a place of mind
THE UNIVERSITY OF BRITISH COLUMBIA

Facilities Management
The University of British Columbia | Okanagan Campus
1138 Alumni Avenue | Kelowna BC | V1V 1V7 Canada
Phone 250.807.9272
facilities.ok@ubc.ca

UBC Okanagan Energy Team
Annual Report
April 2016 – March 2017

June 5 2017

a place of mind
THE UNIVERSITY OF BRITISH COLUMBIA

Facilities Management
The University of British Columbia |
Okanagan Campus
1138 Alumni Avenue | Kelowna BC | V1V 1V7 Canada
Phone 250.807.9272
facilities.ok@ubc.ca

Executive Summary

For the 2016-2017 fiscal year, overall campus energy use intensity was 295 kWhr/yr/m^2. Compared to the prior year, campus electricity consumption increased year over year by about 2% while natural gas consumption increased by about 15%. These increases, in particular the gas consumption, were largely due to the cold winter, which was exacerbated by particularly energy-intensive cold-weather building operational procedures. Building controls upgrades to improve cold weather operation are currently being investigated and are expected to be implemented prior to the next heating season.

The energy team expanded from one member to four in the past year. This newly expanded team is currently working on implementing a number of major energy conservation projects during the next fiscal year. Due to the recent expansion of the energy team and the lead-time of many projects, relatively few major energy conservation measures were completed in FY2016-2017. It is expected that projects began by the energy team in FY2016-2017 and completed in FY2017-2018 will show significant energy reductions in future years. The energy team has set the following energy reduction targets for future years:

- 500 MWHr electricity per year
- 3000 GJ per year of gas until 2020 and 2000GJ of gas post 2020

Compared to a 2013 campus business as usual baseline, campus electrical consumption has gone down by 5% and gas consumption by 18%. These reductions are expected to save $600k in utility expenditures during the first two years of the energy team. Additionally, FortisBC has approved $180,000 in energy conservation incentives for FY2016-2017 and approvals for similar amounts are expected in FY2017-2018.

The work of the energy team has benefits beyond utility cost savings. Over 1100 tons of greenhouse gas emissions are expected to be saved by the energy team in its first two years of operation. In addition, while working to increase the efficiency of campus systems, the energy team collaborates with other campus stakeholders to leverage multiple benefits from projects such as deferred upsizing of capital equipment, increased equipment lifespan and improved building occupant comfort.

Facilities Management
The University of British Columbia |
Okanagan Campus
1138 Alumni Avenue | Kelowna BC | V1V 1V7 Canada
Phone 250.807.9272
facilities.ok@ubc.ca

Definition of Terms

EUI: Energy use intensity is the annual energy consumption of a building per unit of floor area. In this report kWhr/yr/m2 are the units used for EUI.

GHG: Greenhouse gas emissions, generally measured in tons of CO_2.

LDES: Low temperature district energy system. One of two district energy loops on campus, this loop currently operates between approximately 10^{o}C and 30^{o}C. Heating for this loop is provided by boilers while cooling is provided by a mixture of geothermal water and cooling towers.

LDES Active Heating/Cooling: The LDES loop commonly supports heating and cooling loads simultaneously. Heat is thus shared between buildings that need to reject it and those that require it. Heating loads are counted as ‘Active’ only if they occur when the net load on the LDES loop is in heating and likewise for cooling. Loads that occur when the net load on the loop is in the opposite mode are not counted as ‘Active’.

LDES Total Heating/Cooling: The ‘Total’ Heating/Cooling figures count the thermal energy delivered by the LDES plant.

MDES: Medium temperature district energy system. This loop provides hot water for heating; heat is provided by boilers in the Central Heating Plant.

a place of mind
THE UNIVERSITY OF BRITISH COLUMBIA

Facilities Management
The University of British Columbia |
Okanagan Campus
1138 Alumni Avenue | Kelowna BC | V1V 1V7 Canada
Phone 250.807.9272
facilities.ok@ubc.ca

1 Introduction

The goal of the campus energy team is to reduce energy use and associated costs and GHG emissions for the Okanagan campus. Over the past year, the energy team has implemented a number of energy conservation projects and has identified future projects based on potential return on investment and consistency with the campus Whole Systems Implementation Plan. In addition, in order to evaluate the results of previous projects and use experience to guide future ones, the team has been improving campus energy tracking to provide quantitative information for decision making.

Facilities Management
The University of British Columbia |
Okanagan Campus
1138 Alumni Avenue | Kelowna BC | V1V 1V7 Canada
Phone 250.807.9272
facilities.ok@ubc.ca

2 Policy Development

Over the past few months, the energy team has been working on developing the following policies and guidelines.

2.1 Okanagan Campus Energy Policy

A draft of an energy policy for the Okanagan Campus has been generated. The initial draft was based on the Vancouver Campus energy policy with modifications to account for the Okanagan climate. It is planned to co-ordinate the implementation of an energy policy for the Okanagan Campus with the implementation of revisions to the energy policy for the Vancouver Campus.

2.2 Adaptations to UBC Technical Guidelines for Okanagan Campus

Previously it had been proposed to adopt Okanagan Campus specific addenda to UBC Technical Guidelines. However, the UBC Building Operations - Technical Services group felt having campus-specific addenda would be more labyrinthine than necessary. Instead whole specification sections unique to the Okanagan campus have been generated where necessary. These specification sections have been submitted to the Technical Guidelines Review Committee and are expected to be reviewed for adoption in 2017. The specification sections involved are as follows:

- 01 92 00 Monitoring Based Commissioning
- 20 00 30 Indoor Thermal Environment
- 23 05 00 HVAC – General Requirements

2.3 Greenhouse Gas Emissions Targets

The Whole Systems Infrastructure Plan identified targets for campus greenhouse gas (GHG) emissions. Updates to these targets have been completed in order to take into consideration changes to campus growth predictions. As these growth predictions are continuously varying, the energy team is intending to update the GHG emission targets quarterly. These targets are illustrated in the graphs at the end of this report.

Facilities Management
The University of British Columbia |
Okanagan Campus
1138 Alumni Avenue | Kelowna BC | V1V 1V7 Canada
Phone 250.807.9272
facilities.ok@ubc.ca

3 Energy Team

The Energy Team was identified as a part of the campus Whole Systems Implementation Plan and was identified in the Utilities 15/16 Priorities and growth ask. The team currently consists of four members:

- Colin Richardson - Energy Systems Manager
- Glen McIntyre - Energy Specialist
- Terrence Nimegeers - Building Management Systems Technician
- Conner McGoran - HVAC Efficiency Technician

The BMS Energy Technician and Energy Specialist positions began in the spring of 2016 while the HVAC Efficiency Technician position began in mid-May 2017. The Energy Specialist position is partially funded by FortisBC while FortisBC energy conservation incentives are directed to provide funds for the HVAC Efficiency Technician.

The goal of the campus energy team is to track and reduce campus energy use, costs and GHG emissions. These goals are achieved through implementing energy projects, system monitoring, equipment recommissioning and improved operational efficiencies. Some of the key tasks of the team include:

- Implementing detailed reporting to provide input into financial, infrastructure and operational planning as well as verification of results of energy projects.
- Maintaining energy conservation measures in existing campus facilities to yield utility cost savings. Campus expansion and intensification will emphasize the importance of keeping energy creep under control.
- Act as a technical review team providing input and recommendations for retrofits, new construction projects, infrastructure expansion and campus policy and technical guidelines. By providing input to help ensure new projects are built to meet future requirements, the risk of costly future upgrades is minimized.
- Champion the implementation of an Okanagan Campus energy policy.
- Continue to meet annual savings targets of 500 MWh of electricity and 3000GJ of gas compared to prior year.
- Apply for energy efficiency rebates.
- Co-ordinate energy projects with other stakeholder groups in order to optimize efficiencies. For example, by optimizing mechanical system operation, the following can all occur simultaneously: increased energy efficiency, increased equipment lifespan, reduced number of repairs required, reduced risk of system failures and improved indoor air quality.

Facilities Management
The University of British Columbia |
Okanagan Campus
1138 Alumni Avenue | Kelowna BC | V1V 1V7 Canada
Phone 250.807.9272
facilities.ok@ubc.ca

4 Energy Performance for Year

Overall campus electrical consumption increased year over year by about 400 MWhr or less than 2%. This increase can be attributed to a number of factors including a particularly cold winter and successful implementation of a number of gas-electric conversion projects. Electricity costs for FY2016-2017 were $2.5M, an approximately 6% increase over the prior year and averaged $0.084/kWhr.

Overall campus gas consumption increased year over year by about 6000 GJ or more than 15%. This increase is largely due to the cold winter, which was exacerbated by particularly energy-inefficient operational strategies. Planned improvements to cold-weather operation are discussed in the future projects section later in this report. Gas costs for FY2016-2017 were $440,000, an approximately 27% increase over the prior year. The average gas cost for the year was $8.60/GJ.

It is noted that relatively few major energy conservation measures were completed in FY2016-2017. It is expected that projects began by the energy team in FY2016-2017 and completed in FY2017-2018 will show energy reductions in future years. The energy team has set the following energy reduction targets for future years:

- 500 MWHr electricity per year
- 3000 GJ per year of gas until 2020 and 2000GJ of gas post 2020

a place of mind
THE UNIVERSITY OF BRITISH COLUMBIA

Facilities Management
The University of British Columbia |
Okanagan Campus
1138 Alumni Avenue | Kelowna BC | V1V 1V7 Canada
Phone 250.807.9272
facilities.ok@ubc.ca

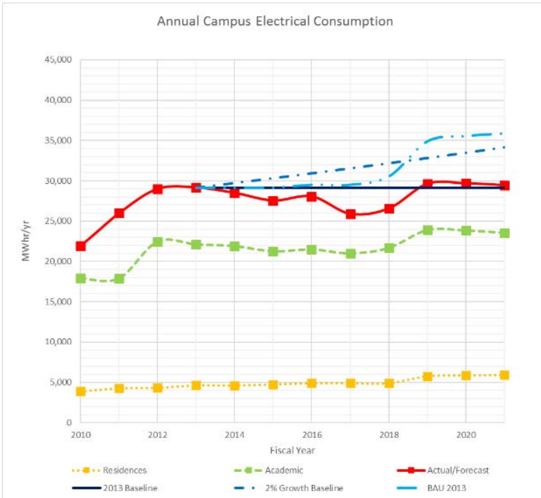
4.1 Overall Campus Energy Performance Plots

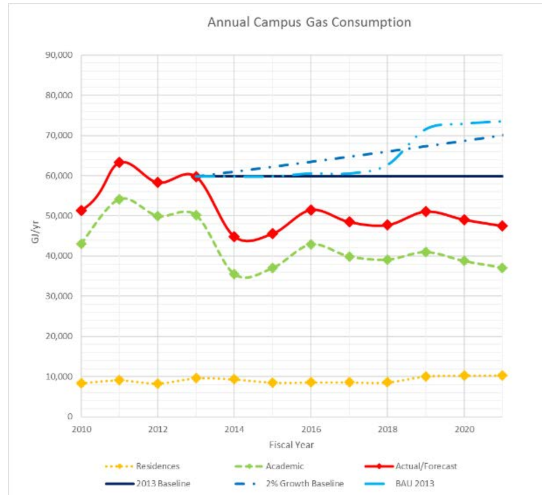
The plots below give an overview of overall campus energy performance. The data series shown can be described as follows:

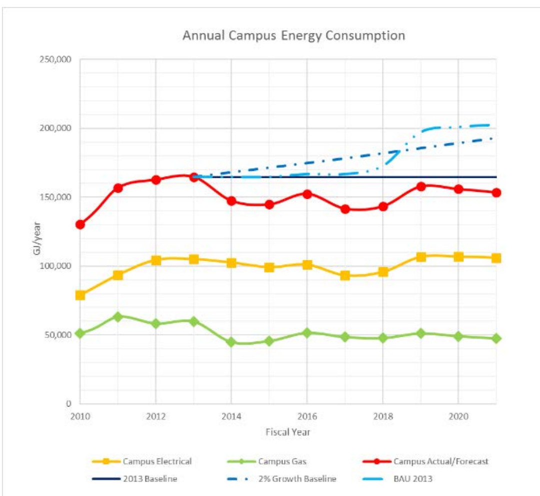
- Campus Actual/Forecast: Historical energy consumption data is used until FY2016-17. For future years, energy consumption is predicted as follows:
  - Academic: known building expansions are included (TLC and Okanagan Commons). For subsequent years, a constant FTE/m^2 ratio is assumed (equal to FY2019-2020 ratio). Campus expansion is thus based on FTE predictions obtained from Campus Planning. New academic buildings are assumed to have an EUI the same as the average academic building the year before. Energy reduction targets of 500 MWHr electricity per year and 3000 GJ per year of gas until 2020 and 2000GJ of gas post 2020 are also included.
  - Residences: planned residence expansions are included. A constant FTE/m^2 ratio is assumed for years after 2020 (ie after the completion of Skeena/Okanagan Commons Residences). The historical EUI for existing residences is used for future years for both existing and new residence buildings.
- 2013 Baseline: Campus energy consumption is set to equal what it was in 2013. Changes in energy cost are purely a reflection of utility rate changes.
- 2% Growth Baseline: Campus energy consumption is assumed to grow at a constant 2% per year rate with 2013 as the starting point.
- BAU 2013: The campus business as usual energy consumption baseline is calculated based on the 2013 campus EUI and the campus building area for the given year. This gives the energy consumption the campus would have if it maintained its EUI at the same value as 2013.

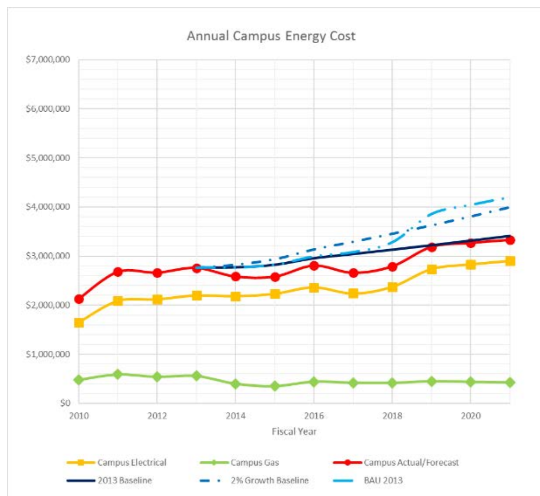
a place of mind
THE UNIVERSITY OF BRITISH COLUMBIA

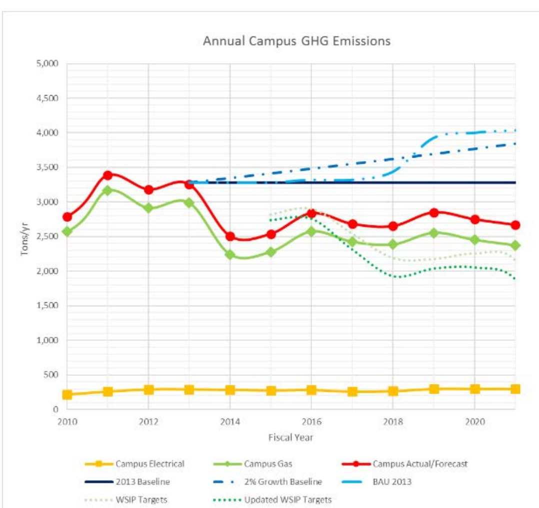
Facilities Management
The University of British Columbia |
Okanagan Campus
1138 Alumni Avenue | Kelowna BC | V1V 1V7 Canada
Phone 250.807.9272
facilities.ok@ubc.ca











Note: Dates listed refer to start of fiscal year. ie FY2016-2017 = 2016

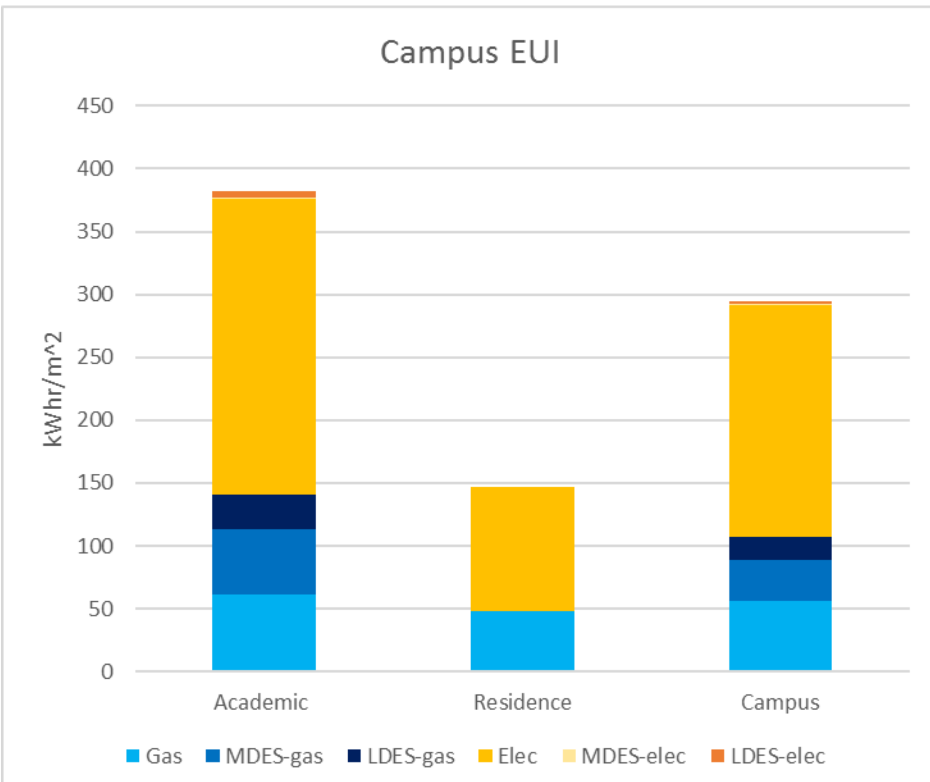
a place of mind
THE UNIVERSITY OF BRITISH COLUMBIA

Facilities Management
The University of British Columbia |
Okanagan Campus
1138 Alumni Avenue | Kelowna BC | V1V 1V7 Canada
Phone 250.807.9272
facilities.ok@ubc.ca

4.2 Energy Use Intensity

Energy use intensity (EUI) is the amount of energy used per unit of floor area. The overall campus EUI was 295 kWhr/yr/m^2 for FY2016-2017. The academic buildings on campus have a higher average EUI than residence buildings due to their more intensive use and the higher energy use of facilities such as laboratories (increased ventilation air, process loads, equipment etc). The average EUI for academic buildings on campus was 382 kWhr/yr/m^2 while it was 147 kWhr/yr/m^2 for residences. The chart below shows the breakdown of EUI per energy source. The electricity and gas used by the two central plants on campus (the Central Heating Plant and the Geoexchange Centre) is attributed to individual buildings proportionate to the fraction of the central plant's output that was consumed by that building.

Overall efficiency of the MDES system defined as thermal energy delivered as a fraction of combustion energy of gas burned by the boilers was 67%. Due to its ability to share heating and cooling loads the LDES system consumed less gas energy than thermal heating energy delivered. This resulted in an effective heating efficiency of 154% for the LDES.

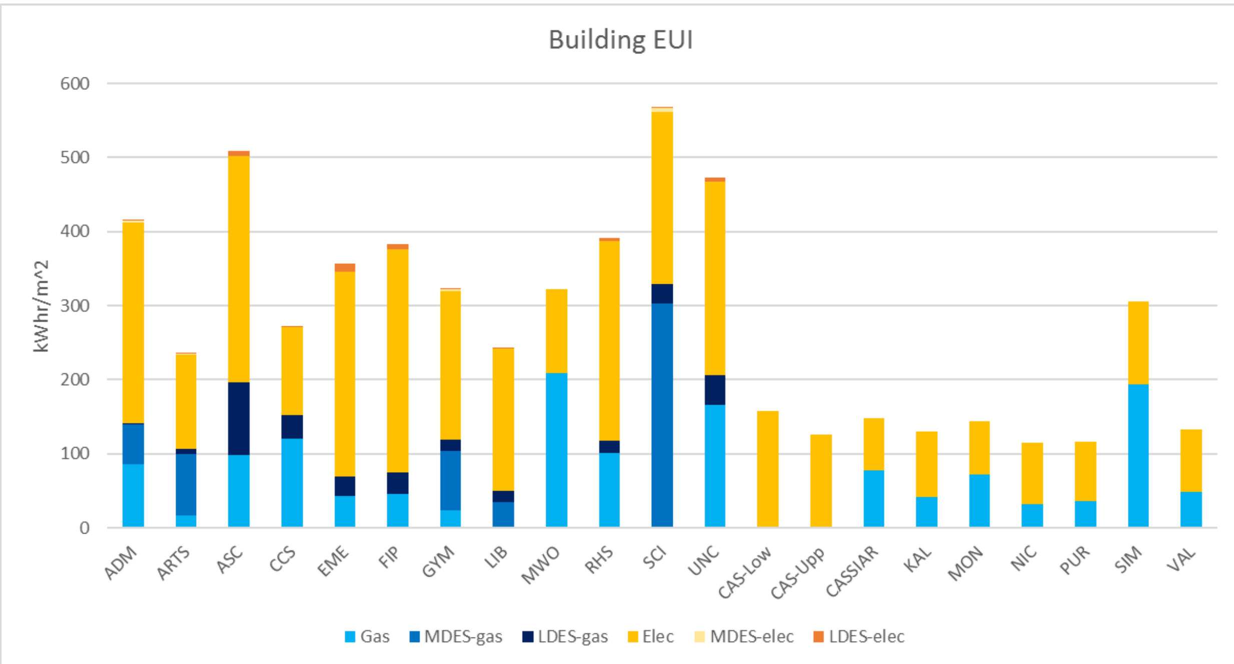


a place of mind
THE UNIVERSITY OF BRITISH COLUMBIA

Facilities Management
The University of British Columbia |
Okanagan Campus
1138 Alumni Avenue | Kelowna BC | V1V 1V7 Canada
Phone 250.807.9272
facilities.ok@ubc.ca

5 Performance by Building

Due to the wide array of building types on campus, energy performance varies widely building by building. The chart below shows the breakdown of EUI per energy source for each building on campus.



It can be seen in the chart above that the EUI of academic buildings tend to be higher with the Science building have the highest EUI, consuming almost 570 $kWhr/yr/m^2$. For the residence buildings, Similkameen has approximately double the average residence EUI.

The energy consumption of a given building is due to a number of different factors such as occupancy, type of use, installed technology, age and state of repair. As such, some buildings can be expected to have higher EUI's. Nonetheless, a high EUI value for a building relative to other buildings of similar types indicates that a building may be a higher-priority target for energy conservation measures.

More detailed investigation into building energy performance has been completed on a building by building basis. A summary of these results is given in the following sub-sections.

Facilities Management
The University of British Columbia |
Okanagan Campus
1138 Alumni Avenue | Kelowna BC | V1V 1V7 Canada
Phone 250.807.9272
facilities.ok@ubc.ca

5.1 Administration Building

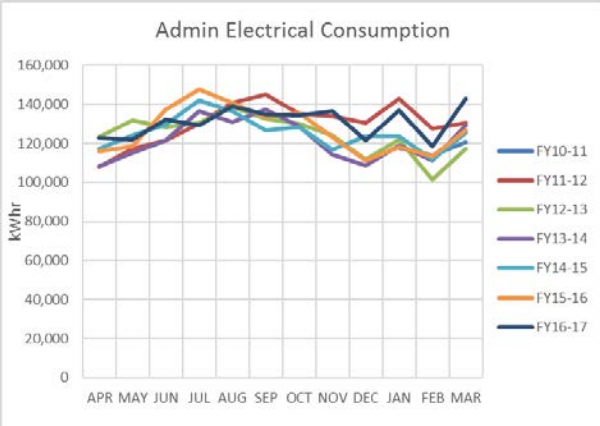
Electrical consumption in the Adm building was up 3% for the year. This increase can be attributed to the replacement of MUA-7. The new unit includes a air-source heatpump that provides heating when outdoor air temperatures are above about 1°C. For the next fiscal year, further electrical consumption increases may be expected as the unit will now provide cooling to the kitchen which was not previously provided. As this unit was installed in the fall of 2016 after the primary cooling season, the impact of providing cooling was not seen in the FY2016-2017 electrical consumption. The increase in consumption can also be attributed to increased fan and pump usage during cold weather. During shoulder seasons heat pump use was increased by locking out heat supplied from the campus MDES when the outdoor air temperature is above 5°C. Additionally, some electric heating was added to specific areas due to heating capacity issues in prior years.

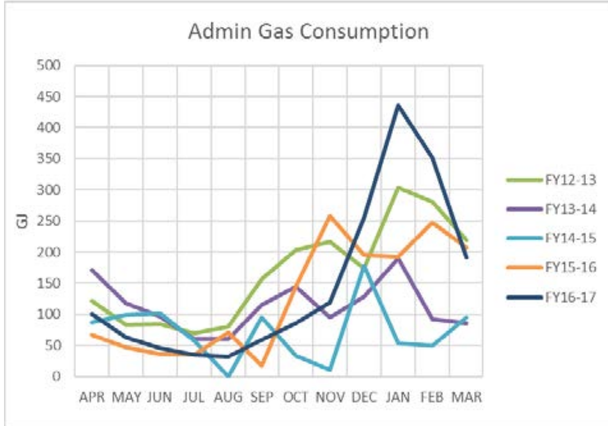
Gas consumption increased 2% year over year; this increase is mild considering the colder weather. It is believed that this gas consumption increase would be larger were it not for the new MUA-7 which is significantly more efficient than the unit it replaced which was at the end of its service life.

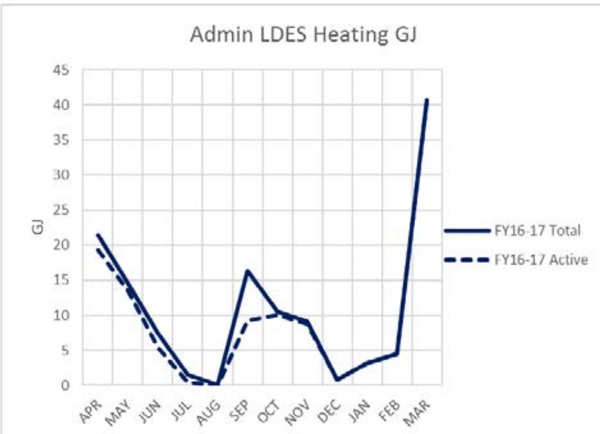
In previous years, heating capacity was noted as an issue in this building. In order to address this, the MDES/building heat exchanger was upgraded, the primary circulator pump P3 was replaced and a number of reheat coils upsized to increase winter heating capacity and evenly distribute heating water throughout the building. Heat pump heat exchangers as well as the heat exchanger between the LDES loop and the building were also cleaned to improve system operational efficiencies.

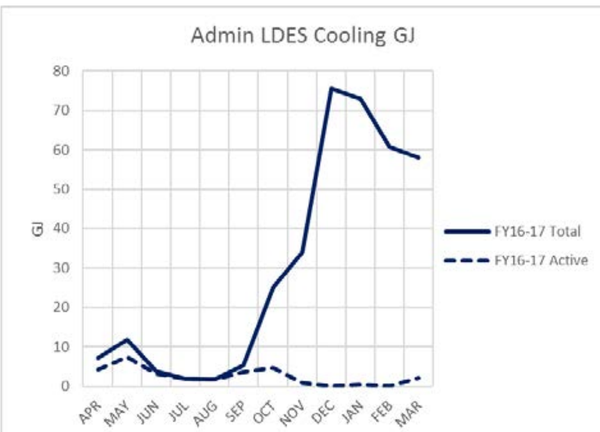
a place of mind
THE UNIVERSITY OF BRITISH COLUMBIA

Facilities Management
The University of British Columbia |
Okanagan Campus
1138 Alumni Avenue | Kelowna BC | V1V 1V7 Canada
Phone 250.807.9272
facilities.ok@ubc.ca









Note that the Admin MDES plot is not available due to metering issues.

a place of mind
THE UNIVERSITY OF BRITISH COLUMBIA

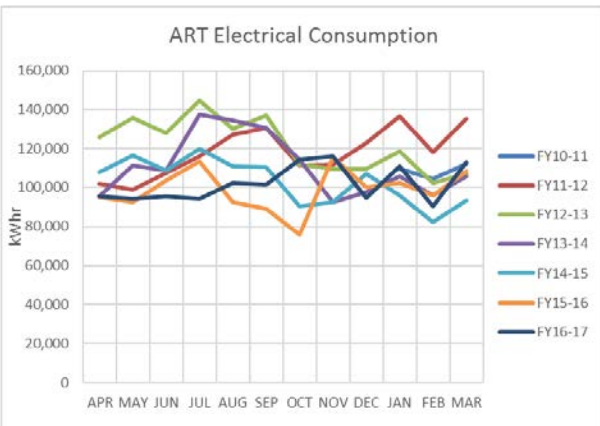
Facilities Management
The University of British Columbia |
Okanagan Campus
1138 Alumni Avenue | Kelowna BC | V1V 1V7 Canada
Phone 250.807.9272
facilities.ok@ubc.ca

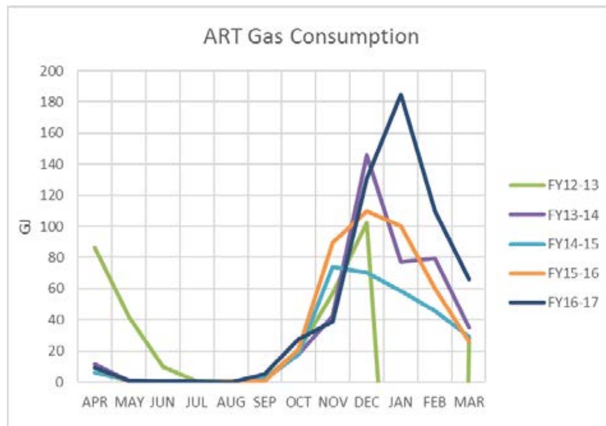
5.2 Arts Building

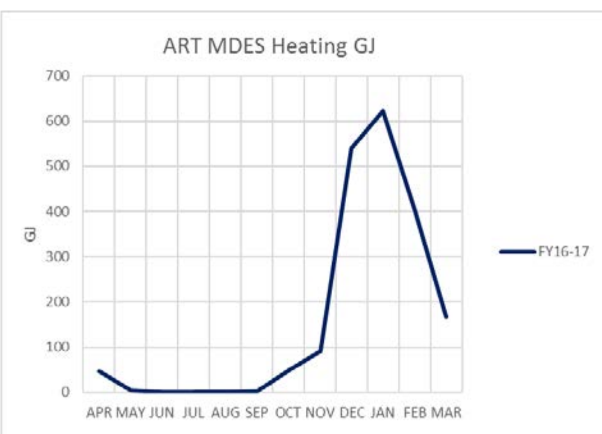
The electrical consumption in the ARTS building was up 3% year over year. This consumption increase can be attributed to increased heat pump usage. Heat pump use was increased during shoulder seasons by locking out heat supplied from the campus MDES when the outdoor air temperature is above 5^{o}C.

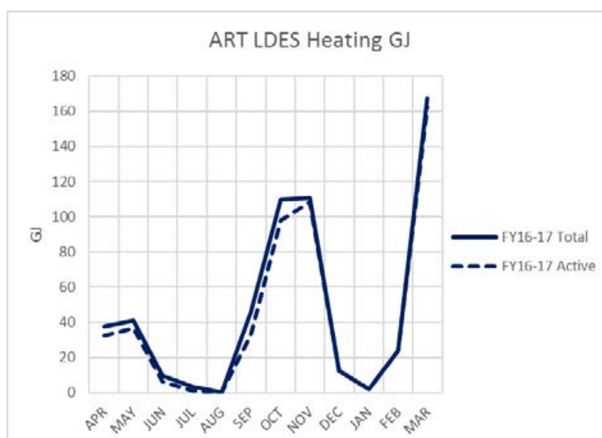
Colder weather during FY2016-2017 resulted in a 36% year over year increase in gas consumption due to increased energy use by gas-fired air-handlers. The impact of the cold weather was exacerbated due to energy-inefficient cold-weather operation procedures. This issue and its planned fix is described in detail in the future projects section.

Additionally, heat exchangers for the heat pumps as well as between the LDES loop and the building were cleaned to improve system operational efficiencies.









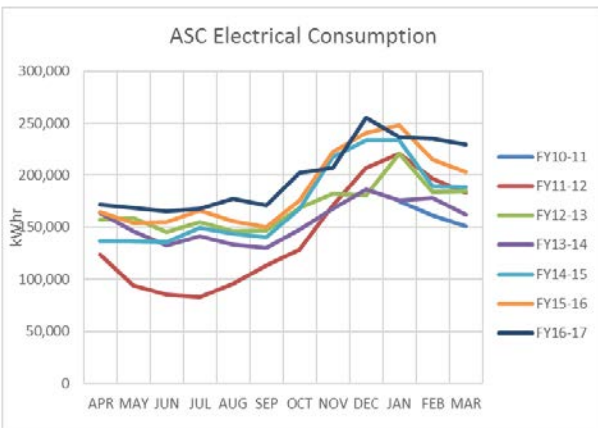
Facilities Management
The University of British Columbia | Okanagan Campus
1138 Alumni Avenue | Kelowna BC | V1V 1V7 Canada
Phone 250.807.9272
facilities.ok@ubc.ca

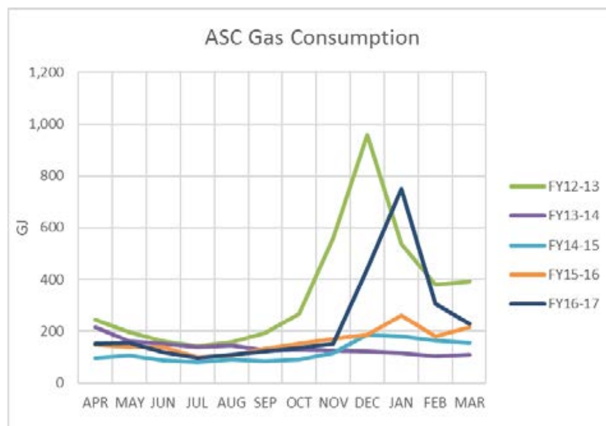
5.3 Arts & Science Building

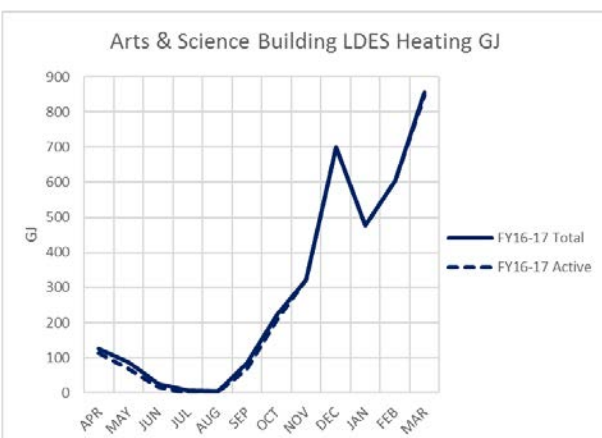
Electrical consumption in the ASC building was up 6% year over year. This energy use is attributed to the cold winter weather. Similarly gas consumption was up due to 44%. Increased use of the building's steam boiler to meet increased laboratory process loads was another significant factor in the increased gas consumption.

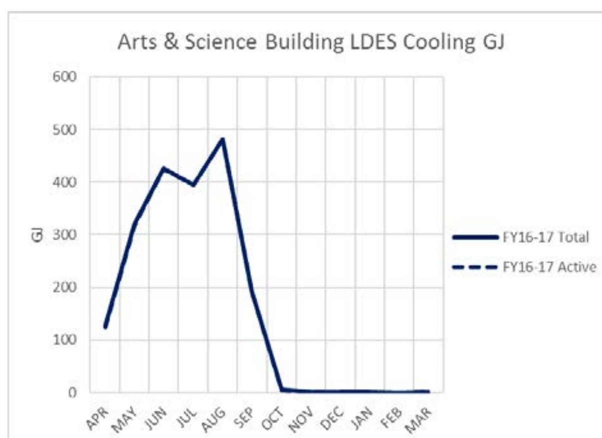
As with several other buildings, the impact of the cold weather was exacerbated due to energy-inefficient cold-weather operation procedures. This issue and its planned fix is described in detail in the future projects section.

The LDES/building heat exchanger was cleaned to improve system operational efficiencies.









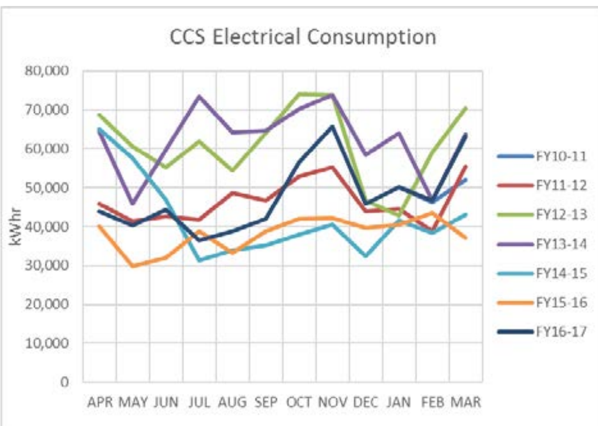
a place of mind
THE UNIVERSITY OF BRITISH COLUMBIA

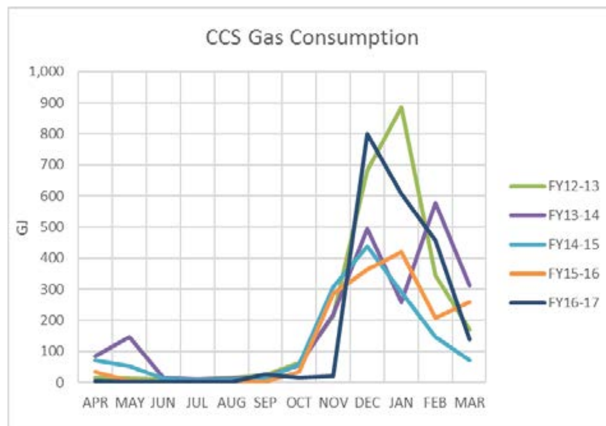
Facilities Management
The University of British Columbia |
Okanagan Campus
1138 Alumni Avenue | Kelowna BC | V1V 1V7 Canada
Phone 250.807.9272
facilities.ok@ubc.ca

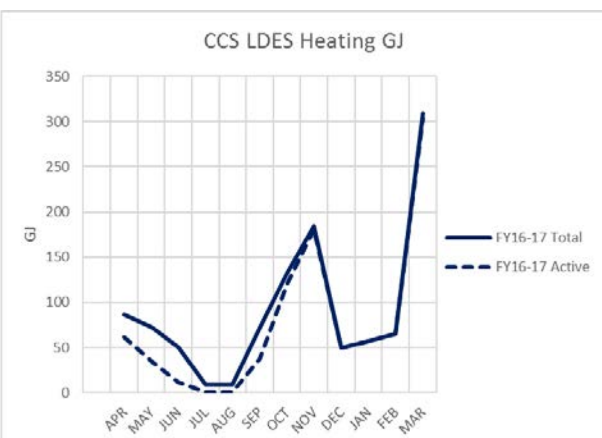
5.4 Creative & Critical Studies Building

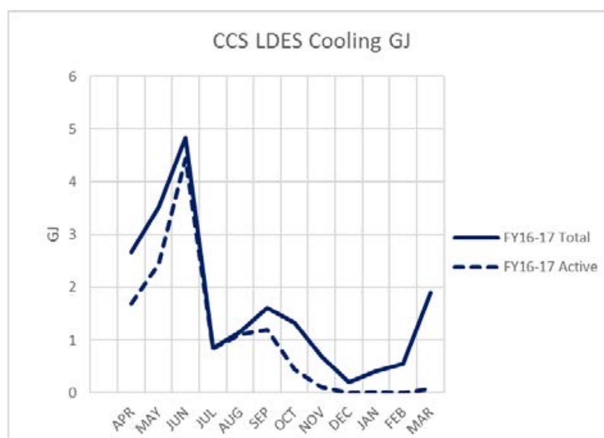
The cold winter weather is believed to have caused the increased energy consumption seen in this building over the past year. The electrical consumption increased by 26% while the gas consumption increased by 31%. The impact of the cold winter weather on gas consumption was exacerbated due to energy-inefficient cold-weather operation procedures. This issue and its planned fix is described in detail in the future projects section.

Mitigating the gas consumption increase and further increasing the electrical consumption increase were controls changes that increased the operation of the heatpumps for heating during shoulder seasons.







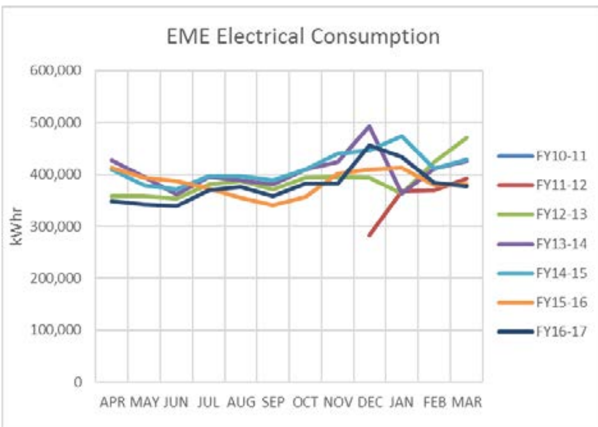


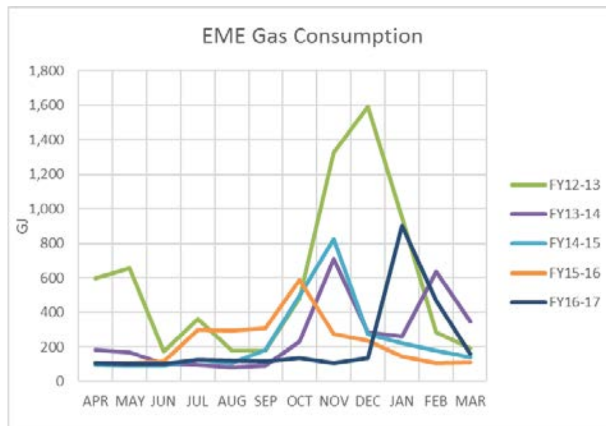
Facilities Management
The University of British Columbia |
Okanagan Campus
1138 Alumni Avenue | Kelowna BC | V1V 1V7 Canada
Phone 250.807.9272
facilities.ok@ubc.ca

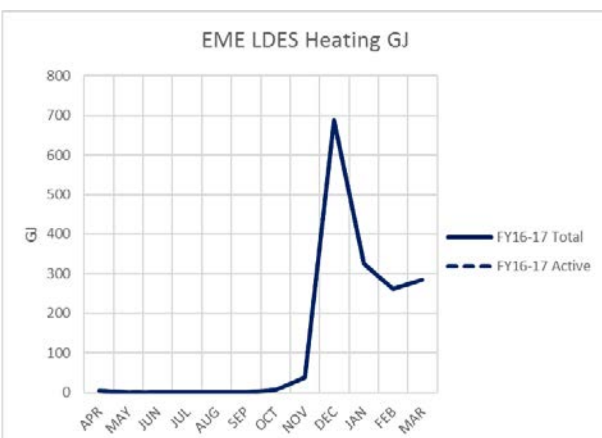
5.5 Engineering, Management & Education Building

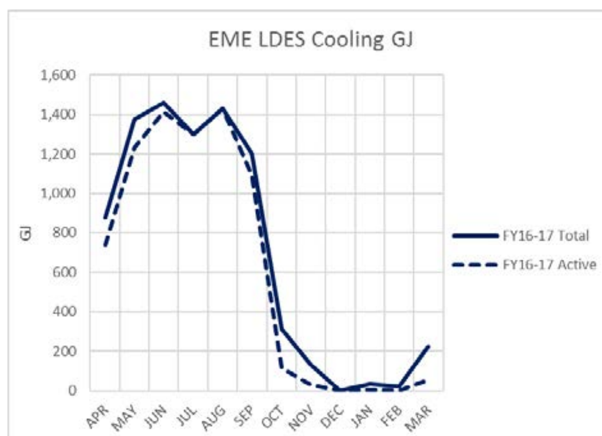
The FY2016-2017 electrical consumption was reduced by about 1% year over year. Annual gas consumption was reduced by about 3%. This gas reduction was in spite of significant boiler use during cold weather. The reduction is believed to be due to corrective actions taken that addressed the mechanical deficiencies that caused excessive gas usage during FY2015-2016.

The LDES heat exchangers and load side of heat pump heat exchangers were cleaned in this building to improve system operational efficiency.









a place of mind
THE UNIVERSITY OF BRITISH COLUMBIA

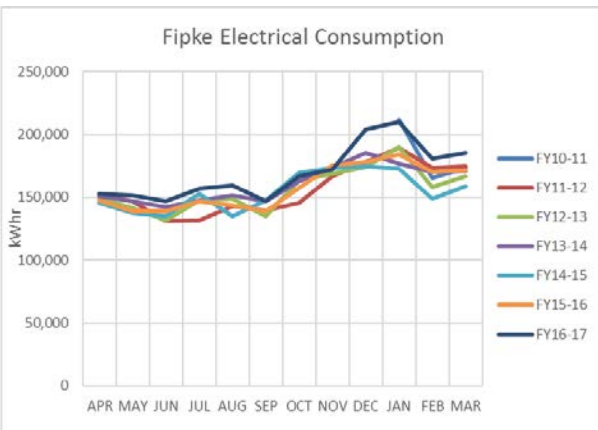
Facilities Management
The University of British Columbia | Okanagan Campus
1138 Alumni Avenue | Kelowna BC | V1V 1V7 Canada
Phone 250.807.9272
facilities.ok@ubc.ca

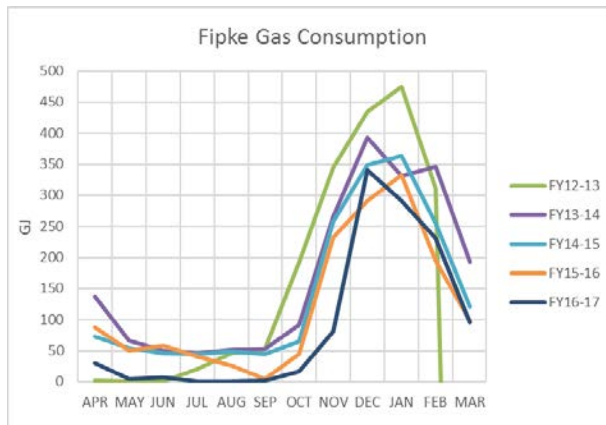
5.6 Fipke Building

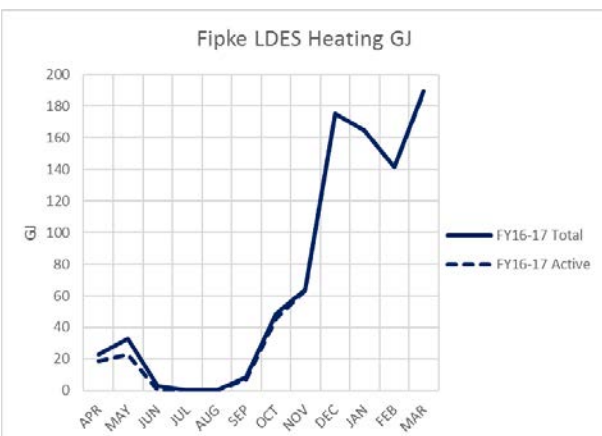
Electrical consumption in the Fipke building increased by 7.5% compared to the prior fiscal year. This increased electrical consumption is believed to be due to cold weather operation as well as the installation of electric hot water tanks.

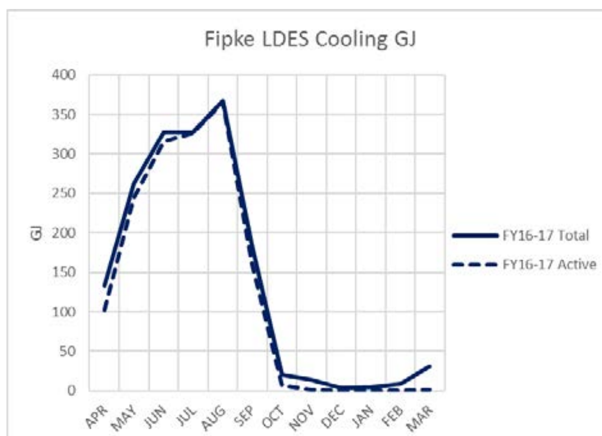
Gas consumption was reduced by 24% despite the cold winter. This reduction is believed to be due to the electric water heaters taking over domestic hot water loads as well as new condensing boilers that were installed in 2015.

The main LDES/building heat exchangers were cleaned Nov 2016 to improve system operational efficiency.







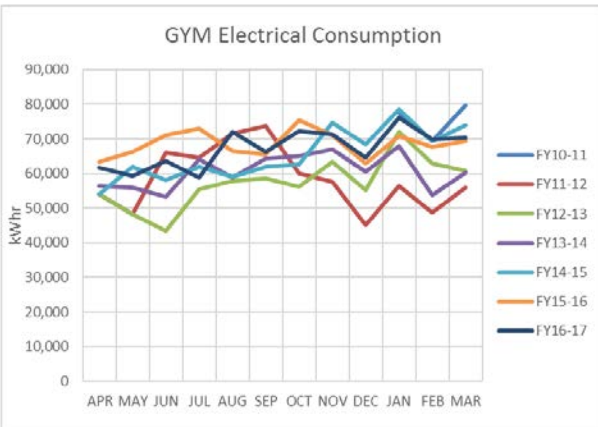


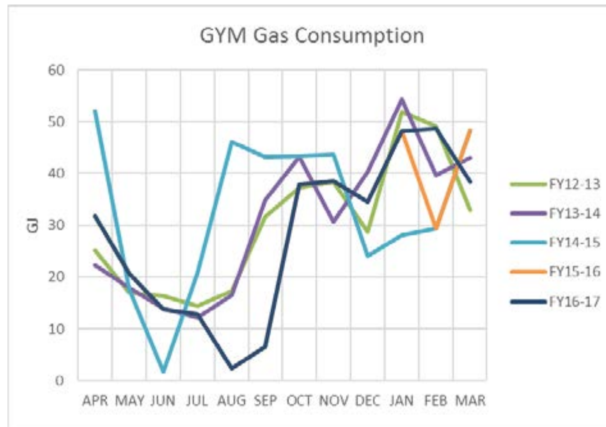
a place of mind
THE UNIVERSITY OF BRITISH COLUMBIA

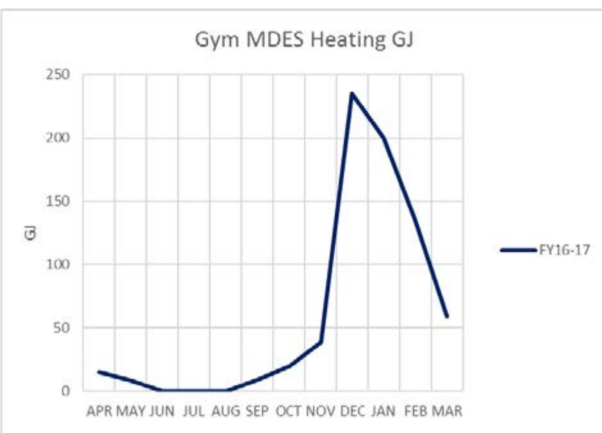
Facilities Management
The University of British Columbia | Okanagan Campus
1138 Alumni Avenue | Kelowna BC | V1V 1V7 Canada
Phone 250.807.9272
facilities.ok@ubc.ca

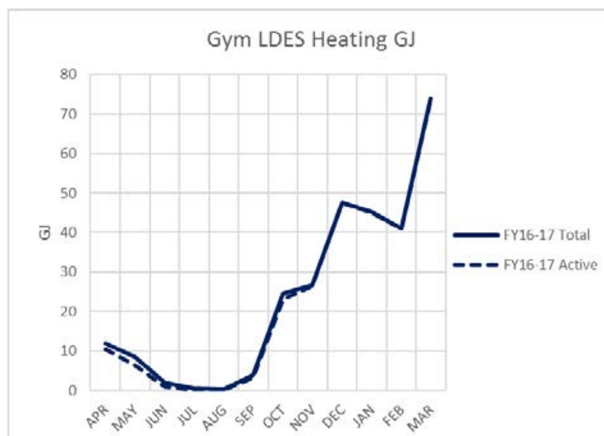
5.7 Gym

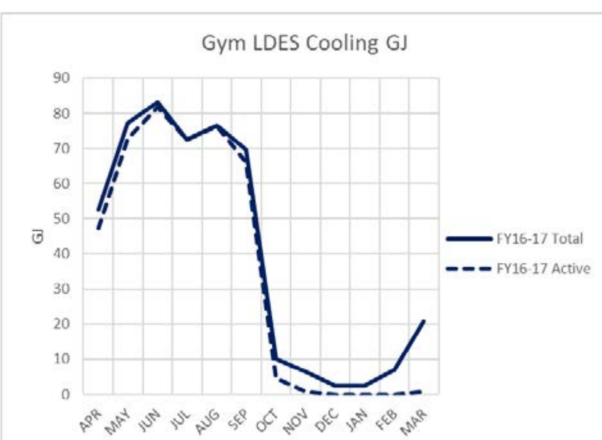
Electrical consumption in the Gym was reduced by about 2% compared to the prior year. The gas meters for this building were non-functional for a large portion of the year. The largest gas load in the gym consists of domestic hot water. This load is believed to be relatively unchanged compared to the previous year so the gas consumption for the gym was assumed to equal that of FY2015-2016.











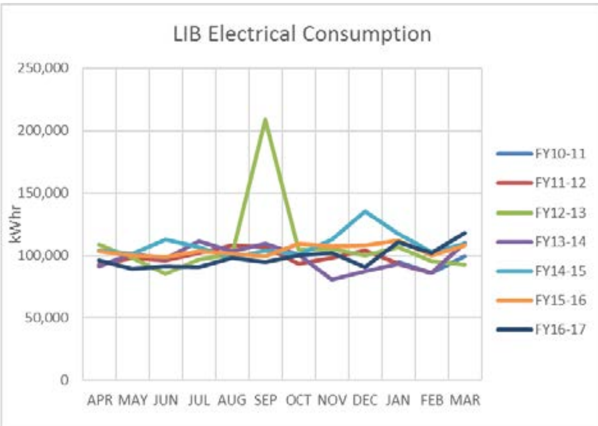
a place of mind
THE UNIVERSITY OF BRITISH COLUMBIA

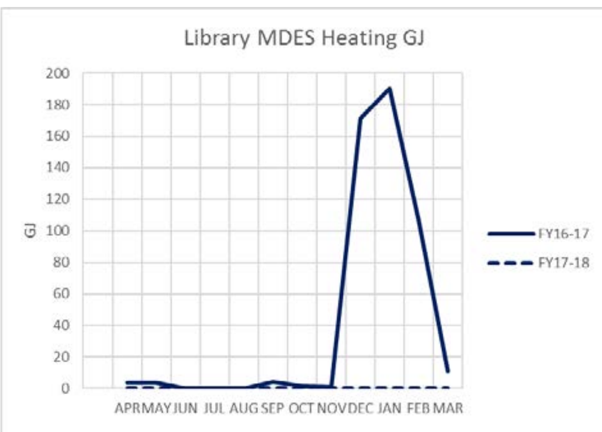
Facilities Management
The University of British Columbia |
Okanagan Campus
1138 Alumni Avenue | Kelowna BC | V1V 1V7 Canada
Phone 250.807.9272
facilities.ok@ubc.ca

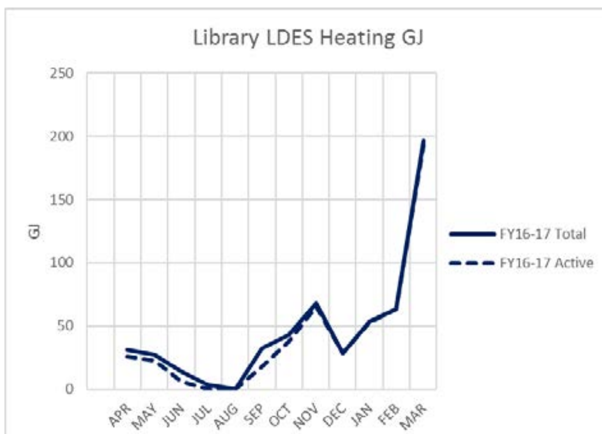
5.8 Library

The library consumed approximately 5% less electricity in FY2016-2017 compared to the previous year. This savings is believed to be due to colder weather as during colder weather, the heating load for the buildings is shifted from the building's heatpumps to the MDES.

The LDES/library heat exchanger as the library's heatpump heat exchangers were cleaned to improve system operational efficiency.







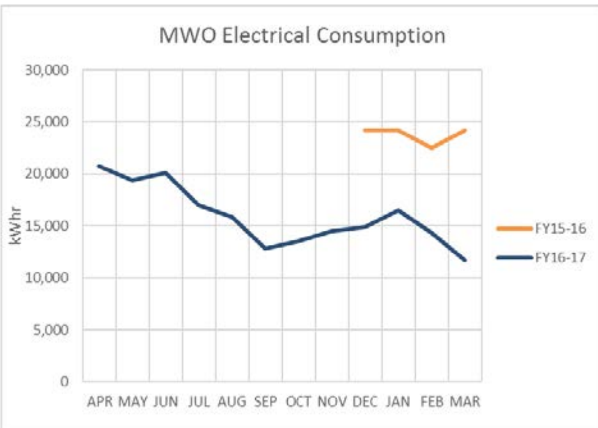
a place of mind
THE UNIVERSITY OF BRITISH COLUMBIA

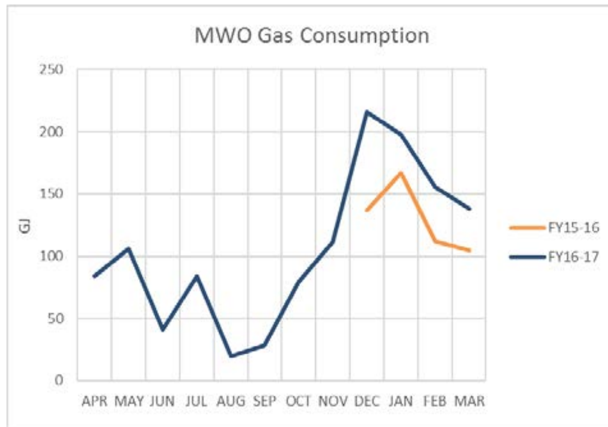
Facilities Management
The University of British Columbia |
Okanagan Campus
1138 Alumni Avenue | Kelowna BC | V1V 1V7 Canada
Phone 250.807.9272
facilities.ok@ubc.ca

5.9 Mountain Weather Office

This building has only been operated by UBCO since December 2015. As such, FY2015-2016 is the first full year of energy use data available for this facility.

Currently, significant interior renovations are underway in this building. Additionally, both the heating and cooling system are planned for replacement in the upcoming year. As a result of these changes, significant reductions in energy use for this facility may occur.





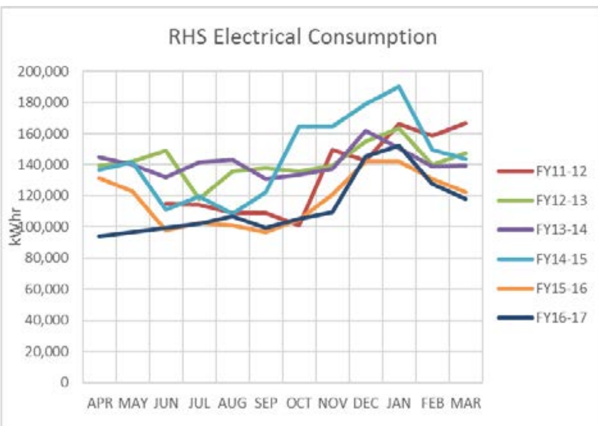
Facilities Management
The University of British Columbia |
Okanagan Campus
1138 Alumni Avenue | Kelowna BC | V1V 1V7 Canada
Phone 250.807.9272
facilities.ok@ubc.ca

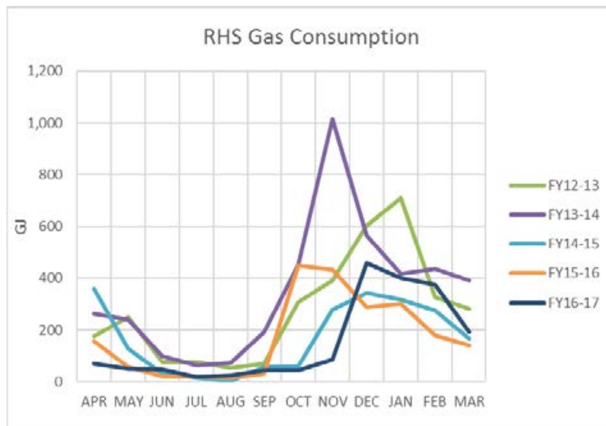
5.10 Reichwald Health Sciences Centre

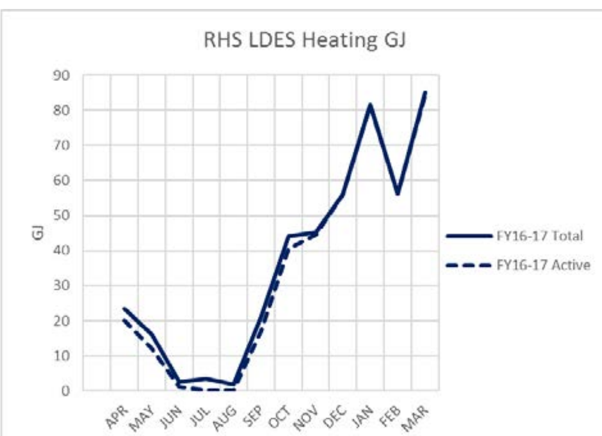
Electricity consumption for FY2016-2017 was 4% lower on a year over year basis due to colder weather which shifted heating load from heatpumps to the building's boilers. Additionally BMS controls improvements reduced instances of simultaneous heating and cooling that was occurring due to issues of intermittent controls system communications.

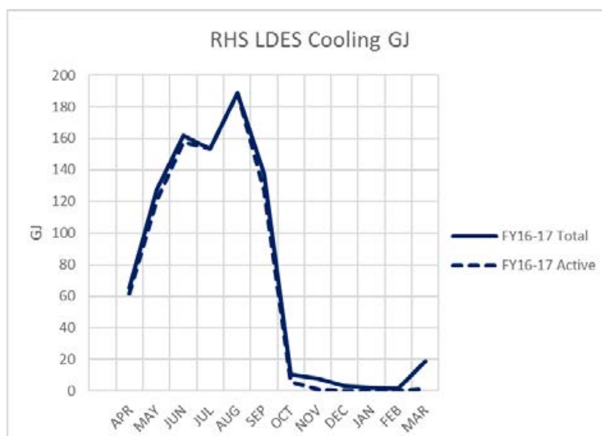
Gas usage increased by about 5% year over year due to cold weather.

The LDES side of the LDES/building heat exchangers were cleaned to improve system operational efficiency.









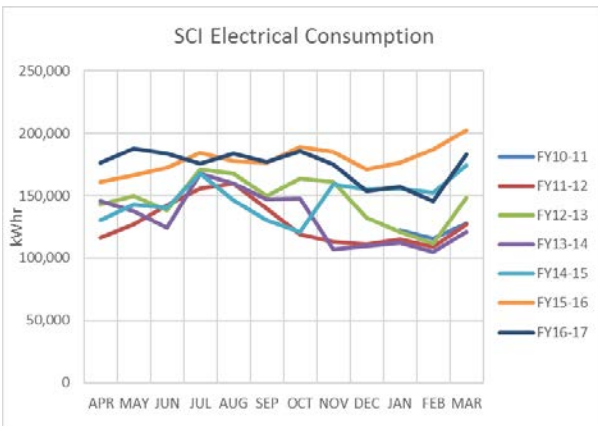
Facilities Management
The University of British Columbia | Okanagan Campus
1138 Alumni Avenue | Kelowna BC | V1V 1V7 Canada
Phone 250.807.9272
facilities.ok@ubc.ca

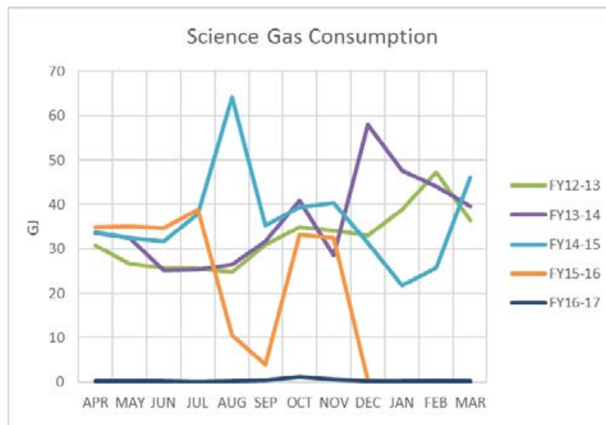
5.11 Science Building

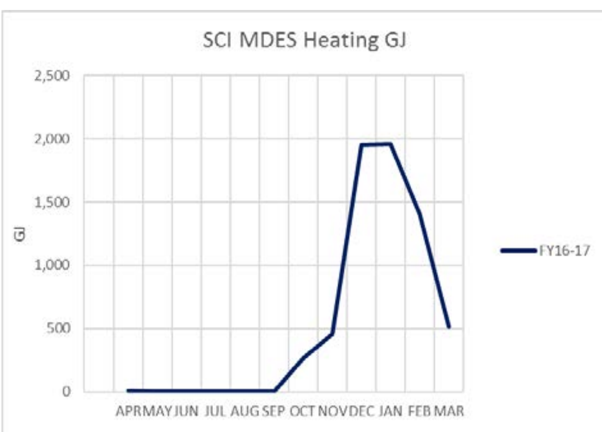
Consumption of electricity was reduced by 3% compared to the prior fiscal year. This reduction is believed to be due to cold weather operation which shifts heating load from the building's heatpumps to the MDES.

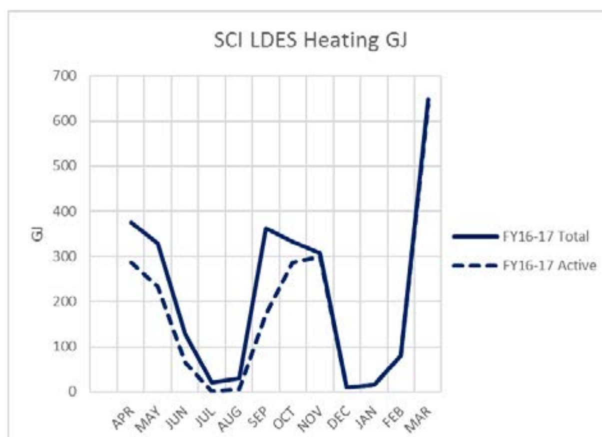
Gas consumption for this building is now very minor due to domestic hot water now being provided with electric tanks. Laboratory gas consumption is now the only use for gas in the building.

The LDES/building heat exchanger as well as the heatpump heat exchangers were all cleaned for improved system operational efficiency.







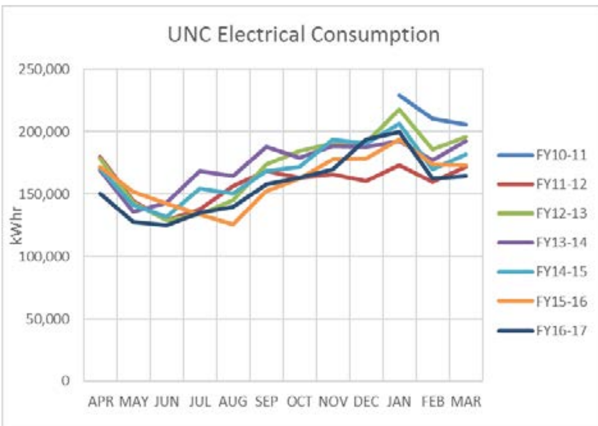


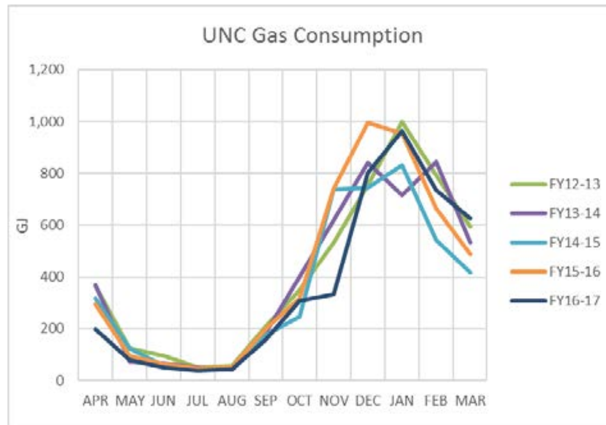
a place of mind
THE UNIVERSITY OF BRITISH COLUMBIA

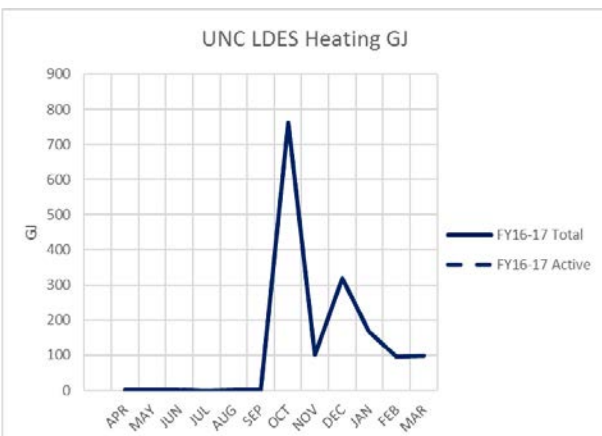
Facilities Management
The University of British Columbia |
Okanagan Campus
1138 Alumni Avenue | Kelowna BC | V1V 1V7 Canada
Phone 250.807.9272
facilities.ok@ubc.ca

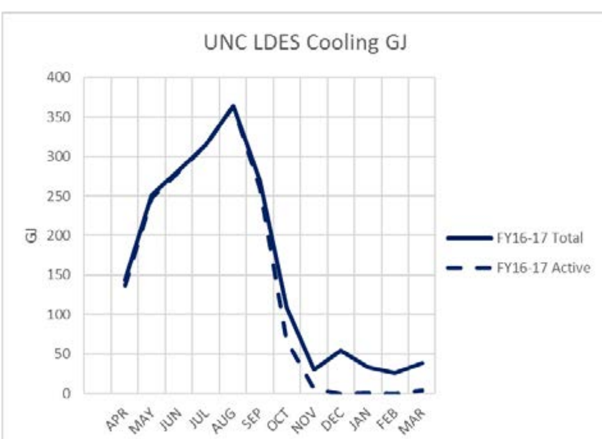
5.12 University Centre

The University Centre's electrical consumption was reduced by about 2% year over year. Gas consumption was reduced by about 18%. The reduction in gas usage is believed to have been due to cleaning of the LDES/building heat exchangers as well as the heatpump heat exchangers. The efficiencies gained due to heat exchanger cleaning allowed the building's heatpumps to provide more of the building's heating, thus reducing gas consumption from the building's boilers.









a place of mind
THE UNIVERSITY OF BRITISH COLUMBIA

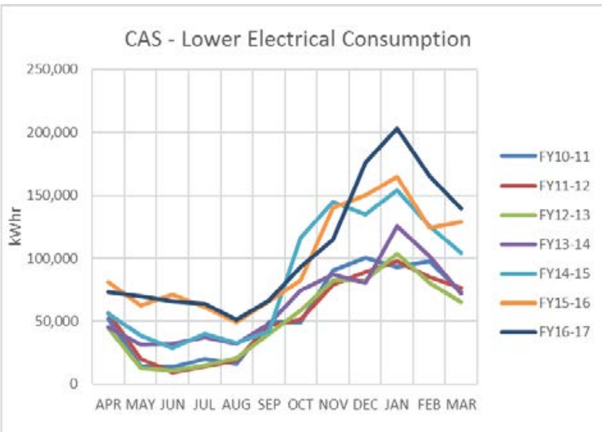
Facilities Management
The University of British Columbia |
Okanagan Campus
1138 Alumni Avenue | Kelowna BC | V1V 1V7 Canada
Phone 250.807.9272
facilities.ok@ubc.ca

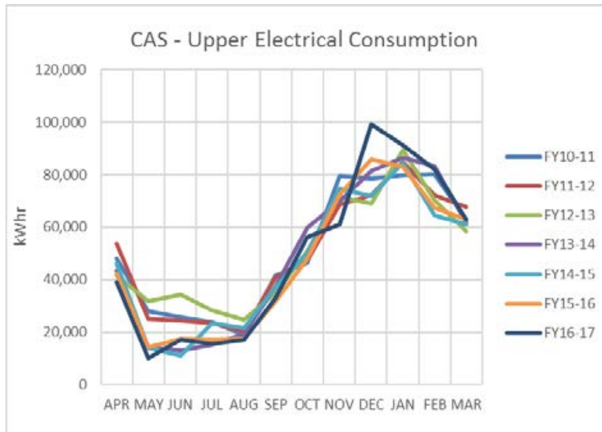
5.13 Residence Building Energy Consumption Plots

Plots of energy consumption for each of the residence buildings are given below. Note that since the MDES and LDES are not connected to any of the residences, only electrical and gas consumption plots are given.

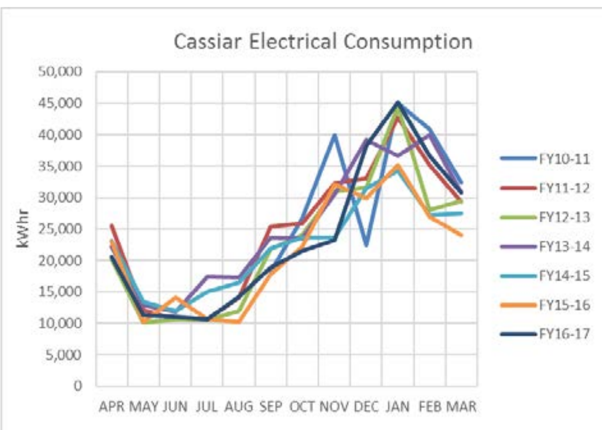
5.13.1 Cascades

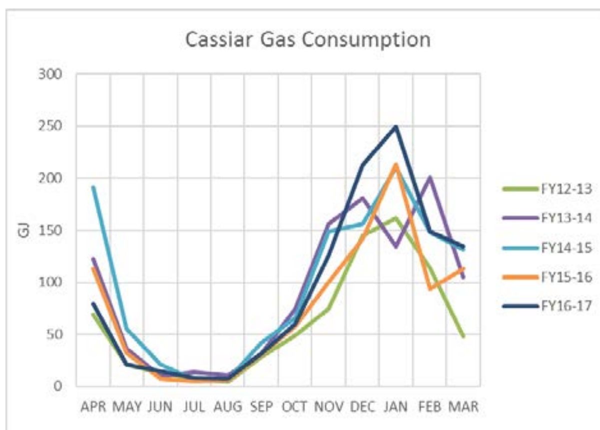
Note that the Cascades residences are electric only and have no gas consumption.



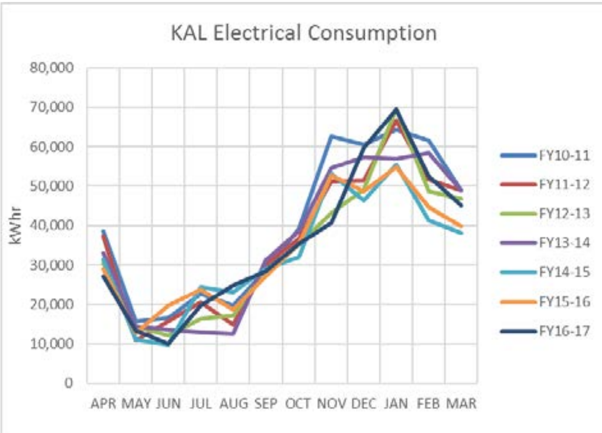


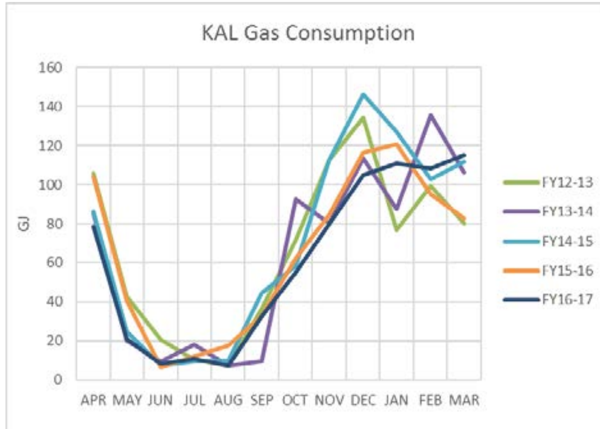
5.14 Cassiar



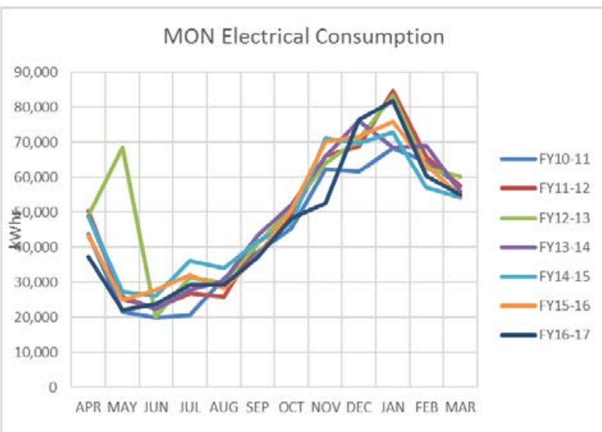


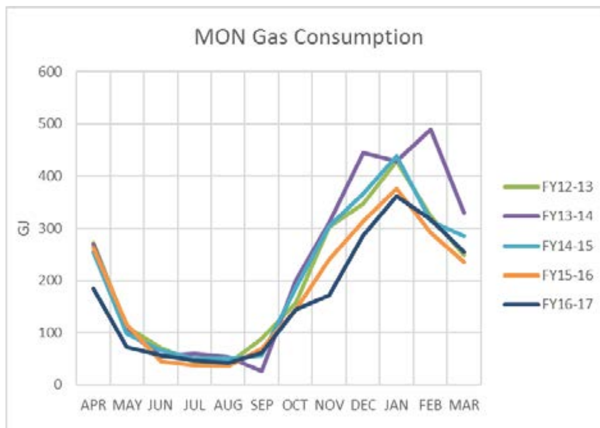
5.14.1 Kalamalka



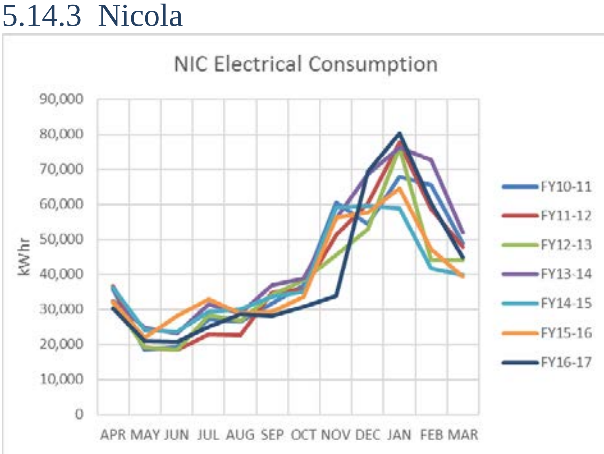


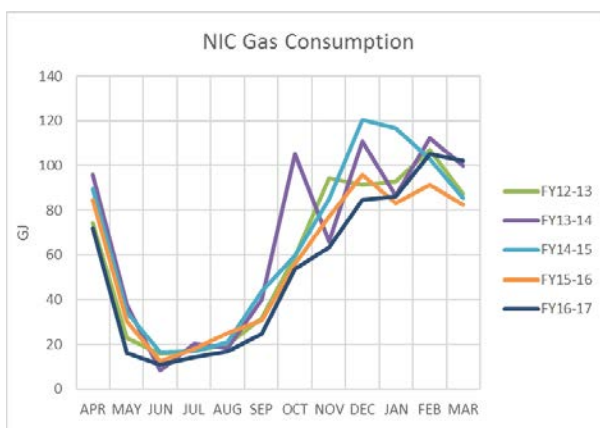
5.14.2 Monashee





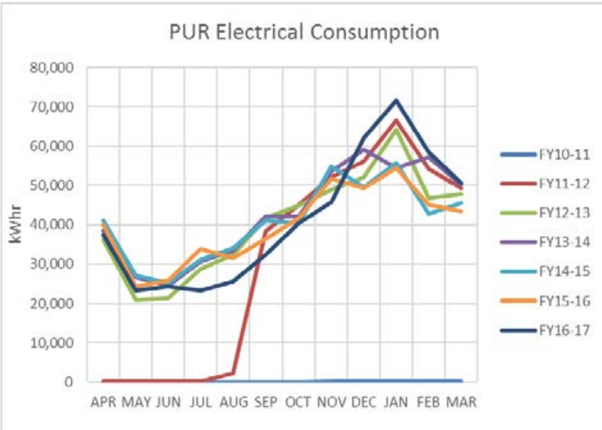
5.14.3 Nicola

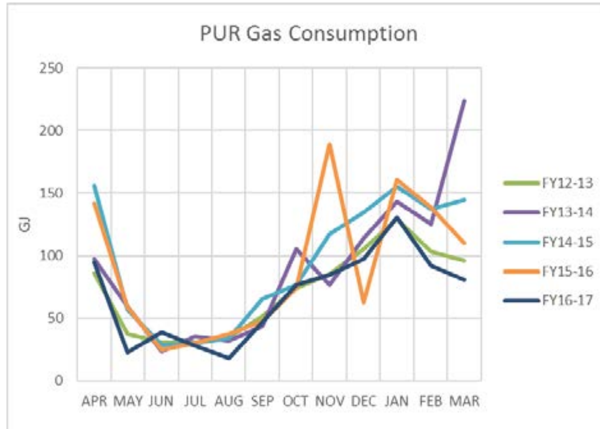




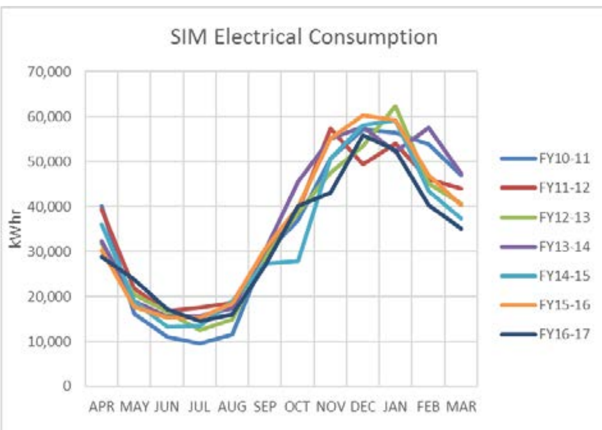
Facilities Management
The University of British Columbia |
Okanagan Campus
1138 Alumni Avenue | Kelowna BC | V1V 1V7 Canada
Phone 250.807.9272
facilities.ok@ubc.ca

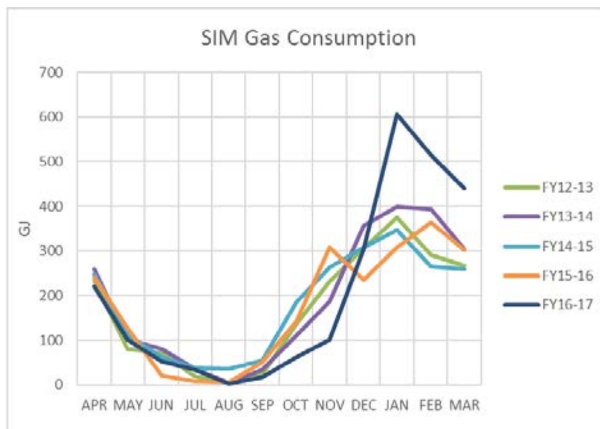
5.14.4 Purcell



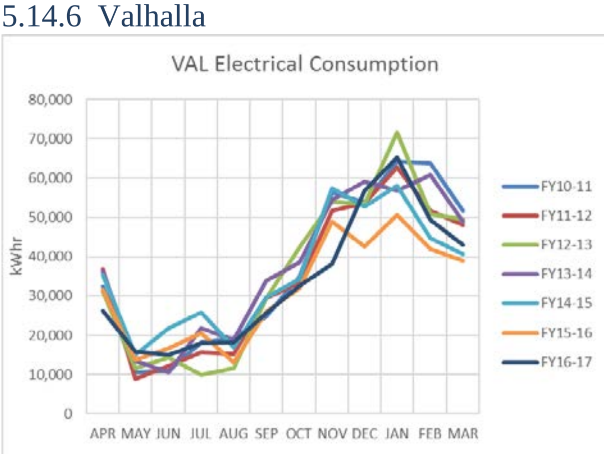


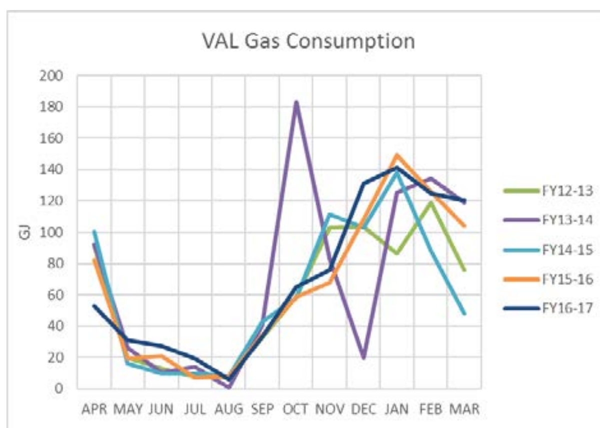
5.14.5 Similkameen





5.14.6 Valhalla





a place of mind
THE UNIVERSITY OF BRITISH COLUMBIA

Facilities Management
The University of British Columbia | Okanagan Campus
1138 Alumni Avenue | Kelowna BC | V1V 1V7 Canada
Phone 250.807.9272
facilities.ok@ubc.ca

6 Completed Projects

Projects completed during FY2016-2017 are briefly described in the subsections below.

6.1 Administration Building MUA

The malfunctioning kitchen makeup air unit for the Sunshine Café has been replaced. The new unit includes an air-source heatpump that provides both heating and cooling with a backup gas burner. With this new unit, energy costs are expected to be $14,400 lower despite the addition of cooling which the previous unit lacked. Gas consumption is expected to be 1390 GJ lower while electrical use is expected to increase by 120 GJ. Final deficiencies identified during commissioning still need to be addressed. Hood exhaust volumes need to be reviewed to allow implementation of fan airflow tracking and possible reductions in outdoor air flow.

6.2 LDES/MDES System Study

As new buildings are planned for the campus, it is important to consider both the capacity of the existing LDES and MDES systems as well as ensure that all HVAC systems in new buildings are designed to function optimally with the district systems. Williams Engineering has provided UBC with a user-adjustable model that simulates the operation of the Okanagan campus district energy systems to assist in optimizing the efficiency of campus energy supply and distribution.

6.3 Administration Building Heating Upgrade – Phase 1

While the initial objective of this project was to address heating capacity issues, options to concurrently increase the efficiency of the system are being investigated. An infra-red study of the building envelope as well as a physical inspection have been completed in order to identify heat loss locations. Completion of suggested remedial actions have not been taken at this time due to competing funding priorities. These actions remain under consideration for future phases of this project.

Facilities Management
The University of British Columbia |
Okanagan Campus
1138 Alumni Avenue | Kelowna BC | V1V 1V7 Canada
Phone 250.807.9272
facilities.ok@ubc.ca

7 Projects in Progress

The following are energy conservation projects that are currently in progress.

7.1 WIFI Occupancy Controls

The number of WIFI devices connected to the campus IT network can be used to estimate the number of occupants in a space. This project consists of software upgrades to the campus BMS to control ventilation rates based on the WIFI count occupancy estimates. The estimated cost for the BMS programming is about $13,8000. Rebates of $25,005 from FortisBC Electric and $18,963 from FortisBC Gas have been confirmed. Note that the rebate value is greater than the estimated project cost and FortisBC has confirmed this rebate amount being acceptable as they have reviewed the amount as a portion of a bundle of measures with varying paybacks. It is expected that the controls programming for this project can be completed within 3 months.

7.2 Supply Air Temperature Reset

Currently, many campus air-handlers base supply-air temperatures on either outdoor air temperatures or a fixed setpoint. Upgrading the BMS control software to set supply-air temperatures based on average heating/cooling valve positions is expected to save $4,900 per year in heating and cooling costs (390GJ of gas and 24,300 kWhr of electricity). This upgrade is expected to cost $5,600 and FortisBC rebates of $4,935 for electricity and $8,943 for gas have been confirmed. This project is pursuing FortisBC Gas incentives and is included in the same review process and schedule described for the WIFI occupancy project described above. Controls programming for this project is expected to be completed within 3 months.

7.3 Supply Air Pressure Reset

Adjusting the supply-air pressure setpoints based on the heating/cooling demand in a building will allow reduced fan speeds and corresponding reduced electrical consumption. Implementing the required BMS software upgrades is expected to cost about $5,100. The FortisBC electrical rebate has been confirmed as $7,905. Note that this value is greater than the estimated project cost. Fortis has confirmed this rebate amount being acceptable as they have reviewed the amount as a portion of a bundle of measures with varying paybacks. Controls programming for this project is expected to be complete in the next 3 months.

7.4 Increased Heatpump Utilization

Optimizing building supply water temperatures will allow existing heatpumps to operate for a larger fraction of the year. Implementation of this strategy is estimated to result in a reduction of natural gas consumption and an increase in electricity use for a net energy cost savings of about $1,200 and a reduction in GHG emissions of approximately 85 tons. Implementation cost is expected to be about $8,200. Controls programming for this project is expected to be complete in the next 3 months.

Facilities Management
The University of British Columbia |
Okanagan Campus
1138 Alumni Avenue | Kelowna BC | V1V 1V7 Canada
Phone 250.807.9272
facilities.ok@ubc.ca

7.5 Science Ventilation Upgrade

Various building changes that have accrued over time have reduced the efficiency of the ventilation in this building which includes a large number of laboratories. In order to improve the ventilation to this building the following work has been proposed:

1. Analyze current airflows including identification of interior penetrations that require remediation.
2. Repair penetrations identified in part 1.
3. Upgrade fume-hoods to allow airflows to be based on face air-velocities.
4. Add occupancy controls to laboratories to allow for reduced ventilation rates when possible.

This project is currently estimated to have the potential to save $52,000 in energy costs per year (2,600 GJ of gas and 415,000 kWhr of electricity) for a project cost of about $150,000. The project has been approved for $25,815 in FortisBC electrical incentives and $55,681 in FortisBC Gas incentives. The first stage of this project, completing an air balancing audit of this building, is planned for May 2017.

7.6 Lighting Upgrade for ADM and CCS Buildings

SIF funding of $227,000 has been obtained for upgrading the lighting in the ADM and CCS buildings. Additional FortisBC electric incentives of $17,000 are estimated for this project.

7.6.1 ADM Building

This project is planned for completion during spring/summer 2017 to take advantage of lower summertime campus occupancy. In order to meet the budget allocated for the project, the theatre lighting area has been removed from the scope of the project. Electrical savings for the remaining scope of the retrofit are estimated to be about 73,000 kWhr/yr.

7.6.2 CCS Building

The available funding was found to not cover the costs of upgrading the lights in this building. As such, the lighting upgrade for this building has been limited to replacing all fluorescent tubes with LEDs in the office/classroom wing. This work has been completed in May 2017 and is expected to save approximately 41,000 kWhr/yr.

7.7 Building Optimization Projects

Currently the effectiveness of the LDES is compromised due to Phase I buildings not being able to operate with supply water temperatures appropriate for the LDES. In order to effectively utilize both the heating and cooling capacity of the geothermal system and cooling capacity of cooling towers, upgrades to Phase I buildings on campus need to take place. SIF funding ($1,200,000) has been obtained to complete the upgrades on three buildings that have been identified as requiring upgrades. Smith + Andersen consultants have been retained to provide the designs for these upgrades. Descriptions of these retrofit projects are given in the subsections below. Additionally, the RHS & EME buildings have had their hydronic controls adjusted to allow for larger LDES supply/return water temperatures and reduced flows. Further optimization on these buildings will be completed as resources allow.

Facilities Management
The University of British Columbia | Okanagan Campus
1138 Alumni Avenue | Kelowna BC | V1V 1V7 Canada
Phone 250.807.9272
facilities.ok@ubc.ca

Completion of all of these projects will allow for a lower water return temperature for the LDES. While this is expected to allow for ground water heating, additional heating, most likely from gas-fired boilers may be required to meet required LDES supply water temperatures particularly during periods of high heating demand.

7.7.1 Fipke

An upgrade of the central plant in this building to a 4-pipe system with hot and cold tanks is planned. The tender for this project has been awarded and construction is scheduled to occur during the spring of 2017 to make optimal use of the shoulder heating/cooling season and reduced summertime usage of the building.

7.7.2 UNC

An upgrade of the central plant in this building to a 4-pipe system with hot and cold tanks is planned. The tender for this project has been awarded and construction is planned to occur during the spring of 2017 to make optimal use of shoulder heating/cooling season and reduced summertime usage of the building.

7.7.3 ASC

The VRF system in this building has been identified as being a key limit on the operation of the LDES system. An upgrade of the central plant in this building to a 4-pipe system with hot and cold tanks is planned to address this and other inefficiencies with the current building's heating and cooling system. Additionally, an upgrade to the building's domestic hot water heating system is planned to allow for the building's heatpumps to simultaneously provide domestic water heating and building cooling.

7.8 Cooling Plant Expansion

SIF funding has been received for installation of an additional cooling tower for the LDES system. This tower will increase the air-cooled capacity of the LDES system. This project is required to be completed by March of 2018 as per the SIF requirements. Tenders for this project are currently open.

7.9 Teaching and Learning Centre

The energy team has been involved as a part of the design process for the proposed new Teaching and Learning Centre. The energy team's goal is to ensure that the design and construction of the facility is consistent with the campus Whole Systems Plan in terms of energy targets and sources. Thus far, the energy team has reviewed and commented on the TLC HVAC and District Energy Options Study, the initial TLC Design Brief, the Mechanical Schematic Design and the Mechanical Issued for Permit and Issued for Tender Drawings.

7.10 Portfolio Manager

We are implementing Energy Star's Portfolio Manager as a tool for communicating the energy performance of the campus. Currently all available energy history for the campus has been uploaded to Portfolio Manager. Ways of giving access to a wider audience using this tool are currently being considered. As a part of implementing Portfolio Manager as a tool, strategies for simpler ways to store comprehensive energy use data for the campus are being pursued.

Facilities Management
The University of British Columbia |
Okanagan Campus
1138 Alumni Avenue | Kelowna BC | V1V 1V7 Canada
Phone 250.807.9272
facilities.ok@ubc.ca

7.11 Peak Load Management

Electricity costs for the campus are a mixture of charges for energy consumption (kWhr) and peak demand (kW). As such, reducing electrical demand at peak times can have significant impacts on campus energy costs. This project is currently being pursued as a partnership between SES consultants and Siemens to develop and implement peak load management algorithms. The project is currently underway and expected to be completed in the next several months.

Further peak load management strategies are planned as further resources are available and will be adjusted based on experience gained from implementation of the initial measures.

7.12 Recommissioning HVAC Systems

The energy team's BMS Technician has been systematically recommissioning campus HVAC systems. Active and passive methods were used during recommissioning of systems in the UNC, CCS and EME buildings to ensure uninterrupted user comfort. Lists of failed equipment and recommended adjustments to setpoints and schedules have been generated and remedial actions have either been completed or logged for action. Some specific examples of significant gains are:

- EME HRV-4 is now scheduled to run during normal building operating hours; estimated annual savings of 260,000kWh and 212GJ of Gas.
- UNC AHU-4 rescheduled to run only during utilized hours; estimated annual savings of 29,700 kWh and 27GJ of Gas.

It is noted that there has been a lack of operations capacity to carry out all necessary repairs. The new HVAC Efficiency Technician position was created in order to partially address this capacity issue. The technician will initially be focused on cleaning heat exchangers in order to improve system efficiencies.

7.12.1 Carbon Dioxide Sensor Calibration

Carbon dioxide sensors are used in various locations across campus to ensure occupants receive good indoor air quality (IAQ) by increasing ventilation rates on demand. Numerous carbon dioxide sensors across campus are slated for recalibration or replacement. Recalibration of sensors that have drifted high and are bringing in more outdoor air than necessary will result in energy savings.

Facilities Management
The University of British Columbia | Okanagan Campus
1138 Alumni Avenue | Kelowna BC | V1V 1V7 Canada
Phone 250.807.9272
facilities.ok@ubc.ca

8 Future Projects

The following is a list of projects that are currently being investigated for potential future implementation.

8.1 Cold Weather Operation Upgrade

During this past year, periods of weather that were significantly colder than recent experience occurred. During these periods, significant increases in gas consumption were noted. Upon further investigation, it was found that during cold weather, buildings were being put into occupied mode overnight which increased outdoor air rates during cold weather and correspondingly increased energy consumption. This mode of operation was implemented due to concerns over maintaining positive building pressurization during cold periods to avoid the risk of building damage due to frozen pipes etc. Controls upgrades that will allow buildings to maintain positive pressurization while minimizing outdoor air rates are being investigated and are expected to be implemented in time for the next heating season. Some of the measures being considered include:

- Adding BMS control to more exhaust fans to allow them to be turned off during unoccupied hours
- Adding building pressurization control capability to the BMS to minimize the outdoor air rates to those required to track the exhaust rates and maintain pressurization

8.2 Fluorescent Tube Lighting Replacement

Due to reduced costs and currently available incentives, replacement of a large number of fluorescent T-8 tubes with LED tubes is currently planned for the spring/summer 2017. Including the FortisBC incentive, 15W LED tubes can be installed for a total cost of about $6/tube. When used to replace a 32W T-8 tube, the cost of the tube is paid back in about a year.

A temporary auxiliary employee has been hired for May and June 2017 to install replacement LED tubes. It is estimated that about 4000 tubes will be able to be installed. The light replacements are expected to occur in the Library, Science and Arts buildings.

8.3 EME DHW Separation from Main Building Boilers

Currently, heating for domestic hot water in this building is provided by the building's main boilers. As a result, these large boilers are required to operate during the summer months in order to provide domestic hot water. A separate dedicated heat source for domestic hot water would be able to operate much more efficiently during summer months. Installation of a new electric water heater is planned for installation during the summer of 2017. To reduce electric energy use, a preheating system that uses heat from the building's heatpumps will be included.

8.4 Science Building Third Floor Heating Upgrade

Heat is currently provided to the third floor of the science building from the central heating plant. Connecting the 3rd floor heating systems to the campus LDES will allow the central heating plant to remain off for longer during shoulder seasons.

Facilities Management
The University of British Columbia |
Okanagan Campus
1138 Alumni Avenue | Kelowna BC | V1V 1V7 Canada
Phone 250.807.9272
facilities.ok@ubc.ca

8.5 Science Building Main Exhaust Fan Variable Frequency Drives

Currently the air is exhausted from the Science building using 3 Strobic exhaust fans. These fans are each driven by approximately 50hp constant speed motors. In order to reduce the amount of exhaust air being drawn through the building, a bypass damper mixes outdoor air into the exhaust stream. Currently, due to the slow response speed of the bypass damper, there is no way to turn off an exhaust fan without causing unacceptably high or low exhaust duct pressurization. Installation of variable frequency drives to these fan motors would allow a fan to be taken on or off-line by gradually ramping up/down its speed to meet the demand.

This project will also enable other projects in the future such as exhaust plume height reduction and improved ventilation flow turn down capability.

8.6 Heat Recovery for AHU 1&2 in Science Building

Currently only a portion of the heat from the main exhaust units in the science building is recovered. This recovered heat is used for tempering outdoor air supplied to the AHU's on the roof. Additional heat recovered could be used to temper outdoor air supplied to AHU-1 and AHU-2 in the basement.

8.7 MDES-LDES Heat Exchanger

Current MDES return water temperatures are too high to allow for maximizing the efficiency of the condensing boilers in the central campus boiler plant. The MDES return water temperature could be reduced substantially using a MDES-LDES heat exchanger to provide heat to the LDES system. Installation and use of this heat exchanger is expected to improve the efficiency of the campus boiler plant by about 10% resulting in about 2000GJ in annual natural gas savings.

Facilities Management
The University of British Columbia |
Okanagan Campus
1138 Alumni Avenue | Kelowna BC | V1V 1V7 Canada
Phone 250.807.9272
facilities.ok@ubc.ca

9 Project Summary

PROJECT	Annual Savings					Start Date	End Date
	$	GJ	kW	kWh	GHG		
SAT Reset	$5,500	400		24,000	20	Mar-2017	May-2017
SAP Reset	$4,400			53,000	1	Mar-2017	May-2017
Increased HP Use	$700	1,700		-166,000	83	Mar-2017	May-2017
WIFI Occupancy	$8,400	500		49,000	25	Mar-2017	May-2017
Load Shed/PDL	$11,000		1200			Feb-2017	May-2017
Recommissioning	$9,200	500		59,000	26		
Science Lab Ventilation Air Audit						May-2017	May-2017
Science Lab Ventilation	$57,200	2600		415,000	134	Jun-2017	Sep-2017
LED replacement of T-8 tubes	$30,200			360,000	4	May-2017	Jul-2017
DHW separation from main boilers	$3,000	1,200		-87,000	59	Jun-2017	Sep-2017
Exhaust heat recovery for AHU 1&2	$46,500	1,500		400,000	79		
Third floor LDES connection	$5,500	900		-26,000	45	Jun-2017	Aug-2017
VFD for Exhaust Strobic Fans	$27,600			328,500	3	Jun-2017	Aug-2017
Admin MAU-7	$9,200	1400		-33,000	70		Complete
Admin & CCS Lighting (LED Upgrade)	$9,600			115,000	1	May-2017	Aug-2017
Fipke Plant Upgrade	$2,200	1,200		-96,000	59	May-2017	Aug-2017
UNC Plant Upgrade	$1,500	800		-64,000	39	May-2017	Aug-2017
Arts & Science Plant Upgrade							
MDES/LDES Hx connection	$17,200	2,000			100		
MDES pipe expansion & boiler upgrade							
Summary of projects	$250,000	14,700	1,200	1,300,000	748		

10 Post Building Commissioning Presentation

The following is a presentation prepared for a requested presentation to the UBCO senate regarding how buildings on campus are commissioned post-occupancy.

Energy Team Priorities for FY 2017-2018

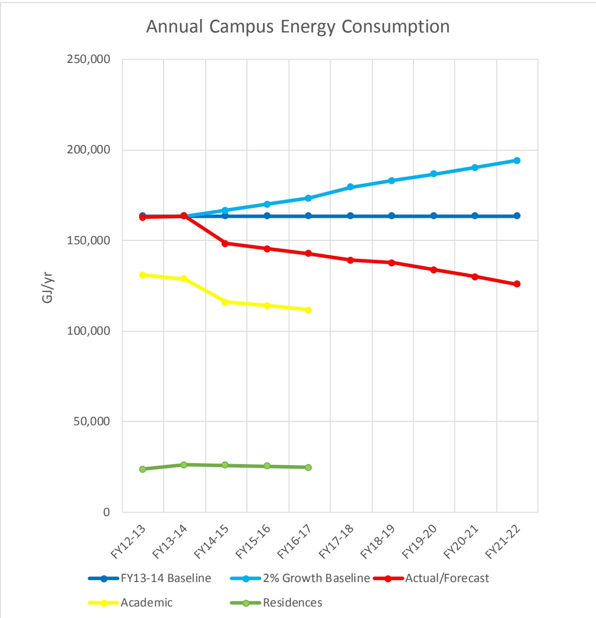
- Maintain energy conservation measures in existing campus facilities to yield energy cost savings
- Emphasize the importance of controlling energy creep during campus expansion and intensification
- Provide input to help ensure new projects are built to meet future requirements and minimize risk of costly future retrofits
- Continue to meet annual energy savings targets of 500,000 kWhr electricity and 3000 GJ of natural gas
- Reinvesting savings from energy conservation into further energy conservation measures

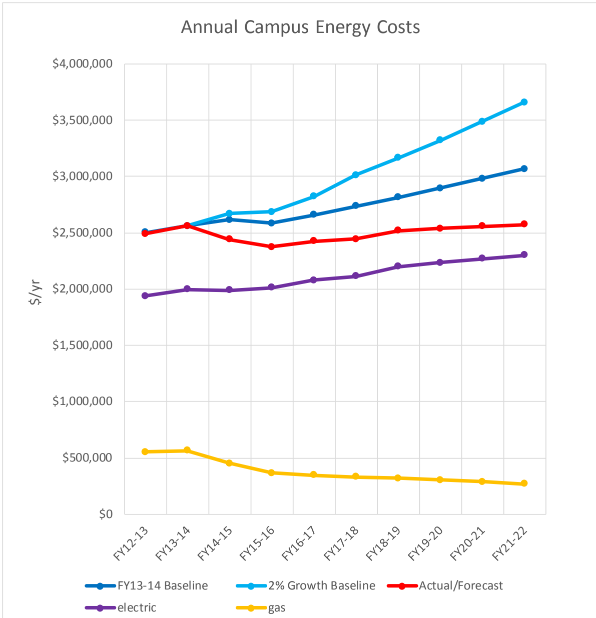
a place of mind
THE UNIVERSITY OF BRITISH COLUMBIA

Facilities Management
The University of British Columbia |
Okanagan Campus
1138 Alumni Avenue | Kelowna BC | V1V 1V7 Canada
Phone 250.807.9272
facilities.ok@ubc.ca

Energy Team Highlights from FY 2016-2017

- Participated in Development of Whole Systems Infrastructure Plan
- Formed Energy Team as a part of the WSIP
- Developed 5-year implementation plan
- $150,000 bundle of energy projects expected to provide:
    - $105,00 in external rebates
    - $130,000 per year of utility cost savings
- Pursued energy savings through synergies with other projects (ie routine capital, SIF, AVED, etc), total projects completed expected to result in savings of $200,000 per year
- Continued campus energy use intensity improvements (EUI)

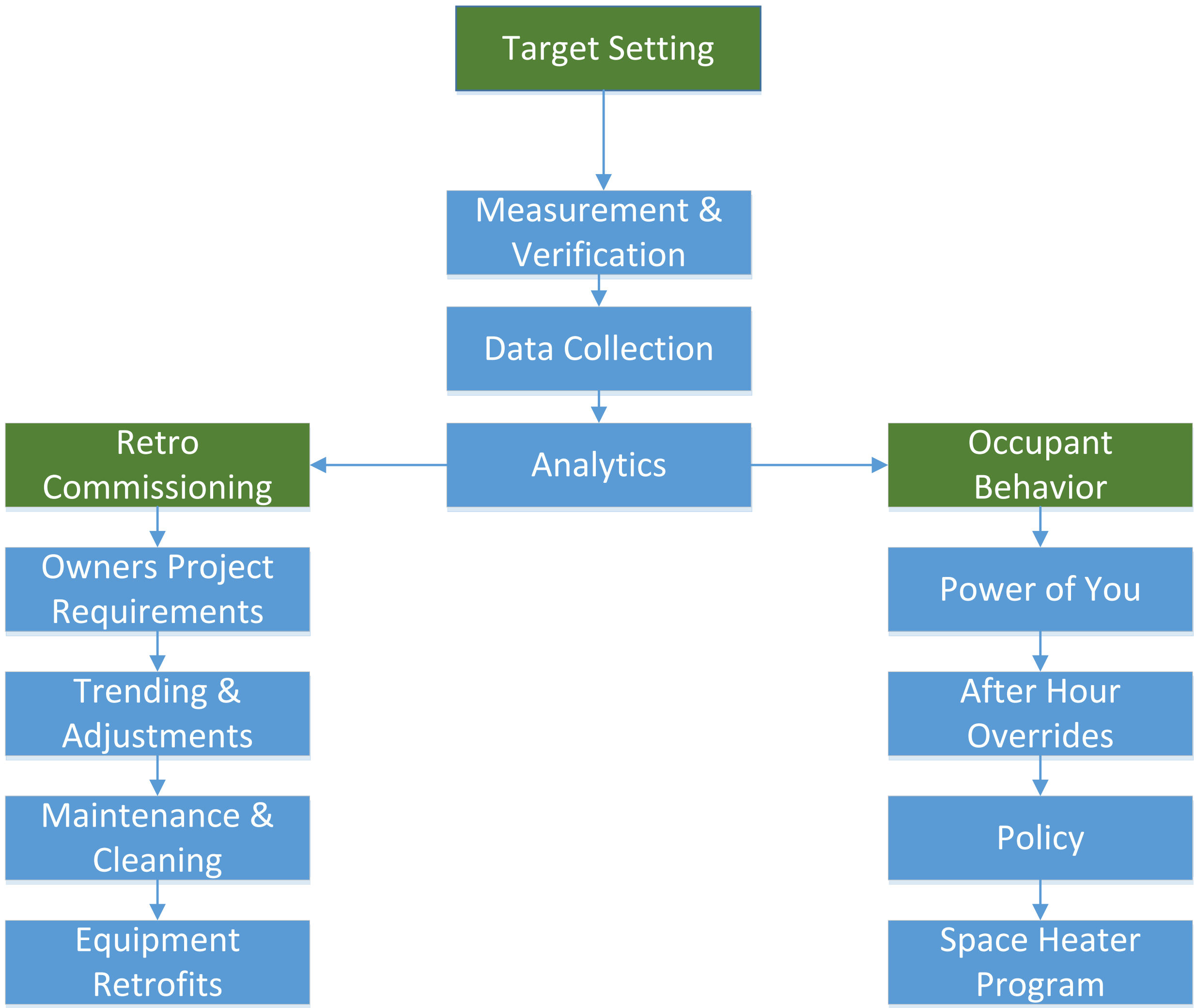




a place of mind
THE UNIVERSITY OF BRITISH COLUMBIA

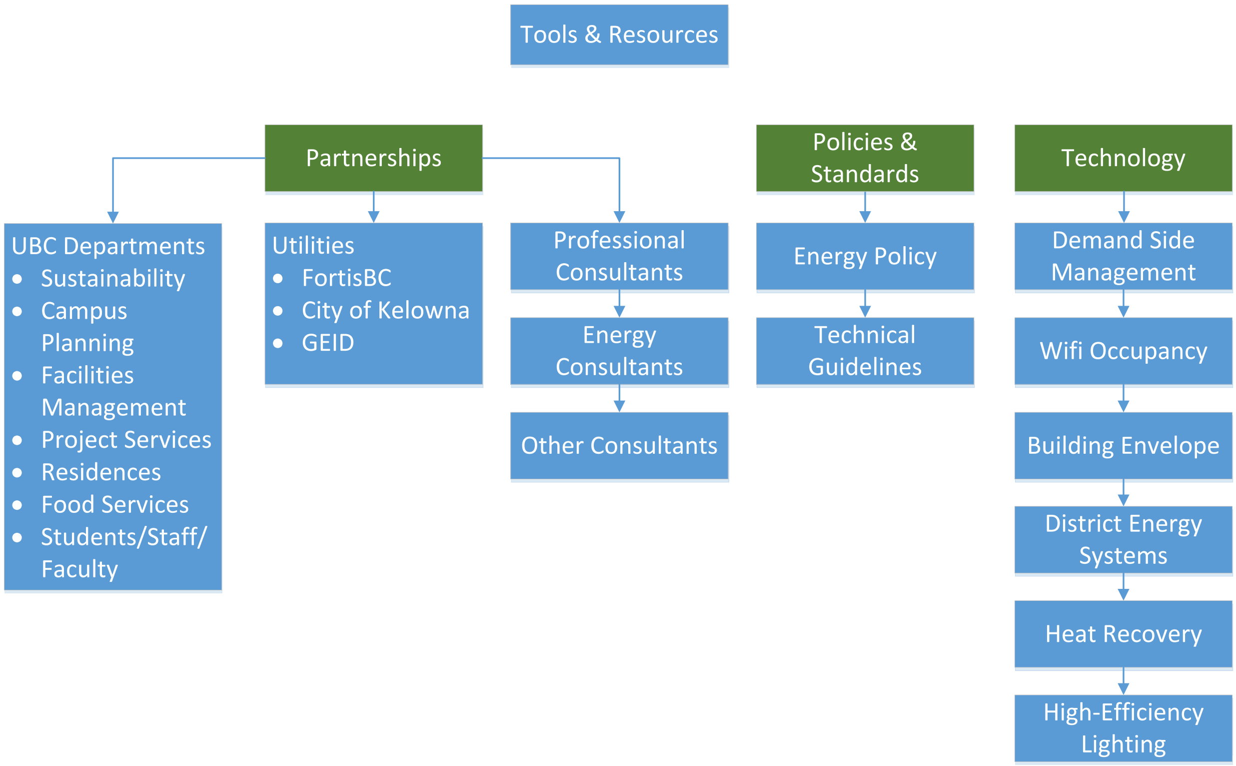
Facilities Management
The University of British Columbia |
Okanagan Campus
1138 Alumni Avenue | Kelowna BC | V1V 1V7 Canada
Phone 250.807.9272
facilities.ok@ubc.ca

Post-Construction Building Energy Optimization Process



a place of mind
THE UNIVERSITY OF BRITISH COLUMBIA

Facilities Management
The University of British Columbia | Okanagan Campus
1138 Alumni Avenue | Kelowna BC | V1V 1V7 Canada
Phone 250.807.9272
facilities.ok@ubc.ca



Energy Lessons Learned

- Continuous monitoring allows rapid identification of issues
- Commissioning of buildings is an important part of new projects
- Proper commissioning of systems can save significant costs later on
- Total Cost of Ownership is an important metric for evaluating project options

RHS Example -A sharp rise in gas consumption was noted. The cause was a setpoint had reverted back to it's original value after a power outage. The setpoint was reset and the default value was changed. Gas savings of 1407GJ (50% of annual usage)

EME Example – The hot and cold building hydronic water systems were mixing. Cold water was returning to the boilers causing them to prematurely rot. The engineering fix resolved this problem but caused the heating to be now served by the boilers instead of heat pumps. A sharp rise in gas consumption alerted us to this. An engineering solution was implemented resulting in hot water injection from the boilers only when required. Prevented huge gas usage. Great success because new fix means boilers not required at -15C.