2016-2025 Energy Policy

ENERGY EFFICIENCY AND INNOVATION

Québec

Ministère de l’Énergie et des Ressources naturelles

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INTRODUCTION

In 2006, the government adopted the *Québec Energy Strategy 2006-2015: Using Energy to Build the Québec of Tomorrow,* which hinged primarily on the revival and acceleration of the development of Québec's hydroelectric potential, the establishment of a wind power option, the diversification of sources of supply of natural gas and oil, and the promotion of greater energy efficiency.

The time has come to review the Québec government's energy-related priorities and orientations. To this end, it is necessary to examine the needs and expectations in respect of the different energy options that are underpinning Québec society's economic vitality and development. At the same time, this marks an opportunity to reassess the relevance, performance and efficiency of the tools that Québec has adopted to ensure the sound governance, development and responsible use of energy resources.

BACKGROUND DOCUMENTS

The series of background documents that the Ministère de l'Énergie et des Ressources naturelles is making available is intended to sustain reflection that will clarify the situation and challenges specific to contemporary Québec. The background documents seek to delineate the focus of reflection in light of success achieved at home and abroad and to raise questions that enable us to make enlightened choices over the coming decade.

This document assembles information and data that present an overall profile of energy efficiency and innovation in Québec. It also sets out the initiatives launched in recent years in Québec and indicates the outcomes.

The first section presents a background discussion on energy efficiency and innovation. The subsequent sections focus on energy efficiency and innovation in Québec, a number of observations and challenges and questions pertaining to energy innovation and on the industrial, transportation, residential, commercial and institutional sectors of the economy in which the key energy efficiency initiatives are applied. The conclusion emphasizes what is noteworthy to discuss the challenges and elaborate a perspective for Québec in the realm of energy efficiency and innovation.

Québec is changing. It must reposition itself bearing in mind its energy consumption profile, the global and continental context and the values that Quebecers cherish from the standpoint of economic development, environmental protection and social justice.

DESCRIPTION OF THE CONSULTATION PROCESS

The Québec government will adopt by the end of 2015 an energy policy covering the period 2016 to 2025. The policy will define the orientations that will enable Québec to:

- participate in a rapidly changing worldwide energy and economic context;
- maintain and, indeed, broaden its leadership in the realm of renewable energies;
- enhance its performance in the realms of energy efficiency, behavioural progress and education pertaining to energy and technological innovation;
- pursue the transition to a low-carbon economy;
- make energy resources a lever of wealth creation and social development in all regions.

The policy will stem from a mobilization and consultation approach that calls upon all Quebecers and stakeholders in Québec society.

In the fall of 2013, the Commission on Energy Issues in Québec visited Québec's regions to ascertain the concerns and collect the reflections of individuals and organizations interested in the environmental, economic and social issues related to energy. A report containing 57 recommendations was drawn from the 460 briefs, 300 presentations, 250 contributions on the Internet or in person during the 47 public consultation meetings, three workshops with the Aboriginal communities and numerous meetings between the commissioners and experts from the universities or public bodies.

As announced on November 7, 2014, the approach will continue with the placing online of five thematic background documents, which will broaden reflection by calling upon the round-table forums comprising Québec, Canadian and international experts.

The round-table forums will explore the following themes:

- energy efficiency and innovation;
- renewable energies;
- hydrocarbons.

At the same time as the experts' deliberations, the public will be invited to comment online on the observations, challenges and questions submitted to the experts. Meetings open to individuals and organizations wishing to express their viewpoints to the representatives of the MERN will be organized for each theme. Aboriginal representatives will also be invited to share the viewpoints of their communities.

On the strength of the outcome of the extensive reflection and debate, the government will make public in the fall of 2015 its 2016-2025 energy policy.

SECTION 1

CONTEXT

Energy is a decisive factor in the quality of life and prosperity of a society. It pervades all facets of life and is essential in a number of ways. The production, transmission and use of energy are a constant concern in most countries. Aside from energy security, the world is facing major energy-related challenges, i.e. combating climate change, environmental protection, uncertainty over energy prices, the satisfaction of the energy needs of populations, economic growth and competitiveness, and the social acceptability of energy resource development projects.

The challenge is to respond to all of these issues and energy efficiency is the most effective means to do so because of the numerous advantages it offers (Appendix 1). Accordingly, the United States, the European Union and China, among others, are focusing their energy policies on energy efficiency, which usually hinges on three levers, i.e. waste reduction, optimum use of existing infrastructure, and recourse to new technologies. The levers make it possible to use less energy and to satisfy the growing needs of populations and, in so doing, to:

- achieve significant financial savings that promote economic growth and corporate competitiveness;
- reduce the environmental footprint of energy resource development;
- reduce the energy costs of businesses and households.

In fact, energy efficiency is often the cheapest and most readily available energy resource. When its profitability has been demonstrated, it is increasingly viewed as the prime energy source to be developed[1]. Recourse to energy efficiency therefore falls within the scope of a defined energy, economic, environmental and social context.

The 2016-2025 energy policy will ultimately decide, in particular, on the key directions adopted to:

- ensure the mastery and coherence of energy choices;
- make energy efficiency a priority energy source;
- develop a culture of energy efficiency and innovation;
- achieve progress in the decarbonization of Québec society and the Québec economy and climate stabilization.

A comprehensive energy efficiency and innovation action plan will also be drawn up in accordance with provisions in the Act respecting energy efficiency and innovation.

[1] INTERNATIONAL ENERGY AGENCY (IEA) (2013), Energy Efficiency Market Report 2013, Paris, 273 pages.

BOX 1
DEFINITIONS

Energy efficiency

Energy efficiency consists in making the best possible use of the energy available to obtain better energy performance. It is improved when less energy is used to produce a given good or service.

The choice of the form of energy, recourse to new technologies, the use of more efficient equipment and processes, awareness-raising measures that engender behavioural change in consumers, training and the application of standards are all tools that can help to achieve improved energy performance[2].

Energy innovation

The term “innovation” often refers to something new, the outcome of research or an invention. Generally speaking, it is understood that innovation represents the development and marketing of a product, a service, or a new or appreciably improved process that satisfies a need through the enhancement of production or well-being[3].

An innovation relies on creativity and puts into practice a new idea. Innovation differs from a simple invention or a discovery through its operational nature and practical implementation. It must, therefore, be reproducible at reasonable cost and satisfy a need. Research is one of the first links in the innovation chain (see Figure 2.22, page 38).

Innovation can also have several objectives. From the standpoint of energy, it makes it possible, for example, to:

- reduce production-related energy costs;
- reduce greenhouse gas (GHG) emissions through the development of motors that use clean energy;
- make the operation of energy-intensive equipment more efficient and economical.
-

Energy intensity

Energy intensity represents the quantity of energy consumed per unit of activity. Gross domestic product (GDP), floor area and the number of households are examples of the units of activity used to measure energy intensity.

GDP is the most frequently used unit of activity. Accordingly, a reduction in the ratio indicates that the economy has produced one unit of GDP by using less energy and thus indicates greater energy efficiency.

Note to readers: Appendix 3 presents the units of measurement and their equivalences.

[2] BUREAU DE L’EFFICACITÉ ET DE L’INNOVATION ÉNERGÉTIQUES. *Definitions* [online] [efficaciteenergetique.gouv.qc.ca/clientele-affaires/technoclimat/definitions] (consulted January 7, 2015).

[3] Definition adapted from: MINISTÈRE DE L’AGRICULTURE, DES PÊCHERIES ET DE L’ALIMENTATION DU QUÉBEC. *L’innovation : définitions et concepts* [online] [mapaq.gouv. qc.ca/fr/Publications/Innovationdefinition.pdf] (consulted November 27, 2014); OECD. “*La mesure des activités scientifiques et technologiques : principes directeurs proposés pour le recueil et l’interprétation de données sur l’innovation technologique*” [online] (oecd.org/fr/science/inno/2367554.pdf) (consulted on November 27, 2014) [ptc.uquebec.ca/rqis/node/115]; Toupictionnaire : *le dictionnaire de politique*, définition de l’innovation, La Toupie [online] [toupie.org/ Dictionnaire/Innovation.htm] (consulted on November 27, 2014).

BRIEF OVERVIEW OF THE SITUATION WORLDWIDE

As noted earlier, energy efficiency is central to the energy policies of most countries, including the member countries of the European Union, China, and the United States. The International Energy Agency (IEA)[4] estimates that worldwide investments in energy efficiency totalled more than US$300 billion in 2011[5]. The investments that 11 IEA member countries[6] made between 2005 and 2010 eliminated the need to consume 570 million tonnes of oil equivalent (mtoe), which represents a saving of roughly US$420 million[7]. Without this energy saving, the countries would have consumed 5% more energy during the period.

Such efforts to reduce energy consumption, in addition to ensuring greater energy security and reducing energy costs, seeks to reduce GHG emissions in order to stabilize rising temperatures to 2°C above the level in 1850 and thereby combat climate change (see Background Document 1: Worldwide and Continental Trends).

The Carbon Trust and Green Bonds are striking examples of international efforts to reduce GHG emissions and of energy efficiency innovation. The Carbon Trust helps businesses and organizations that wish to reduce their environmental impact and facilitate the transition to a low-carbon economy. Green Bonds enable the private sector to fund innovative energy efficiency or renewable energy projects.

OUTLOOK: A GLOBAL CHALLENGE

Over time, but more markedly since 2005-2006, energy efficiency has become a key topic at major meetings and international climate change negotiations. Accordingly, during the most recent G20 summit held in November 2014 in Brisbane, Australia, the member states emphasized the importance of energy efficiency to ensure energy security, satisfy growing energy needs and reduce costs for businesses and households. In a press release, they indicated the importance of a voluntary action plan that would target, in particular, efficiency and vehicle emission standards, network appliances, industrial processes, electricity generation and financing for energy-related projects.

[4] THE INTERNATIONAL ENERGY AGENCY (IEA) is an autonomous agency of the OECD that seeks to produce clean, reliable, accessible energy for its 28 member countries and for non-member countries. Its initiatives focus on four fields:
(1) energy security: promote diversity, efficiency and flexibility in all energy sectors; (2) economic development: ensure stable energy supplies to member countries and promote free-trade zones to foster economic growth and eliminate energy poverty; (3) environmental awareness: publicize at the international level options that curb climate change; (4) worldwide involvement: act in collaboration with non-member countries, especially the main energy producers and consumers, in order to find solutions to common energy and environmental problems.

[5] IEA (2013). *Energy Efficiency Market Report* 2013, Paris, 273 pages.

[6] Australia, Denmark, Finland, France, Germany, Italy, Japan, the Netherlands, Sweden, the United Kingdom and the United States.

[7] The estimate is based on the cost of US$100 for a barrel of oil.

In the press release, the leaders stated: “We reaffirm our commitment to rationalise and phase out inefficient fossil fuel subsidies that encourage wasteful consumption, recognising the need to support the poor”[8].

THE MAIN OBSTACLES TO ENERGY EFFICIENCY

Despite the efforts of several countries and evidence of the advantages of energy efficiency (Appendix 1), its potential is under-utilized. According to International Energy Agency forecasts, nearly two-thirds of energy efficiency potential is untapped[9]. The main obstacles to such use are:

- a lack of information among businesses and consumers on the benefits of energy efficiency and technological possibilities;
- energy prices, which do not always reflect real production and distribution costs. They do not take into account the attendant environmental costs and some forms of energy are heavily subsidized;
- a lack of capital or financing mechanisms to invest in energy efficiency and innovation to cover cost overruns attributable to energy-efficient technologies;
- the reluctance of businesses to invest in energy efficiency. Energy efficiency is perceived as a restrictive, lengthy, uncertain and, indeed, intangible approach that does not generate revenue in the short term;
- social and cultural standards that hamper the adoption by certain population segments of more energy-efficient behaviour and consumption and a shortage of such goods and services of equivalent quality.

To overcome these obstacles and take advantage of the potential of energy efficiency, the World Energy Council[10] has issued nine recommendations that cover both the use of new technologies, financing and regulation, and consumer awareness (see Box 2).

The International Energy Agency has also issued 25 recommendations to promote improved energy efficiency[11]. The recommendations focus on buildings, electrical appliances and equipment, lighting, transportation, industry and energy producers and distributors. The IEA also assesses and ensures follow-up to the recommendations.

[8] FOREIGN AFFAIRS, TRADE AND DEVELOPMENT CANADA (2014), Déclaration du G20, communiqué des dirigeants du G20 [online] [international.gc.ca/g20/assets/pdfs/FINAL_FR_Communique16novembre.pdf] (consulted on January 8, 2015).
[9] IEA (2012b), *World Energy Outlook*, 2012, Paris, 690 pages.
[10] The World Energy Council is a non-profit organization that assembles the representatives of nearly 100 countries with a view to promoting sustainable energy use.
[11] IEA (2011), *25 Energy Efficiency Policy Recommendations. 2011 update* [online] [iea.org/publications/freepublications/publication/25recom_2011.pdf] (consulted on January 6, 2015).

BOX 2

RECOMMENDATIONS OF THE WORLD ENERGY COUNCIL[12]

In the wake of a study of the energy policies of 85 countries, the World Energy Council formulated nine recommendations to promote enhanced energy efficiency.

1. Energy prices must reflect the cost of energy supply to send the appropriate signals to consumers concerning prices.
2. Consumers must be better informed to make enlightened decisions.
3. Smart billing[13] offers considerable potential for energy savings. It enables consumers to better monitor their energy consumption.
4. Innovative financing tools are necessary to support consumers' investments. We must simplify, integrate and centralize information on support mechanisms, diversify sources of financing, facilitate private investments and maintain low interest rates.
5. The quality of energy efficiency equipment and services must be controlled.
6. Regulations must be properly applied and regularly enforced.
7. Consumer behaviour must be analyzed and recognized. We must promote technologies and services that promote energy efficiency.
8. We must monitor the outcomes and real impact of energy efficiency measures and policies.
9. International and regional cooperation in the field of energy efficiency must be enhanced. Countries must collaborate and discuss their experience and outcomes in order to determine the best practices.

[12] WORLD ENERGY COUNCIL (2013), *Energy Efficiency Policies – What works and what does not. Key messages* [online] [worldenergy.org/wp-content/uploads/2013/09/World_Energy_Perspective_Energy-Efficiency-Policies-2013_Executive_Summary.pdf] (consulted on January 9, 2015).

[13] Smart meters monitor and transmit in real time the energy consumption of a building, which makes it possible to pinpoint consumption unitsand achieve savings.

SECTION 2

ENERGY EFFICIENCY AND INNOVATION IN QUÉBEC

BRIEF HISTORY

In Québec, energy efficiency has been a component of energy policies for 40 years. It was initially contemplated as a measure to reduce the energy bills of consumers and has become a tool for economic development and is achieving the status of a full-fledged energy option. Energy efficiency organizations have followed one another over time and have adapted their practices to the changing context.

- 1977: in the wake of the first oil crisis, the Bureau des économies d'énergie was established.
- 1988: the Bureau des économies d'énergie became the Bureau de l'efficacité énergétique.
- 1992: adoption of the Stratégie québécoise de l'efficacité énergétique, with the objective of a 15% reduction by 2001 in the Québec economy's energy intensity.
- 1996: establishment of the Régie de l'énergie, which must, in particular, ensure that energy distributors promote energy savings and include them in their resource plans.
- 1997: establishment of the Agence de l'efficacité énergétique to promote energy efficiency in a sustainable development perspective.
- 2006: adoption of the Québec Energy Strategy 2006-2015:
- Using Energy to Build the Québec of Tomorrow. The Agence de l'efficacité énergétique became autonomous and its mandate was broadened to include innovation in the energy sector.
- 2007: adoption of the Energy Efficiency Act.
- 2008: adoption of the Regulation respecting the annual share payable to the Minister of Natural Resources and Wildlife by energy distributors.
- 2009: adoption of the Plan d'ensemble en efficacité énergétique et nouvelles technologies 2007-2010.
- 2011: adoption of the Act respecting energy efficiency and innovation, restoration to the Ministère des Ressources naturelles of the mandates of the Agence de l'efficacité énergétique and establishment of the Bureau de l'efficacité et de l'innovation énergétiques.

Since the establishment of the first Bureau des économies d'énergie, the nature of the programs offered to households and institutional, industrial and other clienteles has changed, as have the size of the budgets and the means to intervene adopted. The means to intervene are aimed at clienteles in four economic sectors, i.e. the industrial, transportation, residential, and commercial and institutional sectors.

- The industrial sector includes overall manufacturing activity, mining operations and logging, construction and the agri-food industry, which encompasses just over 17 400 establishments. The diversified enterprises in the sector use several forms of energy and their energy portfolio varies according to current prices and the specific nature of production.
- The transportation sector encompasses all means of locomotion used for road and other movements of individuals and goods. In the road transport sector, Québec's light vehicle fleet includes 5 million vehicles and is growing by roughly 2% annually. The heavy vehicle fleet encompasses nearly 160 000 units (excluding tool vehicles) [14].
- The residential sector encompasses all buildings used to house people, i.e. all detached, semidetached or row houses and multi-dwelling condominium or rental structures, including high-rise apartment buildings. The energy needs of the sector (heating, lighting, air-conditioning, the operation of household appliances, and so on) correspond to those of more than 3.4 million households, including nearly 2 million single-family dwellings.
- The commercial and institutional sector covers all commercial, institutional and municipal buildings, including a wide array of buildings and uses, ranging from neighbourhood convenience stores to office towers. This sector of activity includes, in particular, educational, health and housing services and the food service industry.

[14] SOCIÉTÉ DE L'ASSURANCE AUTOMOBILE DU QUÉBEC (2014). *Dossier statistique, Bilan 2013 : accidents, par automobile et permis de conduire*, Québec, 220 pages.

CURRENT GOVERNANCE

THE BUREAU DE L'EFFICACITÉ ET DE L'INNOVATION ÉNERGÉTIQUES

The Act respecting energy efficiency and innovation attributes to the Minister of Energy and Natural Resources responsibility for promoting energy efficiency and innovation under the five-year comprehensive plan. The plan must establish Québec's energy efficiency and innovation orientations, priorities and targets and is approved by the government.

The Minister may elaborate and implement energy efficiency and innovation programs or measures, including measures aimed at GHG emission reduction, and provide technical support for research and development in the field. The Bureau de l'efficacité et de l'innovation énergétiques (BEIE) in the Ministère de l'Énergie et des Ressources naturelles (MERN) mainly assumes such responsibilities. The MERN is also responsible for the implementation of several measures in the 2013–2020 Government Strategy for Climate Change Adaptation that seek to reduce GHG emissions.

The government may also set by regulation energy efficiency and energy conservation standards applicable to new domestic, commercial, industrial or institutional devices powered by electricity or hydrocarbons.

THE RÉGIE DE L'ÉNERGIE

The Régie de l'énergie is a public economic regulation body that has a mandate to reconcile the public interest, consumer protection and the fair treatment of the electric power carrier and distributors. In particular, the Régie sets electricity and natural gas rates. It can observe progress in an energy distributor's attainment of energy efficiency targets but may not demand that it implement a new energy efficiency measure. To this end, the government's policy directions and priorities that can guide the Régie are those in a comprehensive plan in force, currently the plan established for the period 2007-2010, which will be replaced following the adoption of the 2016-2015 energy policy, and those in the 2006-2015 Energy Strategy.

ENERGY DISTRIBUTORS

Electricity or natural gas distributors in Québec must establish energy efficiency or innovation programs that support the policy directions and priorities in the government's comprehensive plan. Their activities fall under the authority of the Régie de l'énergie and are presented in the comprehensive energy efficiency plans.

Pursuant to the Regulation respecting the annual share payable to the Minister of Natural Resources and Wildlife, since 2008, all energy distributors must pay the government an annual share to fund the measures under its comprehensive plan. The share now wholly or partially funds five programs that the BEIE administers, i.e. Novoclimat 2.0, Rénoclimat, Éconologis, Technoclimat and ÉcoPerformance (Appendix 2). The share paid by energy distributors also wholly or partially funds regulatory activities.

OTHER STAKEHOLDERS

In the context of the government's sustainable development approach, several Québec government departments and bodies are intervening in their respective areas of responsibility to achieve greater energy efficiency. Certain government departments and bodies such as the Ministère des Transports, the Ministère du Développement durable, de l'Environnement et de la Lutte contre les changements climatiques, the Ministère des Affaires municipales et de l'Occupation du territoire, and the Régie du bâtiment are contributing through various initiatives and regulations to the definition of structuring measures in respect of energy efficiency and innovation. Other government departments and bodies are achieving energy savings by enhancing the energy efficiency of the infrastructure for which are responsible, e.g. the Société québécoise des infrastructures, the Ministère de la Santé et des Services sociaux, the Ministère de l'Éducation, des Loisirs et du Sport, and so on.

The federal government is acting at several levels. For example, it:

- regulates the energy efficiency of equipment and transportation vehicles;
- offers information to consumers to guide them in making certain purchases (ecoenergetic labeling of new automobiles, electric household appliances, and so on);
- supports research, development and demonstration in respect of new technologies, e.g. networks of laboratories and innovation assistance programs such as the Sustainable Development Technology Canada program and the Green Municipal Fund of the Federation of Canadian Municipalities.

Lastly, the municipalities may also adopt measure that promote energy efficiency in the residential and transportation sectors and engage in effective land use planning and, in particular, urban expansion.

OVERVIEW AND OUTLOOK

Considerable effort has been devoted over the years to energy efficiency and innovation. Between 2008-2009 and 2013-2014 alone, energy distributors and the Québec government (BEIE)[15] invested just over $1.4 billion (Table 2.1). The investments were made in programs covering all areas of activity and engendered recurring energy savings equivalent to more than 41.7 million gigajoules (GJ). They peaked between 2010 and 2012 and have declined since then (Table 2.2). This observations raises a number of questions concerning the investments that must be made in the future but also on ways in which the government and energy distributors can intervene more effectively in respect of clienteles, the fields to be emphasized, and ways of diversifying sources of financing and obtaining the maximum economic, environmental and social spinoff.

Table 2.1

Investments by distributors and the BEIE[16] in energy efficiency and innovation — 2008 to 2014 (in dollars)

Year*	Hydro-Québec[1]	Gaz Métro[2]	FEE[3]**	Gazifère[3]	BEIE[3-4]	Total
2008-2009	155 700 000	8 500 000	4 900 000	300 000	25 200 000	194 600 000
2009-2010	177 300 000	10 400 000	2 600 000	400 000	47 500 000	238 200 000
2010-2011	178 200 000	10 700 000	3 300 000	400 000	81 500 000	274 100 000
2011-2012	179 100 000	10 400 000	3 100 000	400 000	82 300 000	275 300 000
2012-2013	150 000 000	11 100 000	0	300 000	68 800 000	230 200 000
2013-2014	127 000 000	15 000 000	0	500 000	59 500 000	202 000 000
Total	967 300 000	66 100 000	13 900 000	2 300 000	364 800 000	1 414 400 000

* The amounts of financial assistance are estimated using data submitted in rate cases filed with the Régie de l'énergie.
** Fonds en efficacité énergétique de Gaz Métro.
Sources:
[1] Hydro-Québec Distribution: Causes tarifaires – Demandes R-3776-2011, R-3814-2012 et R-3854-2013. Corresponds to the calendar year.
[2] Gaz Métro: Cause tarifaire - Demande R-3837-2013
[3] Ministère de l'Énergie et des Ressources naturelles du Québec, Gaz Métro and Gazifère: Cause tarifaire – Demande R-3692-2009
[4] Includes the share program, the PACC and the PACC 2020.

[15] Agence de l'efficacité énergétique until July 2011.
[16] *Idem*.

Table 2.2

Total energy savings achieved by the BEIE[17] and energy distributors — 2008 to 2014 (in GJ)

	2008-2009	2009-2010	2010-2011	2011-2012	2012-2013	2013-2014	Cumulative
Electricity	3 426 911	3 859 507	3 039 389	3 748 570	3 871 346	2 435 388	20 381 112
Natural gas	1 373 352	1 735 476	2 576 524	2 716 695	2 109 056	2 021 388	12 532 490
Petroleum products	393 451	653 595	1 750 355	1 069 224	2 018 159	2 921 746	8 806 529
Total	5 193 714	6 248 578	7 366 268	7 534 489	7 998 561	7 378 522	41 720 131

Source: Ministère de l'Énergie et des Ressources naturelles.

THE INDUSTRIAL SECTOR

Since 2008-2009, 14 programs aimed at reducing energy consumption in the industrial sector[18] that represent investments of $280 million have generated overall energy savings of 36.3 PJ.

Moreover, under the 2006-2012 Climate Change Action Plan, GHG emission reductions in the industrial sector were estimated at roughly 763 megatons of CO_2 equivalent[19]. The Québec government has established an additional target of 692 megatons of CO_2 equivalent in the new 2013-2020 Climate Change Action Plan.

THE TRANSPORTATION SECTOR

Québec government initiatives are focusing on energy efficiency and GHG emission reduction in the transportation sector:

- the 2013-2020 Climate Change Action Plan has a total budget of $3.2 billion, of which $1.8 billion has been earmarked for initiatives aimed primarily at ecomobility (mass transit, carpooling, car-sharing services, walking, cycling) and, to a lesser extent, freight transportation, including the enhancement of driving practices and transportation logistics;
- the Electric Vehicles 2011–2020 Action Plan made possible the launching, in 2012, of the Drive Electric Program aimed at GHG emission reductions in the transportation sector. To date, the program has generated reductions of some 7 981 megatons of CO_2 equivalent and spurred the electric vehicle market;
- a major portion of the *Transportation Electrification Strategy 2013-2017* is funded by the Green Fund. Recent initiatives such as the Plugged In at Work program or the installation of public charging stations stem from it.

[17] Agence de l'efficacité énergétique until July 2011.
[18] MERN data concerning the industrial sector also include savings achieved in the commercial and institutional sector.
[19] MERN (2014), internal compilation.

THE RESIDENTIAL SECTOR

The energy efficiency initiatives of governments and distributors in the residential sector focus both on new housing and on renovation and the purchase of efficient products. They take the form of financial assistance programs, awareness-raising initiatives, training and regulations.

Accordingly, since 2008-2009, 27 programs devoted to reducing energy consumption in the residential sector totalling $545 million in investments have generated total energy savings of 10.1 PJ.

Under the *2013-2020 Climate Change Action Plan,* the Heating with Green Power program administered by the MERN is contributing to reduced consumption of petroleum products and reducing GHG emissions in the residential sector by financially facilitating the conversion of oil-fired heating systems to systems that rely on renewable energy.

Furthermore, in 2012, the revision of energy efficiency regulations governing homes updated minimal construction requirements. New buildings are 20% to 25% more efficient than those built earlier and that did not benefit from the Novoclimat program.

THE COMMERCIAL AND INSTITUTIONAL SECTOR

Since 2008-2009, 44 programs devoted to reducing energy consumption in the residential sector totalling $545 million in investments have generated total energy savings of 9.5 PJ.

Regulations governing the energy efficiency of new commercial and institutional buildings are being revised[20]. What is more, the Québec Energy Strategy 2006-2015 requires government departments and bodies to attain energy consumption reduction targets.

[20] 2013-2020 Climate Change Action Plan.

ENERGY CONSUMPTION IN QUÉBEC

Between 1992 and 2011, Québec's total energy consumption increased by 209 petajoules (PJ), equivalent to 14.2% (Figure 2.1). During the same period, energy consumption rose in all economic sectors, in particular because of growth in the population and GDP.

Figure 2.1

Final energy consumption by sector (in PJ)

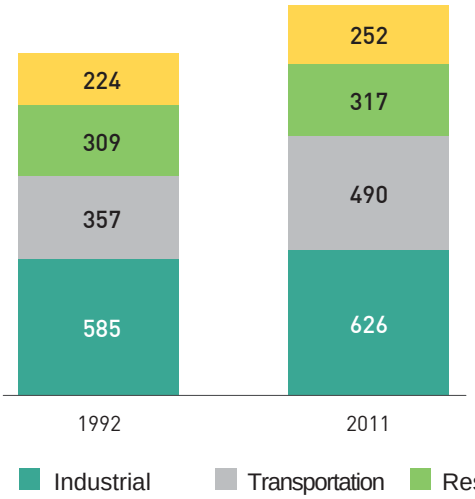
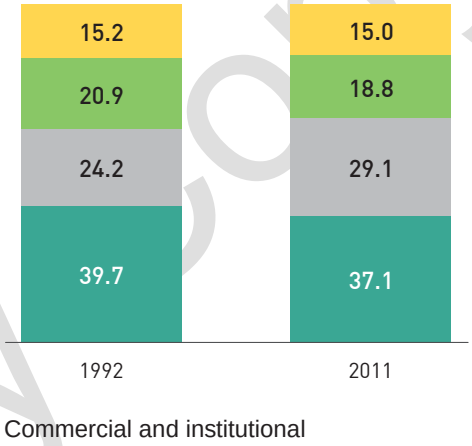


Figure 2.2

Finenergy consumption by sas Final energy consumption by sector (as a percentage)



Source: Ministère de l'Énergie et des Ressources naturelles.

Between 1992 and 2011, several changes occurred in the breakdown by sector of final energy consumption. Accordingly, while the industrial sector's relative share of final energy consumption fell by 2.5 percentage points (from 39.7% to 37.2%), the sector continues to rank first in terms of energy consumption. The transportation sector, which ranks second, is the only one whose relative share of final energy consumption increased during the period 1992-2011, by 4.9 percentage points (from 24.2% to 29.1%). It is the only sector whose relative weight increased during the period. The residential sector, which ranks third, recorded a 2.1 percentage point drop in its share of energy consumption between 1992 and 2011. The weight of energy consumption in the commercial and institutional sector, which ranked fourth, remained fairly stable (Figure 2.2).

The sectoral composition of the final energy consumption of a country or a territory reflects several characteristics:

- the economic structure;
- the size of the territory and land-use planning and its impact on the use of transportation systems;
- the availability of energy sources and access to them (oil, natural gas, hydroelectricity, and so on);
- economic and energy policies.
-

The sectoral structure of certain European countries where the importance of the industrial sector is fairly significant is similar to that in Québec. This is true of Norway, which produces crude oil and has low population density, where the sector accounted in 2011 for 50.5% of final energy consumption.

However, in other countries such as France and the United Kingdom, which have experienced the transition to a service economy over the past three decades, the transportation sector predominates in the sectoral structure. Even in these examples, the industrial sector is noteworthy and ranks second from the standpoint of energy consumption.

In the United States, public policies centred on the automobile have tended to favour the rapid development of individual transportation, which explains to a large extent why the transportation sector is more energy-intensive in states such as California, New York, Massachusetts, and so on.

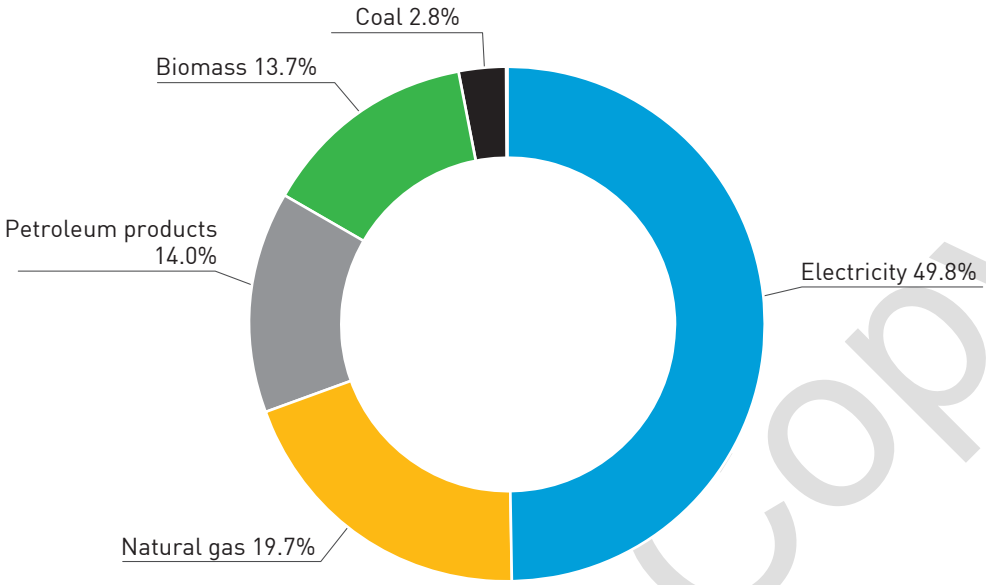
The comparison in Canada is more mixed. On the one hand, the industrial sector dominates the energy consumption table in Alberta and Saskatchewan, where the oil sands are being developed, in a proportion of 55.2% and 43.9%, respectively. On the other hand, the transportation sector is the largest energy consumer in Ontario and Manitoba. Lastly, British Columbia's energy use profile is similar to Québec's.

THE INDUSTRIAL SECTOR

In Québec, energy consumption in the industrial sector increased by 7.0% between 1992 and 2011 and stood at 626 PJ in 2011. Energy is used primarily in the sector to produce heat, generate steam and motive power, and for electrolysis. Its electrical power consumption (Figure 2.3) is high because of the large number of aluminum smelters. The smelting and refining industry (aluminum production and non-ferrous metal refining) and the pulp and paper industry consumed the most energy in 2011 (Figure 2.4).

Figure 2.3

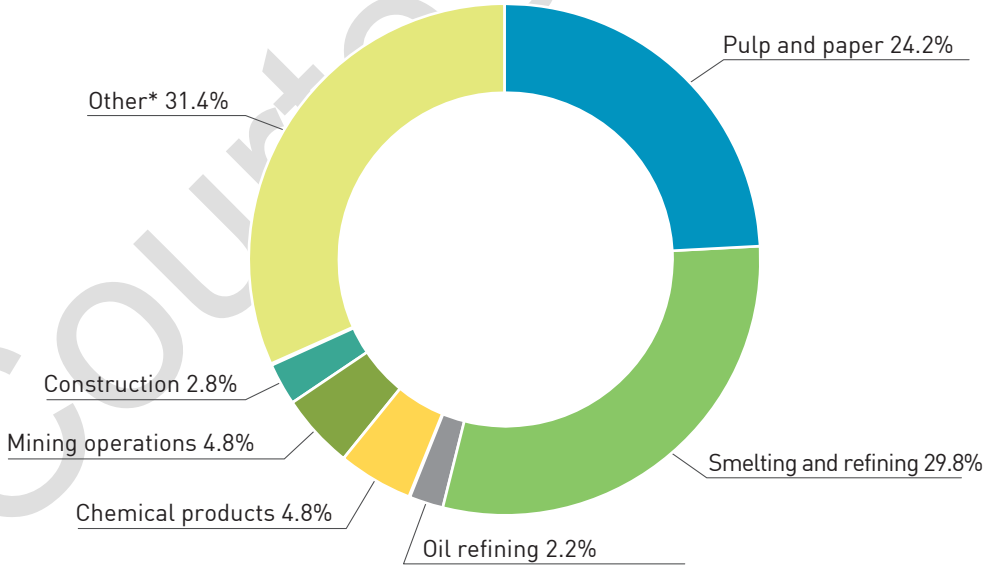
Final energy consumption by form for the industrial sector in 2011



Source: Ministère de l'Énergie et des Ressources naturelles.

Figure 2.4

Final energy consumption by industry in 2011



* The "Other" category includes the cement industry, the steel industry, logging and the food industry.
Sources: Ministère de l'Énergie et des Ressources naturelles and Natural Resources Canada.

The Québec industrial sector's energy consumption profile, in which electricity accounts for nearly half of consumption (Figure 2.3), is unusual. In Canada, the industrial sector's energy portfolio is relatively more diversified and dominated, to varying degrees, by oil, natural gas and electricity. British Columbia is noteworthy in that biomass is its main form of energy. It satisfies more than 43% of the industrial sector's final energy needs.

In the case of several European countries, i.e. Norway, France, Germany, Finland and Sweden, electricity is the main energy source. In other countries, oil (Denmark) or natural gas (the United Kingdom) ranks first. In Finland and Sweden, biomass ranks second after electricity as the most widely used form of energy, i.e. 24% and 31%, respectively. In Finland, district heating, a system for distributing steam heat generated in a centralized location, is fairly important (13%).

BOX 3
INDUSTRIAL ECOLOGY[21]

In order to minimize the environmental repercussions of industries. It encompasses an array of practices aimed Industrial ecology is a field applied to environmental management at reducing industrial pollution[22] and is, as it were, the industry's response to making operational the notion of sustainable development.

By combining sectorial, transversal approaches in an integrated process, industrial ecology proposes to industrialists to streamline production, in particular by optimizing energy, minimizing waste at the source, reusing waste as a raw material for other production processes, and decarbonizing energy. It hinges on a comprehensive, systemic perspective of the operations of an industrial society and takes as an example the cyclical operating of biological ecosystems to optimize energy flows and inventories.

This multidisciplinary field of intervention requires the collaboration of several industries, which, through geographic proximity and shared environmental values, exchange energy or use each other's waste.

The best known example is certainly the symbiosis of Kalundbord, Denmark, where half a dozen enterprises spontaneously began to exchange, according to market forces, waste, steam and water at different temperatures and levels of purity.

In Québec, with the collaboration of the Centre de transfert technologique en écologie industrielle (CTTEI) and Synergie Québec, two industrial symbiosis projects have been carried out with businesses in the Bois-Francs and Shawinigan regions. A pilot project is also under way in Bécancour. The Québec Industrial Waste Exchange Program is another initiative aimed at implementing the industrial ecology approach in Québec[23].

[21] DIEMER AND LABRUNE (2007), *L'écologie industrielle : quand l'écosystème industriel devient un vecteur du développement durable*, Développement durable et territoires [online] [developpementdurable.revues.org] (consulted on January 6, 2015); CENTRE DE TRANSFERT TECHNOLOGIQUE EN ÉCOLOGIE INDUSTRIELLE. *Introduction à l'écologie industrielle* [online] [cttei.qc.ca/ei_introduction.php] (consulted on January 7, 2015).
[22] FORSCH (1995), in Diemer and Labrune (2007), *L'écologie industrielle : quand l'écosystème industriel devient un vecteur du développement durable*, Développement durable et territoires [online] [developpementdurable.revues.org] (consulted on January 6, 2015).
[23] Centre de transfert technologique en écologie industrielle. List of projects [online] [cttei.qc.ca/ei_introduction.php] (consulted on January 7, 2015).

For the United States overall, oil and natural gas account for nearly 70% of industrial energy consumption. The comparison is more mixed in the case of certain states. For example, in the New England states overall, natural gas (33%) and electricity (27%) are the main forms of energy used. Oil and biomass account for nearly 20% each.

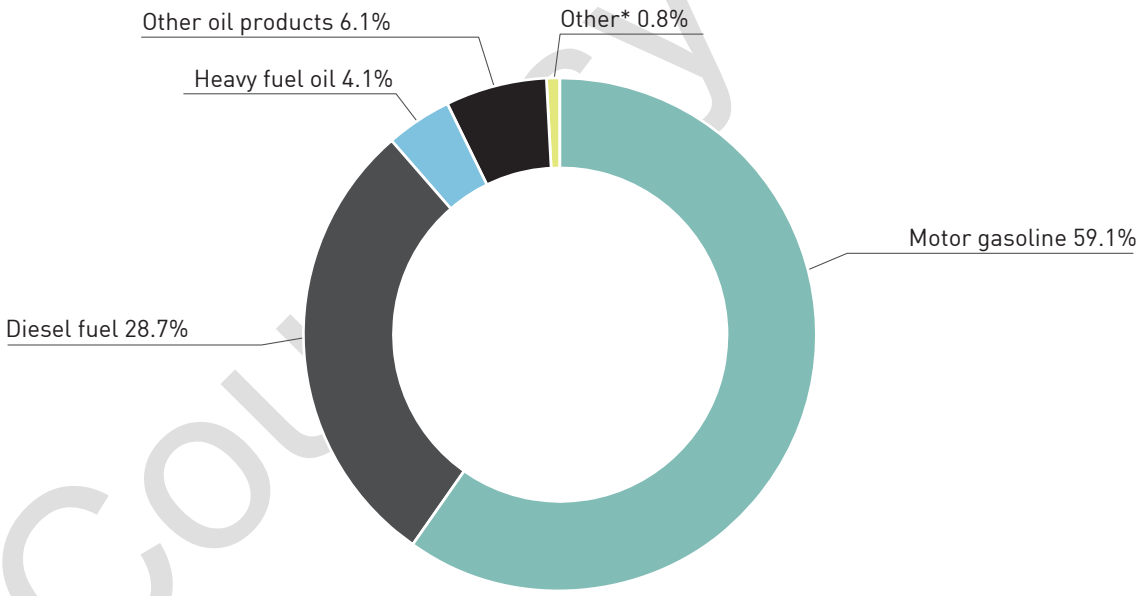
When account is taken of the most recent energy and environmental policies in force or already announced, economic and population forecasts, underlying energy savings and the main industrial projects in development, energy demand in Québec's industrial sector should increase by 1.5% per year, on average, until 2021[24].

THE TRANSPORTATION SECTOR

Oil products account for more than 99% of energy consumption in the Québec transportation sector. Gasoline and diesel fuel account for roughly 87.8% of the energy used (Figure 2.5). In 2011, passenger and freight transportation accounted for 56.7% and 38.8%, respectively, of total energy consumption in the sector (Figure 2.6). Alternative fuels to gasoline and diesel fuel are gaining market share. There are now more than 5 000 fully electric or rechargeable hybrid vehicles on Québec roads and natural gas-powered vehicles are becoming worthwhile options for transportation companies. Hydrogen-powered vehicles are also part of the emerging technologies.

Figure 2.5

Final energy consumption in the transportation sector by form in 2011

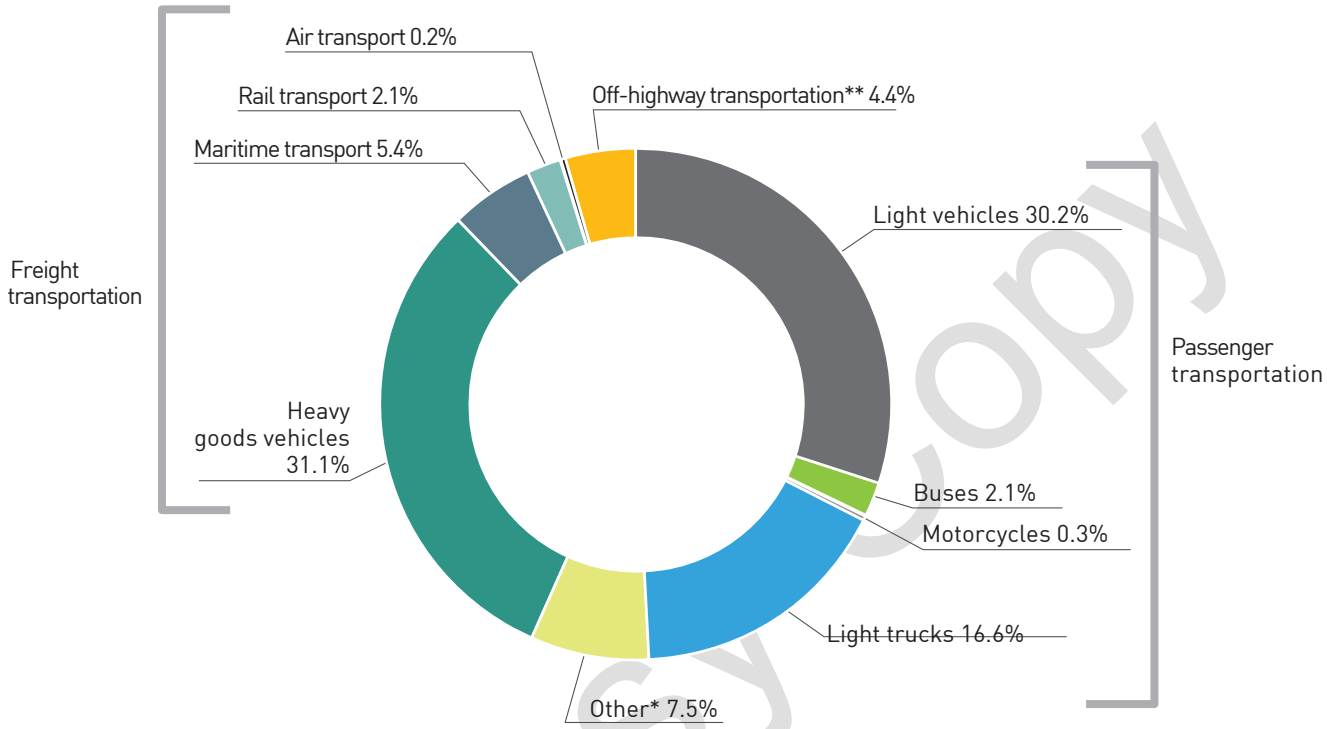


* The "Other" category includes electricity and natural gas.
Source: Ministère de l'Énergie et des Ressources naturelles.

[24] MERN (2014), *Scénario de référence de prévision de la demande d'énergie.*

Figure 2.6

Final energy consumption in the transportation sector in 2011



* The "Other" category includes air passenger transportation, interurban passenger transportation, and so on.
** The "Off-highway transportation" category includes vehicles that are not registered to travel on highways, such as snowmobiles and golf carts.
Sources: Ministère de l'Énergie et des Ressources naturelles and Natural Resources Canada.

The transportation sector in North America has the most homogeneous energy consumption characteristics. Such consumption is characterized by the preponderance of oil, which usually accounts for more than 90% of energy consumption in the sector. Depending on the regions, other forms of energy, including electricity, natural gas and biofuels, are more or less marginal.

The MERN anticipates that energy demand in the transportation sector will be fairly stable in Québec until 2021[25]. Total energy consumption in respect of passenger transportation should fall but such a decline should, however, be offset by an increase as regards freight transportation.

[25] MERN (2014), Scénario de référence de prévision de la demande d'énergie.

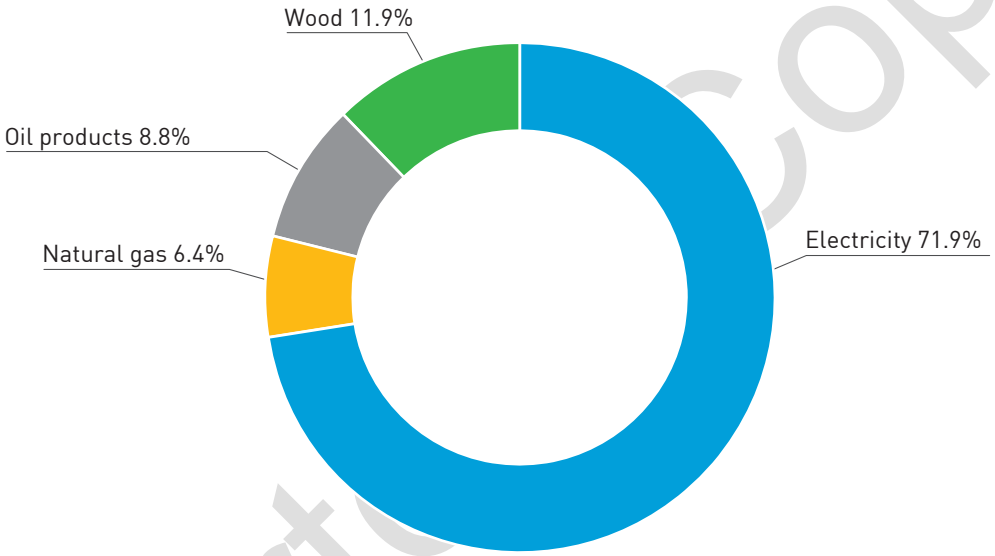
THE RESIDENTIAL SECTOR

Energy consumption in the residential sector increased by 2.6% between 1992 and 2011 and stood at 317 PJ, despite a drop in its relative share of energy demand from 20.9% to 18.8% during the same period.

In Québec, energy consumption in the residential sector is characterized by significant energy demand for space heating and water heating. Advantageous rates for consumers promote electrical power consumption, which accounts for 71.9% of total consumption in the sector (Figure 2.7). Accordingly, electricity (82% of electric heating) satisfies most heating needs, which represent 61.1% of the sector's energy needs (Figure 2.8).

Figure 2.7

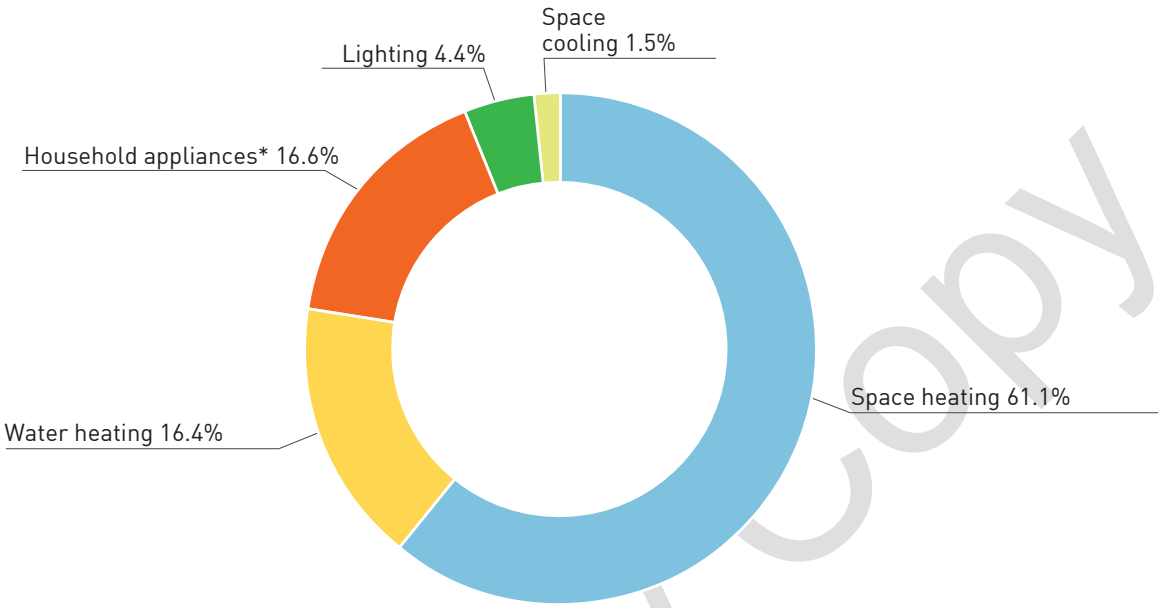
Final energy consumption in the residential sector by form in 2011



Source: Ministère de l'Énergie et des Ressources naturelles.

Figure 2.8

Final energy consumption in the residential sector by use in 2011



* The “Household appliances” category includes refrigerators, freezers, washing machines, dryers, tumble-dryers, stoves, and so on.
Sources: Ministère de l’Énergie et des Ressources naturelles and Natural Resources Canada.

The consumption profile in Norway, Sweden and Manitoba is similar to that in Québec. Elsewhere in Canada, natural gas occupies a significant position in energy consumption in the residential sector.

In certain northern countries (Denmark, Sweden and Finland), steam supplied by district heating networks satisfies a considerable portion of energy needs. In Denmark, for example, steam is the main form of energy used (36.6%), followed by electricity (19.8%) in the residential sector.

Bearing in mind recent energy and environmental policies in force or already announced, the latest economic and population forecasts, and underlying energy savings or rising temperatures, energy demand in Québec’s residential sector should increase by 0.1% per year, on average, until 2021. However, energy demand for space heating, the main use in the sector, should decline, mainly because of the advent of more efficient heating systems, changes made in 2012 to the Québec *Construction Code* and climate change[26].

26 MERN (2014), Scénario de référence de prévision de la demande d’énergie.

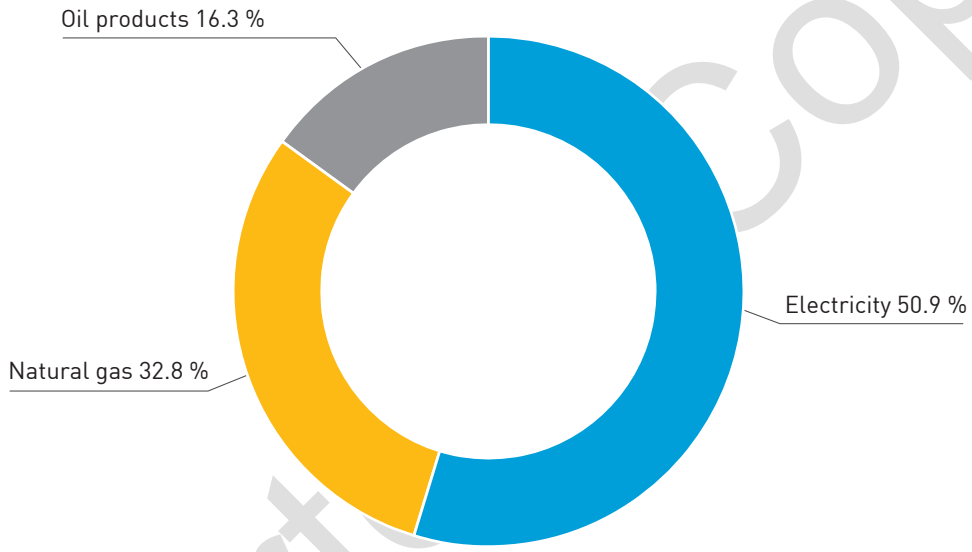
THE COMMERCIAL AND INSTITUTIONAL SECTOR

Consumption in the commercial and institutional sector increased by 12.4% between 1992 and 2001, to 252 PJ, despite the decrease of its relative share in energy demand from 15.2% to 15.0% during the same period.

Energy consumption in the commercial and institutional sector in Québec (Figure 2.9) is characterized by high electrical energy (50.9%) and natural gas (32.8%) consumption, an upward trend that is occurring to the detriment of oil products, whose importance declined from 23.9% to 16.3% between 1992 and 2011.

Figure 2.9

Final energy consumption in the commercial and institutional sector by form in 2011



Source: Ministère de l'Énergie et des Ressources naturelles.

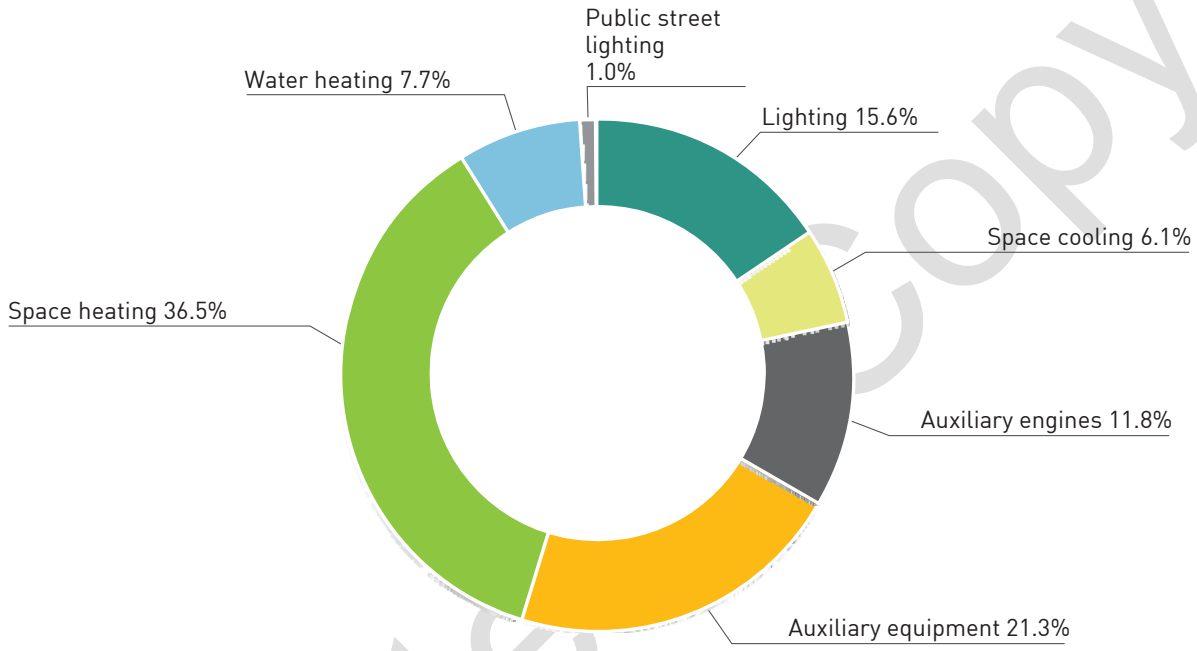
This energy use profile is observed in Norway, France and California. In most of the Canadian provinces, natural gas is the main energy source, followed by electricity.

The use of steam provided by district heating networks is fairly widespread in a number of European countries. In Denmark and Sweden, for example, in 2011 steam was the second most widely used form of energy, at 37.7% and 27.4%, respectively.

In the commercial and institutional sector, energy is mainly used for space heating (36%), to operate auxiliary equipment (21.3%), and for lighting (15.6%) (Figure 2.10). Auxiliary equipment's share of energy consumption almost doubled between 1992 and 2011, which reflects broader penetration by computer equipment in the workplace.

Figure 2.10

Final energy consumption in the commercial and institutional sector by use in 2011



Sources: Ministère de l'Énergie et des Ressources naturelles and Natural Resources Canada.

Bearing in mind recent energy and environmental policies in force or already announced, the latest economic and population forecasts, underlying energy savings or rising temperatures, energy demand in Québec's commercial and institutional sector should increase by 0.7% per year, on average, until 2021[27].

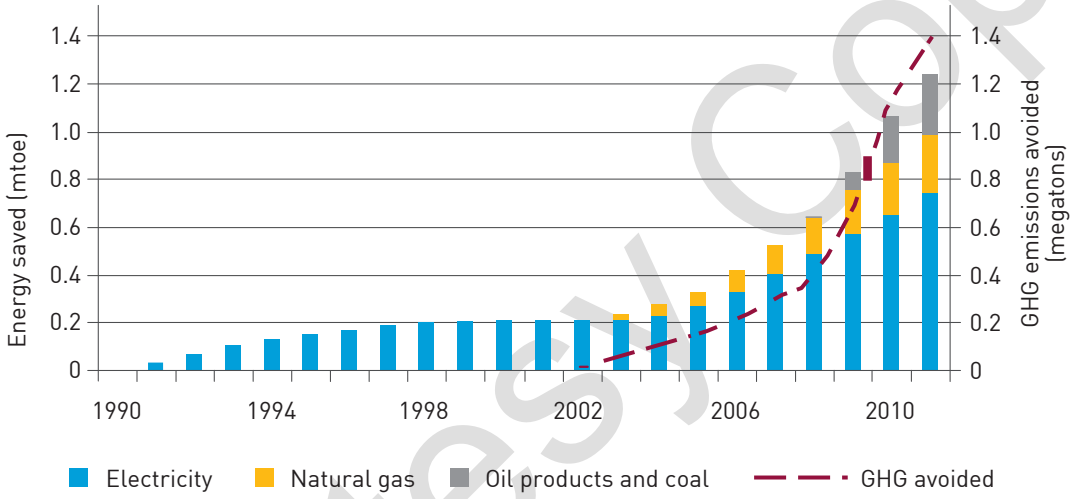
[27] MERN (2014), Scénario de référence de prévision de la demande d'énergie

ENERGY EFFICIENCY GAINS

Between 1990 and 2011, initiatives carried out in Québec in the realm of energy efficiency generated a cumulative total of 1.2 Mtoe of recurring energy savings, i.e. 742 ktoe (8.6 TWh) of electricity, 246 ktoe (280 Mm^3) of natural gas and 252 ktoe of oil products and coal. The fuel savings have, in particular, reduced cumulative GHG emissions by 1.4 megatons of CO_2 equivalent (Figure 2.11). In 2011, the energy efficiency option made available a quantity of energy equivalent to less than 3% of Québec's energy consumption, at an estimated cost of 2.5 cents/kWh[28].

Figure 2.11

Cumulative energy savings and GHG emissions avoided stemming from energy efficiency measures implemented by the government and energy distributors (1990-2011)[29]



Sources: Hydro-Québec Distribution and Ministère de l'Énergie et des Ressources naturelles.

[28] MINISTÈRE DES RESSOURCES NATURELLES (2013), *From Greenhouse Gas Reduction to Québec's Energy Self-sufficiency*, consultation paper of the 2013 Commission on Energy Issues in Québec, Québec, 83 pages.
[29] *Idem.*

Several factors affect energy consumption (see Box 4). The contribution that energy efficiency makes can be estimated by the difference the consumption that would normally be observed according to changes in the factors and the actual level of consumption[30].

BOX 4

FIVE FACTORS IN ADDITION TO ENERGY EFFICIENCY THAT AFFECT ENERGY CONSUMPTION

1. The level of activity describes the growth observed in a segment of the economy. For example, demography and the number of households are used to assess growth in the residential sector. The floor area is used to evaluate growth in the commercial sector. Gross domestic product is used to measure growth in the industrial sector.
2. The structure refers to changes in the composition of a sector. For example, a relative increase in the activity of one industry in relation to another one reflects a change in the structure of the industrial sector.
3. Weather conditions affect the heating and cooling of buildings. They have a marked impact in the residential sector and the commercial and institutional sector.
4. The level of service refers to the penetration rate of appliances and equipment.
5. The level of service takes into account, for example, the use of auxiliary equipment in commercial buildings and electric household appliances in dwelling units.
6. The industrial capacity utilization rate defines the proportion of used or effective capacity in relation to the technically achievable or potential capacity in the industrial sector.

[30] The method applied to Québec is based on the method that of Office of Energy Efficiency uses.

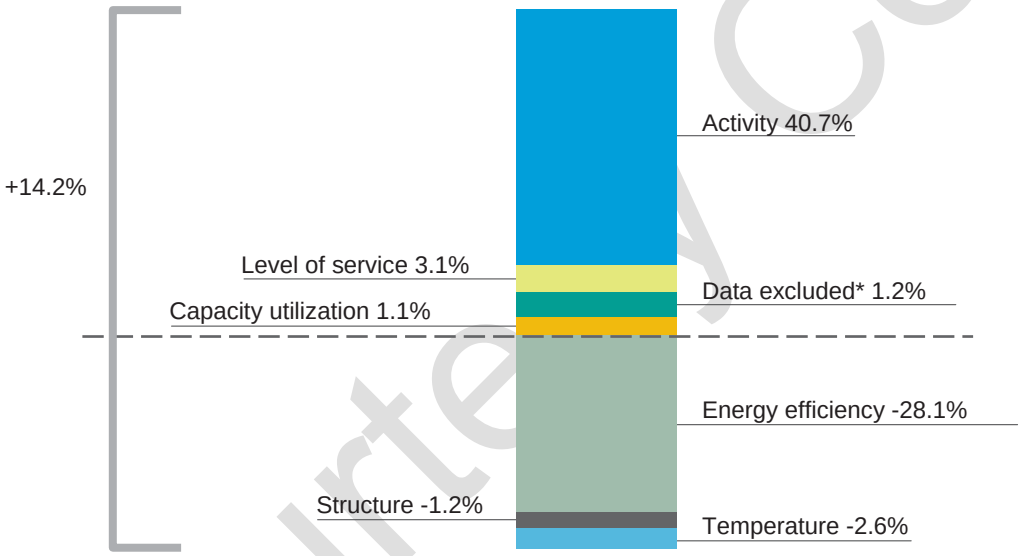
Between 1992 and 2011, the 28.1% improvement in energy efficiency (Figure 2.12) partially offset the overall increase in energy consumption stemming from stronger activity and an increase in the level of service, in all sectors of activity. However, it fell short of expectations because of:

- technological innovations;
- improvements in the thermal envelope of buildings;
- recourse to less energy-consuming technologies;
- changes in consumption habits.

Between 1992 and 2011, the industrial sector achieved more than half of the total energy efficiency gains (53.7%). The residential (23.1%), transportation (13.4%) and commercial and institutional sectors (9.7%) accounted for the remaining gains (Figure 2.13).

Figure 2.12

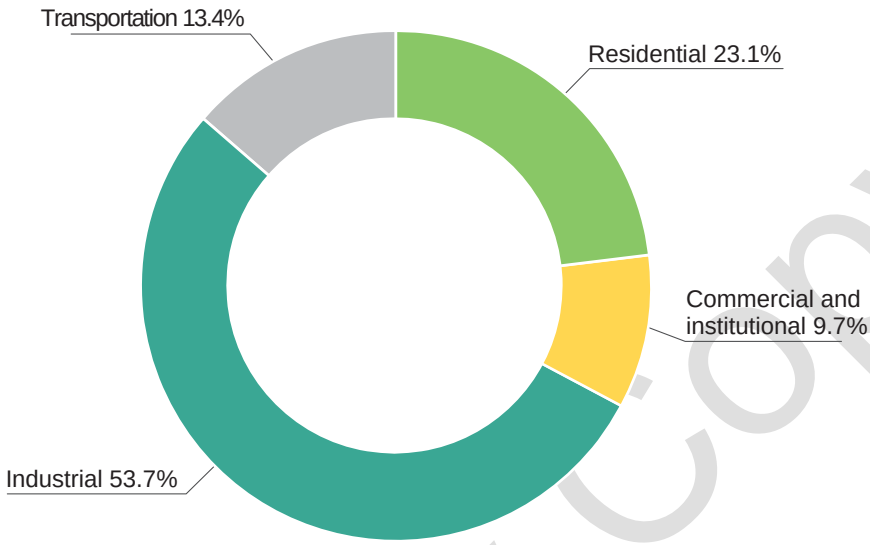
Factors in the growth of energy consumption in Québec (1992-2011)



* "Data excluded" includes upstream mining operations and the agricultural sector.
Sources: Ministère de l'Énergie et des Ressources naturelles and Natural Resources Canada.

Figure 2.13

Breakdown of energy efficiency gains in Québec by area of activity (1992-2011)



Sources: Ministère de l'Énergie et des Ressources naturelles and Natural Resources Canada.

The update of the attainment of energy efficiency targets in the Québec Energy Strategy 2006-2015 reports the findings presented in Table 2.3.

Table 2.3

Forecasts of the attainment of energy efficiency targets for Québec[31]

	Target	% attainment anticipated at the end of 2015
	11 TWh	94
Natural gas	350 Mm^3	100
Petroleum products	2 mtoe	10.5

Source: Ministère de l'Énergie et des Ressources naturelles.

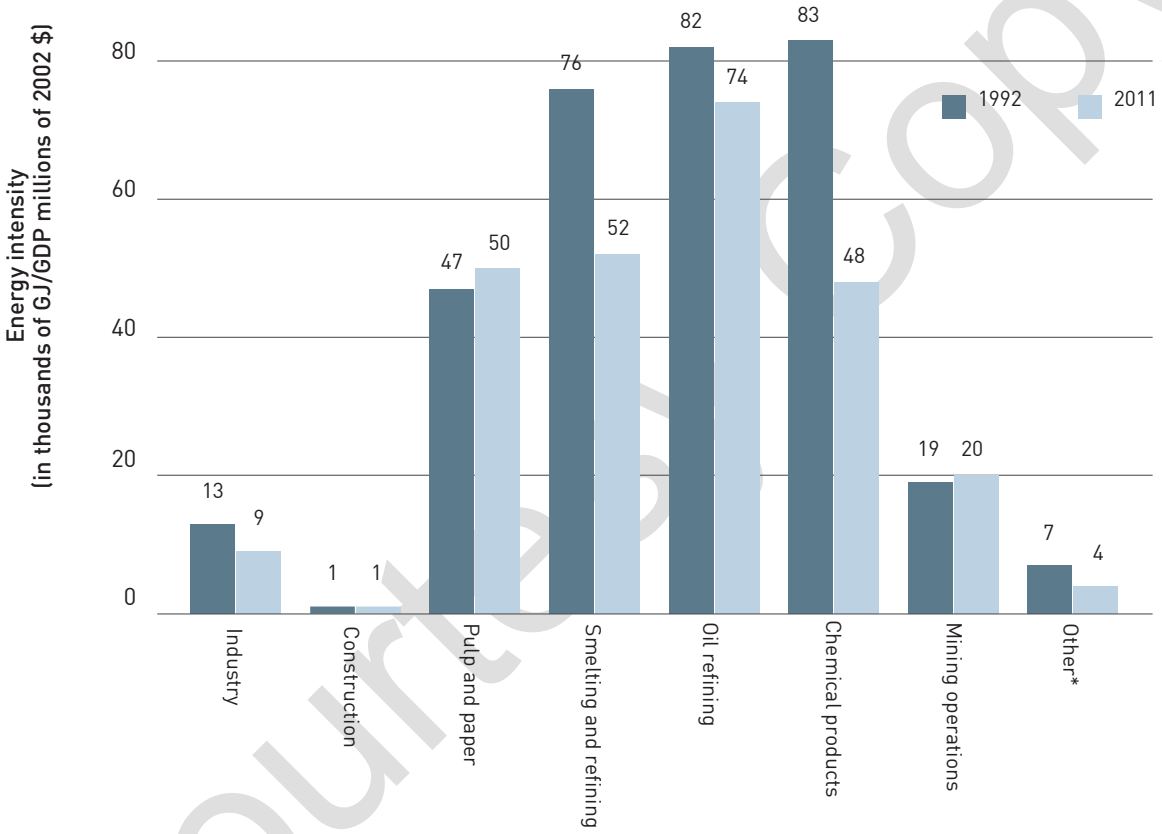
[31] MERN (2014)

THE INDUSTRIAL SECTOR

The biggest energy efficiency gains were achieved in the industrial sector, i.e. 53.7% of the total gains achieved between 1992 and 2011 (Figure 2.13). During the same period, the energy intensity of the industrial sector declined by 1.5% annually, on average, from 13 166 GJ to 9 937 GJ per dollar of GDP[32], a total reduction of nearly 25% (Figure 2.14).

Figure 2.14

Energy intensity by type of industry (1992 and 2011)

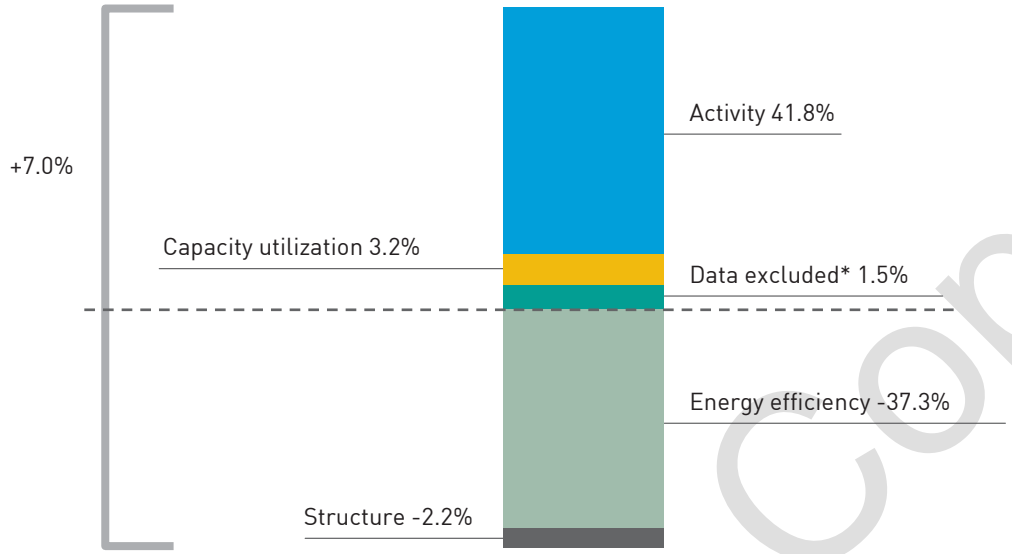


* The "Other" category includes the cement industry, the steel industry, logging and the food industry.
Source: Ministère de l'Énergie et des Ressources naturelles.

[32] In 2002 dollars.

Figure 2.15

Factors in the growth of energy consumption in the industrial sector (1992-2011)



* "Data excluded" includes upstream mining operations and the agricultural sector.
Source: Ministère de l'Énergie et des Ressources naturelles.

The increase in economic activity, measured by growth in gross domestic product, is the factor that most significantly affects energy consumption in the industrial sector, i.e. a 41.8% increase between 1992 and 2011 (Figure 2.15). On the other hand, it is estimated that energy efficiency reduced energy consumption in the sector by 37.3% during the same period[33].

THE TRANSPORTATION SECTOR

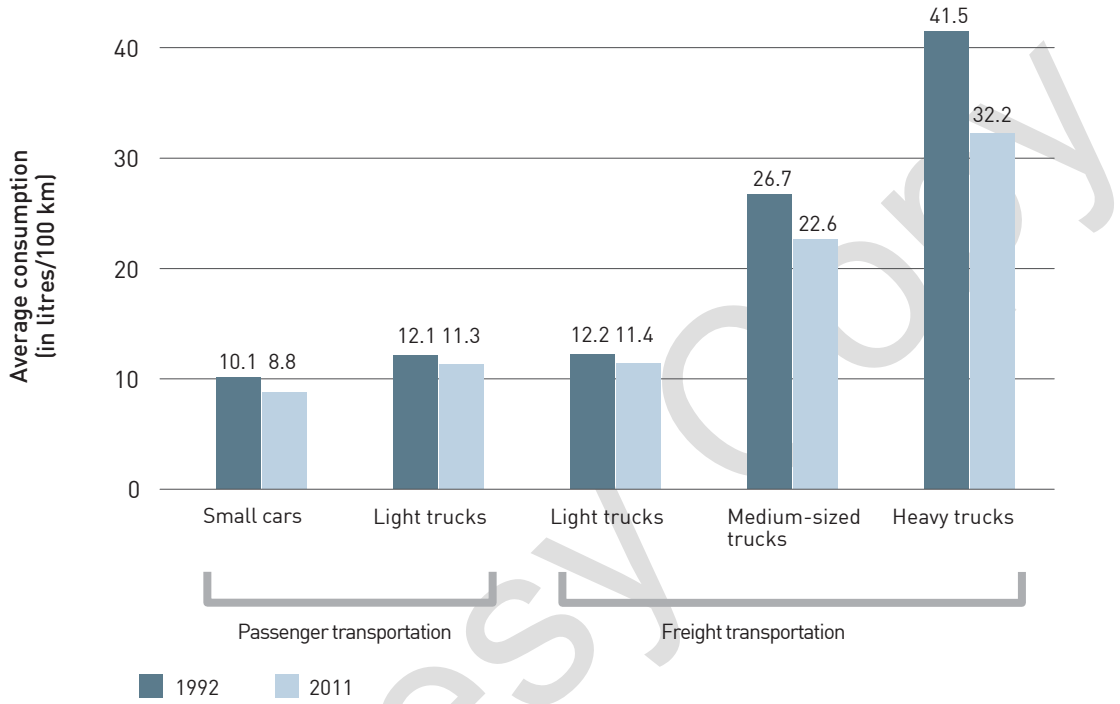
In the transportation sector, average consumption of fuel by distance travelled declined between 1992 and 2011 (Figure 2.16). In the realm of passenger transportation, the average unit consumption of automobiles fell from 10.1 l/100 km to 8.8 l/100 km, a 13.2% improvement. As for freight transportation, the average unit consumption of heavy trucks fell from 41.5 l/100 km to 32.2 l/100 km, a 22.5% improvement. On the other hand, the 60.7% increase in the level of activity (the distance travelled and the quantity of goods) resulted in a net increase in energy consumption in the sector of 37.1% (Figure 2.17).

[33] The MERN excluded date for the agricultural sector from its factorial analysis.

In the longer term, under Canadian fuel consumption and GHG emissions standards, which are aligned with American standards, heavy vehicles of the 2018 model year will emit, on average, 28% less GHG than those of the 2014 model year, while light vehicles of the 2025 model year will consume up to 50% less fuel than those of the 2008 model year[34].

Figure 2.16

Average consumption by means of transportation (1992 and 2011)

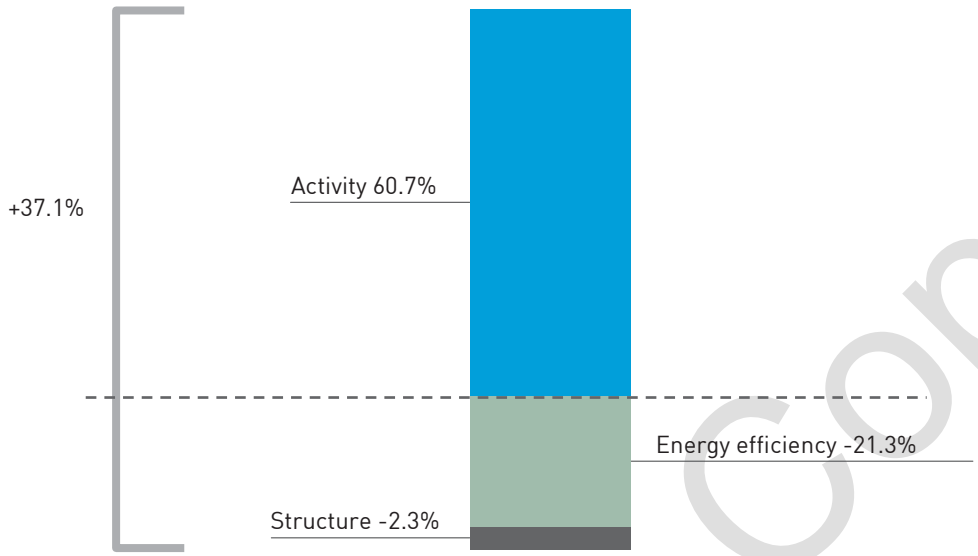


Sources: Ministère de l'Énergie et des Ressources naturelles and Natural Resources Canada.

[34] Environment Canada, *Greenhouse Gas Emission Regulations* [online] [ec.gc.ca/cc/default.asp?lang= Fr&n= E97B8AC8-1] (consulted on December 10, 2014)

Figure 2.17

Factors in the growth of energy consumption in the transportation sector (1992-2011)



Source: Ministère de l'Énergie et des Ressources naturelles.

The reduction in energy consumption by distance travelled reveals that energy efficiency in the transportation sector improved by 21.3% between 1992 and 2011 (Figure 2.17). The support measures adopted focused mainly on technological improvements linked to consumption, such as less energy-consuming engines.

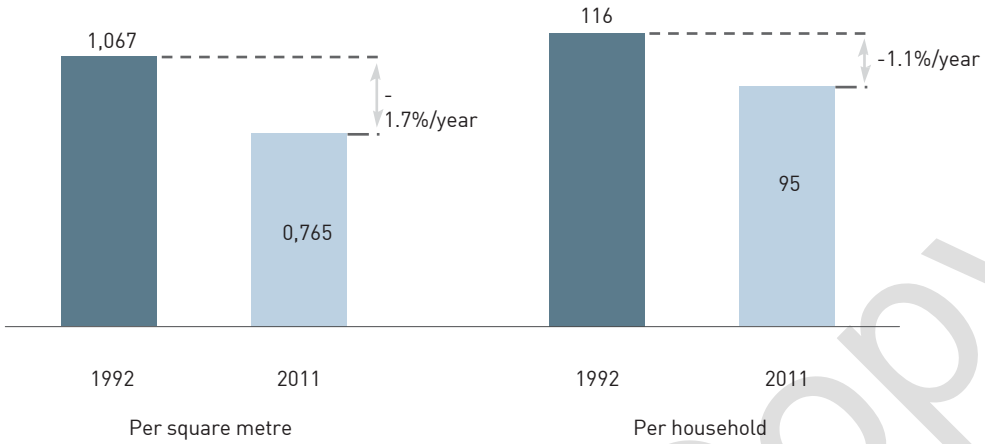
THE RESIDENTIAL SECTOR

Between 1992 and 2011, the energy intensity of the residential sector declined, on average, by one square metre per year and by 1.1%, on average, per household per year, from 1,067 GJ/m^2 to 0,765 GJ/m^2 and from 116 GJ to 95 GJ per household (Figure 2.18), i.e. total reductions of 28.3% and 18.1%, respectively. The reductions occurred even though households used greater numbers of household appliances and the average floor area of dwelling units and cooling needs increased.

Harsh winters, the proliferation of electrical appliances or demographic changes can also affect energy consumption in the residential sector. It is estimated that energy efficiency reduced energy consumption in the sector by 28.9% between 1992 and 2011 (Figure 2.19).

Figure 2.18

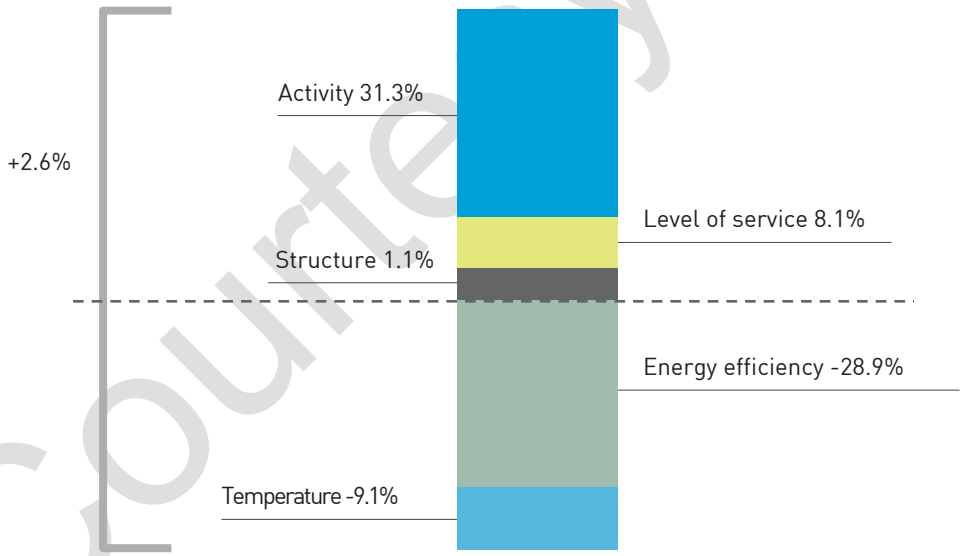
Energy intensity by floor area and households (in GJ)



Source: Ministère de l'Énergie et des Ressources naturelles.

Figure 2.19

Factors in the growth of energy consumption in the residential sector (1992-2011)



Source: Ministère de l'Énergie et des Ressources naturelles.

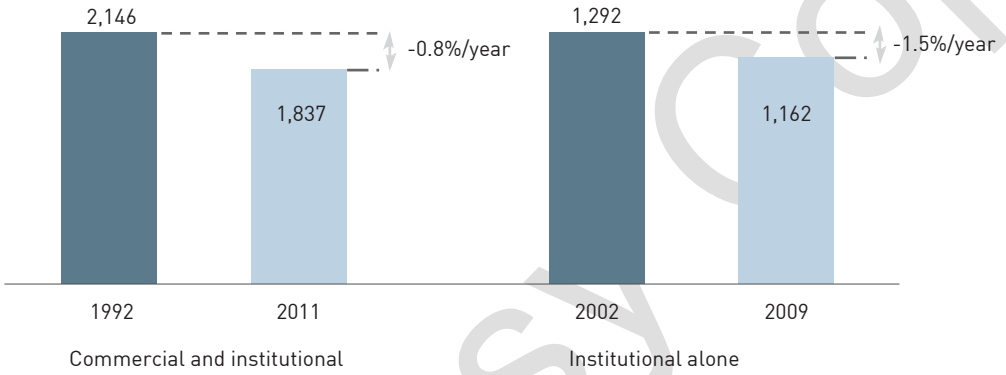
THE COMMERCIAL AND INSTITUTIONAL SECTOR

Energy intensity in the commercial and institutional sector fell by an average annual rate of 0.8% between 1992 and 2011, from 2,146 GJ/m^2 to 1,837 GJ/m^2, a total reduction of 14.4% (Figure 2.20).

An economic downturn or warmer winters can also lower energy intensity. It is estimated that energy efficiency reduced energy consumption in the sector by 16.7% between 1992 and 2011 (Figure 2.21). The measures adopted to promote energy efficiency focus, above all, on the enhancement of the thermal envelope of buildings and recourse to less energy-consuming technologies.

Figure 2.20

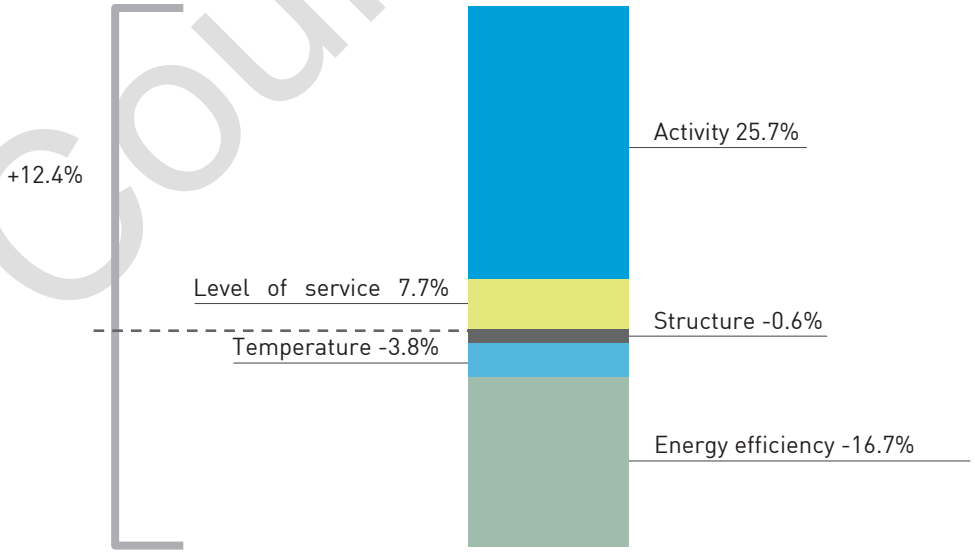
Energy intensity of the commercial and institutional sector (in GJ/m^2)



Source: Ministère de l'Énergie et des Ressources naturelles.

Figure 2.21

Factors in the growth of energy consumption in the commercial and institutional sector (1992-2011)



Source: Ministère de l'Énergie et des Ressources naturelles.

ENERGY INNOVATION

The development and use of new processes and new technologies significantly affect business growth and corporate competitiveness. A report released in August 2014 by the Energy and Mines Ministers' Conference[35] also highlighted the crucial contribution that energy innovation makes by mentioning that the ability to innovate of countries will determine their worldwide energy competitiveness in the coming decades. Aside from its economic benefits, energy efficiency innovation plays a key role in environmental protection, energy security and the well-being of populations.

In Québec, governments have sought to create an environment conducive to energy innovation by granting research and development tax credits, establishing university research funds or adopting innovation policies and industrial strategies.

The *Québec Energy Strategy 2006-2015 – Using Energy to Build the Québec of Tomorrow and the 2006-2012* Climate Change Action Plan have also contributed to the acquisition of new knowledge and the presence of new stakeholders in the innovation chain, some of which have subsequently distinguished themselves in Québec and elsewhere. Sectorial initiatives, such as the *2011-2020 Action Plan for Electric Vehicles*, are part of an international movement to promote electric vehicle technology. Accordingly, in 2012 and 2013, Québec, in collaboration with the Climate Group, carried out the *EV20 Policy Initiative* on electric vehicles. The initiative seeks to share best practices pertaining to the use of electric vehicles. In its capacity as a leader, Québec continues to be active on the international scene, as confirmed by the recent creation of a task force with California on best practices in the realm of electric vehicles.

Furthermore, Québec undertook in 2013 and 2014 with its partners in the annual Conference of New England Governors and Eastern Canadian Premiers to put forward measures that foster penetration by alternative fuel vehicles and the attendant infrastructure for the latter.

From the standpoint of renewable energy, the Québec government has adopted a series of sustained measures in respect of the bioenergy option, such as the creation of the Chaire de recherche sur les biocarburants at the Université de Sherbrooke, the establishment of an Enerkem demonstration plant in Westbury, the development of the Programme d'aide financière pour des projets de conversion énergétique à la biomasse forestière résiduelle, and the reimbursement of the fuel tax on biodiesel.

In 2012-2013 alone, Québec invested $113 million and ranked third among the Canadian provinces, after Alberta and Saskatchewan, for public funds allocated to research, development and demonstration in respect of energy-related technologies in all sectors. The Institut de recherche d'Hydro-Québec (IREQ) accounted for most of the spending ($100 million), which focused, in particular, on electricity generation and transmission.

[35] ENERGY AND MINES MINISTERS' CONFERENCE (2014*), Mobilizing Canada's Energy Advantage: Leveraging Energy Technology Innovation and Efficiency to Drive Competitiveness an Future Prosperity,* Ontario, 61 pages

Between 2002-2003 and 2012-2013, Québec devoted $456 million to research, development and demonstration in respect of energy technologies, of which the Québec government and IREQ earmarked $59.4 million for energy efficiency innovation (Table 2.4)[36].

Table 2.4

Public expenditures on research, development and demonstration pertaining to energy efficiency (2002-2003 to 2012-2013)

AREA OF ACTIVITY	(millions of $)
Industrial sector	29.9
Residential and commercial construction, appliances and equipment	15.2
Transportation sector	13.4
Other	0.9
Total	59.4

Sources: Ministère de l'Énergie et des Ressources naturelles and Natural Resources Canada.

Several Québec government programs support energy innovation. The MERN's Technoclimat program encourages the development of new technologies or innovative process related to GHG emission reduction, energy efficiency and emerging energy sources. The Fonds québécois de la recherche sur la nature et les technologies subsidizes energy-related university research.

Funding for energy-related research increased from $1.8 million in 2000 to $20.5 million in 2011. Such spending earmarked for energy efficiency, bioenergy and sustainable transportation rose from less than $2.0 million in 2000 to more than $10 million in 2011. The federal government is the largest funder of energy-related university research in Québec[37].

[36] MERN (2014).
[37] MEIE (2014).

BOX 5
EXAMPLES OF ENERGY INNOVATION IN QUÉBEC

- Enerkem is creating biofuels and green chemical products, including methanol and cellulosic ethanol, from waste. In collaboration with the Université de Sherbrooke and institutional investors and investors from the clean technologies sector, Enerkem has developed expertise to operate a pilot plant in Sherbrooke and an industrial demonstration plant in Westbury. Enerkem's first commercial plant was established in Edmonton and the company is planning to build similar facilities in Québec.
- AddÉnergie is developing smart charging solutions aimed at promoting the use of electric vehicles on highways. The company provides recharging infrastructure for the Electric Circuit and the RéseauVER^{TM}. AddÉnergie is developing the products and software necessary to operate the networks.
- Rackam and Cascades, with the financial participation of Gaz Métro, inaugurated in October 2014 a concentrating solar power (CSP) system that is equipped with more than 1 490 m^2 of mirrors, which produces hot water in the Cascades industrial complex in Kingsey Falls. It marks a first in the pulp and paper sector.
- Gaz Métro and Transport Robert are collaborating to use liquefied natural gas (LNG) to replace diesel in heavy transportation and thereby reduce GHG emissions. The Route bleue comprises supply infrastructure established with the assistance of the Québec government.

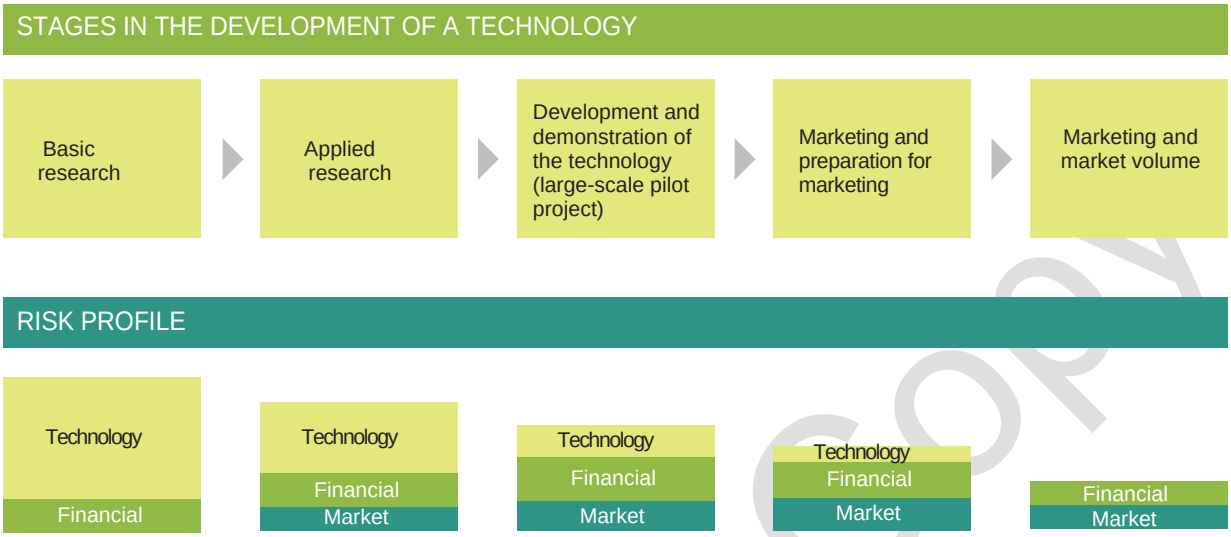
Numerous agencies and enterprises are active in the energy innovation chain (Figure 2.22) in Québec. For example:

- the Institut de recherche d'Hydro-Québec is carrying out innovative projects in electricity generation, transmission and storage, energy efficiency and renewable energies, in transportation electrification and in intelligent networks;
- the Centre des technologies du gaz naturel (CTGN) offers facilities and expertise in the realm of natural gas combustion, energy efficiency and renewable energies;
- consortia that assemble industries and research centres such as InnoVE in the realm of transportation electrification, and Prompt, in respect of the EcoloTICs, are focusing on different forms of energy efficiency;
- universities, CEGEP technology transfer centres and public research centres such as CanmetÉnergie, the Institut de recherche sur l'hydrogène, and the Institut national de la recherche scientifique, are also very active and are advancing innovation in buildings, transportation, agriculture, industry, and so on;
- industry associations (Ecotech, the Association québécoise pour la maîtrise de l'énergie) are promoting green technologies and energy-related innovation;
- 30-odd university research chairs are focusing on energy;
- the venture capital industry[38] is solidly established in Québec and is supporting the development and growth of innovative firms in the energy sector. In 2013 alone, venture capital investments in Québec in the clean energy technologies sector appear to have reached $573.27 million.[39]

[38] Venture capital is one specific means of funding used to support innovative new enterprises.
[39] MINISTÈRE DE L'ÉCONOMIE, DE L'INNOVATION ET DE L'EXPORTATION DU QUÉBEC (2014), *Bulletin Industrie du capital de risque* (2nd quarter) [online] [economie.gouv.qc.ca/objectifs/informer/capital-de-risque/page/bulletins-19547/?tx_igaffichagepages_pi1%5Bmode%5D = single&tx_igaffichagepages_pi1%5BbackPid%5D =78&tx_igaffichagepages_pi1%5BcurrentCat%5D = &tx_igaffichagepagespi1%5BparentPid%5D =11024&cHash= cd52bccfa2541ebf41666619a4238d8a] (consulted on December 10, 2014).

Figure 2.22

Illustration of the innovation chain[40]



Source: Ministère de l'Énergie et des Ressources naturelles.

There are numerous organizations such as SWITCH, the Alliance for a Green Economy in Québec, which are participating actively in social innovation in the realm of energy efficiency by facilitating linkage and experimentation that are mobilizing businesses and individuals. Accordingly, the Regroupement national des conseils régionaux de l'environnement (RNCRE) carried out the Par notre PROPRE énergie campaign, which mobilized socioeconomic agents throughout Québec to promote more efficient use of fossil energies. Other organizations are innovating with respect to awareness-raising, work organization and innovative services such as those offered by travel management centres, public bike-sharing services, and car-sharing.

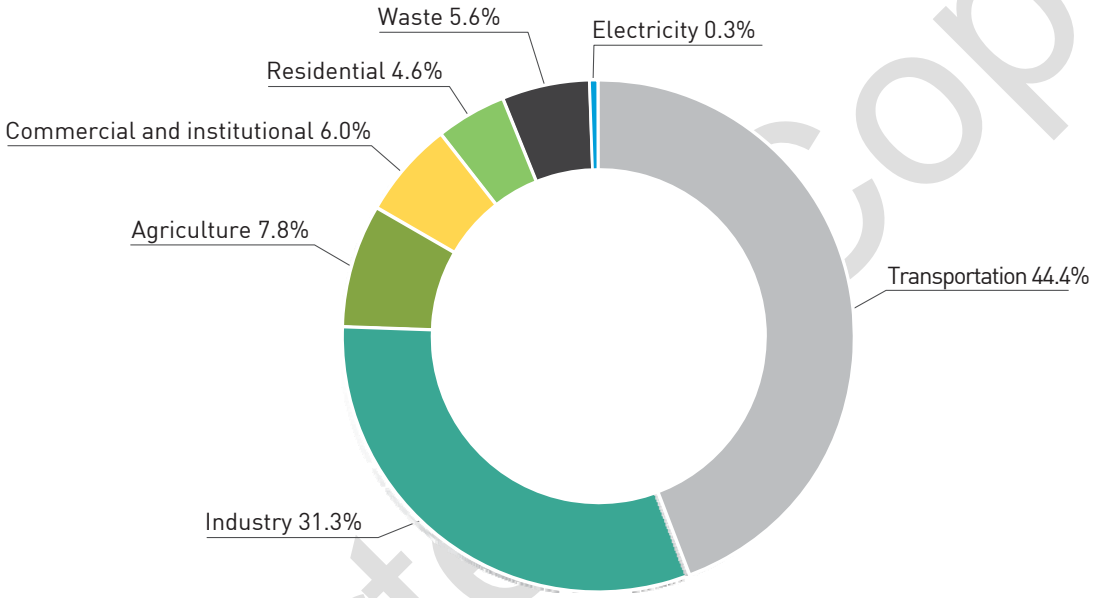
40 Based on TECHNOLOGIES DURABLES DU CANADA. "Des partenariats pour des résultats concrets" [online] [sdtc.ca/uploads/SDTC%20Presentations/SDTC_Corp_F_March%202014.pdf] (consulted on December 1, 2014).

DEVELOPMENTS IN RECENT YEARS

In 2011, Québec's total GHG emissions stood at 81.0 megatons of CO_2 equivalent, i.e.10.1 t per capita. They accounted for 11.5% of Canadian emissions, which stood at 701.0 megatons of CO_2 equivalent[41].

Figure 2.23

GHG emissions by sector in 2011



Source: Ministère du Développement durable, de l'Environnement et de la Lutte contre les changements climatiques.

The transportation sector ranks first and accounts for 44.4% of Québec's GHG emissions À(Figure 2.23). More than 76% of GHG emissions in the sector come from automobile, light truck and heavy truck transportation. Such emissions increased by 32.9% between 1990 and 2011[42], mainly because of growth in the vehicle fleet and an increase in the distances travelled.

[41] MINISTÈRE DU DÉVELOPPEMENT DURABLE, DE L'ENVIRONNEMENT ET DE LA LUTTE CONTRE LES CHANGEMENTS CLIMATIQUES (2014), Inventaire québécois des émissions de gaz à effet de serre en 2011 et leur évolution depuis 1990, Québec, 20 pages.
[42] *Idem*.

The industrial sector, which ranks second, produces 31.3% of Québec's GHG (Figure 2.23). Combustion and industrial processes[43] account for more than 99% of the emissions and are declining because of the modernization of industries and the discontinuance of business by some of them. Part of the reduction is attributable to the conversion from fuel oil to other types of energy such as biomass, natural gas and electricity. It has little relationship to overall energy consumption, which increased between 1992 and 2011.

The commercial and institutional sector, which accounts for 6.0% of Québec's GHG emissions (Figure 2.23), ranks fourth. However, GHG emissions in the sector increased by 15.1% between 1990 and 2011[44] because of higher energy consumption stemming from the increase in floor area.

The residential sector, which ranks fifth, accounts for 4.6% of Québec's emissions (Figure 2.23). The gradual withdrawal of fuel oil reduced GHG emissions in the residential sector by more than 44.6% in 2011 in relation to the 1990 level[45], despite growth in the housing inventory and the average living space.

The electricity generation sector ranks last, with 0.3% of GHG emissions (Figure 2.23) because of the place that hydroelectricity generation occupies in Québec.

[43] MINISTÈRE DU DÉVELOPPEMENT DURABLE, DE L'ENVIRONNEMENT ET DE LA LUTTE CONTRE LES CHANGEMENTS CLIMATIQUES (2014), *Inventaire québécois des émissions de gaz à effet de serre en 2011 et leur évolution depuis 1990,* Québec, 20 pages.
[44] *Idem*.
[45] *Idem*.

SECTION 3

OBSERVATIONS AND CHALLENGES FOR QUÉBEC

Various observations and general and sectorial challenges apply in Québec.

OVERALL FINDINGS

- The most recent orientations and priorities under the *Plan d'ensemble en efficacité et innovation énergétiques* date from 2007, which limits the ability to act of the MERN and the Régie de l'énergie as regards energy distributors.
- Current governance gives rise to numerous measures adopted by governments and energy distributors in the entire array of industry sectors and in innovation. It may be difficult for clienteles to make sense of measures and when an applicant wishes to resort to more than one program in respect of a given project, he must undertake numerous steps.
- Generally speaking, the enhancement of energy efficiency is hampered by resistance to change and because consumers, i.e. businesses, households, institutions, and so on, do not always grasp the interest of investing in energy efficiency.
- In most industry segments, the easiest energy efficiency gains have been achieved. The potential for greater energy efficiency is enormous but impending steps will demand a more integrated approach and the introduction of new ways of intervening.
- The regulatory approach is inexpensive and highly structuring. On the other hand, it demands advanced expertise and must hinge on long-term objectives and enjoy extensive political support. The adoption or amendment of regulations must round out a comprehensive approach to transform markets that relies on initiatives such as the training of stakeholders, pilot projets, and so on.
- Sectoral government policies that significantly affect efficiency and net energy consumption, in particular in the realm of transportation, urban planning, taxation and economic development, are sometimes elaborated without properly considering energy-related challenges.
- Since January 1, 2015, fuel distributors have been subject to a GHG emission cap-and-trade system, which affects energy costs and provides an additional incentive to implement energy efficiency measures.

SECTORAL FINDINGS

THE INDUSTRIAL SECTOR

- The industrial sector is characterized by:
  - high sensitivity to economic vagaries and cost variances, including energy costs;
  - an energy portfolio that varies in light of current prices and the specific nature of production;
  - a limited investment portfolio, which pits investments in energy efficiency against the other strategic priorities of companies.
- The energy that different stages in manufacturing processes requires can account for a significant proportion of production costs and directly affect business profitability. Energy efficiency allows energy-intensive industries to enhance their competitiveness and improve their profit margins.
- Major energy-intensive industries have, in recent years, made noteworthy efforts as regards energy efficiency. However, it is possible to better manage energy through the designing of new or enhanced processes, a better choice of equipment, and advanced training for operators.
- Since 2013, 76 businesses have been subject to the GHG emission cap-and-trade system. They must reduce their GHG emissions either by purchasing emission allowances or by investing in new technologies. Because Québec has already invested heavily in the least expensive energy efficiency measures, the additional gains will be more costly. It could cost certain businesses less to buy carbon credits abroad rather than invest in the enhancement of their own energy efficiency.

THE TRANSPORTATION SECTOR

- Road passenger and freight transportation is a priority focal area given its sustained growth and relative weight in Québec's energy profile.
- Passenger and freight transportation needs are rising because of:
- population growth;
- typical land-use planning in North America, which favours low-density urban sprawl;
- the rapid development of e-commerce, which is creating higher demand for rapid home delivery services;
- just-in-time delivery, i.e. the delivery in a timely manner of small quantities or perishable foods, which has become a standard practice in the commercial sector.

- The technological and economic potential[46] of reduced consumption of oil products in the road transport sector is substantial. It is estimated at 113 PJ by 2021, i.e. the equivalent of 27% of consumption in 2011[47].
- Technological changes are occurring gradually in the road transport sector: the technological development of light vehicles is advancing as they are replaced (their useful life exceeds 10 years) and infrastructure to supply alternative fuels to gasoline or diesel are to be adopted.
- No socioeconomic trend suggests a rapid, durable change in the rate of automobile ownership or automobile travel patterns.
- Numerous road trips engender different problems such as traffic congestion, pollution, the degradation of a territory's resources, the loss of natural spaces, and so on, and costly energy consumption.
- Imports of fossil fuels appreciably affects Québec's trade balance.
- Its clean, abundant electricity offers Québec an undeniable asset to promote transportation electrification.
- To enhance energy efficiency in the transportation sector poses challenges from the standpoint of knowledge acquisition, a reduction in the place of solo car use and land-use planning methods.

[46] Technological and economic potential is the total gains achieved if all technically feasible, economically viable energy efficiency measures fully penetrate their respective markets.

[47] GENIVAR (2013), *Étude du potentiel technico-économique de réduction de la consommation de produits pétroliers du secteur du transport au Québec*, report submitted by Génivar to the BEIE, Québec, 136 pages and appendices.

THE RESIDENTIAL SECTOR

- Residential energy efficiency programs are those of which the public is most aware. Program measures can have an impact over 20, 30 or 40 years or even longer and allow for recurring, substantial energy savings and gains.
- New houses are more efficient but are also bigger and households are using greater numbers of appliances.
- The residential sector is contributing less and less to GHG emissions but remains important in respect of Québec's energy balance.
- The residential sector's impact on peak electric power demand requires the development of technological and behavioural solutions.
- Since 2010, the government has reduced the scope of its promotional campaigns to encourage Quebecers to save energy and to publicize residential programs. This has led to more limited public knowledge of the steps to follow and growing difficulty in encouraging the public to adhere to the programs[48].
- Initiatives aimed at reducing the environmental footprint of buildings are rising. This situation provides an opportunity to consolidate energy efficiency and GHG reduction initiatives in the green construction industry.

THE COMMERCIAL AND INSTITUTIONAL SECTOR

- Energy efficiency in the commercial and institutional sector is less extensive than in the other sectors. Solar energy and geothermal energy are underutilized and LEED buildings are for the time being the exception rather than the rule.
- It is still difficult to ascertain the energy bills of public buildings and to measure the attainment of the targets stipulated in the Québec Energy Strategy.
- Energy monitoring, the energy rating of buildings and energy management are under-used areas for intervention. The limited priority accorded such practices and a lack of information and manpower are impeding these promising initiatives.
- Certain energy efficiency orientations in the public sector, e.g. the procurement policy and energy targets, have a limited impact because of a lack of coordination and synergy.
- Energy efficiency regulations governing commercial and institutional buildings must be reviewed because of changing knowledge.
- Long-term trends in respect of increasingly green buildings, including the construction of net-zero energy consumption buildings that rely on renewable energies, will demand the acquisition of knowledge, the development of expertise, and changes in professional practices.

[48] INFRAS Inc. (2014), *Étude sur les valeurs des Québécoises et Québécois et l'évolution de leurs comportements en matière d'efficacité énergétique*, report submitted to the Bureau de l'efficacité et de l'innovation énergétiques, Québec, 66 pages.

INNOVATION

- Québec can rely on solid expertise through high-quality research and educational establishments, access to qualified workers, and a good network of specialized consultants
- A number of venture capital funds are available in Québec.
- Through financial and fiscal measures, the Québec government has supported several energy innovation projects that are enhancing Québec's profile the world over.
- The funds earmarked for energy innovation in the transportation sector are equivalent to 4% of public expenditures in innovation related to energy efficiency. Apart from the electric vehicle option, which is subject to a government roadmap, relatively few public resources are allocated to transportation-related innovation despite the major challenges that GHG emission reduction in the sector pose.
- Energy innovation can be costly, particularly during the demonstration phase where spending reaches millions of dollars and high technological risks impede private investment. Without government intervention, few new energy technologies can emerge.
- The positive impact of social innovation on the requisite behavioural changes to convert technological innovations into energy efficiency gains is often underestimated.

GENERAL CHALLENGES

- The enhancement of energy efficiency in all areas of activity, in particular through recourse to renewable energy sources and the promotion of the rapid integration of technological changes.
- The availability and stability of skilled human resources and financial resources to support energy efficiency and innovation.
- The coherence and complementarity of the measures implemented by different takeholders and the coordination of private and public interveners.
- Changes in orientations in the realm of energy efficiency and innovation and the adoption of a new comprehensive plan.
- The attainment of Québec's GHG reduction objectives for 2020.
- The long-term changes in the behaviour of individuals and organizations.
- The objectivity and understanding of information concerning energy efficiency and the measures offered and ease of public access to such information.
- The government's exemplariness as regards energy efficiency.

SECTORAL CHALLENGES

THE INDUSTRIAL SECTOR

- The contribution that energy efficiency makes to growth and corporate competitiveness in the industrial sector.
- The need for businesses to obtain a quick return on their energy efficiency investments.
- The optimization of operations and training for operators in connection with energy efficiency.
- The consequences of the GHG emission cap-and-trade system on the competitiveness of Québec businesses.
- The impact of the change in Québec's industrial structure on energy consumption in the sector.

THE TRANSPORTATION SECTOR

- The development of living environments and land-use planning that promote efficient travel.
- The optimization of the movement of individuals and goods that promotes the free movement of persons and smooth travel and enhances corporate competitiveness.
- The gradual replacement of oil products by energy sources with lower GHG emissions.
- The ability to supply alternatives to gasoline and diesel.

THE RESIDENTIAL SECTOR

- The planning of residential developments in an energy efficiency perspective.
- Recognition of environmental facets such as the life cycle of materials in forthcoming initiatives.
- Proper matching of the cycle of regulatory revision and changing knowledge and practices.

THE COMMERCIAL AND INSTITUTIONAL SECTOR

- The maintenance and development of expertise and knowledge in the realm of energy efficiency in the building sciences.
- The integration of best practices and innovations in the sector overall.
- Knowledge of the energy consumption of buildings.
- The training and availability of interveners.
- Changes in regulations.

INNOVATION

- Ongoing government support throughout the innovation chain to ensure that technologies emerge and contribute to Québec's energy objectives.
- Innovation in respect of energy efficiency innovation in the transportation sector bearing in mind its importance in Québec's GHG emissions.

SECTION 4

QUESTIONS

Several questions must be answered to enable Québec to enhance energy efficiency and innovation in all areas of activity.

GENERAL QUESTIONS

1. Which are the best foreign practices from which Québec could draw inspiration?
2. What priorities[49] should the government set with respect to energy efficiency?
3. What measures might be adopted to promote energy efficiency in each area of activity?
4. What means might be used to ensure better coordination of interveners in the realm of energy efficiency and the complementarity of their initiatives?
5. What priority initiatives should be adopted concerning knowledge acquisition and the transfer of expertise?
6. Should governments legislate to make compulsory certain practices such as the inspection and energy rating of buildings or billing consumers according to peak demand periods?
7. Through which measures could the Québec government fulfil its duty to set an example?
8. Should Québec consider issuing Green Bonds, as Ontario does, or other innovative financing mechanisms?

[49] Examples: decentralized energy production and storage; biomass and waste energy conversion; electrified transportation and next-generation transportation; off-the-grid power systems; technologies and processes that promote energy efficiency in buildings, industrial processes and food processing; the information and communications technologies, and so on.

QUESTIONS SPECIFIC TO THE SECTORS

THE INDUSTRIAL SECTOR

A. How might the government ensure that initiatives related to energy efficiency also contribute to changes in Québec's industrial structure?

B. In the future, the carbon market will coexist with energy efficiency programs. How might businesses benefit from this situation?

C. Should the government demand cross-compliance[50] as regards energy efficiency and innovation when new plants are established or financial assistance is granted to support the establishment?

THE TRANSPORTATION SECTOR

D. What are the key trends in the introduction of alternatives to gasoline and diesel in the road passenger and freight transport sector? What means should Québec adopt to support such trends?

E. Should certain less polluting hydrocarbons such as natural gas be used as a transition energy? For what purposes?

F. What means might be promoted to foster intermodality in the transportation sector and ensure energy efficiency gains?

G. What measures might promote ecomobility (the energy efficiency of transportation) in new and established neighbourhoods?

H. Should governments legislate to make compulsory certain practices such as energy inspections of used vehicles?

I. Should Québec draw inspiration from England and certain Scandinavian countries and adopt regulations that allow for the installation of charging stations along streets in high-density residential districts and in rental and condominium buildings?

J. What measures would be likely to have the greatest impact on the behaviour of motorists and businesses and foster the efficient, economical use of energy in the transportation sector?

K. How can we ensure that the supply by automobile manufacturers of electric vehicles satisfies demand in Québec?

L. How might Québec contribute to research, development and demonstration in respect of autonomous vehicles?

[50] Cross-compliance consists in subordinating to environmental criteria (or the observation of environmental demands), access to government financial support programs. MDDELCC, *Écoconditionnalité : le développement et la mise en œuvre d'une approche au Québec* [online] [mddelcc.gouv.qc.ca/milieu_agri/agricole/publi/ecoconditionnalite.htm#definition] (consulted on November 28, 2014).

THE RESIDENTIAL SECTOR

M. What means might be adopted to facilitate understanding of the information intended for households and their access to such information?

N. What means might be adopted to promote participation by businesses, municipalities and households in the government's or energy distributors' programs?

O. Which measures would be most likely to alter the behaviour of households?

THE COMMERCIAL AND INSTITUTIONAL SECTOR

P. Which measures might be adopted to promote changes in the practices of stakeholders in the sector?

Q. How might energy audits contribute to energy efficiency?

INNOVATION

R. What facets of the regulations should be revised or enhanced in order to promote the adoption of new energy technologies in Québec?

S. Which mechanisms might be developed to increase financing for energy efficiency innovation?

T. What roles should governments and the private sector play in financing innovation?

U. Which innovations should be encouraged in the transportation sector?

V. How might Québec further promote partnerships in innovation with other provinces and countries?

CONCLUSION

Like a number of States in the world, Québec is facing energy-related challenges. To satisfy such challenges, energy efficiency should be a focal point of the energy policy. On the whole, energy efficiency means making better use of less of the energy available. Reducing waste, developing and using appropriate technologies, regulating certain practices, and heightening awareness among consumers are all initiatives that make it possible to use less energy and reduce the energy bills of households and businesses.

Energy efficiency also goes further than the reduction of energy consumption alone, since it limits needs in new energy production and transmission infrastructure and substantially reduces GHG emissions. Against a backdrop of uncertainty over energy prices, the fight against climate change and growing social demands concerning any new use of natural resources, energy efficiency might, in Québec and elsewhere in the world, become the key source of energy in the 21st century.

Several initiatives have been carried out in recent years in Québec to enhance energy efficiency in all areas of activity, i.e. financial assistance programs, information and awareness-raising campaigns aimed at consumers and businesses, the regulation of practices in the construction industry, and so on. The measures have engendered substantial energy savings. Accordingly, the energy savings that are easiest to generate have, for the most part, been achieved. Future energy savings will perhaps demand a bigger commitment but the untapped potential is enormous, in particular in the industrial and transportation sectors.

However, numerous obstacles remain to energy efficiency and innovation:

- Businesses and consumers are barely informed of the financial and other benefits of energy efficiency or the technological possibilities available to them. Accordingly, they are reluctant to invest in energy efficiency. A behavioural change demands constant awareness-building initiatives.
- Many stakeholders are promoting energy efficiency but their initiatives are insufficiently coordinated, which makes the measures now on offer less attractive.
- Most of the economic players are resistant to change, which is thus occurring slowly. The transformation of consumption habits also demands sustained effort.
- Energy innovation is costly, particularly during the demonstration phase where spending reaches millions of dollars and high technological risks impede private investment. Few new energy technologies can emerge without government support since businesses are contending with financial challenges that exceed their means.

New strategies and measures must be developed and applied. The vitality and ingenuity of all stakeholders in the innovation chain must be supported and profitably employed. Consumers and businesses must get involved and the government and public bodies must display exemplariness in their initiatives, the management of their buildings, the use of their vehicles, and in procurement.

Participation by individuals and all economic players is essential to make energy efficiency an effective, innovative, open-ended option that creates wealth for Québec. In short, a genuine energy efficiency culture must emerge. Accordingly, the following question arises within the framework of the elaboration of the *2016-2025 Energy Policy*:

> *In the current context in Québec and bearing in mind the social, environmental and economic importance of energy efficiency and the array of spinoff that it engenders, what oversight, measures and financial support must the government adopt to enable Quebecers to benefit to the utmost from the advantages that it offers?*

APPENDIX 1 – THE NUMEROUS BENEFITS OF ENERGY EFFICIENCY[51]

ECONOMIC BENEFITS

Energy efficiency offers obvious economic benefits because of the simple reduction in energy costs. A number of energy efficiency measures are being funded through such avoided costs.

Energy efficiency can enhance corporate competitiveness and possibly affect the prices that consumers pay. Industries that improve their energy efficiency increase their output and reduce their operating and maintenance costs. These factors are increasing the value of businesses.

Investment in energy efficiency can also engender indirect benefits such as job creation and an improved trade balance. In Québec, reduced energy consumption, especially of fossil fuels, can

The rapid development of energy efficiency has also led to the development of ecoenergetic services firms, which offer turnkey services to implement an energy management strategy that hinges on a performance guarantee and a method of reimbursement of investments based on the savings generated.

THE WELL-BEING OF POPULATIONS

Society usually fully accepts the application of energy efficiency measures. Energy savings and, consequently, natural resource conservation, reflect the values and culture of individuals and communities.

In addition to environmental and economic benefits, energy efficiency measures can significantly affect the well-being of populations. For example, the enhancement of energy efficiency in all sectors can directly affect the concentration of airborne pollutants, the reduction of which provides important benefits for human health.

Air temperature, humidity and air quality in dwellings are key factors of health and well-being. The efficiency measures proposed to insulate and replace inefficient heating systems directly affect not only the occupants' budgets but also their health and well-being. Such considerations are important for low-income households and are also helping to make them less vulnerable to energy price increases. Energy efficiency is also becoming a social equity measure.

[51] IEA (2014), *Capturing the Multiple Benefits of Energy Efficiency, Paris*, 232 pages.

ENVIRONMENTAL FOOTPRINT

Global warming is unquestionably the foremost environmental challenge the world over. In Québec, nearly 72% of GHG emissions come from the energy sector[52]. More than half of such emissions (62%) stem from the use of fuels in the transportation sector.

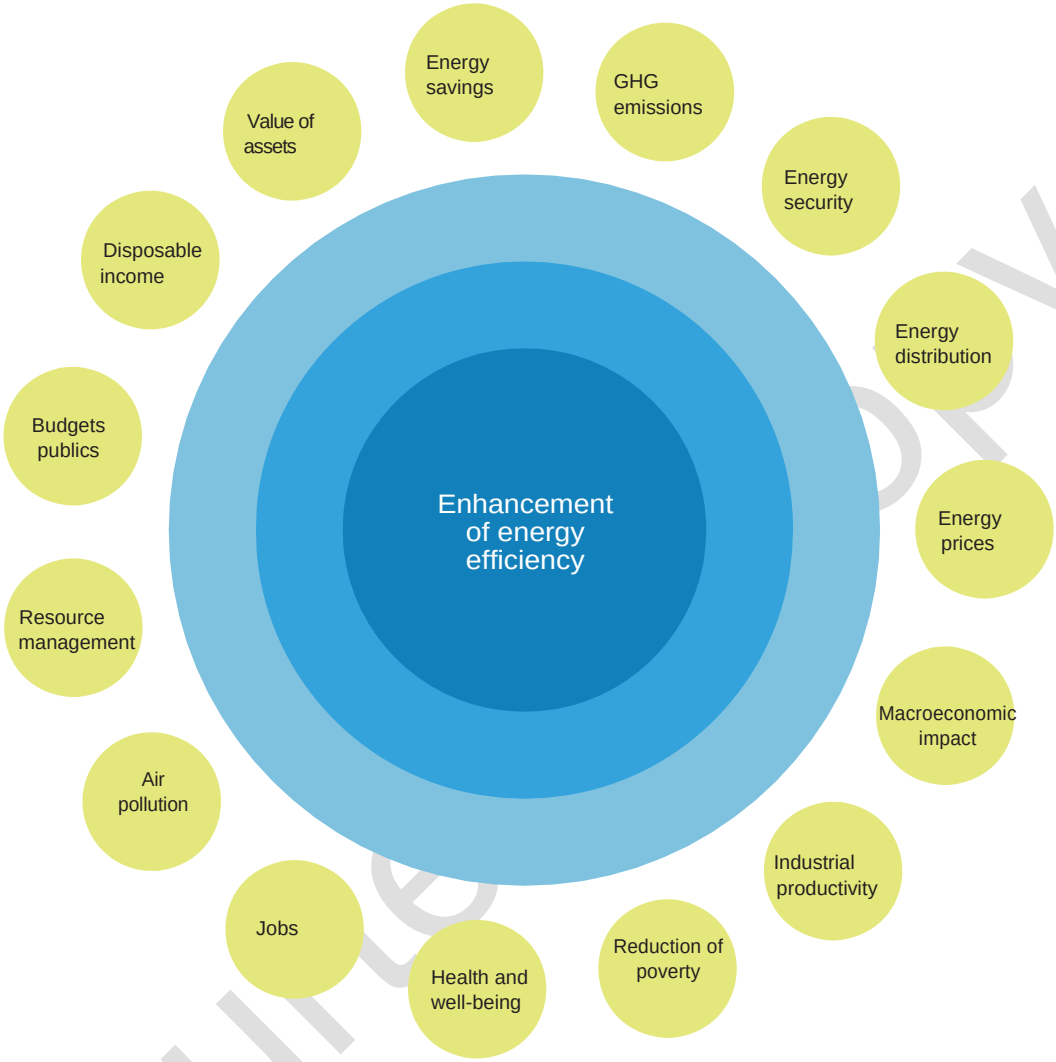
The International Energy Agency has elaborated various scenarios to evaluate energy demand by 2050. According to the IEA, the enhancement of energy efficiency is the leading factor in the GHG emission reduction: depending on the scenario adopted, energy efficiency could contribute between 30% and 50% of the total reduction in GHG emissions[53]. Energy efficiency must be given priority, since it offers the best potential for the reduction of CO_2 emissions[54].

Energy efficiency also reduces the use of non-renewable natural resources. The repercussions of prospecting, mining, transporting and distributing energy resources is also minimized. Such activities usually require heavy infrastructure, substantial investments and, in the case of fossil fuels, can have an appreciable impact on the health and well-being of populations.

[52] MDDELCC (2014), *Inventaire québécois des émissions de gaz à effet de serre en 2011 et leur évolution depuis 1990*, Québec, 20 pages.
[53] IEA (2006), *Energy Technology Perspectives [online] [iea.org/publications/freepublications/publication/etp2006.pdf]* (consulted on December 10, 2014).
[54] IEA (2010), *Energy Technology Perspectives [online] [iea.org/publications/freepublications/publication/etp2006.pdf]* (consulted on November 27, 2014).

Figure A.1

Advantages of energy efficiency[55]



[55] INTERNATIONAL ENERGY AGENCY (2014), *About the Multiple Benefits of Energy Efficiency.* [online] [iea.org/topics/energyefficiency/energyefficiencyiea/multiplebenefitsofenergyefficiency] (consulted on January 9, 205).

APPENDIX 2 – THE BEIE'S ENERGY EFFICIENCY AND INNOVATION PROGRAMS AND MEASURES

PROGRAMS AND MEASURES	DESCRIPTION
Novoclimat 2.0 — Home section	▪ The program applies to new high energy performance homes for single-family dwellings and manufactured homes. ▪ Training, accreditation, inspection, certification and financial assistance. ▪ The program came into force on October 1, 2013 to replace ▪ Novoclimat — Single-family dwelling section.
Novoclimat 2.0 — Small multiple-unit buildings section	▪ The program applies to new high energy performance homes for multiple-unit buildings and condominiums of three or fewer storeys or 600 m^2 and less. ▪ Training, accreditation, inspection, certification and financial assistance. ▪ The program came into force on October 1, 2013 to strengthen the technical requirements of part of the Novoclimat program — Home section.
Novoclimat — Big multiple-unit buildings section	▪ The program applies to new high energy performance homes multiple-unit buildings and condominiums of three or fewer storeys or 600 m^2 and less. ▪ Training, accreditation, inspection, certification and financial assistance.
Rénoclimat	▪ The ecoenergetic renovation program covers the owners of single-family dwellings, semidetached homes or row houses, duplexes and triplexes. ▪ In December 2012, the normative framework was revised to make eligible buildings comprising four to 20 dwelling units.
Heating with Green Power	▪ The program covers the replacement of fossil-fueled systems with systems that use electricity or other renewable sources of energy.
Éconologis	▪ The program is intended to heighten awareness in low-income households of energy efficiency and is offered free of charge.
Écomobile (pilot projets)	▪ Accreditation of organizations that offer driving instruction. ▪ Testing of fuel-efficient driving training for light vehicles.
Overhauling of the mechanical systems of buildings	▪ The program has been jointly developed by Hydro-Québec, Gaz Métro and the BEIE to offer assistance to optimize the operating, among other things, of heating, ventilation and air-conditioning systems in the buildings of the clientele in the business sector. ▪ Since November 11, 2013, Hydro-Québec has no longer accepted new projects within the framework of the program.

PROGRAMS AND MEASURES	DESCRIPTION
Regulation of appliances	▪ Changes in the Regulation respecting the energy efficiency of electrical or hydrocarbon-fuelled appliances. ▪ Determination of the energy efficiency requirements applicable to appliances.
Regulation of buildings	▪ Amendment of the Québec Construction Code to enhance the energy performance of new buildings and dwellings built in Québec. ▪ Collaboration between the BEIE and the Régie du bâtiment du Québec, which administers the Code. ▪ It came into force on August 30, 2012 for the residential sector. An analysis is under way for the commercial, institutional and industrial building sectors.
ÉcoPerformance	▪ The program seeks to reduce GHG emissions and energy consumption by businesses by funding projects or measures related to energy production and consumption and the improvement of processes. ▪ It results from the merging of the PRCML, the PASM, the PESO, the OPTER and the PAIMEB.
Residual Forest Biomass Program	▪ The program seeks to reduce GHG emissions and fossil fuel consumption by funding energy conversion projects involving residual forest biomass. ▪ It results from the merging of the PRCML and the PABC.
Electric vehicles — Drive Electric Program (purchase rebate)	▪ The program offers a purchase/lease rebate for electric or hybrid vehicles. ▪ Financial support to install a home charging station.
Electric vehicles — Major project (Projet 400 VE)	▪ The measure seeks to encourage the acquisition of electric vehicles by the owners of private, municipal and Québec government fleets. ▪ It ended on December 31, 2012.
Electric vehicles — Awareness-raising and promotion	▪ A measure aimed at informing the public about electric vehicles and promoting them.
Electric vehicles — Other measures	▪ Electric vehicle charging stations along highway corridors ▪ Electric taxis ▪ C3E: Centre d'excellence en efficacité énergétique
Plugged In at Work	▪ The program covers the acquisition and installation of a charging station in the workplace.
Technoclimat	▪ The program seeks to reduce GHG emissions and encourage the development of new technologies or innovative processes in the realms of energy efficiency and emerging energy sources.

APPENDIX 3 – CONVERSION TABLES AND UNITS OF MEASUREMENT

Energy equivalent to one tonne of oil equivalent (toe)	
Gigajoule (GJ)	41.85
Kilowatt-hour (kWh)	11 630

GHG emissions equivalent to those from one toe (tonne of CO_2 equivalent/toe)	
Natural gas	2.10
Propane	2.53
Gasoline	2.86
Light fuel oil	2.95
Diesel	3.02
Oil	3.10
Heavy fuel oil	3.10

Volume equivalent to 1 tonne of oil equivalent (toe)	
Oil	1 1161 m^3 7.3 barrels
Natural gas	1 100 m^3
Gasoline	1.20 m^3
Diesel	1.09 m^3
Light fuel oil	1.09 m^3
Heavy fuel oil	1.03 m^3
Propane	1.66 m^3

Prefixes of decimal multiples		
Peta (P)	10^{15}	quadrillion
Tera (T)	10^{12}	trillion
Giga (G)	10^9	billion
Mega (M)	10^6	million
kilo (k)	10^3	thousand

Units of measurement	
GJ	Gigajoule
Ktoe	Kilotonne of oil equivalent
Km	Kilometre
kWh	Kilowatt-hour
l	Litre
m^2	Square metre
Mm^3	Million cubic metres
Mtoe	Million tonnes of oil equivalent
PJ	Petajoule
t	Tonne
toe	Tonne of oil equivalent
tWh	Terawatt-hour

APPENDIX 4 – REFERENCES

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