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UBC Okanagan Energy Operations Annual Report for FY22-23 April 2022 – March 2023

Report Date June 2022

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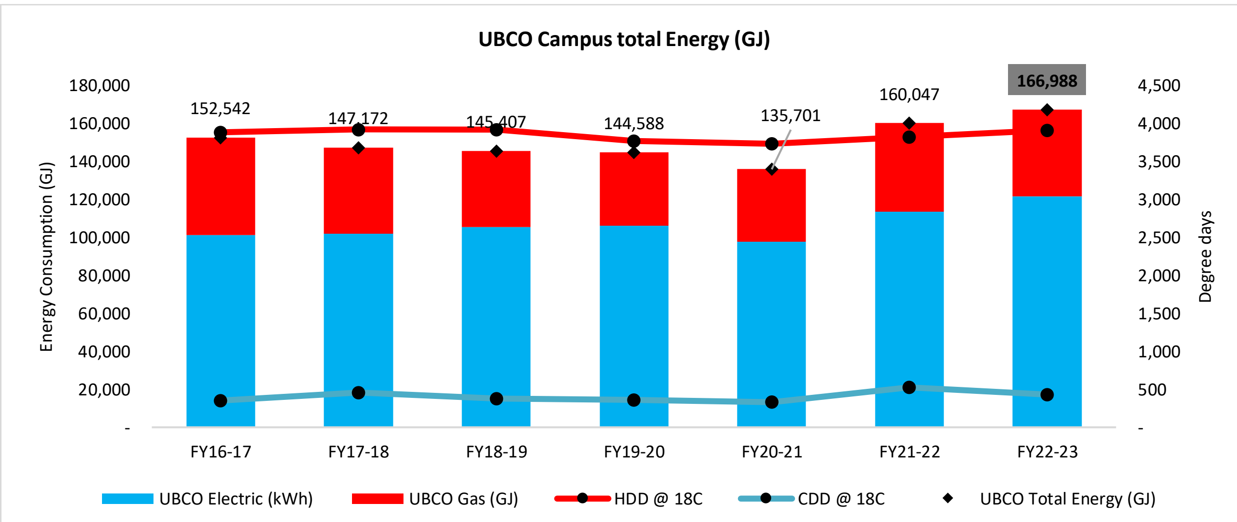
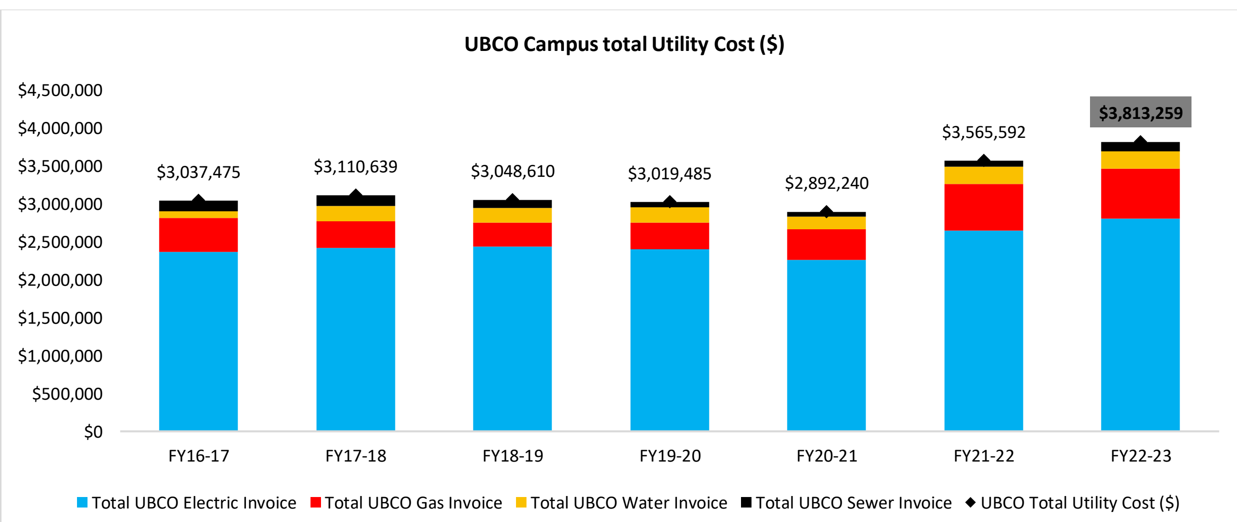
Executive Summary

UBC Okanagan total energy consumption over the last fiscal year (FY22-23) was 166,988 GJ compared to 160,047 GJ for FY21-22, a 4% year over year increase leading to a 6.16% increase in total campus energy utility cost from $3.26M in FY21-22 to $3.46M in FY22-23. The total campus energy consumption includes a 7.25% increase in campus Electricity consumption i.e., from 31,471 MWh in FY21-22 to 33,752 MWh in FY22-23 and a 2.72% reduction in campus Natural Gas consumption i.e., from 46,752 GJ in FY21-22 to 45,481 GJ in FY22-23.

In FY22-23, Heating Degree-Days (HDD) remained relatively consistent at 3,908 degree-days compared to 3,820 degree-days in FY21-22 whereas Cooling Degree-Days (CDD) reduced by around 18% from 525 degree-days in FY21-22 to 432 degree-days in FY22-23.





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Greenhouse gas emissions remained relatively consistent at 2,403 tCO_2e/ year in FY22-23 compared to 2,387 tCO_2e/ year in FY21-22. This emission calculation assumes integrated electricity emission factor. Section 4.16. of this report provides a more detailed analysis on the variance in UBCO GHG emissions as a result of the province adopting a new methodology to determine greenhouse gas emissions intensity factors for electricity use.

Highlights

- DES energy consumption reduced by 10% (3,070 GJ gas reduction and 39 MWh increased electricity consumption) in FY22-23 compared to FY21-22, with similar thermal energy delivered to the buildings. This is primarily due to a few energy conservation efforts i.e., GEO gas boiler setpoint adjustment, GEO cooling tower sequencing update, and increased usage of GEO open loop system for heating and cooling.
- University House electricity consumption increased by 70% (63 GJ or 17.6 MWh increase) as a result of renovation; Innovation Precinct 1 (567 GJ increase) and Innovation Annex 1 (104 GJ increase) energy consumption increased by 15% as a result of renovations and increased occupancy; Gymnasium (722 GJ increase), Library (680 GJ increase) and OM1 (42 GJ increase) energy consumption increased by 15% as a result of increased occupancy; energy consumption for ADM (606 GJ increase), CCS (306 GJ increase), ASC (708 GJ increase), RHS (326 GJ increase), PGF (46 GJ increase), COM (82 GJ increase) on an average increased by 5%; energy consumption for FIP (200 GJ decrease), EME (407 GJ decrease), UNC (285 GJ decrease), ART (247 GJ decrease), UCH on an average reduced by 3% (51 GJ decrease); SCI (1,678 GJ decrease) energy consumption reduced by 9% as a result of high temperature to low temperature coil replacement and demand-controlled ventilation measures implemented.
- Residential energy consumption witnessed a 10-30% increase in FY22-23 compared to FY21-22, with the exception of the Purcell and Similkameen buildings at 4% increase. This is likely due to pre-pandemic occupancy levels for these two buildings in FY21-22.

Energy Team has been actively working on developing appropriate policies and guidelines that assist in meeting long-term campus energy and carbon goals through the following initiatives:

1. **Integrated Energy Strategy:** Advance high-level energy strategy to reach a future state with a view of modernization, renewal, and growth to serve both existing and new loads anticipating campus growth consistent with UBC Okanagan goals, aspirations and resiliency
    a. **Building Energy Targets:** Develop energy targets for net positive ready buildings at Okanagan campus, driving sustainable construction and operations towards a greener future
    b. **Strategic Energy Management Plan (SEMP):** Implement demand-side energy conservation measures (ECMs) to reduce utility costs and achieve Climate Action Plan (CAP) 2030 goals
    c. **District Energy Strategy:** Advance the strategy enabling flexible support for renewal and expansion while ensuring simple building connections and delivering sustainable, affordable, and resilient service to campus customers

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    d. **Campus-Wide High Voltage Master Electric Plan:** Analyze the current campus-wide high voltage electrical distribution systems and develop a strategy to best support the campus's future needs
2. **Building Management System:** Partner with BMS providers to advance campus initiatives, address platform deficiencies, resolve integration issues, maintain the BMS database, and enhance key graphics and trends
3. **Utilities portfolio:** In addition to monitoring the portfolio, Energy Team collaborates with stakeholders and consultants to ensure smooth utility service delivery, negotiating contracts for favorable terms and compliance with regulations.
4. **Energy Monitoring and Data Management Platform:** Develop an intelligent data driven energy monitoring and management system using statistical and advanced data analysis methods. Energy Team is currently exploring Skyspark tool to advance this initiative
5. **Campus Operations and Academics Collaboration:** Work with UBCO academicians and researchers on various initiatives that feed into UBCO Multi-hazard Assessment study
    a. Campus Energy Data analytics platform – complete, in review
    b. District energy modelling and optimization – in progress
    c. Wastewater monitoring for campus community – potential
    d. West campus land development – potential
6. **New campus construction:** Energy Team actively participates in the design and construction process of new campus buildings, working diligently to ensure that these structures adhere to the campus technical guidelines and align with the overarching Whole Systems Plan. Our primary objective is to ensure the seamless integration of sustainable practices and energy-efficient principles into the design and construction of these new buildings
7. **Other:** Technical reviews and setting goals, targets and strategies as early as possible for future campus expansions. Update Technical Guidelines intended to provide minimum standards for campus projects.

In terms of energy efficiency studies/ projects, a few projects have been completed/ in progress like Occupancy-based Demand Controlled Ventilation for ASC and FIP, IAQ-based Demand Controlled Ventilation for SCI, Recommissioning of EME, LED lighting upgrade for PGF, waste heat recovery from strobic exhaust for SCI, Wi-Fi threshold recalibration, and other optimization and monitoring improvements. Energy Team related activities such as energy conservation measure implementation, equipment upgrade, Energy Specialist program, new construction etc. in the past fiscal year received around $265,000 in FortisBC incentives.

Energy Team was also able to uncover incentive opportunities that would have otherwise been overlooked securing an additional average annual rebate of $50,000. Following are few of the projects:

- FY19-20: Office Modular heat pumps, Monashee VRF heat pumps - $95,000
- FY20-21: IP1 equipment, outdoor lighting, Nechako kitchen equipment - $43,000
- FY21-22: SCI VFD retrofit - $25,000
- FY22-23: ART VFD retrofit, IP1 H2 lab equipment - $27,000

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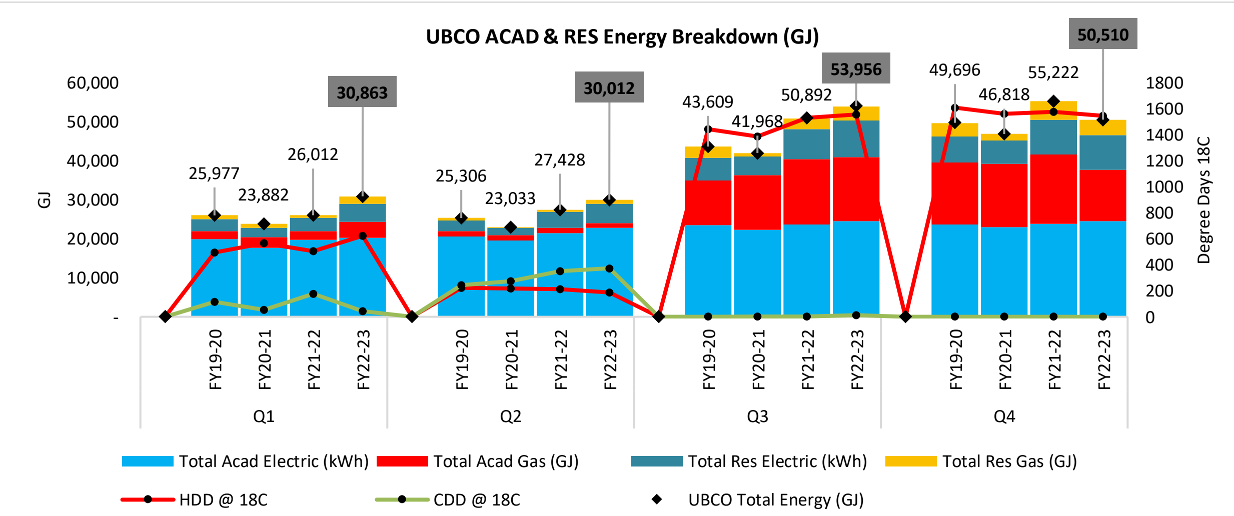
Following table presents DSM-based utility savings, carbon tax savings, FortisBC funded staff position, energy efficiency incentives received by UBCO:

Parameter	FY18-19	FY19-20	FY20-21	FY21-22	FY22-23
Total Utility Cost Savings compared to BAU 2013[1]	$373,400	$394,000	$1,013,200[2]	$649,600	$551,400
DSM-based Utility Savings	$139,400	$171,300	$203,700	$237,100	$266,100
DSM-based Carbon Offset Savings[3]	$4,300	$7,200	$9,800	$9,900	$10,600
External personnel funding	$60,000	$60,000	$95,000	$130,000	$135,000
Energy Efficiency Incentive (Rebates)	$176,000	$238,000	$305,000	$231,300	$131,800



[1] Includes DSM savings. This category includes Routine capital equipment upgrade, new construction buildings etc.
[2] Total Utility Cost Savings for FY20-21 compared to BAU can be considered an outlier because of reduced energy consumption as a result of COVID-19.
[3] This only includes $25/tCO2e of offsets retired by the Ministry on behalf of UBC Okanagan.

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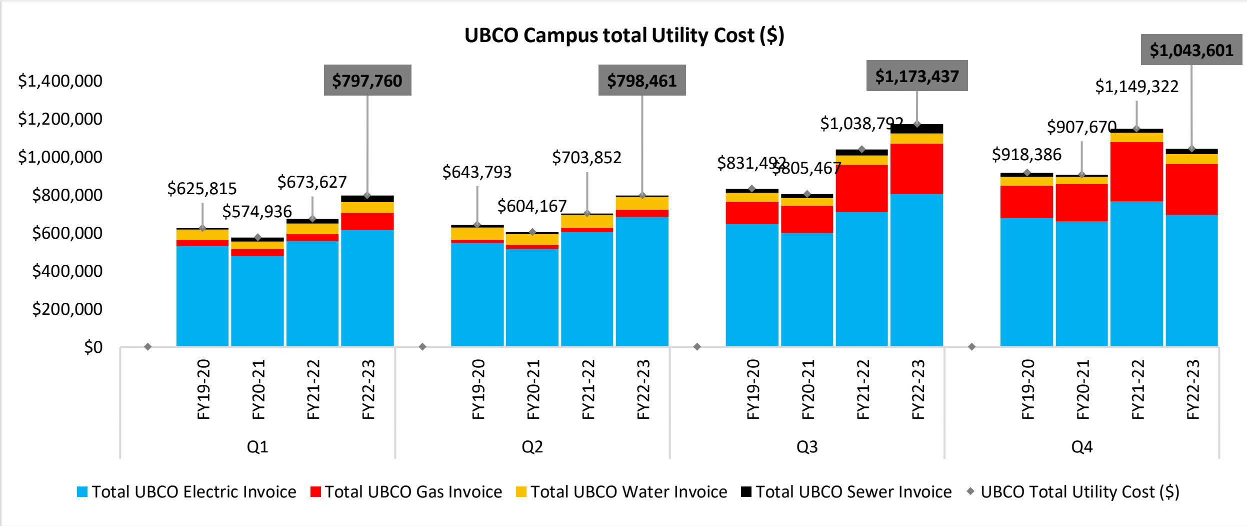

The Figure below shows the total energy consumption and its change for each building categorized by building type from FY21-22 to FY22-23. District Energy System gas consumption reduced in FY22-23 as a result of increased utilization of the open-loop system to meet the building heating demands. UNI, IA1, IP1 are newly renovated buildings on campus. SCI and ARTS building show reduced energy consumption as a result of AHU renovation projects in ARTS and demand controlled ventilation projects in SCI building. However, energy consumption in most residences, excluding Purcell and Similkameen, experienced an increase of approximately 10% to 30%. This rise can likely be attributed to higher occupancy levels following the post-COVID period.

For the complete report and detailed findings, please see this report on our website at https://finance-operations.ok.ubc.ca/corm/energy/energy-team-reports/

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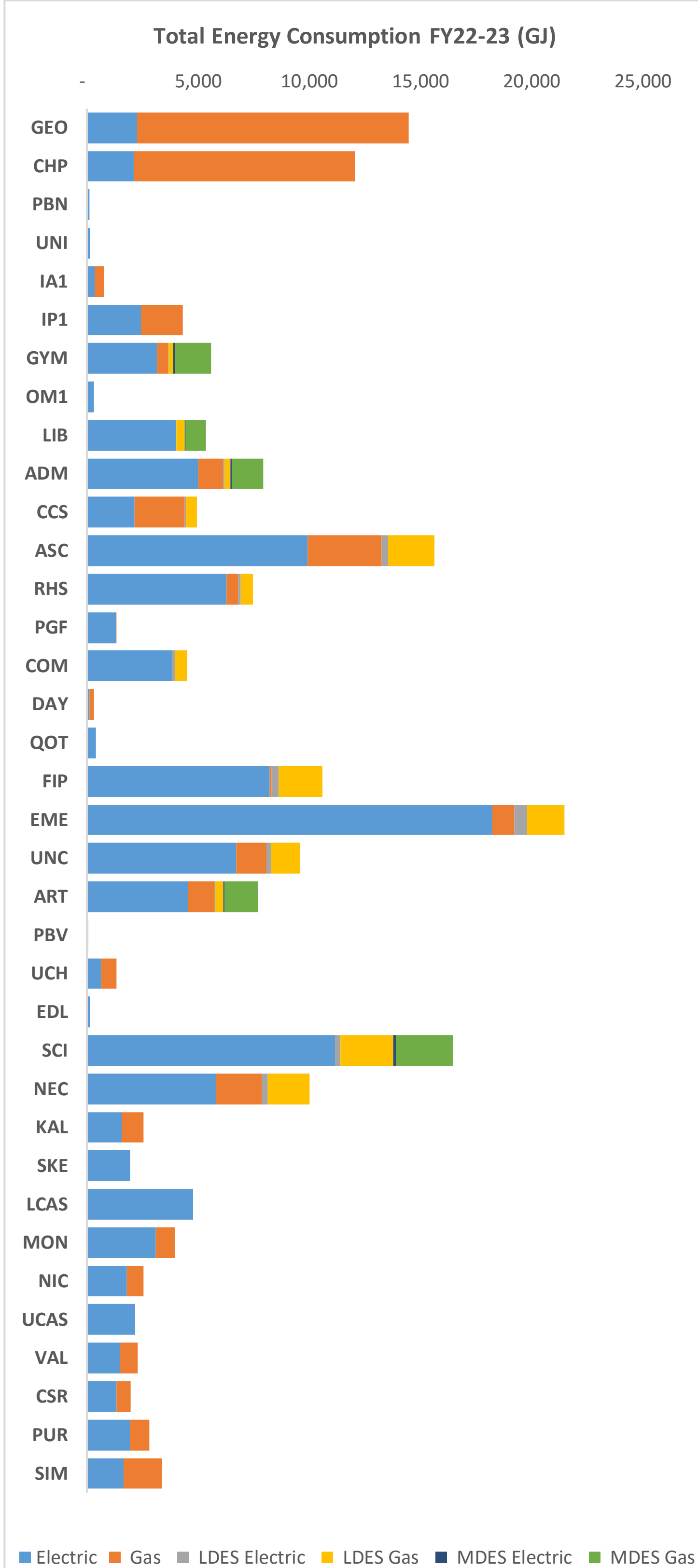
Type	Building	% Total energy change
DES	GEO	-2%
DES	CHP	-18%
ACAD	PBN	108%
ACAD	UNI	71%
ACAD	IA1	16%
ACAD	IP1	15%
ACAD	GYM	15%
ACAD	OM1	15%
ACAD	LIB	15%
ACAD	ADM	8%
ACAD	CCS	7%
ACAD	ASC	5%
ACAD	RHS	5%
ACAD	PGF	4%
ACAD	COM	2%
ACAD	DAY	0%
ACAD	QOT	0%
ACAD	FIP	-2%
ACAD	EME	-2%
ACAD	UNC	-3%
ACAD	ART	-3%
ACAD	PBV	-4%
ACAD	UCH	-4%
ACAD	EDL	-7%
ACAD	SCI	-9%
RES	NEC	33%
RES	KAL	25%
RES	SKE	15%
RES	LCAS	14%
RES	MON	14%
RES	NIC	12%
RES	UCAS	12%
RES	VAL	11%
RES	CSR	10%
RES	PUR	4%
RES	SIM	4%



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Definition of Terms

Acad: Academic
AHU: Air Handling Unit
BMS: Building Management System
CAP: Climate Action Plan
CDD: Cooling Degree Day
COP: Coefficient of Performance
DCV: Demand Controlled Ventilation
DDC: Direct Digital Control
DE: District Energy
DHW: Domestic Hot Water
DSM: Demand-side Management
ECM: Energy Conservation Measure
EIR: Energy Input Ratio
EUI: Energy use intensity
GHG: Greenhouse Gas emissions
GHGI: Greenhouse Gas Intensity
GJ: Gigajoule
HDD: Heating Degree Day
HRV: Heat Recovery Ventilator
HVAC: Heating, Ventilation, and Air Conditioning
LDES: Low temperature District Energy System
MDES: Medium temperature District Energy System
MUA: Make Up Air
MWh: Megawatt Hour
OAT: Outdoor Air Temperature
OPR: Owner’s Project Requirement
RCx: Recommissioning
RES: Residence
RNG: Renewable Natural Gas
SEMP: Strategic Energy Master Plan
tCO_2e: tonnes of carbon dioxide equivalent
TEDI: Thermal Energy Demand Intensity
TES: Thermal Energy Storage
TEUI: Total Energy Use Intensity
TG: Technical Guideline
VAV: Variable Air Volume
VRF: Variable Refrigerant Flow

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1 Energy Team

The Energy Team enables and facilitates energy management and carbon reduction projects at the University of British Columbia Okanagan campus. The Energy Team is an integral part of Campus Operations and Risk Management overseeing the utilities portfolio, working within a mandate of fiscal efficiency, operational excellence, environmental sustainability and innovative demonstrations.

The Energy Team champions appropriate policies and guidelines to assist in meeting campus energy goals. Partnering with University departments, faculties and external stakeholders, Energy Team diligently works to reduce energy use and associated GHGs & costs, and optimize campus energy systems.

Some of the key tasks include:

- Continuous measurement, verification, tracking and analysis of energy use on campus
- Review and report on campus energy performance
- Provide technical guidance to ensure new buildings meet energy efficiency targets consistent with campus energy plans
- Develop and implement campus energy policies
- Conduct energy audits
- Improving efficiency of campus HVAC systems and campus building automation systems
- Identify strategies for energy savings
- Troubleshoot systems and equipment to ensure efficient operation

The Energy Team currently consists of four members i.e., Associate Director, Energy Engineer, Senior Energy Specialist, BMS Specialist, and BMS Technician (Vacant).

2 Overall Campus Energy Performance

Campus energy consumption for FY22-23 totalled 166,988 GJ (46,385 MWh). As can be seen in Figure 1 below, electricity accounted for around 73% of total energy consumed on campus. Furthermore, electricity is more expensive than natural gas. Average electricity costs were $23.04/GJ ($83.00/MWh) in FY22-23 and $15.14/GJ ($54.50/MWh) for natural gas. As a result, electricity accounted for around 81% of campus utility costs. While natural gas has a lower cost per unit of energy, its GHG emission intensity is sixteen times higher than those of electricity (0.18 tons CO_2/MWh for gas versus 0.012 tons CO_2/MWh for electricity). As a result, about 84% 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.

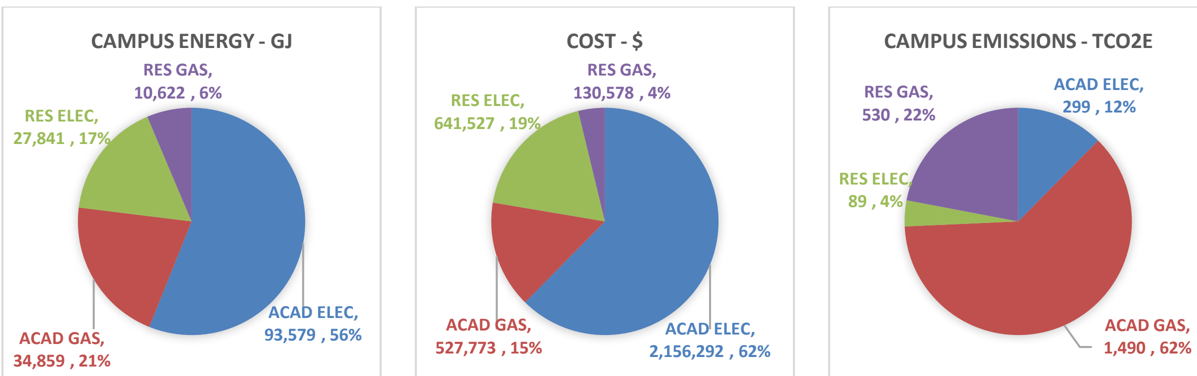

Figure 1: Campus Energy Consumption, costs and emissions by Source for FY22-23[4]

A quantitative model of the dependence of campus energy consumption on weather has been developed (Refer to figure below). Quantitatively, it can be 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.

An EUI increment of 17% was observed from 0.95 GJ/m^2/yr. (262.70 kWh/m^2/yr.) in FY21-22 to 0.99 GJ/m^2/yr. (274.09 kWh/m^2/yr.) in FY22-23. This increment can primarily be attributed to the following factors:

1. Increased energy consumption as a result of campus community return back to campus
2. Energy-intensive new construction buildings (IP1, IA1, NEC) on campus

[4] Campus Energy consumption also includes electricity consumed by leased buildings. However, they represent less than 0.01% of total energy consumption and hence has not been shown in the Figure.

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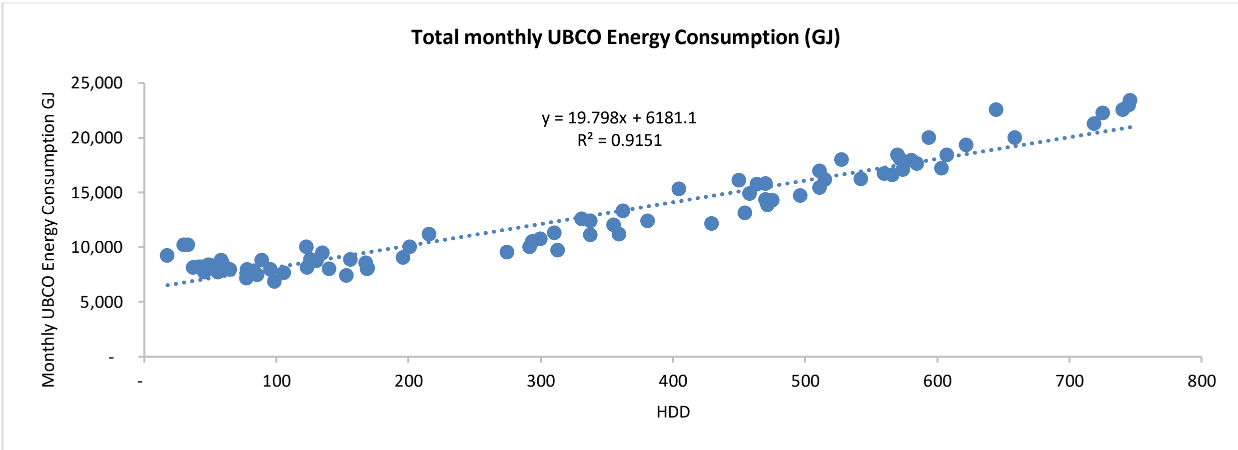

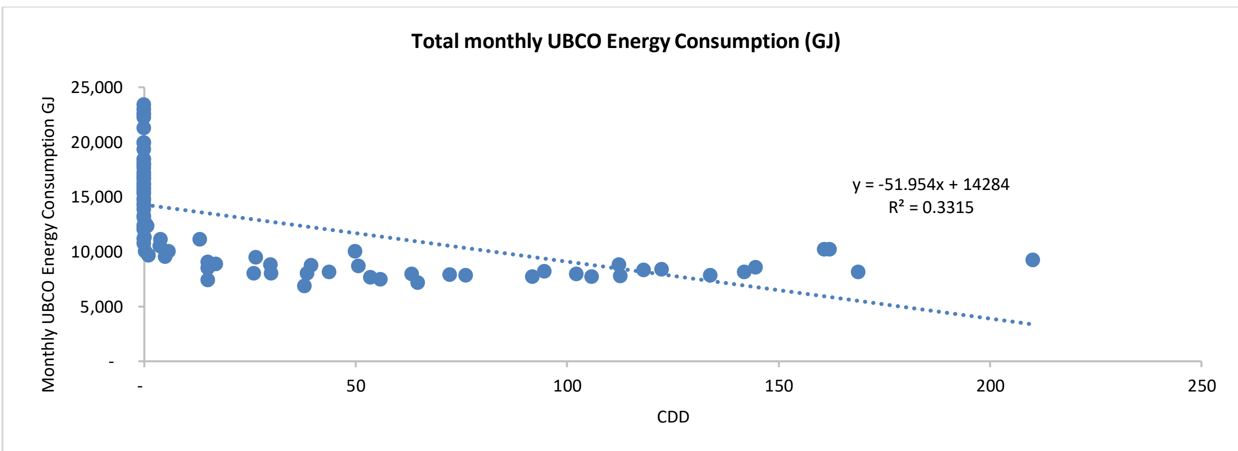

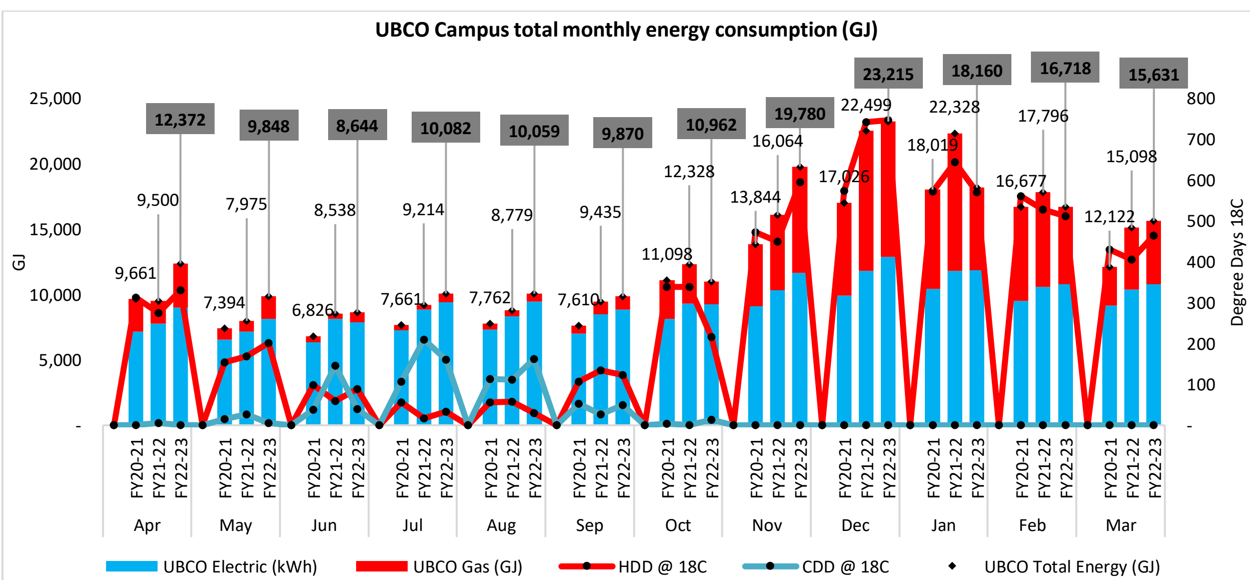

Figure 2: Campus Energy Consumption and Weather Comparison

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2.1 Campus Energy Performance Trends

2.1.1 Costs

As shown in the Figure 3 below, campus utility costs increased from $3.3M to about $3.5M. For FY22-23[5] the average cost of electricity on campus increased by 3.4% from $87/MWh compared to $84/MWh in FY21-22. Costs for electricity is a blend of demand charge (27% of total electricity cost), energy charge (72% of total electricity) and fixed customer charge (1% of total electricity), the rate stated is a blended rate. The increase in electricity consumption resulted in electricity costs increment from $2.64M in FY21-22 to $2.8M in FY22-23, 6% increase.

For FY22-23 the average cost of natural gas on campus was $15.14/GJ ($54.50/MWh) compared to $13.45/GJ ($48.40/MWh) in FY21-22, an 12.6% increase. The increase in natural gas rate resulted in natural gas costs increment from $620,620 in FY21-22 to $663,710 in FY22-23, a 7% increase.

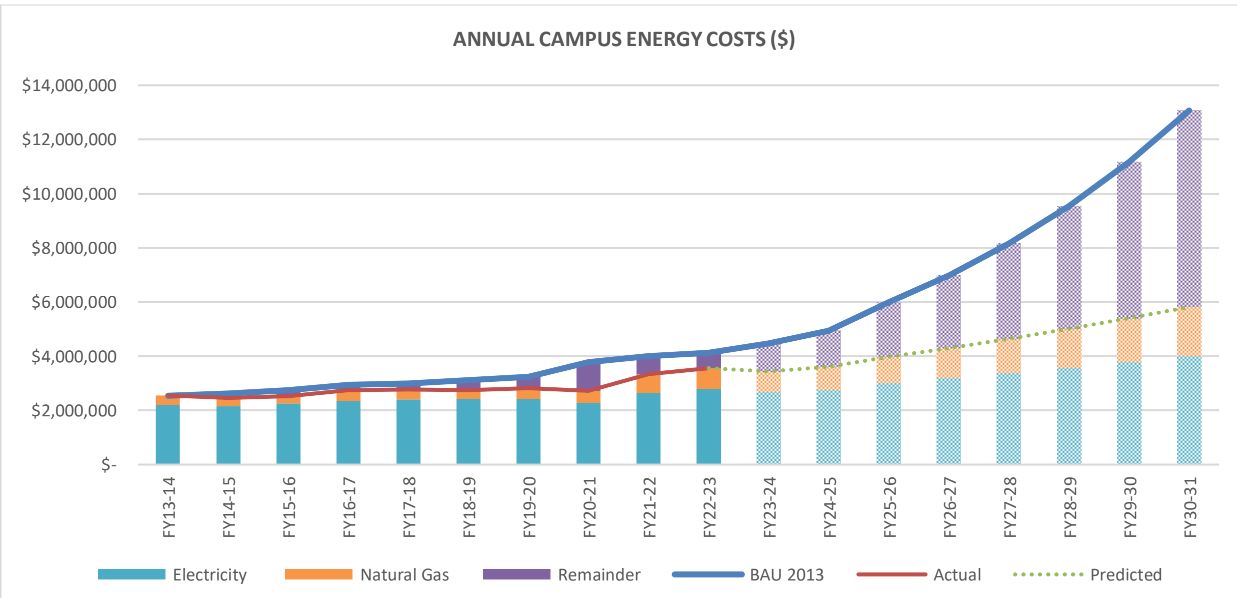

Figure 3: Campus Energy Costs Trend[6]

From FY18-19, the utility costs is expected to be over $625k higher per year ($3.1M in total) compared to 2013 Business as usual scenario without modernization efforts (High-performance building, equipment upgrade, recommissioning etc.) taken at the UBCO campus. Approximately $46k per year ($232k in total) of the savings are attributed to DSM projects funded directly by Energy Initiatives. These savings are shown in black in the Figure 3 above. The remainder of the savings, shown in purple 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 new construction building projects,

[5] The actual average cost of electricity was $83/MWh as a result of a one-time credit issued by FortisBC as BC Cost-of-Living Rebate

[6] 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 (kWh/m2/yr) was maintained constant at the level of a defined reference year i.e. 2013

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recommissioning, routine capital equipment upgrade or improved technical guidelines etc. Note that the black and maroon portion of the columns are not cost incurred but rather are cost avoided.

2.1.2 Greenhouse Gas Emissions

Campus greenhouse gas emissions remained relatively consistent at 2,403 tCO_2e/ year in FY22-23 compared to 2,387 tCO_2e/ year in FY21-22. Note that the black and maroon portion of the columns are not emissions produced but rather are emissions avoided due to implemented energy conservation measures, routine capital equipment upgrade, efficient new construction buildings etc.

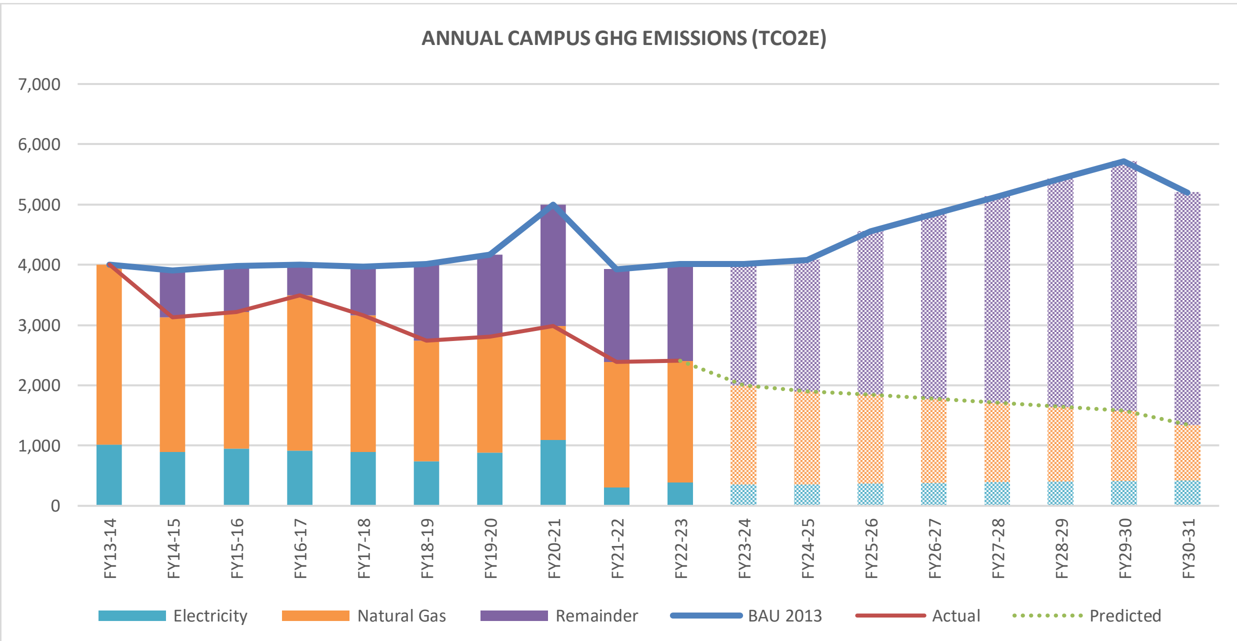

Figure 4: Campus GHG Emissions Trend

2.1.3 Electricity

Electricity consumption increased by around 7.25% year over year to 33,751 MWh in FY22-23 from 31,471 MWh in FY21-22. The rise in electricity consumption can mainly be attributed to the higher occupancy levels on campus following the COVID-19 period.

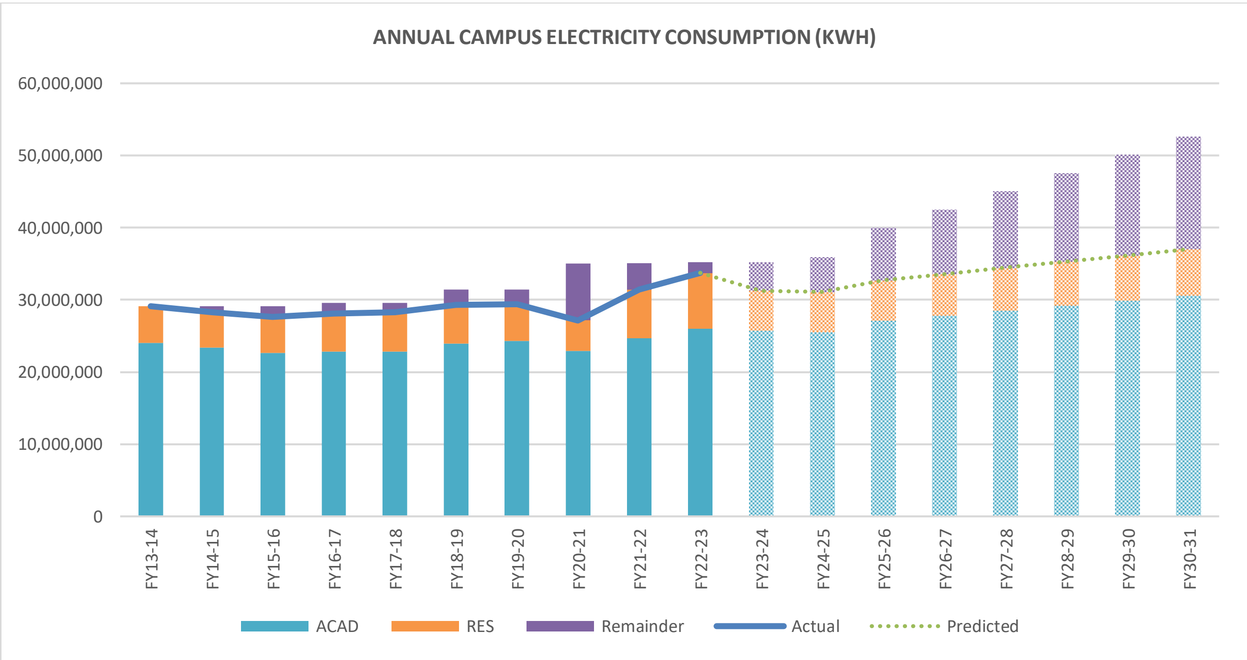

Figure 5: Campus Electricity Consumption Trend

The Figure 6 below shows the distribution of electricity consumption on campus. The electricity consumed within the building is shown separately from the gas consumed by the two campus District Energy Systems (DES). The DES electricity consumption is represented as “Other” in the figure below and is attributed to the buildings based on relative building thermal consumption from the DES.

The academic buildings EME, SCI, ASC, FIPKE, UNC, and RHS are significant consumers of electricity on campus, each accounting for more than 5% of the total consumption. Additionally, Nechako Residence comes close to the 5% threshold. Campus District Energy Systems consume around 2.2% of the total energy consumption primarily for the required pumping operations in the LDES & MDES systems and rejecting heat from the LDES system in cooling season. Residences account for around 23% of the total electricity consumption. Refer to Figure 6 for more information on electricity consumption breakdown.

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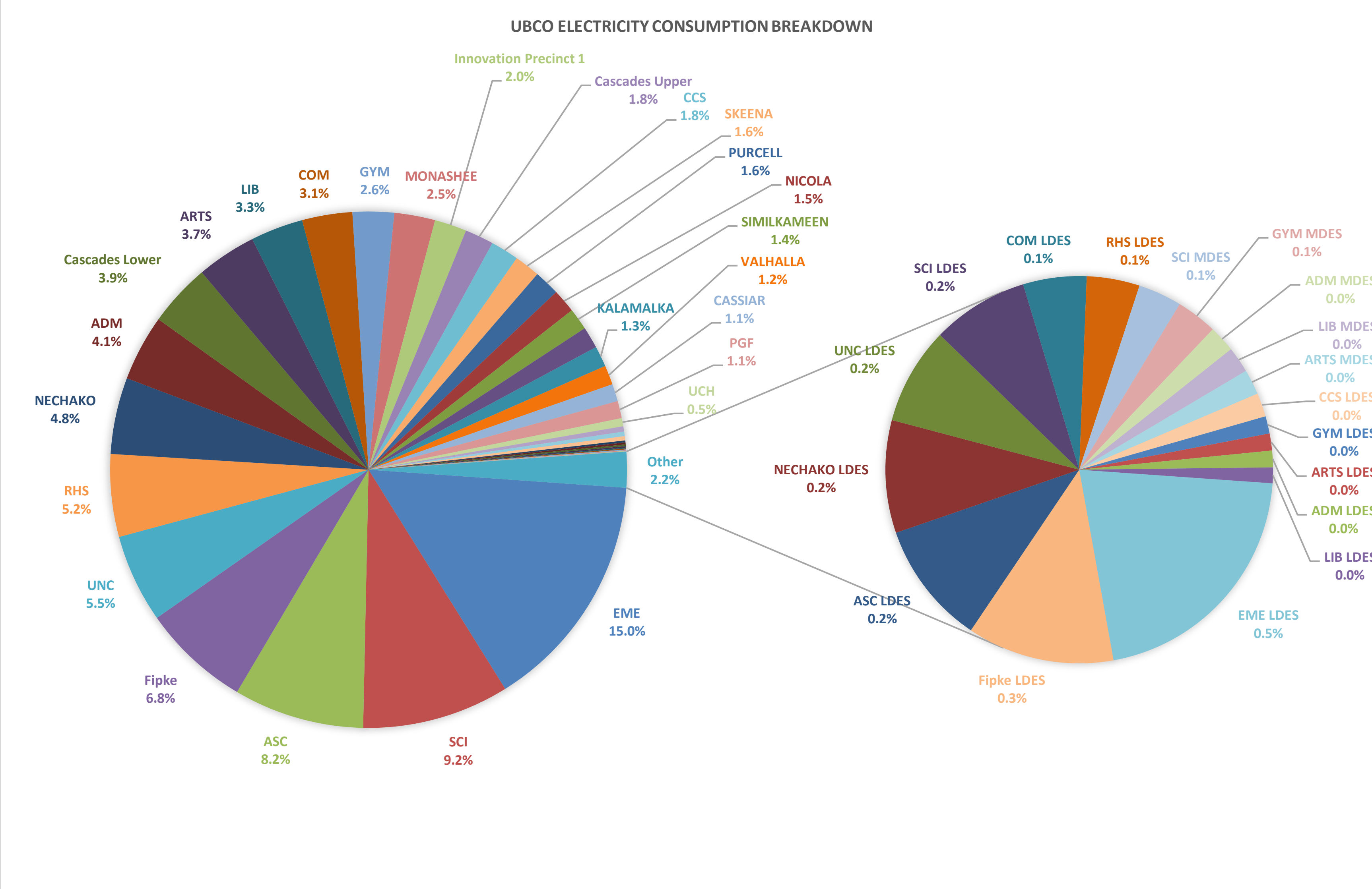

Figure 6: Electricity Consumption for Buildings and DES for FY22-23

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2.1.4 Natural Gas

Consumption of natural gas reduced from 46,752 GJ in FY21-22 to 45,481 GJ in FY22-23, a 2.7% year over year reduction. Natural gas consumption for the residences increased from 8,740 GJ to 10,622 GJ (around 18% increment) primarily due to reduced occupancy in FY21-22, a direct impact of COVID-19.

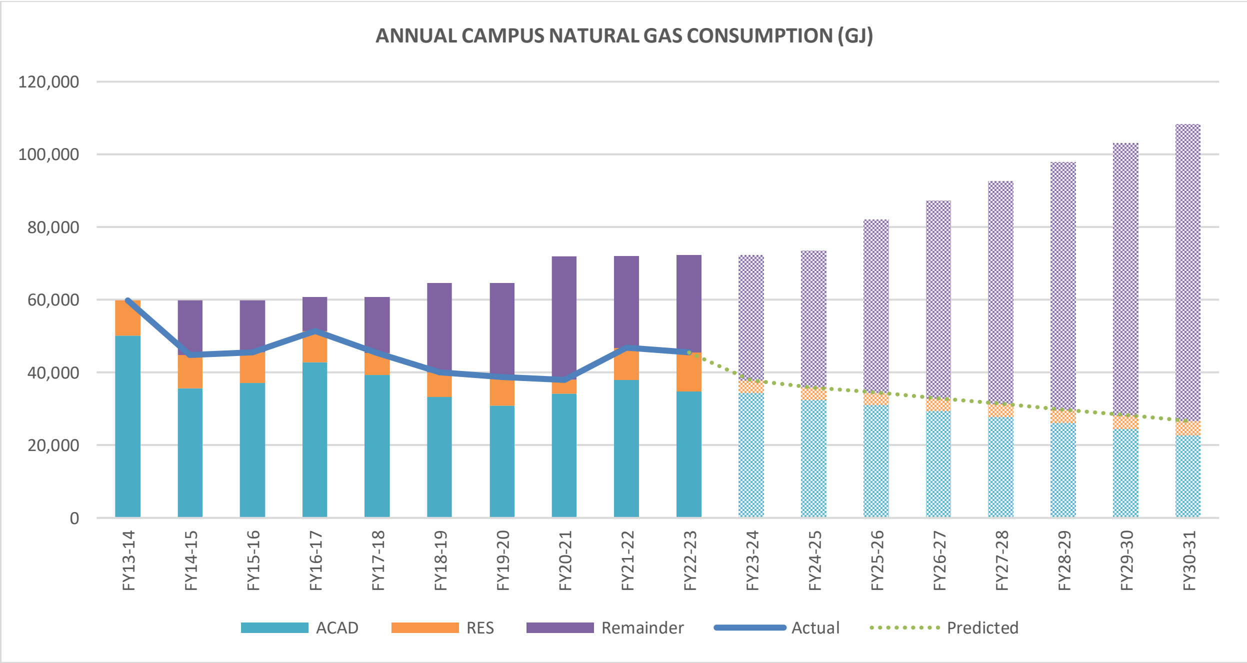

Figure 7: Campus Natural Gas Consumption Trend

The Figure 8 below shows the distribution of gas consumption on campus. The gas consumed within the building is shown separately from the gas consumed by the two campus District Energy Systems (DES). The DES gas consumption is represented as “Other” in the figure below and is attributed to the buildings based on relative building thermal consumption from the DES.

The academic buildings ASC, CCS are significant consumers of gas on campus, each accounting for more than 5% of the total consumption because of the standalone equipment such as gas boilers and gas water heaters within these buildings. Additionally, Nechako Residence comes close to the 5% threshold. As can be seen in the figure, a large fraction (around 49%) of natural gas on campus is consumed by the two district energy systems’ plants by gas boilers (LDES = 27% and MDES = 22%). Residences consume around 23% of the total gas consumption. Refer to Figure 8 for more information on gas consumption breakdown.

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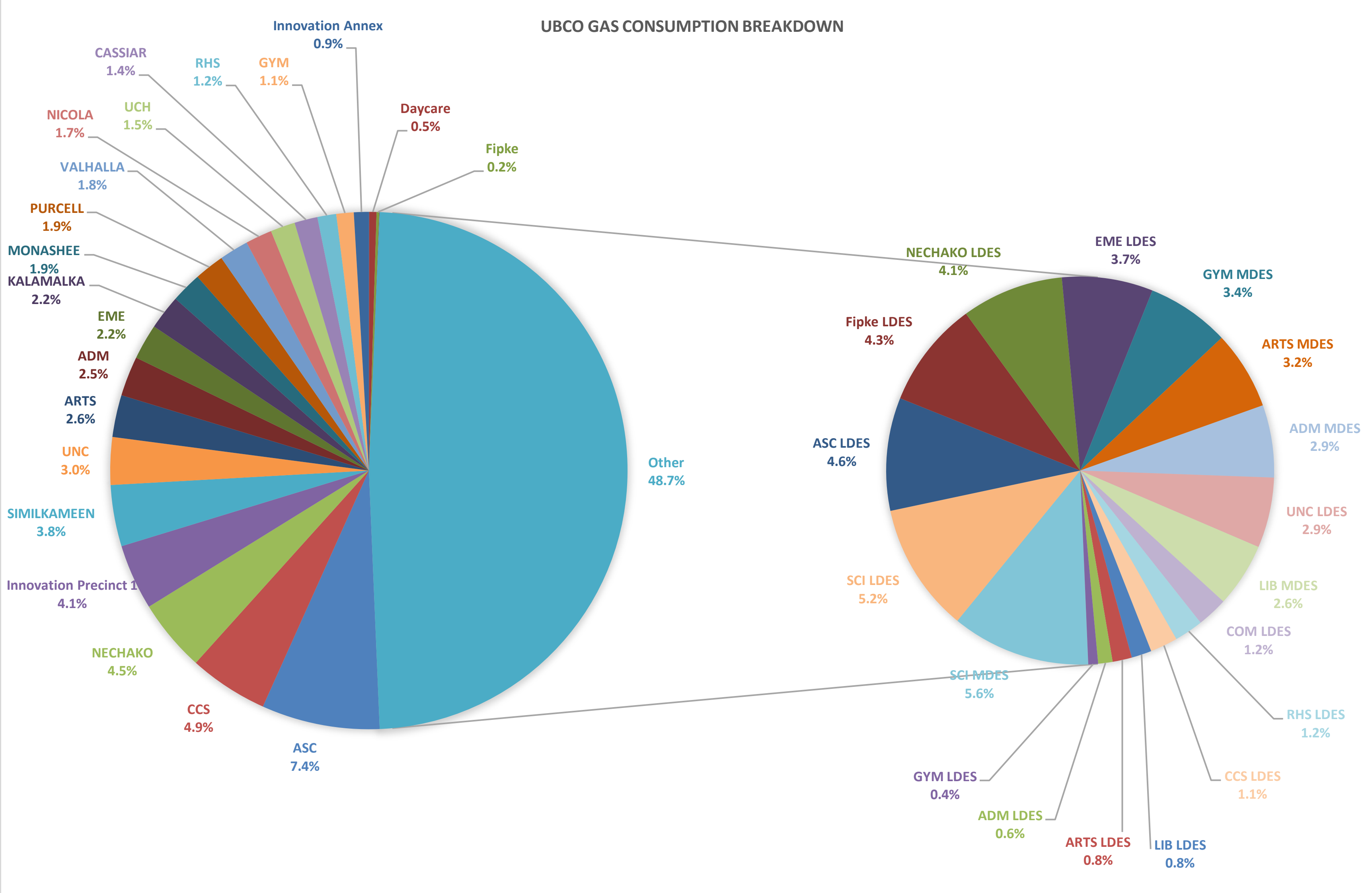

Figure 8: Gas Consumption of Buildings and DES for FY22-23

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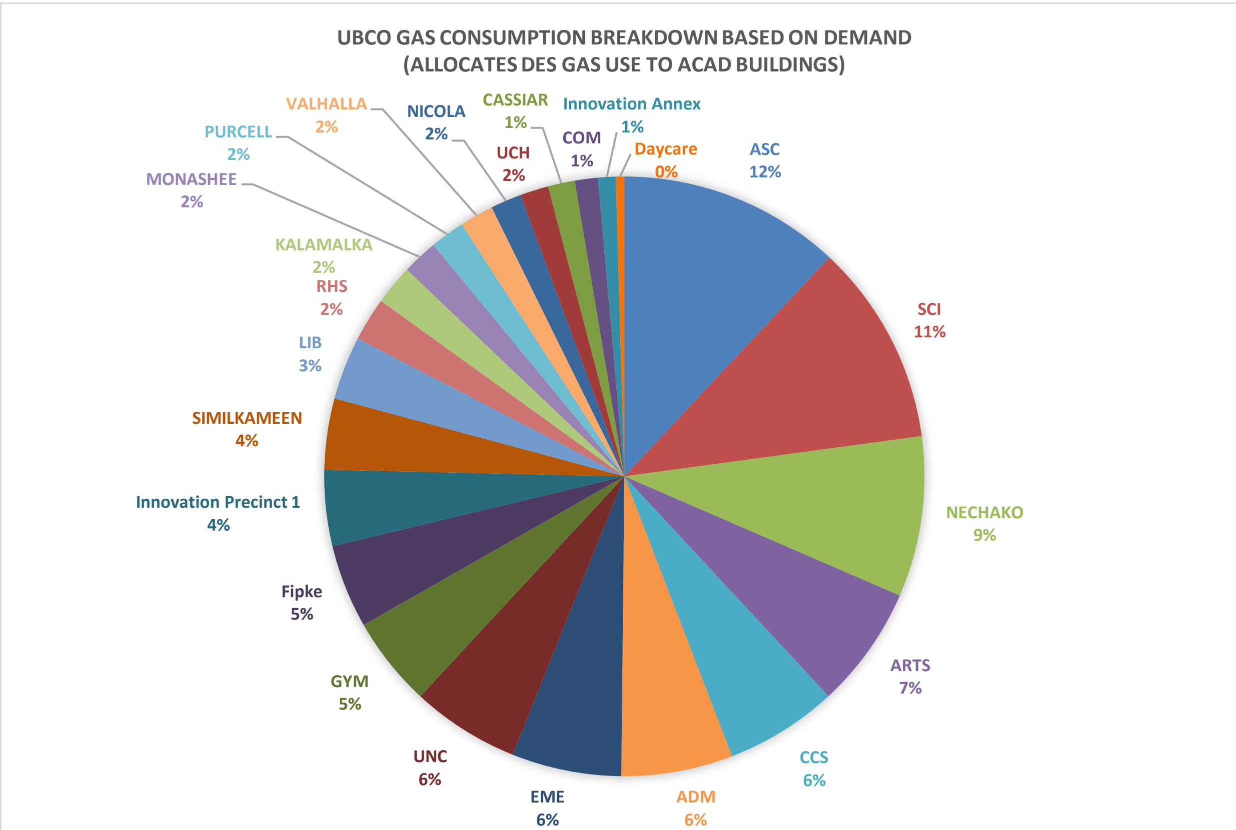
Figure below provides the gas consumption breakdown and allocates DES (LDES, MDES) gas consumption to the respective building based on demand. ASC, SCI, Nechako, ARTS, CCS, ADM, EME, UNC, GYM, and Fipke individually consume more than 5% of the total gas consumption on campus.



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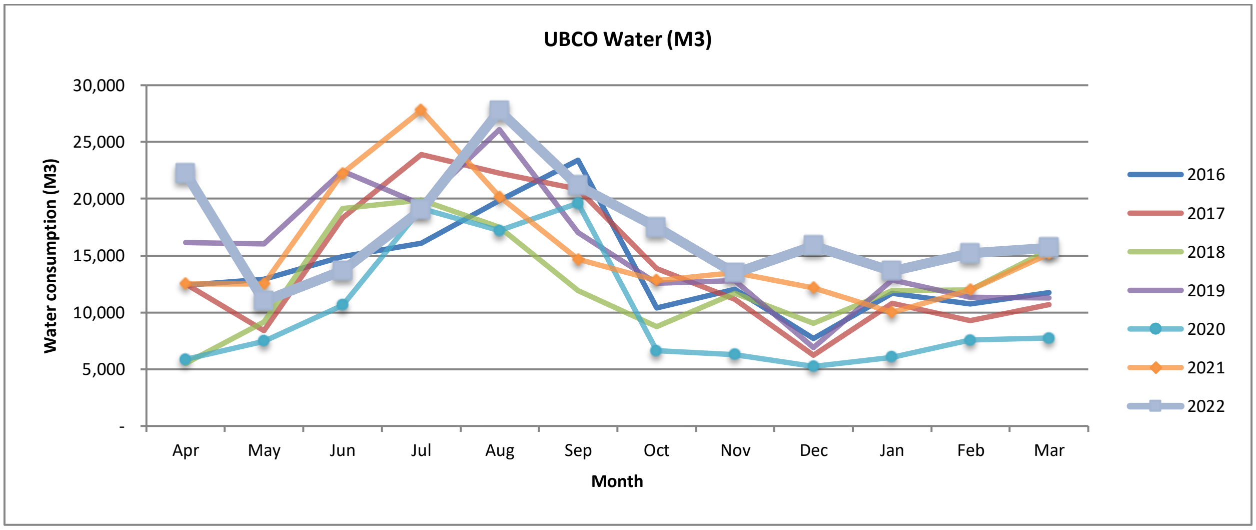
2.1.5 Water and Sewer

Water purchased from Glenmore Ellison Improvement District (GEID) for campus[7] use increased by 11 % from 185,642 m^3 in FY21-22 to 206,268 m^3 in FY22-23 with Academic buildings consuming 47% of the water. Sewer production also increased by 46% from 76,054 m^3 in FY21-22 to 111,057 m^3 in FY22-23. Figure 9 below provides water and sewer trends for the campus.



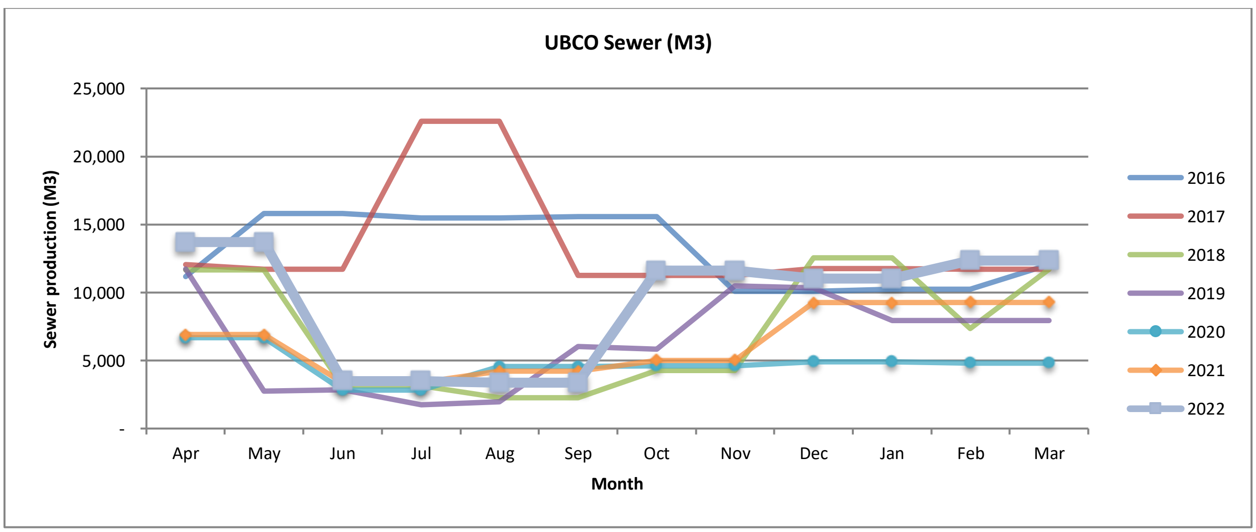


Figure 9: Water and Sewer consumption trend for UBCO campus

[7] Note that this consumption doesn't account for West Campus water use for irrigation. It only includes Academic and Residence building water consumption.

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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 campus Energy Use Intensity (EUI) remained constant at 274 kWh/m2/yr for FY22-23 compared to FY19-20. However, there was a notable 17% increase compared to the previous year, FY21-22. It is important to note that FY20-21 and FY21-22 can be considered outlier years due to the impact of COVID-19, which led to reduced occupancy and potentially affected energy usage patterns. Refer to Figure 10 for more details.

The average EUI for academic buildings on campus was 350 kWh/m^2/yr while it was 158 kWh/m^2/yr for residences. Median Site EUI for Educational College/ Universities is 266 kWh/m^2/yr. and Residence Halls is 183 kWh/m^2/yr. in United States (*Energy Star Portfolio Manager: U.S. Energy Use Intensity by Property Type*). The academic buildings on an average have a higher 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 chart below show the 6-year trend for the breakdown of EUI per energy source for the Academic, Residences and overall campus.

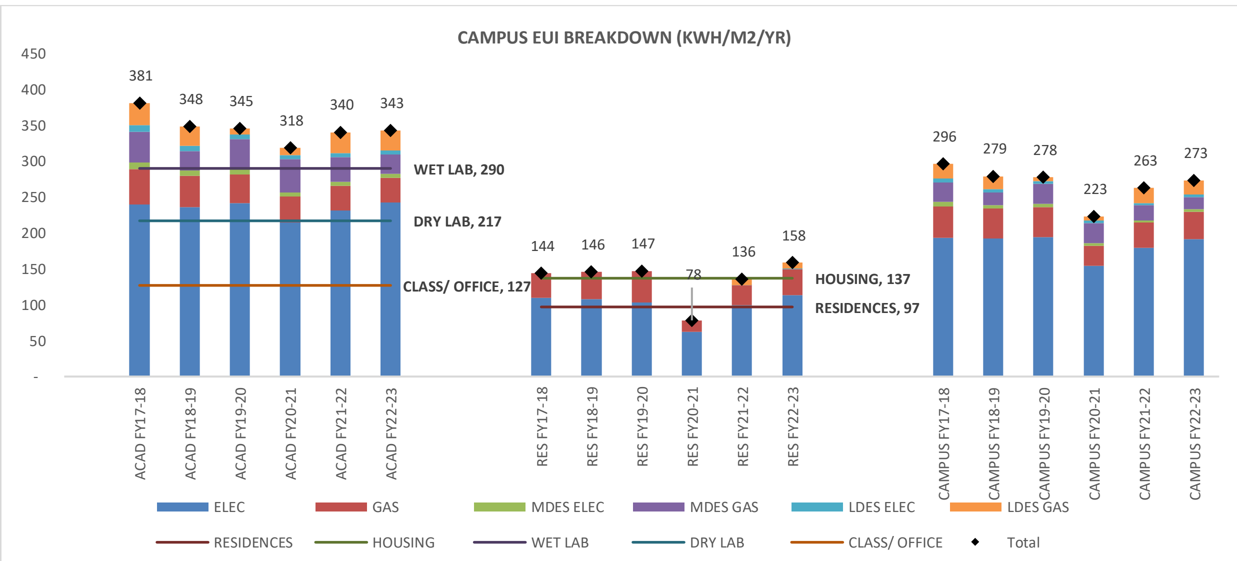

Figure 10: Campus Energy Use Intensities trend

A study was conducted to update TEUI, TEDI, GHGI for five archetype models from the previous UBC Net Positive Modelling Study using Okanagan climate files and building archetypes that are representative of UBCO new construction. The line chart in Figure 10 shows energy targets for various archetypes for Okanagan campus.

As can be seen in the following Figure 11, the PGF, ASC, Fipke, and Science buildings have the highest EUI on campus, primarily because of the laboratories in these buildings. UNC has a commercial kitchen leading to higher EUI. In terms of total energy consumption, EME, SCI, ASC, FIPKE, and UNC have high consumption compared to their peer academic buildings. EME has significantly higher area footprint leading to high energy consumption. SCI, ASC and FIPKE are the lab intensive buildings on campus and UNC has a commercial kitchen leading to increased energy consumption.

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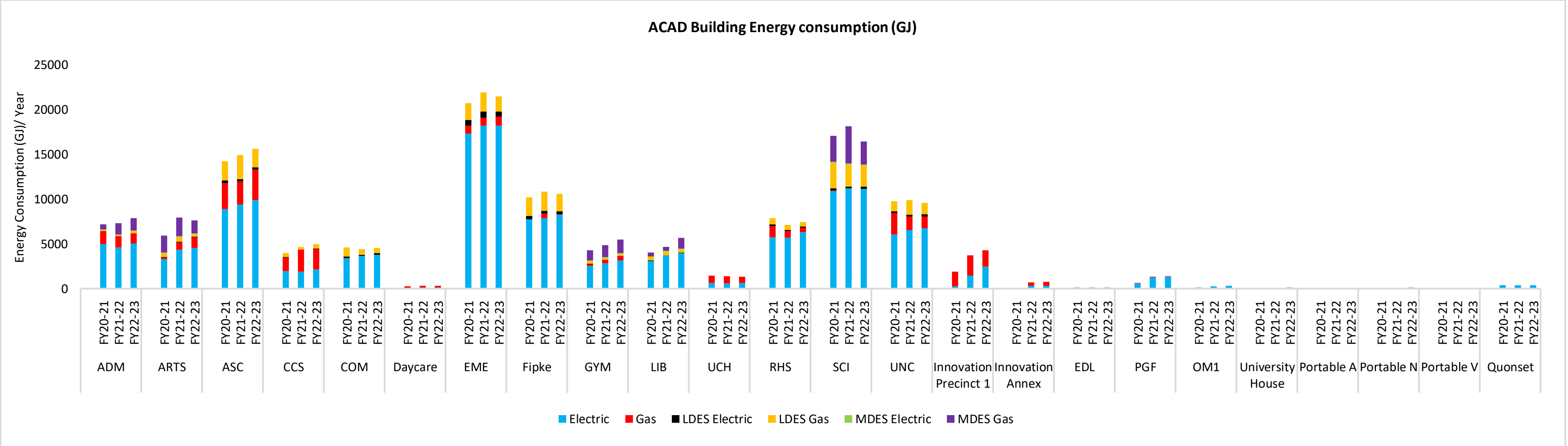


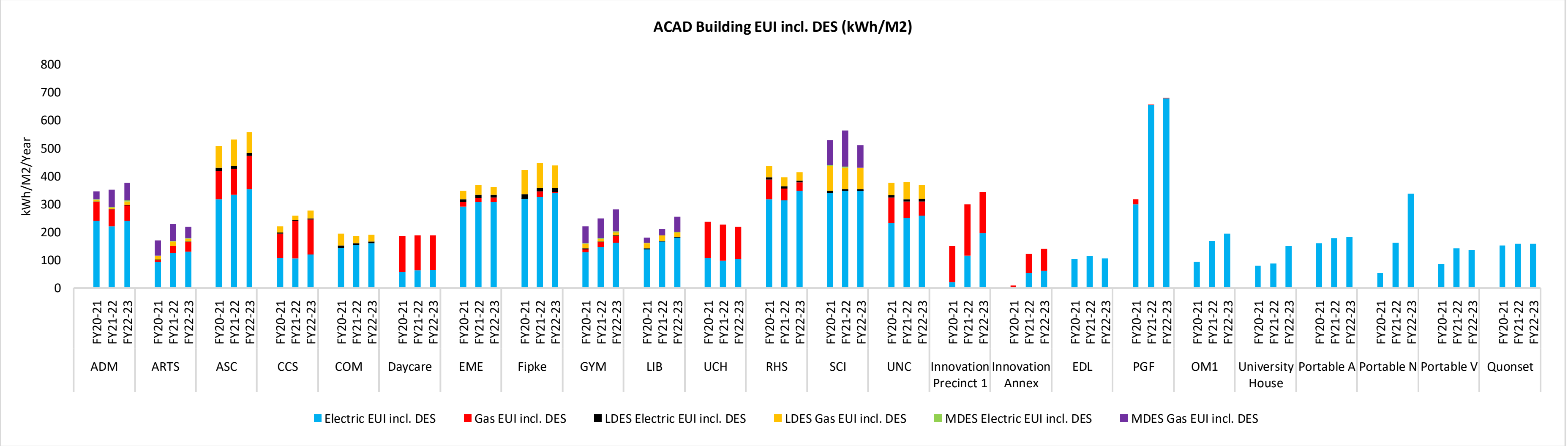
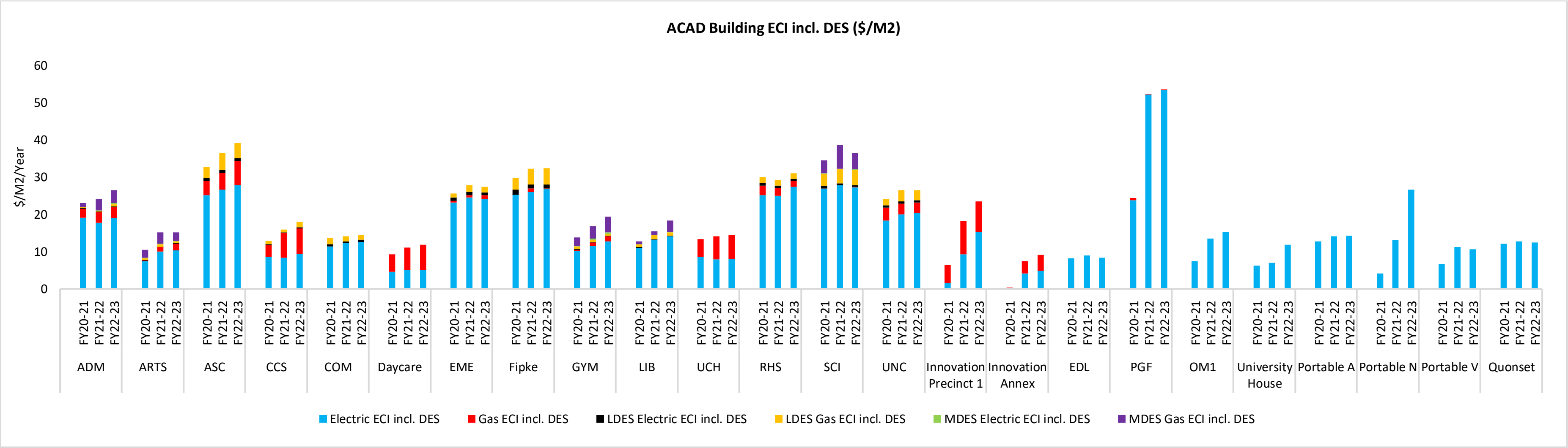


Figure 11: Energy Use and intensity for Campus Academic Buildings



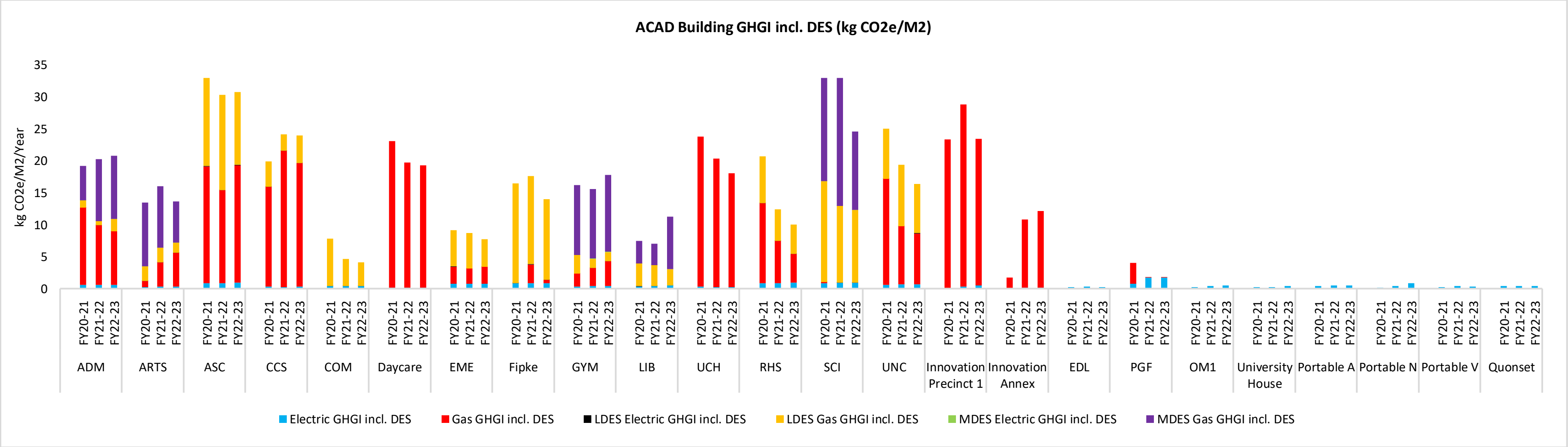


Figure 12: Energy cost and GHG Intensity for Campus Academic Buildings

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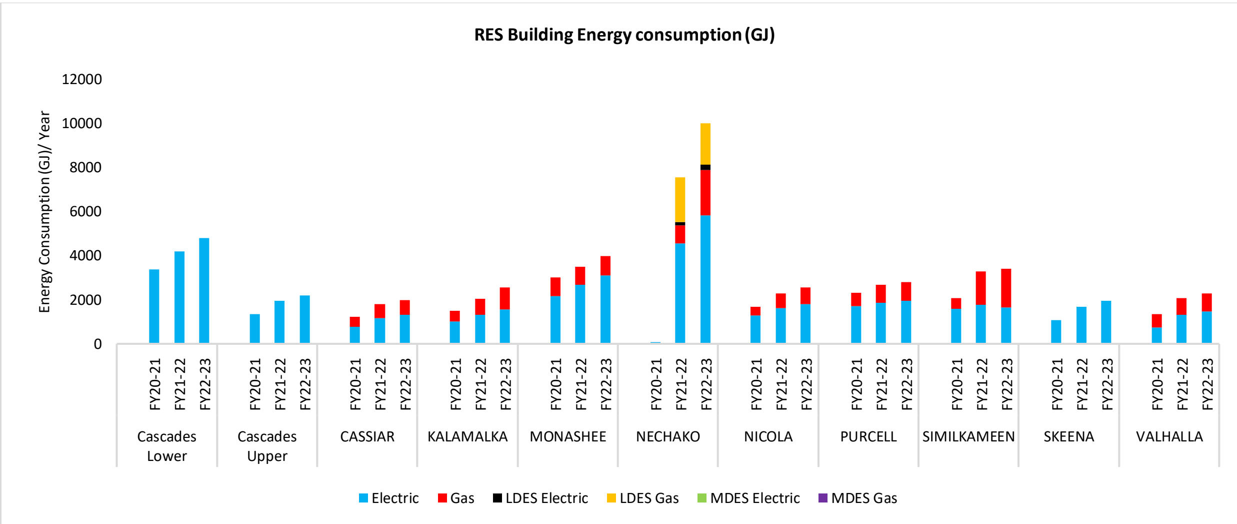
Due to their lower occupancy and use, residence EUIs are significantly lower than those of academic buildings. As mentioned earlier, a reduction in overall intensity was observed in FY20-21 due to reduced occupancy as a result of COVID-19. Nechako EUI is higher because of large commercial kitchen in the building.



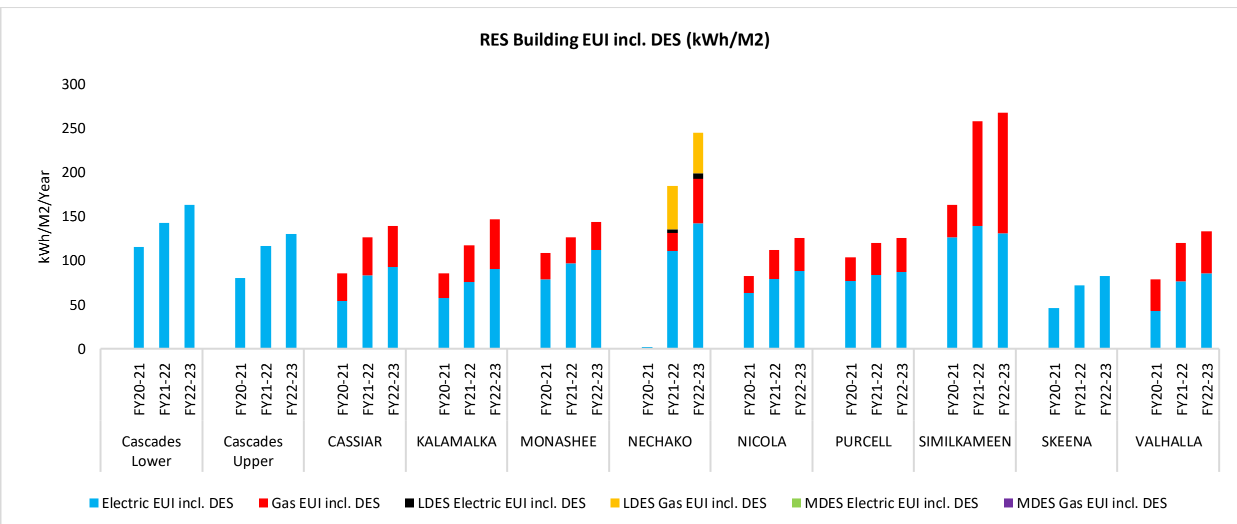


Figure 13: Energy Use and intensity for Campus Residence Buildings

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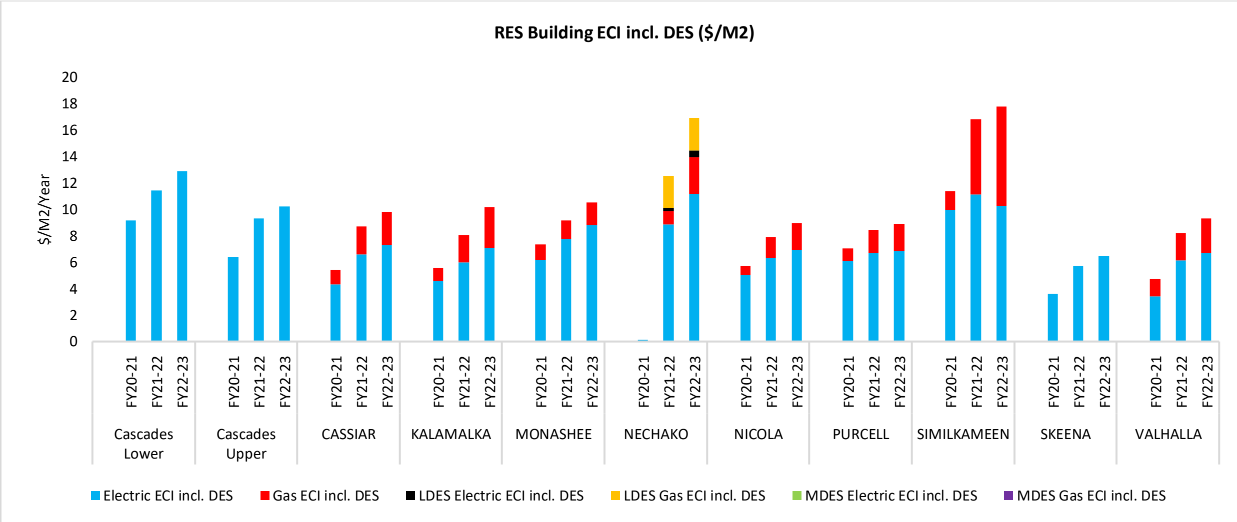

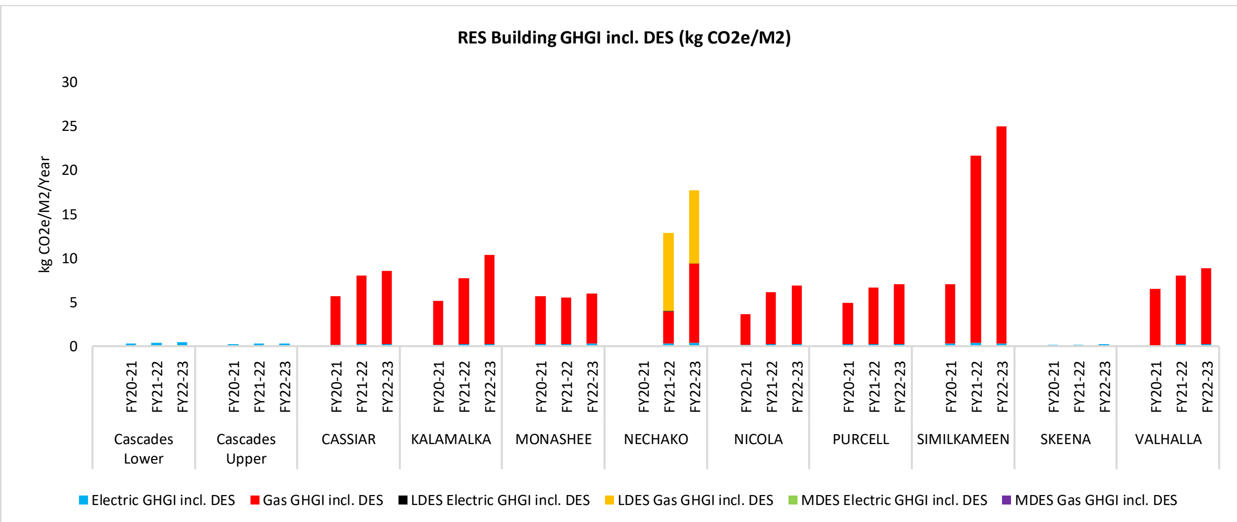

Figure 14: Energy cost and GHG Intensity for Campus Buildings

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.

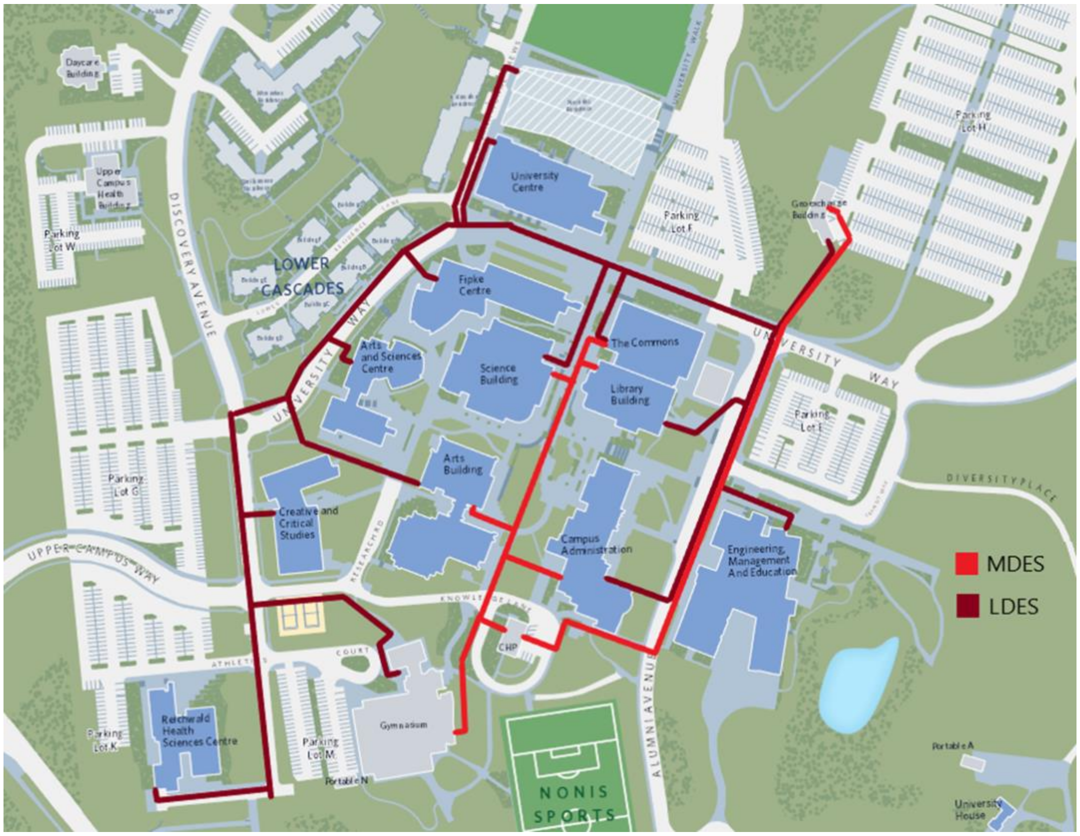

Figure 15: Map of the current status of District Energy Systems

3.1 MDES - Medium Temperature District Energy System

The medium temperature district energy system (MDES) delivers hot water to the five legacy academic buildings on campus (ADM, ARTS, GYM, LIB and SCI with total floor area of 35,500 m^2). Heat is supplied to the building mechanical plant from boilers in the Central Heating Plant (CHP) building at 80°C (176°F) supply water through a 150mm (6”) insulated carbon steel piping over 200 trench meters (656 feet). The boilers in the CHP building consist of:

- 1 x 440 kW (1,500 MBtu/h) natural gas input condensing dual-return boilers
- 2 x 967 kW (3,300 MBtu/h) natural gas input condensing dual-return boilers
- 2 x 1.9 MW (6,500 MBtu/h) natural gas input atmospheric boilers

While three 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

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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.

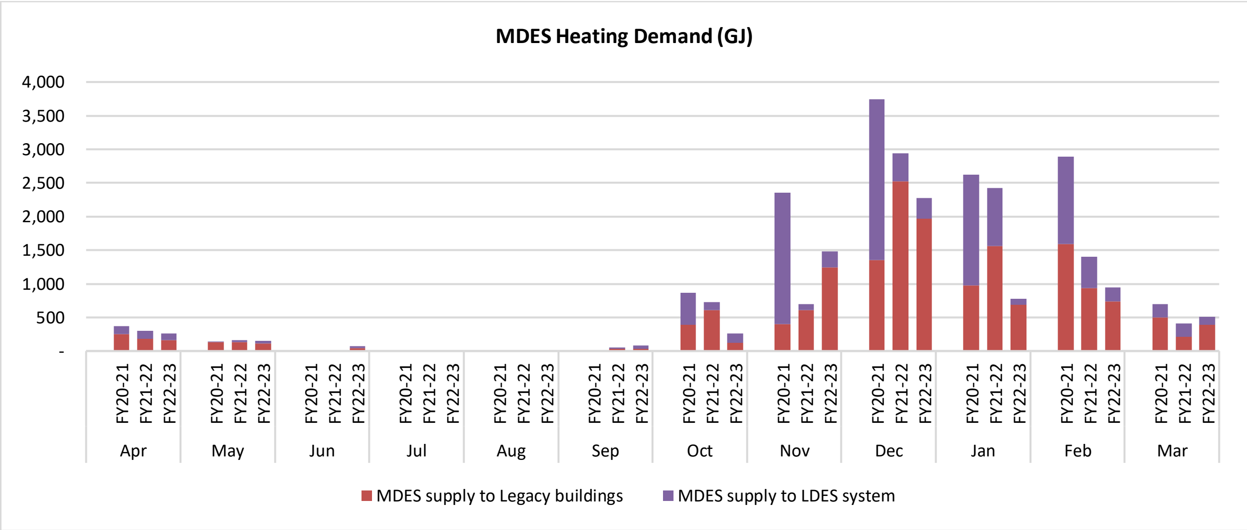

Figure 16: Thermal Energy demand from the MDES plant

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. Although, these load shifts have reduced both the thermal loads on the MDES as well as the gas consumed by the central heating plant.

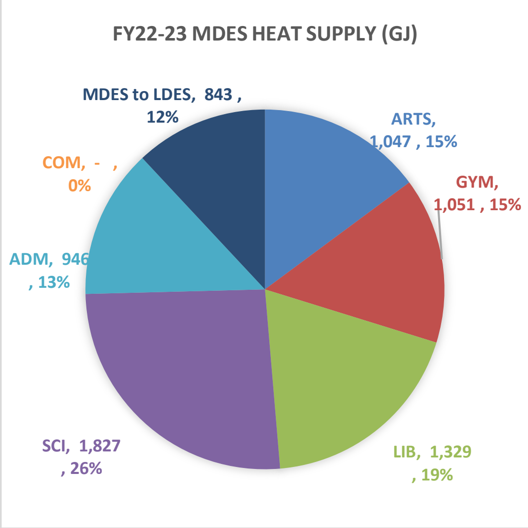

Figure 17: Heat Supplied from the MDES plant to various demand buildings for FY22-23

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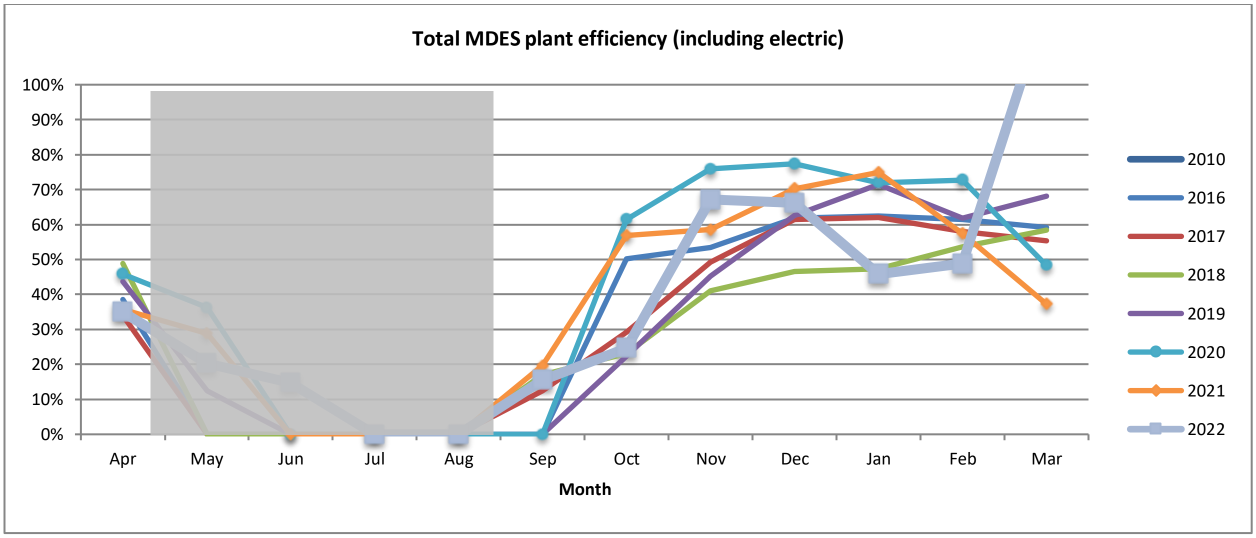

Figure 18: MDES plant efficiency

MDES plant efficiency went down in the heating season of FY22-23 compared to last two fiscal years FY20-21 and FY21-22 due of reduced heat supply to LDES plant from MDES (8,114 GJ in FY20-21 compared to 2,332 GJ in FY21-22 and 1,312 GJ in FY22-23). Investigations are currently underway regarding a known issue where, during part load conditions, a substantial portion of flow is being recirculated through the boilers. As a consequence, the return water temperature to the boilers increases, leading to reduced boiler efficiencies.

3.2 LDES - Low Temperature District Energy System

The low temperature district energy system (LDES) on campus currently delivers ambient temperature water in the range of 8°C to 25°C (46°F to 77°F) to most academic buildings (EME, CCS, FIPKE, GYM, RHS, LIB, SCI, ADM, UNC, COM, ARTS, ASC, NEC) on campus through a PVC pipeline[8]. Heat pumps within the building further use this ambient temperature water as a source for either heating or cooling. Domestic hot water (DHW) pre-heat exists on a case-by-case basis. 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.

In the LDES system, heat is injected or rejected from the loop with a combination of gas boilers, connection with MDES, open-loop groundwater geo-exchange, and fluid coolers. The Groundwater Geo-exchange system contains 4 supply wells that can extract up to a total of 150 lps (2,378 gpm) of groundwater which goes through double-walled shell and tube heat exchangers to extract/ reject heat. The groundwater is then returned to the local aquifer via 2 infiltration basins that can handle 30 lps (476 gpm) of water. LDES system also contains one 1.2 MW (4000 MBtu/h) condensing natural gas boilers. In addition to this boiler, heat exchangers that connect the MDES and LDES plants were installed and made operational in 2019. These heat exchangers allow the dual-return condensing boilers in the MDES central

[8] LDES is not connected to all the Residences (except for the Nechako Commons) and UCH, DAYCARE and 1540 INN DR Academic buildings.

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plant to utilize the low temperature LDES water to achieve high boiler efficiencies. In order to reject heat from the system, three hybrid fluid coolers are used that have a nominal cooling capacity of 1.4 MW (400 tons) each. These are wet cooling towers that utilize evaporative cooling to cool water below the outdoor dry bulb air temperature.

LDES system utilizes a low cost 2 pipe network supplying ambient water to building heat pumps which generate hot and cold water for use within the building. Three 93 kW (125 horsepower) pumps located within the LDES plant circulate water around the LDES loop. The piping network consists of over 2,000 trench meters (6,560 feet) of 400mm (16") PVC uninsulated pipework that is buried below the frost line. Insulation on the distribution piping is not required due to the relative temperatures of the LDES water and the ground.

- Pipes 100 to 300 mm (4 to 12") dia. - AWWA C900 SDR 25 or Series 160 DR 26
- Pipes 350 to 1200 mm (14" to 48") dia. - AWWA C905 SDR 25 or Series 160 DR 26

Every building connected to the current LDES system has its own building scale heat pump system to transfer heat into hydronic heating and/or cooling systems.

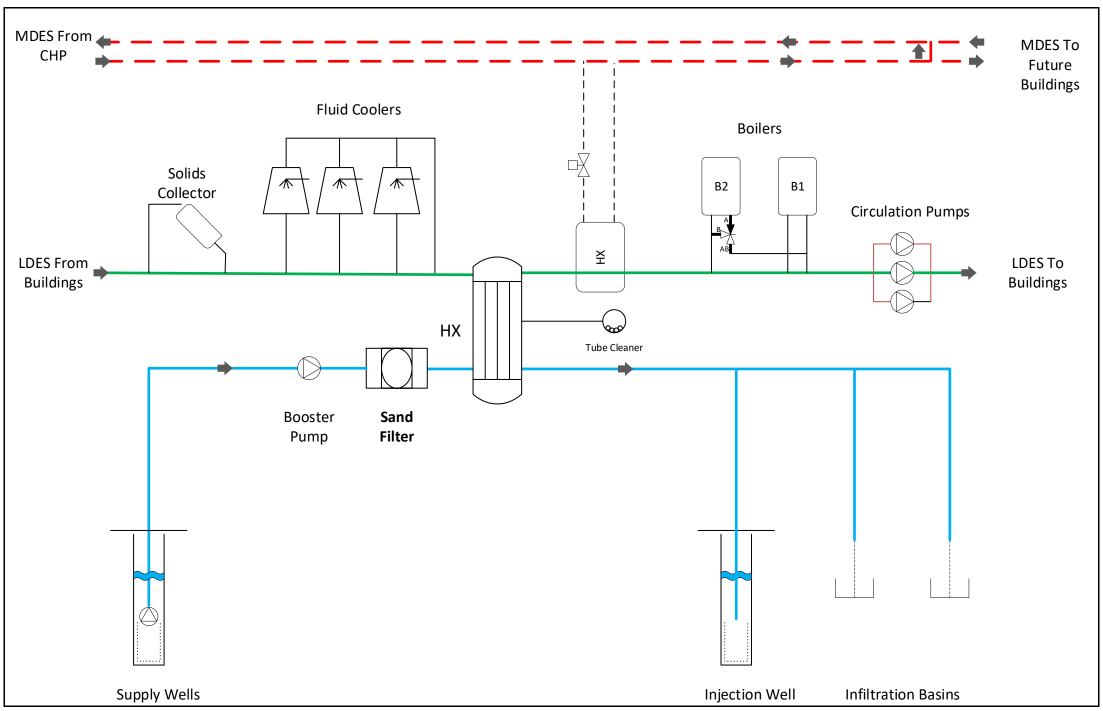


Figure 19: LDES plant block diagram

The Figure 20 below shows the amount of heating/cooling demand from the LDES-connected buildings. The columns above the x-axis represent the heating demand from LDES-connected buildings whereas columns below the x-axis represent the cooling demand from the LDES-connected buildings. In the figure, the energy amounts shown as "Free Heat" or "Free Cool" account (in black) 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 (around 7.50%)

results in energy savings as the central LDES plant does not need to generate the heating/cooling. The "Free" 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 "Free" energy source. An increment in heating and cooling demand was observed in FY21-22 and FY22-23 compared to FY20-21.

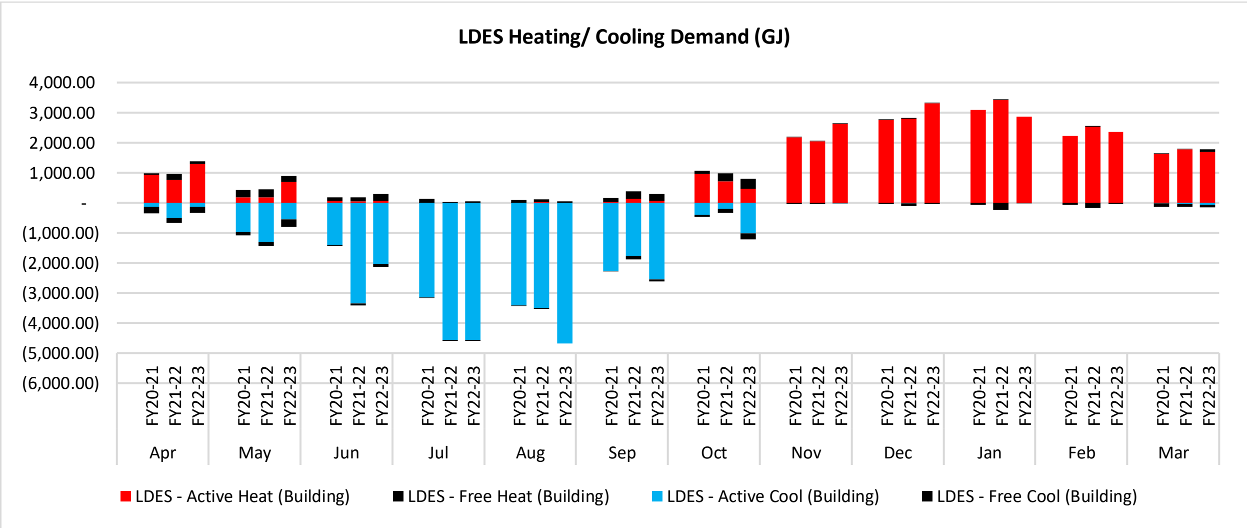


Figure 20: Thermal Energy demand from the LDES plant

Figure 21 shows the various sources of heat injection and rejection in FY22-23 and Figure 22 shows the breakdown heating or cooling supply between various buildings from LDES plant.

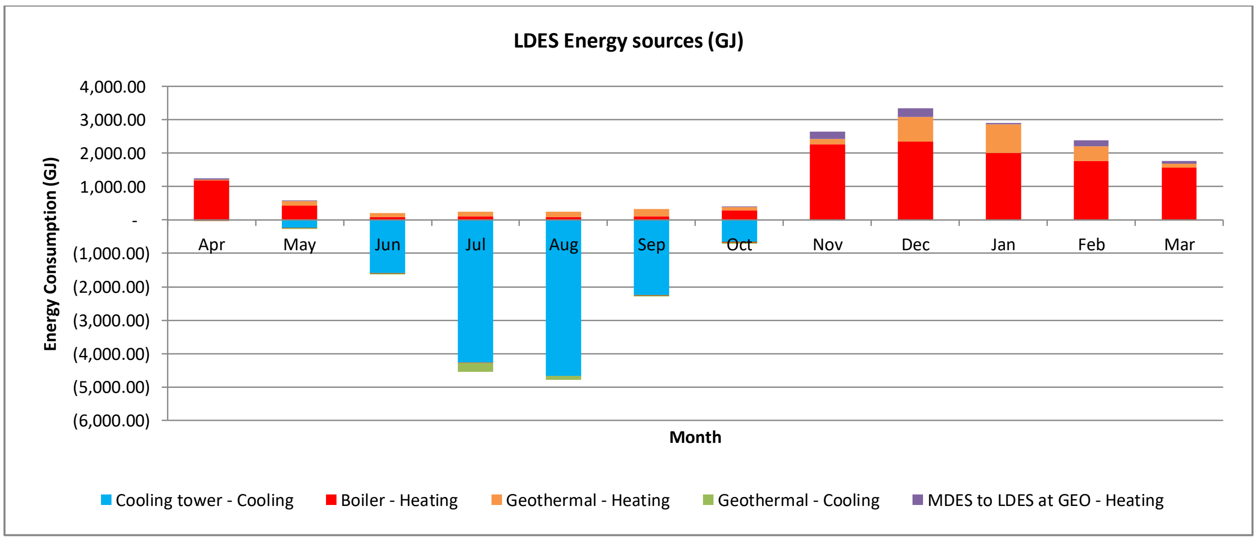
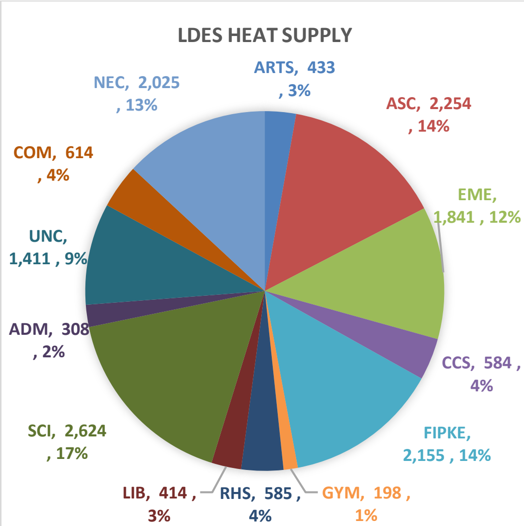


Figure 21: LDES Heating and Cooling Sources for FY22-23



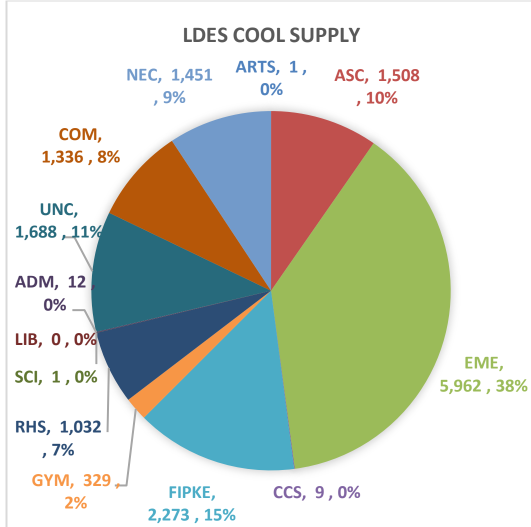
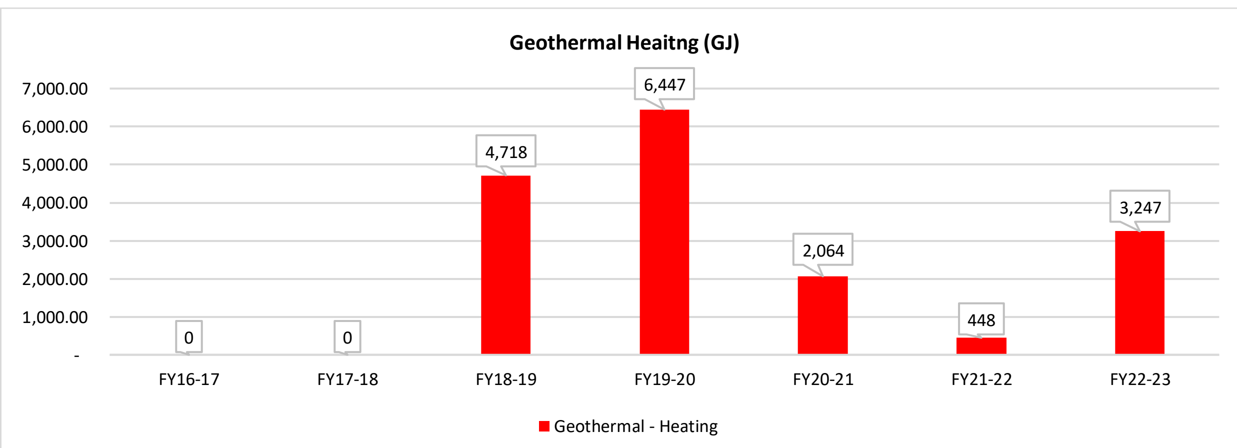


Figure 22: Heat Injected/ Rejected from LDES plant to/from various buildings for FY22-23

3.2.1 LDES – Heating

Heat is provided to the LDES through three different sources 1) a heat exchanger connection to the central heating plant, 2) a high-efficiency condensing boiler, and 3) an open loop groundwater geo-exchange 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. Approximately 3,247 GJ of heat was extracted from geo-exchange system in FY22-23 compared to 448 GJ of heat extraction in FY 21-22 and 2,064 GJ in FY20-21 (Refer to Figure 23). The geothermal can provide effective cooling but does have environmental risks injecting warm water back to the earth.



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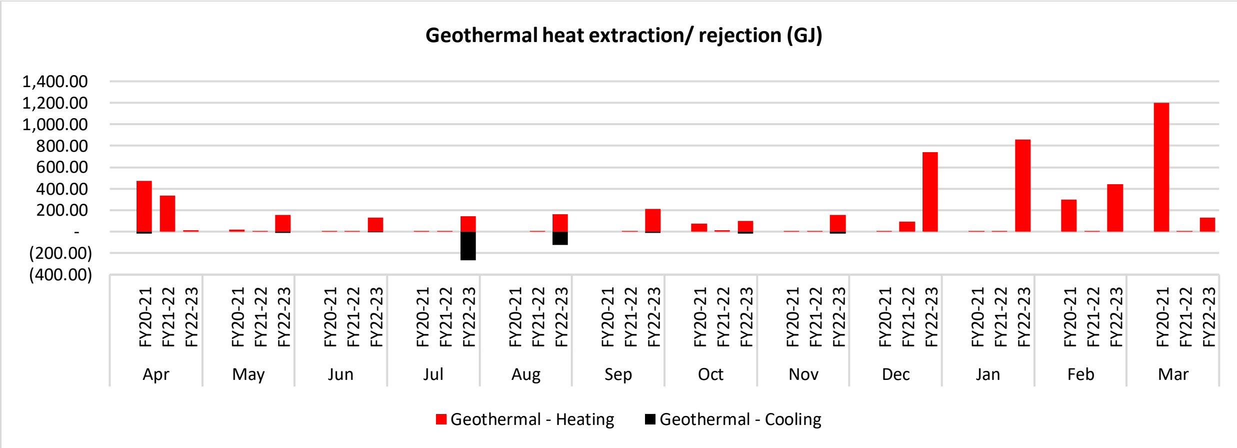

Figure 23: Quantities of Heat extracted/ rejected from Groundwater geo-exchange system

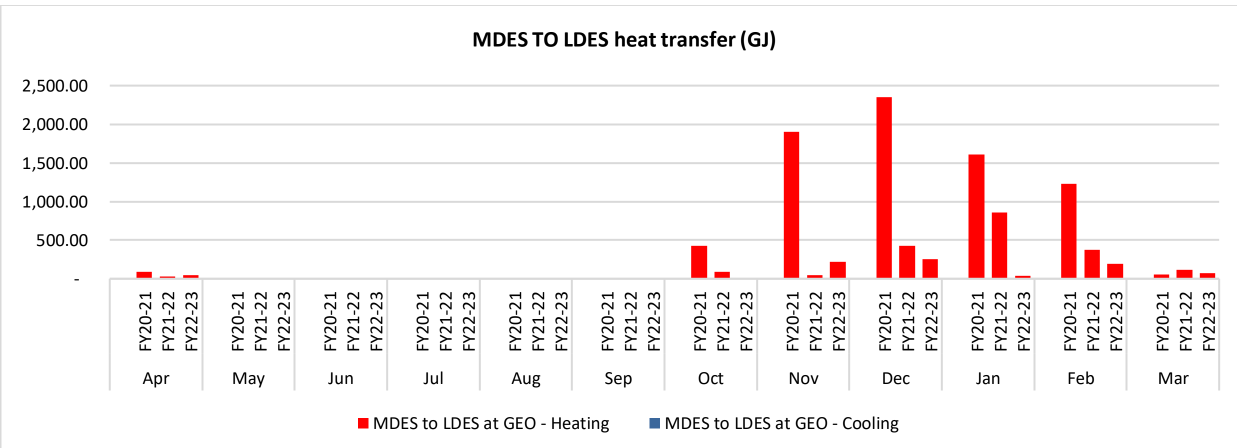

Figure 24: Quantities of Heat extracted from MDES to LDES system

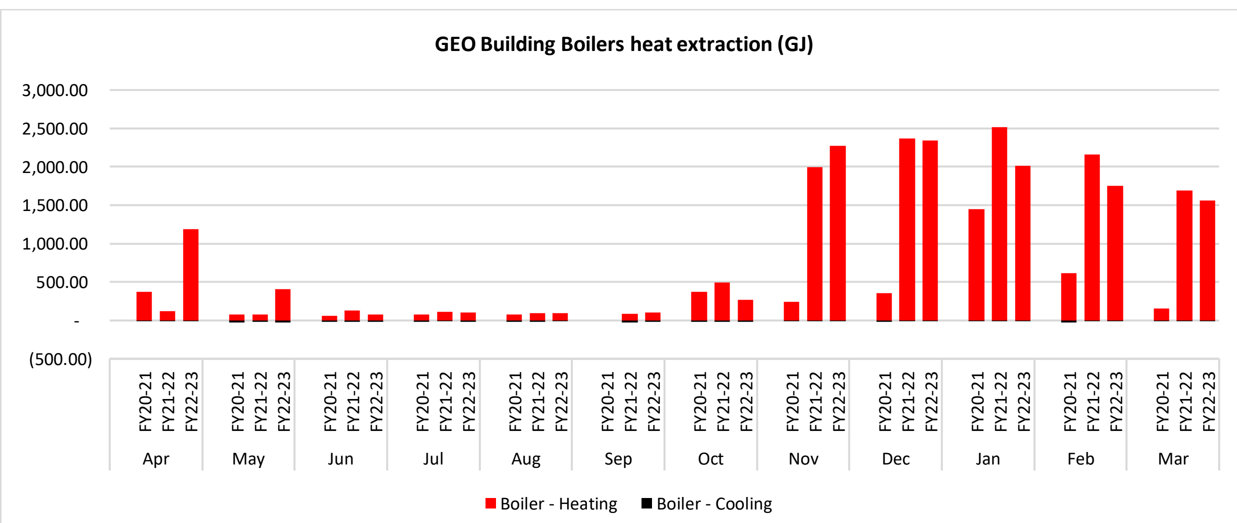

Figure 25: Quantities of Heat extracted from GEO boiler system

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Figure 23, Figure 24, Figure 25 present the historical comparison of various LDES heating sources. Figure 26 shows the heating efficiency for the LDES system. In general, the heating efficiency is less than 100% however, due to open-loop Geo-exchange system efficiency of the system goes above 100%.

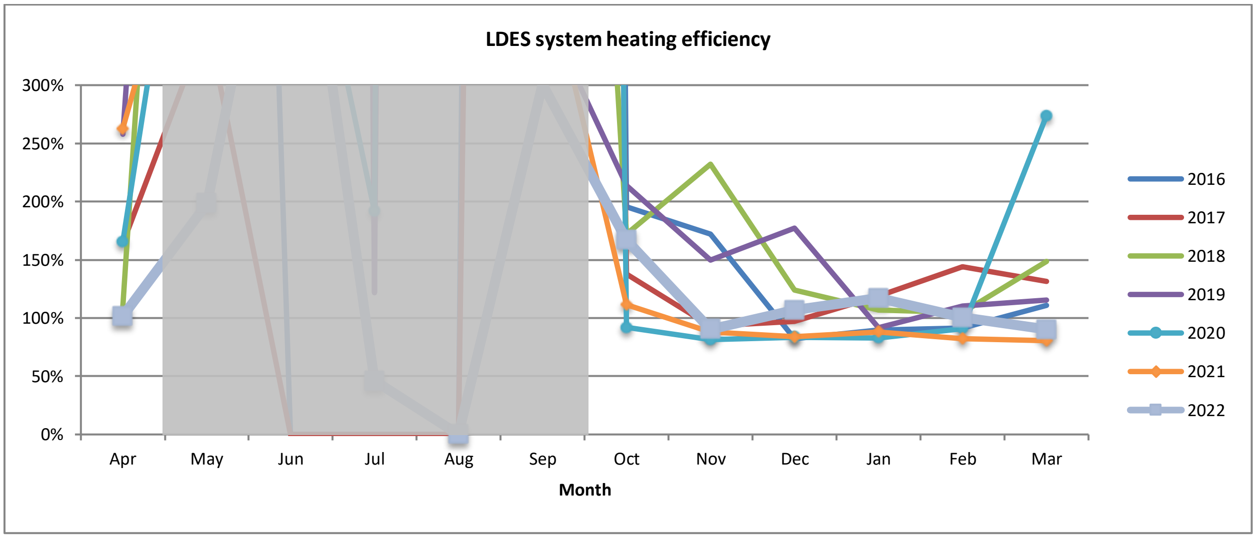

Figure 26: LDES System heating efficiency[9][10]

3.2.2 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 13,658 GJ for FY22-23, similar to cooling load in FY21-22 at 14,232 GJ and FY20-21 at 12,568 GJ.

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.

[9] Refer to months between October to April for heating system efficiency
[10] Due to heat rejection from LDES during summer months, LDES heating efficiency is more than 300%. In order to highlight the LDES heating efficiency during heating season, x-axis is capped at 300%.

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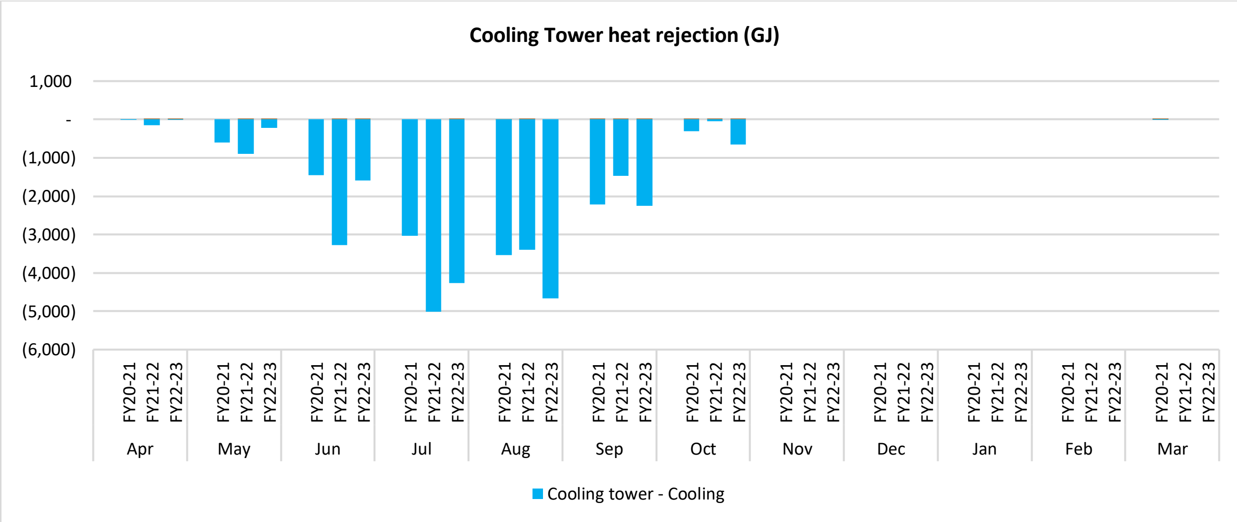

Figure 27: Quantities of Heat rejected by cooling towers

The Figure 27 above shows the heat rejected by the cooling towers in the LDES system. Figure 28 below shows the cooling COP of the LDES system which is around 17 during peak cooling season.

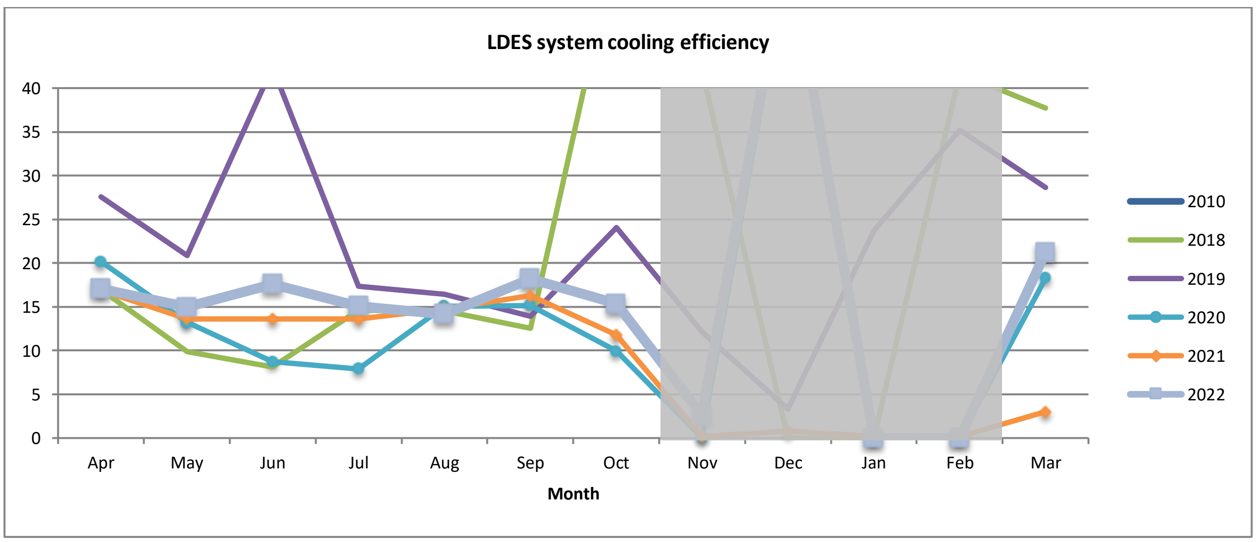

Figure 28: LDES Cooling Towers Heat Rejection Energy Efficiency[11]

[11] Refer to months between March to October for cooling system efficiency

4 Energy Policies and Strategic Development

UBCO Energy Team is involved with development of strategies for optimizing future campus energy use. Appropriate policies and guidelines assist in meeting campus energy goals and as such are championed by the Energy Team. Significant developments in energy-related campus guidelines and policies that occurred in the past quarter are described below.

4.1 Strategic Energy Management Plan (SEMP) 2020

Strategic Energy Master Plan (SEMP) evaluates demand-side measures i.e., 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. The Energy Team is currently in the process of updating the Strategic Energy Management Plan (SEMP). This update involves conducting a variance analysis between SEMP 2020 and the current status, and also develop plans for implementing demand-side measures in the upcoming years.

Energy Team is working on implementing the Energy Conservation Measures (ECMs) identified as per the SEMP 2020. Following are the identified measures for the first two years:

1. Campus-wide lab demand-controlled ventilation
    a. Occupancy- based Demand Controlled Ventilation (Implementation completed for a portion of SCI building, implementation underway for a portion of ASC and FIP building)
    b. IAQ-based Demand Controlled Ventilation (Implementation completed for a portion of SCI building)
2. Recommissioning of existing controls at ARTS building (Completed)
3. Night-time precooling (Completed)
4. Waste heat recovery from strobic exhaust for SCI building (Investigation underway)
5. Recommissioning of existing controls at EME building (Investigation underway)
6. LED lighting upgrade for Plant Growth Facility (Implementation underway)
7. District Energy Optimization (Investigation underway)
8. Waste heat recovery from strobic exhaust for EME building
9. Recommissioning of existing controls at LIB building
10. Conversion of high temp to low temp terminal unit and CAV to VAV for ARTS building

4.2 High- Level Net-Zero Carbon District Energy (DE) Strategy

The UBC Okanagan (UBCO) campus doubled in size between 2008 and 2010 and may again be on a path of significant growth with the addition of the Innovation Precinct. This has motivated further analysis and consideration of district energy strategy with a view of modernization, renewal, and growth to serve both existing and new load.

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

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- Greenhouse gas emissions
- Adaptability to regulatory and technology changes
- Phaseability
- Resiliency

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 was completed in July 2020 and compared different district energy system options against this reference case. The options being compared included a 4-pipe cold and medium temperature DES, a low temperature DES and a hybrid between the two.

As discussed in Section 3.2. the existing strategy[12] to distribute heat from the existing LDES system is to install building scale heat pump system in every building to transfer heat into hydronic heating and/ or cooling systems. Employing this strategy to date has provided many benefits as follows:

- Energy Efficiency and Carbon
  - Compatible with many low carbon and waste heat resources
  - Enables energy sharing within and between buildings
  - Minimal distribution heat losses
  - Optimizes boiler efficiency
- Campus and Building Operations
  - Centralized maintenance
  - Simple and low-cost pipe infrastructure
  - Reduced space requirements for building mechanical equipment
  - Takes advantage of campus system diversity
  - Provides for both heating and cooling

Current LDES benefits aside, the investment in smaller scale heat pump equipment in every connected building has higher capital and operating cost relative to district energy alternatives with more scale (Refer to Figure 30). As such, transition is focused on aggregating load, preserving benefits, and improving performance. Outcome of the DE Strategy Phase 2 identified hybrid cluster plant approach i.e. "Zone-scale heat pumps generating hot & chilled water and distributing through a 4-pipe system to all new buildings within the associated building cluster. LDES connection between the distributed plants" (Strategy # 4) as a low cost strategy for the campus and best positioned to achieve carbon emission reduction goals. District energy utility service simplifies building operations, maximizes resilience, and provides a foundation for the integration of waste heat, renewable energy, and other low carbon energy sources.

[12] Refer to Figure 31 for cost details for this Strategy # 3

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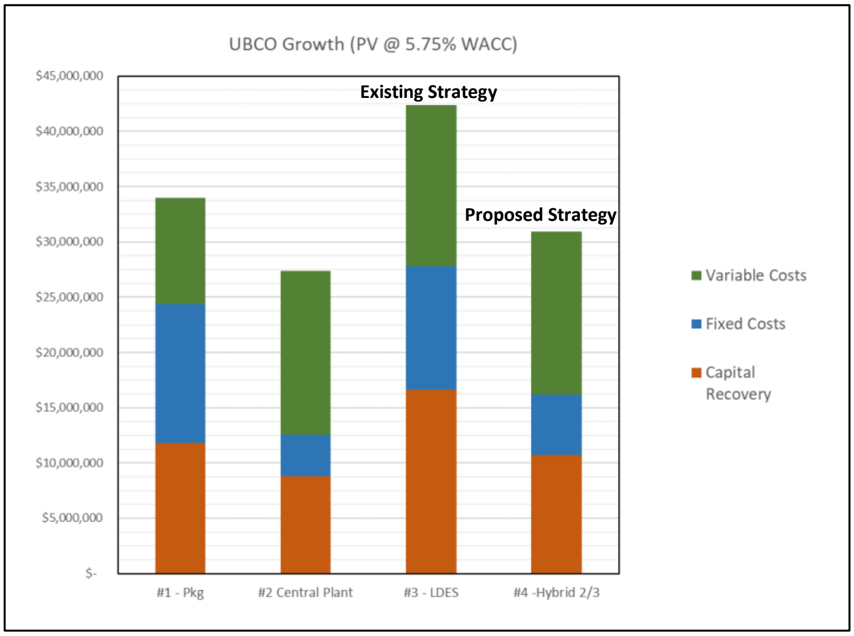

Figure 29: Cost comparison of various alternatives for new building growth

The district energy strategy progressed in three stages and was reviewed by a Whole Systems Steering Committee consisting of three AVP-level representatives from the offices of Finance and Operations (Okanagan), Campus and Community Planning (Vancouver), and Infrastructure and Development (Vancouver), and five director-level representatives from the offices of Integrated Planning and Chief Budget Officer (Okanagan), Campus Operations and Risk Management (Okanagan), Campus Planning and Development (Okanagan), Energy and Water (Vancouver), and Sustainability and Engineering (Vancouver).

A decision was made by the UBC Whole Systems Steering Committee to proceed with utility services as a distributed central plant District Energy System. With the distribution and energy transfer station strategy set, the focus turned to DE decarbonization, as well as a strategy for service to the new Interdisciplinary Collaboration and Innovation (ICI) building on the main campus.

The ICI building was determined to be a good location for a zone scale plant (Cluster plant or mini plant) for the following reasons:

- First opportunity
- Avoid cost and land use of standalone plants in individual buildings
- Proximity to MDES/LDES mainlines
- Proximity to future growth and existing buildings

Energy Team worked with the DE Consultant to advance the schematic design and development of the cluster plant in the ICI building. Figure 31 below provides schematic of the ICI cluster plant. In the ICI cluster plant, electric chillers reject condenser heat to the LDES. Dedicated heat recovery chillers intercept waste heat and cool the LDES to provide space heat and domestic hot water (DHW). Hot and

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chilled water TES provide for peak capacity, electric demand response, and the integration of more waste heat and renewable energy. MDES is designed for backup, peaking, and polishing as needed.

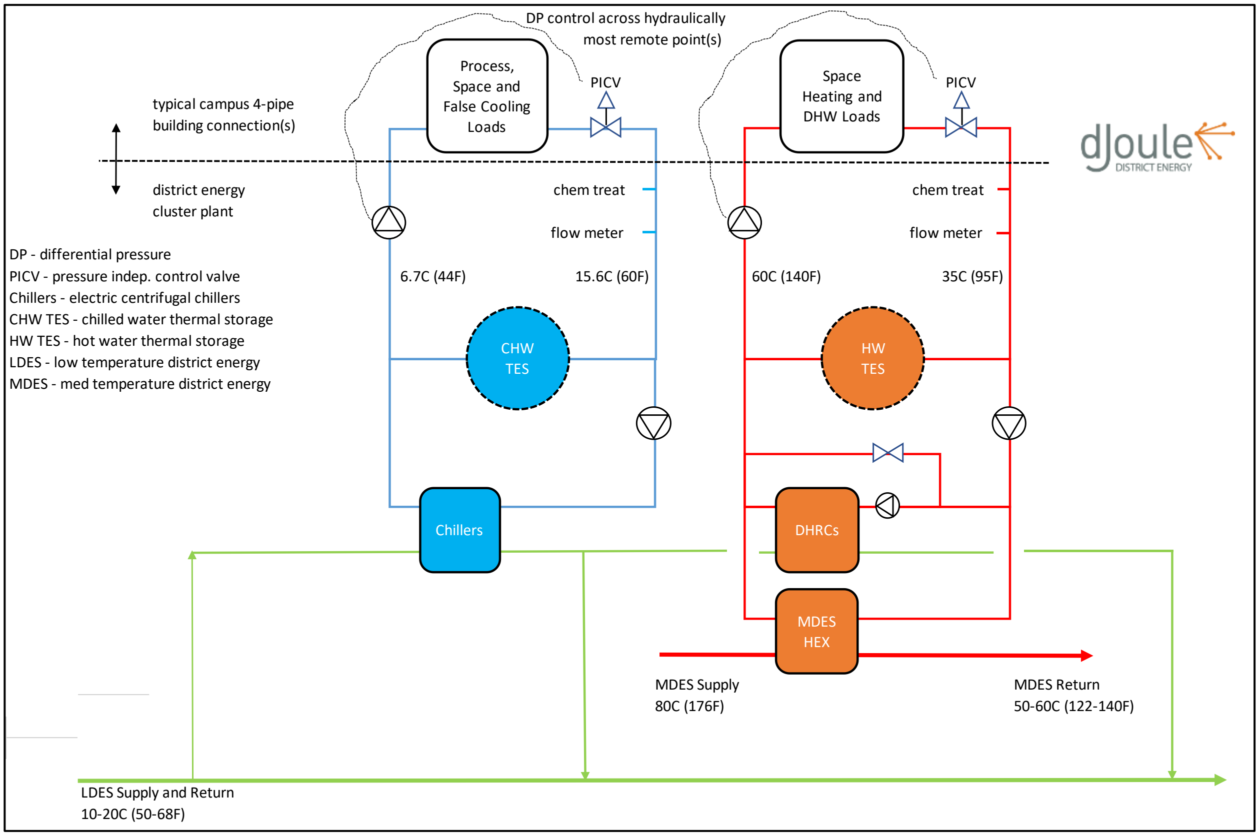

Figure 30: ICI Cluster plant proposed high-level design

The cluster plant at the ICI building was accepted and approved by UBC executive team. Energy Team has been working diligently with UBC Properties Trust and their consultant in implementation of cluster plant at the ICI building and its associated connection with adjacent buildings.

In terms of DE decarbonization, the key strategy for decarbonization features the integration of air source heat pumps (ASHP) and hot water thermal energy storage (TES). This approach is designed for baseload down to outside air temperatures as low as -5C (23 deg F) before gas boiler heat is required. These hours represent less than 10% of the annual operating hours in a year.

The next phase of the DE strategy included schematic design and economic assessment of an Air Source Heat Pump (ASHP) and thermal energy storage (TES) plant near the GEO building.

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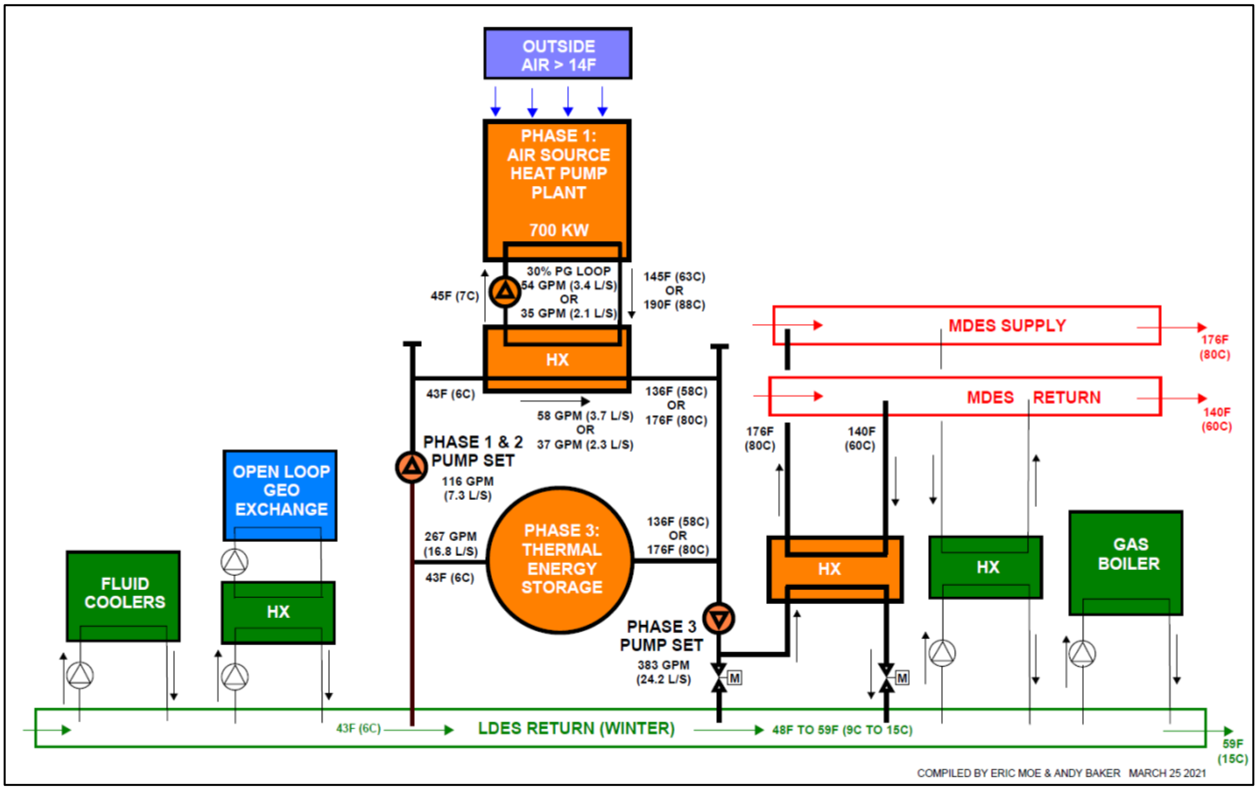

Figure 31: DE Decarbonization schematic design

A schematic design and economic assessment of an Air Source Heat Pump (ASHP) and thermal energy storage (TES) plant near the GEO building was conducted in subsequent DE strategy phase. Currently, work is underway to advance this strategy, explore other low carbon heating sources/ technologies through a study and install ASHP (Phase 1 of DE decarbonization strategy) by FY24-25.

In order to advance DE Strategy, Energy Team has engaged UBCO Project Services and/ or direct consultants to kick off four parallel projects which include:

- Phase 1 of DE decarbonization strategy i.e. installation of ASHP and boilers for heating redundancy and
- Phase 2 of DE decarbonization strategy i.e. Thermal Energy Storage
- Installation of ICI 4-pipe infrastructure to serve heating and cooling demands of surrounding buildings from ICI cluster plant.
- High level concept design for an Upper Innovation Precinct Cluster Plant.

4.2.1 Geo-Exchange Air Source Heat Pump Study

A feasibility study to investigate the ASHP addition for Phase 4A of the TES/ASHP integration, which will provide 700 kW of thermal heating capacity to the LDES. In addition to the ASHP addition, the study will also include the addition of two 1,200 kW backup boilers. A market review of ASHPs was undertaken to get an understanding of what products and technologies are currently available in the market. The technical performances of different options were evaluated by comparing different metrics between units including thermal capacities, efficiencies, turndowns, costs and more.

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Electrical requirement and costing exercises were also conducted as part of this study. Based on the proposed mechanical systems in terms of overall electrical demand, there is sufficient available spare capacity on the existing 1,200 A, 600V geo-exchange service to support the mechanical works without requiring a utility service upgrade with FortisBC.

The implementation of boiler portion of the project is currently underway. Air-Source heat pump portion of the project has been delayed due to budget constraints and will likely be implemented in next 2-3 years.

4.2.2 Thermal Energy Storage (TES) for LDES plant Study

This study will focus on recommending a few TES tanks, recharge strategy along with developing a concept design to install a changeover TES tank including system schematic markups. It will also include sensitivity analysis and a Class D cost estimate to implement the TES tank. In March 2023, the study was finalized, and it determined that the implementation of a Thermal Energy Storage strategy would require a significant investment while yielding relatively minor energy benefits.

4.2.3 ICI 4-pipe infrastructure Study

A study to advance ICI cluster plant connection to existing adjacent buildings was completed in October 2022 by an Engineering consultant. This study investigated the feasibility and cost associated with the installation by only using pre-insulated Logstor steel piping. The estimate showed a significant portion of the costs coming from the high cost of supplying and installing the carbon steel Logstor Twin Pipe product for the heating and chilled water piping.

This existing study is being extended to investigate alternative piping systems that may be more cost effective than the carbon steel Logstor Twin Pipe product and can be used for expansion of the 4-pipe campus district energy system from the Interdisciplinary Collaboration & Innovation Cluster Plant to several surrounding buildings on campus.

In March 2023, the study was finalized, and it recommended HDPE for the chilled water piping network as it is a cost-effective solution that is readily available to the local market, with an abundance of local installation experience. For the heating water piping network, study recommends either the Logstor Twin Pipe or traditional carbon steel pipe due to the degradation of the system pressure in thermoplastic pipes as the system temperature increases.

4.2.4 High-level concept design for an Residence Cluster Plant

This study is being carried out to explore thermal system configurations to meet the demands of two (2) existing residence buildings, Skeena (2020) and Purcell (2011), and two (2) yet-to-be constructed residence buildings. Energy and Carbon performance of four potential thermal system configurations are being evaluated:

- “Business-As-Usual” configuration with standalone systems per residence
- Standalone system configuration with Low Temperature District Energy System (LDES) connection per residence
- Cluster Plant configuration distributing Low Temperature Heating Water (LTHW),

- Cluster Plant configuration distributing Medium Temperature Heating Water (MTHW).

This study was completed in March 2023.

4.3 Campus-Wide High Voltage Master Electric Plan

Energy Team is working with engineering consultant to analyze the current campus wide high voltage electrical distribution systems and develop a strategy to best support the campus's future needs including:

- Prepare for campus buildout and the addition of new buildings including the Innovation Precinct expansion plans.
- The electrification of existing buildings
- Enhance the energy resiliency for advanced research applications.
- Provide energy savings to the campus
- Implementing revenue generating services that produce a return on investment. (ie. Providing infrastructure for electric vehicle charging)
- Allow capability for future onsite generations, combined heat and power, battery storage , local PV
- Highlighting critical loads including heating, cooling, and research related items
- Providing resiliency and redundancy to the campus's electrical systems.
- Achieving UBCOs goal of net zero carbon emissions by the year 2050.
- Analyze the options of continuing with Fortis owned primary transformer vs transitioning to UBC owned primary transformers.

This study is currently underway and is expected to be completed in FY23-24.

4.4 Low Carbon Energy Strategy

Energy Team was tasked by the Whole Systems Steering Committee with developing a High-Level Net-Zero Carbon District Energy (DE) Strategy that would help inform realistic carbon emission reduction targets. The strategy included the completion of pro forma for various alternate energy supply options, as well as a sensitivity analysis and rough "order of magnitude" costs for each option as discussed in Section 4.2. The result was the selection of an option that was deemed to be the lowest cost for the campus, as well as the best option to achieve UBC carbon reduction goals, simplify building operations, maximize resilience, and provide a foundation for the integration of waste heat, renewable energy, and other low carbon energy sources in the future.

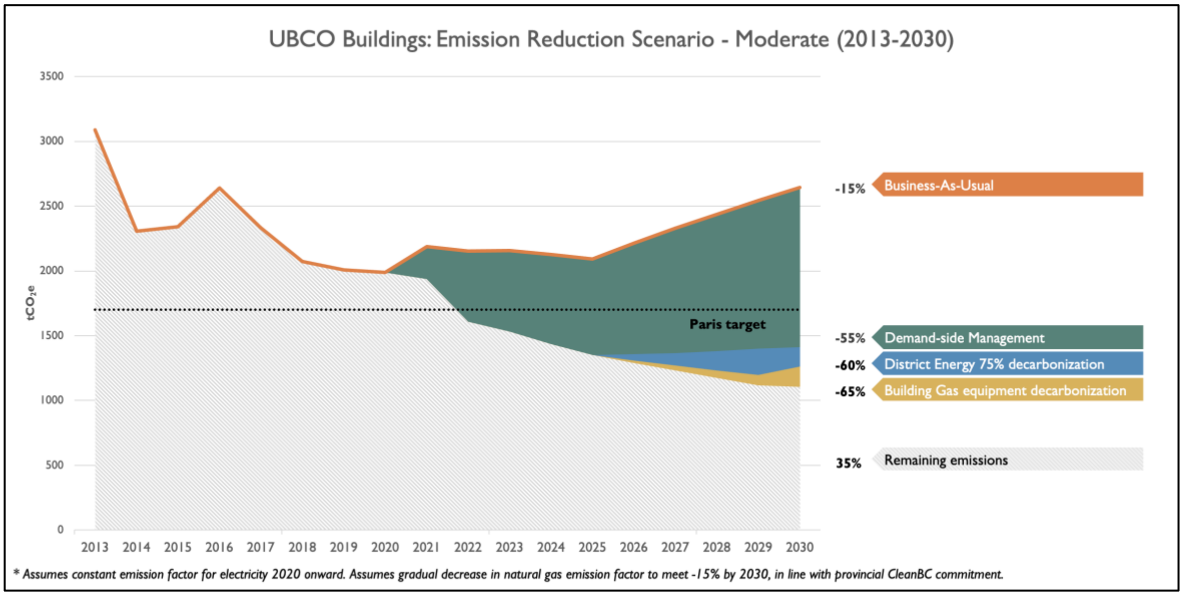

Figure 32: DE Decarbonization schematic design

Based on the strategy, a moderate (realistic) target of 65% emission reduction from 2013 levels by 2030 was recommended and accepted as CAP 2030 target. This can be achieved by partial decarbonization of the central plant, implementing projects that will reduce energy demand, and connecting select existing buildings to central energy supply systems (district energy).

Following are few of the potential challenges to achieving CAP 2030 targets:

- Addition of high-intensive research facilities
- Market economy: Rising costs of new construction buildings might impact implementation of energy efficiency measures as a result of value engineering
- Need for a low carbon energy supply to replace deteriorating Geo-exchange infrastructure
- New construction Residences and leased buildings needs to be aligned with UBCO CAP targets
- Grid electricity emission factor.

Energy Team is currently in the process of updating the energy-related CAP progress. This update involves conducting a variance analysis between CAP 2030 and the current status to inform strategic decisions.

4.5 Building Energy Targets

Energy Team worked with its consultant to update the five archetype energy models (Student Residence (no kitchen), Campus Rental Housing (with Commercial Retail Units and suite kitchen), Low intensity lab building, High intensity lab building, Classroom/Office building) from the previous 2016 UBC Net Positive Modelling Study and reflect UBC Okanagan campus typologies and climate zones based on current UBCO construction practices.

This work included formulating ECM bundles to identify achievable energy and greenhouse gas emission targets (TEUI, TEDI, GHGI) specific to UBCO, and then completing costing and financial analysis to

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identify the most cost-effective strategies to achieve those targets. Applicability of the proposed strategies to existing building retrofits was also considered.

A subsequent work to compare these parameters TEUI, GHGI, TEDI values for various archetypes from the study to other relevant standards and codes was completed in August 2022. This study also provided various energy targets for UBCO building archetypes.

Parameter	**Student Residence**	**Campus Housing**	**Dry Lab**	**Wet Bldg**	**Class / Office**
TEUI kWhr/m^2/yr	97	137	217	290	127
TEDI kWhr/m^2/yr	12	13	43	50	8
GHGI* $kgCO_2/m^2$/yr	6	9	13	16	6
Peak Heating W/m^2	14	10	28	31	29
Peak Cooling W/m^2	14	21	40	53	39
Peak Electric W/m^2	9	11	23	31	19

Energy Team has been working with UBCO leadership to adopt proposed energy targets for net positive ready buildings for Okanagan campus. These targets have been approved and will be included in the UBCO Green building action plan targets and technical guidelines.

Table below provides a snapshot of various Enclosure and Mechanical ECMs recommended by RDH for each archetype. The ECMs were selected based on the previous UBC Net Positive Modelling Study, other project experience, and with cost-effectiveness and market readiness in mind.

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ECMs	Student Residence	Campus Housing	Science Lab (low-density)		Lab (high-density)		Classroom/ Office
			Lab	Non-lab	Lab	Non-lab	
Enclosure							
Fixed windows, U-0.14, SHGC-0.37, VT 63%		X	X		X		X
Operable windows, U-0.17, SHGC-0.37, VT 63%	X	X					
Reduced SHGC to 0.25, VT 57%	X	X	X		X		X
Electrochromic glazing	X	X	X		X		X
Walls R-30	X	X	X		X		X
Roof R-45	X	X	X		X		X
Airtightness – 0.6 ACH @ 50Pa	X	X	X		X		X
Operable exterior shades (E/S/W-facing façade)	X	X	X		X		X
Fixed exterior shades (E/S/W-facing façade)	X	X	X		X		X
Reduced window-to-wall ratio	X	X	X		X		X
Mechanical							
90% efficient centralized HRV with bypass ventilating suites	X	X					
90% efficient centralized HRV with bypass (CRU only for Campus Housing)		X		X		X	X
Reduced corridor make-up air to corridors (10 cfm/unit)	X						
Reduced corridor make-up air to corridors (15 cfm/unit)		X					
Corridor supply air temperature nighttime setback of 18ºC	X	X					
Nighttime free cooling air flush	X	X	X	X	X	X	X
Variable speed FCUs with ECM motors (decoupling of DOAS and FCU if applicable)	X	X	X	X	X	X	X
Radiant heating/cooling ceiling panels (instead of FCUs)			X		X		X
Aircuity sensors to reduce lab ventilation rate (minimum 4 ACH occupied / 2 ACH unoccupied)			X		X		
Make-up air provided to lab from non-lab space			X		X		
Variable speed rooftop fan for lab stack exhaust			X		X		
Water-source heat pump for DHW top-up (from 120F to 140F) using DES hot water loop as source	X	X	X	X	X	X	X
DHW heat recovery	X	X	X	X	X	X	X

4.6 Indoor Air Quality monitoring

In response to COVID-19, UBCO increased ventilation rates in buildings across campus while maintaining comfortable indoor air temperature and humidity. In order to re-engage the occupancy sensors/ Wi-Fi-based controls, Energy Team has been tasked with developing a monitoring tool for CO2 sensors on campus and create a procedure to continue measurement and verification of air quality on campus. The CO_2 monitoring tool has been developed and is currently being actively employed to monitor air quality across the campus.

4.7 Energy Monitoring and Data Management Platform

Energy data for the campus is obtained from a number of sources including utility bills, manual meter readings, and building digital control systems. UBCO Energy Team has engaged with the UBCO School of Engineering to develop a custom data management system for the campus. This project aims to develop an intelligent data-driven energy monitoring and management system for micro-communities using statistical and advanced data analysis methods.

In the meantime, Energy Team has developed a utility tracking tool using advanced programming language knowledge python and excel to track overall campus utility consumption (Electricity, Natural Gas, Water, Sewer) as well as building-level consumption at the monthly, quarterly, and annual interval. The tracking is being done for three different parameters i.e. utility consumption, utility cost, and carbon emissions associated and various intensity parameters EUI, ECI etc.

However, due to the BMS integration challenges during project and limited resource constaints, a display platform has been developed which shows BMS sensor trends for utility meters, KPIs tracked in excel, and also creates a parallel database. In addition, Energy Team is spearheading implementation of SkySpark at UBCO campus. SkySpark is an advanced analytics software platform that enables intelligent monitoring and analysis of building systems and energy data. By utilizing SkySpark, the Energy Team aims to enhance energy efficiency, identify optimization opportunities, and improve overall performance across campus buildings.

4.8 UBCO HVAC Infrastructure Asset Management Database

Energy Team has been working with the Facilities Management to advance and update the Infrastructure HVAC Asset Management database and potentially linking this up with the major capital retrofit projects on campus in the near future. This also includes consolidating campus-wide DDC points, physical meters, and manual metering points in one location and further developing a meter tree. Due to Facilities Management Engineers workload and other issues, progress on this project has been slow. Additional resources have been hired in the CORM department to fast track this project as it will be a critical input to the asset management module of the Enterprise Maintenance Management System that UBCO will be adopting in FY24-25.

4.9 VLAN Upgrade

The intent of this project is to segregate the controls equipment for each building on campus into individual VLANs. This project has been undertaken and currently in progress for three key reasons which include communication control, increased security as well as plan for future additions as more equipment in the controls industry operates primarily with IP interfaces. This includes meters, lighting, chillers, and zone HVAC controllers.

The current network infrastructure is a hybrid configuration with a flat "facilities" VLAN that covers multiple building, in addition all new construction since the Commons (TLC) building has been configured into individual VLANs. This project will migrate the older buildings into their individual VLANs, eventually removing the "facilities" VLAN entirely. Once the VLAN migration is complete, the Desigo server is intended to become the central hub for communication control, avoiding broadcast information between buildings and many firewall rules needed to accommodate facilities network access for all BMS systems. The project is substantially complete.

4.10 Future Campus Construction

In order to ensure that future campus energy goals and targets are met, it is important that new buildings constructed on campus are designed and built to be consistent with the Whole Systems Infrastructure plan as well as other campus plans and goals. As such, the Energy Team has been involved in conducting technical reviews and setting goals, targets, and strategies as early as possible for future campus expansions such as new construction ICI building, Innovation Precinct 1, Nechako, Skeena, OM2. A detailed summary for each new building has been presented in Section 4. of this document.

In August 2021, UBC Executive team took a significant step towards sustainable development on campus by approving first cluster plant and provisions for thermal storage within the ICI building currently in design with occupancy anticipated for Jan 2025. This cluster plant is expected to serve thermal demand to surrounding buildings potentially CCS, ADM, EME, GYM including ICI (South and east of main campus). This will provide significant savings with respect to deep building retrofits and new campus buildings.

ICI is intended to include spatial provisions and corridors to allow plant expansion into a nodal thermal energy plant that serves future developments around the ICI building. This "cluster" plant will produce heating water (HW) and chilled water (CHW) using the LDES and MDES interfaces, before distributing HW and CHW to the ICI building and the building cluster downstream of the ICI. Energy Team has been working with UBC Properties Trust and their consultant for successful design and construction of cluster plant at the ICI building.

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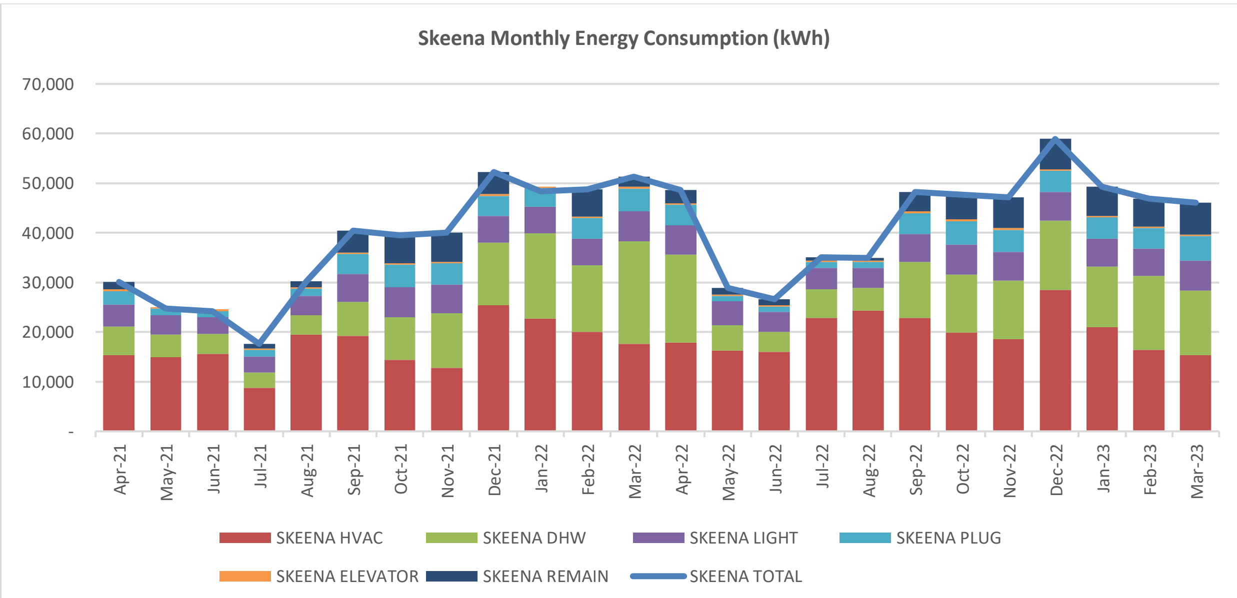
4.10.1 Skeena Energy Performance

Defined by sun floods, through views, and candy-coloured stairwells, the six-storey 6,500 m2 Passive House Skeena residence provides 220 bedrooms and amenity space to UBC Okanagan students. Completing an ensemble of residence buildings encircling the Commons Field, the project focuses on student life and support services while synching up with the existing campus.

This section provides an overview of energy performance of the building in the last 24 months. Skeena residence consists of a total treated floor area of 4,927 m^2 and an EUI of 105 kWh/m^2/year. Boiler in Skeena consumed around 20% of the total hydronic equipment electricity consumption i.e. Boiler (19 MWh) and Air Source Heat Pump (71 MWh) to supply hydronic heating and cooling energy to the building.



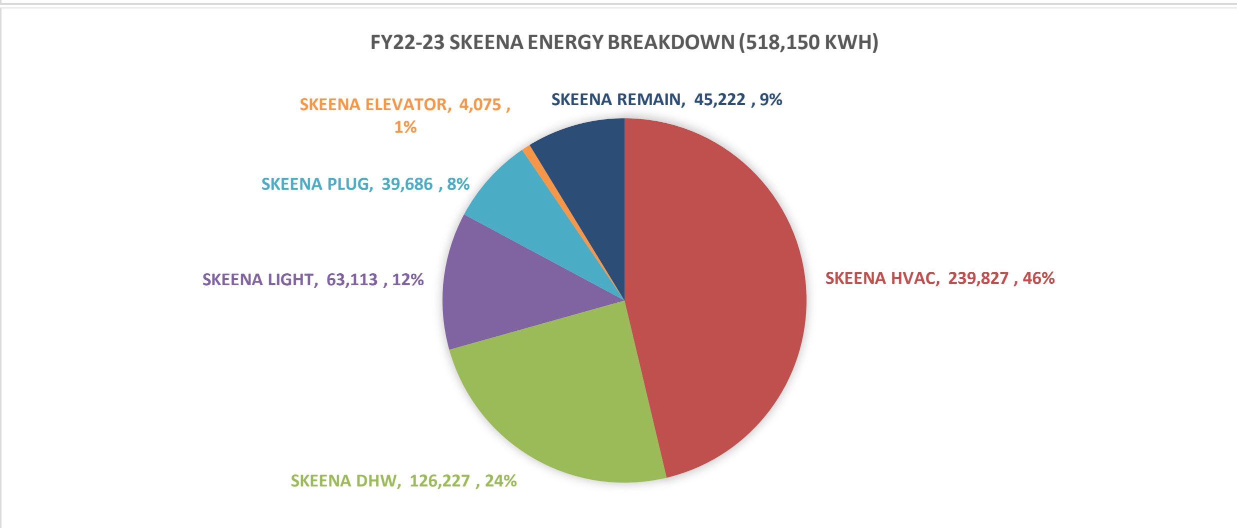


Figure 33: Skeena Energy Performance FY22-23

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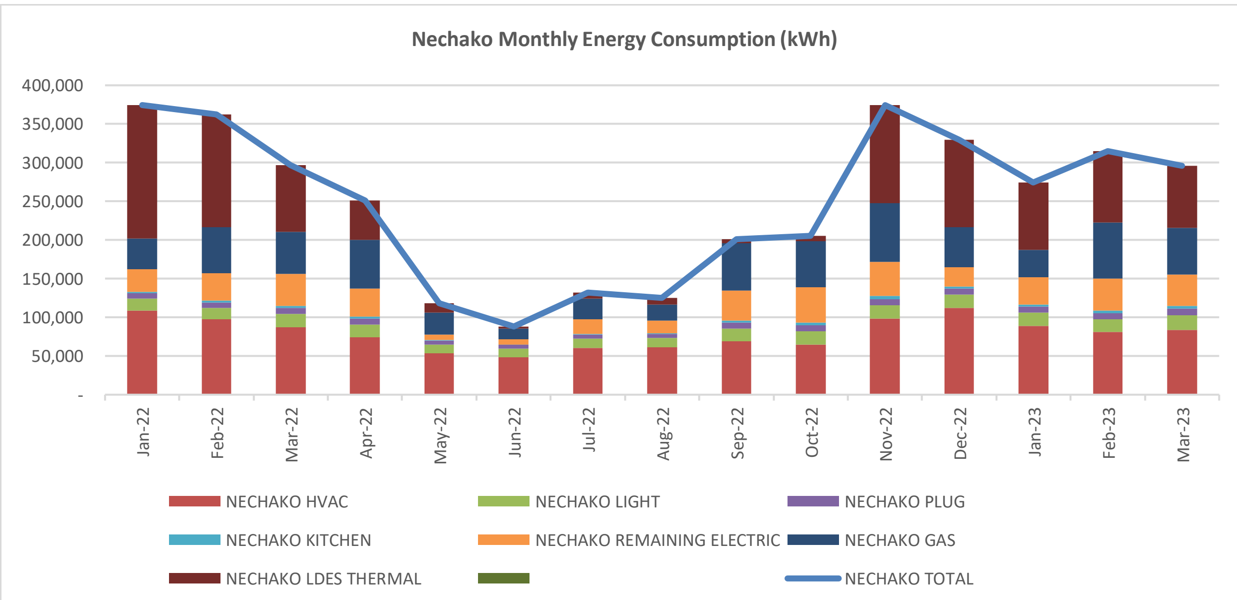
4.10.2 Nechako Energy Performance

The Nechako Residence is located north of the University Centre Building and Plaza, at the south end of the Commons Field. The new facility includes 220 Winter Session residence beds and a commons block component which includes a new 500-seat dining hall with central kitchen, access for students living in residence to social amenities and study space and Student Housing and Conferences front desk for both resident students and seasonal hotel check-in.

This section provides an overview of energy performance of the building in the last 15 months. Nechako residence consists of a total treated floor area of 11,171 m^2 and an EUI of 243 $kWh/m^2/year$.



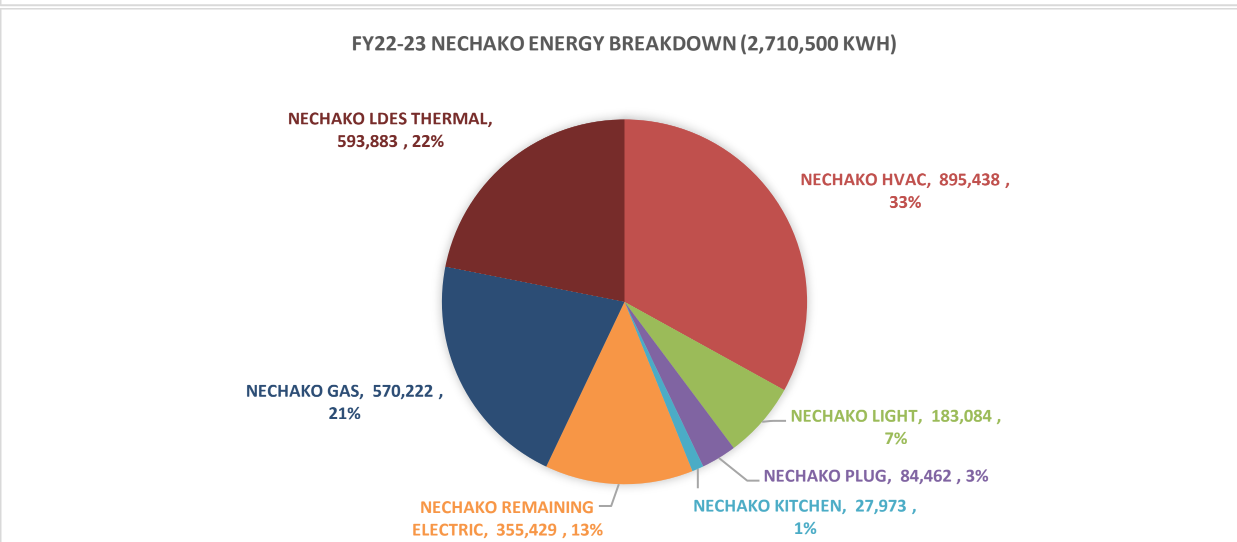


Figure 34: Nechako Energy Performance FY22-23

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4.11 Portfolio Manager

The building energy performance data for UBC Okanagan buildings are updated periodically in the EPA's ENERGY STAR Portfolio Manager and can be accessed using a shared read-only access account. This access allows researchers, consultants, contractors to access energy consumption and related information for UBCO buildings.

Currently, this platform is being used to fulfil the requirements of BC NZER Program for Skeena Residence i.e. set up building in Portfolio Manager and share long-term trending/ logging of the energy data.

4.12 Technical Guidelines

Technical Guidelines are intended to provide minimum standards for campus projects. There are a large number of guidelines that cover both UBC as a whole and some that are specific to the Okanagan campus.

In 2021 with a view to streamline the process, a new Joint Working Group including UBC Vancouver and UBC Okanagan facilities teams has been formed. The Working Group has been set up to provide potential TG updates, collaborate between campuses and between disciplines. The Energy Team has been involved in facilitating regular meetings for the Joint Working Groups and working to update several that are specific to energy performance and monitoring.

4.13 Renewable Natural Gas (RNG)

Energy Team has been working with FortisBC to procure around 10% of UBCO gas consumption and has successfully secured the purchase of the 5,000 GJ RNG starting December 2021. This initiative is in line with the UBCO CAP 2030.

4.14 UBCO Residence Cluster Plant concept design

To support future campus needs, the UBCO Energy Team has been working with its consultant to perform a high-level concept design to outline preliminary requirements and indicative capital costs for a potential Residence Cluster Plant. Similar to the ICI Cluster Plant currently being designed, the Residence Cluster Plant is envisioned to leverage on the existing campus Low Temperature District Energy System (LDES), sourced from geo-exchange.

This plan utilized previous campus information including the UBCO Campus Plan (2015) and the Campus Infrastructure Plan (2020) which detailed the building archetypes, space and use.

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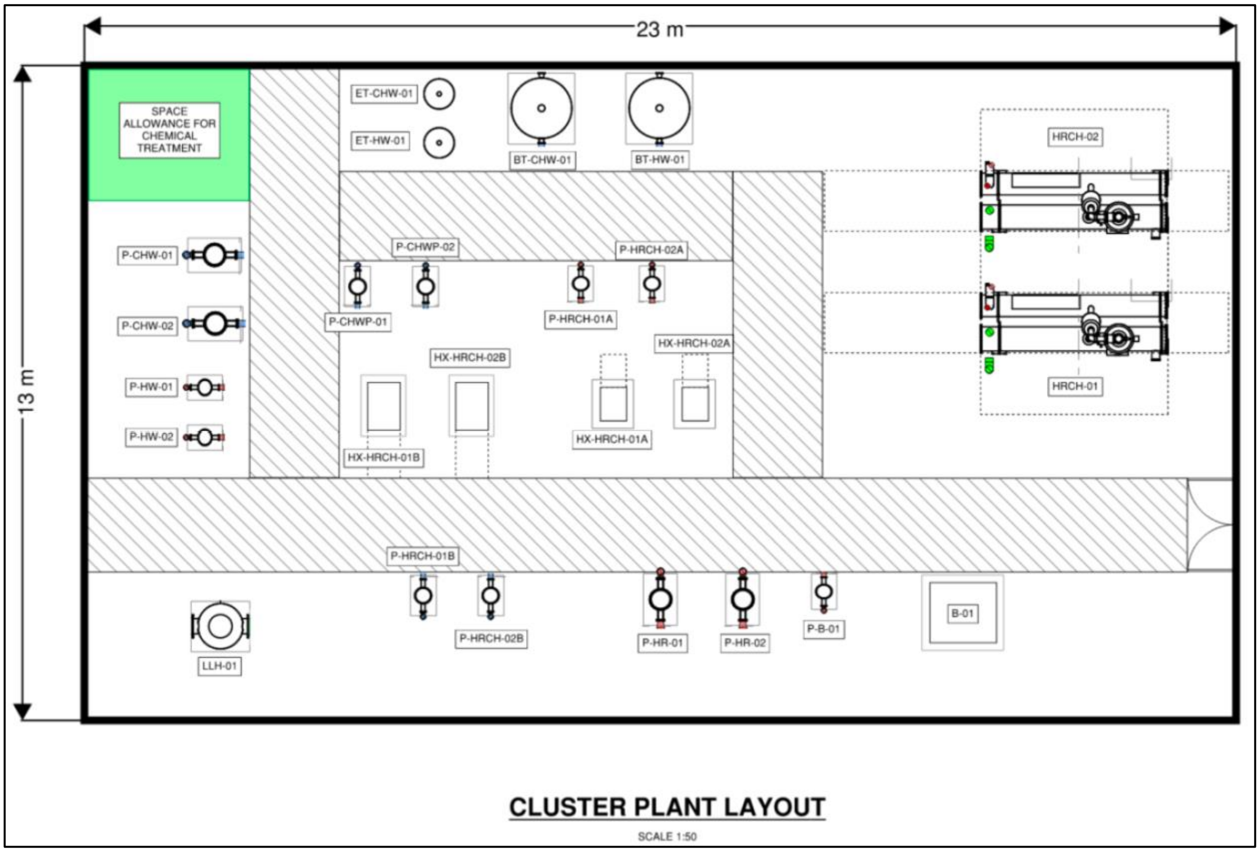

Figure 35: UIPCP Cluster plant equipment layout

A rough order-of-magnitude of the capital costs for preferred option D have been included in the report. The capital costs for Option D is at around $9.3 million. Note that the capital costs do not consider the cost reductions that would occur at the building level, where each of the Lower Innovation Precinct buildings will not have to implement building-level systems. Instead, each building would only require energy transfer stations to enable connection to the Residence cluster plant.

4.15 District Energy Plant efficiency study

Energy Team has been working to analyze performance of DE system and building plant to help optimize overall system performance. The scope of work under this study includes:

- **Energy Trend Analysis**: Validate existing trend logs for each building showing heating water consumption, gas consumption, district energy consumption, and electrical energy.
- **Develop Coefficients of Performance**: Develop a real-time coefficient of performance trends for the central heating plant, district energy plant, and building level heat pumps.
- **Develop Cost Trends**: Using the energy use profile, coefficients of performance, and utility rates, calculate the real-time costs of operation for each building, and for the plants.

Energy Team is working internally to carry out this study which has been kick started by reviewing hydronic schematic for campus buildings and developing COP trends for each building and central plant.

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Energy Team fast tracked a portion of this study to optimize operations of cooling towers. After a careful review of existing operations, Energy Team has put together an add-on sequence of operation (SOO) to

- make cooling towers run more efficiently,
- automate staging of various cooling sources, and
- increase operational capacities of existing cooling towers

This SOO update is expected to provide potentially 300 tons of additional cooling capacity from existing cooling towers. A similar exercise is being carried out to review District Energy heating season performance and investigate optimization opportunities. An average 7.5% efficiency gain for boilers in Geo-Exchange building has already been observed based on recommendations provided by Energy Team. This translates to around 750 GJ of natural gas savings.

4.16 Electricity emission intensity factors modelling for UBCO

The GHG emission trend for the campus primarily follows Natural Gas consumption trend because electricity emission intensity factor for the FortisBC grid in British Columbia is very low at 2.587 tCO_2e/GWh.

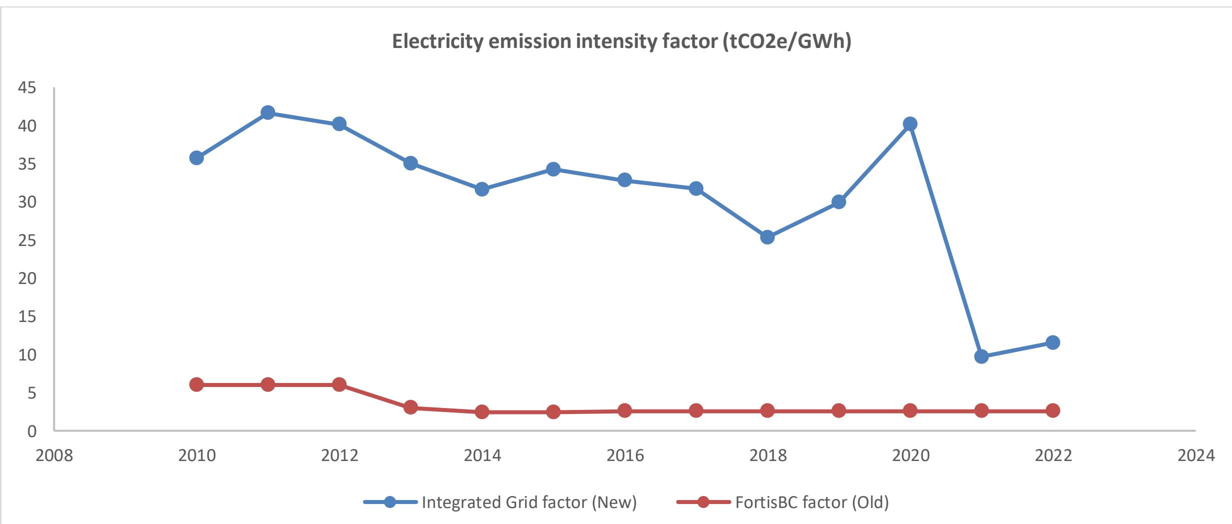

Figure 36: Electricity emissions intensity factor trend

However, in 2020, Ministry of Environment and Climate Change Strategy published a new set of greenhouse gas (GHG) emission intensity factors for electricity use from 2016 to 2020 along with hindcasted grid factors for 2010 to 2016[13].

[13] The new set of emission intensity factor is based on a different methodology. Prior to that, the Ministry of Environment and Climate Change Strategy published, in the B.C. Best Practices Methodology for Quantifying Greenhouse Gas Emissions, provider-based emission intensity factors for electricity purchased from BC Hydro and FortisBC. These factors reflected the emissions intensity of each utility provider's electricity generating fleet. The methods differ in their scope in that the current estimates include all power producers in B.C., as well as considering imported electricity for in-province consumption.

Figure 37 above shows the changes in greenhouse gas emission intensity factors for electricity use for the two methods i.e. Integrated Grid factor (New) and FortisBC factor (Old) an increase by a factor of 4.44.

The new electricity emission factor would result in an increase in total emission by around 300 tonnes CO2e in FY22-23 resulting in electric emissions share to increase from 4% to 16%.

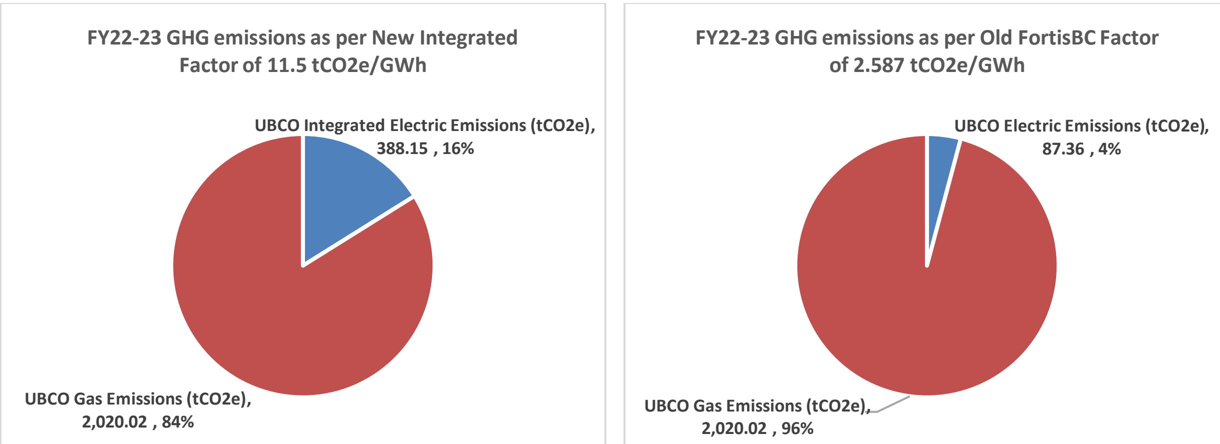

Figure 37: Impact of integrated emissions factor on total UBCO GHG emissions

4.17 Smoke and Indoor Air Quality (IAQ) Particulates

Currently smoke mitigation measures are initiated and implemented manually via a procedure. Air quality can be very localized, and current air quality notifications may not be specific to the local conditions at UBCO campus. Existing indoor air quality monitoring via the BMS currently is mainly limited to CO2. Some buildings also include relative humidity sensing, as well as CO and NO_2 for loading bays.

Wildfires are a common occurrence in the British Columbia, which has a high potential to bring wildfire smoke through Campus and into the buildings. Currently there are procedures in place to respond to wildfire conditions, such as changes to ventilation operation and changes to filtration, however we currently have no quantitative measurements to determine how successful these measures are.

The intent of this project is to implement additional outdoor air quality monitoring on campus to provide quantitative data to initiate air quality mitigation controls. Using a portable indoor meter can determine how successful our measures are in responding to poor outdoor air quality on campus. This information can be used for evaluation and processes can be adjusted accordingly.

4.18 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 Team 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. Energy Team has been working on an ECM template to track potential Energy Conservation Measures identified on campus from various sources such as SEMP, RCx studies, staff inputs, etc. This will act as a one-stop source for any potential energy conservation implementation project and enable the team to select and bundle future retrofit/ modernization projects.

Significant financial support for these projects has been made by FortisBC through various incentive programs. When point of sale rebates are included, over $265,000 of energy efficiency incentives were received this past fiscal year. In addition to these rebates $135,000 was received from FortisBC to support the campus Energy Team staff position. In terms of actual studies/ projects, the following projects have been completed/ in progress over the last year.

5.1 UBCO AQGARD IAQ monitoring system for SCI building

UBCO Energy Team has engaged UBCO Project Services to manage this project to install Siemens AQGARD IAQ monitoring system using multi-parameter Demand Control Ventilation (mp-DCV) System, to reduce energy and operating costs, while improving the indoor air quality (IAQ) in the Science Building.

The new Siemens AQGARD will monitor selected 10 rooms in the SCI building, as well as the AHU's feeding them. The system will sense for CO2 (occupancy based DCV) and IAQ (TVOC's and micro-Particles in the PM 0.3-2.5 range). The system will maximize ventilation at all times when needed and will modulate ventilation based on a high-select between sensed contaminants, occupancy and temperature / thermal load.

This project is expected to achieve energy savings of around 124 MWh Electricity and 1100 GJ Natural Gas with an estimated ROI of just over 3.4 years. The project was completed in FY22-23.

5.2 UBCO ASC FIP Laboratory Rooms Demand Controlled Ventilation (DCV)

This measure was identified as part of 2020 SEMP report. The ventilation rate of non-critical laboratory spaces is not strictly controlled, causing significantly higher air changes per hour than required for occupant health and comfort. The use of upgraded controls equipment and strategies will be considered for reduction and standardization of air changes during both occupied and unoccupied hours. This project is expected to save 541,344 kWh Electricity and 2,677 GJ Natural Gas per year.

The engineering study for this measure was completed and approved by FortisBC in FY22-23 and is expected to be completed in FY23-24.

5.3 Night time flush

Night ventilation, or night flushing, is a passive cooling technique that utilizes the outdoor diurnal temperature swing and the building’s thermal mass to pre-cool a building through increased outdoor airflow at night, allowing radiant cooling to take place during the day when the building is occupied.

By using the natural cooling effect of the night and the cooler air at night simply allowing the cool night air to circulate a structure during the night allows the loss of the heat buildup, or heat mass gathered by the structure during the day. In order to achieve this cooling one simply needs to allow the night air to circulate the building. The cool night air carries away the heat absorbed by the structure during the day. The very nature of concrete or other high specific heat capacity materials makes them perfect to use in conjunction with Night Flushing as the structure will take a long time to absorb enough heat during the day to change its temperature and thereby not only decreasing the cost of maintaining a stable internal climate during the day, but would also drastically decrease the cost of cooling as most of the heat absorbed during the day is lost during the night via Night Flushing. Thermal mass is a property enabling structures to absorb, retain and then release heat energy, this coupled with a high specific heat capacity means that buildings made up of concrete need to absorb a substantial amount to heat to effect a change in temperature.

The summer months in Kelowna can have relatively cool evenings with quickly warming mornings. Electricity tends to peak during this startup cooling. For summer months where the evenings are cool and it is anticipated that significant mechanical cooling load will exist throughout the day, a pre-cooling strategy will be implemented utilizing the existing weather predictor, similar to the existing morning warmup strategy.

Energy Team has contracted the implementation of this measure to Siemens Canada Ltd. The night flush mode is intended to pre-cool buildings with fresh air during unoccupied hours with the goal of delaying the need for mechanical cooling throughout the summer period. Following are the Air Handling Units affected by this night flush measure:

- Arts AHU1-8, RTU1-3
- EME AHU1-8
- Gym AHU1
- Library AHU1-6
- Admin AHU1-9
- EME HRV4

This project was completed in Q3 2022 with an expected savings of 30 MWh.

5.4 Recommissioning study for the EME building

UBCO Energy Team is planning to recommission EME building and has put forward a FortisBC/ BCHydro incentive application to perform a Continuous Optimization study for the EME building. This study is expected to identify deficiencies in the operation of the buildings that were wasting energy, increasing equipment wear and tear, or decreasing occupant comfort. The study was kick started in October 2022 and is expected to be completed by FY23-24.

5.5 Science waste heat recovery

UBCO Energy Team is working with consultant to conduct a study to recover heat from the existing rooftop laboratory exhaust via glycol runaround heat recovery system. Consultant suggested the potential of expanding the existing heat recovery system and coupling the existing exhaust coil runaround heat recovery either to air handler AHU-2 or AHU-3 preheat, or as potential source energy for the Multistack heat pump to displace input energy received from the campus' LDES system. Calculations verify that when the glycol runaround systems data points were acquired at -6˚C, the outside air preheat flow for AHU-1 was 18,188 CFM (8,585 L/S) while the exhaust air flow at the rooftop recovery coil air flow was 26,313 CFM (12,420 L/S); verifying that the exhaust air stream had additional flow and energy available that could not be transferred to AHU-1's preheat coil.

An incentive application under FortisBC's Custom Efficiency Program has been submitted to conduct the study and potentially take advantage of the funding sources available. This study was completed in Q4 2022 with potential implementation in FY23-24 depending on FortisBC incentive.

5.6 Plant Growth Facility LED lighting upgrade

Plant Growth Facility (PGF) reached out to UBCO Energy Team to assist them with a solution for failure of high pressure sodium lighting. Subsequently the Energy Team has been working with researcher at UBCO PGF, Samantha Olivier and lighting vendors to develop a business case for UBCO Plant Growth Facility lighting replacement from existing High Pressure Sodium to LED fixtures.

Below are some of the reported challenges the PGF has been experiencing with existing lighting fixtures:

- Existing lamps have an end of useful life of around 10,000 hours and are failing prematurely.
- Existing lighting does not meet lighting requirements in the winter periods.
- HPS lamps are very inefficient

The project has a simple payback of around 3.5 years and will be little higher when considering interactive heating/cooling effects. The total cost of the project is around $50,000 (including installation) after FortisBC rebates. This project is currently underway with an expected completion by FY23-24.

5.7 Power factor analysis

UBCO Energy Team has been working on analyzing the power factor of all the campus-level and building-level electricity meters. Power factor is a measure of how effectively electricity is being used and is the ratio between Real Power (kW) to Apparent Power (kVA).

Power factor can be corrected by installing capacitors in parallel with the connected equipment or circuit. These can be applied at the equipment, distribution board or at the origin of the installation. They improve the overall electrical efficiency of your electrical supply, so less electrical current is needed to achieve the same result. There are numerus advantages to installing power factor correction devices to your electrical supply. They include:

- A reduction in electricity bills
- Increased load carrying capabilities in your existing circuits
- Reduction of I2R losses in transformers and distribution equipment
- overall reduced power system loses
- Extended equipment life
- Reduced electrical burden on cables and electrical components.

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Table below provides an average power factor for all the UBCO buildings from January 2021 to March 2022 analyzed at 15 minute interval.

Building	**Average Power factor**
ASC	96%
ART[14]	93%
ADM	95%
CHP	94%
FIP	92%
CCS	95%
DAY	94%
EDL	93%
EME	94%
GEO	56%
GYM	95%
LIB	90%
PGF	66%
RHS	85%
SCI	98%
UNC (Current power factor = 90%; Jan 2021 = 38% <*OUTLIER*>)	87%
UCH	54%
OM1	92%
PORT A (Relatively small load)	258%
PORT V (Relatively small load)	78%
Quonset	89%
U HS	88%
Lower A	100%
Lower B	100%
Lower C	97%
Lower D	101%
Lower E	101%
Lower F	101%
Lower G	100%
Upper H (Data not available)	NA
Upper I (Data not available)	NA
Upper J (Data not available)	NA
Upper K (Data not available)	NA
CAS	99%
IP1 (Data not available)	NA
IPA (Data not available)	NA

[14] Calculations suggest a power factor of 31%. However, Energy Team believes due to a 3:1 stepdown transformer, the 3:1 conversion factor was not added back in to the ARTS demand point during the VLAN upgrade project.

Kalamalka	96%
MON	95%
NEC	100%
NIC	96%
PUR	97%
SIM	99%
SKE	97%
COM	91%
VAL	94%

Based on this analysis, Energy Team recommends to verify power factor for ASC, ARTS buildings and improve power factor for GEO, PGF, and UCH buildings.

Facilities Management investigated power factor for UCH and took actions to improve power quality to Upper Campus Health which was improved from 54% to 98%. Similar exercise will be carried out for identified buildings.

5.8 Wifi threshold recalibration

UBCO Energy Team is carrying out an internal project to recalibrate thresholds for the Air Handling Units which are being controlled by Wi-Fi Occupancy sensor[15]. As per the BMS platform Desigo, Air Handling Units and Make Up Air Units which are being controlled by Wi-Fi Occupancy typically have an ON threshold of 5 and OFF threshold of 2[16].

This means that if the total count (number of devices) from all floors for an air handling unit is above a maximum "on count" threshold of 5 (adjustable) or more for 15 minutes (adjustable), the AHU will be enabled for occupied operation.

If the total count for an air handling unit from all floors is less than a minimum "off count" threshold of 2 (adjustable) for 15 minutes and the average room temperature is within 3 deg C of the average room set-point of 21 deg C (adj) the AHU will shut off. If the total count from all floors is less than the minimum threshold for 15 minutes and the average room temp is not within 3 deg C of the average room set-point (adj) the AHU will remain in operation until the room temperature is within 1 deg C (adj) of set-point.

The trends for the actual occupancy were analyzed at 15 minute interval from 1 February 2021 to 31 October 2021. Based on the analysis of the actual occupancy trends, the current ON threshold of 5 is found to be very low compared to the device count observed during the core unoccupied hours i.e. 11 PM to 4 AM.

[15] The Wifi Occupancy takes priority over the air handler Occupancy schedule. Typical Air Handling Unit Occupancy schedule (which varies by space type) is assumed to be Mon – Fri 8 AM to 10 PM. When space is unoccupied, setback heating and optimized start sequences remain active. However, during COVID-19 period occupancy stays on with the scheduled operation, WiFi is not used throughout the day, overnight when the schedule is off, the sequence is unchanged.
[16] The ON and OFF thresholds are true for 80% of the ventilation equipment.

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UBCO Energy Team worked to identify a more appropriate threshold (optimal) for the Air Handling Units and is working to estimate potential energy and cost savings as a result of recalibration.

Air Handling Unit	Current Threshold	2023 Recommended threshold	Area serving
ARTS AHU1	5	7	L1 L2 Building offices
ARTS AHU2	5	5	L1 East Block
ARTS AHU3	8	9	L1 East Block
ARTS AHU4	5	5	L2 North Block
ARTS AHU5	10	8	L3
ARTS AHU6	5	10	L2 L3
ARTS AHU7	5	5	L3
ARTS AHU8	6	11	L1 L2 L3
ARTS RTU1	5	5	L1 Study Area
ARTS RTU2	5	5	L 1 Atrium Area
ARTS RTU3	5	5	L1
ASC AHU1	8	8	L1 Lecture Theatre
ASC AHU2	5	5	L1 Classroom
ASC AHU3	5	5	L1 Cafe
ASC MUA3	5	17	L2 L3 L4 Office VRF Fan Coil
EME AHU1	5	5	L0 L1 Lecture Theatre 50
EME AHU2	5	5	L1 Classroom 1151
EME AHU3	5	5	L1 Classroom 1123
EME AHU4	5	5	L1 Classroom 1121
EME AHU5	6	5	L1 Classroom 1153
EME AHU6	5	5	L1 Classroom 1202
EME AHU7	5	5	L1 Classroom 1203
EME AHU8	5	5	L1 L2 Lecture Theatre VAV
EME HRV04	2	5	L0 High Head labs
FIPKE AHU1	5	5	L2 Lecture Theatre
ADM AHU1	5	5	L1 Café bookstore/ Okanagan Room
ADM AHU2	5	13	L0 IT services
ADM AHU3	5	5	L0 Media/ Lower ADM Offices
ADM AHU4	6	14	L0 L1 ADM Offices
ADM AHU5	3	4	L1 Bookstore
ADM AHU6	2	2	L1 Main lobby
ADM AHU8	10	5	L1 Cafeteria Expansion
ADM AHU9	8	5	L0 Theatre

LIB AHU6	8	13	3rd floor classrooms
LIB AHU5	5	5	2nd floor offices
LIB AHU4	10	12	2nd floor study area
LIB AHU3	5	16	Book and Study Area
LIB AHU2	8	6	Main Floor
LIB AHU1	3	4	Basement Supply

5.9 Monitoring improvements

A few monitoring improvements are continuously being implemented by the UBCO Energy Team. For example, resolving the WIFI occupancy reporting issue, working with Siemens to fix the Desigo deficiencies list, resolving integration between Advantage Navigator and Desigo backend to maintain BMS database, adding missing trends on the key hydronic graphics etc.

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6 New Construction Projects

The Energy Team is involved in the design and construction process for new construction on campus. The Energy Team's goal is to ensure that the design and construction of new buildings on campus are consistent with the campus Whole Systems Plan in terms of energy targets and sources. The Energy Team also co-ordinates the pursuit of energy efficiency incentives from FortisBC.

6.1 Interdisciplinary Collaboration and Innovation (ICI)

The UBC Okanagan Campus (UBCO) is proposing a new building to facilitate world-leading, interdisciplinary/ transdisciplinary research and academic programming, and to advance its mandate as a partner in regional development. Tentatively titled the Interdisciplinary Collaboration and Innovation (ICI) building and is expected to be up to 13,364 gross square meters. Energy Team has been involved in advocating the creation of Owner's Project Requirements (OPR) for the ICI building, reviewing the schematic designs, detailed designs for the building and providing inputs on the building mechanical, electrical systems and energy-related standards/ benchmarks.

6.2 Innovation Precinct 1 (1540 Innovation Drive) Renovations

In 2017, UBC purchased 1540 Innovation Drive – a 1.36-acre land parcel with 24,400 sq. ft. warehouse/office building – at the north end of the university's future Innovation Precinct. This property is of strategic importance as it will be the first example that pairs commercial activity with UBC Okanagan research and learning. It will facilitate innovation and co-location partnerships with local technology companies, support graduate student needs, and help address the shortage of academic space at UBC Okanagan.

The building is being renovated to accommodate research laboratory facilities for Engineering faculty, studio space for Faculty of Creative and Critical Studies Master of Fine Arts students, an industry-UBC partnership research centre, and shared collaborative space.

Energy Team identified $15,000 of prescriptive rebate that equipment installed in IP1 Hydrogen lab was eligible for. We have been working with the Project Manager UBC Properties Trust to apply for an eligible FortisBC incentive for the renovations. The Hydrogen lab is being commissioned and deficiencies in the building is being identified and rectified by UBCO consultants/ contractors.

6.3 Office Modular II (OM2)

UBCO is currently working on a project proposing a new modular structure to address immediate space needs resulting from growth in UBC Okanagan's faculty and program staffing. The proposed building will be located directly north of Office Modular 1 (OM1). The new Office Modular 2 (OM2) building's design, footprint, and function will closely match that of OM1. OM2 will also have washrooms provided that will service the occupants of OM1 and OM2. Project Services has prepared the basis of design document. Energy Team will be working with Project Services to apply for an eligible incentive for the Office Modular building through FortisBC.

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6.4 Daycare extension

The Child Care Facility is a proposed new $3.294M facility, expected to be 520 GSM (5,600 GSF), located adjacent to the existing UBC Okanagan Daycare Building at 1262 Discovery Avenue and operated by the University Children's Learning Centre Society (UCLCS or 'the Centre'). Through the development of a new facility and outdoor play space adjacent to the existing Centre, the Child Care Facility will add 37 new childcare spaces (12 infant/toddler and 25 3-5 year) to the Centre's 57 childcare spaces (22 infant/toddler and 35 3-5 year) accommodated in the Daycare Building.

Energy Team has been involved in reviewing Design Brief of the project and will be working to apply for an eligible incentive for the this extension through FortisBC.

6.5 University House Renovations

UBCO is currently working on renovating its existing U-House building. The intent is to co-locate CORM departments as much as possible and maximize opportunities for collaboration and productive collisions. Energy Team will be working to apply for an eligible incentive for the renovations through FortisBC.

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7 Appendix: Monthly Energy Performance Data for Campus Buildings

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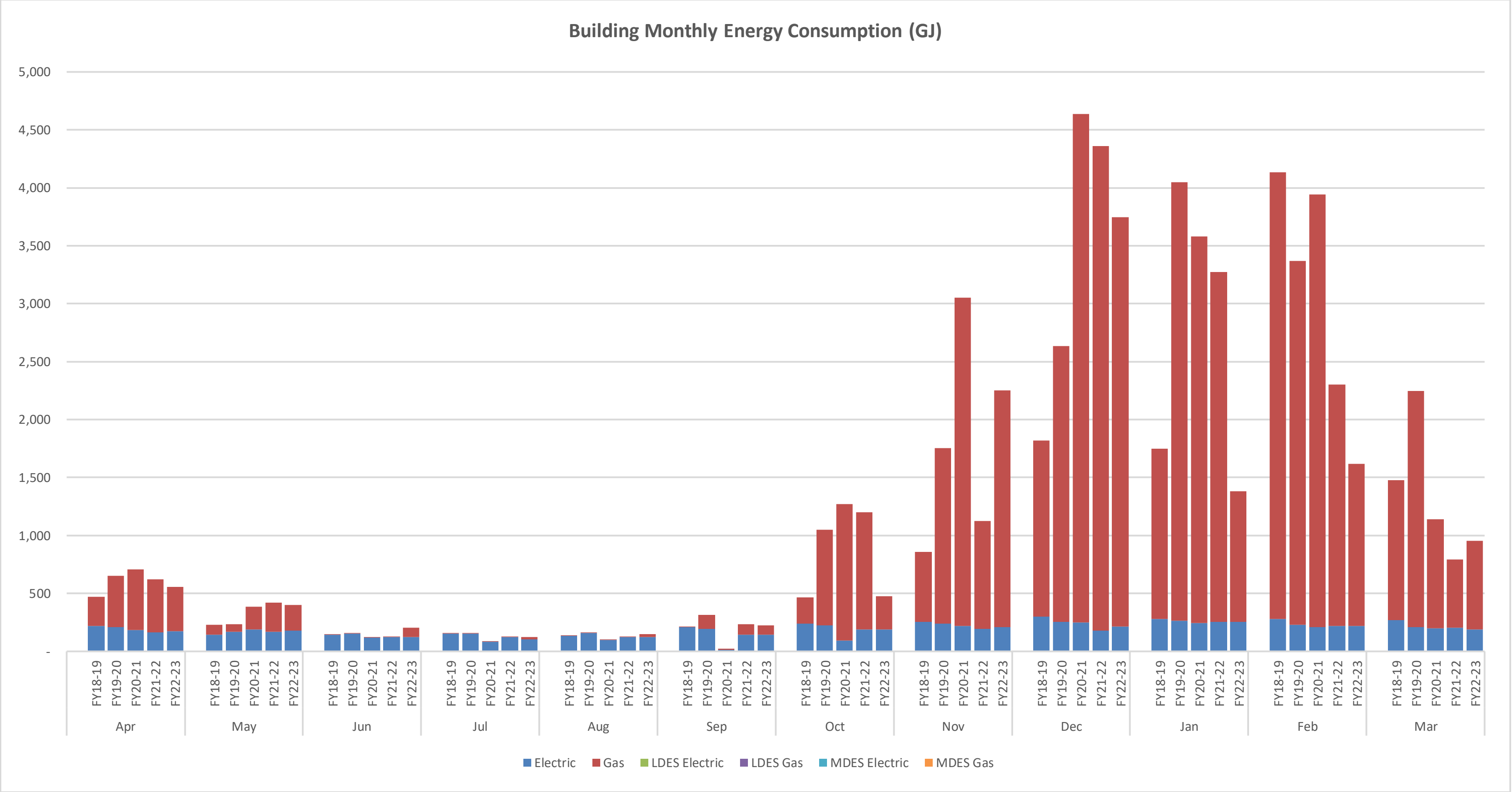
7.1 Central Heating Plant building (DES)



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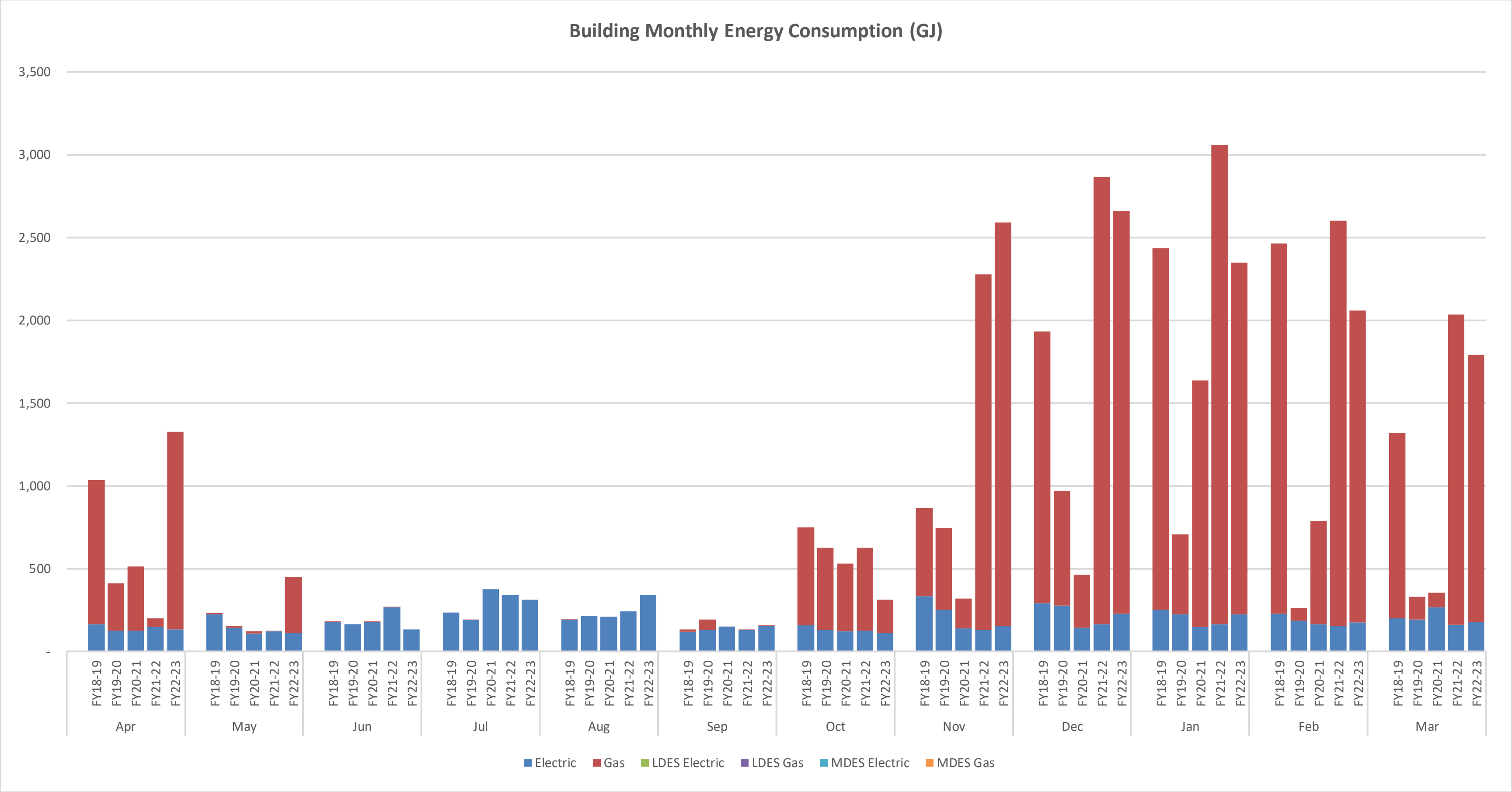
7.2 Geo-Exchange building (DES)



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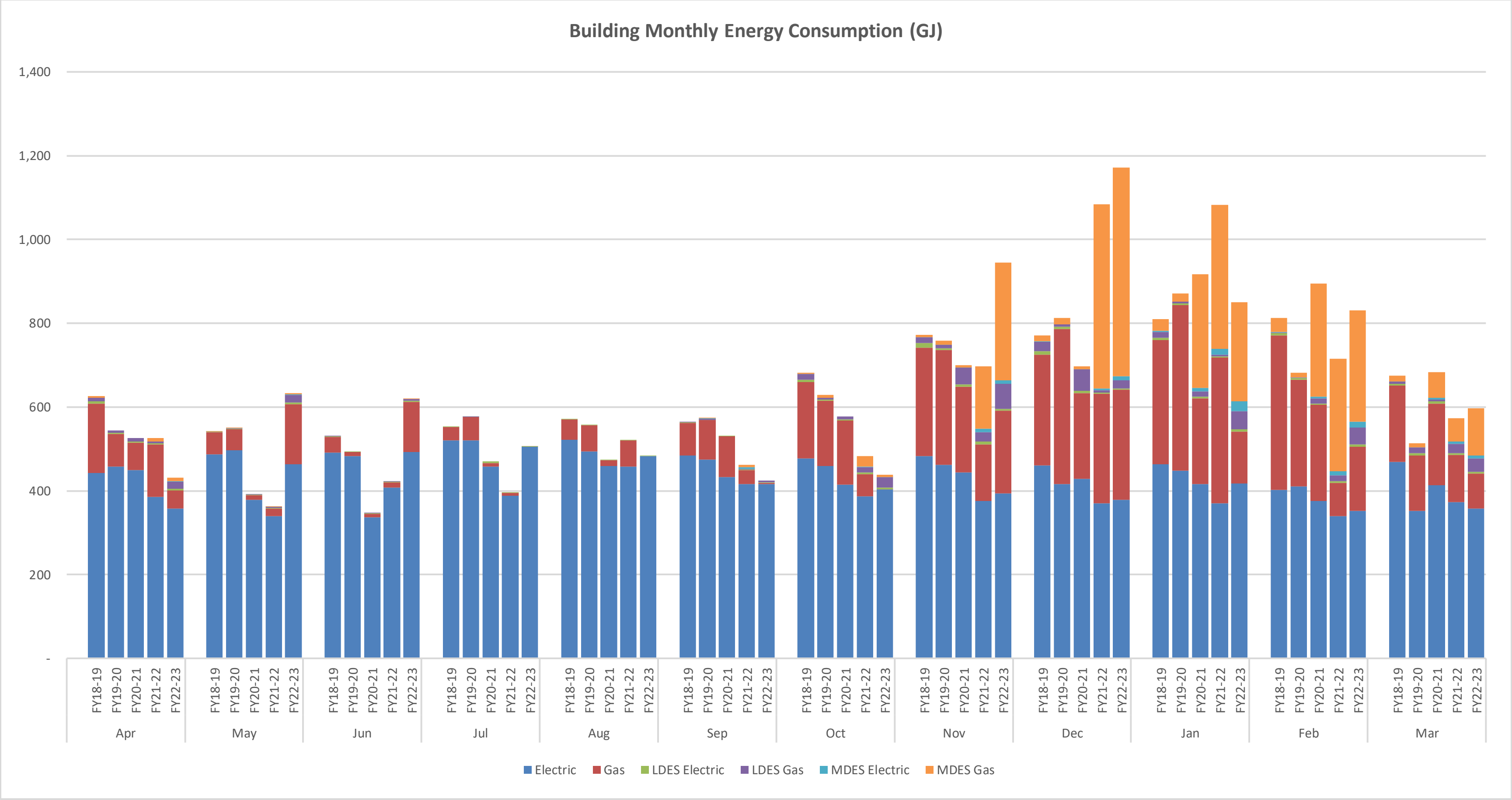
7.3 Administration building (ACAD)



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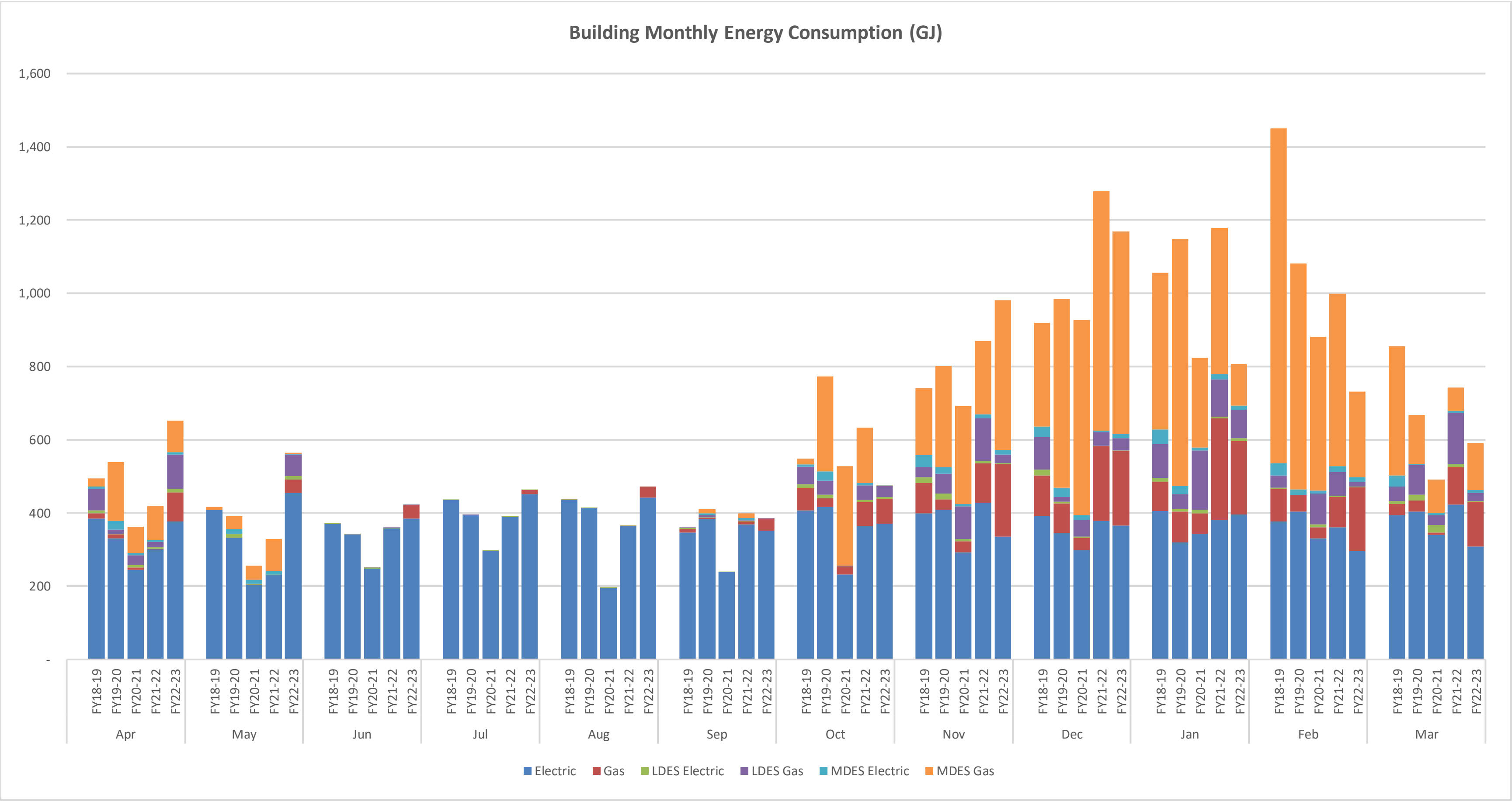
7.4 Arts building (ACAD)



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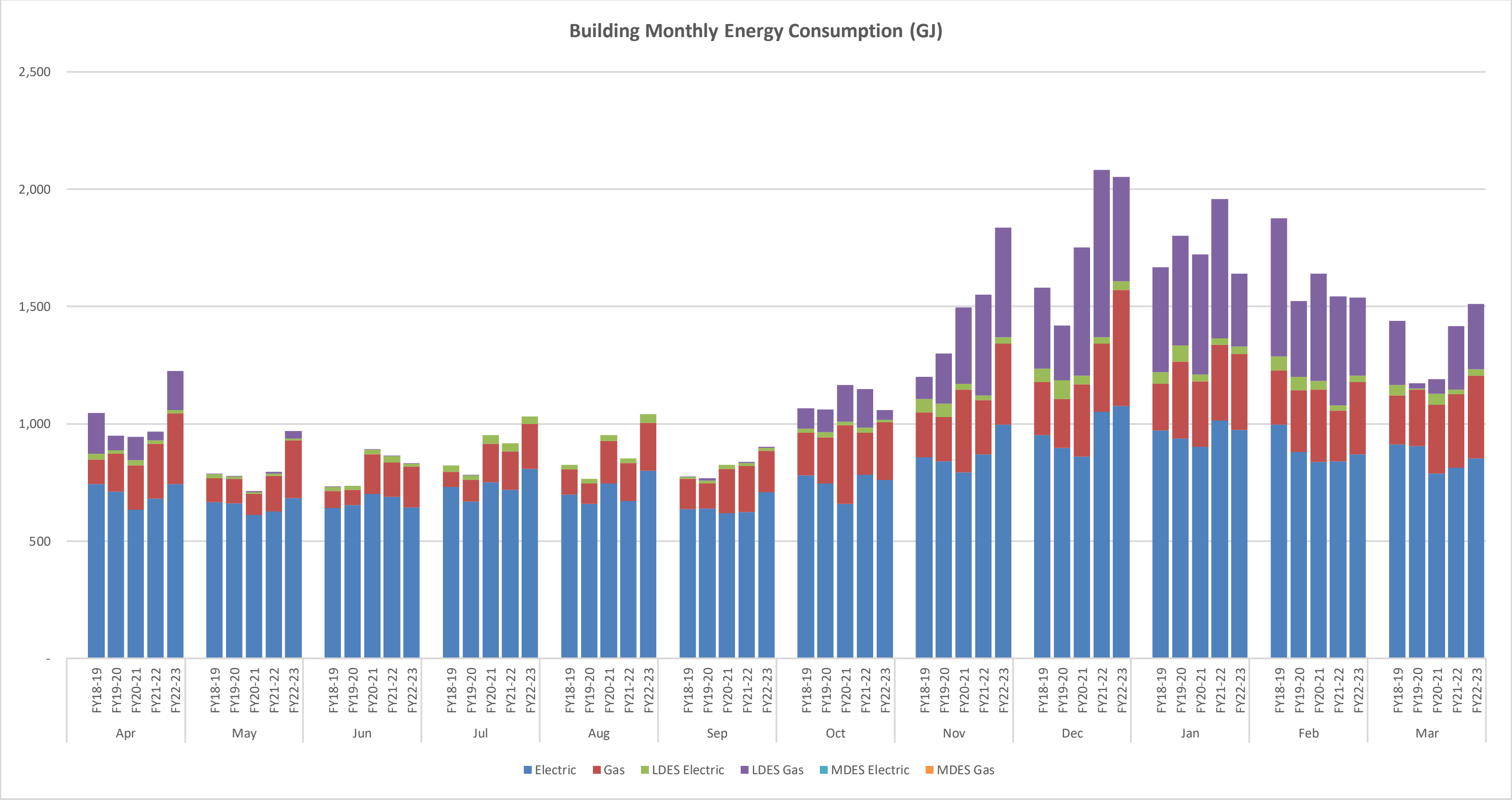
7.5 Arts & Science Centre building (ACAD)



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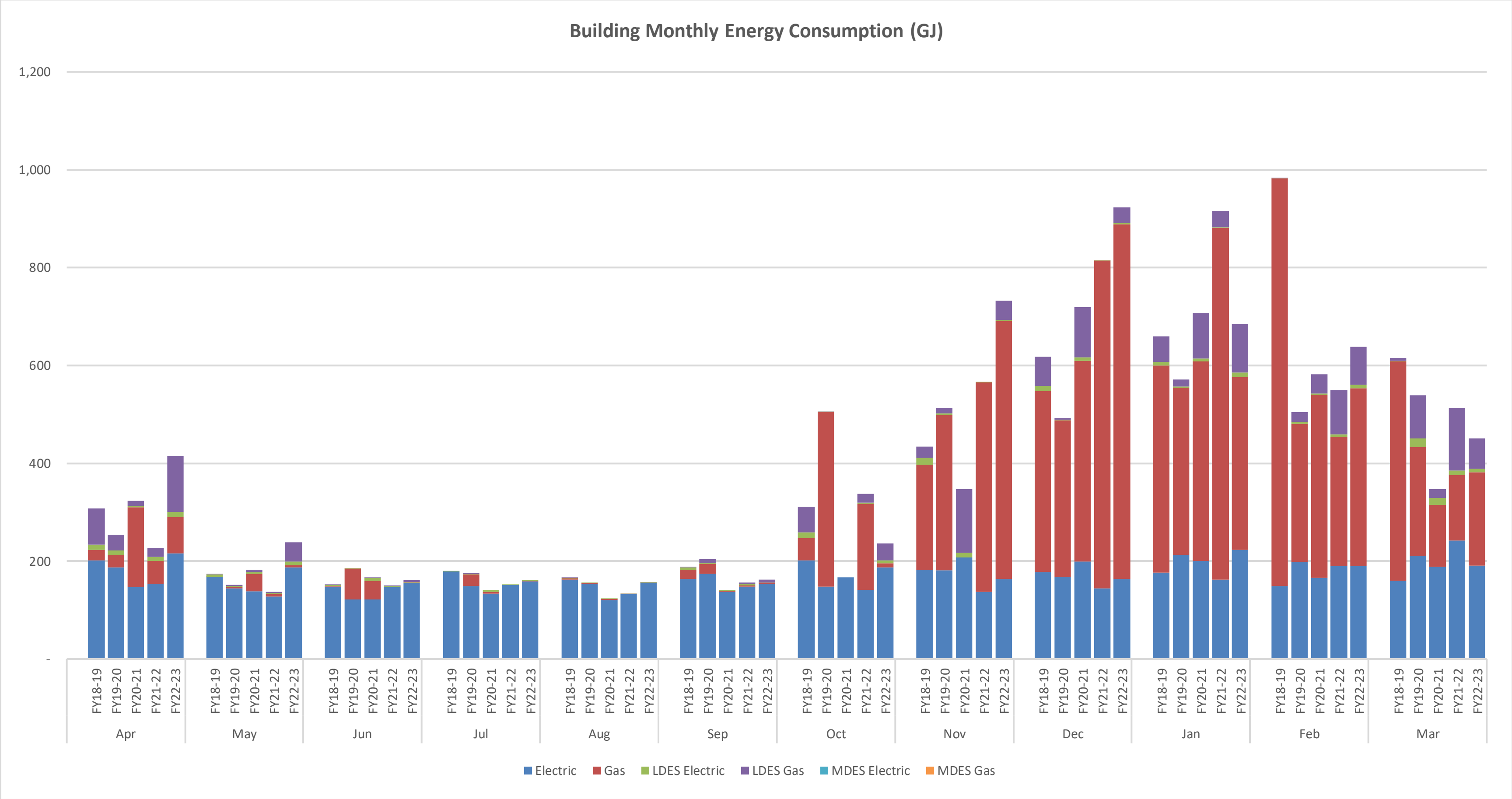
7.6 Creative and Critical Studies building (ACAD)



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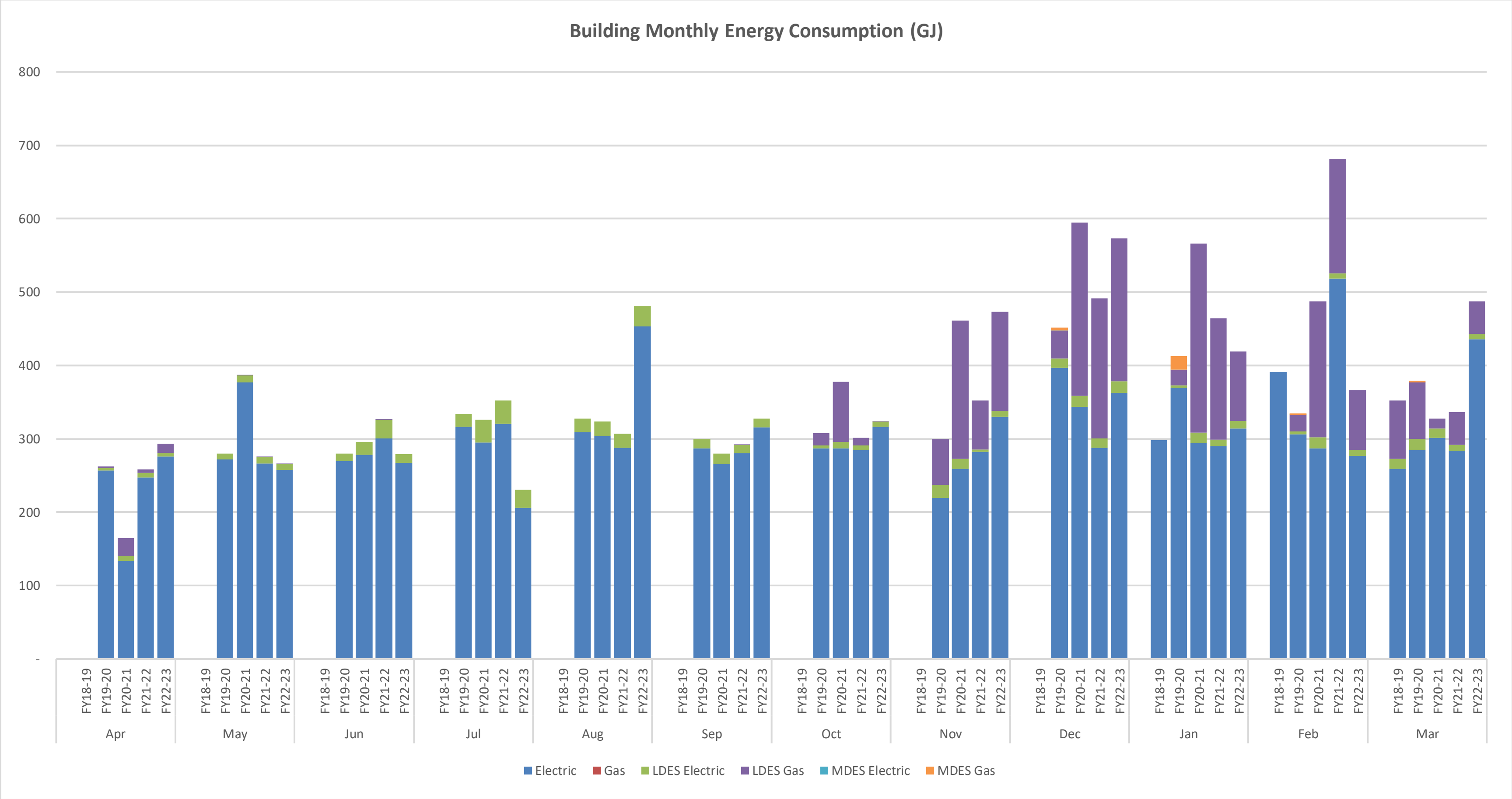
7.7 Teaching & Learning Centre (Commons) building (ACAD)



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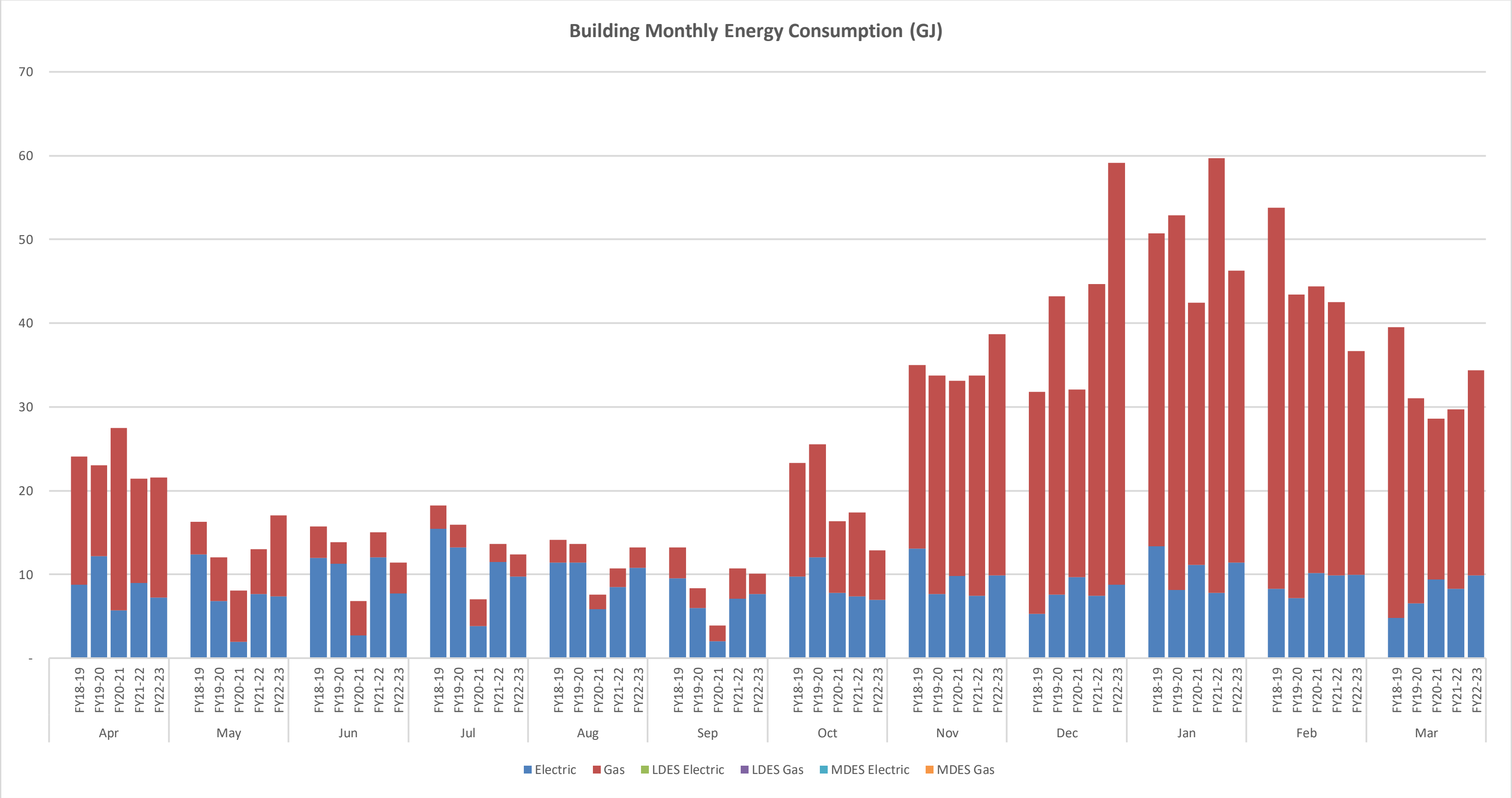
7.8 Daycare building (ACAD)



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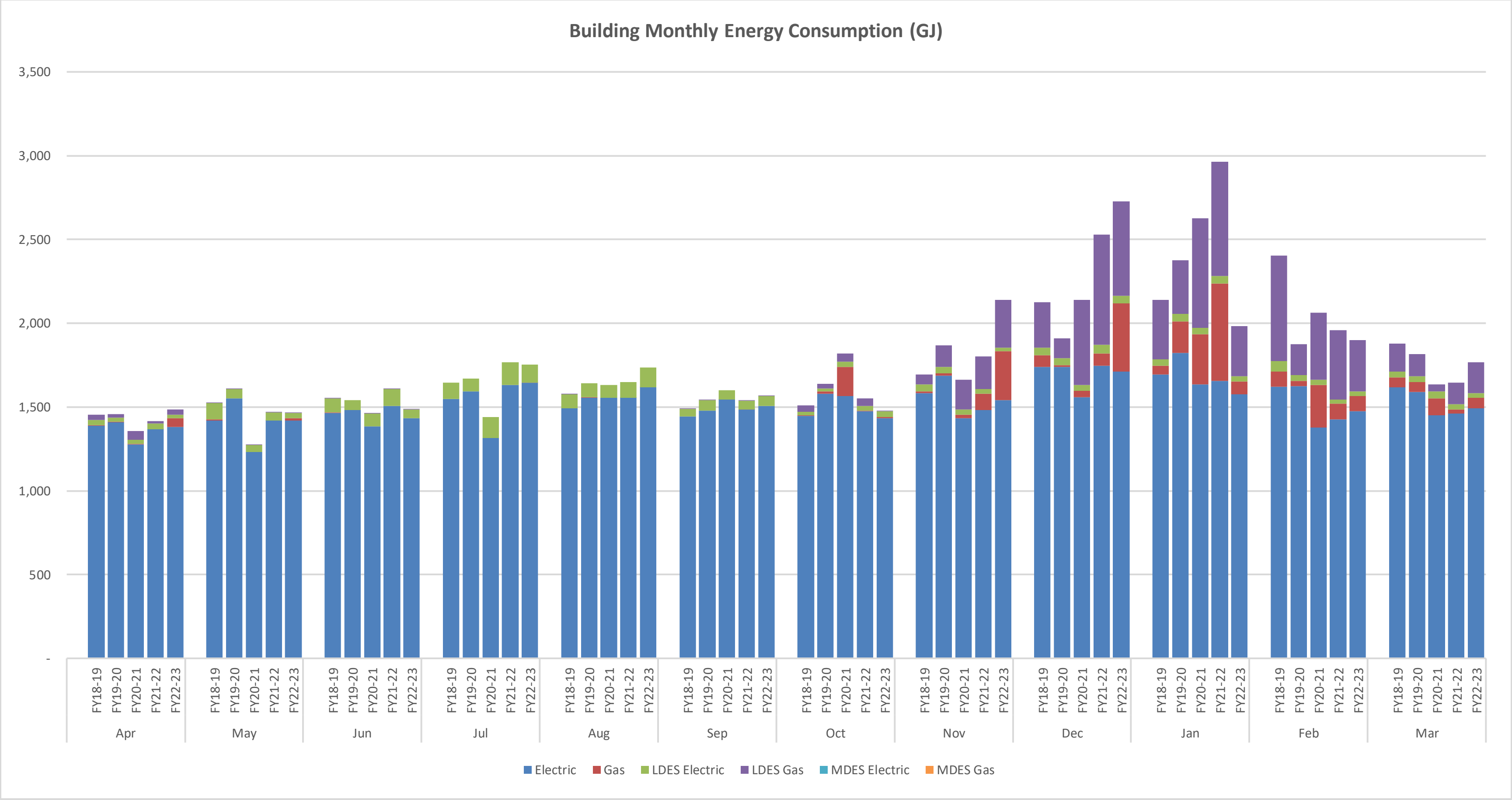
7.9 Engineering, Management and Education building (ACAD)



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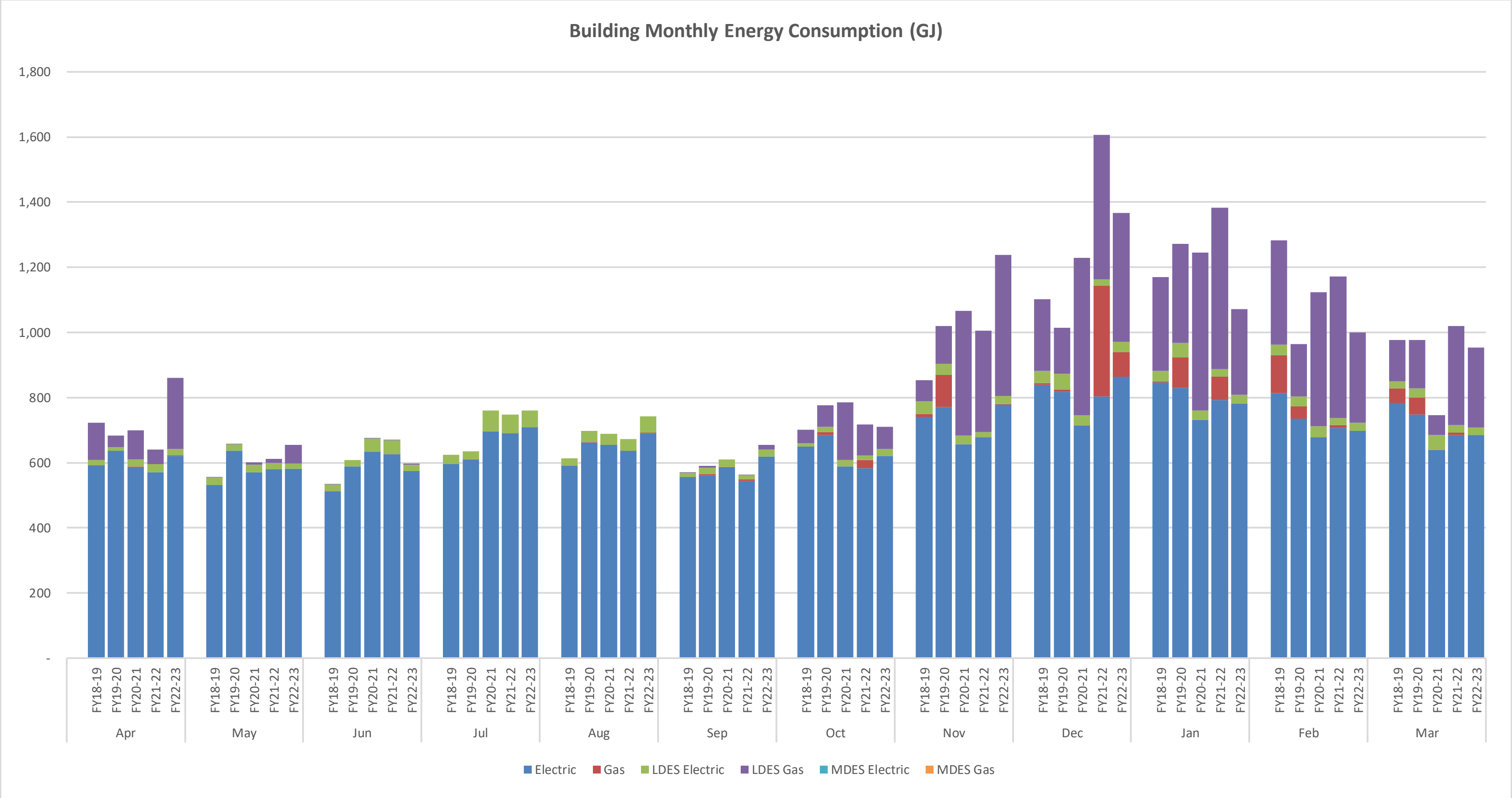
7.10 Fipke building (ACAD)



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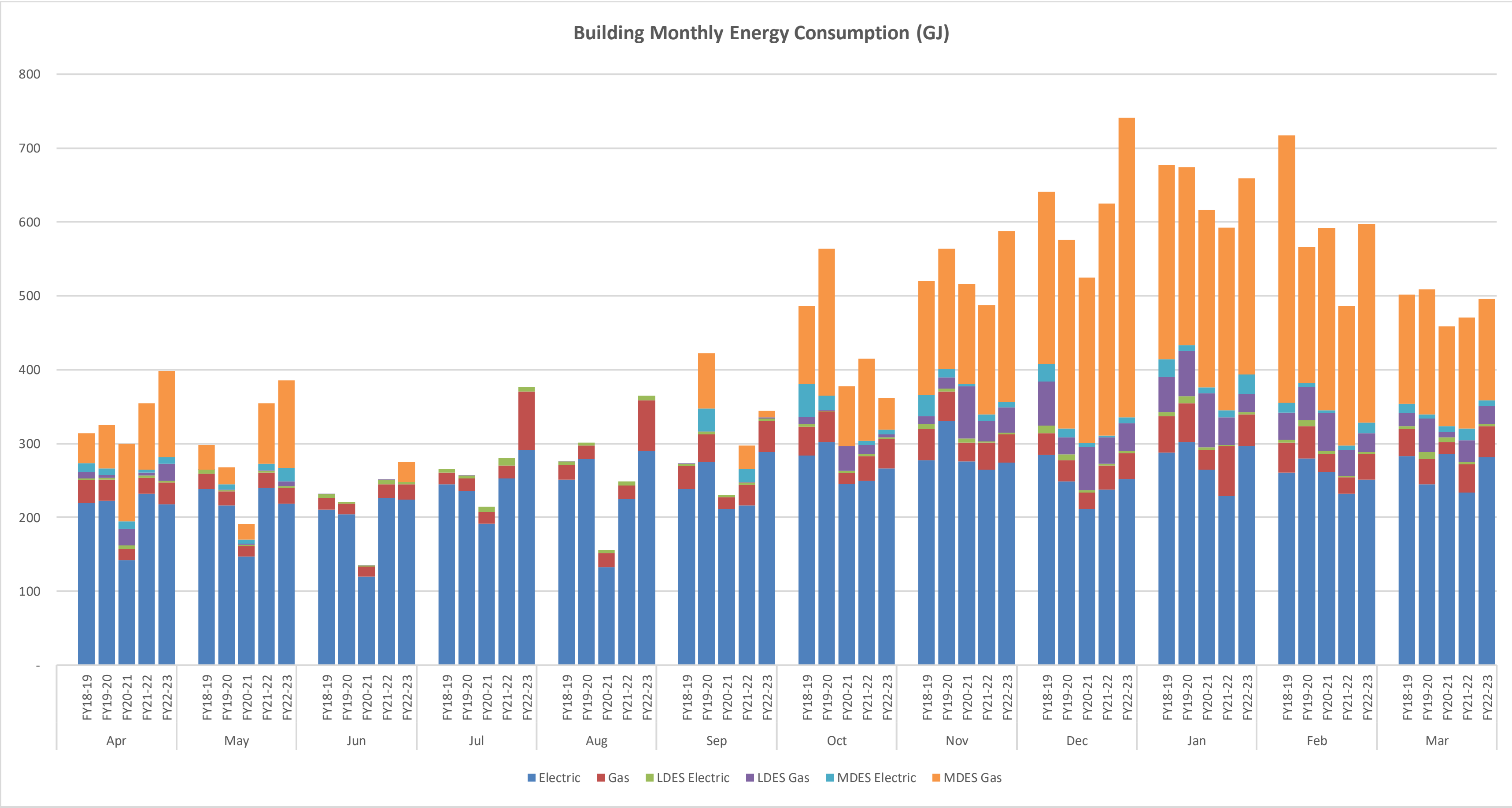
7.11 Gymnasium building (ACAD)



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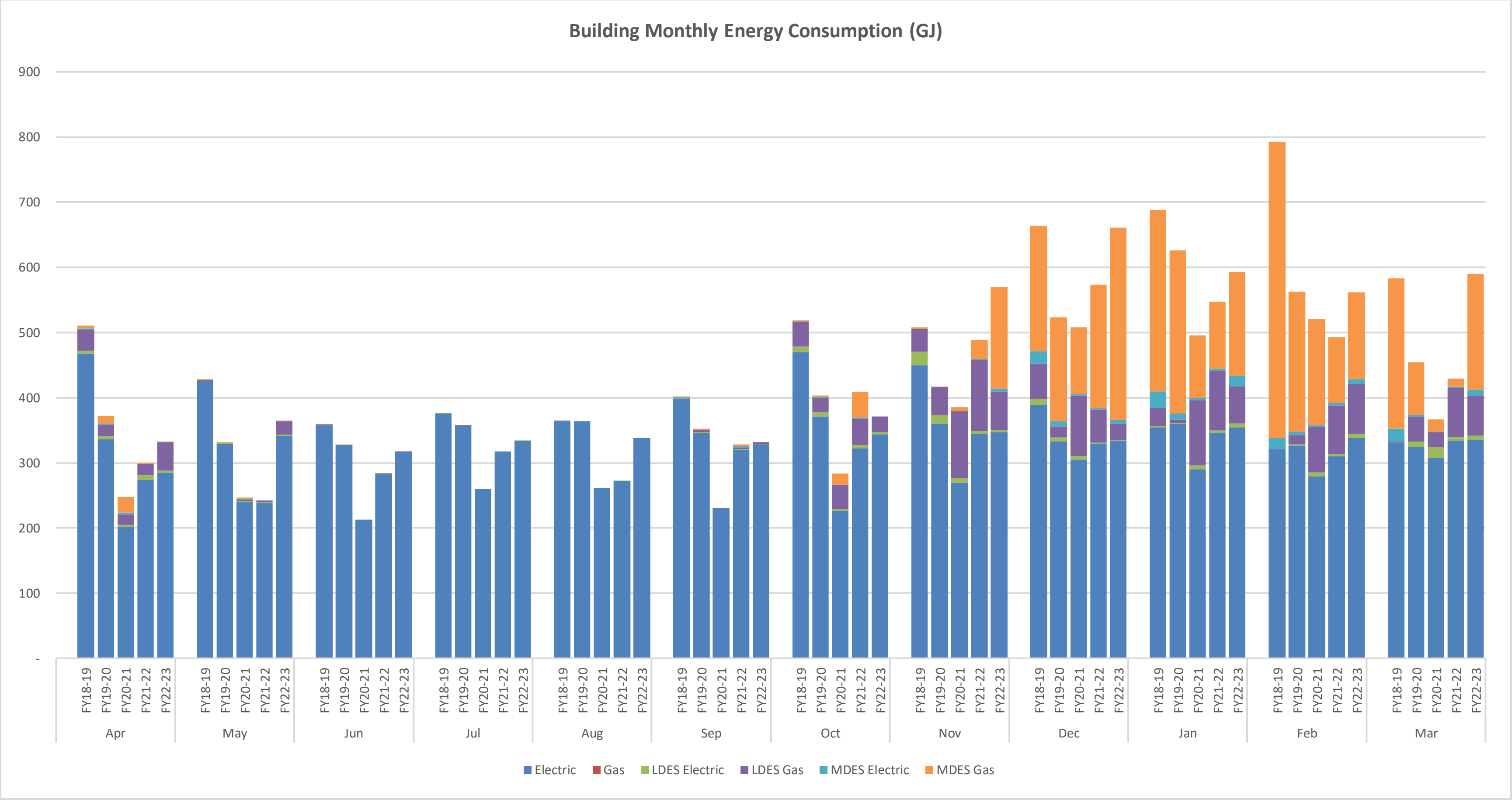
7.12 Library building (ACAD)



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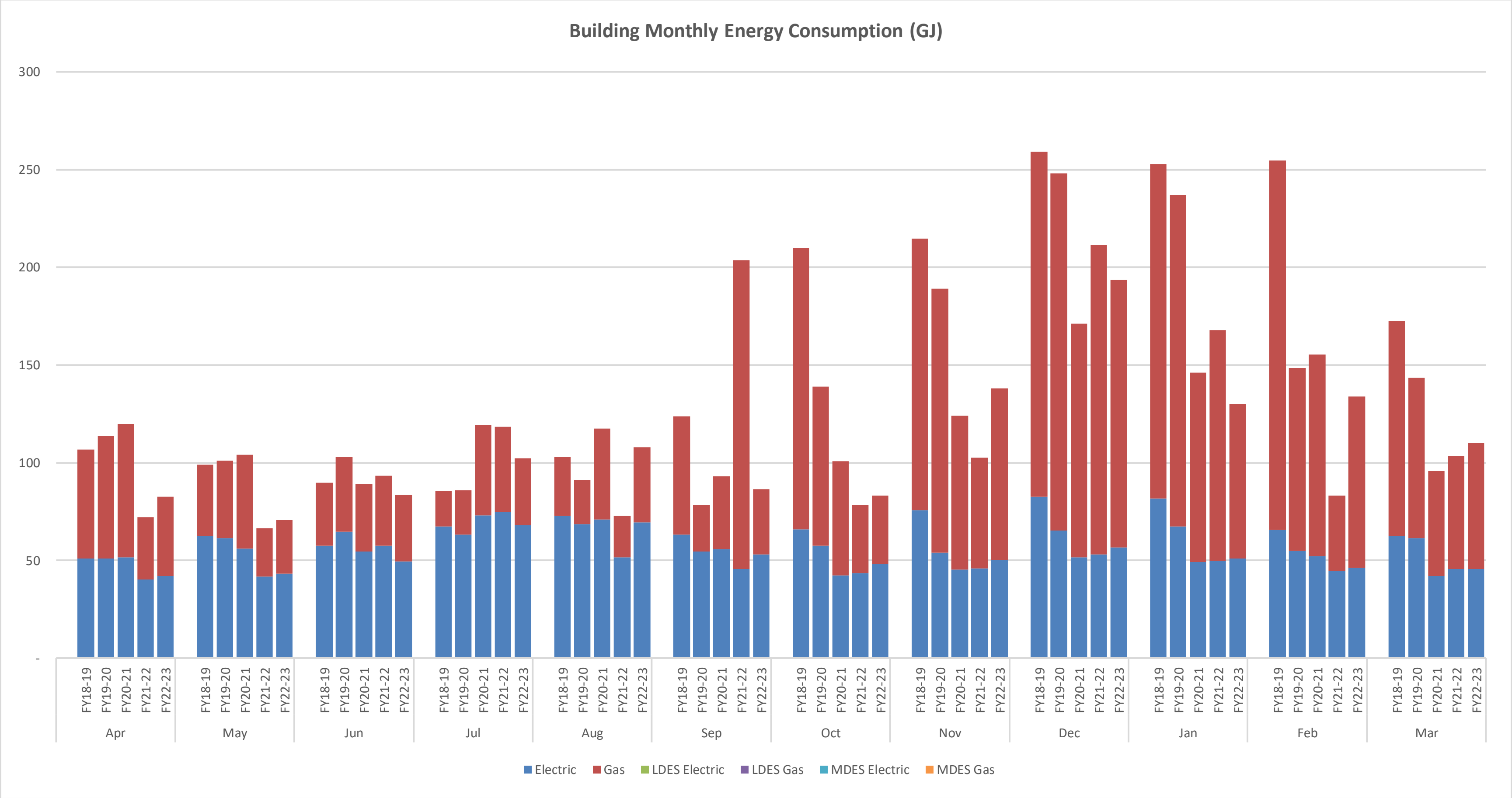
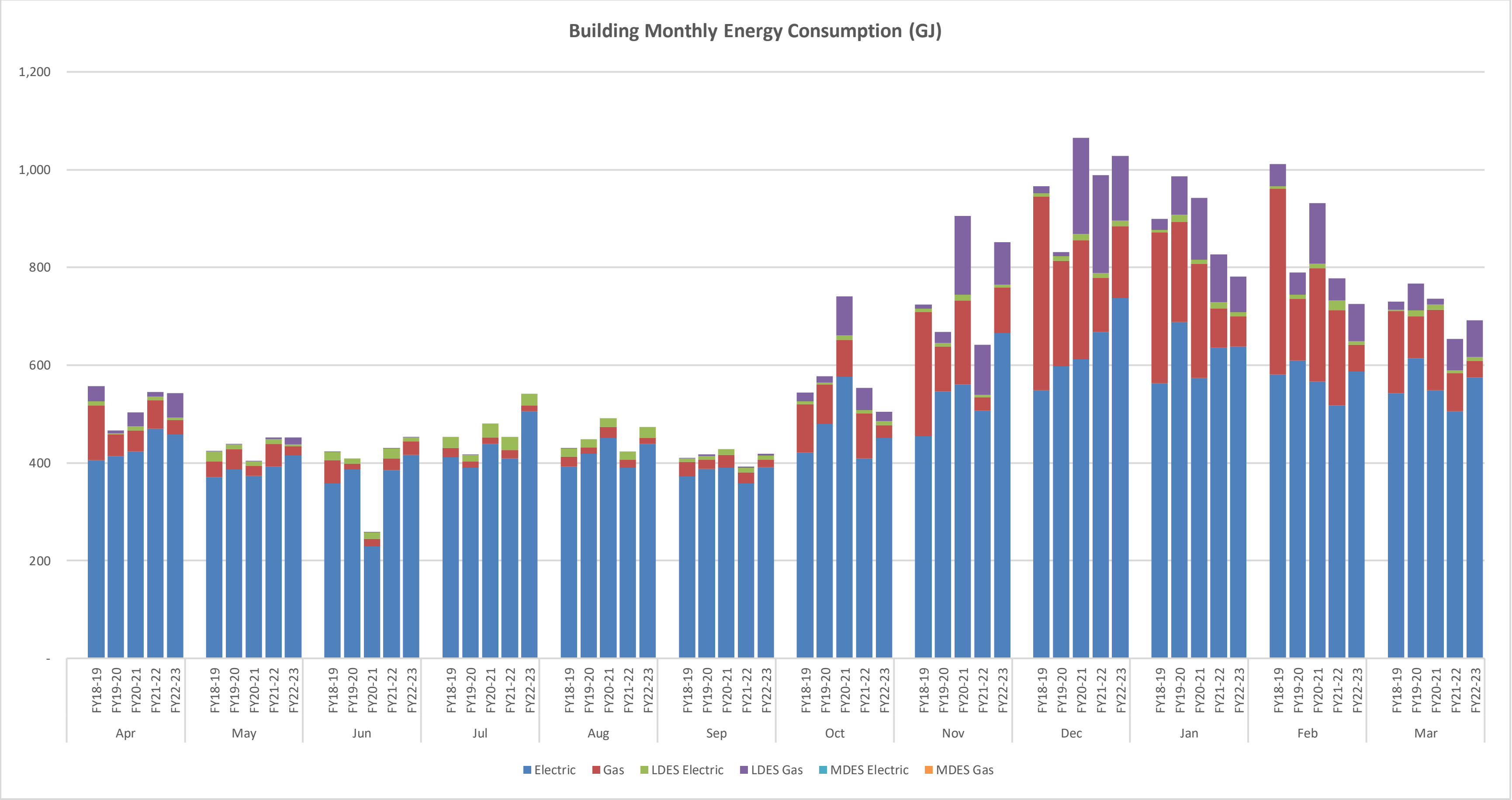
7.13 Upper Campus Health building formerly known as Mountain Weather Office (ACAD)



7.14 Reichwald Health Sciences Centre building (ACAD)



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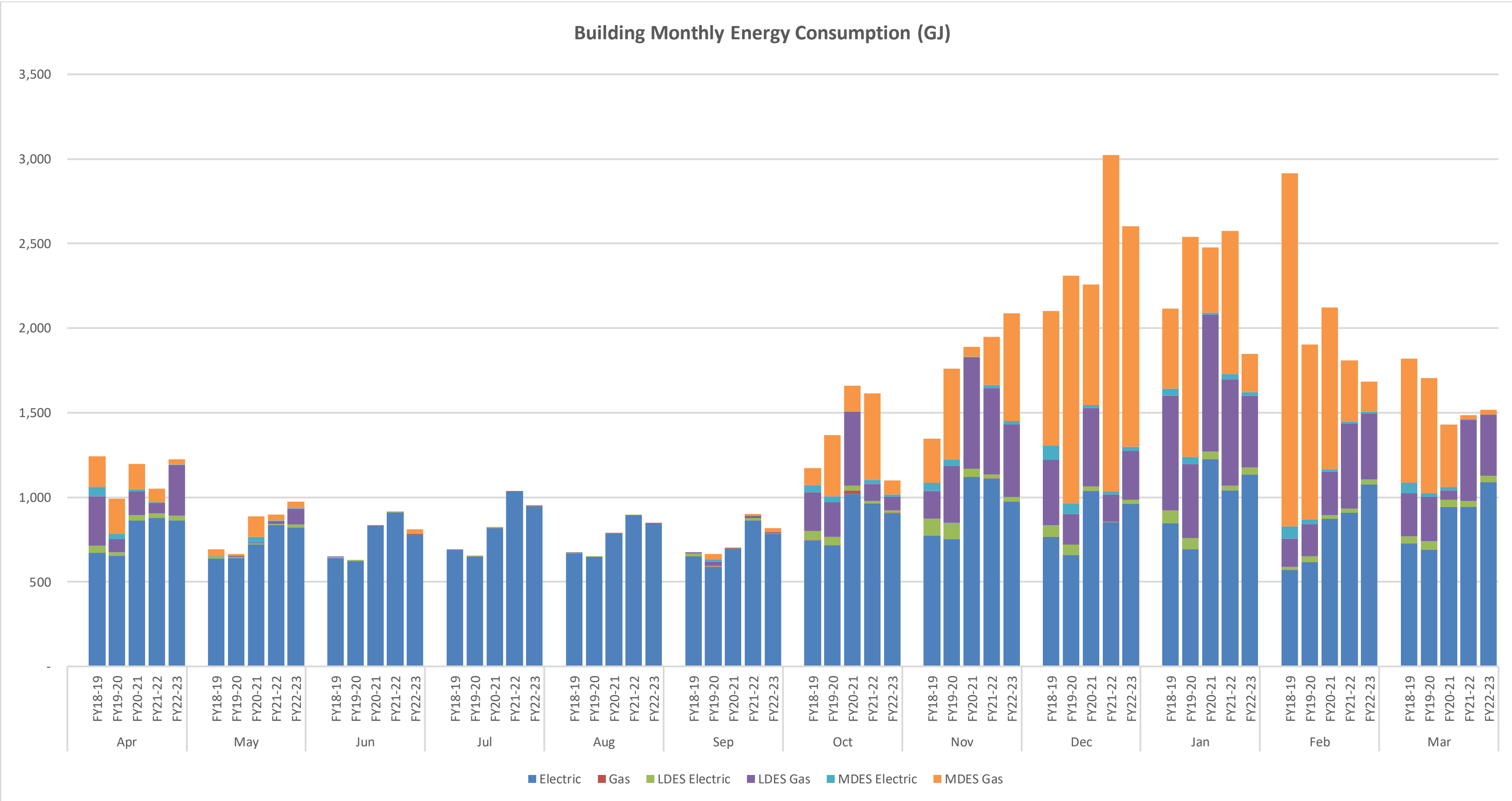
7.15 Science building (ACAD)



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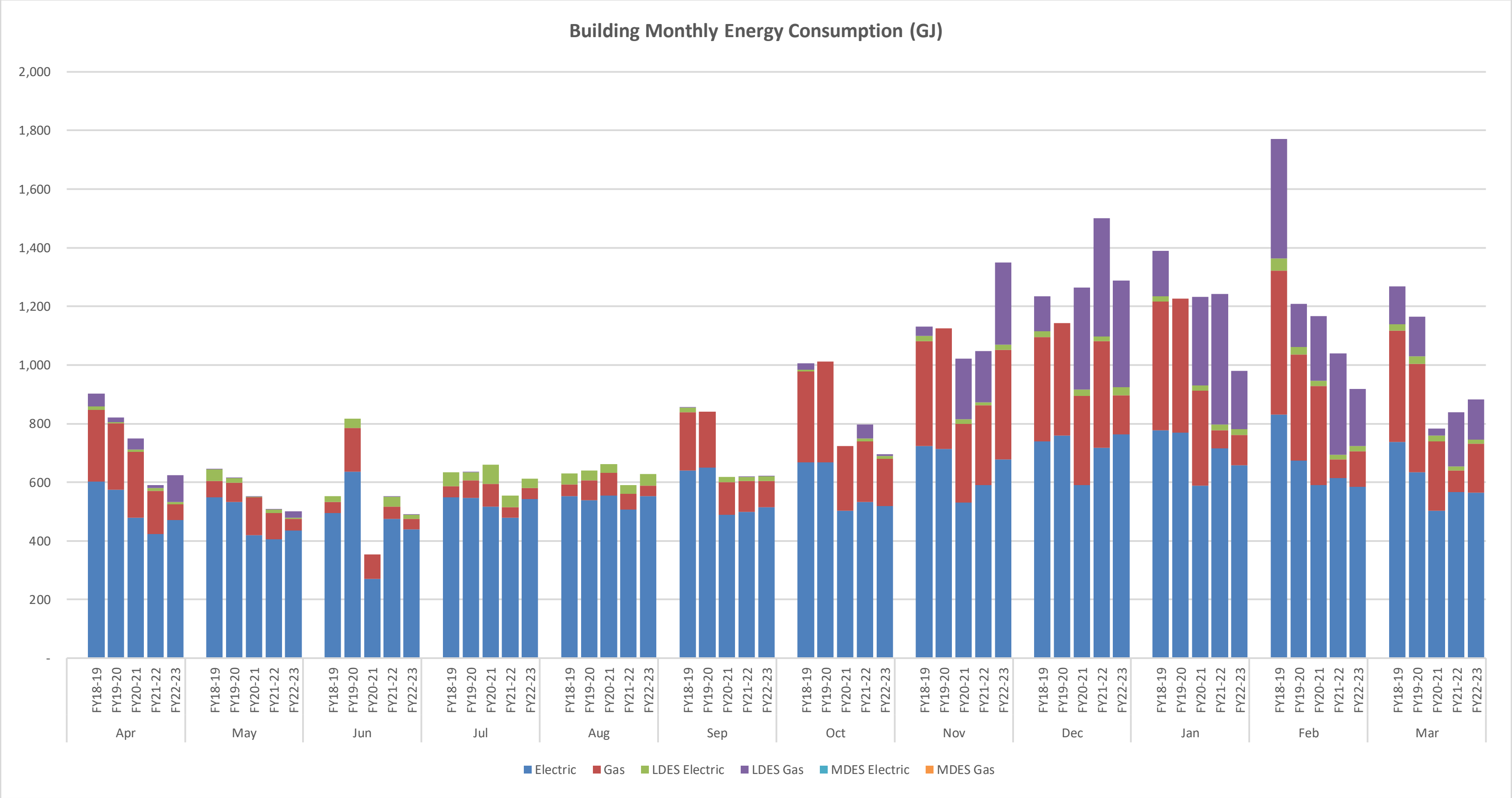
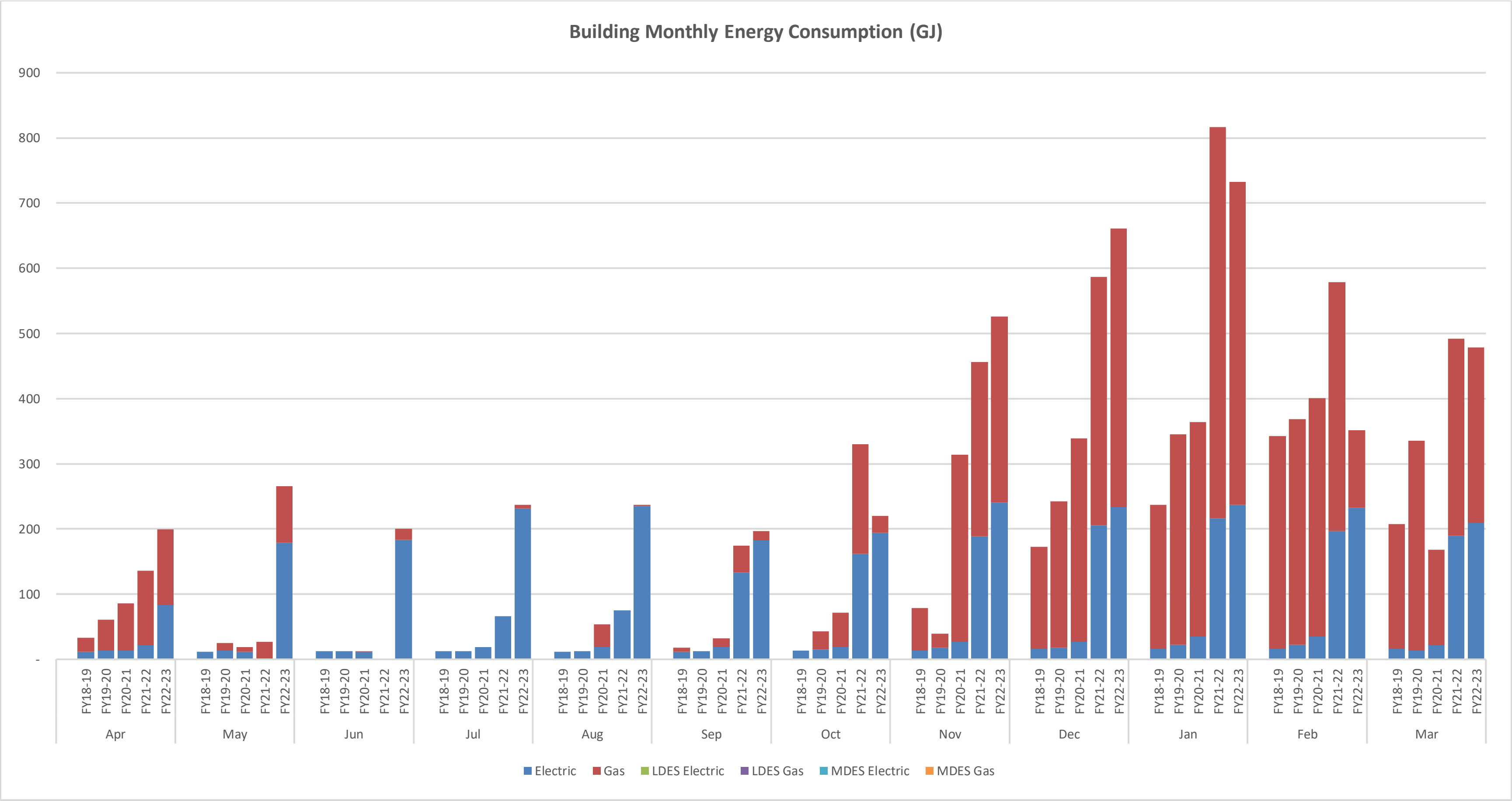
7.16 University Centre building (ACAD)



7.17 1540 Innovation Drive (IP#1) building (ACAD)



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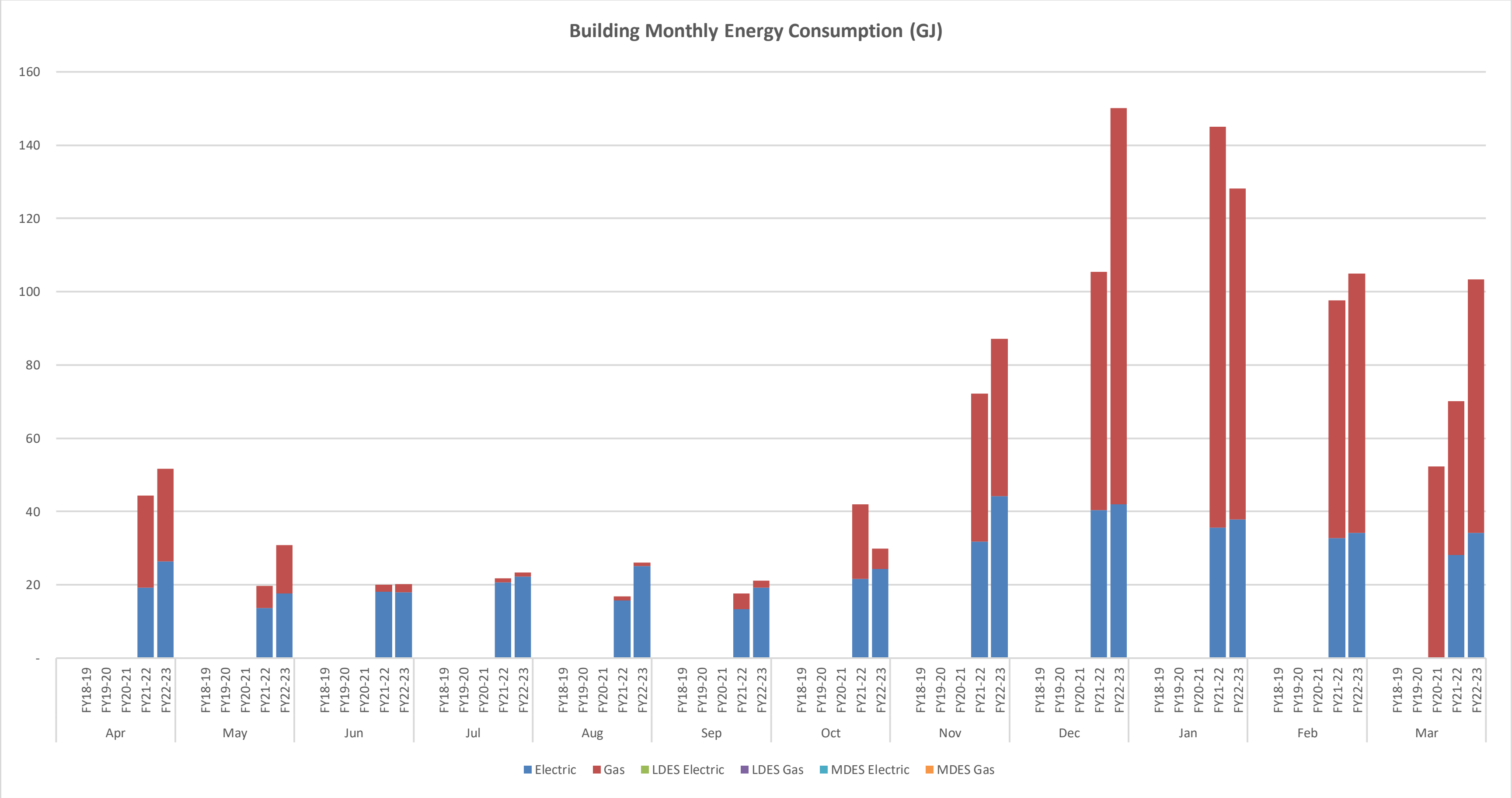
7.18 Innovation Annex building (ACAD)



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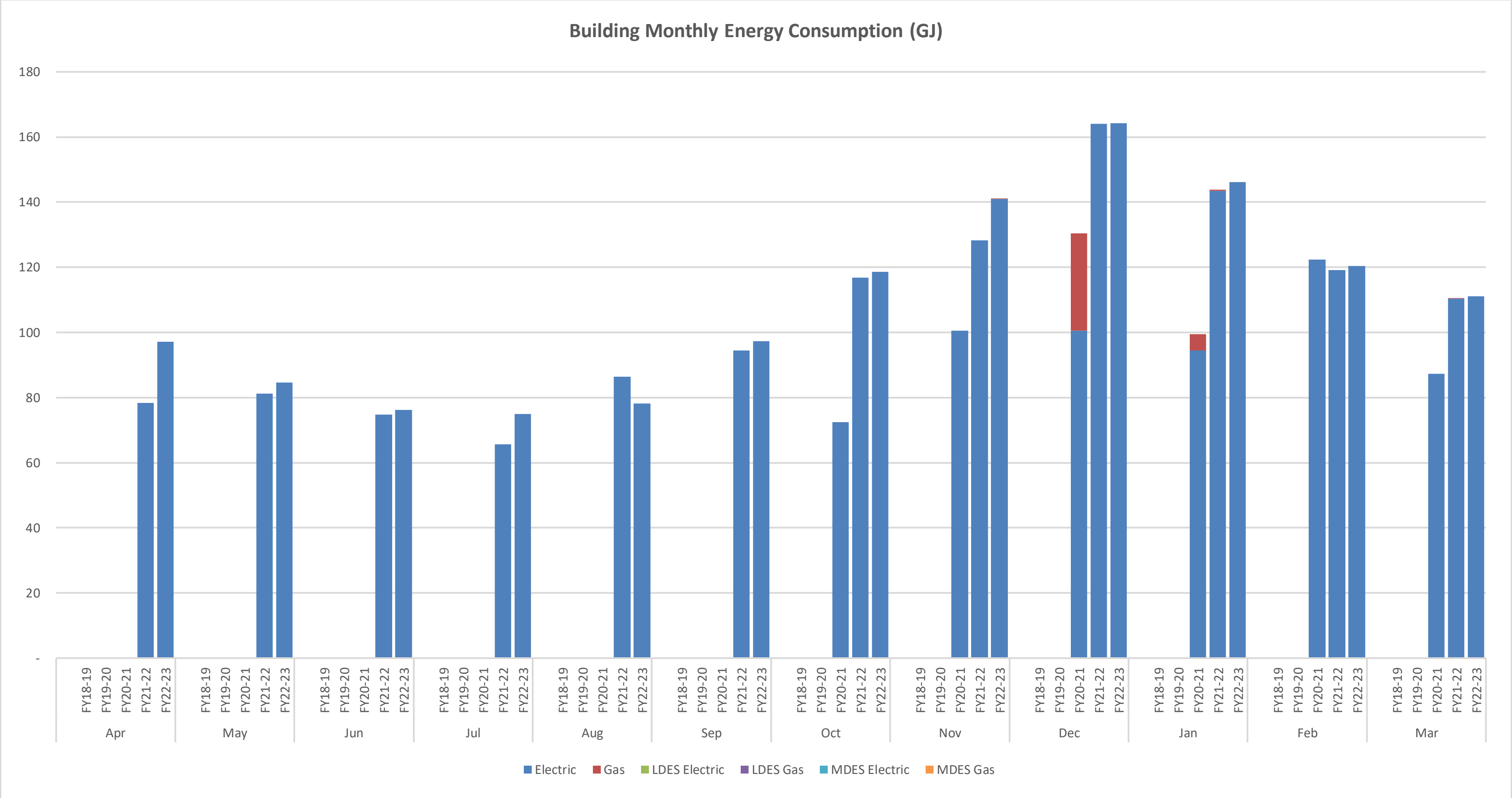
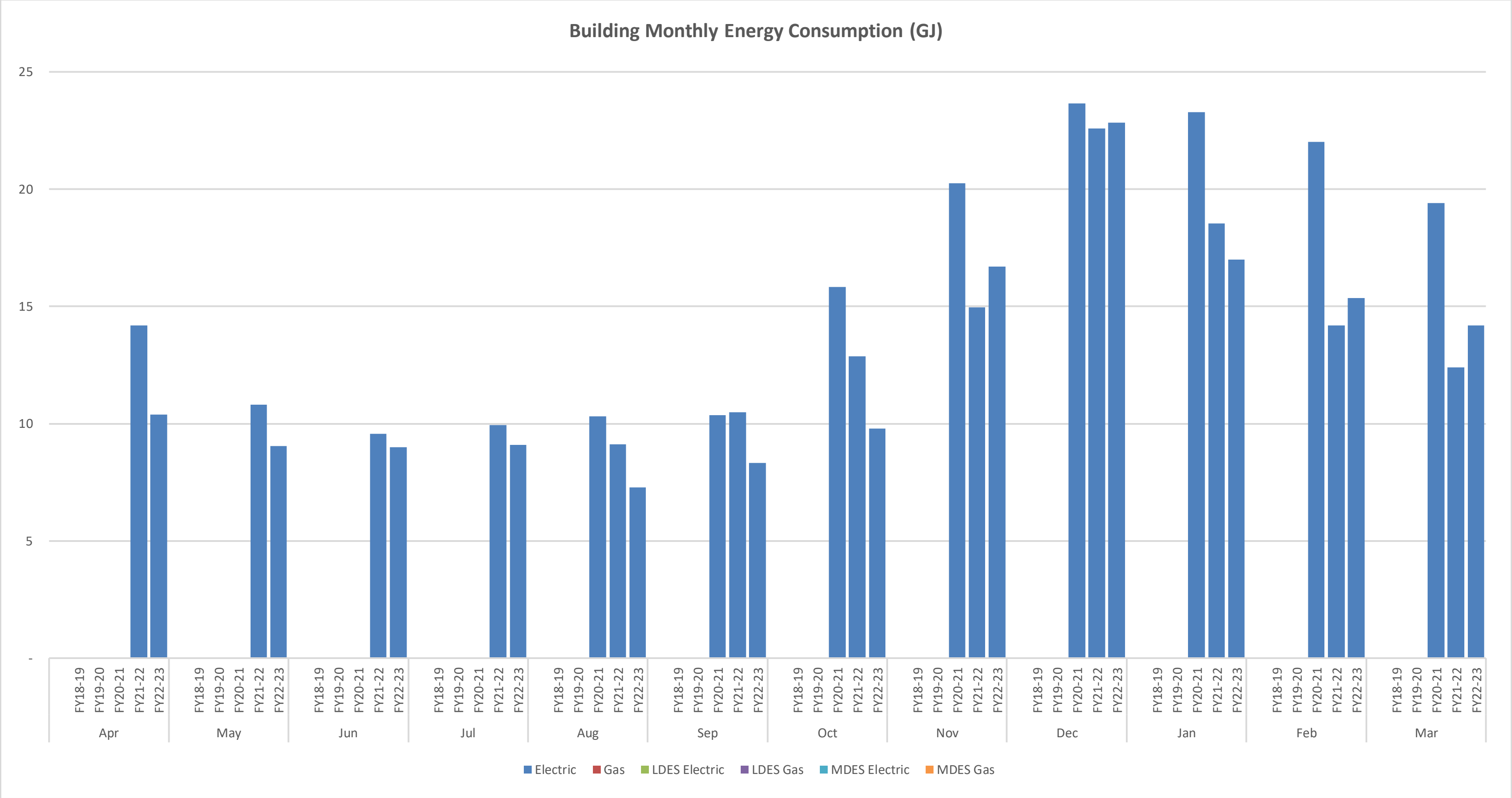
7.19 Plant Growth Facility building (ACAD)



7.20 EDL building (ACAD)



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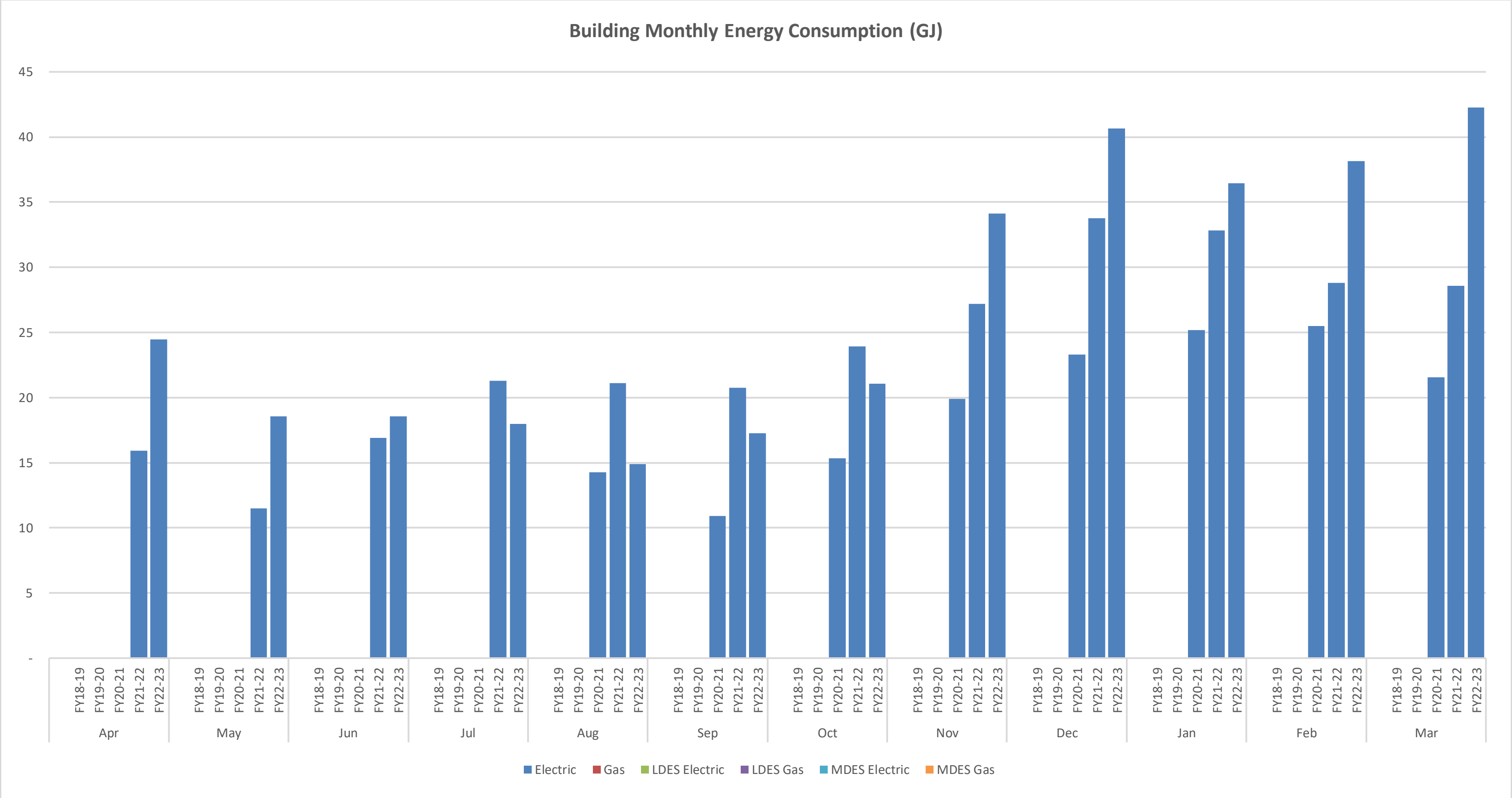
7.21 OM1 building (ACAD)



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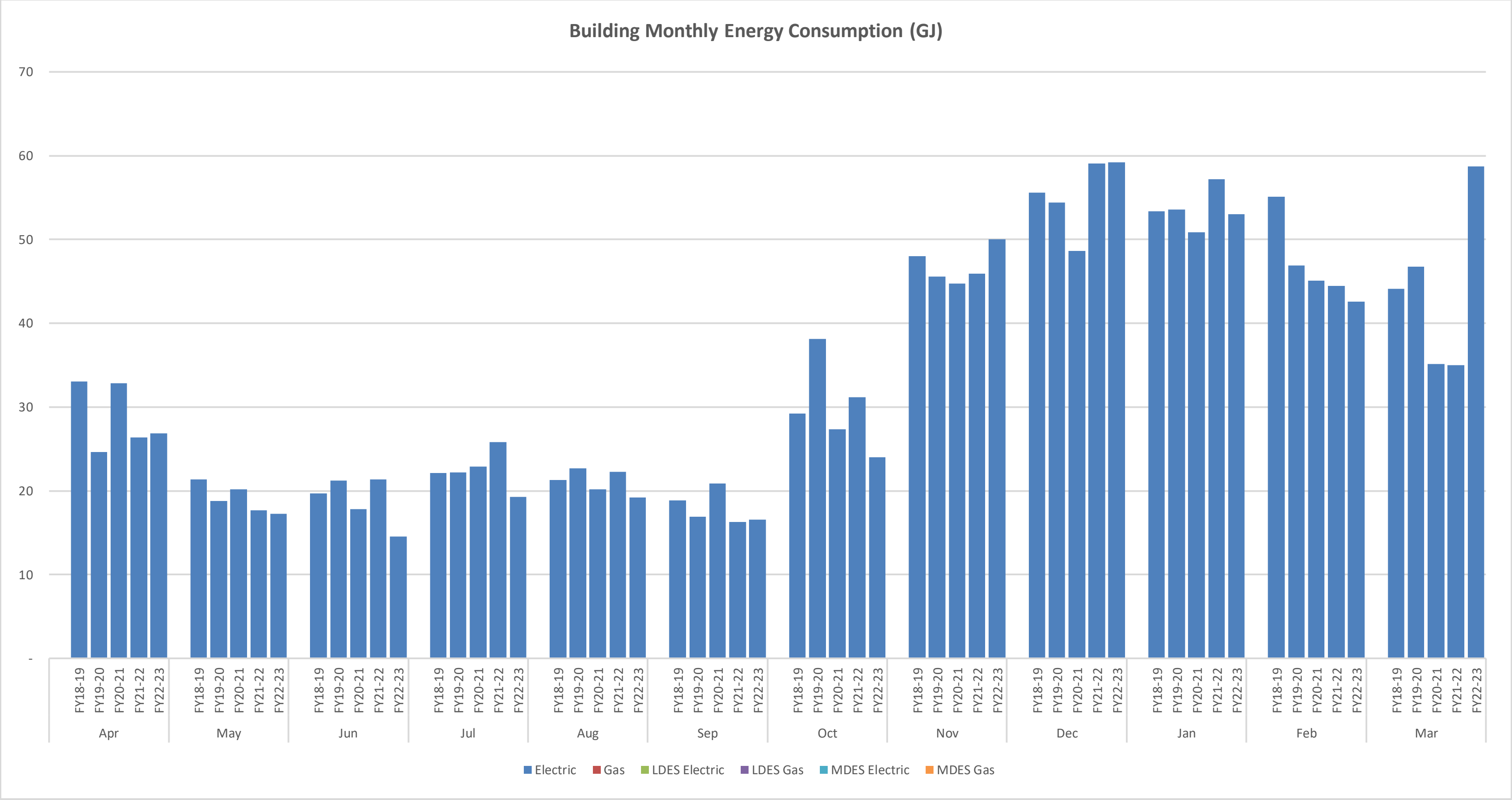
7.22 Quonset building (ACAD)



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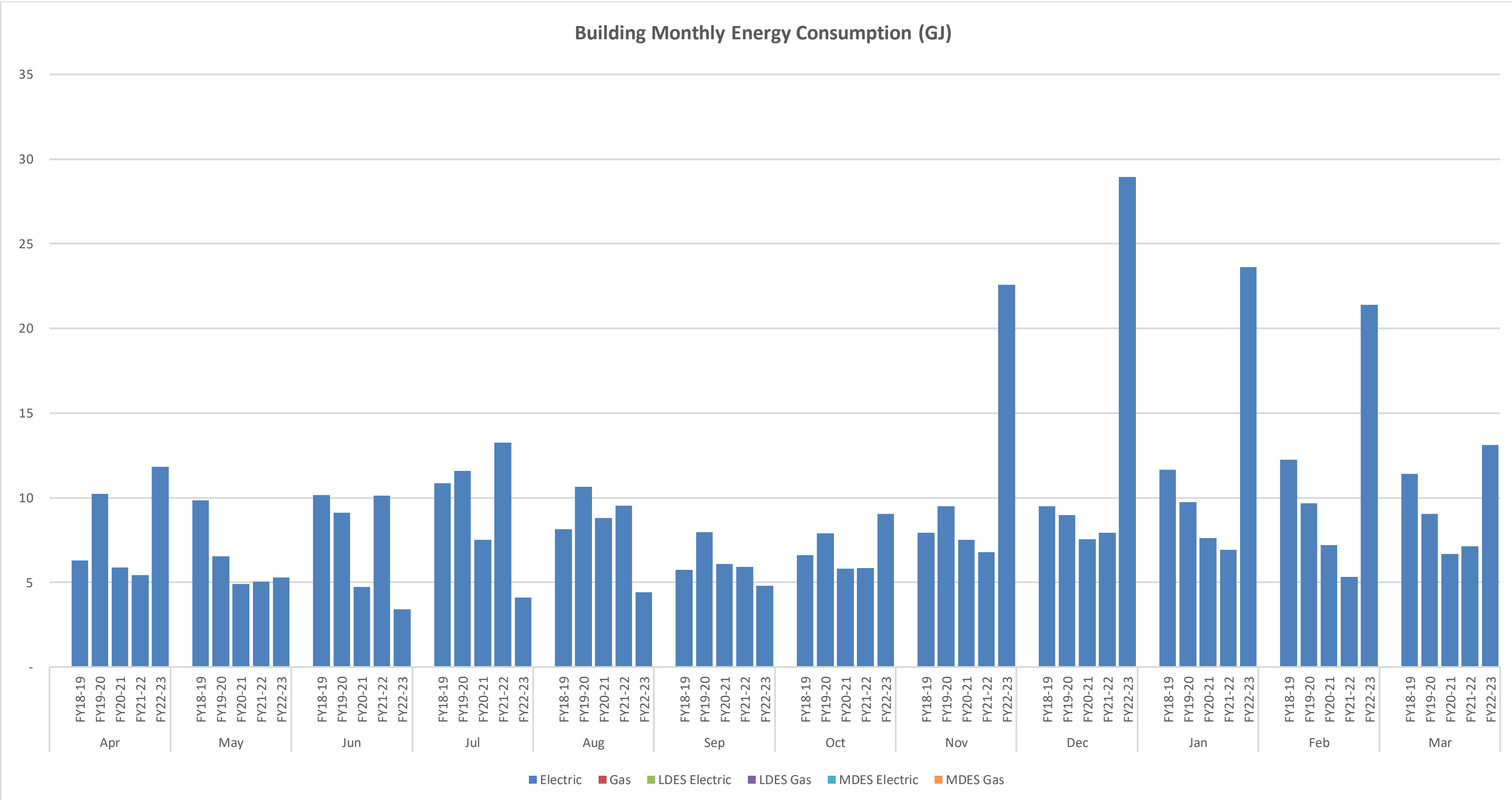
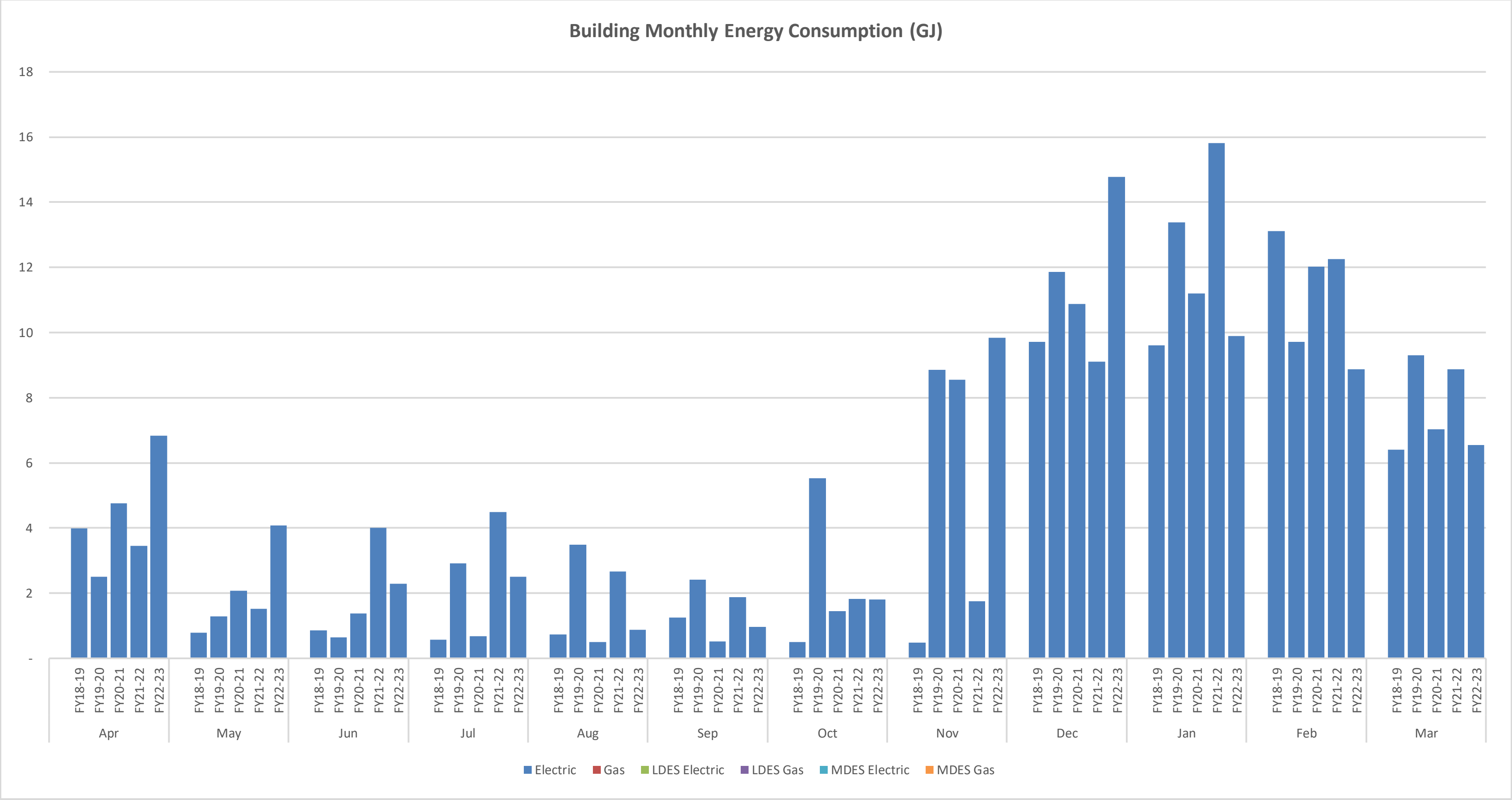
7.23 University House building (ACAD)



7.24 Portable A building (ACAD)



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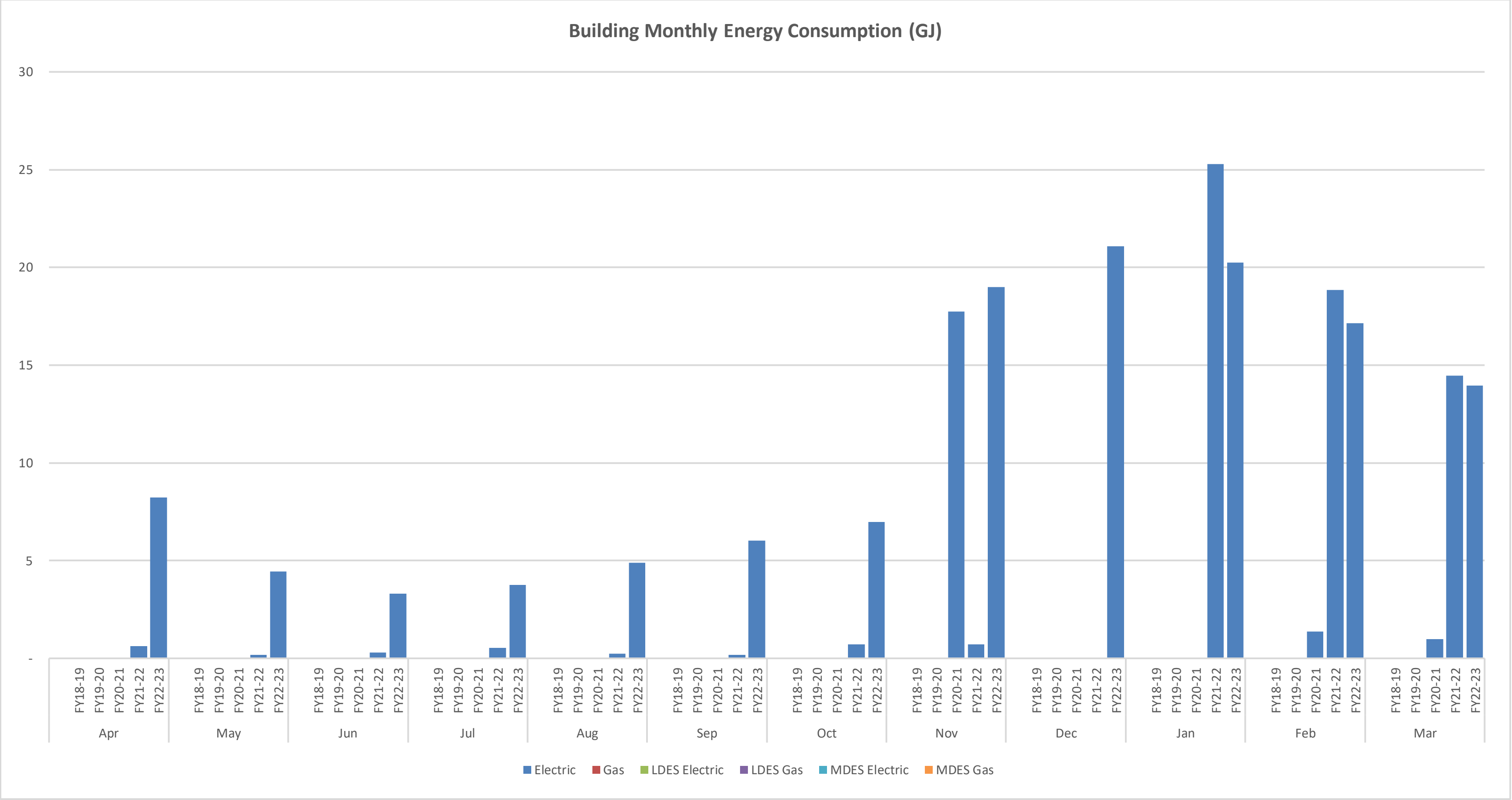
7.25 Portable N building (ACAD)



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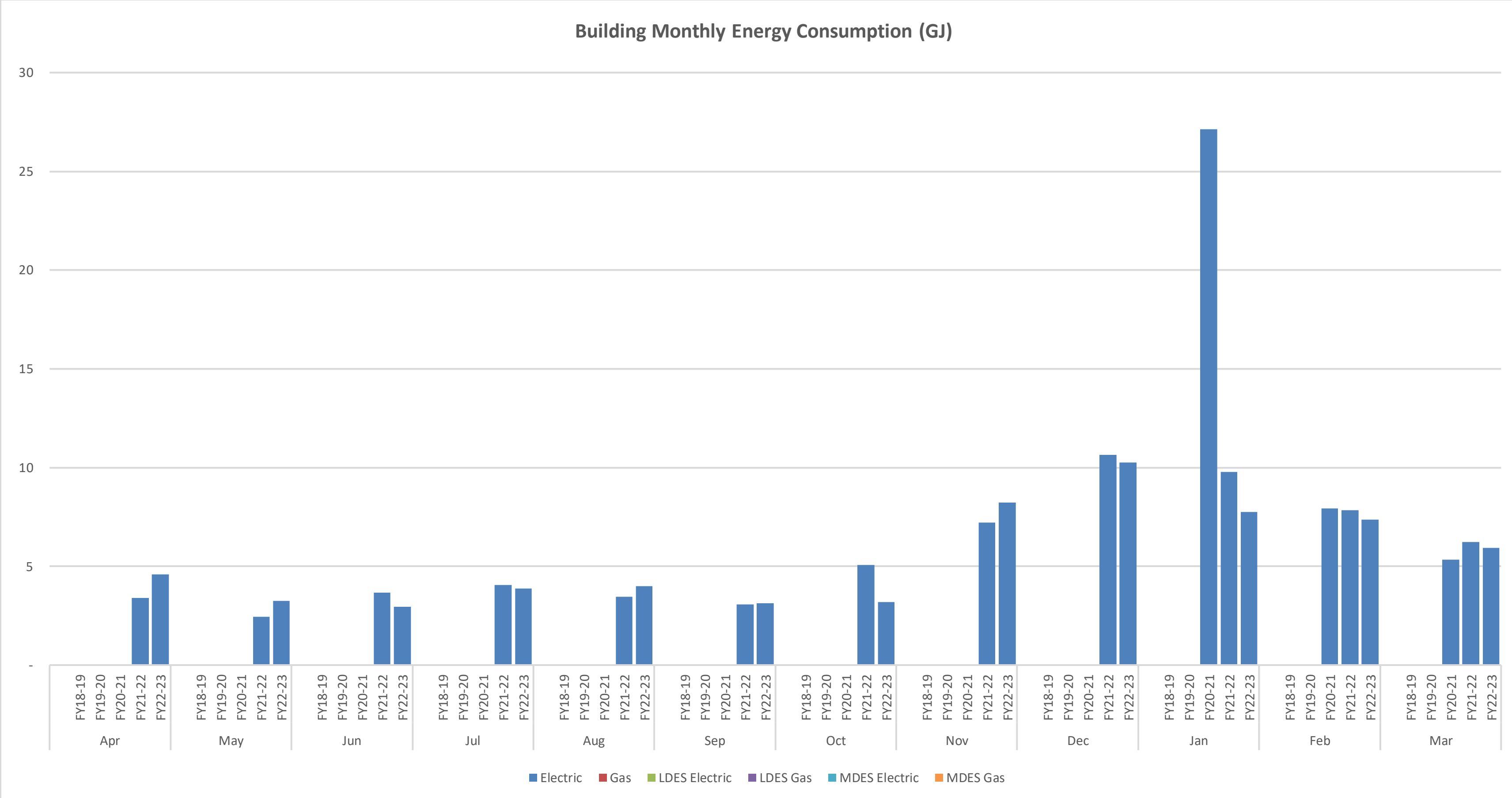
7.26 Portable V building (ACAD)



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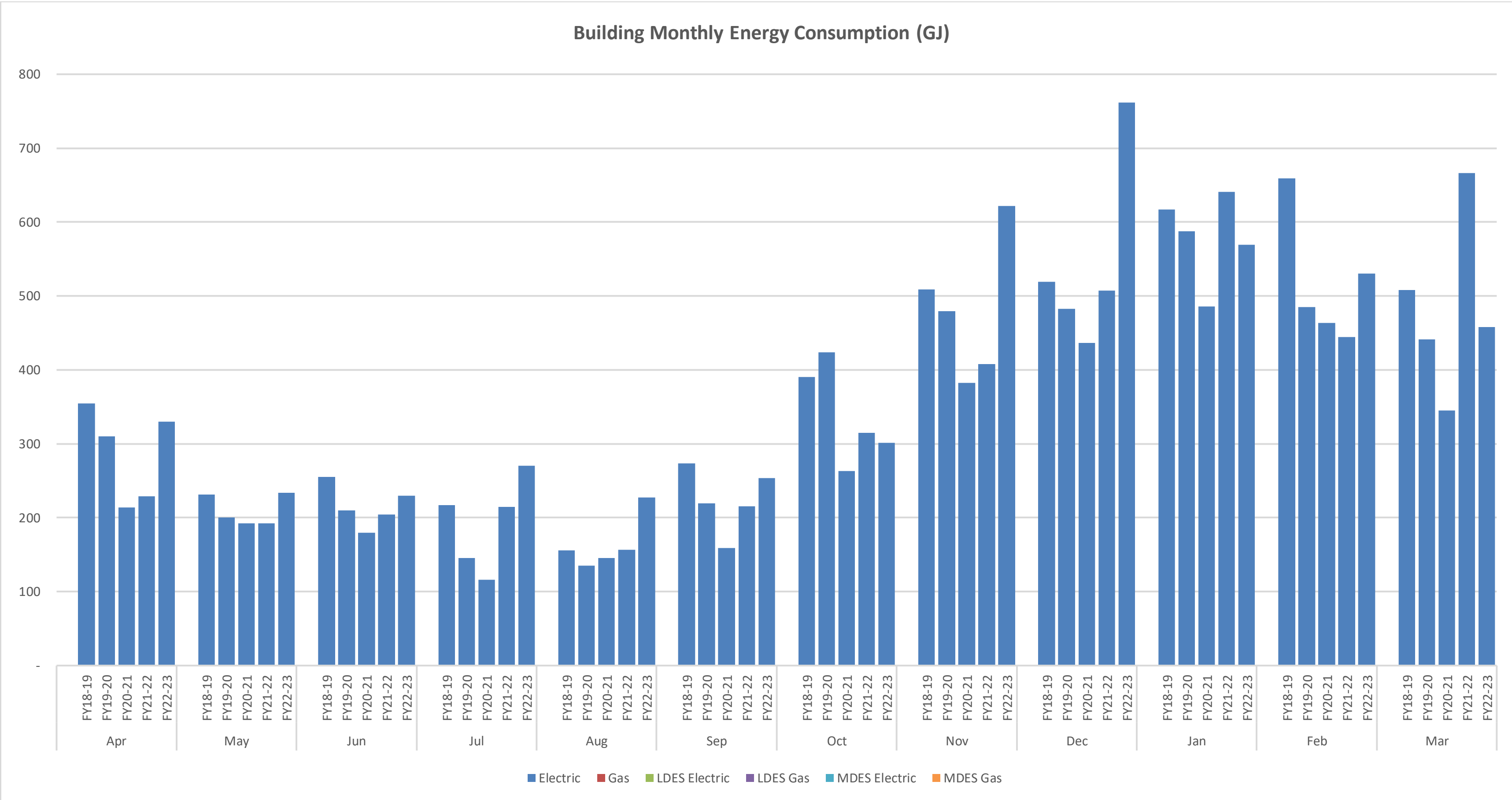
7.27 Lower Cascades Residence building



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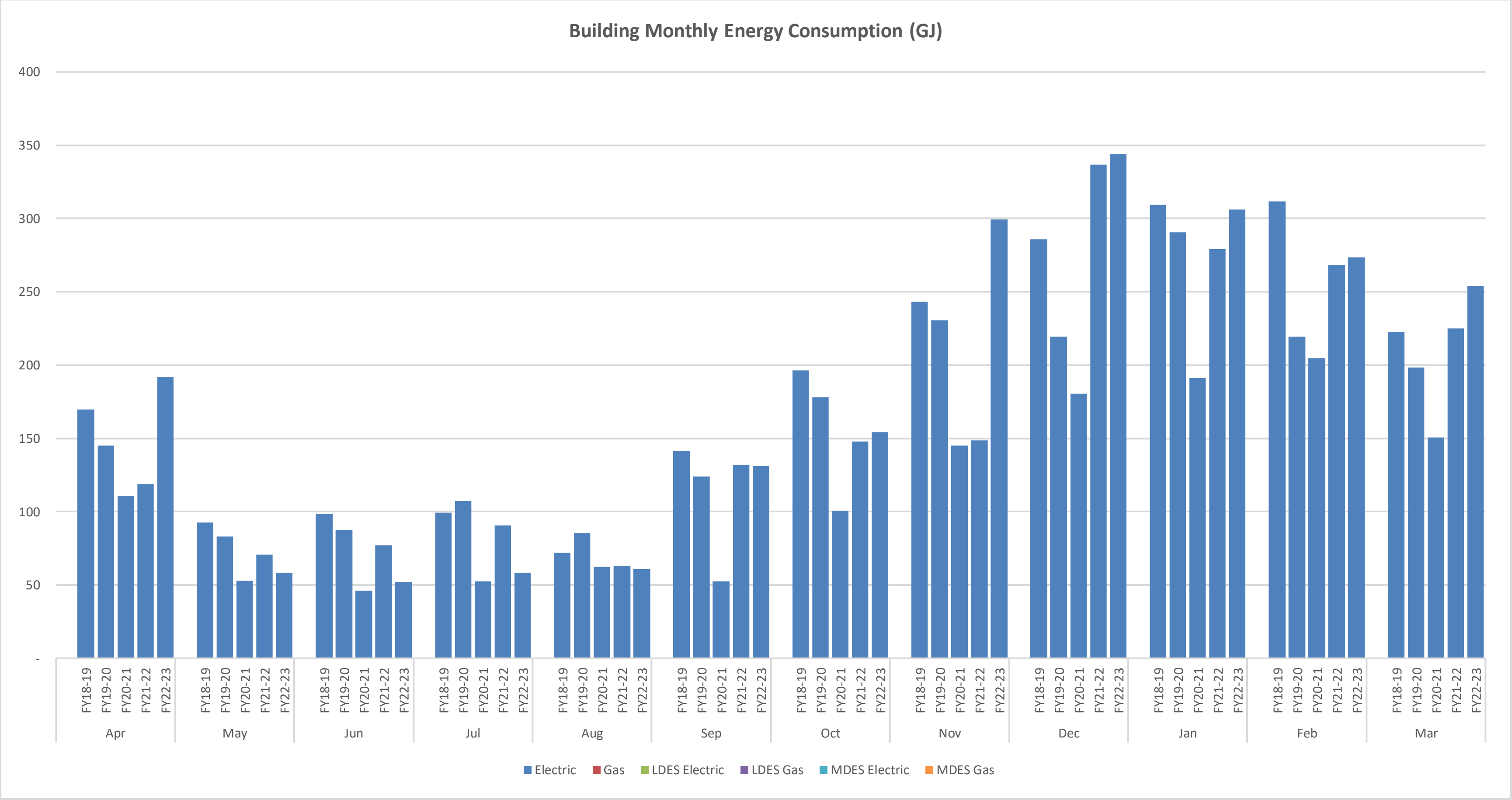
7.28 Upper Cascades Residence building



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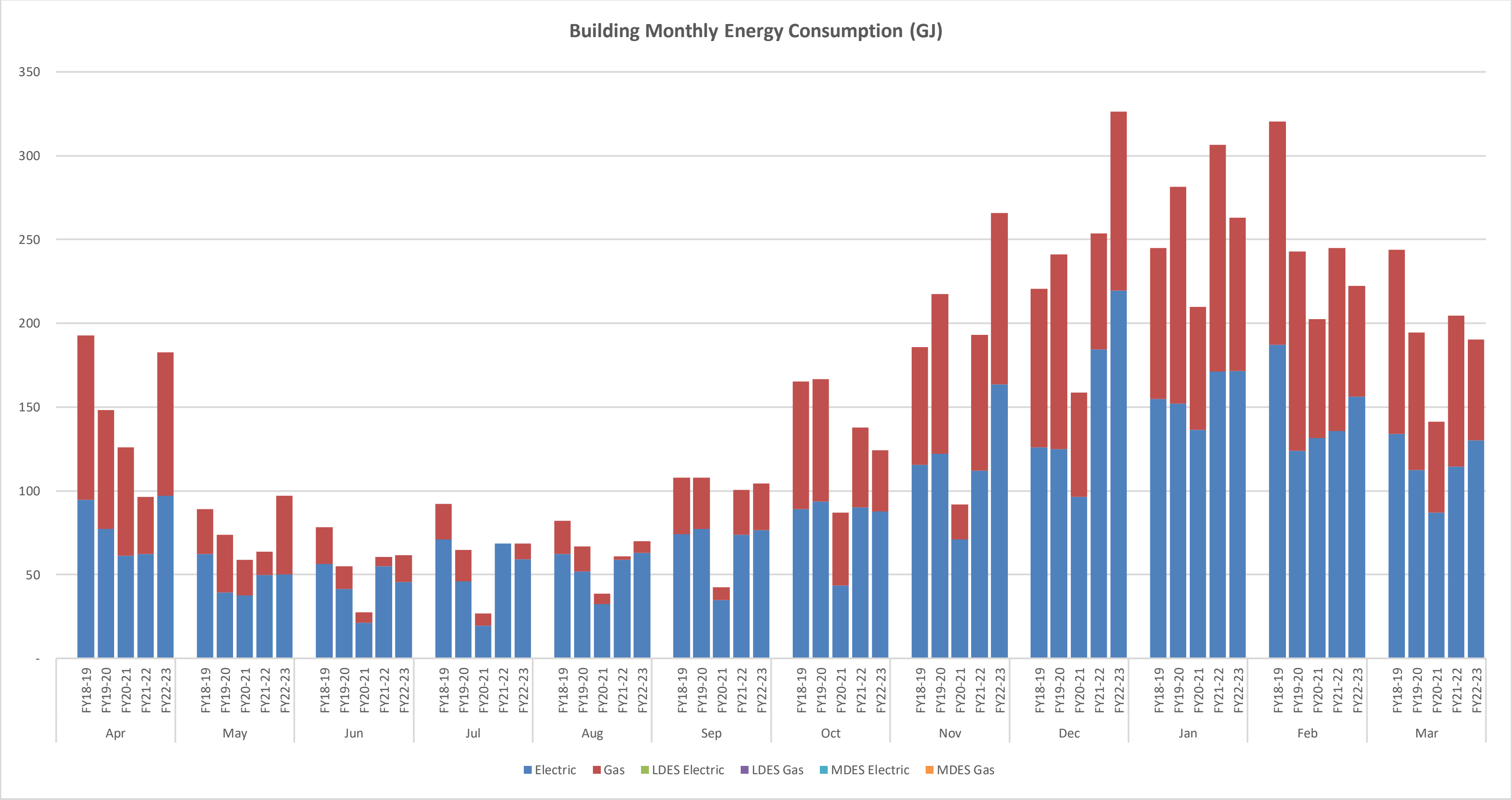
7.29 Cassiar Residence building



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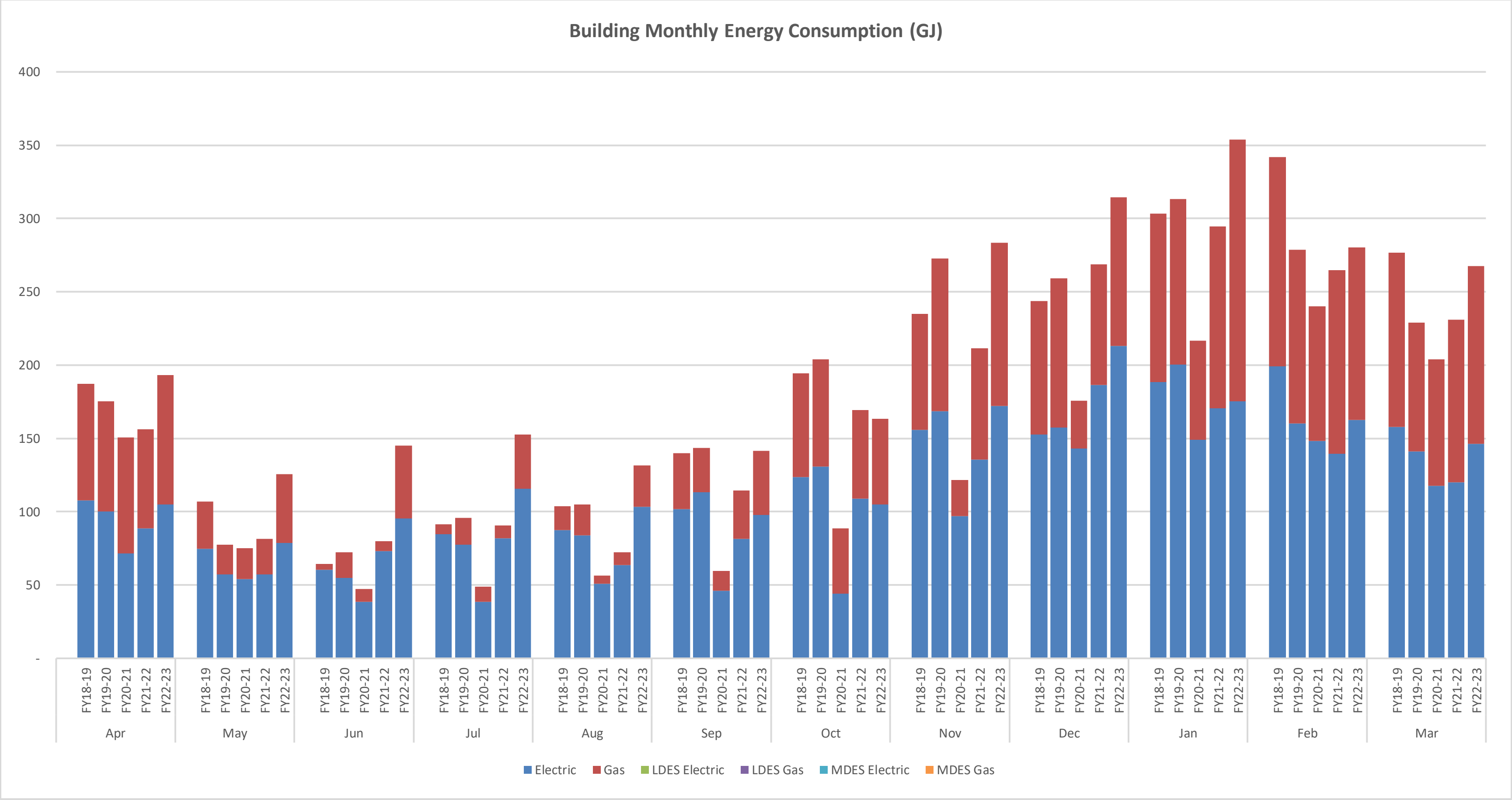
7.30 Kalamalka Residence building



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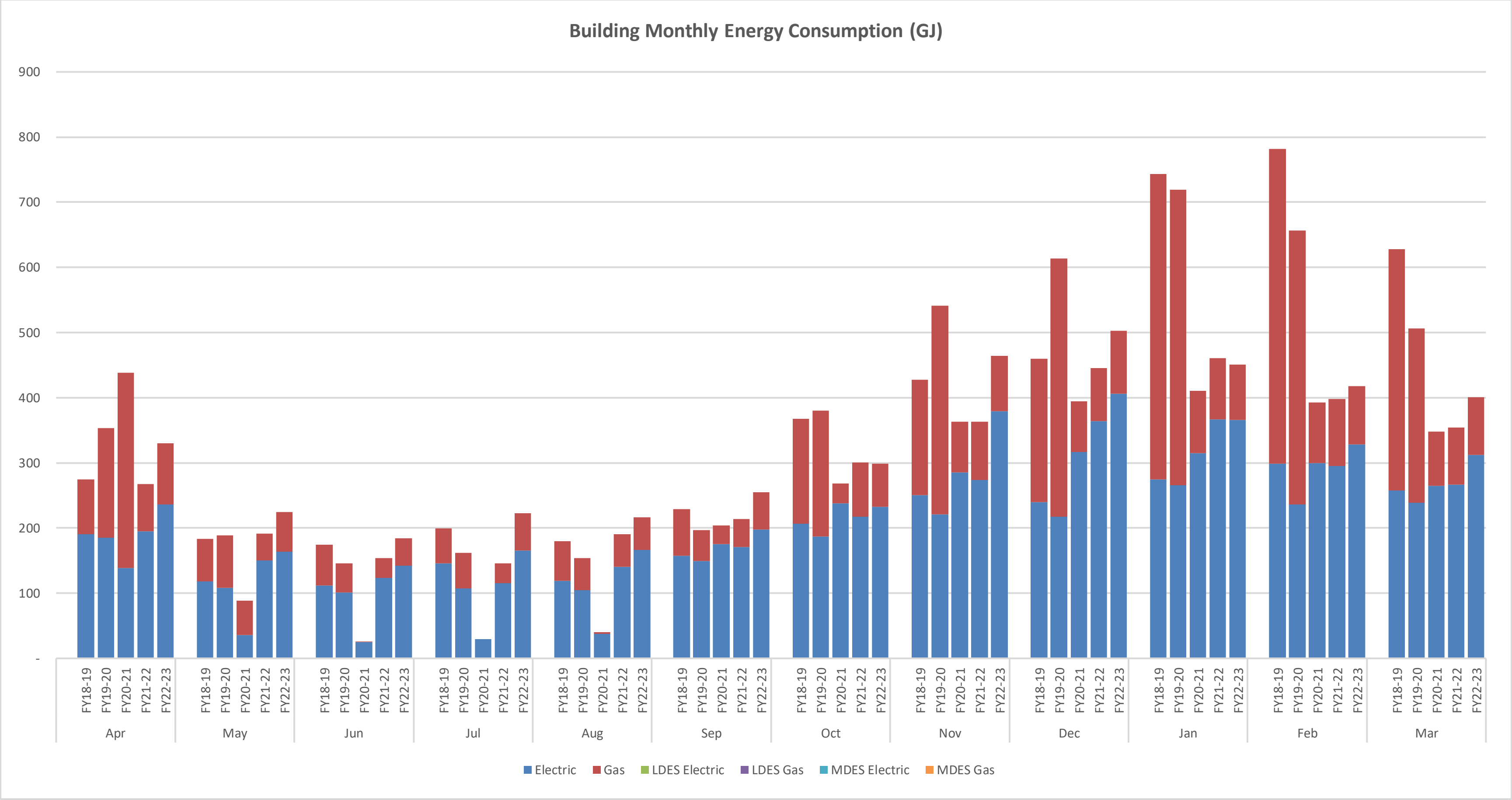
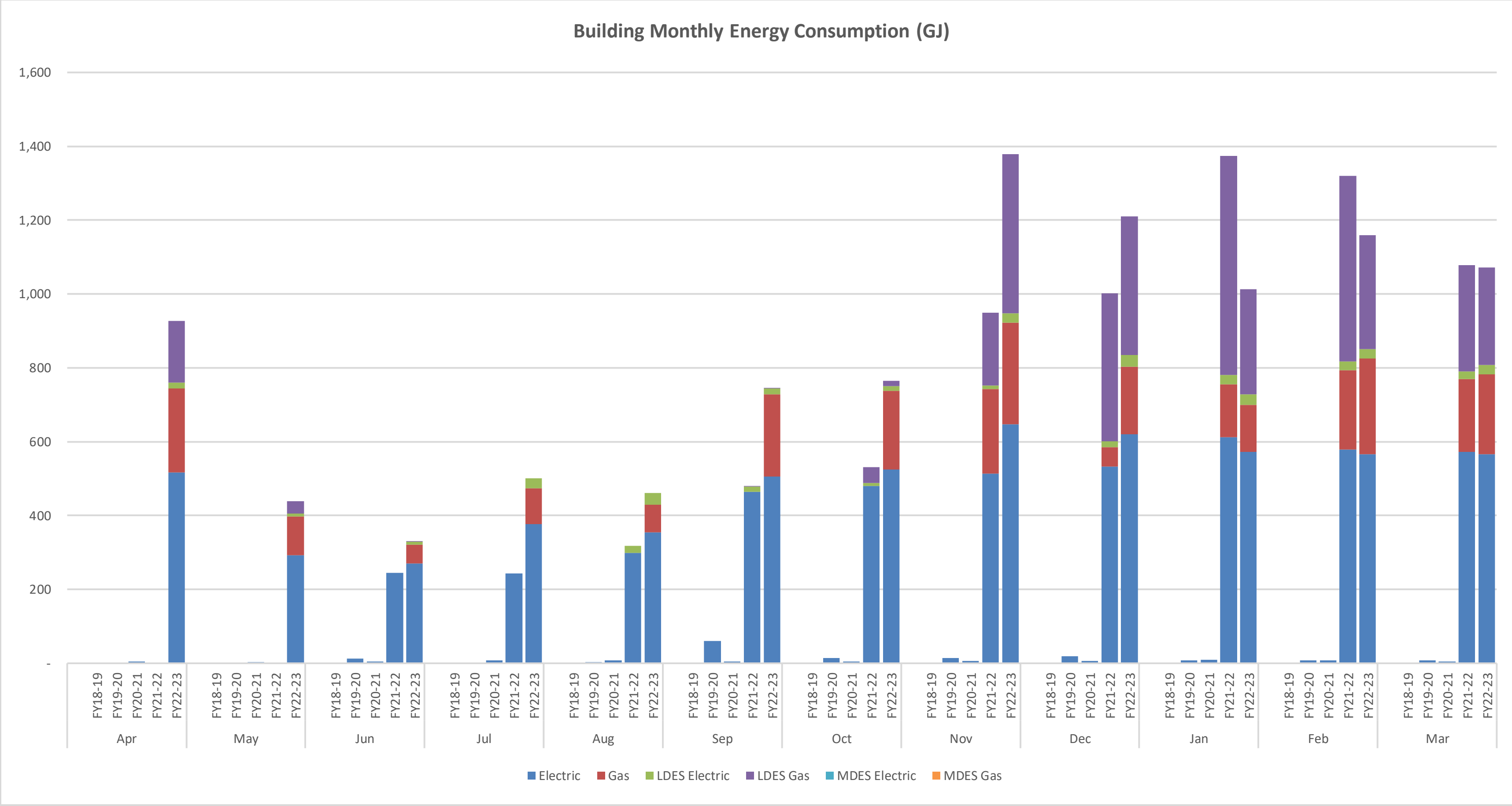
7.31 Monashee Residence building



7.32 Nechako Residence building



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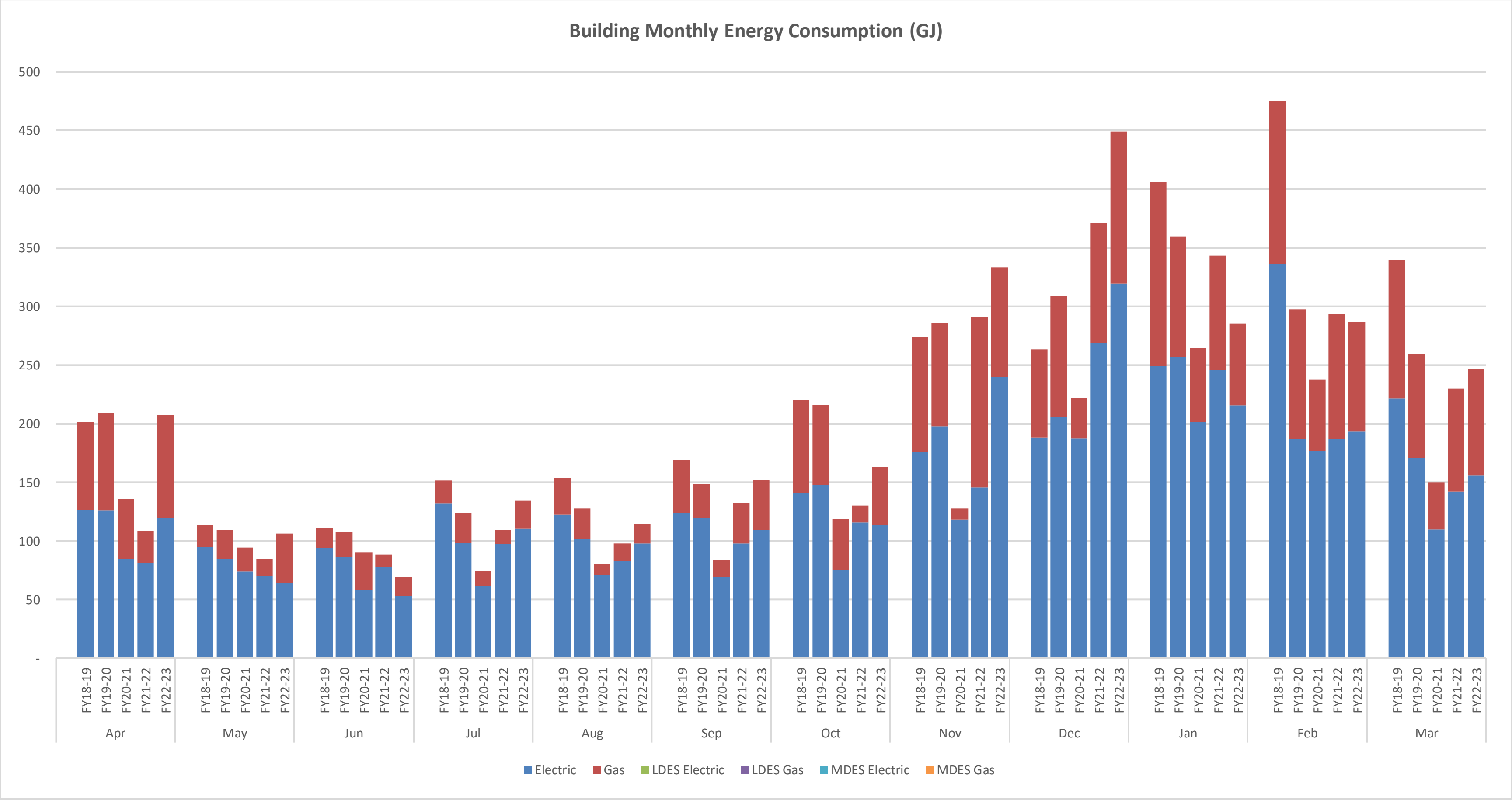
7.33 Nicola Residence building



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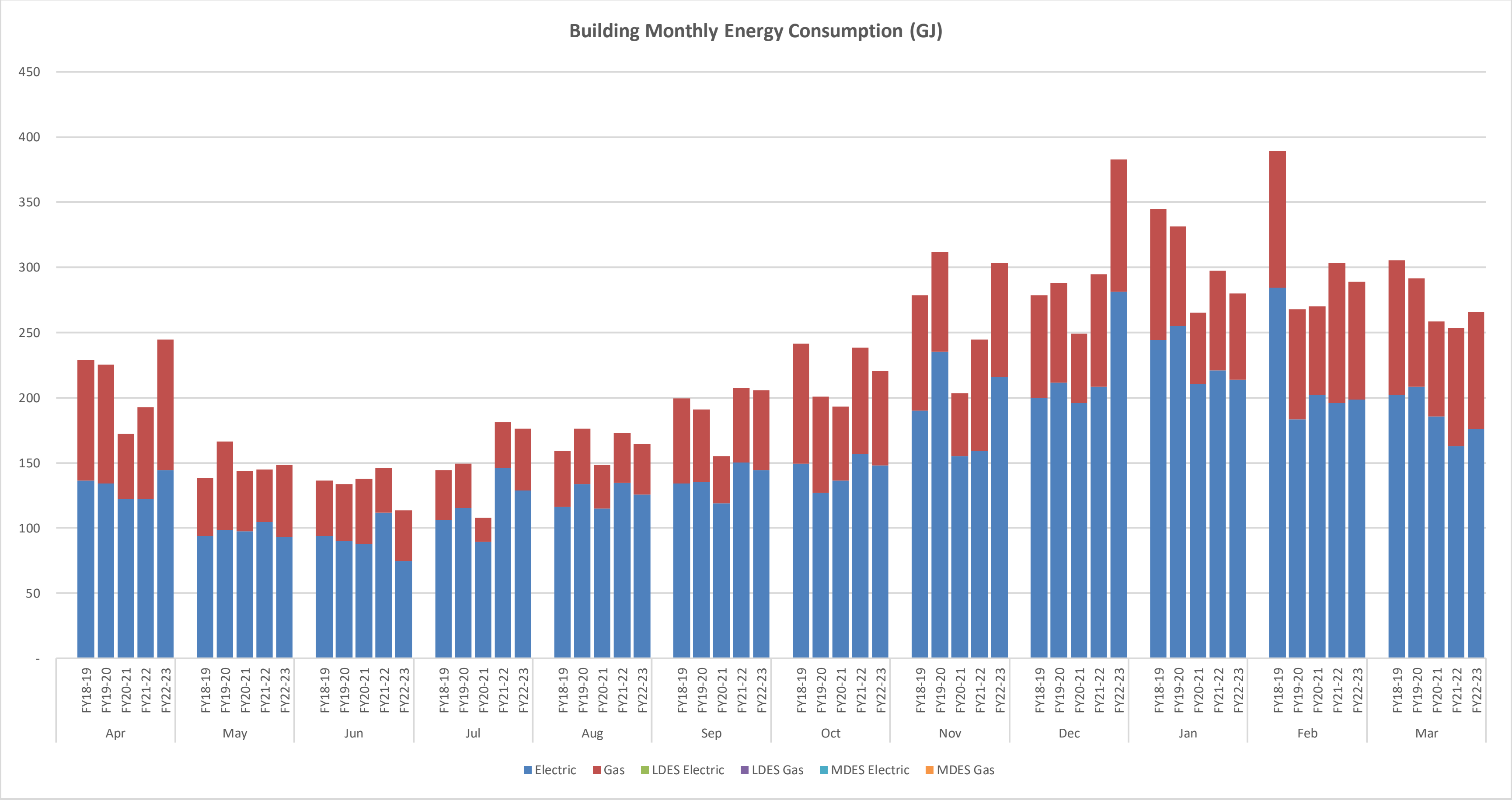
7.34 Purcell Residence building



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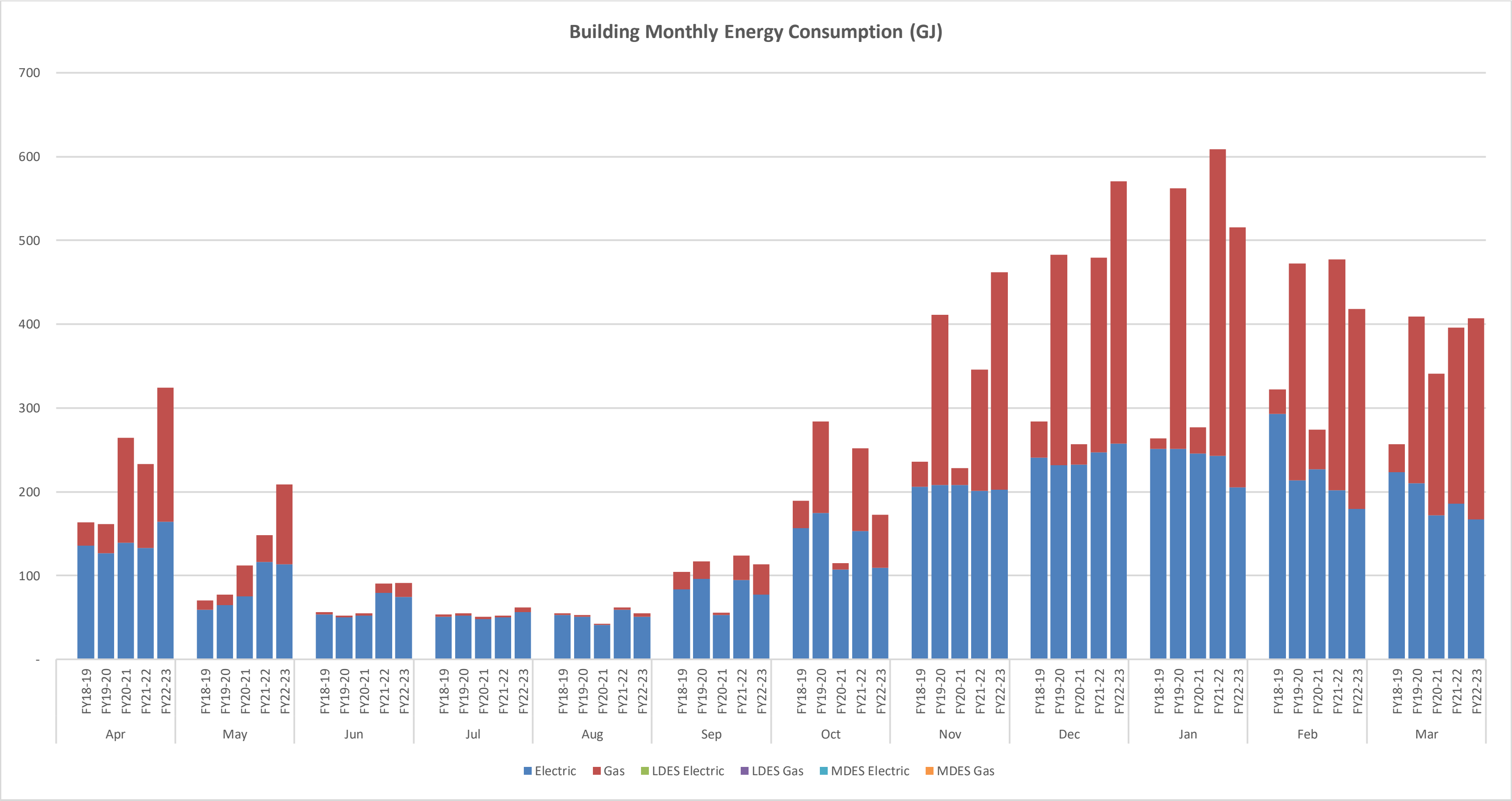
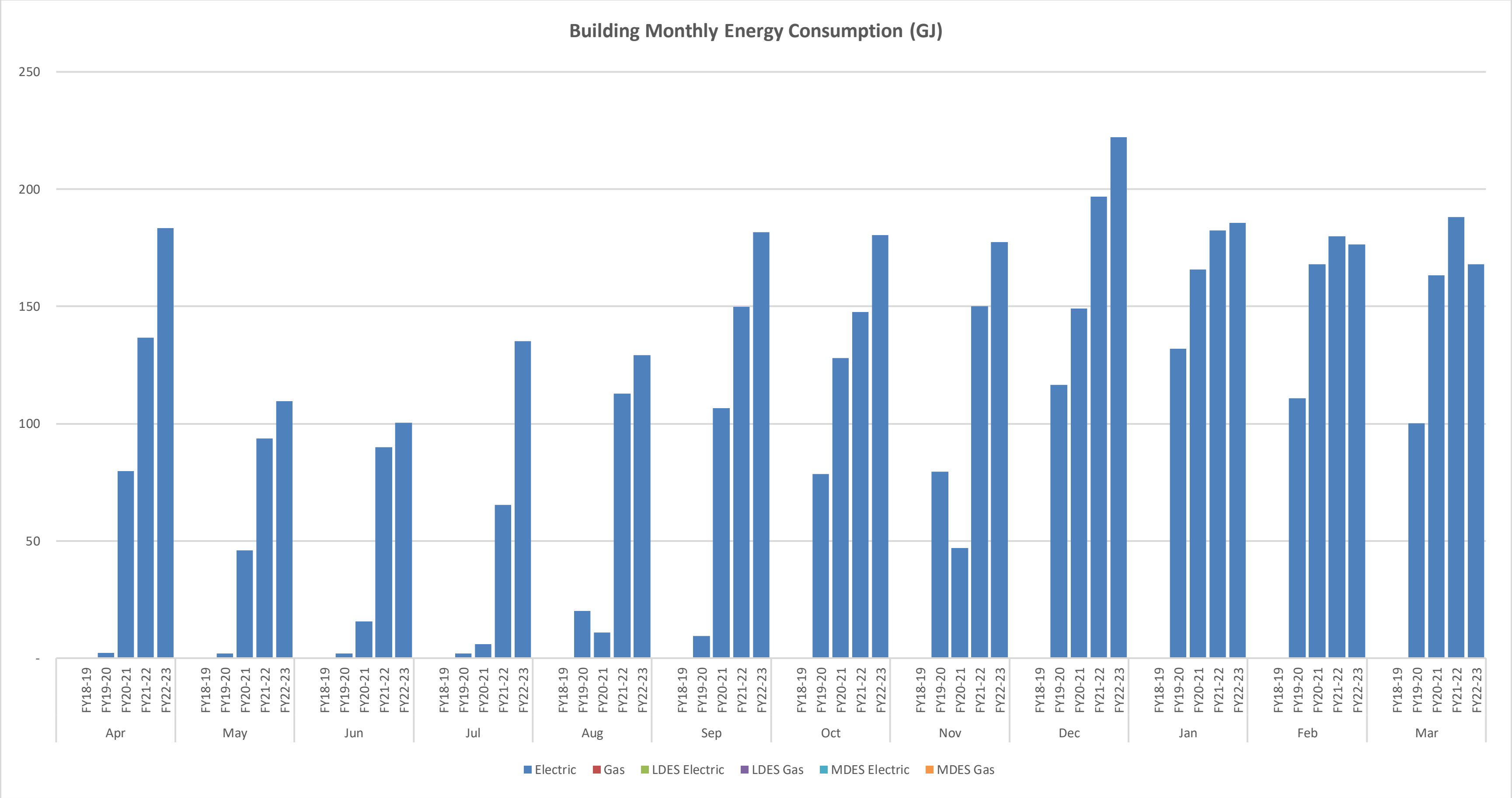
7.35 Similkameen Residence building



7.36 Skeena Residence building



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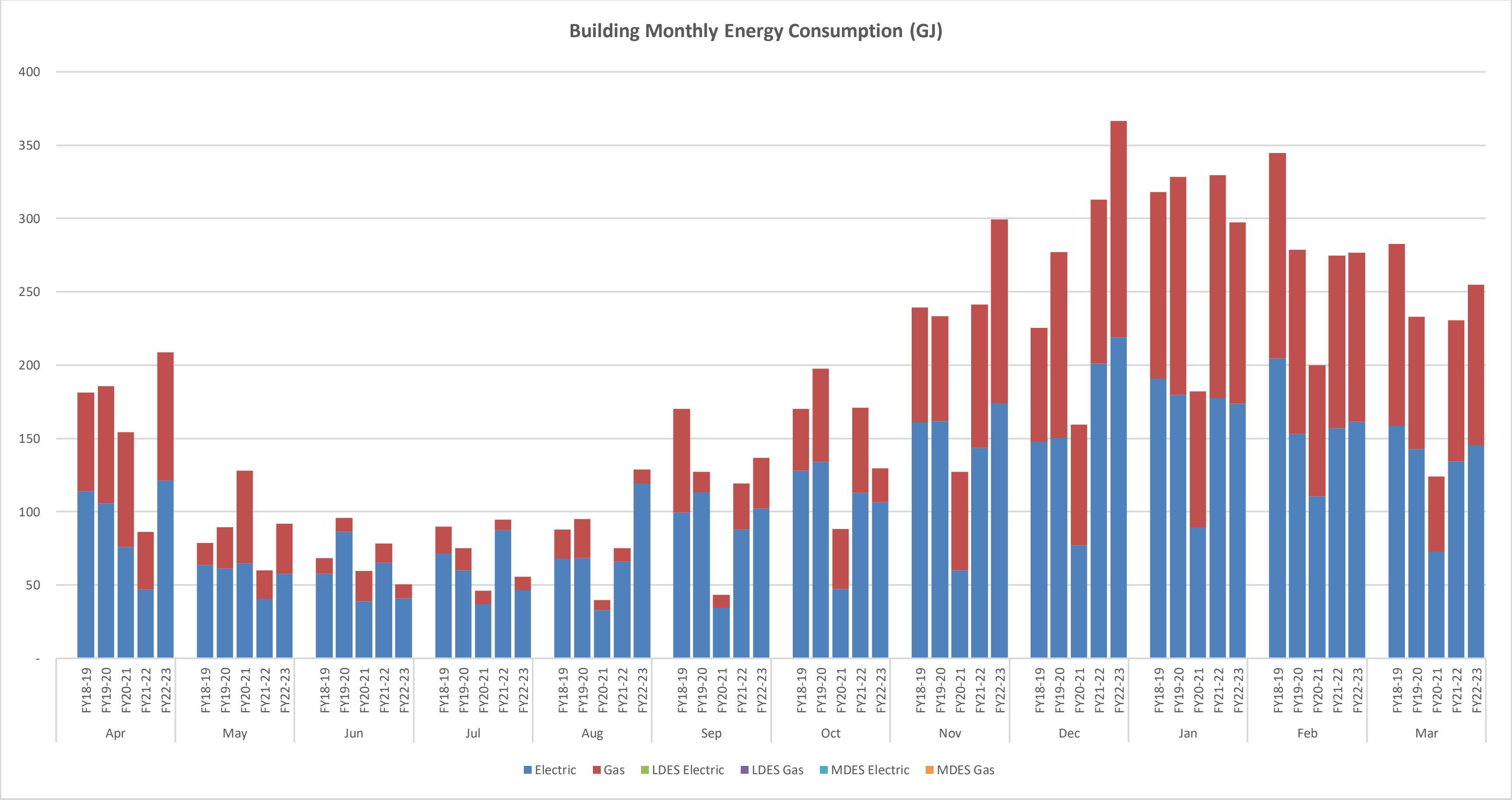
7.37 Valhalla Residence building



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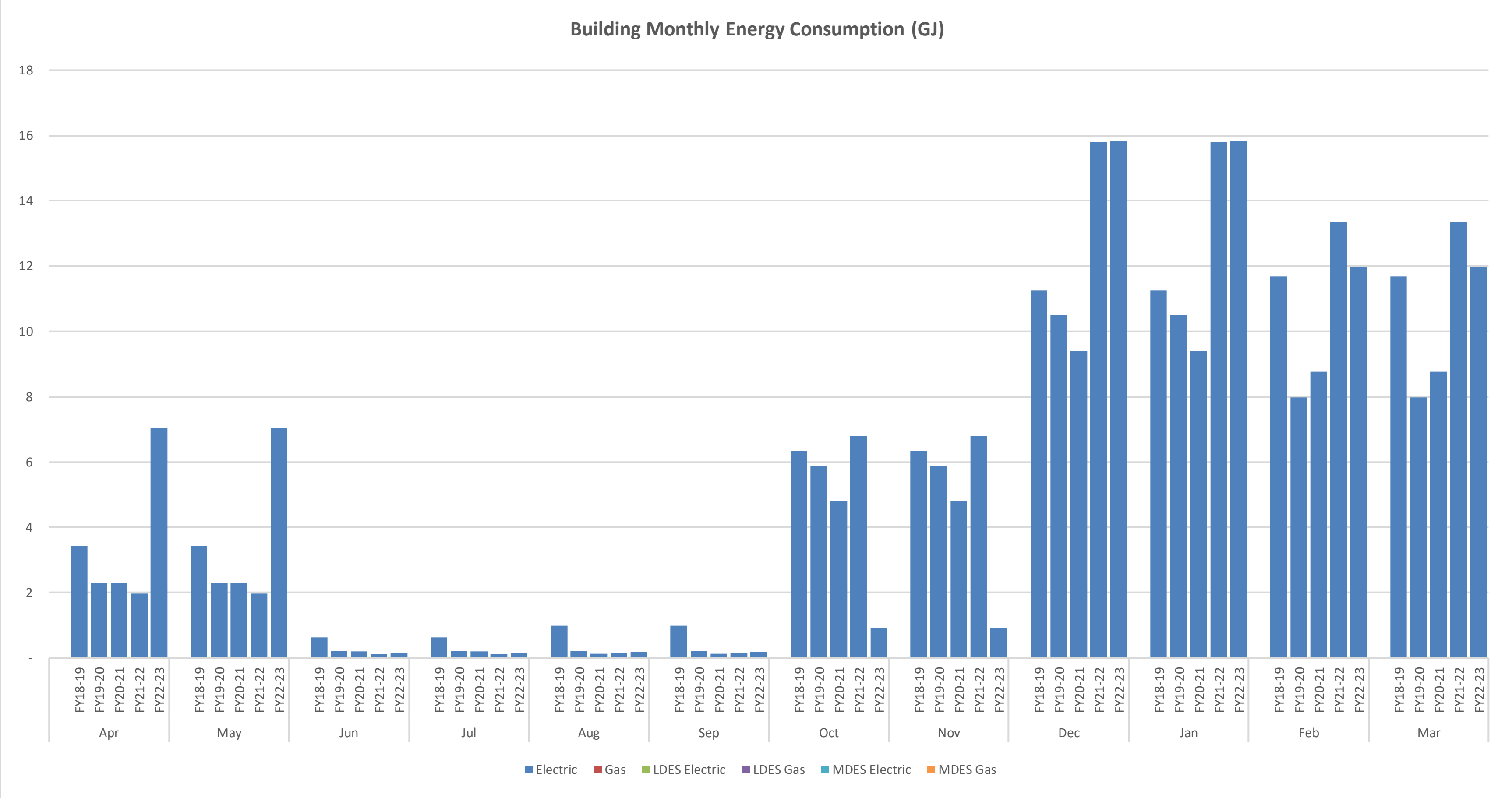
7.38 1200B Curtis building



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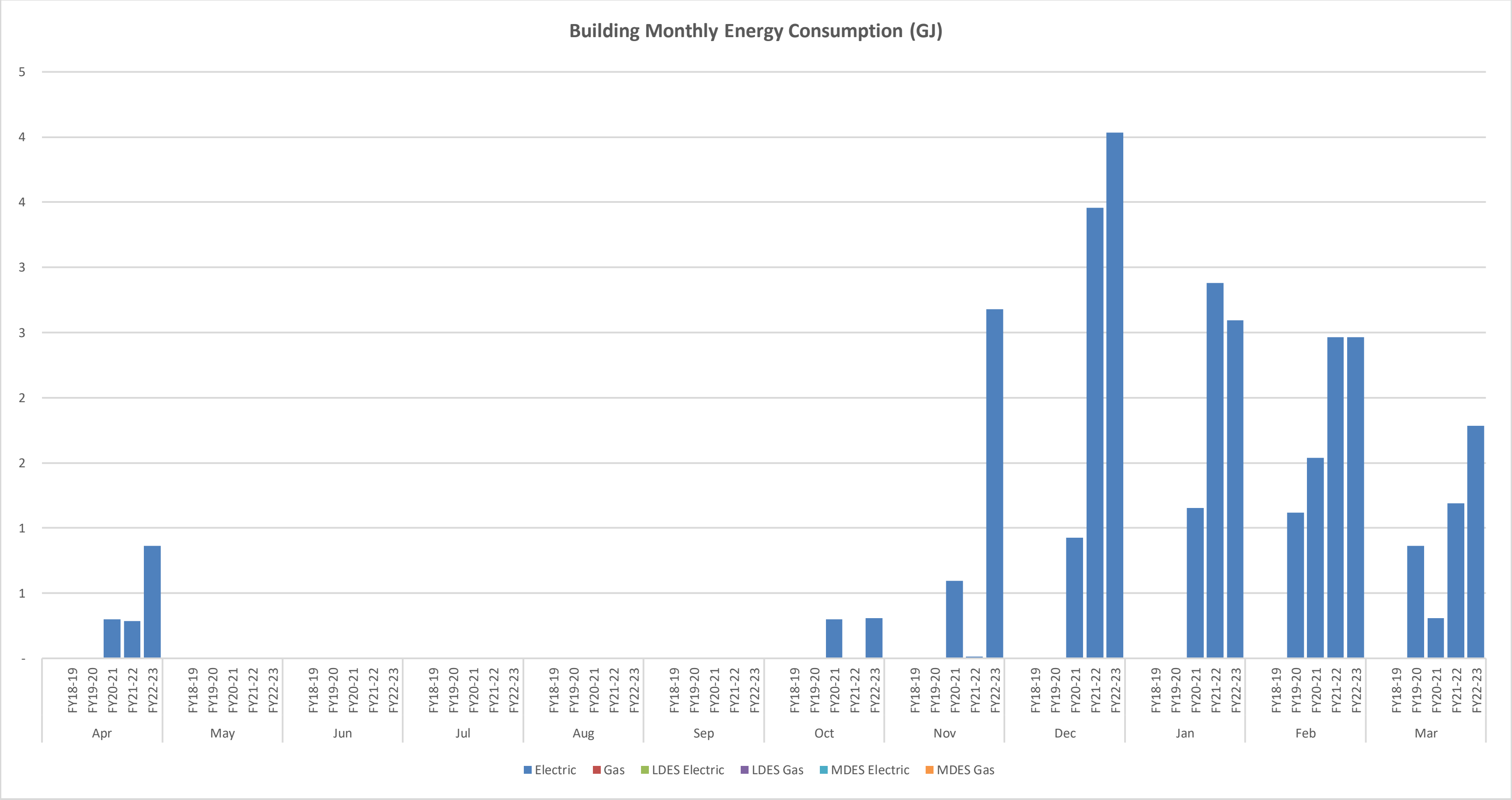
7.39 GEID Vector Well



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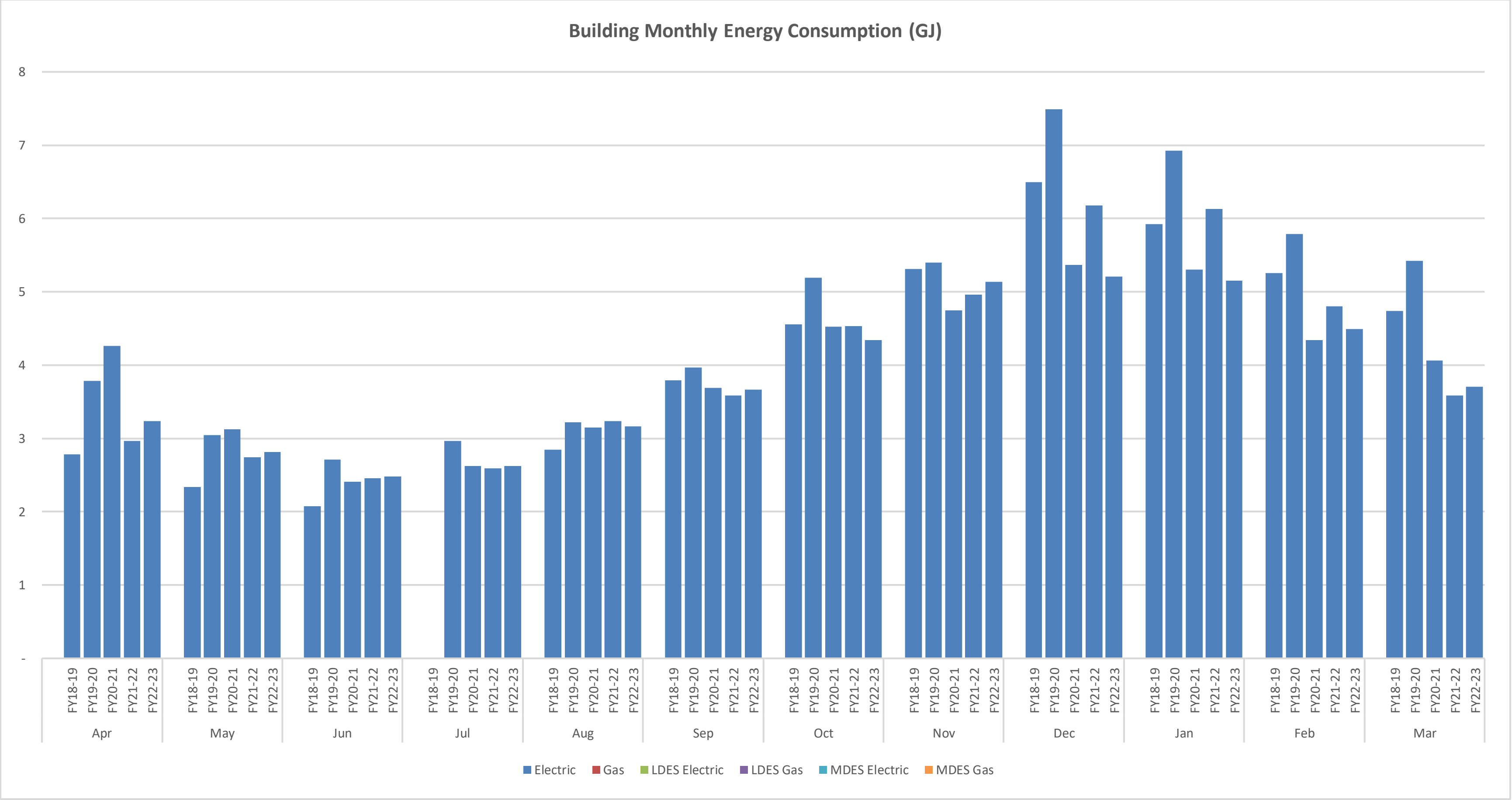
7.40 Innovation Drive H Lot (Includes Trailer)



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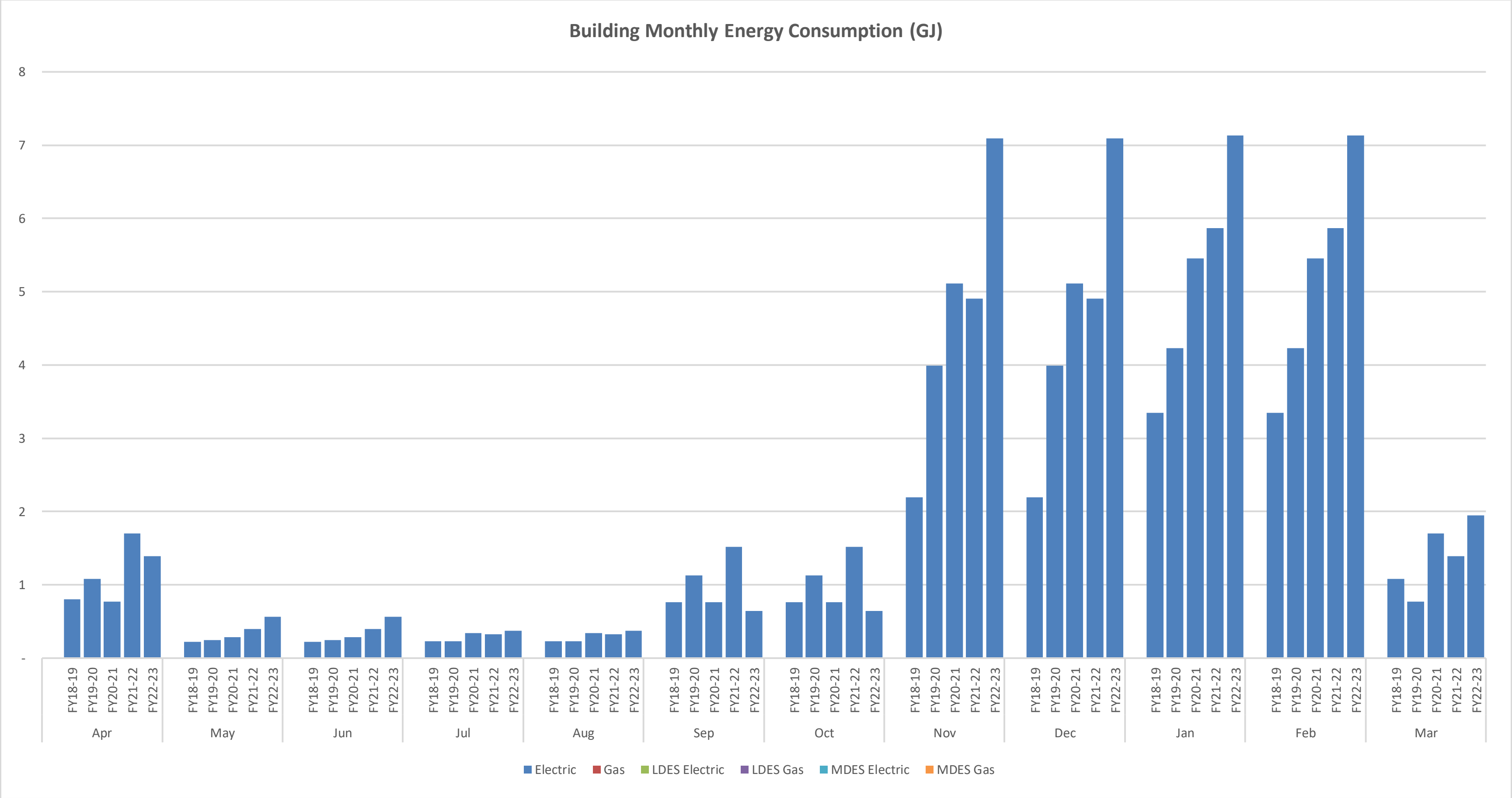
7.41 H Lot (Overflow parking)



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7.42 Parking Lot R