Senate

Canada

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ATTENTION CANADA!
Preparing for our Energy Future

TOWARDS A CANADIAN SUSTAINABLE ENERGY STRATEGY

A Discussion Paper

Seventh report of the Standing Senate Committee on Energy, the Environment and Natural Resources

The Honourable W. David Angus, *Chair*
The Honourable Grant Mitchell, *Deputy Chair*

June 2010

Ce rapport est aussi disponible en français

Des renseignements sur le Comité sont donnés sur le site :

http://www.senate-senat.ca/EENR-EERN.asp

Information regarding the committee can be obtained through its web site:

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Members of the Standing Senate Committee on Energy, the Environment and Natural Resources

Honourable W. David Angus – Chair

Honourable Grant Mitchell – Deputy Chair

Honourable Tommy Banks
Honourable Bert Brown
Honourable Fred Dickson
Honourable Linda Frum
Honourable Daniel Lang
Honourable Paul J. Massicotte
Honourable Elaine McCoy
Honourable Richard Neufeld
Honourable Robert W. Peterson
Honourable Judith Seidman

Ex-officio members of the committee:

The Honourable Senators Cowan (or Tardif) and LeBreton, P.C., (or Comeau).

In addition, the Honourable Senators Callbeck, Campbell, Carignan, Dyck, Eggleton,P.C., Hervieux-Payette,P.C., Housakos, Kenny, Martin, Meighen, Merchant, Moore, Munson, Nolin, Ogilvie, Patterson, Poulin (Charette), Raine, Runciman, Rompkey,P.C., St. Germain,P.C., and Zimmer were members of the committee or participated from time to time during this study.

Staff of the committee:

Ms. Lynn Gordon, Clerk of the committee, Committees Directorate;
Ms. Chelsea Saville, Administrative Assistant, Committees Directorate;
Ms. Sam Banks and Mr. Marc LeBlanc, Analysts, Parliamentary Information and Research Services, Library of Parliament;
Ms. Tracie LeBlanc, Acting Communications Officer, Communications Directorate.

Committees receive their mandates from orders of reference adopted in the Senate Chamber. There are two types of orders of references that a committee may receive: an order of reference to consider a bill or Estimates, or an order of reference to carry out a special study. The following is the order of reference for this study.

Order of Reference – 40-3

STANDING SENATE COMMITTEE ON
ENERGY, THE ENVIRONMENT AND NATURAL RESOURCES
SPECIAL STUDY, ENERGY SECTOR

Extract of the *Journals of the Senate*, March 11, 2010:

The Honourable Senator Angus moved, seconded by the Honourable Senator Andreychuk:

That the Standing Senate Committee on Energy, the Environment and Natural Resources be authorized to examine and report on the current state and future of Canada's energy sector (including alternative energy). In particular, the committee shall be authorized to:

(*a*) Examine the current state of the energy sector across Canada, including production, manufacturing, transportation, distribution, sales, consumption and conservation patterns;

(*b*) Examine the federal and provincial/territorial roles in the energy sector and system in Canada;

(*c*) Examine current domestic and international trends and anticipated usage patterns and market conditions, including trade and environmental measures and opportunities, likely to influence the sector's and energy system's future sustainability;

(*d*) Develop a national vision for the long-term positioning, competitiveness and security of Canada's energy sector; and

(*e*) Recommend specific measures by which the federal government could help bring that vision to fruition.

That the papers and evidence received and taken and work accomplished by the committee on this subject since the beginning of the Second Session of the Fortieth Parliament be referred to the committee; and

That the committee submit its final report no later than June 30, 2011 and that the committee retain all powers necessary to publicize its findings until 180 days after the tabling of the final report.

The question being put on the motion, it was adopted.

Gary W. O'Brien
Clerk of the Senate

Executive Summary: Attention Canada!

The calamitous oil rig disaster in the Gulf of Mexico on April 20th, 2010, is a stunning reminder of the safety and environmental risks associated with our energy systems.

It also highlights how important energy is to modern society as the world searches for energy in increasingly varied and remote places to meet our growing energy needs.

At the same time, energy consumption, which accounts for 84 percent of global carbon emissions, is threatening to irreversibly alter the earth's climate, risking unprecedented economic, social and environmental hardship.

Countries around the world will require innovation in harnessing opportunities created in moving to safe and more sustainable extraction, production, transmission and uses of energy.

Transitioning to a lower-carbon economy will require a strategic examination of not only our consumption and production of hydrocarbons, but all our energy sources. All possible solutions need to be on the table.

As a major producer, exporter and consumer of energy, Canada cannot idly watch from the sidelines. There are just too many jobs, resources and wealth at stake. Canadians are amongst the world's highest consumers of energy on a per capita basis in part because of the cold climate and the vastness of the country and there is little or no likelihood that our energy demands will diminish as we go forward.

On June 4th, 2009, the Standing Senate Committee on Energy, the Environment and Natural Resources undertook a comprehensive study to examine and report on the current and future state of Canada's energy system.

Attention Canada! Preparing for our Energy Future is the committee's first interim report and concludes phase I of our study. It represents the culmination of nearly nine months of study and research including testimony from Canada's leading energy thinkers, research institutions and other stakeholders.

The message is clear: there is urgent need for a national discussion on energy. Canada requires a comprehensive Canadian Sustainable Energy Strategy now.

Groups such as the Energy Framework Initiative, the National Round Table on the Environment and the Economy, Public Policy Forum, Energy Policy Institute of Canada, Canadian Chamber of Commerce, Canada School of Energy and the Environment, the Canada West Foundation, the Pembina Institute and the Energy Council of Canada are working on and/or have raised the need for a common energy framework in order that federal, provincial and territorial governments and other stakeholders work together to

better coordinate Canada's future energy, economic and environmental policies so as to minimize risk and to take full advantage of opportunities of the new energy economy.

The report recognizes the importance of addressing climate change through carbon pricing and the need to improve the sustainable supply of existing and emerging sources of energy. It also discusses the importance of improving the ways we use and conserve energy as a means to address our energy and environmental challenges while also improving economic productivity.

This report recognizes the important economic relationship between Canada and the United States and the need to harmonize where practical our energy policy objectives for the benefit of both countries.

Canada's electricity system is examined, including the potential for further provincial electricity market integration. This report examines items related to energy security, particularly with regard to maintaining and expanding Canada's energy export markets.

The need to innovate and develop technologies that are in line with Canada's competitive advantage is identified as a key issue in meeting Canada's economic, energy and environmental objectives.

The report also identifies issues such as balancing the need for building new energy infrastructure while also addressing the environmental impact it may have on nearby communities. The need to implement effective and smarter regulatory frameworks is also explored.

The report concludes by encouraging the participation of all Canadians in a national energy discussion. To this end, the committee will be seeking views and opinions of Canadians in each region of the country over the coming year.

To facilitate this process, the committee has outlined key questions in how to move forward in developing a Canadian Sustainable Energy Strategy, which will help form the basis of recommendations in the committee's final report expected June 2011.

This interim report is a work in progress. Therefore, it contains no recommendations. The report does not identify every issue. Rather, it represents a preliminary outline of the key issues to be considered in developing a Canadian sustainable energy policy framework for the future. Its purpose is to lay the groundwork for a national energy dialogue and to raise awareness amongst Canadians of the urgent need for a new and smarter energy strategy.

Canadian Energy Snapshot

Canada and World

Global rank[1] of Canada in crude oil reserves (178 billion barrels): 2

Global rank[2] of Canada among producers of crude oil: 7
Percentage of world total: 3.9

Global rank[3] of Canada in hydroelectricity production: 3
Percentage of world total: 11.7

Global rank[4] of Canada in natural gas production: 3
Percentage of world total: 5.6

World ranking[5] of Canada in production of natural uranium: 2
Approximate percentage of world total: 22

Canada and the United States

Rank of the United States[6] as Canada's export market for energy products: 1
The top five source countries of US crude oil imports, in order: Canada, Saudi Arabia, Mexico, Venezuela, and Nigeria[7]

Percentage[8] of oil imported to the US that is supplied by Canada: 21

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[1] Central Intelligence Agency, The World Factbook, Country Comparison, Oil - Proved Reserves, https://www.cia.gov/library/publications/the-world-factbook/rankorder/2178rank.html

[2] International Energy Agency, Key World Energy Statistics 2009, http://www.iea.org/textbase/nppdf/free/2009/key_stats_2009.pdf at page 11.

[3] International Energy Agency, Key World Energy Statistics 2009, http://www.iea.org/textbase/nppdf/free/2009/key_stats_2009.pdf at page 19.

[4] International Energy Agency, Key World Energy Statistics 2009, http://www.iea.org/textbase/nppdf/free/2009/key_stats_2009.pdf at page 13.

[5] World Nuclear Association, (May 27 2010), http://www.world-nuclear.org/info/inf49.html

[6] Centre for Energy, Canadian Leadership in Energy, http://www.centreforenergy.com/Documents/AboutEnergy/ByTheNumbers/CanadianLeadershipInEnergy.pdf

[7] US Energy Information Administration, Frequently Asked Questions, Crude Oil, http://www.eia.doe.gov/ask/crudeoil_faqs.asp

[8] US Energy Information Administration, US Net Imports by country, http://tonto.eia.doe.gov/dnav/pet/pet_move_neti_a_epc0_IMN_mbblpd_a.htm

Percentage[9] of natural gas imported to the US that is provided by Canada: 88

Energy in Canada

Percentage of Canada's energy[10] produced by

natural gas: 34.7
petroleum: 39.5
coal: 8.5
hydro power: 7.8
nuclear energy: 5.9
waste wood, spent pulping liquor and firewood: 3.5
solar, wind and tidal: 0.1

Approximate percentage of Canadian electricity generation that is non-emitting: 75

Percentage[11] of Canadian greenhouse gas emissions resulting from the consumption and production of energy: 81.3

[9] US Energy Information Administration, US Natural Gas Imports by Country, http://www.eia.doe.gov/dnav/ng/ng_move_impc_s1_a.htm

[10] Primary energy consumption, Energy production and consumption percentages from Natural Resources Canada, Important Facts on Canada's Natural Resources, Energy, http://www.nrcan-rncan.gc.ca/stat/energ-eng.php (2008 figures).

[11] Environment Canada, National Inventory Report 1990-2008 Part 3 Greenhouse gas sources and sinks in Canada

Chapter 1
Introduction

Canada is a modern and stable open market economy with an enviable energy profile. The country's vast and diverse energy resources have positioned it among the largest producers and exporters of energy in the world.

Canada's success in leveraging its immense energy resources to create jobs, income and wealth has made it an important energy player on the global stage. But this does not guarantee future success.

Over the next 40 years, the world's population will increase from 6.8 to 9.2 billion[12] mostly in non-OECD[13] countries where substantial economic growth will bring an unprecedented increase in energy demand.

Canada cannot afford to watch from the sidelines.

Climate change will impact the way our energy systems develop. As energy consumption accounts for 84 percent of the world's carbon emissions[14], managing energy demand and finding new ways to curb emissions is central to managing climate change.

The need to move towards a low carbon economy is becoming increasingly evident as nations develop strategies to ensure their energy security needs are met in the wake of diminishing conventional energy supplies.

Successful countries will be those that innovate and harness opportunities created in moving to safe and more sustainable extraction, production, transmission and uses of energy.

Canada cannot afford to watch from the sidelines. Energy is in everything that we do, it is essential in maintaining our quality of life. Strategically leveraging our energy resources, while addressing climate change is so important -there are just too many jobs, wealth and our future prosperity at stake.

On June 4th, 2009, the Standing Senate Committee on Energy, the Environment and Natural Resources undertook a two year study to examine and report on the current

[12] US Census Bureau, International Data Base, http://www.census.gov/ipc/www/idb/worldpop.php

[13] OECD: Organisation for Economic Cooperation and Development

[14] International Energy Agency, World Energy Outlook 2009, p. 168

and future state of Canada's energy systems and to help craft an energy vision for the country.

It is clear that there is a need for a national discussion on energy. The committee found an impressive number of energy policy experts and stakeholders from environmental organizations to industry associations calling for national direction in mapping Canada's energy future.

Groups such as the Energy Framework Initiative, the National Round Table on the Environment and the Economy, Public Policy Forum, Energy Policy Institute of Canada, Canadian Chamber of Commerce, Canada School of Energy and the Environment, the Canada West Foundation, Energy Council of Canada and the Pembina Institute are working on and/or have raised the need for a common energy framework so that federal, provincial and territorial governments and other stakeholders can work together and coordinate energy policies to ensure prosperity for all regions.

This interim report concludes phase I of our in depth study on Canada's energy future. It represents the culmination of nearly nine months of testimony from Canada's leading energy thinkers, research institutions and other stakeholders. It also contains information gathered from fact finding trips to Washington D.C. from the 29th of September to the 2nd of October, 2009, and the Globe 2010 Conference on business and the environment in Vancouver, the 24th to 26th of March 2010.

This interim report contains no recommendations. Rather, it identifies *some* of the major social, economic and environmental challenges, issues, opportunities and options affecting the supply and use of energy in Canada. It presents a road map leading to a more in depth discussion on how the country can develop a Canadian Sustainable Energy Strategy which will help form the basis of recommendations in the final report expected June 2011.

This first interim report is a work in progress. It does not identify every issue. Its purpose is to lay the groundwork to start a national energy conversation. To facilitate this process and to better receive your comments, ideas and concerns, the committee will soon be releasing a website dedicated to this study. We invite you to have a say in Canada's energy future.

Chapter 2
International Outlook

Energy is the defining product of our time. Few products share the same degree of economic, geopolitical, environmental and social significance as energy. As global energy requirements grow in step with population and economic growth, the influence that energy has on the livelihoods of citizens in all nations will increase.

There are four major drivers on the global scene:

2.1 World Energy Demand is Expanding

According to projections by the International Energy Association (IEA), primary energy demand will increase by over 40 percent over the next twenty years.[15] Nearly all growth is due to significant expected population growth combined with rapid urban expansion and industrialization of non-OECD countries such as China and India.

If the world continues on its current path, fossil fuels will supply 75 percent of the overall increase in energy demand.[16]

To understand the scope of expansion, world electricity capacity will increase by 4,800 gigawatts (GW), which is nearly five times the existing electricity capacity of the United States.

Also, oil demand will increase by nearly 25 percent as vehicle ownership swells the global vehicle fleet of passenger vehicles[17] of 770 million in 2007 to 1.4 billion by 2030.

In order to ensure energy security of liquid transportation fuels, countries like China will increasingly rely on energy imports and alternative energy sources to meet its growing demand such as making synthetic transportation fuel through a process that liquefies coal. Indeed, countries from around the world will look to all available forms of energy to meet future energy demand.

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[15] International Energy Agency, World Energy Outlook 2009, based on IEA's reference scenario, which shows how the future might look on the basis of policies so far adopted by governments.

[16] International Energy Agency, World Energy Outlook 2009 -75 percent increase from 2007 to 2030.

[17] Light duty vehicles

2.2 Climate Change and Global Emissions are Growing

Climate change caused by human activity poses great risks to our environment, economy and energy systems. Global energy consumption accounts for nearly 84 percent of the world's carbon emissions. Developing our energy systems in a way that reduces our carbon emissions is the core component of meeting the climate change challenge.

If the world continues on the same path, the IEA estimates that global temperatures could rise by up to six degrees Celsius by 2100. The Copenhagen Accord of December 18, 2009 noted that global average temperatures should not rise above two degrees Celsius in order to avoid dangerous and irreversible climate consequences.[18]

In order to achieve global temperature below the two degree threshold, the world must alter the way it produces and consumes energy. To reach this goal, the IEA estimates that $10.5 trillion U.S. in global new energy investments are needed over the next 20 years.[19]

Addressing climate change also presents significant economic opportunities for countries that encourage efficiency and sustainability in their economies. Fossil fuels will continue to dominate the global energy mix[20], but through conservation, technological growth and investment, the world can ease the transition to a lower carbon energy future.

The IEA predicts that most emission reductions will come from improvements in energy efficiency, carbon pricing, carbon capture and storage, in addition to nuclear and renewable energy production.

2.3 A Trend Towards Increasing Oil Prices

Demand for oil is increasing while conventional oil supplies are tightening. In the future, unconventional fuel sources (including oil sands, offshore oil, heavy oil, biofuels, coal-to-liquids), which are more expensive to produce, will play a greater role in the global energy mix.

Carmen Dybwad of the Canadian Energy Research Institute (CERI) told the committee:

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[18] The United Nation's fifteenth session of the Conference of the Parties in Copenhagen Denmark http://unfccc.int/home/items/5262.php

[19] This is based on IEA's 450 Scenario in its 2009 Outlook that would limit the long run concentration of greenhouse gas below 450 parts per million C02 equivalent; this would still result in increased global warming of 2 degree Celsius but below what most scientists model, as being dangerous.

[20] This is because of fossil fuels' high energy content, portability, relative abundance and because existing infrastructure, technology and the economy have been built around its use.

> "Are we past the point of all the cheap stuff? Yes. All of the oil reserves we have now are harder to get at. It is also heavier, under a lot of water and more sour; in other words, it has more sulphur in it. This is not light sweet crude any more. Very little of that is left in the world. Everything else is simply more expensive to access."
>
> *Evidence November 24, 2009*

As a result, persistent upward pressure on international energy prices is projected. Also energy prices will likely remain volatile in the long term.

2.4 Energy Security

The growth in energy demand and the concentration of remaining oil reserves in fewer countries increases the risk of oil supply disruptions. It is also augments the risk that countries with large oil reserves such as members of OPEC could use their market dominance to further increase the global price of oil.[21]

The IEA reported that there was a trend towards resource nationalism, increasing the prospects of using oil as a geopolitical lever and impeding foreign investments and technology uptake which could result in reduced capacity additions (both upstream and downstream) to keep pace with demand growth.[22]

Chapter 3
Overview of Canada's Energy System

Canada is a modern, secure, stable country with an open market economy blessed with vast and diverse energy resources and a relatively small population base.

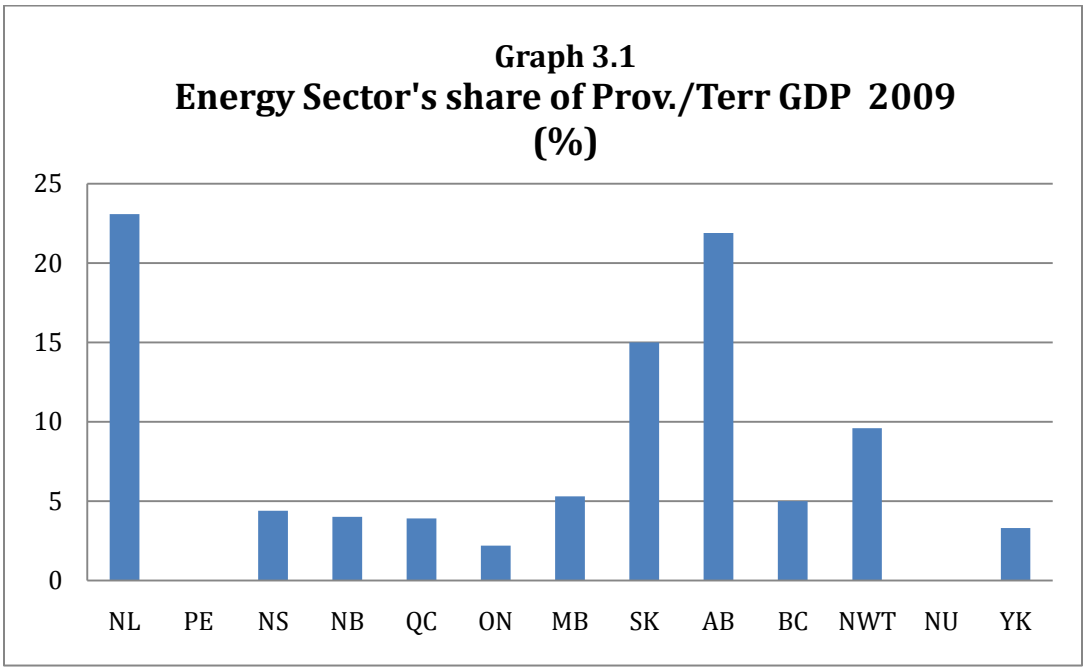
Canada ranks among the world's largest producers and exporters of oil, natural gas, uranium and hydropower. Energy that isn't consumed in Canada is exported almost exclusively to the United States; the two countries share highly integrated energy markets.

The energy sector contributes significantly to the Canadian economy but varies by provinces and territory. In 2008, it represented nearly seven percent of Canadian Gross

[21] International Energy Agency, Oil Supply Security: Emergency Response of IEA Countries 2007

[22] Ibid

Domestic Product (GDP) and provided 363,000 direct jobs.[23] In 2008, energy represented 28 percent of all Canadian merchandise exports.[24] The energy sector is capital intensive and thus creates numerous indirect jobs within the manufacturing, construction and engineering service industries.



Note: Figures for Prince Edward Island and Nunavut are not available due to the confidential nature of the data.

Source: Statistics Canada

Canada's per capita energy consumption is among the highest in the world. This is due to a number of factors including Canada's relatively cold climate, vast geography, dispersed population, large resource-based industrial sector, relatively low energy prices and consumer preferences.

Canada is the world's eighth largest emitter of greenhouse gases (GHGs) accounting for roughly 2 percent of global emissions and emission growth is higher in Canada than most other countries.[25] [26] Canada is among the highest per capita GHG emitters in the world.

[23] National Energy Board, Canadian Energy Overview 2008:An Energy Market Assessment May 2009

[24] Ibid

[25] Natural Resources Canada, Environmental Scan of Canada's Energy Sector 2008

[26] Although, Canada's greenhouse gas emissions were down in 2008 according to the latest federal government's emission report to the United Nations.

Quick Energy Facts

- Canada's oil reserves are estimated at 178 billion barrels, second only to Saudi Arabia. Most of it is in the form of oil sand deposits in the Western Canada Sedimentary Basin.[27]

- Canada has significant offshore oil and gas exploration and production off the coast of Newfoundland and Labrador.

- Canada is among the very few non-OPEC[28] countries where oil production expansion is possible.

- Canada is the third largest producer of natural gas in the world after the United States and Russia. Canada is a large supplier of natural gas to the United States with which it shares a common market.[29]

- Canada has an abundance of coal. In terms of hydrocarbon reserves, coal far exceeds the oil sands.

- Canada has the world's largest reserves of high-grade uranium, mostly in northern Saskatchewan.[30]

- Roughly 75 percent of Canada's electricity energy is produced from non emitting sources.

- Nuclear energy generates nearly 15 percent of Canada's electricity.

- Canada is one of the largest producers of hydropower in the world. The key hydroelectric provinces are British Columbia, Manitoba, Quebec and Newfoundland and Labrador. [31]

- Wind energy accounts for 1.1 percent of total electric power in Canada. It is the fastest growing source of renewable generation in the country.

Canada's primary energy supply consists of resources such as uranium, hydro, natural gas, biomass, wind, coal, and oil. Some sources such as oil are used predominantly for transportation while others -uranium, coal, hydro and wind- are used to generate electricity. Natural gas is often used for space and water heating but it can also be

[27] Oil production is predominantly in Alberta and Saskatchewan.
[28] OPEC: Organization of the Petroleum Exporting Countries
[29] Nearly all of the natural gas production in Canada is in the Western Canada Sedimentary Basin where Alberta takes up the lion's share followed by British Columbia and Saskatchewan. Atlantic Canada has offshore natural gas production, predominantly in Nova Scotia.
[30] In Ontario, New Brunswick and Quebec, nuclear power provides roughly 50.4%, 23.3% and 2.3% of the total provincial electricity mix.
[31] In Newfoundland and Labrador, Quebec, Manitoba and British Columbia hydroelectric power make up 96.3%, 94.34%, 97.4% and 89.5% of their respective electric energy mix.

converted to electricity. Also there is increasing interest in using natural gas as a fuel for transportation.[32]

While "energy" is often referred to as a general term to encompass, all forms of energy it is important to emphasize that different energy sources are often used for different purposes and thus they engender different types of challenges and opportunities. Different forms of energy often cannot easily be substituted for each other, for example with current technology wind energy cannot practically replace oil as a fuel for transportation.

3.1 Canada's Energy Outlook

On the global scene, energy importing countries will be active in securing reliable sources of energy supply.

Oil sands production will dominate the oil sector in Canada as it could triple by 2030 and will be a significant source of direct foreign investment.[33] Most of the increase in oil sands production will be exported, necessitating pipeline infrastructure investment over the next 20 years.[34]

The natural gas profile is shifting; many conventional natural gas fields are maturing while interest in non-conventional gas (tight gas, coal bed methane, shale gas) is expanding as new extraction technology is creating new supply opportunities in North America.[35]

Investment in new electrical transmission and generation is expected to be as large as in the oil sands.[36] Investment in the wind industry will increase substantially; installed capacity could increase from 3,432 MW to 7,700 MW within the next few years.[37]

The workforce is transitioning. The oldest baby boomers[38] are turning 64 this year. Over the next 20

Canada's Northern and Arctic Region

There are currently sizable petroleum resources in Canada's northern regions and many observers are looking to the Arctic as a source of much of the remaining global endowments of oil and gas resources. However, in addition to being a harsh environment, it is an environmentally sensitive region which adds to the challenge of safely extracting hydrocarbons from this region.

[32] Petroleum products are also used to make non fuel products for example natural gas is an important feedstock to produce ammonia for fertilizer production.
[33] Conference Board of Canada, Canadian Outlook 2010, Long Term Forecast
[34] Ibid
[35] British Columbia reserves of shale could potentially reverse the decline; also the Mackenzie Gas Project (if it becomes operational) could boost supply.
[36] Conference Board of Canada, Canadian Outlook 2010, Long Term Forecast
[37] Conference Board of Canada, Canadian Outlook 2010 cited the Canadian Wind Energy Association project forecast as of April 1 2010 http://www.canwea.ca/pdf/Proposed%20projects.pdf, the figure was adjusted to reflect the latest estimate of installed wind capacity.

years, the proportion of working age population will shrink. This means that there will be fewer workers available to replace retiring employees. Both federal and provincial governments face tough challenges in the medium and long term in managing public finances as demands on health care and other government services will increase.[39]

3.2 Legal Jurisdiction

Energy jurisdiction is shared between the federal and provincial governments. As per the *Constitution Act, 1867*, the provinces are owners of their ground resources except for those in Aboriginal and federal lands. As well, the provinces and territories are responsible for electricity systems within their borders.

Federal

The federal government is responsible for the management of energy resources on federal and frontier lands and it regulates the international and interprovincial movement of energy and energy goods.[40] It is also involved in energy matters to the extent of its interest in economic development and energy security.

Since the energy crises of the 1970s, the federal government has played a role in promoting energy efficiency and alternative energies. The federal policy influence over energy has expanded due to the growth in trans-boundary environmental concerns, principally climate change. [41] The main federal energy regulatory agencies are the National Energy Board and the Canadian Nuclear Safety Commission.

The federal government also shares regulatory responsibility over offshore oil and gas resources with Newfoundland and Labrador and Nova Scotia through the Canada-Newfoundland and Labrador Offshore Petroleum Board and the Canada-Nova Scotia Offshore Petroleum Board.

Provincial/Territorial

The provinces and territories are responsible for energy matters relating to economic and energy security within their borders. Provinces may impose royalties and taxes on energy production.

Provincial and territorial boards regulate energy pricing at the distribution level when markets fall under monopoly conditions. In the electricity sector, most provinces/territories (except for Alberta) own Crown utility corporations.

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[38] Demographic cohort born between 1947 and 1966

[39] Conference Board of Canada, Canadian Outlook 2010, Long Term Forecast

[40] The federal government does not regulate interprovincial power lines.

[41] Ibid

The federal government owns the natural resources in the territories but transferred administrative responsibilities of these resources to the Yukon and is working on similar transfers with Northwest Territories and Nunavut. Through the transfer, Yukon essentially obtained resource management powers and responsibilities similar to a province. Currently, resources in Northwest Territories and in Nunavut are administered by the federal Ministry of Indian and Northern Affairs.

First Nations

First Nations through settled land claim agreements often own the resources on their lands as such have authority to administer and authorize access to these resources.

Table 3.1
Major Areas of Resource, Policy and Administration

Provincial/Territorial[1]	Federal
Development and management of resources within provincial/Yukon boundaries	Resource management on non-accord frontier lands[2]
Property and civil rights, i.e. environmental, health, safety, land use, consumer protection, etc.	Uranium/nuclear power
Regulation and legislative framework for energy supplies to consumers, including in many cases ownership of Crown corporations engaged in these activities	Trans-boundary environmental impacts and environmental assessments.
Taxation policy and securing royalties as resource owners	Taxation policy and securing royalties as resources owners on federal lands
Policies in the provincial/territorial interest (economic development, energy security, R&D)	Policies in the national interest (economic development, energy security, R&D)
Intra provincial/territorial movement of energy and energy goods	Interprovincial and international movement of energy and energy goods

[1]The federal government owns the natural resources in the territories but transferred administrative responsibilities of these resources to the Yukon. Currently, resources in Northwest Territories and in Nunavut are administered by the federal Ministry of Indian and Northern Affairs.

[2] Includes offshore areas not within a province and in the territories. There are agreements between the federal government and Newfoundland and Nova Scotia, through Atlantic Accords which include the establishment of a jointly managed Offshore Boards. The Atlantic Accords allow the provinces to keep 100% of royalty revenues as though the resources were on land.

Source: International Energy Agency with modifications

3.3 Key Federal Energy Measures

Targets

The federal emission reduction target is 17 percent from 2005 levels by 2020.[42] This target is aligned with the United States administration's 2020 target and is subject to adjustment to remain aligned with the US emission target.

The federal government is committed to having 90 percent of Canada's electricity provided by non-emitting sources such as hydro, nuclear, clean coal or wind power by 2020. Currently, 75 percent of Canada's electricity system is sourced by non-emitting sources.

US-Canada Clean Energy Dialogue

On February 19th, 2009, Prime Minister Stephen Harper and President Barrack Obama agreed to establish a senior-level US-Canada Clean Energy Dialogue to cooperate on several critical energy science and technology issues, including expanding clean energy research and development, developing and deploying clean energy technology and building a smarter and more efficient electricity grid based on clean and renewable generation.

Clean Technology R&D

In May 2009, the federal government committed $795 million over five years under its Clean Energy Fund to support research, development and demonstration of clean energy technologies including large-scale carbon capture and storage (CCS) demonstration projects. [43] [44]

The federal government also funds and/or supports research, development and deployment in the clean energy area through a variety of means including: Program of Energy Research and Development (PERD), Sustainable Development Technology Canada (SDTC) and CANMET Energy Technology Centre.

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[42] On 30 January 2010, Environment Minister, the Honourable Jim Prentice, announced the submission of Canada's 2020 emissions reduction target under the Copenhagen Accord. The Copenhagen Accord is not legally binding and negotiations are continuing under the United Nation's Framework Convention on Climate Change.

[43] Natural Resources Canada, Science and Technology, Clean Energy Fund Program, http://www.nrcan.gc.ca/eneene/science/ceffep-eng.php

[44] The original Clean Energy Fund announcement committed $1 billion. However, in December 2009, the federal government allocated $205 million from the Clean Energy Fund to finance its ecoENERGY Home Retrofits program which received significant response from Canadian homeowners.

Other measures:

- On April 1st, 2010, the federal government released new proposed regulations to reduce greenhouse gas (GHG) emissions from new passenger vehicles and light trucks beginning with the 2011 model year. These regulations will be harmonized with the mandatory national standards of the United States. The federal government is working towards introducing similar regulations for large trucks.
- The federal government recently released proposed regulations requiring 5 percent renewable content in gasoline by September 1st, 2010.[45] The proposed regulation also include provisions requiring an average 2 percent renewable fuel content in diesel fuel. However, this requirement will be brought in force only when technically feasible.
- The federal government delivers funding for a suite of clean air and climate change programs under its ecoACTION plan providing initiatives ranging from building retrofits and transportation initiatives to technology development, renewable power and biofuels.

Chapter 4
Overview of Major Issues

> "Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs."[46]

Existing energy systems must transform because of pressures on existing energy supply and to avoid unchecked climate change. Historically, energy transformations have not occurred frequently; for example, over the last 200 years there have only been two major energy market transformations:1) from biomass to coal; 2) from coal to oil and gas after the Second World War.[47]

Therefore, energy policy is vital to help speed the pace of change in moving towards sustainable energy systems.

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[45] The Canada Gazette Vol. 144, No. 15 — April 10, 2010

[46] Report of the World Commission on Environment and Development: Our Common Future 1987, commonly known as the Brundtland Report.

[47] Standing Senate Committee on Energy, the Environment and Natural Resources, December 1 2009 evidence from David Layzell, Executive Director of the Institute for Sustainable Energy, Environment and Economy University of Calgary.

Many witnesses stressed that there is no magic bullet solution, instead the focus should be on "silver buckshots" by finding sustainable ways of producing, transporting and consuming energy from a variety of new and existing sources of energy.

4.1 Climate Change

Human activity, mainly through the combustion of fossil fuels, has increased the concentration of greenhouse gases in the atmosphere which impacts the global climate. There is a strong scientific consensus, based on years of research, that climate change is real and happening now.

After a certain threshold of global climate warming there are fears that climate change cannot be controlled. There is a high risk that extreme and irreversible climatic and weather events will cause unprecedented social and economic hardship.

Climate change is a global problem because greenhouse gas emissions do not respect borders, and the activities of any individual country can influence us all. It is also an energy problem, because over 84 percent of carbon emissions derive from energy consumption.

To meet the climate change challenge, and to prosper in a lower-carbon global economy, we will need to transition our energy systems in a way that can also reduce Canada's greenhouse gas emissions. One of the key tools to achieving this is carbon pricing.

4.2 Carbon Pricing

> "Someone explained to me recently that using the atmosphere as a sewer is not a long-term prospect."

Bruce Carson
Canada School of Energy and the Environment
Evidence April 13, 2010

The committee found near unanimity among witnesses –from the petroleum industry to environmental organizations –that supported pricing carbon as the most efficient way to reduce emissions. Given the choice, most witnesses favoured carbon taxes over cap-and-trade but both are market-based approaches for pricing carbon and both can be levied at different stages along the fossil fuel supply chain.

Generally, witnesses stated that a carbon tax would be more economically efficient and less complex to administer than a cap-and-trade system. For either method, it was stressed that carbon pricing should be applied broadly and uniformly throughout the economy and across Canada.[48]

Why do economists favour carbon pricing?

Putting a price on emissions internalizes the environmental costs and financially motivates businesses and individuals to make choices that reduce carbon emissions. By so doing, it increases energy conservation and the competiveness of non or low emitting technologies.

In most carbon pricing schemes, the revenue generated is recycled into the economy by reducing income or payroll taxes or by funding technology research or other incentives that promote sustainable energy technologies.

Because each province and territory's energy circumstances are different, national carbon pricing would have uneven impacts across Canada. These differences would have to be accounted for, perhaps, by ensuring that revenues are returned to the provinces/territories or by applying different rules for high growth regions.

The federal government's position is that it will adopt a cap-and-trade system if the US government proceeds with cap-and-trade legislation. There is a concern with proceeding unilaterally with carbon pricing because it would place trade exposed energy intensive industries at a competitive disadvantage.

Some witnesses agreed that Canada should align with the US so as to not harm Canada's competiveness. However, there was concern that 1) the United States due to the nature of its legislative process may be slow in introducing emission reduction legislation[49]; 2) if or when the United States does introduce legislation it would be tailored to fit their energy and political circumstances and not those of Canada.

4.3 Sustainable Energy Supply

It is essential that Canada innovate and develop technologies to improve the sustainability of its primary energy supply. It also must not miss opportunities and address the challenges posed by moving to renewable energy sources.

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[48] National Roundtable on the Environment and the Economy, Achieving 2050 A Carbon Pricing Policy for Canada 2009

[49] On 26 June 2009 the US House of Representative s passed a bill, the American Clean Energy and Security Act commonly referred to as the Waxman Markey Bill, which would require reductions in greenhouse gas (GHG) emissions through a cap and trade mechanisms. On May 12 2010 Senators John Kerry and Joseph Lieberman introduced a corresponding bill, the American Power Act, in the US Senate but most observers predict that the passage of the Senate bill will not occur rapidly.

4.3.1
Greening the Oil Sands

The Alberta Athabasca oil sands are the second largest proven oil reserves in the world. They will continue to contribute significantly to Canada's energy and economic future and shape Canada's international energy profile.[50] However, intense public attention will continue to focus on the oil sands and increase investor risk, if both its environmental and carbon emission footprints do not improve.[51]

The oil sands extraction and production process require sizable water and energy (natural gas) resources. Carmen Dybwad of CERI pointed out that technology is being explored to substantially reduce water consumption such as vapour extraction, toe-to heel air-injection (THAI) and electro-thermal dynamic stripping.

In a series of reports, CERI examined a number of options to replace part or all of the natural gas used in the processing of bitumen from the oil sands.[52] By switching to nuclear energy or coal gasification with carbon capture and storage, emissions from oil sands production could be reduced substantially. However, the additional costs of switching to these technologies pose a significant barrier.

4.3.2
Carbon Capture and Storage

Some witnesses consider carbon capture and storage (CCS) as one of the few technologies available that can abate carbon emissions on a large scale. There are many different methods of CCS but the most common being explored in Canada is geo-sequestration where carbon emissions are captured from industrial facilities such as a coal fired electricity plant or oil sands upgrader facility (that serves to make synthetic crude oil from bitumen) and then piped and injected underground for storage.

The feasibility of carbon storage is limited to regions that have the appropriate geological formations. Western Canada offers excellent opportunities for CCS because coal generation and oil sands production are located relatively near large storage sites that have depleted oil and gas reservoirs.

Canada and other countries including China and the United States have placed a high priority on CCS. Many countries have been cooperating in the development of CCS technology, including Canada and United States through the US-Canada Clean Energy

[50] In fact, heavy oil and the oil sands accounts for nearly all growth in oil production in Canada since 1990s.
[51] The oil sands account for roughly 5 % of Canada's GHG emissions and this share is projected to grow. However, to put in perspective coal-fired electricity produces roughly 13% of Canada's GHG emissions.
[52] Canadian Energy Research Institute, Green Bitumen: The role of Nuclear, Gasification, and CCS in Alberta's Oil Sands 2009

Dialogue. However, some question the degree of information that can be shared given patent and intellectual property issues.

Currently, the federal government along with certain provinces is investing in large scale CCS demonstration projects; most of the activity is located in Alberta, Saskatchewan and British Columbia.[53]

Some witnesses raised concerns that large scale CCS technology has not been significantly proven and that the scope of the required infrastructure investment make it prohibitively expensive. They recommend redirecting efforts to nuclear energy or renewables.

Other witnesses recognized the expensive nature of CCS technology but believed that costs will go down as the technology becomes more widely deployed.

It was stressed that CCS must be part of the solution because fossil fuels will continue to dominate worldwide energy demand for some time to come.

There is also a need for policy and regulatory development associated with managing and assigning potential health and safety liabilities associated with long-term storage of carbon.

4.3.3
Natural Gas

> "Natural gas could be a bridging fuel."
>
> *The Honourable Jim Prentice, P.C., M.P.*
> *Minister of the Environment*
> *Evidence April 15, 2010*

At committee meetings in Washington D.C. in late September 2009, natural gas was often mentioned by energy policy experts as an example of a transitional fuel due to its relatively low carbon intensity. Natural gas fired electricity generation is seen as a way to displace some of the coal fired thermal plants that currently produce electricity in the US and in Canada.

[53] The federal government committed over $1 billion towards CCS projects through various projects including $466 million in Clean Energy Fund, $240 million for Saskatchewan's Boundary Dam and $151 million under the eco ENERGY initiative. Alberta is very active in this area, it has invested $2 billion to fund four large scale demonstration projects: two are oil sands related (Shell Quest capture and storage of project and the Energy Enhanced project that will transport $C0_2$ by pipeline, the third is a post-combustion coal fired power project and the fourth is a coal gasification project. Saskatchewan is the site of one of the largest CO_2 storage projects in the world: Weyburn-Middale $C0_2$ Enhanced Oil Recovery (EOR) project. British Columbia is also involved in large scale CCS projects via Spectra Energy's Fort Nelson CCS demonstration project which is exploring the feasibility of geological sites to sequester carbon.

The Honourable Jim Prentice, Canada's Minister of the Environment, told the committee that natural gas is a way to provide cleaner energy production while waiting for CCS technology to be developed and commercialized. The Minister added that in displacing coal, natural gas would also reduce mercury emissions and oxides of nitrogen and sulphur which cause smog and acid rain.

There is also potential for natural gas to serve as a transportation fuel particularly for the heavy trucking industry.

The North American market for natural gas has shifted considerably in recent years due in part to new drilling technology for non-conventional natural gas such as shale gas. Because of the size of shale gas reserves, it has the potential to be a significant game changer.[54]

4.3.4 Nuclear

Nuclear energy is going through a renaissance. It is one of the few technologies that can produce, on a large scale, non-emitting base-load electric energy. As such, many countries are turning to nuclear energy to achieve energy security while reducing GHG emissions.

Canada has the world largest uranium reserves and for many years it was the world's largest producer with approximately 22 percent of global production. However, in 2009 it was second to Kazakhstan.[55] Canada's uranium is currently mined in the Athabasca Basin of northern Saskatchewan. Over 80 percent of the uranium mined in Canada is exported.

There are two uranium refineries in Canada and both of them are in Ontario: Blind River and Port Hope. The Blind River refinery is considered the world's largest commercial uranium refinery. Its main function is to produce uranium trioxide UO_3 which is an intermediate product that is shipped to Port Hope's conversion facility for further processing.[56] The purpose of uranium refining is to increase the concentration of uranium oxides to produce fuel grade material.

i. Nuclear Fuel and Waste

Nuclear waste and fuel bundles must be removed and safely managed because they have high levels of radioactivity. The federal Nuclear Waste Management Organization

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[54] Unconventional natural gas can be harvested in many areas across North America. Some of these areas are near urban populations, which have heightened public concern over possible effects of the extraction process.

[55] World Nuclear Association, http://www.world-nuclear.org/info/inf49.html

[56] Cameco, http://www.cameco.com/

was established in 2002 to investigate approaches for managing Canada's used nuclear fuel. It is currently seeking regulatory approvals for the construction of a Deep Geologic Repository in Ontario for the long-term management of intermediate and low-level nuclear wastes.[57]

ii. Canadian Nuclear Safety Commission

The Canadian Nuclear Safety Commission (CNSC) is the federal regulator for the Canadian nuclear industry. Its mandate is to "protect the health, safety and security of Canadians as well as the environment, and respect Canada's international commitments on the peaceful use of nuclear energy."[58]

The CNSC regulates all nuclear related activities including nuclear power plants, uranium mines and mills, uranium processing and research facilities and the management of Canada's radioactive waste.[59] It also regulates the packaging and transport of nuclear material.

iii. Atomic Energy of Canada Limited

The federal government, as owner of the Atomic Energy of Canada Limited[60] (AECL) has developed home grown nuclear technology, notably the CANDU reactor[61] which it has sold both domestically and abroad.[62]

The next generation of CANDU rectors, called the ACR-1000 is currently being developed, according to Natural Resources Canada, "it represents an evolution of the best CANDU features and incorporates up-to-date modular design and construction techniques."[63]

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[57] Canadian Nuclear Association, http://www.cna.ca/english/how_works/managing_fuel_wastes.html

[58] Canadian Nuclear Safety Commission, http://www.cnsc-ccsn.gc.ca/eng/about/index.cfm

[59] However, it does not regulate uranium exploration.

[60] The AECL is a federal crown corporation that provides nuclear technology and services to utilities worldwide. It employs over 5,000 employees; the services it provides are R&D support, construction management, design and engineering to specialized technology, waste management and decommissioning in support of CANDU reactor products.

[61] The design of CANDU reactors differ from other nuclear technology around the world because it uses heavy water as a moderator allowing the use of natural uranium dioxide fuel, removing the need for uranium enrichment.

[62] A total of 22 commercial CANDU reactors have been constructed in Canada and CANDU technology has been exported to Argentina, China, Korea and Romania.

[63] Natural Resource Canada http://nrcan.gc.ca/eneene/sources/uranuc/nucnuc/nuctec-eng.php

After significant consolidation in the sector, there are currently only a few large companies that dominate the global nuclear industry. There is some question whether AECL, a relatively small player on the global stage can compete internationally where large companies dominate the market.

The federal government initiated a review[65] of AECL and is working on a restructuring plan for the Crown Corporation to take advantage of a revitalized global nuclear industry. However, the federal government also announced that it is seeking international bidders to sell off all or part of the AECL CANDU Reactor Division subject to attaining parliamentary authority to do so.[66]

Nuclear Production in Canada

Three provinces in Canada have nuclear facilities: New Brunswick, Québec and Ontario. Nuclear energy provides 23% of New Brunswick's electrical power,[64] 2% of Québec's electrical power and makes up nearly 50% of Ontario's electrical power mix. Nuclear energy generates nearly 15% of Canada's electricity.

Many witnesses believed that nuclear energy must be part of Canada's solution to reduce GHG emissions. If Canada commits to a dramatic go-nuclear strategy, what would the role of the federal government be? Could it encourage provincial investment in AECL reactors by sharing some of the investment risk? Bryne Purchase of the School of the Policy Studies at Queen's University observed that:

> "Without a dramatic "go nuclear policy" domestically — as, for example, France has done — the Canadian market cannot absorb a large number of new nuclear plants. My guess is that, at best, it would be four in Ontario and perhaps two in the West — maybe six, unless we do something dramatic with nuclear power."
>
> *Evidence*
> *December 10, 2009*

Mr. Purchase pointed out that without a sufficient domestic market, AECL would require partnership with a larger nuclear company in order to capture the growing nuclear market abroad. He questioned whether such a partnership would support CANDU technology.

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[64] New Brunswick's Point Lepreau facility is currently being refurbished and is offline.

[65] Natural Resources Canada, The NewsRoom, Government of Canada Moves Forward on Restructuring Atomic Energy Canada Limited, http://www.nrcan-rncan.gc.ca/media/newcom/ 2009/200950-1c-eng.php.

[66] It is expected that the federal government will maintain control of AECL's other activities such as R&D, waste management, and the Chalk River Ontario Laboratory which produces medical isotopes.

4.3.5
Renewable Energy

Renewable energy is an energy source that can be replenished or renewed within a human life span.[67] Canada has substantial renewable energy resources due to its vast and diverse geography. They include: hydro, wind, solar, geothermal, bioenergy and wave and tidal.

In 2008, 16.1 percent of Canada's total primary energy supply came from renewable energy.

a) Renewable Electricity

Witnesses believed that tackling climate change requires renewable energy to play a larger role in the energy mix. However, some questioned whether it is realistic to expect emerging renewable energy technologies to significantly displace large scale electric generation such as coal and nuclear power.

On the whole, Canada's electricity production profile is relatively clean; most of it is in the form of hydropower, followed by solid biomass then wind. Solar and tidal make up a very small portion of Canada's electricity capacity.[68]

Renewable Energy Share of Total Electricity Generation : Canada (2008)	
Hydropower	63.1%
Biomass	1.6%
Wind	1.1%
Solar/tidal	n/a[69]

Source: Canadian Industrial Energy End-Use Data and Analysis Centre

i. Hydro

Large quantities of hydroelectricity are produced in British Columbia, Manitoba, Newfoundland and Labrador, Quebec and Ontario. Hydropower is primarily used to meet base load demand because of its relatively low operating costs. Also, energy can

[67] Natural Resources Canada, http://nrcan.gc.ca/eneene/renren/aboaprren-eng.php#what

[68] International Energy Agency, Energy Policies of IEA Countries, Canada 2009 review

[69] Very small generating capacity: solar photovoltaic (26 megawatts) and tidal energy (20 megawatts)

be stored in reservoirs during off-peak demand when wholesale electricity prices are low then released during high peak demand periods when prices are high.[70]

Large scale hydro projects are under consideration in Manitoba, Newfoundland, Quebec and British Columbia and there is also potential for further development in medium to small hydro and run-of-river developments in British Columbia, Ontario and Quebec.[71]

The committee was told that many US utilities have adopted renewable energy portfolio standards requiring increased renewable energy in their energy mix, which could potentially increase opportunities for Canadian renewable electricity exports. Currently, large hydro does not qualify as renewable energy under many US renewable energy portfolio standards. However, in 2010 Vermont passed legislation that recognized large scale hydroelectricity as renewable under its renewable energy portfolio standard.

ii. Biomass

Biomass is the second largest renewable energy source in Canada.[72] The most common form of biomass energy is found in the pulp and paper and forest products industries through a cogeneration production process.

The wood harvested basically serves two purposes: 1) by being a feedstock for pulp and paper production; and 2) when the waste product (black liquor and solid-biomass residues) is recycled as an energy source to generate heat for drying kilns and to produce steam and electricity for running the plant and/or sale to the electricity grid.

The prospect for biomass fired electricity generation has increased as governments consider options for displacing some of the electricity produced from fossil fuels.[73]

iii. Wind

In Canada, wind power is the fastest growing renewable energy source. As of June 2010, Ontario had the most installed capacity at 1,208 MW followed by Quebec 659 MW and Alberta 656 MW. In Prince Edward Island, wind energy accounts for nearly 90 percent of its total electricity generation.[74]

Many provinces have established renewable portfolio standards, issued requests for proposal for renewable energy and introduced other incentives such as feed-in-tariffs

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[70] Natural Resources Canada, Economic Scan of the Energy Sector 2008

[71] *Ibid*

[72] Historically, solid biomass in the form of wood was the principal source of energy for Canadian households. While wood is used much less today, it is still an important source of heat fuel in many households especially in rural regions of the country.

[73] *Ibid*

[74] Canadian Wind Energy Association, http://www.canwea.ca/farms/index_e.php . PEI's installed capacity is 164 MW

which have principally accelerated growth in the wind industry. Wind power has the advantage of relatively short construction lead times.[75] However, its relatively high cost compared to other electricity sources particularly in lower wind density regions imposes a barrier on its deployment.

iv. Other

A number of promising renewable technologies such as solar, geothermal and wave and tidal energy are on the horizon.

Some witnesses suggested that the deployment of large scale solar generation would be limited in Canada. However, its use in distributed energy applications at the point of consumption in residences and commercial buildings holds promise particularly if costs of the technology can be reduced.[76]

Tidal and wave energy is abundant in Canada. The committee was told that the industry is in its nascent stage but could prove to be a valuable and reliable energy source in the future.[77]

Some witnesses felt that enhanced deep geothermal energy (used to heat water to drive turbines) could be a game changing technology. This type of technology would involve high up-front costs but virtually no fuel costs during operation.[78]

Table 4.1
Some issues associated with emerging renewable electric generation

A carbon price	A price on carbon would encourage the development of existing and new renewable energy technologies and would level the playing field by internalizing environmental costs so that renewable energy can compete with lower cost fossil fuels.
Intermittency and Storage	Wind and solar energy only produce energy when the wind is sufficiently strong or when the sun is shining. At times, power output can be highly variable and difficult to predict causing challenges in maintaining stability within the electricity grid. This issue could be mitigated through new energy storage technologies and smart grids.

[75] National Energy Board, Emerging Technologies in Electricity Generation, An Energy Market Assessment March 2006
[76] Natural Resources Canada, Economic Scan of the Energy Sector 2008
[77] The industry is turning to hydrokinetic in-stream technologies as a first step before developing ocean tidal and wave energy. Nova Scotia is inviting developers to demonstrate in-stream tidal devices through a common demonstration facility in the Minas Channel area of the Bay of Fundy.
[78] Ibid

Distance from Markets	Often the best places to harvest renewable energy are in remote locations far from urban centers where much of the energy needs reside. This requires transmission infrastructure to bring electricity to markets.
Rural	Renewable energy can increase energy options in rural communities and expand economic opportunities in rural regions. For example wind may help augment or displace diesel generators that produce electricity in Northern communities and lower cost of energy and create new employment opportunities.

b) Biofuel

Biofuels are produced as a substitute for gasoline and diesel. In the case of gasoline, biofuel takes the form of ethanol and it is usually made from corn and wheat while diesel biofuel is made from vegetable oils and animal fats.

The federal government is requiring that fuel producers and importers have an average annual renewable fuel content of five percent for gasoline commencing in 2010 and two percent renewable fuel content for diesel fuel and heating oil, no later than 2012. [79]

Some provincial governments have announced and/or already mandating renewable fuel standards for both gasoline and diesel.

The federal government has supported the expansion of the biofuel sector in other ways, by providing funding for biofuel production, assisting farmers to seek opportunities in the sector and through technology development.[80]

Cellulosic ethanol, produced from switch grass, agricultural or forest residues is the next generation of biofuel and is in its demonstration phase. These new forms of biofuels address misgivings sometimes raised over using food grains to produce liquid fuels.

[79] Natural Resources Canada, Energy Scan of the Energy Sector 2008. The federal government recently released in the Canada Gazette Vol. 144, No. 15 — April 10, 2010, regulations requiring 5 percent renewable content in gasoline by September 1st 2010.

[80] International Energy Agency, Energy Policies of IEA Countries, Canada 2009 review

4.4 Sustainable End-Use

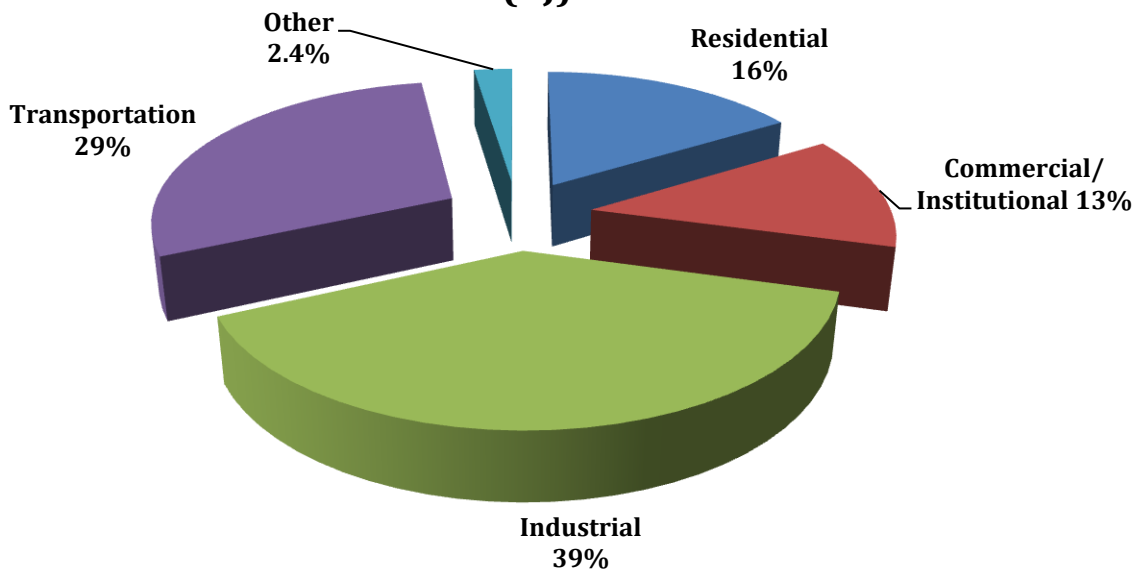
"Future generations will look back on our generation and say,
that was an incredibly precious resource that we did not use effectively.'"

David Layzell
Institute for Sustainable Energy, Environment and Economy,
University of Calgary
Evidence December 1, 2009

4.4.1
Energy End-Use

Energy consumption usually grows in tandem with economic and population growth and can fluctuate depending on energy prices. The industrial sector is the largest consumer of energy followed by transportation, residential, commercial/institutional and agriculture.

Graph 4.1
Canada: Energy End-Use by Sector
2007 (PJ)



Source: Natural Resources Canada

a) Industrial

The industrial sector includes all manufacturing industries, all mining activities, forestry and construction.[81] It is the largest user of energy –and energy consumption grew 28 percent from 1990 to 2007. Mining and pulp and paper industries account for nearly

[81] Natural Resources Canada, Office of Energy Efficiency, Energy Use, Industrial energy use and trends, http://www.oee.nrcan.gc.ca/corporate/statistics/neud/dpa/tableshandbook2/aaa_ca_2_e_4.cfm?attr=0

half of all the energy consumed in this sector.[82] Mining includes oil and gas extraction which is driven by the shift from conventional oil extraction to oil sands operations where energy consumption rose significantly.[83]

b) Transportation

This sector includes road, air, rail and marine transportation. It is the second highest user of energy (mostly refined petroleum products) consisting mostly of passenger vehicles and freight transportation –the latter having the fastest growth. There was a 19 percent growth in energy use from 1990 to 2007 in the passenger subsector, mostly driven by population growth and consumer preference for large passenger vehicles (mini vans and SUVs). [84]

c) Residential

Household use of energy includes space heating, water heating, appliances, space cooling and lighting. Space heating consumes the most energy followed by appliances (both large and small) and water heating. Population growth and the trend towards fewer people per home increased the number of households and energy demand; as well, the average floor space per household for new homes increased by 19 percent from 1990 to 2005. Major appliances increased their energy efficiency considerably; however, these gains were offset by the rise in penetration of small electronic appliances. [85]

d) Commercial/Institutional

This sector includes offices, retail stores, restaurants and educational institutions. Energy is used for heating, operating auxiliary equipment (includes computers), lighting, water heating, auxiliary motors and space cooling. Space heating consumes the most energy followed by auxiliary equipment. [86]

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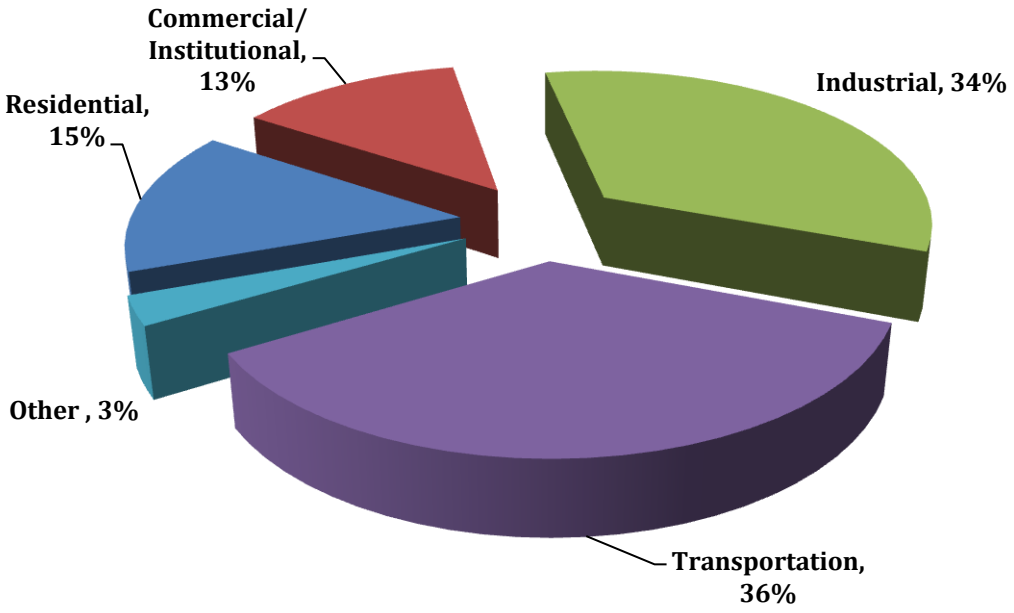
[82] The pulp and paper sector have significantly utilized cogeneration using biomass as an energy source in recent years.
[83] *Ibid*
[84] Natural Resources Canada, Energy Efficiency, Energy-Use, Transportation Sector http://nrcan.gc.ca/eneene/effeff/transintro-eng.php
[85] Natural Resources Canada, Energy Efficiency, Energy-Use, Residential Sector http://nrcan.gc.ca/eneene/effeff/resintro-eng.php
[86] Natural Resources Canada, Energy Efficiency, Energy-Use, Commercial/Institutional Sector http://nrcan.gc.ca/eneene/effeff/comintro-eng.php

4.4.2
Greenhouse gas emissions by End-Use Sectors

Graph 4.2
Canada Energy End-Use: Share of GHG by Sector 2007



Source: Natural Resources Canada

The transportation sector -through mostly passenger and freight vehicles- is the largest emitter of GHGs in Canada. The industrial sector accounts for roughly a third of all GHGs; within this sector, fossil fuel production is a significant contributor to GHGs.[87]

4.4.3
Energy Efficiency: the Low Hanging Fruit

The most cost effective way to reduce GHGs and pollution is to reduce the consumption of energy. This is why it is considered low hanging fruit; in fact, these fruits may actually be lying on the ground in Canada.

[87] Natural Resources Canada, Environmental Scan of Canada's Energy Sector 2008

By improving the way we use energy, it is possible to continue to enjoy energy services and save money at the same time. In so doing it eases the environmental burden including reducing emissions that contribute to climate change; it also reduces waste, increases energy security and extends the life of existing energy supplies for future generations.

Wasted Energy

Did you know that a significant amount of energy produced in Canada is lost when it is converted or used? Some of it is also lost during transmission. If we find ways to consume less, less energy will be wasted.

Improving energy efficiency makes the economy stronger and more productive because it is making more with less so that Canadians are able to spend or invest energy savings on other activities. As the Honourable Perrin Beatty, President and Chief Executive Officer of the Canadian Chamber of Commerce described:

> "If we can improve the efficiency of our use of hydrocarbons, we can significantly cut our costs of production and our cost of supplying goods and services in this country, and it gives us a competitive advantage in the process."

Evidence May 4, 2010

What are some of the barriers preventing energy efficiency investment?

- Lack of appropriate energy price signals
- Lack of information on the long term financial benefits
- Lack of choice or access to energy saving technologies
- Lack of ability to finance energy efficiency investments
- Risk associated with upfront investments even if they benefit over time
- Existing capital stock (older equipment, buildings, etc); while less energy efficient, the assets are still productive

The provinces and territories have the ability to set institutional frameworks for demand-side energy management through public utility boards.

The federal, provincial and territorial governments have programs that improve energy efficiency through: 1) energy efficiency regulations and product standards; 2) incentives and rebates such as retrofit programs; 3) energy literacy programs; 4) R&D funding for energy efficiency technologies.

4.4.4
Systems Approach to Energy Efficiency

We do not buy energy commodities. We buy energy services.

Bob Oliver, Executive Director of Pollution Probe emphasized the notion that energy is rarely consumed for its own sake but instead is consumed for energy services such as cooking breakfast, watching television, driving to the grocery store, playing computer games or running a pulp and paper mill.

By looking at the energy system from the end user perspective, new ways of organizing energy pathways can be considered so that the right type of energy is used in the right way to provide the services we enjoy. For example, natural gas may be more efficiently used to heat a home if it is burned directly in a user's furnace rather than having a gas fired plant convert the natural gas into electricity to fuel an electric heater.

Mr. Oliver told the committee that utility regulators should be more flexible in interpreting their mandates in terms of prices and energy service delivery models.

> "We have to find a way to restructure the role of the regulator to break down the silos between electricity for lighting, natural gas for heat, oil for transportation and never the three will mix. Mixing is exactly the way we will realize the system-wide efficiency improvements that will deliver a sustainable energy system."
>
> *Evidence April 29, 2010*

Designing better and more integrated ways to deliver and consume energy at the community level has attracted a great deal of interest. An integrated system approach considers all aspects of design from land-use, energy sources, transport, water and waste management to achieve efficiency for the whole system. One example is through district heating systems where the waste heat from a factory is captured to heat nearby homes.[88]

4.4.5
Energy Affordability

One of the most effective ways to reduce energy consumption is to increase the price of energy.

[88] Quality Urban Energy Systems of Tomorrow (QUEST) Integrated Energy Systems in Canadian Communities a Consensus for Urgent Action, 2008

Many witnesses pointed out that sustainability requires consumers to pay a price that is reflective of the full cost of providing the energy services. In many instances this does not occur in Canada.

While it may be possible to explain why we need to increase energy prices and to adopt measures such as carbon pricing, the fact remains that overall, even without these measures, energy prices are trending upward and many low income families have little money to spare to absorb the added expenses.

Also, many of these families have fewer options to retrofit their homes, to buy energy efficient appliances or to shop for the latest fuel efficient hybrid vehicles.[89]

Therefore, it may be necessary to provide assistance to low income households, if governments adopt policies that increase energy prices. However, many policymakers believe it is best that the assistance be designed not as a direct energy price subsidy but rather as a transfer of income in order to encourage energy conservation.

4.5 Electricity

> "If we want to deal with greenhouse gas emissions, we need to deal with the electricity sector."
>
> *Pierre-Olivier Pineau,*
> *Associate Professor*
> *Department of Management Sciences, HEC Montreal*
> *Evidence April 20, 2010*

4.5.1 Electricity Systems

In Canada, provinces have regulatory oversight over their electrical systems. Canadian electrical systems are part of an integrated North American electrical grid and while energy is traded on a wholesale basis between provinces, the highest volume of trade occurs North-South with the United States.

The electricity industry within each province is highly integrated where often the generation, transmission and distribution services are provided by a few dominant utilities; some are privately owned but most are Crown owned.[90]

The wholesale price of electricity varies based on supply and demand in electricity markets. Typically, the price of electricity is lower at night due to lower demand.

[89] In fact they have the most to gain because their energy consumption as a percentage of total income is higher than other households, which justifies government support of targeted energy efficiency programs such as home retrofit programs for low income households.
[90] International Energy Agency, Energy Policies of IEA Countries, Canada 2009 review

An important characteristic of electricity is that once it is generated it must be consumed. Doing otherwise may compromise the integrity of the electricity grid. Since many electricity-generating facilities such as coal-fired or nuclear plants cannot be easily shut down, surplus electricity sometimes has to be exported at a reduced rate.

Regions that have hydroelectric storage capacity export electricity exports during peak demand periods and then import to store (by adjusting water levels) during off peak times. However, every jurisdiction could benefit from electricity trades because consumption patterns vary between regions.

4.5.2
Electricity Developments

Canada's electricity infrastructure is aging and is in need of investment. The IEA estimates that Canada's electricity sector will require $190 billion U.S. in new investments between 2005 and 2030.[91]

In the past, the electricity sector has operated under a stable and regulated monopoly structure where new technologies only emerged every 40-50 years. But a change is coming. Some observers predict that climate change policies will affect the electricity sector much more than the petroleum industry.

Table 4.2
Examples of Developments in the Electricity Industry:

Smart Grid Technology	Smart grid typically refers to energy distribution whereby electricity is delivered using two-way digital technology. It increases the interface between the energy supplier and energy user to improve the efficiency, management and reliability of electric systems.
Electrification of transportation	The conversion from petroleum to electricity of current and future vehicle fleets. The development of energy storage technologies is a key issue.

[91] An IEA estimate sited in Natural Resources Canada, Economic Scan of the Energy Sector, 2008

4.5.3
Strengthening Interconnections

> "The Rocky Mountains, in terms of electricity, are not where they are, geographically. They are between Ontario and Manitoba."
>
> *Richard J. Marceau*
> *Canadian Academy of Engineering*
> *Evidence May 6, 2010*

The committee heard witnesses from the Canadian Academy of Engineering which recently released a report on electricity connections in Canada.[92] The Academy recognized that in many cases economic conditions favored North-South connections over trade between provinces, but it urged Canadian governments to strengthen electrical grid interconnections between provinces. Richard Marceau of the Canadian Academy of Engineering recommended the federal government help:

> "fund new electrical grid interconnections between two or more provinces on a cost-shared basis with provinces and possibly the private sector."
>
> *Evidence May 6, 2010*

Transmission and Interprovincial Tensions

Newfoundland and Labrador wants to build a large hydroelectric project on the Churchill River in Labrador and export the power to Ontario, New Brunswick and the Eastern United States. However, the province is currently in a dispute with Quebec over transmission access and the estimated cost of the necessary upgrades to Quebec's transmission infrastructure.

Dr. Marceau told the committee that the current electrical system was designed to be optimized provincially and not nationally. He stated that if more interconnections were made between provinces, all regions could benefit from more effective generation planning, cost optimization, reliability, energy security and reduced carbon footprints.

4.5.4
Integrating Markets

Electricity is not traded between regions at the retail level. Retail prices are regulated by provincial utility boards and are generally determined on a cost basis varying by province according to the volume and type of available generation.[93]

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[92] Canadian Academy of Engineering, Electricity: Interconnecting Canada A strategic Advantage, Report of the Canada Power Grid Task Force 2010

[93] In Alberta, retail competition is occurring for large commercial and industrial users and is transitioning to competitive residential level electricity rates are still overseen by a provincial utility regulator.

The retail price of electricity can vary significantly from province to province. Generally, provinces with large hydroelectric capacity have lower electricity rates.

Pierre-Olivier Pineau of HEC told the committee that all provinces could benefit from market integration so that a household in one province could buy electricity from another province. The result could lead to more electricity trade and more efficient options to reduce emissions. As Mr. Pineau explains:

> "Ontario is investing billions of dollars in renewable projects, but we could achieve the same goal by sending more hydro power from Quebec to Ontario. That would avoid the need to invest billions of dollars in Ontario. It would lower the price of electricity in Ontario. Quebecers would make more money in terms of selling electricity at a higher price to Ontarians. Of course, they would have to pay a higher price in Quebec in order to make some of the energy efficiency adjustments that would allow them to make energy savings and allow them to export more electricity."

Evidence April 20, 2010

However, each region's electricity system has largely evolved in isolation.[94] Long term investments were made based on the existing rates; electricity market integration between regions would alter these rates and may result in cases of stranded capital. A mechanism would have to be put in place to recognize the effect that a changing price structure can have on long term infrastructure investments.

4.6 Energy Security

Canada is one of a handful of oil exporting countries in the world. However, Canada (particularly in Eastern Canadian provinces) continues to import a significant amount of oil and natural gas[95].

4.6.1 Market access

Canada is among the world's largest energy exporters but it sells almost exclusively to a single customer: the United States. Both nations share an integrated energy market extensively connected through roads, ports, pipelines and hydro wires. Canada has profited from having open access to a huge and important energy consumer and the US has also benefited from having a stable, reliable, and secure supply of energy at its doorstep.

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[94] There are good reasons for this such as the long distances between provinces.

[95] Through the Irving's Canaport liquefied natural gas (LNG) receiving terminal in New Brunswick.

However many witnesses expressed concern that Canada's energy sector, particularly the oil sands, are vulnerable to changes in US energy policy and those of its individual states.

Who lights up Broadway? Well, we do! [96]

In order to mitigate risk, witnesses stressed that it was important that Canada diversify its energy markets and in so doing, benefit from the explosive growth in energy demand in Asian markets. One way to do this is to build pipelines that link the West Coast to the Alberta oil sands.

In the fall of 2009, the committee travelled to Washington D.C. and found that many US Congress members understood the important role the oil sands play in maintaining North American energy security, but some misconceptions remain. It was felt that the oil sands require stronger advocacy to explain:

- the direct economic benefits to the US;
- the full extent of the policy development and clean technologies being deployed to mitigate the oil sands' environmental footprint;
- the true life cycle assessment of GHG emissions;
- oil sands' contribution to North American economic and energy security.

4.6.2 Oil Price Shocks

The world changed in 1973 when OPEC was created and quadrupled the price of oil. The world was reminded of this change, six year later, when oil prices spiked again after the Iranian Revolution. Few may remember the fuel shortages, the rationing and the long lines at gas stations. Governments around the world scrambled to respond by developing strident energy policies to ensure security of oil supply.

In Canada, this period marked the birth of the National Energy Program (NEP) [97] (1980-1985), the much maligned federal energy initiative that remains for many a defining failed policy experiment of federal intervention in the energy sector.

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[96] TransCanada's Ravenswood generating station in Queens New York has a capacity of 2480 MW. It is fed by natural gas from the Iroquois pipeline from TransCanada's mainline which is fed by natural gas from Western Canada. This accounts for around 25% of New York City's normal load.

[97] The NEP was introduced after a series of global oil price shocks primarily to achieve national energy self–sufficiency and affordability. The NEP marked a period of federal energy regulatory control combined with federal state building efforts at the expense of the provinces. In summary, the NEP introduced energy price controls,

But could major price shocks happen again?[98] Some witnesses were concerned that another war in the Persian Gulf, major disruptions along key supply chains or additional events such as the massive oil spill caused by the explosion of the Deepwater Horizon (an offshore oil rig) in the Gulf of Mexico in the could lead to serious energy security consequences. Indeed, roughly 38 percent of the world's global crude oil production is offshore.

To mitigate these risks, Dr. Bryne Purchase of the School of the Policy Studies at Queen's University suggested that the federal government look into significantly developing cellulosic liquid biofuels production across Canada, which would have the added benefit of reducing GHG emissions. Cellulosic biofuel is essentially ethanol produced from switch grass, agricultural or forest residues.

4.6.3
Energy Reliability/Resiliency

Many Canadians take energy services for granted. We have come to expect energy to be there quite literally at the flick of a switch whenever we want it. All types of energy distribution systems, whether they are electricity, natural gas or transportation fuels, have methods to ensure that we rarely have to worry about energy services not being there when we need them.

Besides maintenance and upgrades, redundancies and other procedures are built into the system to help continue energy supply in the wake of a disruption.

Peter Boag, President of the Canadian Petroleum Products Institute explained that the lack of provincial harmonization of renewable fuel standards could increase the cost of maintaining resiliency in the system because the product is not easily transferable across jurisdictions. As Mr. Boag explains:

> "If a refinery goes down, one that is a major source of supply within one jurisdiction and produces a product made distinctly for that jurisdiction to a certain standard, whether a renewable fuel standard or a fuel quality standard with respect to certain constituents of the fuel, the resiliency of the system is affected by preventing it from responding to a shortage in one jurisdiction by being able to ship supply from another jurisdiction. The product no longer becomes fungible across borders."
>
> *Evidence March 18, 2010*

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differentiated domestic and export energy prices, increased Canadian ownership in the oil and gas industry, imposed export restrictions and special taxes and provided incentives for oil exploration on federal lands.

[98] NAFTA prevents Canada from implementing policies such as the NEP that interfere with the normal functioning of energy markets in North America.

4.6.4
Climatic Effects on the Energy System

Climate change has the potential to create significant changes in weather patterns that may directly affect the ability to maintain energy supply. An increase in average temperatures and/or a change in precipitation patterns may reduce reservoir levels in provinces that rely on hydroelectricity, thereby increasing costs and curtailing exports.

Changing weather patterns may increase the unpredictability associated with some renewable energy sources such as wind and solar. This could lead to extra costs and challenges in maintaining the integrity of electrical systems.

4.7 Technology and the Economy

"The energy sector is a cornerstone of our prosperity."

The Honourable Perrin Beatty, P.C., President and Chief Executive Officer
The Canadian Chamber of Commerce
Evidence May 4, 2010

Energy underlies nearly every aspect of the economy. In 2008, it represented seven percent of the Canadian GDP employing over 363,000 direct jobs. This sector is growing. Employment growth in the energy sector outstripped most other industries in 2005 and the energy sector represented one fifth of all capital and repair expenditures in the economy.[99]

The energy sector is a major source of revenue for the government. In 2005, royalties, income taxes and land sales in Canada totaled $46.5 billion.[100] Furthermore, growth in one region of the country has positive effects throughout Canada by stimulating construction, transportation, equipment and manufacturing sectors and other support industries.

4.7.1
Clean Technology, Value Added and Spin-offs

"Energy development is our space program."[101]

It is not enough to simply adopt technologies to meet today's energy and environmental challenges. Canada must be a source of innovation, so that value-added and clean energy jobs are created at home, while Canadian know-how is exported abroad.

[99] Natural Resources Canada, Economic Scan of the Energy Sector 2008
[100] *Ibid*
[101] The Canadian Chamber of Commerce, Power up Canadian Prosperity, October 2009

Many other countries are racing to develop and commercialize new generations of energy technologies such as renewable energy, hydrogen fuel cells, energy storage, smart grids and a whole range of products, services and methods that increase energy efficiency and reduce the environment impact throughout the energy value chain. They are not only doing it because it is the right thing to do, but because they want to sell the technology into a growing global market.

Often witnesses pointed to China as a country that on the one hand is a source of alarming growth in pollution and emissions while on the other hand it is leading the clean energy sector on many fronts. Witnesses told the committee that the emerging scale of cutting-edge, green energy technologies in China was truly remarkable.

Today's new energy economy is being compared to the space race of the 1960s which generated significant spin-off technologies that spawned new industry clusters.[102]

David Keith, Canada Research Chair in Energy and the Environment at the University of Calgary, argued that Canada's comparably small population makes it necessary for the country to target its R&D funding to a few specific areas otherwise it could not realistically compete, especially in developing game-changing technologies needed to address climate change.

In essence, a country can reap benefits if it connects its industrial and environmental strategies. Mr. Keith observed,

> "Canada is installing a lot of wind power, so you might say there is a wind industry in Canada. However, it is not a wind industry that will produce the kind of returns that employ people in the way that we are employed here because it is a service industry. The core industry of building wind turbines is a big industry with enormous intellectual property and huge value added, but none of the companies is in Canada."
>
> *Evidence April 20, 2010*

Vicky Sharpe, President and CEO, Sustainable Development Technology Canada (SDTC) pointed out that Canada's competitive advantage may not reside in building wind turbines but instead in producing technology such as sensors that increase their reliability and efficiency.

John Muir, Chair of the Energy Council of Canada, believed that one of Canada's competitive advantages may lie with producing technology for offshore oil production in harsh environments, especially in Arctic environments. Mr. Muir's testimony occurred prior to the April 20 massive oil spill in the Gulf of Mexico. (*It should be noted that the committee undertook a series of emergency hearings on Canadian offshore oil and gas*

[102] *Ibid*

exploration and drilling immediately following the Deepwater Horizon explosion. The committee's findings and comments will be released in a separate report.)

Governments play a vital role in funding pure research so that Canada's leading scientists can explore game-changing ideas. However, once ideas become potentially deployable technologies, governments must prioritize in areas with the potential to reap the most economic, environmental and social benefits to Canada.

4.7.2 Labour Issues

> "People often forget that this improvement requires a lot of human capacity."
>
> *Michael Cleland, President and CEO*
> *Canadian Gas Association*
> *Evidence March 18, 2010*

Canada is undergoing a sizable demographic transition; baby boomers are exiting the workforce, leaving behind fewer people to produce the nation's goods and services. This is occurring at a time of sustained growth in the energy industry coupled with a growing requirement to develop technologies to address GHGs; all the while fewer Canadian youth are enrolling in engineering schools.

The rapid expansion of the oil and gas sector, particularly in the oil sands, is often beset by worker shortages, raising production costs and in some cases delaying projects.

The energy sector must adapt and plan for the succession of a large portion of their workforce particularly as it moves to respond to the next generation of energy technologies. It is critical that society's top people be attracted to this sector if we which to find solutions to our energy challenges.

Similarly, the public sector will be struggling to maintain and attract skilled workers to keep up with the regulatory requirements of a new and changing energy world. As Mr. Cleland explains:

> "In the face of government cutbacks across Canada, both in the federal government and at the provincial level, much of that capacity will be at risk. This situation is something we need to think about. The resources do not just jump out of the ground. The regulatory processes do not just appear."
>
> *Evidence March 18, 2010*

In short, it is human capacity and capability that is at the heart of innovation in all areas and without it we risk our future prosperity.

4.7.3
Impact of High Oil Prices on the Economy

Most observers believe that oil prices will trend upward over the long term which will encourage further investment in oil exploration and production but also increase conservation and the development of alternative energy sources and technologies.

Because oil is so pervasive in the economy, increasing oil prices directly affect the bottom line of nearly all businesses. Airlines or automakers are typically the first and most affected by rising oil prices.

Some have suggested that the recent oil price increases (up to 2008) were the origins of the current global recession.[103]

4.8 Energy and Society

4.8.1
Social Licence to Build and Operate

> "At the end of the day, it is a local issue."
>
> *Tim Weis,*
> *Director, The Pembina Institute*
> *Evidence April 29, 2010*

New production, transmission and distribution projects -whether large wind turbines, a natural gas plant or a pipeline- are often subject to local opposition. This opposition is typically summed up in a single phrase: Not-In-My-Backyard (NIMBY).

Many witnesses felt it essential that Canadians find better ways of discussing and resolving conflicts that arise when energy projects are proposed, especially given the nature of the future challenges facing our energy systems. Mr. Cleland explained :

> "We are digging ourselves deeper and deeper into a hole in Canada as long as we fail to come to grips with that issue. More and more, everywhere we turn, whether it is power lines, pipelines or new energy production projects, local communities are saying no. It is becoming harder and harder to operate. We need a different kind of dialogue if we are to move past that issue."
>
> *Evidence March 18, 2010*

A balance must be struck between private costs and the public good. While it is important to create an environment that attracts private investment and risk, and to ensure that Canadians are secure in their energy needs, it must be emphasized that

[103] The Globe and Mail, Oil prices arn't the effect of the recession; they're the cause, Jeff Rubin, May 31 2009.

local residents often bear a disproportionate share of the costs, including a possible reduction in income, property value or land use. Also, there may be real or perceived health and safety risks associated with living near energy facilities.

There is no easy way around this issue because energy projects must be built.

However, Mr. Cleland told the committee that the blaming language behind NIMBY does not help resolve the issue or address the concerns of local residents. Mr. Cleland observed that "the simple fact is that for local communities, there are local costs that are not necessarily accounted for...".

4.8.2 Regulatory Frameworks

Large energy projects are often subject to long delays. In most cases the blame is pointed squarely at the regulatory process. As the Canadian Chamber of Commerce summed up:

> Regulatory complexity and delays in a multi-jurisdictional regulatory environment create unpredictable and unacceptable long lead times for capital investments in energy projects.[104]

The energy sector is subject to a wide scope of government regulations and assessments that include ensuring health and safety of employees, the public and the environment. This is because energy projects often involve heavy machinery, are sometimes undertaken in remote and harsh locations and their construction and operation may change or affect the surrounding environment.

In many ways environmental assessments and health and safety requirements are vital in easing tensions and in building a social license with Canadians including affected communities.

However, many witnesses felt that the current regulatory process was broken and not prepared to handle the new generation of challenges affecting the energy sector.

Offshore Oil and Gas

The recent rupture of a well and the resulting oil spill in the Gulf of Mexico has greatly intensified the focus on health, safety and environmental risks associated with offshore oil and gas extraction. Currently, Canadian offshore oil and gas activity is occurring near Newfoundland and Nova Scotia.

In the wake of the incident in the Gulf of Mexico, some observers have raised concerns about regulatory safeguards and emergency response preparedness of Canada's current and future offshore oil and gas production facilities. (*Please note the committee will be releasing a report on the current status of operations of Canadian offshore oil and gas exploration and drilling.)*

[104] The Canadian Chamber of Commerce, Power up Canadian Prosperity, October 2009

Part of the problem is that the policy jurisdiction over environmental assessments is shared between provincial and federal governments. Many witnesses felt that this resulted in unnecessary duplication of assessments adding to project cost, creating uncertainties and causing long delays.

Some witnesses welcomed the recent federal initiatives to streamline the regulatory process such as the creation of a Major Projects Management Office (MPMO), an exception list for routine public infrastructure projects and the increased authority given to the Canadian Environment Assessment Agency to streamline its decision making process and the transfer of responsibility for environment assessments to the National Energy Board and the Canadian Nuclear Safety Commission for projects falling under their respective areas of expertise.

However, the recent explosion of the Deepwater Horizon, an offshore oil rig operating in the Gulf of Mexico which left 11 workers dead and is releasing crude oil uncontrollably has brought renewed attention to regulatory/inspection safeguards and emergency response preparedness of Canada's current and future offshore oil and gas facilities.

The goal should be to provide smarter regulation that can process energy project proposals in a timely fashion without compromising *any* aspect of the environment or health and safety of employees or the public.

4.9 Energy Literacy

Energy makes our society go. It is in everything we do. It lights our homes, warms our living rooms, starts our cars, makes our factories run. Energy is fundamental to our way of life but few of us are aware of what goes on behind a light switch.

Despite Canada's vast geography most Canadians (over 80 percent of the population) live in urban areas, causing us to think more about how energy is used rather than how it is sourced.[105] Many of us do not think about what must take place to ensure that energy is affordable and reliably delivered to our homes and our communities.

Witnesses have stated that Canadians' understanding of their energy systems varies by region and by stakeholder and often the information is incomplete. Mr. Oliver of Pollution Probe proposed that this disparity reduces the ability of governments to develop energy policy:

> "The absence of a common reference — an accepted baseline of information — developed for the Canadian public, or a common vocabulary that everyone uses to discuss energy systems in Canada, prevents decision makers in government

[105] Energy Framework Initiative: A Proposal for an Integrated Energy Policy Framework for Canada, December 2009

and industry, as well as engaged citizens, from working together to build effective energy strategies and policies that will help us meet our social, economic and environmental goals."

Evidence April 29, 2010

National agencies that produce and distribute energy information such as Statistics Canada, Natural Resources Canada and the National Energy Board must find ways to communicate energy information and analysis in ways that are accessible to a broad audience.

The Centre for Energy[tm], an initiative spearheaded by the Canadian energy sector is increasing energy literacy and awareness and doing so in a manner that is credible, up-to-date and widely accessible.[106]

The federal government could explore the success of Health Canada's mass media campaign to cut tobacco use as a model for communicating energy and related environmental information to Canadians.

Chapter 5
Developing an Energy Policy Framework

Energy is everyone's business. All of us profit from its benefits. Without energy, we'd shiver the whole winter through in our homes. We'd spend hours, not minutes, getting to work. And work would be manual labour rather than participation in sophisticated technological and knowledge industries that help support our generous standard of living.

Meeting today's challenges and exploiting tomorrow's opportunities is therefore everyone's business as well. Without doubt, the challenges are significant. The climate change debates of the past decade, for instance, have certainly helped focus our attention on a wide range of energy issues. The debates have also helped catalyze innovative responses.

In the spring of 2010, nine committee members attended the Globe 2010 conference in Vancouver, one of the world's largest and longest events dedicated to finding business solutions to environmental challenges. Energy and sustainability experts from across Canada and around the world participated in its intensive sessions. Time and again we heard how business, not-for-profit and governmental organizations are adopting new

[106] CentreforEnergy [tm] http://www.centreforenergy.com/AboutEnergy/

energy policies and practices that actually increase productivity and improve an enterprise's "bottom line" results.

5.1 What are Canadians saying?

After three days of discussion and exchange of ideas at Globe 2010, the conference concluded with a final plenary. Every seat was filled in a room nearly the size of a hockey arena. Microphones set up around the room prompted dozens of participants to line up to ask questions and share their personal experiences in meeting various challenges. One such participant concluded her exchange with panelists by spontaneously declaring "What we really need is a Canadian energy strategy!" The whole room erupted in enthusiastic applause.

Witnesses during our committee hearings and policy papers reviewed in our literature review frequently expressed a similar opinion. For example,

> "We have muddled through in Canada without a framework for decades. Why now? Simply put, it is our view that at no time has there been such a confluence of issues, pressures and opportunities regarding energy, or public discussion of such diversity and intensity. These factors have created a new urgency for this kind of dialogue and debate for the development of an overall strategy."
>
> *Peter Boag, President, Canadian Petroleum Products Institute, Energy Framework Initiative*
> *March 18, 2010*

> "Energy is one of the cornerstones of civilization and is central to Canada's economic and social well-being, but we lack a compelling national energy vision."[107]
>
> *Canadian Academy of Engineering*

> "What we lack are the strategies to leverage [our] assets to our best advantage. … We need to get our policies right if we are going to situate ourselves in the sweet spot at the centre of global networks."[108]
>
> *Canadian International Council*

[107] Canadian Academy of Engineering, Energy Pathways Task Force Phase 1 – Final Report 2007

[108] Open Canada: A Global Positioning Strategy for a Networked Age 2010

"Engagement internationally needs to be reinforced by harmonized action nationally. Canada's national environmental and economic interests jointly demand such an approach."[109]

National Round Table on the Environment and the Economy

"What is Canada's plan? What are its goals for energy? The challenges and opportunities that we face today are too great for us not to have a clear answer to those questions. We need a plan."

The Honourable Perrin Beatty, P.C., President and Chief Executive Officer, The Canadian Chamber of Commerce
May 4, 2010

"At the end of the day, we all want to have a good framework for energy policy in this country."

Murray Stewart, President, Energy Council of Canada
March 16, 2010

5.2 Pathway towards a Canadian Energy Strategy

The committee believes that the time has come for a national conversation about energy that gives voice to a consensus view going forward. Canada does indeed need a Canadian energy strategy.

The pathway towards a Canadian energy strategy is not an easy one, however. Not only are the issues varied and various, so too are the authorities. While the federal government can have significant influence [110] over energy policy in Canada, for example, provinces (and to some extent territories) have full responsibility for energy choices within their own borders. Long term energy and climate change strategies abound at the regional level. Common themes emerge (enhancing or maintaining economic prosperity, developing export markets, reducing GHG emissions, promoting conservation etc.), but no two strategies are the same. Each region has different ways

[109] National Round Table on the Environment and the Economy, Achieving 2050: A Carbon Pricing Policy for Canada 2009

[110] The federal government has responsibility for international trade agreements and other treaties such as the United Nations Framework Convention on Climate Change (UNFCCC). Through its taxation and interprovincial commerce powers, it also shares responsibilities with the provinces for economic development, research and technological development. Energy security, environmental regulations and energy efficiency standards are other areas in which the federal government can have a huge impact on the country's energy systems.

[111] and even different tools [112] for achieving their energy and climate change goals, reflective in part of the different energy and economic circumstances in each region.

Then again, many municipalities are taking control over their own energy policies and practices, as are some Aboriginal governments. Many corporations, private entities and individuals are also moving ahead rapidly with programs and innovations that not only meet their own needs but also contribute to what might ultimately be called a national strategy if only we could find a way to harness everyone's best efforts.

A broadly based Canadian energy strategy would help foster prosperity in all regions. Canadians lack neither the ingenuity nor the inclination to address our energy challenges and opportunities. What we have failed to do so far is forge a sense of common purpose, and recognition that diversity is one of our greatest strengths. Just as there's no single answer to the multiple choices we face, there's no single perspective that will solve the whole puzzle. We all need to get involved.

5.3 Moving forward

In this light, the Senate can play a key role in acting as a catalyst to bring Canadians together in a series of conversations about our energy future. Over the course of the next year, the committee will be asking Canadians in all regions of the country to join the energy dialogue.

From all that the committee has heard and read to date, four overarching questions have emerged to help guide this process. The first question is this: ***What does Canada need energy for and how much do we need?***

We all tend to take energy for granted. Blessed with abundant resources and extensively developed energy systems, we rarely stop to think about what we need energy for or, even more fundamentally, how much energy we require to maintain our quality of life. Getting a firm handle on what we as Canadians collectively desire in this respect would go a long way towards forging a sense of common purpose on the domestic front. It would also provide a common framework within which to explore a

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[111] The provinces and territories are not waiting for the federal government to act. British Columbia and Quebec, for example, have introduced carbon taxes and several are exploring regional cap and trade agreements such as the Western Climate Initiative (WCI), a collaboration of states and provinces working together to identify, evaluate and implement policies to tackle climate change. Participating regions include Arizona, California, New Mexico, Oregon and Washington, Montana, Utah and British Columbia, Manitoba, Ontario and Quebec, Alberta, on the other hand, has implemented mandatory emission intensity targets that include a $15 per tonne penalty for large emitters who fail to meet their emission targets.

[112] Some provinces have introduced incentives such as feed-in tariffs to promote renewable electricity generation while others have invested in carbon capture and storage demonstration projects. British Columbia and Alberta have also initiated funds, the Pacific Carbon Trust and the Climate Change and Emissions Management Fund, respectively, which are dedicated to developing transformative technologies and improving adaptation capabilities.

number of pressing issues such as energy reliability and affordability, consumption patterns, delivery mechanisms and sources and locations of supply from both economic and environmental perspectives and across all regions of the country.

The second overarching question is: ***What does Canada want to achieve in international energy markets?***

Canada has an enviable position as a supplier of energy commodities and electricity to the United States, the world's largest energy market, but various avenues of diversification present themselves. We need to ask ourselves what priority should be given to maintaining secure access to existing markets, securing new markets and developing value-added products and expertise in addition to the sale of primary and secondary energy supplies. Once Canadians have forged a sense of common purpose around what we want to achieve in international energy markets, we can begin to explore how best to support one another in meeting our collective goals. We can also address, in a constructive manner, whatever building blocks are necessary to reach our desired goals across all regions of the country as well as pressing issues such as Canada's clean energy profile.

The third overarching question can be asked this way: ***How best can Canadians engage, at home and abroad, on energy issues?***

Our energy future needs to be a topic of conversation at our kitchen tables and in coffee shops, as well as at boardroom tables and in cabinet rooms and council chambers. How do we facilitate these conversations? What data do we have and /or need to support informed decision-making now and over the decades to come? What tools do both decision-makers and individuals need to participate in implementing a Canadian energy strategy? Internationally, what is Canada's appropriate role in the world with respect to global debates on energy security, open markets for trade and investment and stewardship of the global environment?

Finally, ***what conclusions and recommendations can be drawn from the above?***

- What do we mean by a strategy, i.e., what are its key elements?
- What specific goals should we adopt as the core of a Canadian energy strategy?
- What are the foundational principles that should underpin a Canadian energy strategy?
- What are the key elements of an action plan to put the Canadian energy strategy into play?
- Who are the main players needed to put the Canadian energy strategy into play?
- What can the federal government do to facilitate realization of the strategy?

Chapter 6
Conclusion

A Canadian clean energy strategy is about the future.

It is about working together for the prosperity of all Canadians. It is also about taking responsibility to address climate change and not kicking it to future generations.

Some have suggested that climate change is among the greatest challenges the world has ever known. The committee believes that through human determination, innovation and clear direction we can find a long lasting solution.

Canada has abundant resources; we need to be strategic in how we sustainably extract, develop, process, transmit, market and use these resources.

Working together makes us better.

Improving the sustainability of Canada's energy systems increases productivity and the standard of living for all Canadians. Many of the jobs of tomorrow will be in clean technology industries and Canadians must be part of this future, together.

Like Wayne Gretzky: we must skate where the puck is going and not where the puck has been.

The committee is looking forward to meeting Canadians across the country to listen, discuss and exchange ideas on the best path forward towards Canada's energy future.

APPENDIX 1
Electricity 101

What's watt with electricity?

Electricity is the flow of electrical charge. It is a fundamental aspect of nature and one of the most widely used forms of energy. Energy can be neither created nor destroyed – it can only be transformed or converted from one form to another. Electricity is a "secondary energy source", which means it is derived from the conversion of another, primary, source of energy such as hydro, natural gas, oil, coal, nuclear power, wind, solar or tidal power.

The basic unit of measure of electrical power is a watt. Because a watt is a fairly small unit, electricity is typically measured in 1000-watt units called kilowatts.

The capacity of an electricity generating station is typically measured in megawatts which is a million watts. A gigawatt is a billion watts and this is usually used to describe the total electrical capacity of a region or a country.

In order to measure the amount of energy consumed or produced over a period time, the power (watts) is multiplied by the number of hours it is being used.

For example a kilowatt hour (kWh) represents the use of one kilowatt of electricity for one hour. Put another way, it is the amount of electrical energy steadily transferred to an appliance in one hour by one kilowatt of power.

If you run your microwave for 10 minutes at 1,500 watts then you used 250 (Wh) watts per hour of energy.[113]

In fact your electricity bill is measured in kWh. It is sold in cents per KWh.

Using a real life example, recently the province of British Columbia announced that it was moving forward in building a dam on the Peace River. It is estimated that the dam will have a capacity of 900 megawatts and will produce 4,600 gigawatt hours of electricity each year which will power approximately 410,000 homes per year.

[113] 10 minutes is 1/6 of an hour therefore (1/6* 1500 watts) = 250 Wh, this example was derived from http://www.windsun.com/Inverters/Inverter_selection.htm

Morning energy statistics

The following table gives examples of the energy consumed in the use of some common household appliances in a morning. Of course each household may use different appliances differently, over different periods of time. As well, electricity prices vary across regions. This table is simply for illustrative purposes.

Cost and energy use of selected small home electrical appliances used in the morning

	Est. time used (morning)	Average wattage (W)	Daily energy use (kWh)	Yearly energy use (kWh)	Est. annual cost at ¢12/kWh
Blender	<1 min	350	0.004	1.28	$0.15
Toaster	5 min	1,100	0.092	33.46	$4.02
Coffeemaker	10 min	900	0.150	54.75	$6.57
Regular lamp	1 hr	75	0.075	27.38	$3.29
Compact fluorescent	1 hr	19	0.019	6.94	$0.83
Microwave oven	2 min	1,200	0.040	14.60	$1.75
Iron	10 min	1,000	0.167	60.83	$7.30
Clock radio	1 hr	4	0.004	1.46	$0.18
Hair dryer	5 min	1,200	0.100	36.50	$4.38
Small television	30 min	100	0.050	18.25	$2.19
Desktop computer	15 min	150	0.038	13.69	$1.64
TOTAL	NA	NA	0.739	269.14	$32.30

Note: Electricity prices vary based on region, time of year, the energy source and other factors.

Source: Average wattage of appliances data from BC Hydro, *Power Smart Appliance & Lighting Calculator*, https://www3a.bchydro.com/appcalc/pg1.asp

APPENDIX 2
Energy measurements

Term	Definition
Watt	The basic unit of measure of electrical power. For example, a 60-watt light bulb uses 60 watts of electricity. Because a watt is a fairly small unit, electricity is typically measured in 1,000-watt units called kilowatts.
Kilowatt	A unit of electrical power equal to 1,000 watts. A kilowatt is the amount of electricity required to light 10 100-watt light bulbs.
Kilowatt-hour	A kilowatt-hour is the basic unit for measuring the generation and consumption of electrical energy.
Megawatt	A unit of electrical power equal to 1,000 kilowatts or 1 million watts.
Megawatt-hour (MWh)	A megawatt-hour of electricity is equal to 1,000 kilowatt-hours.
Gigawatt	A billion watts.
Gigawatt-hour	One billion watts of power over an hour. It is the standard unit for measuring electricity production on a national scale.
Joule	A unit of measure of energy. One joule is the equivalent energy of one watt of power radiated or dissipated for one

	second.
Gigajoule (GJ)	A gigajoule is one billion joules. It is the standard unit for bulk sales of natural gas. The amount of energy represented by one gigajoule is equivalent to about 30 litres of gasoline.
Petajoule (PJ)	One petajoule equals one quadrillion (1 x 10^{15}) joules. It is the unit most often used to measure energy production and use on a national scale. One petajoule contains energy equivalent to about 30 million litres of gasoline, enough to power Canada from all sources for a little more than an hour.

Sources:
Alberta Energy
Manitoba Hydro
Natural Resources Canada
Statistics Canada
Oxford English Dictionary

APPENDIX 3
Energy Glossary

Term	Definition
Active solar energy	Solar heating or cooling system that requires external mechanical power to move collected heat.
Annual consumption	The amount of electricity used by a consumer in one year, typically measured in kilowatt-hours (kWh).
Biodiesel	Biodegradable transportation fuel for use in diesel engines that is produced from biomass (defined below).
Bioenergy	Useful renewable energy produced from organic matter. Organic matter may be directly used as a fuel or processed into liquids and gases.
Biofuels	Liquid fuels such as ethanol and biodiesel, made from biomass. These fuels can be used in their pure form or blended with gasolines.
Biogas	Combustible gas produced from decomposing biological wastes.
Biomass	Organic materials containing stored chemical energy. Biomass includes forest residues, agricultural crops and wastes, wood and wood wastes, livestock wastes, animal wastes, fast-growing trees and plants, and municipal and industrial wastes. It can produce steam for industrial processes when burned in a boiler and/or produce electricity through thermal generation.
Bitumen	A very heavy crude oil consisting of a naturally occurring viscous mixture, mainly hydrocarbons heavier than pentane that may contain sulphur compounds and other minerals.

British thermal unit (Btu)	The quantity of heat required to raise the temperature of one pound of water one degree Fahrenheit.
Carbon capture and storage (or carbon capture and sequestration)	A technology involving capturing carbon dioxide emitted from large point sources and storing it underground in geological formations.
Carbon dioxide (CO_2)	A gas produced from decaying materials, respiration of plant and animal life, and combustion of organic matter, including fossil fuels. It is a greenhouse gas.
Carbon leakage	Describes the flight of businesses (motivated to avoid emission reduction policies or regulations) to countries with no emission reduction requirements or/and the price advantage of imports from countries with no climate emission reduction policies competing with products in countries that do have such policies.
Clean technologies	Technologies that protect and/or increase utilization efficiency of primary resources—land, air and water.
Climate change	A long-term shift in climate measured by changes in temperature, precipitation, wind, snow cover and other indicators.
Coalbed methane	Natural gas trapped within coal seams; commonly referred to as natural gas from coal.
Cogeneration	The simultaneous production of electric power and another form of useful energy such as heat or steam from the same fuel source. The heat or steam that would otherwise be wasted can be used for industrial process or other heating or cooling applications.
Conventional crude oil	Crude oil that flows naturally or that can be pumped without being heated or diluted.
Conversion loss	The energy lost during the conversion from primary energy such as petroleum, natural gas, coal, hydro, uranium, wind, biomass and solar energy into electrical energy. Losses occur during generation, transmission and

	distribution of electricity.
Demand	The amount of power required by all of the customers in a given service territory at a given point in time. It is usually measured in aggregate for a utility.
Demand side management	The education of consumers by the utilities on how to manage their electricity demand and load. This may also take the form of energy saving appliances or incentives to consumers to use less electricity at given peak hours.
Distributed generation	Small, modular, decentralized, grid-connected or off-grid energy systems located in or near the place where energy is used.
Distribution	The process of moving power at lower voltages from substations to customers.
District heating	A type of direct use in which a utility system supplies multiple users with hot water or steam from a central plant.
Downstream oil and gas industry	The refining and marketing sector of the petroleum industry. This is in contrast to the "upstream" industry, which refers to companies that explore for, develop and produce petroleum resources.
End use	Any specific activity that requires energy, such as space heating, water heating, and manufacturing processes.
Energy crops	Crops that are grown specifically for energy, either for electricity or liquid fuels. Plants and trees cultivated for energy use include corn, sugar cane, willow, alfalfa, poplar, switchgrass and canola oilseeds.
Energy efficiency	How effectively energy is being used for a given purpose. For example, 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 amount of energy used per unit of activity. Examples of activity measures are households, floor space, passenger-kilometres, tonne-kilometres, physical units of production and constant dollar value of gross domestic

	product.
Energy source	Any substance that supplies heat or power such as petroleum, natural gas, coal, renewable energy and electricity.
Enhanced oil recovery	Any method that increases oil production by using techniques or materials that are not part of normal pressure maintenance or water flooding operations. For example, $C0_2$ can be injected into a reservoir to "enhance" or increase oil production.
Established reserves	Generally defined as proven reserves plus one half probable reserves.
Ethanol	Liquid produced by fermentation of sugars for use as fuel.
Feedstock	Any material converted to another form or product.
Fossil fuel	Any naturally occurring organic fuel, such as petroleum, coal and natural gas.
Generation	The process of converting different forms of energy — hydro, thermal, mechanical, chemical or nuclear — into electricity.
Geothermal energy	Energy available in the ground and rocks beneath the Earth's crust used to heat water to drive turbines to make electricity.
Greenhouse gases	Gases that trap heat near the Earth's surface. These include carbon dioxide, methane, nitrous oxide and water vapor. These gases occur through natural processes such as ocean currents, cloud cover, volcanoes, and human activities such as the burning of fossil fuels.
Greenhouse gas intensity	The amount of greenhouse gas emitted per unit of energy used.
Grid	An electricity transportation system. The electric grid delivers electricity from points of generation to consumers, and the electricity delivery network functions via two primary systems: the transmission system and the

	distribution system. The transmission system delivers electricity from power plants to distribution substations, while the distribution system delivers electricity from distribution substations to consumers. The grid also encompasses numerous local area networks that use distributed energy resources to serve local loads and/or to meet specific application requirements for remote power, village or district power, premium power, and critical loads protection.
Hydrocarbons	Organic chemical compounds of hydrogen and carbon atoms that form the basis of all petroleum products, natural gas and coals. Hydrocarbons may be liquid, gaseous or solid.
Hydroelectric (hydro) power	The use of flowing water to produce electrical energy.
In-situ	In its original place; in position. In-situ recovery refers to various methods used to recover deeply buried bitumen deposits, including steam injection, solvent injection and firefloods.
Installed capacity	The amount of power that can be generated at a given moment if all power plants are running at the same time at full capacity
Kilo-watt hour	A kilowatt-hour is the basic unit for measuring the generation and consumption of electrical energy. A megawatt-hour (MWh) of electricity is equal to 1,000 kilowatt-hours. A kilowatt and a megawatt are units of generation capacity.
Load	The total amount of electricity required to meet customer demand at any moment.
Methane	A very potent greenhouse gas; the release of one tonne of methane has the same GHG impact as 21 tonnes of carbon dioxide.
Natural gas	A gaseous mixture of saturated hydrocarbons that is found in underground deposits, either alone or with petroleum.

Non-renewable resources	Natural resources that cannot be replaced after they have been consumed. This term applies particularly to fossil fuels such as coal, oil and natural gas, but also applies to other mineral resources found in the Earth's crust.
Off-Peak	Generally, the hours from 11:00PM to 6:00AM, when demand for electricity is low.
On-Peak	Generally, the hours from 6:00AM to 11:00PM, when demand for electricity is high.
OPEC	Organization of Petroleum Exporting Countries
Passive solar energy	Technology that uses a building's elements to capture and store the sun's heat.
Peak demand	The maximum power consumption for a facility, measured over a short time period such as 15 minutes or an hour.
Petroleum	A naturally occurring mixture consisting of predominantly hydrocarbons in the gaseous, liquid or solid phase.
Primary energy use	The total requirement for all uses of energy, including energy used by the final consumer or end user, non-energy uses, intermediate uses of energy, energy in transforming one energy form to another (for example, coal to electricity), and energy used by suppliers in providing energy to the market , such as pipeline fuel.
Probable reserves	Those additional reserves that are less certain to be recovered than proven reserves.
Proven reserves	The estimated quantities of crude oil, natural gas and natural gas liquids which geological and engineering data demonstrate with reasonable certainty to be recoverable in future years from known reservoirs under existing economic and operating conditions using existing technology.
Recoverable reserves	Hydrocarbon reserves that can be produced with current technology including those not economical to produce at present.

Renewable energy	Energy sources such as wind, solar, geothermal, hydropower, and various forms of biomass that are continuously replenished on the earth.
Secondary energy use	Energy used by final consumers for residential, agricultural, commercial, industrial and transportation purposes.
Sector	The broadest category for which energy consumption and intensity are considered within the Canadian economy; for example, residential, commercial/institutional, industrial, transportation, agriculture and electricity generation.
Shale gas	Natural gas produced from rock formations consisting mainly of shale or mudstone.
Smart Grid	A smart grid delivers electricity from suppliers to consumers using two-way digital technology to control appliances at consumers' homes to save energy, reduce cost and increase reliability and transparency. It overlays the electricity distribution grid with an information and net metering system. It includes an intelligent monitoring system that keeps track of all electricity flowing in the system. It also incorporates the use of superconductive transmission lines for less power loss, as well as the capability of integrating renewable electricity such as solar and wind. When power is least expensive the user can allow to the smart grid to turn on selected home appliances such as washing machines or factory processes that can run at arbitrary hours. At peak times it could turn off selected appliances to reduce demand.
Smart meters	Electricity meters that capture both the amount of power consumed in the home and when it is being consumed. Combined with other system components, smart meters can communicate consumption information to the customer through in-home displays and other in-home feedback tools. Customers can take advantage of pricing signals generated by new conservation rates, displayed on their in-

	home feedback devices, to better manage their electricity use for additional savings.
Solar energy	Energy produced by the sun.
Sustainable development	Development that meets the needs of the present without compromising the ability of future generations to meet their own needs.
Syngas	A fuel produced from solid hydrocarbons such as coal and petroleum coke. The process uses steam, air and controlled amounts of oxygen to break the solid down, and the resulting gas consists of vaying amounts of carbon monoxide and hydrogen.
Thermal electricity	Electricity generated from burning fossil fuels such as coal, natural gas and refined petroleum products; biomass such as wood, wood waste, pulping liquors and landfill methane; or other waste materials such as used tires.
Thermal generating station	A power plant that burn fuels such as coal, oil or natural gas to produce steam to generate electricity.
Tidal (or ocean) energy	Kinetic energy contained in tidal currents which is converted to electricity by turning turbines.
Time of use (TOU) pricing for electricity	With this form of pricing, electricity prices will vary based on when it is used. This includes by time of day, by day of week (weekdays versus weekend), and by season (winter or summer). TOU pricing is meant to better reflect the way the electricity market works. Prices rise and fall over the course of the day and tend to drop overnight and on weekends based on the amount of supply available and our levels of demand.
Upstream oil and gas industry	Refers to companies that explore for, develop and produce petroleum resources. This is in contrast to the "downstream" market, which refers to the refining and marketing components of the industry.
Wind energy	Energy from moving air which is converted to electricity by using wind to turn electricity generators.

Waste fuel	A name applied to any number of energy sources other than conventional fuels used in the cement industry. It includes materials such as tires, municipal waste and landfill off-gases.
Wood waste	Fuel consisting of bark, shavings, sawdust, low-grade lumber and lumber rejects from the operation of pulp mills, sawmills and plywood mills.

Sources:
BC Hydro
Centre for Energy
Environment Canada
Hydro One
International Energy Agency
Natural Resources Canada
Oxford English Dictionary
Sustainable Development and Technology Canada

APPENDIX 4
Witnesses

40th Parliament, 2nd Session

October 27, 2009	*Centre Hydrolien Industriel Québecois (CHIQ) :*
	Marcel Boridy, Director General
	Nova Scotia Power Inc.:
	James Taylor, General Manager, Carbon Management
	BC Hydro:
	Alex Tu, Senior Strategic Technology Specialist, Office of the Chief Technology Officer
	Triton Consultants Ltd.:
	Michael Tarbotton, President
	Natural Power Consultants:
	Erin Harlos, Renewables Development Manager
	New Energy Corporation:
	Clayton Bear, President and CEO
	Ocean Renewable Energy Group (OREG):
	Chris Campbell, Executive Director
October 29, 2009	*Carleton University:*
	John M.R. Stone, Professor
November 3, 2009	*Natural Resources Canada:*
	The Honourable Lisa Raitt, P.C., M.P., Minister of Natural Resources
	Christine Donoghue, Assistant Deputy Minister, Energy Sector
	Drew Leyburne, Director, Strategic Policy Division, Energy Policy Branch

	Carol Buckley, Director General, Energy Sector
	Martin Aubé, Director General, Strategic Science - Technology Branch
November 24, 2009	*Canadian Energy Research Institute:*
	Carmen Dybwad, Vice President, Business Development and External Relations
November 26, 2009	*National Round Table on the Environment and the Economy:*
	David McLaughlin, President and CEO
	Robert Page, Chair
December 1, 2009	*University of Calgary:*
	David Layzell, Executive Director, Institute for Sustainable Energy, Environment and Economy
	Balsillie School of International Affairs:
	Thomas Homer-Dixon, Professor, Centre for International Governance Innovation, Chair of Global Systems
December 3, 2009	*University of British Columbia:*
	Robert Evans, Professor, Mechanical Engineering
December 10, 2009	*Queen's University:*
	Bryne Purchase, Adjunct Professor, School of Policy Studies

40th Parliament, 3rd Session

March 16, 2010	*Energy Council of Canada:*
	Murray Stewart, President
	John Muir, Chair
March 18, 2010	*Energy Framework Initiative:*
	Michael Cleland, President and CEO, Canadian Gas Association
	Peter Boag, President, Canadian Petroleum Products Institute

March 30, 2010 *Natural Resources Canada:*

The Honourable Christian Paradis, P.C., M.P., Minister of Natural Resources

Malcolm Brown, Associate Deputy Minister

Nada Vrany, Director General, Energy Policy Branch

Carol Buckley, Acting Assistant Deputy Minister, Energy Sector

April 13, 2010 *Canada School of Energy and Environment:*

Bruce Carson, Executive Director

April 15, 2010 *Environment Canada:*

The Honourable Jim Prentice, P.C., M.P., Minister of the Environment

Michael Keenan, Assistant Deputy Minister, Strategic Policy Branch

David McGovern, Assistant Deputy Minister, International Affairs Branch

April 20, 2010 *HEC Montreal:*

Pierre-Olivier Pineau, Associate Professor, Department of Management Sciences

University of Calgary:

David Keith, Canada Research Chair in Energy and the Environment (by videoconference)

April 22, 2010 *Atlantic Provinces Economic Council:*

Elizabeth Beale, President and CEO

April 27, 2010 *Statistics Canada:*

Andy Kohut, Director, Manufacturing and Energy Division

Marie Brodeur, Director General, Industry Statistics Branch

National Energy Board of Canada:

Gaétan Caron, Chair and CEO

April 29, 2010	*Pollution Probe:*	
	Bob Oliver, Executive Director	
	The Pembina Institute:	
	Tim Weis, Director, Renewable Energy and Efficiency	
May 4, 2010	*The Canadian Chamber of Commerce:*	
	The Honourable Perrin Beatty, P.C., President and Chief Executive Officer	
	Shirley-Ann George, Senior Vice-President, Policy	
May 6, 2010	*Canadian Academy of Engineering:*	
	Richard J. Marceau, Member, Board of Directors, and Chair, New Directions and Public Policy Committee	
	Michael A. Ball, Executive Director	
May 11, 2010	*Canada West Foundation:*	
	Roger Gibbins, President and CEO (by videoconference)	
	Sustainable Development Technology Canada:	
	Vicky Sharpe, President and CEO	
	Sailesh Thaker, Vice President, Industry and Stakeholder Relations	
	Rick Whittaker, Chief Technical Officer and Vice President, Investments	