



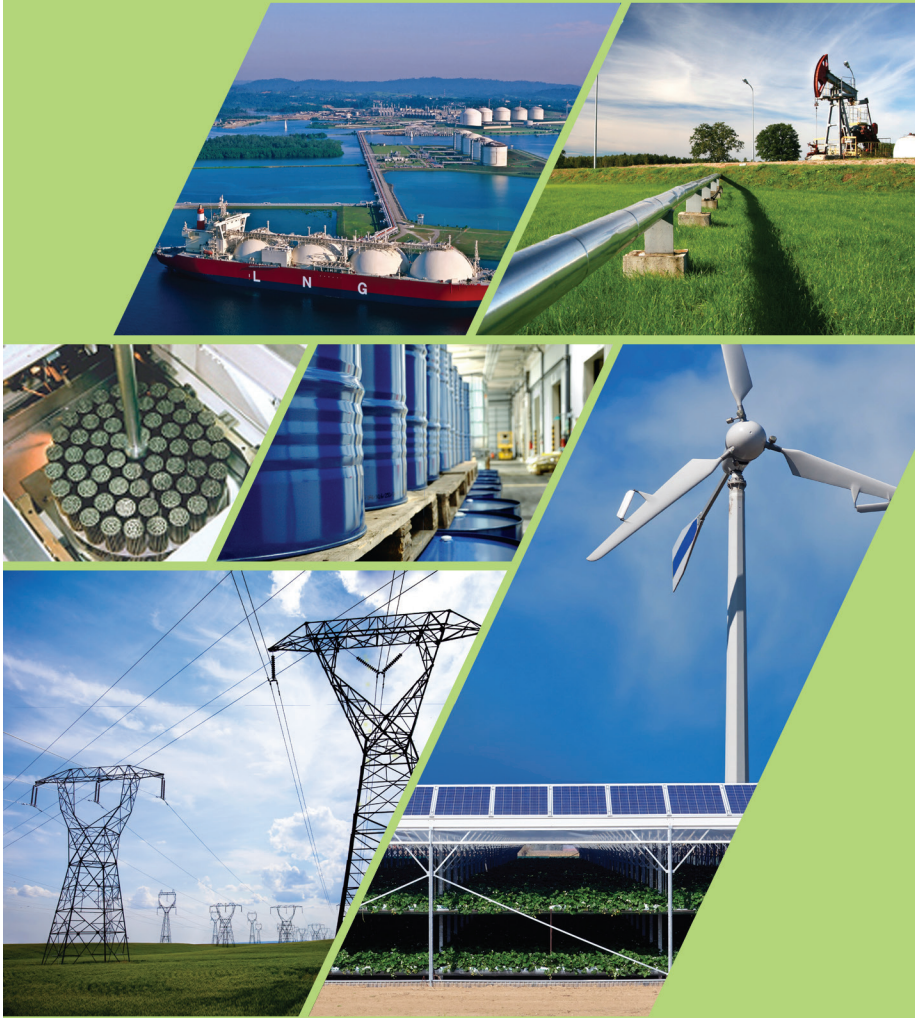
Natural Resources  
Canada

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Canada



# ENERGY MARKETS FACT BOOK

## 2013-2014



Canada





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Canada

# **Energy Markets Fact Book**

## 2013–2014

Canada 

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## **Preface**

The purpose of the Energy Markets 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 2013. All data are 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.

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.



# Contents

1. Energy industries.....	1
2. Crude oil.....	15
3. Petroleum products.....	27
4. Natural gas.....	35
5. Natural gas liquids (NGLs) .....	47
6. Coal .....	49
7. Uranium and nuclear power .....	55
8. Renewable energy.....	61
9. Electricity.....	75
10. Energy demand .....	81
11. Greenhouse gas emissions .....	87
Annex 1: Units and conversion factors .....	89
Annex 2: Sources.....	93





# 1. Energy industries

## Definition

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

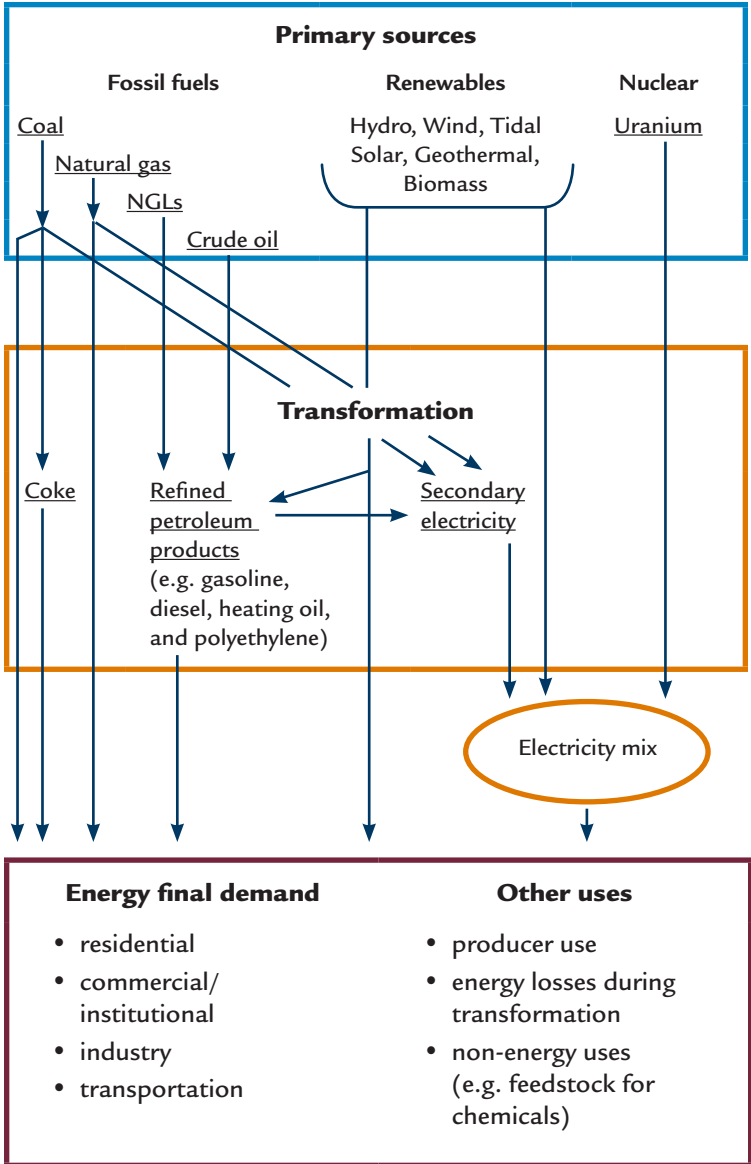
- oil and gas extraction
- coal mining
- uranium mining
- support activities for mining and oil and gas extraction
- pipeline transportation
- natural gas distribution
- biofuels production
- petroleum and coal product manufacturing
- electric power generation, transmission and distribution

Some energy-related industries (e.g. petroleum product wholesaler-distributors) are excluded because of a lack of data.

## Canada's position in the world: An overview

Fuel/power source	Proved reserve/capacity	Production	Exports
Crude oil	3rd	5th	5th
Natural gas	18th	5th	4th
Coal	11th	13th	7th
Uranium	4th	2nd	2nd
Electricity	7th	6th	3rd
Renewable energy	-	7th	-
Hydro electricity	4th	3rd	-
Wind	9th	-	-
Ethanol	-	5th	-

## Energy flow



## Energy and the economy (2012)

### Gross domestic product (GDP)

- approximately \$155 billion or 9.1% of total Canadian GDP in current prices (nominal GDP)\*

\* NRCan estimate

### Employment

- 335,500 direct jobs, including 3,800 self-employed
- 1.9% of total Canadian employment
- 161,000 indirect jobs in electric power and oil and gas engineering construction industries alone\*

\* other industries (e.g. equipment manufacturing, financial services) also generate indirect employment from energy industry investments

**Employment data** is available from Statistics Canada from a number of different sources.

#### **Survey of Employment, Payrolls and Hours (SEPH)**

(CANSIM Table 281-0023) is based on administration data, as well as a sample of 15,000 establishments. Its key objective is to provide a monthly portrait of the level of earnings and the number of jobs and hours worked by industry at the national, provincial and territorial level.

**Labour Force Survey (LFS)** (CANSIM Table 282-007) is based on information obtained through a sample survey of 56,000 representative households across all provinces. It provides timely information on recent developments in the Canadian labour market, such as employment and unemployment for Canada.

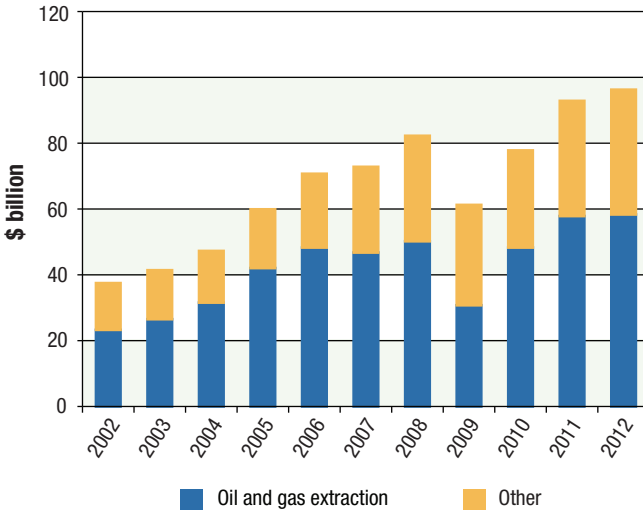
**System of National Accounts** (CANSIM Table 383-0031) uses LFS and SEPH data, as well as administration and census data, to compile the most comprehensive employment data by industry on an annual basis. This data source is referenced in this publication, and more generally, by NRCan when citing annual employment levels for the various natural resources sub-industries.

## Energy and the economy (2012)

### Capital expenditures

- \$96 billion
- 24.6% of total public and private investments in Canada

### Capital expenditures in the energy industry



### Domestic exports\*

- \$119 billion
- 27.8% of Canadian domestic merchandise exports
- 90% of total energy exports are to the U.S.

### Imports

- \$54 billion
- 11.7% of Canadian merchandise imports
- 35.3% of total energy imports are from the U.S.

\* Domestic exports exclude the re-exports of goods that have previously entered Canada and exit in the same condition.

## Government revenues

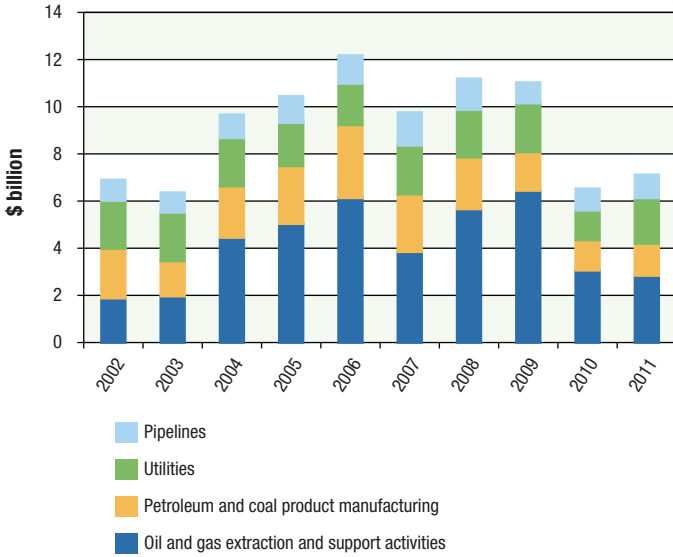
- Federal and provincial/territorial governments in Canada receive direct revenues from energy industries related to
  - corporate income tax, which is levied on corporations operating in Canada
  - indirect taxes, such as sales and payroll taxes
  - crown royalties, which are the share of the value 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 mineral rights for specific properties

Source	2007–2011 average (\$ billions)
Income tax	6.7
Indirect taxes	2.4
Royalties	13.3
Land sales	4.2
<b>Total</b>	<b>26.6</b>

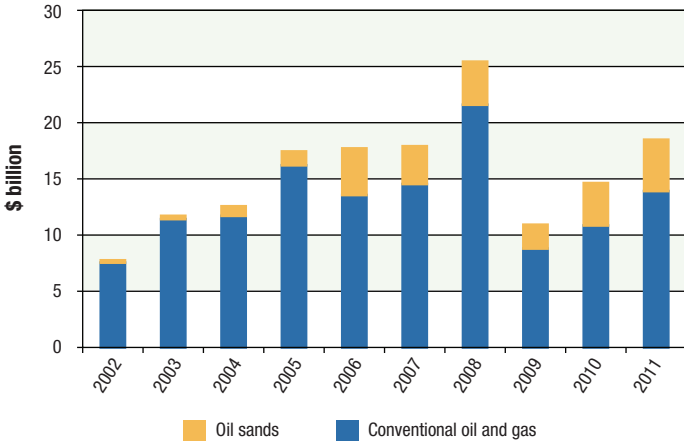
- The largest share of government revenues is collected from the upstream oil and gas industry, which averaged about \$22 billion over the last five years.
- Between 2007 and 2011, the energy industries' share of total taxes paid (12.9%) was in line with their share of total operating revenues (13.5%).

## Government revenues

### Total taxes paid by energy industries



### Total oil and gas crown royalties and land sales in Canada



## Energy research, development and demonstration (RD&D)

### Public expenditures\* on energy RD&D for OECD countries - as a % of GDP (2010)

#1) Finland .....	0.15%
#2) Hungary .....	0.09%
#3) Denmark .....	0.08%
#4) Japan.....	0.07%
<b>#5) Canada .....</b>	<b>0.07%</b>
#6) Netherlands.....	0.06%

\* Expenditures exclude tax incentives.

### Canadian public expenditures on energy RD&D

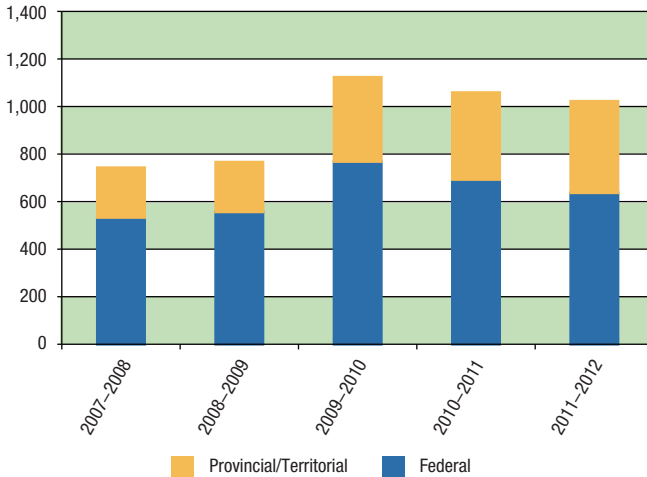
- Federal energy RD&D expenditures of \$637 million in 2011/12
  - key organizations: NRCan (\$255 million), AECL (\$134 million) and SDTC (\$82 million)
  - accounted for 11% of federal RD&D expenditures in all economic sectors (\$6 billion)
- Provincial and territorial energy expenditures of \$385 million in 2011/12
- Combined federal/provincial/territorial energy RD&D expenditures of about \$1 billion in 2011/12
  - represents an increase of \$280 million since 2007/08
  - largest increase in recent years related to the area of carbon capture and storage

### Canadian industry expenditures on energy RD&D

- Canadian industry spent about \$1.45 billion on energy RD&D in 2010.



### Canadian public expenditures on energy RD&D in millions of dollars



### Expenditures on energy RD&D by technology area (\$ millions)

	Federal (2011/12)	Provincial (2011/12)	Industry (2010)
Fossil fuels supply	191	200	1,055
Renewable and clean energy supply	227	79	188
Energy distribution	84	56	87
Energy end use	135	50	120
<b>Total</b>	<b>637</b>	<b>385</b>	<b>1,449</b>

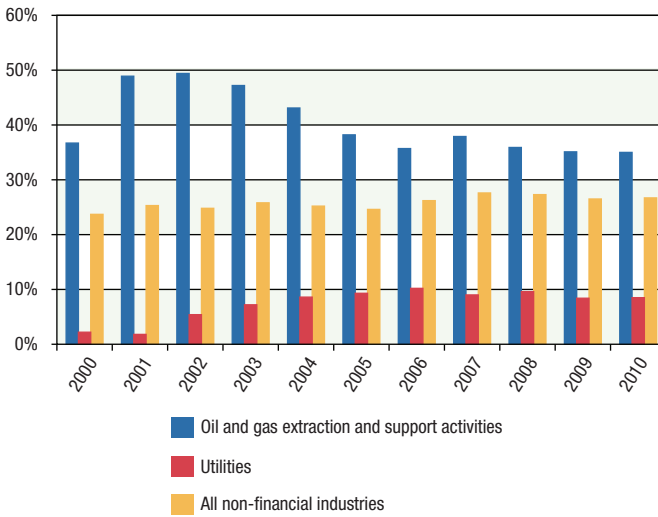
## Investment in Canadian energy industries

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 exist 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.

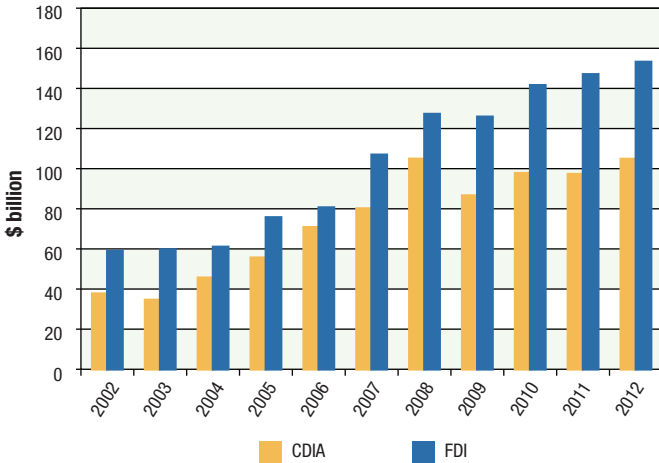
#### Foreign control of Canadian assets



### 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 (FDI) in Canada and Canadian direct investment abroad (CDIA) in the energy industry



### Stock of foreign direct investment (FDI)

- The energy industry's share of overall FDI in Canada has been increasing, reaching 24% in 2012, up from 11% in 1999.
- The stock of FDI from the U.S. in Canada's oil and gas extraction industry, including support services, more than tripled from \$17.5 billion in 1999 to \$58.1 billion in 2012.
- The stock of FDI in oil and gas extraction from Asia and Oceania has also increased rapidly in recent years, more than doubling from \$10.1 billion in 2007 to \$24.8 billion in 2012.

### Stock of Canadian direct investment abroad (CDIA)

- Investment by Canada's energy companies in the U.S. accounts for more than 30% of total energy CDIA and has grown from \$5.5 billion in 1999 to \$32.0 billion in 2012.

## FDI in Canada – major recent deals

### Oil sands

February 2013: China National Offshore Oil Corporation Ltd. (CNOOC) (China) acquired Nexen Inc. for \$19.5 billion (including more than \$4 billion in debt).

March 2012: PetroChina (China) acquired the remaining 40% percent stake in the MacKay River oil sands project from Athabasca Oil Sands Corporation for \$0.7 billion (in addition to the \$1.9 billion paid for a 60% stake in 2009).

November 2011: CNOOC Limited (China) acquired all outstanding shares of OPTI Canada Inc. for \$2.1 billion.

March 2011: Total S. A. (France) and Suncor Energy Inc. formed a strategic alliance to develop the oil sands in Canada for \$1.75 billion.

November 2010: 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 \$1.5 billion.

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

May 2010: China Investment Corp. acquired a 5.24% stake in Penn West Energy Trust, as well as a 45% stake in its oil sands properties, for \$1.25 billion.

March 2010: Devon Energy Corporation (U.S.) acquired a 50% interest in BP's Pike oil sands project for \$0.7 billion.

March 2010: BP (U.K.) acquired a majority stake in Terre de Grace oil sands project from Value Creation for \$0.9 billion.

## FDI in Canada – major recent deals

### Conventional oil and gas

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

March 2013: Spectra Energy (U.S.) agreed to purchase 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 Company Limited (China) agreed to acquire 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.

August 2012: INPEX Corp. (Japan) and JGC Corp. (Japan) agreed to acquire a 40% stake in Nexen Inc.'s Horn River shale gas properties for \$0.7 billion.

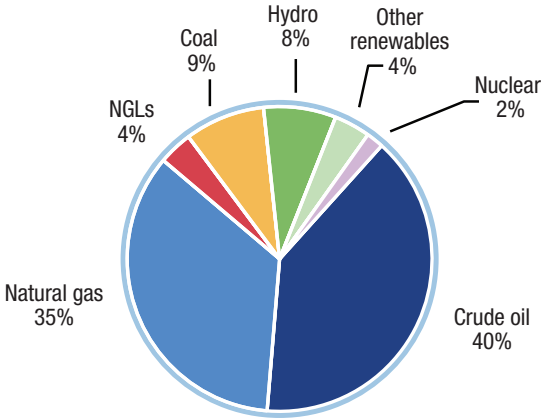
May 2012: URS Corp. (U.S.) purchased Flint Energy Services Ltd. for \$1.5 billion.

April 2012: Toyota Tsusho Corp. (Japan) acquired a 32.5% interest in Encana's coalbed methane (CBM) assets in southern Alberta for \$0.6 billion.

February 2012: Mitsubishi Corp. (Japan) entered into a 40% joint venture with Encana to develop its Cutbank Ridge property for \$2.9 billion.

## Canadian energy production

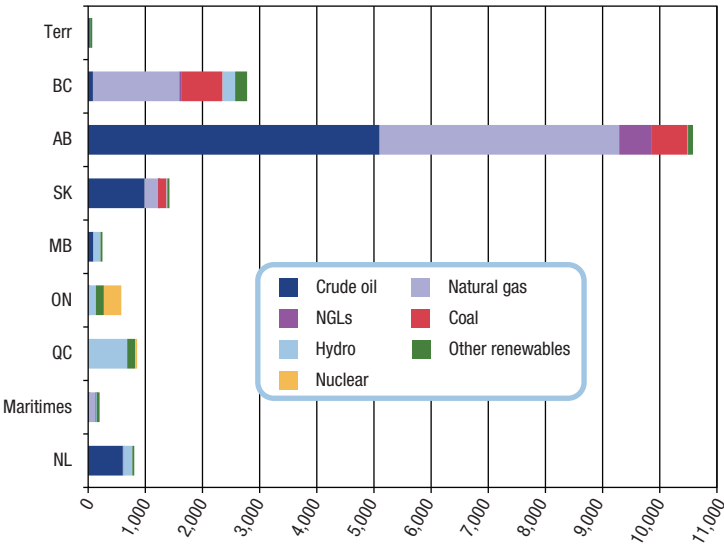
### Primary energy production, by source, 2011



NGLs - natural gas liquids

Note: Other renewables includes power from wind, solar and wood/wood waste, biofuels, and municipal waste.

### Primary energy production, regional totals, 2011 (PJ)



PJ: petajoule

Terr: Yukon, Northwest Territories and Nunavut

Maritimes: PEI, Nova Scotia and New Brunswick

## 2. Crude oil

### 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 control more than 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 tanker ships and railways, transport crude oil between production areas, refineries, and export or import border points.

### Main producer associations

- Canadian Association of Petroleum Producers (CAPP)
- Small Explorers and Producers Association of Canada (SEPAC)
- Canadian Association of Oilwell Drilling Contractors (CAODC)

### Regulatory authority

- Primarily with provincial governments, e.g. Alberta's Energy Resources Conservation Board
- Federal jurisdiction over interprovincial and international oil and gas pipelines through the National Energy Board
- 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\* (2012)

#1) Saudi Arabia .....	12%
#2) Russia .....	12%
#3) United States .....	10%
#4) China .....	5%
#5) <b>Canada</b> .....	<b>4%</b>
#6) Iran .....	4%

### World exports – 44.0 MMb/d\* (2011)

#1) Saudi Arabia .....	16%
#2) Russia .....	11%
#3) Nigeria .....	6%
#4) Iran .....	6%
#5) <b>Canada</b> .....	<b>5%</b>
#6) United Arab Emirates.....	5%

### World proved reserves – 1,638 billion barrels (at the end of 2012)

#1) Venezuela .....	18%
#2) Saudi Arabia.....	16%
#3) <b>Canada</b> .....	<b>11%</b>
(98% of which is oil sands)	
#4) Iran .....	10%
#5) Iraq .....	9%
#6) Kuwait** .....	6%
#7) United Arab Emirates.....	6%

\* includes natural gas liquids (NGLs) but excludes biofuels

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



## Canadian resources

### Proved reserves (at the end of 2012)

*Reserves known to exist and be recoverable under current technological and economic conditions*

Billion barrels

<b>Canada total</b> .....	<b>172.0</b>
• conventional* .....	4.1
• oil sands .....	167.9
• mining.....	33.2
• in-situ.....	134.6

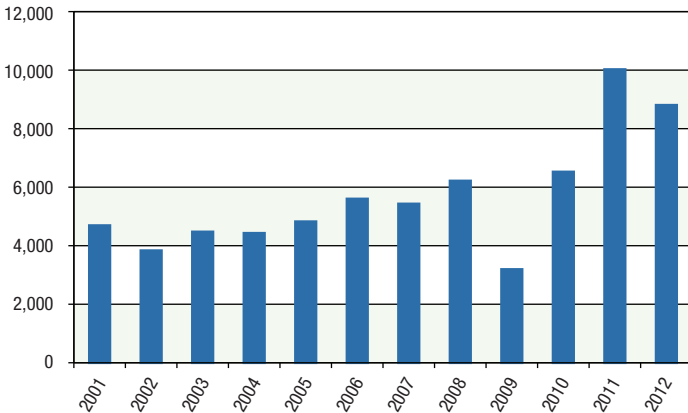
\* Reserves do not include conventional proved reserves of pentanes plus 0.4 billion barrels (a crude-oil equivalent extracted from natural gas wells).

### Oil sands ultimate potential

*Oil estimated to be recoverable as technology improves*

Oil sands (Alberta estimate) ..... 315 billion barrels

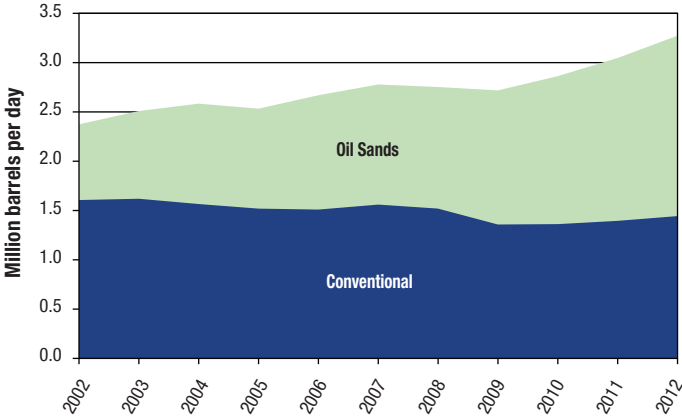
### Crude oil wells drilled in western Canada



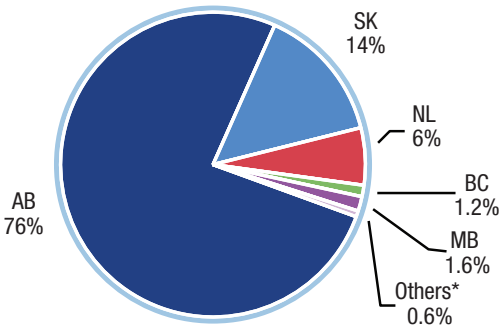
## Canadian production

Starting in 2010, oil sands production has exceeded conventional production.

### Production by type



### Production by province, 2012



\* Others: Nova Scotia, Ontario and the Northwest Territories

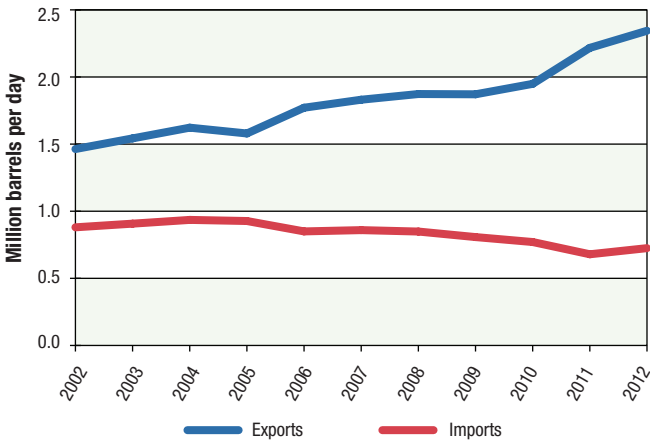
## Canadian supply and demand (2012)

Canadian production .....	3.3 MMb/d
Exports .....	2.3 MMb/d
Canadian oil sent to domestic refineries .....	1.0 MMb/d
Imports by domestic refineries .....	0.7 MMb/d

MMb/d: million barrels per day

## Trade

### Canadian trade of crude oil



### Key facts (2012)

- 99% of Canadian exports are to the U.S.
- Canadian crude oil accounts for 28% of U.S. imports and for 16% of U.S. refinery crude oil intake.
- Canadian imports come from a wide range of countries, including Algeria (20%), Iraq (12%), Saudi Arabia (9%) and Nigeria (7%).

## Prices

### West Texas Intermediate (WTI)

- Reference price for light crude oil delivered at Cushing, Oklahoma (a major pipeline hub)
- Used as 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 United Kingdom
- 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.

### Edmonton Par

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

### Western Canada Select (WCS)

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

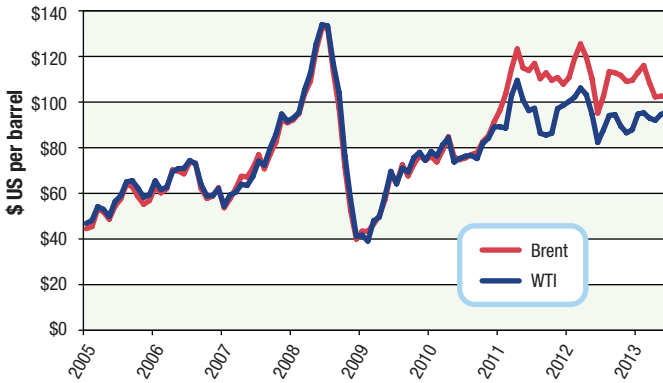
### Maya

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

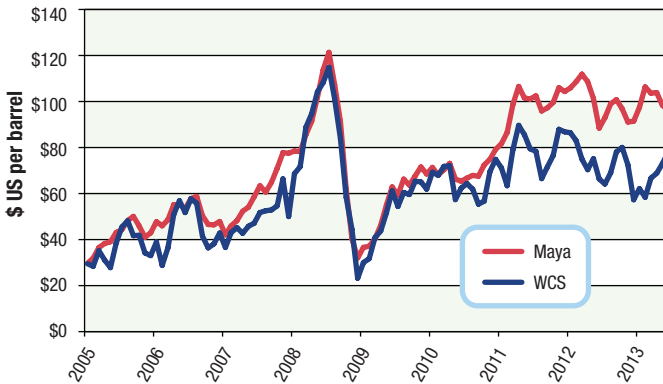
### Highlights for WTI

Average: 1995–2003 .....	US\$23 per barrel
Peak on July 11, 2008 .....	US\$147 per barrel
Average: 2011 .....	US\$95 per barrel
Average: 2012 .....	US\$94 per barrel
Average: 2013 (first 6 months) .....	US\$94 per barrel

### Brent vs. WTI monthly average prices



### Maya vs. WCS monthly average prices



## Oil sands

### Strategic importance

- 98% of Canada's proved reserves
- 55% of Canada's oil production in 2012 or 1.8 million barrels per day
- An estimated \$185 billion of capital investment to date, including \$25 billion in 2012

### Mining method

- For shallow formations of 75 metres or less
- 48% of current production, 20% of resources
- Process: remove overburden, extract oil sands, 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 metres
- 52% of current production, 80% of resources
- Process: drill vertical and/or horizontal wells, inject steam to facilitate the flow of oil
- Over 20 projects in Alberta – largest are Cold Lake (Imperial Oil) and Foster Creek (Cenovus)

### 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 sold directly to refineries capable of processing heavier oils
- Major companies with upgrading capacity: Syncrude, Suncor, Shell and Canadian Natural Resources
- Total upgrading capacity in Canada: 1.35 million barrels per day (see the detailed list in the Petroleum products section)

## Oil sands: environmental challenges

### Water

- mining method: 3 to 4 barrels of water per barrel of bitumen
- in-situ method:  $\approx$ 1 barrel of water per barrel of bitumen
- Oil sands producers recycle about 75% of the water used in the mining method and more than 90% under the in-situ methods.

### Greenhouse gases (GHG)

- 7.8% of Canada's total greenhouse gas (GHG) emissions and 0.1% globally
- GHG emissions per barrel in the oil sands decreased by 26% between 1990 and 2011.

### Land

- area of oil sand resources ..... 142,200 km<sup>2</sup>
- total mineable area .....4,800 km<sup>2</sup>
- total area being mined.....761 km<sup>2</sup>
- tailings ponds ..... 180 km<sup>2</sup>

#### By comparison:

- Canada's total area ..... 10,000,000 km<sup>2</sup>
- Canadian boreal forest ..... 3,200,000 km<sup>2</sup>
- 22% of the Lower Athabasca Region is comprised of conservation areas

## Key existing pipelines

### Enbridge Pipelines

- World's largest pipeline system for crude oil and petroleum products, serving Canada and the U.S.
- Mainline: from Alberta to the U.S. Midwest and Ontario
- Northwest: from Northwest Territories to Alberta
- Line 1: petroleum products from Edmonton to Gretna (Manitoba)
- Line 9: foreign and eastern Canadian crude oil from Montréal to Sarnia [flow reversal under development]
- Alberta Clipper: from Hardisty (AB) to Superior (Wisconsin)
- Southern Lights project: diluent back 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)

### Pembina

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

### Portland-Montreal Pipeline

- Foreign oil – from Portland (Maine) to Montréal

### TransCanada Pipeline

- Keystone Pipeline: from Hardisty (AB) to the U.S. Midwest

### Trans-Northern Pipeline

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

### Spectra Energy

- Express-Platte: from Hardisty (AB) to U.S. Midwest



## Pipeline expansion proposals

Current Canadian crude oil production is nearing maximum pipeline capacity out of western Canada of 3.5 million barrels per day. With western Canadian crude oil production projected to grow over the coming years, several pipeline projects are being proposed to move new production to markets. Below is a list of some of the largest projects.

### Northern Gateway (Enbridge)

- New pipeline from Edmonton to Kitimat (BC)
- Capacity of 525 Mb/d
- Marine terminal would be constructed

### TransMountain Expansion (Kinder Morgan)

- Twinning of existing pipeline from Edmonton to Vancouver
- Incremental capacity of 590 Mb/d
- Marine terminal in Burnaby (BC) would be expanded

### Keystone XL (TransCanada)

- New pipeline from Hardisty (AB) to U.S. Gulf Coast
- Capacity of 830 Mb/d
- Fifteen Gulf Coast refineries are configured to process heavy crudes.

### Mainline Expansion (Enbridge)

- Expansion of Alberta Clipper from Hardisty (AB) to Gretna (MB), with incremental capacity of 350 Mb/d.
- Flow reversal from Sarnia to Montréal, with capacity of 300 Mb/d

### Energy East (TransCanada)

- Conversion of existing natural gas lines to oil, and construction of new oil lines
- From Hardisty (AB) to Saint John (NB)
- Capacity of 1.1 MMb/d

Mb/d: thousand barrels per day

MMb/d: million barrels per day

## Tight light oil / Shale oil

### Definition

- Light oil found in sedimentary rock characterized by very low permeability – typically shale
- The oil is extracted 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 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).
- The International Energy Agency forecasts that the U.S. will become the world’s largest oil producer by 2020 due to the rapid growth in U.S. tight/shale oil production.

### 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%
...	
<b>#10) Canada .....</b>	<b>3%</b>

\*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.

### Main associations

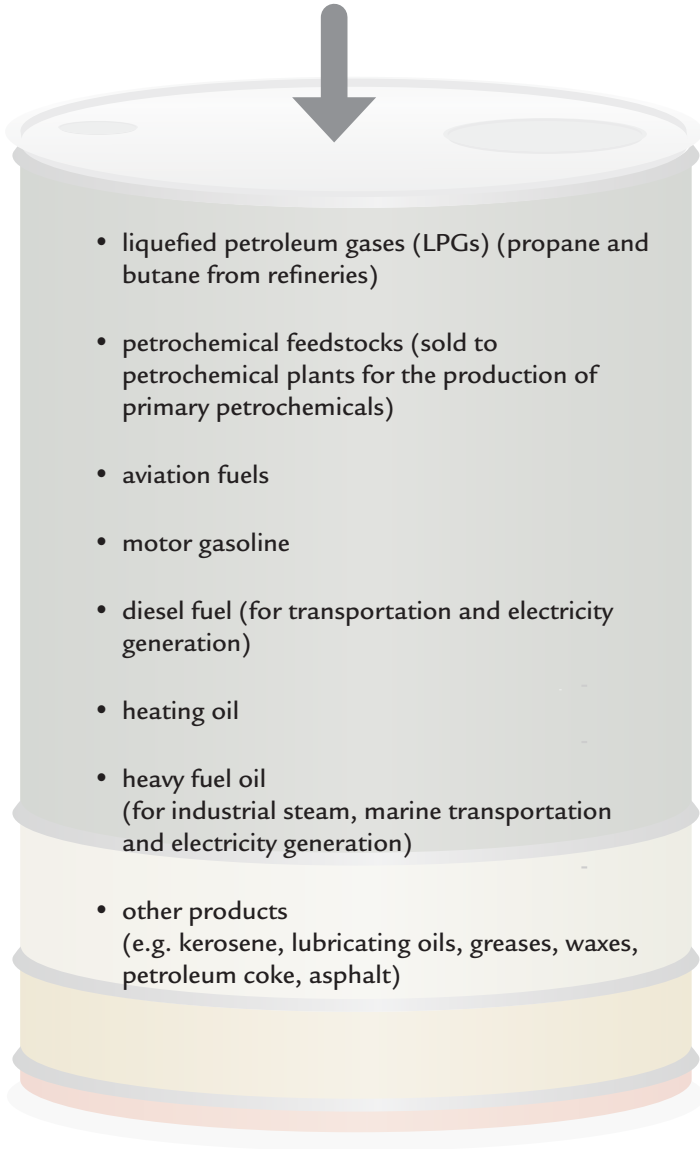
- Canadian Fuels Association (CFA)
- Canadian Independent Petroleum Marketers Association (CIPMA)

### Regulatory authority

- Primarily with provincial governments

### Petroleum refineries

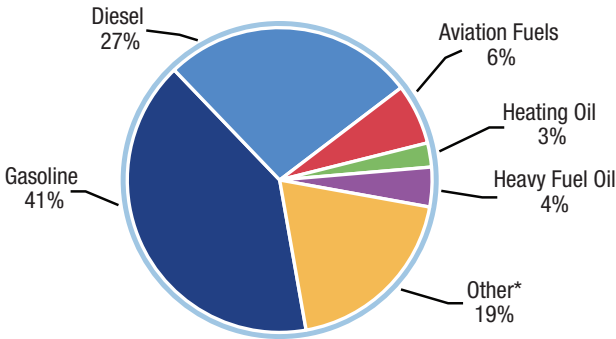
- crude oil distillation
- additional processing (e.g. catalytic cracking and reforming)
- product blending



## Canadian supply and demand (2012)

Crude oil shipped to domestic refineries.....	1.7 MMb/d (99 billion litres)
Canadian production .....	112 billion litres
Imports.....	13 billion litres (mainly through Montréal)
Exports .....	27 billion litres
Domestic sales .....	105 billion litres

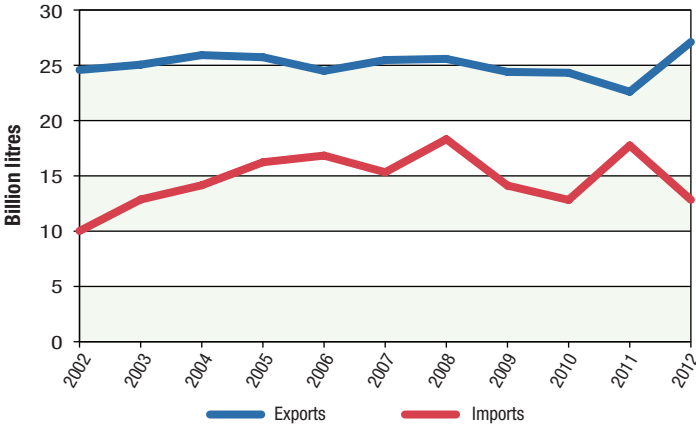
## Sales by product, 2012



\* Other includes propane, butane, petro-chemical feedstocks, lubricating oils, petroleum coke, and asphalt, etc.

## Trade

### Canadian exports and imports of refined petroleum products



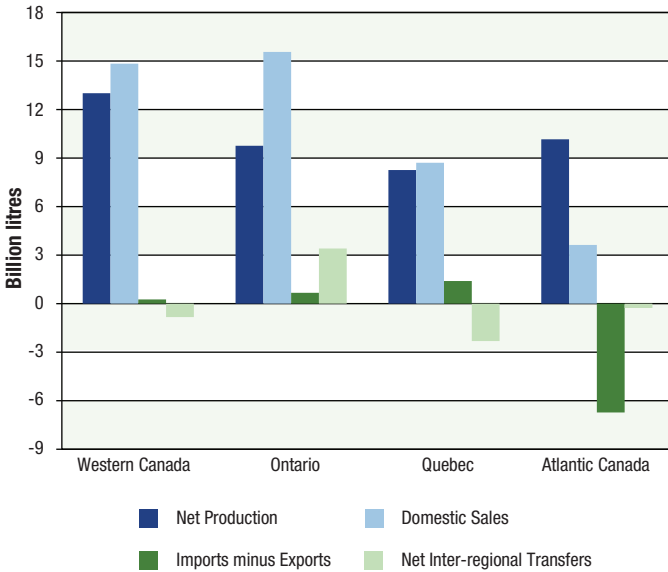
### Key facts (2012)

- 24% of Canadian production of refined petroleum products is exported:
  - 86% of Canadian exports are to the U.S.
  - 26% of U.S. imports come from Canada.
- 12% of Canadian consumption of refined petroleum products is imported:
  - 64% of Canadian imports come from the U.S.
  - Other Canadian imports come from a wide range of countries, including the Netherlands (12%), the United Kingdom (4%) and Mexico (2%).

## Gasoline market regional balance (2012)

- Western Canada imports some gasoline (mainly for the Vancouver area).
- Ontario is supplied by local and Quebec refineries as well as with imported products routed through Montréal.
- Quebec is a producer as well as an importer and exporter.
- Atlantic Canada is a net exporter of gasoline.

## Gasoline supply and demand regional balance



## Canadian petroleum refineries

Location ..... Refinery ..... Capacity

### British Columbia

Prince George ..... Husky Energy ..... 12 Mb/d  
 Burnaby ..... Chevron Canada ..... 55 Mb/d

### Alberta

Edmonton ..... Imperial Oil ..... 187 Mb/d  
 Edmonton ..... Suncor Energy ..... 140 Mb/d  
 Edmonton ..... Shell ..... 100 Mb/d

### Saskatchewan

Regina ..... Consumer's Co-op ..... 145 Mb/d

### Ontario

Sarnia ..... Imperial Oil ..... 124 Mb/d  
 Nanticoke ..... Imperial Oil ..... 112 Mb/d  
 Sarnia ..... Suncor Energy ..... 85 Mb/d  
 Sarnia ..... Shell ..... 75 Mb/d

### Quebec

Québec (City) ..... Valero (formerly Ultramar) .. 265 Mb/d  
 Montréal ..... Suncor Energy ..... 137 Mb/d

### New Brunswick

Saint John ..... Irving Oil ..... 300 Mb/d

### Nova Scotia

Dartmouth\* ..... Imperial Oil ..... 88 Mb/d

### Newfoundland and Labrador

Come by Chance ..... North Atlantic ..... 115 Mb/d

**Total refining capacity** ..... **1,940 Mb/d**

\* Scheduled to be converted to an import terminal  
 Mb/d: thousand barrels per day



## Other plants with crude oil processing

Location ..... Plant..... Capacity

### Asphalt plants

SK	Lloydminster .....	Husky Energy.....	29 Mb/d
	Moose Jaw .....	Moose Jaw Refinery .....	14 Mb/d
<b>Total processing capacity</b> .....			<b>43 Mb/d</b>

### Petrochemical plants (currently using crude oil as feedstock)

ON	Sarnia .....	Nova Chemicals.....	80 Mb/d
	Mississauga .....	Suncor Lubricants.....	16 Mb/d
<b>Total processing capacity</b> .....			<b>96 Mb/d</b>

### Upgraders\*

AB	Fort McMurray ...	Syncrude .....	474 Mb/d
	Fort McMurray ...	Suncor Base U1/U2 .....	267 Mb/d
	Fort Sask .....	Shell Scotford .....	255 Mb/d
	Fort McKay.....	CNRL Horizon .....	114 Mb/d
	Fort McMurray ...	Suncor Millenium .....	90 Mb/d
	Wood Buffalo .....	Nexen-CNOOC.....	72 Mb/d
SK	Lloydminster .....	Husky Energy.....	82 Mb/d
<b>Total upgrading capacity</b> .....			<b>1,354 Mb/d</b>

\* Although upgraders primarily transform heavy crudes into lighter crudes, they also produce some refined products, such as diesel.

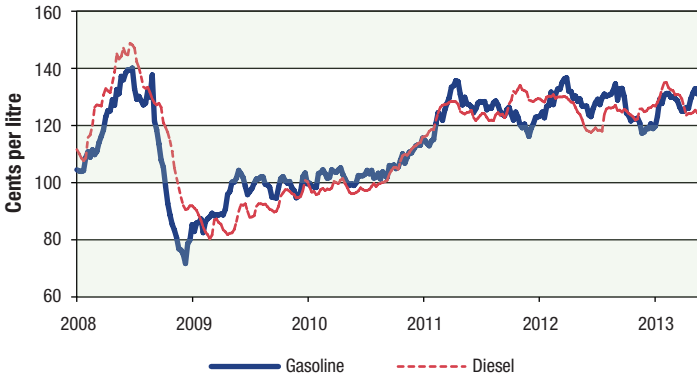
Mb/d: thousand barrels per day

## Retail prices (in cents per litre)

	Gasoline	Diesel
2012		
average Canadian pump price	127.5	125.4
estimated crude cost	61.0	61.0
refining and marketing	27.2	33.6
federal taxes*	15.8	9.7
provincial taxes**	23.5	21.1
2013		
average Canadian pump price (first six months)	127.7	128.1
* 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



## 4. Natural gas

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

### Regulatory authority

- Primarily with provincial governments
- Federal jurisdiction over interprovincial and international natural gas pipelines through the National Energy Board
- 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 – 331 Bcf/d (2012)

#1) United States .....	20%
#2) Russia .....	19%
#3) Qatar .....	5%
#4) Iran .....	5%
#5) <b>Canada</b> .....	<b>5%</b>

### World exports – 99 Bcf/d (2012)

#1) Russia .....	19%
#2) Qatar .....	12%
#3) Norway .....	11%
#4) <b>Canada</b> .....	<b>9%</b>
#5) Netherlands.....	6%

### World proved reserves – 6,793 Tcf (at end of 2012)

#1) Russia .....	25%
#2) Iran .....	17%
#3) Qatar .....	13%
#4) Saudi Arabia.....	4%
#5) United States .....	4%
#6) Turkmenistan.....	4%
...	
#18) <b>Canada</b> .....	<b>1%</b>

Bcf/d: billion cubic feet per day

Tcf: trillion cubic feet

## Canada-U.S. resources

- The natural gas markets in Canada and the U.S. are highly integrated from a supply and demand perspective.
- Together, Canada and the U.S. are estimated to have more than 100 years of supply at current production rates.

### Proved reserves (at the end of 2010)

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

Canada .....	70 Tcf
U.S. ....	305 Tcf
Total .....	375 Tcf

### Technically recoverable resources

*gas estimated to be recoverable as drilling and infrastructure expand*

Canada potential .....	733 – 1,304 Tcf
Canadian conventional .....	357 Tcf
(including Mackenzie, Beaufort and Arctic islands)	
Canadian unconventional.....	376 – 947 Tcf
(shale and tight gas)	
U.S. potential .....	2,600 Tcf
portion that is shale gas.....	687 – 862 Tcf
portion that is coal bed methane.....	159 Tcf
World potential.....	27,890 Tcf
portion that is conventional .....	16,310 Tcf
portion that is unconventional.....	11,580 Tcf

Tcf: trillion cubic feet

## Shale 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 rock layers 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 and Nova Scotia.
- Technological advancements in drilling (long-reach horizontal well bores) and completion techniques (multistage fracking) have allowed commercial production of natural gas from shale.
- These advancements have increased the long-term outlook for the supply of natural gas in North America.

### Global potential

- An updated U.S. Energy Information Administration (EIA) assessment of 137 shale formation in 41 countries, in addition to the U.S. basins, found a total of 7,299 Tcf 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) <b>Canada</b> .....	<b>8%</b>
#6) Mexico .....	7%
#7) Australia.....	6%

Tcf: trillion cubic feet

## Canada-U.S. market (2012)

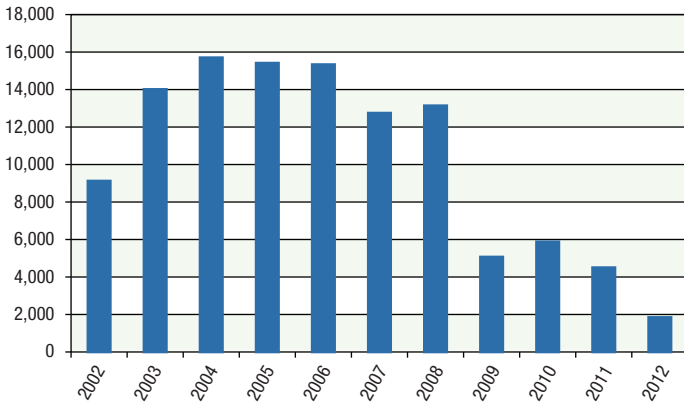
Canada-U.S. market .....	79.8 Bcf/d
Canadian average marketable production .....	13.6 Bcf/d
conventional* .....	38%
unconventional* .....	62%
U.S. average marketable production.....	65.7 Bcf/d
conventional* .....	41%
unconventional* .....	59%
North American LNG** imports.....	0.6 Bcf/d

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

\*\*LNG - liquefied natural gas

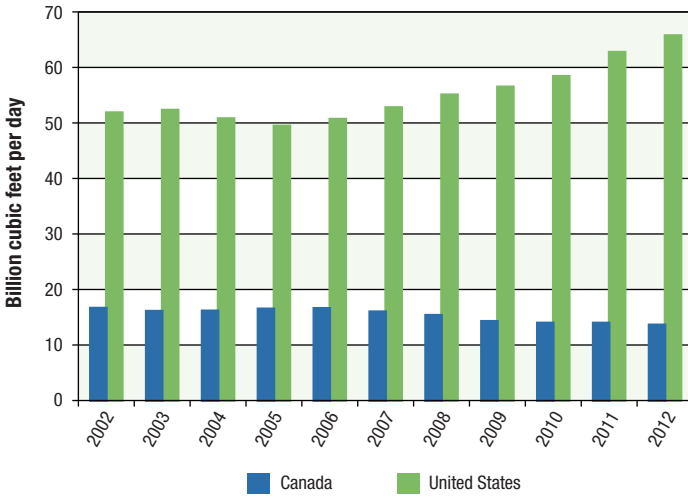
Bcf/d: billion cubic feet per day

## Total natural gas wells drilled in Canada

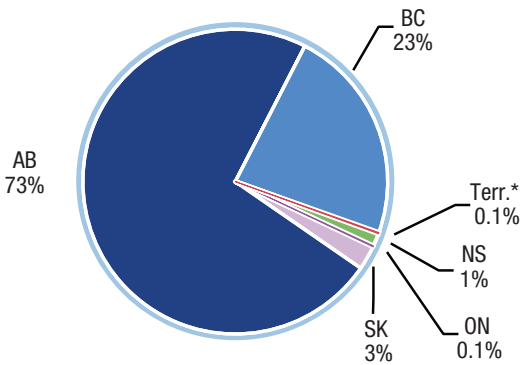


## Canadian production

Canadian and U.S. marketable production of natural gas



Marketable production by province, 2012

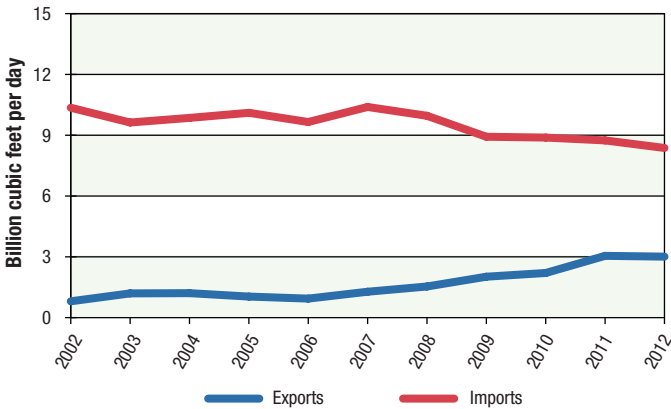


\* Terr.: Northwest Territories and Yukon



## Trade (2012)

### Canadian exports and imports of natural gas



Canadian exports ..... 8.4 Bcf/d

Canadian imports ..... 3.0 Bcf/d

### Key facts

- 61% of Canadian production is exported
  - All Canadian exports go to the U.S.
  - 12% of U.S. consumption comes from Canada
- 37% 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, NB.

Bcf/d: billion cubic feet per day

LNG: liquefied natural gas

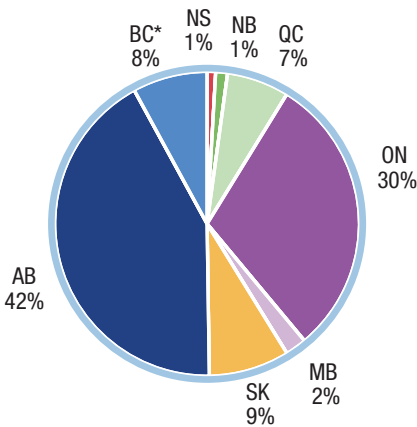
### Domestic market demand\* (2011)

Total.....	7.8 Bcf/d
Industrial .....	2.9 Bcf/d
Residential .....	1.7 Bcf/d
Electricity generation .....	1.5 Bcf/d
Commercial/institutional.....	1.3 Bcf/d
Transportation.....	0.3 Bcf/d
Agriculture .....	0.1 Bcf/d

\* excludes field use and non-energy use

Bcf/d: billion cubic feet per day

### Domestic demand by province, 2012



\* includes Yukon and the Northwest Territories

## Upstream prices

(based on Alberta prices at AECO\*)

Average: 2000–2010 .....C\$5.84/GJ

Average: 2011 .....C\$3.53/GJ

Average: 2012 .....C\$2.31/GJ

Average: 2013 .....C\$3.16/GJ  
(first 6 months)

\* The AECO is the largest trading hub in Canada, and the AECO price serves as a benchmark for Alberta gas transactions.

## Alberta spot prices (AECO)



## Key existing pipelines

### TransCanada Pipelines Ltd.

- 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
- Alberta System (aka Nova): within Alberta
- Main line: Alberta/Saskatchewan border to Quebec/Vermont border
- Foothills: from Alberta to Idaho via BC and from Alberta to Montana via Saskatchewan

### Spectra Energy Corporation

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

### Enbridge Inc.

- third-largest gas pipeline company in Canada
- Alliance Line (50% owner): BC through Alberta; and Saskatchewan to Chicago
- Vector Line (60% owner): Chicago to Ontario
- gas distribution (mostly in Ontario)

### ATCO Pipeline

- gathering and distribution lines within Alberta

### TransGas Ltd.

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

## Proposed LNG export projects

Several projects proposed to export gas from Canada to Asia & Europe, with capacity of 87.1 million tonnes per annum (mtpa) or 12.1 Bcf/d of LNG. In the U.S., there are proposals to export a total of 30 Bcf/d of LNG.

### Kitimat LNG (Kitimat, BC)

- proposed by Kitimat LNG Operating General Partnership (Apache Canada and Chevron Canada)
- maximum capacity of 10 mtpa (1.4 Bcf/d)
- obtained export licence in November 2011
- projected start date of 2017

### Douglas Channel/BC LNG (Kitimat, BC)

- proposed by Douglas Channel Energy Partnership
- maximum capacity of 1.8 mtpa (0.25 Bcf/d)
- obtained export licence in April 2012
- projected start date of 2015

### LNG Canada (Kitimat, BC)

- partners include Shell Canada, Korea Gas Corp., Mitsubishi Corporation, PetroChina Co. Ltd
- maximum capacity of 24 mtpa (3.4 Bcf/d)
- obtained export licence in February 2013
- projected start date of 2019/20

### Pacific Northwest LNG (Prince Rupert, BC)

- partners include: Progress/PETRONAS, Japan Petroleum Exploration (JAPEX)
- maximum capacity of 19.7 mtpa (2.7 Bcf/d)
- projected start date of 2018

### Prince Rupert LNG (Prince Rupert, BC)

- proposed by BG Group
- maximum capacity of 21.6 mtpa (2.9 Bcf/d)
- projected start date of 2020

### Goldboro LNG (Guysborough, NS)

- proposed by Pieridae Energy Canada
- maximum capacity of 10 mtpa (1.4 Bcf/d)
- projected start date of 2019



## 5. Natural gas liquids (NGLs)

### Definition

- Propane, butane and ethane are hydrocarbons obtained from natural gas production and upstream processing.
- 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.

### Notes

- Condensates and pentanes are also hydrocarbons produced from raw natural gas. However, because they are akin to light crude oil, they are included in the “Crude oil” chapter.
- Propane and butane are also produced from the refining of crude oil. They are referred to as “liquefied petroleum gases” (LPGs) and are covered in the “Petroleum products” chapter.
- Most NGLs (with the exception of ethane) are priced similarly to crude oil and with today’s low natural gas prices, producers have been targeting liquid rich reserves.

**Canadian supply (2011)**

Canadian production (from gas plants) .....	493 Mb/d
- propane .....	153 Mb/d
- butane.....	97 Mb/d
- ethane .....	243 Mb/d
Exports .....	101 Mb/d
Imports.....	15 Mb/d

**Domestic demand\*** (2011)

Non-energy use .....	66%
(as feedstocks for petrochemicals)	
Refinery use .....	12%
Other industrial.....	10%
Transportation.....	2%
Agriculture .....	1%
Residential .....	2%
Commercial/institutional.....	5%

\* includes liquefied petroleum gases (LPGs)

Mb/d: thousand barrels per day



## 6. Coal

### Canadian industry structure

- The Canadian coal industry produces coal for use in either
  - 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 – 7.7 billion tonnes

(2012)

#1) China .....	44%
#2) United States .....	12%
#3) India.....	8%
#4) Indonesia.....	6%
#5) Australia.....	5%
...	
<b>#13) Canada .....</b>	<b>1%</b>

### World exports – 1.3 billion tonnes

(2012)

#1) Indonesia.....	30%
#2) Australia.....	24%
#3) Russia .....	11%
#4) United States .....	9%
#5) Columbia.....	7%
#6) South Africa.....	6%
<b>#7) Canada .....</b>	<b>3%</b>

### World proved reserves – 861 billion tonnes

(at the end of 2008)

#1) United States .....	28%
#2) Russia .....	18%
#3) China .....	13%
#4) Australia.....	9%
#5) India.....	7%
...	
<b>#11) Canada .....</b>	<b>1%</b>

Note: Above data exclude coal products such as coke.

## Canadian supply and demand (2012)

Canadian production ..... 67 Mt

Exports ..... 35 Mt

- Major export destinations (by \$ value):

#1) Japan 29%

#2) China 24%

#3) South Korea 18%

- Only 3% of Canadian exports are to the U.S.

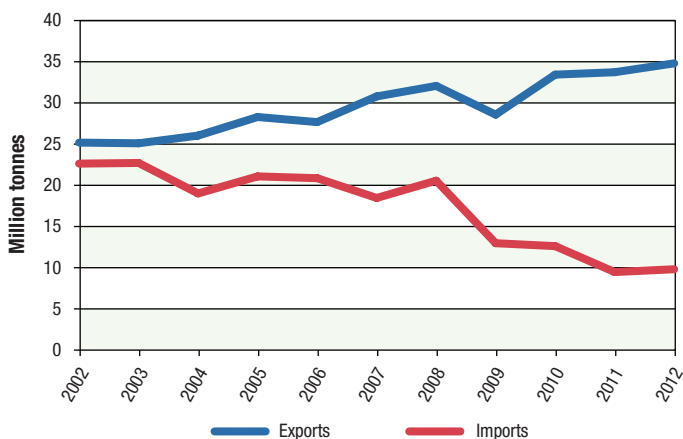
Imports ..... 10 Mt

- 83% of Canadian imports are from the U.S.
- Close to half of imports are destined for use in steel manufacturing, the rest for electricity generation.

Domestic availability ..... 42 Mt

- Mostly for electricity generation in AB, ON and SK
- Also for metallurgical applications

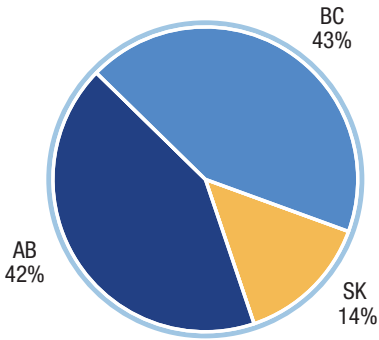
## Canadian exports and imports of coal



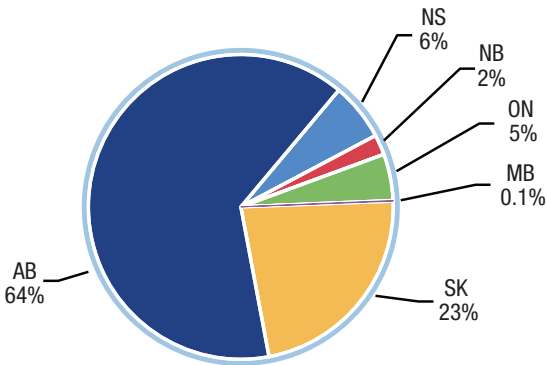
Mt: million tonnes

## Production and use, by province

Production by province, 2012



Coal used for electricity generation by province, 2011



## Coal-fuelled power plants in Canada >500 MW

<u>Facility</u>	<u>Province</u>	<u>Capacity (MW)</u>
Sundance	AB	2,278
Nanticoke	ON	1,880
Genesee	AB	1,335
Keephills	AB	1,301
Lambton	ON	950
Boundary Dam	SK	891
Sheerness	AB	816
Battle River	AB	700
Poplar River	SK	630
Lingan	NS	620

## Announced retirements of coal-fuelled power plant capacity

<u>Province</u>	<u>Capacity (MW)</u>	<u>Closure by 2020</u>	
Alberta	6,580	0	(0%)
Saskatchewan	1,826	132	(7%)
Manitoba	98	98	(100%)
Ontario	3,347	3,347	(100%)
New Brunswick	490	0	(0%)
Nova Scotia	1,288	310	(24%)
<b>Total</b>	<b>13,629</b>	<b>3,887</b>	<b>(29%)</b>

MW: megawatt



## 7. Uranium and nuclear power

### Canadian uranium industry structure

- Canada has a vast supply of uranium in high-concentration deposits, mostly 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.”
- Most of the concentrate produced is shipped to a refinery in Blind River, ON, where it is refined into uranium trioxide ( $UO_3$ ); this product is then shipped to a conversion plant in Port Hope, ON, where it is converted into
  - uranium dioxide ( $UO_2$ ) to supply CANDU-type heavy water reactors
  - uranium hexafluoride ( $UF_6$ ), 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 governed by provincial regulations, but uranium mining falls mainly 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 – 58.3 kt (2012)

#1) Kazakhstan	37%
#2) <b>Canada</b> .....	<b>15%</b>
#3) Australia.....	12%
#4) Niger .....	8%
#5) Namibia .....	8%

### World exports – 48.8 kt (2012)

#1) Kazakhstan	44%
#2) <b>Canada</b> .....	<b>16%</b>
#3) Australia.....	14%
#4) Niger .....	10%
#5) Namibia .....	9%

### World known recoverable resources – 5.3 Mt (at beginning of 2011)

#1) Australia.....	31%
#2) Kazakhstan.....	12%
#3) Russia .....	9%
#4) <b>Canada</b> .....	<b>9%</b>
#5) Niger .....	8%

kt: kilotonne

Mt: million tonnes



## Uranium – Canadian supply and demand (2012)

Canadian production .....9.0 kt

- all uranium from mines in Saskatchewan
- value ≈\$1.0 billion

Exports ..... ≈85% of production

- major export destinations in recent years:
 

#1) Asia	46%
#2) U.S. / Latin America	27%
#3) Europe	27%
- 24% of uranium purchased by U.S. nuclear reactors in 2012 came from Canada.

Domestic use ..... ≈15% of production

- to Canada’s CANDU reactors (ON, QC and NB)

kt: kilotonne

### Spot prices



## Nuclear power – international context

World generation – 2,507 TWh  
(2011)

#1) United States .....	32%
#2) France .....	17%
#3) Russia .....	6%
#4) Japan.....	6%
#5) South Korea.....	6%
#6) Germany.....	4%
#7) <b>Canada</b> .....	<b>3%</b>
#8) Ukraine .....	3%

TWh: terawatt-hour

### CANDU nuclear reactors

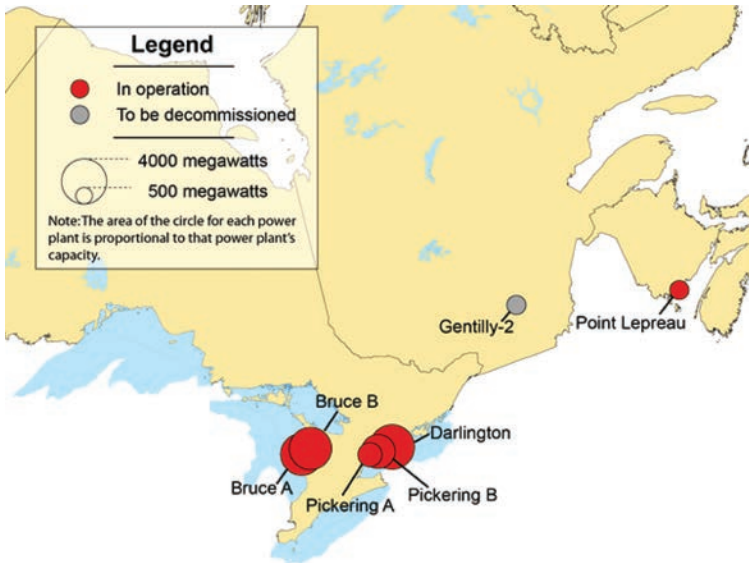
- Canada has developed a unique nuclear reactor called CANDU, for CANada Deuterium Uranium.
- It uses pressurized fuel channels instead of a pressure vessel; natural instead of enriched uranium; and, heavy water as a coolant/moderator instead of light water found in pressurized water reactor designs.
- In addition to Canada, CANDU reactors are found in India, Pakistan, Argentina, South Korea, Romania and China.

## Nuclear power plants in Canada

<u>Facility</u>	<u>Province</u>	<u>Capacity (MW)</u>
Darlington	ON	3,740
Bruce B	ON	3,360
Bruce A	ON	3,300
Pickering B	ON	2,160
Pickering A	ON	1,080
Point Lepreau	NB	680
Gentilly 2*	QC	675

\* shut down in December 2012 for decommissioning

MW: megawatt



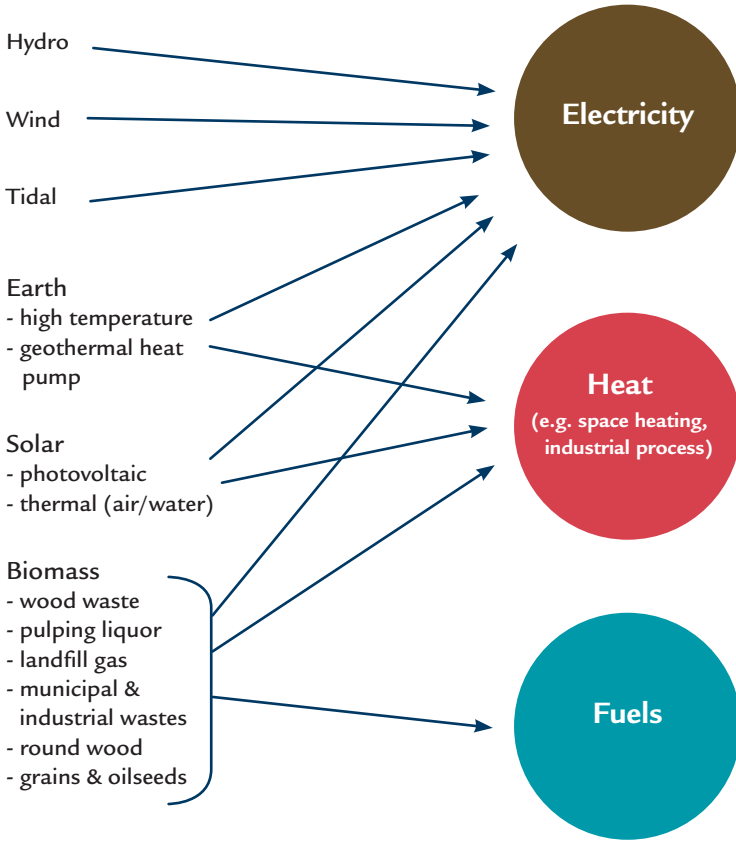


## 8. Renewable energy

### 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** – 71,260 PJ or 1,702 Mtoe  
(2011)

#1) China .....	17%
#2) India.....	12%
#3) United States.....	8%
#4) Brazil.....	7%
#5) Nigeria .....	6%
#6) Indonesia.....	4%
#7) <b>Canada</b> .....	<b>3%</b>

**Share of energy consumption from renewable sources**  
(2010)

World .....	13.0%
OECD countries only.....	7.7%
<b>Canada</b> .....	<b>17.1%</b>

**Canadian production**  
(2011)

**Total renewable energy** – 1,891 PJ or 46.0 Mtoe

Hydro .....	70.3%
Wood/wood waste.....	23.1%
Wind .....	3.68%
Biogasoline .....	1.82%
Municipal waste/landfill gas .....	0.64%
Industrial and other waste .....	0.35%
Solar photovoltaic.....	0.08%
Tidal.....	0.005%

PJ: petajoule

Mtoe: millions of tons of oil equivalent

## Hydroelectricity

### International context

#### World generation of hydroelectricity – 3,491 TWh (2011)

#1) China	20%
#2) Brazil	12%
<b>#3) Canada</b>	<b>11%</b>
#4) United States	9%
#5) Russia	5%

TWh: terawatt-hour

#### Share of hydroelectricity in national electricity generation (2011)

#1) Norway	96%
#2) Brazil	80%
#3) Venezuela	67%
<b>#4) Canada</b>	<b>60%</b>

By comparison:

China	18%
United States	8%



## Hydroelectricity

**Hydroelectricity capacity in Canada – 75,104 MW (2010)**

### Major hydro facilities in Canada >1,000 MW

<u>Power plant</u>	<u>Province</u>	<u>Capacity (MW)</u>
Robert-Bourassa	QC	5,616
Churchill Falls	NL	5,429
La Grande 4	QC	2,779
Gordon M Shrum	BC	2,730
La Grande 3	QC	2,417
La Grande 2A	QC	2,106
Revelstoke	BC	1,980
Mica	BC	1,805
Beauharnois	QC	1,755
Manic 5	QC	1,528
Sir Adam Beck 2	ON	1,499
La Grande 1	QC	1,436
Limestone	MB	1,349
Manic 3	QC	1,244
Kettle	MB	1,223
Bersimis 1	QC	1,125
Manic 5 PA	QC	1,064
Robert H Saunders	ON	1,045
Manic 2	QC	1,041
Outardes 3	QC	1,026
Long Spruce	MB	1,016
Kemano	BC	1,000

MW: megawatt

## Hydroelectricity

### Major projects under construction

<u>Project</u>	<u>Province</u>	<u>Size (MW)</u>	<u>Expected in-service</u>
Waneta Expansion	BC	435	2015
La Romaine Complex	QC	1,550	2014–2020
Muskkrat Falls	NL	824	2017
Lower Mattagami	ON	438	2015
<b>Total</b>		<b>3,247</b>	

### Major projects under regulatory review

<u>Project</u>	<u>Province</u>	<u>Size (MW)</u>
Gull Island	NL	2,250
Keeyask	MB	695
Mica 5/6	BC	1,000
Peace River Site C	BC	1,100
<b>Total</b>		<b>5,045</b>
<b>Projects - Grand total</b>		<b>8,292</b>

MW: megawatt

## Wind power

### International context

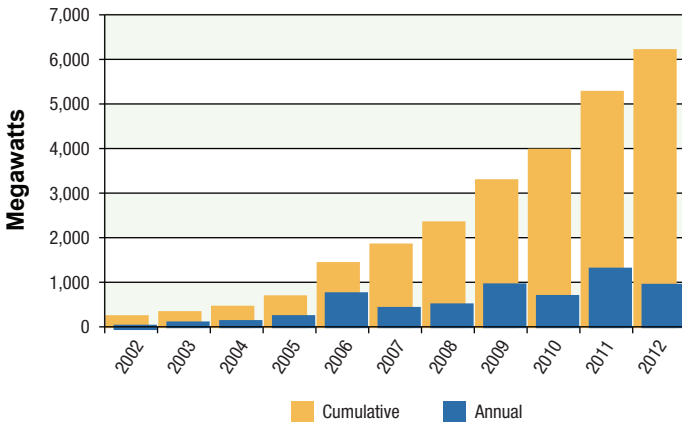
World capacity of wind power – 282,482 MW  
(2012)

#1) China .....	27%
#2) United States.....	21%
#3) Germany.....	11%
#4) Spain.....	8%
...	
#9) <i>Canada</i> .....	<i>2%</i>

### Wind power in Canada

Generation (2011) – 10.1 TWh, 1.6% of total electricity  
Capacity (end of 2012) – 6,201 MW

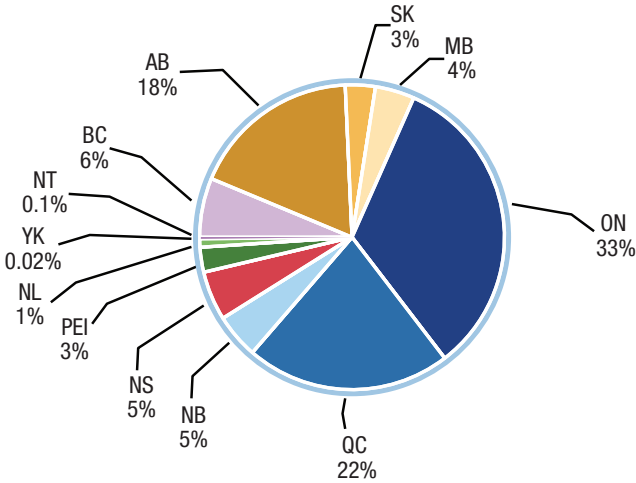
### Installed capacity



MW: megawatt

## Wind power

### Capacity by province, 2012



### Largest wind farms in Canada >100 MW

<u>Facility</u>	<u>Province</u>	<u>Capacity (MW)</u>
Wolfe Island	ON	198
Prince Project	ON	189
Kincardine	ON	182
Comber	ON	166
Massif du Sud	QC	150
Lac Alfred	QC	150
Halkirk Wind Park	AB	149
Dokie Ridge	BC	144
Quality Wind	BC	142
Le Plateau	QC	139
St. Joseph	MB	138

MW: megawatt

## Solar photovoltaic (PV)

### International context

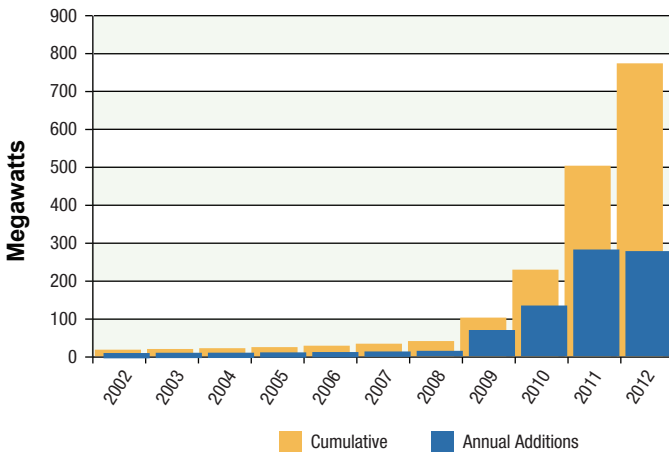
World capacity of solar PV – 100,000 MW (2012)

#1) Germany .....	32%
#2) Italy.....	16%
#3) United States.....	7%
#4) China .....	7%
#5) Japan.....	7%
...	
<i>Canada .....</i>	<i>0.8%</i>

### Solar PV in Canada

Capacity – 765 MW (end of 2012)

#### Installed capacity



MW: megawatt

## Solar photovoltaic (PV)

### Largest solar PV farms in Canada

<u>Facility</u>	<u>Province</u>	<u>Capacity (MW)</u>
Sarnia Solar Project 2	ON	60
Sault Ste. Marie 2	ON	34
Stardale	ON	27
Sault Ste. Marie 1	ON	24
Arnprior	ON	23
Sarnia Solar Project 1	ON	20
St Isidore A	ON	12
St Isidore B	ON	12
Sault Ste. Marie 3	ON	11
Lily Lake Solar Farm	ON	10
Rutley Solar	ON	10

MW: megawatt

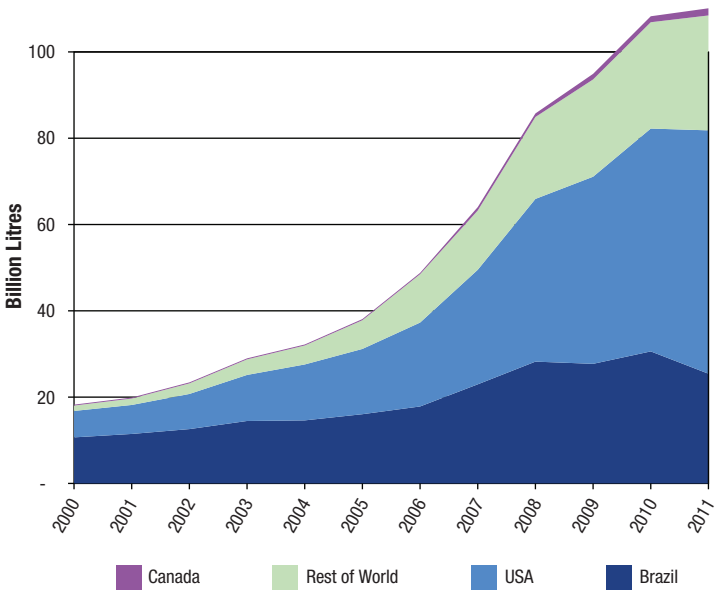
## Biofuels

### International context

World production of ethanol – 110.1 billion litres (2011)

#1) United States .....	51%
#2) Brazil.....	23%
#3) Europe .....	13%
#4) China .....	2%
#5) <i>Canada</i> .....	<i>2%</i>

### World fuel ethanol production



## Biofuels

### Canadian supply and demand

	Ethanol (2012)	Biodiesel (2011)
(million litres)		
Canadian production	1,725	157
Imports	1,022	252
Exports	11	N/A
Domestic use	2,736	N/A

### CBOT ethanol futures prices



CBOT: Chicago Board of Trade



## Biofuels

### Regulations

	<u>Gasoline</u> (% of renewable fuels content)	<u>Diesel</u>
Canada	5.0%	2.0%
BC	5.0%	4.0%
AB	5.0%	2.0%
SK	7.5%	2.0%
MB	8.5%	2.0%
ON	5.0%	*
QC	5.0% **	--

\* under consideration

\*\* target only



## 9. Electricity

### 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
- several provincially focused independent power producers' societies
- several 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.
- NEB regulates international power lines and electricity exports.

## International context

### World generation - 22,201 TWh (2011)

#1) China	21%
#2) United States	20%
#3) Russia	5%
#4) India	5%
#5) Japan	5%
<b>#6) Canada</b>	<b>3%</b>
#7) Germany	3%
#8) France	3%

### World exports - 649 TWh (2011)

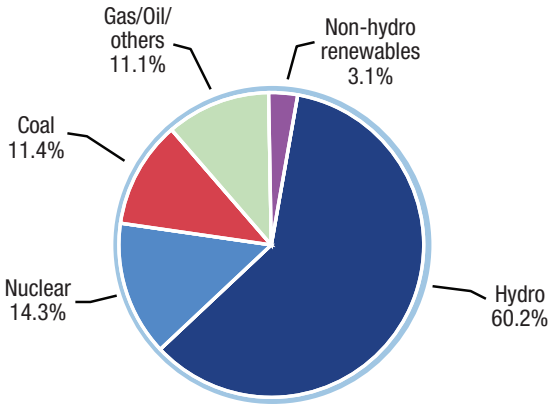
#1) Germany	10%
#2) France	8%
<b>#3) Canada</b>	<b>8%</b>
#4) Paraguay	7%
#5) Switzerland	5%
#6) Czech Republic	4%

TWh: terawatt-hour

## Canadian supply

### Generation in Canada - 618 TWh (2011)

#### Generation by source, 2011



TWh: terawatt-hour

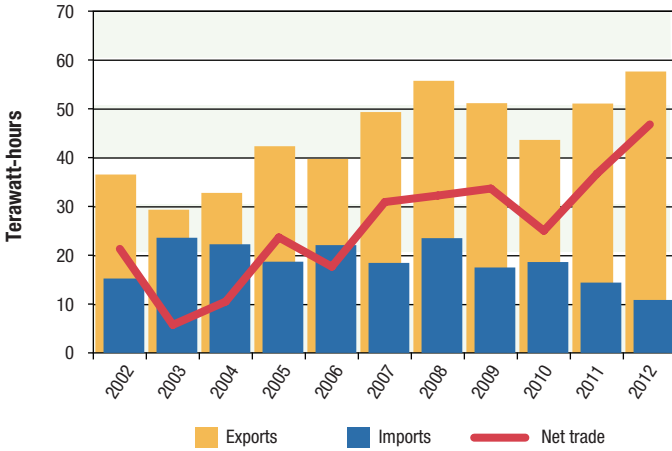
### Generation from non-GHG emitting sources: More than 77%

#### Provincial characteristics

- QC, NL, BC and MB – mostly hydro
- AB, NS and SK – more than half from coal
- ON and NB – diversified mix (nuclear, hydro and fossil fuels)
- PE – electricity mostly from NB

## Trade (2012)

### 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 ..... 58 TWh

Imports..... 11 TWh

TWh: terawatt-hours

### Key facts (2012)

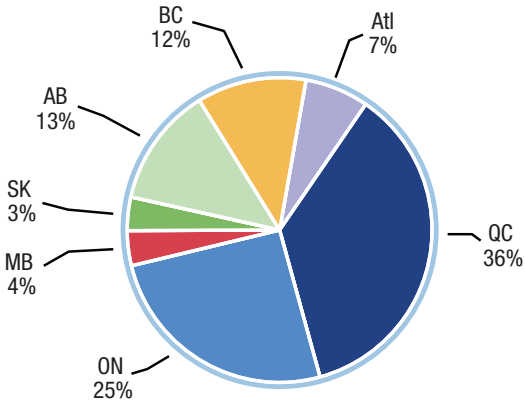
- All Canadian electricity trade is with the U.S.
- Canada exports about 9% of its electricity to the U.S., which meets 2% of U.S. consumption.

## Domestic demand (2011)

End-use	Use (TWh)	% of Total
Producer consumption .....	56 .....	10
Mining, oil and gas extraction .....	30 .....	5
Manufacturing .....	175 .....	31
Transportation .....	4 .....	1
Agriculture .....	9 .....	2
Residential .....	153 .....	27
Commercial, institutional .....	147 .....	26
<b>Total.....</b>	<b>575 .....</b>	<b>100</b>

TWh: terawatt-hour

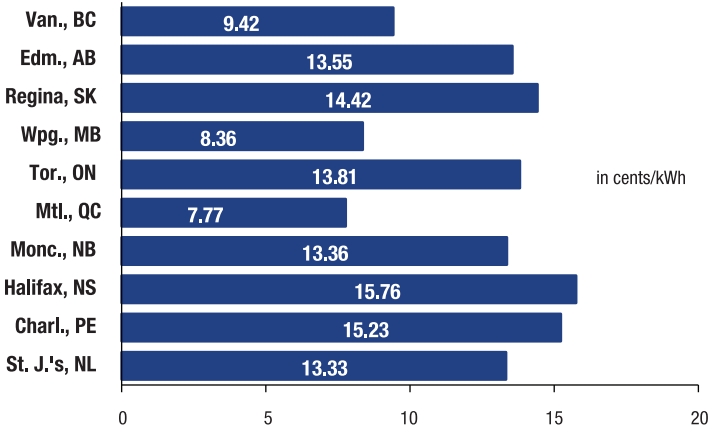
## Electricity demand by province, 2011



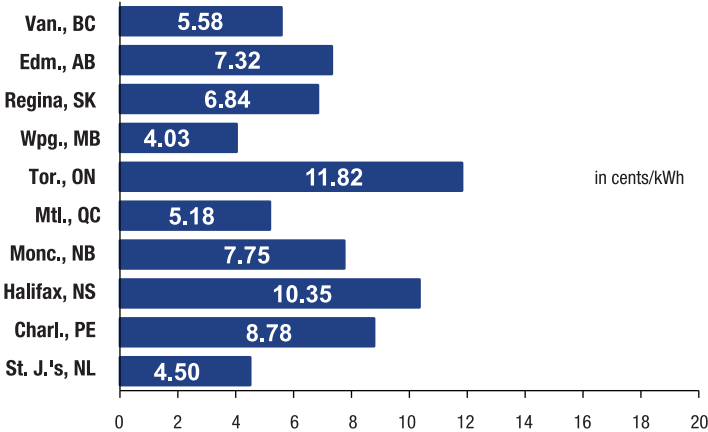
Note: The importance of electricity in Quebec is due to the prevalence of electric space and water heating, as well as the presence of electricity-intensive industries such as aluminum smelting.

## Retail prices

Average residential electricity prices, including taxes, April 2012



Average large industrial electricity prices, including taxes, April 2012



kWh: kilowatt-hour



## 10. Energy demand

### Secondary energy use

- energy used by final consumers in various sectors of the economy
- excludes producer consumption, conversion losses and non-energy uses (e.g. petrochemical feedstocks)

### 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

### Energy efficiency

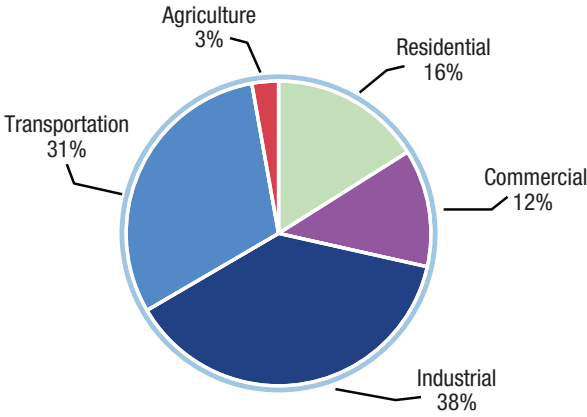
- a measure of how effectively energy is used for a given purpose
- providing a similar (or better) level of service with less energy consumption on a per-unit basis is considered an improvement in energy efficiency

### Energy intensity

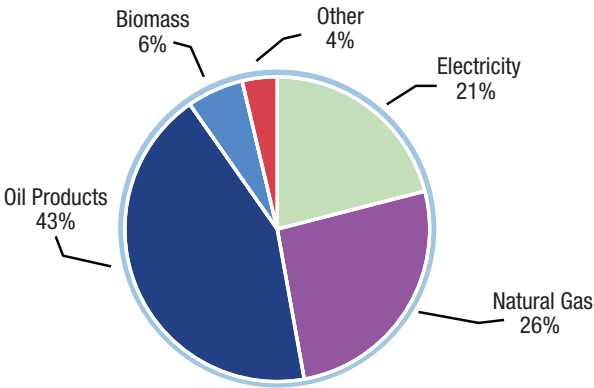
- the ratio of energy use per unit of activity

## Canada's secondary energy use

By sector, 2010



By fuel type, 2010

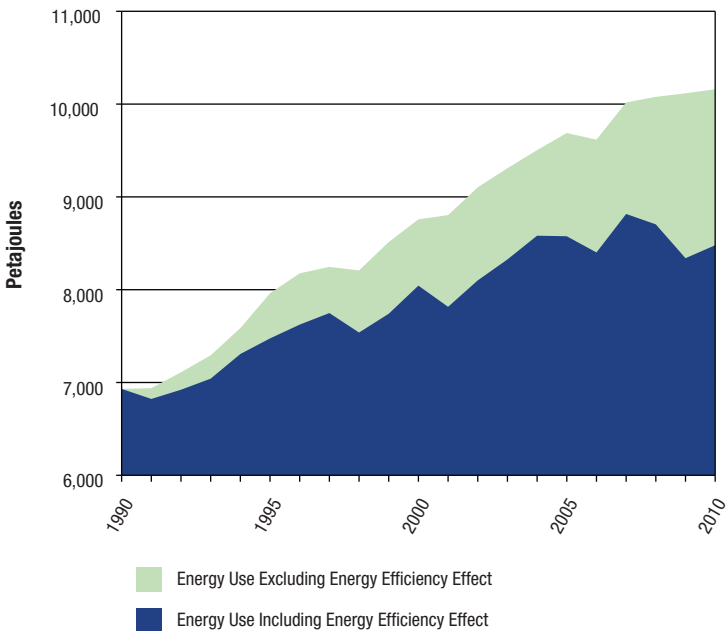


## Energy efficiency













- Energy efficiency in Canada improved by 25% between 1990 and 2010.
- Efficiency improvements slow the rate of growth in energy use:
  - Energy use grew by 22% between 1990 & 2010.
  - Without energy efficiency improvements, energy use would have grown by 47%.
- Energy efficiency savings of 1,681 PJ in 2010:
  - equivalent to end-user savings of \$32 billion
  - avoided 93 megatonnes of GHG emissions

PJ: petajoule

### Secondary energy use with and without energy efficiency improvements (1990–2010)



## Trends in energy use and intensity by sub-sector, 1990–2010

	Energy use <sup>1</sup>	Energy intensity <sup>2</sup>
Residential	 6%	 -29%
Commercial	 22%	 -13%
Transportation (Passenger)	 18%	 -19%
Freight	 70%	 11%
Industrial (forestry, mining, manufacturing, construction)	 19%	 -10%
Industry (w/o upstream mining)	 -6%	 -27%

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.

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

<sup>2</sup> the amount of energy used per unit of activity (e.g. floor space – residential, floor space – commercial, passenger-kilometres, tonne kilometres, and GDP)

## Canadian households

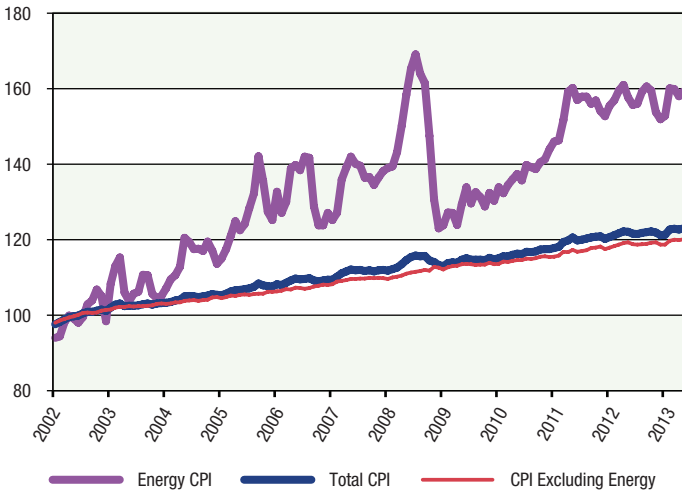
### Household expenditures

- Canadian households spent \$4,671 on average on energy in 2011.
- Energy accounted for 8.5% of total households' expenditures.
- 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)





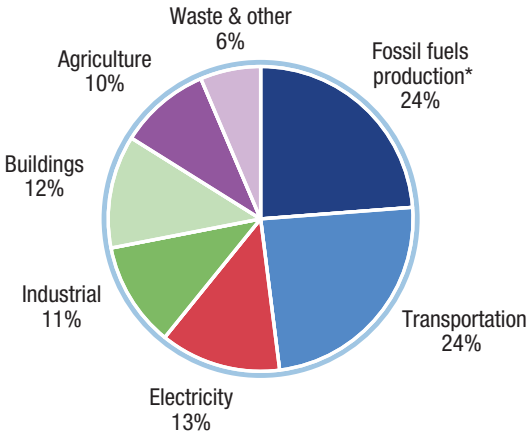
# 11. Greenhouse gas emissions

## Canadian GHG emissions (2011)

Total.....702 Mt  
 Canadian share of global emissions ..... 2%

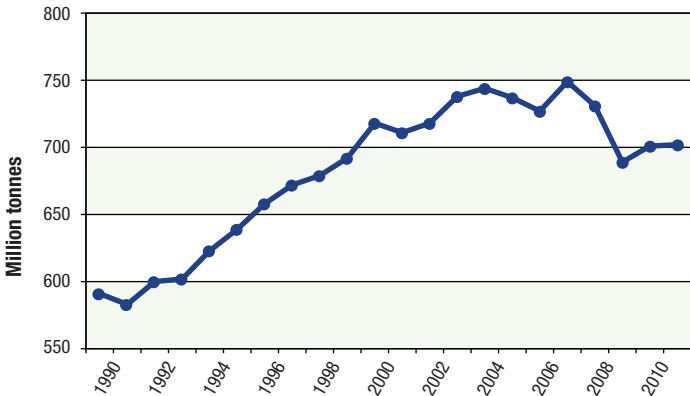
\*See page 23 for information on GHG emissions from the oil sands.

## Canada's 2011 emissions by economic sector



\*includes coal production  
 Mt: million tonnes

## Canada's GHG emissions, 1990–2011







# 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 ( $m^3$ ) = 6.2898 barrels
- IEA: 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 (m<sup>3</sup>) = 35.301 cubic feet

#### Density

- 1 million tonnes LNG = 48.0 billion cubic feet

#### Pricing

volume based:

- cents per cubic metre (¢/m<sup>3</sup>) (customer level in Canada)
- \$ per hundred cubic feet (\$/CCF) (customer level in U.S.)

energy content based:

- \$ per gigajoule (\$/GJ) (company level in Canada)
- \$ per million British Thermal Units (\$/MMBTU) (company level in U.S., LNG)

### Coal

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

### Uranium

- 1 metric tonne = 1,000 kilograms of uranium metal (U)
- U.S.: in pounds (lb.) of uranium oxide (U<sub>3</sub>O<sub>8</sub>)
- 1 lb. U<sub>3</sub>O<sub>8</sub> = 0.84802 lb. U = 0.38465 kg U

## Electricity

### Capacity

- maximum rated output at an instant, expressed in watts or multiples (megawatts or MW, gigawatt or GW)

### 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 MW x 24 hr x 365 d).
- 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 m<sup>3</sup> of crude oil = 39.0 GJ
- 1,000 m<sup>3</sup> 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: 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 (GDP): StatCan CANSIM Table 379-0029, nominal values for recent years estimated by NRCan

Employment: CANSIM Table 383-0031

Capital expenditures: StatCan CANSIM Tables 0029-0005 to 0029-0012

Exports/imports: StatCan International Merchandise Trade Database (from NRCan's TRAGS Database)

Government revenues: StatCan CANSIM Table 180-0003, StatCan Oil and Gas Extraction Survey, Canadian Association of Petroleum Producers (CAPP) Statistical Handbook (Table 01-01C)

Expenditure on energy RD&D: IEA RD&D Budget database; StatCan survey of industry expenditures; and data compiled by NRCan

Investment: StatCan CANSIM Tables 179-0004, 179 0005, 180-0003 and StatCan document 61-220-X

Major recent deals: merger market (based on announcement dates)

Canadian production: StatCan CANSIM Tables 128-0016, 128-0007, and NRCan estimates

## 2. Crude oil

World production and exports: International Energy Agency (*IEA Oil Market Report*)

World proved reserves: *Oil and Gas Journal*, Table World's Top Oil Reserves

Canadian resources: *CAPP Statistical Handbook for Canada's Upstream Petroleum Industry*, Table 02-01A, and Energy Resources Conservation Board (ERCB) Supply/Demand Outlook

Wells drilled in Canada: *Daily Oil Bulletin*

Canadian production: StatCan CANSIM Table 126-0001

Canadian supply and demand: StatCan CANSIM Table 126-0001

Trade: StatCan CANSIM Table 126-0001 and 134-0001, U.S. Energy Information Administration (U.S. EIA), Table US Imports by Country of Origin for Crude Oil, Table Refinery and Blender Net Imports for Petroleum and Other Liquids, Table US Imports of Crude and Petroleum Products by Country of Origin, and Table US Crude and Petroleum Products Supplied, calculations by NRCan

Prices: U.S. EIA Table Spot Prices for Petroleum and Other Liquids

Pipelines: compiled by NRCan

Oil sands: *CAPP Statistical Handbook for Canada's Upstream Petroleum Industry*, Tables 04-16B and 07-03B, and StatCan CANSIM Table 029-0007, compiled by NRCan

Tight Light Oil / Shale Oil: U.S. EIA, Technically Recoverable Shale Oil Resources, June 2013, Table 5

Environmental challenges: compiled by NRCan

### **3. Petroleum products**

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

Canadian supply and demand: StatCan CANSIM Table 134-0004

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

Gasoline supply and demand: StatCan CANSIM Table 134-0004

Canadian petroleum refineries: compiled by NRCan

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

## 4. Natural gas

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

World proved reserves: CAPP Handbook Table 02-13B, and *Oil and Gas Journal*, Table Worldwide Look at Reserves and Production

Canada-U.S. resources: Canadian Society for Unconventional Resources, U.S. Potential Gas Committee

World resources: International Energy Agency, World Energy Outlook 2012, Table 4.3

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 Table US Natural Gas Imports by Country, National Energy Board (NEB) Table Natural Gas Imports, Exports and Liquefied Natural Gas Statistics, Commodity Statistics for LNG imports, LNG Shipment Details

Wells drilled in Canada: *Daily Oil Bulletin* from CAODC Web site

Canadian production: StatCan CANSIM Table 131-0001, U.S. EIA Table Natural Gas Gross Withdrawals and Production



Trade: StatCan CANSIM Table 131-0001, NEB Table Natural Gas Imports, Exports and Liquefied Natural Gas Statistics, Commodity Statistics for pipeline trade, Gas Monthly Summary for the Year, U.S. EIA Table Natural Gas Consumption by End Use, and calculations by NRCan

Domestic demand: StatCan CANSIM Table 128-0017 and 129-0002

Prices: GLJ Publications, *Canadian National Gas Focus*

Pipelines: compiled by NRCan

LNG export applications: compiled by NRCan

## **5. Natural gas liquids**

Canadian supply: StatCan CANSIM Table 128-0012

Domestic demand: StatCan CANSIM Table 128-0012

## **6. Coal**

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

World proved reserves: World Energy Council

Canadian supply and demand: StatCan CANSIM Tables 135-0002 and 135-0002, and StatCan International Merchandise Trade Database (from NRCan's 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 (OECD), 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 (Billion Kilowatt-hours)

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 Balance of OECD Countries, and Energy Balances of Non-OECD Countries*), and U.S. EIA, Table International Energy Statistics, Hydroelectricity net generation

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

Hydro – facilities and projects: compiled by NRCAN

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 – world production of ethanol: U.S. EIA Table International Energy Statistics on biofuels production

Biofuels – supply and demand: Compiled by NRCAN, StatCan and the Canadian Revenue Agency

Biofuels – ethanol prices: Haver Analytics

Biofuels – regulations: compiled by NRCan from provincial Web sites

## 9. Electricity

World generation and exports: International Energy Agency (*IEA Electricity Information*), note: IEA production/generation data are 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 US 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

Canada’s secondary energy use: compiled by NRCan from StatCan

Energy efficiency: Compiled by NRCan

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

Consumer prices: StatCan CANSIM Table 326-0020

## 11. Greenhouse gas emissions

Environment Canada *National Inventory Report*, Part 1 Table 2-5 and 2-13, and Part 3 Table A12-3