Thompson Rivers University
ASHRAE Level 1 Energy Study

Energy Study for:

House 10 – Horticulture

Attention:

Natalie Yao

Energy Specialist

Thompson Rivers University

Prepared by:

SES Consulting Inc.

Suite 410 – 55 Water Street
Vancouver, BC V6B 1A1
Tel: 604.568.1800
www.sesconsulting.com

May 23, 2022

House 10 – Horticulture
- ASHRAE Level 1 Study -

Table of Contents

List of Figures

List of Tables

1. Background Description of Facility, Hardware and Systems

1.1 Overview and Facility Use

House 10, housing the Horticulture department, was originally constructed in 1945. The gross conditioned square footage of the building is 341 m^2 (3,670 ft^2). Two external greenhouses are heated, with a total area of 413 m^2 (4,447 ft^2). The combined area was used for calculations presented in this report.

The facility consists of two houses connected on the ground floor. On the main level, there is a classroom in one house, and a lunch room with kitchen in the other. There are offices on the second level of both sides. The basement is used for storage and houses mechanical systems. There are three greenhouses, only two of which are heated.

1.1.1 Physical condition and window type

The building appears to be well maintained. The windows are double paned. The building insulation contains asbestos so there are no plans to upgrade the insulation in this building. The building will likely be torn down in the near future. Because of this, no insulation upgrades for considered for this facility.

1.2 Mechanical Systems

1.2.1 Ventilation

Ventilation for the first level of the main house is supplied by two gas fired furnaces, one on each side of the house.

1.2.2 Cooling

Two ground mounted cooling units, located outside the building, serve the first level of the house via cooling coils in the furnaces. Two additional window mounted AC units provide cooling to the upper level.

1.2.3 Heating

Two gas fired furnaces provide heating to the first level of the house. The upper level is heated by electric baseboards.

Two of the three greenhouses are heated. Greenhouse 1, which is the closest to the house, is heated by two gas fired unit heaters. On/off switches control these units. Greenhouse 2 is heated by one gas fired unit heater that was recently upgraded and has a thermostat for control of the unit.

1.2.4 Domestic Hot Water

There is one electric domestic hot water tank in the basement. While this DHW tank is nearing the end of its recommended service life, we do not recommend replacing it as this time since the building is likely to be torn down in the near future. If the building plans change, this DHW could be replaced with a heat pump version.

1.3 Lighting System

Linear LEDs provides most of the lighting in the facility. CFLs provide lighting to the bathrooms and hallways. There are T12 linear fluorescents lamps in the greenhouses. TRU is currently in the process of switching all lighting on campus to LED.

1.4 Control Equipment

One programmable thermostat controls space conditioning for each side of the house. These thermostats are located on the ground level.

The gas unit heater in greenhouse 2 recently received an upgrade. The furnace and exhaust fan are controlled via a thermostat. Greenhouse 1 has on/off switches controlling the unit heaters and exhaust fan which maintain a constant temperature.

1.5 Energy Analysis

1.5.1 Energy Use Profile

Figure 1 presents the building's electrical consumption from 2017 onwards. Electricity usage is estimated to be higher in the summer during cooling season. The 2019 data from June and July was excluded from the baseline as it was significantly below the average.

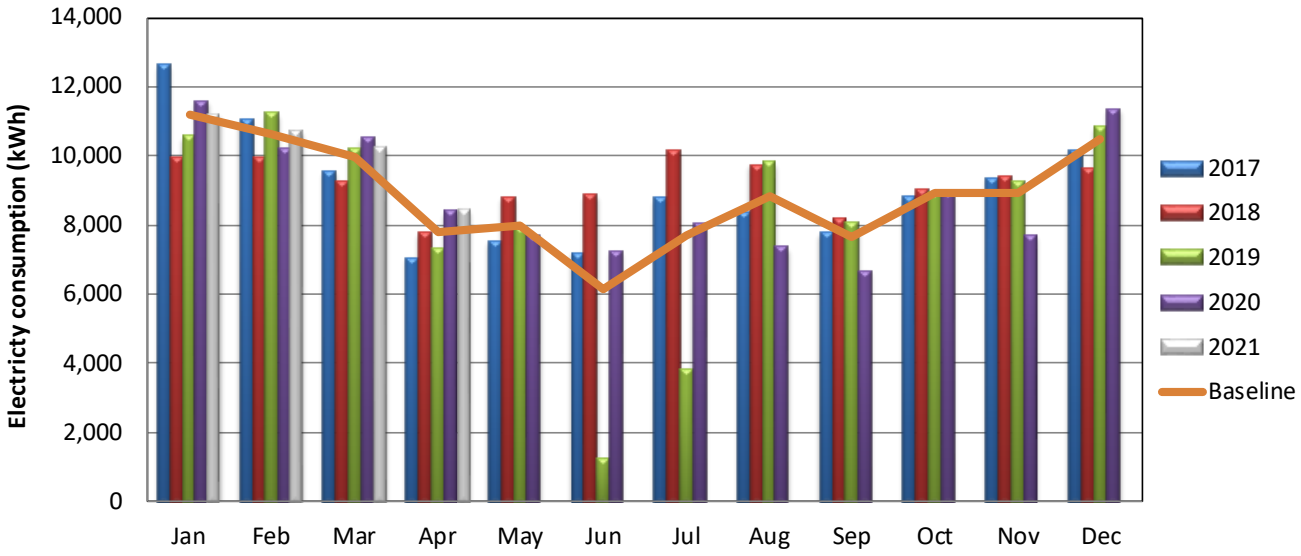

Figure 1: Simulated Monthly Electricity Consumption

Gas data is not available for this facility. Figure 2 presents the building's simulated gas consumption. This was estimated based on equipment sizes and assumed operational hours. Consumption follows a typical heating profile.

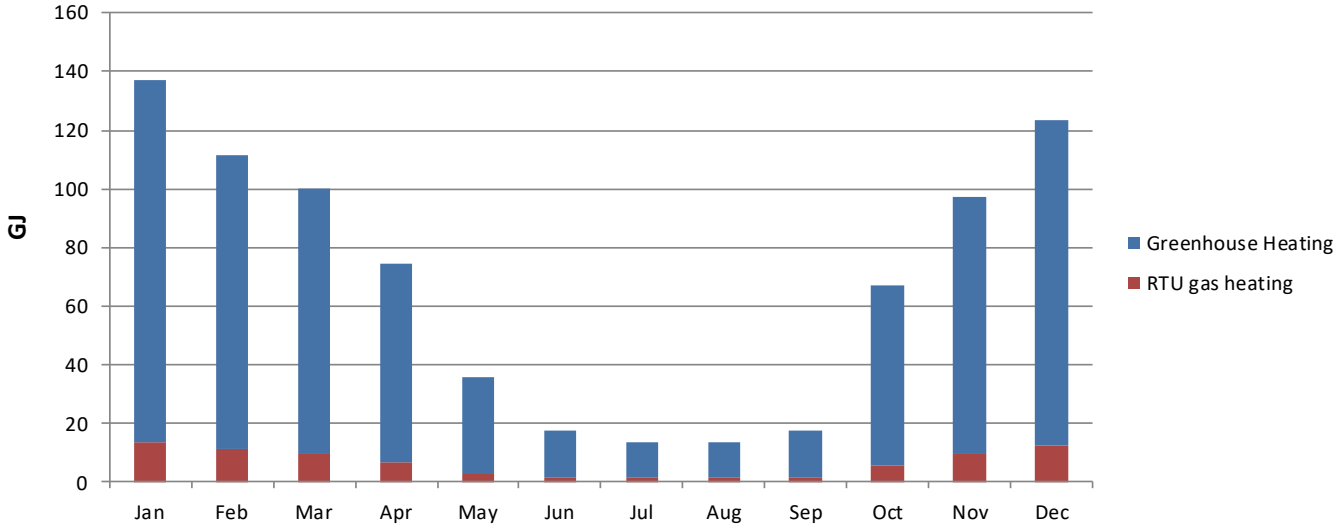

Figure 2: Simulated Monthly Gas Consumption

1.5.2 Energy Intensity Analysis

A summary of Baseline Energy consumption and the corresponding costs and energy intensity for the facility is presented in Table 1. House 10, Horticulture has a Energy Use Intensity (EUI) of 1,590 MJ/m^2.

Table 1: Summary of Baseline Energy Data

Utility	Energy Use (GJ)	EUI (MJ/m2)	Cost ($)	Cost ($/ft2)
Gas	809	1,070	$12,140	$1.50
Electricity	393	520	$6,728	$0.83
Total	**1,202**	**1,590**	**$18,867**	**$2.32**

1.5.3 Energy End Use Breakdown

The energy use is based on estimated operation patterns. The estimated breakdown of electricity consumption by building system is presented in Figure 3.

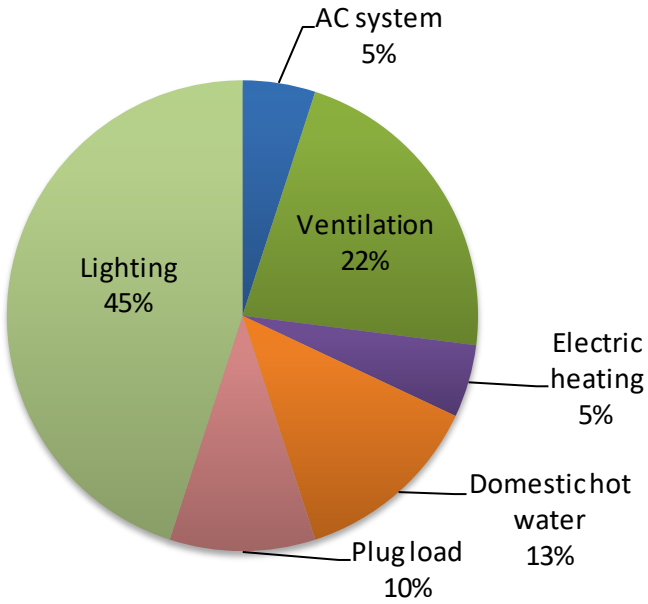

Figure 3: Electricity Consumption

The estimated breakdown of gas consumption by building system is presented in Figure 4.

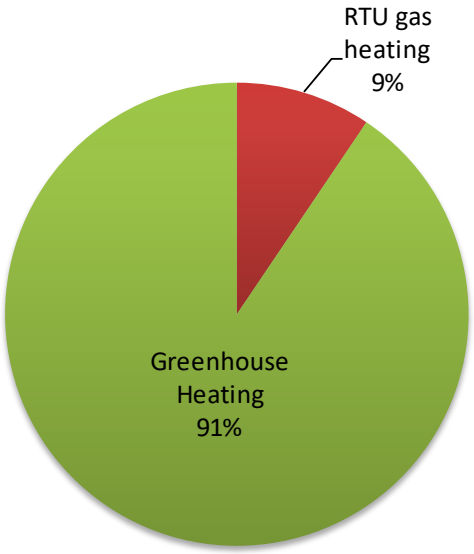

Figure 4: Gas Consumption Breakdown

The estimated percentage of total energy consumption by building system is presented in Figure 5.

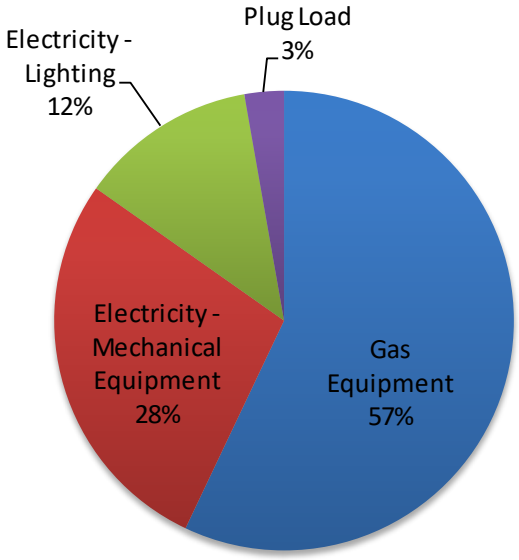

Figure 5: Total Energy Breakdown

2. Conservation Opportunities

The primary objective of this study was to identify and analyse energy conservation opportunities at House 10. The rate schedules used in this analysis for financial savings estimates are presented in Table 2. The financial savings estimates include goods and services tax (GST) and provincial sales tax (PST). For Greenhouse Gas estimates, we have used emissions factors of 0.010 kg CO_2e / kWh of electricity in BC, and 49.87 kg CO_2e / GJ for gas.

It should be noted that the paybacks for the measures consider the carbon tax escalation provided by the federal government.

Table 2: Rate Schedules

Utility	Rate
Electricity	
Marginal Demand Charge	$12.26 / kW (inc taxes)
Marginal Consumption	$0.063 / kWh (inc taxes)
Gas	
Recent Gas Consumption	$15.00 / GJ (inc taxes)

A number of potential conservation opportunities have been analyzed. A detailed explanation as well as an estimated cost and energy saving potential are summarized for these projects. Since some of these measures are mutually exclusive, it does not make sense to present the total savings if all measures are implemented. Table 3 presents the individual measure costs and savings.

2.1 Energy Conservation Measures

A summary of the analysis for the recommended measures is presented in Table 3. Detailed descriptions for each project are presented below. The analysis of the measures does not include incentives provided by BC Hydro or Fortis BC. Based on conversations with operators, the main house building is likely to be torn down in the near future. As such, no upgrades for that portion of the facility were analyzed. The measures presented below are for the greenhouse spaces, which are likely to stay in place, so we believe these measures are good opportunities.

Table 3: Measure Summary

Item	Description	Base Case Cost	Incremental Cost	Total Cost	Effective Payback	NPV	Annual Savings			
							$	GJ	kWh	GHG
1.1	Greenhouse Controls Upgrade		$4,000	$4,000	4.0	3,300	$720	50	500	2.5
1.2	Greenhouse Heat Pumps	$6,600	$17,000	$23,600	2.0	57,400	$5,300	550	(45,800)	27.0
1.3	Renewable Natural Gas				≥ 40		$830			3.8
1.4	Greenhouse Condensing UHs	$6,600	$7,200	$13,800	2.0	19,900	$2,200	140		7.0

2.1.1 Greenhouse Controls Upgrade

There are two heated greenhouses. Greenhouse 2 recently received controls upgrade, but the other greenhouse, Greenhouse 1, uses on/off switches to control the two gas fired unit heaters.

We recommend installing a programmable thermostat in greenhouse 1 to control the unit heaters to a temperature setpoint. This will allow the unit heaters to be turned off fully when the setpoint is achieved rather than relying on staff to remember to turn them off. We also recommend ensuring the unit heater fans are set to auto mode so that they turn off fully when heating is not required. This will likely be beneficial for the plants in the space as well because the temperature will be more consistent.

It should be noted that ducting is inflatable in these units and that the ducts will collapse when the fan is not running. As long as the ducting is properly secured, this should not pose a problem.

2.1.2 Greenhouse Heat Pumps

There are two heated greenhouses with a combined total of three gas fired unit heaters.

This measure recommends upgrading all three unit heaters in the greenhouses with reversible air sourced heat pumps to provide high efficiency heating and mitigate GHG emissions. The existing gas heaters can be kept and used for back up heating in the cold winter months or they can be removed and heat pump models with gas back up can be selected. It should be noted that an incremental cost analysis was used for the analysis of this measure as it is assumed this upgrade only occurs when the UHs in the greenhouse are planned to be replaced.

2.1.3 Renewable Natural Gas

FortisBC offers Renewable Natural Gas (RNG), or biomethane, as an alternative to non-renewable natural gas. This presents an easy path to reducing GHG emissions. The cost of RNG is approximately 1.5 times the cost of non-renewable natural gas, however, there is no additional cost for implementing this measure, given that RNG is delivered using existing FortisBC infrastructure. The analysis of this measure assumes the remaining natural gas in the main building is converted to RNG however, there are options for converting any portion (5%, 10%, 25%, 50%, 100%) of the total gas consumption to RNG. The cost per tonne would be the same regardless of the portion converted. Given the plans for this building, renewable natural gas may be the best option to offset emissions in this facility in the short term.

2.1.4 High Efficiency Greenhouse UHs

There are two heated greenhouses with a combined total of three gas fired unit heaters.

This measure recommends upgrading all three unit heaters in the greenhouses with high efficiency condensing units. It should be noted that an incremental cost analysis was used for the analysis of this

measure as it is assumed this upgrade only occurs when the UHs in the greenhouse are planned to be replaced.

3. Disclaimer

This document was prepared by SES Consulting Inc. for Thompson Rivers University. The scope was to perform a Level 1 Energy Study at this site. An initial investigation has been performed to estimate the probable costs and savings associated with each project. Further detailed design work will be required for project implementation. Any estimates of probable cost are made on the basis of SES's judgment and experience. SES makes no warranty, express or implied, that cost of the work will not vary from the SES's estimate of probable cost. SES accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.