



Thompson Rivers University ASHRAE Level 1 Energy Study

Energy Study for:

House of Learning

Attention:

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House of Learning - ASHRAE Level 1 Study -

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1. Background Description of Facility, Hardware and Systems

1.1 Overview and Facility Use

This 6,215 m², four level building was constructed in 2009. It houses a library, a tiered pit house / lecture hall (The Gathering Place), a library café, a writing center, instructional and study spaces, training labs, classrooms, the First Nation Business Faculty and office areas.

1.1.1 Physical condition and window type

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

1.2 Mechanical Systems

1.2.1 Ventilation

Ventilation is supplied to the building by two air handling units (AHUs) serving the following areas:

- AHU-1, is a constant volume, mixed air unit serving the amphitheatre.
- AHU-2 is a variable volume, mixed air unit serving the rest of the building.
- Fan coil units (FCUs) recirculate the conditioned air for interior zones on each floor.

AHU-1 & 2 each have active heat recovery systems that recover heat from the exhaust air.

1.2.2 Cooling

The House of Learning has a geothermal heat exchanger with three heat pumps. This system can be operated to provide cooling to the heat pump loop, AHU cooling coils and FCU coils.

1.2.3 Heating

The House of Learning has a geothermal heat exchanger with three heat pumps, two of which can be operated to provide heating to the radiant slab heating on each floor. The radiant slab system is supplemented by the boilers when needed.

Additionally, a high temperature heating water loop is supplied by two condensing gas boilers. The following heating systems are connected to the high temperature heating water loop:

- AHU heating coils
- Force flow units
- Perimeter Radiation

It should be noted that this building is in the Phase 2 plan for connection to the district energy plant. When this is connected all domestic hot water (DHW) and all heating water for the building will be provided directly by the district energy plant.

1.2.4 Domestic Hot Water

The primary means of heating DHW in summer operation is via the two electric DHW heaters. In the winter, the gas boilers provide heating for DHW via a heat exchanger.

It should be noted that this building is in the Phase 2 plan for connection to the district energy plant. When this is connected all DHW and all heating water for the building will be provided directly by the district energy plant.

1.2.5 Lighting System

All lighting in the building is LED except for 331 - 6" compact fluorescent pot lights and 23- 4" compact fluorescent pot lights in the building. TRU is currently in the process of replacing all lighting on campus with LED.

1.3 Control Equipment

House of Learning has a Johnson Controls Building Automation System (BAS) that controls all major HVAC equipment.

The lighting system is on a Leviton system. Bringing this system onto the BAS was investigated as part of the COp round 2 study, but was found to be prohibitively expensive. However, operations would like to integrate this onto BAS as the Leviton system cannot be modified by TRU staff.

1.4 Energy Analysis

1.4.1 Energy Use Profile

Figure 1 presents the building's electrical consumption since 2017, after the COp Round 1 commissioning work was completed. The latest energy work completed on the building was the COp Round 2 implementation, which was completed in May of 2021. No energy data is available for after this work was completed and the data in IoTORQ was deemed unreliable. It should be noted that data from April 2020 onwards was excluded due to effects of COVID.

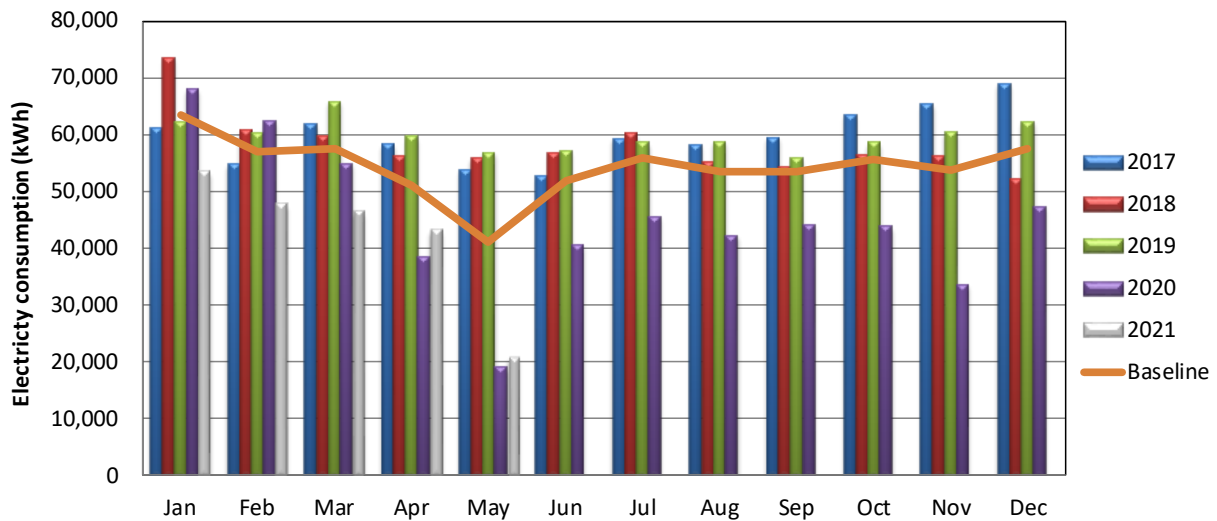


Figure 1: Monthly Electricity Consumption

Figure 2 presents the building's most recent gas consumption data. There is a strong seasonal fluctuation, which is typical for a heating profile. January through March 2020 were noted by operations to be a result of operational changes due to weather so they were not excluded from the baseline.

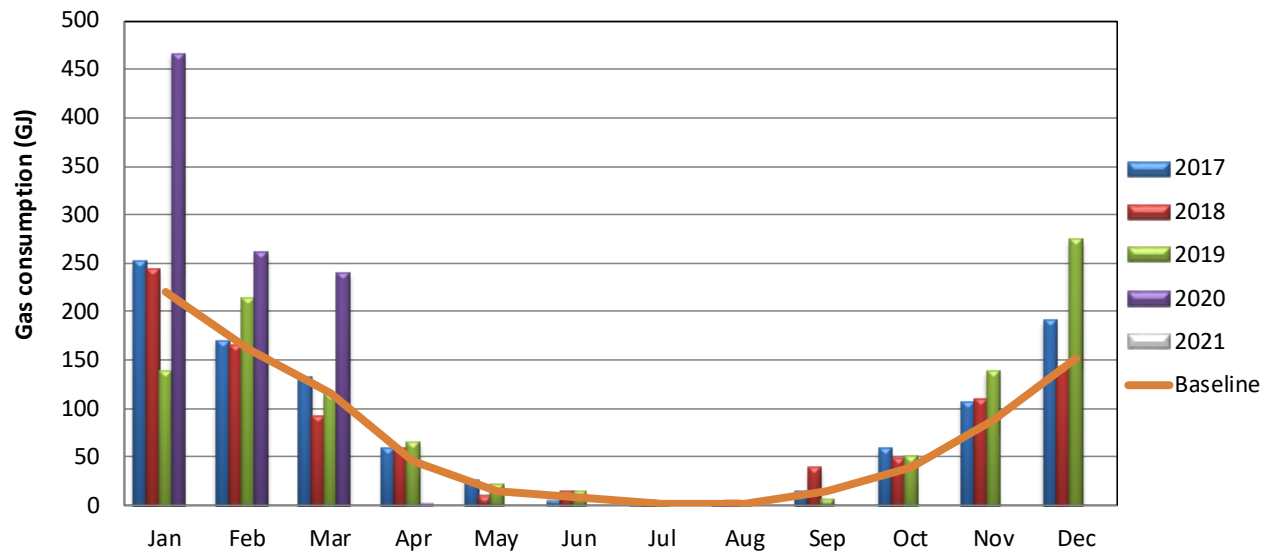


Figure 2: Monthly Gas Consumption

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. House of Learning has a Energy Use Intensity (EUI) of 522 MJ/m², which is well below the average consumption of buildings on the TRU campus. This is primarily due to the efficiency of the heat pump systems within this facility.

Table 1: Summary of Baseline Energy Data

Utility	Energy Use (GJ)	EUI (MJ/m2)	Cost (\$)	Cost (\$/ft2)
Gas	1,110	158	\$16,417	\$0.22
Electricity	2,552	364	\$41,267	\$0.55
Total	3,662	522	\$57,684	\$0.76

1.5 Energy End Use Breakdown

The estimated breakdown of electricity consumption by building system is presented in Figure 3. This energy breakdown uses the COp Round 2 investigation data as more recent consumption data is not available.

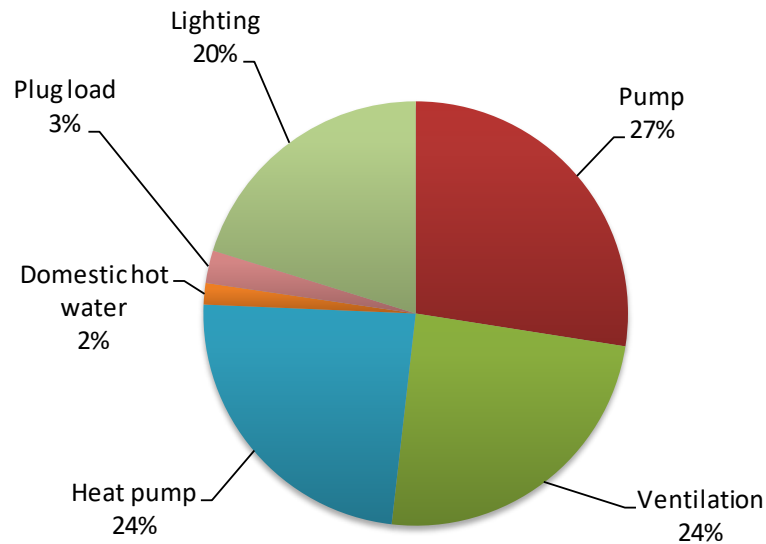


Figure 3: Electricity Consumption

The estimated breakdown of gas consumption by building system is presented in Figure 4. This energy breakdown uses the COp Round 2 investigation data as more recent consumption data is not available. The miscellaneous gas is due to the humidifiers.

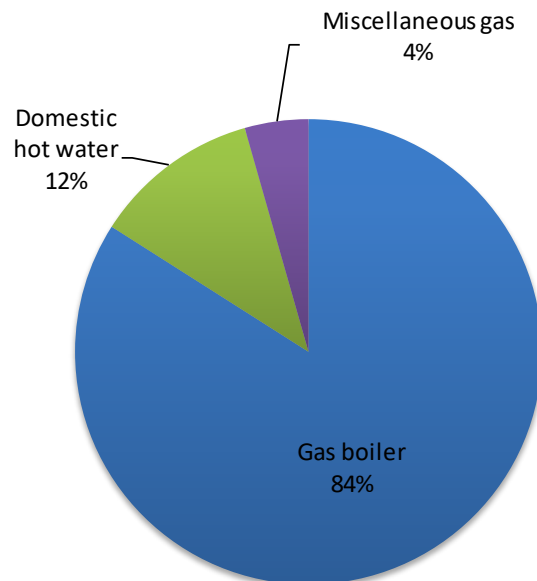


Figure 4: Gas Consumption

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

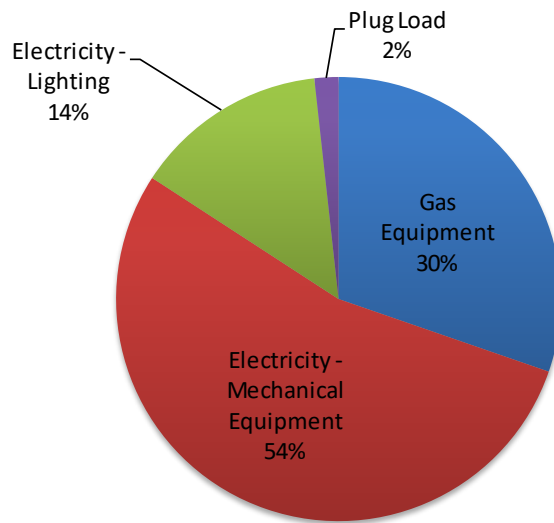


Figure 5: Total Energy Breakdown

2. Conservation Opportunities

The primary objective of this study was to identify and analyse energy conservation opportunities at House of Learning. 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 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
7%	2%	19%	17%	\$0.07

2.1 Energy Conservation Measures

A summary of the analysis for the recommended measures is presented in Table 4. Detailed descriptions for each project are presented below. The analysis for these measures does not include incentives available from BC Hydro or Fortis BC. These should be evaluated prior to making final decisions. This building is in the Phase 2 plan for connection to the central plant. However, we believe all measures analyzed except for the RNG measure are good opportunities regardless of central plant connection.

Table 4: Measure Summary

Item	Description	Base Case Cost	Incremental Cost	Total Cost	Effective Payback	NPV	Annual Savings				
							\$	GJ	kW	kWh	GHG
1.1	BAS RCx		\$8,500	\$8,500	6.0	1,100	\$1,100	30		10,400	1.6
1.2	Pumps VSD Upgrades		\$14,000	\$14,000	8.0	1,600	\$1,400	10	66	7,000	0.6
1.3	Active Heat Recovery Upgrade		\$40,000	\$40,000	14.0	(17,500)	\$1,600	170	(10)	(13,000)	8.4
1.4	AHU-1 VSD		\$20,000	\$20,000	14.0	(7,900)	\$1,100		50	7,800	0.1
1.5	Renewable Natural Gas				9.0		(\$9,360)				42.7

2.1.1 BAS RCx

Although the House of Learning building operation has been mostly optimized, a few remaining opportunities were noted as part of the Coppertree connection and BAS review. They are as follows:

- A few zone temperature sensors were noting over heating of spaces. Some as high as 27°C. This could be a result of sensor faults or actual overheating of the spaces. This should be investigated and remedied.
- FCU-34 was noted to be on afterhours. This could be because of COVID, but we recommend verifying the schedules for all units now that classes have resumed and the units are no longer required to operate continuously.
- The air pressure sensor in AHU-2 may require recalibration.
- The AHU-1 SF/RF and economizer were noted to be cycling and free cooling did not appear to be working optimally. This should be investigated and optimized.
- The Geo loop tuning did not appear to be optimized. We recommend recommissioning this loop control and ensuring the Geo loop is used as the first stage of heating so as to minimize use of the radiant heating. We also recommend verifying that the new Tim Hortons fan coil is functioning as intended to push the heating load onto the geo loop and that the terminal heating in the surrounding spaces is being used as a secondary heat source.
- Pump P-12 was not turning off when all associated systems are off.

2.1.2 Pump VSDs

A significant portion of the building's electrical load comes from pumps. Several of the larger pumps are constant speed, however, demand changes throughout the year. The following pumps are constant speed and would be good candidates for speed control.

- Pump 12 – Perimeter Radiation Supply
- Pump 13 – Perimeter Radiation Supply
- Pump 14 – AHU Heat Supply
- Pump 15 – AHU Heat Supply

This measure recommends installing new variable speed drives or ECM pumps to modulate the speed of pumps based on demand. Older motors may have to be upgraded to high efficiency models if they are not compatible with speed drives. It should be noted that heat pump systems require constant flow so any pumps supplying the

heat pump system were not considered. This measure only looks at the heating pumps as they are the best candidates for upgrade, but it is likely there are other pumps that would be good candidates.

2.1.3 Active Heat Recovery

Existing heat recovery loops for the AHUs use a glycol runaround system, which is a passive method of heat recovery. This measure recommends installing a reversible heat pump in the system. This will create an active heat recovery system and will significantly improve the efficiency of heat recovery.

In addition, the current system is only used to preheat air, but it could be used to both preheat and precool air depending on building demand. We recommend the system be updated to be used for both heating and cooling as part of this upgrade.

2.1.4 AHU-1 VSD

The supply fan (SF) and return fan (RF) on AHU-1, which serves the atrium, are constant volume. It was noted that the pressure in the atrium varied significantly throughout the day as a result of the SF running without the RF. We recommend linking these fans and having them control to a pressure setpoint in the space. The pressure setpoint can be varied based on the outdoor air temperature (OAT).

2.1.5 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 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.