2019

THE STATE OF ENERGY IN QUEBEC

Chair in Energy Sector Management
HEC MONTRÉAL

Québec

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The mission of the Chair in Energy Sector Management is to advance knowledge of energy issues in support of sustainable development, resource optimization and the achievement of an adequate balance between energy sources and societal needs. The Chair's activities are made possible through the support of its partners: BMO, Boralex, Enbridge, ENERCON, Brookfield Renewable, Valero Energy, Énergir, McCarthy Tétrault, Quebec's Ministry of Energy and Natural Resources and PwC.

About Transition énergétique Quebec

The mandate of Transition énergétique Quebec is to support, encourage and promote energy transition, innovation and efficiency, and to ensure an integrated approach to their governance. This public corporation coordinates the implementation of all programs and measures required to achieve government energy targets. Through its strong support of energy innovation and economic development, Transition énergétique Quebec acknowledges the role of energy efficiency as a priority source of energy and aims to reduce Quebec's dependence on petroleum products.

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Note to readers

The State of Energy in Quebec 2019 provides an overview of the most current data on energy issues facing Quebec at the start of 2019. Some data for 2018 was unavailable during the preparation of this report: in some instances, printed data may not reflect the most current developments. The report's contents remain the sole responsibility of the authors.

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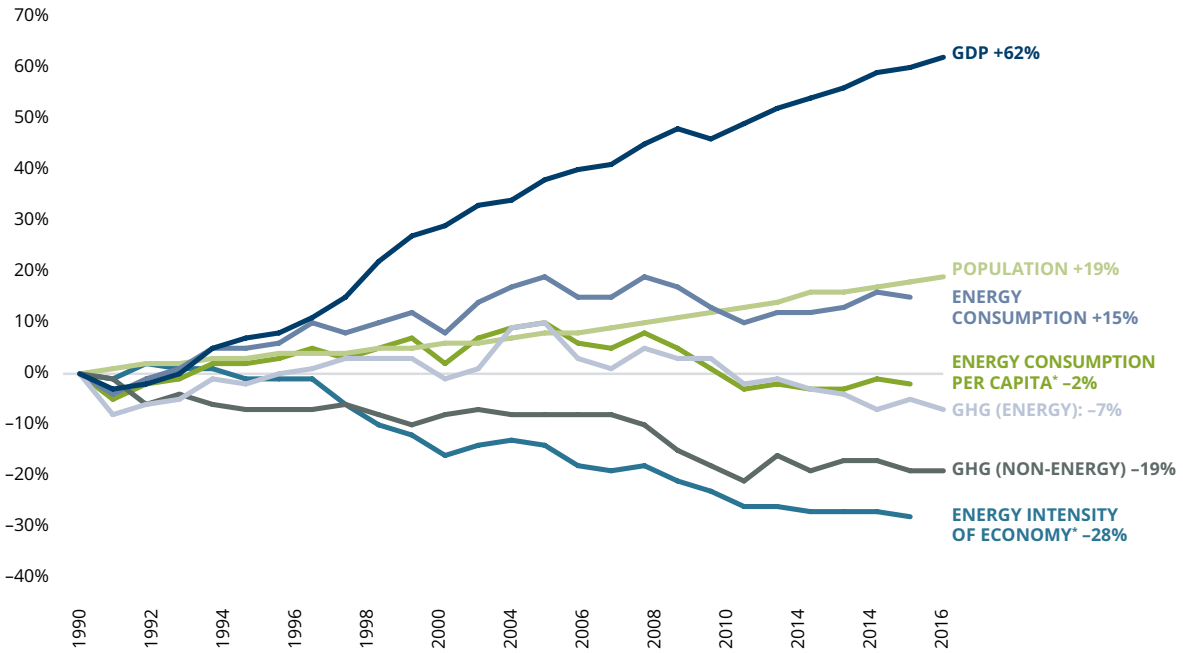
1 INTRODUCTION

While the topic of climate change is widely discussed, with the publication of the Intergovernmental Panel on Climate Change's (IPCC) *Special Report on Global Warming of 1.5°C* in October 2018, for example, there is much less public debate on the energy issues underlying global warming, especially at the systemic level. Yet the production and consumption of energy strongly contribute to greenhouse gas (GHG) emissions directly linked to climate issues. *The State of Energy in Quebec 2019* aims to improve the understanding of Quebec's energy system since the province must rapidly move into an energy transition phase. Indeed, the *2030 Energy Policy* (QEP), published in 2016, has set ambitious goals for Quebec, including a 40% reduction in the consumption of petroleum products compared to 2013 levels.

This fifth edition of *The State of Energy in Quebec* was prepared in the same spirit and with the same independence as earlier versions, with the added contribution of Transition énergétique Quebec (TEQ), a public corporation established in April 2017 with the mandate to "support, encourage and promote energy transition, innovation and efficiency" (Bill 106). TEQ is also responsible for developing the *Energy Transition, Innovation and Efficiency Master Plan.* Released in June 2018, the first master plan for 2018–2023 outlines approaches, goals and measures required for Quebec to successfully achieve its energy transition.

FIGURE 1 • GDP, POPULATION, ENERGY CONSUMPTION, ENERGY INTENSITY AND GHG EMISSIONS IN QUEBEC, 1990–2016



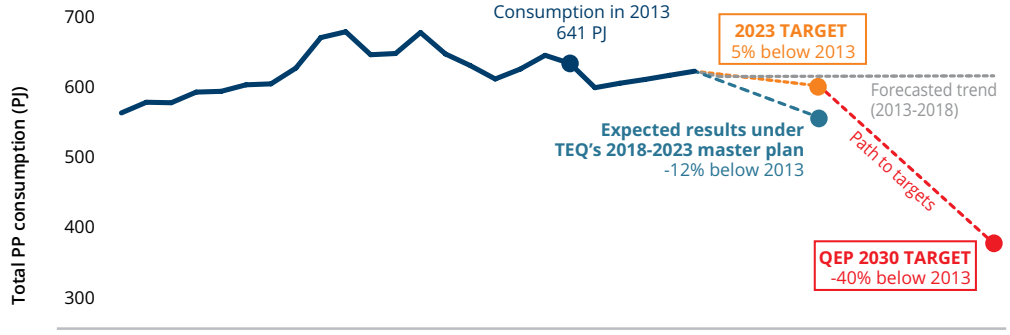
Sources: ECCC, 2018; OEE, 2017; Statistics Canada, 2018 (tables 36-10-0222-01 and 17-10-0005-01).
Note: *2015.

The State of Energy in Quebec provides the most objective overview of Quebec's energy data to help all stakeholders and observers gain a clearer understanding of current energy consumption trends and to better target efforts to meet the province's economic, social and environmental goals.

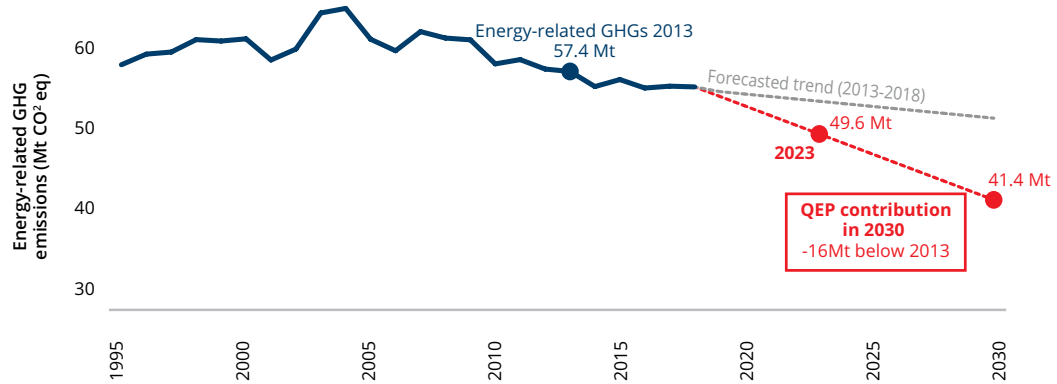
One of the first observations to highlight (Figure 1) is that, between 1990 and 2016, Quebec's economic growth (measured by GDP [Gross Domestic Product]) far outpaced that of its population and energy consumption. Indeed, while GDP increased 62%, energy consumption rose by just 15% and remained

FIGURE 2 • KEY OBJECTIVES AND TARGETS IN QUEBEC'S 2030 ENERGY POLICY (QEP) AND 2023 TARGETS IN THE GOVERNMENT DECREE OF JUNE 7, 2017

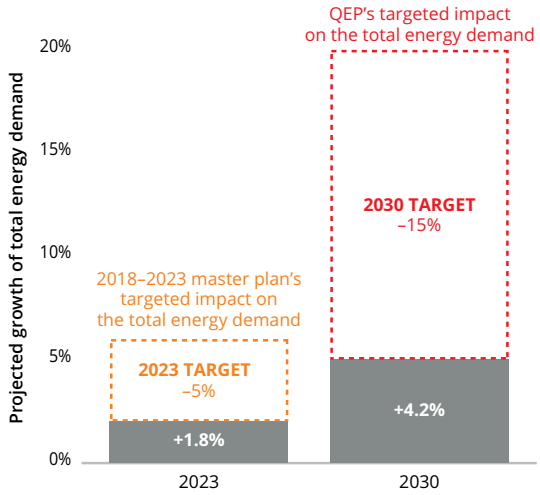
A) Targets to reduce petroleum product (PP) consumption



B) QEP2030's contribution to reducing Quebec's energy-related GHG emissions



C) Energy efficiency improvement targets



Sources: Statistics Canada, 2018 (tables 25-10-0029-01 and 36-10-0222-01); ECCC, 2018; OEE, 2018; Government of Quebec, 2016, 2017.

Note: Data for 2017 and 2018 are based on the authors' estimates. The QEP2030 set five energy targets. The following three are not shown in this graph: eliminate the use of thermal coal (less than 1% of energy consumed in Quebec); increase total production of renewable energy by 25%; and increase production of bioenergy by 50%. According to QEP, the five proposed targets will result in a 16 Mt CO_2 eq reduction of GHG emissions related to the consumption of energy in Quebec (see p.12 of QEP2030).

stable for a decade. These statistics suggest that Quebec has already successfully decoupled economic growth from energy growth. Quebec has started transitioning to less GHG-intensive activities, leading to a slight decrease (-7%) in those linked to energy (oil, natural gas, coal) and a larger decrease (-19%) in non-energy emissions from the industrial, agriculture and waste-management sectors. However, given that the use of energy is responsible for the bulk of GHG emissions (72%; see Section 4), there is still much work to be done to achieve the 2030 target of reducing emissions by 37.5% below 1990 levels. The energy transition allowing us to achieve this target has only just begun.

According to government forecasts, the targets outlined in QEP2 will reduce GHG emissions by 16 million tons CO_2 equivalent (Mt CO_2 eq) in 2030, or 18% below 1990 levels (see Figure 2b). The consumption of petroleum products, which contribute to 55% of GHG emissions, needs to be the focus of the transition. Natural gas and coal contribute to 16% and 1% of emissions respectively, with the remaining 29% attributable to non-energy sources. Figure 2a shows trends in the consumption of petroleum products since 1995 compared to the path to achieving the 2030 targets. While projected trends in the sale of RPPs for 2013–2018 point to only a slight drop in consumption, the 2023 interim target of a 5% decrease compared to 2013 may be surpassed according to results forecasted in TEQ's June 2018 master plan. It will be necessary to walk the talk, however, and think beyond 2023, when reduction targets are even more ambitious by 2030.

Energy efficiency will be key to slowing the increase in energy consumption. Achieving Quebec's energy efficiency targets (see Figure 2c) would cap the increase in consumption at 1.8% by 2023 (compared to 6.8% without efficiency gains) and at 4.2% (compared to 19.2%) by 2030. However, as the economy and the population continue to grow, additional energy production must be emissions free to ensure that total emissions decrease in absolute terms—renewable energies will thus have a major role to play.

This fifth edition of *The State of Energy in Quebec* contains a number of new features, including a discussion of the impact of electric vehicle uptake on power consumption as well as more detailed information on the pricing levels and structures of the three major energy commodities consumed in Quebec: oil, electricity and natural gas. Given that adressing energy pricing will be important for acheiving Quebec's energy transition, the issue was given greater prominence in this 5th edition of the report (see Section 5.1).

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2 2018 IN REVIEW

Quebec's energy sector was marked by many events in 2018. Although not exhaustive, the following list provides an overview of key events that occurred during the year.

JANUARY 9 • HYDRO-QUÉBEC AND THE "DEATH SPIRAL." In an interview, Hydro-Québec CEO Éric Martel mentioned the risk of a "death spiral," a phenomenon referring to a decrease in Hydro-Québec's revenues from sales of electricity due to a growing proportion of independent solar-power producers. Faced with this drop in revenue, the public corporation would be forced to hike electricity rates to maintain a balance with its fixed expenses linked to existing infrastructure (transmission and distribution network). This, in turn, would provide even greater incentives for users to rely on independent electricity generation as a hedge against rising prices, and the resulting "spiral" could prove fatal to the financial survival of the electrical infrastructure.

JANUARY 11 • THE ZERO-EMISSION VEHICLE (ZEV) STANDARD COMES INTO FORCE. Since January 11, 2018, car manufacturers operating in Quebec have been required to earn credits through the sale of zero-emission vehicles (ZEVs) to meet increasingly strict requirements. A new credit-exchange system was implemented and is similar to Quebec's Cap and Trade System for Greenhouse Gas Emission Allowances (carbon market). Between 2018 and 2025, ZEVs are expected to increase from 3% to approximately 20% of total vehicle sales.

JANUARY 25 • LANDMARK HYDROPOWER SALES CONTRACT WITH MASSACHUSETTS. The State of Massachusetts awarded Hydro-Québec the biggest contract in its history to provide 9.45 terawatt hours of hydropower annually over the next 20 years. However, after the New Hampshire Site Evaluation Committee rejected the project for the Northern Pass transmission line, Massachusetts selected the New England Clean Energy Connect project passing through Maine. With the US$0.059/kWh hour contract, the project will help New England achieve an annual reduction of 36 Mt CO_2 eq over the next 20 years. In November, the governor of Vermont stated that the transmission line could go through his state to reach Massachusetts (New England Clean Power Link project).

MARCH 23 • MID-TERM REVIEW OF QUEBEC'S 2013-2020 CLIMATE CHANGE ACTION PLAN AND GREEN FUND. In an advisory paper on the 2017–2018 mid-term review of Quebec's 2013–2020 Climate Change Action Plan (CCAP), the Green Fund Management Board *(Conseil de gestion du Fonds vert)* noted that despite a 40% increase in its initial budget, the CCAP was not on track to achieve it's goal of 20% GHG emission reduction below 1990 levels by 2020. The CCAP's expected reduction potential was lowered by 40%, from 6 to 3.6 Mt CO_2 eq. On March 31, 2016, the CCAP had reduced GHG emissions by 0.34 Mt.

APRIL 17 • QUEBEC'S SUSTAINABLE MOBILITY POLICY - 2030. Quebec announced its *2030 sustainable mobility Policy and Action Plan 2018-2023*. The policy proposes nine targets for 2030, including a 20% reduction of solo car trips, a 40% reduction of petroleum consumption in the transport sector, a 37.5% reduction below 1990 levels of GHG emissions in the transport sector, and a 25% increase in freight tonnages at Quebec ports and intermodal rail centres. The government plans to invest over $9.7 billion to implement the policy, including $2.9 billion in new investments.

JUNE 6 • A NEW OIL AND GAS REGULATORY FRAMEWORK FOR QUEBEC. The regulations for the implementation of the *Petroleum Resources Act* were published in the *Gazette officielle du Québec*. These regulations govern activities related to petroleum-resource exploration, production and storage on land and in bodies of water. They prohibit shale-fracking and fracking within 1,000 meters of the surface in other geological formations. On August 17, the regulations were amended to explicitly prohibit all petroleum-resources exploration, production and storage activities in bodies of water or within one kilometre of any body of water.

JUNE 11 • QUEBEC'S 2018–2023 ENERGY TRANSITION, INNOVATION AND EFFICIENCY MASTER PLAN. Transition énergétique Québec (TEQ) announced its first master plan for 2018-2023. The plan outlines 225 measures totalling $67 billion in investments. Under a government decree dated June 7, 2017, the plan must pursue the orientations and objectives set out in Quebec's 2030 Energy Policy (QEP) and "contribute to achieving QEP objectives" related to five energy targets to reduce GHG emissions by 16 Mt CO_2 eq. Following the implementation of the plan, TEQ forecasts an annual improvement of society's energy efficiency of approximately 1.2% and a 12% decrease in the consumption of petroleum products in 2023 compared to 2013. On June 12, 2018, the Master Plan was submitted to the *Régie de l'énergie* (Quebec's Energy Board) for: 1) approval of its programs and measures regarding the responsibilities of energy distributors and of the financial resources required for their implementation; and 2) guidance on whether the plan can meet the government's energy targets for 2018–2023 (June 7, 2017 Decree). The *Régie* is currently reviewing the plan.

JULY 3 • ONTARIO EXITS THE CARBON MARKET. Newly elected Ontario premier Doug Ford announced the province's withdraw from the cap-and-trade carbon market with Quebec and California. In response, both jurisdictions prohibited the trade of Ontario emission allowances to prevent a surplus of Ontario credits on their market. Ontario's withdrawal from the cap-and-trade market will trigger the application of the federal carbon pricing backstop plan. Under the premiership of Doug Ford, Ontario has expressed its intention to challenge the constitutionality of the federal carbon tax. However, Ontario's withdrawal has not impacted the carbon market in California or Quebec; at the first auctions following this withdrawal, emission allowances reached their second highest price (US$15.05 per tonne [CA$19.77]). For the first time that year, all allowances offered for auction sold out, with 25% of 2021 units bought by non-emitters, a strong sign of market confidence in the system's sustainability.

JULY 16 • THE PROVINCIAL REGULATOR AUTHORIZES HYDRO-QUÉBEC'S TEMPORARY DISSUASIVE RATE FOR CRYPTOCURRENCY MINERS. With some exceptions, the *Régie de l'énergie* accepted Hydro-Québec's June application for a rate of 15¢ per kilowatt hour (¢/kWh) for new clients operating computer equipment for the purpose of mining cryptocurrency. Hydro-Québec has reported approximately 300 requests, approximately half of which were considered serious, for a total demand of approximately 18,000 megawatts (MW), or 40% of its production capacity. In the longer term, electricity pricing conditions for cryptocurrency miners will be set after the *Régie* concludes its study of file R-4045-2018 (Application for pricing and conditions for the cryptographic use of power on the blockchain).

JULY 27 • ELECTRICITY RATE MODULATION DURING PEAK PERIODS. After applying to the *Régie de l'énergie* for a 0.8% rate increase for its residential customers and for most of its business customers as of April 1, 2019, Hydro-Québec intends to offer two new "dynamic pricing" options to cope with winter peaks, with rates that will vary according to the demand on its network. These options would be either a "critical peak credit" of 50¢ for each kWh curtailed at Hydro-Québec's request or a "critical peak rate" with higher prices during peaks (50¢/kWh applicable to a maximum of 3% of hours in the winter period) and lower off-peak prices (about 2¢/kWh less than Rate D in the winter period). Both voluntary rating options would enable customers to reduce their electricity bills by changing their energy habits. The *Régie de l'énergie's* decision on the matter is expected in March 2019.

AUGUST 21 • NATURAL GAS PIPELINE SYSTEM EXPANSION AND RENEWABLE NATURAL GAS REQUIREMENT. The government awarded financial assistance of $10 million to Gazifère for an 18 km natural gas distribution-system expansion project in the Outaouais region of Quebec. This followed the August 14 announcement of a $17.4 million contract to Énergir to expand its pipeline network in the Montérégie region. On August 22, the government also published a draft regulation requiring that deliveries of natural gas distributors contain at least 1% of renewable natural gas (RNG) by 2020 and 5% by 2025. On November 15, a major gas pipeline project was announced to supply the Énergie Saguenay natural gas liquefaction facilities.

OCTOBER 1 • PROVINCIAL GENERAL ELECTION. The Coalition Avenir Quebec (CAQ) won the provincial election and formed a majority government led by François Legault. In its electoral platform, the CAQ promoted clean power exports, a national policy on architecture and urban planning, respect previous commitments to reduce GHG emissions, energy efficiency, and the modernization of national building code requirements.

OCTOBER 8 • IPCC'S SPECIAL REPORT ON GLOBAL WARMING OF 1.5 °C. This report warns that global temperatures are already 1°C above pre-industrial levels and that it would be safer to limit global warming to 1.5°C rather than to 2°C. Limiting warming to 1.5°C would require reducing global GHG emissions to zero as early as 2050, while a 2°C warming scenario requires only an 80% reduction below 1990 levels by 2050. To achieve these objectives by 2050, much greater changes will be required than what has been acheived to date.

3 QUEBEC'S ENERGY SYSTEM

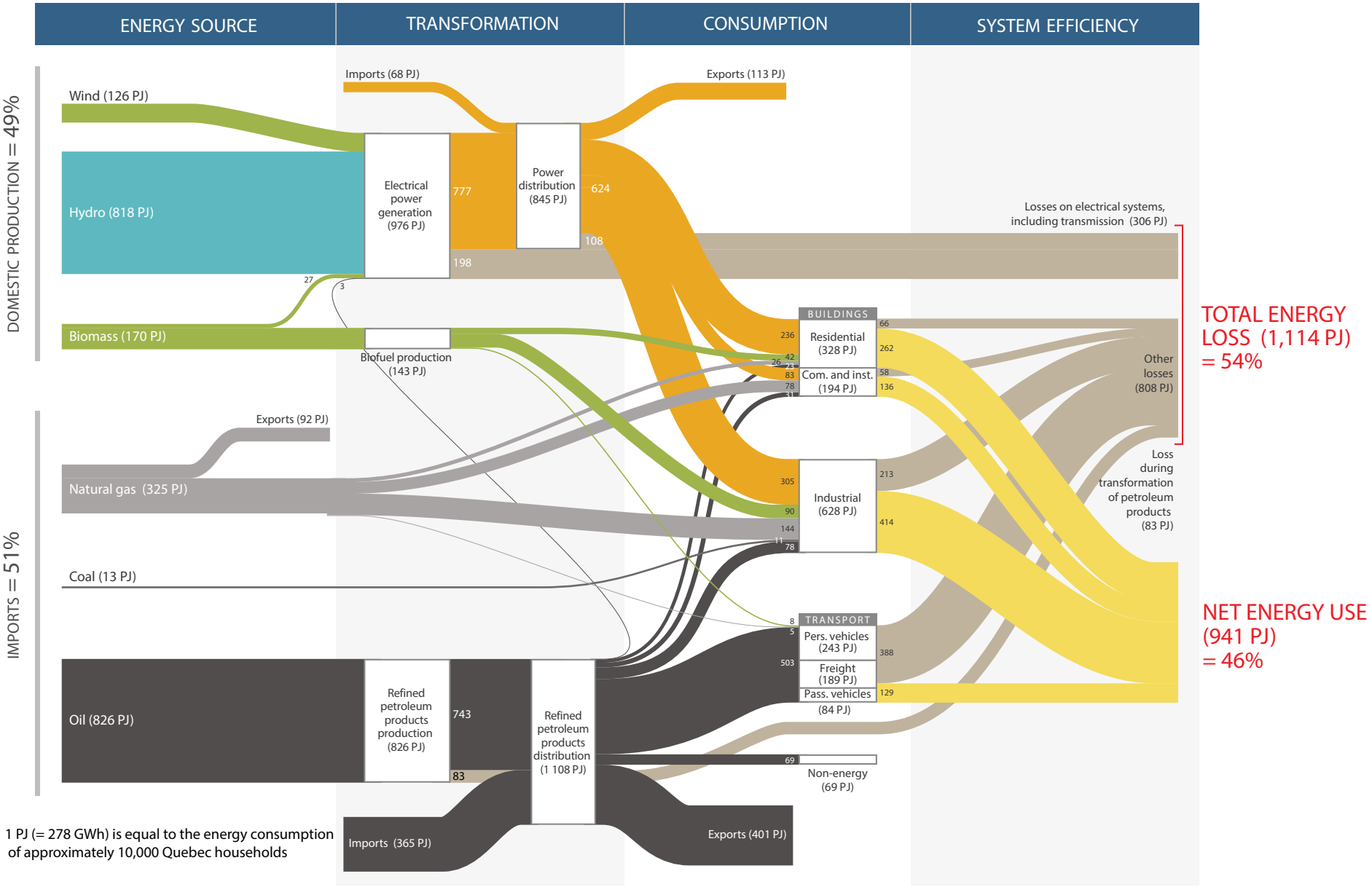
Even for experts, energy is never a simple subject to explain. The energy sector is a complex and dynamic system of interconnected components. As with the human body or natural ecosystems, changing one component can impact others—or even the entire system.

The energy challenges of the 21st century require a more systemic approach to address linkages between energy sources, their transportation, their transformation into different products, their consumption by various sectors, and the system's overall efficiency, while also considering the economic and environmental impacts of every link of the energy chain. Addressing and resolving energy issues is no longer a simple question of determining whether an energy source is "good" or "bad," but of developing a clear understanding of how our different needs, behaviours and consumption patterns support or even favour one type of energy production over another.

Figure 3 offers a visual representation of Quebec's energy system and how energy flows from source to end use. This system distinguishes between primary energy, its transformation into secondary energy, and its consumption by end users. Once transformed, energy is distributed to consumers to satisfy various energy service needs such as lighting, heating, air conditioning, industrial processing and transportation. The total availability of primary energy sources, whether domestically produced or imported, is shown under "energy sources" on the left side of Figure 3. This energy is **transported** (by train or pipeline, for instance) to be transformed or refined into energy products that will be distributed and **consumed** by various sectors (industry, transport, and residential, commercial and institutional buildings). Some fossil fuels are also used for non-energy purposes as raw materials in the production of asphalt, plastic and chemical fertilizers, for example.

At the end of the process (right side of Figure 3 and Section 3.4 of this report), we see the **energy lost**, primarily in the form of heat, due to system inefficiencies during the transformation, transportation and consumption processes. Less than half of the energy produced and transformed serves directly to meet the Quebec economy's demand for energy services. In fact, the system loses 1,114 PJ, or 54%, of the energy it produces and transforms. These results highlight the vital importance of improving the overall efficiency of our energy system.

FIGURE 3 • QUEBEC'S ENERGY BALANCE, 2016



Sources: Statistics Canada, 2018; TEQ, 2018 (preliminary data); OEE, 2018.

Notes: Some totals may not add up due to rounding and to the fact that energy processes of less than 3 PJ are not included in the Figure. Natural gas data inconsistencies are based on data from Statistics Canada. Methodology notes on Figure 3 are available on the website of the Chair in Energy Sector Management: energie.hec.ca.

Prepared by Benjamin Israël with the collaboration of Johanne Whitmore and Pierre-Olivier Pineau (HEC Montréal).

3.1 • ENERGY SOURCES

Primary energy sources refer to energy sources (see Table 1) are all raw energy resources in the natural environment (such as crude oil, coal, sunlight, wind, and running water) that are exploited before their transformation. These energy resources are converted into useful energy products ("secondary" energy) that are consumed by users. This conversion consists of electrical-power generation, natural gas processing or oil refining. In Quebec, crude oil purchased from foreign or Canadian producers is transformed into refined petroleum products (RPP) such as gasoline, diesel or fuel oil. Primary energy sources can be interchangeable insofar as they can be used by consumers to meet their needs for services (lighting, transportation, heating, etc.).

Quebec's energy system differs from that of other regions throughout the world in the sizeable contribution of its local supply of renewable energy (49%), i.e., sources that are not depleted when used. Quebec's two main local sources of primary energy are hydraulic force (transformed into hydroelectricity), wind power and biomass (see Table 1). Quebec's other energy requirements are met by hydrocarbon-based resources, all of which are imported and account for a little over half (51%) of the province's energy needs (see insert on page 10). Oil, over three quarters of which is used in the transportation sector, accounts for 36% of Quebec's energy mix, with natural gas, used primarily in the industrial sector, accounting for 14%. Coal, consumed exclusively in the industrial sector, accounts for less than 1% of Quebec's energy needs. Some 0.1% of the electricity generated in Quebec is produced by generators running on diesel or fuel oil. This meets the needs of off-grid communities, such as in the Îles de la Madeleine and villages in Nord-du-Québec.

In 2012, uranium, used to power Gentilly-2, Quebec's only nuclear power plant (675 MW), generated 3% of the province's energy mix. The plant was permanently closed on December 28, 2012. The Quebec government expects all decommissioning, dismantling and disposal of spent nuclear fuel to be completed by 2062.

TABLE 1 • AVAILABILITY OF PRIMARY ENERGY SOURCES IN QUEBEC, 2016

	Source	PJ	Percentage of total (%)	Equivalence
Imports = 51%	Oil	826	36	137 million barrels
	Natural gas	325	14	8.4 billion m^3
	Coal	13	1	0.6 million tons
Local = 49%	Hydro	818	36	227 TWh
	Biomass	170	7.5	
	Wind	126	6	35 TWh
	Total	**2,278**	**100**	

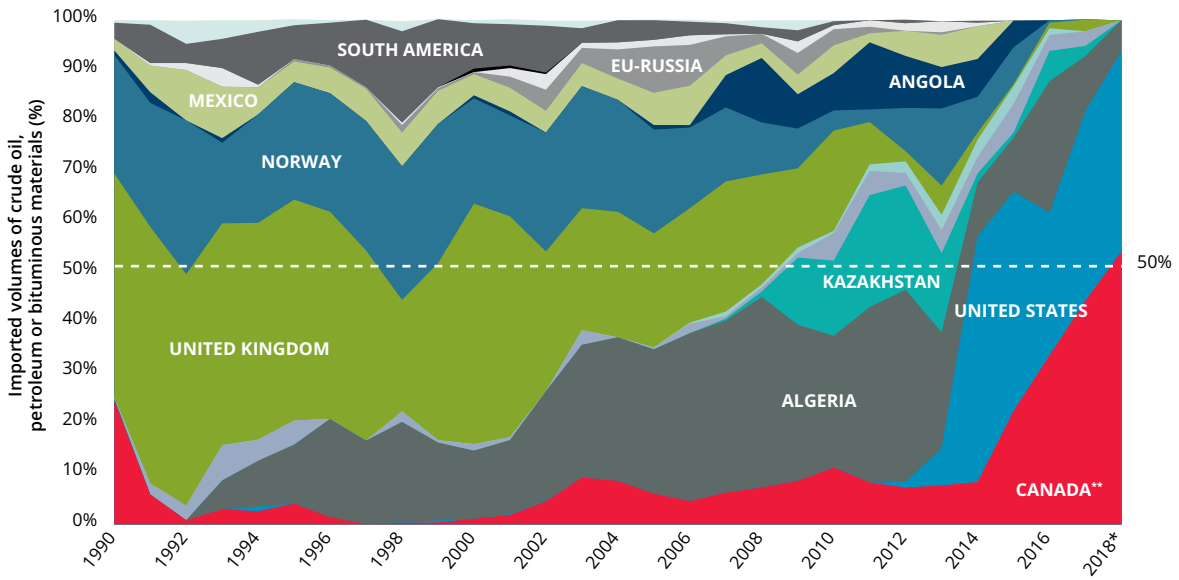
Sources: EIA, 2018; TEQ, 2018 (preliminary data); OEE, 2017; Statistics Canada, 2018.

DID YOU KNOW?

QUEBEC'S OIL SUPPLIES

Since late 2015, the U.S. and Canadian share of Quebec's energy supply has grown considerably. As of June 30, 2018, these two sources accounted for nearly 94% of the province's oil supply (53% from western Canada and 40% from the United States). The U.S. shale boom and the 2015 reversal of Enbridge's 9B pipeline to flow in an eastward direction played a key role in this increase. Figure 4 shows the rapid changes in crude oil supply sources for Quebec's refineries. While Algeria gained a small market share (6%) in 2018, the United Kingdom, Norway and other countries no longer supply oil to Quebec. Refineries sign short-term supply contracts that allow them to quickly switch to the most economic sources of crude oil.

FIGURE 4 • QUEBEC'S CRUDE OIL IMPORTS, 1990–2018



Source: Statistics Canada, 2018 (table 990-0027).
Except *table 25-10-0041-01.

Note: Figure 4 is based on import data from Statistics Canada's table 990-0027 in the *Canadian International Merchandise Trade Database,* which are inconsistent with those from Statistics Canada's table 25-10-0041-01, *Refinery supply of crude oil and equivalent, monthly.*
*** Total of the six first months of 2018 (January to June)*

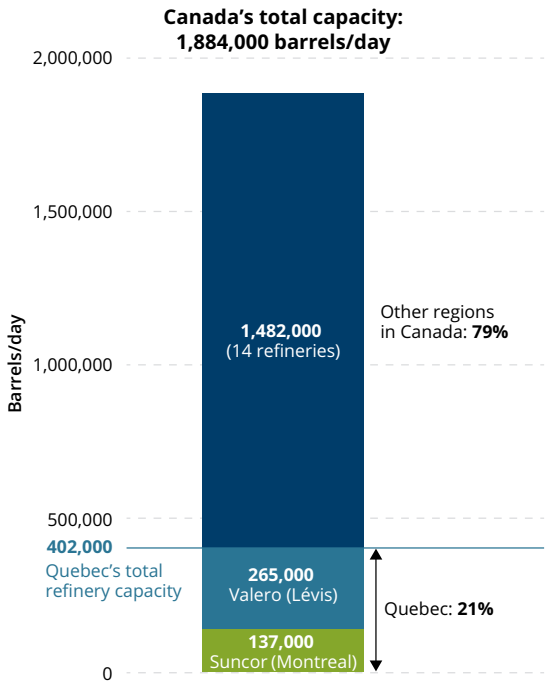
3.2 • TRANSFORMATION AND DISTRIBUTION OF ENERGY

Primary energy sources are processed into various forms of secondary energy to facilitate their transportation, distribution and use. Electricity can be generated from wind power or the hydraulic force of rivers and waterfalls, for example. Biofuel, in the form of wood pellets, biogas, ethanol and biodiesel, can be produced from organic residues or waste. Oil can be used to make refined products such as gasoline and diesel for vehicles. After an extraction process to remove gas liquids (ethane, propane or butane) and impurities, natural gas can be processed into a standard product that can be used directly or transformed into compressed natural gas (CNG) or liquefied natural gas (LNG) to decrease its volume.

HYDROCARBON PRODUCTION

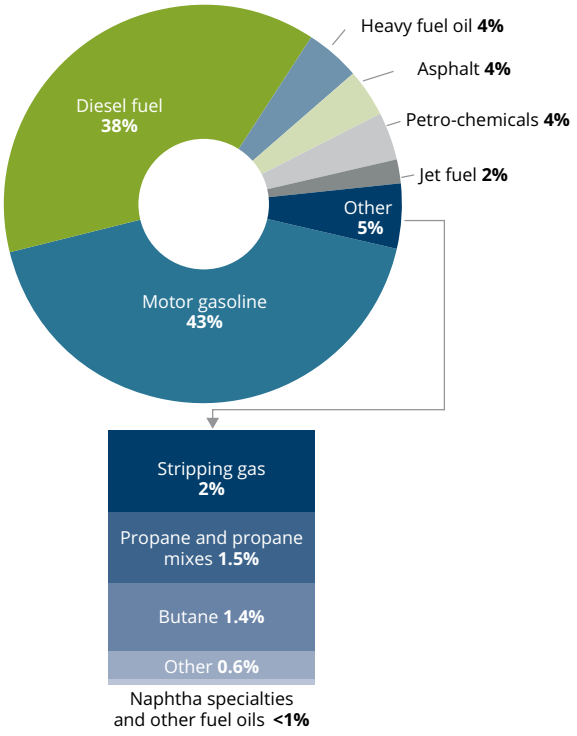
In 2018, Quebec produced no significant quantity of either crude oil or natural gas from fossil sources, despite having industrial facilities to process and refine both energy sources. Two oil refineries are in operation in its jurisdiction, one owned by Suncor (Montreal) and the other by Valero Energy (Lévis). In 2017, their total capacity of **refined petroleum products** (RPP) was 402,000 barrels per day, or 21% of Canada's total refining capacity (Figure 5). That year, gasoline and diesel fuel accounted for almost 80% of total RPP production (Figure 6). In barrels, this capacity exceeds domestic RPP sales in Quebec, averaging 369,000 per day in 2017. So while Quebec imports all its crude oil, it is generally self-sufficient in RPPs, which nevertheless does not stop it from importing and exporting it.

FIGURE 5 • QUEBEC'S TOTAL PETROLEUM PRODUCT REFINING CAPACITY, 2017



Source: CFA, 2018..

FIGURE 6 • PRODUCTION OF REFINED PETROLEUM PRODUCTS IN QUEBEC, 2017



Source: Statistics Canada, 2018 (table 25-10-0044-01).
Note: Data on light fuel oil was confidential in 2017.

Quebec also produces **liquefied natural gas** (LNG) , which is natural gas cooled to its condensing temperature of −162°C. In liquid form, natural gas occupies 600 times less space than in its gaseous state. Liquid natural gas is processed in Énergir's liquefaction, storage and regasification (LSR) facility in Montreal (see Table 2). Initially used to store natural gas for peak periods, the facility now supplies LNG to sectors such as marine and road transportation as a substitute for petroleum products. Quebec industries that are not served by the existing natural gas distribution system can also obtain LNG. In 2016, Énergir's LSR plant tripled its liquefaction capacity to 1,380 m^3 per day. Although the Quebec government approved plans by Stolt LNGaz to build a natural gas liquefaction plant in Bécancour, the project was indefinitely postponed in February 2016. Other projects currently in development in Quebec include the construction of a natural gas liquefaction, storage and transhipment facility in the Saguenay-Lac-Saint-Jean region, with daily export capacity of almost 75,000 m^3. This region will also be home to the first pilot plant for renewable LNG with the construction of six liquefaction plants with a total capacity of 233 m^3 per day.

There are currently 27 public and private fuelling stations for natural gas vehicles in Quebec, and two new public natural gas stations were scheduled to begin operations in Trois-Rivières and Lévis in fall 2018. Of these stations, 23 supply compressed natural gas (CNG) and four supply LNG. As of September 4, 2018, there were almost 780 natural gas vehicles on Quebec roads, approximately 80% heavy goods vehicles and 20% light transport, according to Énergir.

TABLE 2 • OPERATING OR APPROVED LIQUID NATURAL GAZ PLANTS IN QUEBEC, 2018

Company	Location	Production capacity (m^3 LNG/day)	Notes
Énergir	Montreal	**1,380**	Production at the LSR plant: 600 tons of LNG/day.
Sysgaz inc.	Saguenay-Lac-Saint-Jean regional corridor (SLRC)	**233***	The commissioning of the first pilot facility is expected in 2019. The project is for the construction of six liquefaction plants with production capacity of 100 tons of renewable LNG per day. In the long term, the SLRC will be linked to Énergir's existing Blue Road.
GNL Quebec - Énergie Saguenay	Saguenay-Lac-Saint-Jean	**74,429**	Project expected for 2025, currently pending government authorizations (production of 30,137 tons of LNG/day).

Sources: Énergir, GNL Quebec Inc., Sysgaz Inc., 2018 (personal communication).
Note: *Liquefied renewable natural gas (LNG-R)

Quebec industries not yet served by the existing natural gas distribution system can gain access to LNG supply.

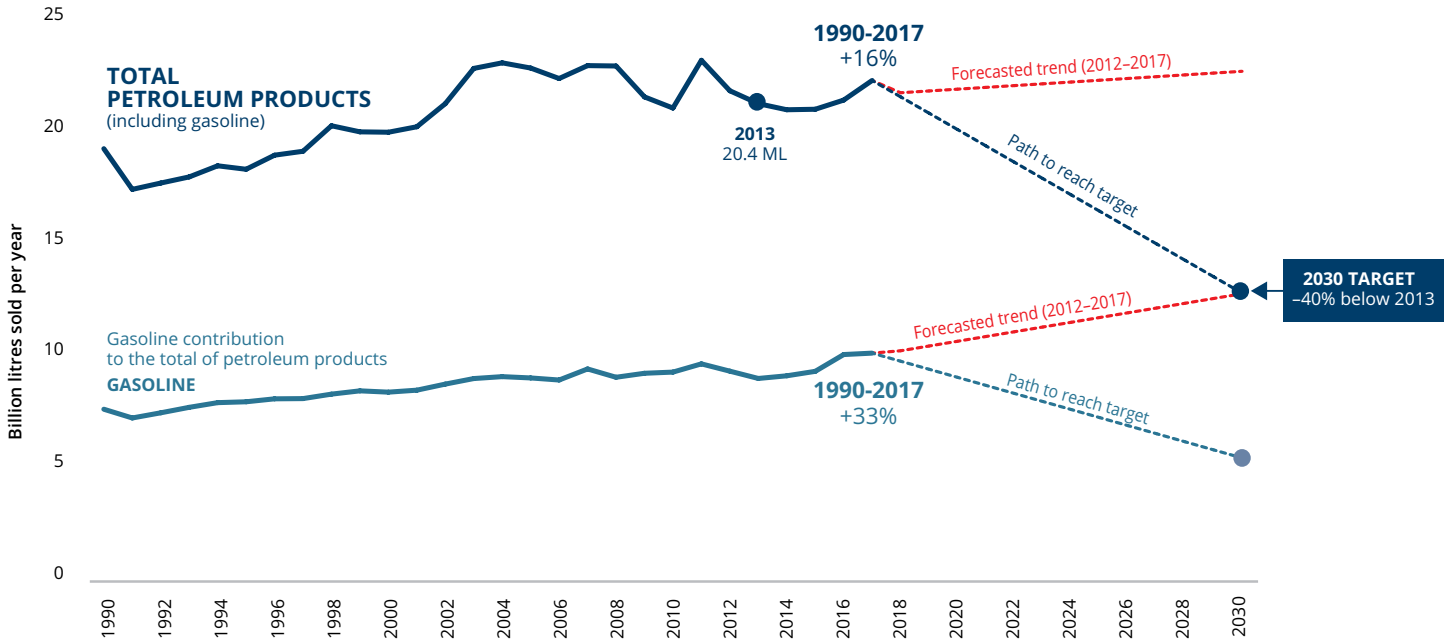
DID YOU KNOW?

REFINED PETROLEUM PRODUCTS IN QUEBEC: SALES AND CONSUMPTION REDUCTION TARGETS

Between 1990 and 2017, total sales of refined petroleum products (RPPs) increased 16%, with gasoline sales increasing 33% (see Figure 7). With 9.7 billion litres sold in 2017, gasoline is the most purchased petroleum product in Quebec, followed by diesel, with over 5 billion litres sold (included in total RPPs in Figure 7).

Sales growth, which was +4.9% between 2013 and 2017, will make it difficult to achieve Quebec's target of reducing consumption of refined petroleum products by 40% compared to 2013 levels by 2030 as set out in the province's 2030 Energy Policy. RPP sales are driven largely by gasoline sales, which rose 12.7% between 2013 and 2017.

FIGURE 7 • TOTAL ANNUAL RPP SALES (INCLUDING GASOLINE), 1990–2017 AND TARGET PATH TO THE 40% REDUCTION IN CONSUMPTION COMPARED TO 2013 LEVELS BY 2030



Source: Statistics Canada, 2018 (table 25-10-0044-0).

PIPELINE TRANSPORT

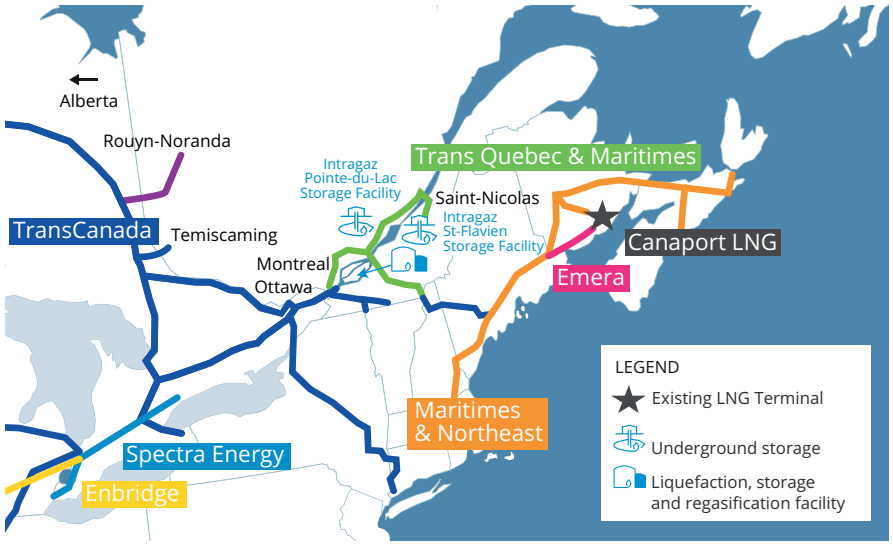
Most pipelines carry crude oil, RPPs and natural gas. As shown in Figure 8, Quebec already has a network of pipelines crossing under the St. Lawrence River and other waterways. The use of this pipeline network has changed over the years. The Portland-Montreal pipeline has often been used, for example, to transport oil carried from Portland, Maine, by tankers too large to navigate the St. Lawrence River to Montreal refineries. However, this use declined considerably after the closure of several refineries (Texaco in 1982, Petro-Canada in 1982, Imperial Oil in 1983, Gulf in 1986 and Shell in 2010). In November 2015, Enbridge's 9B line was recommissioned after being reversed in an eastward direction. With its 300,000 barrels-per-day capacity, this pipeline carries oil from western Canada and the United States to Montreal, reducing the number of overseas tankers required to supply oil to the Valero and Suncor refineries. On October 5, 2017, TransCanada announced the cancellation of the Energy East pipeline project to transport 1.1 million barrels per day from Alberta to Saint John, New Brunswick. It could also have supplied Quebec's refineries.

Natural gas arrives in Quebec through TransCanada's transportation network (see Figure 8) and is then transported through the distribution networks of Gazifère and Énergir. Gazifère, a subsidiary of Ontario's Enbridge Gas Distribution, has some 40,400 clients and operates a 930 km gas network in the Outaouais region. Énergir's network distributes 97% of the natural gas used in Quebec and stretches across more than 10,000 km to serve just over 200,000 clients.

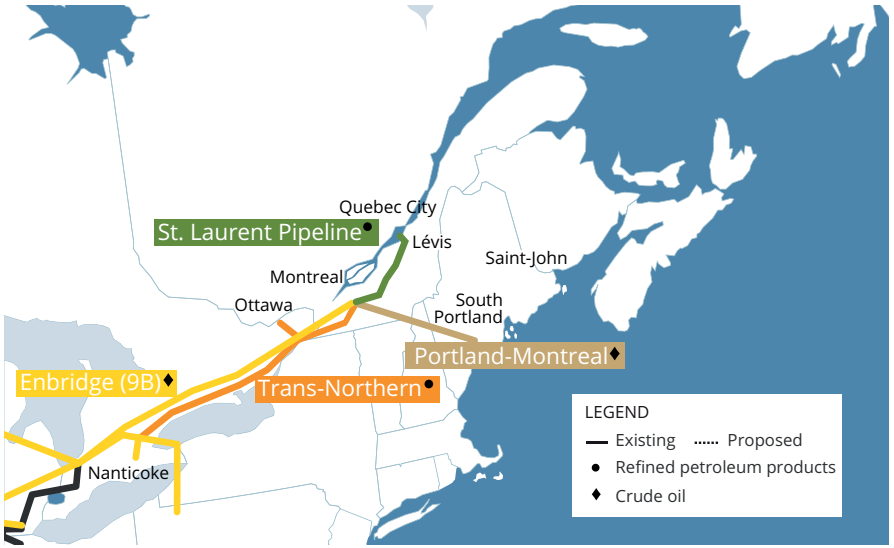
In November 2016, Énergir moved its main supply reception point from Empress, Alberta, to Dawn, Ontario. The Dawn Hub is connected to many significant supply basins in America, including the Western Canadian Sedimentary Basin, the American Rockies, the Mid-Continent, Marcellus and the Gulf of Mexico. The rise of non-conventional shale-gas production in North America is increasing the percentage of shale gas in Quebec's energy network. In 2017, approximately 57% of Énergir's supply was

FIGURE 8 • QUEBEC'S PIPELINE NETWORKS, 2018

Gas pipeline network



Oil pipeline network



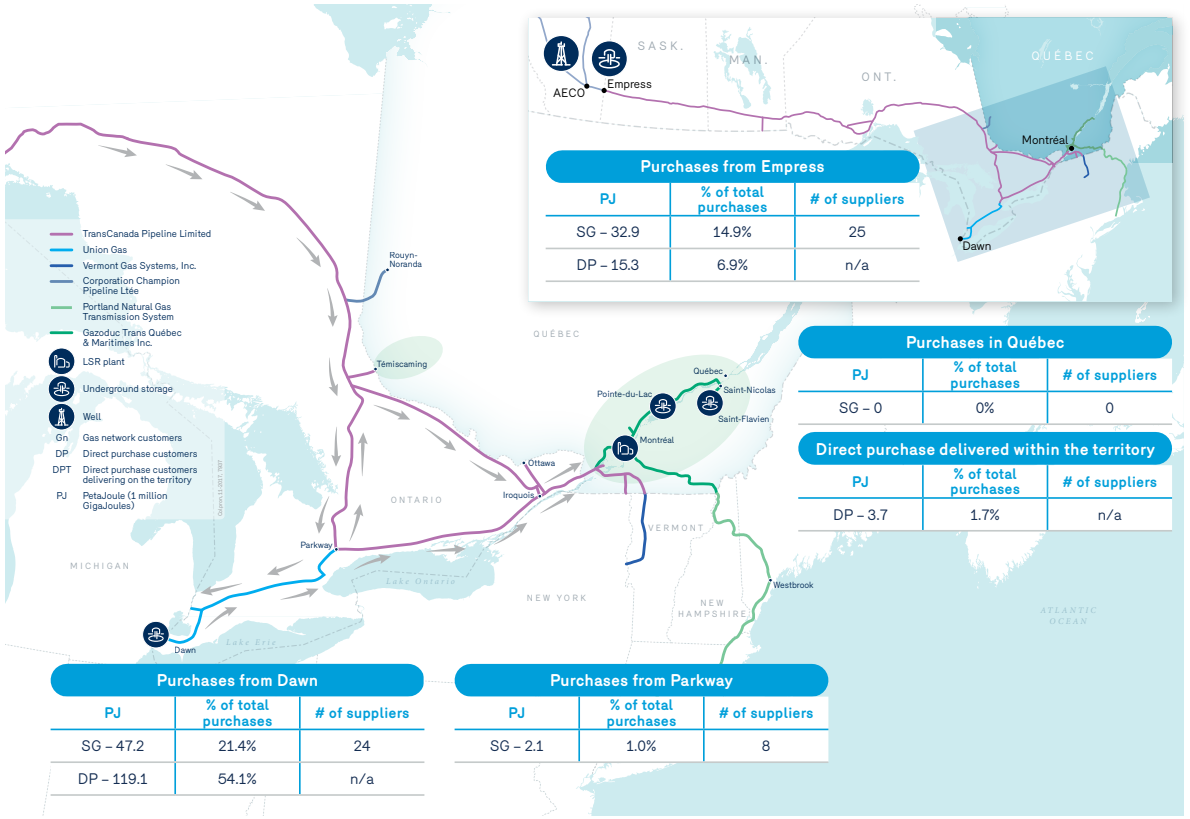
Sources : CEPA, 2018 ; Énergie Valero, 2018 ; TransCanada, 2018 ; Valener inc., 2018

received from the Dawn gas hub and 40% from Empress (see Figure 9).

In late 2017, the first injections of renewable natural gas (RNG) in Énergir's gas network were made from the organic waste reclamation centre in the City of Saint-Hyacinthe. However, this source accounts for less than 0.1% of gas volumes in the network.

Natural gas is stored and injected in the gas pipeline system as demand requires. Énergir uses a storage facility in Dawn, Ontario, belonging to Union Gas Limited, and three storage sites in Quebec: Pointe-du-Lac, Saint-Flavien and Montreal, where the LSR plant is also located.

FIGURE 9 • MAP OF QUEBEC'S GAS SUPPLIES, 2017



Purchases from Empress

PJ	% of total purchases	# of suppliers
SG – 32.9	14.9%	25
DP – 15.3	6.9%	n/a

Purchases in Québec

PJ	% of total purchases	# of suppliers
SG – 0	0%	0

Direct purchase delivered within the territory

PJ	% of total purchases	# of suppliers
DP – 3.7	1.7%	n/a

Purchases from Dawn

PJ	% of total purchases	# of suppliers
SG – 47.2	21.4%	24
DP – 119.1	54.1%	n/a

Purchases from Parkway

PJ	% of total purchases	# of suppliers
SG – 2.1	1.0%	8

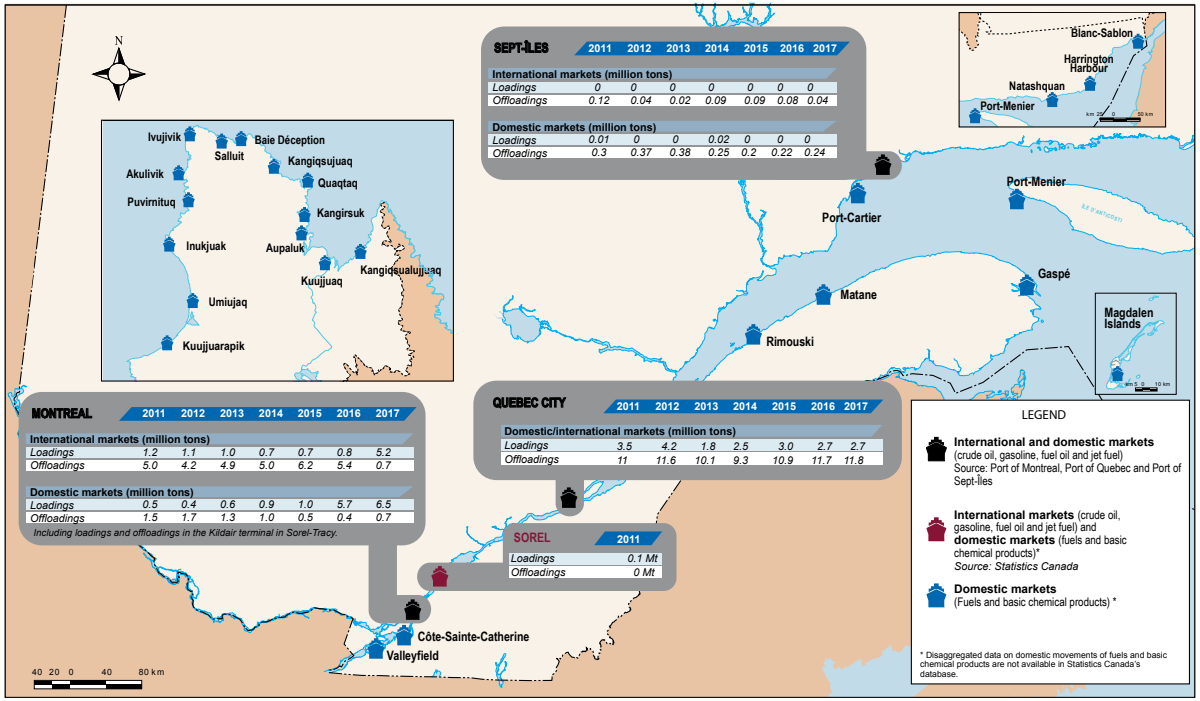
Source : Énergir, 2018.

The rise of non-conventional shale-gas production in North America is increasing the proportion of shale gas in Quebec's energy network.

MARITIME TRANSPORT

Quebec has many ports where oil and RPPs, including gasoline, diesel and fuel oil, can be loaded and unloaded. In some ports, terminals can be used to store petroleum products before they are transported by tank, rail or road within Quebec or to other Canadian or international markets (see Figure 10). In 2012, Statistics Canada stopped collecting data on domestic and international transport activities at Canadian ports since this is now the responsibility of Transport Canada. However, since no new data on port traffic or transported goods has been published, federal and provincial data on the volume of goods handled at Quebec ports is out of date.

FIGURE 10 • MAP OF CRUDE OIL, GASOLINE, FUEL OIL AND JET FUEL HANDLED IN QUEBEC PORTS, 2011–2017



Sources: Statistics Canada, 2012; data collected from the Quebec City, Montreal and Sept-Îles port authorities, 2018.
Note: Map produced by Quebec's Ministry of Transportation. 1 ton of oil ≈ 7.33 barrels.

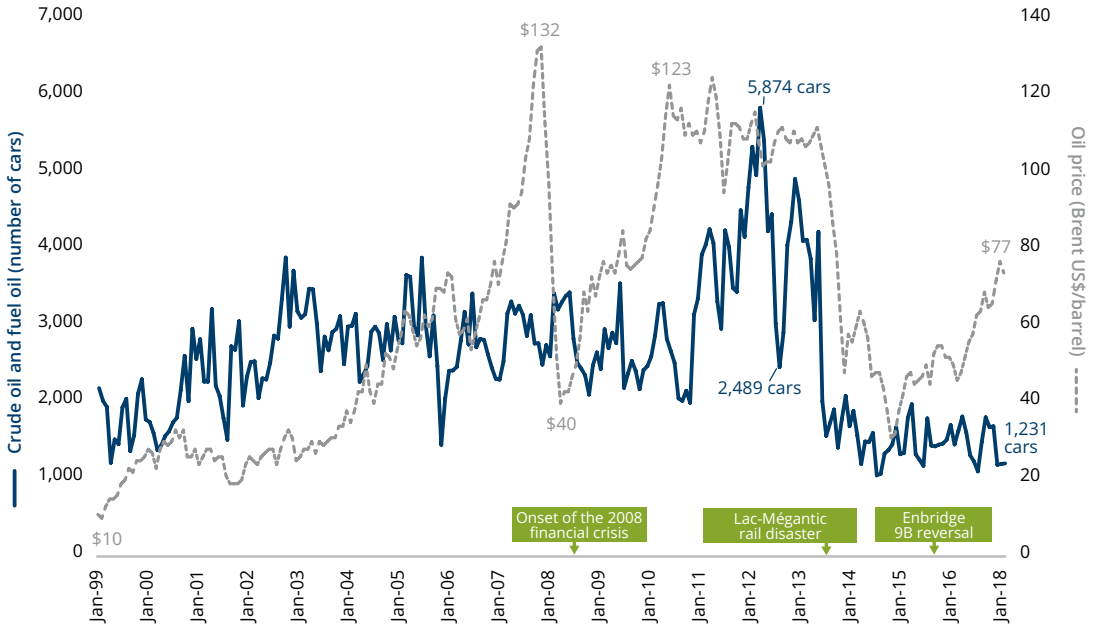
RAIL TRANSPORT

For reasons of confidentiality and competitiveness, no data on the rail transport of RPPs is available for Quebec; Statistics Canada provides aggregated data only for Eastern Canada as a whole. As shown in Figure 11, the rail transport of petroleum products was relatively stable before 2012. Then increased production in the oil sands and increased shale-oil production in western Canada and in the United States, combined with high oil prices, spurred an increase in the rail transport of crude oil and fuel oil. The July 2013 Lac-Mégantic rail disaster occurred three months after carloadings of crude oil and fuel oil had peaked. Following this accident, the number of cars carrying crude oil and fuel oil dipped but then returned to normal in October 2013. Since then, eastern Canada has seen a decrease in carloadings of crude oil and fuel oil, possibly due to the reversal of Enbridge's 9B pipeline.

ROAD TRANSPORT

Less than 10% of the approximately 320,000 kms of Quebec's road system fall under the jurisdiction of the Ministry of Transportation , which oversees provincial highways, regional roads, collector roads and resource access roads. Approximately 106,000 kms of roads, or about one third of the provincial road system, are under municipal management, with other provincial and federal departments and Hydro-Québec responsible for the remaining 183,000 kms[1]. The road system is used by trucks delivering RPPs from refineries and oil terminals (where RPP imports are landed) to gas stations. The transport of petroleum resources accounts for just 1.4% of vehicle/km of goods transported in Quebec[2].

FIGURE 11 • RAILWAY CARLOADINGS OF CRUDE OIL AND FUEL OIL (CARS PER MONTH) IN EASTERN CANADA, BASED ON THE PRICE OF OIL, JANUARY 1999–JUNE 2018



Sources: IEA, 2018; Statistics Canada, 2018 (table 23-10-0216-01).

In June 2018, Quebec's gasoline and diesel distribution system included 2,783 service stations[3]. As previously noted, Quebec also has 27 private or public fuelling stations for natural gas vehicles. In 2019, Quebec City expects to have the province's first multifuel station equipped to fuel hydrogen cell vehicles.

According to the *Régie de l'énergie,* Quebec had 2,876 gas stations at the end of 2016, 3.7% fewer than in 2010. Between 2010 and 2016, total gas station sales increased by 2.5% throughout Quebec, with the exception of Montreal, where gas station sales decreased by 14%. *The Régie de l'énergie* publishes this data every three years, and there is no other source of public data for regional sales of RPPs. The next report is due in 2019.

[1] MTMDET, 2016.

[2] Trépanier et al., 2015.

[3] Statistics Canada, 2018 (Table 33-10-0092-01).

ELECTRICITY PRODUCTION

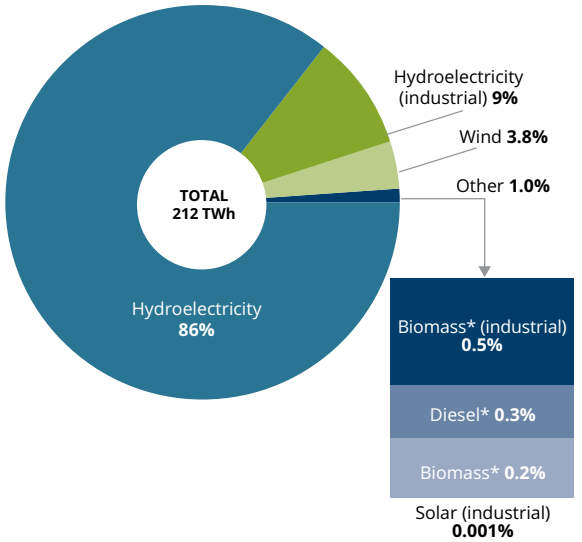
In 2017, Quebec produced 212 TWh of electricity, 95% from hydropower, 3.8% from wind power, and 1% from biomass, solar power and petroleum resources (see Figure 12). Hydro-Québec generates and buys nearly 90% of the pronvince's total hydroelectricity output. It is also involved in many regional exchanges (see Figure 13), although other stakeholders, such as Brookfield Renewable (second largest power exporter in Quebec) are also active in this field. There are more than 60 electricity producers in Quebec, some of which also distribute, broker and export power. Most have contracts with Hydro-Québec Distribution to sell it the power they generate from wind farms, cogeneration facilities, or small hydroelectric power plants.

Quebec's ten power redistributors (nine municipalities and one cooperative[4]) manage small power distribution networks that are separate from Hydro-Québec's. They purchase about 4.5 TWh of power from Hydro-Québec Distribution each year.

Hydro-Québec's TransÉnergie division operates the most extensive transmission system in North America, with 34,479 km lines at various voltages and 17 interconnections to import and export power to Quebec's neighbouring regions (see Table 3 and Figure 14). This system also incurs energy losses: In 2017, Hydro-Québec reported attrition rates of 5.79% for the transmission system and 2.3% for the distribution system[5].

The power distribution system is increasingly used to fuel electric vehicles (EVs). Table 4 shows the total number of electric vehicle charging stations in Quebec, either on the main public system (the Circuit électrique), on several private parallel systems open to the public, in workplaces, or at the homes of EV owners. TEQ data shows that on January 1, 2018, Quebec had 21,897 electric vehicles, including 10,015 battery electric vehicles (BEVs), 11,882 plug-in hybrid vehicles (PHVs), and 44,974 (non plug-in) hybrid vehicles. These vehicles account for 1.4% of the province's passenger vehicle fleet (4,758,010 vehicles[6]).

FIGURE 12 • SOURCES OF ELECTRICITY PRODUCTION IN QUEBEC, 2017



Source: Statistics Canada, 2018 (table 127-0002, preliminary data).

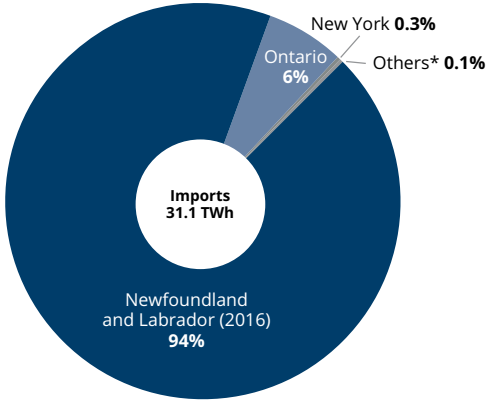
Note: Electricity production from combustion turbines (natural gas) and other unspecified power sources is not included in this figure because of its marginal contribution. *Since 2016, Statistics Canada has aggregated data for electricity production from conventional steam turbines, internal combustion turbines and combustion turbines. Data for biomass, diesel and natural gas were estimated from their respective contributions in 2015.

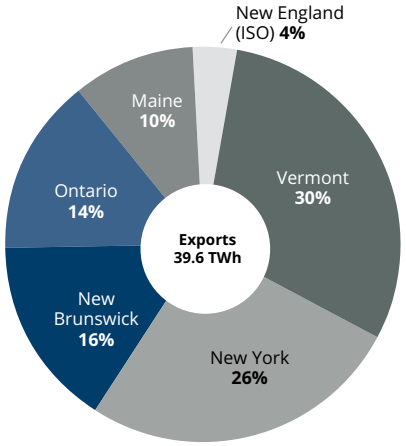
[4] AREQ, 2018.

[5] HQD, 2018; HQT, 2018.

[6] SAAQ, 2018. *Bilan 2017 Dossier statistique*, p.22..

FIGURE 13 • TOTAL IMPORTS AND EXPORTS OF QUEBEC'S ELECTRICITY, 2017





Sources: Statistics Canada, 2018 (table 25-10-0021-01); IESO, 2018; NB Power, 2018; NEB, 2018.

Note: *"Others" includes marginal imports from New Brunswick and Vermont.

TABLE 3 • QUEBEC'S ELECTRICITY NETWORK INFRASTRUCTURE, 2017

Installed generating capacity		
	(MW)	(%)
Hydroelectricity	40,543	89.1%
Wind	3,510	7.7%
Biomass	796	1.7%
Combustion (natural gas, fuel gas)	466	1.0%
Internal combustion (diesel)	191	0.4%
Solar (2015)	20	0.04%
Total	**45,527**	**100%**

Transmission and distribution	
	Lines (km)
Transmission (up to 765 kV)	34,479
Distribution (up to 34 kV) *	224,033

Interconnections (maximum capacity) **			
Region	Number	Imports (MW)	Exports (MW)
Ontario	8	1,970	2,705
New Brunswick	3	785	1,029
Vermont	3	2,170	2,275
New York	2	1,100	1,999
Newfoundland and Labrador	2	5,150	0
Total	**17**	**11,175**	**7,974**

Sources: Statistics Canada, 2018 (table 25-10-0022-01); CANWEA, 2017; Hydro-Québec, 2018, 2014.

Note: Data on installed capacity as of December 2016. *Includes low voltage power lines (106,286 km). **A shared interconnection between New York and Ontario was counted only once in the total; for total exports, 325 MW in simultaneous deliveries was considered for the Ontario/New York interconnection (and not 359 MW).

TABLE 4 • TOTAL ELECTRIC VEHICLE CHARGING STATIONS INSTALLED IN QUEBEC, 2018

	240 V (or less) charging stations			Quick-charge stations		
	2017	2018	Variation 2017-2018	2017	2018	Variation 2017-2018
TOTAL	**11,359**	**18,243**	**+61%**	**121**	**291**	**+140%**
Public stations[1] *including Circuit électrique (installed in Quebec)*	1,713 *1,113*	2,933 *1,435*	+71% *+29%*	121 *91*	291 *113*	+140% *+24%*
Workplace stations[2]	1,951	2,510	+29%			
Residential stations[2]	7,695	12,800	+66%			
TOTAL ELECTRIC VEHICLES (Sept. 30, 2018)	**19,384**	**35,855**	**+85%**			
Battery electric vehicles (BEVs)	8,815	16,255	+84%			
Plug-in hybrid vehicles (PHVs)	10,569	19,600	+85%			

Sources: Quebec Government, 2017; Hydro-Québec, 2018 (personal communication); ISQ, 2017, 2018; TEQ, 2018 (personal communications).

Note: [1] The total number of charging stations available to the public is for March 31, 2017 (2017), and March 31, 2018 (2018). Data on the stations on the "Circuit électrique" are for October 26, 2017 (2017), and October 28, 2018 (2018). [2]Data on workplace charging stations are based on the number of financial grants for the installation of stations under the "Branché au travail" program (as of September 30, 2017, and 2018) and "Roulez électrique" (as of September 30, 2017, and 2018).

FIGURE 14 • MAP OF QUEBEC'S MAIN POWER GENERATION AND DISTRIBUTION FACILITIES, 2017

Source: Hydro-Québec, 2018

Map credits: Géomatique; Hydro-Québec Innovation; Équipement et Services partagés.

Hydro-Québec's TransÉnergie division operates the most extensive transmission system in North America, with 34,479 km lines at various voltages and 17 interconnections to import and export power to Quebec's neighbouring regions.

DID YOU KNOW?

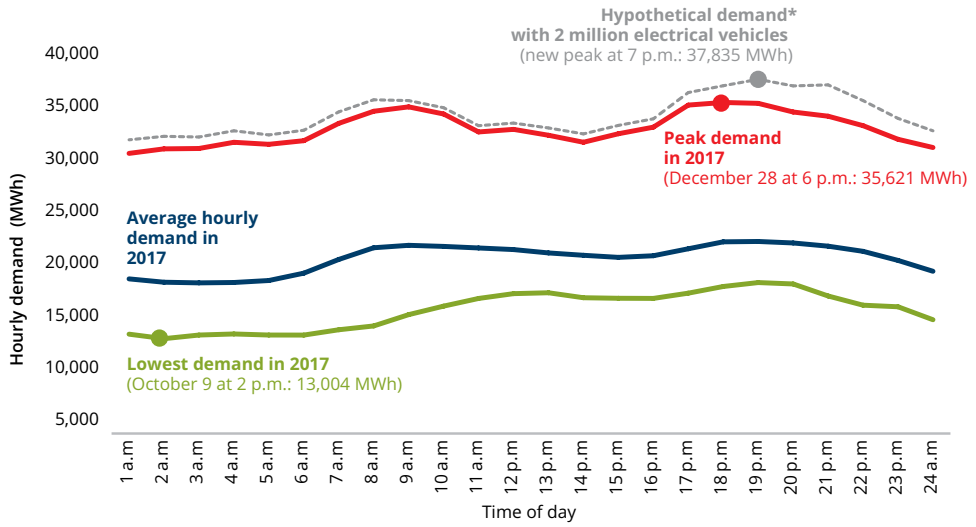
MANAGING PEAK ELECTRICITY DEMAND: AN EVEN GREATER CHALLENGE WITH ELECTRIC VEHICLES

In Quebec, electricity demand varies through time. After hitting a low of 13,004 MWh at 2 a.m. on October 9, 2017, it was 2.7 times higher (35,621 MWh) at 6:35 p.m. on December 28 (see Figure 15). While power generation adapts to meet this changing demand, all Hydro-Québec facilities (power plants, transmission lines and distribution network) must be calibrated to peak demand periods. This maximum capacity level is expensive and is only used for brief periods. In 2017, for example, 85% of maximum capacity demanded was enough to meet demand 95% of the time. To meet the demand for the remaining 5% of the time, the system had to use the additional 15% of the maximum capacity demanded. In other words, approximately 15% of Hydro-Québec's capacity is used just 5% of the time.

If the passenger transportation sector were to reach its target of reducing consumption of refined petroleum products by 40% by replacing 40% of gasoline-powered vehicles with electric vehicles (EVs), approximately two million EVs would charge on Hydro-Québec's network. Based on Hydro-Québec's estimated load profiles for the coldest days of winter (HQD, 2018), this would increase peak demand by 2,000 MW (see Figure 15), or by over 6%. Without changing usage patterns or more actively managing electricity demand, an even larger project than La Romaine (1,550 MW) would be required to meet this demand.

Fortunately, using smart technologies to better manage demand and Quebec's energy efficiency potential, it will be possible to avoid building such facilities, which would be used only during brief periods of the year. It will nevertheless be necessary to promote the use of these technologies, improve energy efficiency – and change our habits.

FIGURE 15 • AVERAGE HOURLY DEMAND, WITH DAYS OF PEAK AND LOWEST CONSUMPTION, 2017



Source: HQD, 2018.

Note: *Hypothetical demand is based on the average charging profile of EVs in Quebec during the three coldest business days of winter in 2017–2018 (HQD, 2018).

BIOFUEL PRODUCTION

In 2016, **biofuels** produced in Quebec met 8% of the province's energy needs. These biofuels are derived mainly from unused forest waste or by-products of the wood processing industry, which are recovered to generate heat or power. Biomass can also include other organic materials, such as agricultural and food waste (e.g., manure, cereal waste, whey, recycled vegetable oils and animal fats) and urban biomass (e.g., municipal sludge, residential food waste and landfills). Based on the source and intended use of biomass, many processes exist to convert it to power, including the production of electricity, biofuels, and renewable natural gas. Hydro-Québec has assessed the potential of forest, agri-food and urban biomass energy conversion in Quebec at 333 PJ per year. However, only 140 PJ, or 42% of its theoretical potential, was exploited in 2011[1].

TABLEAU 5 • BIOFUEL PRODUCTION IN QUEBEC, 2018

	Production capacity (ML/yr)	Location	Source	Status
Biodiesel	**TOTAL > 51**			
Rothsay Biodiesel LLC	45	Montreal	Recycled animal fats, used cooking oils	Operating
Innoltek Inc.* (formerly Evoleum)	6	Saint-Jean-sur-Richelieu	Animal fats, used cooking oils and other oils	Operating. Potential production capacity: 11 ML/yr
Innoltek Inc.*	–	Thetford Mines	--	The facility was closed and transferred to Saint-Jean-sur-Richelieu on December 1, 2017
Bio-Liq	n. a.	Saint-Marc-des-Carrières	Recycled vegetable oils, animal fats and vegetable oil	Operating
Bioénergie La Tuque	–	La Tuque	Forest waste	Currently under review for technical and economic demonstration potential. Operation expected for 2023. Expected capacity: up to 200 ML/yr
Ethanol	**TOTAL 175**			
Greenfield Global	175	Varennes	Corn	Operating
Enerkem	–	Varennes	Sorted industrial, commercial and institutional waste (after recycling)	Proposed commercial facility. Construction expected to begin in 2019. Expected capacity: up to 50 ML/yr
Enerkem	–	Westbury	Wood waste and other residual waste	Demonstration facility and innovation centre for the development of new products. Capacity: 5 ML/yr

Sources: RICanada, 2018; Bio-Liq, 2017; Greenfield Global, 2018; Rothsay Biodiesel, 2018; Enerkem, Evoleum, Innoltek, Bioénergie La Tuque, 2018 personal communications.

Note: *Innoltek Inc. acquired the Evoleum plant in Saint-Jean-sur-Richelieu on December 1, 2017.

In Quebec, **the combustion of solid biomass** is the most common way to convert biomass into energy. According to TEQ's latest (preliminary) data, in 2016, the residential sector consumed approximately 32% of the total forest biomass, mainly as wood fuel. The remaining 68% was used by the industrial sector, mainly in the pulp and paper, wood-processing, and sawmill industries.

The most common **biofuels** in Quebec, ethanol and biodiesel, can be used as partial or complete substitutes for RPPs such as gasoline and diesel. In 2018, there were four commercial biofuel production plants in Quebec and one demonstration plant (see Table 5) with annual production of approximately 51 million litres (ML) of biodiesel and 175 ML of ethanol. A biodiesel production project is currently under assessment in La Tuque, and the construction of a commercial ethanol production facility with annual capacity of 50 ML is scheduled to begin in Varennes in 2019. On October 26, 2018, biodiesel manufacturer Innoltek Inc. transferred all its operations from its plant in Thetford Mines to the Evoleum plant in Saint-Jean-sur-Richelieu acquired in December 2017. As a result of this reorganization, the total production capacity of the two facilities decreased from 11 ML/year in 2017 to 6 ML/year in 2018.

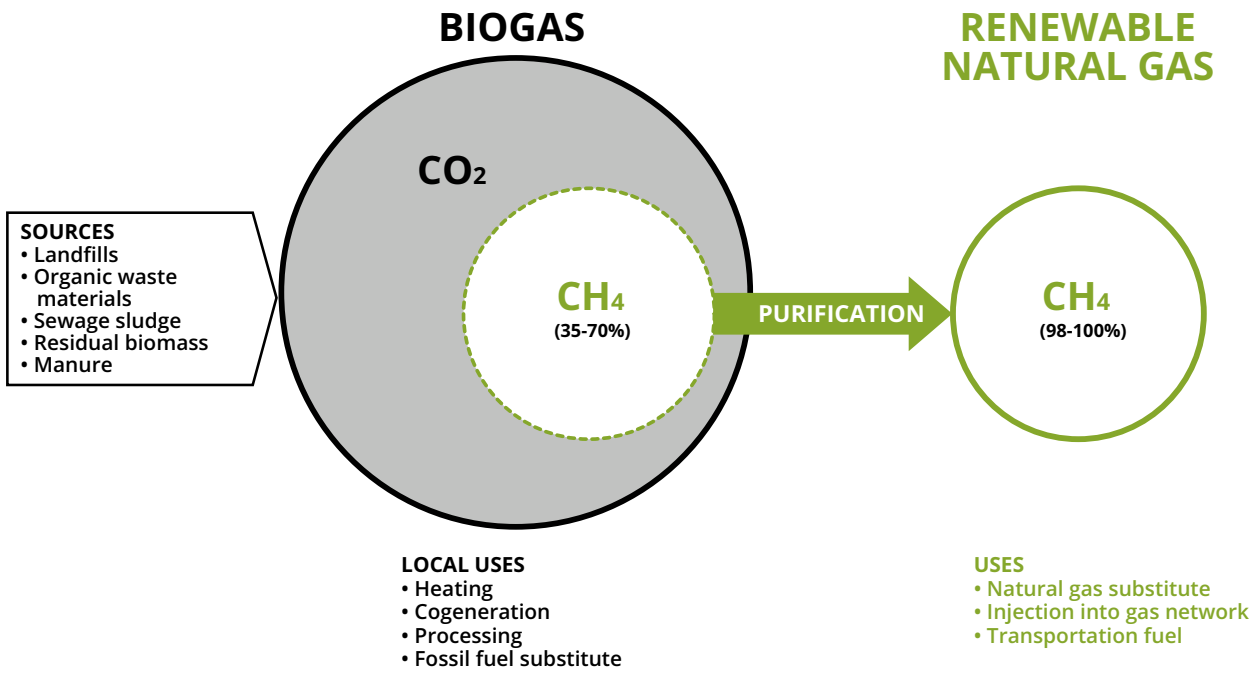
[1]Hydro-Québec, 2014, p. 7.

In Quebec's 2017–2020 Action Plan for implementing the 2030 Energy Policy, the governement aimed to increase the production and consumption of biofuels in Quebec by helping to finance the construction of at least one demonstration plant by March 31, 2020. It also planned to formulate a new regulation requiring at least 2% of renewable biofuel content in diesel (100 ML) and 5% in gasoline (300 ML) by 2020. Since these percentages have been required by the federal government since 2010, Quebec's new regulations introduce nothing new, but they give the province a way to increase biofuel content requirements in the future.

Biogas is a by-product of the decomposition of organic materials in oxygen-free environments such as landfills or agricultural, industrial and municipal anaerobic digesters. Biogas is composed mainly of methane (CH_4) (35% to 70%) and carbon dioxide (CO_2). The refining of biogas produces **renewable natural gas** (RNG) comparable to the natural gas supplied by the gas pipeline network (see Figure 16). Since CH_4 is a more harmful GHG than CO_2, biogas capture can help reduce GHG emissions while providing a local source of renewable energy.

There is currently no official data on all biogas conversion projects and RNG production in Quebec. Table 6 provides an overview of existing and upcoming projects in Quebec. This table is based on various sources, is not exhaustive, and was not confirmed by any government authority.

FIGURE 16 • DIFFERENCE BETWEEN OF BIOGAS AND RENEWABLE NATURAL GAS



Source: Figure created by the authors.

DID YOU KNOW?

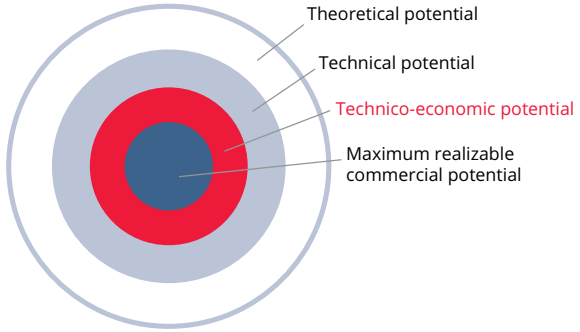
TECHNICO-ECONOMIC POTENTIAL OF RENEWABLE NATURAL GAS IN QUEBEC

A study done for Énergir by WSP and Deloitte assessed the potential for producing renewable natural gas (RNG) in Quebec by 2018 and 2030[8]. RNG's technico-economic potential (TEP), i.e., the portion of the technical potential for which RNG's operating and production costs make it economically viable for producersunder current pricing conditions, before taking into consideration any adoption or market barriers (See Figure 17), was assessed at 25.8 million GJ, based on an average RNG purchase price of $15/GJ (see Figure 18). This compares to $3.42/GJ for conventional natural gas on October 1, 2018[9],[10] and, according to the study, the $15/GJ purchase price is competitive with the price of electricity in Quebec. If this potential is realized, RNG would represent 12% of natural gas volumes distributed by Énergir. By 2030, the TEP was estimated to be between 51 and 182 million GJ/year, with an average purchase price of RNG between $10 and $20/GJ.

In 2018, the main supply sources that could fulfill this TEP at an average purchase price of $15/GJ were the methanation of plant-based agriculture biomass and waste from the agri-food industry (72%) and the capture of biogas from landfills (27%). By 2030, Quebec will need new RNG supplies from second-generation technologies that are not currently widely marketed such as forest biomass conversion. These volumes could help increase the share of renewable energy used in Quebec.

Achieving these results will nevertheless depend on several factors, including the production and purchase price of RNG, new technologies, competition for the

FIGURE 17 • SCOPE OF ASSESSMENT OF RENEWABLE NATURAL GAS PRODUCTION POTENTIAL



Source: Figure based on J. Harvey and Associates Environmental Consulting, 2017

The technico-economic potential of renewable natural gas was estimated at 25.8 million GJ at an average purchase price of $15/GJ in 2018. Fulfilling this potential will depend on several factors, including the production cost and purchase price of RNG.

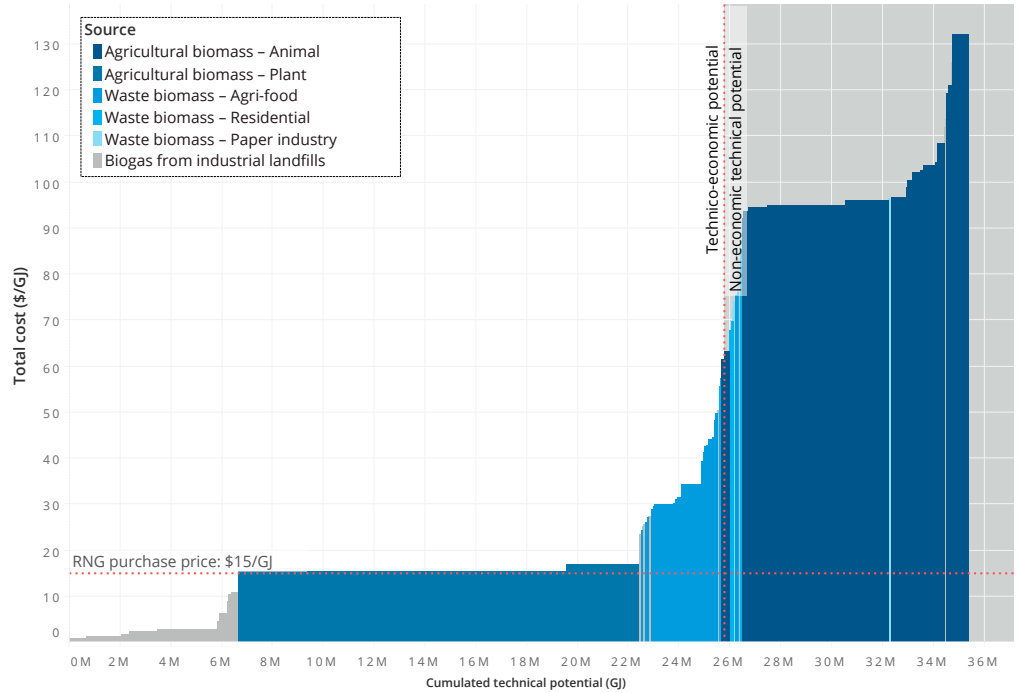
[8] WSP, 2018. *Évaluation du potentiel de production de gaz naturel renouvelable (GNR) au Québec, rapport détaillé préparé pour Énergir,* Ref. WSP: 181-07151-00, p. 86.

[9] Énergir, 2018. Price of natural gas, https://www.energir.com/en/business/price/natural-gas-price/ (accessed on October 29, 2018).

[10] Purchase price does not include costs for transportation, distribution and the cap-and-trade system. Prices vary depending on client type, load profile and total consumption.

DID YOU KNOW? (CONTINUED)

FIGURE 18 • TECHNICO-ECONOMIC POTENTIAL OF RENEWABLE NATURAL GAS PRODUCTION IN QUEBEC, 2018



Source: WSP and Deloitte, 2018.

use and development of the RNG supply, the degree of government intervention, and the prices of carbon and other energy sources.

A BAN ON LANDFILLING ORGANIC MATERIALS?

Quebec's Residual Materials Management Policy – 2011-2015 Action Plan recommends that the government "draw up a strategy to ban the disposal of organic putrescible waste," but no formal ban currently exists in the province. Putrescible organic materials (food waste, green residues such as leaves and grass, municipal and industrial biosolids) have never been banned from landfills, as recommended in the strategy ("ban the disposal of organic materials").

To stop these materials from ending up in landfills, the government has also created a program for the processing of organic materials through composting and biomethanation. Since 2012, the program has provided financial assistance to municipalities wishing to establish composting or biomethanation facilities. Although the program was initially scheduled to conclude in late 2019, a decision was made in 2017 to extend it to the end of 2022 to give municipalities more time to change their residual materials-collection practices.

Source: www.mddelcc.gouv.qc.ca/matieres/pgmr/index.htm

In Quebec, biogas is primarily recovered from landfills and water treatment facilities. On a smaller scale, it is also converted into energy by many small-scale cheese factories. Before processing, it can be used for heat generation or the cogeneration of heat and power. In 2018, projects implemented resulted in the conversion of approximately 221 Mm^3 of biogas in Quebec. In the city of Laval, a project planned for 2022 could convert an additional 9 Mm^3 of biogas.

In some facilities, biogas is purified to produce renewable natural gas (RNG), a substitute for non-renewable natural gas that can be used for the same purposes. In 2018, three projects to produce RNG as a natural gas substitute produced nearly 120 Mm^3 of RNG. Almost 85% of this domestic production was exported to the United States, where its environmental benefits justify higher prices. Nine other projects totalling 77 Mm^3 are also expected in the coming years (see Table 6).

The Quebec government also plans to promote the production of **synthetic gas** by the gasification of solid carbonaceous materials such as residual forest biomass. This type of gas is composed primarily of carbon monoxide (CO) and hydrogen (H_2). In 2015, the government granted $3 million to Pyrobiom Énergies for its residual wood biomass energy conversion project aiming to produce 9 million litres of pyrolysis oil (a substitute for industrial heavy fuel oil) and 3,000 tons of biocoal in La Tuque. The demonstration project ended in 2018, and the plant is now in operation.

Quebec's Residual Materials Management Policy – 2011-2015 Action Plan recommends that the government "draw up a strategy to ban the disposal of organic putrescible waste. Currently, no formal ban exists in the province.

TABLE 6 • SUMMARY OF BIOGAS RECOVERY, RENEWABLE NATURAL; GAS AND SYNTHETIC GAS PRODUCTION PROJECTS IN QUEBEC, 2018

Project	Million m³/year		Number of projects		Source	Main applications
	Implemented	Planned	Implemented	Planned		
BIOGAS* (total min.)	**221.7**	**8.7**	**23**	**1**		
Municipal	8.9	8.7	7	1	LF, MS	Cogeneration (power and heat generation); municipal sludge or wood drying, heating buildings; heating processes
Industry – landfill	213.3	0	9	0	LF, OM ICI, OM, R-ICI	
Industry – agricultural**	0	n.a.	0	n.a.	Manure	
Industry – agri-food	0.00005	n.a.	7+	n.a.	OM, IW	
RENEWABLE NATURAL GAS* (total min.)	**118**	**80.3**	**3**	**8**		
Municipal	16.8	24.2	1	7	OM, R-ICI, MS	Natural gas substitution (sold and injected into the gas network); liquefied RNG production for vehicles
Industry – agricultural**	0	2.1	0	1	Manure, OM ICI	
Industry – landfill	103 (exported to the U.S.)	37.8	2	1	LF	
SYNTHETIC GAS* (total min.)**	**–**	**n.a.**		**1**		
Industry – forestry	–	n.a.		1	Forest waste	Cogeneration; fuel production

Sources: See Whitmore and Pineau, 2017; Énergir, 2018 (personal communication).

Note: There is no official survey of biogas energy recovery projects in Quebec. These data were the best source of information at the time of publishing this report, but they are neither exhaustive nor confirmed. *Biogas contains mostly methane (35% –70%) and carbon dioxide. Purification results in renewable natural gas (RNG) of comparable quality to the natural gas in the gas network. **According to a source at MERN, "farm projects in Saint-Hilaire and Poliquin do not produce biogas." ***Synthetic gas is made from the gasification of solid carbonaceous materials, like coal and biomass, and contains mostly two other fuel gases: carbon monoxide (CO) and hydrogen (H_2).

Legend: MS=municipal sludge, OM=organic materials, R=residential, ICI=institutional, commercial and industrial, LF=landfills, IW=industrial waste, NG=natural gas, RNG=renewable natural gas, n. a. =not available.

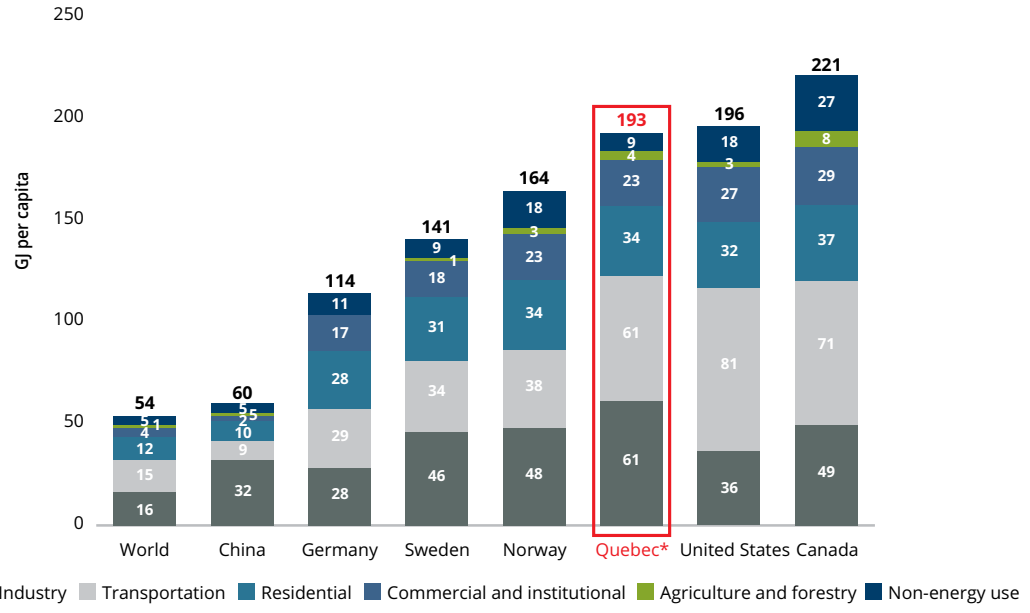
3.3 • ENERGY CONSUMPTION

Once transformed into useful energy products, the energy distributed to consumers can be used in various ways. Nearly two thirds of this energy is used for industrial, commercial or institutional applications, leaving one third to be used directly by Quebec households for lighting, heating, air conditioning, motorisation and transport.

In 2016, Quebec's total energy consumption in all sectors combined was 1,528 PJ. Compared to other countries, this is high per capita consumption. As shown in Figure 19, only Canada and the United States rank higher than Quebec in this area.[11] This is partly due to the industrial sector's use of hydropower, which has attracted energy intensive industries to the province, but also to higher energy consumption for transportation and buildings (residential and commercial) than in European countries with comparable or higher standards of living.

In 2016, nearly 57% of energy used in Quebec was from hydrocarbon sources (oil, natural gas, coal, natural gas liquids [NGLs]), including 44% from renewable sources (see Figure 20a). The industrial sector was responsible for 34% of total energy consumption in Quebec, while the transport sector accounted for 30%, the residential, commercial and institutional building sector for nearly one third (see Figure 20b), and the agricultural sector for only 2%. Non-energy uses, including the production of asphalt, plastic, lubricant and chemical fertilizers, accounted for 4% of total consumption. Over 97% of the energy used in the transportation sector came from petroleum products, while electricity was the main energy source in the residential (73%) and industrial (48%) sectors (see Figure 21). Natural gas

FIGURE 19 • COMPARAISON OF QUEBEC'S ENERGY CONSUMPTION PER CAPITA WITH THAT OF OTHER COUNTRIES, 2016



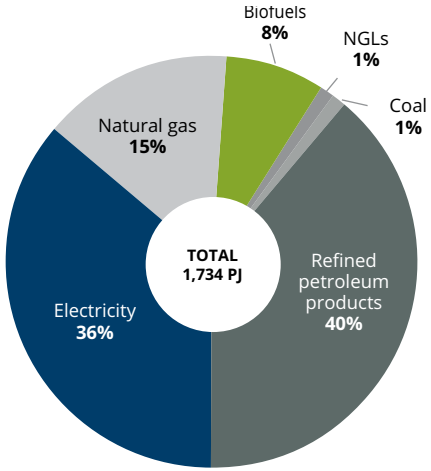
Sources: IEA, 2018; except * for Quebec, Statistics Canada, 2018 (table 25-10-0029-01).

Note: This figure represents energy use by country. Only four small countries have a higher energy use per capita than that of Canada: Trinidad and Tobago, Qatar, Iceland and Luxembourg.

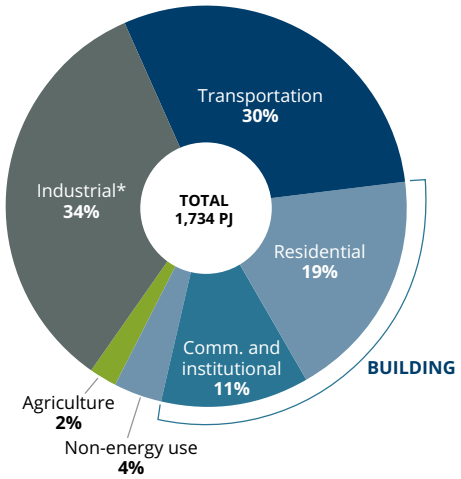
[11] Excluding Trinidad and Tobago, Qatar, Iceland and Luxembourg, all very small countries where specific energy conditions prevail.

FIGURE 20 • QUEBEC'S TOTAL CONSUMPTION BY ENERGY SOURCE AND SECTOR, 2016

A) Consumption by energy source

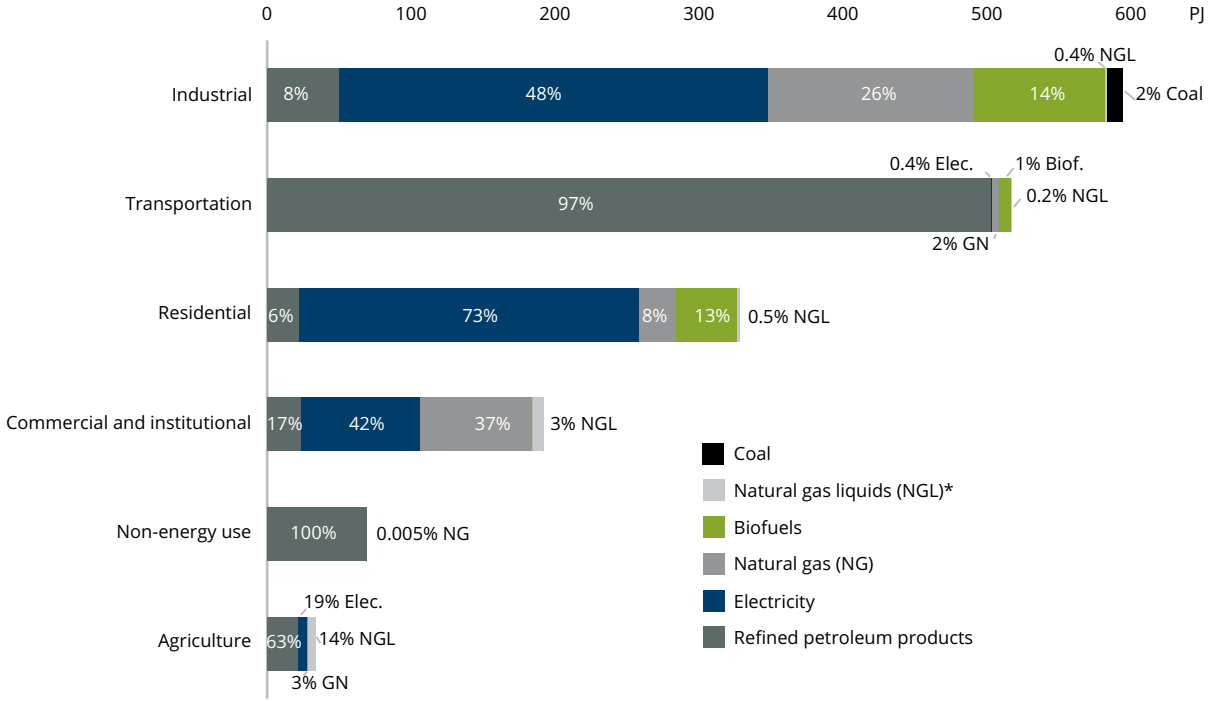


B) Consumption by sector



Sources: Statistics Canada, 2018 (table 25-10-0029-01); TEQ, 2018 (preliminary data); Bert, 2015.

FIGURE 21 • QUEBEC'S CONSUMPTION OF ENERGY SOURCES BY SECTOR, 2016



Sources: Statistics Canada, 2018 (table 25-10-0029-01); TEQ, 2018 (preliminary data); Bert, 2015.
Note: * "NGL" includes propane and butane.

is used mainly for industrial purposes (26%) and for heating in the commercial and institutional sectors (37%).

TRANSPORT SECTOR

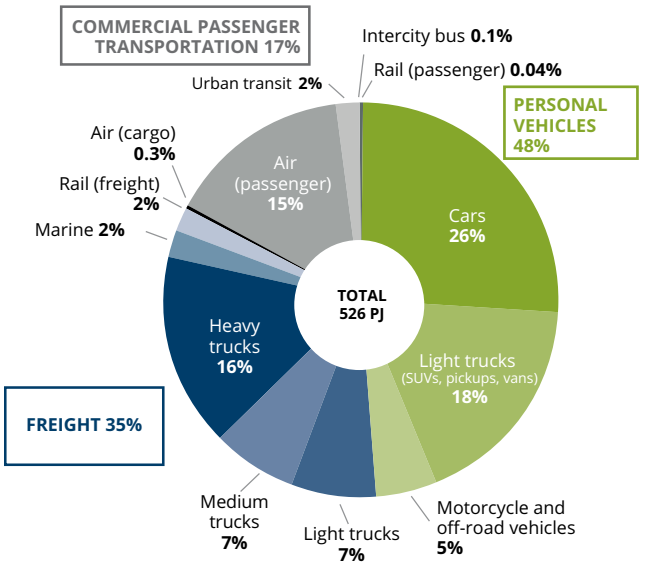
In 2016, the transport sector accounted for one third of Quebec's total energy use (approximately 526 PJ), according to the Office of Energy Efficiency. Overall, the commercial transport of goods and passengers (air, rail, local and intercity) uses slightly more energy than the total fleet of personal vehicles: 52% compared to 48% (see Figure 22). From 1990 to 2016, the sector's total energy use grew by 32%. There was strong growth in the transport of freight (40%) compared to personal vehicles (14%) during the same period (see Figure 23). The decline in consumption by automobiles (-22%) was offset by strong growth in consumption by light trucks (+150%) due to increased sales of this type of vehicle (see box on page 32). There has also been strong growth (+120%) in the air transport of passengers since 1990. Excluding passenger transportation by intercity bus and rail, all modes of commercial transportation consumed more energy in 2016 than in 1990.

All modes of transportation use fossil fuels almost exclusively, with only marginal use of biofuels and electricity (see Figure 24). The transportation sector as a whole accounts for approximately 70% of the total use of RPPs for energy in Quebec. Freight transportation by heavy trucks (86 PJ) and passenger air transportation (80 PJ) accounted for more than 61% of total energy use in the commercial transportation sector (271 PJ).

This data suggests that priority should be given to initiatives to reduce energy consumption and GHG emissions in the commercial transportation sector. Such measures would be particularly useful in helping to achieve government targets to reduce the consumption of RPPs by 40% and of GHG emissions by 37.5% by 2030.

In 2017, the *Société de l'assurance automobile du Quebec* (SAAQ), claimed there were 6.55 million vehicles on Quebec's roads, including 4.98 million passenger vehicles (cars and light trucks, including sport utility vehicles (SUVs), motorcycles, and motorhomes)[12]. Between 1990 and 2016, Quebec's fleet of passenger vehicles grew by 59%, nearly three times more than the province's population growth (+19%). The strongest growth was for light passenger trucks (+262%) and light freight transportation trucks (+253%) (see Table 7).

FIGURE 22 • ENERGY USE IN THE TRANSPORTATION SECTOR BY VEHICLES TYPES (PERSONAL AND COMMERCIAL USES), 2016

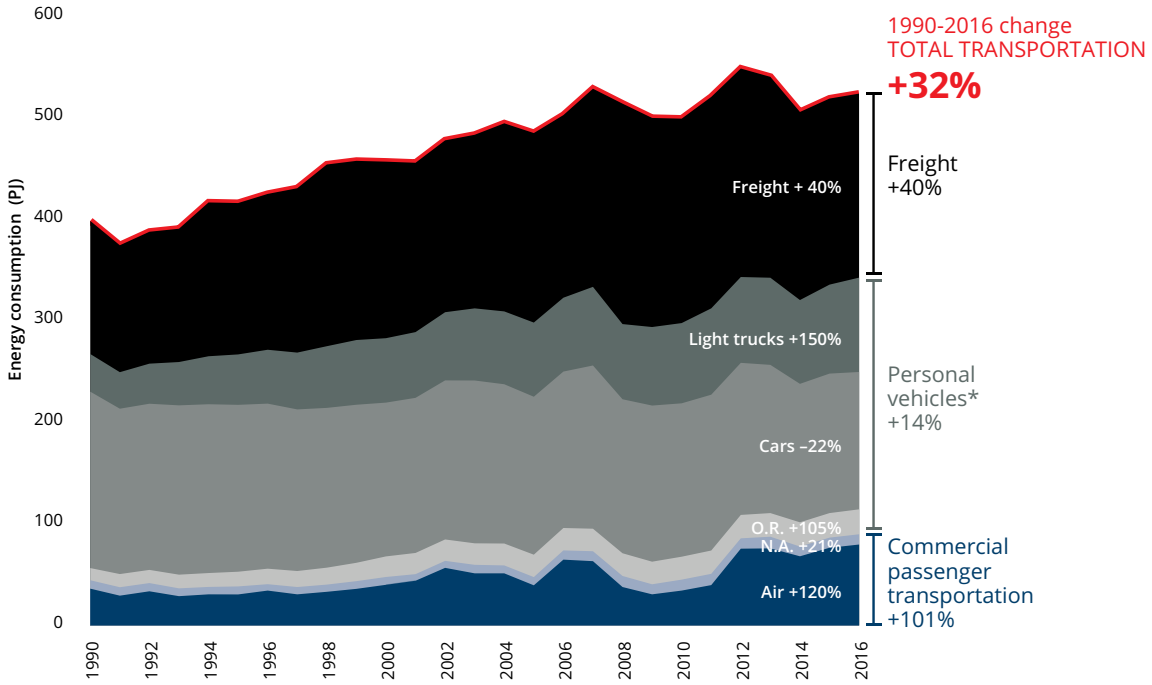


Sources: OEE, 2018.

Note: Air, marine and rail transport data is not available by region. Data on air transport includes domestic and international lines, which include the energy uses examined in the Report on Energy Supply and Demand in Canada (57-003-X).

[12] SAAQ, 2018. p. 150.

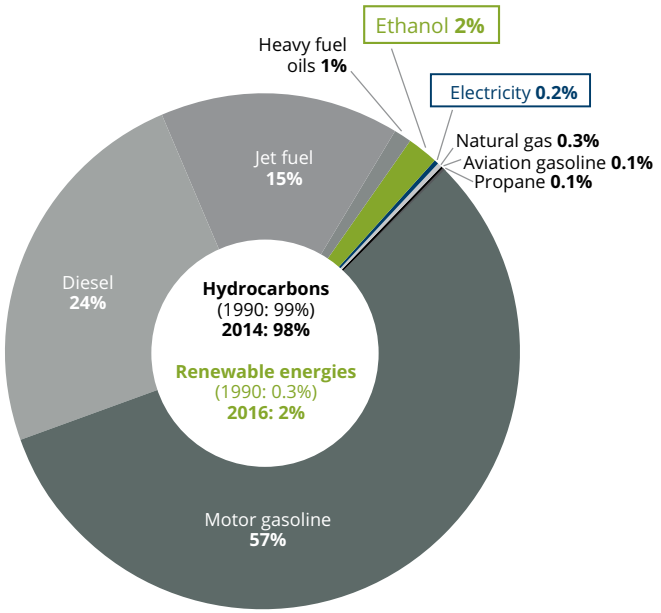
FIGURE 23 • ENERGY CONSUMPTION TRENDS BY MODES OF TRANSPORTATION IN QUEBEC, 1990–2016



Source: OEE, 2018.

Note: O.R.=off-road vehicles; N.A.=Non-air transportation of passengers. *Including motorcycles.

FIGURE 24 • FUELS USED IN TRANSPORTATION IN QUEBEC, 2016



Source: OEE, 2018.

Note: *Data on ethanol dates back to 2014, as no data was available for 2015 and 2016.

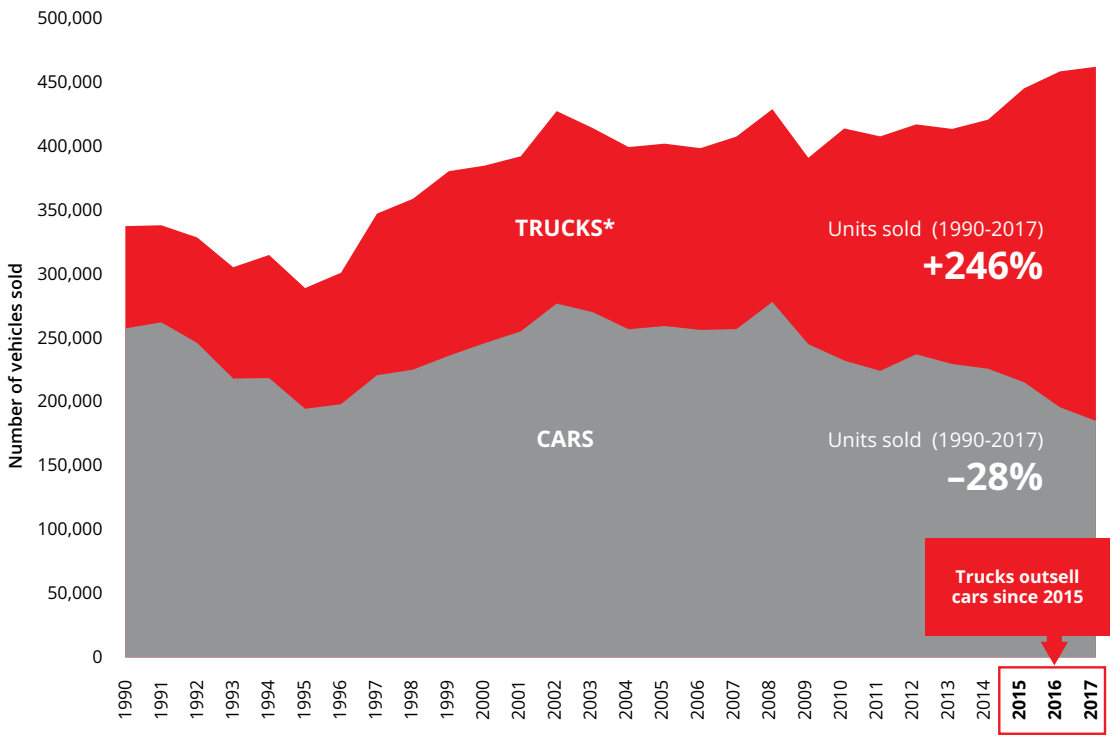
DID YOU KNOW?

QUEBECERS CONTINUE TO PREFER SUVs OVER PASSENGER CARS

In 2017, gasoline sales reached record levels in Quebec (see Figure 7), partly because, once again, Quebecers bought more trucks, including mini-vans, SUVs and pickup trucks. Since 1990, car sales have been falling (-28%), while sales of more energy-guzzling trucks have increased by 246% (see Figure 25). If nothing is done to reverse this trend – such as adopting green taxes or regulations - truck sales will continue to rise to the detriment of car sales, including the major electric vehicle (EV) models.

Since 2015, light trucks have outsold cars in Quebec in terms of both number of vehicles sold and amounts spent. In 2017, Quebecers spent twice as much on light trucks ($12 billion) as on cars ($5.4 billion) (see Figure 26). However, higher truck sales have not been offset by lower car sales: vehicle sales have increased every year in Quebec since 2013. This growth in the number of units sold slowed to 0.8% in 2017, compared to 3% in 2016. The total spent increased by 6.1% in 2017, down from 9.9% the previous year.

FIGURE 25 • CAR AND TRUCK SALES IN QUEBEC, 1990–2017



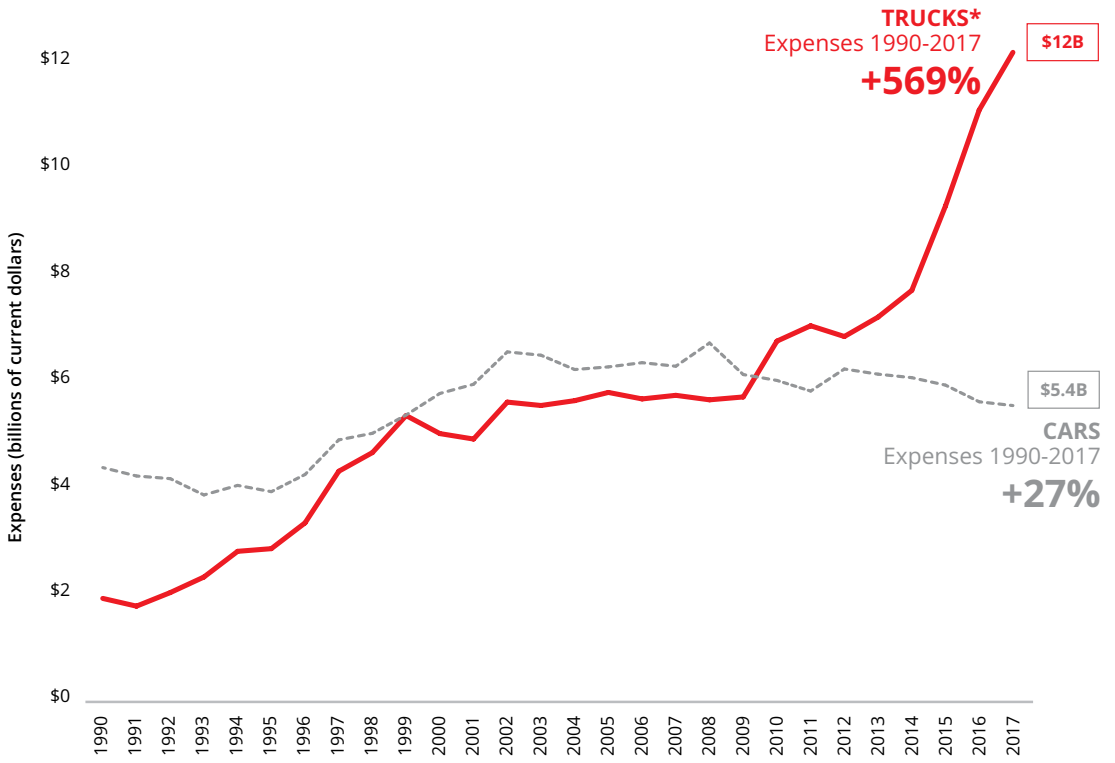
Source: Statistics Canada, 2018 (table 20-10-0001-01).

Note: * Trucks include minivans, SUVs, light and heavy trucks, vans and buses.

PERSONAL VEHICLES: THE MAIN MODE OF TRANSPORTATION FOR QUEBEC WORKERS

According to the *Institut de la statistique du Québec,* of the 3.7 million Quebecers who commuted to work every weekday in 2016, 78% reported using primarily a personal vehicle. Only 14% of workers used public transportation, and 7% used active transportation (walking or biking). Car-pooling was marginal (10%) compared to the use of single-passenger vehicles (68%). The average time spent travelling between home and work was 43 minutes via public transportation compared to 24 minutes via personal vehicle.

FIGURE 26 • EXPENSES RELATED TO SALES OF VEHICLES IN QUEBEC, 1990–2017



Source: Statistics Canada, 2018 (table 20-10-0001-01).

Note: * Trucks include minivans, SUVs, light and heavy trucks, vans and buses.

DID YOU KNOW? (CONTINUED)

THE ENERGY IMPACT OF ELECTRIC VEHICLES

Quebec has set a goal of increasing the number of EVs (battery electric vehicles [BEVs] or plug-in hybrid vehicles [PHVs]) to no fewer than 100,000 by 2020. In early 2018, there were 21,897, including 10,015 BEVs and 11,882 PHVs. Assuming those vehicles were used to drive the same distances as the average car in Quebec, they consumed approximately 45 GWh (45 million kWh), or approximately 2,483 kWh per BEV and 1,665 kWh per PHV. If those EVs had been gasoline powered, they would each have used 1,106 litres (BEV) and 741 litres (PHV) of gasoline. We can therefore estimate that Quebec's EV fleet reduced the use of gasoline by approximately 19.9 million litres (equivalent to 0.2% of the 9 billion litres sold) and that they reduced emissions by 47,000 t CO_2 eq.

As for personal transportation, a 40% reduction in the number of gasoline-powered vehicles (approximately two million) could help reduce by 40% the consumption of petroleum products compared to 2013 levels by 2030. Replacing gasoline-powered vehicles with EVs could reduce the use of gasoline by 2.7 billion liters. EVs would increase power consumption by 5 TWh (5 billion kWh), however. These estimates assume that the proportion of electric SUVs (35%) and electric cars (65%) would be identical to the current proportions in the passenger vehicle category. Figure 15 shows the hypothetical impact of two million EVs on peak electricity demand.

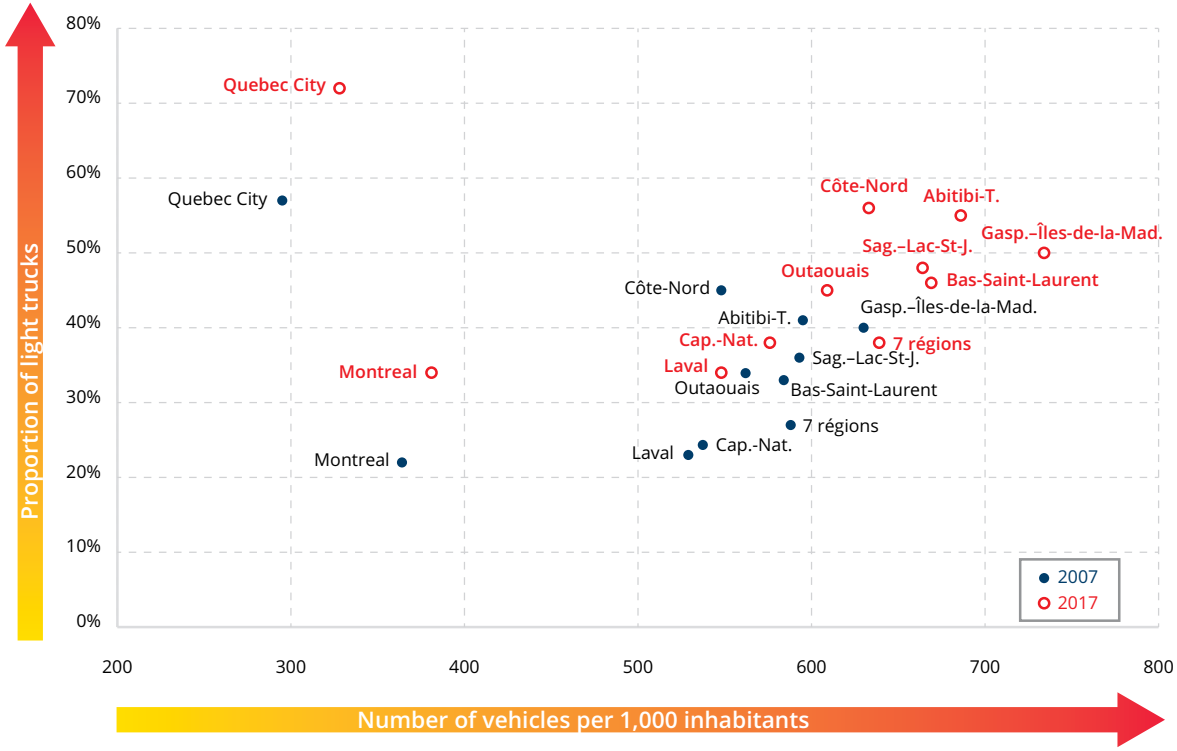
Higher truck sales helped to increase the number of vehicles per capita: from 2007 to 2017, the motorization rate increased from 523 to 567 vehicles per 1,000 Quebecers. During that same ten-year period, the population grew by 9%, while the number of passenger vehicles (cars and light trucks, using SAAQ categories) grew by 18%. In Quebec, light trucks accounted for 27% of vehicles in 2007 and 39% in 2017.

This trend was the same across all Quebec regions (see Figure 27): there were more vehicles per capita, and the proportion of light trucks grew across all regions. This can't be explained by either geography or population density: neither factor changed between 2007 and 2017. What has changed is the vehicle preferences of Quebecers and their ability to purchase light trucks. More Quebecers want to own a personal vehicle, and they are increasingly choosing to purchase light trucks.

There are regional differences in motorization rates and the popularity of light trucks, however. In 2017, Montreal and Nord-du-Québec had the fewest vehicles per capita: 381 per 1,000 in Montreal and 328 in Nord-du-Québec. Gaspésie had the most vehicles per capita: 734 per 1,000 people. Montreal and Laval had the lowest proportion of light trucks (34%), while this proportion exceeded 50% in Gaspésie, Abitibi-Temiscamingue, Côte-Nord, and Nord-du-Québec (72%). It's worth nothing that, in 2007, except for in

Nord-du-Québec, light trucks accounted for less than 50% of passenger vehicles in all Quebec regions. It should also be noted that, since passenger vehicles exclude commercial vehicles, none of the light trucks included in these statistics were used for commercial purposes (agricultural, construction, plumbing, etc.).

FIGURE 27 • PERCENTAGE OF LIGHT TRUCKS AND MOTORIZATION RATE IN QUEBEC'S ADMINISTRATIVE REGIONS, 2007 AND 2017



Sources: SAAQ, 2013, 2018.

Note: *For ease of reading, the data for the seven following regions were aggregated given the similarity of their statistics: Chaudière-Appalaches, Mauricie, Centre-du-Quebec, Estrie, Montérégie, Lanaudière and Laurentides.

Table 7 also shows the preference of Quebecers for individual vehicles. While average gasoline consumption decreased between 1990 and 2016 for all vehicle categories, average consumption per 100 km has decreased 17% for cars and only 12% for light trucks. In 2016, cars used an average of 23% less fuel than light trucks per 100 km (8.4 L compared to 10.8 L) but were less popular. While the average distance driven in personal vehicles decreased by 25% between 1990 and 2016, it increased for freight trucks (+24%), especially for heavy trucks (+55%).

TABLE 7 • TRENDS IN QUEBEC'S VEHICLE FLEET, 1990–2016

	Number of vehicles in 2016 (thousands)	Variation 1990–2016	Sales of vehicles in 2016 (thousands)	Variation 1990–2016	Average distance driven, 2016 (km)	Variation 1990–2016	Average fuel consumption, 2016 (litres/100 km)	Variation 1990–2016	Number of vehicles per 1,000 inhabitants, 2016	Variation 1990–2016
Personal	**5,368**	**59%**	**385**	**24%**	**13,398**	**-25%**	**9.6**	**-15%**	**645**	**37%**
Cars	3,623	*29%*	*200*	*–21%*	*12,639*	*–28%*	*8.4*	*–17%*	*435*	*9%*
Light trucks	1,745	*262%*	*185*	*235%*	*14,157*	*–22%*	*10.8*	*–12%*	*210*	*204%*
Freight	**791**	**162%**	**74**	**173%**	**43,753**	**24%**	**20.6**	**–25%**	**95**	**120%**
Light trucks	487	*253%*	*52*	*227%*	19,845	*–21%*	*10.9*	*–12%*	*59*	*197%*
Medium trucks	221	*118%*	*18*	*124%*	20,792	*–7%*	*21.0*	*–24%*	*27*	*83%*
Heavy trucks	83	*32%*	*5*	*38%*	90,622	*55%*	*29.9*	*–30%*	*10*	*11%*

Sources: OEE, 2018; Statistics Canada, 2018 (table 17-10-0005-01).

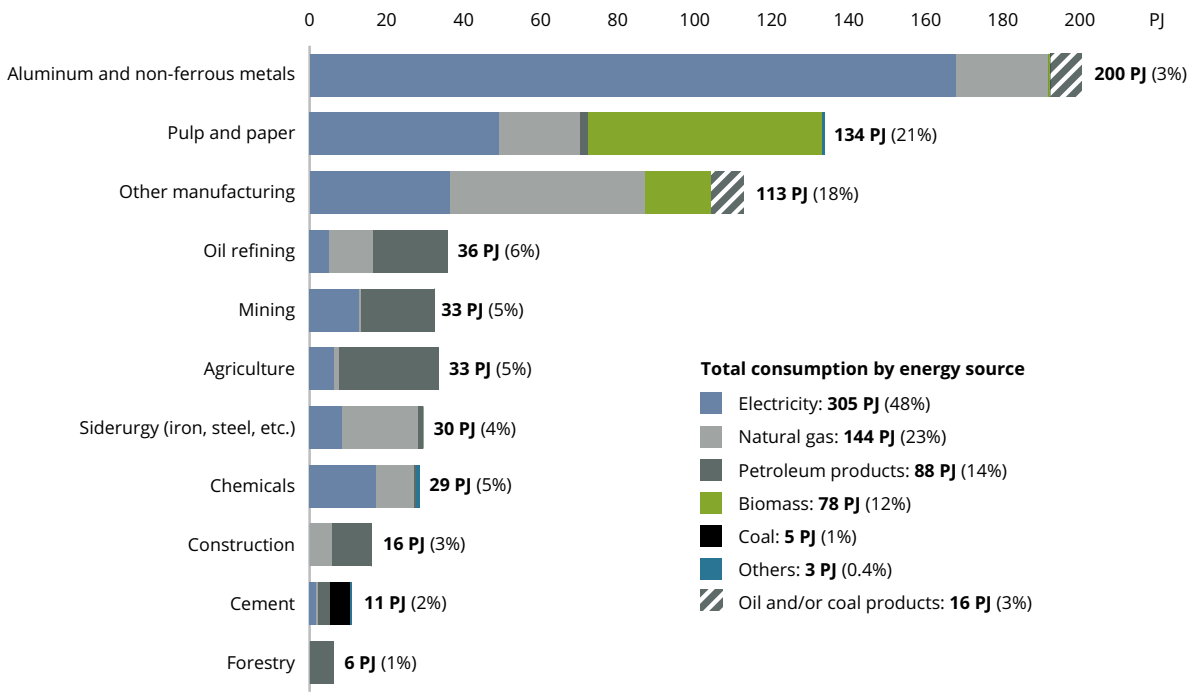
INDUSTRIAL SECTOR

In 2016, the industrial sector (including the agriculture industry) was the biggest energy consumer in Quebec. The industrial sector accounts for approximately 36% (624 PJ) of Quebec's total energy consumption and approximately 24% of the province's energy-related GHG emissions. Including non-energy emissions, the sector is responsible for approximately 45% of Quebec's emissions (see Figure 40), with the manufacturing, aluminum, and pulp and paper industries accounting for 70% of the sector's total energy consumption. Almost 48% of the energy used by all industries is electricity-sourced, followed by natural gas (23%), refined oil or coal products (17%), and biomass (12%) (see Figure 28).

Quebec's industries need vast amounts of energy of various kinds to produce wealth. This energy intensity, measured in megajoules (MJ) per GDP dollar, ranges from just a few MJ in the service sector (commercial and institutional) to several dozen MJ in the industrial sector (heavy industry). Figure 29 shows that while energy intensity is declining in several energy-intensive sectors (refineries, pulp and paper, aluminum), other subsectors, such as manufacturing, chemical products and mining, are increasingly energy-intensive.

Between 1990 and 2016, the industrial sector's total energy-related GHG emissions decreased by 20%, mainly because of declining emissions in the

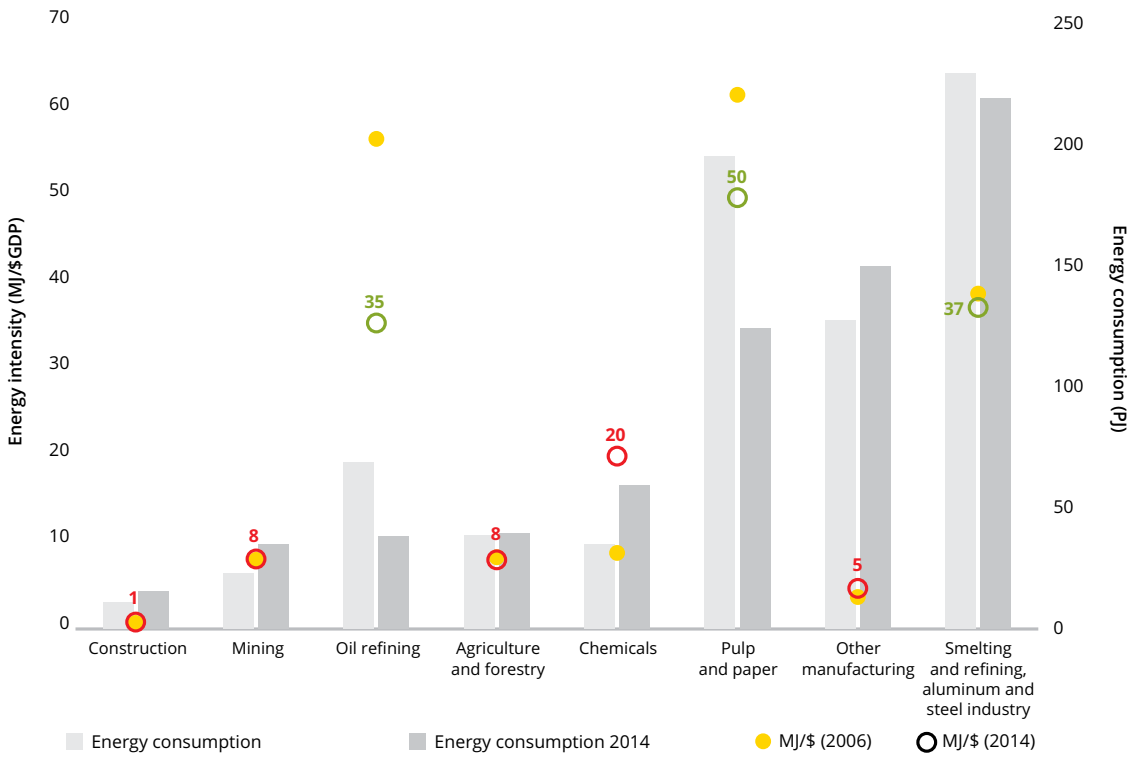
FIGURE 28 • ENERGY CONSUMPTION BY INDUSTRIAL ACTIVITY IN QUEBEC'S, 2016



Sources: OEE, 2018; authors' estimates.

Note: PJ units on the right show total energy consumption per activity, and the percentage between brackets refers to the share of an activity's energy consumption compared to the total consumption of the industrial sector. "Petroleum products" includes diesel, light and heavy fuel oils, stripping gas, petroleum coke, liquefied petroleum gas (LPG) and natural gas liquids (NGL), as well as motor gasoline (agriculture only). "Others" includes steam, waste fuels from the cement industry, coke and coke furnace gas. For confidentiality reasons, the OEE's database does not provide specific data on the use of energy sources in individual activity sectors. However, data on total consumption per activity sector are available. For some undisclosed data, authors have made inferences from earlier data, which were insufficient in some cases.

FIGURE 29 • ENERGY CONSUMPTION AND ENERGY INTENSITY IN THE INDUSTRIAL SECTOR, 2006 AND 2014



Sources: ISQ, 2015; OEE, 2017; Whitmore and Pineau, 2016.

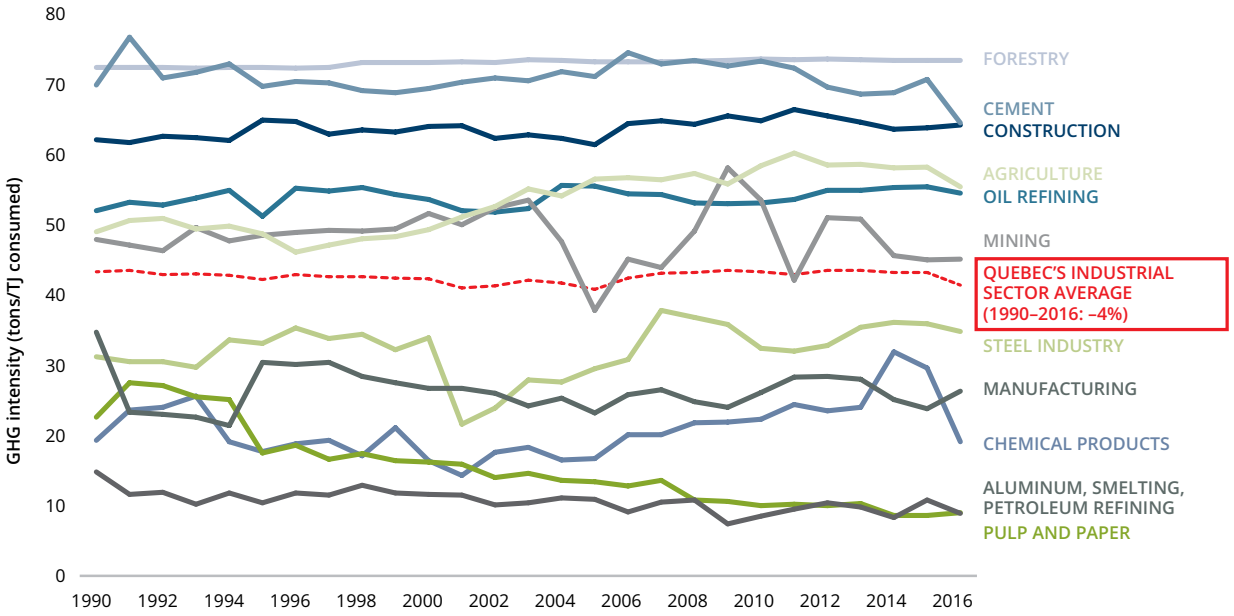
Note: Red circles indicate increasing energy intensity compared to 2006, and green circles indicate decreasing energy intensity.

pulp and paper industry (-74%), and the closing of ArcelorMittal's plant in Lachine (2008), Acier Inoxydable Atlas's plant in Sorel-Tracy (2004) and the Shell refinery in Montreal-East (2010). Excluding emissions in the pulp and paper industry, all other industrial sectors have reduced their emissions by just 3% compared to 1990 levels.

Even more significantly, the intensity of GHG emissions per unit of energy used in industrial subsectors has remained relatively unchanged since 1990 (see Figure 30). The average energy intensity of the industry sector as a whole has decreased by only 4% over the last 26 years. While energy intensity has declined steeply in some sectors, including pulp and paper (-60%), smelting and refining (-40%), and manufacturing (24%), GHG emissions have increased in others, including agriculture (+13%), steel (+12%), oil refining (+6%) and construction (+3%). These subsectors release more GHGs per unit of energy consumed than they did in the past, which suggests that not much progress has been made to decarbonize the industrial sector's energy supply. The largest energy users choose their fuels based on costs and carbon emission caps. A more detailed analysis of the trend reveals that the transition to less GHG-intensive energy sources is likely driven by more favourable pricing conditions compared to

hydrocarbon resources. But when prices become less competitive, cleaner energy supplies become less attractive. However, it should be noted that Figure 28 does not reflect possible decreases in energy use related to energy efficiency.

FIGURE 30 • INTENSITY OF GHG EMISSIONS ASSOCIATED WITH ENERGY CONSUMPTION IN QUEBEC'S INDUSTRIAL SUBSECTORS, 1990–2016



Source: OEE, 2018.

In the industrial sector, GHG emissions per unit of energy consumed have remained relatively unchanged, suggesting that, overall, there is very little decarbonization of their energy supply sources.

BUILDING SECTOR – RESIDENTIAL

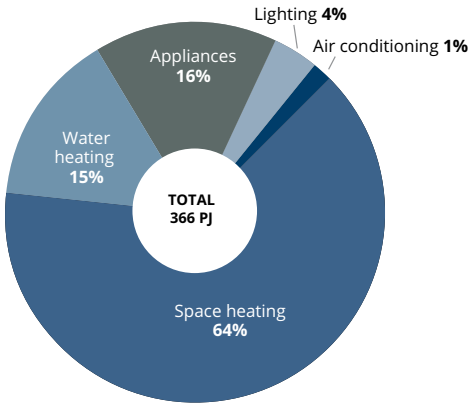
In 2016, the residential sector accounted for approximately 19%, or 36.7 PJ, of Quebec's total energy use. Residential use was 64% for heating, 16% for appliances and 15% to heat water, with lighting accounting for only 4% of the sector's total energy use and air conditioning for 1%. Electricity is the main source of energy in the residential sector (65%), followed by wood fuel (22%) and natural gas (7%) (see Figure 32).

From 1990 to 2016, annual energy use per square metre (energy intensity) decreased from 1.3 to 0.81 GJ, or 37%. This decline was due to improved building energy efficiency and to global warming. Energy consumption per household decreased by just 27%, however, from 139 GJ/year to 102 GJ/year. This was due to the increased average floor area per household: between 1990 and 2016, the average home size increased by 17% (Figure 33).

The number of housing units in Quebec has increased by 40%, while the population has grown by just 19%; this is due to the shrinking size of households. The average floor area has increased not just because of the larger size of homes, but also because the number of single detached and attached homes is increasing faster than the number of apartments. In addition to their smaller size, apartments require 29% less energy per square meter per year than do single-family homes (see Figure 34). A family living in an apartment thus consumes 50% less energy than a family living in a single-family home.

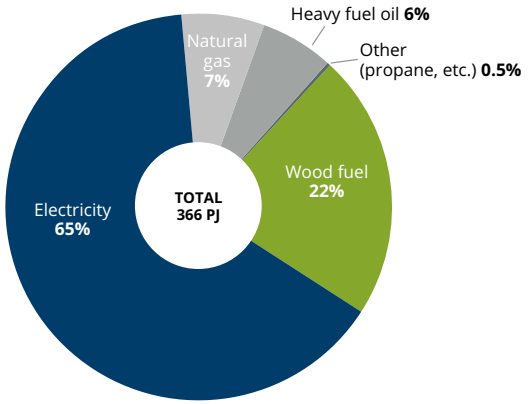
The residential sector's reduced energy intensity has helped offset the increase in total residential energy use caused by the growing population and the larger size of dwellings (see Figure 33). The sector's total energy use nevertheless grew by 2.4% between 1990 and 2016.

FIGURE 31 • ENERGY CONSUMPTION PER TYPE OF USE IN QUEBEC'S RESIDENTIAL SECTOR, 2016



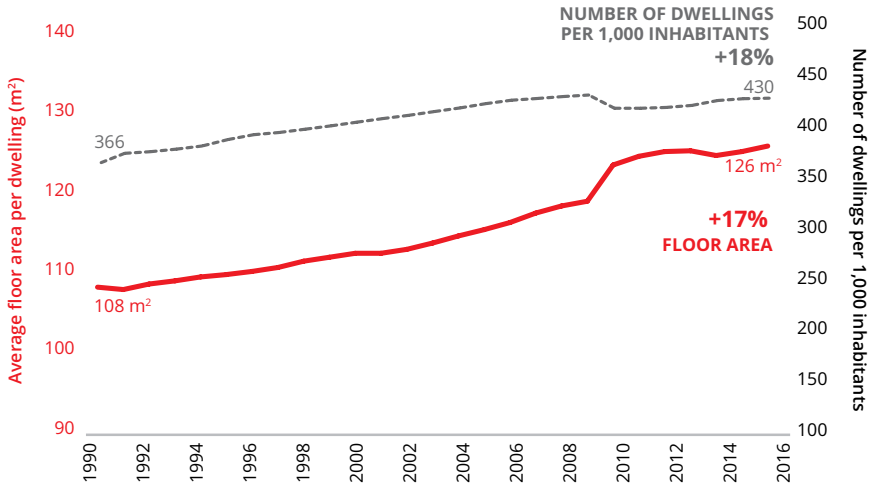
Source: OEE, 2018.

FIGURE 32 • CONSUMPTION PER ENERGY SOURCE IN QUEBEC'S RESIDENTIAL SECTOR, 2016



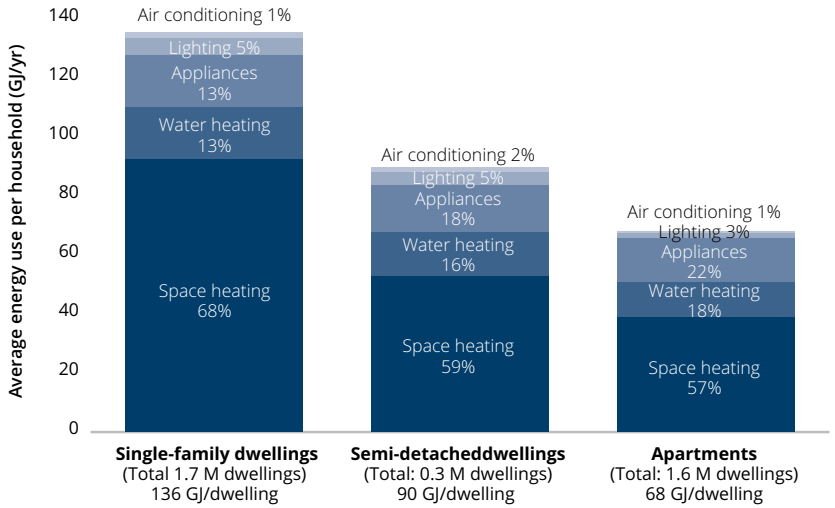
Source: OEE, 2018.

FIGURE 33 • TRENDS IN FLOOR AREA AND NUMBER OF HOUSING UNITS PER 1,000 INHABITANTS IN QUEBEC, 1990–2016



Source: OEE, 2018.

FIGURE 34 • QUEBEC'S AVERAGE ANNUAL ENERGY CONSUMPTION PER HOUSEHOLD AND HOUSING TYPE, 2016



Source: OEE, 2018.

Note: The number of each dwelling type appears between brackets under the bars.

The residential sector's reduced energy intensity has helped offset the increase in total residential energy use, but the sector's total energy use nevertheless grew by 2.4% between 1990 and 2016.

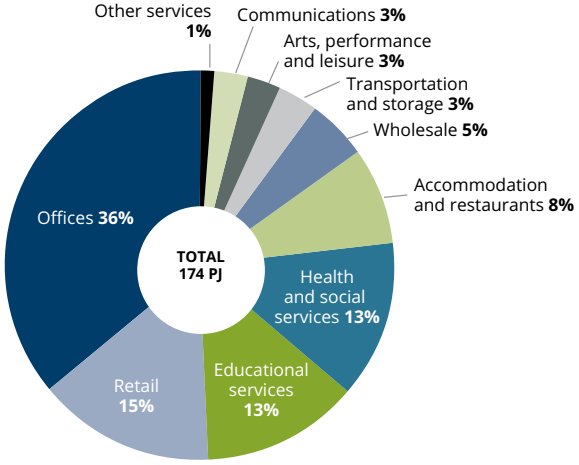
BUILDING SECTOR – COMMERCIAL AND INSTITUTIONAL

In 2016, the commercial and institutional sector accounted for 11% of Quebec's energy consumption. As shown in Figure 35, this sector uses mainly electricity (47%) and natural gas (45%) (see Figure 37) for interior heating, which accounts for half of total energy use among all applications (see Figure 38). The surface area to be heated is of crucial importance in this sector, followed by the use of ancillary equipment (17%) and lighting (11%).

Offices, including those in government buildings and educational institutions, account for more than 50% of the sector's total floor area, or 78 of a total of 143.7 million m^2. These offices are responsible for nearly two thirds of the sector's energy consumption. Activities related to the hotel and restaurant sectors, followed by those in health and social assistance and the information and culture industries (communications), are the most energy intensive per floor area unit (GJ/m^2), however, probably due to their use of specialized equipment.

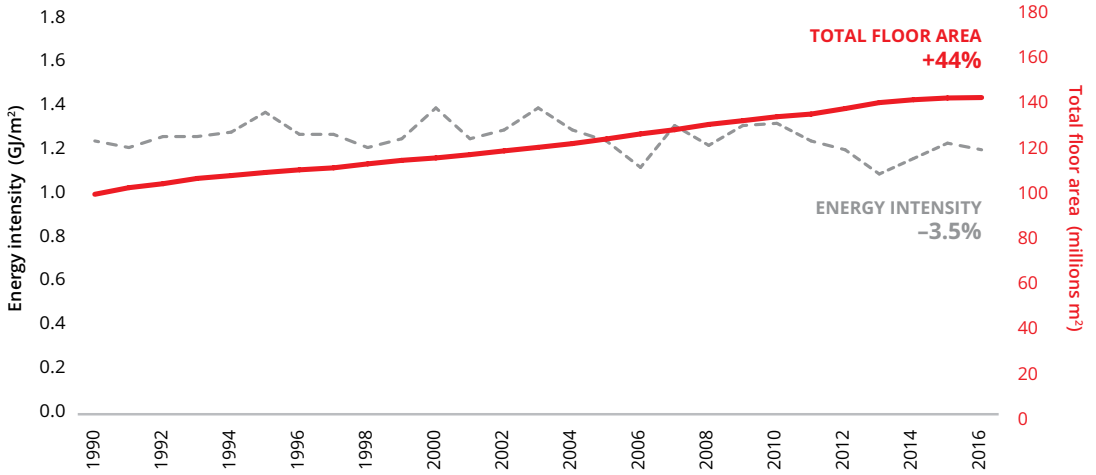
Energy intensity gains in the total energy use per square meter (3.5% improvement since 1990) have been offset by increased energy requirements. This increase has been due to larger heated areas (+44% between 1990 and 2016: see Figure 36) and greater use of ancillary equipment (computers, printers, electronic devices, etc.), whose total energy consumption jumped by 194% during the same period.

FIGURE 35 • CONSUMPTION PER COMMERCIAL AND INSTITUTIONAL SUBSECTORS AND PER ENERGY SOURCE, 2016



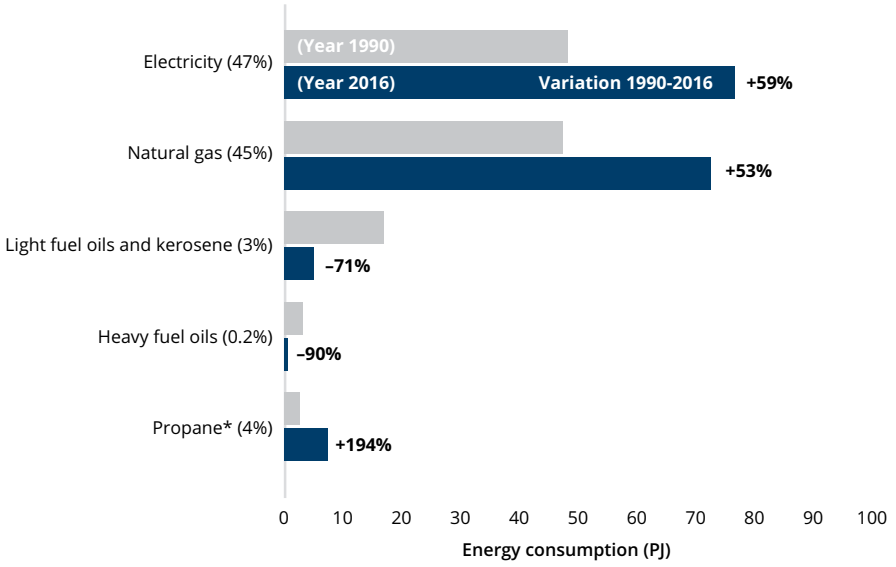
Source: OEE, 2018.

FIGURE 36 • TRENDS IN FLOOR AREA AND ENERGY INTENSITY IN QUEBEC'S COMMERCIAL AND INSTITUTIONAL SECTOR, 1990–2016



Source: OEE, 2018.

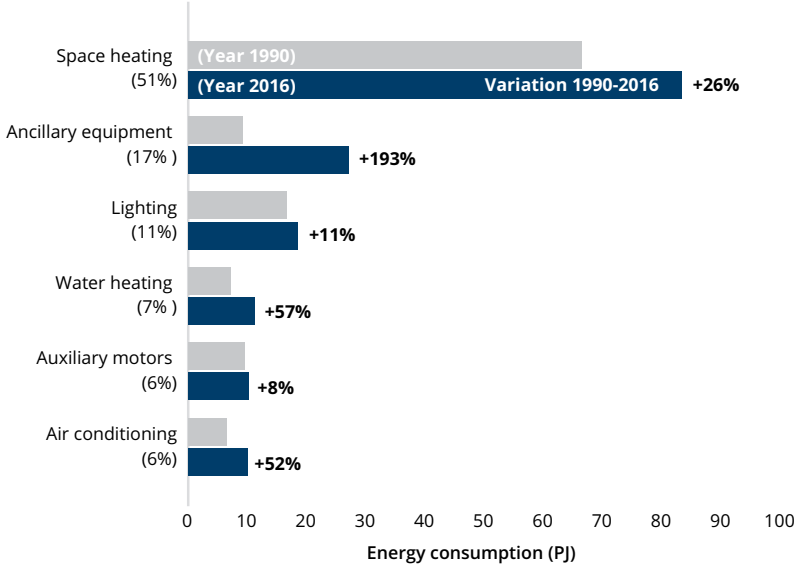
FIGURE 37 • ENERGY CONSUMPTION PER ENERGY SOURCE IN QUEBEC'S COMMERCIAL AND INSTITUTIONAL SECTOR, 1990–2016



Source: OEE, 2018.

Note: * This OEE category includes both propane and coal. However, the use of coal in Quebec's commercial and institutional sectors is zero, or close to zero. The percentages between brackets on the right of energy source categories indicate the contribution of each energy source to the total energy used in a sector.

FIGURE 38 • END USAGES OF ENERGY IN QUEBEC'S COMMERCIAL AND INSTITUTIONAL SECTOR, 1990–2016



Source: OEE, 2018.

Note: Excluding public street-lighting (less than 3 PJ). The percentages between brackets on the right of energy source categories indicate the contribution of each energy source to the total energy used in a sector.

The sector's increased energy use is due to larger heated areas and greater use of ancillary equipment.

3.4 • ENERGY SYSTEM EFFICIENCY

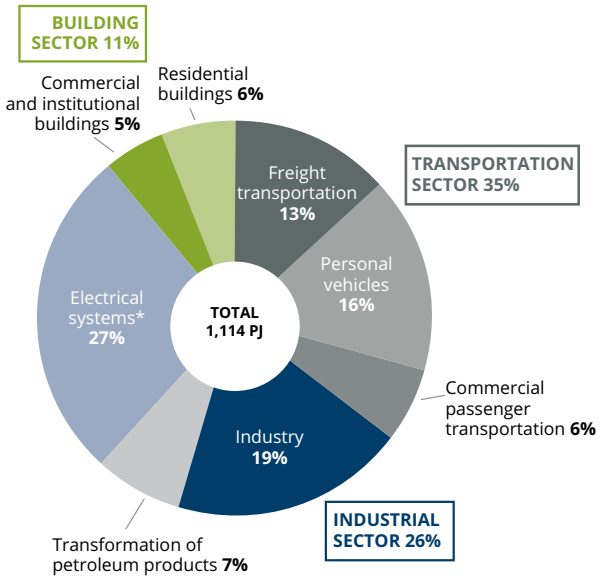
The transformation of energy causes energy losses during its production, distribution and consumption. Minimizing these losses increases the system's productivity, by increasing the amount of energy available to generate economic activities and benefits. Improving the energy system's efficiency makes it more productive and competitive, while driving economic growth by reducing how much energy it takes to generate a dollar of wealth.

Figure 39 shows the main sources of energy losses in Quebec's energy system. In 2016, 54% of the energy travelling through the Quebec energy distribution system was lost and added no value to the economy. Only 941 PJ of energy were available to meet consumer needs, while 1,114 PJ were lost due to system inefficiencies (see "System efficiency" column in Figure 3). In other words, for each energy unit available to consumers, more than one unit (1.2 PJ) was lost in the system.

The transportation sector was responsible for 35% of these losses, compared to 26% in the industrial sector and 11% in the building sector (residential, commercial and institutional). In the transport sector, 77% of energy losses occurred during consumption, compared to 34% and 24% in the industrial and building sectors, respectively. These numbers indicate that the transport sector is much less efficient than others and that reducing its energy losses should be a priority. Several solutions could help to reduce these losses, including more stringent standards or tax measures to reduce fuel consumption, discourage the purchase of energy-intensive vehicles, increase the use of electric motors, and encouraging car-pooling, use of public transportation and active transportation.

Heat produced, but not fully used, is the main cause of energy loss. The production and distribution of electricity, as well as the transformation of petroleum products, generate 27% and 7% of total losses respectively, but that generally corresponds to less than 15% of the energy used in transformation and transportation activities.

FIGURE 39 • SOURCES OF ENERGY LOSS IN QUEBEC'S ENERGY SYSTEM, 2016



Sources: See Figure 3 of this report.

Note: *Losses linked to the generation (conversion of crude energy into electrical energy), transportation and distribution of electricity. "Commercial passenger transportation" includes freight transportation and the revenue-earning transportation of passengers.

Energy efficiency could also be improved in consumption sectors. Technico-economic potential (TEP) assessments of reductions in the annual energy use of various sectors were conducted for Hydro-Québec, Énergir (formerly Gaz Métro) and the *Bureau de l'efficacité énergétique* (now TEQ). This potential provides an estimate of how energy use can be reduced in technically and economically viable ways while maintaining the same level of services.

It was thus determined that there was an annual energy-saving potential of nearly 22% for electricity and 13% for natural gas compared to usage levels in 2010 and 2017, based on the technological and economic conditions during those years. The transportation sector, for instance, could achieve a 24% reduction in its use of petroleum products compared to 2017 levels. The *2018-2023 Energy Transition, Innovation and Efficiency Master Plan* foresees updates to sectoral energy profiles, which could include TEP studies.

In 2016, 54% of the energy travelling through the Quebec's energy distribution system was lost and added no value to the province's economy.

4 GHG EMISSIONS LINKED TO THE ENERGY SYSTEM

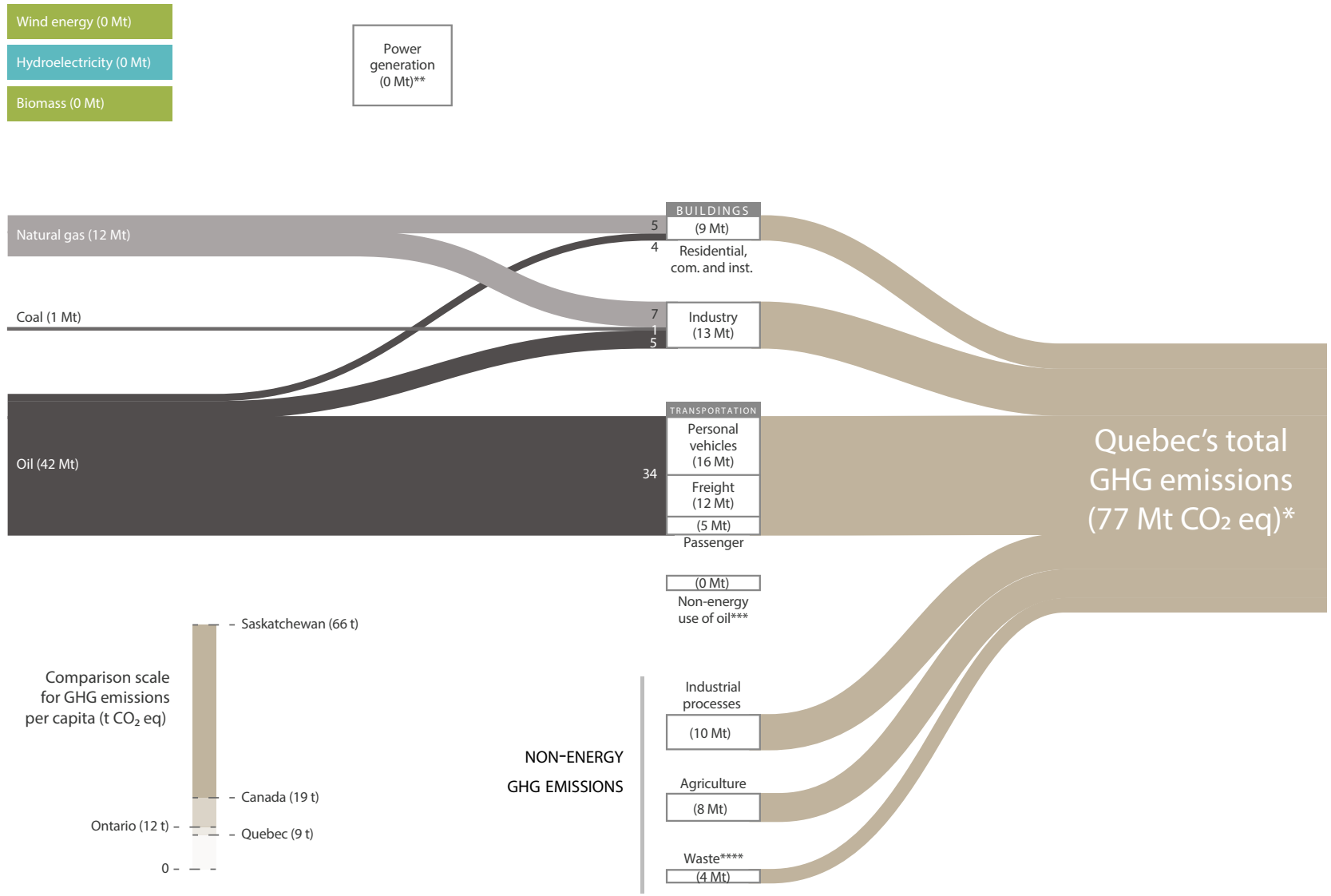
Emissions linked to the production, transportation and consumption of energy account for 72% of Quebec's total GHG emissions. According to the *National Inventory Report (1990-2016): Greenhouse Gas Sources and Sinks in Canada*, published by the government of Canada, Quebec's total GHG emissions were 77 Mt CO_2 eq in 2016, 11% lower than in 1990. Energy-related emissions were 55 Mt and have decreased by only 7% since 1990.

Figure 40 shows the sources of GHGs in Quebec in 2016 and their impact on total emissions. Per capita emissions were 9 t CO_2 eq, the lowest in Canada, which averages 19 t CO_2 eq. Quebec's electricity sector, which relies on hydropower and other renewable energy sources, produces virtually no emissions. The industrial sector emits approximately 13 Mt CO_2 eq, or 17% of provincial emissions. To those industrial emissions must be added non-energy related emission sources: those from industrial processes (10 Mt), and those from agriculture (8 Mt) and waste management (4 Mt).

Figure 41 shows non-energy related industrial emissions (21.9 Mt). Industrial processes that release GHGs, mostly CO_2, without energy combustion are generally associated with the aluminum and agricultural industries. Agriculture releases high levels of methane (CH_4) through livestock farming and dinitrogen oxide (N_2O) through the use of nitrogenous fertilizers. In the waste management industry, the decomposition of organic materials at landfill sites (biogas) also releases CH_4. Finally, other non-energy-related GHG categories, including halocarbons, are released from cement production, along with small

The production, transportation and consumption of energy accounts for 72% of Quebec's total GHG emissions.

FIGURE 40 • OVERVIEW OF QUEBEC'S GREENHOUSE GAS EMISSIONS, 2016



Sources: ECCC, 2018; TEQ, 2018 (unpublished); Statistics Canada, 2018 (table 57-003-X); OEE, 2017.

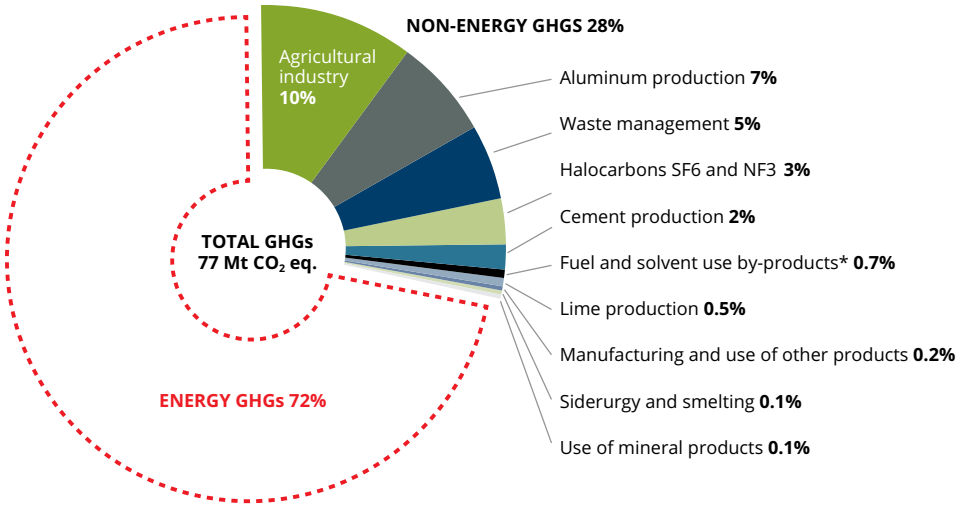
Note: GHG emissions are attributed to the point of energy use and expressed in Mt CO_2 eq. Some totals may not add up due to rounding. *The 77 Mt total for 2016, estimated by Environment and Climate Change Canada, was used, yet there is a difference of approximately 0.3 Mt CO_2 eq in the Figure's total due to the use of different methodologies to estimate emissions for each type of fossil fuel. Methodology notes on the development of this Figure are available on the website of the Chair in Energy Sector Management: energie.hec.ca. **Electricity generation produces 0.2 Mt CO_2 eq. These emissions are not shown on this Figure, as it excludes emissions lower than 1 Mt CO_2 eq. ***The sector includes the production of asphalt, plastic, lubricant and fertilizers.

Credits: Benjamin Israël
Collaboration: Johanne Whitmore and Pierre-Olivier Pineau (HEC Montréal)

amounts of other gases. These gases are used for refrigeration, air conditioning, fire protection and the production of foamed plastic, solvents and aerosols.

The building sector (residential, commercial and institutional) releases 9 Mt of emissions, or 12% of Quebec's total, mainly for heating applications. Emissions have decreased in this sector due to a decline in the use of petroleum products for heating. This contrasts with the transportation sector (road, air, marine, rail, off-road and pipeline), which accounts for nearly 44% of Quebec's overall emissions and runs almost exclusively on fossil fuels. Since 1990, transportation-related emissions have increased by 22%.

FIGURE 41 • QUEBEC'S GHG EMISSIONS BY ENERGY AND NON-ENERGY SOURCES, 2016



Source: ECCC, 2018.

The targets set out in Quebec's 2030 Energy Policy will reduce GHG emissions by 16 million tonnes of CO_2 eq: equivalent to an emission reduction of 18% below 1990 levels.

TABLE 8 • QUEBEC'S GHG EMISSIONS INVENTORY, 2016 (kt CO_2 eq.)

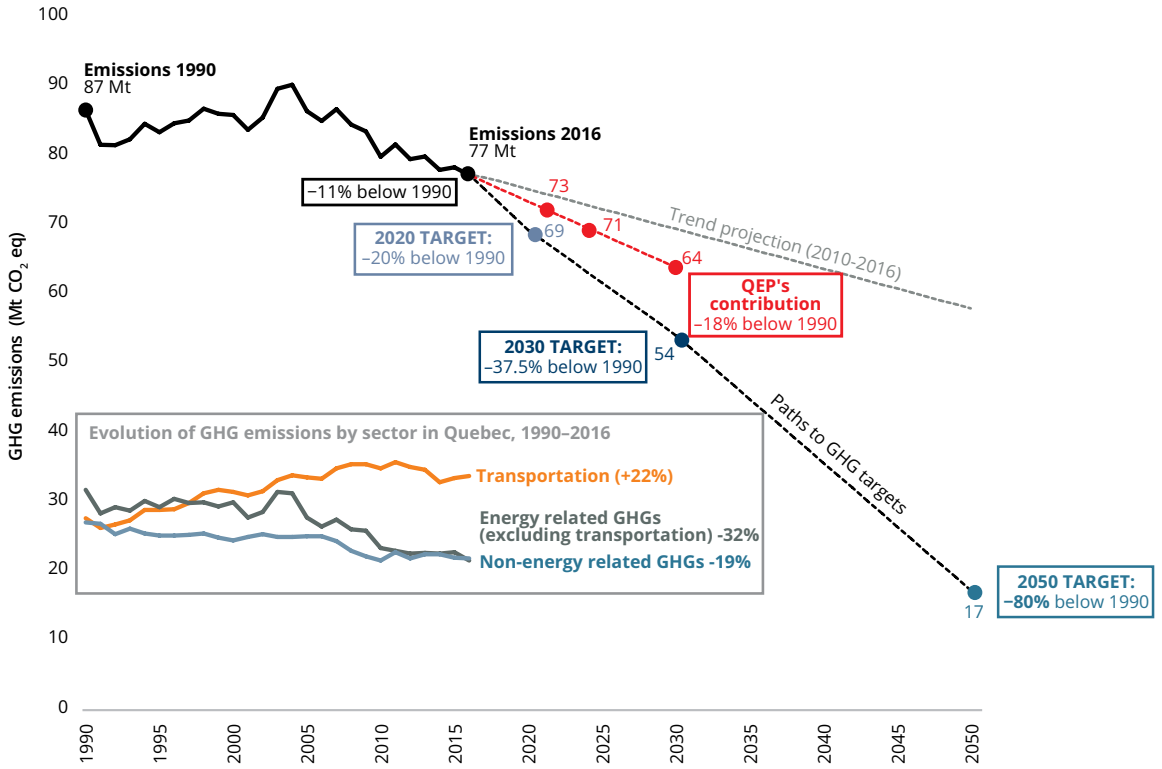
	1990	2015	2016	Variation 1990–2016	Variation 2015–2016
QUEBEC'S TOTAL GHG EMISSIONS	**86,630**	**78,359**	**77,251**	**–11%**	**–1%**
TOTAL ENERGY RELATED GHGs	**59,480**	**56,372**	**55,317**	**–7%**	**–2%**
Stationary combustion sources (subtotal)	**31,352**	**22,546**	**21,248**	**–32%**	**–6%**
Heat and power generation	1,495	208	237	–84%	14%
Oil refining industries	3,461	2,190	1,930	–44%	–12%
Mining and oil and gas production	824	570	648	–21%	14%
Manufacturing	12,294	9,436	8,322	–32%	–12%
Construction	458	351	345	–25%	–2%
Commercial and institutional	4,240	4,854	4,675	10%	–4%
Residential	8,288	4,452	4,597	–45%	3%
Agriculture and forestry	291	484	495	70%	2%
Transportation (subtotal)	**27,702**	**33,536**	**33,764**	**22%**	**1%**
Domestic air transport	820	675	696	–15%	3%
Road transport	17,759	26,663	27,044	52%	1%
Gasoline-powered light vehicles	*10,395*	*9,099*	*9,050*	*–13%*	*–1%*
Gasoline-powered light trucks	*3,495*	*7,469*	*7,825*	*124%*	*5%*
Gasoline-powered heavy vehicles	*766*	*1,782*	*1,870*	*144%*	*5%*
Motorcycles	*16*	*67*	*70*	*327%*	*4%*
Diesel-powered light vehicles	*210*	*204*	*190*	*–9%*	*–7%*
Diesel-powered light trucks	*57*	*155*	*180*	*214%*	*16%*
Diesel-powered heavy vehicles	*2,818*	*7,885*	*7,860*	*179%*	*0%*
Propane- and natural-gas-powered vehicles	*2*	*0*	*0*	*–89%*	*–16%*
Rail transportation	567	682	673	19%	–1%
Domestic marine transportation	1,378	721	740	–46%	3%
Other	7,178	4,796	4,611	–36%	–4%
Off-road vehicles: agriculture and forestry	*999*	*738*	*663*	*–34%*	*–10%*
Off-road vehicles: commercial and institutional	*358*	*583*	*678*	*89%*	*16%*
Off-road vehicles: manufacturing, mining and construction	*2,030*	*1,902*	*1,837*	*–10%*	*–3%*
*Off-road vehicles: residential**	*61*	*264*	*214*	*252%*	*–19%*
Off-road vehicles: other	*3,704*	*997*	*1,031*	*–72%*	*3%*
*Pipeline transportation**	*26*	*325*	*189*	*626%*	*–42%*
Fugitive emissions sources – oil and natural gas	**427**	**290**	**306**	**–28%**	**6%**
TOTAL NON-ENERGY RELATED GHGs	**27,150**	**21,987**	**21,934**	**–19%**	**0%**
Industrial processes and product use	**14,765**	**10,120**	**9,967**	**–32%**	**–2%**
Agriculture	**7,116**	**7,924**	**8,007**	**13%**	**1%**
Waste management	**5,268**	**5,086**	**5,101**	**–27%**	**0%**

Source: ECCC, 2018.

Note: *GHG emissions data for pipeline transportation and off-road vehicles (residential) in 2015 were confidential in the 1990–2016 but public for the 1990–2015 inventory. Data for these variables in 2015 were from the 1990–2015 inventory.

Figure 42 shows the changes in GHG emissions from 1990 to 2016 and the targets set by the province for 2020, 2030 and 2050. While the decrease observed between 2004 and 2016 could suggest a downward trend allowing these targets to be achieved, a more detailed analysis suggests otherwise. The 4 Mt decline between 2009 and 2010 was due mainly to the closing of the Shell refinery in Montreal's east end (1.2 Mt), a 0.6 Mt reduction in GHG emissions in the waste sector, and many small reductions in various other sectors. Between 2010 and 2016, however, emissions remained relatively stable, in the range of 79 to 77 Mt. The downward trend is not sufficient to achieve 2020 and 2030 targets, especially since emissions have been strongly increasing (+22%) in the transportation sector since 1990, offsetting some of the reductions achieved in other sectors. The gap between the trend projections from 2010 to 2016 and the paths that must be taken to achieve those targets reflects the magnitude of the efforts still to be made. Some reduction measures are found in the five energy targets set out in Quebec's 2030 Energy Policy, which will reduce GHG emissions by 16 Mt CO_2 eq, i.e., the equivalent of 18% of such emissions in 1990.

FIGURE 42 • QUEBEC'S GHG EMISSION TRENDS AND REDUCTION TARGETS 1990–2050



Sources: ECCC, 2018; Quebec Government, 2016.

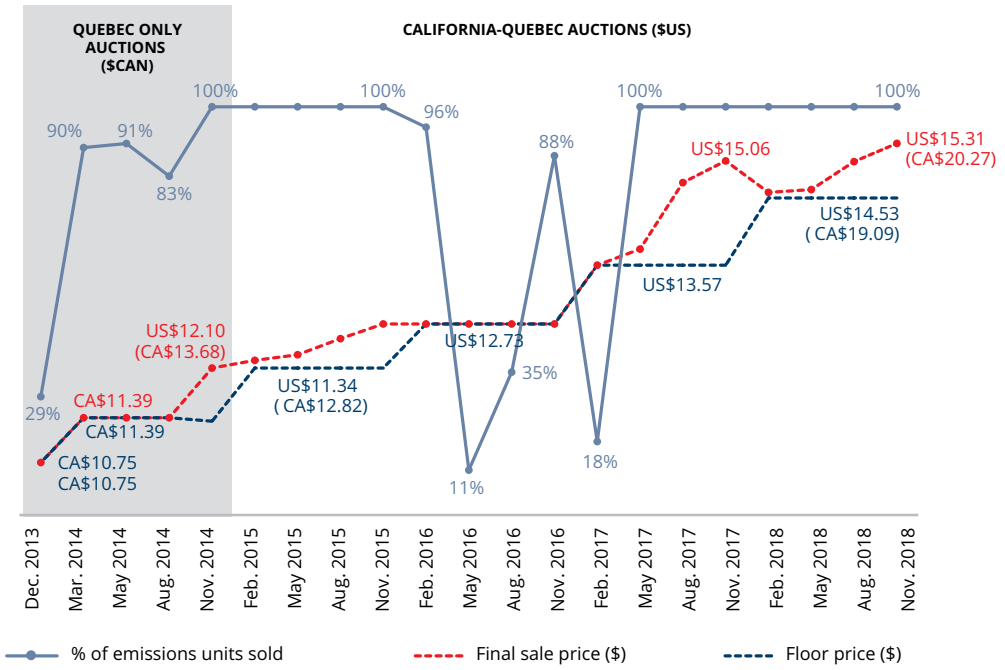
Note: According to Quebec's 2030 Energy Policy (p.12), "The 2030 Energy Policy's contribution to greenhouse gas emissions reduction: The production, transportation and consumption of energy account for 70% of overall greenhouse gas (GHG) emissions in Quebec. The targets proposed in The 2030 Energy Policy alone will reduce GHG emissions by 16 million tons of CO_2 equivalent, i.e. 18% of such emissions in 1990. Such reductions will be added to those already achieved to date (8.5%) and other GHG reductions from non-energy sources." QEP2030 also states that "targets are based on data for 2013, the most recent available."

DID YOU KNOW?

STATUS OF THE CALIFORNIA-QUEBEC CARBON MARKET FOLLOWING ONTARIO'S WITHDRAWAL

Quebec's cap-and-trade system has been linked to California's since 2014 and was linked to Ontario's for part of 2018. The decision of the newly elected Ontario government to withdraw from the carbon market in July 2018 caused the loss of an important partner in the Western Climate Initiative (WCI), the platform linking the cap-and-trade systems of participating provinces and states. Ontario's withdrawal could have undermined Quebec's cap-and-trade system, but that did not happen. As shown in Figure 43, the participation of credit buyers surged in the August and November auctions held after Ontario's exit. This contrasted with the 2016 and 2017 auctions, when doubts about the legality of the California system reduced the number of emission credit purchases to only 11% of the offer. Not only were all available credits sold at the last auction, but a record price was set at the November 2018 auction: US$15.31/t CO_2 eq (CA$20.27). The maximum bid was $71.86 CAD, the highest bid ever made. Unlike at the two previous auctions, all 2021 emission allowances offered at the August and November 2018 auctions were bought above the floor price, indicating confidence in the system's

FIGURE 43 • PRICE OF EMISSION ALLOWANCES $/T CO_2 EQ AND PERCENTAGE OF ALLOWANCES SOLD THROUGH CAP-AND-TRADE AUCTIONS, DEC. 2013–NOV. 2018



Source : MDDELCC, 2018.

DID YOU KNOW? (CONTINUED)

sustainability.
Ontario's withdrawal overshadowed the May 2018 addition of Nova Scotia to WCI's cap-and-trade system. Nova Scotia has not yet linked its market to those of Quebec and California, although it follows the same rules and uses the same electronic platform.

On January 1, 2018, Quebec and California's cap-and-trade system entered its third compliance period, which includes 2020, with targets of reducing emissions to 20% below 1990 levels for Quebec and to 1990 levels for California. Due to relatively high caps and emission reductions achieved by industrial sectors (Quebec) and by the electricity sector (California), the market has a surplus of emission credits, which should taper off in the next few years as the lowering of caps outpaces the reduction of emissions. After the surplus disappears, auction prices for emission credits could spike due to their shortage.

The surplus of emission credits should shrink in the next few years as the lowering of the cap level outpaces that of emissions. After the surplus disappears, auction prices for emission allowances could spike due to their shoratge.

5 ENERGY AND THE QUEBEC ECONOMY

While the energy sector contributes to economic growth by enabling the economy to function and creating wealth, it is also responsible for a significant share of costs and expenses required by economic activity.

In 2017, the production, transportation, transformation and distribution of energy accounted for $13.9G, or 4.2% of Quebec's GDP (see Table 9). In 2016, Quebec households spent $12.7G directly on energy purchases and more than twice that ($36.6G) on non-energy transportation purchases, including vehicles, public transit, and recreational vehicles (see Table 10). Their personal vehicles cost them over $31G, plus $6.5G for fuel.

Household energy expenses vary greatly depending on household income. Figure 44 shows energy expenditures per household income bracket, from the 20% for households with the lowest income (lowest quintile [Q1]) to the 20% of households with the highest income (highest quintile [Q5]). For Q1 households, energy consumption accounts for 6.4% of total expenses, compared to 4.3% for the Q5 bracket. However, in absolute terms, the energy expenses of Q5 families are much higher than those of Q1 households. Each year, lower income households spend $1,660 on energy consumption, compared to $6,098 for the wealthiest. Purchases of gasoline (and other fuels, including diesel) are the main source explaining this difference, although electricity expenses are also higher in more affluent households.

Due to its imports of petroleum (crude oil, natural gas, refined petroleum products, etc.), Quebec's trade balance runs at a wide deficit in the energy sector (−$6G), despite its electricity exports (see Table 11). In 2016, electricity accounted for 10% of Quebec's total imports. However, it should be noted that the trade balance has improved since 2014 due to the declining prices of crude oil and imported petroleum products.

Total
energy expenses
$36.4G

Gross domestic
expenditures in Quebec
$370G

Share of energy expenses
of gross domestic
expenditures
9.8%

Source: MERN, 2016 (preliminary data)

TABLE 9 • TRENDS IN GDP RELATIVE TO QUEBEC'S ENERGY SECTOR, 2013–2017

	GDP (in constant 2007 $G)				
	2013	2014	2015	2016	2017
All industries	**306.2**	**310.9**	**314.1**	**318.9**	**328.7**
Energy sector	*12.9*	*13.3*	*13.4*	*13.5*	*13.9*
Share of the energy sector in all industries	*4.2%*	*4.3%*	*4.3%*	*4.2%*	*4.2%*

Source : Statistique Canada, 2018 (tableau 11-10-0222-01).

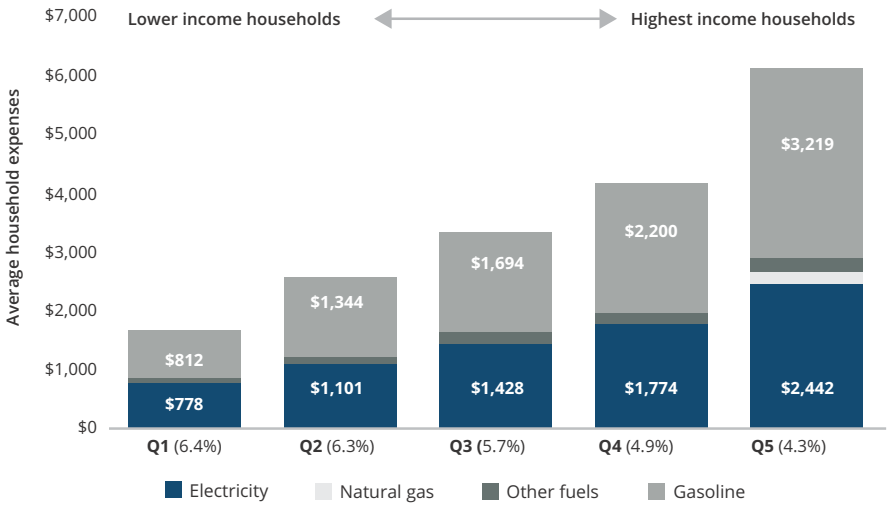
TABLE 10 • QUEBEC'S ESTIMATED DIRECT AND INDIRECT HOUSEHOLD ENERGY EXPENSES, 2016 ($M)

	$M
TOTAL HOUSEHOLD EXPENSES	**250,229**
TOTAL ENERGY EXPENSES (direct and indirect)	**49,390**
Share of direct and indirect energy expenses of total household expenses	***20%***
Direct energy expenses	**12,795**
Main residences	6,046
Electricity	*5,216*
Natural gas	*254*
Other fuels	*576*
Secondary residences (electricity and fuels)	201
Gasoline and other fuels	6,548
Indirect energy expenses	**36,595**
Personal transport	31,163
Vehicle purchases	*14,734*
Vehicle rentals	*138*
Use of vehicles (excluding fuel)	*16,292*
Public transportation	2,924
Recreational vehicles (excluding bicycles)	2,507

Source: Statistics Canada, 2018 (table 11-10-0222-01).

Note: The data provided is based on the total housing units reported in Statistics Canada's population census.

FIGURE 44 • ENERGY EXPENSES OF QUEBEC'S HOUSEHOLD PER INCOME QUINTILE, 2016



Source: Statistics Canada, 2018 (table 11-10-0223-01).

Note: Percentages between brackets refer to the share of energy expenses in the income quintile's total expenses. Income quintiles refer to five equal groups of households, each containing 20% of all households, based on an increasing order of income, so that the first group (Q1) represents the 20% of households with the lowest income, the second (Q2) the next 20% of households with the second lowest income, but lower than 60% of the remaining households, until the fifth quintile (Q5), representing the 20% of households with the highest income.

TABLE 11 • INTERNATIONAL TRADE BALANCE OF QUEBEC'S ENERGY SECTOR, 2017

	Exports		Imports		Balance
	G$	% of total exports	G$	% of total imports	G$
Quebec's overall economy	**85.3**	**100%**	**91.9**	**100%**	**–6.5**
Energy sector	**3.4**	**4%**	**9.4**	**10%**	**–6.0**
Production, transportation and distribution of electricity	*1.2*	*1%*	*0.02*	*0.02%*	*1.2*
Extraction – Oil and gas	*0.0007*	*0.0001%*	*3.9*	*4%*	*–3.9*
Petroleum and coal product manufacturing	*2.2*	*3%*	*5.5*	*6%*	*–3.3*

Source: ISQ, 2018.

5.1 • UNDERSTANDING ENERGY PRICES IN QUEBEC

The price of gasoline varies according to market price fluctuations for crude oil (see Figure 45). Differences between the price at the pump and the market price of oil are explained in Table 12. This difference includes the costs and benefits of refining oil, the costs of transporting oil from the refinery to the gas station, retailer (gas station) margins, various taxes and the cost of carbon emission rights on the carbon market (cap-and-trade-system). However, prices are approximately 5.4¢/litre higher in the Montreal area than in the rest of Quebec due to a 3¢/litre tax to support public transportation in the greater Montreal area and different market conditions in Montreal compared to the rest of Quebec.

The three main types of energy purchased by Quebecers have very different pricing components (see Figure 46). While all estimated costs are based on the quantity of energy purchased (cubic meters for natural gas, kilowatt hours for electricity, litres for gasoline), a large portion of energy costs is fixed. Infrastructure for the distribution and transportation of natural gas and electricity is a fixed investment, which remains unchanged even if consumption decreases. However, the price of gasoline is based largely on the price of oil, whose production varies according to the demand for fuel.

The energy content of all energy forms can be expressed using the same measurement unit: the gigajoule (GJ). Figure 46 shows the relative price for various types of consumer of a GJ of natural gas, electricity and gasoline. It shows that natural gas is the least expensive form of energy and gasoline is the most expensive. But comparisons are not that simple for at least three reasons. First, all forms of energy are not perfect substitutes for one another. Second, the equipment they fuel do not have the same energy efficiency performance, so with 1 GJ of gasoline a gasoline-powered car will travel a much shorter distance than will an electric car with 1 GJ of electricity; this is due to the greater efficiency of electric motors (see Section 3.4).

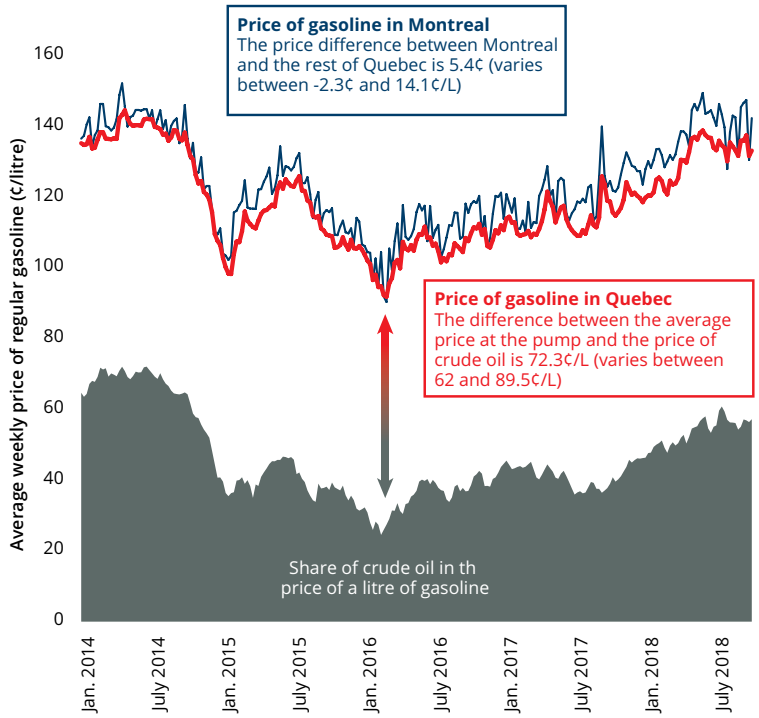
The third reason relates to taxes. Several taxes are imposed on petroleum products, including regular gasoline, but no taxes are imposed on electricity or natural gas. These taxes help to pay for roads and public transit. As car owners turn to fuels other than regular gasoline, tax receipts will decline, creating budgetary imbalances. Tax regimes will have to be adapted, and new tax measures will have to be applied directly to energy sources, road usage or other modes of energy consumption.

Of all Canadian provinces, Quebec has the lowest average residential electricity rate: 8.12¢/kWh in 2016 (see Figure 47). Manitoba is a close second, with 8.29¢/kWh. There are greater differences with other provinces, including Ontario and Prince Edward Island, where average rates are more than twice as high as in Quebec.

In the industrial sector, the average selling price of electricity in Quebec is the second lowest of all provinces, after Newfoundland and Labrador, at 4.25¢/kWh. Ontario's industrial sector has the highest average electricity rate, at 14.75¢/kWh.

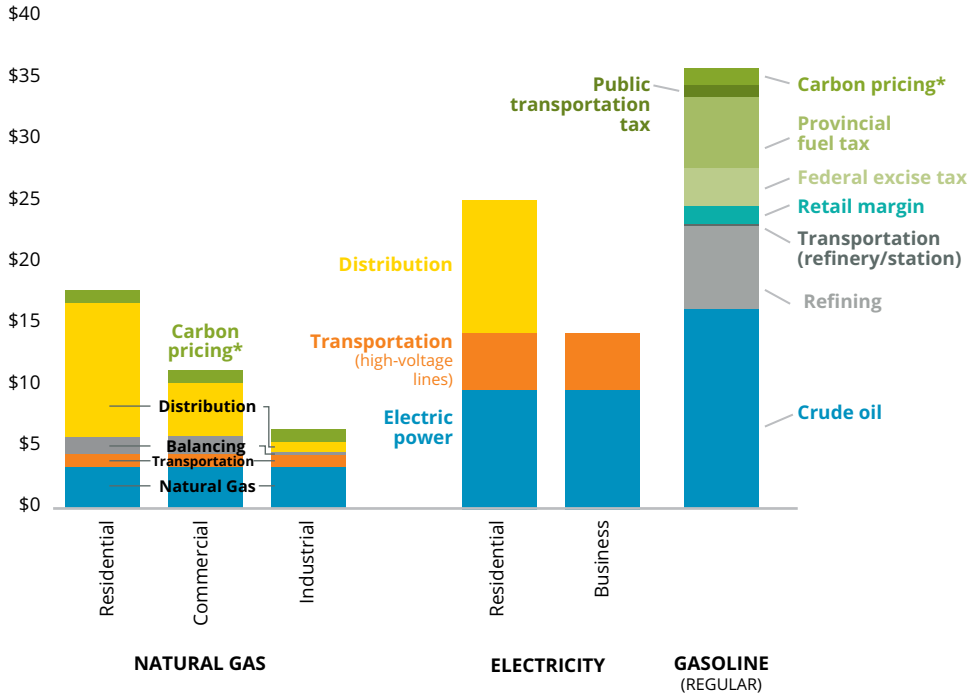
For more information about the price of energy, see *Feuillet d'information sur les prix de l'énergie* on the Chair's website (inFrench only): http://energie.hec.ca/eeq.

FIGURE 45 • WEEKLY BENCHMARK PRICING FOR CRUDE OIL (WTI[13]) AND REGULAR GASOLINE, JANUARY 2014–SEPTEMBER 2018



Sources: Régie de l'énergie, 2018; IEA, 2018.

FIGURE 46 • COMPARISON OF COSTS AND PRICE COMPONENTS FOR NATURAL GAS, ELECTRICITY AND REGULAR GASOLINE IN 2018, PER GJ (EXCLUDING SALES TAX, GST AND QST)

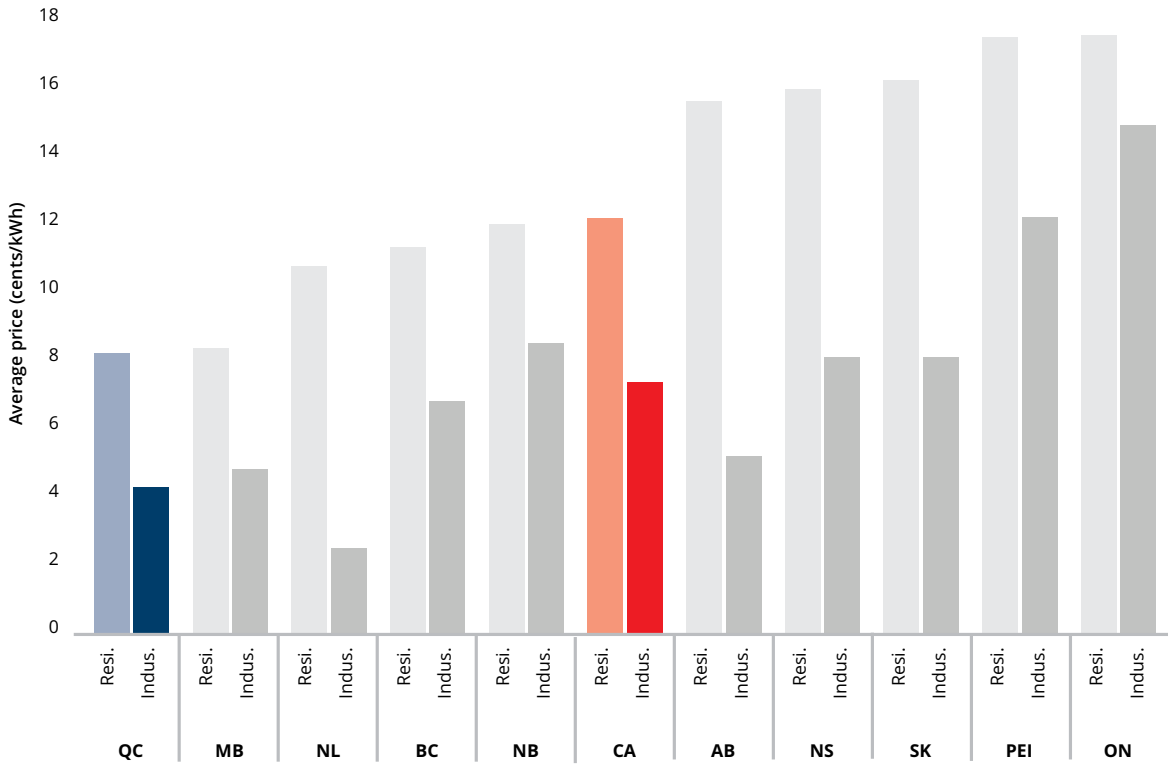


Sources: Énergir, 2018; HQD, 2018; Régie de l'énergie, 2018.

Note: Consumer pricing also varied by consumer type, consumption patterns, total consumption, and cross-subsidization between categories of consumers.
* Cost of carbon pricing throught Quebec's Cap and trade system for greenhouse gas emission allowances.

[13] For a definition of West Texas Intermediate (WTI), see www.eia.gov/tools/glossary/index.php

FIGURE 47 • AVERAGE SALE PRICE OF ELECTRICITY IN THE RESIDENTIAL AND INDUSTRIAL SECTORS (PER PROVINCE), 2016



Sources: Hydro-Québec, 2017; Statistics Canada, 2018 (table 25-10-0021-01).

Note: Excluding provincial and federal tax. Quebec average prices are based on revenue per sector and sales volumes.

Of all Canadian provinces, Quebec has the lowest average residential electricity rate: 8.12¢/kWh in 2016.

TABLE 12 • COST ESTIMATE AND STRUCTURE FOR QUEBEC'S MAIN ENERGY SOURCES, 2018

	Natural gas (¢/m³)				Electricity (¢/kWh			Regular gasoline (¢/litre)
	Residential (<=650 m³/year)	Commercial (btw 3, 650 and 36,500 m³/year)	Industrial (all tariffs, except D1)		Residential and agricultural	Business and industry		
	Based on 2018–2019 forecasts				*Based on 2019 forecasts*			*Based on sales price (before tax) on September 17, 2018*
Natural gas	12.74	12.74	12.74	Electrical energy	3.72	3.72	Crude oil (68.91 USD/barrel)	56.31
Transportation	3.70	3.69	3.45	Transportation	1.77	1.77	Refiner's margin	19.53
Balancing	5.47	5.53	1.03				Transportation cost (refinery-gas station)	0.30
Distribution	40.55	16.29	3.22	Distribution	4.16		Estimated retail margin	5.10
							Federal excise tax	10.00
							Provincial fuel tax	19.20
							Public transportation tax	3.00
GHG Emission allowance (Quebec cap-and-trade system)	3.95	3.95	3.95				Cost of GHG emission allowance (Quebec cap-and-trade-system)	4.66
	66.39	**42.20**	**24.39**		**9.65**	**5.48**		**118.10**

Source: Énergir (2018); HQD (2018); Régie de l'énergie (2018).

Note: Consumer prices also vary based on type, user profile, total consumption and cross-subsidy between users.

6 OUTLOOK FOR 2019

QUEBEC'S *2018–2023 ENERGY TRANSITION, INNOVATION AND EFFICIENCY MASTER PLAN*

The *Régie de l'énergie* will issue an opinion on the ability of Quebec's Energy Transition, Innovation and Efficiency Master Plan to meet the government's energy targets. The *Régie* must also approve the programs and measures that are the responsibility of energy distributors. The Plan will come into force after the *Régie* has issued this opinion. Key issues to be monitored include the ownership of targets and programs to be implemented by various ministries and agencies and the population as a whole. To succeed, the plan must be adopted and carried out by everyone. It must also be implemented in a manner consistent with other government strategies and policies.

CARBON PRICING: FEDERAL SYSTEM VS. QUEBEC'S CARBON MARKET AND GREEN FUND

The federal backstop for carbon pricing announced in 2017 enters into force in 2019 in provinces that have not themselves adopted carbon pricing. That is not the case for Quebec, which is already part of the carbon market. British Columbia and Alberta, which also apply their own carbon tax, as well as other provinces with their own carbon pricing system, are not subject to the federal system. The federal backstop is twofold: a fossil fuel fee (tax) paid by energy distributors and an output-based pricing system for industrial facilities. The implementation of the federal system will inevitably lead to comparisons with Quebec's system, the main difference being Quebec's absolute cap on emissions, which decreases by 3% annually. The cap sets the number of emission credits for auction, which generates income directed to the Green Fund.

Cost management of the Green Fund is now submitted for analysis to the *Conseil de gestion du Fonds vert* (Green Fund Management Board), which is tasked with restoring rigorous management of the funds invested to fight climate change. Several TEQ-managed programs (perspective below) are financed by the Green Fund. But the *Conseil* believes that 32 measures financed by the Fund should be suspended immediately due to suboptimal performance or lack of relevance or justification. The Legault government has proposed an overhaul of the Fund in 2019. GHG emission reductions linked to TEQ programs and other departments will be closely monitored. As 2020 draws near and Quebec aims to reduce emissions to 20% below 1990 levels, it remains to be seen how the reform will impact the ability of the master plan to achieve Quebec's energy targets.

HYDROCARBONS

The government of François Legault seems to be more open to fossil fuel production in Quebec than are other political parties. It will be interesting to see how this sector develops, especially given that oil prices are on the uptrend.

In Gaspésie, Pétrolia's Bourque and Haldimand projects, now owned by Pieridae Energy, may be approaching the production stage. Junex's Galt project, also in Gaspésie, may also take various start-up steps, propelled by political and economic conditions. Questerre Energy could move forward with a demonstration project for the clean production of natural gas in the St. Lawrence Lowlands. This project aims to show that Quebec's production of natural gas by hydraulic fracking could have fewer environmental impacts than the natural gas currently imported. Finally, Énergie Saguenay's natural gas liquefaction project and the gas pipeline to supply it will be debated while impact and environmental assessments are conducted.

BIOFUELS

Whether for the production of ethanol, biodiesel or renewable natural gas (RNG), the conversion of biological material into fuel is booming. Enerkem's project in Varennes, whose construction is set to begin in 2019, will produce biomethanol and then cellulosic ethanol. Pyrobiom Énergies' first plant, completed in 2018 in Parent, markets biocrude and biocoal from recycled forest waste through a fast pyrolysis process. More forest waste could be

converted to biofuels through Bioénergie's La Tuque project, whose construction is expected to begin in 2020, backed by Finnish refiner Neste. Development avenues for RNG are increasingly clear, and its production potential from the biomethanation of agricultural, plant and residual biomass from agri-food industries is better understood.

ELECTRICITY

In March 2019, the *Régie de l'énergie* will decide on Hydro-Québec's application to increase its electricity rates by 0.8% (0.2% for industrial clients). Hydro-Québec has also requested a significant change for residential clients: increasing the threshold for the first energy block from 36 to 40 kWh/day, allowing consumers to use more electricity at a lower price (6.07¢/kWh) before passing to the second block, priced at 9.38¢/kWh.

We also await the Régie's decision on rates for bitcoin (blockchain) miners, particularly on whether a special pricing grid for specific usages will be implemented, opening the door for more applications for usage-based pricing.

Finally, will the Legault government's desire to increase Quebec's electricity exports lead to more exports? Will the transmission line to Maine, aiming to supply electricity to Massachusetts under a 9.45 TWh contract with that state, receive all the necessary approvals to move forward? Only Quebec's energy future will tell.

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MEASURE UNITS

$M	million dollars
$G	billion dollars
TJ	terajoule or trillion joules (unit measure for energye)
PJ	quadrillion (one million billion)
V	volt (measure unit of electric voltage)
kV	kilovolt or thousand volts
km	kilometre (distance measure equal to 1,000 meters)
Barrel	volume unit equivalent to 158.9 litres
t CO_2 eq.	ton of CO_2 equivalents
kt CO_2 eq.	thousand tons of CO_2 equivalents
Mt CO_2 eq.	million tons CO_2 equivalents
m^2	square meter (measure unit for surface area)
m^3	cubic meter (measure unit equal to 1,000 litres)
Mm^3	million cubic meters
kWh	kilowatt-hour or thousand watt-hours (measure unit for electrical energy)
MWh	megawatt-hour or million watt-hours
GWh	gigawatt-hour or billion watt-hours
TWh	terawatt-hour or trillion watt-hours
MW	megawatt or million watts (unit of measure for electric power)
ML/yr	million litres per year

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