Thompson Rivers University
ASHRAE Level 1 Energy Study

Energy Study for:

Old Main Building

Attention:

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- ASHRAE Level 1 Study -

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1. Background Description of Facility, Hardware and Systems

1.1 Overview and Facility Use

The Old Main Building (OM) located in Kamloops, British Columbia, was originally constructed in 1970. The gross conditioned square footage of the building is 25,181 m^2 (270,948 ft^2).

The building is divided into 3 main blocks, A, B and C. The A Block consists of four floors, with the first two stories being original, and the third and fourth floor added in 2014. The top two floors of A Block house the law department, and bottom two floors house classrooms and offices. B block is two stories housing classrooms and offices. C Block is a double height, single floor housing art classrooms, the food court, and the theatre.

1.1.1 Physical condition and window type

The original building appears to be well maintained. The law department was added in 2014 and is in good condition. The windows are double paned.

1.2 Mechanical Systems

1.2.1 Ventilation

Block A:

- AHU 1 is a mixed air variable air volume unit, which serves the first floor of A Block through variable air volume (VAV) terminal units. It shares a return fan with AHU-2. It has hot water pre-heat and chilled water-cooling coils.
- AHU 2 is a mixed air variable air volume unit, which serves the second floor of A Block through VAV terminal units. It shares a return fan with AHU-1. It has hot water pre-heat and chilled water-cooling coils.
- AHUs CM 33 Fan 3, CM 34 Fan 4 and CM 35 Fan 5, located on the third level of A Block, are variable air volume units, which serve the top two floors of A block through VAV terminal units. They have hot water heating and chilled water-cooling coils.
- CM 32 HRV-1 recovers heat from the exhaust stream of the third-floor A block and preheats air for AHU-3, 4, and 5.
- RTUs 11,12,13,14 serve select perimeter and interior zones in A Block 1st and 2nd floor. They are mixed air, constant volume units with gas heating and direct expansion cooling.

Block B:

- RTU BAHU 2 (aka. RTU-2), located in the second-floor mechanical room, is mixed air variable air volume unit with gas heating and direct expansion cooling. It serves B Block 1st floor west through VAV terminal units.
- AHU-3, located in south mechanical room of B Block serves the first and second levels of south side of B block through VAV terminal units. It is a mixed air, variable air volume unit with chilled water cooling and hot water heating.
- CM23 AHU-4, located in north mechanical room of B Block serves the first and second levels of the north side of B block through VAV terminal units. It is a mixed air, variable air volume unit with chilled water cooling and hot water heating.
- RTU-15 is a constant volume unit with gas heating and direct expansion cooling. It serves the printshop in the first floor of B block. ACU-04 also serves the printshop, it is mixed air, constant volume unit with gas heating and direct expansion cooling, it has return air CO_2 sensor.

RTU-9 and 10 are constant volume units with gas heating and direct expansion cooling. They are located in the south west corner of block C and serve the block B first floor.

Block C

- RTUs 01, 02, and 03 serve the theatre in C Block. They air mixed air units with gas heating and direct expansion cooling.
- ACUs 1 through 8 (except ACU-4) are mixed air, constant volume units with gas heating and direct expansion cooling. They serve art classrooms in the C Block. They have return air CO_2 sensors.

1.2.2 Cooling

A Block: Two water cooled chillers provide cooling to cooling coil in the AHUs. Four heat pumps provide both heating and cooling to 1st and 2nd floor east perimeter and interior zones.

B Block: Cooling for AHU-3 and 4 is provided by the chillers in A Block. T=he other AHUs, RTUs and ACUs have direct expansion (DX) cooling.

C Block: Cooling is provided DX cooling in the AHUs.

1.2.3 Heating

A Block: Three gas fired condensing boilers provide hot water to the heating coils in the AHUs, terminal VAVs reheat coils and perimeter radiation units in A Block. Electric baseboards exist in 1st and 2nd floor east perimeter zones.

B Block: Two gas fired boilers provide heating to AHU-3 and 4, reheat coils in the VAVs and the radiation system. The other ACUs, RTUs and AHUs have gas burners.

C Block: Heating is provided by gas burners in the AHUs.

It should be noted that this building is going to be connected to the district energy plant as part of the first phase of connections. This means that all heating water and DHW in the building will come directly from the district energy plant.

1.2.4 Domestic Hot Water

A Block: Two gas fired domestic hot water tanks (DHWTs) provide DHW to the building.

B/C Block: One gas fired DHWT provides DHW to B and C Block.

It should be noted that this building is going to be connected to the district energy plant as part of the first phase of connections. This means that all heating water and DHW in the building will come directly from the district energy plant.

1.3 Lighting System

All lighting was upgraded to LED in 2016.

1.4 Control Equipment

The building was upgraded to an Automated Logic BAS during the 2021 Fortis Bundle A Cycle 1 implementation. Terminal units are still Siemens.

1.5 Energy Analysis

1.5.1 Energy Use Profile

Figure 1 presents the building's electrical consumption since 2018. It has a constant monthly profile throughout the year. There is a notable absence of a cooling profile for this facility. Electricity use in this building has been steadily decreasing since 2014. This is a result of continuous optimization projects on the building including BC Hydro's COp Round 1 implementation work, which was completed in 2018. SES is currently in the process of completing the COp Round 2 investigation study to verify that past measures are still functioning as intended and identify additional controls commissioning opportunities.

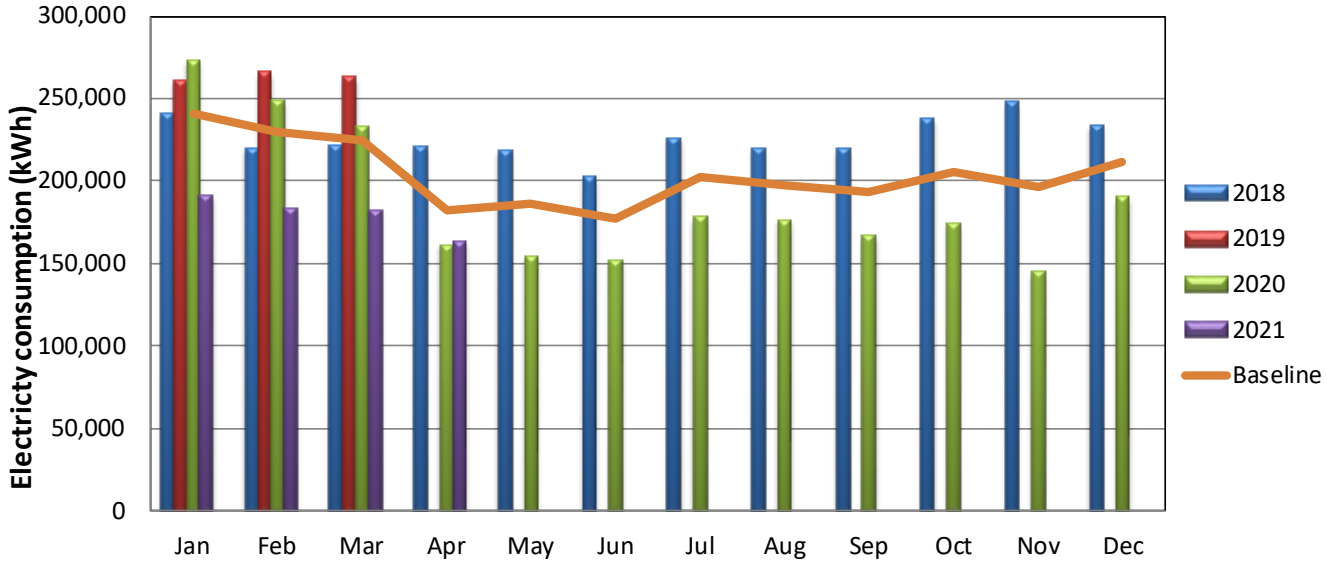

Figure 1: Monthly Electricity Consumption

Figure 2 presents the building's gas consumption since 2018. There is a strong seasonal fluctuation, which is typical for a heating profile. Gas usage in this building has decreased since 2017 as a result of the COp implementation work. It was noted in the Fortis study that there were some issues with the metering in 2017, but this appears to have been resolved.

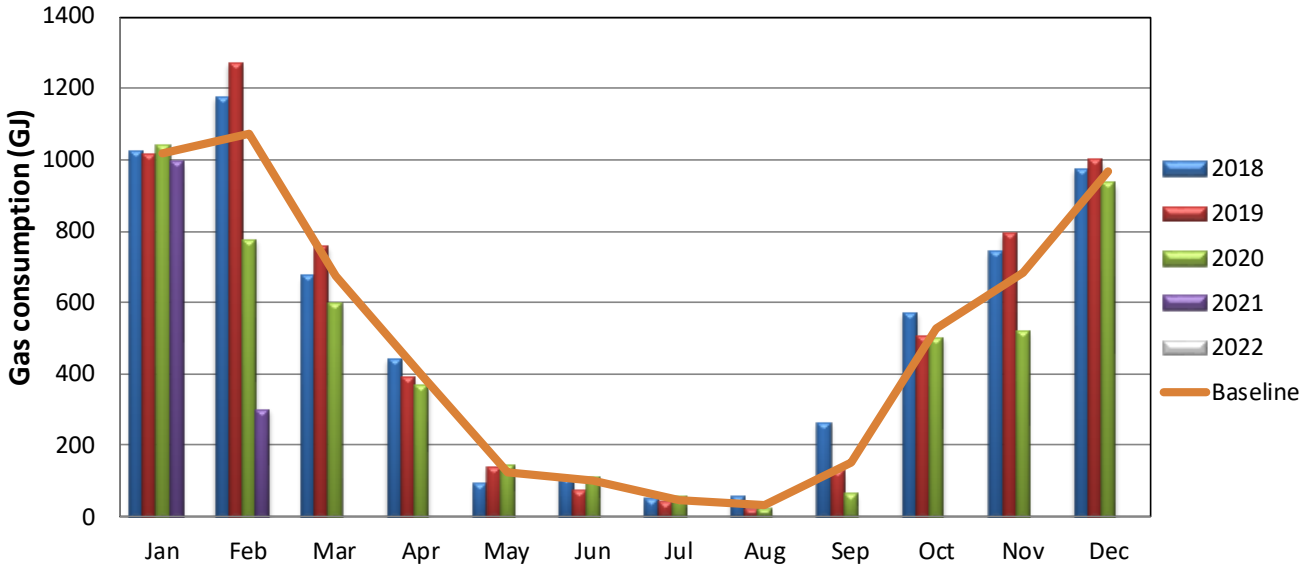

Figure 2: Monthly Gas Consumption

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. Old Main has an Energy Use Intensity (EUI) of 580 MJ/m^2. This has decreased significantly since the Fortis study value of 856 MJ/m^2. This is a result of resolved metering issues as well as optimization work on the building.

Table 1: Summary of Baseline Energy Data

Utility	Energy Use (GJ)	EUI (MJ/m2)	Cost ($)	Cost ($/ft2)
Gas	5,799	230	$84,075	$0.31
Electricity	8,812	350	$154,978	$0.57
Total	**14,610**	**580**	**$239,053**	**$0.88**

1.5.3 Energy End Use Breakdown

The estimated breakdown of electricity consumption by building system is presented in Figure 3. This breakdown is based on the most recent Fortis study information.

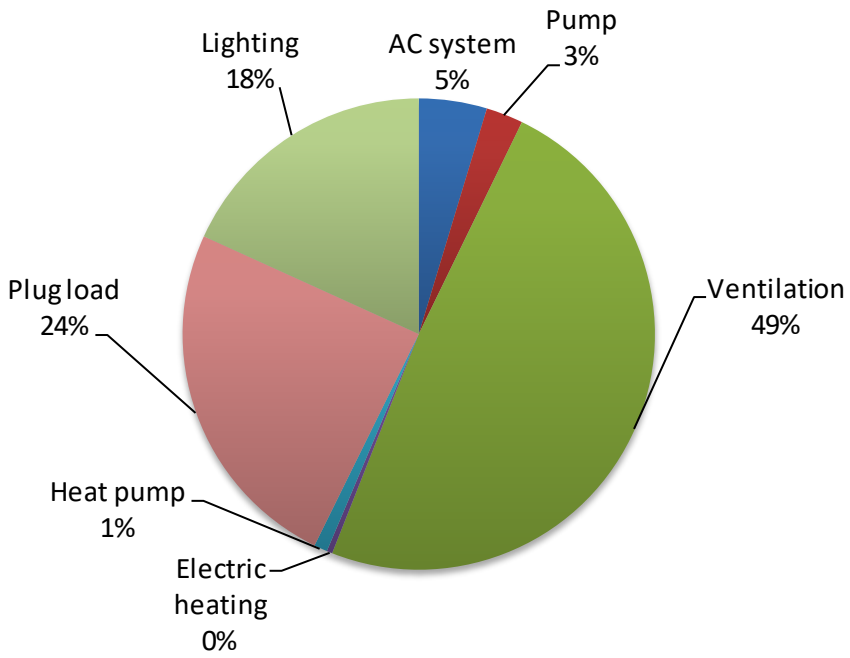

Figure 3: Electricity Consumption

The estimated breakdown of gas consumption by building system is presented in Figure 4. This breakdown is based on the most recent Fortis study.

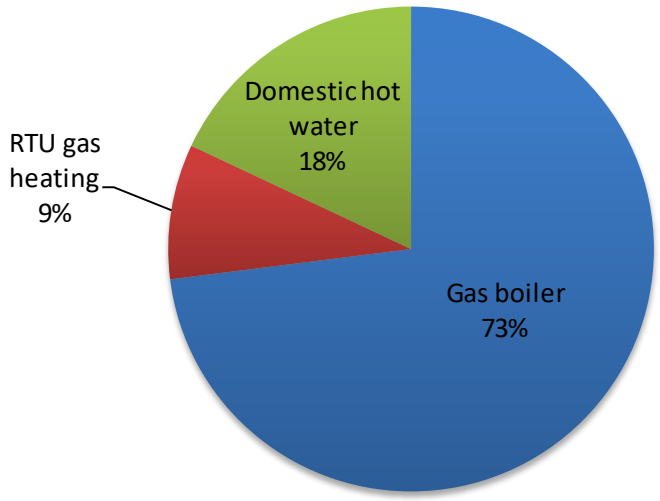

Figure 4: Gas Consumption

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

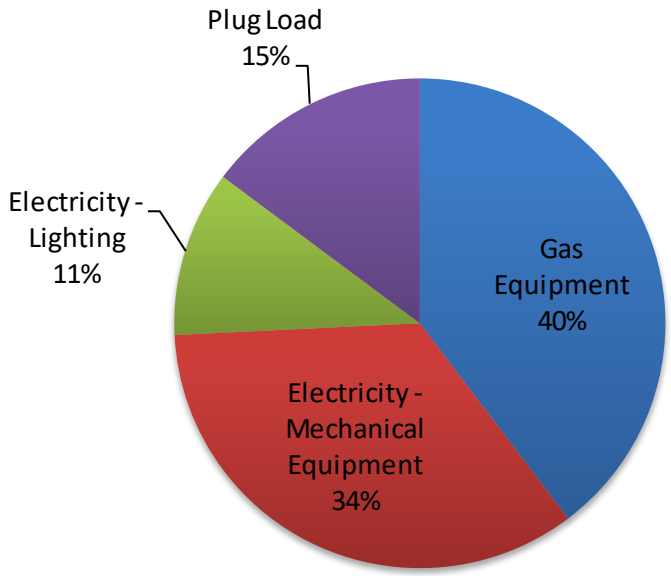

Figure 5: Total Energy Breakdown

2. Conservation Opportunities

The primary objective of this study was to identify and analyse energy conservation opportunities at Old Main. 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 the measures identified below are mutually exclusive, it does not make sense to summarize total savings for all projects. The individual measure savings are presented in Table 3.

2.1 Energy Conservation Measures

This building is planned to be in the first phase of buildings connected to the district energy plant. This means that all heating water and domestic hot water (DHW) in the building will now come directly from the district energy plant. As such, no domestic hot water or heating water measures were considered. If for some reason this connection does not happen, we recommend the following measures be investigated:

- AHU Replacements (Heat Pump and High Efficiency)
- Condensing DHW

The measures presented below are the measures that are still relevant if this connection is pursued. A summary of the analysis for the recommended low-cost measures is presented in Table 3. Detailed descriptions for each project are presented below. The analysis for these measures does not include any incentives from BC Hydro or Fortis BC.

It should also be noted that a BC Hydro COp Round 2 study is currently underway for this building. This study focuses on controls recommissioning opportunities. As such, these measures were not reviewed as part of this study.

Table 3: Measure Summary

Item	Description	Base Case Cost	Incremental Cost	Total Cost	Effective Payback	NPV	Annual Savings			
							$	GJ	kWh	GHG
1.1	High Efficiency RTUs	$100,000	$36,000	$136,000	14.0	(14,900)	$1,700	80	8,100	4.1
1.2	RTU Heat Pumps	$100,000	$65,000	$165,000	11.0	(13,300)	$3,800	340	(20,100)	16.8

2.1.1 High Efficiency RTUs

Although all building heating water is going to be supplied by the district energy plant, RTU-1,2,3 and ACU-1 through 8 are located on the C block and B block south roof and are quite far from any possible heating water piping connection. These units are equipped with gas fired heating and direct expansion cooling and have all either reached or are past their recommended service life. This measure recommends replacing RTU-1,2,3 and ACU 1 through 8 with high efficiency gas fired units with variable speed drives. As these units each serve individual spaces, we recommend implementing a supply air pressure reset to modulate air flow from the units based on the outdoor air temperature in order to maximize the savings associated with this measure. The analysis for this measure uses incremental costing. Based on the gas balancing in this building, these units are significantly oversized for the demand in the spaces. We recommend replacing the existing units with smaller units that more closely match actual demand in the spaces.

2.1.1 RTU Heat Pumps

Although all building heating water is going to be supplied by the district energy plant, RTU-1,2,3 and ACU-1 through 8 are located on the C block and B block south roof and are quite far from any possible heating water piping connection. These units are equipped with gas fired heating and direct expansion cooling and have all either reached or are past their recommended service life. This measure recommends replacing RTU-1,2,3 and ACU 1 through 8 with heat pump units with variable speed drives and gas backup. As these units each serve individual spaces, we recommend implementing a supply air pressure reset to modulate air flow from the units based on the outdoor air temperature in order to maximize the savings associated with this measure. The analysis for this measure uses incremental costing. Based on the gas balancing in this building, these units are significantly oversized for the demand in the spaces. We recommend replacing the existing units with smaller units that more closely match actual demand in the spaces.

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.