HEAPY

Providing High Performance Building Solutions

ASSESSMENT REPORT

Lois and Richard Rosenthal
Center for Contemporary Arts
ASHRAE Level III Audit

April 3, 2023

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I. Introduction

The Lois and Richard Rosenthal Center for Contemporary Arts (CAC), located in Cincinnati, Ohio is committed to large-scale energy reduction. The CAC's goal is to achieve a 50% energy reduction as compared to their 2003 baseline by 2030. Prior to 2023, CAC made some progress toward this goal by implementing their own initiatives. CAC partnered with HEAPY to identify additional energy reduction opportunities through an ASHRAE Level III audit. The energy audit was supported by the Frankenthaler Climate Initiative and the Ohio Department of Development's Energy Audit Grant Program.

Built in 2001, the seven-story museum has been noted for its distinct asymmetrical design and integration with the urban cityscape. Its 2003 baseline Energy Use Intensity (EUI) is 250 kBTU/ft^2-year. The current energy performance is 203.4 kBTU/ft^2-year for the 12-month period ending April 2022, an improvement from the 2003 baseline due to self-directed initiatives such as limited equipment scheduling.

The ASHRAE Level III audit included a detailed review of existing construction documents, a physical survey of the building with its existing systems and an analysis of the building's historical utility usage and costs. The physical survey and utility analysis were the basis for a calibrated energy model of the building, which enabled reliable energy reduction calculations for ECMs and performance predictions for the HVAC systems. The physical site review, and subsequent discussions with Schneider Controls, provided further insight into the building's current performance. Schneider also provided cost estimates for economic feasibility analyses.

The rigor of ASHRAE Level III principles incorporated in this analysis produced investment-grade quality results. The audit identified three key recommendations for further consideration. The economic and energy impacts are summarized below in Table 1 and Table 2. Together, the three measures will result in a cost savings of $50,900 annually and will reduce the building's EUI by 64.6 kBTU/ft^2-year. The energy reduction will improve CAC's EUI to 138.8 kBTU/ft^2-year, a 44% improvement over the 2003 baseline.

Table 1: Economic Summary of Recommended Energy Conservation Measures at CAC

	Energy Conservation Measures (ECM) Identified	Estimated Cost Savings ($/year)	Estimated Investment Cost ($)	Simple Payback (years)
ECM-1	Automate Monthly Energy Reporting	$3,200	$9,500	3.0
ECM-2	Balance Existing AHU Systems	$5,000	$60,000	12.0
ECM-3	Replace Existing Building Automation System (BAS)	$42,700	$299,000	7.0
	Total of all Measures	**$50,900**	**$368,500**	**7.2**

Table 2: Energy Summary of Recommended Energy Conservation Measures at CAC

	Energy Conservation Measures (ECM) Identified	Estimated Electric Reduction (kWh/year)	Estimated Natural Gas Reduction (ccf/year)	Estimated Chilled Water Reduction (ton-hour/year)	Estimated EUI Reduction (kBTU/ft^2-yr)
ECM-1	Automate Monthly Energy Reporting	14,200	1,700	12,800	4.6
ECM-2	Balance Existing AHU Systems	15,800	3,100	31,200	8.6
ECM-3	Replace Existing Building Automation System (BAS)	93,000	10,000	238,000	51.4
	Total of all Measures	**123,000**	**14,800**	**282,000**	**64.6**

II. Facility Overview

Building

The Lois and Richard Rosenthal Center for Contemporary Arts (CAC) is a signature building located in downtown Cincinnati, OH. The seven-story museum is approximately 82,265 square feet and includes galleries, office spaces, meeting rooms, a gift shop, a black box theater, administrative space, and a full-service kitchen. The CAC serves as an art museum, event space, learning center and restaurant.

The CAC building was designed by Zaha Hadid and is noted for its angular architecture, with a concrete and glass façade. The design features vertical cubes and voids on the building's exterior and an innovative 'urban carpet' element to connect the outdoor sidewalk with the inside of the building, acting to invite the city into the museum. A floating grand staircase connects the multi-floor gallery spaces.

Figure 1: Lois and Richard Rosenthal Center for Contemporary Arts (Southeast Exterior)

HVAC CAC's HVAC systems are operated to prioritize consistent temperature and humidity levels in the gallery spaces rather than comfort conditions as in other commercial buildings. CAC must confirm the facility's temperature and humidity history when procuring exhibits for the museum. Typical unoccupied schedules and temperature setbacks are not viable for the gallery spaces.

CAC's HVAC systems are operated to prioritize consistent temperature and humidity in the gallery spaces.

Air Side

CAC has six main variable volume (VAV) air handling units (AHU-1 through AHU-6) that condition the gallery spaces, office areas and back-of-house areas. These six units range from 7½ to 40 HP and typically have chilled water cooling coils only. AHU-3 also has a hot water heating coil as it is a single-zone unit conditioning the lobby's south-facing glazing. Three 5-HP fans (RF-1 through RF-3) provide relief for the lower level through third floor, AHU-5 and AHU-6 respectively.

AHU-7 is a variable volume dedicated outdoor air unit (DOAS) that supplies ventilation air to units AHU-1 through AHU-6. It has dual chilled water coils to enable maximum cooling and dehumidification in the summer months and reduced cooling in the shoulder seasons. The unit also has a humidifier to condition dry outdoor air in the winter. AHU-7 operates continuously during the winter months due to start-up difficulties after nightly shutdowns. Several VAV terminals connected to AHU-4 and AHU-5 are commanded to remain open to mitigate static pressure issues at AHU-7 during lighter-load conditions at night.

Additionally, AHU-8 is a small 1-HP single-zone heating-only constant volume unit that conditions the lobby's east-facing glazing.

AHU-7 conditions and supplies all outdoor air for AHUs 1 – 6.
It runs continuously during the cold weather season.

Drawings of the areas served by each AHU are in the Appendix.

Water Side

CoolCo LLC, in downtown Cincinnati, supplies district chilled water to CAC under a 20-year contract that started when the museum opened in 2003. The contract specifies a peak usage of 195 tons, which has been reduced from the initial contract capacity of 290 tons. Chilled water is supplied at 40°F and consumption is based on a temperature differential of 17°F. CAC circulates chilled water in the building until it reaches 57°F and can be returned to CoolCo.

Two 20-HP variable-speed pumps circulate chilled water from the CoolCo connection point on the lower level to the AHUs on the first floor mezzanine and upper level penthouse. Schneider replaced several three-way cooling coil valves with two-way valves to enable variable-speed pumping.

Two Unilux natural gas-fired 3,600-MBH boilers supply heating hot water to AHU-3, AHU-7, AHU-8, VAV terminal reheat coils and various unit heaters and fin tube. The boilers operate year-round for both winter heating and summer reheat requirements. Two 10-HP constant speed pumps circulate hot water through the building.

CAC's original design employed small steam injection humidifiers at sixteen individual VAV terminals to humidify the gallery spaces. In 2004, the injection humidifiers were replaced with two steam boilers and sixteen new VAV terminals. These terminal boxes are in the penthouse to eliminate water in the gallery areas.

CoolCo LLC supplies district chilled water to CAC.
Chilled water makes up a significant portion of CAC's energy bill.

Current Control Strategies

The building automation system (BAS) is a legacy TAC-branded direct digital controls (DDC) system by Schneider. This system was installed when the building was designed and is now approximately 20 years old. The BAS is accessed by a single workstation in the facility manager's office; it does not have remote-access capability.

Control strategies include energy conservation best practices supported by the BAS's capability. Schedules and temperature setbacks are in place for the non-gallery AHUs, although trend data suggests some schedules are not operating as intended. Temperature resets are limited by the need to control space temperature and humidity levels within a small tolerance. Several valves, dampers, drives, and controllers appear to be compromised and not responding to BAS commands.

Control strategies are limited by the legacy BAS's capabilities and the small tolerance on space temperature and humidity levels.

Lighting

CAC originally had fluorescent lighting throughout the building. Approximately 90% of the interior lights have been replaced with LED fixtures without ballasts. The outside lighting fixtures are high on the building and would require a street closure to access and replace them, so are typically not used. The interior lights in restrooms, staff lounges, and the sixth floor are on occupancy sensors. The lighting in the galleries is turned off at the end of the day by the security staff. A Lutron 4000 lighting control system, which is original to the building, remains in place.

Approximately 90% of the original fluorescent lighting has been replaced with LED fixtures.

Domestic Hot Water

A natural gas-fired AO Smith Cyclone water heater supplies domestic hot water to the building.

Natural Gas Service

A 3-HP booster pump is installed in the natural gas main entering the building in the lower level. The pump increases gas pressure for the boilers in the penthouse, especially when hot water and steam boilers fire simultaneously.

III. Utility Analysis

Annual Utility Consumption and Costs

Table 3: Average Annual Energy Usage and Costs at CAC
(Data period: January 2019 – December 2021)

Utility	Average Annual Consumption (Unit/yr)	Energy Use Intensity (kBTU/ft²/yr)	Average Annual Utility Cost ($/yr)	Average Cost of Utility ($/unit)
Electric (kWh)	709,800 kWh/yr	28.0	$62,300	$0.088/kWh
Natural Gas (ccf)	85,900 ccf/yr	102.3	$47,800	$0.556/ccf
Chilled Water (ton-hrs)	637,500 ton-hrs/yr	88.4	$155,400	$1.000/ton-hr
Total	**18,900 MMBTU/yr**	**218.7**	**$265,500**	**$3.23/ft²**

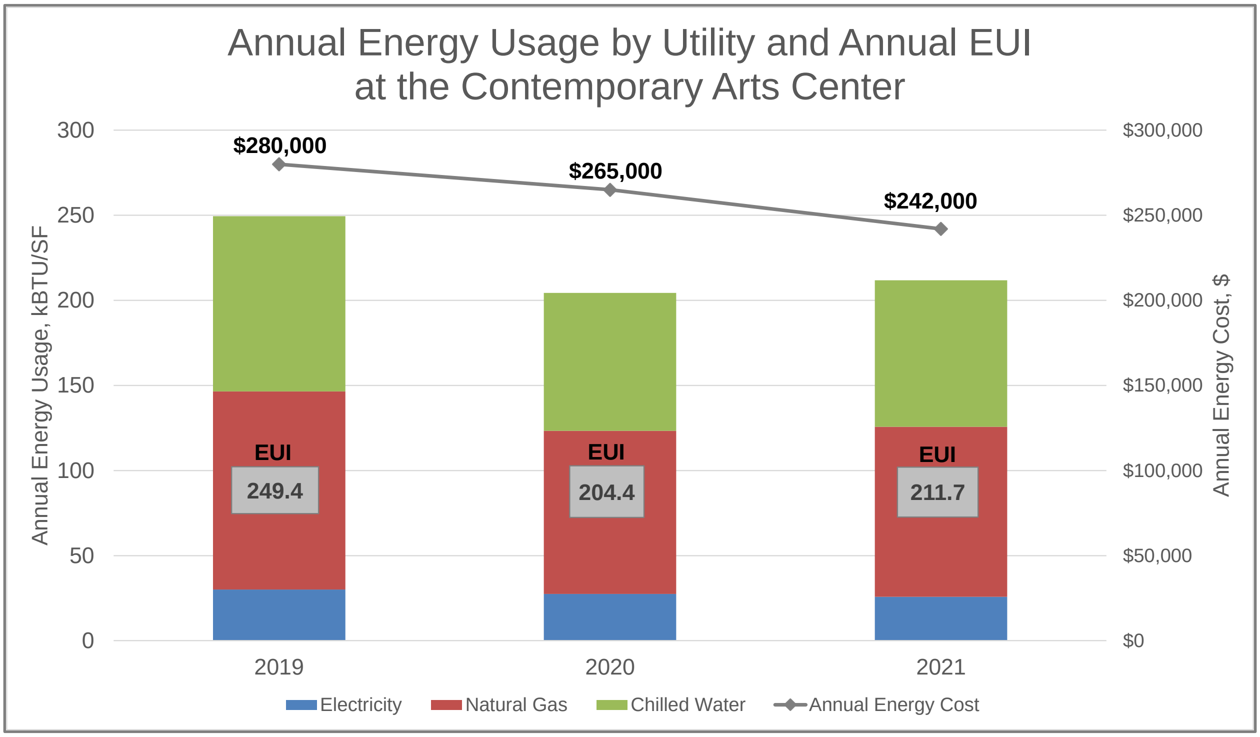

Figure 2: Annual Energy Consumption by Utility at CAC

CAC's average annual electric, natural gas, and chilled water consumption and costs for the three-year period of January 2019 – December 2021 are summarized in Table 3 and Figure 2. Energy usage is weighted towards natural gas (48% of total usage) and chilled water (40% of total usage), while electricity accounts for only 12% of the total energy usage. The building's energy consumption declined in 2020 due to reduced building occupancy and activity during the pandemic. Occupancy and activity levels recovered somewhat in 2021 but are not yet at pre-pandemic levels. Energy costs were lower in 2021 than the other two years analyzed, as electric supply costs from Dynegy reduced from $0.051/kWh to $0.042/kWh in late 2020.

Natural gas (48% of total usage) and chilled water (40% of total usage) account for the bulk of CAC's total energy consumption.

The building's average Energy Use Intensity (EUI) over the three-year period is 218.7 kBTU/ft^2-year. The EUI associated with the period of January – December 2021 is 211.7 kBTU/ft^2-year. From the CAC's ENERGY STAR portfolio, the most recent data for the 12 months ending in April 2022 results in an EUI of 203.4 kBTU/ ft^2-year.

CAC is using its 2003 EUI of 250 kBTU/ft^2-year as a baseline for the 50% energy reduction goal by 2030. Compared to that baseline, the current EUI of 203.4 kBTU/ft^2-year represents an 18.6% reduction already.

CAC's current EUI of 203.4 kBTU/ft^2-year is 19% less than its 2003 baseline of 250 kBTU/ft^2-year.

Electricity Use

Electricity accounts for only 12% of CAC's total annual energy consumption. The CAC building uses electricity for lighting, HVAC fans and pumps, refrigeration, cooking equipment and various plug loads. Since cooling is provided by the district chilled water, the building's electric usage is generally not weather-dependent. Electric usage increases slightly in winter months, which is influenced by operating AHU-7 and several VAV terminals continuously to mitigate morning start-up challenges. Figure 3 shows the building's three-year monthly trend of electric consumption outdoor air temperature.

Electric usage is all base load and not weather-dependent. Increased winter usage is due to AHU-7 operating continuously.

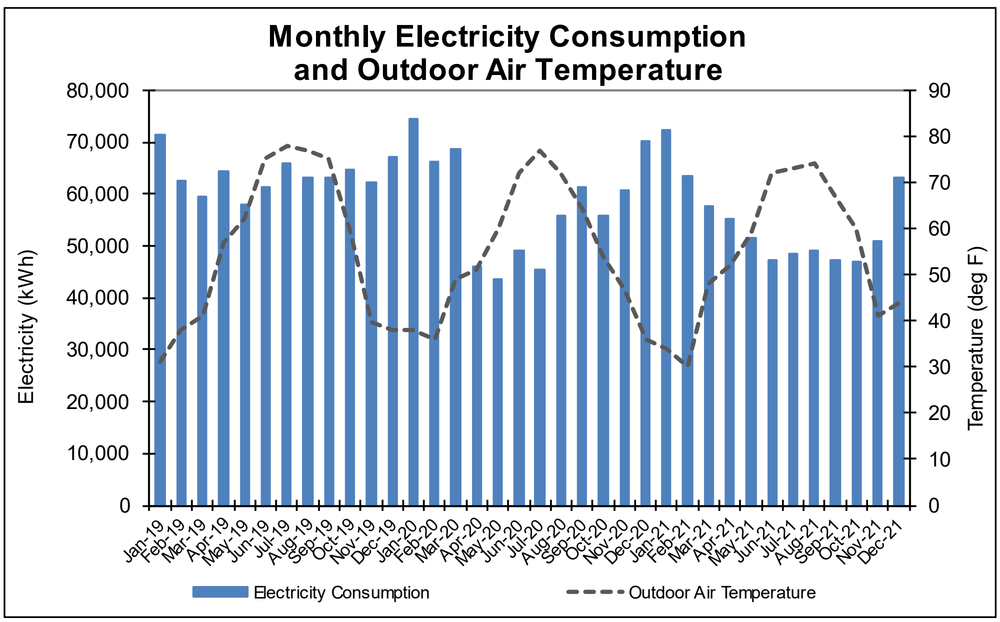

Figure 3: Monthly Electricity Consumption Trend at CAC

Electric Rate Analysis

Electric transmission and distribution are bundled and billed on Duke Energy's Service at Secondary Distribution Voltage (DS) rate. This is the appropriate rate category for this building's voltage and monthly demand. The rate is demand-based with both demand- and energy-based riders. The demand charge is \$6.9678/kW. In addition to the demand charge, a monthly customer charge of \$46.00 for distribution is assessed. Duke Energy defines the minimum billing demand as 85% of the highest monthly kilowatt demand established in the summer period and effective for the next succeeding eleven months. Duke Energy's DS rate, as of November 2022, is summarized in Table 4.

Electric generation, or electric commodity, is supplied by Dynegy Energy Services. Duke Energy includes the commodity charges separately on its monthly bill. From the November 2022 bill, Dynegy supplies the commodity at a flat rate of $0.0424/kWh.

Table 4: Current Electric Charges at CAC

Service Provider and Rate Components	Rate
Duke Energy DS Rate (Transmission & Distribution)	
Customer Charge	$46.00/month
Demand, per kW	$6.9678/kW
Applicable riders, per kW and per kWh	varies; total charges are similar to Demand charge
Dynegy Energy Services (Generation)	
Energy, per kWh	$0.0424/kWh

Natural Gas Use

Natural gas is the largest component of CAC's energy usage at 48% of the total consumption. The CAC building uses natural gas almost exclusively in the central plant to generate heating hot water and steam. Heating hot water is supplied for space heating in the winter months and for dehumidification and terminal reheat in the cooling season. Steam is supplied for humidification in the heating season. Incidental natural gas is used for domestic water heating. Peak monthly winter usage is approximately 12,000 – 13,000 ccf. Natural gas usage declined significantly in August and September 2020 with reduced occupancy during the COVID-19 pandemic. Figure 4 shows the three-year trend of monthly natural gas usage and heating degree-days.

Natural gas is the largest component of CAC's energy usage.
It supplies heat, terminal reheat, humidification and dehumidification.

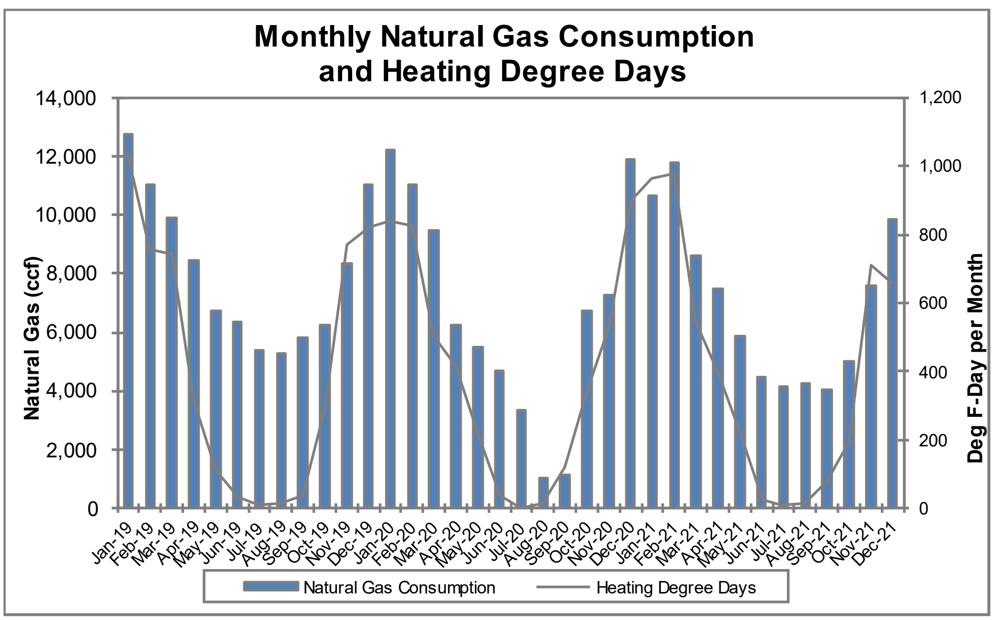

Figure 4: Monthly Natural Gas Consumption and Heating Degree Days at CAC

Natural Gas Rate Analysis

Duke Energy provides natural gas transportation, or delivery, to CAC on its Firm Transportation Service - Large (FT-L) rate. The base delivery charge is $0.099216/ccf, with additional administrative charges and riders. Constellation supplies the natural gas commodity to CAC at a fixed rate of $0.329/therm. Both Duke Energy and Constellation's rates, as of November 2022, are listed in Table 5 below.

Table 5: Current Natural Gas Charges at CAC

Service Provider and Rate Components	Rate
Duke Energy FT-L Rate (Gas Transportation)	
Base charge, per ccf	$0.099216/ccf
Constellation (Natural Gas Commodity)	
Fixed price, per therm	$0.329/therm

Chilled Water Use

Since chilled water accounts for 40% of CAC's total energy use and almost 60% of CAC's total energy cost, it presents a large opportunity for energy reduction. The building uses chilled water for cooling and dehumidification. Chilled water is consumed year-round. Monthly consumption peaks at 80,000 ton-hours during the summer months. Approximately 40,000 ton-hours are consumed in mild and cold weather months. The relatively high winter usage could be driven by the lack of economizing in the air handlers and overheating ventilation air. High usage could also be driven by the practice of recirculating chilled water to attain a 17°F differential before returning the water to the district plant. Figure 6 shows the three-year trend of monthly chilled water usage and cooling degree-days.

Chilled water consumption is high during mild and winter months, possibly driven by water recirculation and the lack of economizing.

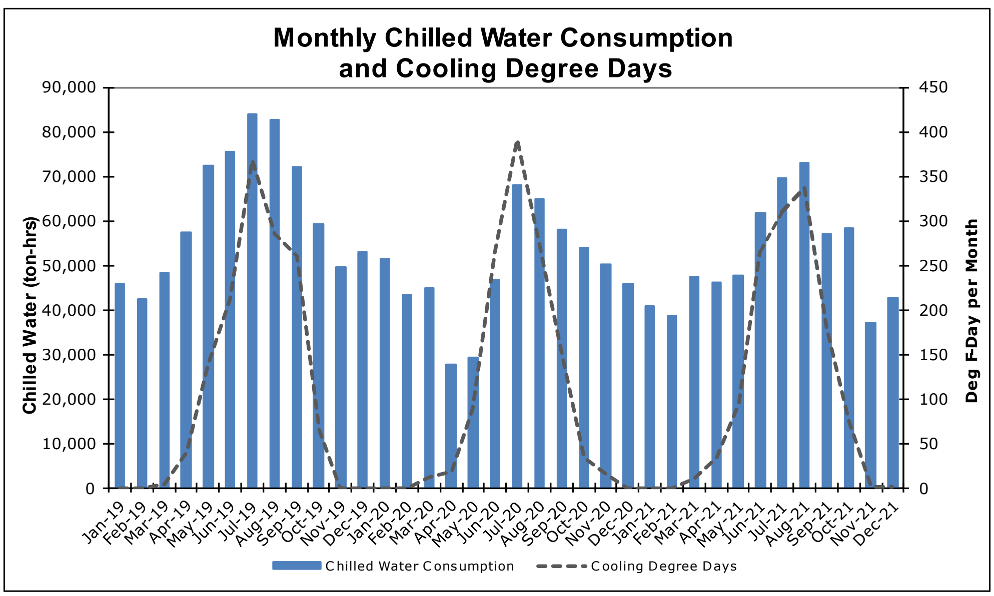

Figure 5: Monthly Chilled Water Consumption and Cooling Degree Days at CAC

Chilled Water Rate Analysis

Chilled water is provided by CoolCo LLC – District Chilled Water Services. CoolCo's monthly charges include a fixed charge for the contracted capacity and a consumption charge. CAC's current contracted peak capacity is 195 tons. The capacity charge is billed at $34.59968/ton for a fixed charge of $6,746.94 each month. Consumption charges include a basic charge of $0.9635/ton-hour and an adjustable charge which is currently $0.04818/ton-hour. CoolCo's rate, as of October 2022, is listed in Table 6.

Table 6: Current Chilled Water Charges at CAC

Service Provider and Rate Components	Rate
CoolCo, LLC – District Chilled Water Services	
Cooling Capacity Charge, per ton Contract Capacity = 195 tons	$34.59968/ton / $6,746.94 fixed charge
Basic Consumption Charge	$0.09635/ton-hour
Adjustable Consumption Charge	$0.04818/ton-hour

IV. Calibrated Energy Model

An ASHRAE Level III audit uses a whole-building computer simulated energy model to accurately model a building's existing energy consumption and predict its reactions to changes in the energy systems. The CAC building was modeled using Carrier's Hourly Analysis Program (HAP). HAP uses the ASHRAE transfer function method for load calculations and detailed 8,760 hour-by-hour simulation techniques for energy analysis. A detailed building model, generated from construction drawings, engineered product data and site observations, was calibrated to its actual electric, natural gas and chilled water utility bills to create a calibrated energy consumption baseline. The calibrated model was adjusted to incorporate the recommended energy reduction strategies to accurately predict savings.

HAP energy model inputs are based on original design documents, engineered product data, site observations and current utility bills.

The sources for specific model inputs are outlined below:

Building Location: The simulation used TMY (Typical Mean Year) weather data for Cincinnati, OH.

Building Geometry: The building was divided into 76 separate conditioned spaces corresponding to areas served by existing AHUs and VAV terminals. Space orientations and dimensions were obtained from the original (2001) construction drawings by Zaha Hadid LTD and HEAPY.

Building Materials: The construction materials and dimensions of exterior walls, glazing, exterior doors, and roof were obtained from original design documents.

Interior Loads – Lighting: Lighting fixture counts were obtained from the original drawings. Wattages were adjusted to typical LED wattages to model the current upgraded lighting. Lighting was scheduled on.

Interior Loads – Plug Loads: Office spaces were assigned a plug load multiplier of 0.2 W/ft^2 and kitchen spaces were assigned 0.5 W/ft^2. Plug loads were not added to gallery or storage spaces. Plug loads were scheduled on for 8 hours daily Saturday – Tuesday and 12 hours daily Wednesday – Friday.

Interior Loads – Occupants: The number of occupants in each space was determined from the indicated space use on the original design documents and supported by onsite observations. The "Office Work" activity level was assigned to the occupants (Sensible-245 BTU/hr/person and Latent-204 BTU/hr/person). The occupants were staggered on a bell-curve schedule 8 hours daily Saturday – Tuesday and 12 hours daily Wednesday – Friday.

Mechanical systems: Eight AHUs and 48 VAV terminals were assigned to 76 spaces as shown on the original design documents. AHUs were modeled with chilled water cooling; hot water heating was added to AHU-3, -7 and -8. Supply fan horsepower and static pressure was taken from the original drawings. AHUs were modeled without economizers, as the units were observed onsite to draw all return air. AHU-7 was modeled with humidification and dehumidification capabilities. Space thermostat setpoints were 71°F cooling and 70°F heating with no setbacks for all AHUs except AHU-6, as observed by control trends. Setbacks were added to AHU-6.

The cooling source was modeled as remote chilled water. The chilled water temperature was set at 40°F with no reset. Two 20-HP variable speed pumps were modeled for chilled water circulation.

The two existing Unilux natural gas-fired boilers were modeled as the heating source. The boiler's input was set at 3600-MBH as observed onsite and efficiency was set at 80%, consistent with Power Flame burner product data. Two 10-HP constant speed pumps were modeled for water circulation.

The existing AO Smith natural gas-fired water heater was modeled for domestic water heating usage. The heater was set at 199-mbh input with 100 gallons of storage. The water heater was modeled with condensing efficiency of 95%.

Existing Utility Usage: The most recent 12 months of data (January 2021 – December 2021) provided by CAC was used for calibration purposes. The provided data included monthly electric usages (both energy and demand), monthly natural gas usages, and monthly chilled water usages as billed by the utilities.

The HAP model was simulated with the listed inputs in place. HAP provides output in the form of monthly electric energy, electric demand, natural gas usage and chilled water usage. The simulated monthly usages were compared to existing utility bills to confirm the building and systems are modeled properly and calibrated to existing usage. Electric calibration results are shown in Figure 6. The HAP simulation resulted in modeled annual electric usage at 93% of the utility bill usage. Natural gas calibration results are shown in Figure 7, where simulated annual natural gas usage is 92% of the actual utility bill usage. Chilled water calibration results are shown in Figure 8, where simulated annual chilled water usage is 105% of the actual utility bill usage.

Note: Carrier HAP's energy simulation differs from the building's 2021 performance in two ways:

- HAP's simulation is based on Typical Mean Year (TMY) weather data for Cincinnati OH, which will necessarily produce differences between actual weather conditions in 2021.
- HAP's energy data is compiled according to calendar months. While CoolCo reads their meter around the 1st of each month, Duke Energy reads around the 22nd of the month. This nominal 10-day offset can impact the shape of the monthly modeled and actual usage curves.

Since modeled annual usage is within 8% of actual 2021 utility bill usage and the model's monthly usage curves parallel the actual usage curves, the model is deemed calibrated to the bills.

HAP-simulated electric usage is 93% of the utility bill usage, simulated natural gas usage is 92% and simulated chilled water is 105%.

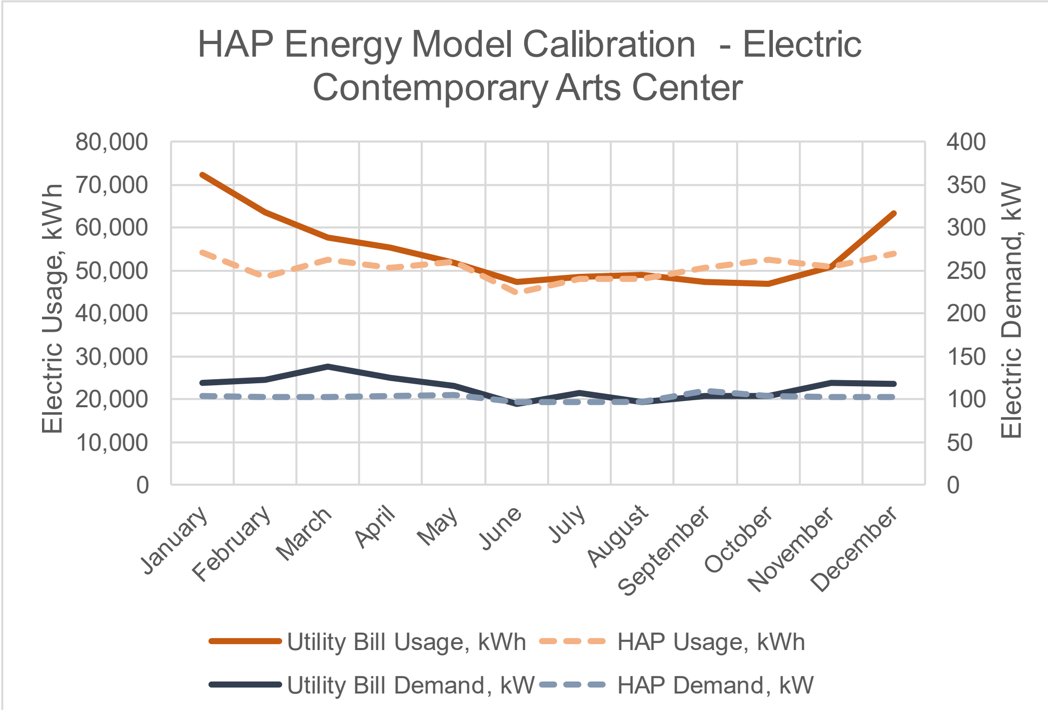

Figure 6: HAP Energy Model Calibration Results - Electric Usage and Demand

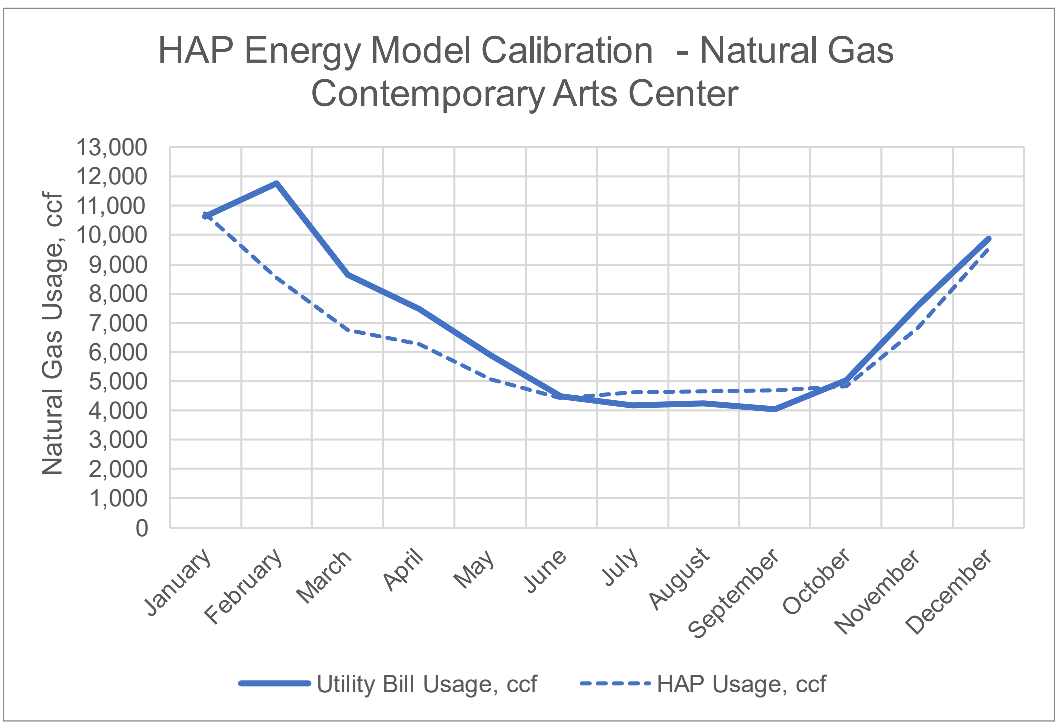

Figure 7: HAP Energy Model Calibration Results - Natural Gas Usage

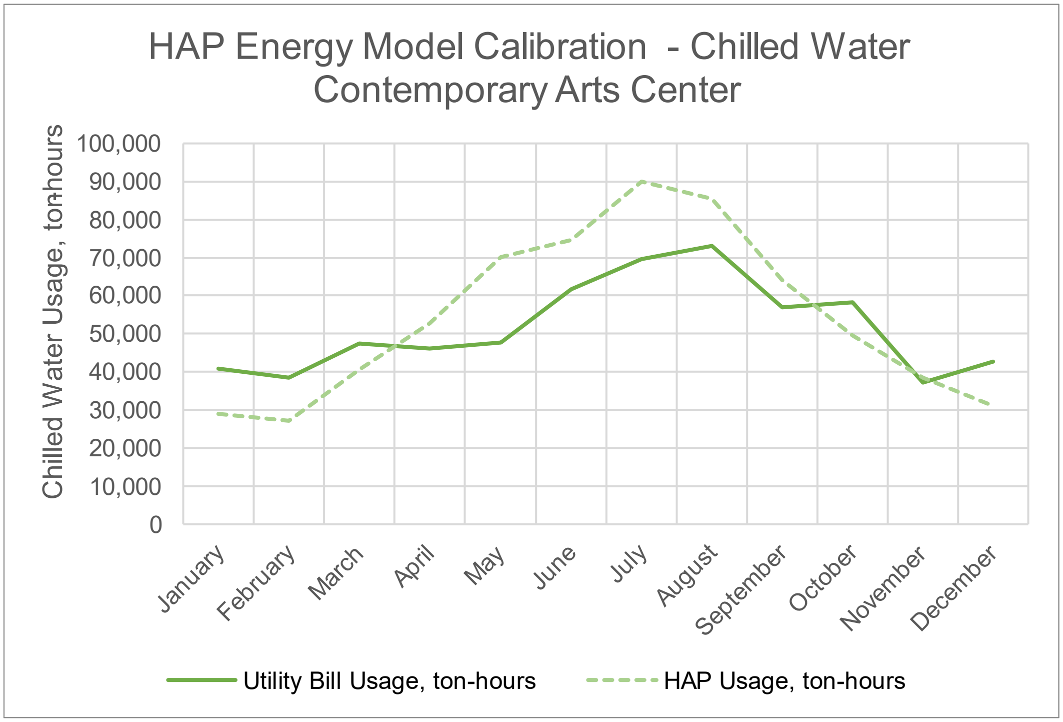

Figure 8: HAP Energy Model Calibration Results – Chilled Water Usage

V. Energy Conservation Measures

As previously discussed in Section III. Utility Analysis, the Contemporary Art Center's current energy use intensity (203.4 kBTU/ft^2-year) is higher than expected for a commercial building, even with the center's strict temperature and humidity requirements. The building's HVAC systems are in reasonably good condition and can perform efficiently but have fallen out of tune and are severely impacted by an aging BAS. The building's envelope is in reasonably good condition with no significant breaks or leaks, although the interior elevation can present challenges to maintaining positive pressure in the structure. Three energy conservation measures were identified for further consideration and are outlined in Table 7 and Table 8.

Table 7: Economic Summary of Recommended Energy Conservation Measures at CAC

	Energy Conservation Measures (ECM) Identified	Estimated Cost Savings ($/year)	Estimated Investment Cost ($)	Simple Payback (years)
ECM-1	Automate Monthly Energy Reporting	$3,200	$9,500	3.0
ECM-2	Balance Existing AHU Systems	$5,000	$60,000	12.0
ECM-3	Replace Existing Building Automation System (BAS)	$42,700	$299,000	7.0
	Total of all Measures	**$50,900**	**$368,500**	**7.2**

Table 8: Energy Summary of Recommended Energy Conservation Measures at CAC

	Energy Conservation Measures (ECM) Identified	Estimated Electric Reduction (kWh/year)	Estimated Natural Gas Reduction (ccf/year)	Estimated Chilled Water Reduction (ton-hour/year)	Estimated EUI Reduction (kBTU/ft^2-yr)
ECM-1	Automate Monthly Energy Reporting	14,200	1,700	12,800	4.6
ECM-2	Balance Existing AHU Systems	15,800	3,100	31,200	8.6
ECM-3	Replace Existing Building Automation System (BAS)	93,000	10,000	238,000	51.4
	Total of all Measures	**123,000**	**14,800**	**282,000**	**64.6**

Energy cost savings are calculated using the current utility rates for the CAC building, as summarized in Table 9.

Table 9: Energy Rates used in ECM Savings Calculations for the Contemporary Arts Center

Energy Source	Rate
Electric	
Demand, per kW	$13.00/kW
Energy, per kWh	$0.0424/kWh
Natural Gas	
Blended Delivery and Energy Charge, per ccf	$0.428/ccf
Chilled Water	
Consumption Charge, per ton-hour	$0.145/ton-hour

ECM 1: Automate Monthly Energy Reporting

Existing Condition

CAC currently tracks its energy information manually. Utility bills are processed for payment, then sent to the facilities staff for manual entry into historical spreadsheets and ENERGY STAR's Portfolio Manager tool. The facilities staff can receive bills several months after the bills' original date, leading to delays in tracking CAC's energy performance. Additionally, manual entry allows for input errors that can adversely impact the ENERGY STAR score.

During the period of this study, HEAPY discovered discrepancies such as duplicate bill entries and inconsistent energy units. Once corrected, CAC's calculated EUI in ENERGY STAR improved 12.1 points (5%).

Recommendations

CAC should engage with an energy bill portal service which automates the collection of utility bills, calculation of energy metrics and transfer of data to ENERGY STAR's Portfolio Manager tool. HEAPY recommends the JadeTrack platform, a cloud-based secure platform that automatically imports utility bills and line item details from each utility portal, calculates benchmarking metrics and graphics, and synchronizes with ENERGY STAR's Portfolio Manager. JadeTrack's data is always current because their program gathers bills from each utility's website portal as soon as the bills are posted. JadeTrack screenshots for an example building are shown below in Figure 9, Figure 10 and Figure 11. Additional information about the portal can be found at jadetrack.com.

HEAPY provides a monthly report that combines snapshots from JadeTrack's platform with engineered analysis and energy management guidance to keep the building's performance on target. A brief email highlights improvements and areas of concern each month, along with a one-page report that can be shared with other stakeholders. A sample report is shown in Figure 12. On average, buildings with the combined HEAPY/JadeTrack service have improved their ENERGY STAR scores by 15 points.

Current, accurate energy data is crucial for CAC to achieve its goal of 50% energy reduction by 2030.

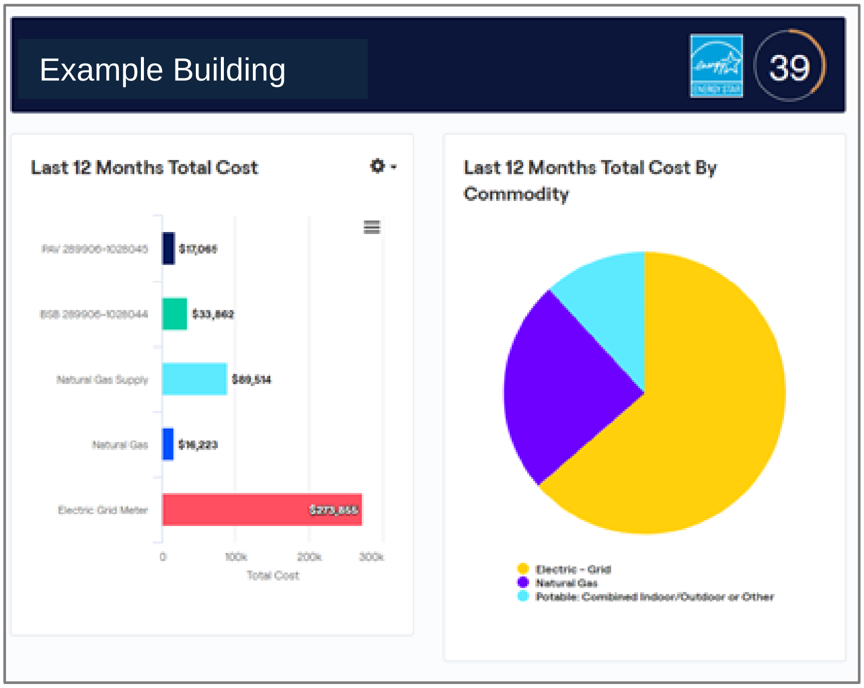

Figure 9: JadeTrack Home Page Example

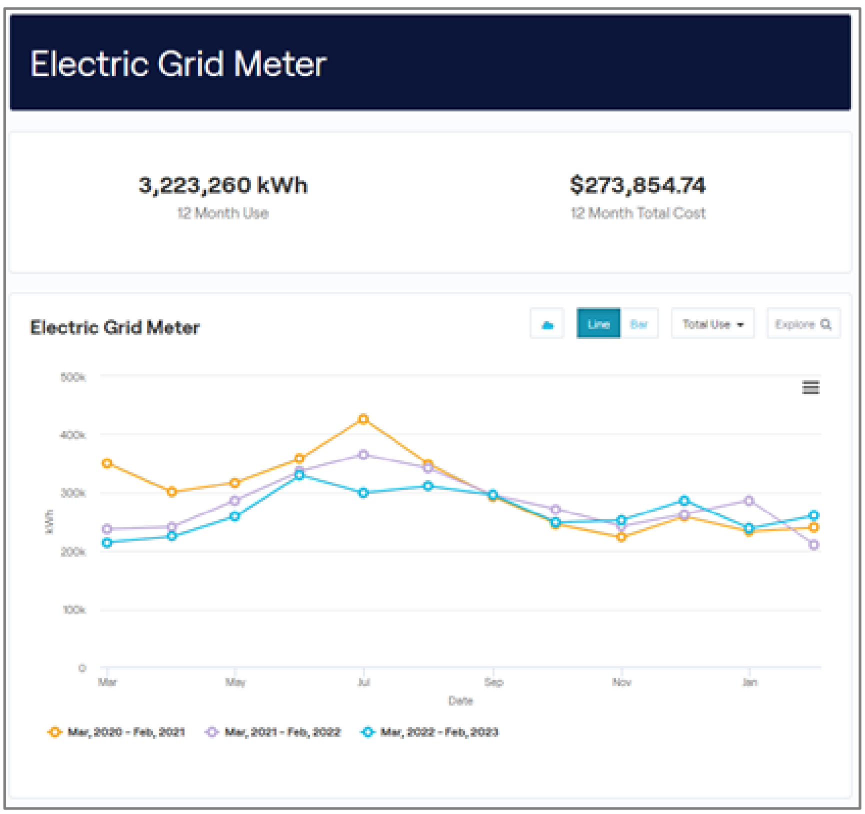

Figure 10: JadeTrack Electric Example

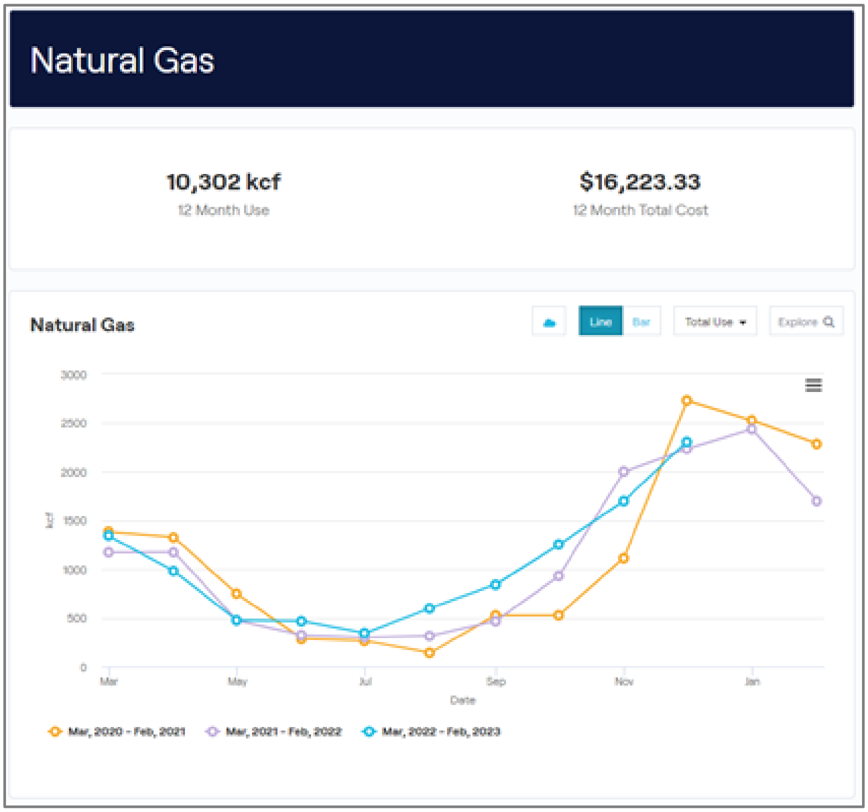

Figure 11: JadeTrack Natural Gas Example

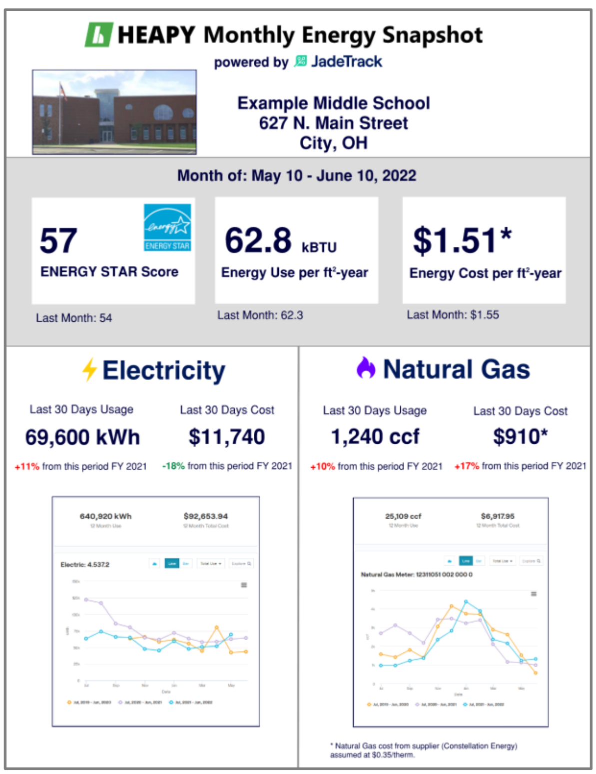

Figure 12: HEAPY Monthly Energy Report Example

Benefits

Current, accurate energy data is crucial as CAC strives to achieve its 50% energy reduction goal by 2030. Automated utility bill collection and analysis will improve the timeliness of information, eliminate data entry errors, and provide critical understanding of the building's actual energy performance. Automatic synchronization with ENERGY STAR's Portfolio Manager will enable up-to-date benchmarking for internal analysis and external reporting. Automation relieves CAC's accounting and facilities staff from the time and efforts for manual utility bill delivery and data entry.

Additionally, monthly reporting and energy coaching will keep the building on target to achieve its 2030 energy reduction goal. The combination of timely data and engineered analysis provides valuable insights customized to the CAC building.

Cost

A one-year subscription of HEAPY's service combined with the JadeTrack portal is $9,500. This includes automated utility bill collection and line item posting for one electric bill, two natural gas bills and one chilled water bill, and ENERGY STAR synchronization on the JadeTrack portal, along with a monthly email containing HEAPY's analysis, energy coaching and a snapshot report. Initial JadeTrack portal set-up and user training is included. A minimum two-year subscription is recommended to track and ultimately fine-tune the building's energy performance.

Savings

In a three-year study of 25,000 commercial buildings, ENERGY STAR determined the organizations who consistently tracked and benchmarked energy achieved an average energy savings of 2.4%[1]. Savings for this measure are conservatively calculated as 2% of current annual usage.

Benchmarking savings are supported by the reduction in EUI discovered in the initial stage of this study, where duplicate bills and inconsistent natural gas energy units were corrected. This tracking and analysis resulted in a 12.1 kBTU/ft^2/year (5%) reduction in CAC's energy benchmark.

[1]ENERGY STAR Portfolio Manager Data Trends – Benchmarking and Energy Savings, November 2016

M & V Plan

IPMVP Option C – Whole Facility Measurement should be used to verify savings for this measure. Post-implementation usage will be established by utility bills for one year following implementation of automated monthly energy tracking and reporting.

Table 10: ECM-1 Economic Summary

Automate Monthly Energy Reporting	
Total Estimated Cost Savings ($/year)	**$3,200**
Estimated Annual Electricity Reduction (kWh/year)	14,200
Estimated Annual Natural Gas Reduction (ccf/year)	1,700
Estimated Annual Chilled Water Reduction (ton-hours/year)	12,800
Total Estimated EUI Reduction (kBTU/ft^2-year)	**4.6**
Total Estimated Cost	**$9,500**
Simple Payback (years)	**3.0**

Savings Assumptions: Savings are based on results of three-year study of 25,000 commercial buildings summarized in ENERGY STAR's *Benchmarking and Energy Savings (November 2016)*. The study reported 2.4% average annual savings for buildings that tracked and benchmarked energy. Savings for this measure were conservatively calculated as 2% of annual usage.

ECM 2: Balance Existing AHU Systems

Existing Condition

Onsite observations and trend data revealed several performance issues that are consistent with unbalanced air and water flow. As AHUs, terminal boxes, pumps, and control systems operate over time, there is a tendency for setpoints, valve positions, damper positions, and fans to drift from their intended operating points. This drift from design parameters creates challenges in providing proper airflow and temperatures, and results in energy performance issues such as frequent equipment cycling and a lack of economizing.

Of particular concern, the return air and outdoor air dampers for AHU-1 through AHU-6 were all observed to be fixed in static positions. Return air dampers were 100% open while outdoor air dampers were nominally 35%-50% open, as shown in Figure 13. Since airflow favors the easier path through the return air dampers, ventilation air may be short-circuiting out of the unit. Mixed Air Temperature data confirmed the actual airflow is weighted heavier with return air than commanded by the BAS.

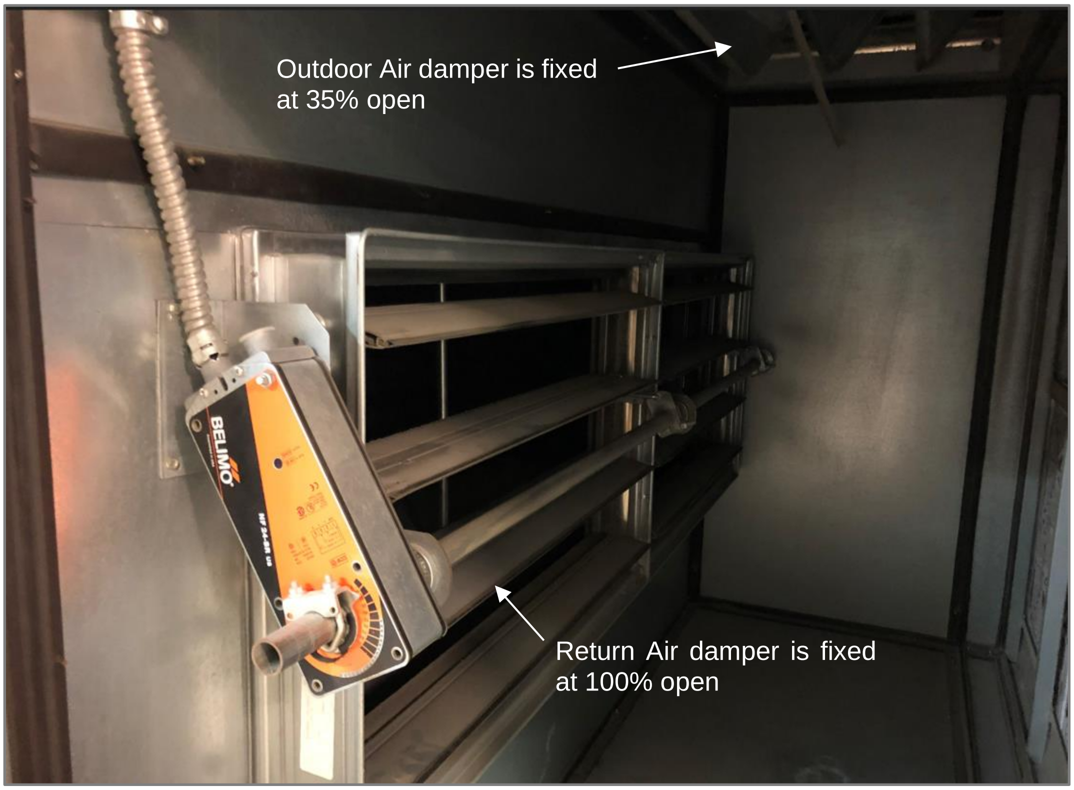

Figure 13: AHU-1 Return Air and Outdoor Air Dampers at Contemporary Arts Center

Recommendations

Perform a Test, Adjust and Balance (TAB) procedure on the airside of the HVAC system, including all AHUs and VAV terminals. A TAB technician will test to determine the current equipment operating parameters such as airflows, temperatures, pressure losses and valve and damper operation. The technician will adjust balancing dampers and valves to return the mechanical equipment to operate at the original design values.

When the systems are balanced and returned to design operating parameters, a ‘spot check’ or representative balance should be scheduled every three to five years, depending on run-hours for each piece of equipment. This periodic check will identify and address small deviations as they occur.

Benefits

A properly balanced system is critical to achieve efficient system operation. Delivering the proper airflow at the proper temperature and humidity to each space will satisfy thermostats quickly and efficiently, allowing the equipment to reduce speed or cycle off as thermostats allow. This will enhance space temperature and humidity strategies, improve occupant comfort, and reduce energy waste due to performance drift over time. Proper balancing will reduce wear on fans, valves, dampers, and pumps by eliminating excessive flow rates.

Airflows, temperatures, and devices drift out of balance over time.
Re-balancing to design parameters can restore efficient operation.

Cost

HEAPY's Commissioning Service team estimated the cost to perform test, adjust and balancing for seven AHUs and 48 VAV terminals as $60,000. TAB will be based on performance parameters listed in the building's original design documents.

Savings

The Building Commissioning Association (BCxA) and Lawrence Berkeley National Laboratory (LBNL) determined a median of 7% energy savings for airside TAB in their comprehensive 2018 Market Survey[1] study of more than 700 buildings. Savings for this measure are conservatively calculated as 5% of CAC's current annual HVAC-related energy usage.

[1] *BCxA 'Value of Commissioning' 2018 Market Survey, published June 2019*

M & V Plan

IPMVP Option C – Whole Facility Measurement should be used to verify savings for this measure. Post-implementation usage will be established by utility bills for one year following implementation of automated monthly energy tracking and reporting.

Table 11: ECM-2 Economic Summary

Balance Existing AHU Systems	
Total Estimated Cost Savings ($/year)	**$5,000**
Estimated Annual Electricity Reduction (kWh/year)	15,800
Estimated Annual Natural Gas Reduction (ccf/year)	3,100
Estimated Annual Chilled Water Reduction (ton-hour/year)	31,200
Total Estimated EUI Reduction (kBTU/ft^2-year)	**8.6**
Total Estimated Cost	**$60,000**
Simple Payback (years)	**12.0**

Savings assumptions: Savings are based on results of 2918 of more than 700 commercial buildings summarized in BCxA's *Value of Commissioning – 2018 Markey Survey (June 2019)*. The study reported 7% average annual savings for airside testing, adjusting, and balancing. Savings for this measure were conservatively calculated as 5% of CAC's annual HVAC-related energy usage.

ECM 3: Replace Existing Building Automation System (BAS)

Existing Condition

CAC's building automation system (BAS) is a legacy TAC-branded direct digital controls (DDC) system by Schneider. This system was installed in 2003 at the building's construction and is now 20 years old. Regular software updates have occurred, but the system is limited by its operation on Windows XP, a 20-year-old software platform that is no longer supported. The BAS does not have remote-access-capability and can only be accessed from a single workstation located in the facility manager's office.

While the BAS is functional, it is at the end of its useful life. It is currently programmed with schedules and temperature setbacks for the non-gallery AHUs, but trend data suggests several AHUs continue to operate fully during the designated unoccupied times. Energy-friendly best practices such as temperature resets and static pressure resets are not supported, although they would be beneficial in the non-gallery spaces. Data cannot be stored and trended easily, which is imperative for equipment diagnostics and troubleshooting, energy analysis, and documentation of space temperatures and humidity levels when procuring art exhibits.

In addition to software deficiencies, several valves, dampers, drives, and controllers appear to be compromised and do not respond appropriately to BAS commands. ECM-2's recommended testing, adjusting, and balancing should identify mechanical equipment and devices for repair. Once repaired, the mechanical devices will be functional, but the existing BAS will continue to limit opportunities for efficient operation.

The existing BAS is 20 years old and at the end of its useful life.
Energy-friendly best practices and data trending are not supported.

Recommendations

Upgrade the existing TAC system to the current-generation EcoStruxure Building platform with an ethernet IP backbone. Migrate the controllers to a newer Windows operating system. These upgrades will provide current energy-friendly capabilities, improve the system's speed for communication and operation, and increase reliability.

Once installed, the system should be programmed with current best practice energy strategies such as:

- Add unoccupied schedules and temperature setbacks for AHU-1, AHU-2, and AHU-3.
- Enable partial economizer cooling for AHU-1 through AHU-6 especially during winter months to eliminate winter chilled water usage.
- Review AHU-7 operation to eliminate excess ventilation during unoccupied hours and resolve need for continuous operation below 25°F outdoor temperature.
- Control chilled water and flow to eliminate unnecessary recirculation to achieve 17°F rise before returning to the district plant.
- Monitor exhaust fan and relief fan operation to maintain appropriate building pressure.

HEAPY, or another design engineer, should be retained to write a comprehensive control sequence for the upgraded system.

Benefits

A current-generation BAS is the key component to achieving CAC's goal of 50% energy reduction by 2030. It will enable energy-friendly operating strategies and correct poorly-functioning, inefficient existing sequences. The new strategies will significantly reduce CAC's energy consumption and provide long-term, sustainable efficient operation.

In addition to improved energy performance, data trending and recording capability will enable onsite mechanical system diagnostics and troubleshooting, energy analysis, and temperature and humidity documentation for art exhibit procurement. The BAS could be enhanced with data analytics to alert the facilities staff of temperature/humidity faults and equipment failures, further improving the building's comfort and resilience.

Cost

Schneider Electric provided a cost estimate to replace CAC's existing legacy TAC system with an upgraded EcoStruxure system. The estimate includes upgraded licensing, design and install labor, and 16 hours of on-site training at a cost of $262,000. Schneider Electric's cost estimate is in the Appendix.

HEAPY estimated the cost for a design engineer to write a comprehensive control sequence for the new system as $7,000. After the control system's implementation, HEAPY estimated the cost for functional testing of the control system, seven AHUs and 48 VAV terminals as $30,000.

The total combined cost for the control system, written sequence of operations and post-installation functional testing is $299,000.

Savings

Savings are based on outputs from a calibrated Carrier HAP energy model of the CAC building. The baseline model described previously in Section IV-Calibrated Energy Model was adjusted to incorporate:

- Unoccupied schedules and temperature setbacks for AHU-1, AHU-2, and AHU-3.
- Partial economizer cooling for AHU-1 through AHU-6.
- Elimination of excess ventilation air during winter unoccupied times due to AHU-7's constant operation.
- Reduced chilled water flow during winter months.

All other inputs remained the same as the calibrated baseline model. The difference between the baseline model and the adjusted model defines the energy reductions associated with the noted adjustments. The model predicts a 24% reduction in overall energy usage with these adjustments in place. The results are shown in Figure 14, Figure 15 and Figure 16.

The calibrated energy model predicts a 24% reduction in overall energy use with improved energy strategies from a new BAS.

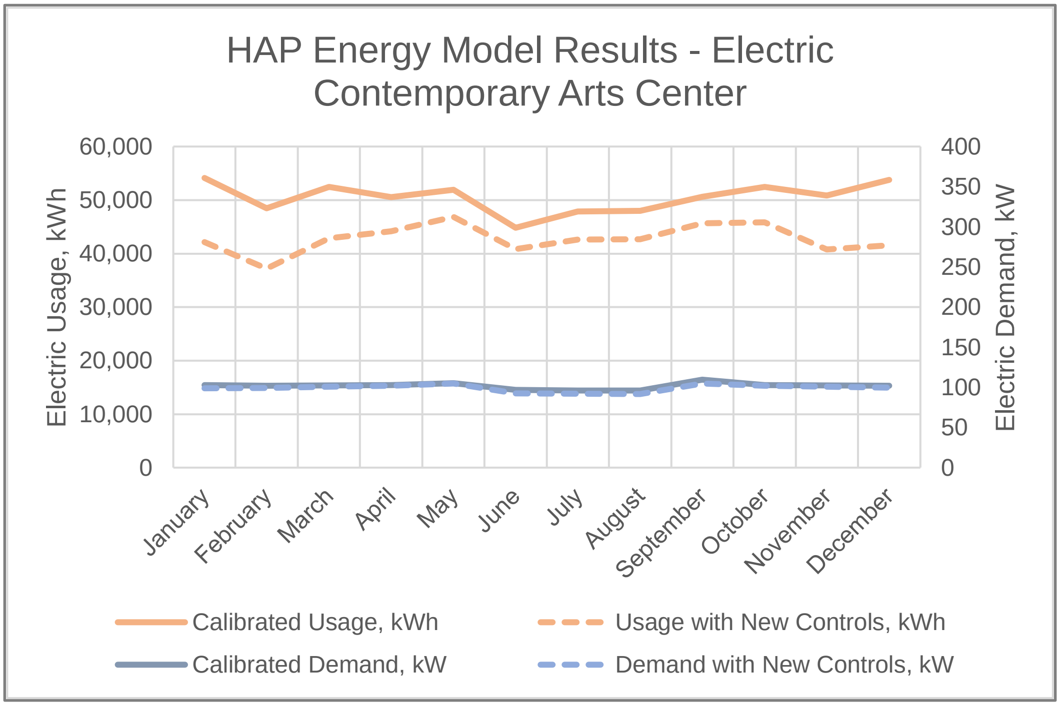

Figure 14: HAP Energy Model Results with New Controls – Electric

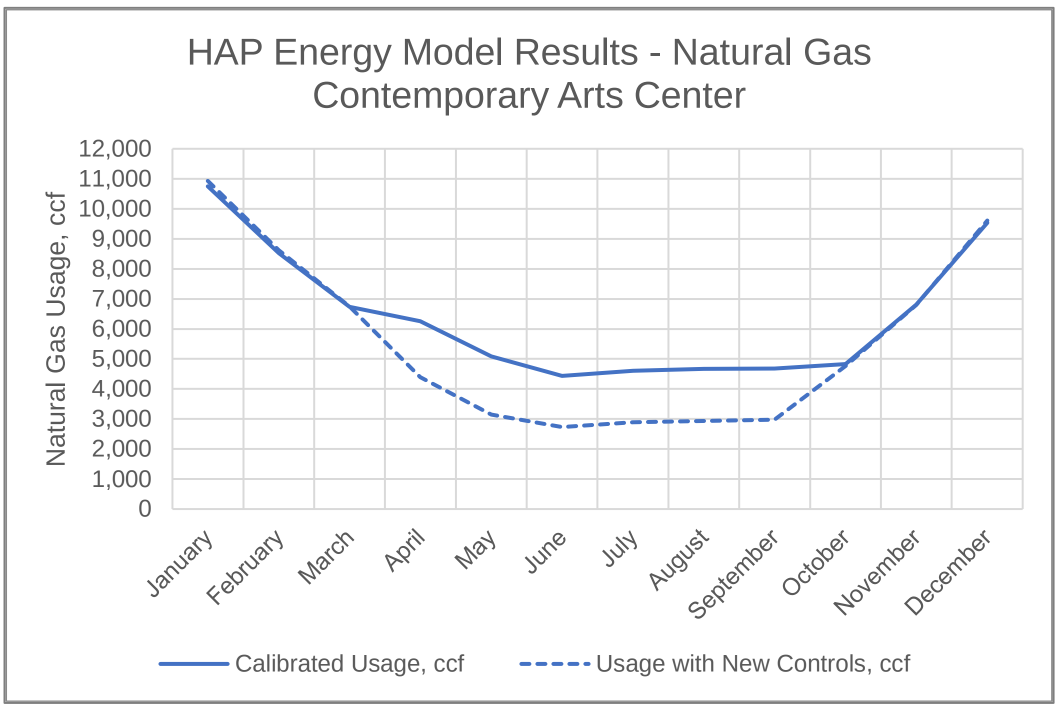

Figure 15: HAP Energy Model Results with New Controls - Natural Gas

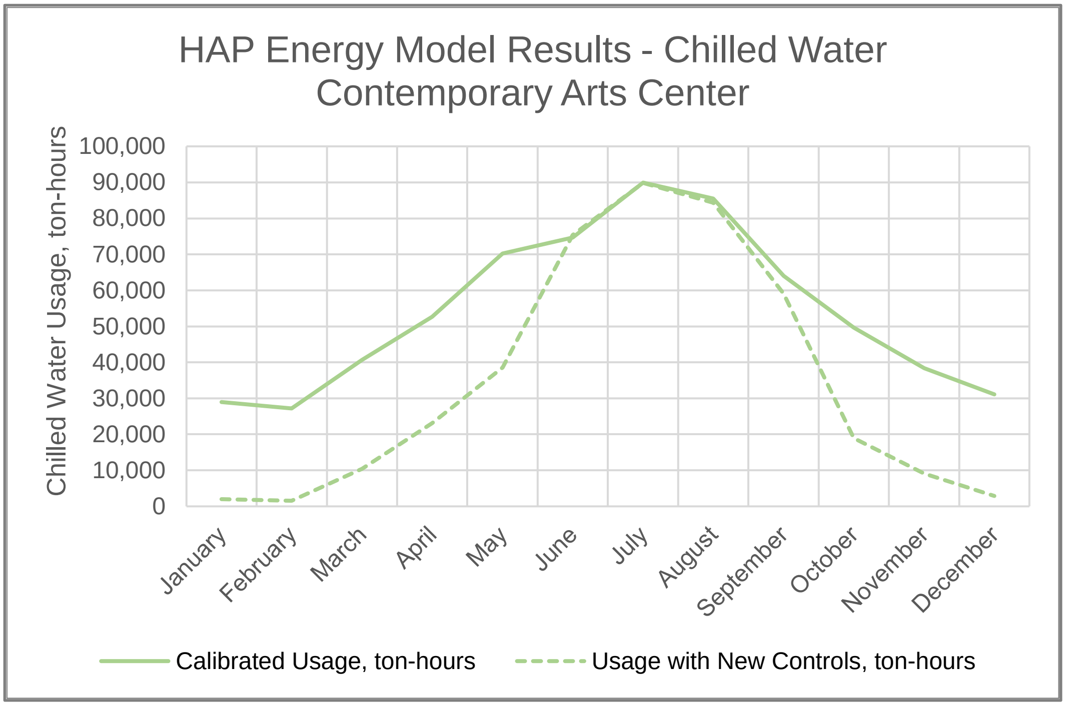

Figure 16: HAP Energy Model Results with New Controls - Chilled Water

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IPMVP Option C – Whole Facility Measurement should be used to verify savings for this measure. Post-implementation usage will be established by utility bills for one year following installation and programming of the new, upgraded building automation system.

Table 12: ECM-3 Economic Summary

Replace Existing Building Automation System (BAS)	
Total Estimated Cost Savings ($/year)	**$42,700**
Estimated Annual Electricity Reduction (kWh/year)	93,000
Estimated Annual Natural Gas Reduction (ccf/year)	10,000
Estimated Annual Chilled Water Reduction (ton-hour/year)	238,000
Total Estimated EUI Reduction (kBTU/ft^2-year)	**51.4**
Total Estimated Cost	**$299,000**
Simple Payback (years)	**7.0**

Savings Assumptions: An energy model of the existing building and internal loads was constructed in Carrier's Hourly Analysis Program (HAP) and calibrated to the building's existing monthly utility usage. Control strategies were adjusted in the model including unoccupied schedules and temperature setbacks for AHU-1 through AHU-3, enabled partial economizer cooling, eliminated excess ventilation air, and reduced chilled water flow in winter months. All other inputs remained the same from the calibrated model. The results of the adjusted model were subtracted from the calibrated baseline model to define the savings attributed to the outlined control strategies.

VI. Operational Consideration

Operational Considerations (OCs) are measures that could improve a building's energy performance but have limited feasibility. HEAPY and the CAC facilities team identified a water-side economizer as a possible energy conservation measure but determined it was not economically feasible. The water-side economizer is presented as an OC should CAC choose to develop and pursue this measure in the future.

OC-1: Water-side Economizer

During the winter months, CAC's monthly chilled water usage is approximately 2/3 the usage during peak summer months, as shown in Figure 17. Chilled water requirements should be minimal during the winter, as economizer cooling should be supplied through ventilation air and dehumidification should not be required. However, large volumes of chilled water are being used in November through March.

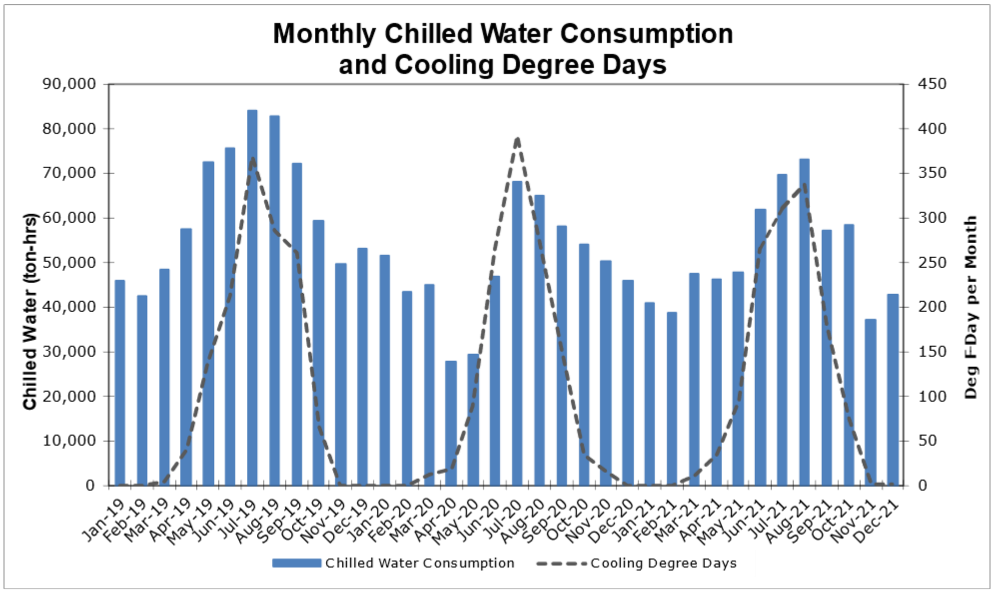

Figure 17: Monthly Chilled Water Usage at Contemporary Arts Center

The new building automation system recommended in ECM-3 should alleviate the conditions driving the winter chilled water usage. A water-side economizer was considered, which would take advantage of free cooling from the cold winter outdoor air in place of purchased chilled water. Schematically, the economizer would consist of a plate-and-frame heat exchanger in the mechanical penthouse and a dry cooler located outdoors near the penthouse. Chilled water would flow to one side of the heat exchanger in place of the district plant connection during the winter. A glycol solution would flow between the heat exchanger and dry cooler, using the cold outdoor air to chill the chilled water. Separate pumps and piping specialties would be required for the new loop, as well as an automated switchover valve between the district plant source and the dry cooler source; a schematic is shown in Figure 18. Final design criteria would depend on the desired economizer tonnage, the switchover temperature between district chilled water and economizer chilled water, and the required chilled water temperature.

Once the new control system is in place, winter chilled water usage should be minimal. The annual cost savings for eliminating further winter chilled water usage were estimated as less than $10,000, which would not support the expected cost to purchase and install a new water-side economizer system.

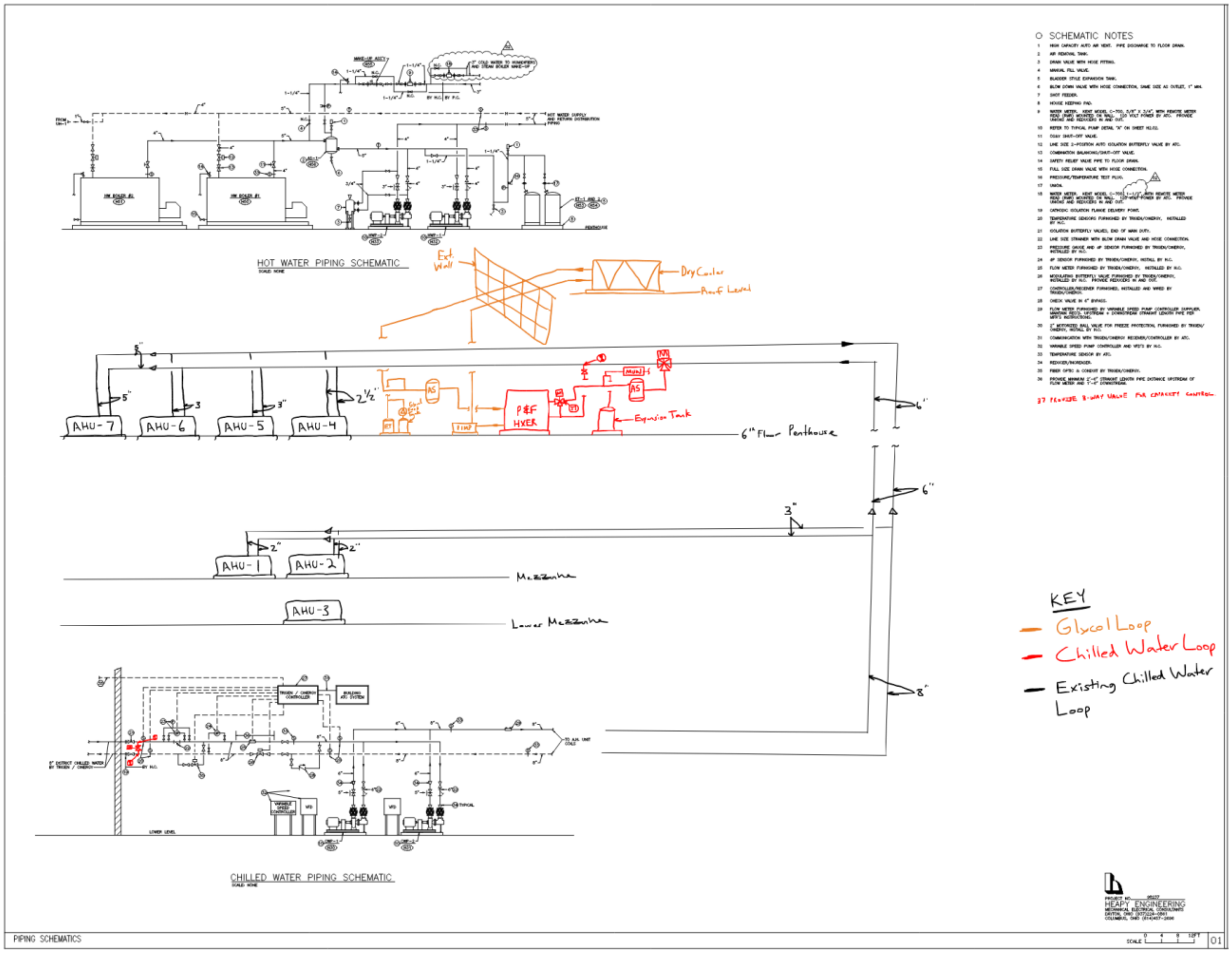

Figure 18: Water-side Economizer Schematic for CAC

VII. Results

The recommended ECMs in this report will help CAC achieve its goal of 50% energy reduction by 2030. When implemented, the measures are estimated to reduce CAC's EUI by 64.6 kBTU/ft^2-year, resulting in an energy performance of 138.8 kBTU/ft^2-year. This represents a 44% improvement from the 2003 baseline of 250 kBTU/ft^2-year. The expected performance after implementation is shown in Figure 19.

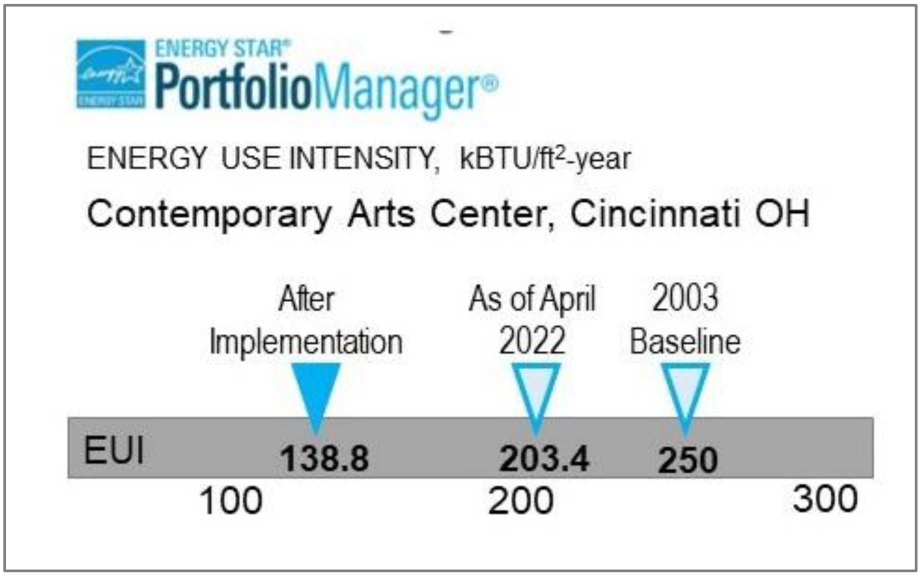

Figure 19: Expected EUI After Implementation at Contemporary Arts Center

The recommended measures will generate $50,900 in annual energy savings which can be reinvested in further energy opportunities at CAC. The estimated energy reductions and cost savings are summarized in Table 13.

Table 13: Summary of Estimated Results for RCMs at the Contemporary Arts Center

RCM	Electric Savings, kWh/year	Natural Gas Savings, ccf/year	Chilled Water Savings, ton-hour/year	Cost Savings
ECM-1: Automate Monthly Energy Reporting	14,200	1,700	12,800	$3,200
ECM-2: Balance Existing AHU System	15,800	3,100	31,200	$5,000
ECM-3: Replace Existing Building Automation System (BAS)	93,000	10,000	238,000	$42,700
TOTALS	**123,000**	**14,800**	**282,000**	**$50,900**
% of Current Annual	**17%**	**17%**	**44%**	**19%**

VIII. Appendix

Schneider Budget Proposal for ECM 3

Schneider Electric

Date: **3/31/23**

To:	**Erin Kelly** **Heapy** **1800 watermark Drive** **Columbus, OH 43215**	**From:**	**Ron Epp** **Schneider Electric, *Digital Energy*** **9928 Windisch Rd** **West Chester, Oh 45069**
Phone:	**(614) 306-1237**	**Phone:**	**(513) 518-3927**
Email:	**ERKelly@Heapy.com**	**Email:**	**Ron.Epp@SE.com**

Project: **Building Automation System Retrofit to Schneider Electric EcoStruxure ~Budget~**
Location: **44 East 6th St., Cincinnati, OH 45202**

Erin,

Schneider Electric proposes to provide budgetary labor, equipment and materials required to retrofit the current Alerton BAS with new EcoStruxure hardware and software for the above referenced facility. The existing Alerton system is original with the construction of the facility and difficult to find replacement parts, software and system support. By upgrading your system to Schneider Electric EcoStruxure, you'll be gaining a completely open system with strong cybersecurity & the newest technology available.

The retrofit can be performed as a single project or could be installed in a phased approach where some of the existing controllers could be migrated to the EcoStruxure front end now and keep other controllers in place to phase-in at a later date. Our plan is to retrofit the main AHU and Plant controllers now and phase in the VAV controllers in the future. All existing VAV terminal unit controllers will be migrated to the EcoStruxure front end with graphics for control and monitoring of each.

Our scope of work includes utilizing the existing control enclosures to house our new EcoStruxure controllers. The BAS system is divided up in multiple control panels located in (4) four areas throughout the facility. The system includes the following:

- ✓ Penthouse CP-1 (Boiler Controls)
- ✓ Penthouse CP-2 (AHU-4, AHU-6 and AHU-7)
- ✓ Penthouse CP-3 (AHU-5 and Smoke Evacuation System)
- ✓ 3rd Floor CP-4 (FTR's, "Miscellaneous" and BTi Replacement with AS-P)
- ✓ 1st Floor CP-5 (AHU-1 and AHU-2)
- ✓ 1st Floor CP-6 (Fire Alarm Monitoring)
- ✓ Lower Level CP-7 (CHW System and AHU-8)
- ✓ Lower Level CP-8 (AHU-3)
- ✓ Variable Locations VAV-1 through VAV-49 with HW Reheat (49)

We would confirm and label all control cables within the existing control enclosures. The old controllers would then be removed and replaced with new Schneider Electric EcoStruxure AS-P and required IO modules. The new controllers would be pre-programmed and bench tested prior to installation for a much easier and coordinated transition.

Page 1 of 7

Below is a list of equipment associated with each panel:

Penthouse CP-1 – HW Boiler System

- ✓ HW Boiler-1 Control, Monitoring & Alarming
- ✓ HW Boiler-2 Control, Monitoring & Alarming
- ✓ HW Pump-1 Control, Monitoring & Alarming
- ✓ HW Pump-2 Control, Monitoring & Alarming
- ✓ HW Supply & Return Temperature Control, Monitoring & Alarming
- ✓ Exhaust Fan-1 Control, Monitoring & Alarming
- ✓ Ventilation Fan Control
- ✓ Cabinet Unit Heaters (CUH) Control, Monitoring & Alarming

Penthouse CP-2 – AHU's 4, 6 & 7

- ✓ AHU-4 Supply Fan & VFD Control, Monitoring & Alarming
- ✓ AHU-4 Mixed Air Damper Control, Monitoring & Alarming
- ✓ AHU-4 Duct Static Pressure Control, Monitoring & Alarming
- ✓ AHU-4 Supply & Return Duct Temperature, CO-2 & Temperature Monitoring & Alarming
- ✓ AHU-4 CHW Coil Control
- ✓ AHU-4 Humidifier Control, Monitoring & Alarming
- ✓ AHU-6 Supply Fan & VFD Control, Monitoring & Alarming
- ✓ AHU-6 Return Fan & VFD Control, Monitoring & Alarming
- ✓ AHU-6 CHW Coil Control
- ✓ AHU-6 Mixed Air Damper Control, Monitoring & Alarming
- ✓ AHU-6 Duct Static Pressure Control, Monitoring & Alarming
- ✓ AHU-6 Supply & Return Duct Temperature, CO-2 & Temperature Monitoring & Alarming
- ✓ AHU-7 Supply Fan & VFD Control, Monitoring & Alarming
- ✓ AHU-7 Outdoor Air Damper Control, Monitoring & Alarming
- ✓ AHU-7 Duct Static Pressure Control, Monitoring & Alarming
- ✓ AHU-7 Supply & Outdoor Duct Temperature/Humidity Monitoring & Alarming
- ✓ AHU-7 Preheat HW Coil Control
- ✓ AHU-7 CHW Coil Control
- ✓ AHU-7 Humidifier Control, Monitoring & Alarming

Penthouse CP-3 – AHU 5 & Smoke Evacuation

- ✓ AHU-5 Supply Fan & VFD Control, Monitoring & Alarming
- ✓ AHU-5 Return Fan & VFD Control, Monitoring & Alarming
- ✓ AHU-5 Mixed Air Damper Control, Monitoring & Alarming
- ✓ AHU-5 Duct Static Pressure Control, Monitoring & Alarming
- ✓ AHU-5 Supply & Return Duct Temperature, CO-2 & Temperature Monitoring & Alarming
- ✓ AHU-5 CHW Coil Control
- ✓ AHU-5 Humidifier Control, Monitoring & Alarming
- ✓ Smoke Exhaust Fans SMF's 1, 2 & 3 Control, Monitoring & Alarming
- ✓ Smoke Exhaust Fan Room Intake Damper Control
- ✓ Smoke Exhaust Make Up Air Fans MUF's 1, 2 & 3 Control, Monitoring & Alarming
- ✓ Smoke Exhaust Relief Fan-1 VFD Control, Monitoring & Alarming
- ✓ Smoke Exhaust Stairwell Pressurization Fans SPF's 1 & 2 Control, Monitoring & Alarming

3rd Floor CP-4 – FTR's & Miscellaneous

- ✓ Fin Tube Heat Valve Control for 3rd & 4th Floors
- ✓ Cabinet Unit Heater Valve Control for 3rd, 4th Floors and Atrium

1st Floor CP-5 – AHU's 1 & 2

- ✓ AHU-1 Supply Fan & VFD Control, Monitoring & Alarming
- ✓ AHU-1 Mixed Air Damper Control, Monitoring & Alarming
- ✓ AHU-1 Duct Static Pressure Control, Monitoring & Alarming
- ✓ AHU-1 Supply & Return Duct Temperature, CO-2 & Temperature Monitoring & Alarming
- ✓ AHU-1 CHW Coil Control
- ✓ Exhaust Fans 2 & 3 Control, Monitoring & Alarming
- ✓ AHU-2 Supply Fan & VFD Control, Monitoring & Alarming
- ✓ AHU-2 CHW Coil Control
- ✓ AHU-2 Mixed Air Damper Control, Monitoring & Alarming
- ✓ AHU-2 Duct Static Pressure Control, Monitoring & Alarming
- ✓ AHU-2 Supply & Return Duct Temperature, CO-2 & Temperature Monitoring & Alarming

1st Floor CP-6 – Fire Command Station

- ✓ AHU-1 Fan Override & Fan Status Indication
- ✓ AHU-2 Fan Override & Fan Status Indication
- ✓ AHU-3 Fan Override & Fan Status Indication
- ✓ AHU-4 Fan Override & Fan Status Indication
- ✓ AHU-5 Fan Override & Fan Status Indication
- ✓ AHU-6 Fan Override & Fan Status Indication
- ✓ AHU-7 Fan Override & Fan Status Indication
- ✓ AHU-8 Fan Override & Fan Status Indication
- ✓ East Stairwell Pressurization Fan Override & Fan Status Indication
- ✓ West Stairwell Pressurization Fan Override & Fan Status Indication
- ✓ Upper West Stairwell Pressurization Dampers Override & Position Indication
- ✓ Upper East Stairwell Pressurization Dampers Override & Position Indication
- ✓ Lower West Stairwell Pressurization Dampers Override & Position Indication
- ✓ Lower East Stairwell Pressurization Dampers Override & Position Indication
- ✓ Atrium Smoke Evac Fans Override & Fan Status Indication
- ✓ Atrium Makeup Fans Override & Fan Status Indication

Lower Level CP-7 – AHU-8 and Chilled Water System

- ✓ AHU-8 Supply Fan Control, Monitoring & Alarming
- ✓ AHU-8 Supply & Return Duct Temperature Monitoring & Alarming
- ✓ AHU-8 HW Coil Control
- ✓ CHW System Primary Supply and Return Temperature Monitoring
- ✓ CHW System Secondary Supply and Return Temperature Monitoring
- ✓ CHW System DP Monitoring
- ✓ CHW System Seasonal Bypass Valve
- ✓ CHW Secondary Return valve
- ✓ Sewage Ejector Pump Monitoring & Alarming
- ✓ Domestic Water Pump Monitoring & Alarming
- ✓ Sump Pump Monitoring & Alarming
- ✓ Fire Pump Monitoring & Alarming

Lower Level CP-8 – AHU-3

- ✓ AHU-3 Supply Fan VFD Control, Monitoring & Alarming
- ✓ AHU-3 CHW Coil Control
- ✓ AHU-3 HW Coil Control
- ✓ AHU-3 Supply & Return Duct Temperature Monitoring & Alarming

Facility Variable Air Volume (VAV) Terminal Units with HW Reheat (Typ-49)

- ✓ Existing Alerton application specific controllers shall remain in place during this phase and be migrated to the EcoStruxure front end via BACnet MSTP.
- ✓ Replacement of each VAV Terminal Unit Controller shall be provided in future phase

This Budget Proposal Includes:

1. Schneider Electric EcoStruxure Workstation Licensing (1)
2. Schneider Electric EcoStruxure Enterprise Server Licensing
3. Required Managed IP Switches
4. Required Automation Server (AS-P) IP Controllers and Associated IO Expansion Modules
5. System Design and Engineering Labor
6. System Installation Labor
7. System Programming Labor
8. System Graphic Development Labor
9. Operational Checkout and As-Built Documentation
10. Up to 16 hours of on-site System Training

Clarifications:

1. Permits of any kind are not included within this proposal
2. This proposal is for budgeting purposes only. An Engineered System Take-off and Estimate will be required for all final pricing
3. CAT6 cabling will be required from each EcoStruxure control panel location (10) to the nearest IP switch or data closet to reside on the facility Ethernet network. These cable drops and static IP addresses shall be provided by others/Contemporary Arts Center and not included within our budget proposal.
4. Workstation PC and/or Server equipment shall be provided by owner/Contemporary Arts Center unless directed otherwise.
5. Some or all of the products and services to be delivered or performed in accordance with this proposal are produced, delivered, performed in, or sourced from areas that may become affected by the COVID-19 pandemic or ongoing global supply chain crisis, including shortage or interruption or delay in the transportation or procurement of raw materials, and/or components. Schneider Electric is not liable for delays due to supply chain.
6. All new materials/equipment provided by Schneider Electric shall be warranted against defects in materials & workmanship for a period of (1) one year.
7. All work is based upon being performed during normal business hours (Mon-Fri) at standard wage rates.
8. Proposal does *not* include provisions and installation of work outside the scope of this quote.
9. Proposal is valid for a period of 30 days and supersedes any previous quote. Please call if we need to discuss any scope or coordination issues
10. Payment terms are lump sum NET 30 days from date of invoice

Total Proposed Budget Investment: **$262,000.00**

If you have questions or require clarification, please feel free to contact me at any time.
We ***sincerely*** appreciate the opportunity to work on this project with you.

Best regards,
Schneider Electric – Digital Energy

Ron Epp
Systems Account Manager
(513) 518-3927 Mobile
Ron.Epp@SE.com

TERMS AND CONDITIONS OF SALE

900512PITC R06/26/20

This quotation and any exhibits and attachments hereto (collectively, "Agreement") and any information contained herein, is the property of Schneider Electric Buildings Americas Inc. ("Seller") and shall constitute proprietary and confidential information unless given to a public entity and required by law to be public information. The party to whom this quotation is addressed ("Buyer") acknowledges the confidential nature of this Agreement and agrees to take all commercially reasonable and necessary precautions to ensure the confidential treatment of this Agreement and all information contained herein. This Agreement will not be used, copied, reproduced, disclosed or otherwise disseminated or made available, directly or indirectly, to any third party for any purpose whatsoever without the prior written consent of Seller. The parties agree to be bound by the following terms and conditions.

1. **Quotations and Acceptance.** The quotation is based solely on the bid documents, which consist of the project drawings, specifications and/or instructions of the Buyer only modified by written agreement or Seller objection. Significant deviations between the actual conditions and circumstances of the work and those specified in the bid documents shall be cause for an adjustment in work scope, price and time allowed for performance. Written quotations shall be valid for no more than thirty (30) days from the date of issue, unless specifically stated otherwise herein. Buyer may accept the quotation by signing and returning a copy to Seller or by returning Buyer's own written instrument or order expressly acknowledging the quotation and terms set forth herein, provided, however, Seller hereby gives notice of its objection to any different or additional terms or conditions contained or referenced in Buyer's order, which will be of no force or effect except as may be expressly agreed to by Seller in writing. It is the intent of the parties that these Terms and Conditions of Sale shall govern the sale of goods delivered and services performed. Upon acceptance, this Agreement constitutes the entire understanding between the parties respecting the goods or services delineated herein and supersede all prior oral or written understandings or representations relating to such goods or services. This Agreement may not be discharged, extended, amended or modified in any way except by a written instrument signed by a duly authorized representative of each party. Seller assumes that the Subcontract Agreement offered will contain terms that are substantively similar to the AIA provisions that are in accordance with the provisions of the prime contract, including any supplements. Upon award, Seller assumes that contract provisions will be reviewed and negotiated in good faith to reach a mutual acceptance of both parties.

2. **Payment.** Absent a contrary provision herein, Buyer will pay Seller monthly progress payments on a net thirty (30) days basis from date of invoice for materials delivered (or stored at an off-site storage facility) and services performed, less any retained reserve which will be mutually agreed upon in writing by the parties. The aggregate amount of any such retained reserves shall be paid by Buyer to Seller within thirty (30) days after the date of substantial completion. If Seller provides a Certificate of Substantial Completion, such certificate shall conclusively establish such date. All invoices due and payable to Seller, less any applicable retained reserve, shall accrue interest at a compounded per annum rate not to exceed 1½% per month (18% per annum) or the maximum rate permitted by law. Acceptance and endorsement by Seller of an instrument for less than the full amount which Seller claims to be due shall not be deemed to be an admission of payment in full and any conditions to the contrary which are noted on such an instrument shall not be binding on Seller. If Buyer does not pay Seller, through no fault of Seller, within seven (7) days from the time payment was due, Seller may, without prejudice to any other remedy it may have, upon seven (7) additional days' written notice to Buyer, stop its work until payment of the amount owing has been received and the contract sum shall be equitably adjusted for reasonable costs of shutdown, delay and startup or in the alternative Seller may terminate this contract for material breach and all monies due Seller for services performed and materials delivered shall be paid upon demand. Seller shall be entitled to recover from Buyer all costs for collection, including reasonable attorneys' and professionals' fees. To the extent payments are received and as required by law, and upon Buyer's request, Seller will furnish mechanics lien waivers as the work progresses.

   Seller reserves a security interest in any goods sold to the extent of the invoiced amount to secure payment of Buyer's obligation. In event of payment default, Seller may repossess such goods and a copy of the invoice may be filed with appropriate authorities as a financing statement to event or perfect Seller's security interest in the goods. At Seller's request, Buyer will execute any necessary instrument to perfect Seller's security interest.

3. **Price and Taxes.** The price for the goods and services hereunder are those shown on the face of this Agreement. The price of this Agreement does not include sales, use, excise, duties or other similar taxes, unless otherwise expressly provided herein. Any taxes (other than taxes due on Seller's net income) that are payable hereunder shall be the responsibility of Buyer. If applicable, Buyer shall provide Seller a copy of any appropriate tax exemption certificate for the state(s) into which the goods are to be shipped.

4. **Changes and Claims**. All materials and labor furnished hereunder shall be in accordance with shop drawings submitted by Seller and approved by Buyer. Any changes in the work as set forth in approved shop drawings, or from the scope of work as described herein, will require a written change order submitted to Seller by Buyer. An equitable adjustment will be made in the contract price or delivery dates or both, and this Agreement will be modified accordingly in writing. The cost or credit to Buyer for performance of such change order shall be determined by mutual written agreement prior to the commencement of any work under such change order. Buyer shall notify Seller promptly in writing of any circumstances arising from the performance of the work herein described which reasonably may be anticipated to result in a claim or back charge to Seller. Upon Seller's receipt of such notification, Seller shall have five (5) working days in which to remedy such circumstances and to avoid the imposition of such claim or back charge. Seller will not be liable for any claim or back charge where Seller has not been notified in the manner as set forth above.

5. **Access and Overtime.** This Agreement is based upon the use of straight time labor only during regular working hours (8:00 a.m. to 5:00 p.m., Monday through Friday, excluding Seller's holidays). If Buyer requests Seller to perform any work outside of regular working hours, overtime and other additional expense occasioned thereby will be charged to and paid by Buyer. If Seller's work is to be performed on the project site, Buyer will afford unrestricted access to Seller and its employees and agents to all work areas.

6. **Damage or Loss to Equipment**. In the case of equipment not to be installed by or under supervision of Seller, Seller shall not be liable for damage to or loss of equipment after delivery of such equipment to the point of shipment. In the case of equipment to be installed by or under supervision of Seller, Seller shall not be liable for damage or loss after delivery by the carrier to the site of installation; if thereafter, pending installation or completion of installation or full performance by Seller, any such equipment is damaged or destroyed by any cause whatsoever, other than by the fault of Seller, Buyer agrees to promptly pay or reimburse Seller an amount equal to the damage or loss which Seller incurs as a result thereof, in addition to or apart from, any and all other sums due or to become due hereunder.

7. **Delays**. Buyer shall prepare all work areas so as to be acceptable for Seller's work required hereunder. Buyer acknowledges that the contract sum is based upon Seller being able to perform the work in an orderly and sequential manner, as Seller so determines. If Seller's performance is delayed, interfered with, suspended, or otherwise interrupted, in whole or in part, by Buyer, other contractors on the project site, or by any other third party or by any act within the power and/or duty of Buyer to control, then Buyer agrees that it will be liable to Seller for all increased costs and damages which Seller incurs as a result thereof. Furthermore, if Seller is delayed at any time in the progress of the work by any act or neglect of Buyer, or by any separate contractor employed by Buyer, or by changes ordered in the work or by labor disputes, fire, delay in transportation, adverse weather conditions, casualties, or any other causes beyond Seller's control, then the time for completion of the work shall be extended for a period equal to the time lost by reason of such delay.

8. **Warranty**. Seller warrants to Buyer that all tangible articles manufactured by Seller will be free of defects in workmanship and material and that the work performed will be of good quality and will conform to the requirements of the bid documents. If the article is installed by Seller, Seller's sole obligation under this warranty shall be to provide, without charge, parts and labor necessary to remedy defects which appear within twelve (12) months from the date of beneficial use or occupancy, as applicable. If Seller provides a Certificate of Substantial Completion, such certificate shall conclusively establish such date. If article is not installed by Seller, the warranty period shall be within twelve (12) months of shipment of said article. Warranty claim must be made to Seller in writing within such twelve (12) month period. All transportation charges incurred in connection with the warranty for equipment not installed by Seller shall be borne by Buyer. Seller warrants that for equipment furnished and or installed, but not manufactured by Seller, Seller will extend the same warranty terms and conditions which Seller receives from the manufacturer of said equipment.

   This warranty is the sole and exclusive warranty given with respect to any articles delivered or services performed by Seller. THE WARRANTIES SET FORTH ABOVE ARE EXCLUSIVE AND IN LIEU OF ALL OTHER WARRANTIES EXPRESS OR IMPLIED (EXCEPT WARRANTIES OF TITLE), INCLUDING, BUT NOT LIMITED TO, WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. This warranty is subject to proper installation of the articles (if installation is not performed by Seller or authorized subcontractors of the Seller) and maintenance and storage of the articles in accordance with the specifications and directions supplied by Seller. This warranty does not apply to any defect, malfunction or failure caused by repairs made by other than or without the consent of Seller or the article has been subject to abuse, misuse, neglect, tampering, accident or damage by circumstances beyond Seller's control, including without limitation, acts of God, war, acts of government, corrosion, power fluctuations, freeze-ups, labor disputes, differences with workmen, riots, explosions, vandalism, or malicious mischief, nor to defective associated equipment or use of the articles with equipment for which they were not sold. All of Seller's obligations under this warranty will immediately terminate and be of no further force or effect if all or any part of the purchase price (including any installment payment) with respect to any article covered by this warranty is not paid to Seller when due. If cause of defect is found not to be Seller's responsibility, standard rates for repair or replacement and labor shall apply.

9. **Limitation of Liability.** In no event will Seller's total aggregate liability in warranty or contract exceed the contract price paid for the specific product or service that gives rise to the claim excluding third party claims for personal injury, death or property damage or as may be required by law. IN NO EVENT SHALL SELLER BE LIABLE FOR ANY LOST PROFITS, LOSS OF USE, LOSS OF GOODWILL, BUSINESS INTERRUPTION OR ANY OTHER SPECIAL, INDIRECT, INCIDENTAL, PUNITIVE OR CONSEQUENTIAL DAMAGES OF ANY KIND EVEN IF SELLER HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES.

10. **Laws and Permits.** Seller shall comply with all applicable federal, state, and local laws and regulation and shall obtain all temporary licenses and permits required for the prosecution of the work. Licenses and permits of a permanent nature shall be procured and paid for by the Buyer. This contract shall be interpreted and governed under and in accordance with the laws of the jurisdiction in which the goods are delivered or services are performed without regard to its choice of law provisions.

11. **Disputes.** Any controversy or claim arising out of or relating to this Contract, or the breach thereof, shall be settled by good faith consultation and negotiation. If those attempts fail, either party shall provide written notice within thirty (30) days to the other to mutually agree on an arbitration process. If a process is not agreed upon within thirty (30) days, final and binding arbitration in accordance with the then current Construction Industry Arbitration Rules of the American Arbitration Association shall commence and judgment upon the award rendered may be entered in any court having jurisdiction thereof. The arbitration shall be held in the federal, state or municipal courts serving the county in which the project is located unless the parties mutually agree otherwise. The prevailing party shall recover all reasonable legal costs and attorney's fees incurred as a result, which shall be promptly paid by the non-prevailing party. Any dispute or demand for arbitration must be commenced within one (1) year after the cause of action has accrued. Nothing herein shall limit any rights Seller may have under construction mechanic or materialmen lien laws. Seller shall have the right to suspend affected services pending resolution of disputes.

12. **Insurance.** The parties shall each maintain insurance coverage including without limitation, Workers' Compensation and Employer's Liability at statutory limits, Automobile Liability covering all owned, hired and other non-owned vehicles, and Commercial General Liability covering public liability and property damage with limits generally required for its respective industry with not less than $1,000,000 minimum coverage per occurrence. Such insurance shall be with reputable and financially responsible carriers authorized to transact business in the state in which the project and services are being performed. No credit will be given or premium paid by Seller for insurance afforded by others.

13. **Clean Up.** Seller agrees to keep the job site clean of debris arising out of its operations. Buyer shall not back charge Seller for any costs or expenses for clean up or otherwise without prior written notice and Seller's written consent.

14. **Severability.** The invalidity or unenforceability of any provision herein shall in no way affect the validity or enforceability of any other provision.

15. **Disclaimer:** Schneider Electric reserves the right to amend, withdraw or otherwise alter this submission without penalty or charge as a result of any event beyond its control arising from or due to the current COVID-19 epidemic or events subsequent to this epidemic / pandemic including changes in laws, regulations, by laws or direction from a competent authority. The Customer acknowledges that the products or part thereof are produced in, or otherwise sourced from, or will be installed areas already affected by, or that may be affected in the future by, the prevailing COVID-19 epidemics/pandemic and that the situation may trigger stoppage, hindrance or delays in Vendor's (or its subcontractors) capacity to produce, deliver, install or service the products, irrespective of whether such stoppage, hindrance or delays are due to measures imposed by authorities or deliberately implemented by the Vendor (or its subcontractors) as preventive or curative measures to avoid harmful contamination exposure of Vendor's (or its subcontractors') employees. The Customer therefore recognizes that such circumstances shall be considered as a cause for excusable delay not exposing the Vendor to contractual sanctions including without limitation delay penalties, liquidated or other damages or termination for default.

AHU Zoning Drawings

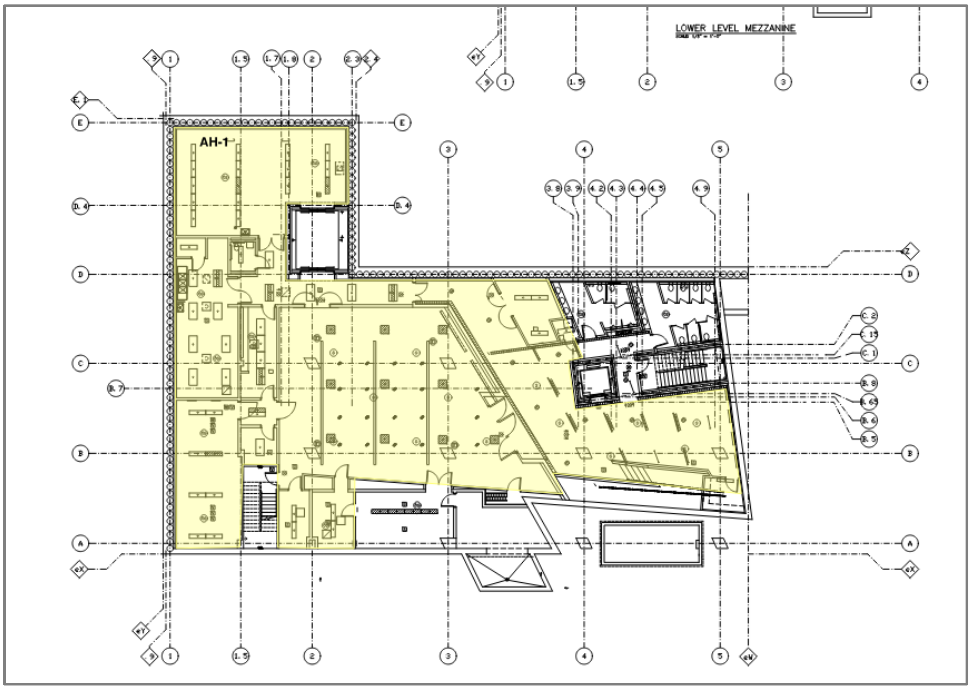

Figure 20: Lower Level Floor AHU-1 Zone

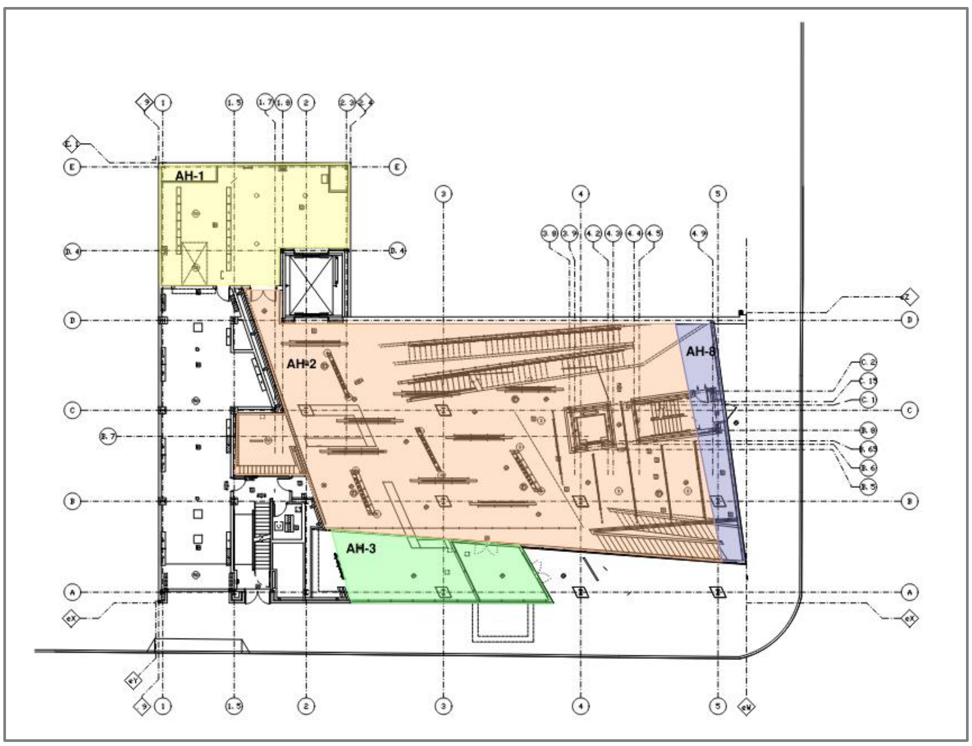

Figure 21: Lobby Floor AHU-1, AHU-2, AHU-3, and AHU-8 Zone

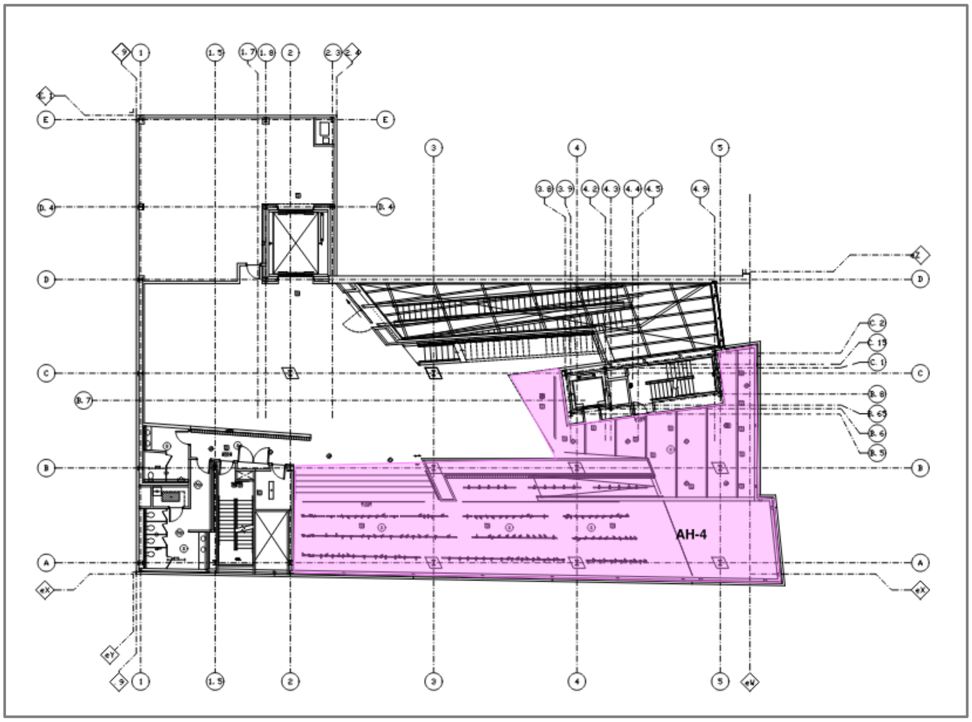

Figure 22: Second Floor AHU-4 Zone

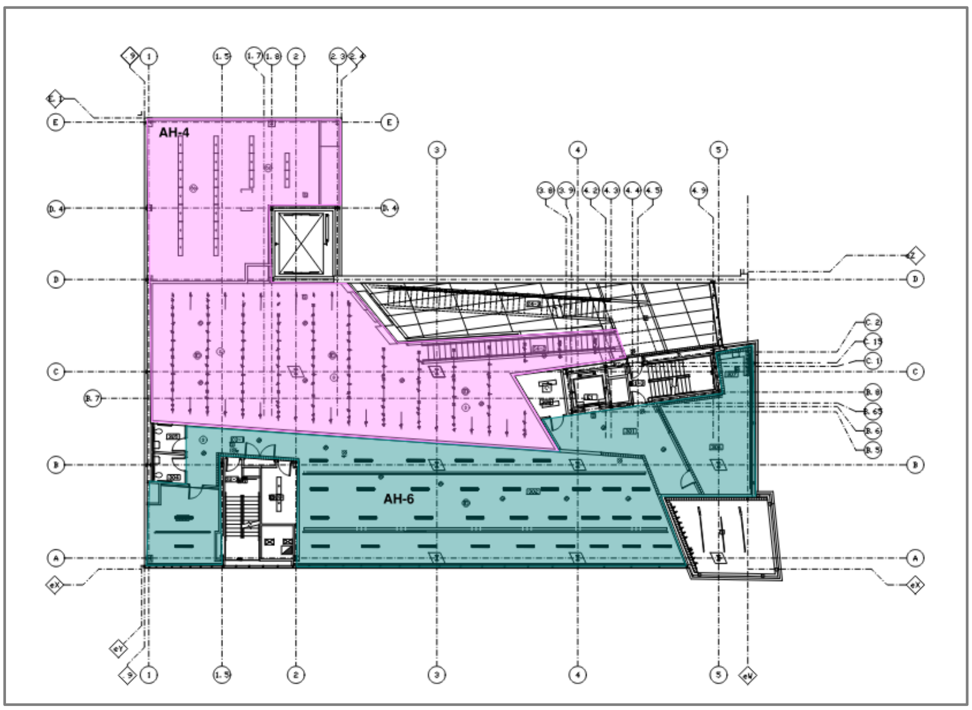

Figure 23: Third Floor AHU-4 and AHU-6 Zone

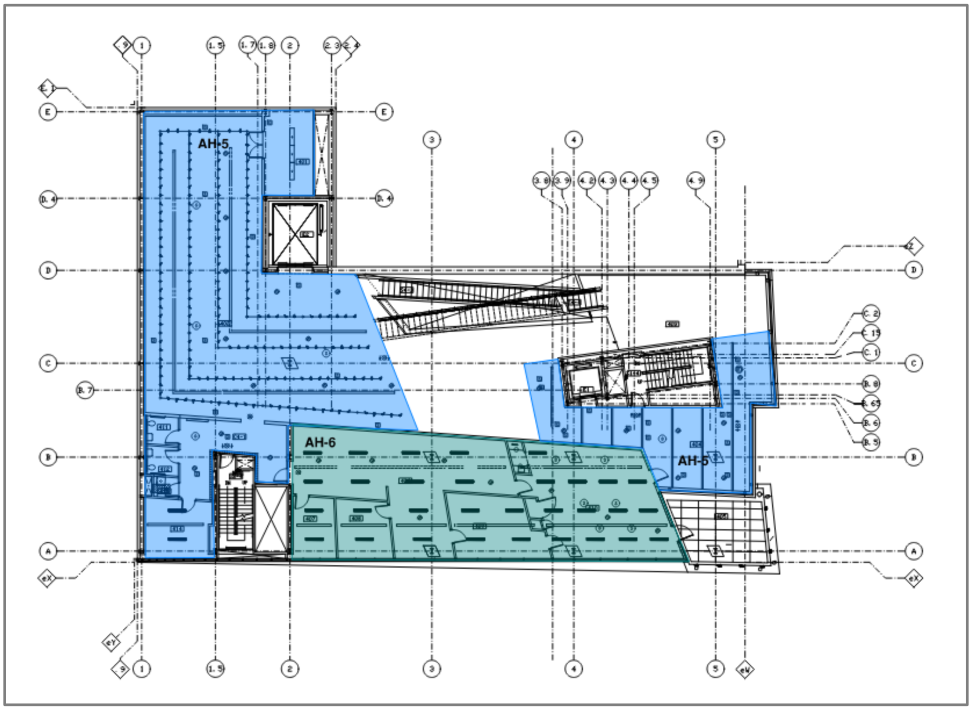

Figure 24: Fourth Floor AHU-5 and AHU-6 Zone

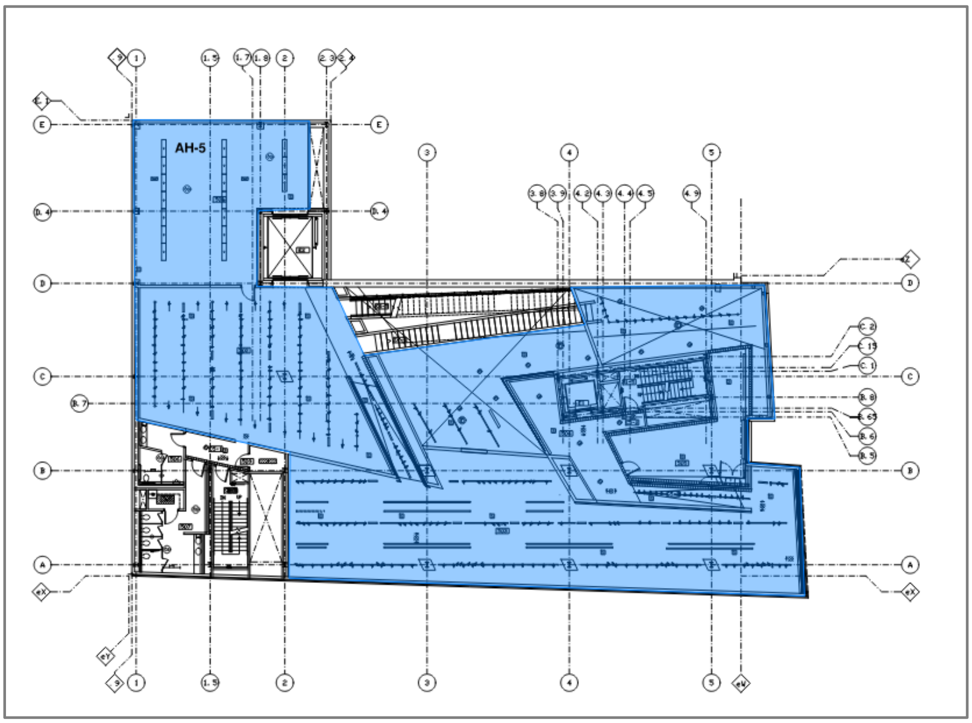

Figure 25: Fifth Floor AHU-5 Zone

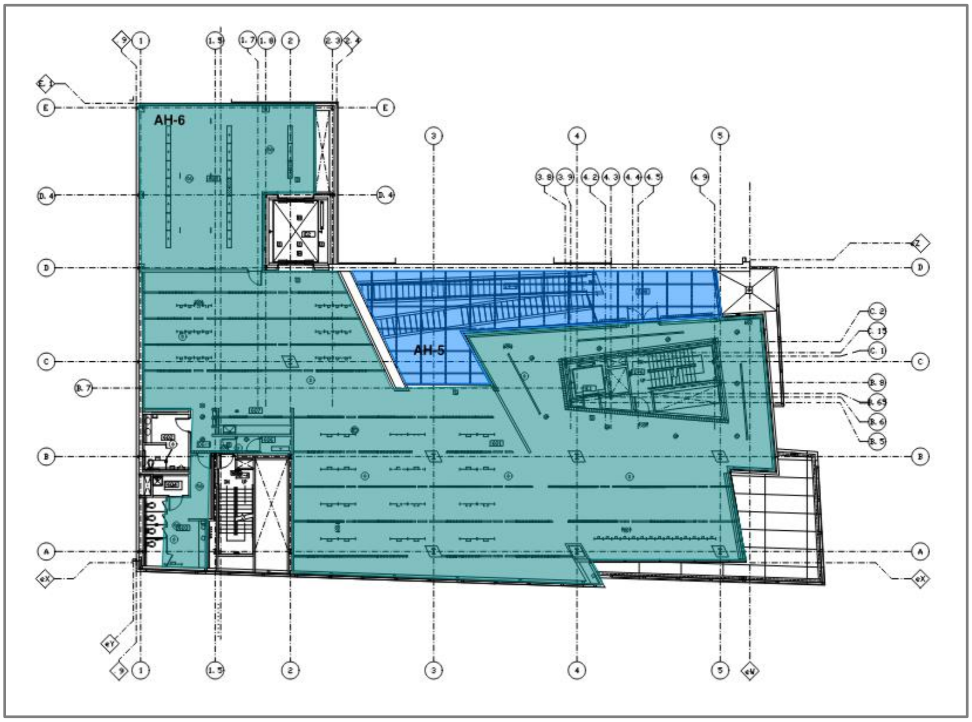

Figure 26: Sixth Floor AHU-5 and AHU-6 Zone