Thompson Rivers University
Gym & CAC Domestic Hot Water Energy Assessment

Prepared for:

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Project Number: 115613124

June 30, 2016

Sign-off Sheet

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Prepared by (signature)

Kenney McNamee

Reviewed by (signature)

Diego Mandelbaum

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Executive Summary

Thompson Rivers University (TRU), commissioned Stantec Consulting Ltd (Stantec) to conduct an assessment of domestic hot water energy use at its Gym and CAC building located at the Kamloops Campus, to identify energy conservation opportunities. A site visit was conducted on November 24th & 25th 2015.

The aim of this study is to analyze the current energy performance, conduct an onsite energy assessment and produce a list of energy conservation measures (ECM's) complete with relevant implementation costs.

The building assessment involved 10,117m^2 (gross) of internal floor space. The opportunity to replace existing domestic hot water heating equipment with condensing boilers was analysed. Domestic hot water consumption at CAC and the Gym is estimated at approximately 360 GJ per year. Given the low consumption of energy for hot water heating at these buildings, it is not recommended to implement capital improvements at this time.

	Measure	**Recommended for Implementation?**
ECM 1	Implement Hot Water Upgrade (including repiping)	×

Any questions regarding this report should be directed to Diego Mandelbaum at (250) 470-6106.

Glossary

BEPI	Building energy performance index
BMS	Building Management System
CDD	Cooling degree days
CFL	Compact fluorescent lamp
DDC	Direct digital control
ECM	Energy conservation measure
GHG	Greenhouse gas
HDD	Heating degree days
HVAC	Heating, ventilation and air conditioning
kWh	Kilowatt hour
LED	Light-emitting diode
NRCan	Natural Resources Canada
VFD	Variable frequency drive

1.0 CONTEXT AND METHODOLOGY

1.1 BACKGROUND

The intent of this report is to provide an energy assessment of the Gym and CAC Buildings for domestic hot water and provide recommendations for improvements in the buildings' operation from an energy performance perspective.

The DHW assessment identifies the potential savings in energy consumption and reduction of greenhouse gas (GHG) emissions resulting from the implementation of energy conservation measures. An opinion of probable costs to implement the measures is also provided backed up using quotations from a third party cost consultant. These capital upgrades will provide ongoing operational savings and a reduction in the environmental impact of the site's operation.

The focus of this study is reductions in natural gas consumption from domestic hot water. Savings from heating ventilation and air conditioning equipment and opportunities for savings in electricity consumption from lighting are not included.

This report has taken into consideration past retrofit work, future capital maintenance requirements and the proposed energy conservation measures to ensure an effective and viable energy assessment report.

1.1.1 Project Scope

This project includes an assessment of natural gas saving opportunities from building domestic hot water equipment.

1.1.2 Complementary Reports

This energy audit was completed as part of a multi-building investigation that includes:

1. Animal Health;
2. Arts and Education;
3. Culinary Arts;
4. Clock Tower;
5. Science Building; and,
6. Campus Activity Centre and Gym (Hot Water Systems Only).

1.1.3 Client Information

Customer Name	Thompson Rivers University
Site Address	Thompson Rivers University 900 McGill Road Kamloops, BC, Canada V2C 0C8
Contact Person	Jim Gudjonson Director, Environment and Sustainability
Contact Information	250-852-7253 / jgudjonson@tru.ca
Site Electricity Provider	BC Hydro / 2741787
Natural Gas Account(s) #	Fortis BC / 1178101

1.1.4 Project Drivers

Thompson Rivers University is committed to reducing energy consumption and greenhouse gas emissions in its operations and conduct business in a sustainable and socially responsible manner. This commitment is driven by the Office of Environment & Sustainability which implements the sustainability components of the Campus Strategic Plan.

A key component of this plan is focused on implementing building efficiency upgrades.[1]

1.1.5 Acknowledgements

Stantec would like to acknowledge the contribution of Thompsons River University staff whose help was invaluable in completing this report. We would like in particular like to thank Jim Gudjonson and Natalie Yao from the Sustainability office for their invaluable help in facilitating this exercise. We would also like to thank Tom O'Byrne whose knowledge of the facility providing an excellent basis for the identification of energy conservation opportunities.

1.1.5.1 Project Funding

This project was made possible through funding from BC Hydro and Fortis BC. This support is gratefully acknowledged.

[1] http://www.tru.ca/sustain/initiatives/Energy_Efficiency_at_TRU.html

1.2 PROCESS

1.2.1 Site Visits

A site visit was conducted on November 24th and 25th , 2015 by Kenneth McNamee & Innes Hood from Stantec. The visit included a detailed interview with staff regarding the building's function, as well as discussing any issues that were persistent and opportunities for operational optimization.

A comprehensive tour of the site was also conducted to evaluate the condition of relevant energy systems.

1.2.2 Utility Analysis

An analysis of building energy consumption provides a good starting point from which to;

1. Identify potential energy conservation measures (ECMs), and
2. Develop a baseline against which ECM performance can be quantified.

The consumption (and demand) registered on historical data for each utility meter can also be examined to identify issues that are affecting the energy performance of the site. Utility data for electricity and natural gas was provided by Thompson Rivers University through its Pulse Energy© subscription.

1.2.3 Utility Rates

In terms of savings related to ECMs, a marginal rate is used which effectively assumes that reduction in consumption and/or demand will only reduce the cost by the rate that applies to the last unit of energy used. These rates are listed in Table 1.

Table 1 Marginal Energy Rates 2015

Item	Value	Unit
Marginal Electricity Cons. Rate	0.08	$/kWh
Marginal Electricity Demand Rate	11.63	$/kW/Month
Natural Gas	10	$/GJ
GHG Emission Costs	25	$/Tonne

1.2.4 Lighting System Assessment

An assessment of the site's lighting installation was excluded from the Scope of Work.

1.2.5 Mechanical System Assessment (Domestic Hot Water Only)

The mechanical portion of the assessment involves taking an inventory of mechanical components, an appraisal of operational times and efficiencies for each mechanical component. This is inclusive of all DHW and process related equipment.

1.2.6 Energy Conservation Measures (ECMs)

ECMs are selected based primarily on the most cost effective opportunity from a simple payback perspective based on the data available and assumptions made. Further criteria include; potential added or reduced maintenance, facility personnel opinion, occupant comfort, integration with existing systems and capital maintenance initiatives.

The energy savings calculations are based on a best estimate of the anticipated reductions taking into consideration direct savings from natural gas and electricity consumption and electrical demand where appropriate.

Stantec engaged a third party cost consultant (BTY) to derive accurate cost estimates. Costs associated with implementing the respective measures are estimated based on the capital cost for the materials and labor (including demolition and installation). Where applicable a retrofit cost (a safety factor to allow for complications arising from installations in existing buildings) and project management cost (including design) are applied to the estimated capital cost at 10% and 15% respectively.

For any systems or equipment that are on site and not functioning (not consuming energy) no energy conservation measures have been considered. The scope of this exercise is to find opportunities to reduce energy consumption and where there is no possibility to do so, no measures have been discussed.

1.2.7 Recommendations

From the options considered, recommendations are put forward based on financial and practical feasibility using indicators such as simple payback and capital cost. A full analysis is set out in **Error! Reference source not found.**.

2.0 BUILDING DESCRIPTION AND CONDITION

2.1 GENERAL DESCRIPTION

2.1.1 History

The Gym and CAC building have a gross floor area of 10,117 m2 as summarized in Table 2.

Table 2: Building Vintage and Size

Code	Name	Year Built	Floor Area [sq m]
CAC	Campus Activity Centre	1992	6,413
G	Gymnasium	1980	3,704

2.1.2 Site Details

Table 3 lists the site specific details including total area and weather data used for modeling weather sensitive savings opportunities.

Table 3 Site Characteristics

Item	Value	Units
Site Area	10,117	m^2
Weather data source	www.degreedays.net	[Base 16°C]
HDD	2,953	°C day/year
CDD	644	°C day/year

Figure 2.1 TRU Kamloops Campus Layout & Gym and CAC Building

2.1.3 Occupancy

Building occupancy is detailed in Table 4. The facilities will typically be occupied with greater frequency during term time; however the hours outlined below are typical.

Table 4 Typical Occupancy Schedule

	Monday - Friday	Saturday	Sunday/Holiday Occupancy
Labs / Classrooms	07:00AM – 10:00PM	-	-
Faculty Offices	07:00AM – 6:00PM	Intermittent	Intermittent

2.2 BUILDING ENVELOPE

Building envelope performance was not in the scope of this study.

2.3 LIGHTING

Building lighting was not in the scope of this study.

2.4 MECHANICAL SYSTEMS

2.4.1 Ventilation

The HVAC system was not included in this study.

2.4.2 Heating

Building heating was not included in this study.

2.4.3 Domestic Hot Water

Domestic Hot Water at the gym and CAC is generated by natural gas fired domestic hot water heaters. In addition, the CAC has a solar domestic hot water pre heater. In general, the water heaters are in fair condition two of the water heaters at the gym are not currently in use and equipment is replaced upon failure. It was noted during the inspection that significant portions of the domestic hot water lines are not insulated.

In discussion with the operator, it was revealed the level of use of the gym has decreased in recent years due to the proximity of the tournament centre.

Table 5 DHW Heater Specification

Manufacturer / Model #	Input (MBH)	Storage Capacity (L)	Rated eff.	Photo
GSW JWS75	360	280	~80%	
AOSMITH	399	380	80%	

CAC solar pre heat tanks				

3.0 BUILDING ENERGY ANALYSIS

3.1 CURRENT ENERGY USE

Energy usage at the facility is derived from two primary sources:

Electricity	Electrical utility data was extracted from the Pulse Energy system provided for the facility for 2012-2015
Natural Gas	Natural gas utility data was extracted from the Pulse Energy system for the facility for 2013-2015. Natural gas consumption is attributable to building heating, and domestic hot water generation.

3.1.1 Electricity Consumption

Not included in this study.

3.1.2 Natural Gas Consumption

Natural Gas consumption from 2013 to 2015 has been profiled below using data extracted from the "Pulse Energy" system. The heating degree day profile for the TRU Kamloops campus has been transposed to provide an indication of natural gas consumption in relation to outdoor air temperature.

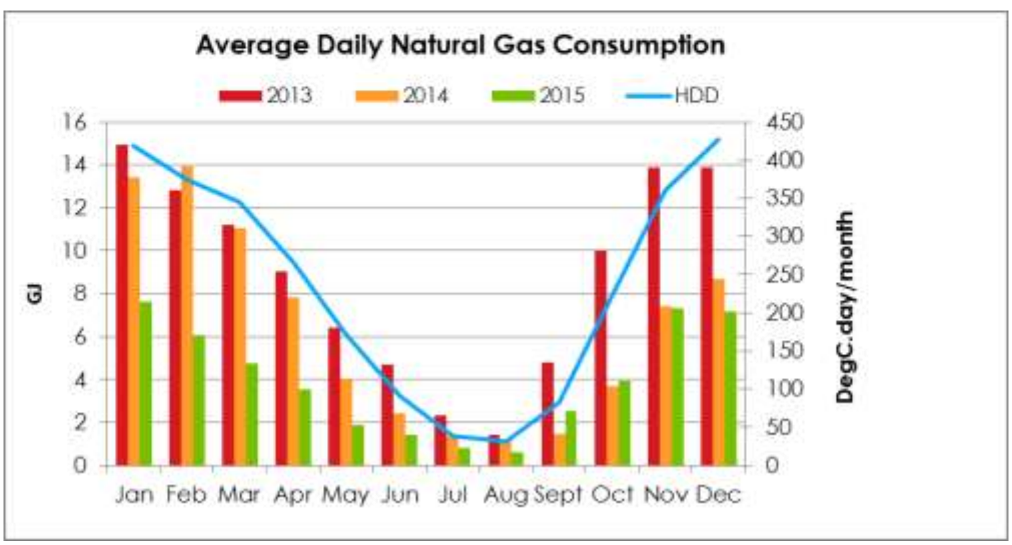

Figure 3.1 CAC Average daily Natural Gas consumption and heating degree-days (2013–2015)

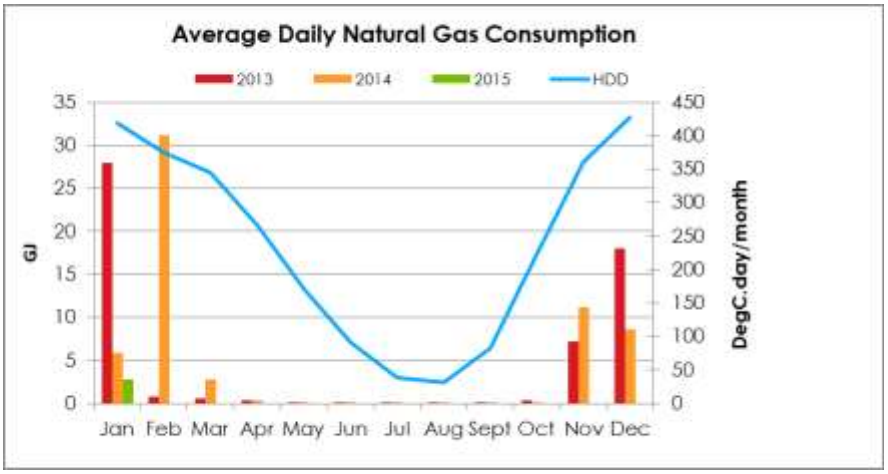

Figure 3.2 Gym Average daily Natural Gas consumption and heating degree-days (2013–2015)

The natural gas intensity profile is reflective of a facility with a significant weather dependent load. Natural gas consumption peaks during colder winter conditions and is reduced during the summer. Peak consumption in 2013 was recorded in January at 15 GJ/day at CAC with summer base load of around 1 GJ/Day. Consumption of 1GJ/Day in June-August 2015 can be attributed to the domestic hot water loads in the building. Similarly for the gym, peak consumption in 2014 was recorded in February at 31 GJ/day at CAC with summer base load of around 0 GJ/Day.

4.0 ENERGY CONSERVATION MEASURES

Energy conservation measures have been investigated and profiled given the most cost effective and practical solutions to improving building performance.

4.1 ECM 1 – REPLACE EXISTING WATER HEATERS WITH CONDENSING BOILERS

The Gym and CAC building incorporates mid efficient domestic hot water heaters. It is proposed that the existing water heaters be replaced with condensing boilers. Condensing boilers incorporate an additional heat exchanger to extract heat by condensing water vapor from the products of combustion. They operate at a minimum efficiency of around 85% even when not condensing and can achieve efficiencies in the range of 85-95%.

4.1.1 Scope of Work

It is proposed the existing DHW heaters be decommissioned and replaced with equivalent capacity condensing boilers. The replacement boiler capacity will be confirmed during the detailed mechanical design of the boiler upgrades. Installation of storage tanks, new combustion flues and insulation of pipe work will be included in this scope of work.

Outline	Description
Baseline equipment	There are multiple natural gas water heaters to provide domestic hot waters. In addition, the CAC building has a solar pre heat system.
Upgrade Description	It is proposed that the existing boiler & water heater be decommissioned and replaced with condensing boilers.
Affected area in building	The existing boilers are located in the boiler room. Modifications to venting through the roof will be also be required.
Service life	The estimated service life of the condensing boilers will be 20 years.
Non energy benefits	Implementation of this measure will reduce greenhouse gas emissions from domestic hot water heating.
Risk assessment	Condensing boilers are a mature technology and are a low risk investment. Before implementation, an assessment must be made as to a route for new flue/stack.

4.1.2 Methodology of Savings Calculations

Savings have been based on an Improvement in building domestic hot water boiler efficiency from 80% to 90% using condensing boilers.

4.1.3 Cost, Saving and Payback

A summary of anticipated costs and savings are as follows:

SIMPLE PAYBACK	
TOTAL RETROFIT COST	$ 552,000
MAINTENANCE SAVINGS	-
TOTAL ENERGY SAVINGS	$406
PAYBACK (years)	1,361

Due to the long payback, this measure is not recommended for installation

4.1.4 Impact on Operations and Maintenance

Installation of condensing boilers will have a positive impact on maintenance expenditure as the older boilers are reaching end of life.

5.0 BUILDING MANAGEMENT AND BEHAVIORAL OPPORTUNITIES

5.1 FURTHER UPGRADES

Other than the proposals outlined in this report, there are no upgrades being planned for this facility at this time.

5.2 PROCUREMENT POLICY

Purchasing efficient products reduces energy costs without compromising quality. It is strongly recommended that a procurement policy be implemented as a key element for the overall energy management strategy at the City of Victoria. An effective policy would direct procurement decisions to select EnergyStar® qualified equipment, in contracts or purchase orders. For products not covered under EnergyStar®, the EnerGuide labeling should be reviewed to select products with upper level performance in their category. Improved energy performance will involve the investment in energy efficient equipment coupled with user education and awareness program.

5.3 STAFF TRAINING AND OCCUPANT AWARENESS

Equipment operation practices and policies can also have a significant impact upon energy consumption. There is generally ample opportunity for energy savings from office equipment and lighting as they may be left on when not in use. An energy efficiency awareness program should be put in place to encourage patrons and staff to turn off equipment when not in use during the day, at the end of the day, and for the weekend.

5.4 RECOMISSIONING & SYSTEM BALANCING

If energy conservation measures are to be implemented (as suggested in this report) then it is recommended a full building re-commissioning take place. Re-commissioning the systems in a building of this vintage can offer real benefits with regard to energy savings and enhanced performance.

6.0 SUMMARY OF ENERGY SAVINGS

6.1 SUMMARY OF ECMS

Installation of condensing water heaters was investigated. Due to the long payback, this upgrade is not recommended.

7.0 CONCLUSIONS AND RECOMMENDATIONS

7.1 CONCLUSIONS

Thompson Rivers University commissioned Stantec to conduct an energy assessment at its Gym and CAC facility to identify energy conservation opportunities. The energy assessment identifies the potential savings in energy consumption resulting from the implementation of energy conservation measures, and an initial opinion of probable costs to implement the measures. These capital upgrades will provide ongoing operational savings and are done so in an environmentally conscientious manner.

The assessment of the site involved domestic hot water use at the gym and CAC buildings. No energy conservation meaures are recommended at this time.

8.0 STUDY LIMITATIONS

This report was prepared by Stantec for Thompson Rivers University. The material in it reflects our professional judgment in light of the following:

- Our interpretation of the objective and scope of works during the study period;
- Lighting energy conservation measures were not included in the scope of work
- Information available to us at the time of preparation;
- Third party use of this report, without written permission from Stantec, are the responsibility of such third party;
- Measures identified in this report are subject to the professional engineering design process before being implemented.

The savings calculations are our estimate of saving potentials and are not guaranteed. The impact of building changes in space functionality, usage; equipment retrofit and weather need to be considered when evaluating the savings.

Any use which a third party makes of this report, or any reliance on decisions to be made are subject to interpretation. Stantec accepts no responsibility or damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

Appendix A CONTACT DETAILS

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Energy Analysis and Report Writing

Appendix B UTILITY CONSUMPTION (2011 – 2013)

CAC

	Annual Natural Gas Utility Records (GJ)								
	2013			2014			2015		
	Monthly	Period Days	Daily Avg.	Monthly	Period Days	Daily Avg.	Monthly	Period Days	Daily Avg.
Jan	463	31	15	417	31	13	236	31	8
Feb	360	28	13	390	28	14	170	28	6
Mar	347	31	11	343	31	11	147	31	5
Apr	271	30	9	234	30	8	106	30	4
May	199	31	6	125	31	4	57	31	2
Jun	141	30	5	73	30	2	42	30	1
Jul	73	31	2	43	31	1	25	31	1
Aug	43	31	1	38	31	1	20	31	1
Sept	144	30	5	44	30	1	76	30	3
Oct	310	31	10	115	31	4	123	31	4
Nov	416	30	14	222	30	7	219	30	7
Dec	431	31	14	269	31	9	223	31	7
Total	**3,197**			**2,313**			**1,444**		

Gym

	Annual Natural Gas Utility Records (GJ)								
	2013			2014			2015		
	Monthly	Period Days	Daily Avg.	Monthly	Period Days	Daily Avg.	Monthly	Period Days	Daily Avg.
Jan	865	31	28	181	31	6	88	31	3
Feb	23	28	1	871	28	31		28	0
Mar	19	31	1	85	31	3		31	0
Apr	9	30	0	10	30	0		30	0
May	5	31	0	4	31	0		31	0
Jun	2	30	0	1	30	0		30	0
Jul	0	31	0	1	31	0		31	0
Aug	1	31	0	0	31	0		31	0
Sept	2	30	0	1	30	0		30	0
Oct	11	31	0	5	31	0		31	0
Nov	214	30	7	336	30	11		30	0
Dec	558	31	18	268	31	9		31	0
Total	**1,708**			**1,763**			**88**		