



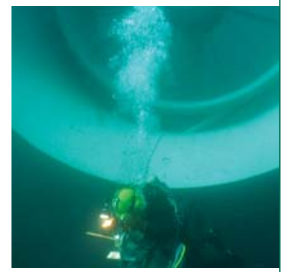

Powering Our Communities

A module of the

Renewable Energy Guide for Local Governments in British Columbia

September 2008

The 'first stop' for local government leaders addressing energy sustainability and climate change

Community Energy Association | Infrastructure Canada | Canada | British Columbia | BC hydro FOR GENERATIONS | FortisBC

About the Community Energy Association

The Community Energy Association is a charitable organization that assists local governments throughout British Columbia to promote energy efficiency and alternative energy through community energy planning and project implementation. For information and many more local government resources, please visit: **www.communityenergy.bc.ca**

Contact Information
Community Energy Association
Vancouver, BC
Tel: 604-628-7076 Fax: 778-786-1613
info@communityenergy.bc.ca
www.communityenergy.bc.ca

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Citing this Document

Please cite this document as: Community Energy Association (2008) – *Powering Our Communities: Renewable Energy Guide for Local Governments in British Columbia.* Vancouver.

Lead author: William A.S. McDowall

Library and Archives Canada Cataloguing in Publication
Powering our communities: a module of the renewable energy guide for local governments in British Columbia.
Includes bibliographical references and index.
ISBN 978-0-9784411-2-8
1. Renewable energy sources – British Columbia.
2. Electric utilities – British Columbia.
3. Municipal government – British Columbia.
I. Community Energy Association (B.C.) II. Title: Renewable energy guide. III. Title: Renewable energy guide for local Governments in British Columbia.
TJ807.9.C3P69 2008   333.793'209711   C2008-905571-3

Cover photo credits (left to right): Laying photovoltaic power panels (Dave Egles, HES Home Energy Solutions); Bear Mountain Wind Park (Aeolis Wind Power Corporation and AltaGas Income Trust); Rutherford Creek power project (Independent Power Producers Association of BC); Hartland Landfill Gas Utilization Project (Capital Regional District); Race Rocks tidal power (Lester B. Pearson United World College of the Pacific).

Printed on 100% post-consumer recycled paper

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Acknowledgements

Production of this Guide has been made possible through financial contributions from Infrastructure Canada, the Province of British Columbia, BC Hydro and Fortis BC. The City of Dawson Creek was an additional project partner.

The Community Energy Association would like to acknowledge, in addition, valuable contributions of the many people and organizations that provided advice and assistance in shaping this document:

Chris Allan, Brent Kirkpatrick and **Paul Remillard**, MetroVancouver
Chris Blondeau, Lester B. Pearson United World College of the Pacific
Randy Cleveland, City of Kelowna
Kim Decker, City of Richmond
Raymond Fung, District of West Vancouver
Arno Hennig, City of Greenwood
Helen Iosfin, Laila Bassim, David Ingleson, Oliver John, Toby Lau, Gordon Monk, Louise Tremblay, Robyn Wark and **Maridee Wersta**, BC Hydro
Susan Jellinck, Toronto Atmospheric Fund
Trevor Jones, Hupacasath First Nation
Erik Kaye and Christina Ianniciello, Ministry of Energy, Mines and Petroleum Resources
Donna McGeachie, BC Transmission Corporation
Tara Tompkins, Ministry of Community Development
Blair Weston, FortisBC

Finally, the Community Energy Association acknowledges the support of the many companies, organizations and governments which granted permission for use of their photos and illustrations in the publication.

Disclaimer

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Acronyms used in this guide

BC .... British Columbia
BCTC ...... British Columbia Transmission Corporation
CEA .... Community Energy Association
FCM .... Federation of Canadian Municipalities
GHG .... greenhouse gas
IPP .... independent power producer
kW .... kilowatt
MW .... megawatt
MSW .... municipal solid waste
NRCan .... Natural Resources Canada
UK .... United Kingdom

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Powering Our Communities

Renewable Energy Guide For Local Governments in British Columbia

Executive Summary

Renewable, clean electricity will play a key role in the future of power supplies. Globally, 25% of investment in the power sector is flowing into renewable energy technologies, and this proportion is growing. Local governments in British Columbia have an important role to play in the transition to a clean, renewable electricity system, and in so doing they can bring significant benefits to their communities.

Clean Electricity in British Columbia

British Columbia's electricity supply is primarily renewable energy from the province's heritage hydroelectric resources. As electricity demand grows, there is a need to supplement that existing resource with additional sources of renewable electricity supply. Recent provincial government policy has created the conditions for local governments to take a role in developing and supporting renewable energy development, by creating opportunities for local governments, individuals and the private sector to develop renewable electricity resources either for their own use or to sell electricity to the power grid.

Renewable Electricity Technologies

British Columbia is fortunate to have prodigious clean energy resources. Opportunities likely to be of interest to local governments in British Columbia include:

- Small or micro hydroelectric power, including opportunities within municipal water systems
- Energy from waste, from anaerobic digestion of organic waste, or gasification
- Landfill gas utilization
- Woodwaste and other biomass sources
- Solar photovoltaic power
- Small wind power
- Fuel cell generation.

Opportunities for Local Governments

Local governments can benefit by developing renewable electricity resources associated directly with the local government operations. Opportunities include:

- Solar photovoltaic panels for street lighting, parking ticket machines and civic buildings
- Landfill gas utilization projects, such as those generating electricity in Vancouver, the Capital Regional District and Kelowna
- Small or micro hydro power plants, either in local rivers, or within the municipal water supply system, as implemented in the District of West Vancouver.

These and other opportunities can provide power for use within local government operations (e.g. through net metering with BC Hydro or Fortis BC), or even to sell (i.e. all the output directly) to BC Hydro or FortisBC.

In addition to exploring opportunities for developing their own renewable electricity resources, local governments can provide support to local businesses and residents interested in developing renewable energy. Support can be provided by:

- Ensuring local bylaws do not create unnecessary barriers to renewable energy
- Promoting renewable energy within new development, using tools such as tax and development cost charge exemptions, density bonuses and development permit checklists
- Starting a dialogue with independent power producers, BC Hydro's industrial customers and the community, to explore opportunities for beneficial and sustainable power projects.

1. Introduction

Powering Our Communities is a module of the Community Energy Association's *Renewable Energy Guide for Local Governments in British Columbia.* http://www.communityenergy.bc.ca/resources/cea-publications-0 It has been written for local governments – elected officials and staff – interested in encouraging the use of renewable sources of energy in their communities. The information applies to local government influence on both the wider community and local government operations.

Did you know? This Renewable Energy Guide is comprised of several modules

The *Renewable Energy Guide for Local Governments in British Columbia* is comprised of a set of modules. Together, the modules describe the renewable energy technologies of interest to local governments (including both heat and power generation technologies); options for establishing community-owned energy projects and utilities; and policy issues and mechanisms that local governments can use to encourage renewable energy in the community.

All modules are available from the Community Energy Association website: www.communityenergy.bc.ca ; under Resources, click on CEA Publications. The website may also include future modules not listed here.

Heating Our Communities

This module describes renewable heating technologies, and opportunities these present to local governments, including:
- Heat recovery
- Ground-, water- and air-source heat pumps (also known as geo-exchange)
- Biomass and biogas
- Solar air and water heating
- District heating.

Powering Our Communities

This module introduces renewable electricity technologies, and opportunities these present to local governments, including:
- Wind
- Solar PV
- Small and micro hydro
- Biomass and biogas
- Geothermal
- Tidal, wave and fuel cell.

The module also explores how local governments can support the development of renewable electricity in the community.

Utilities and Financing

This module describes options for the ownership and operation of local government utilities and energy projects, including
- District energy utilities
- Decentralized utilities
- Municipal electric utilities
- Independent power production.

The module also describes mechanisms that local governments can use to finance renewable energy projects.

Policy and Governance Tools

This module presents policy options for local governments interested in encouraging the uptake of renewable energy in their communities, and describes broader provincial government policy goals around renewable energy and sustainable community planning.

The renewable energy guide has been developed for local governments within the British Columbia legislative context. The guide is also of use to communities across Canada, particularly modules *Heating Our Communities* and *Powering Our Communities.*

This guide deals with renewable energy. Renewable energy includes sources of energy that are neither derived from fossil fuels (such as coal, oil, natural gas and propane) nor from nuclear power. Renewable energy also includes the recovery of waste heat that would otherwise be lost, even if that heat is produced by non-renewable energy sources. This guide does not address energy efficiency, which can often provide cost-effective emissions reductions and savings. Renewable energy should be considered alongside other energy initiatives, including energy efficiency, sustainable transportation and sustainable community planning.

Local governments can bring substantial benefits to their communities by encouraging and supporting the development of renewable electricity. Primary benefits include:

- greenhouse gas (GHG) reductions
- potential air quality benefits
- local economic development through renewable energy job creation, infrastructure development and revenue through taxes and selling power.

Local governments can bring particular benefits to their communities by encouraging community-based energy projects that are locally owned, either by local residents and companies or by the local government itself. Local ownership will ensure that energy expenditures stay within the community, contributing to economic development.

Electrical generation in British Columbia has historically been achieved by large hydro dams and some fossil fuel generation. A shift toward a more diverse electricity supply portfolio is now occurring, partly as a result of the development of renewable electricity technologies. Local governments have opportunities to participate in, and benefit from, the emergence of renewable electricity technologies.

The focus of *Powering Our Communities* is to:

- Describe the electricity system in British Columbia
- Introduce the major renewable electricity technologies
- Present opportunities for local governments that arise from the development of renewable electricity in British Columbia communities

The Cora Linn Dam and FortisBC generating station on the Kootenay River; generating capacity is 49 MW. *Source: FortisBC*

Did you know? RETScreen: a free tool for assessing renewable energy projects

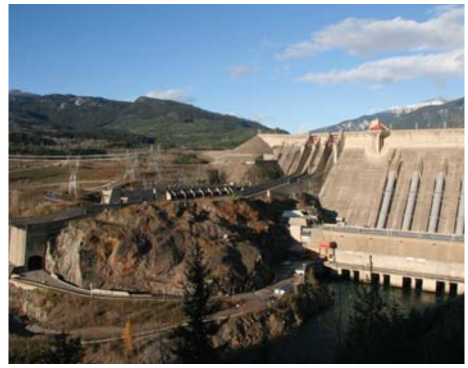
The costs and benefits of renewable energy installations should be assessed carefully, including an assessment of resulting emissions reductions. Natural Resources Canada (NRCan) provides a free software tool, RETScreen, for assessing projects at a pre-feasibility or scoping study stage. The tool may be used to assess most or all of the technologies outlined in this guide: wind, solar, hydro, biomass, geothermal, tidal, wave and current power. The RETScreen database includes regional climate data (such as sunlight and wind speeds), product data (manufacturer and product specifications) and typical costs associated with project development. The tool also facilitates financial analysis, calculating simple paybacks, return on investment, net present value and other indicators of cost-effectiveness.

RETScreen is available from the NRCan website, and NRCan offers periodic free training courses across Canada as well as online learning tools. www.retscreen.net

2. The electricity system in British Columbia

The electricity system in British Columbia is characterized by:

- large-scale *generation* of electricity, mostly hydro
- *transmission* of electricity over long distances using high-voltage power lines
- local *distribution* of electricity to homes and businesses (at a lower voltage)
- *consumption* of electricity in lights, heating, machinery and electrical equipment.[1]



The Mica Dam near Revelstoke has a generating capacity of 1,700 MW; it is operated by BC Hydro.
Source: nix-pix

More than 90% of the electricity produced in BC is generated in hydroelectric plants around the province. Much of the remainder is generated in BC's natural gas generating stations, and in biomass-fired co-generation plants in sawmills. Over the past few years, BC has been a net importer of electricity; up to 10% of the power consumed in BC is generated outside the province.[2] Many remote communities are not connected to the integrated power transmission and distribution grids system – these consumers are supplied with local generators, primarily fuelled by diesel.

The electricity system is primarily owned and operated by the British Columbia Hydro and Power Authority, a crown corporation commonly known as BC Hydro. BC Hydro owns and operates most of the hydroelectric resources that provide the bulk of the province's electricity. BC Hydro also owns the high voltage transmission system, which is planned, managed and maintained by the BC Transmission Corporation, also a crown corporation. BC Hydro also owns and maintains local distribution systems and manages customer services, billing, and the energy efficiency program PowerSmart.

There are other electric utilities in BC aside from BC Hydro. In south central BC, electricity is generated and distributed by FortisBC, a wholly owned subsidiary of Fortis Inc. FortisBC owns and operates four hydroelectric generating plants on the Kootenay river, with a total capacity of 223 MW. In addition, FortisBC owns high voltage transmission lines, and a large network of distribution assets, all of which are located in the southern interior of British Columbia. FortisBC serves, directly and indirectly, approximately 155,000 customers in a service territory that is close to 90,000 square kilometres. The majority of FortisBC customers are located in urban centres, including Kelowna, Oliver, Osoyoos, Princeton, Rossland, Creston, Trail and Castlegar.

In addition, six BC local governments also own electric utilities that distribute power to their residents and businesses. These are Nelson, New Westminster, Penticton, Kelowna, Grand Forks and Summerland. They are described in more detail in *Utilities and Financing,* another module of the Community Energy Association Renewable Energy Guide. Most of these municipal utilities purchase

Did you know? The BC electrical transmission system...

BC Transmission Corporation is responsible for transmission – moving high-voltage electricity along the electricity highway from where power is produced to where it is used. The electricity highway is made up of high-voltage lines that take the power from generation facilities like hydroelectric dams to local substations, where it is reduced to lower-voltage electricity and then lower-voltage lines that distribute the power to homes and businesses.

Generation: Power is generated by BC Hydro, FortisBC and independent power producers.
Transmission: BC Transmission Corporation moves high-voltage electricity from where it is produced to where it is used.
Electricity is "stepped down" at a substation to a lower voltage.
Distribution: Low-voltage electricity is distributed to homes and businesses.

power from other utility companies, rather than generating it themselves; only Nelson Hydro owns and operates its own generation facilities at the Bonnington Dam.

Most electrical generation facilities such as large dams have been located far from urban centres, and thus also far from the centres of consumption. Local governments are more likely to be interested in smaller scale renewable electricity technologies, such as those integrated into buildings and existing infrastructure (bus stops, street lights, wastewater facilities). This module describes all major renewable electricity-generating technologies, focusing on those likely of interest to local governments.

2.1. The changing shape of electricity systems

Recent years have seen changes to the electricity system in BC, both in terms of more independent power generation, and the sorts of generation technologies that are becoming economically and environmentally attractive. These changes have made it easier for local governments to get involved in the development of renewable electricity projects.

The first set of changes surrounds government policy on the ownership and operation of electricity generation. Traditionally, most electricity provision has been by BC Hydro, which owns and operates large generating stations, and distributes power to customers throughout the province. In recent years, the provincial government has restricted the ability of BC Hydro to build new power generation facilities, and has instead directed it to buy new power from other entities. Three kinds of entities commonly develop renewable energy projects in BC, and sell power to BC Hydro:

- Private sector firms
- Local governments, First Nations and sometimes community co-operatives
- BC Hydro customers that also generate their own power, and sell any excess to BC Hydro.

Any of these groups may be referred to as 'independent power producers' or IPPs.

Most IPPs are private companies, but local governments and community co-operatives can also act as power producers, generating electricity and selling it to BC Hydro. BC Hydro buys power from independent producers through competitive calls for power, and other programs (net metering and Standing Offer), discussed in section 2.2. The shift toward independent (non-BC Hydro) power projects has created opportunities for local governments, as well as private companies, to be the lead or a partner in the development of renewable electricity projects.

Secondly, opportunities for renewable energy generation have grown in many jurisdictions, including British Columbia. This is partly because of the development of lower-cost renewable energy technologies, and partly because of increasing policy concern over the environmental impacts of both fossil fuels and large dams. Many small- and medium-scale renewable electricity systems have become more attractive due to lower costs and policies that favour renewable sources of energy. In the long term, this may lead to more renewable electricity resources in the system.

These changes (structure of ownership and operation, and scale of generation facilities) are reflected in BC Hydro's power acquisition processes, explored in the next section.

FortisBC crews working on a power line in Castlegar, next to the Columbia River.
Source: FortisBC

FortisBC is currently completing a Resource Plan that will identify power supply needs and options over the next 20 years. Once this plan is complete and accepted by the BC Utilities Commission, FortisBC will be in a position to work toward acquisition of new power supply resources. IPPs including local governments, would then be invited to submit proposals to meet the identified needs.

2.2. BC Hydro power acquisition process

As outlined above, BC Hydro now buys electrical energy from IPPs and individual customers. There are a number of processes through which BC Hydro acquires electricity, depending on the type and scale of power generation. Local governments generating power in the FortisBC service area may be able to sell power to BC Hydro through the calls for power or standing offer, but have to pay charges to FortisBC to 'wheel' or convey the electricity generated through the FortisBC system to the BC Hydro grid.

2.2.1. Competitive calls for power

When forecasted power consumption exceeds generation, BC Hydro issues a Call for Tenders or Request for Proposals, in which IPPs are invited to propose power projects and power price. BC Hydro evaluation criteria may include, and are not limited to:

- Cost effectiveness, including costs of connection to the transmission and distribution system
- Risk assessment (likelihood of successful project implementation and performance)
- Environmental impacts and benefits
- Beneficial impacts of generation technology and/or regional diversity, and other factors.

BC Hydro then signs an Energy Purchase Agreement with the successful proponents. Further details about BC Hydro's acquisition process are available at www.bchydro.com/info/ipp/ipp956.html

2.2.2. Standing Offer Program

BC Hydro's Standing Offer Program, launched in 2008, facilitates the development of clean electricity projects, supports self-sufficiency and innovation, and alleviates the administrative burden for small projects to bid into BC Hydro calls for power. The program encourages small renewable energy projects with an electricity generating capacity of 50 kW to 10 MW. Eligibility criteria include proven technology, and interconnection to BC Hydro's integrated system (Fort Nelson and Non-Integrated Areas are ineligible). Projects sign a minimum 20-year Energy Purchase Agreement with BC Hydro, at a guaranteed price. Further details about the program are available at: www.bchydro.com/standingoffer

These solar photovoltaic panels are installed on a house in Burnaby. When the panels produce more electricity than is needed by the house, the excess is exported to BC Hydro through net metering.
Source: Vancouver Renewable Energy Co-op

2.2.3. Net metering

Micro-scale or 'microgeneration' systems can supply electricity to a civic building, residence, commercial building, or development to reduce or eliminate their electrical draw from the integrated power grid. For example, a solar photovoltaic panel on the roof of a building will supply a portion of the building's electricity needs. The BC Hydro Net Metering tariff, available since 2004 to all BC Hydro customers, encourages the implementation of microgeneration systems by both local governments and the wider community.

Under this program for any given billing period, if the amount of electricity supplied by BC Hydro is greater than the electricity generated by the customer, the customer will pay for the net electricity at their usual rate. If the customer has generated more electricity than has been supplied by BC Hydro, their electricity charge on the bill will be zero. Any excess electricity will be carried over to the next billing period. At the end of each year, on the customer's anniversary, BC Hydro will credit the customer for any remaining excess generation. FortisBC is currently developing a similar Net Metering tariff for customers in its service area.

Further details about the Net Metering program are available at http://www.bchydro.com/info/ipp/ipp8842.html

Did you know? Defining 'clean power' in British Columbia

The BC Hydro power acquisition processes referred to above, only accept 'clean power.' See the BC government definition document [3] for a complete definition of 'clean.' Technologies which *may* qualify as clean energy include: biogas, biomass, energy recovery, geothermal, hydrocarbon closed-loop, hydro, hydrogen, municipal solid waste, solar, tidal, wave, wind and others.

2.3. Transmission

BC Transmission Corporation (BCTC) offers two forms of service to IPPs: interconnection service and transmission service, both of which are guided by an approved tariff. Typically IPPs sell their power to BC Hydro through energy power calls, described above. In these situations, BCTC only provides interconnection service to the IPP. BC Hydro is then responsible for applying for the transmission service that would move the energy from the IPP to the load. If an IPP has a different market for their energy, they could then apply to BCTC for both interconnection and the applicable transmission service necessary to move their power.

Included in the above services that BCTC provides are engineering services. BCTC completes technical feasibility studies and cost estimates for the IPP to determine what would be required to connect their project to the transmission system. Once an IPP has a confirmed buyer (usually BC Hydro) then BCTC will provide more comprehensive engineering studies to the IPP. BCTC is then responsible for upgrading the transmission system to meet the interconnection requirements of the IPP. The customer's cost responsibilities for the interconnection facilities are covered in BCTC's Open Access Transmission Tariff.

High-voltage transmission towers

Source: BC Transmission Corporation

2.4. Power for remote communities

British Columbia is home to many remote communities, which are neither connected to the integrated electrical system nor to a natural gas source. Many of these communities rely on diesel generators, which are expensive to run, require frequent maintenance, and produce GHGs and other emissions. Energy demand management can reduce these communities' energy consumption and costs, while renewable energy can provide a cost-effective and clean alternative to diesel.

The Ministry of Energy, Mines and Petroleum Resources runs a Remote Community Clean Energy Program, which supports remote community energy systems by providing staff support, financial incentives and coordinated access to partner funding programs. The program began in 2006 with an initial budget of $3.9m, and has supported 10 First Nations and remote communities. Projects funded to date include an upgrade to a run-of-river hydro project in Klemtu. As of 2008, an additional $20 million in program funding is in place to provide financial support to community-led demand side management and clean energy project.[4]

BC Hydro also offers a Remote Community Electrification program, which started in 2005 and is now integrated into the broader provincial program. BC Hydro's Remote Community Electrification program provides electric service to all eligible remote communities that wish to receive service from BC Hydro. Communities must have at least 10 residences occupied year-round to be eligible for the program. BC Hydro utility service typically includes: generating and distributing power (from diesel or renewable energy sources), operating and maintaining the electricity system, planning for future needs, promoting energy conservation, metering and billing customers, providing customer support, and supporting community energy plans. Communities interested in receiving BC Hydro electrical service can contact BC Hydro at rce@bchydro.com or by phone at 1-866-901-8088.

2.5. Provincial electricity policy

The *BC Energy Plan: A Vision for Clean Energy Leadership*, released in February 2007, provides the current policy direction for the electricity system in British Columbia.[5] Highlights of the Energy Plan include:

- Electricity self-sufficiency by 2016 (BC Hydro imports and exports electricity, and in recent years BC has become a net importer)
- All new electricity generation projects to have zero net GHG emissions
- Clean or renewable electricity generation to continue to account for at least 90 per cent of total generation
- Promotion of small-scale clean electricity generation through BC Hydro's Standing Offer program and Net Metering tariff, which provide small generators with the opportunity to sell power to the grid
- Energy efficiency and conservation; the plan includes a target for 50% of BC Hydro's incremental resource needs to be met through conservation by 2020
- Greening the BC Building Code, by incorporating energy and water conservation requirements into the existing code.[6] New building code provisions, in force from September 2008, require that small residential buildings meet a standard of Energuide 77, while commercial, institutional and high-rise residential and buildings must meet the ASHRAE 90.1 (2004) standard.
- Expansion of the Community Action on Energy and Emissions Program[7] and the First Nation and Remote Community Clean Energy Program
- Development of alternative energy economic opportunities, though the establishment of an Innovative Clean Energy Fund to support development of clean power and energy efficiency technologies. Local governments are eligible to apply for funding from this program.[8]
- Continued public ownership of BC Hydro, while encouraging the development of electricity generating projects by the private sector and others (including local government).

In support of the Energy Plan, two strategies for specific sectors have been developed:

- The Bioenergy Strategy aims to advance the use of bioenergy in BC.[9]
- The Energy Efficient Buildings Strategy sets out a range of measures and targets to help the province cut GHG emissions 33% by 2020.[10]

The emphasis on efficiency, self-sufficiency, and the role for entities other than BC Hydro in development of energy projects suggests a clear opportunity for local government involvement in renewable energy.

Local governments have little direct role in the regulation of private sector IPP projects. The Miscellaneous Statutes Amendment Act (2) 2006, more commonly known as Bill 30, removed zoning authority of local governments over power projects occurring on crown land. The Ministry of Energy, Mines and Petroleum Resources has a 2007 guide detailing opportunities for local government participation in the range of regulatory processes governing IPP projects.[11] These processes include water licensing, crown land tenuring and environmental assessment certification. Notification of and feedback from affected local governments and First Nations is required at various stages in all processes. As well, there is potential for public meetings and hearings. The Ministry may also have a forthcoming guide for IPPs on approval processes relating to a range of renewable energy technologies.

The following sections explore various renewable electricity technologies. These sections are then followed by a section exploring opportunities for local governments to encourage renewable electricity production.

Did you know? Renewable electricity and carbon neutral operations

Many local governments in British Columbia have signed up to the Climate Action Charter, indicating their intention to become carbon neutral in their own operations by 2012.[12] Renewable electricity used within government operations can help local governments meet that goal.

3. Wind Power

Wind turbines come in a variety of sizes, shapes and styles. The most common turbines are at two ends of the size spectrum: large 1-3 MW turbines found in commercial wind farms, and micro wind turbines (typically less than 1 kW) used to recharge batteries in off-grid applications such as boats and cottages. There are substantial opportunities for growth in the small- and medium-scale wind turbine market (1-100 kW),[13] suitable for use on farms and other low population density areas.

There have been recent developments in small urban turbines, including turbines on towers situated next to buildings, turbines mounted on buildings, and turbines fully integrated into the building fabric. Studies have indicated that such wind energy could make a significant contribution to energy requirements of buildings, particularly for new and retrofitted buildings where specifically-designed wind devices can be incorporated.[14] Building-mounted turbines are a technically challenging application[15] of wind power, given difficulties with turbulent wind flow patterns found in cities and potential damage to buildings. Monitoring of small urban turbines in the UK suggests that the installation of small wind systems on rooftops and in urban areas is generally not advisable, as they tend to perform poorly when mounted on buildings, though there may be exceptions.[16] A recent UK report mentions small wind turbines, providing further information about considerations and possibilities in a UK context.[17]

Key benefits of wind power:

- Mature technology, major established global industry
- Zero fuel costs
- Relatively cheap source of renewable electricity where wind speeds are sufficient.

3.1. Wind resource in British Columbia

The wind resource in British Columbia varies substantially from one region to another, with the total resource estimated at over 5000 MW.[18] Four main regions are presently under consideration for wind energy development: Peace region, North Coast, Vancouver Island and the south interior. BC Hydro and Environment Canada have both produced wind resource maps, which help identify communities in areas which hold most potential.[19] BC Hydro has also published wind monitoring data for sites in the north coast, Peace River, central interior and Vancouver Island regions.[20] In addition, there are sites throughout the province that present viable opportunities for small wind power projects. Exposed sites such as coastal areas and hilltops, where wind speeds tend to be higher, are often the best sites for wind projects.

Economic viability of wind power projects is strongly tied to wind speeds. Since local geographical features and vegetation have a significant effect on wind speeds, wind monitoring is essential before proceeding with any project.

A study for BC Hydro identified four regions with the best wind resource.

Source: Garrad Hassan Canada Inc.

The Bear Mountain Wind Park, located in north-east BC near Dawson Creek, is a 34 turbine, 102 MW project, accepted by BC Hydro through its 2006 call for power. The project is owned by Alta Gas Income Trust and was developed by Bear Mountain Wind Limited Partnership, comprised of AltaGas Income Trust, Aeolis Wind Power Corporation and the Peace Energy Cooperative. The City of Dawson Creek is supportive of the project.

Bear Mountain Wind Park. Construction began 2007, with expected completion late 2009.

Source: Aeolis Wind Power Corporation and AltaGas Income Trust

3.2. Costs of wind electricity

The wind is free, but the capital equipment needed to harness the wind's energy can be expensive. The cost of wind electricity is a function of the upfront capital investment (and maintenance costs), and the amount of electricity produced.

The costs of wind power vary significantly with scale. BC Hydro estimates the cost of electricity from wind in BC to be around $75-$200/MWh for commercial-scale wind farms.[21] Electricity from smaller wind energy systems tends to have higher costs, at around $180-$440/MWh.[22] The ultimate cost of wind electricity will depend on site specific characteristics, in particular wind speeds and constancy.

A small-scale wind turbine (10-100 kW) will cost around $3000-$8000 per kW. The Canadian Wind Energy Association has developed a cost calculator to estimate the cost of a turbine: http://www.smallwindenergy.ca/en/SmallWindAndYou/Planning/BallparkCost.html

3.3. Will wind work in my community?

The first step in identifying potential wind sites is to examine a wind resource map. This will provide a general idea of the potential in your area. However, wind speeds vary significantly based on local geography, and hence on-site wind monitoring is essential. Currently available wind energy technology requires an average annual wind speed of around 5 metres per second to be viable.

The best opportunities may be remote and off-grid communities, especially those which currently rely on expensive and polluting diesel. Wind power for such communities and facilities can greatly reduce costs, while reducing GHG emissions and other pollutants.

Proposed roof mountings of wind turbines at Dockside Green, Victoria.
Source: Dockside Green

Other opportunities exist in grid-connected communities. Public buildings may provide an opportunity to develop roof-mounted wind turbines, though building-mounted turbines are a technically difficult application of wind technology. Local governments should obtain some form of performance guarantee for any building-mounted wind technologies. Dockside Green in Victoria is piloting installation of wind turbines on the roof of one building. Mounting the turbine on a tower if possible, instead of on a building, is a way to avoid potential technical problems associated with building mountings.

The City of Richmond is testing a new type of lighting system, generating both wind and solar energy, and storing the electricity to a battery to power the street light at night.
Source: City of Richmond

The City of Richmond has installed a pilot hybrid wind-solar system for powering street lights.[23] This technology involves the use of a 600 Watt wind turbine and a 120 Watt solar photovoltaic panel which stores energy from the wind and sun to a battery pack, which in turn, powers the light from dusk to dawn.

Case Study: Exhibition Place Turbine in Toronto

Exhibition Place, on Toronto's waterfront, is host to a 600 kW, 30-storey wind turbine. North America's first urban commercial-scale wind turbine is jointly owned by a local for-profit co-operative (Windshare) and by the City of Toronto's energy utility (Toronto Hydro). The turbine was constructed in 2002, at a total project cost of $1.8m. It produces around 1000 MWh every year, enough to power approximately 100 homes.

As a symbol of clean energy, the turbine has contributed to greatly heightened awareness of the possibilities of renewable energy, community ownership and sustainability. More information is available at http://www.windshare.ca/explace/the_wind_turbine.html

Photo Source: Toronto Atmospheric Fund

Your community may be within an area in which there is a commercial-scale wind farm under investigation. If so, you may have already been contacted by the company developing the project. It will be good to educate elected officials, staff and the community about the implications, impacts and benefits of wind power.

In addition to supporting the Bear Mountain Wind Park power project, the City of Dawson Creek partnered with the Peace Energy Cooperative to evaluate potential for a City-owned wind power project. The study [24] includes:

- a technical assessment of the wind energy resource
- an economic assessment of:
  - potential costs of producing wind energy at a scale suitable to community ownership
  - BC Hydro's Standing Offer Program and other types of "feed-in-tariffs" as a means of financing the project; feed-in-tariffs are the central policy used to propel countries such as Germany, Denmark, and Spain to be world leaders in wind development.
- next steps needed to further advance community-owned wind energy in Dawson Creek.

Electricity is responsible for half the cost of energy spent on city-owned properties. Wind is viewed as a viable option to help Dawson Creek produce its own power, to achieve price stability over time and to become an economic generator by supplying premium green power to the grid.

The NRCan RETScreen tool outlined in section 1 can help determine viability of potential wind energy projects. www.retscreen.net Also a website on small wind developed by the Canadian Wind Energy Association provides useful information, resources and case studies on small wind in Canada: www.smallwindenergy.ca

4. Solar Photovoltaics

Solar photovoltaic (PV) cells convert sunlight into electricity, even when cloud cover restricts direct sunlight. PV is particularly suitable for use in buildings where it can be used to replace roof tiles or cladding, thus partially offsetting the costs of these materials. Recent years have seen rapid growth in solar photovoltaic markets. As a result, the variety of products on offer is now huge, including solar roof tiles and solar glass, in addition to traditional panels that are mounted on rooftops. Solar PV is a relatively expensive form of renewable energy, although prices are expected to continue to fall.

Key advantages of solar PV:

- zero fuel costs
- can be incorporated as an attractive and/or educational feature of a building
- can offset costs of other roofing or cladding materials
- 40-year or more lifespan.[25]

4.1. Solar resource in British Columbia

British Columbia receives substantial solar energy, particularly in the Okanagan, Thompson-Nicola, Peace and East Kootenay regions. Natural Resources Canada has produced a solar resource map for Canada, as well as data for 3500 Canadian communities.[26] BC Hydro has also produced a solar resource map of British Columbia, which can be found at: http://www.canmap.com/green.htm

It is likely that many projects of interest will be 'building-integrated,' that is, solar PV panels will be integrated into a building as a roofing or cladding material. As a result, these projects will be small in scale, and local shading conditions may be the single most important determinant of solar resource. BC Hydro has estimated that approximately one third of residential and commercial rooftops in British Columbia have good solar exposure (that is, are free from direct shading).[27]

Installation of photovoltaic panels in Mission, BC

Source: Vancouver Renewable Energy Co-operative

A solar compactor using photovoltaic technology has been installed at Dockside Green, Victoria.

Source: Dockside Green

4.2. Costs of solar electricity

Solar photovoltaic energy is not cheap. The high costs of the materials mean that upfront costs are high, and payback times correspondingly long. Solar PV energy would be expected to cost around \$500-\$900/MWh.[28] That is, a 3 kW grid-tied solar photovoltaic system will likely cost \$20,000 to \$30,000, including installation, while a much larger 100 kW grid-tied photovoltaic system would cost around \$600,000 to buy and install.[29]

Where PV panels are used to displace alternative cladding materials, this initial cost is substantially offset. Building-integrated solar panels can also add to the architectural, aesthetic and educational value of a building. However, it is otherwise unlikely that a photovoltaic project would be attractive on economic grounds alone.

As solar photovoltaic energy grows worldwide, unit costs are falling. A recent estimate suggests that within 20 years, the cost of solar photovoltaics could fall to \$100/MWh.[30]

4.3. Will solar PV work in my community?

PV systems may be grid-connected to the utility, or stand-alone. One of the best opportunities is likely to be in facilities in communities isolated from the province's integrated electricity system. Many communities already use solar photovoltaic power in parking ticket machines and street or emergency lighting. An interesting application of solar technology is in garbage cans. Solar-powered garbage compactors greatly increase the volume of garbage that can fit into a garbage can. As a result, collections are needed less frequently, saving money and reducing emissions associated with transport.

Other good opportunities are in new municipal buildings, or when a building is having its roof replaced. Many solar photovoltaic manufacturers supply systems that act as a roofing or cladding material, which offsets the cost of the material that otherwise would have been used. Solar PV can be a highly visible symbol of the local government commitment to sustainable energy. NRCan has developed a buyer's guide that may help in choosing the appropriate type of system: http://www.canren.gc.ca/app/filerepository/6AD47BA5A6E74E6C81A17006016101114.pdf

The NRCan RETScreen tool can help determine viability of potential solar energy projects. www.retscreen.net

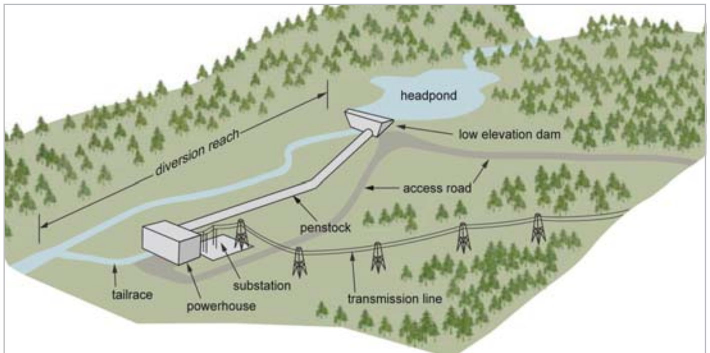
Case Study: Solar lighting in Kelowna

The City of Kelowna is hosting an innovative solar photovoltaic project with funding from NRCan. The Solar-Powered Lighting Project uses solar energy to power 100 lights in public spaces throughout the City, including parks, pedestrian and bike trails, and where needed for security and safety. The solar lighting systems are designed and manufactured by a BC company, Carmanah Technologies. In addition to \$500,000 from NRCan, the City of Kelowna is contributing \$128,000 in cash and in-kind. Kelowna already has over 70 solar PV installations, mostly on parking kiosks and pedestrian signals, and is committed to further developing the City's solar resources.

Photo source: Carmanah Technologies

5. Hydroelectricity

British Columbia is heavily dependent on hydroelectricity, and there is continued investment in hydroelectric generation throughout the province. The flow of water, especially falling down from a higher level, drives a turbine to generate hydro power. This occurs in a variety of forms and at different scales.



Typical run-of-river hydro project.

Source: Soren Henrich, Watershed Watch Salmon Society

Some hydro projects use a dam to store water, while others divert water from the river flow without significant storage. Hydro projects without significant storage are often known as 'run-of-river.' Note that even run-of-river projects may involve small dams, in order to keep the penstock submerged. The definition of run-of-river is based on the amount of water stored behind the dam or weir, usually defined as less than 48 hours of storage capacity.

Definitions of 'small' and 'micro' hydro vary significantly. BC Hydro defines small as 2-50 MW of capacity, and micro as anything below 2 MW. [31]

Many forms of hydroelectric power can be considered environmentally beneficial, because they produce clean power. However, hydroelectric power can have negative environmental impacts, because of damage to river ecology and fish populations, as well as terrestrial impacts associated with power-lines, access roads and construction.

In general, smaller hydro installations (less than 30 MW) are considered less damaging than large dams, and in some jurisdictions size alone has been used to judge environmental impact. Run-of-river hydro is generally considered less damaging than projects involving significant storage behind a dam, as it does not involve flooding areas upstream of the project. However, even small and run-of-river hydro installations may have effect, and all need to be carefully assessed and designed.[32] Watershed Watch Salmon Society has produced a useful citizen's guide to the environmental impacts of run-of-river hydro projects.[33]

Key advantages of hydro:

- among the cheapest sources of renewable electricity
- good opportunities and expertise in BC.

5.1. Hydroelectric resources in British Columbia

Many hydroelectric sites in BC are already under development. In 2000, to facilitate the development of further hydroelectric projects in British Columbia, BC Hydro developed an *Inventory of undeveloped opportunities at potential micro hydro sites in British Columbia*.[34] An additional resource assessment was conducted in 2007.[35] Water licences have been purchased for many of these sites, even where no development has yet taken place. The BC government keeps an online inventory of purchased water licences.[36]

BC Hydro has produced a *Handbook for developing micro hydro in British Columbia* for those seeking to develop small hydro projects in the province.[37] The handbook outlines the process of developing a micro hydro installation, which addresses key stages and issues:

- Business planning
- Site selection
- Financing
- Permitting and approvals
- Grid interconnection and energy sales
- Construction
- Operation and maintenance.

Case Study: Hupacasath First Nation and China Creek

The China Creek small hydro project is a story of successful community partnership and co-operation. The Hupacasath First Nation led a project to develop a small hydro system at China Creek, near Port Alberni. With a generating capacity of 6.4 MW, the project has signed a 20-year power purchase agreement with BC Hydro, and is expected to reduce GHG emissions by 4000–5000 tonnes per year.

In order to develop the project, the Hupacasath created the Upnit Power Corporation, along with minority partners Ucluelet First Nation, Synex Energy and City of Port Alberni. Upnit is a Nuu-chah-nulth word meaning 'a calm place.' The project cost a total of $14.5m, including some financial assistance from FCM's Green Municipal Funds and Western Economic Diversification.

Photo: Hupacasath Chief Judith Sayers and Port Alberni Mayor Ken McRae, during construction of the China Creek hydro project. *Photo source: Hupacasath First Nation*

To help project developers understand the permitting and approvals process, the British Columbia government has produced a *Guide for waterpower projects* for project developers.[38] This guide helps project developers understand the approvals and permitting process, which is likely to involve:

- Purchase of a water licence
- Purchase of land tenure, if the project is on crown land
- Environmental Assessment (mandatory for projects over 50 MW; many smaller projects choose to go through this process)
- Federal environmental assessments may also be necessary, particularly if the project will affect fish, or if federal funds are used in the project.

5.2. Costs of hydroelectric power

BC Hydro's heritage infrastructure has long since paid off the original construction costs, and the power so produced is correspondingly cheap. In contrast, the costs of new hydroelectric power can be much higher, since developing a hydroelectric power project demands significant capital investment.

Costs of small hydro (500 kW to 100 MW) range from around $60-$110/MWh.[39] Costs are higher for small micro hydro systems (less than 500 kW). Costs are site specific, and as a result it is difficult even to provide an indicative cost range.[40] IPPBC describes a typical small hydro installation (5-50 MW) as costing $10-$80 million.[41]

5.3. Will hydro power work in my community?

Opportunities range from tiny systems for single buildings, to larger systems in creeks or even in the municipal water system. The 2007 resource assessment undertaken by BC Hydro will provide a good idea of whether there are opportunities for commercial-scale systems in your area.[42]

The District of West Vancouver is generating power from its drinking water system, with a 200 kW turbine that replaced a pressure-reducing valve.

Source: District of West Vancouver

For smaller systems, there are a number of guidance documents that can help identify opportunities at a local site. The BC Ministry of Agriculture has published guidelines for on-farm use,[43] and NRCan has produced a buyers guide for those seeking to develop very small projects of less than 100 kW.[44]

Drinking water systems can sometimes be fitted with turbines to harness the energy in drinking water flowing downstream. The District of West Vancouver has developed such a project, described in a case study in section 9.3. In the Okanagan, the District of Lake Country is developing a project to install a 1 MW turbine within the Eldorado Reservoir water system.[45] A 2002 study explored the potential for a hydroelectric project in the water system that supplies Nanaimo, and although no projects have yet been developed there, the study provides a useful resource for others considering this option.[46] Other cities generating electricity from water flows or reservoirs within the drinking water system include Portland, OR and Tacoma, WA.

The NRCan RETScreen tool outlined in section 1 can help determine viability of potential hydro power projects. www.retscreen.net

6. Biomass and biogas

BC already has over 600 MW of biomass-fired electricity generation capacity,[47] mostly 'co-generation' plants in the forestry and pulp and paper sectors. Generating electricity through combustion always generates heat, and co-generation (sometimes called 'combined heat and power' or CHP) makes use of this heat for buildings, hot water or industrial processes.

The provincial government is supporting the development of BC's bioenergy resources through the Bioenergy Strategy, published January 2008.[48] The bioenergy strategy was accompanied by a bioenergy information guide for British Columbia, which provides a detailed guide to the technologies, fuel sources and opportunities for bioenergy development in BC.[49]

Key benefits of biomass and biogas:

- low fuel costs, widely available fuel
- opportunities for economic development
- waste management and air quality improvements.

This section explores three sources of bioenergy of interest to local governments in British Columbia: municipal solid waste, biogas from sewage treatment and landfill, and wastes from forest (including pine beetle) and agricultural sectors.

6.1. Municipal solid waste

Municipal solid waste (MSW) has been used to generate electricity for over 100 years, and its use for this purpose has always been controversial. Advocates believe the process to be a sustainable win-win solution to both energy supply and waste disposal. Critics argue that in addition to being polluting, it creates an incentive to create waste, rather than to reduce and recycle which have lower environmental impacts.[50] Generating energy from waste should only be considered as part of an integrated solid waste management plan, that fully explores financial and sustainability implications of other waste management options. Guidance on the use of waste for energy as part of a broader strategy is available from FCM,[51] and the BC Ministry of Community Development has published a report on Integrated Resource Management, which includes energy from waste options.[52]

Case Study: Metro Vancouver's Waste-To-Energy Facility

Metro Vancouver's Waste-to-Energy-Facility (WTEF) is located in Burnaby and commenced operation in March 1988. The facility processes solid waste (i.e. garbage), and originally produced only steam for use in an adjacent paper recycling mill. In 2003 it was upgraded to generate electricity through installation of a turbine and generator in a project known as SEEGEN (Social, Economic and Environmental GENeration of electricity). The WTEF processes around 20% of the lower mainland's garbage, and has historically sold about 135,000 MWh per year of electricity to BC Hydro, enough to power around 15,400 homes. Environmental monitoring over the 20-year period has shown no detectable impact on air quality.

The SEEGEN upgrade cost $36 million, and now earns over $6 million annually in revenues from electricity sales, in addition to revenues from the sale of heat and from tipping fees. The project reduces overall GHGs by producing electricity, and by provision of steam to the adjacent paper recycling mill.

Photo source: MetroVancouver

Energy can be derived from MSW in a number of ways. Waste can be burned in a waste incinerator, and the resulting heat can be used to raise steam and drive a turbine. The fuel is free (or even cost-negative, that is, the facility will be paid to accept fuel through tipping fees), and the technology is proven, having been used for many years. However, incineration of MSW requires sophisticated and expensive emissions controls to prevent release of toxic chemicals into the air. In many parts of the world, local populations have resisted the installation of waste incinerators over fears about exposure to toxic chemicals, particularly dioxins.

New technologies are being developed to generate electricity from MSW, including gasification, which has higher efficiencies and often lower air emissions than traditional incineration. A pilot project in Ottawa is currently demonstrating the feasibility of this process, in partnership with Plasco Energy.[53] The Plasco project has an electricity generating capacity of 4 MW and consumes up to 85 tonnes of MSW per day.

Organic wastes can be used to generate biogas, through a process of anaerobic digestion (breaking down in the absence of oxygen). This process is similar to the production of biogas from the digestion of sewage sludge, which is discussed in 6.2 below.

6.1.1. Costs

BC Hydro recently estimated that MSW incineration projects on Vancouver Island and in the Lower Mainland and Okanagan regions could provide a generating capacity of at least 50 MW, and would cost around $74/MWh.[54] Cost estimation is difficult because only a single project exists so far in BC: MetroVancouver's Waste-to-Energy Facility in Burnaby (see below).

6.1.2. Will it work in my community?

The economic feasibility of producing energy from MSW is largely dependent on the size of the solid waste resource locally available. As a result, it is likely that MSW energy projects would only be possible in BC's largest urban centres.

Energy from waste is controversial, and any project would likely need extensive community consultation to determine whether or not it should proceed. Important community concerns will likely include the potential pollution implications, and the concern that waste management efforts should focus on waste reduction, recycling and re-use, rather than energy generation.

6.2. Biogas

The decomposition of organic waste creates biogas, a mixture mostly of methane and carbon dioxide. Biogas can be used to produce heat or electricity or both, or can be used as a transportation fuel. There are two principal sources of biogas of interest to local governments: anaerobic digesters within sewage treatment systems, and landfills. These are significant sources of GHG emissions, in part because methane is 25 times more damaging to the atmosphere than carbon dioxide.[55] Capturing and burning this gas for energy helps reduce GHG emissions, as well as producing clean energy.

Landfill gas currently accounts for around 8% of BC's GHG emissions. Landfill gas can be captured and either flared (burning the methane and releasing carbon dioxide, a less potent GHG) or used as a fuel for electricity generation. Landfill gas utilization offers one of the most promising opportunities for local governments seeking to develop renewable electricity projects. There are already three IPP projects using landfill gas that are part-owned by local governments in British Columbia (Hartland Landfill in the Capital Regional District, Vancouver Landfill in Delta and the Glenmore Landfill in Kelowna), with others in development. In addition to reducing GHG emissions, landfill gas capture and utilization reduces odours from the landfill and improves local air quality.

Digester gas arising from sewage treatment has been used since 1895, when the City of Exeter, in England, started digesting sewage and using the resulting gas for street lighting. Digestion of sewage sludge typically takes place in larger sewage treatment plants (those processing more than around 11.4 million litres, or 3 million US gallons, per day).[56] The gas arising from digestion is usually either flared, or used to generate heat and power for use within the sewage treatment plant.

Biogas can also be produced from anaerobic digestion of the organic fraction of MSW,[57] greatly reducing the volume of waste going to landfill, or from anaerobic digestion of agricultural waste. There are only a couple of examples of anaerobic digestion of MSW in Canada (such as the Dufferin facility in Toronto), but it is common in Europe. In Sweden, a number of wastewater treatment plants have started to combine digestion of sewage sludge with digestion of kitchen waste, leading to significantly higher production of methane.[58,59] The methane produced is used to run fleets of buses, or for co-generation of heat and electricity.

6.2.1. Costs

For landfill gas, major costs are related to the process of gas capture, rather than use of the gas. Costs vary depending on proportion of gas captured, and size of landfill. As an example, the Regional District of Nanaimo captures 70% of landfill gas from the Cedar Road Landfill, in a project that cost $1.2m.[60] The District currently flares the gas, but is developing a project to sell it for power generation, with an expected capacity of 1 MW. There are also significant ongoing maintenance costs associated with landfill gas capture.

Many landfills in BC already capture and flare their landfill gas; upgrades to make use of the gas would cost much less than a complete capture and utilization project. The provincial government is developing rules to govern landfill gas capture, and the regulation currently under consultation proposes to mandate gas capture for landfills that generate more than 1000 tonnes of methane per year.[61]

The costs of anaerobic digestion of organic waste vary significantly, with larger facilities significantly more cost-effective than those serving small communities. As an indicator of capital cost, a facility that processes 10,000 tonnes per year of organic waste is likely to cost around $10m.[62]

6.2.2. Will it work in my community?

Landfill gas utilization is likely to be economic only at large landfill sites, which generate sufficient quantities of gas. Landfills receiving over 10,000 tonnes/year may be required by provincial regulations to capture at least 75% of landfill gas.[63] This will greatly improve the economics of energy generation from landfill gas for landfills above this size, as the most expensive element of landfill gas utilization, gas capture, will be required. In terms of the amount of energy that can be generated, a rough rule-of-thumb is that a landfill of 1 million tonnes of waste in place is needed to run a 1 MW energy system.[64]

Several landfills in BC already capture landfill gas and use it to generate heat or electricity (see table below, and section 9.3.2 for more detail). Others, such as the

Case Study: Hartland Landfill Gas Utilization Project

The Hartland Landfill serves the 340,000 people of Greater Victoria, receiving around 150,000 tonnes of garbage annually. It began as an unregulated dump in the 1950s, and was taken over by the Capital Regional District in 1985. Landfill gas has been collected and flared at Hartland since 1991, but the energy value of the landfill gas was lost until development of the Hartland Landfill Gas Utilization Project.

The Capital Regional District partnered with Maxim Power, a private company from Calgary, to generate electricity from the gas. The facility became operational in 2004, and has a capacity of 1.6 MW, enough power for approximately 1,600 homes. The project cost a total of $2.7m, with ownership shared by the CRD (which owns 70% of the project) and Maxim Power. This upfront cost does not include the cost of landfill gas collection, which was already undertaken at the site and which often represents the most significant part of a landfill gas utilization project.

Further details are available at www.crd.bc.ca/waste/documents/submission_landfill_gas.pdf

Photo: The Hartland Landfill Gas Utilization Project generates 1.6 MW of power and yields a return to CRD of $200,000 annually.

Photo source: Capital Regional District

Sunshine Coast Regional District's Sechelt Landfill (which receives 12,000 tonnes of waste per year)[65] and Regional District of Nanaimo's Cedar Road Landfill (described in more detail above), are currently developing landfill gas utilization projects.

BC landfills utilizing gas for energy

Landfills	**Size** *(tonnes per year)*
Glenmore Landfill, Kelowna	100,000
Hartland Landfill, Capital Region	110,000
Ecowaste Landfill, MetroVancouver	210,000
Cache Creek, MetroVancouver	370,000
Vancouver Landfill, MetroVancouver	610,000
Coquitlam Landfill[66], MetroVancouver	Closed
Jackman Landfill, MetroVancouver	Closed
Port Mann Landfill, MetroVancouver[67]	Closed

Golder Associates has produced two recent studies for the Ministry of Environment:

1. *Inventory of GHG Generation from Landfills in British Columbia,*[68] identifying 35 BC landfills with disposal rates greater than 10,000 tonnes in 2006; and
2. *Cost Estimation Model for Implementing GHG Emission Reduction Projects at Landfills in British Columbia.*[69]

Environment Canada has profiled some examples of landfill gas capture and utilization,[70] and has produced a guidance document on landfill gas management.[71] More up-to-date and comprehensive guidance is available from the US Landfill Methane Outreach Program: http://www.epa.gov/lmop/res/index.htm#community

Production and use of biogas from sewage sludge digestion occurs at several wastewater treatment plants in BC, including facilities in MetroVancouver, Prince George and Nanaimo. Energy from wastewater treatment digestion is likely only viable at plants that serve a population of 50,000 or more, and economics improve with size. As a rule-of-thumb, enough biogas can be generated from each 1 million litres per day of wastewater to produce up to 9 kW of electricity (or 1 million US gallons to produce up to 35kW of electricity).[72]

Anaerobic digestion of municipal organic waste is likely to be economically viable in larger communities, with a population over 20,000-40,000.[73] A useful guide to anaerobic digestion technologies is available from FCM: http://www.sustainablecommunities.ca/Capacity_Building/Waste/Solid_Waste_as_a_Resource.asp

6.3. Wood waste and agricultural residues

Combustion (or gasification, then combustion) of solid biomass, such as woodwaste and agricultural residues, can be used to generate electricity. This is a well-established technology, with a strong history in BC and elsewhere.

BC has an enormous biomass resource from forestry and agricultural wastes. Recent resource assessments have estimated that enough forest and agricultural residues exist to provide up to half of BC's energy requirements, though this number almost certainly exaggerates the amount that could be recovered in practice.[74] However, there are many users of such 'waste', and accessing biomass for energy generation may not be cheap, even during the current high cutting rates associated with the mountain pine beetle infestation.

It is estimated that the short-term wood resource associated with the mountain pine beetle epidemic will be exhausted by 2014 at current cutting rates. New electricity projects using biomass energy will have a lifespan significantly beyond 2014, and therefore need to have secure access to a source of biomass not dependent on the mountain pine beetle epidemic. One way of doing this is to negotiate an agreement with a forest licence holder such as a local sawmill, or with a local agricultural producer.

The Province has produced a primer to help independent power producers understand forest management in BC, and implications for resource availability. http://www.for.gov.bc.ca/hts/bioenergy/primer_IPP.htm

6.3.1. Costs

The costs of energy generated from woodwaste or agricultural residues are heavily dependent on the cost of the fuel. Energy from sawmill woodwaste can be relatively cheap ($85/MWh), while standing pine-beetle infested wood, or road-side slash waste, is a relatively expensive source of energy ($180/MWh).[75] Capital costs for the generating plant depending on the technology used (direct combustion, or gasification followed by combustion, for example), and are in the range $2.5-$3m per MW of capacity.[76]

6.3.2. Will it work in my community?

The best opportunities for electricity generation from wood and agricultural wastes are where there is a reliable source of fuel within the community, such as a sawmill. However, it may not be easy to secure low-cost fuel even where such a source exists. A good first step is to contact possible sources of biomass energy.

The NRCan RETScreen tool outlined in section 1 can help determine viability of potential biomass energy projects. www.retscreen.net

7. Geothermal power

In some parts of the province, geological formations contain useful heat that could be used to turn water into steam, which could then drive a turbine, thus generating electricity. This technology is well established in other parts of the world, providing reliable and clean power.

There are currently no operating geothermal power projects in Canada. The most promising site in British Columbia is the Meager Creek project near Pemberton, currently under development by Western GeoPower.[77] Until this project has demonstrated commercial viability of geothermal power in BC, it is unlikely that investors will commit to projects elsewhere in the province.

The BC Ministry of Energy, Mines and Petroleum Resources has produced a geothermal resources map, which helps communities identify whether they are likely to have potential to develop geothermal power projects. http://www.em.gov.bc.ca/Geothermal/GeothermalResourcesMap.htm In addition RETScreen may be of some support. www.retscreen.net

8. On the horizon: Wave, tidal and fuel cell technologies

British Columbia is fortunate to have considerable energy resources in its coastal waters. Tidal, wave and current technologies are under development. As technologies develop and costs fall, it is likely that there will be commercially attractive applications throughout coastal BC, but this is still some years away. RETScreen does provide some support on wave and current energies.

Fuel cells are another technology that may provide power in the future. Fuel cells use chemical reactions rather than combustion to produce both electricity and thermal energy. Hydrogen fuel cells, where much of the recent research has been focused, use hydrogen as the fuel source. Because there is no combustion, harmful emissions are extremely low – the only by-product of hydrogen fuel cell electricity generation is water and heat. However, hydrogen must be produced from another source (usually natural gas), in which case there may be GHG emissions associated with its production.

Case Study: Race Rocks tidal power

The islands of Race Rocks, 17km southwest of Victoria, are home to one of the world's few operational tidal power systems. The buildings on Race Rocks (lighthouse, foghorn, and marine education centre) were powered for many years by a diesel generator. The use of diesel was expensive in terms of both maintenance and fuel, and alternative energy options were explored for environmental, educational and economic reasons. Lester B. Pearson United World College of the Pacific, home to two hundred students from one hundred countries, operates the facilities and acts as the eco-guardian of the Race Rocks Ecological Reserve, as part of their commitment to unite people and nations for a peaceful and sustainable future through education.

The Race Rocks tidal energy project was developed as a partnership between Pearson College, Clean Current Power Systems, Encana Corp. and Sustainable Development Technology Canada. The project consists of a 65 kW tidal current turbine, which started generating power in 2006. The tidal power project complements a solar photovoltaic system (made possible with funding from the Ministry of Energy, Mines and Petroleum Resources) and a battery bank, and enables the island to operate facilities without diesel generation.[78]

The tidal turbine operating at Race Rocks is British Columbia's first operating tidal energy system.

Photo source: Lester B. Pearson United World College of the Pacific

9. Opportunities for local governments

Renewable electricity projects can help promote sustainability in the community. They can reduce GHG emissions, promote economic development and local energy security, and foster more sustainable behaviour and attitudes. Local governments have an important role in demonstrating leadership and encouraging the development of renewable electricity.

9.1. Renewable electricity in local government operations

Many of the technologies described above provide opportunities for local governments to contribute to improving the environment and to be a leader in the community by generating electricity. Where a local government is generating energy for its own direct use in buildings and facilities, this is known 'customer generation' or 'self-generation.'

As described in Section 2.2, self-generation reduces the need to purchase electricity from BC Hydro or FortisBC, and can possibly generate revenue through sale of power to the utility; this should be confirmed with the relevant utility at an early stage in any project. Where electricity installations are below 50kW (as is likely the case with solar photovoltaics), power can reduce the electrical bill and excess can be sold to BC Hydro (or potentially FortisBC) through the Net Metering tariff. For installations larger than 50kW, application can be made to sell power to BC Hydro through a standing offer contract.[79]

In British Columbia, electricity costs are among the lowest in the industrialized world. For many technologies, it will be difficult to justify the use of renewable electricity on economic grounds alone. Good opportunities might include:

- PV, which is expensive as a source of power, but which can serve as a highly visible symbol of leadership in the community on sustainable energy
- Micro hydro systems – especially where there are opportunities in the water supply system or water storage facilities
- Landfill gas and digester gas utilization
- Wind power in remote communities, particularly coastal communities and those in the Peace region
- Biomass cogeneration in biomass-rich communities, possibly as part of a district heating system (for more information about district heating, see *Heating Our Communities,* another module of the Community Energy Association *Renewable Energy Guide for Local Governments).*

9.2. Supporting renewable electricity in the community

In many communities, businesses and individuals will be exploring ways to generate their own clean power. In most cases, this will either be solar PV, small wind, or very small hydroelectricity. Local governments have an important role in encouraging this kind of energy development.

9.2.1. Policies to promote renewable electricity in the community

The Official Community Plan can indicate support for renewable energy, perhaps in the context of GHG action and targets. Local governments can encourage the uptake of renewable electricity systems in new developments. Some examples are given here. These and other policy instruments are discussed in further detail in the *Policy and Governance Tools* module of this *Renewable Energy Guide for Local Governments,* available from the Community Energy Association.

Case Study: City of Greenwood solar and wind project

The City of Greenwood is justifiably proud of its heritage, and one of Greenwood's historical gems is the West Kootenay Power Building, built in 1906 to provide power to the community and local industry. The building is now a heritage centre, and in 2000 the City decided that a good way to celebrate the historical role of the building was to use it as a demonstration for renewable energy technologies. With funding from the former Ministry of Community Development, Cooperatives and Volunteers, the first phase of the project included installation of a small wind turbine and solar photovoltaic panels. These were not connected to the electricity grid, but were instead operated in connection with a system of batteries to provide power when renewable energy was not available. In 2007, funding through the Gas Tax Agreement was used to upgrade the project, and connect the system to the grid.

Photo source: Arno Hennig

Examples of policy instruments include:

- **Development Permit Areas** that preserve access to sunlight.
- **Rezoning policies.** Bowen Island uses rezoning to promote green buildings.
- **Density bonuses.** Hailey, Idaho uses density bonuses to promote renewable energy. In BC, the City of Kamloops uses density bonuses to encourage green and energy efficient buildings in the City's North Shore Neighbourhood. The UniverCity development in Burnaby also uses density bonuses to encourage energy efficiency and renewable energy.
- **Tax exemptions and reduced development cost charges.** The District of Maple Ridge uses tax exemptions to promote green buildings, including those with renewable energy.
- **Development permit checklists.** Several BC communities use these to educate developers about green buildings and sustainability. The City of Port Coquitlam's checklist is a good guide.[80]

9.2.2. Removing barriers to local renewable electricity

Planning policies have rarely been written with renewable energy in mind, and sometimes renewable energy technologies clash with planning bylaws and permitting processes. Individuals and businesses often encounter local-level barriers to renewable energy, such as difficulty obtaining an electrical permit or building permit.

Local governments can facilitate installation of renewable electricity systems by:

- Ensuring that building inspectors are familiar with Council support for renewable energy, and that they know where to go for information about renewable energy technologies. The Community Energy Association can help connect inspectors with experts on all the technologies profiled in this guide.
- Ensuring that bylaws to prevent unsightly rooftop equipment do not prevent use of solar energy. The District of West Vancouver promotes solar energy by specifically excluding solar from a bylaw that requires the enclosure or screening of rooftop equipment.[81]
- In regions in which small wind power is likely to be an option, consider passing a bylaw similar to the model zoning bylaw for small wind developed by the Canadian Wind Energy Association.[82] The County of Kings, NS, has adopted wind-friendly zoning bylaws, including small-scale wind turbines as a permitted use in rural residential areas.[83]

9.3. Local governments and independent power production

Independent power producers design and develop power projects, and sell the power to BC Hydro through either the standing offer program or a call for power (see section 2.2). Local governments can take some measures to encourage local IPP projects.

Some BC local governments have become IPPs in their own right, generating electricity and selling it to BC Hydro or FortisBC.

9.3.1. Encouraging local IPP projects

Local governments do not have a direct regulatory role with respect to IPP projects, unless the project takes place on land that requires a rezoning. Local governments are therefore limited in the degree to which they can influence IPP projects in their area, but some local governments are still exploring ways in which they can encourage local IPP projects.

Local governments can encourage the development of renewable power projects by:

- Ensuring that zoning bylaws and rezoning procedures do not create unnecessary hurdles to appropriate renewable energy development on private land.
- Providing support by communicating the benefits of renewable energy to the community, for example through assisting with community engagement processes.
- Providing a welcoming environment for project developers. Some local governments in BC have issued letters of welcome through IPPBC, reassuring project developers that the community is supportive of projects that are socially and environmentally beneficial.

Aerial view of the head pond and weir at the Rutherford Creek run-of-river project near Pemberton.

Source: Independent Power Producers Association of BC

9.3.2. Local government involvement in IPP projects

Several British Columbia local governments have become independent power producers in their own right. So far, all have done this in collaboration with a private partner, who brings experience to the table. The Independent Power Producer's Association of BC (IPPBC) may be able to help local governments to find partners or to learn more about the process (www.ippbc.com). *Utilities and Financing,* available from the Community Energy Association, provides further details about how local governments can establish an independent power project.

Opportunities and advantages

- Potentially good business case, with energy sales forming a source of non-taxation revenue for the local government. However, local governments must balance the potential financial benefits with the substantial business and investment risks associated with IPP development.
- Community ownership creates economic benefits, as energy expenditures are kept within the community.
- Likely to work best where local governments own the resource, as with landfill gas projects.

Examples and resources

Several local governments in British Columbia have become involved in the development and ownership of independent power projects, profiled in the following table; with the exception of the Kelowna project selling power to Fortis BC, all of these sell power to BC Hydro. Feasibility studies are available for many of these projects (see 'further info' in the following table), and these provide a useful resource for other local governments that might be considering costs and benefits of a particular project.

Local Government Independent Power Producers in British Columbia

Vancouver Landfill Gas Utilization Project

City of Vancouver and Corporation of the District of Delta

- Electricity from landfill gas combustion in a co-generation power plant
- Heat distributed to nearby greenhouses
- Partnership with Maxim Power

Further info: Community Energy Association Case Study[84]

Hartland Landfill Gas Utilization Project

Capital Regional District

- Electricity from landfill gas combustion
- Partnership with Maxim Power

Further info: Capital Regional District submission to UBCM community excellence award[85]

Glenmore Landfill Gas Utilization Project

City of Kelowna

- Electricity generated from landfill gas using three 30kW microturbines
- Power sold to FortisBC

Further info: City of Kelowna Glenmore Landfill project description[86]

Eagle Lake Micro Hydro

District of West Vancouver

- Small turbine installed in drinking water reservoir outflow, replacing pressure-reducing valve
- Project was established as a partnership with Cascade Power, a local firm
- Financed directly by District of West Vancouver

Further info: BC Hydro IPP profile[87]

China Creek Micro Hydro

Hupacasath First Nation and City of Port Alberni

- Micro hydro project
- Led by Hupacasath First Nation; City of Port Alberni support role
- Jointly owned by Hupacasath First Nation, Ucluelet First Nation, Synex Energy and the City of Port Alberni

Further info: BC Hydro IPP profile[88]

Waste-To-Energy Facility

Metro Vancouver

- Combustion of municipal solid waste generates electricity, sold to BC Hydro, and heat, sold to an adjacent industrial facility
- Owned by Metro Vancouver, operated by Montenay, Inc.

Further info: Metro Vancouver waste-to-energy facility fact sheet[89]

For further discussion of local government potential for involvement in an IPP project, see the *Utilities and Financing*[90] module of the Community Energy Association *Renewable Energy Guide for Local Governments.*

The Village of Anmore is exploring generation of clean electricity for their community and the Lower Mainland by harnessing micro hydro, solar and micro wind energy. The community has secured grants to assess the feasibility of producing green hydrogen and clean electricity by integrating the three sources of renewable energy.[91]

Nelson Hydro generating station (right) operating since 1907 at Bonnington Falls; Fortis BC plant (left).

Source: Nelson Hydro, City of Nelson

Case Study: District of West Vancouver – Eagle Lake Hydroelectric Project

In the District of West Vancouver, a local resident realized that water flowing through the District's water system was an un-tapped energy resource. The water system uses pressure reducing valves to reduce the high pressure of water flowing downhill from the Eagle Lake Reservoir. By using a turbine instead of a valve, the District could turn its water system into an independent power project.

The Eagle Lake Micro hydro project commenced operation in 2004, with installation of a 200 kW turbine. The system cost around $450,000, the majority of which came from the District's reserve fund. $50,000 was provided as a grant from FCM's Green Municipal Fund for the feasibility work. The system is expected to have a payback of 10-12 years.

The project was developed as a 'Design-Build-Operate-Maintain' public-private partnership, with the District maintaining 100% ownership of the system. The partnership model allowed the district to acquire the necessary expertise, and share the risks associated with project development with the private partner.

Photo source: District of West Vancouver

9.4. Power purchasing policies

In many jurisdictions, it is possible to pay a premium to buy 'green' electricity that has been produced from renewable sources. By purchasing renewable energy credits, a local government can lower its net emissions and encourage development of renewable energy. Disadvantages are the slightly increased cost of power, and the fact that economic benefits of the renewable energy development accrue to the region as a whole, rather than to the local community.

FortisBC offers green power certificates to all customers and rate classes. Every dollar received from customers under the green power rate is used to purchase green power from various suppliers. These green power purchases directly offset power purchases from other sources.

BC Hydro ran a program of this kind for some years, using the green premium to fund clean electricity projects around the province. Several BC local governments bought green power certificates from BC Hydro through this program, including Cities of Kamloops, North Vancouver, and Vancouver, as well as the Township of Langley, Resort Municipality of Whistler, the Capital and Greater Vancouver Regional Districts, and others. BC Hydro's Green Power Certificates program[92] is currently under review; contact BC Hydro for more information.

Overlooking Thunder Meadows, near Fernie, BC

10. Conclusion: A vision for a renewable BC

Renewable energy is a booming global industry, now accounting for 2.4 million jobs.[93] As conventional energy prices rise, and as the world confronts the challenges of climate change, the growth of renewable energy will certainly continue. Cities around the world are seizing opportunities presented by the global shift towards renewable energy supplies, and this guide outlines the ways in which local governments in British Columbia and Canada can realize the economic and environmental benefits of renewable energy.

Looking forward ten years, we can imagine communities in which residents profit from their investments in a local energy system; communities whose energy bills pay for local jobs, not for imports; communities that take pride in their role as clean, green entrepreneurs.

Realizing this vision will take dedication and hard work. The Community Energy Association is committed to helping local governments become leaders in Canada's transition to a low-carbon economy. Contact us for support. We look forward to hearing how your community is developing renewable energy policies and projects, and we'll share your successes with other local governments, as we'll share theirs with you.

Endnotes

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Community Energy Association

Infrastructure Canada

Canada

British Columbia

BC hydro FOR GENERATIONS

FortisBC

T (604) 628-7076 info@communityenergy.bc.ca www.communityenergy.bc.ca