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ENERGY IN QUEBEC
WHAT ROLE FOR NATURAL GAS IN THE CONTEXT OF ELECTRIFICATION?

By Jean Michaud
With the collaboration of Germain Belzile

MEI Ideas for a More Prosperous Society

Gare Windsor, Suite 351
1100 Avenue des
Canadiens-de-Montréal
Montreal (QC)
H3B 2S2 Canada

Phone: 514-273-0969
Fax: 514-273-2581
Website: iedm.org

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HIGHLIGHTS

A common perception is that Quebec could quickly electrify its entire economy. This report will seek to quantify Quebec's current energy production and consumption and illustrate the considerable challenges that the electrification of the Quebec economy represents, particularly the transport sector. Hydro-Québec's production capacity is not infinite, especially during peak winter periods. Yet alternatives to hydroelectricity exist for increasing the province's energy production. Natural gas in particular has several advantages in the Quebec context.

Chapter 1 – Quebec's Energy Profile

- Over half (56%) of the energy consumed in Quebec comes from fossil fuels, while electricity represents 36% of the province's energy profile.
- Hydro-Québec's energy surplus (18 TWh in 2019) represents around 10.3% of Quebec's annual electricity consumption, an amount that could allow electricity's share of the province's energy mix to increase to a little under 40%.
- However, Hydro-Québec is also in negotiations with the City of New York for the purpose of selling it a large part of its surplus, namely 8 TWh, in addition to the fact that the government is trying to attract companies whose operations use a lot of energy.
- Some 30% of Quebec energy consumption is due to the transportation sector, with around half of this energy consumed by personal vehicles, a little more than a third by the transport of goods, and the rest due to the commercial transportation of passengers (mainly by air).
- Some 5.4 million personal vehicles (cars and light trucks) were circulating on Quebec roads in 2017, driving a total of 72 billion km each year, in addition to the 823,000 trucks in service in the province.
- Quebec would need nearly 14 additional TWh per year to recharge personal vehicles if they were all electric, plus almost the same amount to electrify all trucks—supposing that this is technically feasible—for a total of 28 additional TWh.

Chapter 2 – Hydro-Québec's Production Capacity

- Hydro-Québec's total theoretical generating capacity, coming mainly from its hydroelectric generating stations, to which is added the Churchill Falls generating station, wind farms, and other sources, amounts to 47,926 MW.
- However, because of the wind's intermittence, Hydro-Québec's "reliable" electricity production cannot include wind power, and is therefore actually 44,050 MW.
- Hydro-Québec's peak needs were expected to reach 38,387 MW in 2018-2019, plus a reserve of 3,650 MW in order to guarantee the reliability of this supply at all times, for a total of 42,038 MW (and 44,380 MW by 2025-2026).
- During periods of intense cold, heating represents a very substantial portion of electricity demand, which makes Quebec an exception.
- Almost everywhere else in North America, natural gas is widely used for heating, and as a result, peak electricity demand generally occurs in summer due to air conditioning.

Chapter 3 – The Impact of the Electrification of Transportation on the Demand for Electricity

- Supposing that the number of vehicles in circulation in Quebec remains the same as it is today, at the end of a completed energy transition, some 5.4 million personal electric vehicles would require around 37,350 MW just to recharge each day, or almost as much as the province's peak demand in winter.
- Even if, by using smart electric meters, the recharging could be spread out over twelve hours, this would still generate an additional demand of over 3,000 MW each of these twelve hours.
- The 823,000 trucks in service in Quebec, if they were also converted to electricity, would require an additional 3,100 MW to recharge if this was spread over twelve hours, for a total increase in the demand for electricity of 6,100 MW for the duration of the charging.

- In winter, when the demand for electricity is greatest, the need to heat electric cars and trucks (which increases their consumption), combined with batteries' faster loss of charge due to the cold, would prolong the charging time required.
- Electrifying the entire Quebec economy *except for* transportation would require Hydro-Québec to increase its production by around 10,000 MW per decade in order to almost double it, bringing it to around 70,000 MW in 2050.
- Since Quebec's electrical potential is estimated to be a little over 80,000 MW in theory, harnessing all of Quebec's rivers, rapids, and falls could fuel the entire Quebec economy, but social and political pressures, as well as the status of major rivers as aquatic reserves, are likely to be obstacles to such an objective being reached.
- Moreover, electrical energy has its drawbacks: Contrary to fossil fuels that can be stored, electricity must be used the moment it is produced, and produced the moment it is needed.
- Currently, Quebec's energy supply is not too concentrated, with no source representing more than 40% of the province's needs and some 64% of those needs covered by sources other than electricity that can be stored.

Chapter 4 – What Other Solutions Does Quebec Have?

- A lot is heard about the development of solar power in the American Southwest, but in southern Quebec, in December, a solar panel that followed the movement of the sun could provide energy no more than 10.8% of the time.
- Geothermal power runs 24 hours a day, twelve months a year, and is not affected by the weather outside. Its main drawback is its high installation cost, but certain public buildings should be able to accept higher initial financing costs that take into account the value of future savings.
- Doing a better job of insulating buildings, installing better windows and other similar energy efficiency initiatives are the least costly ways of reducing residential, commercial, and industrial energy demand, but the low price of hydroelectricity in Quebec reduces the benefits stemming from such measures.
- Even though the use of domestic, agricultural, and other waste for the production of biofuels is logical when economically justified, its commercialization potential is very limited for the moment.
- Next generation nuclear reactors greatly minimize the risks related to human or design errors, and certain modern technologies use nuclear waste as fuel, which reduces the problem of storing this material, but neither Quebec's population nor its political class currently has any appetite for this kind of energy.
- Most hydrogen used comes from natural gas, and it would be better to use the natural gas itself. Another way to obtain hydrogen is through the electrolysis of water, but this is relatively expensive, which makes it uncompetitive for the time being.
- Natural gas is cleaner than coal or oil, its combustion emitting practically no fine particles. This is why it is generally perceived as a transition solution toward the decarbonization of the global economy.

Chapter 5 – Natural Gas in Quebec

- If Quebec used natural gas instead of electricity for heating, this would free up a large amount of electricity that would facilitate the electrification of other sectors of the economy.
- In 2018, Quebec imported $13.8 billion of fossil fuels. Local gas consumption for the year, at around six billion m^3, represented over $1 billion of this amount.
- Reducing CO_2 and methane emissions in Quebec by refusing to produce natural gas locally, all while consuming natural gas produced abroad—which produces even more harmful emissions—does nothing to improve the global balance sheet.
- Quebec's CO_2 emissions measured on the basis of annual production, some 10 t of CO_2 equivalent per person, are much lower than the Canadian average. However, if we consider Quebec's emissions based on consumption, they are closer to 15 t per person annually, due to the importation of carbon-intensive products, especially oil and natural gas.
- Quebec's recoverable reserves of natural gas, concentrated in the southern part of the St. Lawrence Valley, are estimated to be between 250 billion m^3 and 1,150 billion m^3. At the current rate of con-

sumption, Quebec would have sufficient reserves for at least 40 years.

- Given the network of gas pipelines that already exists in southern Quebec, developing the natural gas reserves under the ground in the province would require the construction of few new gas pipelines.
- However, since the start of the past decade, exploration of potential natural gas deposits in the St. Lawrence Valley has been subject to a series of moratoriums and bans.
- By importing its natural gas, Quebec "hides" the emissions that result from its consumption, for which it is ultimately responsible. In other words, we blame American and Western Canadian producers for our pollution.

Conclusion – For the Responsible Development of Quebec's Natural Gas

If Quebec is to electrify a significant share of its transport sector, it will have to give itself some room to manoeuvre so that electric vehicles can be usable even during periods of high demand. The wider use of natural gas for heating would facilitate the electrification of the province's economy. Moreover, Quebec has substantial reserves of gas, located close to consumers, access to which is facilitated by the existing gas pipeline network.

The benefits related to the development of Quebec's natural gas are brought into stark relief by the almost unprecedented economic crisis that the entire world is facing. In addition to creating high-quality jobs in a time when these are becoming harder to find, the emergence of a gas industry in Quebec would increase its energy independence and place it in a better position to face future crises, if these should disturb normal supply chains.

While it is true that the revival of this industry in Quebec will probably not happen in the short term (due to the prices at which hydrocarbons are currently trading), some reflection is in order on the part of Quebec's provincial and municipal governments. There is no reason to continue hampering the development of natural gas by imposing an arbitrary and unnecessarily burdensome regulatory process.

INTRODUCTION

For several years now, the notion of an "energy transition" has been constantly evoked in Quebec, to the point where it has even given its name to a governmental agency.[1] The common perception is also that Quebec has almost unlimited electricity surpluses that could, if we were serious about it, allow us to quickly electrify the entire Quebec economy. Many are those who believe that we could also provide substantial electrical power to our American and Canadian neighbours.[2]

This report will seek to quantify Quebec's current energy production and consumption and illustrate the considerable challenges that the electrification of the Quebec economy represents, especially when it comes to the transport sector.

Hydro-Québec's production capacity is not infinite, and during peak winter periods, no longer provides much room to manoeuvre given the level of demand.

First, we will establish Quebec's energy balance sheet in order to have a better idea of the shares of different energy sources, especially that of electricity. Then, we will look at Hydro-Québec's production capacity and observe that it is not infinite, and during peak winter periods, no longer provides much room to manoeuvre given the level of demand.

We will then study the impact of the electrification of transportation on the demand for electricity and the Quebec electricity network's ability to deal with it. Finally, we will examine the alternatives to hydroelectricity for increasing Quebec's electrical production, before taking a closer look at natural gas, which has several advantages in the Quebec context.

1. Transition énergétique Québec.

2. La Presse canadienne, "Hydro-Québec pourra écouler une partie de ses surplus au Nouveau-Brunswick," *Les Affaires*, January 10, 2020; Pierre Couture, "Surplus énergétiques: Hydro-Québec perd des ventes de 1 G$ par année," *Le Journal de Montréal*, October 4, 2019; Pierre Couture, "Les surplus d'Hydro-Québec vont coûter une fortune," *Le Soleil*, January 15, 2013.

Author's note

Each fall since 2014,[3] HEC Montréal's Chair in Energy Sector Management has published an in-depth report on the state of energy in Quebec.[4] This document provides a wealth of data on the province's energy sources and its consumption by sector of activity (residential, industrial, transportation, etc.), which constitutes an excellent source of information, and it will be used extensively in the present report.

3. Chair in Energy Sector Management, HEC Montréal, The State of Energy in Quebec, 2020, page updated January 17, 2020.

4. Johanne Whitmore and Pierre-Olivier Pineau, *L'état de l'énergie au Québec 2020*, Chair in Energy Sector Management, HEC Montréal, January 2020.

CHAPTER 1

Quebec's Energy Profile

Over half (56%) of the energy consumed in Quebec comes from fossil fuels (see Figure 1-1). The largest share comes mainly from oil products (40%), with the rest coming from natural gas in its gaseous and liquid forms (15%) and from a small amount of coal (1%, basically used as fuel in cement plants).[5] Electricity represents 36% of the province's energy profile. Biomass, mainly used in the pulp and paper industry and residentially for wood heating,[6] and biofuels (mainly ethanol and biodiesel)[7] complete the picture with 8% of Quebec's energy consumption. A majority of the energy currently used in Quebec therefore comes from fossil fuels.

What about the availability of electricity to replace these fossil fuels? In other words, is there enough electricity produced in Quebec to carry out the energy transition toward clean energy? In 2019, Hydro-Québec sold 208.3 terawatt hours (TWh) of electricity. Of this amount, 33.7 were exported. Quebec consumption is therefore around 175 TWh.[8] Does Hydro-Québec have the capacity to substantially increase this consumption?

Still in 2019, Hydro-Québec had an energy surplus of around 18 TWh (mainly due to its hydraulic reserve and purchases of wind power).[9] These surpluses represent around 10.3% of Quebec's annual electricity consumption. Since electricity provides 36% of the energy consumed in Quebec, 18 additional TWh would allow electricity's share of Quebec's energy mix to increase from 36% to a little under 40%. We still have a ways to go.

We also have to remember that Hydro-Québec is in negotiations with the City of New York for the purpose of selling it a large part of its surplus, namely 8 TWh.[10] If such an agreement materializes, the surpluses available to fuel the energy transition will shrink by as much. Finally, Quebec is trying to attract companies whose operations use a lot of energy,[11] banking on its clean and affordable electricity and its reliable network, which will once again reduce its residual electrical capacity. As a result, the proposed electrification of the Quebec economy will be much more complex than people generally believe, because we will in all likelihood have to build additional installations very soon in order to get there.

Electrifying Transportation

Some 30% of Quebec energy consumption is due to the transportation sector, as shown in Figure 1-2. As for Figure 1-3, it details the breakdown of demand by type of vehicle. It shows that around half (48%) of this energy is consumed by personal vehicles and a little more than a third (37%) by the transport of goods, mainly by road, and that the rest is due to the commercial transportation of passengers, mainly by air.

A majority of the energy currently used in Quebec comes from fossil fuels.

Some 5.4 million personal vehicles (cars and light trucks including SUVs) were circulating on Quebec roads in 2017. These vehicles drive a total of 72 billion km each year, an average of 36.4 km per day, per vehicle.[12] Currently, almost all of these vehicles run on gasoline and consume over 6.8 billion litres of fuel annually.[13] Will Hydro-Québec be able to power all personal vehicles if they are replaced with electric vehicles?

A typical electric car consumes around 19 kWh per 100 kilometres driven.[14] We would therefore need nearly 14 additional TWh[15] per year to recharge personal vehicles if they were all electric. If we also want to electrify the 823,000 trucks[16] in service in Quebec—supposing that

5. Johanne Whitmore and Pierre-Olivier Pineau, *op. cit.*, footnote 4, p. 38.

6. *Ibid.*, p. 23.

7. *Idem.*

8. Hydro-Québec, *Voir grand avec notre énergie propre*, Annual Report 2019, p. 37.

9. Pierre Couture, "Surplus énergétiques: Hydro-Québec perd des ventes de 1 G$ par année," *Le Journal de Montréal*, October 4, 2019.

10. Hydro-Québec, *op. cit.*, footnote 8, p. 6.

11. Samuel Wan, "Quebec to Attract Bitcoin Miners with Cheap Energy, 180 Change Since 2018," *NewsBTC*, April 30, 2019.

12. Johanne Whitmore and Pierre-Olivier Pineau, *op. cit.*, footnote 4, p. 35.

13. *Idem*, author's calculation.

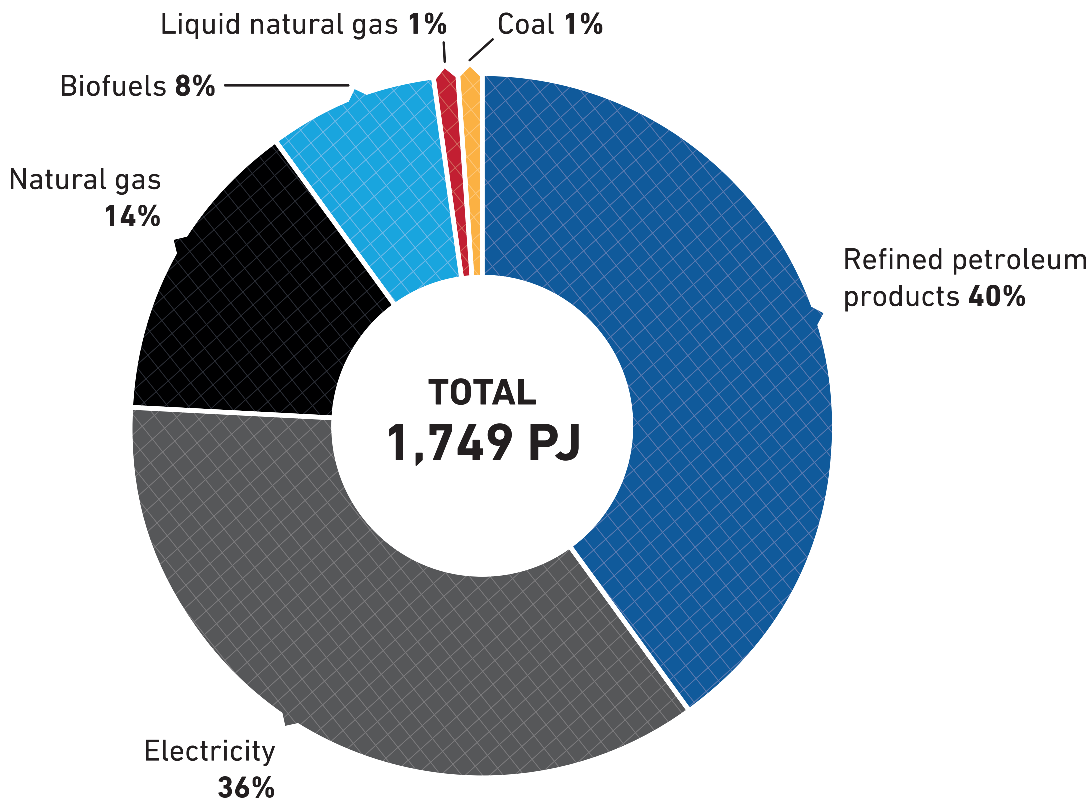
14. This corresponds to the average consumption of a 2019 Nissan Leaf, the most popular fully electric car in Quebec. The energy consumption of an electric car generally varies between 15 kWh and 25 kWh. U.S. Department of Energy, Energy Efficiency & Renewable Energy; AVÉQ, Statistiques SAAQ-AVÉQ sur l'électromobilité au Québec en date du 31 décembre 2019, February 7, 2020.

15. Namely 72 billion km multiplied by an energy consumption of 19 kWh per 100 km.

16. Johanne Whitmore and Pierre-Olivier Pineau, *op. cit.*, footnote 4, p. 35.

Figure 1-1

Total consumption by form of energy in Quebec, 2017



Source: Johanne Whitmore and Pierre-Olivier Pineau, *L'état de l'énergie au Québec 2020*, Chair in Energy Sector Management, HEC Montréal, January 2020, p. 28.

this is technically feasible—this would require almost 14 TWh more every year,[17] for a total of 28 TWh.

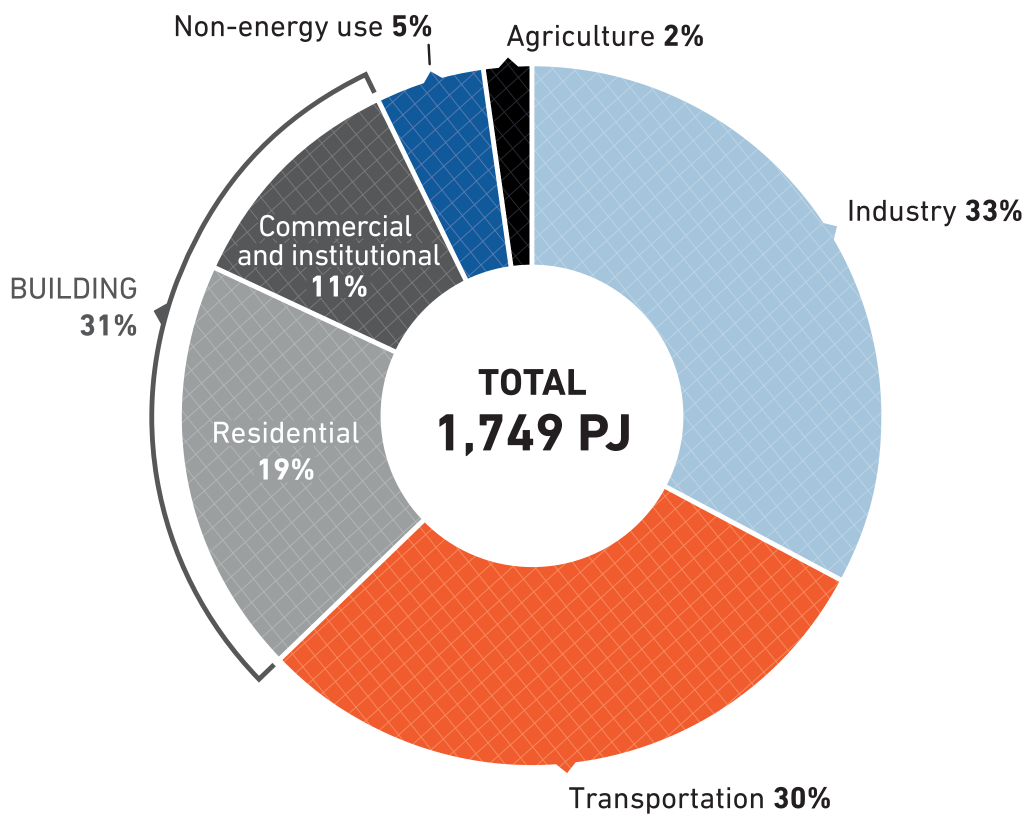
The proposed electrification of the Quebec economy will be much more complex than people generally believe.

Given the current size of the surpluses mentioned above (18 TWh), these 28 additional TWh required just for recharging these road vehicles now converted to electricity already represent a considerable challenge. Given these figures, we will see in Chapter 3 why the electrification of transportation will in all likelihood take longer than the current public discussion might lead one to believe. First, in order to be able to properly appreciate this, we will examine in more detail Quebec's electricity production capacity, as well as electricity demand fluctuations.

17. Namely 36 billion km multiplied by an energy consumption of 38 kWh per 100 km, assuming for simplicity that an electric truck's energy consumption is about double that of a car.

Figure 1-2

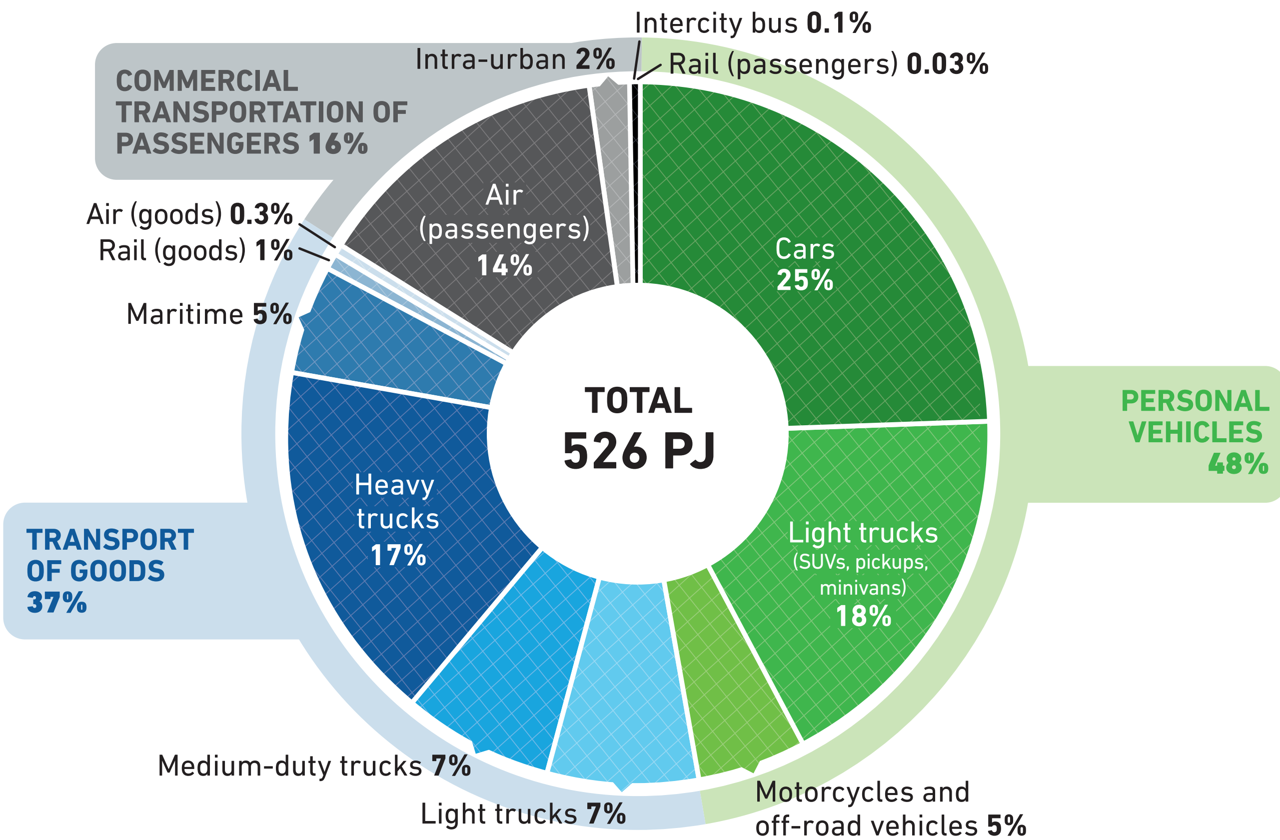
Consumption of energy by sector of activity, Quebec, 2017



Source: Johanne Whitmore and Pierre-Olivier Pineau, *L'état de l'énergie au Québec 2020*, Chair in Energy Sector Management, HEC Montréal, January 2020, p. 28.

Figure 1-3

Energy use in the transportation sector by type of vehicle, Quebec, 2017



Source: Johanne Whitmore and Pierre-Olivier Pineau, *L'état de l'énergie au Québec 2020*, Chair in Energy Sector Management, HEC Montréal, January 2020, p. 29.

CHAPTER 2

Hydro-Québec's Production Capacity

In order to properly evaluate Hydro-Québec's production capacity, we must distinguish two parameters: energy and power. Energy is the quantity of electricity delivered during a given period—a week, a month, a year. Energy is calculated in megawatt hours (MWh or millions of watt hours), gigawatt hours (GWh or billions of watt hours), terawatt hours (TWh or trillions of watt hours), etc. Power is the capacity to deliver a quantity of energy at a precise moment. Power is expressed in watts (W), kilowatts (kW), megawatts (MW), etc.

Hydro-Québec can count on a generating capacity of 37,243 MW, coming mainly from its hydroelectric generating stations, to which is added 5,428 MW from the Churchill Falls generating station, 3,876 MW from wind farms, and 1,379 MW from other sources, for a total theoretical generating capacity of 47,926 MW.[18]

However, because of the wind's intermittence, wind turbines can supply only a portion of their theoretical capacity. According to Hydro-Québec, peak power coming from wind turbines is 1,486 MW, or 38.3% of their peak capacity. In reality, if we rely on Hydro-Québec's production estimates, wind turbines' "capacity factor" is probably lower.[19]

The main problem with producing wind power remains its randomness. It is possible, during a cold snap, for there to be no wind, and for wind turbines to remain immobile. Counting on wind turbines to provide the electricity Quebecers need at a specific moment amounts to hoping that the wind will blow so that we can heat our homes in winter. In reality, Hydro-Québec's "reliable" electricity production cannot include wind power. It is therefore not 47,926 MW, but rather 44,050 MW. This already makes the large-scale electrification of transportation more problematic, as we will see.

Hydro-Québec's peak needs were expected to reach 38,387 MW in 2018-2019, and climb to 40,286 in 2025-2026, according to the public corporation's supply plan.[20] In order to guarantee the reliability of this supply at all times, Hydro-Québec also projects a "reliability reserve," which was 3,650 MW in 2018-2019 and will climb to 4,094 MW in 2025-2026 (see Table 2-1).

This reserve of around 10% of peak demand serves to mitigate unexpected events (plant breakdowns, broken transmission lines, etc.) or simply demand that exceeds expected peak demand. This practice is normal, and indeed, the margin that Hydro-Québec gives itself is lower than what other networks project; Hydro-Ontario, for example, maintains a reserve of nearly 20%.[21]

Counting on wind turbines to provide the electricity Quebecers need amounts to hoping that the wind will blow so that we can heat our homes in winter.

To illustrate the issue of peak demand needs, let us consider the following situation. In late 2017, Quebec experienced a very significant wave of cold. December 28, 2017, at 5:00 pm, electricity demand reached 38,420 MW, requiring at that moment all of Hydro-Québec's "reliable" resources and a portion of reserves for unforeseen events.[22] During periods of intense cold, heating therefore represents a very substantial portion of electricity demand. This characteristic differentiates Quebec from other regions that consume electricity. This is why it is useful to quantify the impact of electric heating on the fluctuation of electricity demand in the province.

Heating in Quebec

One of the main characteristics of electricity demand in Quebec is its great fluctuation with the seasons. In winter, because of heating, electricity consumption is around double summer demand. We know that the maximum peak demand is around three times the minimum demand; in 2018, the former, reached on January 6, was 36,144 MWh, versus a trough of 12,447 MWh on June 24.[23]

18. Hydro-Québec, *op.cit.*, footnote 8, p. 115.

19. The maximum generating capacity of wind turbines is 3,876 MW. If they worked 24 hours a day, 365 days a year, their annual production would be 33.95 TWh (3,876 MW x 24 hours x 365 days). However, on its website, Hydro-Québec estimates that wind turbines provide 11.3 TWh annually. The capacity factor of wind turbines is therefore 33.28% (11.3 TWh/33.95 TWh). Hydro-Québec, *ibid.*, p. 115; Hydro-Québec, Développement durable, notre approche, Transition énergétique et innovations, page consulted on March 2, 2020.

20. In 2019, the peak was in fact 36,159 MW, according to the most recent annual report. *Ibid.*, p. 98.

21. IESO, "Ontario Reserve Margin Requirements – From 2019 to 2023," December 21, 2018, p. 3.

22. Hydro-Québec, *Mieux faire | Voir grand | Bâtir demain, Rapport annuel 2017*, March 13, 2018, p. 77.

23. Johanne Whitmore and Pierre-Olivier Pineau, *op. cit.*, footnote 4, p. 21.

Table 2-1

Hydro-Québec peak need and reliability reserve, 2018-2026

In Megawatts	2018-2019	2019-2020	2020-2021	2021-2022	2022-2023	2023-2024	2024-2025	2025-2026
Peak need	**38,387**	**38,660**	**39,027**	**39,364**	**39,643**	**39,892**	**40,103**	**40,286**
Reserve to respect reliability criteria	3,650	3,831	3,863	3,989	4,022	4,049	4,074	4,094
Peak need – including the reserve	**42,038**	**42,491**	**42,890**	**43,352**	**43,665**	**43,941**	**44,176**	**44,380**

Source: Hydro-Québec, *État d'avancement 2018 du Plan d'approvisionnement 2017-2026*, November 1st, 2018, p. 13.

Figure 2-1 shows the magnitude of the seasonal fluctuation in electricity demand. A simple glance at one's electricity bill (for those of us with electrical heating) confirms this. In fact, Hydro-Québec takes advantage of the very low summer demand to carry out installation and network maintenance.

During periods of intense cold, heating represents a very substantial portion of Hydro-Québec's demand. This characteristic differentiates Quebec from other regions.

Heating with electricity, as 85% of Quebecers do, is an exception.[24] Almost everywhere in North America, natural gas is used, and increasingly so, as it gradually replaces oil heating. As a result, elsewhere on the continent, peak demand generally occurs in summer and is due to air conditioning.[25] In Quebec, electrical heating uses a little over 50 TWh of electricity, or about 30% of total demand.[26]

All of Hydro-Québec's production is designed as a function of winter peaks. Tens of billions of dollars have been spent in order to be able to cover this peak demand period which lasts only a few days over the course of the winter. HEC Montréal's Chair in Energy Sector Management estimated in 2019 that 15% of Hydro-Québec's capacity was used just 5% of the time.[27]

Hydro-Québec has, for instance, a gas thermal power station, called "TAG," in Bécancour, with a capacity of 411 MW, which used to serve to cool the Gentilly 2 nuclear plant in case of emergency. Hydro-Québec only activates this plant during periods of very high demand, a few hours a year at most.[28] There is also another gas power station, belonging to TransCanada, also located in Bécancour, which has not produced electricity for over a decade, but which could feed power to the network if needed.[29]

24. Agence QMI, "Avez-vous le bon système de chauffage?" *Le Journal de Montréal*, December 22, 2019. See also Statistics Canada, Table 2: Type of main heating fuel used, by province, 2011.

25. IESO, Demand Overview, Historical Demand.

26. According to our estimates, electricity demand in the summer (May, June, July, August, and September) is 21,000 MWh; this includes little or no heating. The demand in winter (December, January, and February) is 35,000 MWh; the difference compared to summer consumption basically represents the additional demand related to electrical heating. For the months of spring and fall (March, April, October, and November), we estimated that the demand is midway between the summer and winter months, namely 28,000 MWh. By calculating the total of the additional demand for the year, we obtain a total of around 50.7 TWh, or 29% of Quebec's total annual electricity demand. Hydro-Québec, *op. cit.*, footnote 8, p. 37.

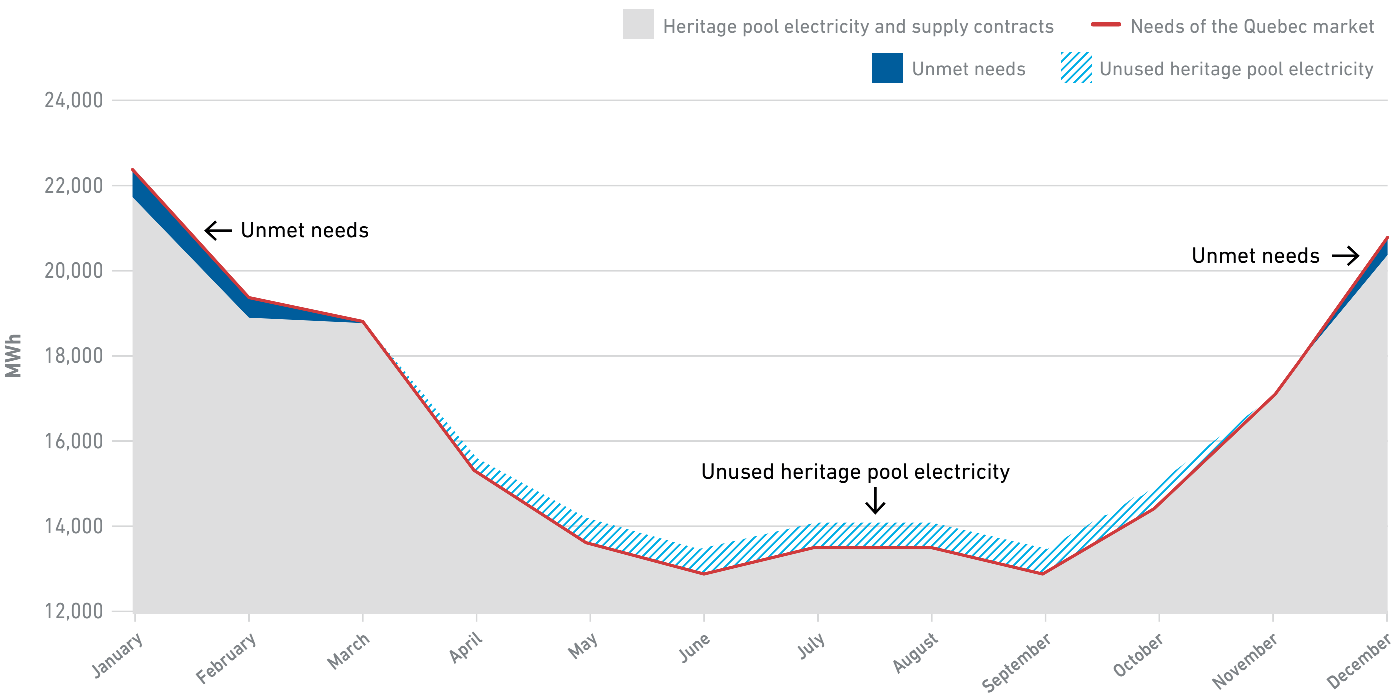
27. Johanne Whitmore and Pierre-Olivier Pineau, *État de l'énergie au Québec 2019*, Chair in Energy Sector Management, HEC Montréal, p. 21.

28. Hydro-Québec, *op. cit.*, footnote 8, p. 115. See also Louis Cloutier, "Hydro-Québec a eu recours à sa centrale d'appoint de Bécancour," *Le Journal de Montréal*, January 3, 2018.

29. François Desjardins, "TransCanada veut faire partie des plans à venir d'Hydro-Québec," *Le Devoir*, December 12, 2019.

Figure 2-1

Seasonal character of Hydro-Québec's electricity needs and supply



Source: Hydro-Québec, "Plan d'approvisionnement 2020-2029," November 1st, 2019, p. 12.

The question that arises in the context of the electrification of transportation is this: During periods of intense cold, does Hydro-Québec have enough power to cover Quebecers' heating needs, all while recharging the cars of an automotive fleet entirely converted to electricity?

CHAPTER 3

The Impact of the Electrification of Transportation on the Demand for Electricity

Supposing that the number of vehicles in circulation in Quebec remains the same as it is today—although it has actually grown nearly three times faster than the population—we would have, at the end of a completed energy transition, some 5.4 million personal electric vehicles travelling 36.4 kilometres a day on average[30] and consuming 19 kWh per 100 kilometres driven, as we saw in the first chapter.[31] For purposes of illustration, suppose that at the end of the day, all of these vehicles are plugged in at the same time using 240-volt, 30-ampere chargers. Charging will take about an hour. During this hour, 37,350 MW would be needed just to recharge these cars,[32] or about the same total as the peak demand that Quebec experienced on December 28, 2017 (see Chapter 2), when electric cars represented a miniscule fraction of the automotive fleet.

This simple calculation shows that Hydro-Québec's production capacity, while very substantial, is not adequate to meet much higher demand peaks. Even if, by using smart electric meters, the recharging could be spread out over twelve hours, this would still create an additional demand of over 3,000 MW for these twelve hours. As can be seen from Figure 3-1, this additional demand, even spread out this way, would significantly eat into the reliability reserve (mentioned in Chapter 2) during peak periods. Consequently, spreading out the electricity demand for recharging car batteries does not solve the problem.

This is not including the 823,000 trucks in service in Quebec, if these were also converted to electricity, travelling around 120 km per day. Supposing that the consumption of a typical truck is double that of a car, recharging the battery of a truck will take on average nearly seven hours. An additional 5,400 MW will therefore be needed to recharge these trucks during this period by using the chargers mentioned above—not accounting for charging related losses—or 3,100 MW if we spread this recharging over twelve hours.[33]

In conclusion, by adding the 3,000 MW needed to recharge personal vehicles to the 3,100 MW needed to recharge commercial trucks, the gradual charging of an electric automotive fleet over twelve hours would increase the demand for electricity by at least 6,100 MW for the duration of the charging, starting at around 6:00 pm, throughout the year, which represents a considerable increase compared to the current demand. This demand peak could be reduced, though, if a portion of vehicles were recharged during the day. On the other hand, in winter, when the demand is greatest, the need to heat electric cars and trucks (which increases their consumption), combined with batteries' faster loss of charge due to the cold, would prolong the charging time needed. Moreover, if Quebec's fleet of cars and trucks continues to grow as it has in recent decades, this situation will be exacerbated.

The gradual charging of an electric automotive fleet over twelve hours would increase the demand for electricity by at least 6,100 MW for the duration of the charging.

This example, while simplistic, demonstrates that the wholesale electrification of the Quebec economy is not assured, and that this transition will require major adjustments to our lifestyle in addition to substantial infrastructure costs. Furthermore, such changes will only be feasible over a long period, probably several decades.

In order to allow the fleet of electric cars to continue growing, Hydro-Québec could find itself required to impose the use of smart electric meters for its clients, as well as a charging sequence. It would dictate to them, for example, when to recharge their cars, when to run their water heaters and their household appliances, and even at what temperature to set their thermostats. Are

30. Johanne Whitmore and Pierre-Olivier Pineau, *op. cit.*, footnote 4, pp. 29 and 35.

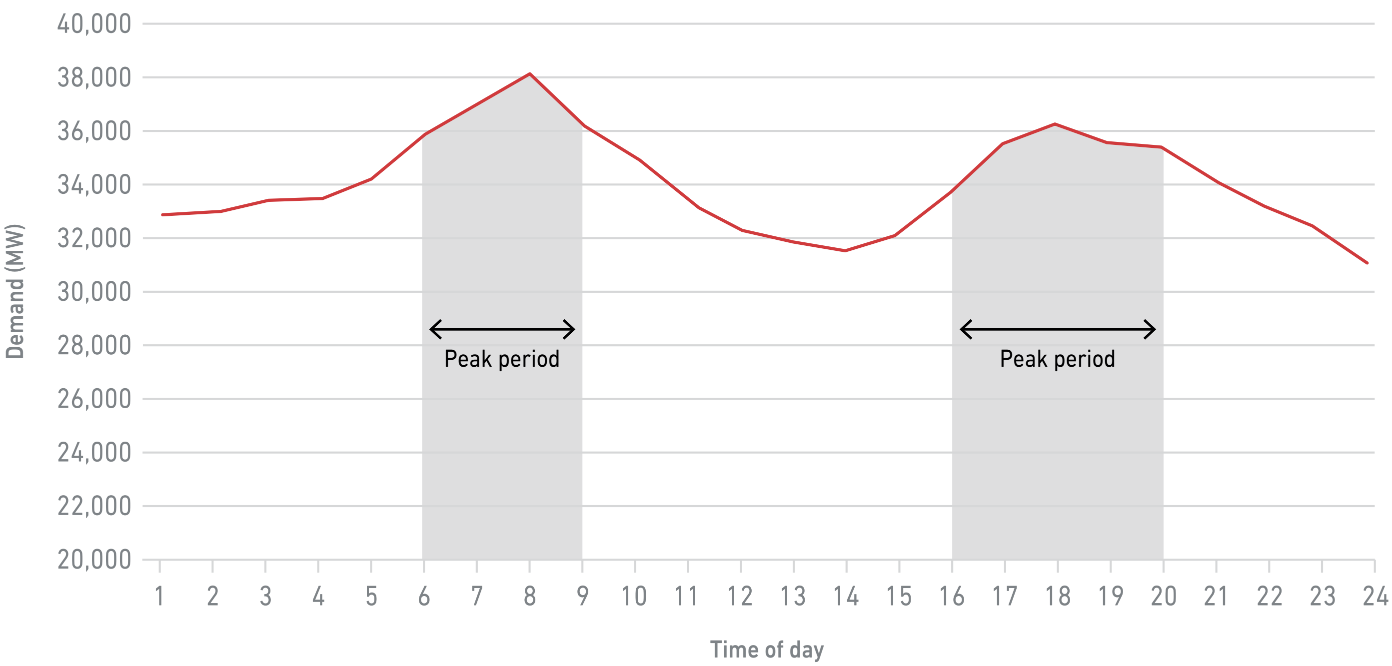
31. U.S. Department of Energy, Energy Efficiency & Renewable Energy; AVÉQ, *op. cit.*, footnote 14.

32. 5.4 million cars travelling on average 36.4 km per day, or around 196.6 million km, and requiring charging equivalent to a consumption of 19 kWh per 100 km. Author's calculations. Johanne Whitmore and Pierre-Olivier Pineau, *op. cit.*, footnote 4, p. 35.

33. The 823,000 trucks transporting goods in Quebec travel on average 43,753 km per year, or around 120 km per day, for a daily total of around 98.7 million km. Supposing that the average consumption of an electric truck is 38 kWh/100 km, then 37,500,000 kWh will be needed every day to recharge them. Each truck will need around 45.6 kW to be recharged, at 6.6 kWh, for a duration of 6.9 hours of charging. Additional power of a little over 5,400 MW will therefore be required if all the trucks are plugged in simultaneously at the end of the day. Author's calculations. Johanne Whitmore and Pierre-Olivier Pineau, *op. cit.*, footnote 4, p. 35.

Figure 3-1

Example of demand fluctuation in winter, January 22, 2019



Source: Hydro-Québec, *État d'avancement 2018 du Plan d'approvisionnement 2017-2026*, November 1st, 2018, p. 7.

Quebecers ready to accept such an intrusion into their private lives?

The Electrification of the Other Sectors of the Quebec Economy

Even without accounting for the electrification of transportation, the growth in electricity demand from electrifying the rest of our economy will exert immense pressure on the Quebec network over the coming decades.

A study published in 2018 shows that electrifying the entire Quebec economy except for transportation would require Hydro-Québec to increase the production from its hydroelectric plants by around 10,000 MW per decade in order to almost double it, bringing it to around 70,000 MW in 2050.[34] As for transportation, this study, which proposes energy scenarios for Quebec up until 2050 for reducing greenhouse gases, concludes that instead of electrifying the transportation sector, we should replace fossil fuels with biofuels. We must note, however, that these biofuels of the future which would make this scenario possible do not exist yet on an industrial scale. For the moment, they are merely a theoretical solution (see Chapter 5).

In winter, when the demand is greatest, the need to heat electric cars and trucks, combined with batteries' faster loss of charge due to the cold, would prolong the charging time needed.

Since Quebec's electrical potential is estimated to be a little over 80,000 MW in theory,[35] we can conclude that by harnessing all of Quebec's rivers, rapids, and falls, it would be possible to fuel the entire Quebec economy, including transportation, but at what cost? Social and

34. Kathleen Vaillancourt *et al.*, "Is there a future for new hydrocarbon projects in a decarbonizing energy system? A case study for Quebec (Canada)," *Applied Energy*, Vol. 218, May 15, 2018, pp. 119 and 121.

35. EEM, "Study of hydroelectricity potential," Study conducted for the Canadian Hydropower Association, 2006, quoted in Kathleen Vaillancourt *et al.*, *ibid.*, p. 119.

political pressures are also likely to be obstacles to such an objective being reached. It should be recalled that Hydro-Québec planned to build structures on the Great Whale River, north of James Bay, but had to abandon the project due to aboriginal opposition.[36] Finally, the construction of hydroelectric power plants on other major rivers, like the Moisie River on the North Shore, is forbidden due to their status as aquatic reserves.[37]

Some see the complete electrification of the Quebec economy as an ideal that we must reach as soon as possible. However, electrical energy also has its drawbacks. Contrary to fossil fuels that can be stored in reservoirs (gasoline in the tanks of cars, service stations, and industrial storage tanks, and caverns and other reservoirs for natural gas, etc.), electricity must be used the moment it is produced, and produced the moment it is needed. The batteries currently available only allow minimal quantities of electricity to be stored—at least, in terms of the typical needs of a household—and are not a solution to this problem. For example, a very expensive battery like the one marketed by Tesla for home use would heat a house for less than one hour.

Electrifying the entire Quebec economy except for transportation would require Hydro-Québec to increase production by around 10,000 MW per decade bringing it to around 70,000 MW in 2050.

A telling example is the ice storm that hit Quebec in January 1998. The multiple power outages that resulted deprived millions of Quebecers of electricity for days, and even weeks.[38] What would all these people have done without their gas-powered cars in which to take shelter and procure the commodities they needed to survive? The disaster would have been total. The proposed transition to electric cars could, sooner or later, turn into a major crisis.

The different levels of government are therefore promoting policies that, considered separately, can seem logical, but when taken together, could threaten the safety of the population. To avoid a possible crisis situation, and to reduce transition costs, it would be wiser to promote hybrid vehicles instead of electric cars equipped only with batteries. These vehicles exert less pressure on the electricity network and are more flexible.

Currently, our energy supply is not too concentrated: No source represents more than 40% of our needs and some 64% of those needs are covered by sources other than electricity that can be stored (see Chapter 1). An energy portfolio is like any other portfolio: Concentrated investment in a single type entails concentrated risk.

In sum, while Quebec is spoiled by an abundance of hydroelectricity, its availability is not infinite. In peak winter periods, Hydro-Québec already struggles to meet demand, primarily due to electrical heating. The way things currently stand, electrifying the entire Quebec economy is therefore unrealistic in the medium term.

36. Michel David, "Un drame canadien," *Le Devoir*, February 20, 2020.

37. Quebec Government, Department of Sustainable Development, Environment, and Parks, "Réserve aquatique projetée de la rivière Moisie – Plan de conservation," March 20, 2008.

38. Some 900,000 homes lost power in Quebec. Environment Canada, Tempête de verglas 1998 – La pire tempête de verglas de l'histoire canadienne, page updated December 18, 2002.

CHAPTER 4

What Other Solutions Does Quebec Have?

As we have just seen, the electrification of the Quebec economy would require the construction of hydroelectric power plants on just about every Quebec river, which could not happen without conflict. In order to maximize the use of electricity, we should first consider reducing hydroelectric demand in winter. Several avenues are open to us.

Wind Power

Around 10% of Hydro-Québec's capacity already comes from wind energy (see Chapter 1). Its great shortcoming is its intermittence: Wind turbines already built in Quebec work around a third of the time (see Chapter 2). Building more of them will not solve the intermittence problem. There will also need to be a Plan B to provide electricity in case of emergency, probably additional gas-fired power plants.

Solar Power

A lot is heard about the development of solar power in the American Southwest. However, the situation in Quebec is a little different: While the sun shines around 3,800 hours a year in Arizona,[39] this figure is barely 2,050 hours a year in Montreal, one of the sunniest places in the province.[40] Moreover, this annual amount hides a lot of variation: The sun shines around 272 hours in July, but only 80 hours in December,[41] and is unpredictable during the season when demand is highest. In southern Quebec, in December, a solar panel that followed the movement of the sun could therefore provide energy no more than 10.8% of the time. The further north we are, the smaller this percentage gets, since the days are shorter and shorter. In sum, even in southern Quebec, the sun does not shine when we would need it to produce electricity.

39. Current Results, Average Annual Sunshine by State, page consulted March 26, 2020.

40. *Ibid.*, Sunshine in Quebec: Average Hours and Days a Year, page consulted March 26, 2020.

41. Weather & Climate, Climate in Montréal (Quebec), Canada, page consulted March 26, 2020.

Geothermal Power

A source of energy that is often neglected is geothermal power, yet it could help reduce the power constraints faced by Hydro-Québec. Geothermal power works the same way as a heat pump. However, instead of drawing heat from the ambient air, it taps the heat from deep underground. Consequently, geothermal power runs 24 hours a day, twelve months a year, and is not affected by the weather outside. Its main drawback is its high installation cost. The prohibitive cost of geothermal power makes it generally inaccessible for individual homes. The low cost of electricity in Quebec—among the lowest in North America—accentuates this effect, both for geothermal power and for other sources of energy.

In southern Quebec, in December, a solar panel that followed the movement of the sun could provide energy no more than 10.8% of the time.

For multi-unit dwellings, developers are generally not the ones who manage the building once it is built; they therefore have no interest in increasing their initial outlays for a benefit they will not enjoy. This is not the case, however, for public buildings: Since the project manager will be the eventual building manager for government buildings (schools, hospitals, etc.), it should be able to accept higher initial financing costs that take into account the value of future savings. The financing of geothermal facilities by government or a paragovernmental body could therefore be a possible solution.

Building Insulation and Other Energy Savings

Doing a better job of insulating buildings, installing better windows and other similar energy efficiency initiatives are the least costly ways of reducing residential, commercial, and industrial energy demand. However, once again, the very low price of hydroelectricity in Quebec reduces the benefits stemming from more effective insulation, for example. Indeed, why spend to buy triple pane windows if the cost of this expense will only be recuperated in twenty years? Quebec's very low prices contribute to higher energy demand and hamper the adoption of measures that could reduce consumption.

Biofuels

Except when they are produced from waste, as is the case for natural gas from landfills, the burning of forest waste by pulp and paper mills, and others, the use of biofuels still has some challenges to overcome. For example, producing ethanol from corn produces barely more energy than is required for the process, and sometimes even less.[42] Collecting forest waste requires heavy equipment that itself consumes large quantities of fuel. Moreover, the processes that could eventually allow for the "digestion" of this raw matter and its transformation into fuel are at an embryonic stage. In sum, even though the use of domestic, agricultural, and other waste for the production of biofuels is logical when economically justified, its commercialization potential is very limited for the moment.

Nuclear Power

Around 10% of electricity is produced by nuclear power around the world thanks to some 440 reactors.[43] Furthermore, next generation nuclear reactors greatly minimize the risks related to the human or design errors that led to the Chernobyl disaster, and more recently, the Fukushima disaster. Certain modern technologies use nuclear waste as fuel, which reduces the problem of storing dangerous material.[44] Such innovations should allow the nuclear industry to experience a renaissance in countries like China and India, where the need for energy will grow substantially for several decades. These countries see nuclear energy not only as a way to limit their GHG emissions, but also as a way to improve the quality of air fouled by harmful particles from coal power plants, which are often located close to urban centres.

The Quebec government, however, decided a few years ago already to close the province's only nuclear plant, and neither the population nor the political class has any appetite for this kind of energy. Furthermore, nuclear energy being produced constantly throughout the year, it would not solve Quebec's particular seasonality problem, created by the demand for heating in winter. However, elsewhere in the world, the nuclear option remains relevant, especially where permanent renewable energy sources like hydroelectricity are not available.[45]

Hydrogen

Hydrogen is not a primary energy source, but a secondary one. In other words, we need another source of energy to manufacture, store, and use hydrogen as a fuel. Currently, most hydrogen used comes from natural gas; given this, it would be better to use the natural gas itself.

Geothermal power runs 24 hours a day, twelve months a year, and is not affected by the weather outside. Its main drawback is its high installation cost.

Another way to obtain hydrogen is through the electrolysis of water, a process that requires large quantities of energy. The hydrogen thus obtained could be accumulated, stored, and used as a fuel during the winter period. It would also be possible to imagine using intermittent energy sources, like wind power, to produce hydrogen. We could also produce hydrogen when the demand for electricity is low, thus equalizing this demand. However, hydrogen production via electrolysis is relatively expensive, which makes it uncompetitive for the time being.[46]

Natural Gas

As mentioned in Chapter 2, natural gas is the most popular energy source for heating in most parts of North America.[47] Natural gas is also cleaner than coal or oil, its combustion emitting practically no fine particles. This is why it is generally perceived as a transition solution toward the decarbonization of the global economy.

42. Arthur R. Wardle, "A Review of the Environmental Effects of the Renewable Fuel Standard's Corn Ethanol Mandate," The Center for Growth and Opportunity at Utah State University, Policy Paper 2018.002, September 2018, p. 13.

43. World Nuclear Association, Nuclear Power in the World Today, page updated March 2020.

44. World Nuclear Association, Processing of Used Nuclear Fuel, page updated June 2018.

45. The federal government, however, has shown a little more interest in nuclear. See Ryan Tumilty, "'Affordable, safe' nuclear power is key to reaching Canada's climate goals: federal minister," *National Post*, February 27, 2020.

46. Sonal Patel, "How Much Will Hydrogen-Based Power Cost?" *Power Magazine*, February 27, 2020.

47. Statistics Canada, Households and the Environment: Energy Use, Analysis, page updated December 19, 2019; Energy.gov, Home Heating systems, U.S. Department of Energy, page consulted March 25, 2020.

CHAPTER 5

Natural Gas in Quebec

As we have seen, the use of electricity for heating makes the Quebec electricity network less effective due to the seasonality of demand. In other words, if Quebec used natural gas instead of electricity for heating, this would free up a large amount of electricity that would facilitate the electrification of other sectors of the economy.

Natural gas is already Hydro-Québec's resource of last resort to produce all the electricity needed for heating during peak winter periods (see Chapter 2). Indeed, even if gas-fired plants are often derided, Hydro-Québec counts on them to produce electricity during periods of high demand, since this solution is much less onerous than building hydroelectric facilities that would work only a few hours a year. And although hydroelectricity is a renewable green energy, we must keep in mind that building hydroelectric dams causes substantial GHG emissions. As these additional facilities are only needed 5% of the time,[48] their environmental impact would be more difficult to justify.

However, producing electricity from natural gas to then use this electricity for heating purposes is very inefficient. This solution should therefore not be used in Quebec, except to manage the peak demand periods described above. While the best electric furnaces have an efficiency of close to 98%, the best gas turbines only have an efficiency of around 62%.[49] Consequently, 58% more heat is produced by burning natural gas in a home gas furnace than through electric heating using electricity produced by a gas-fired plant. Instead of producing electricity for heating from gas, it is more efficient to heat directly with natural gas: More heat is obtained, and therefore less greenhouse gas is produced.

The most realistic way to achieve the goal of reducing electricity demand in winter would be to promote gas heating for homes and other buildings, at least through the use of dual energy heating. In Quebec, the ideal would be to use an electric heat pump above a critical temperature threshold, and gas heating below that threshold.

48. Johanne Whitmore and Pierre-Olivier Pineau, *op. cit.*, footnote 4, p. 21.

49. GE Power, Breaking the power plant efficiency record – GE & EDF unveil a game-changer at Bouchain, page consulted March 25, 2020.

The Use of Natural Gas in Quebec

In 2018, Quebec imported \$13.8 billion of fossil fuels.[50] Local gas consumption for the year, at around six billion m^3, represented over \$1 billion of this amount.[51] Quebecers will probably continue using natural gas for several more decades. The vast majority of the natural gas consumed in Quebec today comes from the United States (see Figure 5-1).

The development of natural gas being more strictly regulated in Canada than in the United States, especially when it comes to fugitive methane emissions,[52] the development of Canadian gas reserves should entail a global reduction in greenhouse gas emissions. It also goes without saying that developing a local resource would reduce the emissions, minimal though they are, due to the transport of gas, which is generally done by pipeline.

If Quebec used natural gas instead of electricity for heating, this would free up a large amount of electricity that would allow for the electrification of other sectors of the economy.

Some will argue that Quebec must contribute to reducing greenhouse gas emissions. However, the issue of climate change is a global problem, not a local one. Reducing CO_2 and methane emissions in Quebec by refusing to produce natural gas locally, all while consuming natural gas produced abroad—which produces even more harmful emissions—does nothing to improve the global balance sheet.

It is true that Quebec's CO_2 emissions measured on the basis of annual production, some 10 t of CO_2 equivalent per person, are much lower than the Canadian average.[53]

50. Johanne Whitmore and Pierre-Olivier Pineau, *op. cit.*, footnote 4, p. 53.

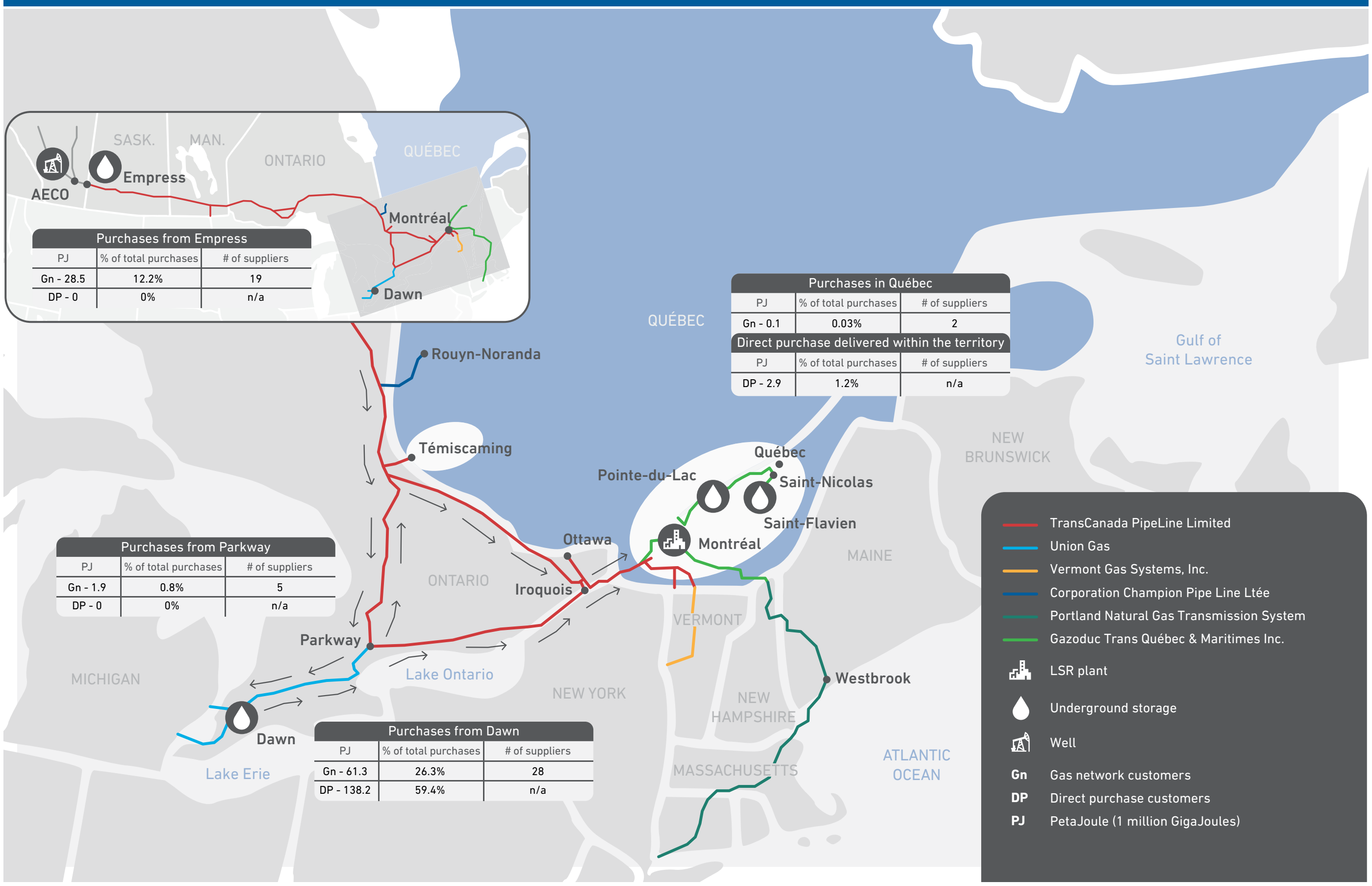
51. Government of Quebec, Department of Energy and Natural Resources, Statistiques énergétiques, Importations de gaz naturel; Énergir, "Approvisionnement en gaz naturel au Québec – Un atout incontournable pour le développement industriel," p. 5, document consulted online on March 25, 2020.

52. Environment and Climate Change Canada, Global Methane Initiative, About methane emissions, page updated April 1st, 2019; Romany Webb, "The Status of Methane Regulation in the U.S.," Columbia Law School, Sabin Center for Climate Change Law, Climate Law Blog, January 31, 2020.

53. Sarah Dobson and G. Kent Fellows, "Big and Little Feet Provincial Profiles: Quebec," *The School of Public Policy Publications*, SPP Communiqué, University of Calgary, Vol. 9, No. 8, September 2017.

Figure 5-1

Sources of Quebec's natural gas supply, 2019



Source: Johanne Whitmore and Pierre-Olivier Pineau, *L'état de l'énergie au Québec 2020*, Chair in Energy Sector Management, HEC Montréal, January 2020, p. 15.

However, if we consider our emissions based on our consumption, they are closer to 15 t per person annually (see Figure 5-2), due to our importation of carbon-intensive products (including those coming from the rest of the country), especially oil and natural gas. Moreover, with our southern neighbours in the process of deregulating particularly harmful methane emissions related to the process of producing natural gas,[54] it would seem to be a good idea to supply ourselves locally, especially if we are in a position to regulate our own emissions.

It is often said that one of the advantages of electricity for the Quebec economy is that it is produced locally. Natural gas could present the same advantages. Quebec's recoverable reserves of natural gas, concentrated in the southern part of the St. Lawrence Valley, are estimated to be between 250 billion m^3 and 1,150 billion m^3.[55] At the current rate of consumption (around six billion m^3),[56] Quebec would have sufficient reserves for at least

Reducing emissions in Quebec by refusing to produce natural gas locally, all while consuming natural gas produced abroad, does nothing to improve the global balance sheet.

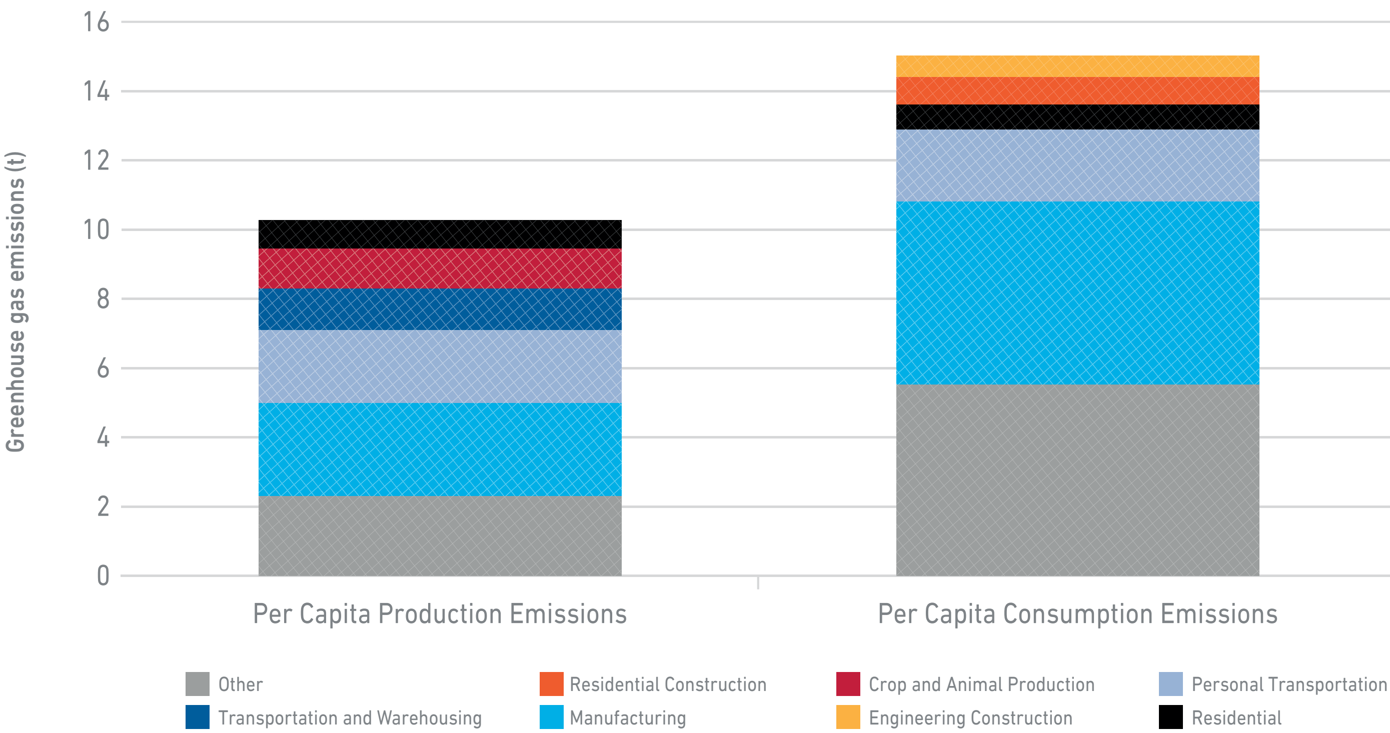
54. One tonne of methane loosed into the atmosphere having the same effect as more than 20 tonnes of CO_2. Futura Planète, "Gaz à effet de serre : CO_2 ou méthane, quel est le pire ?" February 8, 2020.

55. Government of Quebec, Department of Sustainable Development, the Environment, Wildlife and Parks, Études sur les retombées économiques du développement de l'industrie du gaz de schiste dans les basses terres du Saint-Laurent, October 7, 2013, p. 18.

56. Government of Quebec, *op. cit.*, footnote 51.

Figure 5-2

Breakdown by sector of GHG emissions related to production and consumption, Quebec, 2011



Source: Sarah Dobson and G. Kent Fellows, "Big and Little Feet Provincial Profiles: Quebec," *The School of Public Policy Publications*, SPP Communiqué, University of Calgary, Vol. 9, No. 8, September 2017, p. 2.

40 years. If the development costs make economic sense, it would be irresponsible not to take advantage of this local resource, situated near current and potential consumers, which will create jobs and wealth in addition to being intrinsically cleaner than the same resource we are currently importing. It would also be easier to control conditions for local development.

Quebec's Natural Gas Deposits

We have known for a long time that there is natural gas in the St. Lawrence Valley. It is the Utica geological formation that contains this gas. This formation is present in the eastern United States and extends mainly along the south shore of the St. Lawrence Valley.[57]

Quebec's recoverable reserves of natural gas are estimated to be between 250 billion m^3 and 1,150 billion m^3, sufficient for at least 40 years.

As many Quebecers no doubt remember, many wells were drilled in the St. Lawrence Valley in the second half of the 20th century. Two of these provided natural gas commercially for many years. The first was located at Pointe-du-Lac, near Trois-Rivières, and the second at Saint-Flavien, near Highway 20, southwest of Quebec City.[58] These wells were developed conventionally, which is to say without hydraulic fracturing.

57. Denis Lavoie *et al.*, "The Utica Shale and gas play in southern Quebec: Geological and hydrogeological syntheses and methodological approaches to groundwater risk evaluation," *International Journal of Coal Geology*, Vol. 126, June 1st, 2014, p. 86.

58. Jocelyn Duhamel, *L'exploitation gazière au Québec dans un contexte de développement durable – Essai présenté au Centre Universitaire de Formation en Environnement en vue de l'obtention du grade de maître en environnement (M. Env.)*, Centre universitaire de formation en environnement, Université de Sherbrooke, October 2010, p. 30.

Figure 5-3

Quebec's natural gas supply and transport network

Source: Johanne Whitmore and Pierre-Olivier Pineau, *L'état de l'énergie au Québec 2020*, Chair in Energy Sector Management, HEC Montréal, January 2020, p. 14.

Given the network of gas pipelines that already exists in southern Quebec, developing the natural gas reserves that are under the ground in the province would require the construction of few new gas pipelines (see Figure 5-3).

A Moratorium Since 2011

Since the start of the past decade, exploration of potential natural gas deposits in the St. Lawrence Valley has been subject to a series of moratoriums and bans.

Since the start of the past decade, exploration of potential natural gas deposits in the St. Lawrence Valley has been subject to a series of moratoriums and bans. The first moratorium was adopted in May 2011 and banned oil and gas activity in the St. Lawrence River up to Anticosti Island.[59] The same year, Quebec also suspended exploration permits in most of the St. Lawrence Lowlands.[60]

In May 2013, Quebec tabled Bill 37, *An Act to prohibit certain shale natural gas exploration and production activities*. This bill never came into effect, however.[61] In

59. *An Act to limit oil and gas activities*, L.Q., 2011, c. 3.

60. La Presse Canadienne, "Gaz de schiste : aucune autorisation n'a encore été délivrée au Québec," Radio-Canada, February 13, 2017.

61. Quebec National Assembly, *Bill n°37: An Act to prohibit certain shale natural gas exploration and production activities*, tabled May 15, 2013.

September 2018, though, the Quebec government banned hydraulic fracturing for shale gas, this time through regulation.[62] Although drilling conventional wells remains theoretically possible, in practice, embargos on issuing exploration permits, moratoriums, and numerous restrictions make it an exercise in futility.[63]

These moratoriums also have legal impacts due to international agreements signed by Canada. Lone Pine Resources Inc., an American company, exercised the rights that were conferred to it under Chapter 11 of the North American Free Trade Agreement (NAFTA) to launch a request for arbitration alleging that the 2011 moratorium caused damages to its Canadian subsidiary of at least $250 million. This amount was subsequently revised to US$118.9 million. The arbitrage tribunal has still not rendered its decision.[64]

By importing its natural gas, Quebec "hides" the emissions that result from its consumption, for which it is ultimately responsible.

Quebec's stubbornness in refusing to develop its own natural gas resources is hypocritical: By importing its natural gas—from the United States and Western Canada—Quebec "hides" the emissions that result from its consumption, for which it is ultimately responsible. In other words, we blame American and Western Canadian producers for our pollution. Similarly, opposing the construction of pipelines that would be less expensive, less polluting, and safer denies Canadian producers straightforward access to markets.

Quebecers are generally aware that exporting our waste to the developing world is ethically unacceptable. However, they seem unaware that by refusing to develop local reserves, and by importing the gas that covers 15% of our energy needs, they are essentially doing the same thing, since we are "exporting" our pollution to our neighbours.

62. Pascal Dugas Bourdon, "Gaz de schiste: le gouvernement Couillard interdit la fracturation hydraulique," *Le Journal de Montréal*, June 6, 2018.

63. Alexandre Shields, "Forages dans les cours d'eau: la porte reste entrebâillée," *Le Devoir*, September 6, 2018.

64. Global Affairs Canada, NAFTA – Chapter 11 – Investment, Cases Filed Against the Government of Canada, *Lone Pine Resources Inc. v. Government of Canada*, page updated August 1st, 2018; Global Affairs Canada, North America Free Trade Agreement, *Lone Pine Resources Inc. v. Government of Canada*, Arbitrage en vertu du chapitre onze de l'Accord de Libre-Échange Nord-Américain et du règlement d'arbitrage de la CNUDC, réponse du gouvernement du Canada à l'avis d'arbitrage, February 27, 2015.

"Renewable" Natural Gas

Another avenue has recently elicited interest, and been the subject of two reports published in late 2018 and early 2019, namely the production in Quebec of "renewable natural gas" (produced from organic matter like wood or agricultural waste).[65] These reports estimated that the potential of renewable natural gas production could be as high as two-thirds of Quebec's current consumption, by using forest biomass, which would represent a total of 144 million gigajoules (GJ).

Aside from international prices that are currently unfavourable to the development of this more expensive production, a significant technical obstacle must be considered. The production of renewable natural gas from forest biomass (forest production discards, trees damaged by forest fires or contaminated by parasites, for example) would be done through pyrolysis, a process of combustion in the absence of oxygen related to the process for making charcoal. While the process has been known for years, there are very few industrial scale pyrolysis plants. In Quebec, current renewable natural gas capacity is around 120 million m^3 per year, with forthcoming projects that would add another 75 million m^3.[66] In light of this, producing four billion m^3 of natural gas—two-thirds of Quebec's current consumption—from forest biomass by 2030 is more fantasy than reality.

65. Marion Cordier *et al.*, "Production québécoise de gaz naturel renouvelable (GNR) : un levier pour la transition énergétique – Évaluation du potentiel technico-économique au Québec (2018-2030)," Deloitte and WSP, October 2018.

66. Johanne Whitmore and Pierre-Olivier Pineau, *op. cit.*, note 4, p. 26.

CONCLUSION

For the Responsible Development of Quebec's Natural Gas

This research paper has shown that the electrification of the Quebec economy—at least as currently conceived—would encounter substantial hurdles, notably due to the very high winter demand from heating. Since 15% of Hydro-Québec's maximum capacity is only used 5% of the time,[67] and since peaks due to intense cold are uncommon and only last a few hours, making all heating in the province dependent on hydroelectricity would mean that the last turbine set up would work only 0.01% or 0.02% of the time.

We must therefore wonder what the cost of the total electrification of Quebec would be. Also, what would be the environmental footprint of building the dams and power plants that such an operation would require? How many tonnes of GHGs will need to be emitted to build facilities whose frequency of use would be marginal? And how much will continue to be emitted for their maintenance?

If Quebec is to electrify a significant share of its transport sector, it should at least give itself some room to manoeuvre so that electric vehicles can be usable throughout the year, even during periods of high demand in winter. Natural gas, though, can play a much more important role than providing electricity to Hydro-Québec clients during peak periods. As a source of heat for domestic, commercial, and industrial buildings, gas is both efficient and economical. Its wider use, by itself or through dual heating, would greatly facilitate the electrification of the province's economy, without having to double current hydroelectric facilities.

Given the various elements addressed in this paper, a realisable scenario is for Quebec to develop its gas resources while respecting the highest environmental standards. A first phase could see the drilling of control wells for natural gas, initially without hydraulic fracturing. A second stage could lead, after re-evaluation, to the consideration of a second control sector that would this time use hydraulic fracturing.

It goes without saying that the communities affected by this activity will have to be stakeholders in the decision-making process and that developers will have to be completely transparent. If it happened that the results of the extraction from the control wells financially justified the development of local gas resources, a third stage could see the larger-scale deployment of these activities, whose regional economic contribution would be significant. Quebec's gas distribution network could then be extended into urban centres and new developments in order to allow for the home use of natural gas, mainly for heating, for reasons already discussed.

67. Johanne Whitmore and Pierre-Olivier Pineau, *op. cit.*, footnote 27, p. 21.

In sum, Quebec has substantial reserves of clean gas, located close to consumers, which are just waiting to be developed, and access to this resource is facilitated by the existing gas pipeline network which could be extended as needed. If this development were to prove profitable, there would be no justification—even in the context of the large-scale electrification of the Quebec economy and the fight against climate change—not to develop this resource, both for the well-being of Quebecers and that of the planet.

Arming Ourselves Against the Next Crisis

The benefits related to the development of Quebec's natural gas, which exist at all times, are brought into stark relief by the almost unprecedented economic crisis that the entire world is facing. In addition to creating high-quality jobs in a time when these are becoming harder to find, the emergence of a gas industry in Quebec would increase its energy independence and place it in a better position to face future crises, if these should disturb normal supply chains.

Quebec has substantial reserves of clean gas, located close to consumers, which are just waiting to be developed, and access to this resource is facilitated by the existing gas pipeline network.

While it is true that the revival of this industry in Quebec will probably not happen in the short term (due to the prices at which hydrocarbons are being sold as we write these lines), some reflection is in order on the part of Quebec's provincial and municipal governments.

The province's energy profile, Hydro-Québec's production capacity, the increasing demand for electricity that will only continue to grow in the context of large-scale electrification, the alternatives to hydroelectricity that are available here, the presence under Quebec soil of an accessible resource that would allow for economic and environmental gains—all of these factors show that there is no reason for our political decision-makers to continue hampering the development of natural gas, as they have done in recent years by imposing an arbitrary or unnecessarily burdensome regulatory process, thus depriving Quebecers of its potentially considerable benefits. Quebec is ready for the responsible development of all of its resources, and natural gas should be among them.

ABOUT THE AUTHOR

JEAN MICHAUD

Jean Michaud is a registered Professional Engineer and holds a bachelor's degree and a master's degree from Polytechnique as well as an MBA from McGill University. He has worked in finance for over 30 years—mainly as Commodity Trader and Portfolio Manager—at major firms such as Alcan, Barclays, and Caisse de dépôt et placement du Québec where he managed the commodity portfolio which reached C$3 billion. Jean has co-written many articles on energy, CO_2, and carbon taxes, published in major Canadian newspapers. He is also a regular speaker at investment conferences across Canada.

Montreal Economic Institute
Gare Windsor, Suite 351 – 1100 Avenue des Canadiens-de-Montréal
Montreal (QC) H3B 2S2
T 514.273.0969 F 514.273.2581 **iedm.org**

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