North Thompson Green Energy Opportunities Scan

Prepared by the Community Energy Association

Community Energy Association

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Columbia Basin Trust
a legacy for the people

Cariboo Chilcotin Beetle Action Coalition

Omineca Beetle Action Coalition

Acronyms

ASHP	Air Source Heat Pump
BC	British Columbia
CEA	Community Energy Association
CEEI	Community Energy and Emissions Inventory
CEEP	Community Energy and Emissions Plan
CO_2	Carbon Dioxide
EPA	Electricity Purchase Agreement
GHG	greenhouse gas
GHX	Ground Heat Exchanger / geoexchange system / Ground Source Heat Pump
GJ	Gigajoules
IPP	Independent Power Producer
IUP	Investigative Use Permit
kW	kilowatt [10^3 watts]
kWh	kilowatt hour
LFG	landfill gas
MSW	municipal solid waste
mW	milliwatt [10^{-3} watts]
MW	megawatt [10^6 watts]
ODT	Oven Dry Tonne
PTAC	Packaged Terminal Air Conditioner
PV	Solar photovoltaics
RTU	Rooftop Unit
SIBAC	Southern Interior Beetle Action Coalition
TNRD	Thompson Nicola Regional District

Executive Summary

Introduction

This document summarizes the findings of a high level review of potential renewable energy options in the North Thompson area, consisting of the Simpcw First Nation, Barriere, Clearwater, and Electoral Areas A, B, and O. It is intended to provide a basic screening of renewable energy options and identify technologies and specific opportunities that warrant further study. It does not intend to provide input to the potential Barriere biocoal plant, or the potential Simpcw First Nation wood pellet manufacturing plant – both of which will be subject to substantially more rigorous analysis than can be provided by this study.

Background

The table below estimates that $32 million is being exported across the communities due to energy costs each year. There may be the potential for recirculating some portion of this in the region through energy efficiency and renewable energy. It is likely that the energy consumption of certain fuels is underestimated.

Estimated community energy expenditure for all of the communities in the study (source: CEEI for 2007 energy & population data, & research for 2012 local energy costing information)

	Barriere	Clearwater	Electoral Area A *	Electoral Area B *	Electoral Area O *	Simpcw First Nation, Chu Chua *	Total
Total	$8,100,000	$8,800,000	$6,400,000	$1,100,000	$6,400,000	$970,000	$32,000,000

Buildings heated by propane or heating oil may provide particularly attractive opportunities for energy efficiency and renewable energy because of the relatively high costs of these fuels. Generally it is recommended for energy efficiency measures to be conducted first as they have better business cases.

Renewable energy screening

An overview of the applicability of green energy technologies for the study area is shown in the table on the next page. The rankings of technology potential are determined as follows:

- **'High'** is given to technologies that are technically suitable for the study area, commercially proven in BC, and in many situations in the study area are expected to have a good business case.
- **'Medium'** technologies are technically suitable for the study area, commercially proven in BC, but in the study area are less likely to have a good business case.
- The **'speculative'** technology refers to an instance where the situation is at too early a stage to be adequately evaluated.
- **'Low'** technologies may be technically suitable, may be commercially proven in BC, but in the study area are unlikely to have a good business case.

Technology	Potential
Biomass – Woodchip	High
Biomass – Wood Pellet	High
Geoexchange Heating and Cooling	Medium to High
Air Source Heat Pumps Heating and Cooling	High
Run-of-river hydro	High
Solar Thermal	Medium
Waste Heat Recovery	Medium
Wind	Medium
Syngas from biocoal production	Speculative
Municipal Solid Waste (MSW)	Low
Landfill gas (LFG) / wastewater treatment plant gas	Low
Solar Photovoltaic	Low
Geothermal Power Generation	Low
Geothermal Direct Heating	Low

Recommendations

In the recommendations below, "encourage" implies making community members aware of the economic benefits through the provision of information. For local governments, it additionally means using the measures outlined in the CEEPs, and making use of the tools in CEA's 'Policy and Governance Tools' Guide, which can be downloaded for free from the CEA website.

Simpcw First Nation

1. Investigate funding / financing opportunities in Appendix 6 specific to Simpcw, for establishing equity positions in private IPP projects, and developing opportunities for the Band
2. Private IPP projects – try to ensure Simpcw First Nation equity positions in projects being developed privately within the traditional territory, if necessary using outside funding / financing sources. Also try to maximise jobs & skills development potential
3. Run-of-river hydro – pursue opportunities developed and owned by Simpcw First Nation, e.g. Chu Chua Creek
4. Main Band building propane/electric Rooftop Units (RTUs) – investigate replacing these with air source heat pump RTUs, particularly when they are due for replacement
5. Biomass, domestic wood pellet – encourage domestic wood pellet appliances
6. Air source heat pumps / geoexchange – encourage installation of these on existing buildings in the community. Establish policy that encourages or mandates the installation of these systems in new buildings in the community.
7. Wind – pursue opportunities developed and owned by Simpcw First Nation, e.g. near Barriere (recommended to prioritise hydro over wind)

District of Clearwater / Barriere

1. (Clearwater only) Biomass woodchip – contact Interior Health to initiate conversion of Helmcken Hospital to a woodchip energy system, and facilitate connection of buildings off Interior Health owned property (e.g. by allowing use of rights of way) if required

2. Biomass woodchip / wood pellet – following expected successful conversion of Helmcken Hospital, try to initiate development of other potential woodchip / wood pellet opportunities. Good potential opportunities are:
    a. (Clearwater) Raft River Elementary
    b. Hotels / motels, esp. those with pools
    c. Barriere Health Centre
    d. Barriere Secondary
    e. Local industrial buildings
3. Biomass air quality – consider passing a bylaw or making a request to installers of large bioenergy systems to make a contribution to a local air quality fund, that would cancel out the impact on the airshed by assisting replacement of old woodstoves in the community to new cleaner burning woodstoves. This could be conducted in conjunction with the Provincial Wood Stove Exchange Program.
4. Biomass, domestic wood pellet – encourage domestic wood pellet appliances for automated heat, unless there are significant winter air quality concerns.
5. Air source heat pumps / geoexchange – encourage these systems for existing buildings. Establish policy that encourages or mandates the installation of these systems in new buildings in the community. Encourage air source heat pumps for seasonal pools.
6. (Clearwater only) Waste heat recovery – investigate the business case of utilising waste heat within the arena, e.g. for domestic hot water, and/or space heating. Depending on further availability of waste heat, investigate potential for encouraging future high heating / hot water demands (e.g. swimming pool) near to the arena to take advantage of this potential opportunity.
7. Solar thermal – for swimming pools or buildings with high hot water demands, encourage installation of solar hot water systems, or encourage them to become solar ready when being built or undergoing major renovation. Solar blankets can also be encouraged for seasonal outdoor pools.
8. (Barriere only) Biocoal waste heat / syngas – as biocoal project evolves, continue conversations with the project proponent on the nature of any waste heat or syngas opportunity, and indicate the District's willingness to work together to realise it.

1. Introduction & Scope of Work

This document summarizes the findings of a high level review of potential renewable energy options in the North Thompson area, consisting of the Simpcw First Nation, Barriere, Clearwater, and Electoral Areas A, B, and O. It is intended to provide a basic screening of renewable energy options and identify technologies and specific opportunities that warrant further study.

This document does not intend to provide input to the potential Barriere biocoal plant, or the potential Simpcw First Nation wood pellet manufacturing plant. Both of those commercial facilities will be subject to substantially more rigorous analysis than can be provided by this study.

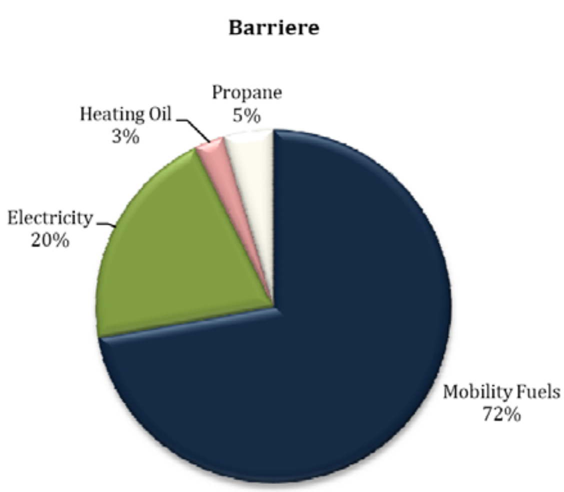
2. Background

2.1. *North Thompson Energy & Emissions Expenditures*

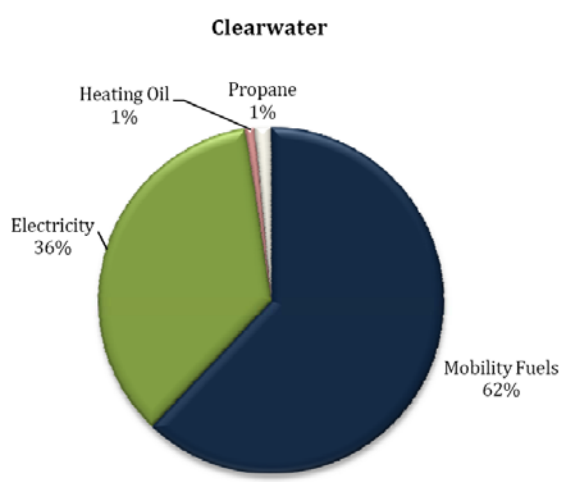
Data for the energy & emissions from communities in the North Thompson can be found in the Province's Community Energy & Emissions Inventories (CEEI). This data can be found for Barriere, Clearwater, and the TNRD Electoral Areas (all of them taken together). TNRD Electoral Areas A, B, and O are however different to some of the other TNRD Electoral Areas in that they do not have access to natural gas, which is less expensive than propane or heating oil. It is highly likely that the typical per capita energy consumption & emissions profile for Barriere and Clearwater is more similar to the typical per capita energy consumption & emissions profile for the other communities in the study than data from other sources.

Although this data can be represented in terms of energy consumption and emissions, most communities, interested in local jobs and economic development, are more interested in dollars.

Estimated per capita energy expenditure for Barriere & Clearwater (source: CEEI for 2007 energy data, & research for 2012 local energy costing information)



Total: $4,682 per person



Total: $3,768 per person

Estimated per capita & community energy expenditure for all of the communities in the study (source: CEEI for 2007 energy & population data, & research for 2012 local energy costing information)

		Barriere	Clearwater	Electoral Area A *	Electoral Area B *	Electoral Area O *	Simpcw First Nation, Chu Chua *	Total
	Population, est.	1,723	2,383	1,514	269	1,514	229	7,632
Per capita energy expenditure	Mobility fuels	$ 3,400	$ 2,300	$ 2,900	$ 2,900	$ 2,900	$ 2,900	$ 17,000
	Electricity	$ 960	$ 1,300	$ 1,100	$ 1,100	$ 1,100	$ 1,100	$ 6,700
	Heating oil	$ 130	$ 30	$ 80	$ 80	$ 80	$ 80	$ 480
	Propane	$ 210	$ 60	$ 140	$ 140	$ 140	$ 140	$ 830
	Total	$ 4,700	$ 3,700	$ 4,200	$ 4,200	$ 4,200	$ 4,200	$ 25,000
Community energy expenditure	Mobility fuels	$ 5,900,000	$ 5,500,000	$ 4,400,000	$ 780,000	$ 4,400,000	$ 660,000	$ 22,000,000
	Electricity	$ 1,700,000	$ 3,100,000	$ 1,700,000	$ 300,000	$ 1,700,000	$ 250,000	$ 8,600,000
	Heating oil	$ 220,000	$ 70,000	$ 120,000	$ 22,000	$ 120,000	$ 18,000	$ 580,000
	Propane	$ 360,000	$ 140,000	$ 210,000	$ 38,000	$ 210,000	$ 32,000	$ 1,000,000
	Total	$ 8,100,000	$ 8,800,000	$ 6,400,000	$ 1,100,000	$ 6,400,000	$ 970,000	$ 32,000,000

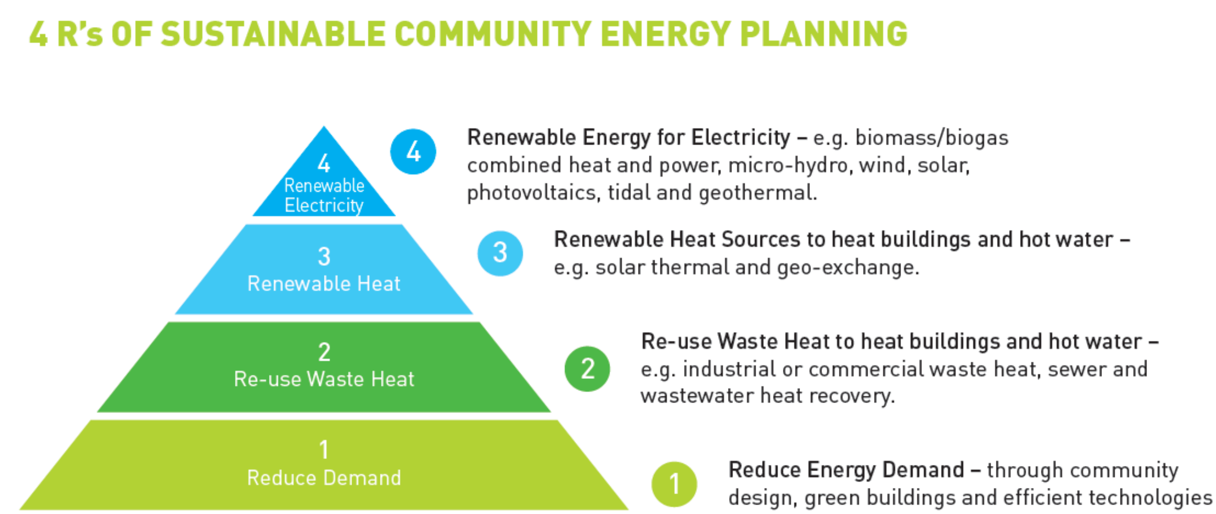
* Because CEEI data is not available for Simpcw First Nation (Chu Chua) or for Electoral Areas A, B, and O (separated out from the other unincorporated areas), it has been assumed that their per capita energy costs are approximately the average of the per capita energy costs for Barriere and Clearwater.

Figures in the previous table are rounded to two significant figures. There may be rounding errors.

Sources of inaccuracy in the CEEI data are described in Appendix 1. One of the most significant sources of error is propane consumption, where for example it is known that the actual propane consumption for Helmcken Hospital exceeds the consumption that the 2007 CEEI data estimates for the entire community of Clearwater. The CEEI data should be taken as a useful guide, but should not be assumed to be 100% accurate. It shows approximately how much money both per capita and for each community that is being exported each year, and approximately how much of that money can be attributed to each form of energy. This money leaves the communities. Reducing the outflows of money, and generating more energy within the communities, may therefore be of significant economic benefit.

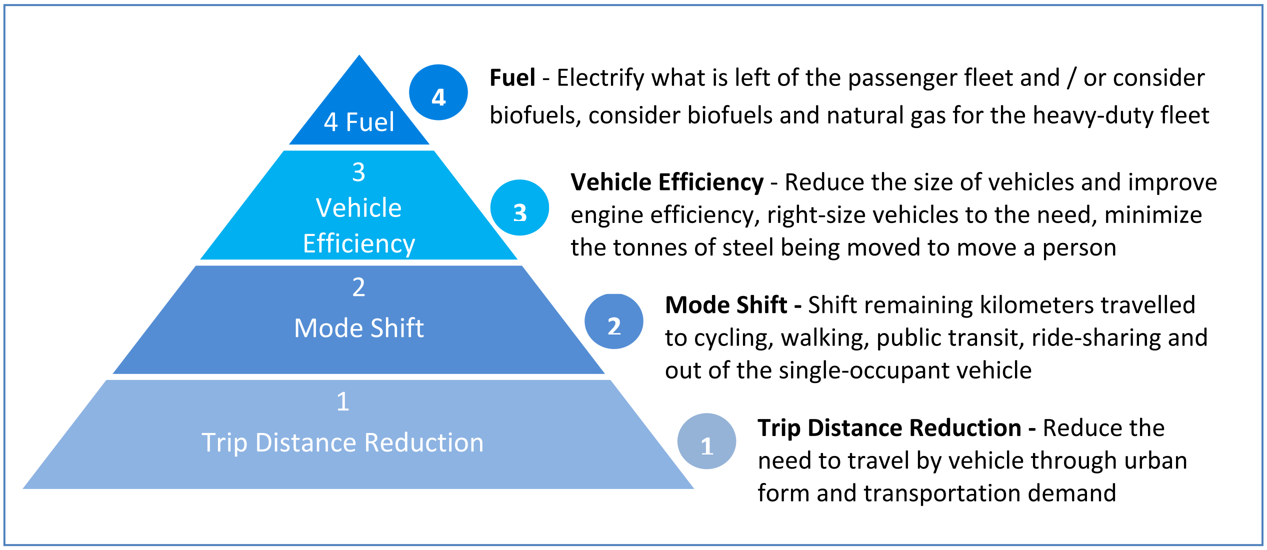
2.2. *Energy efficiency*

This study is focussed on renewable energy opportunities and how they relate to economic development, but the data above also makes the case for energy efficiency. Energy efficiency tends to have a quicker payback, and usually energy efficiency opportunities should be pursued prior to renewable energy opportunities.



Suggested steps in energy planning.
Concept source: Robyn Wark and Jorge Marques, BC Hydro

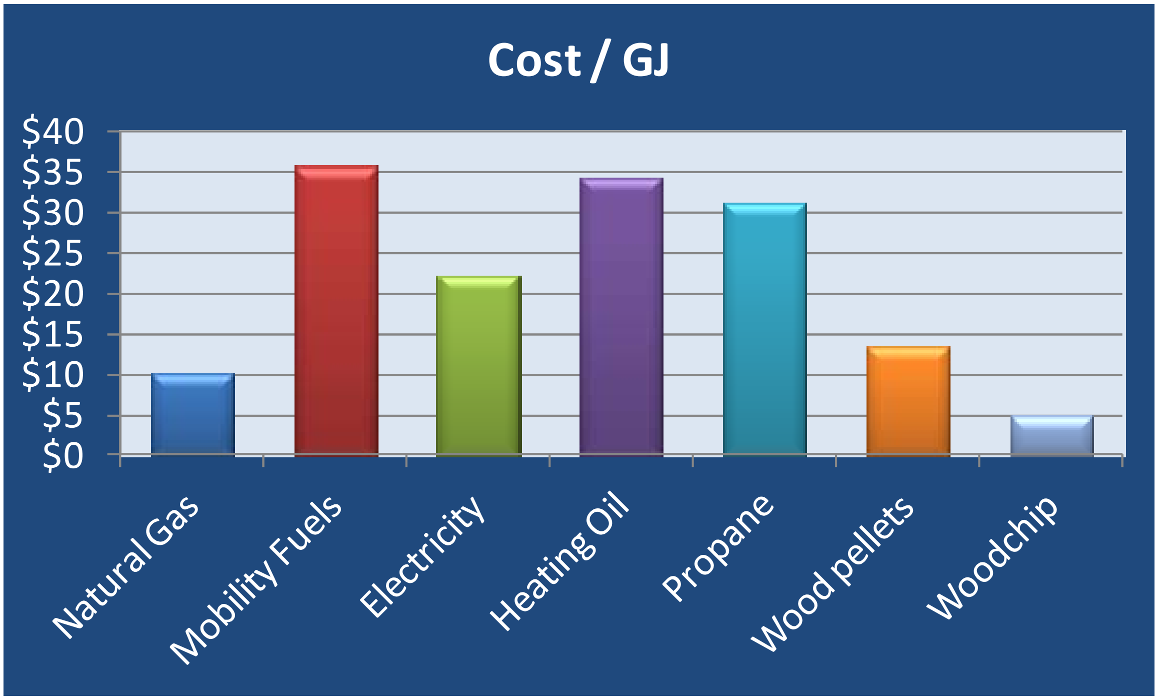
A similar hierarchy can be applied to the transportation sector. In the transportation sector, the easiest step to take is to reduce vehicular trip distances through appropriate urban form (planning) and transportation demand management.



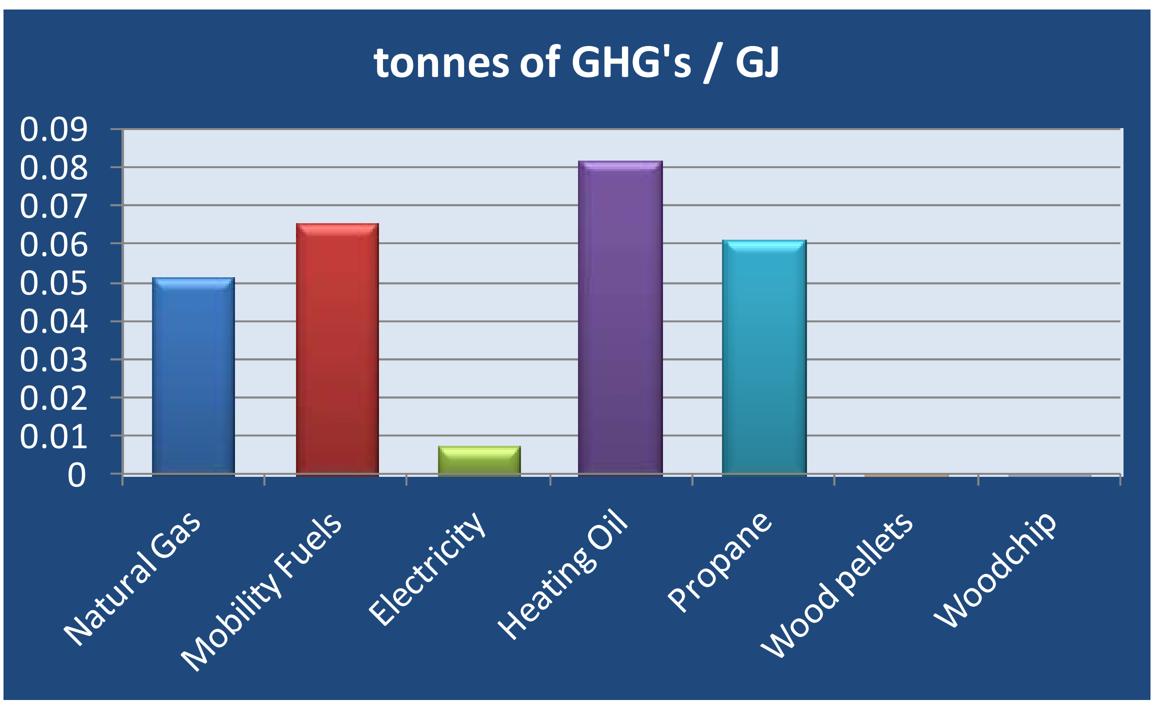
2.3. *Comparison of different fuel types*

Different forms of energy are purchased in different units. Electricity is sold by kWh, mobility fuels, heating oil, and propane are sold by litres. Wood pellets are sold by 40lb bags, or one ton (short ton, not metric tonne) pallets. These forms of energy can be converted to units of energy, such as Gigajoules (GJ), in order to be able to compare them like for like at a cost per unit of energy basis. This method can also be used in order to compare their carbon intensity per unit of energy.

Comparison of costs of different forms of energy, on a dollar per GJ basis (source: research conducted to gather 2012 local energy costing information)



Comparison of carbon intensity of different forms of energy, on a tonnes of CO_2 per GJ basis (source: Smart Tool for Carbon Neutral Government, FortisBC Gas, Environment Canada – Canada's GHG Emissions Inventory)



From the cost / GJ chart, it should also be noted that energy prices vary according to application. The energy prices shown are typical for residential or small commercial. In many cases a large commercial, institutional, or industrial purchaser would be able to obtain lower prices than those shown.

Natural gas is not available in the study area, but is shown in the charts for comparison. From a renewable energy perspective, several important opportunities can be derived from the charts above:

1. Buildings heated by propane or heating oil may provide particularly attractive opportunities for energy efficiency and renewable energy because of the relatively high costs of these fuels.
2. Wood pellets can be a significant renewable energy opportunity because they are a less costly form of energy, as well as having a low carbon intensity according to the Province of BC.
3. Although electricity is as expensive as many of the other forms of energy, a heat pump (either an air source heat pump or a ground source heat pump – also sometimes called a geoexchange or a geothermal system) typically uses 1/2 to 1/3 the energy of a baseboard heater to provide the same amount of heat. This reduces the cost of heat from a heat pump to approximately $7-11 per GJ.

Shifting buildings away from using heating oil, propane, and electric resistance heat (e.g. baseboards) towards using woodchip, wood pellets, air source heat pumps, and geoexchange systems can result in significant GHG reductions community wide, local economic development and significant energy cost savings across the community.

3. Renewable Energy Screening

An overview of the applicability of green energy technologies for the study area is shown in the table below and on following pages. The rankings of technology potential are determined as follows:

- **'High'** is given to technologies that are technically suitable for the study area, commercially proven in BC, and in many situations in the study area are expected to have a good business case.
- **'Medium'** technologies are technically suitable for the study area, commercially proven in BC, but in the study area are less likely to have a good business case.
- The **'speculative'** technology refers to an instance where the situation is at too early a stage to be adequately evaluated.
- **'Low'** technologies may be technically suitable, may be commercially proven in BC, but in the study area are unlikely to have a good business case.

Technology	Description & Examples	Local Conditions	Potential
Biomass – Woodchip	The convention in the bioenergy sector of referring to chipped waste wood as "woodchip" is followed here. Note that this differs from terminology used in the forestry industry. Clean wood waste from forestry operations, or diverted from landfill, can be used to produce heat. Given its substantial forest resource, BC has been slow in its adoption of bioenergy boilers compared to European countries. In rural BC the wood can be obtained at a low cost – see the charts in section 2.3. If stability of supply is of prime importance for some building types (e.g. healthcare), systems can be installed that can utilize woodchip or wood pellet, and they could also retain their conventional energy systems as backup. **Examples:** • In 2011-2012 a woodchip fuelled district energy system was installed in the Village of Enderby to heat 11 buildings including: an Inn, Interior Health building, open air municipal swimming pool, some industrial	• There is great opportunity in the study area for individual systems for buildings with high heating bills, especially those with hydronic heating systems and/or high hot water demands or pools. Good potential building types are: - schools, - health buildings, - municipal buildings, - hotels, - industrial / commercial buildings, - frequently used community halls / churches. • Preliminary research indicates there is more than enough biomass in the area to supply local bioenergy boilers. For further detail, see Appendix 2. • It is recommended to start with one local biomass boiler project to establish local biomass supply chains. Helmcken Hospital is the largest single demand, may be able to include nearby buildings e.g. ambulance building with a district energy loop.	High

Technology	Description & Examples	Local Conditions	Potential
	buildings. It consumes approx 800 tonnes/yr, from clean construction & demolition waste wood, sawmills, and from businesses that manufacture wood products. Capital cost of the entire system was $550k, with an estimated return on investment in 10+ years, and it provides heat for slightly less than the price of natural gas. • In 2005 the City of Revelstoke launched its woodchip fuelled district energy system that heats several buildings in the downtown including a school, community centre, aquatic centre, hotels, offices, and a church. • Westbank First Nation has a small system that can run on woodchips or pellets and heats two buildings totaling 21,000 square feet.	• There are other potential projects in the study area. Motels / hotels in Clearwater, some of which have pools – there may be potential for district energy here as some of them are close to each other. The arena in Clearwater has a high heating demand, but the conversion to a hydronic system would be capital intensive. Barriere Health Centre has a hydronic heating system, and is adjacent to an ambulance building. Some of the motels / hotels in Barriere may have potential. Schools: Barriere Secondary and Raft River Elementary have hydronic systems; unfortunately the other schools have rooftop units / PTACs so they may be better suited for ASHPs (see below) than bioenergy conversion. • Concerns over the impact to air quality are covered in Appendix 3 below.	
Biomass – Wood Pellet	BC is a major global manufacturer and exporter of wood pellets. Use of wood pellets is distributed throughout the Province, but the continued use of more expensive heating options (such as heating oil, propane, and electric resistance heat such as baseboards) is evidence of the large number of opportunities still available. Wood pellets are usually more expensive than woodchips, however wood pellets do have some other advantages: 1. Pellets are better suited for smaller bioenergy installations (e.g. domestic, or other small buildings). 2. They have a greater energy density by volume. The storage of wood pellets is less bulky than the storage of woodchips – useful where space may be limited. 3. Pellets can be transported greater distances, so are less vulnerable to fluctuations in local fibre availability. **Examples:** • Domestic wood pellet stoves are common in rural BC due to the low cost of heating, ease of use, and relatively low capital cost. • Examples of non-domestic propane to wood pellet conversions in BC, that see considerable cost savings: - Baldy Hughes Addiction Treatment Centre and Therapeutic Community district heating system (a community of approximately 80 people near Prince George) - Lillooet Recreation Centre - Nazko Elementary School (Quesnel) - Alexis Creek & Tatla Elementary Schools (west of Williams Lake)	• As demonstrated by the charts in section 2.3, wood pellets are a significant opportunity in the study area. • If the Simpcw First Nation wood pellet plant (or any other potential plant) becomes operational, the local price for wood pellets may be able to further maintain its competitiveness compared to other forms of energy. • There is an economic argument for encouraging domestic wood pellet stoves over heating by propane, heating oil, and electric resistance heat (e.g. baseboards). • Larger wood pellet installations can also be encouraged, although in the right circumstances larger installations would see greater economic benefit by using woodchip. All of the potential opportunities in the woodchip section could also utilize wood pellets. Systems could be installed that can utilize both woodfuels, although these may carry an additional cost. • Local businesses could provide a fully automated service, and refill pellet bins/silos for a fee. • Concerns over the impact to air quality are covered in Appendix 3 below.	High

Technology	Description & Examples	Local Conditions	Potential
	- Bob's Glass (Barriere) • Burns Lake Arena is another example but the conversion of the building to a hydronic heating system was capital intensive given the shift from natural gas.		
Geoexchange Heating and Cooling	Geoexchange (GHX) systems use heat pumps (refrigeration cycle) to move heat from one location to another. The earth or water bodies can act as either the source (heating mode) or sink (cooling mode) for these systems. In many cases, the ground can also be used to store waste heat energy between the season it is produced and the season it is needed. Heat exchange with the ground can occur with a closed loop of piping installed horizontally or vertically in the ground, or if there is adequate ground water available an open-loop system may be used. In rare settings, high production water wells can be a cost effective way to develop large-scale open-loop GHX systems. Due to the well completion costs and flow testing required for open-loop systems, they are usually not cost competitive for residential scale applications unless a relatively shallow, good producing well already exists at the site. Groundwater used for an open-loop system is returned to the same aquifer to avoid any long-term drawdown effects on the local ground water supply. **Examples:** • There are numerous domestic, commercial, and institutional installations in BC due to the low cost of heating / cooling, high comfort, and ease of use. Some examples include the Best Western Inn in Kelowna, Township of Langley City Hall, and Kaslo City Hall. • Tk'emlúps Indian Band in Kamloops is responsible for a large GHX community at Sun Rivers Golf Resort. Each building has a GHX system paid for by a utility, which recovers its costs through monthly ground loop access fees.	Ground heat exchanger (GHX) construction may be relatively expensive in many areas of the region due to challenging drilling and excavating conditions. Although the ease of construction and resulting costs of a GHX system in the region is ranked as medium potential, an overall ranking of high was selected because GHX systems are more cost competitive in areas that are not serviced by natural gas. • **Clearwater –** Much of Clearwater is over low productivity bedrock or moderate productivity sand and gravel aquifers that are not likely to support large-scale open-loop systems. Water well reports indicate estimated flow rates ranging from 0 to 25 gpm with higher flow rates occurring west of the Clearwater River. Individual residences with existing wells that produce more than 15 gpm may be suitable candidates for open-loop systems. Water well logs also indicate drilling in the area is challenging and vertically-bored closed-loop GHXs are expected to be costly to install. Horizontal GHXs are the most promising option for facilities that have sufficient land area such as schools. • **Barriere –** Much of Barriere is over a moderate productivity sand and gravel aquifer. Water well reports indicate estimated flow rates ranging from 0 to 50 gpm with higher flow rates occurring north of the Barriere River. One high productivity well adjacent to the river has an estimated flow rate of 600 gpm – a suitable flow for a district-scale geoexchange system if sufficient heating / cooling demand can be situated near to it. Water well logs also indicate ground conditions in the area are likely to be suitable for both vertically-bored and horizontal closed-loop GHXs. • **Simpcw First Nation, and Electoral Areas A, B, and O –** Mapped aquifers in the region are predominantly low to	**Clearwater –** Medium to High **Barriere –** High **Simpcw First Nation, and Electoral Areas A, B, and O –** High (overall)

Technology	Description & Examples	Local Conditions	Potential
		moderate productivity and drilling conditions are highly variable across the region. In general, drilling conditions are considered to be moderate, however certain sites may possess good to excellent drilling conditions. Site specific evaluations for potential projects are recommended.	
Air Source Heat Pumps Heating and Cooling	Air Source Heat Pumps (ASHPs) operate in a similar manner to geoexchange (GHX) systems but use the outdoor air as the source and sink for heat in either the heating or cooling mode. ASHPs are able to provide efficiency improvements over electric resistance heating down to temperatures of minus 15 °C or lower, however their output capacity becomes lower at colder temperatures and therefore they are normally installed with another heat source such as an electric or fossil fuel furnace that takes over heating at lower temperatures. ASHPs can be versatile – they can be retrofitted to most furnaces with suitable duct work sizes, ASHP Rooftop Units can replace other types of Rooftop Units, and ductless split ASHPs can be installed in buildings without duct work such as those heated by electric baseboards. ASHP's that heat water are also available for both domestic hot water systems and hydronic radiant floor heating. **Examples:** • ASHPs are relatively common in residential and small commercial applications throughout the Lower Mainland and Southern Interior. • The Village of Cache Creek has installed an ASHP in conjunction with an unglazed solar hot water system to heat its outdoor pool.	• Based on climate data from the Blue River weather station, ASHPs are expected to perform well in the lower elevations of the region. Heating is the dominant load in the region and approximately 85% of annual heating requirements in Blue River occur at temperatures above -10 °C. • It may be economical to operate ASHPs at lower than normal temperatures in areas where the alternative is electric resistance heat or high cost propane. • ASHPs for seasonal swimming pools are a particularly good opportunity. Larger seasonal swimming pools may see benefit to linking this with an unglazed solar hot water system.	High
Run-of-river hydro	For this scan CEA has not been able to conduct a map based study of potential hydro sites, and so has relied on existing studies and other research. The potential energy of water flowing from high to low elevation drives a turbine to generate electrical energy. Projects may or may not require a dam or weir to create sufficient head. Medium and high head hydro developments are a mature technology. Low head hydro is an area of significant technical potential for BC and Canada, however usually the business case is not as strong as with medium or high head hydro, partly because the lower head means that more water needs to flow through the turbine to generate the same power. Some of the best business cases should be where some infrastructure is already in place, e.g. drinking and wastewater systems, and existing dams across rivers. Natural Resources Canada has	• BC Hydro RE Mapping shows the region as having low to medium potential for small hydro with the potential increasing in the northern and eastern portions of the area. Many individual opportunities are however known to exist. • There are small residential systems throughout the area, and further potential undoubtedly exists. • For grid connected run-of-river hydro projects, as with other IPP projects, the potential depends not just on the resource, but other factors including access to low cost capital and the price BC Hydro is willing to pay for electricity. • **Clearwater –** A SIBAC funded study has investigated the incorporation of a turbine in Clearwater's drinking water supply system, although this does not appear to be	High (excluding Clearwater drinking water project)

Technology	Description & Examples	Local Conditions	Potential
	identified low and very low head hydro as an area where they are working to improve the economics. In addition, in BC Hydro's 2010 Final Resource Options Report, in the "Run-of-River Hydroelectric Resource Assessment for British Columbia 2010 Update", the boundary conditions set on identifying undeveloped run-of-river hydro opportunities include a minimum static head of 30 metres, and the report states that in general this represents a practical limit to grid connected small hydro from an economic perspective. No head hydro, or kinetic hydro, are hydro turbines that can be placed in rivers and turn the kinetic energy of the flowing water into electricity. The technology is still at an early stage of development and so is not considered. **Examples:** • Numerous examples in BC. E.g. the 19MW Bone Creek project near Blue River developed with the assistance of Simpcw First Nation (owned by TransAlta) • Some municipalities have incorporated turbines in their drinking water supply systems. • Numerous First Nations in BC are involved in run-of-river projects through ownership, revenue sharing, jobs, or contracting. Examples include: - Kokish River and Clint Creek (Namgis First Nation & Brookfield Renewable Power), - Canoe Creek (Tla-o-qui-aht First Nation and Swift Water Power Corporation), - China Creek (Hupacasath First Nation, Ucluelet First Nation, City of Port Alberni, Synex Energy).	economically feasible. • **Simpcw First Nation –** There are sources of financing / funding that Simpcw First Nation can access in order to participate more fully in or lead future run-of-river projects in their traditional territory – see Appendix 6. • **Simpcw First Nation (outside of North Thompson area) –** There are numerous project opportunities in Simpcw First Nation traditional territory, but outside of the North Thompson. The development of some of these is being pursued by IPPs. See Appendix 4. • **Simpcw First Nation, Electoral Area A** – There are some potential opportunities identified in this area. See Appendix 4. • **Simpcw First Nation, Electoral Area B** – There is some IPP activity in this area, with an Electricity Purchase Agreement (EPA) application on a creek with a waterpower licence, some existing waterpower licences, three new waterpower licence applications, and many old waterpower licence applications. There are many other potential opportunities identified in this area. See Appendix 4. • **Simpcw First Nation, Electoral Area O** – There are some potential opportunities identified in this area. See Appendix 4.	
Solar Thermal	With today's technology, solar energy is most efficiently captured as heat. Solar heating can be used for generating hot water and heating buildings through solar hot water collectors, solar air heating building siding systems, and simple passive solar design and orientation of buildings. Solar water heating systems are typically characterized by longer paybacks, due to the high capital cost and the relatively low cost of energy in BC. Unglazed solar hot water systems for open air swimming pools tend to have the best business cases of any kind of solar water heating system. Applications of solar air heating can be cost effective, but are best in parts of BC that receive a significant amount of sunlight in winter (e.g. Peace River region).	• BC Hydro RE Mapping shows the solar potential ranging from high – (> 4 kWh/m^2/day) in the southern part of the region to low (< 3 kWh/m^2/day) in northern and eastern areas. • RETScreen/NASA regional solar radiation estimate for Kamloops is 3.65 kWh/m^2/day. • Depending on the energy source currently being used, open air swimming pools will likely have a good business case for unglazed solar hot water systems and solar blankets. An unglazed solar / air source heat pump system for the municipal outdoor pool at Cache Creek displaces natural gas, and without grants / rebates would have a simple payback of	Medium

Technology	Description & Examples	Local Conditions	Potential
	Solar thermal panels should be situated where they are unshaded for as much of the day as possible. Solar blankets are also a good low cost option for pools, and are particularly well suited for the residential market. Depending on the desired water temperature additional means of heat may be required.	8.6 years. Displacing fuels available in the North Thompson, the same system would have a payback of 3-5 years. • Domestic solar hot water installations will have the following simple paybacks (ranges due to estimates of installation and annual maintenance costs): - Electricity, 20-45 years - Propane, 15-30 years - Heating oil, 14-25 years • Other applications with high hot water demands (e.g. hotels) could have better business cases than homes. CEA's case study data on 14 local government solar hot water installations across BC shows a surprisingly high range of installed costs. This variation is likely due to the differences between the prices installation firms charge, and because the business case is highly case specific to each building. • In anticipation of a future convergence of the price of energy supplied by solar thermal panels with conventional energy, buildings can be made to be 'solar ready' when under construction or being renovated. The Province of BC has guidance for single family homes, and communities can also choose to sign on through the BC Building Code to ensure that all new homes will be solar ready. For other building types, it is recommended to consult with experienced solar hot water installers. The additional capital cost is low, and yet it saves a significant amount on the solar installation cost.	
Waste Heat Recovery	Many industrial and commercial processes generate heat as a by-product that can be recovered and used for building space and water heating, or heating greenhouses. Potential waste heat sources include arena ice plants, grocery store refrigeration, sewage treatment, and many industrial processes. **Examples:** • Many communities in BC already recover some heat from arenas to heat nearby pools, and in McBride the Regional District of Fraser Fort-George is considering recovering heat from an arena to heat a nearby community building. Many arenas also already recover heat for internal use. • Some communities have also experimented with heat recovery from sewage lift stations or wastewater treatment plants.	• **Clearwater** – Best potential opportunity is that the arena could use waste heat internally, for domestic hot water, and potentially for space heating. Cold winters and operating season mean that the ice plant will not operate as efficiently as it would by dissipating heat into the outside air in the cold winter months, but given high conventional energy costs the overall business case may be adequate to proceed. The arena is also adjacent to Clearwater Secondary School, and near to other buildings including motels / hotels, and restaurants, so there is potential for heat recovered from the arena to be used in these buildings. This opportunity is unlikely to be as good because the hotels / motels likely use electric baseboards or PTACs in individual rooms for space heating, which are challenging to retrofit to a district energy system – although domestic hot water in these buildings may be centralised and	Medium

Technology	Description & Examples	Local Conditions	Potential
	• Industrial waste heat recovery is also being practiced in some communities in BC, e.g. Roxul in Grand Forks, and a district energy project is being studied in Kelowna to recover heat from the Tolko mill for downtown buildings.	so could be retrofitted to a district energy system. The Secondary School has Rooftop Units which can also be challenging to connect to district energy. Future development, if it will have a high heating / hot water demand (e.g. swimming pool), is likely to have a good business case by utilizing waste heat from the arena, but due to the arena's operating season it will need supplemental sources of heat. • **Barriere –** if the proposed biocoal facility is successful, waste heat may be available from it.	
Wind	Wind turbines that generate electricity come in a variety of sizes. Commercial scale machines have hub heights and rotor diameters that can be dozens of metres. Economics are highly dependent on wind speed with an annual mean of 5 m/s considered a bare minimum for a successful commercial project. The likely best wind resource in BC, and the majority of the Electricity Purchase Agreements to date, is in the Peace region. A substantial number of Investigative Use Permits (IUP's) have been obtained for wind in BC in the last few years, in all parts of the Province. Small-scale machines for home or farm use are also available, particularly useful for off-grid applications, and can have rotor diameters as small as 0.5 metres. The business case is highly dependent on whether the cost of grid connection can be avoided or diesel generator use can be reduced. **Examples:** • Some local governments in BC have installed small scale wind turbines, including the Village of McBride, and the Town of Port McNeill. • In Nova Scotia, Millbrook First Nation has made a successful application to the Province's community feed-in-tariff program for a 6 MW wind farm. • The first large-scale wind farms built in BC have been in the Peace: Bear Mountain Wind Park near Dawson Creek (34 turbines, 102 MW); and Dokie Wind Project near Chetwynd (43 turbines, 144 MW). • As of October 1, 2011, six more wind farms in BC (five in the Peace, one in northern Vancouver Island) with a total capacity of 542 MW have Electricity Purchase Agreements with BC Hydro.	• BC Hydro RE Mapping shows the region as having low wind resource quality. • RETScreen/NASA regional wind speed estimate for Kamloops is 3.1 m/s. • For grid connected wind projects, as with other IPP projects, the potential depends not just on the resource, but other factors including access to low cost capital and the price BC Hydro is willing to pay for electricity. • **Simpcw First Nation / Electoral Area O** – In December 2010, Invenergy was investigating some locations in Electoral Area O, to the west of Barriere. The Investigative Areas are shown in a map in Appendix 5. The areas were: to the east of Bonaparte Lake and north of Allan Lake (Metoots Hill); south of Allan Lake and north of Skull Creek; and on Gizzard Flats / Poison Hill, east of Shelley Lake (crossing into Area P). Other nearby Invenergy IUPs were in Electoral Areas P & J. The windpower licences and permits for these are inactive. Although the wind resource is unlikely to be as good as some other parts of BC, if funding or low cost financing could be obtained then projects may be competitive – opportunities for Simpcw are highlighted in Appendix 6 below. • Isolated opportunities for small scale off-grid wind turbines may exist in places.	Medium
Syngas from biocoal production	A 'syngas' (a mixture of hydrogen, carbon monoxide, and methane, as well as other gases) may be produced by the biocoal facility, and could potentially be cleaned, piped, and used to heat buildings.	• **Barriere –** if the proposed biocoal facility is successful, this might be an opportunity.	Speculative

Technology	Description & Examples	Local Conditions	Potential
	BC Bioenergy Network is helping to pioneer the development of biocoal plants in BC. They have stated that biocoal production plants generally do produce syngas, however many technologies use this gas in their own production process to reduce their energy inputs. Some technologies however may produce an excess of syngas, which could then be used for district energy. Note that syngas has a different composition and properties to propane or natural gas. Equipment and infrastructure modifications may be necessary. **Examples:** • The basic concept has been substantially proven. From the early decades of the 19th century, until widespread adoption of natural gas in the 20th century, syngas produced by turning coal into coke was distributed through underground pipes to heat buildings & homes in British towns. • Syngas produced from wood has also been used to substitute natural gas. In BC Nexterra have used their gasification technology to do this for large scale applications, e.g. Kruger Products Mill in New Westminster.		
Municipal Solid Waste (MSW)	Municipal solid waste (MSW) is a potential source of recoverable energy, although it is frequently controversial due to pollution concerns.	• A contact at the Regional District stated that this would be a private sector initiative, but does not see the volumes of material generated in the sub-region to make such a project viable. • The Regional District does plan on diverting waste from demolition, land clearing, and construction (i.e. DLC waste). Clean wood waste from this diversion could be chipped, and provided to woodchip biomass systems, or any biocoal or wood pellet facilities that are set up. This opportunity is considered in the biomass woodchip section.	Low
Landfill gas (LFG) / wastewater treatment plant gas	Methane produced at landfills and sewage treatment plants are also potential sources of recoverable energy. The methane is produced by anaerobic bacteria. **Examples:** • The Kelowna landfill has microturbines that generate electricity from landfill gas (LFG) and sell it to the grid, approximately breaking even on costs.	• Both the Barriere & Clearwater landfills will be closed in 2012/2013. It is intended for the LFG to be converted to carbon dioxide on site through biogenic processes and oxidation. Given small volumes, it is unlikely that there will be a good business case in energy recovery unless there is a substantial rise in energy prices. • Given their sizes, it is unlikely that the volumes at the	Low

Technology	Description & Examples	Local Conditions	Potential
	• Salmon Arm landfill, serving a population of about 35,000, sells methane derived from LFG to FortisBC. • Several waste water treatment plants in BC utilize their biogas for electricity and/or heat, including Prince George's and the Regional District of Nanaimo's.	Barriere or Clearwater wastewater treatment plants will be sufficient to provide a good business case for utilization of biogas, unless there is a substantial rise in energy prices. In addition, the design of the planned Ecotek wastewater treatment plant for Barriere means it may not be able to produce biogas as a product.	
Solar Photovoltaic	Solar photovoltaic (PV) cells convert sunlight into electricity. Solar PV is a relatively expensive form of renewable energy, although prices have fallen substantially over the last few years. Building integrated solar panels can add to the architectural, aesthetic and educational value of a building. However, it is unlikely that a grid-connected PV project would be attractive on economic grounds alone. Off-grid projects that can utilize PV to either eliminate the cost for an expensive electrical connection, or reduce generator use, can be cost effective. SolarBC has recently funded installations of PV systems on schools around BC. The range of installed prices are \$5,000-13,000/kW (following recent panel price decreases, the lower end of the range should be more applicable now), applicable for 2.4-5kW systems. About 7-11m^2 of PV panels are needed for each kW of output (more for certain types of panels). PV panels should be situated where they are unshaded for as much of the day as possible.	• BC Hydro RE Mapping shows the solar potential ranging from high – (> 4 kWh/m^2/day) in the southern part of the region to low (< 3 kWh/m^2/day) in northern and eastern areas. • RETScreen/NASA regional solar radiation estimate for Kamloops is 3.65 kWh/m^2/day. Using RETScreen, a PV system in Kamloops could generate approximately 1,500kWh/kW, giving a simple payback of 40-110 years based on the cost range to the left. • PV may be effective for off-grid facilities or dispersed infrastructure like remote cabins, public lighting, pedestrian signals, and parking meters due to eliminating the costs for electrical connection or reducing diesel generator use. • In anticipation of a future convergence of the price of electricity supplied by PV panels with grid electricity, buildings can be made to be 'solar PV ready' when under construction or being renovated. Natural Resources Canada has guidance for homes. For other building types, it is recommended to consult with experienced solar PV installers. The additional capital cost is low, and yet it saves a significant amount on the solar installation cost.	Low
Geothermal Power Generation	High temperature deep ground heat is used to create hot water or steam that powers a binary heat engine or turbine to generate electricity. Geothermal power can be very cost competitive, but requires significant expenditures on exploration and testing to determine project viability. The highest potential site in BC has been under investigation since the early 1970's and commercial power production has yet to come online. **Examples:** • Simpcw First Nation is currently pursuing a potential geothermal power project (which may also have a direct heat component) with Borealis GeoPower at Canoe Reach near Valemount.	• BC Hydro RE Mapping shows low to medium geothermal power potential in the area. Medium potential occurs predominantly west of HWY 5 in the south and west of Murtle Lake in the north. • Geological Survey of Canada mapping identifies test boreholes in the Clearwater-Stillwater area with heat flux of 80-110 mW/m^2. Heat source is radioactive decay. This is a moderate amount of heat. The closest test borehole is approximately 10km from the Clearwater municipal boundary. • Investor interest in further exploration is unlikely until commercial viability is demonstrated at higher potential sites,	Low

Technology	Description & Examples	Local Conditions	Potential
		e.g. Canoe Reach near Valemount, or Meager Creek near Pemberton.	
Geothermal Direct Heating	High temperature deep ground heat can often be used economically as a direct heating source for buildings or greenhouses. Temperatures above 40°C are often sufficient for direct heating applications.	• The low to medium geothermal power potential described above is unlikely to provide suitable conditions for economically viable direct heating opportunities in the region.	Low

4. Recommendations

In the recommendations below, "encourage" implies making community members aware of the economic benefits through the provision of information. For local governments, it additionally means using the measures outlined in the CEEPs, and making use of the tools in CEA's 'Policy and Governance Tools' Guide, which can be downloaded for free from the CEA website.

4.1. *Simpcw First Nation*

1. Investigate funding / financing opportunities in Appendix 6 specific to Simpcw, for establishing equity positions in private IPP projects, and developing opportunities for the Band
2. Private IPP projects – try to ensure Simpcw First Nation equity positions in projects being developed privately within the traditional territory, if necessary using outside funding / financing sources. Also try to maximise jobs & skills development potential
3. Run-of-river hydro – pursue opportunities developed and owned by Simpcw First Nation, e.g. Chu Chua Creek
4. Main Band building propane/electric Rooftop Units (RTUs) – investigate replacing these with air source heat pump RTUs, particularly when they are due for replacement
5. Biomass, domestic wood pellet – encourage domestic wood pellet appliances
6. Air source heat pumps / geoexchange – encourage installation of these on existing buildings in the community. Establish policy that encourages or mandates the installation of these systems in new buildings in the community.
7. Wind – pursue opportunities developed and owned by Simpcw First Nation, e.g. near Barriere (recommended to prioritise hydro over wind)

4.2. *District of Clearwater / Barriere*

1. (Clearwater only) Biomass woodchip – contact Interior Health to initiate conversion of Helmcken Hospital to a woodchip energy system, and facilitate connection of buildings off Interior Health owned property (e.g. by allowing use of rights of way) if required
2. Biomass woodchip / wood pellet – following expected successful conversion of Helmcken Hospital, try to initiate development of other potential woodchip / wood pellet opportunities. Good potential opportunities are:
    a. (Clearwater) Raft River Elementary

b. Hotels / motels, esp. those with pools
c. Barriere Health Centre
d. Barriere Secondary
e. Local industrial buildings

3. Biomass air quality – consider passing a bylaw or making a request to installers of large bioenergy systems to make a contribution to a local air quality fund, that would cancel out the impact on the airshed by assisting replacement of old woodstoves in the community to new cleaner burning woodstoves. This could be conducted in conjunction with the Provincial Wood Stove Exchange Program.
4. Biomass, domestic wood pellet – encourage domestic wood pellet appliances for automated heat, unless there are significant winter air quality concerns.
5. Air source heat pumps / geoexchange – encourage these systems for existing buildings. Establish policy that encourages or mandates the installation of these systems in new buildings in the community. Encourage air source heat pumps for seasonal pools.
6. (Clearwater only) Waste heat recovery – investigate the business case of utilising waste heat within the arena, e.g. for domestic hot water, and/or space heating. Depending on further availability of waste heat, investigate potential for encouraging future high heating / hot water demands (e.g. swimming pool) near to the arena to take advantage of this potential opportunity.
7. Solar thermal – for swimming pools or buildings with high hot water demands, encourage installation of solar hot water systems, or encourage them to become solar ready when being built or undergoing major renovation. Solar blankets can also be encouraged for seasonal outdoor pools.
8. (Barriere only) Biocoal waste heat / syngas – as biocoal project evolves, continue conversations with the project proponent on the nature of any waste heat or syngas opportunity, and indicate the District's willingness to work together to realise it.

APPENDICES

1. Sources of inaccuracy in CEEI data

The following are some of the potential sources of inaccuracy in the CEEI data:

- Due to privacy issues, the electricity consumption from two connections associated with large industry in Clearwater has been withheld.
- Estimated energy consumption from heating oil and propane suffers from inaccuracies as it is difficult to track. The Province has contacted heating oil & propane suppliers from across BC, and tried to estimate consumption in communities. E.g. the estimated propane consumption for Helmcken Hospital alone exceeds the consumption listed in CEEI for the entire community of the District of Clearwater.
- Estimated consumption of mobility fuels in communities is difficult to track. The Province has estimated mobility fuel consumption for communities by taking the number of vehicles that are registered for that community, and taking estimates for the Vehicle Kilometres Travelled (VKT) for the local area. There can be inaccuracies in both of these figures.

2. Supply & demand of biomass for woodchip systems

Several local biomass boilers would consume at most a few percent of the equivalent amount of biomass of the proposed biocoal / wood pellet facilities, and they should also be able to pay more for the biomass than those facilities. The proposed biocoal plant for Barriere may consume tens of thousands of tonnes of biomass each year.

The current estimated minimum long-term Annual Allowable Cut (AAC) for the Kamloops Timber Supply Area (TSA) is 1,820,000 m^3, and 10% of this can be assumed to be left as waste by the roadside, which equates to approximately 60,000 oven dry tonnes (odt's) per year. This does not include other sources, such as hog fuel produced by sawmills.

Research for the more local area indicates there is more than enough biomass locally to supply bioenergy boilers. This table includes roadside waste that would be included in the figure above, but also includes waste available from sawmills.

Potential sources	Oven dry tonnes (odt's) per year, estimated
Wells Gray Community Forest slash	1,100
Lower North Thompson Community Forest slash	700
Silverdew Hardwoods waste wood	600
Wadleggers Sawmill waste wood	1,100
Gilbert Smith Sawmill waste wood	14,000
Canfor waste wood (after they install their own bioenergy system for drying)	16,500
Simpcw First Nation forestry activities, long-term minimum	3,300
Local woodlots	Unknown
Colborne Logging	Unknown
Clean construction & demolition waste – TNRD diversion when eco-depots are built	Unknown
Woodco / Timberco (Barriere)	Unknown
Other sources	Unknown
Minimum estimated total	**37,000**

None of the sources expressed any reservations about supplying a smaller bioenergy facility, except for Wells Gray Community Forest and Simpcw First Nation with respect to chipping slash because of the standard of some of the roads.

Additional sources of biomass can also be available through wildfire mitigation. The District of Clearwater indicated interest in this activity. To give an indication of what may be available, through a project funded by the Pacific Institute of Climate Solutions, UBC, the Green Heat Initiative, and CEA have conducted estimates for some BC communities, and of these the closest in terms of climatic zone is likely to be Sicamous. The project conservatively estimates that 11,000 to 13,000 odt's per year could be available for bioenergy projects from wildfire mitigation around Sicamous. It is likely that a substantial proportion of this biomass could be better used for other purposes (e.g. provided to sawmills, or for pulp), but a substantial proportion could also be used for bioenergy. It could therefore be assumed that if Clearwater engages in community wildfire mitigation work an additional substantial amount of biomass would become available for energy purposes. CEA's work in this field is ongoing, and further details may be provided upon request.

Note that with the development of a biomass project these sources would need to be investigated in more detail. Specifics including cost, moisture content, chip size, species, and likelihood of foreign objects, will vary according to the source.

This is a substantial potential supply for local bioenergy systems. To give an indication, demands for three large local buildings have been calculated in the table below. These have been selected because they have hydronic heating systems for simple bioenergy conversion, and large heating demands.

Potential demands	Oven dry tonnes (odt's) per year, estimated
Helmcken Hospital	260-410
Raft River Elementary	130
Barriere Secondary	80
Estimated demand	**470-620**

Interior Health and the School District both indicated openness to bioenergy conversion, provided there is a suitable business case. From a discussion with a bioenergy installer, Helmcken Hospital is likely enough of an opportunity on its own to justify a system big enough to accept a wide variation in woodchip quality. This is a significant advantage because of the wide variety of sources of biomass available, and local unfamiliarity with supplying fuel to biomass boilers of this scale.

3. Bioenergy – air quality

Emissions	Domestic pellet stove	Domestic oil furnace
NOx	410 g/GJ	1,000 g/GJ
SO_2	11 g/GJ	28 g/GJ
Dust (PM_{10})	130 g/GJ	25 g/GJ

Source: derived from *An Information Guide on Pursuing Biomass Energy Opportunities and Technologies in British Columbia*, BC Bioenergy Network and Province of BC, by Envint Consulting, June 2010 (updated May 2011)

Emissions	Residential – advanced wood combustion techniques, <1MW pellet stoves	Residential – advanced wood combustion techniques, <1MW advanced wood stoves	Residential – non-advanced wood stoves	Residential – small household <$50kW_{th}$ boilers, liquid fuel (includes propane)
NOx	90 g/GJ	90 g/GJ	50 g/GJ	70 g/GJ
SOx	20 g/GJ	20 g/GJ	10 g/GJ	140 g/GJ
Dust (PM_{10})	76 g/GJ	240 g/GJ	810 g/GJ	3 g/GJ
Fine dust ($PM_{2.5}$)	76 g/GJ	240 g/GJ	810 g/GJ	3 g/GJ

Emissions	Commercial / institutional – advanced wood combustion techniques, <1MW automatic boilers	Commercial / institutional liquid fuels, inc. propane (Tier 1 data)
NOx	150 g/GJ	100 g/GJ
SOx	20 g/GJ	140 g/GJ
Dust (PM_{10})	66 g/GJ	21.5 g/GJ
Fine dust ($PM_{2.5}$)	66 g/GJ	16.5 g/GJ

Source: *EMEP/EEA air pollutant emission inventory guidebook 2009 / Technical guidance to prepare national emission inventories*, European Environment Agency, 2009

Emissions	Domestic wood pellet stove	Domestic woodstove, advanced technology / catalytic	Domestic woodstove, conventional
NOx	110 g/GJ	110 g/GJ	110 g/GJ
SOx	16 g/GJ	16 g/GJ	16 g/GJ
Particulates	100 g/GJ	420 g/GJ	2,000 g/GJ

Source: derived from *Residential Wood-Burning Emissions in British Columbia*, by British Columbia Ministry of Water, Land and Air Protection, April 1 2004 (revised May 17 2005)

A variety of data sources are provided above, and where direct comparisons can be made between technologies there are some significant differences between the data sources, and there may be a variety of reasons to explain this (e.g. technology changes in time and by location, and difference in measurement or calculation methodology).

Some of the waste wood that could be used is currently being burnt in the open air, so combustion of this biomass in bioenergy boilers will improve air quality if it is being burnt in the same airshed. However in the case of diverting waste wood that would be used for another purpose (e.g. being sent to Domtar in Kamloops), then combustion of this biomass in local bioenergy boilers would have a slight negative effect on local air quality. Concerns are mainly limited to the impact of particulates (dust), and this can be mitigated by simultaneously encouraging the upgrade of older residential wood stoves to newer clean burning ones. Older residential wood stoves produce much larger volumes of particulate emissions per unit of energy consumed than new residential wood stoves, and much more than new commercial bioenergy boilers. E.g. to mitigate the additional particulate emissions from Helmcken Hospital's conversion to biomass only an estimated 3-11 homes burning 3 cords a year would need to have new stoves installed (the range is due to the different estimates for woodstove emissions, and different estimates for hospital energy consumption).

4. Run-of-river hydro opportunities

4.1. *Projects under construction, and existing EPA agreements*

Simpcw First Nation, outside Thompson Nicola Regional District

Projects currently under development include the 6 MW Castle Creek (aka Benjamin Creek) project near McBride.

As of October 2011, BC Hydro has received ten Electricity Purchase Agreement (EPA) applications from Holmes Hydro for projects near McBride (total capacity – 75 MW).

Simpcw First Nation, Electoral Area B

As of October 2011, BC Hydro has received an Electricity Purchase Agreement (EPA) application for a 2.5 MW run-of-river project on Whitewater Creek (near Blue River).

Electoral Areas A & O

No known projects under construction or existing EPA agreements.

4.2. *Existing water licences, and water licence applications*

Simpcw First Nation, outside Thompson Nicola Regional District

Research on water licences has not been conducted for outside of the study area.

Simpcw First Nation, Electoral Area B

Current waterpower licences exist for Serpentine Creek (obtained in 2010), and Clemina Creek (obtained in 2006), and held by Valisa Energy of Calgary (Valisa is part of TransAlta).

Recently, licences have been requested for Shannon Creek, Carole Creek, and an unnamed lake, by Soler Logging of Clearwater.

Applications submitted in 2009 exist for Pyramid Creek, “ZZ Creek”, and Dora Creek, by North Fork Resources of Chetwynd.

Applications submitted in 2002 exist for Adolph Creek and Allan Creek, by Hydromax Energy of Calgary.

Applications submitted from 2003-2005 exist for Finn Creek, Gum Creek, Hellroar Creek, Whiteriver, Miledge Creek, and Dominion Creek, by Canadian Hydro Developers (taken over by TransAlta).
Moonbeam Creek has an inactive waterpower licence.
The BC Hydro inventory of undeveloped micro hydro opportunities (see below) lists some of the above creeks as potential opportunities

A map showing the locations of existing waterpower licences and applications in Electoral Area B is shown below.

Source: BC Energy Map, RuralBC

Electoral Areas A & O

No known existing water licences or water licence applications.

4.3. *BC Hydro Run-of-River Hydroelectric Resource Assessment for British Columbia 2010 Update*

As part of BC Hydro's 2010 Final Resource Options Report, it commissioned a study of the BC run-of-river hydroelectric resource, published in March 2011, called the "Run-of-River Hydroelectric Resource Assessment for British Columbia 2010 Update".

The study identified a large number of opportunities throughout the study area, and particularly in Electoral Area B. These opportunities can be seen in the BC Energy Map. Due to the number of opportunities in the study area, only opportunities within approximately 10 miles of the highway corridor are listed in the table below. Projects closest to the corridor would save on transmission costs. Despite the number of opportunities identified, the study only identified 6 in the entire Kelly Nicola transmission region that it estimates would produce electricity for $100/MWh ($0.10/kWh) or less (the study only identified 31 such opportunities in all of BC), none of which are in the table below.

Opportunity	Latitude / Longitude of opportunity	Power, MW	Average annual energy output (GWh)	Cost of energy ($/MWh)
Electoral Area A				
ROR 4710 – Moillet Creek	51.70999/-119.76044	0.796	3.118	476.45
ROR 4714 – Brookfield Creek	51.65516/-120.11278	5.184	18.672	142.29
ROR 4717 – Mann Creek	51.57522/-120.15255	13.109	47.217	146.45
Electoral Area B				
ROR 4552 – Allan Creek	52.57659/-119.27106	0.308	0.988	1232.57
ROR 4554 – Allan Creek	52.53805/-119.11913	11.361	45.365	137.81
ROR 4568 – Dominion Creek	52.49485/-119.11199	6.932	27.679	119.9
ROR 4583 – Canvas Creek	52.47709/-119.28472	6.849	27.349	164.85
ROR 4584 – Lempriere Creek	52.46564/-119.20871	14.092	56.272	129.22
ROR 4598 – Miledge Creek	52.28657/-119.18893	4.914	19.623	227.01
ROR 4610 – Bone Creek (upstream from existing)	52.25454/-119.03272	1.661	6.523	346.37
ROR 4617 – Thunder River	52.25133/-119.29211	2.972	11.672	203.54
ROR 4625 – Blue River	52.18498/-119.42503	0.542	2.031	702.03
ROR 4628 – Blue River	52.17267/-119.42622	1.909	7.497	242.37
ROR 4637 – Blue River	52.09042/-119.40356	2.499	9.814	231.14
ROR 4638 – Blue River	52.09037/-119.40275	8.168	27.431	202.59
ROR 4649 – Blue River	52.08315/-119.41939	3.741	12.024	242.72
ROR 4645 – Smoke Creek	52.08606/-119.27428	2.728	10.713	277.78
ROR 4669 – Finn Creek	51.9187/-119.27714	1.61	5.176	562.98

Opportunity	Latitude / Longitude of opportunity	Power, MW	Average annual energy output (GWh)	Cost of energy ($/MWh)
ROR 4677 – Lyon Creek	51.88976/-119.35315	6.671	26.638	115.81
ROR 4695 – Mad River	51.79287/-119.4737	0.889	3.493	437.07
ROR 4699 – Mad River	51.74442/-119.53674	1.374	5.396	387.36
ROR 4706 – Mad River	51.73027/-119.54602	1.149	3.695	429.28
Electoral Area O				
ROR 4735 – Nehalliston Creek	51.47145/-120.23579	3.946	13.944	218.39
ROR 4755 – Chu Chua Creek	51.36125/-120.10496	1.817	5.974	338.67
ROR 4768 – Lindquist Creek	51.31192/-120.20012	0.82	2.339	387.47
ROR 4771 – Lindquist Creek	51.31293/-120.19066	1.642	5.39	351.25
ROR 4811 - Fishtrap Creek	51.09305/-120.21194	2.092	7.549	370.29
ROR 4812 - Fishtrap Creek	51.09584/-120.21303	1.828	5.593	449.56

In addition there are numerous additional opportunities in the Simpcw First Nation traditional territory, but outside the North Thompson.

The study is a map-based study and so carries limitations. The study does not explore all of the options that could be available to project developers at each site, so there may be opportunities to reduce costs. It is known that the table above does not cover all of the potential small hydro opportunities in the study area (for example, the study never listed the opportunity at Whitewater Creek near Blue River, although as of October 2011 an Electricity Purchase Agreement application has been submitted to BC Hydro for a 2,500kW project on the creek; and the study has not listed Shannon Creek and Carole Creek which are currently being pursued by Soler Logging near Avola). Another limitation is that potential project opportunities are assumed not to share infrastructure with other projects that may be developed concurrently.

All costs are represented in 2011 Canadian dollars. The cost estimates include a 30% contingency on civil items, and a 10% contingency on generation equipment and electronic balance of plant. A large number of other assumptions are used to develop costing data. Taxes (except for property tax) are not included. Water rental is included. Unit energy costs are calculated using a 6% real discount rate over 40 years. Operations & maintenance costs are included at 2% of total capital costs, except for power lines which are estimated at 1.1%.

Based on the study, the top <$150/MWh opportunities close to the highway in the study area are:

1. ROR 4677 – Lyon Creek
2. ROR 4568 – Dominion Creek
3. ROR 4584 – Lempriere Creek
4. ROR 4554 – Allan Creek
5. ROR 4714 – Brookfield Creek
6. ROR 4717 – Mann Creek

4.4. *Inventory of undeveloped opportunities at potential micro hydro sites in British Columbia – 2000 BC Hydro report*

BC Hydro conducted an earlier study in March 2000, an "Inventory of undeveloped opportunities at potential micro hydro sites in British Columbia", focussed on projects with a <5MW capacity. The table below shows the opportunities in the study area identified in the report. In addition to those above, these are included because some of them are not previously highlighted, and also because it may provide a different perspective. Significantly fewer opportunities are identified in this study compared to the March 2011 study.

Opportunity	Latitude / Longitude of opportunity	Power, MW	Capital cost ($1,000)	Annual energy output (GWh)	Cost of energy ($/MWh)
Electoral Area A (opportunities near Albreda, in Wells Gray Provincial Park)					
Azure River #1	5235/11948	1.6	12,326	6.3	183
Azure River #2	5235/11947	1.9	14,497	7.5	182
Electoral Area B (opportunities near Albreda)					
Adolph Creek #1	5231/11923	4.7	15,390	18.5	78
Adolph Creek #2	5231/11924	1.3	5,588	5.7	102
Allan Creek	5232/11907	3.1	7,643	12.2	59
Clemina Creek	5234/11905	3.0	5,458	11.8	43
Electoral Area O (opportunity near Chu Chua)					
Chu Chua Creek	5121/12007	1.8	3,246	6.1	50
Electoral Area O (opportunities near Barriere)					
Peterson Creek	5112/12010	0.2	1,118	0.7	155
Skull Creek	5109/12013	0.1	1,260	0.3	349

In addition there are numerous additional opportunities in the Simpcw First Nation traditional territory, but outside the North Thompson.

As with the March 2011 study, it is a map-based study and so carries limitations. It misses many opportunities, including Whitewater Creek, Shannon Creek, and Carole Creek.

In addition, project developers may find ways to improve the $/MWh figure.

It should be noted that BC Hydro defines micro hydro as being less than 2 MW, but because of the degree of imprecision the database was expanded to include project opportunities of up to 5 MW.

The $/MWh figure is estimated in the report by dividing the annual cost of the project by the energy generated, with a real discount rate of 8%, assuming a 40 year project life, and adding 1% of the original capital cost for annual operating & maintenance costs. Certain items are not included, such as taxes and water rents. A range of other assumptions are also used to generate costing data. All of the costing information is set for the year 2000.

The top opportunities on a $/MWh basis in the study area are:

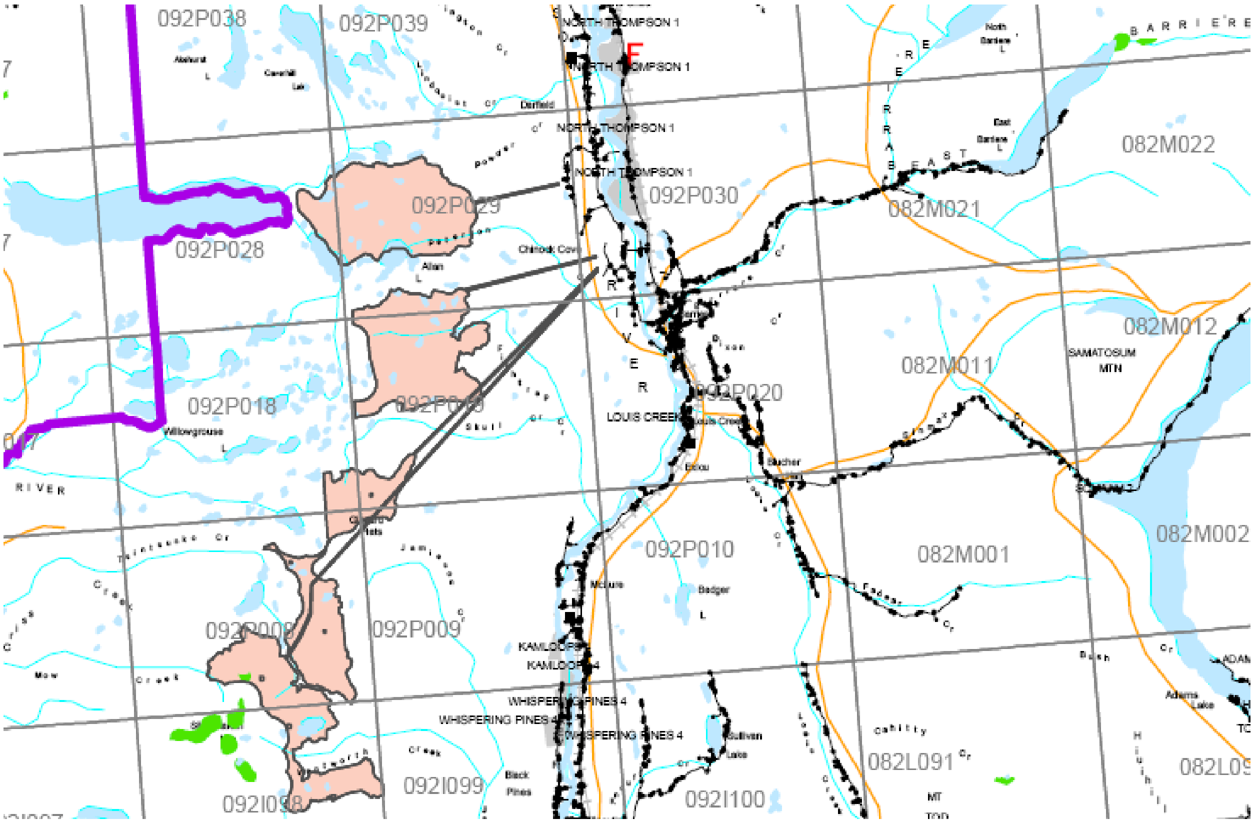
1. Clemina Creek
2. Chu Chua Creek
3. Allan Creek

4.5. *District of Clearwater 'Small Hydro Preliminary Feasibility Study'*

In June 2012 Urban Systems completed a draft of a SIBAC funded report, 'Small Hydro Preliminary Feasibility Study', that assessed the opportunity of generating electricity from watersheds that provide Clearwater with a portion of its drinking water: Russell, Hascheak, and McDougall Creeks. Five options were examined, with a range of capacities from 110 kW to 1,416 kW. The report states that the financial viability for each option is weak, but they could be pursued if sufficient funding could be obtained.

5. Wind – map of inactive windpower licences

A map showing the inactive windpower licences in the study area, and to the south of the study area, is shown below.



Source: Windpower Investigative Areas Map, December 2010, BC Integrated Land Management Bureau

6. Simpcw First Nation – additional funding & financing opportunities

Some additional funding & financing opportunities for Simpcw First Nation, particularly those most relevant to green energy projects, are outlined below.

6.1. *First Nations Clean Energy Business Fund*

The First Nations Clean Energy Business Fund is administered by the Province of BC, through the BC Ministry of Aboriginal Relations and Reconciliation. It provides:

- capacity development funding for feasibility studies or engagement of clean energy project proponents;
- grants to acquire equity positions in projects or assist in the development of community energy projects;
- and revenue sharing based on new, net, incremental revenues to government from clean energy projects.

Capacity funding is limited to $50,000 per applicant; Equity grant is limited to $500,000 per applicant; Revenue sharing is based on provincial resource rents.

The Fund has stated that there are no issues from their perspective in Simpcw applying to this Fund and the First Nations Regeneration Fund.

For further information, contact:
BC Ministry of Aboriginal Relations and Reconciliation
Lindsay Wood, Climate Change Project Advisor
250-356-8759
lindsay.wood@gov.bc.ca
http://www.gov.bc.ca/arr/economic/fncebf.html

6.2. *ecoENERGY for Aboriginal and Northern Communities Program 2011-2016 (EANCP)*

The ecoENERGY for Aboriginal and Northern Communities Program 2011-2016 (EANCP) is focused on providing funding support to Aboriginal and northern communities for clean energy projects. It is delivered by Aboriginal Affairs and Northern Development Canada (AANDC).

The main objective of EANCP is to reduce greenhouse gas emissions from the generation of electricity and heat by supporting the development and implementation of renewable energy projects. EANCP provides funding support for the planning stages of renewable energy projects (up to $250,000 – provided the project will save at least 4,000 tonnes of GHGs over project lifecycle) and for the design and implementation of renewable energy projects integrated with community buildings (up to $100,000).
Applications for funding for fiscal year 2012-2013 opened on May 1st, and will close on July 6th.

For further information see: http://www.aadnc-aandc.gc.ca/eng/1100100034258

6.3. *First Nations Finance Authority (FNFA)*

The First Nations Finance Authority (FNFA) is a voluntary not-for-profit organization whose purposes are to provide low-rate loans, investment options, and capital planning advice to First Nation governments. The FNFA is governed by the First Nation communities that join as Borrowing Members. Eligible capital projects FNFA can finance include independent power projects.

Borrowing Members are able to access loans that:

- have repayment terms up to 30 years;
- do not require collateral;
- can be used to refinance existing debt;
- have interest rates parallel to those available to provincial and local governments;
- have flexible repayment terms;

FNFA is a stand-alone organization separate from the Government of Canada, and its operating policies are set by its Borrowing Members.

For further information contact:
First Nations Finance Authority
250-768-5253
info@fnfa.ca

6.4. *First Nations Regeneration Fund*

First Nations Regeneration Fund is a partnership between Tale'awtxw Aboriginal Capital Corporation (TACC), Tribal Resources Investment Corporation (Tricorp), and Ecotrust Canada. It seeks to assist BC First Nations with acquiring equity positions in renewable energy projects by providing them with access to capital. It has been confirmed that First Nations throughout BC are eligible, regardless of location.

The Fund can help BC First Nations acquire equity positions in renewable energy projects being developed by private organisations in their traditional territory, and can also help First Nations with accessing capital to develop their own renewable energy projects. The Fund lends based on a project, and does not require security against assets. In some circumstances the Fund can also help broker other sources of capital.

For additional information, contact:
Pieter van Gils
604-566-3202
pieter@headwatercapital.ca

7. Contacts

People & organisation that have been contacted during this project are shown below.

Organisation	Contact
Barriere, District of	Colleen Hannigan, CAO
Barriere, District of	Andrew Hayward, Economic Development Officer
BC Bioenergy Network	Michael Weedon, Executive Director
BC Bioenergy Network	Scott Stanners, Director of Research
BC Lodging and Campground Association (BCLCA)	Mary Zuccaro, Energy Advisor
Bob's Glass (Barriere)	
Burns Lake, Village of	Jeff Ragsdale, Development Services Coordinator
Canfor Vavenby	Dwayne Thiessen, Plant Manager
Clearwater Woodlot Association	Warren MacLennan
Clearwater, District of	Leslie Groulx, CAO / Economic Development Officer
Clearwater, District of	Roger Mayer, Sportsplex Supervisor
Fink Machine	Stephen Bearss, Renewable Energy Representative
FrontCounterBC	Megan Williams
Gilbert Smith Sawmill	Carman Smith
Global Biocoal	Sonia Shoukry, President
Green Heat Initiative	David Dubois, Project Coordinator
Headwater Capital / First Nations Regeneration Fund	Pieter van Gils
Interior Health Authority	Ted Spearin, Energy Manager
Lower North Thompson Community Forest	Mike Francis
Ministry of Aboriginal Relations and Reconciliation	Lindsay Wood, Climate Change Project Advisor
Ministry of Forests, Lands and Natural Resource Operation	Rick Sommer, District Manager, Thompson Rivers
Ministry of Jobs, Tourism & Innovation	Marc Imus, Director, Community Economic Development
Morley Lyle (Barriere)	
School District #73 (Kamloops / Thompson)	Art McDonald, Director of Facilities and Transportation
Silverdew Hardwoods Sawmill	Peter Pelton, Owner
Simpcw First Nation	Douglas Brown, Administrator
Simpcw First Nation	Kerri Jo Fortier, Community Planner
Simpcw First Nation	Sam Phillips, Manager, Sustainable Resource Dept
Soler Logging / Longfellows	Wes Beaver
Thompson-Nicola Regional District	Regina Sadilkova, Director of Development Services
Thompson-Nicola Regional District	Peter Hughes, Director of Environmental Services
Urban Systems	John Kenney
Wadlegger's Sawmill	Sepp Wadlegger
Wells Gray Community Forest	George Brcko, General Manager