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Energy Team

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UBC Okanagan Energy Operations
Annual Report for FY23-24
April 2023 – March 2024

Report Date: August 2024

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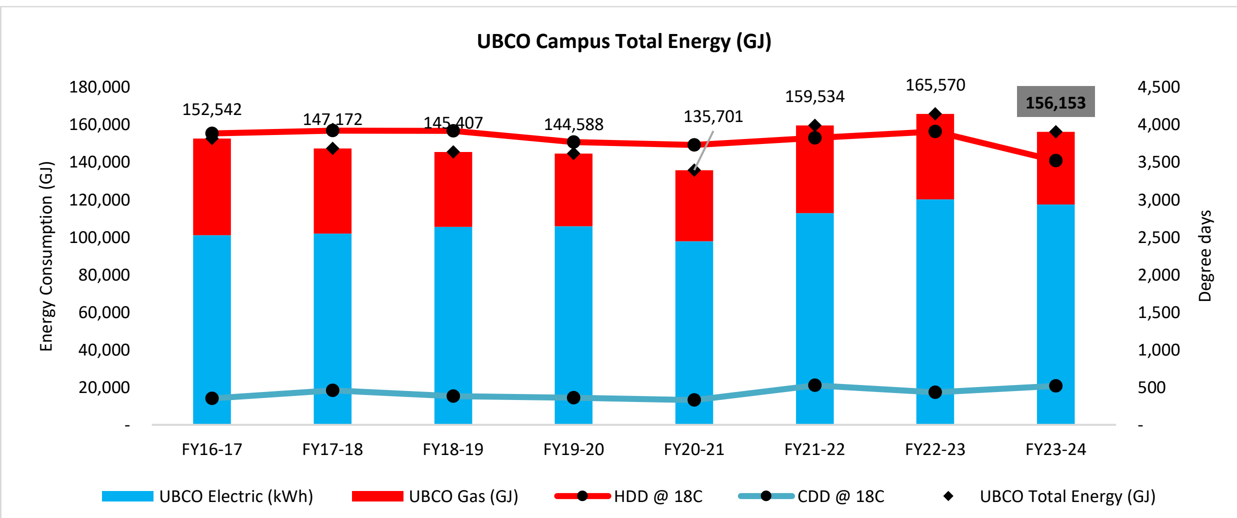
Executive Summary

UBC Okanagan total energy consumption over the last fiscal year (FY23-24) was 156,153 GJ compared to 165,570 GJ for FY22-23, a 5.69% year over year decrease, however the total campus utility cost increased by 4.69% from $3.82M in FY22-23 to $3.99M in FY23-24. The total campus energy consumption includes a 2.25% decrease in campus electricity consumption i.e., from 33,358 MWh in FY22-23 to 32,606 MWh in FY23-24 and a 14.8% reduction in campus Natural Gas consumption i.e., from 45,481 GJ in FY22-23 to 38,770 GJ in FY23-24.

In FY23-24, the Heating Degree-Days (HDD) decreased from 3,908 in FY22-23 to 3,518 whereas Cooling Degree-Days (CDD) increased by around 20% from 432 in FY22-23 to 520 in FY23-24. In other words, it was warmer in both winter and summer of FY23-24.

UBCO Campus total energy (GJ) and cost ($) trending charts are shown below:



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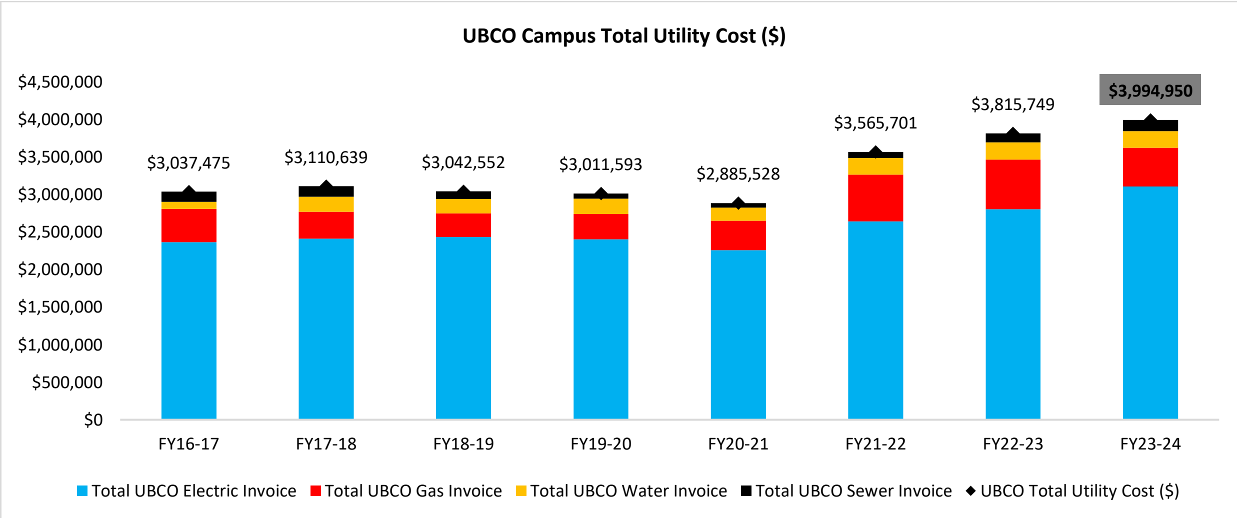

Greenhouse gas emissions (GHG) decreased by 4% from 2,403 tCO_2e/year in FY22-23 to 2,303 tCO_2e/year in FY23-24. This emission calculation assumes integrated electricity emission factor. B.C.'s Grid Electricity GHG Emission Intensity Factors in tonnes CO2-equivalent per Gigawatt-hour for 2023 was 11.3 tCO2e/GWh[1].

Highlights

- DES energy consumption reduced by 19% (5,346 GJ gas reduction and 141 MWh increased electricity consumption) in FY23-24 compared to FY22-23, with similar thermal energy delivered to the buildings.
- Year over year energy consumption change for the following buildings:
  - University House electricity consumption decreased by 8.5%.
  - Innovation Precinct 1 and Innovation Annex 1 energy consumption increased by 10% and 20% as a result of renovations and increased occupancy.
  - The following buildings used more energy: Portable N, Innovation Annex, Innovation Precinct 1, OM1, Quonset, UNC, EDL, NECHAKO, Cascades Upper.
- Residential energy consumption decreased by 4% in FY23-24 compared to FY22-23.

[1] The grid emission intensity factor is based on the BC Electricity emission intensity factors for grid-connected entities, source: https://www2.gov.bc.ca/gov/content/environment/climate-change/industry/reporting/quantify/electricity

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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 through the following initiatives:
    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.
    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 to ensure smooth utility service delivery, negotiating contracts for favorable terms and compliance with regulations.
4. **SkySpark platform:** develop an intelligent data driven energy monitoring and management system using statistical and advanced data analysis methods. The Energy Team is currently implementing SkySpark tool to advance this initiative.
5. **Campus operations and academics collaboration:** Work with UBCO academics and researchers on various initiatives that feed into UBCO Multi-hazard Assessment study. For example:
    a. District energy modelling and optimization – in progress.
6. **New campus construction:** the 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 Infrastructure Plan. Our primary objective is to ensure the seamless

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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 and projects, a few projects listed below have been completed:

- Occupancy-based Demand Controlled Ventilation for ASC and FIP,
- IAQ-based Demand Controlled Ventilation for SCI,
- Recommissioning of EME,
- Waste heat recovery from strobic exhaust for SCI (in progress)
- Wi-Fi threshold recalibration, and
- Other optimization and monitoring improvements.
- RCx of Upper Health

Energy Team related activities such as energy conservation measure implementation, equipment upgrade, FortisBC Energy Specialist program, new construction etc. by the past fiscal year received around $361,000 in FortisBC incentives.

The Energy Team is actively working with other internal departments at the university to identify and secure rebates capturing a valuable benefit that would have otherwise been overlooked. Following are few of the project examples with received rebates:

- 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
- FY23-24: Boiler upgrade in residence - $4,300

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

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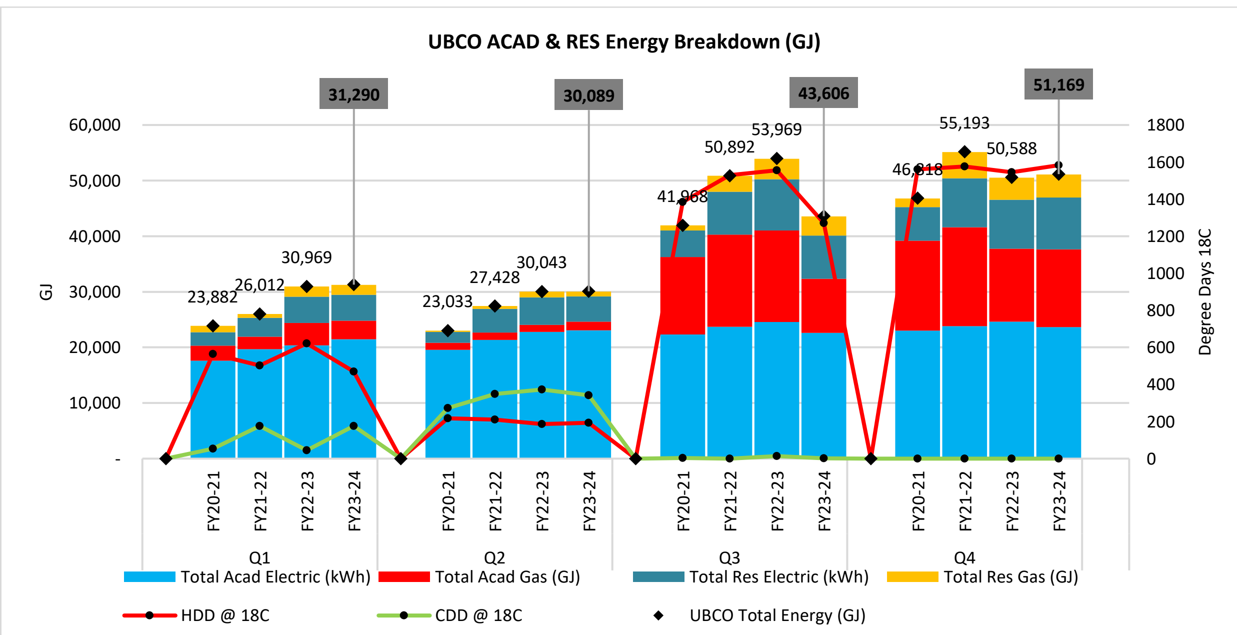
Parameter	FY20-21	FY21-22	FY22-23	FY23-24
Total Utility Cost Savings compared to BAU 2013[2]	$1,013,200[3]	$649,600	$551,400	$691,100
DSM-based Utility Savings (cumulative)	$203,700	$237,100	$266,100	$361,900
DSM-based Carbon Offset Savings[4] (cumulative)	$9,800	$9,900	$10,600	$14,200
External personnel funding	$95,000	$130,000	$135,000	$140,000
Energy Efficiency Incentive (Rebates)	$305,000	$231,300	$131,800	$218,238

UBCO ACAD & RES Energy Breakdown (GJ) graph by quarter:



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[2] Includes DSM savings. This category includes Routine capital equipment upgrade, new construction buildings etc.

[3] 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.

[4] This only includes $25/tCO2e of offsets retired by the Ministry on behalf of UBC Okanagan.

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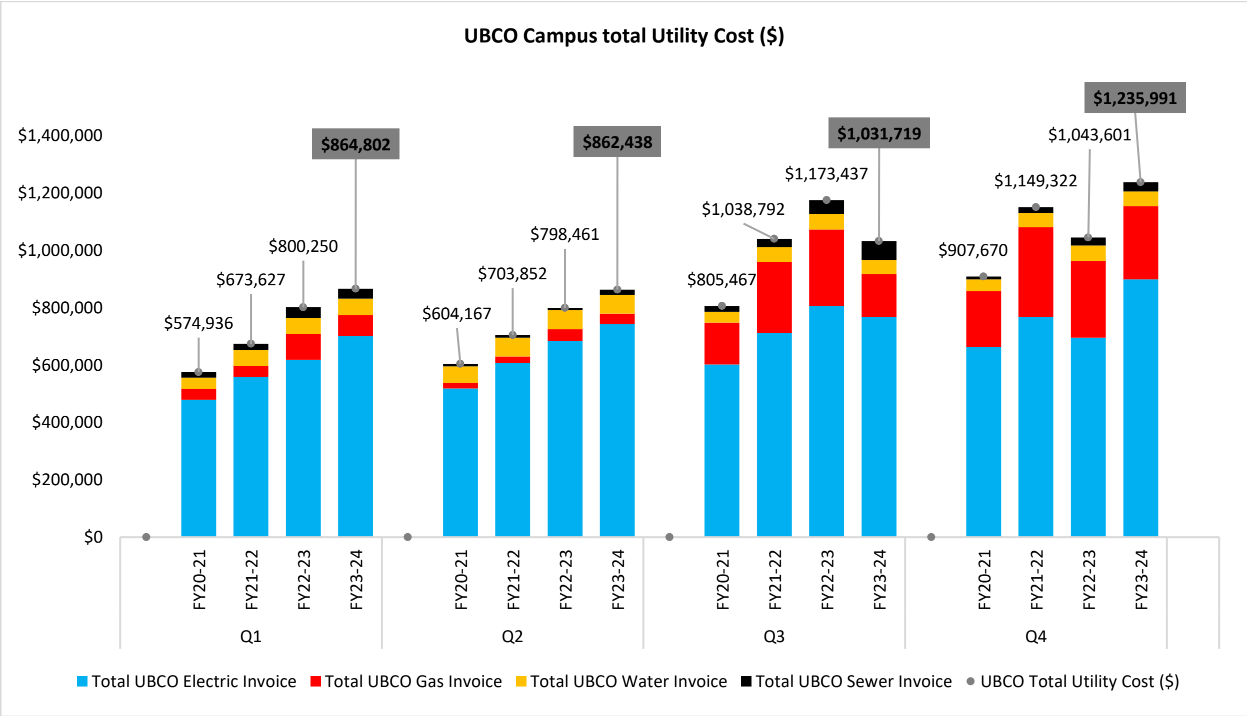

The illustration on the next page shows the total energy consumption and its change for each building categorized by building type from FY22-23 to FY23-24. The colour coded "% Total Energy Change" is separated by the following sections: DES, ACAD and RES.

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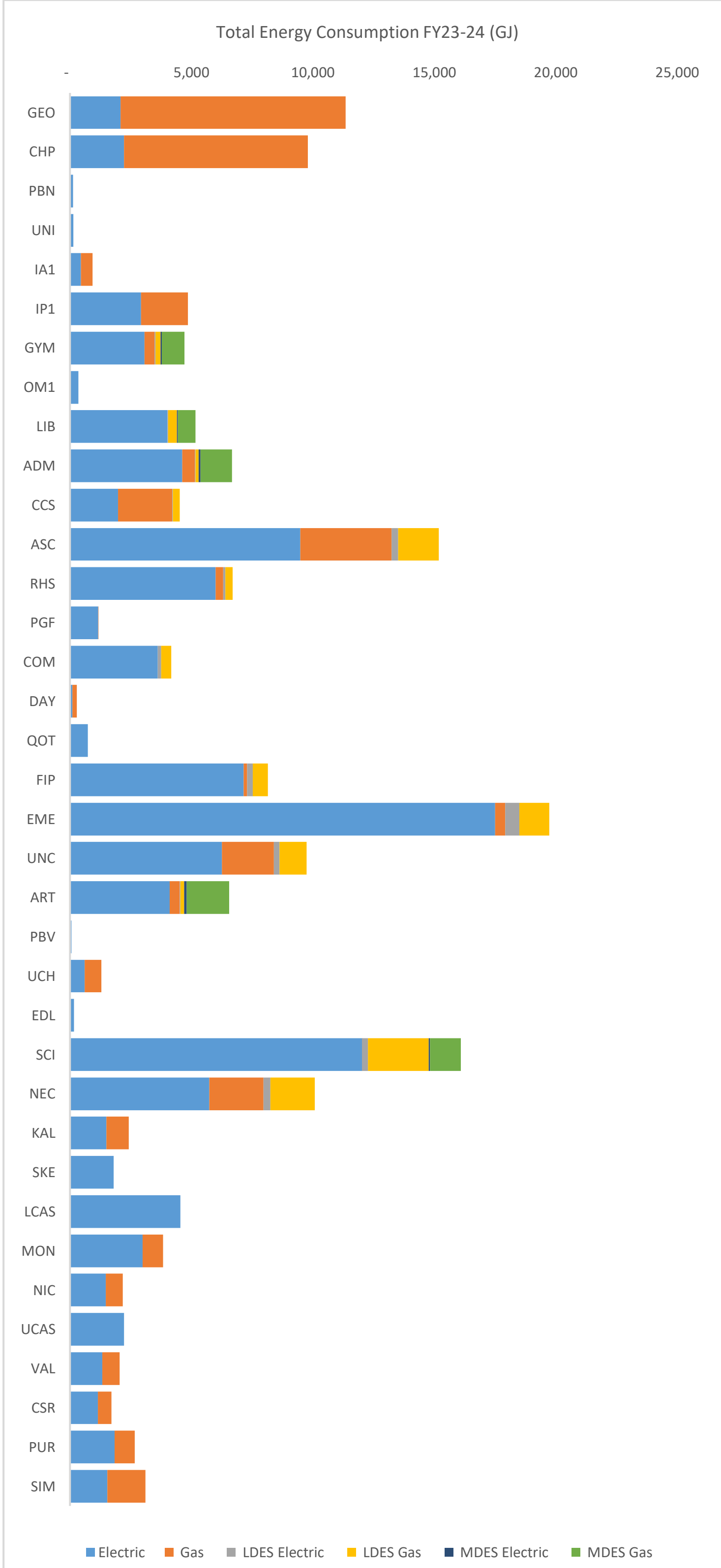
Type	Building Name	% Total Energy Change
DES	GEO	-21%
DES	CHP	-15%
ACAD	PBN	2%
ACAD	UNI	-9%
ACAD	IA1	20%
ACAD	IP1	10%
ACAD	GYM	-14%
ACAD	OM1	14%
ACAD	LIB	-2%
ACAD	ADM	-15%
ACAD	CCS	-8%
ACAD	ASC	-2%
ACAD	RHS	-10%
ACAD	PGF	-10%
ACAD	COM	-7%
ACAD	DAY	-9%
ACAD	QOT	84%
ACAD	FIP	-23%
ACAD	EME	-7%
ACAD	UNC	2%
ACAD	ART	-14%
ACAD	PBV	-15%
ACAD	UCH	-1%
ACAD	EDL	8%
ACAD	SCI	-1%
RES	NEC	1%
RES	KAL	-4%
RES	SKE	-7%
RES	LCAS	-4%
RES	MON	-3%
RES	NIC	-14%
RES	UCAS	3%
RES	VAL	-10%
RES	CSR	-13%
RES	PUR	-4%
RES	SIM	-8%



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List of Acronyms

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

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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 five members i.e., Associate Director, Thermal Energy Manager, Senior Energy Specialist, and 2 BMS Specialists.

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2 Overall Campus Energy Performance

Campus energy consumption for FY23-24 totalled 156,153 GJ. As can be seen in Figure 1 below, electricity accounted for around 75% of total energy consumed on campus. Furthermore, electricity is more expensive than natural gas. Average electricity rate was $0.0953/kWh and $13.2/GJ for natural gas in FY23-24. As a result, electricity accounted for around 86% of campus utility costs. While natural gas has a lower cost per unit of energy, its GHG emission intensity is 16 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.

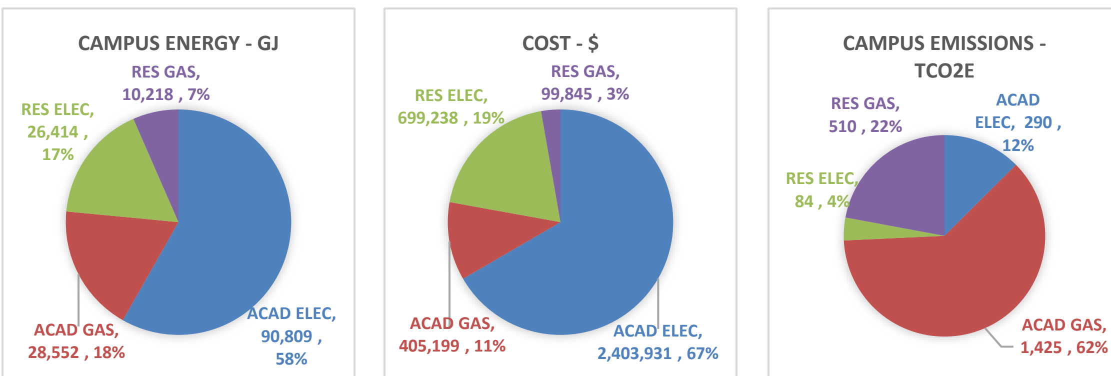

Figure 1: Campus Energy Consumption, costs and emissions by Source for FY23-24[5]

A quantitative model of the dependence of campus energy consumption on weather has been developed (refer to Figure 2 on the following page). Figure 2 below shows that the total campus energy consumption correlates to changing weather in winter (HDD) better than in summer (CDD) .

The total campus EUI decreased by 6% from 272 kWh/m^2/yr in FY22-23 to 256 kWh/m^2/yr in FY23-24. This decrease can primarily be attributed to the milder winter.

The weather correlations to UBCO total energy use are shown on the next page.

[5] 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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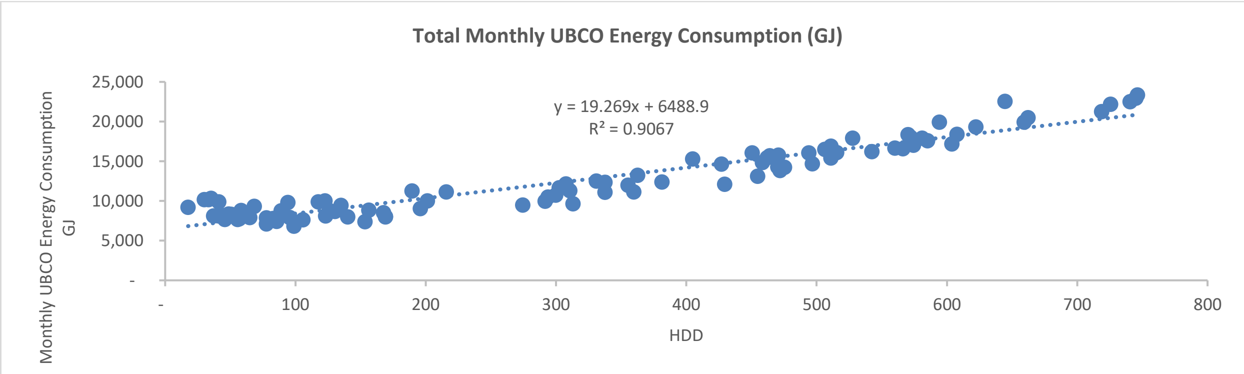

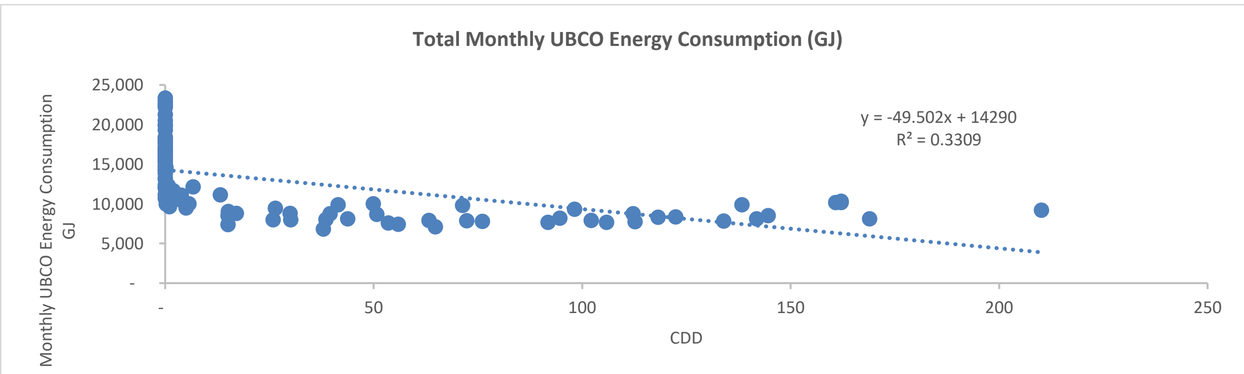

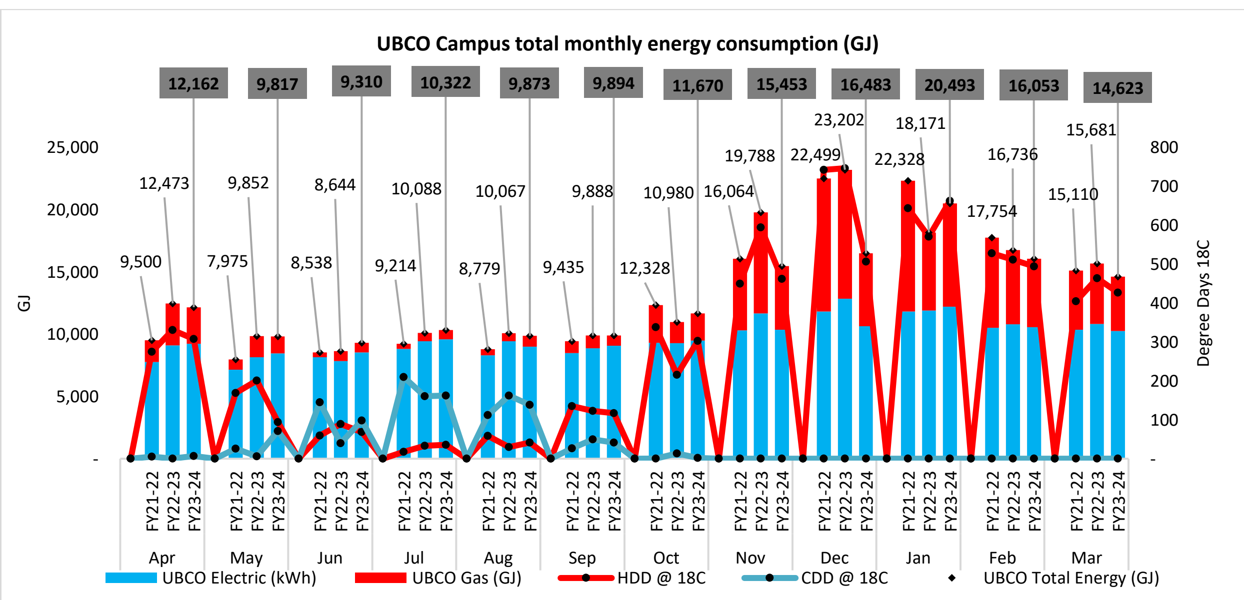

Figure 2: Campus Energy Consumption and Weather Comparisons

2.1 Campus Energy Performance Trends

2.1.1 Costs

As shown in Figure 3 below, campus energy costs remained relatively the same $3.5M. For FY23-24 the average electricity rate on campus increased by 13% from $84/MWh compared to $95/MWh in FY22-23. Costs for electricity is a blend of demand charge (average 30% of total electricity cost), energy charge (average 69% of total electricity) and fixed customer charge (average 1% of total electricity), the rate stated is a blended rate.

For FY23-24 the average cost of natural gas on campus was $13.2/GJ compared to $14.6/GJ in FY22-23, an 9% decrease.

The electricity rate increase was higher than we anticipated. Energy consumption was lower, but the energy cost increased.

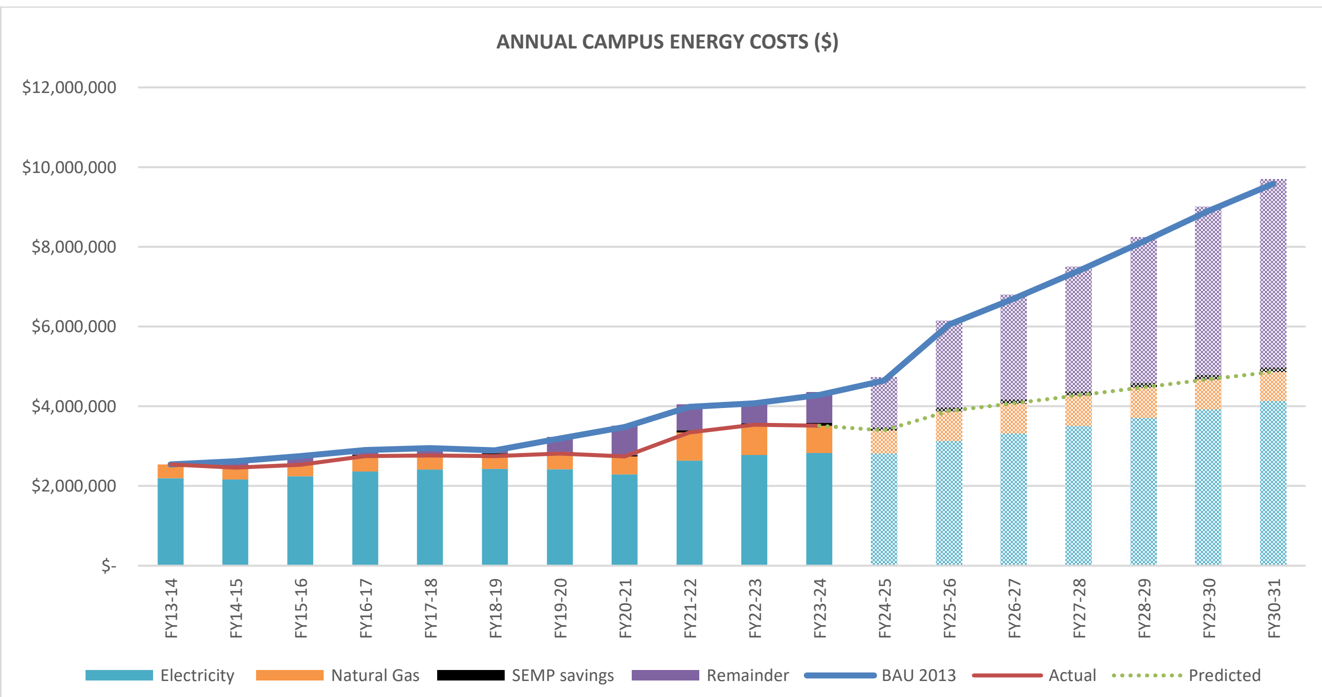

Figure 3: Campus Energy Costs Trend[6]

[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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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 Figure 3 above. The remainder of the savings, shown in purple in Figure 3, are attributed to measures funded by other sources (federal SIF program, BC PSFS funding etc.) or cumulative measures that are difficult to individually measure such as new construction building projects, 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

As illustrated in Figure 4, campus greenhouse gas emissions decreased by 4% (2,403 tCO_2e/year in FY22-23 compared to 2,309 tCO_2e/ year in FY23-24). 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.

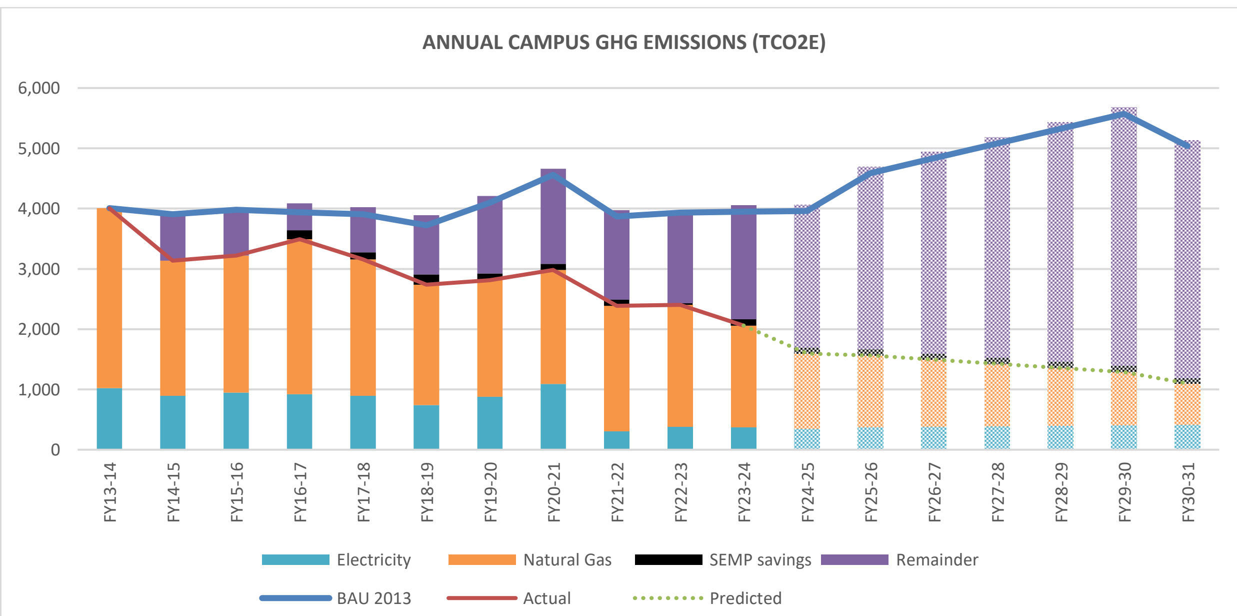

Figure 4: Campus GHG Emissions Trend

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2.1.3 Electricity

Electricity consumption decreased by 2.25% year over year to 32,606 MWh in FY23-24 from 33,358 MWh in FY22-23. The trend is shown in Figure 5. The reduction in electrical consumption is mostly weather-related.

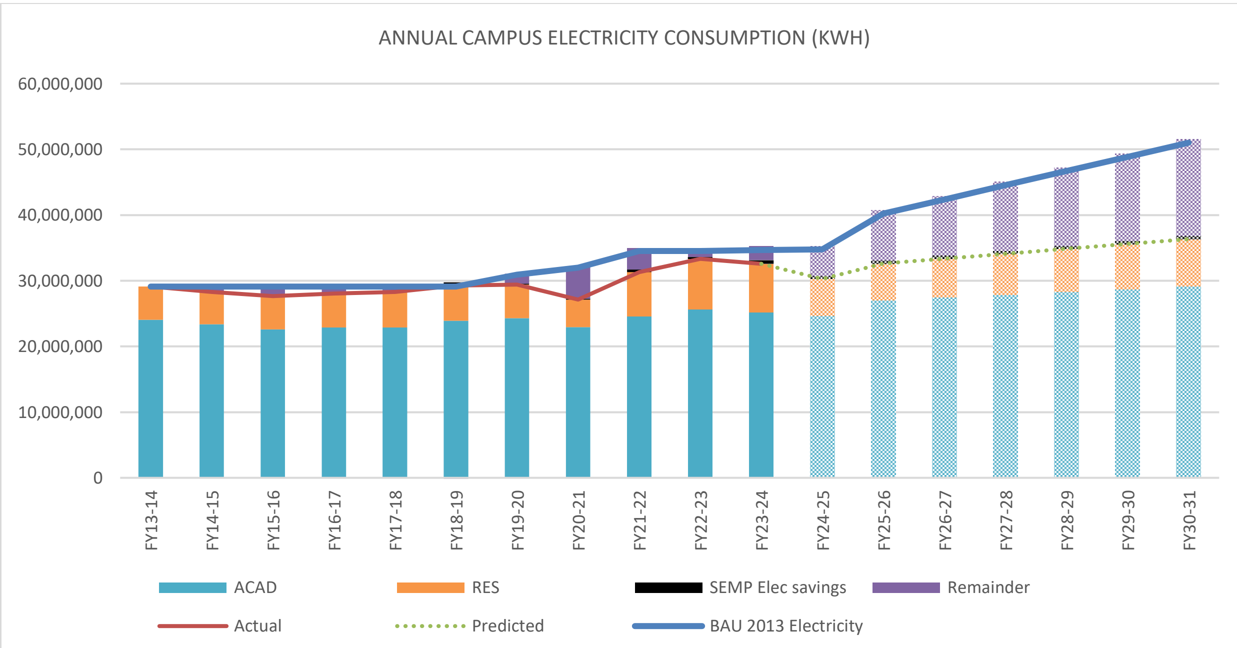

Figure 5: Campus Electricity Consumption Trend

The Figure 6 on the following page 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 Figure 6 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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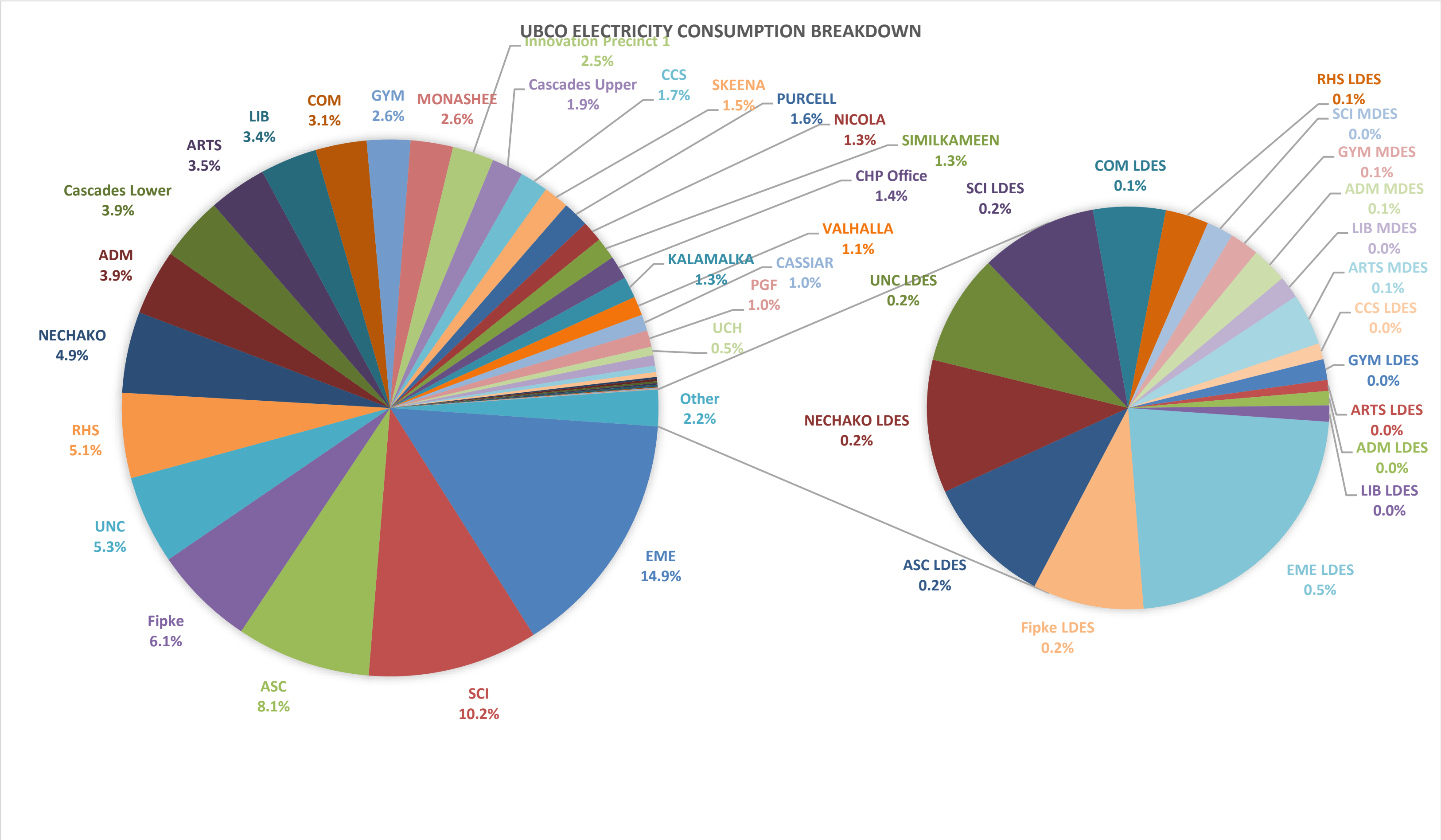

Figure 6: Electricity Consumption for Buildings and DES for FY23-24

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2.1.4 Natural Gas

Consumption of natural gas reduced from 45,481 GJ in FY22-23 to 38,770 GJ in FY23-24, a 15% year over year reduction as shown in Figure 7.

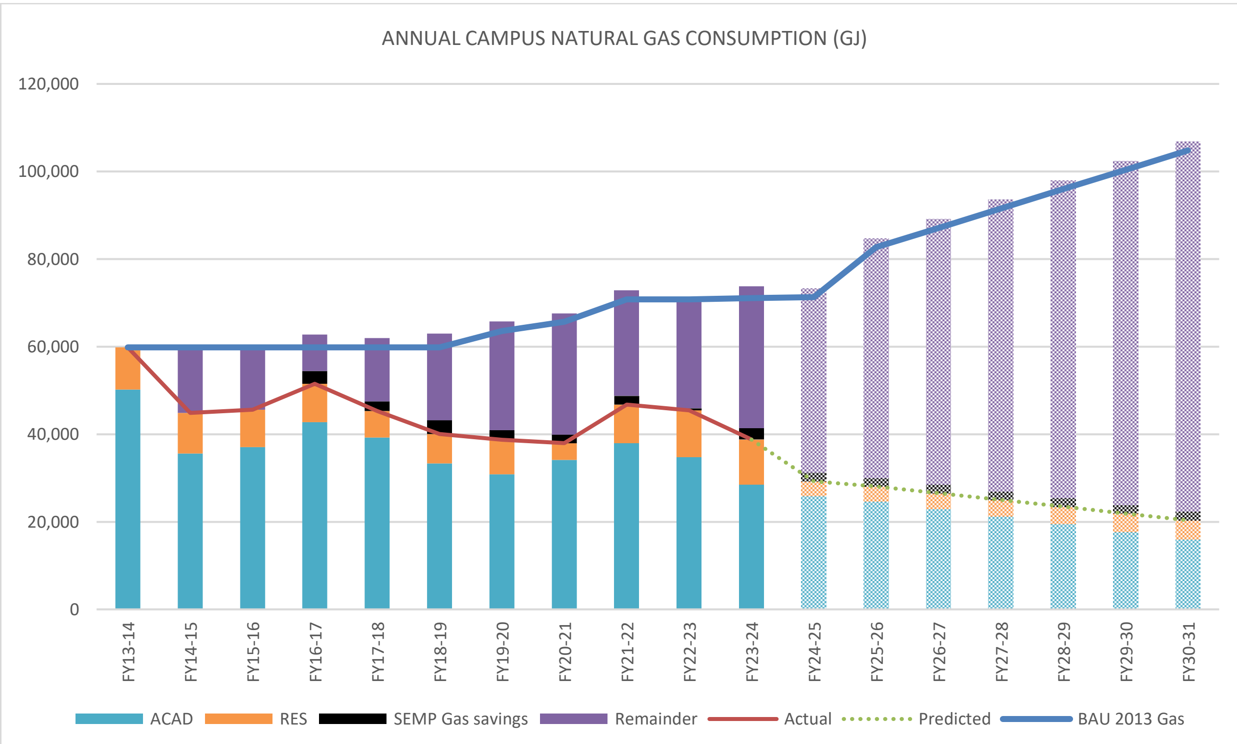

Figure 7: Campus Natural Gas Consumption Trend

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 Figure 8 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 electricity 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 surpassed the 5% threshold. As can be seen in Figure 8 below, a large fraction (around 43%) of natural gas on campus is consumed by the two district energy system plants gas boilers (LDES = 24% and MDES = 20%). Residences consume around 26% of the total gas consumption.

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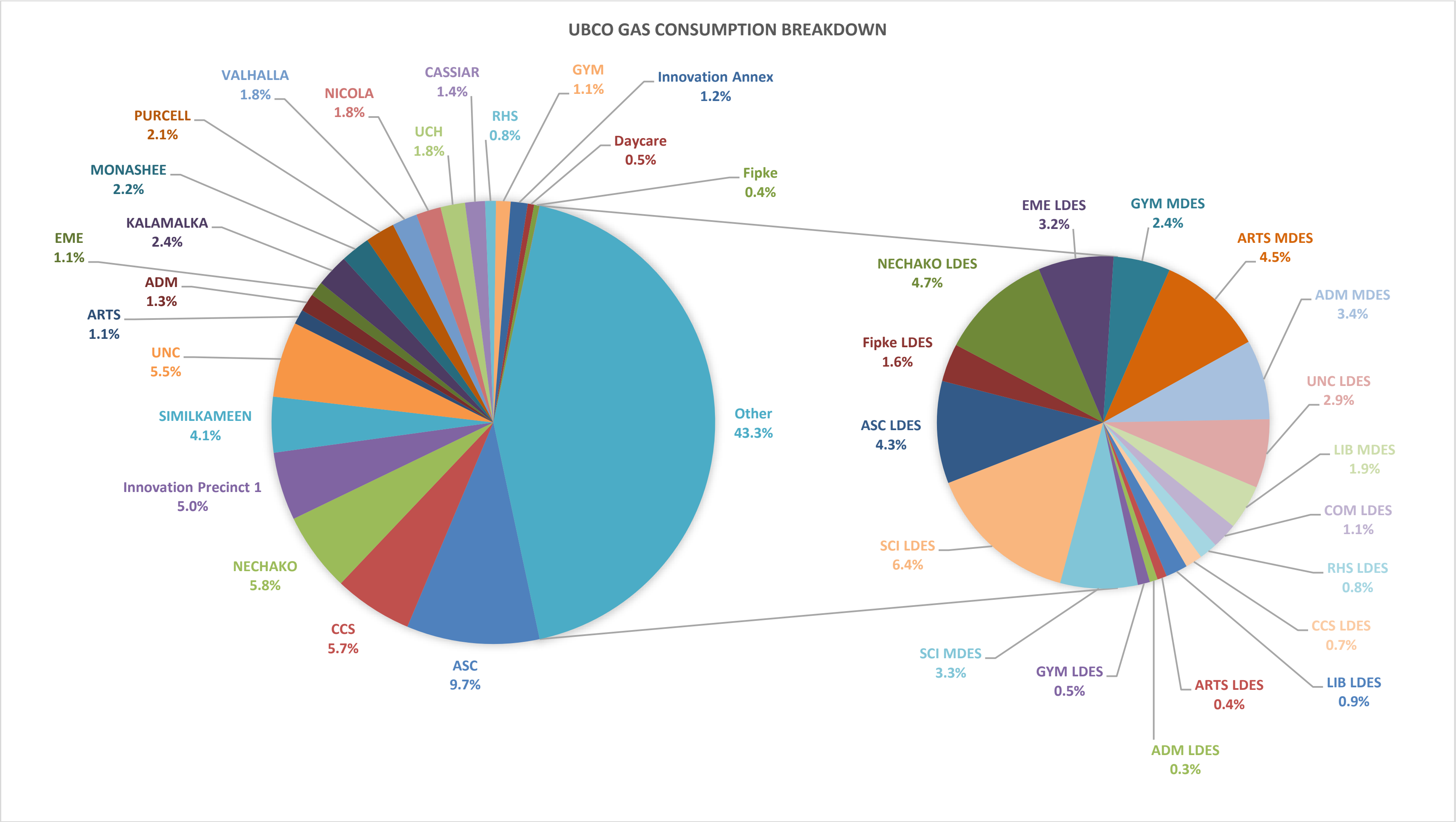

Figure 8: Gas Consumption of Buildings and DES for FY23-24

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Figure 9 below illustrates the gas consumption breakdown where DES (LDES, MDES) gas consumption is allocated 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.

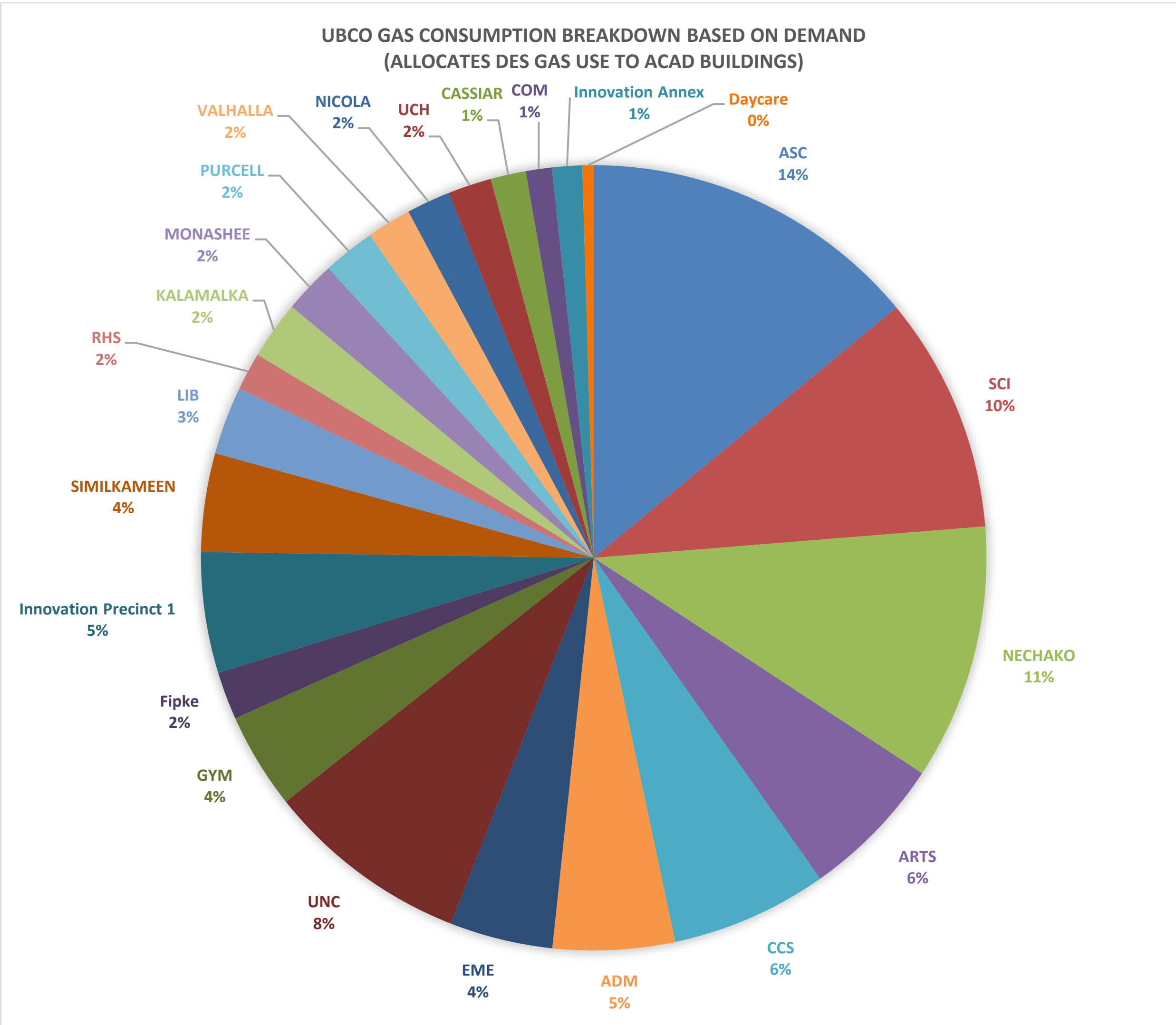

Figure 9: UBCO gas consumption breakdown based on demand (Allocates the gas use to ACAD buildings) for FY23-24

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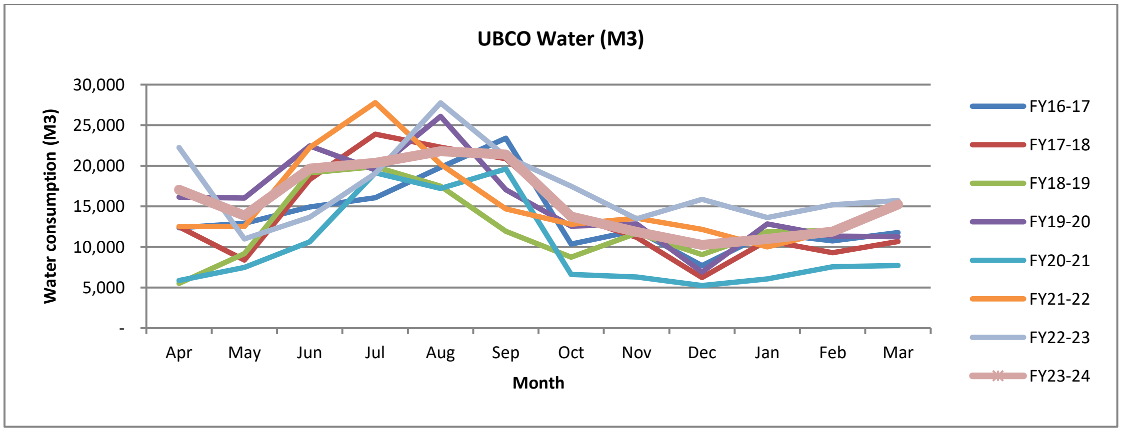
2.1.5 Water and Sewer

Water purchased from Glenmore Ellison Improvement District (GEID) for campus[7] use decreased by 9% from 206,268 m^3 in FY22-23 to 188,061 m^3 in FY23-24 with Academic buildings consuming 46% of the water. Sewer production increased by 22% from 111,057 m^3 in FY22-23 to 135,859 m^3 in FY23-24. Figure 10 below illustrates water and sewer trends for the campus. The City of Kelowna moved and recalibrated the sewer meter in July 2023 that resulted in reporting the higher flow.



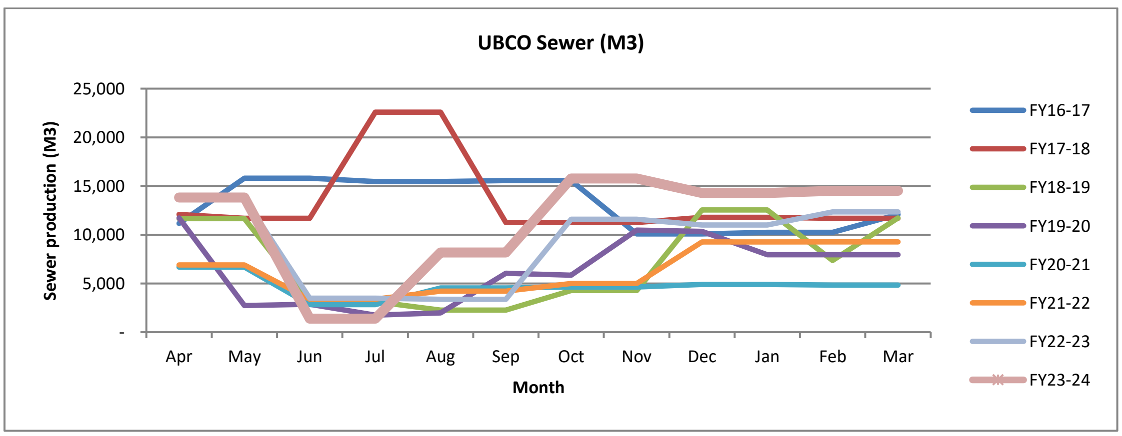


Figure 10: Water and Sewer consumption trend for UBCO campus

[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) decreased from 274 kWh/m²/yr in FY22-23 to compared to 256 kWh/m²/yr in FY23-24. Refer to Figure 11 for more details.

The average EUI for academic buildings on campus was 318 kWh/m^2/yr while it was 151 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.

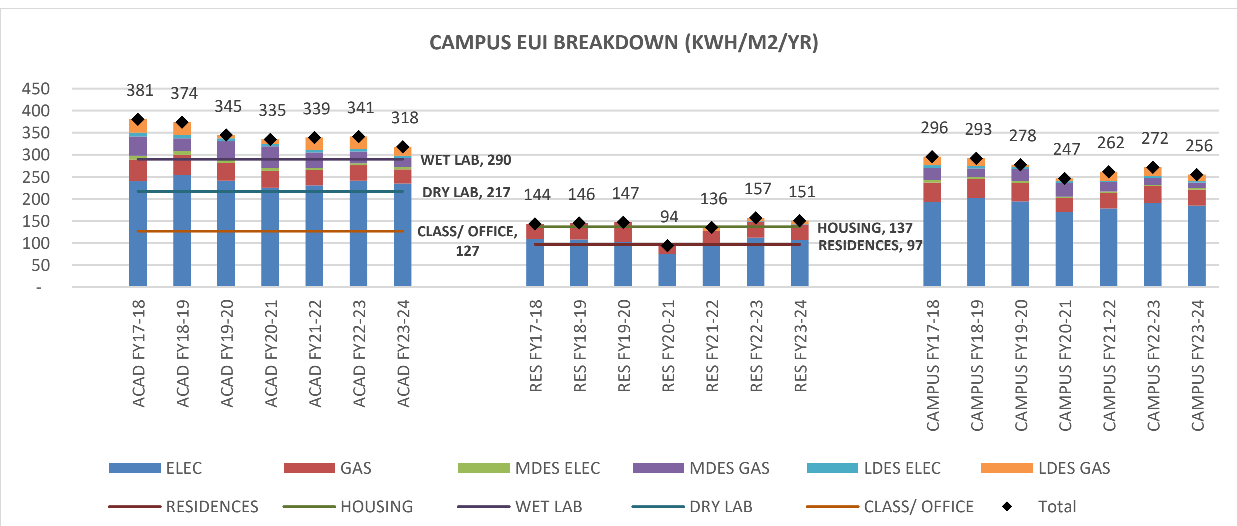

Figure 11: Campus Energy Use Intensities trend

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 11 shows energy targets for various archetypes for Okanagan campus.

As can be seen in the following Figure 12, 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

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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. Energy Cost GHG Intensities for academic buildings are shown in Figure 13.

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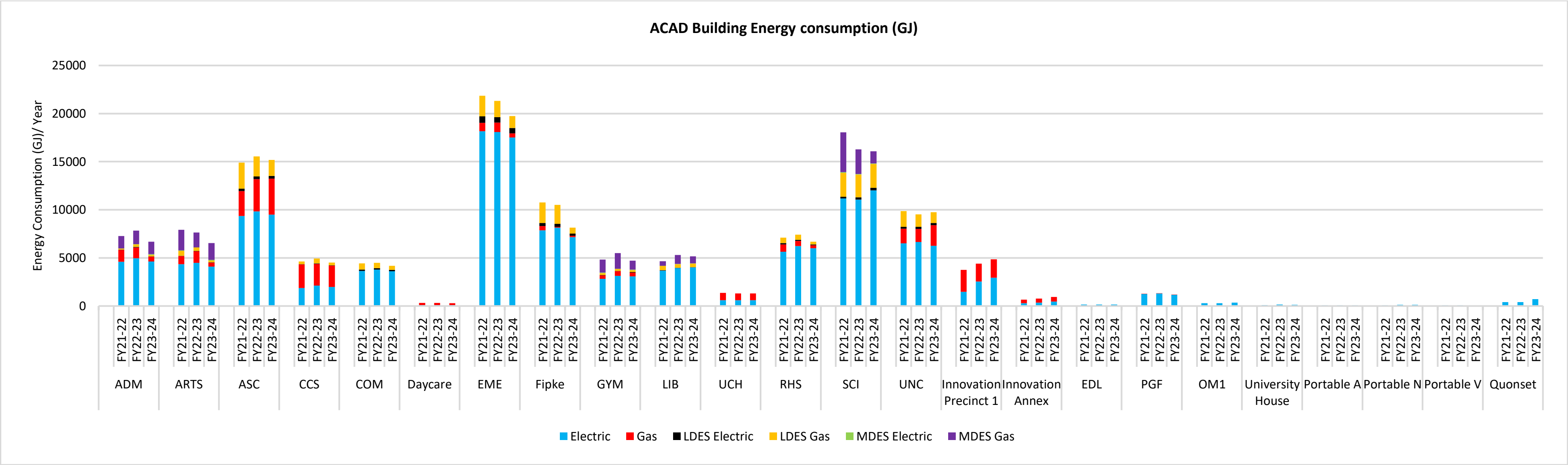


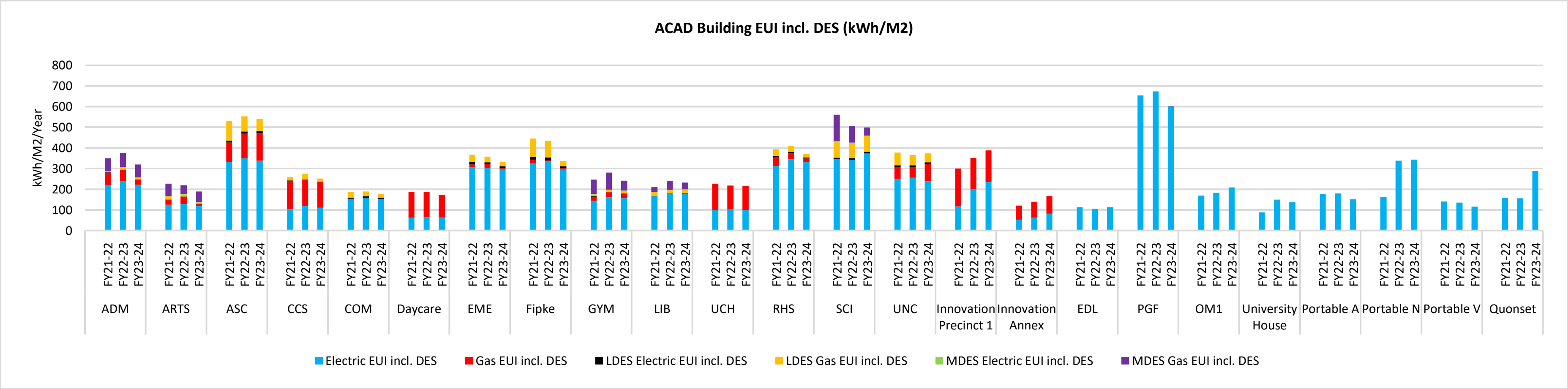
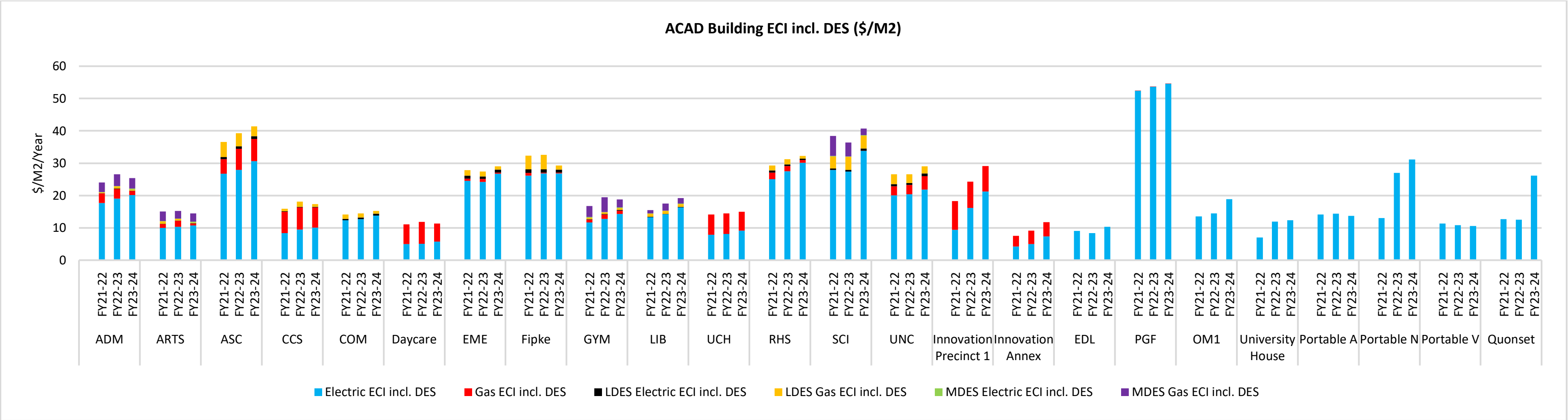


Figure 12: Energy Use and intensity for Campus Academic Buildings



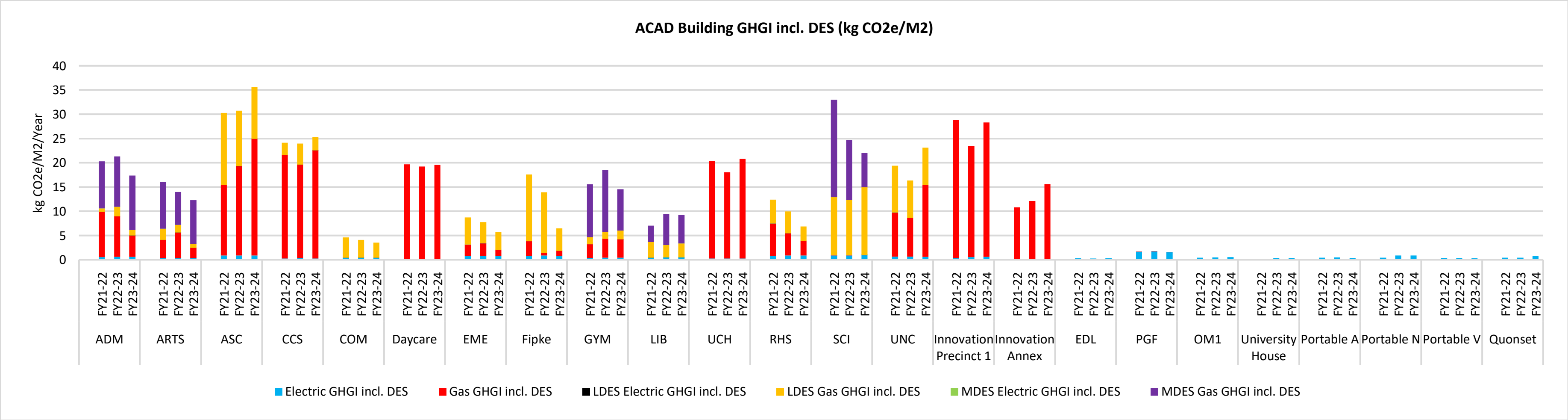


Figure 13: Energy cost and GHG Intensity for Campus Academic Buildings

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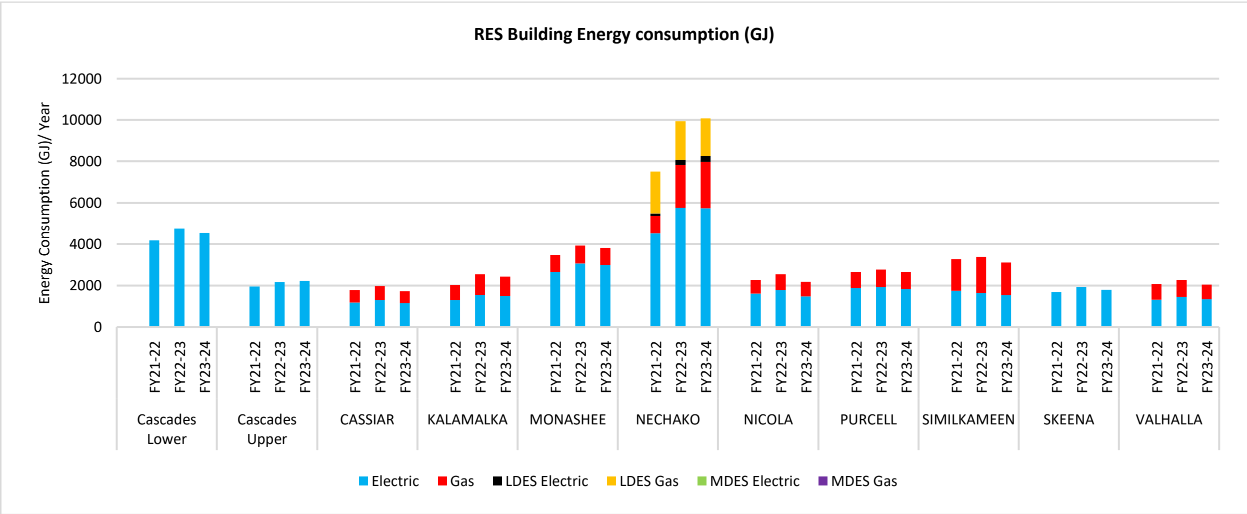
Due to their lower occupancy and use, the EUIs of the residence buildings are significantly lower than those of academic buildings as shown in EUI comparison chart in Figure 14. Nechako EUI is higher because of large commercial kitchen in the building.



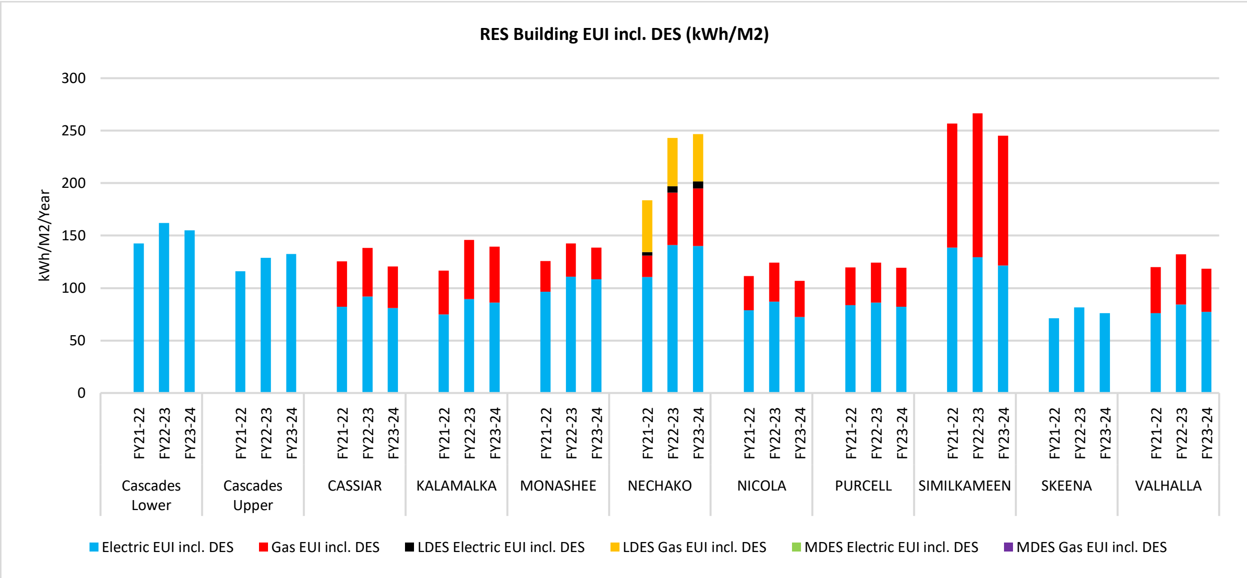


Figure 14: Energy Use and intensity for Campus Residence Buildings

The GHG intensity chart in Figure 15 shows that Similkameen building is the most GHG intensive residence buildings on campus.

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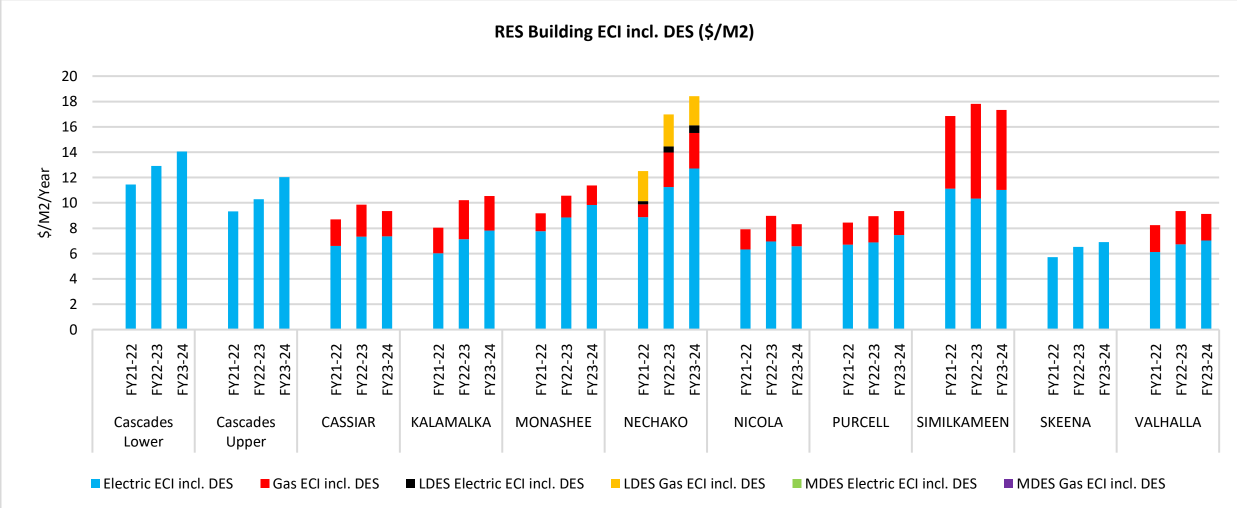

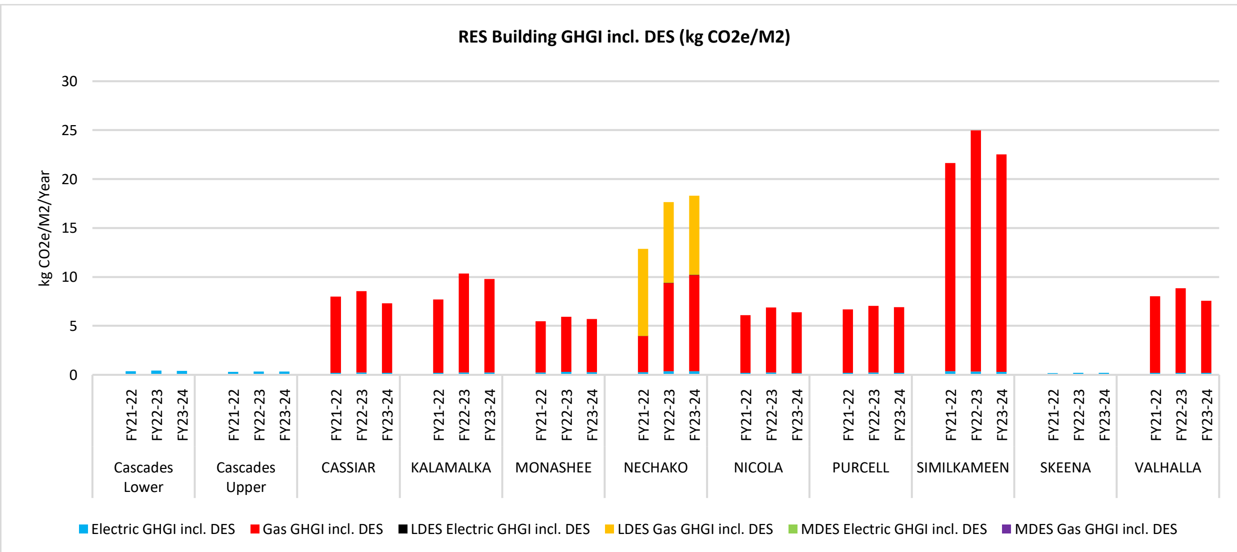

Figure 15: Energy cost and GHG Intensity for Campus Buildings

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 and the distribution map shown in Figure 16.

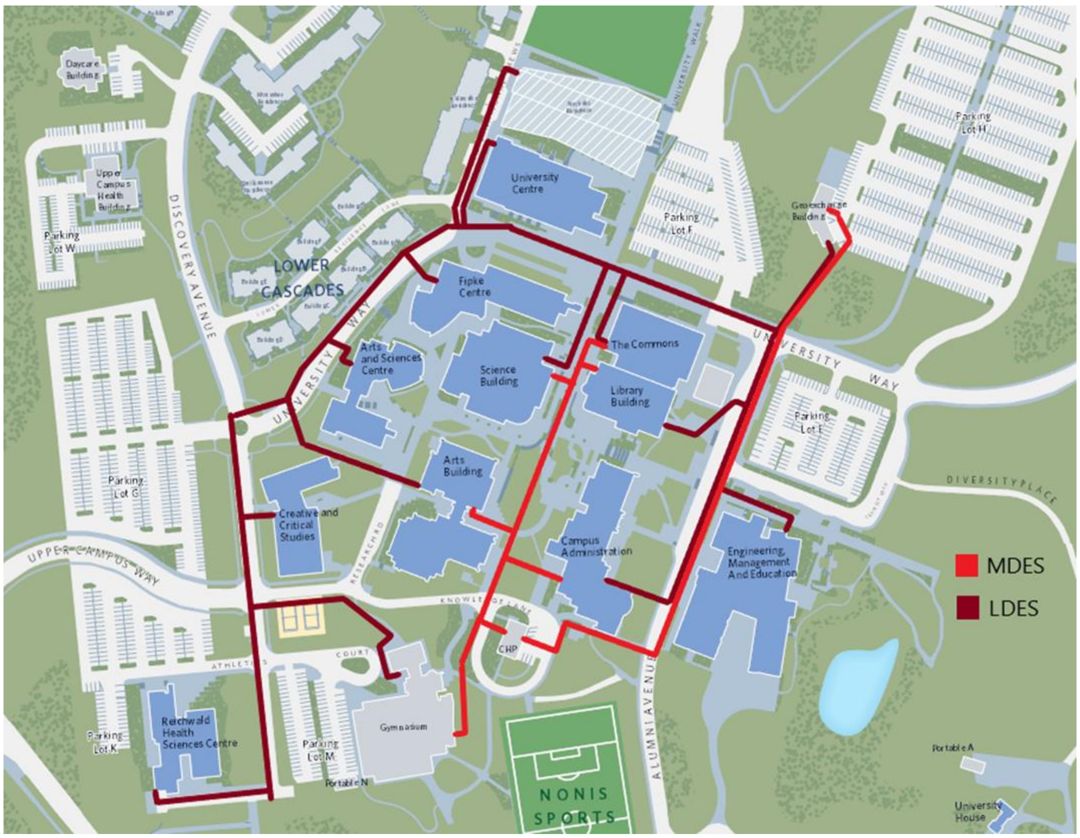

Figure 16: Map of the current status of District Energy Systems

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

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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 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. The total energy produced by MDES is shown in Figure 17.

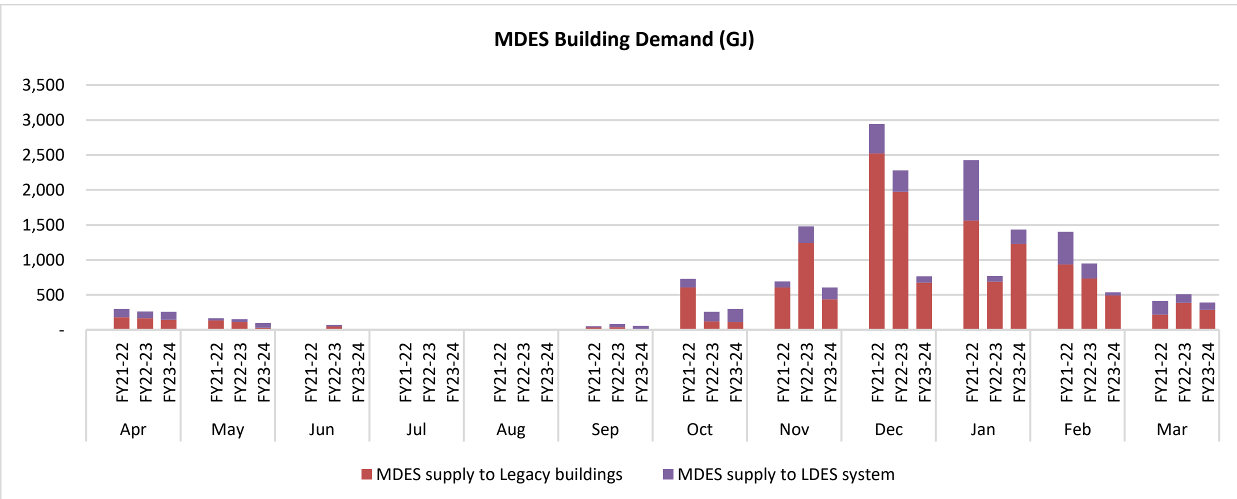

Figure 17: Thermal Energy demand from the MDES plant

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. The MDES energy demand breakdown among the buildings and supply to LDES is shown in Figure 18 below.

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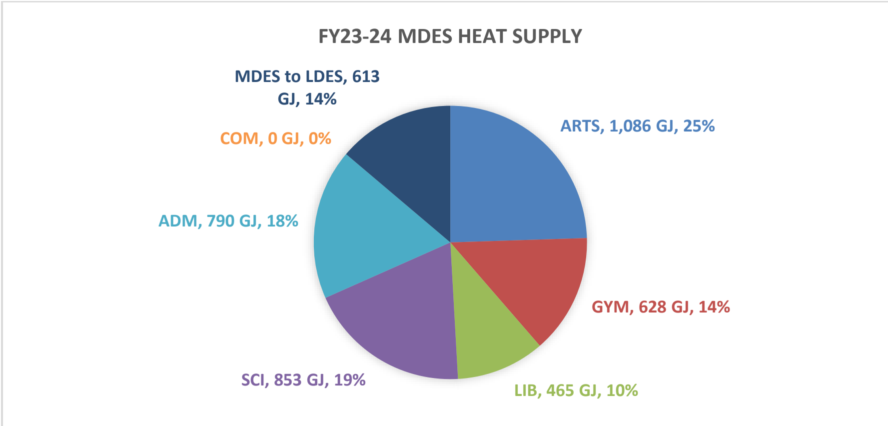

Figure 18: Heat Supplied from the MDES plant to various demand buildings for FY23-24

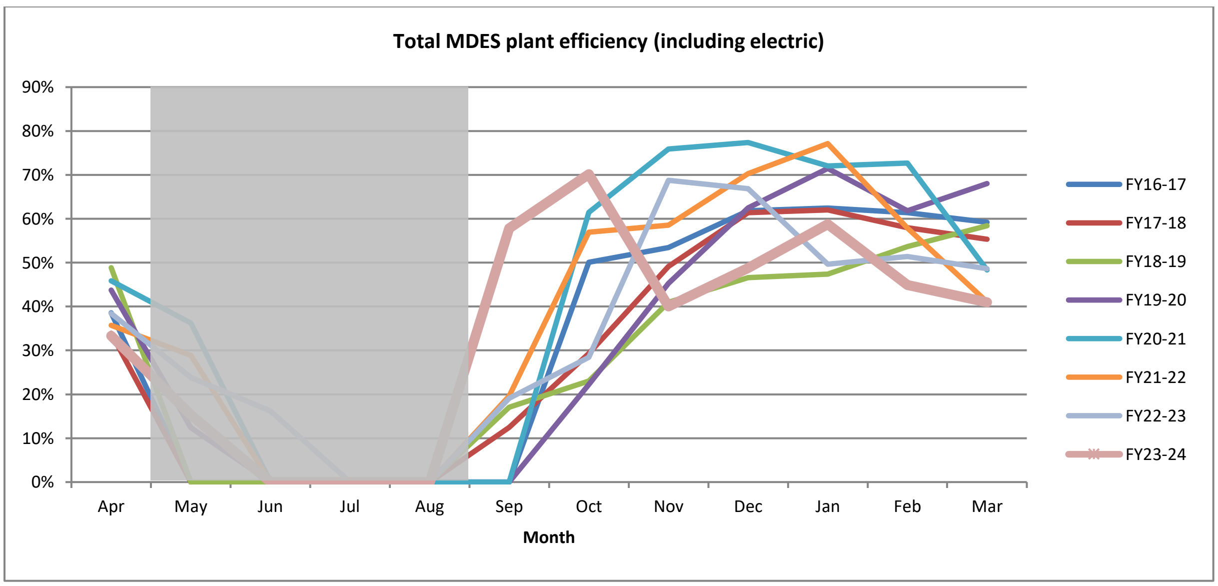

Figure 19: MDES plant efficiency

As shown in Figure 19 above, MDES plant efficiency continued to deteriorate in the last heating season of FY23-24 compared to last two fiscal years FY21-22 and FY22-23 due to reduced heat supply to LDES plant from MDES (8,114 GJ in FY20-21 compared to 1,312 GJ in FY22-23 and 1,044 GJ in FY23-24). 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.

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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 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. Types of pipes are listed below:

- Pipes 100 to 300 mm (4 to 12”) dia. - AWWA C900 SDR 25 or Series 160 DR 26

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[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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- 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. The basic schematic diagram is shown in Figure 20 and Figure 21 below.

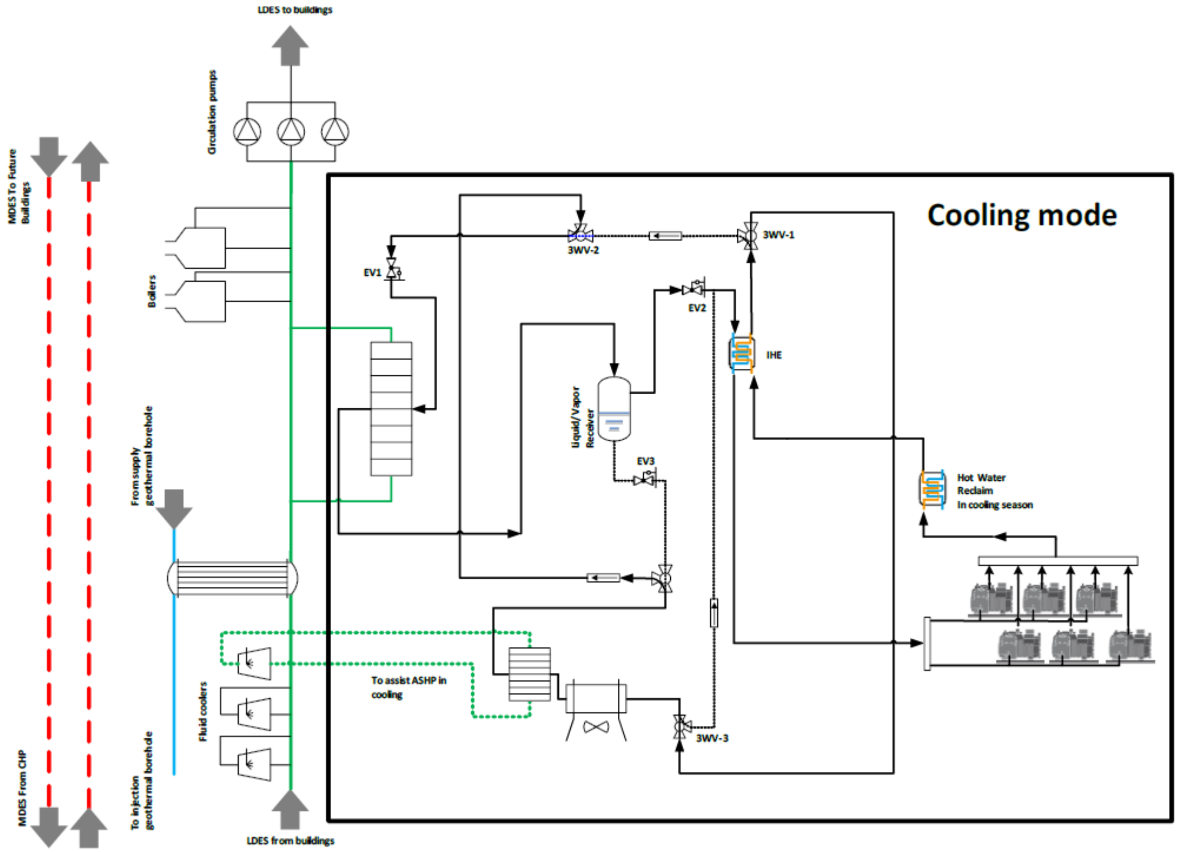

Figure 20: LDES plant block diagram with planned Air Source Heat Pumps in cooling mode

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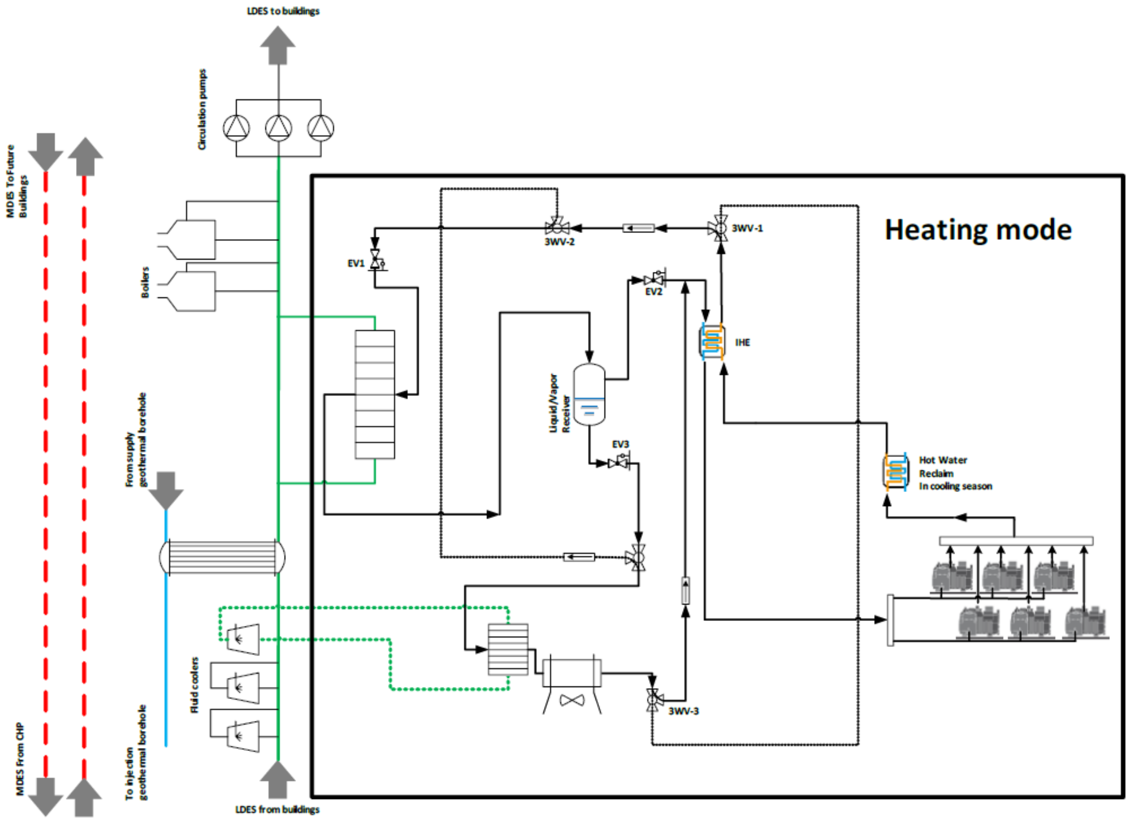

Figure 21: LDES plant block diagram with planned Air Source Heat Pumps in heating mode

The Figure 22 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 Figure 22, 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 8%) 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.

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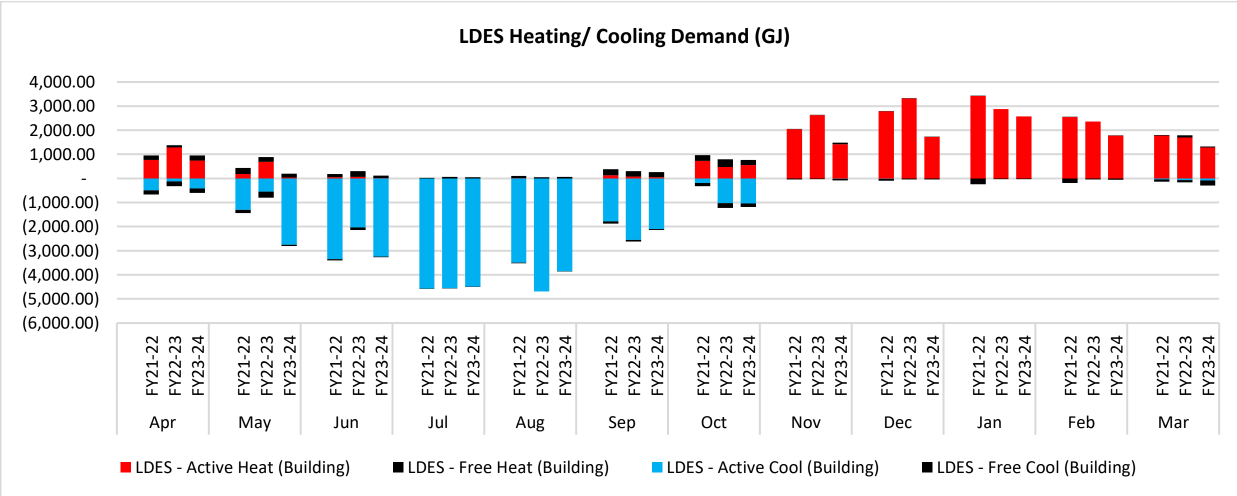


Figure 22: Thermal Energy demand from the LDES plant

Figure 23 shows the various sources of heat injection and rejection in FY23-24 and Figure 24 shows the breakdown heating or cooling supply between various buildings from LDES plant.

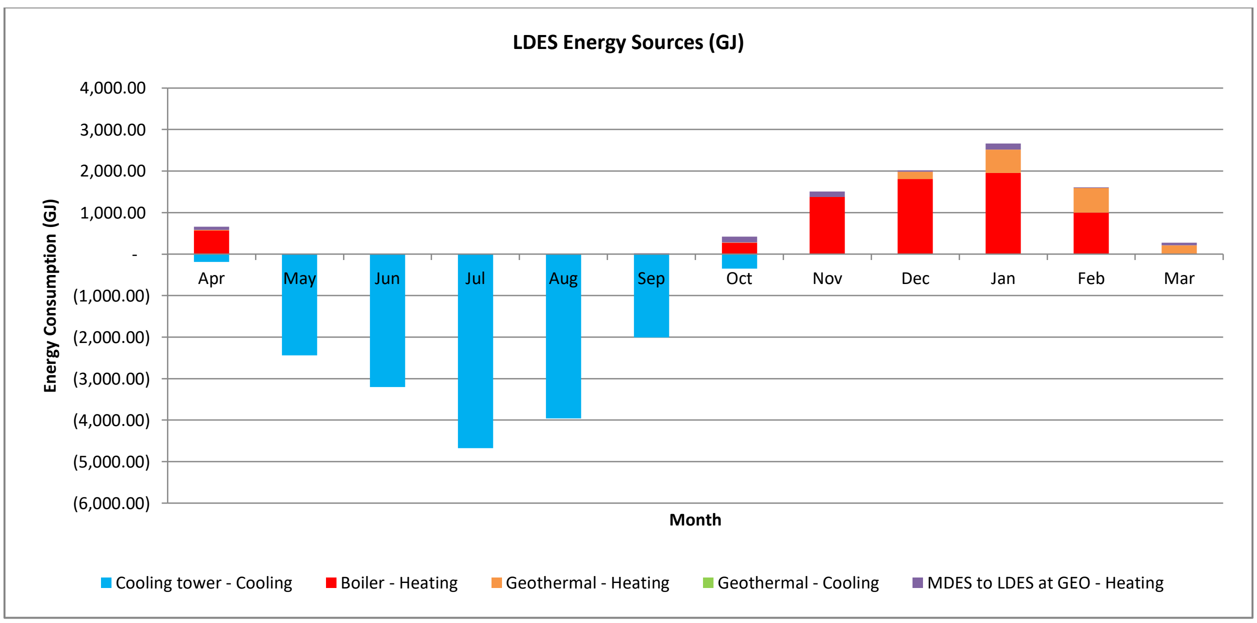


Figure 23: LDES Heating and Cooling Sources for FY23-24

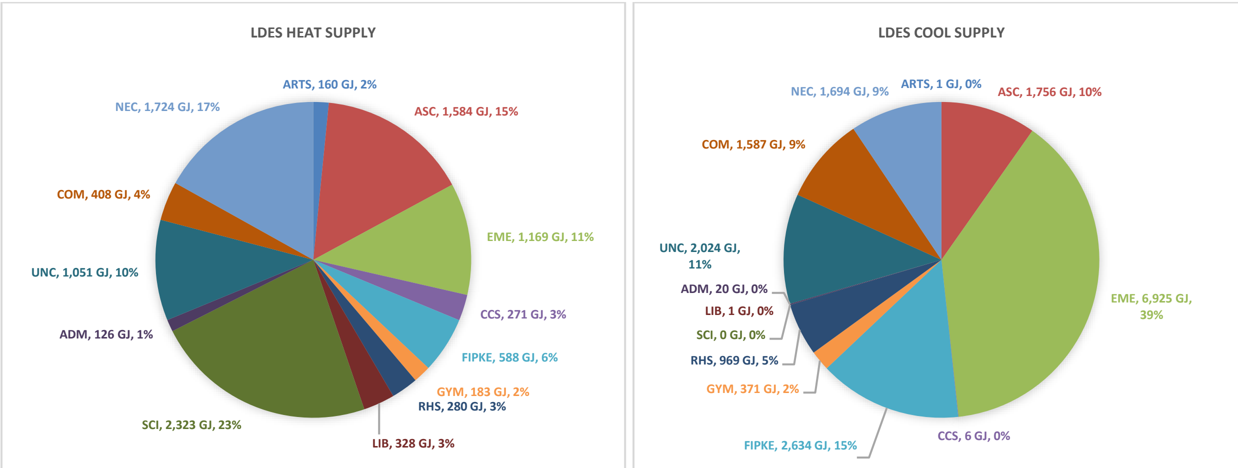
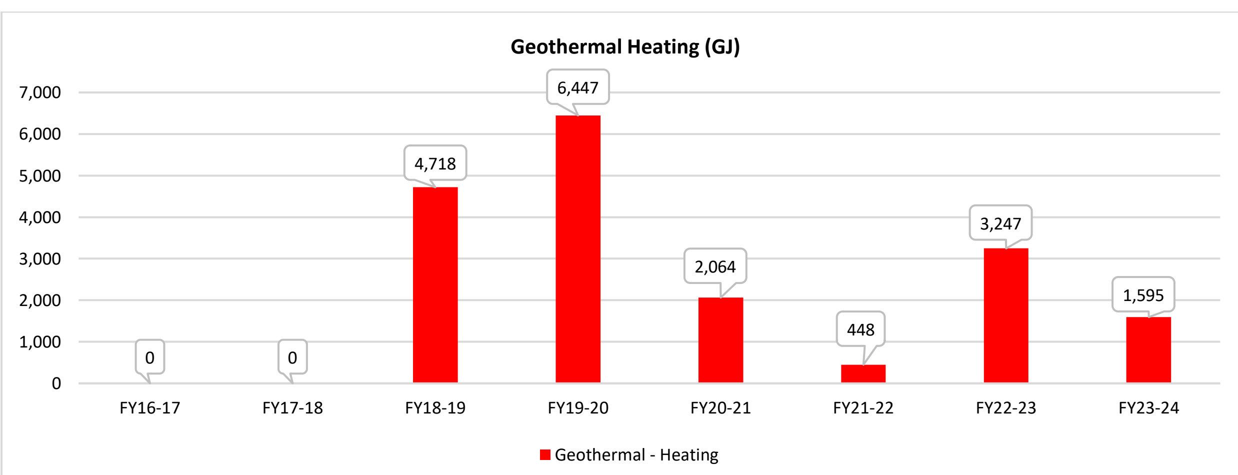


Figure 24: Heat Injected/ Rejected from LDES plant to/from various buildings for FY23-24

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. 1,595 GJ of heat was extracted from geo-exchange system in FY23-24 compared to 3,247 GJ of heat extraction in FY22-23 and 448 GJ in FY 21-22 (Refer to charts in Figure 25). The geo-exchange can provide effective cooling but does have environmental risks injecting warm water back to the ground.



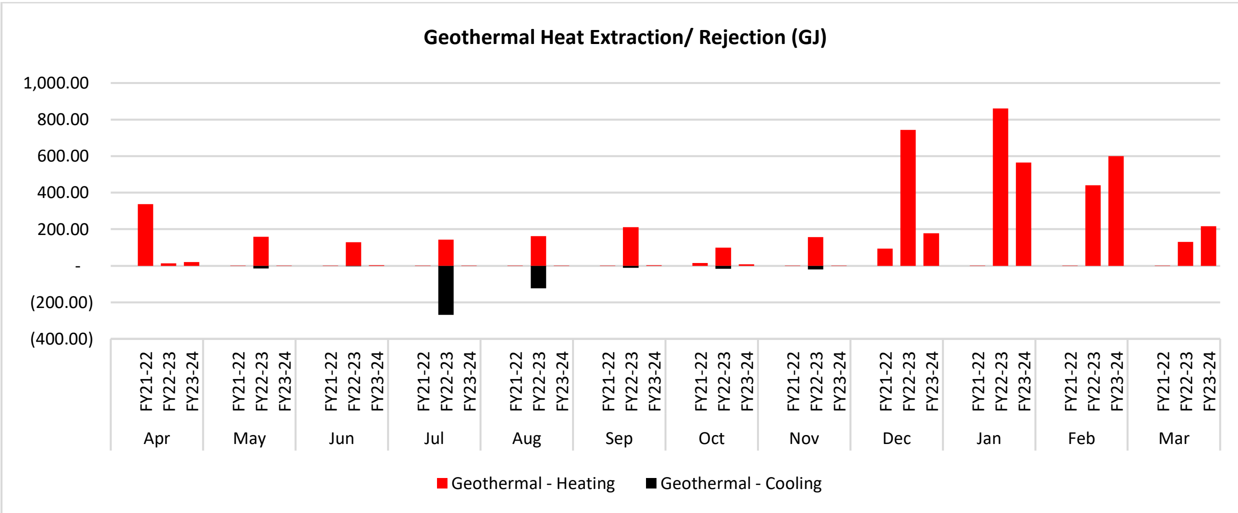


Figure 25: Quantities of Heat extracted/ rejected from Groundwater geo-exchange system

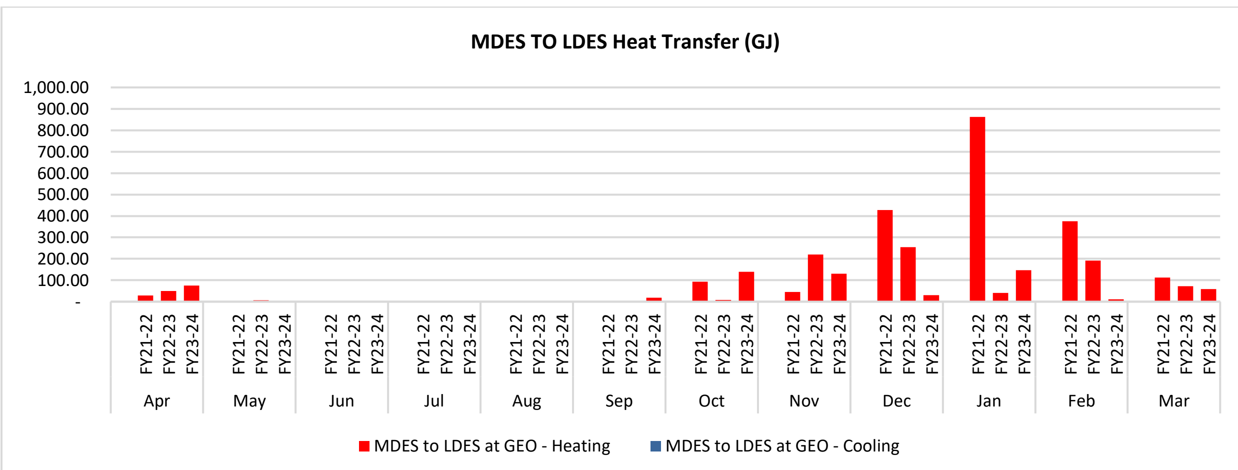


Figure 26: Quantities of Heat extracted from MDES to LDES system

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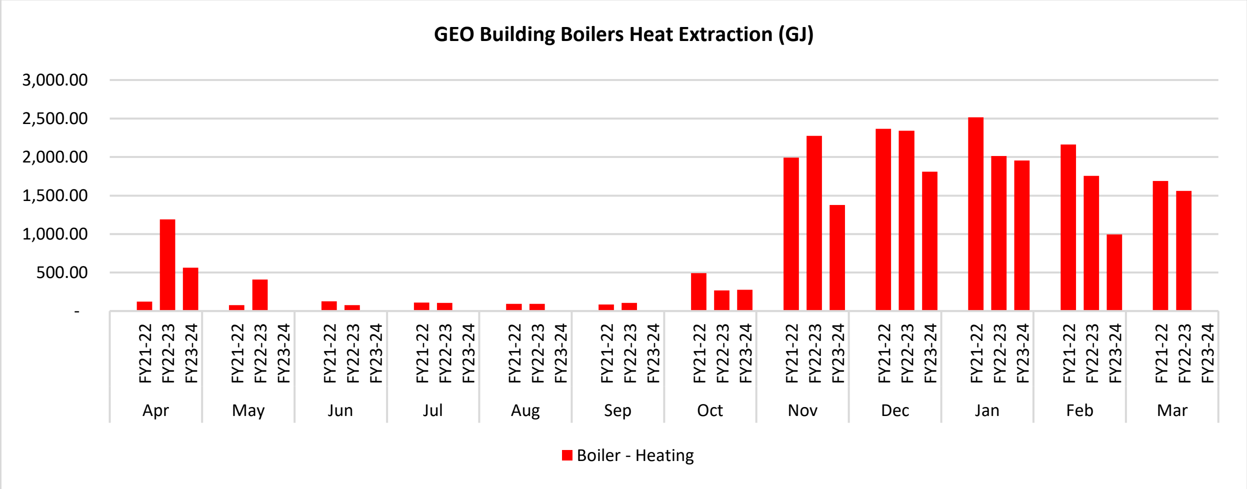

Figure 27: Quantities of Heat extracted from GEO boiler system

Figure 25, Figure 26 and Figure 27 above present the historical comparison of various LDES heating sources. Figure 28 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%.

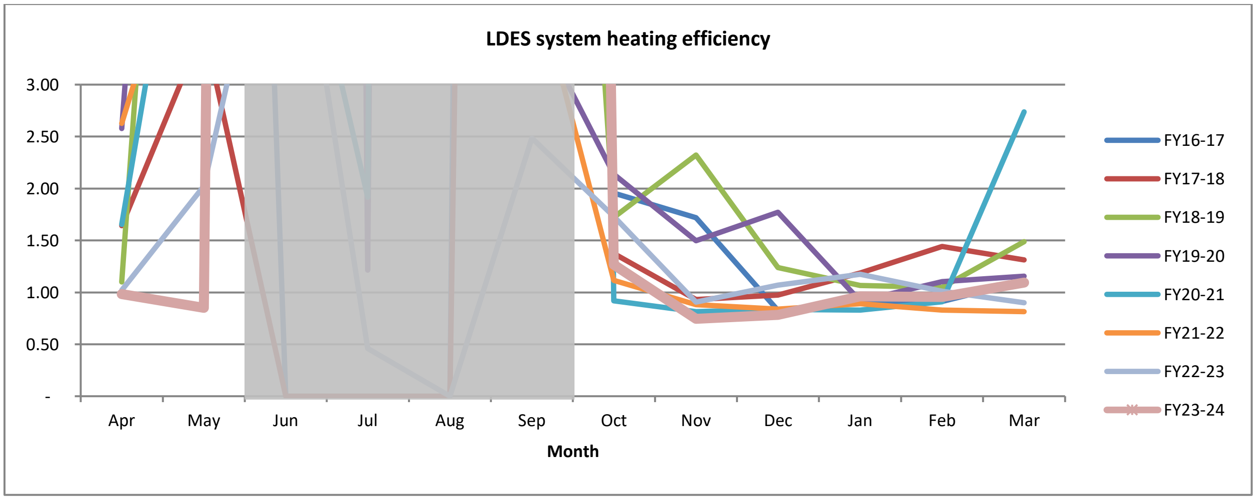

Figure 28: LDES System heating efficiency[9][10]

[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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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 16,820.18 GJ for FY23-24, similar to cooling load in FY22-23 at 13,658 GJ and FY21-22 at 14,232 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.

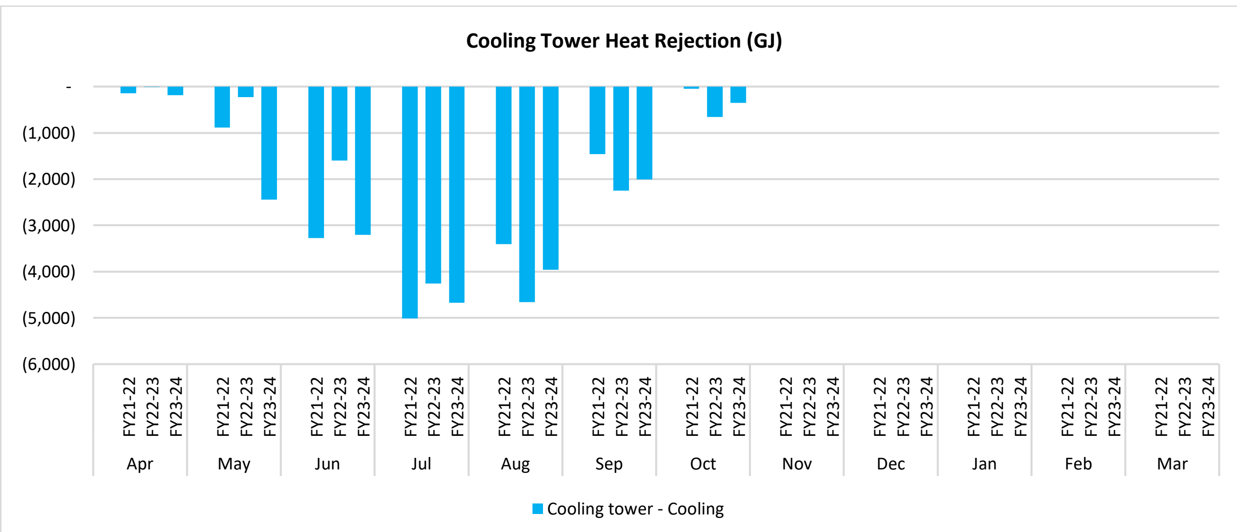

Figure 29: Quantities of Heat rejected by cooling towers

Figure 29 above shows the heat rejected by the cooling towers in the LDES system. Figure 30 below shows the cooling COP of the LDES system which is on average 17 during peak cooling season.

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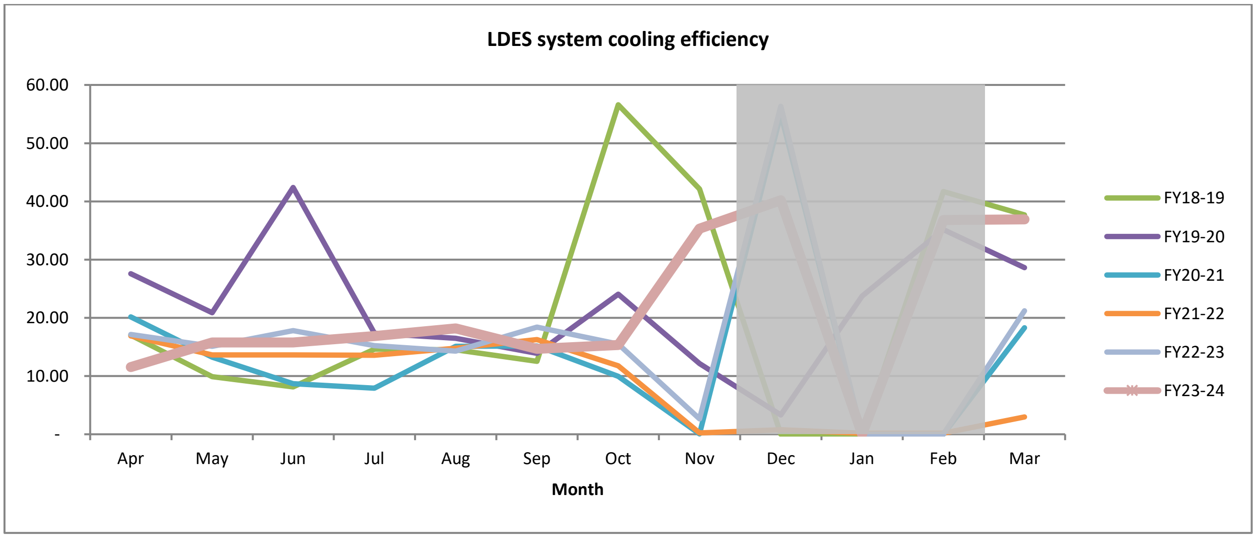

Figure 30: LDES Cooling Towers Heat Rejection Energy Efficiency[11]

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

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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) 2023 Update

In line with UBC's Climate Emergency Declaration, UBCO is pursuing a greenhouse gas (GHG) emissions reduction target of 65% below 2013 levels by 2030, based on gross GHG values as per Climate Action Plan (CAP). Energy Team has been tasked with developing appropriate policies and guidelines that assist in meeting long-term campus energy and carbon goals.

The 2023 update of the Strategic Energy Master Plan (SEMP) is a comprehensive integration of diverse initiatives aimed at advancing our high-level energy strategy. This update is in alignment with our goal to reach a future state with a view of modernization, renewal, and growth to meet current and future energy needs in line with UBC Okanagan's goals and resilience. Following are the various initiatives integrated under the 2023 edition of SEMP:

- Utilities tracking and forecasting (campus future utility needs and costs)
- Demand-Side Management (energy efficiency and optimization)
- Building Energy Targets (targets for net-positive ready buildings)
- Decarbonization with targets from the CAP (Climate Action Plan)
- Campus Growth (Buildings and FTE)
- Renewal and Modernization

In recent years, the UBCO Energy Team transitioned from heavy reliance on external consultants to establishing an internal expertise in energy and data analysis, KPI reporting, and BMS improvement. This strategic shift has yielded significant benefits, including cost savings, improved control, faster response times, knowledge retention, customization capabilities, long-term planning, and increased adaptability to changing energy dynamics. While some of the work is still being outsourced to meet external funding partner requirements, our in-house capabilities have allowed us to conduct thorough energy evaluations, monitor performance indicators, and optimize our BMS, resulting in Net Present Value (NPV) of $600,000 for a $400,000 investment, in addition to external energy efficiency benefits of $500,000. This strategy positions UBCO to make well-informed decisions, drive down operational costs, and effectively align our energy management strategies with our overarching sustainability objectives.

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Following are the recommended cost-effective strategies as per Strategic Energy Management Plan 2023:

- Add 1.5 MW CO2 ASHP (Benefits: meet decarbonization targets, capacity increases, future proofing).
- Increased demand side reduction program to approximately $500k per year due to better ROI and achieve required CAP targets by directly reinvesting FortisBC energy rebates.
- Retrofits/Modernization/Stranded Loads should be scheduled in alignment with DE strategy to minimize future capital costs.
- Periodically update the Strategic Energy Master Plan (SEMP) to stay aligned with technological advancements, evolving regulations, market trends, and environmental goals.

4.2 Demand-Side Management Program

Energy Team is working on implementing the Energy Conservation Measures (ECMs) as per Strategic Energy Management Plan (SEMP) 2023. Following are the identified measures recently completed or currently underway:

- Campus-wide lab demand-controlled ventilation
  - IAQ-based Demand controlled ventilation for campus AHUs and/ or MUAs (Project implementation completed for a portion of SCI building)
  - Occupancy-based Demand controlled ventilation for campus AHUs and/ or MUAs (Study completed for ASC FIP, project implementation underway)
- Waste heat recovery from strobic exhaust for SCI building (Investigation completed, project design underway)
- LED lighting upgrade for Plant Growth Facility (Implementation completed)
- Recommissioning of existing controls at EME building (Investigation complete, implementation to be scheduled)
- District Energy Optimization (Investigation underway)
- People counter HVAC scheduling (Investigation underway)
- Conversion of CAV to VAV and high temp to low temp terminal units for ARTS building (Investigation to be scheduled)

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

A decision was made by the UBC steering committee to proceed with district energy utility services where district scaled water source heat pumps provide hot and cold water to the

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buildings. 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 x̌əl sic snpax̌nwixʷtn (XSS) building on the main campus.

Energy Team has been working with DE consultants to advance the schematic design and development of the various cluster plants on campus LIPCP, Residence cluster plant, Commons cluster plant. These projects included a high-level concept design to outline preliminary requirements and indicative capital costs for a potential Lower Innovation Precinct Cluster Plant (LIPCP), Residence Cluster Plant, and Commons Cluster Plant.

In terms of DE decarbonization, the key strategy for decarbonization features the integration of air source heat pumps (ASHP) in a transition to a future state that is affordable, sustainable, and resilient in service to connected customers.

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.

4.4 Campus-Wide High Voltage Master Electric Plan

Energy Team has been 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. This study was completed in Q2 of FY23-24 and recommends the following:

- Design and implement EV charging infrastructure plan
- Upgrade main feeders (project sheet#1) – in progress
- Upgrade Admin TX (project sheet#5)
- Perform a campus-level power quality study
- Add a new switch near 74N2606 to service the Innovation Precinct (project sheet#2)
- Study -Develop a plan to accommodate zero-emission vehicles on campus, including electric and hydrogen vehicles for fleet vehicles, service vehicles, staff, faculty, and students.(project sheet#4)
- Develop a microgrid plan for the campus that can leverage various
- DERs such as solar, battery energy storage, combined heat & power, hydrogen, and vehicle-to-grid (V2G) and operate in islanding mode. (Project Sheet#3)
- Undertake a solar study to determine available roof-top siting locations and structural capability on existing roofs.

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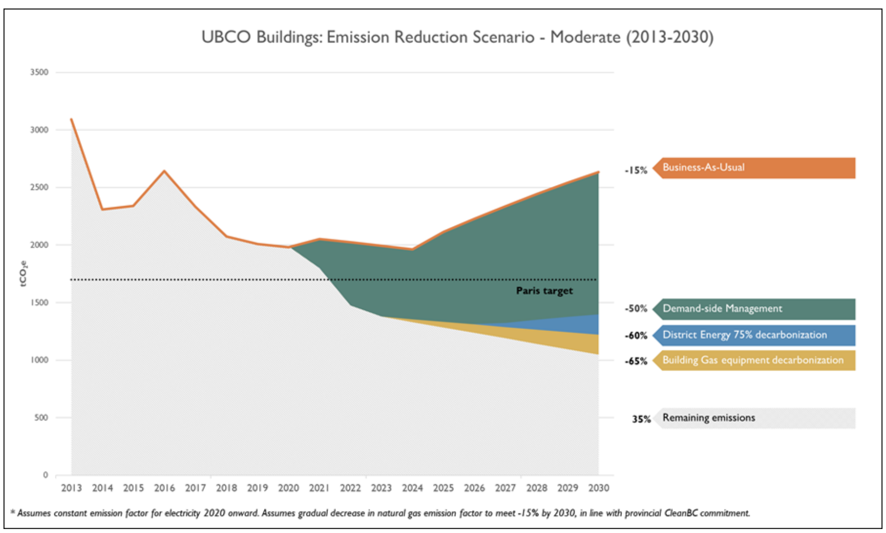
- Undertake a distributed energy resource study for the UBC Okanagan campus that evaluates onsite generation and energy assets options.

4.5 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.

4.6 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. 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.



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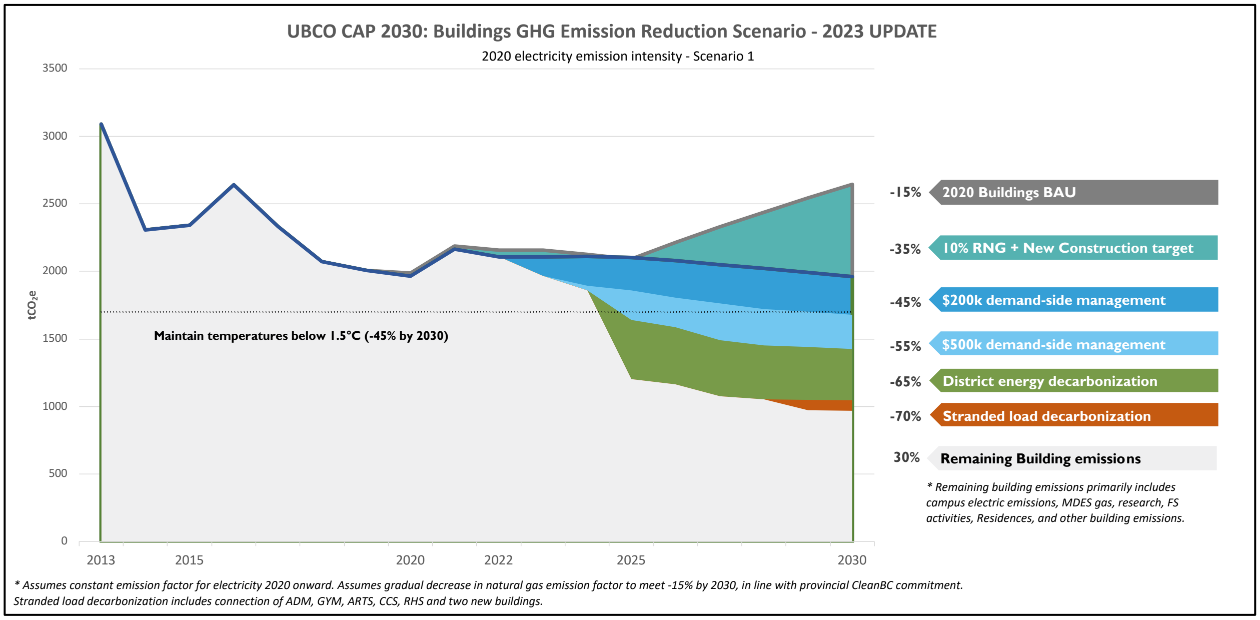
Based on the strategy, a moderate (realistic) target of 65% emission reduction[12] from 2013 levels by 2030 is recommended. This can be achieved by partial decarbonization of the central plant, implementing projects that will reduce energy demand, and connecting select existing buildings to central energy supply systems (district energy). The Campus Action Plan 2030 plan has been signed off by the UBC executive committee. Further work is being performed to keep track of the progress.



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

[12] Note that when conducting the scenario analysis, the electricity emission factor used in 2020 was 2.587 tCO_2e/GWh and assumed constant till 2030. However, in Q1 FY21-22 this factor has been retroactively updated by Ministry of Environmental and Climate Change Strategy to 35 tCO_2e/GWh for 2013 and 40.1 tCO_2e/GWh for 2020. This modelling results do not reflect this change.

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- Grid electricity emission factor

4.7 UBCO Net Positive Modelling Study – Archetype Update and Analysis

Energy Team worked with RDH Building Science Inc. 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 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.

4.8 Campus Energy Monitoring and Data Management

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 developed a utility tracking tool using advanced programming language knowledge python and excel to track overall campus utility consumption (Electricity,

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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.

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.

4.9 UBCO CO2 Air Source Heat Pump Project Summary

A key strategy in decarbonizing UBCO's core operations cost-effectively is the expansion of central plant using low carbon energy equipment (air source heat pumps). These heat pumps would be used to address the base load heating requirements instead of gas boilers which would be used during peak heating demand (during the coldest months). Continuing to use the gas boilers to handle peak heating loads results in reduced capital costs for Air-Source heat pumps and enables significant decarbonization with a relatively modest equipment size. Two new condensing boilers (3,000 MBTU and 5,000 MBTU) are installed in the UBCO District Energy system to handle the peaking demand by campus.

The proposed CO2 air source heat pump solution not only addresses environmental concerns (possibility of per- and polyfluoroalkyl substances (PFAs), which could pose significant long-term environmental hazards) linked to conventional refrigerants but also provides significant improvements in efficiency and operational flexibility. This project improves the Overall system efficiency from 72% to 174%. UBCO’s low-temperature district energy system (5th generation district energy network) provides a unique opportunity and novel application for CO2 refrigerant-based Air-source heat pump.

4.10 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.

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4.11 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. The next implementation is planned in 2025.

4.12 UBCO Upper Residence Cluster Plant Concept Design

The study was 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. This study was completed in 2023 and available to assist the design project.

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 Upper Innovation Precinct Cluster Plant (UIPCP). The plant layout is shown in Figure 31. Similar to the XSS Cluster Plant currently being designed, the Upper Innovation Precinct 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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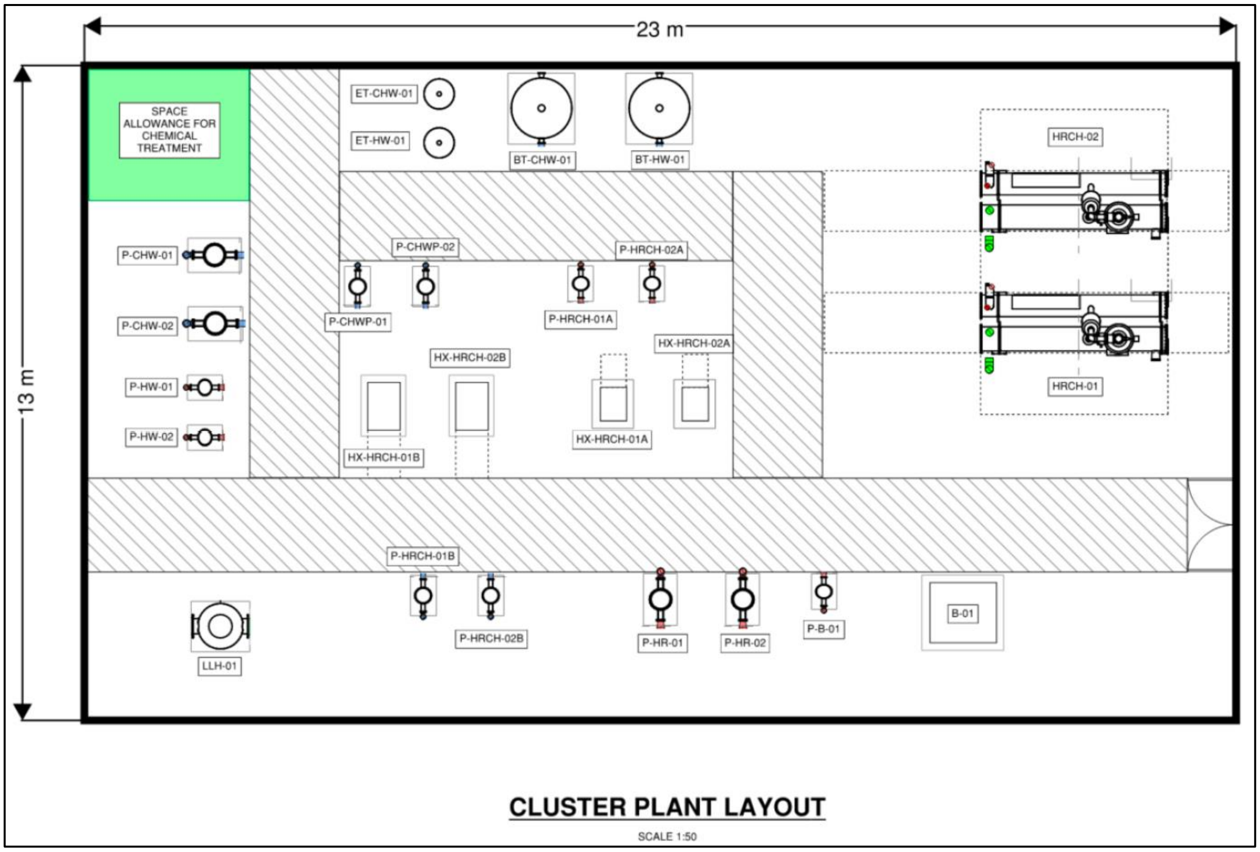

Figure 31: UIPCP Cluster plant equipment layout

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 UIPCP.

4.13 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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4.14 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 XSS building, Childcare. A detailed summary for each new building has been presented in Section 6. 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 XSS 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 XSS (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 XSS 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 XSS 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 XSS building.

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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 $221,000 of energy efficiency incentives were received this past fiscal year. In addition to these rebates $140,000 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 ASC FIPKE 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 with an approved external funding of $90,000 and project implementation completed in November 2023.

5.2 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. BC Hydro approved consultant Falcon Engineering will be contracted to provide support in performing this recommissioning 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 investigation phase of the project started in October 2022 and the project is expected to be completed in Q1 FY24-25.

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5.3 Science Heat Recovery Study

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. The consultant identified to UBC Okanagan that the existing glycol runaround heat recovery system that interconnects recovered laboratory exhaust energy to the air handler AHU-1 system's outside air preheat ducting appeared to have spare capacity, because the exhaust coil's discharge air temperature held at 9.7˚C at an outdoor air temperature of -6˚C.

The 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 an approved external funding of $140,000. The project is expected to be implemented in FY24-25.

5.4 Air Handling Unit Supply Air Temperature Reset

For three of the academic buildings (ADM, LIB, SCI), the reset of the supply air temperature (SAT) was tied to heating valve positions resulting in lower air handler setpoints during night setback periods. To address this issue, the SAT reset logic was adjusted to respond to cooling demand (number of cooling requests from different zones) rather than heating demand. This modification is expected to ensure that the SAT reset is aligned with the cooling requirements, preventing unnecessary reduction of the air handler setpoint during night setback scenarios. The project was completed in September 2023 and will be monitored to measure the savings.

5.5 Upper Campus Health Controls Recommissioning

Upper Campus Health was identified as having high energy usage and poor temperature control throughout the year, as well as simultaneous heating/cooling of AHU1. To address these concerns, the building controls programming was examined in detail, PID loops were tuned to enhance the responsiveness of the control system and ASHRAE standard programming were implemented wherever applicable. These interventions were aimed at optimizing energy

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efficiency, rectifying temperature control deficiencies, and eliminating the occurrence of simultaneous heating and cooling in AHU1. The project was completed in September 2023 and will be monitored to measure achieved savings.

5.6 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, adding missing trends on the key hydronic graphics, evaluating the people counter hardware to control ventilation, etc.

5.7 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 has been completed in November 2023.

5.8 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

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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.

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% in 2022. Similar exercise will be carried out for identified buildings next year.

5.9 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. The project is being implemented in phases, where the major addition of 12 sensors completed in Q2 FY23-24.

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5.10 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. 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. As a result of the plant efficiency study a parallel study has been completed to recommend solutions to the following identified issues:

1. LDES fluid cooler efficiency improvement: A significant portion of flow is being recirculated through the fluid coolers during part load conditions, which decreases the return water temperature to the cooling tower and reduces fluid cooler efficiencies. The primary system (plant to buildings) is a variable flow system, whereas boiler pumps are constant flow.
2. MDES Boiler efficiency improvement: During part load conditions, a significant portion of flow is being recirculated through the boilers, which increases the return water temperature to the boilers and reduces boiler efficiencies.

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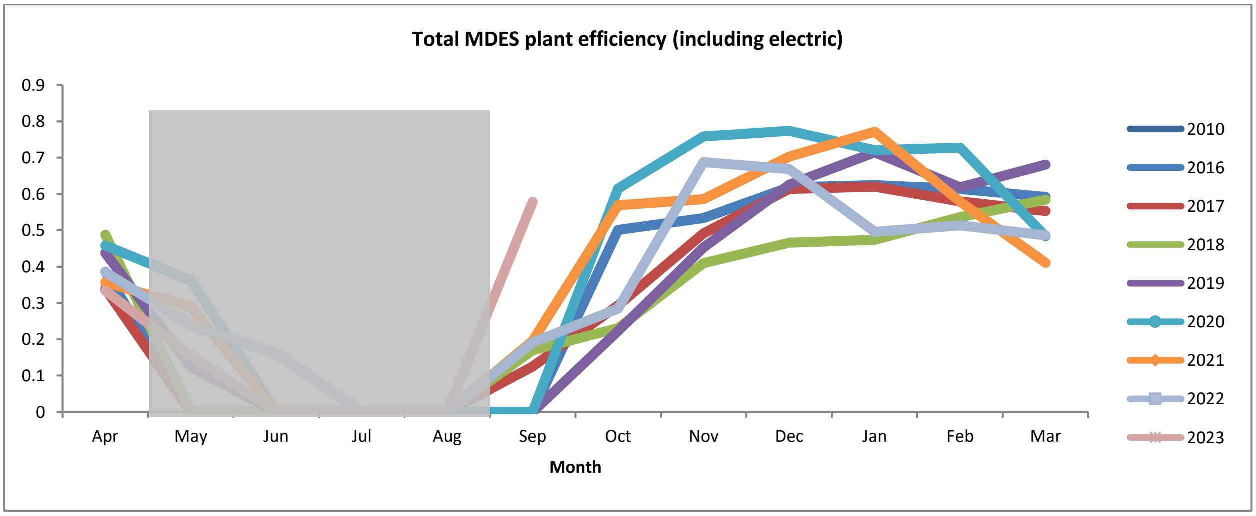
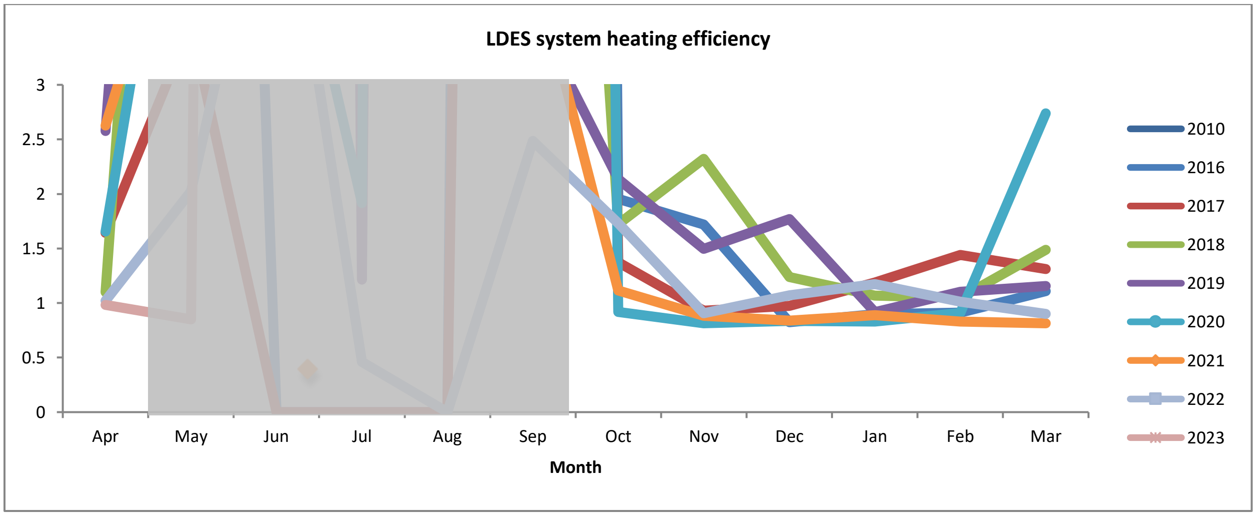
3. LDES fluid cooler free cooling operation: When free cooling operation is enabled during summer months, all three cooling towers operate at 100% to lower supply water temperature as much as possible. This creates an issue as at times LDES main loop flow is only a few hundred gallons whereas fluid cooler operates at 1000 gallons each.
4. Commons building LDES control valve and chiller operation: Review Commons LDES and chiller operations and suggest operations improvement. Currently, the LDES valve at Commons cycles frequently from 0 to 100%.





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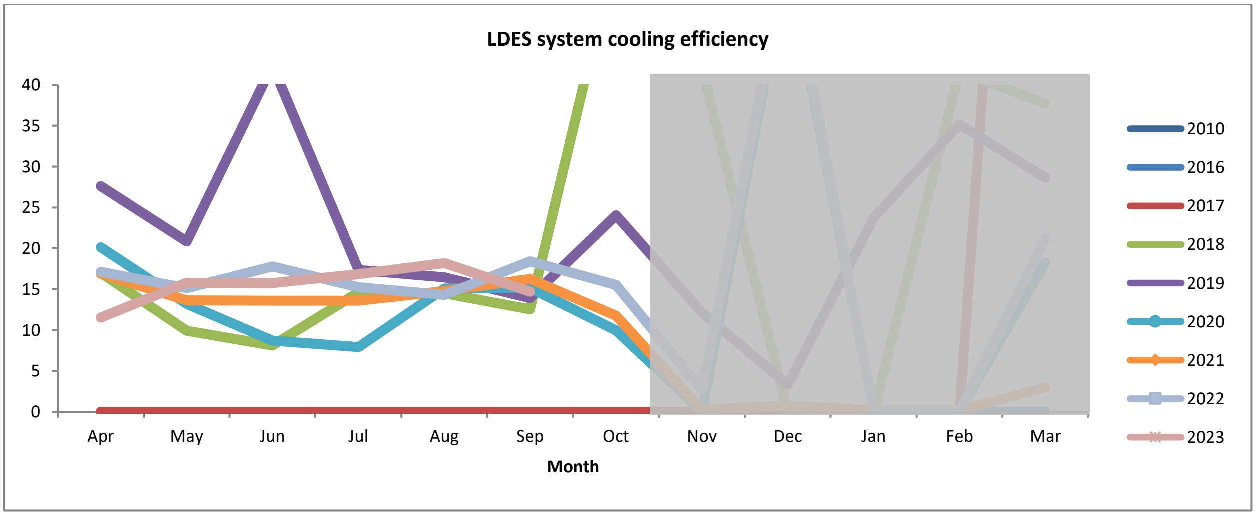

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6 New Construction Projects

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 The X̌əl Sic Snpax̌nwixʷtn (XSS)

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. Titled the x̌əl sic snpax̌nwixʷtn (XSS) 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 XSS 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 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 has been working with Project Services to apply for an eligible incentive for the Office Modular building through FortisBC. The incentive were received for installing low temperature VRF heat pumps in Q3 FY23-24.

6.3 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.

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

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7 Appendix: Monthly Energy Performance Data for Campus Buildings

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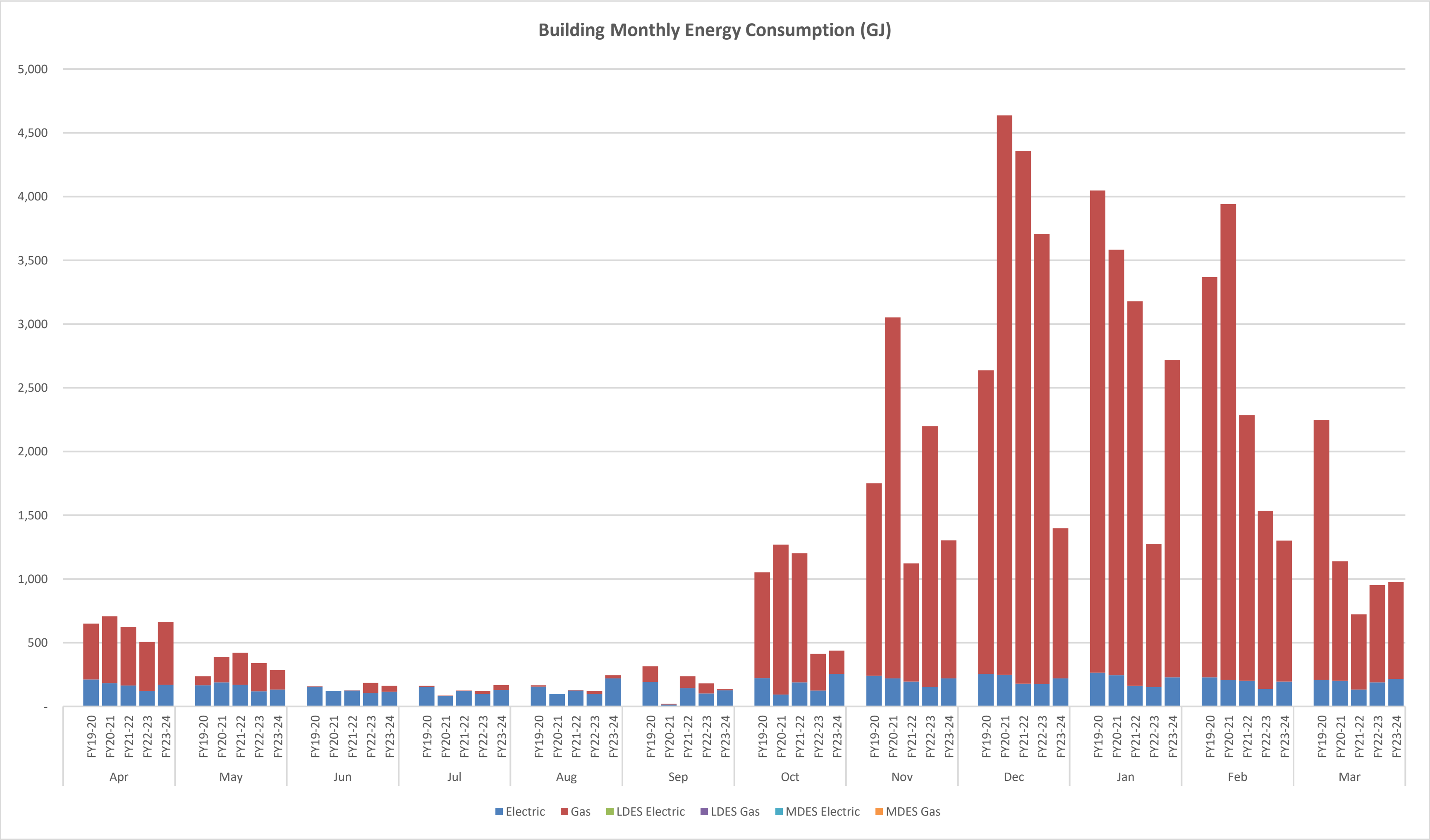
7.1 Central Heating Plant building (DES)



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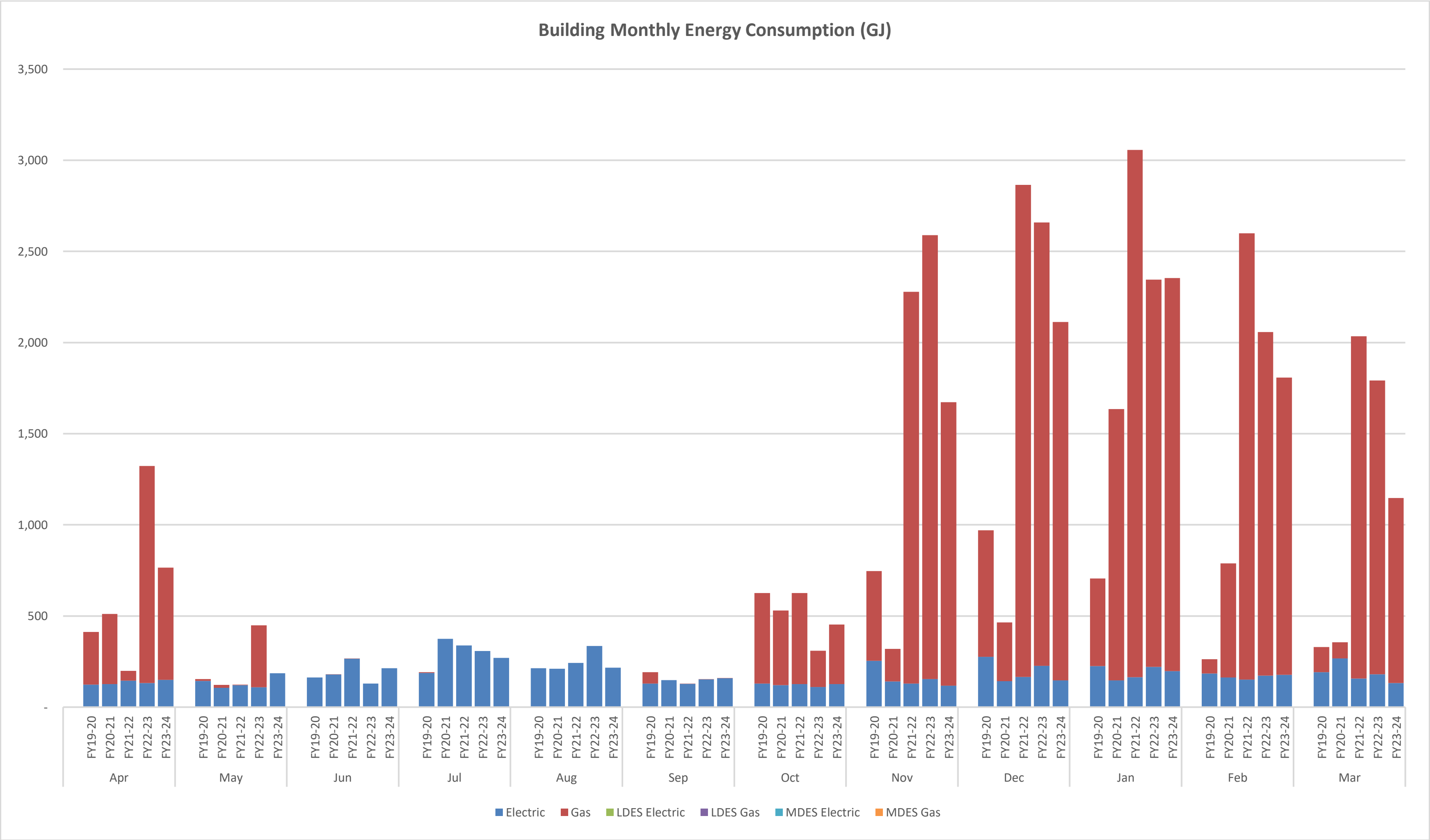
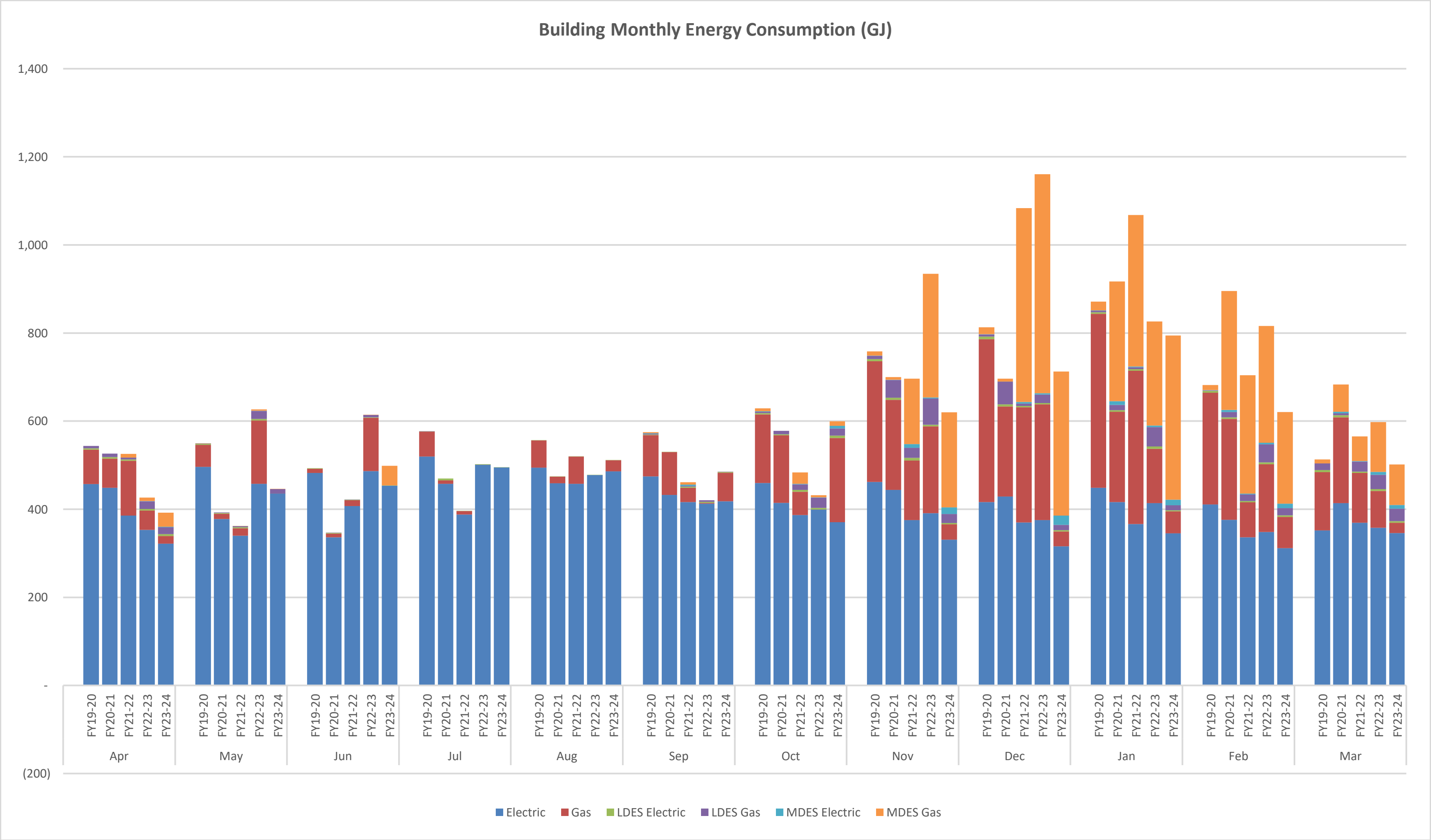
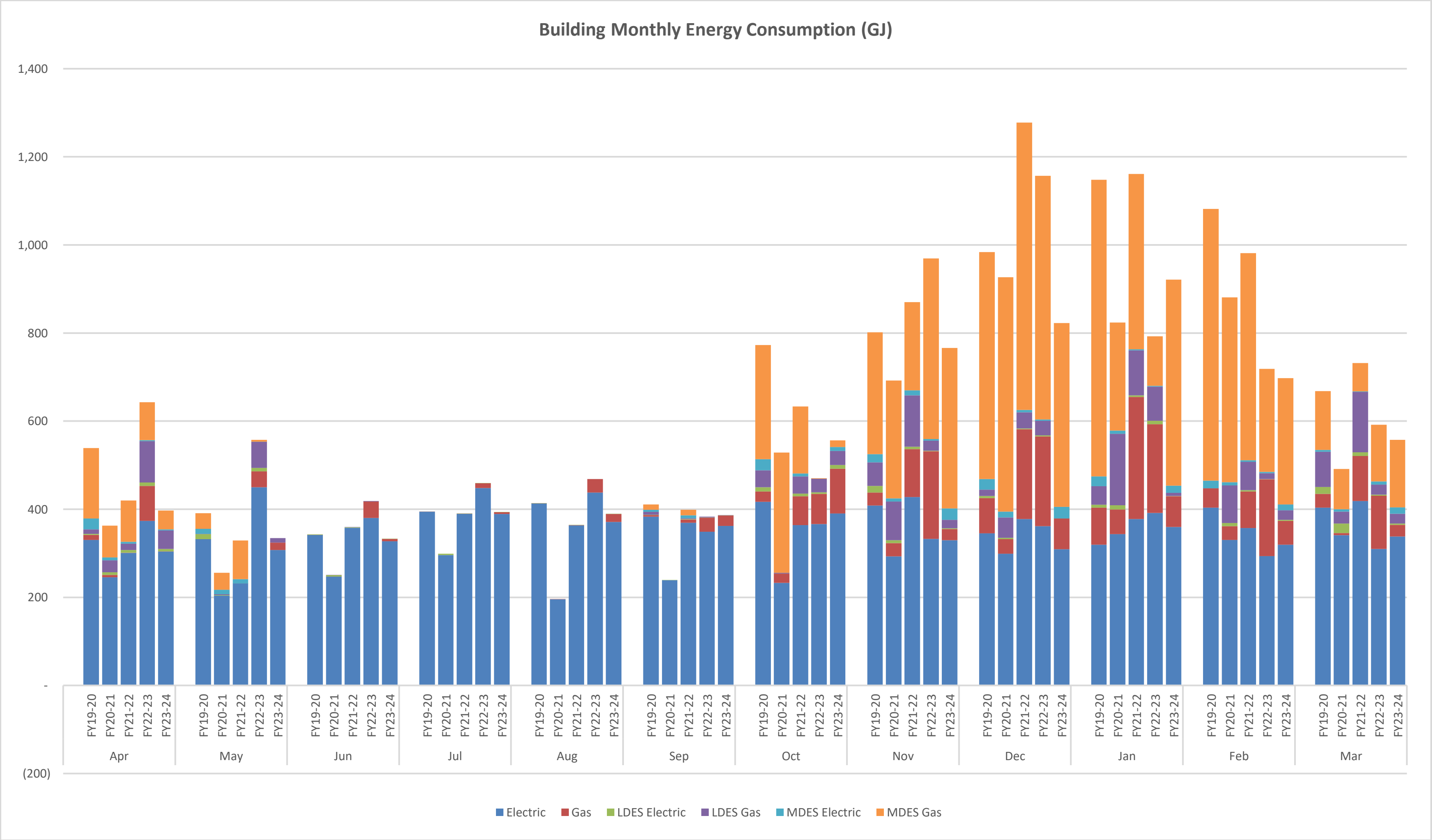
7.2 Geo-Exchange building (DES)



7.3 Administration building (ACAD)



7.4 Arts building (ACAD)



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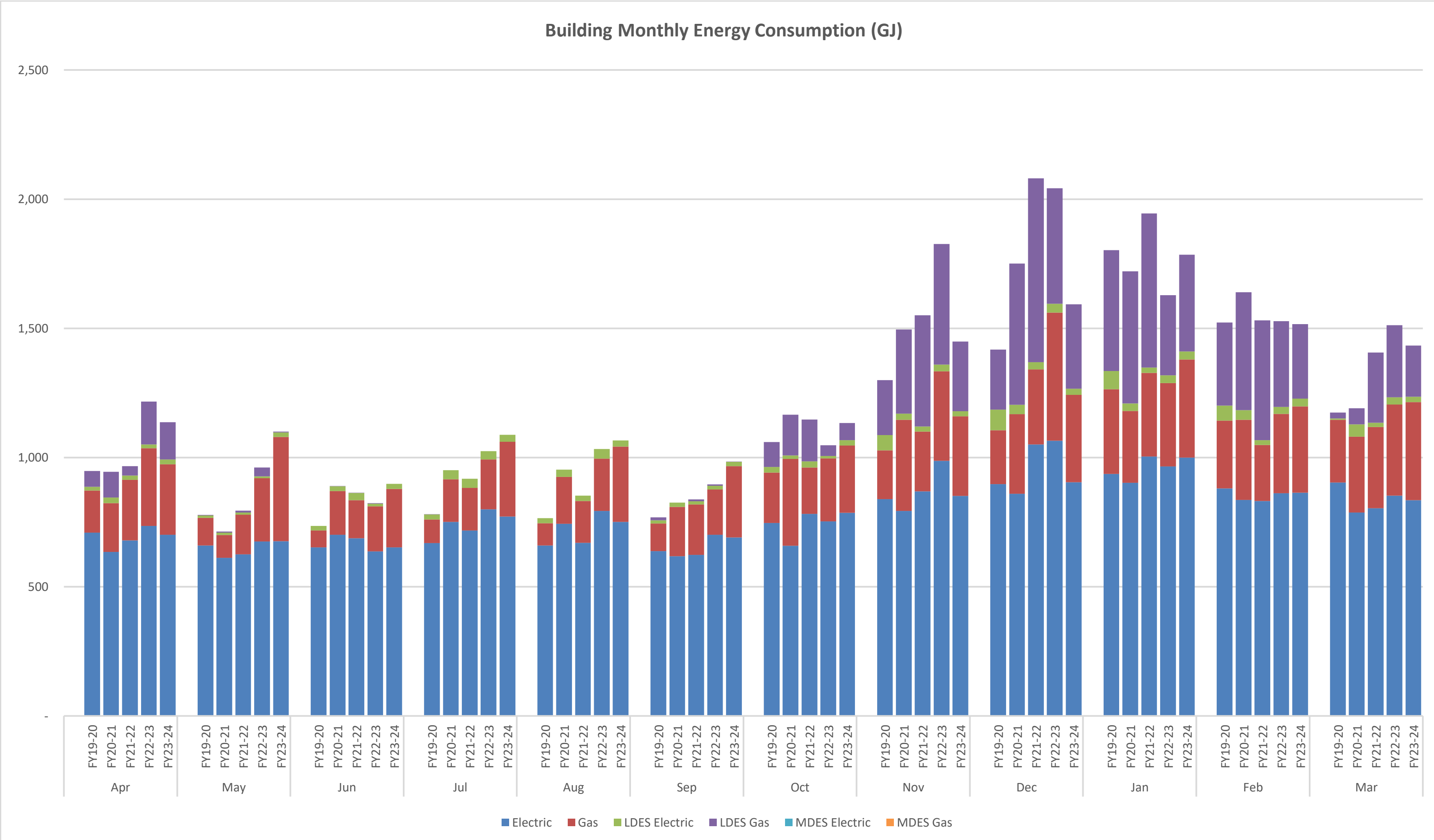
7.5 Arts & Science Centre building (ACAD)



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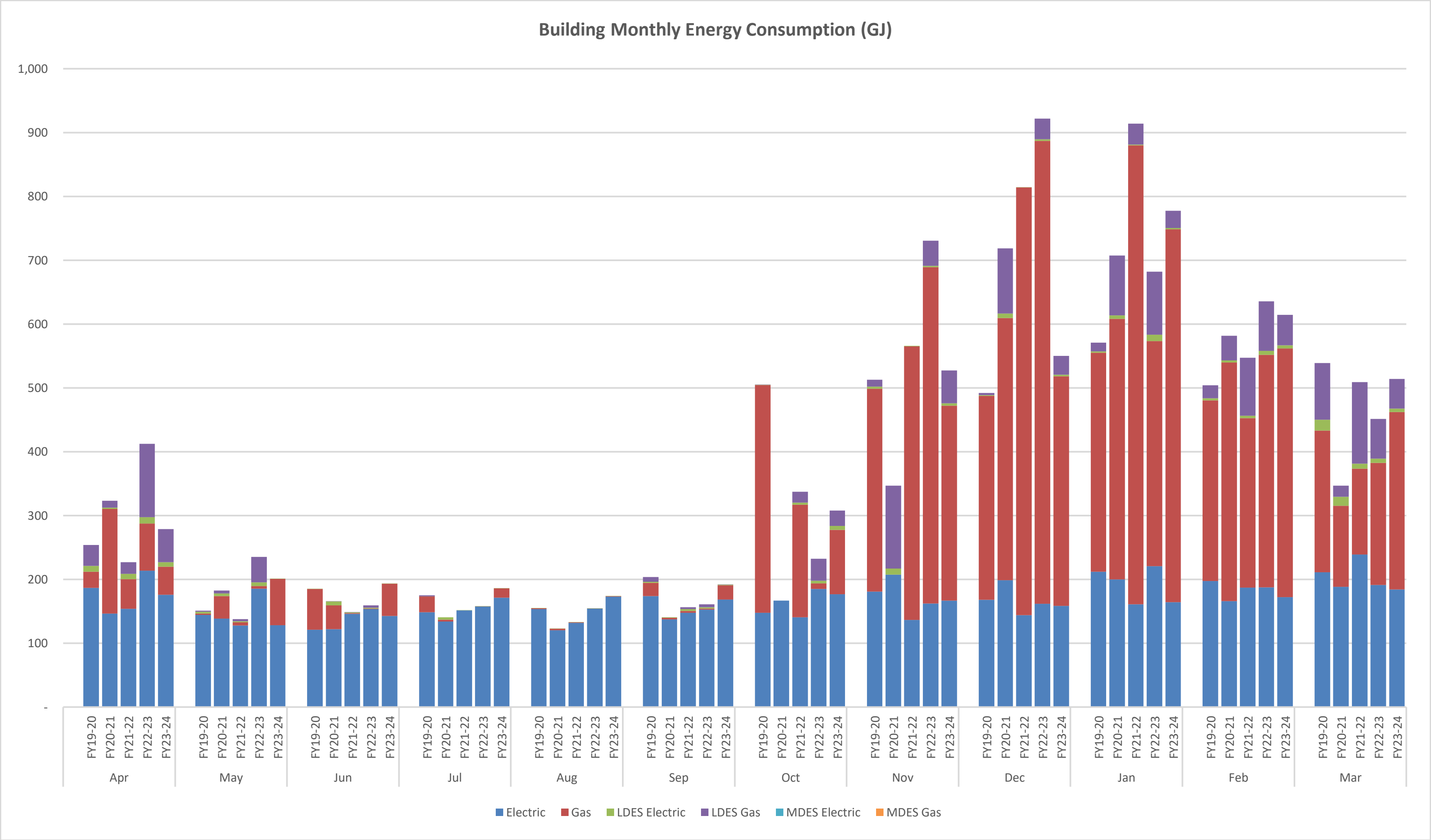
7.6 Creative and Critical Studies building (ACAD)



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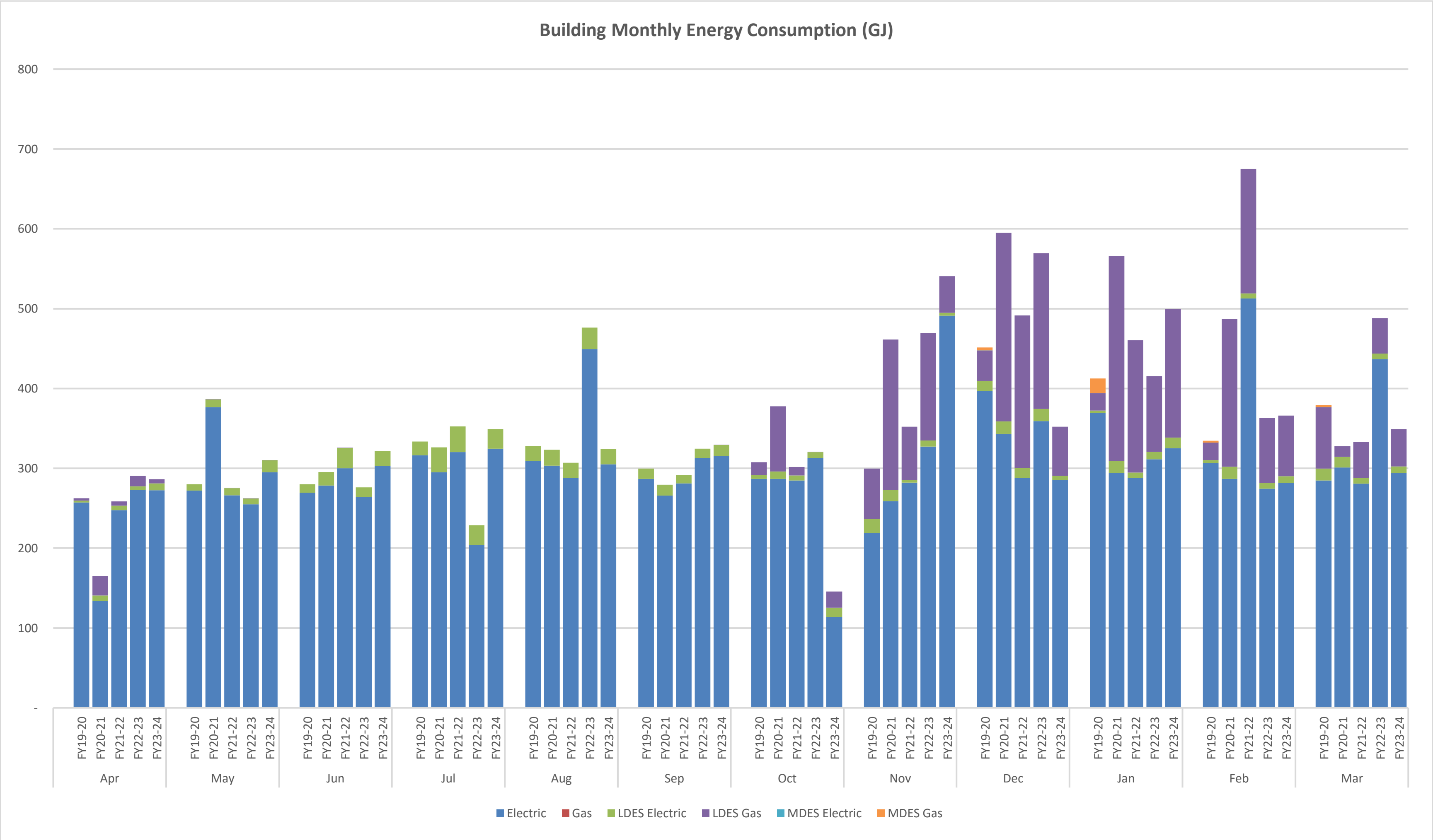
7.7 Teaching & Learning Centre (Commons) building (ACAD)



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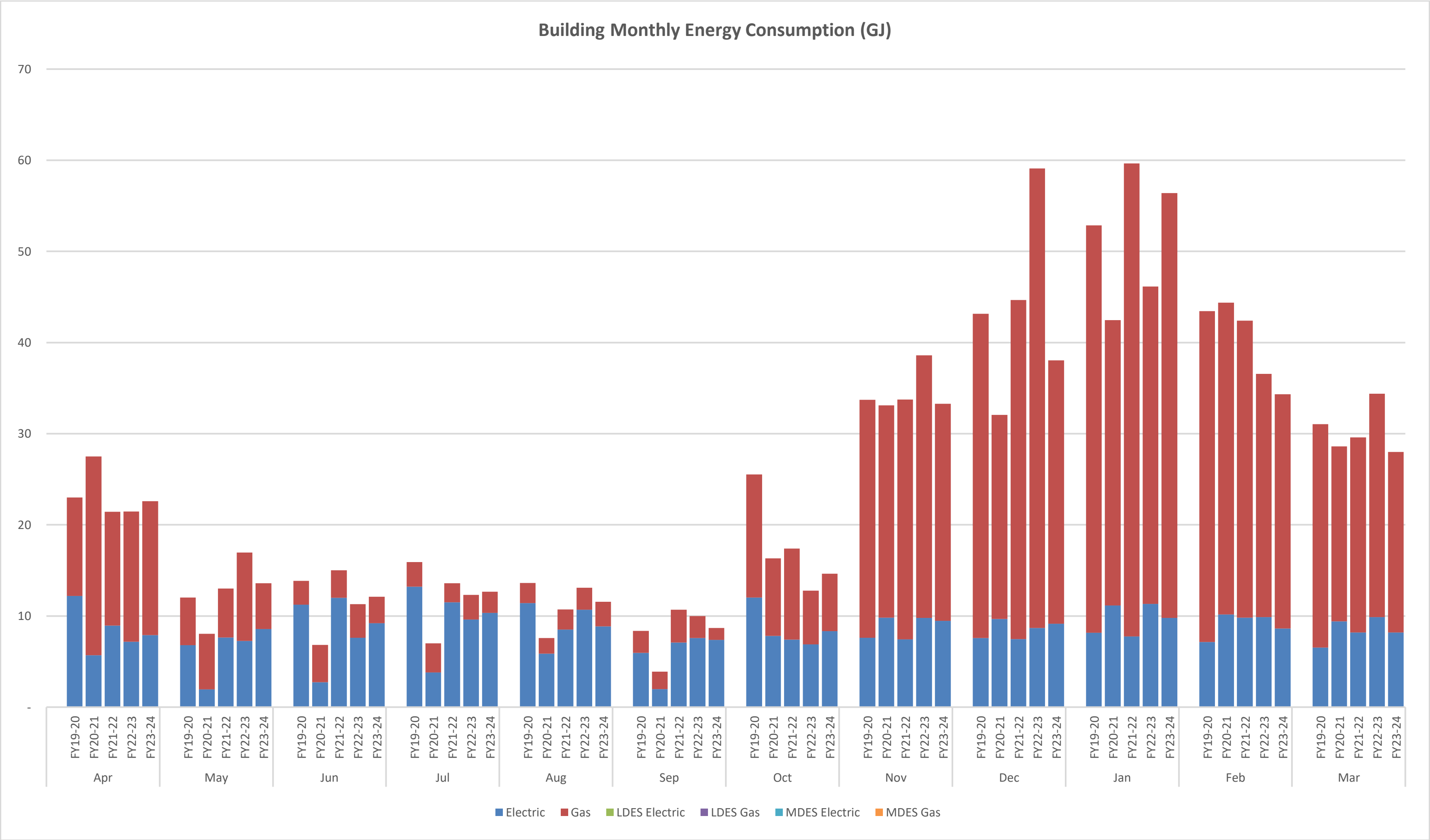
7.8 Daycare building (ACAD)



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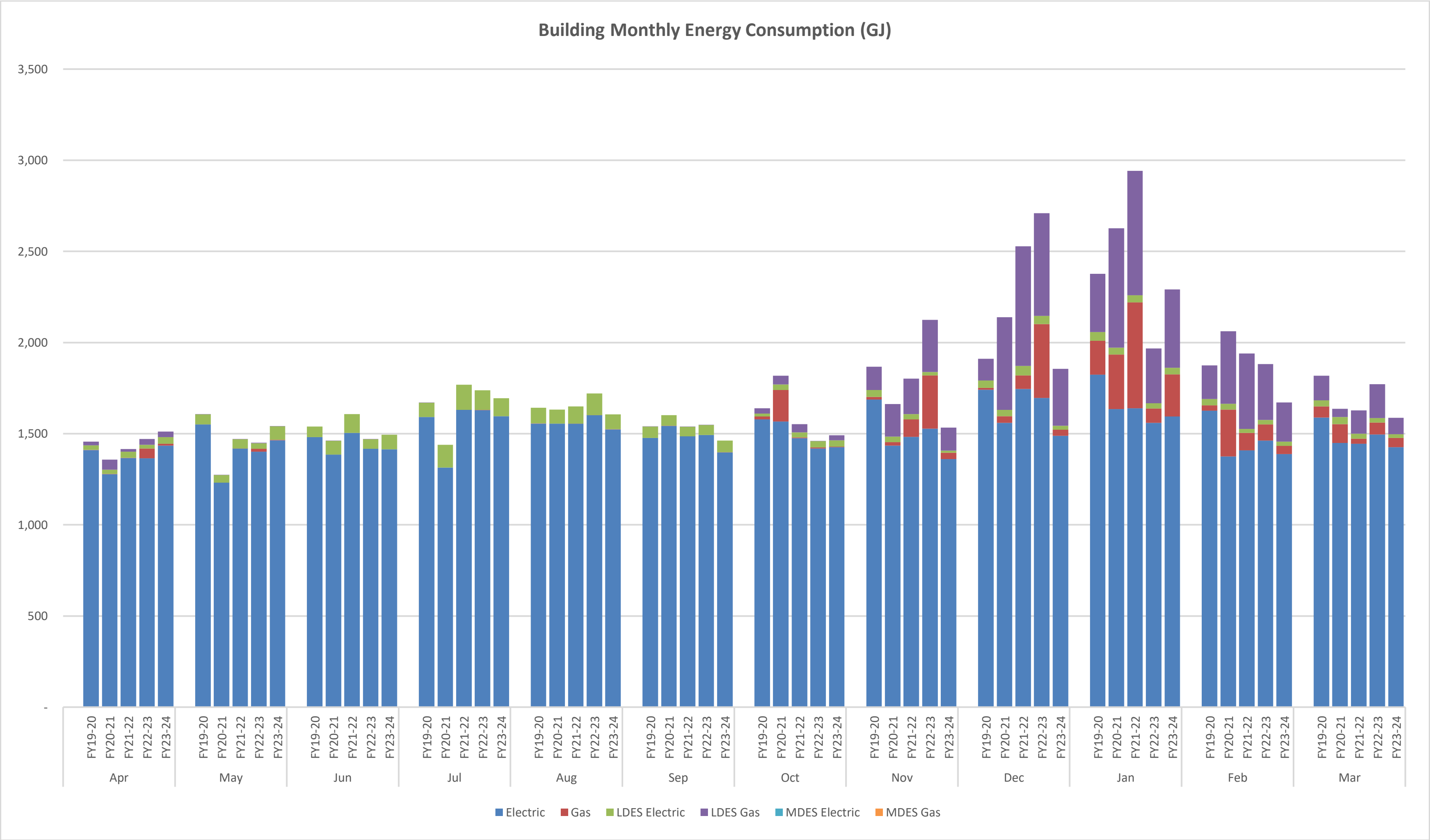
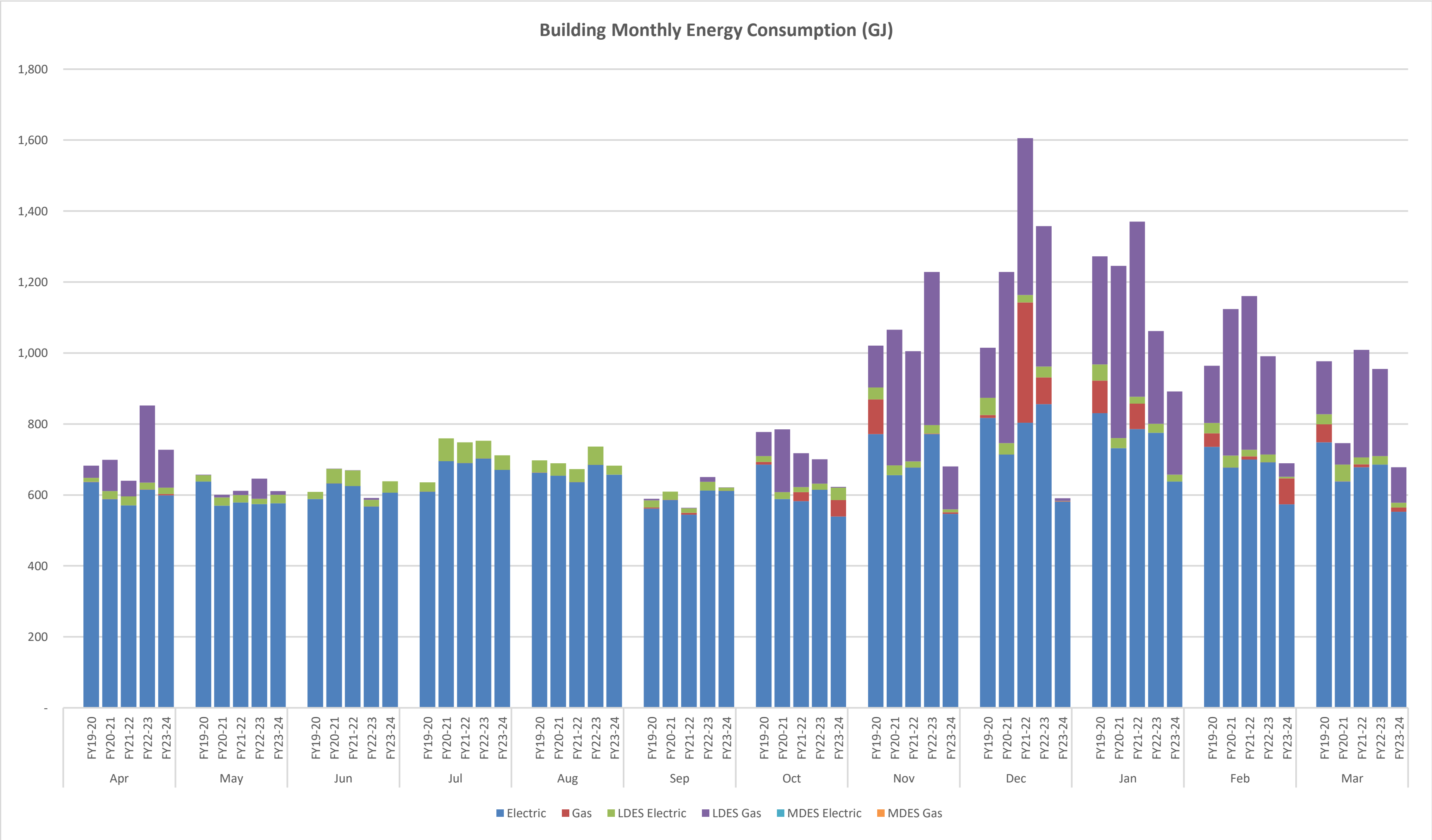
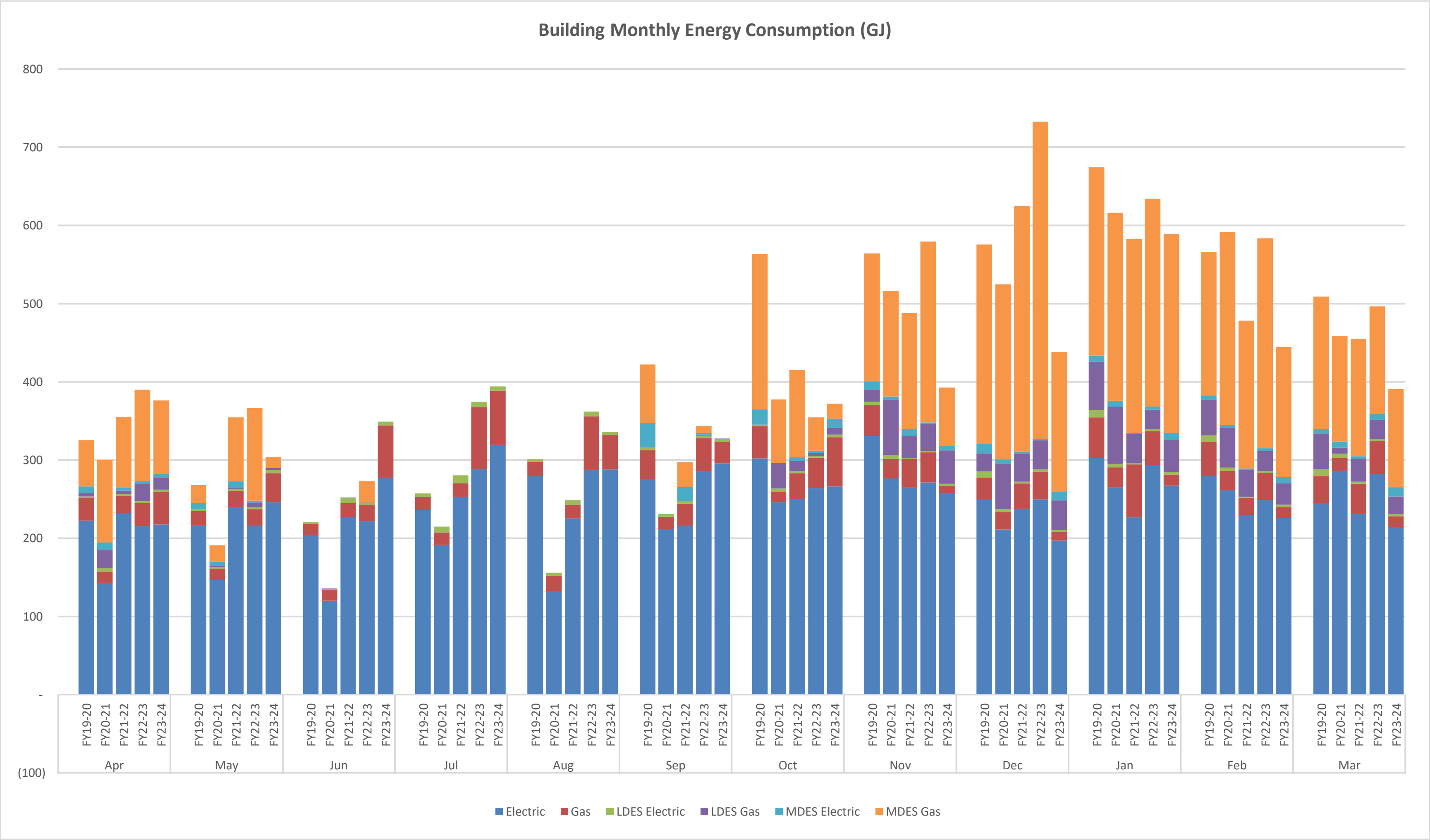
7.9 Engineering, Management and Education building (ACAD)



7.10 Fipke building (ACAD)



7.11 Gymnasium building (ACAD)



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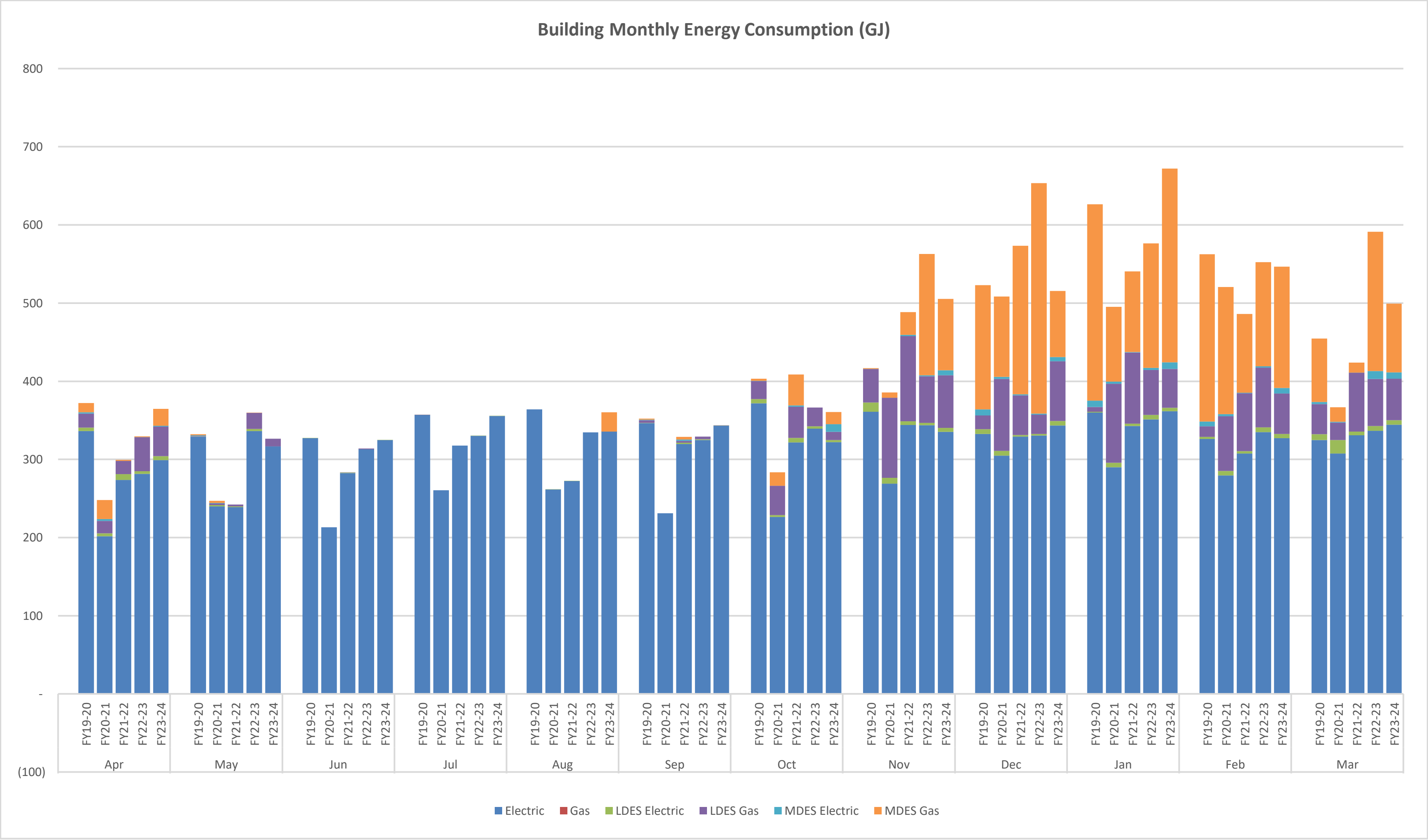
7.12 Library building (ACAD)



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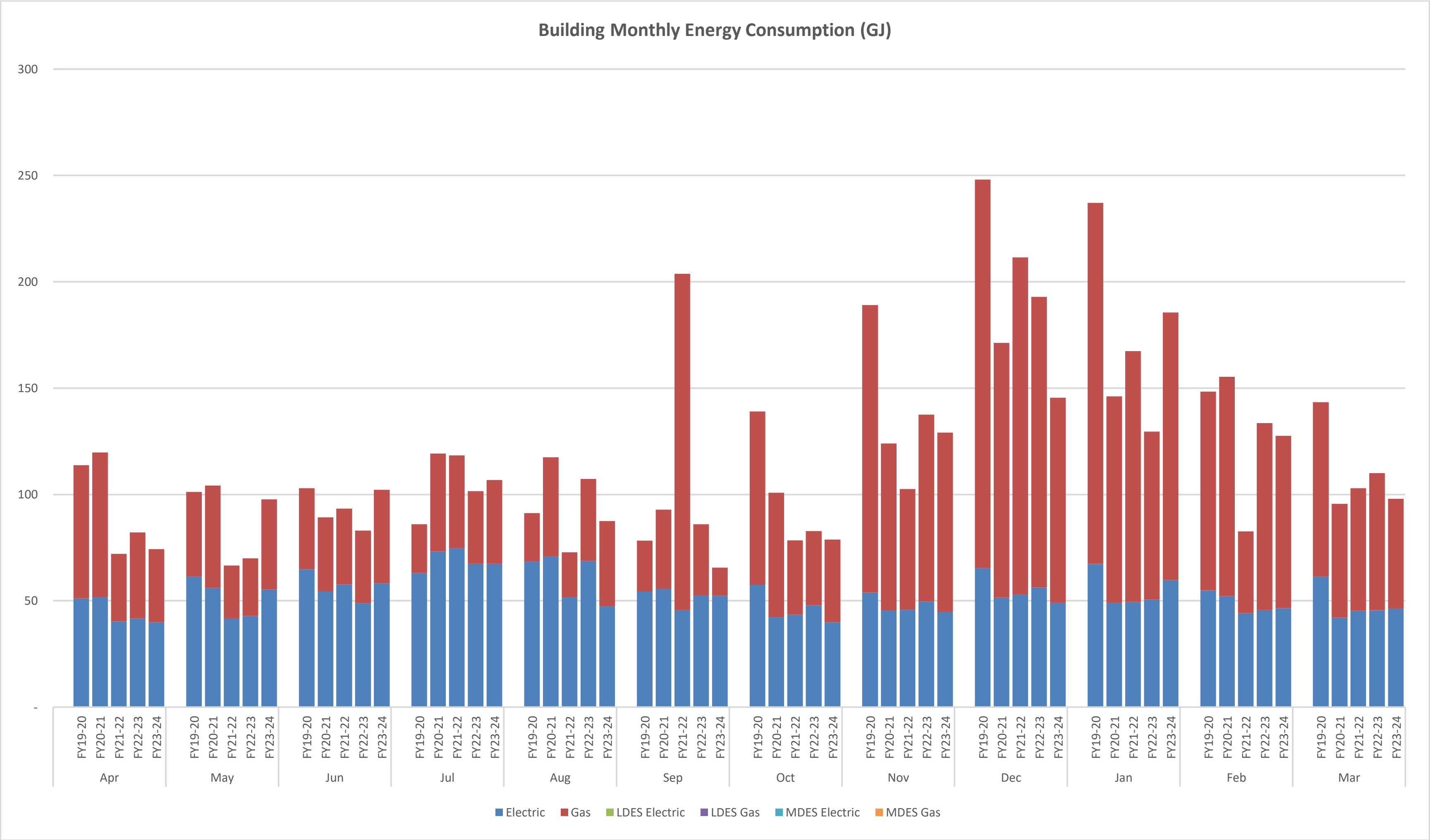
7.13 Upper Campus Health building formerly known as Mountain Weather Office (ACAD)



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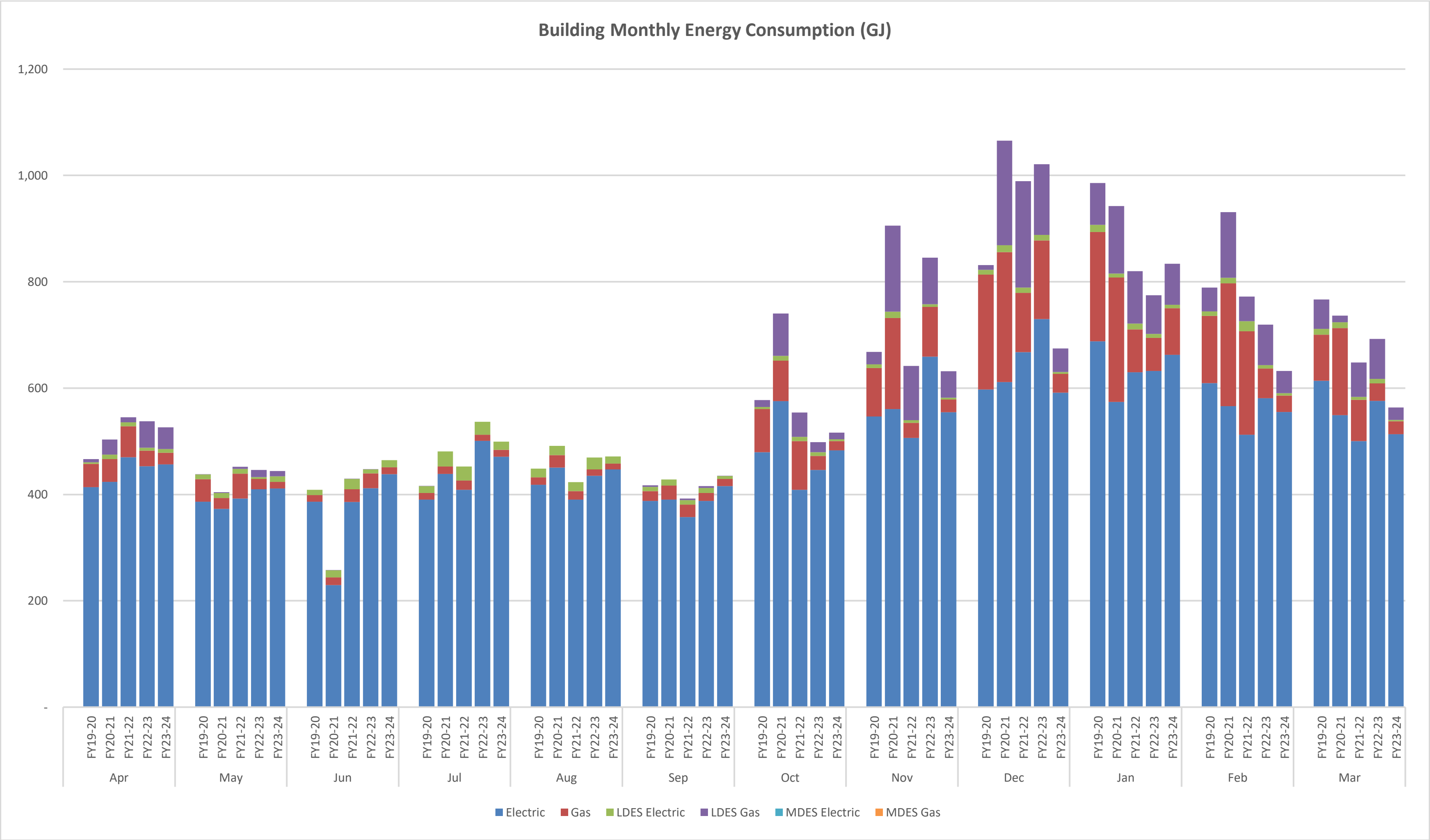
7.14 Reichwald Health Sciences Centre building (ACAD)



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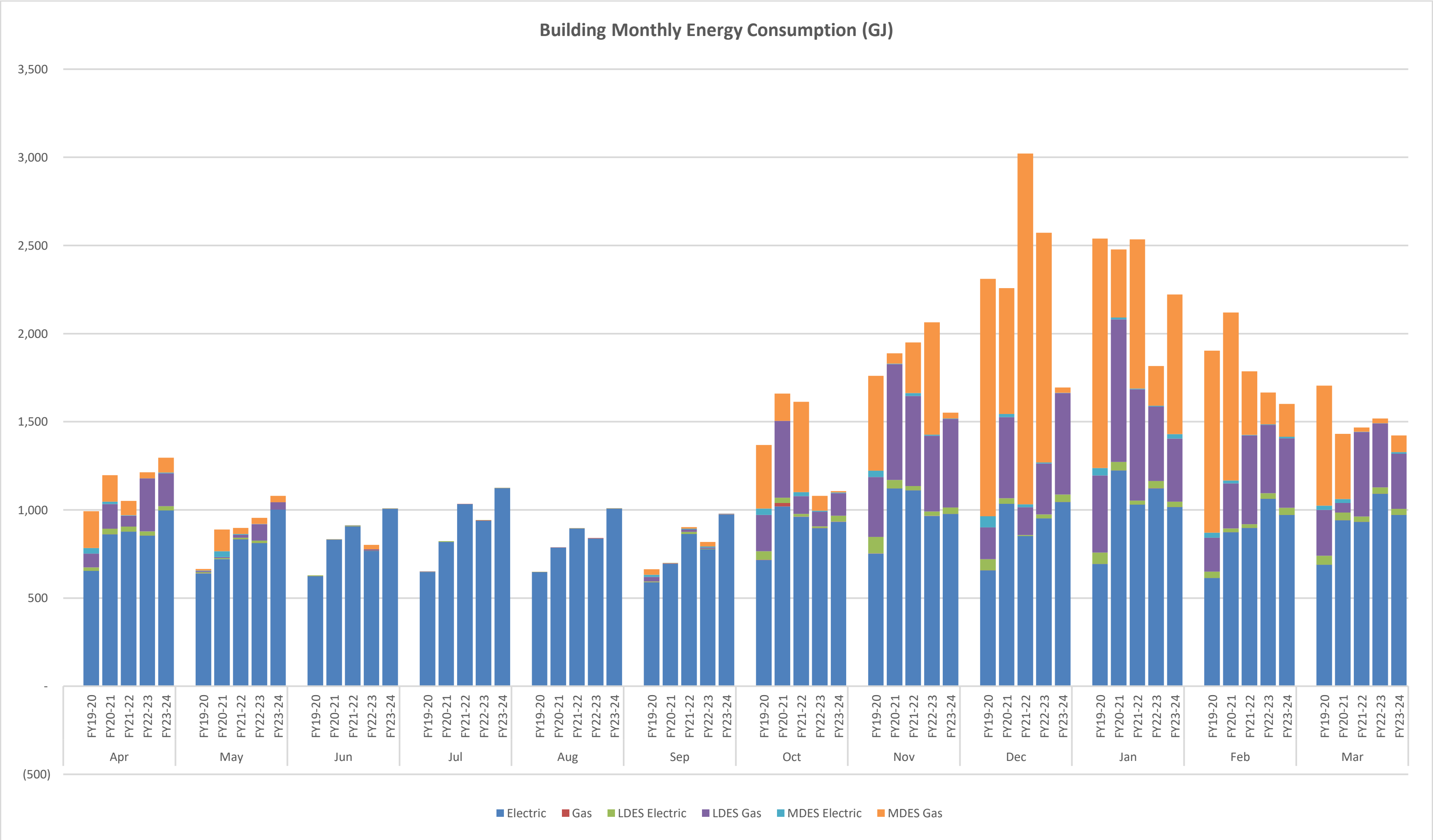
7.15 Science building (ACAD)



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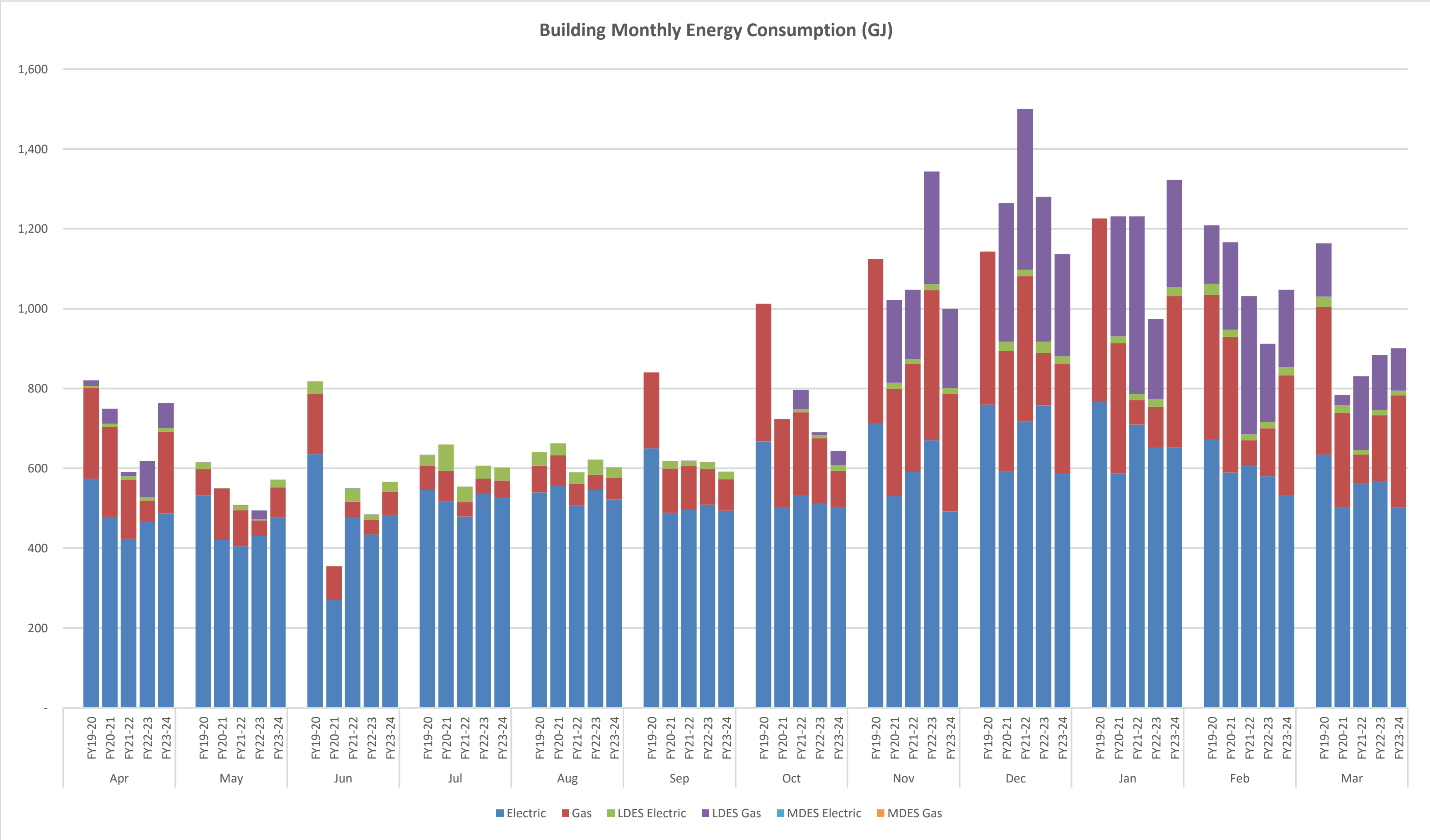
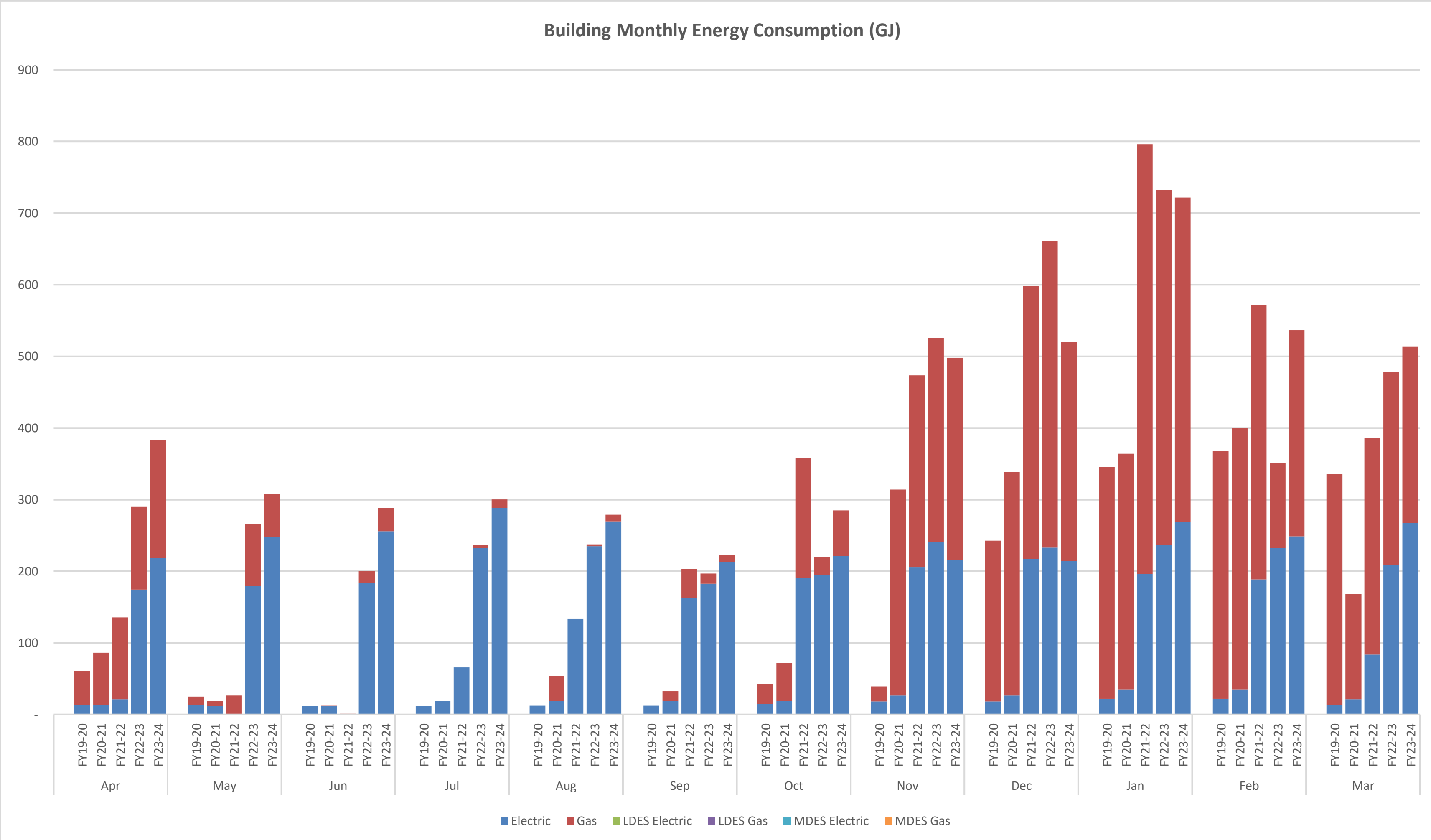
7.16 University Centre building (ACAD)



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



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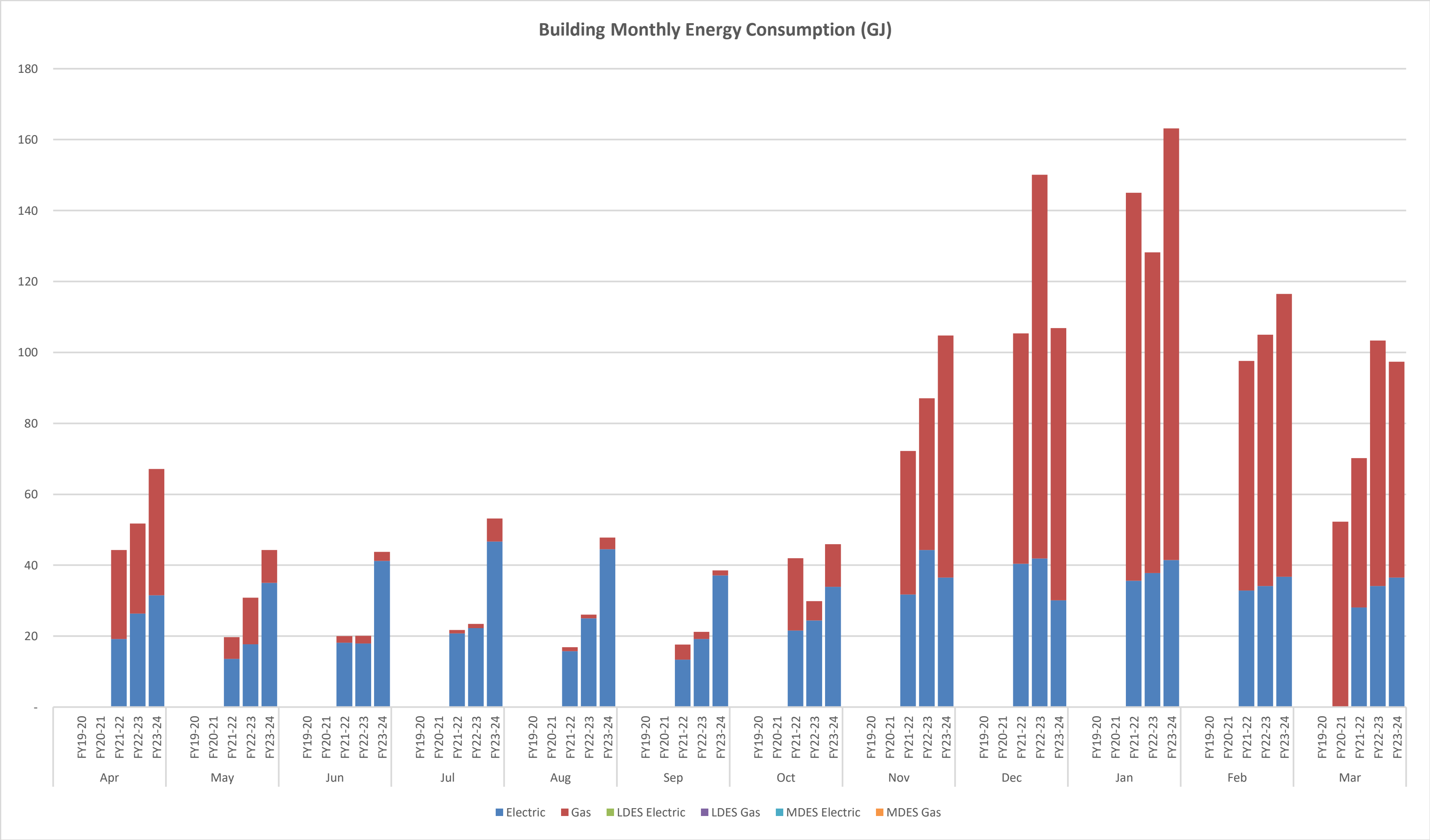
7.18 Innovation Annex building (ACAD)



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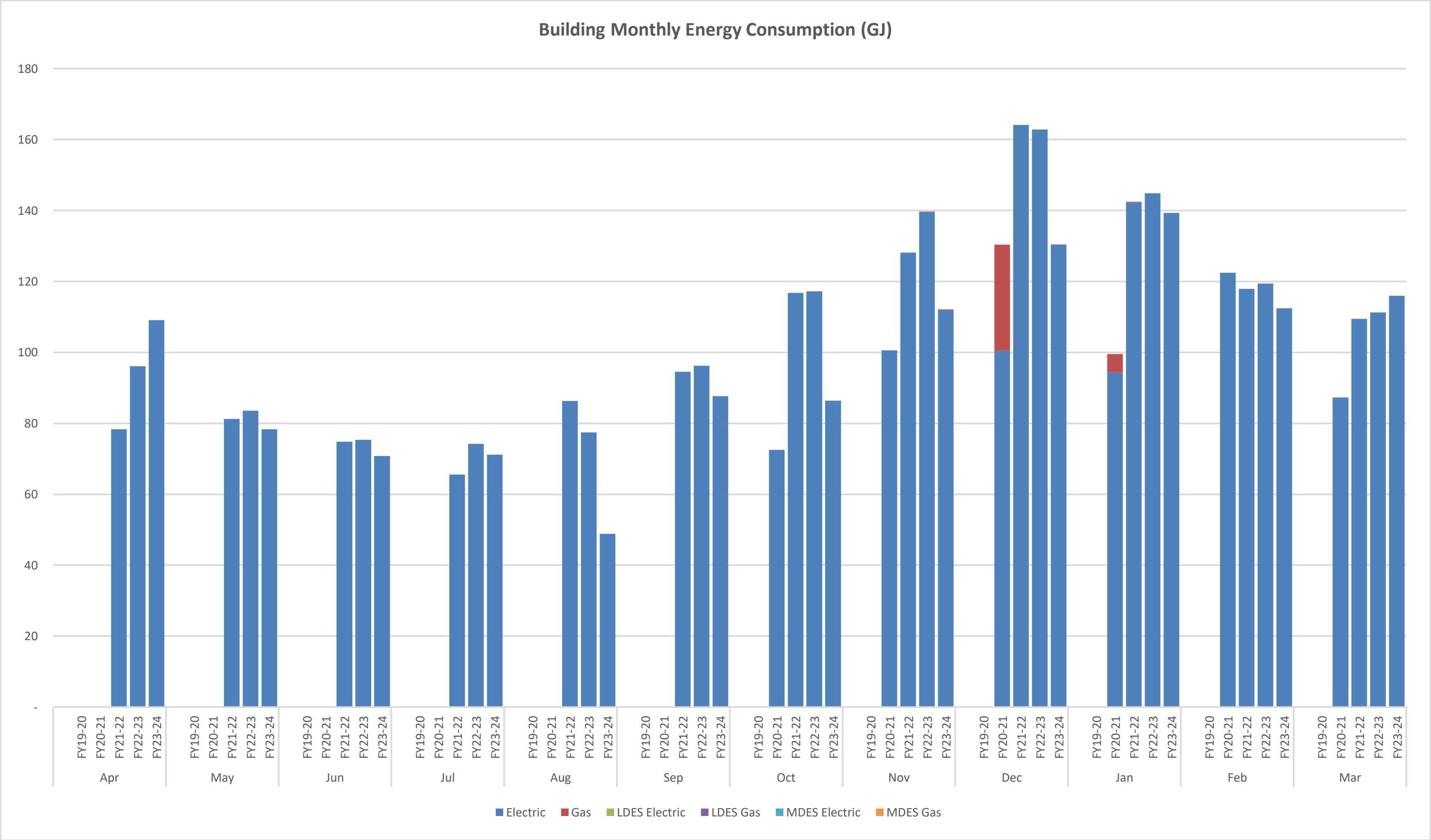
7.19 Plant Growth Facility building (ACAD)



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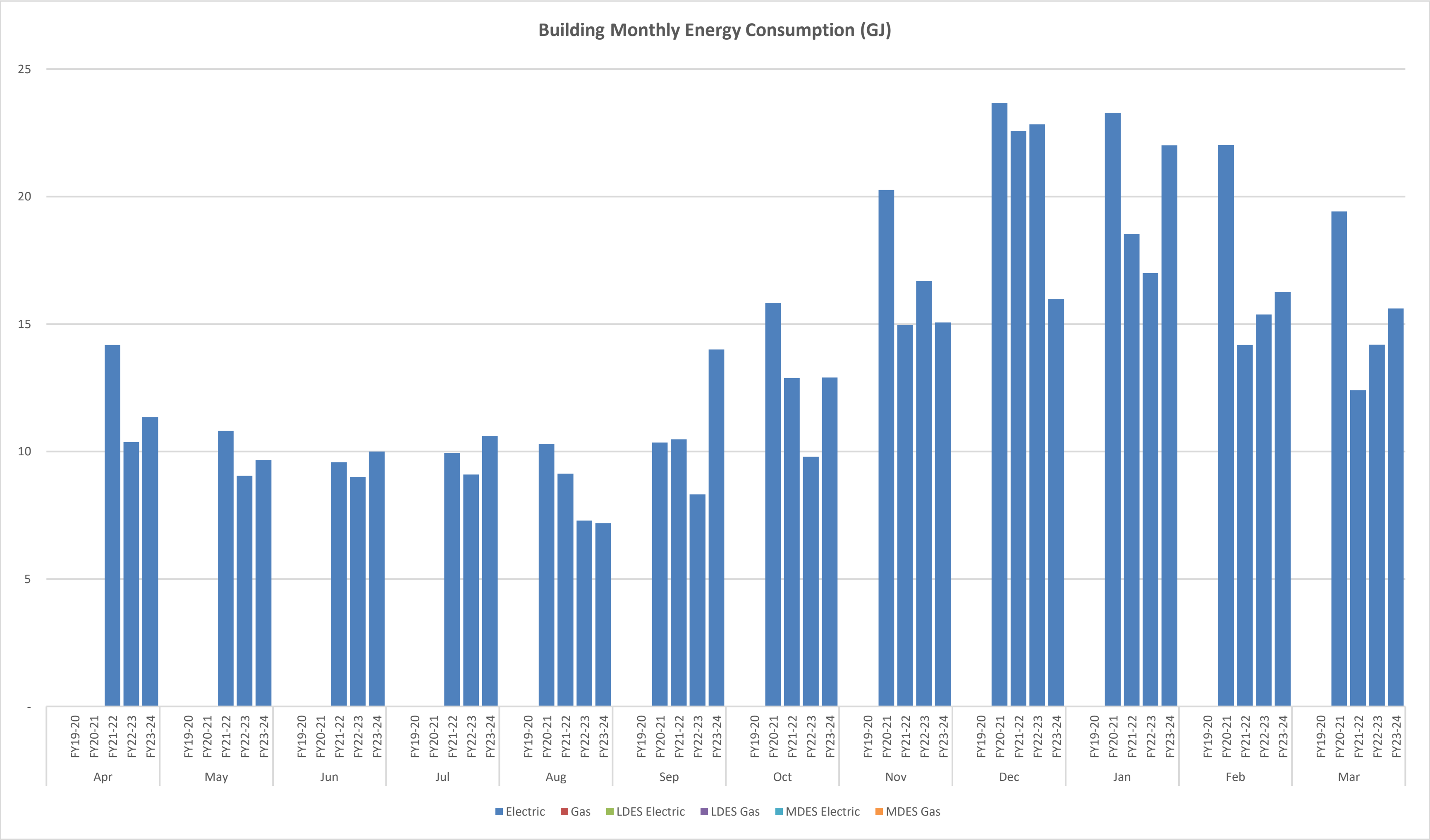
7.20 EDL building (ACAD)



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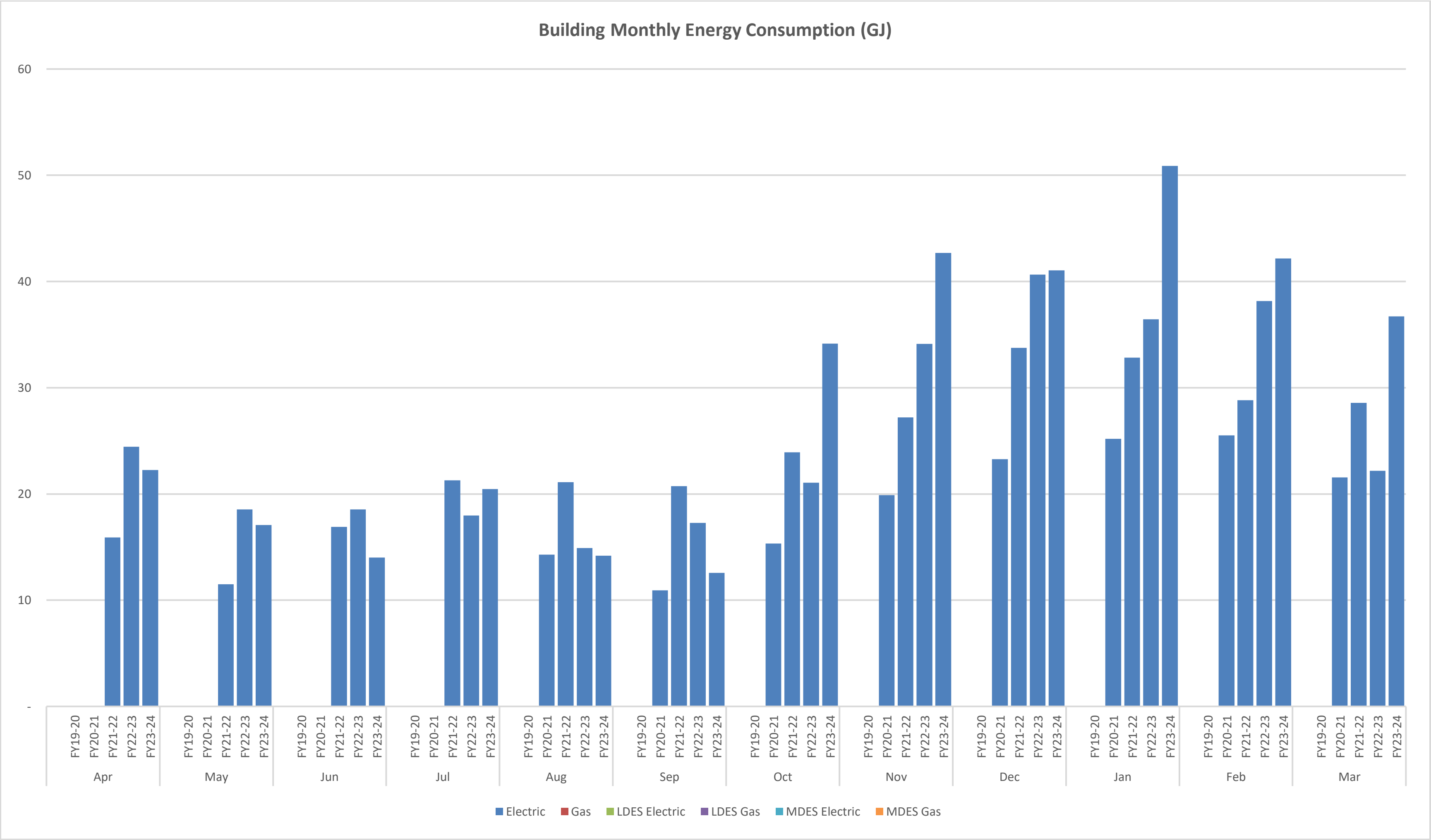
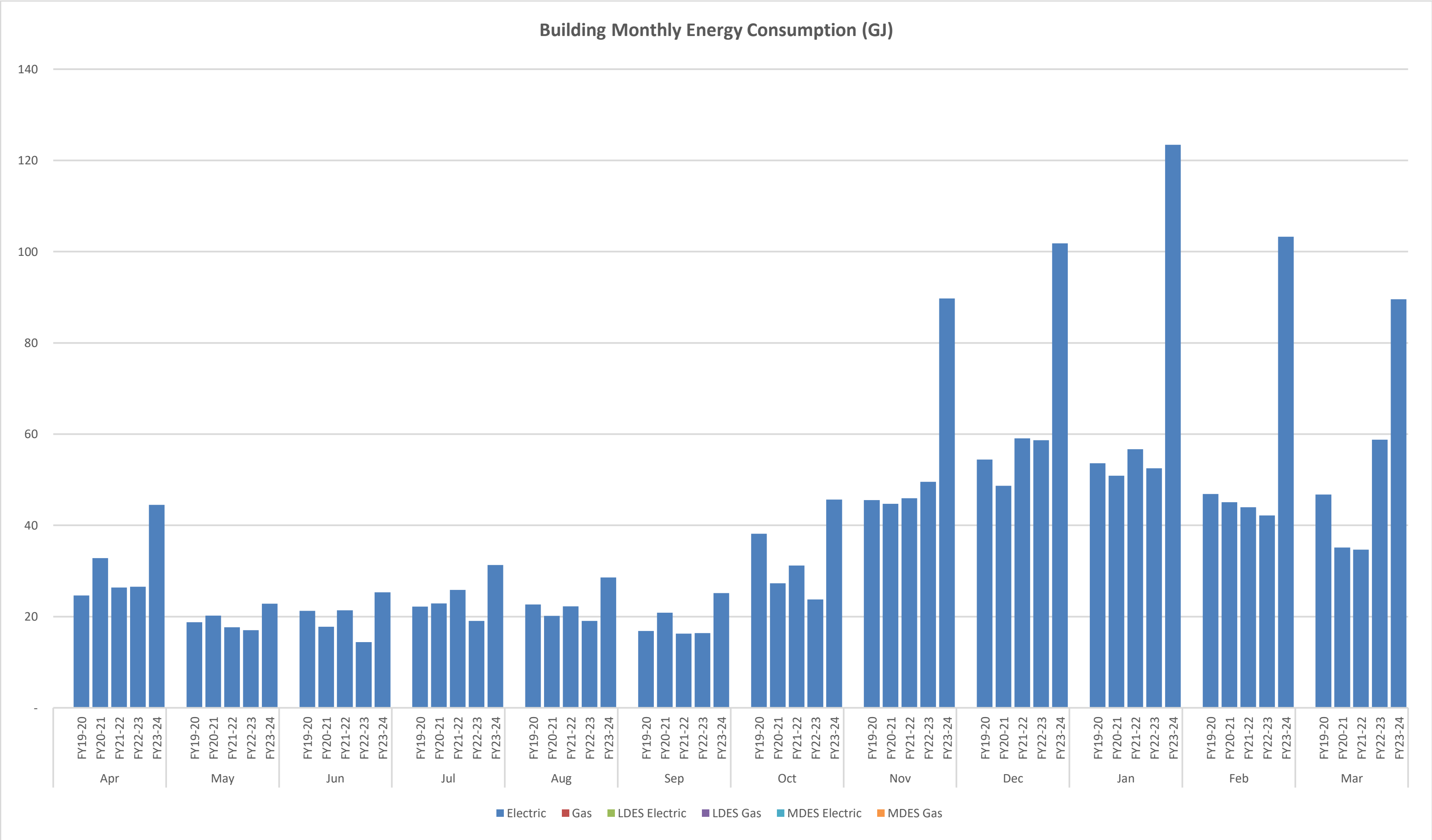
7.21 OM1 building (ACAD)



7.22 Quonset building (ACAD)



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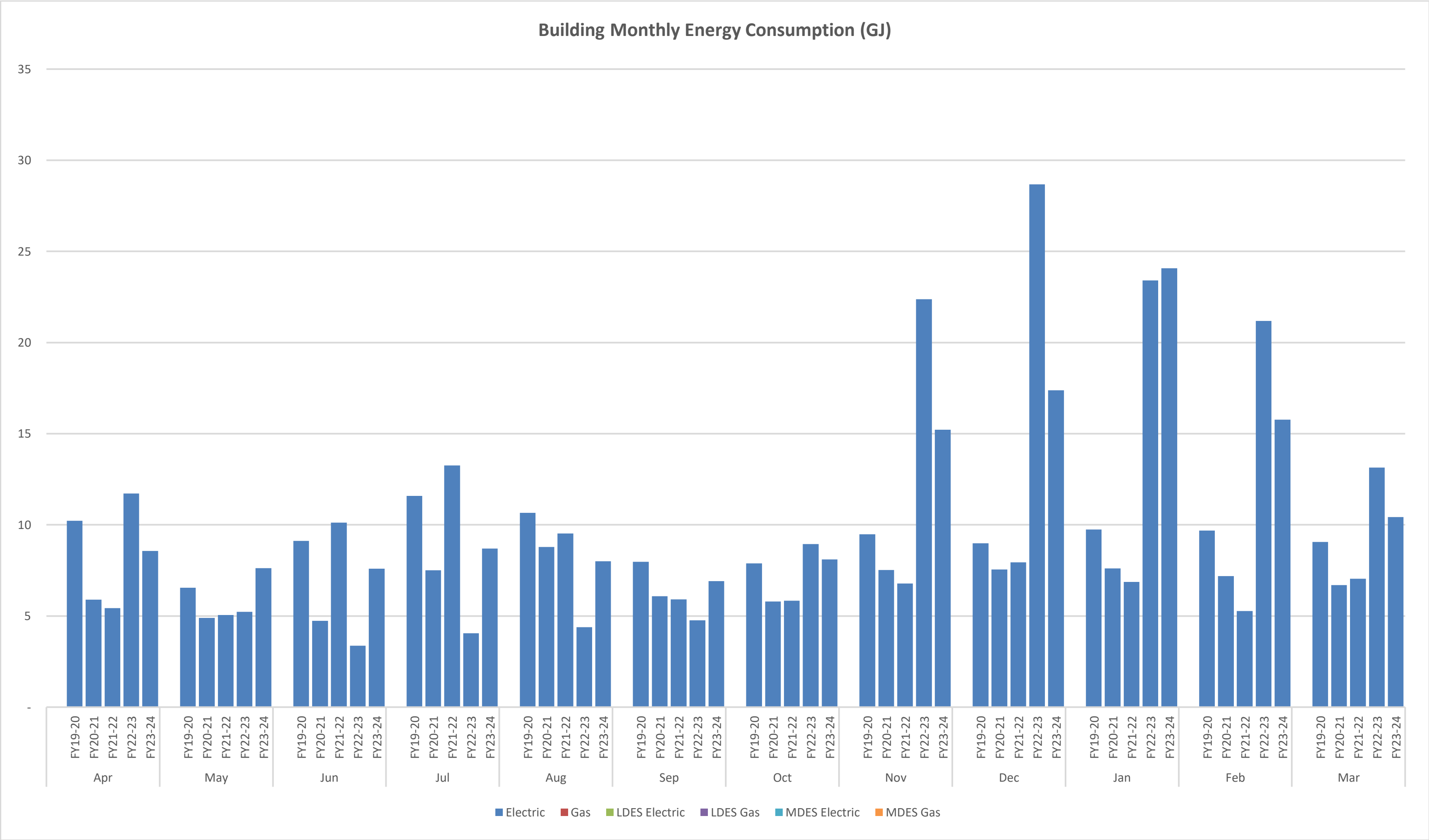
7.23 University House building (ACAD)



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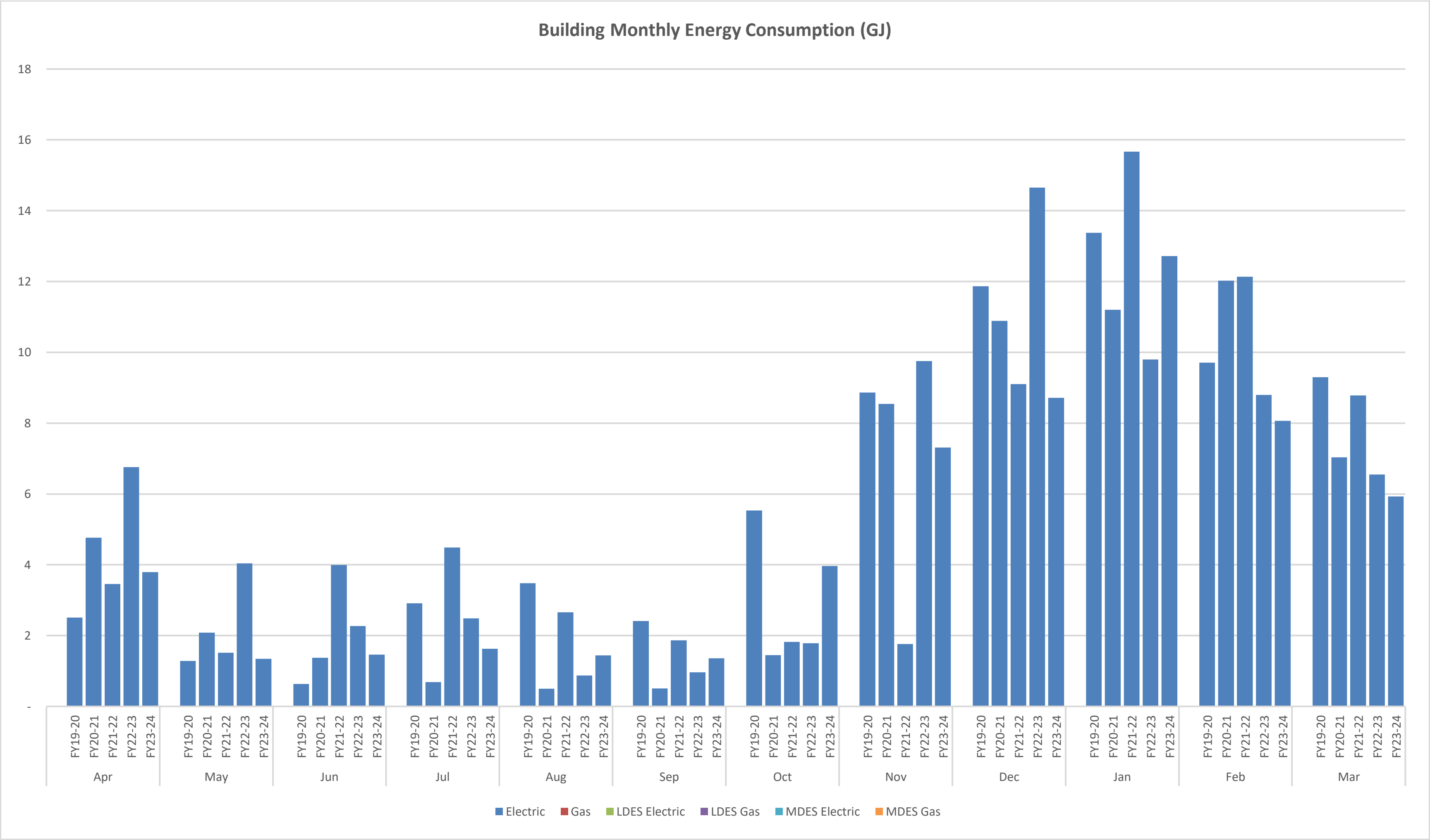
7.24 Portable A building (ACAD)



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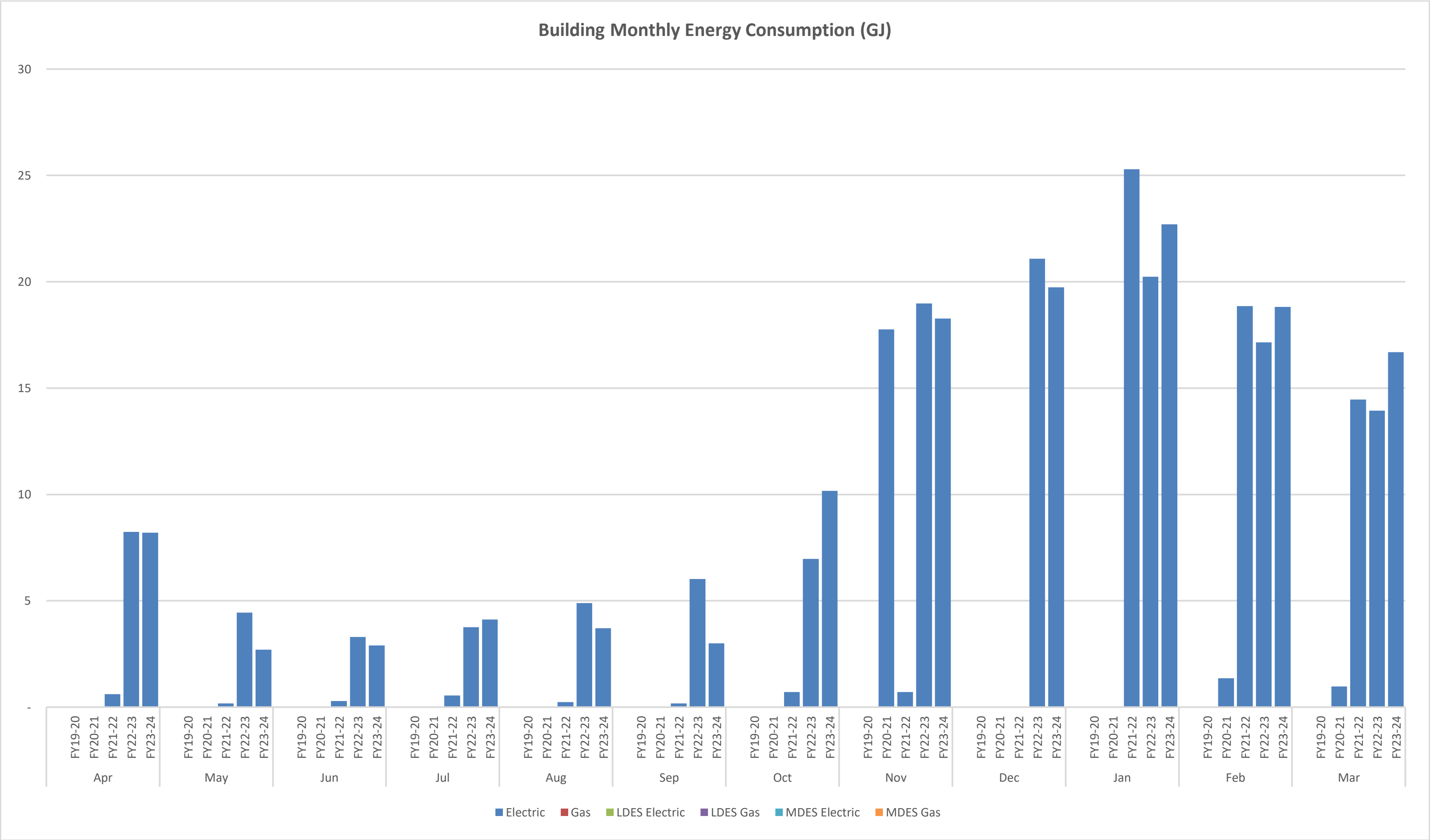
7.25 Portable N building (ACAD)



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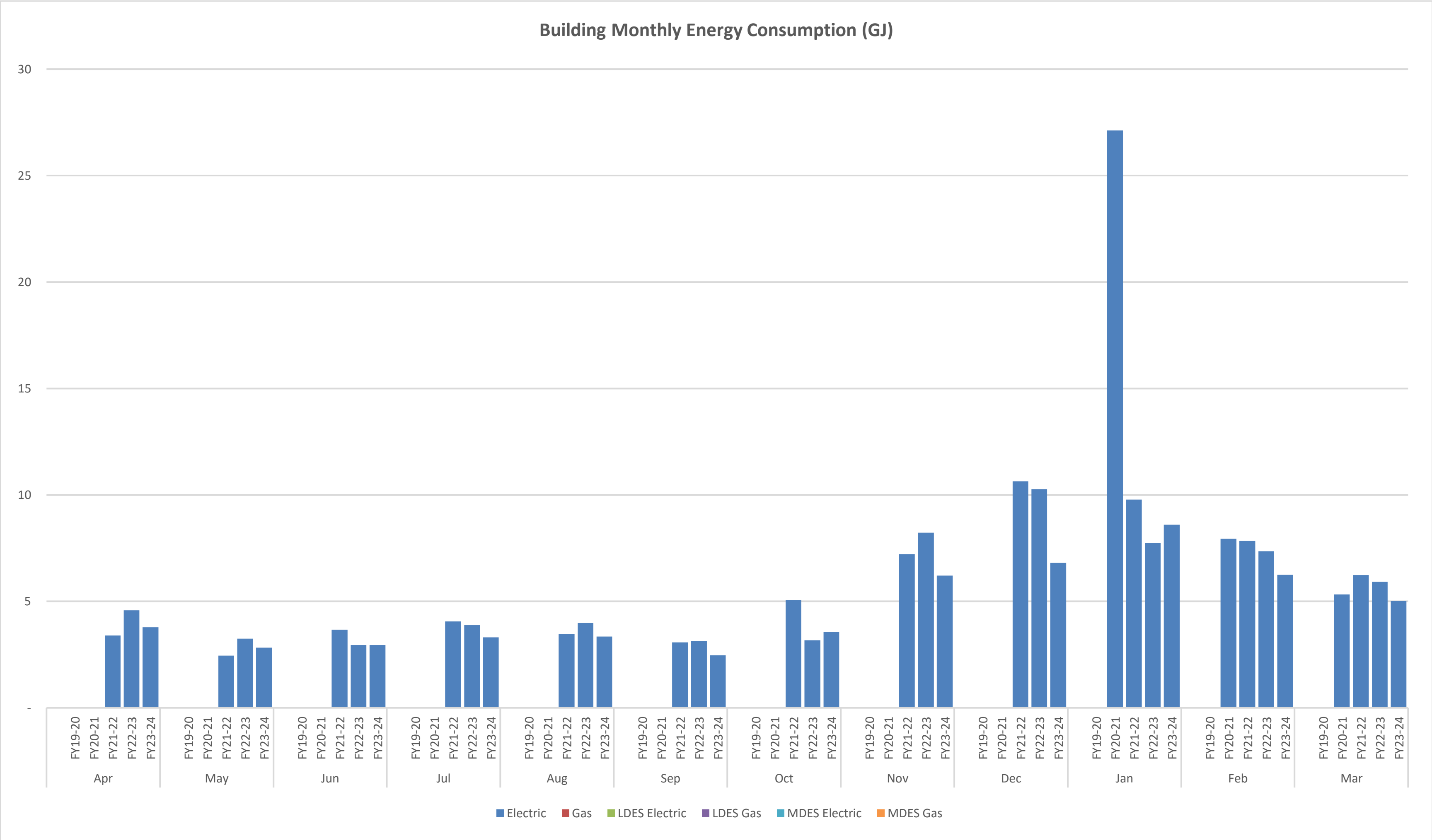
7.26 Portable V building (ACAD)



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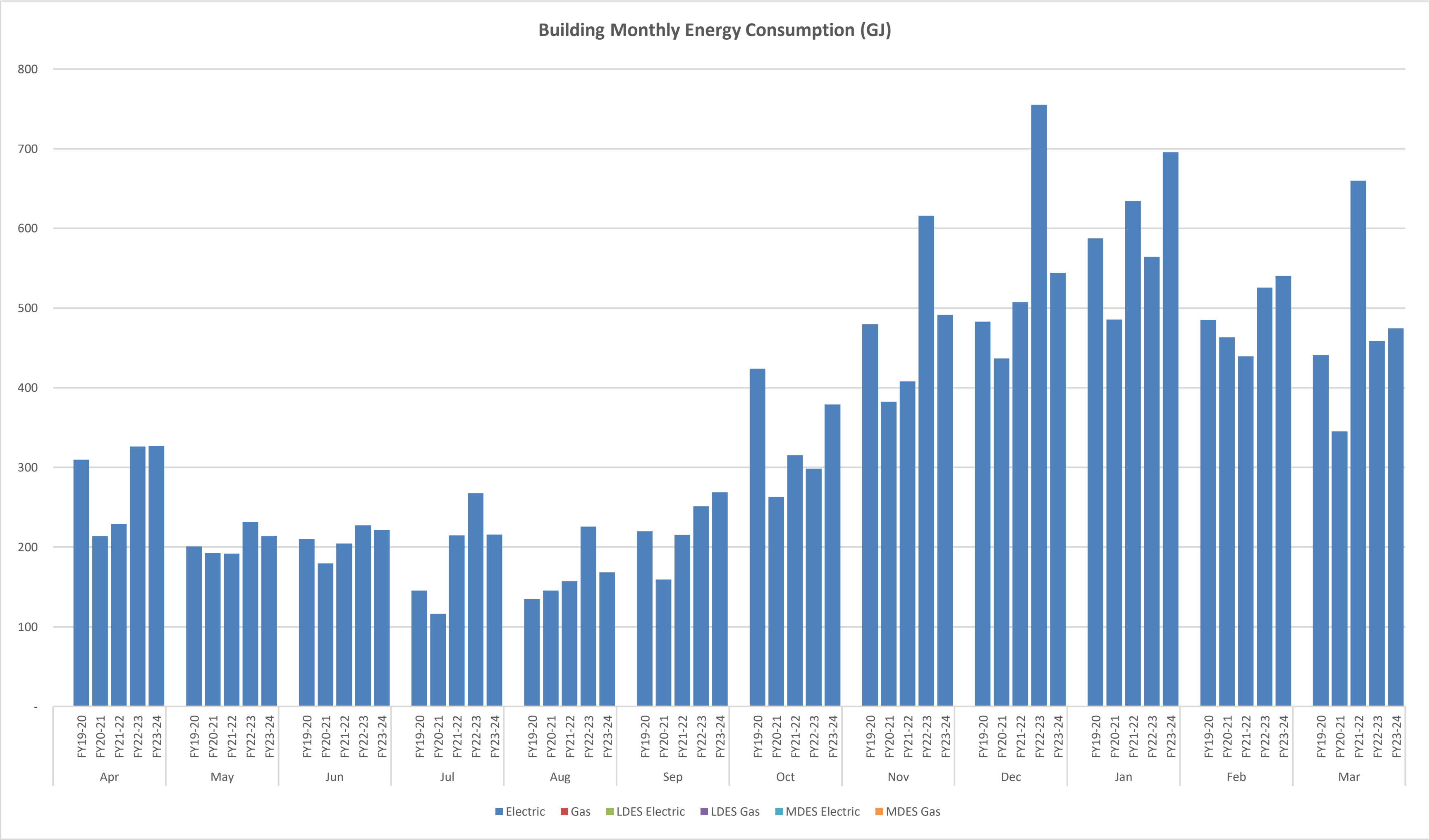
7.27 Lower Cascades Residence building



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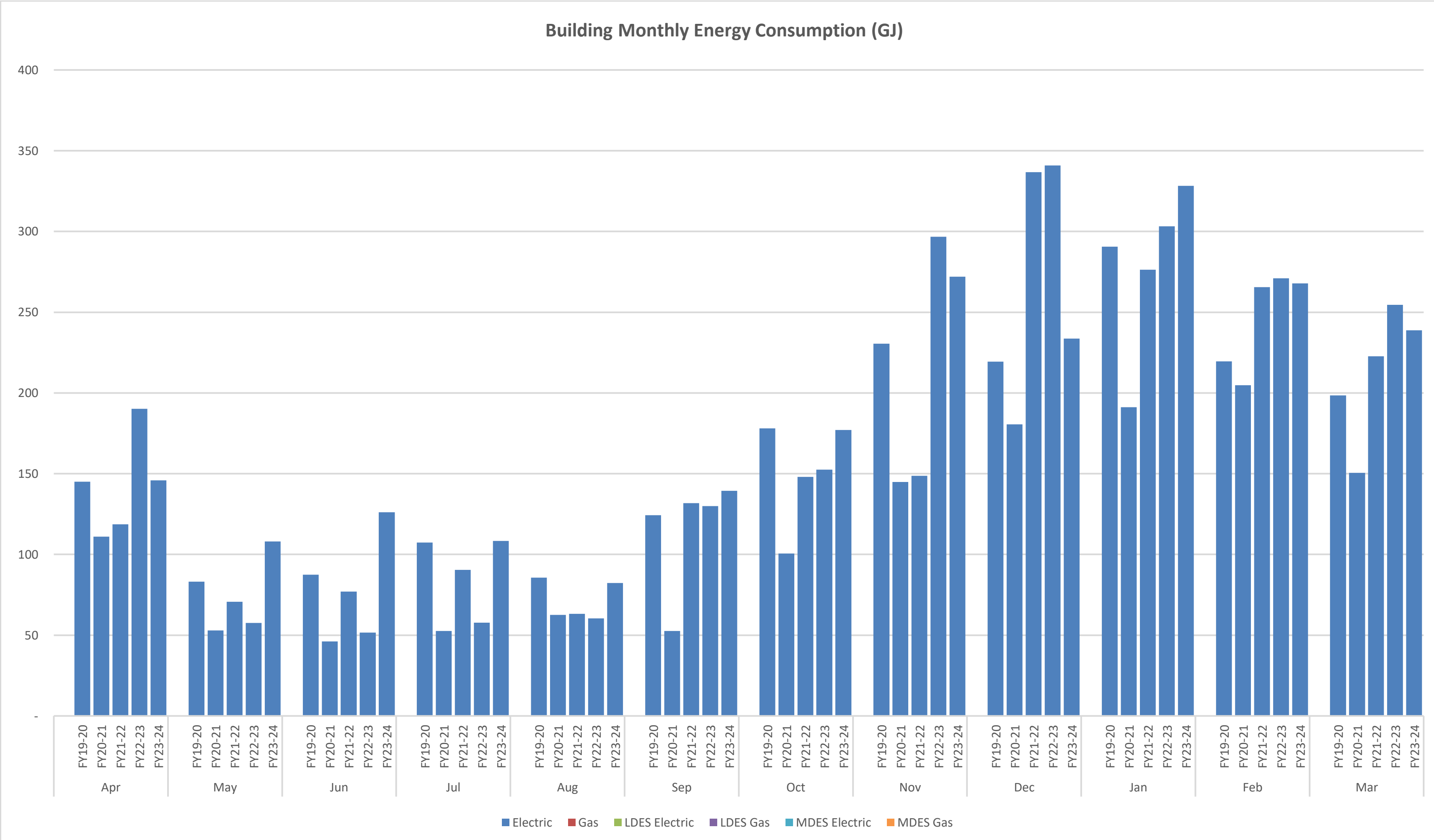
7.28 Upper Cascades Residence building



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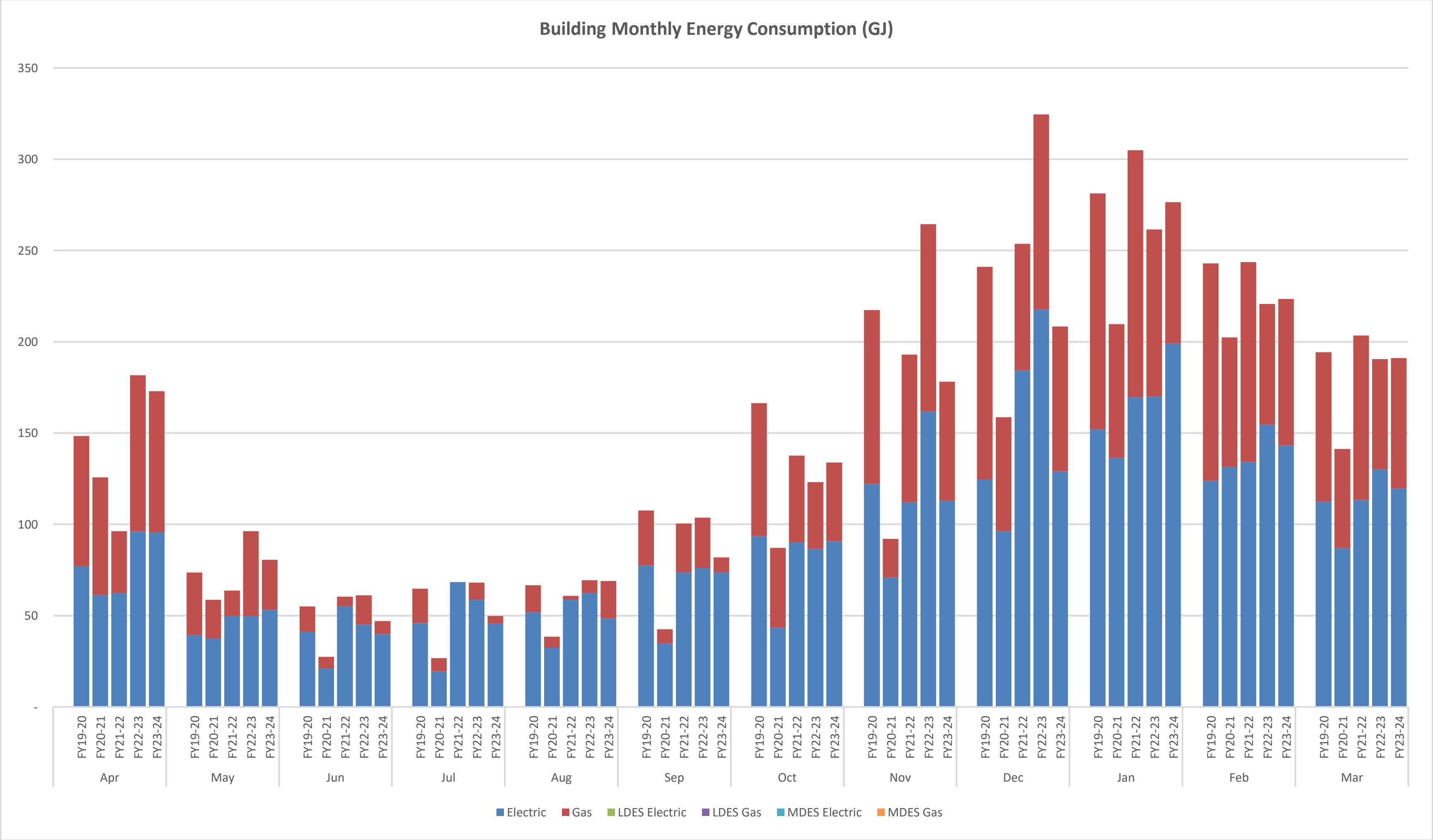
7.29 Cassiar Residence building



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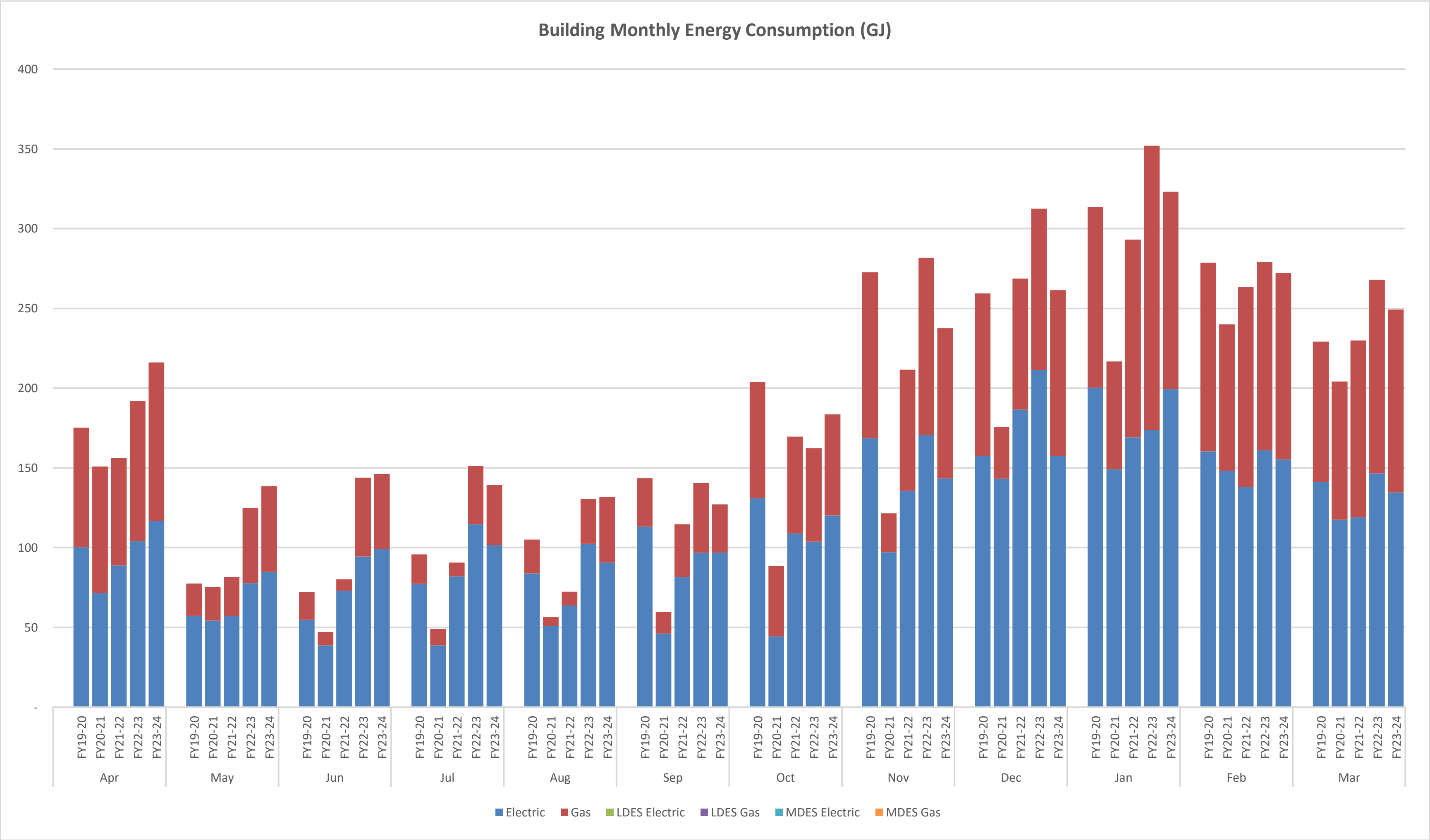
7.30 Kalamalka Residence building



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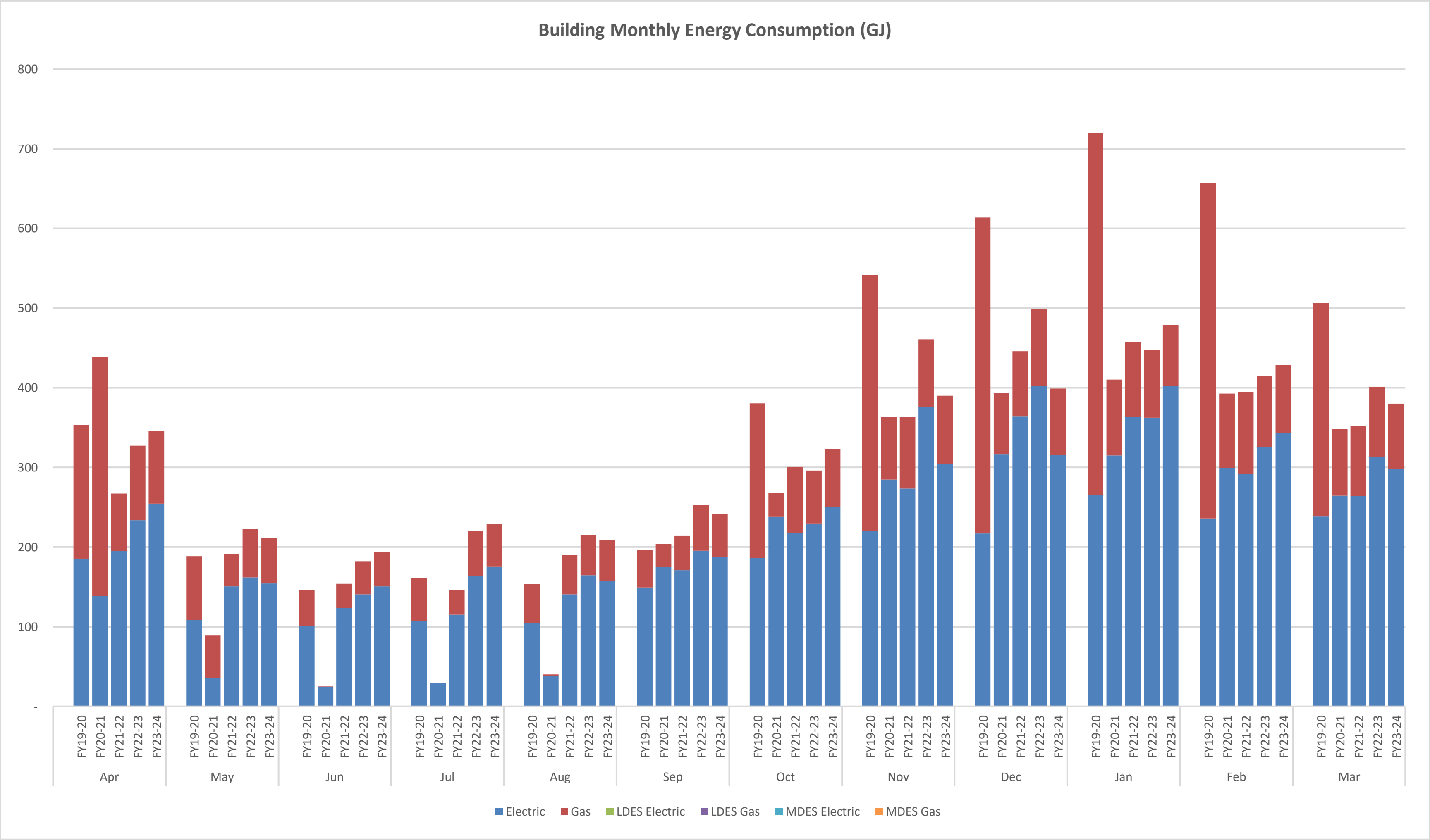
7.31 Monashee Residence building



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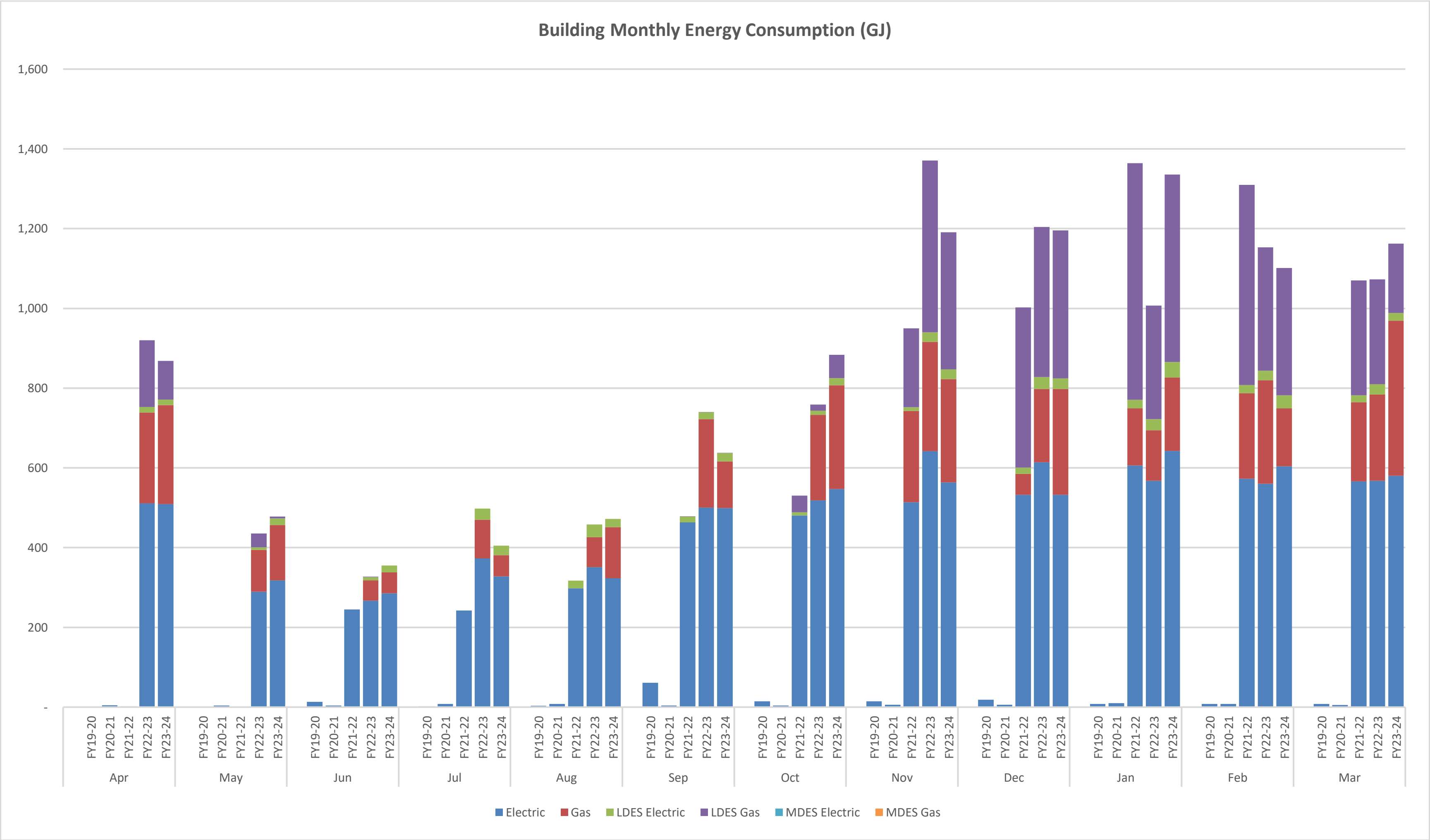
7.32 Nechako Residence building



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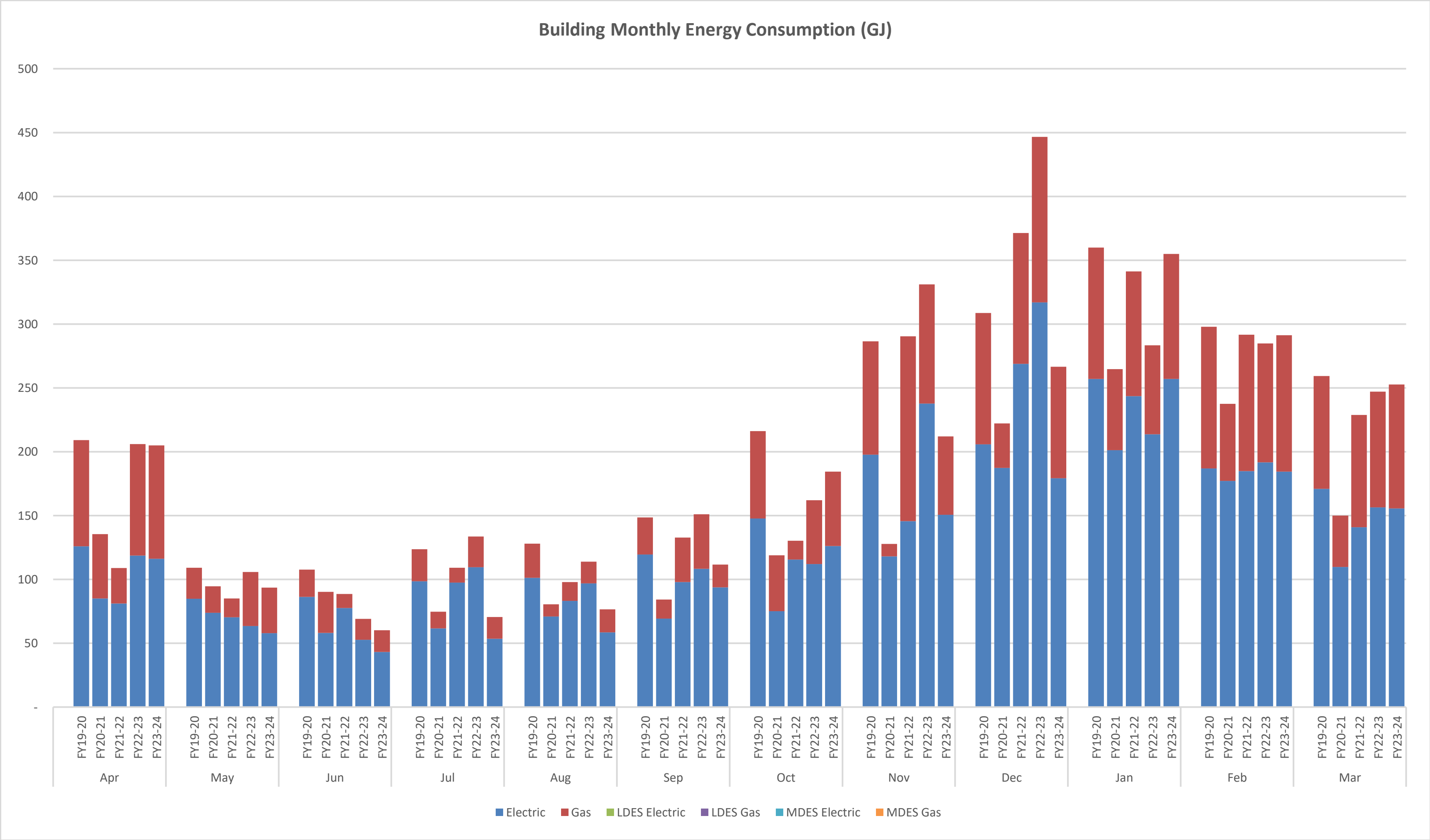
7.33 Nicola Residence building



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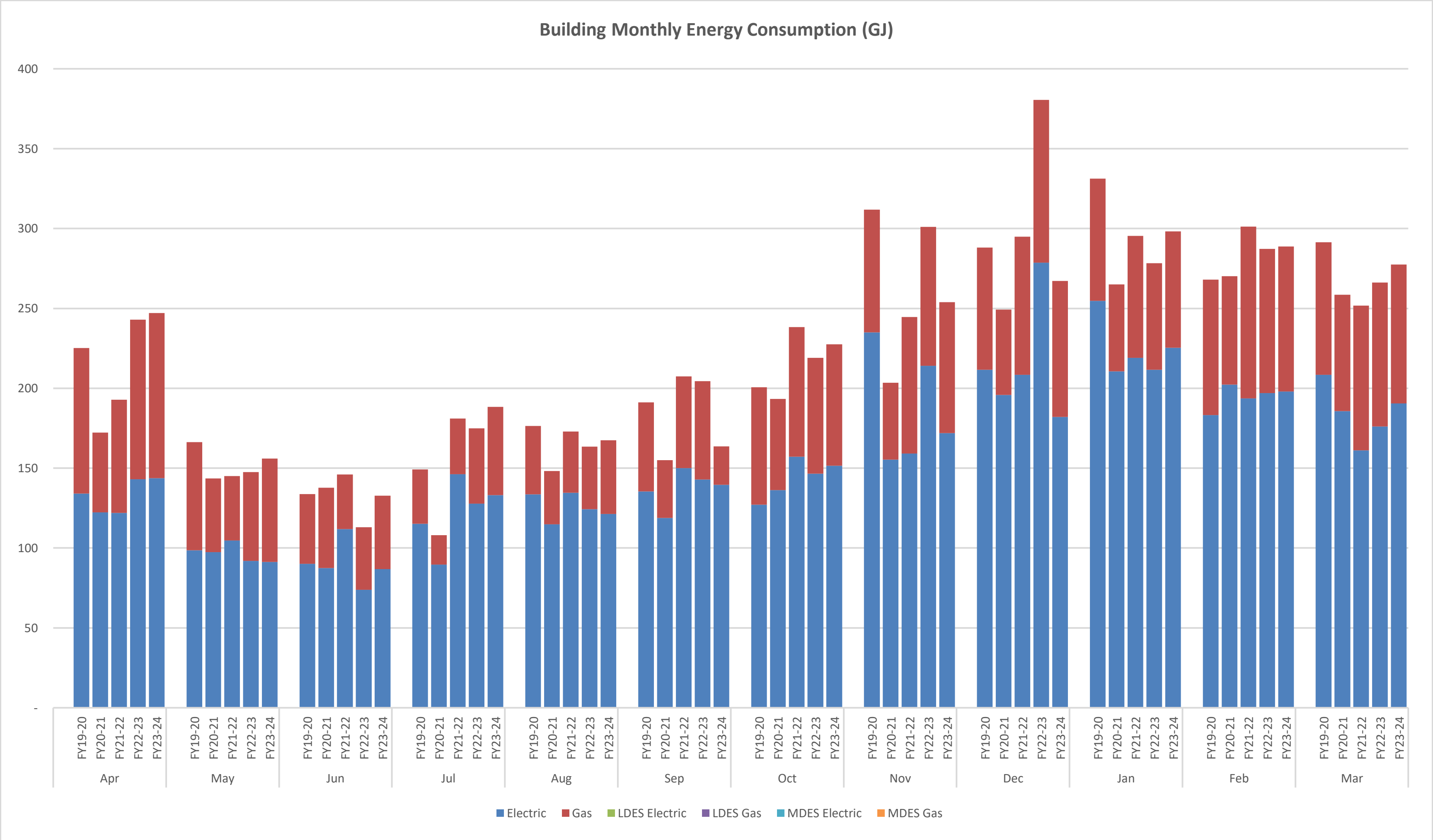
7.34 Purcell Residence building



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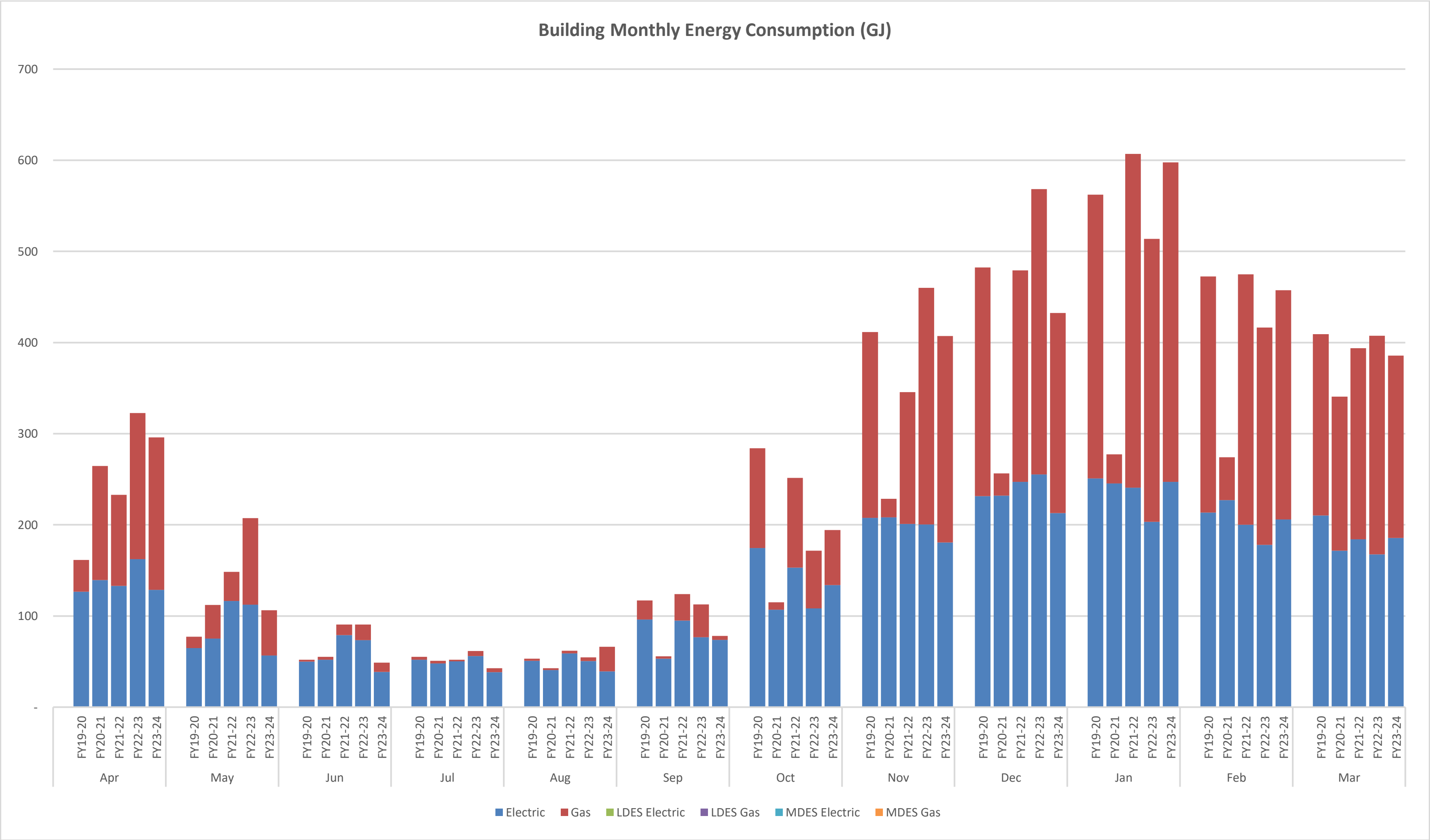
7.35 Similkameen Residence building



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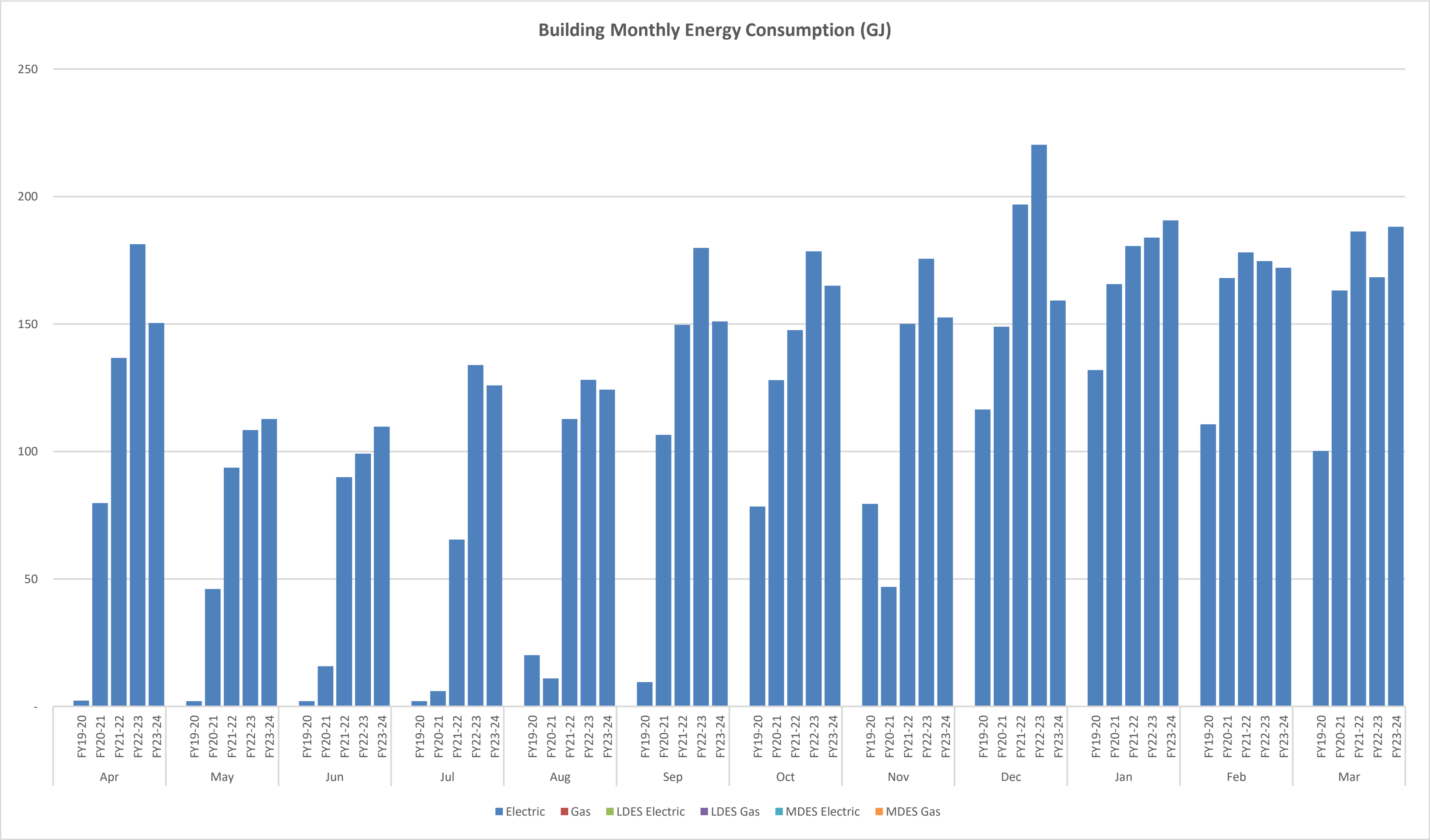
7.36 Skeena Residence building



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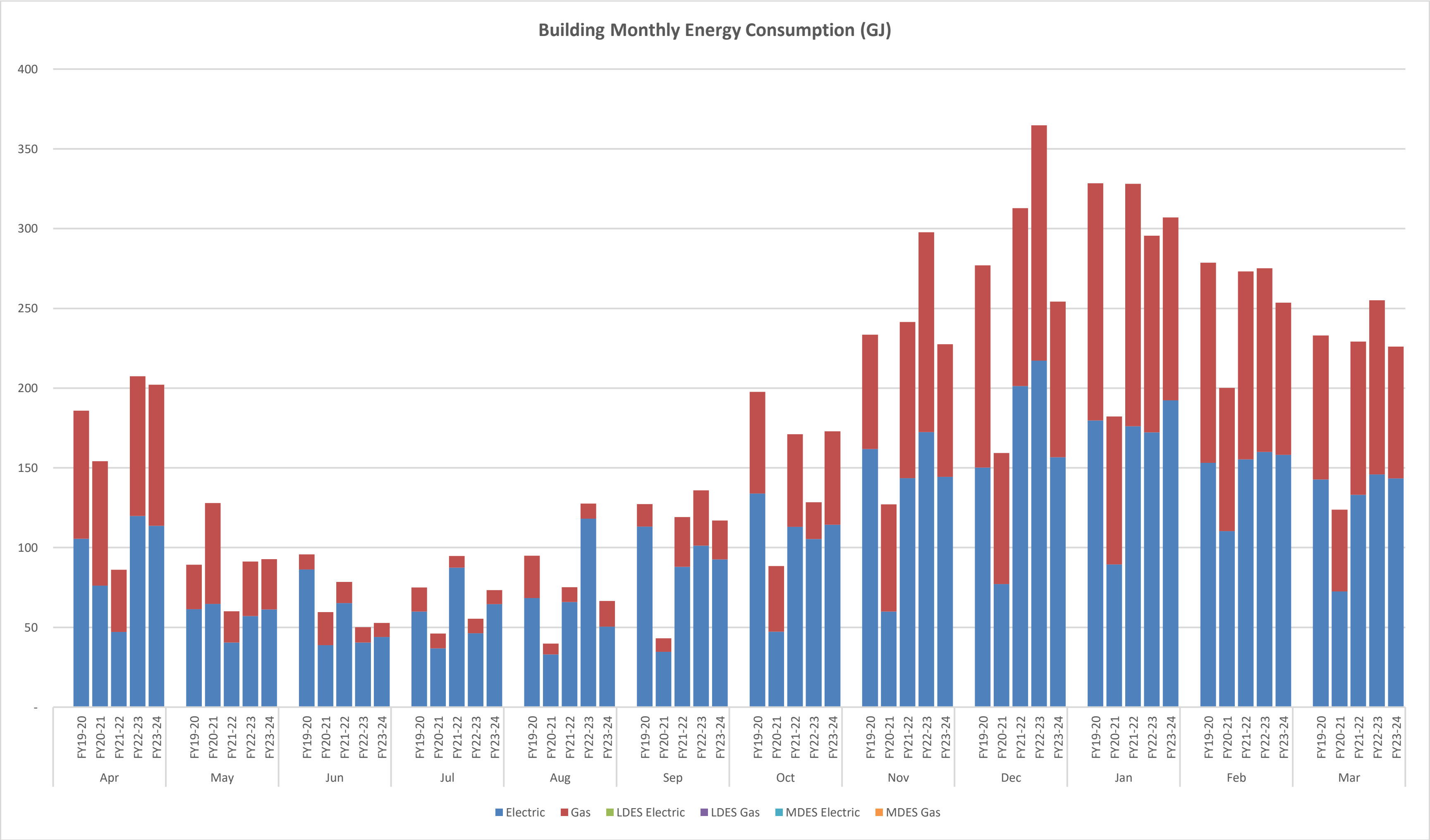
7.37 Valhalla Residence building



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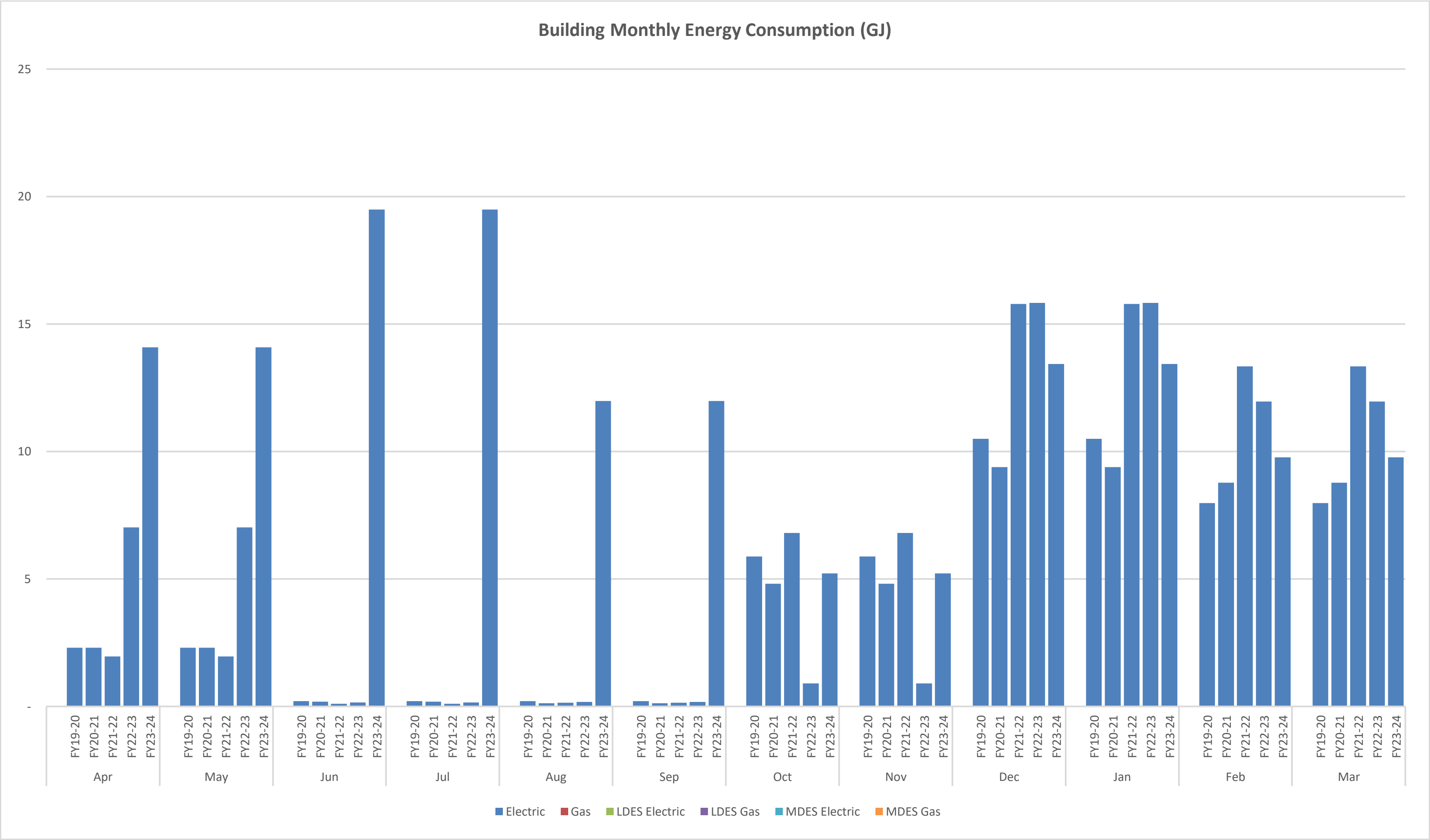
7.38 1200B Curtis building



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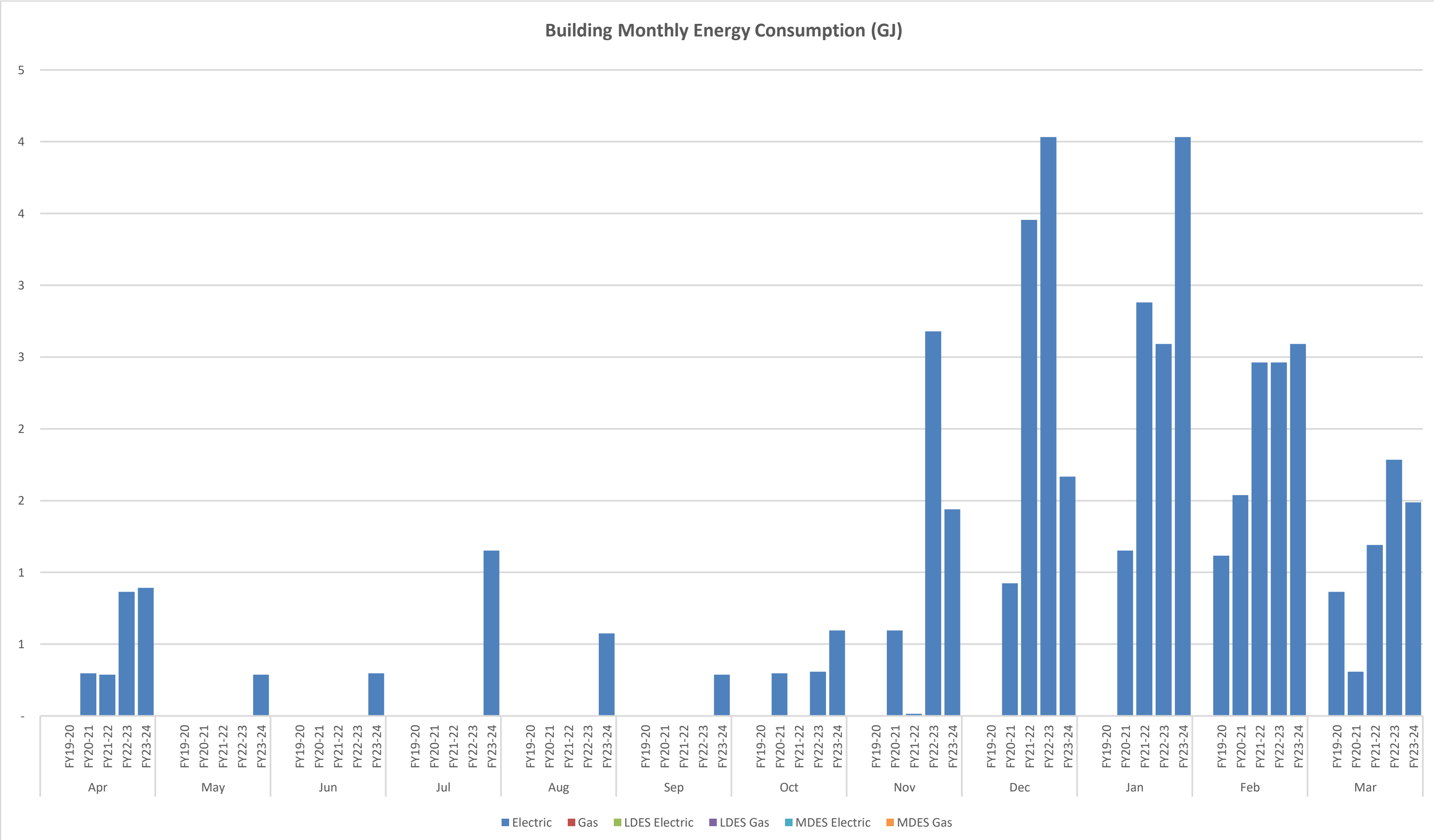
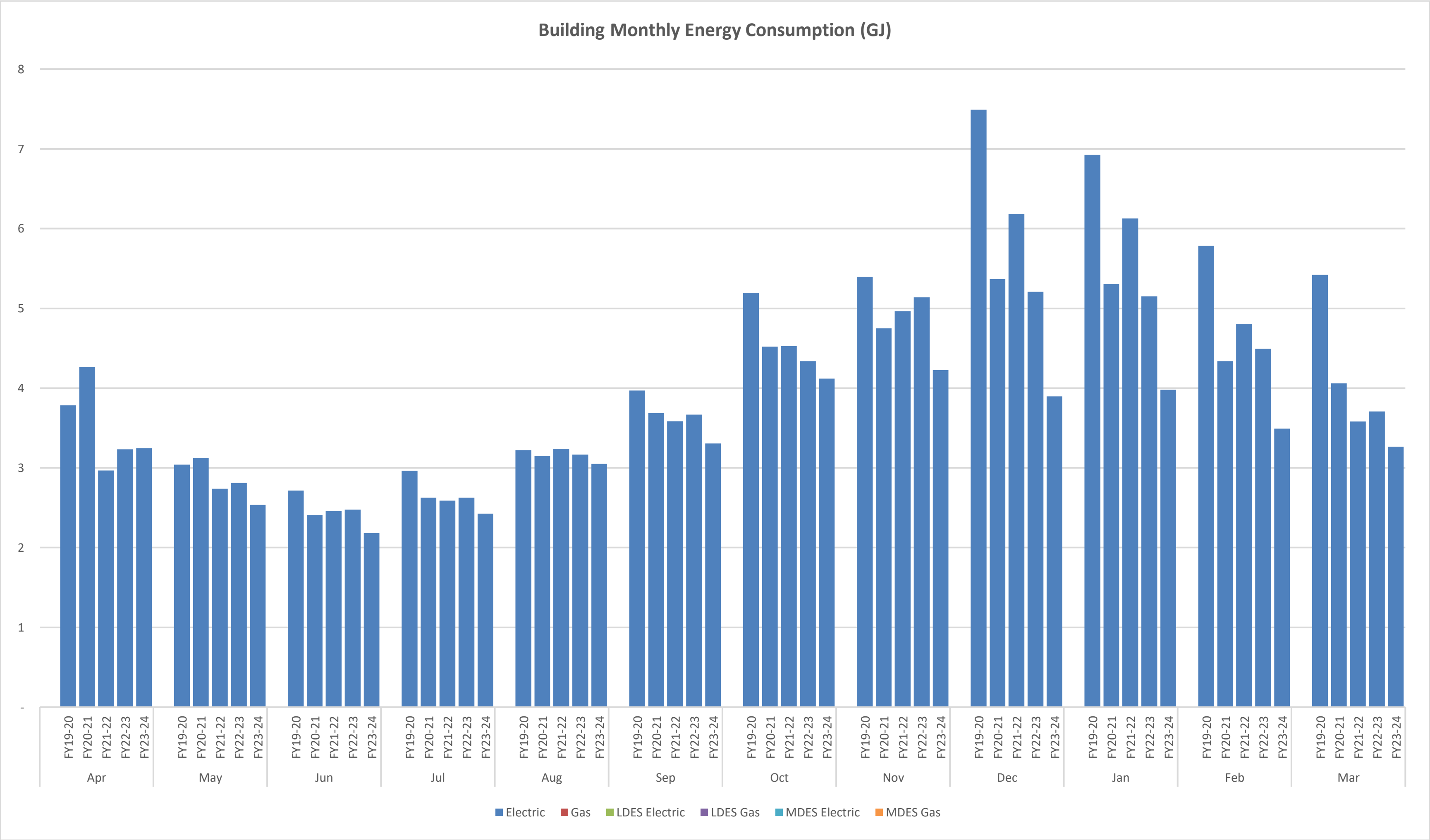
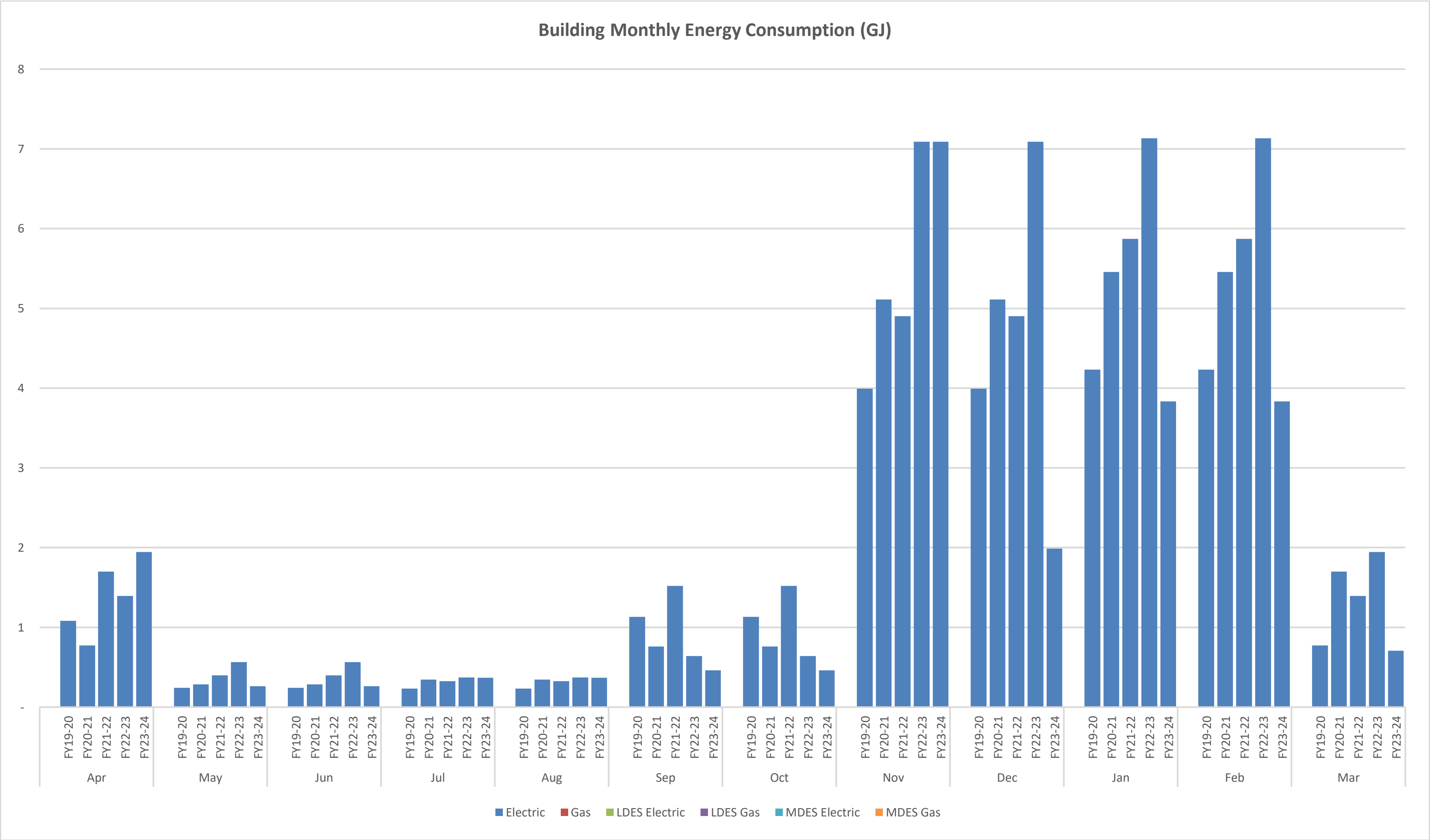
7.39 GEID Vector Well



7.40 Innovation Drive H Lot (Includes Trailer)



7.41 H Lot (Overflow parking)



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7.42 Parking Lot R