



Thompson Rivers University ASHRAE Level 1 Energy Study

Energy Study for: **Arts and Education Building**

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Arts and Education
- ASHRAE Level 1 Study -

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1. Background Description of Facility, Hardware and Systems

1.1 Overview and Facility Use

The Arts & Education building was originally built in 1991 and is comprised of a 3-storey structure with a gross floor area of 5,660m². The building gets its name from the fact that many Faculty of Arts classes and labs are held in the building as well as it being home to teaching options like Early Childhood Education and Bachelor of Education (Elementary).

1.1.1 Physical condition and window type

The original building appears to be well maintained. Building fenestration is a mixture of older single and newer double-glazed units. Window and door systems are typically constructed in aluminum frame and some windows are operable.

1.2 Mechanical Systems

1.2.1 Ventilation

Ventilation for the building is provided by SF-1, a variable volume, 100% outdoor air unit with two hot water heating coils. This unit provides conditioned air to water source heat pumps located in the spaces. The heat pumps receive pre-heated supply air from SF-1 and are connected to the heating water loop, via a heat exchanger, and the cooling tower loop. The conditioned air from the heat pumps is supplied to the spaces through ceiling mounted constant volume diffusers. Return air is drawn through ceiling mounted grilles and ducted back to the heat pumps.

1.2.2 Cooling

There are two heat pump loops, one for the east side and one for the west side of the building. There is one cooling tower for each wing of the building. The cooling towers provide cooling for their respective heat pump loops. The heat pump loop can bypass the cooling tower when in heating mode.

1.2.3 Heating

Heating water for the building is generated by two natural gas condensing boilers, one boiler serves each wing of the building. These boilers were installed within the last 5 years. The heating water loops provide heating for the followings systems.

- Heat pumps, via a heat exchanger
- Hot water radiation units in the stairwells

A heat recovery chiller was installed in 2018. It recovers heat from the washroom exhaust air on both the East and West Wings of the building. The heat is then supplied directly to the boiler loops. It should be noted that since the Automated Logic BAS switchover, the heat recovery chiller does not appear to be working optimally. This is addressed in the energy conservation measures section.

This building is in the Phase 2 connection plan for the district energy system. The district energy system will replace all heating water and domestic hot water (DHW) in the building.

1.2.4 Domestic Hot Water

DHW at the facility is generated by a natural gas fired domestic hot water heater. This heater was installed in 2013.

This building is in the Phase 2 connection plan for the district energy system. The district energy system will replace all heating water and DHW in the building.

1.3 Lighting System

All lighting in the building has been upgraded to LED.

1.4 Control Equipment

This building was upgraded from a Siemens BAS to an Automated Logic one during the Fortis Bundle A Cycle 1 Implementation project in 2021. All main systems are on BAS. It was noted that post this switchover there are some issues with the building. These are addressed in the conservation opportunities section below.

1.5 Energy Analysis

1.5.1 Energy Use Profile

Figure 1 presents the building's electrical consumption since 2018. Data from June 2020 through December 2020 was excluded from the baseline as it was lower than the average as a result of the reduced operation during COVID. There were also several other outlier values that were excluded as they were either significantly above or significantly below the baseline data. Data from May 2021 onwards was taken from IoTORQ.

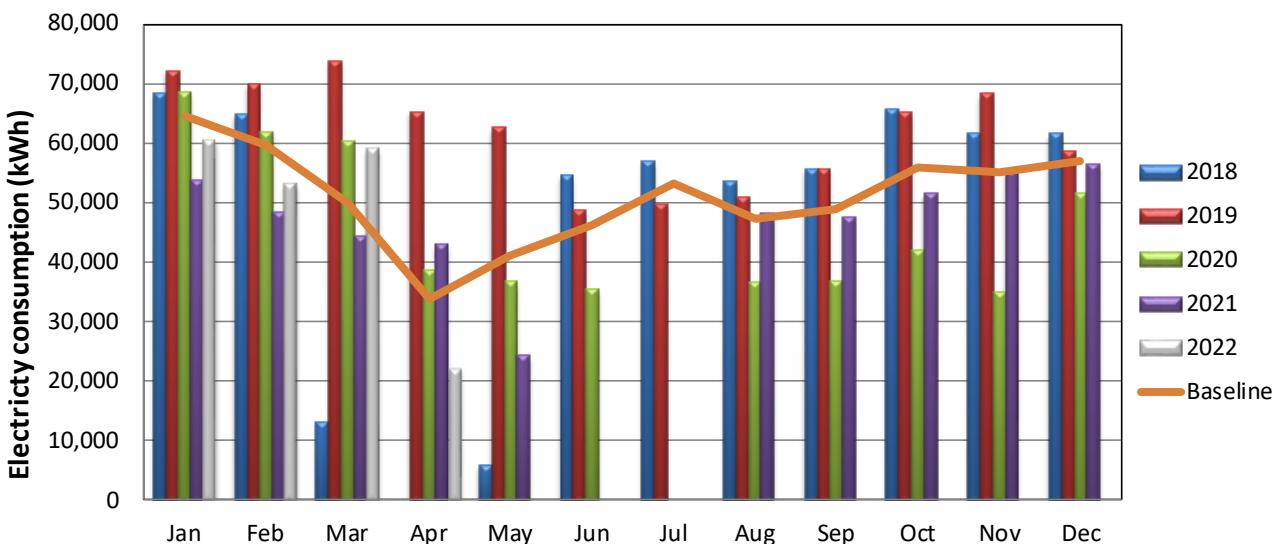


Figure 1: Monthly Electricity Consumption

Figure 2 presents the building's gas consumption since 2016. There is no data for 2017. The decrease from 2019 onwards is a result of the heat recovery chiller (HRC) installation, which happened in 2018. However, based on our review of the existing BAS operation, the heat recovery chiller is no longer functioning optimally. Since no more recent data was available, the current gas consumption baseline was estimated assuming the HRC is functioning at 50%. Data past April 2021 was not available and the data in IoTORQ appears to have a scaling issue so it was not used.

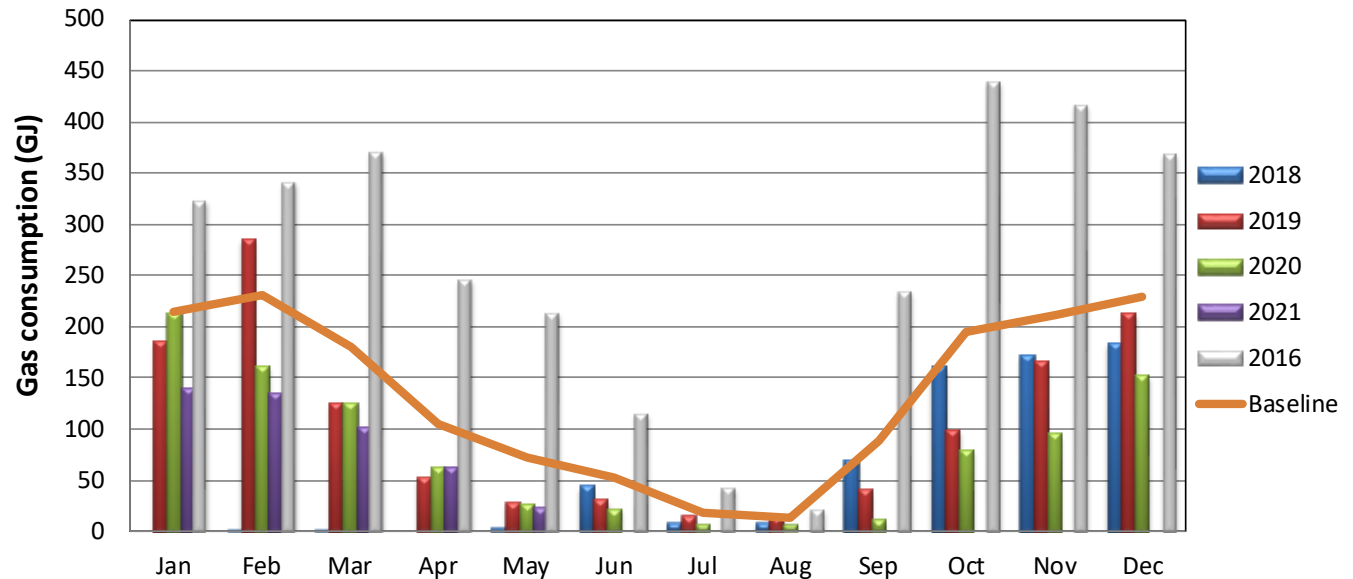


Figure 2: Monthly Gas Consumption

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. Based on the current observed operation, the Arts and Education building has an Energy Use Intensity (EUI) of 783 MJ/m².

Table 1: Summary of Baseline Energy Data

Utility	Energy Use (GJ)	EUI (MJ/m2)	Cost (\$)	Cost (\$/ft2)
Gas	2,195	377	\$15,334	\$0.24
Electricity	2,364	406	\$38,744	\$0.62
Total	4,559	783	\$54,078	\$0.86

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.

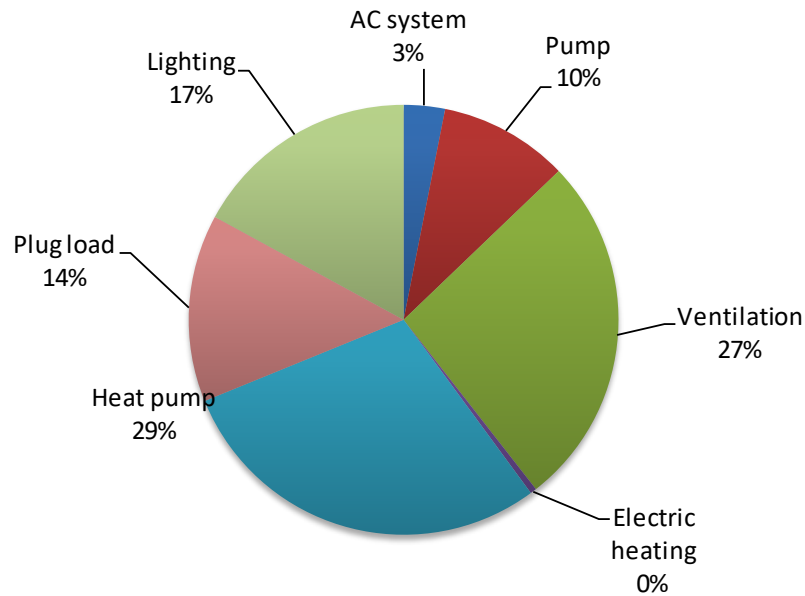


Figure 3: Electricity Consumption

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

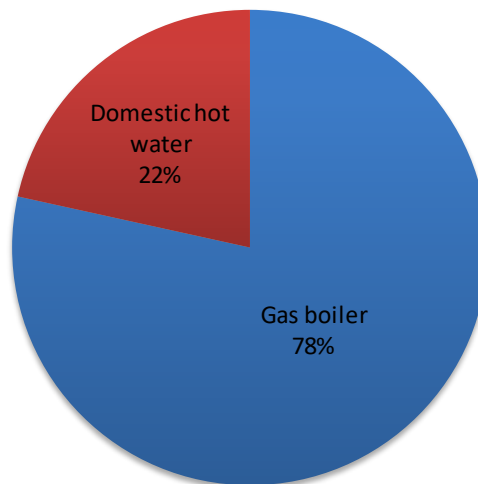


Figure 4: Gas Consumption

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

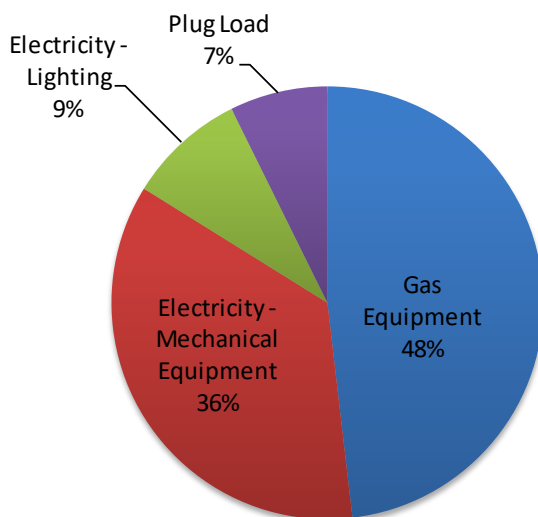


Figure 5: Total Energy Breakdown

2. Conservation Opportunities

The primary objective of this study was to identify and analyse energy conservation opportunities at the Arts and Education building. The rate schedules used in the 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 CO₂e / kWh of electricity in BC, and 49.87 kg CO₂e / 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.

If all of the recommended measures are implemented, we estimate the following savings outcomes:

Table 3: Estimated Savings

Energy footprint	Electricity	Natural Gas	Greenhouse gases	Cost per ft ²
20%	-1%	43%	41%	0.14

2.1 Energy Conservation Measures

A summary of the analysis for the recommended measures is presented in Table 2. Detailed descriptions for each project are presented below. Although this building is in the Phase 2 plan for connection to the district energy plant, all measures except the RNG measure will still be good opportunities even if the building is connected.

Table 4: Measure Summary

Item	Description	Base Case Cost	Incremental Cost	Total Cost	Effective Payback	NPV	Annual Savings			
							\$	GJ	kWh	GHG
1.1	BAS Commissioning		\$16,000	\$16,000	1.0	104,800	\$12,700	940	(22,600)	46.7
1.2	Pump VFDs		\$13,000	\$13,000	9.0	(1,000)	\$1,000	10	14,400	0.6
1.3	Renewable Natural Gas				≥ 40		(\$5,080)			23.1

2.1.1 BAS Commissioning

This building was switched from a Siemens system to an Automated Logic system during the Bundle A Cycle 1 Fortis Implementation project in 2021. SES and Care Systems are currently in the process of implementing the controls recommissioning measures from the Fortis Study Bundle B Cycle 2 on this building. During this process, several significant issues that were outside the scope of the existing implementation were noted with the building operation. These included improper sequence operations on equipment, a large error signal in the control loop as well as the following operational issues and opportunities for optimization.

- The dedicated heat recovery chiller (DHRC) is enabled, but its mix-valve at 0% position
- Evaporator pump was running while DHRC is not enabled
- SF-1 operates with apparent minimum 30% position on return heating coil valve (RHCV), which leads to SAT being over setpoint
 - Error is significant, SAT regularly exceeds 45°C
 - We suggest that an averaging pre-heat SAT sensor be installed, and that the pre-heat coil be operated at lower setpoint, 8C, to bring heating demand down, and provide better control of SAT
- SF-1 SAP swings above and below SAP setpoint
 - Re-tune of control loop suggested.
- Control span of remote BAS control needs to be confirmed for DHRC and boilers
 - Ensuring that min/max signals achieve expected setpoint values at the equipment side
- The cause of the alarm trips needs to be determined for Boiler-1
- It was noted be operating that SF-1 was operating 24/7 and does not appear to have an optimal start. The terminal heat pumps appear to be operating from 5 am – 10 pm daily, which is likely longer than necessary. We recommend all schedules be reviewed and optimal start be added.

The list above should cover the majority of the existing issues; however, we still recommend budgeting for a full commissioning of the new system to identify terminal devices that need replacement and ensure the building is functioning as intended. Though there will be some energy savings associated with this measure, the main purpose is to fix operational issues and commission the system. We recommend budgeting for a full commissioning for any future building BAS switchovers to avoid similar issues on other buildings.

2.1.2 Pump VFDs

The existing boiler pumps in the facility are constant speed although demand changes throughout the year.

We recommend installing new variable speed drives to modulate the speed of the following pumps based on demand:

- Boiler Pump P-1 East
- Boiler Pump P-1 West

- Heat Pump Loop Pump P-1 East
- Heat Pump Loop Pump P-2 West

Older motors may have to be upgraded to high efficiency models if they are not compatible with speed drives. As the heat pump loop pumps serve terminal heat pumps in the spaces, they will have minimum flow requirements. These will need to be considered and safe guards should be put in place to ensure these pump speeds do not drop too low.

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 all the domestic hot water 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 this building, renewable natural gas may be the best option to offset emissions in this 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.