



Thompson Rivers University ASHRAE Level 1 Energy Study

Energy Study for:

The Library

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

May 25, 2022

The Library - ASHRAE Level 1 Study -

Table of Contents

1. BACKGROUND DESCRIPTION OF FACILITY, HARDWARE AND SYSTEMS	1
1.1 OVERVIEW AND FACILITY USE	1
1.2 MECHANICAL SYSTEMS	1
1.3 LIGHTING SYSTEM.....	1
1.4 CONTROL SYSTEM.....	1
1.5 ENERGY ANALYSIS.....	2
2. CONSERVATION OPPORTUNITIES.....	5
2.1 ENERGY CONSERVATION MEASURES.....	5
3. DISCLAIMER	7

List of Figures

FIGURE 1: MONTHLY ELECTRICITY CONSUMPTION	2
FIGURE 2: MONTHLY GAS CONSUMPTION.....	3
FIGURE 3: ELECTRICITY CONSUMPTION.....	4
FIGURE 4: TOTAL ENERGY BREAKDOWN.....	4

List of Tables

TABLE 1: SUMMARY OF BASELINE ENERGY DATA	3
TABLE 2: RATE SCHEDULES.....	5
TABLE 3: MEASURE SUMMARY	5

1. Background Description of Facility, Hardware and Systems

1.1 Overview and Facility Use

The OLARA building, formally known as the library, was constructed in 1975. The gross conditioned square footage of the building is approximately 3,276 m² (35,263 ft²). This two-level building houses various types of study areas, offices and bookshelves.

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:

- Four rooftop units (RTUs), RTU-1 to 4, provide ventilation to the building via variable air volume boxes (VAVs). All four RTUs were replaced in 2016.

1.2.2 Cooling

Direct expansion (DX) cooling coils in the RTUs provide cooling to the building.

1.2.3 Heating

Natural gas burners in the RTUs provide heating to the building.

Additional heating is provided to the bathrooms, stairwells, entrances and storage room by electric force flow units.

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 a single electric DHW heater. 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. As such, DHW upgrades were not investigated for this building.

1.3 Lighting System

Building was upgraded to 100% LED in March 2016.

1.4 Control System

The library has a Reliable control building automation system (BAS) that controls all major equipment.

The occupied spaces throughout the library are controlled by digital thermostats with occupancy sensors, each controlling a VAV box damper. Each VAV box has a vane relief system to manage duct pressure function without RTU variable speed drives (VSDs).

The main exhaust fan is manually switched between high-speed and low-speed operation during winter and summer seasons.

Perimeter radiation units in are controlled by analogue thermostats in the spaces they serve.

1.5 Energy Analysis

1.5.1 Energy Use Profile

Figure 1 presents the building's electrical consumption since 2016. There is no data available for 2019. The 2021/2022 data was taken from the new energy management software, IoTORQ. It appears to be consistent with the other years monthly data. The baseline calculation was done using all available data, but ignoring outlying values such as July 2017.

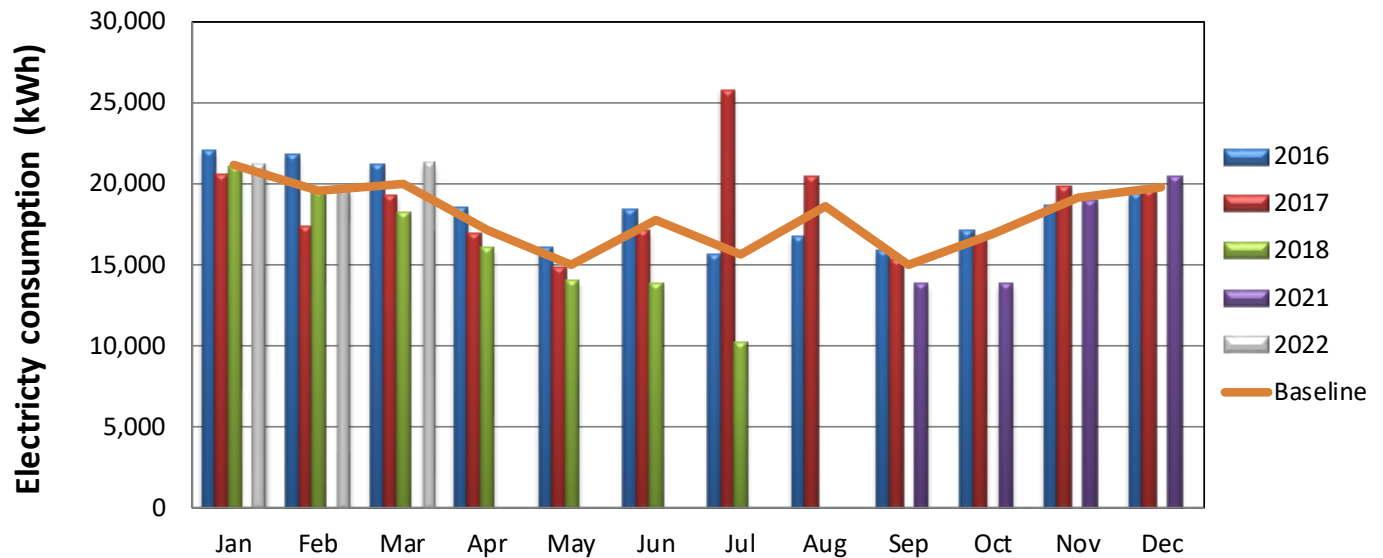


Figure 1: Monthly Electricity Consumption

Figure 2 presents the building's gas consumption from 2014 through 2017. No data past 2017 is available. The month-to-month data is very inconsistent and there appears to be an issue with the meter. Rather than using this data, the baseline gas consumption was calculated using the building inventory and usage from the BAS. It should be noted that the gas consumption profile was updated based on the current RTU operation.

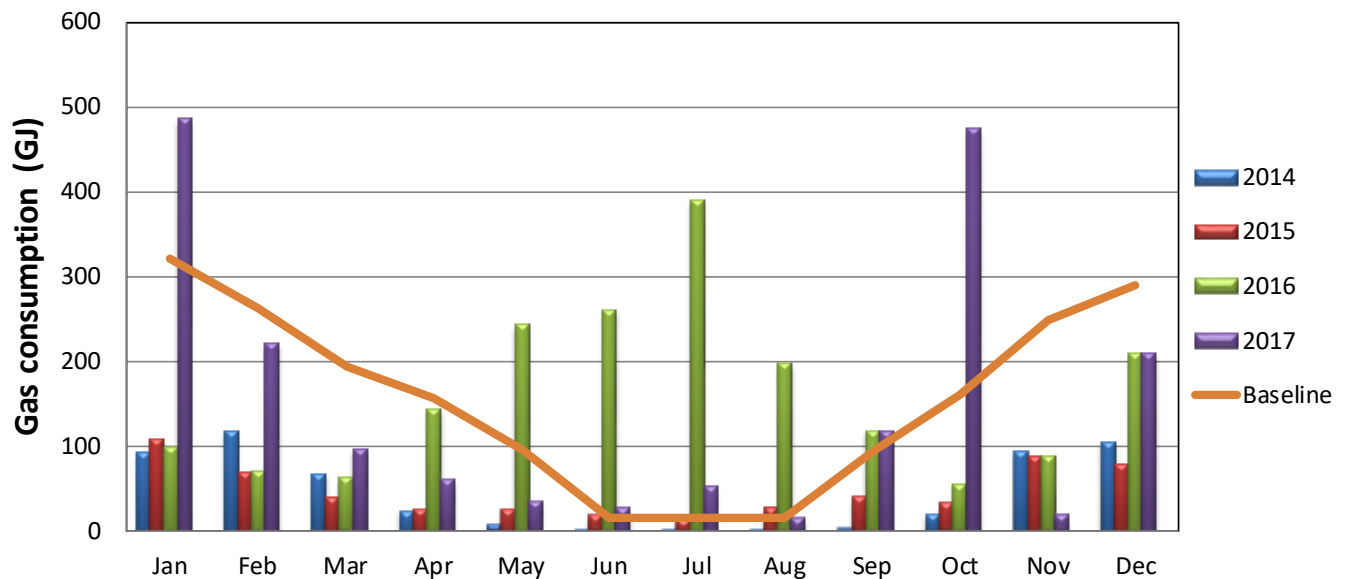


Figure 2: Monthly Gas Consumption

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 Library has an Energy Use Intensity (EUI) of 567 MJ/m². This is based on current operational trends on the BAS and has decreased from the Fortis study value of 825 MJ/m². This reduction is a result of improved operation resulting from the switchover from Johnson controls to Reliable controls as well as the Bundle A Cycle 1 Fortis implementation measures.

Table 1: Summary of Baseline Energy Data

Utility	Energy Use (GJ)	EUI (MJ/m ²)	Cost (\$)	Cost (\$/ft ²)
Gas	1,094	330	\$16,413	\$0.47
Electricity	777	237	\$13,667	\$0.39
Total	1,871	567	\$30,080	\$0.85

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. Gas is only used for space heating.

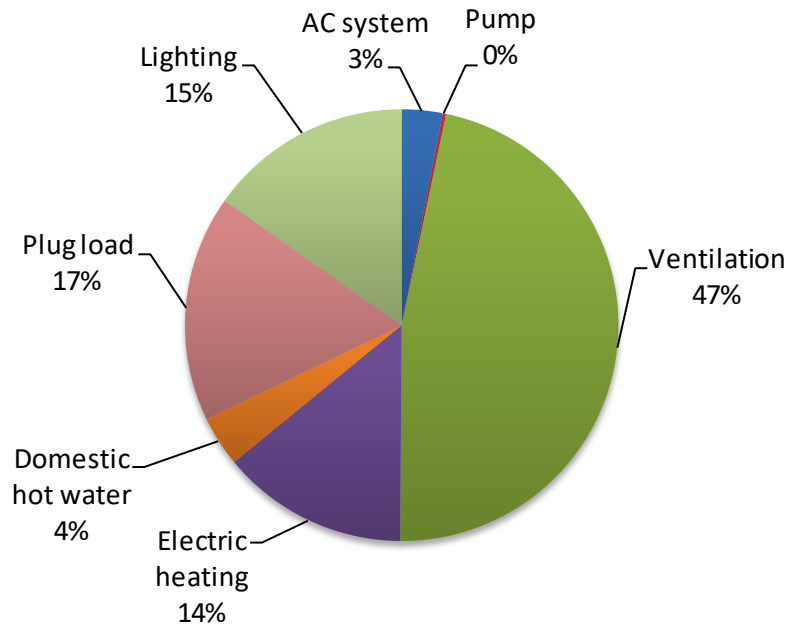


Figure 3: Electricity Consumption

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

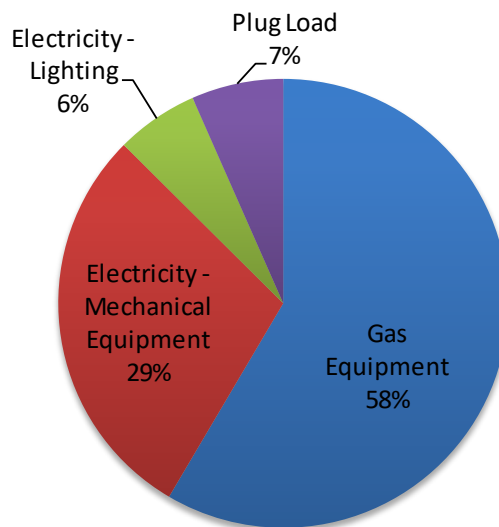


Figure 4: Total Energy Breakdown

2. Conservation Opportunities

The primary objective of this study was to identify and analyse energy conservation opportunities at The Library. 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. Since some of these measures are mutually exclusive, it does not make sense to summarize total energy savings from all measures. The individual measures savings can be found in Table 3.

2.1 Energy Conservation Measures

This building is in the first phase of buildings connected to the district energy plant as part. 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:

- High efficiency RTU upgrade
- RTU heat pumps
- Air sourced heat pump for DHW
- Renewable Natural Gas

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 3. Detailed descriptions for each project are presented below. The analysis for these measures does not include incentives from BC Hydro or Fortis BC.

Table 3: Measure Summary

Item	Description	Base Case Cost	Incremental Cost	Total Cost	Effective Payback	NPV	Annual Savings			
							\$	GJ	kWh	GHG
1.1	Scheduling		4,500	4,500	1	19,300	2,900	50	32,800	2.8
1.2	RTU VSDs		24,000	24,000	16	(12,000)	1,100		10,400	0.1
1.3	RTU VSDs with VAV Upgrade		70,000	70,000	17	(40,000)	2,700		25,900	0.3

2.1.1 Scheduling

Scheduling adjustments were completed on all RTUs during the Fortis study, however, based on a preliminary review of the BAS, there appear to be additional opportunities.

- RTU-2 was noted to be scheduled on from 7:00 am – 11:00 pm most days. It also appears to be cycling quite a bit on the weekends.
- RTU-1 was noted to be on 24/7 since before February
- RTU-3 appears to be cycling on over the weekends and running longer than necessary

It is likely these increased schedules are a result of COVID measures; however, the units should now be able to be returned to normal operation.

2.1.1 RTU VSDs

All four RTUs at the Library serve variable air volume (VAV) diffusers, however, the RTUs themselves are constant volume units. This measure recommends installing variable speed drives (VSDs) on fan motors, modulating fan speeds. The existing VAVs configuration is such that full flow is always provided to the VAV and the flow is either directed into the space or into the ceiling plenum and back to the RTU. This configuration means that the supply air pressure (SAP) in the RTU cannot be reset based on demand in the space. In this case, we recommend that the SAP be reset based on the outdoor air temperature (OAT). While resetting the SAP based on OAT will yield some savings, it is preferable to do this reset based on actual demand in the space.

It should be noted that because the payback for this measure is longer than the remaining life on the RTUs, this measure is not recommended. We recommend waiting to do this upgrade until the RTUs are due to be replaced and then selecting models that have built in VSDs. Since this building is in the first phase of connection to the district energy plant, it is likely that the existing gas fired RTUs will be replaced with RTUs equipped with hot water heating coils to allow heating to be provided by the district energy plant.

2.1.2 RTU VSDs with VAV upgrade

All four RTUs at the Library serve variable air volume (VAV) diffusers, however, the RTUs themselves are constant volume units. In addition, the existing VAV configuration is such that full flow is always provided to the VAV and the flow is either directed into the space or into the ceiling plenum and back to the RTU. This configuration means that the supply air pressure (SAP) in the RTU cannot be reset based on demand in the space. It was also noted by Houle that the current VAVs do not have built in flow sensors so the flow sensors were installed downstream. This causes unstable flow measurements due to the turbulence of the air exiting the VAVs. This measure recommends installing variable speed drives (VSDs) on fan motors and replacing the existing VAVs with standard VAV models that have built in flow sensors. This will allow the SAP of the RTU to be reset based on actual demand in the spaces. It will also allow for accurate flow measurements and better overall control. As part of this upgrade, it may be valuable to bring in an air balancer to rebalance the VAVs. Given the issues with the existing flow measurements it is not possible to determine if the spaces are properly balanced. Costing for an air balancer was not included in the analysis of this measure.

While this measure has a slightly longer payback than the basic RTU VSD measure, it will also have operational benefits, therefore, it is recommended over the basic RTU VSD measure. Given the long payback, we still recommend waiting to do this upgrade until the RTUs are due to be replaced and then selecting models that have built in VSDs. Since this building is in the first phase of connection to the district energy plant, it is likely that the existing gas fired RTUs will be replaced with RTUs equipped with hot water heating coils to allow heating to be provided by the district energy plant.

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.