COMMISSION SUR LES ENJEUX ÉNERGÉTIQUES DU QUÉBEC

From Greenhouse Gas Reduction to Québec's Energy Self-sufficiency

CONSULTATION PAPER

UN QUÉBEC POUR TOUS

Québec

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The unabridged version and the summary of this document are available online at consultation**energie**.gouv.qc.ca

Ministère des Ressources naturelles.

Legal deposit - Bibliothèque et Archives nationales du Québec, 2013

ISBN (printed version): 978-2-550-68617-0

ISBN (PDF): 978-2-550-68618-7

Distribution code: 2013-4003

MESSAGE FROM MARTINE OUELLET

MINISTER OF NATURAL RESOURCES

Against a backdrop of combating climate change, significant increases in oil prices and upheavals stemming from the exploitation of non-traditional hydrocarbons, energy has been of paramount concern for the past decade.

Such changes, which occasionally occur far from Québec, have had a direct impact on the Québec economy.

Québec possesses numerous tools and levers to adapt to changes in the worldwide energy sector. It is an important energy producer and renewable sources account for nearly half of its energy consumption, a proportion that is almost unique in the world. Québec must, nevertheless, import all of the oil and natural gas that it consumes, which accounts for 53% of its energy base.

Québec is displaying a sense of solidarity with all inhabitants of the planet and has undertaken to significantly reduce its greenhouse gas emissions. To this end, it must reduce its consumption of fossil fuels by means of vigorous energy efficiency programs and transfers to renewable energies, especially in the transportation sector.

While the course to be followed is fairly easy to spell out, the approach to be adopted to attain these targets remains to be defined. How can we use Québec's significant renewable energy surpluses? How can we ensure that Quebec industries constantly make better use of energy in order to enhance their competitiveness worldwide? How can we successfully electrify transportation? What approach should we adopt in response to the possibility that Québec possesses significant oil reserves?

In order to arouse common reflection on all of these energy questions and implement an ambitious new energy policy focused on the future, the government has established a roving consultation commission. During this extensive democratic exercise, Quebecers will have an opportunity to make known their perspectives concerning Québec's energy future, either by participating in the public meetings or by submitting a brief.

I invite you to participate actively in the public consultations, which will help define a new perspective of Québec in the realm of energy. Based on the comments obtained, the government will be in a position in 2014 to table an entirely new energy policy for Québec.

For the sake of Québec's energy future, I hope that the consultation commission will give rise to fruitful exchanges.

MESSAGE FROM THE CO-CHAIRS

We are indeed honoured to co-chair the Commission sur les enjeux énergétiques du Québec. As this consultation paper indicates, Québec has reached a watershed in its energy future, which brings to mind the turning point it experienced in the early 1980s. At that time, it sought to develop significant amounts of hydroelectricity that were newly available and to protect itself against new oil shocks. It did so brilliantly: in eight years, Québec reduced its oil consumption by over 40%.

Today, the cost of imported oil is a significant aspect of the challenge Québec is facing. However, this aspect is combined with the environmental question and, more specifically, combating climate change, which is central to our energy concerns. If clean energy and energy efficiency seem to be indispensable avenues for Québec's energy and economic development, the course it must follow has yet to be determined.

We will meet with Quebecers in all regions of Québec to hear them and listen to them present their perspectives of the challenges that we are facing and possible solutions to meet them. The challenges cannot be resolved by only a handful of people. The solutions and directions proposed must be supported by all Quebecers in order for this exciting project to succeed.

We look forward to meeting you.

Normand Mousseau

Professor of physics, Université de Montréal

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Caution

Most of the data concerning energy consumption and energy efficiency in Québec come from Statistics Canada. Data for 2010 were not available when this document was written. The delay distorts the estimation of the most recent trends and, in particular, those regarding the impact in the longer term of high oil prices and the slow emergence from the worldwide financial crisis on Québec's energy profile.

INTRODUCTION

WHY IS QUÉBEC ADOPTING A NEW ENERGY POLICY?

Energy planning in Québec is not recent. Starting in 1945, the government of Adélard Godbout adopted an initial policy governing the electrification of Québec in the wake of the establishment the preceding year of Hydro-Québec. The corporation undertook the development of electricity in Québec when electricity was nationalized in 1963, under René Lévesque, then a government minister, and the government of Jean Lesage. Energy development projects subsequently proliferated under the Société québécoise d'initiatives pétrolières (SOQUIP), established in the late 1960s, with the planning and construction of the La Grande Complex in James Bay and the construction of nuclear power plants between 1970 and 1983. The projects, several of which extended over several decades, were supported by deliberate policies concerning the choice of energy options and the pace of development. They define Québec's current energy situation, on which any new energy policy must be based.

Over the past 20 years, the Québec government has focused on several occasions on the energy question. In 1992, it published an energy efficiency strategy aimed, first and foremost, at reducing the energy bills of residential and industrial consumers. In 1995, it launched a major public consultation in order to establish a broader energy policy. Published in 1996, the policy led, in particular, to the establishment of the Régie de l'énergie and the Agence de l'efficacité énergétique. In 2006, the government proposed a new energy strategy that targeted energy production and supply and also focused on energy efficiency and technological innovation. For the first time, it set an energy efficiency target for petroleum products and asked the Agence de l'efficacité énergétique to elaborate a comprehensive plan devoted to energy efficiency and new technologies.

The situation has changed considerably since 2006. The increasingly concrete environmental impacts of climate change, the high volatility of oil and natural gas prices, the 2008 financial crisis and significant upheavals in the global energy sector were all reasons for elaborating a new energy policy. Now is the time to conduct a thorough review in order to determine the changes in the realm of energy that will enable Québec to meet the challenges that it is facing and create a more prosperous, cleaner society.

In recent years, energy has returned to the forefront of the worldwide political, economic and environmental scene. For example, Europe, the United States and Ontario have proposed new orientations aimed at reducing greenhouse gas (GHG) emissions, increasing the share of renewable energies in their energy balances, and developing greater energy independence. Québec has followed suit, and numerous groups and organizations such as Solidarité rurale du Québec, the Regroupement national des conseils régionaux de l'environnement, Équiterre, Maîtres chez nous au XXIe siècle, and so on, have proposed their own perspective of energy development in Québec.

This consultation paper is intended to take stock of the energy question in Québec and define a framework for a public consultation on a new energy policy. This will afford all Quebecers an opportunity to make themselves heard and contribute to Québec's next change in energy policy.

The Bureau d'audiences publiques sur l'environnement will shortly conduct another consultation process, focusing specifically on shale gas exploration and exploitation throughout Québec's territory. The two consultations will complement each other. In each instance, the commissioners will ensure that a distinction is made between the two and observe the mandate granted to them. The attendant consultation reports will underpin, respectively, the drafting and implementation of the forthcoming Québec energy policy.

A RAPIDLY CHANGING SECTOR

The energy sector has been changing for the past decade in Québec, North America and the rest of the world. For this reason, Québec must position itself to meet and anticipate challenges at the national and international levels.

- Climate change is an undeniable reality. Québec is one of the rare North American jurisdictions to have adopted a target aligned with major international treaties and to have made the fight against climate change one of its priorities. In 2009, the government announced that it was targeting by 2020 a 20% reduction in greenhouse gas emissions in relation to the 1990 level. The government's current target is to reduce greenhouse gas emissions by 25% by 2020.
- Between 2002 and 2008, the price of a barrel of oil quintupled. Since late 2010, the price of Brent oil, which determines the price of Québec imports, has hovered around $100, an unprecedented level over such a long period. This is costing Québec a great deal. In 2012, oil imports accounted for $13.7 billion of its $20.8-billion trade deficit.
- At the same time, the exploitation of non-traditional hydrocarbons, above all, shale gas, has upset the North American energy market. The wider availability of this energy source has caused natural gas prices to plummet, along with electricity prices, which is, accordingly, considerably reducing interest in less economically competitive renewable energies.

To meet these challenges, we cannot simply borrow the solutions that other countries have adopted. We must innovate from the standpoint of policy and technologies, since Québec is noteworthy for several reasons.

- Renewable energy sources account for nearly 50% of Québec's energy needs, a situation that is unique in North America. Most of the energy is produced in Québec, which makes it the biggest renewable energy producer in North America and one of the biggest producers in the world.
- Québec now has available significant surpluses of clean, cheap energy.
  While the rest of the planet is seeking to replace polluting energy with clean energy, the challenge facing Québec is to learn to use its clean energy as efficiently as possible and to make it a key lever of prosperity.
- Over one thousand companies are operating in the energy sector in Québec, both in the manufacturing sector and the services sector. The new energy policy may, therefore, draw on a strong industrial base to face the challenges before us.
- Recent exploration work suggests the existence of significant fossil hydrocarbon reserves. Their development could create a new industry and represent substantial revenues for all Quebecers. Such development would also broaden, on the whole, Québec's energy self-sufficiency.

However, the picture is not entirely rosy, since Québec must contend with a number of constraints.

- With an average per capita consumption of 5 tonnes of oil equivalent (toe), Quebecers are among the biggest energy consumers in the world. If such demand is attributable, in particular, to the harsh climate, geography, and Québec's economic development choices, we clearly can and must seek to enhance our energy efficiency.

- Although it is making genuine progress, Québec is lagging behind in respect of energy intensity (energy consumption/GDP) in relation to other States or countries, which is directly harming its competitiveness both at the continental and worldwide levels.
- Oil needs are growing more rapidly than the population, despite improvements in motor vehicles. The increase stems from the growing number of vehicles on our roads.

Québec is now faced with several choices to ensure its energy security and its economic development. The choices must hinge on facts recognized and accepted by the public at large and political, social, community and economic stakeholders.

The energy history of recent decades reveals that while strong trends are dominating change in Québec, it is nonetheless possible to achieve sweeping change. However, to attain a pronounced shift, it is essential to fully grasp the current situation.

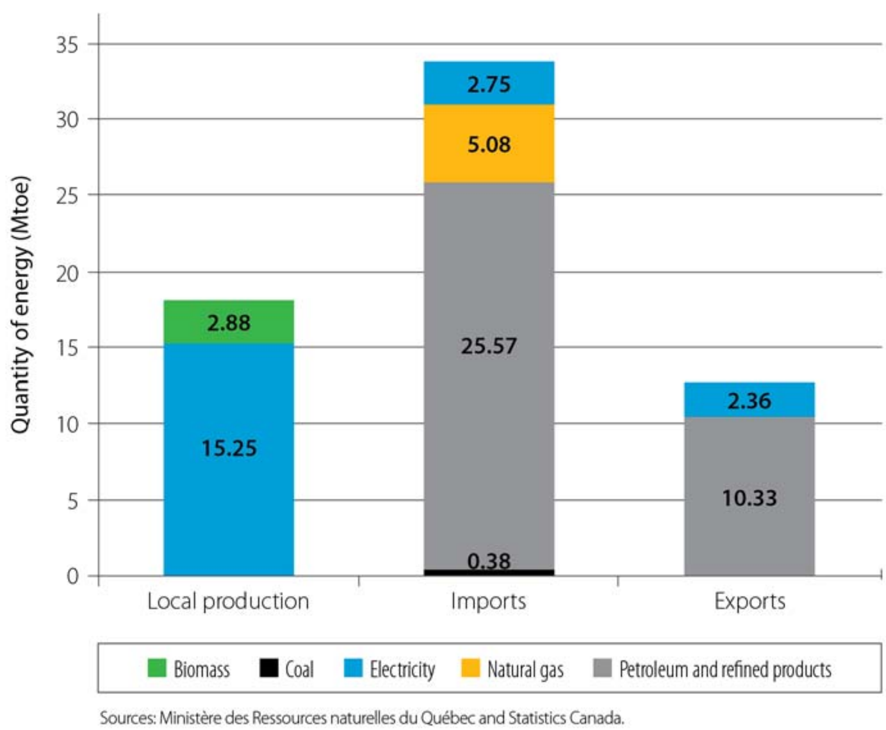
Québec's energy policy must rely on three key components: energy production and supply, energy use and environmental impact, and social and economic development. It must consider the distinctive nature of energy in Québec and key worldwide trends. The question is immense but also represents a stimulating project, the first stage of which is indicated below.

THE CURRENT SITUATION

1. Energy production and supply in Québec

Québec is an important energy producer and processor. From the standpoint of production, hydroelectricity is its main option but it also produces heat and electricity by means of biomass, organic waste and wind with over 1 930 MW of installed capacity as of December 31, 2012 and an additional 1 850 MW planned by 2015.[1]

Figure 1.1 Energy output and exchanges in Québec (2009)



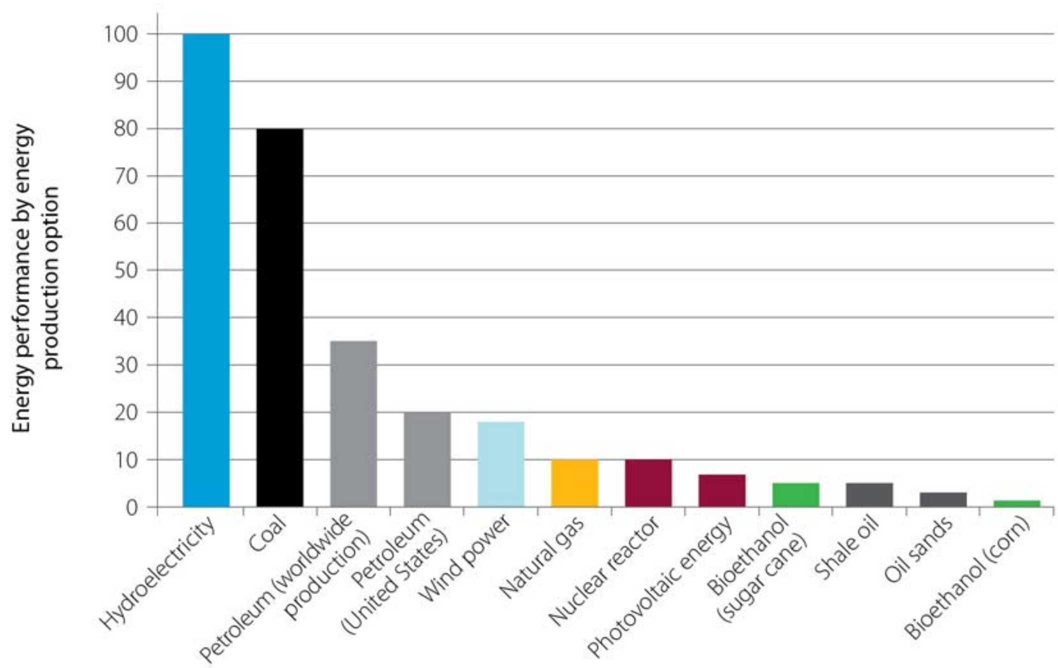
Note: Local production takes into account storage, inter-product transfers and other corrections, including losses and self-consumption on production sites. Imports and exports include interprovincial exchanges, in particular electricity generation from Churchill Falls.

From the standpoint of processing, Québec has two oil refineries whose energy capacity is equivalent to its hydroelectricity output and are, in principle, sufficient to satisfy Québec's gasoline and petroleum product needs. This is a reminder that oil and electricity occupy equal positions in Québec's energy balance and, consequently, that over 50% of the energy consumed in Québec comes from outside the province (Figure 1.1).

Energy performance by energy production option

Energy returned on energy invested (EROEI) measures the quantity of energy necessary to produce a given quantity of energy. It is in indicator that makes it possible to compare the cost of energy in the complete process of producing a form of energy. For the traditional energy options, such performance tends to decline as more accessible, easy to exploit deposits or resources are exhausted or prove to be insufficient. For example, in the United States, it is estimated that the energy performance of the exploitation of petroleum (including the exploration phases) has fallen from 100 for 1 in 1930 to 5 for 1 in existing shale gas and that it appears to be even lower for oil derived from the Alberta oil sands. Conversely, in the case of emerging renewable energies, energy performance tends to increase as technology stemming from innovation improves.

Figure 1.2 Comparison of energy performance by energy production option(EROEI) for different primary energy production options Energy performance by energy production option



Sources: D.J. Murphy and C.A.S. Hall (2010), "Year in review—EROI or energy return on (energy) invested," Annals of the New York Academy of Sciences, 1185: 102-118.

Note: The calculation of energy returned on energy invested (EROEI) is still subject to debate, which explains the occasionally significant discrepancies in estimates found in the literature. Some observers believe that the EROEI required to maintain the social and economic functions in our societies is 3:1,[2] a limit that we are approaching or would indeed exceed with the exploitation of unconventional hydrocarbons.

Greenhouse gas emissions by energy production option

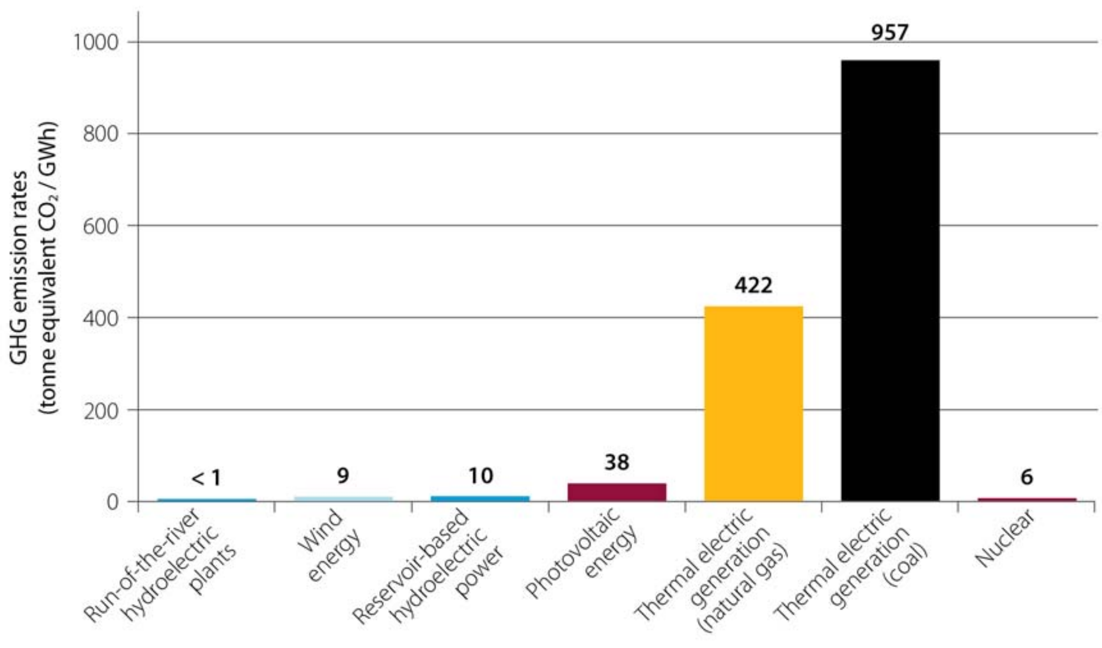
Moreover, like any other human activity, any energy production or energy processing from one form of energy to another, e.g. natural gas to electricity, is accompanied by a loss of energy and environmental impact. Against a backdrop of climate change, GHG emissions from each energy option are a representative measurement of the options' impact on climate.

The chart below indicates the quantity of GHG emissions by energy option according to a life cycle approach over 100 years. Wind power and reservoir-based hydroelectric power generate the equivalent of 10 g of CO_2 per kWh of electricity generated, while a coal-fired power plant emits nearly 1 kg, i.e. 100 times more. On this basis, run-of-the-river hydroelectric plants do not, so to speak, emit any GHG.

It should be noted that GHG emissions linked to hydraulic power are more intense during the first years of priming a reservoir created for the purpose of generating electricity. They subsequently decline considerably to attain the same level as a natural lake after a dozen years.

The electricity generated in Québec is, therefore, among the cleanest energies in the world.

Figure 1.3 Greenhouse gas emission rates for different electricity



Source: *Plan directeur 2010-2020*, Hydro-Québec Production and Chaire de recherche industrielle CRSNG/HQ sur la biogéochimie du carbone dans les écosystèmes aquatiques boréaux (BiCEAB).

kW or kWh?

Kilowatts and kilowatt-hours are used to quantify electricity. One kilowatt (kW) is a unit of power that is equivalent to 1000 watts, which represents the amount of energy available at a given time. For example, it is the power of the motor that determines how much time it takes an automobile to go from 0 to 100 km/h or to pass another vehicle on the highway. It is also the available power that allows Hydro-Québec to satisfy heavy demand for electricity when it is cold.

One kilowatt-hour (kWh) is a unit of energy equivalent to the work executed by a machine with a power of 1 kW for one hour. For example, it defines the quantity of gasoline in the tank of an automobile, which determines the distance to be covered but not the speed of the trip. It is also a measurement of energy production, i.e. the amount of electricity generated during a given period. The kilowatt-hour can be converted into joules, litres of gasoline, tonnes of oil equivalent and cubic metres of natural gas.

1.1 Fossil hydrocarbons

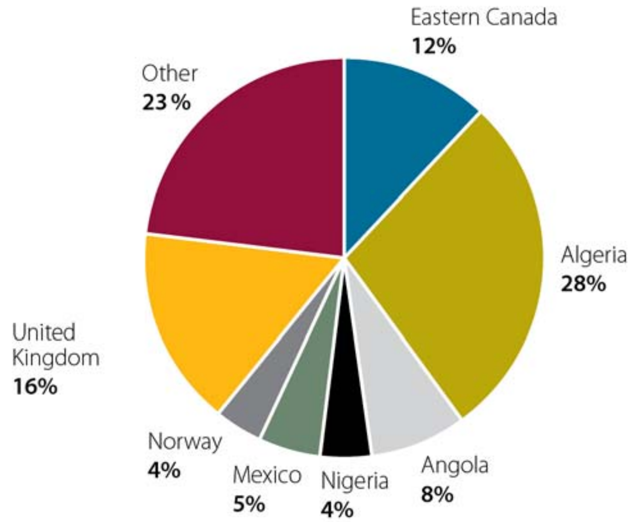
Despite its significant production of renewable energy, Québec relies on hydrocarbons to satisfy over 50% of its energy needs. This source is essential, since the use of hydrocarbons is solidly rooted in our consumption habits, goods production processes, and the attendant social and industrial infrastructure. Such dependency is very costly. In fact, despite the media attention accorded the topic, Québec is not currently producing any fossil hydrocarbons.[3] It must, therefore, import all of the oil, natural gas and coal consumed or processed in its territory.

1.1.1 Oil and gas

Québec has, for a long time, been a significant exporter of gasoline and other petroleum products. With the closing in 2010 of the Shell refinery in Montréal-Est, its crude oil processing capacity was reduced by roughly 405 000 barrels a day or 21 Mtoe per year, which covers slightly more than its daily needs. Today, two refineries share this conversion capacity, i.e. the Ultramar refinery in Lévis (265 000 barrels a day), and the Suncor (formerly Petro-Canada) refinery in Montréal-Est (140 000 barrels a day).

In 2009, prior to the closing of the Shell refinery, which had a maximum refining capacity of roughly 29 Mtoe, Québec imported 20 Mtoe of oil, mainly from Africa (39%), the North Sea (20%) and Newfoundland and Labrador (12%) (Figure 1.3). It also imported nearly 7 Mtoe of refined products, essentially from abroad, and exported 10 Mtoe thanks to its refineries, more than two-thirds of them to the other Canadian provinces.[4] The net result for Québec as regards refined products is exports totalling 3.5 Mtoe and domestic consumption of 16.5 Mtoe of oil and petroleum products (Figure 1.5).

Figure 1.4 Origin of crude oil delivered in Québec (2010)



Note: The category "other" includes occasional suppliers such as Russia, Venezuela, Iraq, the United States and several others.

1.1.2 Natural gas

Québec imports all of the natural gas that it consumes, i.e. 5.6 billion m^3 or 5.1 Mtoe, equivalent to one quarter of its oil imports. Natural gas comes mainly from Western Canada. TransCanada PipeLines transports the natural gas and Gaz Métro and Gazifère, two companies regulated by the Régie de l'énergie du Québec, distribute it (Figure 1.4).

Studies have been conducted with a view to extending the pipelines to the Côte-Nord to satisfy the mining industry's energy needs. However, for the time being, the projects do not seem profitable and have been suspended.

Despite the discovery of geological structures with high natural gas production potential in the Utica Shale, unconventional natural gas is not exploited in Québec.

A moratorium on shale gas exploration in Québec

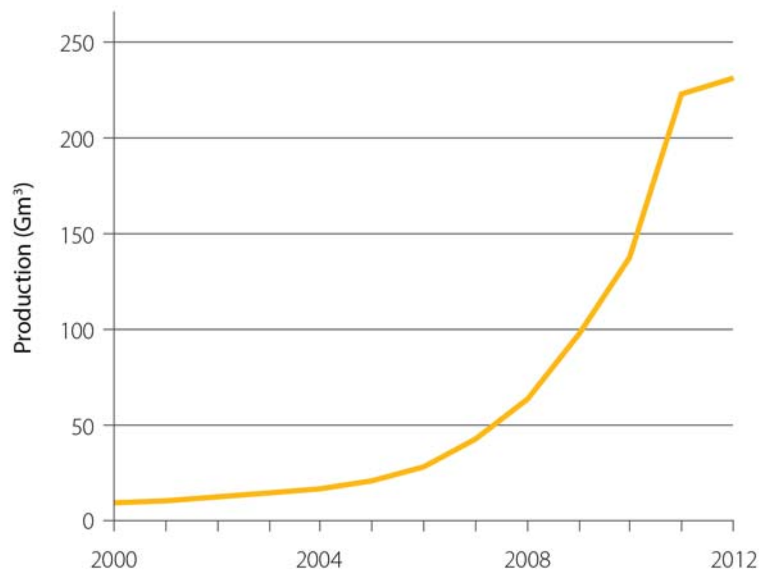
In March 2011, shale gas exploration in the St. Lawrence Lowlands was suspended pending the outcome of a study conducted by the Comité de l'évaluation environnementale stratégique sur le gaz de schiste. The committee included representatives of the industry, government, civil society and the municipal, university and environmental sectors. On February 6, 2013, the government announced a moratorium on shale gas and transferred to the Bureau d'audiences publiques sur l'environnement the studies requested to enable the latter to organize a broader consultation.

The origin of the natural gas consumed in Québec

Shale gas and conventional natural gas are identical from a chemical standpoint and it is impossible to determine the origin of the natural gas consumed in Québec. However, since a growing volume of the natural gas produced in North America is extracted from major gas-bearing shale deposits, i.e. nearly 30% of American output in 2011, and the natural gas market spans the entire continent, it is likely that there is shale gas in the gas distributed in Québec.

While debate is ongoing, a number of researchers have suggested that methane emanations during shale gas exploitation make it a source of energy that is as noxious as coal from the standpoint of greenhouse gas emissions. The growing presence of shale gas in the natural gas consumed in Québec thus poses a challenge under Québec's program to combat climate change.

Figure 1.5 Change since 2000 in shale gas production in the United States



Source: US Energy Information Administration (*Annual Energy Outlook 2013*, Early Release).

Figure 1.6 Map of natural gas and oil supply infrastructure in Québec

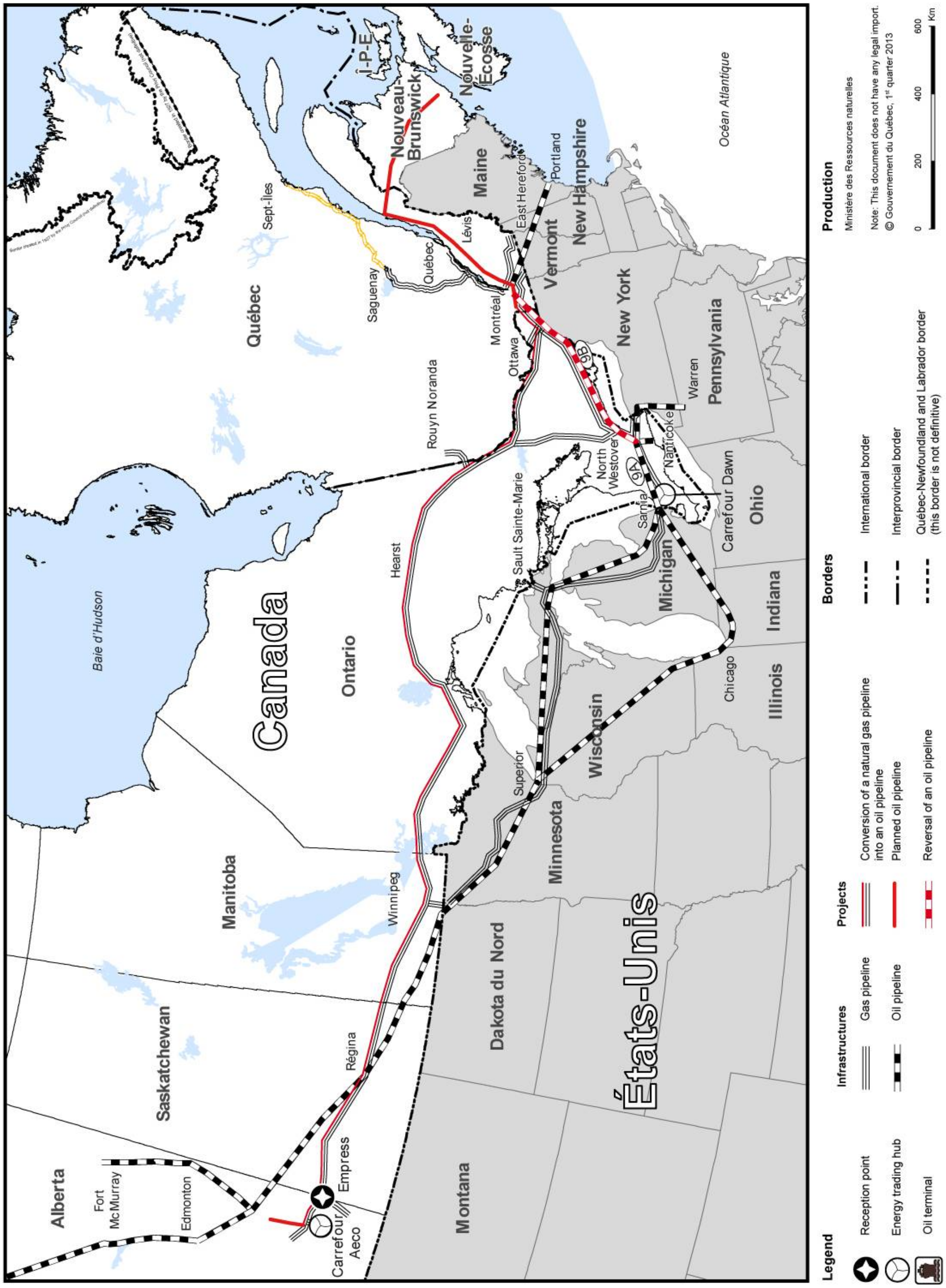
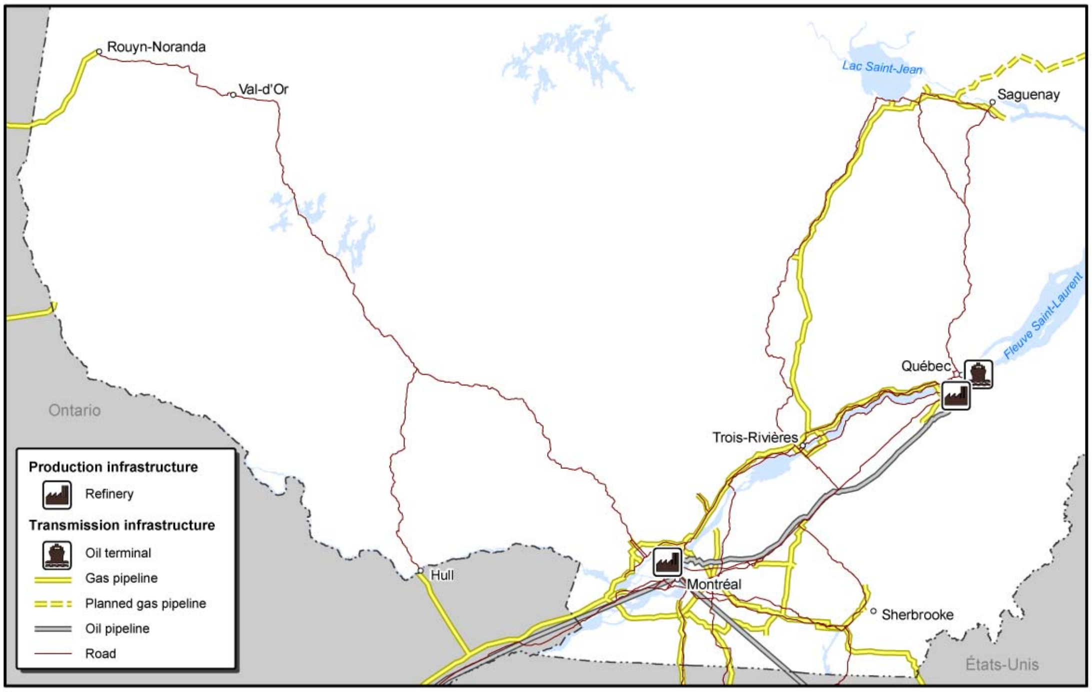


Figure 1.7 Illustration of oil and natural gas transmission infrastructure in Québec



1.1.3 Security and cost of hydrocarbon supplies

The risks associated with oil and natural gas supply are considerably different from those linked to electricity supply. The oil market is global and regardless of the source of supply, Québec, like most countries, is competing with the entire planet to obtain oil. Since it does not have direct access to Canadian oil, it has not been able to take advantage of the significant price discrepancy observed in recent years between Canadian and foreign oil.

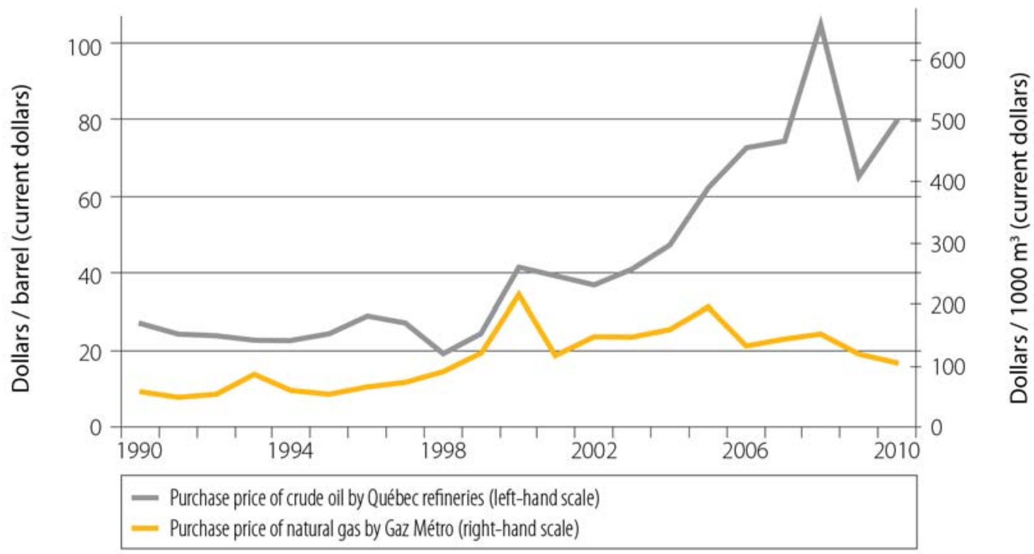
Two Québec projects to obtain oil supplies from Western Canada, mainly extracted from the oil sands, are now in the discussion phase. The National Energy Board (NEB) is evaluating the first project, which calls for the reversal of the Enbridge oil pipeline linking Sarnia to Montréal. The reversal of the Sarnia-North Westover, Ontario section (line 9A), was approved in July 2012. On February 19, 2013, the NEB announced a public hearing for the North Westover to Montréal section (line 9B). The public hearing was initially planned in the late summer but will be held instead in the fall of 2013. TransCanada Corporation's Energy project was made public in the first quarter of 2012. The pipeline hinges on the conversion of an existing gas pipeline between Alberta and Ontario. New pipeline sections must be built in Alberta, Saskatchewan, eastern Ontario, Québec and New Brunswick to link the converted pipeline to eastern markets. Lastly, related facilities, i.e. pumping stations, storage tank terminals and maritime facilities, are required to ensure the transmission of Alberta crude oil to New Brunswick and beyond. The project was subject to a call for binding bids, which ended on June 17, 2013. While the project is still in the preliminary phase, the premiers of Québec and New Brunswick have already announced the creation of a task force that will determine its economic, environmental, technological and legal impacts.

As for natural gas, supplies are now obtained across the continent. The natural gas market has experienced considerable upheavals in recent years. Until 2008, North American specialists and governments feared a marked drop in natural gas production on the continent and supported the construction of liquefied natural gas terminals intended for overseas supplies. Massive shale gas exploitation in the United States in recent years has engendered surpluses, which has caused prices to plummet. Today in North America, for the same quantity of energy, natural gas sells for roughly four or five times less than crude oil does, an unusual situation that is upsetting the balance between different energy sources (Figure 1.7).

This situation is certainly unstable in the medium term. The proposed liquefied natural gas terminals now destined to export natural gas should help North America integrate the global natural gas market and, possibly, restore the price of natural gas to its historic level in relation to that of oil. Be that as it may, failing a major change, Québec may be expected to have access to fairly cheap natural gas for several more years.

However, nothing is certain, as upheavals in the energy sector in recent years show. If Québec's access to hydrocarbon markets over the coming decade does not raise great concern, it is nonetheless impossible to know the price to be paid for hydrocarbons. What is more, it is unlikely that prices will drop appreciably in the oil sector.

Figure 1.8 Change in the supply price in Québec of oil and natural gas (1990 2010)



Sources: Gaz Métro (2012), annual report as of September 30, 2012, R-3831-2012 and Ministère des Ressources naturelles du Québec.

Note: The scales have been adjusted to reflect the energy content of the two forms of energy.

Indeed, while reliance is growing on unconventional oil, which is costly to exploit, the base price of oil has risen from $20 to roughly $100 a barrel in a decade (Figure 1.8), which has caused Québec's trade deficit to skyrocket. During this period, the cost of crude oil purchases increased from $7.2 billion in 2002 to over $13.7 billion in 2012. Over the past year, the value of the oil routed to the two Québec refineries alone represented the equivalent of two-thirds of Québec's trade deficit, which reduces accordingly the expenditures and investments available for other economic sectors.[5]

Table 1.1 Change over one decade in the cost of supply of crude oil and natural gas compared with that of Québec's trade balance (in billions of current dollars)

	Crude oil			Natural gas	Hydrocarbons Total	Québec's international trade		
Years	Foreign	Canadian*	Sub-total	Canadian*		Exports	Imports	Balance
2002	7.1	0.1	7.2	1.3	8.5	68.5	62.1	6.3
2010	12.0	0.2	12.3	1.4	13.7	59.2	77.9	-18.7
2011	10.9	0.2	11.1	1.4	12.5	63.6	84.2	-20.6
2012	13.7	NA	NA	NA	NA	63.5	84.4	-20.8

* The value of interprovincial trade is an estimate calculated according to volumes and average annual price.

Sources: Ministère des Ressources naturelles du Québec, Institut de la statistique du Québec and Statistics Canada.

Note: Prior to the closing in 2010 of the Shell refinery, the refining capacity of Québec refineries appreciably exceeded the needs of Québec consumers for refined products. The net balance of oil re-exported in the form of processed products therefore declined starting in 2011.

1.2 Biofuels

While almost half of the energy consumed in Québec is renewable, it is also because of biomass. Indeed, the production of biofuels in Québec satisfies just over 7% of energy needs, equivalent to 2.8 Mtoe.

Roughly one third of biofuel production in Québec comes from fuelwood, which is usually consumed locally. This source of energy is renewable and the greenhouse gas emissions associated with it are low. However, if it is improperly used, it can be a significant source of fine, highly noxious particles, and other pollutants.

Part of the available biomass is also turned into fuel or value-added fuel. This true, for example, of wood pellets, the production of which stands at 153 000 t a year, and compressed wood logs, production of which stands at 22 000 t a year and provides fuel that is easier to handle.

Since 2007, Québec has also produced 150 million litres of first-generation ethanol, in particular from corn grain. To attain the government's objective of incorporating 5% ethanol in gasoline starting in 2012, i.e. roughly 450 million litres, it has been necessary to import 300 million litres, mainly from the United States, Brazil and Ontario.

Furthermore, Québec produces some biodiesel on a commercial basis. A plant that has been in operation since 2005 produces 60 million litres of biodiesel a year using animal fat, recycled cooking oil, fat from restaurants and other oils. This production, which is mainly exported, represents roughly 1% of Québec's diesel consumption.

Biofuels and the carbon balance

Biofuels are not entirely carbon neutral since fossil fuels are used to manufacture them. Moreover, numerous environmental groups have criticized the use of first-generation ethanol because of the marked environmental impact of the production of corn grain on the international basic foodstuffs market.

On the other hand, the use of waste such as bagass in Brazil and logging residues in Québec is much more worthwhile from an energy and environmental standpoint, since the carbon balance of their production is low. The conversion of straw or forest residues into high value-added fuel nonetheless engenders difficulties. For this reason, the Québec government and its partners are investing substantially to develop a second-generation industrial process that will allow for the conversion of cellulosic material into ethanol. For the time being, such solutions are costly, operate on a small scale and their profitability is increased by the parallel production of more sought-after value-added coproducts. The situation is similar with respect to the use of biogas, whose profitability hinges on the cogeneration and sale of electricity and heat.

1.2.1 Security and cost of supply

The question of the supply of first-generation ethanol by means of organic waste or forest residues must be examined.

Fuelwood and its derivatives, forest residues and other biofuels display an energy density below that of fossil fuels, which affects transportation costs. Accordingly, it takes three times more fuelwood, by volume, than anthracite coal to generate the same amount of heat. Generally speaking, such fuels are consumed or processed near the production site. This is a fundamental constraint. The use of biofuels to produce electricity and cogeneration will thus be particularly worthwhile in forest regions that are still active.

A similar problem arises with respect to biogas, which is very costly to transport. Such hydrocarbons must, therefore, be consumed near the production site, which means the multiplication of local facilities, often small in scope, which increases regional economic spinoff but also production costs. The implementation of an ambitious program to combat climate change might enhance the profitability of such activities.

1.3 Electricity

Electricity generation is Québec's leading economic contribution to the natural resource sector. The electricity sector, which generated some 227 TWh in 2011, including Québec's output and output from Churchill Falls, represented $12 billion, compared with $8 billion for the mining sector and $9.5 billion for the forest sector.

As of December 31, 2011, Québec's electricity generation capacity reached 42 600 MW, of which nearly 40 000 MW was hydraulic (Figure 1.9). The remainder of the generation capacity comes from wind turbines, thermal cogeneration power plants that use biofuels, and diesel, natural gas and light fuel oil power plants that serve autonomous networks or that are used at peak periods or during power outages.

Capacity, energy and demand

The generation capacity of 42 600 MW represents the maximum capacity of all categories of generation equipment installed in Québec's territory. All of the facilities are never in operation simultaneously. The average utilization rate is roughly 46% and it varies considerably depending on the method of generation and the time of year. Indeed, the oil-fired auxiliary thermal station, which uses light oil, is only used 2% of the time during the winter peak period. As for wind turbines, their utilization rate is 30%, depending on the availability of wind. The annual utilization rate of major hydroelectric power plants generally stands at 60%, depending on energy needs. Demand varies considerably over a period of 24 hours and depending on the season. In July, it can fall to 20 000 MW, but exceeded 39 000 MW during the cold snap in January 2013.

1.3.1 Hydroelectricity

Hydro-Québec has an installed capacity of over 35 000 MW and ranks among the world's leading hydroelectricity producers. Following the closing of the Gentilly-2 power plant, hydroelectricity, a renewable energy source, accounts for 99.5% of the installed capacity of its generating fleet. Québec's hydro-power plant output capacity is bolstered by equipment belonging to the municipalities (0.1% of Québec's capacity), independent producers (4.7%) and industrial autogenerators in the aluminum and pulp and paper sectors (7.2%).

In order to develop the regional economy, in 2006 the Québec government decided to offer interested businesses and groups the possibility of developing small hydroelectric power plants that generate 50 MW or less, insofar as the projects, under community control and supported by the community, benefit the regions.

On June 30, 2010, Hydro-Québec selected 13 projects totalling 150 MW. To date, four power plants are in operation (48.2 MW), two project have been abandoned (2.3 MW), and the last 16-MW project is being completed. On February 5, 2013, bearing in mind Québec's electricity surpluses and the need to protect our rivers, the government halted the granting of hydropower in the Québec public domain in respect of the six other projects whose development was less advanced. To support the communities affected by this decision, an interdepartmental committee under the supervision of the Minister of Municipal Affairs, Regions and Land Occupancy and Minister of Transport was set up to determine the catalyst socioeconomic development projects to be implemented in the short term.

1.3.2 Wind energy

The wind power option comprises independent producers from which Hydro-Québec purchases output at set rates. This option was established in Québec starting in 1998. By the spring of 2013, the industry's installed capacity stood at just over 1 700 MW. In 2015, it should exceed 3 350 MW. The industry will then be in a position to deliver annual energy output of roughly 10 TWh. In May 2013, the government announced that it would add new projects totalling productive capacity of an additional 800 MW. The projects will ensure the long-term survival of the wind power manufacturing industry in Québec.

1.3.3 Thermal generation

The productive capacity of the thermal generation option is provided by the Bécancour gas turbine power plant (Hydro-Québec), powered by light oil and used during winter peak periods, and the Bécancour cogeneration power plant (TransCanada Energy), which only operated from September 2006 to December 2007.[6] With the drop in energy demand in the industrial sector and the commissioning of renewable energy power plants, Hydro-Québec is not contemplating using the latter power plant before 2018, according to current scenarios.

Hydro-Québec is also operating 24 small diesel power plants, with a total capacity of 131 MW. The power plants provide electricity for 30 communities in remote areas and supply off-the-grid power systems in the Îles de la Madeleine, Nunavik, the Basse-Côte-Nord region, on Île d'Anticosti, in the Haute-Mauricie region and in Schefferville.

The operation of diesel- and oil-fired power plants is costly because of the price of fuel. The plants also produce a significant portion of greenhouse gas emissions. Natural gas power plants are less expensive to operate and less polluting but nonetheless have a much higher carbon balance than that of renewable energies.

The thermal generation option also includes a dozen biomass-based cogeneration power plants (227 MW), above all forest residues, and six biogas power plants (59 MW), which use methane derived from landfill sites. Other production facilities (145 MW) should be added in the coming years. Even with the sale of part of the heat produced, the power plants, which are contributing to the profitability of the forest product industry, are expensive to operate. They are noteworthy mainly for their contribution to reducing greenhouse gas emissions and supporting local economies.

1.3.4 Nuclear-power option

With the recent decision to close Gentilly-2, the only commercially operated nuclear power plant in Québec, the government is permanently halting the nuclear-power option. The decision is above all of an economic nature. Since 2008, given the increase in the overall anticipated rehabilitation cost from $3.5 billion to $6.5 billion, the total cost of the electricity generated by the power plant has risen from 8.6 to 12.3¢/kWh. Against a backdrop of electricity surpluses and low export prices, the closing of Gentilly-2 will lead to a $215-million increase in Hydro-Québec's annual net earnings starting in 2017.

The increase in the cost of building and upgrading nuclear reactors is also contributing to a repositioning in many other countries with respect to this energy option. Accordingly, even before the Fukushima accident, the Ontario government had abandoned the construction of new power plants following the receipt of bids that considerably surpassed its estimates.

Aside from costs, the Fukushima accident in March 2011 revived fears about this energy option. In the wake of the accident, Germany, for example, announced the immediate closing of eight of its 17 reactors in 2011 and all of its nuclear power plants by 2022. Switzerland also announced that it would not replace its power plants. The Italians voted in a referendum against the revival of nuclear power in their country. The Québec government's decision to close the Gentilly-2 nuclear power plant in the fall of 2012 therefore reflects a worldwide trend.

Hydro-Québec anticipates that the decommissioning, dismantling and removal of spent nuclear fuel will occur over a minimum period of 50 years. The evacuation of spent nuclear fuel depends on the availability of a permanent storage site whose development is placed under the responsibility of the Nuclear Waste Management Organization (NWMO), which anticipates being able to accept spent nuclear fuel from Québec starting in 2050. To reduce this time limit, the Committee on Agriculture, Fisheries, Energy and Natural Resources in the Québec National Assembly recommended in March 2013 that a feasibility study on quicker decommissioning of Gentilly-2 be carried out.

The Gentilly-1 power plant

The Gentilly-1 power plant, closed in 1979, is an experimental reactor that operated sporadically in the 1970s. Its owner, Atomic Energy of Canada Limited (AECL) is now reviewing its decommissioning plan for this power plant and is contemplating its possible dismantling between 2053 and 2103. The Committee on Agriculture, Fisheries, Energy and Natural Resources in the Québec National Assembly recommended in March 2013 that a request be submitted to the federal government for AECL to promptly submit a decommissioning plan for the Gentilly-1 power plant.

1.3.5 Supply and exports

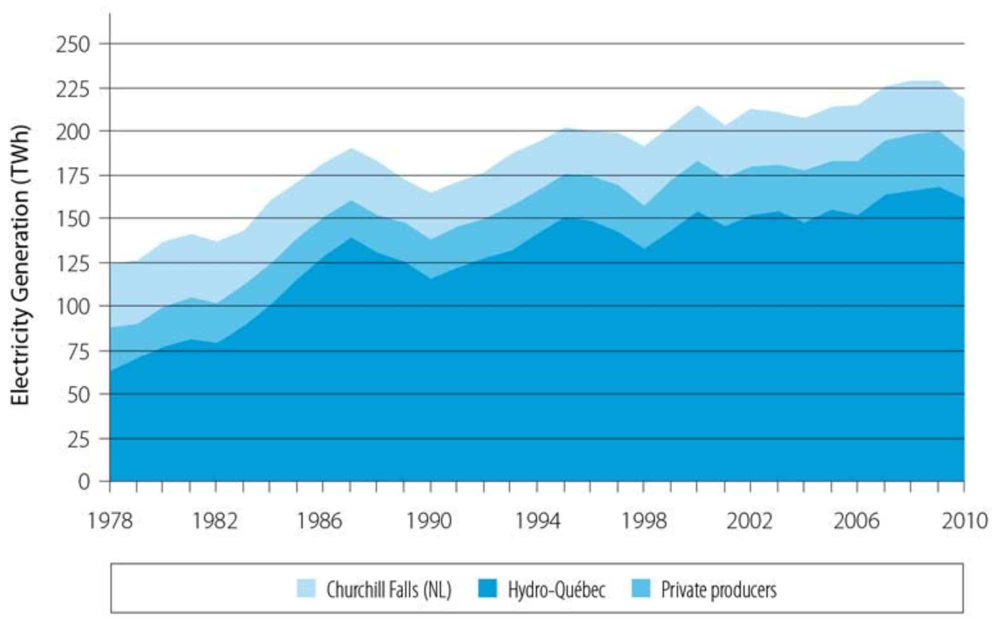
Hydro-Québec operates 16 interconnections with Ontario, New Brunswick, Vermont and New York State, totalling 7 994 MW in export mode and 10 850 MW in import mode. Aside from an export contract (capacity of 225 MW) with Vermont until 2039, most exports occur on the short-term and spot markets.

Moreover, by benefiting from especially advantageous current prices, for example at night, Hydro-Québec is acting as a sort of battery for the northeastern portion of the continent by "storing" in its reservoirs energy purchased at low prices for subsequent resale at higher prices. However, electricity exports are limited by transmission capacity to major consumption centres in neighbouring states, which explains Hydro-Québec's participation in new transmission line projects to New York State and the New England states.

Hydro-Québec is also purchasing almost all of the output from the Churchill Falls power plant until 2041 (5 428 MW), i.e. roughly 29 TWh a year.

There is a strong correlation on the North American market between the price of electricity and the price of natural gas, which, under current conditions is very low. This appreciably reduces the value of electricity exports, which nonetheless continue to be a significant source of revenue. Indeed, Hydro-Québec's earnings from net exports stood at $1.2 billion in 2012 and accounted for $363 million of the utility's net earnings. This means that 11% of the volume of net electricity sales accounted for 13% of net earnings, i.e. earnings per kilowatt-hour significantly higher than that sold in Québec. While they are noteworthy, net export sales have declined appreciably in relation to 2009, when they corresponded to 10% all electricity sales and generated 22% of the utility's net earnings, i.e. over $672 million.

Figure 1.9 Change in gross electricity generation by type of producer (1978-2010)



Sources: Ministère des Ressources naturelles du Québec, Hydro-Québec and Statistics Canada.

Note: Gross output includes electricity consumed to operate the power plants and losses associated with delivery to consumers.

1.3.6 Security and challenges

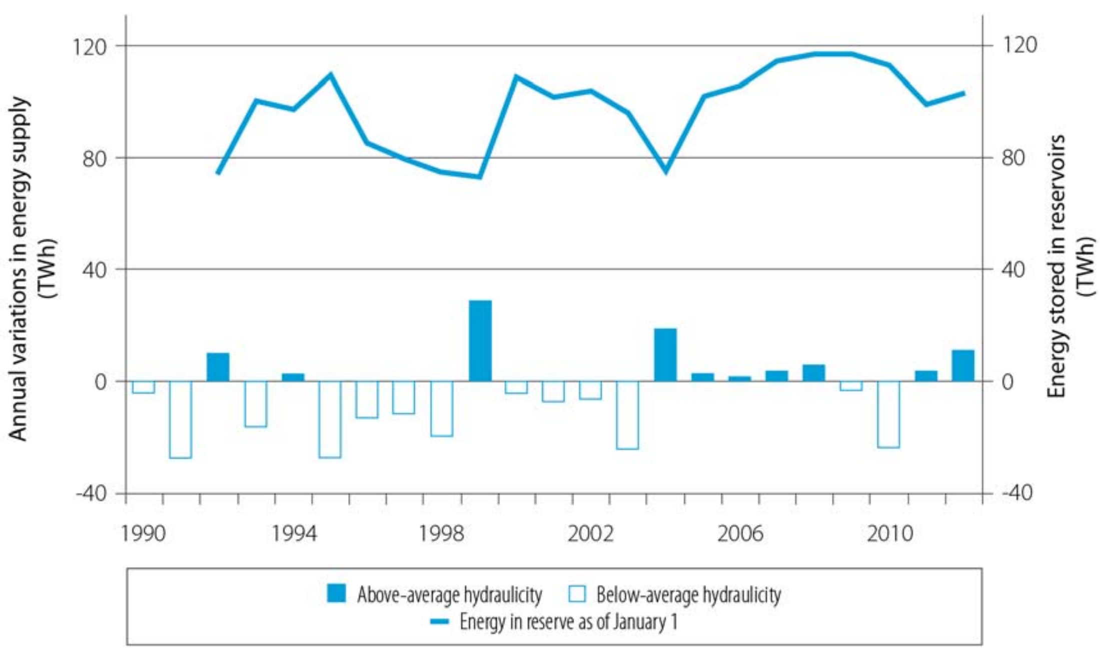
The scope of Hydro-Québec's power transmission network and the distance between generation sites and electricity consumption centres poses well-known challenges and numerous mechanisms have been established to minimize their impact (Figure 1.9).

Natural water supply is a key source of uncertainty (Figure 1.12). Although multi-year water management is possible in many reservoirs, Québec has experienced several fairly dry periods in recent decades. The consequences of climate change, which foreshadow changes in precipitation and temperature models, must therefore be reassessed regularly to determine their impact on natural water supply.

Moreover, the main supply challenge facing Hydro-Québec is to satisfy energy needs during the winter peak period. While resources are sufficient to meet North American reliability criteria, often very costly management means must be adopted during the coldest days of winter.[7]

Figure 1.10 Annual change in water supply in relation to normal values and change in energy supply in Hydro-Québec reservoirs (1990-2010)

Note: The amount stored is evaluated on January 1 of each year. Energy stored and supplies are expressed in TWh.

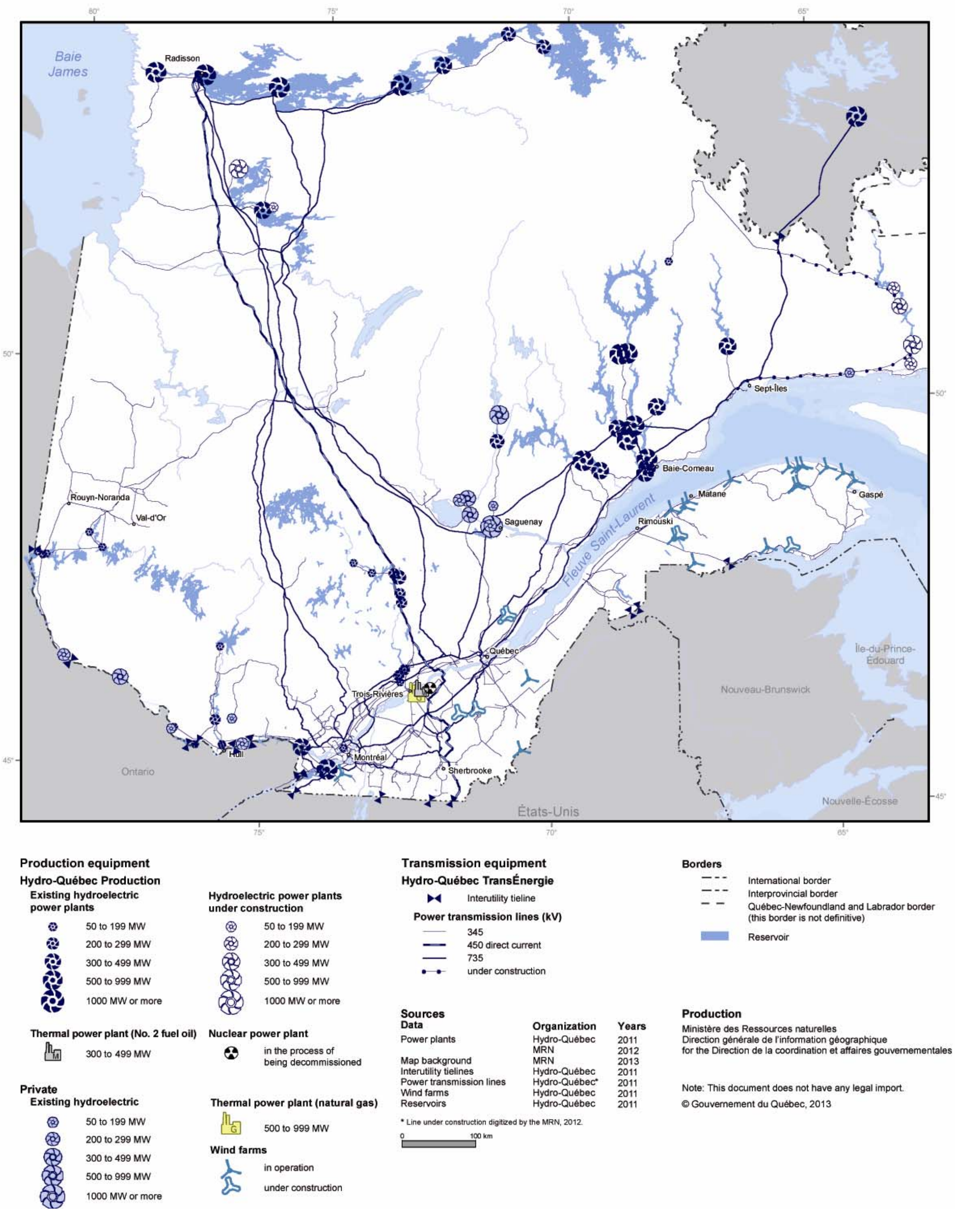


Source: Plan stratégique d'Hydro-Québec 2009-2013.

Once the availability of the resource is assured, a strategy must be developed to optimize spinoff from energy production. The strategy must take into account the size of the market. This is apparent in Alberta, where a lack of oil transportation infrastructure has confined the Western Canadian oil market to the regional level, generating a shortfall of roughly $30 a barrel in relation to the price of West Texas Intermediate (WTI)[8]. The situation is similar in the natural gas sector, where imbalance in the continental market has for several years kept the prices well below their historic level in relation to the price of oil on world markets.

While such imbalance is continent-wide, the structure of the electricity market is much more regional, which reflects, in particular, the technical challenges posed by electricity transmission over long distances and the obstacles that promoters wishing to build new power transmission lines encounter. The maximum development of electricity through exporting is therefore reduced in relation to exporting of fossil fuels. Consequently, a more diversified approach is needed to properly develop Québec's electricity resources.

Figure 1.11 Map of major electricity generation and transmission infrastructure



A colossal network

The challenge facing Hydro-Québec is enormous from the standpoint of electricity transmission. Several generation sites are far removed from major consumption centres and the utility must transport its electricity over very great distances. Indeed, 50% of the electricity consumed in Québec comes from James Bay, 15% from the Côte-Nord and 15% from Newfoundland and Labrador. Hydro-Québec is virtually the only electricity supplier in this immense territory that is equivalent to 21% of the land area of the United States. To serve its clientele, it has available some 34 000 km of power transmission lines.

Figure 1.12 Illustration of Québec superimposed on the neighbouring American states

1.4 Geothermal energy, solar power and underwater generators

Despite often intense media coverage, emerging energy options such as geothermal, passive solar, active solar (photovoltaic) and underwater generator energy account for much less than 1% of Québec's energy production. These decentralized forms of energy are usually used on the production site itself.

There are several explanations for the limited penetration of new production technologies. Their production costs are high in relation to that of electricity, construction standards are not sufficiently demanding and the training of construction and renovation workers in this field is inadequate. It is, therefore, difficult for consumers to choose these new energy options.

However, at present, the production of heat by geothermal or active or passive solar energy systems for homes and commercial and institutional buildings is already competitive with electric or natural gas heating. On the other hand, the generation of electricity through solar photovoltaic technologies is still very expensive. Such production emits four times more GHG than reservoir-based hydroelectric power (see Figure 1.3).

Hydrokinetic power is a promising innovation to harness the energy of rivers and tides. It is generated by means of a hydraulic turbine submerged on the bed of a river to convert the energy from water flowing there. Given its barely invasive and reversible nature in the natural environment where it is installed, hydrokinetic power is a promising option, especially to supply remote establishments not connected to Hydro-Québec's network. This form of energy also affords Québec an opportunity to further master electricity generation technologies stemming from its hydropower.

1.5 Energy efficiency

The notion of energy efficiency was introduced in the 1970s, mainly to help consumers reduce their energy bills. In recent decades, it has become apparent that energy efficiency should also be deemed a source of supply for the producer. Indeed, the adoption of energy conservation measures often costs a lot less than the addition of new means of production, above all in the electricity sector. For this energy option, the cost of generation and transmission facilities, planned a long time in advance, accounts for a significant portion of the cost of the energy delivered.

The development of energy efficiency costs one third of what it would cost to build new power plants and between one fifth and one sixth of what it would cost to produce energy from biomass or by means of wind power (Table 1.2).

Table 1.2 Cost of different energy options in 2012 (¢/kWh)

Option	Average cost
Energy efficiency	2.5
Big hydroelectric power plants	2.1
Small hydroelectric power plants	8.1
Wind turbines	9.0
Biomass	11.1

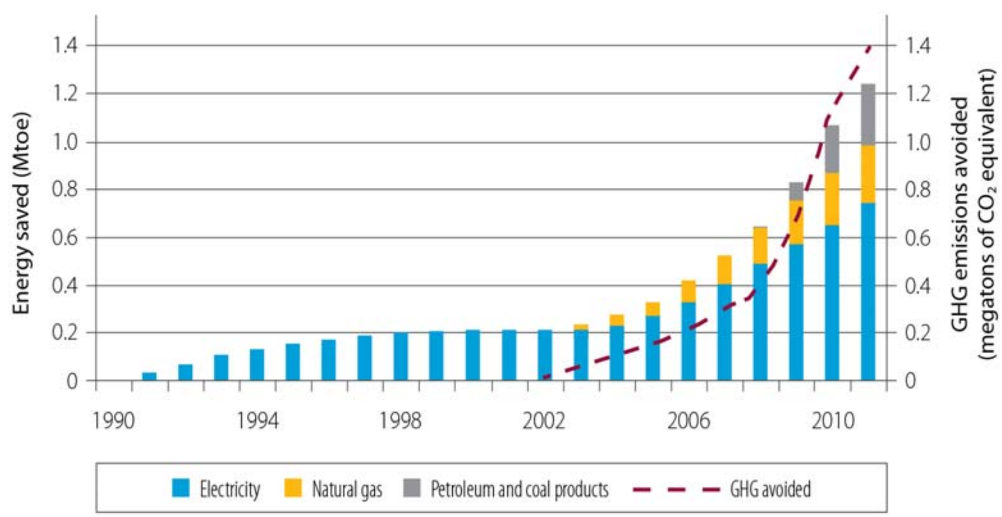
Sources: Hydro-Québec (2012), *Rapport annuel 2012*.

Hydro-Québec Distribution (2012), Application submitted to the Régie de l'énergie du Québec concerning the establishment of electricity rates for 2013-2014, (HQD-5, document 1 - R-3814-2012).

Note: The average cost indicated is that of generation, excluding transmission and distribution costs. By contrast, the most recent estimated cost price of electricity generated by the La Romaine Complex, now under construction, is 5.9¢/kWh.

Since 1990, energy efficiency initiatives carried out in Québec have engendered an overall total of 1.2 Mtoe in recurrent energy savings, i.e. 742 ktep (8.6 TWh) of electricity, 246 ktep (269 Mm^3) of natural gas, and 252 ktep of petroleum and coal products. The fuel savings have reduced cumulative emissions by 1.4 megatons of CO_2 equivalent (Figure 1.13). Total energy savings are now equivalent to just under 3% of Québec's energy production.

Figure 1.13 Cumulative energy savings and GHG emissions avoided stemming from energy efficiency measures implemented by the government and energy distributors (1990-2011)



Sources: Hydro-Québec Distribution and Ministère des Ressources naturelles du Québec.

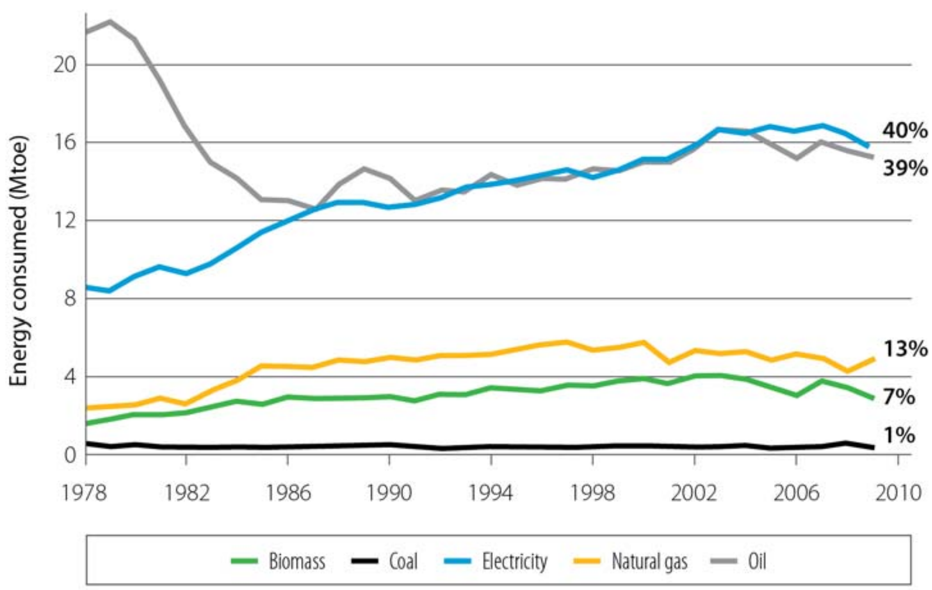
Despite these worthwhile gains, energy savings in respect of natural gas and oil are limited in relation to those achieved from the standpoint of clean energy. Indeed, the latter energy options, which satisfy 53% of Québec's energy needs, account for only 35% of energy savings, an imbalance that cannot continue within the framework of a program to combat climate change.

2 ENERGY CONSUMPTION IN QUÉBEC

In 2009, Quebecers consumed 39 Mtoe of energy, equivalent to 5.0 toe per capita, broken down as follows: 1.0 toe in the industrial sector, 1.5 toe in the transportation sector, and 2.5 toe in the commercial and institutional sector and the industrial sector. Of the energy consumed, 53% was produced by fossil fuels and 47% was from renewable sources.[9] This imbalance differs from the average worldwide (81% of energy comes from fossil energy such as oil, coal and natural gas, 6% from nuclear power, and 13% from renewable energies).[10]

The commissioning of the La Grande Complex in James Bay in the 1970s and the oil crises drastically changed Québec's energy profile. Between 1979 and 1987, oil consumption plummeted by over 40% (Figure 2.1), which engendered significant changes in consumption patterns. First, a considerable share of demand declined in favour of electricity, offered at competitive prices, but also natural gas and biomass. Next, Quebecers altered their consumption habits and, through energy conservation programs, reduced their net energy consumption by over 13%. However, this effort was short-lived since, starting in 1983, energy demand rose steadily until the 2008 financial crisis, despite the energy efficiency programs implemented since then.

Figure 2.1 Change in consumption of different forms of energy (1978-2009)



Source: Ministère des Ressources naturelles du Québec.

The replacement of various forms of fossil energy by electricity continued vigorously until the early 1990s, then slowed considerably thereafter. Over the past 20 years, oil and electricity have thus each accounted for roughly 40% of demand. Consumption of biomass, natural gas and coal has remained fairly stable at 2.9 Mtoe, 5 Mtoe and 0.4 Mtoe, respectively.

What is 39 million toe?

It is the equivalent of 270 million barrels of oil, 450 TWh or 1 600 PJ (petajoules). One PJ is equivalent to 10^{15} joules or one million billion joules. The joule is the unit of measurement of energy, work or amount of heat under the International System of Units (SI).

Per capita average annual energy consumption in all areas of activity stands at 5 toe, 35 barrels of oil or 60 000 kWh. It is as though each man, woman, child and nursing infant left 70 100-watt light bulbs on continuously during an entire year or consumed 15 litres of gas day after day.

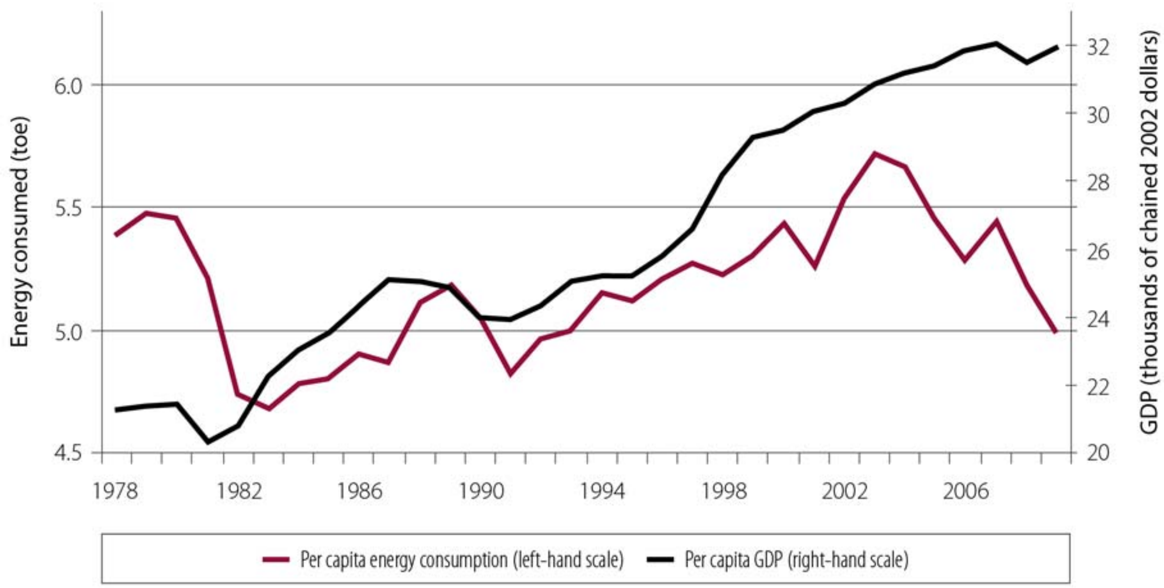
2.1 Changing energy demand

Between 1990 and 2009, total energy consumption in Québec rose from 35 Mtoe to 39 Mtoe, an increase of just over 11%.

This increase closely matched growth in Québec's population. Over the past 30 years, per capita energy consumption has thus remained at around 5 toe, with fluctuations of roughly 0.5 toe depending on annual temperature and the state of the economy. As Figure 2.2 shows, the oil crises and energy conservation initiatives caused per capita energy consumption to fall sharply in the early 1980s, from 5.5 toe to 4.7 toe, then to rise to 5.7 toe in 2003, before returning to 5 toe, the average, in 2009.[11]

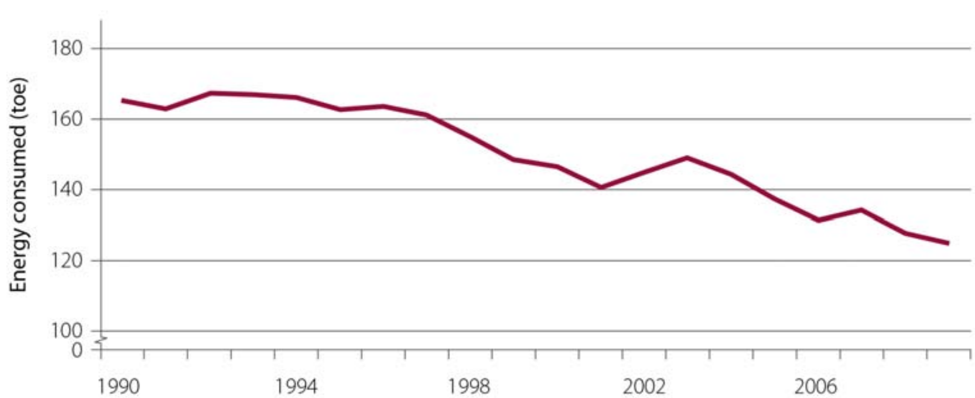
In the absence of recent data from Statistics Canada, it is impossible to say whether this trend has persisted over the past three years.

Figure 2.2 Change in average energy consumption and per capita gross domestic product (GDP) (1990-2009)



Energy consumption per million dollars of GDP, called energy intensity, makes it possible to evaluate the quality of energy use. A high energy intensity means that a great deal of energy is necessary to produce a given amount of wealth. The higher the energy intensity, the lower the efficiency.

Figure 2.3 Change in the quantity of energy required (in toe) to produce $1 million of gross domestic product (GDP) in 2010 dollars (1990-2009)



Sources: Ministère des Ressources naturelles du Québec and Statistics Canada.

Figure 2.3 shows the change in energy intensity since 1990 in Québec. Between 1990 and 2009, GDP increased from $202 billion to $296 billion (constant 2010 dollars), up 46% and four times the increase in energy consumption. Energy intensity thus declined from 174 toe per million constant 2010 dollars to 132 toe per million constant 2010 dollars during this period, a 24% reduction.

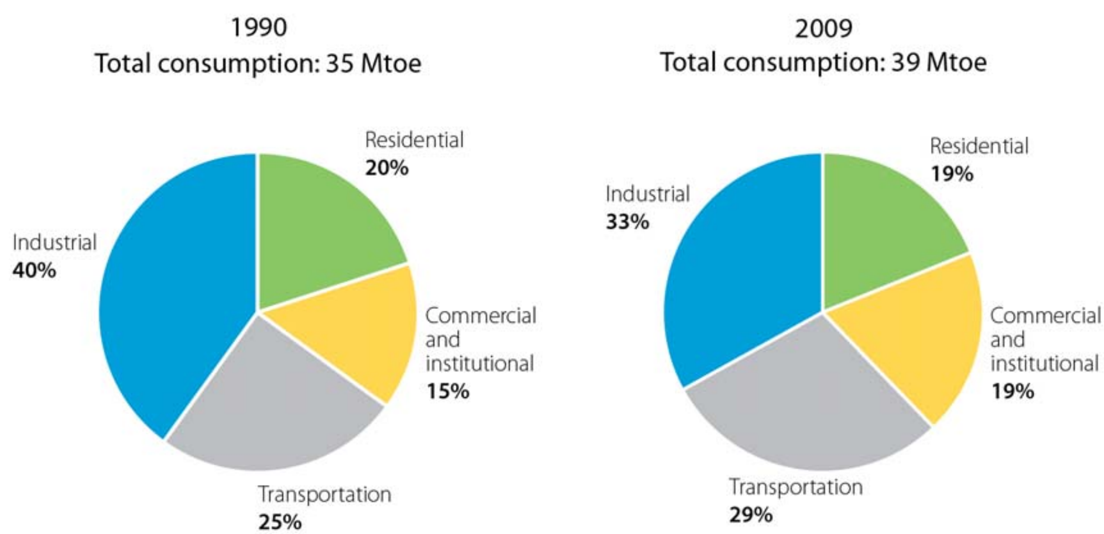
The decrease is attributable to genuine internal changes:

- growth in the less energy-consuming service sector;
- the consolidation of the forest product industry, which is especially energy intensive;
- genuine energy efficiency gains in all sectors of the economy, more specifically in the industrial sector.

2.2 Consumption by economic sector

While per capita energy consumption has been fairly stable for the past 30 years, significant transfers have occurred between different energy expenditure items.

Figure 2.4 Relative share of energy consumption in different areas of activity in 1990 and in 2009

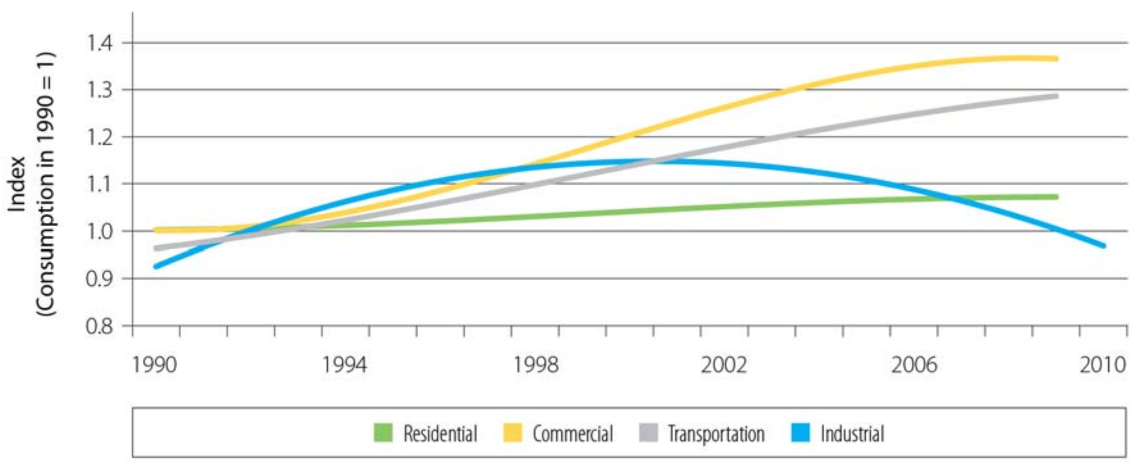


Sources: Ministère des Ressources naturelles du Québec and Statistics Canada.

Figure 2.4 indicates the change in energy consumption in Québec's four key economic sectors (residential, commercial and institutional, transportation and industrial) from 1990 to 2009. As the definition of the sectors differs from one country to the next, the fine comparison of sectorial consumption in Québec and that in other States or countries is rather tricky. However, Québec's overall consumption profile is similar to that of the other developed countries. Generally speaking, industry accounts for between 30% and 40% of a State's energy balance, transportation accounts for between 25% and 30%, and the remainder is divided between the residential sector and the commercial and institutional sector.

Energy consumption in Québec's economic sectors has changed considerably over the past 20 years. The proportion in the residential sector has remained fairly constant. As for the commercial and institutional sector and the transportation sector, they monopolized 48% of the energy consumed in 2009, compared with 40% in 1990. This increase occurred at the expense of the industrial sector, whose consumption declined in 19 years from 40% to 33% of Québec's total energy consumption (Figure 2.5). Since the commercial and institutional sector and the transportation sector consume more fossil fuels than the industrial sector (Figure 2.6), this transfer means increased demand for such fuels.

Figure 2.5 Trend in the change in energy consumption in each of four sectors of activity (1990-2009)



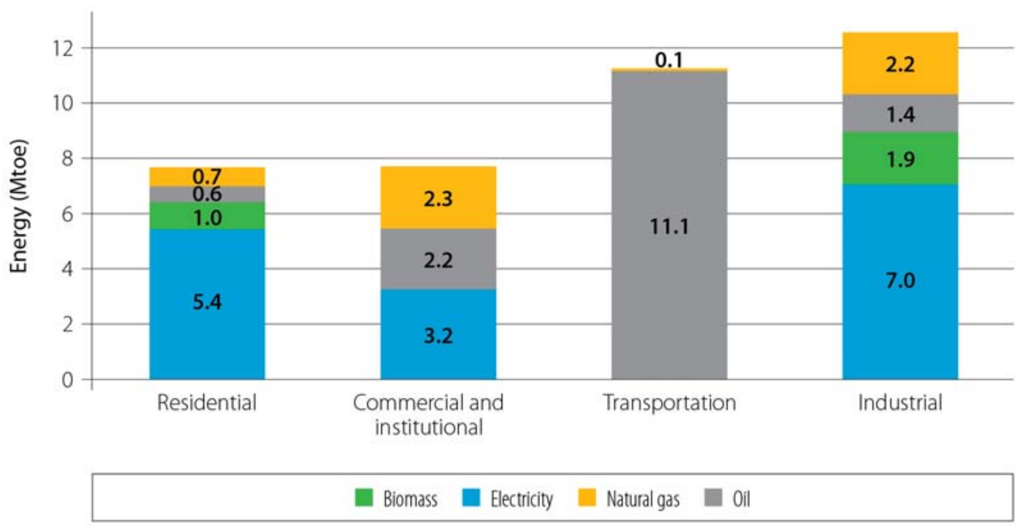
Sources: Ministère des Ressources naturelles du Québec and Statistics Canada.

2.2.1 The residential sector

The residential sector accounts for roughly 20% of Québec's energy base, i.e. 7.6 Mtoe. Annual per capita consumption stands at 1 toe, equivalent to seven barrels of oil or 12 000 kWh, an amount that has remained constant since 1990. Electric home heating (64%) and water heating (12%) account for three-quarters of the total. Heating oil's share has declined constantly. Some 34 000 new households a year are opting for basic electricity service, most of them with electric heating, and over 10 000 households are replacing their oil-fired heating systems with an electric heating system.[12]

With these transfers, it is the residential sector that relies most extensively on renewable energy, relatively speaking (Figure 2.6). Electricity (71%) and biomass (13%) satisfy over 84% of needs. Heating oil (7%), whose share continues to decline, and natural gas (9%) account for the remainder.

Figure 2.6 Quantity of different forms of energy used by four sectors of activityin Québec in 2009



Sources: Ministère des Ressources naturelles du Québec and Statistics Canada.

Despite the growing number of households and the steady increase in the average floor area of dwelling units, the amount of energy used in this sector was stable between 1990 and 2009. The explanation is that the improvement in the energy efficiency of household appliances, the installation of electronic thermostats and improved home insulation were largely recovered to heat more luxurious, bigger homes or to run ever greater numbers of energy-intensive devices such as spas and television sets. In a word, the per capita energy savings were entirely devoted to new uses, which did not allow for a reduction in or indeed the stabilization of total energy consumption in the residential sector.

2.2.2 The commercial and institutional sector

Consumption in the commercial and institutional sector stood at 7.5 Mtoe in 2009 and it is poised to surpass the residential sector. During the period 1990-2009, net energy consumption in the sector increased by 43% or 2.3 Mtoe. This considerable increase is attributable, in particular, to the shift in the economy toward the service sector, which led to a 33% increase in the floor area of commercial and institutional buildings during the period.[13]

In addition to consuming more energy, the commercial and institutional sector is much less green than the residential and industrial sectors. Accordingly, nearly 60% of the energy consumed in this sector comes from fossil fuels, i.e. natural gas (28%) and oil (29%), and the remainder from hydroelectricity.

For reasons of cost and response time, natural gas and oil heating are preferred in big buildings. This expenditure item represents roughly 40% of the energy consumed in the sector and exceeds 50% when account is taken of water heating and air conditioning, with auxiliary equipment (32%) and lighting (15%) accounting for the remainder.[14]

These data show that the commercial and institutional sector has strong potential for energy gains. However, the size of buildings, their use and ownership structure mean that neither tenants nor landlords deem the cost of energy to be a priority, which relegates the search for energy efficiency to the background, behind numerous other business considerations.

2.2.3 The transportation sector

Unlike other countries, the transportation sector in Québec emits the most greenhouse gases. Indeed, oil satisfies 99% of its needs, natural gas, 0.8%, and electricity, 0.2% (to run the Montréal Métro and the Montréal–Deux-Montagnes commuter train). This sector alone accounts for 11.1 Mtoe or 73% of all of the oil consumed in Québec and for 44% of GHG emissions in Québec as a whole.

Under pressure from governments and through technological progress, e.g. the manufacturing of precision parts and new materials and aerodynamic vehicle design, the energy consumption of motor vehicles has declined considerably over the past 20 years. Accordingly, heavy trucks consumed on average 22% less diesel (33 L/100 km) in 2009 than in 1990, and small automobiles fell from 10.5 L to 8.9 L/100 km, a 15% decrease during the period.[15]

Despite the enhanced energy efficiency of motor vehicles, energy consumption in the transportation sector increased 30% between 1990 and 2009, a per capita increase of 15%, partly because of a net increase of over 2 million vehicles on Québec roads during the period, accentuated by a constantly growing preference among Quebecers for light trucks. The proportion of light trucks in relation to all light vehicles thus increased from 29% to 35% between 2003 and 2011.[16]

In the same way, new distribution strategies such as the just-in-time approach spurred a marked upturn in the number of heavy trucks on the roads. In only eight years, between 2003 and 2011, the number of trucks rose from 112 000 to 126 000, up 13%.[17]

In the meantime, the impact on oil consumption of the advent of electric vehicles on Québec roads is still negligible, since the most attractive models have only appeared very recently and their impact has yet to be felt. In December 2012, it was estimated that in Québec there were only 1 000 electric or rechargeable hybrid vehicles operated by individuals and just over 100 in businesses and public agencies, i.e. 0.02% of Quebecers vehicle fleet.

Mass transit performs better from the standpoint of the amount of energy consumed per passenger-kilometer traveled and the forms of energy used. Indeed, interurban and intra-urban bus transportation consumes 2.2 times less energy than individual transportation per kilometer traveled. Electrified public transit (the Métro and the Montréal–Deux-Montagnes commuter train), transports half of the users of public transport in Québec with an energy efficiency 12 times greater than that of individual transportation.

However, in 2009, only 5% to 6% of road kilometers traveled for personal reasons relied on mass transit in Québec, although this percentage is rising, in particular because of broader availability. The addition of services in Montréal and the significant increase in the price of gasoline and road congestion have led to an upturn in the number of passenger-kilometers served of 3.6% a year since 2006.

Published in April 2011, the *Electric Vehicles 2011–2020 Action Plan* sets the objective for 2020 of:

- ensuring that 25% of new light passenger vehicle sales are electric vehicles (rechargeable hybrids or all electric);
- increasing from 1 500 to 5 000 the number of jobs in the electric vehicle industry.

By 2030, over 95% of mass transit trips should be made in electric public transit.

Two years after the launching of the action plan, seven years from the target date, the number of electric vehicles on the road accounts for only 0.02% of the light vehicle fleet. Without new measures, the target of 25% new electric vehicles in 2020 will be hard to achieve.

As for the industry, efforts are concentrated on the development of two prototypes of electric bus (a microbus and an urban bus) whose components are manufactured in Québec. Investments total $73 million, including $30 million from the Québec government.

In its *Plan stratégique 2020*, the Société de transport de Montréal anticipates a shift to all-electric vehicles by 2025. To this end, it will, in particular, abandon diesel buses starting in 2013 in favour of hybrid and electric buses, trolleybuses and the electrification of commuter trains. Because of opposition from Canadian National and Canadian Pacific, which own the rail lines, proposals to electrify this mode of transportation have been suspended for the time being. The Société de transport de Laval plans to replace its diesel buses with electric buses between 2015 and 2030.

Several transportation companies have also launched electric bus pilot projects. Indeed, the Réseau de transport de Québec has been operating eight electric buses since 2008, the Société de transport de Laval received its first electric bus in 2012, and the Société de transport de Montréal has purchased six microbuses, slated to go into service in 2013.

2.2.4 The industrial sector

The industrial sector is Québec's biggest energy consumer. This is to be expected, since clean, competitively priced energy is one of the levers on which Québec relies to attract investors and industries. The smelting and refining industry (including aluminum smelters) and the pulp and paper industry alone consume 20% of the energy produced in Québec.

However, the current level of consumption in the industrial sector is below the historic trend (Figure 2.5). During the period 2003-2009, it fell appreciably, from 17 Mtoe to 12.7 Mtoe, a drop of more than 25% in the sector and over 10% of Québec's total consumption. This outcome stems, by and large, from reduced demand for energy by the smelting and refining, pulp and paper, steel and petrochemical industries. The establishment of a few energy-intensive industries such as mines or aluminum smelters would be sufficient to reverse the situation.

Moreover, the industrial sector, which enjoys, in particular, an especially competitive electricity rate and efficient electrotechnologies, is much greener than the commercial and institutional sector. Indeed, 69% of the energy used comes from renewable sources or sources with low greenhouse gas emissions, i.e. electricity (56%) and biomass (15%). Natural gas accounts for 15% of energy supply, oil, 11%, and coal, 3%.

Despite the drop in demand observed since 2003, energy efficiency analyses reveal the existence of strong potential energy gains to be achieved in the industrial sector (see Section 3).

2.3 Greenhouse gases and the fight against climate change

The reality of climate change is now well established. Scientific proof has been accumulating for several decades and observations often surpass forecasts. Despite objections from certain interest groups, there is no longer any doubt that climate change stems from human activity and the massive use of fossil fuels as a source of energy.

Québec's historic choices in respect of its energy development, which rely on immense water and forest resources, are proving today to be especially enlightened. Indeed, these renewable sources, which have low greenhouse gas emissions, are contributing to satisfying nearly 50% of energy needs, which ranks Québec among world leaders in this regard, with Norway (62%) and Sweden (44%), far ahead of Washington State (32%), Oregon (32%), Manitoba (29%), Denmark (24%), British Columbia (< 20%) and Germany (10%).

Québec's commitments pertaining to greenhouse gas emissions

Target year 2012: Reduce by 6% GHG emissions below the 1990 level, the reference year.[18]

- The reduction achieved should, instead, stand at 2% because of the marked increase in GHG emissions in the commercial and institutional sector and the transportation sector.

Target year 2020: The commitment made in 2009 was to reduce by 20% emissions below the 1990 level.[19]

The government's current target is to reduce greenhouse gas emissions by 25% by 2020.

- Seven years from the deadline, the programs that will make it possible to achieve these targets have yet to be defined.

The role of greenhouse gases

Life on Earth is possible because gas molecules in the atmosphere prevent heat from solar radiation from escaping into space. This phenomenon significantly reduces daily temperature fluctuations and maintains an average temperature of 15°C on the planet. The main molecules are water (H_2O), in the form of vapour, carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O). Such gases allow solar energy to penetrate in the form of light and ultraviolet rays but act as a mirror for infrared light, which makes up most of the energy reflected. They act as a thermostat and regulate the temperature on the planet and enable it to support life.

Since the beginning of the industrial era, around 1750, a significant increase has been noted in the concentration of certain greenhouse gases in the atmosphere, i.e. 35% in the case of CO_2, 148% in the case of methane, and 18% in the case of nitrous oxide, all of which are directly linked to human activity. Accordingly, the combustion of fossil fuels, deforestation and certain industrial processes are releasing enormous quantities of CO_2 into the atmosphere. Methane, a decomposition product, is essentially linked to the production and combustion of hydrocarbons but also to agriculture and stock-rearing. As for N_2O, formed when organic matter and fossil fuels break down and burn, it comes from stock-rearing, spreading nitrogenous fertilizers and the use of fossil and organic fuels.

The molecules have a useful life in the atmosphere and a potential to reflect heat that is specific to them. To facilitate the comparison, such properties have be reduced to a unit of reference, i.e. one molecule of CO_2 surviving 100 years in the atmosphere. According to this scale, one molecule of methane will thus have a heating effect 21 times greater than one molecule of carbon dioxide, and one molecule of nitrous oxide, 310 times greater.

Over 20 years, during which time we must act, the greenhouse effect of methane is 72 times greater than that of CO_2, while the global warming potential of nitrous oxide is 289 times higher.

Based on its historic choices and aware of the adverse impact of climate change on humankind, Québec has decided to actively commit itself to combating climate change. It participated in the deliberations leading to the Kyoto Protocol aimed at limiting the increase in the concentration of greenhouse gases in the atmosphere and in the average global temperature to 2°C.

In 2006, the National Assembly of Québec endorsed the Kyoto Protocol and the government implemented an initial action plan on climate change for the period 2006-2012. The action plan targeted the attainment of the Canadian goal of reducing by 6% GHG emissions by 2012 (below the 1990 level). Following the adoption, in 2009, of a new 20% reduction target below the 1990 level, to be achieved by 2020 (a target comparable to that of the European Union), a second action plan focusing on the period 2013-2020 was tabled in June 2012.

The Kyoto Protocol

The Kyoto Protocol is part of a process aimed at reducing GHG emissions to a level that limits the impact of climate change. The approach emerged in the wake of the first Earth Summit held in Rio de Janeiro, Brazil, in 1992.

At the 3rd United Nations Conference on Climate Change, held in Kyoto in 1997, the participating countries agreed on an initial international treaty. Accordingly, the Kyoto Protocol sets legally binding objectives and deadlines for reducing GHG emissions in the economically powerful nations. The objectives range from -8% to +10% in relation to individual emissions in the countries in 1990, with a view to reducing in 2012 their overall emissions at least 5% below the 1990 level.

To come into force, the treaty had to be ratified by at least 55 countries responsible for over 55% of total global emissions. It came into force in February 2005 when Russia signed the agreement, but in the absence of the world's leading emitter, the United States. In December 2012, Canada was the first signatory country to officially withdraw from the Kyoto Protocol.

Act II of the Kyoto Protocol, signed in late 2012, covers the period until 2020. The European Union, Australia and a dozen other industrialized nations have reiterated their commitment to the Kyoto Protocol and have adopted the new target of a 20% reduction by 2020 in their emissions. The countries account for roughly 15% of global emissions. While Québec may not, as a federated State, ratify the new agreement, it announced that it was adopting the new target voluntarily and out of solidarity.

Moreover, Québec has joined various groups of federated States and regions that are seeking to develop a common approach to reduce their GHG emissions. To this end, on January 1, 2013, it established a GHG emission cap-and-trade system (a carbon exchange) that it shares with California, a first in North America. The efficacy of the carbon exchange will, however, be significantly reduced in the absence of a continental or, indeed, a global agreement and direct, targeted measures.

In the absence of sufficiently drastic measures in the past, it is very likely that the 6% GHG reduction target for 2012 will not be attained. Table 2.1 indicates the change in GHG emissions from 1990 to 2010, the last year for which data are available.

Table 2.1 Change in greenhouse gas emissions — 1990-2010

Sources of GHG emissions	Amount of emissions (megatons of CO_2)		Change in emissions (%)	Share of total emissions (%)
	1990	2010	1990-2010	2010
Transportation sector	27.41	35.06	27.9 ↑	42.5
Residential sector	6.61	3.96	-40.1 ↓	4.8
Commercial and institutional sector	4.21	4.99	18.5 ↑	6.1
Combustion, industrial sector	14.05	12.56	-10.7 ↓	15.2
Oil refining and fugitive emissions	3.30	3.64	10.4 ↑	4.4
Electricity generation	1.46	0.21	-85.6 ↓	0.3
Total — Energy	**57.04**	**60.42**	**5.9**	**73.3**
Agriculture	6.21	6.55	5.5 ↑	7.9
Organic waste	7.32	4.60	-37.2 ↓	5.6
Industrial processes	13.17	10.84	-17.7 ↓	13.1
Solvents and other products	0.05	0.06	24.0 ↓	0.1
Total — Excluding energy	**26.75**	**20.05**	**-17.6 ↓**	**26.7**
TOTAL	**83.80**	**82.47**	**-1.6 ↓**	**100.0**

Source: Ministère du Développement durable, de l'Environnement, de la Faune et des Parcs (2013), *Inventaire québécois des émissions de gaz à effet de serre en 2010 et leur évolution depuis 1990*.

In the 20 years between 1990 and 2010, GHG emissions decreased by 1.6% in Québec. The population grew by 12% and GDP (in constant dollars) rose by 46%. While efforts overall, although insufficient, have pointed in the right direction, such is not the case with energy production. Indeed, GHG emissions stemming from energy production and consumption have undergone a net increase of over 5.9%, which is considerable given that the sector accounts for three-quarters of emissions in Québec. The entire energy sector is, therefore, responsible for the status quo in respect of GHG emissions, more specifically the use of fossil fuels for transportation and heating in the industrial, commercial and institutional sectors.

As for energy consumption, the residential and industrial sectors achieved a significant reduction in emissions. The marked decrease in the residential sector (40%) is attributable above all to the replacement of oil-fired heating by electric heating, a trend that has persisted because of high oil prices.

With a reduction of 1.5 megatons of CO_2 equivalent in 20 years, the industrial sector has also appreciably reduced its greenhouse gas emissions. The decrease reflects, among other things, the efforts of the aluminum industry, which produces 59% of industrial emissions, and the impact of the closing of the last magnesium manufacturing plant in Québec. The reduction occurred, by and large, between 2005 and 2010, through the major efforts of the smelting and refining, pulp and paper, steel and petrochemical industries. Since 2008, the enhanced emissions performance in the industrial sector has also stemmed from a slowdown in the global economy, a situation that could be reversed by an economic recovery.

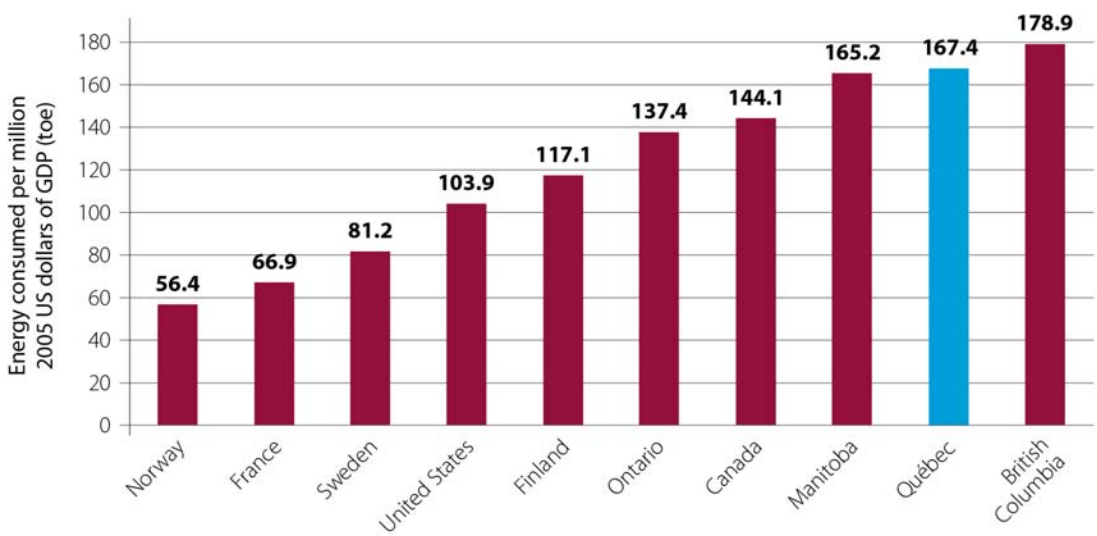
As noted earlier, despite a substantial GHG emission reduction in the residential and industrial sectors, net emissions stemming from energy consumption have increased by 5.9%. The increase is attributable to considerable growth in the commercial and institutional sector, in which emissions have risen by nearly 20% since 1990, and the transportation sector (30%). The latter sector is now responsible for 43% of all emissions in Québec, i.e. a 7.6-megatons of CO_2 equivalent increase. If the situation is not remedied in the commercial and institutional sector and the transportation sector, it will be impossible for Québec to abide by its commitments in combating climate change.

2.4 Québec in the world

Québec is one of the biggest energy consumers in the world, with a per capita consumption rate of 5 toe. Like Canada (5 toe), it ranks behind the United States (4.3 toe) and most other countries. Winters and the size of the territory are often invoked to justify this level of consumption. A comparison with northern countries such as Finland (4.4 toe), Norway (3.7 toe) and Sweden (3.3 toe), whose climate and population density are similar to those of Québec, reveals that it would be possible to consume a great deal less.

It goes without saying that the level of energy consumption affects GHG emission levels. Accordingly, Québec's emissions (10.5 t CO_2) are double those of Sweden (5.3 t CO_2), a country that is in many ways similar to it.

Figure 2.7 Comparison of Québec's energy intensity with that of other territories and countries (2009)



Sources: Ministère des Ressources naturelles du Québec, Statistics Canada, Office of Energy Efficiency, Natural Resources Canada and Enerdata.

Note: The energy intensity of the economy reflects the average amount of energy required from all sources to generate a comparable unit of gross domestic product (GDP). The unit of GDP used here is millions of 2005 US dollars.

The energy-consumption gap is attributable to industrial choices. Indeed, Québec has chosen to rely on its competitively priced hydroelectricity to attract energy-intensive industries such as aluminum smelters, which account for over 10% of Québec's energy balance. The energy-consumption gap also stems from high energy intensity: to produce $1 of wealth, Québec uses 60% more energy than the United States, twice as much as Sweden, and three times as much as Norway (Figure 2.7). This relative inefficiency is costly. Roughly 9.5% of Québec's GDP covers energy expenses, one-third of which leave the province instead of serving Québec's social and economic development.

In recent years, Québec's relative position has not improved. Between 1990 and 2009, it reduced its energy intensity by 24% while the rest of the world reduced its energy intensity in a sustained manner (Table 2.2). Many countries and territories that are already more productive than Québec succeeded in reducing their energy intensity by 30% to 67% during this period, thereby enhancing their competitiveness and widening the gap with Québec.

Table 2.2 Rate of change in GDP, per capita energy consumption and the energy intensity of the economy in different North American and European jurisdictions (1990 to 2010)

	Percentage change between 1990 and 2010		
Jurisdiction	**GDP (%)**	**Per capita energy consumption (%)**	**Energy intensity of the economy (%)**
Oregon	65.0	-22.3	-67.2
Washington State	68.6	-29.4	-67.0
Germany	33.5	-9.4	-30.2
United States	63.5	-6.6	-29.2
Ontario*	51.0	-15.7	-29.1
Sweden	52.2	-0.8	-28.6
British Columbia*	61.1	-10.8	-25.0
Canada	60.5	-1.7	-24.8
Québec*	46.1	-1.3	-24.4
Manitoba*	45.4	3.8	-21.3
Denmark	37.3	2.8	-19.3
France	35.7	4.9	-13.7
Finland	45.5	19.3	-11.9
Norway	67.1	34.0	-7.5

* Data for the Canadian provinces apply to the period 1990-2009.

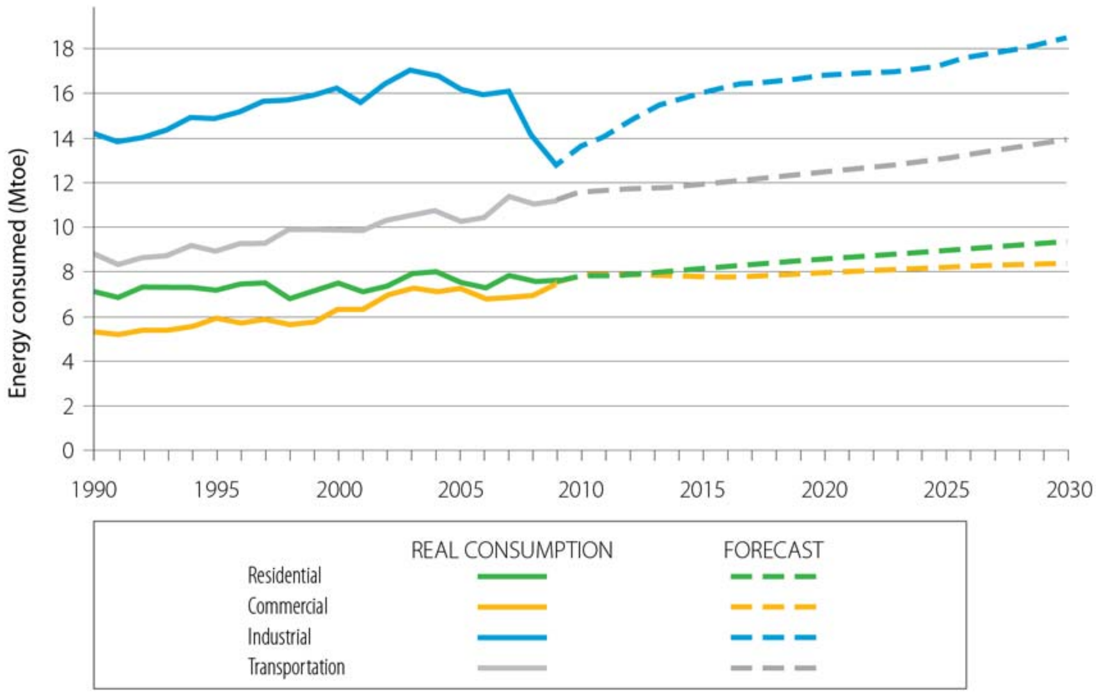
Sources: World Bank, US Archival Federal Reserve Economic Data, US DOE – Energy Efficiency & Renewable Energy in My Stat, and Ministère des Ressources naturelles du Québec.

2.5 Québec's energy needs in the coming years

In the current context, energy consumption should continue to rise in the coming years, as the energy growth reference scenario of the National Energy Board indicates[20] (Figure 2.8). Accordingly, energy demand during the period 2009-2030 should increase in all sectors, i.e. the residential sector, the commercial and institutional sector, the transportation sector, and the industrial sector. All told, the model anticipates 18% growth, i.e. an increase in total energy consumption from 39 Mtoe in 2009 to 46 Mtoe in 2020 and to 50 Mtoe in 2030. Electricity should remain the main source of energy (40% of the total), and oil should decline slightly to 37% in favour of biomass (8%) and natural gas (14%) (Figure 2.9).

Forecasts for the industrial sector are uncertain, since the arrival or departure of an energy-intensive company can significantly disrupt the overall picture. However, forecasts for the other three sectors are in keeping with the trends observed over more than 20 years. Under the programs defined by current energy policy, growth in the residential sector should continue slowly, in keeping with the increase in the population. The National Energy Board's model also anticipates limited growth in energy consumption in the commercial and institutional sector. However, the increase in recent years appears to indicate instead a marked increase, similar to that anticipated in the transportation sector, i.e. a significant increase of roughly 1% a year, thereby pursuing a trend solidly established for two decades.

Figure 2.8 Projections of energy consumption by area of activity by 2030



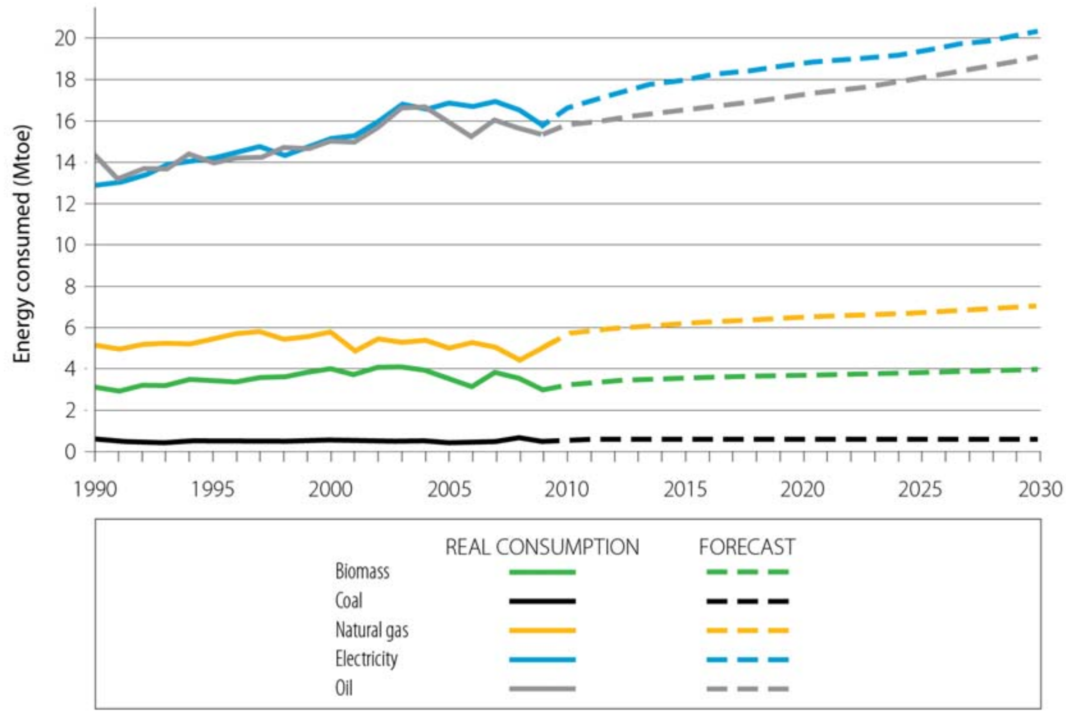
Sources: Ministère des Ressources naturelles and National Energy Board.

Note: The projections have been calculated by means of the adaptation of the 2011-2035 reference model of the National Energy Board based on real historic data from the Ministère des Ressources naturelles.

The impact of this trend on oil and natural gas needs is significant since the commercial and institutional sector and the transportation sector monopolize a considerable share of the use of these sources of energy. Excluding the industrial sector and according to the 2009 consumption report (Figure 2.6), in 2020, 1.4 Mtoe (2.5 Mtoe in 2030) of oil and 0.25 Mtoe (0.4 Mtoe in 2030) of natural gas should be added to the energy balance. Demand for electricity, stemming mainly from the residential sector, should grow only slightly (Figure 2.9).

According to this scenario, green energies (electricity and biomass) will remain dominant in the industrial sector. The development of the mining sector, a big consumer of fossil fuels, should nonetheless significantly increase the share of these fuels in Québec's energy balance and alter forecasts.

Figure 2.9 Projections of energy consumption by area of activity by 2030



Sources: Ministère des Ressources naturelles and National Energy Board.

Note: The projections have been calculated by means of the adaptation of the 2011-2035 reference model of the National Energy Board based on real historic data from the Ministère des Ressources naturelles. The consumption forecasts by forms of energy have been obtained by assuming that the distribution of the forms of energy consumed by sector remain the same as in 2009, as illustrated in Figure 2.6.

3 ENERGY EFFICIENCY IN QUÉBEC

For 30 years, Québec has incorporated energy efficiency into its energy strategies. However, in a context where it has large surpluses of clean, renewable energy at lower cost, it might be tempting to curtail energy efficiency initiatives. Spinoff from energy efficiency on the economy of a State far exceeds the avoided costs of construction of new energy production infrastructure. Indeed, energy efficiency is one of the mainsprings of the productivity and competitiveness of a State's economy that directly contributes to the enhancement of the quality of life of its citizens.

The pursuit of energy efficiency is not confined solely to countries and States with limited resources. To the contrary, North America, Europe and China are among the numerous States that have grasped that the ever more judicious use of energy has a structuring effect on their economies. Indeed, this creates quality jobs and enhances worldwide productivity and competitiveness.

To enhance energy efficiency is also to optimize the use of resources to create a lever for economic growth. Throughout the world, it is apparent that energy efficiency rarely engenders a net reduction in a State's level of energy consumption. Generally speaking, the energy saved is monopolized by new sectors of the economy or to enhance the quality of life, thereby enriching society in an accelerated manner.

Energy efficiency in Québec

January 1977

In the wake of the first oil crisis, the Québec government established the Bureau des économies d'énergie. The body implemented, with its partners, a home insulation program and promoted energy savings in the public and parapublic sectors. In 1988, it became the Bureau de l'efficacité énergétique.

1990-1999

An initial series of energy efficiency programs was introduced for all of Hydro-Québec's residential, commercial, institutional and industrial customers. The programs promoted products and ecoefficient behaviour, as well as supporting insulation, optimizing electro-mechanical systems or enhancing industrial processes.

December 1992

The government announced the S*tratégie québécoise de l'efficacité énergétique*, with the objective of reducing the energy intensity of the Québec economy by 15% by 2001.

November 1996

In the wake of a major public debate on energy, the Régie du gaz naturel was replaced by the Régie de l'énergie, whose mandate from then on covered electricity. The energy policy entitled *L'Énergie au service du Québec* stipulated that the Régie must ensure that energy distributors include in their resource plans energy savings that are profitable for them.

Energy efficiency in Québec (continued)

December 1997

The Agence de l'efficacité énergétique was established, with the mission to promote energy efficiency in a perspective of sustainable development.

2000

In the wake of amendments to the *Act respecting the Régie de l'énergie,* Gaz Métro and Gazifère submitted an initial comprehensive energy efficiency plan. Hydro-Québec followed suite in 2002.

May 2006

The government announced the *Québec Energy Strategy 2006-2015,* entitled *Using Energy to Build the Québec of Tomorrow*. It includes ambitious energy efficiency objectives concerning electricity, natural gas and, for the first time, oil. The objectives multiply by eight the overall energy efficiency target in relation to previous targets. The mandate of the Agence de l'efficacité énergétique is broadened to include support for and the promotion of energy innovation.

April 2009

The Régie de l'énergie approved the *2007-2010 Energy Efficiency and New Technology Master Plan.* With the launching of the *2006-2012 Climate Change Action Plan,* the Agence de l'efficacité énergétique assumed the management of the numerous attendant programs, funded by a royalty on hydrocarbons paid to the Green Fund and a share from distributors.

July 1, 2011

The Ministère des Ressources naturelles assumed the mandates, resources and funding sources of the Agence de l'efficacité énergétique, which became the Bureau de l'efficacité et de l'innovation énergétiques, whose mandate is to foster and promote energy efficiency and innovation.

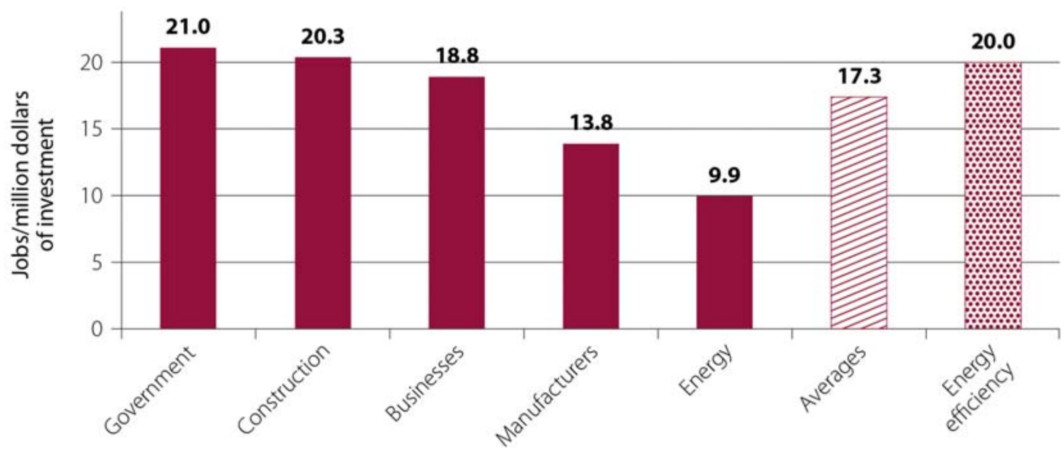
Since the early 2000s, the Québec government, energy distributors (Hydro-Québec, Gaz Métro and Gazifère), and other stakeholders have implemented initiatives and numerous programs. The list of current programs is available on the website of the Bureau de l'efficacité et de l'innovation énergétiques.

The transfer of the energy saved to other uses has been observed in most of the member countries of the Organisation for Economic Co-operation and Development (OECD), where per capita energy consumption has been stable for several decades. Accordingly, Germany, the United States, Canada, Québec, Sweden, Denmark and France experienced a variation of less than 10% in their per capita energy consumption between 1990 and 2010, despite growth in GDP ranging from 34% to 64% (Table 2.1).

3.1 Genuine economic advantages

Energy efficiency frees up resources and dollars that can be used to carry out new activities and generate significant spinoff for society. Above all, energy efficiency is a formidable economic development tool. First, the sector generates direct jobs in the realization of projects. Next, the money saved on energy bills is reinvested in the economy overall, which creates indirect and induced jobs. Indirect jobs are generated in the supply chain and in the manufacture of more efficient equipment and devices. Induced jobs are generated through the redistribution of income stemming from newly created direct and indirect jobs.

Figure 3.1 Number of jobs created in the United States by area of activity



Source: *Energy Efficiency Job Creation*: Real World Experiences. Casey J. Bell. October 2012. An ACEEE White Paper.

Energy efficiency generates more jobs than a direct investment in the energy sector. By way of an example, the US economy creates on average 17 direct, indirect and induced jobs a year per million dollars of investment. The energy efficiency sector generates 20 jobs, and the energy sector, nine jobs a year (Figure 3.1).

The same type of spinoff has been noted in Québec. Between 2002 and 2012, energy efficiency subsidies and the share of customers represented $2 billion that generated, according to our estimates, roughly 40 000 direct, indirect and induced person-years.

Over an average useful life of 10 to 15 years, the annualized average cost of energy efficiency measures is:

- 2.5¢/kWh[21] saved, less than the lowest cost of supply of Hydro-Québec Distribution, i.e. 2.79¢/kWh of heritage pool electricity;[22]
- less than the cost of supply of natural gas and oil distributors;
- comparable to that of the American states.

3.2 Québec and North America

In its 2006-2015 energy strategy, Québec established electricity, natural gas and oil conservation targets. Let us compare these targets with those of other North American jurisdictions.

3.2.1 Electricity

In Québec, the electricity conservation target is 11 TWh of cumulative savings by 2015, i.e. average annual savings of 0.5% of demand. In 2012, cumulative savings since 2002, or the reduction in demand, reached 6.8 TWh, equivalent to just under 0.4% of annual demand. At this pace, the target of 11 TWh cannot be achieved in 2015.[23]

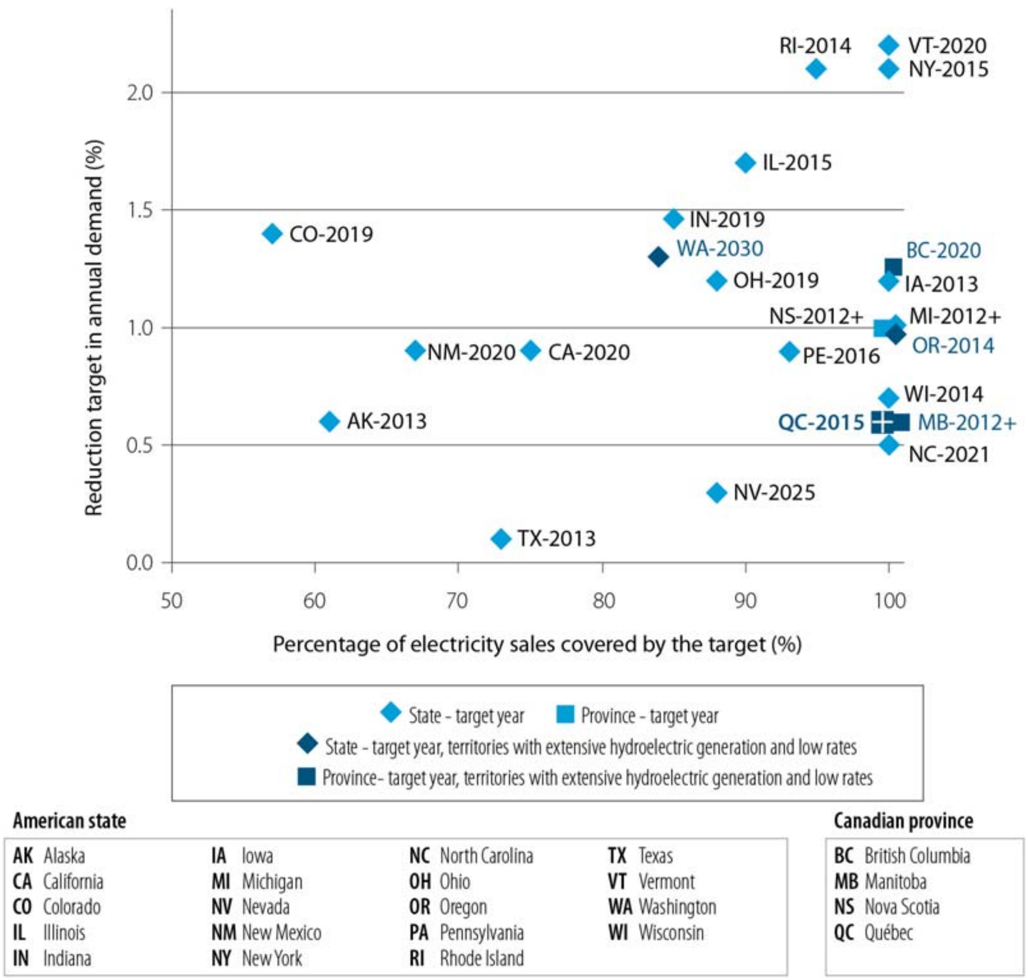
Moreover, 25 American states and three Canadian provinces (British Columbia, Manitoba and Nova Scotia) have also adopted reduction targets in demand over different time spans (Figure 3.2). If we focus on the regions with significant hydroelectric generation and rates comparable to Québec's, it is apparent that such regions have targets higher than Québec's, which they attain and even surpass year after year:

- British Columbia (BC-2020), 90% of electricity generation is hydro-based;
  target of 1.25% savings/year until 2020;
- Manitoba (MB-2012+), 96% of electricity generation is hydro-based: target of 0.6% savings/year beyond 2012;
- Washington State (WA-2030), 85% of electricity generation is hydro-based: target of 1.3% savings/year until 2030;
- Oregon (OR-2014), 91% of electricity generation is hydro-based: target of 0.98% savings/year until 2014.

In comparison, Québec's target (QC-2015) of 0.5% energy savings/year until 2015 is slightly below that of Manitoba and markedly lower than those of other regions that are major producers of hydroelectricity and benefit from competitive rates, i.e. Washington State (1.3%), Oregon (0.98%), and British Columbia (1.25%).

Since the current cost of energy efficiency in Québec, i.e. 2.5¢/kWh (updated), is identical to the average cost in the American states, it does not represent an impediment to the implementation of energy efficiency targets that are as ambitious as those adopted by the other regions that are major producers of hydroelectricity.

Figure 3.2 Level and scope of energy efficiency targets for electricity in force in American states and Canadian provinces



Sources: ACEEE. The 2012 State Energy Efficiency Scorecard and Dunsky, 2012. Balisage en efficacité énergétique (report produced for the Ministère des Ressources naturelles du Québec).

3.2.2 Natural gas

The Québec government is aiming for a target of 350 million m³ of cumulative natural gas savings in 2015. In recent years, average annual savings have hovered around just over 0.5% of demand. This target is being achieved.

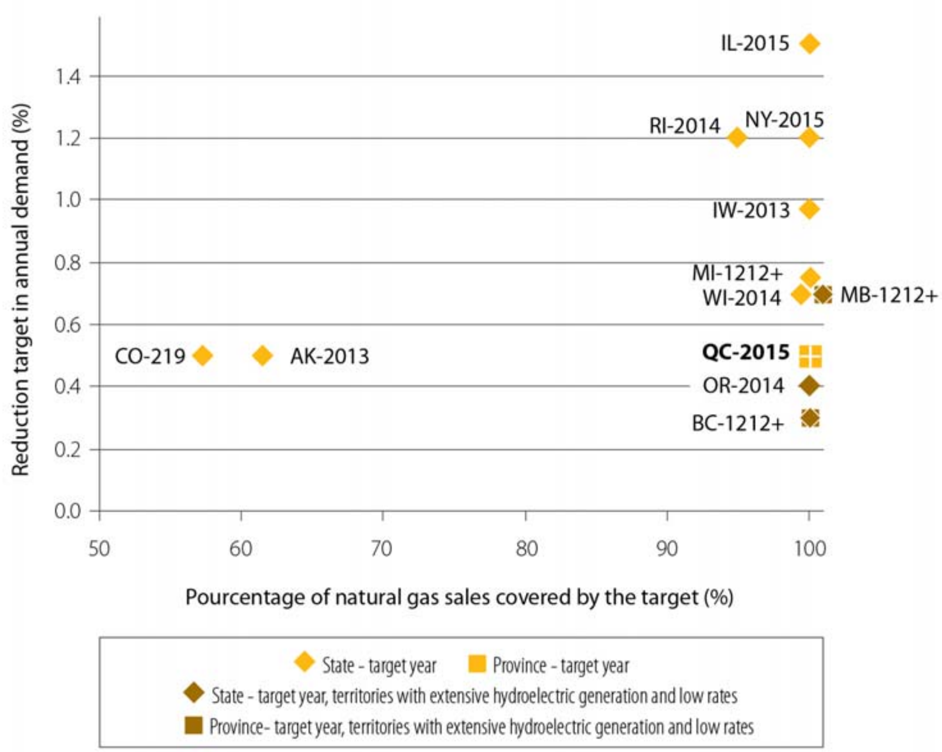
Nine American states and two Canadian provinces (British Columbia and Manitoba) have also adopted reduction targets in demand over different time spans.

Figure 3.3 indicates the percentage of average annual reduction in demand for a given proportion of natural gas sales. The following targets have been adopted in regions where there is extensive hydroelectric generation and rates are comparable to those in Québec:

- British Columbia (CB-1212+): the target of 0.3% savings /year until 2020 is smaller than Québec's target;
- Manitoba (MB-2012+): the target is 0.7% savings/year beyond 2012;
- Oregon (OR-2014): the target of 0.4% savings/year until 2014 is slightly lower than Québec's.

While Québec's target for reduction in demand for natural gas is below that of numerous states, it is comparable to and even slightly higher than those of other regions that engage in hydroelectric generation.

Figure 3.3 Level and scope of energy efficiency targets for natural gas in force in American states and Canadian provinces



Sources: ACEEE. The 2012 State Energy Efficiency Scorecard and Dunsky, 2012. Balisage en efficacité énergétique, report produced for the Ministère des Ressources naturelles du Québec.

3.2.3 Oil

Under its 2006-2015 energy strategy, Québec set an initial oil conservation target of 2 Mtoe in order to reduce oil's share from 39% to 35% of Québec's energy base. Since then, Québec achieved only 0.3 Mtoe in cumulative savings between 2002 and 2012, i.e. barely 15% of its target (2 Mtoe) by the year 2015. Indeed, energy efficiency programs covering oil began late and their impact culminated in 2010 and has lagged subsequently. It will, therefore, be difficult to achieve the anticipated reduction.

Elsewhere in North America, programs directly targeting reduced reliance on oil are rare. The targets tend instead to be integrated into the GHG reduction initiatives that are presented in the following section.

3.2.4 The contribution that energy efficiency is making to GHG reduction

In 2009, Québec adopted a greenhouse gas reduction target of 20% by 2020 in relation to the 1990 level, i.e. a reduction of 16.8 million tonnes of CO_2 equivalent in relation to 1990. The government's current target is a 25% GHG emission reduction by 2020, which means eliminating nearly 21 million tonnes of GHG emissions by that date.

This target is higher than that in other regions in North America, including regions that engage in extensive hydroelectric production. Accordingly, British Columbia, Ontario and Oregon, Washington State and the New England states are seeking to reduce emissions by 15% by 2020 in relation to the level in 2005 (1990 in the case of Ontario).

The anticipated contribution from energy efficiency to the GHG reduction target is estimated at 6.9 megatons of CO_2 equivalent from the 2 Mtoe of oil and 350 million m^3 of natural gas targeted by the 2006-2015 energy strategy mentioned earlier (Figure 3.4). The energy efficiency gains achieved to date stand at only 1.5 megatons of CO_2 equivalent, including 0.9 megatons avoided in respect of oil and 0.6 megatons of savings as regards natural gas. These reductions correspond to 22% of the targeted contribution by energy efficiency and a reduction of only 1.8% in GHG emissions in relation to 1990.

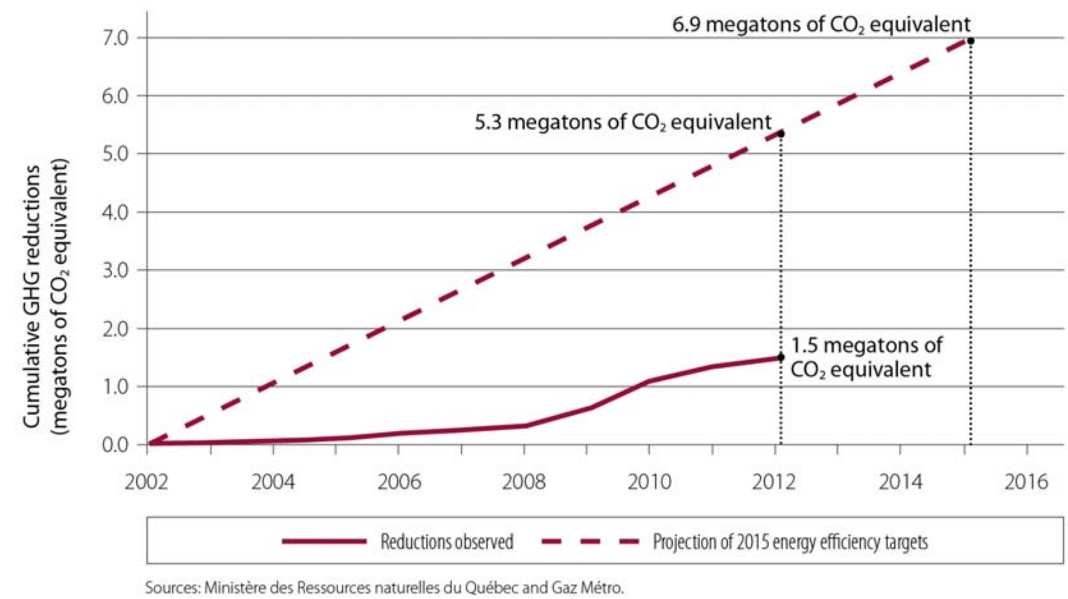
At this rate, Québec will not attain the 25% target. It must absolutely adopt sweeping measures to do so.

3.2.5 Facilitating means

In recent years, 25 American states have modified their regulatory mechanisms in order, among other things, to support electricity and natural gas distributors contending with lost revenue stemming from their energy efficiency activities, in particular during the last economic slowdown. Accordingly, certain states are offering bonuses to administrators, an additional return on capital resources in the case of distributors who have surpassed their objective, or compensation based on outcomes, program by program.

Several regions in North America have achieved genuine success in the realm of energy efficiency. This is true, in particular, of Washington State, Oregon and New England, as well as British Columbia.

Figure 3.4 Contribution of energy efficiency to GHG reduction (2002-2012)



Note: Chart showing the effective cumulative reduction in GHG emissions avoided in Québec from 2002 to 2012 in comparison with energy efficiency targets for oil and natural gas by the year 2015

These regions have adopted effective means of intervention adapted to their context. In British Columbia, BC Hydro, which generates and distributes electricity, is implementing energy efficiency programs. In Washington State and Oregon, Bonneville Power Administration is involved in energy efficiency in collaboration with distributors. In Oregon, the Energy Trust of Oregon is offering private electricity and natural gas distributors energy efficiency programs. Closer to home, in Vermont, energy efficiency is under the responsibility of Efficiency Vermont, a non-profit organization that reports to the state energy board.

In Québec, the Bureau de l'efficacité et de l'innovation énergétiques and natural gas and electricity distributors share responsibility for energy efficiency. As for the challenge that combating climate change poses, Québec must clearly review its regulatory mechanisms and optimize all of the means of intervention in the realm of energy efficiency.

3.3 A significant, cheap source of supply

The energy saved is being used increasingly as a genuine source of supply in the same way as electricity, biomass and hydrocarbons by avoiding reliance on additional supplies from more costly sources. What is more, energy efficiency programs can be implemented more rapidly than other sources of supply.

In 20 years, Québec has achieved energy savings of 1.2 Mtoe, i.e. 5.9% of its total energy production. However, there is still appreciable potential for energy savings. In the residential sector, the commercial and institutional sector and the industrial sector, energy savings at a cost lower than that of other sources of energy stand at several Mtoe.

Energy savings do not necessarily reduce consumption. In the residential and commercial sectors, they usually offset growth in demand. In the industrial sector, energy savings are contributing to reducing the cost per unit manufactured, thereby enhancing the competitiveness of the product, which in some instances promotes growth in demand and, consequently, an overall increase in consumption.

Energy efficiency is more than a source of supply. It is a means of improving a society's productivity in all respects by enhancing the ratio of the social and economic added value per unit of energy consumed.

Societies improve themselves under the impetus of new technologies and new practices, including new energy efficiency approaches. Without constant effort in the realm of energy efficiency, Québec could fall behind in its development in relation to other societies that devote considerable efforts in this respect.

4 THE ENERGY INDUSTRY

The weight of the energy industry in Québec's GDP is considerable. The electricity industry alone encompasses over 1 000 enterprises,[24] in addition to the petrochemical and oil refining industry, and the natural gas distribution industry. Direct jobs in the energy sector can be broken down into the following main categories:

- electricity, natural gas or oil producers, carriers and distributors;
- production, transportation and distribution equipment manufacturers;
- electrical equipment manufacturers;
- hydrocarbon and biomass processors;
- consulting engineering firms;
- other service companies (excluding construction);
- electrical transmission equipment manufacturers;
- industries involved in research and development of new products in the energy sector.

Aside from these businesses, numerous organizations and suppliers serve the industry, along with university, public and private research centres, government bodies and other organizations such as associations.

In the petrochemical and oil refining sector, most jobs are located in Montréal-Est (the Suncor refinery) and in Lévis (the Ultramar refinery). In the electricity sector, some 1 000 businesses operating in all regions of Québec are solidly established in their communities and nearly three-quarters of head offices are located in Québec. They are also present abroad and 30% of their sales are now made in over 180 countries, both in the case of local enterprises and those whose head offices are located abroad.

In a word, the energy industry occupies an important place in the Québec economy. The electricity sector alone accounts for between 45 000 and 55 000 direct jobs, including those at Hydro-Québec, with an average wage of $72 000.[25]

The electricity industry's exports alone (excluding Hydro-Québec) stood at $2 billion in 2012 and were destined for markets that are more diversified than is the case for Quebec industries overall, i.e. 35% elsewhere than the United States. This innovative industry also devotes between 2.5% and 3% of its sales to research and development, of which one-third is invested in the development of new products and services.

The forthcoming Québec energy policy will be elaborated in light of discussions, reflections and debate that will take place in the coming months.

In order to facilitate discussions, it will be necessary to specify the objectives, guidelines and challenges that underpin the policy. Some possible solutions will also make it possible to better grasp the scope of the changes anticipated by the new policy.

CHALLENGES, GUIDELINES AND AVENUES FOR A NEW ENERGY POLICY

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5 THE OBJECTIVES OF THE FUTURE ENERGY POLICY

The future energy policy will target six strategic objectives:

1. Reduce greenhouse gas emissions.

2. Use electricity surpluses to step up the electrification of transportation and develop the industry.

3. Promote energy efficiency in all sectors and for all energy sources to ensure regional development.

4. Rely on the production of renewable energies (hydroelectricity and wind energy) and develop emerging renewable energies (underwater generators, passive solar energy, geothermal energy, and so on) and foster development and innovation.

5. Responsibly explore and exploit Québec's hydrocarbon reserves and harness this resource in order to enrich all Quebecers.

6. Ensure the long-term security and diversity of Québec's energy supplies.

Overall, these objectives will enable Québec to attain, in a broad sense, greater energy self-sufficiency.

The public consultations are intended to define the means to attain these objectives, i.e. the measures that we wish to adopt. They are also designed to determine the origin and breakdown of the significant investments required to attain these objectives. Several solutions already seem especially promising:

1. Make energy efficiency and the lever of clean energy two mainstays of economic development in all of Québec's regions.

2. Significantly reduce the consumption of hydrocarbons in favour of electricity consumption by developing the requisite technologies, in particular in the transportation sector, which would position Québec in the vanguard worldwide.

3. Engage in land-use planning by integrating energy considerations as core values.

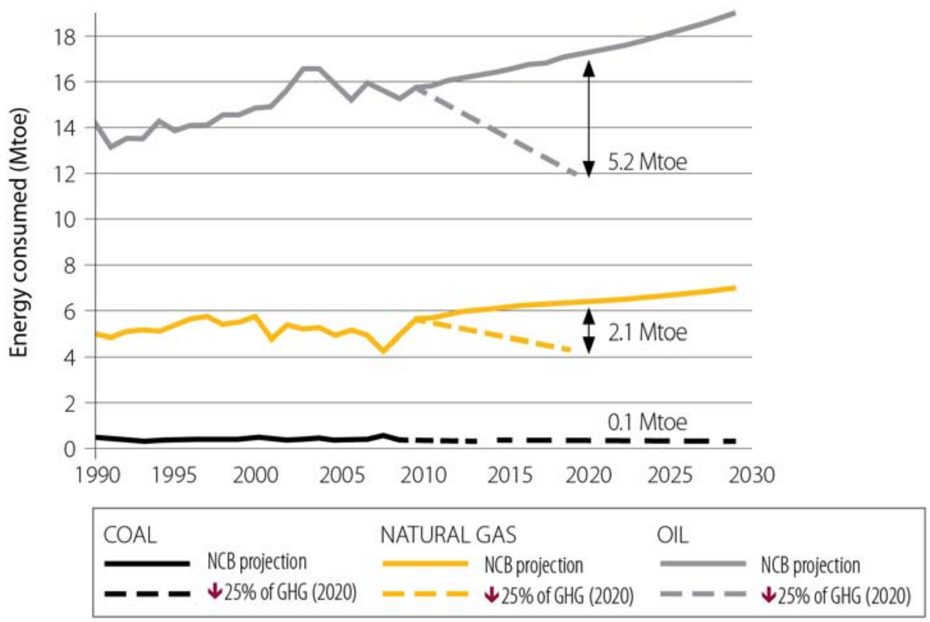
The scope of the task encourages us to draw inspiration from practices related to energy policy from other countries but also to innovate and develop new ideas and technologies that reflect Québec's special conditions.

This is a demanding, exciting challenge for Québec society.

6 COMBATING CLIMATE CHANGE

The second action plan on climate change, tabled in June 2012, seeks the attainment of the Québec target to combat climate change adopted in 2009, i.e. a 20% reduction by 2020 in GHG emissions in relation to the 1990 level, equivalent to a reduction of over 15 megatons of CO_2 equivalent of the 82 megatons of CO_2 equivalent emitted in 2010. The government's current target is a 25% reduction in GHG emissions by 2020, equivalent to eliminating 21 megatons of CO_2 equivalent for a target of 25%. Since energy production and consumption in all sectors of the economy account for 73% of GHG emissions, a genuine change in energy policy is essential. The goal is not only to reduce the consumption of fossil fuels but also to reverse a general trend toward higher consumption (Figure 6.1). To attain a 25% GHG reduction target by 2020, we must reduce by more than 7.4 Mtoe consumption of fossil fuels in relation to the current trend increase in consumption.

Figure 6.1 Estimate of the discrepancy in fossil energy consumption between the reference scenario, without new GHG reduction measures, and a scenario that would attain by 2020 the 25% GHG reduction target in relation to 1990



Note: The reference scenario is calculated by means of an adaptation of the 2011-2035 reference model of the

NCB projection: The estimate of fossil energy consumption according to the normal course of business, i.e. without new government measures starting in 2010.

2020 GHG target: The estimate of fossil energy consumption that would allow for the attainment of the objective of reducing by 2020 GHG emissions by 25% in relation to 1990.

While the scope of change anticipated in the energy sector appears considerable, it is not excessive. It should be noted that in the early 1980s, Québec succeeded in changing its oil consumption habits radically: it reduced by oil use by 9 Mtoe between 1978 and 1987, a 41% drop in nine years.

As was the case in the early 1980s, Québec has a major asset to achieve the transition, i.e. considerable reserves of clean energy and very competitively priced energy efficiency potential. This allows it to contemplate both a net reduction in the energy intensity of the Québec economy and the electrification of sectors that consume hydrocarbons, in particular the transportation, commercial and institutional, and industrial sectors.

To attain its GHG reduction objective, Québec should also act in cooperation with its neighbours. Since 2008, Québec has been a partner of the Western Climate Initiative (WCI), an intergovernmental forum that also includes California, British Columbia, Manitoba and Ontario. The WCI established a carbon market, whose first two members are California and Québec. The market has been in force since January 2013 for the industrial sector and electricity generation. Despite interest in such a program, the absence of other members at the continental or indeed the global level strongly limits the North American carbon market's ability to attain its goal, just as the European carbon market is finding it difficult to attain its objective. Under the circumstances, the Québec government must introduce other robust measures in order to achieve its GHG emission targets.

The achievement of the 25% GHG emission reduction target is a daunting one. To meet it, it will be necessary to contemplate combating climate change as an economic development opportunity on the basis of energy efficiency and clean energy. If it meets the challenge, Québec could become a leader in the next global energy revolution.

What does the 25% greenhouse gas emission reduction target represent?

The 25% GHG reduction target in relation to 1990 applied to the energy sector means that we must further reduce our fossil energy consumption (oil, natural gas and coal) by roughly 23% in relation to the current level. If we are to do so by 2020, here is the level of effort that we should achieve were a single measure applied in each of the four sectors.

The **residential** sector:

- Convert approximately 100 000 dwelling units that still heat with oil or natural gas to electricity (out of roughly 650 000 housing units not heated electrically).

The commercial and institutional sector:

- Convert to electricity roughly 31 000 buildings, e.g. livestock farms, farms, institutional buildings, places of worship, hospitals and schools.

The transportation sector:

- Withdraw from roads or convert to electricity approximately 2.1 million automobiles or light trucks (nearly 50% of the vehicle fleet).

The **industrial** sector:

- Reduce by over two-thirds emissions from the aluminum industry.

7 ENERGY EFFICIENCY, A MAINSTAY OF QUÉBEC'S ECONOMIC DEVELOPMENT

Energy efficiency is usually linked to environmental gains and to the savings that stem directly from its application. It also strongly stimulates economic activity. It creates jobs, enhances business productivity, improves the quality of life, and increases collective wealth. It is one of the dimensions of the development of a society.

By eliminating energy waste, without added value, energy efficiency frees up dollars that can create added economic value and increase corporate competitiveness. It redirects to Québec investments usually allocated to gas and oil purchases on foreign markets, thereby increasing local spinoff.

To achieve the optimum impact, energy efficiency initiatives must be ongoing and seek to permanently alter the market, the culture and consumption habits. To this end, energy efficiency must become independent of the scope of energy surpluses and lost revenues that energy distributors sustain. Québec could draw inspiration from countries such as Norway that have delinked energy efficiency from such vagaries by defining a set conservation rate assumed by all clienteles and assigned to energy efficiency.

Since Québec will have at its disposal substantial surpluses of clean energy for several years to come, it would be tempting to abandon energy efficiency. Québec is not the only State to have recorded electricity surpluses in recent years, although Québec's surpluses are especially big. A number of American states have ended up with surpluses during the latest economic crisis, which could have threatened the survival of energy efficiency programs. Rather than abolish the programs, the states have preferred to adopt regulatory mechanisms that seek to avoid withdrawal in this respect and acknowledge the positive economic impact of energy efficiency.

7.1 Catching up is necessary in all sectors...

We must acknowledge that, despite significant efforts, Québec is lagging behind in the realm of energy efficiency in relation to other jurisdictions, both from the standpoint of objectives and strategies and outcomes. The lag stems from a loss of interest in energy efficiency in the 1990s and that has clearly not been overcome to date.

Accordingly, the large-scale industrial sector has, in particular, been targeted the world over for a dozen years. States see in it a preferred means of achieving energy savings at very low cost while enhancing the competitiveness of their industrial sector.

As of March 2013, 2057 industrial sites had obtained ISO 50001 certification, only of one of which is located in Québec.[26] Projects carried out in the United States and Ireland show that energy management engendered annual savings of 2% to 3% with the prospect of 20% to 30% over a period of 10 years, in addition to considerably enhancing productivity.[27] Big energy-intensive enterprises are operating in Québec, which is seeking to attract others in order to sell its electricity surpluses. It is in its interests to adopt a rigorous policy in this respect. To this end, it can rely on energy management techniques focused on the continuous improvement and lean manufacturing methods that have been quickly established since 2005. The new ISO 50001 standard, a model energy management system, was published in 2011.

The commercial and institutional sector and the residential sector must not be outdone. Energy consumption in the commercial and institutional sector, in particular, continues to rise at a steady pace with extensive reliance on fuel oil and natural gas. By quickly adopting new construction and renovation standards based on best international practices, the government must foster the construction of new commercial and residential buildings with low energy consumption and at low cost.

Existing buildings must also be targeted. New programs are necessary to convince the commercial and institutional sector to invest in energy efficiency and to help households carry out the necessary work. The programs create significant numbers of jobs and engender spinoff in the short and long terms.

7.2 … by targeting hydrocarbons in particular

Most energy efficiency programs in North America seek, above all, to reduce consumption of electricity, which is usually produced from fossil fuels. In order to reduce greenhouse gas emissions by 25%, Québec cannot simply borrow programs offered elsewhere on the continent. It must innovate and develop new ideas and technologies that reflect its special conditions.

Hydrocarbons (oil, natural gas and coal) now satisfy 53% of Québec's energy needs and it is essential to reduce reliance on them in order to achieve climate change targets. Generally speaking, Québec should contemplate, above all, a marked improvement in the energy efficiency of economic sectors that use oil and gas products. It should also encourage the replacement of such products with renewable sources such as electricity, biofuels, thermal solar energy, and geothermal energy.

7.3 … by relying on knowledge

The search for energy efficiency and the replacement of fossil fuels by clean energies must rely on basic research and the development of new technologies and new leading-edge industrial sectors. Such advances allow for energy efficiency gains that enhance the competitiveness of industries and the quality of life of all citizens.

The *Plan d'ensemble en efficacité énergétique et nouvelles technologies* prepared by the Bureau de l'efficacité et de l'innovation énergétiques (BEIE) has already made it possible to inventory new technologies to be developed that are not supported by other government programs or by electricity and natural gas distributors. The BEIE has implemented two programs to support innovation: 1) the Programme d'aide à l'innovation en énergie (PAIE), which is contributing through financial assistance to the development of new technologies or innovative processes and to the development of emerging energy options; and 2) the Programme de démonstration des technologies vertes (Technoclimat™), which supports demonstration projects in respect of innovative technologies and processes that offer sound potential to reduce greenhouse gas emissions.

Other initiatives seek to promote technological research and development in the realm of energy efficiency. Accordingly, in addition to directly funding research at the Institut de recherche d'Hydro-Québec (IREQ) and the Laboratoire de technologies de l'énergie (LTE), Hydro-Québec Distribution (HQD) offers the Projets d'initiatives structurantes en technologies efficaces (PISTE) and Initiatives de démonstration technologique et d'expérimentation (IDEE) programs. In the same way, the Centre des technologies du gaz naturel (CTGN) is developing natural gas technologies and applications for Gaz Métro.

This research and development must be broadened and better integrated in order to maximize the impact of such initiatives on energy efficiency programs.

Examples of exemplary energy efficiency practices

Québec wants to make energy efficiency one of the key economic development levers in order to rank among the most efficient societies in this respect. To this end, it is essential to thoroughly review the current context and rely on the best international practices. Below, by way of an example, are some practices that could be adapted to conditions in Québec:

1. Make energy efficiency a priority energy supply option and foster competition between it and all other energy production options.

2. Encourage distributors to adopt ambitious targets and robust means to achieve them.

3. Foster broader collaboration between distributors and regulatory bodies.

4. Tighten regulations concerning buildings and land-use planning.

5. Find a stable source of funding from energy producers and distributors.

6. Place greater emphasis on integrated programs that encourage changes in the culture and behaviour of individuals, and programs that alter the market.

7. Demand from big industrial customers significant efforts to improve their use of energy.

8. Improve the ability to engage in real-time monitoring in all energy sectors.

9. Ensure follow-up and make accessible to all Quebecers detailed information on targets, investments, benefits and administrative and marketing expenses stemming energy efficiency initiatives.

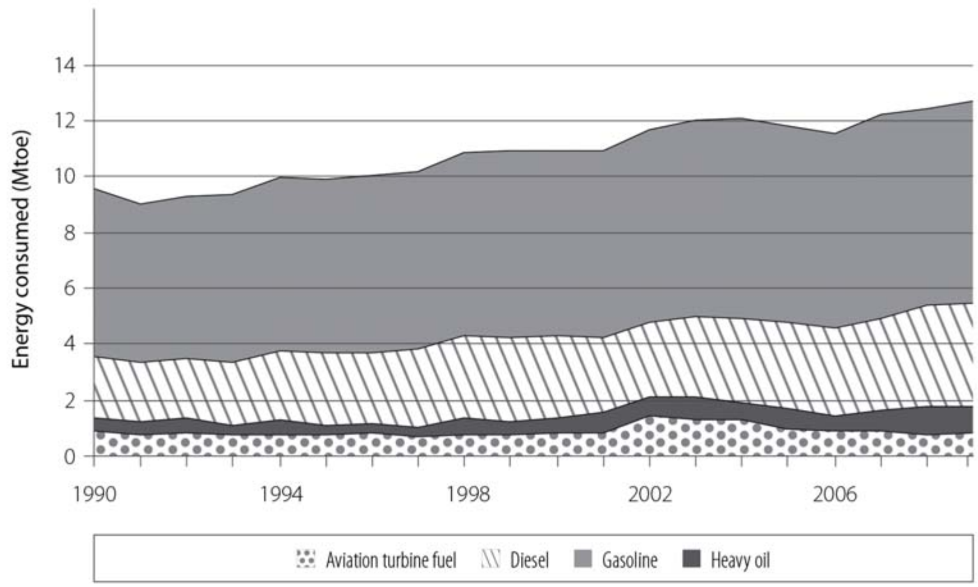
10. Support research and development in order to bolster the energy efficiency sector by making it innovative and prosperous.

8 MEET THE CHALLENGE POSED BY TRANSPORTATION

Along with the commercial and institutional sector, the transportation sector has experience over the past 20 years the quickest increase in fossil energy consumption, i.e. a net increase of 2.5 Mtoe of fossil fuels (Figure 8.1). In 2012, oil purchases in the transportation sector, which monopolize roughly 73% of the oil consumed, contributed roughly $10 billion to Québec's trade deficit in addition to generating 42% of all greenhouse gas emissions in Québec. Against the backdrop of the fight against climate change, it is essential to change this sector in order to improve Québec's environmental and economic health.

To this end, a number of avenues seem indispensable. While the nature of the changes and the strategies to be adopted will be discussed within the framework of the consultation on the future energy policy, we can immediately examine the challenges linked to them.

Figure 8.1 Energy consumption in the transportation sector by type of fuel



Sources: Ministère des Ressources naturelles du Québec and Office de l'efficacité énergétique.

Note: The shares of electricity and natural gas are too small to appear in the chart.

8.1 Individual transportation

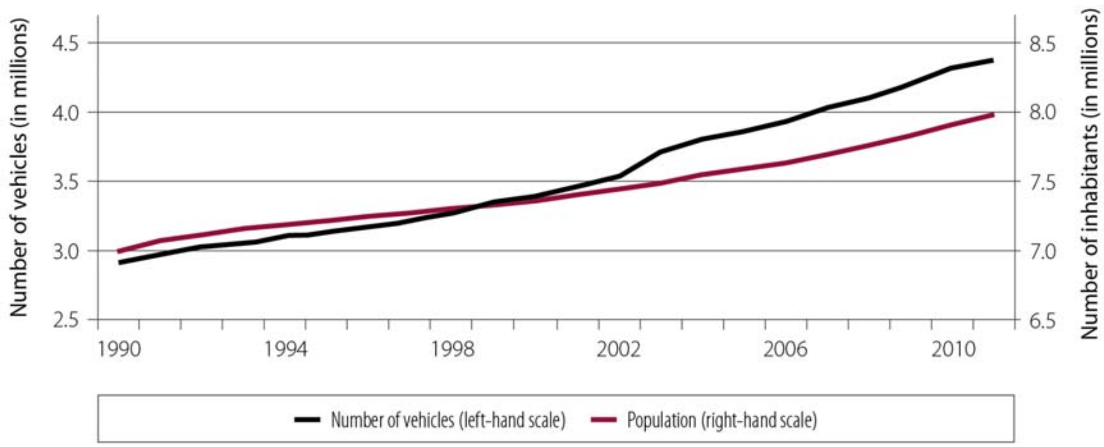
We cannot reduce oil consumption in Québec without significantly altering the personal vehicle fleet and the vehicle fleet used for freight transportation. Between 1990 and 2010, the number of passenger vehicles increased from 2.91 million to 4.31 million, a 1.4 million vehicle leap in 20 years. This is equivalent to an increase of roughly 2% a year, three times that of the population, which reflects a worldwide trend. In 2010, there were 545 vehicles per 1 000 inhabitants, which ranked Québec as regards the number of vehicles behind the United States (814 vehicles per 1 000 inhabitants) and Canada overall (619 vehicles per 1 000 inhabitants) and within the average for European countries.[28] Québec's vehicle fleet is more ecoenergetic than the North American average and it also has lower per capita GHG emissions in the transportation sector (4.6 tonnes of CO_2 equivalent) than the rest of Canada (6.4 tonnes of CO_2 equivalent) and the United States (6.0 tonnes of CO_2 equivalent).[29] This exemplary efficiency makes all the more daunting the challenge for Québec to reduce its GHG emissions.

Bearing in mind the average annual increase of 2% in the number of vehicles on the roads and of 1.4% in the attendant emissions, even if Québec attained the target proposed in 2011 of ensuring that 25% of all vehicles sold in 2020 are electric vehicles, the absolute number of new gasoline- and diesel-powered vehicles would be almost the same as in 2010 (Figure 8.2). Not only that, but light trucks, which are more energy-intensive than automobiles, would account for a constantly rising share of the fleet. Accordingly, even with one of the greenest car fleets in the world, Québec would succeed in stabilizing GHG emissions in the transportation sector but not in reducing them. This leads us to conclude that only a sweeping change in the very structure of modes of transportation will enable us to achieve GHG emission targets pertaining to individual transportation.

Despite this challenge, numerous factors militate in favour of the rapid electrification of individual transportation. First, an electric motor is almost four times more efficient[30] than a gasoline engine. In the same way, with sound technology, an electric car offers the same range as a gasoline-powered car at a comparable or lower cost per kilometre. Moreover, unlike most countries in which electricity generation relies on fossil fuels, Québec's hydropower engenders virtually no GHG emissions. Accordingly, the replacement of oil by electricity as a source of energy would radically improve Québec's GHG emissions without modifying the lifestyle of its residents. Lastly, electrical resources are available: Hydro-Québec could immediately supply with minimal changes to its distribution network one million electric vehicles, i.e. roughly 20% of the current car fleet. This proportion could increase considerably with the right infrastructure.

The implementation of a program to electrify personal vehicles in conjunction with the establishment of an industry to produce electric components or assemble such components would offer Québec an outstanding opportunity. At present, all of the electric vehicles driven on Québec's roads are manufactured abroad. A comparison of a gasoline-powered vehicle and an electric vehicle, even taking into account energy consumption, reveals that the repercussions on Québec's trade balance are appreciably the same for both vehicles. Today, money saved through reliance on electricity instead of oil is used, by and large, to pay for an imported battery. It would be to Québec's advantage to manufacture the batteries here. For the shift to electric cars to be worthwhile from an economic standpoint, Québec must find avenues that enable it to benefit from direct spinoff, e.g. by manufacturing batteries.

Figure 8.2 Change in the population and the number of passenger vehicles registered in Québec between 1990 and 2011



Sources: Société de l'assurance automobile du Québec and Institut de la statistique du Québec.

8.2 Public transportation and active transportation

A reduction in the consumption of petroleum products and the transportation sector's energy intensity also depend on a significant increase in other modes of passenger transportation such as mass transit and shared transportation, as well as active transportation, such as walking and cycling.

While the electrification of mass transit is an essential goal, we must first ensure that this mode of transportation satisfies users' needs. To this end, we must offer simplified trips that are at least as quick as car travel by facilitating intermodal travel and ensuring better quality transportation. Such efforts are profitable, as the recent enhancement of transportation offerings in the Montréal area have shown, which led to a striking increase in mass transit ridership. They also have a cost: the establishment of mass transit infrastructure demands substantial investments.

Other avenues must also be considered. With the proliferation of bicycle paths and the advent of BIXI self-service bicycles, the bicycle is an increasingly popular means of transportation in Montréal and not only a sporting or leisure activity. Because of winter conditions and the snow-removal policy in effect, bicycle paths are really only available roughly eight months of the year, even in Montréal. This limitation does not exist in all northern countries where the bicycle is deemed to be a year-round mode of transportation. Self-service motor vehicle services are also proliferating elsewhere in the world. Combined with mass transit, the services offer complete freedom of movement without the necessity of everyone's owning a car.

Most individual trips are now concentrated in the Greater Montréal area, which is why a considerable effort is being made there in the realm of public transit. Elsewhere in Québec, the main challenge stems by and large from low population density and high car ownership rates. However, all regions must follow suit.

Multiple targets

To reduce the consumption of fossil energy, the transportation sector must undergo a sweeping change. Such change can take several forms. Below, by way of indication, are some targets that are frequently evoked in reflection aimed at promoting greener transportation:

1. Invest in mass transit, preferably electric transport.

2. Promote the electrification and enhanced energy efficiency of personal vehicles.

3. Promote carpooling in order to reduce the number of personal vehicles on the roads.

4. Integrate active and collective transportation solutions into land-use planning plans.

5. Review current zoning to draw local services closer.

6. Facilitate active transportation through the promotion and multiplication of services and incentives such as year-round bicycle paths, intermodal systems that integrate bicycles, parking and showers in the workplace.

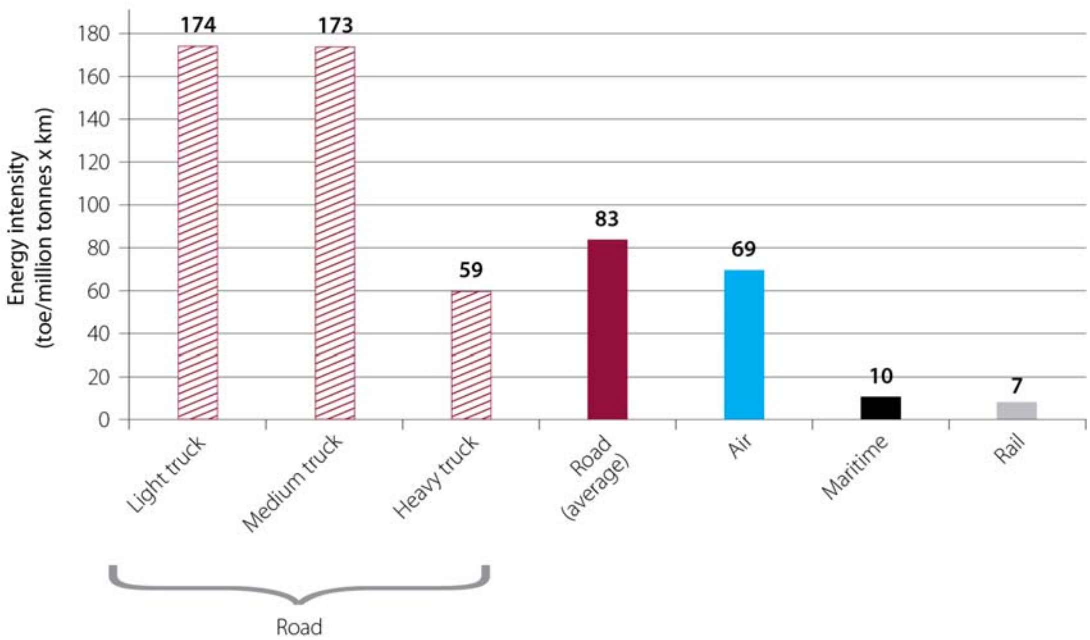
7. Use electric cars and trucks as a lever to develop a local industry to manufacture high-tech components.

8. Support research and development devoted to the new transportation technologies.

8.3 Freight transportation

Freight transportation occupies a central place in the Québec economy and the North American economic space. Because of its competitive advantages (flexibility, rapidity and cost), road transport dominates the other modes of freight transportation in Québec and the continent overall. In trade between Québec and the United States in 2007, trucks monopolized 59% of the value of freight transported, followed by rail transportation (19%) and air freight (15%).[31] Despite this breakdown, road transport is 20% more energy-intensive than air transport, and 10 to 12 times more energy-intensive than trains or ships for the same quantity of freight transported (Figure 8.1).[32]

Figure 8.3 Comparison of the energy intensity of different modes of freight transportation in Canada



Source: Office of Energy Efficiency (energy consumption database).

Over the past 20 years, heavy trucks are the mode of transportation that experienced the biggest increase (154%) in energy consumption in Québec. Québec's population grew by only 12% during this period. In the meantime, the number of light trucks used to transport freight increased by 137% and the tonne-kilometre index rose by 149%. The enhanced energy efficiency of light, medium and heavy trucks was thus largely offset by growth in the vehicle fleet and the increase in the kilometrage recorded and the tonnage transported.

Freight transportation accounts for nearly 40% of the oil consumed and GHG emissions in the transportation sector. It must also change in the coming years if Québec wishes to attain its emissions reduction target and reduce its dependence on oil. Several avenues must be explored in this respect.

Accordingly, the transfer from diesel to natural gas could certainly, against a backdrop of continent-wide low natural gas prices, contribute to reducing oil consumption and enhancing Québec's economic record. The combustion of natural gas generates less GHG emissions per unit of energy produced and Québec's emissions budget would also improve. In the medium term, the marked price difference between natural gas and oil is unlikely to persist. In the same way, according to several studies, the production of shale gas should lead to fairly substantial methane leaks that would offset the gains in respect of GHG emissions at the time of combustion. The choice of the natural gas option does not, therefore, seem to be a solution in the medium term.

Because of the tonnage displaced, the electrification of freight transportation poses more complex challenges than the electrification of passenger transportation. The most worthwhile gain unquestionably comes from urban and periurban transportation, which displays high energy intensity. In the short term, this sector could be electrified, as is the case, in particular, in France and in other countries, because of the short distances to be travelled. If charging stations were provided on the premises of certain customers, the size of batteries could be reduced, thereby lowering acquisition costs. As for long-distance transportation, the transfer to other models, such as rail or maritime transportation, must also be examined, along with the use of hybrid on-highway trucks (see box on the following page).

Revolutionary technologies

The reduction in our dependence on hydrocarbons affords us an opportunity to dream and reflect on revolutionary technologies. Here are two fascinating, intriguing examples. The consultation will provide an opportunity to propose many others.

The suspended in-wheel motor monorail

The suspended in-wheel motor monorail is a new mode of public transit that is flexible and adapted to our territory. It could be a potentially rapid, affordable system of electric transportation used to transport both passengers and freight.

The suspended monorail would include autonomous shuttles the size of a bus that could accommodate 60 seated passengers. The independence of the shuttles would ensure frequent departures without the obligation to fill a 360-passenger set, as is the case with a train. The shuttles could also transport freight as the infrastructure could handle 10-tonne containers. The shuttles could travel at speeds of up to 250 km/h and would attain their maximum speed in less than 30 seconds. They would stop in small cities along the main route without unduly lengthening travel time.

The suspended monorail is now in the concept stage. A feasibility study and, possibly, a pilot project alone will make it possible to properly assess the viability of this ingenious project.

Electrified on-highway trucks

The energy consumption of intercity truck transportation travelling over long distances at high speed is considerable but remains relatively moderate bearing in mind the loads transported. Since the energy intensity of batteries is much lower than that of diesel, transportation by autonomous electric truck would not satisfy the industry's demands. Given that major highway corridors are limited in number and heavily used, it would be preferable to electrify the corridors by means of a network of overhead wires to which trucks would be connected, thereby travelling most of the distances in electric mode. Beyond the system of overhead wires, the trucks could travel, like hybrid locomotives, using a motor running on a diesel generator. The Germany company Siemens recently proposed such a technology that it will test shortly on a 27-km highway near the port of Los Angeles, California.

9 LAND-USE PLANNING

Territorial development inevitably affects energy demand in general and the transportation sector in particular. Indeed, the structure of cities and towns determines, by and large, the travel needs of residents and the modes of transportation necessary. Once a real estate project has been completed, impact on demand for transportation will last at least during the useful life of the dwellings and, generally, even longer. Accordingly, commercial megacentres, which comprise immense, isolated businesses separated by parking lots located at the crossroads of highways, have imposed the use of private vehicles even to travel from one store to another.

Land-use planning and ecomobility

Land-use planning and ecomobility[33] are acknowledged to be among the key determinants of the efficient use of energy and independence as regards fossil energy. A study conducted for the Ministère des Affaires municipales, des Régions et de l'Occupation du territoire in 2012[34] proposes 10 land-use planning conditions that can be grouped into five objectives:

1. Foster comprehensive efficiency, i.e. take into account in location and occupation choices all of the environmental, societal and economic costs.

2. Favour services and local travel through the amendment of zoning and the densification of the urban fabric.

3. Develop lively living environments aimed at ensuring continuous use of sites and thereby contribute to their conviviality.

4. Promote mixed uses and functions in neighbourhoods, along streets, even in buildings and promote the cohabitation of uses and clienteles.

5. Enhance access to the territory and the free flow of traffic to ensure the conditions under which energy is used for travel, communications and trade.

Sustainable urban development is increasingly considered to be the solution to be applied upstream from different problems related to transportation and home heating, for example. Among other things, it seeks the optimum use of resources such as energy, materials, time, and so on, a reduction in the detrimental impact of urban development on the environment, and the creation of pleasant, socially integrating living environments that promote the health of residents and social diversity. Accordingly, it is possible to reduce demand for energy at the source by developing denser, more diversified neighbourhoods. This solution minimizes the need to travel by car between the home and the workplace, businesses and recreational sites and satisfies residents' wishes concerning the quality of the living environment.

Passenger transportation is an indispensable component of society: transportation infrastructure and networks organize relationships in the city and between the city, the surrounding area and the world. It links and contributes to defining relations between individuals, businesses, institutions and the territory.

An energy policy must, therefore, focus on land-use planning by targeting, more specifically, the development of the urban fabric, service areas and the ability to integrate different modes of passenger transportation (individual, collective and active), freight transportation and energy transportation. Any land-use planning, e.g. zoning, real estate, commercial or industrial projects or proposed transportation lanes should include, in its evaluation, energy and ecoclimatic considerations.

10 USE ELECTRICITY AS A LEVER

Québec enjoys a rare advantage in the world, i.e. significant surpluses of clean energy. The challenge that it is facing consists in using such surpluses optimally as a lever for economic, social and environmental development, without neglecting energy efficiency.

Below are some possible avenues:

1. Replace hydrocarbons in all fields by electricity and other forms of clean energy.

2. Support the development of industrial clusters in the following sectors: the manufacture of components related to the electrification of mass transit, freight transportation and the construction of buses, light trucks, and so on.

3. Attract and develop an industry that consumes clean energy by means, among other things, of new international standards aimed at creating a "green" label for clean energy.

4. Broaden research and development efforts pertaining to the electrification of transportation and clean energies.

5. Attract and develop value-added manufacturing enterprises.

A "green" label for clean energy

Québec is an important producer of renewable energy and it would be to its advantage to actively promote the elaboration of international standards that lead to the creation of a "green" label. The label, displayed on products and services, would ensure quality from the standpoint of greenhouse gas emissions.

A "green" label would guarantee the added value of electricity generated in Québec, which would promote the competitiveness of industries established in Québec, the development of new processes using electricity, and the diversification of Québec's industrial base.

10.1 Hydro-Québec's role

Hydro-Québec obviously appears to be one of the main driving forces in Québec's development. The government-owned corporation belongs to all Quebecers and provides competitively priced, predictable energy supplies, which structurally bolsters the Québec economy. On the one hand, it protects for the most part consumers against major energy price fluctuations on international markets. On the other hand, it attracts energy-intensive industries that act as anchors for economic and regional industrial development.

Hydro-Québec is the spearhead of Québec's energy production. In 2006, the mandate to operate gas and oil options was withdrawn from it and it has had to relinquish to the private sector the development of the wind power and small-scale hydropower options.

The decision will have to be reviewed in light of experience with wind power, acquired in recent years, and technological breakthroughs in the oil and gas sector, again with a view to optimizing environmental, social and economic spinoff in Québec. More fundamentally, it is the entire process of planning and developing new means of energy production that must be rethought in order to target not only energy production but also the optimization of economic spinoff related to production infrastructure.

Given the economic conditions that prevent Hydro-Québec from finding buyers at a worthwhile price for current electricity surpluses, the utility could be more proactive in the realm of the electrification of transportation and industrial processes. It could also broaden its efforts in the energy efficiency field. Such efforts could hinge on the government's economic development instruments in order to attract and guide industries of all sizes for which access to clean energy represents a net competitive advantage.

Hydro-Québec offers benefits for all Quebecers

The development of Québec's hydroelectric power potential is a source of wealth for all Quebecers:

- big construction sites generate thousands of jobs;
- Quebecers benefit from competitive electricity rates;
- Québec consulting engineering firms have acquired know-how that it is recognized the world over.

The Québec government enjoys extensive direct financial spinoff:

- in 2012, earnings from net exports stood at $1.2 billion, with a net profit of $363 million;
- between 2001 and 2012, profit from Hydro-Québec's activities more than doubled, from $1.1 billion to over $2.7 billion;[35]
- water-power royalties paid to the Generations Fund will reach $682 million in 2012-2013, including $592 million from Hydro-Québec and $90 million from private producers;
- since the inception of the dividend program in 1981, Hydro-Québec has paid the government $20.3 billion in dividends;
- since the establishment of the Generations Fund in 2006, over $5.2 billion in water-power royalties, of which Hydro-Québec has paid over 60%, has helped to reduce the debt burden and restore fairness between the generations.

10.2 Emerging renewable energy options

Despite anticipated clean energy surpluses, the pursuit of the development of decentralized small-scale energy production options remains relevant in certain cases. However, each project must be assessed in a comprehensive context defined by the new energy policy. Since electricity is a high-quality source of energy, it would be preferable to rely where possible, in the case of heat production, on another source of renewable energy. Accordingly, we could explore cogeneration and trigeneration processes that reduce polluting as emissions from industrial and municipal waste.

10.2.1 Electricity generation

The development of a wind power industry in Québec has led to the establishment of several manufacturing enterprises, especially in the Gaspé Peninsula and Bas-Saint-Laurent region, or in the service sector, i.e. research and development, design, maintenance, and so on. Moreover, the Technocentre éolien, the Institut de recherche d'Hydro-Québec, the Créneau éolien Accord, the École de technologie supérieure, the Groupe Collegia and the Université du Québec à Rimouski have also developed know-how in technological innovation and specialized manpower training. All told, the wind power industry has generated some 2 600 direct jobs in Québec, including 800 in these regions.

While wind power development projects designed several years ago are drawing to a close, a new strategy must be adopted. It is in this perspective that the Québec government announced on May 10, 2013 the attribution of 800 MW to be satisfied by new wind power projects. To further pursue the development of a wind power manufacturing option, a detailed analysis of needs engendered, among other things, by the reconditioning of existing wind turbines here and abroad must make it possible to determine ways of increasing the technological value of components manufactured in Québec and, therefore, increase economic spinoff in Québec. In this respect, the year 2025 is decisive since, at that point, the industry can rely on the renewal of the existing wind farms to pursue its development.

The pursuit and development of wind power to produce electricity will maintain and create jobs in Québec's regions and enrich the know-how acquired in this field. The government should seek to ensure the pace of implementation of new productive capacity and the overall level of production that will not only ensure the long-term development of the industrial wind power option in Québec but also the possibility for the industry to carve out a bigger share on export markets.

Lastly, numerous autonomous networks that serve remote communities and certain mining companies still rely on fuel oil and propane as their main energy sources. Such autonomous networks, whose production costs exceed 50¢/kWh, represent opportunities to develop and test emerging clean energy option such as underwater generators.

10.2.2 Heat production

Heat production relies on numerous lower-quality energy sources. For over 30 years, the conversion of heating in Québec has essentially meant shifting from fuel oil to electricity, a highly flexible source of energy. As an example, while a combustion engine converts into work 20% on average of the energy of oil, the electric motor exceeds 90% efficiency. There is good reason to prefer solutions such as residual biomass heat networks, geothermal energy and solar energy to replace the use of fossil fuels in heating.

For example, different solutions could be offered to consumers to help them choose a source of heat with low GHG emissions, such as geothermal energy and biofuels, including fuelwood, forest and agricultural residues, and biogas. To this end, such sources of energy must be made competitive through more efficient technologies and the creation of new value-added products.

10.3 Exporting

Only yesterday, exporting our surpluses of clean electricity to our American neighbours seemed an intelligent way to combat climate change and take advantage of our resources. Indeed, the output of hydroelectric power plants, bearing in mind their overall life cycle, generates very few GHG in relation to the output from thermal power plants (Figure 1.2).

Several factors compel us to reassess this strategy. First, the arrival of shale gas on the North American energy market has driven down electricity prices, which has considerably reduced the profits that Hydro-Québec usually derives from its exports. The low price of electricity in the northeastern United States is also limiting the development of new clean energy production capacity, since the cost is now higher than the current price.

In addition, Québec's export capacity is seriously limited by congestion on the electricity transmission networks to which it has access. It would, therefore, be necessary to optimize transmission infrastructure and strengthen it by developing new corridors towards consumption centres. Accordingly, a 1200-MW and a 1000-MW interutility tieline project under study seek to link Québec to southern New Hampshire and the New York metropolitan area. Collaboration with the residents concerned along the routes represents a key factor for the realization of the projects.

What is more, Québec must continue to ensure that the policies of the American states and Canadian provinces with which it maintains business relations in the realm of energy consider large-scale hydropower to be a source of clean energy. Such a status would enable Hydro-Québec to promote its resources among its neighbours by twinning them with other, intermittent renewable energies such as wind power. This approach would reduce the use of natural gas- or coal-fired thermal power plants whose energy efficiency is roughly 50% and would have the advantage of significantly enhancing North America's GHG emissions record.

Within the framework of the future Québec energy policy, although it is only one possible avenue in the optimization of spinoff from clean energy, electricity exports remain an important avenue that must be contemplated.

10.4 Greater emphasis on research and innovation

The optimum use of energy, especially in the context of the fight against climate change, underpins the existence of an innovative industry at the forefront of technology. To this end, Québec should implement a concerted research and innovation strategy launched in the industrial clusters organized in networks with the universities and sectorial research centres. Such basic, applied research should be supported by public and private funds that target energy innovation.

11 MANAGE HYDROCARBONS

Regardless of the key directions adopted in the future energy policy, hydrocarbons will continue to account for a significant portion of Québec's energy balance and economy. These energy sources offer numerous advantages that make them difficult to replace for certain uses. For example, oil is easy to transport and has high energy density. It will, therefore, continue for several years to be an important energy source for the transportation sector.

As we have seen, Québec's fight against climate change has led to an appreciable GHG emission reduction. The government's current target is to reduce greenhouse gas emissions by 25% by 2020, which is equivalent to lowering by nearly one-third our current consumption of fossil fuels. Consequently, once the target has been reached, Québec will nonetheless continue to use over 15.5 Mtoe of oil, natural gas and coal annually, which represents, at the current price, nearly $10 billion of imported products. In this context, the challenges posed by the management of hydrocarbons are considerable:

1. Adopt an oil management model in order to ascertain the relevance of any oil exploitation project in Québec, in a spirit of respect for the environment while maintaining a dialogue with communities and maximizing collective economic spinoff.

2. Properly structure the proposed development projects.

3. Ensure the security of natural gas and oil supplies.

4. Strive for optimum use of hydrocarbons.

5. Pursue research and development in the realm of biofuels and other efficient, clean fuels.

11.1 Ensure oil and natural gas supplies

Since Québec imports all of the fossil fuels that it consumes, the security of oil and natural gas supplies cannot be overlooked. While a worldwide oil shortage is not to be feared in the coming decade, important changes continue to occur in the world energy balance, changes that Québec must try to anticipate and to which it must constantly adapt.

Security of supply hinges, in particular, on two refineries in Québec, which supply both oil and gasoline, which in turn reduces Québec's vulnerability on the hydrocarbon market in addition to supporting the petrochemical sector, one that is important to its economy.

While most of the oil consumed comes from abroad, oil production in North America is increasing rapidly. It is in this context, for example, that the question of the reversal of flow and the construction of pipelines linking Alberta and Québec are being posed. The change would give access to cheaper oil while diversifying sources of supply. Québec must, therefore, evaluate the project's economic spinoff and environmental impacts. Since the production of the oil is linked to significant GHG emissions, Québec must also ascertain whether obtaining oil from the oil sands is compatible with its program to combat climate change.

As for natural gas, North American production should satisfy the continent's needs in coming years. Here again, however, the environmental impact of unconventional sources and GHG emissions must be assessed.

11.2 Target optimum use

It should be recalled that one of the core principles of energy efficiency is the use of the right source of energy in the right place. Oil and natural gas have advantages that are not always easy to replace, whether from the standpoint of transportation or the production of heat.

The reduction of energy consumption must, therefore, seek both efficiency gains, in particular with more economical vehicles, and the uses for which new energy sources exist. By reducing the use of fossil fuels to applications where they are irreplaceable, we will then increase the energy efficiency of the Québec economy overall.

11.3 Efficient biofuels

There are other ways aside from electrification to limit GHG emissions in the transportation sector such as reliance on biofuels instead of oil. The challenge consists in developing biofuels that have minimal environmental impact.

Because the biofuel sector is in the nascent stage, we must further support research and development devoted to the production and use of biofuels. Several avenues remain to be explored and significant advances are imminent.

11.4 The exploitation of oil

For several years, rising oil prices and the advent of new techniques to develop unconventional resources have revived interest in fossil hydrocarbon exploitation, including in Québec.

Recent studies reveal the existence of geological formations suited to the presence of oil potential in Québec. In eastern Québec, three sectors have received particular attention and have been subject to more sustained exploration activities in recent years. All told, nearly 350 exploration wells have been drilled, which is comparatively few in relation to other North American geological basins,[36] in the Gaspé Peninsula, Île d'Anticosti and Old Harry structure sectors located in the Gulf of St. Lawrence, near Québec's eastern boundary.

In the Gaspé Peninsula, between Gaspé and Murdochville, exploration work is under way in the Galt, Haldimand and Bourque sectors to ascertain the most appropriate options to develop hydrocarbon potential. The region's oil potential is estimated at roughly 330 million barrels.

Exploration work is also under way on the Île d'Anticosti. According to recent studies, the Macasty geological formation might contain 46 billion barrels of oil,[37] between 2% to 5% of which is apparently recoverable using current techniques.

The Gulf of St. Lawrence, in particular the Old Harry geological structure located on either side of the Québec–Newfoundland and Labrador border, is also attracting attention. While geological studies are encouraging from the standpoint of oil and gas reserves in this structure, no exploration drilling has yet been carried out to confirm the presence of oil and gas. Based on models, not on real data, the Geological Survey of Canada estimates the hydrocarbon potential of the Maritime Basin in the Gulf of St. Lawrence at roughly 1 100 billion m^3 of natural gas (1.0 Gtoe) and 1.5 billion barrels of oil (0.2 Gtoe).[38] According to Corridor Resources, the Old Harry structure alone, located at the eastern extremity of the Madeleine Basin, might contain reserves totalling roughly 5 billion barrels of oil or 0.2 trillion m^3 of natural gas.[39]

These estimates represent hundreds of billions of dollars in potential value and, depending on the royalty regime and the ownership structure of the exploration and exploitation companies, might engender tens of billions of dollars of revenue for Quebecers.

However:

1. we still do not know the nature and real volume of the hydrocarbons locked in the geological structures;

2. we do not know the volume of hydrocarbons that might be exploited using existing techniques;

3. studies are continuing to indicate the volume and proportion of the reserves that might be exploited in a spirit of respect for the environment and communities. Were the studies to prove positive, it would probably still take several years before big-scale oil production begins.

11.4.1 Conditions governing the exploitation of oil

The government wishes to establish proper oversight before it proceeds with hydrocarbon development in Québec. The conditions must take into account the 16 principles in the *Sustainable Development Act,* grouped together under four themes:

1. The protection of all facets of the environment.

2. Respect for communities.

3. The optimization of economic spinoff for all Quebecers now and in the future.

4. Stringent supervision and oversight.

Respect for the environment

Several projects have reached different stages of development and Québec is developing new expertise in the hydrocarbon sector. Among other things, it must ensure that the sector develops in a spirit of respect for the environment, which marks a new field of environmental intervention for it. In the meantime, it must evaluate the scope and nature of the environmental impacts stemming from the development of its resources.

This is the goal, for example, of two strategic environmental assessments conducted by private companies on hydrocarbon exploration and exploitation in the marine environment, the first of which was launched in 2009. Following an analysis of the preliminary observations of the first assessment, the Québec government has prohibited hydrocarbon exploration and exploitation in the portion of the St. Lawrence River located upstream from the Île d'Anticosti and on the islands located in this part of the river.

The second strategic environmental impact assessment, now under way, will be used to evaluate in a comprehensive, integrated manner the environmental, social and economic impacts of possible hydrocarbon exploration and exploitation work in marine environments in the Baie des Chaleurs and the Gulf of St. Lawrence, in a 110 000-km^2 zone that includes the Québec portion of the Old Harry structure. The study should be completed in 2013. For the time being, a moratorium prohibits all oil and gas exploration and exploitation activities in these sectors.

Beside the studies, the government must ensure that the standards governing the realization of hydrocarbon exploration and exploitation activities ensure the security of individuals and property, environmental protection, and responsible management of the resource. Accordingly, the standards must:

- apply to the entire development process, site preparation and restoration and including well drilling and completion activities;
- cover all of the requisite infrastructure;
- make it possible to clearly determine problematical situations that might arise;
- guarantee that the government does not inherit costs stemming from oil or gas exploration and exploitation long after wells have been closed permanently;
- integrate the GHG emissions section inherent in the extraction of hydrocarbons into Québec's program to combat climate change.

Government involvement in petroleum exploration

Oil drilling first occurred in Québec in 1860 in the Gaspé Peninsula. However, the first important discovery of hydrocarbons took place in Pointe-du-Lac in 1955, i.e. a natural gas deposit that revived interest in hydrocarbons.

In **1963**, in addition to providing all of Québec with electricity, Hydro-Québec was granted a hydrocarbon exploration permit covering the estuary and part of the Gulf of St. Lawrence.

In **1969**, the Québec government established the Société québécoise d'initiatives pétrolières (SOQUIP), with a mandate to evaluate Québec's oil and gas potential, participate in the development of third-part hydrocarbon discoveries, and negotiate and conclude agreements for the purchase, importing and resale of hydrocarbons. Hydro-Québec's permits were transferred to SOQUIP and several years later, the exploration rights held by Shell on the St. Lawrence Lowlands.

From **1969 to 1984**, SOQUIP conducted major geophysical surveys, land-based and underwater drilling, alone or with partners, that led among other things to the discovery of the Saint-Flavien natural gas deposit.

Starting in **1984**, SOQUIP concentrated on the supply and distribution of natural gas and halted its exploration activities. In 1998, it was integrated into the Société générale de financement, thereby ending a proactive approach to the management of natural gas supplies in Québec.

In **August 2002**, Hydro-Québec submitted its *Plan d'exploration pétrole et gaz naturel au Québec 2002-2010*, which proposed the investment over 10 years of $330 million to develop potential hydrocarbon resources in eastern Québec. It suggested attracting to Québec major exploration companies to develop eastern Québec's hydrocarbon potential, especially in the marine environment. It also proposed supporting smaller exploration companies to bolster Québec's energy supplies. Hydro-Québec created the Oil and Gas Division, which would, in particular, establish partnerships with private companies.

Between **2002 and 2004**, Hydro-Québec's Oil and Gas Division conducted oil and gas exploration work in the Gaspé Peninsula and on the Île d'Anticosti. In 2003, the division signed a partnership agreement with Corridor Resources for the development of the Old Harry geological structure.

In **2005**, government interest in Hydro-Québec's Oil and Gas Division dwindled and the division only had $3 million to cover exploration activities.

In **2006**, the government halted the activities of Hydro-Québec's Oil and Gas Division, which sold its exploration permits to private companies.

In **2008**, Hydro-Québec signed with Pétrolia a priority royalty agreement[40] for the development of hydrocarbons that was linked to the exploration permits held on the territory of the Île d'Anticosti.

Today, Québec, through its government corporations, is a partner of the two main oil and gas companies active in exploration in Québec. In late January 2013, Investissement Québec held 10% of the shares of Pétrolia and 12% of the shares of Junex. The Caisse de dépôt et placement du Québec held 5% of Junex's shares.

Respect for communities

Respect for communities must be at the forefront of hydrocarbon exploration and exploitation. It demands that a balance be struck between the advantages and drawbacks for the population living near exploitation sites, local communities, and all Quebecers.

Such balance cannot be achieved without the completely transparent information and without the search for solutions that mitigate the repercussions of the exploitation of these resources for those who are affected the most. It must result from public consultations and the obligation to account for changes in the project that stem from the consultations. Dialogue must continue throughout the project to take into account the changes inherent in the development of such an undertaking.

The optimization of economic spinoff

Oil and gas exploitation must promote the enrichment of all Quebecers, who collectively own the resource. To ensure that it derives the maximum possible spinoff, the Québec government must review the concept of economic rent as regards hydrocarbon exploitation. Among the key factors, mention should be made of:

- the establishment of a royalty and ownership regime that allows for maximum spinoff for society, based on models elsewhere in the world;
- the revision of the method of attributing permits, rights and rates in order to ensure that the government better manages the territory and its resources and oversight over their exploitation;
- the assurance of local and regional economic spinoff;
- the intergenerational distribution of revenues derived from these non-renewable resources.

Stringent supervision and oversight

It is important to properly structure hydrocarbon exploration and exploitation activities by implementing, in particular, a rigorous follow-up and supervision process to ensure compliance with legislation and regulations, both from the standpoint of the administrative and technical analysis of applications and follow-up to the work. To this end, the government is seeking to modernize the regulations and legislation that govern such activities. The new framework will offer both the public and the industry greater security.

Once the standards have been established, the government must ensure that it has sufficient human and financial resources to adequately oversee the industry and ensure compliance with legislation. In keeping with the user-payer principle, such oversight should be self-financed by means of the duties and fees that the industry pays.

The government and local and regional administrations must work together to match as solidly as possible oil exploration and exploitation and community development plans.

CONCLUSION

Energy affects all facets of our society. When we decide to replace our heating system with a more efficient, less polluting one during home renovations, use public transit or rely on carpooling to travel or even to buy an electric or hybrid vehicle when changing vehicles, we are making a personal decision that concerns energy. The same is true when a business expands its premises, a new shopping centre is built or a big industry establishes itself in Québec. Energy is always a consideration when a municipality reviews its development plan or the government levies a tax on gasoline, funds a new highway and adopts new greenhouse gas emission targets.

Energy is central to trade, regional development and access to all manner of goods. That is why upheavals on the energy market in recent years have directly affected each one of us.

Québec's future energy policy seeks to prepare us to better face these changes and better equip ourselves in order to use energy in an increasingly judicious manner. It also seeks to make the fight against climate change an economic lever that will transform Québec into a richer, greener society.

Québec experienced an initial major change in energy policy when it commissioned the La Grande Complex in the wake of the two major oil crises in the 1970s. Thirty years later, we must repeat the exercise and complete the transition to clean energy initiated at that time by targeting, above all, the renewable energies.

This challenge cannot be met without a good dose of audacity. For this reason, the opportunity is available to all Quebecers to make known their viewpoints, make comments and propose possible solutions.

Of course, certain key avenues are already obvious: put energy efficiency at the forefront of all common decisions, electrify transportation, support, first and foremost, the knowledge-based economy, and exploit our energy resources in such a way that all Quebecers obtain optimal spinoff.

However, we must go beyond platitudes and pat formulas in order to find an avenue that fosters a national consensus and the anticipated shift, an avenue that will guarantee optimum use of the substantial investments and funds that must be allocated to it in the coming years. It is up to all of us to meet the challenge to make Québec, through its clean energy, a rich, prosperous society.

APPENDIX 1

GLOSSARY [41]

Brent : The reference price on the world oil market. Brent refers to oil produced in the North Sea.

Biofuel: A fuel of plant or animal original used to produce heat, e.g. wood, forest waste, biogas, biodiesel and biofuels.

Thermal power plant (gas- or oil-fired): A power plant that produces electricity by means of heat generated by the combustion of fossil or nuclear fuels, fuel or biofuels.

CO2 (carbon dioxide): The main greenhouse gas, which comes, above all, from the combustion of fossil fuels.

Cogeneration: A technique to simultaneously generate electricity and useful thermal energy, e.g. steam, hot water or combustion gas, using a fuel such as natural gas or wood chips.

Avoided cost: The cost of additional energy supply that can be avoided through energy efficiency.

Ecoenergetic: Something that economizes energy.

- Direct, indirect and induced jobs;
- Direct jobs: jobs generated by investment projects;
- Indirect jobs: jobs resulting from increased demand for project-related materials and equipment from manufacturers and distributors;
- Induced jobs: jobs resulting from financial savings from energy efficiency reinvested by consumers in the market.

Geothermal energy: A source of heat naturally present in the ground that can be exploited to heat buildings.

Greenhouse gases (GHG): Gases found in the atmosphere of natural or anthropic origin that absorb and reflect infrared rays from the Earth's surface.

Energy intensity: The ratio of the quantity of energy consumed per production unit. For a country, energy intensity is usually measured in toe/million dollars of GDP.

Solar wall: A passive solar collector comprising a covering installed a few centimeters from a south-facing wall to preheat, through circulation between the wall and the covering, air used to ventilate spaces or applications such as agricultural or industrial drying.

Gross domestic product (GDP): The value of all goods and services produced within the geographic confines of a country or a territory during a given period.

Technico-economic potential: Energy savings whose measurement is technically achievable and economically viable, compared with the cost of a new supply.

Off-the-grid power systems: An electrical power grid that is not linked to Hydro-Québec's main network.

Intelligent network: A power system to which has been added functions stemming from the information and communications technologies with a view to enhancing performance, reliability and responsiveness, from generation facilities to consumers.

Active solar energy: The use of the sun's heat by means of heat collection and redistribution devices, such as solar water heaters.

Passive solar energy: The use of the sun's heat to heat buildings or water by means of passive methods such as the positioning of buildings and the use of solar covers on swimming pools.

Photovoltaic solar energy: The use of the sun's energy to generate electricity.

Hybrid car and rechargeable hybrid: A vehicle than runs on gasoline and electricity. A rechargeable hybrid vehicle has a battery that usually has a range of several dozen kilometres in all-electric mode and that can be recharged by plugging it into the electrical power grid.

41 Sources: Office québécois de la langue française, Ministère des Ressources naturelles du Québec and Hydro-Québec.

Acronyms and initialisms

AECL: Atomic Energy of Canada Limited

SEA: Strategic environmental impact assessment

GHG: greenhouse gases

HQD : Hydro-Québec Distribution

GDP: gross domestic product

EROEI: energy returned on energy invested

NWMO: Nuclear Waste Management Organization

APPENDIX 2

Conversion factor of one toe in energy, volume, weight and GHG emissions units

Energy conversion factors			
Energy		Electrical energy	Energy (heat)
toe	GJ	kWh	BTU
1	41.85	11 630	39.7 million

Conversion factor of one toe into units of volume							
Natural gas	Oil	Gasoline	Diesel	Light fuel oil	Heavy fuel oil	Propane	Coal
1000 m³/toe		Barrels/toe		m³ per toe		Tonne/toe	
1.10	6.933	1.20	1.09	1.09	1.03	1.66	1.43

Source: Ministère des Ressources naturelles.

GHG emission factors of one toe of different fuels							
Natural gas	Oil	Gasoline	Diesel	Light fuel oil	Heavy fuel oil	Propane	Coal
tonne equivalent of CO_2 per toe							
2.10	3.10	2.86	3.02	2.95	3.10	2.53	3.63

Prefixes of decimal multiples

Peta (P): 10^{15}

Tera (T): 10^{12}

Giga (G): 10^{9} billion

Mega (M): 10^{6} million

kilo (k) : 10 thousand

Units of measure

J	joule (unit of energy	a common multiple: **GJ (10^9 J)**
W	watt (a unit of electrical power)	a common multiple: **MW (10^6 W)**
Wh	watt-hour (a unit of electrical energy)	a common multiple: **kWh (10^3 Wh)**
toe	tonne of oil equivalent (unit of energy)	a common multiple: **Mtoe (10^6 toe)**
t	metric tonne (unit of weight)	
m^3	cubic metre (unit of volume equivalent to 1 000 litres)	a common multiple: **Mm^3 (10^3 m^3)**
barrel	(a unit of volume = 45 US gallons or 58.9 L)	
tonne of CO_2 equivalent	tonne of CO_2 equivalent (a unit of measurement of greenhouse gases)	

[1]Source: Hydro-Québec.

[2] Charles A. Hall *et al*. (2009), "What is the Minimum EROI that a Sustainable Society Must Have?," *Energies*, Vol. 2, 2009.

[3] Except for several exploration wells in the Gaspé Peninsula.

[4] Since data on petroleum coke, liquefied petroleum gas and aviation fuel are confidential, data on imports and exports of petroleum products are approximate. However, the net outcome of 3.5 Mtoe is accurate.

[5] In 2010, trade in refined products displayed a positive balance of $1.4 billion.

[6] In 2012, Hydro-Québec permanently closed the Tracy heavy fuel oil power plant (495 MW) and the La Citière gas turbine power plant (308 MW). The Cadillac gas turbine power plant (162 MW) has been out of service for several years. The facilities were used sporadically during the winter peak period. The Gentilly-2 nuclear power plant ceased to generate electricity on December 28, 2012.

[7] Electricity demand reached a historic peak of 39 120 MW on January 23, 2013.

[8] Government of Alberta (January 24, 2013), Benchmark crude oil prices, http://alberta.ca/albertacode/images/Benchmark-Crude-Prices.pdf.

[9]The share of renewable energies varies slightly according to the processing of the biomass used for heating. This information is especially hard to compile at the global level.

[10] International Energy Agency (2012), *Key World Energy Statistics 2012*.

[11] The drop in consumption, as we will see later, stems essentially from a sharp decrease in activity in the industrial sector.

[12] Hydro-Québec, *Plan stratégique 2009-2013*, page 4.

[13]National Energy Use Database, Office of Energy Efficiency.

[14]National Energy Use Database, Office of Energy Efficiency.

Note: Given that the Office de l'efficacité énergétique and the Ministère des Ressources naturelles do not use the same definition of the "commercial and institutional sector," the data are sometimes hard to compare. It is, however, possible to observe a certain trend.

[15] Génivar (2012), *Étude du potentiel technico-économique de réduction de la consommation de produits pétroliers du secteur du transport au Québec*, study submitted to the Bureau de l'efficacité et de l'innovation énergétiques.

[16] Société de l'assurance automobile du Québec (2012), *Statistiques 2011*.

[17] Société de l'assurance automobile du Québec (2012), *Statistiques 2011*.

[18] Ministère du Développement durable, de l'Environnement et des Parcs (2006), *2006-2012 Climate Change Action Plan.*

[19] Order in Council 1187-2009, November 18, 2009.

[20] National Energy Board (2011), *Canada's Energy Future: Energy Supply and Demand Projections to 2035*.

[21] Considering the cumulative cost of $1.3 billion (2013 dollars) for annual savings of 6 TWh accumulated after 10 years, the present-day cost of the energy savings is on the order of 2.5¢/kWh (nominal discount rate of 5.74%).

[22] The cost of heritage pool electricity will be indexed on the basis of the consumer price index starting in 2014.

[23] Decision of the Régie D-2013-037, R3814-2012, 2013-03-12 and data from the Ministère des Ressources naturelles du Québec.

[24] Association de l'industrie électrique du Québec (2009), *L'industrie électrique : génératrice de prospérité pour le présent et l'avenir du Québec* (data revised in 2012).

[25] Association de l'industrie électrique du Québec (2009), *L'industrie électrique : génératrice de prospérité pour le présent et l'avenir du Québec* (data revised in 2012) and Ministère des Ressources naturelles (2011).

[26] German Federal Environment Agency (2013), NA 172 Normenausschuss Grundlagen des Umweltschutzes (NAGUS).

[27] Aimee McKane (2013), Superior Energy Performance: Getting the Most Value from ISO 50001- Energy Management Systems. J. O'Sullivan (2009), Energy Management System - The Irish Perspective - Sustainable Energy Ireland.

[28] Actualitix website: www.actualitix.com/wp-content/uploads/2012/04/voiture-pour-1000-habitants.png.

[29] Ministère du Développement durable, de l'Environnement et des Parcs (August 2011). *État des lieux de la lutte contre les changements climatiques au Québec*, consultation document.

[30] According to the US Department of Energy, gasoline engines have an energy efficiency of 14% to 26%, depending on the running speed. Commercial electric motors can maintain an energy efficiency of 85% to 95% (C. Burt, X. Piao, F. Gaudy, B. Busch and NFN Taufik (2006), *Electric Motor Efficiency under Variable Frequencies and Loads*, ITRC Report No. R 06-004).

[31] Institut de la statistique du Québec (2007), *Valeur des échanges commerciaux entre le Québec et les États-Unis en 2007*.

[32]Transportation Energy Data Book, Edition 31, 2012, US DOE & PTE Transport_Bilan_Data.

[33] Ecomobility is the study and implementation of physical or incentive measures designed to satisfy the needs of the members of a society to move freely and guarantee access by all individuals to places of public use and mass transit equipment, from the standpoint of urban planning and land-use planning choices and practices, in a perspective of sustainable development.

[34] Catherine Marchand (2012), *La ville de demain*, research report produced on behalf of the Ministère des Affaires municipales, des Régions et de l'Occupation du territoire.

[35] The accounting treatment of the abandonment of the operation of the Gentilly-2 nuclear power plant in 2012 led to an extraordinary reduction of net proceeds of $1.88 billion, which brought the latter to $860 million.

[36] In Québec, barely 800 drillings have been carried out since 1860, compared with over 28 000 in British Columbia and 400 000 in Alberta.

[37] Sproule (2011), Resource Assessment of the Macasty Formation in Certain Petroleum and Natural Gas Holdings on Anticosti Island for Petrolia Inc. and Corridor Resources Inc. Junex (2011), Junex made public an independent report on the oil potential of its Anticosti permits (September 28, 2011 press release).

[38] D. Lavoie, et al. (2009), Petroleum Resource Assessment, Paleozoic Successions of the St. Lawrence Platform and Appalachians of Eastern Canada.

[39] Macquarie Tristone (2012), Corridor Resources Inc. 2012 Joint Venture Opportunity - Old Harry Prospect.

[40]41 Sources: Office québécois de la langue française, Ministère des Ressources naturelles du Québec and Hydro-Québec.

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