





<b>KITSELAS BIOMASS COMBINED HEAT AND POWER</b>																						
<b>GITAUS COMMUNITY ENERGY AUDIT</b>																						
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<p><b>Project Description:</b> KitseLas First Nation is developing a project that will utilize forest residuals as fuel in a biomass combined heat and power system with the goal of offsetting fossil fuel consumption, creating local economic opportunities, and strengthening the community's energy security.</p>		<p><b>Sealed:</b></p>																				
<p><b>Document Description:</b> This document contains an inventory of all existing and planned infrastructure with associated energy consumption values. The intent is for this information to help guide the selection, sizing, and configuration of a future biomass energy system.</p>																						
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## 1 EXECUTIVE SUMMARY

Gitaus is a community of the Kitselas First Nation and consists of primarily residential homes in addition to a few community/administration buildings. The buildings rely primarily on electrical heating and wood stoves, or a combination of both.

Based on the approach of this energy audit, a summary of the estimated energy consumption values for the community of Gitaus is shown below:

	Consumption (kWh)	Base Demand (kW)	Average Load (kW)	Maximum Load (kW)	Peak Demand (kW)	Adjusted Peak (kW)
Existing Residential Home (Single)	20,135	0.9	2.3	4.3	13.5	10.8
Existing Residential Homes (Total)	1,630,939	72	186	344	1,095	876
Community Buildings	457,659	20	52	97	193	154
New Development (40-Unit)	291,830	13	33	62	128	102
<b>Total</b>	<b>2,380,428</b>	<b>105</b>	<b>272</b>	<b>503</b>	<b>1,416</b>	<b>1,132</b>
Space Heating	1,520,055	67	174	321	918	734
Water Heating	345,228	15	39	73	211	168
Plug Loads	369,668	16	42	78	209	167
Lighting	145,477	6	17	31	78	62

Table 1: Gitaus Community Energy Consumption

## 2 PROJECT BACKGROUND

Kitselas First Nation is in the early stages of analyzing the feasibility of a biomass combined heat and power system in the community of Gitaus, BC. In late 2020, Clean Energy Consulting Inc. (CEC) was engaged by Westland Resources Ltd., who is managing the project on behalf of Kitselas, to provide a high-level summary and cost assessment for the construction of a district heat system in the community which would be tied into the prospective biomass CHP system. This study captured some of the considerations around the capital costs and construction efforts required to develop the system; however, an investigation into the energy consumption of the community was also needed to help determine the size and technology selection of the future biomass CHP system. In early 2021, CEC was re-engaged to complete an energy audit of the community based on community info provided by Westland Resources.

## 3 COMMUNITY OVERVIEW

Gitaus is a Kitselas First Nation community located approximately 19 kilometres east of Terrace, BC on the Kitselas IR No. 1 reserve.



Figure 1: Gitaus Building Categories

Three categories of buildings were analyzed in this study:

### 3.1 Existing Residential Homes

The community of Gitaus includes 81 residential homes which vary in size from 900 to 2,300 square feet. The homes were built between 1991 and 2011, and rely on electric baseboards, central electric forced air, and wood stoves for space heating.

### 3.2 Community and Administration Buildings

The community buildings included in this study are the Education Centre, Elders Centre, Youth Centre, Administration building, Land and Resource building, Fire Hall, Northwest Inter-Nation Family and Community Services (NIFCS) building, as well as two shops. These buildings rely on electric heaters or natural gas for heating with the exception of the Administration building which uses a geothermal system tied into a forced-air system using a ground-source heat pump. The forced-air system uses electricity to operate the heat pump and blower and is provided with supplementary heat from the geo-exchange network.

### 3.3 New Development

A new 40-unit housing development has been proposed for Gitaus and the design phase is currently underway. The details surrounding building size, construction type, and mechanical systems are not yet confirmed/provided to CEC at the time of this audit. Additional construction plans have been suggested such as a community hall, commercial development facility, and a wastewater/sewage treatment plant; however, these developments were not included in the scope of this study. It is to

be assumed that whenever the term “New Development” is referenced in this report, it is referring to the 40-unit housing development only.

## 4 ASSUMPTIONS

### 4.1 Peak Demand

Because hourly energy consumption data could not be obtained from the BC Hydro (BCH) energy bills provided, a method for estimating peak demand was required. For this study, peak demand was calculated based on the concept of load factor. Load factor is a ratio that characterizes the peak load relative to the actual energy consumption. It is calculated using the formula:

$$LF = (\text{Consumption During Period (kWh)} \times 100) / (\text{Peak Demand (kW)} \times \# \text{ Hours in Period})$$

According to a study from the U.S. Department of Energy – Office of Scientific and Technical Information in which 178,368 homes were studied, a typical load factor for residential homes is approximately 0.170, 0.261 for apartments, and 0.271 for commercial/institutional buildings. This load factor in combination with the annual energy consumption can be used to forecast the peak demand (kW).

### 4.2 Energy Use Breakdown

Using NRCan historical data from 2000 to 2018, an average end-use breakdown was calculated and applied to the consumption values at Gitaus in order to assign a proportion of the total energy use to each end use. These proportions were categorized depending on if the home was single detached, singled attached, an apartment, or a commercial/institutional building. These values were compared with other credible sources to confirm validity.

End Use	% of Total Energy Consumption			
	Single Detached	Singled Attached	Apartment	Commercial/Industrial
Space Heating	67	58	53	55
Water Heating	16	21	24	6
Plug Loads	13	17	20	24
Lighting	4	4	3	15

Table 2: Energy End Use Breakdown

### 4.3 Diversity Factor

A diversity factor of 0.8 was applied to the peak loads to calculate the “adjusted peak load”, which accounts for the reality that not all peak energy demands will occur simultaneously across all consumers. Despite there being periods of high energy intensity, there will still be a level of dispersion of energy usage which lowers the total peak demand. For approximating this situation, 0.8 is a typical factor.

### 4.4 Other Assumptions

- Maximum and base demands for the reference data, RETScreen, and new 40-unit development data sets were approximated based on a linear relationship between the base, maximum, and average loads calculated from the BCH energy bill data.

- 
- BCH energy bill data provided for four homes in Gitau was applied to all other existing residential homes according to which home it was most similar to. This is not an accurate method and it would be preferable to have a larger sample size of energy bills to generate more reliable baseline data.
  - Air conditioning loads were grouped into the “Plug Loads” category of the energy end-use breakdown for simplicity.
  - Building construction, occupancy, appliance types, etc. were estimated based on reasonable assumptions within RETScreen.
  - To estimate the energy consumption using the reference data involving an energy intensity factor (GJ/m<sup>2</sup>), basements and garages are required to be excluded. For the existing residential homes in Kitselas, it was assumed that if a home was larger than 1,000 ft<sup>2</sup>, the basement area is equal to 70% of the entire house footprint. This area was deducted from the provided building sizes and used in the energy calculation. The impact of this assumption is minimal as the “Reference Data” data set was only assigned a 5% weight to the “Blended Data” methodology of estimating energy consumption.
  - Exact sizes for the buildings in the new, 40-unit development area are not yet known so approximations were made using Google Earth.
  - Wood stove usage in the community was not factored into the energy consumption due to a lack of information on its use. For this information to be used effectively, the amount of firewood used for the homes with provided BCH bills would have to be known. Currently, only estimated firewood use for the entire community is known which, when seeking total household energy consumption, creates issues when applied to single homes with varying electrical consumption. It is unknown the proportion of energy that is obtained from electrical sources or firewood for that specific consumer.

## 5 DATA SETS

An energy audit is only as accurate as the information that is available to complete the analysis. The information shown in this report is based on a combination of actual historical community energy usage, typical values, and reference information that factors in actual community data.

A few different methods were used to develop a community energy profile, each with their own assumptions, drawbacks, and levels of accuracy.

### 5.1 Energy Bills

BC Hydro energy bills for four residential homes were provided to CEC which showed total electricity consumption (kWh) on a monthly basis. This information was then further broken down into the average daily consumption (based on the number of days per month), and subsequently the average daily demand (kW). From these results, the average annual consumption, minimum daily demand, and maximum daily demand were determined. It should be noted that these values are approximations only as they are based on apportioning the monthly consumption evenly to each day. Realistically, there will be fluctuations in usage throughout the month depending on a variety of environmental, occupancy, and seasonal variations.

In order to simulate the total energy consumption of the community based on the provided energy bills, each home in the community was assumed to have the same energy consumption as the data in the energy bills. The provided energy bills contained homes with electric heating, wood stoves in addition to electric heating, an electric furnace, and with square footages between 900 ft<sup>2</sup> and 2300

ft<sup>2</sup>. Once the building inventory was populated, each home was assigned the data that best fits with the data shown in the energy bills based on the heating system type and size. Although this is not an entirely accurate method, considering that each home’s characteristics and usage will differ from the sample BCH bills, it is the best compromise given the small sample size of actual community energy usage data.

Once each building in the building inventory list was assigned an annual consumption, base load, average load, maximum load, and peak demand, the consumption values were summed and the demand values averaged to provide indicative values for the entire community. Missing from this are the community/administrative buildings as well as the new development as their consumption and demand cannot be accurately deduced from the residential energy bills provided.

For buildings 1, 2, and 3, extra months of data were included; however, any months beyond 12 were not considered as the seasonal variations would distort the results. Building 4 was not used significantly in the analysis as it only contained 6 months of data and thus a total annual energy profile cannot be established.

Lastly, a diversity factor of 0.8 was applied to peak loads to represent the concept that a coincident maximum load will not occur as peak demands for each consumer will occur at varying times.

A summary of the estimated energy consumption is shown in Table 3 below:

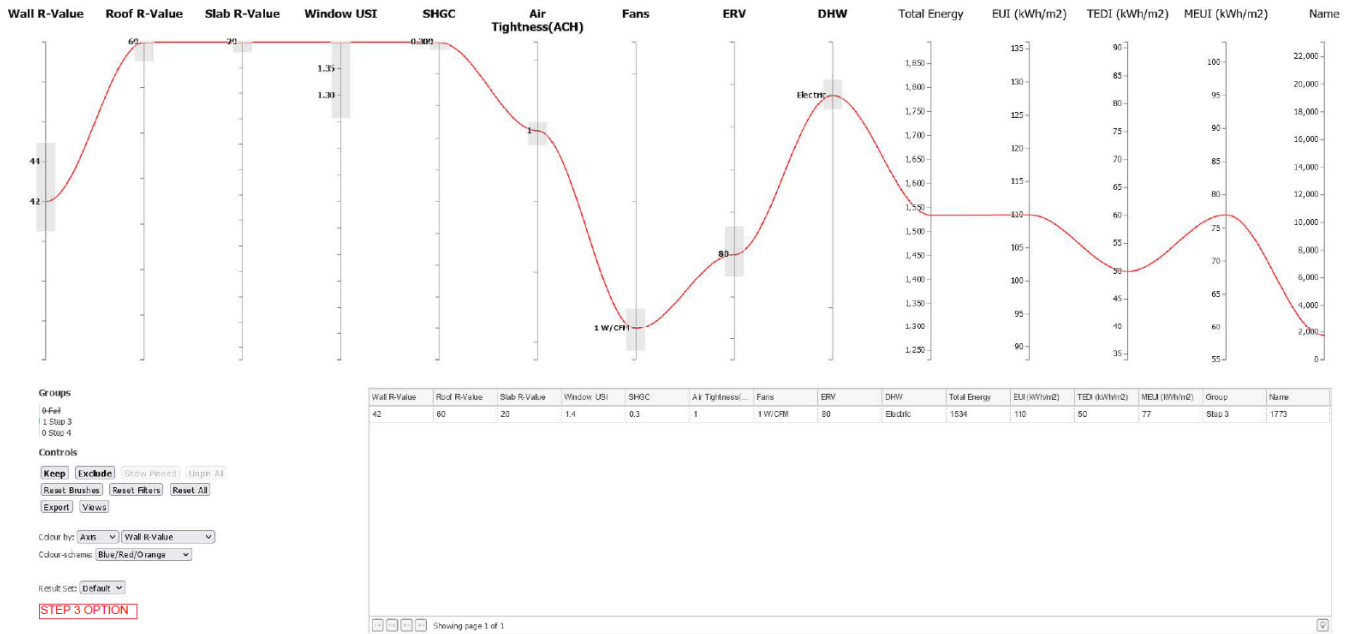
	Consumption (kWh)	Base Demand (kW)	Average Load (kW)	Maximum Load (kW)	Peak Demand (kW)	Adjusted Peak (kW)
Existing Residential Home (Single)	17,604	0.7	2.0	3.9	11.8	9.5
Existing Residential Homes (Total)	1,425,898	59	163	317	957	766
Community Buildings			N/A			
New Homes			N/A			
<b>Total</b>	<b>1,425,898</b>	<b>59</b>	<b>163</b>	<b>317</b>	<b>957</b>	<b>766</b>
Space Heating	960,141	39	110	213	645	516
Water Heating	224,107	9	26	50	150	120
Plug Loads	183,590	8	21	41	123	99
Lighting	58,059	2	7	13	39	31

Table 3: Summary of Energy Consumption Based on Actual BCH Bills

Note: individual heating bills used to calculate the estimated total community energy consumption are available upon request.

## 5.2 New Development Data

CEC was provided with a site plan of the proposed new 40-unit housing development designed by David Naime + Associates Ltd., as well as projected energy consumption data from a “Building Energy Performance Map” prepared by Morrison Hershfield. Approximate building footprint dimensions were obtained from Google Earth based on the site layout. This value was used in conjunction with the EUI (energy use intensity, kWh/m<sup>2</sup>) factor listed in the “Building Energy Performance Map” to estimate the energy consumption and demand for the total new development. The EUI used in the analysis was taken from the “Step 3 Option”, 110 kWh/m<sup>2</sup>, as this was the higher value between the two options.



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Figure 2: Building Energy Performance Map

### 5.3 Reference Data

This approach involved obtaining reference energy consumption data from a variety of sources and averaging the results to generate estimated energy consumption and demand values which were applied to the buildings in Gitau. More specifically, this approach incorporates two methods for estimating energy consumption: typical energy consumption and typical energy consumption based on building size.

Firstly, average annual energy consumption for a residential home in British Columbia was established based on a combination of data from Statistics Canada and NRCan between the years 2007 and 2015. This resulted in an average annual consumption value of 26,332 kWh. Next, a separate annual energy consumption value was determined based on an energy intensity factor (GJ/m<sup>2</sup>) defined by data generated from Statistics Canada. This energy intensity factor varies depending on the square footage of the home and excludes the basement and garage. Building sizes in Gitau were provided to CEC and verified for relative accuracy using Google Earth. The appropriate energy intensity factor was applied to each home in Gitau which produced an estimated annual energy consumption for each home. These values were then averaged with the previously calculated value of 26,332 kWh. Note that for the purpose of this audit, the buildings proposed in the new 40-unit development were assumed to be the same as the existing residential homes as detailed information on the type and size of these buildings has not yet been made available.

Because this approach does not involve utilizing actual BCH energy bills, base, average, and maximum demands were more challenging to estimate. A base vs. average load and maximum vs. average load factor (linear ratio) was calculated from the provided energy bills and applied to the average load calculated from the reference data. This resulted in estimated base and maximum loads for the data produced from this method. Peak demands were calculated using the “load factor” formula described in Section 4.1. The disadvantage of this method is that the reference data only pertains to a general location of “British Columbia” rather than specifically to Gitau or Terrace, BC. Therefore, the energy consumption values may be underestimated considering that the climate in Gitau is likely colder than the climatic conditions assumed in the reference data.

	Consumption (kWh)	Base Demand (kW)	Average Load (kW)	Maximum Load (kW)	Peak Demand (kW)	Adjusted Peak (kW)
Existing Residential Home (Single)	27,558	1.2	3.1	5.8	18.5	14.8
Existing Residential Homes (Total)	2,232,193	98	255	471	1,499	1,199
Community Buildings	563,959	25	64	119	238	190
New Development (40-Unit)	1,102,317	49	126	233	740	592
<b>Total</b>	<b>3,898,469</b>	<b>172</b>	<b>445</b>	<b>823</b>	<b>2,477</b>	<b>1,981</b>
Space Heating	2,452,309	108	280	518	1,569	1,255
Water Heating	618,560	27	71	131	407	326
Plug Loads	609,301	27	70	129	375	300
Lighting	218,299	10	25	46	126	101

Table 4: Summary of Energy Consumption Based on Reference Data

## 5.4 RETScreen

This method involved using RETScreen Clean Energy Management Software developed by NRCan to establish estimated annual and peak energy consumption values for the buildings in Gitau. Historical climate data for Terrace, BC was selected and assumptions were made for variables such as building construction, electrical appliance quantity and type, occupancy, lighting type and schedules, etc. The resultant total energy consumption for a residential home in Gitau was 27,772 kWh.

	Consumption (kWh)	Base Demand (kW)	Average Load (kW)	Maximum Load (kW)	Peak Demand (kW)	Adjusted Peak (kW)
Existing Residential Home (Single)	27,772	1.2	3.2	5.9	18.6	14.9
Existing Residential Homes (Total)	2,249,532	99	257	475	1,511	1,208
Community Buildings	565,223	25	65	119	238	190
New Development (40-Unit)	1,110,880	49	127	235	746	597
<b>Total</b>	<b>3,925,635</b>	<b>173</b>	<b>448</b>	<b>829</b>	<b>2,495</b>	<b>1,996</b>
Space Heating	2,469,634	109	282	521	1,580	1,264
Water Heating	623,183	27	71	132	410	328
Plug Loads	613,282	27	70	129	378	302
Lighting	219,536	10	25	46	127	101

Table 5: Summary of Energy Consumption Based on RETScreen Data

## 6 RESULTS

### 6.1 Energy Consumption

The final results were based on a blend of the aforementioned data sets as this method was deemed the most accurate and produces results most suitable for sizing a future CHP system. For this approach, the data sets described in Section 5 were blended together with varying weights depending on the level of confidence with the accuracy or applicability of that particular data set. For the existing residential homes and community buildings, energy consumption and demand values for data resulting from BCH energy bills, historical reference data, and RETScreen values were amalgamated with weightings of 75%, 5%, and 20%, respectively. For the new 40-unit development buildings, the values were taken solely from calculations based on the information provided in the site layout and “Building Energy Performance Map”.

	Consumption (kWh)	Base Demand (kW)	Average Load (kW)	Maximum Load (kW)	Peak Demand (kW)	Adjusted Peak (kW)
Existing Residential Home (Single)	20,135	0.9	2.3	4.3	13.5	10.8
Existing Residential Homes (Total)	1,630,939	72	186	344	1,095	876
Community Buildings	457,659	20	52	97	193	154
New Development (40-Unit)	291,830	13	33	62	128	102
<b>Total</b>	<b>2,380,428</b>	<b>105</b>	<b>272</b>	<b>503</b>	<b>1,416</b>	<b>1,132</b>
Space Heating	1,520,055	67	174	321	918	734
Water Heating	345,228	15	39	73	211	168
Plug Loads	369,668	16	42	78	209	167
Lighting	145,477	6	17	31	78	62

Table 6: Summary of Energy Consumption Based on Blended Data

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## 7 ENERGY PROFILE

An energy profile is a method of displaying an energy consumer's consumption according to a defined timescale. This allows for a visual representation of how and when the user uses their energy throughout the day, week, month, etc. The location on an energy profile graph where the usage is at a maximum indicates the time in which peak demand occurs along with the associated energy intensity at that moment. Peak demand is defined as the highest electrical power demand occurring over a defined duration. It is an important factor when analyzing energy consumption as it establishes the required sizing of associated electrical infrastructure. The time of peak demand varies depending on the building's usage and occupancy patterns. In Gitau, the energy profiles of the residential homes will likely be fairly consistent but will differ from the energy profiles of the community buildings.

Unfortunately, the BC Hydro energy bills provided for the four homes in Gitau do not display the data with enough granularity to determine actual peak demand or the time it occurs. Because residential homes in British Columbia are only charged a daily flat fee plus a consumption-based rate and no demand charges, only the monthly consumption amount is relevant to calculating the final cost to the customer. However, when sizing a future energy system, it is important to consider the daily energy profile of these residential homes as future infrastructure will need to be appropriately sized to handle the maximum demand of these users.

Despite the inability to generate an exact load profile for Kitselas, there is a typical load profile for British Columbia that can be applied to the residential homes in Kitselas to provide an indicative summary of energy use on an hourly and monthly basis. Community buildings will differ slightly but should follow the same trends. As shown in Figure 3 below, minimum energy consumption occurs in the early morning when there is minimal electrical consumption due to few appliances or lighting operating. Around 7:00 a.m., energy intensity begins to rise as residents wake up and begin operating appliances and running hot water. This energy use climbs to a peak between 8:00 a.m. and 10:00 a.m. before lowering slightly during the afternoon. Energy use then rises again to the daily peak between 3:00 p.m. and 6:00 p.m., presumably when residents return home from work and begin operating cooking appliances, doing laundry, etc. This usage then tapers off as the evening progresses and lowers to the minimum usage point between 1:00 a.m. and 3:00 a.m. From a weekly perspective, usage typically is higher on weekends when occupants are more likely to be at home using appliances, hot water, and other energy-consuming equipment. This energy profile is only an approximation of a typical household and will vary depending on the occupants' habits and energy usage patterns. For a commercial building (or in the case of Kitselas, community/administrative buildings), similar trends in energy usage for daily consumption will likely be noticed; however, energy consumption during working hours may be more pronounced than in a residential scenario. Additionally, weekend energy consumption will likely be significantly less than weekdays depending on business hours.

Seasonal variation in an energy profile is quite significant in colder climates such as Gitau. Typically, the winter months result in higher energy consumption due to heating requirements and increased indoor occupancy. Figure 4 shows an indicative yearly energy profile that can be applied to Gitau for conceptual purposes. As shown, energy use is highest during the harshest winter months and decreases towards summer. Often there is a slight rise in consumption during the hottest month or two due to air conditioner usage; however, it is unknown how prevalent the use of air conditioners is within Gitau.

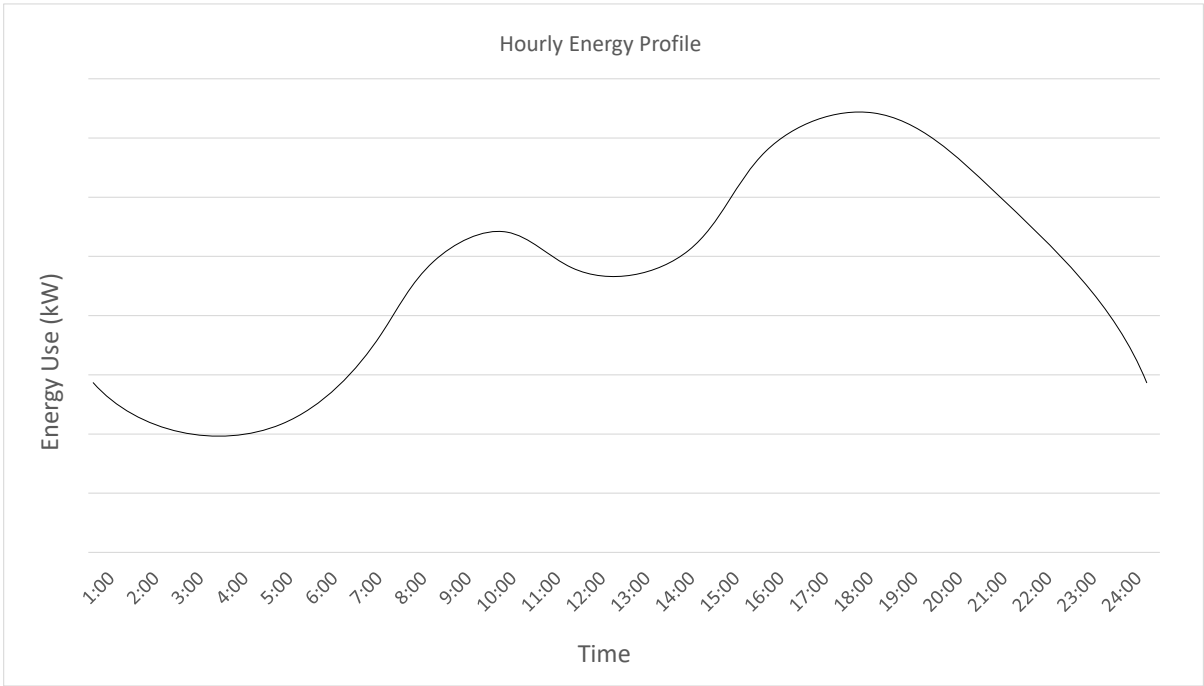


Figure 3: Hourly Energy Profile

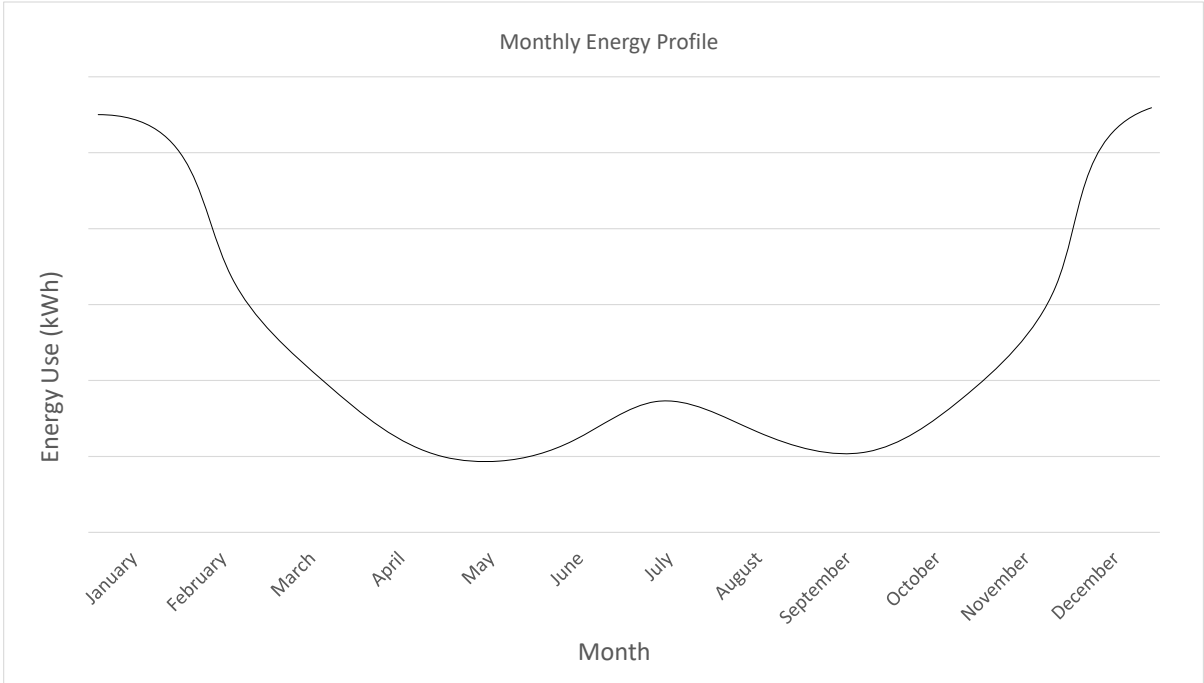


Figure 4: Monthly Energy Profile

## 8 BIOMASS CHP CONSIDERATIONS

Using the results from the blended data, the electrical and heating loads were totalled and shown below. Based on the energy consumption of the existing buildings as well as the new 40-unit development, a CHP system would need to be designed to provide approximately 394 kW of thermal energy and 109 kW of electrical energy at a minimum. During periods of peak energy consumption (903 kW of thermal energy and 230 kW of electricity), a battery or other form of peaking system should be utilized to handle these durations of high demand.

	Consumption (kWh)	Base Demand (kW)	Average Load (kW)	Maximum Load (kW)	Peak Demand (kW)	Adjusted Peak (kW)
Electricity	515,145	23	59	109	287	230
Thermal Energy	1,865,283	82	213	394	1,128	903
<b>Total</b>	<b>2,380,428</b>	<b>105</b>	<b>272</b>	<b>503</b>	<b>1,416</b>	<b>1,132</b>

Table 7: Electrical and Thermal Demand for Proposed CHP System

The task of analyzing the feasibility of implementing a biomass CHP system in a community requires significant consideration and forward thinking. One of the first considerations, however, should be around the purpose of implementing this technology. A biomass CHP, as indicated by the term, produces electrical energy in addition to thermal energy so it is important to consider how these two forms of energy are currently utilized in the community and how they will be utilized in the future. Both the quantity of energy used as well as the time it is used (hourly and seasonally) are important factors in selecting the appropriate energy system.

Based on the results of this energy audit, it is demonstrated that the community currently requires a peak electrical capacity of 230 kW and a peak thermal capacity of 900 kW. Currently, this demand is primarily met from the electrical grid which supplies electricity for power and space heating (except for a minority of energy from wood stove, fossil fuel, and geothermal sources) meaning that if a CHP system were to be implemented, a use for the heat portion of the process would need to be established. Typically, CHP systems generate more thermal energy than electrical and so in community energy applications, this thermal energy is sometimes used in a district heating network to provide space heating for end-users. However, at Kitselas, since the primary heating source for residential homes is through electrical baseboards, integration with a district energy system proves challenging. As outlined in a previous report Clean Energy Consulting Inc. prepared for Westland Resources regarding designing a district heating system in Gitau (*“Facility Considerations, Part 1: District Heating – Sections 1A, 2A”*), retrofitting the predominant space heating system is a difficult and costly undertaking. District energy systems are better suited to hydronic heating applications where integration can be completed with an “energy transfer station” to tie into the existing heating loop. In situations where the existing heating system is based on electric baseboards or a central furnace, the likely possibility for integrating with a district heating system would mean installing an entirely new hydronic heating system.

However, if a CHP system were to be implemented in Gitau, the thermal energy could be utilized in other forms other than space heating of the existing buildings such as for greenhouses, snow melt systems, future industrial processes, or for supplying heat to future developments that utilize a hydronic heating system. Additionally, the administration building in Gitau is a relatively significant energy consumer and creates an opportunity for it to be retrofitted for integration with a CHP system. This building uses approximately 500 GJ of energy in which around half of that is used for space heating. Since the heating is currently provided from a geothermal system (ground-source heat pump) combined with a forced-air system, it is possible to retrofit the system to allow the CHP system to supplement it with additional heat.

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## 8.1 Equipment Efficiency Considerations

Although the primary heating source for most buildings in Gitau is electric baseboard or electric furnaces which can be assumed to have an efficiency near 100%, if there are any heating systems based on natural gas or diesel, an efficiency factor of 80% should be applied to these consumers. This means that the amount of energy delivered is actually 20% higher than what is needed to heat the space. For the purpose of sizing a CHP system with a district energy network, this efficiency should be considered since a district energy system and energy transfer station should be sized to provide the exact amount of heat the consumer requires (accounting for minor heat losses due to pipe length and heat exchangers), which will be less than the energy previously required for a fossil-fuel based system.

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## 9 REFERENCES

- [1] B. Dewar and R. Brouwer, "Kitselas First Nation Combined Heat and Power using Wood Residue, Phase 1: Prefeasibility Assessment Final Report," Terrace, BC, Canada, 2020.
- [2] Statistics Canada, "Table 25-10-0060-01 Household energy consumption, Canada and Provinces," 01 12 2017. [Online]. Available: <https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=2510006001&pickMembers%5B0%5D=2.1&cubeTimeFrame.startYear=2011&cubeTimeFrame.endYear=2015&referencePeriods=20110101%2C20150101>.
- [3] Statistics Canada, "Households and the Environment Survey: Energy Use, 2007, Catalogue no. 11-526-S," 2007. [Online]. Available: <https://www150.statcan.gc.ca/n1/pub/11-526-s/2010001/t006-eng.htm>.
- [4] Natural Resources Canada, "Energy Efficiency Trends in Canada 1990 to 2013," [Online]. Available: <https://www.nrcan.gc.ca/energy/publications/19030#a3>.
- [5] Statistics Canada, "Households and the Environment: Energy Use, 2007," 2010.
- [6] BC Hydro, "Average household usage can vary," [Online]. Available: <https://www.bchydro.com/search.html#?cludoquery=What%20is%20the%20average%20power%20usage%20for%20a%20residential%20customer%3F&cludopage=1>.
- [7] A. Parekh and P. Wang, "Survey Results of User-Dependent Electricity Loads in Canadian Homes," Natural Resources Canada.
- [8] Natural Resources Canada, "Energy Use Data Handbook Tables," [Online]. Available: <https://oee.nrcan.gc.ca/corporate/statistics/neud/dpa/menus/trends/handbook/tables.cfm>.
- [9] J. R. New, M. B. Adams, E. Garrison, W. Copeland, B. Smith and A. Campbell, "Nailing the Peak: City-Scale, Building-Specific Load Factor and Contribution to a Utility's Hour of Critical Generation," 2019.
- [10] Morrison Hershfield, "Building Energy Performance Map - "Step 3 Option"".
- [11] David Naime + Associates Ltd., *Kitselas First Nation - Site Plan*, 2019.
- [12] G. Watkins, "A Third Factor in the Variation of Productivity: The Load Factor," *The American Economic Review*, vol. 5, no. 4, p. 34, 1915.
- [13] Clean Energy Consulting Inc., "Kitselas District Energy System".