UBC Okanagan Energy Operations
Annual Report for FY19-20
April 2019 – March 2020

Report Date June 2020

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Executive Summary

UBC Okanagan energy costs for FY19-20 were roughly flat compared to the prior year at $2.7M. Greenhouse gas emissions were reduced approximately 4% to 1930 tons CO_2/yr mainly due to a reduction in natural gas usage. Energy conservation measures implemented in the past fiscal year received $147 000 in FortisBC incentives.

An updated Strategic Energy Master Plan is currently under development and is expected to be complete in July 2020. In addition, a campus District Energy Strategy is underway and will provide recommendations for the direction of campus district energy systems. Both the SEMP and the DES will provide guidance to the development of a campus Carbon Action Plan with the SEMP estimating the carbon savings possible by reducing energy demands and the DES detailing ways to decarbonize the remaining required campus heating.

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Definition of Terms

BAU: The 'Business as Usual' reference case is the total cost or amount of energy that would be consumed by the campus if the energy use intensity (kWhr/yr/m^2) was maintained constant at the level of a defined reference year. For this report 2013 is generally used as the reference year.

EIR: The 'Energy Input Ratio' is the amount of energy input into the system per unit of energy output. In general, this equates to the inverse of efficiency.

EUI: Energy use intensity is the annual energy consumption of a building per unit of floor area. In this report kWhr/yr/m^2 are the units used for EUI.

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

LDES: Low temperature district energy system. One of two district energy loops on campus, this loop distributes ambient temperature water between approximately 5ºC and 30ºC. Heating and cooling for this loop is provided by boilers, geo-exchange water and cooling towers.

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

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1 Energy Operations Department

The need for a campus energy team was identified as a part of the campus Whole Systems Implementation Plan and was initiated in 2016. Previously the Energy Team was a part of the UBC Okanagan Facilities Management department. Beginning in 2019, the team was elevated to be its own department with UBC Okanagan Campus Operations and Risk Management and is now know as Energy Operations.

The Energy Operations Department currently consists of four members:

- Energy Systems Manager
- Energy Specialist
- Building Management Systems Technician
- HVAC Efficiency Technician

In addition, an Energy Analyst has been hired and will join the department by July 2020.

FortisBC has provided funding for the Energy Specialist position 2016. In order to support increased energy management capacity, the Energy Specialist funding is expected to transition to financially supporting two positions: the new Energy Analyst position and elevating the Energy Specialist funding to that of a Thermal Energy Manager.

The goal of the campus Energy Operations Department is to track and reduce campus energy use, costs and GHG emissions. These goals are achieved through developing and implementing:

- Strategic Plans: Strategic Energy Master Plan, District Energy Strategy
- Energy standards and policies
- Energy projects
- System monitoring
- Equipment recommissioning and improved operational efficiencies.

Some of the key tasks 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
- Develop strategies, policies, guidelines and defined project requirements to optimize future campus energy consumption

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- 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.

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2 Overall Campus Energy Performance

Campus energy consumption for FY18-19 totalled 39 700 MWhr. As can be seen in Figure 1 below, electricity accounted for the majority of energy consumed on campus. Furthermore, electricity is more expensive than natural gas. Average electricity costs were $78.97/MWhr last year compared to $34.56/MWhr for natural gas. As a result, electricity accounted for over 85% of campus utility costs. While natural gas has a lower cost per unit of energy, its GHG emission factors are eighteen times higher than those of electricity (0.18 tons CO_2/MWhr for gas versus 0.0026 tons CO_2/MWhr for electricity). As a result, about 95% of campus GHG emissions are the result of natural gas consumption. The low emission factor used for electricity is due to electricity supplied to UBC Okanagan mostly being sourced from hydroelectric generators. Note also that the emission factor currently used for the FortisBC electric grid is much lower than that for BC Hydro.

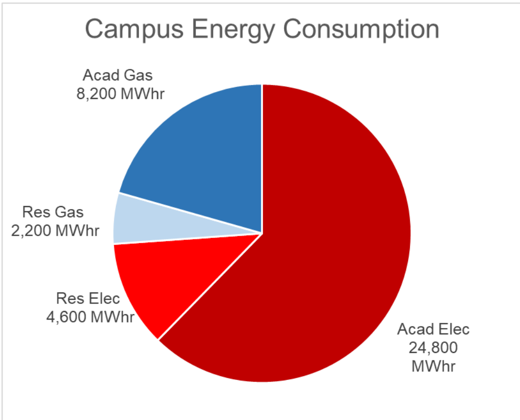

Figure 1: Campus Energy Consumption by Source

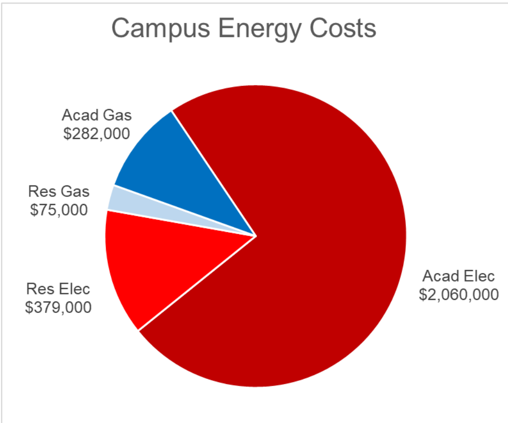

Figure 2: Campus Energy Costs by Source

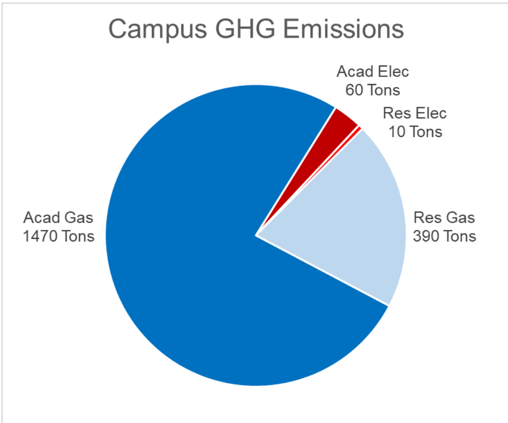

Figure 3: Campus GHG Emissions by Source

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A quantitative model of the dependence of campus energy consumption on weather has not been developed at present. Qualitatively however, it can bee seen in the figure below that variations in natural gas consumption track heating degree day variations while electricity usage has less dependence on weather variations.

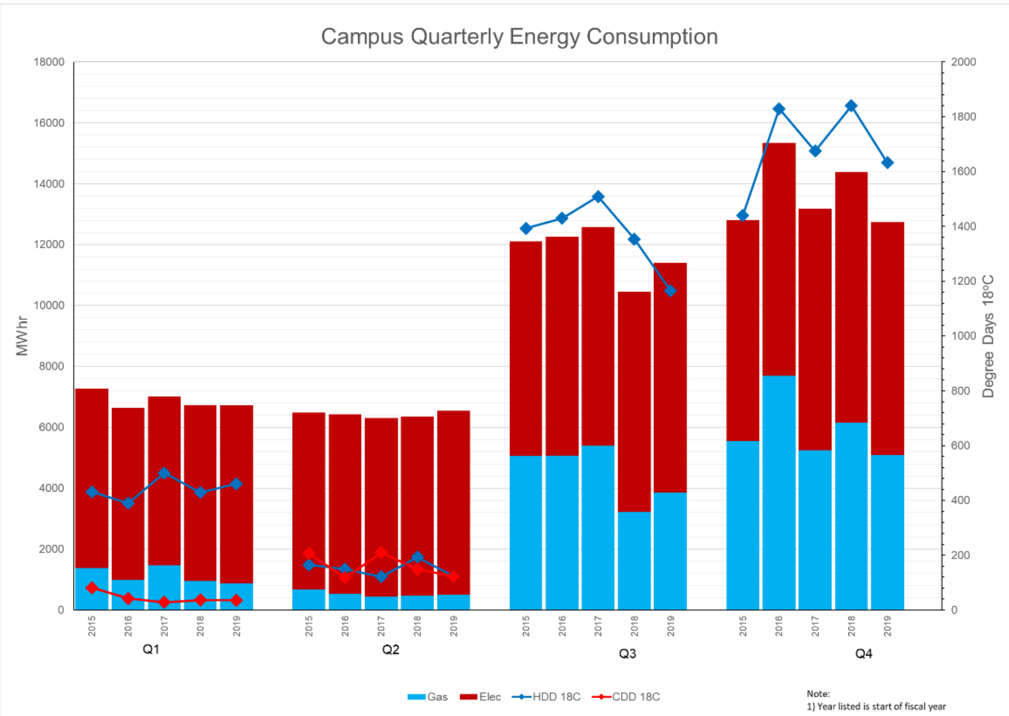

Figure 4: Campus Energy Consumption and Weather Comparison

2.1 Campus Energy Performance Trends

2.1.1 Costs

As shown in the figure below, campus utility costs were roughly flat year over year at about $2.7M. For FY19-20 the average cost of electricity on campus was $78.97/MWhr compared to $80.37/MWhr in FY18-19, a 1.7% decrease. Costs for electricity is a blend of energy consumed and peak demands, the rate stated is a blended rate. Note that provincial sales tax on electricity was eliminated reducing the electricity rate compared to the prior year. The combined decrease in electricity cost rates and an increase in consumption resulted in a slight reduction in electricity costs from $2.35M in FY18-19 to $2.32M in FY19-20.

Natural gas costs have continued to be low compared to historical trends but increased about 5% year over year, rising to $34.56/MWhr in FY18-19 from $33.01/MWhr in FY17-18. These natural gas rates include carbon offset costs. The combined increase in gas cost rates and reduced consumption resulted in gas costs being flat year over year at $357k.

Without energy conservation measures implemented in the last 3 years, it is expected that utility costs would be over $500k higher per year. Approximately $140k of these savings are attributed to projects funded directly by Energy Operations. These savings are shown in light green in the figure below. The remainder of the savings, shown in beige in the figure, are attributed to measures funded by other sources (federal SIF program, BC AVED funding etc) or cumulative measures that are difficult to individually measure such as recommissioning or improved technical guidelines.

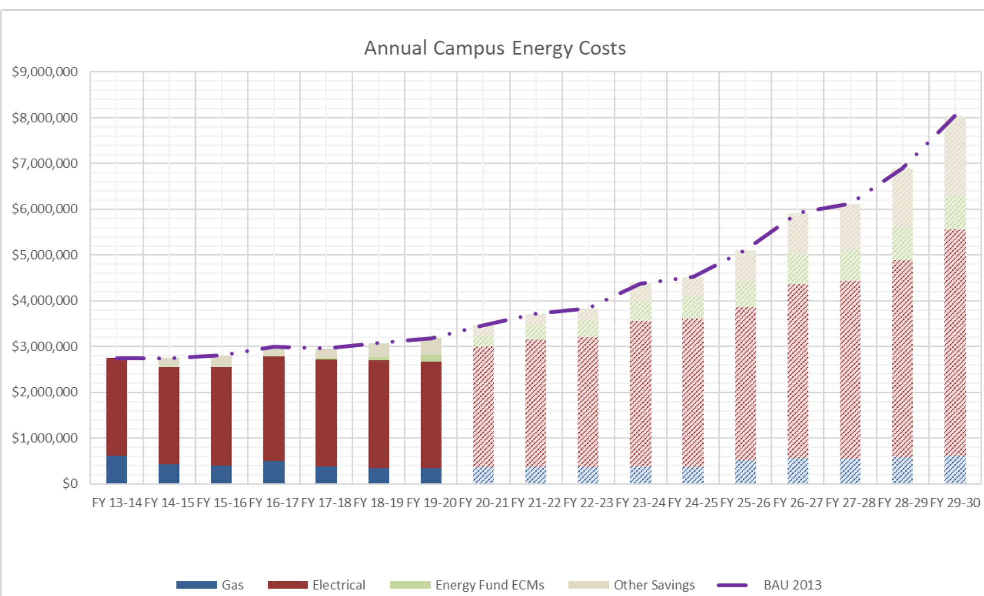

Figure 5: Annual Campus Energy Costs

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2.1.2 Greenhouse Gas Emissions

Campus greenhouse gas emissions were reduced by approximately 4% to about 1934 tons CO_2/yr using current emission factors as calculated by the province. As the majority of campus GHG emissions are due to natural gas usage, these reductions can primarily be attributed to reductions in natural gas consumption. Note that the green and beige sections of the columns are not emissions produced but rather are emissions avoided due to implemented conservation measures.

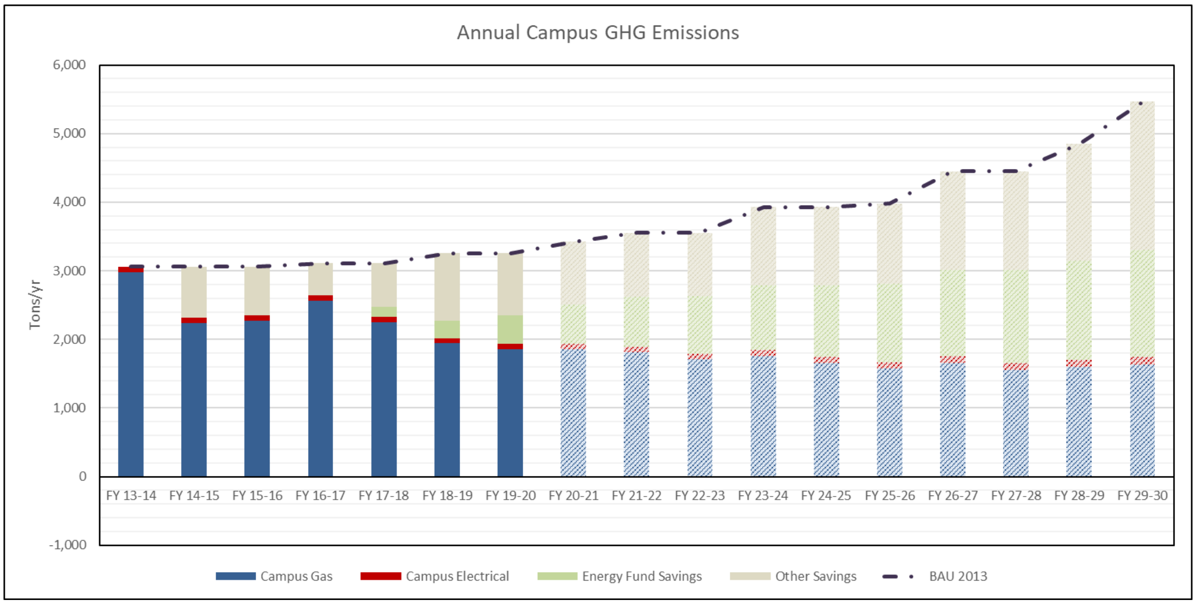

Figure 6: Annual Campus GHG Emissions

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2.1.3 Electricity

Electricity consumption was up about 0.5% year over year to 29 300 MWhr. This increase can be attributed to: campus intensification, new construction and electrification projects that reduced natural gas usage but increased electricity consumption. Increases due to these factors were mitigated by electricity conservation measures such as lighting upgrades.

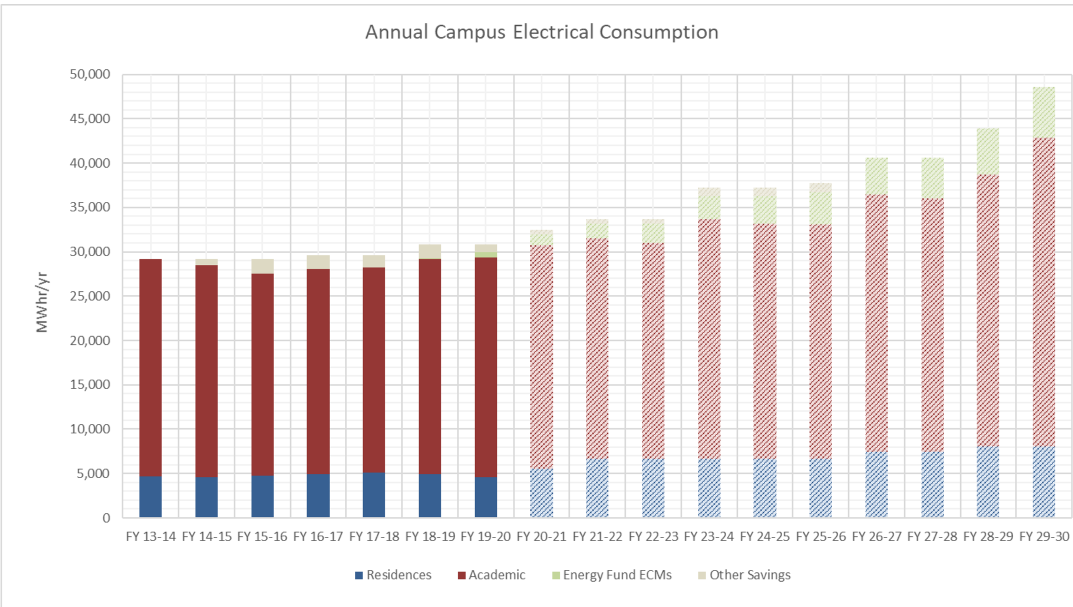

Figure 7: Campus Electricity Consumption Trend

2.1.4 Natural Gas

Consumption of natural gas was reduced from 38 900 GJ in FY18-19 to 37 200 GJ in FY19-20, an 4% year over year reduction.

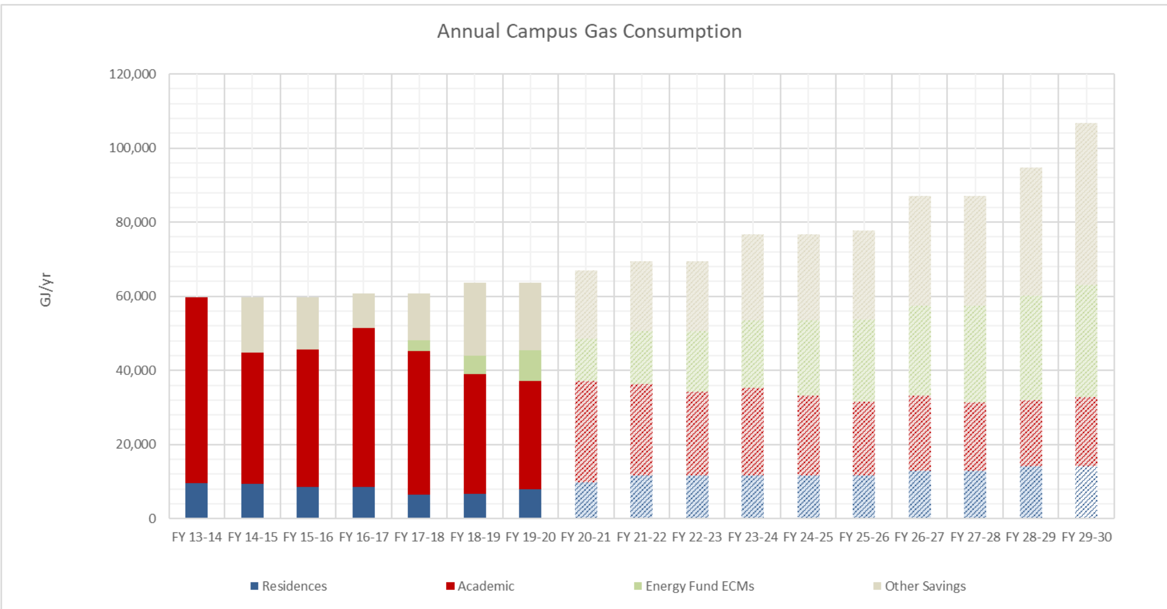

Figure 8: Campus Natural Gas Consumption Trend

The figure below shows the distribution of gas consumption on campus. The consumption consumed within the building is shown separately from the gas consumed by the two campus district energy systems (DES). The DES gas consumption is attributed to the buildings based on relative per building thermal consumption from the DES. As can be seen in the figure, a large fraction, but not the majority, of natural gas consumed on campus is consumed by the district energy systems' plants.

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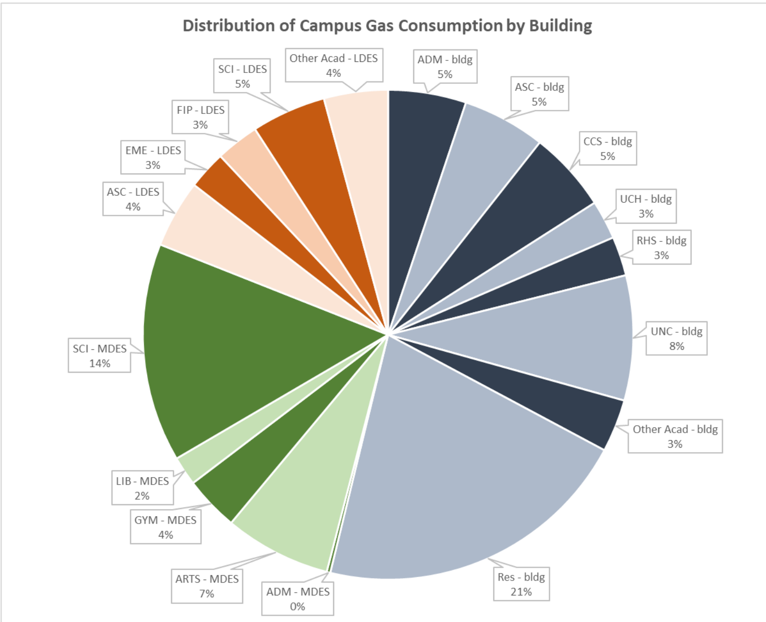

Figure 9: Gas Consumption of DES and Buildings

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2.2 Distribution of Campus Energy Use

Energy use intensity (EUI) is the amount of energy used per unit of floor area. The overall campus EUI was 268 kWhr/yr/m^2 for FY19-20, a 3.6% reduction over the prior year. 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 charts below show the breakdown of EUI per energy source for the campus and individual buildings.

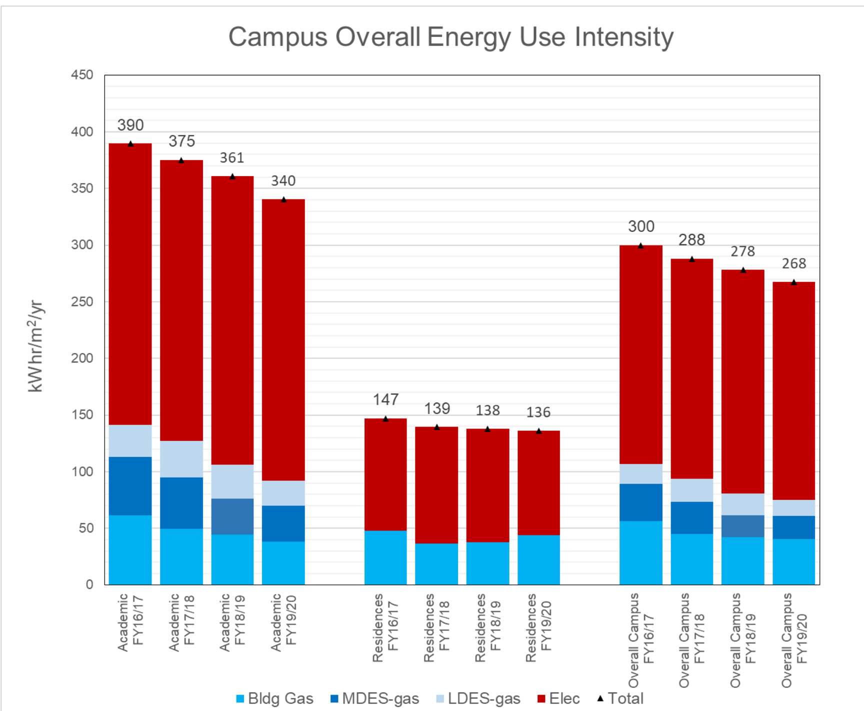

Figure 10: Campus Energy Use Intensities

The average EUI for academic buildings on campus was 340 kWhr/yr/m^2 while it was 136 kWhr/yr/m^2 for residences. For the last three years, the EUI for academic buildings has been reduced by just under 4% per year. For residences, FY17/18 saw an EUI reduction of over 5% while for FY18/19 and FY19/20 the EUI was mildly reduced.

As can be seen in the following figure, the Science building has the highest EUI on campus but has shown significant reductions in gas usage for heating (via both the MDES and LDES). Other energy intensive buildings include Arts&Science, which is also a lab-intensive building as well as UNC which has a commercial kitchen. Due to their lower intensity occupancy and use, residence EUIs are significantly lower than those of academic buildings. The significant drop and subsequent increase in energy use in the Similkameen residence was due to a reduction in ventilation air provided in the Similkameen residence due to broken equipment which was later replaced.

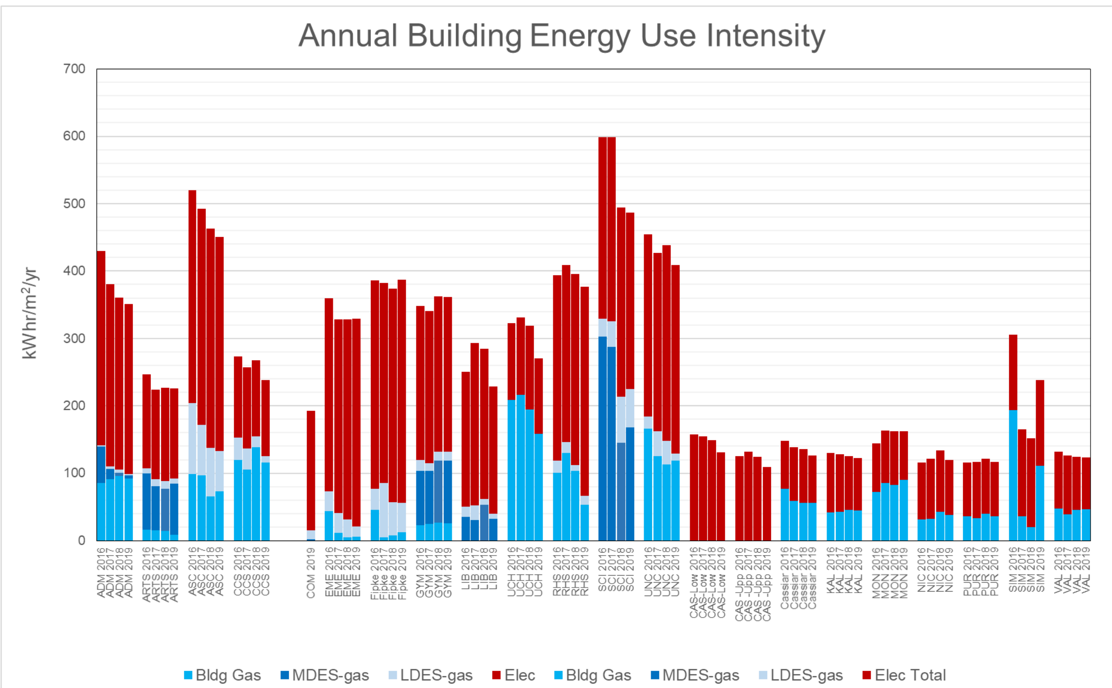

Figure 11: Energy Use Intensity for Campus Buildings

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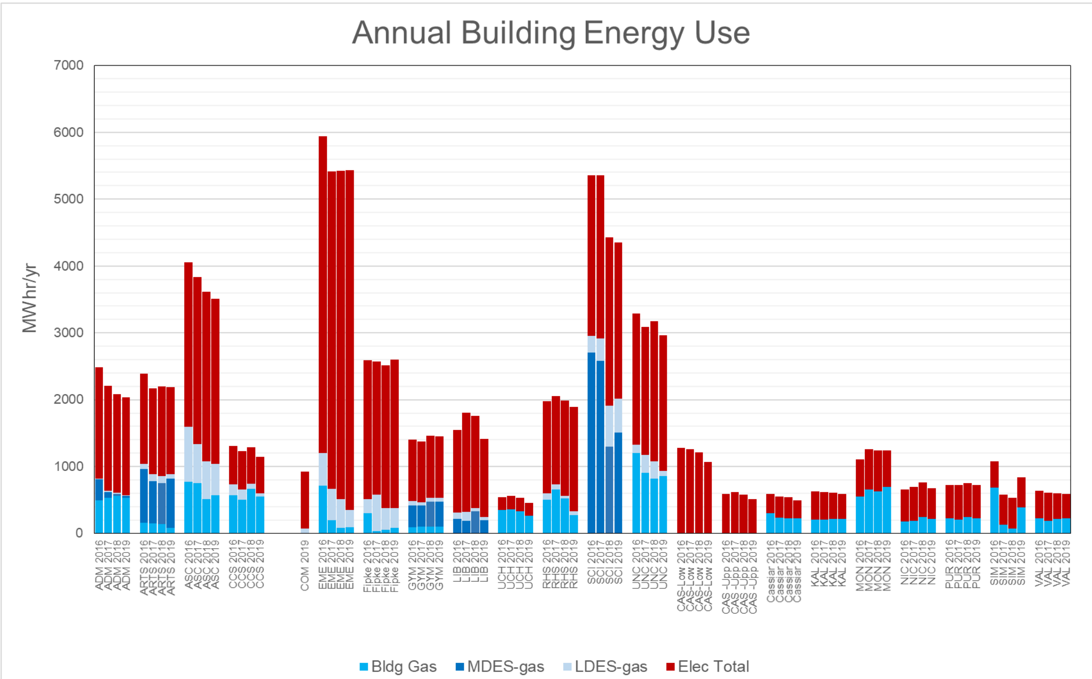

Figure 12: Energy Use for Campus Buildings

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3 Campus District Energy Systems

The UBC Okanagan campus is served by two district energy systems. The characteristics and performance of these systems are described below.

3.1 MDES - Medium Temperature District Energy System

The medium temperature district energy system (MDES) delivers hot water to the five original academic buildings on campus (Admin, Arts, Gym, Library and Science). Heat is supplied to the system from boilers in the central heating plant. While some of these boilers are high-efficiency condensing units, their efficiencies are compromised due to the high water temperatures required by the buildings that the system serves. However, there is now a thermal connection between the campus medium (MDES) and low (LDES) temperature district energy systems. By using the MDES return water as a heat source for the LDES, colder water can be returned to the boilers in the central heating plant, increasing their efficiencies. This system was installed in the fall of 2019 and operating parameters and strategies are still being optimized.

Significant heating loads have been transferred off of the MDES and onto the LDES in the last several years to take advantage of the higher efficiency of the LDES system. As can be expected, these load shifts have reduced both the thermal loads on the MDES as well as the gas consumed by the central heating plant. Note that due to the MDES/LDES connection, some of the gas consumed in the central heating plant can now associated with the LDES.

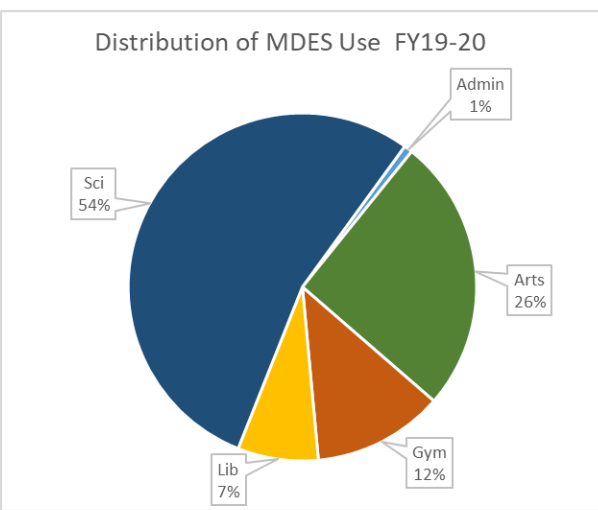

Figure 13: MDES Building Loads

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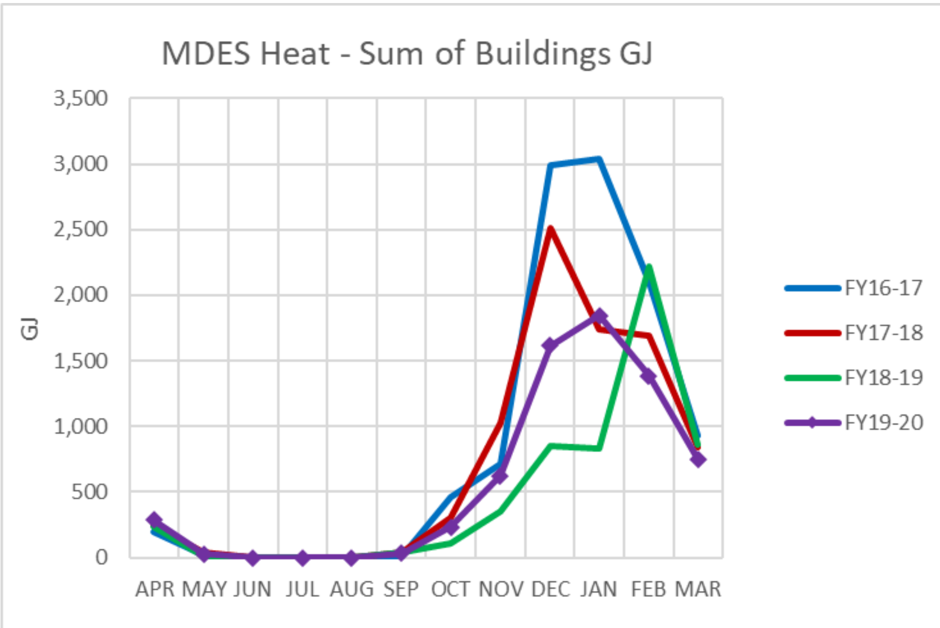

Figure 14: Thermal Energy Delivered by MDES

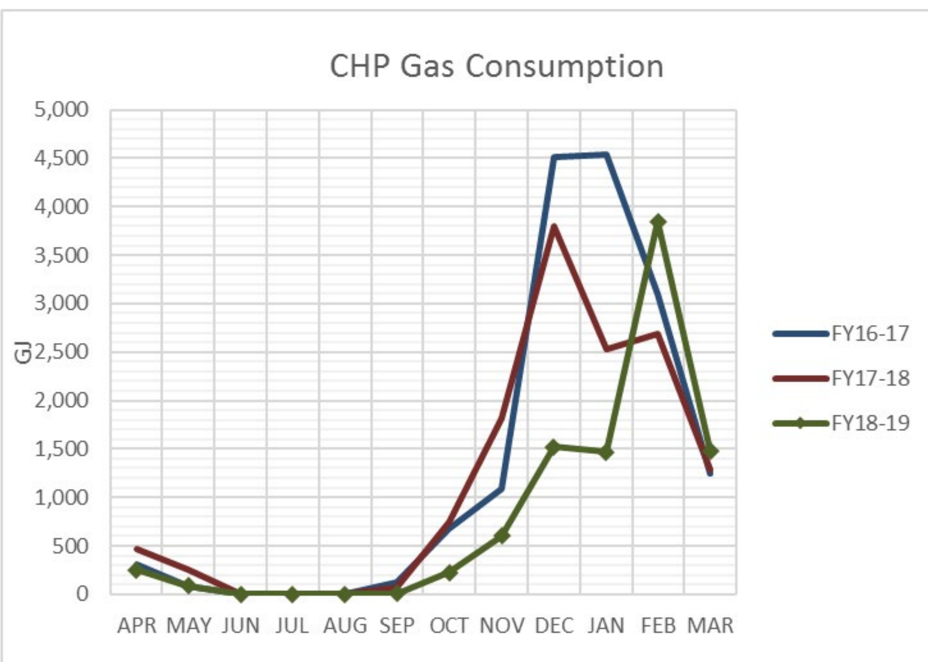

Figure 15: MDES - Central Heating Plant Gas Consumption

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3.2 LDES - Low Temperature District Energy System

The low temperature district energy system (LDES) on campus currently delivers roughly ambient (8ºC-25ºC) water to most academic buildings on campus. Heatpumps within the building can use this ambient temperature water as a source for either heating or cooling. For heating, at the present time all buildings connected to the LDES also have independent boilers or MDES connections for supplemental and backup heating. Several buildings that are connected to the LDES utilize the system for heating only and use building-level chillers for cooling.

The figure below shows the amount of heating/cooling used from the different LDES sources in FY19-20. In the figure, the energy amounts shown as "Shared" account for heating/cooling that the LDES plant did not need to generate due to heat being transferred between buildings when some buildings are in cooling whilst others are in heating and vice versa. This shared energy results in a savings as the central LDES plant does not need to generate the heating/cooling. The "Shared" values shown however do not account for heating/cooling diversity within buildings. For example heat extracted from a data centre and reused within a building would show up as a reduced building heat load whereas if the heat was transferred into the LDES loop and used by another building it would be accounted for as a "Shared" energy source.

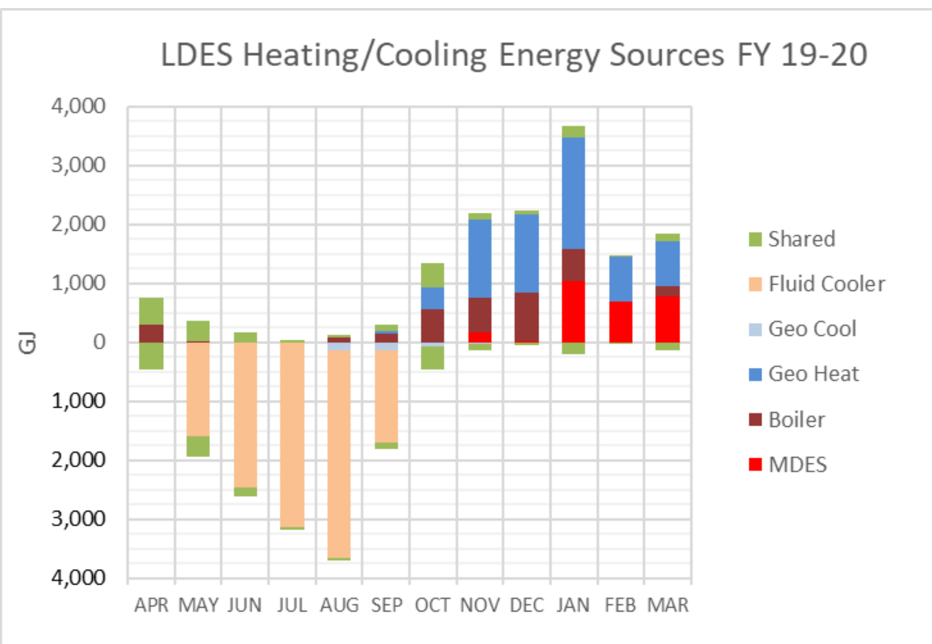

Figure 16: LDES Heating and Cooling Sources FY18-19

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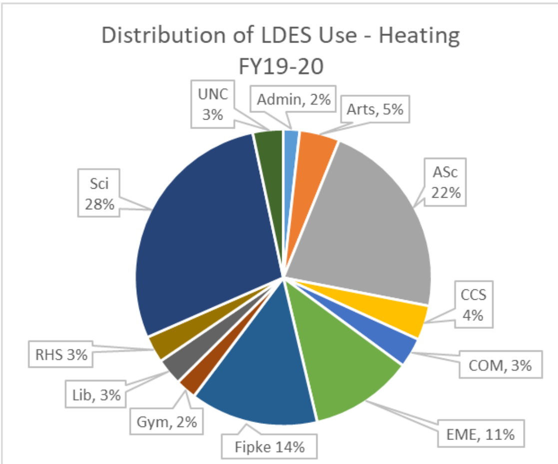

Figure 17: LDES Building Heating Loads

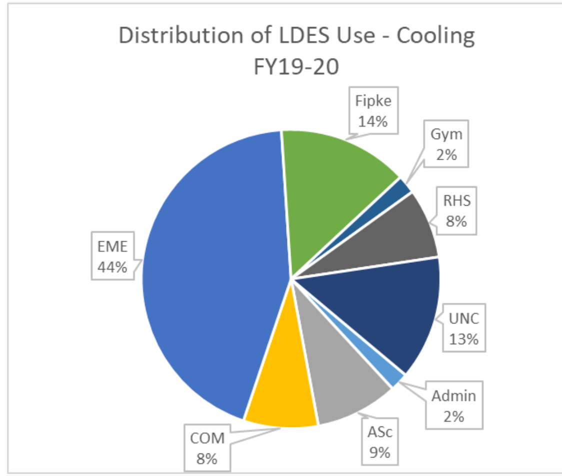

Figure 18: LDES Building Cooling Loads

3.2.1 LDES – Heating

Heat is provided to the LDES from: a heat exchanger connection to the central heating plant, a high-efficiency condensing boiler and a geo-exchange groundwater system. Due to the water temperature requirements of a number of buildings, the LDES return water temperature has historically been too warm to utilize groundwater heating. However, upgrades in limiting buildings have been completed that allow for return water temperatures compatible with utilizing groundwater as a heat source. The amount of heat extracted from groundwater is shown in the figure below. As can be seen in the figure, over 1800GJ of heat was extracted from groundwater in January 2020. The amount of heat extracted from groundwater before January was limited by high LDES return water temperatures. After January the heat extraction was reduced due to capacity limits with the groundwater injection system. It was found that the flow rate of water that the injection system could handle declined over time as the system was used continuously. A study and pilot project on ways to increase the capacity of the system was completed over the winter. Unfortunately it found that feasible options to increase capacity are likely limited.

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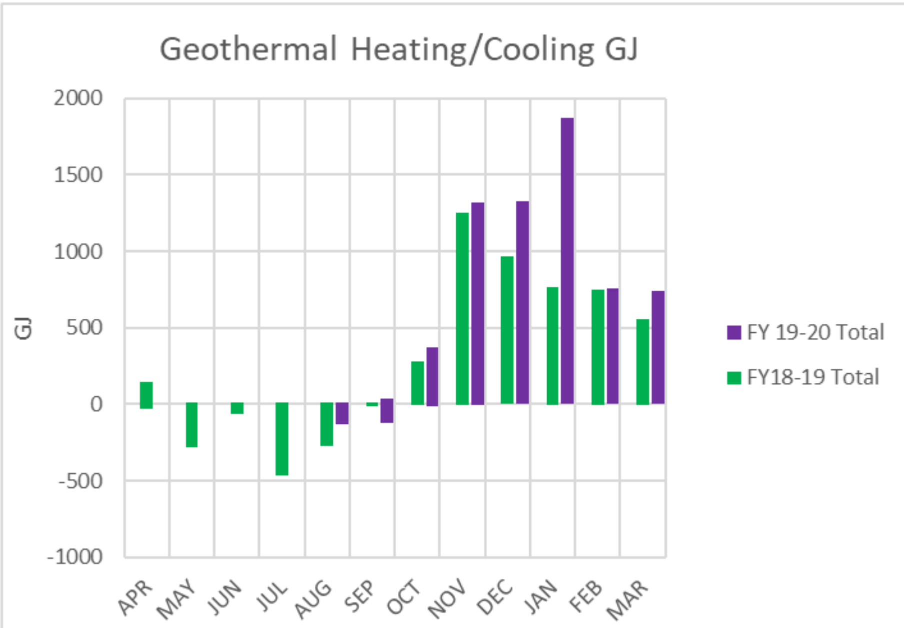

Figure 19: Quantities of Heat Extracted From Groundwater

Utilization of groundwater heating requires electricity use in order to run the required pumps. The figure below shows the amount of electricity used by the required pumps as a fraction of the amount of heat extracted (or heat injected during the cooling season) from the groundwater. This value is defined as the Energy Input Ratio or EIR. As can be seen in the chart, during the heating season electricity use varied from less than 5% to greater than 15% of the value of heat extracted. Optimization efforts to reduce this ratio are underway. Of particular importance is the LDES return water temperature. The colder the return water temperature is, the more the groundwater can be cooled before being returned to the ground and correspondingly the greater the amount of heat that can be extracted from a given amount of groundwater. As such, the success of efforts to reduce the LDES return water temperatures from campus buildings can be seen in the reduced EIR in FY19-20 versus FY18-19.

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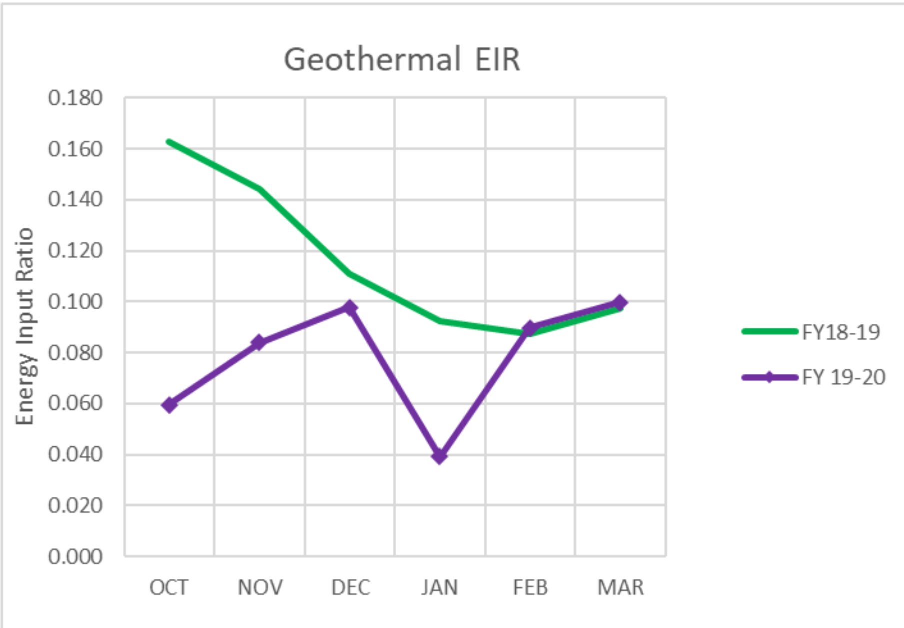

Figure 20: Groundwater Heat Extraction Energy Input Ratio

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3.3 LDES – Cooling

In addition to heating, the low temperature district energy system provides cooling to several academic buildings on campus. Note that not all buildings connected to the LDES utilize the system for cooling, several of the older academic buildings utilize the system for heat only and have air-source chillers to supply their cooling needs.

Cooling loads on the LDES totalled 14 200 GJ for FY18-19, a 14% increase from FY18-19. A large portion of this increase is due to the new Commons building which was not online for the FY18-19 cooling season.

Almost all LDES cooling is provided by cooling towers attached to the system. Groundwater cooling is intentionally limited in order to reduce wear and maintenance on the groundwater extraction and infiltration systems and preserve their use for heating, where a much greater potential for GHG emissions reductions exists. The figures below shows the heat rejected by the cooling towers and their EIR which is defined as the amount of electricity consumed by the towers as a fraction of the amount of heat they reject.

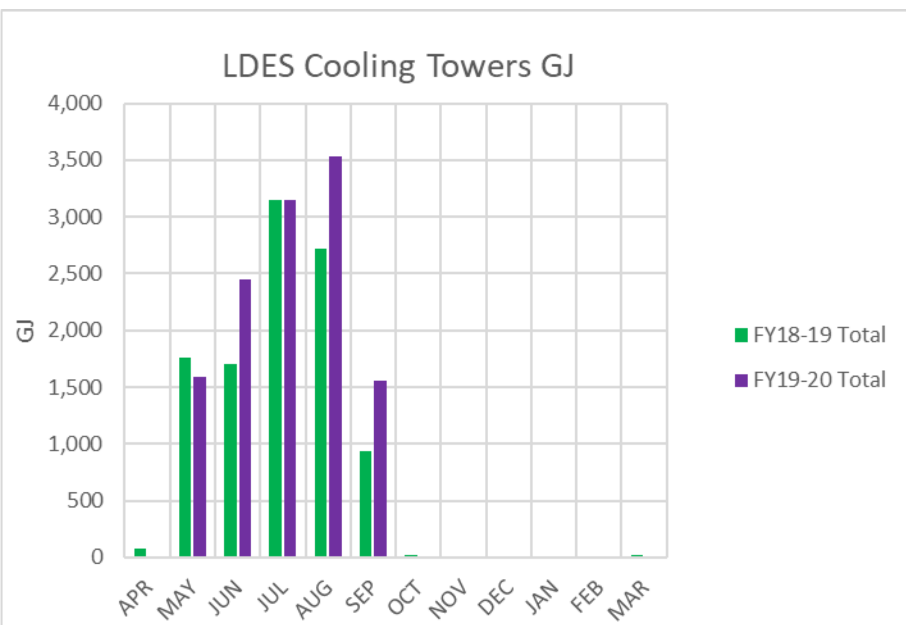

Figure 21: Cooling Towers Heat Rejection

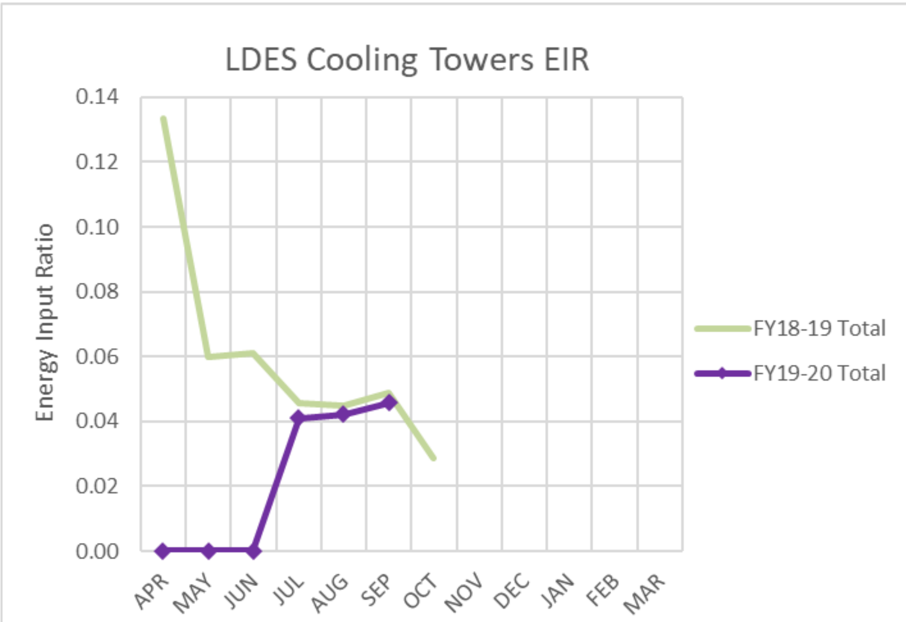

Figure 22: LDES Cooling Towers Energy Input Ratio

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4 Energy Policies and Strategic Development

UBCO Energy Operations is involved with development of strategies for optimizing future campus energy use. In order to set and meet achievable goals the Energy Operations is working on development of campus strategies, technical guidelines as well as requirements for campus projects.

4.1 Campus District Energy Strategy

A strategy to guide possible further development of the district energy systems on the Okanagan campus is under development. The first phase of this project was completed in the fall of 2019 and included a synopsis of the current state and generated a reference case using packaged heating and cooling equipment within buildings. The second phase of this project is expected to be complete in July 2020 and will compare different district energy system options against this reference case. The options being compared include a 4-pipe cold and medium temperature DES, a low temperature DES and a hybrid between the two.

The strategy is intended to guide how district energy systems on campus evolve to meet the requirements of an expanding campus. The strategy considers:

- capital and operational costs
- greenhouse gas emissions
- adaptability to regulatory and technology changes
- phaseability
- resiliency

The District Energy Strategy will inform other plans and strategies such as the campus Climate Action Plan. An update on this section is expected once the DES is presented in July 2020.

4.2 Strategic Energy Master Plan

While the District Energy Strategy evaluates the efficiencies of heating and cooling sources, the Strategic Energy Master Plan (SEMP) evaluates options to reduce loads including heating, cooling and electrical loads. A 5 year SEMP was created in 2016 and again in 2018 with the intention of continuing with updates every 2 years. For the 2020 update a longer 10 year horizon was chosen for the SEMP along with a more detailed look at projects recommended for implementation in the first 5 years. Work on this plan is currently underway and is expected to be completed in July 2020.

4.3 Technical Guidelines

Technical Guidelines are intended to provide minimum standards for campus projects. There are a large number of guidelines that apply to the UBC Okanagan campus. Energy Operations is working to update several that are specific to energy performance and monitoring. Guidelines

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that have been updated so far include: Monitoring Based Commissioning, Indoor Thermal Environment and General HVAC Requirements.

4.4 Owner's Project Requirements

The UBC technical guidelines define minimum standards for all projects on campus as applicable. However, in addition to these generally applicable requirements, there are specific requirements for individual projects; these requirements are highlighted in the 'Owner's Project Requirements' document. Energy Operations is leading OPR creation to ensure that requirements for energy efficiency are met.

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5 Energy Conservation Projects

In order to reduce utility costs, energy consumption and GHG emissions, energy conservation measures (ECMs) are regularly implemented on campus. A summary of the ECM projects completed over the past year is given in the table below.

PROJECT	Cost	Potential External Incentive	Net Cost	Payback	Payback After Incentive	Annual Savings			
						$	GJ	kWh	GHG
Lighting	$50,000	$17,628	$32,372	6.0	3.9	$8,303		100,000	1
Science Ventilation Continued	$60,000	$24,824	$35,176	5.0	2.9	$11,998	753	58,416	38
Infiltration Basin Upgrade Pilot	$50,000		$50,000	4.6	4.6	$10,778	1,500	-41,700	75
LDES Low Flow Pump	$30,000		$30,000	12.0	12.0	$2,491		30,000	0
Data Analytics	$15,000		$15,000						
MDES/LDES Plant Connections	$1,100,000	$11,200	$1,088,800			$5,516	560		
Total FY19-20 $200k Energy Team	$205,000	$42,452	$162,548	6.1	4.8	$33,570	2,253	146,716	114
Total Completed in FY19-20	$1,290,000	$53,652	$1,236,348	32.2	30.9	$40,031	2,813	146,716	114

* Note Residence and New Construction Projects are not including in this table.

Significant financial support for these projects has been made by FortisBC through various incentive programs. When point of sale rebates are included, over $87 000 of energy efficiency incentives were received this past fiscal year. In addition to these rebates $60 000 was received from FortisBC to support the campus Energy Specialist position. An application has been made to FortisBC to transition the Energy Specialist funding to funding for two positions, an Energy Analyst and a Thermal Energy Manger which would increase the FortisBC support for Energy Operations staff to $130 000 per year.

5.1 Lighting Upgrades

Upgrades of campus lighting to LED fixtures is ongoing. The majority of LED upgrades that are believed to be cost effective have been implemented. However, availability of cost-effective LED lamps continues to increase. As this occurs further areas on campus are targeted for upgrades. Upgrades also occur during renovations. LED upgrades completed in the past year are expected to save over 100 000 kWhr per year.

5.2 Science Ventilation Upgrade

Due to the large number of laboratories in the building and their associated high ventilation rates, the Science building is the largest consumer of natural gas on campus (almost all of which is consumed indirectly through both campus district energy systems). Reducing the ventilation rates to avoid unnecessary over-ventilation is a key energy conservation measure. Measures taken to date include:

- Upgrading fumehoods to variable volume control to allow for reduced airflow when the hood's sash is down
- Installation of air quality sensors and controls to adjust ventilation rates based on air quality/chemical contamination
- Add occupancy controls to laboratories to allow for reduced ventilation rates where and when possible

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- Add variable-frequency drives to the building's Strobic exhaust fans.

This project has been ongoing over a number of years as additional measures are implemented as found/funded. Measures completed in the past year are believed to save over 750 GJ of natural gas and 58 000 kWhr of electricity per year.

5.3 Library Data Centre Heat Recovery

The data centre in the Library produces a significant amount of heat year-round and there are plans to expand it. In order to utilize the heat produced by the data centre during cold weather, a hydronic connection was made between the library data centre and the new adjacent Commons (TLC) building's central heating/cooling plant. With this connection, cooling for the data centre will be provided by the Commons' central plant with the heat being available for use in the Commons building. This system is expected to save 480 GJ of natural gas and 53 MWhr of electricity consumption annually.

5.4 Recommissioning of RHS, UCH and EME Buildings

Recommissioning studies for these three buildings were undertaken in order to identify deficiencies in the operation of the buildings that were wasting energy, increasing equipment wear and tear or decreasing occupant comfort. FortisBC covered the full cost of the recommissioning studies. Reports for RHS and UCH have been received and indicate over $50 000 worth of repairs that if implemented are estimated to save $8000/yr in energy costs. The final report for EME is still pending. Once all three reports are received the repairs will be prioritized and completed based on available funding.

5.5 Fortis Residential Efficiency Program

This program involved an energy audit and subsequent replacement of water fixtures and LED lamps where appropriate in the Purcell, Similkameen and Valhalla residences. The audits found that all of the lamps in the buildings that were cost effective to replace had already been replaced. However low flow water fixtures were identified and replaced in order to reduce hot water consumption. The $20 000 cost of this project was entirely covered by FortisBC. Natural gas savings are estimated to be 470 GJ/yr.

5.6 LDES Optimization

Optimizations with the operation of the low temperature district energy system (LDES) have reduced the water flows required in the system during low-load periods. The reductions have been such that the minimum flows in the existing system pumps are often larger than what is required by the LDES loop. In order to reduce pumping energy as well as wear and tear on the large pumps, a smaller pump was installed for use during low load periods.

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5.7 MDES/LDES Connection

The main boilers in the central heating plant are high-efficiency condensing units. However, their efficiencies are compromised due to the high water temperatures required by the medium temperature district energy system (MDES) and the building systems it serves. In addition, the low temperature district energy system (LDES) plant has a primary high efficiency condensing boiler that cannot handle the full LDES heating load. A secondary low efficiency atmospheric boiler in the LDES plant was used frequently to meet the LDES heating loads. This project replaced the low efficiency LDES boiler with a heat exchanger connection to the central heating plant / MDES. As a result, the low temperature heating requirements of the LDES serve to reduce the return water temperature to the central heating plant, increasing the efficiency of its boilers. This system was installed in the fall of 2019 and operating parameters and strategies are still being optimized.

5.8 Data Analytics System Development

Energy data for the campus is obtained from a number of sources including utility bills, manual meter readings and building digital control systems. This data is tracked by a number of linked spreadsheets. Due to efforts to more thoroughly analyze campus energy consumption, these linked spreadsheets have become increasingly complicated and the need for a new system was identified. Additionally, the low temperature district energy system on campus is non-standard in that it provides both heating and cooling to buildings simultaneously through a common ambient temperature loop. A commercial off the shelf data management system that could seamlessly handle the campus LDES was not found. As a result, UBCO Energy Operations has engaged with the UBCO School of Engineering to develop a custom data management system for the campus.

5.9 HVAC System Efficiency Maintenance

UBCO Energy Operations has employed an HVAC Efficiency Technician since the spring of 2017. This technician has been cleaning heat exchangers and other campus HVAC equipment. Improved operational efficiencies were expected and are being noted as the technician has found and cleaned significantly fouled equipment. Trends in the fouling of equipment are being used to optimize cleaning schedules as systems with faster/slower fouling rates are identified.

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6 New Construction Projects

Two new major buildings are currently under construction on campus. Both of these are residence buildings.

6.1 Skeena Residence

The Skeena Residence is a new residence building that is planned to be the first Passive House Certified building on campus. Energy Operations has provided detailed feedback on the design of this building. Completion of this building is expected for the summer of 2020. Based on the expected energy performance, FortisBC incentives of $157k have been approved. Completion of this building is expected in August 2020.

6.2 Nechako Housing Commons

The Nechako building is a new residence building with a large cafeteria and other campus amenities included. While Energy Operations has provided detailed feedback on the design of this building, as a residence building decisions for this building are the responsibility of UBC Student Housing and Hospitality Services. Completion is expected for summer 2021. Based on the modelled energy performance of this building, $167k of FortisBC incentives have been approved.

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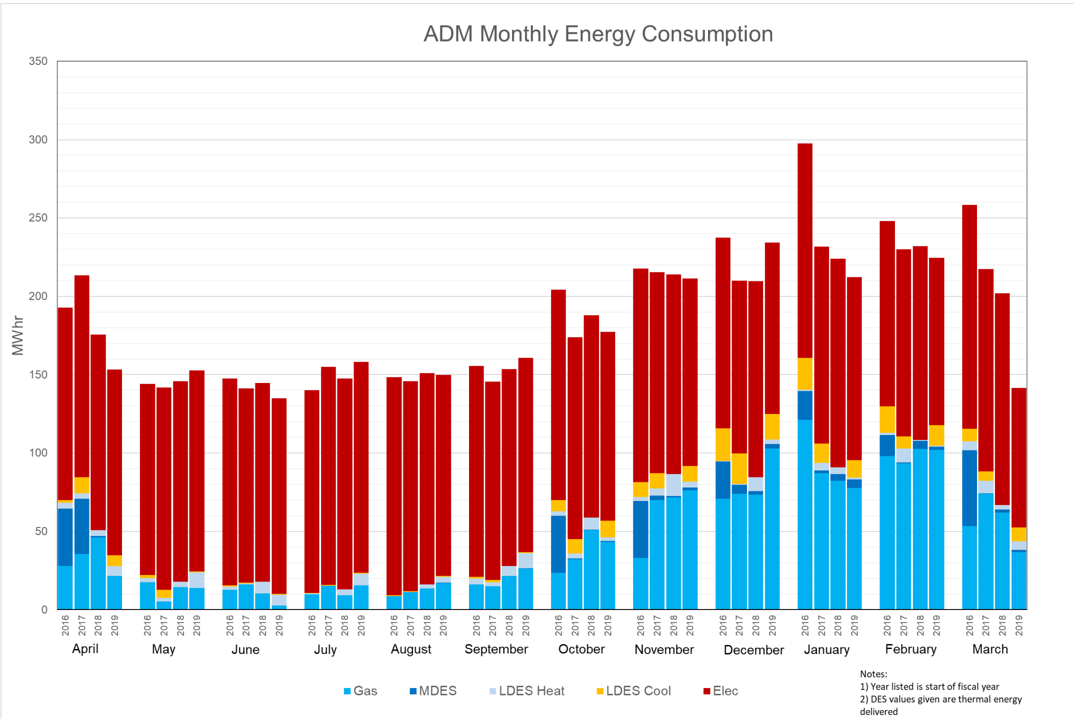
7 Monthly Energy Performance Data for Campus Buildings

7.1 Administration



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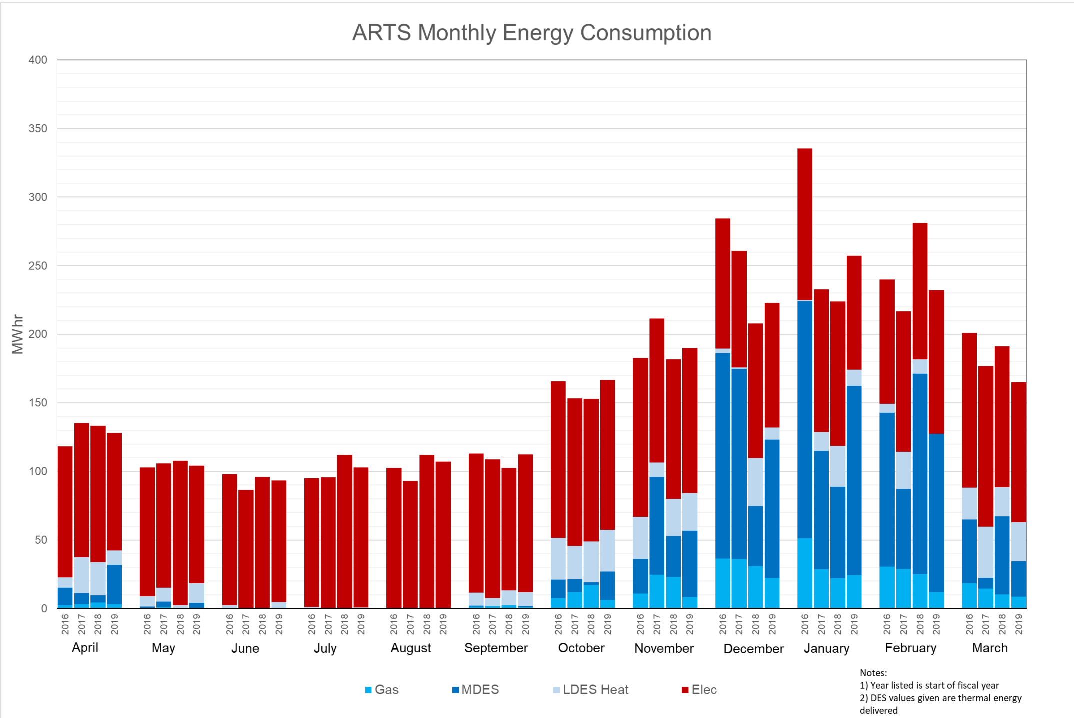
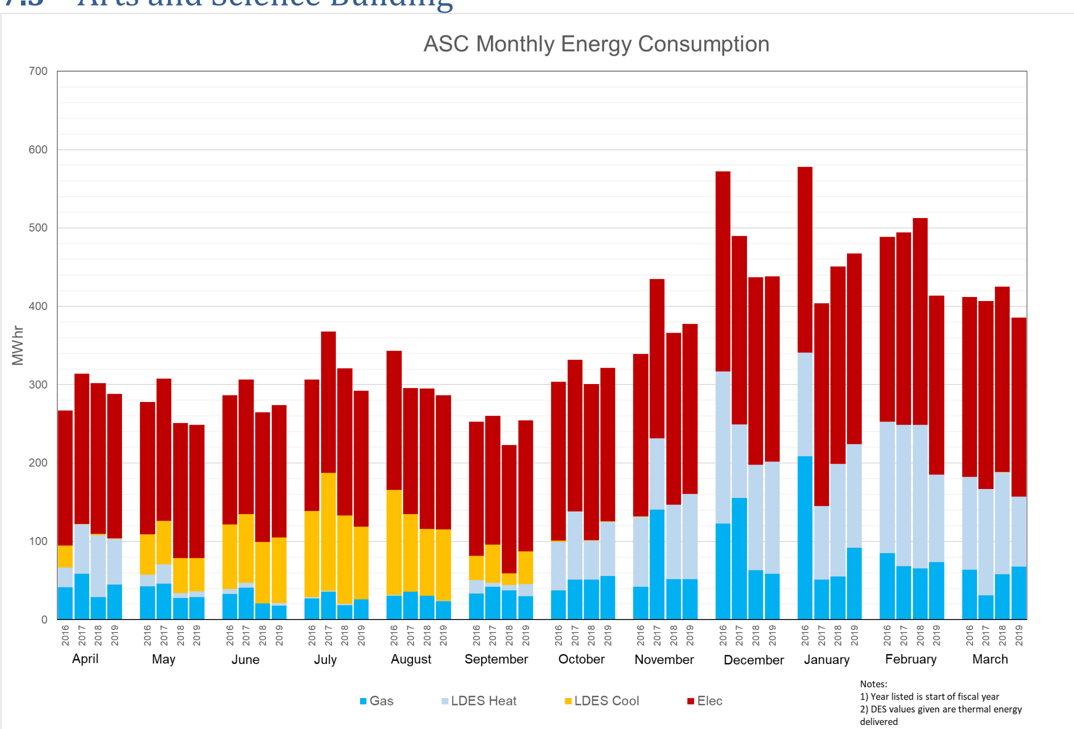
7.2 Arts



7.3 Arts and Science Building



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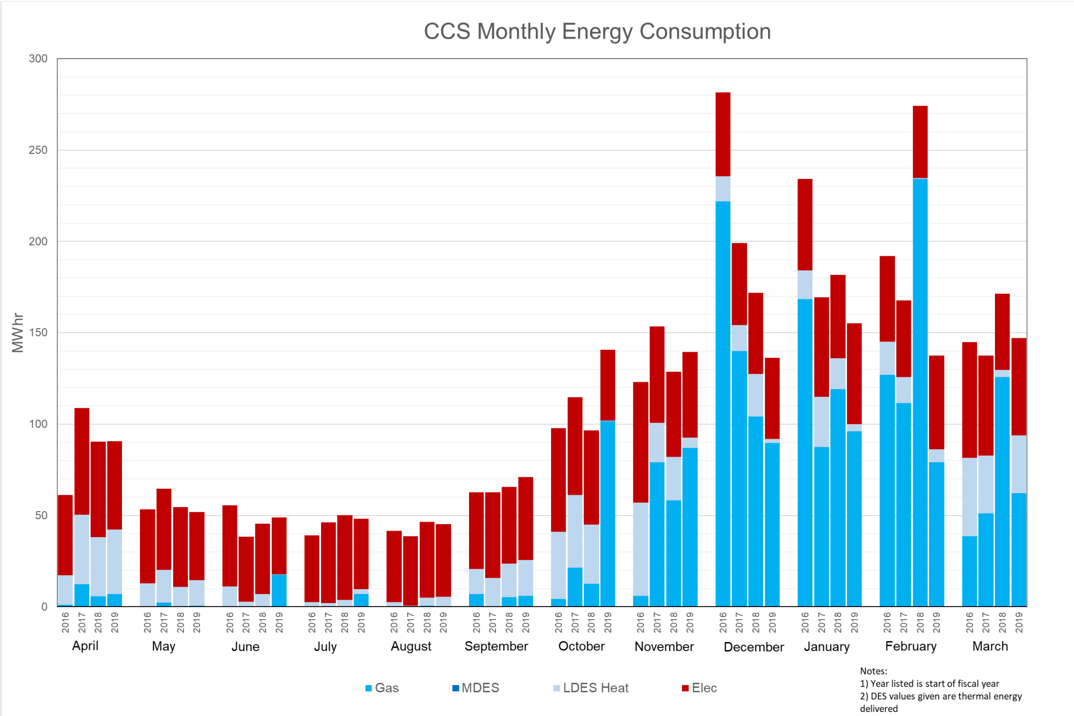
7.4 Creative and Critical Studies



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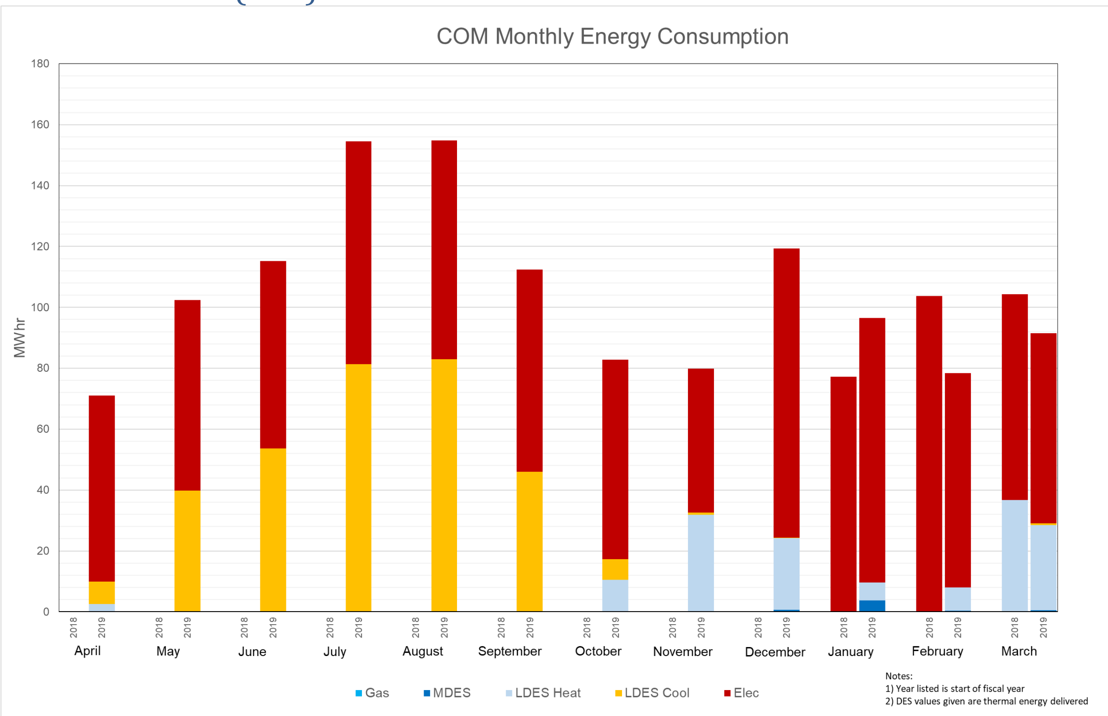
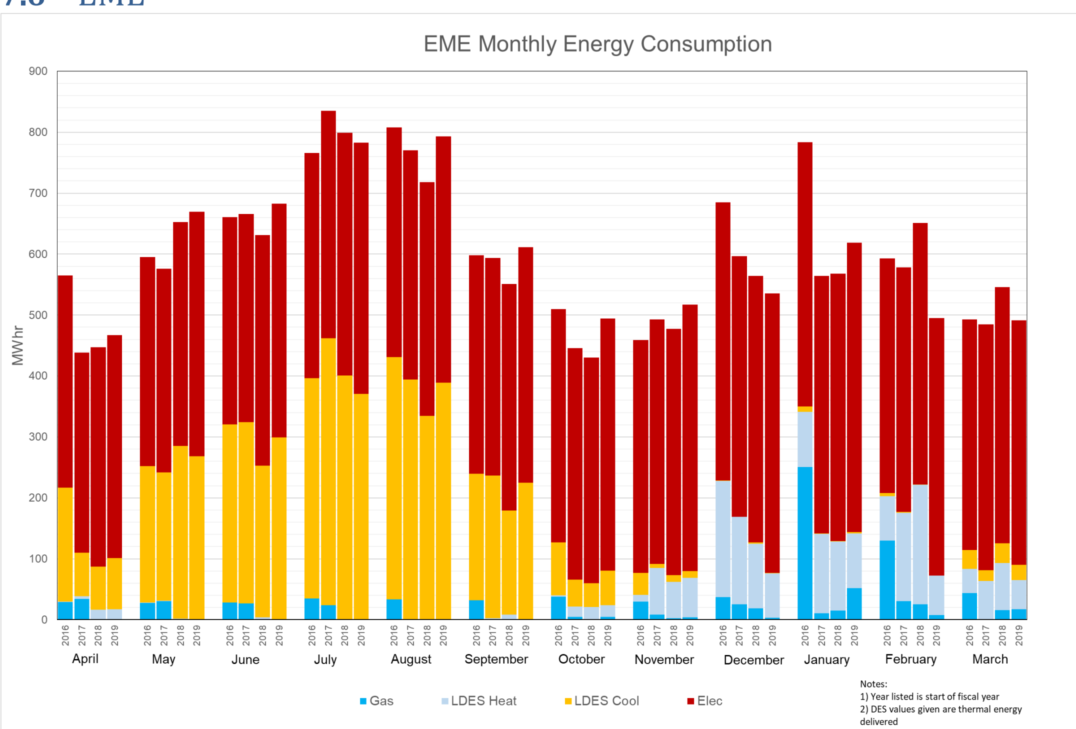
7.5 Commons (TLC)



7.6 EME



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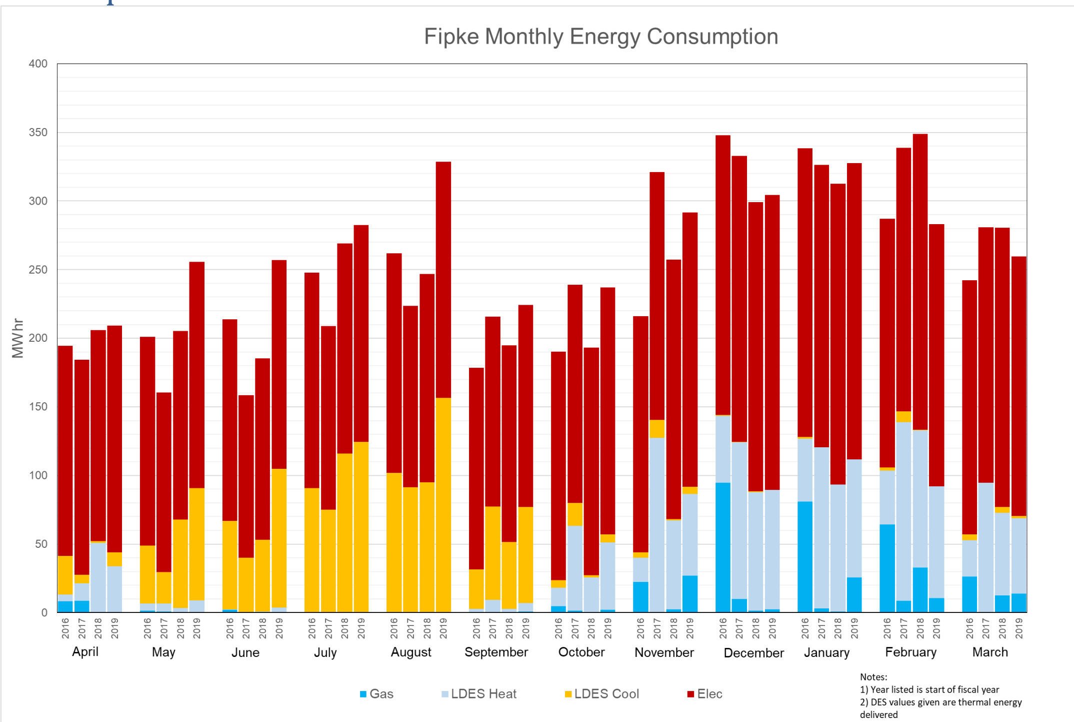
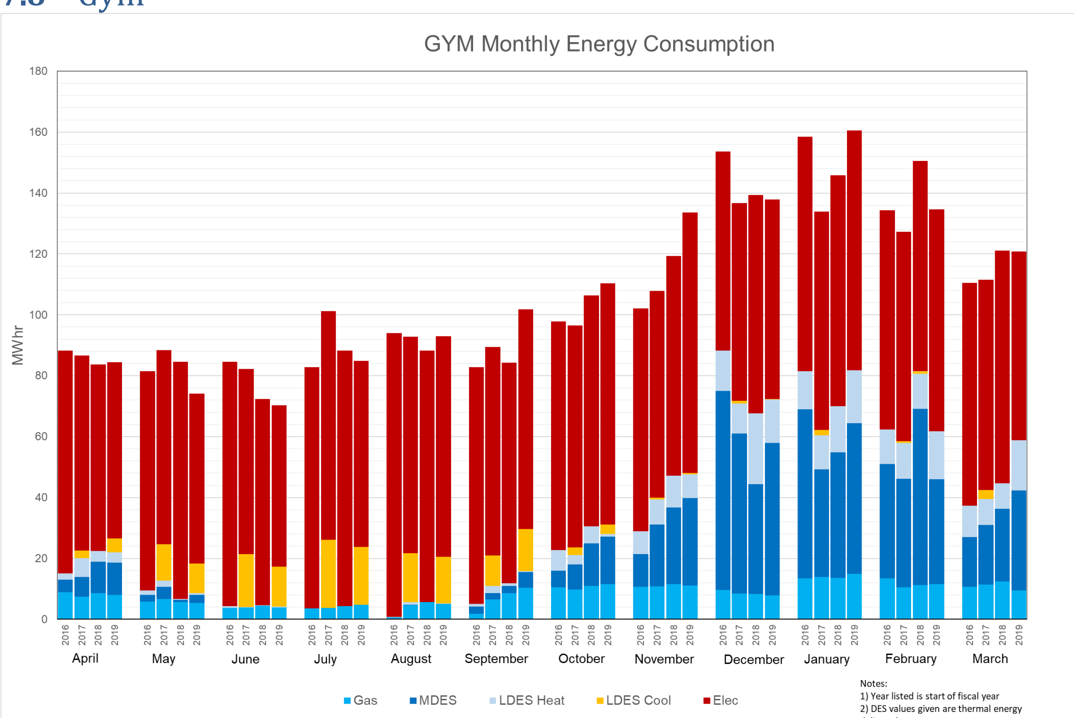
7.7 Fipke



7.8 Gym



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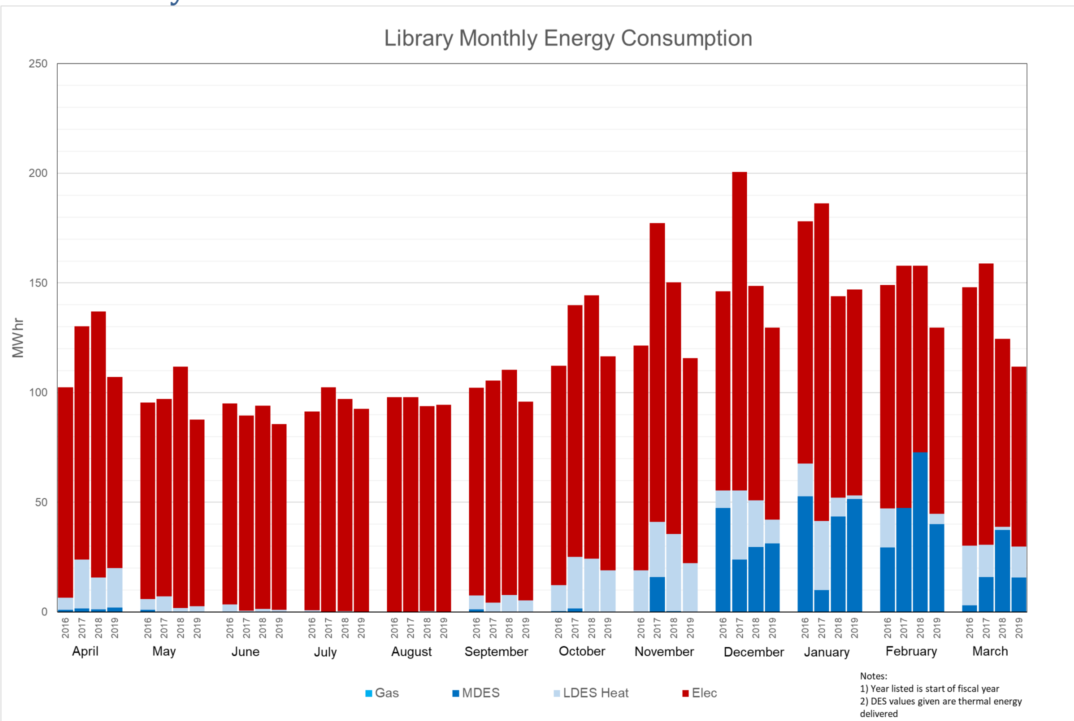
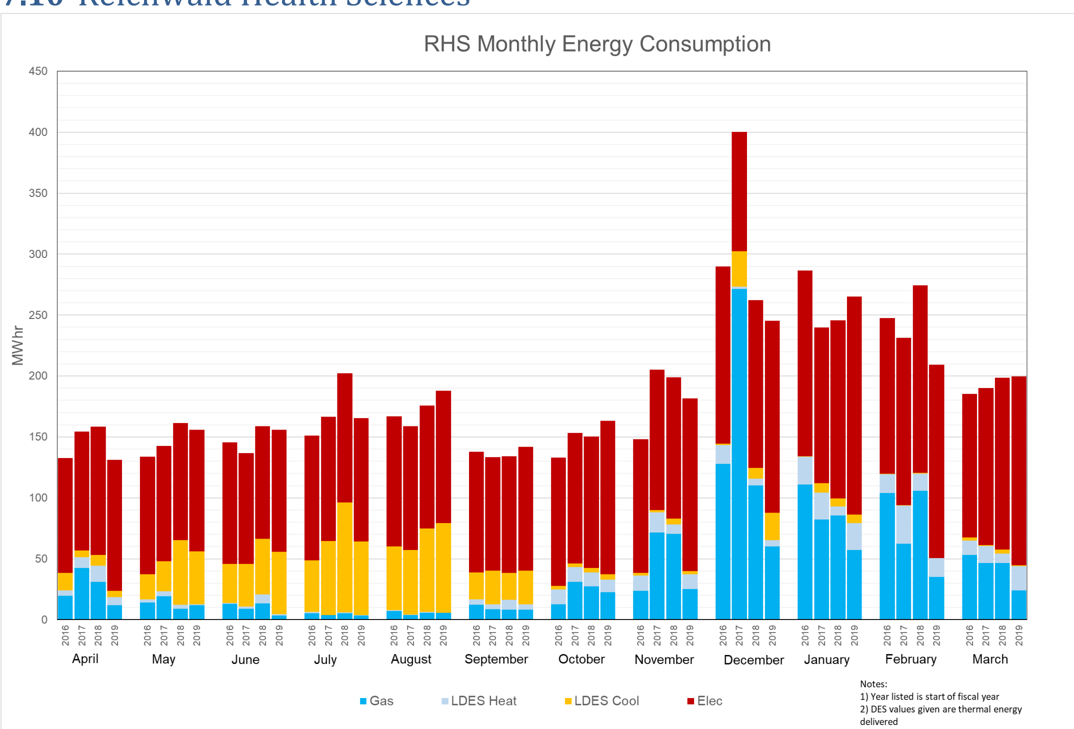
7.9 Library



7.10 Reichwald Health Sciences



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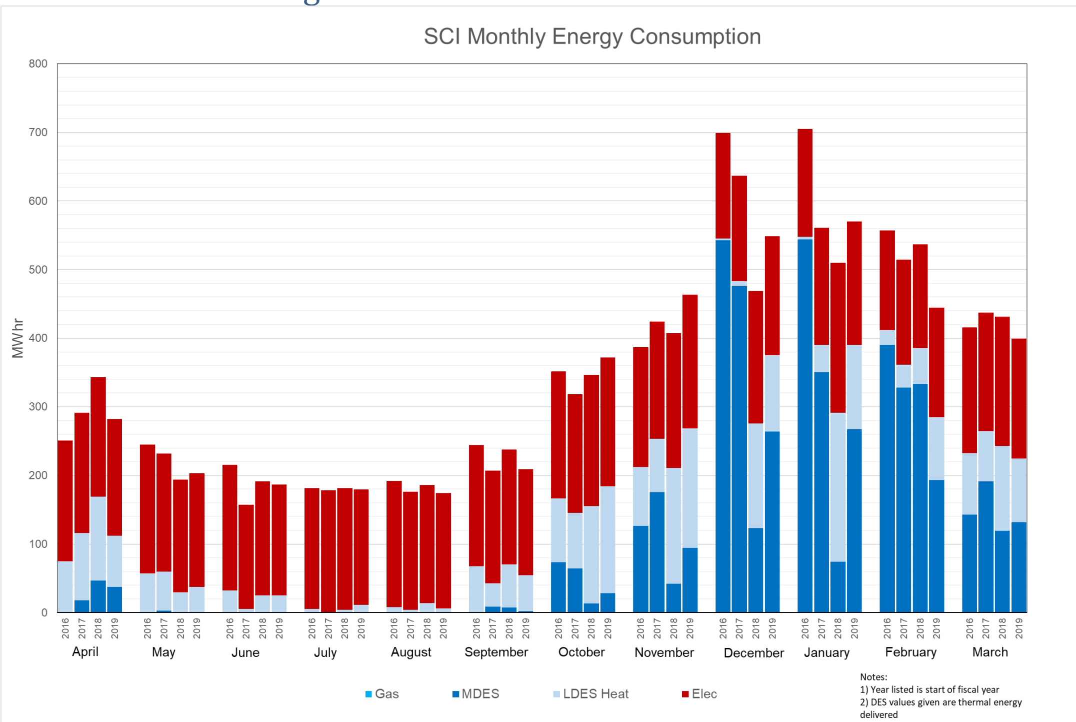
7.11 Science Building



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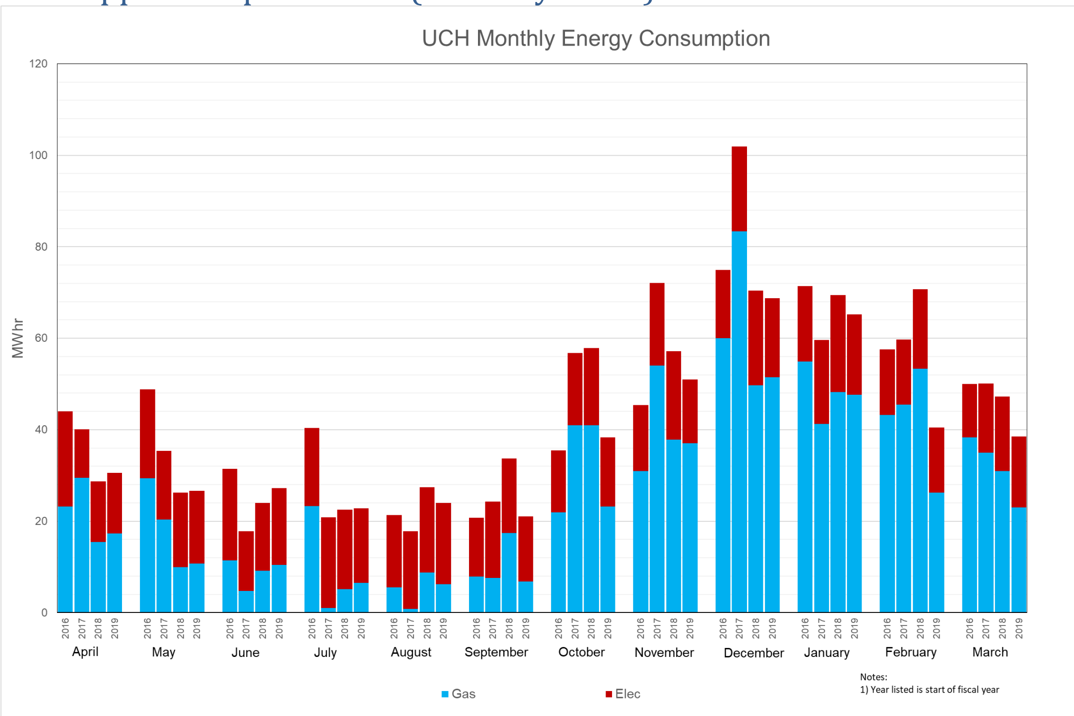
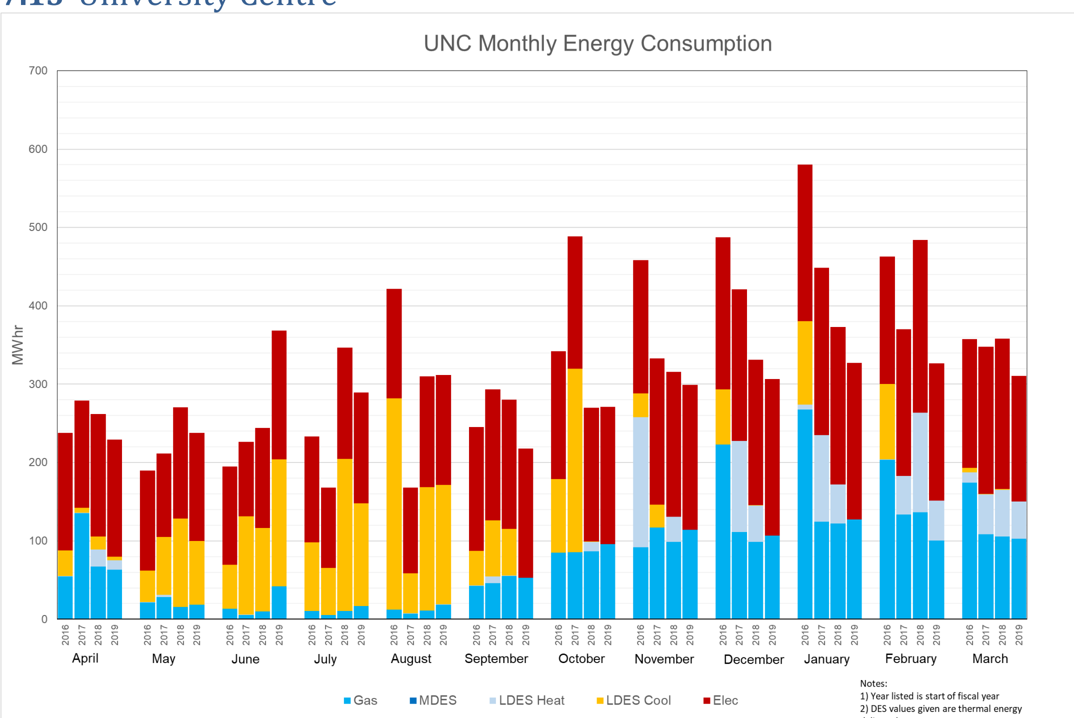
7.12 Upper Campus Health (formerly MWO)



7.13 University Centre



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7.14 Residences