



Thompson Rivers University ASHRAE Level 1 Energy Study

Energy Study for:

International Building

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

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International Building - ASHRAE Level 1 Study -

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1. Background Description of Facility, Hardware and Systems

1.1 Overview and Facility Use

The International Building was constructed in 2005. The gross conditioned square footage of the building is approximately 4,579 m² (49,288 ft²). The first three floors of the building house classrooms and offices, with a small observatory on the 4th floor. At the entrance to this building there is an atrium foyer, which serves as a general seating area.

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

The following major ventilation systems exist in this building. All air handling units (AHUs) are original to the building.

- AHU-1 is a mixed air system located in the 3rd floor north mechanical room. It serves the north half of the building via variable air volume (VAV) boxes with reheat coils. It is a variable air volume unit with a hot water preheat coil and a chilled water cooling coil
- AHU-2 is a mixed air system located in the 3rd floor south mechanical room. It serves the south half of the building via variable air volume (VAV) boxes with reheat coils. It is a variable air volume unit with a hot water preheat coil and a chilled water cooling coil
- AHU-3 is a mixed air system located in mechanical room 132, serving the foyer. It is a constant volume unit with a hot water preheat coil and a chilled water cooling coil.

1.2.2 Cooling

The following major cooling systems exist in this building:

- An air-cooled chiller serves the chilled water loop that circulates to all the AHU cooling coils.
- Four dedicated split-type DX cooling systems serve the computer and language laboratories, located on the second floor. Two units are for computer labs 1 and 2, and another two for language labs 1 and 2. The outdoor units are mounted on the roof.

1.2.3 Heating

Two mid-efficiency natural gas boilers provide heating water to the following systems. The boilers are original to the building.

- AHU heating coils
- VAV box reheat coils
- Forced flow heaters
- Radiant slab heating in the Foyer

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

Domestic hot water (DHW) is provided by four electric tank-type DHW heaters, located in the building's ceiling spaces. Three of the DHW tanks have been replaced recently.

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 in the building has been upgraded to LED.

1.4 Control Equipment

All equipment in the mechanical rooms of this building was switched from a Siemens system to an Automated Logic system in November 2021. The VAVs and remainder of the building terminal units are still on the Siemens system. It should be noted that since this switchover, operations has had significant issues with this building. These issues are likely a result of both the switchover and the terminal devices failing due to their age.

1.5 Energy Analysis

1.5.1 Energy Use Profile

Figure 1 presents the building's electrical consumption since 2017. Data from March 2020 onwards was excluded from the baseline as it is significantly lower than the average. This is a result of the reduced operation during COVID. This building does not have any available data past April 2021 and is not setup on IoTORQ.

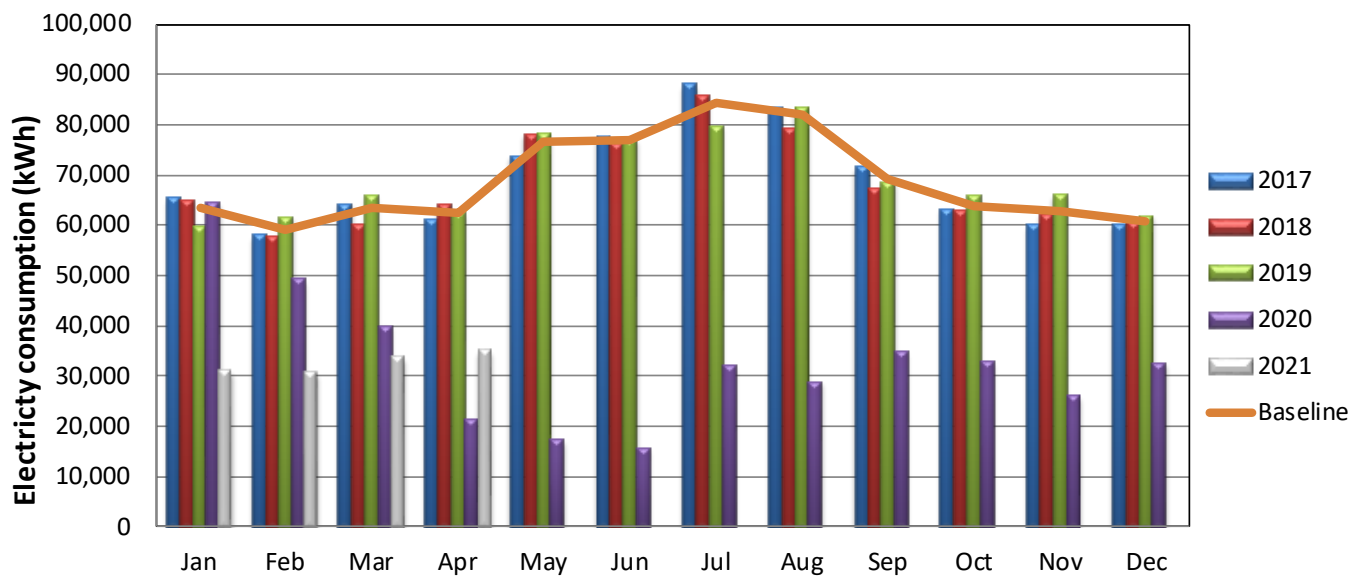


Figure 1: Monthly Electricity Consumption

Figure 2 presents the building's gas consumption since 2017. There is a strong seasonal fluctuation, which is typical for a heating profile. The baseline gas consumption was calculated based on all available data. Data from March 2020 onwards was kept as it was similar to the other years and does not appear to have been significantly affected by COVID operation. This building does not have any available data past April 2021 and is not setup in IoTORQ.

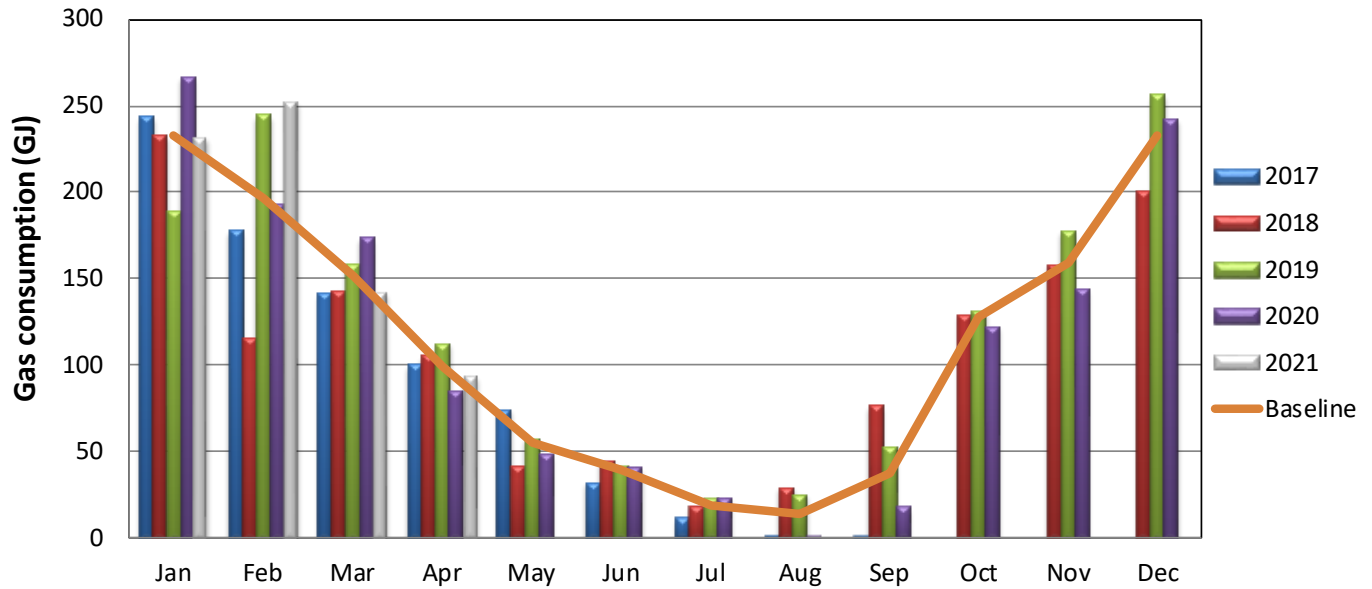


Figure 2: Monthly Gas Consumption

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. The International Building has an Energy Use Intensity (EUI) of 402 MJ/m². This has decreased since the L1 study completed in 2017 as the building square footage was updated. We suspect this square footage is incorrect as an EUI of 402 MJ/m² is extremely low for a building like this. However, this square footage has been confirmed with operations. The square footage does not affect the analysis of savings for the project.

Table 1: Summary of Baseline Energy Data

Utility	Energy Use (GJ)	EUI (MJ/m ²)	Cost (\$)	Cost (\$/ft ²)
Gas	1,375	127	\$16,529	\$0.14
Electricity	2,969	275	\$49,973	\$0.43
Total	4,344	402	\$66,502	\$0.57

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.

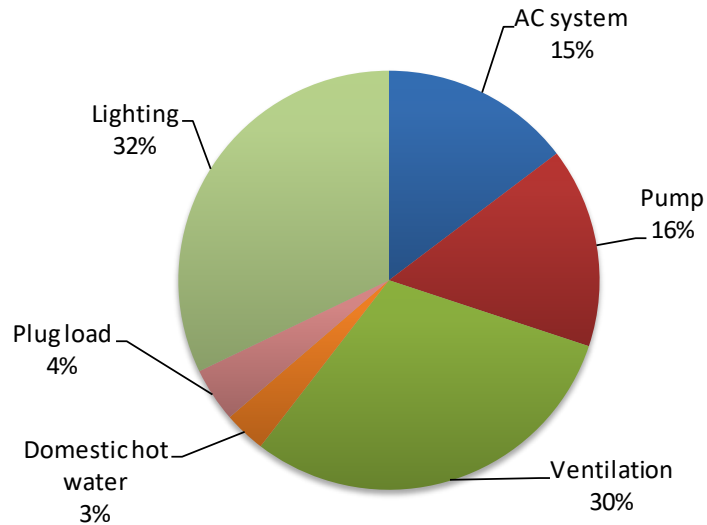


Figure 3: Electricity Consumption

The estimated percentage of total energy consumption by building system is presented in Figure 4. Gas is only used for space heating.

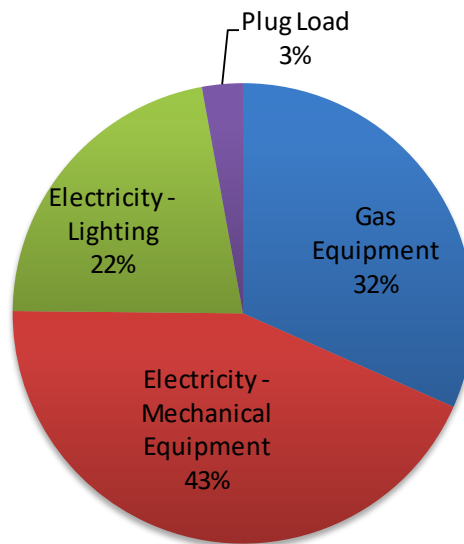


Figure 4: Total Energy Breakdown

2. Conservation Opportunities

The primary objective of this study was to identify and analyse energy conservation opportunities at the International 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 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.

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
1%	2%	1%	1%	0.01

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:

- Condensing Boiler Upgrade and Resizing

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		\$6,800	\$6,800	10.0	(3,200.0)	\$480	10		4,300	0.5
1.2	VAV Control RCx		\$5,700	\$5,700	8.0	(1,200.0)	\$600		18	5,300	0.1
1.3	AHU-3 VSDs		\$5,200	\$5,200	9.0	(100.0)	\$460		15	4,500	
Total			\$17,700	\$17,700	11.5	(4,500.0)	\$1,540	10	33	14,100	0.6

2.1.1 Controls Commissioning

All equipment in the mechanical rooms of this building was switched from a Siemens system to an Automated Logic system in November 2021. The VAVs and remainder of the building terminal units are still on the Siemens system. Since the switchover, the operations team has had significant issues with this building. These include but are not limited to radiant heating valves and VAV failing and comfort complaints from occupants. These

issues are likely a combination of old terminal devices and issues with the commissioning of the building. In addition, a preliminary review of the BAS has noted the following opportunities for optimization.

- Chiller has gone into alarm as of 13:00, April 10. The TRU operations team is aware of alarm condition. Scheduling of chiller operation may need review, as the circulator, P-3/4, VFDs were in manual and OFF. Re-zeroing of pressure transmitter may also be beneficial. The transmitter is reading 39.25 PSI while P-3/4 are with confirmed OFF statuses.
- AHU-1 supply fan (SF) is operating below setpoint, average of 300Pa. Setpoint is 400Pa. We suggest re-tuning of the control for this unit.
- AHU-2 SF is operating below setpoint, average of 200Pa. Setpoint is 400Pa. We suggest re-tuning of the control for this unit.
- Based on the Kaizen trending, the chiller pump P-3 does not appear to be interlocked with the chiller. We recommend interlocking these.

SES and Care Systems are currently in the process of implementing the controls recommissioning measures from the Fortis Study Bundle B Cycle 1 on this building. These measures will cover some 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 likely 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.

2.1.1 VAV Control RCx

The VAVs in the building already appear to have a dual maximum program setup. However, it was noted that the setpoints were not optimized. Some of the setpoints were noted to be extremely high and the heating and cooling minimums were often noted to be different. In an optimized dual maximum control, there should be a single minimum setpoint and two maximum setpoints (one for cooling demand and one for heating demand).

We recommend updating the VAV flow setpoints to optimize the control. Specifically, the minimum cooling and heating setpoints should be the same and the maximum setpoints should be re-evaluated. It is also possible that some of the minimum setpoints are higher than required by ASHRAE guidelines. These can also be evaluated during implementation. The main building systems in this building were recently switched from the Siemens system to Automated Logic, but all terminal devices are still on the Siemens system. It was noted that the terminal VAVs are old and many are failing. A review of the VAVs should be done at this time to identify any malfunctioning VAV boxes that should be replaced. Given the age of these devices, a full VAV replacement may be recommended. This should be further investigated. The switchover, VAV review and any replacement costs were not included in the analysis of this measure as that should be covered by operations.

2.1.2 AHU-3 VSDs

The supply fan for AHU 3 is constant volume. This unit serves the Foyer.

Installing variable speed drives on the supply fan motor will allow for the reduction of fan speeds during periods of low demand. We also recommend applying a dynamic supply air pressure reset program to further optimize savings.

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.