Thompson Rivers University
ASHRAE Level 1 Energy Study

Energy Study for:

Campus Activity 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 25, 2022

Campus Activity 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

The Campus Activity Centre (CAC) building located in Kamloops, British Columbia, was originally constructed in 1992, and has gone through a number of renovations. TRU World (International student services), and the International Centre were added in 2012. The CAC houses the student union, bookstore, classrooms, offices, a conference centre, a pub, and a cafeteria. The gross conditioned square footage of this three-story building is 7,041 m^2 (75,789 ft^2).

1.1.1 Physical condition and window type

The original building appears to be well maintained. The windows are double paned and are from 1992.

1.2 Mechanical Systems

1.2.1 Ventilation

The ventilation of the original building is provided by the following systems:

- An air handling unit (AHU-1) supplies outdoor air (OA) to the 1st and 2nd floors through variable air volume (VAV) boxes
- A fan coil unit (FCU-1) supplies OA to the Rotunda (aka Centre Court)
- 2 heat recovery ventilators (HRV-1 and HRV-2) supply OA to the 3rd floor addition through nine fan coil units (FC-1 to -9)

The ventilation to the Independent Centre is supplied by the following roof top units (RTUs). Please note that RTU 1 and 2 serve VAV boxes yet the fans are constant volume and the heating is gas fired. We are uncertain how supply pressure is managed in the duct without VSDs. The gas-fired heating limits the potential for adding a VSD.

- RTU-1 supplies the first-floor offices and lecture rooms via VAVs with electric reheat
- RTU-2 supplies the 2nd floor workspaces via VAVs with electric reheat
- RTU-3 and RTU-4 supply the open workspace via constant volume diffusers
- RTU-5 supplies OA to the TRUSU Boardroom via constant volume diffusers with no reheat and the open workstations through VAVs with HW reheat coils

1.2.2 Cooling

A chiller and cooling tower in the original building supply chilled water (CHW) to the cooling coil in AHU-1.

The five RTUs in the Independent Centre contain direction expansion (DX) cooling coils and provide cooling to the original building and the Independent/International Centre.

Cooling for the 3rd floor is provided by the DX cooling in the FCUs on the 3rd floor.

1.2.3 Heating

Three gas-fired condensing boilers (B-1, B-2 and B-4), installed in 2015, provide heating water for the following systems. B-3 has been recommissioned to provide DHW. B-1, 2, 4 now provide heating water for the whole building via the following:

- AHU-1 heating coils
- AHU-1's box reheat coils
- FCU-1's heating coil

- Radiant panels in the 1st – 3rd floors of the original building
- RTU-5's VAV box reheat coils

Additional heating is supplied by the following systems:

- Natural gas fired indirect heaters: RTU-1 through RTU-5
- Passive Heat Recovery: HRV-1 and HRV-2 each have a heat wheel, to recover heat from exhaust air (EA) to preheat incoming OA supplied to the fan coils (1-9)
- Electric reheat coils
    - RTU-1 and RTU-2 VAV boxes
    - HRV-1 and HRV-2 preheat and heating coils
    - Elec reheat coils in FC-1 through FC-9
- Variable Refrigerant Flow Heat Pumps: VRF HP coils in FC-1 through FC-9 provide both heating and cooling

This building is in the Phase 2 plan for connection to the district energy plant. This means all heating water and domestic hot water for the building will be provided directly from the district energy plant.

1.2.4 Domestic Hot Water

Domestic hot water (DHW) is supplied by B-3 with B-4 being used as backup. There used to be a solar hot water preheat system, but it has been decommissioned.

There is also a small electric DHW tank in the 3rd floor mechanical room. It provides DHW for the 3rd floor.

This building is in the Phase 2 plan for connection to the district energy plant. This means all heating water and domestic hot water for the building will be provided directly from the district energy plant.

1.2.5 Lighting System

All building lighting is LED except for 242 remaining pot lights. These are in the process of being switched from CFL to LED by the facilities team.

1.3 Control Equipment

The CAC building was switched from a Siemens Insight system to an Automated Logic front end during the 2021 Fortis Bundle A Cycle 1 Implementation. All major systems are on BAS except the heat pumps serving FC-1 through 9. It should also be noted that since the switch from the Siemens system to Automated Logic, the DHW system is no longer on BAS.

1.4 Energy Analysis

1.4.1 Energy Use Profile

Figure 1 presents the building's electrical consumption from 2017 to May of 2021. No reliable data was available past that point. There is electricity data in TRU's new energy monitoring software IoTORQ, but it does not appear to be properly consolidated and as such was not included. The decrease in consumption from April 2020 onwards is likely a result of reduced operation due to COVID. This data was excluded from the baseline calculation.

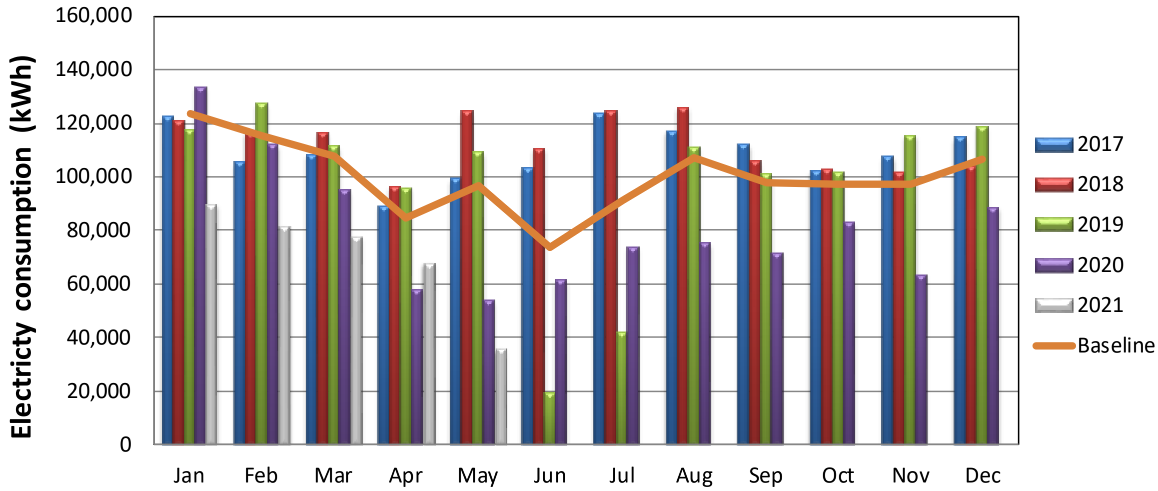

Figure 1: Monthly Electricity Consumption

Figure 2 presents the building's gas consumption from January 2014 to September 2017. There appears to be an issue with the meter from July 2017 onwards and there is no reliable data after that point. Gas consumption appears to have gone down since 2014, but has been steadily increasing since then.

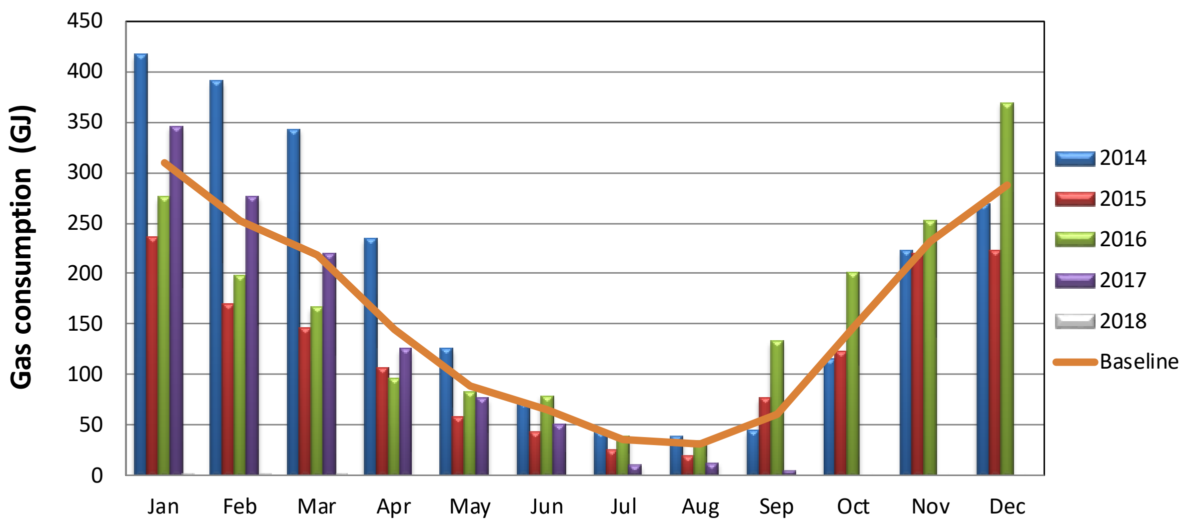

Figure 2: Monthly Gas Consumption

1.4.2 Energy Intensity Analysis

A summary of Baseline Energy consumption and the corresponding costs and energy intensity for the facility is presented in Table 1. CAC has a baseline Energy Use Intensity (EUI) of 897 MJ/m².

Table 1: Summary of Baseline Energy Data

Utility	Energy Use (GJ)	EUI (MJ/m2)	Cost ($)	Cost ($/ft2)
Gas	1,873	260	$28,101	$0.36
Electricity	4,585	637	$80,638	$1.04
Total	**6,458**	**897**	**$108,739**	**$1.40**

1.4.3 Energy End Use Breakdown

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

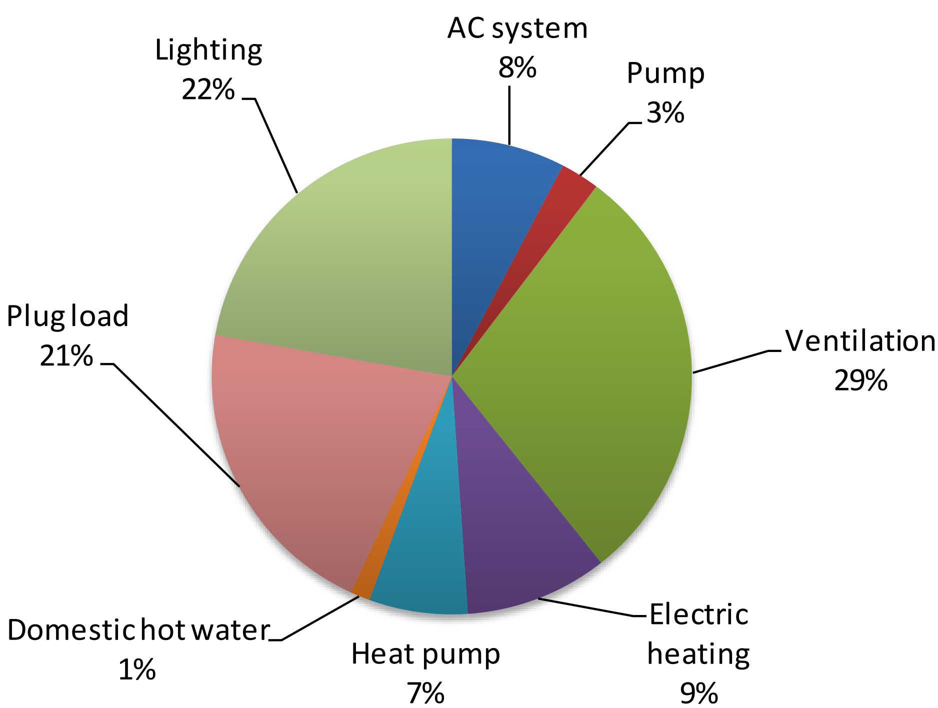

Figure 3: Electricity Consumption

The estimated breakdown of gas consumption by building system is presented in Figure 5. Miscellaneous gas is attributed to kitchen gas usage.

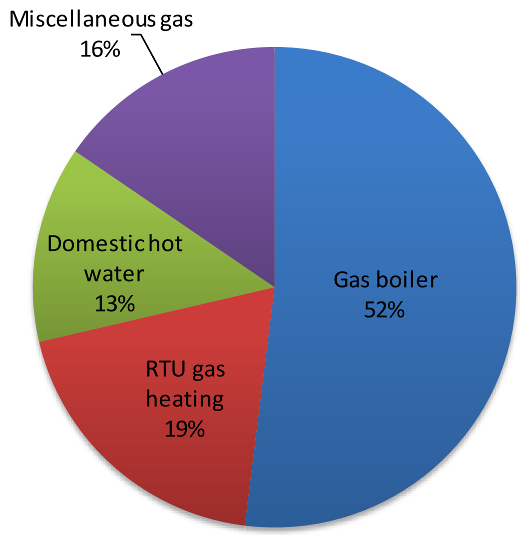

Figure 4: Gas Consumption

The estimated percentage of total energy consumption by building system is presented in Figure 6.

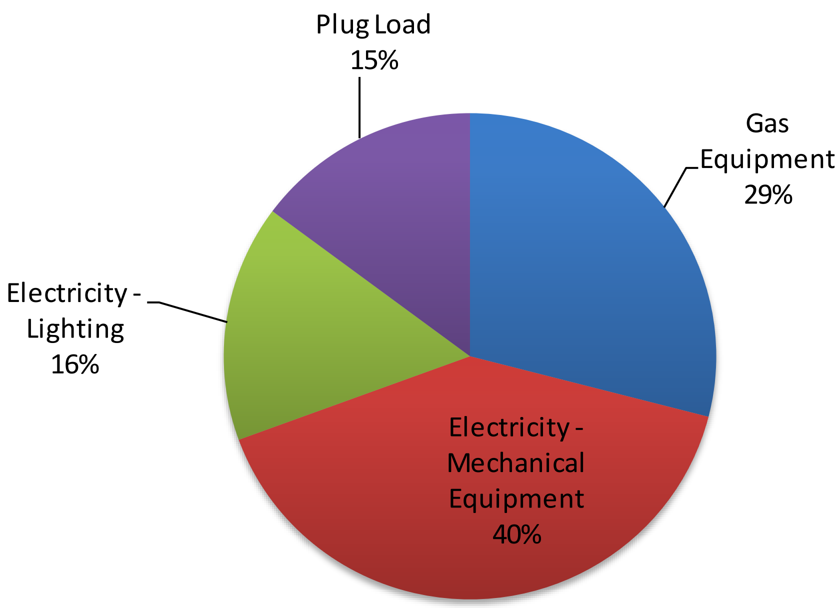

Figure 5: Total Energy Breakdown

2. Conservation Opportunities

The primary objective of this study was to identify and analyse energy conservation opportunities at Campus Activity Centre. 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. As some of these measures are mutually exclusive, it does not make sense to present total measure savings. The individual measure savings summaries can be found 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. These should be evaluated prior to making a final decision. This building is in the Phase 2 plan for connection to the central plant. However, we believe all the measures outlined below except the renewable natural gas measure are good opportunities even if the building is connected.

Table 3: Measure Summary

Item	Description	Base Case Cost	Incremental Cost	Total Cost	Effective Payback	NPV	Annual Savings				
							$	GJ	kW	kWh	GHG
1.1	BAS Commissioning		9,300	9,300	12.0	(4,400)	500	20.0		4,100	1.0
1.2	High Efficiency RTU	57,500	21,000	78,500	6.0	13,700	2,900	80.0	45.0	19,000	4.2
1.3	RTU Heat Pump	57,500	35,000	92,500	6.0	21,400	4,300	320.0		(7,800)	15.9
1.4	Renewable Natural Gas				≥ 40		(2,660)				12.1

2.1.1 BAS Commissioning

The Campus Activity Centre was switched from Siemens to Automated Logic during the Fortis Implementation Bundle A Cycle 1 completed in 2021. Based on discussions with Automated Logic and TRU operations, a full commissioning of this system has not yet been done. Based on a preliminary review of the system, this building appears to have minimal deficiencies as compared to some of the other buildings, however we still recommend doing a full commissioning of the system to ensure everything is functioning as intended on the new system. Moving forward, we recommend budgeting for a full a commissioning whenever buildings are switched to a new BAS. The opportunities identified through a preliminary review are as follows. It should be noted that this was a high-level review as a full BAS review is not within the scope of this project.

- DHW is no longer on BAS. We recommend this be added and the DHW pump be scheduled off afterhours.

- AHU/RTU graphics are missing key variables such as supply air temperature setpoint (SAT), that are important for monitoring

In addition, The HRVs and FCUs are not controlled via BAS. We recommend integrating these controls onto BAS and controlling their values based on demand in the space. This will need be investigated to ensure it is feasible.

2.1.2 High Efficiency RTU

RTU-1,2,3, and 4 are equipped with standard efficiency indirect gas fired heating and DX cooling. They are from 2001 and are nearing the end of their recommended service life. This measure recommends replacing these RTUs with high efficiency condensing models with variable speed drives. This building is noted as being in the Phase 2 plan for connection to the District Energy Plant. However, the boilers and DHW system are in the first floor of the main CAC building while the RTUs are on the roof of the Independent Centre. It would not make sense to bring heating water piping all the way up to the RTUs. Therefore, this measure would make sense even if this building is connected in the future. The analysis for this measure uses incremental costing. It should be noted that based on the gas balancing for this building, these units are oversized. When replacing these units, we recommend selecting units that more closely match actual demand from the spaces.

2.1.3 RTU Heat Pumps

RTU-1,2,3, and 4 are equipped with standard efficiency indirect gas fired heating and DX cooling. They are from 2001 and are nearing the end of their recommended service life. This measure recommends replacing these RTUs with heat pump models with variable speed drives and gas backup. This building is noted as being in the Phase 2 plan for connection to the District Energy Plant. However, the boilers and DHW system are in the first floor of the main CAC building while the RTUs are on the roof of the Independent Centre. It would not make sense to bring heating water piping all the way up to the RTUs. Therefore, this measure would make sense even if this building is connected in the future. The analysis for this measure uses incremental costing. It should be noted that based on the gas balancing for this building, these units are oversized. When replacing these units, we recommend selecting units that more closely match actual demand from the spaces.

2.1.4 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 DHW 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.

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.