Energy Team
The University of British Columbia |
Okanagan Campus
1060 Diversity Place | Kelowna BC | V1V 1V7 Canada

UBC Okanagan Campus
Energy Team
Quarterly Report
October 2021 – December 2021

Report Date: 2021-01-31

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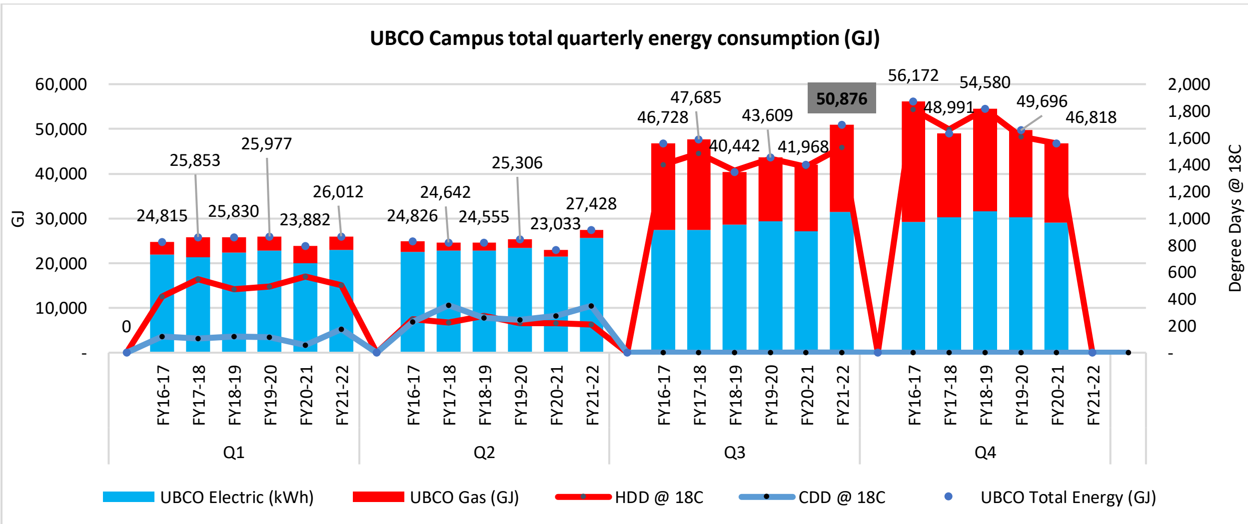
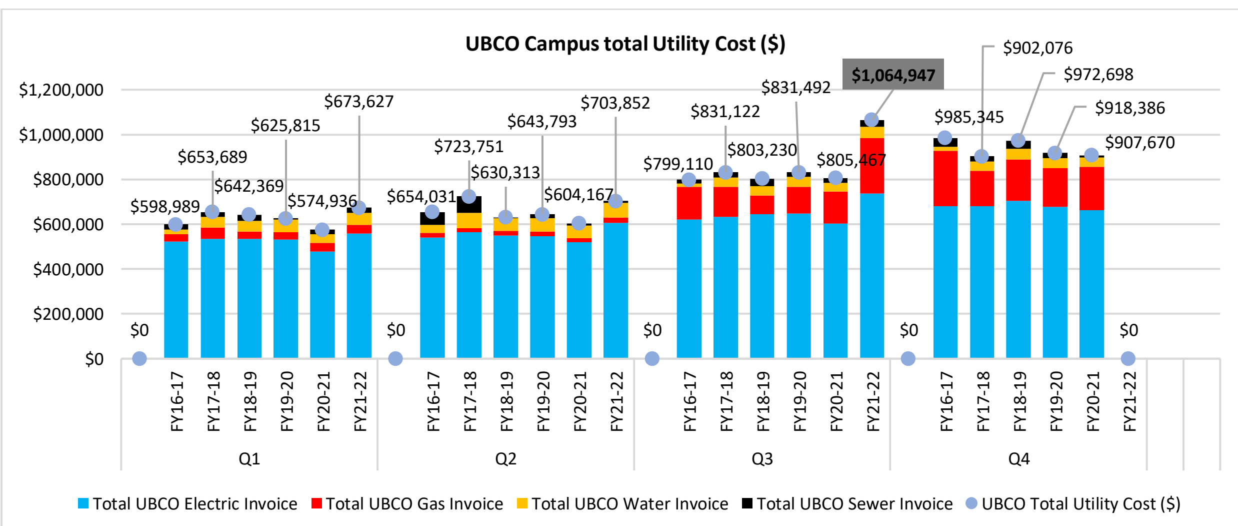
1. Overview of the Third Quarter of FY 2021-2022

UBCO Campus total energy consumption over the past quarter (Q3 2021) was 50,876 GJ compared to 41,968 GJ for Q3 last fiscal year (Q3 2020), a 21% year over year quarterly increase leading to a 32% increase in total campus energy utility cost. This total energy consumption includes a 16% increase in campus Electricity consumption i.e. from 7,533 MWh in Q3 2020 to 8,726 MWh in Q3 2021 and an increase of 31% in campus Gas consumption i.e. from 14,848 GJ in Q3 2020 to 19,464 GJ in Q3 2021.





In Q3 2021, a 10% increase in Heating Degree-Days (HDD) was observed i.e. from 1,384 degree-days in Q3 2020 to 1529 degree-days in Q3 2021.

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The increase in energy consumption is in direct correlation with the degree days experienced during the period along with following key factors:

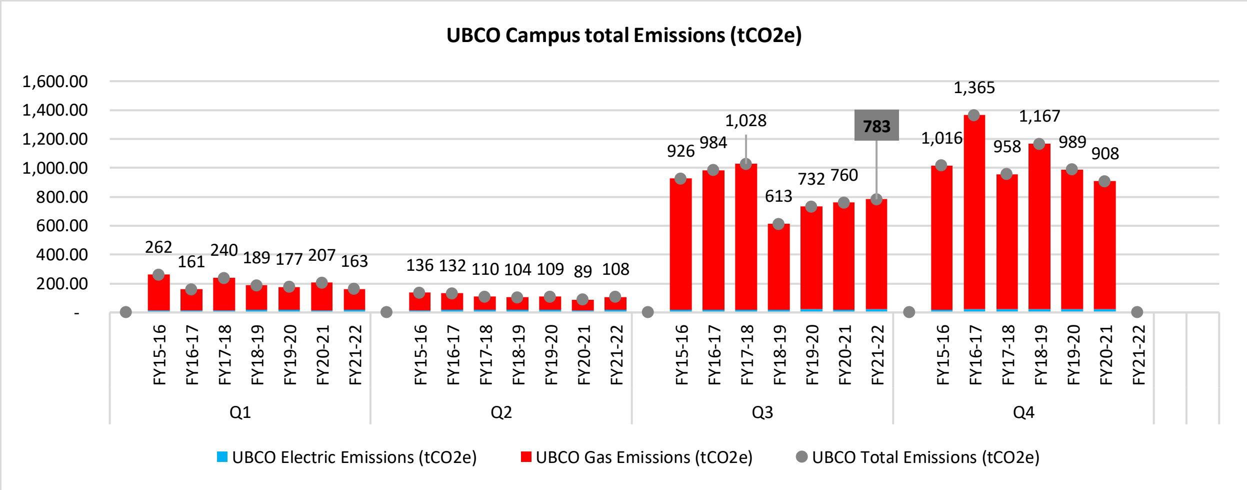
Electricity:

- As UBCO community transitioned back to campus, a 61% increase (812 MWh) in Residences electricity consumption was observed i.e. from 1,328 MWh in Q3 2020 to 2,140 MWh in Q3 2021. This can be primarily attributed to operations and commissioning of two new Residences Skeena (53% increment i.e. 137 MWh Q3 2021 vs 90 MWh Q3 2020) and Nechako (424 MWh Q3 2021 vs 5 MWh during construction). Other noteable Residences are Valhalla (148% increment i.e. by 76 MWh), Nicola (40% increment i.e. by 42 MWh), Kalamalka (51% increment i.e. by 41MWh), Cassier (84% increment i.e. by 49 MWh), and Upper Cascades (49% increment i.e. by 58 MWh).
- A 6% (383 MWh) increase in electricity consumption for Academic buildings was observed. This can be primarily attributed to operations and commissioning of the research laboratory building Innovation Precinct 1 (155 MWh Q3 2021 vs 20 MWh Q3 2020). Other notable buildings are ARTS (42% increase i.e. by 96 MWh), ASC (17% i.e. by 108 MWh), LIB (24% i.e. by 54 MWh), UNC (13% i.e. by 60 MWh), PGF (50% i.e. by 38 MWh).
- Interestingly, a few academic buildings observed reduction of electricity consumption. These buildings are ADM (12% i.e. by 43 MWh), CCS (26% i.e. by 42 MWh), COM (by 10 MWh), RHS (10% i.e. by 46 MWh), SCI (8% i.e. by 70 MWh).

Natural Gas:

- A 215% increase (1,947 GJ) in Residences gas consumption was observed i.e. from 905 GJ in Q3 2020 to 2,852 GJ in Q3 2021. This can be primarily attributed to operations and commissioning of new Residence Nechako (282 GJ) and increased Gas consumption in Similkameen (798% increment i.e. by 422 GJ), Nicola (196% increment i.e. by 173 GJ), Kalamalka (116% increment i.e. by 118 GJ). Other Residences show an increment of around 50% gas consumption.
- A 20% (2,668 GJ) increase in gas consumption for Academic buildings was observed primarily by District Energy plants (LDES and MDES) (9,301 GJ in Q3 2020 to 11,470 GJ in Q3 2021 i.e. by 2170 GJ). Other notable buildings are FIPKE (3000% i.e. by 364 GJ[1]), ARTS (344% i.e. by 293 GJ), CCS (210% i.e. by 863 GJ).
- Interestingly, a few academic buildings observed reduction of gas consumption. These buildings are ADM (20% i.e. by 113 GJ), ASC (30% i.e. by 296 GJ), EME (25% i.e. by 56 GJ), RHS (53% i.e. by 260 GJ), SCI (90% i.e. by 18 GJ[2]).

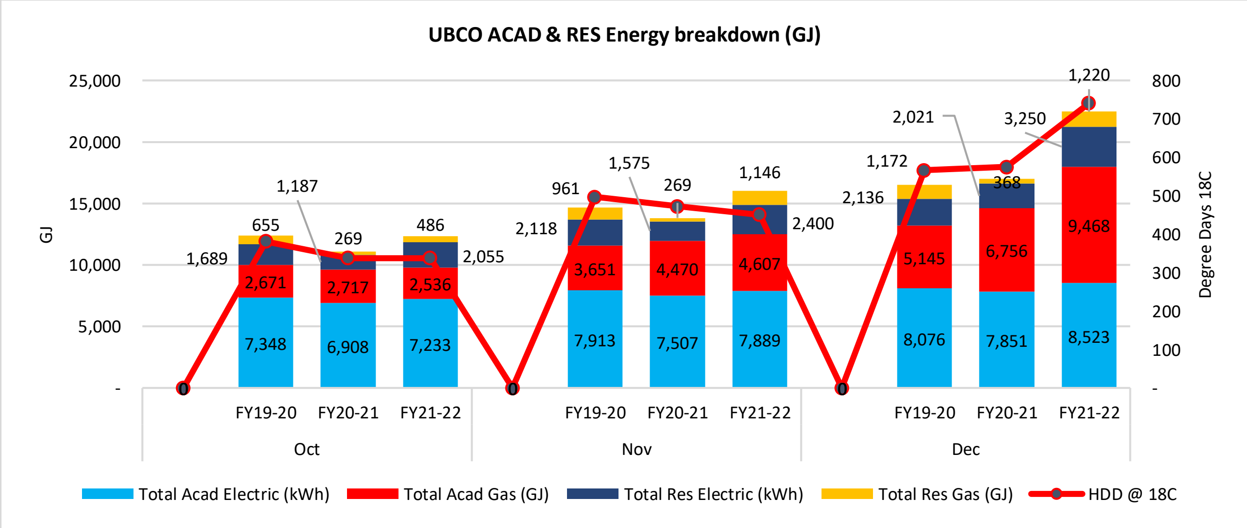
[1] Fipke gas consumption in Q3 2020 was around 0 GJ
[2] SCI gas consumption in Q3 2021 is around 0 GJ



The figure above shows quarterly trend of total GHG emissions for UBC Okanagan campus from FY15-16 to FY21-22 assuming electricity emission intensity factor of 2.587 tCO_2e/GWh[3]. Note that the increase in total GHG emission from Q3 2020 to Q3 2021 is only 23 tCO2e. This increment should have been more than 230 tonnes CO_2e because the campus Natural Gas consumption increased by 4,615 GJ from 14,848 GJ in Q3 2020 to 19,464 GJ in Q3 2021. However, in line with CAP 2030, UBCO has successfully secured the purchase of 5,000 GJ RNG (4,000 GJ in December and 1,000 GJ in January) starting December 2021 resulting in reduced total GHG emissions.

Section 2.15. of this report provides a more in depth analysis on the UBCO campus total emissions as public sector organizations will be using a new set of integrated grid emission factor for electricity use.

The figure below shows the breakdown between Academic and Residences energy consumption for the second quarter.



[3] 2020 B.C. BEST PRACTICES METHODOLOGY FOR QUANTIFYING GREENHOUSE GAS EMISSIONS
https://www2.gov.bc.ca/assets/gov/environment/climate-change/cng/methodology/2020-pso-methodology.pdf

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2. Policy Development

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.

2.1. 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.
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:

- Campus-wide lab demand-controlled ventilation – Occupancy Controlled Ventilation (Underway)
- Recommissioning of existing controls at ARTS building (Underway)
- Demand controlled ventilation for campus AHUs and/ or MUAs
- Night-time precooling
- Recommissioning of existing controls at campus buildings

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

The main campus is expected to grow with the addition of the Innovation Precinct. This motivated further analysis and consideration of district energy strategy with a view of modernization, renewal, and growth to serve both existing and new load.

A decision was made by the UBC steering committee to proceed with district energy utility services where district scaled water source heat pumps provide hot and cold water to the buildings. With the distribution and energy transfer station strategy set, the focus turned to DE decarbonization, as well as a strategy for service to the new 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 DE consultant to advance the schematic design and development of the cluster plant in the ICI building. Figure below shows a proposed high-level design for the cluster plant.

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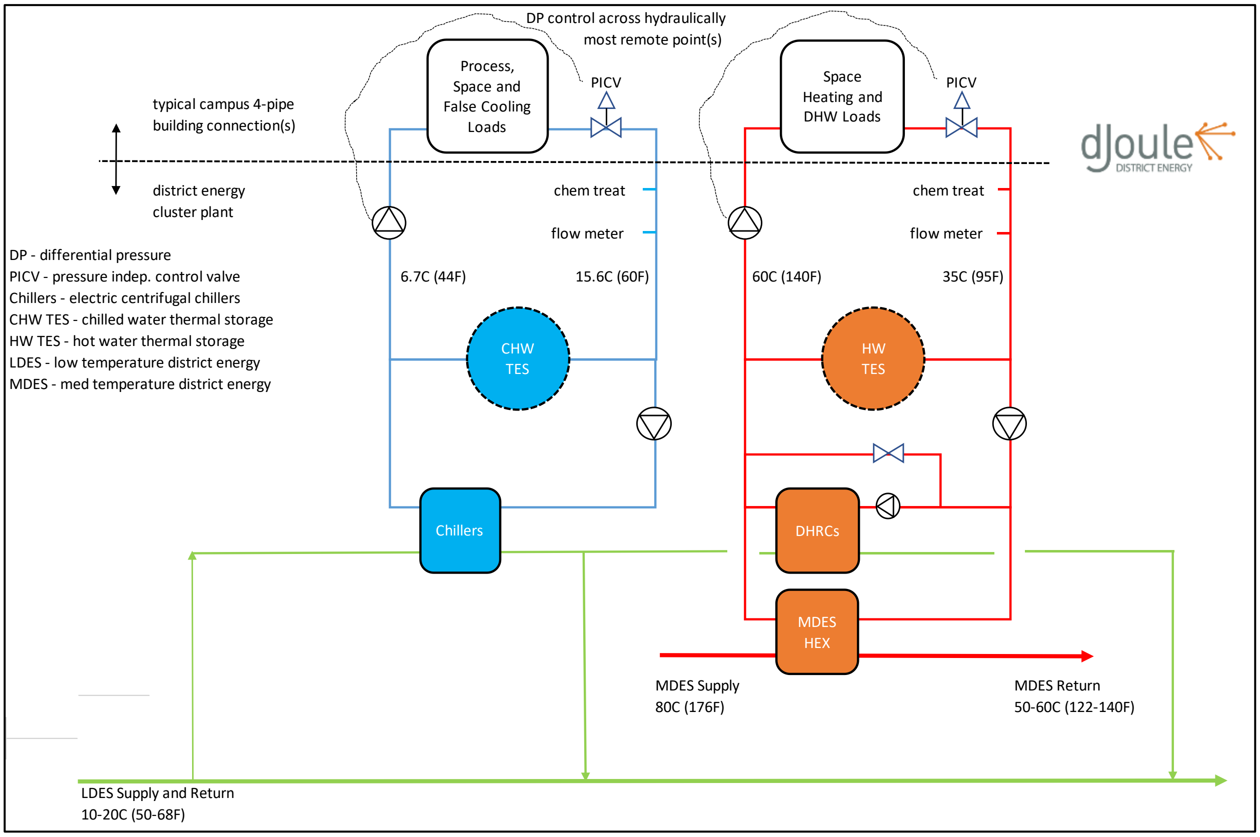


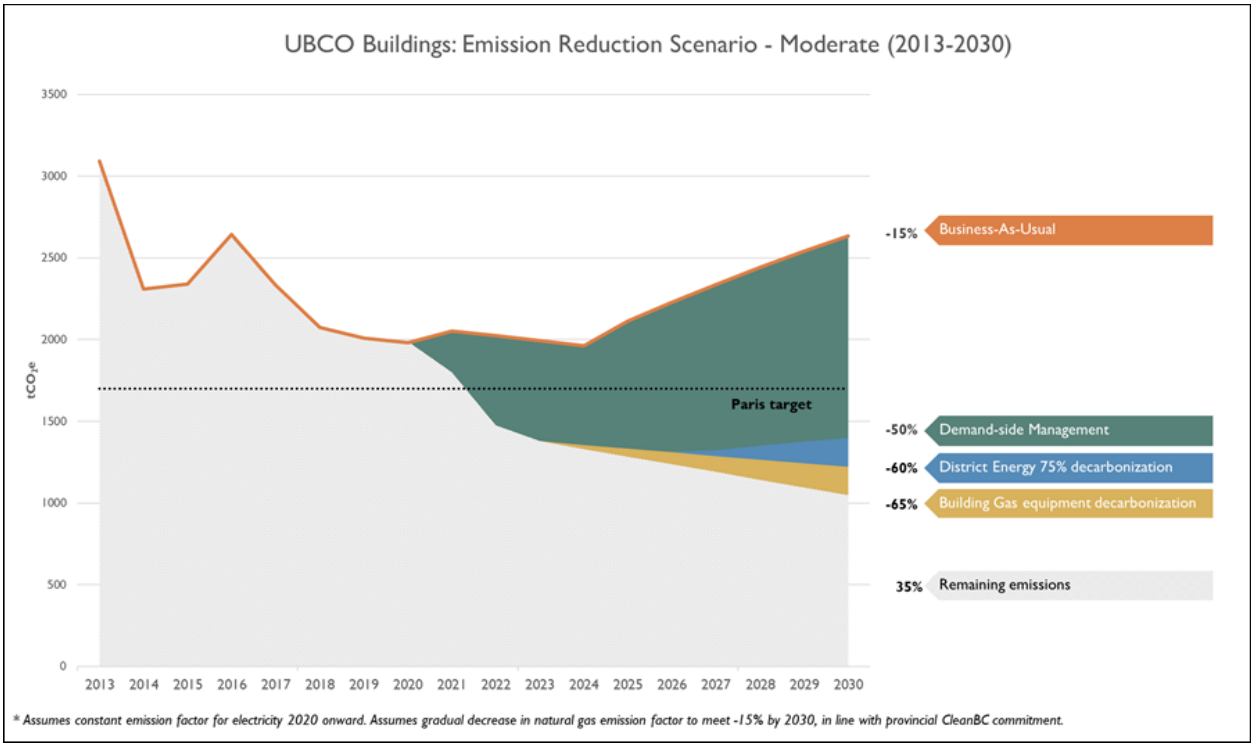
The cluster plant at the ICI building was accepted and approved by UBC executive team. Energy Team has been working diligently with UBC Properties Trust and their consultant in implementation of cluster plant at the ICI building and its associated connection with adjacent buildings.

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

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) in next three to five years.

2.3. Low Carbon Energy Strategy

Energy Team has been working with campus Sustainability department to help inform realistic carbon emission reduction targets under Low Carbon Energy Strategy based on work being done as part of Strategic Energy Master Plan and High-Level Campus Carbon Energy Strategy.



Based on the strategy, a moderate (realistic) target of 65% emission reduction[4] from 2013 levels by 2030 is recommended. This can be achieved by partial decarbonization of the central plant, implementing projects that will reduce energy demand, and connecting select existing buildings to central energy supply systems (district energy). The Campus Action Plan 2030 plan has been signed off by the UBC executive committee. Further work is being performed to keep track of the progress.

2.4. UBCO Net Positive Modelling Study – Archetype update and Analysis

Energy Team has been 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.

Key assymptions considered in the study in line with Technical Guidelines and future UBCO campus construction practices:

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

- All archetypes have been assumed to be connected to the campus district energy system for hydronic heating, cooling and hot water.
- Full mechanical cooling have been added to reflect typical practice
- Window to Wall Ratio (WWR) for the reference scenario has been assumed as 40%
- Residence buildings assume centralized HRVs (70% effectiveness) to serve ventilation demand connected with constant volume 4-pipe constant speed Fan Coil Units connected to DE system. Make-up air units provide tempered outdoor air to corridors for pressurization (20 cfm/unit), hydronic heating and cooling coils connected to DE system. This MUA increased to 30 cfm/unit to account for dryer and kitchen exhaust
- Two types of HVAC options have been modelled for the non-lab space of other three archetypes:
  - Option 1: VAV system with central cooling, connected to DE system. Reheat and perimeter heat losses addressed by local hydronic baseboard convectors and integrated heat recovery through 70% effectivess.
  - Option 2: Outdoor air to be provided by Dedicated Outdoor Air System (DOAS)[5] with 70% heat recovery effectiveness. 4-pipe constant speed Fan Coil Units in Classroom/ office areas providing heating and cooling, connected to DE system.
- Laboratory spaces on campus have been modelled as 100% outdoor air delivered via separate system with no re-circulation with 40% heat recovery effectiveness and 4-pipe constant speed Fan Coil Units for heating and cooling.
- Low-intensity lab has a fume hood density of 25 lineal meter of fume hood per 1000 m^2 of lab area with flow rate reduction, wind responsive VFD, and low pressure drop. The fume hood are 6 feet wide and ventilation rate is driven by general air change rate requirement.
- High-intensity lab has a fume hood density of 35 lineal meter of fume hood per 1000 m^2 of lab area with flow rate reduction, wind responsive VFD, and low pressure drop. The fume hood are 4 feet wide and ventilation rate is driven by general air change rate requirement.
- The lab air handler design flow rate is based on largest of "8 ACH" or "100% open @ 188 L/s/m fume hood". During occupied hours, operation flow rate is based on largest of "8 ACH" or "60% closed @ 45 L/s/m fume hood and 40% open @ 188 L/s/m fume hood". During unoccupied hours, operation flow rate is based on largest of "4 ACH" or "95% closed @ 45 L/s/m fume hood and 5% open @ 188 L/s/m fume hood".
- Domestic hot water has been modelled to be served from Central storage tank system (120 F) connected to district heating with electric water heater for top-up.
- Occupant schedules as per NECB and ASHRAE guidelines
  - Residences: Around 30% - 50% between 8 AM to 5 PM and 90% 6 PM to 7 AM[6]
  - Retail: Mon to Sat 7 AM to 9 PM; Sun 9 AM to 7 PM

[5] Although the DOAS + FCUs system has its disadvantages compared to VAV, such as higher maintenance due to terminal filter replacement, it has benefits such as higher heat recovery effectiveness and the ability to decouple the heating and ventilation system and thereby reduce fan and heating cooling energy. Further, the DOAS + FCUs baseline system has the potential to be improved in terms of fan energy and free cooling availability. Free cooling can be achieved by using a high-performance HRV that allows for bypass as needed. However, since the DOAS system is typically sized for the ventilation requirements, the free cooling ability is limited compared to the VAV system which is sized to provide a greater air flow rate than the ventilation requirement alone.

[6] Schedule based on NECB 2015 Table A – 8.4.3.2 (1) G

  - Labs: Mon to Fri 7 AM to 10 PM; Sat, Sun 7 AM to 6 PM
  - Classrooms: Mon to Fri 8 AM to 10 PM; Sat, Sun Unoccupied
  - Offices: Mon to Fri 7 AM to 10 PM; Sat 7 AM to 5 PM; Sun Unoccupied
- Electricity emission factor is assumed at 40.1 tCO_2e/GWh
- Carbon cost is assumed at 250 $/ tCO_2e

Individual ECMs appropriate to each archetype were combined into two ECM bundles for modelling and costing i.e. Enclosure bundle and Mechanical measure bundle. RDH has provided a final version of the report which will be further used to inform Okanagan campus energy targets. Energy Team will be presenting the results of this project at the MCRC meeting.

2.5. 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.

2.6. 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.

2.7. 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.

2.8. 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. The project is currently at 100% Design Development stage and the 100% DD package is currently being reviewed by UBCO team.

2.9. 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.

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.

2.10. 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.

2.11. CCS deep retrofit study

With the distribution and energy transfer station strategy set (Refer to Section 2.2. and 2.8.), 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%[7]. 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.

A study is being carried out to provide deep retrofit recommendations and individual replacement options for main and terminal HVAC equipment within the CCS building. Following are the expected deliverables from this study:

- Overall HVAC system retrofit strategy to fulfill a major building upgrade
- Recommendations for replacement of individual system and terminal HVAC equipment if equipment fails before end of life
- Equipment lists updated to include replacement suggestions and costs

The project is expected to complete by end of March 2022.

2.12. Renwable 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.

2.13. UBCO Lower Innovation Precinct Cluster Plant concept design

To support future campus needs, the UBCO Energy Team has subcontracted Integral Group Consulting to perform a high-level concept design to outline preliminary requirements for a potential Lower Innovation Precinct Cluster Plant. 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. The potential Cluster Plant will generate 4-pipe CHW & HW services using heat pumps coupled with the LDES as a heat source or sink. CHW & HW will be

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[7] Altus Group: Facilities maintenance 101; https://www.altusgroup.com/services/insights/facilities-maintenance-101-how-to-get-the-most-from-your-maintenance-budget/

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distributed to future Lower Innovation Precinct buildings. This project kick started in January 2022 with an expected completion by end of March 2022.

2.14. District Energy Plant efficiency study

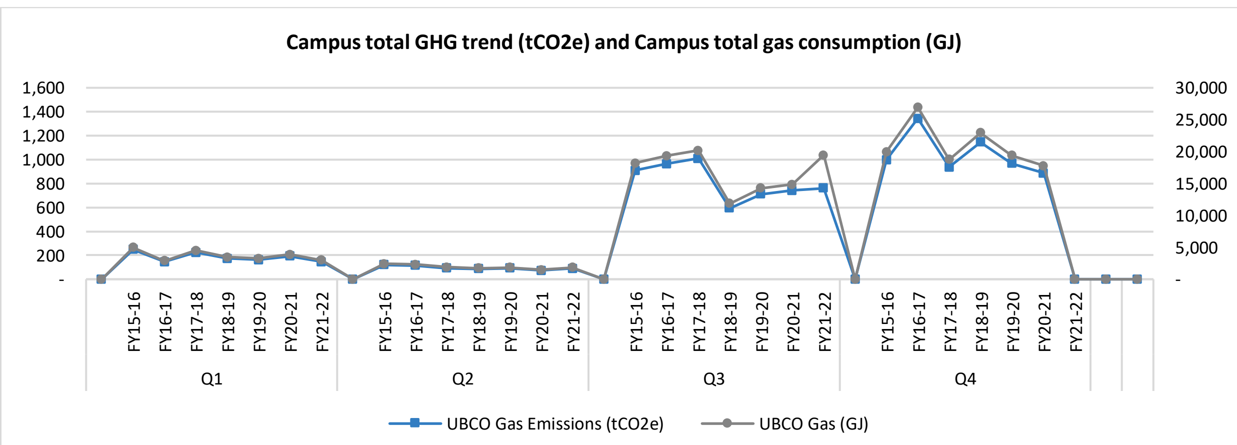
Energy Team has been working to analyze performance of DE system and building plant to help optimize overall system performance. The scope of work under this study includes:

- **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 as the three buildings.

2.15. 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 tCO_2e/GWh (Refer to Figure below).



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[8].

[8] 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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Figure below 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 15.

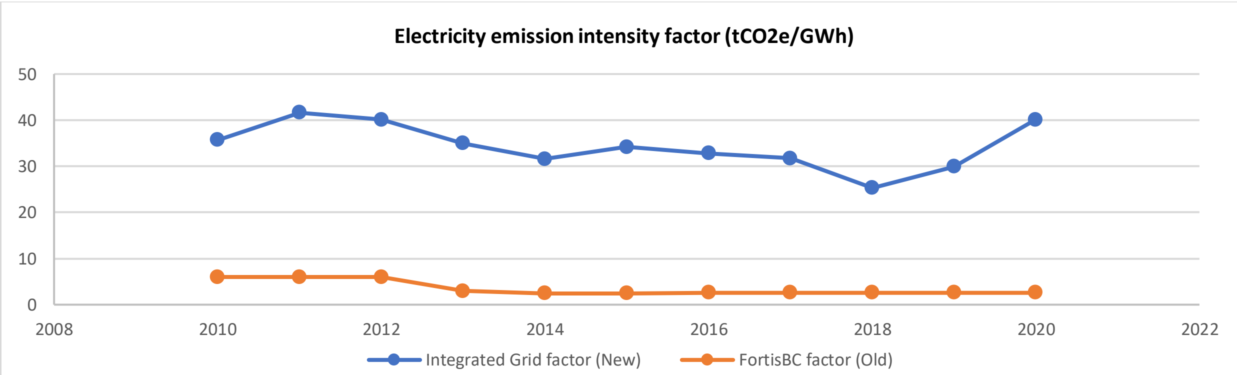
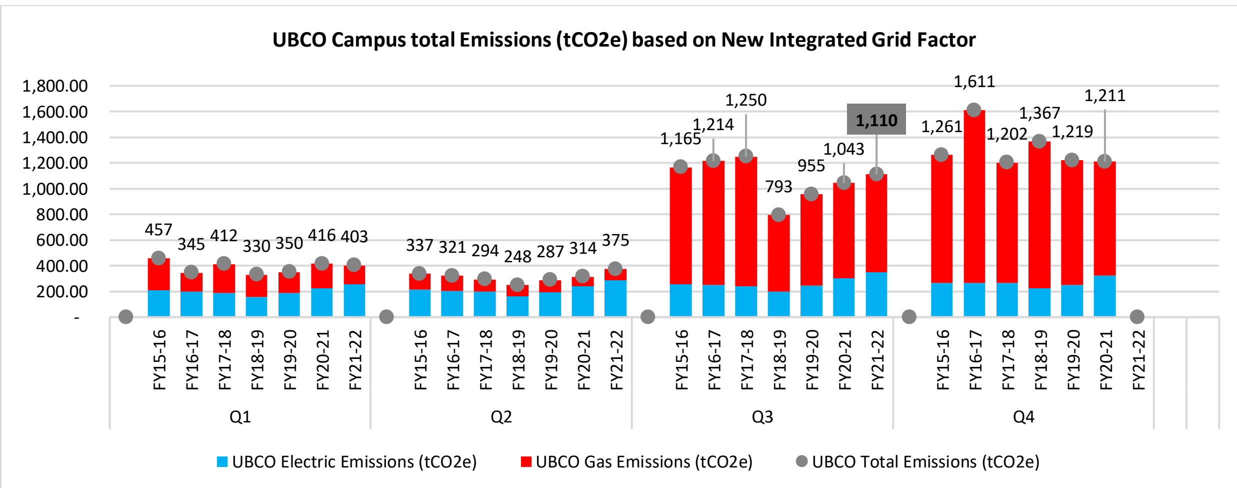
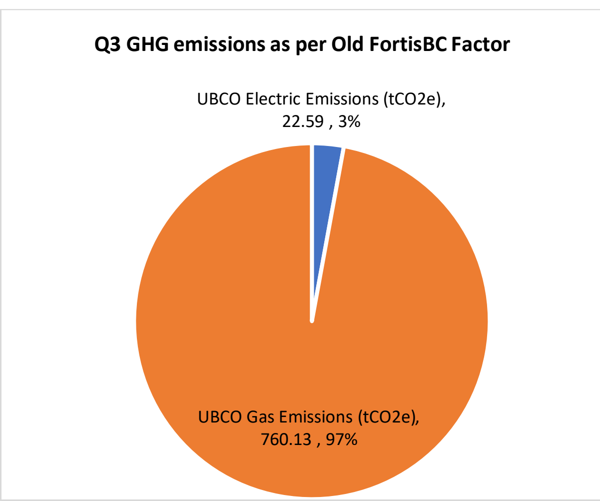
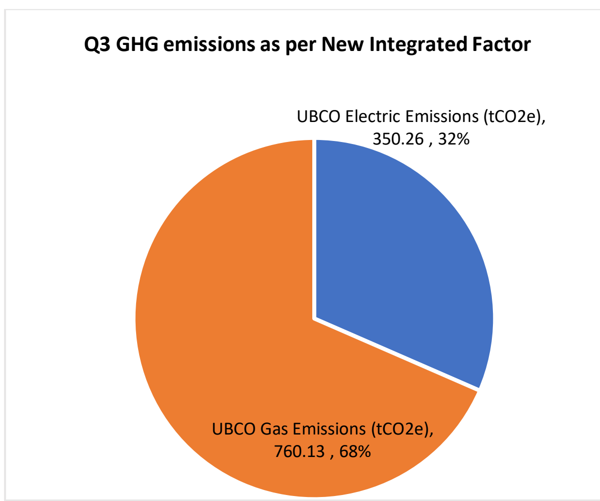


Figure below shows quarterly trend for total GHG emissions if new integrated grid factors are used. The new electricity emission factor would result in a drastic increase in total emission by around 200 – 400 tonnes CO2e per quarter resulting in electric emissions share to increase from 3% to 32% for Q3 2021.







3. Energy Conservation Projects

In order to reduce utility costs, energy consumption and GHG emissions, energy conservation measures (ECMs) are regularly implemented on campus. In terms of actual studies/ projects, the following projects have been completed/ in progress over the last quarter.

3.1. 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.

3.2. 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.

3.3. 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.

SES Consulting has submitted draft report in December 2021 for this study which is being reviewed.

3.4. 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 Hanldling Units affected by this night flush measure:

- Arts AHU1-8, RTU1-3

- EME AHU1-8 - enable and verify night cooling operation for AHU-1-8 in existing SSTO operation
- Gym AHU1
- Library AHU1-6
- Admin AHU1-9
- EME HRV4 – high head lab, occupied by wifi occupancy only, no existing scheduling exists or setback heating or cooling modes

This project is expected to be completed by Q1 2022.

3.5. 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 the third week of January 2022 which is being reviewed by UBCO.

3.6. 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[9]. 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[10].

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.

---

[9] 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.

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

The trends for the actual occupancy were analyzed at 15 minute interval from 1 February 2021 to 31 October 2021. Based on the analysis of the actual occupancy trends, the current ON threshold of 5 is found to be very low compared to the device count observed during the core unoccupied hours i.e. 11 PM to 4 AM. UBCO Energy Team is working towards finding a more appropriate threshold (optimal) for the Air Handling Units and also estimating potential energy and cost savings as a result of recalibration.

3.7. RHS HVAC issues study

Since, the building was handed over there has been many issues to do with lack of heat to end of system rooms, cascaded heat pump trips, boiler operation and air handler pre heat coil operation. Progress to address these issues has been made and now the heat pump and boiler operations are fairly stable. However, there are still heating complaints in the buildings potentially due to following issues:

- Hydronic Supply flow and temperature may not be controlled adequately due to all or some of the below issues:
    - Main hydronic pump control pressure sensors are located in 3rd floor mech room may not be in the ideal location(s)
    - Buffer tanks inlets are undersized
    - Hydronic balancing especially on ground floor may be causing lack of heat/flow to remote units.
- Hydronic temperatures in conjunction with flow may not be ideal due to possibly some of the below items:
    - Cascaded heat pump configuration could cause heat pump performance issues.
    - HWS supply temperature 2 setpoint is based on OAT and WSHP operation on demand.
- Boiler operation issues are affected by:
    - MUA/AHU preheat glycol demand sequencing
    - HWS supply temperature 1 setpoint sequencing is to allow backup for WSHP heating.

UBCO Energy Team has contracted Falcon Engineering to confirm current suspected hydronic issues causing heating complaints, identify best solution for corrective action to known solutions in a priority order, and provide proposal, costs and corrective actions to provide solutions.

The study project kick started in January 2022 with an expected completion by end of March 2022.

3.8. 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.

4. 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.

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4.1. 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. The project is currently at 100% Design Development stage and the 100% DD package is currently being reviewed by UBCO team.

4.2. 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. Energy Team has been working with the Project Manager UBC Properties Trust and their contractors to apply for an eligible FortisBC incentive for the renovations.

The building is currently in its Commissioning phase and deficiencies the building is being identified and rectified by UBCO consultants/ contractors.

4.3. Office Modular II (OM2)

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

4.4. 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. The scope of work is currently being developed and Energy Team will be working with Construction Management Office to apply for an eligible incentive for the renovations through FortisBC.

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4.5. UBC Okanagan's Downtown site

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.

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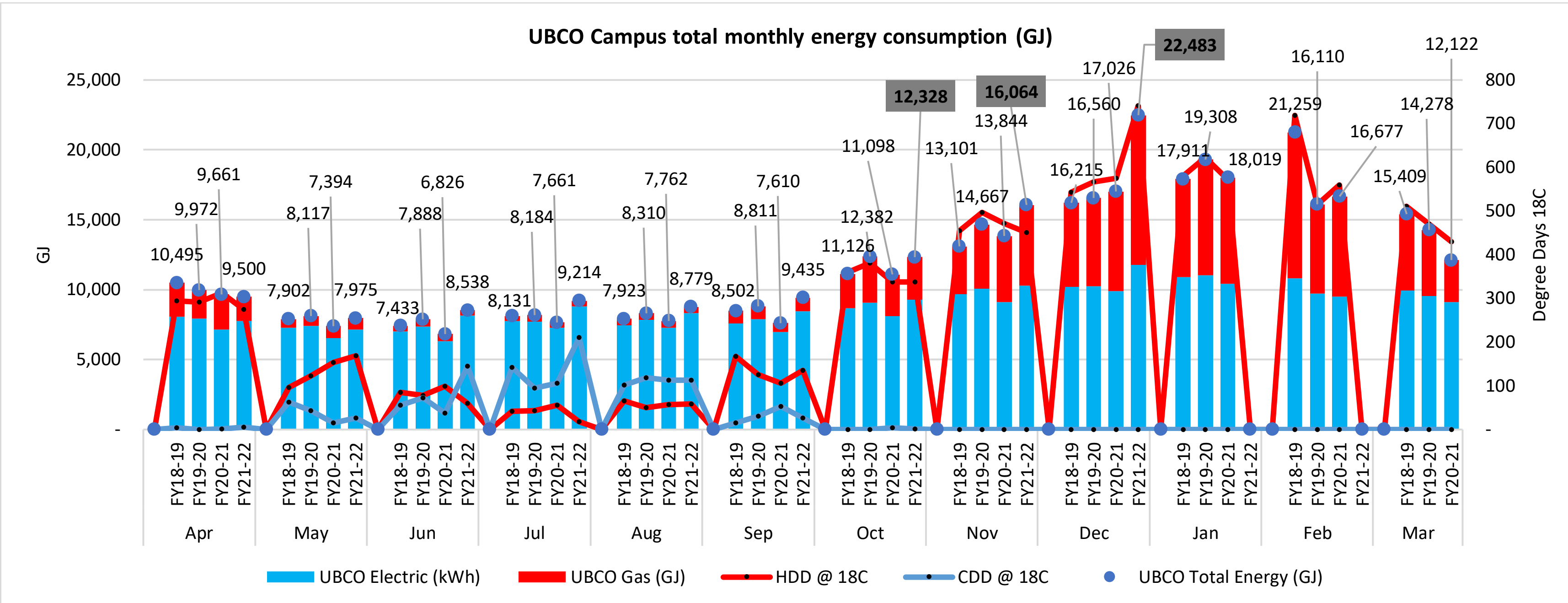
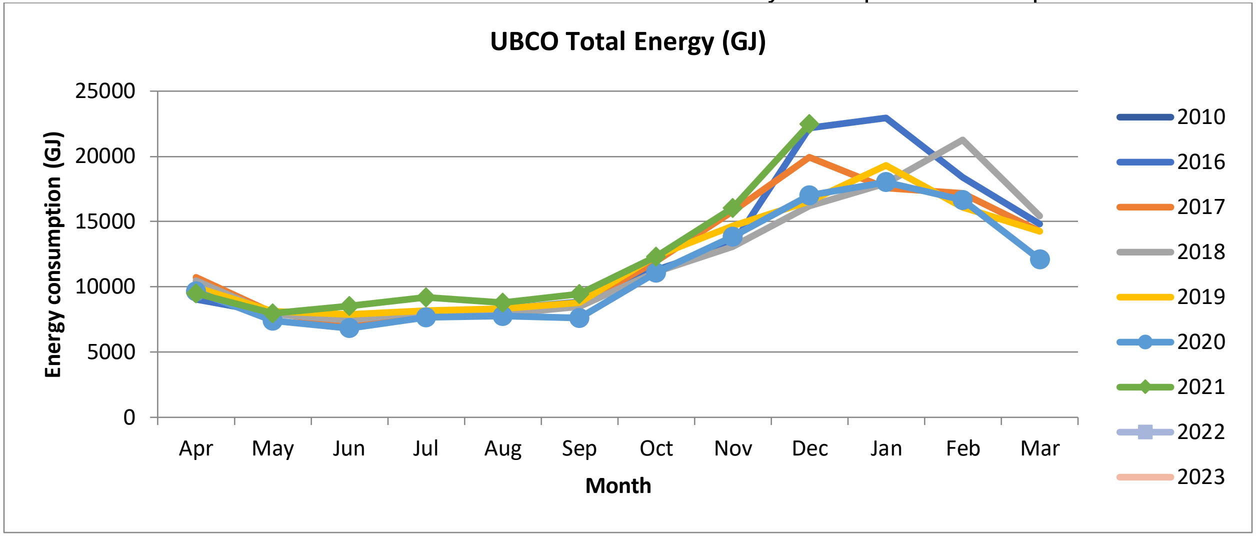
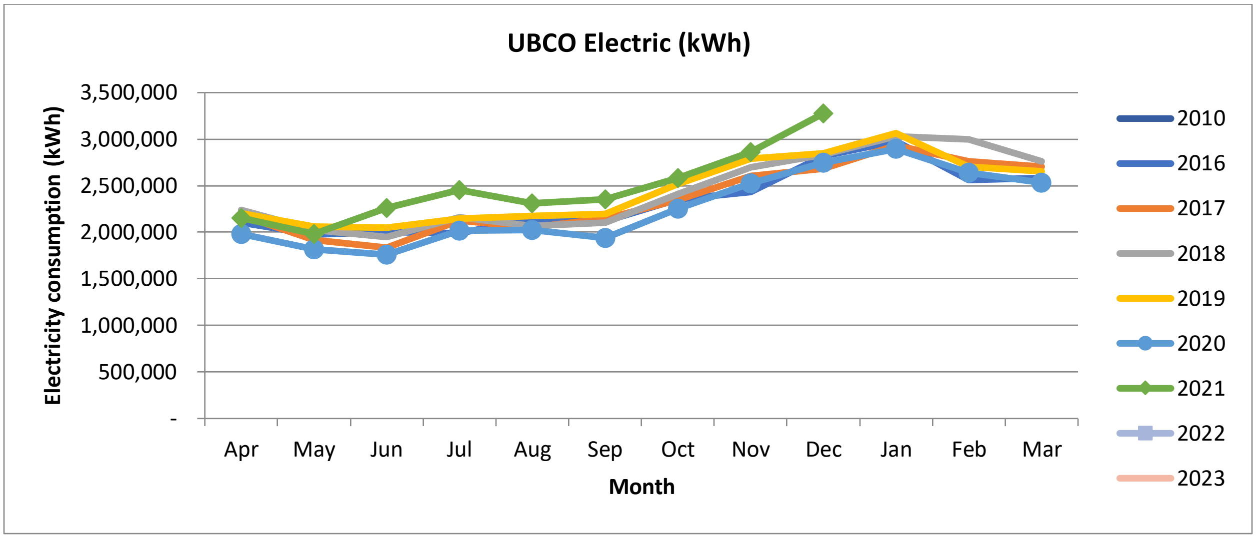
5. Monthly Energy Performance Graphs

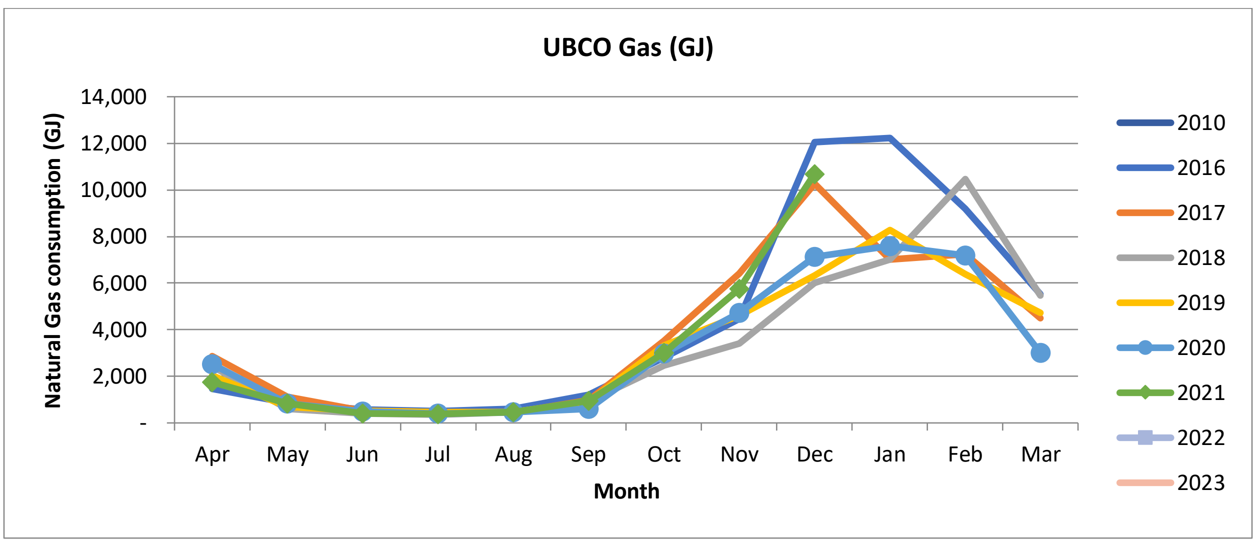
This section presents various figures which show and compares the month over month energy consumption from FY 18-19 to FY 21-22[11].

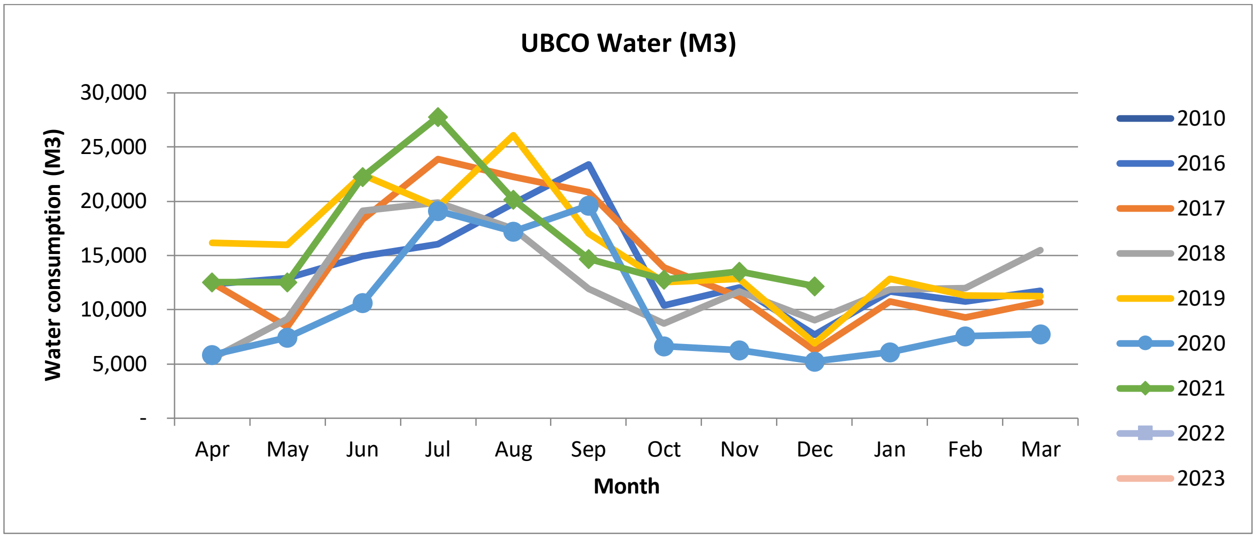


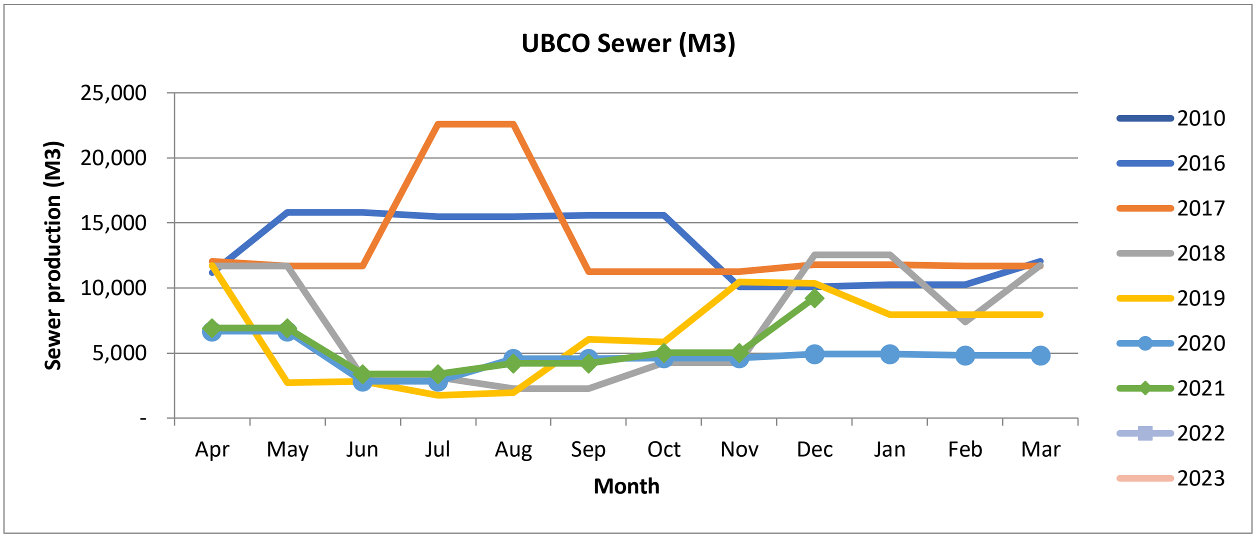
[11] For section 5, any year listed in the graph is start of the fiscal year.

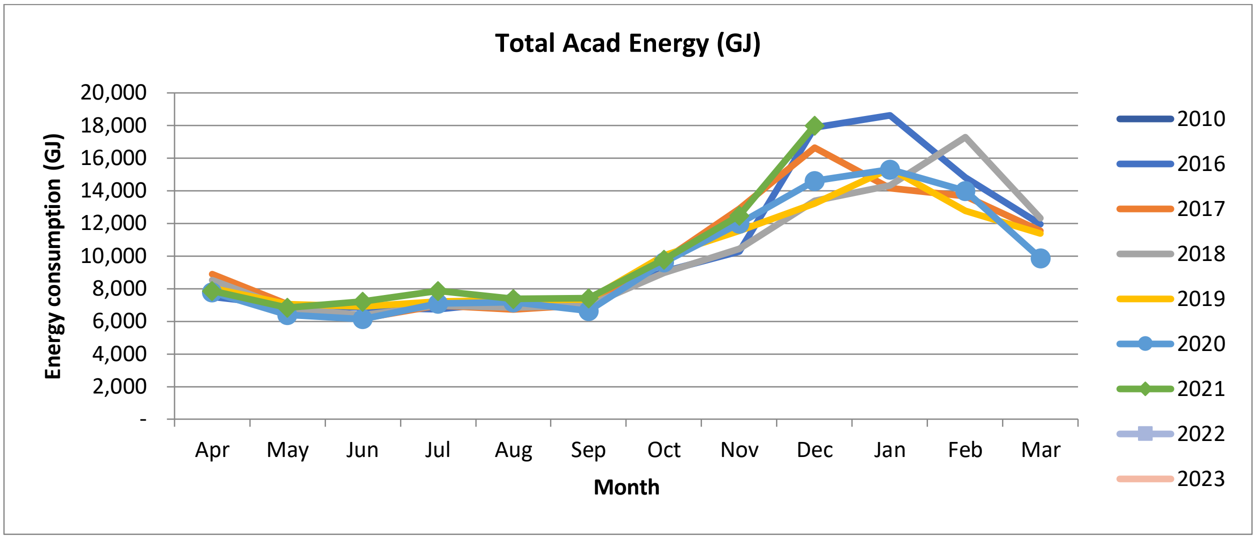

UBCO Total Energy (GJ)
Energy consumption (GJ)
25000
20000
15000
10000
5000
0
Apr May Jun Jul Aug Sep Oct Nov Dec Jan Feb Mar
Month
2010
2016
2017
2018
2019
2020
2021
2022
2023

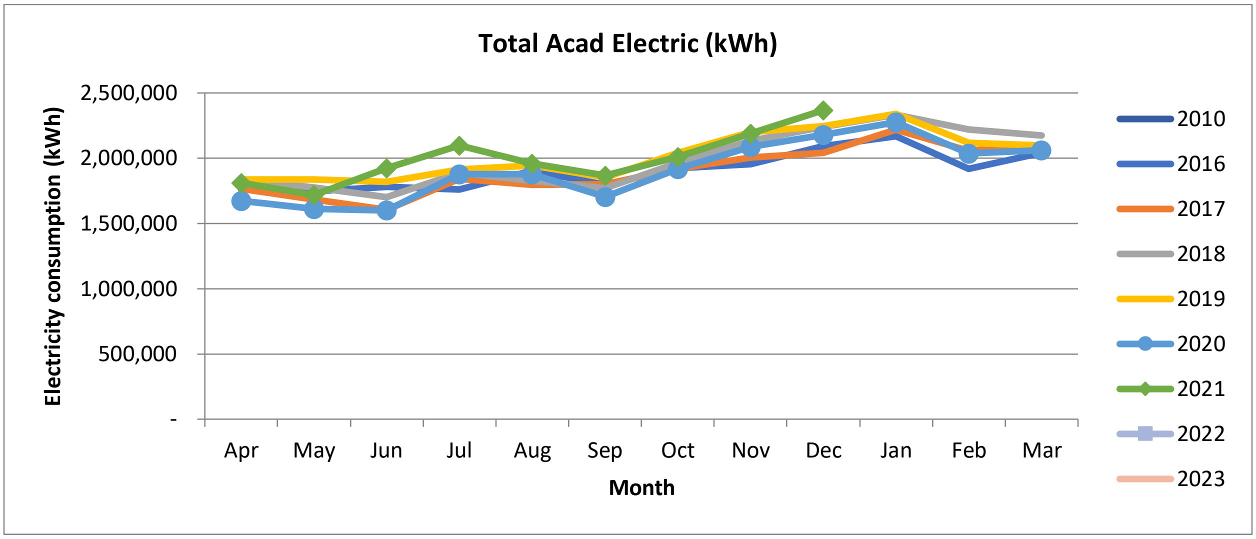

UBCO Electric (kWh)
Electricity consumption (kWh)
3,500,000
3,000,000
2,500,000
2,000,000
1,500,000
1,000,000
500,000
-
Apr May Jun Jul Aug Sep Oct Nov Dec Jan Feb Mar
Month
2010
2016
2017
2018
2019
2020
2021
2022
2023

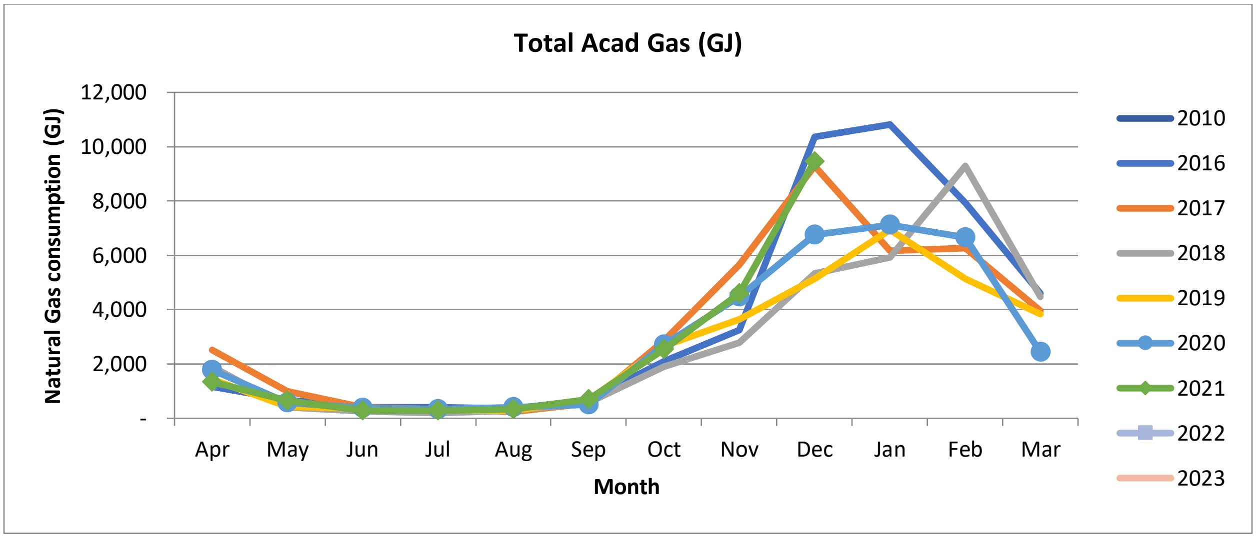

UBCO Gas (GJ)
Natural Gas consumption (GJ)
14,000
12,000
10,000
8,000
6,000
4,000
2,000
-
Apr May Jun Jul Aug Sep Oct Nov Dec Jan Feb Mar
Month
2010
2016
2017
2018
2019
2020
2021
2022
2023


UBCO Water (M3)
Water consumption (M3)
30,000
25,000
20,000
15,000
10,000
5,000
-
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Month
2010
2016
2017
2018
2019
2020
2021
2022
2023


UBCO Sewer (M3)
Sewer production (M3)
25,000
20,000
15,000
10,000
5,000
-
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Month
2010
2016
2017
2018
2019
2020
2021
2022
2023


Total Acad Energy (GJ)
Energy consumption (GJ)
20,000
18,000
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
-
Apr May Jun Jul Aug Sep Oct Nov Dec Jan Feb Mar
Month
2010
2016
2017
2018
2019
2020
2021
2022
2023


Total Acad Electric (kWh)
Electricity consumption (kWh)
2,500,000
2,000,000
1,500,000
1,000,000
500,000
-
Apr May Jun Jul Aug Sep Oct Nov Dec Jan Feb Mar
Month
2010
2016
2017
2018
2019
2020
2021
2022
2023


Total Acad Gas (GJ)
Natural Gas consumption (GJ)
12,000
10,000
8,000
6,000
4,000
2,000
-
Apr May Jun Jul Aug Sep Oct Nov Dec Jan Feb Mar
Month
2010
2016
2017
2018
2019
2020
2021
2022
2023

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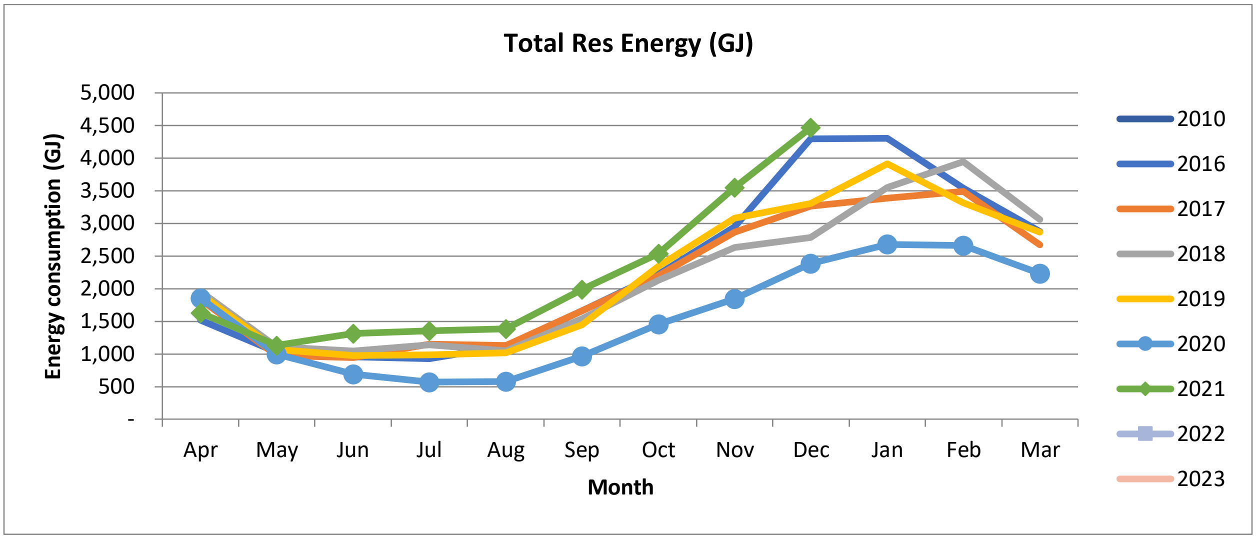

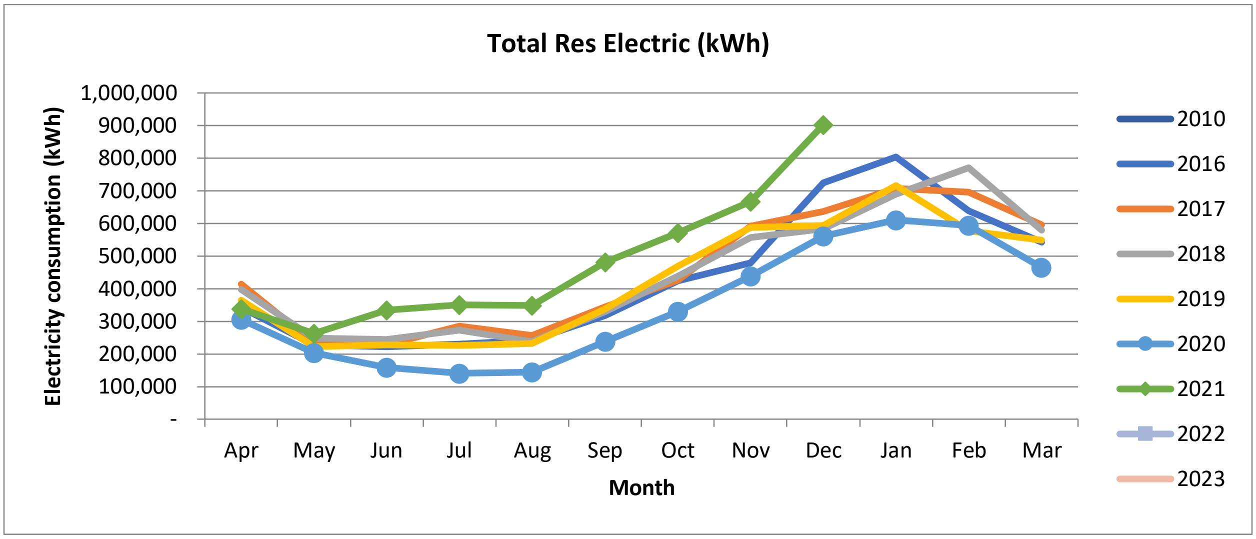

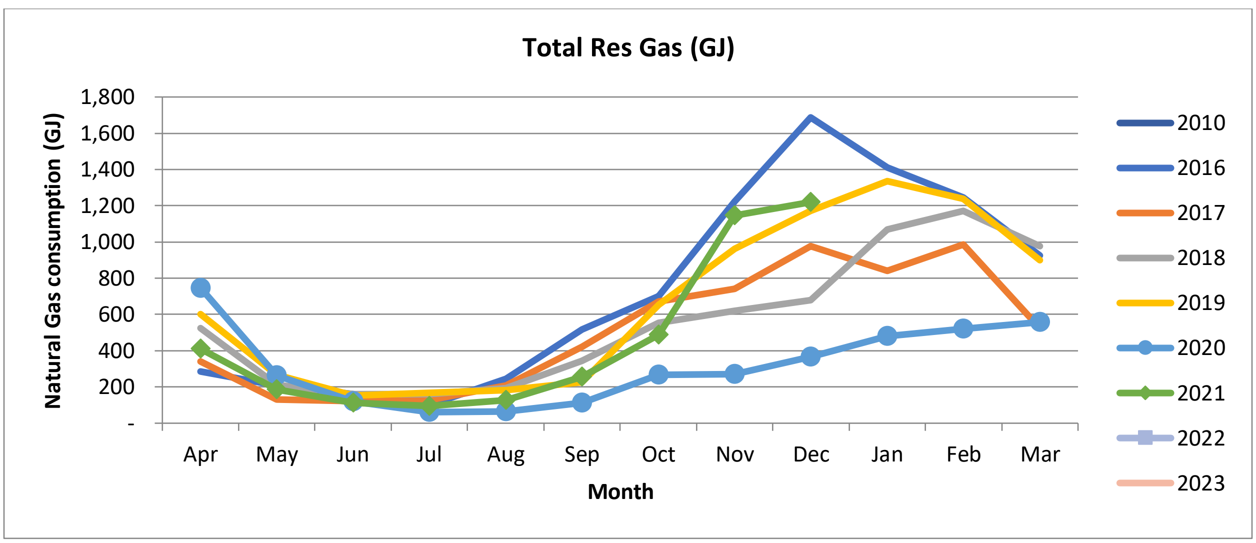

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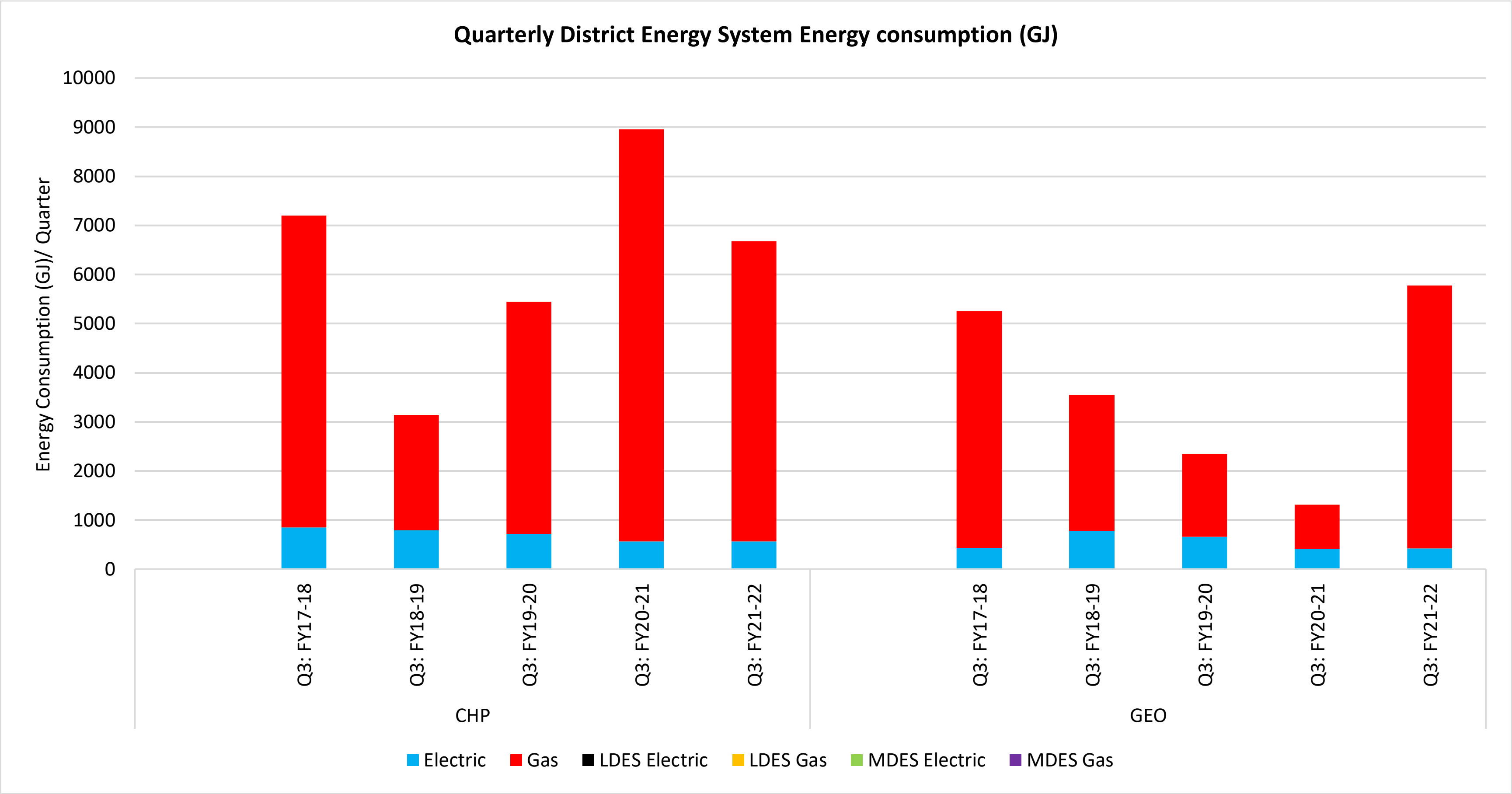

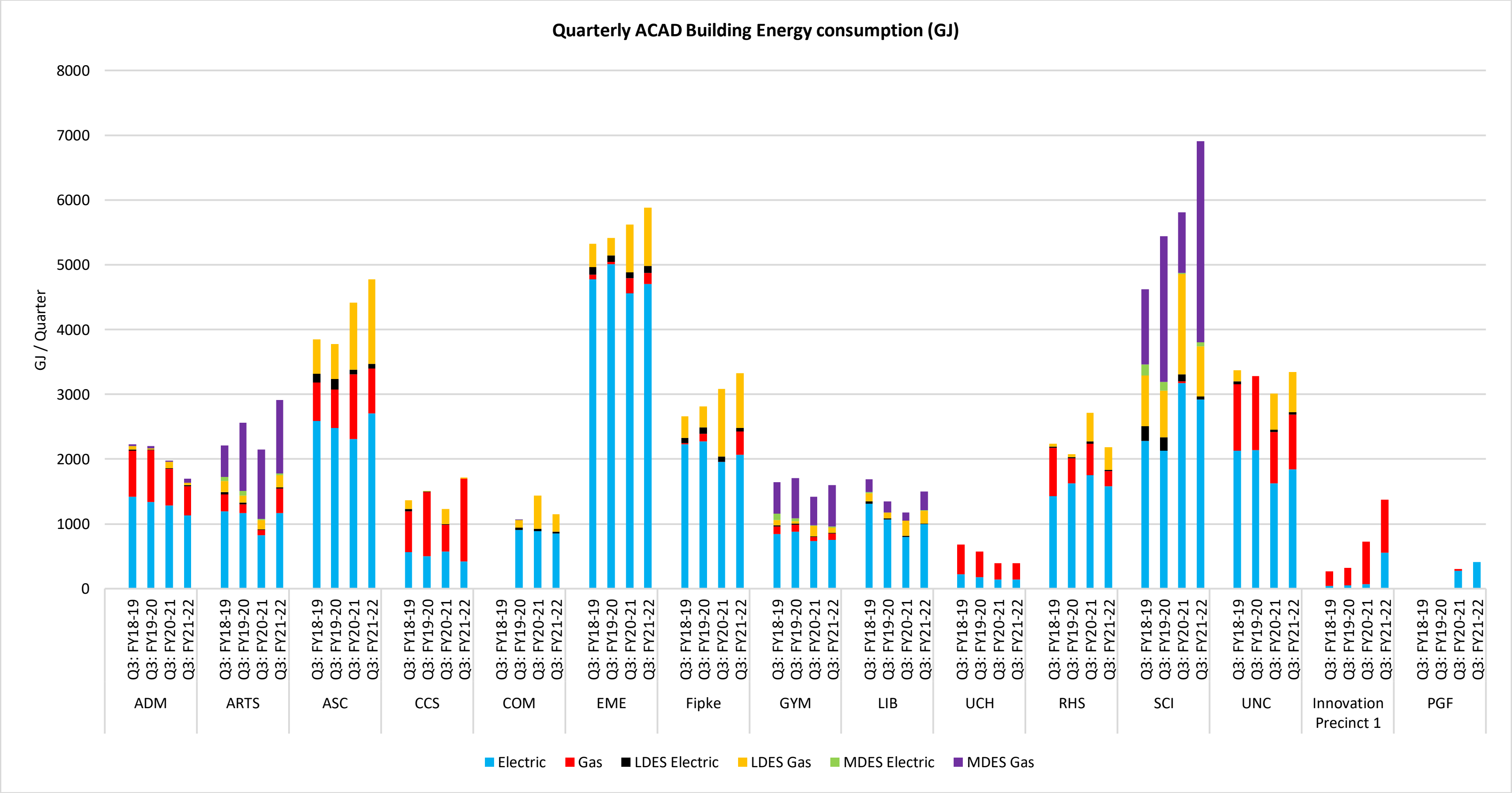
Quarterly ACAD Building Energy consumption (GJ)
GJ / Quarter
0
1000
2000
3000
4000
5000
6000
7000
8000
Q3: FY18-19
Q3: FY19-20
Q3: FY20-21
Q3: FY21-22
ADM
ARTS
ASC
CCS
COM
EME
Fipke
GYM
LIB
UCH
RHS
SCI
UNC
Innovation Precinct 1
PGF
Electric
Gas
LDES Electric
LDES Gas
MDES Electric
MDES Gas

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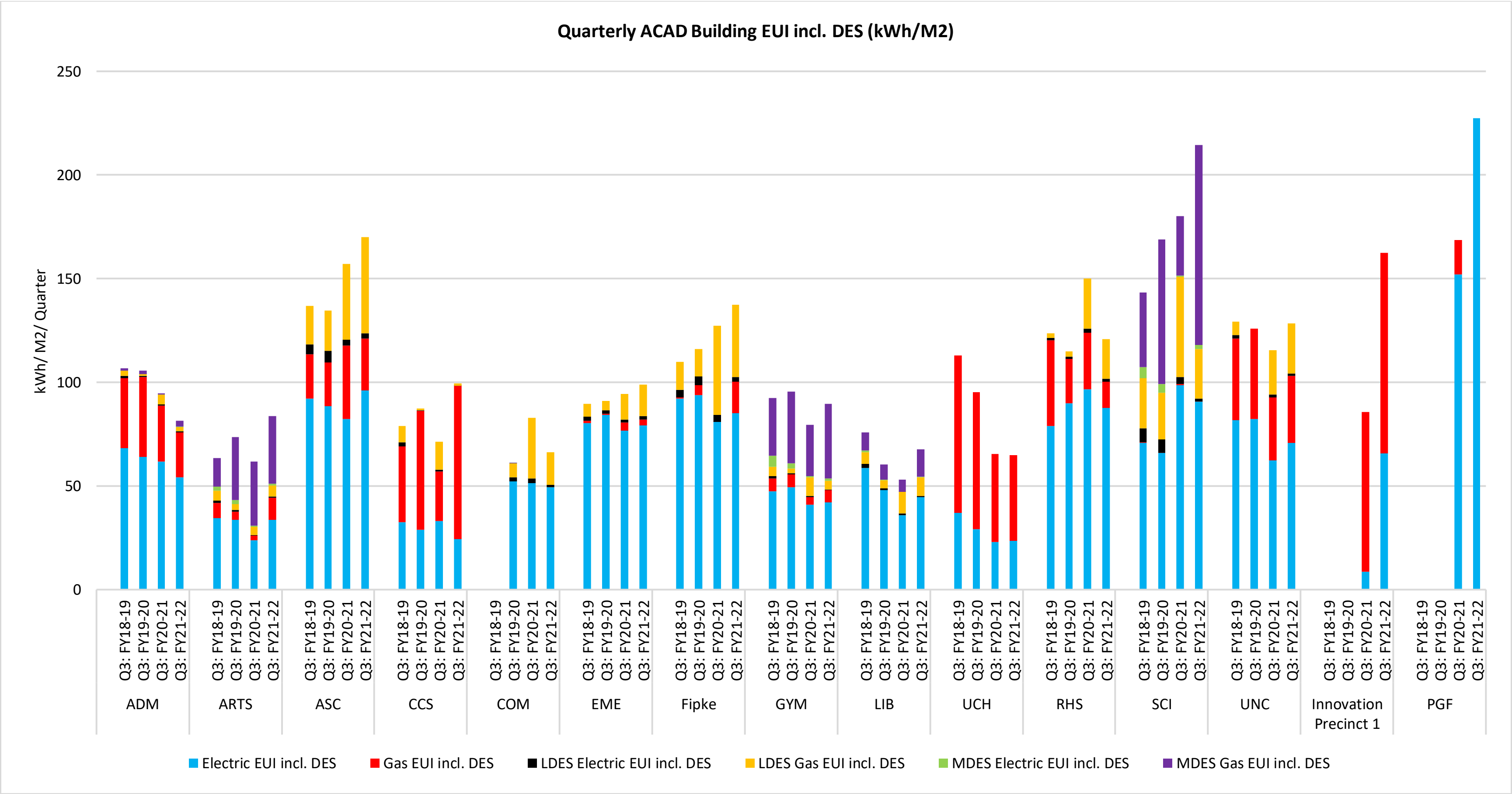

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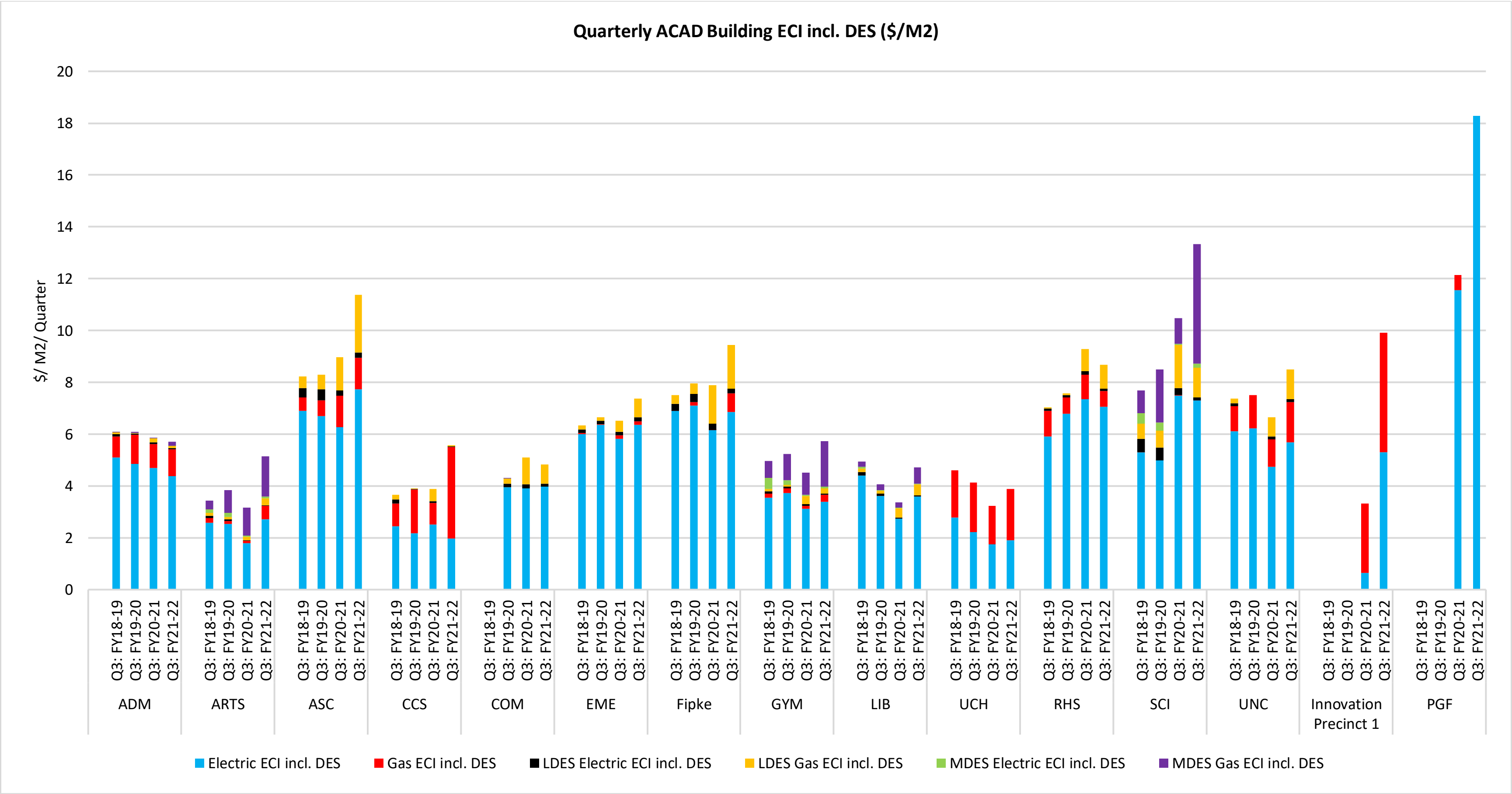

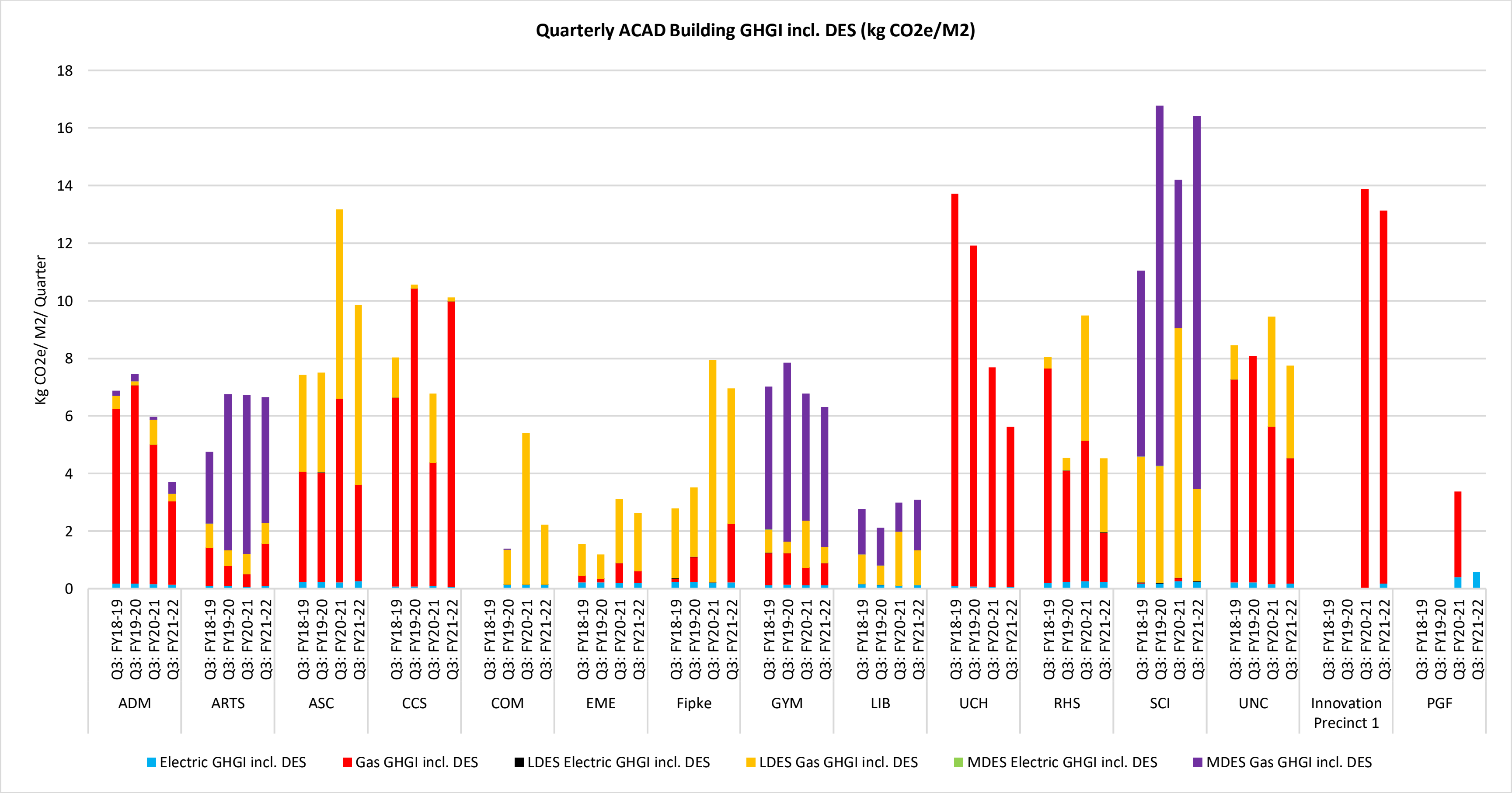

* Assuming electricity emission factor of 2.587 tCO_2e/GWh (old FortisBC grid factor)

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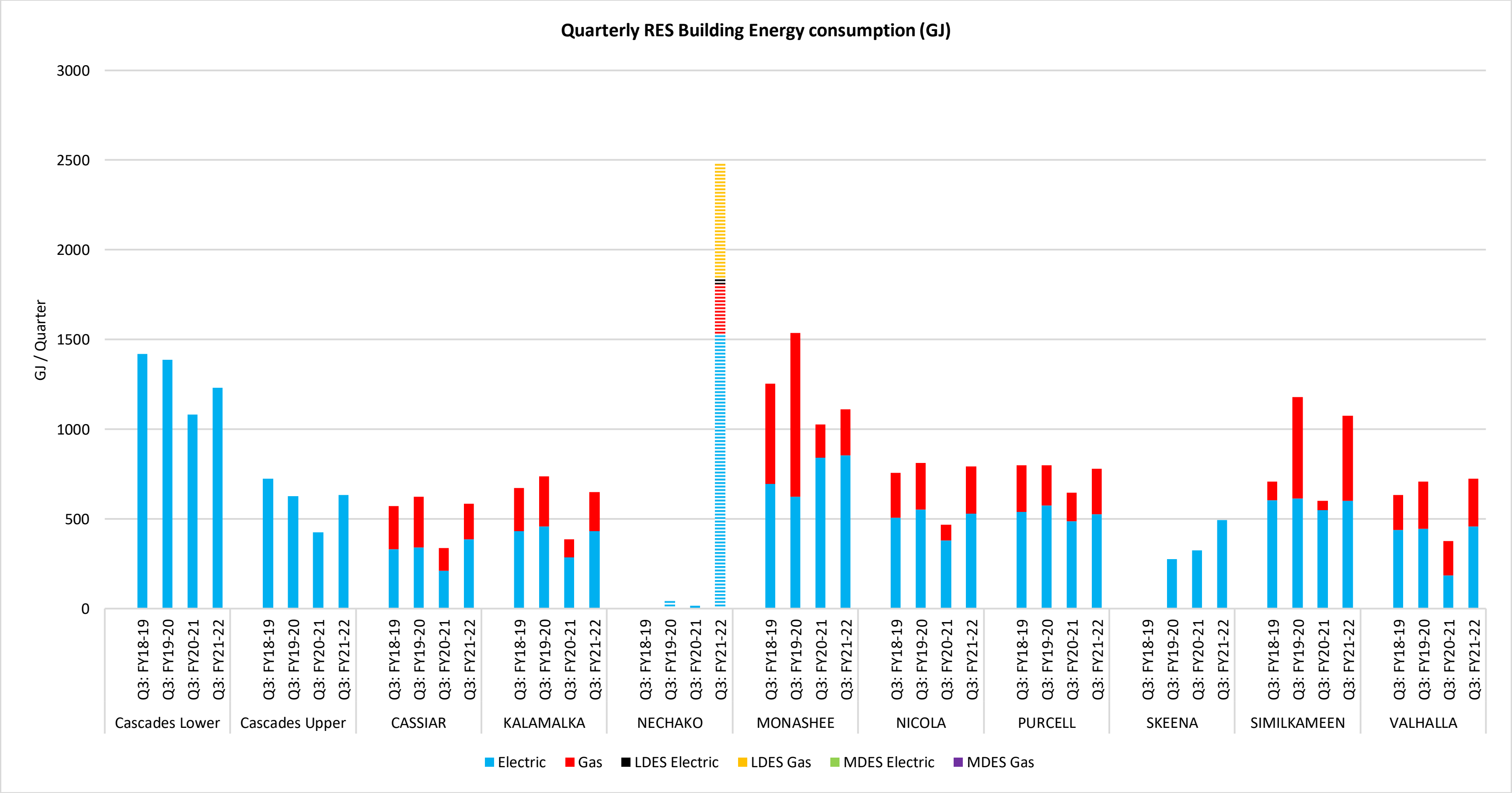

Note: Narrow Horizontal pattern fill represent energy consumption during construction.

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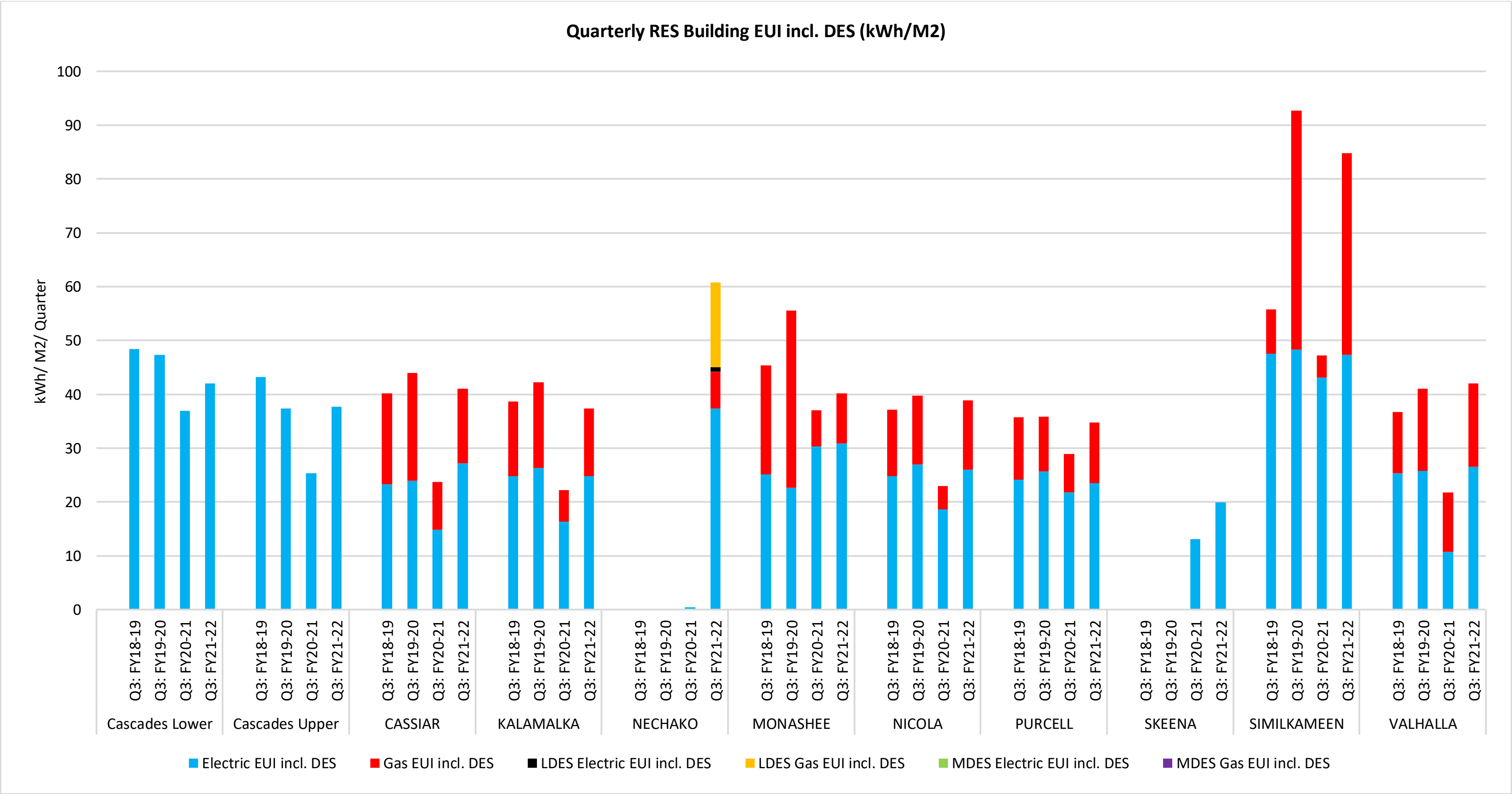

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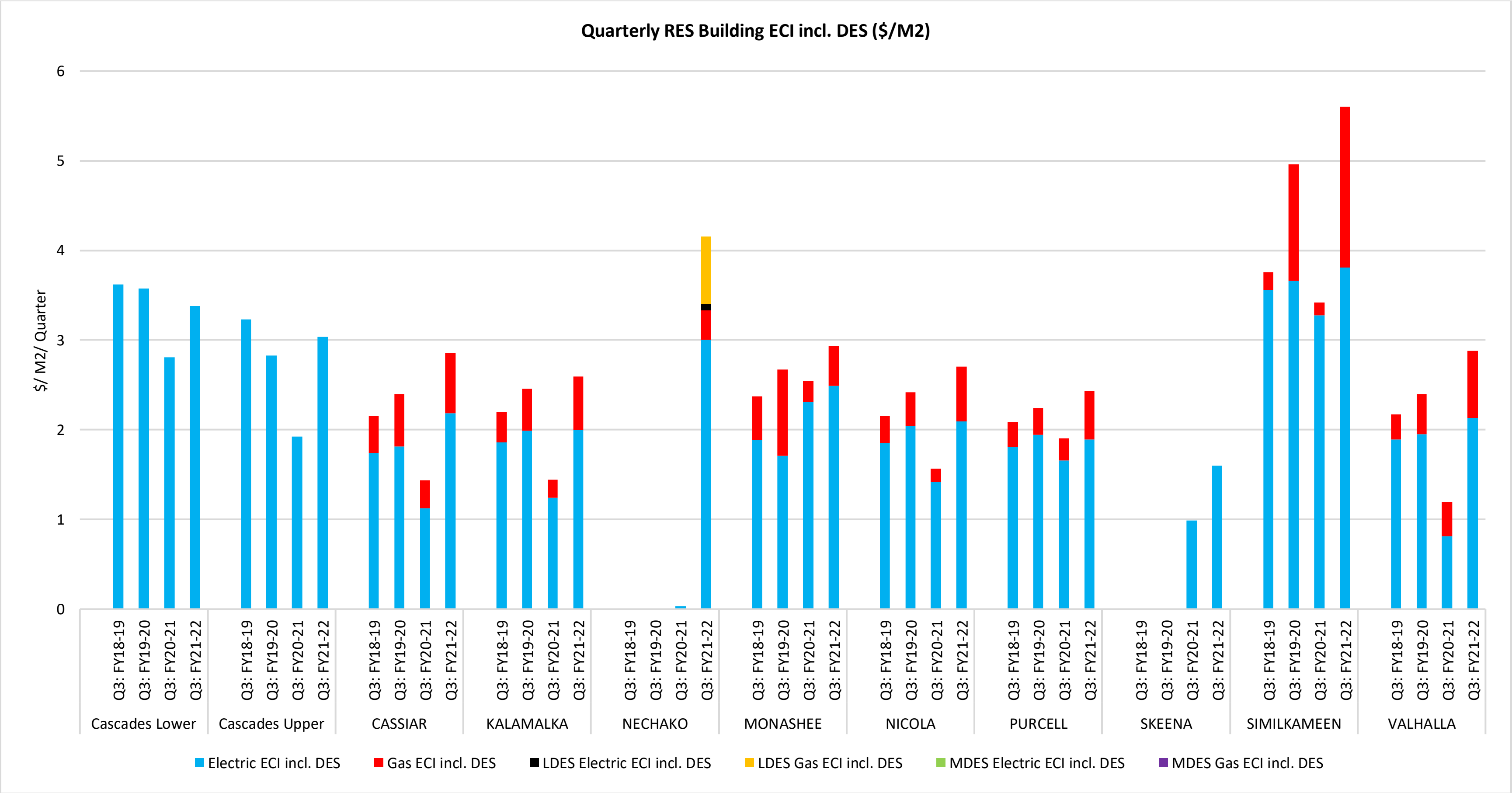

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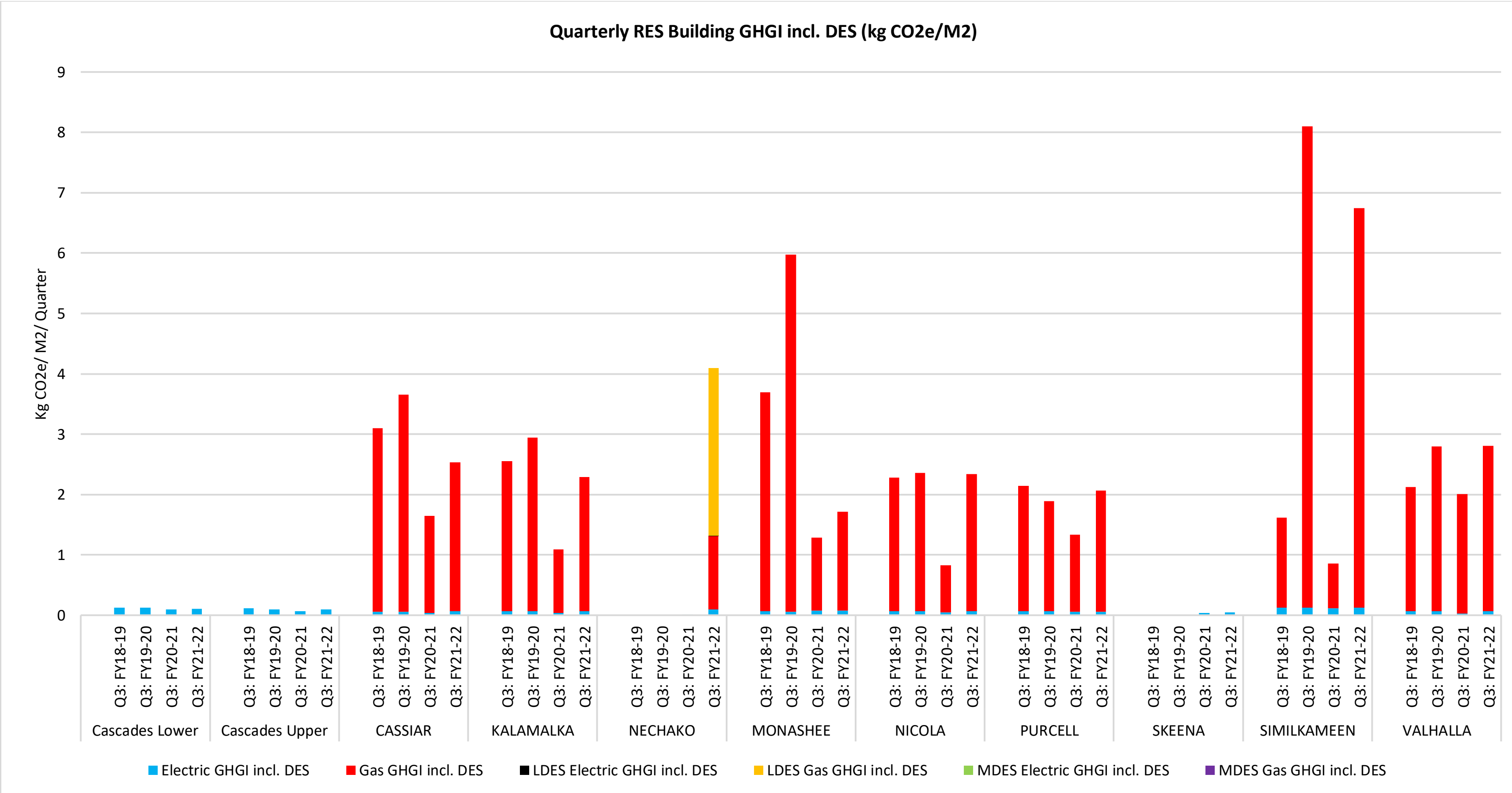

* Assuming electricity emission factor of 2.587 tCO_2e/GWh (old FortisBC grid factor)

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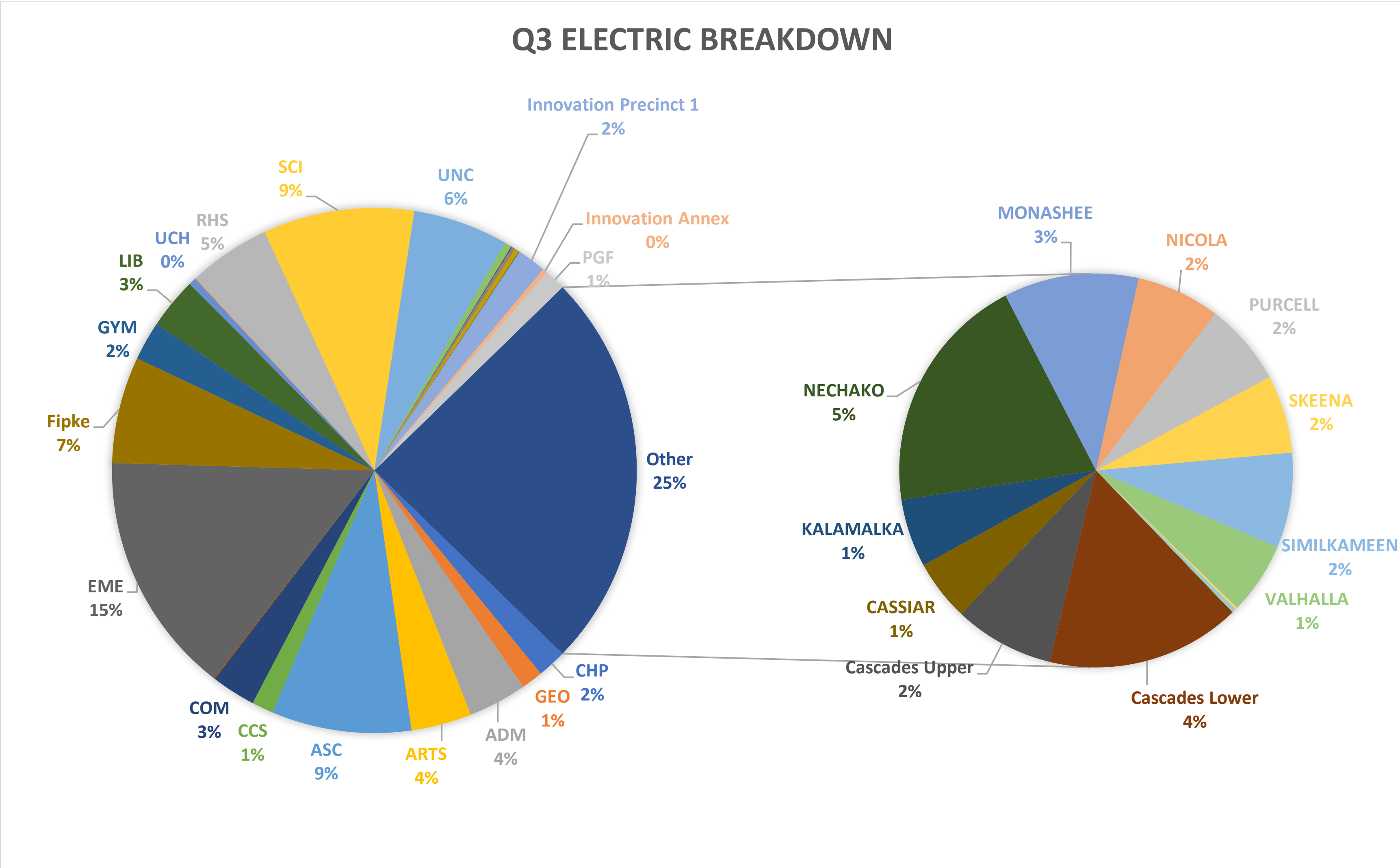
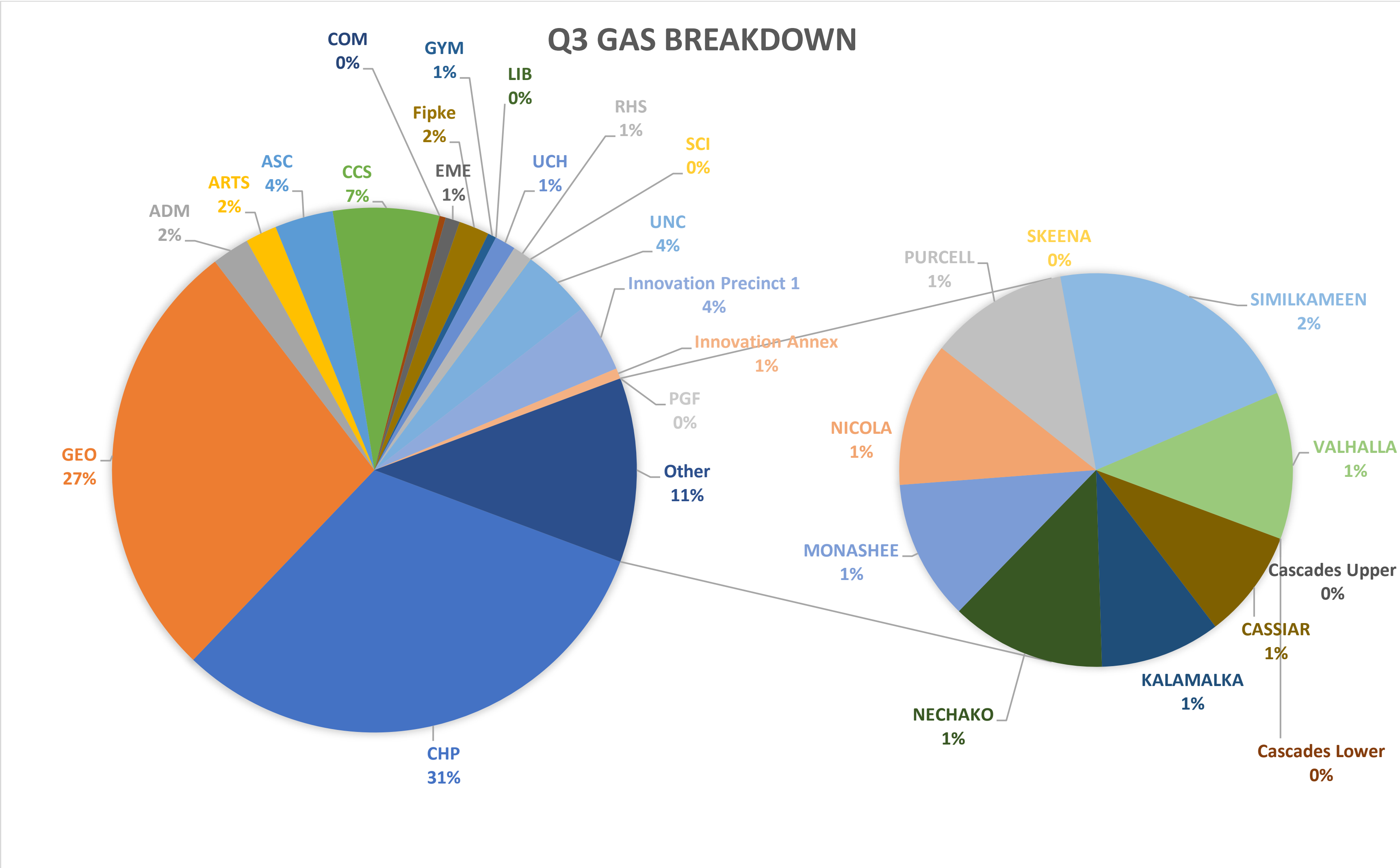


Note: Building electricity and gas consumption values shown are for consumption within the building. Indirect gas consumption via MDES & LDES is not included.



Note: Building electricity and gas consumption values shown are for consumption within the building. Indirect gas consumption via MDES & LDES is not included.

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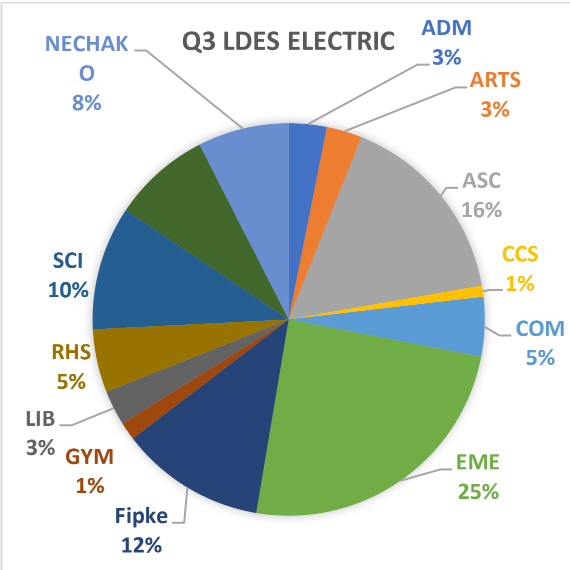
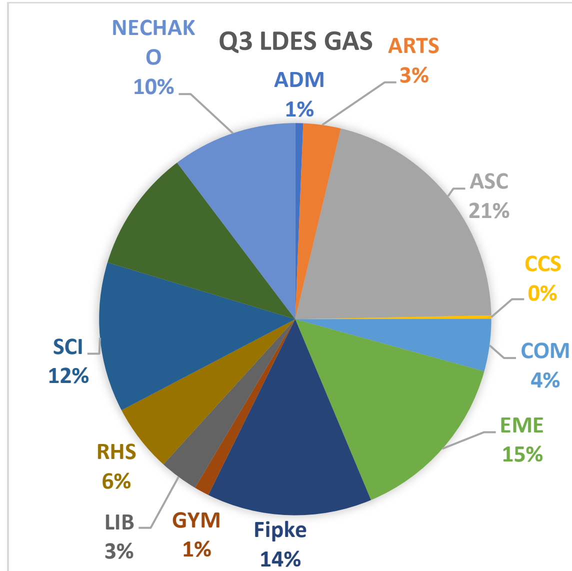
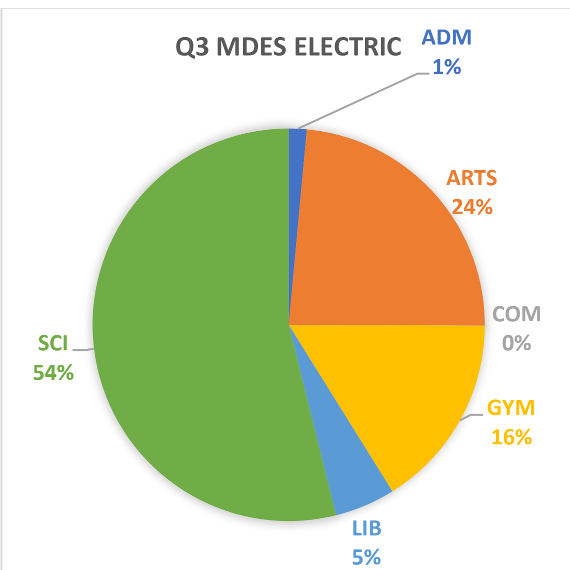
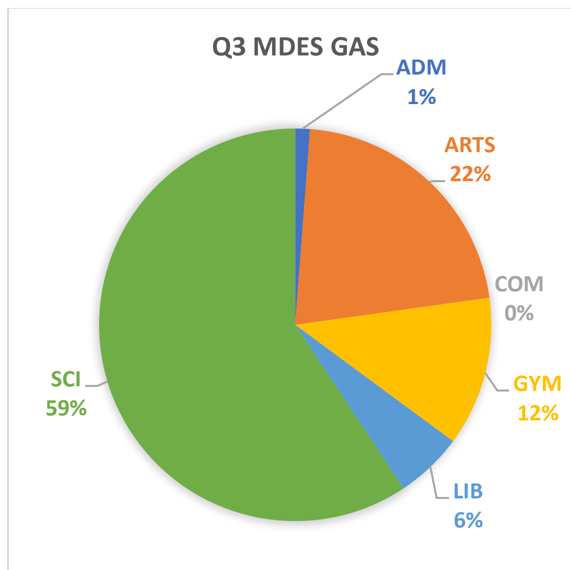
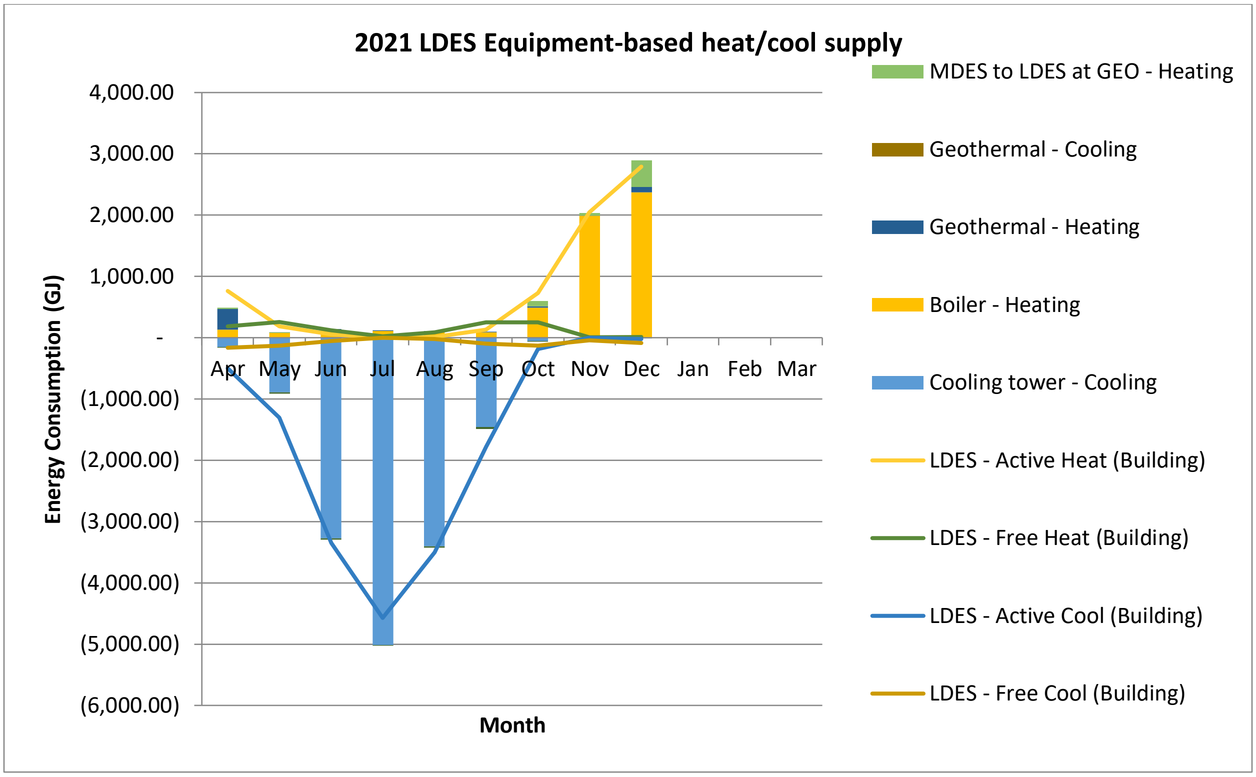
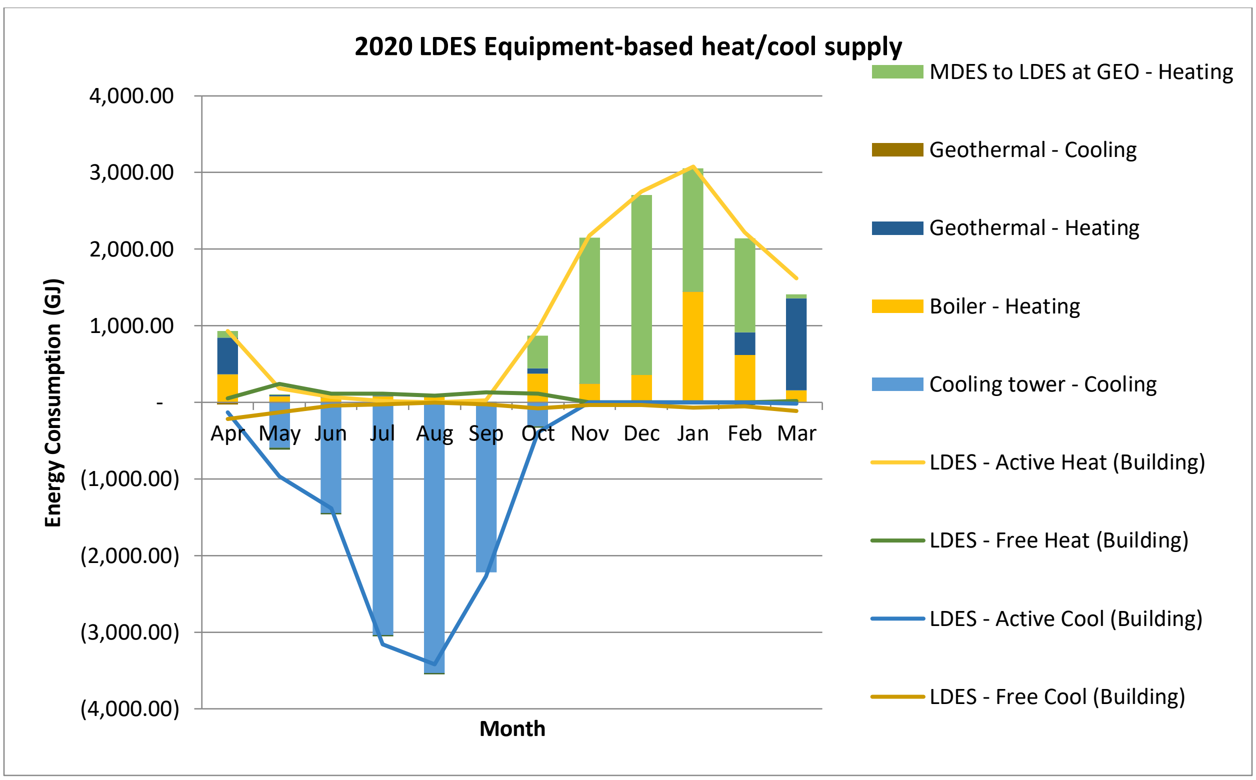









2021 LDES Equipment-based heat/cool supply
4,000.00
3,000.00
2,000.00
1,000.00
-
(1,000.00)
(2,000.00)
(3,000.00)
(4,000.00)
(5,000.00)
(6,000.00)
Energy Consumption (GJ)
Apr May Jun Jul Aug Sep Oct Nov Dec Jan Feb Mar
Month
MDES to LDES at GEO - Heating
Geothermal - Cooling
Geothermal - Heating
Boiler - Heating
Cooling tower - Cooling
LDES - Active Heat (Building)
LDES - Free Heat (Building)
LDES - Active Cool (Building)
LDES - Free Cool (Building)


2020 LDES Equipment-based heat/cool supply
4,000.00
3,000.00
2,000.00
1,000.00
-
(1,000.00)
(2,000.00)
(3,000.00)
(4,000.00)
Energy Consumption (GJ)
Apr May Jun Jul Aug Sep Oct Nov Dec Jan Feb Mar
Month
MDES to LDES at GEO - Heating
Geothermal - Cooling
Geothermal - Heating
Boiler - Heating
Cooling tower - Cooling
LDES - Active Heat (Building)
LDES - Free Heat (Building)
LDES - Active Cool (Building)
LDES - Free Cool (Building)

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