BUEC 663

Canadian Renewable Energy Policy and the Evolution of Renewables in the Canadian Electricity Industry

By:

Sukhraj Batoo

Ginni Sangha

Gurpreet Purhar

Samir Rashid

Date:

February 9, 2007

Canadian Renewable Energy Policy and the Evolution of Renewables in the Canadian Electricity Industry

Canadian energy policy over the past decade has been focused significantly on sustainable development. It has come a long ways from the late 70's and early 80's. During that time, policy was created to deal with issues of production and supply. Today it is aligned more with broader economic, environmental and public interests of Canadian and global economies (NRC, Energy in Canada 2000)

Currently, Canadian energy policy is shaped by commitments that are made both at the national and international level. For example, in 1997 a key commitment was made by several countries to help reduce green house gas (GHG) emissions. Canada's part of the deal was to reduce GHG emissions to six percent below 1990 levels by 2008 to 2012. Another example is the Canada–U.S. Clean Air Agreement, which governs the emissions of sulphur dioxide and nitrous oxides. Other significant commitments such as the North American Free Trade Agreement (NAFTA) also have an impact on how energy policy is created in Canada. At the domestic level, the federal government has federal-provincial agreements that also shape the country's energy markets. The Western and the Atlantic accords are a good example of this.

In Canada's constitution, jurisdiction over energy is divided between the federal and provincial governments. This constitutional division of powers requires that federal, provincial and territorial governments work together in areas such as climate change, environmental assessment and the regulation of Canada's energy infrastructure. Generally, provincial governments are responsible for resource management within their borders. This would cover issues related to intra-provincial trade, commerce and environmental impacts. The Federal government, on the other hand, deals with inter-provincial and international movements of energy. Non-

governmental players, also influence the energy policy development process. Examples of these would be environmental organizations, energy producers as well as users to name a few.

Over the past decade, environmental issues have moved to the forefront of energy policy issues. As a result, governments worldwide have been focusing on creating energy policies that are environmentally friendly (CRFS July 25th 2006). In Canada, for example, the new conservative government came out with a Canadian Renewable Fuels Strategy on July 25th 2006. This intent of this strategy is for it to act as a guide for policy makers when they are implementing measures to increase the use of renewable energy. Renewable energy sources include water, biomass, wind, solar, earth and waste stream energy. Governments are interested in integrating economic and environmental goals to pursuer sustainable development.

Using fiscal instruments to shift the economy onto a path that balances environmental, social and economic goals is certainly not a new paradigm. The main difference between fiscal instruments and command –and-control regulatory approaches is that compliance decisions are shifted from the regulator to the regulated community. For example, a price on carbon or carbon dioxide emissions would provide an incentive to reduce carbon intensity and make fossil fuels relatively more expensive compared to renewables. Sweden and Norway already have CO_2 taxes (American Geophysical Union). A generation subsidy for renewable energy is another tool that could be used to improve the competitiveness of renewable sources versus fossil fuels. Canada currently has a Market Incentive Program, as do the U.S. and several European countries.

When it comes to the topic of funding, the Canadian government's funding on renewable energy technologies increased 15% between 1990 and 1999, at an annual growth rate of 1.5%. However, this number doubled between 1999 and 2002. When this is considered, the annual growth rate between 1990 and 2002 was in the order of 6% (Renewable Grid-Power Electricity 2004). On

average, 17 percent of Canada's energy supply comes from renewable sources. Most of the renewable energy production, however, comes from hydro-electricity and wood. If the estimate includes large hydro and all biomass installations, then Canada's total installed base of renewable electricity generation capacity is over 70,000 MW, or about 60% of the total; virtually all of this capacity is large hydro. Excluding hydro, the installed capacity from wind and biomass is 2,200 MW and is only 2% of the total (Renewable Grid-Power Electricity 2004). Thus, there is still a lot of potential for renewable energy sources in Canada when it comes to electricity generation.

Alberta Renewable Energy Policies

The Alberta Research Council which is owned by the province of Alberta initiated the "Solar Thermal Building Products" program which helps transition technology from the lab to residential housing, with the primary goal of creating a zero energy home whose solar system is capable of fully meeting the typical energy demands of a residential home (Alberta Research Council).

The government of Alberta, through the ministry of environment, has been a partner in funding the "Drake Landing Solar Community" which has, for the first time in North America, integrated energy efficient technologies and solar energy in order to store solar energy underground in the summer and redistribute the energy to help heat each home in the community during the winter (Drake Landing Solar Community).

The Alberta government has deregulated energy and has allowed individual energy producers to sell energy on the grid. As such two methods of purchasing wind power have emerged. The first method, which is not practical in urban settings, is to install a wind turbine on the property. The second method is to purchase wind generated electricity certificates from retailers.

The Alberta government is committed to enhancing bioenergy technology and infrastructure and has developed a nine-point bioenergy plan. The recent announcement on October 3, 2006 committed the Alberta government to provide $239 million over five years to encourage manufacturers to bring more bioenergy technologies to the marketplace and produce renewable energy from organic materials (Canadian Bioenergy Corporation). An additional $30 million was committed to help establish infrastructure needed to distribute bioenergy.

In November 1999, the Alberta government setup the "Climate Change Central" as an agency to promote the development of innovate responses to global climate change. Recently, on June 29, 2006, Climate Change Central has taken on a major role in coordinating the Alberta Solar Municipal showcase project, which has the intention of demonstrating to Albertans the viability of grid-connected solar photovoltaic systems (Climate Change Central).

On August 30, 2006, the government of Alberta announced the creation of the Energy Innovation Fund to help with the development of "research, advanced technologies, market development and innovative projects focusing on energy supply and protection of the environment". A portion of the $200 million allocated for this fund is expected to be used towards the development of renewable energy sources.

To promote "green energy", Alberta Infrastructure, a department of the Government of Alberta has committed to buying 45% of its energy to heat government owned facilities such as offices, courthouses etc. from a "green energy" provider, and has entered into a 20 year contract with a company who produces electrical energy from hydroelectric plants.

SOURCES OF RENEWABLE ENERGY

Renewable energy is produced by using water, wind, sun, Earth's heat, and plants, sources that are continuously supplied by nature. Using these energy sources can produce usable forms of energy, most often electricity, but also heat, chemicals, or mechanical power. The drive to use renewable energy is due to the limited supply of non-renewable sources such as coal, oil and natural gas and the pressure to decrease greenhouse gases and air pollutants such as sulfur dioxide and nitrogen oxides. (Centre for Research and Information on Canada). Figure 1 shows that approximately 12% of Alberta's generating capacity comes from renewable energy now.

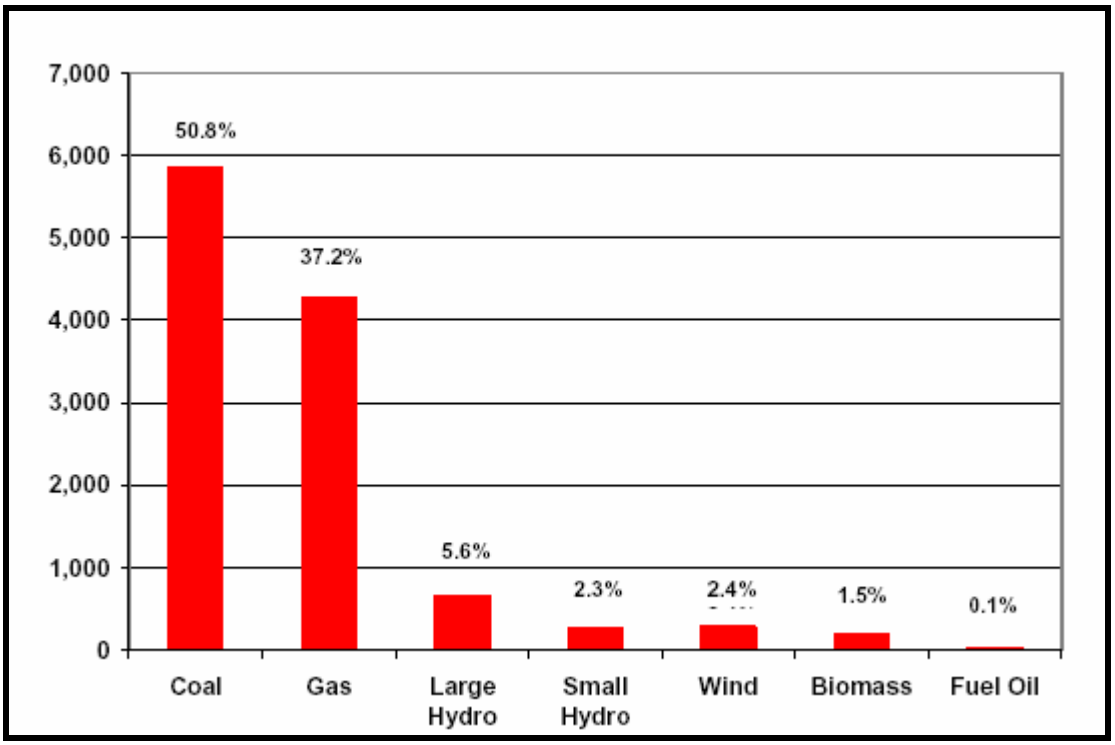

Figure 1: Alberta's Generating Capacity (MW)

Hydroelectric

Hydroelectric is the main source of electricity in Canada, representing nearly two-thirds of all electricity produced. It has been used for years and is a renewable energy source dependent on the hydrologic cycle of water, which involves evaporation, precipitation and the flow of water

due to gravity. The main components of a hydroelectric facility are the dam, the powerhouse that contains the mechanical and electrical equipment, and the waterways. A dam is used to control water from a lake or river. Water is released from the dam to turn turbines, which drive generators that produce electricity.

Benefits of hydroelectric energy include zero emissions, low operating and maintenance costs, reliable and flexible operations with respect to changes in load demand, and long operating lives (i.e. as much as half a century). Hydropower stations are the most efficient energy conversion technologies because they have efficiencies of over 90%.

Hydropower can negatively impact the surrounding environment and people. Hydropower plants can cause low dissolved oxygen levels in the water. This is harmful to riparian (riverbank) habitats and is addressed using various aeration techniques, which oxygenate the water. In addition, maintaining minimum flows of water downstream of a dam is also critical for the survival of riparian habitats.

Solar Energy

Solar energy refers to the energy supplied to the earth by the sun. Solar energy is converted into electricity by using photovoltaic and solar-thermal technologies. Photovoltaic systems consist of wafers built of silicon or other conductive materials. When sunlight hits the wafers, a chemical reaction occurs, resulting in the release of electricity. Solar-thermal technologies focus the sun's rays with mirrors or other reflective devices on a liquid. This results in the production of steam, which is then used to turn a generator and create electricity.

Solar energy has minimal impact on the environment. Air emissions associated with generating electricity are negligible because no fuels are combusted. No water is required by photovoltaic systems however solar thermal technologies may tap local water resources if the fluid that is being heated to create steam is water. In the case that this is occurring, water can be condensed from steam back into liquid form and be re-used. Moreover, neither of the technologies discharges any water or pollutants. (U.S. Environmental Protection Agency 2006). Solar energy installations do not damage the land but do they prevent it from being used for other purposes and negatively impact wildlife habitat. Typically, a utility-scale solar power plant requires approximately one square kilometer for every 20-60 megawatts (MW) generated. (Union of Concerned Scientists 2005).

Wind Energy

Wind turbines use two or three long blades to collect the energy of motion contained in the wind. The blades spin when wind blows over them subsequently turning the generator to produce electricity. To create a sufficient amount of electricity for a town or city, several wind turbine towers are placed in groups or rows to create a "wind farm".

Wind energy systems range in size from very small micro systems, which can be mounted on a pole and produce 100W or less, to 1.5MW turbines that can supply energy to the electrical grid. These systems require constant wind and are designed to begin operating at speeds greater than 15 km/h. They stop at very high wind speeds to protect themselves from damage. When calculating whether a site has enough wind energy to effectively operate a wind energy system, the average annual wind speed and the number of days the wind is above 15km/hr is very important.

Biomass

Biomass power plants use organic material such as fuel crops, agricultural wastes, sewage sludge, and waste. Agricultural wastes include materials such as cornhusks, rice hulls, peanut shells, grass clippings, and leaves. During photosynthesis, plants convert solar energy into chemical energy. This energy is released as heat energy when plant material is burned. Biomass power plants burn biomass fuel in boilers. Heat released as a result of this process is used to heat water into steam, which turns a steam turbine to generate electricity.

Biomass plants emit nitrogen oxides, a small amount of sulfur dioxide, and carbon dioxide depending on the type of biomass burned and generator used. Biomass power plants require water because the boilers burning the biomass need it for steam production and for cooling. If this water is continuously re-used in the process, the amount of water needed is reduced. Using water from lakes or rivers can result in negative impacts on the aquatic life.

Biomass power plants impact land in many ways by requiring large areas of land for equipment and storage. Fuel crops also require large areas of land and over time can deplete the soils' nutrients. These crops need to be managed so that they stabilize the soil, reduce erosion, provide wildlife habitat, and serve recreational purposes. If these biomass plants burn a waste source such as construction wood waste or agricultural waste, they can provide a benefit by freeing areas of land that might otherwise have been used for landfills or waste piles. (U.S. Environmental Protection Agency 2006).

Geothermal Energy

The heat contained in the liquid rock (magma) within the Earth's core continuously produces geothermal energy. When this heat naturally creates hot water or steam, it can be piped to the

surface where it is used to turn a steam turbine so that electricity is generated. Geothermal energy can also be obtained by piping water underground. The water extracts heat from the hot, dry rocks beneath the Earth. The water is then returned to the surface to turn a steam turbine and generate electricity.

The advantages of using geothermal energy are that it may be relatively cheap for regions near resources, produces no carbon dioxide and few atmospheric pollutants compared to fossil fuels, can provide a continuous supply of energy for a long time, require minimal use of land than fossil fuel plants, and requires no fuel. Another benefit of geothermal energy is that rock deposits are widespread and found all over the world. (BC Hydro 2002). One of the main disadvantages of geothermal energy is that geothermal power plants require water. Usually, the hot water that is removed from the ground is re-injected back into wells. However, a small quantity of water used by the plants in the process of creating electricity may evaporate and thus not be returned to the ground. If water is continuously not re-injected into the ground after use to maintain pressure underground, it may cause subsidence of the land. Furthermore, those geothermal plants that rely on hot, dry rocks for energy require large amounts of water from local resources to extract the energy from the dry rocks. (U.S. Environmental Protection Agency 2006).

Contribution of Renewable Energy to the Grid in Canada

The table below shows the percentage of electricity contributed by each Renewable energy Technology (RET) to the total electricity generated, in 2003, from these sources in Canada. Hydro is the largest contributor to the grid as there are large hydro projects in operations in British Columbia and Quebec. Solar and Geothermal have no contribution to the grid as they are being used to generate energy for homes and small businesses.

Source	Capacity (MW)	Supply (GWh/yr)	% Of Total RET
Wind	316	970	8%
Hydro	1800	9460	78%
Solar	0.092	0.1	0%
Biomass	128	900	7%
Geothermal	0	0	0%
Landfill Gas	85	670	6%

Source: Case Study on Renewable Grid-Power Electricity – Baseline Study and Economic Report (Page 13, Exhibit 3.2)

Cost Comparison: Wind vs. Biomass

Wind and Biomass are two sources of renewable energy that are contributing to the electricity grid and still have a lot of potential for growth. This section contains a brief cost comparison between a Wind Power plant and a Biomass Plant.

Wind

The principal cost drivers of the wind power are investment costs and operating and maintenance costs. The capital costs for a wind power plant has risen over the past few years due to increase in steel prices and pent up demand from the US developers. The prices have jumped up from $1700 - $1800 / kW in 2004 to $1850 - $2250 / kW since 2004.

Cost and Performance Characteristics of a Wind Plant	
Capacity (MW)	50
Heat rate (Btu/kWh)	10,280
Overnight cost (2003 $/kW)	1,134
Fixed Operating and Maintenance (2003 $/kW)	26.81
Lead time (years)	3

Source: Assumptions to the Annual Energy Outlook (Page 70, Table 38)

Biomass

Biomass has the potential to make a significant contribution to the electricity production and substantially reduce environmental impacts. But to realize this potential, biomass power plants must be competitive on a cost and efficiency basis. Currently, Biomass plants have significant operating and maintenance costs.

Cost and Performance Characteristics of a Biomass Plant	
Capacity (MW)	80
Heat rate (Btu/kWh)	8,911
Overnight cost (2003 $/kW)	1,757
Fixed Operating and Maintenance (2003 $/kW)	47.18
Variable Operating and Maintenance (2003 $mills/kW)	2.96
Lead time (years)	4

Source: Assumptions to the Annual Energy Outlook (Page 70, Table 38)

Conclusion and Recommendations

Renewable energy technologies have great potential for growth in Canada. Canada currently relies heavily on coal, oil and natural gas for its energy. However, as energy and environmental issues arise, Canada's renewable energy resources will play a role in its energy future. Although Canada is not a leader among industrialized countries in the development of renewable energy through government policy, there are several programs in place. Federal and provincial initiatives such as Wind Power Production Incentive (WPPI), Canadian Renewable and Conservation Expenses (CRCE) and Renewable Power Production Incentive (RPPI) are some examples of programs that are currently in place to promote renewable energy.

References

Natural Resources Canada, Energy in Canada 2000

Canadian Renewable Fuels Strategy, (S&T)^2 Consultants Inc, Meyers Norris Penny LLP July 25th 2006

American Geophysical Union, http://www.agu.org/sci_soc/prrl/prrl0233.html

Case Study on Renewable Grid-Power Electricity, Marbek Resource Consultants May 21, 2004

Alberta Research Council. http://www.arc.ab.ca/index.aspx/arc/4788

Alberta Research Council. http://www.arc.ab.ca/index.aspx/arc/5560

Utilities Consumer Advocate. http://www.ucahelps.gov.ab.ca/103.html

Drake Landing Solar Community. http://www.dlsc.ca

Canadian Bioenergy Corporation. http://www.canadianbioenergy.com/news.php?nid=6

Climate Change Central.
http://www.climatechangecentral.com/default.asp?V_DOC_ID=835

Climate Change Central.
http://www.climatechangecentral.com/default.asp?V_DOC_ID=2113

Government of Alberta. http://www.gov.ab.ca/home/index.cfm?Page=1496

Government of Alberta. http://www.gov.ab.ca/acn/200303/14035.html

BC Hydro. 2002. *Education - 8-12 - Geothermal Energy.*
http://www.bchydro.com/education/8-12/8-12_2820.html.

Centre for Research and Information on Canada.
http://www.cric.ca/en_html/guide/energy/renewable_energy.html#whatis.

Natural Resources Canada. 2007. *Wind Energy Systems.*
http://www.canren.gc.ca/prod_serv/index.asp?CaId=146&PgId=759#Uses.

Union of Concerned Scientists. 2005. *Environmental Impacts of Renewable Energy Technologies.*
http://www.ucsusa.org/clean_energy/renewable_energy_basics/environmental-impacts-of-renewable-energy-technologies.html.

U.S. Environmental Protection Agency. July 2006. *Electricity from Non-Hydroelectric Renewable Energy Sources.* http://www.epa.gov/cleanrgy/renew.htm#solar.