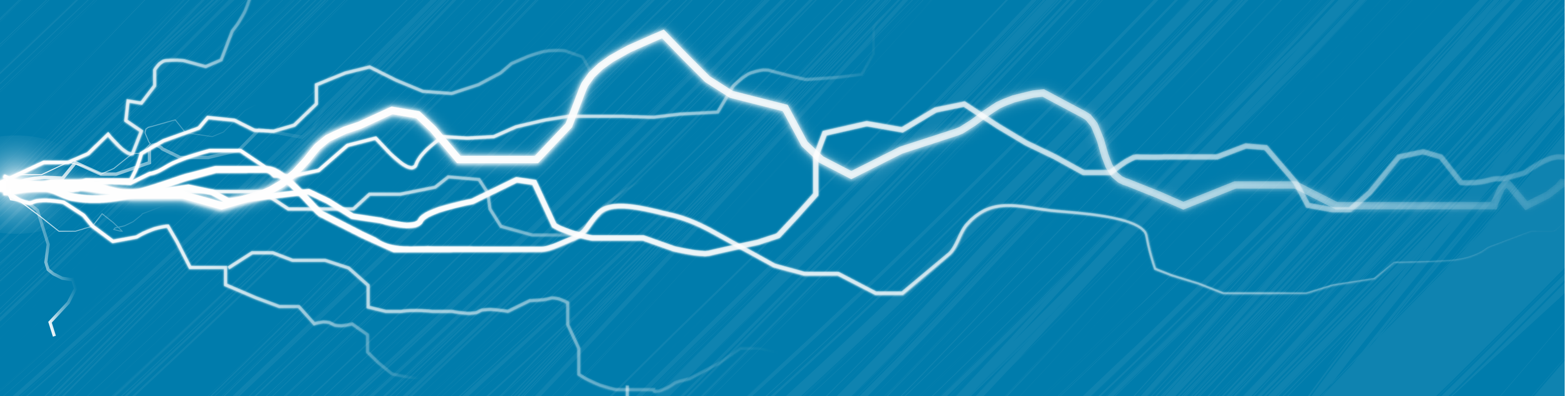
SWCC

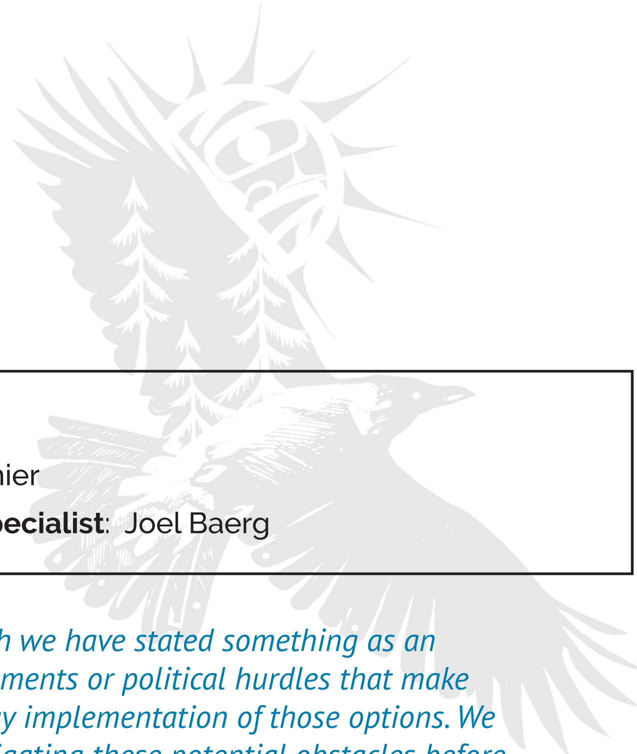
Skeena Watershed Conservation Coalition

UPPER SKEENA RENEWABLE ENERGY

A Practical Decision-Making Guide

August 2025





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It is important to note that even though we have stated something as an option, there may be regulatory requirements or political hurdles that make it difficult and/or costly, which can delay implementation of those options. We strongly recommend thoroughly investigating these potential obstacles before proceeding with any option.

EMPOWERED ENERGY SOLUTIONS TEAM

Skeena Watershed Conservation Coalition's (SWCC) work focuses on the conditions for change at a community level in our watershed. Each year, SWCC delivers an ongoing schedule of activities that support the development of future leaders, collaborates with elected leaders, creates sustainable employment opportunities and collaborates with community economic development practitioners. Renewable Energy and energy use are very important topics in the Upper Skeena as a key component to a healthy ecosystem and community in the future. This approach earned SWCC the recognition as one of the top ten most effective and innovative organizations in Canada – twice!

Raven design by Leah Pipe and Bo Smith

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PROJECT OBJECTIVE

In a time where there are more options for everything in the market, including such products as heating technologies, renewable energy infrastructure, and home retrofitting options, we (the Skeena Watershed Conservation Coalition) are trying to simplify decision-making for the community.

Our goal is to concentrate and distill up-to-date energy-related information to make informed decisions easier for the residents, businesses, and local governments of the Upper Skeena region. We've developed a Decision-Making Matrix to simplify the process of selecting home heating systems, exploring renewable energy alternatives, and starting your journey towards energy retrofiitting your home.

HOW DOES THE UPPER SKEENA *ENERGY* DECISION-MAKING MATRIX WORK?

For the purpose of our project and the decision-making matrix, we are evaluating the best option between alternatives based on various impactful factors and their relative importance, while employing the following steps:

STEP 1: Finding the alternatives

Decision matrices help pinpoint the best option amongst a set of existing choices that are regionally suitable. Therefore, identifying the options is the first step before building decision matrices.

STEP 2: Identifying crucial points

Next, you must identify the important considerations to factor into your decision. These considerations will help you find the optimal decision with limited subjectivity.

The criteria and definition for the renewable energy decision-making matrix is outlined on the following page.

For renewable energy decisions the following criteria is used:

CRITERIA	HOW THIS GUIDE APPLIES THE CRITERIA
Strength of Resource	How much of the resource (sunlight, wood, gas, wind, water) that feeds your renewable energy technology is available? For example, with solar you need sunlight. However, sunlight fluctuates with weather and season. Is there enough dependable sunlight to rationalize the purchase? Another example is wood biomass. How much fiber is available? What is the long-term outlook in terms of supply and sustainability?
Typical Cost of Development	The cost to develop renewable energy in Canada can vary depending on the project's size and scale, location, the infrastructure purchase, shipping costs and labor.
Typical Regulatory Considerations	These are the rules that businesses and developments must follow to both build and operate legally. Examples of regulatory requirements include environmental regulations, labor laws, consumer protection laws, and occupational safety and health regulations. It is important to know what you will need to do legally before thinking about developing.
Reliability of Technology	How reliable is the technology? Is the technology well advanced of the testing process? For funders it is often mandatory the technology has a minimum readiness level of six or better. Level Six Technology readiness level: Is when a technology (model or prototype) is near the desired configuration. The technology will have been tested in a simulated environment. https://www.canada.ca/
Physical Requirements	The physical requirements include the space that the renewable infrastructure requires (ie., ground mounted solar panels can take up acres of space) as well as the physical requirements of the building and shelter needed for the renewable energy infrastructure (i.e., combined heat and power systems need multiple buildings for things like chip or pellet storage/drying facility).
Environmental Impacts	Is there an impact to the environment in the manufacturing process of products, and are there GHG's emitted from the power and heat generation?

STEP 3: Creating a decision matrix

To prepare a matrix grid for comparing important factors requires you to list all your options as the row labels on the table. Include the list of factors as the column headings.

STEP 4: Filling out the decision matrix (scoring)

The next step in building a decision matrix is to rate every consideration on a predetermined scale.

Upper Skeena *Energy* Decision-Making Matrix Scoring

Scoring will be done though 1 to 5 for given criteria:

1 Point – Lowest Score. Does not meet any of your criteria.

2 Points – Low score. Does not meet most of your criteria.

3 Points – Moderate score. Does meet some of your criteria.

4 Points – High score for your selected criteria.

5 Points – Perfect score for your selected criteria.

USING THE *ENERGY* DECISION-MAKING MATRIX:

1. **Examine the matrix grid of viable options and their given criteria for renewable energy technology options for the Upper Skeena.**
2. **Choose the option you want to learn more about for each section/option. There is a summarized version of the decision options and supplemental information if you want to have a comprehensive look at the technologies.**

The higher the scoring, the more aligned the choice is based on the criteria.

UPPER SKEENA *ENERGY* DECISION-MAKING MATRIX

Renewable Energy Technology	Strength of Resource in Region	Typical Cost of Development	Typical Regulatory Considerations	Reliability	Physical Requirements	Environment Impacts	SCORE
SOLAR PV	4/5 Moderate The available solar power, or Global horizontal irradiation (GHI), is in 1000 +/- 60kWh/m2 for most viable spaces in the upper Skeena, making it a viable power solution. This is significantly better than further West and similar to much of Northern BC.	4/5 Low Low to moderate $1-2 per watt for utility-scale installations, to $2-4 per watt for smaller-scale projects. Without incentives, payback periods for non-battery backed installations typically range from 7 to 16 years, but with incentives can be virtually instantaneous. **For Upper Skeena residents looking for independent (off grid) power systems you need* *batteries which significantly increases system costs.*	5/5 Low Regulatory conditions are also favorable toward solar installations, and the process to install an approved on-grid or off-grid solar system is simple and well outlined.	4/5 Highly reliable source of energy. Solar panel production levels are warrantied for 25-30 years and have a lifespan of >40yrs. Batteries are commonly warrantied for 10 years and are expected to last 15-25 years depending on use. The reliability of solar production is also high. It varies day to day and with the seasons, but long-term yearly production levels are predictable.	4/5 Easily scalable to almost any size, making it suitable for both high and low power demand applications; residential, commercial, industrial and utility scale.	4.5/5 Lowest envivironmental impacts of all power generation technologies. Once installed, solar power is a noise pollution-free source of power that generates zero emissions	25.5 /30 High Potential opportunity for development in the Upper Skeena.
WIND POWER	1/5 Low Areas with an Annual Mean Wind Speed (AMWS) of around 15 metres per second are best Upper Skeena has an Average 3-3.5 m/s, no active wind tenures in region	1/5 High Very Capital Intensive	1/5 Significant, particularly if there are no active wind tenures	2/5 Low in the Upper Skeena Region Areas with an Annual Mean Wind Speed (AMWS) of around 15 metres per second are best	2/5 High Large amounts of space I.e., A 2 MW wind turbine may need between 40 and 70 acres of land to avoid interference from other turbines	3/5 High Potential Impacts: -Habitat damage and disturbance -Negative impacts to bird and bat species	10/30 Limited opportunity for larger-scale develop-ment in the Upper Skeena

Renewable Energy Tenchlogy	Strength of Resource in Region	Typical Cost of Development	Typical Regulatory Considerations	Reliability	Physical Requirements	Environment Impacts	Score
SMALL HYDRO POWER Run of River	2/5 Low because of no active water licenses for power generation in region	2/5 High Typical Costs of projects are divided between 35% to facility building and similar costs to hooking into power grid	2.5/5 High, particularly if there are no active water licenses for power generation in the region	3/5 High When there has been a good snowpack and precipitation Droughts and climate change impacts impact reliability	2/5 Easily scalable to almost any size, making it suitable for both high and low power demand applications; residential, commercial, industrial and utility scale.	3/5 Potential Impacts include: -aquatic ecosystems and fish -riparian communities and species -terrestrial ecosystems	13.5/30 Limited opportunity for larger-scale development in the Upper Skeena
BIOENERGY	4/5 High Significant fuel availability for low cost Potential politics around fiber supply	3/5 Moderate Too high depending on scale	3.5/5 Biomass facilities are heavily regulated by the BC Ministry of Environment and Climate Change Strategy	3/5 Simple Process High fuel flexibility Low operation and maintenance costs	2/5 High Industrial sized project site of approximately 2-40 acres Area needed for log storage and associated infrastructure.	3/5 Biomass results in the release of GHG emissions and pollutants into the air With proper planning and technology selection, it is possible that the biomass District Heating System will be carbon neutral	18.5/30 Potential opportunity for development in the Upper Skeena
GEOTHERMAL HEAT PUMPS **Heating and Cooling** **Renewable Energy/Hybrid**	4/5 High	1.5/5 High Often several times more expensive than air source heating and cooling systems that have the same capacity. Up-front costs are high but are offset by long term reliability and low maintenance costs	1.5/5 High for large projects Geothermal projects in BC are subject to the Geothermal Resources Act and a full range of provincial licencing and permitting covering land leases, drilling permits, wildlife protection, public health and safety, environmental monitoring and protection, road construction and water use. (http://cleanenergybc.org)	5/5 High System life is estimated at up to 24 years for the inside components and 50+ years for the ground loop.	2.5/5 Large amount of space for Horizontal closed loop systems A minimum 70ft x 70ft - 5000sq ft. of space needed. 6ft to 10ft in depth Vertical Closed loops systems take less space. This system has pipes drilled 300ft into the earth.	2.5/5 There is high potential for negative environmental impacts especially for commercial size installations. Environmental impacts include: Land disturbance, Water usage, Air emissions, Induced seismicity, Groundwater contamination Habitat disruption, Low greenhouse emissions	17/30 High System life is estimated at up to 24 years for the inside components and 50+ years for the ground loop.

Upper Skeena Renewable Energy Decision-Making Matrix

SCORING SUMMARY

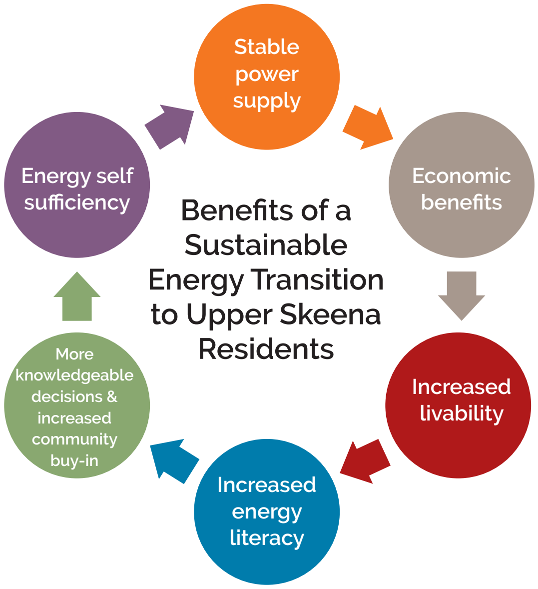
Renewable Energy	Strength of Resource in Region	Typical Cost of Development	Typical Regulatory Cosiderations	Reliability	Physical Requirements	Environmental Impacts	Total /30
SOLAR PV	4	4	5	4	4	4.5	25.5/30
WIND POWER	1	1	1	2	2	3	10/30
SMALL HYDRO (ROR)	2	2	2.5	3	2	2	13.5/30
BIOENERGY	4	3	3.5	3	2	3	18.5/30
GROUND SOURCE HP	4	1.5	1	4.5	4	2.5	17/30

Note: *So far our research in wind power, bioenergy, and small hydro has been focused on large scale. Our future work will dive into looking at smaller scale residential versions of each of the above.*

WHY IS RENEWABLE ENERGY IMPORTANT IN THE UPPER SKEENA REGION?

RENEWABLE ENERGY:

- Reduces greenhouse gas emissions: Renewable energy sources like wind and solar emit little to no greenhouse gases, which are the primary cause of climate change.
- Improves public health: Burning fossil fuels releases carbon dioxide into the air, which contributes to respiratory diseases and other health issues.
- Creates jobs: Renewable energy creates jobs in manufacturing, installation, and other sectors.
- Improves energy security: Renewable energy can reduce dependence on imported fuels.
- Provides affordable energy: Renewable energy can be cheaper than fossil fuel.
- Promotes economic growth: Renewable energy can create economic development in rural areas.



HOW CAN THE UPPER SKEENA REGION TRANSITION TO RENEWABLE ENERGY?

Governments, businesses, and individuals can work together to invest in renewable energy.

The goal is to treat both this project website and decision-making matrix as a living document to keep the tools and findings relevant and useful.

OUR RESEARCH APPROACH

RENEWABLE ENERGY

For the renewable energy decision making matrix, we worked with a renewable energy specialist who gave us current information of the renewable energy generation technologies available today and what the homeowner and business owner needs to know and consider before purchasing.

We developed the following criteria to get a full understanding of the renewable energy options:

- *Strength of Resource in the Region*
- *Typical Cost of Development*
- *Typical Regulatory Considerations*
- *Reliability*
- *Physical Requirements and*
- *Environmental Impacts*

RENEWABLE ENERGY PRODUCT DECISION-MAKING

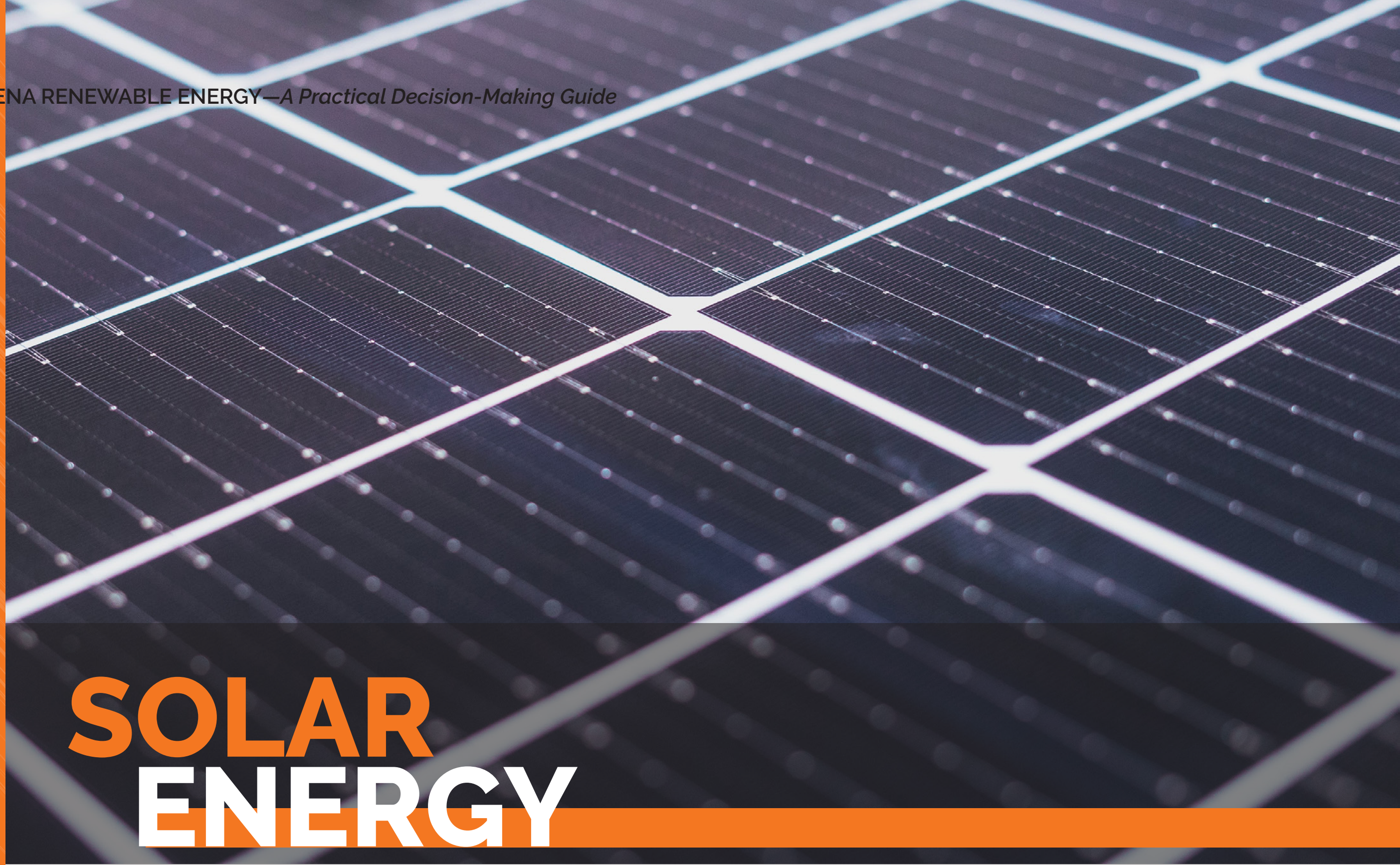
For the renewable energy decision-making we were able to examine our findings within the Upper Skeena Regional Energy Plan (REP) framework. From here, we were able to get a baseline for where to start amassing which renewable-clean energy opportunities we could use.

Our earlier work in the REP led us to the renewable energy options with the components that supported the viability for examination in the Upper Skeena Region. These included:

- *Solar*
- *Small hydropower (run of river)*
- *Wind power*
- *Bioenergy*

IMPLEMENTATION CONSIDERATIONS

It is important to note that even though we have stated something as an option, there may be regulatory requirements or political hurdles that make it difficult and/or costly, which can delay implementation of those options. We strongly recommend thoroughly investigating these potential obstacles before proceeding with any option.



SOLAR ENERGY

OVERVIEW

Solar PV systems capture energy from the sun and convert it into electricity for use in homes, commercial buildings, and infrastructure–like lighting and electric fences. Grid-tied systems (such as the one in the image below) have the ability to send excess power produced by solar installations to the BC Hydro grid. Off-grid systems require energy storage solutions, such as batteries, to capture excess solar power produced by the panels.

Each solar PV system is sized and developed to meet a site's specific requirements. This includes consideration of:

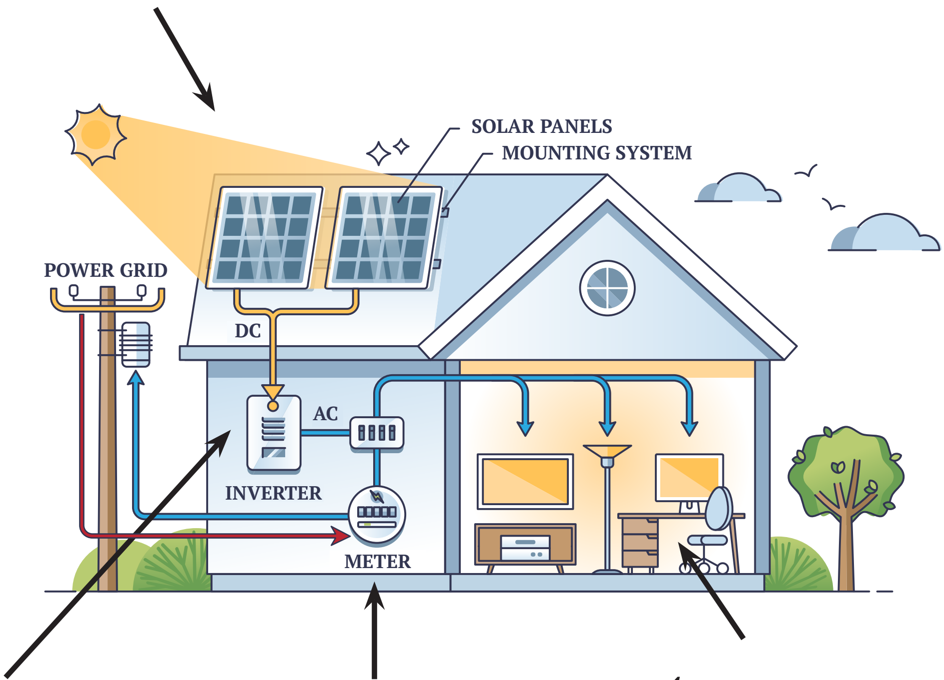
- System connection to the grid
- Battery storage requirements (when off grid)
- Site (roof or unobstructed ground) surface area
- Azimuth (building orientation)
- Roof slope
- Site shading
- Energy demands of the building

OPERATION OF A GRID-TIED SOLAR PV SYSTEM

The figure below provides an overview of the equipment required for a grid-tied system. As some community members are connected to BC Hydro's grid, the image below represents a solar installation similar to those which could be installed in the rural Upper Skeena for residents with a BC Hydro connection.

Grid-tied Solar PV system components and their function:

1. **Solar Panels:** *Sunlight falls on solar panels during daylight hours. The solar panel converts the sun's energy into Direct Current (DC) electricity which is sent to the inverter.*



2. **Inverter:** *The inverter converts the Direct Current into Alternate Current (AC) electricity which can then be readily used for household consumption.*

3. **Bi-Directional Meter:** *If there is more solar production than consumption at any given time, excess electricity is sent to the utility company through the bi-directional meter. The meter tracks how much energy is consumed or produced and sent to the grid.*

4. **Power for a Building:** *After travelling through the bi-directional meter, solar power can be used to power lights, plugs, and appliances in the building; and*

5. **Utility Power:** *When the building's demand exceeds solar production, utility power is provided.*

Operation of a Grid-Tied Solar PV System

ROOF-MOUNTED SYSTEMS

These are installed on the roof of a building. Roof-mounted solar PV systems are connected directly to a building's roof and existing electrical system. They provide power directly to the building as required.

These systems are specific to each building, and account for a roof's slope, surface area and azimuth, along with the other factors outlined above. Anticipated wind and snow loads are also considered when designing a roof-mounted solar PV system.

The image below provides an example of a roof-mounted solar PV system.

Roof-Mounted Solar PV System

GROUND-MOUNTED SYSTEMS

Ground-mounted solar installations utilize space afforded by fields and open areas, as shown in the image below. Unlike roof-mounted systems, ground-mounted installations can be constructed as steady (immobile) systems, or as tracking systems which follow the sun throughout the day or seasonally.

A ground-mounted system may be installed in cases where a roof is not suited for a solar installation. This may occur when:

- The roof is old or in poor condition
- The roof area is insufficient to support a cost-effective solar installation
- A roof does not have the correct azimuth for solar energy production, such as when a roof is facing north
- Shading occurs from a tree or building in proximity to the installation

Ground-Mounted Solar PV System

The foundations of ground-mounted systems will vary depending on the ground and soil type at the site. Due to the additional mounting and foundational equipment required for ground-mounted systems, these installations are typically more expensive than a roof-mounted system.

KEY CONSIDERATIONS FOR SOLAR POWER

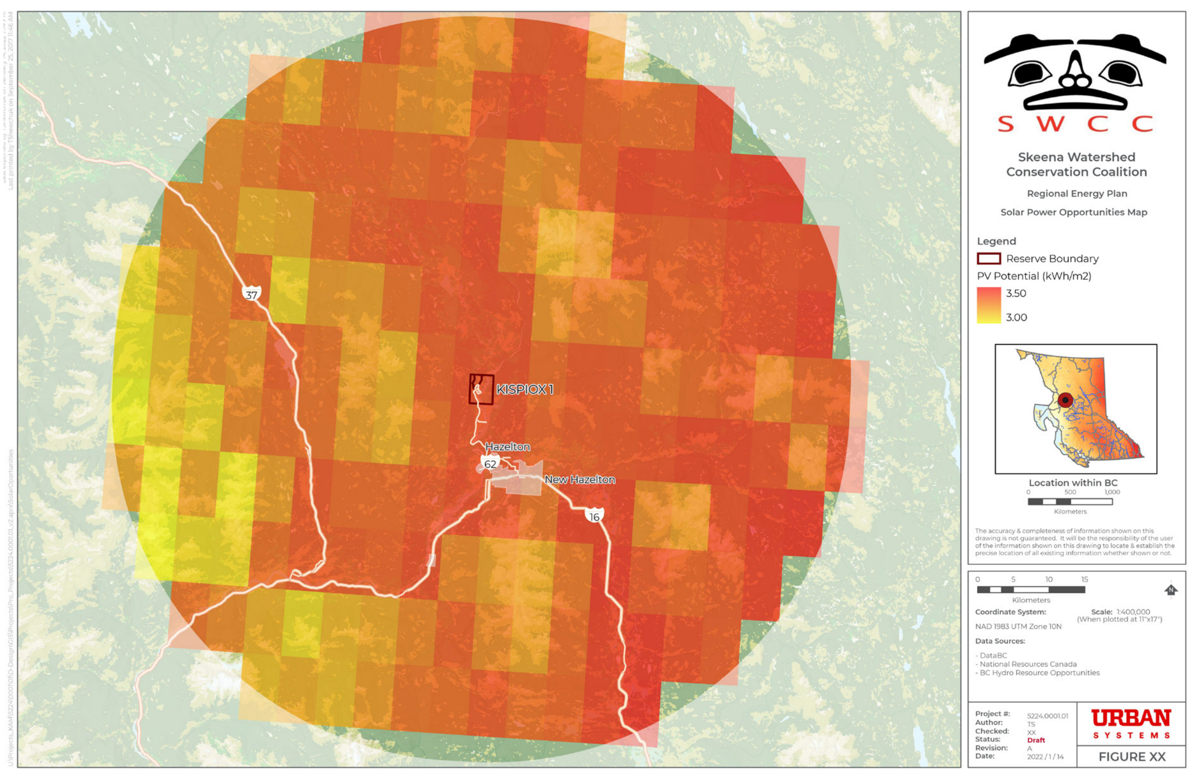
The success of a solar PV project at a site depends on multiple factors, including:

- Solar radiation
- Local climate conditions
- Site shading restrictions
- Accessibility to the grid for interconnection
- Electricity rates

The location and orientation of the solar array are crucial in assessing the potential viability of a solar PV project and its expected energy production.

Typically, a solar PV installation will produce the greatest amount of power if it is facing due south at an angle equivalent to the site latitude, but this varies depending on the geographical location of the installation and site shading restrictions.

To assess the viability of solar PV projects in the Upper Skeena, a preliminary assessment of solar resources has been completed. This includes referencing NRCan data and BC Hydro's Integrated Resource Plan Solar Potential Map.



Solar Energy Potential in the Rural Upper Skeena

SOLAR PV PROJECTS AND BC HYDRO NET METERING REGULATIONS

BC Hydro's only active electricity procurement program is the Net Metering Program. The regulations of the Net Metering Program require participants to build renewable energy projects which are no larger than 100 kW and only supply power to a single home or building per year.

Should participants build a renewable energy system producing more electricity than the building uses on an annual basis, the surplus electricity is sold to BC Hydro at the market rate. The market price for annual surplus electricity is calculated on January 1 every year and is based on the daily average wholesale electricity prices in mid-British Columbia for the previous calendar year. The price is converted to Canadian dollars using the average annual exchange rate from the Bank of Canada for that year.

Due to the high installation cost of solar PV systems, and the lower rate of electricity sold to BC Hydro, the most cost-effective option for a solar PV installation is to size the project to meet the annual electricity demands of the home or building on which it is installed. If desired, a solar PV installation which produces more than a building's annual electricity demand could be constructed. However, a more cost-effective option is to size the system to meet a building's annual electricity demands.

Modern inverter and batteries

ENERGY EFFICIENCY

The efficiency of solar energy technology has been steadily increasing and is currently around 21-24% efficient. This is a huge improvement and has made the collection of solar energy much more feasible in lower light conditions, particularly in the winter months, making it a viable source of energy even in Northern climates. This is bolstered because solar panels operate more efficiently when cold. When sun-hours are shorter in the winter, and less light is hitting the panels, they still have an increased efficiency due to temperature.

In the Skeena region, the available solar power, also known as Global Horizontal Irradiation (GHI), is typically between 940-1060 kWh/m2 for the spaces that would be considered usable for solar installations. This is sufficient to make solar PV a viable source of power.

PHYSICAL REQUIREMENTS

Solar panel technology is highly portable. It can be transported and set up in virtually any location. Because of the physical components it is easily scalable to almost any size, making it suitable for both high and low power demand applications.

The primary physical requirement for solar power installations is space, though they can be installed in many different ways (rooftop, ground-mounted, tops of poles, or even as fences). Often these systems can be installed in locations that are unutilized or underutilized and leverage existing infrastructure or spaces.

Regulatory conditions are also favorable toward solar installations, and the process to install an approved on-grid or off-grid solar system is simple and well outlined.

USDAgov-flickr.com

ENVIRONMENTAL IMPACTS

Solar power has one of the lowest environmental impacts of all power generation technologies. If handled properly, almost all of a solar system's environmental impact is in the manufacturing process. In most cases, those impacts are outweighed by the carbon reductions and other offsets solar provides. Once installed, solar power is a noise and pollution-free source of power that generates zero emissions. Solar panels can be installed on existing facilities, eliminating land disturbance or any increase in land usage. Alternatively, where existing structures are not available, solar panels can be installed in ways that integrate with and even enhance animal life or agricultural systems (i.e. covered fruit farms or livestock facilities).

COST

Pricing for solar generation and storage equipment has steadily dropped over the past several decades and has reached a price point where it is being considered as a viable alternative to grid connections, even when the grid is relatively close and accessible. Pricing varies a great deal from one location and project to another based on factors such as project size, system type (grid-tied with batteries, grid-tied without batteries, or off-grid), panel mounting type (rooftop, ground-mount, pole-mount, or other), ground conditions, proximity to materials and labour, and other factors.

Sadi Hockmuller - pexels.com

Prices for grid-tied solar installations without batteries currently vary from $1-2 per watt for utility-scale installations, to $2-4 per watt for smaller-scale residential and commercial projects.

Off-grid systems or grid-tied systems with batteries start at approximately $3 per watt without an upper limit due to the wide range of battery storage options and capacities.

ENERGY SECURITY

Solar power is on the higher end of the range of security in terms of renewable energy sources. While solar radiation is a constant resource, access to it fluctuates due to a few factors such as seasonal changes in sun hours or cloud cover. If systems are correctly designed with these factors in mind, solar power can be highly dependable.

Once operational, a well-designed solar system requires almost no attention or maintenance. This makes it a highly secure power source. With new battery technology systems, solar systems can be expected to last for decades with only minor maintenance and no need for outside inputs.

RELIABILITY

A well-designed solar power system is a highly reliable source of power. Solar panels have no moving parts, typically have 25–30-year performance warranties, and can be expected to operate for more than 40 years without replacement.

The electronics are simpler to install and easier to replace than ever before, and in many cases the replacement of system components does not require the system to cease operations. Likewise, battery technology has massively increased in lifespan and reliability, allowing for faster charging, the ability to reliably operate in any temperature region in Canada, and the capacity of a system to run for decades without replacing anything.

Cristian Rojas - pexels

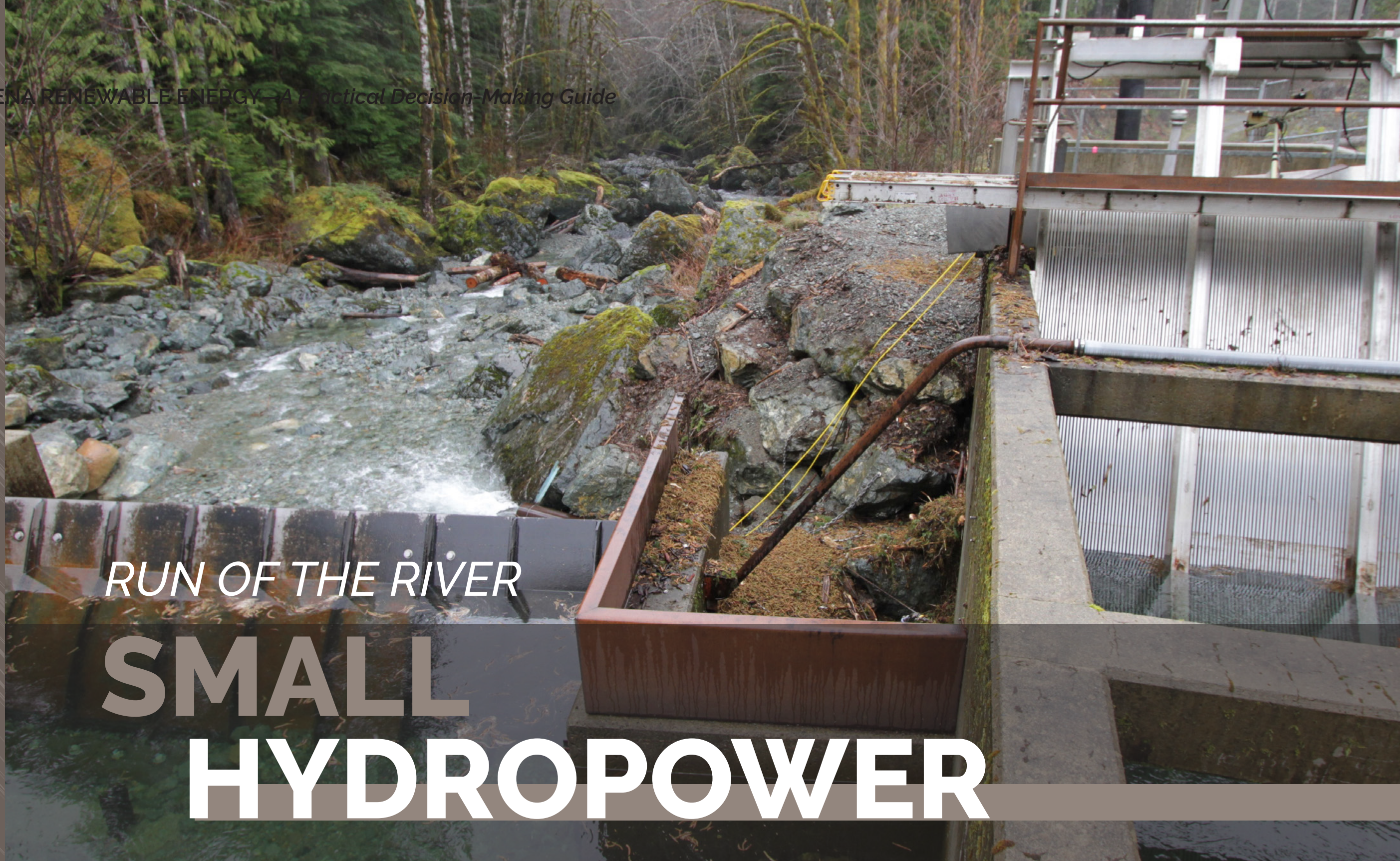
BATTERY TECHNOLOGY

Over the past two decades, battery technology changed significantly, largely driven by the demand for portable electronics, renewable energy storage, and electric vehicles. Lithium-ion (Li-ion) batteries have become the industry standard, offering significant improvements in energy density, lifespan, and safety compared to older technologies like nickel-cadmium (NiCd), nickel-metal hydride (NiMH), or lead-acid batteries. Innovations in material science, such as the use of cobalt, nickel, and manganese in cathodes, have allowed batteries to store more energy in smaller, lighter packages. These breakthroughs have enabled the shift toward alternative energy solutions by providing efficient storage for solar and wind power systems.

In addition to material advancements, manufacturing and design innovations have drastically improved battery performance and sustainability. Modern batteries are now capable of faster charging, better temperature tolerance, and longer cycle lives, all of which reduce waste and enhance reliability. Improved battery management systems have also optimized energy usage, extended battery life, and reduced degradation. As a result, today's batteries are meeting the growing energy demands of a connected world while increasingly supporting global efforts toward sustainability.

FINAL THOUGHTS ON SOLAR PV

When considering the decision-making criteria for this project, solar PV currently presents the strongest opportunity for Upper Skeena Region residents to access reliable, cost-efficient renewable energy.



RUN OF THE RIVER

SMALL HYDROPOWER

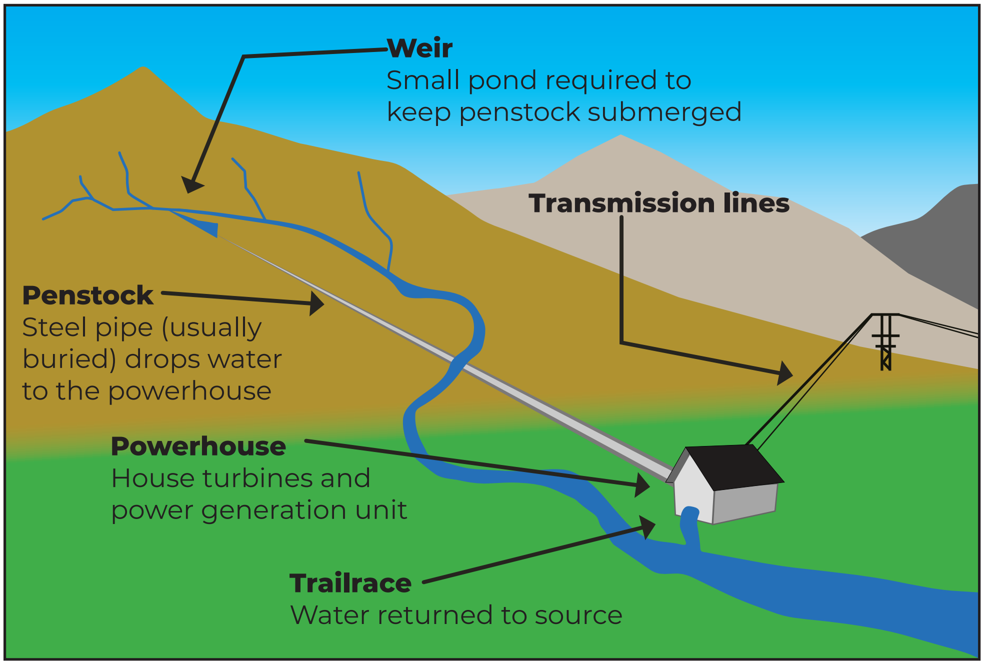
OVERVIEW

Hydropower projects utilize the kinetic energy of water (produced from the movement of water down a slope) and convert it into electricity. Each project is composed of the following major components:

- **Headworks:** The pond and structure at the head (top) of the hydropower project, used to divert water from a river, stream, or canal into the intake structure.
- **Intake structure:** The structure used to collect / withdraw water from the source, used to filter or remove any debris from the water prior to it entering the penstock.
- **Penstock:** The water from the intake structure flows into/through the penstock and down the gradient before reaching the powerhouse.
- **Powerhouse:** The powerhouse contains turbines which convert the water’s energy into electricity.
- **Tailrace:** This structure allows water to flow back into the stream.
- **Transmission line:** The transmission line transports the power produced in the powerhouse to the main BC Hydro grid

COMPONENTS OF A SMALL HYDROWER GENERATION PROJECT

A general configuration for a small hydropower generation project is illustrated below.



Small Hydropower Generation Process

The feasibility of a small hydroelectric project is dependent on many factors, with the two largest factors being the availability of stream flow and the elevation change (head). Flow can vary seasonally, and this primarily dictates the levels of energy generated. The feasibility of a project is also largely dependent on specific site conditions, such as proximity to the electrical grid, ease of access to the site, and local topography.

Environmental impacts associated with the development of a small hydropower project should also be considered. These impacts, outlined below, can vary significantly depending on the type of hydropower project, the size, and its location.

- **Flooding of upstream areas:** A small dam or diversion weir is typically required to ensure that the intake structure remains covered.
- **Fluctuations to downstream water levels:** An upstream diversion can cause fluctuations in downstream water levels, which may impact fish habitat; and
- **Fish habitat / barrier:** Fish travelling upstream require a system or structure to allow for safe passage over the project.

Typically, the development of a small hydropower project takes between two and five years. Many environmental and technical studies need to be completed in order to complete the project design work, and several provincial and federal regulatory approvals are required prior to construction.

KEY CONSIDERATIONS FOR SMALL HYDROPOWER

Should an individual or community wish to develop a small-scale hydropower project, several site considerations need to be considered.

SITE REQUIREMENTS

The head height and flow of water available determine the amount of power that can be generated. When planning a hydropower plant, attention needs to be paid to the seasonal and yearly differences in water availability.

ENGINEERING & INFRASTRUCTURE REQUIREMENTS

Micro and pico hydropower plants are often best suited for isolated areas where there is no electricity grid. Off-grid power plants require local load controlling to stabilize frequency and voltage of supply. Their advantage is they are generally designed for single households or small villages and can be developed with local materials and labour. For small pico hydro turbines, the turbine/generator set can be bought as a module "off the shelf", whereas from micro power plants upwards, the turbines are especially designed for the location.

PLANNING REQUIREMENTS

To proceed with a small hydropower scheme, obtaining the authorization to utilize all the land concerned is necessary. Finding out how contractors will access the different areas of the hydropower site with the necessary equipment is also important. This can be done by approaching the applicable parties with interests in the lands and resources (Indigenous communities, the Government of BC, and the Government of Canada) and relevant landowners at an early stage to identify any objections to the proposed project and to secure access to the land.

APPLICATION

Micro hydropower systems are suitable for off-grid power generation and can be connected to the BC Hydro grid through the net metering program. These micro systems are available as small as 0.1 kW for a battery-based system up to a 100 kW.

Typically, the development of a small hydropower project takes between two and five years. Many environmental and technical studies need to be completed in order to complete the project design work, and several provincial and federal regulatory approvals are required prior to construction. See the supplemental information on page 25 for more details.

ENVIRONMENTAL CONCERNS

Small hydropower systems impose a smaller impact than larger systems on aquatic ecosystems and local communities. However, like all forms of hydro-based generation technologies, small systems need to be carefully vetted because they cannot completely prevent stresses on ecosystems and human well-being.

Environmental impacts, outlined below, can vary significantly depending on the type of hydropower project, the size, and its location.

- **Flooding of upstream areas:** A small dam or diversion weir is typically required to ensure that the intake structure remains covered.
- **Fluctuations to downstream water levels:** An upstream diversion can cause fluctuations in downstream water levels, which may impact fish habitat.
- **Fish habitat/barrier:** Fish travelling upstream require a system or structure to allow for safe passage over the project. Hydropower projects should not be constructed in fish bearing streams, apart from in a small number of cases where significant mitigation measures are implemented, and appropriate regulatory bodies are in approval.

As discussed above, hydropower projects are subject to several limitations. In particular, BC Hydro does not have an active or current energy procurement program, thus eliminating the viability of such opportunities which are greater than 100 kW in capacity. Smaller-scale projects (less than 100 kW) are subject to a number of environmental and planning requirements, including securing a water license for power generation purposes.

In Canada, small hydro has found a niche in replacing polluting diesel generators in remote communities (often First Nations).

RUN OF RIVER VS. CONVENTIONAL STORAGE HYDRO

In conventional storage hydro, a dam is placed across a river to create a reservoir with most of the water impounded behind the dam and the downstream flow regulated. This changes the natural variation of flow for the entire downstream river.

Run of River (ROR) hydro projects have a much smaller environmental footprint compared to traditional reservoir storage hydro. They typically have little water storage capacity thus less land is flooded, reducing the potential footprint. With ROR hydro, only a portion of the stream flow is affected, and only a short length of the river experiences reduced flows. The volume of water a ROR project may divert through penstocks to run turbines depends significantly on stream morphology and environmental characteristics–a typical plant utilizes less than two-thirds of a river's annual flow. Immediately below ROR hydro powerhouses, all flows diverted to produce power are returned to the stream and the natural downstream flow patterns are preserved.

However, without storage, ROR hydro supplies electricity only as natural flow allows. Flow conditions conducive to ROR power generation do not always correspond to times when electricity demand is high. Accordingly, both technologies have advantages and disadvantages and should be viewed as complementary resources.

Without a dam for storing water, there is no stored power. This means the capacity factor of run of the river projects varies between 40% and 80%. (http://www.energybc.ca/runofriver.html)

(https://cleanenergybc.org/sector/run-of-river/)

Land-use and operational policies of other agencies, including BC Hydro, are also applicable where their legislation provides for jurisdictional responsibility.

Waterpower projects may be on Crown land, private land, or a combination of Crown and private lands. The province is responsible for the review of Crown land waterpower project proposals.

Look at the supplemental information on the following page for how you proceed when looking at a small hydro project and its viability.

Atlas Gas northwestern BC run of river hydro-electric project

SUPPLEMENTAL INFORMATION FOR SMALL HYDROPOWER

The following information is the sequence of steps to follow for waterpower projects in BC.

ENVIRONMENTAL ASSESSMENT

A proposed clean energy project may also require an Environmental Assessment under the Environmental Assessment Act, which is led by the Environmental Assessment Office.

APPLICATION DOCUMENTS

Waterpower projects require a water licence, and in most cases a Crown land tenure adjacent or appurtenant to the water being used. Making an application for a water licence prior to initiating the Crown land tenure application process is recommended; however, both application processes will prompt for the other related application in the system.

Components of the project that may be situated on Crown land and require a Crown land tenure include the following:

- Powerhouse site
- Penstock
- Intake structures
- Tailrace
- Switchyards
- Transmission lines
- Roadways
- Construction staging areas

THE FOLLOWING DOCUMENTS SHOULD BE REVIEWED PRIOR TO SUBMITTING YOUR APPLICATION:

Waterpower Policy

Development Plan Information Requirements

Clean Energy Guidebook

Sample Site Maps

THE FOLLOWING DOCUMENTS SHOULD BE COMPLETED PRIOR TO SUBMITTING YOUR APPLICATION:

Water licence application

THE FOLLOWING DOCUMENTS *MUST* BE COMPLETED PRIOR TO SUBMITTING YOUR APPLICATION:

Crown Land Application (including site map)

Waterpower List/Development Plan Information Requirements

Investigative Plan template (if applicable)

WHO MAY APPLY?

To apply for a waterpower project Crown land tenure, you must be:

- A Canadian citizen or permanent resident at least 19 years of age, or
- A partnership or corporation registered in the province of BC.

TYPE OF TENURE

Waterpower projects on Crown land are authorized by two types of Crown land tenure. At the initial or investigative stage an investigative licence is issued for up to 5 years to allow for site investigation and to obtain information required to complete the development plan for project initiation.

At the project initiation phase, a multi-tenure instrument is applied for. It combines a number of previously available tenure rights under one tenure instrument. It's issued for the period that corresponds to the electricity purchase agreement period of up to 40+ years. If an electricity purchase agreement is not obtained, then the term is limited to 10 years in most circumstances.

FEES AND RENTS

You'll be required to pay an application fee, as outlined in the Crown land fees schedule, and rental fees.

Crown Land Tenure Application - Authorization Guidance - Natural Resource Online Services

Rents are determined based on the type of rights being transferred and land values.

- Rent for an investigative licence is $675 per year.
- Rent for rights associated with a multi-tenure instrument are broken out by use – licence of occupation rights are calculated at 7.5% of land value, a lease is 8%. For uses that are similar in nature to utilities, rent is 7.5% or 8% of zone land value based on different rights being issued.

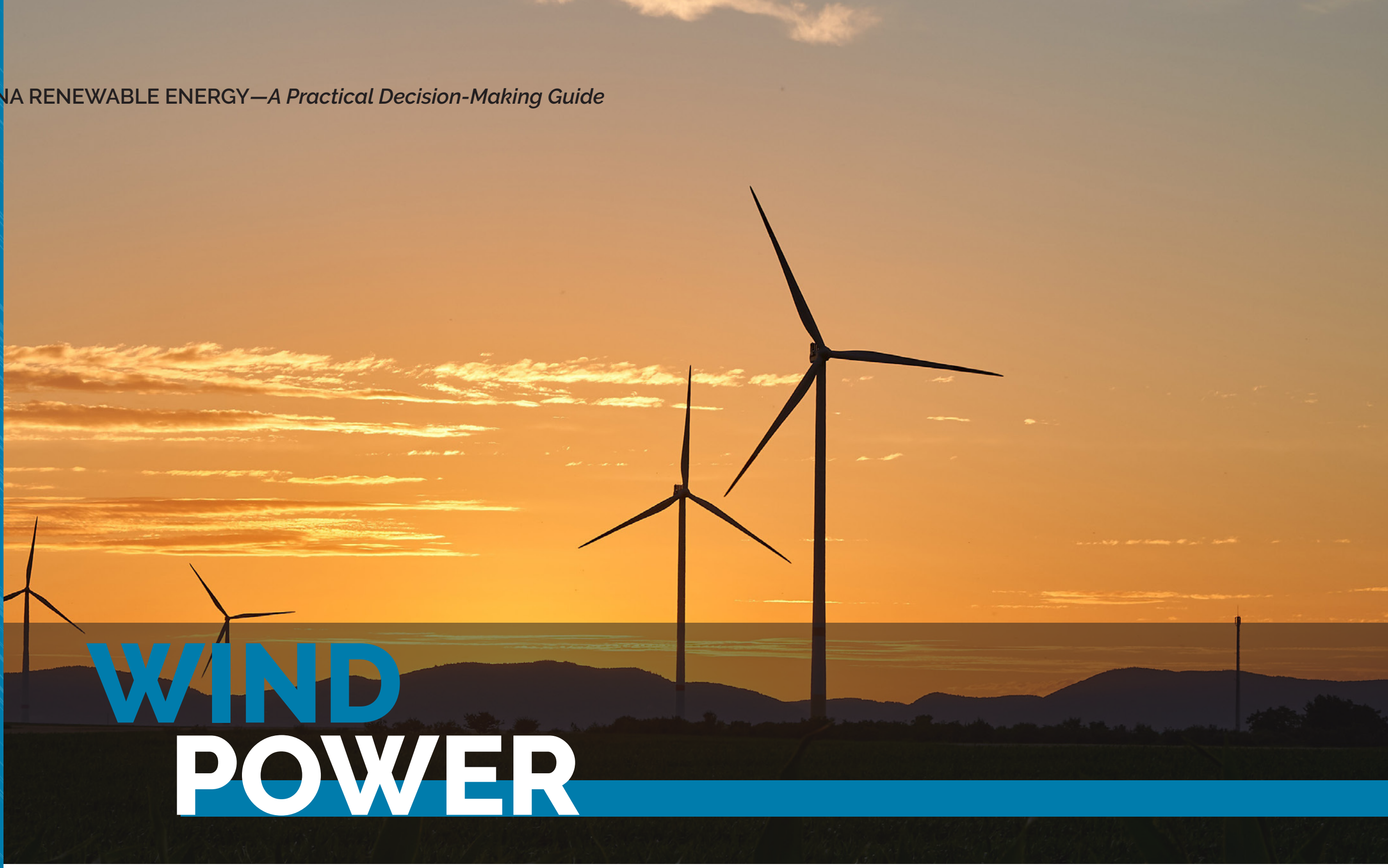
When considering clean energy power production, review the information on the Water Application Fees and Rental Rates page.

CONSULTING WITH FIRST NATIONS

Consultation with First Nations is an important part of land and resource decision-making.

FINAL THOUGHTS ON SMALL HYDROPOWER (ROR)

Small hydropower has the potential to be a contributor to community power needs but there are substantial regulatory and political hurdles to overcome.



WIND POWER

OVERVIEW

Wind power projects convert the energy in the movement of the wind to electricity. The feasibility of a wind energy project is extremely dependent on the wind speeds at the proposed project location and on the overall project development costs.

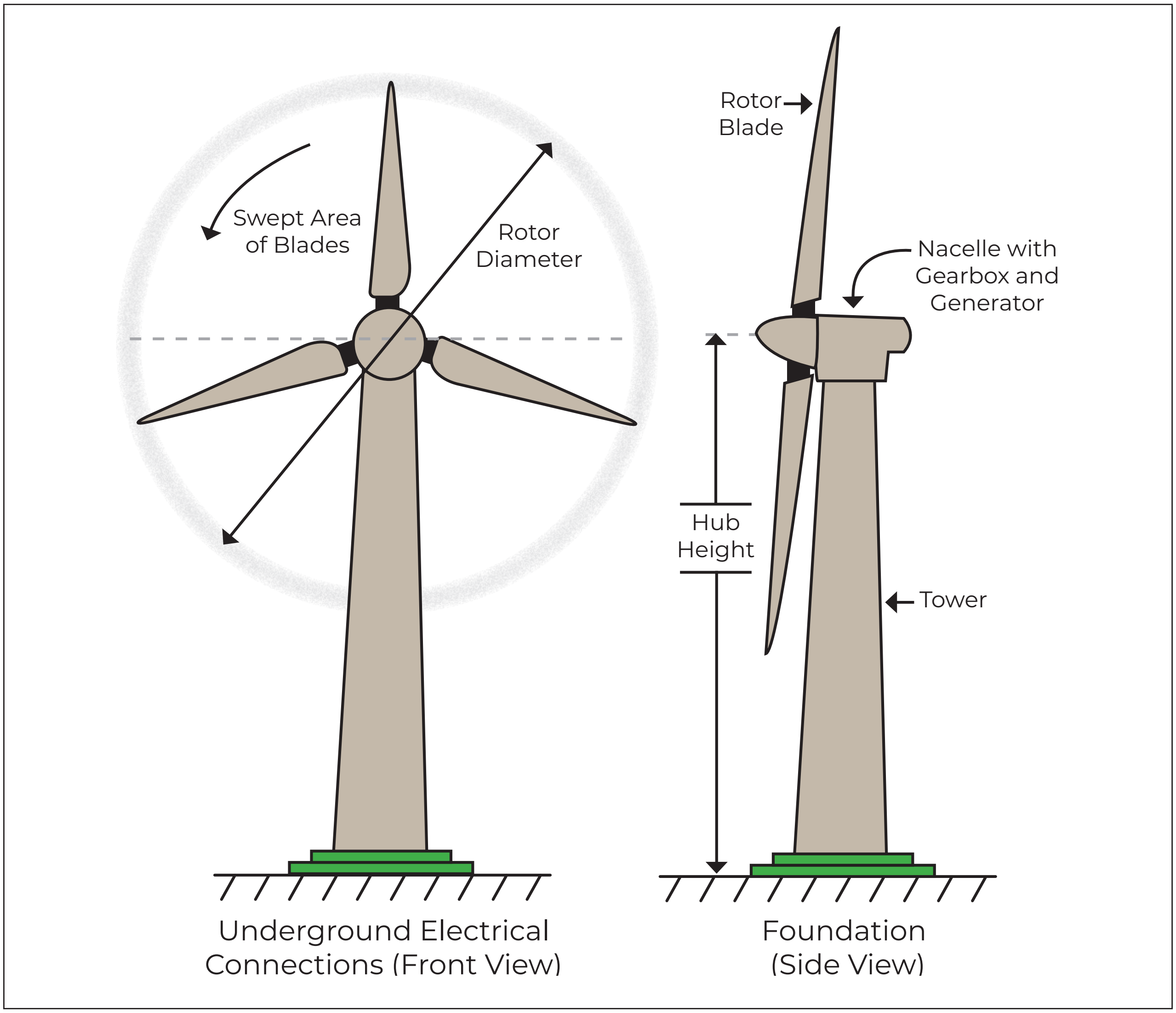
The major components of a wind energy system include:

- **Rotor and blades:** Convert wind energy into mechanical energy in the rotor shaft
- **Gear box:** Matches the rotor shaft speed to the generator.
- **Tower:** Supports the rotor above the ground, elevates the rotor and blades to capture higher wind speeds.
- **Foundation:** Supports the tower.
- **Control system:** Starts and stops the wind turbine

In addition to the components outlined above, road access and grid connection needs to be established to the site/project. The infrastructure required to construct, transport, and service the turbines requires road access, which can be challenging given the size of these components. Grid connections, in some cases, may require a transmission/power line to be built over a long distance, resulting in significant capital costs as well as the need for significant environmental approvals.

COMPONENTS OF A WIND TURBINE

The image below depicts the major components of a wind turbine.



Major Components of a Wind Turbine

Wind turbines are available at large scales, with a capacity of 500 kW to 10 MW, and at smaller scales, with a capacity of 200 W to 100 kW.

KEY CONSIDERATIONS FOR WIND POWER

SITE REQUIREMENTS

The amount of energy generated by a wind turbine depends on:

- Air density (mass per unit volume)
- Air speed
- Area of the rotor
- Area of the blades

Ground conditions for the siting of wind turbines also need to be considered such as soil stability, site drainage, and hydrological effects (water supply and quality and watercourse crossings).

PLANNING REQUIREMENTS

To help determine the suitability of the site for a wind energy system, an estimate of the site's average annual wind speed needs to be determined. The wind resource can vary significantly over an area of just 1 square mile because of local terrain, local structures, and vegetation influences on the wind speed and flow. The siting also needs to consider zoning, permitting, and covenant requirements.

ENVIRONMENTAL CONCERNS

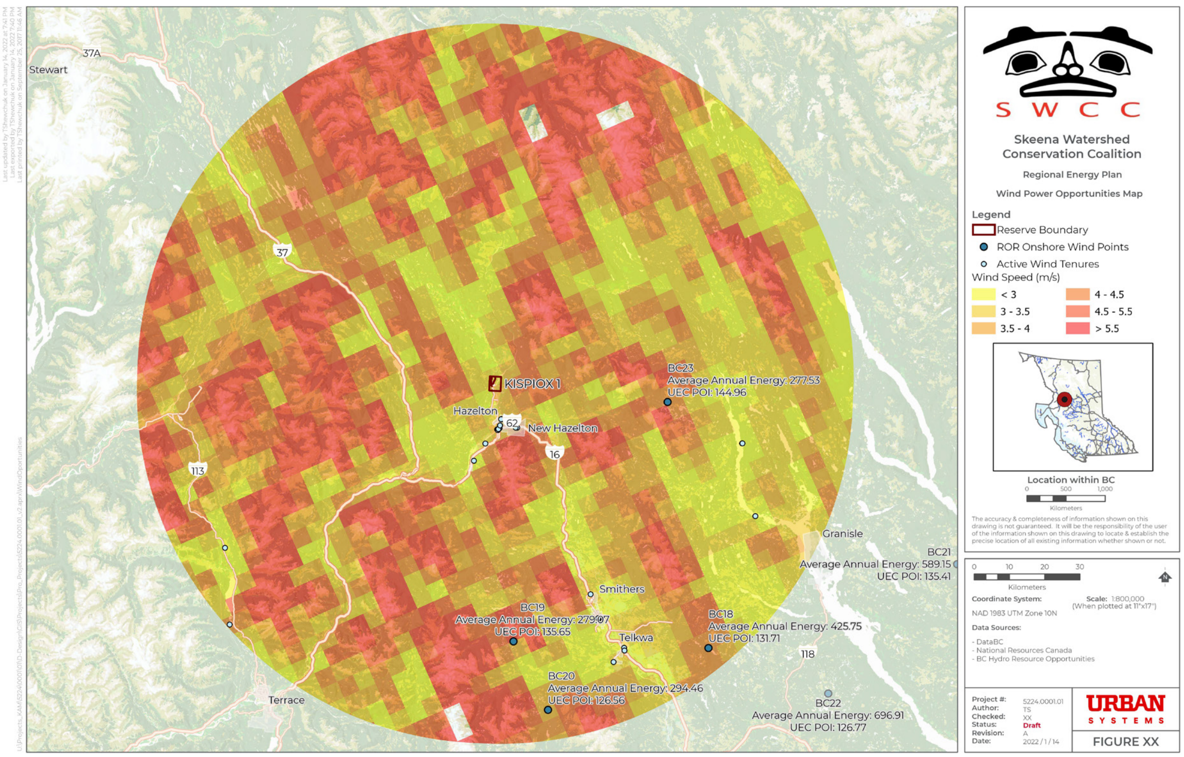
Wind turbines cause noise pollution as they rotate and cause visual problems for some people. During the turbine's life cycle, there are instances where greenhouse gas emissions occur and waste is released that contributes to pollution and climate change. The instances in the life cycle include manufacturing, material composition, transportation, installing, maintenance, and decommissioning. Installation of wind turbines calls for vegetation and forest clearing that can result in soil erosion, change of micro-climate, loss of animal habitat, and uncompetitive use of land. Additionally, wind turbines cause a decline in the number of flying animals like bats and birds due to collision with rotating wind turbines

dikilitas - pexels.com

WIND POWER OPPORTUNITIES ASSESSMENT

The development of a wind energy project typically includes extensive studies on wind resources at the site, the acquisition of permits, design and specification of equipment, equipment purchase, construction, and commissioning.

An opportunities assessment was completed to determine if viable wind development opportunities exist within the Kispiox Valley. To identify such opportunities, BC Hydro's 2013 Resource Options Report (ROR) and the Ministry of Forest, Lands, and Natural Resource Operations' database for wind tenures was referenced. The map below shows the wind energy potential in the Upper Skeena region.



Wind Energy Potential in the Rural Upper Skeena Region.

Through our research it was deemed that there is not enough reliable volume or frequency of wind in the Upper Skeena to warrant wind power as an energy producing possibility.

WIND POWER

FINAL THOUGHTS ON WIND POWER

When considering the decision-making criteria for this project, wind power scores the lowest in viability as a renewable energy opportunity because of the lack of current dependable wind, cost of development, physical space required, and regulatory requirements. In some areas of the Upper Skeena Region, it may be a consideration to have a micro system to add to your energy system.

BIOENERGY

OVERVIEW

Biomass energy systems are a form of renewable energy technology which burns biological fuel sources for heat and power. During its life cycle, organic matter like trees and plants collect energy from the sun in a process called photosynthesis. As the organic matter–called biomass–decomposes or is burned, the stored energy gets released as biomass energy.

A biomass energy system has the following components:

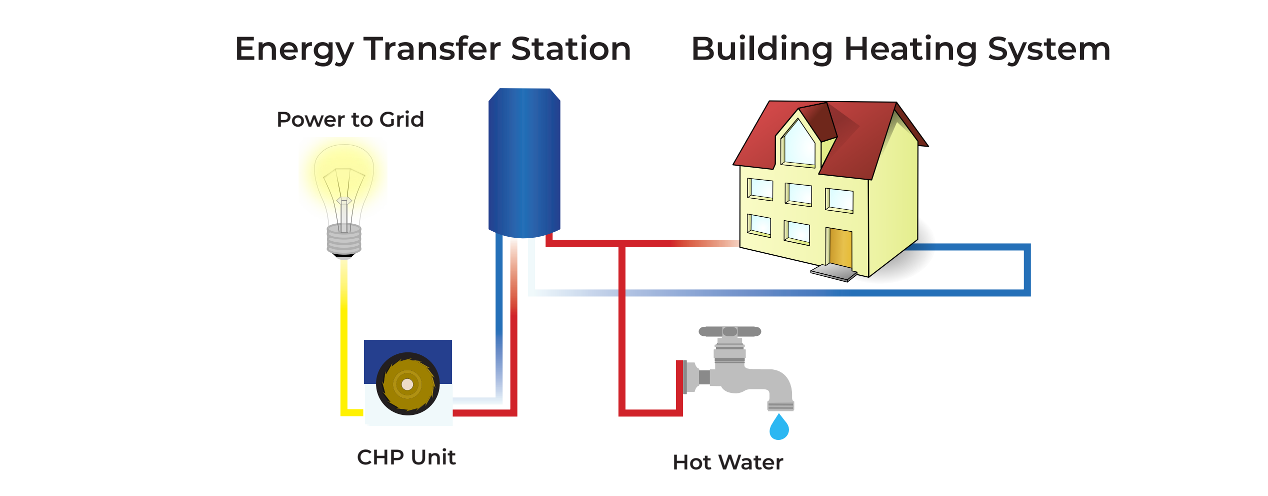
- **Fuel storage:** The biomass system requires a location for wood pellets or chips to be kept dry.
- **Biomass boiler:** The biomass boiler burns the fuel and converts it to heat and/or power.
- **Heating liquid storage:** The heating liquid requires a storage location when not in use.
- **Heating liquid distribution system:** The heating liquid circulates through the pipes connected to each building, providing heat for each customer.
- **Energy transfer station:** The heating liquid flows through the energy transfer stations, allowing the energy to be used by the buildings.

COMBINED HEAT AND POWER (CHP) SYSTEM

Electrical and thermal energy (heat) can be efficiently generated through a bioenergy Combined Heat and Power (CHP) system. A CHP system has the ability to produce a portion of a building's (or network of buildings') electricity requirements, and can fully or partially displace the reliance on fossil fuels for heating.

Typically, CHP systems will be connected to a number of buildings, which are then supplied with heat and power from the centralized system. The CHP unit burns wood chips or pellets to create thermal energy and electricity for the buildings.

A biomass CHP system consists of the following major components (mentioned above). Each of these components are pictured in the image below.



Summary Overview of a CHP System

BENEFITS OF COMBINED HEAT AND POWER

A CHP power plant can deliver multiple benefits and advantages compared to conventional energy production.

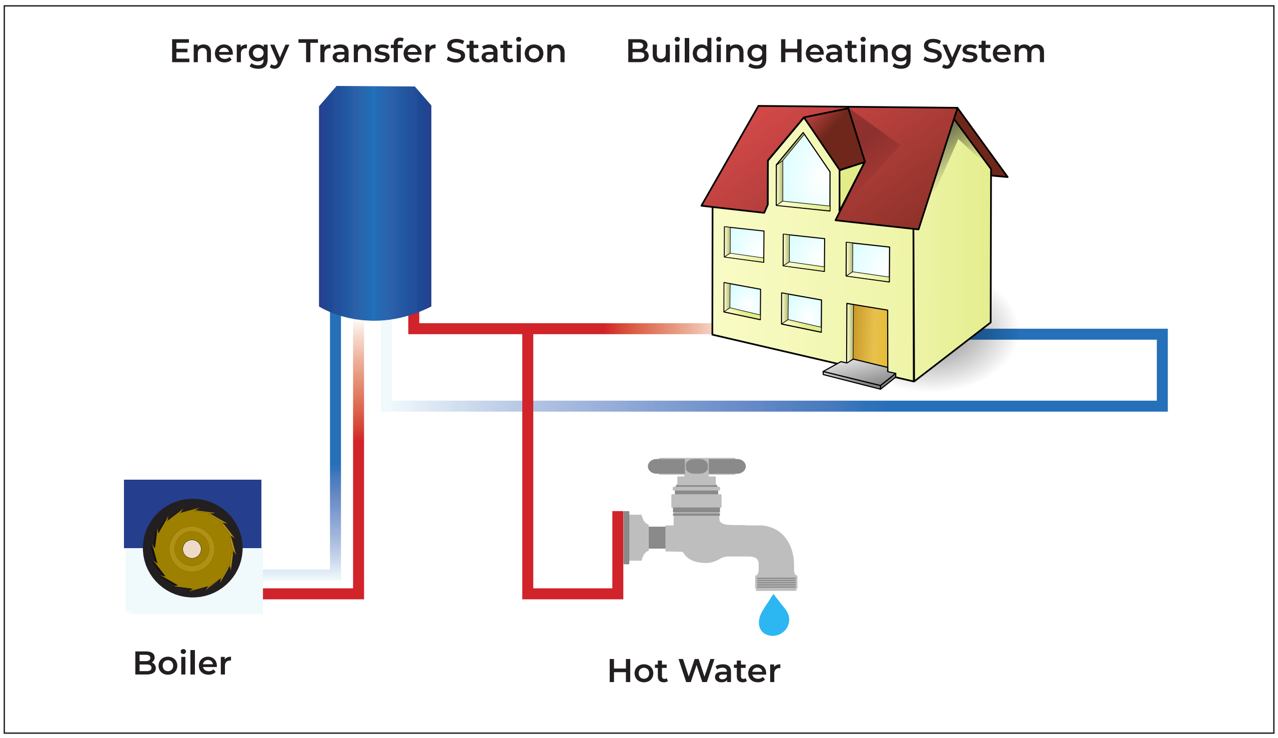
- **Increased efficiency:** CHP produces both electricity and heat and does so using less fuel compared to other energy plants. Plus, it captures heat and steam to generate additional power, further lowering the need for fuel.
- **Reduced emissions:** Because CHP systems burn less fuel, they can reduce emission of greenhouse gases and other air pollutants.
- **Reduced costs:** CHP's efficiency drives down operating costs and can provide a hedge against electricity cost increases.
- **Reliability:** CHP is an on-site energy plant, so it lowers reliance on the energy grid and can deliver higher energy security and electricity production reliability even in a disaster or grid disruption.

BIOENERGY

DISTRICT HEATING SYSTEMS

District heating system (DHS) projects provide heat for buildings connected to the network. Biomass heat-only systems typically have higher capital costs than conventional heating systems. However, cost savings are often realized over time (e.g., fuel cost savings). A typical biomass DHS includes the following major components, as depicted in the image below.

- Building heating system (furnace)
- Energy transfer station
- Heating liquid distribution system
- Boiler



Summary Overview of a Biomass DHS

KEY CONSIDERATIONS FOR BIOENERGY

SITE REQUIREMENTS

A biomass energy plant requires an industrial sized site of approximately 2-40 acres, along with a reliable water supply and sufficient supply of biomass fuel to maintain a consistent energy output. A network of insulated pipes is required to convey hot water away from the installation, while other district heating systems use steam or thermal oil to distribute heat. For district heating to be viable, a high concentration of clustered target buildings needs to be present.

PLANNING REQUIREMENTS

The development of a bioenergy project requires the identification of a secure and sustainable fuel source. The most common biomass fuel sources used in bioenergy projects include:

- Wood pellets
- Wood chips
- Logging and mill residues and wastes
- Wood from non-marketable timber and associated wastes
- Accessibility to the grid for interconnection
- Electricity rates

Willfried Wende - pixabay.com

For the success of any DHS, there must be a steady, preferably local, supply of biomass available. This can include secondary wood product manufacturers, waste wood from sawmills, logging slash, clean construction, and demolitions waste or farms. Ideally, a long-term supply contract from one or several suppliers should be negotiated to ensure an uninterrupted supply of fuel. Distance from fuel source to biomass facility is critical to project feasibility and supply contract success. Transportation of wood fuel is often the largest limiting factor in biomass fuel supply.

ENVIRONMENTAL CONCERNS


Alexas_fotos - pixabay.com

Bioenergy is a unique type of renewable energy since unlike solar, wind or hydro, generating power from biomass results in the release of GHG emissions and pollutants into the air. The carbon impact of bioenergy depends on the combustion technology, method of biomass harvesting, re-growing effects, the type of biomass used and the energy source it is displacing. With proper planning and technology selection, it is possible that the biomass DHS can be carbon neutral.

It should be noted that in some cases, "waste wood" (such as slash) is burned as a means of wood disposal. This can result in the unnecessary release of GHG emissions into the air, when the wood could alternatively be burned as a means of heat generation in homes or a bioenergy system.

Additionally, there are other environmental consequences to consider:

- **Pollution:** Outside of contributing carbon dioxide emissions, burning biomass in a solid, liquid, or gaseous state can also emit other pollutants and particulate matter into the air, including carbon monoxide, volatile organic compounds, and nitrogen oxides.
- **Water use:** Plants require water to grow; when energy companies grow trees and other crops for a bioenergy plant, they use a lot of water for irrigation. On a large scale, this exacerbates drought conditions, impacting aquatic habitats and the amount of water supply available for other purposes (food crops, drinking, hydropower, etc.).

BIOMASS OPPORTUNITIES ASSESSMENT

Typically, bioenergy systems are feasible when connected to a cluster of buildings concentrated in one area with a high heating load/demand. Building clusters or areas with a high density of buildings are ideal for bioenergy systems due to:

- **Reduced capital costs:** Clusters of buildings require shorter primary and secondary piping distribution networks, reducing the capital and construction costs associated with installing the piping network.
- **Higher system efficiency:** An area with a high density of buildings requires shorter piping networks. As the heating fluid travels a shorter distance, the bioenergy system requires less energy and fuel to distribute the heat to all connected buildings.
- **Different heating loads:** Buildings used for different purposes will likely have different heating loads. Connecting a variety of buildings to a bioenergy system places heating loads on the boiler at different times of day, increasing the efficiency of the system and reducing the amount of heat wasted.

For a biomass energy project to be feasible for communities within the Upper Skeena, the following criteria needs to be kept in mind. These include:

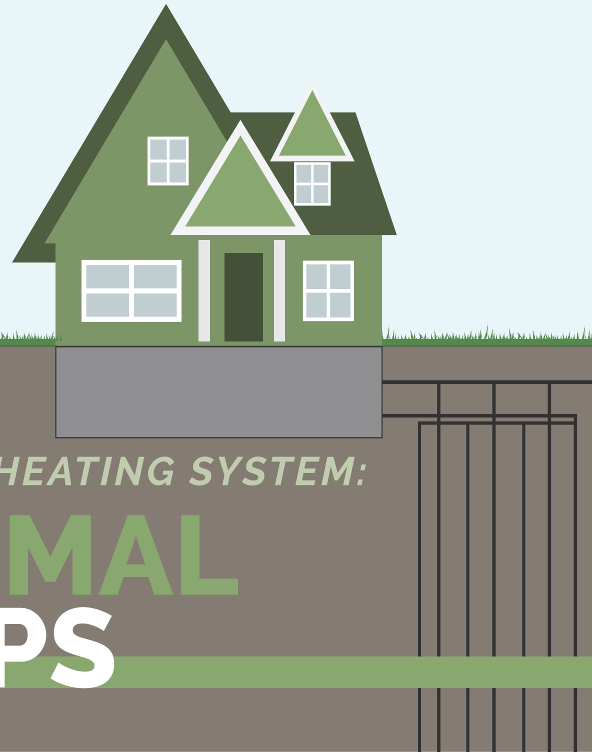
- An onsite location with considerable space requirements (2-40 acres), along with a reliable water supply. A network of insulated pipes will have to be constructed to transport hot water from the installation to the buildings using the district heating system;
- A steady, preferably local, fuel source. This can be in the form of wood pellets, wood chips, or logging residue;
- Whether the buildings being supplied with bioenergy require major modifications to accommodate a district energy system; and
- A closely clustered group of target buildings.

If these requirements are met in a financially feasible manner, moving on to the next step in a biomass energy project may be possible. I.e., conducting an environmental impacts/concerns assessment to take into account various environmental factors such as deforestation, pollution, and water usage.

FINAL THOUGHTS ON BIOENERGY

When considering the decision-making criteria for this project, bioenergy has the potential to be a contributor to community energy needs in the future. The current barriers for bioenergy in the Upper Skeena are education on the current technology to understand how efficient and clean the energy production is, regulatory hurdles, and the high cost for large bioenergy installations.

It is important to note that as more biomass is produced, an equivalent amount of carbon is absorbed, making modern bioenergy a near-zero emissions fuel. It is the largest source of renewable energy globally, accounting for almost 55% of renewable energy (excluding traditional use of biomass) and over 6% of global energy supply. (ttps://www.iea.org)



RENEWABLE/HYBRID ENERGY HEATING SYSTEM:

GEOTHERERMAL HEAT PUMPS

OVERVIEW

Ground-source heat pumps use the *earth or ground water* as a source of thermal energy in heating mode, and as a sink to expel heat energy when in cooling mode.

These types of systems contain two key components:

- **Ground heat exchanger:** This is the heat exchanger used to add or remove thermal energy from the earth or ground. Various heat exchanger configurations are possible and are explained later in this section.
- **Heat pump:** Instead of air, ground-source heat pumps use a fluid flowing through the ground heat exchanger as their source (in heating) or sink (in cooling).

On the building side, both air and hydronic (water) systems are possible. Operating temperatures on the building side are very important in hydronic applications. Heat pumps operate more efficiently when heating at lower temperatures of below 45 to 50°C, making them a better match for radiant floors or fan coil systems. Care should be taken when considering their use with high temperature radiators that require water temperatures above 60°C. These temperatures generally exceed the limits of most residential heat pumps.

SYSTEM CLASSIFICATIONS

Depending on how the heat pump and ground heat exchanger interact, two different system classifications are possible.

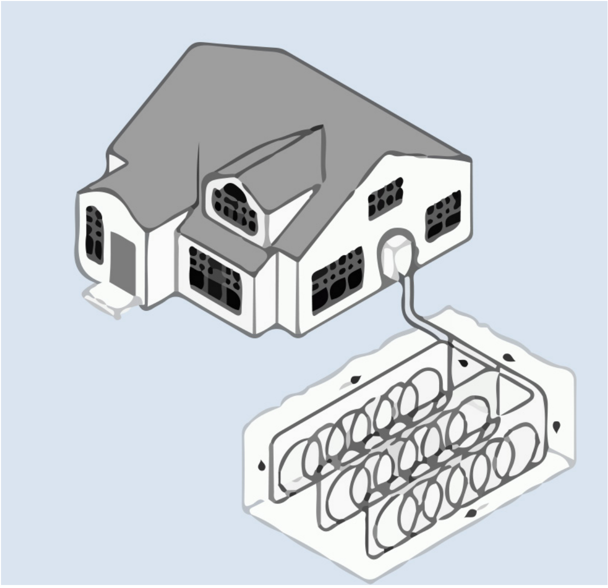
- **Secondary loop:** A liquid (ground water or anti-freeze) is used in the ground heat exchanger. The thermal energy transferred from the ground to the liquid is delivered to the heat pump via a heat exchanger.
- **Direct Expansion (DX):** A refrigerant is used as the fluid in the ground heat exchanger. The thermal energy extracted by the refrigerant from the ground is used directly by the heat pump– no additional heat exchanger is needed.

In these systems, the ground heat exchanger is a part of the heat pump itself, acting as the evaporator in heating mode and condenser in cooling mode.

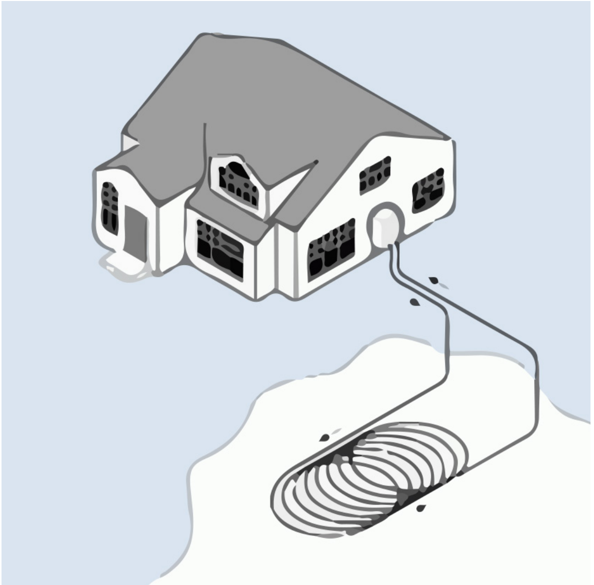
ROLES IN THE HOME

Ground-source heat pumps can serve a suite of comfort needs in your home.

- **Heating only:** The heat pump is used only in heating. This can include both space heating and hot water production.
- **Heating with "active cooling":** The heat pump is used in both heating and cooling.
- **Heating with "passive cooling":** The heat pump is used in heating and bypassed in cooling. In cooling, fluid from the building is cooled directly in the ground heat exchanger.



Closed Loop Systems -Horizontal



Closed Loop Systems -Pond/Lake

KEY CONSIDERATIONS OF GEOTHERMAL

ENERGY EFFICIENCY

In Canada, where air temperatures can go below –30°C, ground-source systems are able to operate more efficiently because they take advantage of warmer and more stable ground temperatures. Typical water temperatures entering the ground-source heat pump are generally above 0°C, yielding a Coefficient of Performance (COP) of around 3 for most systems during the coldest winter months.

INSTALLATION COSTS AND REQUIREMENTS

The installation price of a geothermal system can be several times that of an air-source system of the same heating and cooling capacity. The wells or ground loops come at a very high expense but can last for a long time.

EQUIPMENT RELIABILITY AND MAINTENANCE

System life is estimated at up to 24 years for the inside components and 50+ years for the ground loop.

Like all heating equipment, routine maintenance will keep your system at peak efficiency, save on energy, and keep repairs to a minimum. Annual (yearly) servicing is recommended. You should have all home heating equipment regardless of fuel type, serviced annually, by a certified professional.

ESSENTIAL CHECKS FOR GEOTHERMAL SYSTEMS

- Check and adjust the coolant levels to ensure proper heat transfer.
- Inspect ground loops for leaks, damage, or soil erosion.
- Clean or replace air filters to maintain optimal airflow.
- Inspect and clean air ducts to remove any dirt or debris.

(https://www.fieldinsight.com)

PHYSICAL REQUIREMENTS

Geothermal energy is primarily used for heating and cooling in residential homes. There are three types of heating and cooling systems currently in use: vertical closed loop systems, horizontal closed loop systems and open loop systems. Each type operates by basic refrigeration principles.

In a vertical closed loop system, refrigerant and water are pumped through pipes drilled over 300 feet into the earth. On the way, the liquid is either heated or cooled by the earth (depending on the season). It's then compressed by the heat pump once inside the home. This compression raises the temperature to whatever indoor temperature the home is set to.

- Vertical closed loop systems are the most common type of geothermal exchange system.
- Horizontal closed loop systems run that same refrigerant through +300 feet of pipes buried in a grid. These are typically laid 6 to 10 feet underground. That requires a sizeable amount of space (at least 5000 ft. sq.). If you have the space, horizontal ground loops are generally more cost-effective since you don't need a drilling rig to install them.

  https://greenbuildingcanada.ca/geothermal-energy-homes-canada/

ENVIRONMENTAL IMPACTS

Key points about geothermal environmental impacts:

Land disturbance: Drilling and construction activities can disrupt the landscape, although these areas can be reclaimed after development.

Water usage: Geothermal power plants may require significant water for cooling, which can be a concern in water-scarce regions. (More on a commercial development)

Air emissions: While generally low compared to fossil fuels, geothermal plants can release gases like hydrogen sulfide, which can have a strong odor if not properly managed.

Induced seismicity: In some cases, large-scale geothermal projects can trigger small earthquakes, although this is typically not a major concern and can be mitigated through careful site selection and monitoring.

Groundwater contamination: Improper management of geothermal fluids could potentially contaminate groundwater sources.

Habitat disruption: Development can alter local ecosystems and affect wildlife populations.

Positive environmental aspects of geothermal energy:

Low greenhouse gas emissions: Geothermal power plants generate electricity with minimal carbon dioxide emissions, contributing to mitigating climate change.

(Google, 2025)

SUMMARY OF FINDINGS

RENEWABLE ENERGY DECISION MAKING SUMMARY

When considering the renewable energy decision-making criteria for this project (see page 7):

SOLAR PV

Solar PV presents the strongest opportunity for the Upper Skeena Region residents to get reliable cost-efficient renewable energy.

WIND POWER

Wind power scores the lowest in viability as a renewable energy opportunity because of the lack of current dependable wind, cost of development, physical space required, and regulatory requirements. In some areas of the Upper Skeena Region, it may be a consideration to have a micro system to add to your energy system.

SMALL HYDROPOWER (RUN OF THE RIVER)

Small hydropower has the potential to be a contributor to community power needs but there are substantial regulatory and political hurdles to overcome.

BIOENERGY

Bioenergy has the potential to be a contributor to community energy needs in the future. The current barriers for bioenergy in the Upper Skeena are education on the current technology to understand how efficient and clean the energy production is, regulatory hurdles, and the high cost for large bioenergy installations.

As more biomass is produced, an equivalent amount of carbon is absorbed, making modern bioenergy a near-zero emissions fuel. It is the largest source of renewable energy globally, accounting for almost 55% of renewable energy (excluding traditional use of biomass) and over 6% of global energy supply.[1]

[1]*https://www.iea.org*

Burning fossil fuels is changing our climate—creating more extreme weather, bigger forest fires, deeper droughts, and more frequent flooding throughout BC. Climate change has created an urgent need to move away from reliance on fossil fuels and make the switch to powering our economy with clean energy.[2]

Our goal at Skeena Watershed Conservation Coalition (SWCC) is to empower the Upper Skeena community with the tools and information needed to transition to a cleaner, low-carbon future through this practical guide, which will be accessible on our project website.

Within the Upper Skeena Decision-Making Matrix, our team has collected the most objective and up-to-date information on these energy topics. However, as technology changes and improves, we intend to update the information on the website as needed.

We hope this guide will be helpful to you in your energy decisions.

Sincerely,

The SWCC Team

[2] https://www2.gov.bc.ca

Photo Credits

Pg. 10. Close up of Solar Panel Photo. Photo by Los Muertos crew.pexels.com

Pg. 12. Roof Mounted System. Photo provided by Urban Systems

Pg. 13. Ground Mounted Systems. Photo provided by Urban Systems

Pg. 15. Modern Inverters and Batteries. Photo by GOTT Energy, Prince George BC

Pg. 16. Crew installing Roof Mounted Solar Panels. Photo by USDAgov-flicker.com

Pg. 17. Solar Panel with Crow (modified). Photo by mrganso, connie_sf-pixabay.com

Pg. 17. The Wallet. Photo by Sadi Hockmuller-pexels.com

Pg. 18. Solar Technician. Photo by Cristian Rojas-pixels.com

Pg. 19. Batteries. Photo by GOTT Energy, Prince George BC

Pg. 20. Hupacasath First Nation Run of the River renewable energy hydro Port Alberni. Photo by Green Energy Futures. www.creativecommons.org.CC-BY-2.0

Pg. 24. Alta Gas Run of the River Project. Photo by https://www.terracestandard.com

Pg. 28. Wind Turbines at Dusk. Photo by Markus Distelrath. www.pixabay.com

Pg. 30. Man, and Dog with Wind Turbine. Photo by Dikilitas – pexels.com

Pg. 32. Biomass. Photo by Idaho National Laboratory. www.creativecommones.org CC-BY-2.0

Pg. 35. Wood Pellets. Photo by Willfried Wende – pixabay.com

Pg. 36. Photo of Flame. Photo by pixabay.com

Pg.39. Geothermal System. Image provided by Natural Resources Canada

S W C C

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