cleaner forms of energy
- energy security concerns
- uncertainties about future demand levels given a renewed focus on energy efficiency and energy conservation
- escalating costs of new generation projects and clean energy in particular
- investment uncertainty in a world of divergent regulatory and market structures as well as the current credit crunch

How the North American industry responds to these challenges is partly a function of the industry's structure and evolving government policy.

Industrial Structure

The electric power industry is the most capital-intensive industry, requiring on average about three dollars of investment to create one dollar of revenue. The electric industry value chain has three major components: power generation, transmission, and distribution. In some cases, with partially liberalized power markets, the retail sector is regarded as a fourth component. Electricity has very specific properties for a myriad of applications that are now fundamental to advanced economies. Electricity is unique among fuels in that it is delivered instantaneously and is not presently capable of large-scale economical storage. This latter characteristic has major implications for reliability of electricity supply.

5 Statistics Canada, *Energy Statistics.*
6 National Energy Board, *Electricity Exports and Imports.*

The American and Canadian electric power industries have evolved in very different ownership patterns. The structure of the US industry is highly regional and fragmented. Until recently, most utilities there had a monopolistic and regulated local franchise for electrical services. Unlike many industries in the United States, such as oil refining, cement, and mining, the electric utility industry has very low levels of corporate concentration. The largest US power producers are American Electric Power and Duke Energy, with power generation capacity of about 38,000 MW[7] and 35,000 MW,[8] respectively; but each represents only about 3 percent of total US generating capacity. This indicates a significant level of fragmentation for such a large capital-intensive industry.

The US electric power industry has gone through significant change in the last decade and a half, largely through increasing deregulation and creation of more competitive electricity markets. A wave of deregulation swept the industry for about 10 years beginning in the mid-1990s, resulting in the current hybrid system of coexisting regulated and deregulated entities. Deregulation has been regionally focused, primarily in the US Northeast, California, and Texas. The hybrid system of regulated and deregulated markets prevailing across North America poses significant challenges for the development of coherent and integrated electricity policy-making.

Despite US trends toward deregulation, this shift has actually spurred very little industry consolidation. Often, this is due to the arduous terms imposed on any mergers and acquisitions by state public utility commissions. Most American power companies are publicly traded utilities, often vertically integrated through generation, transmission, and distribution, operating in dominant local franchise areas within or across contiguous states. Independent merchant generators have emerged in recent years but have not established a large or firm foothold compared with conventional utilities.

From a transmission perspective the US electric power industry is not fully integrated but consists of three discrete regional systems (the Eastern Interconnect, the Western Interconnect, and Texas). Only a minority of electric power companies are owned by governments, most notably the Tennessee Valley Authority and the Bonneville Power Administration, both federally owned and established in the 1930s during the Great Depression. Both these entities remain electricity powerhouses in their respective regions. In addition, there are many smaller municipally owned generators and rural electric cooperatives.

The Canadian power industry has evolved differently in its ownership, with most entities being provincially owned Crown corporations that are vertically integrated across generation, transmission, and distribution. The Canadian power industry is also regionally fragmented with relatively modest interconnections across the country. As in the United States, there is no national grid system.

The only provinces that do not have provincially owned Crown corporations are Alberta, Nova Scotia, and Prince Edward Island. In Nova Scotia, Nova Scotia Power was a Crown corporation until privatization in 1993. In Alberta, the power generation industry has historically consisted of two publicly traded companies, TransAlta and ATCO Power, as well as EPCOR, a municipal generator owned by the City of Edmonton. EPCOR recently spun off its generating assets into a separate company called Capital Power Corporation, with the parent company retaining the electric transmission and distribution assets as well as water interests. Finally, several new independent power entrants have come into the Alberta electric power generation system in recent years due to provincial deregulation in 1999. In Prince Edward Island, Maritime Electric Company Limited is the fully integrated power company for all Island customers and has been so since 1918.

7 American Electric Power, "About Us."
8 Duke Energy, "About Us."

The trends toward deregulation and liberalized power markets are more muted in Canada. Most of the provincial Crown corporations have remained intact despite efforts by many provincial jurisdictions to engage in "creeping" elements of competition and privatization, largely through an active request-for-proposal (RFP) process. This enables Crown corporations to encourage competition through open bids for new power generation. Open bidding is used by most Crown corporations to encourage the building of renewables, though some provinces, Ontario in particular, have also used this process to attract competitive bids for large-scale natural-gas-fuelled generation.[9] The result of competitive bidding has been significant growth in private independent generators, a subsequent lowering of costs for Canadian consumers, and the right market signals for building new power generation.

Electric utilities in both Quebec and Ontario are among the largest in North America in generation capacity. Hydro-Québec is the second-largest electricity generator in North America, with 36,429 MW of capacity.[10] Canada also exports significant amounts of electricity each year to the United States; exports are partially offset by some imports of electricity from south of the border (table 1).

Table 1. Canadian Electricity Trade by Province, 2008

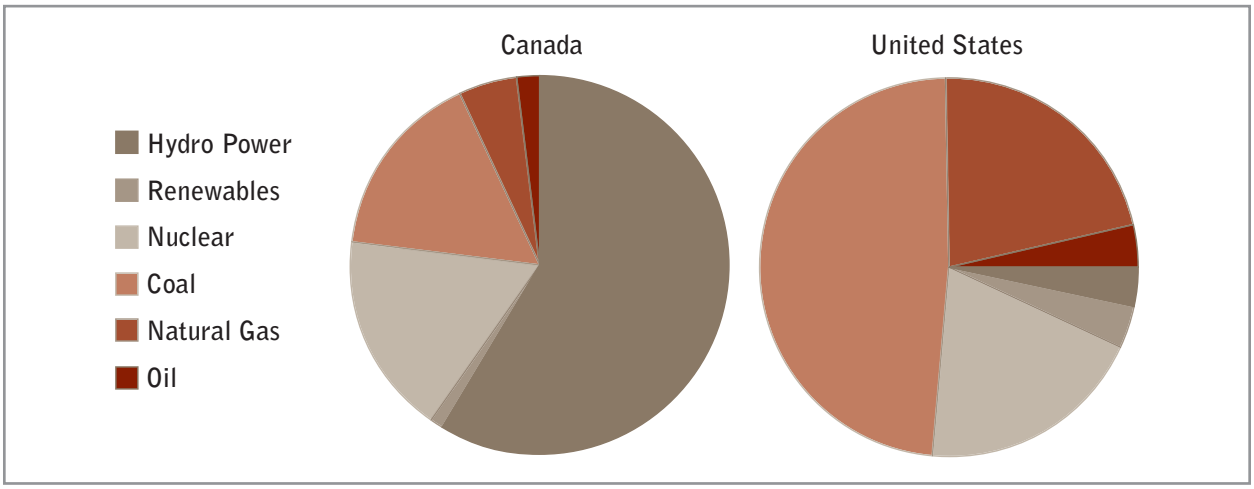
PROVINCE	EXPORTS (MWh)	IMPORTS (MWh)	EXPORT REVENUE ($000)
British Columbia	8,081,431	11,514,053	573.0
Alberta	227,847	761,348	14.2
Saskatchewan	137,199	431,648	9.3
Manitoba	9,880,366	87,878	476.5
Ontario	18,570,879	7,997,884	1,072.4
Quebec	17, 454,743	1,352,462	1,534.4
New Brunswick	1,367,247	1,081,483	109.0
Nova Scotia	12,688	272,688	1.0
Canada	55,732,401	23,499,444	3,799,678

Source: National Energy Board, *Electricity Exports and Imports*.

One of the most significant differences between American and Canadian power generation is the fuel mix. In 2007, US electricity production was dominated by coal-fired production at 48.4 percent; nuclear accounted for 19.4 percent and natural gas for 21.6 percent. Canada has a vastly different mix, with a high percentage of hydro accounting for more than half the power generation (58.4 percent); nuclear comes in at 17.1 percent and coal at 15.9 percent (figure 1). This is a very important issue in a world that is becoming increasingly concerned about global warming and developing carbon mitigation strategies. In electricity production, this is Canada's ace in the hole.

9 Ontario Power Authority, "Electricity Contracts."
10 Hydro-Québec, *Powering Our Future*.

Figure 1. Canada and United States Fuel Mix for Power Generation, 2008



Source: Energy Information Administration and Statistics Canada, 2008

The Canadian electricity grid is not well integrated from east to west. Periodically, the topic of an integrated east-west Canadian grid does surface as part of a national vision. Historically, the reality of electricity flows has shown a much greater orientation southward to the United States than between provinces. The links within the three prairie provinces, between Ontario and Manitoba, and between the various Atlantic provinces are all weak. Modest transmission links have been built between Alberta and British Columbia and between Ontario and Quebec. By contrast, there are very significant transmission links between Quebec and the US Northeast; between Ontario and Michigan, New York, and Pennsylvania; between Manitoba and the US Midwest; and on the West Coast, between British Columbia and the Pacific Northwest and California.

Why is this the case? Seasonal factors are important, given that Canada generally has a winter-peaking electricity system, whereas much of the United States has a summer-peaking system driven by high air conditioning loads. Thus, Canada often has surplus electricity just at a time of US peak demand. In addition, export power prices tend to be higher than prices that can be achieved in domestic markets. Canadian producers can, therefore, maximize economic benefits for themselves and, in the case of Crown corporations, benefit their customers through lower power rates.

This does not mean, however, that Canadian consumers would not benefit from improved integration within Canada on a regional basis. For example, there could be significant benefits from increasing integration between British Columbia and the three prairie provinces, because of both the complementary nature of the diverse fuel mixes (hydro, wind, and steam generation) and the time zone synergies (for instance, the early-evening peak demand period in British Columbia occurs when Manitoba's peak has passed, due to the two-hour time difference). Improved grid integration both within Canada and with contiguous American states could bring consumers better efficiency, lower power prices, and increased reliability.

Policy Evolution

The electric power industry was for many years regarded as a natural monopoly, and in many respects this still holds true for the transmission and distribution components but less so for power generation and retail services. In addition many governments still regard electricity as a public good not amenable to market forces. These factors are the essence of a continuing discourse and ambivalence about the restructuring of the power business.[11]

Deregulation and Electricity Pricing: A Primer

Until the 1990s most of the electric power industry in North America was a regulated, cost-of-service industry. That is, the industry applied to the local regulatory bodies in the states and provinces for rate increases based on achieving a rate of return assessed as reasonable by the regulatory bodies. Capacity additions were proposed by the utilities, with costs and timing approved by the various regulatory bodies. Electricity prices varied significantly, largely reflecting the fuel mix. Generally, those with hydroelectric and coal capacity had low power prices: for example, many of the Canadian utilities as well as American utilities with extensive hydro and coal assets in the US Midwest, US Southeast, and Pacific Northwest. The US Northeast and California tended to have much higher electricity prices due to increasing dependence on oil and the high cost of the nuclear capacity installed in the 1980s.

The evolution of the electric power business as a highly regulated industry was largely due to perceptions that electricity was a public good and therefore could not be exposed to the vagaries of market forces. The scale economies of the large transmission and distribution sectors in particular and their associated natural monopoly status were persuasive arguments for regulation. More recently, some economists and policy developers have argued that at least power generation could be amenable to commoditization, in much the same way as are other fuels such as oil, natural gas, and coal. The debate remains polarized to this day, hence the hybrid power systems that now prevail across North America, supporting both a regulated and a deregulated industry.

In economic terms, the decision was often about the cost of a new marginal generation unit (usually a gas-fired combined-cycle turbine) compared with the embedded cost of electricity in the total system. If the cost of power from a new marginal unit was lower than the embedded cost of electricity, there was an incentive for deregulation (as in the US Northeast and California), but if the new marginal cost was higher than the embedded cost, there was an incentive to remain with regulation (as in the US Southeast and parts of the Midwest and much of Canada).

In reality, there is a spectrum of regulation and deregulation. The most extreme form of deregulation mimics true commodity markets, where new capacity is built on spec, taking a bet on future market requirements and timing. This entails a high level of risk and accounts for the volatile nature of most commodity market prices, reflecting temporary supply-demand disequilibrium.

Few jurisdictions in North America have allowed electricity markets to function as pure commodity markets with no new capacity payment guarantees. (Alberta is one of the few jurisdictions that have pure energy markets with no compensation for the risk of building new capacity.) Many of the deregulated American states have implemented complex "synthetic markets" involving capacity payments to offset the risk of building new power generation capacity.

Other markets in both the United States and Canada have retained purer forms of regulation based on a guaranteed return on investment for new assets. Some markets, including many Canadian provinces, still have a predominantly regulated environment for "heritage assets" but have permitted various degrees of competition for new generation, often through competitive bidding and long-term contracts for power.

11 Joskow, "Difficult Transition"; Hogan, "Market Design."

Differing ownership characteristics in the US and Canadian electricity industries have resulted in very different policy directions. In combination with historic price levels, this variety has had an important impact on attitudes toward deregulation. The wave of deregulation that swept the United States between 1995 and 2005 was much more muted in Canada due in part to government ownership, coupled with generally much lower retail power prices. Even in the United States, deregulation occurred largely in areas that had high electricity prices. In areas with low-cost power in the form of coal-fired or hydro generation, there was little incentive to proceed along the deregulation path. As a result, many midwestern and southern states continue to be regulated and have competitive electricity rates.

In Canada, proponents of deregulation also encounter an environment of public ownership of the electric power industry in most provinces. Outright privatization of Crown corporations has usually been met with strong opposition in Canada, with only one—Nova Scotia Power—being entirely privatized in recent years. However, "creeping privatization" has occurred in many provinces, where the current policy seeks to increase competition for building new generation assets through an open bidding process. Many Crown corporations, however, still see electric power as a public good requiring strong regulation and lack of exposure to market forces for "heritage assets," and in some provinces electric power is still used as an instrument of economic and industrial development.

Canada has been far more resistant to deregulation because of the dominant role of low-cost hydro power in many provinces (notably Newfoundland and Labrador, Quebec, Manitoba, and British Columbia) and coal in other provinces (Alberta, Saskatchewan, and Ontario). Therefore, deregulation had little to offer most provinces in terms of lower electricity prices and an attitude of "Why bother?" prevailed.

The only exceptions were Alberta and Ontario, where deregulation has taken hold, driven in part by political ideology that favours competitive markets. Both provinces experienced early problems associated with deregulating into a market with very tight power supply. The result in Alberta was, temporarily, a strong escalation in prices. Deregulation was salvaged only by the government action of providing subsidies to residential customers and small-business owners in order to insulate them from the surge in market prices. Similarly, in Ontario, rapidly escalating prices resulted in the province backing out of full deregulation into a complex hybrid system of regulation and deregulation. Ontario has managed to use competitive markets in building significant new capacity—largely in natural-gas-fired generation as well as renewable wind and solar power. This has been achieved through competitive bidding processes under the auspices of the Ontario Power Authority.

Clean Energy in North America: A New Paradigm

A big challenge confronting the North American power industry is a growing focus on clean energy. In reality, clean energy is now synonymous with moving toward a low-carbon future driven by climate change concerns.

The power industry is responding to political and public demand for power that meets more exacting environmental standards by significant capital investment in new forms of energy as well as potential retrofits to existing power generation assets, such as carbon capture and storage for coal facilities. These investments will make an already highly capital-intensive power business even more so. Their costs will require American and Canadian consumers to internalize the cost of controlling greenhouse gas emissions through significantly higher power prices. Alternatively, consumers persuade governments to subsidize the higher costs of various forms of clean energy, as in the Ontario government's recently announced Feed-in Tariff program.[12] This program will pay 13 to 83 cents a kilowatt hour, a price that is in some cases 10 times the current market price.

12 Ontario Power Authority, "Renewable Energy."

What Is Clean Energy?

There is no universal definition of clean energy; the term has probably evolved over time to mean something different today than it did 20 years ago. Strictly speaking, there is no such thing as pure clean energy, because energy is used to produce the equipment required for production of any form of energy – including renewables (for example, turbines for wind power production and silicon in photovoltaic cells).

In its original definition, clean energy was often seen as synonymous with renewable energy. This included any type of energy that resulted in zero emissions and was constantly replenished. Under this definition, renewables included wind power, biomass, solar power, geothermal energy, hydroelectric power, and ocean power. However, in light of the seriousness of climate change, clean energy now often means energy with zero carbon emissions.

In this paper clean energy is defined to mean all renewables plus nuclear energy. It does not include carbon capture and storage, a technology that extracts carbon from fossil fuels and stores it in underground reservoirs. The process is still in its infancy and many questions remain around it from both a technological perspective and a regulatory and liability perspective. Therefore this paper excludes carbon capture and storage from the definition of clean energy; it is not likely to be included by most experts until major issues surrounding its development have been resolved and the technology has a stronger likelihood of commercial reality.

Moving to clean energy is a far greater challenge in the United States, where 48.4 percent of the energy industry's power comes from coal-fired generation. It is much less of an issue for the Canadian power industry, where carbon-free hydro, nuclear, and renewables already generate 77 percent of our current electricity yield.

The US economy emitted about 7.15 billion tons of greenhouse gases in 2007 (measured by carbon dioxide equivalent): 5.0 percent in the residential sector, 5.7 percent in the commercial sector, 19.4 percent in the industrial sector, 27.9 percent in the transportation sector, 34.2 percent in the electric power sector, 7.0 percent in the agricultural sector, and 0.8 percent in other sectors.[13] Not surprisingly, the electricity sector and the transportation sector are at the forefront of carbon policy development, especially given the dominant role of large coal-fired power plants in the US electric power industry.

The first major moves toward carbon management in the United States have occurred at the state level, reflecting in part the reluctance of the Bush administration to move toward a clean energy or low-carbon platform. Many states have been proactive in clean energy, largely in three specific areas:

- the establishment of Renewable Portfolio Standards (RPSs) to catalyze the development of renewables
- the establishment of Energy Efficiency Resource Standards through improved building codes and appliance standards in order to reduce energy consumption
- engaging in regional carbon management regulatory schemes

By the end of March 2009, 33 states had implemented RPSs; 28 had mandatory programs and 5 states had voluntary goals.[14] About two-thirds of these states were mandating a 15- to 20-percent renewable power component in their overall electric generating portfolios by 2020. As a reference point, today only 4.5 percent of US generating capacity is fuelled by renewables, representing only about 2.5 percent of actual electricity production. These RPSs are clearly very challenging.

In addition, 20 states have established various programs taking aim at increasing electricity efficiency and curtailing growth rates for future electricity demand. In 5 states these programs are included within the states' RPSs, while in the other 15 states they are stand-alone Energy Efficiency Resource Standards.

13 United States, Environmental Protection Agency, "Greenhouse Gas Fast Facts."
14 United States, Environmental Protection Agency, "Renewable Portfolio Standards."

Despite the reluctance of the Bush administration to act on any concrete program for carbon emissions, 22 states have also cooperated in creating three distinct regional climate change alliances to reduce carbon emissions:

- the Regional Greenhouse Gas Initiative (RGGI), consisting of 10 northeastern states
- the Midwestern Regional Greenhouse Gas Reduction Accord, consisting of five American states and the province of Manitoba
- the Western Climate Initiative, which includes seven western states and four Canadian provinces (Quebec, Ontario, Manitoba, and British Columbia)

By 2008 only the RGGI was actually operational. By September that year it had implemented a carbon cap-and-trade system even though current carbon trading prices remain very low, at US$3.50/tonne. The other two regional groups are in the process of negotiating final rules and regulations aimed at formal mechanisms for reducing carbon emissions.

The election of President Barack Obama in November 2008 ignited a strong movement toward clean energy including carbon management, growth in renewable technologies, and energy efficiency. The Obama cabinet is liberally sprinkled with department heads who possess strong "green credentials," with key appointees including the secretary of energy, Steven Chu, and the administrator of the Environmental Protection Agency (EPA), Lisa Jackson.

On March 21, 2009, the Waxman-Markey Bill (H.R. 2454) was introduced in the US House of Representatives, with the objective of reducing greenhouse gas emissions by 17 percent by 2020, by 42 percent by 2030, and by 83 percent by 2050, all relative to a 2005 baseline.[15] The bill gained House acceptance with amendments and was passed as the American Clean Energy and Security Act on June 26, 2009. This act would give authority to the EPA to control emissions through a market-based cap-and-trade system. The act covers about 85 percent of economy-wide greenhouse gas emissions (6.1 billion tonnes of carbon-dioxide-equivalent greenhouse gases). Offset programs would allow significant additional abatement beyond the cap-and-trade program. The implications of this proposed legislation are most profound for the US electric power sector, given that half of its power generation is fuelled by coal. Removing this amount of coal generation would require huge investments in alternative and more expensive forms of clean energy. As of this writing, the act still needs Senate approval, which looks very uncertain in the current political climate. Thus federal action on carbon management will likely be deferred, potentially for several years.

The Obama administration already included a plethora of clean energy initiatives in the American Recovery and Reinvestment Act of 2009, which was signed into law on February 17, 2009.[16] These include, for example, the following programs:

- extension of the Production Tax Credits for renewable energy for three years beyond October 2008
- a new 30-percent tax credit for investment in selected renewable energy projects
- the authorization of an additional US$1.6 billion of clean renewable energy bonds and US$2.4 billion of qualified energy consumer bonds
- a new tax credit for energy efficiency improvements on existing homes
- a new tax credit for citizens purchasing plug-in hybrid electric vehicles (PHEVs) with at least 5 kilowatt hours of battery capacity
- funding to develop more advanced battery technologies for American manufacturing facilities
- loan guarantees for carbon capture and storage projects
- grants of US$11 billion for electric grid programs, including US$4.6 billion for smart-grid electricity transmission systems

15 American Clean Energy and Security Act of 2009, accessed July 5, 2009. http://www.govtrack.us/congressbill.xpd?bill =h111-2454.
16 American Recovery and Reinvestment Act, 2009, accessed August 12, 2009. http:// www.opencongress.org/bill/111-h1/text.

In addition, the Obama administration is looking at establishing a federal Renewable Electricity Standard to ensure that by 2012, 10 percent of US electricity is produced from renewables and by 2020, 20 percent.

In Canada, clean energy policies have been led by provinces rather than at the federal level (table 2). Energy efficiency programs have been developed by many provinces. Ontario and British Columbia, in particular, have established aggressive energy efficiency and conservation targets. The BC Energy Plan, published in 2008, set very ambitious targets for conservation; BC Hydro must meet 50 percent of its incremental demand needs through conservation by 2020.[17] This represents about 20 percent of British Columbia's domestic consumption of electricity.

The Ontario Green Energy and Green Economy Act was passed on May 14, 2009, and has similarly aggressive energy conservation targets, including a reduction of peak electricity demand of 6,300 MW by 2015.[18] This is equivalent to 20 percent of current peak electricity demand. Moreover, Ontario has stipulated a goal of an annual 2.5-percent improvement from 2015 to 2027. Targets in both provinces appear very ambitious in consideration of reasonable assumptions for future economic growth. While these goals may be over-ambitious, the growth rate in future electricity demand will likely be low, at around 0.5 to 0.7 percent annually in most provinces.

As discussed previously, four Canadian provinces have also become fully engaged members of regional climate change programs dominated by American states. In Canada, British Columbia has been the most active on actual carbon legislation, introducing a comprehensive $10/tonne carbon tax on fossil fuels in July 2008, with specific annual tax increments over the next four years.[19] By 2012, British Columbia's carbon tax will reach $30/tonne—the most aggressive program to date in North America and comparing favourably with the cap-and-trade system operating in the European Union.[20]

Table 2. Provincial and Federal Greenhouse Gas Emission Targets, 2009

PROVINCE	TARGET
British Columbia	33% below 2007 levels by 2020; carbon tax effective July 2008, starting at $10/tonne, rising to $30/tonne by 2012
Alberta	CO_2 capped at 2007 levels by 2020 and reduced by 14% by 2050
Saskatchewan	32% below 2004 levels by 2020
Manitoba	6% below 2000 levels by 2012 and 18% below 1990 levels by 2020
Ontario	6% below 1990 levels by 2014, 15% below 1990 levels by 2020, and 80% below 1990 levels by 2050
Quebec	6% below 1990 levels by 2012; small carbon tax on refined oil products
New Brunswick	At 1990 levels by 2012, 10% below 1990 levels by 2020
Prince Edward Island	10% below 1990 levels by 2020
Nova Scotia	10% below 1990 levels by 2020
Newfoundland and Labrador	10% below 1990 levels by 2020
Canada	20% below 2005 levels by 2020; plans to introduce cap-and-trade system

Source: Manitoba, "Next Steps."

Renewable Portfolio Standards in the United States have catalyzed rapid expansion in renewable power development, especially wind power, with more modest growth in solar and biomass development as well. In Canada, governments tend to set targets rather than mandates for renewables, but most provinces have embarked upon significant programs to boost renewables in their generation portfolios. As in the United States, the largest component of Canadian renewables is wind, but in some provinces these programs also include small hydro, biomass, and solar.

17 British Columbia, Energy, Mines and Petroleum Resources, *BC Energy Plan*.
18 "Ontario Legislature."
19 British Columbia, "Backgrounder."
20 Ellerman and Joskow, *European Union's Emissions Trading System*.

Table 3. Wind Capacity in Canada, 2009 and 2020 (Forecast)

PROVINCE	WIND CAPACITY, MW December 2009	WIND CAPACITY, MW 2020 (Forecast)
British Columbia	102	1,000-2,000
Alberta	590	2,000-3,000
Saskatchewan	171	300-500
Manitoba	104	600-1,200
Ontario	1,168	3,000-4,000
Quebec	659	4,000-5,000
New Brunswick	195	400-500
Prince Edward Island	164	200-300
Nova Scotia	110	300-400
Newfoundland and Labrador	55	100-200
Canada	3,319	11,900-17,100

Source: Canadian Wind Energy Association, "Canadian Wind Farms"; and projections by author.

In the United States, wind capacity was 4,417 MW in 2002 and reached 35,159 MW in 2009.[21] In 2000, Canadian wind capacity was 140 MW; it reached 3,319 MW in 2009 (table 3).[22] Wind capacity in the United States has the potential to reach 100,000 MW by 2020, although this would still represent only 7 percent of total US generating capacity. Similarly, wind capacity in Canada could reach about 11,900 to 17,100 MW by 2020, constituting 8 to 11 percent of generating capacity. It is important to realize that these capacity numbers translate into less than one-third as much actual electricity production, given that the average wind turbine has a load factor of about 30 percent.

Electricity Trade: The Canadian Opportunity

The challenges of global warming and moving to a low-carbon future are immense. The electric power industry in the United States in particular has a massive task of weaning itself off coal-fired generation. This fundamental US need is in perfect juxtaposition to Canadian capabilities for delivering clean electricity exports.

Canadian opportunities exist at three tiers:

- physical exports of clean electricity from established resources such as hydro power, wind, and possibly nuclear power
- development through research and commercial deployment of new technologies in areas such as smart grids, new renewables, and the whole area of energy efficiency and energy conservation
- development of a knowledge-intensive clean electricity services business at the global level

The renewed focus in the United States on both energy security and clean energy provides strong economic opportunities for increasing Canada's electricity exports to the United States. Canada has the advantage of a large endowment of both hydro power and wind power in many regions. Unlike fossil fuels, which are concentrated in the west, electricity generation is widely dispersed. Hence, electricity exports are unlikely to lead to regional conflicts in Canada and will receive much broader regional support. Hydro power is by far the largest single source of clean energy exports and could be significant in at least five provinces. Wind power is even more widespread, with all provinces having access to economically viable wind power, and many could provide intermittent clean energy exports to the United States. The benefits to Canada could be significant in terms of

21 American Wind Energy Association, *AWEA Year End 2009*.
22 Canadian Wind Energy Association, "Canadian Wind Farms."

local economic development (often in remote areas with higher unemployment), improvement in Canada's trade balance, and enhanced revenues for both Crown corporations and independent power developers.

The development of more exports to the United States could also spin off a series of second-tier value-added businesses with impacts for both domestic and transborder projects. The recent deep global recession has probably had lasting effects on North American society, including slower long-term economic growth, leading to less growth in electricity demand. In turn, the demand for new capacity to meet domestic demand will be modest from growth alone, although additional capacity will be required to meet plant retirements and potentially expanding exports.

While investment in power generation to serve domestic markets may slow down, the power transmission system will require significant upgrades to connect distributed or remote resource developments, such as hydro power and wind energy, and to evolve toward smart grids.[23] There is no agreed-upon definition of what constitutes a smart grid. The term seems to mean an electric grid system that will be more reliable, more flexible, and capable of providing far more information to both suppliers and consumers than current grid systems. It certainly includes smart meters in households, remote detection of damaged cables, potential electricity storage systems, and better integration of intermittent renewables. Smart grids would benefit both domestic markets in Canada and export markets. In fact, any moves toward improved grid integration between Canada and the United States will benefit the reliability and security of the overall power system. Automated metering systems will likely lead to more energy conservation as real-time pricing information is conveyed to consumers, especially in a world of time-of-use pricing (where electricity prices are highest in peak demand periods).

Improving the Canadian transmission system does not mean choosing between domestic markets and export markets; instead, both would benefit. There have long been discussions on building a Canada-wide fully integrated east-west grid to replace the more isolated regional interconnects that we have at present. Recent proponents include the Canadian Academy of Engineering[24] as well as the leader of the official opposition, Michael Ignatieff.[25] Better integration of the transmission system from east to west as well as from north to south would result in a more stable and reliable grid, less subject to blackouts. Power exports could be a spur to smart grids, better integration of intermittent renewables, and the development of spinoff knowledge-intensive industries such as automated metering, electronic controls, and electricity storage.

Finally, a third tier of benefits could accrue on a broader scale with the growth of global energy services. These would include expertise in large project development such as hydro power facilities, nuclear power, long-haul transmission, smart grids, new renewable technologies, regulatory systems, and energy efficiency and energy conservation. The major emerging economies in China and India in particular could be attractive markets for our technology and expertise.

The American power system is aging. About half of US electric production is provided by coal, and the average age of the coal-fired fleet in the United States is 35 years. This means significant coal capacity is genuinely geriatric, with many plants exceeding 50 years of service. While maintenance can keep the coal-fired fleet going for many more years, the combination of age plus carbon costs could lead to a much earlier retirement of many older, inefficient coal-fired plants.

For many years, some American states have been creating policies that favour clean energy. Until recently, clean energy policy at the federal level was weak, but the Obama administration is now actively developing a strong clean energy agenda, as previously discussed. These trends do not bode well for the future of coal-fired power.

23 "Wiser Wires."
24 Canadian Academy of Engineers, "Report."
25 Kusch, "Ignatieff Keen."

Canada is in a strong position to develop clean electricity exports to the United States in three key areas: hydroelectric power, wind energy, and nuclear power. But what is the societal case for increasing power exports to the United States? Canada's domestic market will continue to require new power generation facilities to meet growth in electricity demand as well as to replace aging capacity. If electricity use in the transport sector becomes substantial, the growth in demand for electricity could be somewhat higher than now expected.

The scale of development and the resulting capacity of some forms of power generation, including hydroelectric power and nuclear power, could exceed local or regional demand in Canada. Power could then be exported to the United States and become an integral component of overall power generation economics. Seasonality of demand also provides prime opportunities for Canadian power exports, with many US markets being summer-peaking and most Canadian markets being winter-peaking. This not only enables our electricity generation plants to operate at near full capacity year-round, but also provides good financial returns to many provincial Crown corporations and profits for independent power producers. The economics of some forms of clean energy, such as hydro power and wind, can be attractive in some areas. Nuclear energy development faces more significant hurdles, especially because of high capital costs and concerns about long-term waste storage (table 4).

Table 4. Cost Competitiveness of Alternative Power Generation Technologies, 2010

	CAPITAL COSTS (C$/KW)	LEVELIZED COSTS (C$/MWh)	LIFE OF PLANT (years)
Hydro power	4,500-5,500	75-90	100
Nuclear	6,000-7,000	110-130	30-60
Conventional coal (supercritical boiler)	2,700-3,200	80-90	40-60
Combined-cycle natural gas	1,250-1,500	70-80	30-40
Wind	2,200-2,500	100-110	30-40

Source: Kernow Consulting Corporation.

Hydro Power Potential in Canada

Canada ranks second in the world in hydro power production. In 2007, Canadian hydro facilities produced 355 TWh of power from 71 gigawatts (GW) of hydro power capacity.[26] Hydro power dominates the electricity generation mix in Newfoundland and Labrador, Quebec, Manitoba, and British Columbia and is also an important part of the generation portfolio in Ontario, Alberta, and Saskatchewan. Most of the easily accessible hydro power has been developed in Canada; future developments would be in more northern latitudes or more remote locations, requiring incremental transmission capacity to bring the power to markets in southern Canada or to the United States.

There are still large potential hydro sites in Newfoundland and Labrador, Quebec, Ontario, Manitoba, British Columbia, Alberta, and Yukon (table 5). The gross remaining hydro power potential in Canada is about 163 GW of capacity.[27] "Gross" means it could be developed if there are no technical, economic, or environmental impediments. Over the next 15 years a range of projects already under consideration could conceivably result in incremental capacity of 14,963 MW. At current costs these hydroelectric projects could represent around $75 billion of investment (not including the cost of expanded transmission facilities). If all this power were exported, it could provide incremental export revenues of over $10 billion annually. (In reality, some of it would be required to meet increasing domestic power demand.)

26 Canadian Hydropower Association, *Hydropower in Canada*.
27 ÉEM, "Survey."

Table 5. Potential Large Hydroelectric Power Projects in Canada, 2009-25

PROVINCE	PROJECT	MW	POSSIBLE COMMISSION DATE
Newfoundland and Labrador	Lower Churchill Project	3,000	2020+
Quebec	Eastmain A	768	2012
	Sarcelle	120	2012
	Romaine	1,500	2015+
	Petit Mecatina	1,500	2020+
Manitoba	Wuskwatim	200	2011
	Gull	600	2020+
	Keeyask	695	2020+
	Conawapa	1,380	2025+
Alberta	Slave River	1,800	2020+
British Columbia	Revelstoke Unit 5	500	2011
	Mica Units 5 and 6	1,000	2015
	Peace "C"	900	2020+
	Plutonic Power	1,000	2015
Total		14,963	

Sources: Nalcor Energy, "Lower Churchill Project"; Hydro-Québec, "Construction Projects"; Manitoba Hydro, "Projects"; author's personal communication with TransCanada Corporation; BC Hydro, "Site C: An Option" and "Projects"; Plutonic Power Corporation, "Project Map."

Wind Potential in Canada

Canada is endowed with large wind resources across the country although their quality varies significantly between regions. In a global context, Canada has high-quality wind resources. Annual mean wind speeds in Canada are in the range of 6.5 to 9.0 metres per second, levels at which wind power can be an attractive commercial proposition.

Wind resources in Canada are not evenly distributed, but most areas of the country have pockets of economically viable wind. The most impressive wind resources lie in parts of coastal and offshore British Columbia, the southern part of the prairie provinces, the Great Lakes and southwest Ontario, northern Quebec and the Gaspé Peninsula, and many areas of onshore and offshore Atlantic Canada. All Canadian provinces now have some wind development. Ontario, Quebec, and Alberta are leaders in wind development to date, supported by strong provincial policies and targets (table 3).

Wind as an energy resource is attractive from the environmental and carbon footprint perspectives. However, several challenges remain. Wind is an intermittent resource. Most wind farms produce power only about 30 percent of the time, although some wind farms in southeastern Alberta have capacity factors well over 40 percent. Furthermore, optimal wind sites can be located at great distances from existing transmission lines, so the overall costs of connecting to the grid can be high. Offshore wind is generally stronger and more constant than onshore wind. Developing offshore wind, however, is significantly more capital-intensive than onshore wind projects. Wind production also tends to peak at night (an off-peak demand time) and in the winter months. Thus, wind availability does not necessarily tie in well with demand peaks.

Wind power often requires higher reserve capacity and balancing of the overall electric power system, subjecting projects to higher network integration costs. The cost of integrating wind power, however, is largely dependent on alternative available generation technologies. Various studies have calculated a wide range of needs for additional reserve capacity, from 3 to 20 percent, depending largely on the mix of fuel generation in the system.

Balancing wind generation with hydro storage offers particularly intriguing and potentially cost-effective trade-offs. Wind power generated in real time can effectively be stored by hydro power plants as water in reservoirs, in which case the capacity reserve required in a hydro-dominated system may be as low as 3 percent. Such arrangements hold particular promise in British Columbia, Manitoba, Quebec, and Newfoundland and Labrador, which have a strong base combination of hydro power and wind resources.

Nuclear Potential in Canada

One of Canada's more significant technology achievements in the last several decades has been the development of a unique nuclear reactor design called the CANDU ("CANadian Deuterium Uranium"). This reactor uses deuterium oxide as the heavy water that serves as both a moderator and a coolant for the reactor. The CANDU reactor is unusual in using natural uranium for the fuel cycle rather than enriched uranium. Proponents of this technology assert many advantages that they claim have made CANDU a global success story over the past three decades. In reality, however, the domestic market was the key for success of the CANDU technology; the CANDU technology was never accepted in key markets in western Europe and the United States.

The CANDU technology is now at a crucial juncture. There are 48 CANDU reactors in service in seven countries, including Canada, where the technology is in place in three provinces: Ontario, Quebec, and New Brunswick.

To meet growing global needs for nuclear power, Atomic Energy of Canada Limited (AECL) has responded with a new advanced model of the CANDU reactor called the ACR-1000. Marketing this new design is now the key to the long-term survival of the CANDU technology. Government policy, including foreign policy, will be critical in maintaining Canada's position in nuclear power in the future.

ATOMIC ENERGY CANADA LIMITED

Atomic Energy of Canada Limited (AECL) has two key divisions, the CANDU Reactor Division and the Research and Technology Division. Natural Resources Canada recently conducted a review of AECL.[28] About the CANDU Reactor Division, the May 2009 report concluded that it is both undersized and undercapitalized to participate effectively in the global nuclear industry. The review said CANDU would benefit from a strategic alliance with one or more partners with global scale, to best leverage CANDU technology and the division's highly skilled and experienced workforce for greater penetration of global nuclear markets.

These conclusions are fundamental to the survival of CANDU technology in the longer term. A strategic alliance would entail either entering into a joint venture with one of the large global players, such as General Electric, AREVA, or Westinghouse, or building upon the informal Team CANDU arrangement that already exists and includes such global players as Babcock and Wilcox Canada, GE-Hitachi Nuclear Canada, SNC-Lavalin Nuclear, and Hitachi Canada.

Such an arrangement is essential to the continuation of the CANDU technology beyond a purely servicing role for existing reactors. Even it, however, would not guarantee the survival of new CANDU technology in the current economic environment amid a global structure of large entrenched nuclear developers. However, the strategic alliance should at least maintain a strong presence for both nuclear technology development (even of a technology other than CANDU) and the skilled workforce in Canada.

In a carbon-constrained world, nuclear power could experience a renaissance. There is considerable impetus for nuclear power in North America, Asia, and Europe, with some forecasts predicting a doubling of global nuclear power generation over the next 25 years. The high capital costs of nuclear power, however, remain a significant hurdle to development.

28 Natural Resources Canada, *Review.*

The challenge for AECL and its new ACR-1000 is gaining the first commercial sale. But without commercial proofing in Canada, it may be very difficult for AECL to make sales elsewhere.

The current environment, together with recovery from the global financial crisis, is not promising for the development of the ACR-1000. Ontario recently suspended its new nuclear procurement process despite receiving bids from AECL, AREVA NP, and Westinghouse Electric Company. Only the submission from AECL was compliant with the terms of the RFP. The Ontario government's concerns about pricing and AECL's uncertain future resulted in a suspension of the procurement process.[29] The financial crisis has left all governments in Canada with less revenue for discretionary spending, and financing of a nuclear plant is unlikely to figure in their plans.

Nuclear energy may have future potential in Canadian power development. But three issues remain. The first is the uncertain future of the CANDU technology. The second is the high costs of recent new nuclear developments, which have escalated to around $6,000 to $7,000 per kilowatt of capacity. The third is the current lack of permanent safe nuclear waste storage facilities, still a serious concern for many Canadians and most environmental groups. These factors may limit the potential of nuclear power to support electricity exports to the United States. New Brunswick is the only province so far that has expressed an interest in the ACR-1000. The reactor would be built at Pointe Lepreau, with power exports being an essential component of the overall economics and feasibility of the plant. Financing challenges, however, remain formidable.

Critical Success Factors for Electricity Developments and Exports

Electricity development and exports are not without their challenges and detractors. Increasingly in Canada we are experiencing the "development dilemma": as a society we want the conveniences of a modern economy, but we want a low, preferably zero, ecological footprint as well.

A realistic solution will require some trade-offs between economic development and the environment. While there has been much discussion on the negative impacts of fossil fuels, no mode of power generation is without environmental impact, including all forms of so-called clean energy. Ultimately we must decide upon paths of development that minimize impacts on land, air, and water resources, but still meet society's demands for energy. In particular, environmental issues and aboriginal issues need to be addressed in a sensitive and inclusive manner. An effective, timely, smart regulatory process is a critical component for growth in electricity exports.

Hydro power development is viewed by most people as clean energy, but large projects have opponents who challenge this definition. With the replacement of a terrestrial environment by an aquatic environment, there are impacts on land use, terrestrial ecology, and migration routes of some critical wildlife such as caribou. Water quality and biological productivity in artificial reservoirs can be affected by soil erosion and sedimentation, with adverse effects on fish populations.

Another issue raised by some environmentalists is mercury pollution, because of the tendency of hydro dam reservoir development to encourage the production of methyl mercury. Methyl mercury tends to bioaccumulate in fish, particularly during the early years of reservoir impoundment. Mercury levels in reservoir fish have been found to be three to six times those in fish living in naturally occurring lakes. Many studies have shown that mercury levels in reservoir fish do return to normal levels after a period of 20 to 30 years, but even if these findings are valid, mercury remains a concern.[30]

29 "Ontario Suspends."
30 Canadian Dam Association, "Frequently Asked Questions."

In Canada, many hydro developments are in or near areas inhabited by aboriginal people. Both reservoir impoundment and power transmission lines can take up aboriginal lands and disrupt the migration paths of various forms of wildlife. Developments can affect the traditional aboriginal way of life, including trapping, hunting, and fishing. Engagement of aboriginal people is vital to executing a plan of increased electricity exports, particularly from hydro power. Programs must be designed that defuse potential conflicts and ensure that economic and social benefits accrue to the aboriginal residents. Economic development is the key to resolving the social hardships of many aboriginal communities.

The final report of the World Commission Report on Dams in November 2000[31] provided a framework for dialogue on hydro power development with seven key priorities:

- gaining public acceptance
- comprehensive options assessment
- addressing existing dams
- sustaining rivers and livelihoods
- recognizing entitlements and sharing benefits
- ensuring compliance
- sharing rivers for peace, development, and security

Canadian hydro power developers are strong adherents to these principles. The success of both Hydro-Québec[32] and Manitoba Hydro[33] in the development of new hydro power facilities in recent years is testament to the proactive policies of large hydro power developers in Canada.

Smaller-scale "run-of-river" hydro power projects are often seen as having lower environmental impacts so they are looked upon more favourably. However, these projects have recently been receiving more negative attention because of their effects on fish and because of conflicts with other activities such as recreation and tourism. This criticism has been escalating for some run-of-river projects in British Columbia, although it is unclear whether the objections are to the environmental effects, the private ownership of these power developments, or both.

Project development must be planned to minimize environmental and social externalities, such as any harm done to aboriginal communities. That said, hydro power projects can also provide significant economic and social benefits to aboriginal populations. More and more, future success will depend on early engagement, with focused efforts to meet communities' long-term objectives. In turn, however, the aboriginal communities have a responsibility to appreciate that many projects are high-risk, capital-intensive ventures. These investments cannot tolerate extreme demands for economic rent or protracted, adversarial regulatory approval processes.

Wind resources are not free from negative externalities. To some people, wind turbines are unsightly – at least en masse. Some birds and bats have been killed, and the turbines create noise pollution. Many of these problems can be addressed. Wind developments can be placed in remote areas where noise pollution is not an issue. The killing of birds can often be minimized by following a careful set of siting criteria that ensure that the turbines are not on migration paths. Aesthetics are not an issue in remote areas but can be a concern in more populated areas and areas of outstanding natural beauty. Ontario's aggressive wind development program has recently run into objections from residents.[34]

31 United Nations Environment Programme, Dams and Development Project, "The World Commission on Dams."
32 Hydro-Québec, *Our Commitment to the Future*.
33 Nisichawayasihk Cree Nation, "Benefits."
34 Wind Concerns Ontario, website; Canwest News Service, "Ontario Wind Farms."

Nuclear energy is another "clean energy" form that can elicit much controversy. In many developed countries, nuclear power has languished for years. No new nuclear plants have come on stream in North America since the final Darlington nuclear unit in Ontario in 1993. The debate on climate change, however, could lead to a renaissance for nuclear power, given its carbon-free status. Most environmental groups remain opposed to nuclear development nevertheless. The dominant concern remains long-term safe disposal of nuclear waste.

In the eyes of some, nuclear waste remains the Achilles' heel of nuclear development, but climate change has given fresh impetus to the push for new nuclear plants in North America. The industry has a proven track record of safe temporary onsite storage, with no incidents of leakage into the environment. Many options for permanent disposal are being evaluated, given that longer-term solutions will ultimately be required to resolve the waste issue.

Many electricity developments need large infrastructures, and their impacts on land use, communities, and the environment must be mitigated. Overcoming opposition to development is a key consideration in promoting a more aggressive export policy for electricity. Transmission lines can run through long corridors, wind turbine farms can disrupt scenic views, the mere existence of nuclear power plants can intimidate many people, and hydro power developments can change landscapes significantly. Potential impacts on flora and fauna also require due consideration. The "not-in-my-backyard" phenomenon is a growing force and needs to be successfully managed if we are to facilitate the development of the infrastructure needed to boost power exports to the United States. Smarter regulation of development means not the avoidance of regulatory oversight but the creation of a more streamlined process that gets to approval or non-approval more expeditiously and with minimized jurisdictional overlap.

SMART REGULATION

The regulation of large energy projects in Canada has become complex and cumbersome. The overlapping jurisdictions of the federal and provincial governments are a factor. In addition, hearings have become ever more protracted and bent on over-review, creating lengthy project delays. Ironically, most projects do receive approval ultimately, but the drawn-out review process comes at a severe net loss to society.

The first key to improvement is to give the regulatory process the force of law, precluding participants from resorting to the courts once a regulatory decision on a project has been made. Several court cases have made it clear that regulatory processes may satisfy the Crown's duty to consult and, where appropriate, accommodate the interests of intervenors.[35]

The guiding principle of any regulatory process should be due diligence throughout a review, but within the context of efficiency, effectiveness, and timeliness. A 2008 report by a federal working group has set out a workable framework for improved regulatory oversight of large energy projects.[36] The report addresses many issues plaguing the regulatory process for large projects today, including overlapping jurisdictions; it recommends improving the timeliness of the review and approval process, keeping the volume of regulatory requirements manageable, and making the information requirements focused and relevant.

There has to be a more effective process that benefits both proponents and opponents of large projects. Canada should move toward a "smart" regulatory system that results in basic decision-making process much earlier in the process.

Smart regulation is an important aspect of electricity development and export policy. In addition, concepts of net societal benefit and projects of national or regional importance need to be brought front and centre in determining the merits of large projects and the efficacy of regulatory decision-making.

35 For example, *Brokenhead Ojibway Nation et al. vs. Attorney General of Canada (National Energy Board) et al. See Nettleton et al.*, "Federal Court."
36 Canada, Energy and Mines Ministers' Regulatory Performance Improvement Working Group, *Key Factors*.

If exports increase, domestic consumers of electricity will also need to be reassured that this growth will not mean potentially large increases in their own electricity prices. Price increases should not occur if the projects are designed at the right scale and with the right contracts. In many cases, exports will allow the development of large projects that could never be justified on the grounds of domestic demand alone. Scale economies can be leveraged if export markets can be drawn upon to support scale. This is especially true of large hydro and nuclear developments in regions with small grids (such as many of the Atlantic and prairie provinces). Such projects can lead to competitive domestic electricity prices in combination with incremental returns on electricity exports, particularly if these exports are to enter US markets, where electricity prices are often quite high.

Awareness, consultation, and mitigation are the best solutions to concerns and objections. No energy development is totally benign in its effects, but mitigation strategies can often effectively address problems and are integral to the planning and execution process. In the end, society needs energy, and choices must favour the energy options with the least harmful externalities. Many forms of clean energy, such as hydro power, renewables, and nuclear energy, fall into this category, especially in a world preoccupied with global warming and the links between energy and anthropogenic greenhouse gas emissions.

Given the right regulatory structure and sustainable practices by electricity developers, clean energy development for exports has many positive economic attributes for Canadian society. These include the generation of wealth and prosperity, including improving the quality of life for many aboriginal people. Such development contributes to a favourable international trade balance and can make significant contributions to employment, including many high-calibre jobs in engineering, plant design, new technology development, project management skills, and environmental compliance. Because of the location of many hydro power and wind developments, aboriginal people could be significant beneficiaries. Electricity exports could be a prime platform for the creation of more knowledge-intensive jobs in research and development and the provision of global services in engineering, construction, and procurement.

Electricity Exports and Foreign Policy

Historically, Canada has been a long-term net exporter of electricity to the United States. The power has come mainly from the hydro-rich provinces of Quebec, Manitoba, and until recent years British Columbia, but also from nuclear and coal generation plants in Ontario at times of surplus production. Now the basic question is whether we are entering a new energy paradigm that opens up a much larger scope for electricity exports to the United States. If so, how can foreign policy be employed to foster growing electricity exports to the United States, and to create a platform for growth in the provision of value-added services and technology on a global scale?

A new paradigm of Canadian energy exports would be a result of the coalescence of two key forces in the United States: the drive toward clean energy and the need for energy security. Both forces have become priority issues of the Obama administration, and one should not be considered in isolation from the other. The new administration has moved very quickly on clean energy through proposals for a cap-and-trade system for greenhouse gas mitigation, a federal Renewable Electricity Standard, and large incentives for clean energy under the American Recovery and Reinvestment Act.

The administration is determined to lessen dependence on imported oil from areas of geopolitical uncertainty. Presumably, potential large-scale imports of liquefied natural gas will also come under similar scrutiny for reasons of energy security. Combine this progression in US energy policy with large undeveloped reserves of hydro power and wind resources in Canada, plus the possibility of the export of surplus power from nuclear plants, and Canada is well positioned to take advantage of evolving commercial opportunities. In the much longer term, other renewable sources of energy such as geothermal, solar, and ocean power could also become competitive and be a source of increasing electricity exports.

Foreign policy can play a crucial role in propelling Canada to the status of a global energy player and one with green credentials. The following factors form the basis of such a strategy:

- Energy policy in the United States is driven by two overwhelming goals: cleaner, low-carbon fuels, and more secure forms of energy. A new American policy could include, for example, a much broader use of electricity with the commercialization of electric vehicles, thereby diminishing reliance on less secure Middle East oil. It would also include replacement of coal by cleaner forms of energy, preferably with strong energy security credentials. Hydro power in particular is a very attractive option, given Canada's large endowment.
- Canada's nuclear industry is at a critical juncture. The new version of the CANDU reactor is on very shaky ground. However, even without new CANDU technology, Canada can still use its extensive nuclear expertise and skilled workforce to forge a strategic alliance with a global nuclear power developer to support an export services business. Nuclear power is one path to the reduction of global greenhouse gas emissions, making the outlook for the global nuclear industry very positive.
- Foreign policy can also catalyze a larger Canadian electricity services industry in areas where Canada has embedded expertise such as large hydro developments, wind energy, nuclear energy, and transmission and distribution. This role includes leveraging our expertise in engineering, procurement, and construction of projects in hostile environments. In particular, Canadian foreign policy can assist in preserving Canada's advantage in nuclear technology at a time when this industry could be in a renaissance.
- Canada's federal government needs to work with the US federal government to facilitate expansion of new smart electricity transmission systems for Canadian electricity, including improved domestic grid interconnections as well as facilities to increase exports to US markets. Smart grids will ultimately have major implications in such areas as electricity storage, real-time smart metering, energy efficiency, and increasing reliability of the grid system. These knowledge-intensive areas have domestic significance but could also be leveraged for export-led development.

The North American Free Trade Agreement has cemented our relationship with the United States. Canada is the largest trading partner for the United States, as the United States is for Canada. Energy issues generally are pulling us together even more. Clean energy in the form of electricity may be a key bridge between the United States and Canada, particularly given the complex issues around oil sands exports. While the United States would like to take more Canadian oil for energy security reasons, oil from the oil sands is often perceived in the United States as "dirty oil," so importing it challenges another key tenet of the Obama administration: clean energy and low carbon emissions. Electricity exports have value not just in meeting the growing need for electricity in the United States. They also develop a stream of payments for carbon offsets from the shutdown of coal-fired generation there.

Energy Security for the United States

Energy security has been on the US government agenda since the first OPEC crisis of 1973. Each administration since that time has made it a priority issue. Words, however, have been in much greater supply than action on this issue. The current administration may be different. The geopolitics of energy, particularly of oil, remain turbulent, and the administration shows an increasing desire to become less dependent on foreign oil. While foreign oil poses the greater risk to the United States, its power industry also faces formidable challenges in a more carbon-conscious society.

Movements toward cleaner forms of energy in order to mitigate greenhouse gas emissions make achieving energy security more difficult. As with oil, the US electric power industry is facing a conflict between energy security and cleaner energy use. Coal-fired electricity is responsible for almost half of US electricity production. Although this form of generation is a major source of greenhouse gas emissions in the United States, it makes an important contribution to energy security since it relies almost exclusively on domestic resources.

Energy security, whether the energy comes from oil sands, natural gas, or electricity generation, is Canada's ace in the hole. As the United States reduces coal-fired electricity generation, Canada is well placed to help fill part of this void, not just with secure electricity exports but also with other clean power options.

Industries cannot capitalize on this opportunity without support. The Canadian federal government needs to play a catalyzing role by creating a framework for secure, clean electricity exports to the United States. Foreign policy is a critical platform upon which a long-term business for the Canadian power industry can be built. The focus must be on energy security and expanded energy trade, including all forms of energy, not just electricity. This initiative should go beyond existing forums such as the Canada-US Clean Energy Dialogue, which focuses solely on clean energy research and development cooperation – in itself a laudable objective.[37] Secure energy has a different connotation than clean energy alone, because oil and natural gas exports are also critical to both the health of the Canadian economy and energy security for US consumers. Clean electricity exports can help to counterbalance some of the carbon emissions of oil and gas exports until longer-term solutions and alternatives to fossil fuels are developed.

A Canada-US Energy Trade Council

Canada's credentials as a secure energy supplier are unquestioned in the United States, but our role as a major energy exporter has both political and economic dimensions. Advancement of Canadian exports could be achieved by establishing a formal mechanism to discuss North American energy security: a Canada-US Energy Trade Council.

An ad hoc approach to electricity exports is more likely to preclude our successful capture of economic opportunities than a more formal body at the federal level. The Canadian federal government would take on a leadership role in this council but work closely with the provinces, as they are the owners of the resources.

The key terms of reference for the electricity section of the Canada-US Energy Trade Council would include the following:

- To comprise members appointed by the prime minister of Canada and the president of the United States, including executive-level representatives of regulatory agencies in energy, environment, and economic development
- To develop a clear set of objectives for the council based on expanding cross-border energy trade, including a growing role for Canada in meeting American energy needs for clean energy and energy security
- To develop a common definition of clean energy
- To develop a compatible regulatory framework for clean energy and greenhouse gas emissions, not necessarily identical but broadly similar for the two countries
- To facilitate the development of infrastructure, such as cross-border transmission lines and the projects leading toward a smart grid
- To facilitate cross-border exchange of technology developments in clean energy and the more efficient usage of electricity
- To pursue common goals for the development of new applications of electricity, notably in the transport sector (for the United States, supporting the case for energy security through diversification away from offshore oil imports)
- To develop mechanisms for the full participation of states and provinces, where the key decisions on fuel choice, technology, and energy policy are often formulated

37 Canada, Office of the Prime Minister, "Annex."

The objective of the formalization of a common policy is to create a platform of certainty and opportunity so that developers of electricity can pursue increasing exports from Canada to the United States, with benefits for the citizens of both countries.

The primary focus of this paper has been electricity exports to the United States. However, spinoff benefits from electricity development include value-added opportunities that could become increasingly important in the future. For example, marketing our expertise in engineering, procurement and construction, regulatory constructs, and environmental mitigation in the power generation value chain could be an expanding global business. In addition, we are at the early stages of developing expertise in renewables development, smart grids, and technology pertaining to energy efficiency and energy conservation.

Conclusions and Implications for Foreign Policy

Canada is a country richly endowed with resources for the production of electricity, most of which can be classified today as clean energy. These resources can not only be used to meet the slow growth of electricity demand in Canada, but also can be leveraged to provide secure, clean energy to the United States. With the right balance and a smart regulatory framework, such electricity exports can be pursued with a net societal benefit and positive economic attributes for Canada. Furthermore, Canada's expertise in the development of clean energy, including hydro power, renewables and nuclear power, can be leveraged into a larger global energy services business.

Resource development in Canada is often wrongly perceived as low-value economic activity. This is clearly incorrect in the context of electricity development, which includes advanced knowledge in areas such as project management, nuclear research and development, engineering services, clean energy research and development, environmental offset developments, and research and development of new transmission systems and smart grids. In addition, Canadian clean energy exports can create significant additional revenues through carbon offsets. The benefits of electric power development extend well beyond the export of electricity as a commodity and include the potential for Canadian industry to be a global provider of high-value energy services.

Foreign policy can play a critical and positive role in fostering the development of an exportable clean energy business, for both electricity exports to the United States and global energy services. Several potential benefits are evident, as outlined below.

Canada-US Energy Trade Council

This council could communicate the role of Canadian energy exports and the benefits to citizens of both countries, develop a set of objectives to provision for the electricity supply, and garner support for highly compatible regulatory and clean energy standards between the two countries. This approach should unlock net gains for Canadian society and well-being. Electricity developments, however, must meet strict standards beyond economic ones, including social and environmental criteria. A smart regulatory system should ensure a wide perspective of views can be assessed and that concerns from aboriginal groups, environmentalists, and a broader public can be accommodated in a timely manner.

International Trade Development

Expanding exports to the United States would improve Canada's trade balance, job creation, economic growth, and regional development. Regional development implications can be especially important because hydro power and wind developments often occur in areas with limited economic opportunity. Major benefits could also accrue to the aboriginal population.

In addition, Canada has the potential to boost its international participation in many forms of clean energy development, including technology research and development that can broaden its global role as a major supplier of value-added energy services. Foreign policy can play an important role in facilitating market development for these services, especially in the rapidly growing economies of China and India, which together account for 37 percent of global population. Broadening our trade base should be a primary focus of foreign policy, given our large dependence on one trading partner – the United States.

Federal-Provincial Relations

Projects that result in positive federal-provincial relations rather than conflicts are always welcome in a country with high levels of decentralized decision-making. Electricity exports certainly fall into this category, given that most provinces across Canada have the potential to become net exporters of clean electricity. Indeed, expansion of the electricity grid for exports could also lead to the development of a more integrated domestic grid, which could help all regions.

Clean Electricity Policy and Foreign Policy

Exports of clean electricity could help boost Canada's international reputation as a clean energy provider and help to counterbalance our exports of more controversial oil from oil sands developments. Canada's role in clean electricity production and exports is poorly understood globally, and our foreign policy should use our credentials in this area to boost our standing in the international environmental community.

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