



Thompson Rivers University ASHRAE Level 1 Energy Study

Energy Study for: **Materials Distribution Centre**

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May 26, 2022



Materials Distribution Centre - ASHRAE Level 1 Study -

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1. Background Description of Facility, Hardware and Systems

1.1 Overview and Facility Use

The Materials Distribution Centre located on Thompson Rivers University Campus in Kamloops, British Columbia, was originally constructed in 2006. An addition to the original building was built in 2013. The gross conditioned square footage of the building is 1,991 m² (21,431 ft²). The original building houses the facilities offices, a warehouse, and shipping area. Shipping and receiving offices are located in the warehouse. The new addition houses carpentry, mechanical/electrical workshop spaces, and some offices.

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:

- Original building
 - A heat recovery ventilator (HRV-1) preheats outdoor air for heat pumps 1 through 7 with exhaust air from the mechanical room and washrooms
 - Water source heat pumps 1 through 7 provide outdoor air from HRV-1 to the office spaces and lunch room
 - Water source heat pumps 8 through 13 provide recirculated air to the warehouse
 - The warehouse space has exhaust fans and outdoor air dampers for ventilation.
- Addition
 - A mixed system air-handling unit, AHU-1, provides ventilation to the Carpentry and Mechanical/Electrical Workshop.
 - A gas-fired furnace, FU-1, provides return air for the rest of the addition.
 - Each workshop has a designated exhaust fan that the occupants control with a switch.

1.2.2 Cooling

The following major cooling systems exist in this building:

- A cooling tower rejects heat from the heat pump loop water loop, which serves water source heat pumps 1 through 13 in the original building.
- Two condensing units (CU) provide cooling to the cooling coils in AHU-1 and FU-1 in the addition

1.2.3 Heating

The following major heating systems exist in this building:

- Original building
 - Two condensing gas fired boilers supply heat to the heat pump loop.
 - Gas fired unit heaters are located above the bay doors in the warehouse to provide supplemental heating.
- Addition
 - The gas fired burner section in AHU-1 provides heating to Carpentry and Mechanical/Electrical Workshop.
 - The gas fired furnace (FU-1) provides heating to the rest of the addition.

- Two gas fired unit heaters provide supplemental heating to the Carpentry and Mechanical/Electrical Workshop.

1.2.4 Domestic Hot Water

There is one electric hot water tank in the original building and one in the addition building.

1.3 Lighting System

TRU is currently in the process of upgrading all lighting on campus with LED. Based on conversations with facilities, all lighting in this building should have been converted to LED. Any lighting that is not yet converted will be converted shortly.

1.4 Control Equipment

The building is controlled using an Automated Logic Building Automation System. Unit heaters in the workshops are controlled by local thermostats.

1.5 Energy Analysis

1.5.1 Energy Use Profile

Figure 1 presents the building's electrical consumption since 2017. Baseline electricity consumption was calculated based on all available data, discounting outliers.

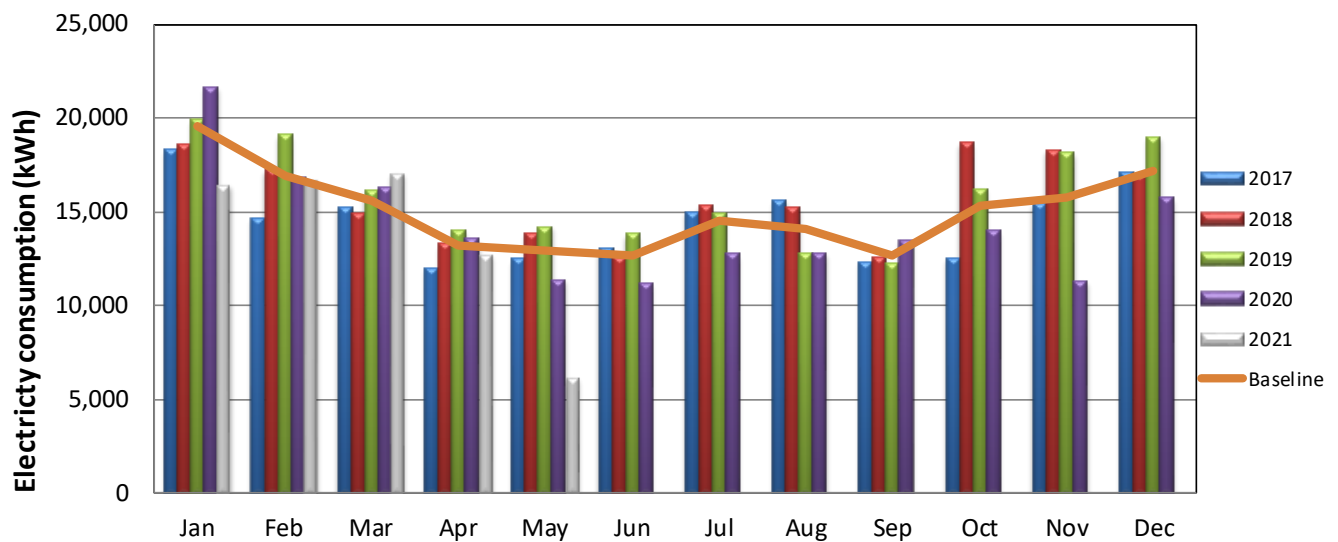


Figure 1: Monthly Electricity Consumption

Figure 2 presents the building's gas consumption since 2017. The energy history for this building has been increasing since 2017. Given the equipment in the building and existing operational trends, we feel this gas data is too high. It is possible there is an issue with the meter or another building is attached to the meter as well. As such, the gas baseline for this building was estimated using equipment inventory and BAS trending information. We recommend the gas meter be investigated for this building to determine what is going on.

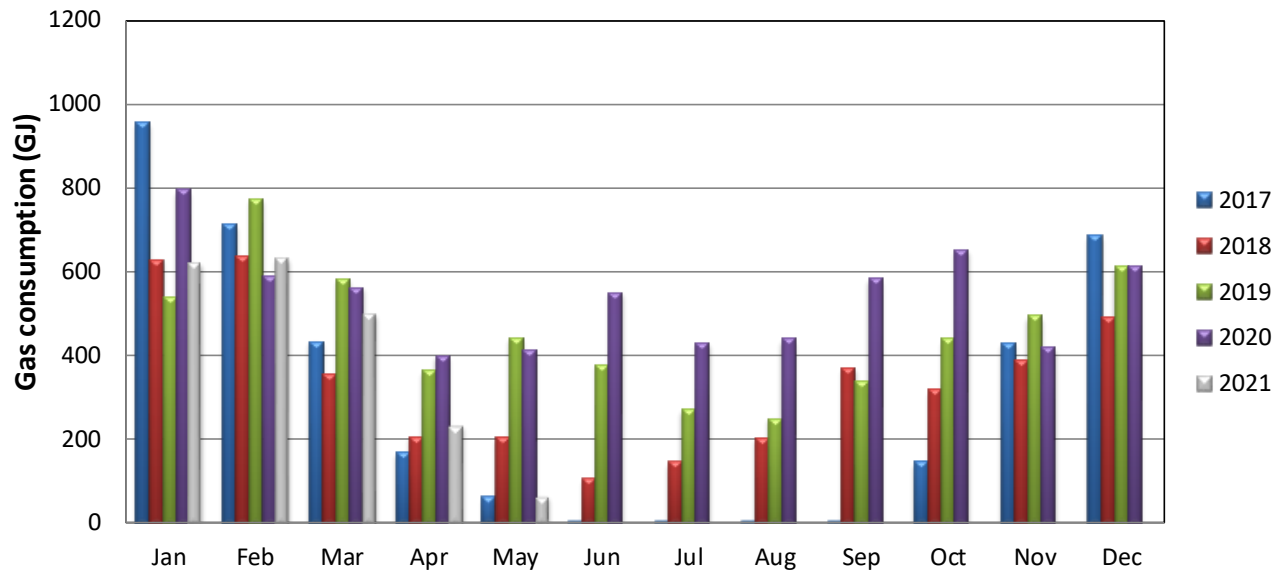


Figure 2: Monthly Gas Consumption

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 Material Distribution Centre has an average Energy Use Intensity (EUI) of 1,137 MJ/m². It should be noted that the energy intensity of this building has increased significantly since the Fortis study completed in 2020. This is because energy consumption data was only available up to early 2019 when that study was completed. Data after the Fortis measures were implemented was not available, but we suspect the gas usage will have gone down. This should be verified when more recent data is available.

Table 1: Summary of Baseline Energy Data

Utility	Energy Use (GJ)	EUI (MJ/m2)	Cost (\$)	Cost (\$/ft2)
Gas	1,621	810	\$24,322	\$1.13
Electricity	650	327	\$11,440	\$0.53
Total	2,272	1,137	\$35,762	\$1.67

1.5.3 Energy End Use Breakdown

The estimated breakdown of electricity consumption by building system is presented in Figure 3.

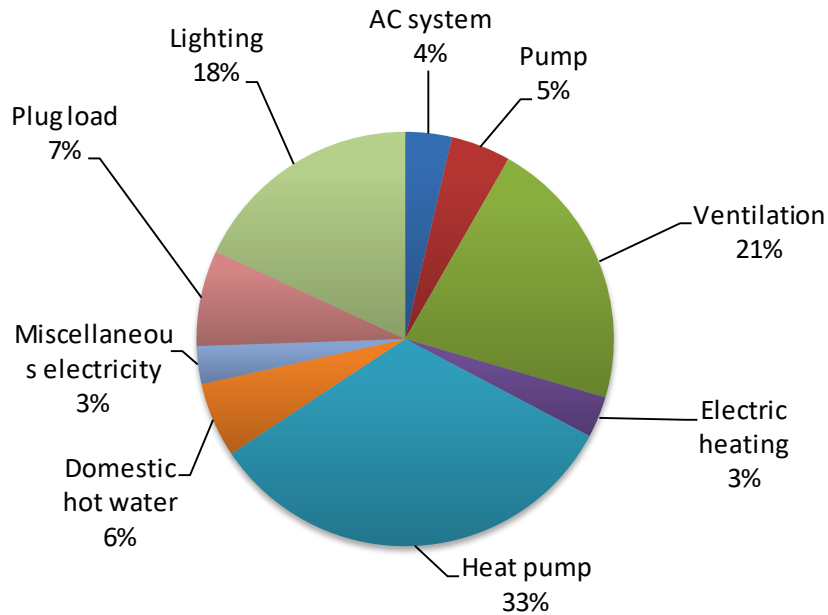


Figure 3: Electricity Consumption

The estimated breakdown of gas consumption by building system is presented in Figure 4. The supplemental gas heating is the unit heaters.

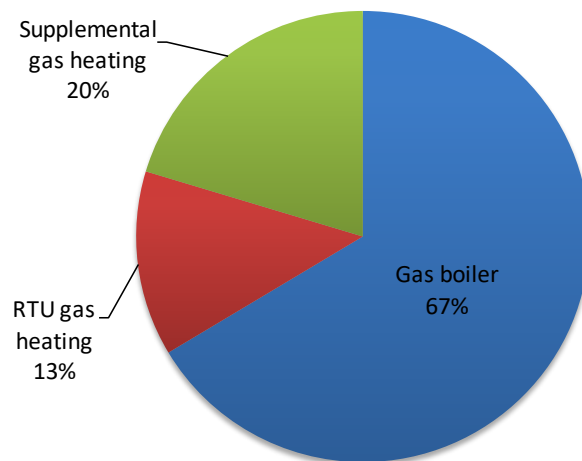


Figure 4: Gas Consumption

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

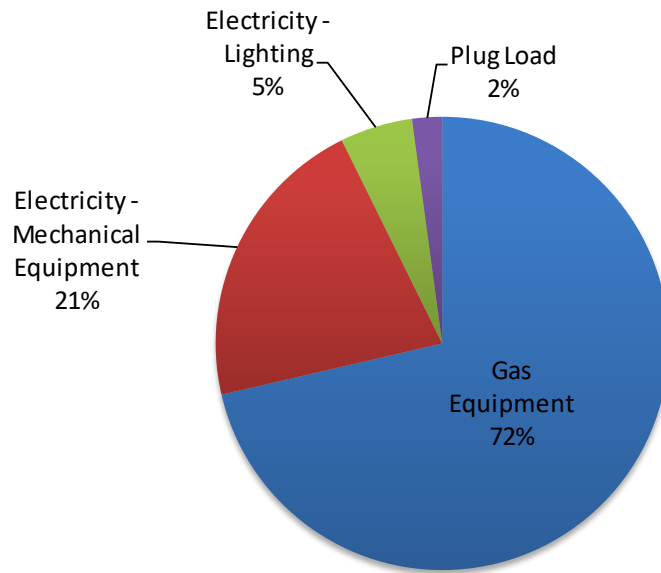


Figure 5: Total Energy Breakdown

2. Conservation Opportunities

The primary objective of this study was to identify and analyse energy conservation opportunities at the Materials Distribution Centre. 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. As some of these measures are mutually exclusive, it does not make sense to present total measure savings. The individual savings 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. The analysis for these measures does not include incentives from BC Hydro or Fortis BC. Based on conversations with Stantec, it is unlikely this building will be connected to the district energy plant given its location on campus. As such, all the measures below present good opportunities.

Table 3: Measure Summary

Item	Description	Base Case Cost	Incremental Cost	Total Cost	Effective Payback	NPV	Annual Savings				
							\$	GJ	kW	kWh	GHG
1.1	Additional Controls RCx		8,000	8,000	≥ 40	(3,300)	560	30		900	1.5
1.2	DHW Heat Pump	1,500	4,000	5,500	10.0	(1,500)	310		17	1,600	
1.3	Addition Heat Pumps	10,000	15,000	25,000	7.0	5,300	1,500	150		(12,500)	7.4
1.4	Warehouse Offices		7,000	7,000	3.0	7,100	1,700	60		11,100	3.1
1.5	Renewable Natural Gas				≥ 40		11,400				51.8

2.1.1 Additional Controls RCx

Although a controls recommissioning was recently completed on this building, several opportunities for further optimization were identified during the final verification phase.

- There are several temporary schedules inserted into all TRU buildings, these cause the actual schedules to be overridden. Often there are multiple schedules on one system. We recommend removing all temporary schedules to avoid confusion and ensure the systems are scheduled correctly. Additional training for operators would be valuable to teach them how to use schedules correctly in Automated Logic
- AHU-1 is currently being controlled as if it was a 100% outdoor air (OA) unit. We recommend updating the sequences on this unit, specifically the supply air temperature (SAT) control.
- The heat pump loop was recently recommissioned, however, several physical limitations with the loop design prevented the recommissioning from fully optimizing this control. Because the boilers are directly connected to the loop and the loop temperature limits are so low, the boilers are operating in on/off mode rather than being allowed to modulate based on a temperature. This increased cycling decreases the life of the boilers and causes increased cooling tower usage as the loop quickly overheats. We recommend the following to further improve the heat pump loop system.
 - Separate the boiler loop from the heat pump loop with a control valve. Based on conversations with the boiler manufacturer, Viessman, there is no way to control boiler modulation directly from the BAS so physically separating the loops appears to be the only option. However, further research should be done prior to implementing this measure to determine if there is another controller that could be used that would allow modulation.
 - Install a heating water supply temperature (HWST) temperature sensor on the boiler loop
 - Update the control so that primary boiler loop is kept at a higher temperature and the control valve is used to modulate the temperature in the secondary heat pump loop
- In addition, the gas usage has been increasing significantly since 2018. This should be investigated and remedied as part of this project. It should be noted that no gas savings were claimed for this as we suspect there is an issue with the meter rather than the building operation.

2.1.2 DHW Heat Pump

DHW for the building is currently provided by two electric DHW heaters.

The existing electric domestic hot water tank (DHW), located in the original building's mechanical room, has reached the end of its service life. Replacing the existing DHWT with a new air-source heat pump (ASHP) model would allow for the majority of the building's domestic hot water demands to be met by a heat pump

with an estimated coefficient of performance of 2.5, reducing electricity consumption over the existing electrical-resistance DHWT. This would not reduce occupant access to domestic hot water, as the unit would have an integrated electric heating coil for back-up. Incremental costing was used for the analysis of this measure as the existing unit is due to be replaced.

It should be noted that the addition building DHWT was not considered as part of this measure as has not reached the end of its service life, but we also recommend upgrading it to a heat pump model when it is due to be replaced.

2.1.3 Addition Heat Pumps

There are two condensing units that provide cooling to the addition building via coils in the furnace (FU-1) and AHU-1. We recommend replacing these condensing units with reversible heat pumps. The heat pumps would provide both efficient heating and cooling for the furnace and AHU, with the gas heating in both units being used for back up on cold days. Incremental costing was used in the analysis of this measure as it assumes this upgrade happens when the existing condensing units are due to be replaced. It should be noted that this measure does not look at replacing AHU-1 or FU-1, although when those units are due to be replaced, we recommend upgrading them to high efficiency condensing models.

2.1.4 Warehouse Offices

There are currently makeshift open-air offices in the warehouse space. There are 7 offices in total in the warehouse (1 mail station, 2 shipping stations and 4 work stations – the work stations are set up in groups of 2). These offices have caused issues over the years as the occupants are always cold and it is impossible to keep the warehouse at a comfortable temperature despite setting the supply air temperature of the heat pumps at 23°C. Several recommendations to remedy this situation have been made over the years, but based on conversations with operations and staff, we feel the best option is to install a bay door lockout so that heating for the warehouse is disabled when the bay doors are open and provide individual radiant heaters to the occupants in the spaces to ensure they are comfortable. Based on the fortis implementation verification work, it appeared that UH-3 and UH-4 were operating when doors were opening so we believe this measure represents a good opportunity.

2.1.5 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 natural gas used by the boilers 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, renewable natural gas may be the best option to offset emissions in this facility 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.