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Ontario, Québec, Electricity and Climate Change

Advancing the Dialogue

Summary Report

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Executive Summary

This report summarizes the findings of two workshops convened in early 2015 to 'Advance the Dialogue' on collaboration on electricity and climate change matters between Ontario and Québec. The workshops were funded through the Social Sciences and Humanities Research Council's Connection Grant program, and organized by project proponents Drs. Mark Winfield and Pierre-Olivier Pineau, of York University and HEC Montréal, respectively. This executive summary reviews some of the key highlights from the proceedings

Recent developments in continental natural gas markets have depressed prices for electricity in the US Northeast, thereby hindering the competitiveness of Canadian electricity exports. Québec in particular has seen the value of its exports to the US stagnate, even as the quantity has increased. Outside of approximately 300 hours of peak demand per year – a window limited in part by transmission infrastructure bottlenecks - the rates the province receives for its exports to the US have hovered around 3 - 4¢ per kilowatt hour for the past seven years.

In Ontario, meanwhile, lower natural gas prices have come at an opportune moment as the province recently retired its coal-fired generation stations and largely replaced them with natural gas-fired plants. However, the province now faces the imminent need to refurbish its nuclear facilities at Darlington and Bruce B. The costs to refurbish just the Darlington facility are estimated at 8.7¢ / kWh. The record of cost overruns, delays and cancellations on nuclear refurbishment projects in Ontario casts considerable uncertainty over the reliability of this estimate.

Based solely on the difference in US export rates in Québec and the estimated costs of refurbishment in Ontario, there appears to be considerable opportunity in increased electricity trade between the provinces. However, all of this takes place in the context of mounting pressure to address climate change. 2020 emissions targets are only 5 years away. If Ontario relies on natural gas to replace the missing capacity during nuclear refurbishments, electricity-related emissions in the province could increase by 60% or more.

Moreover, Québec's participation in the WCI-based carbon market with California has created concerns about net capital outflow southward, while rates for large hydro exports do not as of yet reflect its contribution to renewable or clean energy in the US Northeast.

Accordingly, there are at least three options for collaboration on electricity and climate change between Ontario and Québec:

OPTIONS FOR COLLABORATION

OPTION 1

A small scale, limited agreement to swap capacity at times when load curves in the provinces are complementary (i.e., from Ontario to Québec in the Winter; Québec to Ontario in the summer). This option has limited implications for rates or revenues and little impact on greenhouse gas emissions in either province, though it is the avenue both provinces appear to be pursuing at present.

OPTION 2

A longer-term, larger-scale trade agreement for a capacity sufficient to either, a) replace natural gas-fired generation during nuclear refurbishment or, b) replace Darlington in its entirety, avoiding the need for refurbishment. Either avenue offers considerable climate change benefits and the certainty necessary for investment into transmission infrastructure between the two provinces. This option also lessens risks for both provinces stemming from future natural gas prices and the costs of nuclear refurbishment.

OPTION 3

A 'Grand Bargain' on electricity and climate change between th e provinces, building on Option 2 by incorporating, among other things, Ontario's participation in the WCI carbon market and arrangements to use storage capacity in Québec to balance intermittent wind and solar resources into a larger 'vision' for the future of low-carbon electricity systems in Canada.

There are numerous opportunities for both provinces to gain by close collaboration under Options 2 or 3. Broadly speaking, these opportunities are economic, technical, environmental, and political. *Economic benefits* include lower rates in Ontario and more revenue in Québec; *technical benefits* include electricity system planning flexibility, intermittent balancing potential, and increased efficiency in Québec; *environmental benefits* include the avoidance of increased emissions associated with natural gas-fired electricity in Ontario and a Canadian partner in carbon markets for Québec; and *political opportunities* include the chance to demonstrate leadership on electricity and climate change to domestic audiences and to Canada at large and building a stronger relationship between the two provinces.

Nevertheless, there are some risks and uncertainties associated with collaboration that have the potential to act as barriers if they are not resolved. These potential barriers include the extent of Québec's surplus capacity; the level of future demand in Ontario; the potential for industry to relocate to Ontario and the possibility that Ontario would wheel cheap imports to its US neighbours at higher rates; the pace and impact of actions to address climate change in the US; and, in particular, future natural gas prices and the costs of nuclear refurbishment.

Risks and uncertainties can be largely resolved by acquiring more information. There are, however, some more resolute historical and institutional barriers to collaboration. Perhaps the largest is the historically 'provincialist' mindset in the provinces regarding domestic electricity systems. This mindset, coupled with the tendency to 'look South' for export markets, has led to a patchwork of largely unconnected systems in Canada, a quality one speaker characterized as *désarticulés*. Moving toward a more collaborative approach on electricity and climate change could be perceived as a loss of autonomy or provincial identity by politicians and/or the public, depending on the extent of integration achieved.

Public opposition to collaboration could also act as a barrier, particularly among Québec ratepayers if rates increase due to market integration and in Ontario among private generators displaced by cheaper imports. The historic importance of the nuclear industry to Ontario's economy and electricity system suggests that there may be strong incumbent interests in the province to continue down the nuclear path as well.

From an administrative and regulatory standpoint, the barriers that exist are really more a consequence of inaction than intervention – for example, the energy chapter of the 1995 interprovincial free-trade agreement (the 'Agreement on Internal Trade') remains to be written. At the federal level, interest in provincial electricity systems appears almost non-existent (the focus being primarily on fossil fuel production in Alberta and Saskatchewan) and the National Energy Board does not regulate interprovincial electricity trade. However, the National Energy Board Act does include provisions that require any province seeking an export license to both inform and give first right of refusal to potential Canadian partners. Poor data availability, insufficient institutional resources, and a growing lack of decision-making transparency and accessibility in both provinces acts as a hindrance to informed policy making as well.

One last barrier may be the lack of an adequate 'vision' for what interprovincial collaboration on electricity and climate change could or should look like in Canada, moving forward. Without a strong sense of what the Canadian energy future looks like and the place of collaboration in it, efforts to address global issues like energy and climate change are likely to remain disjointed among the provinces, and ineffectual. The findings of these workshops indicate that there is a historic opportunity for Québec and Ontario to provide just such a vision.

Résumé à l'intention des décideurs

Le présent rapport résume les conclusions de deux tables rondes tenues au début de 2015 visant à « passer à l'action » à propos d'une plus grande collaboration entre l'Ontario et le Québec en matière d'électricité et de changements climatiques. Financées par le programme Connexion du Conseil de recherches en sciences humaines, les tables rondes ont été organisées par les professeurs Mark Winfield et PierreOlivier Pineau, de l'Université York et de HEC Montréal, respectivement. Le résumé à l'intention des décideurs présente les points saillants de ces événements.

La récente évolution des marchés du gaz naturel sur le continent a fait baisser les prix de l'électricité dans le nordest des ÉtatsUnis, affaiblissant ainsi la compétitivité des exportations d'électricité du Canada. Le Québec en particulier a observé la stagnation de la valeur de ses exportations vers les ÉtatsUnis, malgré une hausse de la quantité d'électricité disponible. À l'exception d'une période de pointe de la demande d'environ 300 heures par année – d'ailleurs limitée en partie par les goulots d'étranglement de l'infrastructure de transmission – les tarifs obtenus par la province pour ses exportations aux ÉtatsUnis se sont maintenus autour de trois à quatre cents par kilowattheure (kWh) au cours des sept dernières années.

Entretemps, en Ontario, la baisse des prix du gaz naturel est survenue à un moment opportun, alors que la province a récemment mis hors service ses centrales thermiques au charbon et les a remplacées en grande partie par des centrales au gaz naturel. Cependant, la province fait maintenant face à la nécessité immédiate de procéder à la réfection des centrales nucléaires de Darlington et BruceB. Les coûts pour la réfection de la seule centrale de Darlington sont estimés à 8,7 ¢/kWh. Les antécédents de dépassements de coûts, de retards et d'annulations dans les projets de réfection de centrales nucléaires en Ontario soulèvent une incertitude considérable à l'égard de la fiabilité de cet estimé.

En se basant exclusivement sur la différence entre les tarifs d'exportations du Québec vers les ÉtatsUnis et le coût estimé de la réfection en Ontario, il semble exister une excellente occasion d'accroître le commerce d'électricité entre les provinces. Cependant, cette situation se déroule dans le contexte d'une pression croissante pour contrer les changements climatiques. Il reste moins de cinq ans pour atteindre les cibles de réduction des émissions de gaz à effet de serre de 2020. Si l'Ontario utilise le gaz naturel pour pallier le manque de capacité pendant la réfection des centrales nucléaires, les émissions liées à l'électricité de la province pourraient augmenter de 60 % ou plus. Par ailleurs, la participation du Québec au marché du carbone fondé sur la Western Climate Initiative (WCI) avec la Californie a suscité des préoccupations à l'égard d'une sortie nette de capitaux vers le sud, alors que les tarifs pour un grand volume d'exportation d'énergie hydroélectrique ne reflètent pas encore la contribution de celle-ci au domaine des énergies renouvelables ou propres dans le nordest des ÉtatsUnis.

Par conséquent, il existe au moins trois options de collaboration en matière d'électricité et de changements climatiques entre l'Ontario et le Québec :

OPTION 1 **Un accord limité à petite échelle qui permet un échange de capacité lorsque les courbes de charge des provinces sont complémentaires (c'estàdire de l'Ontario vers le Québec en hiver et du Québec vers l'Ontario en été). Cette option présente des implications limitées sur les tarifs et les revenus, et un faible impact sur les émissions de gaz à effet de serre de chaque province. Il s'agit toutefois de l'avenue que les deux provinces privilégient actuellement.**

OPTION 2 **Un accord commercial à plus long terme et à plus grande échelle qui offre une capacité suffisante pour remplacer soit a) la production d'électricité par des centrales au gaz naturel pendant la réfection des centrales nucléaires ou b) l'entière centrale Darlington, élimi-**

OPTION 2

nant ainsi la nécessité de procéder à sa réfection. Les deux avenues procurent des avantages considérables en matière de changements climatiques, en plus de la stabilité nécessaire pour investir dans l'infrastructure de transmission entre les deux provinces. Cette option diminue également les risques, pour les deux provinces, associés à l'évolution du prix du gaz naturel et aux coûts de réfection des centrales nucléaires.

OPTION 3

Une « grande entente » entre les provinces sur l'électricité et les changements climatiques qui s'appuie sur l'option 2 et intègre notamment la participation de l'Ontario au marché du carbone de la WCI et des dispositions visant l'utilisation de la capacité de stockage d'électricité du Québec pour compenser la nature intermittente des sources d'énergie éolienne et solaire, en une vision plus large pour l'avenir des systèmes électriques à faibles émissions de gaz à effet de serre au Canada.

Les options 2 et 3 offrent de nombreuses possibilités de gain par une étroite collaboration des deux provinces. Globalement, ces occasions sont de nature économique, technique, environnementale et politique. *Les avantages économiques* comprennent des tarifs plus bas en Ontario et plus de revenus pour le Québec; *les avantages techniques* comprennent une flexibilité dans la planification du réseau électrique, un potentiel d'équilibrage intermittent et une efficacité accrue au Québec; *les avantages environnementaux* comprennent l'évitement d'une hausse des émissions liées à la production d'électricité à partir du gaz naturel en Ontario et un partenaire canadien sur le marché du carbone pour le Québec; et *les avantages politiques* comprennent l'occasion de faire preuve de leadership en matière d'électricité et de changements climatiques *à l'échelle provinciale et nationale, ainsi que le renforcement de la relation entre les deux provinces*.

Toutefois, cette collaboration comporte *des risques et des incertitudes* qui pourraient constituer des obstacles s'ils ne sont pas pris en considération. Ces obstacles potentiels comprennent l'envergure de la capacité de production excédentaire d'électricité au Québec; le niveau de la demande future en Ontario; le risque potentiel que le secteur industriel se déplace vers l'Ontario et la possibilité que l'Ontario exporte aux ÉtatsUnis, à des tarifs plus élevés, de l'électricité importée du Québec; le rythme et l'impact des mesures mises en œuvre pour contrer les changements climatiques aux ÉtatsUnis; ainsi que tout particulièrement les prix futurs du gaz naturel et les coûts de réfection des centrales nucléaires.

Les risques et les incertitudes peuvent être en grande partie résolus par la collecte de plus de données. Cependant, il existe des *barrières* historiques et institutionnelles qui pourraient entraver plus sérieusement la collaboration. La mentalité historiquement « provincialiste » des provinces à l'égard de leur réseau électrique intérieur constitue possiblement la plus importante. Jumelée à la tendance à « se tourner vers le sud » pour les marchés d'exportation, cette mentalité a mené à une mosaïque de réseaux essentiellement déconnectés les uns des autres au Canada, qu'un paneliste a qualifiés de *désarticulés*. L'adoption d'une approche plus coopérative en matière d'électricité et de changements climatiques pourrait être perçue comme une perte d'autonomie ou d'identité provinciale par les politiciens et le public, selon le degré d'intégration atteint.

L'opposition publique pourrait aussi constituer un obstacle à la collaboration, notamment parmi les contribuables du Québec si les tarifs augmentaient à la suite de l'intégration des marchés, et parmi les producteurs privés d'électricité de l'Ontario, qui seraient déclassés par des importations meilleur marché du Québec. L'importance historique de l'industrie nucléaire pour l'économie et le réseau électrique de l'Ontario suggère que de puissants intérêts en place dans la province pourraient peut-être aussi exercer des pressions pour poursuivre sur la voie du nucléaire.

Du point de vue administratif et réglementaire, la présence d'obstacles constitue davantage une conséquence de l'inaction que de l'intervention. Par exemple, le chapitre sur l'énergie de l'accord de libre-échange interprovincial de 1995 (Accord sur le commerce intérieur, ACI) reste à écrire. De plus, l'intérêt du gouvernement fédéral à l'égard des réseaux électriques provinciaux semble pratiquement inexistant (l'accent étant mis essentiellement sur la production de combustibles fossiles en Alberta et en Saskatchewan), et l'Office national de l'énergie ne réglemente pas le commerce interprovincial d'électricité. Cependant, la loi sur l'Office national de l'énergie prévoit des dispositions stipulant que toute province à la recherche d'un permis d'exportation doit informer ses partenaires canadiens potentiels et leur concéder le droit de premier refus. En outre, la disponibilité restreinte des données, l'insuffisance des ressources institutionnelles, ainsi qu'un manque croissant de transparence et d'accessibilité relativement aux processus décisionnels des deux provinces sont autant d'éléments qui entravent l'élaboration de politiques en toute connaissance de cause.

Enfin, un ultime obstacle peut s'expliquer par l'absence d'une vision bien définie de la forme que pourrait ou devrait prendre dans l'avenir une collaboration interprovinciale au Canada en matière d'électricité et de changements climatiques. En l'absence d'une perception claire de l'avenir énergétique canadien et de la place que la collaboration y occupera, les efforts visant à résoudre les enjeux mondiaux comme l'énergie et les changements climatiques risquent fort de demeurer dispersés et inefficaces au sein des provinces. Les conclusions de ces tables rondes indiquent qu'une occasion historique se présente pour le Québec et l'Ontario en vue d'établir une telle vision à long terme.

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Introduction

All Canadian provinces have interconnections between their domestic electricity system and those of their neighbours, but to date these have been used mainly to export electricity to US markets. In some cases (i.e., provinces with large hydro-electric resources) this arrangement has substantially benefited the exporting province, as electricity rates in the US are typically higher. Canadian hydroelectricity imports may also qualify for inclusion under some states' renewable portfolio standard programs, thus justifying an additional premium and ensuring reliable demand. However, recent developments in hydraulic fracturing ('fracking') have led to a North American natural gas 'glut' that has depressed prices for both US natural gas and for gas-fired electricity, thus making Canadian electricity exports less profitable (Bernard, 2013; Lanoue & Mousseau, 2014). The value of Canadian hydroelectricity exports has indeed dropped – for instance, the average annual price that Québec receives for its electricity exports fell by approximately 50% from 2008 to 2012 (Équiterre and Ontario Clean Air Alliance Research, 2014).

At the same time, in Ontario, efforts at refurbishing the province's fleet of aging nuclear power plants has been defined by a record of delays, major cost-overruns and even project failures. The situation has prompted growing interest in potentially less expensive and risky alternatives to continuing down the refurbishment path, as was proposed in the province's most recent Long-Term Electricity Plan for the Darlington and Bruce nuclear facilities (Government of Ontario, 2013). Moreover, increased interest in renewable energy in both Canada and the US is leading to greater reliance on intermittent sources of electricity. This has been particularly the case in Ontario as a result of the province's 2009 Green Energy and Green Economy Act. Finally, though the province successfully phased out its coal-fired electricity generating plants in 2014, the potential for increased reliance on natural gas during the planned, decade-long nuclear refurbishment process raises new concerns about increasing greenhouse gas emissions during a critical period in the global transition to a lower-carbon energy future.

2020 is only five years away. Many jurisdictions worldwide (Québec and Ontario included) are soon going to have to take a hard look at the likelihood of meeting their self-ascribed emissions targets for that year. Late-game moves to hit targets could disrupt global and regional energy markets, possibly threatening price stability, accessibility and overall energy security, especially if preparatory actions are not taken in time. There will be increasing pressure to undertake conservation measures and improve energy efficiency, reduce price discrepancy against surrounding markets, and to secure access to affordable, reliable and clean sources of electricity. Political pressure will also mount to take meaningful action toward addressing climate change; an imperative which, in Canada, simultaneously increases the need for but also sharpens inter-provincial differences regarding a national energy strategy.

As a result there may be substantial benefits in terms of advancing sustainability and Canadian prosperity in pursuing greater inter-provincial electricity system collaboration, particularly between Ontario and Québec. This report summarizes the results of two recent workshops convened to discuss just such an opportunity, funded with a Connection Grant from the Social Science and Humanities Research Council (SSHRC) awarded to project proponents Drs. Mark Winfield and Pierre-Olivier Pineau from the Faculty of Environmental Studies, York University and the Chair in Energy Sector Management, HEC Montréal, respectively. Based on the presentations and discussion periods at each workshop, as well as the related academic and grey literature research, this report will identify and discuss the different options for collaboration, as well as the opportunities, barriers, risks and uncertainties associated with them.

Background

North American real spot prices for natural gas peaked in the winter of 2005 at approximately $10.90 / million BTUs. They peaked a second time in June of 2008 at $9.48. Four years later, prices hit a near 10-year low of $1.37 in April 2012 - all against the backdrop of growth in US natural gas production of nearly 26% during the same period. Prices remain near historic lows today, while production continues to increase (roughly 36% higher in 2014 than in 2005).

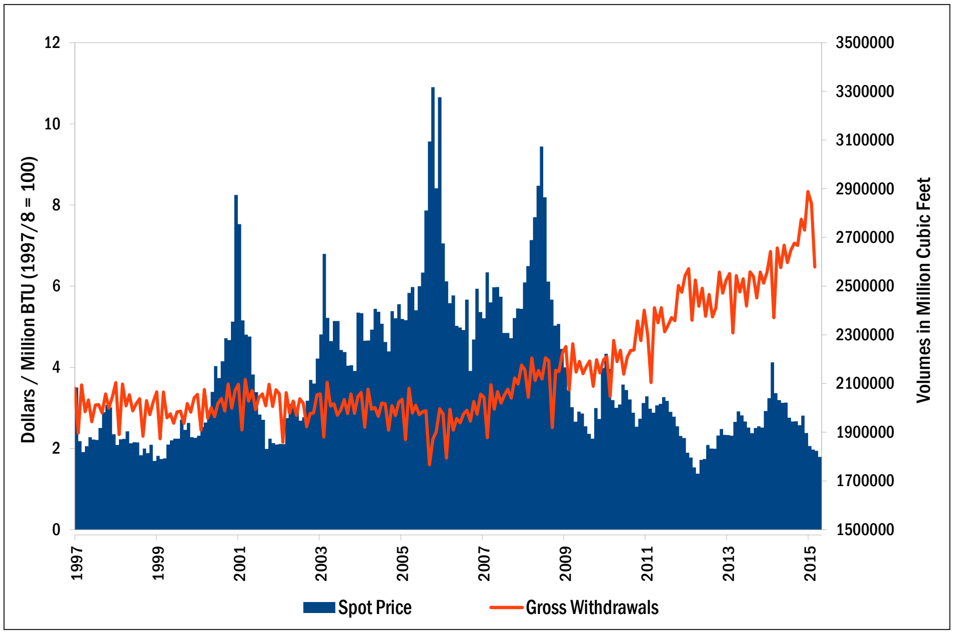


Figure 1) US Natural Gas Spot Prices and Gross Withdrawals (U.S. Energy Information Administration, 2015a, 2015b)

This so-called 'gas glut', owning largely to increased use of hydraulic fracturing in the US (International Energy Agency, 2009, pp. 50–51), has had important ramifications for electricity markets and politics in Canada. Few Canadian provinces actually rely on natural gas -fired generation plants for their electricity – only about 6% of electricity generated in Canada in 2013 came from natural gas, and of that almost 89% came from just three provinces: Ontario (42%); Alberta (33%); and Saskatchewan (13.5%) (Statistics Canada, 2013a, 2013b).[1] For these provinces, lower prices may incentivize continued or increased reliance on the fuel moving forward. In the remaining provinces, however, particularly those that seek to export hydroelectricity to their southern neighbours in the United States, low gas prices threaten their competitive advantage. Indeed, each of the main hydroelectric producing provinces export significant quantities of their total generation to the US: 14.5% for BC, 27% for Manitoba, and 17% for Québec (Statistics Canada, 2013c).

1 It should be noted, however, that the share of electricity generated by gas within each of these provinces, i.e., the importance of gas to the provincial electricity generation profile, varies: Only 10% of Ontario electricity came from gas, while in Alberta that figure was 18.5% and for Saskatchewan it is 21%. Nova Scotia and New Brunswick also both rely on gas for approximately 13% of their electricity.

For Québec in particular, that figure has been growing for the past 10 years. From 2005 to 2013 – the same period in which gas prices have dropped so significantly - the share of total generation exported to the US has grown from roughly 6% to nearly 17%. The value that Québec receives for that electricity has not, however, grown in proportion to the quantity of exports. As indicated in Figure 2 below, the value of Québec's exports is closely tied to the quantity of firm exports to the US, which in recent years has comprised a relatively small share of the increasing total quantity of exports. In other words, Québec is increasingly exporting more electricity at lower prices than it can get for firm exports.

Electricity prices in Québec are among the lowest in all of North America. According to Hydro-Québec (HQ), the average rate paid by residential customers in Montréal on April 1st, 2014 was 7.06¢ / kWh (and only 5.05¢ for large-power customers). In contrast, rates are 13.45¢ in Ottawa, 13.78¢ in Toronto, 20.42¢ in Boston and 30.74¢ in New York. The situation makes the potential profits from exports clearer (Hydro-Québec, 2014b). Exports do account for a proportionally large share of Hydro-Québec's profits from generation, as is shown in Figure 3 drawn from HQ's 2014 Annual Report (Hydro-Québec, 2014a). However, according to a report produced by the Ontario Clean Air Alliance (OCAA) and Équiterre, the average annual export price Québec receives for its electricity fell by more than 50% between 2008 and 2012 (Équiterre and Ontario Clean Air Alliance Research, 2014).

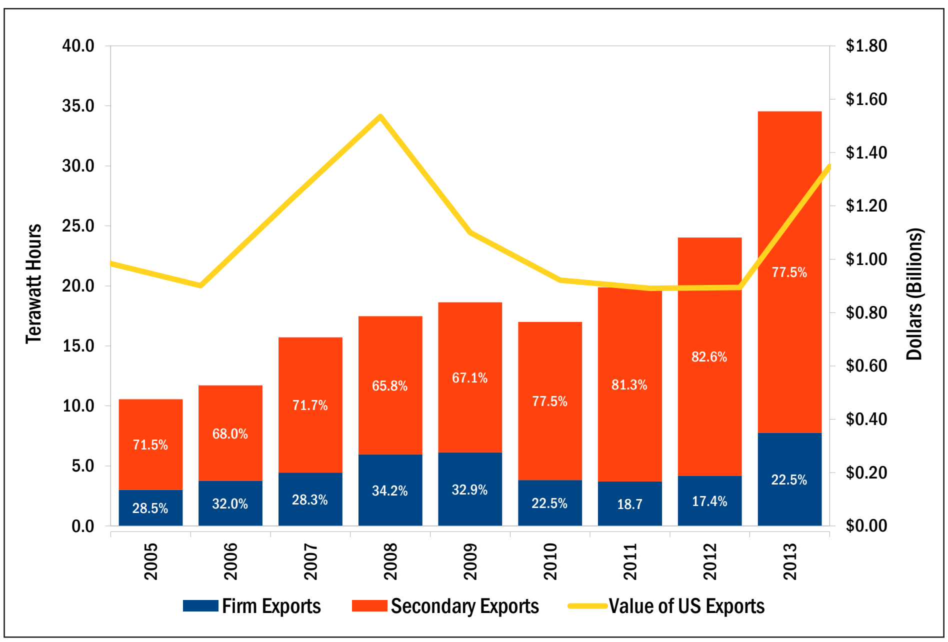


Figure 2) Québec's Electricity Exports to the US (Statistics Canada, 2013c)

The problem, as the 2014 Québec Commission on Energy noted, is

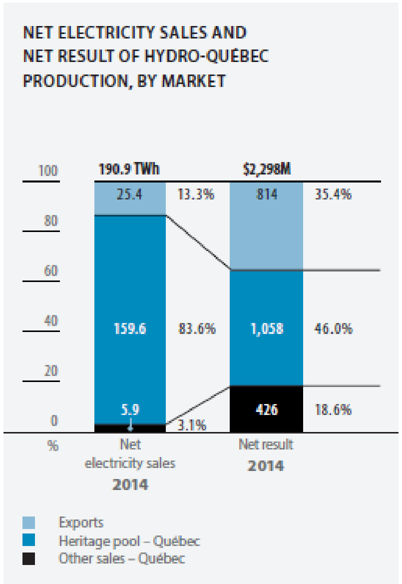


Figure 3) Trends in Energy Prices

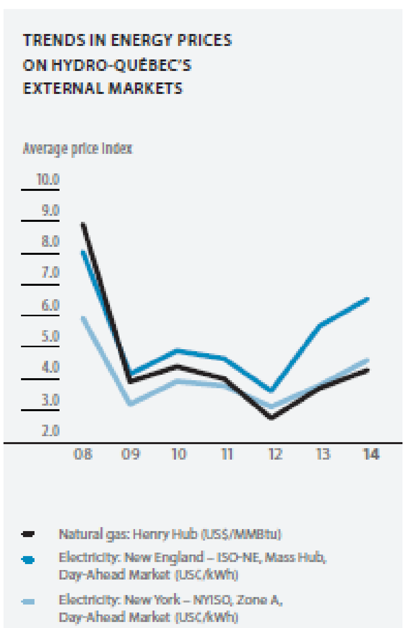


Figure 4) Hydro-Québec's Electricity Sales

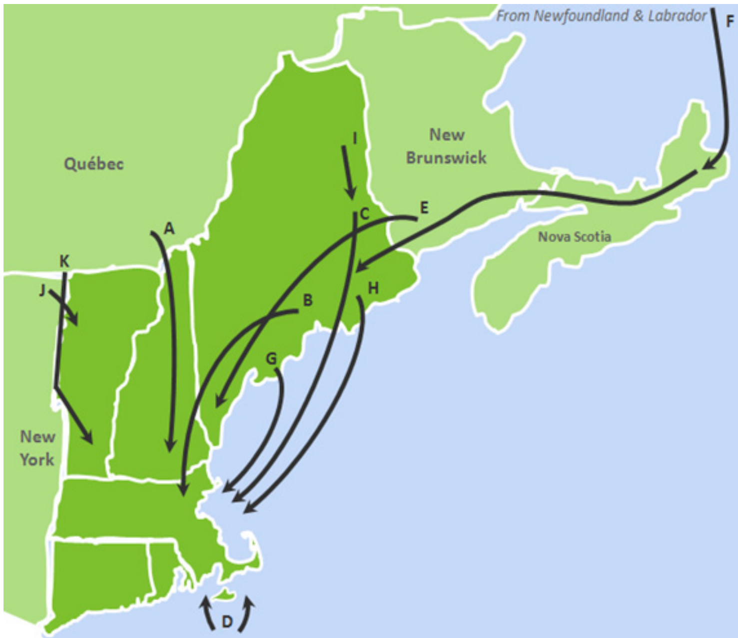
that transmission capacity constraints limit the amount of electricity Québec can export during the 300 hours of peak demand in a year, when exports attract top dollar. The rest of the time the province exports electricity at about 1¢ above its cost of production, or around 3¢/kWh (Hydro-Québec, 2014a; Lanoue & Mousseau, 2014; Pineau, 2012). The capacity limit is reportedly around 10 TWh, or approximately a third of the total quantity of exports in 2013. Although Hydro-Québec did contest the price figures used by OCAA and Équiterre, citing an average export price between January and March 2014 of 8¢ / kWh, the annual figures for 2014 were considerably lower (Marquis, 2014). Figure 4, also from HQ's 2014 Annual Report, shows the average export price alongside spot natural gas prices in select Northeastern US markets (Hydro-Québec, 2014a).

Québec is relatively well-connected to its neighbours, with a maximum export capacity of 8,380 MW and a maximum import capacity of 6,125MW (one-third of Québec's current export capacity, or 2,788MW, is with Ontario. With access to over 45,000 MW of generating capacity,[2] this represents a theoretical maximum export capacity of nearly ~18%. Upgrades and planned new transmission projects in the Northeast United States could significantly increase capacity. For instance, the 1,000 MW Champlain Hudson Power Express to New York City or the Northern Pass transmission project in New Hampshire that bring another 1,200 MW of electricity from Québec to the New England markets (Burkom, 2014; ISO New England, 2014; Northern Pass Transmission, LLC, 2015; The Canadian Press, 2014).

In short, as natural prices have dropped, Québec's traditional export markets have, unsurprisingly, shifted toward that fuel for electricity generation purposes. Older, less-efficient (and dirtier) oil and coal-fired plants have been replaced with cleaner, more efficient natu-

2 Installed capacity owned by Hydro-Québec is 36,643 MW, but it has access to 5,428 MW from the Churchill Falls generating station in Newfoundland-Labrador under a contract lasting until 2041; 2,857 MW produced by wind farms in the province; 48 MW from small hydropower plants, and approximately 206 MW from domestic biomass and biogas cogeneartion plants

ral gas-fired plants. According to the ISO-NE's 2014 Regional System Plan natural gas accounted for 45.1% of electric energy, a share high enough to have the consequence that marginal prices for wholesale electricity are set by



Representative Projects and Concept Proposals

A) Northern Pass—Hydro-Québec/ Northeast Utilities

B) Northeast Energy Link— Emera Maine/National Grid

C) Green Line—New England ITC

D) Bay State Offshore Wind Transmission System— Anbaric Transmission

E) Northeast Energy Corridor—Maine/New Brunswick/ Irving

F) Muskrat Falls/Lower Churchill—Nalcor Energy

G) Maine Yankee—Greater Boston

H) Maine—Greater Boston

I) Northern Maine—New England

J) Plattsburgh, NY—New Haven, VT

K) New England Clean Power Link— TDI New

Figure 5) Planned Transmissions Projects, US Northeast (ISO New England, 2014)

natural gas prices (thus Hydro-Québec's dilemma). The shift has prompted increasing concerns about the energy security of and transmission capacity for gas in the six New England States. However, gas-fired electricity's share of supply is nevertheless expected to grow by up to 48% as early as 2017 (ISO New England, 2014, pp. 30–31).

Québec hydro has one benefit that natural gas does not – it is associated to very low emissions levels (not counting the impacts of initial dam construction and reservoir creation). Growing concerns about air emissions and climate change, as well as existing and new federal and state regulations regarding emissions targets, fossil fuel plants and renewable portfolio standards in the US Northeast, suggest Québec electricity could play an important role in reducing emissions in the Northeast. A 2011 study found that, based on data for 2006 to 2008, Québec electricity exports have led to emissions reductions of up to 24 megatonnes of GHGs across New York, New England and New Brunswick (Amor, Pineau, Gaudreault, & Samson, 2011).[3] Recent policy and procurement developments in the US, particular at the New England States Committee on Electricity (NESCOE) and at the state level as well in Vermont, Massachusetts and Connecticut, suggest that clean electricity imports may also be able to obtain a premium due to increasing demand and their low-carbon character (Amor et al., 2011; Burkom, 2014; ISO New England, 2014).

It is important to place these developments within the context of state/provincial level efforts to combat climate change, such as the cap-and-trade system established in the Regional Greenhouse Gas Initiative (RGGI) in nine US Northeast states. The RGGI dates back to 2003. A market for CO2 allowances was established in 2008, but applies only to fossil fuel-fired electric power generators. Both Ontario and Québec act as observers to the RGGI, but do not participate in the market (RGGI, Inc., 2015).

Another initiative of importance, in particular for the relationship between Ontario and Québec, is the Western Climate Initiative (WCI). The WCI began in 2007 as an agreement by several western and southwestern US states to explore options for reducing greenhouse gas emissions, but expanded in 2008 to include two more states and four Canadian provinces – British Columbia, Manitoba, Ontario and Québec. Among the initiatives considered by the WCI was the creation of a 'cap-and-trade' system to set emissions reduction targets and establish a market for trading allowances. Since that time, most participating states have withdrawn, leaving only California and the four Canadian provinces as formal 'partners'. Of these partners, only California and Québec currently participate in the cap-and-trade market that was established in 2011. All of these developments have had important implications for the province of Ontario as well. Ontario's decision to phase out its coal plants by 2014 was fortuitously timed to take advantage of low natural gas prices. According to the 2013 Long-term Energy Plan, natural gas-fired generation increased by 38% from 2003 to 2012, from approxi-

3 The paper found a net increase in emissions for exports to Ontario, though this was largely due to increased coal-fired electricity imports from Ontario to Québec under the scenario. As Ontario no longer has any coal plants, the net impact would probably be much less, if not negative as well.

mately 16 TWh to 22 TWh (Government of Ontario, 2013, p. 43). Figure 6 below shows the trends in the share of total generation composed by natural gas and coal in Ontario between 2005 and 2013, according to Statistics Canada data.

The bulk of Ontario's electricity comes from hydroelectricity and nuclear. Over the same period, generation from these two sources accounted on average for 23% and 53%, respectively, of total generation in the province (Statistics Canada, 2013a). Nuclear in particular plays a large role in the province's electricity system and economy. According to the government's 2013 Long-term Energy Plan, the nuclear industry is a large employer in Ontario, an important technological export for the province, and a significant part of Canada's science and innovation capacity (Government of Ontario, 2013). Support of the CANDU reactor design and domestic nuclear sector has thus been part of a larger industrial strategy in Ontario since the 1960s (Freeman, 1996).

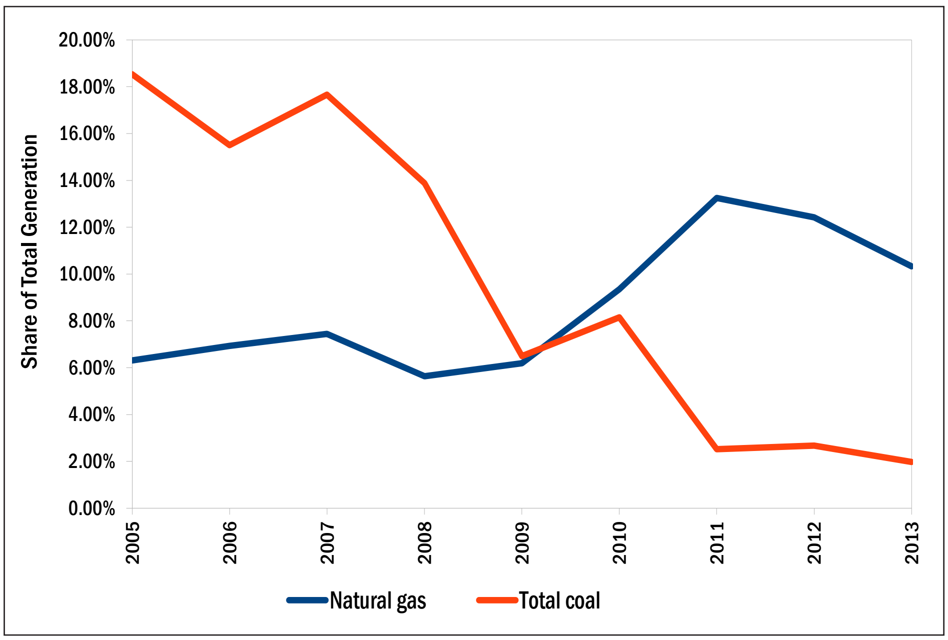


Figure 3) Natural Gas and Coal in Ontario's Electricity Generation, 2005-2013 (Statistics Canada, 2013a)

It should therefore be of little surprise that the most recent energy plans produced by the province have continued to support the sector and its place in the electricity system of the future. The 2010 Long-term Energy Plan called for the construction of additional capacity at the Darlington facility. Structural changes to Ontario's economy and gains in conservation and energy efficiency have since reduced the demand forecast to the point where the additional capacity was no longer considered necessary. However, the 2013 LTEP commited to refurbishing 8,500MW of capacity at the

Darlington and Bruce nuclear stations over 16 years, suggesting that "refurbished nuclear is the most cost-effective generation available to Ontario for meeting baseload requirements" (Government of Ontario, 2013, p. 29). According to Ontario Power Generation, the estimated cost of refurbishing the Darlington facility will not exceed $12.9 billion in 2013 dollars, including capitalized interest and "future escalation" (Ontario Power Generation, 2014). Bruce Power on the other hand estimates that the cost of refurbishing its facility could reach $15 billion ("Nuclear Refurbishment," 2013).

While estimates on the end cost-per-kilowatt hour vary, official figures tend to hover around 8.7¢ (Ontario Power Generation, 2014; Spears, 2014a), though external estimates have run as high as 37¢ (Mark Winfield and Pierre-Olivier Pineau, 2014; Ontario Clean Air Alliance Research, 2011). The history of delays and cost overruns associated with past refurbishments lends itself to some circumspection regarding the estimates. The process has been beset by some delays and cost overruns already (Spears, 2014c). Moreover, additional concerns have been raised about the fuel Ontario will have to rely on to compensate for the lost nuclear capacity during refurbishment; namely,

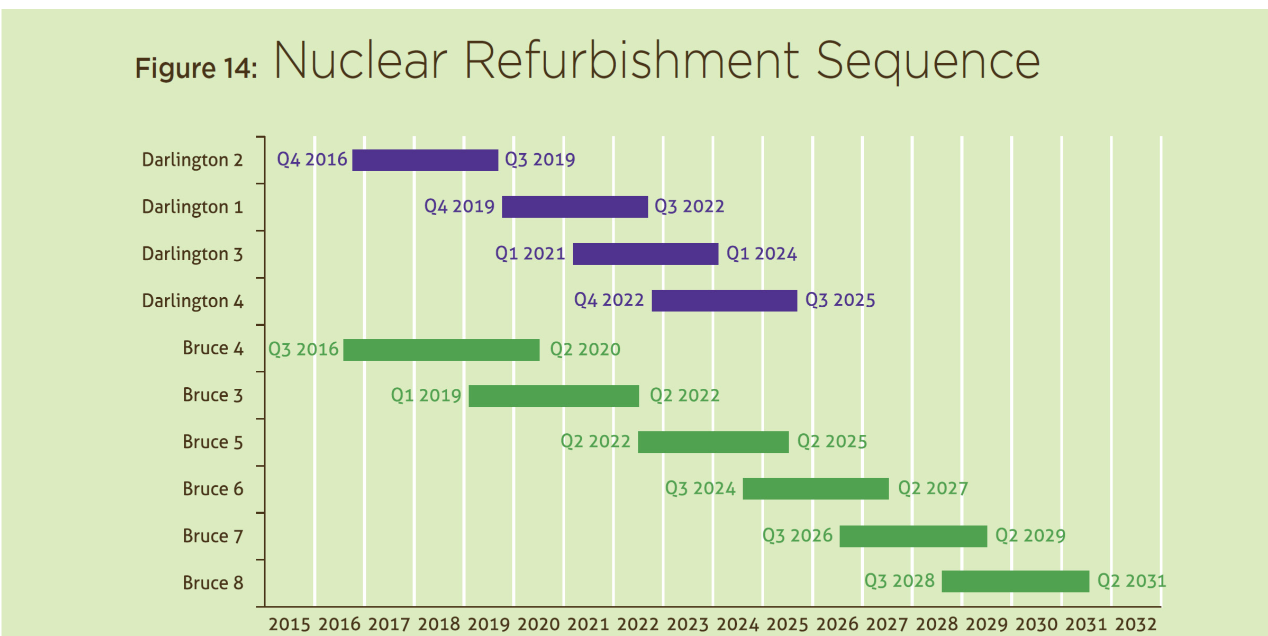


Figure 5) Nuclear Refurbishment Schedule (Government of Ontario, 2013)

natural gas. Not only will increased reliance on gas raise Ontario's greenhouse gas emissions during an important stage in the province's transition to a lower-carbon economy, the lengthy refurbishment period (lasting until the mid-2020s) increases the risk that natural gas prices could rise, thereby increasing again the costs of domestic electricity production.

Given the cost estimates surrounding nuclear refurbishment in Ontario, the long-run uncertainty around natural gas prices, the low cost of generation in Québec and the reduced export prices in that province's traditional export markets, it is of little surprise that increasing attention is being paid to the potential of electricity trade between Canada's two largest provinces (Équiterre and Ontario Clean Air Alliance Research, 2014; Mark Winfield and Pierre-Olivier Pineau, 2014; Pineau, 2012, 2014). In fact, even Ontario's most recent Long-Term Energy Plan calls for the exploration of opportunities for importing clean electricity, noting that "an import arrangement with a neighbour to guarantee the firm delivery of clean power could offer a cost-effective alternative to building domestic supply" (Government of Ontario, 2013, p. 45). Greater collaboration, according to proponents, could have multiple benefits for both provinces. Economically, both provinces stand to fair better than they do under the continuation of the status quo. Environmentally, low-carbon electricity imports from Québec could substitute for increased use of natural gas-fired electricity, thus lowering or at least preventing additional GHG emissions in Ontario. Electricity systems in both provinces could benefit as well, as the potential for more storage capacity in Québec could help balance increased intermittent generation in Ontario, and exports from Ontario in the winter could help balance Québec's system during its peak demand season.

The election of Liberal majority governments in both Ontario and Québec, both of which are appear to want to take a leading role on climate change issues, is encouraging for those provinces securing a productive working relationship (Spears, 2014a). Progress at the inter-provincial level through the Council of the Federation's working group on a 'Canadian Energy Strategy, which aims to release its final report in August 2015, also bodes well for formalizing collaboration opportunities and creating a vision for a future Canadian energy system (The Council of the Federation, 2013).

Québec's participation in the WCI cap-and-trade market with California is a strong step towards implementing effective carbon pricing in yet another Canadian province, and Ontario's recent indication of its intent to join as well further legitimizes those efforts (Yakabuski, 2015). In fact, Ontario and Québec formally indicated their intent to collaborate on both electricity and climate change in late 2014 through two separate memoranda of understanding (MOUs). The MOU on electricity proposed a 'seasonal capacity swap' of 500MW, which was recently formalized as an agreement between the IESO and Hydro-Québec Energy Marketing (IESO / OPA, 2015; Office of the Premier, 2014a, 2014b).

There remain some uncertainties associated with greater electricity collaboration between Ontario and Québec. This report summarizes the findings of two workshops that were recently organized by the Sustainable Energy Initiative in the Faculty of Environmental Studies at York University and the Chair of Energy Management at HEC Montréal to discuss electricity collaboration from the perspective of both provinces. The origins and structure of these workshops will be discussed briefly in the following section, and the findings on options for collaboration, the specifics on the potential benefits to be accrued from greater collaboration as well as the barriers, risks and uncertainties following thereafter.

Findings from the Workshops

In May 2014, the Sustainable Energy Initiative in the Faculty of Environmental Studies at York University, under the direction of co-chair Mark Winfield, convened a preliminary workshop to explore the opportunities for electricity collaboration between Ontario and Québec. The workshop consisted of presentations by Pierre-Olivier Pineau, Chair of Energy Management at HEC Montréal; Jack Burkom, Senior Vice-President of Commercial Development at Brookfield Energy Marketing; and Jack Gibbons, Chair of the Ontario Clean Air Alliance. The event was well attended,

Timeline

2007-8	Western Climate Initiative (WCI) established, British Columbia, Manitoba, Ontario and Québec become partners in the program;
	Regional Greenhouse Gas Initiative (RGGI) carbon market is established in the US Northeast, covering only the power sector;

and produced a fruitful discussion session following the presentations. The case for more collaboration subsequently received some attention in the media (Simpson, 2014; Spears, 2014b).

Two months later, the OCAA and Équiterre released a joint report, *Exporting Electricity: To Promote Greater Collaboration Between Québec and Ontario* (Équiterre and Ontario Clean Air Alliance Research, 2014). In that report, the authors suggested that greater electricity exports from Québec to Ontario could produce benefits of up to $12 billion over 20 years in both provinces, assuming an export price of 5.7¢ / kWh (half-way between the estimated cost of refurbishing Darlington and the average export price for Québec exports in the Northeast US between 2008 and 2012). For Ontario, these benefits would stem from a cheaper source of electricity than nuclear refurbishment; for Québec, they would come from a long term contract at a rate well above the current average export price. The report also suggested that Québec could reinvest the additional revenues into social programs and/or debt reduction, leading to additional social benefits. The report also received some media coverage (Gibbons, 2014; Marquis, 2014).

Seeking to 'advance the dialogue' on inter-provincial collaboration even further, Mark Winfield and Pierre-Olivier Pineau, in collaboration with the OCAA and Équiterre, submitted an application to the Social Sciences and Humanities Research Council's Connection Grant program in August 2014, seeking to fund two more workshops – one in Toronto, and one in Montréal. The grant was awarded on October 1st, 2014. The purpose of these workshops was to build on the earlier event in May, looking not only at electricity imports into Ontario, but electricity and climate change collaboration between the two provinces as a whole. Accordingly, the aim was to use each workshop to establish a dialogue between provincial counterparts in government and industry regarding collaboration in the electricity sector, to facilitate policies that advance sustainability and inter-provincial prosperity.

The first workshop took place on Friday, January 9th, 2015,

Timeline, cont'd

2009-10	First 3 year compliance period under the RGGI begins in January; Arizona withdraws from the WCI;
2011	Most remaining partnering US states withdraw from the WCI; New Jersey withdraws from the RGGI; Québec and California announce a 1-year delay on the enforcement of emission caps;
2012 **Jan**	WCI cap-and-trade program to begin, market initially limited to California.
July	Council of Federation agrees to renew 2007 'A Shared Vision for Energy in Canada'; strikes Canadian Energy Strategy Working Group headed by Alison Redford;

Timeline, cont'd

2012 **Dec.**	Québec enacts regulations to harmonize its cap-and-trade system with California's under the Western Climate Initiative (WCI). An Order-in-Council is adopted at the same time setting the annual caps on emissions for the period 2013-2020, in order to achieve target of 20% below 1990 levels by 2020;
2013 **Jan.**	Compliance obligation under California and Quebec's cap-and-trade system begins to be enforced;
July	Québec Minister of Natural Resources creates the Commission sur les enjeux énergétiques, mandated to assess system, challenges, experiences outside Quebec, consultation with stakeholders;

at Osgoode Hall's Professional Development Centre downtown Toronto. Following an introduction by Dr. Winfield, presentations were given by York University Ph.D student Colleen Kaiser; the Globe and Mail's national columnist Jeffrey Simpson; HEC Montréal's Pierre-Olivier Pineau; and Professor of physics at Université de Montreal and co-chair of the Québec Commission on Energy Issues, Normand Mousseau. The presentations were followed by closed discussion session held under Chatham House rule. The second workshop was held at HEC Montréal's campus, April 10th 2015. Presentations were given by Mark Winfield, York University; Daniel St-Onge, Managing Director of Commercial Development, Brookfield Renewable Energy Group; Jack Gibbons, OCAA; and Gaétan Caron, Executive Fellow at the School of Public Policy of the University of Calgary and former Chair and CEO of the National Energy Board of Canada.

Options for Collaboration

At least three separate options for collaboration on electricity were identified in the workshops. This section will briefly outline each option. It is important to note, however, that these workshops were not convened to discuss these options specifically; rather, they came to light during the course of the presentations and discussions. The ensuing discussion of opportunities, barriers, risks and uncertainties will not therefore speak specifically to each option.

A Small-scale Seasonal Swap

The least Ontario and Québec could do would be to pursue a limited, small-scale 'seasonal capacity swap' to take advantage of the complimentary annual demand trends in each province. Québec's peak demand occurs during the winter; Ontario's in the summer. The former is driven by residential home heating demand, the latter by residential air conditioning. The existing intertie infrastructure is capable of handling ~500MW of firm electricity trade (though it could handle considerably more with some upgrades).

This option is being pursued by the two provinces, under the 2014 MOU noted earlier. While this option does help to mitigate seasonal supply shortages, it may not do much to reduce emissions – particularly if the marginal electricity being exported to Québec comes from natural gas in Ontario (though this could be better than relying on imports from the US Northeast). Moreover, this option does not provide the long-term certainty that may be required to justify increasing transmission infrastructure investments on either side to support more trade, will probably not affect average rates in either province, and provides little support in terms of balancing intermittent supply in Ontario. It nevertheless represents a good starting point for future collaboration.

A Larger, Long-term Power Purchase Agreement

The second option is really two different sub-options, though both revolve around negotiating a longer-term agreement between Ontario and Québec to export a larger quantity of electricity from the latter to the former. The benefit of this arrangement being negotiated as a formal, long-term agreement is that such an agreement would, by removing uncertainty, incentivize greater investment in the intertie and transmission infrastructure necessary to support greater trading capacity (St-Onge, 2014). With better infrastructure comes enhanced system planning flexibility, and greater potential to shift electricity back and forth to balance intermittency. The difference hinges on the quantity of electricity exported and the electricity source it replaces in Ontario.

1) Substitute for Natural Gas during Nuclear Refurbishment

The first option is to negotiate an agreement that could supply Ontario with sufficient electricity to negate the need to rely on additional natural gas during the refurbishment of the Darlington nuclear station. As shown in Figure 7 above, the refurbishment schedule takes one reactor out of service at a time, with some overlap between reactors, for 3 years, or 144 months in total. The refurbishment window is actually 108 months, considering the

Timeline, cont'd

2013 **Nov.**	British Columbia joins Council of Federation's Canadian Energy Strategy Working Group
	Québec's National Assembly unanimously approves agreement to harmonize cap-and-trade systems with California
2014 **Jan.**	Linking of Québec and California's carbon markets officially comes into effect;
Feb.	Québec's Commission sur les enjeux énergétiques released its final report; Québec's government tables budget and announces two week recess;
Mar.	Québec's government is dissolved, election period begins
Apr.	The Liberal Party under Phillippe Couillard wins a majority government with 70 seats in Québec's 41st General Election

Timeline, cont'd

2014
May

The Sustainable Energy Initiative in the Faculty of Environment Studies at York University hosts its first workshop on electricity collaboration between Ontario and Québec, presentations by Jack Burkom (Brookfield); Jack Gibbons (OCAA); and Pierre-Olivier Pineau (HEC Montréal)

An election is called in Ontario when the NDP indicates it will vote against the minority Liberal government's budget;

June

The Liberal Party under Kathleen Wynne wins a majority government with 58 seats in Ontario's 41st General Election

July

The OCAA and Équiterre release their report, "Exporting Electricity: To Promote Greater Collaboration Between Québec and Ontario", with some media coverage;

overlap) (Ontario Power Generation, 2014). Therefore, in the 9 years between 2016 and 2025, somewhere between ~400MW and ~800MW of missing capacity will need to be made up for at any given moment. These figures do not include the capacity that would be lost to refurbishment of the Bruce B reactors).

This capacity shortage will most likely be met by Ontario's relatively new natural gas generation capacity, much of it built over the past decade to compensate for the phase out of coal. Consequently, official estimates project GHG emissions associated with increased natural gas usage to increase by 60% between 2020 and 2025 (of electricity-related GHGs) (Miller, 2014). However, conflicting projections from Ontario Power Generation and uncertainty around underlying assumptions suggest that this figure could be even higher. Figure 8 shows the projected range of electricity

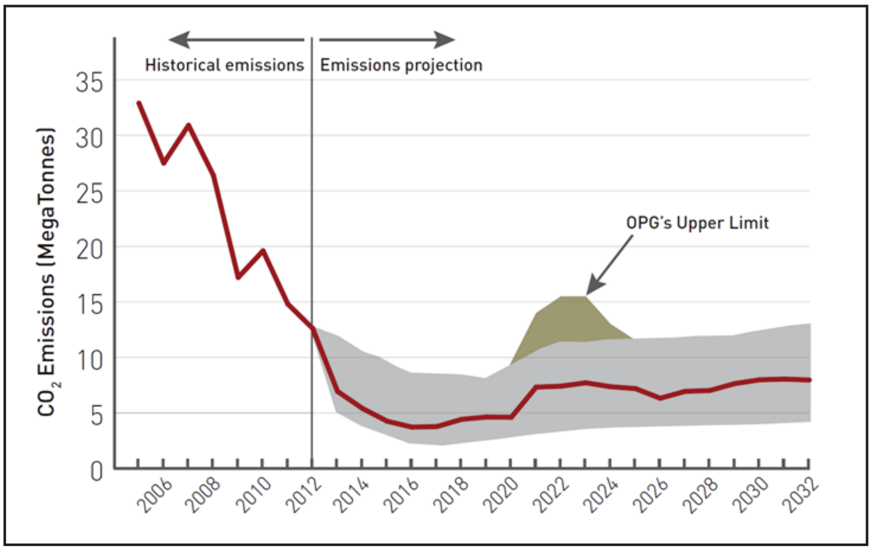


Figure 8) Projected Electricity Emissions in Ontario, OPA/OPG (Miller, 2014, p. 51)

sector emissions given by the Ontario Power Authority (in grey), and the 'upper limit' projection given by OPG (coinciding with the overlapping of the second, third and fourth phases of refurbishment at Darlington). The discrepancy is in part due to different assumptions used by OPA and OPG's use of the 2010 LTEP (rather than the 2013 version) as the basis for their data.

Furthermore, though gas prices are low now, there is longer-term uncertainty about its price volatility – a commitment to natural gas could end-up being more costly than expected. In addition, Ontario's recent announcement to join the WCI cap-and-trade market implies there will be additional costs for natural gas as a result of carbon pricing in the near future. By pursing this option for collaboration, Ontario could mitigate these environmental and economic risks by signing a longer-term contract with Québec to provide the lost capacity.

2) Substitute for Nuclear Refurbishment (Darlington)

Under this option, Ontario would not proceed with the Darlington refurbishment at all, opting instead to rely on Québec imports to make up for the ~3,600 MW of lost capacity. Even at OPG's low estimate of 8.7¢ / kWh, imports from Québec could be a cheaper option, although going this route would require relatively substantial upgrading of the intertie infrastructure. As noted earlier, current intertie infrastructure is capable of handling 500 MW of firm imports. It would cost approximately $325 million to increase that figure to 1,000MW, $500 million for 1,800MW, and $1.4 billion for 3,300 MW (IESO / OPA, 2014, pp. 23–26). However, it is important to note that upgrades to reach 3,300MW import capacity could take 7 to 10 years, the cost for which is cumulative of the aforementioned upgrade scenarios (i.e., ~$2.2 billion to reach 3,300 MW) and would also require additional transmission infrastructure in Québec.

This option would preclude the use of additional natural gas that would otherwise be required during nuclear refurbishment (as under sub-option 1 above), and could have additional intermittent balancing benefits given the upgraded infrastructure. Moreover, the investment risks in building infrastructure are much lower compared to the potential for cost-overruns during nuclear refurbishment.

Timeline, cont'd

2014 Aug.	Québec becomes a formal partner to the Council of the Federation's Canadian Energy Strategy initiative; the Premiers announce their intention to finalize a strategy by August 2015
Oct.	SSHRC Connection Grant is awarded to Winfield/Pineau to host two more workshops on electricity collaboration between Ontario and Québec
Nov.	A joint-meeting of cabinet ministers between Ontario and Québec leads to two Memoranda of Understanding – one for a 'Seasonal Capacity Swap' of 5,00MW to exploit complimentary peak demand periods in both provinces and explore other opportunities for collaboration, and another to collaborate on climate change issues through the Council of the Federation and the Canadian Council of Ministers of the Environment First join auction of carbon allowances in Québec/California linked carbon market;

Timeline, cont'd

2015 **Jan.**	First 'Advancing the Dialogue' event held in Toronto, with an audience of ~70 people, including key stakeholders in the Ontario electricity system, with presentations by Colleen Kaiser (York University), Jeffrey Simpson (the Global and Mail), Pierre-Olivier Pineau (HEC Montréal) and Normand Mousseau (Université de Montréal);
April	Second 'Advancing the Dialogue' workshop held in Montreal, with an audience of ~70 people, including important stakeholders in the provinicial electricty systems, with presentations by Mark Winfield (York University), Daniel St-Onge (Brookfield), Jack Gibbons (OCAA), and Gaétan Caron (University of Calgary)

A 'Grand Bargain'

The third and final option in some ways is a combination of the above, though incorporating collaboration on climate change more explicitly. The options above focus more or less exclusively on electricity trade between the two provinces, in particular exports from Québec to Ontario. While the background analysis and discussion at the workshops suggests this would be to the mutual benefit of both provinces, interest (economic and political) in electricity trade seems mostly to be on the Ontario side. Environmental benefits from electricity trade, where applicable, are really more of desirable knock-on effects stemming from the core policy action (i.e., economically-beneficial electricity trade).

The logic under this option is that, given the high cost of electricity in Ontario and the low cost in Québec, and their complimentary peak demand seasons, coupled with the latter being the sole (at the time of the workshops) Canadian province to participate in a cap-and-trade market with California and both provinces' Premiers being interested in demonstrating leadership on the climate change portfolio, there may be grounds to strike a 'grand bargain' of sorts on electricity and climate change collaboration between Ontario and Québec.

The exact form of such an agreement is somewhat unclear, but its core elements would a long-term agreement regarding Ontario access to Quebec electricity capacity, at a price lower than the current cost estimates for nuclear refurbishment, in exchange for Ontario's participation in the cap-and-trade market with Québec and California. Ontario's recent announcement that it will be joining the WCI carbon market, like the capacity swap agreement, is a step in the right direction, but is very preliminary in nature. What this option represents, therefore, is the formalization of a collaborative approach to climate change and electricity between Canada's two most populated provinces, a move that would combine all the environmental and economic benefits of the options above with the political rewards that such a 'vision' for the future would provide.

Opportunities

There are a number of good reasons why Ontario and Québec should pursue collaboration on electricity and climate change issues as outlined above. These reasons can broadly be classified under four main headings: economic and social benefits; energy system improvement; climate change mitigation; and political opportunities. This section will review the nature and extent of these opportunities as discussed in the background literature and in the workshops.

Economic and Social Benefits

Perhaps the foremost reason given by proponents for greater collaboration is the economic benefit that both provinces would receive. In a nutshell, Ontario stands to pay at least 8.7¢ / kWh to refurbish Darlington. Québec, on the other hand, is currently exporting a good deal of electricity at rates close to half of that. Why not meet in the middle?

This is indeed the argument given in the Équiterre and OCAA report, and was restated by OCAA Chair Jack Gibbons in his presentation in Montréal (Équiterre and Ontario Clean Air Alliance Research, 2014; Gibbons, 2015). If Québec and Ontario were to negotiate a trade agreement at 6¢ / kWh, each province would be better off by approximately $14 billion over the course of a 20 year agreement – Ontario through savings, Québec through additional revenue. Notwithstanding potential capacity bottlenecks, such an agreement could eliminate up to 80% of the surplus capacity in Québec that the Québec Commission on Energy Issues projected to be in place between 2020-2030 (Gibbons, 2015; Lanoue & Mousseau, 2014; Mousseau, 2015). Given that marginal capacity additions are currently being made in Québec at rates up to 10¢ / kWh, an export price of 6¢ / kWh to Ontario, subject to the same annual review and modification as under Québec's last long-term agreement with Vermont, would certainly be better than to continue on exporting at non-peak hour prices.

A general argument can be made in favor of market integration on the grounds that integration is more economically efficient than the alternative. Several presenters made such a case. Gaéton Caron cited the example of deregulation in the natural gas market in the 1980s as an example of the benefits that can be accrued from integrating markets (Caron, 2015). Removing interference in markets not only improves economic efficiency, Caron suggested, but can actually benefit energy security overall, by lessening the likelihood of unexpected policy or political actions and/or the unexpected actions of major market participants. Moving toward a common market could also help to create a more positive investment climate, and improved competition, innovation, research and development, operating under a clear, reliable and predictable regulatory framework. Similarly, both Pineau and Mousseau, while differing on the implications of integration for domestic prices, agreed on the folly of Québec exporting electricity at rates well below the cost of regional, low-carbon marginal additions. Just as Saudi Arabia would be foolish to export oil at its cost of production when the global market prices is much higher, Québec should not be subsidizing its neighbours' need to acquire more low-carbon energy (Mousseau, 2015; Pineau, 2015).

Greater market integration between a higher-rate jurisdiction and a lower-rate one does carry risks of increasing pressures to raise domestic prices in the latter, just as it would lower rates in the former. Such an affect in Ontario and Québec would produce different constellations of winners and losers – and thus proponents and opponents - as discussed in more detail in the following section. However, based on modeling done by Pineau and de Villemeur, the impacts of greater integration between Ontario and Québec on rates in either province may not be dramatic (Billette de Villemeur & Pineau, 2016). Under the scenario they considered, prices would decrease in Ontario (depending, of course, on the scale of integration) while increases in Québec would be constrained by limited transmission capacity. Moreover, the overall additional profit from trade with Ontario would more than make up for increased rates in Québec and could be used to soften the blow for consumers, leading to welfare improvements across the board (Équiterre and Ontario Clean Air Alliance Research, 2014; Pineau, 2015).

Higher rates in Québec would likely lead to other energy system improvements such as increased energy efficiency investment and reduced use of electricity for home heating. Both improvements, discussed in more detail below, would free up more capacity for Québec to export to Ontario and other jurisdictions and lessen the supply shortages Québec experiences over the winter (Gibbons, 2015; Pineau, 2015). Moreover, by choosing to export more to Ontario and less to the US Northeast, Québec would lower its exposure to exchange rate risk (Gibbons, 2015).

Energy System Improvements

Economically, both provinces stand to benefit from greater integration of their electricity systems. Integration would offer additional benefits for the energy system in both provinces.

It is important to distinguish between electricity system integration and collaboration. The economic and social benefits noted above stem largely from increased electricity exports from Québec to Ontario, an activity that would require, as noted earlier, investment in the physical transmission infrastructure in both provinces. Increased trade could act as a driver for price harmonization across the two regions, depending on the level of market integration pursued (see Table 1 below). Yet while greater physical and economic integration of each province's electricity systems may thus go hand-in-hand, they do not require an approach to electricity system planning much different than the present, 'provincialist' status quo (Simpson, 2015). In other words, Ontario and Québec do not need to be anything more than trading partners to see some of the benefits of electricity system integration. As will be discussed in the following section, this condition actually reinforces some uncertainties that act as a barrier to further collaboration between Ontario and Québec.

Integration, however, is not synonymous with collaboration (though it may be a necessary condition for it). One of the clearest opportunities to greater integration, for instance, would be the increased ability to balance complimentary load curves in each province. Québec's peak demand occurs in the winter, when the increased load owing to electrical home heating actually creates conditions of supply shortage. The discrepancy between Québec's average annual baseload and its peak demand in the winter can reach nearly 20,000 MW (Pineau, 2015). Ontario's peak demand, on the other hand, occurs during the summer, due mainly to air conditioning. There is an opportunity here for a collaborative approach to mitigating supply shortages during times of peak demand. Indeed, this is exactly what the 2014 MOU seems intended to do.

Pursuing a larger and longer-term approach to integration would open up even larger opportunities for collaboration leading to energy system improvement in each province. Namely, increasing the physical capacity for trade between the two provinces could dramatically increase the potential to balance intermittent renewable sources of electricity in Ontario. Ontario is set to increase its supply of wind by 2,800 MW by 2018 (roughly doubling the current installed capacity of 2,925 MW) and solar by 3,475 MW by 2025 (from 40 MW at present) (Winfield, 2015). The province already has to regularly dump electricity into its own and foreign markets at a loss (negative prices). Without the ability to store that electricity, those assets could be effectively be stranded. Québec, however, has an effective storage capacity of approximately one-year of demand, or 185 TWh (Mousseau, 2015). What's more, according to discussion at the Toronto workshop, only about 50% of that capacity is actually used. A long-term agreement for increased exports from Québec to Ontario would thus incentivize investments in the physical integration that would be necessary to support a collaborative approach to balancing demand and supply intermittency in both provinces (St-Onge, 2014).

Collaboration also creates an opportunity to move away from an aging nuclear technology, namely the pressurized heavy water Generation II CANDU reactor (PHWR) design in use at Darlington and Bruce nuclear facilities. As will be discussed below in more detail, domestic use of CANDU reactors was at one point an important element of Ontario's industrial strategy, demonstrating the feasibility and attractiveness of a Canadian energy technology. However, recent trends suggest a consolidation of the global nuclear industry away from PHWR toward light-water cooled designs (LWR). Only about 11% of the world's 438 operating nuclear reactors at the end of 2014 where PWHRs, and of the 70 reactors currently under construction only 5 are PHWRs, all being built in India using indigenous technology (58, or 83%, are light-water reactors – the prevailing technology in the industry) (International Energy Agency and Nuclear Energy Agency, 2015, pp. 25–26). As noted earlier, investments in the infrastructure necessary to import a quantity of electricity from Québec sufficient to nearly replace the output of all four reactors at Darlington are a fraction of the scale of projected investment to refurbish them. That infrastructure, once built, also has the ancillary benefit of supporting load and intermittency balancing.

Another potential side effect of greater integration between the Ontario and Québec electricity systems could be improved energy efficiency in Québec. Given greater exposure to regional markets, the impetus in Québec might be to raise domestic rates (Pineau, 2012, 2013). Higher domestic rates in Québec would increase the incentive for consumers to invest in efficiency improvements to reduce their bills. Alternatively, higher electricity rates could induce some fuel switching for home heating purposes or push consumers to adopt more efficient electrical heating technologies (i.e., heat pumps instead of electric resistance heating). Government of Quebec could modernize building codes to improve efficiency as well. Even without raising domestic rates, Québec would gain by improving efficiency under integration, as all of these measures would have the net impact of reducing demand in the province and thereby free up more resources for export (at higher rates) (Pineau, 2015).

Climate Change Mitigation

More efficient electricity consumption in Québec is desirable from both an economic and a systems-management perspective, but given that the province has almost no greenhouse gas emissions from its electricity system, the direct impacts of collaboration on climate change mitigation in Québec may be limited. Rather, the primary direct impacts would be in Ontario.

Under both the refurbishment period and permanent substitution scenarios the primary GHG impact would be the avoidance of the impacts of natural gas fired generation during the refurbishment process. Permanent substitution of hydro imports for nuclear would avoid the risk of the need for the long-term substitution of natural gas-fired generation for nuclear in the event of the failure of refurbishment projects. As noted earlier, estimates of the future GHGs emissions associated with increased natural gas use during the Ontario nuclear refurbishments vary, but could range as high as 15 Mt (approximately 10 Mt of which appears in Figure 8 to be related to the overlapping refurbishment schedule around 2020). In its latest update on its

2007 Climate Change strategy, the Government of Ontario projects a 'gap' of ~19 Mt by which it will exceed its emissions targets for 2020 (the target is 150.55 Mt and the projection for 2020 is 170 Mt). However, that estimate uses OPA's most probable projection line (in red in Figure 8), and thus does not consider the uncertainty surrounding that forecast (Ministry of Environment and Climate Change, 2014, p. 37). In other words, additional emissions from natural gas use could reverse much of the reductions from the phase-out of coal, and make it that much more difficult for Ontario to achieve its 2020 target.

But if electricity imports from Québec are replacing nuclear power in Ontario, then perhaps from a climate change perspective Québec's hydro would be better sent to the US Northeast where it will likely have a larger impact? As noted earlier, studies have suggested that the net GHG reductions stemming from Québec hydro exports to the US Northeast could be on the order of about 24 Mt. One complication, exacerbated by the low price of natural gas, is that the environmental benefits of Québec's low-carbon, large hydro is not necessarily captured in the price it receives for that electricity in this export markets. However, this situation is going to change. Through the New England States' Committee on Energy (NESCOE), states in the Northeast are coordinating on renewable energy regulation and procurement (e.g., renewable energy credit programs and renewable portfolio standards) (NESCOE, n.d.). In February 2015, Rhode Island, Connecticut and Massachusetts issued a draft joint RFP to acquire 2 TWh of Class I renewable energy and/or large hydro (Soliciting Parties, 2015). As one presenter described the situation in Montréal, the impending inclusion of large hydro in renewable portfolio schemes in the US Northeast promises to absorb some of the lowest cost, cleanest electricity from Northeastern markets, to Ontario's detriment (St-Onge, 2014). In other words, the emissions reductions associated with importing electricity from Québec will go to whomever is willing to pay the most for them (Caron, 2015).

This bolsters the case for a grander collaborative approach to electricity and climate change. In both the Toronto and the Montréal workshops, the notion of a grand bargain between Ontario and Québec on climate change (e.g., cap-and-trade) and electricity (e.g., increased integration) was identified as an opportunity of mutual benefit to both provinces. Recent events have complicated the case and outlook for such a bargain. Before Ontario announced its intention to join, Québec and California were the only to jurisdictions in North America to participate in a common cap-and-trade market. This raised concerns about a net-capital outflow from the former to the latter, given the higher expected costs of reducing emissions in Québec. Prior studies estimated the marginal abatement cost in Québec to be between $59 and $69 per tonne of CO2 equivalent emissions in 2020, but only $27-54 per tCO2e in California. Under a linked system, given California's much larger size, allowance prices will be set more by costs in California than in Québec. The result is that, while Québec can be expected to have to purchase more allowances in California than it can sell (leading to a net flow of revenue to California) it will do so at a cost much lower than what it would have to pay in an unlinked system. So while California does gain from trade so does Québec - just not as much (Purdon, Houle, & Lachapelle, 2014, pp. 35–37).

Ontario's entry into the carbon market could reduce the risk of a capital outflow from Quebec.4 However, it still remains to be determined exactly how Ontario will implement the cap-and-trade system. It seems likely that carbon pricing in Ontario will eventually drive up the cost of natural gas-fired electricity, meaning that Québec may be able to obtain a portion of the clean energy premium it does not currently receive in US markets. As a result, the plausibility of importing Québec hydro to substitute for natural gas in Ontario becomes ever more real under Ontario's impending carbon market. It is also important to recall that the infrastructure expansion associated with a larger, collaborative approach on electricity would allow Ontario to add more renewable generation capacity and make more effective use of that capacity as a substitute for carbon-intensive energy sources like natural gas

4 Capital outflow could be limited because Ontario's entry would increase the price of carbon due to the additional demand for emission rights. This price increase could induce further reductions in emissions in Quebec, reducing the need for Quebec to buy emissions rights. The impact depends of course of the price elasticity of for emission rights in the different jurisdictions.

Political Opportunities

The last class of opportunities stemming from integration and collaboration are political in nature. As such, they are a bit harder to capture accurately with figures and charts. In general, we might consider a political 'opportunity' to exist where there is a chance for producing greater accord between two or more parties. In that sense, collaboration between Ontario and Québec is itself its own political reward. During the course of the workshops, however, at least three more specific political opportunities were identified: building a stronger Canadian federation; mitigating public opposition to or discontent with existing electricity and climate change measures; and, lastly, the opportunity for Ontario and Québec to demonstrate leadership on energy and climate change issues.

The notion of collaboration between two Canadian provinces on a matter pertaining to energy or electricity stands in contrast the long dominant 'provincialist' / self-sufficiency model that most provinces have followed since the 1960s (Winfield, 2015). The logic underpinning this model was that a province's electricity system could be an important component of its industrial development policy (Simpson, 2015). The large public investments into hydroelectricity in British Columbia, Manitoba and Québec, and into nuclear in Ontario flowed from these notions. What examples there have been of interprovincial 'collaboration' on electricity matters have tended to leave a bad taste in the mouths of at least one of the parties. Indeed, when the idea of importing electricity from Newfoundland through Québec to Ontario was floated in the late 1990s, incoming Newfoundland Premier Danny Williams reportedly scuttled the talks due to his animosity toward Québec stemming from the infamous 1970s Upper Churchill Falls hydroelectricity contract between the two provinces (Simpson, 2015). Collaboration between Ontario and Québec would mark a shift in how Canadian provinces have historically seen themselves in terms of the independence of their electricity systems, potentially ushering in an era of greater provincial cooperation.

There is another dimension to the potential strengthening of the Canadian federation associated with collaboration. According to one presenter, provinces have historically been somewhat reticent about getting involved with Québec when sovereigntist governments have been in power (Simpson, 2015). The current, strongly federalist, Couillard Liberal government may recognize that relations between Québec and neighbouring provinces are not as strong as they could be. Accordingly, there is an opportunity for all parties to forge stronger ties while interest is strong in Québec. Indeed, it may also be in the interest of the federal government to take a more active role in facilitating inter-provincial collaborative efforts of this kind (as opposed to taking the strictly hands-off approach it has for some time) as "works in the general interest of Canada" (Simpson, 2015).

A collaborative approach to climate change and electricity might also help to ameliorate opposition to existing (or possible future) policy initiatives in both provinces. In Ontario, a long-term agreement with Québec could provide both a lower price and price certainty than the proposed nuclear refurbishments, helping keep rates for consumers lower in the long-run. Access to storage capacity could help to balance intermittency from increasing amounts of wind and solar power by storing excess supply when available and releasing it when it is not. The increased flexibility from such an arrangement could also work to minimize the amount of nuclear power that has to be exported at a loss to neighbouring markets during periods of low demand, either by storing it or, as suggested above, by replacing Darlington altogether. Québec, conversely, would get a better price for its electricity exports, the proceeds of which it could redirect into social programs, thus making the province richer overall. On the climate change front, Québec gains a Canadian partner in its cap-and-trade market, potentially reducing the amount of capital outflow to California from that province. A coordinated carbon price will also help to limit any potential leakage that could result from having a price in one jurisdiction and none in the other. Public opinion in both provinces may also be less inclined to turn against climate change mitigation efforts if the costs are seen as being shared amongst close partners.

Lastly, pursuing a collaborative approach to electricity and climate change presents, at this moment, a great opportunity for Ontario and Québec to demonstrate strong leadership in the run up to the Council of the Federation's release of its official 'national energy strategy' for Canada in August 2015 (Winfield, 2015). Much of the attention on matters pertaining to energy politics in Canada has focused on fossil fuel transportation from Alberta/

Saskatchewan, either through British Columbia to the coast or through Manitoba, Ontario and Québec to refineries in the east. The Council of Federation's Working Group on a Canadian Energy Strategy was in fact initially chaired by then-Premier of Alberta, Alison Redford, and did not initially include either British Columbia or Québec. Now that all the provinces are participating, and given the change of government in Alberta, the opportunity exists for Ontario and Québec to play a leadership in the development of a more comprehensive national energy strategy.

Barriers, Risks & Uncertainties

Given the numerous opportunities to greater collaboration on electricity and climate change from which both provinces stand to benefit, it is curious that more has not been done to pursue them. It is true that Ontario and Québec have of late been making important steps towards a more collaborative relationship, as evidenced by the 2014 MOU on electricity and climate change and by Ontario's formal announcement regarding the cap-and-trade market. Nevertheless, there remain some important barriers that could restrict further progress. Some of these barriers are political or economic in nature, though many are just risks or uncertainties that could be resolved simply though more information, or may in fact play in favour of more collaboration. We will discuss the risks and uncertainties first, and conclude with a discussion of the barriers to collaboration.

Risks & Uncertainties

First among the uncertainties that cloud the potential for collaboration is capacity. This is a multidimensional concern. One question concerns the size and availability of surplus capacity in Québec in the future. As noted earlier, the study by the Québec Commission on Energy, reiterated by Mousseau in his presentation in Toronto, estimates the potential future surplus in 2020-2030 to be on the order of 40-50 TWh, or roughly 25% of current annual production (Lanoue & Mousseau, 2014; Mousseau, 2015). That estimate depends on several factors – continuation with currently planned capacity additions, the absence of significant investments in energy efficiency, future demand in the province, no new transmission lines, and other factors. Moreover, as was suggested during the discussion, the surplus may in fact not be as big a problem as it would seem, as only ~50% of Québec's storage capacity is presently utilized and therefore could absorb some of the surplus.

Another area of uncertainty related to capacity are the investments in transmission infrastructure on the Québec side that would be necessary to support larger-scale exports to Ontario. The recent study by the Ontario Power Authority into the province's interties put figures on the scale of the investments required in Ontario. However if substantial investments are also required in Québec, the net costs of integration would be higher. Furthermore, while in Ontario, additions would mostly be along existing transmission corridors, in Québec this may not be the case. Public opposition to new transmission corridors could present a barrier to collaboration in Québec (see below).

On the other side, there is also some uncertainty regarding future demand in Ontario, as is demonstrated in Figure 9 and Figure 10. A key question is, how much of the drop in demand since 2005 has been due to an underlying structural shift in the provincial economy as opposed to cyclical economic conditions? Ontario's official demand forecasts still exceed 170 TWh / 27,500 MW of gross demand in 2030 (Ontario Power Authority, 2014). Under a stronger demand

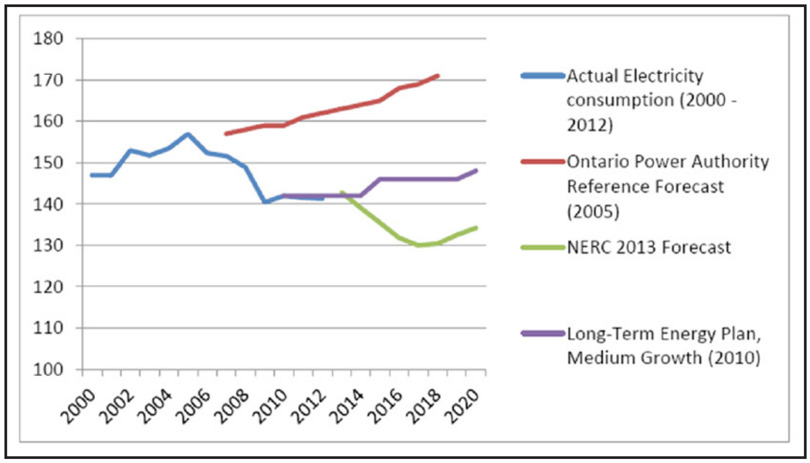


Figure 9) Ontario Electricity Consumption 1975-2013 (Forecast 2013-2018) Twh/yr (Winfield, 2015)

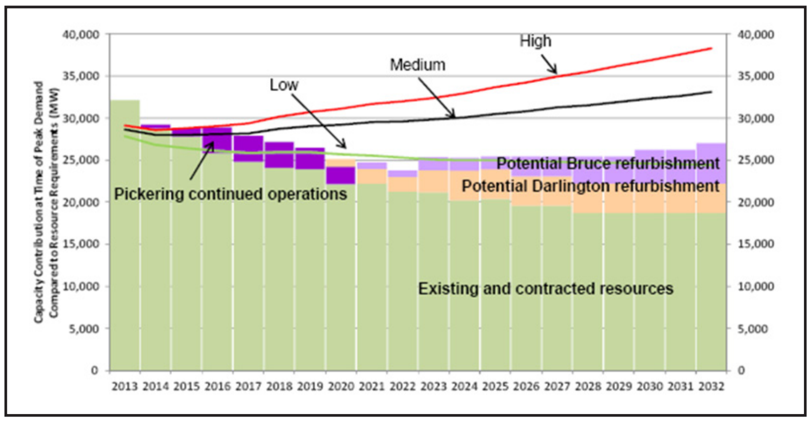


Figure 10) Ontario Power Authority - Demand Growth Scenarios

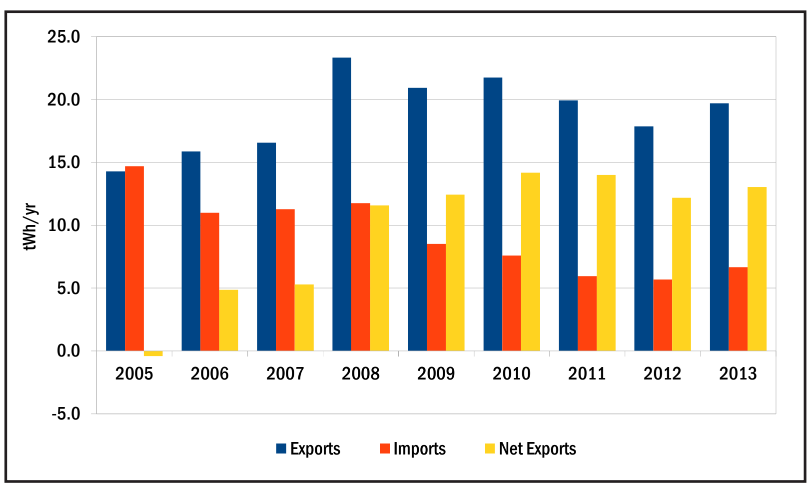


Figure 11) Ontario Imports and Exports of Electricity, US and Inter-provincial (Statistics Canada, 2013c)

forecast, a better case can be made for pursuing all options (though substituting imports for nuclear would more difficult) but if demand tracks closer to the low growth scenario in Figure 10, the desire to pursue inter-provincial integration without replacing some domestic supply may be weaker. In fact, there is a further question of whether Ontario already has a capacity surplus, having been a net-exporter in electricity since 2006.

Some of those exports are due to the need to dumping of surplus nuclear generation, particularly at night. Even under low demand scenarios and the evident surplus capacity Ontario has at times, it is not clear why the province would choose to pursue the risky refurbishment of nuclear facilities when it may be able to meet its current needs (and more) by collaborating with Québec. It would also be replacing a power source that needs to run at capacity at all times with one that could be reliably called upon when needed.

Another class of uncertainties might be termed 'distributional' in nature – that is, how will the risks and rewards associated with collaboration be distributed amongst partners and consumers? In terms of investment in infrastructure, the answer could be as straightforward with each province being responsible for its own infrastructure (or contracting out to any party willing to bear the risks). Even so, the additional infrastructure investments are likely only realistic in support of a long-term contract. In Ontario, because Hydro One is already unbundled, it would likely just apply to pass the costs of new infrastructure onto consumers. Some regulatory changes could be required to do the same in Québec.

One concern that was raised during the discussion in Montréal was the risk of current or prospective industries choosing to locate or relocate in Ontario, rather than Québec, if the difference in electricity rates between the two provinces was reduced. There were also concerns that that Ontario could in turn wheel the imported electricity to its US neighbours at a higher price. The discussion on the first issue concluded that this was unlikely to be a serious concern, as rates in Ontario will continue to rise even under collaborative scenarios, - just not as much as they could without importing electricity from Québec, and that Quebec's comparative advantage in electricity rates would be maintained. The second concern is more complex, but could potentially be dealt with by an upfront agreement about the final destination of electricity imported from Quebec. Moreover, if the environmental benefits of Québec's hydro resources were to be recognized through carbon pricing, that would help to fight the perception of Québec as a source of cheap supply and limit the opportunities for arbitrage.

In administrative terms, there are a number of things that would need to be concluded under even the limited 'capacity swap' scenario. The situation may be simpler on the Québec side, since there is really only one entity to deal with (i.e., Hydro-Québec), even if this entity can be politcally complex to manage. However, the hybrid market structure in Ontario could create some additional complications. For instance, will swaps only take place when there is a capacity shortage? If not, will imports take the place of domestic generation? If so, how will the IESO decide who shuts down? Will private generators get to bid to contribute to the 500 MW swap? Under a more extensive integration scenario, the challenges associated with Ontario's competitive could be heightened, if, as discussed below, domestic producers can't compete with cheaper imports from Québec. A further administrative uncertainty, given Ontario's recent announcement to join the WCI carbon market, is how Ontario will proceed to issue allowances, and to which sectors. Will Ontario follow a staggered approach as has Québec, beginning with large industry first before including distributors of fossil fuels? Or will Ontario simply match Québec's current implementation of the cap? How Ontario proceeds could have implications for the recognition of the environmental benefits of Québec's hydro, vis-à-vis natural gas.

There is also a question around timing and developments in the United States. If NESCOE moves first and manages to procure a long-term contract with Québec that recognizes the low-carbon benefit of large hydro, much of this discussion will be moot. The window for action may actually be shorter than it seems, since decisions about whether or not to refurbish Darlington (if indeed that decision has not already been made) will need to be made soon, and NESCOE has already release a draft RFP including large hydro. In a broader sense, actions to address climate change in the United States at the federal level (e.g., EPA regulations requiring states to have carbon reduction plans) also add to the uncertainty of future electricity markets, especially if they affect the price of natural gas.

The final set of risks and uncertainties relates to prices. There are two prices in particular that add to the uncertainty and risk associated with collaboration: the future price of natural gas and the actual cost of nuclear refurbishment. Both factors will influence the price that Ontario and Québec would agree to under a larger, long-term scenario. Much of the impetus for collaboration stems from the circumstances where Québec is exporting more electricity at lower, spot market rates due to the drop in natural gas prices at the same time that Ontario must make a ~$13b decision to move ahead with nuclear refurbishments. As long as the future for natural gas remains uncertain, it may make sense for Québec to continue with the spot market instead of committing itself into a long-term low-price contract. Indeed, the last such contract it signed was with Vermont in 2010 at a rate of 5.8 ¢/kWh (though subject to annual revision). If gas prices remain low for the foreseeable future however, a deal with Ontario at 6-7 ¢ / kWh, subject to the same kind of annual revision as in the Vermont contract, may be a good deal.

The view from Ontario depends on the perspective taken with respect to the cost risks of nuclear refurbishment. Previous refurbishment efforts have all run dramatically over their initial estimates, as much as 2x or more, and in some cases were canceled due in part to increasing costs. If, as the OCAA and Équiterre note in their report, the price for nuclear power emerges as high as 37¢/kWh due to delays and overruns, there is no doubt that importing that electricity from Québec in a long-term contract, subject to annual rate revision and even given the possibility of low natural gas prices for the foreseeable future, is a better deal for both provinces.

Désarticulés – Historical and Institutional Barriers to Collaboration

Owing to their separate historical and institutional evolutionary pathways, Canadian provincial electricity systems are, at present, highly *désarticulés* – disjointed, dislocated, even 'wrecked' (Caron, 2015). This characteristic manifests itself in several ways, one of which is the technological composition of each system. In that respect, perhaps the most basic distinction that can be made amongst the provincial electricity systems is between those provinces that historically had significant hydroelectric capacity, and those that have not. Québec, Newfoundland, Manitoba, and British Columbia all belong to the first group, each relying on large hydro to meet the vast majority of their domestic electricity demand. The electricity systems in these provinces are characterized by low production costs (and low domestic rates), public ownership, and a dynamic export orientation (Pineau, 2013). Lacking access to sufficient hydroelectric resources, the other provinces have had to chart somewhat different courses, but mostly relying on coal and gas. In Ontario's case, the system was initially also almost entirely hydroelectric. However, by the 1950s, demand began to outstrip the available hydroelectric resources and the province moved to introduce substantial coal-fired and then nuclear capacity into the system.

Figure 11) North American Electricity Transmission Lines > 500kV

This basic distinction is reflected in Figure 12, showing North American interprovincial and international transmission lines of a capacity greater than 500kV. Moving from West to East, the two groups of electricity systems roughly alternate between each other. The provinces with the greatest export capacity (in terms of infrastructure) are those belonging to the 'hydroelectric' group. What is more, these transmission lines, with few exceptions, tend to run south toward the United States. When compared with the highly interlinked American states, the relative paucity of interconnection between the provinces becomes much clearer. It also demonstrates the long-standing tendency of Canadian provinces to 'look South' (rather than East-West) for electricity export markets (Winfield, 2015).

But this Southern orientation is not strictly an accident of geography. The dominant mid-20th century electricity policy paradigm emphasized industrial development and provincial self-sufficiency as key objectives for system development (Simpson, 2015). Investments in electricity infrastructure were seen as elements of broader provincial economic development strategies, and as such, tended to be geared more toward provincial competitiveness and export opportunities than system and market integration.

Though this policy paradigm was largely supplanted by a renewed emphasize on economic liberalism (i.e., deregulation, competition and privatization) in the 1980s and 1990s, electricity markets have proven harder to reform (G. Doern, 2005; G. B. Doern & Gattinger, 2003). As a consequence, the 'provincialist' mindset continues to have very real and concrete implications regarding the potential for collaboration today.

One such implication is the general preference for, and reluctance to share, decision-making autonomy over provincial resources. Depending on the level of integration, provincial authorities would be expected, if not required, to share management and control of the system, conduct joint-planning exercises, or even make hard decisions about where (i.e., in which province) investment in additional capacity or transmission infrastructure would be best spent. The provincialist legacy, placing so much emphasis on retaining control over the electricity system in order to have it serve in the domestic social or economic interest, acts as a barrier to integration.

That being said, there are at least four 'levels' of integration possible (as shown in Table 1), and the level required to take advantage of the opportunities noted above probably need not exceed creating a 'Loose Power Pool'. Though there would be some requirement to collaborate in policy decision-making, implementation and system management at that level, it would certainly not spell the end of provincial autonomy over their respective electricity systems .

A potentially more complicated aspect of the provincialist legacy is that the provincial identities are closely intertwined with the provincial electricity systems. This may especially be the case in the hydro-rich provinces, where the low production costs stemming from the large public investments in capacity in the mid-20th century allowed these provinces to offer much lower rates to domestic consumers than they would otherwise pay in a larger, regional markets. The low price for electricity in these provinces is thus considered, either implicitly or explicitly in regulation, part of the provincial 'heritage' – a contract between the province and the public to maintain privileged rates for domestic rate payers. It may be politically challenging to

Table 1) Four levels of integration (Adapted from Pineau, 2012)

	Physical inter-connection	Loose Power Pool	Tight Power Pool	Competitive Electricity Market
Planning	Independent but with information exchange	Independent but with certain common projects	Common	Left to market forces (under monitoring of regulators)
System operation	Synchronization of activities	Coordination of production	Centralized planning	Independent network operator
Basis for electricity trades	Firm long term or emergency contracts	Benefit sharing	Benefit sharing	Competitive market
Sources of cost reduction	Economies of scale	+reliability and reserves	+ minimization of total production costs	+ competition
Price	Set in a distinct manner	Set in a distinct manner but directly influenced	Set in a common process	Freely set by the marketplace
Regulation	Independent	Independent	Common	Common

Physical Interconnection – regions remain independent in regulatory/commercial terms; integration exists only through physical links with structured trades.

Loose Power Pool – some coordination in both planning and production, some efforts to share resources, but separate regulatory institutions and commercial practices;

Tight Power Pool – integration goes beyond physical links and limited structured trades, with converging or similar regulations and similar commercial practices;

Competitive Electricity Market – characteristics of a common energy pool, but with emphasis on market forces; regulation reduced in favour of competition; converged regulatory/commercial systems raise domestic rates beyond the minimum required to cover system operating and maintenance costs, even if there are additional system benefits to be gained from higher rates (e.g., increased efficiency, reduced demand, etc).

As noted above, depending on the level of integration between Ontario and Québec, there might be increased pressure to increase rates in the latter. It is likely that domestic consumers in Québec would find this unacceptable. Opinions on the desirability higher electricity prices in Québec varied among presenters at the workshops. It is worth noting that economic analyses conducted by two separate presenters suggested overall economic gains to Québec flowing from integration. The overall increase in revenues could be used to offset rate increases domestic consumers, particularly those at the lower end of the income scale (Gibbons, 2015; Pineau, 2015).

One last, related implication of provincialism is the existence of domestic interests in maintaining the status quo. Here we are speaking mainly of economic interests with a stake in the electricity system as it currently exists in either province. These interests that may be threatened by greater integration and collaboration between Ontario and Québec. Just as domestic consumers in Québec would be exposed to higher rates under integration, domestic producers could be exposed to lower rates in Ontario (Gibbons, 2015; Pineau, 2015). As discussed earlier, the hybrid market structure in Ontario creates some uncertainties about how integration would actually proceed in that province. It is unclear how producers in Ontario would be affected up to 3300MW of electricity where to be made available from Québec at ~6c / kWh. Similarly, given its economic importance and institutional role in the province, Hydro-Québec may be less interested in engaging in negotiations around collaboration, particularly if they are perceived to threaten its autonomy.

Perhaps the most significant 'interest' to consider in this respect is the nuclear industry in Ontario. As noted earlier, an important aspect of the provincialist mindset was that electricity systems could be used as part of an industrial development strategy. Ontario's historic reliance on nuclear power can be interpreted accordingly; of the ~29 CANDU reactors active worldwide 19 are in Ontario, where the technology was originally developed. As a result, the interest in continuing with nuclear is institutionally deeply entrenched in the province, and is not restricted to Bruce Power and Ontario Power Generation (Gibbons, 2015; Simpson, 2015).

Beyond the historical legacy of provincialism, there are some additional barriers to collaboration. Some of the administrative and regulatory infrastructure needed to facilitate collaboration has yet to be fully developed. For instance, the chapter of the on energy of the Agreement on Internal Trade (AIT)has never been completed and is ostensibly still under negotiation. As a result, a policy framework for free trade in electricity among all provinces, let alone Ontario and Québec, does not yet exist and must be created anew every time negotiations are opened. CAMPUT5 – the non-profit organization representing the provincial energy and utility regulators – could, perhaps in concert with the National Energy Board (NEB), play a larger role in facilitating coordination amongst separate provincial regulators.

At the federal level, the NEB poses no significant barrier for inter-provincial electricity trade. In fact, the National Energy Board Act actually has provisions designed to promote interprovincial collaboration. Unlike inter-provincial gas pipelines or international electricity trade, inter-provincial electricity trade and infrastructure is not regulated by the NEB. As a result, any facility involved in East/West trade would be regulated by its respective provincial regulation. Section 119.08(01) of the Act requires applicants for an international export license to first inform other Canadian actors with a stated interest in purchasing that electricity prior to securing any deals with international partners, and to give partners with a specified interest in selling within Canada the same terms and conditions as they would a foreign partner (Caron, 2015).

One administrative barrier that was raised several times in both workshops was the lack of transparency and accessibility in both provinces with regard to electricity planning and administration. In both Ontario and Québec, observers have noted a growing reluctance on the part of utility companies, system operators, and political authorities to engage in the kind of open

5 The acronym historically stood for the 'Canadian Association of Members of Public Utility Tribunals', though this name was dropped from the organization's constitution in 2011.

public discourse and information sharing that would facilitate new ideas and input from the public (Mousseau, 2015; Pineau, 2015; Winfield, 2015). There is also a question of administrative capacity, at least in Québec, to engage sufficiently or effectively in the analysis necessary to making informed policy decisions (Mousseau, 2015).

Public opposition to certain technologies and new infrastructure in both provinces also complicates collaboration. In Ontario, opposition to wind power could act as a barrier to further build out of that technology under a scenario in where more storage capacity becomes available through Québec to balance intermittent supply. In Québec, public opposition to new transmission infrastructure could hinder the enhancements necessary to support expanded electricity trade between the two provinces. Discussions at the Toronto workshop indicated that opposition in Québec to transmission infrastructure may have more to do with the deals to which the investments are attached. However the potential for opposition to new infrastructure to act as a barrier is nonetheless present. At a more general level, the preference in both provinces for investments in electricity being closely tied to domestic job creation could also hinder infrastructure investments if it is perceived that more jobs will be created or maintained by redirecting that investment into domestic electricity industries (e.g., nuclear refurbishment).

Last, and perhaps the most important barrier to collaboration, is the lack of a vision for what a future system built more around provincial electricity and climate change collaboration could or should look like. This issue was raised in both workshops – without a renewed Canadian energy/electricity vision, it is more likely that we will continue on the current trajectory. There has been little interest at the federal level in engaging in such discourse.. Developments at the provincial level through the Council of the Federation are perhaps more promising, but it remains to be seen how far the provinces will go toward establishing a new vision for electricity and climate change in Canada

Conclusion

Québec cannot get a fair price for its electricity exports; Ontario is about to commit itself to a costly and risky process of refurbishing its aging nuclear facilities. The opportunity to 'meet halfway' and sign a long-term agreement for electricity trade at a rate that gives recognition to the low-carbon character of large hydro and is below even the most conservative estimates for nuclear refurbishment costs seems self-evident. What the findings from the workshops suggest, and what this report as attempted to illustrate, is that collaboration on electricity and climate change need not – and perhaps should not – stop there.

At the same time, there are a number of risks, uncertainties and barriers that may hinder progress on collaboration. However, as the discussion above indicates, many of these can be addressed simply by maintaining and advancing dialogue. The aim of these workshops was to do just that – to gather knowledgeable experts from a diversity of backgrounds to contribute to a more comprehensive understanding of the benefits and barriers to collaboration. In particular, we sought to bring information to decision-makers in both provinces, and to facilitate continued interaction between decision-makers and stakeholders.

Perhaps the most important conclusion to draw from the workshops is that there is, at present, a historic opportunity for Québec and Ontario to craft a new *vision* for the future of energy and climate change collaboration at the provincial level in Canada. In doing so, they would be building a stronger bridge between Canada's two most populated provinces, demonstrating leadership to the rest of Canada, and helping to move away from the long-standing provincialist mindset that has dominated electricity system governance in Canada since the early 20th century.

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