Thompson Rivers University
ASHRAE Level 1 Energy Study

Energy Study for:

Gymnasium

Attention:

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Gymnasium
- ASHRAE Level 1 Study -

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1. Background Description of Facility, Hardware and Systems

1.1 Overview and Facility Use

The Gymnasium, located on Thompson Rivers University Campus in Kamloops, British Columbia, was originally constructed in 1976. The gross conditioned square footage of the building is 3,701 m^2 (39,837 ft^2). The building contains a weight lifting area, locker rooms, large gym space, offices and squash courts. The courts are no longer in use, but are used for storage. Following the opening of the nearby Tournament Capital Centre in 2007, the Gymnasium sees very little use compared to previous years.

1.1.1 Physical condition and window type

The original building appears to be in fair condition. The windows are double paned.

1.2 Mechanical Systems

1.2.1 Ventilation

The following major ventilation systems exist in this building.

- AHU-4 aka. AC-1, is a mixed air system located outside of the building, serving the exercise studio in the basement of the building. This unit was upgraded in 2005.
- AHU-1 is a mixed air system serving the bleachers/gymnastics area on the main floor.
- AHU-2 is a mixed air system serving the upper gym area.
- AHU-3 is a dual duct, mixed air system that serves five zones: squash courts, Foyer & Athletic, handball court, classrooms, and offices. It was upgraded in 2015.

1.2.2 Cooling

All the AHUs are equipped with direct expansion cooling.

1.2.3 Heating

The following major heating systems exist in this building:

- All air handling units are equipped with gas-fired heating sections
- Electric heaters provide supplemental heating to entrance areas

This building is going to be connected to the district energy plant as part of the first phase of connections, Phase 1A. The district energy plant will provide all heating water and domestic hot water (DHW) in the building.

1.2.4 Domestic Hot Water

Two condensing gas-fired tanks provide hot water for the gym. **It was noted that the tank temperature was at 43ºC, which is a risk of breeding legionella.** It's recommended that TRU increase the temperature setpoint of the tanks.

This building is going to be connected to the district energy plant as part of the first phase of connections, Phase 1A. The district energy plant will provide all heating water and domestic hot water (DHW) in the building.

1.3 Lighting System

Based on conversations with operations staff, all lighting has been upgraded to LED in this building.

1.4 Control Equipment

An Automated Logic BAS controls all major equipment including AHUs, DHW and exhaust fans (EFs). This was switched from Siemens to Automated Logic in 2019.

1.5 Energy Analysis

1.5.1 Energy Use Profile

Figure 1 presents the building's electrical consumption since 2017. There was no data for the summer of 2019 and data from the summer of 2020 was excluded from the baseline as it was significantly below the average of the other years. This is likely a result of reduced operation during COVID.

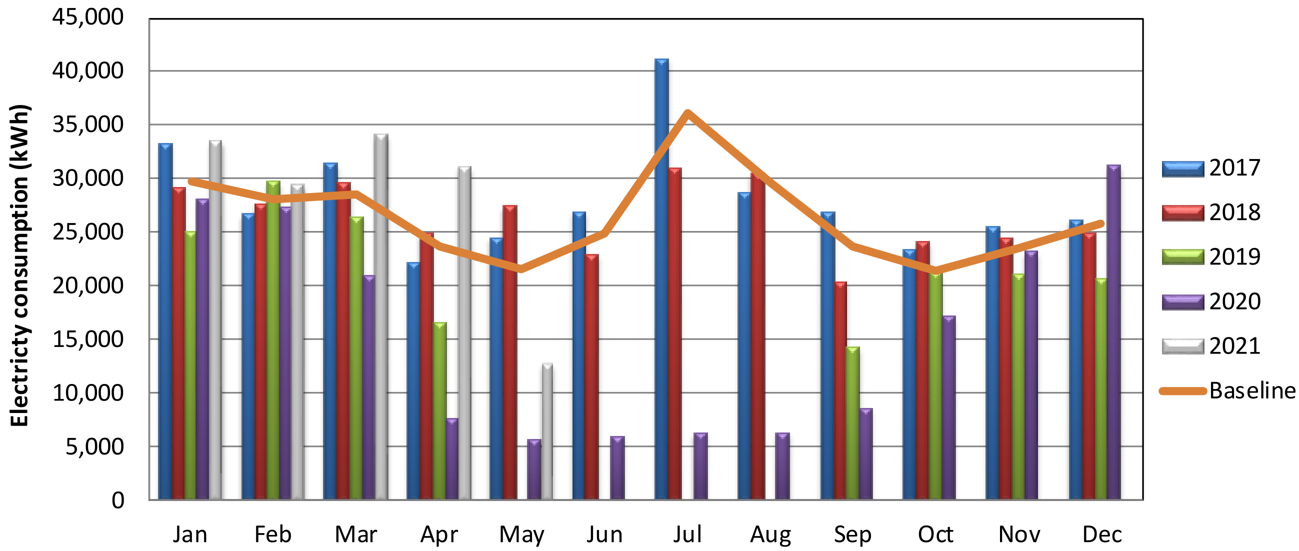

Figure 1: Monthly Electricity Consumption

Figure 2 presents the building's gas consumption since 2014. There are significant gaps and discrepancies in the data. As such the baseline gas consumption was estimated based on the equipment inventory and BAS trend logs.

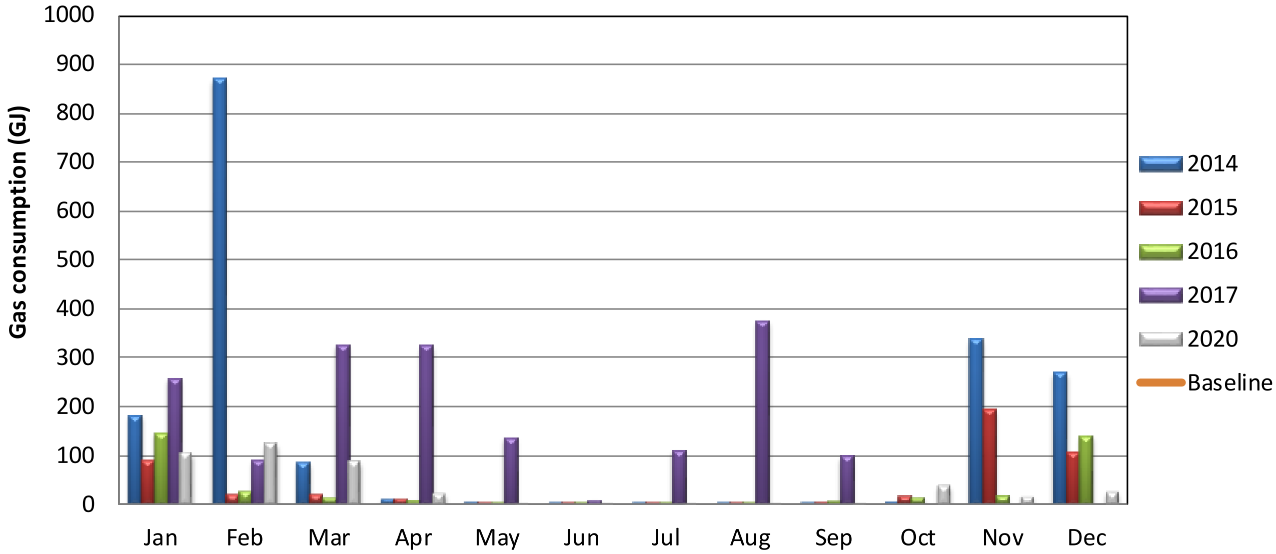

Figure 2: Monthly Gas Consumption

1.5.2 Energy Intensity Analysis

A summary of the baseline energy consumption and the corresponding costs and energy intensity for the facility is presented in Table 1. The Gym has an Energy Use Intensity (EUI) of 740 MJ/m^2.

Table 1: Summary of Baseline Energy Data

Utility	Energy Use (GJ)	EUI (MJ/m2)	Cost ($)	Cost ($/ft2)
Gas	1,576	430	$15,582	$0.39
Electricity	1,140	310	$17,686	$0.44
Total	**2,716**	**740**	**$33,269**	**$0.84**

1.5.3 Energy End Use Breakdown

The energy use breakdown is based on engineering judgement, following a detailed review of building systems. The estimated breakdown of electricity consumption by building system is presented in Figure 3.

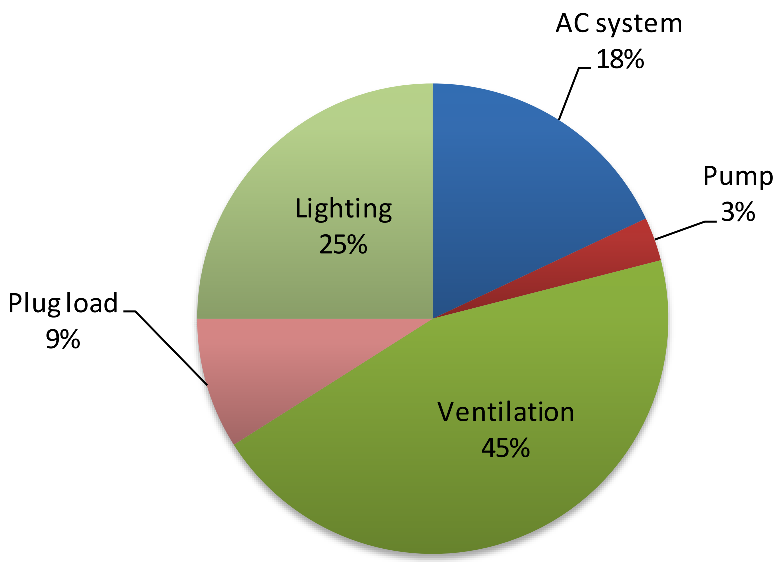

Figure 3: Electricity Consumption

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

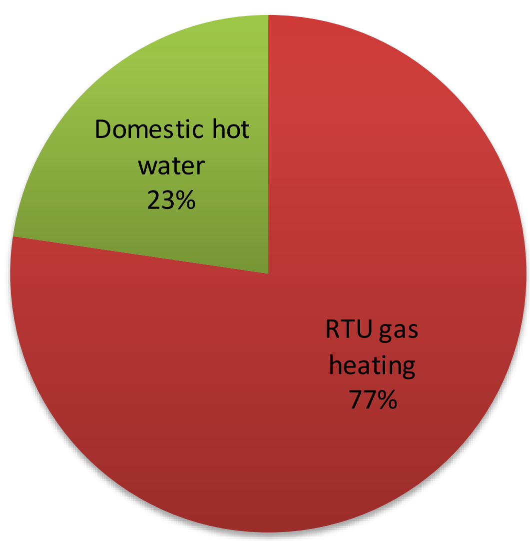

Figure 4: Gas Consumption

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

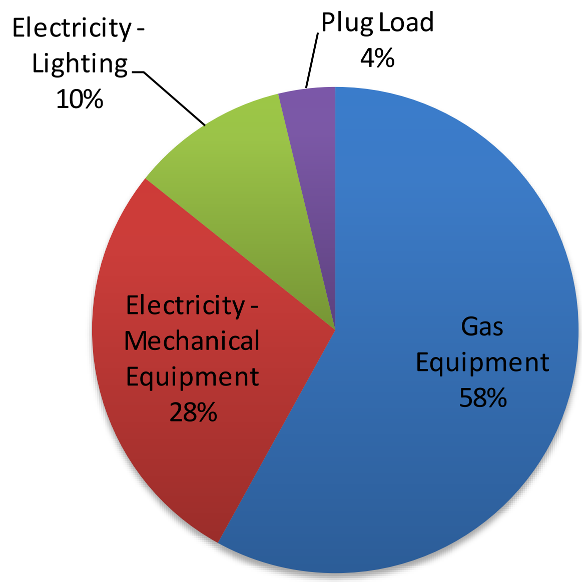

Figure 5: Total Energy Breakdown

2. Conservation Opportunities

The primary objective of this study was to identify and analyse energy conservation opportunities at the Gymnasium. The rate schedules used in this analysis for financial savings estimates are presented in It should be noted that the paybacks for the measures consider the carbon tax escalation provided by the federal government.

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
16%	16%	16%	16%	0.18

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:

- RTU Heat Pumps
- High Efficiency Condensing RTUs
- 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 4. Detailed descriptions for each project are presented below. None of the measures analyzed include incentives provided by Fortis or BC Hydro. In some cases, the incentives provided will significantly reduce costs and overall project paybacks. These should be considered prior to final measure selection.

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 Recommissioning		$8,300	$8,300	2.0	23,200	$3,600	120		28,500	6.3
1.2	AHU-3 Retrofit		$28,000	$28,000	6.0	17,600	$3,700	140	27	21,400	7.2
Total			**$36,300**	**$36,300**	**5.0**		**$7,300**	**260**	**27**	**49,900**	**13.5**

2.1.1 Controls Recommissioning

This building was switched from a Siemens BAS to an Automated Logic BAS in 2019, however, based on a preliminary review of the BAS, there are still opportunities for optimization.

- None of the air handling units (AHUs) have an optimal start sequence and AHU-4 specifically was noted to come on at 2:00/3:00 am in order to get up to temperature in the morning. We recommend implementing an optimal start routine for all AHUs. The optimal start program will analyze space and weather conditions to determine the best time to start up to make sure that spaces are comfortable by the time occupants arrive, but not before.
- Based on the Kaizen review of this building, the free cooling of AHU-4 does not appear to be optimized. We recommend reviewing the free cooling control for all units.
- AHU-2's supply fan (SF) was noted to be short cycling, its VSD was set at a constant 85% and the supply temperature setpoint (SAT) was very high and was also cycling. We recommend recommissioning the AHU-2 SF control, doing VSD reset based on the outdoor air temperature and recommissioning the SAT control.
- The room temperature (RT) sensors for the gym spaces were noted to be cycling more than makes sense for a space of that size. It is possible these sensors need to be relocated. The return air temperature (RAT) sensors were also noted to have issues. These issues are causing cycling of the unit's supply air temperature (SAT). We recommend investigating the RT and RAT sensors to determine if they need to be replaced or moved.
- AHU-2 and AHU-4 have occupancy sensors visible in the BAS programming, however, based on the trends, all AHUs are operating all day long. In addition, AHU-2 was noted to be operating 24/7. We

recommend recommissioning the occupancy control for these sensors and adding an occupancy counter. The schedules should also be reviewed at this time.

2.1.2 AHU-3 Retrofit

AHU-3 is a dual duct unit that serves five zones: squash courts, foyer & athletic, handball court, classrooms, and offices via constant volume mixing boxes. The squash courts, and handball court are being used storage. Although it is possible that the existing AHUs in the building will be replaced due to the connection to the District Energy Plant, AHU-3 was just replaced in 2015 so it is unlikely that this unit will be replaced in the near future.

This measure includes several sub measures to fully retrofit AHU-3.

- Convert the constant volume mixing boxes to VAV mixing boxes to modulate flowrates based on actual demand.
- Implement a VFD upgrade for the supply fan (SF) and return fan (RF) of AHU-3.
- Install occupancy sensors in the space and return air CO_2 sensing in the unit to modulate the flow and amount of fresh air based on actual demand in the space.
- Implement SAT reset and demand control ventilation.

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.