# Rethinking Electricity Pricing in Canada

## Richer, Greener and Fairer


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# Executive Summary

Canadians emitted 750 million tons (Mt) of $CO_2$-equivalent greenhouse gases (GHGs) in 2006 and have to reduce these emissions by 50 to 85% before 2050, scientists say. The electricity sector is responsible for 117 Mt, the largest single source in Canada. In this sector, reducing these emissions can be financially profitable, while at the same time improve social justice. This is true for three reasons: (1) most electricity prices are not based on the *value* of electricity, but on its costs; (2) the cost of producing electricity in Canada is much lower than its value; and (3) richer households use much more energy than other ones (and therefore "environmental wealth", in the form of water or $CO_2$). This analysis also holds for the United States, and including the US electricity markets would only strengthen the arguments. However, only the Canadian markets are considered here.

Better price signals should therefore be implemented across Canada. Although some initiatives providing better economic incentives to consumers can be found (two-step and time-of-use rates and carbon taxes in BC and Quebec), these programs remain inadequate. They indeed maintain inefficient price gaps between provinces and are socially ineffective wealth redistribution tools. Also, they cannot, by their provincial nature, adequately tackle the GHG challenge, which requires a coordinated approach.

If electricity prices were leveled across Canada, in one way or another, more wealth would be generated – and the right signals for energy efficiency would be sent. In addition, by adding a GHG price, an even greater consumption/production shift would happen, with hydropower provinces consuming less and exporting more, for the benefits of many consumers, producers and the environment.

With a $40/ton carbon price, the following outcomes would be achieved, in the electricity sector only:

- 29 Mt reduction in GHG (-25% of the sector's emissions);
- a minimum of $6 billion in additional profits to hydropower producers; and
- $3.5 billion in carbon tax revenues.

Such outcomes would make it possible to compensate groups made worse off with the change (electricity producers using fossil fuels and consumers in "hydro" provinces), so that they would be willing to accept it.

From a social perspective, there are also gains to be made. Because higher-income households use more electricity and generate more carbon, while not paying the adequate value for their use, they consume a much greater share of the environmental wealth than what any social justice principle could explain. Fairness and efficiency will be introduced in the energy system only when consumers will pay the market price for electricity and for their GHG emissions.

Three actions can lay the ground for an environment conductive to change, and three strategies are proposed to implement electricity price increase in provinces with low-prices.

*Actions to prepare change*

1. Reduction of non-price energy efficiency barriers
2. Targeted Assistance (to low-income households)
3. Building up trust in the use of new wealth

*Possible strategies for change*

- Progressive Price Increase
- Announced Price Shock
- Voluntary Buyout

Such pricing reform is major, but the eagerness of Canadians to be richer, greener and fairer should not be underestimated. When such sustainable solutions are available, no society can afford to ignore them.

# 1. Introduction: Canada's Sustainability Challenge and its Electricity Sectors

## The General Context

Canadians emitted 750 million tons (Mt) of $CO_2$-equivalent greenhouse gases (GHGs) in 2006, according to *Canada's 2006 Greenhouse Gas Inventory* (EC, 2008a).[1] This is about 22% more than the 1990 emission level and about the same as in 2000 (EC, 2008b). GHG emissions are an issue because they are the key driver of human-induced climate change, which already warms the Earth and will continue to increase global temperature, as documented in the 4th Assessment Report by the United Nations Intergovernmental Panel on Climate Change (IPCC, 2007a). Consequences of climate change include extreme weather events, less resilient ecosystems (providing fewer ecological goods and services such as clean air and fresh water), change in crop productivity, and greater stress on water resources. In order to limit the increase of global average temperature to "only" 2 to 2.4°C, a reduction of GHG emissions between 50% and 85% from 2000 level is required by 2050 (IPCC, 2007b).

If GHG emission reductions are necessary to limit the Earth's warming, there are other positive consequences of fewer GHG emissions. Indeed, as more than 80% of Canadian GHG emissions are energy related (from the extraction and burning of fossil fuels), reducing GHG emissions is very akin to reducing fossil fuel consumption.[2] Co-benefits from reducing energy-related GHG emissions are numerous: improved energy security (from reduced energy imports), cleaner air (from less smog), reduced health care costs (from the improved health due to less smog) and increased long-term competitiveness from innovations in energy efficiency. These co-benefits are discussed in NRTEE (2005) and Stern (2007), among other publications.

This paper presents arguments to develop a strong approach to GHG emission reductions in the electricity sector, based on better electricity and carbon pricing. Co-benefits in terms of economic and environmental gains are presented in section 3, along with social ones. This section and section 2 provide some important energy and institutional background, with a discussion of current electricity and carbon tariffs implemented in BC, Ontario and Quebec (75% of the Canadian population). Section 4 discusses possible barriers to change and avenues to move forward.

## Canadian Emissions and the Electricity Sector

Among the many different sources of Canadian GHG emissions shown in Figure 1, the single largest one is the electricity sector.[3] This stationary GHG emission source is responsible for 16% of all emissions, which represented 117 Mt of $CO_2$ emissions in 2006, 22% more than in 1990. The three other energy-related GHG sources are other stationary sources (28%), transportation (different mobile sources responsible for 25% of all emissions) and fugitive sources (9%).[4] The four largest other stationary sources are the fossil fuel industry (9%), the residential sector (5.5%), the commercial and institutional sector (4.5%) and the manufacturing industry (3%, for a combined 22% of all emissions). These four sub-sectors emit GHG as a by-product of heat generation, obtained by burning oil, natural gas or sometimes coal. Numbers by provinces vary a lot, depending on their industrial structure and their access to hydropower for electricity production.

[1] The primary GHGs are carbon dioxide ($CO_2$), methane ($CH_4$) and nitrous oxide ($N_2O$). For more information on all GHGs and those dealt with under the Kyoto Protocol, see the GHG entry of the glossary of IPCC (2007a). In international GHG accounting, national totals exclude emissions from "Land Use, Land-Use Change and Forestry Sector". Without this source of $CO_2$ (and sometimes sink) the official Canadian 2006 GHG total is 721 Mt.

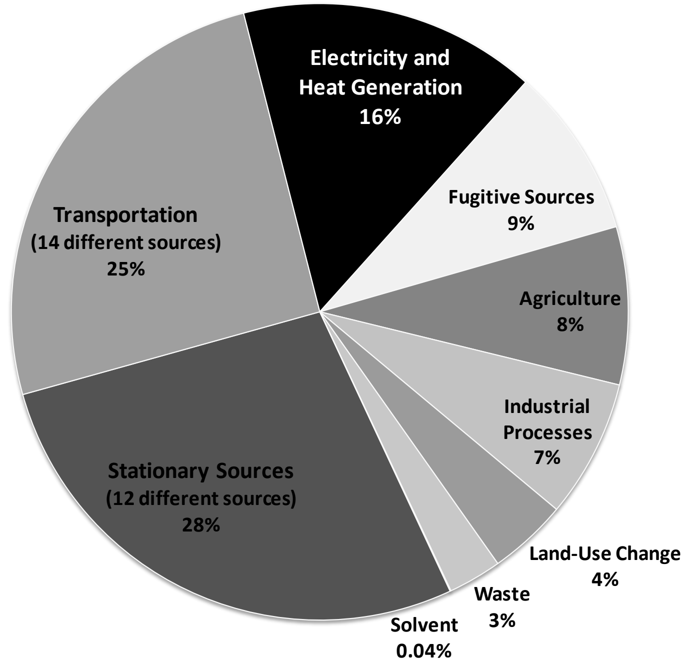
[2] Capturing $CO_2$ and storing it underground is an alternative to reducing fossil fuel consumption, but an expensive one that could only partially offset GHG emissions, since the available storage is limited. This process is currently only used in enhanced oil and gas recovery projects in Canada (Weyburn), Norway (offshore) and Algeria (In Salah), in a favorable fiscal environment (subsidies in Canada and carbon tax in Norway).

[3] The electricity sector is labeled "Electricity and Heat Generation" in official accounting, but heat generation represents less than 1% of emissions from electricity and heat in Canada (EC, 2008b).

[4] Fugitive sources are leaks of GHG (mostly methane) in the process of extracting, producing, refining and distributing coal, oil and natural gas.

The remaining "non-energy-related" GHG sources are agriculture (mostly methane, from livestock, and $N_2O$ resulting from the use of nitrogen fertilizers), industrial processes (releasing GHGs from chemical processes), land use changes (removal/addition of forest), waste (methane from landfills) and solvent. Let's note that GHG emissions related to land use are not credited for (or against) countries in official GHG accounting, even if their numbers are reported.

**Figure 1. Canada's 2006 GHG Emissions: 750 Mt (EC, 2008a)**




There are two reasons to consider the electricity sector as a key sector in GHG reduction initiatives. First, as already mentioned, it is the largest single source of GHG emissions, even if other stationary sources and transportation each represent more emissions, when their various components are added. Second, as transportation is currently almost entirely relying on oil, moving away from it to reduce GHG emissions will require an alternative energy source – which will largely be electricity.[5] Indeed, almost all major car companies are offering or announcing hybrid, plug-in hybrid and entirely electric cars. Also, there is a large development potential for public transit and rail, which can both be entirely electrified. These two trends will further increase the demand on power plants and on the electricity network.

With the decreasing use of oil in transportation, fossil fuel industry-related emissions will also decrease, because less gasoline will have to be produced. Indeed, emissions from conventional oil production and oil sands extraction represent the largest share of fossil fuel industry emissions, a stationary source of GHG (EC, 2008b). Also, in order to avoid using electricity for heating purposes when better alternative heat sources are available (such as heat from co-generation, from a geothermal heat pump, from solar energy or natural gas), the correct price signals have to be put in place in the energy sector in general, and in the electricity sector in particular.

Consequently, as electricity demand will continue to grow in the future, particularly from its increased used in transportation, foundations of the sector have to be sustainable. They are however not sustainable now, due

[5] Biofuels and hydrogen can technically be alternative fuels. They will be used, but only to a limited extent because producing these fuels in large quantities is problematic in terms of land use (for biofuels), life-cycle impacts, cumulative energy demand and, for hydrogen, costs, distribution and safety.

to major flaws in electricity markets and its pricing structure, as detailed in this paper. In short, these flaws results in important missed financial gains, higher than necessary environmental damages, such as GHG emissions but also land impacts from avoidable projects, and socially indefensible environmental wealth distribution.

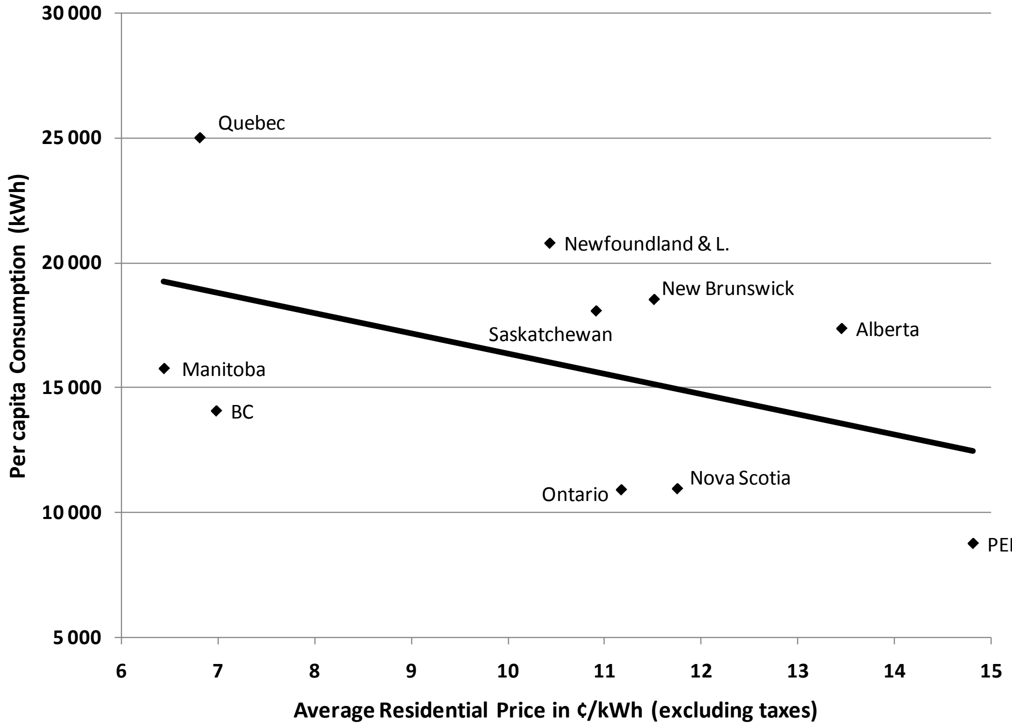
## Overview of Provincial Electricity Markets

Canadian electricity markets (and similarly US electricity markets) are characterized by unique disparities in consumption and price levels. As illustrated in Figure 2, some provinces have extremely high consumption and low prices (e.g. Quebec), while some other provinces have low consumption and high prices (e.g. Prince Edward Island, PEI). Indeed, the ratio of per capita consumption between the highest consumption province and the lowest one is 2.86 (meaning that the highest consumption province uses 2.86 times more electricity, per capita, than the lowest consumption one). This is more than the similar ratio of total energy use per capita, which is only 2.28 in Canada[6], or more than the ratio of per capita energy use for transportation or in the residential sector: 2.18 and 2.08 respectively.

In terms of prices, provincial differences are also enormous: electricity is up to 2.3 more expensive in the highest-price province (PEI), compared to the lowest price province (Manitoba). Such price differential is found all across Canada: in a majority of provinces, residential consumers pay more than 10 cents per kilowatt-hour (kWh), on average, while in British Colombia (BC), Manitoba and Quebec they pay 7 cents/kWh or less (on average). Similar differences exist for commercial and industrial electricity prices (for details, see Hydro-Quebec, 2008a). For comparison purposes, between 1990 and 2008, the highest *max/min* price ratio for unleaded regular gasoline across Canada was 1.66, with an average ratio of 1.28 for this period (Statistics Canada, 2009c). Numerous websites monitor gas prices across Canada to warn consumers about price differences. However, for electricity, where price differentials are much bigger and long-lasting, nothing is ever mentioned.

[6] This is the 2006 ratio of total energy consumption per capita in Alberta (403 Gigajoules, GJ) and in PEI (177 GJ). The average energy consumption per capita in Canada was 229 GJ in 2006 (Statistics Canada, 2009b).

**Figure 2. Provincial Per Capita Annual Electricity Consumption and Average Price (Statistics Canada, 2008 and Hydro-Quebec, 2008a)**




Many factors explain differences in consumption, beyond price: industrial structure, temperature (yearly heating and cooling "degree days") and income levels, just to name the major ones. Price differences, however, have their roots in two totally different sources: technology used in generation and type of price regulation. As shown in Figure 3, four provinces have their electricity generation sector dominated by hydropower: BC, Manitoba, Quebec and Newfoundland and Labrador (NL). Except for NL, which exports most of its low-cost electricity to Quebec, these provinces have extremely low production costs. Other provinces, with more supply from coal, natural gas and nuclear power plants, have higher costs.

These higher (operation) costs lead to higher prices. However, the type of price regulation also plays an important role in price levels: all provinces, except Alberta and to some extent Ontario, sell electricity according to "average cost" principles, and most generation companies are mandated by law to sell electricity within their jurisdiction first. Only surplus can be exported. In the case of Alberta and Ontario, even if an hourly market price is determined in an open spot market[7], most consumers (residential and small businesses) are not directly exposed to these market prices because of the "Regulated Rate Option" in Alberta, and of the "Regulated Price Plan" in Ontario.[8] These plans allow consumers to pay at any given time a different price than the market price. For instance, on January 14th 2009, at 9.20 a.m., Ontario consumers under the regulated plan paid 5.6 or 6.5 ¢/kWh (depending on their individual cumulative consumption, see Table 1) when the market price was actually 13.16 ¢/kWh (Ontario, 2009). However, over the planning period, the regulated and market prices converge, because the regulated price in these two provinces is based on market price forecasts (and not on costs, as in other provinces), plus or minus adjustments to settle past differences.

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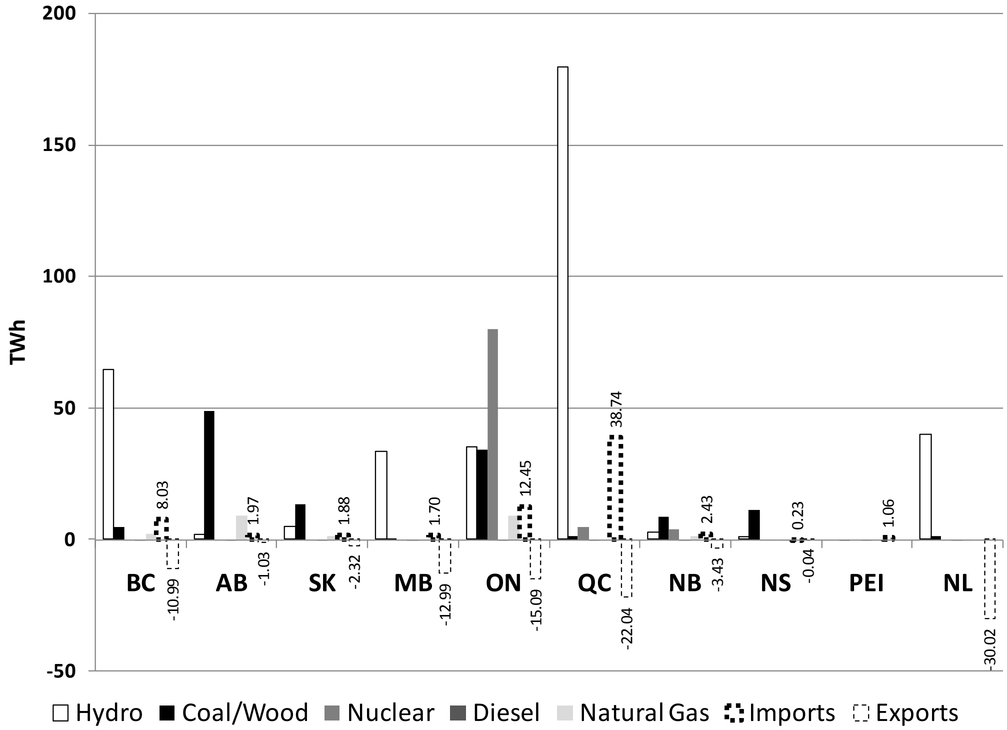
[7] Operated by the Alberta Electric System Operator (www.aeso.ca) and, in Ontario, by the Independent Electricity System Operator (www.ieso.ca).

[8] Consumers in these two provinces have also the choice to opt for competitive contracts, under which they directly pay the market price. These contracts are not popular, however.

**Figure 3. Provincial Electricity Production by Source, Imports and Exports, 2007 (Statistics Canada, 2009a)**




In the case of BC and Quebec, provincial regulation guarantees access to an important amount of energy, which is sold at historical low cost. In BC, the "Heritage Contract" guarantees about 49 TWh of energy, every year, at a price of 2.53¢/kWh (BCUC, 2003). In Quebec, the "Heritage Pool" provides an annual 165 TWh of energy to consumers at a price of 2.79¢/kWh (Hydro-Quebec, 2008b). A similar framework also exists in Ontario, for nine nuclear and hydro plants called "Prescribed Generation Assets" operated by Ontario Power Generation (OPG). The production of these plants (between 60 and 70 TWh annually) cannot be sold at market price: the nuclear production (about 50 TWh) is sold at a regulated 5.68¢/kWh, while the hydro production (about 20 TWh) is sold at 3.79¢/kWh (OEB, 2008a). The additional generation from OPG and other producers is sold at market price.

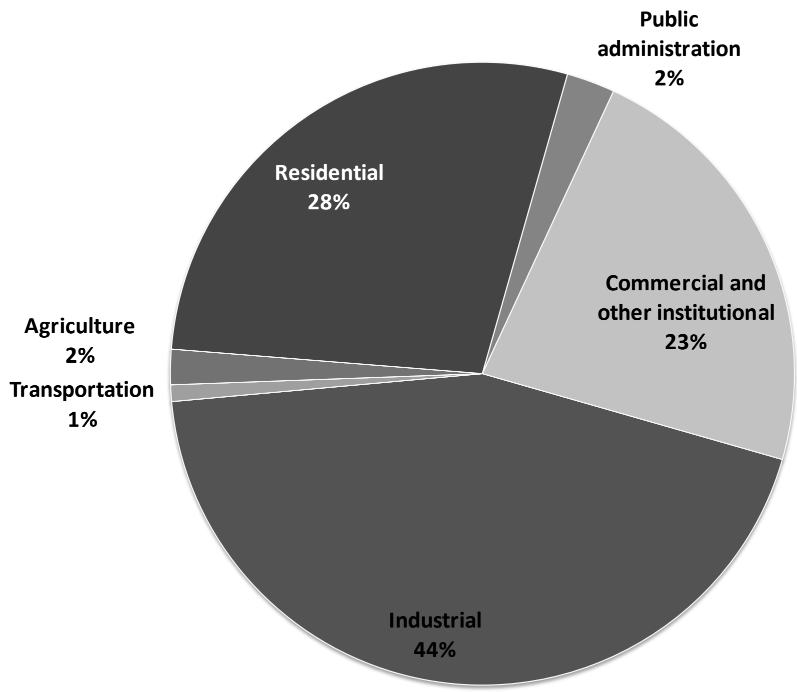
In all provinces (except Alberta and Ontario), utility boards (or commissions) approve "average cost" rates, based on the total estimated cost of supply in their province, including a "reasonable" rate-of-return for the owner of the electricity company. This owner is usually the provincial government, except in PEI, Nova Scotia, NL, Ontario and Alberta, where investor-owned companies also generate electricity. In the case of Manitoba, for 2007-2008, this type of price regulation resulted in the sale of 21 TWh within the province, for an average revenue of 5.22¢/kWh (including distribution costs). On the other hand, 10.6 TWh of exports produced an average revenue of 5.90¢/kWh, excluding distribution costs (Manitoba Hydro, 2008). In the previous year, equivalent numbers were 5.07 and 7.22¢/kWh, even better illustrating the important financial gap between the provincial price and the regional value of electricity.

Taking the combined "low-cost" hydro production of just BC, Manitoba, Ontario and Quebec, there are 250 TWh annually sold in Canada at about 3¢/kWh (not including transmission and distribution costs).[9] This represents about 50% of the Canadian electricity demand, reaching 527 TWh in 2006, as shown in Figure 4.

[9] However, the total hydropower production in 2006 was 319 TWh by utilities, plus 33 TWh by industries (paying very low, if any, water rights) for a total of 352 TWh of hydroelectricity production (Statistics Canada, 2008).

Consumers of all types benefited from these low prices, albeit not evenly distributed across Canada and across income groups.

**Figure 4. Canada's Electricity Demand by Sector in 2006: 527 TWh (Statistics Canada, 2008)**




Because an energy subsidy is defined as "any government action that lowers the cost of energy production, raises the price received by energy producers or ***lowers the price paid by energy consumers***" (UNEP, 2002, emphasis added), this type of price regulation in the electricity sector is a subsidy to consumers.[10] Indeed, many electricity consumers in Canada pay a lower price than the market price they would pay, simply because their provincial government regulates the price of electricity to its production cost and only allow exports after provincial needs are satisfied. This has two immediate consequences:

- Investments in energy efficient equipment and the use of alternative energy are deterred by the low cost and availability of electricity (a "substitution effect", in economic terms, favoring more electric-intensive equipments).
- Consumption of electricity is inflated by its artificially low price (an "income effect", in economic terms, favoring higher consumption, simply because of its relative low costs).

In sections 2 and 3, the economic, environmental and social impacts of these subsidies are detailed, and estimates of gains to be made in these fields are provided. But before going to these topics, a quick overview of current international trends in the electricity sector shows how much Canadian electricity policy is lagging behind international experiences.

## International Electricity Sector Trends

Under the Canadian constitution's article 92A *Laws respecting non-renewable natural resources, forestry resources and electrical energy*, the electricity sector is outside federal jurisdiction. This explains why such diversity in prices, consumption levels and regulatory frameworks is observed (the same could be said about the US situation). Little coordination happens between provinces (and US states) beyond technical and

[10] Similar definitions can be found in other sources, such as IEA (2000) and EIA (2000).

reliability issues, which happens through the North American Electric Reliability Corporation (NERC) and its eight regional entities.

This situation is however far from optimal, because of the resulting market distortions in investment and consumption choices. Furthermore, from a planning perspective, pooling resources and operating at a larger scale brings many benefits, such as avoiding higher-cost generation options when lower-cost ones exist. It can, however, have some shortcomings: vulnerability increases, because failures can spread through the interconnected system (this is what happened on August 14$^{th}$, 2003, during the Northeast blackout). Overall, however, under adequate oversight, benefits largely dominate possible problems. This explains the international trends in electricity market integration, progressively harmonizing regulation and prices in different jurisdictions (see Box 1 for more details). In Canada, however, little discussion and no plan exists to better integrate electricity sectors, either East-West or North-South, with the US.

**Box 1. International Trends in Electricity Market Integration**

All over the world, even in Latin America (e.g. Andean Energy Alliance) and Africa (e.g. Southern African Power Pool), different states formalize and harmonize the institutional framework of their electricity sector. Four initiatives are briefly described below: one that has failed (the US one), and three more successful ones (European Union, Nordic countries and Australia).

- ***US failed attempt: Standard Market Design in Regional Transmission Organizations (RTOs)***. The US Federal Energy Regulatory Commission (FERC) pushed, until 2005, for the creation of RTOs using a standard market design. This would have removed state regulation power in electricity pricing and provided a framework for more competition and electricity exchange across jurisdictions. However, resistance from states losing some regulatory power and from consumers losing their exclusive access to local low-cost electricity prevented this policy to be implemented (FERC, 2005; Benjamin, 2007).
- ***European Union common rules for the internal market in electricity***. A 2003 directive by the European Union (EU) forced all member countries to open their transmission network under common rules, open investment in generation and to offer supply choice to all consumers by 2007. Although disparities still exist among member countries, due to the lack of transmission capacity and consumer resistance (particularly in lower-cost countries, such as France), transparency over electricity supply and price increases, notably through new organizations such as the association of European Transmission System Operators (connecting system operators from all EU countries) and EuroPEX (Association of European Power Exchanges).
- ***NordPool: the first integrated international electricity market***. Nordic countries (Norway starting in 1991, Sweden joining in 1996, Finland in 1998, Eastern Denmark in 2000 and Western Denmark in 2007) are the first group of countries to harmonize their national electricity regulation to allow hourly spot trading among four different countries. Consumers can choose their electricity supplier and a common electricity price – only subject to transmission constraints – characterizes the market across jurisdictions.
- ***Australia's National Electricity Market***. Since 1998 (2005 for Tasmania), all Australian jurisdictions (except the state of Western Australia and the Northern Territory) started to trade electricity in a common market. Residential consumers were given choice over their electricity supplier and a single market price – subject to transmission constraints – characterizes the market. The interconnected grid spans over 4,000 km, North to South (NEMCO, 2008). This is about the distance between Halifax and Calgary or Vancouver and Montreal.

# 2. Price Signals for Sustainability

## Market Prices

Since the collapse of many communist states in the early 1990s, there is a strong worldwide agreement that in most cases, the allocation of goods and services is better achieved under a well functioning market price system. The interaction of supply and demand determines the market price, rather than set by a governmental plan. Such free interface between buyers and sellers allows consumers to express their preferences directly in the market (so that these preferences don't have to be discovered and interpreted by planners) and directly rewards suppliers if they provide adequate products, or not if they don't. Many goods and services in our society are provided through such a system, even vital goods such as food, housing and *some* types of energy (oil and natural gas, for instance). Electricity mostly escapes this system, with planned average cost pricing, or improved variations of average cost pricing, as described in the next section.

There are also, however, cases when such free markets fail to work adequately, resulting in market prices and available quantities not reflecting the real value of products. This leads to inefficient outcomes, with either too much or too little of products sold, compared to the optimal situation. These cases are called "market failures" (see Box 2 for more details). In such cases, governments have the legitimacy to be involved in the market, to correct the market failure.

Because early electricity markets were characterized by natural monopoly features, suffered from market power issues and displayed public good features, government have been historically involved in the power sector. For the sake of simplicity, average cost prices were implemented and remained in use in many jurisdictions. The next sub-sections cover current attempts to improve price signals in electricity and carbon in Canada, over practices inherited from the past.

**Box 2. Market Failures**

There are four general types of market failures, each calling for some type of government interference in the market, to improve the outcome (see for instance Case et al., 2002):

1. ***Market power***. Some buyers or sellers have more power than others in the market and can directly influence prices (e.g. some alleged examples are OPEC, Microsoft or Wal-Mart; this latter example being a possible example of a large wholesale buyer influencing suppliers).
2. ***Public good***. Some products are such that it is very difficult to prevent consumers to benefit from them once they are produced, and are also such that one's consumption does not affect the consumption of others. In these cases, consumers have little individual interest to pay for their own consumption – hoping a "free ride" will be available. Governments are therefore in a legitimate position to make sure these goods are still provided, and paid for through taxation. Fireworks, the security offered by the police and the army, justice, primary and secondary education are traditional example of public goods. Reliability, in the electricity sector, is another example.
3. ***Externalities***. When the production or the use of a product has impacts that do not directly affect the producer or the user, but everyone, there is an externality. Producers and consumers, not directly gaining or losing from these impacts, are not ready to pay for these, even though there are some real consequences. Noise from neighbors is a traditional example of a negative externality. GHG emissions are another.
4. ***Imperfect information***. When some information is unknown to either the buyer or the seller, the market price and quantity may not reflect the correct evaluation of the product by either party, leading to inefficient decisions. Examples of such cases happen in second-hand cars markets (the seller knows more about the car than the buyer) or in energy-using products (such as refrigerators or cars). In these latter cases, future energy consumption has to be fully known and understood when making an investment decision, but it is not always the case due to imperfect information.

If there is a market failure, governments are legitimate to take action: by either reducing the market power (through competition laws); providing the products or paying a supplier to do so; regulating or taxing to account for the externality; and, finally, to ensure information is as transparent and as widely available as possible to all markets participants.

# Current Price Signals in Electricity: Increasing Block and Time-of-Use Prices

## Increasing Block Prices

Only in Alberta and Ontario can residential electricity consumers be billed according to real-time market prices. In other provinces, regulated "increasing block prices" are used (in Ontario also, for most residential consumers). This tariff corresponds to an average cost price that has two steps (and possibly more, in theory), with an increasing price for electricity consumption beyond the first step threshold. See Table 1, where this "step-rate" is illustrated for the cases of BC, Ontario and Quebec.

The step rate is still an "average cost" price because the price face by consumers is an average of all production costs. It sends, however, a better price signal to consumers because as their consumption increases, they pay a higher price – reflecting to some extent the higher production cost of a higher consumption. It also aims at protecting lower income consumers by ensuring they can buy a given quantity of electricity at a lower price.[11]

As shown in Table 1, in BC, Ontario and Quebec (accounting for 75% of the Canadian population), most residential consumers pay a monthly charge, a first price for their consumption up to the threshold and then a higher price. We can see that step 1 and 2 prices are lower in BC and Quebec than in Ontario, partly because the Ontario step prices is adjusted every six months to market conditions, while the BC and Quebec prices can only evolve yearly, if the provincial regulator approves an increase. BC and Quebec prices are maintained at a low level because of the high proportion of hydropower sold at low "heritage price", as described before. Let's also mention that the Ontario price is a sum of two components: an "electricity" charge and a bundle of other charges totaling 3.77¢/kWh, in Toronto.[12] In BC and Quebec, energy, distribution and transmission prices remain bundled together.

**Table 1. Step-Rate Residential Tariff in BC, Ontario and Quebec, 2009**

| | British Columbia | Ontario (Toronto) | | Quebec |
|---|---|---|---|---|
| | Conservation Rate (Residential Inclining Block) | Regulated Price Plan | | Rate D |
| | | Summer (*May 1–Oct 31*) | Winter (*Nov 1–April 30*) | |
| Fixed charge /month | $3.77 | $16.3 | | $12.36 |
| Step 1 price /kWh | 5.91¢ | 5+3.77 = 8.77¢ | 5.6+3.77 = 9.37¢ | 5.45¢ |
| Threshold /month | 675 kWh | 600 kWh | 1,000 kWh | 913 kWh |
| Step 2 price /kWh | 8.27¢ | 5.9+3.77 = 9.67¢ | 6.5+3.77 = 10.27¢ | 7.46¢ |
| | As of April 1, 2009 | As of May 1, 2008 | As of Nov 1, 2008 | As of April 1, 2009 |
| | BC Hydro (2009a) | OEB (2009), Toronto Hydro (2009) | | Hydro-Quebec (2009a) |

In Table 2, the annual electricity consumption of three types of consumers is presented: those living in apartments, single attached houses and single detached houses. Obviously, electricity consumption increases with the size of homes. The percentage of total electricity consumption purchased at step 1 price decreases as home size increases. For instance, BC households living in apartments buy 100% of their electricity at step 1 price, while only 62% of the consumption of households living in a single detached house is sold at that price. In all cases, a majority of the electricity consumption in these three provinces is sold at the lower step 1 price, which is much lower than the market price in the case of BC and Quebec. In BC, consumers living in apartments do not fully use their "allocation" of electricity sold at step 1 price: they only use on average 6,528 kWh per year, when they have the right to use 8,100 kWh at 5.91¢/kWh. If electricity could be re-sold, there would be a

[11] For example, in BC, the BC Utilities Commission required that the increasing block price be revenue neutral when it was introduced in 2008. This meant that the price per kwh for the first block of consumption fell relative to the price before. Thus, if consumers kept consumption within the first block, they would pay less than under the uniform price.

[12] These charges are the distribution charge, the network service charge, the wholesale market service charge and the debt-retirement charge. The amount of some of these charges varies across local distribution companies.

secondary market for this unused portion of cheap electricity! A similar feature exists in Ontario, but the price differential between step 1 and 2 is much lower.

**Table 2. Household Electricity Consumption and Amount Covered at Step 1 Price (OEE, 2009)**

| | | Apartments | Single Attached Row House | Single Detached |
|---|---|---|---|---|
| **BC** | % of households | 24% | 14% | 62% |
| | Annual Electricity Consumption (kWh) | 6,528 | 9,707 | 13,088 |
| | **Annual Consumption at Step 1 price:** ***max 8,100*** | ***>100%*** | ***83%*** | ***62%*** |
| **Ontario** | % of households | 11% | 18% | 71% |
| | Annual Electricity Consumption (kWh) | 4,864 | 9,484 | 11,501 |
| | **Annual Consumption at Step 1 price:** ***max 9,600*** | ***>100%*** | ***>100%*** | ***83%*** |
| **Quebec** | % of households | 33% | 16% | 51% |
| | Annual Electricity Consumption (kWh) | 12,680 | 20,217 | 21,544 |
| | **Annual Consumption at Step 1 price:** ***max 10,950*** | ***86%*** | ***54%*** | ***51%*** |

As, on average, electricity consumption grows with income (e.g. Pineau, 2008), most consumers paying the step 2 price have a larger income. This means that although step 2 price are higher, they represent a small share of consumers' income, and these consumers will tend to not react to these price signals. Borenstein (2008) studied the very steep increasing block tariffs of California and hints that consumers tend to be unresponsive to the increasing marginal price they face. Also, he finds that means-tested programs are better as an equity tool (for income redistribution) than increasing block prices. Indeed, these step rates allocate cheap quantities of electricity to consumers that are usually not targeted by welfare programs. Furthermore, higher-income households tend to use their full allocation of cheaper electricity much more often than lower-income households.

## Time-of-Use Prices

In order to better reflect real-time prices, time-of-use (TOU) pricing are also being implemented in these three provinces. To achieve this, smart meters are being installed, allowing electricity consumption to be monitored second by second, rather than as a cumulated amount at the end of the billing period (as it is still the case for most consumers).

Table 3 shows how current TOU programs in Ontario and Quebec charge different amounts for one kWh, depending on the time of the day. In Ontario, prices vary between 7.77 and 12.57¢/kWh, while in Quebec extremes are both lower and higher: 3.55 to 18.06¢/kWh (not all TOU programs have such "critical peak" electricity price in Quebec, however).

Ontario has the most ambitious goal: to have all homes and businesses equipped with smart meters by 2010. As of September 2008, local distribution companies across Ontario had installed 1.7 million smart meters (Conservation Bureau, 2008a:51). However, only 20,000 consumers had the TOU price in July 2008 (OEB, 2008b). The Quebec TOU program is only a pilot program in four cities. This pilot program started in December 2008 and will end in March 2010. In BC, a *Smart Metering & Infrastructure Program* is announced and should be implemented by 2012, but no detail is available so far.

While TOU programs provide better real price signals to consumers, price levels should still correspond, at least to some extent, to market prices. This is not always the case. For instance, in Quebec, the lowest off-peak price would not even cover the Ontario transmission, distribution and other charges (3.55¢ versus 3.77¢/kWh). Even with TOU prices, Quebec consumers still pay (indirectly) subsidized electricity prices, except, maybe, during critical peak periods.

**Table 3. Residential Regulated Time-of-Use Rates in Ontario and Quebec (in cents per kWh), 2009**

<table>
<tr><th></th><th colspan="3">Ontario Smart Meters</th><th colspan="4">Quebec "RÉSO" Tariff</th><th colspan="4">Quebec "RÉSO+" Tariff</th></tr>
<tr><th></th><th>All year</th><th>Summer</th><th>Winter</th><th colspan="2">Summer</th><th colspan="2">Winter</th><th colspan="2">Summer</th><th colspan="2">Winter</th></tr>
<tr><th></th><th>WKD</th><th colspan="2">Weekdays</th><th>WKD</th><th>Weekdays</th><th>WKD</th><th>Weekdays</th><th>WKD</th><th>Weekdays</th><th>WKD</th><th>Weekdays</th></tr>
<tr><td>6 -7</td><td rowspan="7">7.77</td><td colspan="2">7.77</td><td rowspan="7">4.60 /6.56</td><td rowspan="6">6.10 /8.06</td><td rowspan="7">4.29 /6.27</td><td rowspan="6">6.52 /8.50</td><td rowspan="7">4.60 /6.56</td><td rowspan="6">6.10 /8.06</td><td rowspan="7">3.55 /5.50</td><td>6.10/8.06</td></tr>
<tr><td>7-11</td><td>10.97</td><td>12.57</td><td>6.10/8.06 or 18.06 up to 25 times*</td></tr>
<tr><td>11-17</td><td>12.57</td><td>10.97</td><td>6.10/8.06</td></tr>
<tr><td>17-20</td><td rowspan="3">10.97</td><td>12.57</td><td rowspan="2">6.10/8.06 or 18.06 up to 25 times*</td></tr>
<tr><td>20-21</td><td rowspan="2">10.97</td></tr>
<tr><td>21-22</td><td>6.10/8.06</td></tr>
<tr><td>22-6</td><td colspan="2">7.77</td><td>4.60/6.56</td><td>4.29/6.27</td><td>4.60/6.56</td><td>3.55/5.50</td></tr>
<tr><td></td><td colspan="11">WKD=Week ends and holidays</td></tr>
<tr><td></td><td colspan="3">Summer: May 1–Oct. 31; Winter : Nov. 1–April 30</td><td colspan="8">First 15 kWh per day / beyond 15 kWh<br>Summer: April 1–Nov. 30; Winter : Dec. 1–March 31</td></tr>
<tr><td></td><td colspan="3">Ontario prices include electricity price and all charges (total of 3.77¢/kWh, Toronto Hydro charges).</td><td colspan="4"></td><td colspan="4">*Up to 25 times per winter, Hydro-Quebec can call (or e-mail) consumers one day in advance to announce a “critical peak” period, with a price of 18.06¢/kWh.</td></tr>
<tr><td></td><td colspan="3">Toronto Hydro (2009) and OEB (2009)</td><td colspan="8">Hydro-Quebec (2009b)</td></tr>
</table>

Note: BC Hydro is introducing the *Smart Metering & Infrastructure Program*. It will reach approximately 1.8 million residential and commercial BC Hydro customers by late 2012 (BC Hydro, 2009b:24). However, there is currently no publicly available information on rate design.

## Demand-Side Management and Energy Efficiency

In parallel to step and TOU rates, electricity companies in Canada also promote a better use of electricity through demand-side management (DSM) and energy efficiency programs. These programs usually provide rebates for energy efficient appliances and light bulbs, support for expert energy assessments and grants for home retrofits, among other initiatives. Table 4 illustrates direct DSM spending in BC, Ontario and Quebec for 2005, 2006 and 2007. If the cost of avoided (or "saved") MWh is high (from $86 to $232 in Table 4), compared to producing one MWh (from less than $30 to $100 or more), it must be remembered that the avoided MWh is *recurring* over many years. This means that the investment per avoided MWh will save, over the years, many times the cost of producing one MWh.

Despite being successful and cost-effective (when investment costs are assessed against avoided future costs), the yearly savings are marginal compared to the electricity produced and imported in these three provinces: less than 1% in BC, and less than 0.5% in Ontario and Quebec. Also, measurement of the energy saved is always challenging, "since savings represent the absence of energy use or demand." "[…] Savings are determined by comparing measured use or demand before and after implementation of a program, making suitable adjustments for changes in conditions" (EVO, 2007). At least in the case of Ontario, the reported "data quality is a concern due to missing data and the application of somewhat different methodologies" (Marbek Resource Consultants, 2008).

**Table 4. Summary Features of DSM Initiatives in BC, Ontario and Quebec**

| | | 2005 | 2006 | 2007 | Source |
|---|---|---|---|---|---|
| BC (BC Hydro) | DSM Spending (Million$) | 71 | 90 | 94 | BC Hydro (2005, 2006, 2007) |
| | TWh Saved | 0.60 | 0.58 | 0.55 | |
| | *Cost of avoided MWh* | *$118* | *$155* | *$171* | |
| | Total Available TWh | 65.79 | 68.56 | 69.25 | Stat. Canada (2009a) |
| | *Percentage Saved* | *0.92%* | *0.85%* | *0.79%* | |
| Ontario (Local Distribution Companies) | DSM Spending (Million$) | 36 | 72 | 55 | Marbek Resource Consultants (2008) |
| | TWh Saved | 0.16 | 0.52 | 0.63 | |
| | *Cost of avoided MWh* | *$221* | *$138* | *$87* | |
| | Total Available TWh | 158.03 | 153.36 | 155.31 | Stat. Canada (2009a) |
| | *Percentage Saved* | *0.10%* | *0.34%* | *0.41%* | |
| Quebec (Hydro-Quebec) | DSM Spending (Million$) | 91 | 149 | 172 | Hydro-Quebec (2007b, 2008b) |
| | TWh Saved | 0.87 | 0.45 | 0.64 | |
| | *Cost of avoided MWh* | *$202* | *$232* | *$199* | |
| | Total Available TWh | 207.86 | 204.20 | 202.74 | Stat. Canada (2009a) |
| | *Percentage Saved* | *0.42%* | *0.22%* | *0.32%* | |

In any cases, there is a wide recognition in the energy efficiency literature that "adequate pricing is a necessary condition for promoting energy efficiency" (WEC, 2008). Price must provide the right market signals, and reflect the opportunity cost of the use of the resources, along with negative externalities when they exist. Indeed, among the eight different energy efficiency barriers identified by the Ontario Power Authority, the first is *price signals* (OPA, 2007). Other barriers are the lack of awareness, the limited product and service availability, consumer preference, limited or uncertain finance, the level of transaction effort required, the risk that the energy efficient product may not perform as promised, split incentives and institutional, regulatory, or legal barriers. See also IEA (2007) for more details on market barriers and market failures inhibiting energy efficiency improvements.

## Carbon Pricing in Canada

GHG emissions driving climate change are probably the most extraordinary market failure of human history, as discussed in the Stern review of the economics of climate change. Four features make this market failure an extraordinary one (Stern, 2007): (i) climate change is an externality with global causes and global consequences; (ii) climate change will have long-lasting impacts, with future costs borne by future generations; (iii) uncertainties about the timing and the scope of impacts is high; and finally (iv) these impacts are likely to have significant effects on the economy, not just marginal ones.

Despite the increasing recognition of the seriousness of climate change, its causes and the existence of a market failure, governments around the world have not introduced any significant policies to deal with GHG emissions. The two most discussed approaches are (1) an absolute ceiling on allowed emissions, leading to a "cap-and-trade" system, and (2) a levy imposed on every emission of GHG, leading to a "carbon (or $CO_2$) tax".[13] Two initial provincial steps in such directions have however been taken in Canada, covering fossil fuels (gasoline, diesel, natural gas, coal, propane, and home heating fuel):

- ***Quebec fossil fuel duty***. Since October 2007, fossil fuel distribution companies in Quebec have to pay a duty equivalent to about $3/ton of $CO_2$ (Gouvernement du Québec, 2007). This amount corresponds to the amount each distributor has to pay, per ton, to reach an annual contribution of $200 million to the "Green Fund" created by the government, to promote energy efficiency initiatives. This annual total contribution is fixed by decree by the government.
- ***BC Carbon Tax***. Since July 2008, a $10/ton of $CO_2$ tax applies to fossil fuels sold in BC. This tax is scheduled to increase by $5 a year for the next four years, reaching $30/ton by 2012. This tax is revenue neutral, with an equivalent decrease in other individual and corporate taxes (Province of British Columbia, 2009).

These levies are intended to internalize, to some extent, the GHG externality. They rely on the fact that consumers, in their attempts to get the most out of their money, will start investing in less GHG-intensive transportation modes and heating sources, and will also use less fossil fuel when they keep their current stock of GHG-emitting equipment.

Because electricity production in BC and Quebec is dominated by hydropower (Figure 3), these carbon levies will not affect the price of electricity. However, these levies will accentuate an already problematic market distortion: because electricity is relatively cheaper than alternatives in these jurisdictions, compared to other ones (like in Alberta or Ontario), electricity consumption is higher than what it would be in a level playing field. Electricity becomes a substitute to energy-efficient equipment and other forms of energy due to its lower price. With the additional levy on $CO_2$ and average cost pricing in electricity, the competitiveness of electricity is further increased. This is problematic because it does not promote investment in energy efficiency, both structurally (equipments) and behaviorally (uses of equipments).

In order to send a correct price signal to energy consumers, not only a price on GHG emissions should be implemented, but also a price for electricity that fully reflects its value. Unless the two are done, consumers in will not face prices reflecting the real value of energy.

Figure 5 shows how much GHG is emitted per megawatt-hour (MWh, equivalent to 1,000 kWh), both directly (at the generation site) and indirectly (through up- and down-stream activities related to electricity generation).[14] Coal-produced electricity leads to GHG emissions of about 1 t/MWh (equivalent to 1 kg/kWh), while natural gas-produced electricity is responsible for about half this amount. Nuclear and hydropower emit almost no GHG (with emissions only coming from uranium mining and the construction of power plants and lines).

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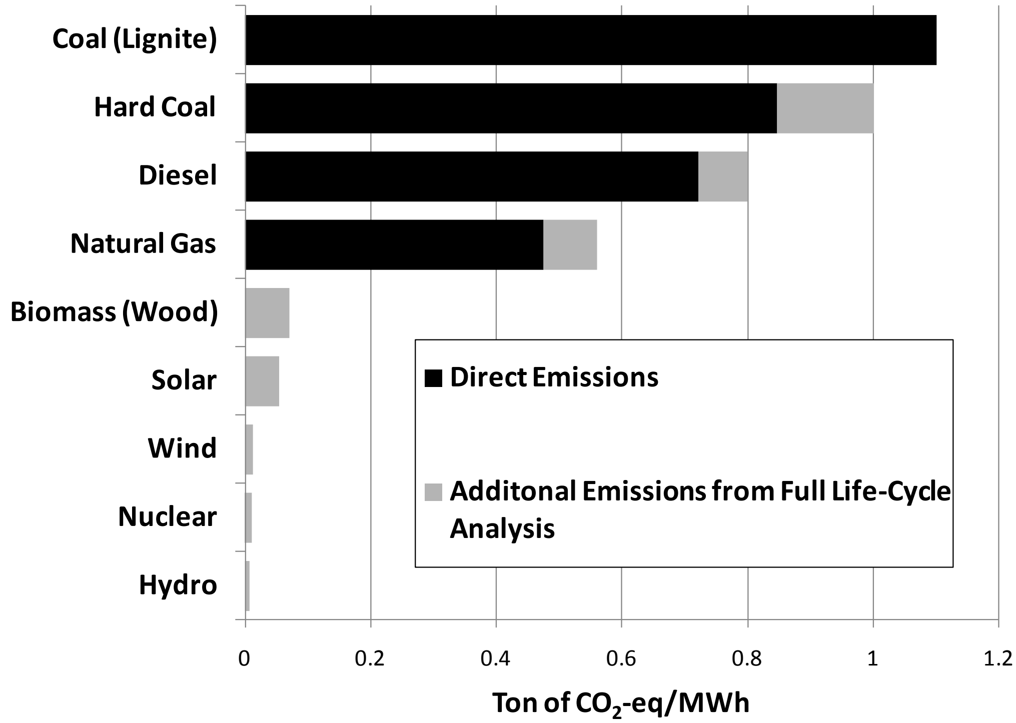
[13] This levy should in principle be applied to all GHGs, including methane and $N_2O$, and not only to $CO_2$. However, probably because of political pressures from the agricultural sector, methane and $N_2O$ tax are usually not included nor discussed.
[14] Like extraction activities, dam building, photovoltaic panel construction, etc.

**Figure 5. GHG emissions per MWh of Electricity from Different Sources (Wesser, 2007)**




If a carbon tax similar to the BC one was implemented in Alberta, electricity price would rise by about 1¢/kWh each time the carbon tax increases by $10/ton. From its current level of about 11.5¢/kWh (Figure 2), the Alberta residential price would reach 14.5¢/kWh with a $30/ton carbon tax, while the BC electricity price would remain at 5.91¢/kWh (and 8.27¢/kWh, after the threshold). The opportunity cost for BC Hydro, already selling to BC consumers largely below the export value most of the time, would rise by an amount equivalent to the carbon tax. For the owners of BC Hydro, BC citizens, this is a dramatic situation where, by regulation, their assets are made much less profitable than what they could be.

But there is also an environmental cost in this policy: every MWh of hydropower not exported leads to more fossil fuel-produced electricity. This comes from the fact that provinces with little hydropower have little non-fossil fuel alternatives and cannot import much from “hydro” provinces. These provinces indeed mostly keep their hydropower for themselves, and because aggregate electricity use is higher than it would be with prices closer to marginal costs of generation, any hydropower generated is typically fully consumed.

## Conclusion on Current Canadian Electricity Prices

As this section showed, only limited price signals are provided to electricity consumers. These limited financial incentives further complicate DSM and energy efficiency. There is therefore a large scope for improvement in electricity pricing in Canada, which would bring many benefits. The following section estimates both the economic, environmental and social gains to be made, if the correct price signals for sustainability were implemented: a market price for electricity, accompanied by a GHG-price, throughout Canada.

# 3. Economic, Environmental and Social Benefits

## Market Price Scenario: 6¢/kWh (Energy Only)

Industrial electricity prices across Canada varied in 2007 from 3.19¢/kWh in Manitoba to 7.74¢/kWh in Ontario (Hydro-Quebec, 2007a, see also the Appendix).[15] These prices can be used as close estimates of "energy only" provincial prices (prices without distribution costs). If electricity markets across Canada were opened, or if regulators set the price of electricity at a level close to its market value, a common price for electricity would appear. Only transmission constraints and costs would create a difference. We assume in this scenario that such a Canadian market price is, on average, 6¢/kWh.[16] This price is chosen because it is between actual prices in various provinces and it was also the average hourly electricity spot price in the competitive New York electricity market, between 2006 and 2008 (NYISO, 2008).

If this price of electricity was charged all across Canada (ignoring possible transmission constraints and leaving transmission and distribution costs unchanged in each province), then the final price for different types of consumers would decrease in Alberta, Ontario, Nova Scotia and PEI, while it would increase in all other provinces. Given a price elasticity[17] of -0.2 (a conservative estimate), overall consumption would decrease by about 12 TWh (-2.35%) across Canada, with some increases in former "high-cost" provinces and some decrease in former "low-cost" provinces. Table 3 provides the breakdown by province.

**Table 3. Quantity and Revenue in the Canadian Electricity Market (Statistics Canada, 2008, and author's computation)**

| | Quantity (TWh) | | | Revenues ($ billion) | | |
|---|---|---|---|---|---|---|
| | 2006 Demand | New price (6¢/kWh) | *Change (%)* | Initial | New price (6¢/kWh) | *Change (%)* |
| AB | 60.33 | 61.65 | *2.19%* | $5.29 | $4.86 | *-8.18%* |
| BC | 61.59 | 56.17 | *-8.80%* | $3.30 | $4.37 | *32.36%* |
| MB | 18.70 | 16.86 | *-9.84%* | $1.00 | $1.39 | *39.02%* |
| NB | 13.89 | 13.85 | *-0.30%* | $1.20 | $1.22 | *1.11%* |
| NL | 10.52 | 9.84 | *-6.54%* | $0.78 | $0.94 | *20.37%* |
| NS | 10.22 | 10.45 | *2.26%* | $1.05 | $0.96 | *-8.19%* |
| ON | 139.51 | 144.94 | *3.89%* | $14.31 | $12.34 | *-13.79%* |
| PEI | 1.21 | 1.24 | *2.54%* | $0.16 | $0.14 | *-8.93%* |
| QC | 192.67 | 181.74 | *-5.67%* | $11.28 | $13.70 | *21.44%* |
| SK | 18.02 | 17.56 | *-2.52%* | $1.35 | $1.47 | *9.33%* |
| **Total** | **526.67** | **514.31** | *-2.35%* | **$39.73** | **$41.40** | *4.21%* |

Overall revenues, on the other hand, would increase by 4.21% (as shown in Table 3), despite lower prices in some provinces. Costs, however, would decrease, due to the decrease in coal and natural gas-produced electricity. Hydro and nuclear power outputs, costing less but limited, would remain at the same level. Reduced sales within former "low-cost" provinces would be sold in former "high-cost" provinces, as a substitute to fossil-fuel-electricity production.

Given this reduced consumption (mostly in Quebec, BC and Manitoba), additional exports from these provinces could more than surpass the additional consumption in Ontario and Alberta. The overall 12 TWh consumption

[15] More recent data are not used because at the time of this study, only 2006 electricity consumption data were available from Statistics Canada.

[16] See Box 5 for a discussion on *average* versus *hourly* market prices.

[17] Price elasticity measures the proportionate change in quantity when there is a price change. A value of -0.2 means that a 10% price increase leads to a 2% decrease in sales. Price elasticity in electricity is usually assumed to be low in the short run (about -0.2), and larger in the long run (about -0.8), see for instance the literature review in Lijesen (2007).

reduction would lead to a GHG emission decrease of 9 Mt. This would be achieved by reducing coal use, but also natural gas-produced electricity in Alberta and Ontario. These 9 Mt represent about 8% of the current electricity sector emissions, and 1.2% of total Canadian GHG emissions.

## Carbon Tax Scenario ($40/ton)

Under a $40/ton of $CO_2$ carbon tax, the price of electricity would further increase. If there was only coal-produced electricity, the price would increase by 4¢/kWh. However, as there is much hydropower, nuclear and natural gas-produced electricity in the production portfolio, the simplifying assumption that the price only increases by 2¢ is made here. Therefore, the new market price of electricity in this scenario is 8¢/kWh.[18]

As shown in Table 4, overall consumption decreases by 7.81% in Canada, with very different change magnitudes in different provinces. Indeed, despite the new carbon tax, former “high-cost” provinces would experience almost no price increase due to the new, lower-cost, hydro imports. Sharp quantity reductions would happen in Quebec, BC and Manitoba. However, producers in these provinces would benefit from the now recognized additional value their electricity has (i.e. no GHG emissions). This would lead to important revenue increases. In these cases, additional revenues are additional profits, because no additional cost is imposed on their production.

**Table 4. Quantity and Revenue in the Canadian Electricity Market (Statistics Canada, 2008, and author’s computation)**

| | Quantity (TWh) | | | Revenues ($ billion) | | | |
|---|---|---|---|---|---|---|---|
| | 2006 Demand | New price (8¢/kWh) | *Demand change (%)* | Initial | New price (8¢/kWh) | *Change (%)* | *Carbon tax revenue* |
| AB | 60.33 | 58.73 | *-2.65%* | $5.29 | $4.22 | *-20.17%* | $1.59 |
| BC | 61.59 | 52.09 | *-15.42%* | $3.30 | $4.92 | *49.11%* | $0.22 |
| MB | 18.70 | 15.79 | *-15.58%* | $1.00 | $1.61 | *61.18%* | $0.02 |
| NB | 13.89 | 13.19 | *-5.05%* | $1.20 | $1.13 | *-6.00%* | $0.30 |
| NL | 10.52 | 9.20 | *-12.57%* | $0.78 | $1.07 | *37.11%* | $0.01 |
| NS | 10.22 | 10.03 | *-1.88%* | $1.05 | $0.75 | *-28.94%* | $0.38 |
| ON | 139.51 | 138.79 | *-0.51%* | $14.31 | $14.07 | *-1.65%* | $0.53 |
| PEI | 1.21 | 1.20 | *-0.93%* | $0.16 | $0.16 | *3.59%* | $0.00 |
| QC | 192.67 | 169.90 | *-11.82%* | $11.28 | $16.25 | *44.03%* | $0.05 |
| SK | 18.02 | 16.64 | *-7.66%* | $1.35 | $1.31 | *-3.13%* | $0.43 |
| **Total** | **526.67** | **485.56** | ***-7.81%*** | **$39.73** | **$45.51** | ***14.54%*** | **$3.53** |

With an overall 41 TWh consumption decrease, electricity production across Canada would also decline. Again, less of the more expensive coal and natural gas-produced electricity would be generated in Alberta, Saskatchewan and Ontario and hydropower imports would be used instead. This would reduce GHG emissions by about 29 Mt: a sharp 25% drop from current electricity sector emissions; equivalent to a 4% drop from the Canadian total.

[18] This would also be justified by the presence of the American market, where about half of the electricity comes from coal power plants. Given that the other half is much less carbon intensive, the price of electricity would not increase by the full amount of the carbon tax.

**Box 3. Methodological Details**

No economic model of the Canadian electricity market currently allows a realistic market price to be computed, taking into account current production technologies across Canada and demand responsiveness. This latter issue – demand responsiveness – is a problematic point because it is impossible to know exactly how various consumers (industrial, commercial and residential) will react to new prices. The assumption that all consumers have a -0.2 price elasticity is a very conservative one. Consumers, especially in higher consumption provinces (such as Quebec), have a high energy efficiency potential (through electronic thermostat, better insulation, better hot water management and investment in more efficient appliances – to name some promising areas). In the absence of a detailed economic model, and for the sake of creating simple, illustrating scenarios, a relatively simple methodology was used here. More details are also provided in the Appendix.

**Price**. Three set of prices have been used before computing new provincial consumptions: industrial, commercial and residential prices. Changes in consumption levels were computed from 2006 level (Statistics Canada, 2008), using the price elasticity mentioned above.

**Revenue estimates**. They are the sum of revenue for each sector, in each province (US exports revenues are not included in these scenarios).

**Production**. It remains the same for all hydro and nuclear producers. Only producers using coal and natural gas for electricity generation see their production fall (because of their higher costs). The decrease corresponds to the new hydropower available, due to lower demand in BC, Manitoba and Quebec.

**GHG reduction**. Reductions in both coal and natural gas-produced electricity have been used to compute resulting GHG emission cuts, using only *direct* emissions (Figure 5). Better estimate of the share of coal and natural gas decreases would require a much more detailed analysis of hourly loads in different provinces, beyond the scope of this study.

For more methodological details, see Pineau (2007a and b) and Pineau (2008).

## Summary of Economic and Environmental Gains

Under the two scenarios considered, important additional profits are made by hydropower producers. Consumers in former “high-cost” provinces are also winners, because they mostly avoid price increases – electricity prices would even decrease if no carbon tax was implemented. Losers are generation companies with coal and natural gas capacities and consumers in former “low-cost” provinces. In both cases, the new wealth generated by the removal of consumption subsidies and by the carbon tax could be used to compensate groups made worse off; if such compensation is deemed required.

Additional profits *within their province* only, for Hydro-Quebec, BC Hydro and Manitoba Hydro would be about $2.4, $1.6 and $0.4 billion, respectively, without the carbon price – compared to current net incomes of about $2.9, $0.4 and $0.35 billion (Hydro-Quebec, 2008b; BC Hydro, 2007; Manitoba Hydro, 2008). This means that these producers could more than double their profitability simply by charging a market price to their consumers. As a “free bonus”, the atmosphere would be saved 9 Mt of GHG, through additional exports.

These financial profits are before including the GHG externality. With a carbon price of $40/ton, it is $5, $1.6 and $0.6 additional billion these three producers would make – only within their province. Additional export revenues would further increase their profitability. The environmental gain, 29 Mt of GHG emissions saved, would generate $3.5 billion in carbon tax revenues. This amount would be available for energy R&D, energy efficiency initiatives (such as improved public transportation systems, making cities more efficient by removing traffic jams and air pollution) or compensation for groups made worse off in the process.

**Box 4. Transmission Capacity**

The analysis made in this paper assumes no transmission constraints, so that all the reduced hydropower consumption in BC, Manitoba and Quebec can be sent to other provinces, as substitute energy to fossil fuel-produced electricity. This is of course a simplifying assumption and current transmission networks are not designed to operate the electricity market in such an integrated manner.

However, there a few facts that must be taken into account before thinking that transmission constraints are a major obstacle to these scenarios. First, although challenging from a social acceptability perspective, transmission upgrades can be done. Their social acceptability will increase if environmental benefits are explained to all stakeholders – which is currently not the case, as no coherent energy-environmental policy exists in North America.

Second, there is much unused transmission capacity between BC and Alberta and between Ontario and Quebec. According to the BC Transmission Corporation (2008), when exporting to Alberta in 2007, the line was used at an average of 182 MW out of a 1,200 MW transmission capacity (utilization factor of 15%). When importing, the line was used at an average of 201 MW, out of a 1,000 MW capacity (utilization factor of 20%). In the Quebec-Ontario case, Quebec can export up to 1,295 MW to Ontario and import up to 720 MW (HQ TransÉnergie, 2009). In 2007, on its main transmission line ("HQ-LAW"), the utilization factor during export hours was 37%, and 79% during import hours. The line was also totally unused during 3,110 hours out of the 8,760 of the year (35% of the time). This shows that although during some peak hours full transmission capacity is certainly reached, most of the time these interconnections still have plenty of unused capacity.

Finally, the scope of the BC and Quebec imports from their neighbors illustrates an environmentally perverse trading scheme between these two provinces and Alberta and Ontario. At night, when coal-produced electricity is cheap, BC and Quebec reduce their hydropower production to fill-up their reservoirs. These imports partly meet local loads, saving some hydropower. Then, when the price of electricity rises in export markets, the "saved" MWh of hydropower are sold. This is profitable, but it leads to additional coal-produced electricity at night, in Alberta and Ontario. This is only possible because the real cost of producing fossil-fuel electricity is not considered: the GHG externality remains unaccounted for. With a carbon tax, the profitability of such trading would decrease and further emission reductions would be achieved.

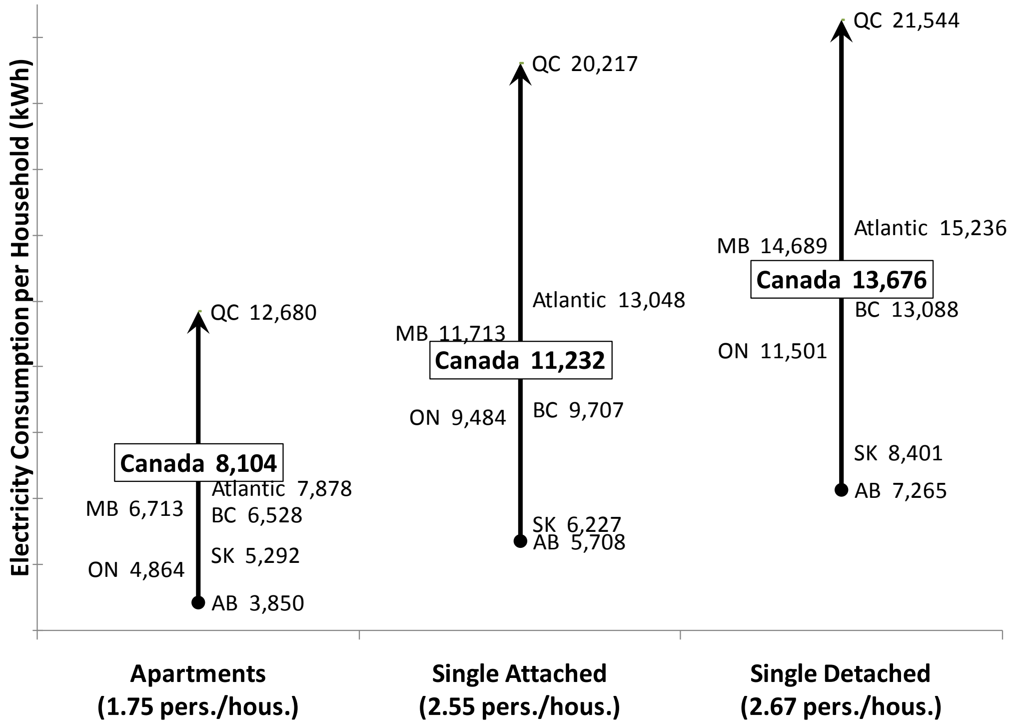
## Social Gains

Beyond these clear economic and environmental gains, social justice would also increase under market prices for electricity – given that some safeguards are put in place for low-income consumers. Under the current electricity and GHG regulation, electricity is provided below its real value (in many provinces) and everyone can freely emit GHG (except in BC and Quebec, to some limited extent). This corresponds to two indirect subsidies given to energy consumers.

These electricity and GHG subsidies, available without discrimination, benefit mostly those who consume more electricity and fossil fuel energy. These consumers typically happen to be the more wealthy ones. As a proxy for wealth, "type of house" is used in this section (either "apartment", "single attached" or "single detached"). Such a proxy is used, instead of directly using income, because less income-energy data are available.[19]

[19] The link between income and increased energy use can however easily be made. See Pineau (2008) for an illustration of the BC case and how much high-income households use more electricity.

**Figure 6. Residential Electricity Consumption per Household and House Type, 2006 Average kWh, with Canadian Average Number of Persons (pers.) per Household (hous.) (OEE, 2009)**

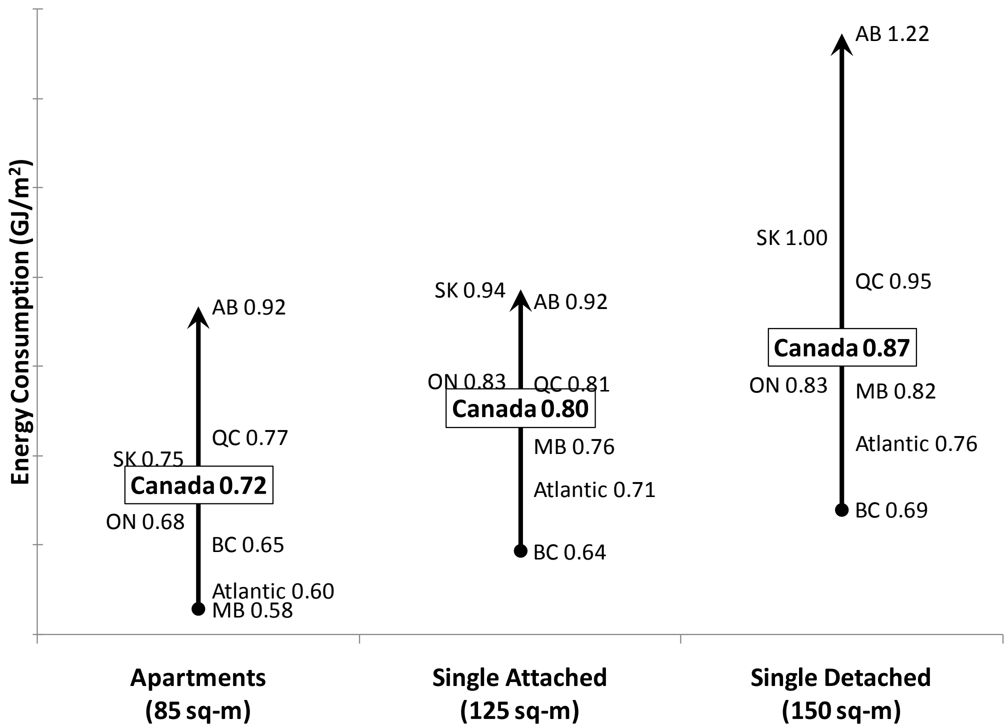



As Figure 6 clearly shows (and also Table 2), in the case of electricity, the bigger the house, the larger the electricity consumption. This is true in all provinces. It is of course especially problematic in provinces where the price of electricity is heavily subsidized: BC, Manitoba and Quebec. This means that higher-income households use more of the collective natural resources (hydropower), when the whole society could benefit more from this environmental wealth if it was not provided at so little cost to all consumers. The current system, especially in these three provinces, heavily favors the already more wealthy, for historical reasons, but at a great financial and environmental cost. If most people would agree with a policy ensuring a fair energy access to low-income households, no one would ever defend the "right" for high-income citizens to have access to energy at subsidized price, as it is however currently the case.

The situation is very similar when all types of energy (and therefore GHG emissions) are considered. Figure 7 shows how larger houses, in addition to being larger (and therefore consuming more energy), also use more energy *per square meter*. Again, this is a trend across all provinces: the bigger the house (and, with a high correlation, the richer the household), the more energy inefficient it is. The gap is particularly astonishing between single attached and single detached houses in Alberta: their energy consumption, per square meter, jumps from 0.92 GJ to 1.22 GJ per year (a 33% increase). It is also surprising to see how apartments in Alberta are as energy inefficient as single attached houses, while everywhere else apartments are *more* energy efficient.

On the other side of the spectrum, Manitoba displays the best energy efficiency – given that its climate requires more energy than coastal provinces. However, even in Manitoba, larger houses are less energy efficient than smaller ones. This also displays the higher allocation of environment wealth higher income households get, without paying for it.

**Figure 7. Residential Total Energy Consumption Intensity and House Type, 2006 Average GJ per Square Meter, with Canadian Average Floor Space per House Type (OEE, 2009)**




Because of the negative externality GHG represent, the current situation basically means that the GHG environmental subsidy given by nature is mostly taken by higher income households, in their larger, more inefficient houses. No social principle could justify such a disproportionate distribution of the ability to pollute.

### Box 5. Hourly Market Prices or Average Market Prices?

Unlike most products, electricity demand has to be met instantaneously. Furthermore, demand changes every second. As a consequence, consumers could in principle be exposed to a constantly changing market price. If in (economic) theory this would be good, it could create some practical problems: no one wants to monitor prices 24h/24. This is why some "average" market price could be used, reflecting the value of electricity *on average*, rather than at every moment. Such a solution, adopted by Alberta and Ontario because of the resistance to *real-time* pricing, is a better compromise than a price that does not reflect the market value at all, as it is the case in other Canadian provinces.

A move towards real-time prices will be easy to manage, with low transaction costs, when some programmable rules will allow consumers to automatically reduce their consumption at pre-defined price thresholds. This avoids the need to monitor prices all the time – but it requires houses to be fully computerized and that consumers know their own willingness to pay.

Before we get such technological advances implemented, average market prices (as used in the two scenarios of this section) are a good comprise.

# 4. Strategic Actions to Implement Change

## Obstacles to change

Changes suggested in this paper, a single market price for electricity and a carbon tax, are major changes. The challenge they represent is great, would it be only because the Canadian Constitution is involved. Furthermore, many groups may oppose such changes, because they go against their direct or indirect interests:

1. Provincial governments, fearing to lose some provincial power.
2. Consumers in low-cost provinces, complaining about price increases.
3. Producers in high-cost provinces, fearing market share losses.
4. Some land owners, opposing new transmission lines.
5. Risk-averse individuals, disliking the additional volatility in electricity prices, due to fluctuating market conditions.
6. Social protection groups, arguing that increased electricity prices will make electricity too expensive for low-income households. Therefore, in this logic, *all households should pay the low price* (as it is currently the case).
7. Government skeptics, opposing the idea of any additional revenue to government-owned companies (such as BC Hydro, Manitoba Hydro or Hydro-Quebec) or to governments (through a carbon tax), on the premise that they will waste these resources.

Because most concerns in these seven points have some legitimacy, they will require adequate responses. Some initial answers are provided below.

First, Provincial governments would not have to lose more power than in any free-trade agreement, and might even retain exactly as much power as they had before. The only requirement is to *harmonize* electricity institutions, as Nordic countries have done. No transfer of power has to be done to a higher level, as long as each provincial market is comparable to its neighbors.

Second, some compensation schemes can be designed to deal with points 2 and 3. It should be reminded that because the current regulation is inefficient, more wealth will be generated with these changes. It will lead to possibilities to make everyone better off – if financial transfers are made. For point 4, negotiations and compensations should also allow solutions to be found.

For points 5 (risk aversion), some insurance scheme can be designed, exactly as "fixed rate" mortgage buyers insure themselves against flexible rates. Electricity market regulators will have to make sure that such options are available, as they are now in Alberta and Ontario.

Special energy access programs will have to be designed to offer credible evidence that low-income households that need support actually receive support to cover their energy needs. Such programs have to be designed to target the right population – unlike current low electricity rates in many Canadian provinces that reach everyone, but benefit high-income households more.

Finally, governments can try to demonstrate that additional revenues will actually benefit everyone in the society, by providing a better quality environment and more efficient markets. Investments in public goods such as efficient transportation, improved air quality, reliable energy systems, well-designed cities, among others, should convince most people that additional government resources can work for the benefit of all. However, these additional revenues are also entirely legitimate revenues, arising from the value of hydropower and carbon. Exactly as natural resources royalties are paid to provincial governments, adequate water right charges and carbon prices should be paid to government by hydropower producers and carbon emitters. To the extent that these water and carbon royalties are set according to market principles, no additional justifications should be given by governments to collect these payments.

## Main allies in change and possibly opposing groups

Many Canadian individuals, groups, and organizations already advocate more integrated energy policies and market rules in Canada and across North America. With this support, and adequate consideration given to legitimate concerns, change can happen. Here is a non-exhaustive list of Canadian organizations favoring more integration in the Canadian electricity sector:

> **Natural Resources Canada:** "Options for strengthening our approach to achieving GHG emission reduction through federal-provincial-territorial partnerships could include projects such as strengthening the national electricity grid, helping to harness Canada's hydroelectricity and other renewable energy potential, supporting Ontario in its commitment to phase out its coal-fired power plants and investing in clean coal." (NRCan, 2005:5)
>
> **C.D. Howe Institute**: The case for integrating regional electricity integration is made in Pierce, Trebilcock and Thomas (2006).
>
> **Conference Board of Canada**: "Optimization of Canada's electric power grid is an additional example of the challenges of balancing federal and provincial stakeholder, policy and regulatory interests." (Churchill, Coad and Dickson, 2007:35)
>
> **Energy Dialogue Group**: "Good governance of the public policy and regulatory process – through direct governmental engagement with the public, cooperation between governments, and efficiencies in how government operates and oversees the public interest in respect to infrastructure, can serve to advance the objectives of an energy framework for Canada." (Energy Dialogue Group, 2007:29)
>
> **Canadian Electricity Association**: "Measures that harmonize differing market rules and transmission scheduling and pricing systems improve market liquidity and enhance cross-border trade." (CEA, 2007:12)

With many groups already aware of the efficiency gains to be made, some allies exist to help change to happen. However, some consumers groups, industrial associations and low-income advocacy groups might perceive the proposed pricing changes as detrimental. To overcome their fear, they should be convinced of three fundamentals: (1) energy efficiency gains can offset most or all of the price increase; (2) targeted programs can be designed to better support groups requiring assistance; and (3) economic gains will make society as a whole richer, including them. The next subsection details how these three fundamentals can be promoted, through three specific actions. Three strategies are then suggested to implement change.

## Strategies to Make Change Acceptable to All

Three important actions have to be taken, first to help decrease energy consumption, second to provide targeted assistance to low-income households (and possibly to other groups), and third to reassure voters that the added wealth will be used properly.

1. **Reduction of non-price energy efficiency barriers**. Beyond energy prices, there are many information gaps to fill, so that energy efficiency technologies become better known. Also, access to capital has to be eased to allow more energy efficiency investments to be made. Finally, split incentive situations (such as owner-tenant) have to be carefully studied so that adequate mechanisms are put in place to align financial incentives with environmental (and efficiency) goals.
2. ***Targeted Assistance***. In order to make sure that higher price levels do not adversely affect low-income households, direct means-tested programs should be implemented (such as, for instance, the federal Goods and Services Tax/Harmonized Sales Tax credit). This would expose all consumers to the correct price signal, while making sure electricity remains affordable. As low-income households use less electricity, on average, the cost of such "electricity credit" would remain small (see Pineau, 2008, for an estimation of the cost of such credit in BC). For some industrial groups, some assistance could also be designed, if international competition justifies it.

3. **Building up trust in the use of new wealth**. Higher electricity and carbon prices will not drain resources, but on the contrary create wealth, as consumers become more efficient. However, this new wealth will be financially concentrated in the hands of governments (collecting carbon revenues) and water right holders (mostly provincial governments). Consensus has to be built on areas to invest this new wealth, and high accountability and transparency standards must apply to those managing it. Investment funds such as the Alberta's "Heritage Fund", or Norway's "Government Pension Fund", can be created, to make sure governments do not simply increase their own spending.

Higher electricity prices in formerly low-cost provinces can be made acceptable to consumers through many different strategies. Concretely, three options can be designed to implement change.

***Progressive Price Increase***. Provincial governments can announce, in parallel to energy efficiency programs (1) and the creation of trust funds (2), that electricity prices will progressively increase by significant steps every year (e.g. 15%) for a couple years, until they reach a level similar to the regional market price. This is for instance the strategy used by the BC provincial government for introducing the carbon tax (Province of British Columbia, 2009).

***Announced Price Shock***. Instead of progressively increasing electricity prices, provincial governments in low-cost provinces could announce years in advance (for instance 3 years) a 50% price increase (or what is required to level electricity prices to the regional level). This provides ample time for consumers to adapt, by adopting known energy efficiency measures. This price "threat" can indeed motivate consumers to reduce their electricity consumption by about 14% or more: this percentage is the energy efficiency potential of residential consumers, as identified in Quebec in the current low-cost environment (AEE, 2008). This strategy is explained and recommended by the political scientist Jean-François Lisée (2008).

***Voluntary Buyout***. A possibly more socially acceptable strategy would be to offer the option to all electricity consumers to accept a voluntary price increase. This increase would be put in the context of environmental conservation and social equity, but it would also be associated with a direct monetary compensation, offsetting, to some extent, the price increase. The monetary compensation would be financed through increased future revenues (both domestically and form new exports). This would correspond to a voluntary (but permanent) buyout off the current electricity pricing structure. This strategy would have the benefit to leave unaffected consumers (and voters) strongly opposed to price increases, and to provide adequate price signals to other consumers. Given what is known on consumer decision making in such public good context, if the choice situation is well framed, cooperation is to be expected. See for instance Andreoni (1995) for a convincing analysis on consumers' willingness to "give" more if they are presented with option benefitting all (a "public good" situation). This altruistic behavior (paying more for the greater environmental good) would be further enhanced by the monetary offset, making possible, for instance, energy efficiency investments.

# 5. Conclusion

If sustainable development is to happen, it will only be through some significant changes in our current investment and consumption patterns. Electricity markets are currently not designed to promote the optimal use of electricity, and electricity trade across Canada does not allow the most efficient investment in, and operations of, the electricity system.

Correct price signals in provincial electricity markets would lead to significant economic, environmental and social gains: more than $6 billion in additional profits, 29 Mt in GHG reductions and a less skewed environmental wealth distribution among citizens. Although some significant barriers to change are present, none is insurmountable. Through adequate leadership and real considerations given to groups made worse off in the transition towards better electricity pricing, success can be achieved. For instance, three strategies could be employed to level electricity prices across Canada: *Progressive Price Increase, Announced Price Shock* or *Voluntary Buyout*. For these three strategies, three actions should be implemented in parallel: (1) Reduction of non-price energy efficiency barriers, (2) Targeted Assistance (to help low-income electricity consumers), and (3) Building up trust in the use of new wealth.

Although such improvements would not entirely solve the GHG challenge, these are profitable changes and are required for a simple reason: being consistent with our belief in price signals and markets. Indeed, refusing price signals in electricity and denying the cost of externalities are in direct contradiction with our economic principles. The Canadian society, and the world, cannot grow and prosper on such fundamental inconsistency.

If one believes that Canadians voters are mature enough to support good policies, adequately explained and presented, then nothing prevents us to move in the direction of a sustainable prosperity.

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# Appendix: Methodological Details

The initial situation in the ten provinces is described below. Prices come from Hydro-Quebec (2007a) and consumption levels from Statistics Canada (2008). The industrial price is used as the provincial reference price for electricity.

| | Electricity price (Can$ cents) | | | Consumption (TWh) | | | |
|---|---|---|---|---|---|---|---|
| | Industrial, high voltage | Residential | Commercial (small power) | *Industrial* | *Residential* | *Small Power* | ***TOTAL*** |
| AB | 6.88 | 11.58 | 11.42 | 35.47 | 8.15 | 16.70 | **60.33** |
| BC | 3.65 | 6.65 | 7.27 | 29.42 | 17.72 | 14.45 | **61.59** |
| MB | 3.19 | 6.44 | 6.34 | 6.06 | 5.65 | 6.99 | **18.70** |
| NB | 5.88 | 10.96 | 11.06 | 6.33 | 5.38 | 2.18 | **13.89** |
| NL | 3.98 | 10.34 | 11.19 | 5.07 | 3.33 | 2.12 | **10.52** |
| NS | 7.04 | 11.75 | 11.57 | 3.08 | 3.91 | 3.23 | **10.22** |
| ON | 7.74 | 11.45 | 11.15 | 40.38 | 43.97 | 55.15 | **139.51** |
| PE | 7.42 | 13.38 | 14 | 0.20 | 0.16 | 0.85 | **1.21** |
| QC | 4.35 | 6.68 | 8.59 | 98.51 | 57.02 | 37.14 | **192.67** |
| SK | 5.11 | 10.91 | 8.76 | 8.00 | 2.92 | 7.09 | **18.02** |
| | | | | **232.52** | **148.23** | **145.92** | **526.67** |

With a new national price of 6¢/kWh (an estimated equilibrium price resulting from the free flow of electricity across provinces and the US), prices would change and new consumption levels would be obtain in each consumption sector, and each province, as detailed below.

| | Price change | | | New Consumption (TWh) | | | | |
|---|---|---|---|---|---|---|---|---|
| | Industrial | Residential | Small Power | *Industrial* | *Residential* | *Small Power* | ***TOTAL*** | *TWh change* |
| AB | -12.79% | -8.22% | -8.35% | 36.38 | 8.29 | 16.98 | **61.65** | 2.19% |
| BC | 64.38% | 26.11% | 24.43% | 25.63 | 16.79 | 13.75 | **56.17** | -8.80% |
| MB | 88.09% | 30.38% | 30.71% | 4.99 | 5.31 | 6.56 | **16.86** | -9.84% |
| NB | 2.04% | 1.08% | 1.07% | 6.30 | 5.37 | 2.18 | **13.85** | -0.30% |
| NL | 50.75% | 16.34% | 15.29% | 4.56 | 3.22 | 2.06 | **9.84** | -6.54% |
| NS | -14.77% | -9.71% | -9.88% | 3.17 | 3.99 | 3.29 | **10.45** | 2.26% |
| ON | -22.48% | -17.92% | -18.49% | 42.20 | 45.55 | 57.19 | **144.94** | 3.89% |
| PE | -19.14% | -11.87% | -11.29% | 0.21 | 0.17 | 0.87 | **1.24** | 2.54% |
| QC | 37.93% | 19.81% | 16.11% | 91.04 | 54.76 | 35.95 | **181.74** | -5.67% |
| SK | 17.42% | 7.54% | 9.22% | 7.73 | 2.87 | 6.96 | **17.56** | -2.52% |
| | | | | **222.19** | **146.32** | **145.79** | **514.31** | -2.35% |

With a carbon tax of $40/t, the new estimated equilibrium price is 8¢/kWh (obviously a very gross approximation, but still providing a realistic point of reference).

| | Price change | | | New Consumption (TWh) | | | | |
|---|---|---|---|---|---|---|---|---|
| | Industrial | Residential | Small Power | *Industrial* | *Residential* | *Small Power* | ***TOTAL*** | *TWh change* |
| AB | 16.28% | 8.82% | 8.93% | 34.31 | 8.01 | 16.41 | **58.73** | -2.65% |
| BC | 119.18% | 39.55% | 37.44% | 22.41 | 16.32 | 13.37 | **52.09** | -15.42% |
| MB | 150.78% | 42.76% | 43.14% | 4.23 | 5.17 | 6.39 | **15.79** | -15.58% |
| NB | 36.05% | 16.21% | 16.08% | 5.87 | 5.21 | 2.11 | **13.19** | -5.05% |
| NL | 101.01% | 27.99% | 26.43% | 4.05 | 3.14 | 2.01 | **9.20** | -12.57% |
| NS | 13.64% | 7.55% | 7.66% | 2.99 | 3.85 | 3.18 | **10.03** | -1.88% |
| ON | 3.36% | 2.22% | 2.28% | 40.11 | 43.78 | 54.90 | **138.79** | -0.51% |
| PE | 7.82% | 4.15% | 3.98% | 0.20 | 0.16 | 0.84 | **1.20** | -0.93% |
| QC | 83.91% | 35.33% | 29.82% | 81.98 | 52.99 | 34.93 | **169.90** | -11.82% |
| SK | 56.56% | 20.94% | 24.81% | 7.10 | 2.80 | 6.74 | **16.64** | -7.66% |
| | | | | **203.25** | **141.43** | **140.88** | **485.56** | -7.81% |