



GENERATING RENEWABLE ELECTRICITY WITH DISTRIBUTED GENERATION: A SELF-ASSESSMENT TOOLKIT FOR B.C. FIRST NATIONS

FOR GENERATIONS

DOCUMENT INFORMATION

This document was developed by the Energy Planning and Economic Development Group within BC Hydro.

DISCLAIMER

FOR MORE INFORMATION ON THE SELF-ASSESSMENT TOOLKIT, PLEASE CONTACT:

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PART I: INTRODUCTION TO THE DISTRIBUTED GENERATION TOOLKIT

1. INTRODUCTION

BC Hydro is seeing more and more First Nations and non-First Nations communities with a new interest in the role of energy and how it is used. Many of these potential opportunities encompass renewable resources such as wind, hydro, biomass and solar, to name just a few.

The Distribution Generation (DG) Toolkit will assist BC Hydro customers that have a desire to achieve energy self-sufficiency through developing energy projects on their own or in partnership. The toolkit is designed to review the applicant's readiness by identifying the project requirements and processes to pursue a DG project. Additionally, the Toolkit will encourage applicants to identify and connect early with applicable interest groups.

WHAT IS DISTRIBUTED GENERATION?

Distributed generation is defined as small-scale power sources located at or near a customer's site. In general, DG projects range in size between a few kilowatts (kW) to 15 megawatts (MW), and produce enough energy to power from one to over 5,000 homes. DG promises many benefits, which could include efficiency gains[1], increased reliability[2], and local economic development.

WHY DISTRIBUTED GENERATION?

A DG approach can respond to customer's goals around energy self-sufficiency and a desire to be more involved in energy decisions that affect them. BC Hydro has undertaken several measures that can support DG, including a Net Metering program and the Standing Offer program both of which target smaller-scale generation projects under 15 MW. In addition, demand-side solutions have also been achieved through the Integrated Customer Solutions process for industrial and commercial customers. There is no maximum size project in this process.

PURPOSE OF THIS TOOLKIT

First Nations in B.C. play a key role in energy planning, infrastructure, and the regulation of land-use, all of which are important to the uptake of DG. BC Hydro has developed this Toolkit to support First Nations communities in identifying and scoping opportunities with the most potential.

This Toolkit is comprised of three parts:

- Part I begins with this introduction, describing the layout of this Toolkit, and includes some preliminary questions about readiness to pursue DG;
- Part II includes technology-specific information, and associated appendices, serving as modules to explore the energy potential of locally available resources, and to screen potential projects; and,
- Part III describes other general considerations in DG project development.

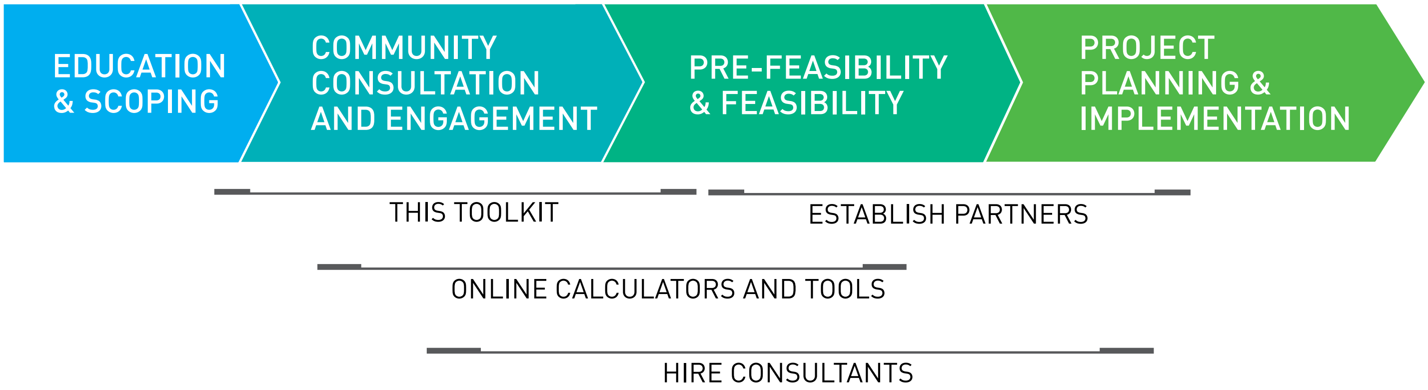
The role of the Toolkit in the DG project development process is illustrated in Figure 1. It should be emphasized that the Toolkit is not intended to replace feasibility studies. Rather, it provides useful high-level information that may assist First Nations communities to identify the best opportunities for DG. Only a limited selection of renewable energy technologies are contained in the Toolkit. The list has been restricted to market-ready, proven technologies that generate electricity at the community-scale, including:

- Combined Heat and Power from Waste Resources
- Small and Micro Hydro
- Solar Photovoltaics
- Wind

[1] Over long distances, the transmission of electricity often results in line losses of approximately 7 per cent. Where DG allows consumption close to the point of generation, these losses can be minimized.

[2] Many power outages are caused by trees falling on transmission lines. Where DG can localize generation, power may continue to be provided during outages.

Figure 1. Timeline for DG Project Planning



USING THE TOOLKIT

The Toolkit has been designed for workshops that can be planned and conducted by First Nations. An initial group meeting can be used to define goals, context, and roles. During this initial period, a project leader (or "champion") could be selected. This person will lead the implementation of the Toolkit, facilitate discussions, assemble results, and ensure progress with other members of the group. A second group meeting can be held to discuss preliminary findings and to prioritize the best opportunities for DG. The steps in this process are illustrated in Figure 2.

Figure 2. Suggested Process for Using the Self-Assessment Toolkit

INITIAL CONSIDERATIONS

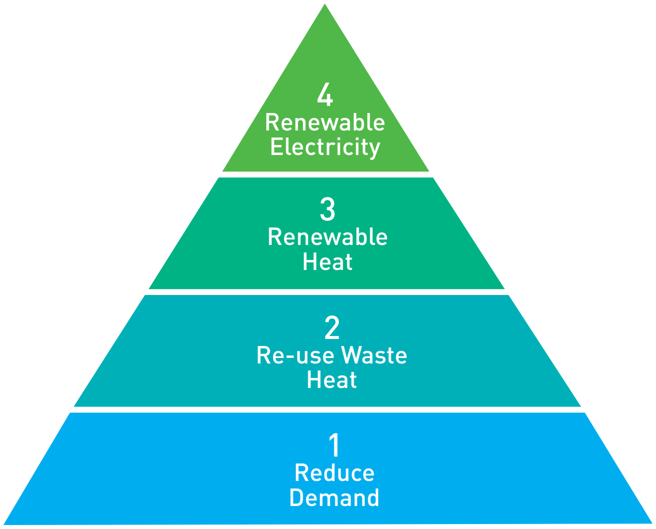
The Toolkit is intended to complement work that may already be underway in your community's Official Community Plan (OCP), Sustainability Plan, Energy Plan and/or Greenhouse Gas (GHG) Reduction Plan. Distributed Generation is just one component of a much wider breadth of renewable energy options available to First Nations communities.

Figure 3 illustrates how interested parties might prioritize strategies to reduce energy consumption and mitigate energy-related GHG emissions. For example, a First Nations community might decide to focus their efforts on reducing GHG emissions. The first step, as suggested in Figure 3, should be the consideration of any efficiencies that can be achieved through demand reduction, followed by the use of waste heat and the generation of heat from renewable sources, before pursuing a DG opportunity.

Through a clear understanding of your community's key goals and interests, it should be much easier to decide which, if any, DG opportunities might best meet your objectives. In order to explore these linkages, some possible guiding questions are listed below:

- Does your community have goals pertaining to energy self-sufficiency? Do these goals include electricity?
- What are the major environmental objectives your community seeks to meet?
- Is the provision of energy explicitly tied to local economic development? For example, is there an objective to create green jobs in your community?

Figure 3. Community Energy Planning Hierarchy



1. REDUCE ENERGY DEMAND	through community design, green buildings, and efficient technologies.
2. RE-USE WASTE HEAT TO HEAT BUILDINGS AND HOT WATER	e.g., industrial or commercial waste heat, sewer and waste water heat recovery.
3. RENEWABLE HEAT SOURCES TO HEAT BUILDINGS AND HOT WATER	e.g., solar thermal and geo-exchange.
4. RENEWABLE ENERGY FOR ELECTRICITY	e.g., biomass/biogas combined heat and power, micro-hydro, wind, solar, tidal and geothermal.

This Toolkit is intended to help First Nations communities explore and compare local DG opportunities. The results derived from the Toolkit may help to build on current plans, policies, and actions related to energy management and GHG reduction, and to enable a shared understanding of the costs and benefits associated with locally-generated renewable electricity.

NEXT STEPS

Complete the 'Are you ready to explore Distributed Generation opportunities' form.

ARE YOU READY TO EXPLORE DISTRIBUTED GENERATION OPPORTUNITIES?

This questionnaire can feed into your existing or emerging energy plan. These preliminary questions are intended to explore your readiness to explore DG opportunities.

ARE YOU READY TO EXPLORE DISTRIBUTED GENERATION?		NOTES
Have you completed an energy plan for your community, or are you in the process of completing one?		
☐ Yes	☐ No	
Have you explored opportunities to increase energy efficiency within your community and current/ existing operations? For example, by providing incentives, education, or regulations related to energy efficiency in buildings. Conservation and efficiency are generally more cost-effective than generation and should be considered first.		
Contact Power Smart Sustainable Communities for more information at **www.bchydro.com/powersmart**.		
On a community-wide basis? ☐ Yes ☐ No	**On a corporate basis?** ☐ Yes ☐ No	
Have you explored the potential value of energy generation in community economic development? DG opportunities may complement existing strategies to generate employment and increase economic activity, e.g., green jobs or attracting a data centre.		
☐ Yes	☐ No	
Describe the staff or resources that are available to explore your DG opportunities. The process of completing The Toolkit, and the resulting discussion, could take anywhere from ten to dozens of staff-hours, depending on data availability, the size of your community, and what opportunities are available to you. Be sure to generate a realistic timeline for completing this process. If you do not have the staff to do this, do you have access to money you could use to hire a consultant that could assist with this process?		
Does your community have experience owning and/or operating a utility or corporation?		
☐ Yes This experience may benefit your project(s) and could inform your decisions regarding which ownership models to pursue.	☐ No	
Would your community consider partnerships with a utility, another community, or with the private sector? For example, a project might be sited in your community but owned and operated by a private service provider, or several communities may wish to share ownership of one DG project.		
☐ Yes This experience may benefit your project(s) and could inform your decisions regarding which ownership models to pursue.	☐ No	
Are you ready to begin assessing the DG opportunities within your community and do you have adequate staff time or resources available? (i.e., did you respond "yes" to most of the questions above?)		
☐ Yes Proceed to Part II of the Toolkit.	☐ No Consider what issues need to be addressed before continuing.	

PROCEEDING TO PART II:

If it has not already been done, designate a project champion for the remainder of the Toolkit completion process and subsequent meetings. Consider discussing approximate timelines and expectations for completion of other sections of the Toolkit, and designate appropriate staff to complete each section.

PART II: ASSESSING OPPORTUNITIES FOR DISTRIBUTED GENERATION: MATCHING RESOURCES AND TECHNOLOGIES

2. INTRODUCTION

Each resource or technology described in Part II has a corresponding appendix. These appendices are intended to facilitate the matching of locally-available resources to a generation technology, and also to help you assess the scale and siting options for these opportunities. Each appendix includes a list of assessment questions to be considered.

For information on the unit energy cost for each technology there is a useful reference in BC Hydro's Resource Options Report, found at **http://www.bchydro.com/energy-in-bc/meeting_demand_growth/irp/document_centre/reports.html.**

2.1 OPPORTUNITIES TO GENERATE COMBINED HEAT AND POWER FROM WASTE RESOURCES

Biomass and municipal solid waste are commonly used as fuel to produce electricity. Most biomass conversion technologies are capable of producing a combination of heat and electricity.[3] These technologies are often referred to as "Combined Heat and Power" (CHP) or "Cogeneration", and currently available systems can be extremely efficient.

CHP generates 1 to 4 times as much heat energy as it does electricity, depending on the conversion technology chosen and the design of the system. Most CHP projects are driven by the heat component. This means that the value of the heat sold will have a larger influence on the financial viability of a project than the value of electricity. Other factors affecting the financial feasibility of these systems may include the state of existing infrastructure,[4] the cost of obtaining fuel (biomass or waste heat inputs), the capital and operating costs of the CHP technology chosen, and the distance from the CHP system to users for the heat. In addition, economies of scale can substantially influence costs.

For small-scale CHP systems sized for individual buildings, product vendors and installers generally recommend that CHP systems should be scaled to meet the demand for heat rather than the electricity demand. As a rule of thumb, facilities that have a simultaneous electric and thermal demand for at least 4,000 hours per year, such as a greenhouse, are good candidates for exploring CHP opportunities.[5] Without a sufficient quantity and consistency of demand, the economics of heat only projects may be more attractive.

In urban contexts, the potential for CHP exists where there is potential for district energy. This scale of demand is often associated with a large, dense, mixed-use development or re-development, or where a cluster of institutional and residential buildings are located within a few hundred metres of each other.

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[3] Although several projects exist in B.C. a combination of heat and electricity are usually more economically viable at smaller-scales.

[4] For example, is the system to be added to an existing facility already connected to the grid, or will it be built as a standalone site on undeveloped land?

[5] Source: E Source, 2006. Distributed Generation: Reciprocating Engines, Microturbines, Fuel Cells, Stirling Engines, and Photovolataics. Available at: **www.mge.com/business/saving/madison/PDF/P_PA_44.pdf.**

Many different fuels can be used for CHP. The following sections explore technologies that are commonly used to recover energy from waste resources through CHP, including combustion and gasification of wood biomass, anaerobic digestion of organic waste, and waste-to-energy from municipal solid waste (MSW). Although rare, there are also some opportunities to use industrial waste heat for power generation. Such retrofits can turn a large amount of waste heat into a useful resource.[6]

An important part of the success of a biomass energy project is that a consistent supply of fuel must be available over the life of the facility. Market availability and price for biomass can fluctuate, so an important consideration is the ability to secure access to the required biomass supply at a reasonable price over the long term, which may be as much as 20 to 30 years.

There are currently a number of different technologies that could be used to convert biomass to energy. Figure 4 introduces some of the most common CHP technologies that are suited for different waste types.

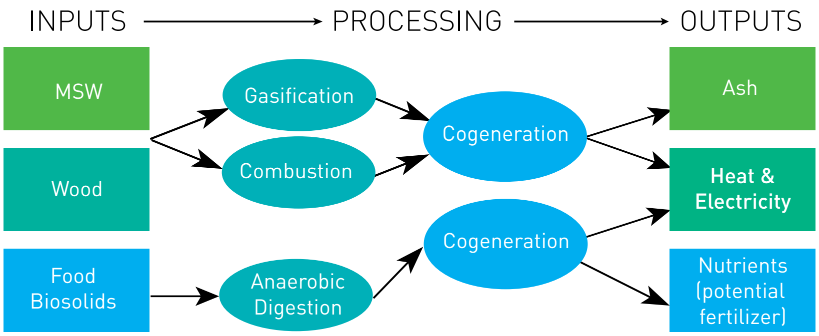


Figure 4. Waste Combined Heat and Power Input/Output Flow Diagram

COMBINED HEAT AND POWER—GENERAL CONSIDERATIONS

If you are interested in exploring your community's opportunities for a CHP project, you may want to consider the following steps. Appendix A provides further detailed questions for you to answer.

1. Identify and quantify the heat sale opportunity. This step involves identifying:

- Customers who could purchase the heat (e.g., municipal complexes, hospitals, new residential developments)
- Whether there are opportunities for a district energy system
- The potential revenue that could accrue from heat sales and / or any savings from greenhouse gas reductions

2. Identify the fuel available for the project

- Local sources in the area (e.g., existing mills, landfills, community forest licences, etc.)
- Availability of the fuel—potential availability over many years
- Cost of the fuel

3. Identify potential technical solutions

- Size of the project (combustion and heat load)
- Appropriate size of generator
- Technology considerations (boiler versus gasifier versus hot oil)

4. Consider electrical component

- Grid access—nearest distribution line
- Revenue from electricity sales

[6] This document focuses on CHP from waste products. While there is potential to use other fuel sources (e.g., bioenergy crops) these require a more complex analysis of supply options.

2.1.1 WOOD WASTE

Figure 5. Wood Waste.

Wood is the largest biomass resource in B.C. and is considered a carbon neutral feedstock. Common sources of wood waste include forestry residue left by logging operations, lumber mills (e.g., bark, sawdust), municipal wood waste (including construction and demolition wood), and wood from other operations, such as road maintenance and even backyard tree trimming.

In B.C., the most common technologies for generating energy from wood waste are direct combustion or gasification. There is a wide variety of technologies in the market place, and the selection of a particular technology will depend on factors such as the type of wood waste and cost.

Some factors, in addition to the importance of a secure supply of biomass, affecting the feasibility of generating energy from wood waste include the moisture content of the feedstock and the distance over which it will have to be transported. The moisture content of different feedstock can vary greatly[7], and it is worth noting that the higher the moisture content, the lower the energy value per tonne of biomass.[8] Transportation of the feedstock (e.g., distance from source, and type of transportation that would be used) is also a factor that should be considered when determining your feedstock options.

The land requirements for a wood biomass CHP system should also be considered. The physical footprint of a biomass system can range from 100 m^2 for a small-scale system to several hectares for a large-scale system. In addition, larger systems may require wide access roads, storage facilities, and feedstock handling areas.

CHP FROM WOOD BIOMASS—KEY FACTS

FACTOR	DESCRIPTION
Description of technology	Wood based biomass can be combusted directly or gasified to generate electricity and heat (cogeneration).
Characteristic of generation	Provides firm electricity.
Beneficial community characteristics	Biomass technologies are highly scalable and can be sized to suit small or large scale electricity and heat generation.
	High heat demand, due to CHP having high heat production capacity (e.g., potential for district heating).
Potential costs	Capital: $3 to $5 million/MW of electrical capacity.[9]
Average lifetime	20 years and up.
Environmental considerations	May result in local air emissions.
	Waste diversion: turning wood waste into useful biomass feedstock helps achieve waste reduction goals.
Social considerations	May result in the creation of new jobs.
Land use considerations / site requirements	Size (footprint): 100 m^2 to several acres; land area is needed for the plant, access roads, storage facilities, and feedstock handling.
	Noise: feedstock delivery and handling (can be reduced through careful siting, sound barriers and soundproof equipment).
	Traffic: increased truck traffic (from one pickup truck per day to several tandem trailer trucks, depending on scale of project).

[7] For instance, wood pellets have a moisture content of around 8 per cent, while sawmills are often closer to 30 per cent and fresh cut "green" wood is often over 50 per cent.

[8] Combustion and gasification work best with dry feedstock (below 20-25 per cent moisture content), but can use feedstock with up to 55 per cent moisture level.

[9] This cost range excludes the heat distribution system, which can add several million dollars to a project unless the heat is sold to a user next to the power plant.

KEY CONSIDERATIONS FOR WOOD BIOMASS

The most important consideration is the consistent availability of biomass (both quantity and quality) over the entire life-cycle of the project, which may be as long as 20 to 30 years. Further feasibility work should account for this risk.

Alternative uses for wood waste, such as recycling, reuse, or composting of wood waste exist, and decisions regarding how to allocate remaining waste should be made carefully.

Where high pressure steam is used in a project, common to many of the most established CHP technologies, safety regulations in B.C. may require an on-site power plant operator from a certified expert (e.g., a power engineer) for twenty-four hours per day. This can impact staffing costs, which may in turn influence technology selection.[10]

Further pre-feasibility work can be conducted using Natural Resource Canada's RETScreen Tool, which can be used to model both district energy and biomass-CHP systems.

RESOURCES, TOOLS, AND INFORMATION FOR WOOD BIOMASS

Natural Resources Canada RETScreen Tool , available at **www.retscreen.net/ang/home.php.**

2.1.2 BIOGAS

Biogas results from the decomposition of organic matter in the absence of oxygen. Two different methods can be used to generate and/or capture biogas from solid waste: concentrated anaerobic digestion and landfill gas capture. Digester projects are usually concentrated containment cells that are best suited for agricultural, compost or waste water treatment processes.

LANDFILL GAS

Though landfill gas is produced through a digestion process, it doesn't typically involve the installation of digester equipment; rather it is a more passive process where biogas is captured and collected from microbial processes occurring in an existing landfill. There are three basic components to a landfill gas to energy system: a gas well collection field blower and flare station; a utilization facility consisting of biogas conditioning and treatment and energy utilization elements that may include gas storage, thermal heat boilers, electrical power generation; and transportation fuelling.

A number of landfill gas projects are currently in operation in B.C. A landfill will naturally undergo anaerobic digestion process in an uncontrolled condition. An engineered landfill controls the migration gas or liquids from escaping through the use of ground liners and capping systems. The liner/capping system is designed to control water absorption and landfill gas from escaping into the atmosphere. The engineered landfill gas collection system may consist of gas extraction wells, manifold stations, and pipe and leachate management connection system. Gas wells are drilled in a grid or clustered pattern on the landfill depending on the areas of methane concentrations. Piping connects each well to a main header line (which may include manifold stations) that terminates at a vacuum blower/flare station. Well field operating and biogas capture efficiencies vary greatly depending on the design and management of the landfill facility.

In 2009, the Province of B.C. issued a regulation that required landfills with over 100,000 tonnes or more of municipal solid waste (as of January 2009) with an annual waste acceptance rate exceeding 10,000 tonnes to undertake an assessment of landfill gas generation. The regulation focuses on reducing greenhouse gas emissions from landfills and identifying potential opportunities to increase landfill recovery. The Ministry of Environment has a number of guidelines and references available on its website to support landfill gas use, and these are listed at the end of this section.

RESOURCES, TOOLS, AND INFORMATION FOR BIOGAS PROJECTS

B.C. Ministry of the Environment: Landfill Gas Management Regulation. **http://www.env.gov.bc.ca/epd/codes/landfill_gas/index.htm**

[10] Other technologies, such as biomass gasification, may avoid these costs because they can produce heat and electricity without using high pressure steam.

CHP FROM LANDFILL GAS—KEY FACTS	
FACTOR	**DESCRIPTION**
Description of technology	System that captures and collects biogas generated from the decomposition of landfill waste.
Characteristic of generation	Provides firm capacity for electrical generation.
Beneficial community characteristics	Waste tonnage thresholds greater than 10,000 tonnes/year; relatively high amount of organic material.
Potential costs	There is a wide range of variability in the capital cost of the recovery systems due to variations in site locations, site configurations and gas production ranges.
Average lifetime	Depends on landfill size and fill rate, generally 30 to 50 years.
Environmental considerations	May have local air emissions, but would be less than existing emissions from landfill without control and capture of biogas.
Social considerations	Reduction in/mitigation of odours, explosion concerns and toxic hazards. May result in the creation of new jobs.
Land use considerations / site requirements	Utilization facilities installed on existing landfill sites within existing use, zoning and permit guidelines. Will improve the holding material capacity of the landfill air space when managed correctly.

2.1.3 ANAEROBIC DIGESTION FROM ORGANIC WASTE

Anaerobic digestion (AD) is a process for creating biogas from "wet" organic wastes, such as food scraps, manure, or municipal sewage. AD projects are commonly found at wastewater treatment plants, farms, landfills, and municipal scale food and yard waste facilities. The biogas produced by AD can be combusted (burned) to create a combination of heat and electricity (CHP). At the end of the AD process, the remaining materials have a high nutrient content, and can often be composted.[11]

Figure 6. AD facility in Toronto. This facility uses food waste from a small municipality and surrounding agricultural industry. Source: City of Toronto, 2010.

There are many types of organic waste than can be used for AD. Some produce more biogas than others, and factors such as moisture content, chemical contamination, and seasonal availability can each affect how useful the waste is for AD. For example, fats, oils, and greases have a high biogas yield, while manure and yard waste have relatively low yields.

MUNICIPAL ORGANIC WASTE

Larger AD projects for municipal waste are relatively new in Canada, although they are common in other countries. A facility processing 15,000 tons per year of food waste could have an electrical output capacity of around 1 MW, and could provide enough electricity for 1,500 B.C. homes.

The footprint for a municipal AD facility could be quite large, ranging from the size of a city block to the size of a football field. In many cases, an AD facility is sited on industrially zoned land.

Existing composting facilities may provide good sites to locate this type of AD facility, as they may already have infrastructure for further processing (composting) nutrients after the AD process is complete.

[11] This compost, which takes approximately one to three months to finish, may provide additional revenue and environmental benefits through fertilizer sales.

CHP FROM MUNICIPAL ORGANIC WASTE (FOOD AND YARD)—KEY FACTS	
FACTOR	**DESCRIPTION**
Description of technology	"Wet" organic waste (food scraps, yard waste, by-products from bakeries and breweries, etc.) can be used to create biogas through anaerobic digestion. Biogas can be used for CHP, and the process also creates compost (fertilizer).
Characteristic of generation	Provides firm electricity.
Beneficial community characteristics	Urban communities with a population of at least 100,000.
	Areas with heat demand (i.e., potential for district energy).
Potential costs	Capital: $10 to $40 million for a 1 to 5 MW facility,[12,13] (installed cost, highly approximate); sensitive to economies of scale.
	Annualized Operation & Maintenance: skilled full-time operator(s) required.
Average lifetime	20 years and up.
Environmental considerations	May generate local air emissions.
Social considerations	May contribute to noise impacts.
	May also improve water quality.
	May result in the creation of new jobs.
Land use considerations / site requirements	Size (height): 5 to 30 metres, depending on design.
	Size (footprint): medium to large footprint (400 to 10,000 m^2) likely smaller than local sewage treatment plant if a similar population is served.
	Odour: level is similar to a sewage treatment plant or waste transfer station and should be zoned appropriately.
	Noise: from cogeneration process is minimal.
	Traffic: potential for increased trucking (ranges from 1/week to several/day, depending on project size).

[12] Lane County Food Waste to Energy, 2009, available at **www.oregon.gov/energy.** Search Lane County Foodwaste to Energy.

[13] Goodfellow Agricola Consultants Inc, 2007, The Elorin Bioenergy Feasibility Study: Anaerobic Digestion for Bioelectricity Production available at, **www.ormi.com/r_files/69-ConsolidatedADReportFinalMarch25.pdf.**

FARM WASTE

Due to the high costs of manure management and high demand for fertilizer, on-farm AD projects are popular in many jurisdictions. A number of projects are in development in B.C.[14] Livestock farms, particularly dairy farms, may provide viable sites for biogas production. On-farm AD facilities can import waste from other farms, and also benefit from using off-farm organic wastes such as those from bakeries or vegetable waste from grocery stores.

For an approximate idea of energy potential, electrical capacity can be estimated at approximately 0.15 kW per dairy cow,[15] or 1,200 kWh per year, and likely several times as much heat. This capacity could increase by approximately 50 per cent if food waste is used in the project. Although it may be unlikely that a First Nations or a local government would own a farm-based AD project, they may wish to play a role as a facilitator or waste aggregator, as they are in a unique position to match potential off-farm waste streams with project proponents and to remove some potential legal and administrative barriers.

CHP FROM FARM WASTE—KEY FACTS

FACTOR	DESCRIPTION
Description of technology	Anaerobic digestion is commonly used to manage dairy waste. This can reduce odour and increase revenue to farms. It is increasingly common for municipal organic waste to be added to an on-farm biogas digester to increase biogas and revenue to the farm.
Characteristic of generation	Provides firm electricity.
Beneficial community characteristic	Communities with intensive dairy farms.
Potential costs	Capital: $3,000 to $12,000/kW; several hundred thousand to several million dollars, depending on scale.
	Annualized Operation & Maintenance: skilled full-time operator may be required.
Average lifetime	20 years and up.
Environmental considerations	Utilizes waste material that would otherwise need to be disposed of.
Social considerations	May reduce odours.
	May reduce pathogens.
	May improve water quality.
	May result in the creation of new jobs.
Land use considerations / site requirements	Size (height): 5 to 30 metres, depending on design.
	Size (footprint): 1/4 hectare to 1 hectare.
	Odours : is lower in comparison to other treatment options.
	Noise: from cogeneration process is minimal.

[14] For more information on farm-based anaerobic digestion, including a listing of current projects, see the Anaerobic Digestion Initiative Advisory Committee of B.C. Website **www.bcfarmbiogas.ca/ad_info/exampleprojects** and Waste Management Factsheet. B.C. Ministry of Agriculture and Land. Order No. 382.600-1 February 2008. An overview of on-farm biogas products.

[15] Based on information from Government of Alberta, Economic feasibility of Anaerobic Digesters (2008) available online at **www1.agric.gov.ab.ca/$Department/deptdocs.nsf/all/agdex12280.**

MUNICIPAL LIQUID WASTE (BIOSOLIDS)

AD and CHP are already practiced at most large wastewater treatment plants to reduce odour and to meet on-site demand for heat. Treatment plants sized for as few as 10,000 people may include CHP from AD, although it is more likely to occur at facilities several times larger. For an approximate idea of generation potential, effluent from 250,000 people could be used to provide 1 MW of electrical generation potential, or more than 8,500 MWh per year.[16]

Some existing treatment plants can be upgraded to increase biogas outputs. Sewage treatment plants may also provide a place in which to site AD facilities for municipal food and yard waste, either by co-digesting food waste within the treatment plant, or by sharing capital and operating costs between multiple AD facilities.

Figure 7. The Greater Nanaimo Pollution Control Centre uses biogas from wastewater treatment, and operates a cogeneration unit with a capacity of around 300 kW. Source: Regional District of Nanaimo.

CHP FROM MUNICIPAL LIQUID WASTE—KEY FACTS

FACTOR	DESCRIPTION
Description of technology	Anaerobic digestion is commonly used in wastewater treatment plants to reduce odours. The biogas can be used for CHP. Much of the heat can be used on-site at the treatment plant.
Characteristic of generation	Provides firm electricity.
Beneficial community characteristics	Urban communities with population >40,000.[17]
	Existing wastewater treatment plant with biogas capture.
Potential costs	Capital: approximately $3,000 to $15,000/kW, installed, for the cogeneration equipment.
	Annualized Operation & Maintenance: skilled full-time operator may be required.
Average lifetime	20 years and up.
Environmental considerations	Small to medium footprint (250 m^2 to 1 hectare) assuming that AD is already taking place at the wastewater treatment plant.
Social considerations	May reduce odour.
	May result in the creation of new jobs.
Land use considerations / site requirements	Size (height): 5 to 30 metres, depending on design.
	Size (footprint): 250 m^2 to 1 hectare, assuming AD is already taking place at the wastewater treatment plant.
	Odours: is lower in comparison to other treatment options Noise: from cogeneration process is minimal.

[16] Based on the output of existing wastewater treatment plants in Canada that feature cogeneration systems.

[17] Source: Community Energy Association, A Tool Kit for Community Energy Planning in British Columbia: Volume 2, 2006 available at **www.communityenergy.bc.ca/sites/default/files/CEAtoolkit.Volume2.EnergyIdeas_0.pdf.**

RESOURCES, TOOLS, AND INFORMATION FOR ANAEROBIC DIGESTION

Anaerobic Digestion Initiative Advisory Committee of B.C. Website
www.bcfarmbiogas.ca/ad_info/exampleprojects.

Federation of Canadian Municipalities, Solid Waste as a Resource: A Review of Waste Management Technologies, 2004, available at
www.fcm.ca/documents/tools/GMF/Solid_Waste_as_a_Resource_Review_of_Waste_Policies_EN.pdf.

Government of Alberta, Economic feasibility of Anaerobic Digesters, 2008, available online at
www1.agric.gov.ab.ca/$Department/deptdocs.nsf/all/agdex12280.

2.1.4 COMBINED HEAT AND POWER FROM MUNICIPAL SOLID WASTE

While previous sections of this document have focused on generating heat and power from source separated biomass, including wood waste, food waste, and biosolids, it is also possible to use mixed municipal solid waste (MSW) to generate energy.

Several technologies exist that can generate heat and power from MSW. Most popular among these is incineration technologies, which have relatively low capital costs due to their technical simplicity. Other technologies, such as gasification, are increasingly common for MSW management. However, they generally require more careful control over the type and quality of waste used in the process.

Typical incineration facilities in Canada have a total capacity of between 150,000 and 300,000 tons per year. Facilities can be designed to maximize energy recovery by extracting both electricity and heat. The amount of energy generated depends primarily on the composition of the waste and the technology selected. For an approximate idea of energy output, a MSW combustion plant in Burnaby, B.C., produces approximately 470 kWh of electricity and 760 kWh of heat per tonne of MSW.

Figure 8. The Metro Vancouver Waste-to-Energy Facility in Burnaby processes approximately 280,000 tons of MSW each year.
Source: Metro Vancouver

Another important consideration is the ash produced by waste-to-energy (WTE) facilities. This represents approximately 10 per cent of the original waste volume (size) and up to 25 per cent of its mass (weight). In some cases this ash can be recycled into products like road aggregate, cement substitutes, and landfill cover. In other cases, it will be sent to a landfill.

In B.C., MSW must receive approval by the Ministry of Energy, Mines and Natural Gas to be considered clean and renewable.

WASTE TO ENERGY FROM MUNICIPAL SOLID WASTE—KEY FACTS	
FACTOR	**DESCRIPTION**
Description of technology	MSW can be incinerated or gasified to generate electricity and/or heat (cogeneration).
Characteristic of generation	Provides firm electricity.
Beneficial community characteristics	WTE facilities may be better suited to larger communities or regional districts, with at least 250,000 households.
	High heat demand (potential to sell heat to other users).
Potential costs	Capital: $3 to $8 million per MW of electrical capacity; highly dependent on technology, the amount of upfront sorting required, and emission control technologies.
Average lifetime	25 to 35 years.
Environmental considerations	GHG emissions may be reduced, but it depends on what percentage of organics is diverted from the waste stream.
	Other air emissions may occur, although the use of advanced combustion controls can reduce these emissions.
	Can reduce the amount of waste sent to a landfill, although residual ash will still need to be managed.
Social considerations	Improves existing processes by making them more efficient.
	Reduces demand by generating electricity and heat from waste products.
	May result in the creation of new jobs.
Land use considerations / site requirements	Size (footprint): large building, usually outside urban core.
	Odour: may generate concerns about odours and air quality.
	Traffic: may increase truck traffic.

2.1.5 INDUSTRIAL WASTE HEAT RECOVERY

Figure 9. Electricity is generated from recovered heat at this natural gas compressor station in Savona, B.C.
Source: Pristine Power Inc.

In many cases, waste heat is a by-product of industrial processes, equipment, and machinery. Finding a use for waste heat increases the efficiency of a system, and may reduce the need for energy from the grid.

Waste heat can either be used to further regulate temperature by driving a heating (or cooling) process, or it can be used to generate electricity.

Waste heat recovery to produce electricity is a long-standing practice, and new technological developments such as the Organic Rankine Cycle have enabled an even broader range of waste heat to be utilized.

Industries use large amounts of energy during the production process. Therefore they are the most likely to produce waste heat in the quantity and quality (high temperature) suited to power production. Common examples include smelters, wood processing and drying facilities, glass furnaces or ceramic kilns, chemical industries, oil and gas, and food processors. Even some existing cogeneration facilities may benefit from waste heat recovery due to technological progress since the time of construction.

Communities may wish to look at matching owners or operators of excess (waste) heat with potential users for the heat. They may also wish to consider joint ownership models for infrastructure to generate electricity, or to use waste heat in the development of district energy systems if electricity generation is not feasible.

ELECTRICITY FROM INDUSTRIAL WASTE HEAT—KEY FACTS

FACTOR	DESCRIPTION
Description of technology	Electricity is recovered from waste heat of a sufficiently high temperature, preferably >100°C.[18]
Characteristic of generation	Provides firm electricity, assuming waste heat source is constant.
Beneficial community characteristics	Communities which possess industries that produce high-temperature waste heat, e.g., steel industry, wood processing, heating plants, etc.
	Natural gas compressor stations may also be well-suited to this form of power generation.
Potential costs	Capital: high upfront capital cost; costs are highly project-specific, influenced by scale, exhaust temperature, fuel type, and contaminants.
	Annualized Operation and Maintenance: influenced by fuel source and contaminant content. The heat may be available for free.
Average lifetime	Likely 20 years and up.
Environmental considerations	When only waste heat is used, zero emissions.
Social considerations	Reduces demand for energy by utilizing waste by-product.
	May result in the creation of new jobs.
Land use considerations / site requirements	Size (footprint): ranges from zero where the heat recovery system can be located in an existing building or structure, to a small power plant (the size of a large house).
	Noise: the noise impacts from most waste heat recovery technologies will be minimal.

[18] Although some systems may be feasible at temperatures of around 80°C.

2.2 OPPORTUNITIES TO GENERATE ELECTRICITY FROM SMALL AND MICRO HYDRO

2.2.1 RUN-OF-RIVER HYDRO

Hydro power, or "hydro", refers to the process of utilizing flowing water to drive a turbine and generate power. Hydro technologies are highly scalable, but the most applicable types for First Nations and local governments are likely small to medium hydro (2–50 MW of installed capacity) and micro hydro (<2 MW of installed capacity). The size of the hydro project depends on the characteristics of the water source and the surrounding terrain. Most small and micro hydro projects use a technique called "run-of-river". Figure 10 shows an example of a run-of-river project:

1. Water is collected at the intake pipe.
2. Water travels down the penstock to the power station.
   - "Head" is the change in elevation from the intake pipe to the power station.
3. Water flowing through the power station turns a turbine to create power.
   - Water is discharged back into the stream.
4. The power is sent to the grid.

Figure 10. Hystad Creek small hydro project near Valemount.

Hydro projects can be constructed on different types and sizes of rivers, streams or creeks, but the optimal characteristics are steep, deep and narrow water bodies. It is also important that the water flow is substantial year-round if the site is to produce power consistently.

The planning, construction, operation, and associated financial and environmental costs of a run-of-river hydro project are highly site-specific. Therefore, careful analysis needs to be conducted on each potential site.

RUN-OF-RIVER HYDRO—KEY FACTS	
FACTOR	**DESCRIPTION**
Description of technology	Run-of-river hydro is the process of utilizing flowing water from a river or stream to drive a turbine and generate electricity.
Characteristic of generation	Electricity may be firm or intermittent, depending on stream flow, and is often subject to seasonal variations.
Beneficial community characteristics	Communities with deep rivers running down steep slopes.
	Streams and rivers should be free of fish and/or species at risk.
	Accessible water sources (roads or wide trails).
Potential costs	Capital: $1,300 to $4,000 per kW installed.
	Annualized Operation & Maintenance: 2-3 per cent of capital cost per year.[19]
Average lifetime	Up to 100 years.
Environmental considerations	Diversion of river flow (per cent depends on project).
	Construction may impact surrounding area (water, soil, trees).
Social considerations	May result in the creation of new jobs.
Land use considerations / site requirements	Penstock: 30 to 500 m long, 1 to 20 m wide.
	Powerhouse: site specific (small shed to large house).

[19] Based on a calculation from: Small Hydro Generation Building Block Profile, 2003, available at **www.agf.gov.bc.ca/clad/strategic_land/blocks/cabinet/independent_power.pdf.**

KEY CONSIDERATIONS FOR RUN-OF-RIVER HYDRO

Once you have identified a potential site (e.g., river or creek) that appears feasible, the next step is to provide some certainty around river head, flow, and accessibility. The process commonly includes a formal hydrology study lasting at least one year. In some cases, the river or stream under consideration may already be listed in the Inventory of Undeveloped Opportunities at Potential Micro Hydro Sites in B.C., listed at the bottom of the page. It may be possible to select a stream in the inventory that you know to be similar in characteristics to the site you are considering and assume the same hydro potential.

Some pre-feasibility work could be conducted using RETScreen, a free online tool. If you are confident that the site will be viable, you may wish to consider applying for some of the relevant permits and licenses (see section 3.3).

Another important consideration is the proximity of a site to the grid, or to a source that will use the power. Generally, the closer a project is to the grid, the more economically viable it is due to reduced cost of building grid infrastructure.

More detail on the process for hydro power project development can be found at the links provided below.

Figure 11. A Powerhouse for a 5-10 MW hydro project. Courtesy of Cloudworks Energy Inc.

Figure 12. A Penstock Pipe for a 5–10 MW hydropower project. Courtesy of Cloudworks Energy Inc.

RESOURCES, TOOLS, AND INFORMATION FOR RUN-OF-RIVER HYDRO PROJECTS

BC Hydro Handbook for Developing Micro-Hydro in B.C. (2004) available at **www.bchydro.com/planning_regulatory/energy_technologies/micro_hydro.html.**

Inventory of Undeveloped Opportunities at Potential Micro Hydro Sites in British Columbia, available at **www.bchydro.com/planning_regulatory/energy_technologies/micro_hydro.html.**

Green Energy Study for British Columbia Phase 2: Mainland available at **www.bchydro.com/content/dam/hydro/medialib/internet/documents/environment/pdf/green_energy_study.pdf.**

Ministry of Environment website, available at **www.env.gov.bc.ca/.**

B.C. Ministry of Agriculture and Lands, On-Farm Hydroelectric Fact-Sheet (2006), available at **www.gov.bc.ca/agri/.**

Natural Resources Canada RETScreen Tool , available at **www.retscreen.net/ang/home.php.**

Search for A Buyer's Guide: Micro-Hydropower Energy Systems, 2004, available at **http://canmetenergy.nrcan.gc.ca/sites/canmetenergy.nrcan.gc.ca/files/files/pubs/buyersguidehydroeng.pdf.**

Small Hydro Generation Building Block Profile, 2003, available at **www.agf.gov.bc.ca/clad/strategic_land/blocks/cabinet/independent_power.pdf.**

2.2.2 PRESSURE REDUCING VALVES HYDRO PROJECT

Another type of hydro power opportunity can be found in local drinking water systems. Many systems contain pressure reducing valves (PRVs), which are intended to reduce the water pressure. PRVs can be replaced with micro-hydro turbines that can reduce water pressure while also generating electricity. These types of hydro projects are often cost-effective and have minimal impact on the environment. They can also be timed with the regular upgrade or replacement schedule for existing PRVs. However, in most cases the actual electricity generating potential will be quite small, likely 5 to 50 kW.

Figure 13. A 23 kW PRV Hydro project, recently constructed in the District of North Vancouver.

PRV HYDRO—KEY FACTS

FACTOR	DESCRIPTION
Description of technology	PRV hydro is the process of utilizing pressure reducing valves in local water systems to drive a turbine and generate electricity.
Characteristic of generation	Firm electricity, if a constant flow is available.
Beneficial community characteristics	Accessible sites.
	High pressure PRV (>30 PSI).
	PRV has consistent flow.
Potential costs	Capital: $1,300 to $4,000 per kW installed.
	Annualized Operation & Maintenance: 0.5-1 per cent of capital cost per year.
Average lifetime	30 years and up.
Environmental considerations	Construction may impact surrounding area (water, soil, trees).
Social considerations	May result in the creation of new jobs.
	Contributes to energy self-sufficiency.
Land use considerations / site requirements	Powerhouse: site specific (small shed to large house).

KEY CONSIDERATIONS FOR PRV HYDRO

Many communities with a drinking water system have PRVs. PRVs are technically simple, and local water utilities typically possess many of the essential permits and licences for water use. The key barrier is most likely to be the project economics, which are most affected by the scale of the opportunity.

2.3 OPPORTUNITIES TO GENERATE ELECTRICITY FROM SOLAR PHOTOVOLTAICS

Solar photovoltaic (PV) cells convert sunlight into electricity. They can be connected to the grid, or to a battery. The modular design of solar cells makes solar PV systems scalable to a wide variety of applications, ranging from street lights to large industrial applications.

In general, PV systems are easy to install and have very low maintenance requirements.[20] When mounted on rooftops, they are also generally visually unobtrusive.

Solar panels can function through clouds, but they cannot absorb energy when shaded by solid objects. Any potential site must be checked for physical obstructions that might cast shadows on the solar panels, such as tall trees or other buildings.

Solar is just one form of clean energy that speaks to the traditions and values of First Nations. In 2012, the T'Sou-ke First Nation on Vancouver Island successfully completed four solar demonstration projects through BC Hydro's Net Metering Program. Each project was selected to evaluate a different photovoltaic system: the Canoe Shed, a 40 kW project with a straight grid-tie; the Band Administration office, a 22 kW ground mounted PV with an additional 7 kW on the roof utilizes a grid tie with a back-up battery for storing unused solar energy; and, the Fisheries building, a 6 kW call to grid net metering project.

The capacity for solar installations is determined by solar exposure. An online solar PV potential map provided by Natural Resources Canada can provide high-level assessments of solar exposure and electrical capacity for a community. However, a roof-specific solar assessment should be conducted by a certified professional to determine the solar energy potential.

Figure 14. Roof-mounted solar PV panel.

Figure 15. T'Sou-ke First Nation solar projects demonstrate solar options for the community.

SOLAR PHOTOVOLTAICS—KEY FACTS

FACTOR	DESCRIPTION
Description of technology	Solar photovoltaic panels convert light energy into electricity. They can be connected to a battery or directly into the grid, generating electricity whenever the sun is shining.
Characteristic of generation	Provides intermittent electricity.
Beneficial community characteristic	Unobstructed south facing sites.
Potential costs	Capital: $6,000 to 8,000 per kW installed (assumes no battery).[21] Annualized Operation & Maintenance: 9–12 per cent of capital cost per 10 years (for inverter replacements).
Average lifetime	25 to 30 years.
Environmental considerations	Physical footprint of PV panels.
Social considerations	Contributes to energy self-sufficiency.
Land use considerations / site requirements	Size: 8 m^2/kW installed capacity.

[20] An inverter replacement is the most likely maintenance requirement over the life of a solar PV system. The length of warranties for inverters generally varies between 2 and 20 years.

[21] Canadian Solar Industry Association website: **www.cansia.ca/market-intelligence/solar-photovoltaics.**

KEY CONSIDERATIONS FOR SOLAR PHOTOVOLTAICS

As described above, where unobstructed land or roof space is available, some type of solar installation is likely to be technically feasible. An assessment of solar availability using a qualified professional should be undertaken to ensure that shading patterns will not become a problem in other parts of the year. Be sure to consider that some types of obstructions (trees, buildings, etc.) can change in size over time.

RESOURCES, TOOLS, AND INFORMATION FOR SOLAR PHOTOVOLTAICS

A list of qualified installers is available from Solar B.C. at **www.solarbc.ca/**, or from the Canadian Solar Industries Association at **www.cansia.ca/**.

The Natural Resources Canada Photovoltaic Potential and Solar Resource Map of Canada can provide useful information about local solar energy availability. The Map is available at **https://pv.nrcan.gc.ca.**

2.4 OPPORTUNITIES TO GENERATE ELECTRICITY FROM WIND

Wind turbines are available in a wide range of sizes, from small building-mounted turbines to large ground-mounted turbines around 100 metres tall. Smaller turbines are often compatible with urban areas, as they are relatively quiet. However, wind speeds are generally much lower as there are more obstructions from surrounding buildings and objects. In general, the taller the turbine, the more wind is likely to be available, which increases economic viability.

Siting and compatible land use will be a major part of assessing the compatibility of wind in a community. The noise level is fairly low for smaller-scale turbines: in most cases less than 55 decibels. Taller wind turbines can have a visual impact, which varies by location. Due to these reasons, siting will need to be considered carefully for wind energy projects.

Wind energy is generally considered a mature technology, therefore changes in system pricing are expected to occur gradually. However, the key driver of a successful project is the wind resources (speed) at the site where the turbine is installed. Wind speeds are lowest closer to the ground, as there are more obstructions to block the wind.

Small wind turbines (e.g., 5 to 20 kW) are sometimes mounted on buildings, as shown in Figure 17.

SITING

Generally the strongest, most consistent wind resources are located at sites with the following characteristics:

- Coastal or lakeside
- On a ridge, perpendicular to prevailing winds
- Flat or gently rolling ground
- At least 10 metres above any physical wind barriers located within a 100 metre radius
- At least 0.16 hectares (1,600 m^2) in area
- Experience average annual wind speeds >18km/hour

Figure 16. Wind turbine.

Figure 17. Building-mounted wind turbines.

Figure 18. Coastal turbines mounted on flat ground, more than 10 m above any nearby physical barriers, with substantial setbacks from other buildings.

Figure 19. Example of a ridge-mounted wind turbine. Note gently rolling ground and lack of obstructions.

WIND—KEY FACTS	
FACTOR	**DESCRIPTION**
Description of technology	Turbines that can be mounted on buildings or as standalone systems, generally with rated capacities between 1 kW and 1 MW.
Characteristic of generation	Provides intermittent electricity.
Beneficial community characteristics	Communities with high average wind speeds.
	Average wind speed greater than 18km/h (5m/s).
Potential costs	Capital: $3,000 to $6,000 per kW installed.
	Annualized Operation & Maintenance: Size dependent, typically 1–3 per cent of capital cost.
Average lifetime	25 to 30 years.
Environmental considerations	No air emissions or GHGs.
	Wildlife (depending on siting).
Social considerations	Contributes to energy self-sufficiency.
Land use considerations / site requirements	Size (height): at least 10 metres above any nearby physical barriers.
	Size (footprint): likely at least 1,600 m^2 for standalone turbine, none for building-mounted.
	Visibility: standalone turbines in urban and rural settings will be visible; building-mounted turbines can be designed with a low visual impact.
	Noise: generally under 55 decibels.
	Location: siting and compatible land use.
	Shadow Flicker: a setback, of at least 10 times the diameter of the rotor, from homes/businesses may be required to reduce the impact of shadow flicker.

KEY CONSIDERATIONS FOR WIND

If you have not already done so, consider pursuing some pre-feasibility work using free online assessment tools, such as those listed below. Ballpark Cost Calculator is the simplest of these, while the Wind Energy Atlas and RETScreen will be able to provide more detailed data.[22]

Although these can provide valuable information, an accurate understanding of available local wind resources is fundamental to the viability of a wind energy project. In general, a one year monitoring study for any selected site should be conducted in order to assess available wind resources.

Another important consideration is the proximity of a site to the grid, or to a source that will use the power. Generally, the closer a project is to the grid, the more economically viable it is due to reduced cost of building grid infrastructure.

TOOLS FOR WIND SPEED AND PROJECT ECONOMICS

The following free online tools may be of use during the pre-feasibility stages of project development, and can generally be accessed by staff with little background in wind or energy project development:

Canadian Wind Energy Atlas, available at **www.windatlas.ca/en/index.php.**

Canadian Wind Energy Association—Ballpark Cost Calculator, available at **www.smallwindenergy.ca/en/SmallWindAndYou/Planning/BallparkCost.html.**

Natural Resources Canada RETScreen Tool, available at **www.retscreen.net/ang/home.php.**

[22] A substantial amount of research suitable for large-scale wind resource assessments and project development information is available from the BC Hydro website at **www.bchydro.com/planning_regulatory/energy_technologies/wind_energy.html.**

3. GENERAL CONSIDERATIONS FOR PURSUING A DISTRIBUTED GENERATION PROJECT

Part III of the Toolkit introduces some of the additional considerations that should be taken into account at the early stages of project development. It is intended to guide you in finding answers to the following questions:

- What are the steps in connecting your project to the BC Hydro grid?
- Is it possible to sell electricity from your DG project to BC Hydro?
- Is it possible to reduce your energy load?
- What permitting considerations are required for the DG opportunities you have identified? Which permitting agencies must be contacted?
- What ownership model(s) would you consider pursuing for your DG project?
- What are some of the available sources of funding which might be applied to a DG project? Does it appear likely that these would apply to the DG project(s) you are considering?

3.1 INTERCONNECTIONS

If you are planning to connect your project to the BC Hydro grid, you must undertake an interconnection process. This usually entails the submission of an interconnection request, interconnection studies, an interconnection agreement and then the installation of interconnection equipment. The studies are necessary so that BC Hydro can understand the impacts to its system and facilities and provide an estimate of the costs associated with any additional equipment or upgrades that may be required prior to signing an agreement.

The type of interconnection study and process may vary depending on the size and location of your project, and whether you are participating in a BC Hydro energy procurement process (see next section). The studies also provide a cost estimate of the project's interconnection requirements, which may influence the economic viability of the project. The costs of interconnection vary substantially from project to project and should be considered early in the project planning process.

Figure 20. A BC Hydro crew working on distribution lines.

Three key factors determine the cost of interconnection:

The size of the project:

Smaller projects usually have lower interconnection costs, especially if the project is under 50 kW.

The capacity, type, and quality of existing grid infrastructure:

There are different types of grid infrastructure that may or may not support interconnection. In addition, some existing grid infrastructure may already be functioning at peak capacity, meaning that there may not be room on the line to connect your project. In either case, grid interconnection may require substantial upgrades to transmission or distribution infrastructure. This can have a large impact on interconnection costs.

The proximity of existing grid infrastructure:

A project that is several kilometres from existing grid infrastructure is likely to require new infrastructure. This can have a large impact on interconnection costs.

The interconnection process is conducted by BC Hydro Interconnections. Further information, including costs of studies, can be found at **www.bchydro.com/interconnections**.

3.2 ENERGY PROCUREMENT

DG projects can be either supply- or demand-side solutions. A demand-side solution would see the customer utilize the electricity for their own use, reducing energy-related costs. This could be achieved through various Power Smart initiatives. Further information can be found at **www.bchydro.com/powersmart.**

For a DG project to sell electricity to the grid, an agreement must be reached with BC Hydro. Generally, this agreement is called an Electricity Purchase Agreement (EPA) and is a contract that defines the terms and conditions by which BC Hydro purchases electricity. In the case of smaller projects <50 kW, a Net Metering Program is a simpler process and does not need a contract.

Depending on the installed capacity of the electricity generator, DG projects may fall under the Net Metering program, Integrated Customer Solutions (ICS) under Power Smart, the Standing Offer Program (SOP) or Remote Community Electrification Program for Non-Integrated Areas.[23]

Further information and the Net Metering application form can be found at **www.bchydro.com/netmetering.**

Further information on the SOP, including the eligibility requirements and the program rules can be found at **www.bchydro.com/standingoffer**.

Further information on ICS, including eligibility requirements and the program rules can be found at **www.bchydro.com.** Search for ICS.

3.3 PERMITTING

There are many provincial ministries, federal departments and agencies involved with permitting and approvals. First Nations are encouraged to contact FrontCounter B.C.[24] (the B.C. government's "single window service" for citizens and businesses seeking Crown permits) for assistance seeking natural resource authorizations and permits for Crown resources) for assistance understanding the permitting requirements.

The B.C. Government has also developed an Independent Power Producer (IPP) Guidebook,[25] which provides further information about permitting. Note the IPP Guidebook is intended for projects of all sizes, including large utility-scale projects.

Note that annual fees for permits and licences vary by project and should be taken into consideration during the project planning phase.

3.4 FIRST NATIONS

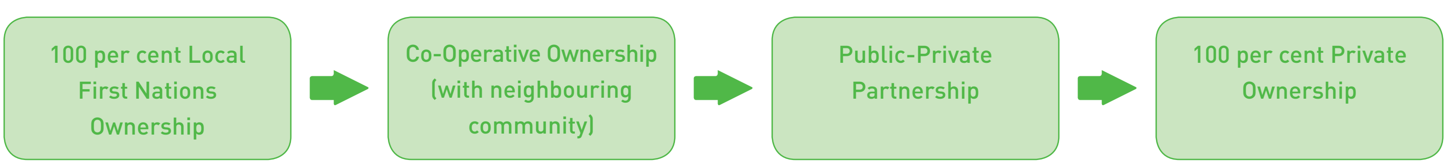
Since the traditional territories of other First Nations may overlap with the project area, BC Hydro encourages First Nations to contact FrontCounter BC to obtain information about the consultation requirements related to their projects. First Nations may need to consult with other First Nations whose traditional territories overlap the project area.

3.5 OWNERSHIP & FINANCING

3.5.1 OWNERSHIP MODELS

Another important consideration in developing a DG project in your community is determining the ownership structure. Different structures can influence risk, financing, and the ways in which revenues and costs are shared throughout the life cycle of the project. The continuum of possible ownership models is represented in Figure 21.

Figure 21. Sample Ownership Models for a Distributed Generation Project.



[23] **www.bchydro.com/energy-in-bc/acquiring_power/current_offerings.html.**

[24] **www.frontcounterbc.gov.bc.ca.**

[25] **www.agf.gov.bc.ca/clad/IPP_guidebook.pdf.**

Identifying potential project partners and selecting an ownership model are both factors which should be considered early in the project planning process. More information specific to the B.C. context, including several case studies, is contained in the Community Energy Association's Guide to Utilities & Financing.[26] The Commission on Environmental Cooperation's Guide to Developing a Community Renewable Energy Project also contains useful analysis and descriptions of potential ownership models, with a broader focus on the North American context.[27]

3.5.2 FUNDING

As with most public infrastructure projects, DG may require a substantial up-front investment and may have a long payback period. Funding can reduce the financial barriers related to planning and implementing renewable energy projects. A variety of funding opportunities may be available from BC Hydro, the Provincial Government, the Federal Government, and non-profit organizations such as the Federation of Canadian Municipalities. The availability of funding will likely reflect the ownership model you seek to pursue; some funds may only be available to projects wholly owned by a First Nations community, while others may only be available through partnerships. As funding opportunities change frequently, it is important to look at up-to-date lists. The following links provide regularly updated lists of funding opportunities available to First Nations and local governments in B.C.:

- The B.C. Ministry of Energy and Mines-Community Energy Solutions provides information and resources on provincial programs for communities, as well as a funding and guidelines. The Guide is available at **www.empr.gov.bc.ca/RET/CommunityEnergySolutions/Pages/default.aspx.**
- The Community Energy Association provides a Guide titled Funding Your Community Energy and Climate Change Initiatives. A majority of the funding opportunities listed may apply to some types of DG projects. The Guide is available at **www.communityenergy.bc.ca/resources/cea-publications-0.**
- First Nations Clean Energy Business Fund aims to promote increased First Nations participation in the clean energy sector. The Guide is available at: **www.gov.bc.ca/arr/economic/fncebf.html**.
- ecoEnergy for Aboriginal and Northern Communities Program 2011 -2016 provides funding support to Aboriginal and northern communities for clean energy projects through Aboriginal Affairs and Northern Development Canada. The Guide is available at **www.aadnc-aandc.gc.ca/eng/1100100034258/1100100034259**.

3.6 NEXT STEPS IN DISTRIBUTED GENERATION PROJECT DEVELOPMENT

This Toolkit was created to assist First Nations communities in identifying and scoping opportunities for DG. When one or more potential opportunities have been identified, further work is required before conducting feasibility studies. It is likely that this work will require a combination of the following:

- Engage Chief and Council
- Allocate resources, such as budget and staff
- Integrate results into relevant planning processes (such as a Community Energy and Economic Development Plan and Strategy)
- Identify and engage potential project partners, regulatory agencies, and BC Hydro
- Apply for funding
- Conduct pre-feasibility or feasibility analysis

The purpose of the Toolkit is to support First Nations in identifying and understanding DG opportunities, and gain a greater understanding of the costs and benefits associated with locally generated renewable electricity.

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[26] Community Energy Association, Guide to Utilities and Financing: Renewable Energy Guide for Local governments in British Columbia, 2008, available at **www.communityenergy.bc.ca/resources-introduction/utilities-and-financing-renewable-energy-guide-for-local-governments-in-bc**.

[27] Commission for Environmental Cooperation, Guide to Developing a Community Renewable Energy Project, 2010, available at **www.cec.org/Storage/88/8461_Guide_to_a_Developing_a_RE_Project_en.pdf**.

Thank you for completing Generating Renewable Electricity with Distributed Generation: A Self-Assessment Toolkit for B.C. First Nations.

For further information, email **distributed.generation@bchydro.com**.

GLOSSARY

Capacity: the instantaneous power output or electricity demand at any given time, normally measured in kilowatts (kW) or megawatts (MW). A transmission facility's ability to transmit electricity at any instant.

Clean Energy Act: the Clean Energy Act, SBC 2010, c. 22, as amended from time to time.

Clean Energy: energy that qualifies as energy generated by a clean or renewable resource under British Columbia's Clean Energy Act, SBC 2010, c.22, as amended from time to time.

Clean or Renewable Energy: defined by the Clean Energy Act as including biomass, biogas, geothermal heat, hydro, solar, ocean, wind or other prescribed resources.

Distributed Generation: small-scale power sources located at or near a customer's site.

Electricity Purchase Agreement (EPA): the contract that defines the terms and conditions by which BC Hydro purchases electric energy.

Energy Self-suffiency: the ability for communities to meet part of, or all of, their energy needs.

Firm Capacity: Capacity whose availability is assured to the purchaser.

Firm Energy: Energy considered assurable to the customer to meet all agreed upon portions of the customer's load requirements over a defined period.

Intermittent Energy: electricity supply that fluctuates or is not available at all times. For example, wind energy only produces power when the wind is blowing.

Non-Firm Energy: Energy available for sale in varying amounts depending on season and water conditions. Generally sold on an interruptible (non-guaranteed) basis.

Permits: permits, certificates, licences, and other approvals required for the design, construction, ownership, operation, maintenance and decommissioning of the seller's plant and the delivery of energy to the point of interconnection.

Units of Power: used to measure capacity. For example, a 1 MW (megawatt) system would have a maximum output of 1 MW at any given moment.

1 kilowatt (kW) = 1,000 watts

1 megawatt (MW) = 1,000 kilowatts

1 gigawatt (GW) = 1,000 megawatts

Units of Energy: the common measurements of energy quantity produced or consumed. For example, a system with a 1 MW capacity operating for one hour would produce one megawatt hour (MWh) of electricity. 1 MWh is approximately 1/10 the electricity consumed by an average B.C. household over a one-year period.

1 kilowatt hour (kWh) = 1,000 watts for 1 hour

1 megawatt hour (MWh) = 1,000 kWh

1 gigawatt hour (GWh) = 1,000 MWh

APPENDIX A.1
COMBINED HEAT AND POWER FROM WOOD WASTE WORKBOOK

Appendix A.1 contains a number of self-assessment questions to help guide your consideration of DG opportunities related to combined heat and power from wood waste in your community, and also to help you assess the scale and siting options for these opportunities.

SITING ASSESSMENT FOR CHP FROM WOOD WASTE			NOTES
Does your community possess any of the following facilities? Are there plans to construct or modify them? A wood biomass CHP plant could potentially be co-located here, which may decrease capital and operating costs through shared staffing, transportation infrastructure, or equipment. One or more of these facilities may also become customers for excess heat from a CHP project.			
Facility	**Existing**	**Planned or Planned Upgrade**	
District Energy System	☐	☐	
Hospital	☐	☐	
University	☐	☐	
Industrial Sites	☐	☐	
Former or current milling or forestry operations	☐	☐	
Other: ____________________	☐	☐	
Please list some potential sites for a biomass/CHP project. The main criteria to look for are high heat demand and sufficient physical space for a plant. The site can be identified in the list above, or it can be a different site altogether. 1. ____________ 2. ____________ 3. ____________ 4. ____________ 5. ____________			

For each site identified, please complete the following page. You may wish to save or print several copies of the page.

Figure 22. Dockside Green's gasification system is housed in a building designed to fit right into the urban neighbourhood. It provides heat and hot water via a district heating system. Source: Nexterra Systems Corp.

Figure 23. University of South Carolina's gasification system. Source: Nexterra Systems Corp.

SITING ASSESSMENT FOR CHP FROM WOOD WASTE (Continued)		NOTES
Site Name: ______________________ **Site Location:** ______________________		
Is the site zoned for industrial use, and are the surrounding land use designations compatible with an industrial facility? These factors can influence the viability of a site for large-scale biomass, including availability, public response to a proposed site, construction costs, and other factors. If site is on a reserve, the applicant is advised to review the Indian Act or First Nations Land Management Act to identify current land use designations.		
☐ Yes Opportunity to site large-scale biomass facility.	☐ No May require rezoning for large-scale biomass. Site may still be suitable for small-scale biomass facility.	
Is the site near any potential heat users which might wish to purchase waste heat? Proximity to industries, institutions or high-density neighbourhoods with high heat demand may be beneficial for the economics of a biomass CHP project. Generally the distance should be less than 1 km, although some projects are economical at distances of several kilometers.		
	Please specify site name or location:	
High density developments or re-developments	______________________	
Industrial facilities with high on-site heat demand	______________________	
Greenhouses	______________________	
Institutions (e.g., hospitals, universities, etc.)	______________________	
Is there an on-site power plant operator in place at the site or in the community? For example, an industrial building with a certified operator for a large boiler.		
☐ Yes There may be an opportunity for shared staffing costs.	☐ No	
Please evaluate the potential site with respect to truck, rail or barge access, using a high/medium/low rating system. You will have to define what the terms high, medium and low mean for your community based on your community's geography and existing transportation infrastructure.		
Truck access	______________________	
Rail access	______________________	
Barge access	______________________	
What are the main land use designations along the proposed biomass transportation routes (e.g., residential, commercial, industrial, parks)? This factor can influence the public acceptance level of the chosen project location.		
Surrounding land use 1	______________________	
Surrounding land use 2	______________________	

QUANTITY AND AVAILABILITY OF URBAN WOOD WASTE		NOTES
Estimate the amount of wood waste that is within your territory that is close proximity to the site, or if in a First Nations group that already has an agreement with a municipality, the amount of wood waste currently being disposed of in a landfill annually from each sector.		
From the residential sector:	____________ X 0.0065[28] tons = ____________ # of residents tons/year generated	
From the Industrial, Commercial & Institutional Sector:	____________ X 0.046 tons = ____________ # of employees tons/year generated	
From Demolition, Land Clearing & Construction:	____________ X 0.331 tons = ____________ $ value of building permits tons/year generated	
Total:	____________ tons/year generated	
These figures are based on 2008 statistics for Metro Vancouver and will differ significantly by urban area. Where possible, each community should use recent data. Information may be available from the local Solid Waste Management department, the Regional District, or the Ministry of the Environment.		
Recalculate the above estimates based on future projections—assess wood waste from territory annually in 20 years. This is intended to give a picture of waste availability over time. Please attempt to account for intended waste reduction and diversion goals, as well as changes in population and employment.		
From the residential sector:	____________ X 0.0065[28] tons = ____________ # of residents tons/year generated	
From the Industrial, Commercial, & Institutional Sector:	____________ X 0.046 tons = ____________ # of employees tons/year generated	
From Demolition, Land Clearing & Construction:	____________ X 0.331 tons = ____________ $ value of building permits tons/year generated	
Total:	____________ tons/year generated	
Where possible adjust estimates based on expected demographic and economic changes in your community.		
Are you aware of any current users/consumers of this wood waste?		
☐ No	☐ Yes (please provide details)	

[28] These numbers are based on Metro Vancouver's 2008 Solid Waste Composition Study available at www.metrovancouver.org/about/publications/Publications/SolidWasteCompositionStudyFinal-2007.pdf.

QUANTITY AND AVAILABILITY OF URBAN WOOD WASTE		NOTES
Estimate the total amount of "clean" and "non-clean" wood waste[29] disposed of from all sectors.		
Clean wood waste: _________________________ tons/year X 50%[30] = ________________________________ Total from previous page tons/year clean wood waste		
Non-clean wood waste: _________________________ tons/year X 50% = ________________________________ Total from previous page tons/year non-clean wood waste		
For communities outside Metro Vancouver, this figure may be available through the local or regional Solid Waste Management Department.		
Is there a plan to adopt policies and programs to divert more wood from landfills? Examples include waste diversion requirements tied to building permits and adding wood waste drop-off areas with low tipping fees to transfer stations.		
☐ Yes If possible, consider this in adjusting expectations around the available quantity of wood waste below.	☐ No	
What fraction of total wood waste currently sent to landfills might be available for your intended use in the short-term? Based on your long-term projections and waste diversion targets, how does urban wood waste availability change over time? This question is intended to prompt a discussion about the challenges of securing a supply of biomass, and the importance of accounting for waste diversion to other uses. Note that only a portion of waste currently sent to the landfill is likely to be diverted, and only a portion of diverted waste is best used for energy generation. Other diverted waste should go to reuse or recycling.		
Short-term availability (within 2 years) ________________________________ per cent of waste diverted ________________________________ tons/year clean wood waste available for energy generation ________________________________ tons/year non-clean wood waste available for energy generation	Long-term availability (in 20 years) _____________________________ per cent of waste diverted _____________________________ tons/year clean wood waste available for energy generation _____________________________ tons/year non-clean wood waste available for energy generation	

[29] "Clean" wood waste is untreated, unpainted, and uncontaminated. It is often subject to a simpler permitting process and lower capital costs for emission control equipment, and should be considered separately from other wood-biomass (waste).

[30] This percentage is based on Metro Vancouver's 2008 tonnage data for disposed wood waste.

QUANTITY AND AVAILABILITY OF FOREST AND MILL RESIDUE		NOTES
Please identify wood processing operations located in or near your community. Mill residue (e.g., bark, sawdust, shavings) is one of the most common forest biomass sources in British Columbia.		
Pulp and paper mills	____________________ ____________________	
Sawmills	____________________ ____________________	
Other mills	____________________ ____________________	
Potential data sources: Internet search, business licences, phone book, local government staff.		
For each mill, please estimate wood waste quantities currently available		
Type (e.g., bark, sawdust, shavings, heritage piles/old mill waste, other)	**Quantity** (where possible, estimate "dry" quantity instead of "green" or "wet" quantity)	
____________________	____________________ tons/year	
____________________	____________________ tons/year	
____________________	____________________ tons/year	
____________________	____________________ tons/year	
Total:	____________________ **tons/year**	
You will likely need to contact the mills directly to obtain this information.		
Please identify companies engaged in forestry (logging) operations accessible to your community.		
____________________ ____________________		
Potential data sources: Internet search, business licences, phone book, local government staff.		
Please estimate wood waste quantities available from forestry (logging) operations accessible to your community.		
Type (e.g., forest and roadside slash, standing timber residuals, other)	**Quantity**	
____________________	____________________ tons/year	
____________________	____________________ tons/year	
____________________	____________________ tons/year	
____________________	____________________ tons/year	
Total:	____________________ **tons/year**	
Please estimate wood waste quantities available from fire protection operations accessible to your community.		
____________________ tons/year		
Estimate the total amount of mill residue and forest residue generated in or accessible to your community. Please add up the estimates from the above questions.		
____________________ tons/year		

QUANTITY AND AVAILABILITY OF FOREST AND MILL RESIDUE				NOTES
Are any of the feedstocks identified in this section (Mill & Forest Residue) currently being diverted to other uses? Whether or not the feedstocks are currently being used is likely to affect your ability to use the resource for your intended use.				
Source e.g., Sawmill	**Type** e.g., Sawdust	**Use** e.g., Sold for pellet production	**Quantity**	
___________________	___________________	___________________	___________ tons/year	
___________________	___________________	___________________	___________ tons/year	
___________________	___________________	___________________	___________ tons/year	
___________________	___________________	___________________	___________ tons/year	
___________________	___________________	___________________	___________ tons/year	
		Total:	___________ **tons/year**	
Contact the owner of the resources to get this information.				
Estimate the total amount of mill and forest residue that may currently be available for a biomass project in your community. Please subtract the total currently diverted to other uses from the total mill and forest residue.				
______________________________ tons/year This indicates the quantity of wood residue that may be available in or near your community for biomass projects and is contingent on the applicant's ability to negotiate long-term contracts to obtain the resource.				
How might the availability of mill and forest residue change over time (e.g., 20 years)? How volatile is the supply and availability of this biomass?				
☐ This biomass supply and pricing are highly secure over the long-term	☐ This biomass supply and pricing are somewhat secure over the long-term	☐ This biomass supply and pricing are not secure over the long-term		

ENERGY POTENTIAL (HEAT AND POWER) FROM WOOD WASTE		NOTES
How much wood biomass might be available annually for energy (heat and power) generation in your community over the short term (e.g., 2 years)? Please add the total amounts from urban and forestry/ wood-processing based sources.		
____________ **tons/year x 19 tons/GJ**[31] ____________ Total clean GJ/year (total energy available)		
____________ **tons/year x 19 tons/GJ** ____________ Total non-clean GJ/year (total energy available)		
Note: Around 2/3 of total energy available should be considered part of the heat component, the remaining 1/3 would be the electricity component (this is a rule of thumb; actual efficiency depends on technology selected). To determine how many MWh of electricity could be generated use the following conversion: 1GJ/year=0.28 MWh/year.		
How much wood biomass might be available annually for energy (heat and power) generation in your community over the long term (e.g., 20 years)? Please add the total amounts from urban and forestry/ wood-processing based sources.		
____________ **tons/year x 19 tons/GJ** ____________ Total clean GJ/year (total energy available)		
____________ **tons/year x 19 tons/GJ** ____________ Total non-clean GJ/year (total energy available)		
Note: Around 2/3 of total energy available should be considered part of the heat component, the remaining 1/3 would be the electricity component (this is a rule of thumb; actual efficiency depends on technology selected). To determine how many MWh of electricity could be generated use the following conversion: 1GJ/year=0.28 MWh/year.		
Are you aware of other projects being considered in or near your community that might compete to access these feedstocks?		
☐ Yes This may reduce the availability of the wood for your intended use.	☐ No	

[31] An approximate figure based on data from BIOCAP Canada, An Information Guide on Pursuing Biomass Energy Opportunities and Technologies in British Columbia for First Nations, Small Communities, Municipalities and Industry. Prepared for the B.C. Ministry of Energy, Mines and Petroleum Resources and B.C. Ministry of Forests and Range, 2008 available at **www.energyplan.gov.bc.ca**.

SUMMARY OF OPPORTUNITIES FOR CHP FROM WOOD WASTE			NOTES
What possible opportunities exist based on your responses above?			
Project Type	**Siting Opportunities**	**Potential Energy Output**	
1. ______________________________	______________________________ ______________________________	______________________ ______________________	
2. ______________________________	______________________________ ______________________________	______________________ ______________________	
3. ______________________________	______________________________ ______________________________	______________________ ______________________	
Are any of these opportunities mutually exclusive? (Is the same supply of waste needed for more than one project?)			
☐ Yes Please specify this in the notes.	☐ No		

APPENDIX A.2
ANAEROBIC DIGESTION FROM ORGANIC WASTE WORKBOOK

Appendix A.2 contains a number of self-assessment questions to help guide your consideration of DG opportunities related to anaerobic digestion from organic waste in your community, and also to help you assess the scale and siting options for these opportunities. The sections should be completed by someone in the community who has knowledge or experience in this subject area. These types of projects are generally located in urban communities.

PART 1: MUNICIPAL ORGANIC WASTE

SITING ASSESSMENT FOR CHP FROM MUNICIPAL ORGANIC WASTE			NOTES
Does your community possess any of the following facilities? Are there plans to construct or modify them? These facilities might help to decrease capital costs and operating costs through co-location, shared staffing, transportation infrastructure, or equipment. They also may have lower requirements for odour controls, further reducing costs. And, one or more of these facilities may become customers for excess heat from a CHP project.			
Facility	**Existing**	**Planned or Planned Upgrade**	
District Energy System	☐	☐	
Wastewater treatment plants	☐	☐	
Composting facilities	☐	☐	
Large industrial food-producers (e.g., greenhouses or fish processors)	☐	☐	
Industries with substantial on-site heat or power production	☐	☐	
Other: ____________________	☐	☐	
Please list some potential sites for a municipal waste/CHP project. The site can be identified in the list above or can be a different site. Ideally, sites identified will be large, possess some existing infrastructure, and be sited away from residential uses. 1. ____________________ 2. ____________________ 3. ____________________ 4. ____________________ 5. ____________________			

For each site identified, please complete the following page. You may wish to save or print several copies of the page.

SITING ASSESSMENT FOR CHP FROM MUNICIPAL ORGANIC WASTE (Continued)		NOTES
Site Name: ______________________________ **Site Location:** ______________________________		
Is the site zoned for industrial use, and are the surrounding land use designations compatible with an industrial facility? These factors can influence the technical and social availability of the site, and may influence project costs.		
☐ Yes	☐ No The site may require rezoning.	
Is the site near any potential heat users which might wish to purchase waste heat? Proximity to industries, institutions or high-density neighbourhoods with high heat demand may be beneficial for the economics of a municipal waste CHP project. Generally the distance should be less than 1 km, although some projects are economical at distances of several kilometers.		
	Please specify site name or location:	
High density developments or re-developments	______________________	
Industrial facilities with high on-site heat demand	______________________	
Greenhouses	______________________	
Institutions (e.g., hospitals, universities, etc.)	______________________	
Is there an on-site power plant operator in place at the site? For example, an industrial building with a part- or full-time operator for a large boiler.		
☐ Yes This could reduce staffing costs for CHP projects, such as by having one operator for two facilities.	☐ No	
Please evaluate the potential site with respect to truck, rail or barge access, using a high/medium/low rating system. You will have to define what the terms high, medium and low mean for your community based on your community's geography and existing transportation infrastructure.		
Truck access	______________________	
Rail access	______________________	
Barge access	______________________	
What are the main land use designations along the proposed biomass transportation routes (e.g., residential, commercial, industrial, parks)? This factor can influence the public acceptance level of the chosen project location.		
Surrounding land use 1	______________________	
Surrounding land use 2	______________________	

QUANTITY AND AVAILABILITY OF RESIDENTIAL FOOD AND YARD WASTE		NOTES
Estimate residential organic waste currently sent to landfills annually. Include all compostable wastes.		
Total organic waste: (food & yard)	____________________ X 0.048[32] tons = ____________________ # of residents tons/year generated	
Food Waste:	____________________ X 0.036 tons = ____________________ # of residents tons/year generated	
Yard Waste: (incl. leaves and small branches)	____________________ X 0.007 tons = ____________________ # of residents tons/year generated	
Contaminated Paper: (incl. paper plates, pizza boxes, etc.)	____________________ X 0.004 tons = ____________________ # of residents tons/year generated	
These figures are based on 2008 statistics for Metro Vancouver and will differ significantly by urban area. Where possible, each community should use recent data. Information may be available from the Regional District or the Ministry of the Environment.		
Recalculate the above estimates based on future projections—assess residential organic waste sent to landfills annually in 20 years. This is intended to give a picture of waste availability over time.		
Total organic waste: (food & yard)	____________________ X 0.048 tons = ____________________ # of residents tons/year generated	
Food Waste:	____________________ X 0.036 tons = ____________________ # of residents tons/year generated	
Yard Waste: (incl. leaves and small branches)	____________________ X 0.007 tons = ____________________ # of residents tons/year generated	
Contaminated Paper: (incl. paper plates, pizza boxes, etc.)	____________________ X 0.004 tons = ____________________ # of residents tons/year generated	
Where possible adjust estimates based on expected demographic changes.		

[32] This estimate is based on Metro Vancouver's 2008 Solid Waste Composition Study available at www.metrovancouver.org/about/publications/Publications/SolidWasteCompositionStudyFinal-2007.pdf.

QUANTITY AND AVAILABILITY OF COMMERCIAL AND INDUSTRIAL FOOD AND YARD WASTE		NOTES
Estimate Industrial, Commercial, & Institutional organic waste currently sent to landfills annually. Include all compostable wastes.		
Total organic waste: (incl. food & yard)	____________ X 0.12 tons = ____________ # of residents tons/year generated	
Food Waste:	____________ X 0.098 tons = ____________ # of residents tons/year generated	
Yard Waste: (incl. leaves and small branches)	____________ X 0.01 tons = ____________ # of residents tons/year generated	
Contaminated Paper: (incl. paper plates, pizza boxes, etc.)	____________ X 0.015 tons = ____________ # of residents tons/year generated	
These figures are based on 2008 statistics for Metro Vancouver[33] and will differ significantly by urban area. Where possible, each community should use recent data. Information may be available from the local Solid Waste Management department, the Regional District, or the Ministry of the Environment.		
Recalculate the above estimates based on population projections—assess Industrial, Commercial, & Institutional organic waste sent to landfills annually in 20 years. This is intended to give a picture of waste availability over time.		
Total organic waste: (incl. food & yard)	____________ X 0.12 tons = ____________ # of residents tons/year generated	
Food Waste:	____________ X 0.098 tons = ____________ # of residents tons/year generated	
Yard Waste: (incl. leaves and small branches)	____________ X 0.01 tons = ____________ # of residents tons/year generated	
Contaminated Paper: (incl. paper plates, pizza boxes, etc.)	____________ X 0.015 tons = ____________ # of residents tons/year generated	
Where possible adjust estimates based on expected demographic and economic changes.		

33 Source: Metro Vancouver's 2008 Solid Waste Composition Study available at www.metrovancouver.org/about/publications/Publications/SolidWasteCompositionStudyFinal-2007.pdf.

OVERALL ASSESSMENT FOR MUNICIPAL ORGANIC WASTE			NOTES
How much organic waste is currently sent to landfills in your community annually? Please refer to the totals on previous pages to complete this section.			
Residential: ___________ tons/year +	**IC&I:** ___________ tons/year	**Total:** =____________________ tons/year	
Is there a plan to adopt policies and programs to divert organic waste from landfills? i.e. Is there a plan in place to begin separating these resources at source or a plan to increase diversion?			
☐ Yes This will determine the amount of waste available for anaerobic digestion.	☐ No Without access to source-separated organic waste, anaerobic digestion is not likely to be financially viable.		
Accounting for waste diversion targets, please estimate what fraction of the organic waste sent to landfills might be available for your intended use in the short-term (e.g. within 2-5 years).			
Residential: ___________ tons/year +	**IC&I:** ___________ tons/year	**Total:** =____________________ tons/year	
What project size can you consider pursuing over the short-term, based on this amount? Please note that this is highly dependent on technology choice and feedstock.			
_________________________ tons X 0.00007 MW[34] = __________________________________ MW capacity (electricity)			
Accounting for waste diversion targets, please estimate what fraction of the organic waste sent to landfills might be available for your intended use annually in 20 years.			
Residential: ___________ tons/year +	**IC&I:** ___________ tons/year	**Total:** =____________________ tons/year	
What project size can you consider pursuing over the long-term, based on this amount?			
_________________________ tons X 0.00007MW = __________________________________ MW capacity (electricity)			
Are you aware of other projects being considered in or near your community which might compete for access to this waste?			
☐ Yes This may reduce the availability of this organic waste.	☐ No This information should be researched. If there is no nearby competition this could help ensure organic waste will be available at a reasonable cost.		

34 This is a highly approximate estimate based on a relatively small number of case studies from other jurisdictions.

PART 2: LANDFILL GAS

<table>
<tr><th colspan="3">SITING ASSESSMENT FOR CHP FROM LANDFILL GAS</th><th>NOTES</th></tr>
<tr><td colspan="3">Does your community possess any of the following facilities? Are there plans to construct or modify them? These facilities might help to decrease capital costs and operating costs through co-location, shared staffing, transportation infrastructure or equipment. They also may have lower requirements for odour controls, further reducing costs. And, one or more of these facilities may also become customers for excess heat from a CHP project.</td><td rowspan="9"></td></tr>
<tr><td>Facility</td><td>Existing</td><td>Planned or Planned Upgrade</td></tr>
<tr><td>District Energy System</td><td>☐</td><td>☐</td></tr>
<tr><td>Wastewater treatment plants</td><td>☐</td><td>☐</td></tr>
<tr><td>Composting facilities</td><td>☐</td><td>☐</td></tr>
<tr><td>Large industrial food-producers (e.g. greenhouses or fish processors)</td><td>☐</td><td>☐</td></tr>
<tr><td>Industries with substantial on-site heat or power production</td><td>☐</td><td>☐</td></tr>
<tr><td>City or regional landfills</td><td>☐</td><td>☐</td></tr>
<tr><td>Other: ___________________________________</td><td>☐</td><td>☐</td></tr>
<tr><td colspan="3">Please list some potential sites for a landfill gas/CHP project. The site can be identified in the list above or can be a different site. Ideally, sites identified will be large, possess some existing infrastructure, and be sited away from residential uses.
1. ____
2. ____
3. ____
4. ____
5. ____</td><td></td></tr>
</table>

For each site identified, please complete the following page. You may wish to save or print several copies of the page.

SITING ASSESSMENT FOR CHP FROM LANDFILL GAS (Continued)		NOTES
Site Name: ____________________ **Site Location:** ____________________		
Is the site zoned for industrial use, and are the surrounding land use designations compatible with an industrial facility? These factors can influence the technical and social availability of the site, and may influence the project costs as they relate to odour control, equipment and construction costs.		
☐ Yes	☐ No This may reduce the viability of this site	
Is the site near any potential heat users that might wish to purchase waste heat? Proximity to industries, institutions or high-density neighbourhoods with high heat demand may be beneficial for the economics of a biomass CHP project. Generally the distance should be less than 1 km, although some projects are economical at distances of several kilometres.		
	Please specify site name or location:	
High density developments or re-developments	____________________	
Industrial facilities with high on-site heat demand	____________________	
Greenhouses	____________________	
Institutions (e.g., hospital, universities, etc.)	____________________	
Is there an on-site power plant operator in place at the site? For example, an industrial building with a part- or full-time operator for a large boiler.		
☐ Yes This could reduce staffing costs for CHP projects,such as having one operator for two facilities.	☐ No	
Please evaluate the potential site with respect to truck, rail or barge access, using a high/medium/low rating system. You will have to define what the terms high, medium and low mean for your community based on your community's geography and existing transportation infrastructure.		
Truck access	____________________	
Rail access	____________________	
Barge access	____________________	
Electrical distribution line	____________________	
Pipeline	____________________	
What are the main land use designations along the proposed biomass transportation routes (e.g. residential, commercial, industrial, parks)? This factor can influence the public acceptance level of the chosen project location.		
Surrounding land use 1	____________________	
Surrounding land use 2	____________________	

PART 3: FARM WASTE

SITING ASSESSMENT FOR ON-FARM ANAEROBIC DIGESTION		NOTES
Does your community possess any intensive dairy farms? (e.g. between 100–300 cows in a single building)		
☐ Yes	☐ No Please skip this section	
Please identify any intensive dairy farms or clusters of dairy farms which might be suited to anaerobic digestion (Clusters should be within a few hundred metres of each other as dairy waste is expensive and difficult to transport). **Site 1.**______________________ **Site 2.**______________________ **Site 3.**______________________ **Site 4.**______________________ **Site 5.**______________________		

POWER ASSESSMENT FOR CHP FROM ON-FARM ANAEROBIC DIGESTION	NOTES
Please estimate the potential electrical capacity based on the number of head of cows	
______________ X 0.15kW/cow = ______________ Total number of cows kW installed capacity	
Please estimate the total potential electrical capacity if municipal food waste (e.g. restaurant waste) were included.	
______________ X 1.50 = ______________ kW installed capacity (from above) kW installed capacity	

Note: Other types of on-farm organic waste, such as manure from chickens, may also be possible feedstock for anaerobic digestion. However, the economics may be challenging where the manure can also be applied to land or composted directly. Therefore, this Toolkit does not try to quantify all opportunities related to on-farm organic waste.

PART 4: MUNICIPAL LIQUID WASTE (BIOSOLIDS)

SITING ASSESSMENT FOR CHP FROM MUNICIPAL BIOSOLIDS			NOTES
Does your community possess a Wastewater Treatment Plant that uses anaerobic digestion?			
☐ Yes Skip the following question.	☐ No Respond to the next question.		
Are you already considering to construct a facility, or upgrading an existing facility, that would use anaerobic digestion during the treatment process?			
☐ Yes Please proceed to the next question.	☐ No If you are already considering an upgrade to a system which uses anaerobic digestion, continue with this section. Otherwise, move directly to the next section of the document.		
Is there a plan to build, upgrade, modify, or expand the facility within the short or medium term? For example, within the next 10 years.			
☐ Yes It may be possible to equip or retrofit the facility to maximize biogas output for power production, increase capacity to allow some types of food waste, or share capital costs for cogeneration and plant operations with other types of DG project.[35]	☐ No You may wish to research this at a future date.		
Is the site of the treatment plant near any of the following facilities? These facilities might help to decrease capital costs and operating costs through co-location, shared staffing, transportation infrastructure, or equipment. And, one or more of these facilities may also become customers for excess heat from a CHP project.			
Facility Type	**Existing**	**Planned or Planned Upgrade**	
District Energy System	☐	☐	
Composting facility	☐	☐	
Large industrial food-producers (e.g. greenhouses or fish processors)	☐	☐	
Industries with substantial on-site heat or power production, including greenhouses	☐	☐	
Other: ______________________	☐	☐	

OWNERSHIP OF SEWAGE TREATMENT FACILITY		NOTES
Does your community have sole ownership of the sewage treatment plant under discussion?		
☐ Yes This may make the planning and implementation of a cogeneration system easier.	☐ No You may wish to consider involving the other parties as early as possible in your discussions.	

35 For example, some facilities "co-digest" food waste along with biosolids to increase energy output.

POWER ASSESSMENT FOR CHP BIOSOLIDS	NOTES
What is the current potential electrical capacity from liquid waste in your community?	
______________ X 0.004 kW = ______________ Population served / kW potential electrical capacity ______________ /1,000 = ______________ kW potential electrical capacity / MW potential electrical capacity	
What is the potential electrical capacity from liquid waste in your community in 20 years?	
______________ X 0.004 kW = ______________ Population served / kW potential electrical capacity ______________ /1,000 = ______________ kW potential electrical capacity / MW potential electrical capacity	
What is the potential increase in electrical capacity for communities with existing CHP units at the treatment plant?	
______________ - ______________ = ______________ Potential electrical capacity / Current electrical capacity / Potential increase in capacity from a facility upgrade	

SUMMARY OF OPPORTUNITIES FOR ANAEROBIC DIGESTION—MUNICIPAL ORGANIC WASTE, FARM WASTE, AND BIOSOLIDS			NOTES
Based on your responses above, what possible opportunities exist?			
Project Type (Food waste, liquid waste, farm waste, or combined)	**Siting Opportunities**	**Potential Electrical Output**	
1. ______________	______________ ______________	______________ ______________	
2. ______________	______________ ______________	______________ ______________	
3. ______________	______________ ______________	______________ ______________	
4. ______________	______________ ______________	______________ ______________	
5. ______________	______________ ______________	______________ ______________	
Are any of these opportunities mutually exclusive? (Is the same supply of organic waste needed for more than one project?)			
☐ Yes Please specify this in the notes.	☐ No		

APPENDIX A.3
COMBINED HEAT AND POWER FROM MUNICIPAL SOLID WASTE WORKBOOK

Appendix A.3 contains a number of self-assessment questions to help guide your consideration of DG opportunities related to combined heat and power from municipal solid waste in your community, and also to help you assess the scale and siting options for these opportunities. The sections should be completed by someone in the community who has knowledge or experience in this subject area.

SITING ASSESSMENT FOR ENERGY FROM MSW	NOTES
Please list some potential sites for combined heat & power projects. **The site should be located near other industry/customers who can utilize the heat. Ideally, sites identified will be large, possess some existing infrastructure, and be located away from residential uses.** 1. ____________________ 2. ____________________ 3. ____________________ 4. ____________________ 5. ____________________	

For each site identified, please complete the following page. You may wish to save or print several copies of the page.

SITING ASSESSMENT FOR ENERGY FROM MSW (Continued)		NOTES
Site Name: ______________________ **Site Location:** ______________________ **(street address or approximate intersection)**		
Is the site zoned for industrial use, and are the surrounding land use designations compatible with an industrial facility? These factors can influence the viability of a site, including compatibility with other land uses, public response to a proposed site, construction costs, and other factors.		
☐ Yes	☐ No May require rezoning.	
Please evaluate the potential site with respect to truck access, using a high/medium/ low rating system. You will have to define what the terms high, medium and low mean for your community based on your community's geography and existing transportation infrastructure.		
High:	______________________	
Medium:	______________________	
Low:	______________________	
What are the main land use designations along the proposed biomass transportation routes (e.g. residential, commercial, industrial, parks)?		
Surrounding land use 1	______________________	
Surrounding land use 2	______________________	
Is the site near any potential heat users that may wish to purchase waste heat? Proximity to industries, institutions or high-density neighbourhoods with high heat demand may be beneficial for the economics of a MSW CHP project. Generally the distance should be less than 1 km, although some projects are economical at distances of several kilometers.		
	Please specify site name or location:	
High density developments or re-developments	______________________	
Industrial facilities with high on-site heat demand	______________________	
Greenhouses	______________________	
Institutions (e.g., hospital, universities, etc.)	______________________	

QUANTITY AND AVAILABILITY OF MSW

NOTES

How many households are there in your community?

☐ > 250,000 WTE (incineration) is typically used in areas of at least 250,000 households, given large economies of scale.	☐ < 250,000 WTE (incineration) unlikely to be a viable option. Consider partnering with neighbouring communities.

Potential data source: B.C. Stats, local government staff.

Estimate MSW currently sent to landfills annually. If possible, use data specific to your community.

________________________ x 0.613 tons/capita[36] = ______________ tons/year

\# of residents

Potential data source: B.C. Municipal Solid Waste Tracking Reports (Ministry of the Environment); local Solid Waste Management Department. Please note that per capita disposal rate (in tons) varies across regional districts.

Recalculate the above estimate based on population projections. Estimate MSW sent to landfills annually in 20 years. If possible, use data specific to your community.

General estimate

________________________ x 0.613 tons/capita[37] = ______________ tons/year

\# of residents

Potential data source: B.C. Municipal Solid Waste Tracking Reports (Ministry of the Environment); local Solid Waste Management Department. Please note that per capita disposal rate (in tons) varies across regional districts.

Is there a plan to adopt policies and programs to divert waste from landfills? i.e. Is there a plan in place to begin separating these resources at source, or a plan to increase diversion?

☐ Yes This will reduce the amount of waste available for energy generation.	☐ No

Accounting for waste diversion targets, please estimate what fraction of the waste sent to landfills that might be available for energy generation.

______________________ - ______________ = ____________________

Total Generated - Total Diverted = Total Available for Energy Generation

What project size can be considered based on this amount?

________________________ / 17,000 tons/MW[38] = ____________________

tons per year / 17,000 tons/MW = MW capacity (electrical)

Are you aware of other projects being considered in or near your community which might compete for access to this waste?

☐ Yes This may reduce the availability of this waste.	☐ No

---

36 (B.C. average, 2006)

37 (B.C. average, 2006)

38 Based on energy content and efficiency of Metro Vancouver's Burnaby Incinerator.

APPENDIX A.4
INDUSTRIAL WASTE HEAT RECOVERY WORKBOOK

Appendix A.4 contains a number of self-assessment questions to help guide your consideration of DG opportunities related to industrial waste heat recovery in your community, and also to help you assess the scale and siting options for these opportunities. The sections should be completed by someone in the community who has knowledge or experience in this subject area.

SITING ASSESSMENT FOR ELECTRICITY FROM WASTE HEAT		NOTES
Does your community possess industrial sites, or is it expected that any will be built in the near future?		
☐ Yes Please proceed with this section.	☐ No There may not be opportunities for power generation from waste heat in your community.	
What potential large waste heat generators exist in your community? e.g. any industry that uses high-temperature processes, such as a wood processing facility or a foundry. 1. ______ 2. ______ 3. ______ 4. ______ 5. ______		

For <u>each</u> site identified, please complete the following page. You may wish to save or print several copies of the pages.

SITING ASSESSMENT FOR ELECTRICITY FROM WASTE HEAT (Continued)		NOTES
Site Name: ____ Site Location: ____		
Is the waste heat concentrated? e.g., is the waste heat emitted through a stack or chimney?		
☐ Yes Might be worth further investigation of electrical generation potential.	☐ No Focus on using for temperature regulation instead of electricity.	
Finding this out will likely require a discussion with facility operators and owners, or potentially a site visit and inspection.		
Is the waste heat likely hot enough for power generation? (i.e., >100°C) Significantly higher temperatures are preferable and are more likely to make the projects economically viable.		
☐ Yes Might be worth further investigation.	☐ No It is more likely that that the waste heat could be reduced through increased efficiency, or used for heating applications (e.g., for district energy) than for power generation.	
Has a study been conducted by the owner of the waste heat that addresses its potential uses as heat (both on and off-site) and opportunities to produce electricity? On-site use such as hot-water heating is likely to have a faster economic payback.		
☐ Yes Please utilize the data from the study.	☐ No Consider cooperating with the facility to explore mutually beneficial uses for the waste heat.	

OVERALL ASSESSMENT FOR ELECTRICITY FROM WASTE HEAT	NOTES
Which sites warrant further investigation for power production? *i.e., is there an available source of high-temperature waste heat in the community?*	
Please list your responses. 1. ____________________ 2. ____________________ 3. ____________________ 4. ____________________ 5. ____________________	
Do any sites warrant further investigation for heat recovery or increased efficiency?	
Please list your responses. 1. ____________________ 2. ____________________ 3. ____________________ 4. ____________________ 5. ____________________	

APPENDIX A.5
SUMMARY TABLE FROM COMBINED HEAT AND POWER WORKBOOKS

SUMMARY OF OPPORTUNITIES FOR COMBINED HEAT AND POWER FROM WASTE RESOURCES				NOTES
Based on your responses to the previous sections on combined heat and power from wood waste, food waste, mixed municipal solid waste, and waste heat, what opportunities exist? Which ones might be worth further consideration? If possible, rank these opportunities relative to each other based on how feasible they appear.				
Project Type (Wood waste gasification or combustion, anaerobic digestion of food or biosolids, WTE from municipal solid waste, or waste heat)	**Siting Opportunities (rate as high, medium, or low)**	**Potential Electrical Output**	**Ranking**	
1. ___________________________	___________________________	______________________		
2. ___________________________	___________________________	______________________		
3. ___________________________	___________________________	______________________		
4. ___________________________	___________________________	______________________		
5. ___________________________	___________________________	______________________		
Are any of these opportunities mutually exclusive? (i.e., is the same supply of waste needed for more than one project?)				
☐ Yes Consider marking this clearly in the notes section.	☐ No			

APPENDIX B
SMALL AND MICRO HYDRO WORKBOOK

Appendix B contains a number of self-assessment questions to help guide your consideration of DG opportunities related to small and micro hydro in your community, and also to help you assess the scale and siting options for these opportunities. The sections should be completed by someone in the community who has knowledge or experience in this subject area.

PART 1: RUN-OF-RIVER

SITING ASSESSMENT FOR RUN-OF-RIVER	NOTES
Please list potential siting opportunities, i.e., the largest rivers or streams within your community. 1. ____________________ 2. ____________________ 3. ____________________ 4. ____________________ 5. ____________________	
Potential data sources: imap B.C., BC Hydro Inventory of Undeveloped Opportunities at Potential Micro Hydro Sites in B.C.: **www.bchydro.com/planning_regulatory/energy_technologies/micro_hydro.html**.	

For each site identified, please complete the following page. You may wish to save or print several copies of the page.

Note: It is also recommended that you print a map featuring your community and potential sites (streams and rivers) before continuing.

OPPORTUNITIES TO SITE A RUN-OF-RIVER HYDRO POWER PROJECT (Continued)			NOTES
Is there enough space to construct a penstock pipe? The penstock pipe needs a long and narrow strip of space with minimal obstructions from the intake pipe to the powerhouse. The penstock pipe length is at least 10 per cent greater than the head and can be up to 1,000 m depending on the head and slope.			
☐ Yes	☐ No The site may not be viable		
Potential data source: local map, site visit			
Is there likely to be enough space to construct a powerhouse? The powerhouse can be the size of a backyard shed for small projects, or a large house for more sizeable projects.			
☐ Yes	☐ No The site may not be viable.		
Potential data source: local map, site visit			
Does the proposed site have adequate space to construct a hydro power project? (Did you answer yes to both of the above questions?)			
☐ Yes Please continue with the next section of the questionnaire.	☐ No It appears unlikely that you could construct this type of project here. Please consider other sites.		
Ownership of land			
Who owns the land surrounding the site? Who will you need to contact for more information? The surrounding land is needed to construct several elements of a hydro project.			
☐ Owned by the Crown You will likely need to contact the Integrated Land Management Bureau or FrontCounter BC.	☐ Owned Privately You will likely need to contact the Land Titles Registry Offices.	☐ Owned by a First Nation or is on a reserve You will need to contact the Band office.	
Are there other uses for the land or water?			
☐ Are there recreational uses? (e.g., can a kayak operate in the same body of water?)	☐ Are there other uses?		
For queries, contact: Transport Canada **www.tc.gc.ca/eng/menu.htm.**			
Could the project affect mining claims in the area?			
☐ Yes	☐ No		
For queries, contact Ministry of Energy and Mines at www.**gov.bc.ca/empr/.**			

OPPORTUNITIES TO SITE A RUN-OF-RIVER HYDRO POWER PROJECT (Continued)			NOTES
Are there any environmental barriers to the suggested site? Projects with potential impacts to the local ecology may be required to undergo an environmental assessment and incorporate preventative measures that may result in a longer and more complex process.			
☐ Is the site in fish-bearing waters? Site should be located upstream of any fish-bearing areas, and may require additional approvals.	☐ Is the site in a nature reserve (wildlife, parks, etc.) or a protected area? Provincial Park use permits will not be issued for any components of a power project.	☐ Are there species at risk within the boundaries of the project?	
For queries, contact: Environmental Stewardship Division of the Ministry of Environment at www.**env.gov.bc.ca/esd/.**			
Is the site accessible by existing roads? Road access is required for constructing most aspects of the project (powerhouse, penstock, intake, etc.)			
☐ Yes This may reduce costs. Forest service roads or decommissioned roads can be ideal for site access.	☐ No You will need to construct roads that may require additional approvals.		
For queries, contact Transport Canada at www.**tc.gc.ca.**			
If you do not have current road access, does the terrain appear suitable for road construction?			
☐ Yes	☐ No Difficult terrain (steep slopes, dense forests) often leads to higher costs.		
Potential data source: local maps, site visit.			
Will construction impact timber or forest service roads?			
☐ Yes Approval will likely be required from the Province.	☐ No		
For queries, contact: Ministry of Forests, Lands and Natural Resource Operations at **www.gov.bc.ca/for/.**			

HYDRO POWER CAPACITY ESTIMATE		NOTES
What is the "head" and "flow" available at this site? "Head" is the change in elevation from the intake pipe to the powerhouse, usually measured in metres. "Flow" is the quantity of water, often expressed as metres cubed per second.		
______________ metres (m) Head	______________ Cubic metres per second (m^3/s) Average Flow[39]	
For queries, contact the Water Stewardship Division at www.**env.gov.bc.ca/wsd/**. If local hydrology data is not available, a site-specific study will need to be conducted.		
What is the potential capacity of a project installed at this site?		
______________ X ______________ X 4.91[40] = ________________________ Head (m) Flow (m3/s) kW installed capacity		
Potential data source: local map, site visit.		
What is the potential electrical output of a project installed at this site?		
___________________ X 8.7 = ________________________ **MWh per year** kW installed capacity		
Are there existing volumes of water available on the water system? Access to use water will require a water licence under the Water Act.		
☐ Yes You will need to apply for a water permit.	☐ No You may be able to purchase the permit from the current owner. If you cannot obtain a permit, you should not continue with the project.	
Contact the Water Stewardship Division of the Ministry of Environment **www.env.gov.bc.ca/wsd/.**		

SUMMARY OF RUN-OF-RIVER HYDRO POWER OPPORTUNITIES		
Are there any potential projects you have identified for further exploration based on available data on water volumes and potential siting opportunities? Please summarize key information about the potential site(s) below.		
Site Name	**Key Strengths or Advantages of Site**	**Key Barriers or Challenges of Site**

[39] Note: a hydro turbine will need to be sized for a consistent flow, e.g., the flow rate consistently available for at least 80 per cent of the year. If the flow is highly variable, the quantification method here may greatly overestimate hydro power potential.

[40] Assumes 50 per cent conversion efficiency and average water density of 1,000 kilograms per cubic metre.

PART 2: PRESSURE REDUCING VALVES

Please complete the following table for each of your PRVs:

<table>
<tr><th colspan="2">PRV ASSESSMENT</th><th>NOTES</th></tr>
<tr><td colspan="2">Site Name: ______________________________
Site Location: ______________________________</td><td rowspan="2"></td></tr>
<tr><td colspan="2">Potential data source: local water utility data.</td></tr>
<tr><td colspan="2">What is the energy potential at the site?</td><td rowspan="3"></td></tr>
<tr><td colspan="2">____________ X ____________ X 4.91 = ____________
Head (m) Flow (m^3/s) kW installed capacity</td></tr>
<tr><td colspan="2">Potential data source: local water utility data.</td></tr>
<tr><td colspan="2">Does the site possess any of the following characteristics?</td><td rowspan="3"></td></tr>
<tr><td>☐ Is this a future site? (not yet constructed)</td><td>☐ Is this an existing site due for an upgrade or replacement?</td></tr>
<tr><td colspan="2">Potential data source: local water utility data.</td></tr>
</table>

<table>
<tr><th colspan="3">SUMMARY OF PRV OPPORTUNITIES</th></tr>
<tr><td colspan="3">Are there any potential projects you have identified for further exploration based on available data on pressure (head/flow) and potential siting opportunities? Please summarize key information about the potential site(s) below.</td></tr>
<tr><td>Site Name</td><td>Key Strengths or Advantages of Site</td><td>Key Barriers or Challenges of Site</td></tr>
<tr><td></td><td></td><td></td></tr>
</table>

APPENDIX C
SOLAR PHOTOVOLTAICS WORKBOOK

Appendix C contains a number of self-assessment questions to help guide your consideration of DG opportunities related to solar power in your community, and also to help you assess the scale and siting options for these opportunities. The sections should be completed by someone in the community who has knowledge or experience in this subject matter.

QUANTITATIVE ASSESSMENT	NOTES
Please record the solar PV potential in your community.	
______________________________ **kWh/kW installed**	
Potential data source: PV and solar potential map for Canada, available at www.**nrcan.gc.ca**.	

SITING ASSESSMENT FOR SOLAR PHOTOVOLTAICS				NOTES
Please identify potential site categories that you may be interested in exploring:				
☐ **Roof-mounted**	☐ **Ground mounted**	☐ **Street light-mounted**	☐ **Other off-grid infrastructure**	

For each potential site, please apply the following questions.

SITING ASSESSMENT FOR SOLAR PHOTOVOLTAICS (Continued)		NOTES
Site Name: ______________________________ **Site Location:** ______________________________		
Is the site south facing?		
☐ Yes This is optimal	☐ No May require additional mounting equipment.	
Potential data source: site visit.		
Is the site free of obstructions that might cast a shadow on it?[41]		
☐ Yes This is optimal	☐ No May reduce electricity output or make site infeasible.	
Over the life of the panels (e.g., 25 years) is the site likely to remain free of obstructions which might cast a shadow on them?		
☐ Yes	☐ No May reduce electricity output or make site infeasible.	

[41] During the winter, when the sun is low in the sky, shadows can extend a long ways from an object. A qualified installer can estimate sun angles at your specific site to determine whether such shadows are likely to be a problem.

APPENDIX D
WIND POWER WORKBOOK

Appendix D contains a number of self-assessment questions to help guide your consideration of DG opportunities related to wind power in your community, and also to help you assess the scale and siting options for these opportunities. The sections should be completed by someone in the community who has knowledge or experience in the subject matter.

QUANTITATIVE ASSESSMENT FOR WIND POWER		NOTES
Has a formal site-specific wind monitoring study been completed for your community, or for a site within your community?		
☐ Yes Please use the data to answer the following question.	☐ No Please review the data sources suggested below before proceeding.	
Potential data source: Canadian Wind Energy Association's Ballpark Cost Calculator, available at **www.smallwindenergy.ca/en/SmallWindAndYou/Planning/BallparkCost.html.** You may also use the Canadian Wind Energy Atlas, which can provide more detailed results.		
What is the average wind speed in your community?		
January	_______ metres/second, _______ km/hour	
February	_______ metres/second, _______ km/hour	
March	_______ metres/second, _______ km/hour	
April	_______ metres/second, _______ km/hour	
May	_______ metres/second, _______ km/hour	
June	_______ metres/second, _______ km/hour	
July	_______ metres/second, _______ km/hour	
August	_______ metres/second, _______ km/hour	
September	_______ metres/second, _______ km/hour	
October	_______ metres/second, _______ km/hour	
November	_______ metres/second, _______ km/hour	
December	_______ metres/second, _______ km/hour	
Annual	**_______ metres/second, _______ km/hour**	
Do the wind speeds in your community appear suited to power generation?		
☐ Yes Proceed with the remainder of this section.	☐ No It is still possible that a specific site in your community will have sufficient wind speeds to consider a project. If you feel that there is a specific area with significantly higher wind speeds than the rest of the community, please proceed with this section. Otherwise, you may wish to concentrate on other DG opportunities.	

Please note that in order to determine an accurate picture of available wind resources, a minimum 1-year monitoring study should be conducted.

SITING ASSESSMENT FOR WIND POWER	NOTES
Please list any potential wind sites based on the criteria listed above. 1. ______________________________ 2. ______________________________ 3. ______________________________ 4. ______________________________ 5. ______________________________	

For each site identified, please complete the following page. You may wish to save or print several copies of the page.

SITING ASSESSMENT FOR WIND POWER (Continued)		NOTES
Site Name: ______________________________ **Site Location:**[42] ______________________________		
Is a wind turbine compatible with the existing land uses surrounding the site?		
☐ Yes	☐ No Could impact viability of project.	
Considerations include: proximity to residences, zoning, industrial activities, etc.		
Is a wind turbine compatible with the future land uses surrounding the site? Consider a time frame of approximately 25 years.		
☐ Yes	☐ No Could impact viability of project.	
For example, see the Official Community Plan or land use plan.		
Is the site located in an ecologically sensitive area? Could the development increase risk to any wildlife?		
☐ Yes Could impact viability of project.	☐ No	
For more information, please see Wind Turbines and Birds: A Guidance Document.[43]		
Is the proposed site known to be sensitive with respect to hydrology? Could the project impact water supply or affect flood risk?		
☐ Yes Could impact viability of project.	☐ No	
Is the proposed site known to be sensitive with respect to soil quality?		
☐ Yes Could impact viability of project.	☐ No	
Could public response be an issue to this site for the project?		
☐ Yes Could impact viability of project.	☐ No	
Are there any other possible sites that might be explored based on traditional ecological knowledge?		
☐ Yes Traditional ecological knowledge within your community.	☐ No	
Are there any other barriers to using this site? If yes, please list below.		
☐ Yes	☐ No	
______________________________ ______________________________ ______________________________ ______________________________		

[42] If possible, provide a photo of this site, including surrounding lands. It may be useful for future discussions.

[43] Environment Canada, Wind Turbines and Birds: A Guidance Document for Environmental Assessment, March 2006, available at www.**bape.gouv.qc.ca/sections/mandats/eole_matane/documents/DB15.pdf**.

SITING ASSESSMENT FOR WIND POWER (Continued)		NOTES
Is the site accessible by existing roads? Road access is required for constructing most aspects of the project.		
☐ Yes This may reduce costs. Forest service roads or decommissioned roads can be ideal for site access.	☐ No You may need to construct roads, which will add costs and may require additional approvals.	
For queries, contact Transport Canada at **www.tc.gc.ca.**		
If you do not have current road access, does the terrain appear suitable for road construction?		
☐ Yes	☐ No Difficult terrain (steep slopes, dense forests) could lead to higher costs.	
Potential data source: local maps, site visit.		
Will construction impact timber or forest service roads?		
☐ Yes Approval will likely be required from the Province.	☐ No	
For queries, contact: Ministry of Forests, Lands and Natural Resource Operations at **www.gov.bc.ca/for/.**		

SUMMARY OF WIND ENERGY OPPORTUNITIES		
Are there any potential projects you have identified for further exploration based on available data on wind speeds and potential siting opportunities? Please summarize key information about the site(s) below.		
Site Name	**Key Strengths or Advantages of Site**	**Key Barriers or Challenges to Site**