# Thompson Rivers University
# ASHRAE Level 1 Energy Study

*Energy Study for:*

**Daycare**

**Attention:**

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# The Daycare
## - ASHRAE Level 1 Study -

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# 1. Background Description of Facility, Hardware and Systems

## 1.1 Overview and Facility Use

The Daycare was constructed in 1993. It has a single floor with a gross floor area of 442 $m^2$ (4,756 $ft^2$), containing children's play areas, offices, and a small kitchen.

### 1.1.1 Physical condition and window type

The original building appears to be well maintained. The windows are double paned. It was noted by the facilities team that this building is scheduled for demolition as the new daycare building is now completed and will be occupied as of September 2022.

## 1.2 Mechanical Systems

### 1.2.1 Ventilation

Ventilation is supplied by three air handling units (AHUs) which ventilate the occupied spaces through diffusers in the ceiling. One AHU is located in the mechanical room and remaining two are located in the attic.

### 1.2.2 Cooling

Cooling is provided by AHU direct expansion (DX) cooling coils. The three condensing units are located on the roof.

### 1.2.3 Heating

A single natural gas condensing boiler provides heating water to the following systems. This boiler was installed in 2018. This boiler is oversized for the building and gas requirements. The boiler serves the following:

- AHUs heating coils
- Radiant slab heating (3 zones)

### 1.2.4 Domestic Hot Water

Domestic hot water (DHW) is provided by a single condensing natural gas tank-type heater, located in the mechanical room.

## 1.3 Lighting System

The building has a combination of CFL lighting and T8 fluorescent lighting. It should be noted that the operations team is currently in the process of replacing all campus lighting with LEDs.

## 1.4 Control Equipment

The Daycare's HVAC system, including all three AHUs, the boiler, and radiant slab system is controlled by the Siemen's BAS. The building has three zones, each served by an AHU and a radiant slab control valve. Each zone contains a single digital thermostat. The lighting system is controlled by a low-voltage system.

## 1.5 Energy Analysis

### 1.5.1 Energy Use Profile

Figure 1 presents the building's electrical consumption since 2018. Baseline electricity consumption was calculated based on an average of 2019 onwards to ensure more conservative energy savings estimates as the data for 2018 and before was notably higher. Based on our records no significant work has been done to this building since prior to the original BOMA level 1 studies done in 2017/2018, therefore the cause for the decrease in electricity consumption is not known.

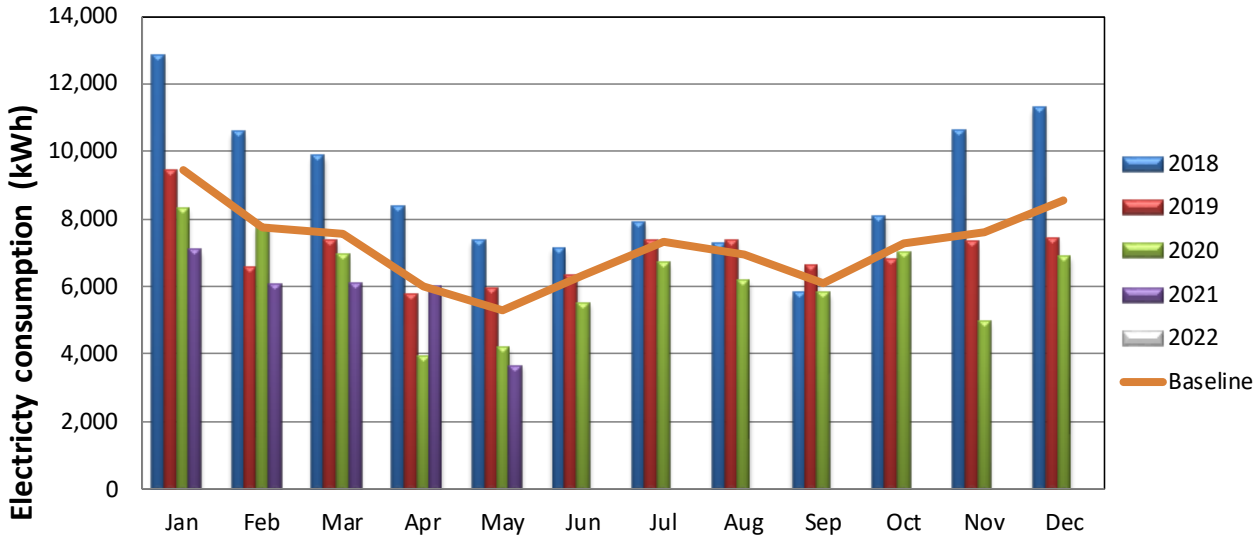


**Figure 1: Monthly Electricity Consumption**

Natural gas metering is not available for the houses or the Daycare. Figure 2 presents the building's simulated gas consumption based on the new condensing boiler nameplate information, assumed domestic hot water sizing and estimated usage in the building.

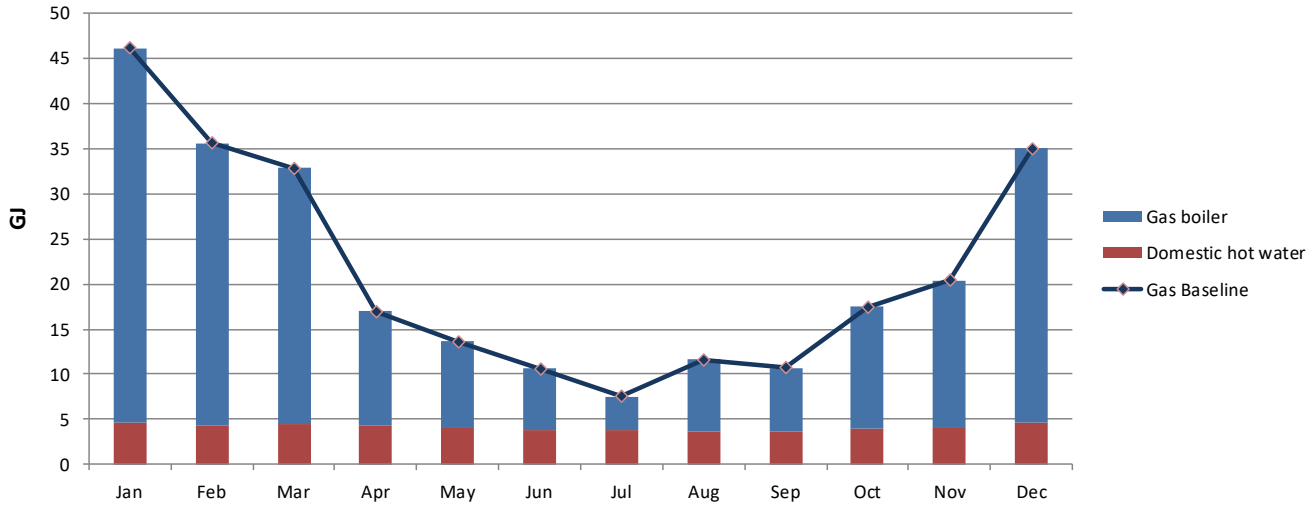


**Figure 2: Monthly Gas Consumption**

### 1.5.2 Energy Intensity Analysis

A summary of the energy use intensity (EUI) and the corresponding costs for the facility is presented in Table 1. The Daycare has an estimated EUI of 1,210 MJ/m$^2$.

**Table 1: Summary of Baseline Energy Data**

| Utility | Energy Use (GJ) | EUI (MJ/m2) | EUI (kWhe/ft2) | Cost ($) |
|---|---|---|---|---|
| Gas | 259 | 580 | 15 | $3,878 |
| Electricity | 280 | 630 | 16 | $5,456 |
| **Total** | **539** | **1,210** | **31** | **$9,333** |

### 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.

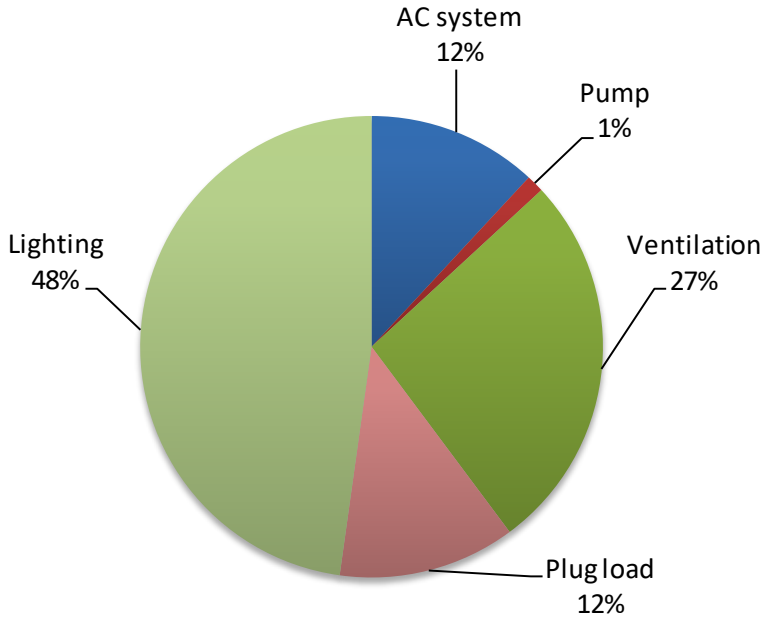


**Figure 3: Electricity Consumption**

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

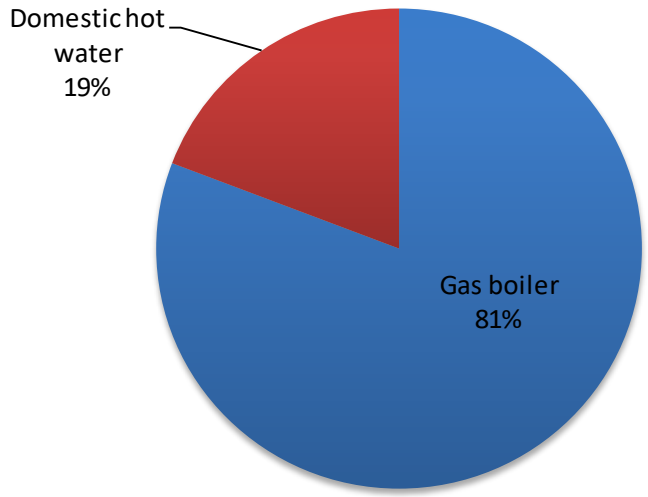


**Figure 4: Gas Consumption**

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

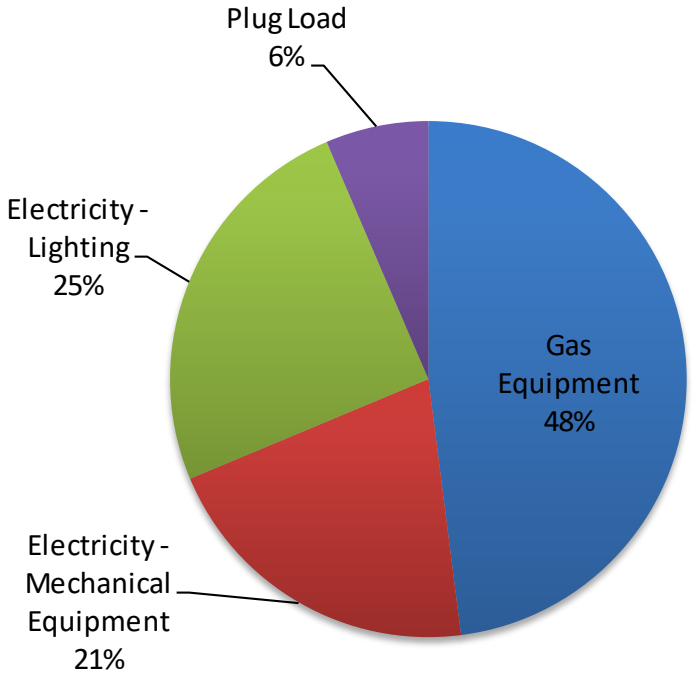


**Figure 5: Total Energy Breakdown**

# 2. Conservation Opportunities

The primary objective of this study was to identify and analyse energy conservation opportunities at The Daycare. 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. As some of these measures as mutually exclusive it does not make sense to present the total savings for all measures. The individual measure summaries can be found in Table 3.

## 2.1 Energy Conservation Measures

A summary of the analysis for the recommended measures is presented in Table 3. 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. Based on conversations with operators, this building is scheduled for demolition in the near future. As such, it may not make sense to implement any energy conservation measures on it. If for some reason, plans for this building change, the measures presented below may make sense.

**Table 3: Measure Summary**

| Item | Description | Base Case Cost | Incremental Cost | Total Cost | Effective Payback | NPV | Annual Savings | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | $ | GJ | kWh | GHG |
| 1.1 | BAS RCx | | $6,600 | $6,600 | 5.0 | 2,700 | $1,100 | 50 | 4,500 | 2.5 |
| 1.2 | Laundry | | $2,000 | $2,000 | 7.0 | (100) | $200 | 10 | 1,000 | 0.5 |
| 1.3 | Heat Pumps | $30,000 | $18,000 | $48,000 | 13.0 | (6,900) | $720 | 90 | (9,100) | 4.4 |
| 1.4 | Renewable Natural Gas | | | | ≥ 40 | | ($770) | | | 3.5 |

### 2.1.1 BAS RCx

No recommissioning has been completed on this building since it was originally recommended in 2017. Based on a preliminary review of the building automation system (BAS) sequences, several optimization opportunities were identified. We recommend doing a full controls recommissioning on this building to identify additional opportunities and optimize control.

- OAT Lockouts: The building has no outdoor air temperature (OAT) lockouts. We recommend implementing OAT lockouts for the boiler and condensing units.
- Optimal Start: There is no optimal start in place. An optimal start sequence may be programmed to minimize run times while ensuring the spaces are comfortable when occupants arrive in the morning.

For additional precautions during COVID, a night time purge that delivers 3 air changes per hour (ACH) can be added. The optimal start program will analyse 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. During colder weather, the outside air dampers will be kept closed during the startup period to further reduce heating loads. Schedules should also be reviewed when this measure is implemented. Occupant engagement plays a critical role in successfully implementing a scheduling project. Occupants should be surveyed to determine actual HVAC requirements.

- Boiler HSWT RCx: A new condensing boiler was installed in 2018 in this facility however, based on a BAS review, the heating water supply temperature (HWST) was 60 °C meaning the boiler may not be operating in condensing mode. As the supply temperature to the zones was only 33°C at the time, we are confident the boiler HWST could be reduced in this building while still maintaining effective heating in the zones. We recommend recommissioning the boiler HWST programming. A return water temperature sensor should be added to the loop during the implementation of this measure.

### 2.1.2 Laundry

The daycare has two dryers and one washer. While one dryer looks to be energuide rated, the other appliances do not appear to be high efficiency. We recommend upgrading the laundry washers and dryers with efficient Energy Star models when they are due to be replaced. Since the exact age of the washer/dryer was not known, incremental costing was not used for the analysis of this measure. If the new washer and dryers allow, we also recommend programming the default cycles on the washing machine to cold water in order to save on DHW consumption. This would only set the default cycle to cold-water; staff would still be able to select a warm water cycle if required.

### 2.1.1 Heat Pumps

Cooling for the air handling units (AHUs) is currently provided by three condensing units located on the roof. This measure recommends replacing these condensing units with reversible heat pumps. This would allow them to be used for heating as well and would reduce the building boiler usage. Based on the data provided, the condensing units appear to be original to the building and are thus past end of life. An incremental cost analysis was used for this measure as it is assumed the heat pumps are only installed when the original condensing units are replaced.

### 2.1.2 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 boiler 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, RNG may be the best option to reduce emissions from this building 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.