



Thompson Rivers University ASHRAE Level 1 Energy Study

Energy Study for:

Science and Health Building

Attention:

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Science and Health - ASHRAE Level 1 Study -

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1. Background Description of Facility, Hardware and Systems

1.1 Overview and Facility Use

The Sciences and Health building was originally built in 1980 and is comprised of a 3-storey structure with a gross floor area of 114,368 ft² (10,629 m²). The building contains computer labs, study spaces, lecture and lab classrooms, research labs, offices and a coffee shop.

1.1.1 Physical condition and window type

The original building appears to be well maintained. Building fenestration typically comprises 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 supplied by the following systems:

- SF-1 and SF-2, which are 100% outdoor air (OA), variable volume units with hot water heating coils. They provide ventilation to terminal heat pumps in the east and west zones respectively.
- AH-1 is a 100% OA, constant volume unit with hot water heating. It provides ventilation to terminal heat pumps in the central zone.
- SF-103 is a 100% OA, constant volume unit with gas fired heating. It provides ventilation to the lab spaces in the west wing.
- SF-104 is a 100% OA, variable volume unit with gas fired heating and direct expansion (DX) cooling. It provides ventilation to the lab spaces in the central wing.
- AHU-2 is a mixed air, constant volume unit with a hot water heating coil. It provides ventilation directly to the boiler room. It runs 24/7.

1.2.2 Cooling

There are two cooling towers that provide cooling to the east and west terminal heat pump water loops respectively. SF-104 has DX cooling.

1.2.3 Heating

There are four natural gas condensing boilers in the building. There are two boilers for the east wing and two boilers for the west wing. The boilers provide heating water for the following.

- West and East heat pump loops
- Pre-heat coil in SF-2
- Hot water radiation units
- Hot water unit heaters in greenhouse
- Force flow heaters

SF-103 and SF-104 have gas fired heating sections. 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

DHW for the building is provided by a single natural gas DHW heater.

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1.3 Lighting System

All building lighting has been upgraded to LED.

1.4 Control Equipment

The building has a Siemens BAS. All major HVAC systems are on BAS except DHW, lighting. The operations team is planning on switching this building to an Automated Logic BAS in late 2022. The terminal devices may also be replaced as part of this upgrade as they have reached the end of their recommended service life.

1.5 Energy Analysis

1.5.1 Energy Use Profile

Figure 1 presents the building's electrical consumption since 2017. There is no data available past January 2020. The IoTORQ data appears to have some issues with the month-to-month summation and was not used.

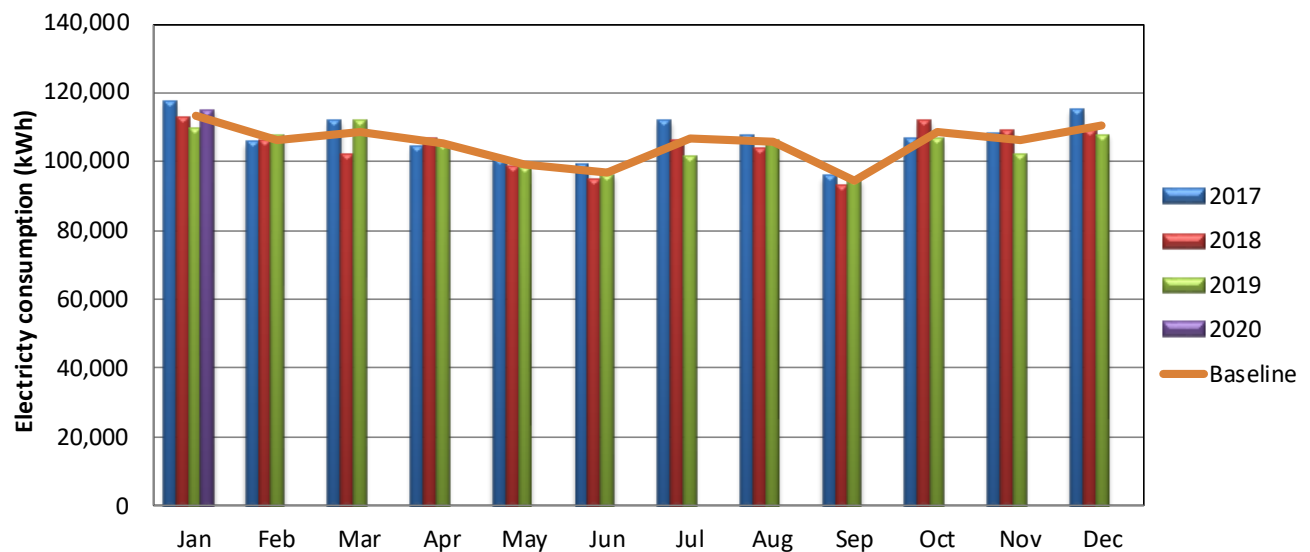


Figure 1: Monthly Electricity Consumption

Figure 2 presents the building's gas consumption since 2017. There were some discrepancies in the recent patched data provided. As such, a combination of the consumption data provided for the 2018 Fortis study and the most recent data was used. Although it looks like the data has decreased slightly as a result of COVID, all months were used to calculate the baseline since the accuracy of the data was uncertain. Including these months provided a more conservative estimate of the building energy consumption. The data in IoTORQ appears to have a scaling issue so it was not used.

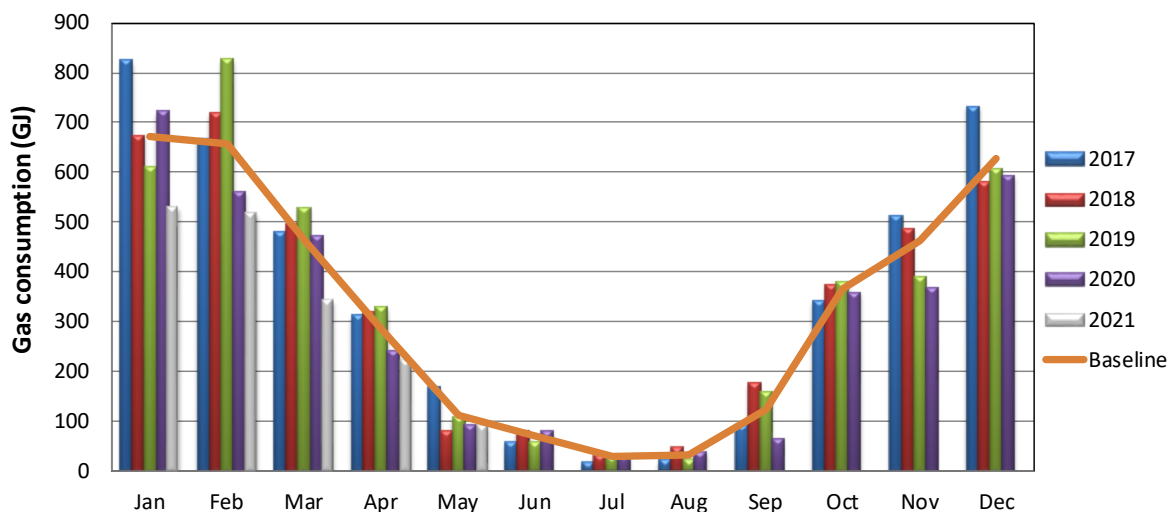


Figure 2: Monthly Gas Consumption

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 Sciences building has an Energy Use Intensity (EUI) of 795 MJ/m².

Table 1: Summary of Baseline Energy Data

Utility	Energy Use (GJ)	EUI (MJ/m2)	Cost (\$)	Cost (\$/ft2)
Gas	3,902	367	\$50,859	\$0.44
Electricity	4,545	428	\$35,786	\$0.31
Total	8,447	795	\$86,645	\$0.76

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. The large plug load is a result of the computer labs and research equipment in the building.

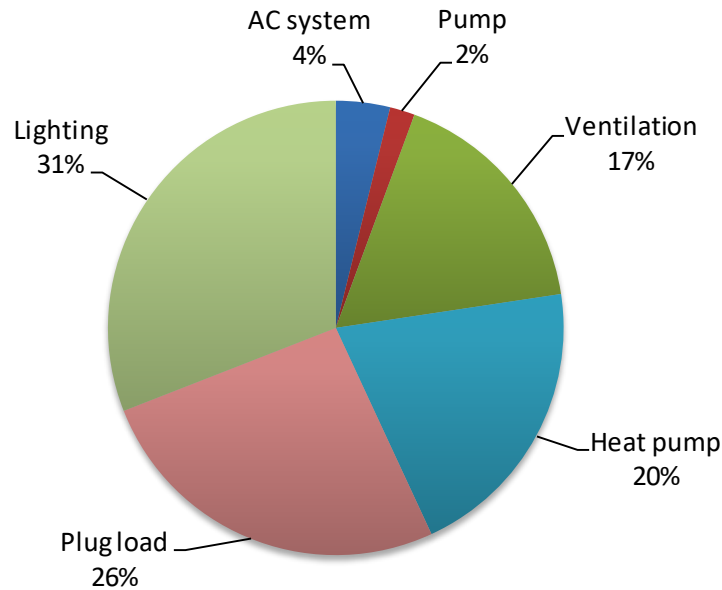


Figure 3: Electricity Consumption

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

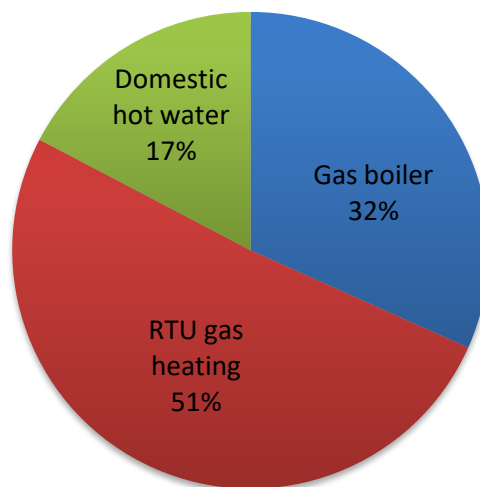


Figure 4: Gas Consumption

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

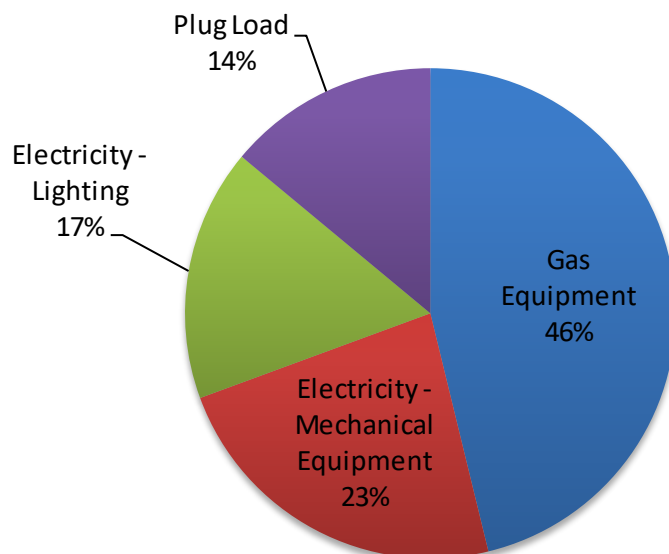


Figure 5: Total Energy Breakdown

2. Conservation Opportunities

The primary objective of this study was to identify and analyse energy conservation opportunities at the Sciences building. 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 following measures are implemented, we estimate the following savings outcomes:

Table 3: Estimated Savings

Energy footprint	Electricity	Natural Gas	Greenhouse gases	Cost per ft ²
9%	4%	15%	14%	0.11

2.1 Energy Conservation Measures

This building is 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:

- Parallel to series heating conversion
- Gas absorption heat pumps to replace boilers and DHW
- 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 measures is presented in Table 4. Detailed descriptions for each project are presented below.

Table 4: Measure Summary

Item	Description	Base Case Cost	Incremental Cost	Total Cost	Effective Payback	NPV	Annual Savings				
							\$	GJ	kW	kWh	GHG
1.1	Controls Commissioning		\$14,000	\$14,000	8.0	(3,300)	\$1,200	30	33	6,400	1.6
1.2	Lab Optimization		\$55,000	\$55,000	4.0	50,400	\$11,700	560	58	40,800	28.3
Total			\$69,000	\$69,000	5.3		\$12,900	590	91	47,200	29.9

2.1.1 Controls recommissioning

SES is currently in the process of implementing the 2020 Bundle B Cycle 1 Fortis study recommendations on this building. However, there are still several opportunities for optimization.

- SF-1/2 appear to not be maintaining supply air pressure (SAP) setpoint.
 - SF-1 VFD appears to be constantly operating in manual mode
 - SF-2 is operating at an average duct static pressure of 59Pa. The static pressure setpoint appears to be 100Pa.
- Not all closet HPs have occupancy sensor installed. It is possible these are the ones that are consistently occupied, but we recommend reviewing this to see if there are any additional opportunities.
- We recommend re-wiring the West Boilers, De Dietrich ECO 310, to switch from low/high fire to fully-modulating control of the burner to improve controllability. This will result in energy savings.
- SF-1, SF-2 and AH-1 have a constant supply air pressure setpoint. We recommend implementing an SAP reset for these units. This measure was recommended in the original Fortis study, but was not implemented as no Fortis incentives were provided.
- It was noted that many of the outdoor air temperature (OAT) sensors were 4°C different than the weather station readings. We recommend these be checked to ensure there is a sunshield present and that the readings are accurate. This measure was recommended in the original Fortis study, but was not implemented.

It was noted by the facilities team that there are plans to switch this building from a Siemens BAS to an Automated Logic BAS in late 2022. We recommend that a full commissioning be done after this work and that the above opportunities be further investigated at this time. While it is very likely this measure will result in energy savings, the main purpose is to verify that the building is functioning optimally. Doing a full commissioning after a BAS switchover is critical to the success of project as there are often remaining deficiencies and additional opportunities post switchover that need to be addressed.

2.1.1 Lab Optimization

SF-103 and SF-104 provide conditioned air for the lab spaces in the building. These units currently operate 24/7 as some of the lab spaces have temperature sensitive equipment. However, based on conversations with the building operator, it is estimated that only five labs require 24/7 operation. Lab spaces are usually

kept at a negative pressure to prevent contaminants in the lab space from entering the corridors. However, for multiple lab spaces in this building it was noted that the fume hood air flow exhausted out of the space was less than the supply air entering the space. This results in labs that are positively pressurized, which not only results in excessive energy use, but also poses a potential safety issue. It was also noted that the flow setpoints for the lab spaces are not optimized to reflect demand and that one of the flow sensors is broken (S360). Additionally, some of the fume hood exhaust dampers were reading negative values and the fume hood air flow was above setpoint. The fume hood exhausts are all variable volume and the controls were done by Siemens in 2018.

We recommend installing a variable speed drive (VSD) on SF-103 and implementing a supply air pressure (SAP) reset for SF-103 and SF-104, which already has a VSD. This will modulate the SAP based on the exhaust flow from the lab fume hoods to ensure the labs are not over pressurized. The flow setpoints in the lab spaces should also be re-evaluated at this time to ensure they are optimized and that all flow sensors are functioning as intended. It is recommended that a specialist firm such as Aircurity be brought into this project.

It should be noted that SF-103 was installed in 2013. If this unit is nearing the end of its recommended service life by the time this measure is implemented, it may make more sense to replace the unit entirely with either a high efficiency condensing model with VSD or a heat pump model with VSD. The current unit does not have cooling so if there is demand for cooling in the space, a heat pump may be preferred. Although this building is in the first phase of connection to the district energy plant, it is likely that the size of heating water pipes going up to the roof are not sufficient to tie another AHU into the loop. This should be confirmed because if there is capacity, it likely makes sense to replace SF-103 with a unit with a hot water heating coil.

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.