Maximizing Energy Efficiency and Renewable Energy in British Columbia

October 2006

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The observations, conclusions and recommendations are the responsibility of Pollution Probe and the Pembina Institute.

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Global Context for Energy Efficiency and Renewable Energy

This report examines the potential for enhancing energy efficiency and renewable energy deployment in British Columbia and introduces policy options to maximize that potential. The focus is on exploring various policy options that could make BC a world leader in the vitally important area of sustainable energy management.

There is increasing interest around the world in energy efficiency and the development of renewable energy technologies. Countries are concerned about the growing demand for energy, diminishing and unstable supplies of conventional energy sources, and increasing fossil-fuel related air pollution and climate change. The deployment of energy efficiency and renewable energy technologies respond to these concerns and offer many benefits, including job creation, rural development, price hedging, energy security, reduced air pollution and climate change mitigation, resulting in less damage to human health and the environment.

Germany, Spain, the United States, India, Denmark and Japan have taken the lead in the development of energy efficiency and renewable energy technologies. Canada has only recently begun to take advantage of its enormous low-impact renewable energy resources. In the spring of 2006, Canada became the twelfth country in the world to surpass 1,000 megawatts (MW) of installed wind capacity.[1] In contrast, Germany now has installed more than 18,000 MW of wind capacity.

The implementation of policies supporting energy efficiency and renewable energy has been an essential part of federal government strategies to reduce greenhouse gas emissions. Provincial governments are also supporting energy efficiency and renewable energy to meet climate change objectives, achieve regional air quality targets, reduce demand for imported energy and increase local energy security, and to promote economic development and domestic job creation.

[1] Canadian Wind Energy Association (CanWEA) 2006. July 4, 2006, Issue #54 (2006). CanWEA. www.canwea.ca/downloads/WindLink/Issue_54.htm

Introduction

In British Columbia, energy consumption has increased over the past 10 years at an average rate of 1.5 per cent per year. Projected population and economic growth indicate that the demand for energy services is likely to continue growing in the future. Energy efficiency and renewable energy offer a viable alternative to new conventional sources of energy supply to meet that growing demand. Deciding between these options will have significant implications for land, water and air quality, as well as BC's greenhouse gas (GHG) emissions. Energy efficiency and low-impact renewable energy offer an alternative with significantly fewer environmental impacts, and with many other benefits.

This report provides an overview of energy activities in British Columbia and a summary of the opportunities available to improve energy efficiency, enhance energy conservation and develop renewable sources of energy. As British Columbia moves forward, it is essential to have an understanding of the current resource context and potential.

The report has four parts:
- Part 1 describes the current energy situation in British Columbia
- Part 2 contains a summary of energy use in the province and explores options for expanding energy efficiency and conservation measures
- Part 3 presents options for developing renewable energy sources for electricity generation (referred to as green power) and for heating and cooling (green heat)
- Part 4 outlines the roles of different institutions and jurisdictions that promote renewable energy and energy efficiency technologies

This report was inspired by the presentations and discussions at a workshop held in Vancouver in March 2006 that was conducted by Pollution Probe, the Pembina Institute and the BC Sustainable Energy Association. These three groups were working together as members of the Canadian Renewable Energy Alliance (CanREA). The workshop included representatives from federal, provincial and municipal governments, utilities, the private sector, first nations and non-governmental organizations (NGOs).

Scope

This report focuses on options for energy demand reduction and renewable energy supply in all stationary energy uses in BC (60 per cent of total energy consumption). The transportation sector accounts for the remaining 40 per cent of energy consumption, which also results in substantial levels of local air pollution and greenhouse gas emissions. Transportation energy demands and their associated impacts clearly need to be considered in a comprehensive energy plan; however, transportation is beyond the scope of this report.

Energy efficiency means providing the same services with less energy. Examples of more energy efficiency practices include building better insulated homes and buildings, installing high-efficiency lighting, using high-efficiency industrial motors, using hybrid vehicles, retrofitting furnaces and hot water tanks, and sealing leaks in walls and around doors and windows.[i]

Energy conservation means to using less energy services. Examples of energy conservation practices include reducing engine idling and using less cooling, heating or lighting. It also includes changing urban design to reduce the need for individual motorized transport, and reducing general consumption, especially of over-packaged goods.[ii]

Demand-Side Management (DSM) refers to programmes delivered by electric or gas utilities designed to acquire savings in energy use and reduce load. Typically, DSM programs consist of the planning, implementing and monitoring activities of utilities that encourage consumers to reduce their energy consumption and modify their pattern of electricity or gas usage.[iii]

[i] CanWEA 2006. July 4, 2006, Issue #54 (2006). CanWEA. www.canwea.ca/downloads/WindLink/Issue_54.htm

[ii] Ibid.

[iii] Electronic Industries Alliance (EIA). "Electric Utility Demand Side Management 1997." EIA. www.eia.doe.gov/cneaf/electricity/dsm/dsm_sum.html (accessed October 18, 2006)

Green Power refers to sources of low-impact renewable electrical energy that meet the criteria set by the Environmental Choice Program, currently the most commonly used definition in Canada. The Environmental Choice Program gives EcoLogo[M] recognition to electricity products from naturally renewed sources (such as the wind, water, biomass and sun) where the sources and technologies have small environmental impacts (such as less intrusive hydro and biomass combustion with lower air emissions). BC Hydro has entered into an agreement with the Environmental Choice[M] Program (ECP) to certify existing and new green energy supplies contracted from independent power producers (IPPs).

Clean Energy, as used by the BC Ministry of Energy, Mines and Petroleum Resources, refers to electricity generated from resources and facilities built in British Columbia that have a smaller environmental impact relative to conventional generation sources and technology. The definition is intended to be dynamic and incorporates an expectation of continuous improvement in energy development — economically, environmentally and socially.

Community Power is defined by the Ontario Sustainable Energy Association as locally owned, locally sited and democratically controlled distributed renewable generation that minimizes environmental impacts.[iv]

[iv] OSEA. "Community Power — The Way Forward." Canadian Renewable Energy Association.

Recommendations

The recommendations made in this report focus on policy options that British Columbia could implement to maximize the potential for energy efficiency and renewable energy deployment. They are based on multi-stakeholder input and advice from the Canadian Renewable Energy Association (CanREA) and have been derived from each organization's expertise in the fields of renewable energy and energy efficiency.

The recommendations have been grouped into categories, including targets, better resource planning, financing, as well as skills and knowledge development.

Set Targets

1. ***Targets to reduce greenhouse gas emissions:*** The target should be consistent with those adopted by Federation of Canadian Municipalities, the Conference of New England Governors and Eastern Canadian Premiers, the State of California and other jurisdictions, as well as those proposed by the David Suzuki Foundation for Canada:
   - A reduction in Canada's GHG emissions to 25 per cent below 1990 levels by 2020
   - A reduction in Canada's GHG emissions to 80 per cent below 1990 levels by 2050[2]

   Short-term targets should be established, including implementation of measures by 2010 that demonstrate progress against benchmarks.

2. ***Targets to improve energy efficiency:*** The targets should focus on both energy efficiency and energy conservation,[3] and they should be set in a way that prioritizes energy efficiency as the preferred means of meeting demand if it is equally or more cost effective than low-impact renewables. The targets should build upon current targets set by utilities for demand-side management and those set by MEMPR for new and existing buildings with a goal of meeting 100 per cent of new demand with energy efficiency. Improving upon mechanisms already used by Fortis BC and Terasen, strong incentives should encourage utilities to exceed their agreed-upon targets, and corresponding penalties should discourage them from failing to be in compliance.

3. ***Targets to increase low-impact renewable energy***: The target should improve upon BC's current voluntary target of 50 per cent "BC clean" energy to mandate that 100 per cent of new electricity generation in the province be sourced from low-impact renewable energy.

All targets need to be legally-binding, aggressive, and achievable. They also need to be clearly articulated for the short, medium, and long term so that progress is measurable and strong signals are provided to energy producers and consumers.

Support the Energy Options that are in the Best Interests of all British Columbians

4. The Premier should direct the BC Utilities Commission to interpret its legal mandate "to serve the public interest" more widely, in order to account for the public's interest in social, health, environmental impacts (including cumulative environmental

[2] These goals are consistent with GHG emission reduction targets contained within: The Case for Deep Reductions: Canada's Role in Preventing Dangerous Climate Change. 2005. www.davidsuzuki.org/files/climate/Ontario/Case_Deep_ Reductions.pdf; Oregon Strategy for Greenhouse Gas Reductions. http://egov.oregon.gov/ENERGY/GBLWRM/Strategy.shtml; Governor Announces New Steps to Curb Global Warming in Oregon http://governor.oregon.gov/Gov/press_041305a.shtml

[3] Energy conservation is defined as the way we use energy to meet our needs. Energy efficiency is defined as the most efficient equipment and measures.

impacts), job creation, and support for innovative technologies, as well as the price of electricity.

5. The province should consider creating an agency that is responsible for setting energy efficiency targets, coordinating energy efficiency efforts across delivery agents and energy types, measuring success at achieving energy efficiency, and developing and delivering programs. Previously established programs could become the responsibility of this agency.[4]

Implement Financing and Regulation Mechanisms to Support the Immediate and Ongoing Deployment of Energy Efficiency and Renewable Energy

6. The province should support the EnerGuide for Houses program and additional financing should be made available for efficiency upgrades in all building types, with particular focus given to low-income citizens. Financing mechanisms should also be established to support green heat technologies,[5] such as GeoExchange and solar hot water systems

7. Building Code and Energy Efficiency Act should be updated as targets are achieved so that improved levels of energy performance (including green heat) are required in all future construction and purchasing decisions. These updates should occur on a regular three to five year cycle and serve as a starting point for new short-term targets.

8. We recommend the advanced renewable tariff (ART) as the best way to support the development of a low-impact renewable electricity generation industry, deployed, as required, with other policy mechanisms. ARTs have been used with great success in Germany, Spain, Denmark and other countries, where they have fostered vibrant domestic energy industries. Advanced Renewable Tariffs permit the interconnection of renewable sources of electricity with the grid and specify the price paid for the electricity generated. Benefits include: increased local support and participation in community-based and developed power projects, fiscal confidence necessary to finance low-impact renewable energy development, job creation, manufacturing and investment opportunities, and Province-wide renewable energy development.

9. A study should be completed that identifies the effect of financial incentives and disincentives on energy efficiency and renewable energy, including those for fossil fuel energy sources. A system benefits charge should also be studied as a mechanism to support renewable energy and energy efficiency development.

Develop the Skills and Knowledge to Increase BC's Ability to Take Advantage of Energy Efficiency and Renewable Energy Resources

10. The province should devote resources to developing and supporting post-secondary and certificate-based training programs for designers, engineers, project managers, utility personnel and other related energy efficiency and renewable energy jobs.[6]

[4] These types of agencies have been effective at supporting the acquisition of energy efficiency in different jurisdictions because they are able to focus solely on efficiency opportunities, while maintaining a broad perspective across sectors and energy types.

[5] Green Heat is the use of renewable energy to heat or cool a building (or heat water) using these technologies in the residential or commercial-institutional sectors: geothermal (earth energy) heat pumps, solar thermal water heaters, solar thermal air pre-heaters, and advanced biomass heaters.

[6] These programs should build on existing programs, such as the Association for Canadian Community Colleges renewable energy program and the Geo-Exchange geo-thermal certificate program.

11. A study should be completed to identify the potential for the large-scale integration of low impact renewable energy into BC's grid, the use of BC's hydro reservoirs to firm up variable energy from renewables, and potential grid bottlenecks.

12. A study should be completed to explore opportunities for combined heat and power (CHP) within BC.

On behalf of CanREA Members:

BC Sustainable Energy Association
David Suzuki Foundation
One Sky — The Canadian Institute of Sustainable Living
The Pembina Institute
Pollution Probe

Part 1: The Current Energy Context in British Columbia

To provide an overview of the context in which energy decisions will be made, this section discusses current and future energy supply and demand in BC and the associated greenhouse gas emissions. Energy and greenhouse gas emissions from the transportation sector are included in this section to help provide a complete picture, but as mentioned in the introduction, the discussion of options is limited to stationary energy use.

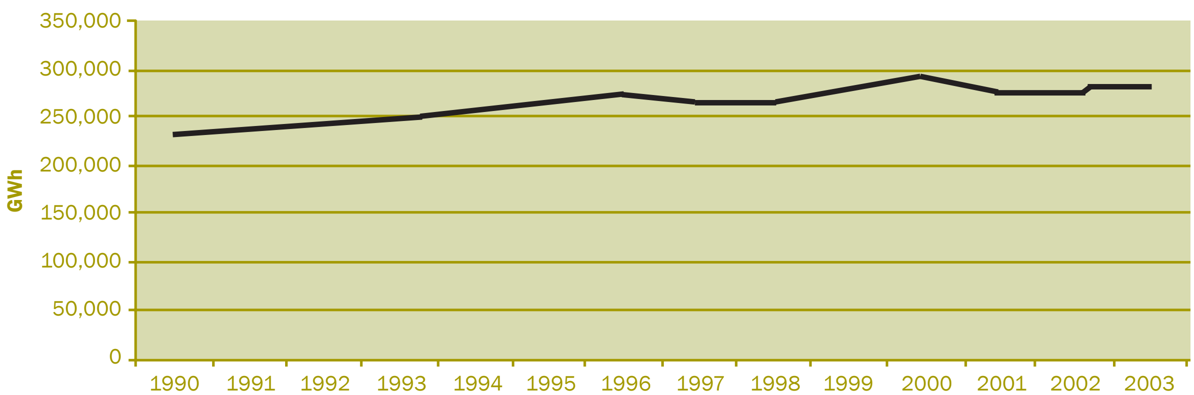
Energy Consumption

Energy consumption in British Columbia has increased over the past 10 years at an average rate of 1.5 per cent per year, as indicated in Figure 1. Projected population and economic growth indicate that the demand for energy services is likely to continue growing in the future. The energy efficiency and conservation and energy supply resources available in BC to meet these demands are discussed in Parts 2 and 3.

Energy demand in BC is met primarily through electricity (about ninety per cent hydro generation), natural gas, wood waste and petroleum-based products. Figure 2 contains a general breakdown of energy use by type of resource in BC. It does not include resources that are produced for export. Although not shown in the figure, energy efficiency and conservation initiatives, such as Hydro's Power Smart programs, have played a role in BC's energy mix. Estimates of how much total energy has been saved through those initiatives are not available.

Switching the focus to end-uses instead of fuels, Figure 3 breaks down energy use by five main sectors: residential, commercial, industrial, agricultural and transportation. It indicates the percentage of energy used by each sector for stationary purposes (buildings, industrial processes, etc.) and the percentage used for non-stationary purposes (transportation). For the industrial and agricultural sectors, natural gas, electricity and wood waste consumption are used as an approximation of stationary energy

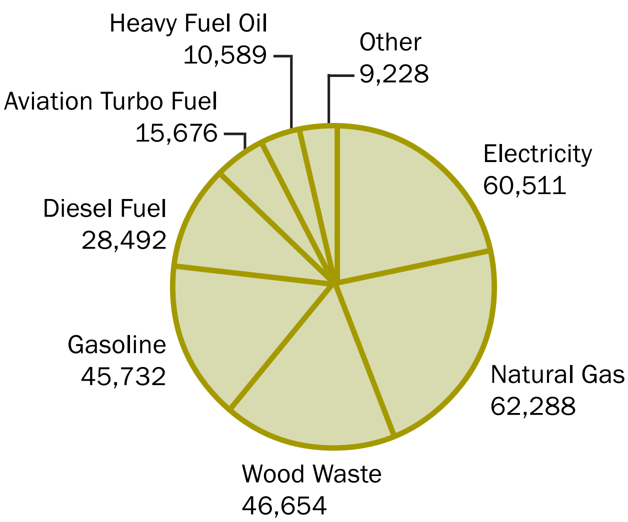
Figure 1: Total energy consumption in British Columbia and Territories from 1990–2003 (GWh)



Source: NRCan Comprehensive Energy Use Database, 2003. http://oee.nrcan.gc.ca/corporate/statistics/neud/dpa/comprehensive_tables/index.cfm?attr=0
Industrial natural gas use reduced by ten per cent to account for Territorial industry. All other numbers reflect use in BC and Territories. Numbers provided by NRCan for industrial use are incomplete due to confidentiality concerns.

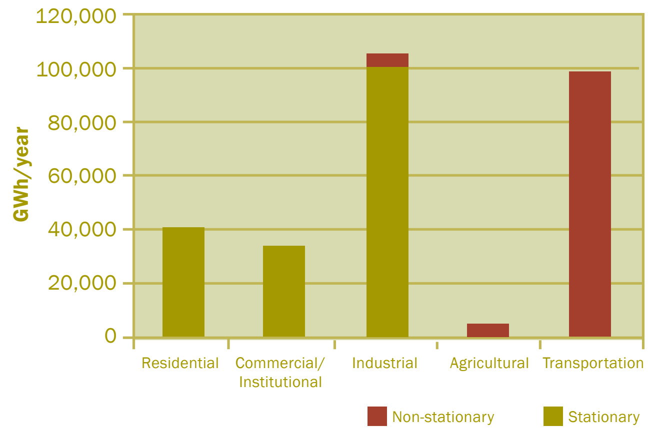
consumption.[7] Figure 3 shows that, overall, stationary energy consumption accounts for approximately 60 per cent of total energy consumption in BC.

Figure 2: Energy use by source for British Columbia (GWh), 2003



Source: NRCan Comprehensive Energy Use Databases for BC and Territories, 2003.
Industrial natural gas use reduced by ten per cent to account for Territorial industry. All other numbers reflect use in BC and Territories.

Figure 3: Energy consumption by sector



Source: NRCan Comprehensive Energy Use Databases for BC and Territories, 2003. http://oee.nrcan.gc.ca/corporate/statistics/neud/dpa/comprehensive_tables/index.cfm?attr=0
Industrial natural gas use reduced by ten per cent to account for Territorial industry. Stationary energy use for Industrial and Agricultural sectors assumed to be the sum of electrical, natural gas and wood waste. Numbers provided by NRCan for industrial energy use are incomplete due to confidentiality concerns.

[7] This assumption may miss a small amount of fuel that is being used for stationary purposes, but the data was not available to make this assessment.

Imports and Exports

British Columbia has substantial conventional energy resources, with the amount produced and consumed, and the resulting surplus or deficit, shown in Table 1. It is the second largest natural gas producer[8] and the second largest coal producer[9] in Canada. As seen in Table 1, BC produces more natural gas and coal than it consumes. In 2003, it exported 97 per cent of the coal produced and 73 per cent of the natural gas produced. While it is the fourth largest oil producer in Canada,[10] it consumes more oil than it produces. In 2003, it imported 76 per cent of the oil consumed in the province. For electricity, BC both imports and exports electricity over the course of a year, trading with the United States and Alberta. With the exception of several low water years, 1995, 2001, 2004, BC has been a net exporter of electricity in each of the last 10 years.[11, 12]

Table 1: BC production and consumption of energy resources

Resource	Produced per year	Consumed per year	Surplus/deficit
Oil (2004)[a]	15,728,000 barrels	73,365,000 barrels	-57,637,000 barrels
Coal (2000)[b]	26,482,075 tonnes[e]	780,830 tonnes	25,701,245 tonnes
Electricity (2003)[c]	63,000 GWh	60,000 GWh	3,000 GWh
Natural Gas (2004)[d]	949 billion cubic feet	255 billion cubic feet	694 billion cubic feet

a CAPP. "BC." CAPP. www.capp.ca/default.asp?V_DOC_ID=674 (accessed October 16, 2006)
b Ministry of Energy, Mines and Petroleum Resources (MEMPR). "British Columbia Historial Coal Production and Value." www.em.gov.bc.ca/mining/MiningStats/31coaltotal.htm
c Ministry of Labout and citizens' Services. "BC Stats." *Exports, December 2005*, 05-12 (2005). Ministry of Labout and citizens' Services. www.bcstats.gov.bc.ca/pubs/exp/exp0512.pdf
d CAPP. "BC." CAPP. www.capp.ca/default.asp?V_DOC_ID=674 (accessed October 16, 2006)
e Includes both metallurgic and thermal.

8 Canadian Association of Petroleum Producers (CAPP). "British Columbia." CAPP. www.capp.ca/default.asp?V_DOC_ID=713 (accessed October 16, 2006)
9 CAPP. "Coal in Canada." CAPP. www.coal.ca/coalincan.htm (accessed October 16, 2006)
10 CAPP. "BC" CAPP. www.capp.ca/default.asp?V_DOC_ID=713 (accessed October 16, 2006)
11 Ministry of Labout and citizens' Services. "BC Stats." *Exports, December 2005*, 05-12 (2005). Ministry of Labout and citizens' Services. www.bcstats.gov.bc.ca/pubs/exp/exp0512.pdf
12 Because the majority of BC's electricity is hydro generated, BC has the ability to control the production of electricity to a greater degree than other jurisdictions that rely on coal or nuclear generation: it is easier to stop and start the flow of water over a dam than to stop and start a thermal or nuclear generator. As a result, is it generally cost effective for BC to import coal or nuclear generated electricity at off-peak times from the US and Alberta when it is cheap, and export electricity at high-peak times when the price is higher. BC also balances its own use of thermal generation with imports, depending on which is cheaper. In general, exports exceed imports, with the exception of a few low water years.

Current and Future Electricity and Natural Gas Consumption

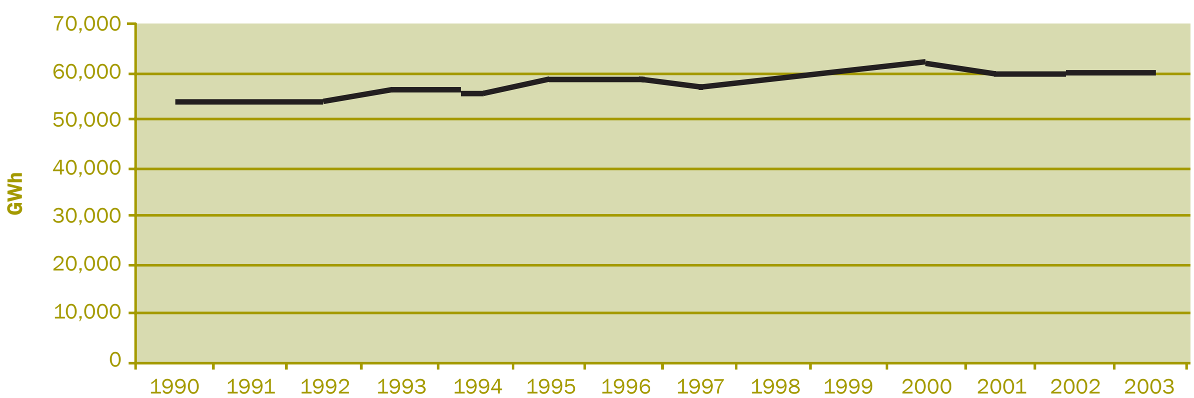
This section provides a more detailed exploration of the demand for two of the three main sources for stationary energy uses: electricity and natural gas. Although wood waste is also a significant source for stationary energy consumption (primarily to fire pulp mill boilers, cogeneration plants, power plants and other facilities), it does not operate in the same regulated utility environment that electricity and natural gas do. As such, much less information is available and no detailed discussion is provided in this section.

Electricity

In British Columbia, per capita electricity demand has been fairly stable over the past fifteen years, and total electricity demand has been increasing. NRCan estimates (2003) indicate that BC consumed nearly 60,000 GWh/year of electricity in its residential, commercial and industrial sectors.[13] Figure 4 indicates the growth trend for electricity use in BC for the past fifteen years. The vast majority of this electricity (more than ninety percent) is supplied by BC Hydro, with an additional five percent being supplied by Fortis BC to customers in the southern interior.[14] The remaining five per cent of electricity is generated by other producers, including, Columbia Power Corp, Island Cogen, Alcan, Teck Cominco and about forty other industrial self-generators and independent power producers throughout the province.[15] Many of these are pulp and paper mills that use wood waste to generate energy.

Ninety percent of BC's supply is produced by hydro-electric generating stations. Approximately six per cent is provided through existing purchase contracts, and four per cent will be provided through market purchases and thermal generation (see previous section for a discussion of electricity imports and exports).[16] Until the 2006 call for power, BC had no installed wind or coal capacity.

Figure 4: BC historical electricity use 1990–2003



Source: NRCan Comprehensive Energy Tables, includes BC and Territorial use. http://oee.nrcan.gc.ca/corporate/statistics/neud/dpa/comprehensive_tables/index.cfm?attr=0

[13] Natural Resources Canada (NRCan). "Comprehensive Energy Use Database." NRCan. http://oee.nrcan.gc.ca/corporate/statistics/neud/dpa/comprehensive_tables/index.cfm?attr=0 (accessed October 16, 2006)

[14] FortisBC. "FortisBC announces 2006 results." *FortisBC News Releases*, February 2, 2006.

[15] MEMPR. "Fact Sheet: BC Electricity Resources." MEMPR. www.gov.bc.ca/empr/popt/factsheet_electricity.htm

[16] BC Hydro. *Integrated Electricty Plan*. 2006. BC Hydro. www.bchydro.com/info/epi/epi8970.html (accessed October 16, 2006)

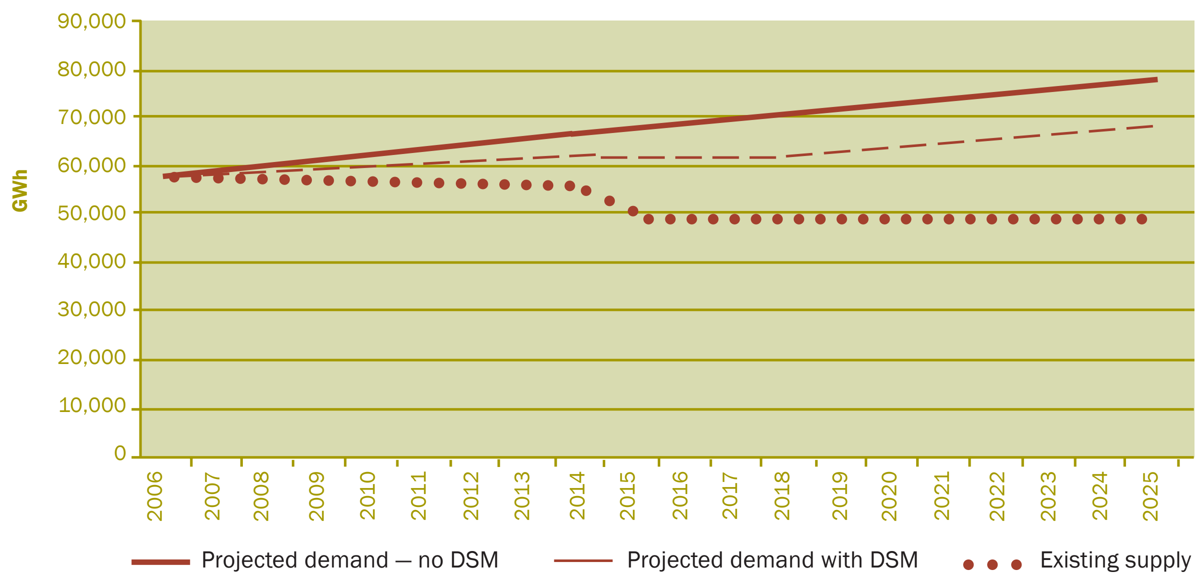
Future electricity demand projections

In its 2005 Integrated Electricity Plan (IEP), BC Hydro projected that, in the absence of demand-side management (DSM) programmes, BC Hydro's annual electricity demand in BC would be expected to grow from approximately 57,800 GWh[17] in 2006 to 77,900 GWh by 2025. With current DSM strategies in place, annual demand is expected to be reduced to approximately 68,300 GWh by 2025. These projections are shown in Figure 5.

BC Hydro's existing supply is also shown in Figure 5. This projection includes existing hydroelectric and thermal facilities, existing purchase contracts and existing Resource Smart[18] projects. As is evident in Figure 5, there is a growing gap between existing supply and demand after 2008, even with DSM programs in place.[19] BC Hydro's 2006 Long Term Acquisition Plan (LTAP) outlines how BC Hydro intends to fill the growing gap.[20] The LTAP is outlined in Table 2 and it includes existing supply, additional planned supply scheduled to come on line (but not included in Figure 5), and future options currently under consideration.

With respect to the additional planned supply outlined in the LTAP, BC Hydro recently announced the results of its 2006 Call for Power. The contracts include 38 projects totaling approximately 7,000 GWh per year, including 29 hydro (3,077 GWh/year), three wind (979 GWh/year), two biomass (1,186 GWh/year), two waste heat (75 GWh/year) and two coal/biomass (2,033

Figure 5: BC Hydro demand and supply projections to 2025[21]



Source: BC Hydro 2006 IEP.

[17] BC Hydro accounts for approximately 90 per cent of BC's electricity. Therefore, numbers presented in BC Hydro's estimate are lower than what will actually be expected for the whole province.

[18] Resource Smart is a BC Hydro program intended to increase and restore generating efficiencies and capability of BC Hydro's current generating facilities.

[19] The decline in supply shown in Figure 5 (between 2014 and 2015) is due to expected decline in electricity generation by current facilities, most notable of which is the closing of Burrard Thermal.

[20] The LTAP can be found in chapter 8 of BC Hydro's Integrated Electricity Plan. www.bc.hydro.com/rx_files/info/info43514.pdf

[21] BC Hydro. *Integrated Electricty Plan*. 2006. BC Hydro. www.bchydro.com/info/epi/epi8970.html (accessed October 16, 2006)

Table 2: Existing, proposed and potential future resources from the LTAP

Existing supply	Additional planned supply	Future options
DSM	Expanding DSM	Further expanded DSM
Heritage hydro	2006 Call for power (2,500 GWh/year)	New technologies
Heritage thermal	2007 Call for power (5,000 GWh/year)	Large-scale coal or hydro
Resource Smart	2009 Call for power (5,000 GWh/year)	
Purchase contracts	2009 Additional market purchases	

GWh/year) projects.[22] This is a significant increase over the 2,500GWh/year estimate for the 2006 call included in the LTAP.

Natural Gas

About 95 per cent of the province's natural gas is provided by Terasen Gas.[23] BC's natural gas supply is mainly extracted from the Western Canadian Sedimentary Basin (Northeast British Columbia and Alberta) and can also be sourced from the US.[24] In BC, per capita and total natural gas use has fluctuated over time due to a combination of factors, of which changes in prices and climate were the dominant ones. NRCan and Terasen data from 2003 indicate that BC consumed approximately 62,000 GWh of natural gas in that year.[25] Figure 6 indicates the trend in natural gas consumption for the past 15 years. Note that natural gas use is presented in terms of GWh instead of petajoules to provide for easier comparison to other energy sources.

Future natural gas demand projections

In its 2006 Conservation Potential Review (CPR), Terasen Gas estimated that, in the absence of continued demand-side management initiatives, natural gas consumption in the residential, commercial and manufacturing sectors (including Vancouver Island) would grow from the base year (2003/04) consumption of approximately 40,500 GWh/yr to 49,400 GWh/yr by 2015/16. With current DSM strategies in place, annual demand would be expected to reach 46,200 GWh/year by 2025.[26] Figure 7 illustrates this projected growth.

[22] BC Hydro. "CFT Results: F2006 Call for Power." BC Hydro. www.bchydro.com/info/ipp/ipp47608.html (accessed October 16, 2006)

[23] Terasen Gas. "About Terasen Gas." Terasen Gas. www.terasengas.com/_AboutTerasenGas/default.htm (accessed October 16, 2006)

[24] Terasen Gas. "Resource Plan." Terasen Gas. www.terasengas.com/NR/rdonlyres/etcnssyr2vysupiq25wcyx2fnpasz2q6o2vionp2jvhwak7jamgsrsk2ir77c7qtkbhoasrubrkvhrcuz7fk4dhhbwe/TGI+2004+Resource+Plan.pdf (accessed October 16, 2006)

[25] NRCan. "Comprehensive Energy Use Database." NRCan. http://oee.nrcan.gc.ca/corporate/statistics/neud/dpa/comprehensive_tables/index.cfm?attr=0 (accessed October 16, 2006)

[26] Marbek Resource Consultants. 2006. Terasen gas Residential Conservation Potential Review.

Figure 6: BC historical gas use, 1990–2003[27, 28]

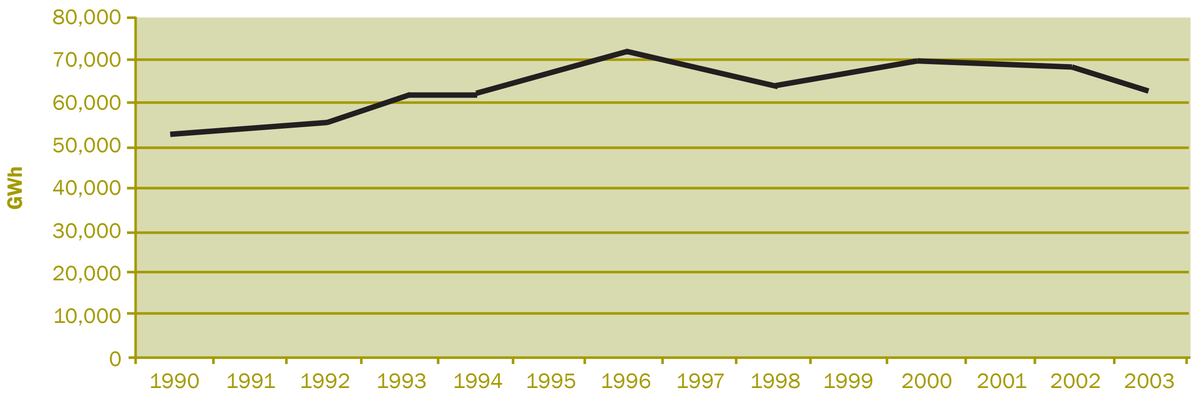
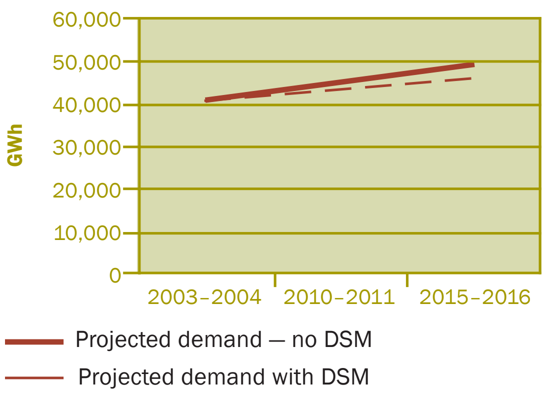


Figure 7: Terasen Gas Demand Projections[29, 30]



In order to meet increasing demand, Terasen Gas is considering the following options:

In general

- Significant increase in DSM[31]

Coastal Transmission System[32]

- Pipeline looping[33] in the northern leg of the system serving Coquitlam and Burrard Thermal
- Compressors at Langley
- Other storage options
- Contract demand reductions

Interior Transmission System[34]

- Pipeline looping between Winfield and Penticton
- LNG storage facility between Vernon and Falkland

[27] NRCan. "Comprehensive Energy Use Database." NRCan. http://oee.nrcan.gc.ca/corporate/statistics/neud/dpa/comprehensive_tables/index.cfm?attr=0 (accessed ???).

[28] Industrial natural gas use reduced by ten per cent to account for Territorial industry. All other numbers reflect use in BC and Territories.

[29] Marbek Resource Consultants. 2006. Terasen Gas Residential, Commercial and Manufacturing Conservation Potential Reviews.

[30] Terasen's demand projections do not include natural gas used for electricity generation and so are less than demand indicated in Figure 6.

[31] Marbek Resource Consultants. 2006. Terasen Gas Residential, Commercial and Manufacturing Conservation Potential Reviews.

[32] Terasen Gas. "Resource Plan." Terasen Gas. www.terasengas.com/NR/rdonlyres/etcnssyr2vysupiq25wcyx2fnpasz2q6o2vionp2jvhwak7jamgsrsk2ir77c7qtkbhoasrubrkvhrcuz7fk4dhhbwe/TGI+2004+Resource+Plan.pdf (accessed October 16, 2006)

[33] A pipeline loop is the addition of a second pipeline that is usually parallel to an existing one.

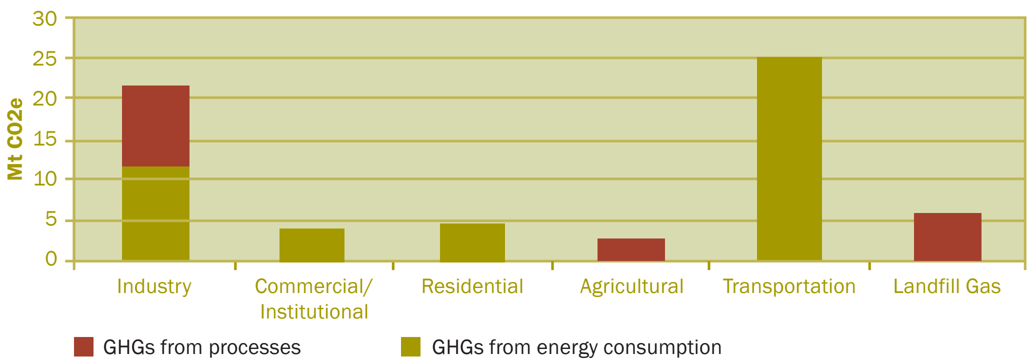
[34] Terasen Gas. "Resource Plan." Terasen Gas. www.terasengas.com/NR/rdonlyres/etcnssyr2vysupiq25wcyx2fnpasz2q6o2vionp2jvhwak7jamgsrsk2ir77c7qtkbhoasrubrkvhrcuz7fk4dhhbwe/TGI+2004+Resource+Plan.pdf (accessed October 16, 2006)

Greenhouse Gas Emissions in British Columbia

In 2003, British Columbia generated 63.4 megatonnes (Mt) of total greenhouse gas (GHG) emissions, representing 8.7 per cent of Canada's total. Between 1990 and 2003 the province's total emissions increased 12.1 Mt or 24 per cent.[35] The GHG emissions produced in BC are shown in Figure 8. The emissions are grouped according to sector and then further broken down into those resulting from energy consumption (e.g., heating or transportation) and those resulting from other GHG emitting processes (e.g., fugitive emissions or waste decomposition).

In British Columbia's Strategic Plan for 2006/07–2008/09, the province stated its goal to improve the ranking of its per capita GHG emissions in relation to other provinces and US states, specifically Oregon, which now emits less GHG emissions per capita than BC.[37] While this goal may provide some direction for BC to reduce its GHG emissions, it runs the significant risk of allowing total GHG emissions to rise even if per capita emissions are decreasing. The per capita goal fails to connect with Canada's Kyoto commitment (i.e., reducing GHG emissions to six per cent below 1990 levels between 2008 and 2012), or any longer term targets for significant GHG reductions (e.g., the targets suggested for Canada by the David Suzuki Foundation and the Pembina Institute of 25 per cent below 1990 levels by 2020 and 80 per cent below 1990 levels by 2050).[38]

Figure 8: British Columbia's GHG emissions per sector in 2003[36]



Source: Environment Canada GHG Inventory.
Note that Industrial GHGs include fugitive emissions and emissions from industrial processes, as well as from energy consumption. Agricultural GHGs include emissions from agricultural processes, as well as from energy consumption. No sectors include emissions from electricity generation. These numbers do not include the consumption of BC energy products outside of BC (e.g., exported coal consumption in the US) or the GHG emissions associated with imported electricity (e.g., coal-fired electricity imported from Alberta).

35 Environment Canada. "Canada's Greenhouse Gas Inventory, 1990–2003." Environment Canada. www.ec.gc.ca/pdb/ghg/inventory_report/2003_report/toc_e.cfm (accessed October 16, 2006)

36 Environment Canada. "Canada's Greenhouse Gas Inventory, 1990–2003." Environment Canada. www.ec.gc.ca/pdb/ghg/inventory_report/2003_report/toc_e.cfm (accessed October 16, 2006)

37 Province of British Columbia. "STRATEGIC PLAN 2006/07–2008/09." www.bc.budget.gov.bc.ca/2006/stplan (accessed October 16, 2006)

38 David Suzuki Foundation and the Pembina Institute. "The Case for Deep Reductions." www.davidsuzuki.org/files/climate/Ontario/Case_Deep_Reductions_Summary.pdf (accessed October 16, 2006)

The shortcomings of the current situation were recently highlighted by the award of power purchasing contracts to two coal/biomass generating facilities. Currently in BC, the GHG emissions from electricity generation are low because the majority of BC's electricity is generated from hydro sources. The GHGs associated with these new plants will be approximately 1.83 Mt, which will represent an increase of nearly 140 per cent in GHG emissions from electricity generation in the province.

With the exception of targets for government operations (16 per cent) and agriculture (eight per cent), BC has not set specific overall GHG emission reductions targets.[39]

[39] Province of British Columbia. "STRATEGIC PLAN 2006/07–2008/09." www.bc.budget.gov.bc.ca/2006/stplan (accessed October 16, 2006)

Part 2: Options for Improving Energy Efficiency and Conservation

This part of the report explores opportunities to expand energy efficiency and conservation in British Columbia. When looking for ways to meet growing energy demand, there is a tendency to focus on building new supply-side sources. However, opportunities to improve energy efficiency can achieve the same results, and are often cheaper than supply-side options and offer additional benefits. These can include: lower environmental impacts by avoiding emissions of greenhouse gases and air and water pollutants; reducing land degradation associated with conventional energy production and consumption; local economic development opportunities and associated new jobs; and protection from price volatility.[40] These potential benefits provide the justification for energy efficiency and conservation resources to be given first consideration when determining the best way to meet new demands.

Within British Columbia, there is tremendous potential for energy efficiency and conservation to contribute to the energy supply mix, only a small portion of which is currently being captured. Other jurisdictions have implemented comprehensive energy efficiency strategies that aim to meet most future growth in energy demand through efficiency.[41] If BC were to follow these examples and build upon current efforts to improve energy efficiency and conservation, many of the electricity and natural gas expansion plans for the province would not be necessary.

[40] Canadian Renewable Energy Alliance (CanREA). "Energy Efficiency and Conservation — The Cornerstone of a Sustainable Energy Future." CanREA. ww.canrea.ca/pdf/CanREAEEPaper.pdf (accessed October 16, 2006)

[41] Pembina Institute. "Successful Strategies for Energy Efficiency." Pembina Institute. www.pembina.org/pdf/publications/EESStrats_SS_FINAL.pdf (accessed October 16, 2006)

Current Activities, Resource Potential and Future Plans in BC

BC Hydro, Terasen Gas, Fortis BC and the Ministry of Energy, Mines and Petroleum Resources are currently all stewarding energy efficiency initiatives. While these programs have met with some success, all of the studies examining the potential for energy efficiency improvements in BC point to significant untapped potential that exists to further reduce demand.

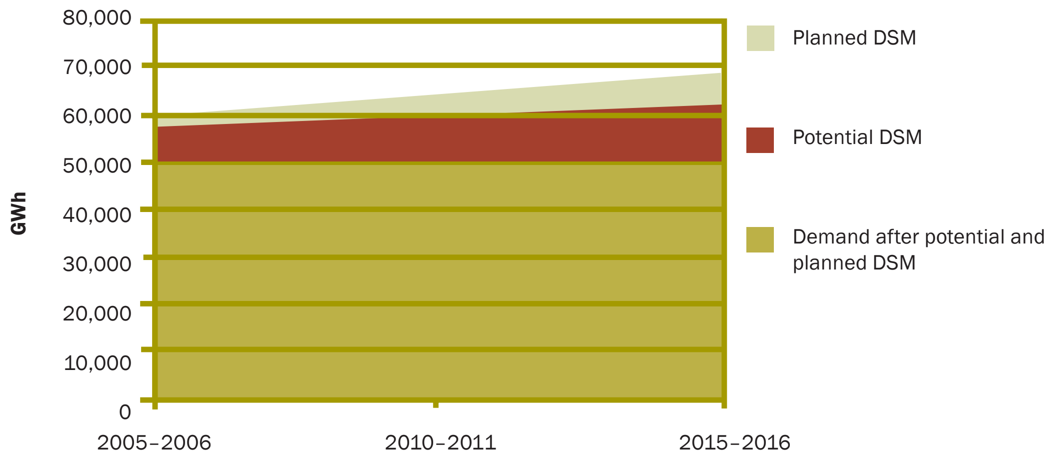
BC Hydro

Power Smart and Resource Smart are the main components of BC Hydro's current DSM programme, started in 1989 and 1987, respectively. Power Smart is BC Hydro's main energy efficiency programme. It is intended to reduce end-user energy consumption through public education and incentive programmes. BC Hydro's Long Term Acquisition Plan (LTAP) and Conservation Potential Review (CPR) indicate planned and potential energy efficiency, respectively. Comparing these two reports paints a picture of how close BC Hydro's plans come to meeting its identified potential.

The LTAP calls for the expansion of BC Hydro's energy efficiency programme to include projected demand reductions of 5,900 GWh/year by 2015 and 9,600 GWh/year by 2025.[42] These targets represent reductions of 64 per cent of new projected demand in 2015 and 48 per cent in 2025. According to the CPR, there is potential for even greater electricity savings. For 2015, the CPR estimates that the economic potential for DSM is 12,000 GWh/year. This represents a decrease in new demand of 135 per cent, which would be a decrease from current total electricity demand.

[42] BC Hydro. *Integrated Electricity Plan.* 2006. BC Hydro. www.bchydro.com/info/epi/epi8970.html (accessed October 16, 2006)

Figure 9: BC Hydro's planned and potential DSM compared to Demand[43, 44]



Both the planned and economic potential DSM are shown in Figure 9. The lines illustrate that while the planned DSM reflects progress, there are still significant potential DSM opportunities for electrical energy efficiency in BC.[45]

BC Hydro's Resource Smart programme is a much smaller programme than Power Smart. It is intended to increase and restore the generating efficiencies and capability of BC Hydro's current generating facilities that can be lost over time. Efficiencies are gained by retrofitting, updating or modifying existing facilities. By increasing the efficiency and capacity of existing generation facilities, the construction of new facilities can be avoided. Since 1987, the Resource Smart programme has added or restored almost 1,300 GWh/year.[46] By 2012, additional Resource Smart projects will add an additional 404 GWh/y of energy capability and 90 MW of new dependable capacity.[47]

Terasen Gas

Terasen Gas operates a number of education, awareness and incentive programmes aimed at both residential and commercial customers to increase energy efficiency and encourage energy consumption.

In 2004, Terasen Gas completed a Conservation Potential Review (CPR) to determine the extent of possible natural gas savings through DSM. Figure 10 shows the anticipated demand with no DSM, the savings that Terasen views as the most likely achievable, and the savings that Terasen estimates to be economically viable. The most likely DSM savings potential is estimated to be 3,200 GWh in 2015/16, which if achieved, would represent 36 per cent of new demand since 2005/06. In a stable-demand scenario, in which there is no increase in demand, 100 per cent of new demand would be met by energy efficiency. Such a scenario, which exceeds the current economic potential, is certaintly technically feasible, and could be economically viable if the costs of energy efficiency equipment are lower or energy prices are higher than assumed in the CPR.

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43 Marbek Resource Consultants. 2002. BC Hydro 2002 Conservation Potential Review.

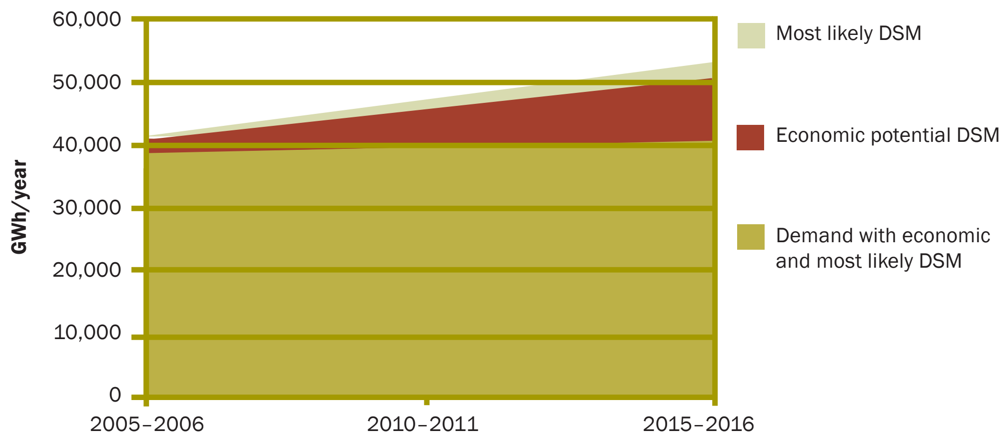
44 BC Hydro. *Integrated Electricity Plan.* 2006. BC Hydro. http://www.bchydro.com/info/epi/epi8970.html (accessed Oct 16, 2006)

45 BC Hydro is currently updating its 2002 CPR, so a larger potential for efficiency savings may be identified.

46 BC Hydro. *Integrated Electricity Plan.* 2006. BC Hydro. http://www.bchydro.com/info/epi/epi8970.html (accessed Oct 16, 2006)

47 Ibid.

Figure 10: Terasen Gas' most likely and potential DSM compared to projected demand



Source: Terasen Gas. 2006. CPR

Ministry of Energy Mines and Petroleum Resources

In 2003, buildings in the residential and commercial sectors, including lights, appliances and heating, consumed 65,500 GWh, or twenty-six per cent of energy consumption in BC.[48] To better understand the potential for improved energy efficiency in new and existing buildings and homes in BC, the Ministry of Energy, Mines and Petroleum Resources commissioned several studies to examine the life cycle costs and benefits of various opportunities. The results from the studies were varied, but they all showed a collection of cost-effective opportunities not currently part of standard building and retrofit practices.[49]

In order to help British Columbians to take advantage of these opportunities, the Ministry launched a strategy to improve energy efficiency in BC's buildings. The 2005 report, entitled *Energy Efficient Buildings: A Plan for BC*, outlines the first provincial targets for energy efficiency in the building sector in Canada. These targets are outlined below for new and existing buildings in BC.[50] In addition to coordinating with existing utility DSM programs and Federal programs, the Province's strategy includes several of its own initiatives to achieve the targets. These include the Community Action on Energy Efficiency programme, the Energy Savings Plan, and potential improvements to the Energy Efficiency Act and Building Code.

[48] NRCan. "Comprehensive Energy Use Database." NRCan. http://oee.nrcan.gc.ca/corporate/statistics/neud/dpa/comprehensive_tables/index.cfm?attr=0 (accessed Ocotber 16, 2006)

[49] These reports are not available electronically but can be ordered through the Ministry of Energy, Mines and Petroleum Resources Alternative Energy Branch at www.em.gov.bc.ca/AlternativeEnergy/Alt_Energy_%20Home.htm

[50] MEMPR. "Energy Efficient Buildings: A Plan for BC." MEMPR. www.em.gov.bc.ca/AlternativeEnergy/EnergyEfficiency/Energy_efficient.pdf (accessed October 16, 2006)

Sector	Target to be met by 2010
New detached single-family and row houses	Achieve EnerGuide for Houses rating of 80 (R-2000 energy standard)
New multi-unit residential buildings	Achieve reductions 25% better than the Model National Energy Code for buildings
New commercial, institutional and industrial buildings	Achieve reductions 25% better than the Model National Energy Code for buildings
Existing detached single-family and row houses	Reduce energy consumption by 12% in 17% of buildings
Existing multi-unit residential buildings	Reduce energy consumption by 9% in 16% of buildings
Existing commercial, institutional and industrial buildings	Reduce energy consumption by14% in 20% of buildings

Part 3: Options for Expanding the Use of Renewable Energy

British Columbia has an abundance of renewable energy resources for use in electricity generation or for heating and cooling purposes. Some of BC's renewable energy options include ocean, wind, solar, biomass, small/micro hydro and geothermal energies. This part of the report explores opportunities to expand renewable energy use for electricity generation (called green power). It also offers some examples of the use of renewables for heating and cooling purposes (called green heat).

Green Power for Electricity Generation

Introduction

Over the past four years, British Columbia has introduced a number of initiatives to increase its supply of green power for electricity generation.. The following section summarizes those initiatives without assessing if they are sufficient and effective. The remainder of the section then provides a synopsis of the known resource potential for ocean, wind, solar, small/micro hydro, geothermal and biomass energy in the province and the state of the technology to harness this power in each case.[51] The current state of development of each energy source in the province is discussed, followed by the policy changes recommended by stakeholders in each sector to help their sector achieve the maximum technical potential. Appendix C provides an overview of current green power initiatives in each province.

In November 2002, the province released *Energy for our Future: A Plan for BC* that includes a voluntary target for electricity distributors requiring 50 per cent of new electricity generation to be from clean sources defined as "renewable or resulting in net environmental improvement over existing generation".[52] In September 2005, a revised version of the *BC's Clean Electricity Guidelines* was released that includes: biogas energy, biomass energy, cogeneration, energy recovery generation, geothermal energy, hydrocarbon energy, hydro energy, hydrogen, solar energy, supply-side efficiency gains, tidal energy, wave energy, wind energy and other potential BC clean electricity sources.[53]

Since 2002, BC Hydro has issued three calls for independent power producers (IPPs) to bid in a Green Power Generation (GPG) process. The 2001/02 bid resulted in 16 signed projects for one biogas and 15 small hydro projects. The 2002/03 bid resulted in 16 signed projects: 14 hydro, one landfill gas and one wind energy project.[54, 55] Due to problems with project financing, a number of the projects (including the one wind project) that originally received contracts were not built.

In July 2006, BC Hydro announced the results of the F2006 Open Call for Power. There were 38 contracts to IPPs including, 29 hydro, three wind, two biomass, two waste heat, and two coal/biomass projects. These represent the first wind projects in BC and also the first coal projects.[56]

BC Hydro has also developed a net metering programme. Net Metering allows small power

[51] For a more detailed discussion of the technologies see Pollution Probe's *Primer on the Technologies of Renewable Energy* available at www.pollutionprobe.org.

[52] MEMPR. "Energy for our Future: A Plan for BC." MEMPR. www.gov.bc.ca/empr/popt/energyplan.htm (accessed October 18, 2006)

[53] MEMPR. "BC Clean Electricity Guidelines." MEMPR. www.em.gov.bc.ca/AlternativeEnergy/Clean_Energy_2005.pdf (accessed October 18, 2006)

[54] BC Hydro. "Green Criteria." BC Hydro. www.bc.hydro.com/info/ipp/ipp959.html (accessed October 18, 2006)

[55] BC Hydro. "Green IPPs." BC Hydro. www.bc.hydro.com/info/ipp/ipp958.html (accessed October 18, 2006)

[56] BC Hydro. "CFT Results: F2006 Call for Power." BC Hydro. www.bc.hydro.com/info/ipp/ipp47608.html (accessed October 18, 2006)

producers to sell back excess electricity to the BC Hydro grid. Residential and commercial users who wish to connect a 50 kW or less generating unit using a 'BC Clean' (as defined by the BC Government) energy source to the BC Hydro distribution system may do so under net metering.[57] If the producer generates less than the electricity used over a billing period, the customer will be charged for the amount of electricity that they are short. If the customer generates more electricity than what is consumed, the electricity charge will be zero and the total difference credit will be carried over to the next billing period. At the end of each year on the customer's anniversary date, a credit will be issued by BC Hydro for any remaining excess generation at a rate of 5.4 cents per kWh.[58] To date, uptake for the net metering program has been relatively slow, with only twelve solar PV systems having applied as of April 2005.

The Net Metering programmes are a fundamental component of a sustainable electricity generation mix. They encourage the development of small green power community projects that take advantage of distributed generation, thereby strengthening the electricity grid and introducing green power into communities in a more inclusive manner. Germany, the world leader in installed wind power capacity, credits its success largely to the development of community-owned power; a key ingredient in overcoming objections at the local level, often characterized as not-in-my-backyard syndrome (NIMBY).

To develop a green power strategy for the region, it is important to understand the resources available and the status of technologies to harness that power. Whereas the total 'resource potential' for green power generation is large, there are a number of technical and policy limitations that prevent rapid and widespread deployment. These limitations define the 'technical potential'. This distinction is important since it determines the difference between the total available resource and the amount of the resource that can be captured with present technology. For instance, transmission capacity and grid access are technical limitations to wind development in some areas. Upgrades and extensions to transmission systems may therefore be necessary to enable the development of the full technical potential of green power sources in British Columbia. In regard to assessing the resource potential, The Delphi Group has prepared a report for the Commission for Environmental Cooperation, *Reviewing Gaps in Resource Mapping for Renewable Energy in North America*, which takes a comprehensive look at renewable energy resource mapping in Canada with a focus on market drivers, limitations to mapping and barriers.[59]

In 2005, Premier Gordon Campbell, established the Alternative Energy and Power Technology Task Force to build an implementation plan based on the strategic plan previously released by the Premier's Technology Council, *A Vision for Growing a World-Class Power Technology Cluster in a Smart Sustainable British Columbia.*[60] The Task Force released *A Vision and Implementation Plan for Growing a Sustainable Energy Cluster in British Columbia* based on a series of formal and informal meetings, discussions, and interviews on dozens of topics with government, industry, NGOs, academia, outside expertise and best practices.[61] The provincial government should continue with its commitment and focus in developing the province's vast energy efficiency and renewable energy potential.

57 BC Hydro. "Net Metering." BC Hydro. www.bc.hydro.com/info/ipp/ipp8842.html (accessed October 18, 2006)

58 BC Hydro. "Net Metering." BC Hydro. www.bc.hydro.com/info/ipp/ipp8842.html (accessed October 18, 2006)

59 Commission for Environmental Cooperation (CEC). "Reviewing Gaps in Resource Mapping for Renewable Energy in North America." CEC. www.cec.org/pubs_docs/documents/index.cfm?varlan=english&ID=2021 (accessed October 18, 2006)

60 Premier's Technology Council. "A Vision for Growing a World-Class Power Technology Cluster in a Smart Sustainable British Columbia." www.gov.bc.ca/bcgov/content/docs/@2Ig53_0YQtuW/vision_for_bc_power_techv428.pdf (accessed October 18, 2006)

61 Altnerative Energy and Power Technology Task Force. "A Vision and Implementation Plan for Growing a Sustainable Energy Cluster in British Columbia." Alternative Energy and Power Technology Task Force. www.em.gov.bc.ca/AlternativeEnergy/AEPT_report.pdf (accessed October 18, 2006)

Wind

Societies have been using the power of the wind for more than 2,000 years, but wind as a source of energy for commercial electricity production did not come into its own until the early 1970s. The modern versions of windmills are called wind turbines. As of October 18, 2006 the installed wind capacity in Canada was 1,049 MW. However, there are no installed grid-connected wind turbines in BC.[62] In the recent BC Hydro call for power, three wind turbines won contracts for generation, which, when installed, will total approximately 325 MW of capacity.[63] Unlike many other provincial jurisdictions in Canada, BC has no specific target for wind energy.

The Technology

Wind turbines today come in a range of sizes, from the 400 watt turbine, designed for use at a cottage, to large commercial turbines of up to five MW capacity. Utility-size turbines are becoming increasingly larger to take advantage of economies of scale. Each model will have its own specific power curve, which indicates the power produced at varying wind speeds. In general, wind turbines start to produce electricity at winds as low as 13 km/h, but generally operate best in locations where the annual average wind speed is 20 km/h or greater. Production increases until wind speeds hit about 55 kilometers an hour. When winds blow at 90 kilometres an hour or more, most large wind turbines shut down for safety reasons. Wind turbines can be sited on and offshore.

Market Readiness

Wind power technology has achieved full commercial status and is able to compete with conventional energy sources for electricity generation in many locations. Competitiveness depends on the competing technologies and the market conditions for acquiring new power production. The cost of wind power in Canada ranges from six to 12 cents per kWh depending on the location and resource availability. This still exceeds the wholesale price of electricity in many jurisdictions. A substantial benefit of wind power is it is not subject to fuel cost variability once the turbines are installed.

Resource Potential

The suitability of a given site for a wind project depends on many factors, including wind resource, accessibility and proximity to transmission lines. BC is considered to have an excellent wind resource, particularly at three sites: the Peace region, North Vancouver Island and the Northern coast. Of these, the Peace region has the best access to existing transmission capacity.

In 2000, BC Hydro launched a wind monitoring initiative that saw the erection of wind monitoring equipment at a number of locations throughout BC. Currently, these stations have either been decommissioned or private parties are operating them. BC Hydro released a complete set of data up to August 2004, but will not be releasing any further data.[64]

In 2005, to fill the information gap, a report was completed by Garrad Hassan for BC Hydro, providing an assessment of the potential and estimated costs of wind energy in the province. It concluded that the province had an achievable wind potential of 5,000 MW, including 3,500 MW in the three onshore regions mentioned above, and 1,500 MW in offshore sites.[65] Added to this potential are the benefits of wind/hydro integration. BC is fortunate to have existing reservoirs that can capitalise on synergies

[62] CanWEA. "Canada's Current Installed Capacityr." CanWEA. www.canwea.ca/images/uploads/File/FACT_SHEETS/nouvelle_fiche_-_anglais_2.pdf (accessed October 18, 2006)

[63] BC Hydro. "CFT Results: F2006 Call for Power." BC Hydro. www.bc.hydro.com/info/ipp/ipp47608.html (accessed October 18, 2006)

[64] BC Hydro. "Wind Monitoring." BC Hydro. www.bc.hydro.com/environment/greenpower/greenpower1764.html (accessed October 18, 2006)

[65] Garrad Hassan. "Assessment of the Energy Potential and Estimated Costs of Wind Energy in British Columbia." BC Hydro. www.bc.hydro.com/rx_files/info/info26565.pdf (accessed October 18, 2006)

between wind and hydro energy sources. With large-scale wind development, BC Hydro can use its hydro reservoirs to support short-term wind output variations, and in turn use wind to support long-term variations in hydro levels.[66]

Environment Canada has also developed a Canadian Wind Energy Atlas, which is a web-based tool that allows the user to browse through results from previous numerical simulations to determine wind energy potential in a given site.[67] The atlas includes colour maps representing average wind velocity and power, as well as corresponding geophysical characteristics. A detailed assessment tool called Anemoscope has also been developed that allows users to identify areas best suited for wind farms at the meso (5 km) and micro scale (1 km to 100 m).[68]

Current Activities

Currently, one of the main opportunities for wind energy development is the awarding of contracts via BC Hydro's Open Calls for Power. The 2006 Call for Power process saw submissions from 53 separate projects, including six wind projects. Of these, three wind projects totaling 325 MW of installed capacity were awarded energy contracts.

The three projects — Dokie Wind, Bear Mountain and Mount Hays — will represent the first utility-scale wind projects in the province and mark a promising new era for wind as an important contributor to BC's energy needs. They will result in BC clean energy infrastructure investments of some $650 million and are projected to provide more than $100 million in direct provincial, regional and federal taxes and fees during their operational lives. The projects will also generate significant benefits and opportunities for local communities and First Nations.[69]

While the Calls for Power provide an opportunity for alternative energy sources in BC, there are still barriers for wind power development. The largest barrier identified by the CanWEA BC Caucus is the requirement in Calls for Power for a 'monthly firm bid' with liquidated damages for failure to supply.[70] CanWEA believes that there would be many more successful wind projects in Call for Power bids if such a requirement were modified to better reflect wind's characteristics (specifically, its variability).

On October 14, 2005 the Ministry of Energy, Mines and Petroleum Resources announced a new participation rent policy for wind power projects located on Crown land. The Ministry reports that it will ease the financial risk for wind power producers by offering no participation rents for the first 10 years of commercial operations.[71]

Future Needs

The recommendations for the development of the wind industry in BC provided here represent the needs identified by CanWEA's BC Caucus. They are provided here as the industry perspective and do not necessarily reflect the recommendations of the authors. CanWEA's recommendations include:

- Implement procurement processes that recognize wind's characteristics… CanWEA believes that the Call for Power process, as currently described, seriously disadvantages wind with respect to other technologies.

[66] Robert Hornung. "Letter to Honourable Richard Neufeld." CanWEA. www.canwea.ca/images/uploads/File/Wind_Energy_Policy/Provincial/BC/Letter_to_BC_Minister_of_Energy_-_March_14_-_Final.pdf (accessed October 19, 2006)

[67] Environment Canada. "Canadian Wind Energy Atlas." Environment Canada. www.windatlas.ca/en/index.php (accessed October 18, 2006)

[68] AnemoScope. "Wind Energy Simulation Toolkit." AnemoScope. www.anemoscope.ca (accessed October 17, 2006)

[69] Personal Communication with Canadian Wind Energy Association (CanWEA), August 9, 2006.

[70] Garry Hamilton. "Maximizing Green Power for Electricity Generation — Wind Energy" in *Maximizing Energy Efficiency and Renewable Energy in BC*, ed. Pollution Probe. www.pollutionprobe.org/Happening/pdfs/gp_march06_van/workshopnotes.pdf (accessed October 18, 2006)

[71] MEMPR. "Wind Power Policy Supports Alternative Energy Industry." *MEMPR News Release*, October 14, 2005.

CanWEA recommends that either a) subsequent Calls for Power be designed to better account for wind's characteristics; or b) the government mandate BC Hydro to issue a call for tenders specifically for wind capacity. The government may also, as in the case of Ontario, consider establishing a 'Standard Offer Contract' process to promote smaller wind projects, in addition to scheduled Calls for Wind Power over the next five to 10 years.

- Collaborate closely with the wind industry on development of BC's updated Energy Plan.[72]
- "Implement a streamlined permitting process. The current process, which is much more laborious than that found in other jurisdictions, hampers wind power development. Both federal and provincial reviews are required, and the number of new project proposals has meant that capacities at the Ministry in Victoria are insufficient to deal with applications in a timely manner. A long-term provincial commitment would create a stable investment context that could further the industry in BC."[73]

Ocean

The oceans contain vast quantities of energy embodied in waves, tides and ocean currents. So far, very little of what is available is being utilized. There are, however, a number of projects underway exploring how energy can predictably, perpetually, efficiently, effectively and economically be captured from waves and tidal currents. The energy source, the technology to capture it, and the status of the technologies varies in each project and in every jurisdiction.

The Technology

The focus on technology to harness tidal energy is on capturing power from the tidal stream (with related approaches to marine currents).

The 20 MW Annapolis Royal Tidal Power Generating Station in the Bay of Fundy in Nova Scotia is a pilot project built in the 1980s to demonstrate a barrage power system, which creates a dam to hold back water at high tide then releases it at low tide to generate electricity, similar to a large hydro dam. It is one of only three tidal barrage projects in the world.

The current generation of tidal technology extracts the kinetic energy using underwater devices similar to wind turbines. The blades or rotors are mounted on pilings or pads on the seafloor and are completely submerged in water where currents from tides have velocities of between two and three metres per second. This tidal stream technology is being tested at various locations around the world and is expected to be commercially available soon. Several companies in Canada are developing tidal stream technology, including Blue Energy, Clean Current, Coastal Hydropower and New Energy Corp. in British Columbia. The world's leading tidal power technology companies are expressing interest in exploiting BC resources.

Wave energy converters rely on the up and down motion between wave crest and trough to generate electricity. There are several types of systems: some extract the energy from surface waves, and others use the energy from pressure fluctuations below the water's surface or from the wave itself. Some systems are fixed in position, while others move with the waves. The more common methods used to capture the energy from waves include floats or buoys driving generators, or turning the wave motion into an oscillating water column forcing air back and forth through a generator-driving turbine.

The first wave energy farms are being planned for Portugal and Spain. These farms will be made up of multiple modules deployed in 50 to 100 meter depths, anchored, and sending power ashore by cable. SyncWave and AquaEnergy Canada are

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72 Robert Hornung. "Letter to Honourable Richard Neufeld." CanWEA. www.canwea.ca/images/uploads/File/Wind_Energy_Policy/Provincial/BC/Letter_to_BC_Minister_of_Energy_-_March_14_-_Final.pdf (accessed October 17, 2006)

73 Garry Hamilton. "Maximizing Green Power for Electricity Generation — Wind Energy" in *Maximizing Energy Efficiency and Renewable Energy in BC*, ed. Pollution Probe. www.pollutionprobe.org/Happening/pdfs/gp_march06_van/workshopnotes.pdf (accessed October 16, 2006)

working in BC on point absorber technologies, and other approaches are being tested in Eastern Canada. BC Hydro explored options for wave projects at Ucluelet in the early 2000s, attracting attention of local and international developers and creating an expectation in the community, both of which endure. Domestic and international developers continue to look actively at this and other high-energy areas on the BC coast.

Market Readiness

Most ocean energy technologies are still in the demonstration and pilot production phases and not yet able to provide commercially competitive power. A number of different approaches are likely to emerge for producing power efficiently and economically to suit different locations, scales, types of power or product outputs, etc. Several countries have been investing in ocean energy research and development (R&D) as they bid to become leaders in this emerging energy field. Industry representatives believe Canada has the potential to join the leading countries in this sector if sufficient R&D funding is made available; however, Canadian support for ocean energy technologies (i.e., wave power) has constituted only 0.18 per cent of all federal Canadian clean energy funding initiatives announced and funded since 2003.[74]

The International Energy Agency has forecast ocean energy cost reductions, coming with experience, that will make wave and tidal stream powered electricity generation cost competitive. Recent forecasts by the UK Carbon Trust and Electric Power Research Institute projects also suggest that this goal is reachable.[75, 76]

Resource Potential

Currently, the Canadian Hydraulics Centre of the National Research Council of Canada (CHC) is developing The Canadian Ocean Energy Atlas. The overall aim of the project is to quantify and map Canada's renewable energy resources from ocean waves and marine currents and make the results available to all Canadians through a digital ocean energy atlas.[77] Phase 1 of the project has been completed, providing information on Canada's potential from offshore wave energy and tidal current resources. Currently, Phase II is beginning.[78] Results estimate BC's potential offshore wave energy resources to be 37,000 MW in the Pacific and potential tidal current energy resources to be 4,015 MW.[79] Several of the tidal stream technology developers are looking at instream generation resources, such as rivers, irrigation canals, dam inflows and spillways. Technical approaches will be similar for use in ocean currents. These resources have not been identifies or assessed yet.

Current Activities

Several groups are active in ocean energy research in Canada, with some work carried out through the ocean technology clusters that make up the Ocean Science and Technology Partnership. The Clean Energy Centre and Ocean Engineering groups at UBC are engaging with the sector; several companies have tested at the UBC wave tank. The Integrated Energy Systems Group at the University of Victoria is actively involved in technology development, and student projects are assessing approaches to integrate wave and tidal power. The Ocean Renewable Energy Group (OREG) is another active organization with

74 Emile Baddour. "Ocean Energy: An Update." National Research Council Canada. www.pollutionprobe.org/Happening/pdfs/exploregpatlantic/baddour.pdf (accessed October 16, 2006)

75 Carbon Trust. "Future Marine Energy." Carbon Trust. www.oreg.ca/docs/Carbon%20Trust%20Report/FutureMarineEnergy.pdf (accessed October 16, 2006)

76 Electric Power Research Institute (EPRI). "EPRI Ocean Energy Program." EPRI. www.epri.com/oceanenergy/oceanenergy.html#reports (accessed October 16, 2006)

77 National Research Council-Canadian Hydraulics Center (NRC-CHC). "Low-Head Hydro: The Canadian Ocean Energy Atlas." NRC-CHC. www.nrcan.gc.ca/es/etb/cetc/cetc01/TandI/lowhead_ocean_e.htm (accessed October 16, 2006)

78 For updates and an overview of the project see www.oreg.ca/atlas.html

79 Andrew Cornett and Michael Tarbotton. "Inventory of Canadian Marine Renewable Energy Resources." NRCouncil-CHC. www.oreg.ca/docs/May%20Symposium/Cornett.pdf (accessed July 10, 2006).

industry, government and academic members. Its vision is a "Canadian sustainable ocean energy sector, serving domestic and export power needs and providing projects, technologies and expertise in a global market".[80] OREG has outlined a national target of 25,000 MW of installations by the year 2025. In March 2006, this group also released *The Path Forward. A Plan for Canada in the World of Renewable Ocean Energy*, which identifies immediate actions to develop the sector to ensure Canada's competitive position with industry leaders, such as the UK and other European Union countries. It sets out a broader sector development plan.[81]

The federal government has created an interdepartmental working group, the Federal Ocean Energy Working Group (FOEWG). As a result, Natural Resources Canada has now included ocean energy within the renewable energy initiatives and a number of foundation projects have been launched.[82]

The work by BC Hydro in the early 2000s has encouraged an ongoing interest in ocean energy within BC Hydro and the BC government. In 2005, the provinces of New Brunswick and Nova Scotia engaged in a study by the US-based Electric Power Research Institute. The 2006 presentation of results has stimulated intense interest in the region, by utilities, governments and industry, in moving tidal stream energy ahead.

Actual development of ocean energy projects has begun in BC. The Pearson College-EnCana — Clean Current Tidal Power Demonstration Project is expected to be completed in 2006. It will be Canada's first free-stream tidal power project. It is deployed in the ocean near Race Rocks Ecological Reserve, located ten nautical miles southwest of Victoria. It will have an installed capacity of 65 kW. In 2006, the project was expanded to include the installation of solar panels that will contribute at least 6.5 kW via a grant from the Ministry of Energy, Mines and Petroleum Resources.[83]

Sustainable Development Technology Canada (SDTC) has funded a tidal power generation project on the province's west coast. The project will install up to 500 kW of power-generating capacity in a narrow channel between Maude Island and Quadra Island, adjacent to Seymour Narrows, near Campbell River, BC.[84]

Future Needs

The below recommendations for the development of the ocean industry in BC represent the needs identified by OREG and do not necessarily reflect the recommendations of the authors.

In March 2006, OREG released *The Path Forward. A Plan for Canada in the World of Renewable Ocean Energy*, which outlines an action plan for ocean energy development in Canada that involves multi-stakeholder participation and a comprehensive range of action items. Topics outlined include: technology, sector building, research, testing and evaluation resources, business, delivering market products, creating investor value, bringing in the integrated companies, policy and regulatory environment, and integrating Canadian and international efforts.

OREG has also outlined a broad-range of action items that include

- The introduction of a policy that diversifies energy resources in BC
- Interconnection standards

80 OREG. "About." OREG. www.oreg.ca/about.html (accessed October 17, 2006)

81 OREG. "The Path Forward." OREG. www.oreg.ca/docs/OREG%20docs/OREG%20_The%20Path%20Forward_v7sm.pdf (accessed October 18, 2006)

82 OREG 2005. July 27, 2005. Vol. 1 Issue 5. OREG. www.oreg.ca/docs/Biweeklies/OREG%20BiWeekly%20July%2027.pdf (accessed July 10, 2006)

83 Pearson College. "The Pearson College-EnCana — Clean Current Tidal Power Demonstration Project at Race Rocks." Pearson College. www.racerocks.com/racerock/energy/tidalenergy/tidalenergy.htm (accessed October 18, 2006)

84 Sustainable Development Technology Canada (SDTC). "$48 Million in Clean Technologies Funding Approved by Sustainable Development Technology Canada." *SDTC News Releases*, July 5, 2006.

- Power purchasing agreements
- Higher pricing for pioneer ocean energy projects bridging to commercial pricing
- An RFP from BC Hydro targeted at pre-commercial technologies for demonstration and development purposes
- A development initiative for emerging energy options
- A streamlined R&D effort to avoid parallel work that would lead to the creation of a Center of Excellence for ocean energy in BC
- Facilitation of the regulatory process and creation of ocean energy development zones
- Funding initiatives, such as royalty holidays, grants, accelerated depreciation and green power credits.

Solar

Energy from the sun can be harnessed to warm residential buildings, heat water and generate electricity using three different methods: passive solar architecture, active solar heating and photovoltaic (PV) power generation. This section focuses on solar PV for electricity generation.

The Technology

Photovoltaic technology turns the radiant energy of the sun into direct current electrical energy. PV or solar cells are small semiconductor devices that produce a flow of electricity when the sun shines on them. They are module units that are grouped together to produce electricity in useful amounts. Photovoltaic modules can be integrated into buildings (rooftops and façades) and other structures and offset part or all of the associated electricity consumption. According to a recent study by Pelland and Poissant (2006), building integrated photovoltaics could supply about 46 per cent of the residential electricity needs of an average Canadian household.[85] In addition, photovoltaic systems can also be used as centralized power stations supplying electricity to the grid.

Market Readiness

Photovoltaic technology costs continue to be high, although they have seen a significant decline in the last 10 years since this technology has been promoted by a number of countries. For example, countries such as Japan, Germany, and the United States have established major programmes to promote solar roofs, resulting in more than 400,000 solar PV rooftop installations worldwide. PV is currently not very efficient, requiring a large surface area, which contributes to its high cost. PV panels available commercially today convert only 12 to 15 per cent of the sun's light into electricity, but research and development continues to improve these figures.

Resource Potential

Many people incorrectly believe that the solar energy resource in a temperate climate like Canada's is insufficient for running solar energy systems. In fact, the solar resource in Canada is generally very good and compares favourably with other regions of the world, due in part to its "clear-sky" climate.[86]

BCSEA reports that BC has an impressive solar energy potential, very similar to Germany, a world leader in solar energy installation and development.[87] BCSEA reports the provinces long-term PV potential to be 6,000 MW.

The BC Hydro Green Energy Study estimates residential building integrated PV (BIPV) to be 280 MW for detached or semi-detached homes, with a cost of between 90 and 110 cents per kWh, and 160 MW from BIPV for commercial

[85] Sophie Pelland and Yves Poissant. "An Evaluation of the Potential of Building Integrated Photovoltaics in Canada." CANMET Energy Technology Centre-Varennes, NRCan. http://ctec-varennes.nrcan.gc.ca/fichier.php/codectec/En/2006-047/2006-047_OP-J_411-SOLRES_BIPV.pdf (accessed October 18, 2006)

[86] World Energy Council. "Survey of Energy Resources. Solar Energy. Canada." World Energy Council. www.worldenergy.org/wec-geis/publications/reports/ser/solar/solar.asp (accessed October 18, 2006)

[87] BCSEA. "Huge Green Power Reserves Can Fuel Jobs, Economy." BCSEA. www.bcsea.org/media/051121-taskforcerelease.asp (accessed October 18, 2006)

buildings, with a cost of between 40 and 70 cents per kWh.[88] BC Hydro reports, from a utility perspective, that BIPV is not feasible for production of green energy in British Columbia due to limited resource potential and the high cost for electricity generation.[89]

Current Activities

Currently, solar panels are being incorporated into the Pearson College-EnCana — Clean Current Tidal Power Demonstration Project that will contribute at least 6.5 kW using a grant from the Ministry of Energy, Mines and Petroleum Resources.

The Ministry of Energy, Mines and Petroleum Resources is also involved in an education initiative called the BC Solar for Schools Project.[90] It is a "pilot programme developed to teach future generations about the potential of clean, solar energy to reduce greenhouse gas emissions and the threat of global climate change".[91] Currently, two BC schools have installed solar power systems.

Also, as of April 15, 2005, 12 PV projects had applied under the net metering programme. Of these 12, eight projects are generating electricity with an installed generation of 34.91 kW, and four projects, totalling 23.68 kW, need to sign an interconnection agreement.

The province also has two of the largest Canadian PV manufacturers, Xantrex and Carmanah Technologies. They are part of a growing number of globally competitive companies that export their products all over the world and benefit from the booming market where PV solar solutions are the best option.[92]

Future Needs

There are few technical barriers to solar energy applications — the technologies are market ready, but they are often poorly understood and up-front costs are still high. Supportive policies are needed to educate people about the benefits of PV and to help finance the up-front costs. Until the multiple benefits of solar energy are fully accounted for, including potential for offsetting energy demand, low maintenance requirements, no operation costs, long operating life and so on, the sector will not achieve its full technical potential.

Solar energy efficiency is affected by a number of factors, including climate, terrain, building and site suitability. Many of these can be easily addressed with careful planning and siting considerations. Municipalities are key players to support solar energy in urban settings since shading is an important concern. Suitable sites need to be identified, developed and protected from shading.

A representative from the Canadian Solar Industries Association (CANSIA) made the following recommendations for BC.[93] These recommendations represent an industry perspective and do not necessarily reflect the recommendations of the authors:

- Develop lower costs PV modules
- Ease borrowing
  - Low/no interest loans
  - Certification and licensing to reassure lenders
- Building Integrated Photovoltaic (BIPV)
  - Credit for building materials and labour costs
  - Raises a new barrier — compliance with building code

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88 BC Hydro. "Green Energy Study for British Columbia. Phase 2: Mainland." BC Hydro. www.bchydro.com/rx_files/environment/environment3927.pdf (accessed October 18, 2006)

89 BC Hydro. "Green Energy Study for British Columbia. Phase 2: Mainland." BC Hydro. www.bchydro.com/rx_files/environment/environment3927.pdf (accessed October 18, 2006)

90 MEMPR. "BC Solar for Schools Project." MEMPR. www.solarforschools.ca (accessed October 18, 2006)

91 MEMPR. "BC Solar for Schools Project." MEMPR. www.solarforschools.ca (accessed October 18, 2006)

92 Personal Communication with Natural Resources Canada, September 11, 2006.

93 CanSIA has also produced a strategy document, *Sunny Days Ahead — Insuring a Solar Future for Canada 25 Million Megawatt-hours by 2025*, see www.cansia.ca/downloads/sunnydaysahead.pdf.

- Increase market to realize economies of scale
  - Offer $0.43/kWh for 20 years
- Stop talking about payback, solar electricity is an investment
- Dispel myths

Biomass

Biomass is a blanket term referring to all organic matter. When referring to biomass as a renewable energy source, it includes plants, trees and residues from crops, such as corn stalks and wheat straw. It includes organic waste from municipalities and waste from forestry operations, including sawdust, timber slash and mill waste. Biomass is a very flexible renewable resource that allows various processes and uses. These include thermal, microbial and chemical processes that can be used for power generation, steel and cement making, transportation fuels, space heating, plastic, paints and chemical production. Currently, about six per cent of the total energy consumed in Canada is from biomass sources mostly for industrial process heat, electricity generation and residential space heating. Corn and other agricultural products are also used to generate ethanol and biodiesels for the transportation market.[94]

Biomass is a renewable energy source that is considered to be carbon neutral. When biomass is converted to energy the carbon dioxide it adds to the atmosphere is offset by the carbon dioxide than is sequestered when it was growing. If it is used as a substitute for fossil fuels for electricity generation, it will reduce greenhouse gas emissions. However, biomass power plants emit other criteria air pollutants. The amounts emitted depend on the type of biomass that is burned and the type of generator used. To be recognized as low-impact renewables under the Environmental Choice Program, biomass power plants must meet specific limits on the level of emissions of carbon monoxide (CO), particulate matter (PM), nitrogen oxides and sulphur oxides.[95] In BC, there are certified bioenergy-fuelled electricity plants and there is work being done on a biomass gasification plant. Gasification plants are usually low in air pollutant emissions.

Although not a focus in this paper, it is important to note that when biomass is used to generate electricity, the heat produced is equally important and can be used for heating purposes. Where this displaces the use of fossil fuels, there is a corresponding reduction in emissions of greenhouse gases and criteria air pollutants. This approach also increases the efficiency of the biomass. According to BIOCAP, traditional open-pit combustion of biomass offers an energy efficiency of about five to ten per cent. However, techniques such as gasification for power generation can bring the efficiency up to forty per cent, while combined heat and power extraction can capture 80 per cent of the total energy. Canada, for the most part, is failing to take advantage of this potential.[96]

The Technology

Biomass differs from other green power technologies, as human intervention is required for both the production of the energy resource and the conversion into electricity generation.

Biomass has a low energy density and high logistic costs. Focus is placed on efficient collection of biomass as well as the transportation and preparation of feedstock before converting it to energy. Transportation

[94] NRCan. "Improving Energy Performance in Canada — Report to Parliament Under the *Energy Efficiency Act* for the Fiscal Year 2004–2005." NRCan. http://oee.nrcan.gc.ca/Publications/statistics/parliament04-05/chapter7.cfm?attr=0 (accessed October 18, 2006).

[95] For more information on the specified limits for emissions see the Environmental Choice[M] Program Certification Criteria Document CCD-003 for the Product: Electricity — Renewable Low-impact. www.environmentalchoice.com/images/ECP%20PDFs/CCD_003.pdf#search=%22ECP%20CCD-003%20%22

[96] BIOCAP Canada. "Biomass: Key to a Clean Energy Future." BIOCAP Canada. www.biocap.ca/images/pdfs/Backgrounders/Biomass_Backgrounder.pdf (accessed October 18, 2006)

types and distances from feedstocks to electricity generating plants, need to be carefully considered due to associated air pollution and GHG emissions in the transportation process. Sustainable forest and air quality management are integral parts of large-scale biomass utilization for energy purposes.

Biomass is a clean fuel if processed and converted with modern techniques and currently can be combusted nearly as cleanly as fossil gas. Unfortunately, few high quality installations are found in BC.

There are several ways of turning biomass into heat and electricity, including direct combustion, anaerobic digestion, co-firing, pyrolysis and gasification. The simplest way of generating electricity from biomass is to burn it. This is called direct combustion. Any organic material that is dry enough can be burned. The heat, in some cases, is used to boil water to produce steam, which turns a turbine attached to a generator to create electricity. In many instances, the combined production of heat and power (CHP) provides heat for processes and heat for buildings and water. The basic biomass technology is not unlike that for fossil fuels used for electricity generation, such as coal. It is possible to burn both coal and biomass in some power plants in a process called co-firing. Solid biomass can also be converted to a liquid (in a process known as pyrolysis) or a gas (through gasification) and combusted. These latter two processes are less well established.[97]

Various technologies for biopower production have different efficiencies. Small combustion technologies are often less than 20 per cent efficient, whereas large combustion technologies can be as high as 40 per cent efficient, and gasification coupled with combined cycle could have an even greater efficiency.

Biomass technology is mostly developed in Europe where advanced research is done with large amounts of public and private sector funding. Recently, the focused has turned to cost reduction in feedstock preparation and transportation logistics, which are the main roadblocks for the faster employment of biomass for energy production. Research in these areas has begun at the University of British Columbia by the Biomass and Bioenergy Research Group at the Department of Chemical and Biological Engineering. Much of the focus is directed towards size reduction, densification, economic modeling and life cycle assessment. This parallels research in other forest-based economies around the world. Unfortunately, researchers have expressed concern that insufficient R&D resources are available in Canada for this research.[98]

Market Readiness

Biomass power production has many proven operations around the world, particularly in the United States and Finland. The majority are combustion operations, although gasification is becoming increasingly popular due to the substantially reduced air pollution emissions. While most of the technologies are market ready, continuing research is needed to increase the efficiency of technologies and maximize energy extraction.[99]

Resource Potential

Biomass is a significant producer of domestically used energy in BC and has the potential to develop in the short and medium term. Most of this energy is produced as process heat for the industry and is an integral part of the forest industry.

There are three biomass options available for BC These include wood fiber-based biomass, such as forest industry residues and fiber crops; agriculture-based biomass, such as cereal crops

[97] Personal Communication with Staffan Melin, Wood Pellet Association of Canada, September 20, 2006. For more information see www.pellet.org/Web/Page.aspx?Page=216

[98] Personal Communication with Staffan Melin, September 20, 2006.

[99] BIOCAP Canada. "Exploring the Potential for Biomass Power in Ontario." BIOCAP Canada. www.biocap.ca/files/Ont_bioenergy_OPA_Feb23_final.pdf (accessed October 18, 2006)

and residues, oilseed crops and animal effluent; and municipal biomass, such as municipal solids and municipal effluent.[100] BC Hydro's Green Study explored the following biomass options: wood residue, municipal solid waste (MSW), landfill gas (LFG), demolition and land clearing (DLC), and new technologies (gasification). Estimates in the Green Study for wood residue, DLC, LFG and MWS, are considered to be low by the biomass industry. A main source of contention when considering biomass resource potential are the divergent opinions regarding how much biomass can be harvested sustainably.

A multitude of wood fiber availability assessments have been done over the years, but none have been a comprehensive assessment of full biomass potential. Most of the assessments reflect the information or opinion of the industry involved in harvesting the forest under stationary conditions. These assessments have, in almost all cases, focused on the fringe volumes going to incinerators (beehive burners) or landfill and have not included the total biomass inventory.[101] The statistics for beehive burners tend to be less accurate as a result of the licensing structure to keep them open. The following graph illustrates the extraction of energy products (heat and electricity) from biomass as well as hydro and fossil gas in 2003 in BC and provides a perspective on the theoretical potential for biomass based on an annual harvest of 75 million cubic metres. As the harvest volumes are increasing, partly as a result of the mountain pine beetle (MPB) infestation, the volumes of biomass available on an annual basis is also increasing. Depending on the harvesting techniques used, some estimates indicate 40 to 50 per cent of the biomass from an average tree life cycle is left behind in the forest after harvesting.[102]

The mountain pine beetle infestation significantly has increased BC's biomass potential significantly, though it should be considered if this is the best use of the infested wood. About five per cent of the 960 million cubic metres of trees expected to be killed by 2012 would provide about 300 MW of electricity for 20 years at an estimated production cost of $0.07 per kWh.[103] Large amounts of biomass are also available in landfill sites in BC, with most of the carbon still remaining. This material could be mined and converted to energy with supportive policy mechanisms that could prevent.the release of methane, a gas with about 21 times higher global warming potential than CO_2, that is found in many landfull sites. In addition, BIOCAP[104] reports that there is significant potential for new biomass production for use as an energy resource though this is a contentious issue requiring thorough review. Examples include:

- **Intensive forest managemen**t (e.g., pre-commercial thinning, fertilization, replanting with superior or faster-growing genotypes) would increase forest biomass production by 25 per cent or more, and the additional biomass could be used as an energy resource without compromising the forestry sector production of wood products or pulp and paper. Given the current roundwood production in BC of 74 million m^3 per year with biopower potential of about 9,500 MW (assumes 40 per cent efficiency and 80 per cent capacity factor:
    - If a 25 per cent increase in biomass was allocated to provide an energy resource, this could support about 2,400 MW of renewable base load biopower capacity.
    - If a ten per cent increase in biomass capacity were allocated for electricity generation, this would support about 950

[100] John Swann. "Maximizing Green Power for Electricity Generation — Biomass" in *Maximizing Energy Efficiency and Renewable Energy in BC*, ed. Pollution Probe. www.pollutionprobe.org/Happening/pdfs/gp_march06_van/workshopnotes.pdf (accessed October 18, 2006)

[101] Personal Communication with Staffan Melin, September 20, 2006.

[102] Personal Communication with Staffan Melin, September 20, 2006.

[103] Amit Kumar, Shahab Sokhansanj and Peter Flynn. "British Columbia's Beetle Infested Pine: Biomass Feedstocks for Producing Power." BIOCAP Canada. www.biocap.ca/images/pdfs/2005-04-30_Final_Report.pdf (accessed October 18, 2006)

[104] The BIOCAP Canada Foundation funds research and build multisector collaboration on biomass capital in Canada. They provided the following calculations.

MW of renewable base load, biopower capacity.

- **For biomass crops**, the introduction of fast-growing, low-input biomass crops, such as willow, switchgrass or Miscanthus, could also provide a major biomass resource. Biomass crops can produce more than ten dry tonnes per hectare per year and can be grown on pasture lands, marginal agricultural lands and converted forest lands.
  - One million hectares could produce ten million dry tonnes per year that could provide 2500 MW of renewable base load, biopower capacity.
  - 100,000 hectares could produce one million dry tonnes per year that could provide 250 MW of renewable base load, biopower capacity.[105]

The question of optimal use for biomass resources needs to be addressed. Green power technologies, such as wind, solar, hydro, ocean and geothermal energies, can only be used as a source of electrical power or heat. Along with these functions, biomass can also provide liquid fuels, chemicals and materials. A study should be completed to identify where biomass resources could best be utilized. From a greenhouse gas perspective, the biggest return is for heat and power.[106]

A number of variable economic factors affect the potential for conversion of biomass to energy. The Wood Pellet Association of Canada has provided the following information: Due to gradual degradation, the MPB infested trees will not be suitable for lumber or pulp production for between three and seven years, depending on location. To prevent natural fires, the majority of the trees will have to be slash-burned, and replanting will be the provincial government's responsibility as the trees are located on crown land. The Wood Pellet Association of Canada has suggested that the BC government abolish the stumpage fee for much of the degraded tree stands and let the industry produce energy or pellets from the material. This would reduce the greenhouse gas emissions associated with slash burning or with the natural decomposition of the wood. The cost for harvesting and transporting such wood would be carried by the industry, but not the cost for building roads and reforestation. The government bureaucracy is not set up to handle this type of arrangement and is simply not able to respond to such proposals without policy directives at the minister level.

- A new forest management regime will emerge over time with a far more intensive extraction of low-grade material such as clearing, thinning (probably in several stages) and perhaps pruning in high value stands. This will produce biomass of commercial value and become part of the fire management of the forest.
- New harvesting machinery is constantly developed, which changes the economics of harvesting low-grade trees for direct conversion to chips or bundles for energy production.
- Decreased cost sensitivity for feedstock due to:
  - A gradual increase in market value of renewable energy as climate change mitigation policies are implemented which means less sensitivity to cost for feedstock.
  - New densification as well as liquification technology under development for wood will allow increased worldwide distribution of wood fuel and increased competitiveness with fossil fuel such as fossil gas and coal.
  - New low cost methods for increasing calorific value in bulk wood fuels will allow increased substitution of coal for heat and electricity production.
  - New methods for use of low-grade biomass, such as branches, tops, stumps and even needles in production of high-grade fuels will make available large amounts of harvest residue for energy purposes (see graph above).

[105] Personal Communication with Dr. David Layzell, BIOCAP Canada, September 21, 2006. For more information see www.biocap.ca/?index.cfmlg=f &meds=section&section=36&category=20

[106] D.G. Layzell and J. Stephen. 2005. "Climate Change and Managed Ecosystems" in *Linking Biomass Energy to Biosphere Greenhouse Gas Management*, ed. Jaqtar Bhatti, Chapter 11. CRC Press.

  - Better use of bark for commercial bio-fuels as a result of advances made in the thermal conversion stage.
- A substantial part of the stream of pulp chips will likely be diverted to energy production or wood pellet production due to the gradual decline in the requirement for long fiber in paper making (this trend is already very clear in North America and overseas, and will escalate. Over time, we may see more mill closures in BC).

Current Activities

There are approximately 1,500 MW of installed biomass electricity generating facilities capacity in BC.[107] The bulk of this power is from wood residue produced provincially at pulp and paper mills. It also includes 55 MW produced by independent power producers utilizing biomass technologies such as landfill gas.[108]

Several biomass projects have been awarded in BC Hydro's calls for Green Power Generation from independent power producers. In the 2000/01 call, one landfill gas cogeneration utilization project was awarded (5.0 MW capacity). In the 2002/03 call, one landfill gas project was awarded (1.85 MW capacity). And in the 2006 open call for power, one woodwaste and coal project was submitted, as well as two woodwaste projects.

In 2005, the Ministry of Forests and Range announced that some MPB infested wood in Prince George would be used to manufacture wood pellets to be used as biofuel in European power plants. On May 31, 2006, the Ministry of Forests and Range as well as Energy, Mines and Petroleum Resources, announced that a bioenergy strategy is being developed by the province "to promote new sources of sustainable and renewable energy, and to take advantage of pine beetle-attacked timber".[109] This follows several other strategies developed by the government over the years for better utilization of the significant amount of biomass available in BC.[110]

The dynamic development of the wood pellets industry in Canada, particularly in BC, is due to overseas export markets. The lack of domestic use indicates a need for the development and implementation of a renewable energy strategy that makes better use of this resource. Wood pellets are produced from sawdust and shavings from sawmills and planer mills as residue (also referred to as wood waste). In 1996, the wood pellets industry in BC produced less than 60,000 metric tonnes, and in 2005 production reached 650,000 tonnes. By the end of 2006, the production capacity will reach close to 900,000 tonnes annually, with high utilization levels due to overseas export markets. The consumption in BC is limited to approximately 20,000 tonnes in 2006, with little or no growth potential.[111]

Wood pellets are the most transportable of all bio-fuels and are distributed in small bags, jumbo bags, containers, tank trucks, rail cars and ocean vessels. With a new generation of robust pellets (primarily ligno-cellulose, but also herbaceous) coming to the market within the next five years, this product will become a major trading commodity since it can be used as a substitute for thermal coal with small modifications to the large coal burning plants world-wide.[112]

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[107] Forest Products Association of Canada. "Fact Sheet: Electricity Generation Within the Forest Products Industry. " (Ottawa: Forest Products Association of Canada, 2005).

[108] BC Hydro. "Green Energy Study for British Columbia. Phase 2: Mainland." BC Hydro. www.bchydro.com/rx_files/environment/environment3927.pdf (accessed October 18, 2006)

[109] Ministry of Forests and Range, MEMPR. "BC Develops Bioenergy Strategy to Include Beetle Wood." Ministry of Forests and Range, MEMPR. www2.news.gov.bc.ca/news_releases_2005-2009/2006FOR0056-000704.htm (accessed October 18, 2006)

[110] Personal Communication with Staffan Melin, September 20, 2006.

[111] Personal Communication with Staffan Melin, September 20, 2006.

[112] Personal Communication with Staffan Melin, September 20, 2006.

Future Needs and Considerations

These recommendations are from experts within industry and academia and do not necessarily reflect the recommendations of the authors:

Given the many different types of biomass resources found in a range of sectors from agriculture to municipal waste, there is no uniform biomass-energy-based industry in Canada, such as is found in almost all European countries. The industries' disparate nature and lack of incentives in Canada is a barrier to change. Better alignment is needed among the various areas, as well as a united voice that pushes for policy support. Particular areas needing attention include better resource assessment for sustainable production in all sectors and ensuring the generation of heat and/or electricity, or alternatively the conversion to commercial renewable fuels, close to source to reduce transportation costs. A stronger emphasis on energy in terms of heat applications (not only for electricity generation) is needed and should be developed by organizations other than electrical utilities.[113]

Costs can also be reduced through enhanced efficiency, for which more R&D is required. Public education and participation, as well as linkages with rural communities to ensure maximum local benefits are also important areas to explore in this sector.[114]

[113] Personal Communication with Staffan Melin, September 20, 2006.

[114] Personal Communication with Dr. David Layzell, September 21, 2006.

[115] Personal communication with Natural Resources Canada, September 13, 2006.

Small Hydro

Small hydro is the largest green power contributor in British Columbia. In 2004, Natural Resources Canada reported an installed capacity of 653 MW for sites less than or equal to 50 MW in size and an installed capacity of 244 MW for sites less than or equal to 25 MW in size.[115]

The Technology

Hydroelectric plants convert the potential energy of water to electrical energy by taking advantage of a drop in the elevation of the water. Some hydroelectric stations use a river's natural drop in elevation. Others use dams to raise water levels upstream of the station and increase the drop in height to produce more electricity and/or to store water and release it to produce electricity to match changes in demand. Hydropower developments with a low environmental impact are often termed "run of river," which refers to plants that use the flow of the river in a manner that does not appreciably alter the existing flows and water levels. Appropriate development of hydro resources can bring about environmental and socio-economic benefits through integrated design, multipurpose planning and community involvement.

Hydropower is generally divided into small and large capacity plants.[116] Definitions of small hydro vary in Canada and can refer to plants with capacities up to 50 MW. Low-head run-of-river (less than 15 metre drop) plants can have site capacities greater than 50 MW. The size of the hydropower project doesn't dictate its impact on the environment. Rather, the design of the project will determine the extent of flooding, displacement of communities and wildlife,

[116] Large hydro projects often require dams that may cause extensive flooding of environmentally sensitive areas. Dams and reservoirs may also destroy or alter fish habitat and migration routes for fish and wildlife, as well as require people to relocate their communities. Cumulative environmental impact of many small hydro sites on a river system could be significant. Small-capacity hydroelectric plants should not be looked at in isolation.

greenhouse gas emissions and other environmental considerations. Hydropower only in line with Canada's Environmental Choice EcoLogoM criteria is considered part of a green power package,

Market Readiness

Conventional hydropower technology is the most mature of all renewable electricity sources and is competitive with all other electricity technologies. To develop hydropower meeting the Environmental Choice Program (ECP) criteria, various techniques exist to minimize ecological impacts, but there are issues related to cost and efficiency. In addition, many low-head sites near urban centers have not been developed due to the higher cost of the large equipment.

Resource Potential

Small hydro resource assessment is considerably more developed than assessments for other green power technologies in BC. A number of initiatives have been taken, including *Inventory of Undeveloped Opportunities at Potential Micro Hydro Sites in British Columbia*, *Green Energy Study for British Columbia*, and *Green Energy Study for British Columbia (Small Hydro)*.[117] The Green Energy Study estimates a resource potential of approximately 2,450 MW, with production costs between $0.04 and $0.09 per kWh. Statistics Canada has also developed an inventory of existing sites and the Canadian Hydropower Association completed an inventory of hydropower potential in Canada in 2006. It should be noted that small hydro is defined as either less than 25 MW or 50 MW, depending on the agency.

Current Activities

In the 2000/01 BC Hydro call for power, 15 small hydro projects were awarded (total capacity 172.45 MW). In the 2002/03 call, 12 small hydro projects were awarded (total capacity 202.82 MW). And in the 2006 call for power, 29 hydro projects were awarded (total capacity 832.76 MW). In the three calls for power, small hydro comprised a larger portion of awarded contracts than other green power options.

Geothermal Electricity Generation

Currently there is no installed geothermal electricity generation in British Columbia.[118] However, the province has abundant geothermal resources.

The Technology

Geothermal energy uses large amounts of energy in the earth's crust in the form of steam or hot water to produce electricity. For geothermal facilities to be installed, local geography must have the right features. As geothermal energy requires a source temperature of more than 100°C, areas with recent volcanic activity offer high-grade resources.[119] There are three geothermal power plant technologies that include **dry steam,** in which the steam from the geothermal reservoir is routed directly through turbine/generator units to produce electricity, **flash steam plants,** in which water at temperatures greater than 182°C is pumped under high pressure to the generation equipment at the surface, and **binary cycle plants,** in which the water or steam from the geothermal reservoir

[117] BC Hydro. "Small Hydro Assessment Reports." BC Hydro. www.bc.hydro.com/environment/greenpower/greenpower1751.html (accessed October 18, 2006)

[118] Geothermal for electricity generation is dependent on indigenous resources referred to by scientists as the "geothermal gradient" meaning the increase of temperature with depth in the Earth's crust. The geothermal gradient is not uniform around the world though BC has a high geothermal gradient meaning temperature increases more rapidly with depth and there is potential for electricity generation. Comparatively, geothermal for heating and cooling uses the warmth of the Earth, groundwater and water in lakes to heat the air and water in buildings. This will be discussed in the Geoexchange section.

[119] NRCan. "About Earth and Geothermal Energy." NRCan. www.canren.gc.ca/tech_appl/index.asp?CaID=3&PgID=8 (accessed October 18, 2006)

never comes in contact with the turbine/generator units.[120]

Market Readiness

Geothermal sources for electricity generation are widely used throughout the world espeically in Asia, Europe, New Zealand, Mexico and the United States. The US Capacity is 2,800 MW, which is projected to increase by 50 per cent over the next five years.[121] Geothermal energy is also baseload power, with a capacity factor of approximately 100 per cent.

Resource Potential

In the Green Energy Study, BC geothermal potential was identified at between 150 and 1,070 MW, with production costs between $0.05 to $0.09 cents per kWh.[122] The Ministry of Energy, Mines, and Petroleum Resources has compiled a *Geothermal Resources Map*. [123]

Current Activities

Western GeoPower Corp. is currently assessing the potential for a 100 MW geothermal plant at South Meager, which is 170 kilometers north of Vancouver.

[120] US Department of Energy. "Geothermal Technologies Program." US Department of Energy. www1.eere.energy.gov/geothermal/powerplants.html (accessed October 18, 2006)

[121] Alyssa Kagel. "Geothermal Energy 2005 in Review, 2006 Outlook." Renewable Energy Access. www.renewableenergyaccess.com/rea/news/story?id=41267 (accessed October 18, 2006)

[122] BC Hydro. "Green Energy Study for British Columbia. Phase 2: Mainland." BC Hydro. www.bchydro.com/rx_files/environment/environment3927.pdf (accessed October 18, 2006)

[123] MEMPR. "Geothermal Resources Map." MEMPR. www.em.gov.bc.ca/Geothermal/GeothermalResourcesMap.htm.(accessed October 18, 2006)

Green Heat — Renewable Sources for Thermal Energy

The term Green Heat refers to renewable energy technologies that are used for heating and cooling. The main renewable sources used are solar thermal, geoexchange (earth energy systems) and biomass. This section is limited to brief summaries on solar thermal water heating and geoexchange.

Passive solar refers to architectural techniques used to capture the sun's energy without the use of mechanical equipment. These techniques rely on the design of buildings and the types of materials used to construct them. Through a combination of a high-performance thermal envelope, efficient systems and devices, and full exploitation of the opportunities for passive solar energy, as much as 50 to 75 percent of a household's building energy needs can either be eliminated or satisfied through passive solar means.[124]

Active solar energy systems use solar collectors to capture the sun's energy to heat air and water. In Canada, the most widely used active solar technologies heat air and water for use in houses, offices, factories and apartment buildings. There is substantial potential to offset polluting energy use through solar hot water heaters in residential, commercial and industrial settings.

The use of biomass is a more complicated issue and is not included in this section. For example, while the use of wood burning for home heating or other purposes can reduce greenhouse gas emissions where it replaces the use of fossil fuels, it can also increase criteria air pollutants. More work needs to be done to determine how to take advantage of the GHG reductions associated with biomass use for thermal energy while keeping the release of other air pollutants to levels that allow jurisdictions to meet their targets for reductions in criteria air contaminants.

[124] Cédric Philibert. "The Present And Future Use Of Solar Thermal Energy As A Primary Source Of Energy." The InterAcademy Council. www.iea.org/textbase/papers/2005/solarthermal.pdf (accessed October 18, 2006)

Solar Water Heating Systems

Water heating is one of the most cost-effective uses of solar energy. Solar water heaters can be used for residential, institutional and commercial water heating. Solar water heating systems offer a wide range of benefits. As they are not connected to the power grid, their use decreases electricity demand. If they replace the burning of fossil fuels for water heating (either directly or from electricity generation), their use reduces greenhouse gas emissions and criteria air pollutants. For residential installations, a solar water heating system can eliminate up to two tonnes of CO_2 emissions per year, in proportion to energy savings. Conventional water heating contributes about 19 million tonnes of GHGs each year to Canada's greenhouse gas emissions.[125]

The benefits can include considerable decreases in hot water heating costs, which account for approximately 22 per cent of energy usage in a Canadian home. The energy savings depend on the size of the collectors and storage tank, appliance efficiency, amount of sunlight in the region and the amount of water used.[126]

Canada has a low ranking for installed solar water heating systems, compared to other parts of the world. In 2001, Europe had an installed capacity of 6.4 m^2/1,000 people; China had an installed capacity of 3.9 m^2/1,000 people; and Canada had an installed capacity of 0.08 m^2/ 1,000 people. Europe and China have also set targets for 100 million m^2 by 2010 and 230 million m^2 by 2015, respectively.[127]

[125] NRCan. "Residential Sector — GHG Emissions." NRCan. http://oee.nrcan.gc.ca/corporate/statistics/neud/dpa/tablesanalysis2/aaa_00_2_e_4.cfm?attr=0 (accessed October 18, 2006)

[126] NRCan. "About Solar Energy." NRCan. www.canren.gc.ca/tech_appl/index.asp?CaId=5&PgId=121 (accessed October 18, 2006)

[127] Nitya Harris. "The Solar Hot Water Acceleration Project" in *Maximizing Energy Efficiency and Renewable Energy in BC*, ed. Pollution Probe. www.pollutionprobe.org/Happening/pdfs/gp_march06_van/workshopnotes.pdf (accessed October 17, 2006)

The Technology

There are different types of solar water heating systems, many of which use a small solar electric (photovoltaic) module to power the pump needed to circulate the heat transfer fluid through the collectors. The use of such a module allows the solar water heater to operate even during a power outage. There are generally three main components for all systems that include a solar collector (converts solar radiation into useable heat), a heat exchanger/pump module (transfers heat from solar collector into potable water), and a storage tank (stores solar heated water).[128] A solar water heating system will function during power outages if it has a photovoltaic pump. Solar water heating systems in Canada need a conventional system as backup for periods when there is no sunshine.

In addition to residential use, solar water heating systems can also be used in commercial applications, such as car washes, hotels and motels, restaurants, swimming pools, laundromats, fish hatcheries, apartment buildings, condominiums, university residences, the hospitality industry and so on. This technology can be applied to any commercial or industrial application using large amounts of hot water.[129]

Market Readiness

BC has been described as a good market for solar water heating systems. The Canadian Solar Industries Association (CanSIA) reports that solar water heating systems have the best energy price of any technology, with a comparative electricity cost of approximately five cents per kWh (BC's average rate is more than six cents per kWh). A residential installed system will typically cost about $5,000. One of the main challenges is a lack of financing mechanisms to assist in covering the upfront costs.

[128] NRCan. "An Introduction to Solar Hot Water Heating Systems." NRCan. www.canren.gc.ca/app/filerepository/BC4150C5F0A34FC7A872AA6039AB1904.pdf (accessed October 17, 2006)

[129] NRCan. "An Introduction to Solar Hot Water Heating Systems." NRCan. www.canren.gc.ca/app/filerepository/BC4150C5F0A34FC7A872AA6039AB1904.pdf (accessed October 17, 2006)

Resource Potential

There is immense resource potential in the province for solar water heating technologies. With proper financing mechanisms and an awareness campaign in place, solar water heating systems can provide significant reductions in electricity demand, which includes a number of spin-off benefits, such as a substantial decrease in projected resources required to maintain, upgrade and expand the transmission grid. NRCan estimates potential water heating energy savings from solar water heating systems installation to be 43 per cent in Vancouver and Kamloops, 39 per cent in Victoria, and 36 per cent in Prince George.[130]

Current Activities and Future Needs

These recommendations do not necessarily represent the views of the authors.

A Solar Hot Water Acceleration Project is currently underway in British Columbia, led by BCSEA. The project has a multi-stakeholder project advisory team.[131] The goal is to test the acceleration of the installation of solar hot water systems in communities in BC by identifying and removing the barriers. [132] A rebate of up to $900 is offered to the first 50 homeowners who are eligible from NRCan's REDI[133] Program in the province of BC.

BCSEA reports that the main challenges include the cost of systems, limited number of manufacturers, unavailability of CSA certified systems, limited number of qualified installers, no certified installers, and low awareness of solar water heating systems in most communities.[134]

Financing options have been suggested, such as interest-free loans or 'solar utilities', which provide financing with no up-front costs. For municipalities, local improvement charges could be implemented, enabling the municipality to buy solar water heating systems that would then be paid back by residents via a user tax. The certification of systems is also strongly needed for several reasons, including the difficulty for building inspectors faced with uncertified systems. Currently, BCSEA is working with local colleges to train solar installers. BCSEA is increasing awareness with the municipalities of Dawson Creek and the City of Vancouver, and also through the energy efficiency programme at the Ministry of Energy, Mines and Petroleum Resources.[135]

The success of the Solar Hot Water Acceleration project has enabled BCSEA to target a 100,000 Solar Roofs Program in BC. To reach the 100,000 solar roofs target, BCSEA supports three policy measures that include, standard offer contracts (including the heat portion of renewable energy systems); regulations requiring solar thermal for new residential buildings, such as the Barcelona Solar Thermal Ordinance; and financial incentive programmes for solar water heating systems.[136, 137]

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130 NRCan. "Solar Water Heating Systems." NRCan. www.canren.gc.ca/app/filerepository/AC5201041AFA42A1BFD51EA128F787CF.pdf (accessed October 17, 2006)

131 BCSEA. "Solar Hot Water Acceleration Project." BCSEA. www.solarbc.org (accessed October 17, 2006)

132 Nitya Harris. "The Solar Hot Water Acceleration Project" in *Maximizing Energy Efficiency and Renewable Energy in BC*, ed. Pollution Probe. www.pollutionprobe.org/Happening/pdfs/gp_march06_van/workshopnotes.pdf (accessed October 17, 2006)

133 NRCan. "Renewable Energy Development Initiative (REDI)." NRCan. www2.nrcan.gc.ca/es/erb/erb/english/view.asp?x=455 (accessed October 17, 2006)

134 Nitya Harris. "The Solar Hot Water Acceleration Project" in *Maximizing Energy Efficiency and Renewable Energy in BC*, ed. Pollution Probe. www.pollutionprobe.org/Happening/pdfs/gp_march06_van/workshopnotes.pdf (accessed October 17, 2006)

135 Nitya Harris. "The Solar Hot Water Acceleration Project" in *Maximizing Energy Efficiency and Renewable Energy in BC*, ed. Pollution Probe. www.pollutionprobe.org/Happening/pdfs/gp_march06_van/workshopnotes.pdf (accessed October 17, 2006)

136 REN21. "Policy Landscapes/Solar Hot Water/Heating Promotion Policies." REN21. www.ren21.net/globalstatusreport/gsr4c.asp (accessed October 17, 2006)

137 Nitya Harris. "The Solar Hot Water Acceleration Project" in *Maximizing Energy Efficiency and Renewable Energy in BC*, ed. Pollution Probe. www.pollutionprobe.org/Happening/pdfs/gp_march06_van/workshopnotes.pdf (accessed October 17, 2006)

Geoexchange

Geoexchange technologies, also known as earth energy systems or ground/water-source heat pumps, are used for space conditioning and hot water heating in buildings and homes. Much like solar water heating systems, geoexchange systems can provide reduced demand for electricity and other conventional fuel sources and provide substantial savings to home and businesses owners over the long term. BC Hydro estimates a savings of more than 50 per cent on heating costs in comparison to electric resistance heating, such as with an electric furnace, and up to 30 per cent on air conditioning costs.[138]

Significant GHG reductions can be achieved. In fact, geoexchange systems are touted as having the single largest GHG mitigating potential of all market-ready, building space conditioning systems. The Canadian Geoexchange Coalition (CGC) reports, "the average home in Canada (i.e., 2500 sq. feet) can reduce carbon dioxide (CO_2) emissions by 2.5 to 5 tonnes annually by using geoexchange technology instead of electric heat or fossil fuels".[139]

The Technology

Geoexchange technology uses heat from the earth, ground water or surface water that has temperatures that are a constant seven to 13 degrees Celsius year-round (or any other readily available thermal source/sink) for space heating, cooling and water heating for both residential and commercial applications.

Heat is collected and transferred from the earth/water/thermal source via a series of fluid-filled pipes that run to a building; the low temperature sourced heat is then compressed and the temperature is raised for inside use. Heat is not created through combustion, but instead is transferred from the thermal source to the building through the use of a heat pump system (making this a renewable energy source). For cooling purposes, the system flow is reversed, thereby transferring the heat from the building to the ground/water/thermal sink where it is absorbed. Therefore, one system can be used for space heating, cooling and hot water heating. Unlike conventional systems, a slightly lower temperature, but a steady stream of heat, is transferred into the building and therefore does not offer a blast of heat, we with more common systems. Geoexchange systems are ideally suited for hydronic radiant in-floor heating/cooling, heating tubes in laneways to melt snow in the winter, hot water for outside hot tubs, capturing and transferring underutilized thermal sources (such as the heat removed from an arena ice slab and used to heat an adjacent pool) and energy to heat domestic/commercial hot water.[140]

Market Readiness

Geoexchange systems are more widely used in commercial and multi-residential buildings than in residential homes. The main commercial installations include factories, retail stores, office buildings, recreational facilities and schools.[141] Aside from condominiums, cluster housing capable of using a district system, and large single family homes, the main barrier to widespread installation for residential units is a lack of financing mechanisms to cover the up-front costs. Installation costs are approximately $13,000 to $15,000 for a 2,000 square foot house. GeoExchange BC has developed an *Inventory of GeoExchange System Installations in BC* that includes a listing of known commercial and multi-residential geoexchange projects in the province. A total of 72 installations are listed that are either operating or in the construction phase, demonstrating an increasing interest.[142]

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138 BC Hydro. "Geothermal Heat Pumps." www.bchydro.com/powersmart/elibrary/elibrary685.html (accessed October 18, 2006

139 Canadian GeoExchange Coalition (CGC). "FAQ — General Questions." www.geo-exchange.ca/en/whatisgeo/faqs.htm (accessed October 18, 2006)

140 NRCan. "About Earth and Geothermal Energy." www.canren.gc.ca/tech_appl/index.asp?CaId=3&PgId=8 (accessed October 18, 2006)

141 Canadian GeoExchange Coalition (CGC). "FAQ — General Questions." www.geo-exchange.ca/en/whatisgeo/faqs.htm (accessed October 18, 2006)

142 GeoExchange BC. "Inventory of GeoExchange System Installations in BC." GeoExchange BC. www.geoexchangebc.ca/resourcedir/InstallationsBC.pdf (accessed October 18, 2006)

Resource Potential

There is immense resource potential for geothermal systems in BC. Because geoexchange systems are highly versatile, adaptable and capable of tapping onto a wide array of thermal sources/sinks, there is essentially a design appropriate for any conceivable application. Depending upon the conditions that prevail for each specific site, the size and type of system may be easily adapted. It is interesting to note that even sewer and water mains and road surfaces are currently being tapped as thermal sources/sinks.

Current Activities and Future Needs

These recommendations are based on multi-stakeholder input and do not necessarily represent the views of the authors. There are some programmes in place that help overcome the financing barriers that exist for new and retrofit geoexchange installations. The BC Ministry of Provincial Revenue has exempted qualifying geoexchange systems from the social service tax (PST) if purchased or leased for residential purposes during the period from February 16, 2005 to April 1, 2007. Also, BC Hydro's High Performance Buildings Program (new construction) provides incentives for geoexchange systems, both for simulation studies and electricity conservation-based incentives.

The private sector is offering financing mechanisms to cover installation costs for residential and commercial applications, such as installing the exterior ground loop portion of the geothermal system for the customer and then maintaining and leasing it to them. Other companies are offering competitive financing options, and some financial institutions are now recognizing geoexchange as a reputable system and are offering conventional loans for their installation.

Further financing mechanisms have been implemented by private energy utility infrastructure companies that provide funds for the installation of multi-unit residential projects, including subdivision, single family and commercial projects. The company owns and operates the system. Clients make monthly payments, which are fixed to the cost of living increases. Utility costs are lowered and the key barrier to geoexchange installation (large upfront infrastructure costs) is overcome. This type of financing structure can be modeled in various ways as each project may have different and unique characteristics.

Part 4: Broadening Involvement in Energy Efficiency and Renewable Energy

This section reviews some of the current and potential actions on energy efficiency and renewable energy outside of utilities and provincial governments. It provides examples of how a broader community of stakeholders can be involved and further integration between efficiency and renewable energy can be achieved. This is a key contribution to widespread development of both efficiency and renewable energy.

Net-Zero Energy Homes

Overview

"A net-zero energy home at a minimum supplies to the grid an annual output of electricity that is equal to the amount of power purchased from the grid. In many cases, the entire energy consumption (heating, cooling and electrical) of a net-zero energy home can be provided by renewable energy sources".[143]

There is growing interest in applying available energy efficiency and renewable energy technologies to develop buildings that use net-zero energy. While there are some net-zero energy buildings in use now, we need to work towards this target for building on a commercial scale. At the international level, the World Business Council on Sustainable Development (WBCSD) is leading an initiative to map out how to transform the building industry to move towards net-zero buildings, to identify the barriers and to develop mechanisms to address them.[144]

The successful construction of residential homes that attain a 'net-zero energy' status requires the integration of numerous technologies and design parameters across the entire home, including well-insulated walls, proper ventilation and heat exchange, highly efficient appliances, and electricity generated from one or more renewable energy sources. The package of systems that eventually comes together to form a net-zero energy home can vary significantly and will depend on a variety of factors, including size and construction of home, cost, location and access to resources. Net-zero technologies include: a minimum R2000 or higher energy-efficient building standard, Energy Star appliances, photovoltaic roof, passive solar heating and solar daylighting, earth energy systems, heat recovery technologies and solar thermal. Most importantly, these technologies and design parameters already exist today and have been successfully implemented and proven in a wide variety of climates in Canada and around the world.[145]

In Canada, in 2004, the Net-Zero Energy Home (NZEH) Coalition was formed with the intention to promote the use of existing renewable energy technologies and energy efficiency/conservation technologies for the construction of homes that consume no energy on an annual net-basis and significantly reduce greenhouse gas emissions. Members of the Coalition include: home builders, industry, not-for-profit organizations, utilities and government. Demonstration initiatives have been developed with the support of Canada Mortgage and Housing Corporation (CMHC), Natural Resources Canada, Industry Canada and Environment Canada.[146] The coalition's vision is for all new home construction to be net-zero energy homes by 2030.

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143 Net-Zero Energy Home Coalition (NZEH). "What is a net zero energy home." www.netzeroenergyhome.ca (accessed October 18, 2006)

144 GreenBiz.com. "Top Global Companies Join Forces to Make 'Net-Zero' Buildings a Reality." GreenBiz.com. www.greenbiz.com/news/news_third.cfm?NewsID=30713&CFID=14603724&CFTOKEN=91835526 (accessed October 18, 2006)

145 Delphi Group. "Net-Zero Energy Home: A Sustainable Energy Solution for Canada." Industry Canada. www.netzeroenergyhome.ca/downloads/government%20report%20on%20workshop_e.pdf (accessed October 18, 2006)

146 Net Zero Energy Home Coalition. www.netzeroenergyhome.ca/index.htm

Current Activities

On July 20, 2005, the Ministry of Labour and Housing announced one million dollars in funding through CMHC to launch the first phase of a Canadian net-zero energy healthy housing initiative facilitated through a government/industry partnership. The initiative is "designed to help reduce the energy intensity of Canada's housing sector, support the growing renewable energy and sustainable housing industries, and help Canada meet its goal of reducing GHG emissions".[147] There are three phases associated with the pilot demonstration phase that include, phase I — request for expressions of interest (May 15–July 10, 2006); phase II — design development (July 31–November 6, 2006); and phase III — construction demonstration monitoring (December 2006–July 2009). The demonstration projects will provide exposure to markets, capacity development, and a platform for larger scale grid-tied systems helping minimize strain from taxed electricity grids, thus facilitating the transition to a sustainable electricity system.[148] Twenty teams have been selected to proceed to the second phase to develop and submit a detailed design for their demonstration projects by November 2006. These include three teams from British Columbia-Quiniscoe Homes Ltd, TQ Construction Ltd. Sustainable Building Centre (SBC) Brantwood and Dockside Green Ltd.

Barriers

A number of barriers will need to be addressed to build net-zero energy homes on a commercial scale. There are long-term investment risks for builders and manufacturers — especially for suppliers in Canada that do not have export capacity, as the domestic market is not well developed. Other challenges include the absence of existing guidelines or standards to enable proper valuation of net-zero energy homes — financial institutions require this certainty to consider financing options, such as green mortgages; and risks associated with the high level of uncertainty in the regulatory and operating environments in Canada, such as metering and building codes. Builder risks include capital costs and initial minimal utilization.[149]

Policy and Support Recommendations

Recommendations include: energy balancing through the grid, net metering and feed-in-tariffs, which give customers full credit for energy produced; and time-of-use metering, which encourages consumers to match energy load with energy production. BC has implemented net metering. Government support has proven to be the key to successful deployment in other jurisdictions. The Government of BC should provide financial support for early adopters, to clear up regulatory and institutional bottlenecks, and to work with stakeholders to create a roadmap. The NZEH coalition is currently providing "a window of expertise and advice" for the net-zero energy homes strategy. A collaborative approach with the coalition should be undertaken by the province to develop supportive policies and programmes.

Cooperatives

Overview

The cooperative development model for renewable energy usually means local ownership of the project that can be set up by locals or a specialist developer. To date, cooperative development for renewable energy has been largely focused on wind power. It began in the 1970s in Denmark, where today co-ops are responsible for installing 80 per cent of the

[147] Government of Canada. "Minister Announces Funding for Sustainable Housing." *Government of Canada News Releases*, July 20, 2005.

[148] Konrad Mauch. "Maximizing Green Power for Electricity Generation — Wind Energy" in *Maximizing Energy Efficiency and Renewable Energy in BC*, ed. Pollution Probe.

[149] Konrad Mauch. "Maximizing Green Power for Electricity Generation — Wind Energy" in *Maximizing Energy Efficiency and Renewable Energy in BC*, ed. Pollution Probe.

country's turbines. This has facilitated turbine manufacturing, the creation of an industry, and Denmark's leading position in wind turbine manufacturing in the world. In Germany, the world's single largest market and world leader in installed wind power capacity (18,427.5 MW as of December 2005), approximately one-third of all wind capacity has been built by associations of local landowners and nearby residents.

Cooperative development has been demonstrated to overcome objections at the local level, also known as not-in-my-backyard (NIMBY syndrome). The NIMBY syndrome has the power to halt renewable energy development. In the UK in the late 1990s, two-thirds of all wind projects were halted at the permitting level. Ontario is beginning to experience this as projects announced from a tendering process are being built. Cooperative development also provides increased benefits for local populations by allowing them to directly invest and benefit from the projects their communities host.

Renewable energy cooperative development began in Canada in 2003, when the world's first urban wind turbine was erected on the Toronto waterfront by the Toronto Renewable Energy Co-operative (TREC). Ed Hale, Director of TREC has outlined the differences between cooperatives and business corporations in the table below.

From TREC's work, the Ontario Sustainable Energy Association (OSEA) was formed to implement community sustainable energy projects across Ontario and serve as an advocate for renewable energy community ownership. OSEA has been building a network of communities that are pooling information and experiences towards the development of cooperative renewable energy projects. OSEA was the main advocate for the recently introduced Standard Offer Contract (SOC) programme in Ontario that guarantees a pre-determined price for renewable energy projects less than 10 MW and guarantees connection to the transmission grid. The policy has been modeled after Germany's feed-in tariff law, one of the main drivers in Germany's widespread development of renewable energy.

The Val-Eo Cooperative in Quebec is also developing a cooperative model for wind resource development with financial support from Government of Canada's Cooperatives Secretariat under the Cooperative Development Initiative. Funding has also been allocated to share the model with communities in Quebec and the rest of Canada.[150]

Co-op Model: Key Differences

Co-operatives (share cap)	Business Corporations
One Member One Vote	Voting power linked to capital invested
Board comes from membership	Directors may not have stake in corporation
Members must vote on bylaws	Board controls bylaws
Limited liability	Limited liability
Taxable income	Taxable income
Securities subject to Financial Securities Commission of Ontario; capital can be raised more easily from community	Securities subject to Ontario Securities Commission; tight rules on raising of capital

[150] Renewable Energy Access. "Canadian Cooperative Share Wind Project Development Model." Renewable Energy Access. www.renewableenergyaccess.com/rea/news/story?id=45385 (accessed October 18, 2006)

Current Activities

In BC, the Peace Energy Cooperative was established in 2002. The group's major project is establishing a wind park on Bear Mountain near Dawson Creek. In partnership with Aeolis Corp., the Peace Energy Cooperative holds a minority share in the Bear Mountain wind project that received a power purchasing agreement from BC Hydro in the 2006 call for power. Permitting and financing for the project are now underway.

Barriers

Barriers include a lack of political will, organizational and development expertise, enabling policy from government, and startup capital.[151]

Policy and Support Recommendations

The following recommendations represent the views of an industry representative and do not necessarily reflect those of the authors. Two primary conditions need to exist for widespread cooperative development — a contract to purchase renewable energy power with a guaranteed price before project development (standard offers) and guaranteed connection to the transmission grid. Currently, the province introduces new generation through a request for proposals (a tendering process), which cooperatives are not able to bid into. For widespread cooperative development to occur, policy to support the use of standard offers should be introduced. The key differences between the request for proposals and standard offers is listed in the table below.

Accompanying supportive policies should be developed, such as net metering, which the province has established.

Knowledge barriers can be overcome by establishing training programmes for organization structure, project evaluation, permitting processes and equipment evaluation and selection. A start-up capital fund needs to be established, as well as coordination among groups to facilitate resource and knowledge sharing.[153]

Financial barriers can be overcome by the establishment of a Cooperative Fund for Community Power, as community groups do not have access to the venture or risk capital available to commercial corporations. Initial incorporation and studies are required before community investment capital can be raised.[154]

Request for Proposals	Standard Offers
High submission cost	Low submission cost
Time sensitive, financial uncertainty	Always open
Requires financial guarantees	All completed projects eligible
Suitable for projects >50MW	Can work for large or small projects
Projects only viable in the best sites	Incentives for distributed generation
Too uncertain to attract manufacturing	Encourages local manufacturing[152]

[151] Ed Hale. "Maximizing Green Power for Electricity Generation — Wind Energy" in *Maximizing Energy Efficiency and Renewable Energy in BC*, ed. Pollution Probe.

[152] Ed Hale. "Community Wind Development." Ontario Sustainable Energy Association. www.pollutionprobe.org/Happening/pdfs/gp_march06_van/hale.pdf (accessed October 18, 2006)

[153] Ed Hale. "Maximizing Green Power for Electricity Generation — Wind Energy" in *Maximizing Energy Efficiency and Renewable Energy in BC*, ed. Pollution Probe.

[154] Ed Hale. "Maximizing Green Power for Electricity Generation — Wind Energy" in *Maximizing Energy Efficiency and Renewable Energy in BC*, ed. Pollution Probe.

First Nations

Overview

First Nations Communities in BC are significant and active stakeholders in the development of energy efficiency and renewable energy. In the province, there are 198 First Nations (most not under treaty) and almost 500 reserves, with many groups organized under tribal councils. For BC's off-grid First Nation communities (approximately 20), two major concerns are the high costs and environmental impacts associated with diesel generators.

Many First Nations are interested in pursuing energy efficiency and renewable energy projects as a means to reduce energy costs, develop local economies and increase local sovereignty over their energy supply, while reducing the environmental impact on their traditional lands. Some sustainable energy options include: energy efficiency technologies and management practices, green power, and district heating. There are numerous opportunities for distributed generation in non-grid connected communities.

Current Activities

Both the provincial and federal governments have been active in facilitating development. Indian and Northern Affairs Canada (INAC) developed a four-year (2004–2008) national Aboriginal and Northern Community Action Program (ANCAP). In August 2003, the Government of Canada announced new funding totaling approximately $30.7 million over four years for climate change and energy initiatives in Aboriginal and northern communities. ANCAP is focused on engaging Aboriginal and northern communities in all provinces and territories to become active partners in climate change action. Many First Nations in BC have taken advantage of this programme, which grants up to $250,000 for large projects, although typically the projects have been much smaller.

The provincial government has committed to training programmes for Aboriginals and enhanced First Nations consultation by engaging the community in various initiatives, such as the Integrated Electricity Plan.

The First Nations Community convened an Energy Summit in October 2006 in Prince George. The First Nations Summit and the Union of BC Indian Chiefs were mandated by resolution to convene the summit and develop a BC First Nations Energy Plan.

BC Hydro has also awarded several green power projects in the ongoing Green IPPS, such as the China Creek Hydro Project developed by Hupacasath First Nation in Port Alberni where 72.5 per cent of the Upnit Power Corporation is owned by the Hupacasath First Nation.

The Squamish First Nation has developed five run-of-river projects totally 104 MW and is developing another 49 MW run-of-river project that is currently waiting for rezoning.

The Xeni Gwet'in First Nation is planning to reduce its consumption of diesel by including PV-genset hybrids in a community plan.[155, 156] About 30 residences would use the PV-hybrid systems. This is a demonstration project partly funding by Xantrex and the Government of Canada's Technology Early Action Measures (TEAM) programme. TEAM is an interdepartmental technology investment programme that supports projects designed to demonstrate technologies that mitigate greenhouse gas (GHG) emissions and sustain economic as well as social development.[157, 158]

The Ministry of Energy, Mines and Petroleum Resources is completing its *First Nation and Remote Community Clean Energy Program*, which will implement renewable energy and energy

155 Personal Communication with Natural Resources Canada, September 11, 2006.

156 For further information on the Xeni Gwet'in First Nation see http://www.xenigwetin.com

157 Personal Communication with Natural Resources Canada, September 11, 2006.

158 For further information on the program see www.xantrex.com/DocumentDepot/press/08222006.pdf

efficiency in several First Nations communities. The incentive level for the projects will be calculated on the basis of the total electricity and emissions impacts anticipated in the first year of project operation. This includes the displacement of diesel-fired electricity supplies in remote communities (i.e., off the integrated BC Hydro electrical grid) and the displacement of fossil-fuelled generating stations on the integrated system (e.g., natural gas turbines). The displacement must be achieved with zero-emission, alternative energy resources or energy-efficient technologies and management practices that promote energy conservation.[159]

The Ministry also initiated the First Nations and Remote Community Clean Energy Program in 2006. The programme supports BC First Nations in the implementation of their Community Energy Planning action plans. The programme also provides financial incentives (totalling $3.8 million) to ten First Nations communities who develop and implement zero-emission electricity supply projects and demand-side efficiency and management options. The incentives will be applied to the communities' clean energy project capital costs and, to a maximum of 20 per cent of eligible costs, local training in the field of alternative energy and energy efficiency, leading to increased employment opportunities.[160]

The incentive rates for displaced fossil fuel-derived electricity are as follows:

- Large projects in remote communities — over 1 million kilowatt-hours (kWh) of annual output: 0.30 $/kWh generated in the first year of operation
- Small projects in remote communities — under 1 million kilowatt-hours (kWh) of annual output: 0.45 $/kWh generated in the first year of operation
- Projects on the integrated grids — BC Hydro or Fortis BC: 0.15 $/kWh in the first year of operation

BC Hydro has launched a Remote Community Electrification programme to ensure remote communities currently not served by BC Hydro receive electric service. In 2006, BC Hydro communicated with 50 to 60 First Nations and six civic communities. Questionnaires were completed and workshops were held that included an opportunity for First Nations communities to give feedback on BC Hydro's electrification eligibility criteria and to assist in creating prioritization criteria. An agreement was reached that the communities who could demonstrate the greatest hardship and a good level of commitment would take priority. A target has been established to connect three communities per year for the first four years that will increase to ensure 50 communities, 26 of which are First Nations, are electrified in the next 10 years. Priority connection for First Nations communities has not been established but seven of the first eight communities are First Nations.[161]

Barriers

Barriers to the implementation of renewable energy technologies and energy efficiency improvements faced by on-grid communities and off-grid communities vary considerably. While some First Nations communities (both on and off-grid) are leading the way in terms of renewable energy and energy efficiency, others face unemployment and a lack of local financial and human resources, which can lead to limited capacity to pursue these projects.

Funding presents a challenge to First Nations communities' involvement in renewable energy and energy efficiency in three main ways:

1. Indian and Northern Affairs Canada (INAC) funding approach — The current funding

[159] MEMPR. "Annual Service Plan Reports." MEMPR. www.bc.budget.gov.bc.ca/Annual_Reports/2005_2006/empr/Highlights_of_the_Year.htm (accessed October 18, 2006)

[160] MEMPR. "Annual Service Plan Reports." MEMPR. www.bc.budget.gov.bc.ca/Annual_Reports/2005_2006/empr/Highlights_of_the_Year.htm (accessed October 18, 2006)

[161] BC Hydro. "Report on Performance. Remote Community Electrification." BC Hydro. www.bchydro.com/info/reports/2005annualreport/report39496.html (accessed October 18, 2006)

formula used by INAC for energy costs hides the full costs of energy consumption from individual band members and therefore limits the individual benefits that can be seen by reducing energy consumption. In some extreme cases, the funding formula can actually encourage energy consumption to provide more budgeting flexibility in upcoming years. In addition, capital funding decisions do not necessarily consider the full life-cycle cost of a project. As renewable energy projects often have higher initial costs, but lower operating costs over time, these options can be overlooked.

2. Limited funding for alternative energy projects — First Nations face challenges in securing financing for renewable energy and energy efficiency projects as funders and financers tend to be less familiar with these types of projects than with conventional energy systems.

3. Overlapping jurisdictions — Within INAC, renewable energy projects can fall under Capital Projects, Economic Development, Public Works and even Claims, making the administrative navigation cumbersome. There are also overlapping provincial and federal jurisdictional issues, which further complicate the process.

Off-grid communities also face a number of challenges related to diesel generator use. Generators are sometimes oversized to meet peak demand. However, generators have a declining lifespan and efficiency if run below capacity. As a result, energy consumption is increased to ensure that the generator's lifespans are not reduced; this is a direct disincentive to conserve energy.

Policy and Support Recommendations

Policy support and recommendations to increase the use of renewable energy and energy efficiency in First Nations communities are as follows:

- Implement new funding formulae by INAC that do not penalize energy consumption and transparently outline how energy costs are being met. This would help to empower communities to make better energy decisions. For both sides to benefit, First Nations and INAC could share the savings.[162]

- Most off-grid community members do not see the financial cost of their energy consumption directly and therefore do see any incentive to conserve. Creating a link between consumption and cost would help to illustrate the individual savings that could be achieved. A creative rate design may be needed to avoid creating new challenges for those living in poverty.

- Capacity building within First Nations communities and within INAC, with regard to the implementation of renewable energy solutions, will be necessary to move forward.

- Consideration should be given to BC Hydro taking over current generating systems for off-grid communities. The BC Hydro Remote Communities Electrification Initiative aims to provide electrical service to remote communities over the next 20 years. Funding for this programme could be increased to improve the rate at which communities can be served.

- Funding from the ANCAP programme should be continued to help facilitate further projects aimed at promoting energy efficiency and renewable energy development in First Nations communities. Other funding sources should also be identified.

Other policy and support recommendations mirror those presented in the cooperatives section above.

[162] Personal communitcation with Tim Weis, Pembina Institute, September 20, 2006.

Municipalities

Overview

There are 154 municipalities in BC. Each has the potential to make a significant contribution to the development of energy efficiency and renewable energy technologies. Measures can be implemented for both municipal operations and the entire community. For municipal operations, renewable energy strategies include: procurement, municipal buildings and infrastructure. For municipal buildings, solar water and solar air heating, photovoltaics, ground -or water-source heat pumps, and ocean/lake cooling are easily implemented viable options. Municipal infrastructure options include district heating, waste heat usage, green power from municipal water supplies, and landfill gas utilization.[163]

The development of energy efficiency and renewable energy technologies can be facilitated through community energy planning. "Community energy planning involves community and energy strategies that can be applied at the local level by planners, engineers, developers, and the public in cooperation with utilities. It encompasses land use planning and transportation, site planning and building design, infrastructure efficiency, and alternative energy supply".[164]

Municipal initiatives can also occur as individual projects that are not a component of a larger plan, such as government procurement initiatives. Developers are also in a position to make a major contribution by creating sustainable transit-supportive communities that incorporate environmentally sensitive and energy-efficient design, as well as the planned use of renewable energy technologies, such as district heating that employs a renewable fuel source.

Current Activities

There are a number of energy efficiency and renewable energy activities and programmes currently under way at the municipal level, initiated by a range of institutions, including utilities, the provincial government, NGOs and municipal governments.

Fortis BC has developed a programme called Partners in Efficiency, which helps municipal, commercial, industrial and institutional customers "identify and implement a higher level of energy efficiency in their capital upgrades". The programme includes funding, financial incentives and a monitoring component.[165] BC Hydro also works closely with municipalities through their Power Smart programmes.

Several municipalities, such as the Resort Municipality of Whistler and the Township of Langley, have purchased Green Power Certificates available from BC Hydro and Fortis BC. Several municipalities have developed energy efficiency and renewable energy technologies at the municipal scale. For example, Kelowna is developing a groundwater geoexchange system to heat and cool $400 million worth of buildings for the UBC-Okanagan campus in Kelowna. It has also taken advantage of Fortis BC's Partners in Efficiency programme, have implemented a landfill gas electricity project, and has upgraded 80 city-owned buildings and saved almost four million kilowatt hours of electricity per year.[166]

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[163] Laura Porcher. "Maximizing Green Power for Electricity Generation — Wind Energy" in *Maximizing Energy Efficiency and Renewable Energy in BC*, ed. Pollution Probe. www.pollutionprobe.org/Happening/pdfs/gp_march06_van/workshopnotes.pdf (accessed October 18, 2006)

[164] Community Energy Association (CEA). "What is Community Energy Planning." CEA. www.communityenergy.bc.ca/tk_i_whatis.htm (accessed October 18, 2006)

[165] Kelowna Energy Management Committee Publication. "Partners in Efficiency." *Energy Matters*, Winter 2005. Kelowna Energy Management Committee Publication. www.city.kelowna.bc.ca/CityPage/Docs/PDFs/Environment%20Division/Energy%20Management/Energy%20Matters%20Winter%202005.pdf

[166] City of Kelowna. "Energy Management." City of Kelowna. www.city.kelowna.bc.ca/CM/Page887.aspx (accessed October 19, 2006)

The Town of Revelstoke recently opened its district heating system, serving a number of public and private buildings in the downtown. Utilizing wood waste from the local mill, this is the first renewably based district heating system in BC.

The Ministry of Energy, Mines and Petroleum Resources has recently launched the Community Action on Energy Efficiency (CAEE) initiative, which provides resources to municipalities that are pursuing energy efficiency initiatives.

The federal government is also providing gas tax money to municipalities that is intended to fund infrastructure and public transit projects that result in cleaner air, water, or reduced greenhouse gas emissions.

Barriers

Barriers include: risk averseness of engineers and designers, longer payback periods, high capital cost at the early stage of market development, lack of financing opportunities, low electricity purchase prices, public opposition, and air quality implications of biomass power.[167]

Policy and Support Recommendations

Policy recommendations include: Official Community Plan statements on energy efficiency and the use of renewables, policies and standards for civic buildings, and policies to encourage efficiency in private sector new construction[168, 169] Policies should be developed with accompanying bylaw and community engagement programmes. Bylaw recommendations include: district energy zones mandating buildings to use district energy systems, solar access requirements, and density bonuses for efficiency or renewables. Community engagement is required for full development of conservation programmes and development of renewable energy systems. Communities should be provided with information, training, education, labeling, awards and incentives.[170]

Creation of Integrated Sustainability Plans (ISPs) is also recommended. ICSPs provide a decision-making framework for municipalities to help ensure that all decisions reflect the community's goals for sustainability.

[167] Laura Porcher. "Maximizing Green Power for Electricity Generation — Wind Energy" in *Maximizing Energy Efficiency and Renewable Energy in BC*, ed. Pollution Probe. www.pollutionprobe.org/Happening/pdfs/gp_march06_van/workshopnotes.pdf (accessed October 18, 2006)

[168] Laura Porcher. "Maximizing Green Power for Electricity Generation — Wind Energy" in *Maximizing Energy Efficiency and Renewable Energy in BC*, ed. Pollution Probe. www.pollutionprobe.org/Happening/pdfs/gp_march06_van/workshopnotes.pdf (accessed October 18, 2006)

[169] Canada Green Building Council. "LEED." www.cagbc.org/building_rating_systems/leed_rating_system.php (accessed October 18, 2006)

[170] Laura Porcher. "Maximizing Green Power for Electricity Generation — Wind Energy" in *Maximizing Energy Efficiency and Renewable Energy in BC*, ed. Pollution Probe. www.pollutionprobe.org/Happening/pdfs/gp_march06_van/workshopnotes.pdf (accessed October 18, 2006)

Next Steps

The benefits for implementing the full potential of energy efficiency and renewable energy in British Columbia are substantial. It offers a wide range of benefits, including manufacturing for domestic and international markets, job creation, rural development, price hedging, greater energy security, reduced air pollution, climate change mitigation and reduced negative impacts on human health and the environment through the transition away from conventional energy sources.

British Columbia needs a provincial strategy that includes targets and timelines for the development of energy efficiency and renewable energy to their fullest potential in order to reap the maximum benefits. The strategy should identify short-term actionable items that can be implemented quickly and longer-term items with plans for laying the foundation now for future implementation.

It is hoped that the work in this document can be used to help inform the development of an energy efficiency and renewable energy strategy for British Columbia and show the willingness and capacity of stakeholders, including industry, municipalities, First Nations, academia and NGOs, to participate fully in its development and implementation.

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Appendix A: Summary of Common Renewable Energy Policies

This document provides an overview of common strategies deployed in many parts of the world to promote renewable energy. It is not an extensive document; rather, it has been put together to introduce some of the key concepts discussed at two renewable energy workshops held in the Atlantic Region in 2005. Additionally, acronyms frequently used within the industry are identified and defined.

Green Power

Green Power is defined as low-impact sources of grid-tied renewable energy, including wind, solar, small hydro, biomass, geothermal, tidal and wave energy projects that meet the criteria for EcoLogo[M] certification for electricity generation as developed by the Environmental Choice Programme.

Renewable Energy

Renewable energy is a broader term that applies to all end-uses including electricity, heat and transportation. It refers to "energy obtained from the continuous or repetitive currents of energy recurring in the natural environment".[1] Energy from the sun, gravity and the earth's rotation are the ultimate sources for these energy currents. These are further identified by the element from which they originate to include energy from: wind, sun, biomass, heat from the earth (geoexchange) and different forms of water movement (wave, tidal, run-of-river, hydro dam).

Types of Renewable Energy Promotion Strategies

Regulatory

Regulatory strategies establish the desired level of renewable energy penetration to be achieved; the market decides how to achieve it. Quotas and certificates are commonly used to assign targets and monitor progress.

Quotas, often referred to as **Renewable Portfolio Standards (RPS)**, oblige distribution companies to generate a certain proportion of their energy from new renewable sources. RPSs, which are set and enforced by government, typically apply to the electricity sector, but are being explored for the heating sector (referred to as Renewable Heat Obligations). Under an RPS or 'Obligation' (as they are known in the UK), electricity retailers must use an increasing share of renewable power in their energy mix. This can be achieved either by building new facilities or by purchasing renewable power from independent providers. Such a system assures that each provider is subject to the same burden and that the cheapest renewable power options prevail.

Renewable Energy Certificates (RECs) are often used to implement a Renewable Portfolio Standard. A trading system allows utilities to buy green power certificates, representing units of renewable power production, in order to fulfill their obligations, if that is cheaper than creating their own facilities. Such programmes allow a power retailer to generate its own renewable electricity, buy it (in the form of RECs representing the green benefits of green power), or pay a fine for noncompliance. Trading RECs is like selling green power at a premium, as an extra price has to be paid for the certificate in addition to the wholesale power price. Through such a trading provision, governments allow power retailers to fulfill their renewable energy sales quotas the cheapest way, which may not be in their own service area.

[1] J. Twidell and A. Weir. 1986. *Renewable Energy Resources.* London: E. & F.N. Spon.

Tendering — Developers are invited to bid for the construction/development of a certain amount of renewable energy capacity. If the proposals are considered viable and price competitive within the same technology band, they are awarded a contract. Contracts are typically for a relatively long period to facilitate financing. For the successful operations, a guaranteed surcharge per unit output is typically granted for the entire contract period. Tendering is often used by utilities to meet the requirements of a Renewable Portfolio Standard.

Financial incentives

Renewable energy generators are given direct financial support in the form of a subsidy or a customer base rate to encourage development. Feed-in laws are a common mechanism used in Europe to ensure the interconnection of renewable sources of electricity with the electric-utility network, while specifying how much renewable generators are paid for their electricity. There are two versions of the feed-in law:

Feed-in tariffs are a statutory arrangement regulating the price paid to generators (producers) for electricity. They encourage the development of renewable energy by providing a price above that paid for electricity generated from conventional sources of energy. Any intended producer is guaranteed the feed-in tariff for each unit of electricity exported to the grid if the form of generation meets the stated requirements; no bidding process or tendering is involved. Feed laws set the price paid for renewable energy as a simple percentage of the retail tariff. For example, the initial German feed-in tariff (law) stipulated that renewable sources of energy would be paid 90 per cent of the retail rate. The cost above the wholesale price is then evenly shared among all electricity consumers. This contrasts with obligation programmes where increased tariffs are only available to selected winners after competitive tendering.

Advanced Renewable Tariffs (ARTs) are the more recent version of the feed-in tariff and differ in some important ways. ARTs permit the interconnection of renewable sources of electricity with the electric-utility network at the same time as they specify how much the renewable generator is paid for its electricity. Arts are more sophisticated than feed laws and can be tailored to different renewable technologies and to different regions of a country. There are often several tiers of payments depending upon technology and how long the generator has been in service.

Financial incentives — incentive-type policies are usually in the form of some monetary inducement to the consumer to purchase a particular product or to the producer to produce it. Incentives are often distributed as rebates and subsidies that lower the cost of a product, or in the form of a tax exemption that reduces the burden of purchasing the product.

Common rebate programmes in Europe include the promotion of small, decentralized photovoltaic systems. Authorities and electric utilities subsidize investment costs by private individuals or organizations, and commercial or industrial companies. The average rebate payments typically cover 60 to 70 per cent of the investment costs. Another example is the Canadian federal government Wind Power Production Incentive (WPPI) programme that pays eligible wind producers $0.012 per kWh to ensure a certain level of return, thereby making it a safer investment.

Voluntary

Voluntary strategies are mainly based on the willingness of consumers to pay premium rates for renewable energy. Voluntary approaches are either investment focused or generation based.

Investment focused — Examples include shareholder programmes, donation projects and ethical trusts that essentially raise money to support/pay for building renewable energy generation.

Shareholder programmes have been particularly successful in Germany. Private customers purchase shares of the renewable energy plant (i.e., in blocks of 100W capacity) thus becoming a shareholder of the company owning the plant.

Within donation programmes, subscribers contribute to a fund for renewable energy projects. The projects developed are unrelated to the subscriber's energy usage.

Within ethical trusts, a company committed to funding a specified renewable energy plant issues shares to subscribers.

Generation based — These are typically green power programmes that require customers to pay a premium to have a proportion of their energy generated by renewable energy. The premium or surcharge per kWh helps to meet the extra costs of generation — those particularly associated with capital costs of the new plant. Green electricity labels are now being used in European countries to accredit green premiums to provide consumers with the assurance that the accredited suppliers do indeed utilize renewable energy.

Net Metering — This is a particular kind of pricing policy that is used to compensate owners of small power systems for electricity fed into the grid. In a net metering arrangement an electricity generator, usually small-scale renewable energy generation, is connected to the electricity grid. The metering system tracks electricity generated and electricity used by the consumer. During times of surplus production, (i.e., when more power is produced than is consumed on-site) the surplus power is 'sold' to the utility at the retail price. Net metering is a kind of financial incentive to encourage renewable electricity generation that does not require government expenditure since the arrangement is made with the utility.

Common Acronyms in the Renewable Energy Policy Debate

ARTs: Advanced Renewables Tariff
CHP: Combined Heat & Power (or Co-generation)
IPP: Independent Power Producer
PPA: Power Purchase Agreement
RECs: Renewable Energy Certificate
RPS: Renewable Portfolio Standard
R&D: Research and Development
WPPI: Wind Power Production Incentive

Appendix B: Summary of Workshop Comments

A workshop was held in March, 2006, *Maximizing Energy Efficiency and Renewable Energy in BC,* where participants were asked to comment on BC's current energy efficiency and conservation programmes, targets and institutions. Participants included representatives from provincial government, utilities, industry, academics, and NGOs. Below are the summary comments from the workshop.[1]

Question #1: Comments on Policies/Programmes/ Initiatives

- We need a new rate structure — something similar to stepped rate structure for large industrial consumers (e.g., establish a baseline for each consumer class where 90 per cent of consumption is at base rate, while the last ten per cent is charged a premium).
- Least cost mandate of BCUC/Energy Plan for utilities does not adequately account for social and environmental impacts.
- Building codes need to be brought in line with best practice for energy efficiency.
- Building codes need to reflect the equipment, lighting, and appliances in addition to the shell.
- Should the Province have a more marquee energy efficiency programme (e.g., 1,000,000 solar roofs) that are very visible and tangible and have a basis in the community?
- There is a critical need to train builders and developers on energy efficiency techniques and technologies. The Province has a role in providing for this training.

Question #2: Comments on Targets

- For each sector, there should be mandated targets for aggressive reductions in greenhouse gas emissions and improvement in air quality.
- Our targets are not stringent or comprehensive enough.
- The government needs to set ambitious medium and long-term targets for energy efficiency in all sectors.
- All targets, including those for utilities, should be mandated.
- Targets should be set in recognition of the global nature of energy issues, with specific attention paid to the risk of increasing, and more volatile prices, on BC's economy and the risks of climate change for the province.

Question #3: Comments on Institutions

- The province needs a multi-stakeholder group to oversee climate change and air quality targets with a focus on how they relate to energy efficiency and energy supply issues.
- A dramatic shift towards energy efficiency is going to require a mechanism to reward utilities for achieving energy efficiency if they are the delivery agents.
- If the Province has a separate body for energy efficiency, should that agency also be tasked with renewable energy? Similarly, an energy efficiency body could tackle all areas of efficiency (i.e., electricity/gas, water, transportation and so on).
- There is a lack of research into the potential for energy efficiency and analysis of our success at achieving energy efficiency (e.g., poor in comparison to California).
- There was interest in a separate body to coordinate/deliver energy efficiency in the province, but there was not consensus on the exact mandate or scope of such a body. Additional questions about whether such a body would be housed within government/ NGO/utility or some combination.

1 For a complete set of Workshop Notes see www.pollutionprobe.org/Happening/pdfs/gp_march06_van/workshopnotes.pdf.

- We should have an agency that is independent from the utilities that can build relationships directly with all municipalities (e.g., Efficiency New Brunswick[2] which has been modeled after Efficiency Vermont[3]).
- Important to note that many structural changes would be significant departures from business-as-usual. This would need to be carefully considered to ensure we are better able to pursue energy efficiency. For example, a situation where utilities loose sight of energy efficiency and are focused solely on new supply is not desirable. Although a valid concern, it has been managed in other jurisdictions through careful design and effective government oversight.
- If an agency is created, adequate resource allotment is critical to deliver the energy efficiency mandate.
- British Columbia's Energy Plan will look at three phases: electricity is first, then oil & gas, but it does not look at the other sectors. Decisions will have impacts on energy efficiency as well. These issues should all be integrated — the current energy plan renewal does not allow this.

[2] Efficiency NB. "About." Efficiency NB. www.efficiencynb.ca/about-e.asp

[3] Efficiency Vermont. "About Us." Efficiency Vermont. www.efficiencyvermont.com/pages

Appendix C: Green Power Provincial Targets and Policies

Information Updated October 20, 2006

Nova Scotia — RPS for 5 per cent of total generation must be renewables by 2010.

- Sources include: small-scale hydroelectricity, wind power and biomass fuels
- Sources must be built after 2001 as per Electricity Act
- 10 per cent of total generation from renewables by 2013. In draft form that will soon be available for public consultation
- Province considering 20 percent to come from renewables by 2013
- Spring 2006 — tidal power contract to be awarded

New Brunswick — RPS for additional 10 per cent of total consumption by 2016.

- RPS established in regulation under the Electricity Act that includes a one per cent addition per year of Environmental Choice Programme approved generation between 2007 and 2016
- Most common sources include: wind, biomass, hydro and landfill gases
- By 2009 — 200 MW of wind power to be in operation
- By 2016 — up to 400 MW of wind energy to be purchased by NB Power.
- Tidal-energy demonstration projects to be identified

Prince Edward Island — Target for 30 per cent of energy needs from renewable resources by 2016.

- December 2005 — Renewable Energy Act proclaimed including an RPS and guaranteed feed-in tariff for community, wind cooperative and large systems. Utilities must acquire 15 per cent from renewables by 2010. Regulations for net metering for small scale generators.
- Sources include wind, solar, hydro and biomass
- Bonds issued allowing islanders to invest in a wind farm
- Fall 2006 — tendering to begin for wind-hydrogen village. August 2007, first phase of demonstration project to be in operation

Newfoundland — RFP for 25 MW to be released December 2005.

- November 2005 — Public Discussion Paper released *Developing an Energy Plan for Newfoundland and Labrador*; consultations still ongoing
- December 2005 — 25 MW wind RFP released; first phase completed; finalized feasibility studies due in August 2006
- June 2006 — Newfoundland and Labrador Hydro to oversee a wind monitoring program
- October 2006 — 25 MW wind power RFP awarded
- October 2006 — announced intention to release 25 MW RFP for wind power

Québec — Targets for 4,000 MW of wind by 2015.

- Contracts signed for approximately 1,200 MW of wind
- 2,000 MW of wind to be delivered by December 2013 (300 MW by December 2009, 400 MW by December 2010, 400 MW by December 2011, 450 MW by December 2012, 450 MW by December 2013)
- Wind power development to be facilitated by integration with large hydroelectric projects currently under development
- May 2007 — bids to be submitted

Ontario — RPS for 5 per cent (1,350 MW) by 2007 and 10 per cent (2,700 MW) by 2010 of total generation to be new renewables.
Currently:

- *Wind:* 139 MW (operating), 67.5 MW (complete), 1,104 MW (in progress)
- *Small Hydro:* 8 MW (operating), 43 MW (in progress)
- *Biomass:* 2.5 MW (operating), 5 MW (in progress)
- November 2006 — standard offer contract program to be introduced modeled after feed-in tariff. There is no limit but expected to result in 1,000 MW of green power by 2016

Manitoba — Target for 1,000 MW of wind by 2014.

- October 2004 — wind power strategy developed
- March 2006 — 99 MW wind project operating
- Winter 2007 — RFP to be released for 300 MW of wind
- Wind and hydroelectric integration to be considered
- 2013–14, 2015–16, 2017–18 — 200 MW of wind are targeted for each time frame depending on economic viability. To include smaller, community-based wind projects

Saskatchewan — Target for 150 MW of wind by 2005. 100 per cent of new generation until 2010 to be operations that do not add to GHG emissions.

- Projects include: wind (major component), energy conservation, small hydro, distributed generation (includes cogeneration), and Environmentally Preferred Power (EPP) Program (low environmental impact generation such as, flare gas and heat recovery systems)
- December 2005 — 50 MW wind farm operating
- May 2006 — 25 MW wind power project selected for EPP
- October 2006 — Short-term recommendations, including renewable energy, to be presented to the Premier
- June 2007 — Final report including a blueprint for the medium and long terms for renewable energy development and conservation to be presented to the Premier

Alberta — Target for 3.5 per cent of total generation by 2008.

- 3.5 per cent renewables target represents about 560 MW of new capacity
- A 900 MW "threshold" (maximum) of wind energy established due to transmission constraints; ongoing analysis and stakeholder engagement to increase threshold
- 20 kWs of solar PV to be installed on municipal buildings; project began July 2006

British Columbia — 50 per cent of new generation to be "clean energy" by 2012.

- Voluntary goal for electricity distributors
- Sources include wind, solar, ocean, biomass, hydro, geothermal, fuel cells, efficiency measures and cogeneration
- April 2005 — release of *Alternative Energy and Power Technology: A Strategy for BC*
- 2006 RFP: 325 MW of wind, 140 MW of biomass and 238 MW of small hydro (defined as no greater than 50 MW)