Integrating Thermal and Hydro Electricity Markets: Economic and Environmental Costs of *not* Harmonizing Pricing Rules

(non-technical) Executive Summary (1-2 pages)

a) Motivations underlying the research

Market deregulation and smart grids have been much discussed in the electricity literature. Often presented as a way to better manage energy production and consumption, they are however usually considered within a single market only. In contrast, electricity market integration between different jurisdictions is much less studied. Furthermore, when the benefit of electricity market integration are considered, they typically relate to the sole opportunities attached to the optimization of the supply system over a larger region. Gains from harmonizing pricing rules are mostly overlooked, if not completely ignored. Given the important number of jurisdictions where electricity prices are still regulated on the basis of average costs (as opposed to market-based prices), many gains can be expected from not only integrating markets, but also from harmonizing pricing rules. This is especially true when hydropower is considered. In the U.S. and Canada, the latter is mostly sold at (historically low) cost to local consumers, while less lucky regional consumers have to buy power at much higher market (or regulated) prices.

The motivation of this research is to study the economic and environmental outcomes of integrating a “hydro jurisdiction” with another one, dominated by thermal generation. Price and welfare impacts are studied, with a specific concern to winners and losers, as well as greenhouse gas (GHG) emission changes.

b) Short account of the research performed

We model a full year of production and consumption for a hydro jurisdiction and a thermal one. Three different market regimes are compared: complete autarky (no trade across jurisdiction), trade across jurisdictions, while the hydro one is pricing at average cost and the thermal one at marginal cost (shallow integration) and finally trade across jurisdictions when both jurisdiction are pricing at marginal cost (deep integration).

Our model is then calibrated with data from the provinces of Quebec and Ontario, both in Canada. The calibration and all subsequent calculations are based upon the 8760 hours of the year 2007, which is used as a reference.
Quebec is a large hydropower producer (about 200 TWh annually, which are sufficient to cover the whole consumption). Prices, which are regulated at average cost, counts among the lowest in North America. By contrast, generation in Ontario, the neighbor jurisdiction, is dominated by thermal technologies. There, a competitive market provides marginal cost signals to consumers.

The two power systems are linked by interties that allow some trade to happen. “Native load” in Quebec, which corresponds to the expected consumption in Quebec at the regulated price, is however protected. Except when production exceeds native load, net-exports are not possible: the yearly balance of trade toward neighboring jurisdictions cannot be positive. The hydropower producer must limit its trade activities to arbitrage opportunities with the thermal system (taking advantage of hourly price differentials and of its storage capacity). The actual situation therefore corresponds to a shallow integration regime. We compare it to autarky and deep integration, where native load would not be protected anymore.

c) Main conclusions

From a welfare perspective, shallow integration is likely the worst of all regimes. While some efficiency gains result from the limited trade, those follow from the decrease in price associated with the possibility of arbitraging between low and high load periods in the thermal jurisdiction. Since price and production are unchanged in the hydro-jurisdiction, this decrease in price in the thermal jurisdiction has to be met by an increase of production in that same jurisdiction. We find that each dollar of welfare improvement is associated with an increase of 46.5 kg of GHG emissions. In other words, *removing* the interties could be a relatively affordable CO_2-reduction opportunity, at $21.5/tonne.

The main conclusion from this research however is that a shift to deep integration would allow *both* a welfare increase and a decrease in GHG emissions. In other words, deep integration leads to a *negative* abatement cost, estimated in our model at -$37/tonne, in strike contrast to usually positive carbon prices.
Yet, our results also show that consumers in the hydro jurisdiction lose with deep integration. The hydro producer's profit increase nevertheless by a larger amount, so that overall, welfare still increases in that jurisdiction, as in the thermal one. Importantly, it also says that consumers in the hydro jurisdiction could be fully compensated for their welfare loss. In the thermal jurisdiction, consumers experience a price decrease and producers have lower profits, as a result of their reduced market share.

d) Potential benefits, applications and policy implications of the work

This research has clear policy implications: countries seeking to reduce GHG emissions in the most efficient way should consider integrating their electricity sector, especially when hydropower (or nuclear power) is sold at regulated average cost. There is a potential to directly increase welfare *and* reduce emissions by harmonizing pricing rules across jurisdictions.
Careful consideration should however be given to consumers in the low-cost, regulated jurisdiction, because they stand to lose from deep integration. This may be done by means of lump-sum rebates that, if carefully computed, can potentially make the shift toward deep integration beneficial for each and all consumers.