UBC Okanagan Energy Operations Annual Report for FY21-22
April 2021 – March 2022

Report Date May 2022

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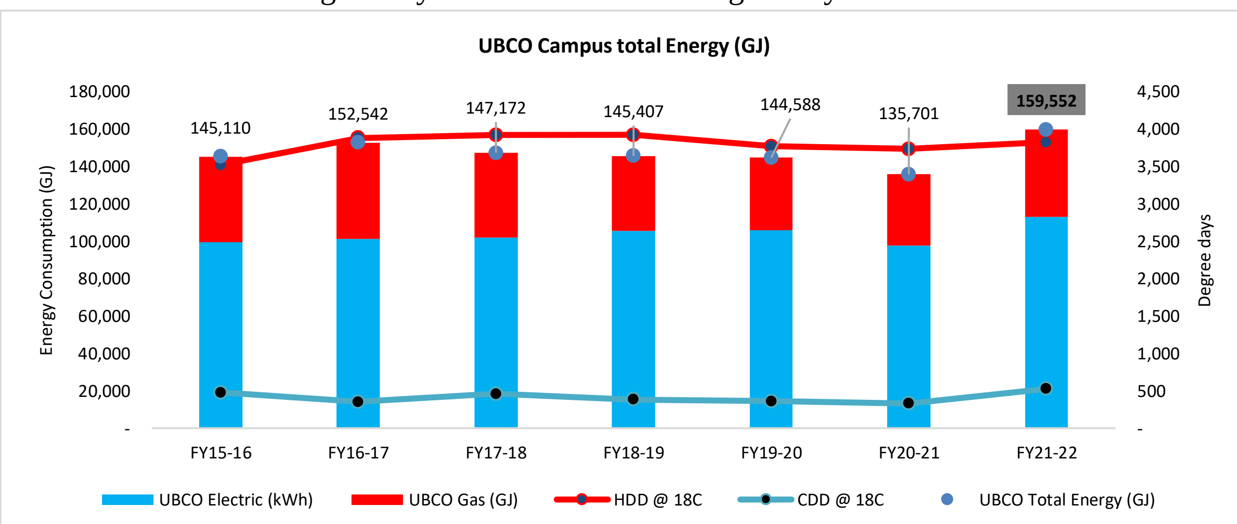
Executive Summary

UBC Okanagan total energy consumption over the last fiscal year (FY21-22) was 159,552 GJ compared to 135,700 GJ for FY20-21, a 17.60% year over year increase leading to a 22.70% increase in total campus energy utility cost from $2.66M in FY20-21 to $3.26M in FY21-22. FY21-22 faced extreme weather events i.e. -29°C on 27th December 2021 and 44°C on 29th June 2021[1], increased occupancy as campus community returned back to campus and volatile natural gas market with around 30% increase in Natural Gas costs.

The total campus energy consumption includes an 15.40% increase in campus Electricity consumption i.e., from 27,149 MWh in FY20-21 to 31,333 MWh in FY21-22 and a 23.10% increase in campus Natural Gas consumption i.e., from 37,965 GJ in FY20-21 to 46,752 GJ in FY21-22.

In FY21-22, Heating Degree-Days (HDD) remained relatively consistent at 3,820 degree-days compared to 3,729 degree-days in FY20-21 whereas Cooling Degree-Days (CDD) increased by around 60% from 330 degree-days in FY20-21 to 525 degree-days in FY21-22.



[1] Winter Outdoor Design Temperature for UBCO = -20C and Summer Outdoor Design Temperature for UBCO = 33C

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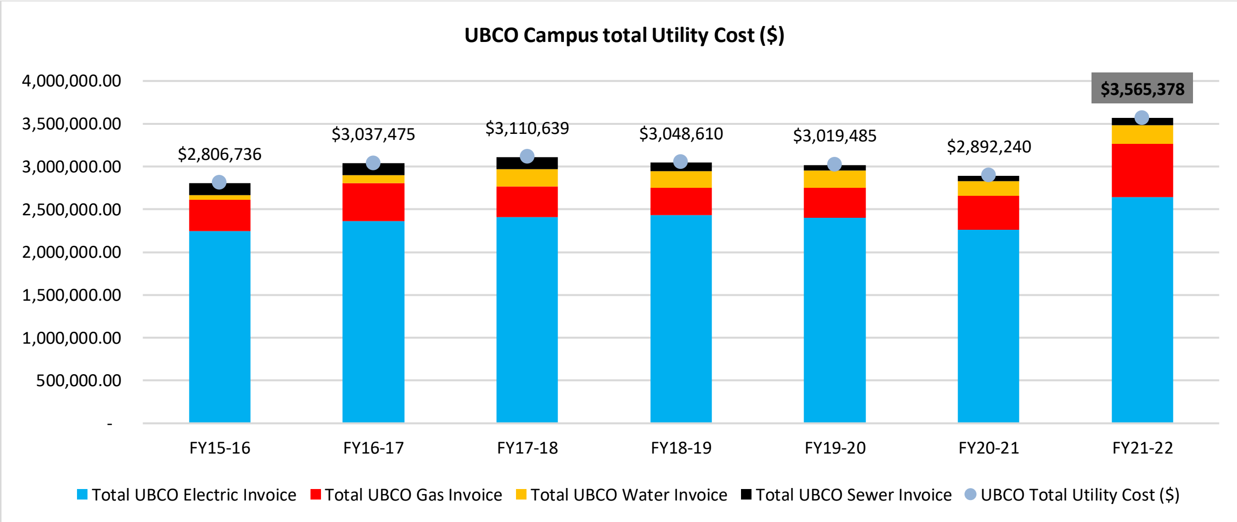

Greenhouse gas emissions increased by approximately 8.60% to 2,134 tCO_2e/ year from 1,965 tCO_2e in FY20-21 primarily due to increase in Natural Gas consumption. This emission calculation assumes constant electricity emission factor of 2.587 tCO_2e/ GWh. Section 4.15. of this report provides a more detailed analysis on the updated electricity emission factor.

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. **Strategic Energy Management Plan (SEMP):** Implement potential demand-side energy conservation measures (ECMs) to reduce utility costs and achieve Climate Action Plan (CAP) 2030 goals
2. **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
3. **UBCO Net Zero Energy Ready:** Update the 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 with TEUI, TEDI, GHGI results for each archetype to feed into UBCO Green Building Action Plan
4. **Building Management System:** Work with UBCO BMS service providers to fix the platform deficiencies, resolve integration issues between backend platforms (Desigo, SBS bridge, Advantage Navigator etc.) to maintain BMS database, add missing trends on the key hydronic graphics
5. **Energy Monitoring and Data Management Platform:** Develop an intelligent data driven energy monitoring and management system for micro communities using statistical and advanced data analysis methods

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6. **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 – ongoing collaboration
    b. Wastewater monitoring for campus community – potential
    c. West campus land development – potential
7. **Other:** Technical reviews and setting goals, targets and strategies as early as possible for future campus expansions, updating the infrastructure HVAC Asset Management database and updating 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 Lab Demand Controlled Ventilation, Recommissioning of Arts Building, lighting projects, WiFi threshold recalibration, and other monitoring improvements. Energy Team related activities such as energy conservation measure implementation, equipment upgrade, personnel funding, new construction etc. in the past fiscal year received around $330,000 in FortisBC incentives.

Year over year Energy Team has identified and secured rebates up to $95,000 which otherwise would have been missed benefit. 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

Recommendations

- Improve existing building recommissioning process on campus buildings
- Connect new campus buildings to existing District Energy System
- Centralize UBCO incentive processing via Energy Team
- Involve Energy Team at project initiation stage for energy-related projects

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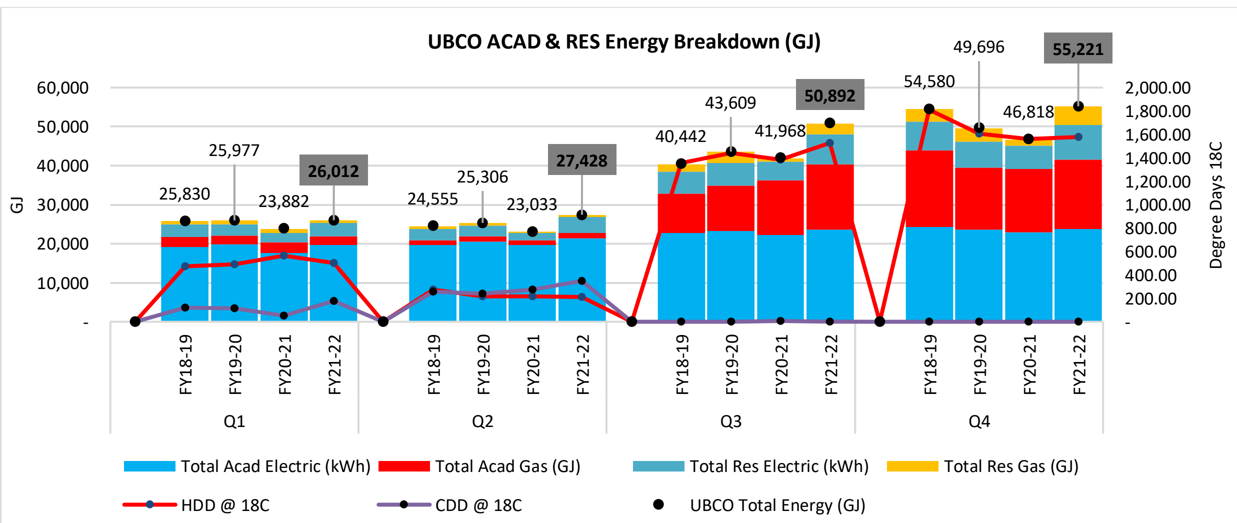
Following table presents DSM-based utility savings, carbon tax savings, FortisBC funded staff position, energy efficiency incentives received by UBCO:

Parameter	FY18-19	FY19-20	FY20-21	FY21-22
Total Utility Cost Savings compared to BAU 2013[2]	$378,700	$431,000	$1,063,900[3]	$714,700
DSM-based Utility Savings	$66,300	$31,900	$32,420	$103,700[4]
DSM-based Carbon Offset Savings[5]	$4,000	$2,800	$2,380	$2,880
External personnel funding	$60,000	$60,000	$95,000	$130,000
Energy Efficiency Incentive (Rebates)	$176,000	$238,000	$305,000	$231,300

The figure below shows that Residences Electricity and Natural Gas consumption reduced in FY20-21 as a result of COVID-19 and a few energy conservation measures implemented. However, as the campus community transitioned back to campus, energy consumption increased in Q3 (fall semester) and Q4 (winter semester) of FY21-22. This increase in energy consumption can also be attributed to new buildings commissioned on campus.



[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] Includes UCH, RHS, EME building RCx, Misc LED upgrades, Monashee VRF upgrade. Doesn't include PGF improved envelope, OM1 heat pump.
[5] This only includes $25/tCO2e of offsets retired by the Ministry on behalf of UBC Okanagan.

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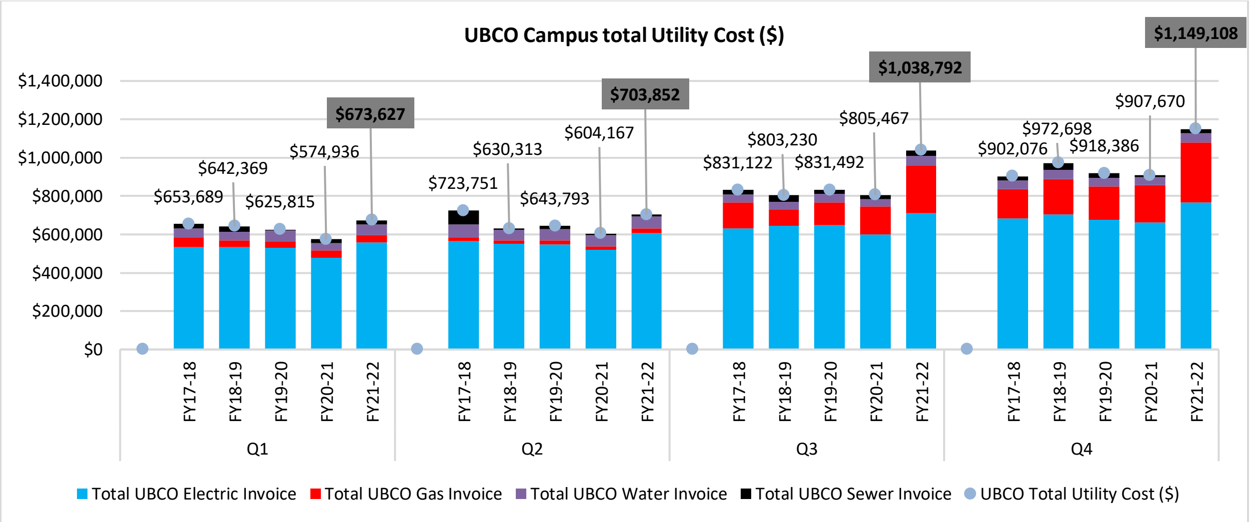

The Figure below shows the total energy consumption and its change for each building categorized by building type from FY20-21 to FY21-22. NEC, PGF, IP1, and IA1are the new buildings on campus. GEO building energy consumption increased by 162% primarily due to commissioning of Nechako building which is being serviced by LDES plant and reduced supply from Geo-exchange building. All the existing residences except Monashee energy consumption increased by around 20% – 60%. Monashee energy consumption increase is only 16% which might be as a result of installation of energy efficient VRF heat pump.

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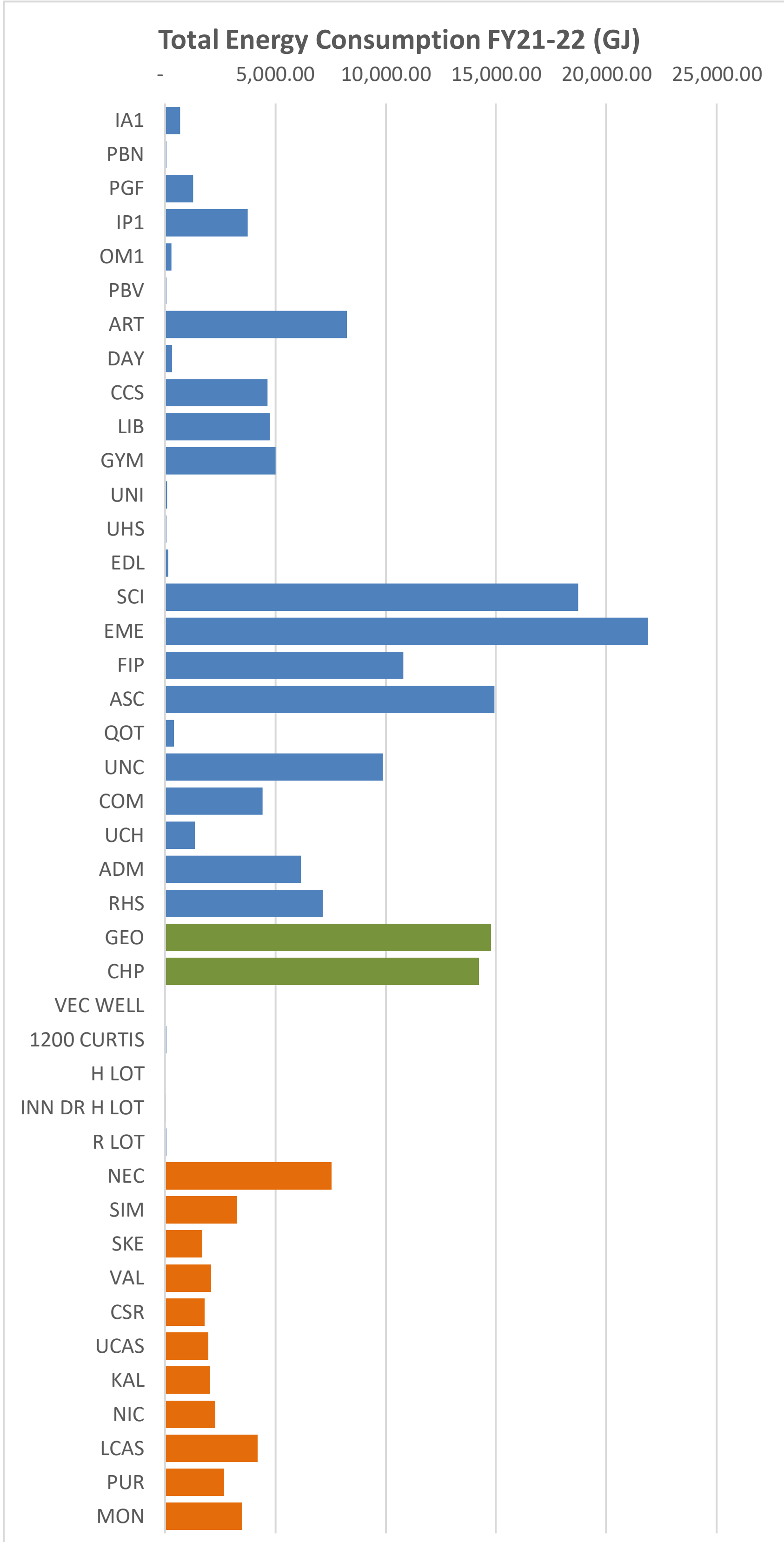
TYPE	BUILDING	% CHANGE
ACAD	IA1	1186%
ACAD	PBN	209%
ACAD	PGF	106%
ACAD	IP1	99%
ACAD	OM1	81%
ACAD	PBV	66%
ACAD	ART	36%
ACAD	DAY	21%
ACAD	CCS	18%
ACAD	LIB	17%
ACAD	GYM	14%
ACAD	UNI	11%
ACAD	UHS	11%
ACAD	EDL	10%
ACAD	SCI	8%
ACAD	EME	6%
ACAD	FIP	6%
ACAD	ASC	5%
ACAD	QOT	4%
ACAD	UNC	1%
ACAD	COM	-3%
ACAD	UCH	-4%
ACAD	ADM	-8%
ACAD	RHS	-10%
DES	GEO	162%
DES	CHP	-25%
OTHER	VEC WELL	101%
OTHER	1200 CURTIS	49%
OTHER	H LOT	5%
OTHER	INN DR H LOT	0%
OTHER	R LOT	-11%
RES	NEC	10319%
RES	SIM	58%
RES	SKE	56%
RES	VAL	53%
RES	CSR	48%
RES	UCAS	45%
RES	KAL	37%
RES	NIC	36%
RES	LCAS	24%
RES	PUR	21%
RES	MON	16%



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Definition of Terms

AHU: Air Handling Unit
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
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
OAT: Outdoor Air Temperature
OPR: Owner's Project Requirement
RCx: Recommissioning
RNG: Renewable Natural Gas
SEMP: Strategic Energy Master Plan
tCO2e: 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. Often 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 (District Energy Systems and Buildings).

Some of the key tasks include:

- Develop strategies, policies, guidelines and defined project requirements to optimize future campus energy consumption
- Act as a technical review team providing input and recommendations for retrofits, new construction projects, infrastructure expansion and campus policy and technical guidelines. By providing input to help ensure new projects are built to meet future requirements, the risk of costly future upgrades is minimized
- Implement detailed reporting to provide input into financial, infrastructure and operational planning
- Plan and implement energy conservation measures in existing campus facilities leveraging external funding opportunities to yield utility cost savings. Campus expansion and intensification emphasizes the importance of keeping energy creep under control
- Continuous measurement, verification, tracking and analysis of energy use on campus
- Co-ordinate energy projects with other stakeholder groups in order to optimize efficiencies. For example, by optimizing mechanical system operation, the following can all occur simultaneously: increased energy efficiency, increased equipment lifespan, reduced number of repairs required, reduced risk of system failures and improved indoor air quality.

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

FortisBC has provided funding for the Energy Specialist position since 2016. In order to support increased energy management capacity, in FY19-20 the Energy Specialist funding was transitioned to financially supporting two positions.

2 Overall Campus Energy Performance

Campus energy consumption for FY21-22 totalled 159,552 GJ (44,320 MWh). As can be seen in Figure 1 below, electricity accounted for around 70% of total energy consumed on campus. Furthermore, electricity is more expensive than natural gas. Average electricity costs were \$23.42/GJ (\$84.30/MWh) in FY21-22 and \$13.27/GJ (\$47.80/MWh) for natural gas. As a result, electricity accounted for around 80% of campus utility costs. While natural gas has a lower cost per unit of energy, its GHG emission intensity is eighteen times higher than those of electricity (0.18 tons CO_2/MWh for gas versus 0.0026 tons CO_2/MWh for electricity). As a result, about 96% 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 [6]. Note also that the emission factor currently used for the FortisBC electric grid is lower than that for integrated grid factor published by BC Ministry of Environment & Climate Change Strategy.

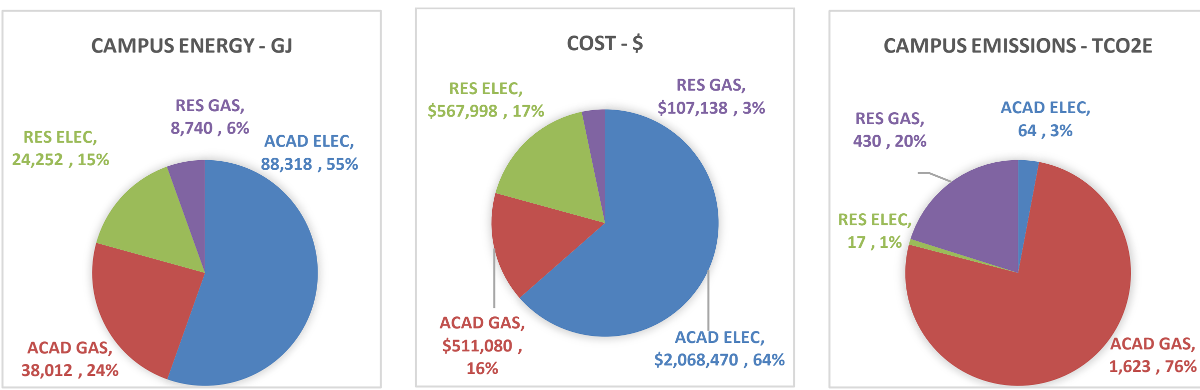

Figure 1: Campus Energy Consumption, costs and emissions by Source for FY21-22[7]

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 0.80 GJ/m^2/yr. (222.84 kWh/m^2/yr.) in FY20-21 to 0.94 GJ/m^2/yr. (261.51 kWh/m^2/yr.) in FY21-22. This increment can primarily be attributed to the following factors:

1. Increased energy consumption as a result of campus community return back to campus

[6] Electricity emission factor changed in 2021. However, this report assumes 2.587 tCO_2e/GWh.
[7] 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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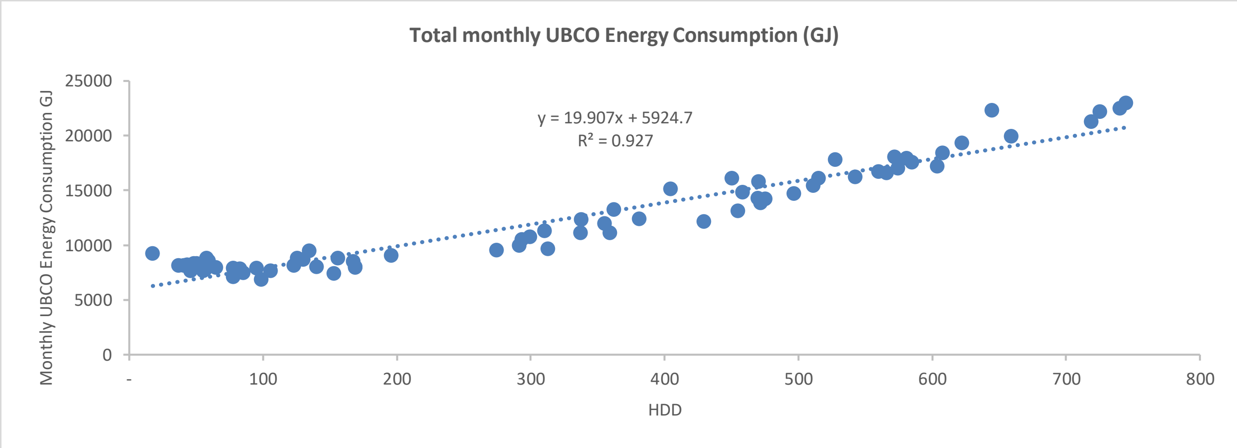
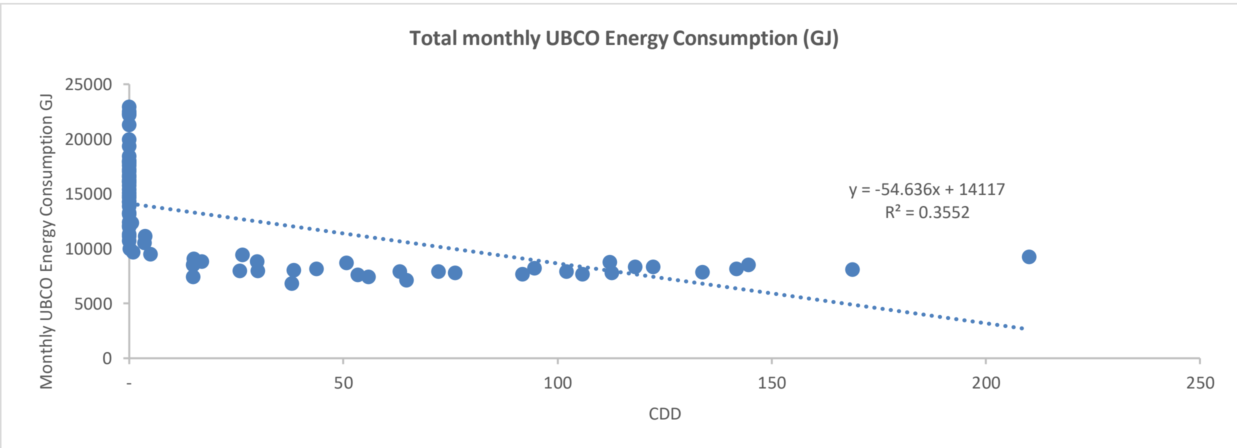
2. Energy-intensive new construction buildings (IP1, IA1, NEC) on campus in FY20-21





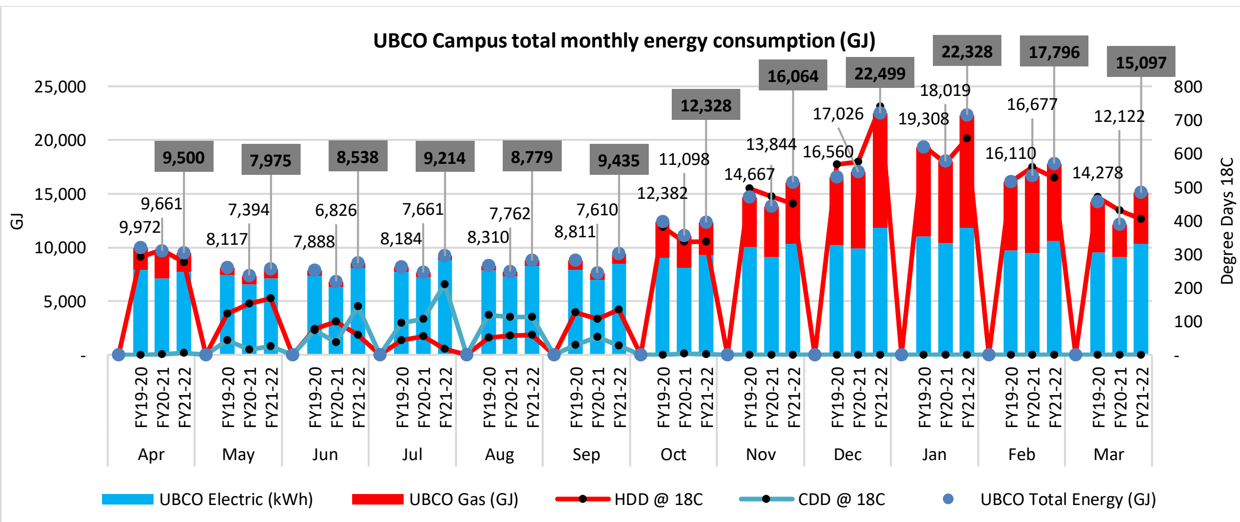


Figure 2: Campus Energy Consumption and Weather Comparison

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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 $2.7M to about $3.37M. For FY21-22 the average cost of electricity on campus remained relatively flat at $84.31/MWh compared to $83.69/MWh in FY20-21, only a 0.7% increase. 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 $2.27M in FY20-21 to $2.64M in FY21-22, 16.30% increase.

For FY21-22 the average cost of natural gas on campus was $13.27/GJ ($47.79/MWh) compared to $10.50/GJ ($37.68/MWh) in FY20-21, a 27 % increase. This increase includes 10.70% share of Renewable Natural Gas which has a premium of more than $7/GJ over conventional Natural Gas (a total premium of $30,870 for 5000 GJ RNG). The combined effect of increase in Natural Gas consumption from 37,965 GJ in FY20-21 to 46,752 GJ in FY21-22 and 27% Natural Gas price increase resulted in total Natural Gas costs increment from $397,330 in FY20-21 to $620,620 in FY21-22, a 56.20% increase.

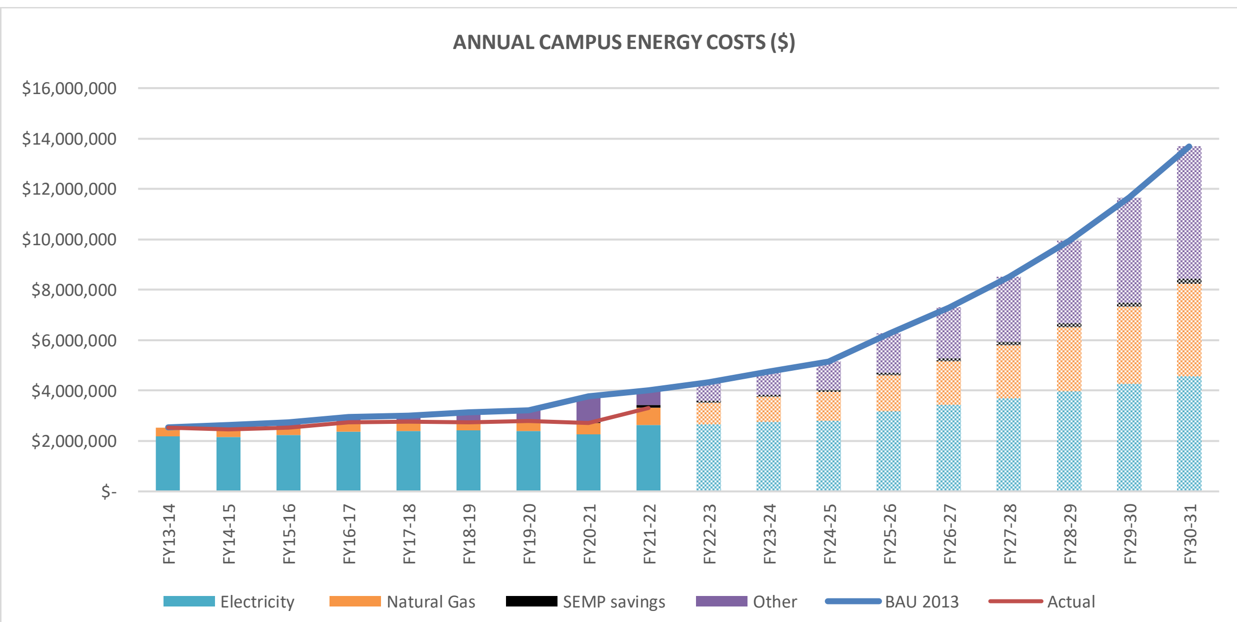

Figure 3: Campus Energy Costs Trend[8]

[8] 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. For this report 2013 is generally used as the reference year.

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From FY17-18, the utility costs is expected to be over $500k higher per year ($2.5M in total[9][10]) compared to 2013 Business as usual scenario without modernization efforts (High-performance building, equipment upgrade, recommissioning etc.) taken at the UBCO campus. Approximately $58k per year ($290k in total) of the savings are attributed to DSM projects funded directly by Energy Initiatives. These savings are shown in black in the Figure 5 below. 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, recommissioning, routine capital equipment upgrade or improved technical guidelines etc.

[9] Excludes DSM-based savings.
[10] This number is a little higher in FY20-21 compared to previous years due to COVID-19 as a result of reduced occupancy.

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2.1.2 Greenhouse Gas Emissions

Campus greenhouse gas emissions increased by approximately 8.60% from 1,965 tons CO_2 in FY20-21 to about 2,133 tons CO_2 in FY21-22 using current emission factors as reported in "2018 B.C. Methodical guidance for quantifying greenhouse gas emissions" for public sector organizations, local governments and community emissions. As the majority of campus GHG emissions are due to natural gas usage, this increment can primarily be attributed to increased natural gas consumption. Although Natural Gas consumption increased by about 23%, but emissions increased only by 8.60% because of introduction of around 5,000 GJ (10.7%) of RNG. 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.

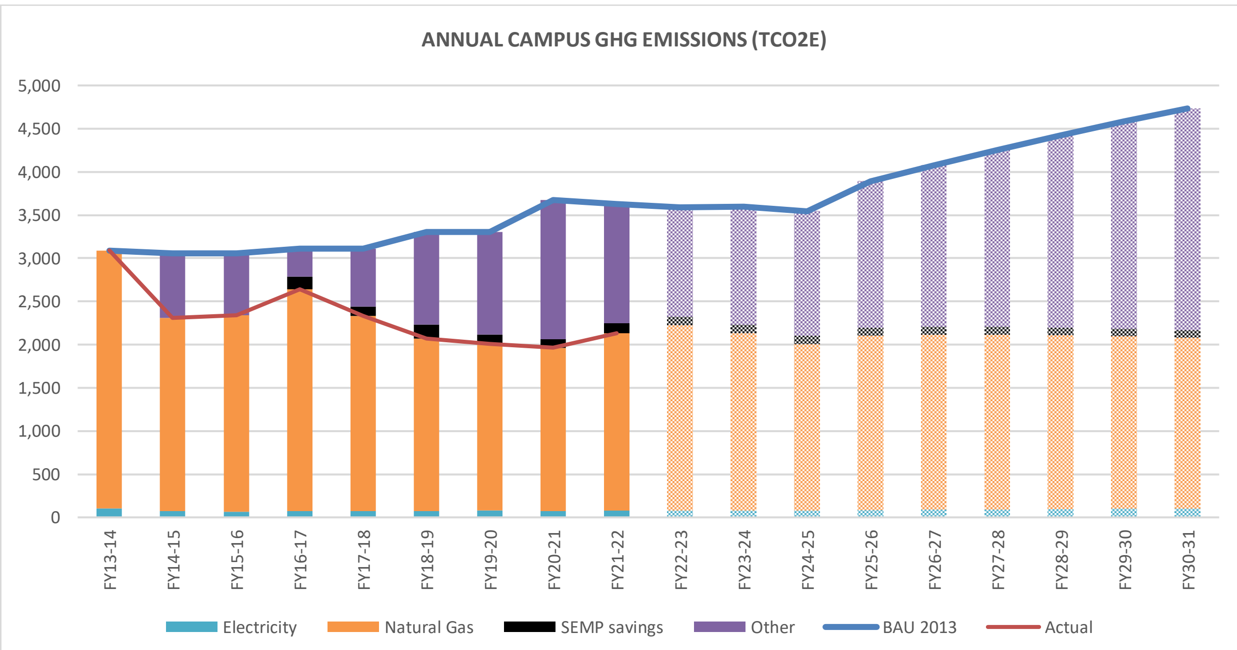

Figure 4: Campus GHG Emissions Trend

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2.1.3 Electricity

Electricity consumption increased by around 15.40% year over year to 31,269 MWh in FY21-22 from 27,091 MWh in FY20-21. This increment in electricity consumption can be primarily attributed to an outlier FY20-21 (due to COVID-19).

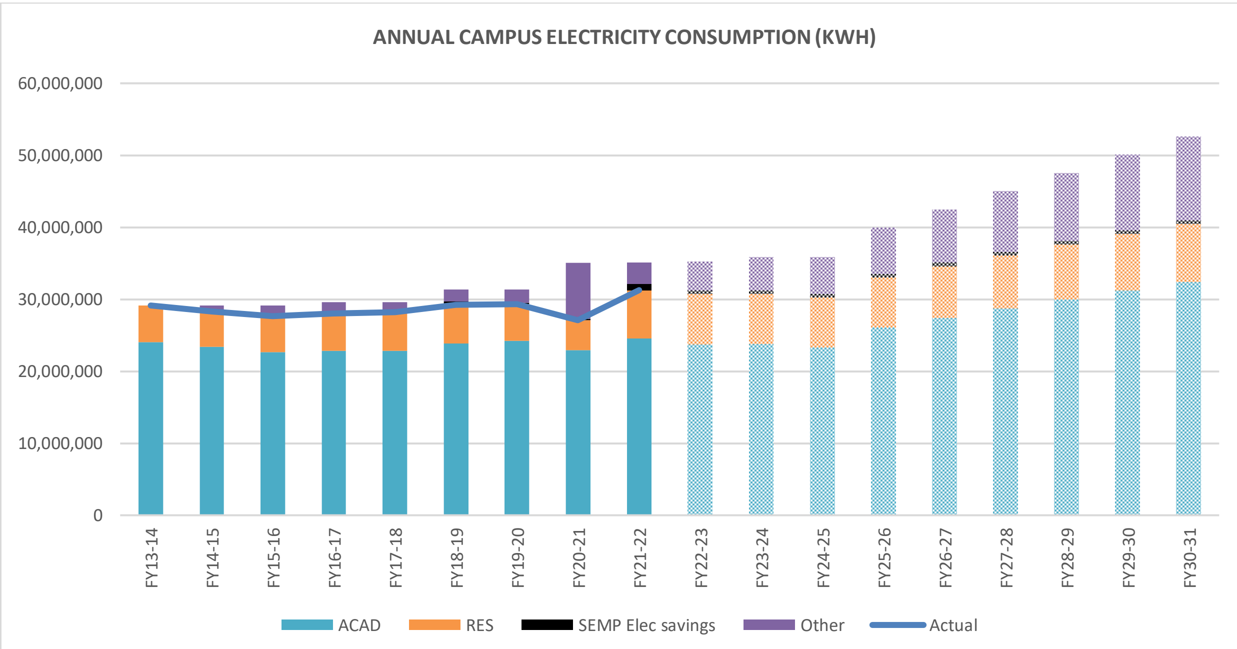


Figure 5: Campus Electricity Consumption Trend

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.

EME, SCI, ASC, FIPKE, UNC, and RHS are the Academic buildings which individually consume more than 5% of the total electricity consumption on campus. 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 21% of the total electricity consumption. Refer to Figure 6 for more information on electricity consumption breakdown.

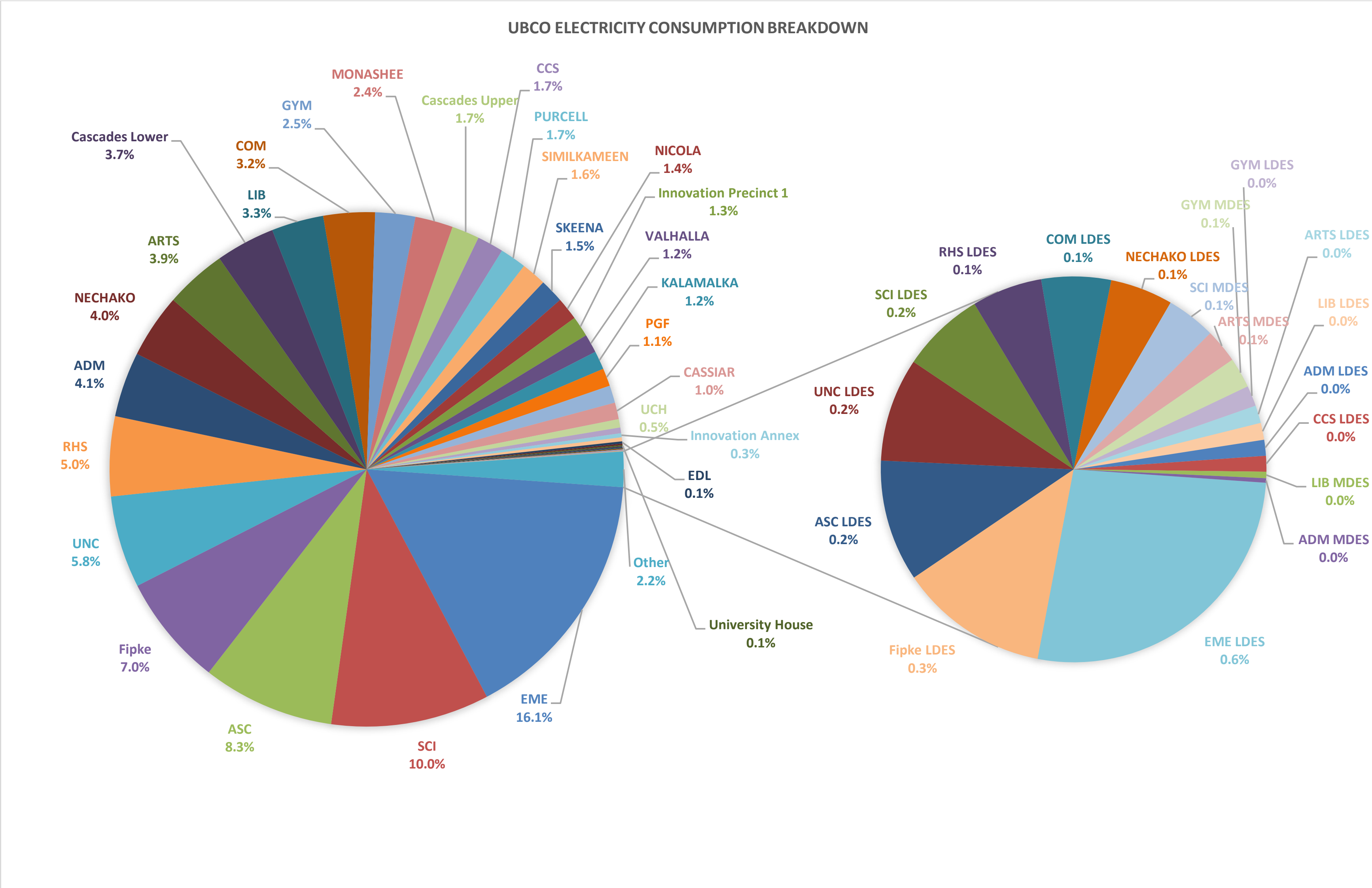


Figure 6: Electricity Consumption for Buildings and DES for FY21-22

2.1.4 Natural Gas

Consumption of natural gas increased from 37,965 GJ in FY20-21 to 46,752 GJ in FY21-22, a 23% year over year increase. Natural gas consumption for the residences increased from 3,832 GJ to 8,740 GJ (around 128% increment) primarily due to reduced occupancy, a direct impact of COVID-19 in FY20-21.

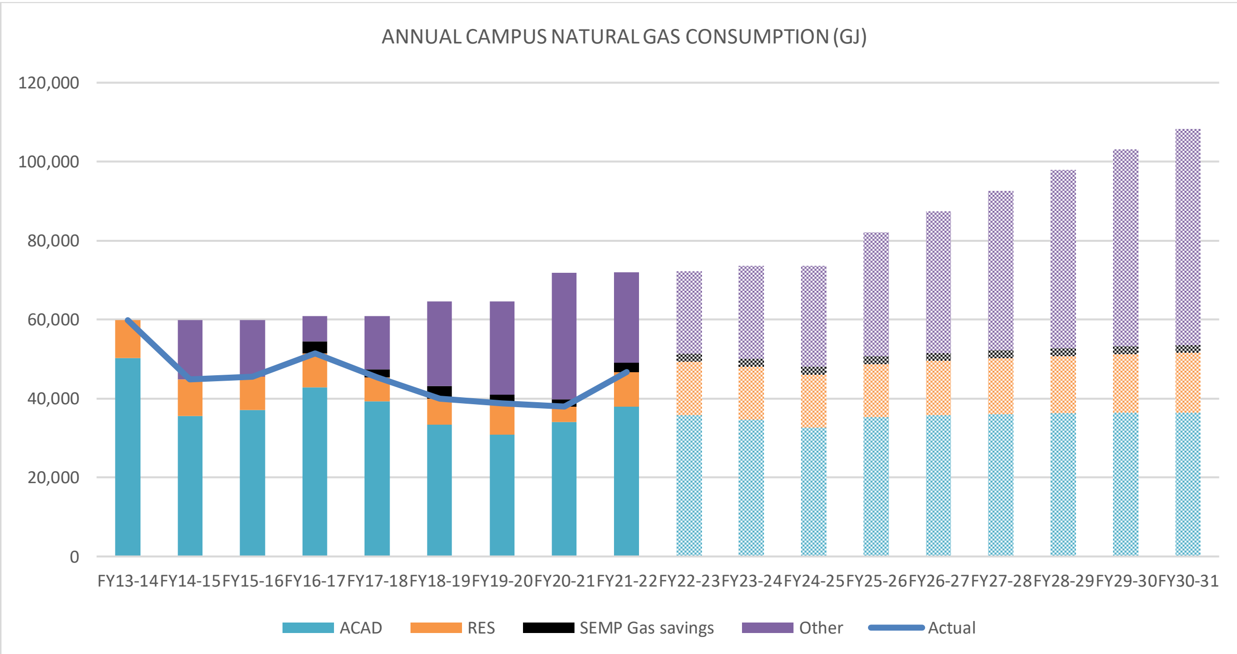


Figure 7: Campus Natural Gas Consumption Trend

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.

ASC, CCS, are the Academic buildings which individually and directly consume more than 5% of the total campus Natural Gas because of the standalone equipment in the buildings (gas boilers, gas water heaters). As can be seen in the figure, a large fraction (around 54%) of natural gas on campus is consumed by the two district energy systems' plants by gas boilers (LDES = 33.85% and MDES = 20.14%). Residences consume around 18.70% of the total gas consumption. Refer to Figure 8 for more information on gas consumption breakdown.

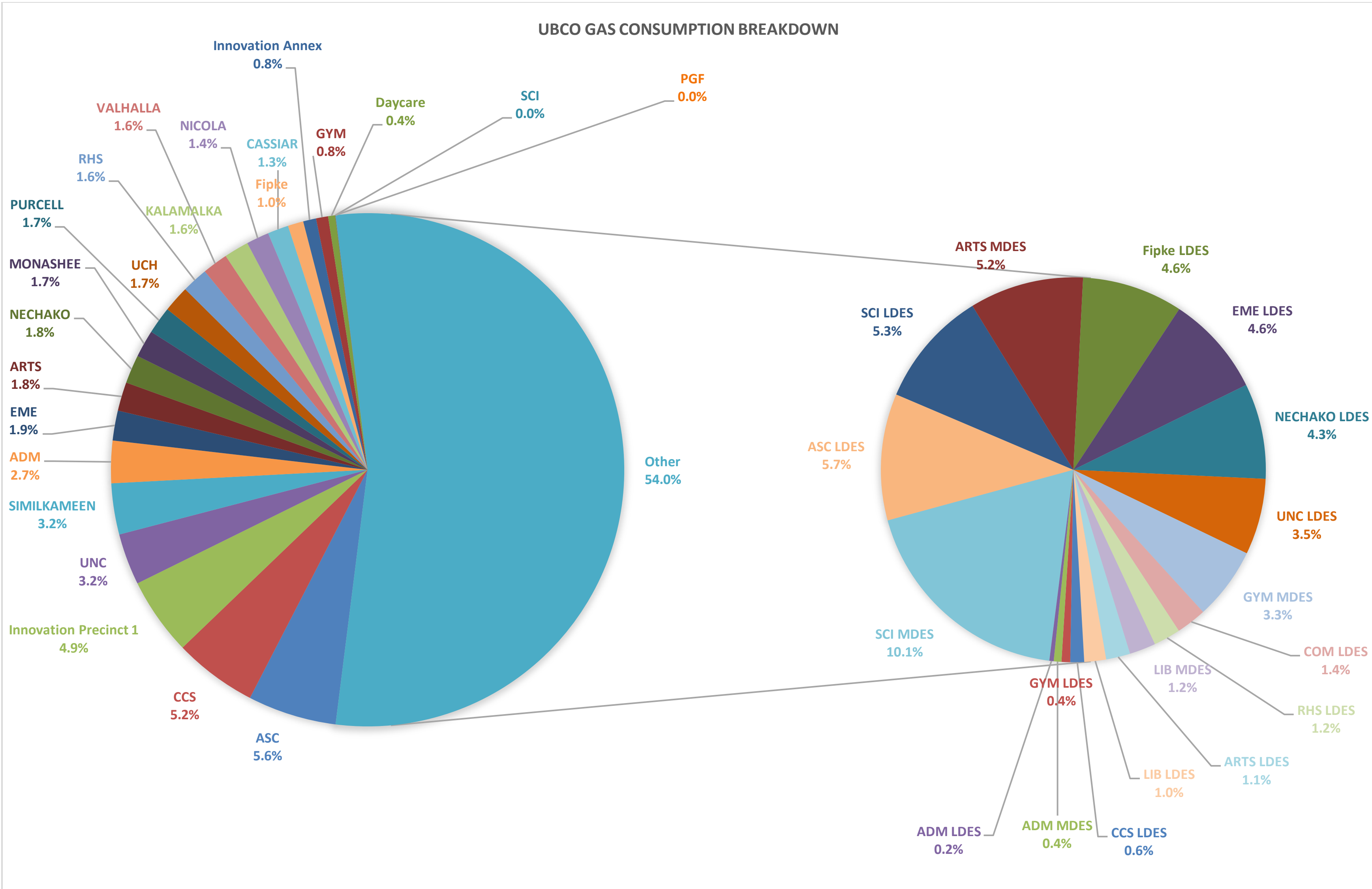
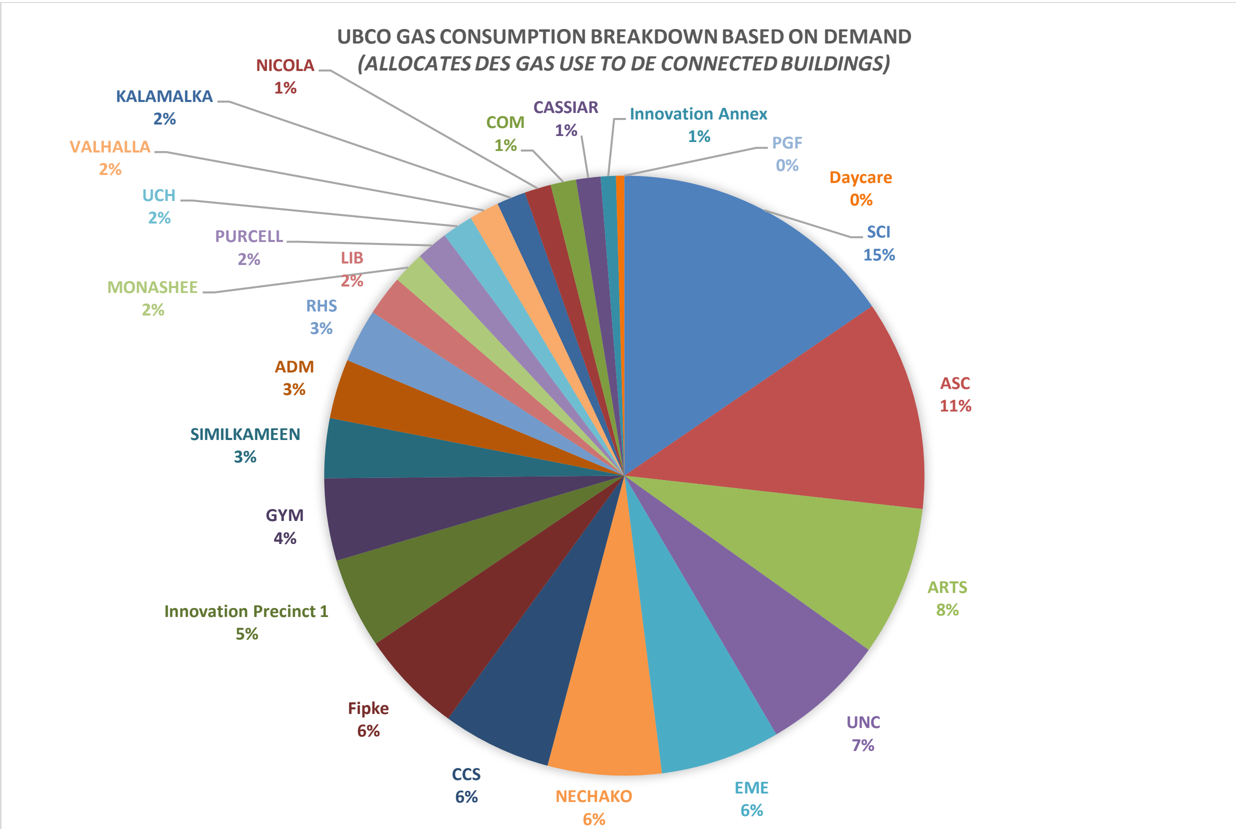


Figure 8: Gas Consumption of Buildings and DES for FY21-22

Figure below provides the gas consumption breakdown and allocates DES (LDES, MDES) gas consumption to the respective building based on demand. SCI, ASC, ARTS, UNC, EME, Nechako, CCS, Fipke, RHS, and IP1 consume more than 5% of the total gas consumption on campus.



2.1.5 Water and Sewer

Water purchased from Glenmore Ellison Improvement District (GEID) for campus[11] use increased by 55.43% from 119,434 m^3 in FY20-21 to 1185,641 m^3 in FY21-22 with Academic buildings consuming 47% of the water. Sewer production also increased by 33.78% from 56,851 m^3 in FY20-21 to 76,054 m^3 in FY21-22. Figure 9 below provides water and sewer trends for the campus.

[11] 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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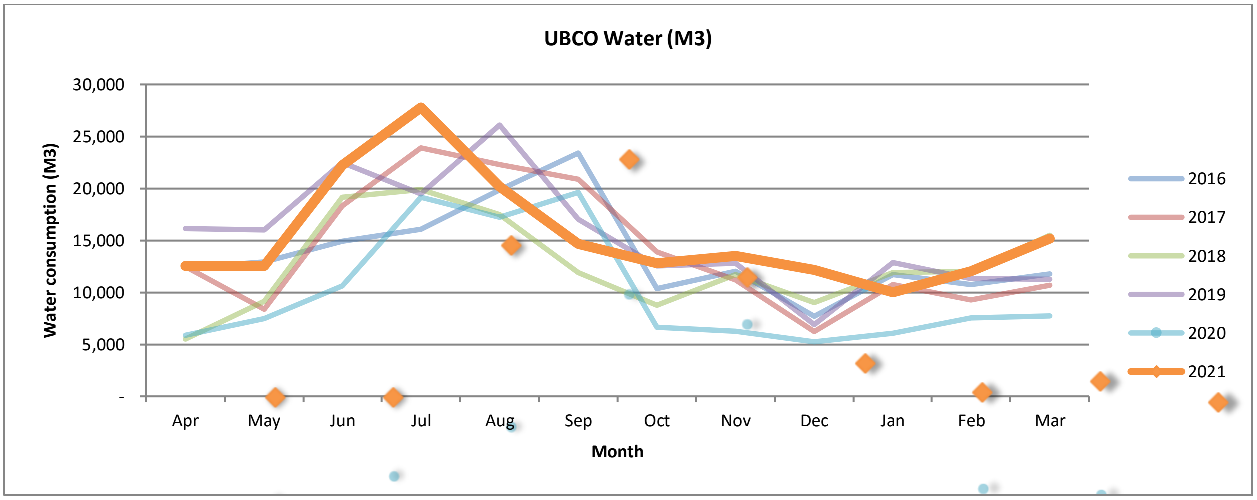

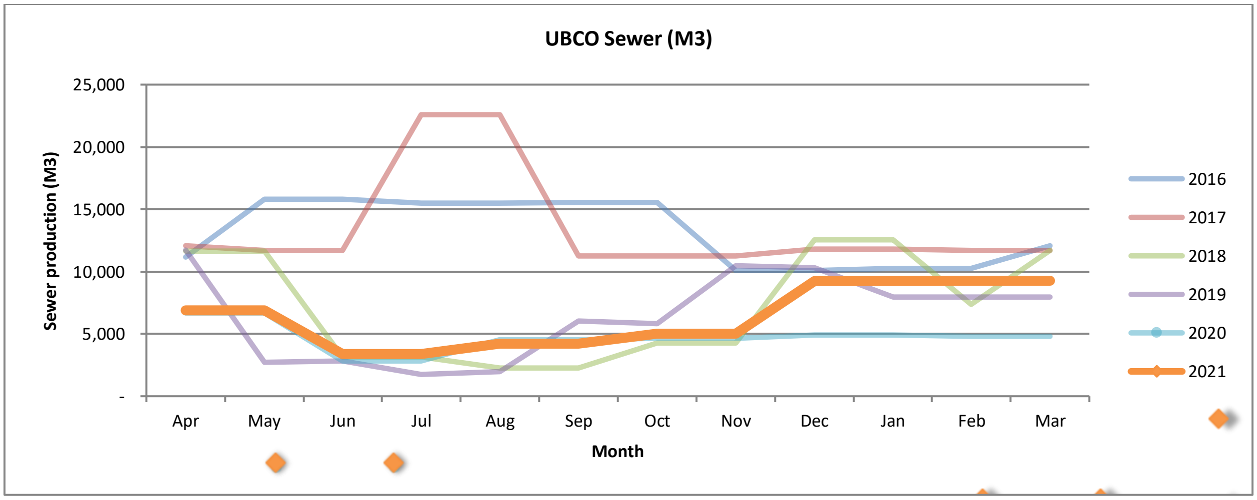

Figure 9: Water and Sewer consumption trend for UBCO campus

2.2 Distribution of Campus Energy Use

Energy use intensity (EUI) is the amount of energy used per unit of floor area. The overall campus EUI was 262 kWh/m^2/yr. for FY21-22, an 18% increment over the prior year FY20-21. FY20-21 can be considered an outlier year due to COVID-19 resulting in reduced occupancy. However, this is a 6% reduction in overall campus EUI compared to FY19-20. Refer to Figure 10 for more details. The average EUI for academic buildings on campus was 339 kWh/m^2/yr. while it was 136 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.

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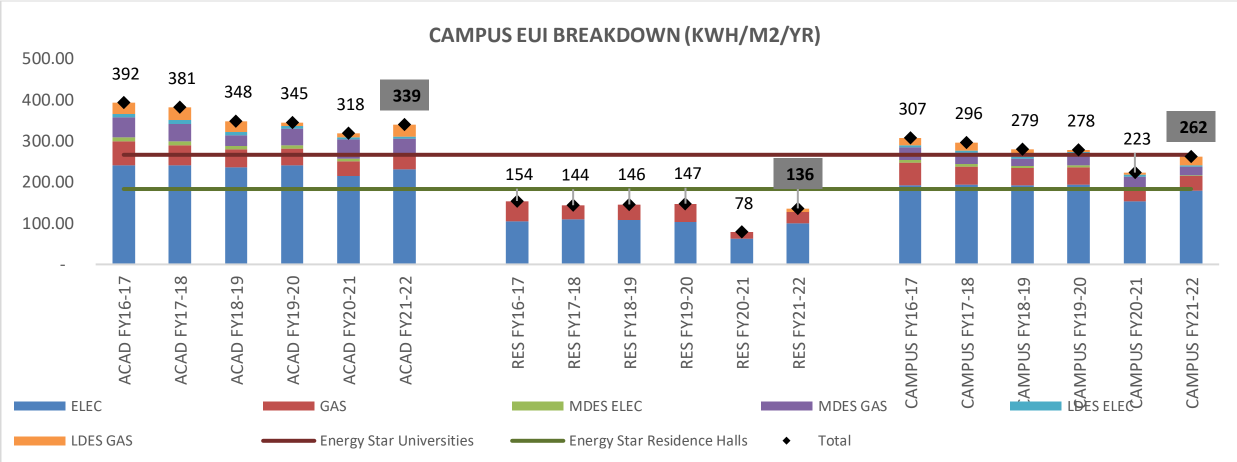

Figure 10: Campus Energy Use Intensities trend

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. Following table provides a summary of the different metrics for the baseline scenario:

	Student Residence (100% Residential)	**Campus Rental Housing (contains Commercial Retail Units)**	**Lab Building (Low fume hood density)**	**Lab Building (High fume hood density)**	**Classroom/ Office**
Modified TEUI (kWh/m^2/yr.)[12]	136	176	335	431	157
TEDI (kWh/m^2/yr.)	24	25	63	85	21
DHW (kWh/m^2/yr.)	24	39	12	14	13
GHG (kgCO_2e/m^2/yr.)	9	12	19	25	8

As can be seen in the following Figure 11, the ASC, Fipke and Science buildings have the highest EUI on campus, primarily because of the laboratories in these buildings. A project is underway in the Science building to reduce lab ventilation rates. Refer to section 5.1 of this report for more information. Similar project will be carried out for the ASC and FIPKE buildings in the next fiscal year. Also, FortisBC funded Recommissioning activities were performed for the EME, RHS and MWO buildings. 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. Figure 12 provides a comparison between total energy consumption for the various Academic buildings on campus.

[12] Modified TEUI calculation considers Chillers and Water Source Heat Pumps to be part of District Energy System and is not included in the TEUI calculation. It assumes hot and chilled water is purchased from District Energy System. So, in order to calculate actual EUI, thermal water demand (hot water or chilled water) needs to be multiplied with the plant efficiencies.

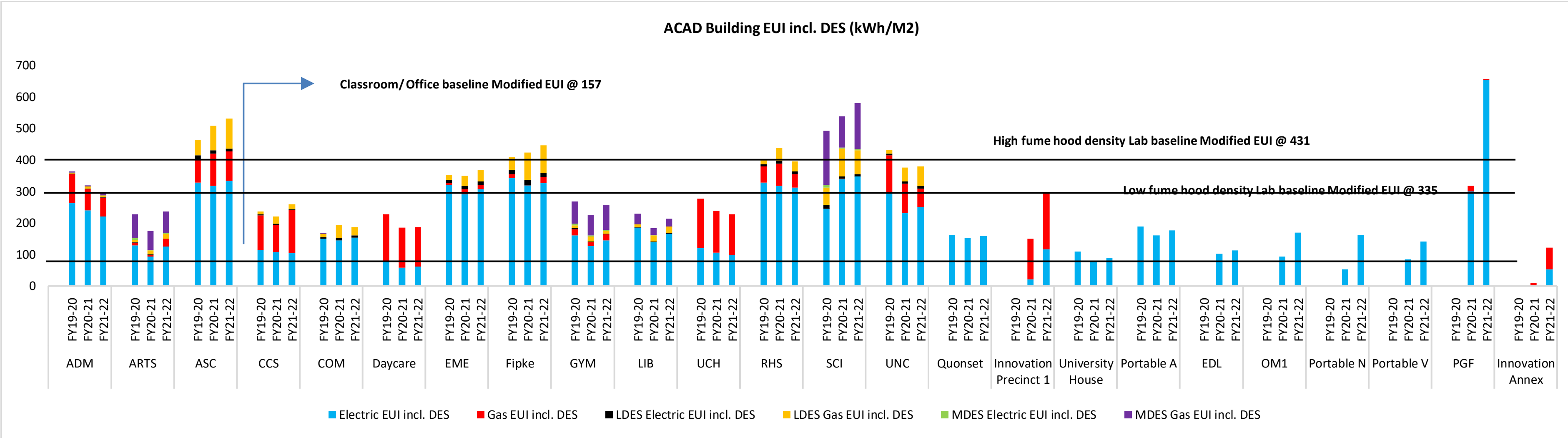

Figure 11: Energy Use Intensity for Campus Academic Buildings[13]

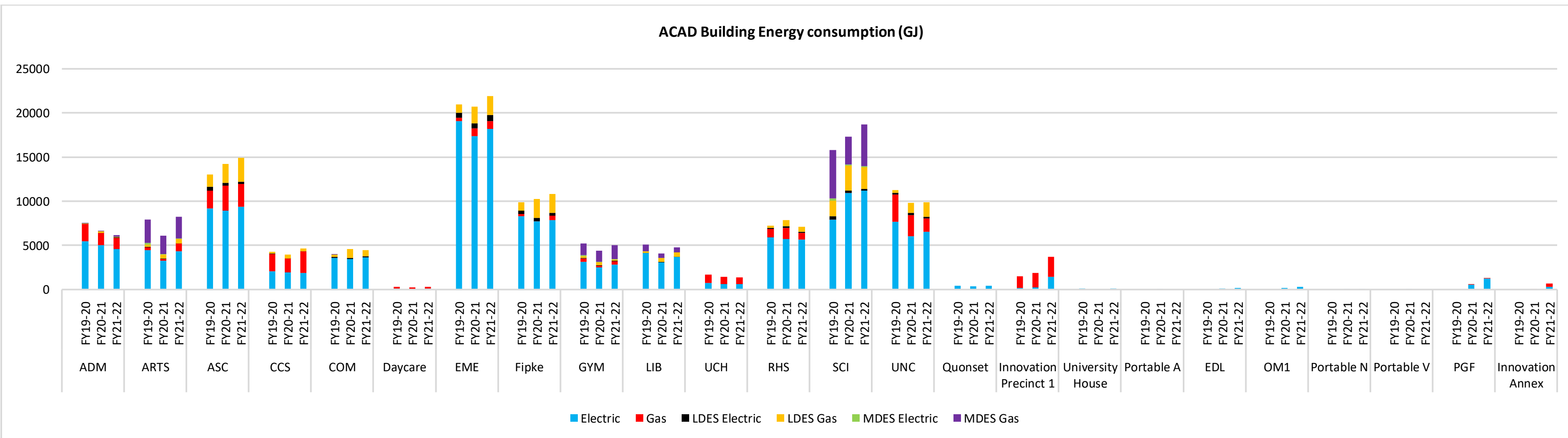

Figure 12: Energy Use for Campus Academic Buildings

[13] Refer to Footnote 11.

Due to their lower intensity 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.

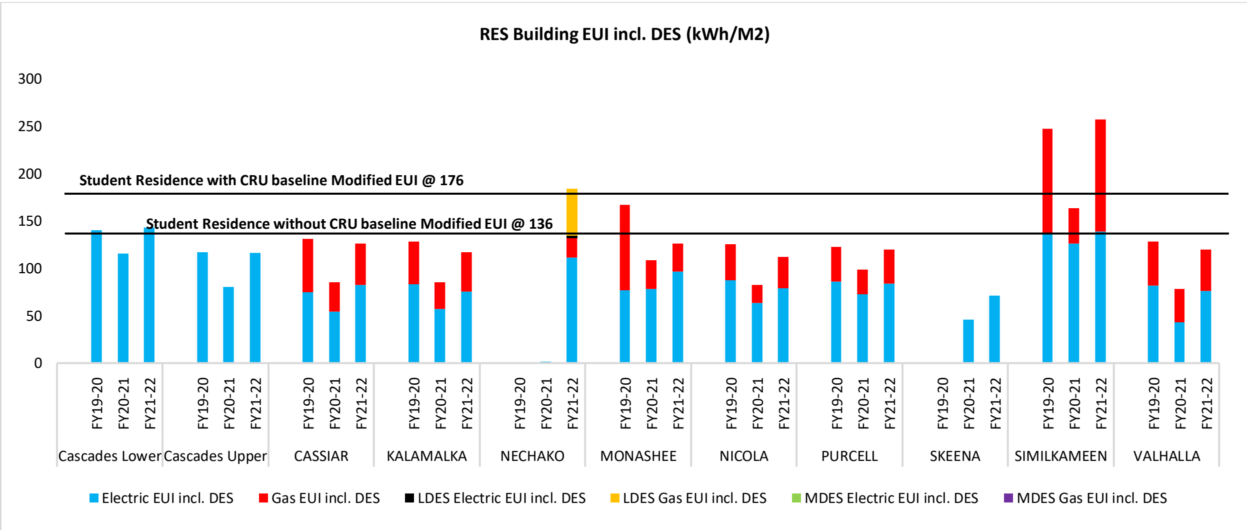

Figure 13: Energy Use Intensity for Campus Residence Buildings[14]

Figure 14 provides a comparison between total energy consumption for the various Residence buildings on campus.

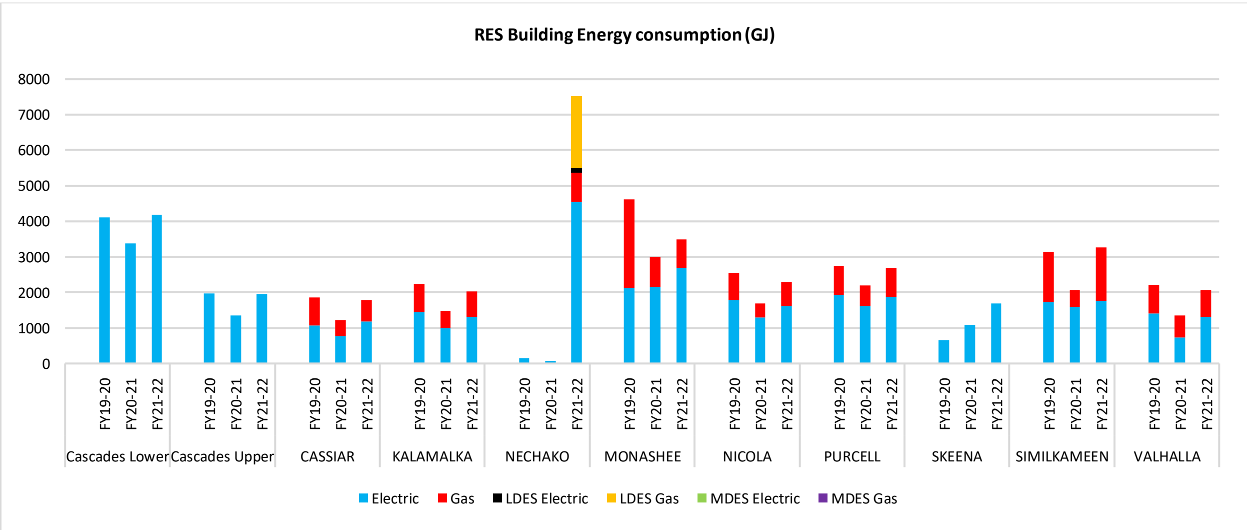

Figure 14: Energy Use for Campus Buildings

[14] Refer to Footnote 11.

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.

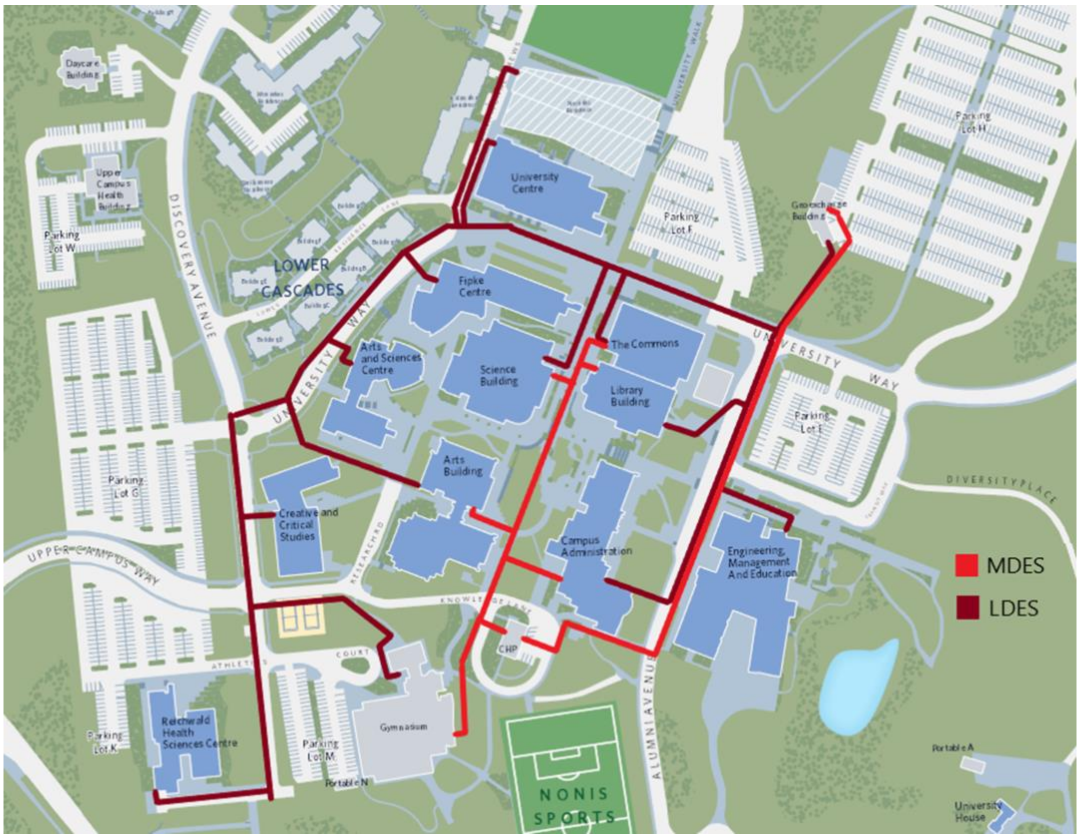

Figure 15: Map of the current status of District Energy Systems

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

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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.

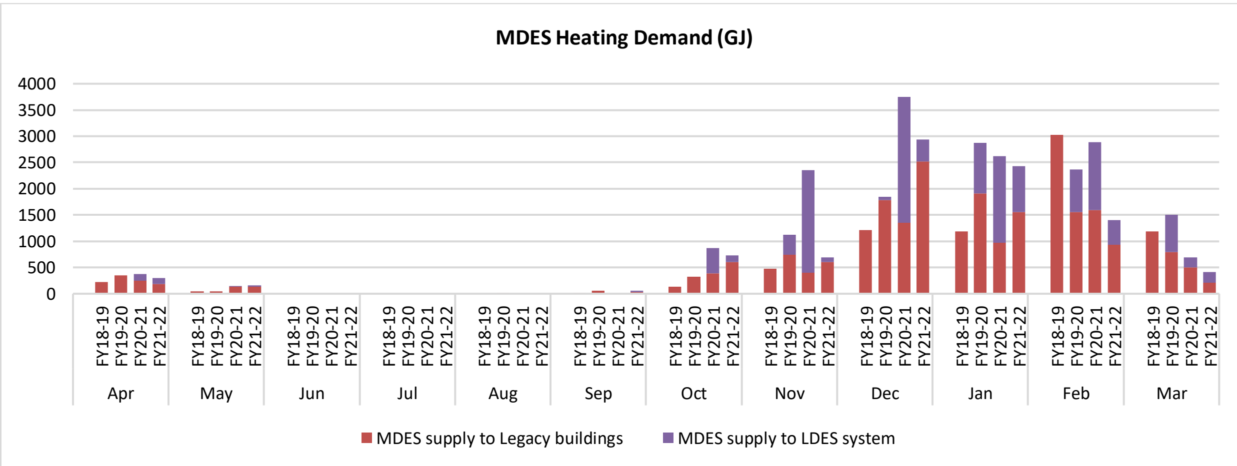

Figure 16: Thermal Energy demand from the MDES plant

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. A test was conducted to understand the cost-benefit analysis of increasing the supply water temperature on heat loss in the LDES loop and increased COP for building-level heat pumps. For this test, LDES supply water temperature setpoint was increased from 9°C to 15°C from November 2020 to January 2021.

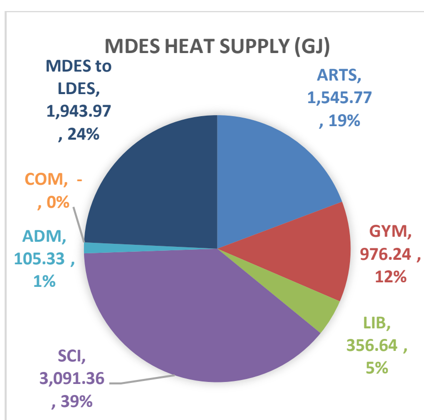

Figure 17: Heat Supplied from the MDES plant to various demand buildings for FY21-22

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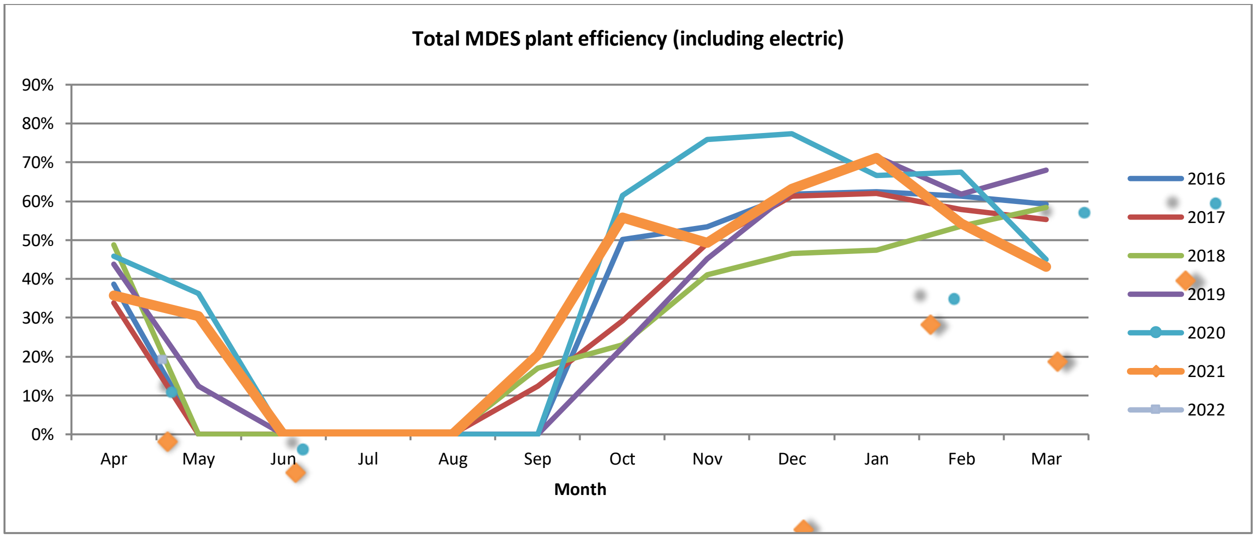

Figure 18: MDES plant efficiency

MDES plant efficiency went down in the heating season of FY21-22 compared to FY20-21 due of reduced heat supply to LDES plant from MDES (7,653 GJ in FY20-21 compared to 1,945 GJ in FY21-22). When MDES boilers provide heating energy to LDES loop, LDES plant returns a lower temperature water to MDES boilers, resulting in increased efficiency.

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[15]. 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

[15] 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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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.

- 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.

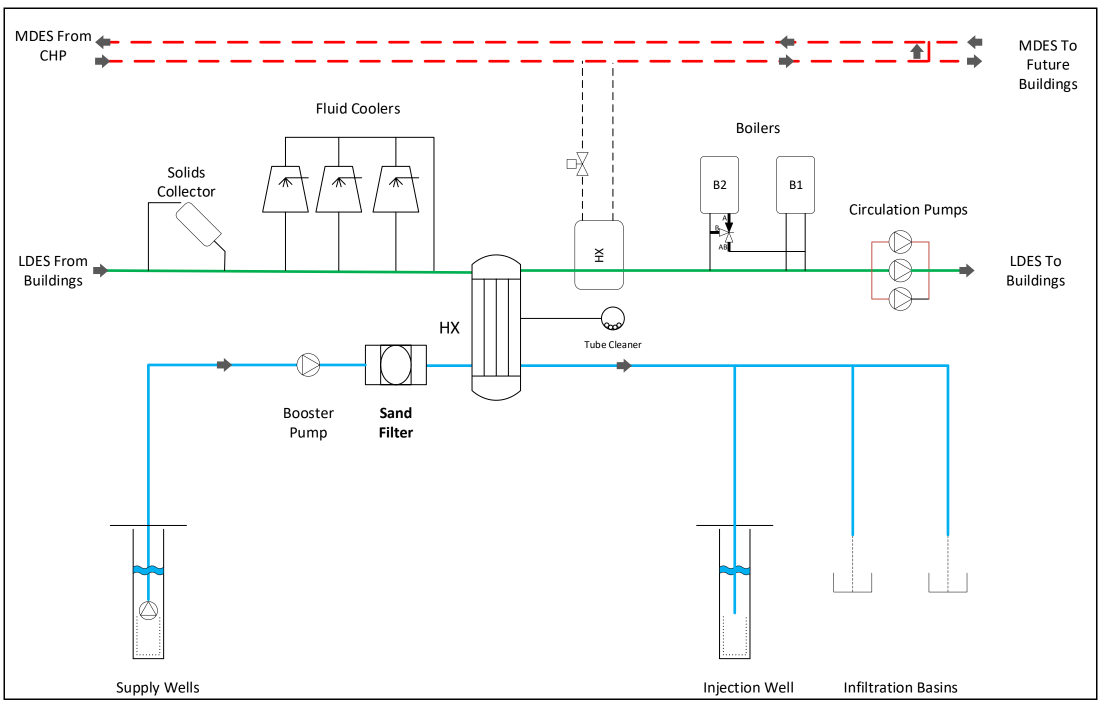

Figure 19: LDES plant block diagram

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-

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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 8.40%) 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 compared to FY20-21.

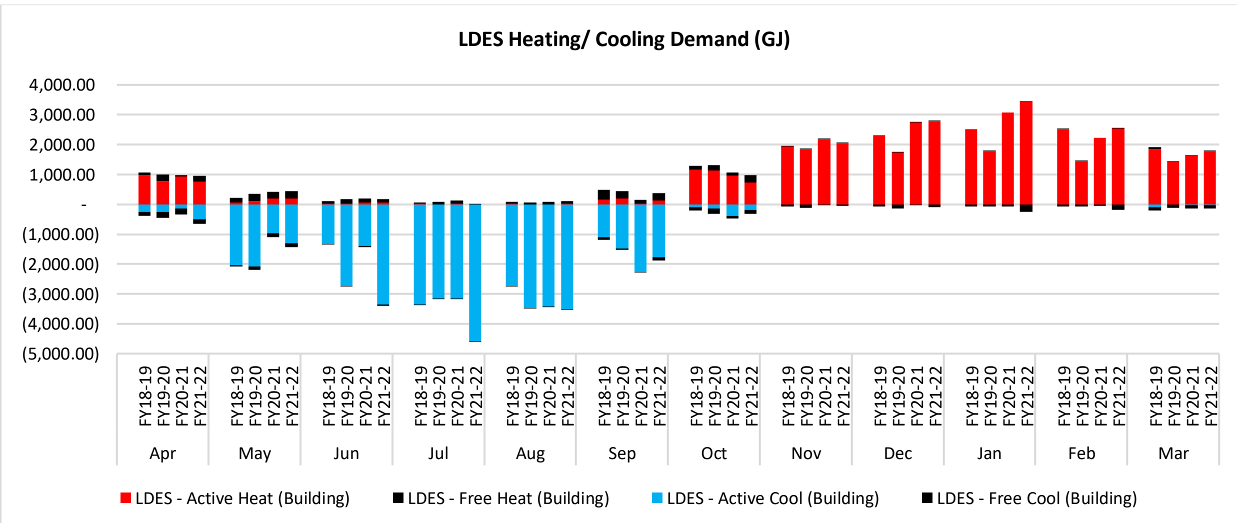

Figure 20: Thermal Energy demand from the LDES plant

Figure 21 shows the various sources of heat injection and rejection in FY21-22 and Figure 22 shows the breakdown heating or cooling supply between various buildings from LDES plant.

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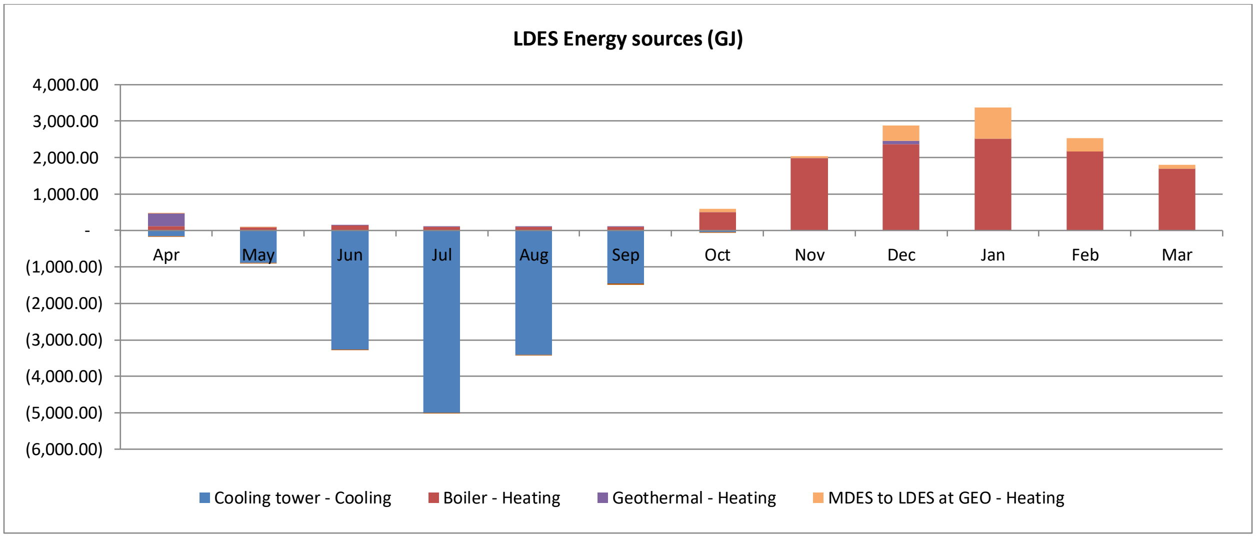

Figure 21: LDES Heating and Cooling Sources for FY21-22

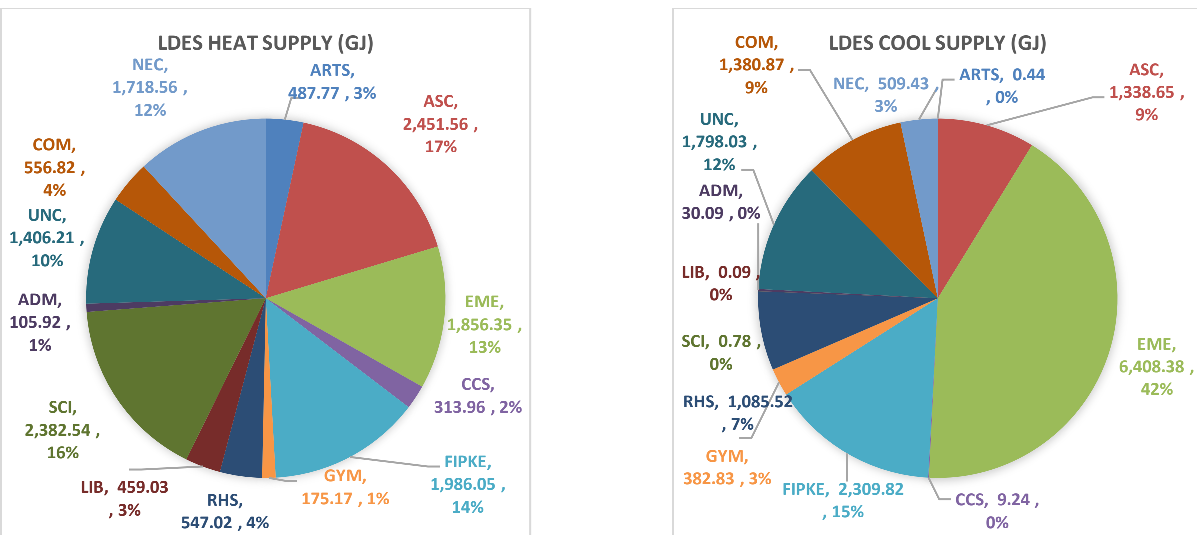

Figure 22: Heat Injected/ Rejected from LDES plant to/from various buildings for FY21-22

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 448 GJ of heat was extracted from geo-exchange system in FY21-22 compared to 2,064 GJ of heat extraction in FY20-21 which might be due to operational reasons (Refer to Figure 23). Geothermal heat output reduced from FY19-20 to FY20-21 as a result of LDES

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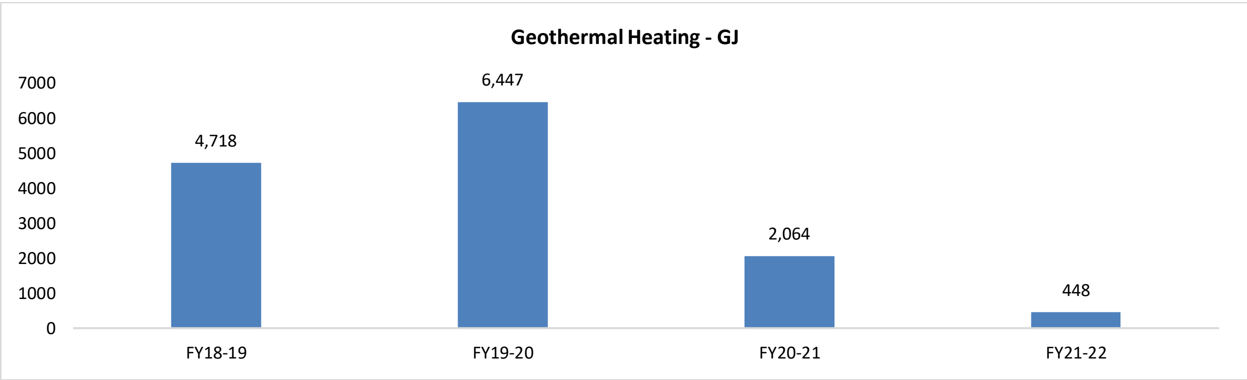
testing in which LDES supply water temperature setpoint was increased from 9C to 15C from November 2020 to January 2021. This test was conducted to understand the cost-benefit analysis of increasing the supply water temperature on heat loss in the LDES loop and increased COP for building-level heat pumps. The geothermal can provide effective cooling but does have environmental risks injecting warm water back to the earth.



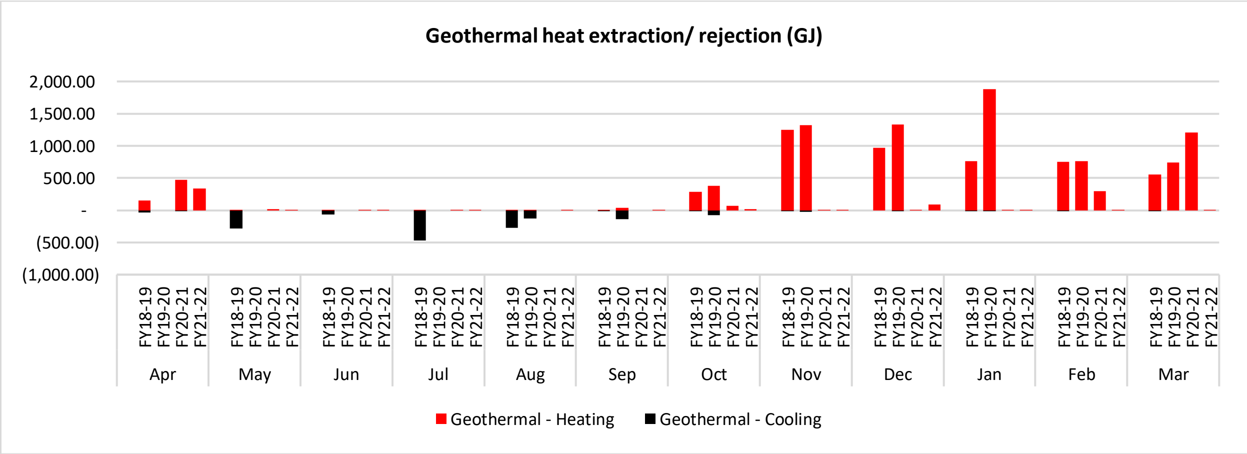


Figure 23: Quantities of Heat extracted/ rejected from Groundwater geo-exchange system

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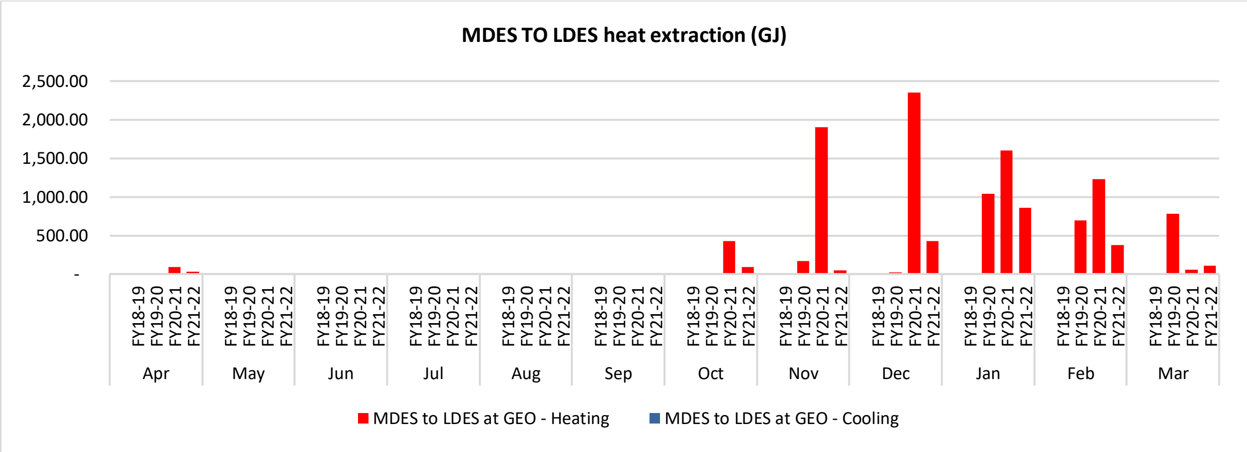

Figure 24: Quantities of Heat extracted from MDES to LDES system

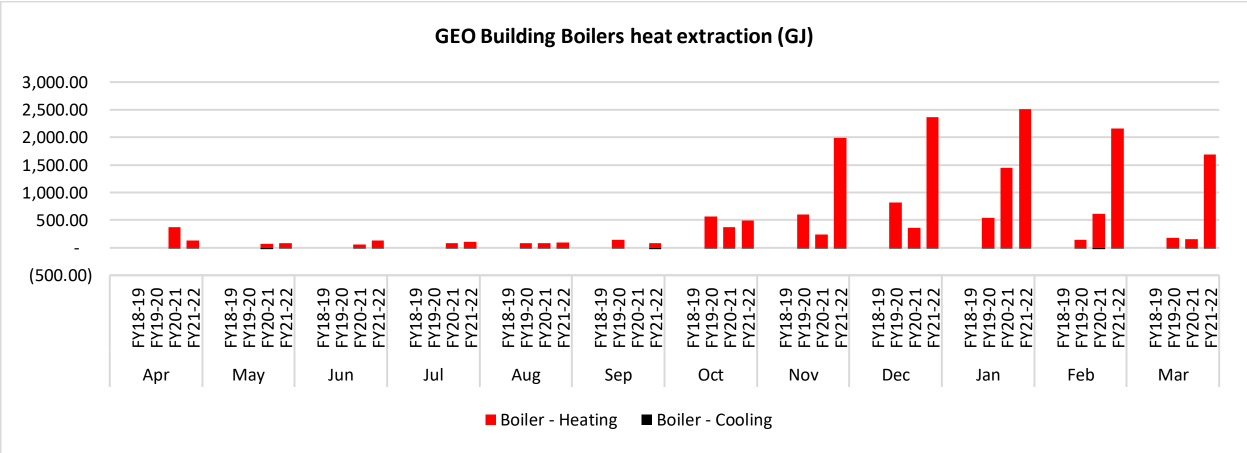

Figure 25: Quantities of Heat extracted from MDES to LDES system

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%. Refer to 2021 values from October to February where efficiency is below 100% as the open loop system was not operational.

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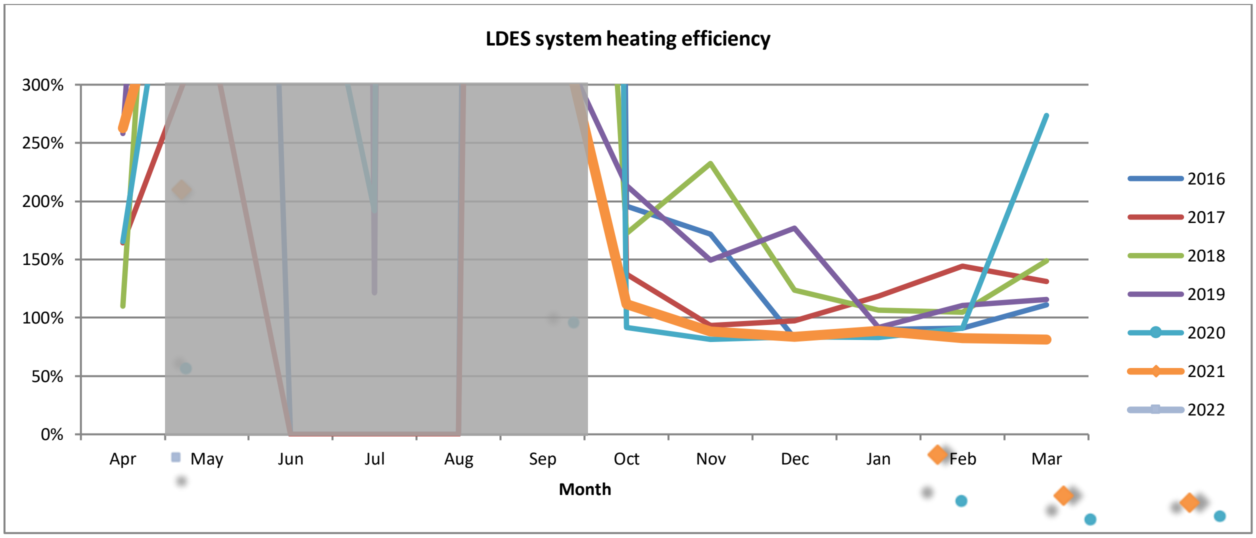

Figure 26: LDES System heating efficiency[16][17]

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 14,232 GJ for FY21-22, a 13.2% increase from 12,568 GJ in FY20-21.

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.

[16] Refer to months between October to April for heating system efficiency
[17] Due to measurement error and 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%.

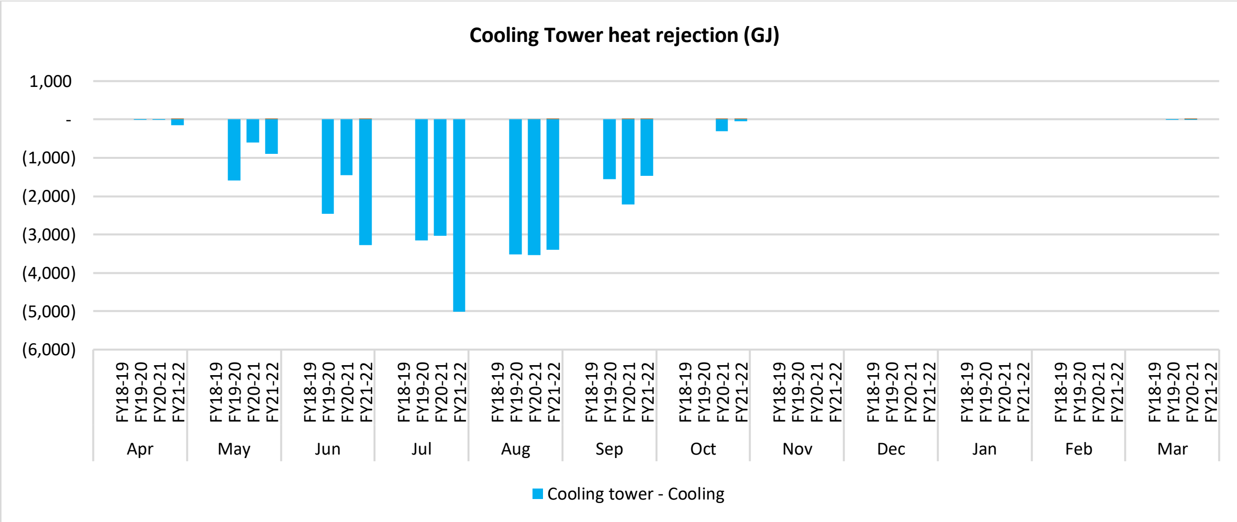

Figure 27: Quantities of Heat rejected by cooling towers

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 15 during peak cooling season.

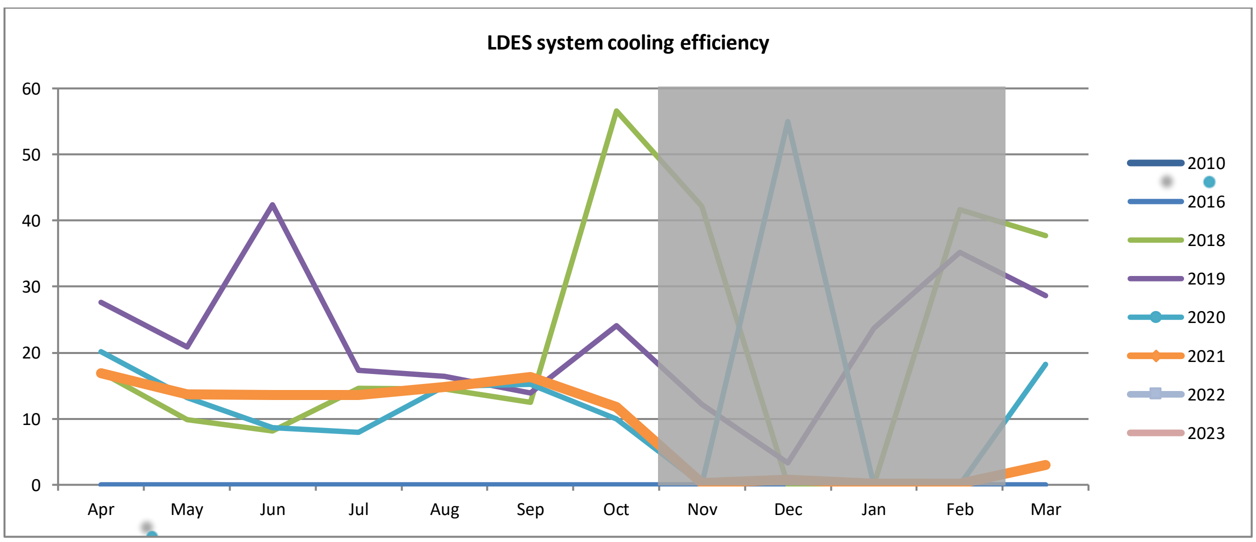

Figure 28: LDES Cooling Towers Heat Rejection Energy Efficiency[18]

[18] 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) 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.

SES Consulting projected three DSM scenarios based on different implementation plans for the identified project bundles, as presented in Figure below:

- DSM-1: This is based on the implementation of project bundles FY2021 and FY2022, with no additional energy conservation efforts beyond that.
- DSM-2: This is based on the full implementation of project bundles FY2021 and FY2022, with savings from the remaining bundles (FY2023 – FY2025) linearly scaled to match an annual budget of $200k.
- DSM-3: This is based on the implementation of all project bundles (FY2021 – FY2025) as planned over the next five years, with the GHG emissions reduction over the remaining five years (up to FY2031) extrapolated.

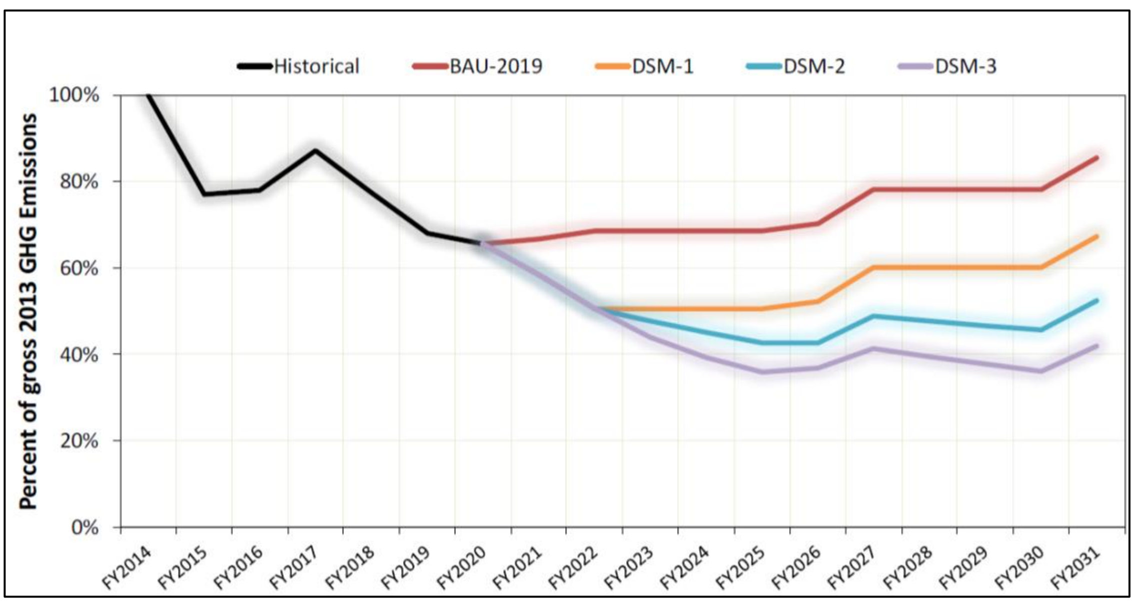

Figure 29: SEMP 2020 Modelled DSM scenarios

DSM-2 has been the chosen strategy to set and meet the goals with respect to carbon emissions reduction. The same has been used in the CAP emissions scenario modeling which was used as the basis of CAP 2030 goal.

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 – Occupancy Controlled Ventilation (Underway for SCI building)
2. Recommissioning of existing controls at ARTS building (Underway)
3. Demand controlled ventilation for ASC MUA-2
4. Demand controlled ventilation for FIP MUA-1
5. Demand controlled ventilation for FIP MUA-2
6. Demand controlled ventilation for SCI AHU-7
7. Demand controlled ventilation for SCI AHU-8
8. Night-time precooling (Underway)
9. Recommissioning of existing controls at ASC building
10. Recommissioning of existing controls at FIP 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
- 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.

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As discussed in Section 3.2. the existing strategy[19] 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.

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

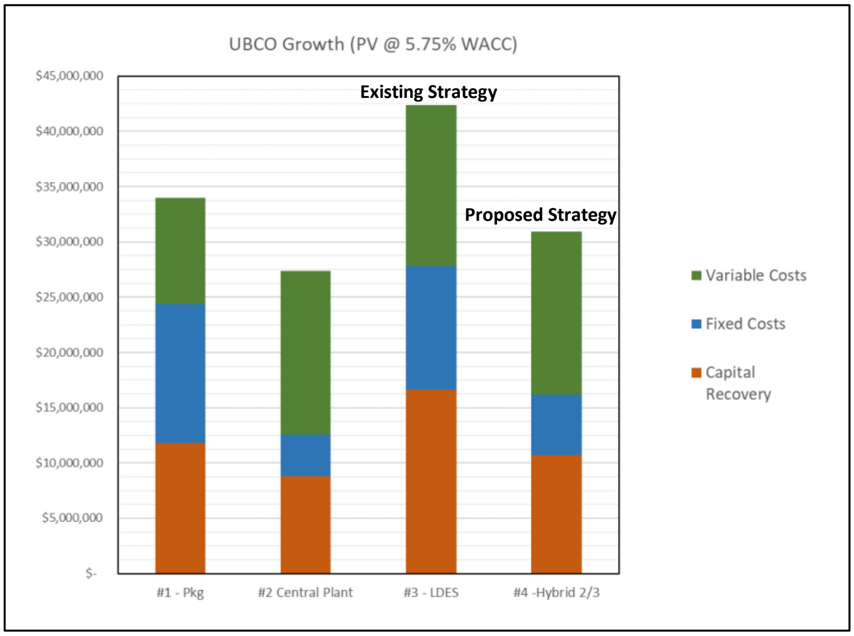

Figure 30: Cost comparison of various alternatives for new building growth

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 dJoule LLC to advance the schematic design and development of the cluster plant in the ICI building. Figure 31 below provides schematic of the

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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 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.

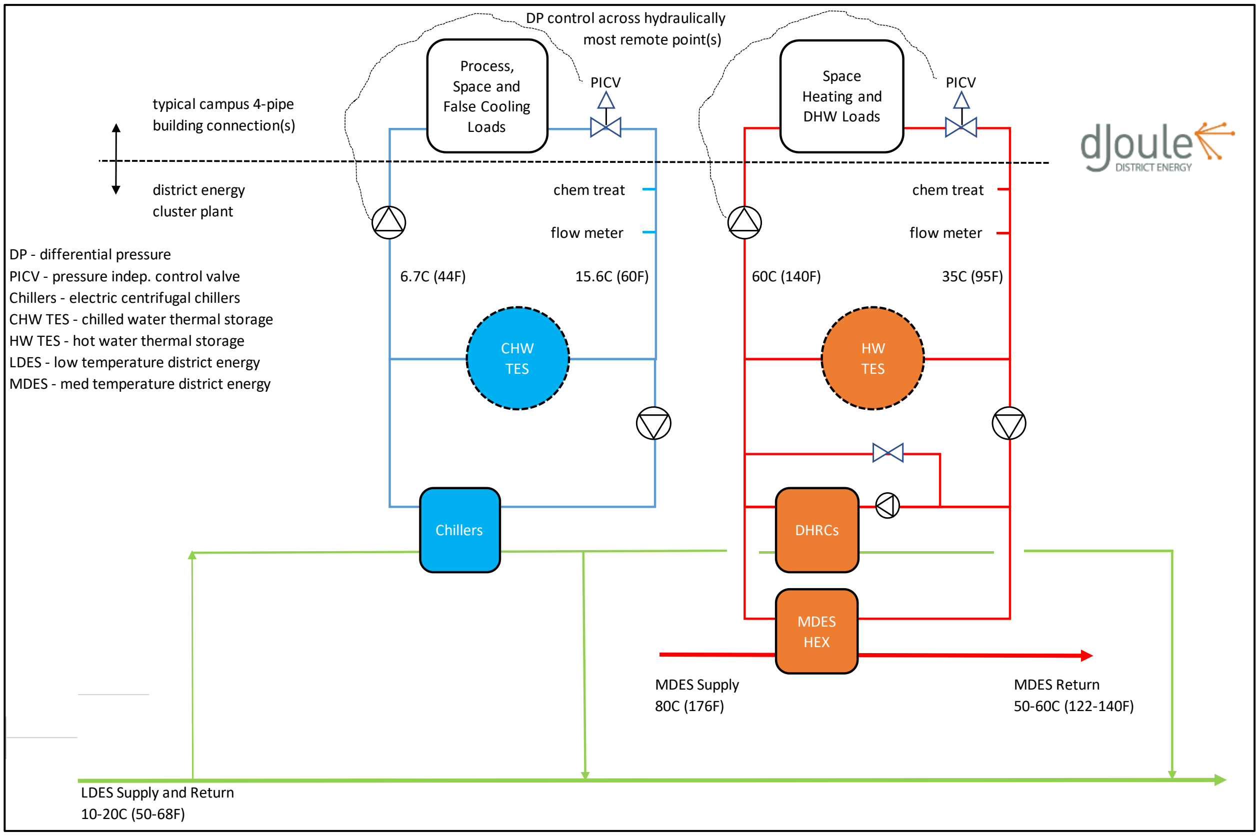

Figure 31: ICI Cluster plant proposed high-level design

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.

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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.

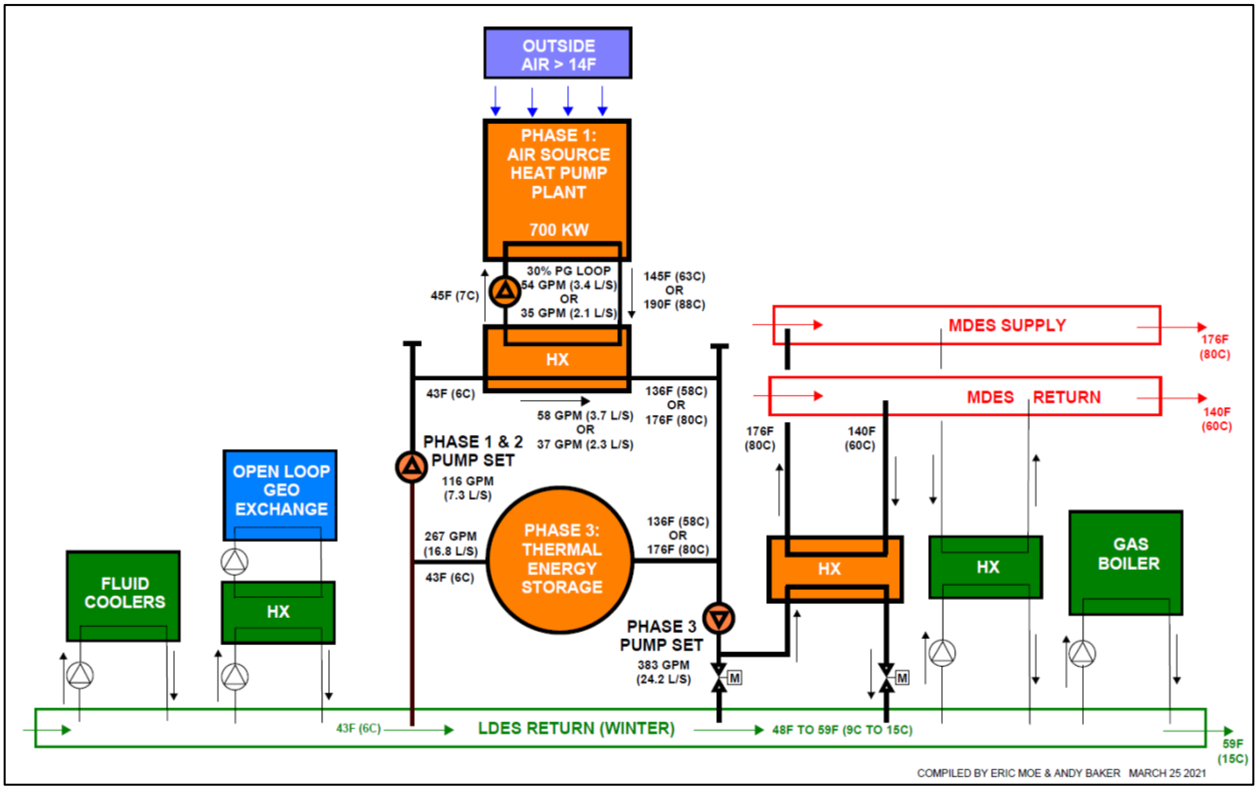

Figure 32: DE Decarbonization schematic design

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 planned for FY22-23 and install ASHP (Phase 1 of DE decarbonization strategy) by FY23-24.

Energy Team has engaged UBCO Project Services to kick off two parallel projects which include

1. Phase 1 of DE decarbonization strategy i.e. installation of ASHP and
2. Installation of ICI 4-pipe infrastructure to serve heating and cooling demands of surrounding buildings from ICI cluster plant.

4.3 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

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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.

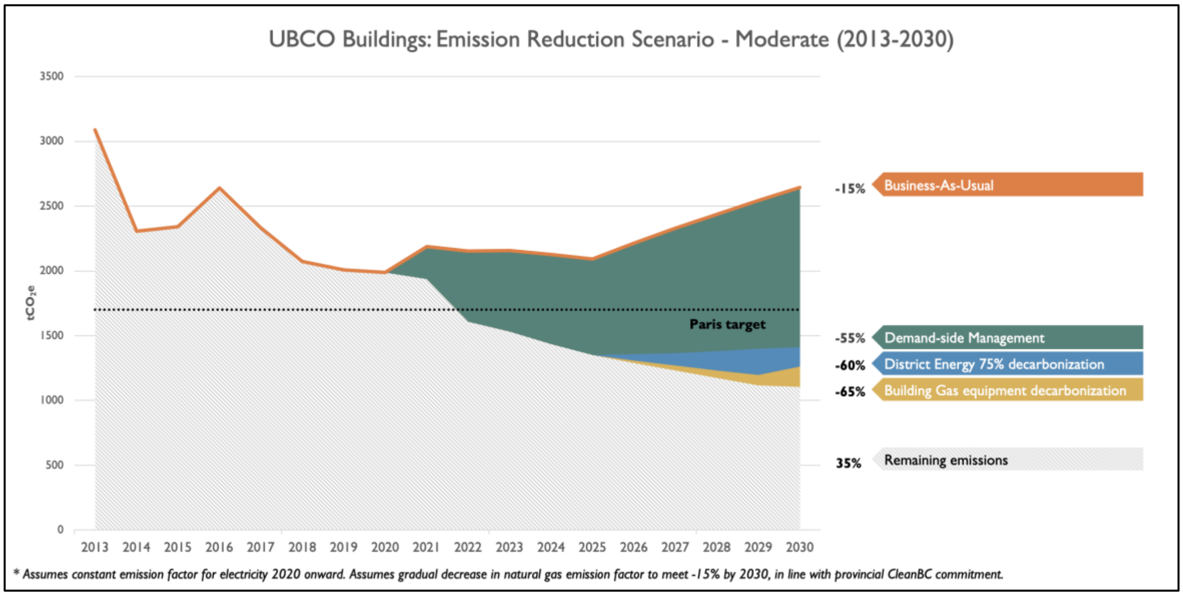

Figure 33: DE Decarbonization schematic design

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.

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4.4 UBCO Net Positive Modelling Study – Archetype update and analysis

Energy Team was working 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 includes 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 is also considered. This work completed in Q3 of FY21-22.

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.

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 18°C	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

This study also provided various energy targets for UBCO building archetypes which are expected to be used to develop Green Building Action Plan Targets for UBCO campus.

4.5 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. Currently, work is underway to connect the backend of the dashboard (R platform) with the existing Siemens Desigo system (UBCO is using this system to maintain campus operations through trend log reviews) to create a parallel database which can be further used for energy monitoring.

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.

4.6 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 FY22-23.

4.7 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.

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4.8 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.

4.8.1 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 since its commissioning.

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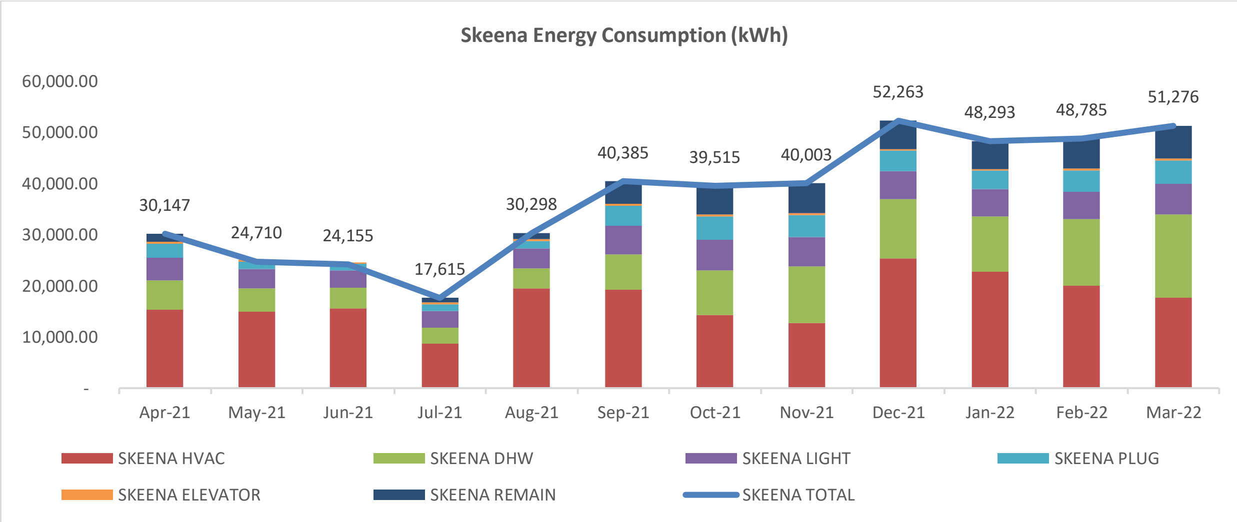

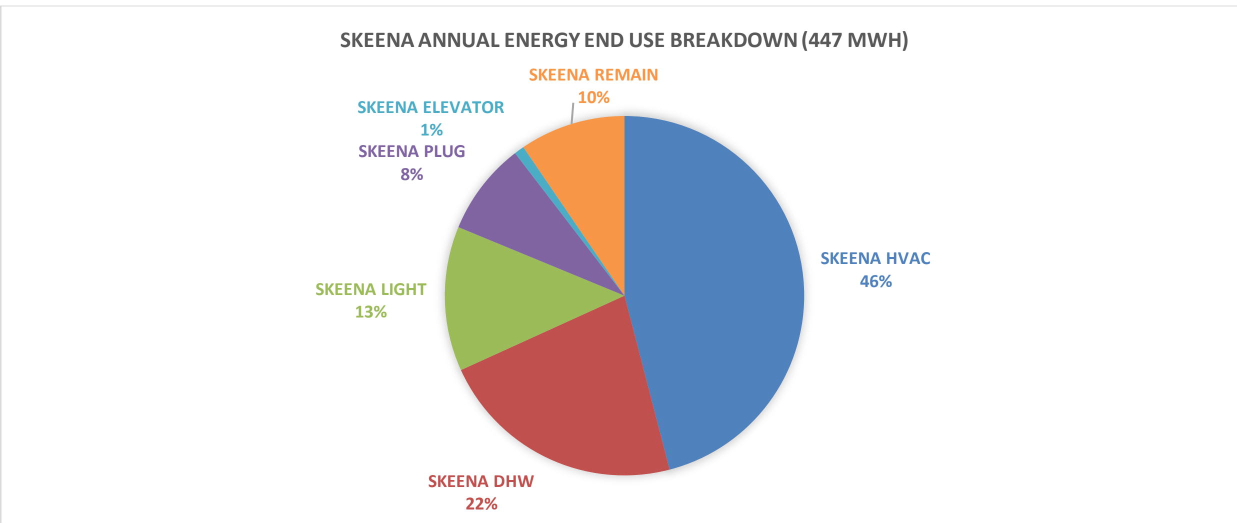

Skeena EUI is 68.77 kWh/m2. Boiler in Skeena consumed around 30% of the total hydronic equipment electricity consumption i.e. Boiler (27 MWh) and Air Source Heat Pump (67 MWh) to supply hydronic heating and cooling energy to the building.

4.9 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.

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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.

4.10 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.

Major update to HVAC TG: UBC's Climate Action Plan (CAP) has set a target of 100% reduction in GHG emissions below 2007 levels by 2050[20]. In support of this plan, natural gas shall not be used as the primary heating source in domestic water heating and in new and replacement air handling and space heating equipment, including but not limited to rooftop units, unit heaters, space heaters, etc. Natural gas may be used as a backup heating source at the unit wherever required to ensure heating requirements can be met. Refer to "Section 22 30 00 Plumbing Equipment" for Domestic water heating and "Section 23 05 00 HVAC – General Requirements" for Heating, Ventilating, and Air Conditioning (HVAC).

4.11 CCS Deep Retrofit study

With the distribution and energy transfer station strategy set (Refer to Section 4.2. and 4.8.), the focus now turns to existing building upgrades. Several buildings on campus have a significant range of equipment and systems that are, or are approaching end-of-life. Many of the equipment in the existing building are on deferred maintenance. Many studies have shown that delaying maintenance can increase future costs and capital expenditures by as much as 400% to 600%[21]. It also contributes to safety hazards, energy inefficiency, and reputational damage for organizations.

An assessment of these systems and appropriate recommendations for end-of-life replacements and deep retrofits will enable decisions to be made that will align with the DE strategy and CAP goals and targets. A prior evaluation will realise any enabling projects that will be required ahead of time. Also, if a premature failure occurs an appropriate solution can be implemented.

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[20] Please note that these targets are for UBC Vancouver campus.
[21] Altus Group: Facilities maintenance 101; https://www.altusgroup.com/services/insights/facilities-maintenance101-how-to-get-the-most-from-your-maintenance-budget/

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A study was carried out to provide deep retrofit recommendations and individual replacement options for main and terminal HVAC equipment within the CCS building.

In order for the CCS building to be ready for the cluster plant conversion, new 6" (150mm) chilled water and 4" (100mm) or 6" (150mm) heating water mains will be brought up to the CCS building from the new cluster plant. These services will enter the building in near the location where the existing LDES service is brought in. The heating and cooling terminal units will all need to be converted to be compatible with the lower heating water temperatures. Following two options were evaluated for this work:

- Replace air handling units and fan coils i.e.
  - Replace MUA-1 with new unit that includes a switch over coil and improved filtration,
  - Replace RTU-1,2,3,4 with new roof mounted units that include switch over coils,
  - Replace FC-1 through 14 with new fan coils that have static fan for improved filtration.
- Rebuild major equipment only i.e.
  - Replace MUA-1 heating coil with new switchover heating/ cooling coil
  - Replace RTU-1,2,3 heating coil and DX coil with new switchover. Remove or abandon existing DX systems.
  - Provide switch-over control valves for FC-1 through 14 cooling coils and new two port valves on the existing heating coils.

Similar study is being carried out for ADM building to inform building retrofit and connection with ICI cluster plant.

4.12 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 (4,000 GJ in December and 1,000 GJ in January) starting December 2021. This initiative is in line with the UBCO CAP 2030 and has a total premium of $30,870 for 5,000 GJ RNG.

4.13 UBCO Lower Innovation Precinct Cluster Plant concept design

To support future campus needs, the UBCO Energy Team has engaged Integral Group Consulting to perform a high-level concept design to outline preliminary requirements and indicative capital costs for a potential Lower Innovation Precinct Cluster Plant (LIPCP). Similar to the ICI Cluster Plant currently being designed, the Lower 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. The concept design considered two options for the location of the cluster plant i.e., Option A: Adjacent to the existing Geoexchange building and Option B: Within basement of a future Lower Innovation Precinct building.

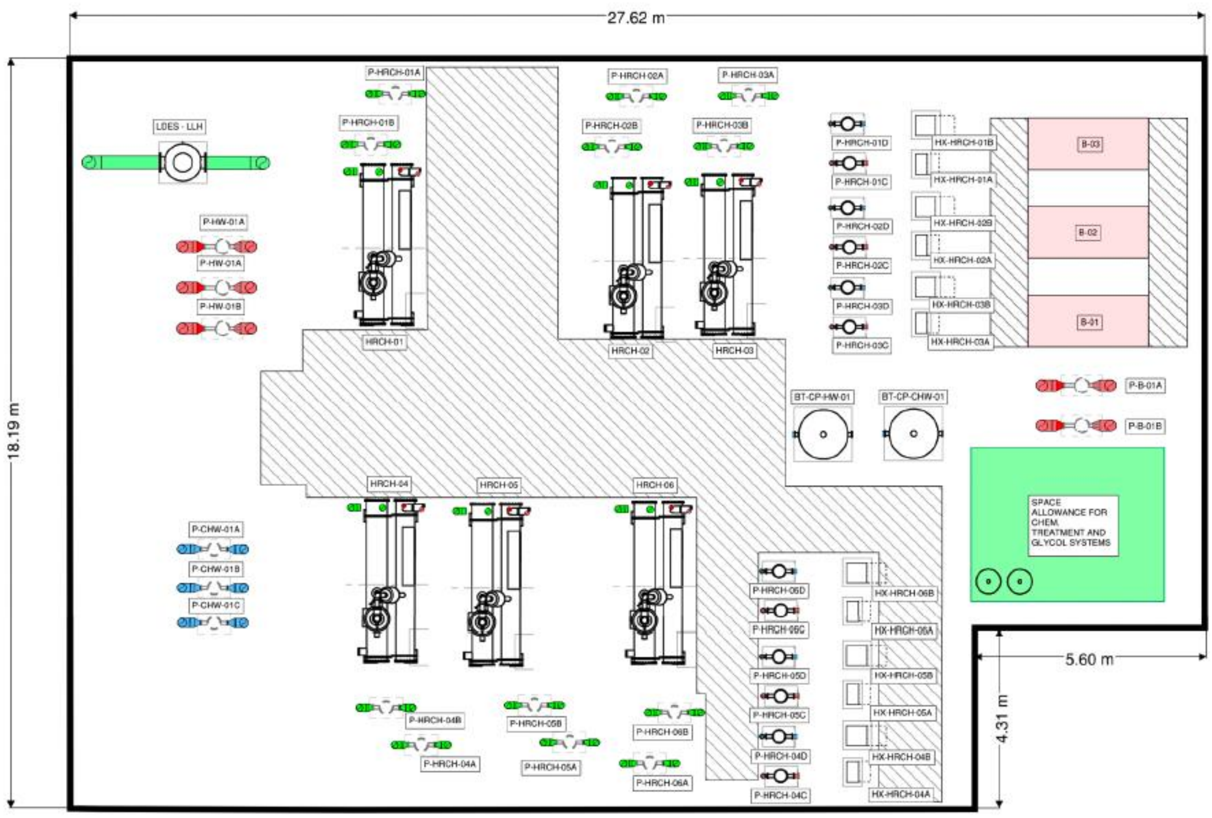

Figure 34: LIPCP Cluster plant equipment layout

A rough order-of-magnitude of the capital costs for both options have been included in the report. The capital costs for both location options are similar at around $27.5 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 LIPCP.

Option A has a higher architectural cost associated to the construction of a standalone structure, as opposed to Option B where IP-15 will be expanded to accommodate the new Cluster Plant. Both options have similar mechanical costs as the LIPCP has near identical equipment, with the exception that Option A will not require gas-fired condensing boilers for peaking by leveraging the MDES for heating.

Although the capital costs have no significant difference, when electrical and distribution provisions have been factored, Option B could provide greater construction efficiency by construction the Cluster Plant in conjunction with IP-15.

One idea proposed to service the new Cluster Plant was to install a new privately owned substation fed via a new high voltage primary service from FortisBC. There are inherent benefits to such an approach, the most important being that spare capacity can be built into the initial system to allow for future additions on the campus without requiring additional service upgrades from FortisBC. This can avoid additional project delays or costs.

The option to obtain a high voltage primary service represents a more resilient, longer-term solution rather than looking at this from a narrow, single project framework. Increased loads can be supported to deal with more intensive research demands. Next steps from this report and recent energy-related discussions in UBCO are to carry out:

- Upper Innovation Cluster Plant High Level Concept Design for Residences
- Campus-Wide High Voltage Master Plan
- High Level Concept Design of Existing Campus West Cluster Plant
- UBCO Energy Roadmap

4.14 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 with SCI, EME and COM buildings.

4.15 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 tCO2e/GWh.

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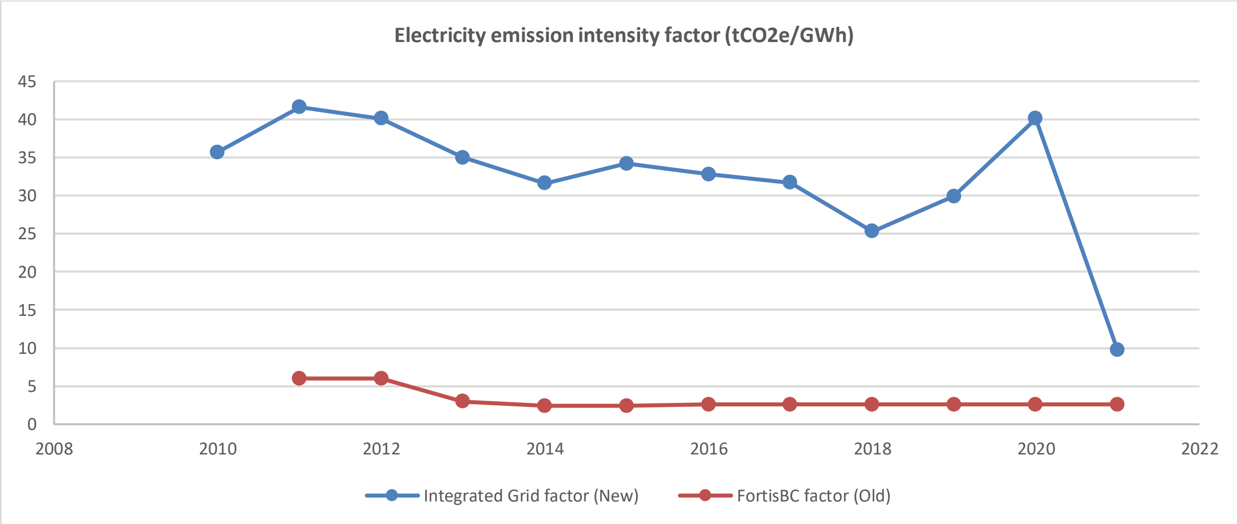

Figure 35: Electricity emissions intensity factor trend

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[22].
Figure 34 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 3.75.

The new electricity emission factor would result in an increase in total emission by around 223 tonnes CO2e in FY21-22 resulting in electric emissions share to increase from 3.80% to 12.90% for FY21-22.

4.16 RHS HVAC Study

Energy Team worked with Falcon Engineering to investigate and uncover the causes to some of the problems being experienced with the hydronic systems and make recommendations with estimates for repair. Following are a few of the issues to investigate:

- Significant portions of the first floor cannot achieve setpoints in summer and winter conditions. This indicates a lack of flow condition. Flow characteristics on the third floor Central Plant may be hindering items in first floor.

[22] 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.

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- Central Plant piping configuration could be optimized to improve capacity, efficiency, and equipment life expectancy.
- Boiler systems are required to operate to satisfy air handling systems

Following are some of the observations from the study:

- Many areas of the facility are chronically cold in the winter season.
- The bulk of the existing terminal heating equipment is undersized.
- Some of the existing HVAC systems are not configured to good engineering practice.
- The existing mechanical systems are not under proper control.
- The existing mechanical systems use a disproportionate amount of energy.
- Significant upgrades to HVAC systems are required to bring systems to good design practices, guidelines and standards
    - Phase 1 – High priority upgrades: Replace Terminal Equipment for the Worst Performers (56 units)
    - Phase 2 – Moderate priority upgrades: Reconfigure Heat Pumps, Reconfigure Buffer Tanks, Controls Re-Program and Re-Commission
    - Phase 3 – Low priority upgrades: Demand control ventilation, Replace Terminal Equipment for the 2nd Worst Performers (18 units)
    - Phase 4 – Future Consideration, Reconfigure Hydronics Systems to Optimize Performance: Option A: with Campus Central Energy Source, Option B: with Current Building Energy Source

4.17 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. In FY21-22, Energy Team has worked to update OPR for new construction ICI building, & Energy transfer station (Cluster plant) and create OPR for ICI 4-pipe infrastructure, & ASHP DE decarbonization project.

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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 $231,300 of energy efficiency incentives were received this past fiscal year. In addition to these rebates $130,000 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 Science Laboratory Rooms Demand Controlled Ventilation (DCV)

SES Consulting identified this measure in their 2020 SEMP report for the FY20-21 implementation. 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 66,800 kWh Electricity and 800 GJ Natural Gas per year.

UBCO Energy Team had put forward an incentive application to perform an engineering study for this project to better determine the cost and benefits of this project. However, due to a delay in the application processing from FortisBC, the project went forward without support from FortisBC.

Siemens Controls is the prime contractor working on this project which is being managed by UBCO's Project Services along with the help of the Energy Team. Following labs have been identified for this first phase of the project:

- Priority 1 Labs: 121, 142, 143, 145, 358, 374
- Priority 2 Labs: 119, 127, 141
- Priority 3 Labs: 336, 338, 345, 347, 355, 363 (second phase of the project)

The construction start date is the first week of February 2021 and was completed in January 2022. A study is currently underway to implement the same measure in the lab-intensive ASC and FIPKE buildings.

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5.2 Recommissioning study for the Arts building

UBCO Energy Team has put forward an incentive application to perform a Recommissioning (RCx) study for the ARTS building. SES Consulting has been contracted to provide support in performing this recommissioning for the ARTS 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. This RCx study was completed in Q3 2021 which identified 92 MWh electricity and 490 GJ gas consumption. The following 5 out of 8 ECMs have been selected for implementation.

- ECM-1: Outdoor air temperature (OAT) lockout optimization
- ECM-2: Free cooling optimization
- ECM-3: Demand control ventilation (DCV) optimization
- ECM-4: Supply air pressure (SAP) setpoint reset
- ECM-6: Room occupancy sensor (OS) scheduling

The implementation of these ECMs is currently underway and is expected to be completed by Q1 2022. However, energy consumption in the Arts building increased because of a recent HVAC upgrade project in Arts which led to increase in ventilation rate of the building as it was under ventilated prior to the project.

5.3 UBCO ASC FIPKE Laboratory Rooms Demand Controlled Ventilation (DCV)

SES Consulting identified this measure in their 2020 SEMP report for the FY20-21 implementation. 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.

UBCO Energy Team worked to collect background data for this project and had submitted an incentive application for SES Consulting to perform an engineering study for this project to better determine the cost and benefits of this project.

The incentive application for engineering study was approved by FortisBC in September 2021. The scope of work is to estimate the financial and energy savings impact associated with Laboratory rooms DCV ECM (Reduced air-changes per hour in appropriate zones served by the aforementioned ventilation systems with controls recommissioning including new sensors, switches, and programming changes) for air handlers FIPKE AHU-2, FIPKE MUA-1, FIPKE MUA-2, FIPKE MUA-3, FIPKE MUA-4, ASC MUA-1, ASC MUA-2, and ASC MUA-3.

Energy Team is working with SES Consulting to complete this study and implement the measure.

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5.4 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 is expected to be completed by Q1 2022.

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5.5 FIPKE waste heat recovery

Currently the strobic system, which is composed of three fans, exhausts air to the atmosphere without any heat recovery. A feasibility study is being conducted in the Fipke building to increase exhaust air heat recovery by Emergent Mechanical Engineering Ltd. This study is expected to provide sufficient level of detail to support a business case whether to proceed with the energy conservation measure.

Heat in the building is currently being served by stand-alone boilers and heat from the LDES. This study is likely to consider installation of a glycol runaround loop to recover heat from the exhaust. This heat can be used to pre-heat supply air to another unit.

A final version of the report was issued in January 2022 and the measure was deemed to be cost ineffective.

5.6 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[23]. 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[24].

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

[23] 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.
[24] The ON and OFF thresholds are true for 80% of the ventilation equipments.

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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.

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

Air Handling Unit	Current ON Threshold	Calculated ON Threshold	Recommended ON Threshold	Area serving
ARTS AHU1	5	14	14	L1 L2 Building offices
ARTS AHU2	5	5	5	L1 East Block
ARTS AHU3	8	23	23	L1 East Block
ARTS AHU4	5	14	14	L2 North Block
ARTS AHU5	10	21	21	L3
ARTS AHU6	5	19	19	L2 L3
ARTS AHU7	5	16	16	L3
ARTS AHU8	6	11	11	L1 L2 L3
ARTS RTU1	5	1	5	L1 Study Area
ARTS RTU2	5	1	5	L 1 Atrium Area
ARTS RTU3	5	3	5	L1
ASC AHU1	8	5	8	L1 Lecture Theatre
ASC AHU2	5	1	5	L1 Classroom
ASC AHU3	5	3	5	L1 Cafe
ASC MUA3	5	25	25	L2 L3 L4 Office VRF Fan Coil
EME AHU1	5	4	5	L0 L1 Lecture Theatre 50
EME AHU2	5	3	5	L1 Classroom 1151
EME AHU3	5	2	5	L1 Classroom 1123
EME AHU4	5	8	8	L1 Classroom 1121
EME AHU5	6	4	6	L1 Classroom 1153
EME AHU6	5	1	5	L1 Classroom 1202
EME AHU7	5	11	11	L1 Classroom 1203
EME AHU8	5	10	10	L1 L2 Lecture Theatre VAV
EME HRV04	2	6	6	L0 High Head labs
FIPKE AHU1	5	4	5	L2 Lecture Theatre
ADM AHU1	5	9	9	L1 Café bookstore/ Okanagan Room
ADM AHU2	5	19	19	L0 IT services
ADM AHU3	5	8	8	L0 Media/ Lower ADM Offices

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ADM AHU4	6	24	24	L0 L1 ADM Offices
ADM AHU5	3	4	4	L1 Bookstore
ADM AHU6	2	1	2	L1 Main lobby
ADM AHU8	10	4	10	L1 Cafeteria Expansion
ADM AHU9	8	4	8	L0 Theatre
LIB AHU6	8	20	20	3rd floor classrooms
LIB AHU5	5	8	8	2nd floor offices
LIB AHU4	10	12	12	2nd floor study area
LIB AHU3	5	25	25	Book and Study Area
LIB AHU2	8	9	9	Main Floor
LIB AHU1	3	4	4	Basement Supply

This recalibration is expected to save around 325 MWh of electricity consumption, 1,626 GJ of natural gas consumption resulting in $43,800 utility savings and 82 tCO2e emissions reduction.

5.7 Nechako Commons Kitchen Equipment

Nechako Commons is a new residence building with a large cafeteria and other campus amenities included. Energy Team has been working with the Project Manager UBC Properties Trust and contractors to apply for eligible FortisBC incentives for the kitchen equipment[25]. Energy Team identified additional $10,000 of eligible rebate for Nechako Commons cafeteria which brings the total to $24,000 of rebate for the appliances in Nechako Commons.

5.8 Lighting Upgrades

Upgrades of campus lighting to LED fixtures is ongoing. The majority of LED upgrades that are believed to be cost effective have been implemented. However, availability of cost-effective LED lamps continues to increase. FortisBC rebate for the LED upgrades completed in FY21-22 was around $16,000 in point-of-sale rebate which is expected to save over 100,000 kWh (conservative estimate) per year.

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.

[25] Food services (Nechako kitchen and convenience store) was out of scope of the modelled energy performance of the building based on which FortisBC's new construction rebate application was approved.

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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 $10,000 of prescriptive rebate that equipment installed in Innovation Precinct # 1 was eligible for. We have been working with the Project Manager UBC Properties Trust and contractors Falcon Engineering to apply for an eligible FortisBC incentive for the renovations.

The building was commissioned in Q3 FY21-22 and deficiencies 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.

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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.

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.

6.6 UBC Okanagan's Downtown site

The UBC Okanagan Campus (UBCO) is proposing a new building. Planning is underway for UBC Okanagan's downtown Kelowna site with a number of community-accessible facilities being considered, including a new public gallery, creative innovation spaces, and a public engagement and learning suite.

In partnership with UBC Properties Trust, UBC is planning a new building at 550 Doyle Avenue. Once design and approvals are in place, construction is expected to begin in mid-2022.

7 Appendix: Monthly Energy Performance Data for Campus Buildings

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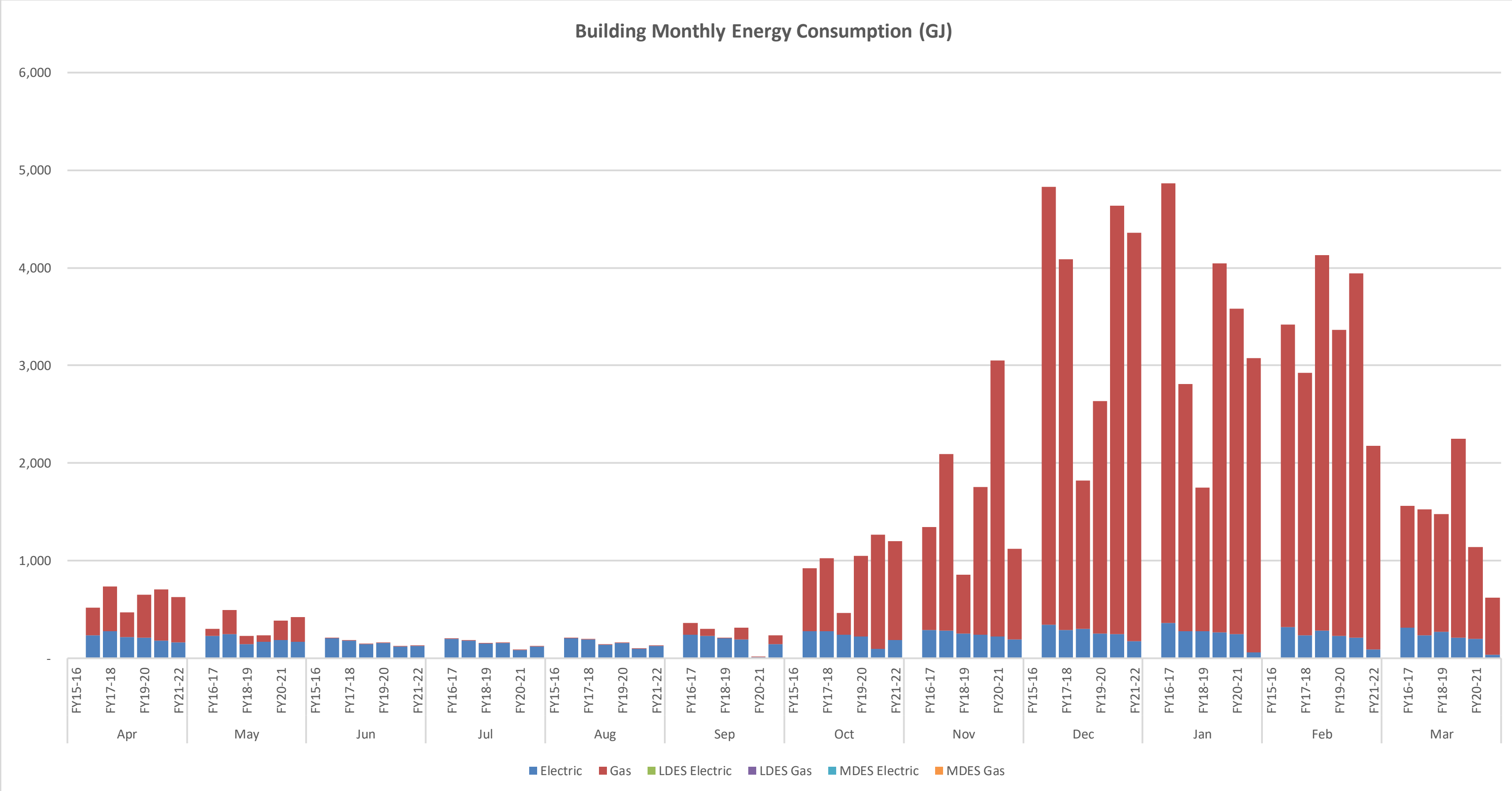
7.1 Central Heating Plant building (DES)



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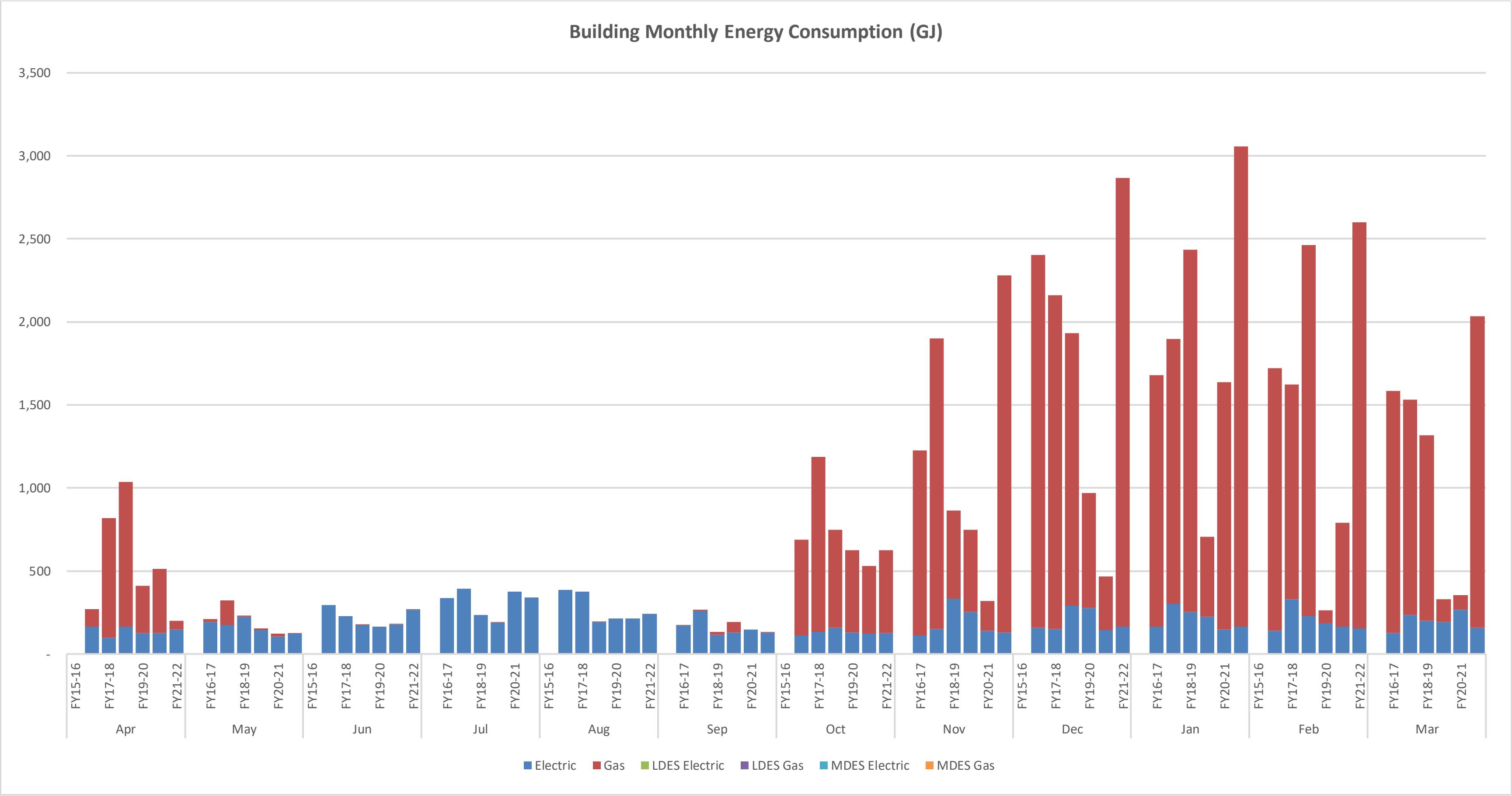
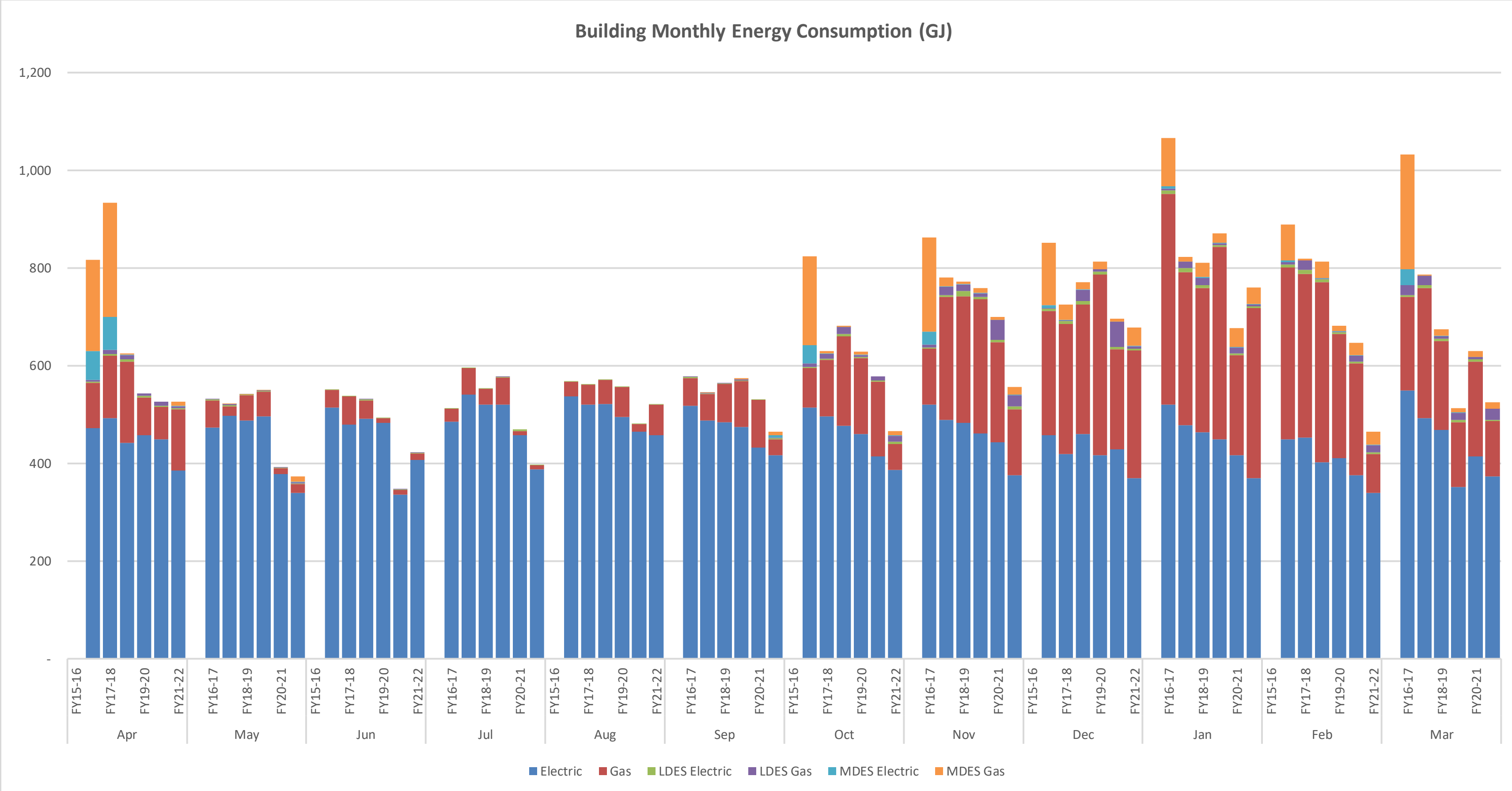
7.2 Geo-Exchange building (DES)



7.3 Administration building (ACAD)



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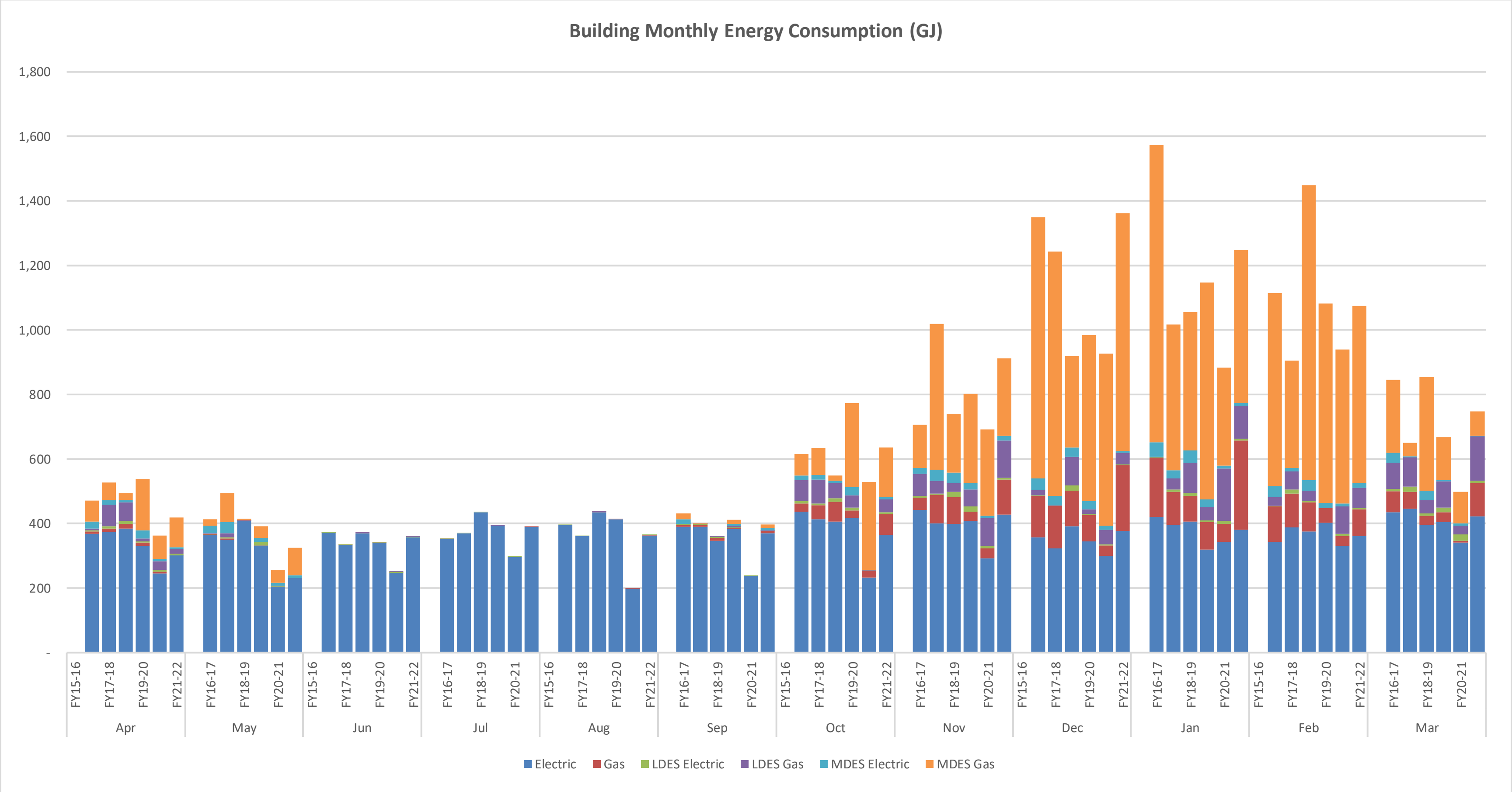
7.4 Arts building (ACAD)



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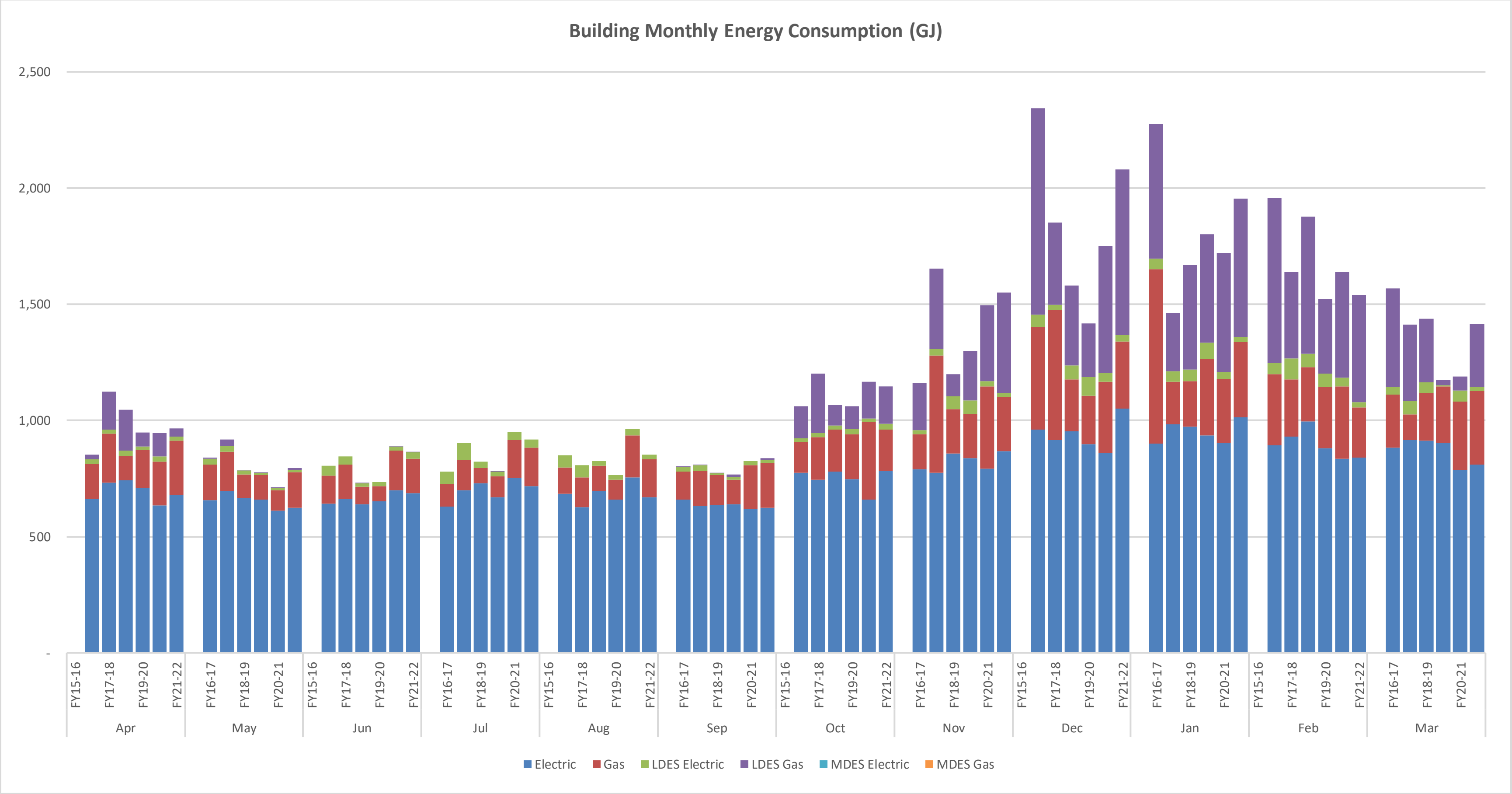
7.5 Arts & Science Centre building (ACAD)



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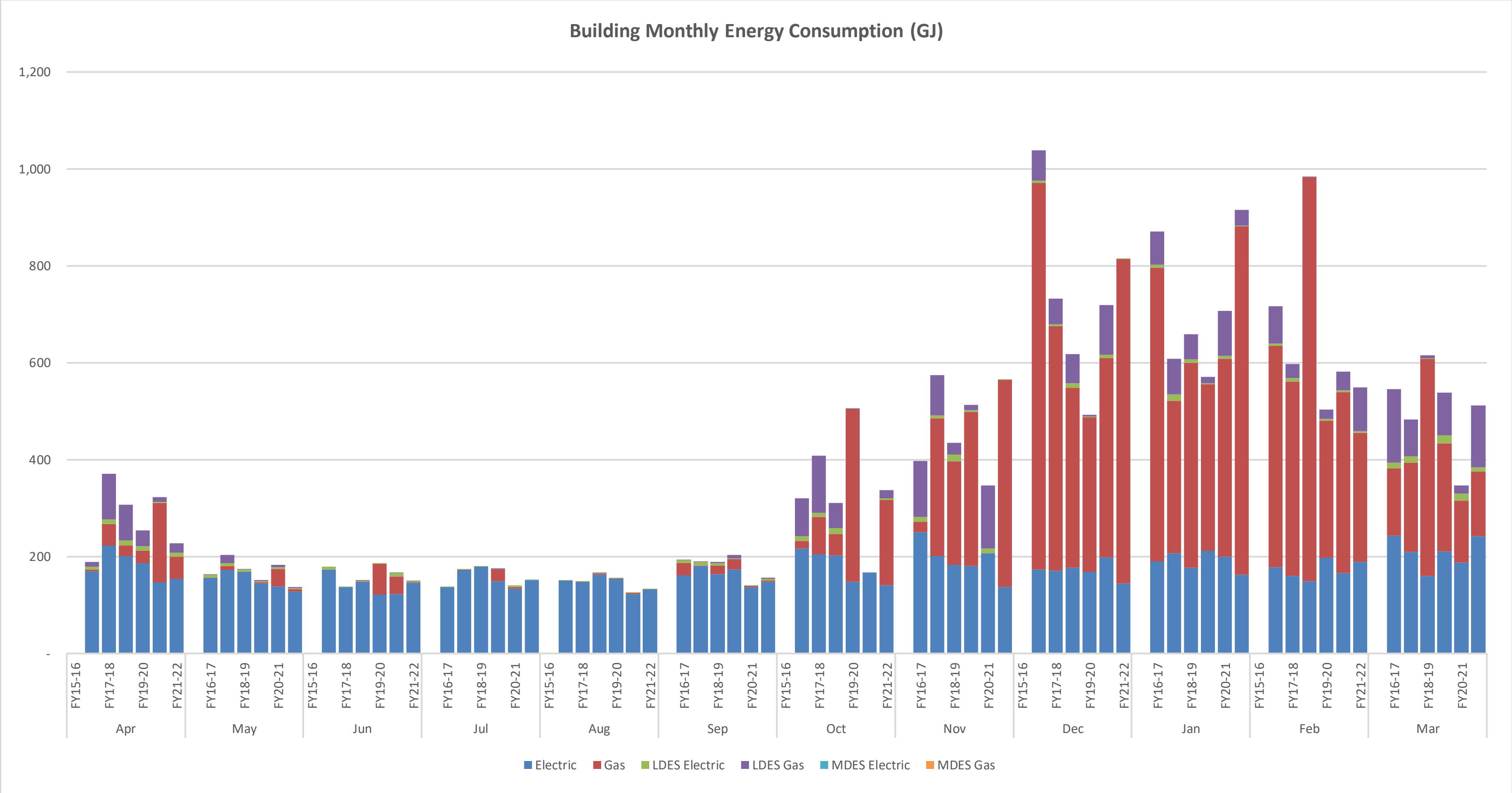
7.6 Creative and Critical Studies building (ACAD)



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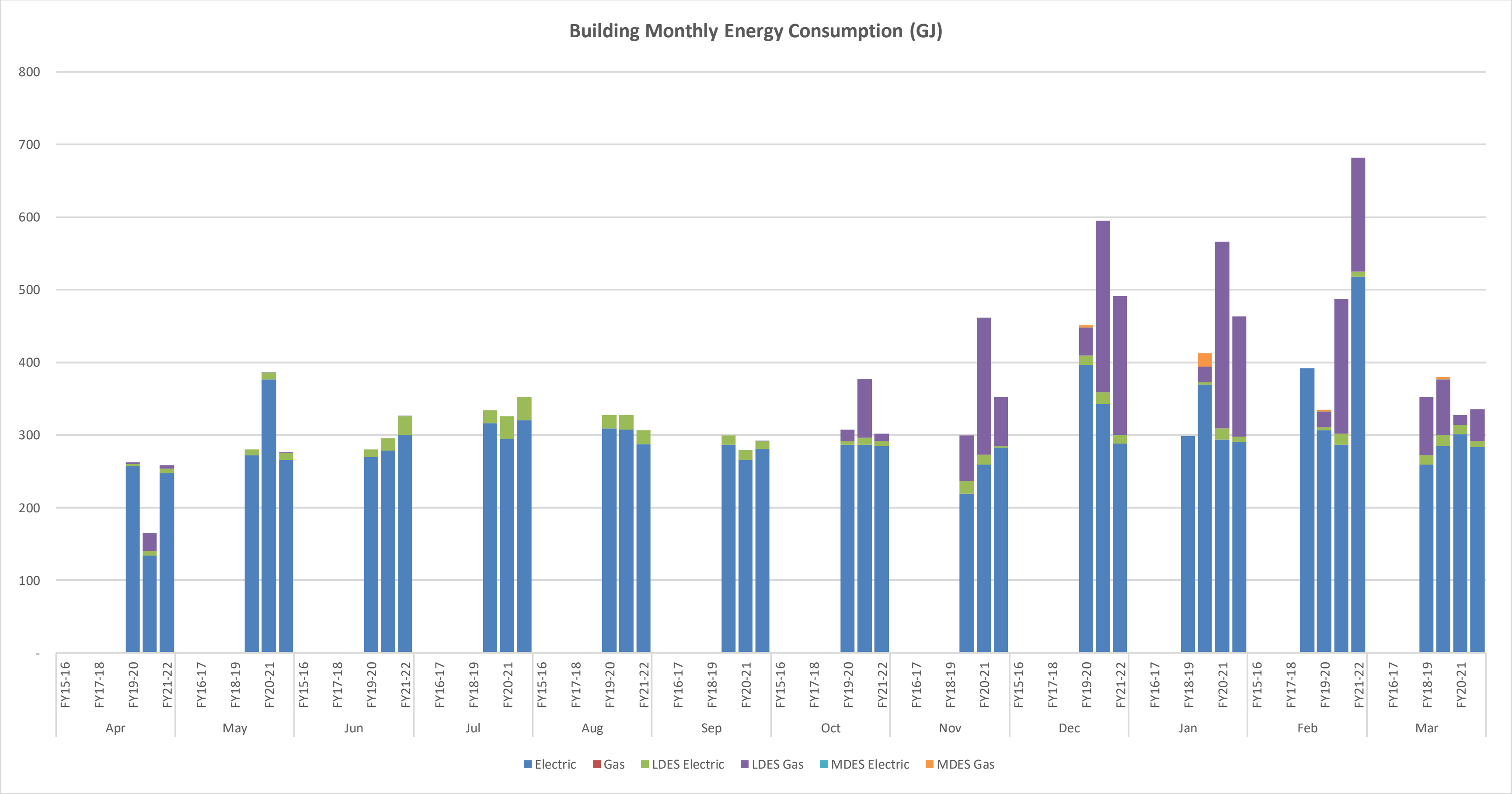
7.7 Teaching & Learning Centre (Commons) building (ACAD)



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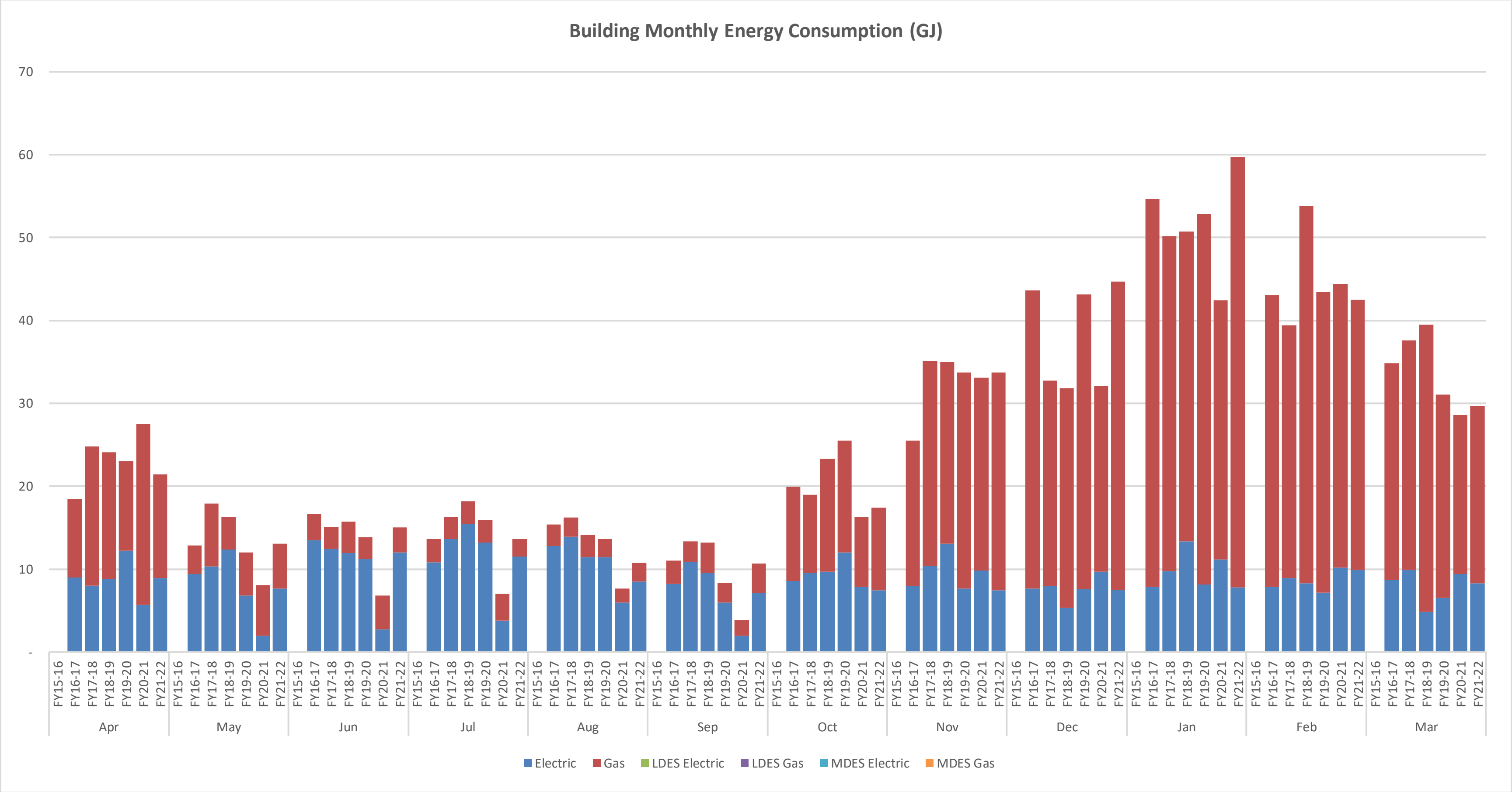
7.8 Daycare building (ACAD)



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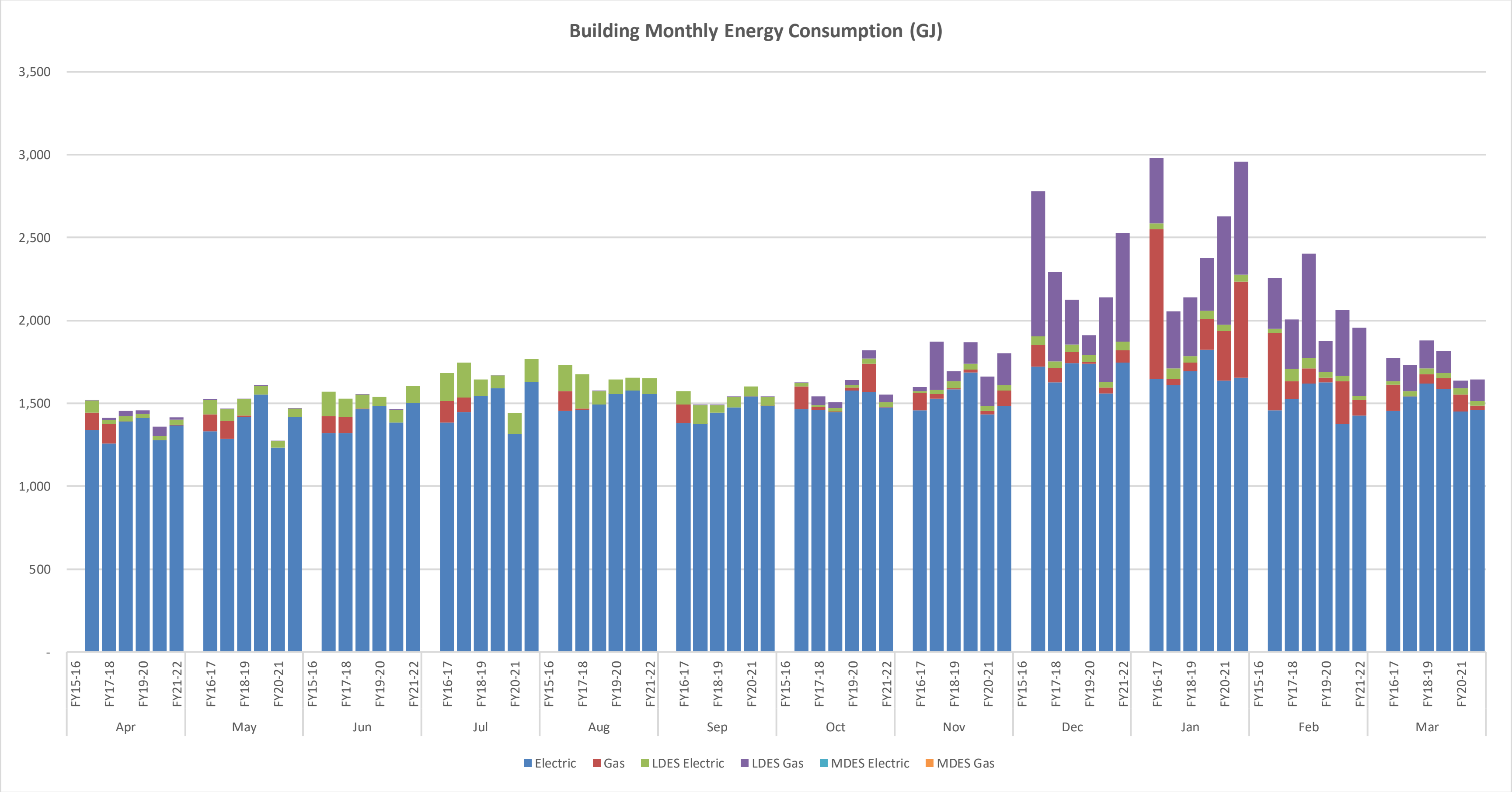
7.9 Engineering, Management and Education building (ACAD)



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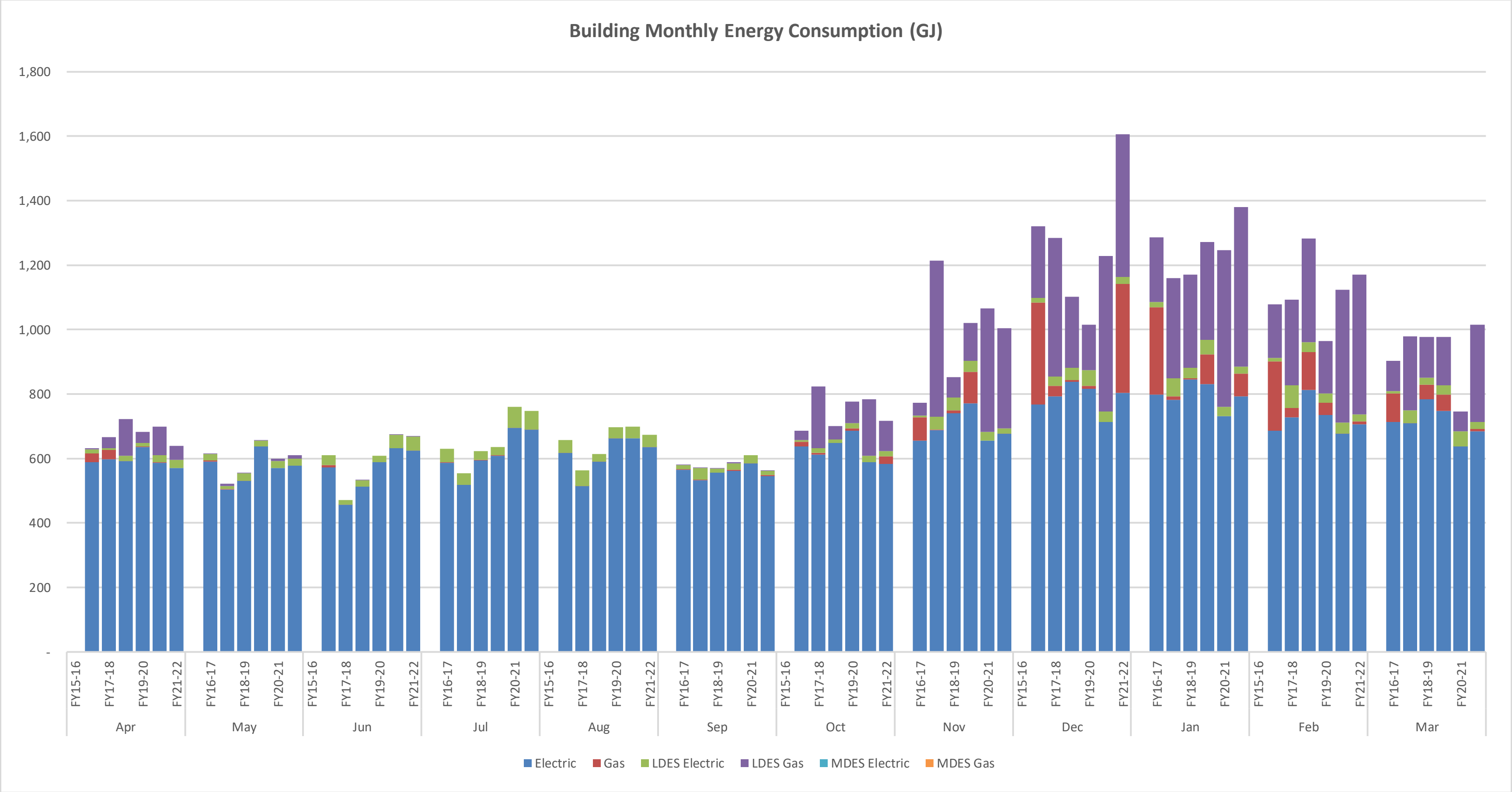
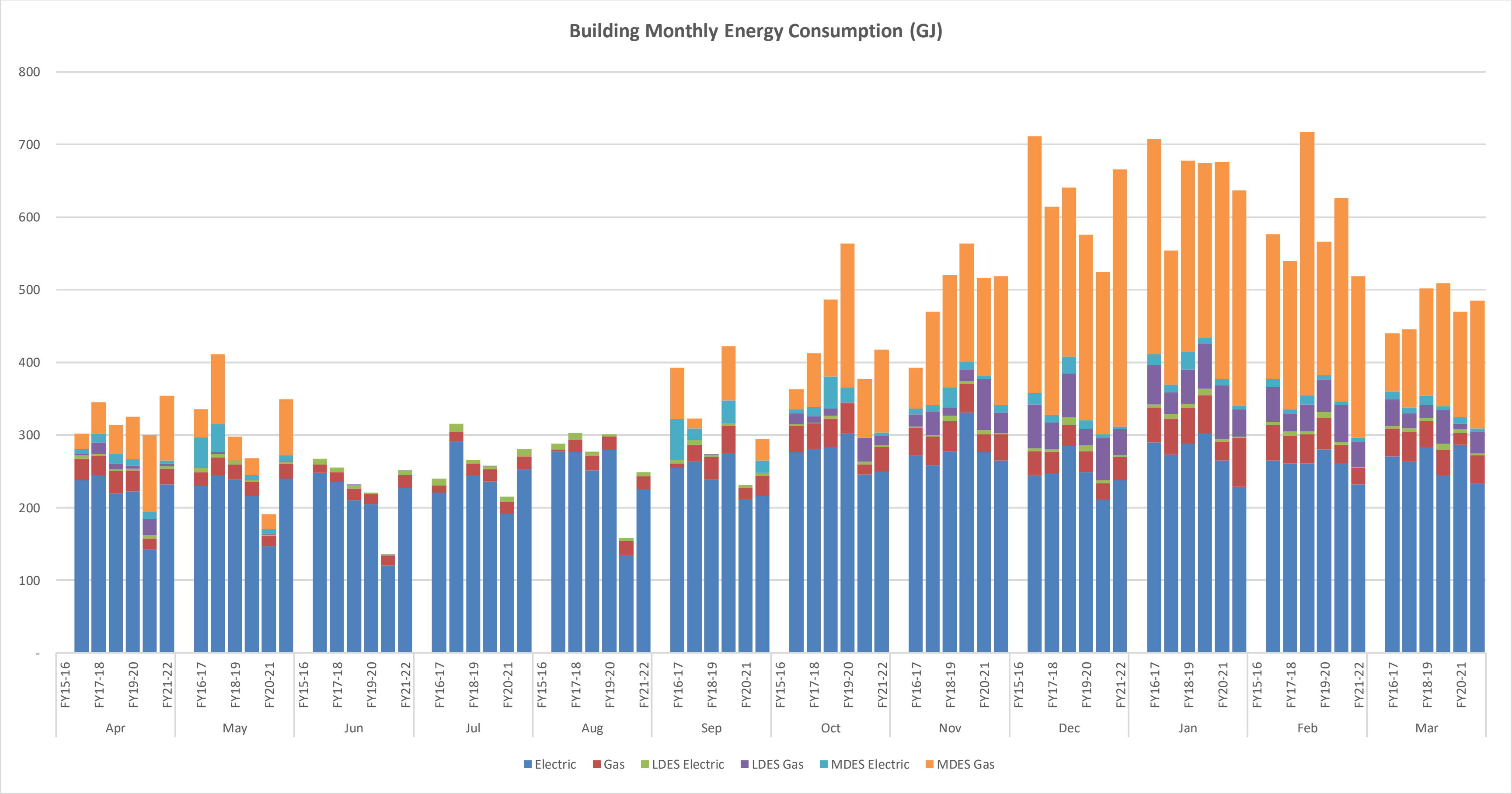
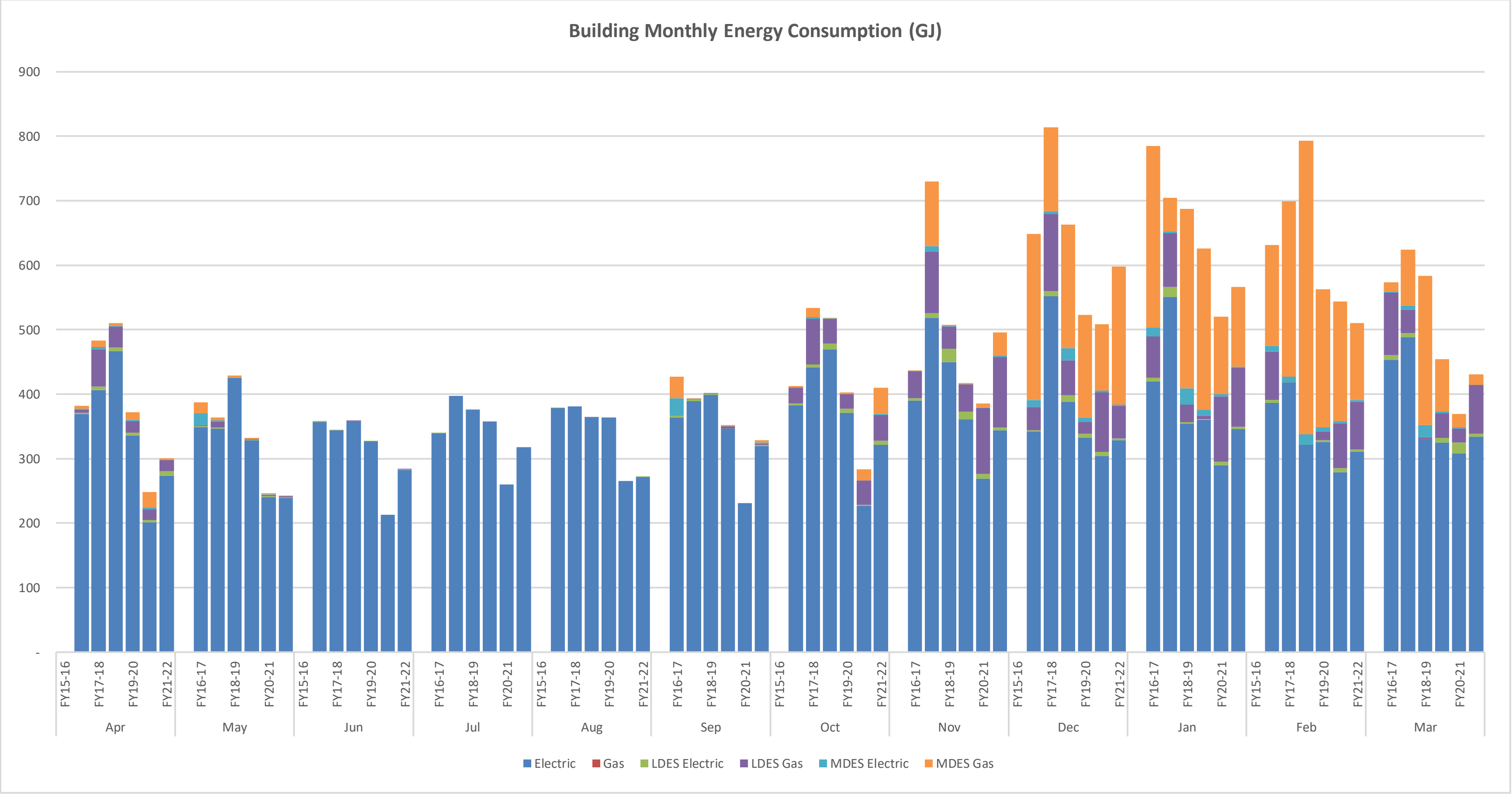
7.10 Fipke building (ACAD)



7.11 Gymnasium building (ACAD)



7.12 Library building (ACAD)



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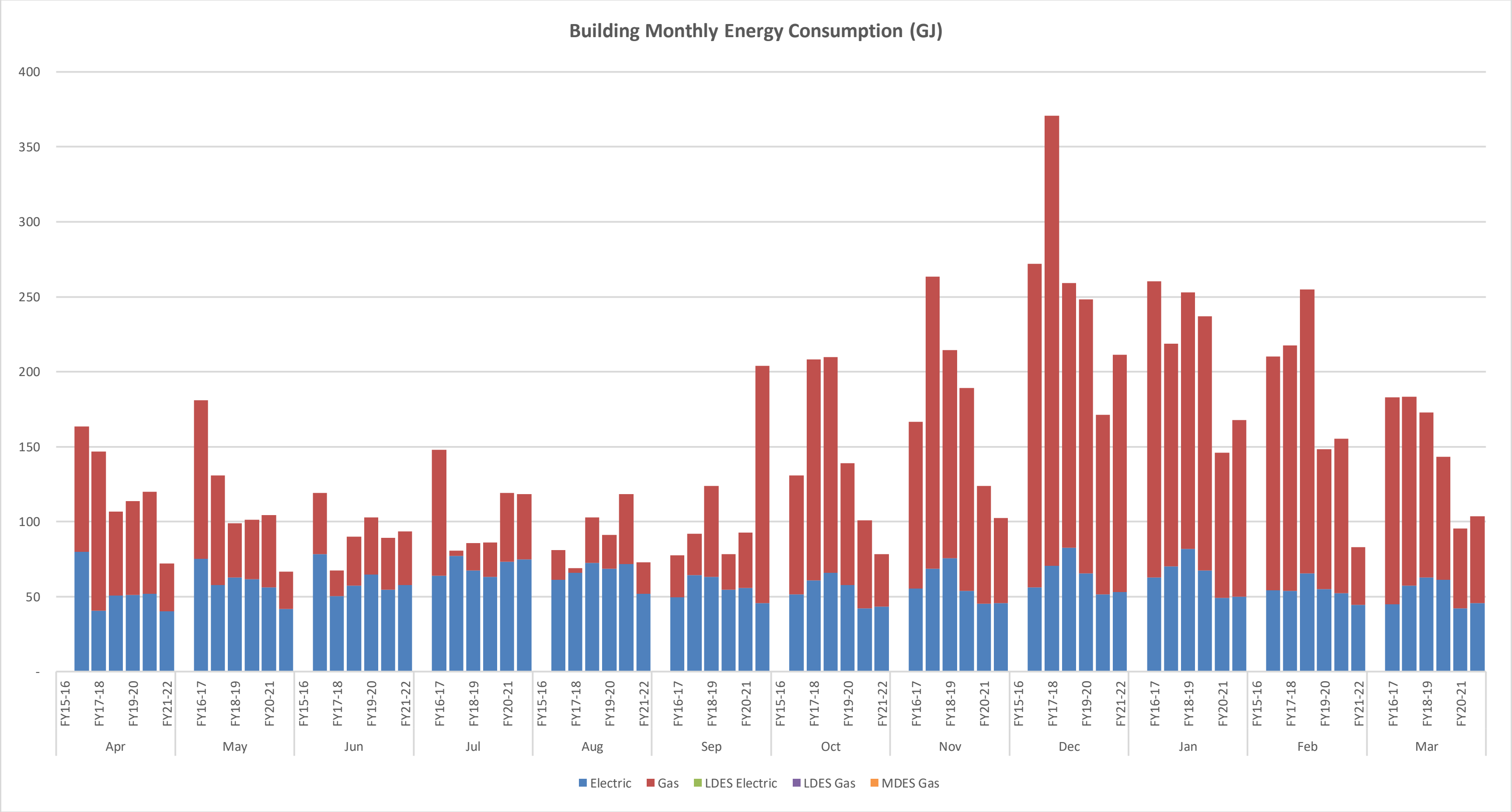
7.13 Upper Campus Health building formerly known as Mountain Weather Office (ACAD)



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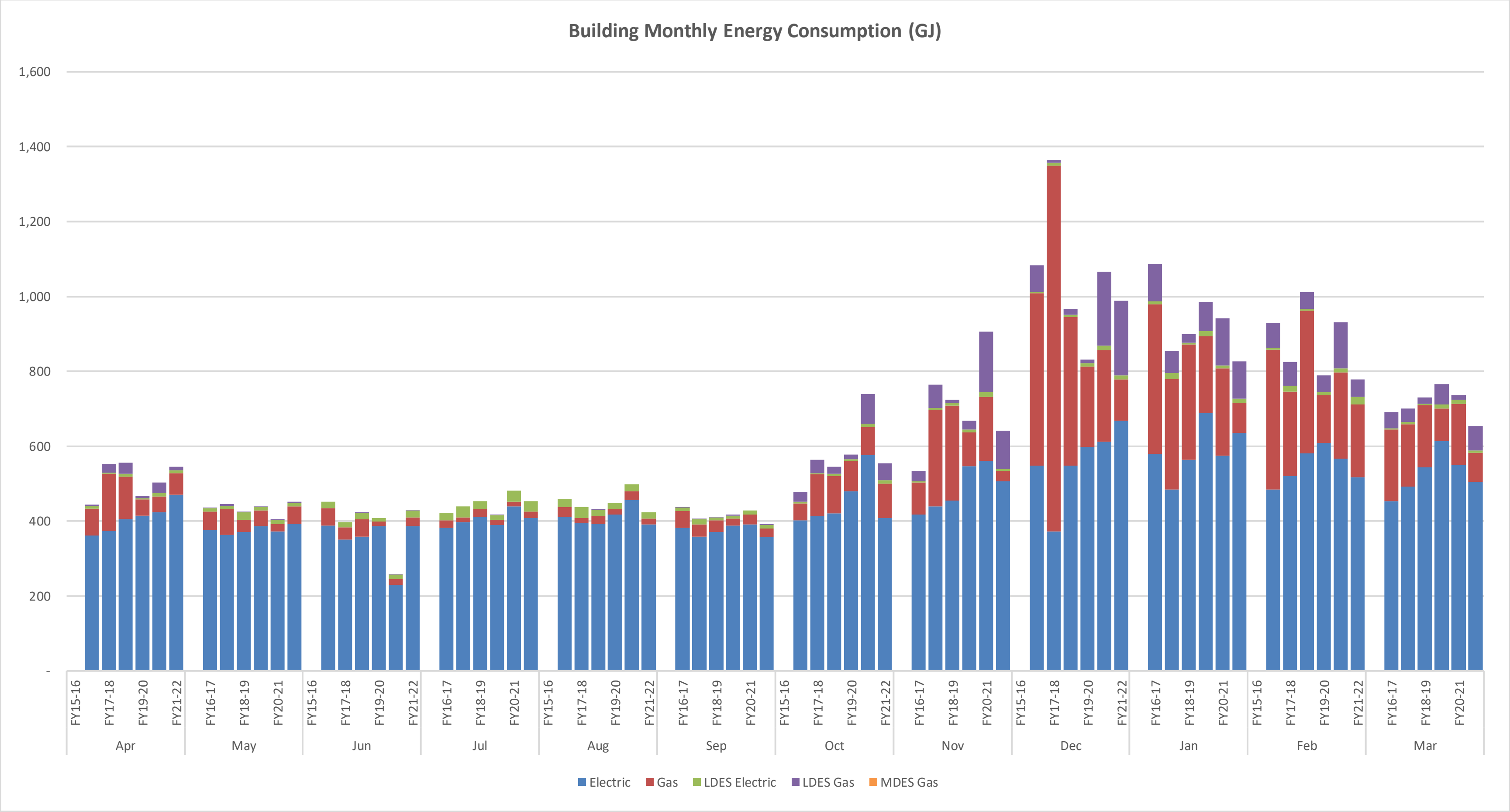
7.14 Reichwald Health Sciences Centre building (ACAD)



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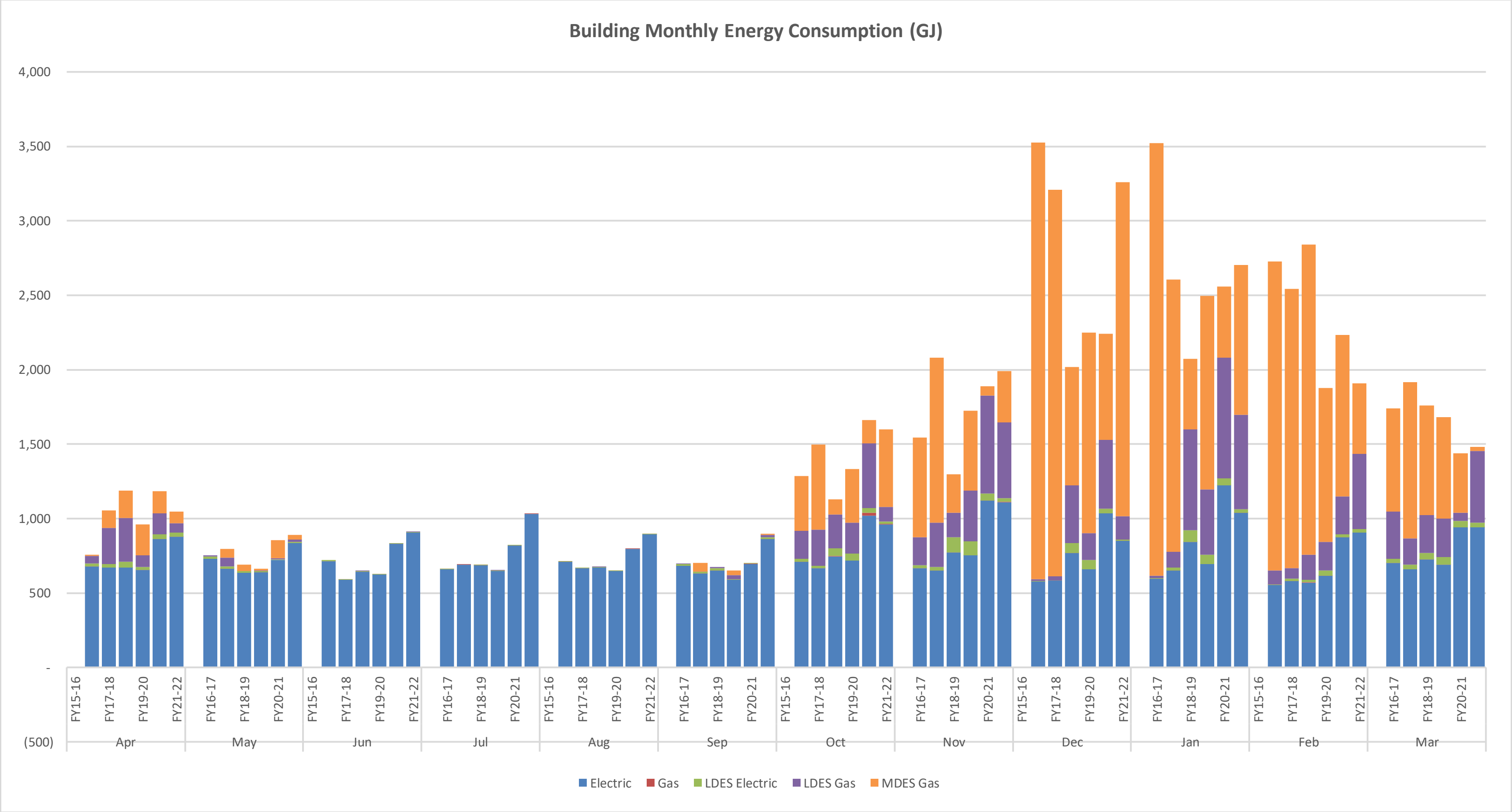
7.15 Science building (ACAD)



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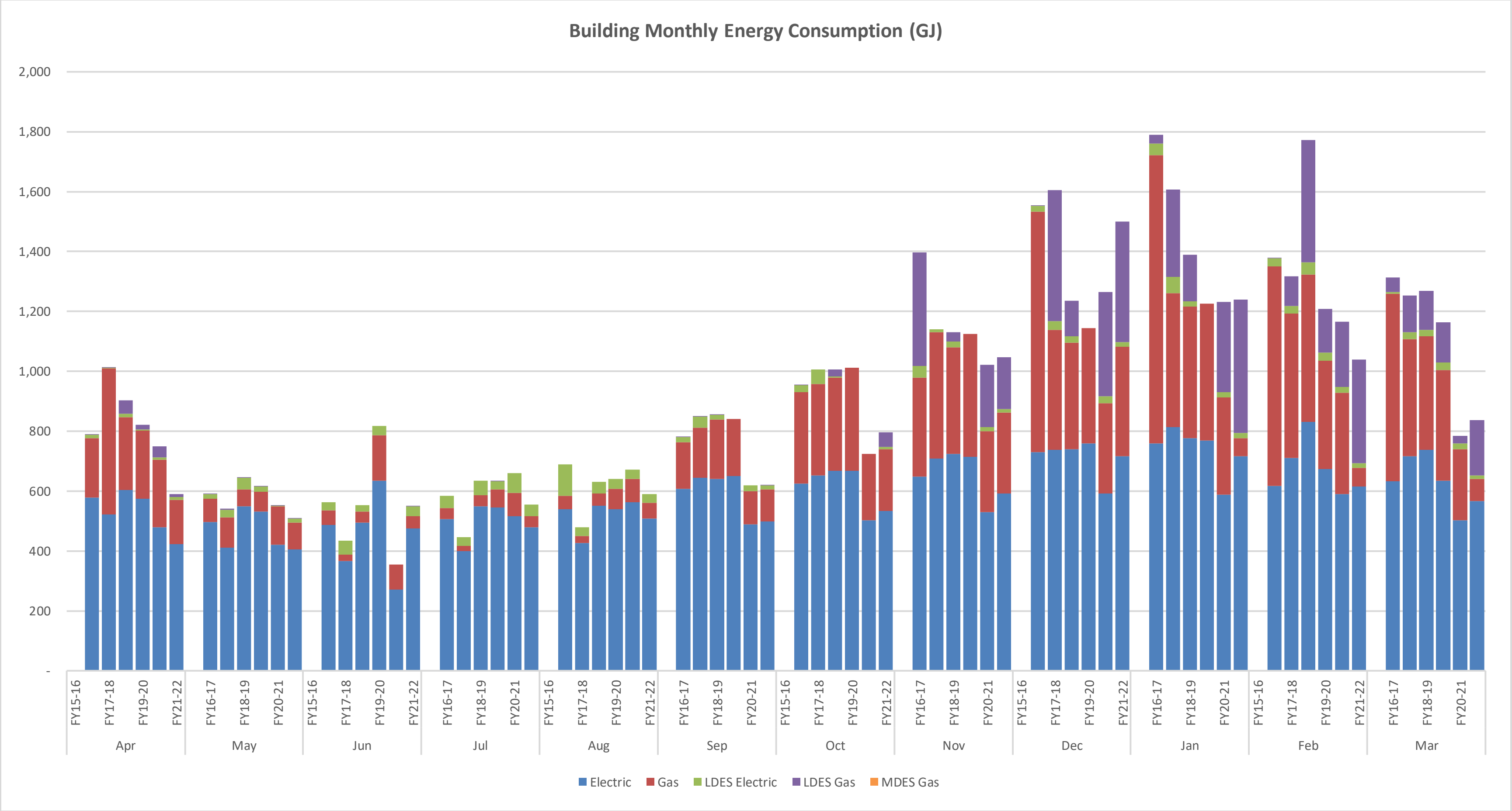
7.16 University Centre building (ACAD)



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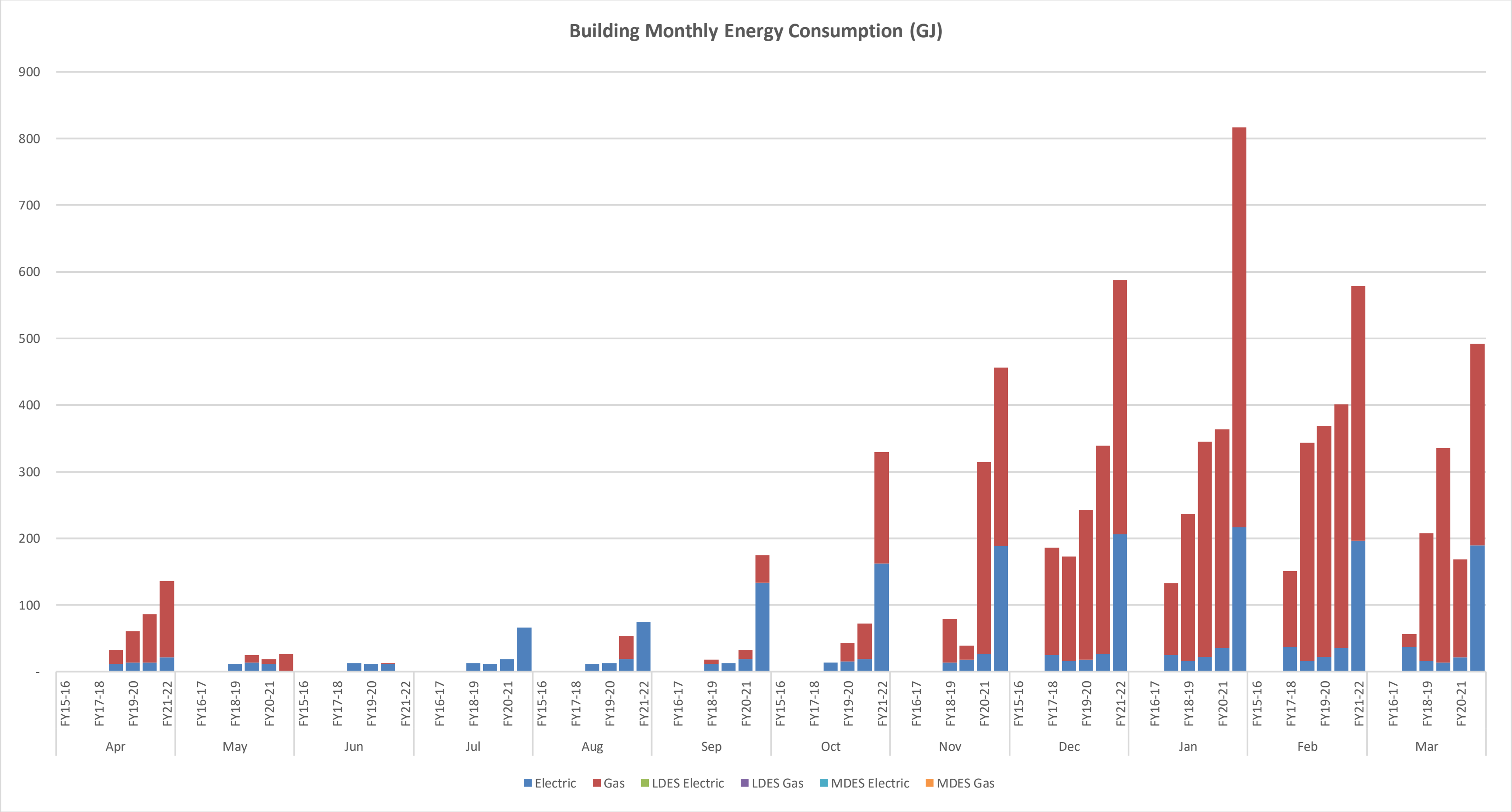
7.17 1540 Innovation Drive (IP#1) building (ACAD)



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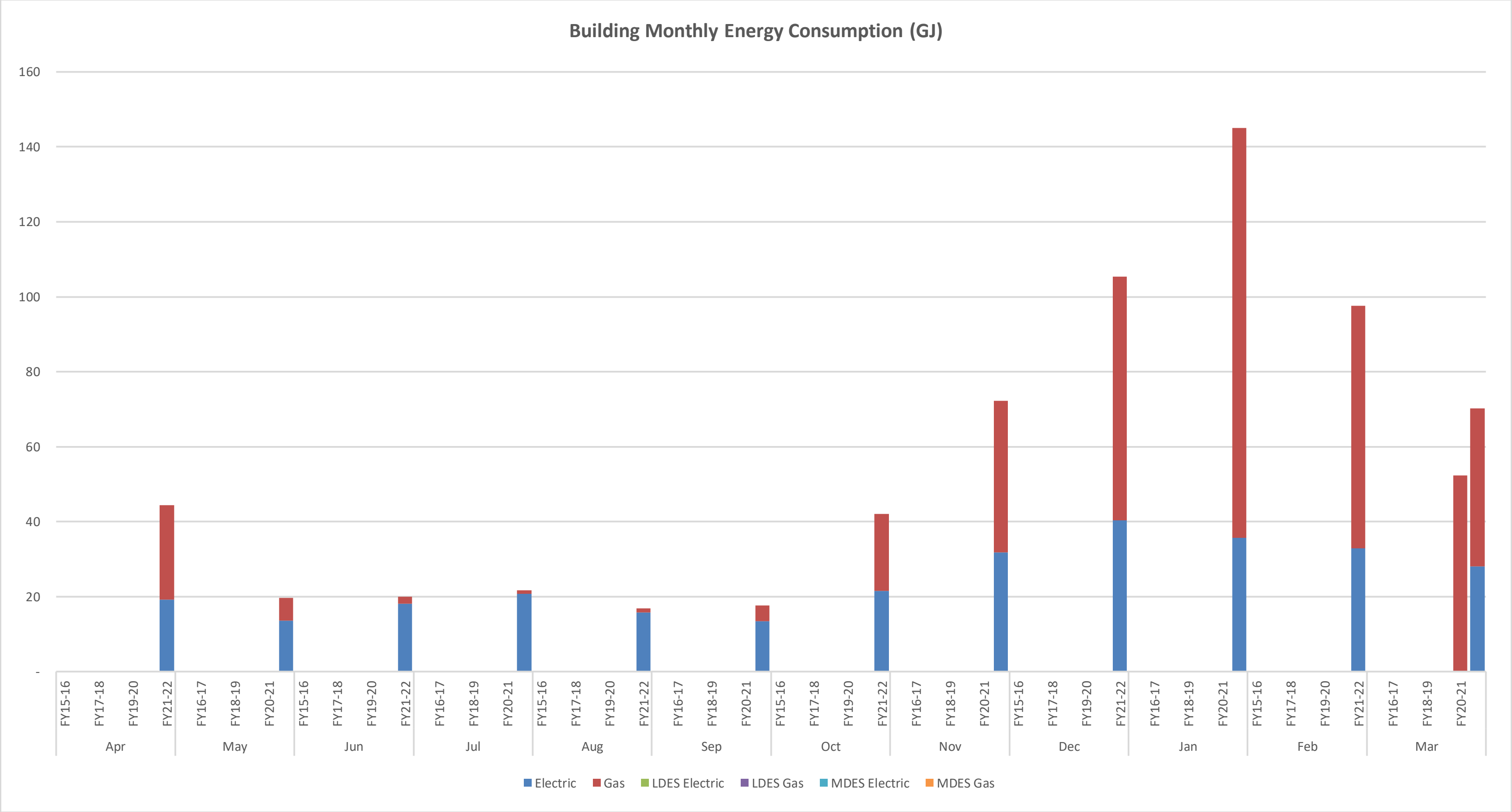
7.18 Innovation Annex building (ACAD)



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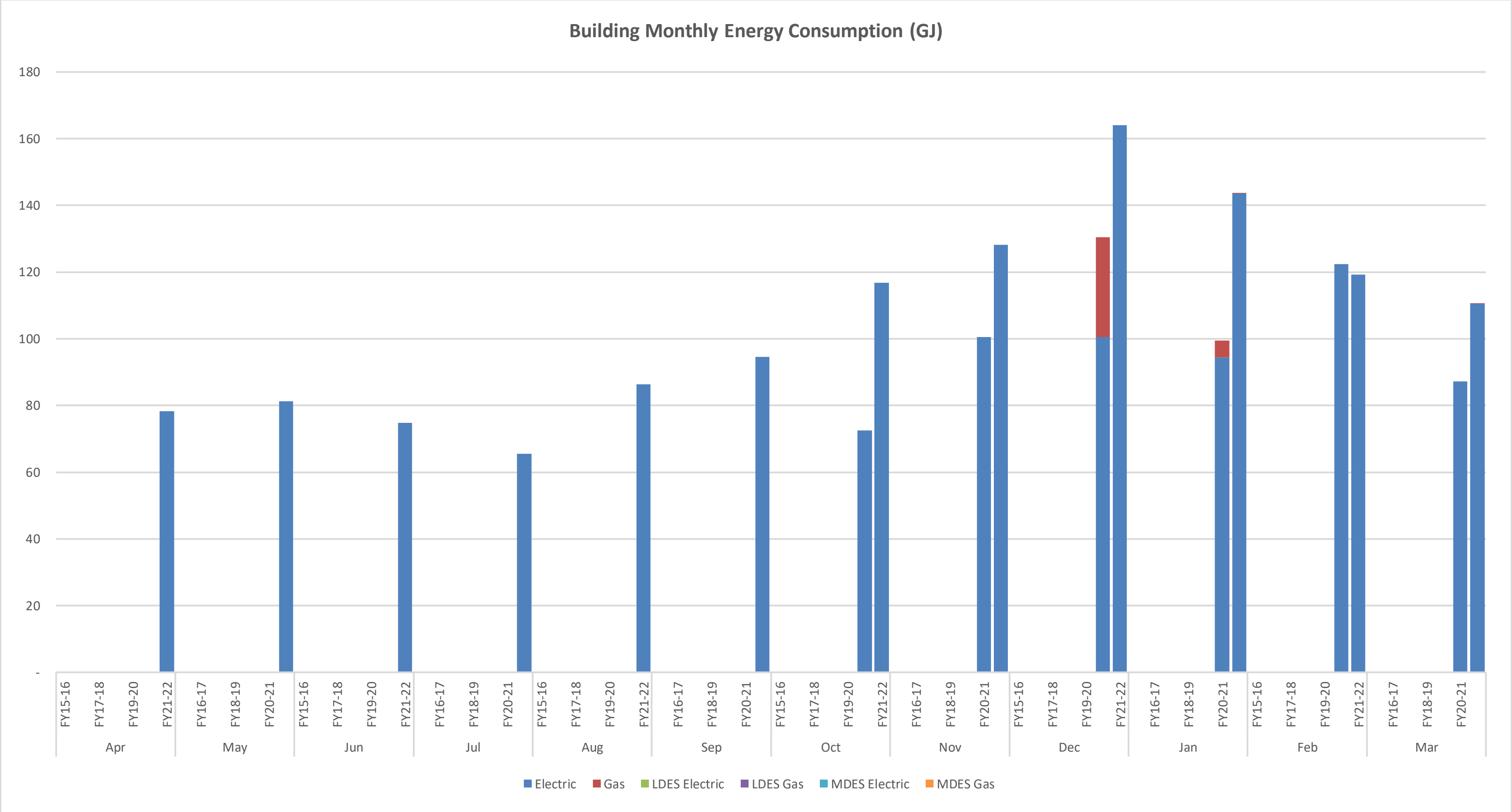
7.19 Plant Growth Facility building (ACAD)



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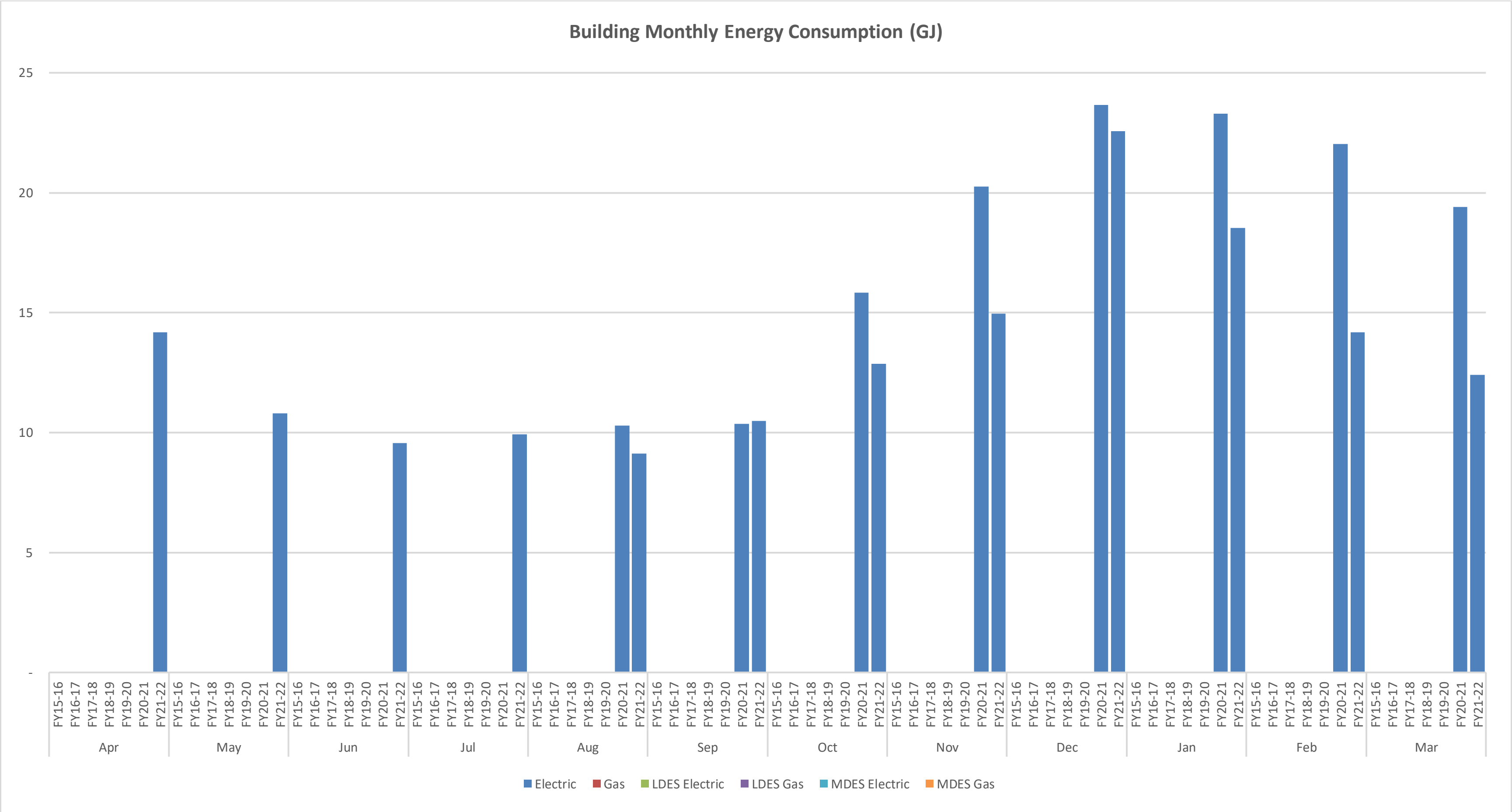
7.20 EDL building (ACAD)



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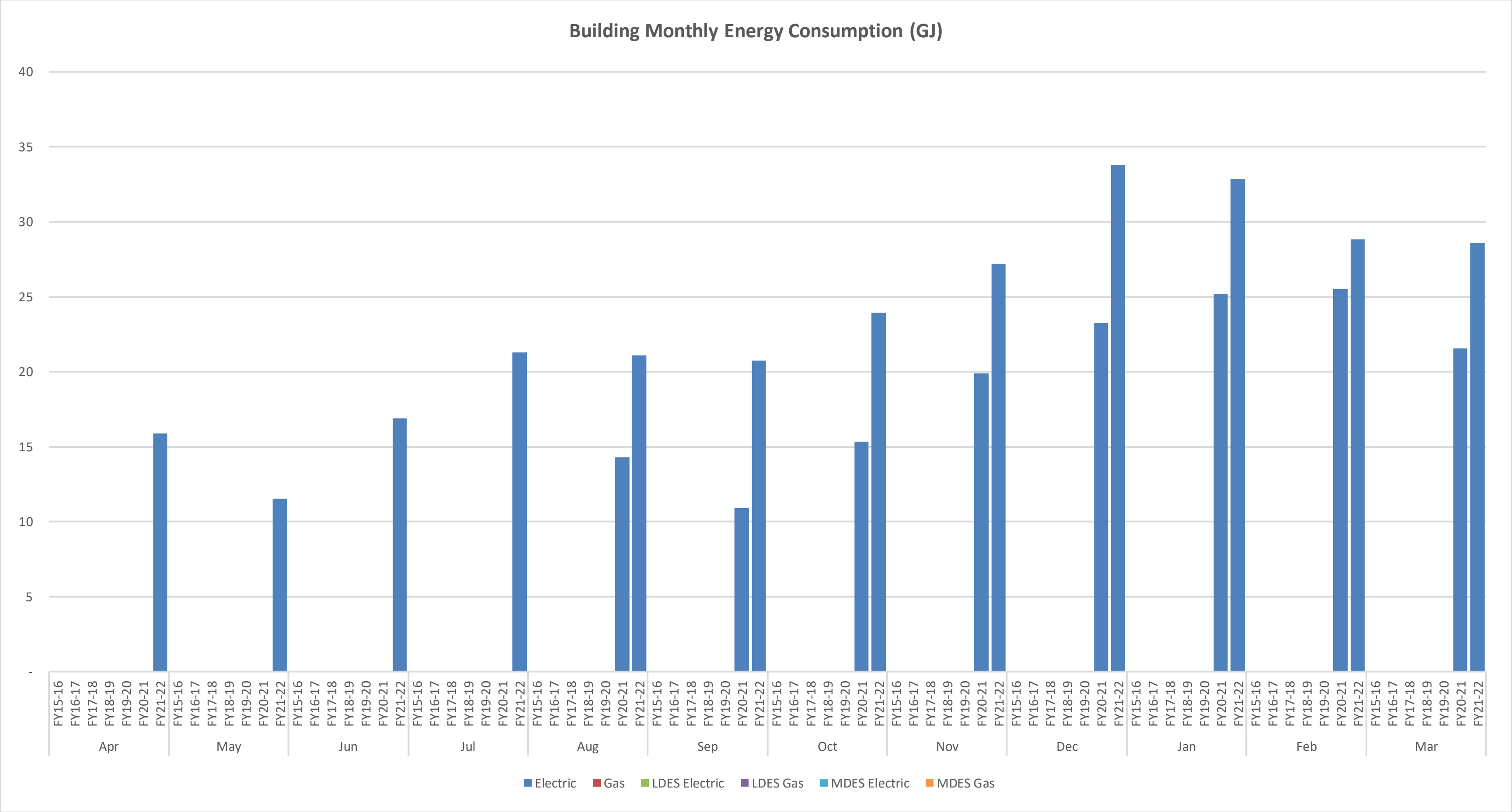
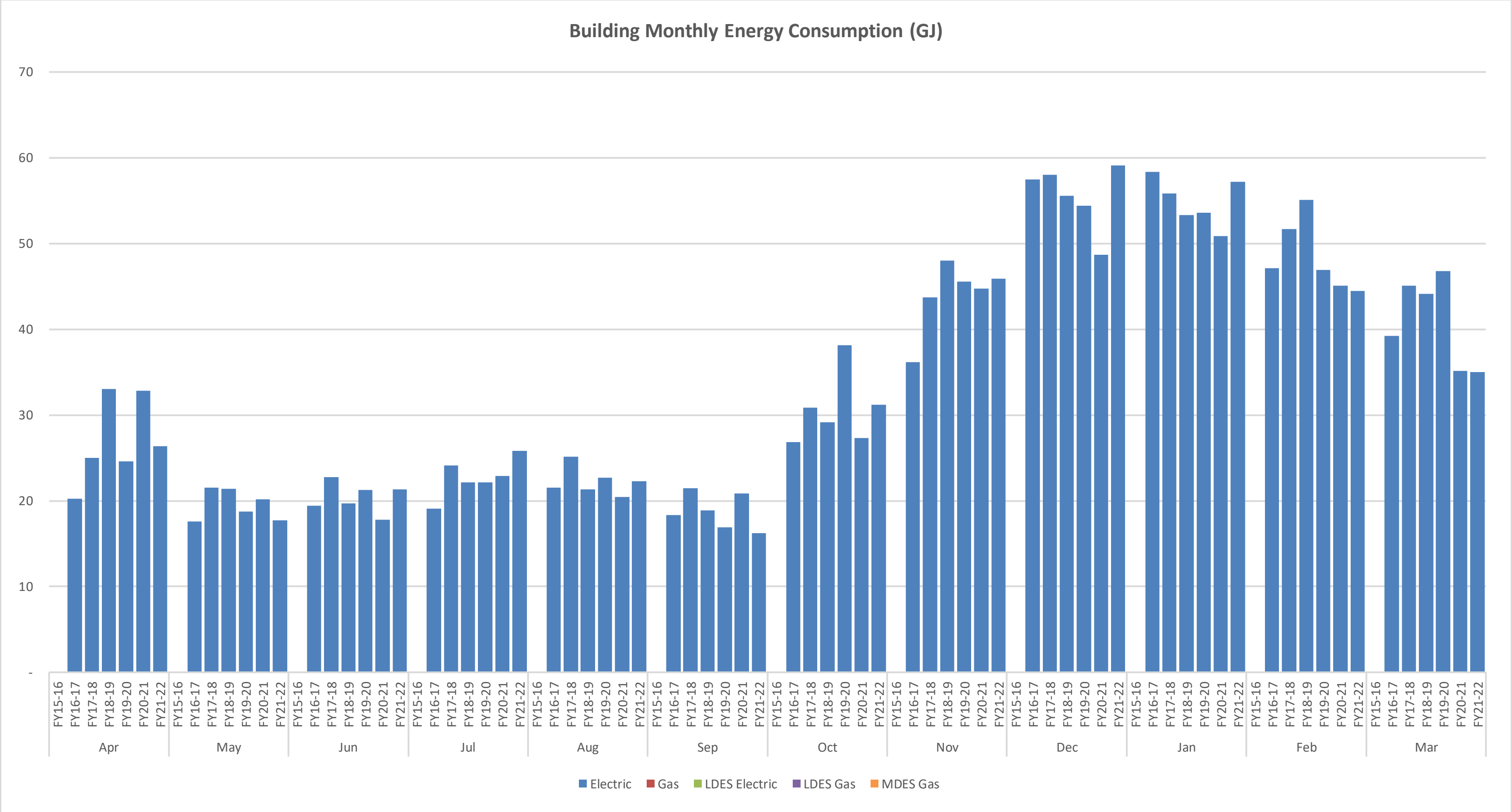
7.21 OM1 building (ACAD)



7.22 Quonset building (ACAD)



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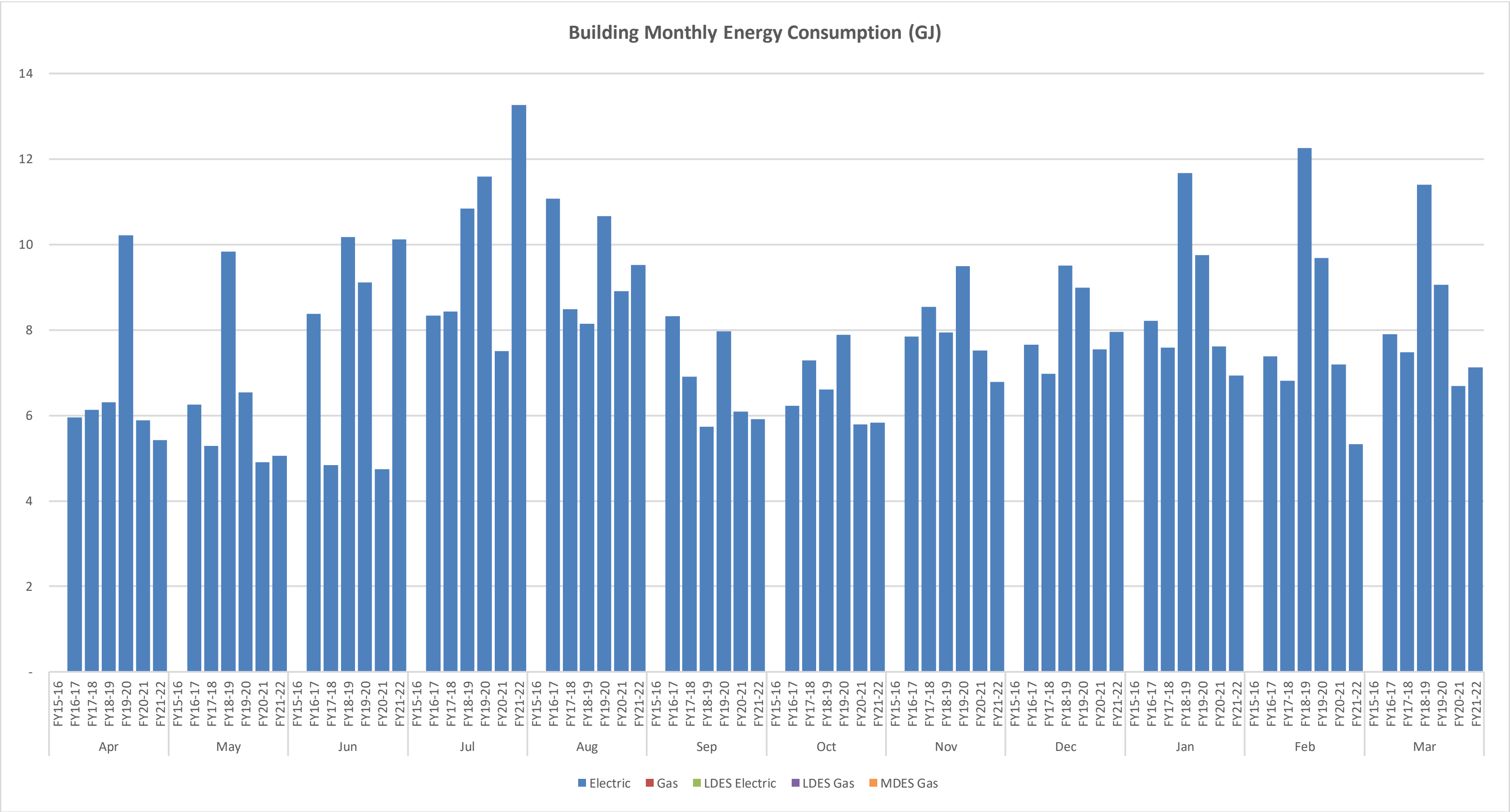
7.23 University House building (ACAD)



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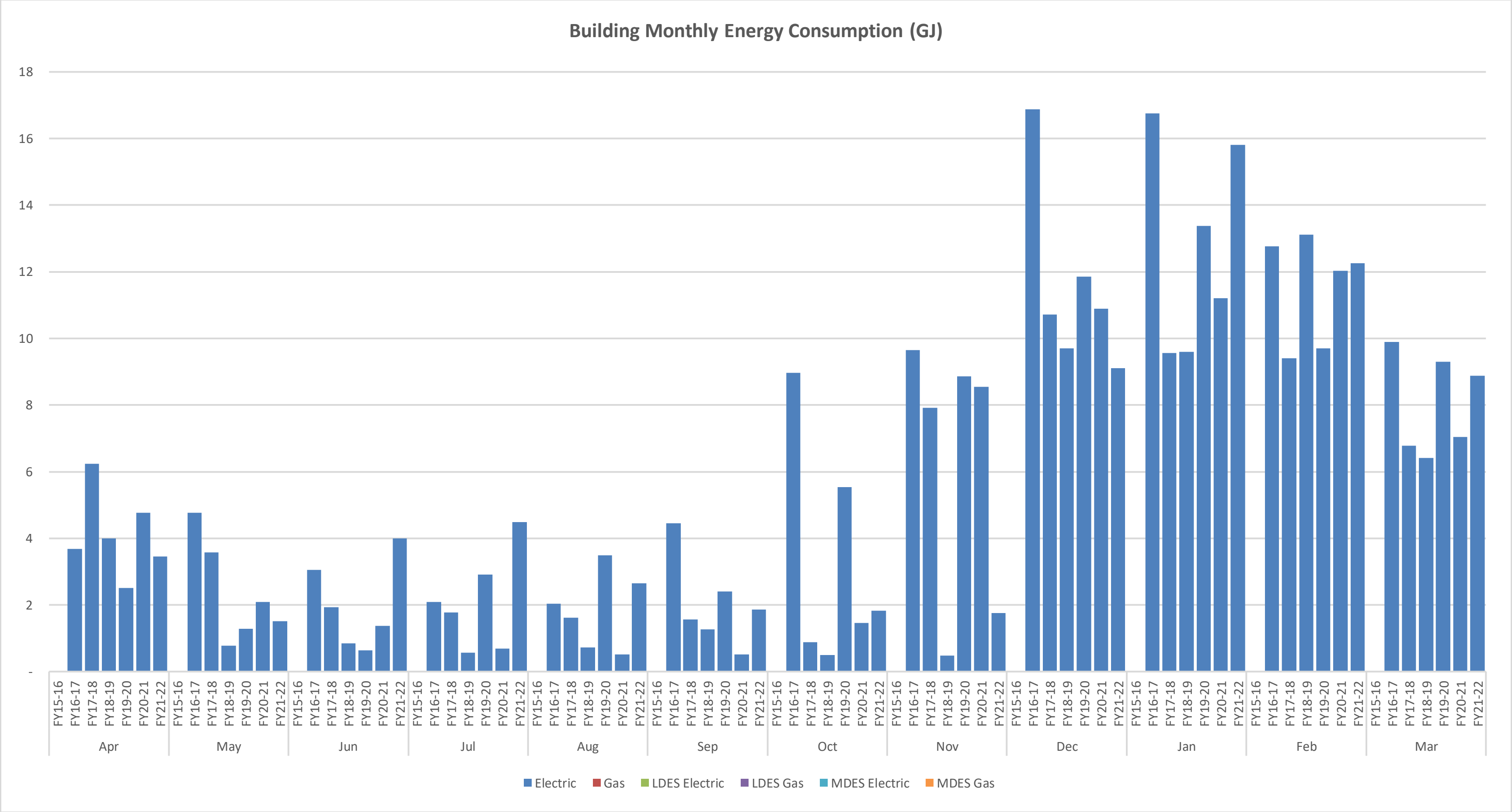
7.24 Portable A building (ACAD)



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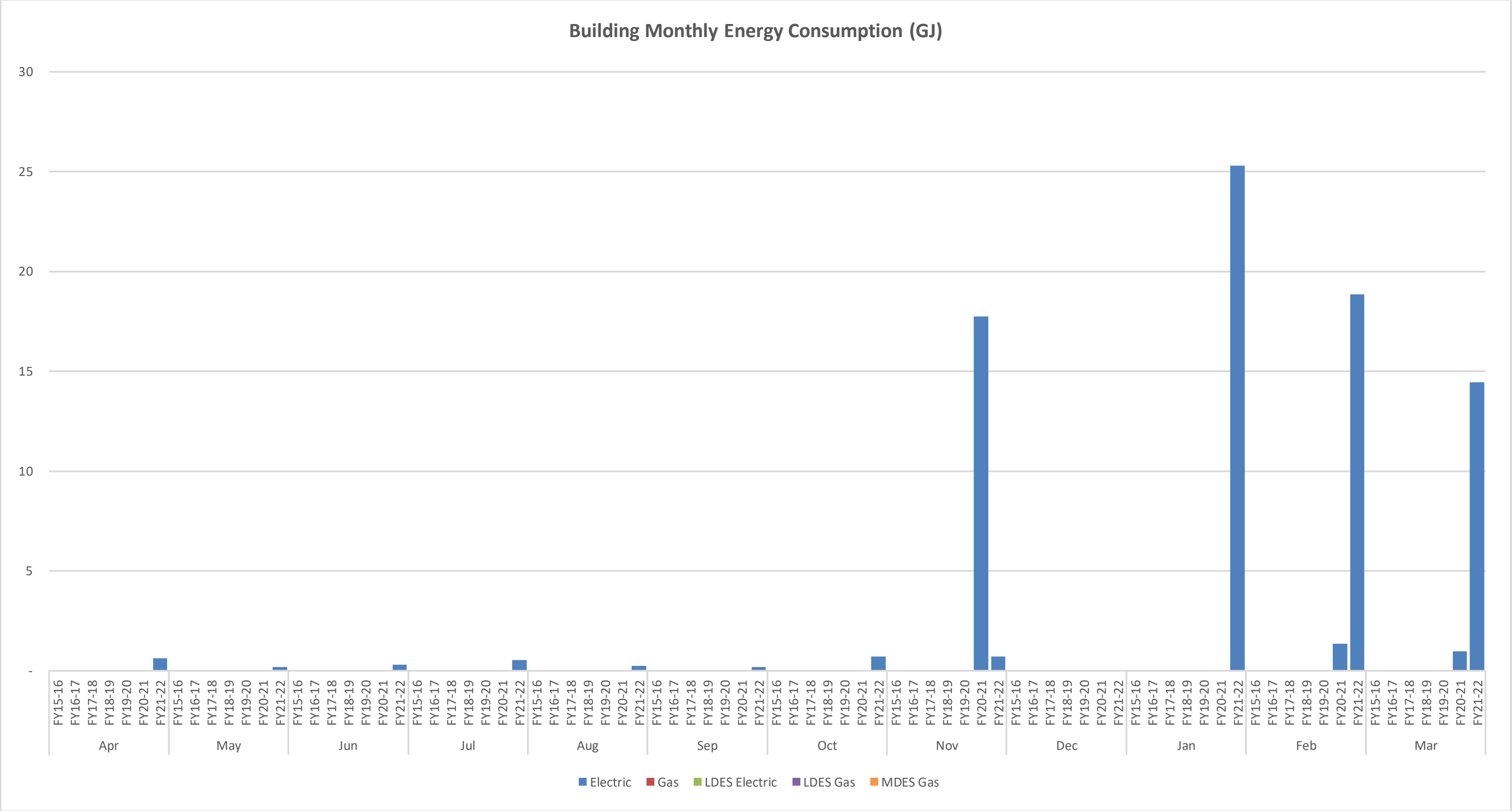
7.25 Portable N building (ACAD)



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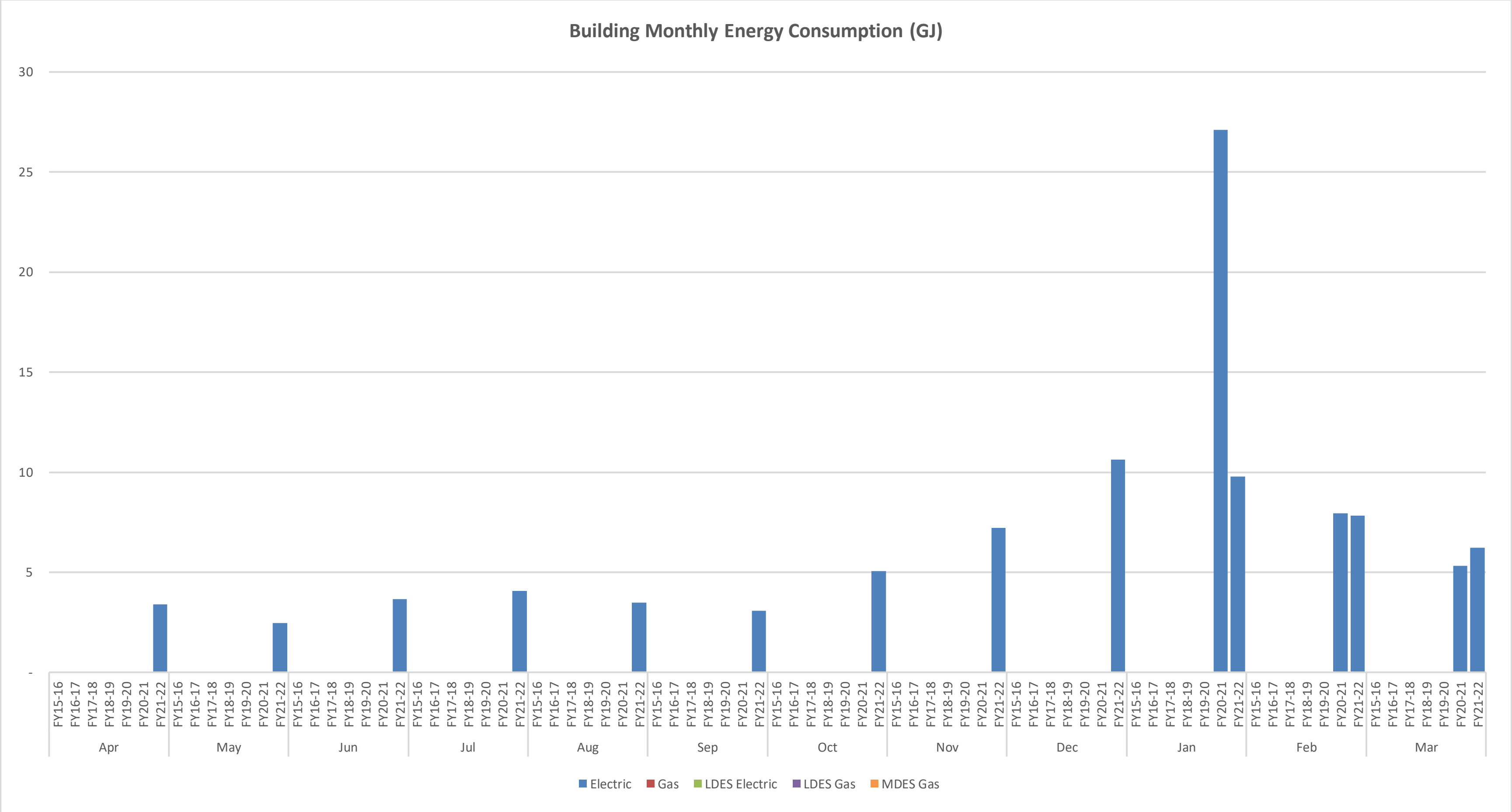
7.26 Portable V building (ACAD)



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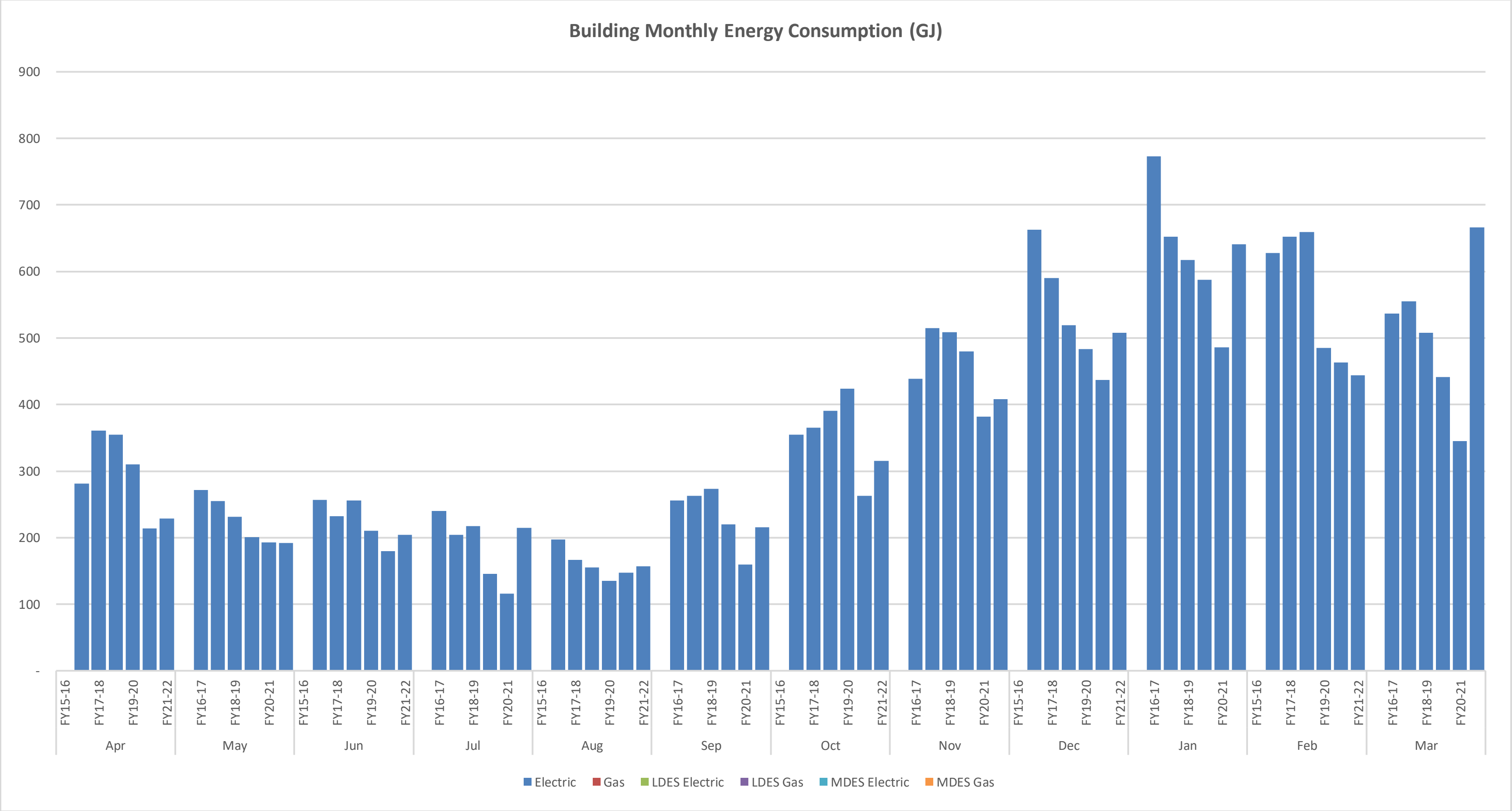
7.27 Lower Cascades Residence building



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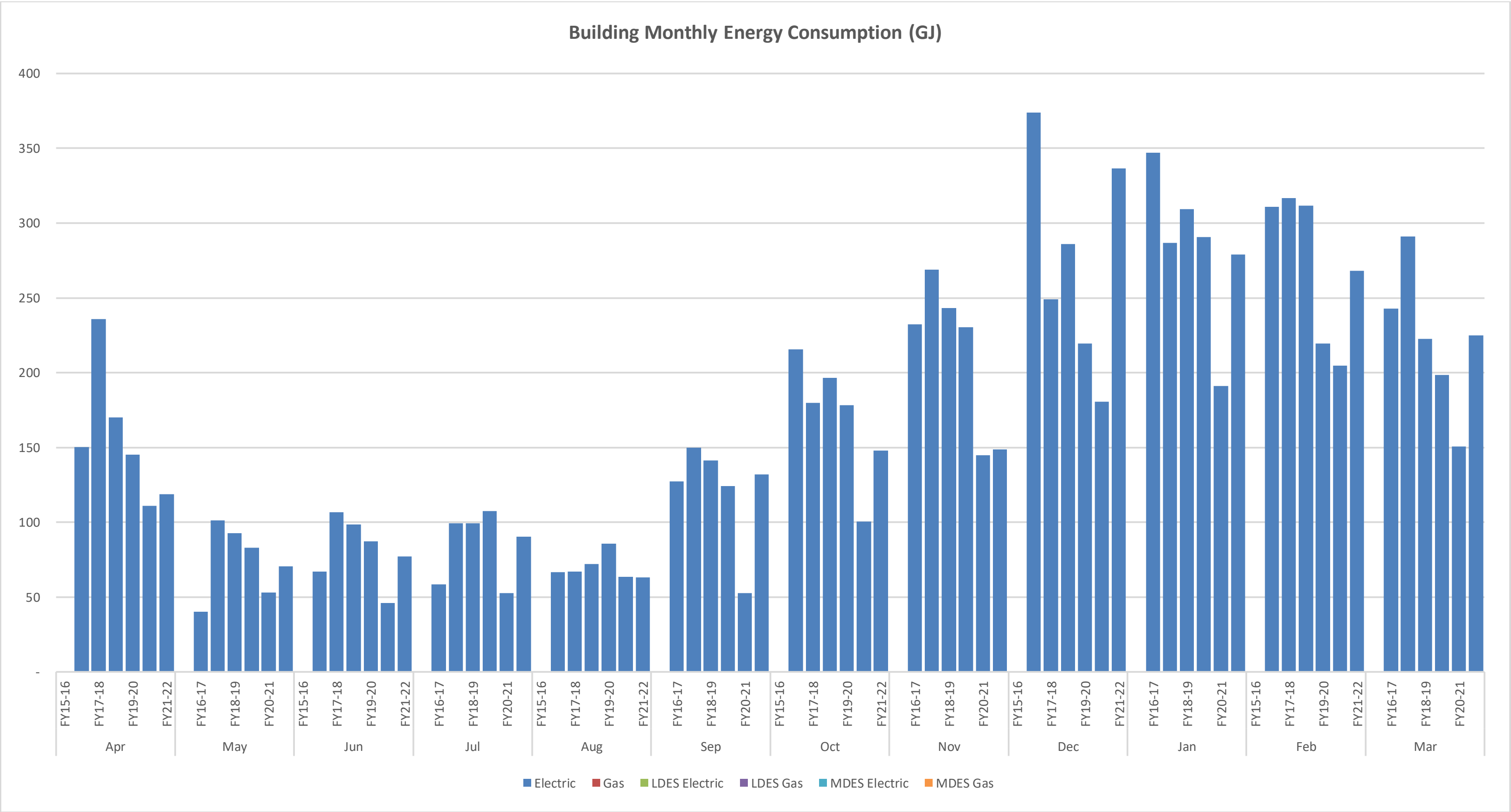
7.28 Upper Cascades Residence building



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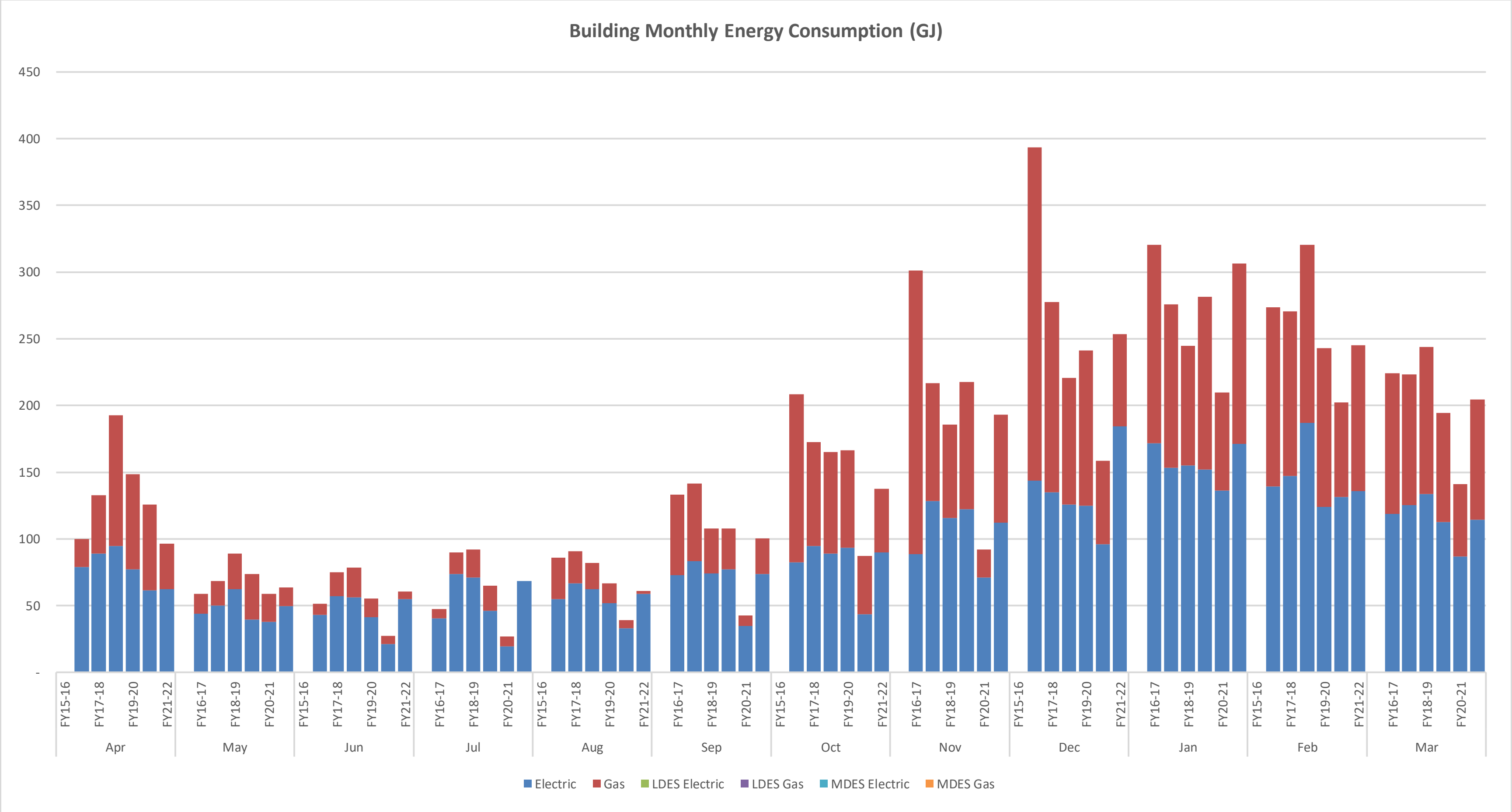
7.29 Cassiar Residence building



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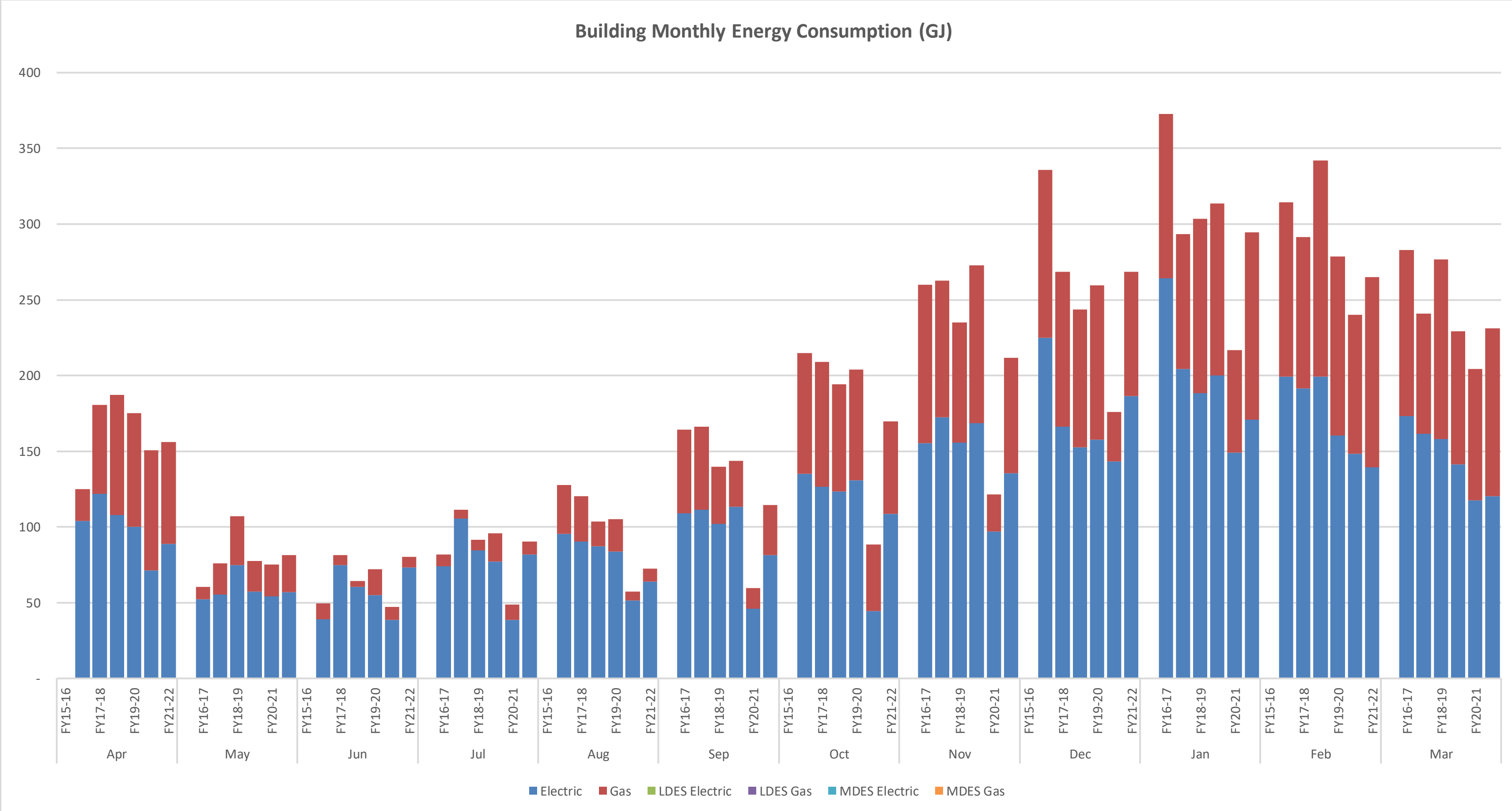
7.30 Kalamalka Residence building



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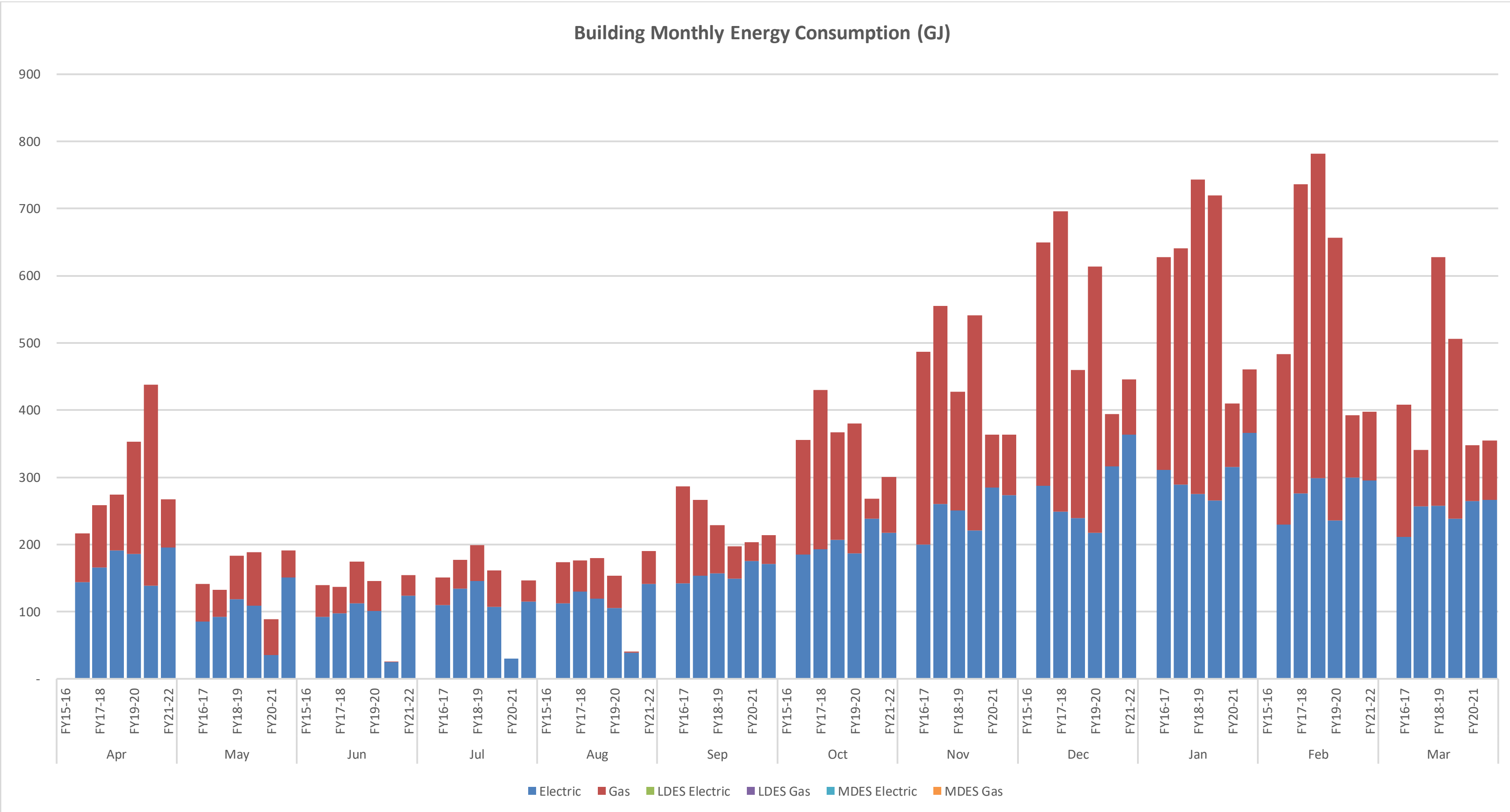
7.31 Monashee Residence building



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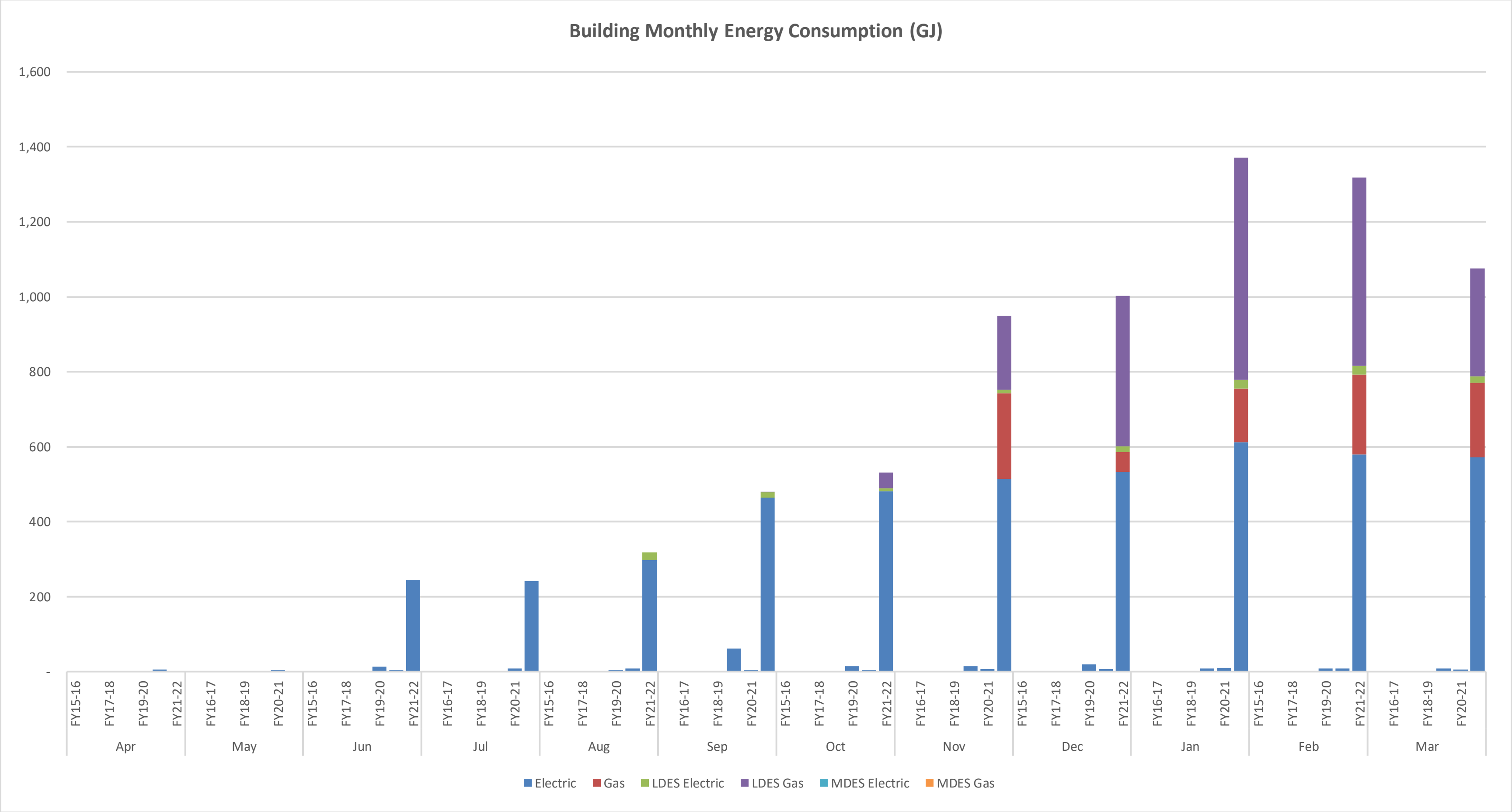
7.32 Nechako Commons Residence building



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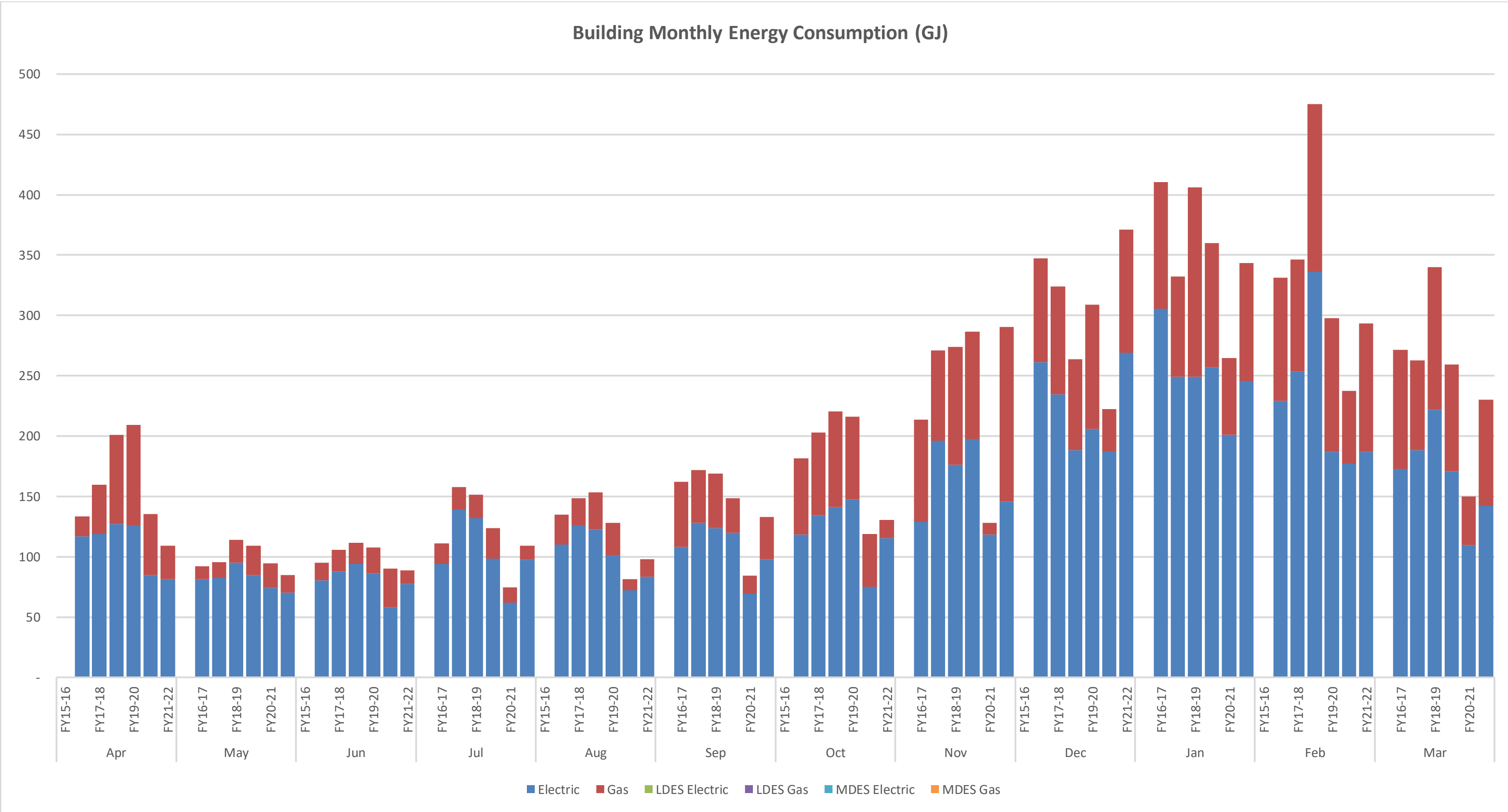
7.33 Nicola Residence building



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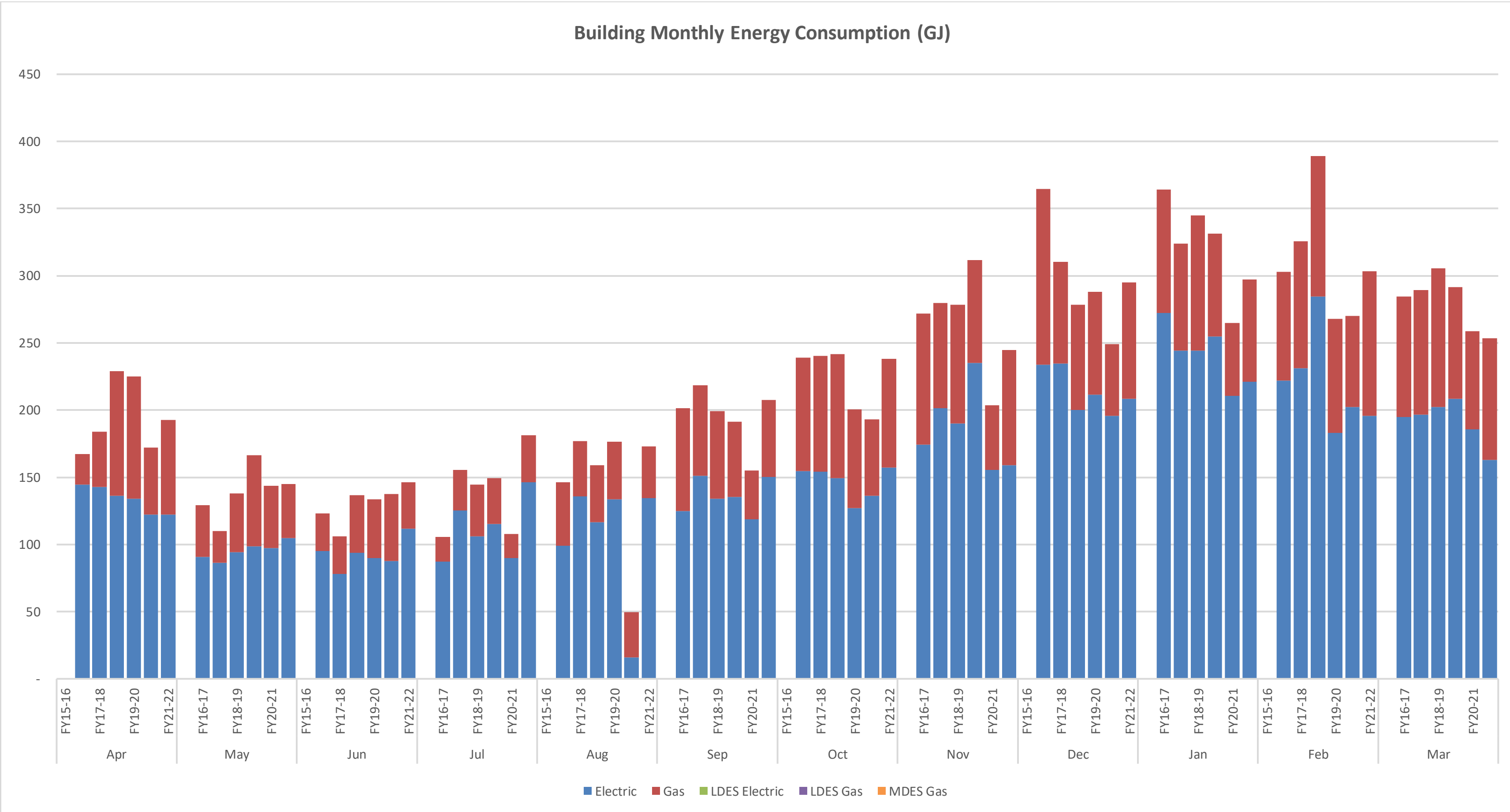
7.34 Purcell Residence building



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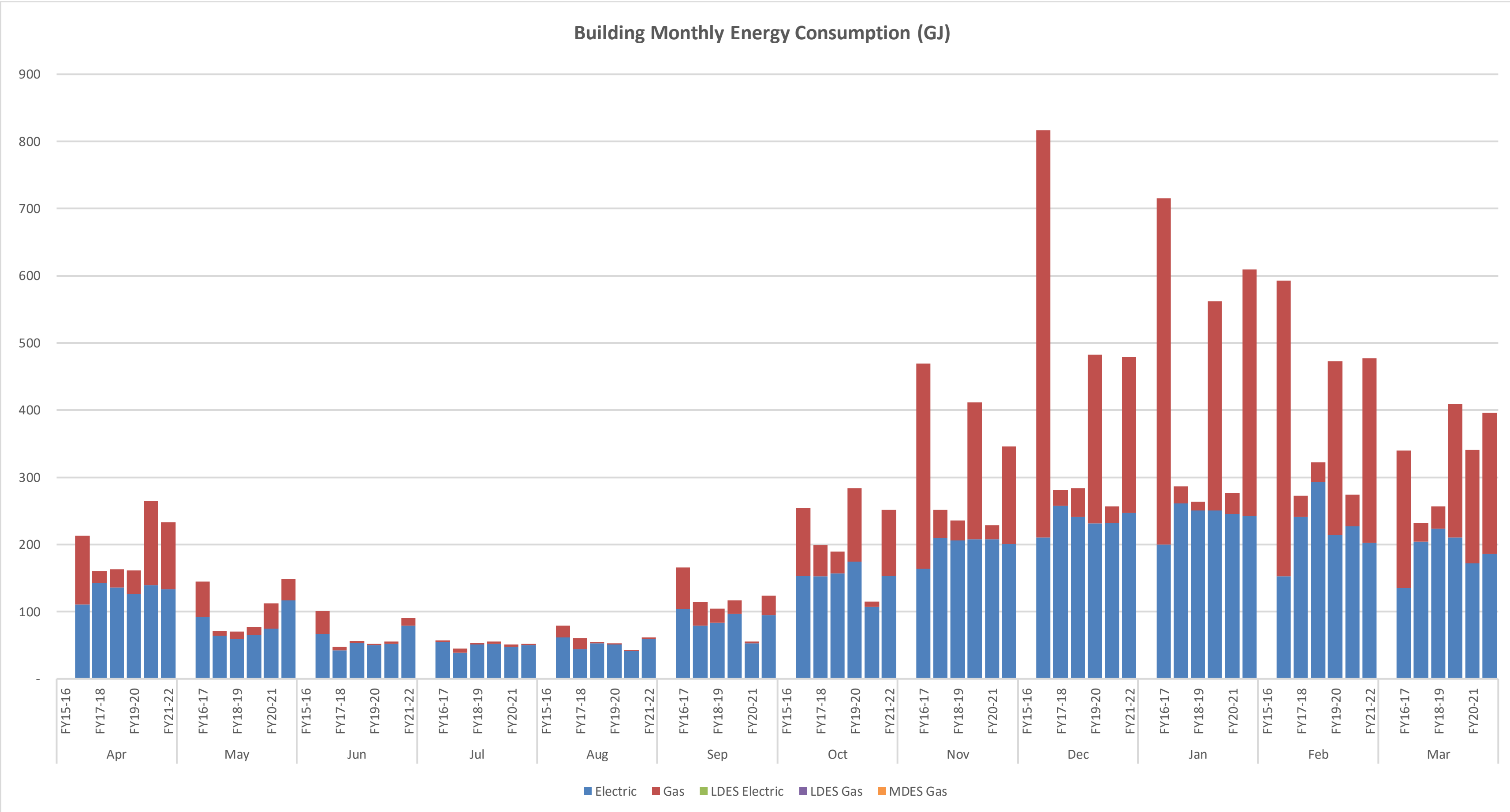
7.35 Similkameen Residence building



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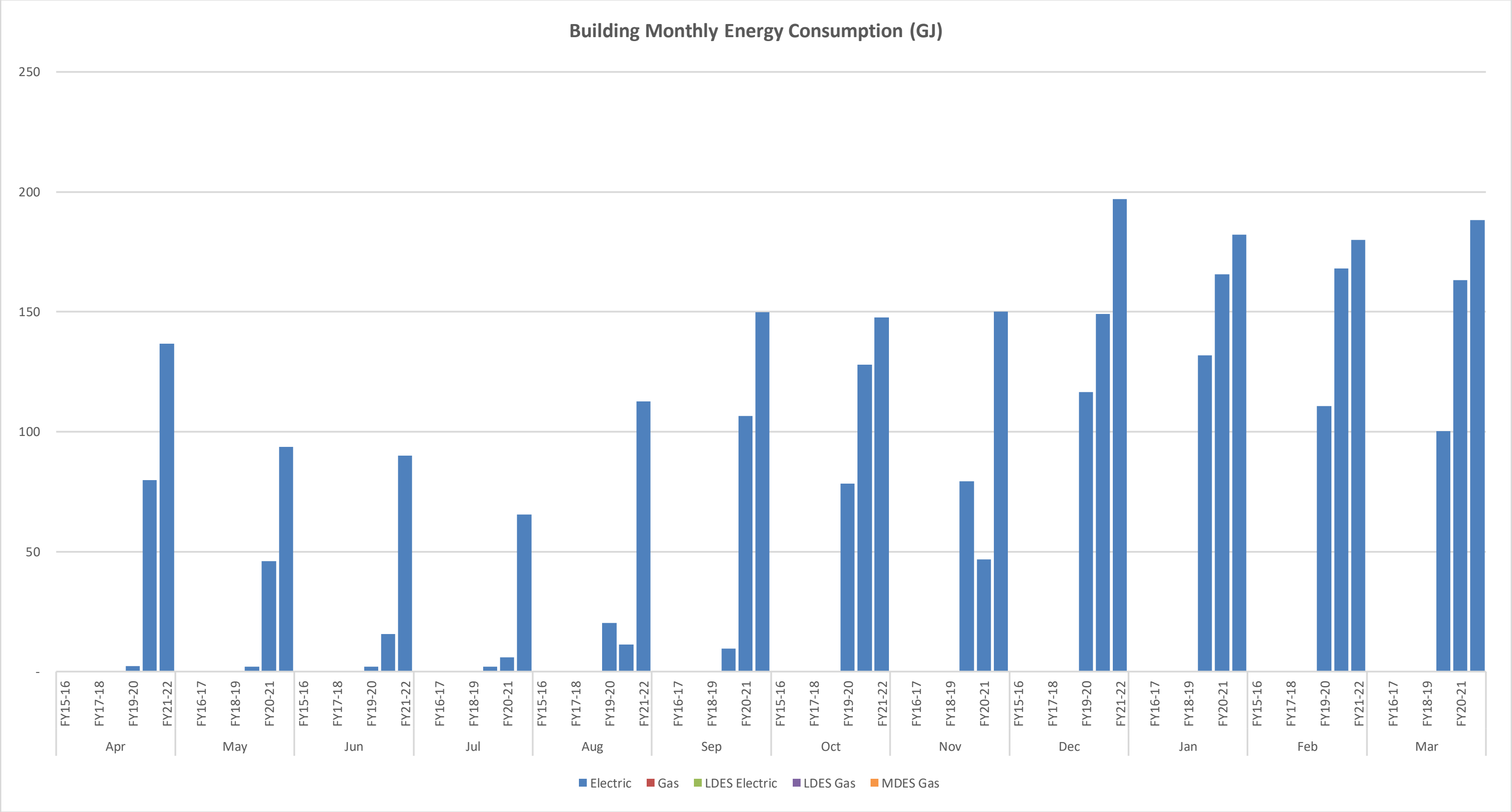
7.36 Skeena Residence building



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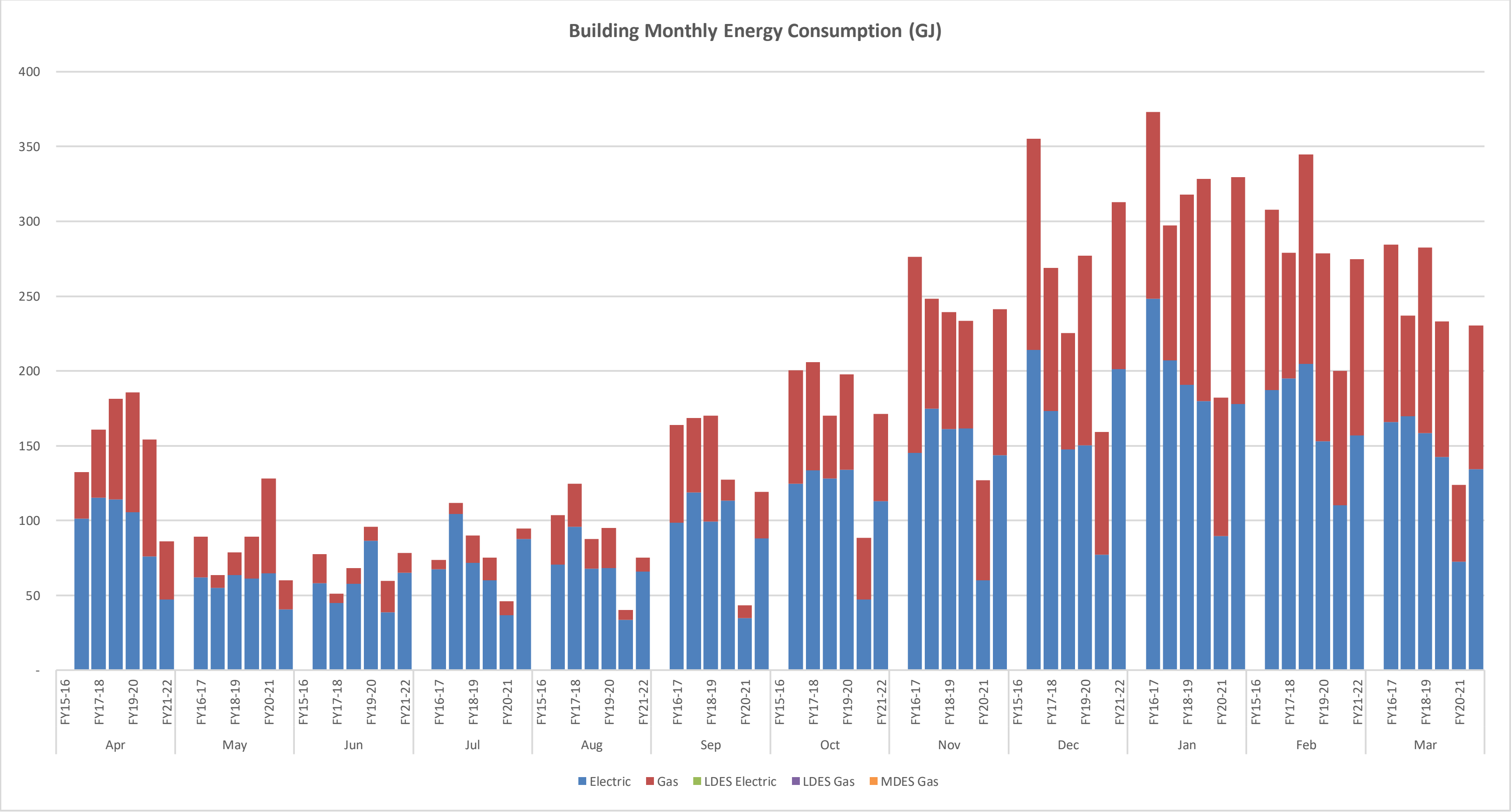
7.37 Valhalla Residence building



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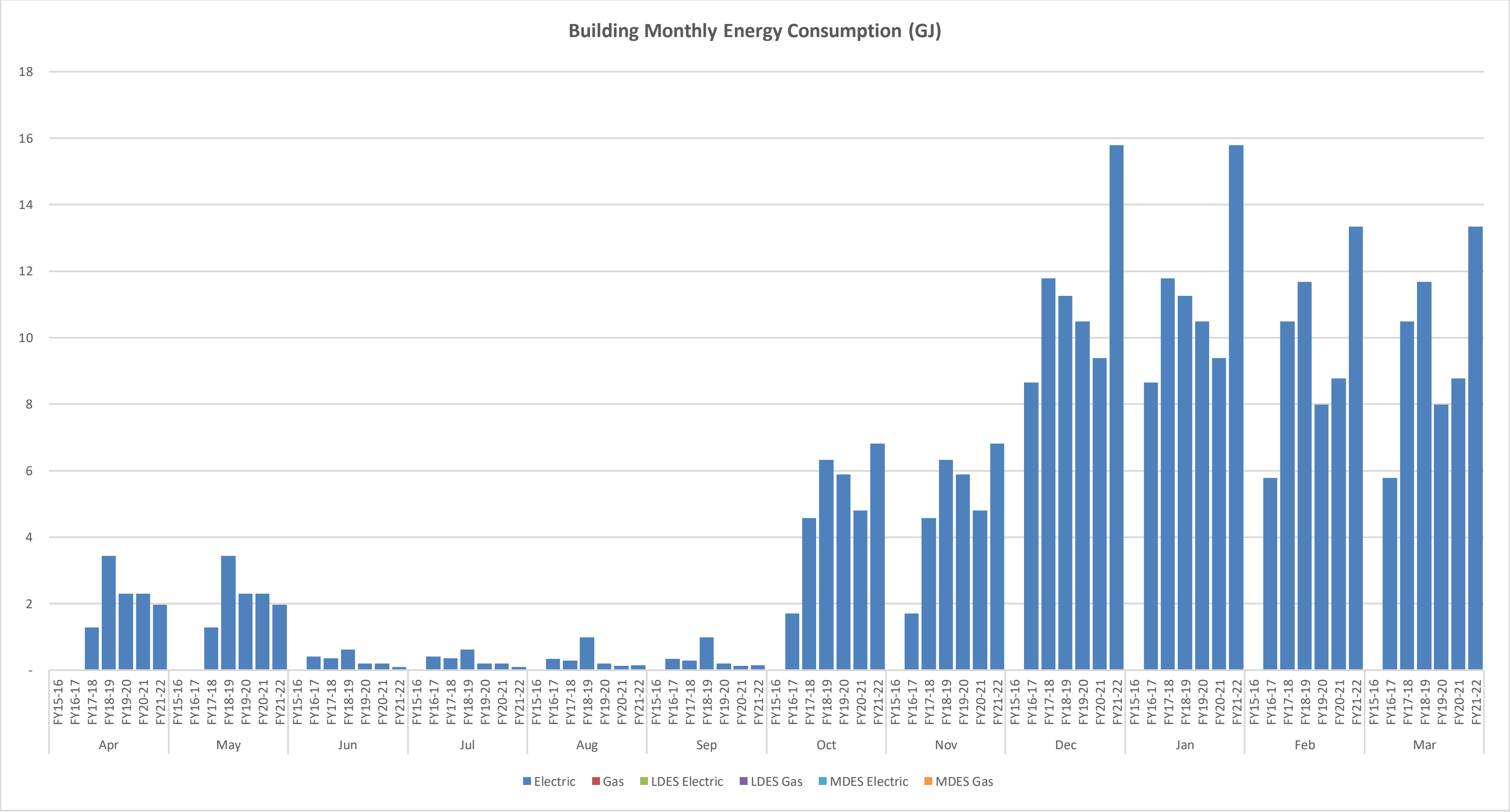
7.38 1200B Curtis building



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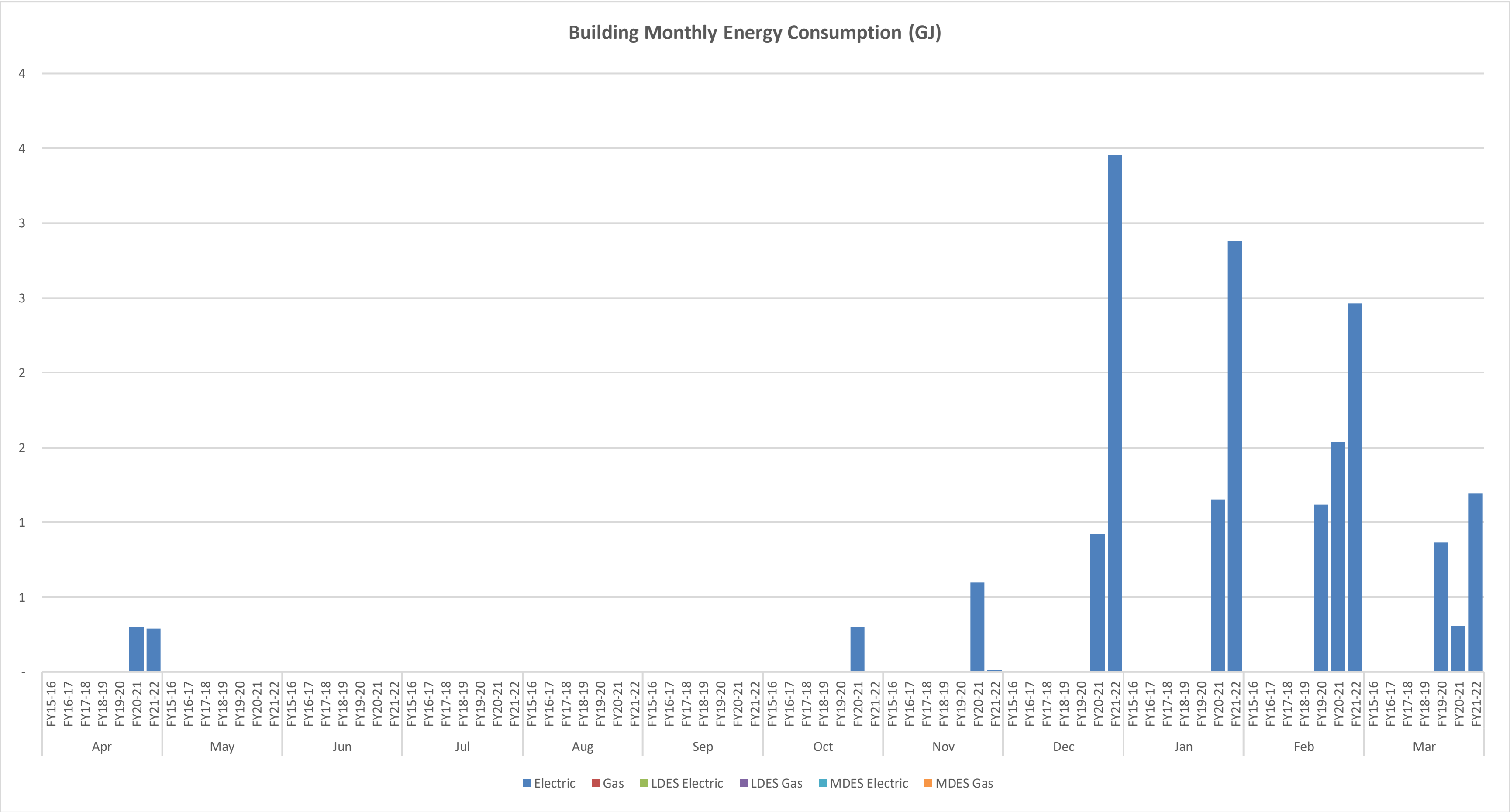
7.39 GEID Vector Well



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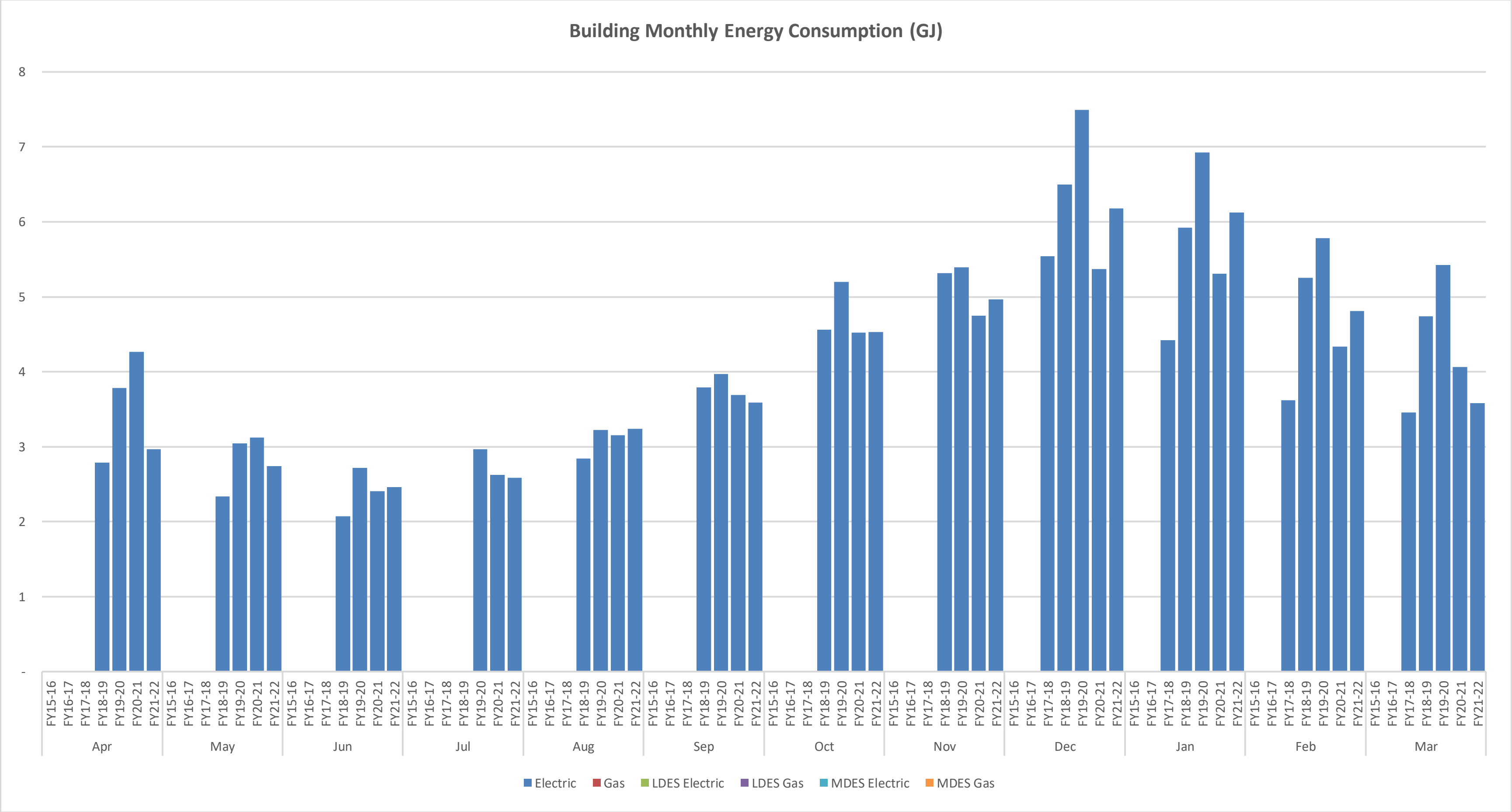
7.40 Innovation Drive H Lot (Includes Trailer)



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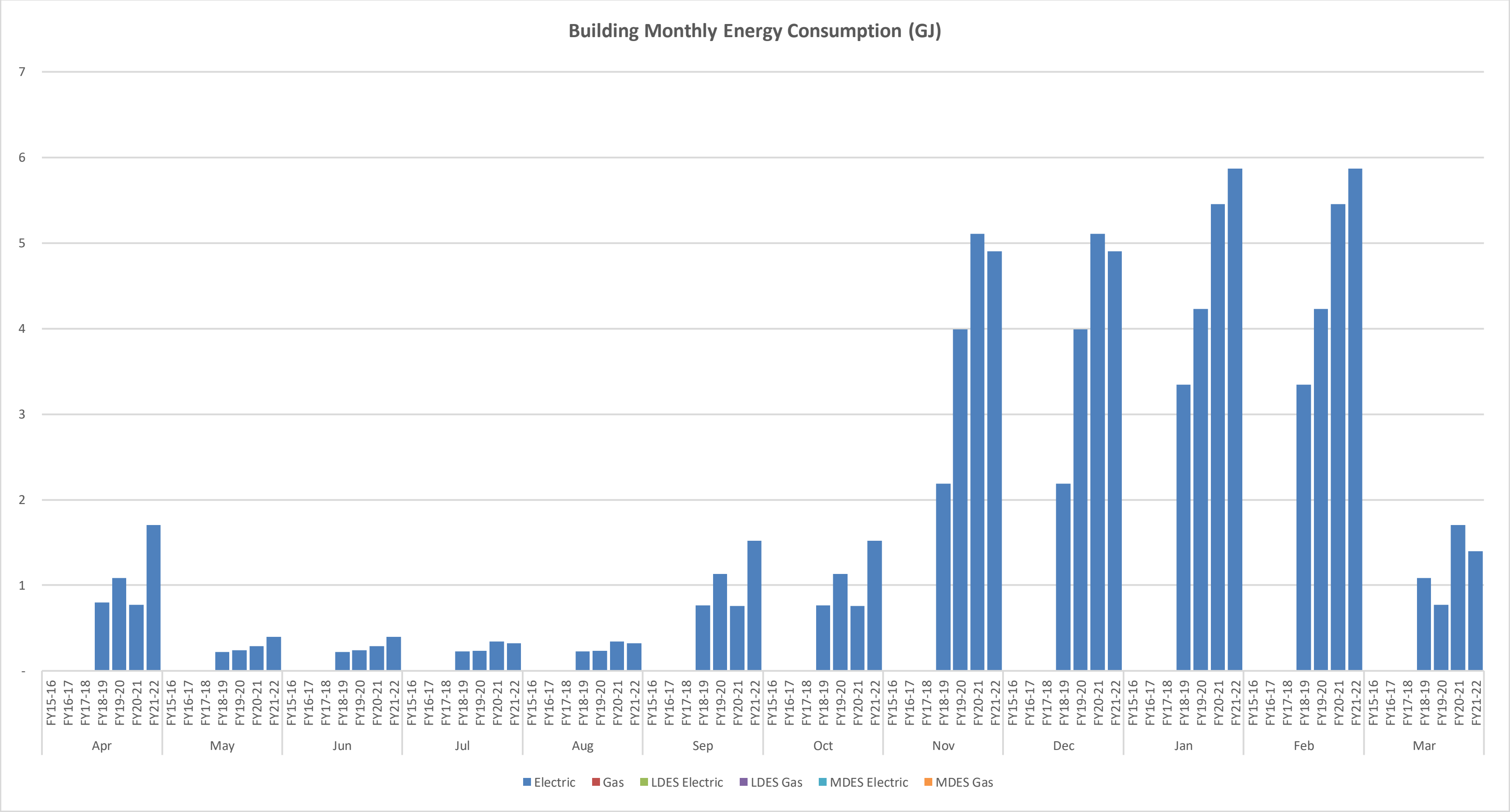
7.41 H Lot (Overflow parking)



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7.42 Parking Lot R