Canada's Energy Profile in 40 Questions

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Foreword

As one of the information capsules in this booklet points out, the energy sector alone represents almost 10% of Canada's GDP and provides jobs for hundreds of thousands of Canadians. Energy production is not only an intrinsically important sector; it also has impacts on all other economic activities, on the environment, and on our quality of life.

It is therefore not surprising that over the past few years, these questions have taken on a growing importance in our lives. Not a day goes by without hearing about some debate or controversy related to energy: new pipeline or hydroelectric dam construction projects, subsidies for wind turbines, criticisms of the oil sands, closings of nuclear power plants, energy efficiency programs, etc.

The average person will often have trouble making sense of these debates, which sometimes require technical knowledge. And as is the case in every other area of public life, those who are less well-informed are more easily taken in by myths, by the distortion of facts and by the misinformation that circulates regarding these subjects.

That's why we at the Montreal Economic Institute have taken it upon ourselves to answer, in this booklet, 40 basic questions people might have about Canada's energy sector. As you will see, the answers are relatively short, factual, easy to understand, and supported by official sources. They cover as many subjects as possible, in addition to offering information on the energy situation of the various parts of the country.

This booklet is part of a larger research and educational initiative on energy questions taken up by the MEI a few years ago, which has aroused a lot of interest and received substantial media coverage.

Canada is, on a global scale, an energy superpower. Its future prosperity and dynamism will depend in large part on our ability to develop these abundant resources while respecting the environment and affected local communities. The better informed we are, the more we will be able to find this balance and make the right decisions.

Enjoy!

Michel Kelly-Gagnon
President, Montreal Economic Institute (iedm.org)

Canada's Energy Profile in 40 Questions

Q1

How large a share do different energy sources have in global production and consumption?

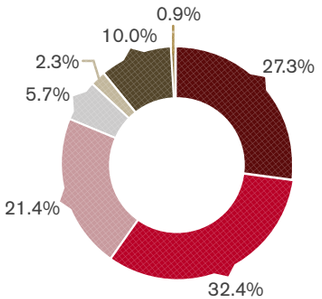
Until the start of the 19th century, human beings depended on human and animal muscular strength, on the combustion of biomass (wood, manure, etc.) and, to a lesser extent, on wind power (windmills and sailboats) and hydraulic power (watermills) to produce energy. Subsequently, they learned how to exploit fossil fuels like coal and oil.

Today, multiple energy sources exist. On a human time scale, some are renewable, while others are not. Renewable energy sources are those whose supply is essentially unlimited, like the sun, the wind, biomass and water. Non-renewable energy sources are those that we find in the ground and that are available in fixed quantities, like natural gas, oil, coal and uranium.

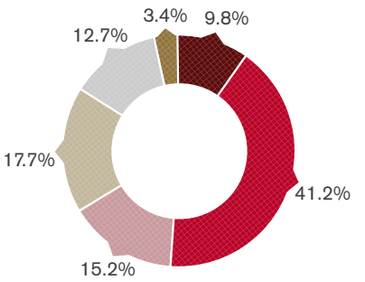
The expression “primary energy” refers to the quantity of energy available in nature that is transformed, stored and transported to end users. However, due to losses of energy at each of these stages, the quantity of “final energy” available for consumption is always less than the quantity of primary energy.

In 2010, the global supply of primary energy was 12,717 Mtoe (millions of tonnes of oil equivalent). Of this amount, 81% was from fossil fuels (oil, natural gas and coal). Global consumption of final energy represented 8,677 Mtoe. Fossil fuels accounted for 66% of this total.

Global supply of primary energy (12,717 Mtoe)



Global consumption of final energy (8,677 Mtoe)



Source: International Energy Agency, ***Key World Energy Statistics 2012***, 2012, pp. 6 and 28.

Q2

What place does Canada occupy globally when it comes to the production of various forms of energy?

On the international level, Canada is a small economy. Its GDP represents barely 1.76% of global production. Nonetheless, it is ranked among the main producers of energy, in 6th place with 3.1% of global production, behind only China, the United States, Russia, Saudi Arabia and India.

Thanks to the diversity of its natural resources, Canada succeeds in positioning itself as a leader in the production of several forms of energy:

Oil: In 2011, with 169 megatonnes (Mt) of crude oil, or 4.2% of global production, Canada was the 6th largest producer of black gold in the world, behind Saudi Arabia, Russia, the United States, Iran and China. The same year, Canada was also 8th among producers of petroleum products with 2.6% of global production.

Natural gas: In 2011, Canada was 3rd among producers of natural gas, just behind Russia and the United States. The country produced 160 billion cubic metres (bcm) of natural gas, 4.7% of global production. It was also 4th among natural gas exporters.

Hydroelectricity: In 2010, with 352 TWh, 10% of global production, Canada was 3rd among hydroelectricity producers, and 4th among exporters.

Nuclear power: In 2010, with 91 TWh, 3.3% of global production, Canada was ranked 7th among producers of nuclear power, and 8th among net exporters.

Form of energy	Ranking	Percentage of global production
Crude oil	6th	4.2%
Petroleum products	8th	2.6%
Natural gas	3rd	4.7%
Hydroelectricity	3rd	10.0%
Nuclear power	7th	3.3%
All forms of energy	6th	3.1%

Source: International Energy Agency, ***Key World Energy Statistics 2012***, 2012.

Q3

What is the forecast for the evolution of global energy demand?

The International Energy Agency has developed three scenarios to predict the future of global energy demand based on the governmental policies that are adopted:

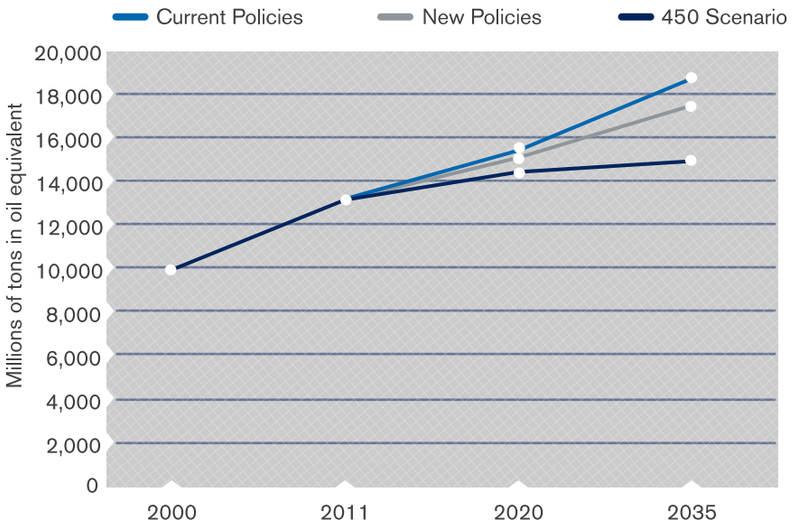
- The “Current Policies” (CP) scenario takes into account initiatives already in place or planned, but assumes no additional measures for reducing greenhouse gas emissions.
- The “New Policies” (NP) scenario includes all of the measures of the CP scenario, to which are added a series of supplementary actions.
- The “450” scenario envisions the complete transformation of the energy sector with the goal of reducing the concentration of greenhouse gases in the atmosphere to 450 parts per million. In this scenario, the probability of limiting global warming to 2°C above the preindustrial norm would be 50%.

As shown in the graph, the global demand for energy will increase from now until 2035 in all three scenarios due to economic and demographic growth.

The share of fossil fuels (oil, gas and coal) will fall from 82% in 2011 to 80% in 2035 in the CP scenario, to 76% in the NP scenario or to 64% in the 450 scenario. This reduction in the share of fossil fuels is basically due to decreasing consumption of coal and oil.

On the other hand, natural gas’s share will increase slightly, from 21% of the global demand for energy in 2011 to 23% in 2035 in the CP scenario, to 24% in the NP scenario or to 23% in the 450 scenario.

Global energy demand forecasts
(Until 2035)



Source: International Energy Agency, ***World Energy Outlook 2013,*** November 2013, p. 58.

Q4

What is the forecast for Canadian energy demand?

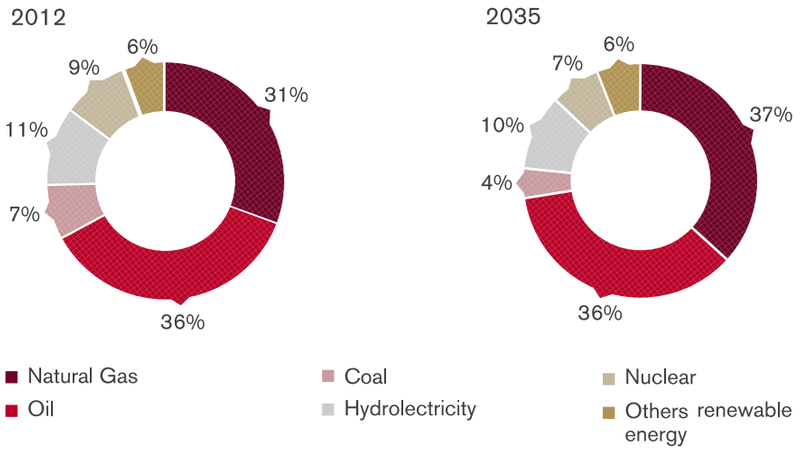
In November 2013, the National Energy Board (NEB), an independent federal regulatory agency, published a detailed study on the future of energy in Canada. The document presents projections based on a Reference Case representing the "most likely" situation taking into account new programs and standards either in effect or announced, as well as two alternate scenarios.

According to the NEB's projections, the demand for energy in Canada will continue to increase in all of the scenarios. In the Reference Case, demand will rise from 10,704 petajoules (PJ) in 2012 to 13,655 PJ in 2035, an increase of 28%. If energy prices are higher than in the Reference Case, the increase will be just 21%, whereas it will be 30% if prices are lower. This increase is the result of greater demand from all sectors, but especially from the industrial sector.

According to the Reference Case, demand for coal and nuclear energy will fall between now and 2035. However, an increase of 18% is expected for electricity, of 47% for natural gas, of 22% for oil, and of 24% for biofuels and other forms of energy.

The proportions of each energy source in the Canadian energy basket will not vary much, however, between now and 2035, again according to the NEB. In 2012, fossil fuels (oil, coal and natural gas) represented 74% of energy demanded. In 2035, this figure will have risen slightly to 77% of national demand.

Canadian energy demand



Source: National Energy Board, ***Canada's Energy Future 2013: Energy Supply and Demand Projections to 2035***, Government of Canada, November 2013.

05

Where does the energy sector stand in the Canadian economy?

In addition to helping keep Canadians comfortable, energy production provides major economic benefits. The oil and gas industry contributes more than any other to the Canadian economy.

Production: In 2013, the energy sector accounted for 9.5% of Canadian GDP, a proportion that has varied only slightly since 2007. The hydrocarbon industry alone constitutes 5.8% of GDP, more than the educational services or the retail trade sector.

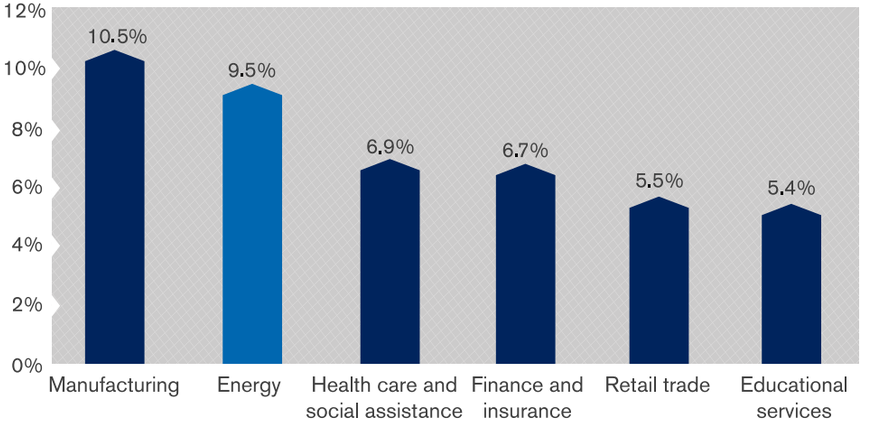
Employment: In 2012, the energy sector provided jobs to 335,000 people, or 1.9% of total employment in Canada. The oil and gas sector alone accounted for 186,635 of these workers in 2011, or more than half.

Compensation: Workers in the oil and gas extraction sector were those who received the highest average weekly compensation in 2012, at $2,298.87. This is 2.6 times the average weekly compensation of Canadian workers.

Exports: At more than $105 billion, energy products were Canada's biggest export, accounting for 22.7% of total merchandise exports in 2012. More than 93% of energy exports consisted of oil, natural gas and refined oil products, compared to 1.8% for electricity.

Government revenues: The oil and gas industry paid $18 billion in taxes and royalties in 2012.

Share of some industries in Canada's GDP (2013)



Sources: Statistics Canada, Table 379-0031, Gross domestic product at basic prices. Natural Resources Canada, ***Energy Markets Fact Book 2013-2014***, page 4. Petroleum Human Resources Council of Canada, "Canada's Oil and Gas Labour Market Outlook to 2015," Spring 2012. Statistics Canada, Table 281-0027, Average weekly earnings, by type of employee, for selected industries. Statistics Canada, Table 228-0059, Importations et exportations de marchandises. Canadian Association of Petroleum Producers, Basic Statistics, 2012.

Q6

Is Canada suffering from Dutch disease?

The Dutch disease is an economic theory which dates back to the 1970s. At that time, the Netherlands began mining natural gas fields off their coast. This is believed to have brought an appreciation of their currency and a decline of manufacturing employment, this sector being less competitive in the foreign markets.

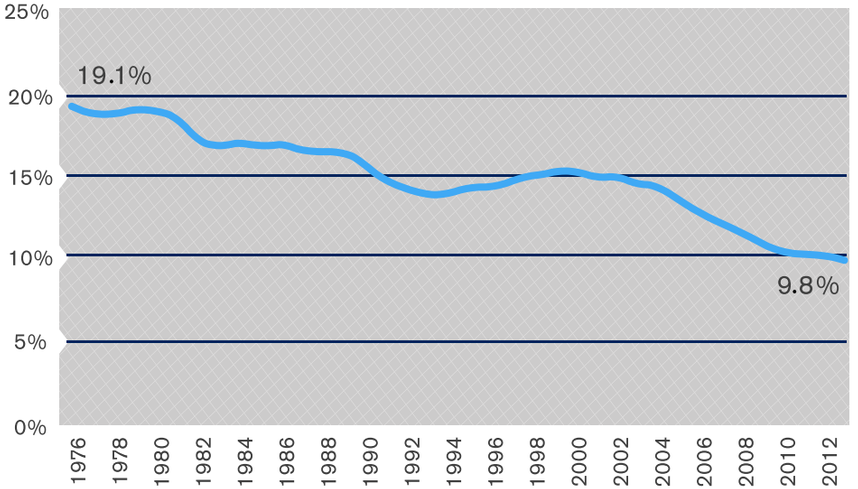
According to some, the Canadian manufacturing sector, mainly located in Ontario and Quebec, would today be negatively affected in the same way.

It is true that the Canadian dollar has increased significantly in value since its low of US$0.61, reached January 21st, 2002, thanks in part to Alberta's extraordinary economic activity.

However, the long-term decrease in the relative importance of manufacturing sector jobs is not due to the strong dollar and Alberta's oil sands. Neither is it specific to Canada. It can be observed in all of the world's advanced economic regions, including those that produce little or no oil like Europe and Japan. It stems primarily from the manufacturing sector's large gains in productivity.

Over decades, there is only a very moderate connection between the exchange rate and the manufacturing employment share. According to an econometric estimation, for each 1% increase in the value of the Canadian dollar, manufacturing's share of employment falls by 0.016 percentage points. In other words, the appreciation of the Canadian dollar from US$0.61 to US$1.00 would reduce Canadian manufacturing's share of employment only by around 1 percentage point, while it has dropped nine points between 1976 (19%) and 2013 (10%).

Manufacturing employment share in Canada (since 1976)



Sources: Millan Mulraine, "What's Behind the Canadian Manufacturing Sector Recession?," TD Economics Special Report, March 2008. John R. Baldwin and Ryan Macdonald, "The Canadian Manufacturing Sector: Adapting to Challenges," Statistics Canada, Economic Analysis Research Paper, 2009. Statistics Canada, Table 282-0008, Labour force survey estimates (LFS). Haver Analytics, Manufacturing employment share.

Q7

What kinds of energy are produced in Canada?

Canada covers a vast area rich in a variety of energy resources. In 2012, total primary energy production, comprising energy as found in nature before it is converted or transformed, reached 17.3 million terajoules (TJ). Crude oil (43%) and natural gas (35%) dominate Canadian energy production, followed by primary electricity production (10%).

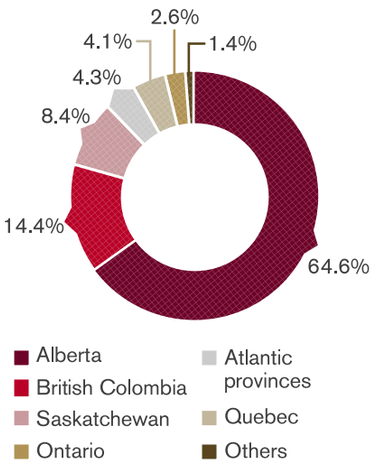
In terms of trends, crude oil's share has grown in the last 15 years after accounting for just 31% of the total in 1995, while the share for gas was 42% that year. Electricity production remained relatively stable throughout this period at about 10% of the total.

By region, Alberta is the top primary energy-producing province. It also ranks first in fossil energy production, with 76% of total oil production, 72% of natural gas production and 91% of production of natural gas liquids (NGL).

British Columbia comes second, with 14% of total primary energy production, though with 45% of coal production, 23% of natural gas production and 14% of electricity production. Next comes Saskatchewan, with 8% of total primary energy production, dominated by crude oil, with its production accounting for 15% of the total.

Primary energy production (2012)

By province:



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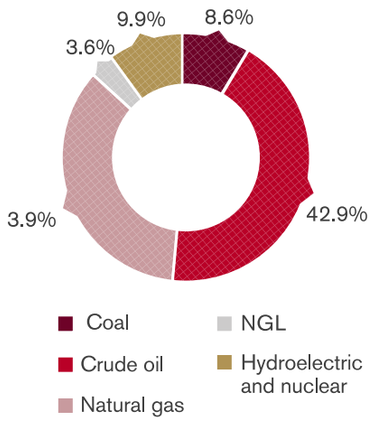


Source: Statistics Canada, Table 128-0016, Supply and demand of primary and secondary energy in terajoules.

Q8

What kinds of energy are used in Canada?

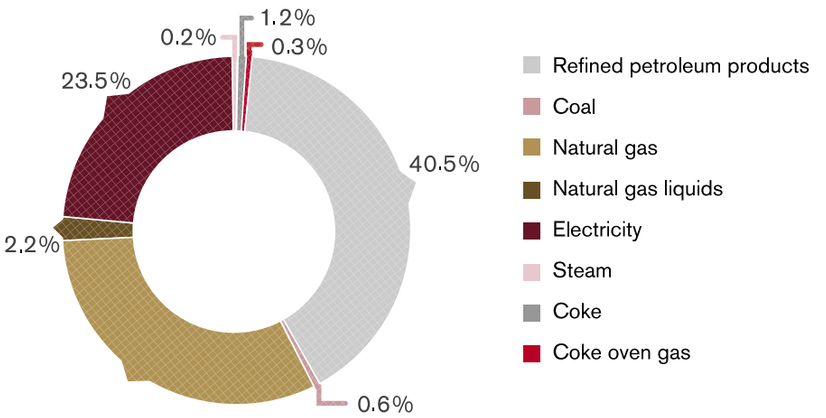
In 2011, total energy consumption in Canada reached 8.2 million terajoules, the equivalent of 1.32 billion barrels of oil, a 20.4% increase since 1995. Energy consumption per capita is 10th highest in the world, but has increased by only 2.3% over this period.

Fossil fuels, including refined petroleum products, coal, natural gas and natural gas liquids, met 74.9% of energy needs, while electricity accounted for 23.5% of total energy consumed. By comparison, in 1995, fossil fuels and electricity made up 73.1% and 24.5% of total energy consumption, respectively. This change is explained primarily by a 26% increase in the consumption of refined petroleum products.

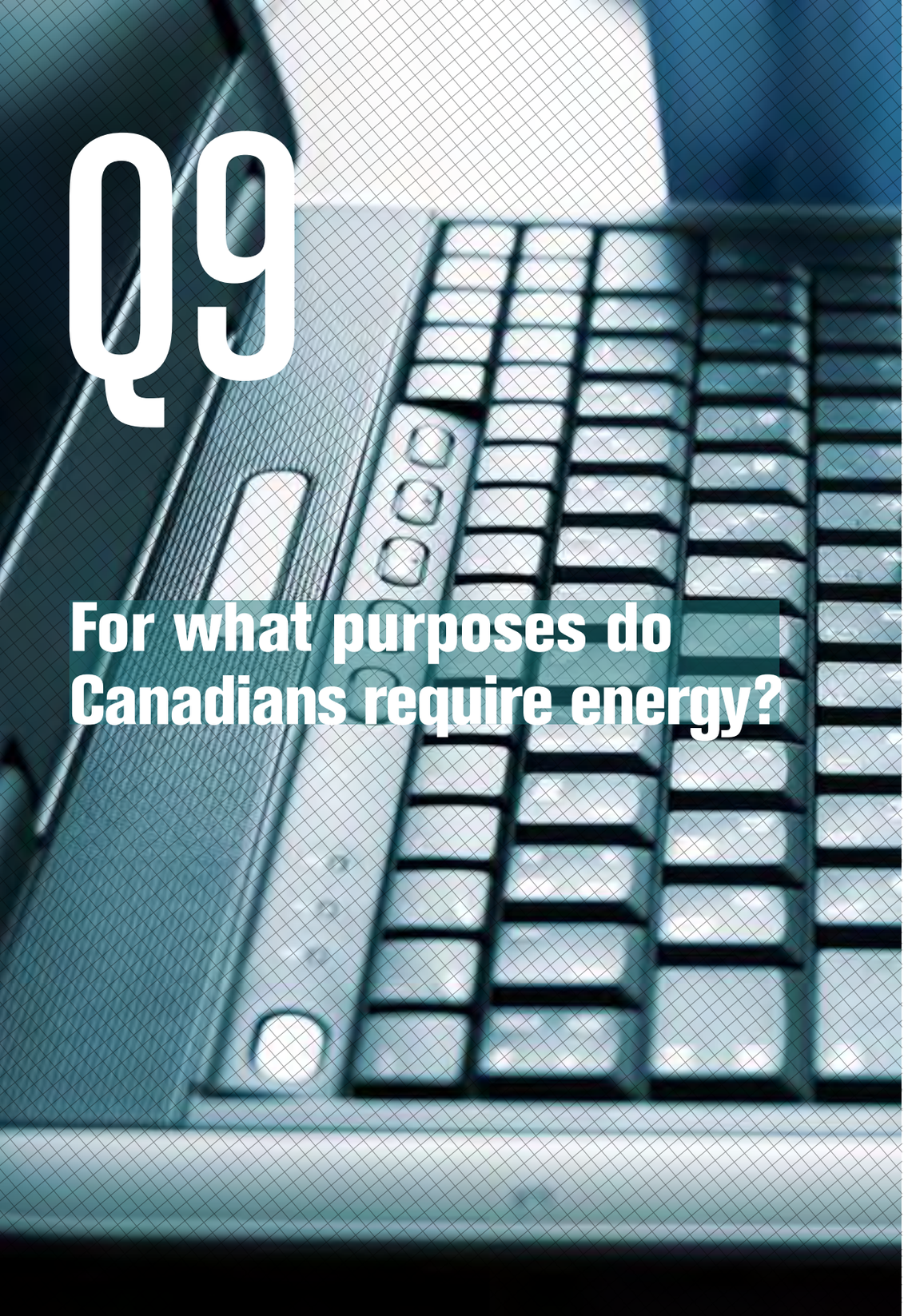
Ironically, it is in Alberta that refined petroleum products represent the smallest proportion of energy consumption. On the other hand, natural gas is used more there than elsewhere. It is also the province where energy consumption has risen the most since 1995, by 62%. Saskatchewan is second with a 26% increase. Only British Columbia reduced its total energy consumption (-1.2%).

Although Canada is a significant producer of energy, both in the form of electricity and of fossil fuels, certain provinces export a good part of their production, while others must import to meet a portion of their energy needs, especially when it comes to crude oil and refined petroleum products.

Energy consumption by source (2011)



Sources: Statistics Canada, ***Report on Energy Supply and Demand in Canada: 2011 Revision***, January 2014. Statistics Canada, Table 128-0016, Supply and demand of primary and secondary energy in terajoules. World Bank, Energy use (kg of oil equivalent per capita).



Q9

For what purposes do Canadians require energy?

Energy, essential to every detail of our daily lives, is used to transport us, to help our businesses operate, to provide us with heat and light, and to run a variety of household appliances.

More than one-third of Canadian energy consumption is absorbed by industries. About half of industrial consumption is accounted for by mining and by the pulp and paper industry.

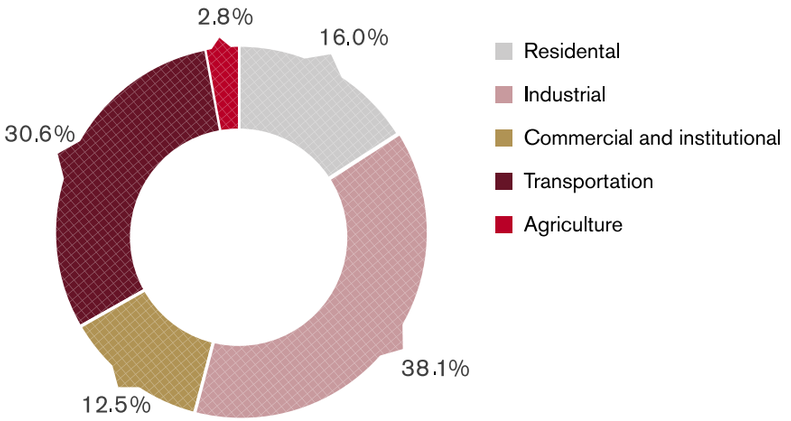
Next comes transportation, with passenger transportation accounting for the largest share, followed by freight transportation.

Energy consumption in the residential and institutional sectors appears more modest, at 16.0% and 12.5% of the total respectively. In both instances, space heating consumes by far the most energy. Appliances' energy consumption represents only 2.2% of total energy consumption.

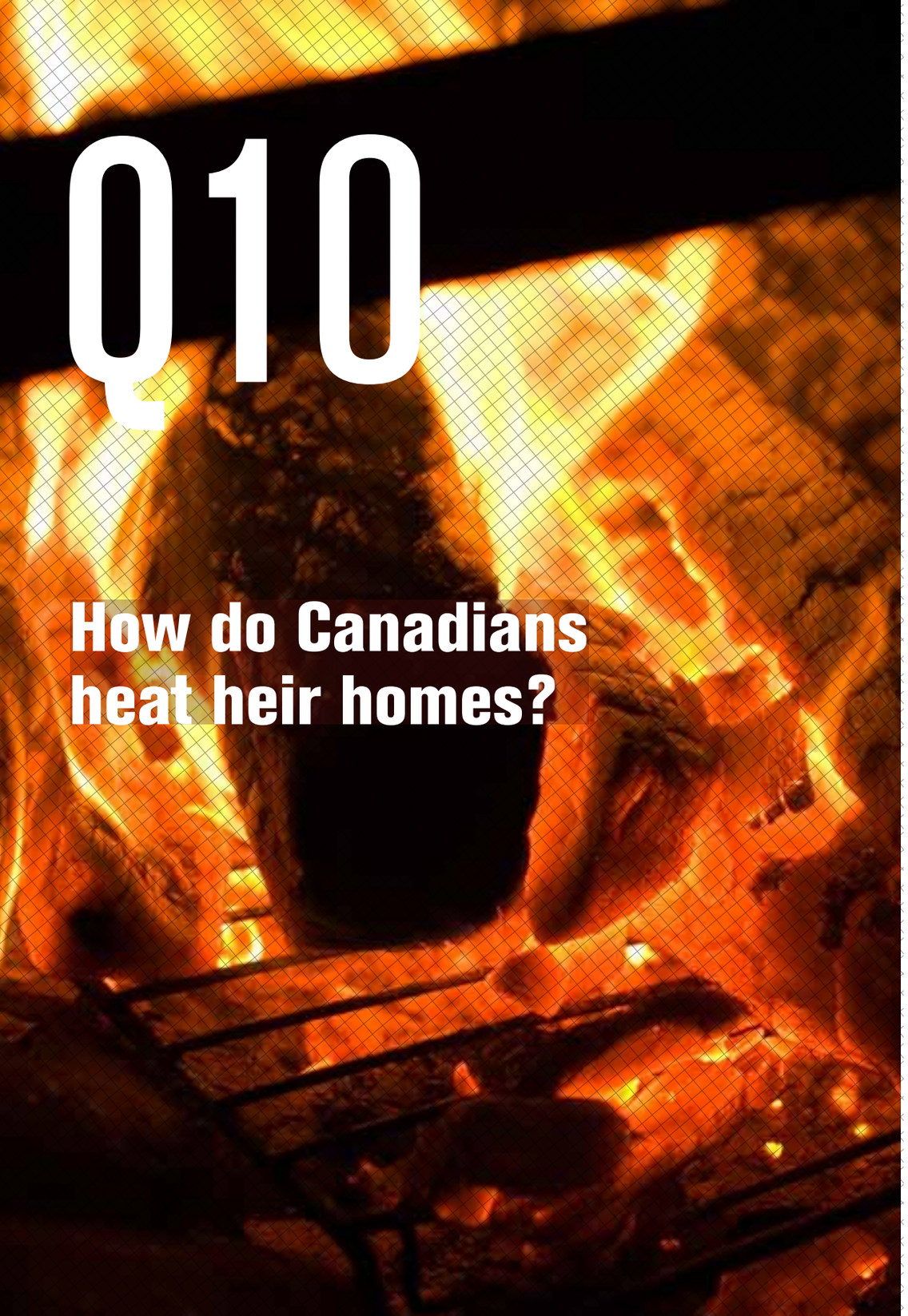
Between 1990 and 2010, demand in the industrial, commercial and institutional and residential sectors grew by 19.1%, 22.0% and 6.1% respectively. The transportation sector, with an increase of 38.2%, saw a sharper rise, mostly from freight transportation by heavy trucks. Passenger transportation in cars actually used less energy in 2010 than 20 years before.

At 2.8% of total demand, the farm sector would appear to be a marginal consumer, but this is where the second highest growth in demand has been recorded since 1990, at 22.8%.

Energy consumption by sector (2010)



Sources: Natural Resources Canada, Energy Use Data Handbook Table, Canada's Secondary Energy Use by Sector, End-Use and Sub-sector. Statistics Canada, Table 128-0016, Supply and demand of primary and secondary energy in terajoules.



Q10

How do Canadians heat heir homes?

Around half of Canadian households heat their homes with natural gas, while a third of them use electricity and fewer than 10% use oil.

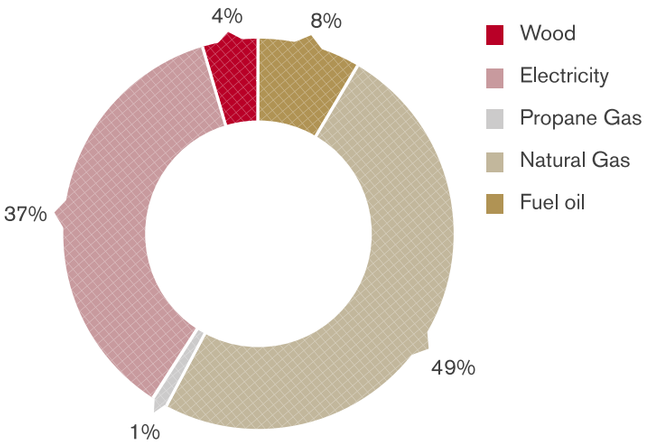
There are large regional differences, however, as the picture changes completely from one province to the next. Albertans (93%) and Saskatchewanians (87%) almost all heat their homes with natural gas, while in Ontario 72% of households use gas and 17% use electricity.

In British Columbia, natural gas predominates by a narrower margin (56%), followed by electricity (35%).

In Quebec, on the other hand, 80% of households rely on electricity to heat their homes. Oil, also called “heating oil,” comes in second (9.2%), followed by wood (6.5%). Natural gas, so prevalent in the West, is a distant fourth (3.6%).

In the Atlantic provinces, oil is the most-used energy source in Prince Edward Island (61%) and Nova Scotia (59%). It is also a significant player in Newfoundland and Labrador (23%). Interestingly, wood still plays a non-negligible role as a heating fuel in these provinces. As for natural gas, it is hardly used at all.

Percentage of Canadian households by primary heating fuel used (2009)



Source: Statistics Canada, Table 203-0019, Survey of household spending (SHS), dwelling characteristics at the time of interview, by province, territory and selected metropolitan areas. Note: The latest available data from Statistics Canada are from 2009, but they still undoubtedly provide a good picture of the general situation since heating habits change very slowly.

Q11

What role did Canada play in the emergence of the oil industry?

The Canadian contribution to the launching and development of the petroleum industry begins with the Nova Scotia-born and raised medical doctor and geologist Abraham Pieno Gesner (1797-1864) who, after much trial and error, developed in 1846 a lamp fuel first called “keroselain” (from the Greek keroselaion for wax oil), but soon rechristened kerosene. Kerosene lamp was a significant improvement in terms of price and illumination over competing products using whale oil.

The first crude oil well from which kerosene and other products were refined on a commercial scale was dug in 1858 by a crew under the direction of James Miller Williams (1818-1890) in what would become Oil Springs in southwest Ontario.

The material was then processed in North America’s first crude oil refinery in Hamilton–making Ontario (and not Pennsylvania) the very first North American jurisdiction where commercial petroleum was produced, refined and marketed.

Canadians can also boast of having built the world’s first modern crude oil pipeline when in 1862 such a structure connected the Petrolia oilfield to the nearby town of Sarnia.

As for Alberta, its industry developed when a gusher sprung out in 1947, about 30 kilometers south of Edmonton, from a well at a depth and type of rocks then thought unlikely to harbor crude oil.

Commemorative stamps

“Abraham Gesner : Father of the Oil Industry,” issued March 17, 2000

“Kerosene 1846,” issued June 17, 1988

Sources: Ontario Ministry of Natural Resources, History of Hydrocarbon Exploitation in Ontario.
Earle Gray, ***Gesner and Williams: Two Canadians who launched the World’s Petroleum Industry***, Petroleum History Society, 2008.
Kendall Beaton, “Dr. Gesner’s Kerosene: The Start of American Oil Refining,” ***Business History Review***, Vol. 29 (1955), No. 1, pp. 28-53.
Canada Post, Canadian Postal Archives Database.

Q12

What is oil good for?

Asking what oil is good for may seem odd given that the answer appears so obvious. And yet, in addition to being an indispensable source of energy for transportation and heating, oil is also a raw material used in the manufacture of a great many products that fill our daily lives and contribute to our quality of life.

We need only look around us to become aware of the omnipresence of the by-products of hydrocarbons, especially polymers. These substances have properties that have made them very popular: they can be rigid or supple, transparent or opaque, superabsorbent or waterproof, soluble or insoluble in water, thermoplastic or thermosetting, electrical conductors or insulators. Because of these various properties, polymers are used in many areas.

At home: From the kitchen to the bathroom, from our gardens to our cupboards, polymers can be found in various forms: plastic containers, shower curtains, toys, electrical appliances and devices, flooring, school supplies, Teflon kitchen items, clothing made from polyester, nylon and other synthetic fabrics, patio furniture, candles, mattresses, etc.

Health and wellbeing: Heart valves, hearing aids, contact lenses, pharmaceuticals, perfumes, makeup, shampoo, shaving cream, disposable diapers, toothpaste, etc.

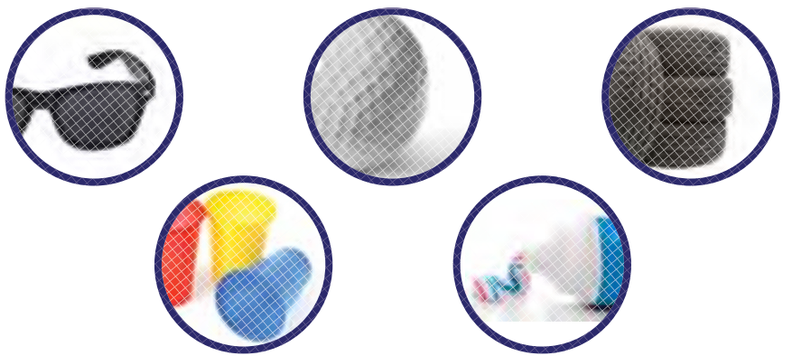
Sports and leisure: Sports equipment, various balls, protective gear, CDs and DVDs, fishing line, etc.

Industry: Tires, automobile interiors, glue, wood substitutes, pipes, paints, insulation, packaging material, water treatment, etc.

Agriculture: Fertilizer, insecticides, agricultural equipment, high-absorption products, etc.

Even Canada's new bank notes are made from polymers!

Products made from petroleum



Sources: Department of Electrical and Computer Engineering, Everyday Polymers, Colorado State University. Oil and Gas Info, What products are made from oil and gas?

Q13

What does the petrochemical industry do?

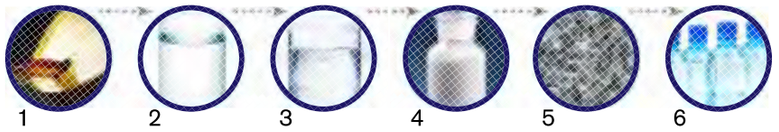
Oil refining activities are not limited to the production of gasoline for transportation, which in fact represents just some 47% of all petroleum products in North America. Refined petroleum products also feed into the petrochemical industry, which produces a vast array of everyday consumer goods.

For example, in Montreal's east end, the Suncor refinery and three petrochemical companies (Chimie ParaChem, CEPSA and Selenis) form what is called the "polyester production chain." Polyester is the most widely used synthetic fibre in the world, used especially in the manufacture of clothing, but also in making various other industrial and consumer goods.

At the beginning of the production chain, Suncor produces xylene from oil. Chimie ParaChem in turn transforms xylene into crystals, which are then melted to produce highly purified paraxylene. CEPSA transforms paraxylene into purified terephthalic acid. The majority of CEPSA's production of acid is used in turn as a raw material by the final link in the polyester production chain, Selenis.

Finally, Selenis produces a saturated polyester plastic, polyethylene terephthalate, which is used in the manufacture of recyclable plastic bottles, textile fibres, food packaging, carpets and transparent films. Among the well-known consumer goods that use Selenis products are Kraft mayonnaise containers.

The polyester production chain



1. Crude oil
2. Xylene
3. Paraxylene
4. Purified terephthalic acid (PTA)
5. Polyethylene terephthalate
6. Consumer goods : water bottles and plastic containers

Sources: Société de développement économique Rivière-des-Prairies • Pointe-aux-Trembles • Montréal-Est, ***Est industriel info***, 2011. U.S. Energy Information Administration, Frequently Asked Questions. What are the products and uses of petroleum? Natural Resources Canada, ***Canadian Crude Oil, Natural Gas and Petroleum Products***, May 2011, p. 21.

Q14

Will we reach peak oil?

Peak oil theory is based on the idea that global oil production has already reached, or will soon reach, a peak, after which it will begin to decline.

This theory, presented for the first time in the 1950s, imagines that the production curve for oil is bell-shaped, starting at zero and rising rapidly, and that once approximately half of the resource has been exploited, it reaches a maximum that will never be surpassed. Once the peak has been reached, production starts to decline until the resource is completely exhausted.

Supporters of this theory predicted that this peak in production would arrive in 2005. Then the date was pushed back to 2011, and most recently to 2020.

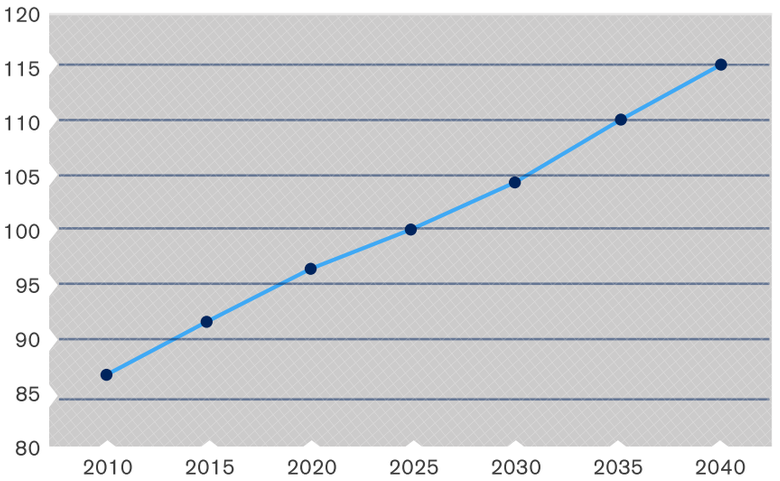
However, even if oil is not a renewable source of energy, exploitable oil reserves are not fixed and can even increase.

This is because high prices stimulate innovation and encourage entrepreneurs to use ingenuity and perseverance to grow the supply.

This is precisely what has happened in the oil industry in Canada and the rest of North America, where technological advances have improved the recovery rates for existing fields. They have also made possible the cost-effective recovery of resources that were previously inaccessible.

For all of these reasons, peak oil may be pushed back indefinitely, and even if it arrives someday, technological advances will in the meantime have allowed us to discover other energy sources and will have reduced demand.

Global liquid fuel production forecast, in millions of barrels per day (2010-2014)



Sources: U.S. Energy Information Administration, Table A5, World liquids consumption by region, ***International Energy Outlook 2013***, 2013.
U.S. Energy Information Administration, World liquid fuels production in the Reference case 2010-2040 (Table 3), ***International Energy Outlook 2013***, 2013.

Q15

How large are the proven global reserves of oil and natural gas?

Oil and natural gas come from the fossilization of organic matter underground. Since this process takes several million years, these resources are considered non-renewable on a human time scale. How many years do we have left until we've used them all up?

No one knows what fraction of hydrocarbons below the Earth's surface will ultimately become exploitable. Currently proven reserves constitute the most conservative estimate of the available quantity of energy. Since exploration continues and technology keeps evolving, the size of reserves is regularly revised.

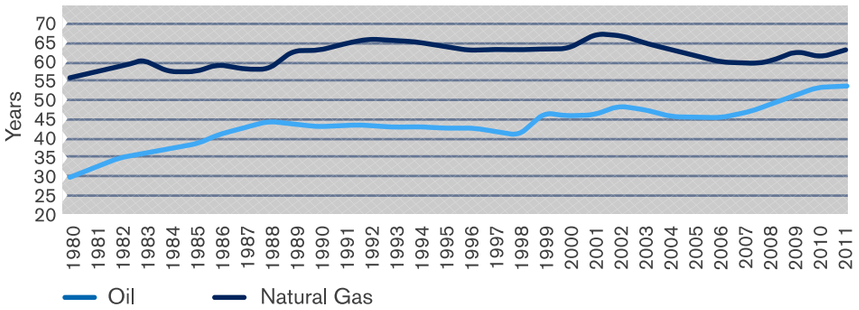
In 2011, these reserves totalled 1,653 billion barrels of oil and 208 trillion m^3 of natural gas, an increase of 142% and 157% respectively compared to 1980 estimates.

The "reserves-to-production" ratio (R/P) indicates the number of years that current reserves will last if production remains at the current level. In 2011, the R/P ratio was 54 years for oil and 64 years for natural gas. In 1980, the figures were 30 years and 56 years respectively.

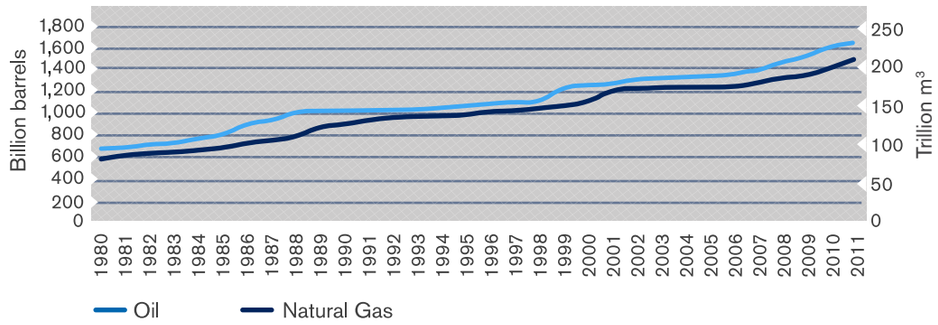
The increase in the R/P ratio for oil is the result of average annual increases of 2.9% for proven reserves and 0.9% for production. As for the R/P ratio for natural gas, it is explained by the combination of average annual increases of 3.1% for reserves and 2.7% for production.

For thirty years, the quantities of proven reserves have therefore grown more rapidly than production, pushing back the moment when these resources will be exhausted.

Reserves-to-production ratios for oil and natural gas (1980-2011)



Proven reserves of oil and natural gas (1980-2011)



Source: BP, ***BP Statistical Review of World Energy 2012***, 2012.

Q16

Is the future of hydrocarbons to be found in the Arctic?

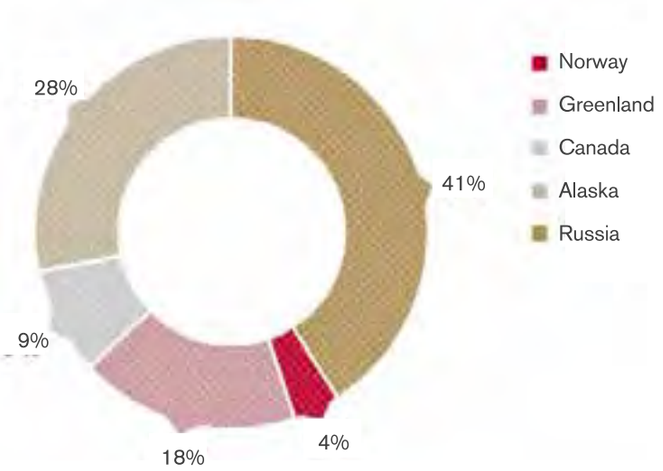
The Arctic region contains substantial natural resources, including hydrocarbons like oil and natural gas. In 2008, the US Geological Survey estimated that 13% of conventional oil, 30% of technically extractable natural gas and 20% of natural gas liquids that have yet to be discovered but that are presumed to exist on the planet are to be found north of the Arctic Circle.

The vast majority of these resources would be in Russia, Alaska and Greenland. Only 9% of the oil and 4% of the natural gas in the Arctic is thought to be within Canada's territory, totalling 8.4 billion barrels of oil and 4.3 trillion cubic metres of natural gas. The Canadian Arctic's potential reserves are far from negligible, however. The Arctic would hold one quarter and one third, respectively, of all the conventional crude oil and natural gas reserves in Canada.

Nevertheless, numerous climatic and technological obstacles make potential zones of exploration in the Arctic difficult to access. These obstacles explain the lack of infrastructure like roads, ports and pipelines, whose presence is a necessary precondition to the development of the region's hydrocarbon resources. Projects like the construction of the Mackenzie gas pipeline connecting the Beaufort Sea to Alberta are also dependant on agreements with First Nations and on environmental approval.

Given these obstacles, the viability and the profitability of exploiting hydrocarbons in the Arctic remain uncertain, even if exploration projects continue to be developed there.

Distribution of estimated Arctic oil reserves by region



Sources: Frédéric Beauregard-Tellier, "The Arctic: Hydrocarbon Resources," Publication PRB 08-07E, Parliamentary Information and Research Service of the Library of Parliament, 2008. Lars Lindholt and Solveig Glomsrod, "The role of the Arctic in future global petroleum supply," Discussion Paper No. 645, Norway Statistic Research Department, February 2011, p. 7.

07

What is Canada's shale gas potential?

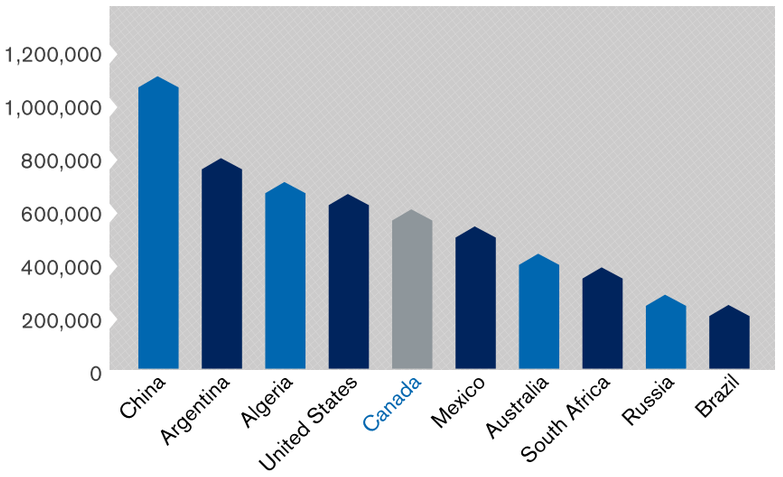
Canada has the fifth largest technically recoverable shale gas reserves in the world, with 573,000 billion cubic feet. Recovering these resources is made possible thanks to new technology like horizontal drilling and hydraulic fracturing in shale rock formations.

It must be pointed out that technically recoverable resources represent the volume of natural gas that could be produced with current technology, whereas economically recoverable resources are those resources that can be profitably produced under current market conditions. In practice, economically recoverable resources are a lot more limited than those that can technically be recovered.

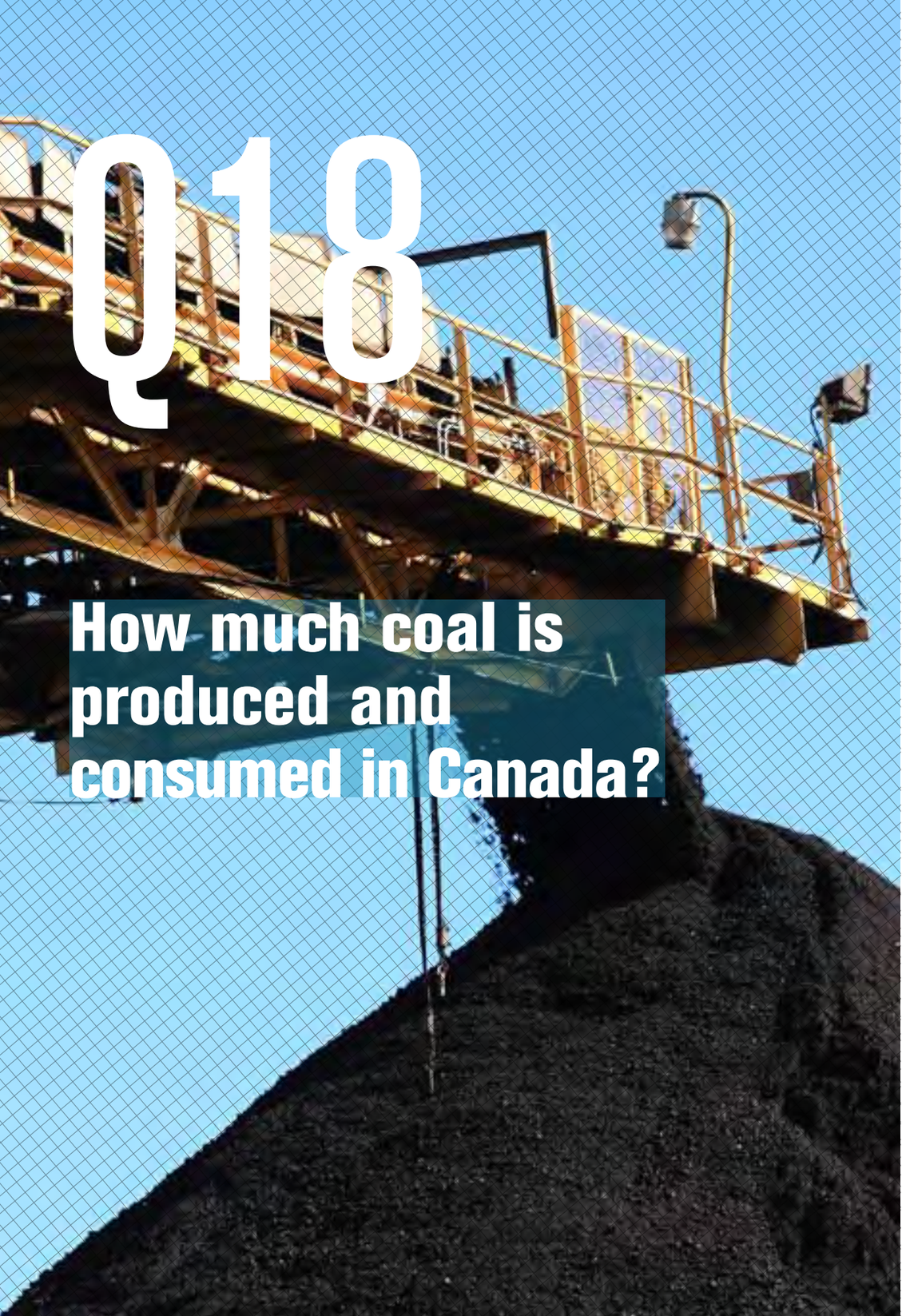
The production of shale gas in Canada reached 700 billion cubic feet in 2012, which is far behind the 9,600 billion produced in the United States. Shale gas represented 15% of total natural gas production in Canada and 39% in the United States. Just ten years ago, this supply source was marginal.

Canada's shale gas potential is basically located in five large sedimentary basins in British Columbia and Alberta. The rest is located in four deposits in Quebec, Nova Scotia and New Brunswick, where exploration is still in its early stages.

Quantity of technically recoverable shale gas by country
(in billions of cubic feet, 2013)



Sources: U.S. Energy Information Administration, ***Technically Recoverable Shale Oil and Shale Gas Resources: An Assessment of 137 Shale Formations in 41 Countries Outside the United States***, 2013. U.S. Energy Information Administration, "North America leads the world in production of shale gas," ***Today in Energy,*** October 23, 2013.



Q18

How much coal is produced and consumed in Canada?

In 2012, Canada held 0.8% of the world's proven coal reserves, of which 6.6 billion tonnes is considered recoverable using existing technologies. Coal production in Canada, 67 million tonnes in 2012, accounted for 0.9% of worldwide production.

Of this total, 38 million tonnes was thermal coal used in electricity production, representing 59% of the electricity consumed in Alberta and 27% in Saskatchewan.

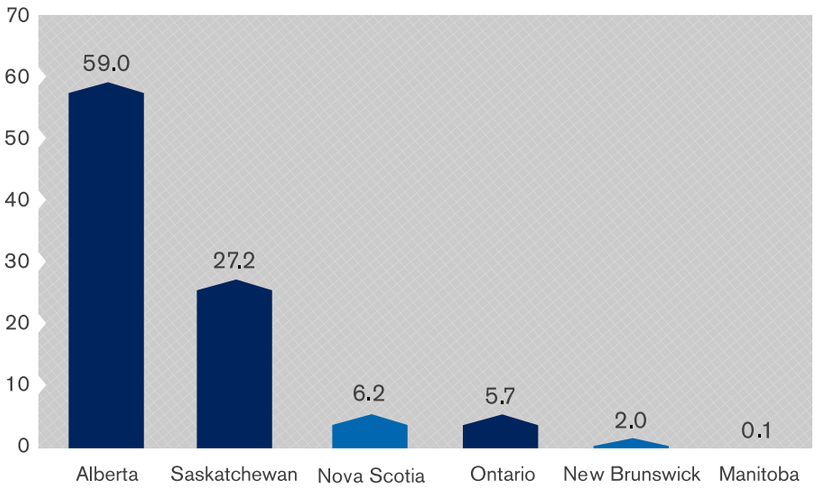
Another 29 million tonnes was metallurgical coal used in steel production. A small portion of this coal is consumed by the Canadian steel and cement industries, but most of it is exported to Asia.

Most of Canada's 22 operating coal mines are located in the western provinces, namely British Columbia, Alberta and Saskatchewan. Some also operate in Nova Scotia and New Brunswick.

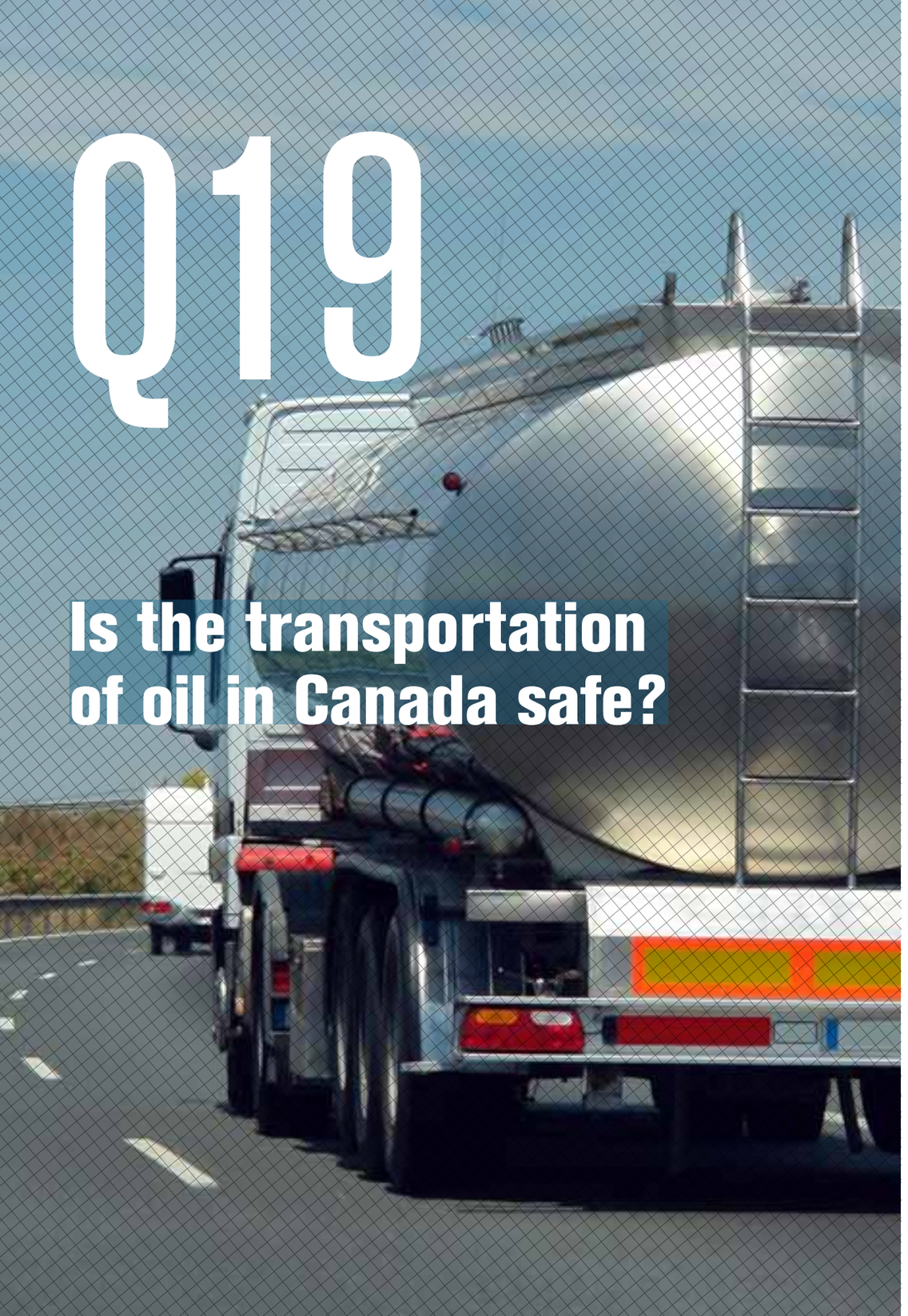
Coal is generally seen as being among the energy sources that contribute most heavily to carbon emissions. Instituting measures to reduce greenhouse gas emissions, in particular closing or modernizing coal-fired electric power plants, should therefore help reduce coal consumption in Canada.

There exist however technologies to reduce atmospheric emissions, such as carbon capture and storage, that may help coal use continue into the future.

Coal consumed for the production of electricity (in tons)



Sources: BP, ***BP Statistical Review of World Energy 2012***, 2013. Coal Association of Canada, Production, 2013. Natural Resources Canada, About Coal, 2011. Natural Resources Canada, "Canada's Mineral Production Roars in 2011, Meows in 2012," ***Information bulletin***, March 2013. Statistics Canada, Table 127-0004, Fuel consumed for electric power generation, by electric utility thermal plants.



Q19

Is the transportation of oil in Canada safe?

Recent tragedies and spills have made us all reconsider the safety of oil transportation in North America.

The increased production of oil in recent years has led to more oil being transported between production sites and refineries. The pipeline is the most efficient, the most reliable, the safest and the most cost-effective way of transporting large quantities of oil over long distances. However, due in particular to difficulties associated with getting new pipeline projects approved, oil transportation by train has grown exponentially.

On the one hand, spills, leakages and pipeline breaks represent a tiny percentage of the volume of oil circulating in pipelines. The risk of a train spill was six times higher than the risk of a pipeline accident over a period of 8 years between 2004 and 2012. However, North American pipelines spilled three times more oil than trains for comparable distances over the same period.

On the other hand, in terms of serious accidents resulting in injuries or deaths, the pipeline is the safest means of transportation. Between 2005 and 2009, it is road transportation that experienced the highest rates of serious accidents in the United States, with 19.95 incidents per billion ton-miles (which is to say, tons of freight transported a distance of one mile). Train transportation was second with 2.08, while pipeline transportation experienced just 0.58 incidents per billion ton-miles.

Incident comparison between various oil transportation modes (2005-2009)

Mode of transportation	Average billions ton-miles shipment per year	Average incidents per year	Incidents per billion ton-miles
Road	34.8	695.2	19.95
Railway	23.9	49.6	2.08
Liquid pipeline	584.1	339.6	0.58
Gas pipeline	338.5	299.2	0.89

Sources: Diana Furchtgott-Roth, "Pipelines Are Safest For Transportation of Oil and Gas," ***Issue Brief***, No. 23 (June 2013). Diana Furchtgott-Roth, "Quebec tragedy reminds us pipelines are safest way to transport oil," ***The Globe and Mail***, July 7, 2013. U.S. Department of Transportation, ***Pipeline and Hazardous Materials Safety Administration, Building Safe Communities: Pipeline Risk and its Application to Local Development Decisions***, October 2010, pp. 23-28. Eliot Caroom, "Pipelines Spill Three Times as Much Oil as Trains, IEA Says," ***Bloomberg***, May 14, 2013.

Q20

What are the main export markets for Canadian oil?

Practically all (99%) of Canadian crude oil exports are currently directed to the American market. However, especially due to the remarkable development of technologies allowing the exploitation of shale oil, the United States have significantly increased their oil production since 2008, and by 2015 will be the top producer in the world. As a result, American imports of Canadian oil could well decline in the near future.

Canadian oil is basically landlocked due to insufficient transportation infrastructure. For the moment, oil extracted from the oil sands has no way of directly reaching the main North American refineries and the emerging markets of Asia.

Under these conditions, Canadian producers want to direct their oil to the US states that border the Gulf of Mexico, which are home to 39% of the country's refining capacity. To sell what they produce, it is also becoming essential for them to gain access to new markets in Asia and Europe by equipping themselves with the infrastructure needed to reach the Pacific and Atlantic Oceans.

Thanks especially to Alberta's oil sands, Canadian oil production could increase considerably in the coming decades. According to a forecast from the Canadian Association of Petroleum Producers, it will go from 3.2 million barrels per day in 2012 to 6.7 million by 2030. This growth in production, however, is dependent on the transportation infrastructure that will allow it to reach the refineries and markets where demand is increasing.

Canada's major pipeline projects

Sources: National Energy Board, Estimated Canadian Crude Oil Exports by Type and Destination (2012 Q1-Q4 Tables), 2012. U.S. Energy Information Administration, Number and capacity of petroleum refineries, 2013. Canadian Association of Petroleum Producers, Crude Oil Forecast, Markets & Transportation, June 2013, p. i. Grant Smith, "U.S. to Be Top Oil Producer by 2015 on Shale, IEA Says," ***Bloomberg***, November 12, 2013. U.S. Energy Information Administration, World liquid fuels production in the Reference case 2010-2040 (Table 3), ***International Energy Outlook 2013***, 2013.

Q21

Will Canada become a major exporter of liquefied natural gas?

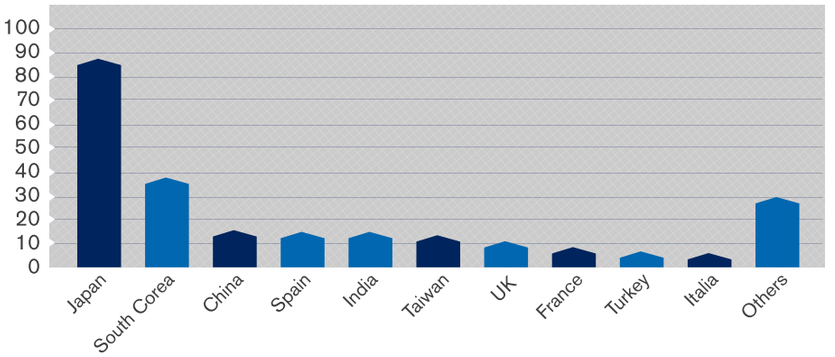
Significant demand exists in Asia for liquefied natural gas. For example, Japan, the world's top importer, has been seeking to replace all its nuclear energy with other energy sources such as natural gas ever since the Fukushima nuclear accident in March 2011. China and India are also potential major buyers.

These buyers, currently supplied from Qatar, Malaysia or Australia, would like to take advantage of lower-priced liquefied natural gas from North America. Supplies of technically recoverable shale gas abound nor only in the United States, where this sector has been booming in the last few years, but also in British Columbia and Alberta.

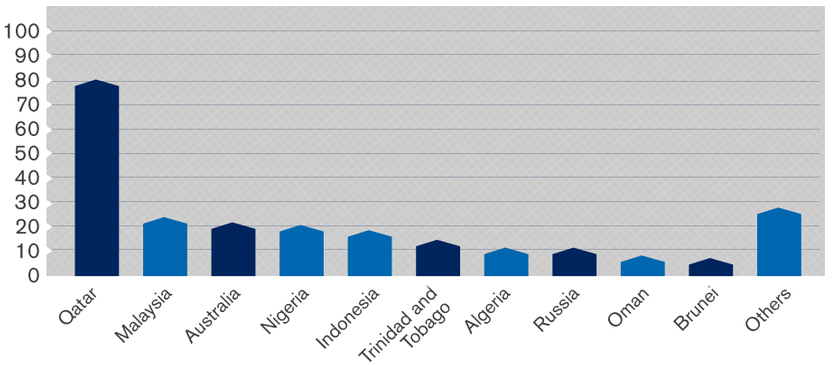
This is why various investment projects to build the infrastructure needed to export liquefied natural gas are currently being examined. The aim is to be able to transport natural gas by pipeline to the British Columbia coast, convert it to liquid natural gas at liquefaction plants and then load it onto specialized methane tanker ships.

This infrastructure will be built only when the projects have received all necessary approvals and after the signing of long-term contracts with buyers to ensure its financial viability. Meanwhile, other countries such as Australia and the United States are likely to boost their production to meet Asian demand. For these reasons, it will be several more years before we know whether Canada can position itself as a major exporter of liquefied natural gas.

Main LNG importing countries in 2012, in millions of tons per year



Main LNG exporting countries in 2012, in millions of tons per year



Sources: U.S. Energy Information Administration, ***Technically Recoverable Shale Oil and Shale Gas Resources: An Assessment of 137 Shale Formations in 41 Countries Outside the United States***, 2013. International Gas Union, ***World LNG Report 2013***, 2013.

Q22

How much hydroelectricity is produced in Canada?

Hydroelectric power plants provide 16.5% of global electricity production. They constitute a predominant source of electricity in certain regions of Canada, a country that possesses the third largest reserve of freshwater in the world and whose territory receives abundant annual precipitation. Over 63% of the electricity produced in Canada comes from hydroelectric generating stations.

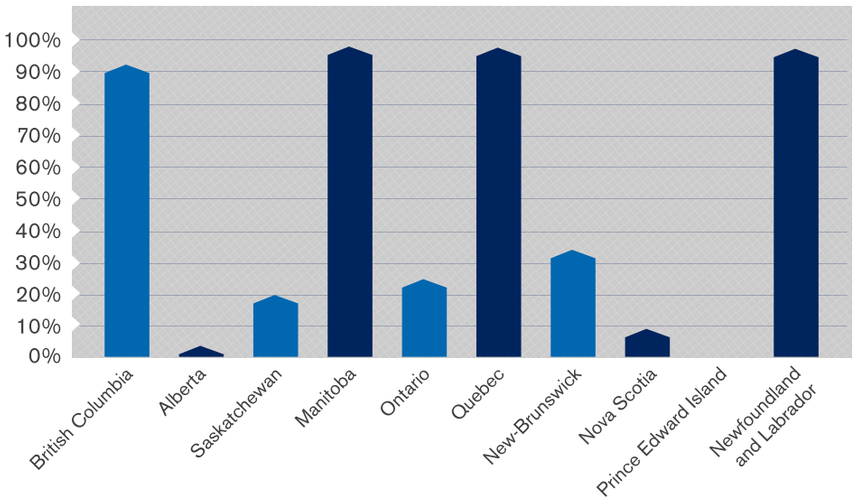
Canada is the third largest producer of hydroelectricity in the world, behind China and Brazil. In 2012, 376 TWh of hydroelectricity were produced in Canada, accounting for 10.5% of global production.

Four provinces dominate the production of hydroelectricity. Quebec produced 194 TWh of hydroelectricity in 2012, which represents 52% of total Canadian production. It is followed by British Columbia (64 TWh), Newfoundland (42 TWh) and Manitoba (32 TWh). Each of these provinces produces over 90% of its electricity using hydroelectric power plants.

Hydroelectricity is the least expensive form of electricity produced in Canada, followed by nuclear power and then by electricity produced by coal generating stations. This explains in part why provinces whose needs are primarily provided for by hydroelectricity have lower rates.

Even though it dominates the production of electricity, hydro power represents just 7.5% of primary energy production in Canada, far behind crude oil and natural gas.

Proportion of electricity generated by hydroelectric power plants per province, 2012



Sources: International Energy Agency, ***Key World Energy Statistics***, 2013. Natural Resources Canada, Additional Statistics on Energy, 2013. Canadian Electricity Association, Canada's Energy Industry, 2013. Canadian Electricity Association, Key Canadian Electricity Statistics, May 2013.

Q23

Where in North America is electricity the cheapest?

Electricity rates vary enormously between the different regions of North America. The cost of production is primarily determined by the supply source (hydroelectricity, nuclear power plant, gas-, diesel- or coal-fired power plant, etc.). As for the costs of distribution and transportation, they are influenced by geography and demographic density.

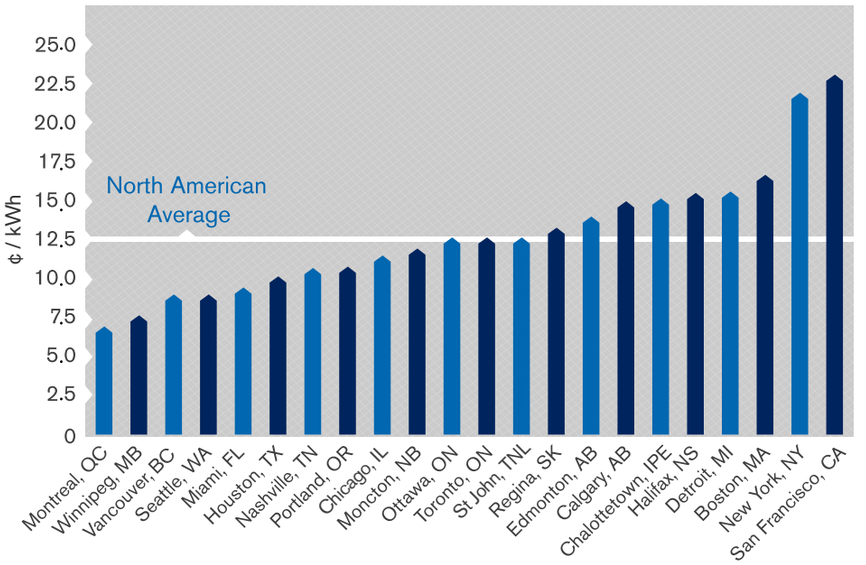
Each step, from production to distribution to transportation, can either be run by private companies, controlled by a government monopoly or be part of a hybrid system. The resulting market structure of these arrangements also has an influence on the cost of electricity. The residential price of electricity is controlled by a governmental regulatory body in every Canadian province except Alberta.

Montreal (6.9 ¢/kWh), Winnipeg (7.6 ¢/kWh) and Vancouver (8.9 ¢/kWh) are the three large cities in North America with the lowest residential electricity rates. This is due especially to the fact that the main supply source in the three provinces where these cities are located is hydroelectricity.

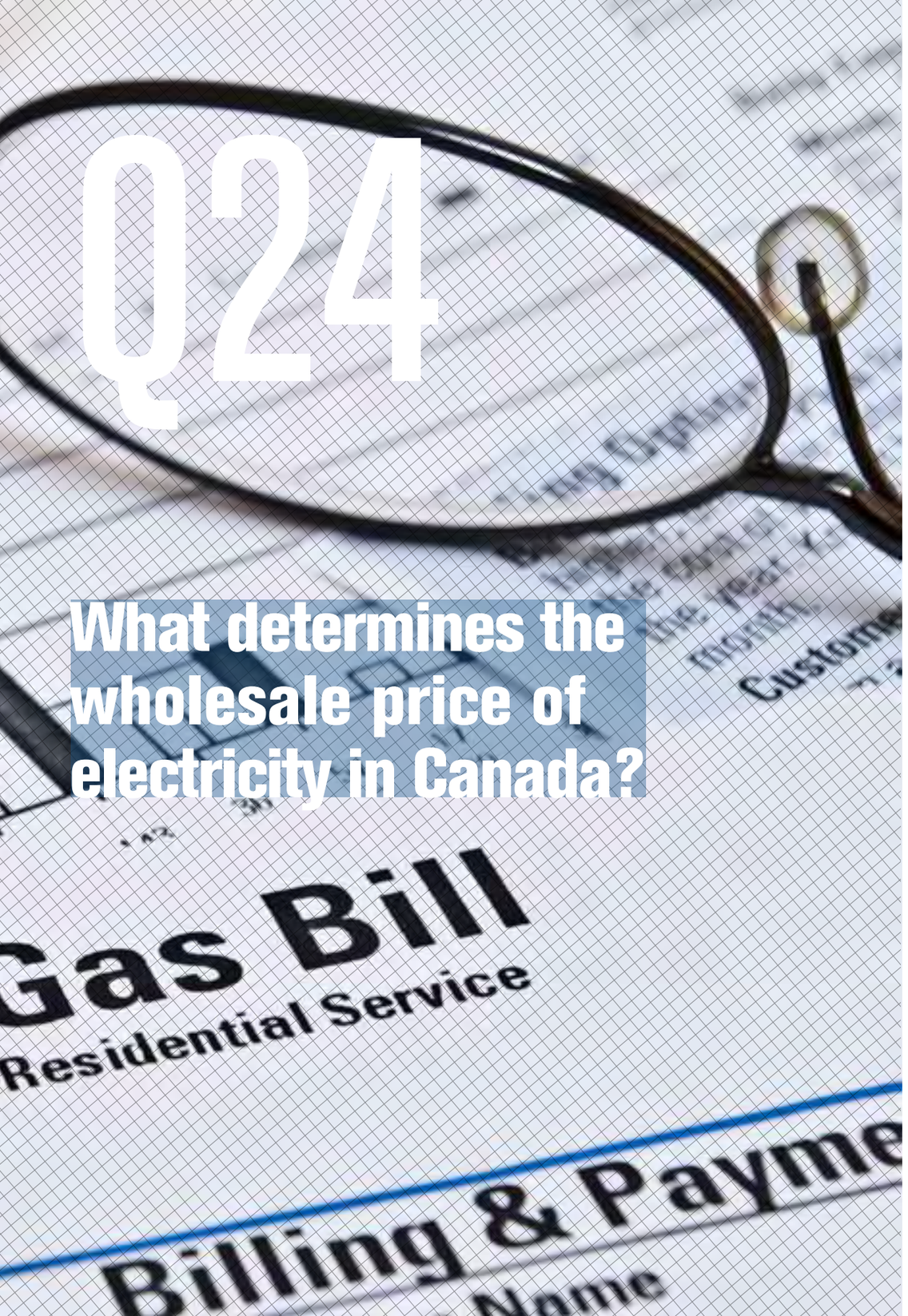
Seattle (9.0 ¢/kWh) and Miami (9.5 ¢/kWh) are the American cities where households pay the least for their electricity. New York (21.7 ¢/kWh) and San Francisco (22.9 ¢/kWh) are the ones where they pay the most.

In other Canadian cities, the price varies between 11.8 ¢/kWh (Moncton) and 15.5 ¢/kWh (Halifax). The North American average is 12.85 ¢/kWh.

The price of electricity in some North American cities (2013)



Sources: Natural Resources Canada, About Electricity, 2013. Hydro-Québec, ***Comparaison des prix de l'électricité dans les grandes villes nord-américaines,*** 2013.



Q24

What determines the wholesale price of electricity in Canada?

Electricity rates for residential consumers are regulated and do not change very often in most provinces. However, for the distributor that buys electricity wholesale in order to resell it to residential clients, the price is constantly changing.

The total quantity of electricity demanded fluctuates all the time. On the other hand, since electricity produced cannot be stored, it must be used instantly one way or another.

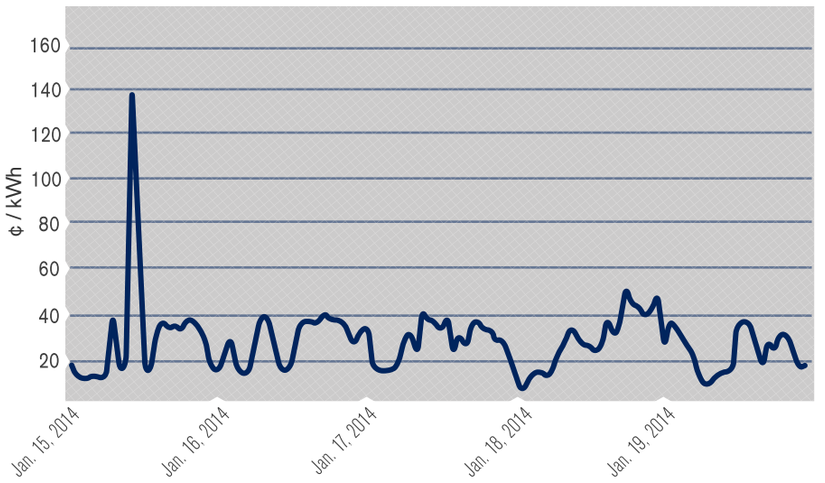
It is of course impossible to shut down and restart nuclear power plants on a dime, or to modify the speed of the wind, in order to produce the precise quantity of electricity demanded. Other sectors, though, like hydroelectric plants with dams and natural gas plants, do have more flexibility in terms of production.

It is price that serves to balance out the kilowatt hours (kWh) produced and consumed on the wholesale market. Even the large provincial electricity monopolies find it beneficial to engage in trade with suppliers from other provinces or from the United States in order to meet their needs or use up their surpluses.

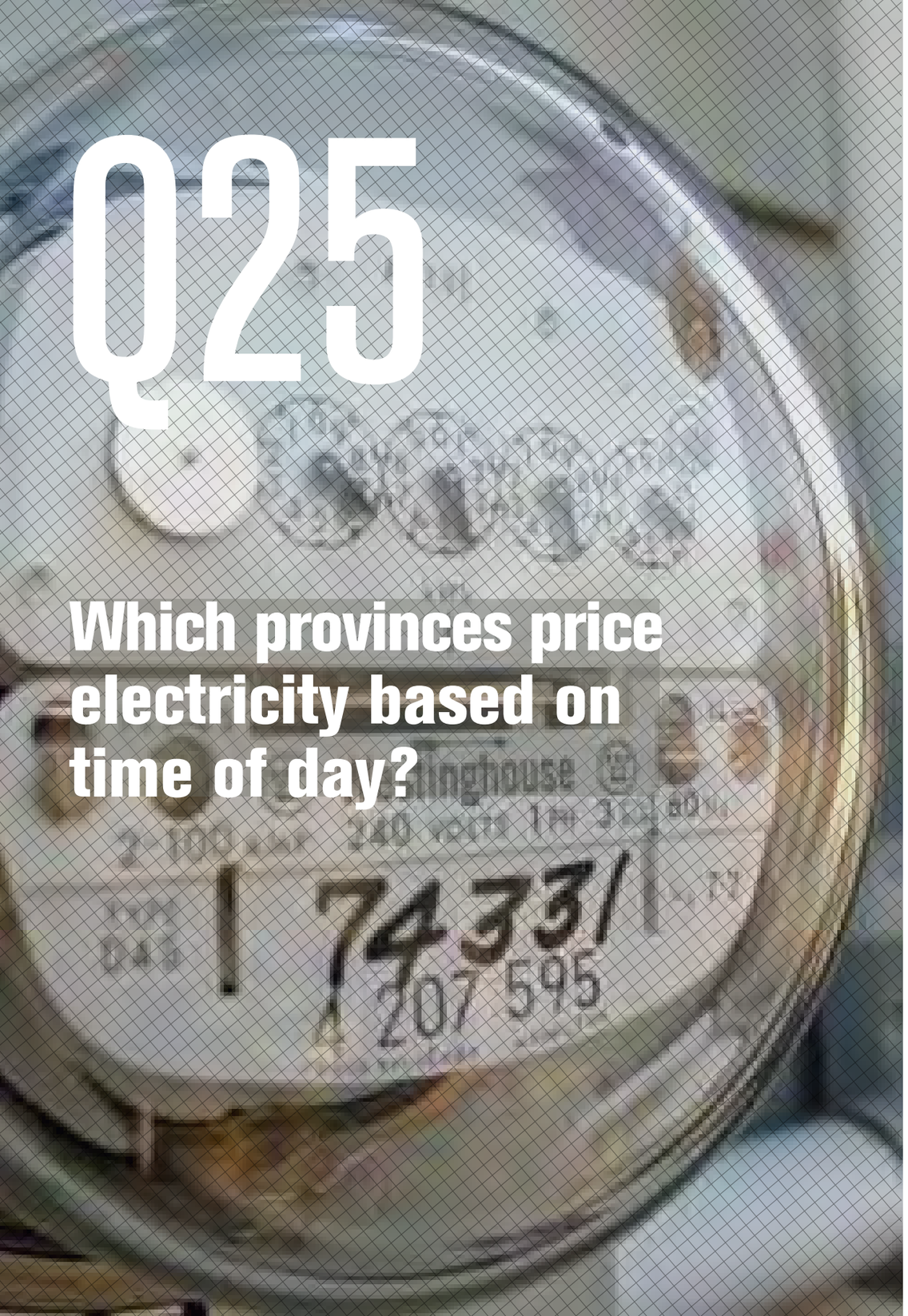
In the cases of Alberta and Ontario, hundreds of producers, transporters, distributors and large industrial consumers of electricity have direct access to a stock exchange that fine tunes supply and demand. These prices can oscillate by several cents/kWh in a single hour and even sometimes reach negative values.

Contrary to these rapid fluctuations in the very short term, average long-term prices depend on the general evolution of the cost of electricity produced by the various energy sectors.

Hourly evolution of the wholesale price of electricity in Ontario, (from January 15 to 19, 2014)



Sources: Independent Electricity System Operator, Ontario. National Energy Board, Electricity - How Canadian Markets Work.



Q25

Which provinces price electricity based on time of day?

In Canada, two provinces have adopted variable electricity pricing based on the time of day: Ontario and Nova Scotia.

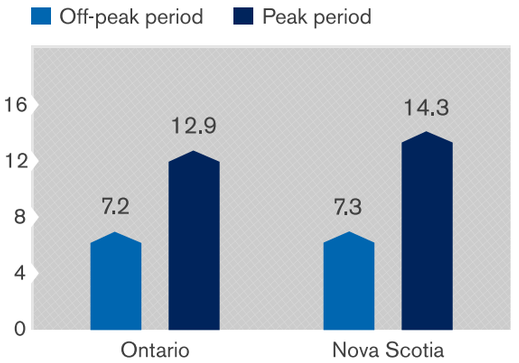
Since the electricity needs of Canadians vary from one moment to the next, at certain times, the electricity transportation and distribution grid is particularly strained. These are referred to as periods of peak demand for electricity. In addition, during winter cold snaps, heating needs also increase the demand for electricity.

Businesses that supply electricity must adapt to these variations. This can mean that the least expensive power plants, which are almost constantly running, are insufficient to meet the demand and that those with higher production costs must be called upon for extra power.

In order to reflect the fact that the demand for electricity is stronger during peak periods and that production costs are higher, Ontario installed smart meters that track how much energy is consumed at what times. In order to encourage consumers to use electricity as economically as possible, one kilowatt hour can cost 7.2¢ during off-peak hours but sell for 12.9¢ during peak hours. In Nova Scotia, rates vary between 7.3¢/kWh and 14.3¢/kWh.

In provinces that have not made this choice, rates can nonetheless vary. For example, in Quebec, the first 30 kWh used each day cost 5.41 ¢/kWh, while additional electricity used is pricier, at 7.78¢/kWh.

Variable electricity rates depending on the time of day, (in cents per kilowatt hour)



Sources: Ontario Hydro, Ontario Hydro Rates. Nova Scotia Power, Time-of-day Rates. Hydro-Québec, Tarifs résidentiels d'électricité, Structure du tarif D, Rates in effect on April 1, 2013.

Q26

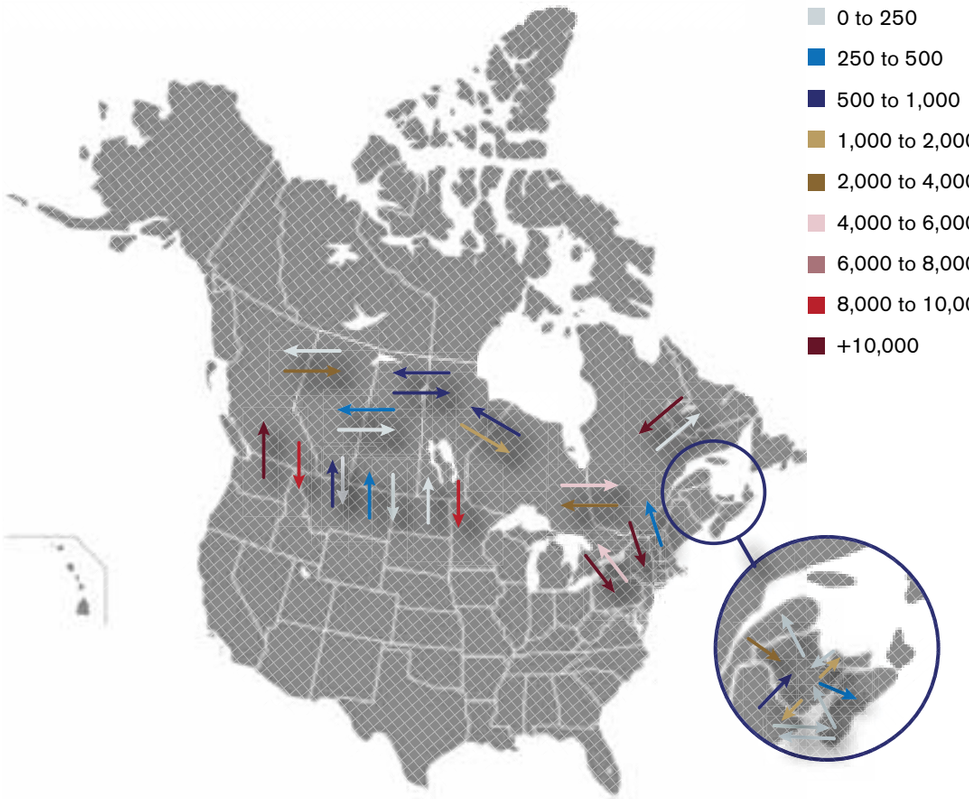
How is North America's electricity network organized?

The North American electricity network is the world's largest electricity production, transmission and distribution system. The North American market generates 830 gigawatts of demand and comprises 340,000 kilometres of high-voltage transmission lines.

For both physical and administrative reasons, the network is divided into four synchronized-frequency systems, referred to as interconnections. The Quebec interconnection covers all of Quebec. The eastern interconnection groups the Maritime Provinces, Ontario, Manitoba and Saskatchewan, while the western one encompasses Alberta and British Columbia. The Texas interconnection does not cover any Canadian territory.

Since the electricity network consists of a large number of production, distribution and transmission operations that are nevertheless connected with each other, network reliability is delegated on a regional basis to non-profit organizations. Three of them operate on Canadian territory: the Northeast Power Coordination Council, the Midwest Reliability Organization and the Western Electricity Coordination Council.

A majority of electricity exchanges in Canada occur between provinces and U.S. states. Only Alberta, Saskatchewan and Nova Scotia are net electricity importers. The other provinces are all net exporters. In 2012, Canada's net exports to the United States stood at 47,000 gigawatt-hours, or 7.9% of Canadian production.



Sources: The Energy Library, North American electricity grid. Canadian Electricity Association, Canada's electricity industry, 2013.

Q27

What kinds of energy are produced in Quebec?

Quebec is in a special situation in that electricity is practically the only form of energy produced in the province. In 2012, this production totalled 200 TWh, 97% of which was from hydroelectric power plants.

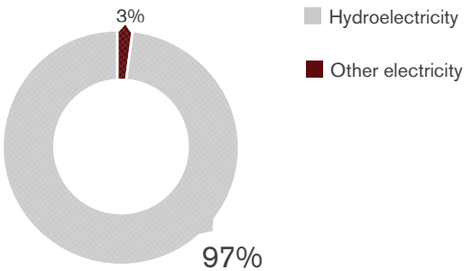
The other source of energy is biomass, which is to say fuel wood and forestry industry residue, which serve to produce heat and a small amount of electricity.

Practically all energy produced in Quebec therefore comes from renewable sources. Quebec and Prince Edward Island are the only two Canadian provinces that do not produce hydrocarbons: no oil, no natural gas, and no coal.

The Crown corporation Hydro-Québec, which owns 60 hydroelectric generating stations, is one of the largest producers of hydroelectricity in the world. Hydro-Québec produces the vast majority of the electricity in the province. The rest of production is undertaken by private producers or municipalities. For example, Rio Tinto Alcan, which owns 28 dams, is the second largest producer of hydroelectricity in Quebec. The City of Sherbrooke, for its part, runs eight hydroelectric plants.

Private producers of wind power produced 2.6 TWh of electricity in 2012, which represents 1.2% of all electricity produced and purchased by Hydro-Québec. Cogeneration from biomass represented just 0.76% of available electricity production in 2010. A few diesel generating stations also produce electricity in remote regions.

Proportion of electricity produced by hydroelectric power plants in the province of Quebec :



Sources: Canadian Electricity Association, Key Canadian Electricity Statistics, May 2013. Hydro-Québec, ***Rapport annuel 2012***, 2013. Hydro-Québec, ***Rapport sur le développement durable 2012***, 2013. Quebec department of natural resources, Production d'électricité.

Q28

Is electricity the main source of energy in Quebec?

To compare consumption levels of different forms of energy, they are measured by tonne of oil equivalent (toe), which is the quantity of energy released by burning one tonne of oil. In 2010, Quebec's energy consumption amounted to 39.4 million toe, or 4.98 toe per inhabitant. This puts it 21st in the world in per-capita energy consumption.

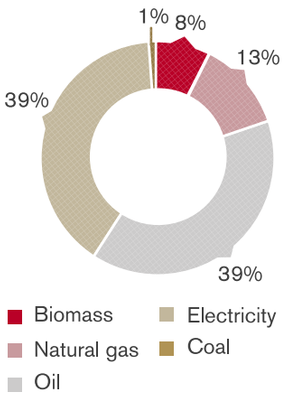
Electricity is the largest source of energy consumed in Quebec, accounting for 39.3% of total energy supply. Quebecers are the world's second greatest per capita electricity consumers, behind only Icelanders.

The industrial sector consumes 46.4% of all electricity in Quebec. The smelting and refining industries, including aluminum plants, as well as the pulp and paper industry, account for a substantial share of industrial consumption.

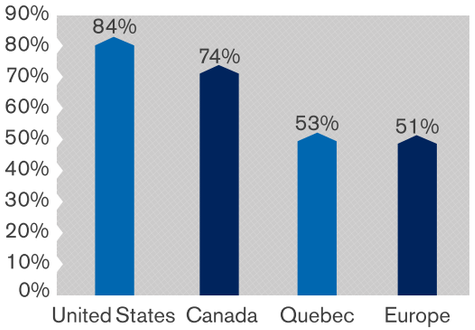
Oil is also a crucial element in Quebec's energy reality, however. It is the second most heavily consumed form of energy, nearly tied with electricity at 38.6% of total supply. Transportation accounts for 74.9% of this oil consumption.

Fossil fuels remain dominant in Quebec, because adding other hydrocarbons such as natural gas and coal brings this category to 53% of energy supply, lower than Canada as a whole (74%) and the United States (84%) though slightly higher than Europe (51%).

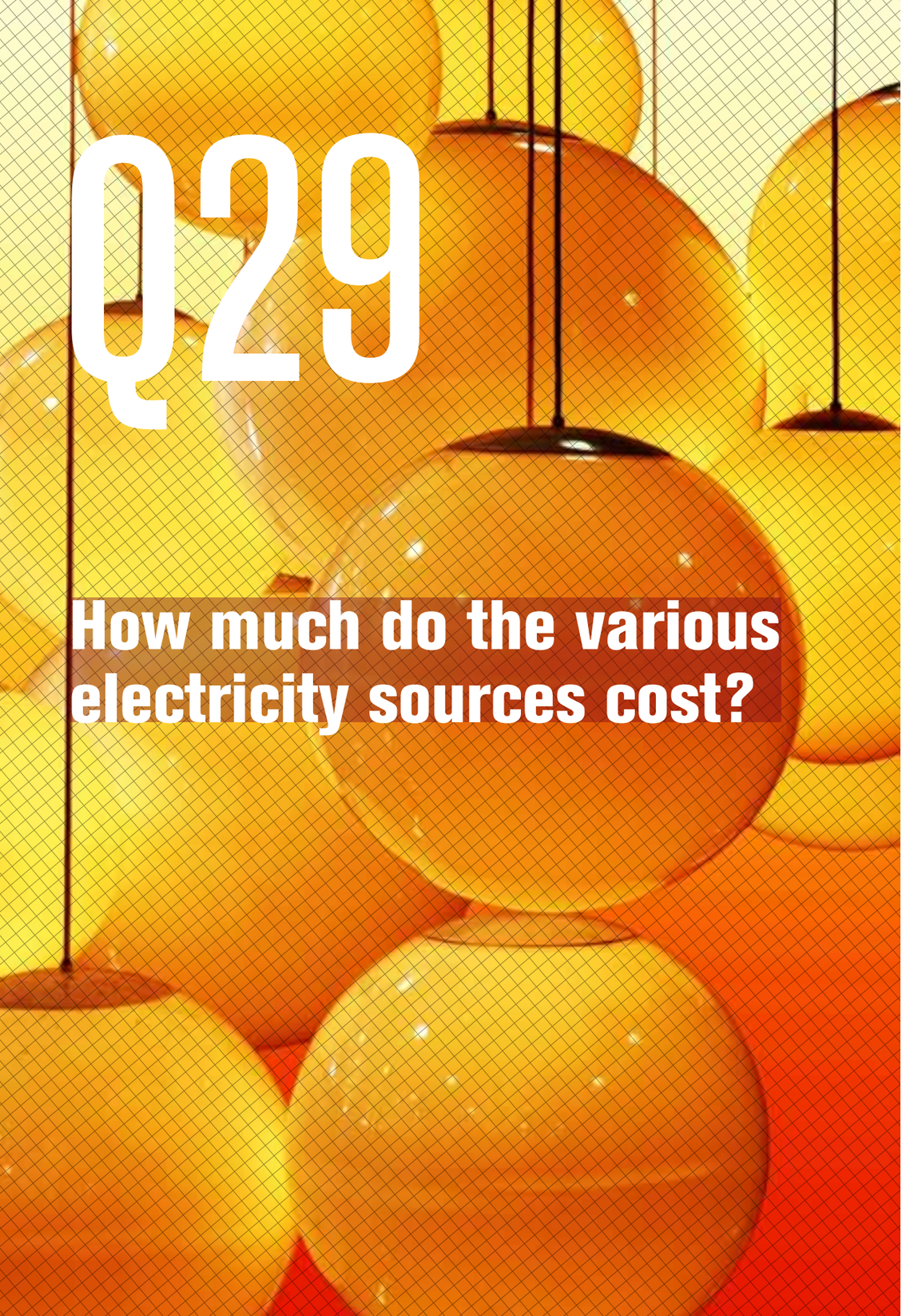
Energy supply in Quebec by source (2009)



Proportion of fossil energy in total consumption



Sources: Quebec department of natural resources, Final consumption by form of energy. Quebec department of natural resources, Total energy consumption. Eurostat, Consumption of energy, 2012. World Bank, Energy use (kg of oil equivalent per capita), 2009. World Bank, Fossil fuel energy consumption (percentage of total), 2009.



Q29

How much do the various electricity sources cost?

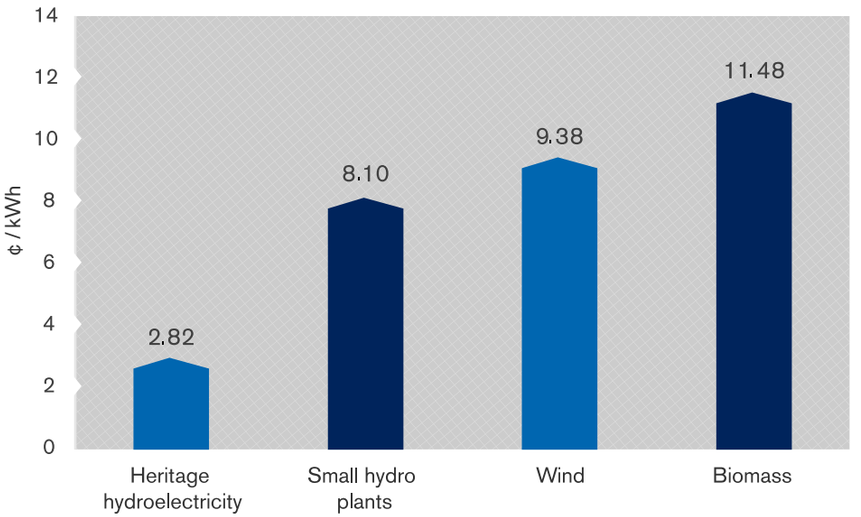
The prices that electricity distributors pay for their supplies vary from one province to another and by source of supply. The example of Hydro-Québec shows this clearly.

Most electricity sold by Hydro-Québec comes from what is called the heritage electricity bloc. This is a large quantity of energy produced by Quebec's main hydroelectric plants and by the Churchill Falls plant in Labrador. The production cost of this heritage electricity is the lowest of all energy sources, at about 2.1 cents per kilowatt-hour (¢/kWh). This electricity is reserved for Hydro-Québec's distribution subsidiary, which buys it at 2.82 ¢/kWh.

Hydro-Québec Distribution also buys electricity from other producers under provincial government guidelines. Electricity from biomass-based cogeneration is purchased at an average price of 11.48 ¢/kWh, while energy from small hydro plants is bought at 8.1 ¢/kWh. Meanwhile, wind energy is sold to Hydro-Québec at an average price varying between 7.8 and 12.3 ¢/kWh.

The average price of the electricity sold by Hydro-Québec Distribution to Quebecers and to outside markets was 5.76 ¢/kWh in 2012. Hydro-Québec's domestic rates are set by the Régie de l'énergie, whereas prices for electricity exports are determined by the market. All sources of supply that cost more than the average selling price are indirectly subsidized.

Hydro-Québec costs of electricity supply, by source



Sources: Hydro-Québec, ***Rapport annuel 2012***, 2012. Assemblée nationale du Québec, ***Loi sur la Régie de l'énergie***. Hydro-Québec Distribution, Application R-3814-2012, July 2012.

Q30

Are Canadians driving around in electric cars?

In Canada, the road transportation sector accounts for 19% of greenhouse gas emissions. Retail sales of refined oil products for transportation represent, on their own, 20% of Canadian energy demand.

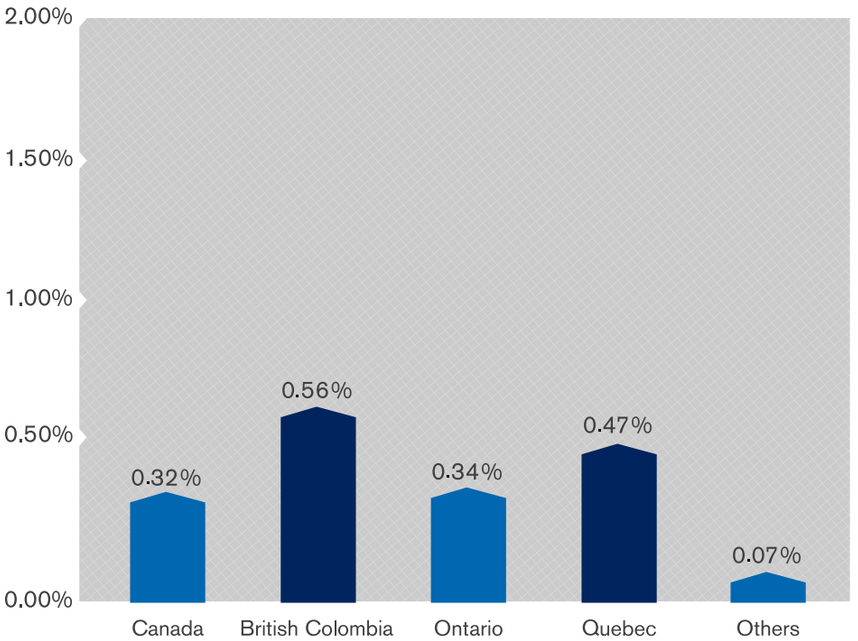
Electric cars, since they use electricity instead of traditional fuels, are being put forward as an alternative to oil consumption in the transportation sector. However, they currently account for just a small fraction of Canada's automotive fleet. Only 4,059 of Canada's 20.3 million cars and light trucks (0.02%) run on electricity.

To promote their use, Ontario, Quebec and British Columbia reimburse part of the purchase price of these vehicles, with the amount varying between $5,000 and $8,500. Governments also subsidize the purchase and installation of electric charging stations.

These provincial subsidies have resulted in Ontario, Quebec and British Columbia accounting for 97% of all electric cars bought in Canada up to now. Despite this, electric cars still comprise only 0.44% of the market for car sales in these three provinces.

Other new vehicle propulsion technologies, such as hydrogen engines and fuel cells, may soon emerge on the Canadian market and compete with traditional electric cars.

Share of electric cars in total car sales, by province (2013)



Sources: Environment Canada, ***National Inventory Report 1990-2011: Greenhouse Gas Sources and Sinks in Canada***, 2011. Statistics Canada, ***Report on Energy Supply and Demand in Canada – 2011 Revision***, Table 2-1, Primary and secondary energy, terajoules – Canada, No. 57-003-X, 2011. World Wildlife Fund (WWF) Canada, ***Transportation rEVolution: Electric vehicle status update 2013***, 2013.

Q31

What proportion of greenhouse gas emissions are due to the development of the oil sands?

After Saudi Arabia and Venezuela, Canada is the country with the largest proven oil reserves, with 173 billion barrels. Over 97% of these reserves exist in the form of oil sands made up of a mixture of sand, water, clay and bitumen.

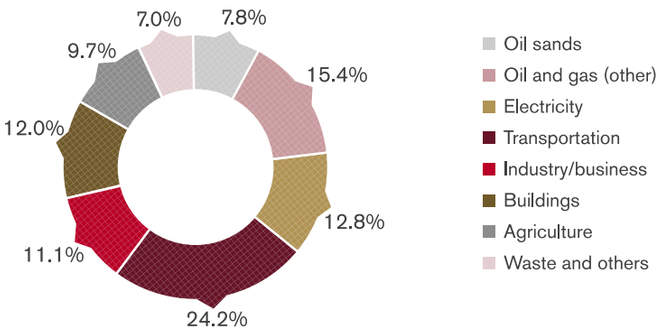
Bitumen is a heavy, thick form of oil, such that at 10°C, it is as hard as a hockey puck. The extraction of bitumen requires that it be heated, which uses more energy and generates more greenhouse gases (GHGs) than the production of conventional oil. The development of the oil sands is therefore subject to particular attention.

However, the extraction stage represents just a small part of the GHG emissions generated by oil over the course of its life cycle. Its combustion accounts for 70% to 80% of these emissions. The difference in GHG emissions between oil extracted from the oil sands and conventional oil is therefore just between 5% and 10%.

In 2011, the development of the oil sands generated 7.8% of the 702 megatonnes of CO2 equivalent of GHGs emitted by Canada, or 55 megatonnes. On a global scale, Canadian bitumen is responsible for less than 0.1% of total GHG emissions.

Although in absolute terms, GHG emissions due to the oil sands increased by 62% between 2005 and 2011 because of increased production, significant technological improvements by the oil sands industry between 1990 and 2011 led to a 26% reduction in emissions per barrel.

GHG emissions per economic sector in Canada (2011)



Sources: Environment Canada, Canada's Emissions Trends, October 2013. Environment Canada, "National Inventory Report: Greenhouse gas sources and sinks in Canada, The Canadian Government's Submission to the UN Framework Convention on Climate Change," Parts 1, 2 and 3, 2013. Natural Resources Canada, "Oil sands: GHG Emissions," May 2013.

Q32

How can the production of natural gas help reduce GHG emissions?

Among fossil fuels, natural gas is the one that emits the least carbon dioxide (CO_2) relative to the amount of energy it produces. Oil products and coal emit more.

For this reason, relying more on natural gas to satisfy the demand for electricity production, home heating and transportation could help reduce greenhouse gas emissions.

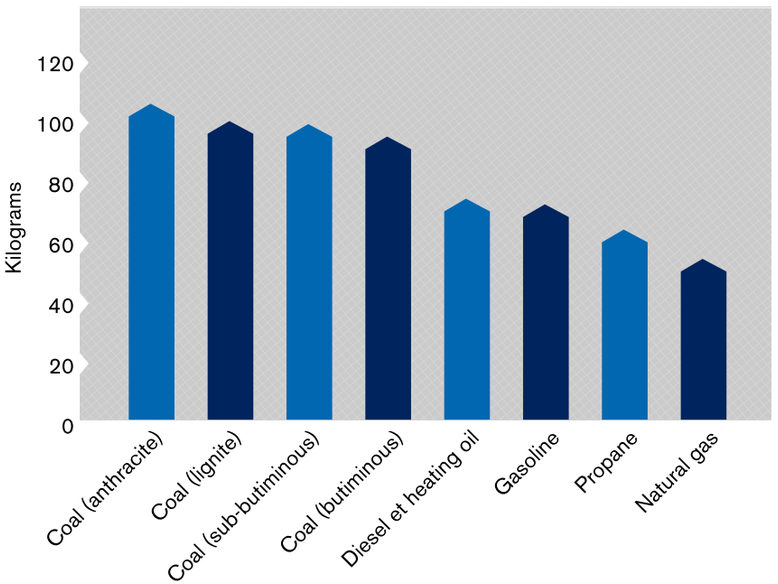
Greenhouse gas emissions from the production of electricity using natural gas amount to about half of those from the production of electricity using coal over the total life cycle (which is to say from production to distribution to final use).

Alberta, Saskatchewan and Nova Scotia each produce over half of their electricity by burning coal and therefore have the most significant potential for replacing coal with natural gas.

When it comes to home heating, natural gas could replace oil in Nova Scotia, where 59% of families heat their homes with oil, and in Prince Edward Island, where 76% do.

Natural gas vehicles (basically trucks and buses) can also help reduce greenhouse gas emissions by 20% to 25% compared to vehicles that run on diesel.

Quantity of CO_2 emitted by different fuels for the same quantity of energy (1 million BTUs)



Sources: Natural Resources Canada, ***Energy Markets Fact Book 2013-2014***, 2013. Statistics Canada, Table 203-0019, Survey of household spending (SHS), dwelling characteristics at the time of interview, by province, territory and selected metropolitan areas. Go with Natural Gas, ***Why Natural Gas?***, 2012.

Q33

What role does wind energy play in Canadian energy consumption?

Wind energy has grown spectacularly in recent years. Between 2008 and 2013 alone, Canada's production capacity climbed 229%. It now stands at 7,803 MW. But this energy source accounts for only 1.47% of all electricity produced in Canada.

The desire of governments to develop clean, renewable energy sources explains wind energy's growth. However, producing it runs up against major constraints. For example:

(1) Wind energy depends on air density and on the power and regularity of winds. This means it is intermittent, variable and unpredictable. As such, additional electricity production systems are needed to avoid interruptions in supply.

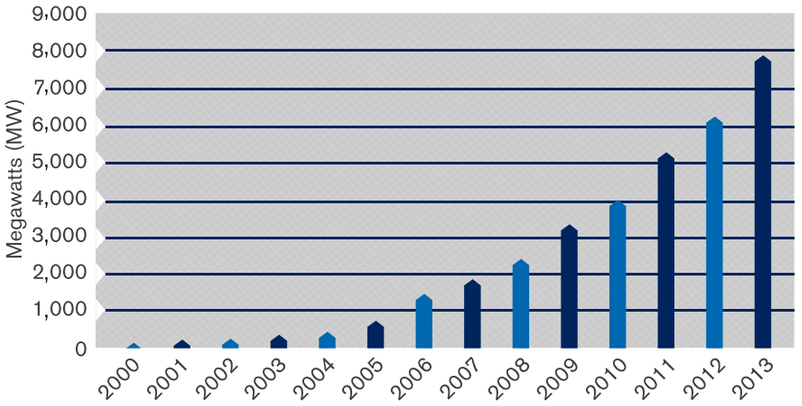
(2) Unlike fossil energy, wind energy is not concentrated in particular places. Accordingly, exploiting it requires large areas.

(3) Wind energy is still not competitive with other forms of energy in terms of cost, and its production is subsidized nearly everywhere. In Quebec alone, Hydro-Québec subsidizes wind energy indirectly by as much as $700 million a year.

(4) Wind turbine blades are deadly obstacles for birds and bats. By some estimates, more than a million of these flying creatures may have died this way in the United States in 2012.

(5) Turbine noise, vibrations and beacons may upset the quality of life, sleep and health of people living near wind farms.

Wind energy installed capacity in Canada (since 2000)



Sources: Canadian Wind Energy Association, "Powering Canada's Future," January 2013. Canadian Electricity Association, Key Canadian Electricity Statistics, May 2013. Youri Chassin and Guillaume Tremblay, "The Growing Cost of Electricity Production in Quebec," Montreal Economic Institute, June 2013. K. Shawn Smallwood, "Comparing bird and bat fatality-rate estimates among North American wind-energy projects," ***Wildlife Society Bulletin***, March 2013, Vol. 37, No. 1. Minnesota Department of Health Environmental Health Division, "Public Health Impacts of Wind Turbines," May 2009.

Q34

What is Canada's geothermal potential?

Geothermal energy involves a process that uses temperature differences between the air and the ground or a body of water. This energy source offers the advantages of being renewable, unlimited and accessible everywhere. However, it is not widely used in Canada because installation costs are high compared to other available forms of heating. It covers its costs only over a long period.

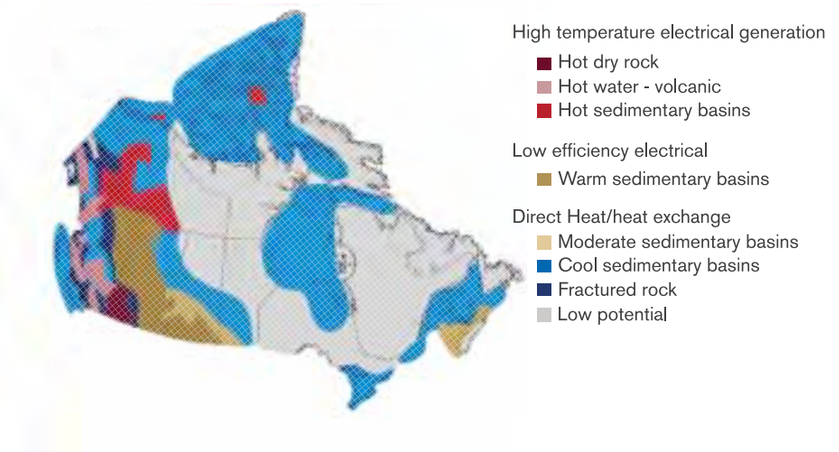
This energy system has seen significant growth since 2005 but is still not very common. In terms of home use, tens of thousands of homes use geothermal energy for heating and air conditioning. Geothermal facilities are found mostly in Ontario.

Geothermal energy can also have industrial applications, through steam production. Use can also be made of deep geothermy, in contrast to home installations that use surface geothermy. This involves digging down to depths where the rock is very hot and then circulating water there for conversion to steam. This process may be used as well to produce electricity.

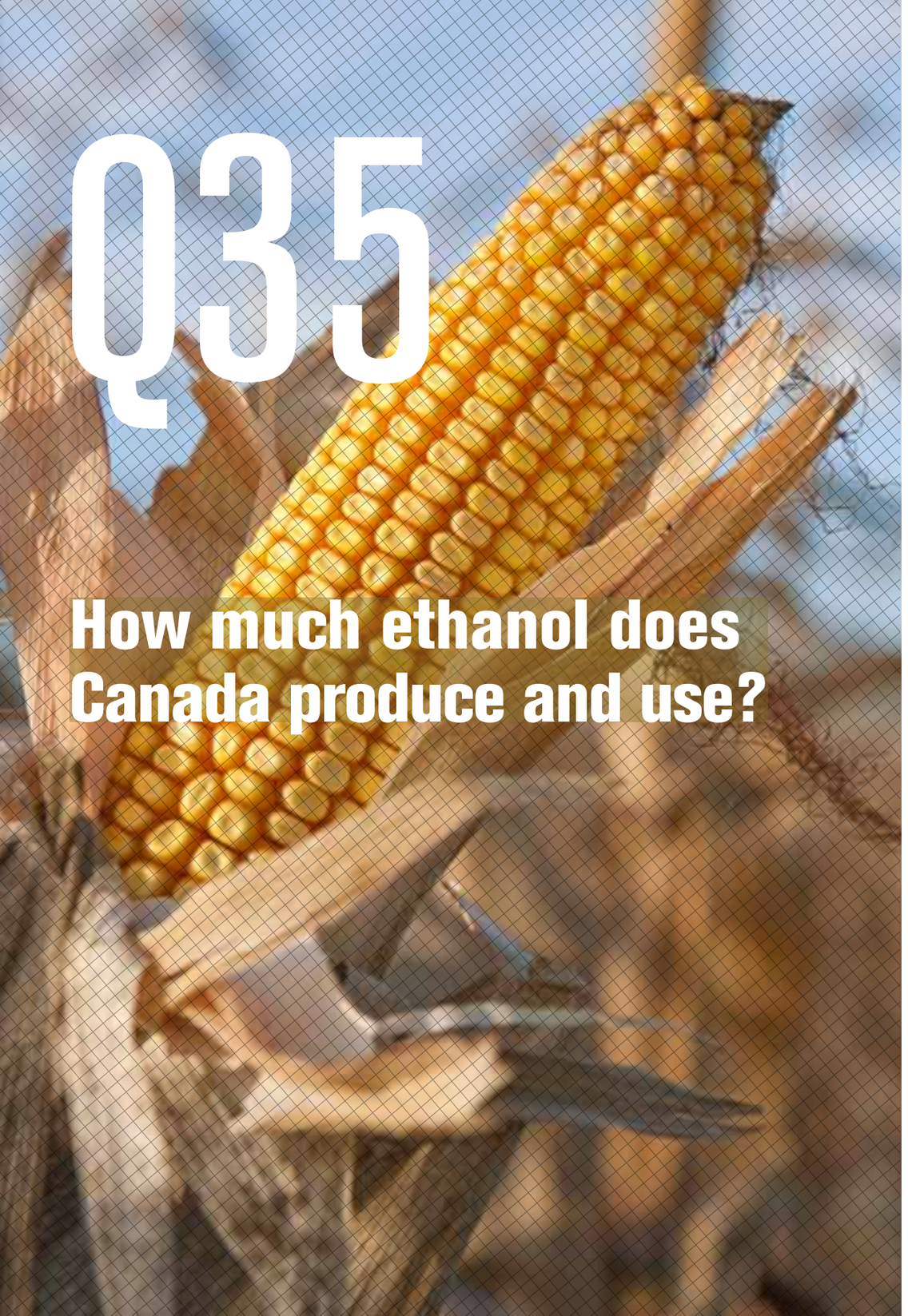
In practice, the economics of deep drillings depend heavily on geology. The use of geothermal energy for industrial purposes is therefore found mostly in places with a relatively recent volcanic past, such as Iceland, where hot rocks are found at exceptionally shallow depths.

In Canada, deep geothermy is found only in experimental projects or demonstrations. The greatest potential exists in sparsely populated parts of Western Canada, particularly in British Columbia and the Northwest Territories.

Distribution of geothermal potential in Canada based on end use



Sources: Canadian GeoExchange Coalition, ***The State of the Canadian Geothermal Heat Pump Industry 2011: Industry Survey and Market Analysis***, February 2012. Natural Resources Canada, ***Geothermal Energy Resource Potential of Canada***, 2012.



Q35

How much ethanol does Canada produce and use?

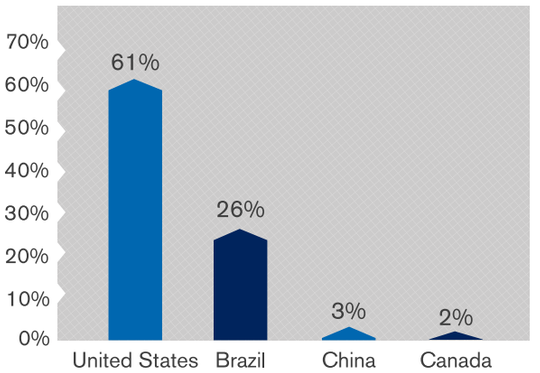
Ethanol is a form of alcohol whose combustion produces energy and that can therefore be used as fuel to run the engines of certain vehicles. It is the most widely used biofuel in the transportation sector. Since few engines are designed to run solely on ethanol, this fuel is usually mixed with traditional gasoline. In 2012, gasoline sold in Canada contained an average of 5.6% ethanol.

It is a federal government regulation requiring oil companies to sell gasoline containing a minimum of 5% ethanol that created the Canadian demand for ethanol. In addition, there also exist similar provincial laws.

Thanks to the support of federal government subsidies, 1.73 billion litres of ethanol were produced in Canada in 2012, while 2.40 billion litres were consumed. Canada is therefore a net importer of ethanol. It is the 4th largest producer in the world, but accounts for just 2% of global production. The three top producers are the United States, Brazil and China, who together account for fully 90% of global production.

In Canada, ethanol is produced from two grain crops, namely corn (78%) and wheat (21%). This kind of production is increasingly controversial. The European Union recently decided to limit the importation of ethanol made from agricultural crops because of concerns that its production creates environmental problems and also threatens food security by causing grain prices to rise in developing countries.

Production of ethanol by country as a proportion of global production (2012)



Sources: USDA Foreign Agricultural Service, Global Agricultural Information Network, "Canada Biofuels Annual," CA13034, 2013. F. O. Licht, cited in "2013 Ethanol Industry Outlook," Renewable Fuels Association, 2013.

Q36

How much uranium is produced in Canada?

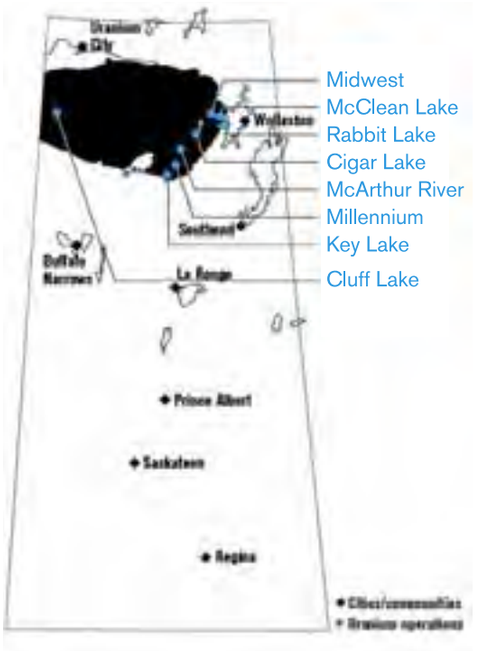
Canada is a significant producer of uranium, a metal that is used almost exclusively to produce electricity in nuclear power plants. In 2012, some 9,000 tonnes of uranium were extracted from Canadian soil, accounting for 15.4% of global production. Only Kazakhstan produces more (36.5%).

Nearly all (85%) of Canadian production is exported. The rest is used in the Pickering, Darlington and Bruce CANDU reactors in Ontario, and in the Point Lepreau reactor in New Brunswick. The Gentilly-2 nuclear plant in Quebec was shut down in December 2012. Around 15% of electricity in Canada is produced by nuclear generating stations.

Like all metals, uranium is extracted from underground or open pit mines. All Canadian uranium mines currently in operation are located on a few sites in northern Saskatchewan. That's where we find the underground McArthur River Mine, first in the world in terms of production with over 7,500 tonnes of uranium extracted per year from a high-grade deposit.

Uranium mines operate in much the same way as other mines since the natural radioactivity of the rock poses no immediate danger to workers, although it does require heightened surveillance. However, it is important for solid and liquid residues from uranium mines to be properly disposed of to make sure that in the longer term, they do not contaminate surrounding waters or the food chains of local populations.

Uranium operations in Saskatchewan



Sources: World Nuclear Association, Uranium in Canada and Nuclear Power in Canada. Saskatchewan Mining Association, Uranium.

Q37

What is the place of biomass and heating wood in Canada?

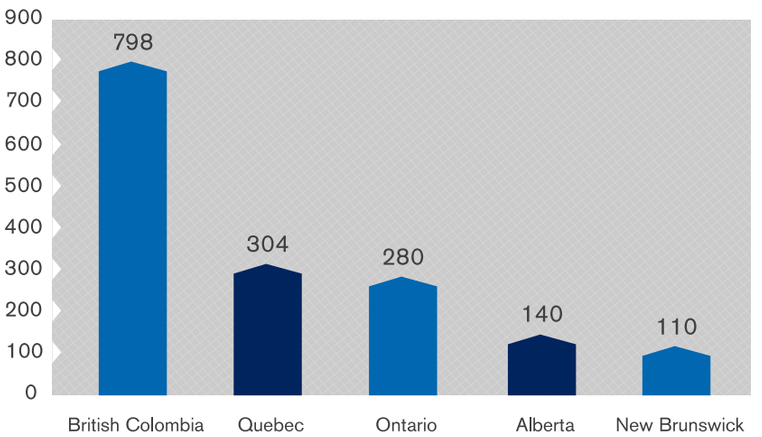
Canada's forests are a major source of renewable energy in the form of biomass and heating wood.

Wood is the most commonly used biomass, either in the form of logs or of waste from industrial activities, those of the pulp and paper industry in particular. Biomass may be converted into bioenergy for producing heat or electricity.

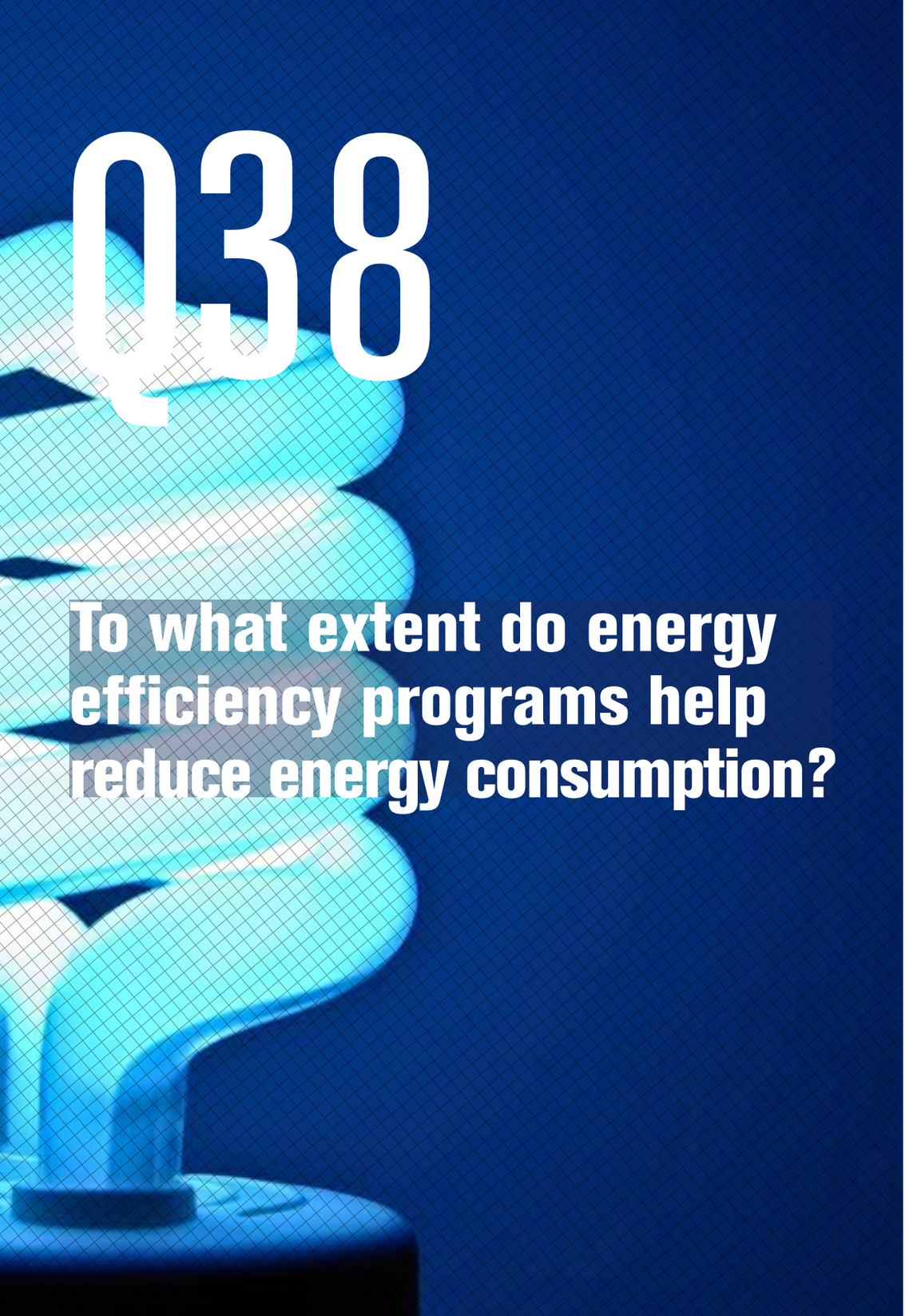
Wood and spent pulping liquor were used to provide 7.5% of all electrical energy produced in Canada in 2012. In 2010, 61 power plants across Canada used bio-energy and had a total electricity production capacity of 1,700 megawatts. In the same year, they generated 8.3 million megawatt-hours of electricity with wood residue and spent liquor. Electricity production capacity from burning biomass is found primarily in provinces with the greatest forestry activity, including British Columbia, Ontario, Quebec, Alberta and New Brunswick.

Wood also plays a significant role in home heating in some provinces. In 2009, 4.3% of Canadian households used wood as a primary or secondary source for heating their homes. The proportion was highest in the Atlantic Provinces – at 21.3% in New Brunswick, 16.5% in Prince Edward Island, 14.6% in Newfoundland and Labrador, and 11.9% in Nova Scotia.

Bioenergy generating capacity in megawatts in Canada, by province (2010)



Sources: Natural Resources Canada, About Renewable Energy, 2013. Natural Resources Canada, Biomass, bioenergy and bioproducts, 2013. Natural Resources Canada, Bioenergy from biomass, 2013. Statistics Canada, Table 203-0019, Survey of household spending (SHS), dwelling characteristics at the time of interview, by province, territory and selected metropolitan areas. Statistics Canada, Table 128-0014, Electricity generated from fossil fuels, annual (Gigawatt hours).



Q38

To what extent do energy efficiency programs help reduce energy consumption?

Many governments place great hope in energy efficiency measures to limit energy consumption, reduce costs and keep greenhouse gas emissions to a minimum.

This is true of Canada where, as an example, residential energy consumption per square metre fell 29% between 1990 and 2010. Technological progress has brought more energy-efficient appliances and heating systems onto the market, along with the use of better insulation techniques. This lower energy intensity is also evident in most other sectors of the economy.

Despite this, total energy consumption continues to rise, in the residential sector and elsewhere. This phenomenon is due primarily to demographic and economic growth that leads to our consuming more.

We also need to take account of the "rebound effect," behavioural changes that undermine expected energy savings resulting from more efficient energy use.

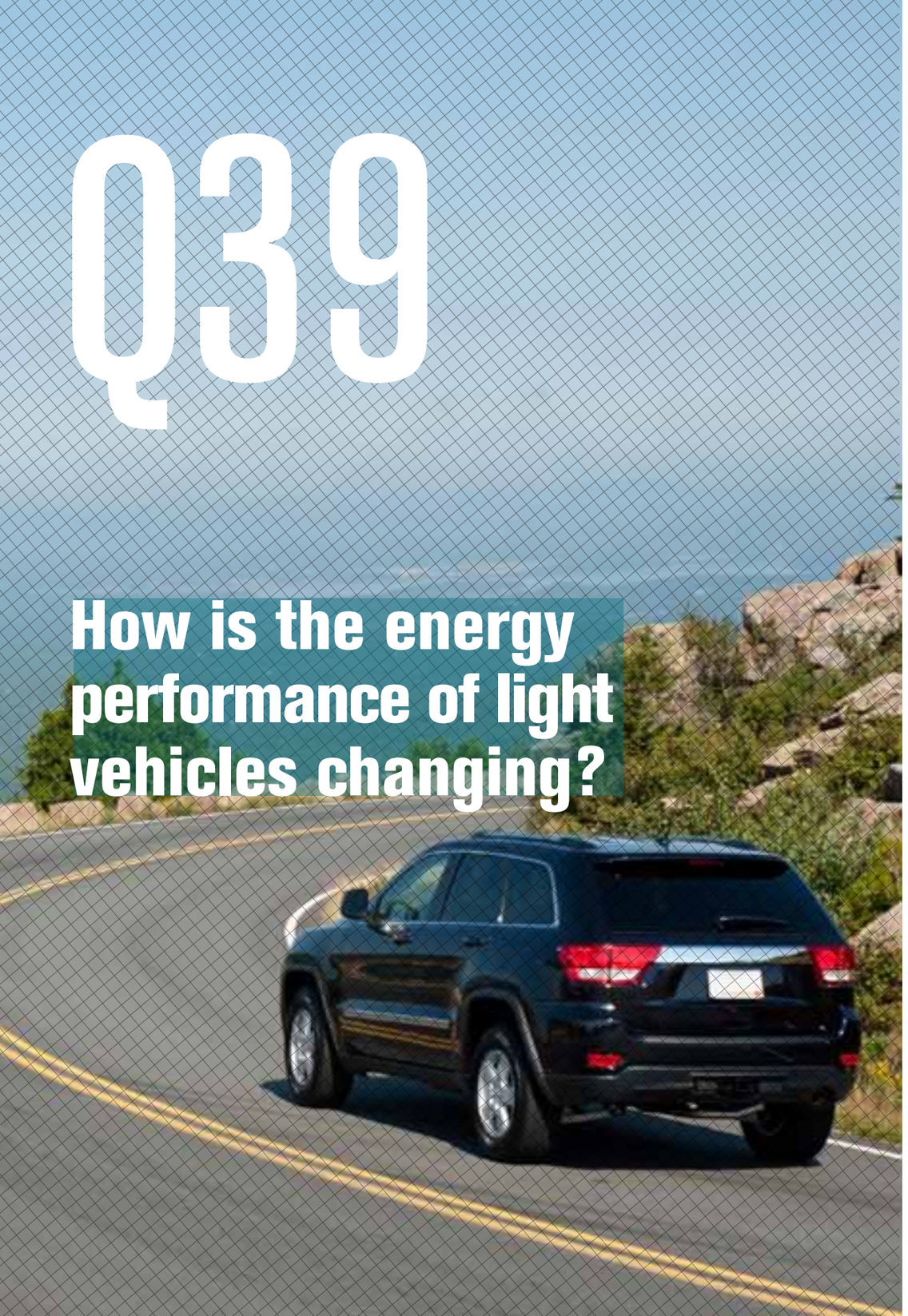
For example, more efficient vehicles lead people to move around more and to substitute cars for other means of transportation. Moreover, the higher number of trips produces greater demand for other goods and services, such as tires, vehicle maintenance, food and lodging services, and so on. Finally, lower trip costs may encourage households to head for the suburbs, bring about changes in the industrial structure or favour economic growth.

Together, these effects result in ever-increasing energy consumption, even though we may be consuming this energy more efficiently.

Energy intensity and energy consumption in Canada (1990 - 2010)

Sector	Variation in energy intensity	Variation in total energy consumption
Residential (Gigajoules/m2)	-29.4%	+6.1%
Commercial and institutional (Gigajoules/m2)	-13.0%	+22.0%
Industrial (Megajoules/dollar of real GDP $2002)	-10.4%	+19.1%
Passenger transport (Megajoules/passenger-km)	-19.1%	+17.9%
Freight transport (Megajoules/tons-km)	+10.9%	+70.5%
Agricultural (Megajoules/dollar of real GDP $2002)	-7.0%	+22.8%

Sources: Natural Resources Canada, Comprehensive Energy Use Database. Sheetal Gavankar and Roland Geyer, "The Rebound Effect: State of the Debate and Implications for Energy Efficiency Research," Bren School of Environmental Science and Management (University of California), 2010.



Q39

How is the energy performance of light vehicles changing?

In Canada, one third of energy consumption is attributable to the transportation sector, essentially the transportation of travellers. This sector has experienced substantial progress, especially with regard to the energy performance of light vehicles.

The energy consumption of light vehicles (in petajoules) fell by 13.3% from 1990 to 2010. This reduction took place despite the fact that more and more people are travelling more and more total kilometres. In fact, the number of passenger kilometres travelled by light vehicles increased by 7.3% over the same period.

This change is in contrast with the transportation sector in general, where the consumption of energy actually increased by 38.2% over the same period, primarily due to the transportation of goods.

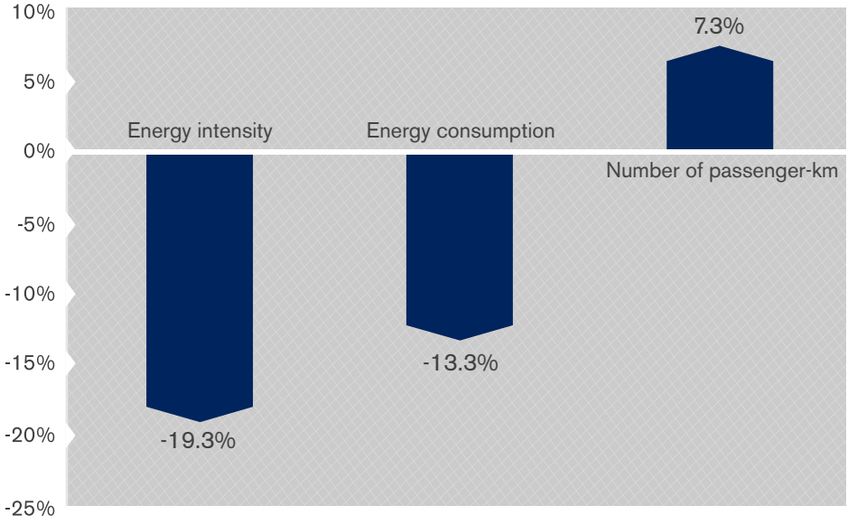
What explains this performance? The falling energy intensity of light vehicles.

When it comes to the transportation of travellers, energy intensity refers to the quantity of energy needed to displace one person over a distance of one kilometre. Between 1990 and 2010, this intensity fell by 19.3%, from 2.33 to 1.88 megajoules per passenger kilometre covered.

Furthermore, due to changes in vehicle design, the average quantity of CO_2 emitted per year by light vehicles fell by 19.3% between 1995 and 2013, from 5,520 kg to 4,455 kg.

In summary, over time, vehicles are becoming more efficient, are guzzling less fuel and are cleaner overall.

Change in light vehicles energy performances (1990-2010)



Sources: Natural Resources Canada, Office of Energy Efficiency, Energy Use Database. Natural Resources Canada, Office of Energy Efficiency, Fuel-Consumption Ratings.

Q40

What role does natural gas play in road transportation?

Over 15 million vehicles around the world are fueled by natural gas, most of them in Latin America and the Asia-Pacific region. Motors are easily adapted to burn it and produce fewer atmospheric emissions than those that use gasoline.

Special tanks are required to contain the gas at high pressure or low temperature, however. These expensive, bulky tanks provide less autonomy—as measured by the distance that can be travelled between fill-ups—than gasoline or diesel, but more than electric propulsion.

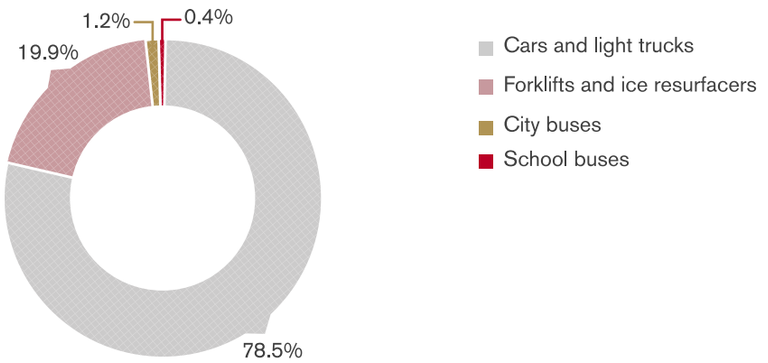
Such an investment is easier to justify when a vehicle is heavy, when it has room for this kind of tank and when it travels many miles over its useful life (for example, a tow truck).

In Canada, where road vehicles sometimes travel long distances between regions not served by natural gas pipelines, nearly 10,000 vehicles were fuelled by natural gas in 2010. There were also some 2,400 forklifts and ice resurfacers using the same technology.

Before the very rapid growth of shale gas development in the United States in recent years, the price of Canadian gas was too high to maintain enough demand to justify the construction of new service stations. Now that natural gas prices have fallen, new opportunities may arise.

Finally, natural gas also plays an indirect role in the road transport sector. It serves to produce electricity for electric vehicle users in Canada, as well as steam used to extract oil from the oil sands.

Distribution of the 12,000 natural gas vehicles in Canada



Sources: The Natural Gas Vehicle Knowledge Base. Natural Resources Canada, ***The Natural Gas Use in the Canadian Transportation Sector Deployment Roadmap***.

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"Canada is, on a global scale, an energy superpower. Its future prosperity and dynamism will depend in large part on our ability to develop these abundant resources while respecting the environment and affected local communities. The better informed we are, the more we will be able to find this balance and make the right decisions."

Michel Kelly-Gagnon
President, Montreal Economic Institute (iedm.org)