Thompson Rivers University
ASHRAE Level 1 Energy Study

Energy Study for:

House 6&7 - Research Centre

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 22, 2022

House 6&7 - Research Centre
- 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

This facility was originally constructed in 1945. It has 2 floors and a gross floor area of 640 m^2 (6,886 ft^2).

The original building (the Research Centre) consists of a two-floor structure, with two separate basements. The 2nd floor of the East and West sections contain offices, and either a kitchen or washroom. The 1st floors contain offices, lab rooms, a meeting room, and a central workspace. The basements each contain mechanical rooms, lab spaces, and offices.

The building's new addition (Faculty Annex) was added in 2010 and consists of a single-story structure, attached to the original building. The building space primarily consists of offices, a kitchen, meeting room, two washrooms, and a mechanical room.

1.1.1 Physical condition and window type

The building appears to be well maintained. The windows are double paned. It was noted by the operations team that the insulation in the houses contains asbestos and that the houses are likely to be torn down in the near future. As such, no insulation upgrades were considered for this facility.

1.2 Mechanical Systems

1.2.1 Ventilation

Ventilation to the original building is supplied by the following systems:

- A roof-top unit (AC-1), provides ventilation to the central workstations though diffusers in the ceiling
- There are two natural gas fired air handling units that provide heating and ventilation to the east and west sides of the building. They are located outside.

Ventilation to the new addition is provided by four gas furnaces, located in the mechanical room, supplying ventilation through diffusers in the ceiling.

1.2.2 Cooling

Cooling for the original building is supplied by a direct expansion (DX) cooling coil located in AC-1.

Cooling for the new addition is provided by four reversible heat pumps that are connected to the gas furnaces. They providing heating and cooling the new addition.

1.2.3 Heating

Heating for the original building is supplied by the following systems:

- AC-1 contains a gas fired burner
- The two gas fired AHUs located outside provide heating to the east and west sides of the building.

Heating for the new addition is supplied by the following systems:

- Four reversible heat pumps connected to the gas furnaces supply heating to the new addition spaces
- Four gas furnaces in the mechanical room supply supplemental heating
- Three force flow units with electric resistance heaters supply heating to the three entrances

1.2.4 Domestic Hot Water

Domestic hot water (DHW) is supplied to the original building by a single electric DHW tank, located in the East basement mechanical room.

Domestic hot water (DHW) supplied to the new addition by a single electric DHW heater tank, located in the mechanical room.

1.3 Lighting System

The majority of the buildings, approximately 95%, is illuminated by TLEDs. The remaining ~5%, mainly stairwells, washrooms and storage areas, are illuminated with CFL bulbs. TRU is currently in the process of replacing all lighting on campus with LED.

1.4 Control Equipment

The original building's HVAC equipment is controlled by three programmable thermostats serving the following areas:

- The East and West AHUs are controlled by thermostats in the meeting room, and West corridor, respectively
- The RTU is controlled by a programmable thermostat in the workspace area

The new addition's four heat pumps are each individually controlled by four programmable thermostats located in the office spaces of the new addition.

1.5 Energy Analysis

1.5.1 Energy Use Profile

Figure 1 presents the building's electrical consumption since 2018. The data from July 2020 onwards was excluded from the baseline as it was significantly lower than the average, likely as a result from decreased usage during COVID.

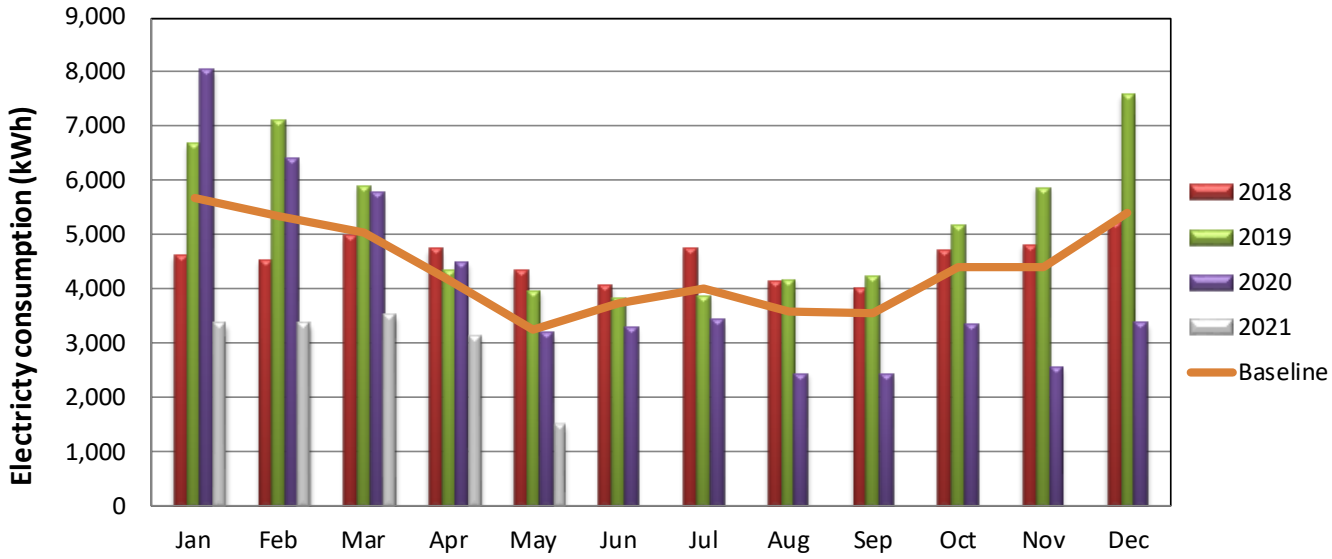

Figure 1: Monthly Electricity Consumption

Gas consumption data was not available for this building. Figure 2 presents the building's simulated gas consumption based on estimated equipment runtime profiles and inventory information.

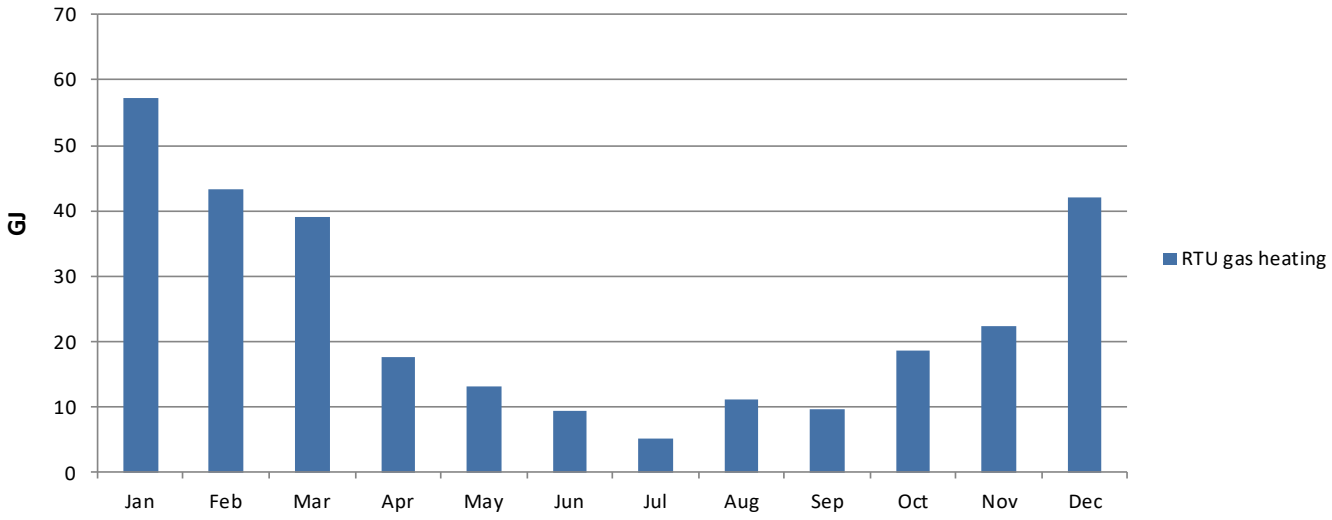

Figure 2: Monthly Gas Consumption

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 6&7 – Research Centre has an Energy Use Intensity (EUI) of 785 MJ/m^2.

Table 1: Summary of Baseline Energy Data

Utility	Energy Use (GJ)	EUI (MJ/m2)	Cost ($)	Cost ($/ft2)
Gas	288	450	$4,326	$0.63
Electricity	214	335	$3,770	$0.55
Total	**503**	**785**	**$8,096**	**$1.18**

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. Gas is only used for space heating.

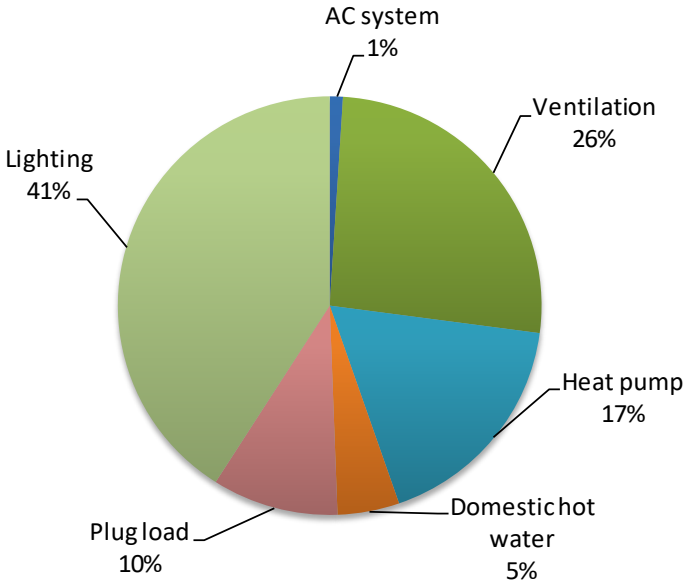

Figure 3: Electricity Consumption

The estimated percentage of total energy consumption by building system is presented in Figure 4.

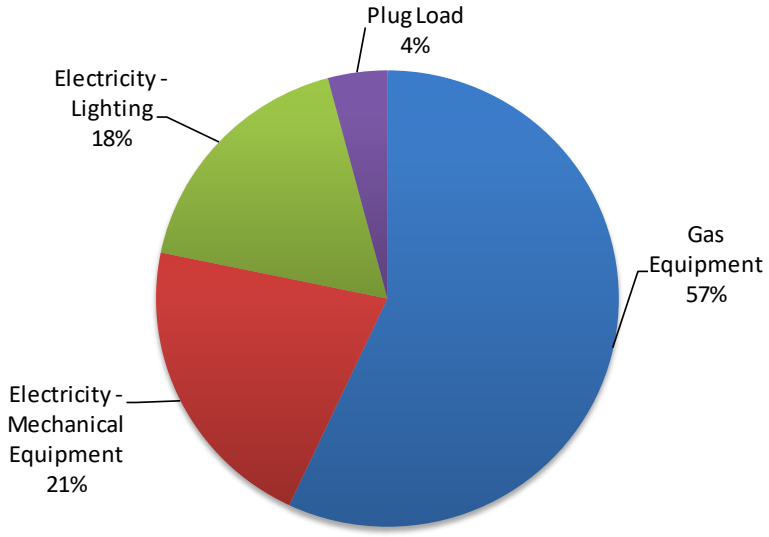

Figure 4: Total Energy Breakdown

2. Conservation Opportunities

The primary objective of this study was to identify and analyse energy conservation opportunities at Houses 6 and 7. 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 measure savings. The individual measure savings are presented in Table 3.

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 for these measures does not include incentives from BC Hydro or Fortis BC. Although it was noted by operations that many of the houses on campus will be torn down in the near future, given that the building addition was only added in 2010, it is unlikely that this is one of those buildings. As such, implementing energy conservation measures on this building may make sense.

Table 3: Measure Summary

Item	Description	Base Case Cost	Incremental Cost	Total Cost	Effective Payback	NPV	Annual Savings			
							$	GJ	kWh	GHG
1.1	Heat Pump AHUs	$30,000	$18,000	$48,000	6.0	11,900	$2,200	220	(18,200)	10.8
1.2	High Efficiency AHUs	$30,000	$11,000	$41,000	6.0	6,800	$1,400	90	500	4.5
1.3	Renewable Natural Gas				≥ 40		($430)			1.9

2.1.1 Heat Pump AHUs

Heating for the original building is supplied by the gas fired heating sections of AC-1 and the two external AHUs. Based on the documentation provided, all of these units are original to the building and have past their recommended service lives. Given the minimal gas usage in the building, it is unlikely it will be connected to the central plant. This measure recommends these three units be replaced with heat pump units with variable speed fans and gas backup for the the colder winter months. This would also allow cooling to be provided for the offices on either side of the original building. No cooling demand was noted for these spaces so no additional cooling costs were included in the analysis of this measure. The analysis of this measure using incremental costing.

Two programmable thermostats control the supply air temperature for the two furnaces in the basements of the original building, while the building is divided into at least 4 distinct zones. Often there is a temperature differential between the first and second floor. We recommend installing additional thermostats on the second floor to vary the supply temperature based on the average space temperature conditions. Though this is not an energy savings measure, it may be completed at the same time as the upgrade to improve occupant comfort.

2.1.1 High Efficiency AHUs

Heating for the original building is supplied by the gas fired heating sections of AC-1 and the two external AHUs. Based on the documentation provided, all of these units are original to the building and have past their recommended service lives. Given the minimal gas usage in the building, it is unlikely it will be connected to the central plant. This measure recommends that these three units be replaced with new high efficiency units with variable speed fans. Please note the analysis of this measure using incremental costing.

Two programmable thermostats control the supply air temperature for the two furnaces in the basements of the original building, while the building is divided into at least 4 distinct zones. Often there is a temperature differential between the first and second floor. We recommend installing additional thermostats on the second floor to vary the supply temperature based on the average space temperature conditions. Though this is not an energy savings measure, it may be completed at the same time as the upgrade to improve occupant comfort.

2.1.2 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 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 the building, this measure may be the best option to offset emissions at the facility in the short term.

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.