



Natural Resources
Canada

Ressources naturelles
Canada

ENERGY

FACT BOOK



2015-2016



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Preface

The purpose of the *Energy Fact Book* is to provide key information on energy markets in Canada in a format that is easy to consult.

This edition is based on data and information available as of July 2015. All data is subject to revisions by statistical sources. In some instances, more than one source may be available and discrepancies in numbers may occur because of conceptual or methodological differences. In addition, some numbers may not add correctly because of rounding.

This publication was assembled by the Energy and Economic Analysis division of the Energy Policy branch with the help of subject experts from across the Energy sector and the Minerals and Metals sector of Natural Resources Canada.

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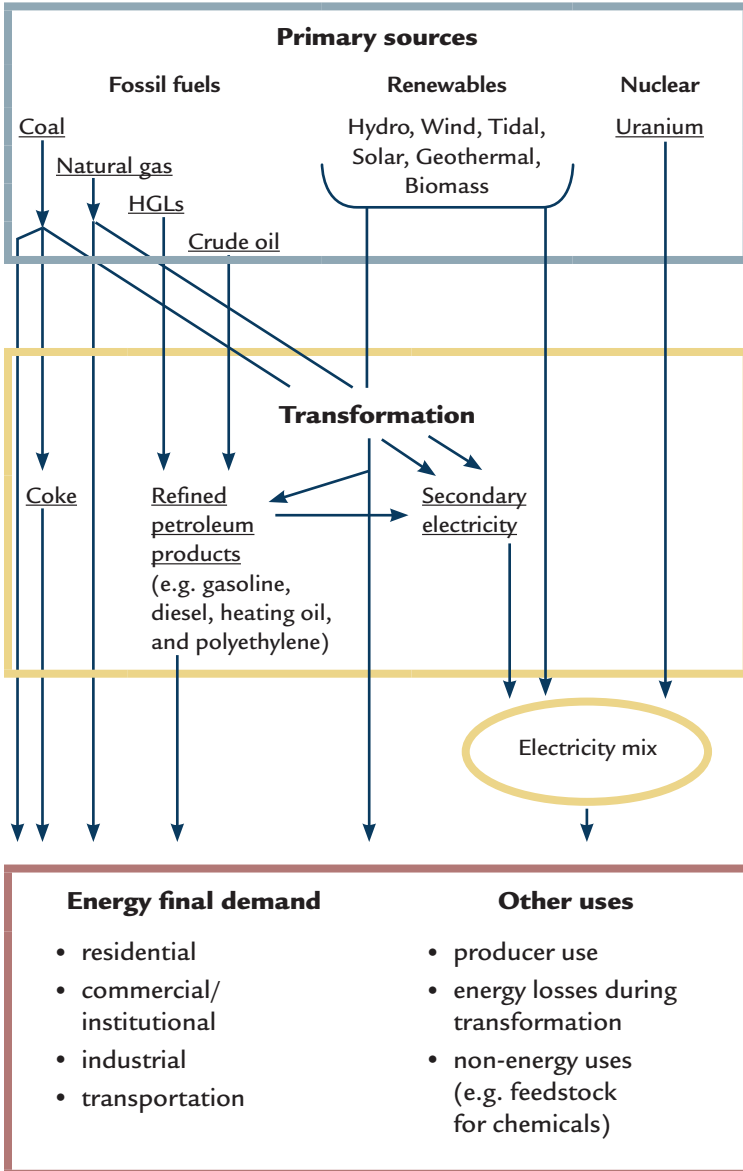
Definition

In this publication, the following industries are considered to be energy industries:

- oil and gas extraction
- coal mining
- uranium mining
- support activities for oil and gas extraction
- electric power generation, transmission and distribution
- pipeline transportation
- natural gas distribution
- biofuels production
- petroleum refineries

Clean energy industries such as renewable and nuclear electricity generation, biofuels production and carbon capture and storage facilities are contained within the definition of energy industries. Some energy-related industries (e.g. petroleum product wholesaler-distributors and coal product manufacturing) are excluded because of a lack of data.

Energy flow



Canada's position in the world (2014)

Resource	Proved reserve/ capacity	Production	Exports
Crude oil	3rd	5th	3rd
Natural gas	18th	4th	4th
Coal	15th	12th	8th
Uranium	4th	2nd	2nd
Electricity	7th	6th	2nd
Renewable energy	–	7th	–
Hydroelectricity	4th	2nd	–
Wind	7th	–	–
Biofuels	–	5th	–

Note: Rankings relate to proved reserves for oil, natural gas, coal and uranium. Other resource rankings relate to capacity.

Energy and the economy (2014)

Gross domestic product (in current prices)

Industry	Nominal GDP* (\$ billions)	% of Canadian GDP
Energy (Direct)	185	10.0
• Oil and gas**	144	7.8
• Electricity	36	2.0
Energy (Indirect)***	69	3.7
• Oil and gas	52	2.8
Total (Direct + Indirect)	254	13.7
• Oil and gas	196	10.6

Employment

Industry	Employment (jobs)	% of total employment
Energy (Direct)	289,850	1.6
• Oil and gas**	191,900	1.1
• Electricity	85,655	0.5
Energy (Indirect)***	660,840	3.6
• Oil and gas	550,590	3.0
• <i>Oil and gas construction</i>	204,160	1.1
Total (Direct + Indirect)	950,690	5.2
• Oil and gas	742,490	4.1

About 12,000 Aboriginal people living off-reserve are directly employed in the energy sector.

* NRCan analysis

** Oil and gas includes oil and gas extraction, support activities for oil and gas extraction, natural gas distribution, petroleum refineries, and pipeline transportation.

*** NRCan analysis; includes industries (e.g. equipment manufacturing, construction, financial services) that supply goods and services to the energy industry.

Energy and the economy (2014)

Energy trade

Resource/ product	Exports*			Imports
	% of Canadian production	% to U.S.	% of U.S. imports/ consumption	% of Canadian consumption
Crude oil	76	97	39/18	31
RPPs	25	92	22/3	12
Natural gas	52	100	98/10	25
Coal	49	3	9/0.1	19
Uranium	80	51	20/18	-
Electricity	10	100	89/2	2

Exports*

- \$146 billion
- 30% of Canadian domestic merchandise exports
- 93% (\$136 billion) of total Canadian energy exports are to the U.S.
- Oil and gas domestic exports totaled \$137 billion, of which 96% were to the U.S.

Imports

- \$55 billion
- 11% of Canadian merchandise imports
- 68% (\$37 billion) of total energy imports are from the U.S.

* Exports refers to domestic exports, which exclude the re-export of goods that have previously entered Canada and exit in the same condition.

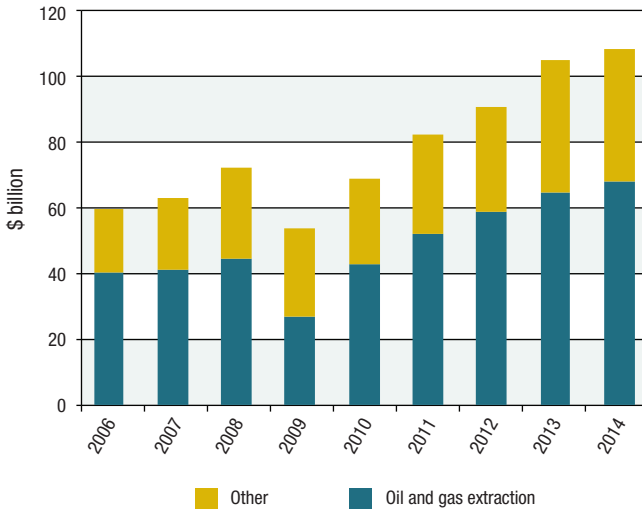
Energy and the economy (2014)

Capital expenditures*

- \$109 billion
- 41% of total non-residential and machinery and equipment investments in Canada
- Oil and gas industries accounted for \$83 billion or 31% of the Canadian total.
- Oil and gas companies spent an additional \$6.6 billion on exploration in 2013.

* excludes residential expenditures and intellectual property investments such as exploration expenses

Capital expenditures in the energy industry



Energy and the economy

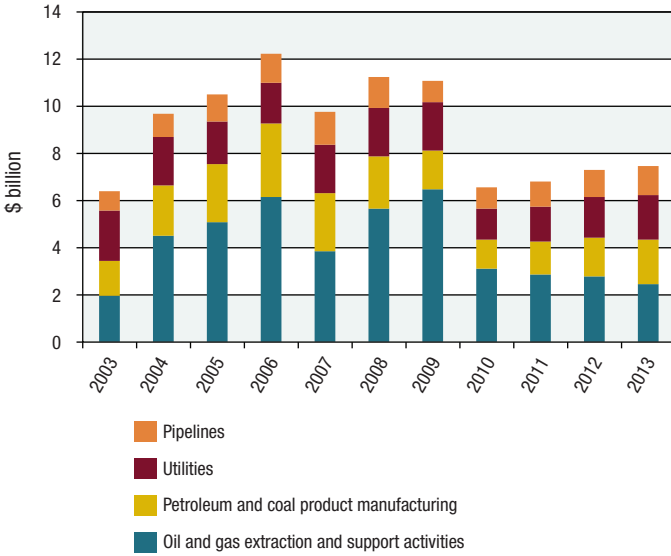
Revenues to government

- Federal and P/T governments in Canada receive direct revenues from energy industries related to:
 - corporate income taxes, which are levied on corporations operating in Canada
 - indirect taxes, such as sales and payroll taxes
 - Crown royalties, which are the share of the value of oil and gas extracted that is paid to the Crown as the resource owner
 - Crown land sales, which are paid to the Crown in order to acquire the resource rights for specific properties

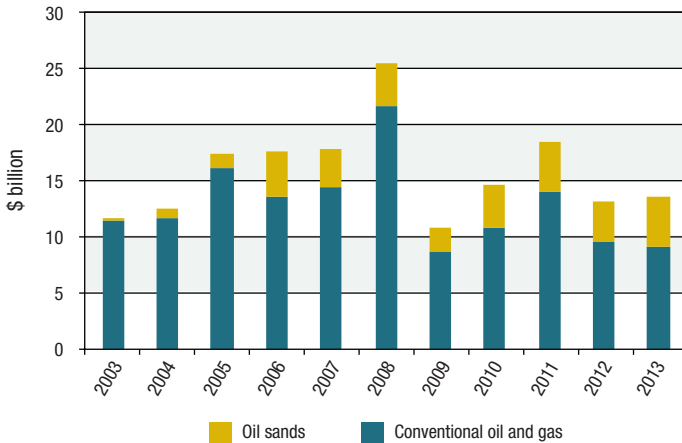
Source	2009–2013 average (\$ billions)
Income tax	5.5
Indirect taxes	2.3
Royalties	11.2
Land sales	2.9
Total	21.9

- The largest share of government revenues is collected from the oil and gas industry, which averaged \$20.3 billion over the last five years, including \$17.7 billion from upstream oil and gas extraction and its support activities.
- Between 2009 and 2013, the energy industries' share of total taxes paid (10.5%) was in line with their share of total operating revenues (13.0%).

Total taxes paid by energy industries



Total oil and gas Crown royalties and land sales in Canada



Energy research, development and demonstration

Public expenditures* on energy RD&D for OECD countries – as a % of GDP (2012)

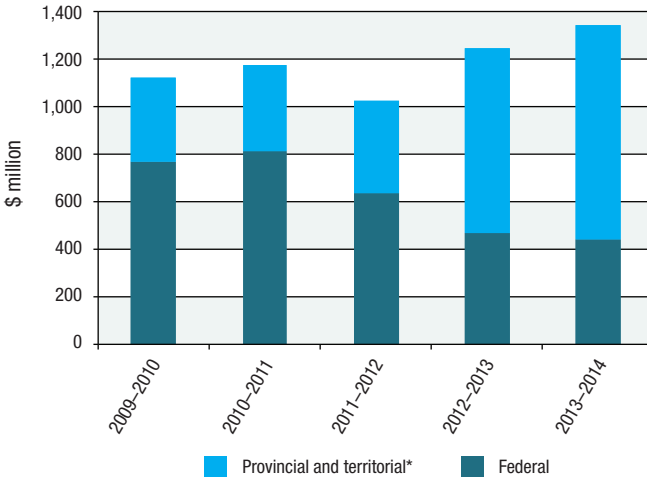
1) Finland	0.12%
2) Norway.....	0.11%
3) Hungary	0.09%
4) Japan.....	0.07%
5) Canada	0.07%
6) France	0.05%

* Expenditures exclude tax incentives.

Canadian public expenditures on energy RD&D

- Combined federal/provincial/territorial energy RD&D expenditures of about \$1.34 billion in 2013/14, up from \$1.25 billion in 2012/13
 - increase largely due to investment by SaskPower, a provincial utility, in the Boundary Dam carbon capture and storage project
- Federal energy RD&D expenditures of \$445 million in 2013/14
 - key organizations: NRCan (\$125 million), AECL (\$108 million), NSERC (\$83 million) and SDTC (\$61 million)
 - accounted for approximately 6.5% of federal RD&D expenditures in all economic sectors
- P/T governmental energy RD&D expenditures of \$897 million in 2013/14
 - includes expenditures of \$686 million by utilities and other publicly owned entities
 - encompasses a significant capital investment by SaskPower in the Boundary Dam carbon capture and storage project

Canadian public expenditures on energy RD&D



* Provincial and territorial includes utilities.

Canadian industry expenditures on energy research and development

- Canadian industry spent about \$2 billion on energy R&D in 2013.

Expenditures on energy RD&D by technology area

	(\$ millions)		
	Federal (2013/14)	Provincial (2013/14)	Industry (2013)
Fossil fuels supply (including CCS)	101	723	1,532
Renewable and clean energy supply	203	138	273
Energy end use	141	36	197
Total	445	897	2,001

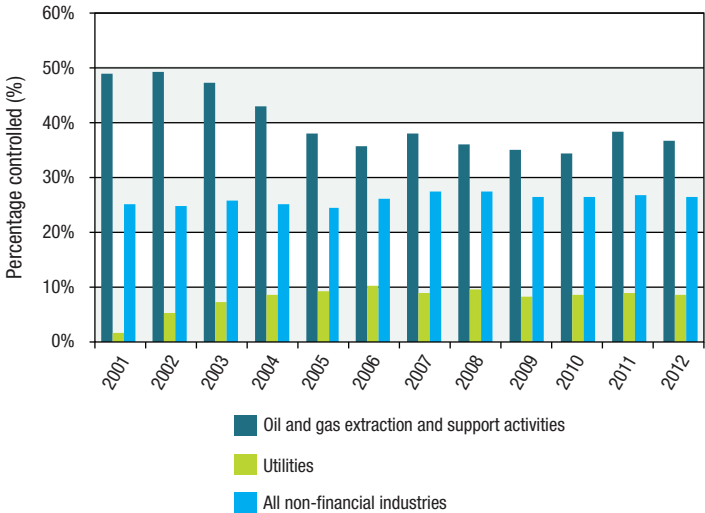
Investment in Canadian energy industries

Canada's energy industries operate within open markets, where investments by both Canadian and foreign companies ensure an efficient, competitive and innovative energy system.

Foreign control of Canadian assets

Foreign control is a measure of the extent to which foreign entities operate in Canada. Generally, a corporation is deemed to be foreign-controlled if more than 50% of the shares are owned by one or more foreign companies.

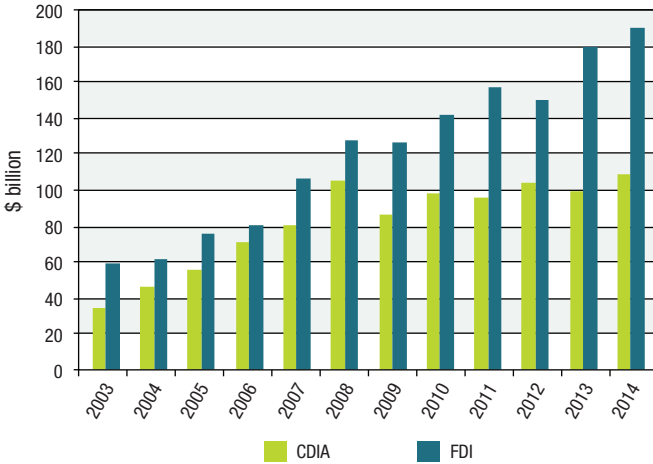
Foreign control of Canadian assets



Direct investment in Canada and abroad

Direct investment is defined as a company owning voting equity interest in a foreign enterprise and is measured as the total equity value at the time of acquisition.

Stock of foreign direct investment in Canada and Canadian direct investment abroad in the energy industry



Stock of foreign direct investment

- The stock of FDI in the energy sector is estimated to have reached \$190 billion in 2014, up from \$39 billion in 2000.
- The energy industry’s share of overall FDI in Canada has also been steadily increasing, reaching more than 25% in 2014, up from 12% in 2000.
- The stock of FDI from the U.S. in Canada’s oil and gas extraction industry, including support services, more than tripled from \$18.9 billion in 2000 to \$57.8 billion in 2014.

Stock of Canadian direct investment abroad

- Investment by Canada’s energy companies in the U.S. accounts for 45% of the stock of energy CDIA and has grown from \$8.9 billion in 2000 to \$48.7 billion in 2014.

FDI in Canada – major recent deals

Electricity

May 2015: Berkshire Hathaway Energy (U.S.) acquired AltaLink from SNC-Lavalin Transmission Ltd. for \$3.1 billion.

Oil sands

April 2014: PetroChina (China), through its wholly owned subsidiary Phoenix Energy Holdings Limited (China), acquired the remaining 40% stake in Dover Commercial Project from Athabasca Oil Corporation for \$1.23 billion.

August 2013: ExxonMobil Canada (U.S.) and Imperial Oil (U.S.) jointly acquired 100% of ConocoPhillips' Clyden oil sands lease for a combined total of \$751 million.

March 2013: Total S.A. (France) sold its 49% interest in the Voyageur Upgrader Limited Partnership to its partner Suncor Energy for \$515 million.

February 2013: China National Offshore Oil Corporation Ltd. (CNOOC) (China) acquired Nexen Inc. for \$18.4 billion.

March 2012: PetroChina (China), through its wholly owned subsidiary, acquired the remaining 40% percent stake in the MacKay River oil sands project from Athabasca Oil Sands Corporation for \$670 million.

November 2011: CNOOC Limited (China) acquired OPTI Canada Inc. for \$2.2 billion.

January 2011: PTT Exploration and Development (Thailand) acquired a 40% interest in Kai Kos Dehseh oil sands project from Statoil (Norway) for \$2.3 billion.

October 2010: Total S. A. (France) acquired UTS Energy Corporation for \$1.1 billion.

June 2010: Sinopec International Petroleum (China) acquired from ConocoPhillips a 9.03% stake in the Syncrude oil sands project for \$4.75 billion.

Conventional oil and gas

December 2014: Repsol S.A. (Spain) acquired Talisman Energy Inc. for \$16.3 billion.

May 2014: Crescent Point Energy Corp. (U.S.) acquired CanEra Energy Corp. for \$1.1 billion.

March 2014: Progress Energy Resources Corp. (Malaysia) acquired a stake in Montney acreage in northeast British Columbia from Talisman Energy Inc. for \$1.5 billion (\$700 million in cash, \$800 million of drilling costs).

January 2014: Indian Oil Corp. (India) purchased Canadian shale gas assets from Progress Energy Resources Corp (Malaysia) for \$1 billion.

January 2014: Compañía Española de Petroleos (CEPSA) (UAE) acquired Coastal Energy Company for \$2.3 billion.

September 2013: Centrica plc (U.K.) (60%) and Qatar Petroleum International Ltd. (Qatar) (40%) acquired the conventional portion of Suncor Energy Inc.'s natural gas and crude oil assets in western Canada, for \$1 billion.

March 2013: Spectra Energy (U.S.) acquired the Express-Platte crude oil pipeline system from the Ontario Teachers' Pension Plan, Borealis Infrastructure (OMERS) and Kinder Morgan for \$1.5 billion.

February 2013: Exxon Mobil Corporation (U.S.) agreed to acquire Celtic Exploration Ltd. for \$3.1 billion.

December 2012: PetroChina International Company Limited (China) acquired a 49.9% interest in Encana's Duvernay land holdings in west-central Alberta for \$2.2 billion.

December 2012: PETRONAS (Malaysia) acquired Progress Energy Resources Corp. for \$6 billion.

Canadian energy assets

In 2013, 436 Canadian energy companies were identified as having energy assets either in Canada or abroad:

- 62 companies (14%) had energy assets with a value in excess of \$1 billion.
- 213 companies (49%) had interests outside of Canada (in 83 countries).
- 168 companies (38%) had energy assets in at least two countries.

These Canadian energy assets (CEA) grew to \$494.9 billion, an increase of 11% from the 2012 value.

Canadian energy assets abroad (CEAA) totaled \$121.0 billion in 2013, an increase of 20% from the 2012 value.

Canadian energy companies were present in 83 countries in 2013 with the majority (68%) of CEAA value located in the U.S.

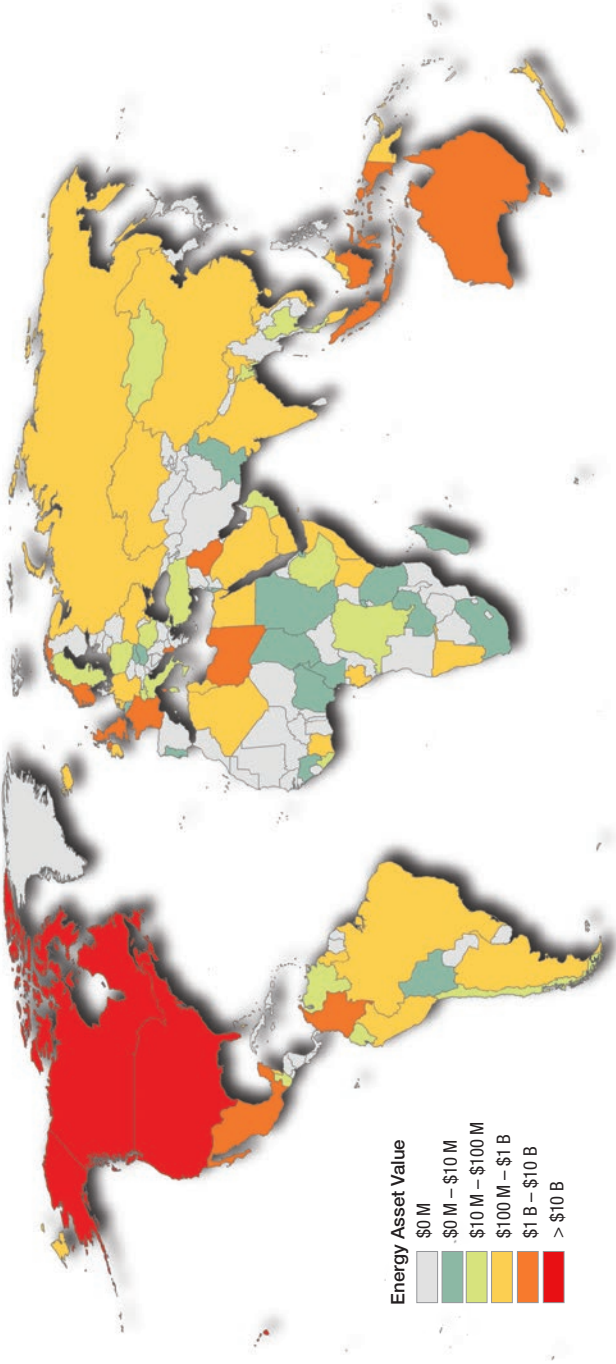
Canadian energy assets by region, 2012 and 2013

Region	Canadian energy assets (CDN\$ billions)*		Variation in percentage
	2012	2013	
Africa	3.93	4.27	9%
North America (U.S. and Mexico)	69.30	84.46	22%
Americas (South and Central America, Caribbean)	8.30	12.06	45%
Asia	5.33	5.50	3%
Europe	10.82	11.92	10%
Oceania	2.90	2.83	-2%
Total Canadian energy assets abroad	100.58	121.04	20%
Canada	343.54	373.91	9%
Total Canadian energy assets	444.12	494.95	11%

* Source: NRCan.

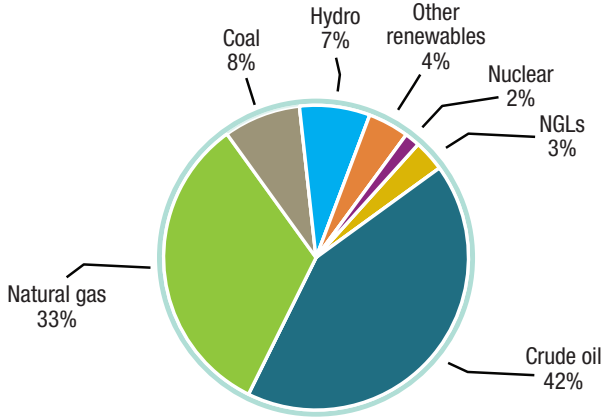
Values may not sum due to rounding.

Global distribution of Canadian energy assets



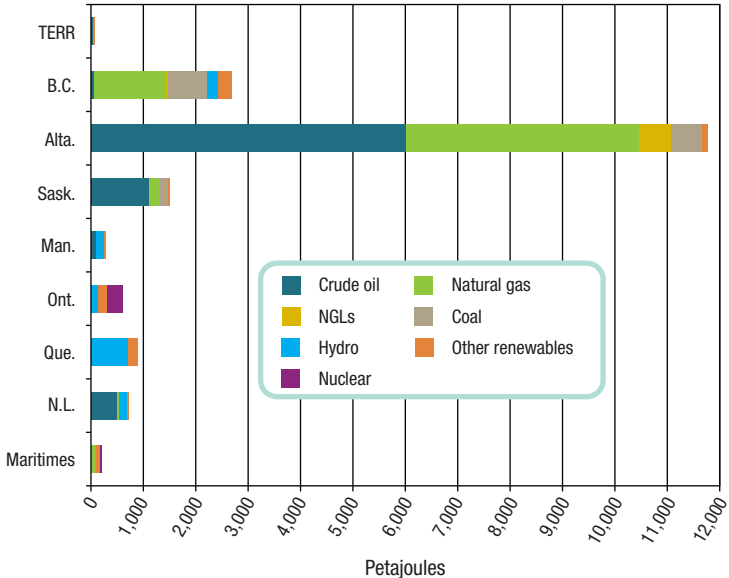
Canadian energy production

Primary energy production, by source, 2013



“Other renewables” includes wind, solar, wood/wood waste, biofuels and municipal waste.

Primary energy production by region and source, 2013



TERR: Yukon, Northwest Territories and Nunavut

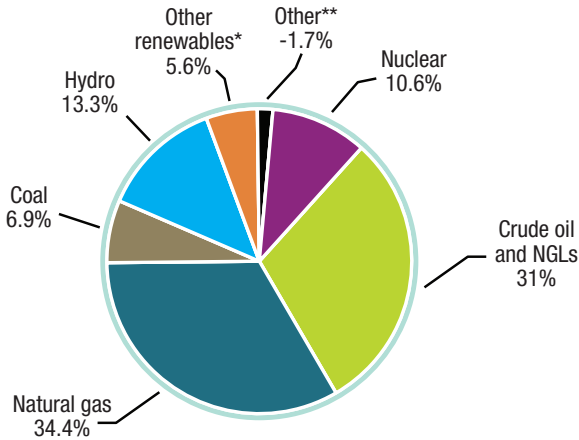
Maritimes: Prince Edward Island, Nova Scotia and New Brunswick

Canadian primary energy supply

TPES represents Canada’s energy supply, which consists of Canada’s own energy production plus imports, less exports, less energy stored in international marine and aviation bunkers and +/- stock changes.

For the purposes of TPES, electricity production and trade are calculated using the energy content of the electricity (i.e. at a rate of 1 TWh = 0.086 Mtoe), with the exception of nuclear electricity, which is calculated assuming a 33% conversion efficiency factor increase (i.e. 1 TWh = (0.086 ÷ 0.33) Mtoe). This conversion factor explains the difference in the share of nuclear energy between primary energy production and TPES.

Total primary energy supply, by source, 2013



Renewable energy sources make up 18.9% of Canada’s TPES in 2013.

* “Other renewables” includes wind, solar, wood/wood waste, biofuels and geothermal.

** “Other” includes non-renewable industrial and municipal waste and electricity trade.

Canadian industry structure

- The upstream oil and gas industry comprises several hundred companies that engage in activities such as exploration, drilling, production and field processing.
- The 10 largest companies are responsible for half of oil and gas production in Canada.
- A variety of firms provide support services to oil and gas extraction operations such as contract drilling and maintenance.
- Oil pipelines, as well as trucks, tanker ships and railways, transport crude oil between production areas, refineries, and export/import border points.

Main associations

- Canadian Association of Petroleum Producers (CAPP)
- Explorers and Producers Association of Canada (EPAC)
- Canadian Association of Oilwell Drilling Contractors (CAODC)
- Canadian Energy Pipeline Association (CEPA)

Regulatory authority

- Primarily with provincial governments, e.g. Alberta Energy Regulator
- Federal jurisdiction over interprovincial and international oil and gas pipelines through the NEB
- The Canada-Newfoundland and Labrador Offshore Petroleum Board and Canada-Nova Scotia Offshore Petroleum Board are responsible for the regulation of oil and gas activities in their corresponding offshore areas.

International context

World production* – 90.9 MMb/d (2014, preliminary)

1) United States	14%
2) Saudi Arabia	13%
3) Russia.....	12%
4) China	5%
5) Canada	5%

World exports* – 43.6 MMb/d (2013)

1) Saudi Arabia	17%
2) Russia.....	11%
3) Canada	6%
4) United Arab Emirates.....	6%
5) Iraq	5%

World proved reserves – 1,656 billion barrels (at the end of 2014)

1) Venezuela	18%
2) Saudi Arabia**	16%
3) Canada	10%
(97% of which is oil sands)	
4) Iran	10%
5) Iraq	9%

* includes crude oil, NGL, additives and other hydrocarbons (including the receipts of additives).

** includes half of the Saudi-Kuwaiti “neutral zone,” with total proved reserves of 5 billion barrels

Canadian resources

Remaining established reserves

(latest available data as of July 2015)

reserves known to exist and are recoverable under current technological and economic conditions

Billion barrels

Canada total..... 171.0

- conventional* 4.7
- oil sands 166.3
 - mining..... 32.5
 - in situ..... 133.8

* Reserves also include proved reserves of pentanes plus (a crude-oil equivalent that is associated with oil production).

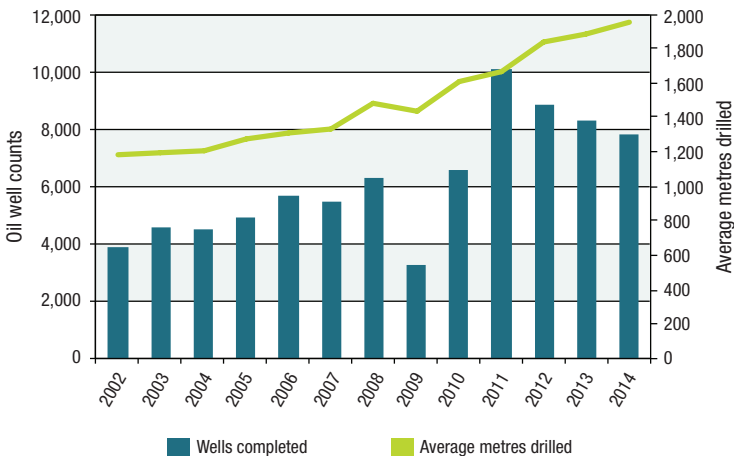
Oil sands ultimate potential

oil estimated to be recoverable as technology improves

Oil sands (Alberta estimate) 315 billion barrels*

* includes cumulative production to date

Oil wells completed and average metres drilled in western Canada

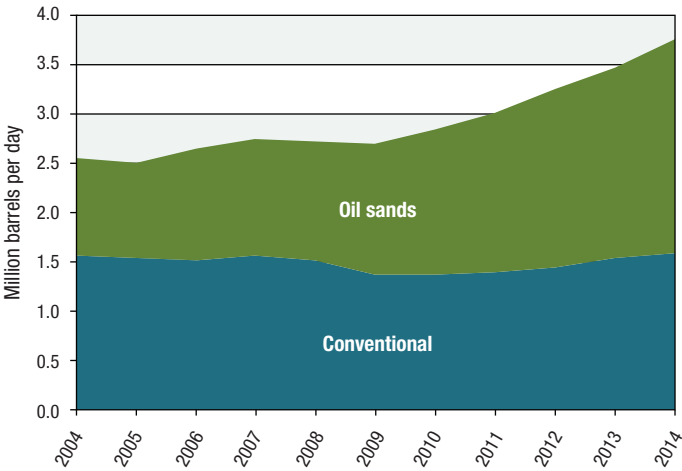


Canadian production

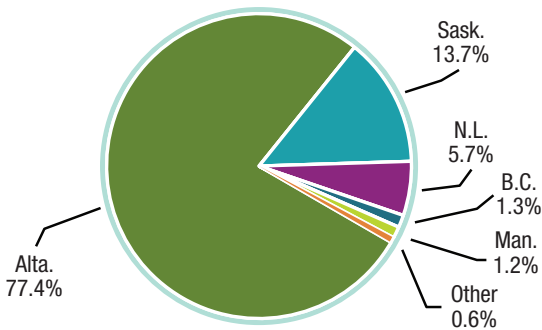
Oil sands production has exceeded conventional production since 2010.

In 2014, oil sands production was 2.2 MMb/d compared to 1.6 MMb/d of conventional oil.

Production by type



Production by province, 2014



“Other”: Nova Scotia, Ontario and the Northwest Territories

Canadian supply and demand* (2014)

Canadian production	3.8 MMb/d
Exports	2.9 MMb/d
Domestic supply.....	1.2 MMb/d
Imports**	0.7 MMb/d

* includes condensates and pentanes plus

** includes both imports to refineries (0.5 MMb/d) and those delivered to fields for use as diluent (0.2 MMb/d)

Trade

Canadian trade of crude oil



Key facts (2014)

- 97% of Canadian crude oil exports are to the U.S.
- Canada was the largest foreign supplier of crude oil to the U.S., accounting for 39% of total U.S. crude oil imports and for 18% of U.S. refinery crude oil intake.
- Canadian crude oil imports come from a wide range of countries, including primarily the U.S. (54%), Saudi Arabia (11%), Iraq (8%) and Norway (5%).

Prices

West Texas Intermediate

- Reference price for light crude oil delivered at Cushing, Oklahoma (a major pipeline hub)
- Used as the benchmark price for North American crudes
- Underlies oil futures contracts on the NYMEX

Brent

- Reference price for light crude oil delivered at the Sullom Voe terminal in the U.K.
- Used as a benchmark price for North Sea crudes, as well as for many other crudes around the world
- During the 2000s, Brent and WTI traded within a few dollars of each other.

Canadian Light Sweet

- Reference price for light crude oil (similar quality to WTI) delivered at Edmonton

Western Canada Select

- Reference price for heavy crude oil (e.g. blended bitumen) delivered at Hardisty, Alta.
- It takes more energy to produce refined products (e.g. gasoline) from heavy crudes, therefore WCS trades at a discount compared to lighter crudes.

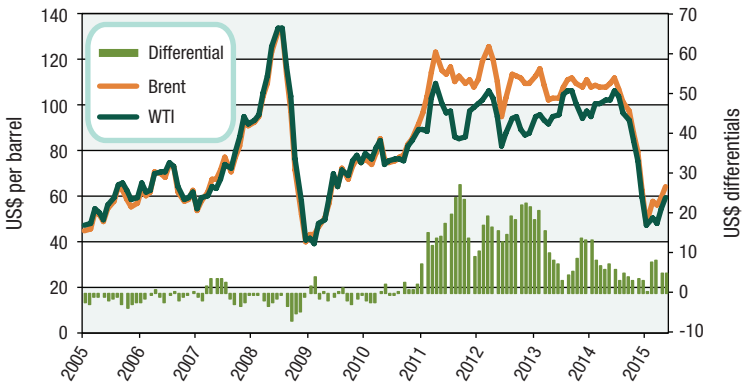
Maya

- Reference price for heavy oil produced in Mexico (similar quality to WCS)

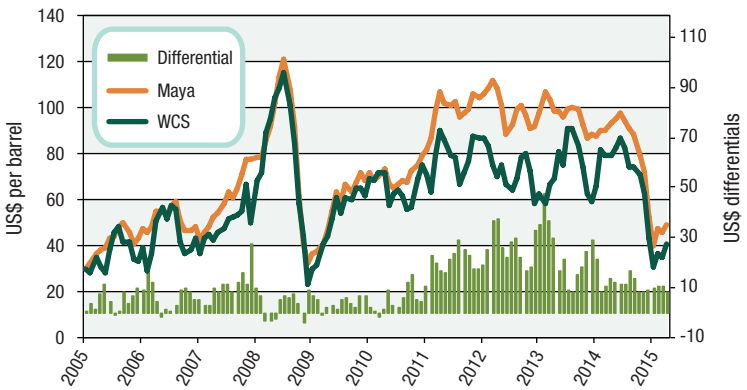
Highlights for WTI

Average: 1995–2003	US\$23 per barrel
Peak on July 11, 2008	US\$147 per barrel
Average: 2012	US\$94 per barrel
Average: 2013	US\$98 per barrel
Average: 2014	US\$93 per barrel
Average: 2015 (first 6 months)	US\$53 per barrel

Brent versus WTI monthly average prices



Maya versus WCS monthly average prices



Oil sands

Strategic importance

- 97% of Canada's proved reserves
- 58% of Canada's oil production in 2014 or 2.2 MMb/d
- An estimated \$243 billion of capital investment to date, including just over \$30 billion in 2014

Mining method

- For shallow formations of 75 m or less
- 45% of current production, 20% of resources
- Process: remove overburden, extract oil sands ore, separate oil from sand using steam, pump tailings into settling basins
- Six large projects in Alberta: Syncrude Mining Project, Suncor Base Mine, CNRL Horizon Mine, Athabasca Oil Sands Project – Muskeg River and Jackpine Mine, and Imperial's Kearl Mine

In situ method

- For formations deeper than 75 m
- 55% of current production, 80% of resources
- Process: drill vertical and/or horizontal wells, inject steam to facilitate the flow of oil
- More than 20 projects in Alberta – largest are Cold Lake (Imperial Oil) and Firebag (Suncor)

Bitumen upgrading

- Crude bitumen from oil sands may be transported to upgraders for processing to make it lighter – “synthetic crude oil.”
- Bitumen may also be blended and sold directly to refineries capable of processing heavier oils.
- Major companies with upgrading capacity: Syncrude, Suncor, Shell, Canadian Natural Resources, Husky and Nexen-CNOOC
- Total upgrading capacity in Canada of 1,425,000 b/d (facilities are listed in the Petroleum products section)

Oil sands: environmental challenges

Water

- mining method: 3 to 4 barrels of new water required per barrel of bitumen
- in situ method: an average of 0.4 barrels of fresh water required per barrel of bitumen
- Oil sands producers recycle around 80% of the water used in established mines and approximately 94% for in situ production.

Greenhouse gases

- 8.5% of Canada's total GHG emissions and 0.1% globally
- GHG emissions per barrel of oil produced in the oil sands in 2013 were 30% below 1990 levels.

Land

- area of oil sand resources 142,200 km²
- total mineable area 4,800 km²
- total area being mined..... 904 km²
- tailings ponds 220 km²

By comparison:

- Canada's total area 10,000,000 km²
- Canadian boreal forest 3,200,000 km²
- 22% of the Lower Athabasca Region is comprised of conservation areas

Key existing pipelines

The current crude oil pipeline capacity out of western Canada is about 3.7 million barrels per day.

Enbridge

- World's largest pipeline system for crude oil and petroleum products, serving Canada and the U.S.
 - Mainline: Alberta to the U.S. Midwest and Ontario
 - Northwest: from the Northwest Territories to Alberta
 - Line 9: from Sarnia to Montréal, eastward flow expected in 2015
 - Southern Lights: diluent from Chicago to Edmonton

Kinder Morgan

- North America's largest pipeline company and largest transporter of refined products
 - Trans Mountain Line: from Edmonton to British Columbia (crude oil and petroleum products) and to Washington State (crude)
 - Cochin Pipeline: transports light hydrocarbon liquids from Fort Saskatchewan, Alta. to Windsor, Ont. Also moves light condensate westbound from Illinois to Fort Saskatchewan.

Pembina

- Second-largest oil pipeline system in western Canada
 - 9 pipelines for conventional and unconventional oil
 - Bitumen Line: from Fort McMurray to Edmonton

Portland-Montreal Pipe Line

- Crude oil – from Portland, Maine, to Montréal

TransCanada Pipeline

- Keystone Pipeline (2010): from Hardisty, Alta. to the U.S. Midwest

Trans-Northern Pipelines Inc.

- Petroleum products – from Montréal to Eastern Ontario, Toronto and Oakville

Spectra Energy

- Express-Platte: from Hardisty, Alta. to the U.S. Midwest

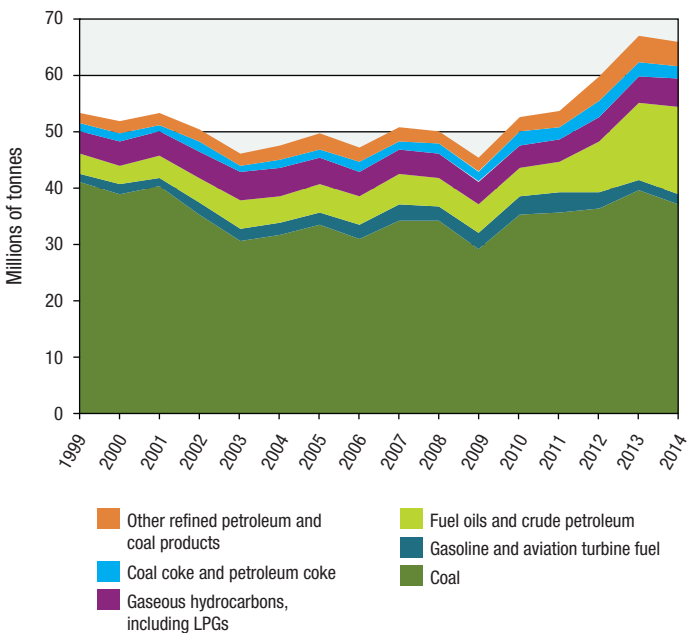
Rail transportation

Energy-related products accounted for 19% of the total tonnage transported by rail in Canada in 2014, which is slightly higher than the average of 17% between 1999 and 2013.

In 2014, coal accounted for 56% of all energy products transported by rail in Canada, a decrease from 77% in 1999.

The tonnage of fuel oils and crude petroleum transported by rail has almost tripled since 2011.

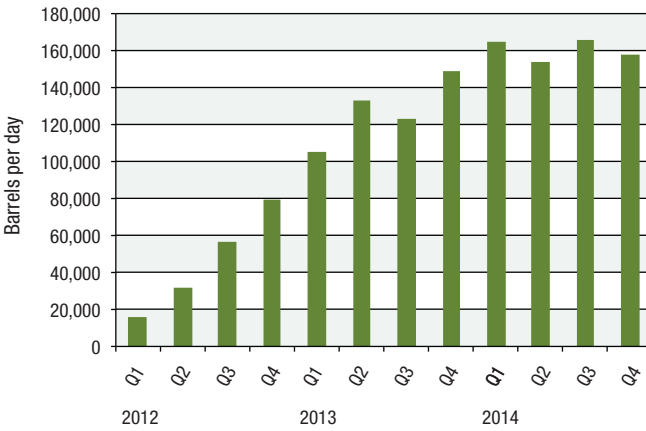
Railway carloads for energy commodities in Canada



The recent increase of crude shipments by rail has led to increased investment in loading facilities. The current rail loading capacity out of western Canada is approximately 776,000 b/d, which represents a 160% increase from 2013.

Exports

Quarterly volumes of crude oil exported to the U.S. by rail



Major crude by rail on-loading facilities in operation, 2014 (≥30,000 b/d)

Operator	Location	Province	Capacity (b/d)
Cenovus Energy	Bruderheim	Alberta	100,000
Keyera/Enbridge	Cheecham	Alberta	32,000
Kinder Morgan/Imperial	Strathcona County	Alberta	210,000–250,000
Pembina	Edmonton	Alberta	40,000
Keyera/Kinder Morgan	Edmonton	Alberta	30,000–40,000
Gibson/USDG	Hardisty	Alberta	120,000
Altex	Lashburn	Saskatchewan	35,000
Crescent Point	Stoughton	Saskatchewan	45,000
Tundra	Cromer	Manitoba	30,000

Light tight oil/Shale oil

Definition

- Light oil found in sedimentary rock characterized by very low permeability – typically shale
- The oil is extracted by using horizontal drilling combined with multi-stage hydraulic fracturing – the same techniques used for shale gas extraction.

Note: “Shale oil” should not be confused with “oil shale,” which are shale rocks rich in decomposed matter still in a solid state.

Potential in Canada and the U.S.

- Tight oil resources are largely found in a belt ranging from central Alberta to southern Texas.
- The Bakken (North Dakota, Montana, Saskatchewan, Manitoba) and Eagle Ford (south Texas) tight oil formations are the largest sources of tight oil production in North America.
- Prospective resources have also been identified throughout the Rocky Mountain region, the U.S. Gulf Coast and the northeastern U.S./eastern Canada (including Anticosti Island and western Newfoundland and Labrador).

World technically recoverable shale oil* resources 345 billion barrels (2012)

1) Russia.....	22%
2) United States.....	17%
3) China	9%
4) Argentina.....	8%
5) Libya	8%
...	
10) Canada	3%

* Shale formations are a subset of low permeability tight oil formations.

3

Petroleum products

Canadian industry structure

- Petroleum refineries transform crude oil into a wide range of refined petroleum products (e.g. gasoline, diesel).
- Other plants such as asphalt plants, upgraders and some petrochemical plants also process crude oil to produce a limited range of products.
- A variety of firms distribute refined petroleum products at the wholesale and retail levels.
- Pipelines and tanker ships are commonly used to transport products over long distances, while tanker trucks and trains are more often used for regional and local distribution.
- LPGs produced by refineries included in the “Hydrocarbon gas liquids” chapter are also reported as an RPP in this chapter.

Main associations

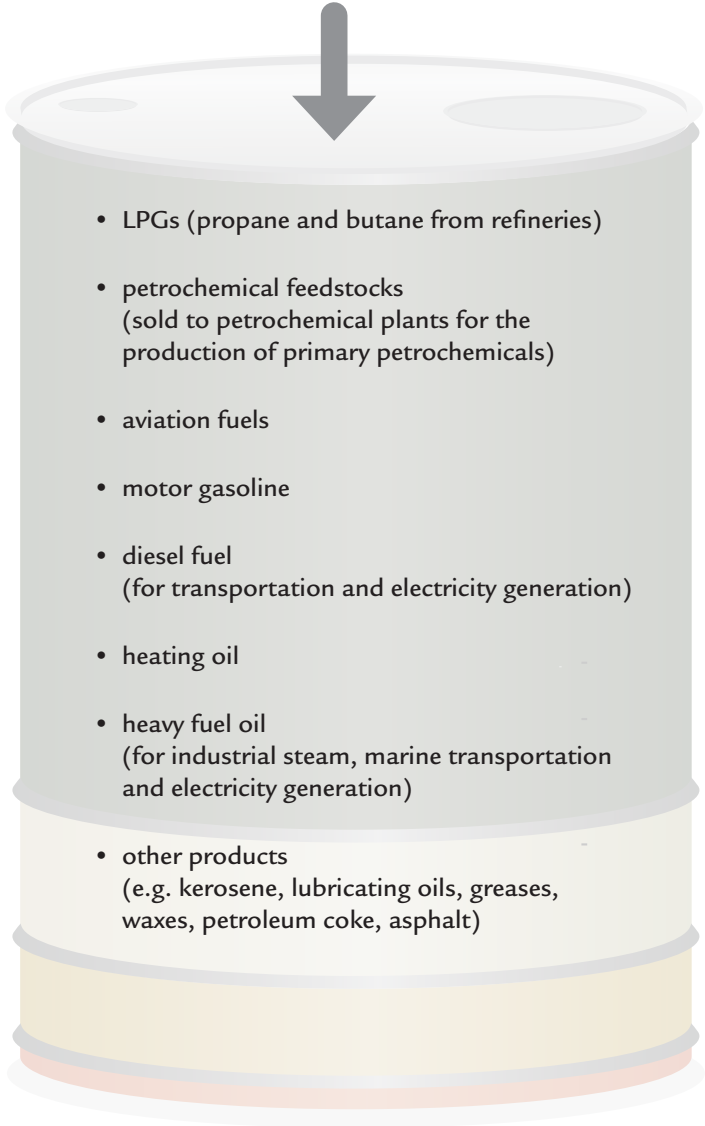
- Canadian Fuels Association (CFA)
- Canadian Independent Petroleum Marketers Association (CIPMA)

Regulatory authority

- Primarily with provincial governments

Petroleum refineries

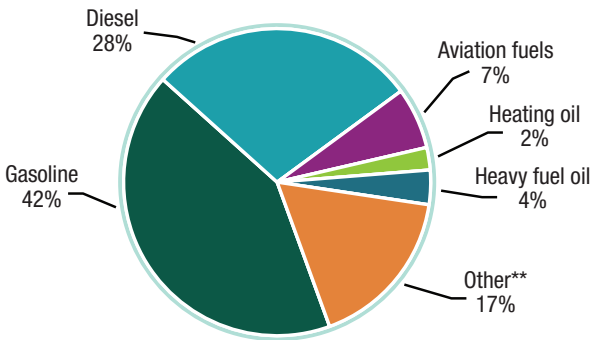
- crude oil distillation
- additional processing (e.g. catalytic cracking and reforming)
- product blending



Canadian supply and demand (2014)

Crude oil shipped to domestic refineries.....	1.7 MMb/d (100 billion L)
Canadian production	1.9 MMb/d (109 billion L)
Imports.....	0.2 MMb/d (13 billion L)
Exports	0.5 MMb/d (27 billion L)
Domestic sales	1.9 MMb/d (108 billion L)

Sales by product, 2014*



* Certain product shares are based on NRCan analysis.

** “Other” includes LPGs, petro-chemical feedstocks, lubricating oils, petroleum coke, asphalt, etc.

Trade (2014)

Canadian exports and imports of refined petroleum products



Key facts (2014)

- 25% of Canadian production of refined petroleum products is exported:
 - 92% of Canadian refined petroleum product exports are to the U.S.
 - 22% of U.S. imports come from Canada.
- 12% of Canadian consumption of refined petroleum products is imported:
 - 76% of Canadian imports come from the U.S.
 - Other Canadian imports come from a wide range of countries, including the Netherlands (10%), the U.K. (3%) and Finland (2%).

Retail prices (in cents per litre)

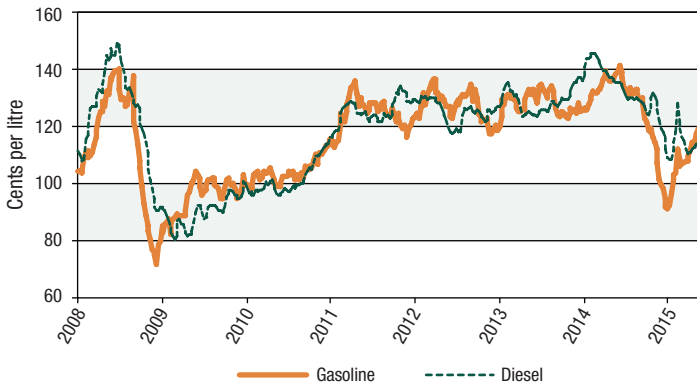
	Gasoline	Diesel
2014		
average Canadian pump price	128.1	133.90
estimated crude cost	62.9	62.90
refining and marketing	25.9	39.20
federal taxes*	15.8	10.40
provincial taxes**	23.4	23.07
2015		
average Canadian pump price (first six months)	108.3	113.70

* includes the GST and federal excise tax

** includes the provincial portion of the HST

Changes in retail prices for fuel tend to mimic those for crude oil.

Weekly retail gasoline and diesel prices



Canadian petroleum refineries

Location	Refinery	Capacity
British Columbia		
Prince George	Husky Energy	12,000 b/d
Burnaby	Chevron Canada	55,000 b/d
Alberta		
Edmonton	Imperial Oil	187,000 b/d
Edmonton	Suncor Energy	142,000 b/d
Fort Saskatchewan	Shell Canada	100,000 b/d
Saskatchewan		
Regina	Federated Co-operatives	130,000 b/d
Ontario		
Sarnia	Imperial Oil	121,000 b/d
Nanticoke	Imperial Oil	112,000 b/d
Sarnia	Suncor Energy	85,000 b/d
Corunna	Shell Canada	75,000 b/d
Quebec		
Levis	Valero (formerly Ultramar)	265,000 b/d
Montréal	Suncor Energy	137,000 b/d
New Brunswick		
Saint John	Irving Oil	313,000 b/d
Newfoundland and Labrador		
Come by Chance	North Atlantic	115,000 b/d
Total refining capacity		1,849,000 b/d

Other plants with crude oil processing

Location	Plant	Capacity
Asphalt plants		
Saskatchewan		
Lloydminster	Husky Energy	29,000 b/d
Moose Jaw	Moose Jaw Refinery	19,000 b/d
Total processing capacity		48,000 b/d
Petrochemical plants (currently using crude oil as feedstock)		
Ontario		
Mississauga	Suncor Energy	17,000 b/d
Total processing capacity		17,000 b/d
Upgraders*		
Alberta		
Fort McMurray	Syncrude	465,000 b/d
Fort McMurray	Suncor Base U1/ U2/Millennium	438,000 b/d
Fort Saskatchewan	Shell Scotford	240,000 b/d
Fort McKay	CNRL Horizon	135,000 b/d
Wood Buffalo	Nexen-CNOOC	72,000 b/d
Saskatchewan		
Lloydminster	Husky Energy	75,000 b/d
Total upgrading capacity		1,425,000 b/d

* Although upgraders primarily transform heavy crudes into lighter crudes, they also produce some refined products, such as diesel. The capacities reported are with regard to inputs of heavy crude oil or bitumen.

4

Hydrocarbon gas liquids

Definition

- Hydrocarbon gas liquids (HGLs) include natural gas liquids (NGLs) (propane, butane, and ethane) and olefins produced by natural gas processing plants and upstream processing or by crude oil refineries.
- Propane and butane, which are produced from natural gas processing plants or from refining crude oil, can be liquefied and sold as liquefied petroleum gas (LPG).
- Condensates and pentanes plus are also HGLs obtained directly from the field or from a natural gas processing plant. However, because these HGLs are considered to be a crude oil equivalent, they are included in the "Crude oil" chapter.

Notes

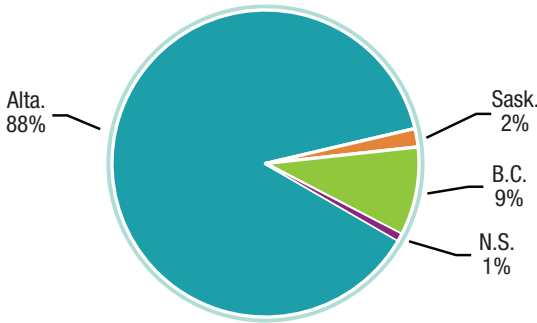
- These gases can be easily liquefied, and therefore are commonly referred to as "liquids."
- When these liquids are present in natural gas, it is called "wet" gas; when they are not present or have been extracted, the natural gas is called "dry" gas.

Canadian supply* (2014)

Canadian production	559.5 Mb/d
– propane	198.7 Mb/d
– butane	124.0 Mb/d
– ethane	236.9 Mb/d
Exports	111.6 Mb/d
Imports.....	56.9 Mb/d

* excludes condensates and pentanes plus, which are included as part of crude oil, and includes refinery-produced LPGs

Production of NGLs by province*, 2014



* includes only gas processing plant production

Canadian industry structure

- The upstream oil and gas industry comprises several hundred companies that engage in activities such as exploration, drilling, production and field processing.
- The midstream natural gas industry processes raw natural gas and transports it through pipelines from producing areas to transmission pipelines or consuming areas.
- The downstream natural gas industry comprises natural gas utilities that distribute natural gas to end-use consumers by operating extensive networks of local distribution pipelines.

Main associations

- Canadian Association of Oilwell Drilling Contractors (CAODC)
- Canadian Association of Petroleum Producers (CAPP)
- Canadian Energy Pipeline Association (CEPA)
- Canadian Gas Association (CGA)
- Canadian Society for Unconventional Resources (CSUR)
- Explorers and Producers Association of Canada (EPAC)
- Industrial Gas Users Association (IGUA)

Regulatory authority

- Primarily with provincial and territorial governments
- Federal jurisdiction over interprovincial and international natural gas pipelines through the NEB
- The Canada-Nova Scotia Offshore Petroleum Board and Canada-Newfoundland and Labrador Offshore Petroleum Board are responsible for regulations of oil and gas activities in their corresponding offshore areas.

International context

World production – 341 Bcf/d (9.7 Bcm/d)
(2014, preliminary)

1) United States	21%
2) Russia.....	18%
3) Iran	5%
4) Canada	5%
5) Qatar	5%

World exports – 100 Bcf/d (2.8 Bcm/d)
(2014, preliminary)

1) Russia.....	18%
2) Qatar	12%
3) Norway.....	10%
4) Canada	8%
5) Netherlands	6%

World proved reserves – 6,966 Tcf (197 Tcm)
(beginning of 2015)

1) Russia.....	24%
2) Iran	17%
3) Qatar	13%
4) United States	5%
5) Saudi Arabia.....	4%
...	
18) Canada	1%

Canada-U.S. resources

- The natural gas markets in Canada and the U.S. are highly integrated.
- Canadian marketable resources can sustain current production levels for up to 300 years.

Proved reserves (at the end of 2013)

reserves known to exist and that are recoverable under current technological and economic conditions

Canada.....	72 Tcf
U.S.	338 Tcf
Total	410 Tcf

Marketable/technically recoverable resources

Canadian marketable resources: gas estimated to be marketable, after allowing for the removal of impurities and after accounting for any volumes used to fuel surface facilities

U.S. technically recoverable resources: gas estimated to be recoverable as drilling and infrastructure expands

Canada total.....	885–1,566 Tcf
Canadian conventional.....	357–436 Tcf
Canadian unconventional.....	528–1,130 Tcf
	(coal-bed methane, shale and tight gas)
U.S. total	2,431 Tcf
portion that is shale and tight gas.....	664 Tcf
portion that is other.....	1,766 Tcf
World total	28,499 Tcf
portion that is conventional	16,421 Tcf
portion that is unconventional.....	12,078 Tcf

Shale and tight gas

Features of shale

- Ultra-low permeability sedimentary rock containing natural gas
- Gas is extracted by using horizontal drilling and hydraulic fracturing.

Hydraulic fracturing (fracking)

- Creates fractures in sedimentary rock formations by using pressurized water, mixed with small amounts of sand and additives, to release the natural gas

Potential in Canada

- Shale gas resources are found in British Columbia, Alberta, Saskatchewan, Manitoba, Ontario, Quebec, New Brunswick, Nova Scotia and the territories.
- Technological advancements in drilling (long-reach horizontal well bores) and completion techniques (multistage hydraulic fracturing) enable commercial production of shale gas.
- These advancements have increased the long-term prospects for the supply of natural gas in North America.

Further details on Canada’s shale potential are available at nrcan.gc.ca/shaleresources.

Global potential

- An updated U.S. Energy Information Administration assessment of 137 shale formations in 41 countries, in addition to the U.S. basins, found a total of 7,299 Tcf (207 Tcm) of technically recoverable shale gas resources.

World technically recoverable shale resources –

7,299 Tcf (2012)

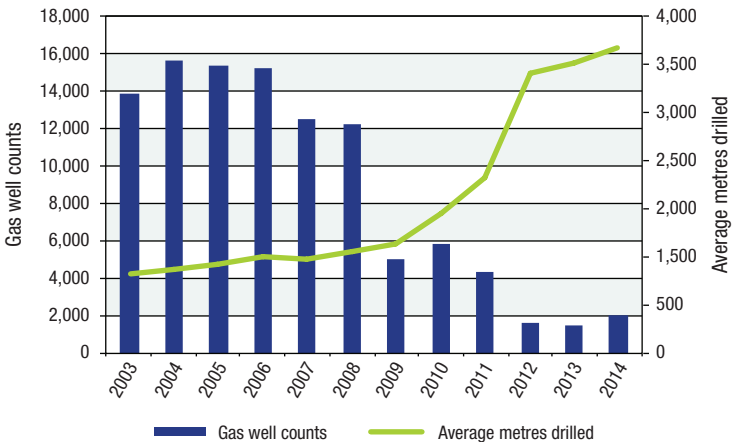
1) China	15%
2) Argentina.....	11%
3) Algeria.....	10%
4) United States	9%
5) Canada	8%
6) Mexico.....	7%
7) Australia.....	6%

Canada-U.S. market (2014)

Canada-U.S. market	84.9 Bcf/d
	(2.4 Bcm/d)
Canadian average marketable production	14.2 Bcf/d
	(0.4 Bcm/d)
conventional	28%
unconventional*	72%
U.S. average marketable production.....	70.5 Bcf/d
	(2.0 Bcm/d)
conventional	35%
unconventional*	65%
North American LNG imports.....	0.22 Bcf/d
	(0.01 Bcm/d)

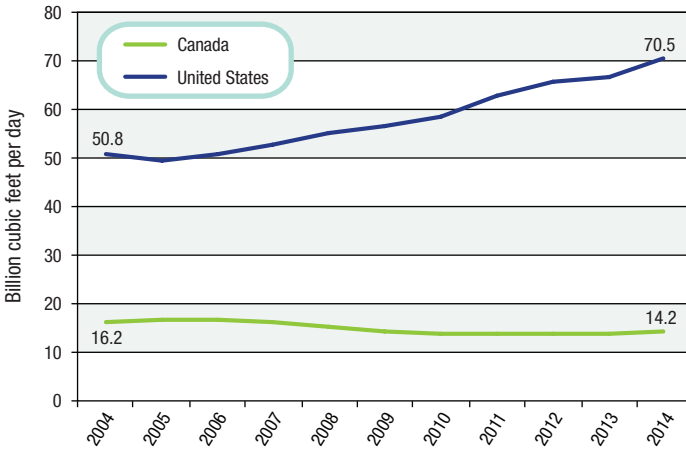
* Unconventional gas includes tight gas, coalbed methane and shale gas.
U.S. percentages by type are based on 2010 data.

Natural gas wells completed and average metres drilled in western Canada

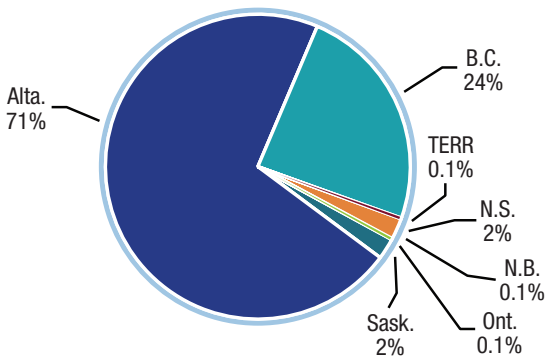


Canadian production (2014)

Canadian and U.S. marketable production of natural gas

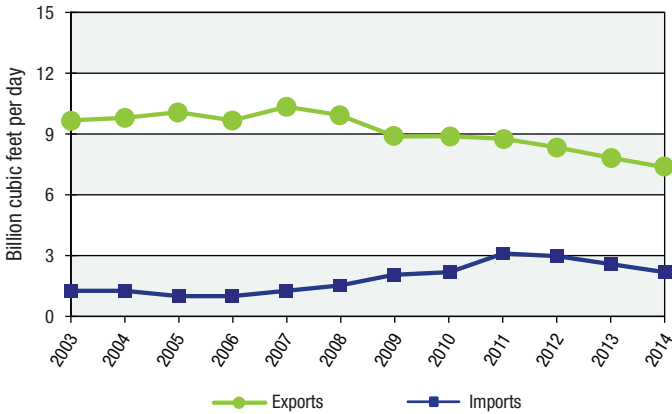


Marketable production by province, 2014



Trade (2014)

Canadian exports and imports of natural gas



Canadian exports	7.4 Bcf/d (0.20 Bcm/d)
Canadian imports	2.1 Bcf/d (0.06 Bcm/d)

Key facts

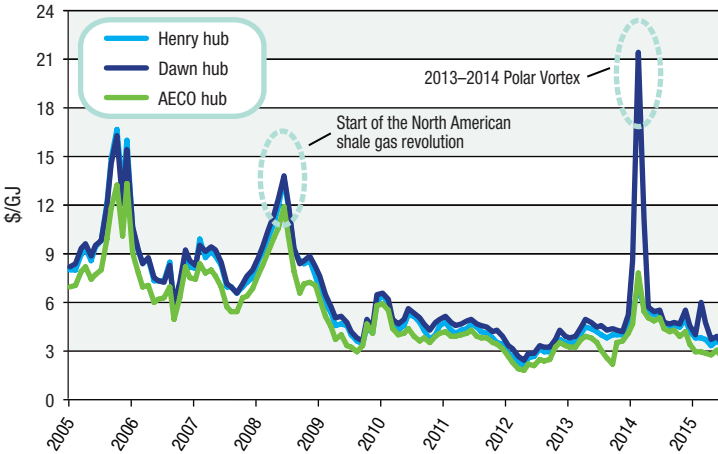
- 52% of Canadian production is exported
 - All Canadian exports go to the U.S.
 - 98% of U.S. imports and 10% of U.S. consumption come from Canada
 - The value of Canadian net exports (exports minus imports) totaled \$10.6 billion in 2014.
- 25% of Canadian consumption is imported from the U.S.
- Since 2009, Canada has also imported small amounts of natural gas from other countries through the Canaport LNG terminal in Saint John, N.B.

Upstream prices (AECO hub* average prices)

Average: 2003–2012	\$6.04/GJ
Average: 2013	\$3.35/GJ
Average: 2014.....	\$4.74/GJ
Average: 2015	\$2.84/GJ
(first 6 months)	

* The AECO hub is Canada’s largest natural gas trading hub, and the AECO price serves as a benchmark for Alberta wholesale natural gas transactions.

Monthly average natural gas spot prices



Key existing pipelines

TransCanada Pipelines

- Canada's leading natural gas pipeline company serving markets in Canada, the U.S. and Mexico, tapping into virtually all natural gas basins in North America
- NGTL System: serving Alberta and British Columbia
- Canadian Mainline: several pipelines in the same corridor from the Alberta/Saskatchewan border to Québec (city) with several interconnections to the U.S. along the way
- Foothills: from Alberta to Idaho via British Columbia and from Alberta to Montana via Saskatchewan

Spectra Energy

- Canada's second largest gas pipeline company
- Maritimes & Northeast Pipeline: Nova Scotia and New Brunswick to the U.S.
- Union Gas: gas distribution and transmission in Ontario and the eastern U.S.
- West Coast Energy: a pipeline in British Columbia

Enbridge Inc.

- Third-largest gas pipeline company in Canada
- Largest local gas distribution company in Canada (Enbridge Gas Distribution of Toronto)
- Alliance Line (50% owner): British Columbia through Alberta; and Saskatchewan to Chicago
- Vector Line (60% owner): Chicago to Ontario

ATCO Pipeline

- Gathering and distribution lines within Alberta

TransGas Ltd.

- Gathering, transmission and storage facilities in Saskatchewan
- Owned by SaskEnergy Inc. (provincial distributor)

Liquefied natural gas

Twenty-six LNG export facilities have been proposed for Canada – 20 in British Columbia, 2 in Quebec, 1 in New Brunswick and 3 in Nova Scotia – with a total proposed export capacity of 362.6 mtpa of LNG (or approximately 49 Bcf/d of natural gas). Since 2011, the NEB has issued 10 long-term export licenses for a proposed export capacity of approximately 155 mtpa.

Proposed Canadian LNG export terminals (as of September 1, 2015)

Project	Location	Total capacity	
		Natural gas (Bcf/d)	LNG (mtpa)
British Columbia			
Douglas Channel LNG	Kitimat	1.00	7.50
Kitimat LNG	Kitimat	1.30	10.00
LNG Canada	Kitimat	3.47	26.00
Pacific Northwest LNG	Prince Rupert	2.74	19.68
Prince Rupert LNG	Prince Rupert	2.91	21.60
Woodfibre LNG	Squamish	0.33	2.10
WCC LNG	Prince Rupert	4.00	30.00
Triton LNG	Kitimat or Prince Rupert	0.32	2.30
Aurora LNG	Prince Rupert	3.10	24.00

Project status:

- Export license issued
- Applied for export license
- Application not yet filed

**Proposed Canadian LNG export terminals
(as of September 1, 2015) (continued)**

Project	Location	Total capacity	
		Natural gas (Bcf/d)	LNG (mtpa)
Kitsault Energy Project	Kitsault	2.70	20.00
WesPac Marine Terminal	Delta	0.50	3.00
Steelhead LNG	Sarita Bay	3.40	24.00
Grassy Point LNG	Grassy Point	2.70	20.00
Discovery LNG	Campbell River	2.63	20.00
Haisla LNG	Kitimat	0.83	6.40
Orca LNG	Prince Rupert	3.20	24.00
Stewart LNG	Stewart	3.99	30.00
NewTimes Energy	Prince Rupert	1.60	12.00
Malahat LNG	Mill Bay	0.85	6.00
Watson Island LNG	Prince Rupert	Unknown	
East Coast			
Énergie Saguenay	La Baie, Que.	1.56	11.00
Stolt LNGaz	Becancour, Que.	0.07	0.50
Saint John LNG	Saint John, N.B.	0.68	5.00
Goldboro LNG	Guysborough County, N.S.	1.40	10.00
Bear Head LNG	Richmond County, N.S.	1.59	12.00
A C LNG	Middle Melford, N.S.	2.07	15.50

Project status:

- Export license issued
- Applied for export license
- Application not yet filed

Canadian industry structure

- The Canadian coal industry produces coal for use in:
 - metallurgical applications
 - thermal applications (e.g. electricity generation)
- Numerous firms provide services to coal producers such as exploration, equipment supply, engineering services and transportation.
- Some power-generating companies not only use coal for electricity generation but also own coal mines or are involved in coal production. Other companies generate electricity from purchased coal.

Main association

- Coal Association of Canada

Regulatory authority

- Primarily with provincial governments

International context

World production – 7.9 billion t (2014, preliminary)

1) China	46%
2) United States	12%
3) India.....	8%
4) Australia.....	6%
5) Russia.....	4%
...	
12) Canada	1%

World exports – 1.4 billion t (2014, preliminary)

1) Indonesia.....	30%
2) Australia.....	27%
3) Russia.....	11%
4) United States	6%
5) Columbia.....	6%
...	
8) Canada	2%

World proved reserves – 892 billion t (at the end of 2011)

1) United States	27%
2) Russia.....	18%
3) China	13%
4) Australia.....	9%
5) India.....	7%
...	
15) Canada	1%

The above data excludes coal products such as coke.

Canadian supply and demand (2014)

Canadian production 69 Mt

Exports 34 Mt

- major export destinations (by \$ value):

1) Japan26%

2) China21%

3) South Korea20%

- only 3% of Canadian exports are to the U.S., representing 9% of U.S. coal imports

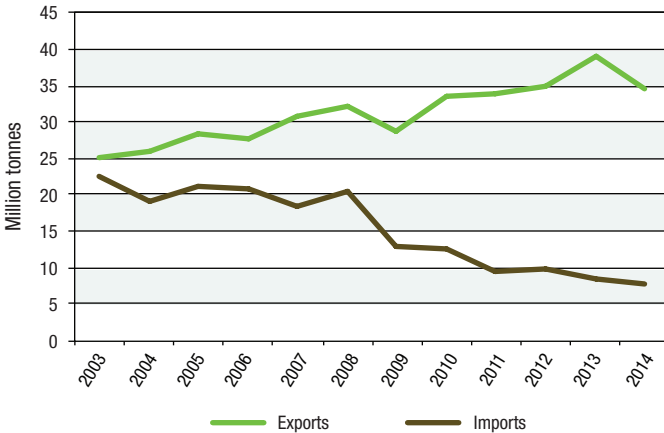
Imports..... 8 Mt

- 78% of Canadian imports are from the U.S.
- Close to half of imports are destined for use in steel manufacturing (metallurgical coal); the rest are for electricity generation (thermal coal).

Domestic availability 42 Mt

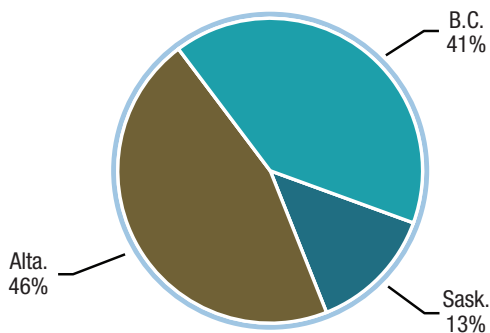
- mostly for electricity generation in Alberta and Saskatchewan
- also for metallurgical applications

Canadian exports and imports of coal



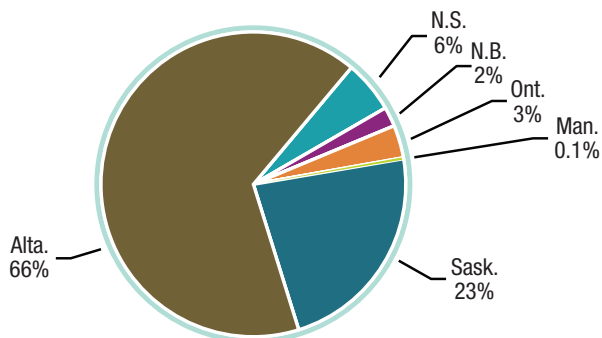
Production and use, by province

Production by province, 2014*



* NRCan estimate

Coal used for electricity generation by province, 2013



Coal-fueled power plants in Canada >500 MW (2015)

Facility	Province	Total capacity (MW)
Sundance	Alberta	2,126
Genesee	Alberta	1,361
Keephills	Alberta	1,285
Sheerness	Alberta	816
Boundary Dam*	Saskatchewan	765
Battle River	Alberta	700
Poplar River	Saskatchewan	630
Lingan	Nova Scotia	620

* As of October 2014, SaskPower's Boundary Dam (unit 3 – 120 MW electricity production) became the world's first commercial-scale coal-fired power station equipped with CCS technology.

Announced retirements of Canadian coal-fired power plant capacity (2015)

Province	Total capacity (MW)	Closure by 2020 (MW)	Share of capacity (%)
Alberta	6,438	0	0
Saskatchewan	1,700	0	0
Manitoba**	97	0	0
Ontario	0	0	0
New Brunswick	490	0	0
Nova Scotia	1,288	310	24
TOTAL	10,013	310	3

** As per provincial regulations, the 97-MW Brandon coal-fired power plant may be used only in emergency situations.

Canadian uranium industry structure

- Canada has a vast supply of uranium, which includes large high-grade deposits that are located in northern Saskatchewan.
- Key producers are Cameco Corporation and AREVA Resources Canada Inc. – two of the world’s largest uranium mining companies.
- Once mined, uranium ore is used to produce a uranium oxide concentrate (U_3O_8) commonly known as “yellowcake.”
- A large portion of the uranium concentrates from Canada and from around the world is shipped to a refinery in Blind River, Ontario, to produce high-purity uranium trioxide (UO_3), an intermediate product.
 - uranium dioxide (UO_2) to supply CANDU-type heavy water reactors
 - uranium hexafluoride (UF_6), which is exported to be enriched and used as fuel in light water reactors
- Key users in Canada are power generators with nuclear reactors (e.g. Ontario Power Generation).

Regulatory authority

- Mining is mostly governed by provincial regulations, but uranium mining is also under federal jurisdiction.
- The Canadian Nuclear Safety Commission regulates mines and mills and all subsequent stages of the nuclear-fuel cycle, including conversion, refining, fuel fabrication, nuclear reactor operation and nuclear fuel waste management.

Uranium – international context

World production – 56.2 kt

(2014, preliminary)

1) Kazakhstan	41%
2) Canada	16%
3) Australia	9%
4) Niger	7%
5) Namibia	6%

World exports – 46.3 kt

(2014, preliminary)

1) Kazakhstan	50%
2) Canada	16%
3) Australia	11%
4) Niger	9%
5) Namibia	7%

World known recoverable resources – 5.9 Mt

(at the beginning of 2013)

1) Australia	29%
2) Kazakhstan	12%
3) Russia	9%
4) Canada	8%
5) Niger	7%

Uranium – Canadian supply and demand (2014)

Canadian production 9.1 kt

- All the uranium comes from mines in Saskatchewan.
- annual value ≈\$1.0 billion
- Based on long-term contracts*, uranium from Canadian mines is generally sold in
 - 1) Asia 41%
 - 2) North America/Latin America..... 36%
 - 3) Europe..... 23%

* These values can vary based on changes in regional demand.

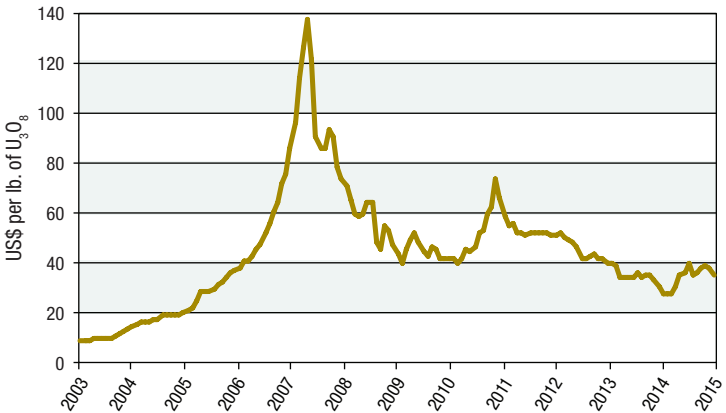
Exports ≈80% of production

- 18% of uranium purchased by U.S. nuclear reactors in 2014 came from Canada, making Canada the second-largest foreign supplier of uranium to the U.S. after Australia.

Domestic use ≈20% of production

- to Canada’s CANDU reactors (Ontario and New Brunswick)

Spot prices



Nuclear power – international context

World generation – 2,364 TWh
(2013)

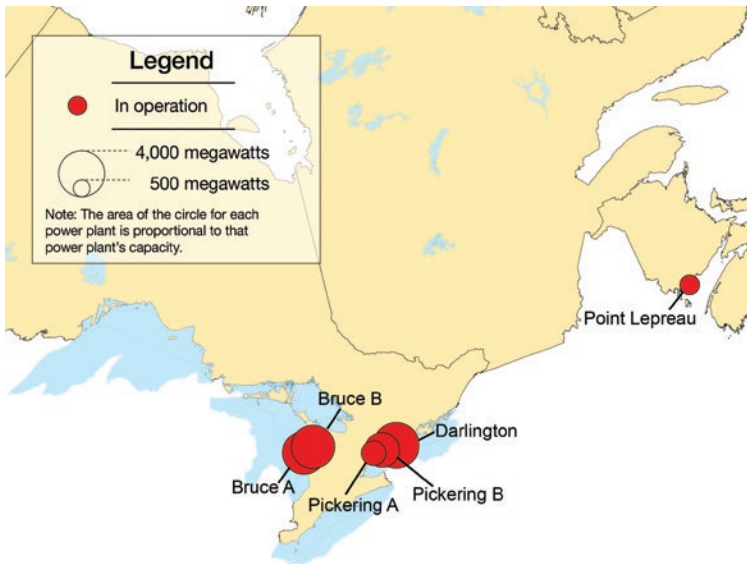
1) United States	33%
2) France	17%
3) Russia.....	7%
4) South Korea.....	6%
5) China	5%
6) Canada	4%
7) Germany.....	4%
8) Ukraine.....	3%

CANDU nuclear reactors

- Canada has developed a unique nuclear reactor called CANDU, for CANada Deuterium Uranium.
- The CANDU reactor is a pressurized heavy water reactor (PHWR) that uses heavy water (deuterium oxide) as a moderator and coolant and natural uranium for fuel. The majority of power reactors in use in the world are light water reactors (LWRs) which use normal water as the moderator and coolant and enriched uranium for fuel.
- In addition to Canada, CANDU reactors are found in India, Pakistan, Argentina, South Korea, Romania and China.

Nuclear power plants in Canada

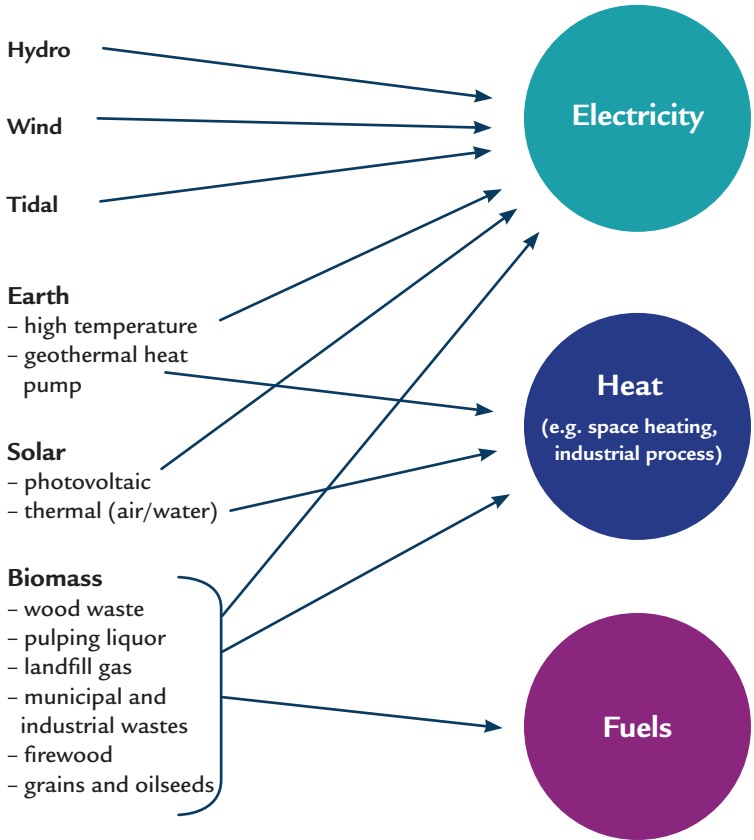
Facility	Province	Total capacity (MW)	Units
Darlington	Ontario	3,740	4
Bruce B	Ontario	3,360	4
Bruce A	Ontario	3,300	4
Pickering B	Ontario	2,160	4
Pickering A	Ontario	1,080	2
Point Lepreau	New Brunswick	705	1



What is renewable energy?

- Renewable energy is obtained from natural resources that can be naturally replenished or renewed within a human lifespan – that is, the resource is a sustainable source of energy.
- Some natural resources, such as moving water, wind and sunshine, are not at risk of depletion.
- Biomass is a renewable resource only if its rate of consumption does not exceed its rate of production.
- A wide range of energy-producing technologies and equipment has been developed over time to take advantage of these natural resources.
- Usable energy can be produced in the form of electricity, industrial heat, thermal energy for space and water conditioning, and transportation fuels.

Main sources and uses in Canada



International context

World production – 76,530 PJ or 1,828 Mtoe
(2013)

1) China	18%
2) India.....	11%
3) United States	8%
4) Brazil	6%
5) Nigeria	6%
6) Indonesia.....	4%
7) Canada	3%

Share of energy supply from renewable sources
(2013)

World	13.5%
OECD countries only.....	9.0%
Canada	18.9%

Canadian production
(2013)

Total renewable energy – 1,989 PJ or 48 Mtoe

Hydro	70.700%
Solid biomass (e.g. wood/waste)	24.000%
Wind	2.090%
Biogasoline	1.810%
Municipal waste/landfill gas	0.730%
Industrial and other waste	0.310%
Biodiesel	0.200%
Solar photovoltaic.....	0.070%
Solar thermal	0.080%
Tidal.....	0.003%

Hydroelectricity – international context

World generation of hydroelectricity – 3,791 TWh (2013)

1) China.....	25%
2) <i>Canada</i>	11%
3) Brazil.....	11%
4) United States.....	7%
5) Russia.....	5%

Share of hydroelectricity in net electricity generation (2013)

1) Norway.....	96%
2) Brazil.....	69%
3) Venezuela.....	68%
4) <i>Canada</i>	63%

By comparison:

China.....	17%
United States.....	7%

Hydroelectricity

Hydroelectricity capacity in Canada – 75,707 MW
(2013)

Major hydro facilities in Canada ($\geq 1,000$ MW)

Power plant	Province	Total capacity (MW)
Robert-Bourassa	Que.	5,616
Churchill Falls	N.L.	5,429
La Grande 4	Que.	2,779
Gordon M. Shrum	B.C.	2,730
La Grande 3	Que.	2,417
La Grande 2A	Que.	2,106
Revelstoke	B.C.	1,980
Beauharnois	Que.	1,906
Mica	B.C.	1,805
Manic 5	Que.	1,528
Sir Adam Beck 2	Ont.	1,499
La Grande 1	Que.	1,436
Limestone	Man.	1,349
Manic 3	Que.	1,244
Kettle	Man.	1,223
Bersimis 1	Que.	1,125
Manic 5 PA	Que.	1,064
Robert H. Saunders	Ont.	1,045
Manic 2	Que.	1,041
Outardes 3	Que.	1,026
Long Spruce	Man.	1,016
Kemano	B.C.	1,000

Hydroelectricity

Major projects under construction

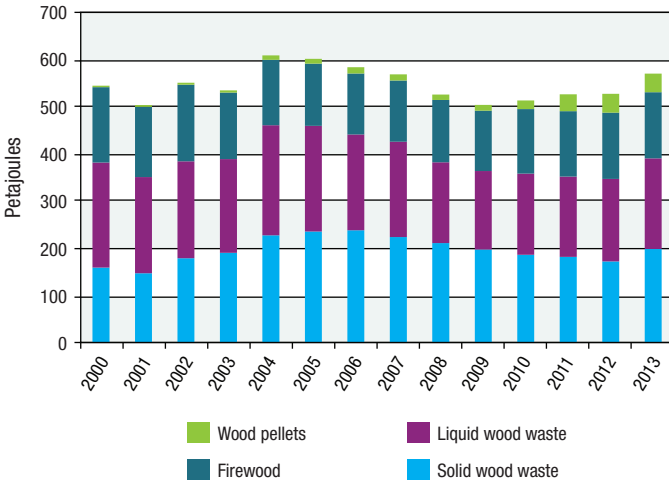
Project	Province	Total capacity (MW)	Expected in-service
La Romaine Complex	Que.	1,550	2014–2020
Muskrat Falls	N.L.	824	2017
Keeyask	Man.	695	2021
Total		3,069	

Wood and wood waste (2013)

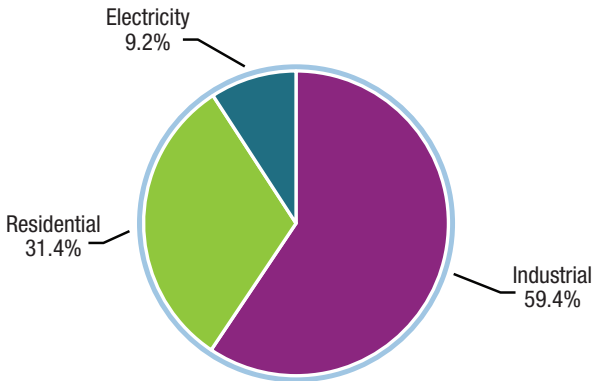
Wood and wood waste account for the largest share of renewable energy production in the OECD, at 37.2%.

In Canada, that share is 24% – the second largest after hydro’s 70.7%.

Canadian production



Wood fuel use, by sector (2013)



Wind power – international context

World capacity of wind power – 369,597 MW
(2014)

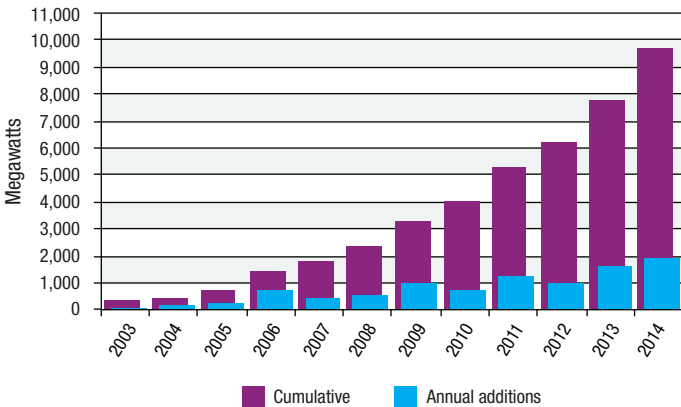
1) China	31%
2) United States	18%
3) Germany	11%
4) Spain	6%
5) India	6%
6) United Kingdom	3%
7) <i>Canada</i>	3%

Wind power in Canada

Generation – 11.5 TWh, 1.9% of total electricity (2013)

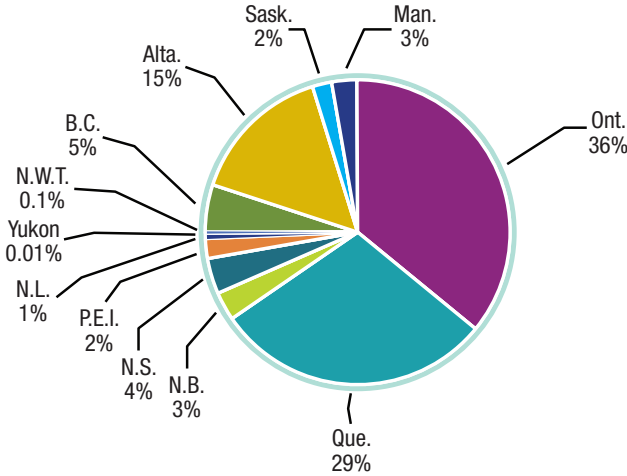
Capacity (at the end of 2014) – 9,694 MW

Installed capacity



Wind power

Capacity by province, 2014



Selected largest wind farms in Canada (≥149 MW)

Facility	Province	Total capacity (MW)
Lac Alfred (I and II)	Que.	300
Blackspring Ridge*	Alta.	299
South Kent Wind Farm*	Ont.	270
Wolfe Island	Ont.	198
Prince Project	Ont.	189
Kincardine	Ont.	182
Comber	Ont.	166
Riviere du Moulin*	Que.	150
Massif du Sud	Que.	150
Halkirk Wind Park	Alta.	149
Jericho Wind Farm*	Ont.	149
Grand Renewable Energy Park*	Ont.	149

* new as of 2014

Solar photovoltaic – international context

World capacity of solar PV – 177,000 MW

(2014)

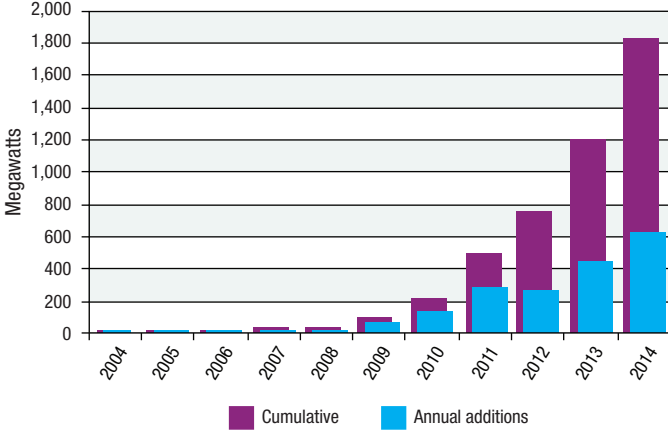
1) Germany.....	22%
2) China	16%
3) Japan.....	13%
4) Italy.....	10%
5) United States.....	10%
...	
Canada	1%

Solar PV in Canada

Capacity – 1,837 MW

(at the end of 2014)

Installed capacity



Solar photovoltaic

Selected largest solar PV farms in Canada (≥ 11 MW)

Facility	Province	Total capacity (MW)
Sol-Luce Kingston*	Ont.	100
Grand Renewable Energy Park*	Ont.	100
Sarnia Solar Project 2	Ont.	60
Sault Ste. Marie 2	Ont.	34
Stardale	Ont.	27
Sault Ste. Marie 1	Ont.	24
Arnprior	Ont.	23
Sarnia Solar Project 1	Ont.	20
St. Isidore A	Ont.	12
St. Isidore B	Ont.	12
Sault Ste. Marie 3	Ont.	11

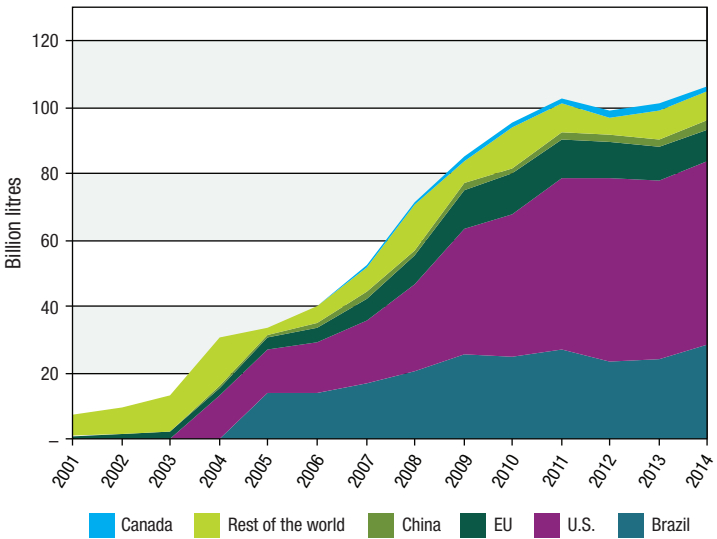
* new as of 2014

Biofuels – international context

World production of biofuels – 106.4 billion L (2014)

1) United States	52%
2) Brazil	27%
3) European Union.....	9%
4) China	2%
5) <i>Canada</i>	<i>2%</i>

World biofuels production

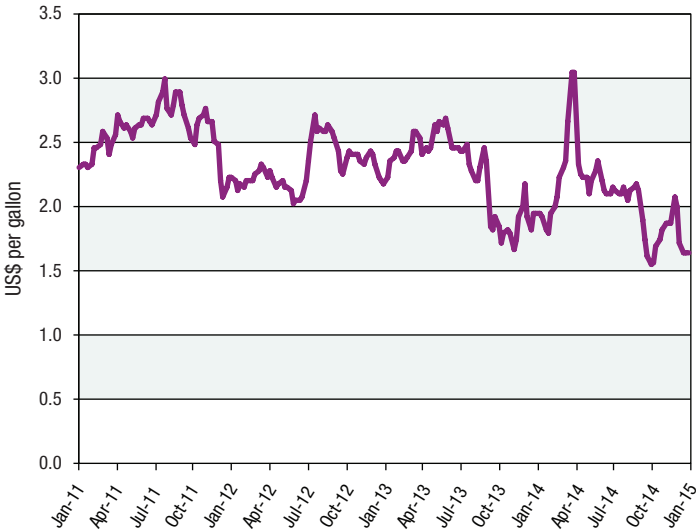


Biofuels

Canadian supply and demand

Activity	Ethanol (2014)	Biodiesel (2014)
	Mb/d (million L)	
Canadian production	29.8 (1,731)	N/A
Imports	19.6 (1,138)	8.7 (506)
Exports	N/A	5.0 (289)
Domestic use	49.4 (2,869)	N/A

Chicago Board of Trade ethanol futures prices



Biofuels

Regulations

	Gasoline	Diesel
	(% of renewable fuels content)	
Canada	5.0	2
British Columbia	5.0	4
Alberta	5.0	2
Saskatchewan	7.5	2
Manitoba	8.5	2
Ontario	5.0	2
Quebec	5.0*	–

* Not regulated, target only

- The federal *Renewable Fuels Regulations*, administered by Environment Canada, require fuel producers and importers to have an average renewable content of at least 5% based on the volume of gasoline that they produce or import commencing on December 15, 2010.
- Fuel producers and importers of diesel fuel are also required to have an average annual renewable fuel content of at least 2% of the volume of diesel fuel that they produce and import commencing July 1, 2011 (heating distillate oil volumes for space heating purposes were excluded from the diesel regulations starting January 1, 2013).

Canadian industry structure

The electricity industry performs three main activities:

- generating electricity by using various energy sources and technologies
- high-voltage transmission of electricity, usually over long distances, from power plants to end-use markets
- distributing electricity to end-users, usually through low-voltage, local power distribution lines

In some provinces, electricity is provided by vertically integrated electric utilities that are often provincial Crown corporations.

Major associations

- Canadian Electricity Association
- Provincially focused independent power producers' societies
- Source-specific associations (e.g. Canadian Hydropower Association and Canadian Wind Energy Association)

Regulatory authority

- Primarily under provincial jurisdiction
- Provincial governments exercise their jurisdiction through provincial Crown utilities and regulatory agencies.
- The NEB regulates international power lines and electricity exports.

International context

World generation – 23,391 TWh

(2013)

1) China	24%
2) United States	19%
3) India.....	5%
4) Russia.....	5%
5) Japan.....	5%
6) Canada	3%
7) Germany.....	3%
8) France	3%

World exports – 663 TWh

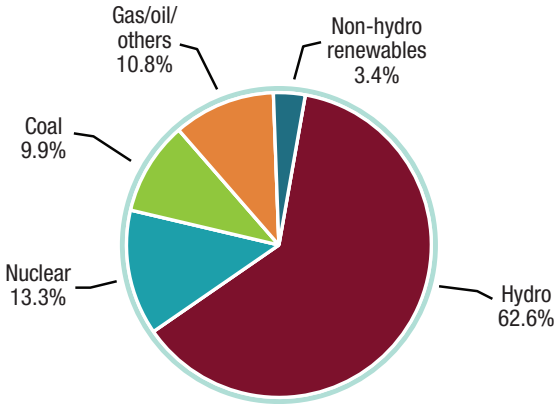
(2013)

1) Germany.....	11%
2) Canada	10%
3) France	9%
4) Paraguay	7%
5) Switzerland.....	5%
6) Czech Republic	4%

Canadian supply

Generation in Canada – 620 TWh
(2013)

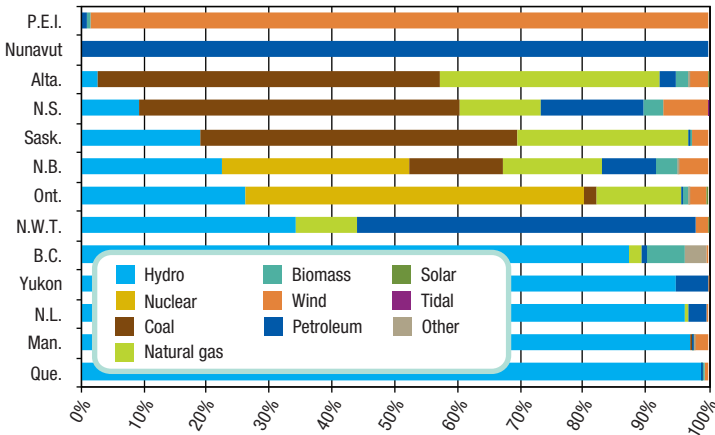
Generation by source, 2013



Generation from renewable sources:
66%, first in the G7

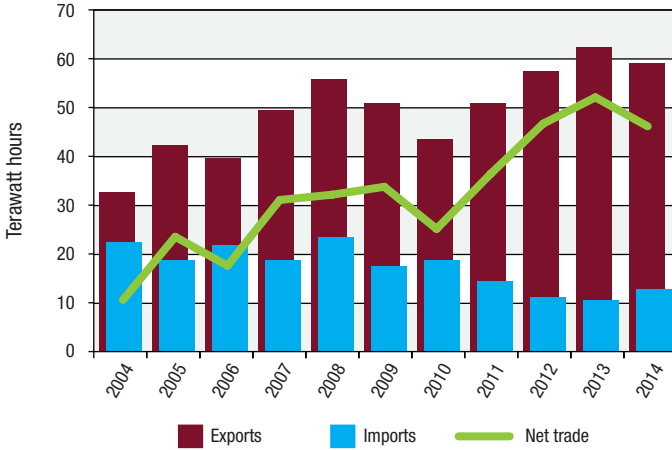
Generation from non-GHG emitting sources:
79%, second in the G7 after France

Provincial characteristics



Trade (2014)

Canada's electricity trade with the U.S.*



* includes only electricity traded under purchased contracts; excludes electricity transferred under non-financial agreements (e.g. under treaty obligations)

Exports 59 TWh

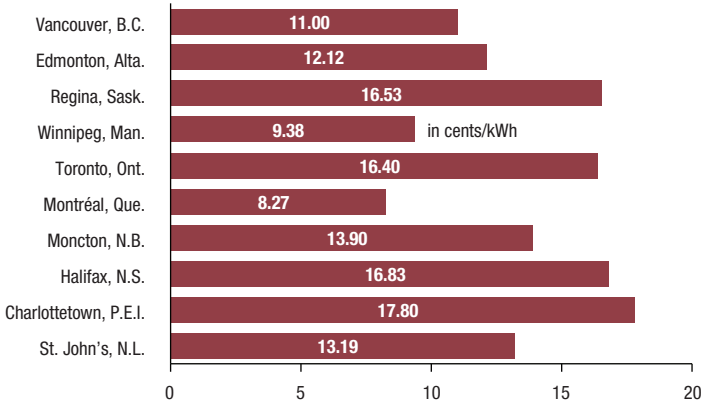
Imports..... 13 TWh

Key facts (2014)

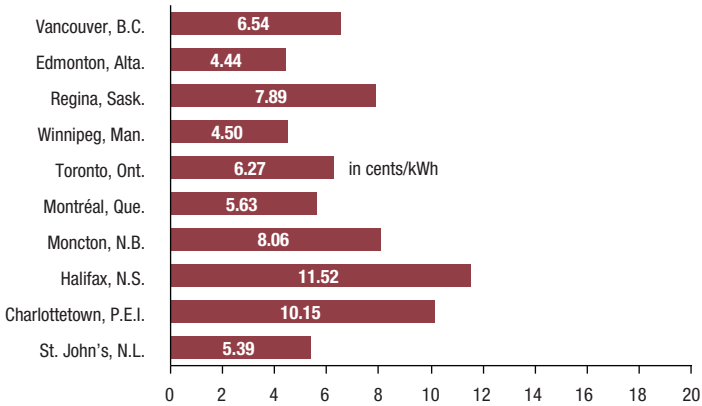
- All Canadian electricity trade is with the U.S.
- Canada exports about 10% of its electricity to the U.S., which meets 2% of U.S. consumption.

Retail prices

Average residential electricity prices, including taxes, April 2015



Average large industrial electricity prices, including taxes, April 2015



Primary energy use

- Primary energy use measures the total energy requirements of all users of energy.
- Primary energy use includes secondary energy use. Additionally, primary energy use includes the energy required to transform one form of energy into another (e.g. coal to electricity); the energy used to bring energy supplies to the consumer (e.g. pipeline); and the energy used to feed industrial production processes (e.g. NGLs used as feedstock by the chemical industries).
- In 2012, the total amount of primary energy consumed was estimated at 12,394.3 PJ.

Secondary energy use

- Secondary energy use accounts for the energy used by final consumers in various sectors of the economy.
- Secondary energy use includes the energy used to run vehicles in the transportation sector; the energy used to heat and cool buildings in the residential and commercial/institutional sectors; and the energy required to run machinery in the industrial and agricultural sectors.
- In 2012, secondary energy use accounted for about 70% of primary energy use, or 8,734.5 PJ.

All subsequent use of the phrase “energy use” in this section refers to secondary energy use, unless otherwise stated.

Factors affecting energy use

- level of activity – the number of households and the floor space of residences; short-term variations in industrial output
- sectoral structure (e.g. growth and decline of energy-intensive industries)
- weather – leading to changes in heating and cooling requirements
- service level (i.e. the penetration rate of devices and equipment, such as residential air conditioners)
- capacity utilization rate – the proportion of the installed production capacity that is in use
- energy efficiency
- These indicators can help explain the growth in energy use in a particular sector.

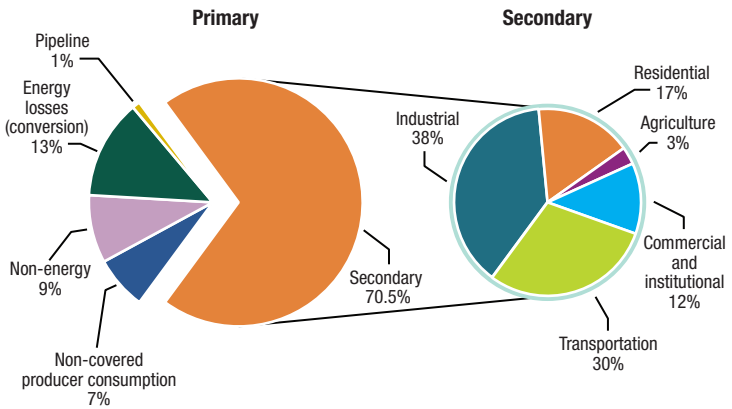
Energy efficiency

- a measure of how effectively energy is used for a given purpose
- providing a similar (or better) level of service with less energy consumption on a per-unit basis is considered an improvement in energy efficiency

Energy intensity

- the ratio of energy use per unit of activity (such as floor space, GDP, Pkm, Tkm, etc.)

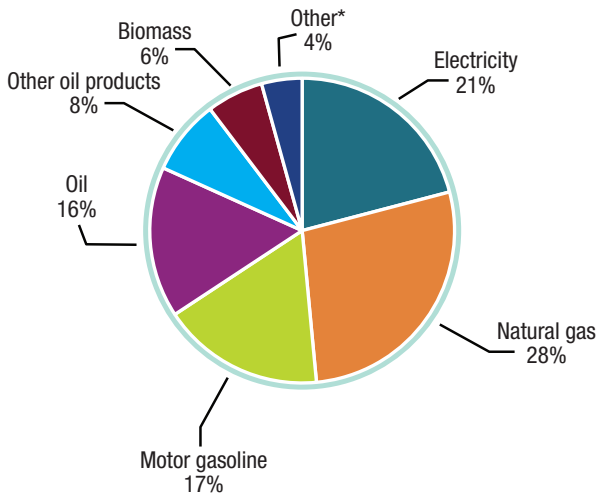
Primary and secondary energy use by sector, 2012



Not every fuel is consumed predominantly as secondary energy. For example, about 68% of the natural gas liquid supply in Canada is used as a non-energy feedstock in the petrochemical industry.

Canada's secondary energy use – 8,734 PJ (2012)

Energy use by fuel type, 2012



* "Other" includes coal, coke, coke oven gas, NGLs and steam and waste.

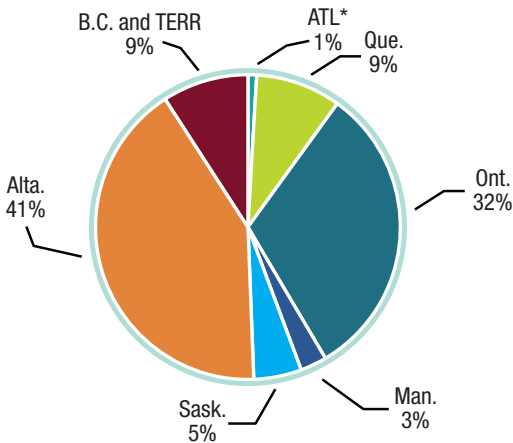
Natural gas energy use

(2012)

Total natural gas energy use was 2,408.9 PJ in 2012.

Sector	Energy use (PJ)	% of the total
Residential	632.1	26.2%
Commercial	464.4	19.3%
Industrial	1,273.1	52.8%
Transportation	1.8	0.1%
Agriculture	37.6	1.6%
Total	2,408.9	100%

Natural gas energy use by province, 2012



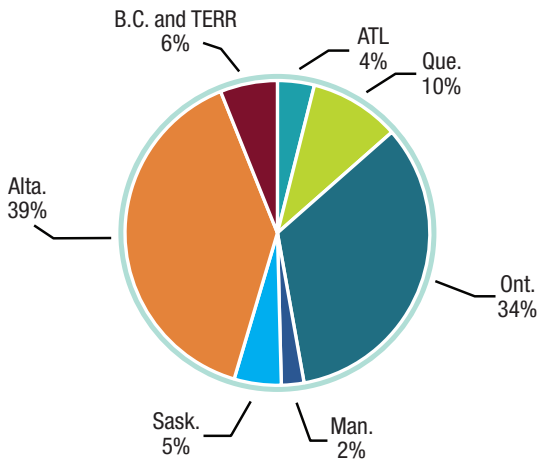
* Atlantic provinces.

Natural gas liquids energy use (2012)

Total natural gas liquids energy use was 166.6 PJ in 2012.

Sector	Energy use (PJ)	% of the total
Residential	18.6	11.2%
Commercial	42.0	25.2%
Industrial	83.5	50.1%
Transportation	13.0	7.8%
Agriculture	9.4	5.7%
Total	166.6	100%

Natural gas liquids energy use by province, 2012

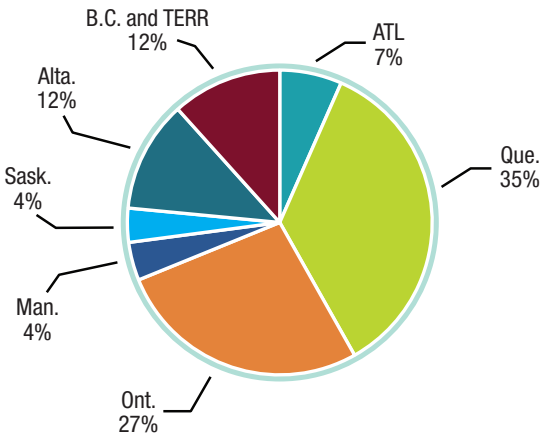


Electricity energy use (2012)

Total electricity energy use was 1,827.2 PJ in 2012.

Sector	Energy use (PJ)	% of the total
Residential	543.3	29.7%
Commercial	532.8	29.2%
Industrial	714.2	39.1%
Transportation	3.8	0.2%
Agriculture	33.0	1.8%
Total	1,827.2	100%

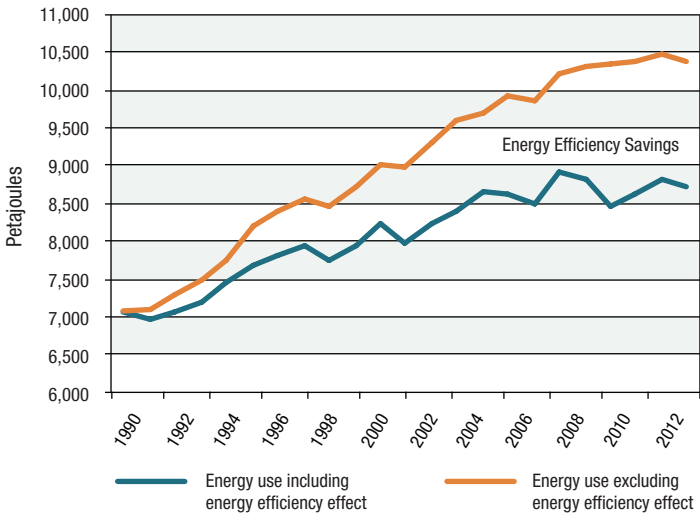
Electricity energy use by province, 2012



Energy efficiency

- Energy efficiency in Canada improved by 24.2% between 1990 and 2012.
- Efficiency improvements slow the rate of growth in energy use:
 - Energy use grew by 23.4% between 1990 and 2012.
 - Without energy efficiency improvements, energy use would have grown by 47%.
- Energy efficiency savings of 1,643 PJ in 2012:
 - equivalent to end-user savings of \$37.4 billion

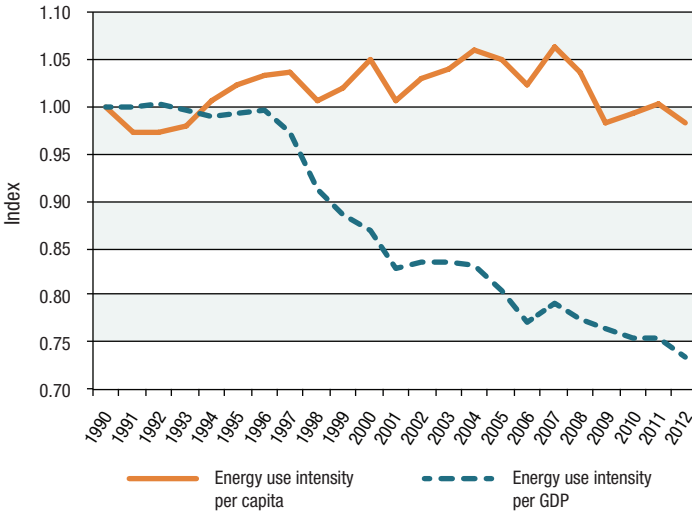
Secondary energy use with and without energy efficiency improvements 1990–2012



Energy intensity

- Canada used 27% less energy per dollar of GDP in 2012 than in 1990.

Total secondary energy use intensity per capita and unit of GDP index 1990–2012 (1990=1)



Trends in energy use and intensity by subsector, 1990–2012

	Energy use ¹		Energy intensity ²	
Residential	↑	2%	↓	-31%
Commercial	↑	23%	↓	-15%
Transportation (passenger)	↑	12%	↓	-23%
Freight	↑	78%	↑	14%
Industrial (forestry, mining, manufacturing, construction)	↑	24%	↓	-13%
Industry (w/o upstream mining)	↓	-6%	↓	-19%

¹ energy used by final consumers to deliver energy services in various sectors of the economy (e.g. space heating, process heating and lighting)

² the amount of energy used per unit of activity (i.e. floor space – residential, floor space – commercial, Pkm, Tkm and GDP)

- The lower rate of growth in energy use caused a decline in energy intensities.
- Most industries saw a reduction in their energy intensity due in part to gains in energy efficiency.

Canadian households

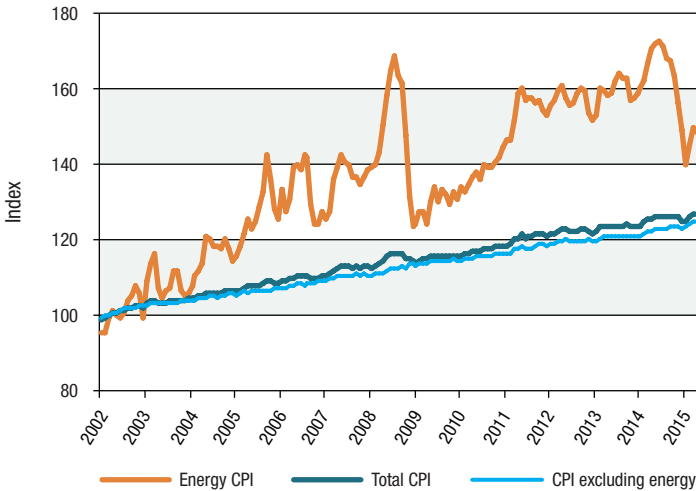
Household expenditures

- Canadian households spent \$4,611 on average on energy in 2013.
- Energy accounted for 7.9% of current household consumption.
- Lower-income households spend a larger share of their disposable income on energy.

Energy retail prices

- The “energy” component of the consumer price index has been volatile in recent years.
- This volatility reflects mostly the variations of upstream oil and gas prices and their impact on consumer products such as gasoline.

Consumer price index (2002=100)



Residential sector

1990

- 2.8 people per house
- 116 million m² of living space
- 9.9 million households
- 15 appliances per household
- 23% of occupied floor space cooled

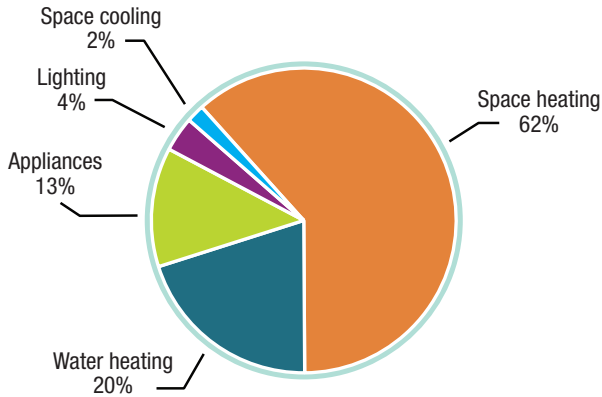
2012

- 2.6 people per house
- 133 million m² of living space
- 13.7 million households
- 21 appliances per household
- 48% of occupied floor space cooled

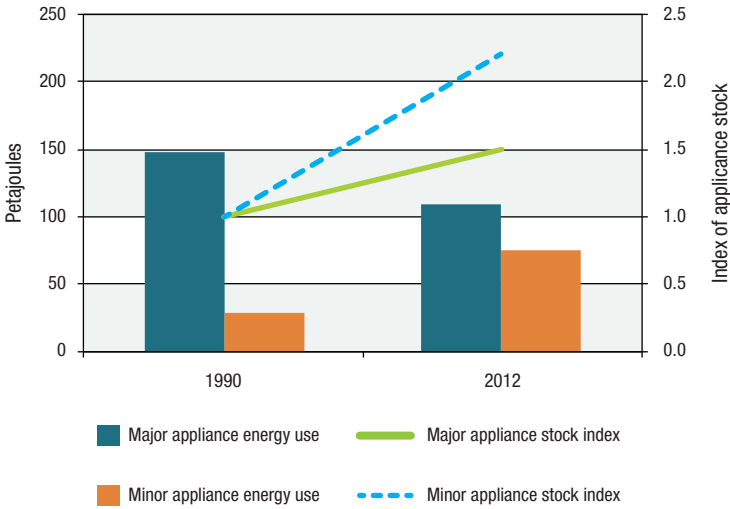
Overview – 1990–2012 period

- Residential energy efficiency improved by 41%, saving 584.2 PJ of energy and \$10.6 billion in energy costs.
- Residential energy use increased by 2.3%, but would have increased by 43% without energy efficiency improvements.
- Energy intensity decreased by 26% per household.

Energy use by end-use, 2012

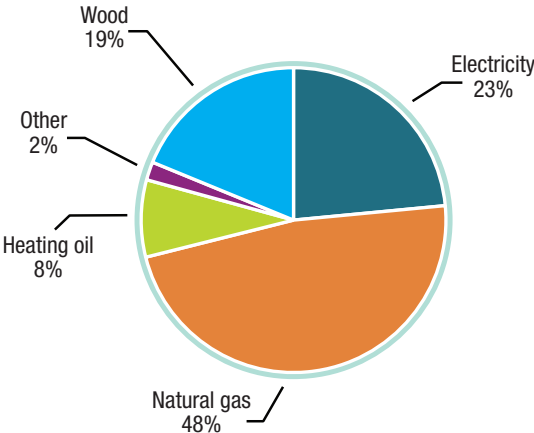


Residential energy use and index of appliance stock by appliance type 1990 and 2012

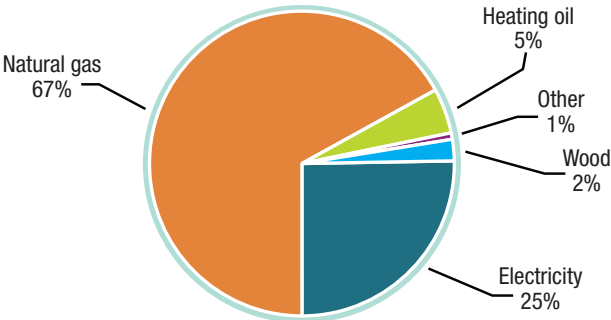


Energy efficiency gains were realized, to a large extent, by the replacement of less efficient heating and cooling systems with regulated medium- and high-efficiency systems. Space heating and water heating represented the majority of the energy used in the residential sector.

Residential space heating by fuel type, 2012



Residential water heating by fuel type, 2012



Commercial and institutional sectors

1990

- 867 PJ
- 509.9 million m² of floor space
- 9 million employees

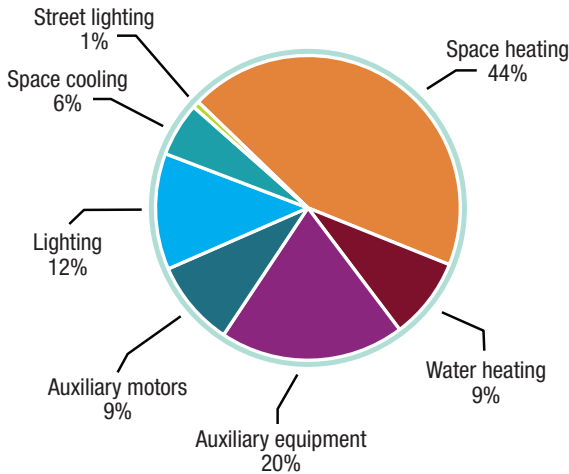
2012

- 1,069 PJ
- 741.0 million m² of floor space
- 13 million employees

Overview – 1990–2012 period

- Energy efficiency for the commercial and institutional sectors has improved by 33%, saving 283.5 PJ of energy and \$6.9 billion in energy costs.
- Energy use by these sectors increased by 23%, but it would have increased by 57% without energy efficiency improvements.
- Energy intensity for these sectors decreased by 15% per square metre of floor space.

Energy use by end-use, 2012



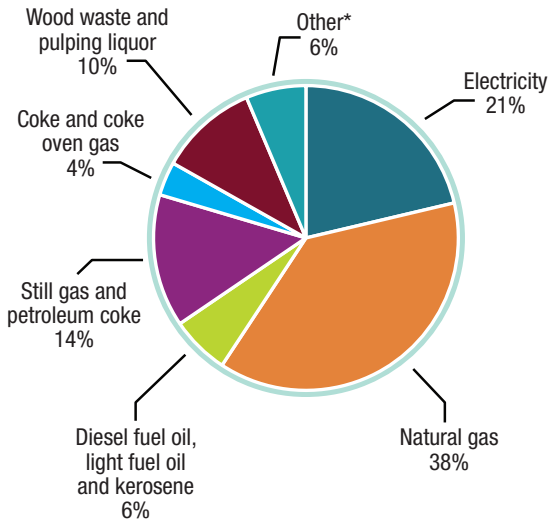
Industrial sector

Overview – 1990–2012 period

- Energy efficiency for the industrial sector improved by 10%, saving 261.9 PJ of energy and \$3.3 billion in energy costs.
- Energy use by this sector increased by 24%, but it would have increased by 33% without energy efficiency improvements.
- Energy intensity for this sector decreased by 13% per dollar of GDP.

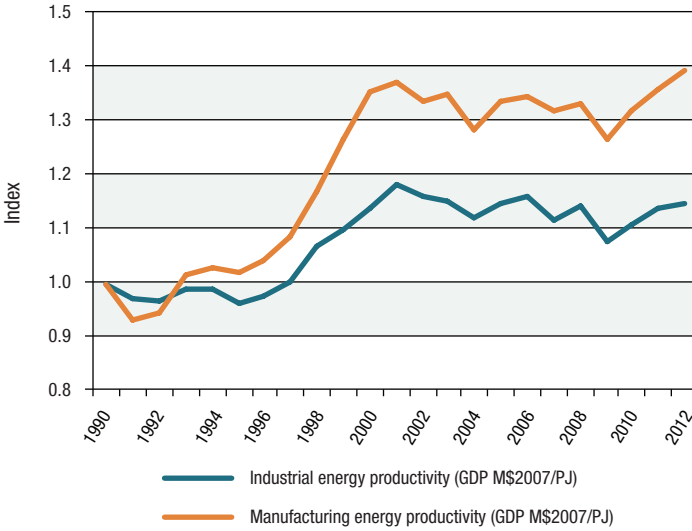
The industrial sector includes all manufacturing, mining (including oil and gas extraction), forestry and construction activities, and in 2012, these industries spent \$42.4 billion on energy.

Energy use by fuel type, 2012

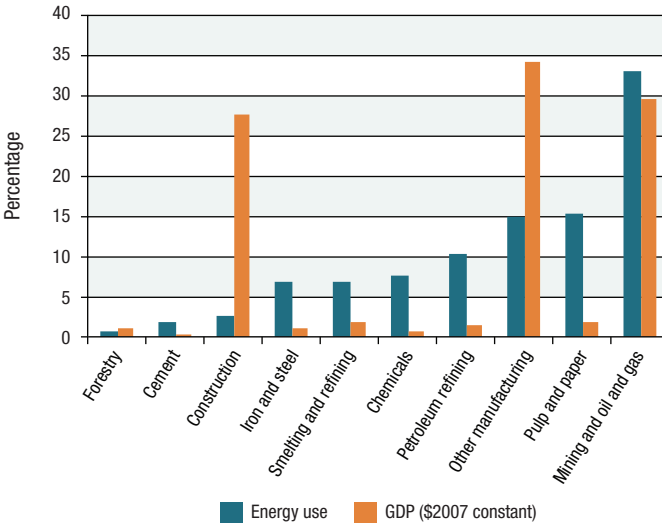


* "Other" includes steam and waste.

Indexed industrial and manufacturing energy productivity per year (1990–2012)



Distribution of energy use and activity by industry, 2012

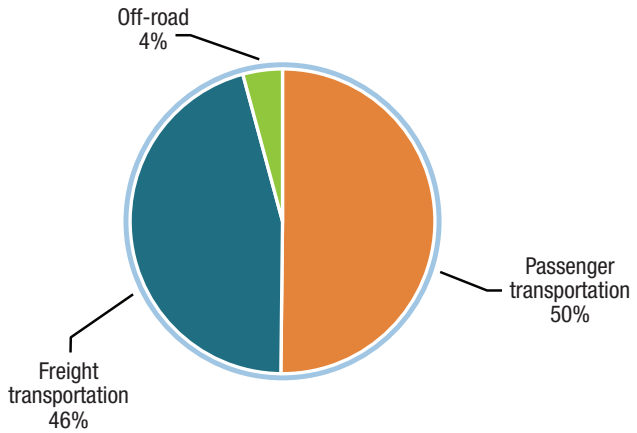


Transportation sector

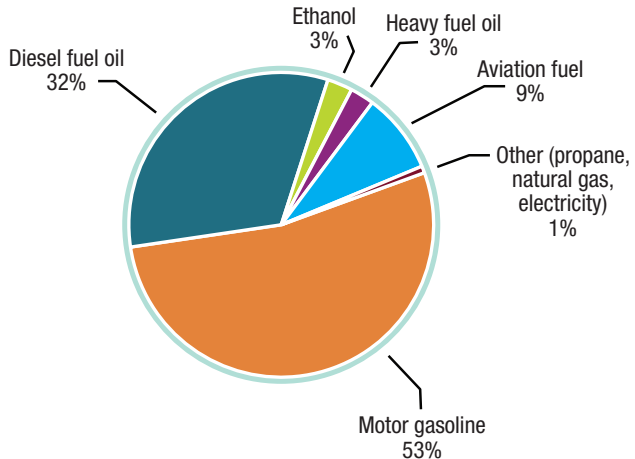
Over the 1990–2012 period

- Energy efficiency has improved by 29%, or 513.3 PJ, resulting in savings of \$16.6 billion.
- Total energy consumption increased by 38%.

Energy use by transportation type, 2012



Energy use by fuel type, 2012



Passenger transportation

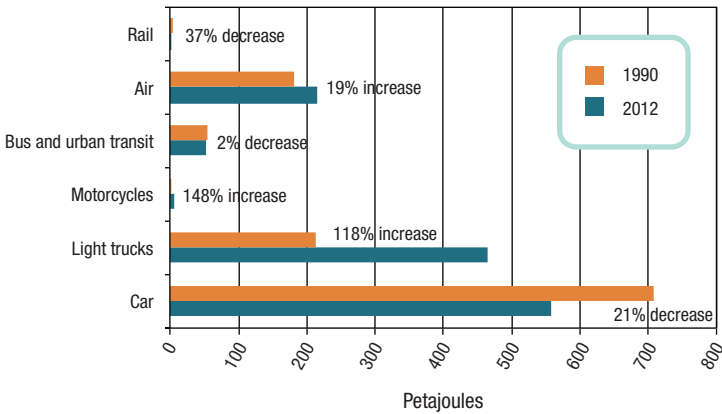
1990

- 14.2 million vehicles
- 19.4% are light trucks
- 17,293 km/year per vehicle
- 379.3 billion Pkm covered

2012

- 19.8 million vehicles
- 36.2% are light trucks
- 15,770 km/year per vehicle
- 506.7 billion Pkm covered

Energy consumption for passenger transportation by mode, 1990 and 2012



Freight transportation

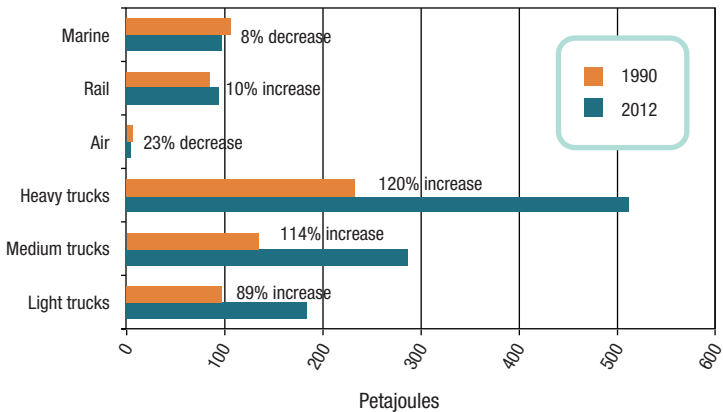
1990

- 1.9 million freight trucks
- 297,000 heavy trucks
- 72,005 km/year for heavy trucks
- 115.0 billion Tkm travelled

2012

- 4.3 million freight trucks
- 432,000 heavy trucks
- 80,943 km/year for heavy trucks
- 295.2 billion Tkm travelled

Energy consumption of freight transportation by mode, 1990 and 2012



Canadian GHG emissions (2013)

Total* 726 Mt CO₂ equivalent

* (excludes land use, land use change and forestry estimates)

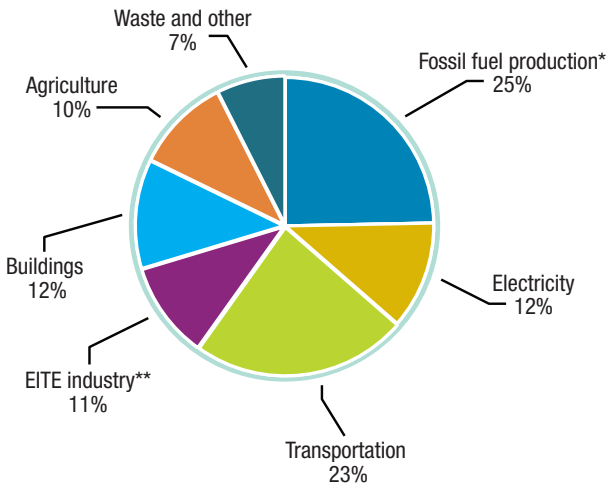
Canada's emissions constitute less than 2% of global emissions.

Between 2005 and 2013, Canada's GHG emissions decreased by 3.1% while the economy grew by 12.9%.

Over that same period, GHG emissions from electricity production decreased 30% and emissions from fossil fuel production increased 15%, leading to an overall decrease of 4.3% in emissions from energy production.

* See the "Crude oil" chapter for information on GHG emissions from the oil sands.

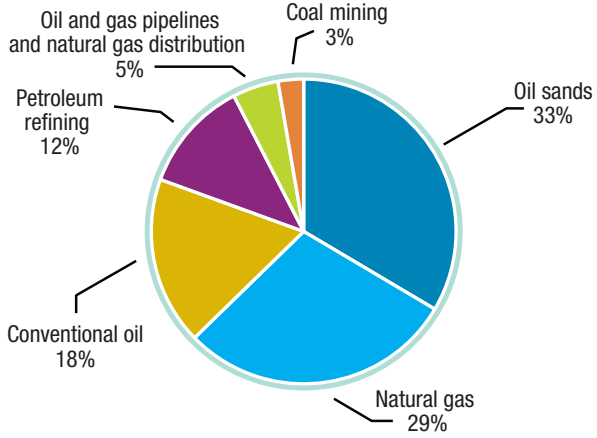
GHG emissions by economic sector, 2013



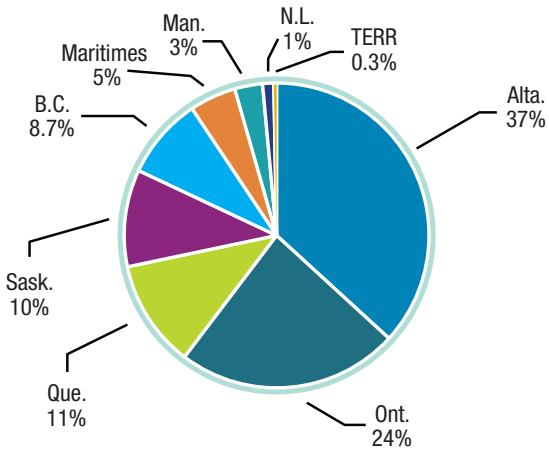
* includes coal production

** EITE: emissions intensive, trade exposed (Mining; Smelting and Refining of Non-Ferrous Metals; Pulp and Paper; Iron and Steel; Cement; Lime and Gypsum; Chemicals and Fertilizers)

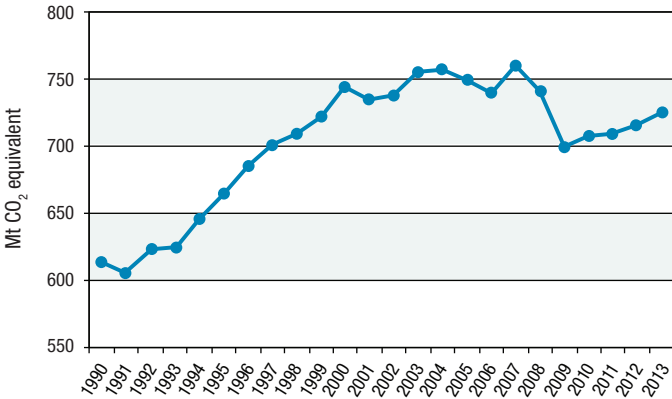
GHG emissions by fossil fuel subsector, 2013



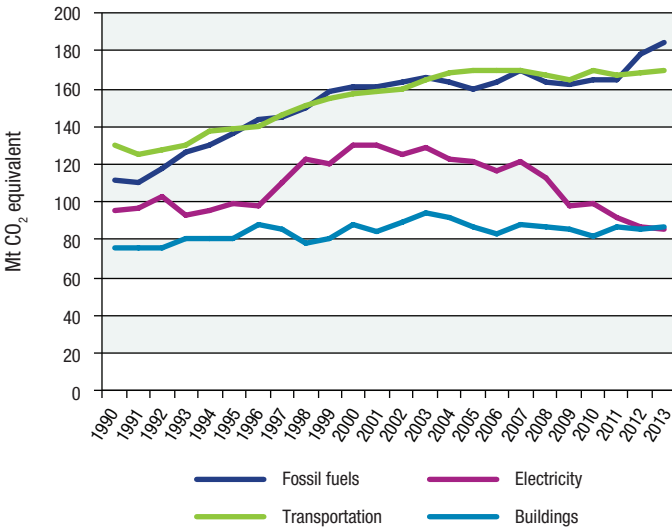
GHG emissions by province, 2013



GHG emissions, 1990–2013



GHG emissions, selected economic sectors, 1990–2013



Annex 1: Units and conversion factors

Prefixes and abbreviations

Metric

kilo	=	k	=	thousand
mega	=	M	=	million
giga	=	G	=	billion
tera	=	T	=	trillion
peta	=	P	=	10^{15}

Notes

- Tonne may be abbreviated to “t.”
- Roman numerals are sometimes used with imperial units (this can create confusion with the metric “M”):
 - M = thousand
 - MM = million

Crude oil

Upstream

- reserves/production usually in *barrels* or multiples (million barrels)
- production/capacity often in *barrels per day* or multiples (thousand barrels/day or Mb/d, million barrels/day or MMb/d)
- metric: 1 *cubic metre* = 6.2898 barrels
- International Energy Agency: uses weight (*tonnes*) rather than volume

Downstream

- volumes of refined products usually in litres
- 1,000 litres = 1 cubic metre
- U.S.: 1 U.S. gallon = 3.785 litres

Natural gas

Volume

- reserves/production usually in cubic feet or multiples (billion cubic feet or Bcf, trillion cubic feet or Tcf)
- production/capacity often in cubic feet per day or multiples (Bcf/d, Tcf/d)
- metric: 1 cubic metre = 35.3147 cubic feet

Density

- 1 million t LNG = 48.0 billion cubic feet

Pricing

volume based:

- cents per cubic metre ($\text{¢}/\text{m}^3$) (customer level in Canada)
- \$ per hundred cubic feet ($\text{\$/CCF}$) (customer level in the U.S.)

energy content based:

- \$ per gigajoule ($\text{\$/GJ}$) (company level in Canada)
- \$ per million British thermal units ($\text{\$/MMBTU}$) (company level in the U.S., LNG)

Coal

- 1 metric tonne = 1,000 kilograms
- U.S.: 1 short ton = 2,000 pounds
- 1 metric tonne = 1.10231 short tons

Uranium

- 1 metric tonne = 1,000 kilograms of uranium metal (U)
- U.S.: in pounds of uranium oxide (U_3O_8)
- 1 lb. U_3O_8 = 0.84802 lb. U = 0.38465 kg U

Electricity

Capacity

- maximum rated output that can be supplied at an instant, commonly expressed in megawatts (MW)

Total capacity

- installed generator nameplate capacity

Generation/sales

- flow of electricity over time, expressed in watt-hours, or multiples:
 - kilowatt-hours or kWh (e.g. customer level)
 - megawatt-hours or MWh (e.g. plant level)
 - gigawatt-hours or GWh (e.g. utility level)
 - terawatt-hours or TWh (e.g. country level)

From capacity to generation

- A 1-MW unit operating at full capacity over one hour generates 1 MWh of electricity.
- Over one year, this unit could generate up to 8,760 MWh ($1 \text{ MW} \times 24 \text{ hr} \times 365 \text{ days}$).
- Units are rarely used at full capacity over time because of factors such as maintenance requirements, resource limitations and low demand.
- “Capacity factor” is the ratio of actual generation to full capacity potential.

Energy content

Rather than using “natural” units (e.g. volume, weight), energy sources can be measured according to their energy content – this allows comparison between energy sources.

- metric: joules or multiples (gigajoules or GJ, terajoules or TJ, petajoules or PJ)
- U.S.: 1 British thermal unit (BTU) = 1 054.6 joules
- IEA: energy balances expressed in oil equivalent
 - thousand tonnes of oil equivalent (ktoe)
 - million tonnes of oil equivalent (Mtoe)

Typical values

- 1 m³ of crude oil = 39.0 GJ
- 1,000 m³ of natural gas = 38.3 GJ
- 1 MWh of electricity = 3.6 GJ
- 1 metric tonne of coal = 29.3 GJ
- 1 metric tonne of wood waste = 18.0 GJ
- 1 metric tonne of uranium = 420,000 GJ to 672,000 GJ

Annex 2: Abbreviations

b/d	barrels per day
Bcf/d	billion cubic feet per day
Bcm/d	billion cubic metres per day
CCS	carbon capture and storage
CDIA	Canadian direct investment abroad
CO ₂ equivalent	carbon dioxide equivalent
EIA	Energy Information Administration (U.S.)
FDI	foreign direct investment
G7	Seven wealthiest major developed nations: Canada, France, Germany, Italy, Japan, U.K. and U.S.
GDP	gross domestic product
GHG	greenhouse gas
GJ	gigajoule
GST	Goods and Services tax
HGL	hydrocarbon gas liquids
HST	Harmonized Sales tax
IEA	International Energy Agency
kg	kilogram
km	kilometre
km ²	square kilometre
kt	kilotonne
lb.	pound
L	litre
LNG	liquefied natural gas
LPG	liquefied petroleum gases
m	metre
m ²	square metre
m ³	cubic metre
Mb/d	thousand barrels per day
MMb/d	million barrels per day
MMcf/d	million cubic feet per day
Mt	million tonnes; megatonne
Mtoe	million tons of oil equivalent
mtpa	million tonnes per annum
MW	megawatt

Annex 2: Abbreviations

NEB	National Energy Board
NGL	natural gas liquids
NRCan	Natural Resources Canada
NSERC	National Science and Engineering Research Council of Canada
OECD	Organisation for Economic Co-operation and Development
PJ	petajoule
Pkm	passenger-kilometre
Provinces	Alta. – Alberta B.C. – British Columbia Man. – Manitoba N.B. – New Brunswick N.L. – Newfoundland and Labrador N.S. – Nova Scotia N.W.T. – Northwest Territories Ont. – Ontario P.E.I. – Prince Edward Island Que. – Quebec Sask. – Saskatchewan
P/T	provincial/territorial
PV	photovoltaic
RD&D	research, development and demonstration
R&D	research and development
RPP	refined petroleum products
SDTC	Sustainable Development Technology Canada
Tcf	trillion cubic feet
Tcm	trillion cubic metres
Tkm	tonne-kilometre
t	tonnes
TPES	total primary energy supply
TWh	terawatt-hour
UAE	United Arab Emirates
U.K.	United Kingdom
U.S.	United States
US\$	United States dollars
WCS	Western Canada Select
WTI	West Texas Intermediate

Annex 3: Sources

1. Energy industry

Canada's position in the world: electricity capacity from the United Nations; for other data, see relevant chapters

Gross domestic product: StatCan CANSIM Table 379-0029, nominal values for recent years estimated by NRCan

Employment: CANSIM Table 383-0031, StatCan Aboriginal People and the Labour Market Estimates from the Labour Force Survey, 2014

Capital expenditures: StatCan CANSIM tables 029-0045, 029-0046, and 029-0051

Exports/imports: StatCan International Merchandise Trade Database (TRAGS Database)

Government revenues: StatCan CANSIM Table 180-0003, StatCan special tabulation (royalties), Canadian Association of Petroleum Producers, *Statistical Handbook*, Table 01-01C

Expenditure on energy RD&D: IEA RD&D Budget database; StatCan survey of industry expenditures; Statistics Canada, *Federal Scientific Activities 2014/2015*, Research and Development Cat. No. 88-204-X; and data compiled by NRCan

Foreign control: StatCan CANSIM tables 179-0004, 179-0005, 180-0003 and StatCan document 61-220-X

Investment: StatCan CANSIM Table 376-0052

Major recent deals: S&P Capital IQ, Canoils, Bloomberg (based on closing dates when available)

Canadian energy assets: NRCan estimates based on company financial statements and annual reports

Canadian production: StatCan CANSIM tables 127-007, 128-0016, 128-0007, and NRCan estimates

Total primary energy supply: IEA Annual Database, World Energy Balances and IEA SLT questionnaire

2. Crude oil

World production and exports: International Energy Agency (IEA *Online Data Services*)

World proved reserves: *Oil and Gas Journal*, Survey: Worldwide Look at Reserves and Production

Canadian resources: CAPP, *Statistical Handbook – for Canada’s Upstream Petroleum Industry*, April 2015; Alberta Energy Regulator (AER), *Alberta’s Energy Reserves 2014 and Supply/Demand Outlook 2015–2024*

Wells completed and metres drilled in western Canada: June Warren-Nickle’s Energy Group, Canadian Association of Oilwell Drilling Contractors (CAODC)

Canadian production: StatCan CANSIM Table 126-0001 and NRCan analysis

Canadian supply and demand: StatCan CANSIM tables 126-0001, 134-0001, 133-0003

Trade: StatCan CANSIM Table 126-0001 and StatCan International Merchandise Trade Database (TRAGS Database), U.S. Energy Information Administration, *Imports by Country of Origin, Refinery and Blender Net Input for Crude Oil*

Prices: U.S. EIA Tables on Spot Prices for Crude Oil and Sproule Worldwide Petroleum Consultants

Pipelines: compiled by NRCan

Oil sands: CAPP *Statistical Handbook for Canada’s Upstream Petroleum Industry*, Table 04-16B, StatCan CANSIM tables 029-0046 and 126-0001, Alberta Energy Regulator (AER) *Alberta’s Energy Reserves 2014 and Supply/Demand Outlook 2015–2024*, Table R3.2, and NRCan analysis

Light tight Oil/Shale Oil: U.S. EIA, Technically Recoverable Shale Oil Resources

Environmental challenges: compiled by NRCan

Crude by rail: CANSIM Table 404-0002, *CAPP Crude Oil Forecast, Markets & Transportation – June 2015*, NEB *Canadian Crude Oil Exports by Rail – Quarterly Data*

3. Petroleum products

Canadian refineries: compiled by NRCan from company information and Conference Board of Canada, Canada's Petroleum Refining Sector, and other published sources

Canadian supply and demand: StatCan CANSIM tables 134-0001 and 134-0004, NRCan analysis

Trade: StatCan CANSIM Table 134-0004, U.S. EIA, U.S. Imports by Country of Origin for Petroleum and Other Liquids, and StatCan International Merchandise Trade Database (TRAGS Database)

Gasoline prices: Fuel Focus, average retail prices for regular gasoline and diesel fuel, and data compiled by NRCan

Canadian petroleum refineries: Canadian Fuels Association, Canadian Association of Petroleum Producers

4. Hydrocarbon gas liquids

Canadian supply: StatCan CANSIM tables 134-0004 and 131-0002

Trade: NEB for Exports; and StatCan International Merchandise Trade Database (TRAGS Database) for Imports

Production by province: *CAPP Statistical Handbook*, tables 3.5a, 3.6a, 3.14a

5. Natural gas

World production and exports: International Energy Agency, *IEA Natural Gas Information*

World proved reserves: *Oil and Gas Journal*

Canada reserves: *CAPP Statistical Handbook*, Table 02-13B

Canada resources: NEB, *Canada's Energy Future 2013*

U.S. reserves: U.S. EIA, *Natural Gas Reserves Summary*, dry gas

U.S. resources: Potential Gas Committee, *Report of Potential Supply of Natural Gas in the United States, 2013* and U.S. EIA, *Technically Recoverable Shale Oil and Shale Gas Resources: An Assessment of 137 Shale Formations in 41 Countries Outside the United States*, June 2013

World resources: International Energy Agency, *World Energy Outlook* 2013, Table 3.3

Shale gas: U.S. EIA, Technically Recoverable Shale Gas Resources, June 2013, Table 6

Canada-U.S. market: compiled by NRCan from StatCan, U.S. EIA, US Natural Gas Imports by Country, National Energy Board, Natural Gas Imports, Exports and Liquefied Natural Gas Statistics, Commodity Statistics for LNG imports, LNG Shipment Details

Wells completed and metres drilled in western Canada: JuneWarren-Nickle's Energy Group and CAODC

Canadian production: StatCan CANSIM Table 131-0001

U.S production: U.S. EIA Table Natural Gas Gross Withdrawals and Production

Trade: NEB, Natural Gas Imports, Exports and Liquefied Natural Gas Statistics, Commodity Statistics for pipeline trade, Gas Monthly Summary for the Year, U.S. EIA, Natural Gas Consumption by End Use and calculations by NRCan

Canadian domestic demand: StatCan CANSIM tables 128-0017 and 129-0002

Prices: GLJ Energy Publications, *Canadian National Gas Focus*, 2002–2014

Pipelines: compiled by NRCan

LNG export applications: compiled by NRCan

6. Coal

World production and exports: International Energy Agency, *IEA Coal Information*

World proved reserves: World Energy Council

Canadian supply and demand: StatCan CANSIM Table 135-0002 and StatCan International Merchandise Trade Database (TRAGS Database)

Coal-fuelled power plants: compiled by NRCan from StatCan and other sources

7. Uranium and nuclear power

World production and exports: World Nuclear Association

World known recoverable resources: Organisation for Economic Co-operation and Development, Nuclear Energy Agency, International Atomic Energy Agency

Canadian supply and demand: compiled by NRCan from company information; also published by the World Nuclear Association

Purchases by U.S. nuclear reactors: U.S. EIA Table Uranium Purchases by Owners and Operators of Civilian Nuclear Power Reactors

Spot prices: Ux Consulting Company

Nuclear power world generation: U.S. EIA Table Nuclear Electricity Net Generation

Nuclear power plants in Canada: compiled by NRCan from StatCan and other sources

8. Renewable energy

International context: International Energy Agency (*IEA Renewables Information*)

Domestic production: International Energy Agency (*IEA Renewables Information*), based on StatCan and NRCan data

Hydro – international context: International Energy Agency (*IEA Electricity Information, Energy Balances of OECD Countries, and Energy Balances of Non-OECD Countries*)

Hydro – capacity in Canada: StatCan CANSIM Table 127-0009 and compiled by NRCan

Hydro – facilities and projects: compiled by NRCan

Wood and wood waste – share of renewables: International Energy Agency (*IEA Renewables Information*)

Wood and wood waste – production: StatCan CANSIM Table 128-0018, StatCan International Merchandise Trade Database (TRAGS), NRCan

Wood and wood waste –wood fuel use by sector:

International Energy Agency, IEA *Renewables Information*

Wood and wood waste – trade: StatCan International Merchandise Trade Database (TRAGS)

Wind – international context: Global Wind Energy Council

Wind – generation in Canada: StatCan CANSIM Table 127-0007

Wind – capacity in Canada: compiled by NRCan from multiple sources (e.g. Canadian Wind Energy Association, StatCan, NRCan)

Solar PV – international context: *Renewable Energy Policy Network for the 21st Century*

Solar PV – capacity in Canada: *Canada’s Annual Report to the IEA Implementing Agreement on PV* and compiled by NRCan

Biofuels – Canadian production of biofuels: compiled by NRCan; World production of biofuels (with the exception of Canada): Bloomberg New Energy Finance and F.O. Licht

Biofuels – supply and demand: production: NRCan, ecoENERGY for Biofuels program (which collects data from most but not all biofuels companies operating in Canada); imports/exports: StatCan International Merchandise Trade Database; domestic demand: estimation based on production plus imports minus exports

Biofuels – ethanol prices: Chicago Mercantile Exchange and Chicago Board of Trade (CME Group)

Biofuels – regulations: compiled by NRCan

9. Electricity

World generation and exports: International Energy Agency, IEA *Electricity Information*, note: IEA production/generation data is expressed on a “gross” basis, i.e. before generating station use

Canadian supply: compiled by StatCan and NRCan

Trade: National Energy Board Table *Electricity Exports and Imports Statistics*, StatCan, and U.S. EIA Table *Retail Sales of Electricity to Ultimate Customers*

Domestic demand: StatCan CANSIM Table 128-0017

Prices: Hydro-Québec report *Comparison of Electricity Prices in Major North American Cities*

10. Energy demand

Primary and secondary energy use: compiled by NRCan based on StatCan CANSIM Table 128-0017

Canada's secondary energy use: compiled by NRCan based on StatCan CANSIM Table 128-0017

Natural gas energy use: StatCan CANSIM tables 128-0017 and 129-0002

Electricity energy use: StatCan CANSIM Table 128-0017

Natural gas liquids energy use: StatCan CANSIM Table 128-0012

Energy efficiency: compiled by NRCan

Energy intensity: compiled by NRCan

Household expenditures: StatCan CANSIM tables 203-0001, -0003, -0007, -0010, -0021, and 326-0020

Consumer prices: StatCan CANSIM Table 326-0020

Residential sector: NRCan energy use data and analysis based on StatCan *Report on Energy Supply Demand in Canada* (RESD)

Commercial and institutional sector: NRCan energy use data and analysis based on StatCan RESD

Industrial sector: NRCan energy use data and analysis based on StatCan RESD

Transportation sector: NRCan energy use data and analysis based on StatCan RESD

11. Greenhouse gas emissions

Environment Canada *National Inventory Report* and NRCan analysis

