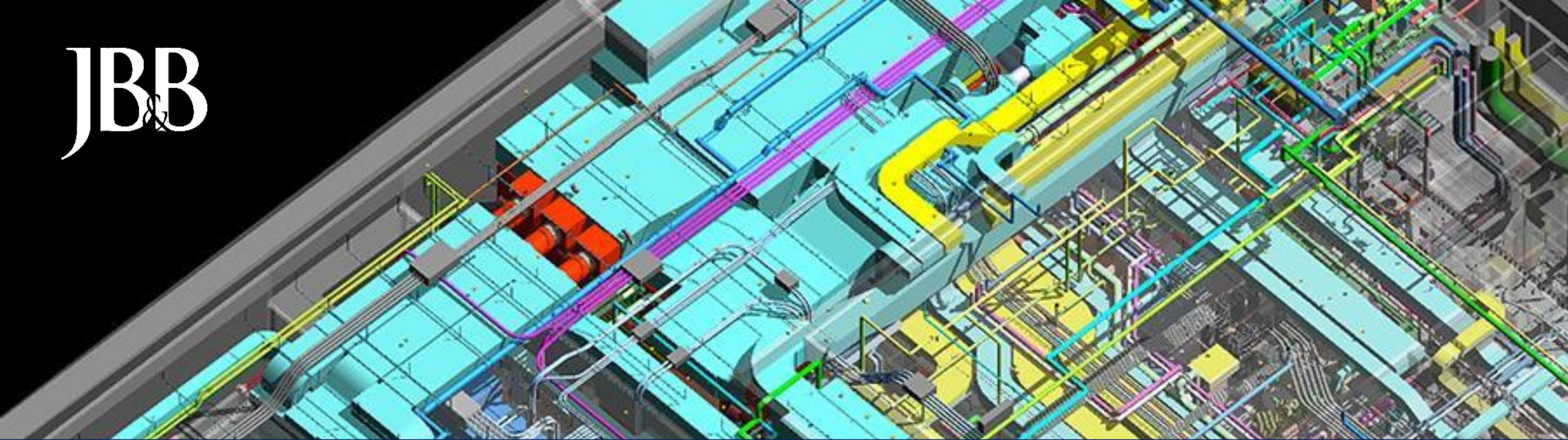


JB&B

Energy Efficient IAQ Mini-Bid Preliminary Report No. 4

Presented to:

NYSERDA

OCTOBER 23, 2020

AGENDA

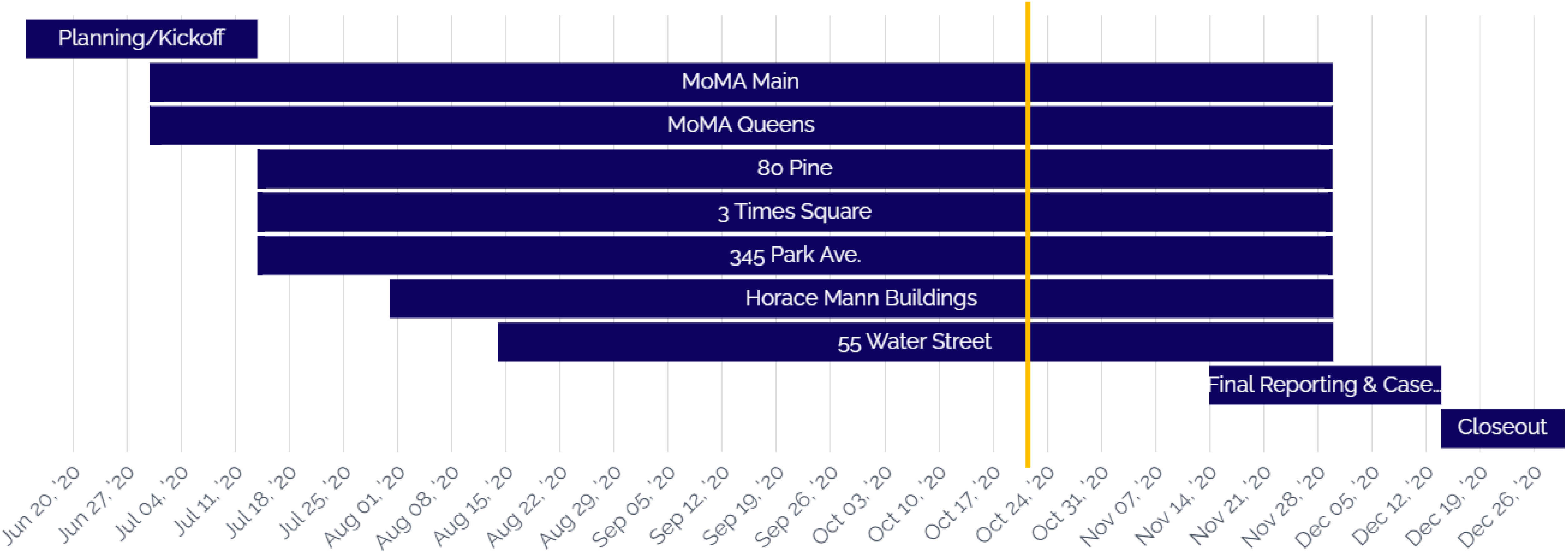
- Housekeeping Items
- MoMA Main Update
- MoMA QNS Update
- 55 Water Street Update
- 80 Pine Update
- 3 Times Square Update
- 345 Park Ave. Update

HOUSEKEEPING ITEMS

SCHEDULE UPDATE (NEW)

Progress to Date and Recommended Changes

- **Changes:**
  - No Changes



APPROACHING IAQ

Recommended Actions Related to HVAC Systems

	Increase Outdoor Air Ventilation	More Precise Temperature and Humidity Control	Upgrade Particulate Filtration	Portable Room Air Cleaners (HEPA)	Ultraviolet Germicidal Irradiation (UVGI)
CDC	X	X	X	X	X
World Health Organization	X	X	X	X	
ASHRAE	X	X	X	X	X
REHVA	X			X	
ASHE	X	X*	X		
International WELL Building Institute™	X	X	X		X

*ASHE requires specific temperature and humidity design parameters as part of their standard.

** Organizations such as the American Society for Microbiology (ASM) has reiterated the recommendations above.

APPROACHING IAQ

Tiered Approach

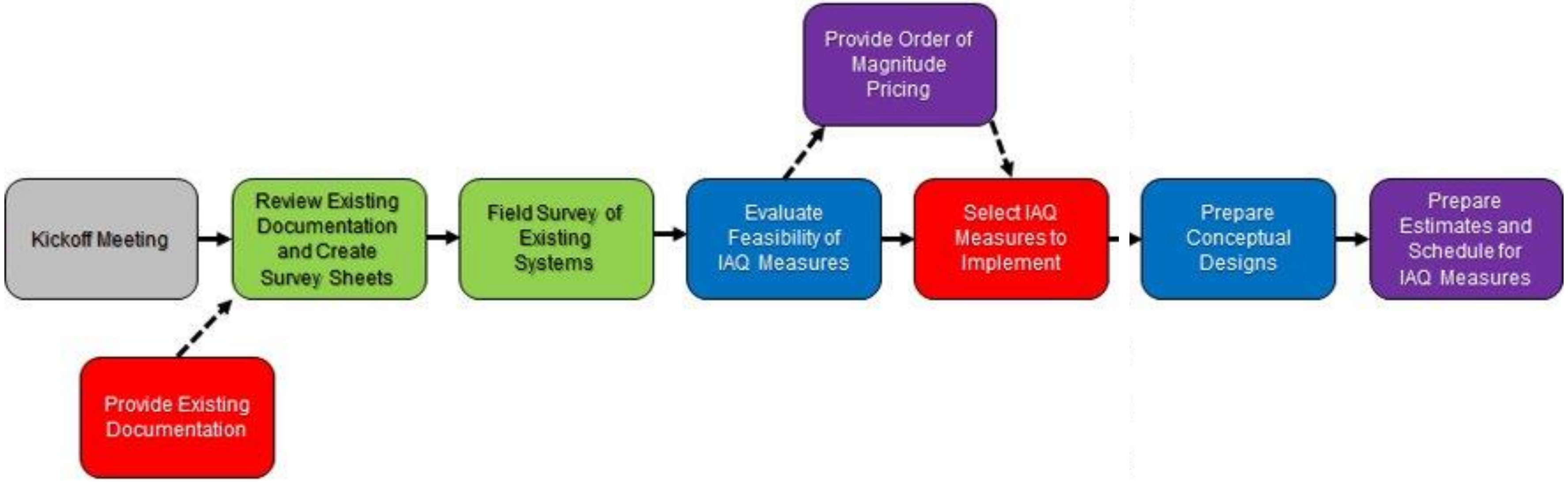
- **Tier 1**
  - Enhanced Supply Air Filtration (Increased MERV level)
  - Portable HEPA Filter Units
- **Tier 2**
  - Increased Outside Air
  - UV-C Emitters & Upper Room UVGI
  - Increased Quantity of Air Changes
  - Ventilation Effectiveness
  - Real Time Air Monitoring
  - Humidification Strategies
- **Tier 3**
  - Active Agents Injected into Supply Air
  - Bipolar Ionization
  - Dry Hydrogen Peroxide
  - Probiotic Air Purifier
  - Disinfecting Filtration System
  - Photocatalytic Oxidation
  - Photohydroionization
  - Far-UV
  - Aerosol Disinfection System - Triethylene Glycol

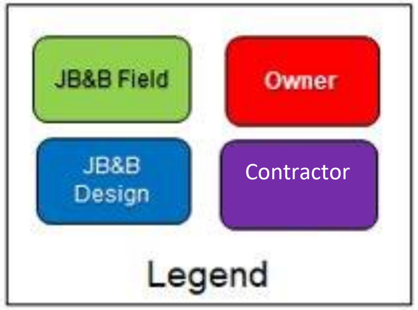
- Tier 1: Strategies that are easy to implement with minimal disruption.
- Tier 2: Strategies that are slightly more difficult to implement but are well researched and have citable data about efficacy of strategy.
- NYSERDA EE IAQ will focus on Tier 1 & Tier 2 strategies in alignment with industry guidelines and publications.

- Tier 3: Emerging technologies.
- Tier 3 strategies and other emerging technologies are outside the scope of EE IAQ.

APPROACHING IAQ

JB&B IAQ Process



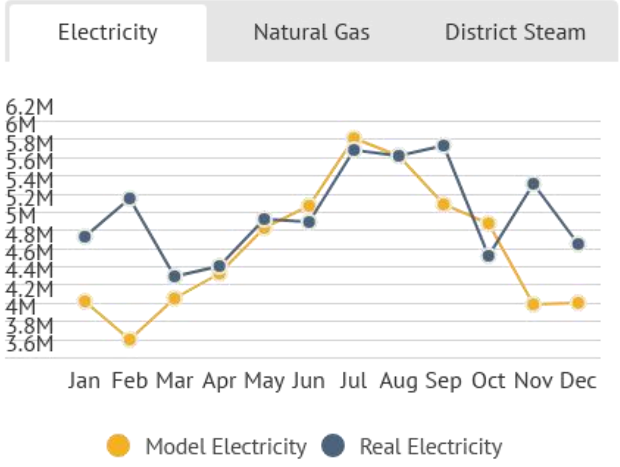


- Measures are evaluated for feasibility based on IAQ survey effort.
- Final IAQ recommendations are based upon industry recommendations, feasibility outcomes, and Client feedback on preferred strategies.

ENERGY MODELING PACKAGES

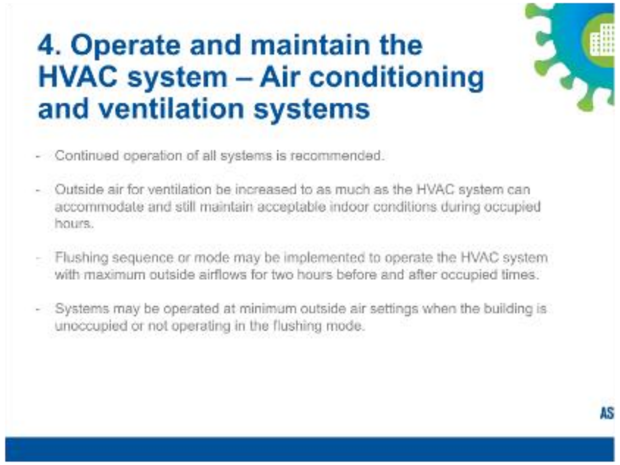
Current Understanding

Baseline Energy Model



- Pre-COVID facility energy use
- Operation assuming 100% occupancy

ASHRAE Recommendations Model


4. Operate and maintain the HVAC system – Air conditioning and ventilation systems

- Continued operation of all systems is recommended.
- Outside air for ventilation be increased to as much as the HVAC system can accommodate and still maintain acceptable indoor conditions during occupied hours.
- Flushing sequence or mode may be implemented to operate the HVAC system with maximum outside airflows for two hours before and after occupied times.
- Systems may be operated at minimum outside air settings when the building is unoccupied or not operating in the flushing mode.

AS

- ASHRAE Commercial Guidance document
- MERV-13/14 filters
- Highest % OA possible during Occupied hours
- Flushing sequence for 2 hrs before/after Occupied hours
- No DCV
- Case-by-case ERV

Energy Efficiency Model

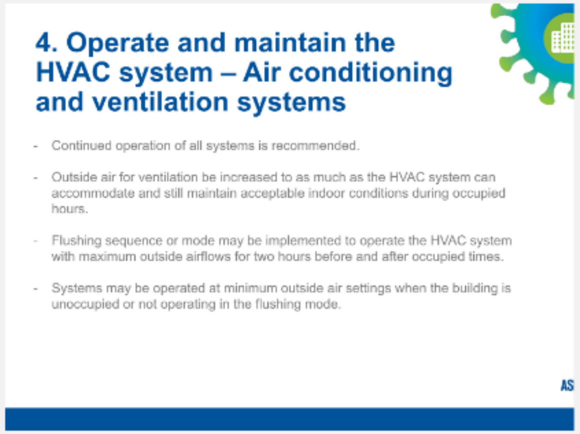
- Base Upgrade Package: UV & suggested ventilation level mods
- Additional Energy Efficiency Package: Filtration level mods, control sequence, additional monitoring, etc.

ENERGY MODELING

Approaching the ASHRAE Recommendations Model

- For buildings **with** an existing calibrated energy model:
    - Energy model inputs adjusted to reflect ASHRAE recommendations
- For buildings **without** an existing calibrated energy model:
    - Spreadsheet calculations for each individual IAQ strategy
    - Resource: Airborne Infection Risk (AIRC) and Ventilation Increase Impact (VII) Calculator from NYC DCAS and Building performance Lab

ASHRAE Recommendations Model



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- ASHRAE Commercial Guidance document
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- Highest % OA possible during Occupied hours
- Flushing sequence for 2 hrs before/after Occupied hours
- No DCV
- Case-by-case ERV

IAQ STRATEGY EVALUATION (NEW)

Approaching "Feasibility" of IAQ Strategies

IAQ Measure	Feasible	Not Feasible	Other Assumptions
Increase in Air Filtration	• If additional motor capacity is available. **AND** • If only alternation needed is changing out the filter rack. **AND** • If there is space in the unit to increase the filter rack size.	• If a new fan motor is required. **OR** • If modifications to the existing AHU casing are required. **OR** • If there is not enough room in the unit to replace the filter rack.	Evaluation is based on the pressure drop of a dirty filter. Increased air filtration may also be feasible if the initial pressure drop increases, but final pressure drop does not increase. Filter replacement would be more frequent in this case.
Increase in OA %	• If physical size and configuration of ductwork and louvers support an increase in OA%. **AND** • If only required change to existing system is controls-related programming.	• If alterations to ductwork would be required. **OR** • If alterations to OA dampers or louvers would be required. **OR** • If there are very strict temperature or humidity requirements that could be impacted by an increase in OA% (example: museum)	Evaluation of increasing OA% will be evaluated as weather permits.
UV-C in Central AHUs	• If AHU has 30 inches of space between fan inlet and cooling coil. **OR** • If return air duct has 5 ft of accessible straight run.	• If AHU does NOT have 30 inches of space between fan inlet and coil. **OR** • If return air duct DOES NOT have 5 ft of accessible straight run.	Current electrical distribution has capacity for inclusion of UV-C where "feasible". 30" or 5ft space requirement is based on emitter intensity needed to achieve a minimum dosage of1 ,300 microJ/cm^2 at "end of life".
Upper Room UV	• If space is an enclosed area with low ventilation and people tend to be static (corridors or seating areas). NOTE: Areas with low ventilation air will take longer for pathogens to get diluted or removed via the spill air path, so providing upper-room UVGI will help inactivate potential pathogens within those areas. **AND** • Architectural wall and ceiling finishes are UV tolerant or are not particularly important to O&M staff.	• If space has adequate ventilation and people tend to be transient. **OR** • If ceiling heights are atypically high. **OR** • If architectural wall and ceiling finishes are NOT UV tolerant or are important (example: museum)	Current electrical distribution has capacity for inclusion of UV-C where "feasible". High air circulation can help make upper-room UVGI more effective by bringing the air into the effective zone of the fixture.
Localized HEPA Air Filtration Units	N/A	N/A	HEPA filtration units are assumed to always be feasible and that outlets are available to plug them in.

MOMA MAIN

MOMA MAIN

Overview

- Building Name: The Museum of Modern Art (Main Campus)
- Building Location: 11 West 53rd Street, New York, NY
- Building Typology: Cultural Institution – Museum | Non-Profit | Owner-Occupied
- Occupancy Types: Art Gallery, Office, Retail
- Size: 743,800 sqft
- Operating Hours: 10:30 AM – 5:30 PM Monday through Sunday
- Systems Impacting IAQ:
  - Pretreatment Units (PTU) to pre-condition ventilation air
  - Variable Air Volume Central Air Handling Systems (various configurations & vintages)
  - Air filtration strategy (galleries and art storage/preservation): MERV 8 pre-filter, MER 14 first stage particulate filter, MERV 15 dual pass gaseous phase filters, MERV 15/16 final filter
  - No airside energy recovery
- Other Notes/Information:
  - Gallery spaces have stringent temperature & humidity criteria for preservation of the art: 70°F ±2°F and 50% ±5% RH in accordance with an ASHRAE AA Preservation Category

MOMA MAIN TASK LIST STATUS

Data Collection & Review

- ☑ Minimum 12-Months Pre-COVID Utility Data
- ☑ Existing Building MEP Drawings
- ☑ BMS Sequence of Ops
- ☑ Conduct Preliminary Site Walkthrough
- ☑ Conduct Operator Interviews

Develop Baseline Energy Model

- ☑ Total Annual Energy Use Breakdown by End Use
- ☑ Benchmark Building
- ☑ Develop Preliminary ECMs

Site Survey & Energy Efficient IAQ Recommendations

- ☑ Conduct Detailed Site Visits
- ☑ Develop Filtration and Airside Equipment Operation Log
- ☑ Develop IAQ Recommendations
- ☑ Refine Preliminary ECMs

Energy Efficient IAQ Energy Analysis

- ☑ ASHRAE Recommendations Energy Model
- ☑ Energy Efficiency Model

Economic Analysis

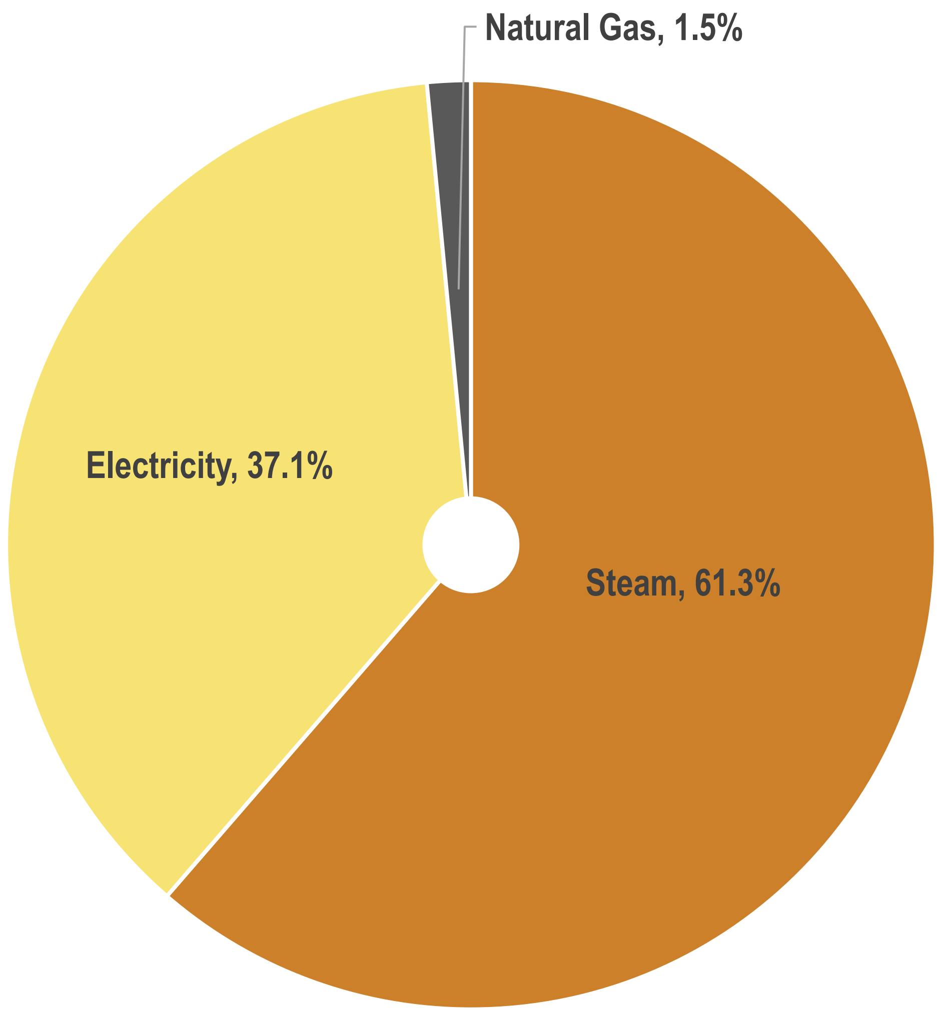
- ☑ Develop Design Document for Cost Estimator
- ☑ Collect Cost Estimates
- ☑ Conduct Economic Analysis

Final Reporting

- ☐ Final Report **(In Progress)**
- ☐ Case Study Documentation **(In Progress)**

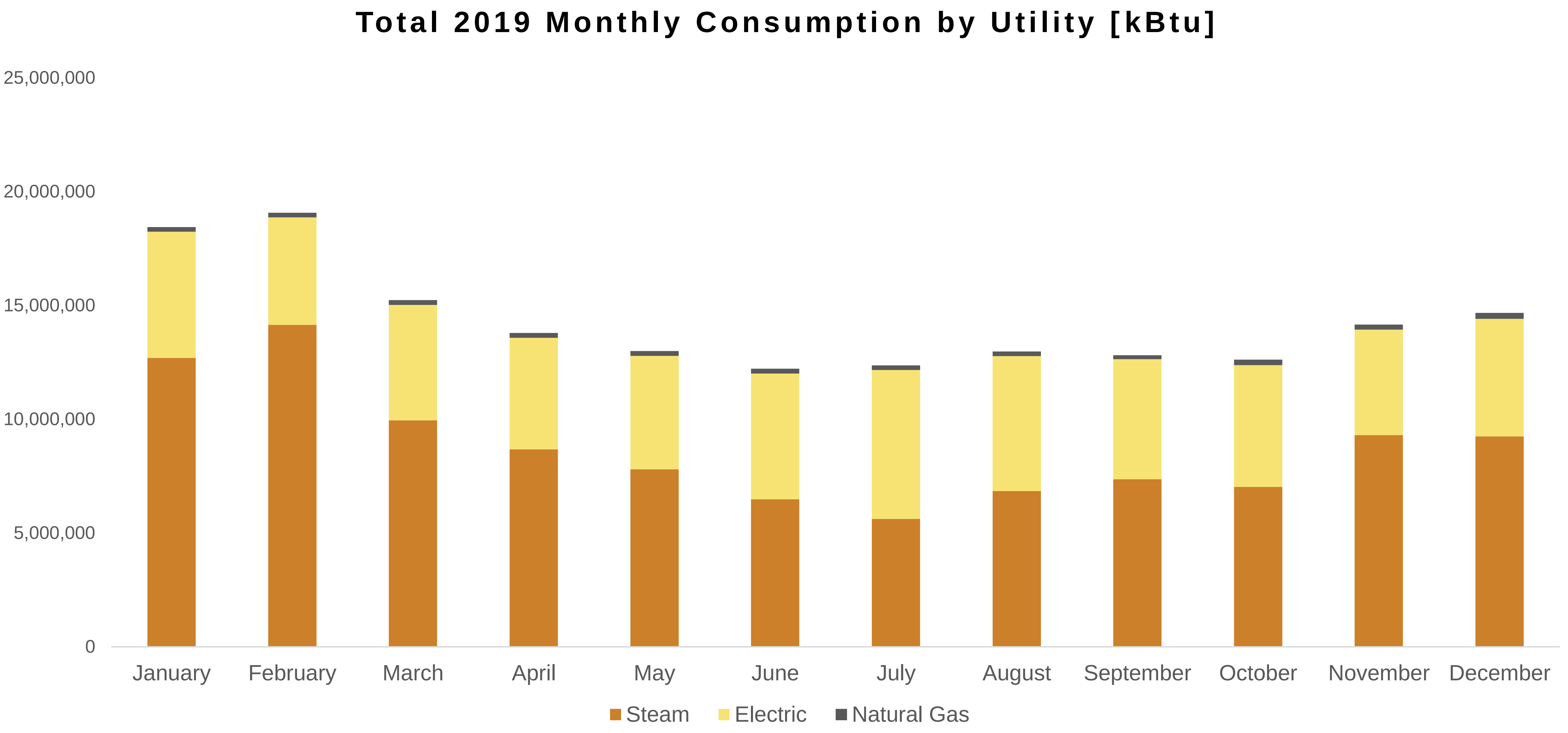
BASELINE ENERGY MODEL

2019 Energy Consumption by Utility



Energy Source	Energy Consumption [kBTUs]	% Energy Consumption
Electricity	63,630,436	37.1%
ConEd Steam	105,128,235	61.4%
Natural Gas	2,601,160	1.5%

BASELINE ENERGY MODEL

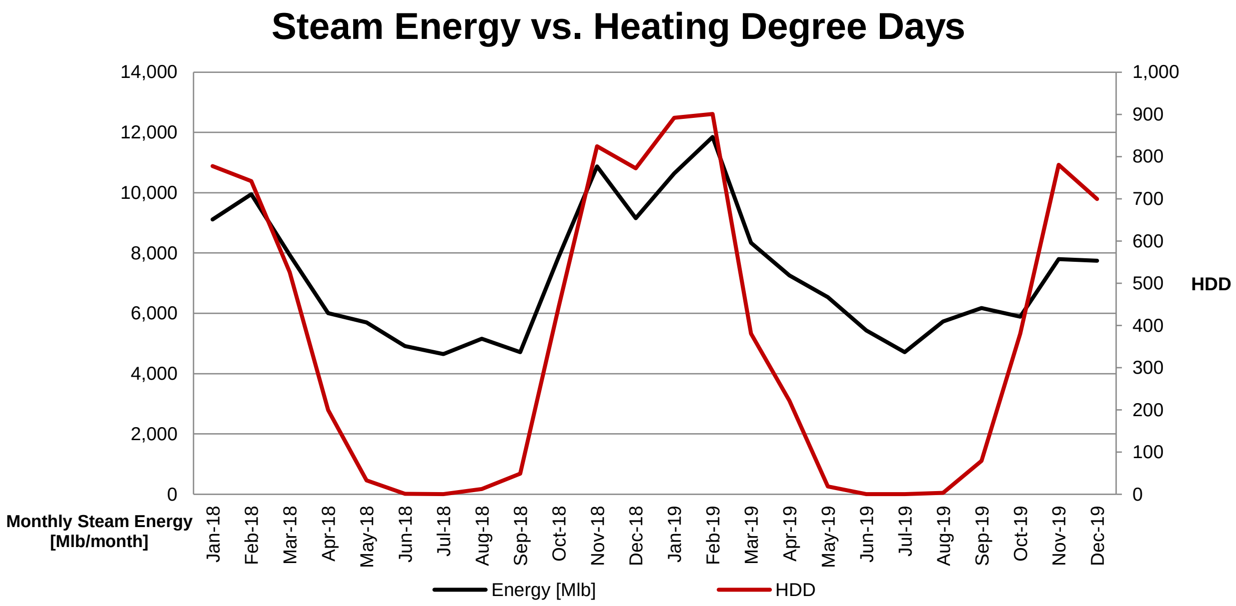


Total 2019 Consumption: 171,397,290 kBtu

BASELINE ENERGY MODEL

Steam

Year	Month	Energy [ConEd Mlb]	Days	HDD
2018	January	9,113	28	777
2018	February	9,954	32	742
2018	March	7,939	27	526
2018	April	6,005	29	200
2018	May	5,694	31	33
2018	June	4,914	29	1
2018	July	4,651	28	0
2018	August	5,159	31	13
2018	September	4,708	28	49
2018	October	7,873	29	444
2018	November	10,878	32	825
2018	December	9,150	29	772
2019	January	10,635	28	892
2019	February	11,849	32	901
2019	March	8,335	27	381
2019	April	7,262	29	222
2019	May	6,534	31	19
2019	June	5,433	29	0
2019	July	4,710	28	0
2019	August	5,731	31	3
2019	September	6,171	29	79
2019	October	5,884	28	381
2019	November	7,793	32	781
2019	December	7,742	29	699



Notes:

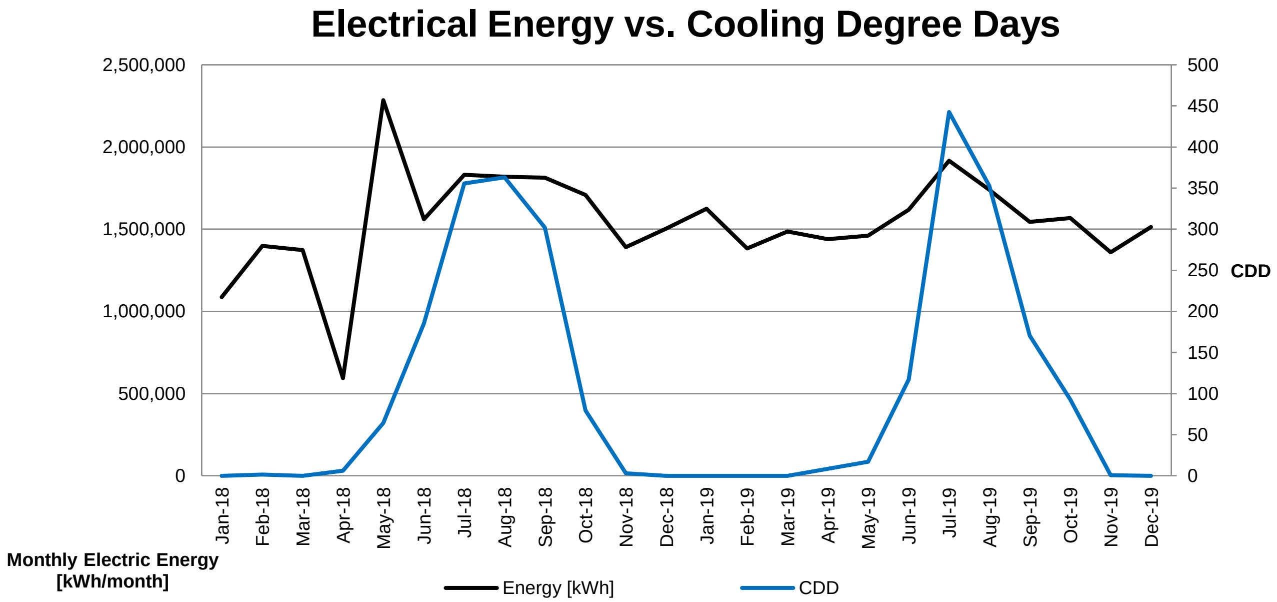
1. A regression analysis was utilized to develop a baseline energy model for heating end uses in the building. This analysis often allows the energy auditing team to better understand the facilities' heating energy profile and will form the analytical foundation for energy reduction analysis associated with ECMs impacting building heating loads.

2. **Insight:** The regression analysis shows that MoMA Main's steam profile follows an expected trajectory, with steam usage driven by outside air temperature in the winter and humidity control requirements year-round.

BASELINE ENERGY MODEL

Electricity

Year	Month	Energy [kWh]	Power [kW]	Days	CDD
2018	January	1,086,787	2,536	22	0
2018	February	1,397,600	2,556	29	2
2018	March	1,372,000	2,340	28	0
2018	April	593,600	2,649	30	6
2018	May	2,284,800	2,866	28	64
2018	June	1,559,200	3,000	29	186
2018	July	1,831,200	3,185	30	356
2018	August	1,818,400	3,218	28	363
2018	September	1,812,800	3,244	29	302
2018	October	1,707,200	3,070	31	80
2018	November	1,389,600	2,621	28	3
2018	December	1,503,200	2,827	30	0
2019	January	1,623,414	2,532	33	0
2019	February	1,383,200	2,575	29	0
2019	March	1,486,400	2,701	30	0
2019	April	1,438,400	2,651	28	9
2019	May	1,460,800	2,845	28	17
2019	June	1,618,400	3,015	29	117
2019	July	1,916,800	3,138	31	443
2019	August	1,738,400	3,079	28	353
2019	September	1,544,000	2,951	29	171
2019	October	1,567,200	2,856	31	93
2019	November	1,358,400	2,865	28	1
2019	December	1,513,600	2,502	32	0



Notes:

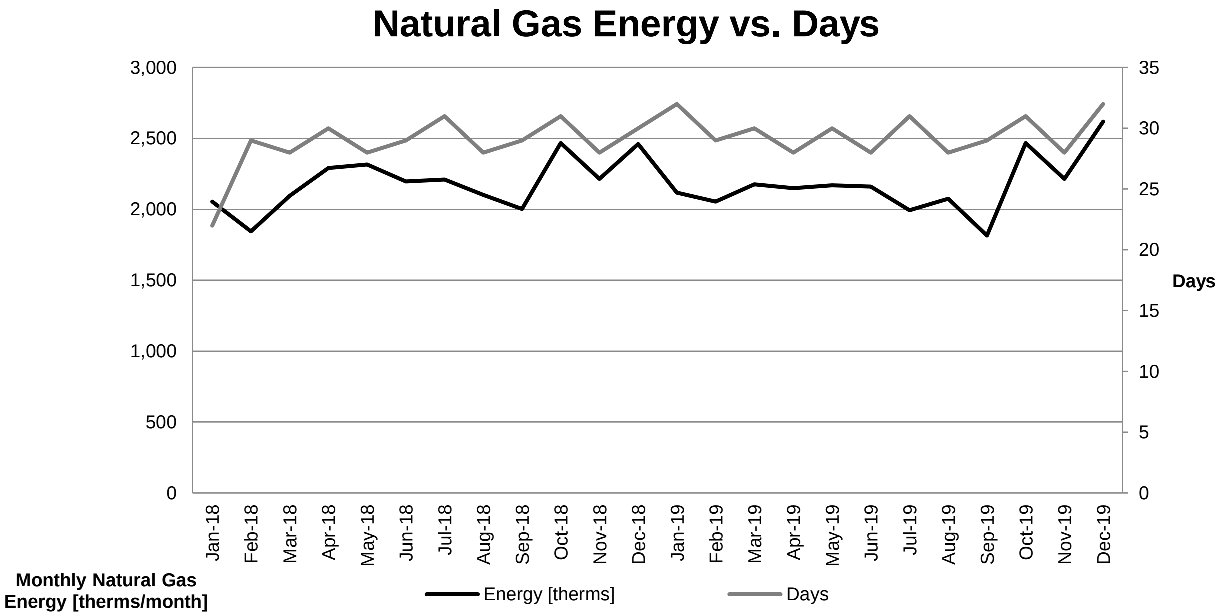
1. A regression analysis was utilized to develop a baseline energy model for cooling end uses in the building. This analysis often allows the energy auditing team to better understand the facilities' cooling energy profile and will form the analytical foundation for energy reduction analysis associated with ECMs impacting building cooling loads.

2. **Insight:** The regression analysis shows that MoMA's cooling energy profile is consistent year-round due to the stringent temperature and humidity requirements for Museum gallery spaces. Peaks in the summer months are due to additional cooling load as outside temperatures rise.

BASELINE ENERGY MODEL

Natural Gas

Year	Month	Energy [therm]	Days
2018	January	2,054	22
2018	February	1,844	29
2018	March	2,094	28
2018	April	2,291	30
2018	May	2,315	28
2018	June	2,197	29
2018	July	2,211	31
2018	August	2,101	28
2018	September	2,003	29
2018	October	2,467	31
2018	November	2,215	28
2018	December	2,461	30
2019	January	2,118	32
2019	February	2,054	29
2019	March	2,177	30
2019	April	2,150	28
2019	May	2,169	30
2019	June	2,160	28
2019	July	1,994	31
2019	August	2,074	28
2019	September	1,815	29
2019	October	2,467	31
2019	November	2,215	28
2019	December	2,619	32

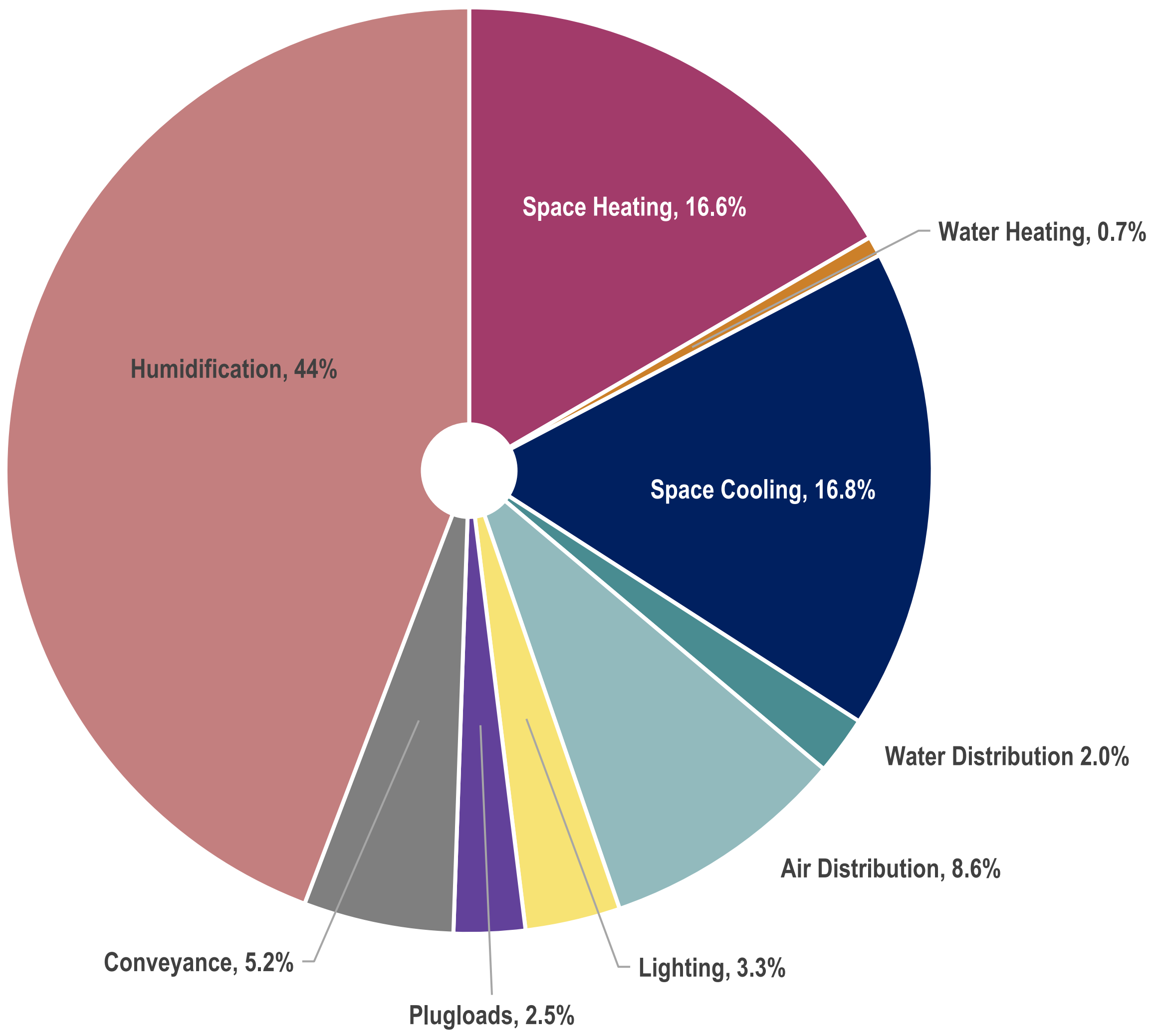


Notes:

1. A regression analysis was utilized to develop a baseline energy model for natural gas uses in the building. Natural gas is utilized for cooking in the museum's café.

2. **Insight:** The analysis shows that MoMA Main's cooking energy profile follows a typical trajectory and is driven by the number of days that the building's restaurant is open and operational.

Total 2019 Consumption by End Use



End Use	Energy Consumption (kBtu)	% Energy Consumption
Space Heating	28,373,022	16.6%
Water Heating	1,188,774	0.7%
Space Cooling	28,709,029	16.8%
Water Distribution	3,484,022	2.0%
Air Distribution	14,693,900	8.6%
Lighting	5,667,729	3.3%
Plug Loads	4,250,797	2.5%
Conveyance	8,942,825	5.2%
Humidification	75,566,439	44.1%

Notes:

1. The end use categories are based on ASHRAE Standard 211-2018 Guidelines.
2. Equipment runtimes are based on discussions with building staff and standard assumptions, along with a 2020 LL87 report, where applicable.
3. Humidification and space heating end uses require further refinement.

IAQ ONSITE SURVEY

AHU and Filtration Media Inventory

- Inventory includes fan data, coil data, pre & final filtration strategies, make and model of each SF & RF, duct dimensions, etc.
- Information will be used to determine feasibility of IAQ recommendations and to evaluate energy impact of IAQ measures.

Unit Number	Fan Info								
	Service	Floor	Room	VFD	Fan Manufacturer	Model Number Motor	ID/Serial Number Motor	Model Number Fan	Serial Number Fan
ACW-23	Level 11 Offices	11	11th Floor Core 1 MER	Yes	Trane	MOGB	BX08	MCCB021UA0B0UA	K02K59722A
ACW-24	Level 12 Offices	12	12th Floor Core 1 MER	Yes	Trane	MOGB	BX08	MCCB021UA0B0UB	K02K59709A
ACW-25	Level 13 Offices	13	13th Floor Core 1 MER	Yes	trane	N/A	N/A	MCCB021UA0B0UB	K02K59729A
ACW-26	Level 14 Offices	14	14th Floor Core 1 MER	Yes	Trane	M0GB	BX08	MCCB021UA0B0UB	K02K59750A
ACW-27	Level 15 Offices	15	15th Floor Core 1 MER	Yes	Trane	MOGB	BX07	MCCB021UA0B0UB	K02K59742A
ACW-28	Comm. & Elec. RM's, Mez, 1st, 2nd Floors	2	2nd Floor Core 1 Storage Room	Yes	Trane	X70380211010	9QM56T17D5346B P	BCVC054G1A0A1M03F	T02K73396
ACW-29	Interstitial Glass Space	Mezzanine	Central Plant	Yes	Trane	M0GB	BX05	MCCB008UA0B0UA	K02K56594A

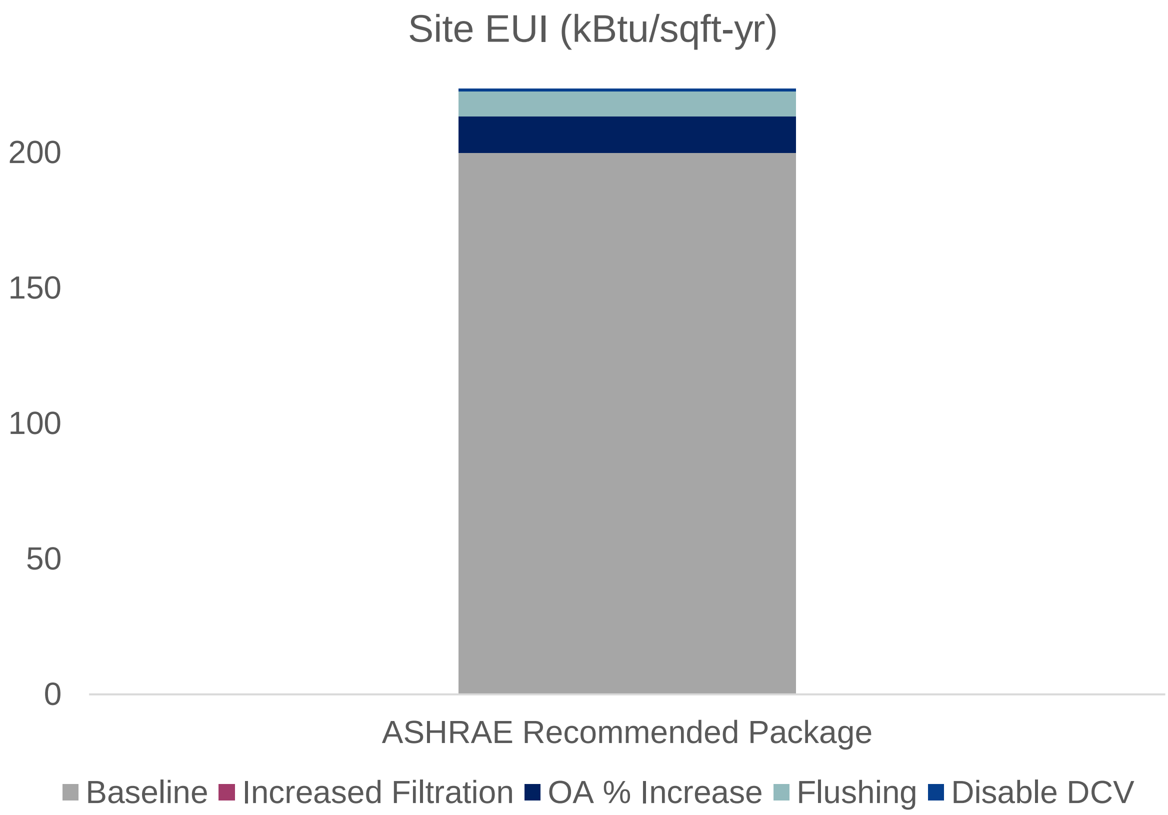
ASHRAE MINIMUM RECOMMENDATIONS

Overview

ASHRAE Minimum IAQ Recommendation	Feasible?	Notes and Comments
Increase in Air Filtration to minimum MERV-13	☑	• **Most airside systems at the facility already use a higher level of filtration (MERV-15/16) than the minimum recommendation due to art preservation requirements.** • AHUs already have the required final filtration rack assemblies within each unit (i.e. a 12" deep filter rack) to accommodate MERV-16 filtration where it does not already exist. • Fan systems can accept MERV-16 filters without increasing the motor size of the unit. • Filters are a Tier 1 upgrade as they directly remove particles within the airstream and are considered non-disruptive and cost efficient.
Increase in OA % to highest level possible during occupied hours without impacting interior comfort criteria	☑ (with limitations)	• **Due to the tight environmental control requirements of the museum space both in cooling and heating operation, there are limitations on increasing the outside air quantity of the AHU systems above current design levels.** • Museum spaces need a tightly controlled leaving air temperature setpoint from the AHUs in order to properly cool and dehumidify in the summer. • The heating season poses a similar issue with humidifying the airstream; increasing the outside air will strain the humidification capacity of the existing steam humidification and could cause internal RH% to be depressed. • Beyond the psychometric restrictions outlined above, the main MoMA campus also has an infrastructure limitation on the delivery of additional outside air: the AHUs located in the mezzanine and sub-cellar spaces are served by dedicated outside air fan systems, which have very limited capacity to supply additional outside air above current design criteria. • Even with replacement of the fans, the ductwork risers running through the buildings limit the OA air supply to the lower levels. • **With the higher level of filtration in the facility (MERV-15/16), increases in OA may not be necessary*.**
Disable Demand Controlled Ventilation (DCV)	☑	• Most airside systems have DCV capabilities which can be enabled and disabled from the Building Management system.
Flush building 2 hours before and 2 hours after occupancy	☑	• Programming may be implemented to "flush" the building 2 hours before and after occupancy at an additional 3 outside air changes.

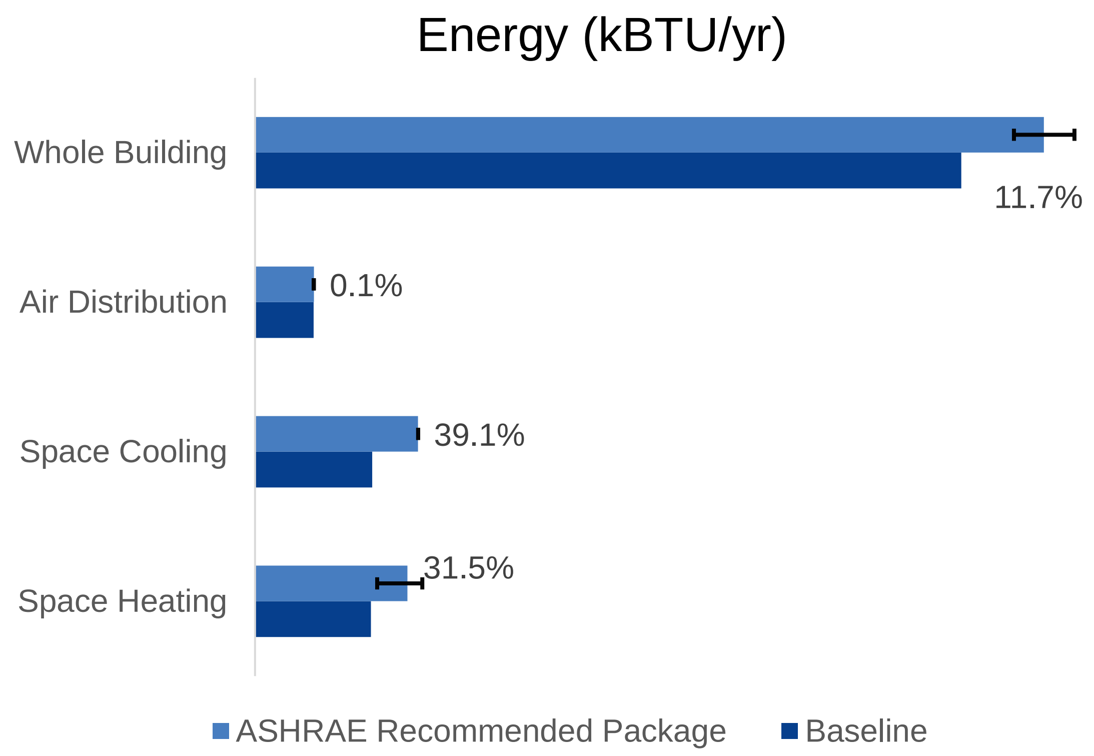
*Source: Azimi P, Stephens B. HVAC filtration for controlling infectious airborne disease transmission in indoor environments: Predicting risk reductions and operational costs. *Build Environ*. 2013;70:150-160. doi:10.1016/j.buildenv.2013.08.025

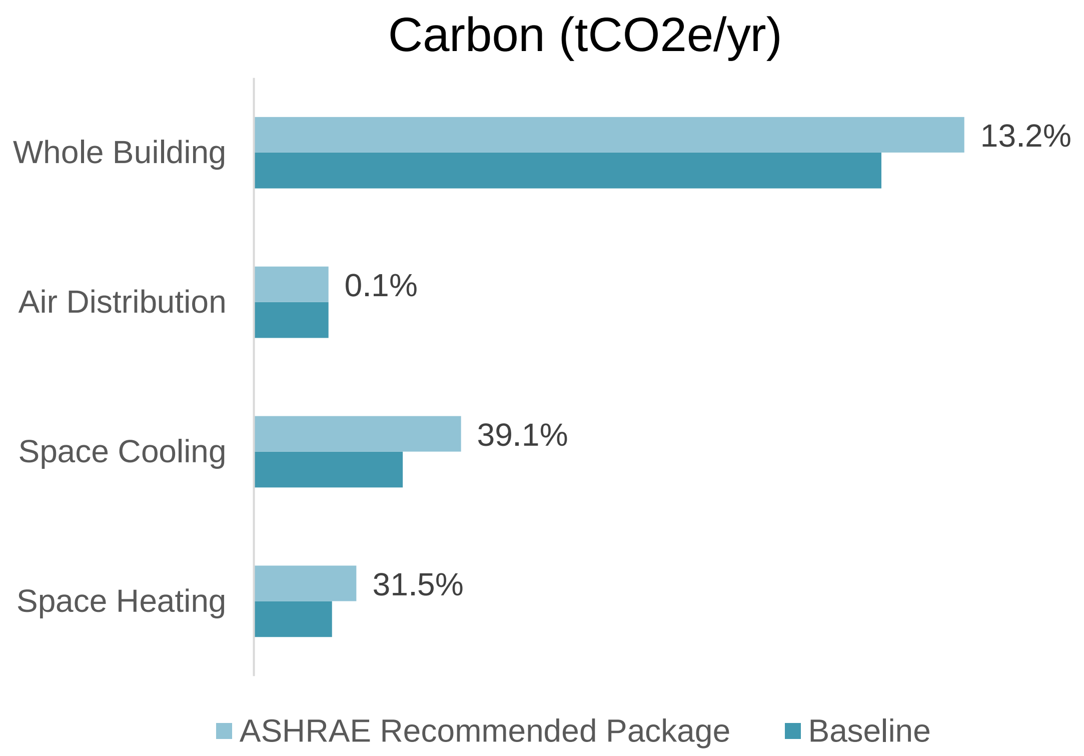
ASHRAE RECOMMENDED PACKAGE – SITE ENERGY INCREASE (NEW)



	Baseline	Projected Final
Site EUI	199.9	214.8 – 231.9

ASHRAE RECOMMENDED PACKAGE – % INCREASE BY END USE (NEW)

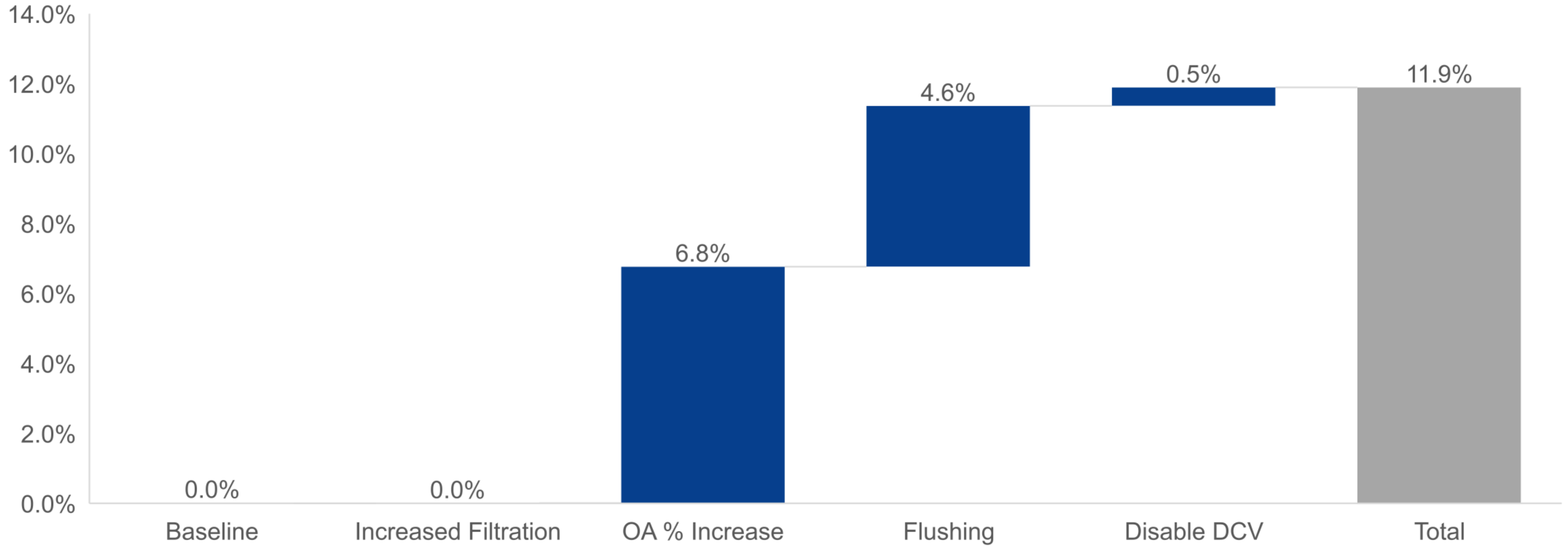




Whole Building	Space Heating	Space Cooling	Fans
+7.5 - 16.0%	+5.4 - 57.1%	+39.1%	+0.1%

Whole Building	Space Heating	Space Cooling	Fans
+13.2%	+31.5%	+39.1%	+0.1%

ASHRAE RECOMMENDED PACKAGE – AVERAGE ENERGY INCREASE BY MEASURE (NEW)



Increased Filtration	OA % Increase	Flushing	Disable DCV	Total
+0.0%	+3.9% - 9.2%	+1.2% - 1.9%	+0.3% - 1.0%	+5.4% - 12.1%

ASHRAE RECOMMENDED PACKAGE – MAXIMUM OA % INCREASE AND 2- HOUR FLUSHING (NEW)

ASHRAE Recommendation Package	Whole Building Energy Impact	Notes
Increased Filtration	0.0%	Increase to MERV 13
OA % Increase	3.9% - 9.2%	Average 21% to 52% OA increase **continuously reset** to maximize coil capacities.
Flushing	3.2% - 5.8%	2 hour flushing before and after occupancy
Disable DCV	0.3% - 1.0%	-
Total	**7.5% - 16.0%**	
Existing Building EUI	**199.9**	
Post ASHRAE Recommended Package EUI	**214.8 - 231.9**	

ALTERNATE PACKAGES – OVERVIEW & PRELIM RESULTS (NEW)

Strategy	ASHRAE Recommended Package	Alternate IAQ Enhancement Packages			
	Baseline	**EE Package 1**	**EE Package 2**	**EE Package 3**	**EE Package 4**
Filtration	MERV-13	MERV-16	MERV-13 (MERV-16, if UV-C is **NOT** feasible)	MERV-13	MERV-13
OA%	Maximized OA Adjustment	Design OA	Design OA	Design OA	30%
Flushing	2 hours before and after occupancy	3 OACH	3 OACH	3 OACH	3 OACH
UV	N/A	N/A	Central AHU **OR** Upper Room	N/A	N/A
Portable HEPA Units	N/A	N/A	N/A	4-6 Additional ACH	N/A
DCV	Disabled	Disabled	Disabled	Disabled	Disabled

ENERGY EFFICIENCY PACKAGE – OVERVIEW & PRELIM RESULTS (NEW)

Strategy	Energy/Carbon/Cost Impacts		
	Energy Increase	Carbon Increase	Utility Cost Increase
ASHRAE Recommended Package	+11.9%	+13.2%	+13.2%
EE Package 1	+1.9%	+2.6%	+2.8%
EE Package 2	+1.7%	+2.4%	+2.6%
EE Package 3	+2.1%	+2.9%	+3.2%
EE Package 4	+3.4%	+4.2%	+4.3%

NOTES, ASSUMPTIONS & RESOURCES

- Three (3) units were targeted for an increase in filtration. All other observed units have MERV-13 and above.
- Forty-one (41) of ninety-six (96) units are targeted for the OA % Increase, Flushing, or Disable DCV measures. Other units were are not targeted for the following reasons:
- The units serve mechanical or unoccupied space;
- Sufficient information about the equipment was not available onsite to support the analysis of these measures.
- Information regarding the original design conditions of the equipment was not available to support the analysis of these measures.
- Steam humidification impacts were not evaluated in the OA % Increase, Flushing, or Disable DCV measures due to limitations of the excel-based modeling tool.
- For the OA % Increase, Flushing, and DCV measures, constant year-round differences in supply and return temperatures were calculated for three different scenarios as a sensitivity analysis:
- 52°F supply air and 70°F return air
- 60°F supply air and 68°F return air
- 65°F supply air and 70°F return air
- During unoccupied periods, the units are assumed to resume their design OA %, rather than the increased OA % proposed in this study.

NOTES, ASSUMPTIONS & RESOURCES

- During unoccupied periods, the units are assumed to resume their design OA %, rather than the increased OA % proposed in this study.
- Resource: ASHRAE Standard 211-2018
- Resource: ASHRAE Epidemic Task Force guidance
  - Building Readiness (05/21/2020)
  - Commercial (04/20/2020)
  - Filtration & Disinfection (05/27/2020)
- Resource: Airborne Infection Risk (AIRC) and Ventilation Increase Impact (VII) Calculator v1.0 (07/2020)
- Existing LL87 Report (Kohler Ronan 2018-2019) utilized as a check on JB&B analysis.
- Existing documentation from MoMA Expansion project (JB&B design).
- Energy Star Portfolio for Utility Data (Con Ed benchmarking link enabled).
- Existing schedule sheets utilized for Energy Use Breakdown.
- Con Ed Facility Assessment Report (07/2020) reviewed for additional EEM opportunities.
- Azimi P, Stephens B. HVAC filtration for controlling infectious airborne disease transmission in indoor environments: Predicting risk reductions and operational costs. Build Environ. 2013;70:150-160. doi:10.1016/j.buildenv.2013.08.025

NEXT STEPS (NEW)

- Expected DRAFT for Final Report Delivery to MoMA Main and NYSERDA by 11/15.
- Study at MoMA Main is substantially complete.

MOMA QNS

MOMA QNS

Overview

- Building Name: The Museum of Modern Art Queens (MoMA QNS)
- Building Location: 45-20 33rd Street, Long Island City, QNS
- Building Typology: Art Storage/Industrial | Non-Profit | Owner-Occupied
- Occupancy Types: Storage, Office
- Size: 140,000 sqft
- Operating Hours: 10:00 AM – 5:00 PM Thursday through Monday & 10:00 AM – 7:45 PM Friday
- Systems Impacting IAQ:
  - Dedicated outdoor air unit for ventilation air connected to indoor variable air volume air handling units | DX rooftop units
  - Air filtration strategy (art storage/preservation): MERV 8 pre-filter, MER 14 first stage particulate filter, MERV 15 dual pass gaseous phase filters, MERV 15 final filter
  - No airside energy recovery
- Other Notes/Information:
  - Art storage spaces have stringent temperature & humidity criteria for preservation of the art: 70°F ±2°F and 50% ±5% RH in accordance with an ASHRAE AA Preservation Category. The Library Stacks is considered a specialty zone, which must maintain 65°F ±2°F and 35% ±5% RH

MOMA QNS TASK LIST STATUS

Data Collection & Review

- ☑ Minimum 12-Months Pre-COVID Utility Data
- ☑ Existing Building MEP Drawings
- ☑ BMS Sequence of Ops
- ☑ Conduct Preliminary Site Walkthrough
- ☑ Conduct Operator Interviews

Develop Baseline Energy Model

- ☑ Total Annual Energy Use Breakdown by End Use
- ☑ Benchmark Building
- ☑ Develop Preliminary ECMs

Site Survey & Energy Efficient IAQ Recommendations

- ☑ Conduct Detailed Site Visits
- ☑ Develop Filtration and Airside Equipment Operation Log
- ☑ Develop IAQ Recommendations
- ☑ Refine Preliminary ECMs

Energy Efficient IAQ Energy Analysis

- ☑ ASHRAE Recommendations Energy Model
- ☑ Energy Efficiency Model

Economic Analysis

- ☑ Develop Design Document for Cost Estimator
- ☑ Collect Cost Estimates
- ☑ Conduct Economic Analysis

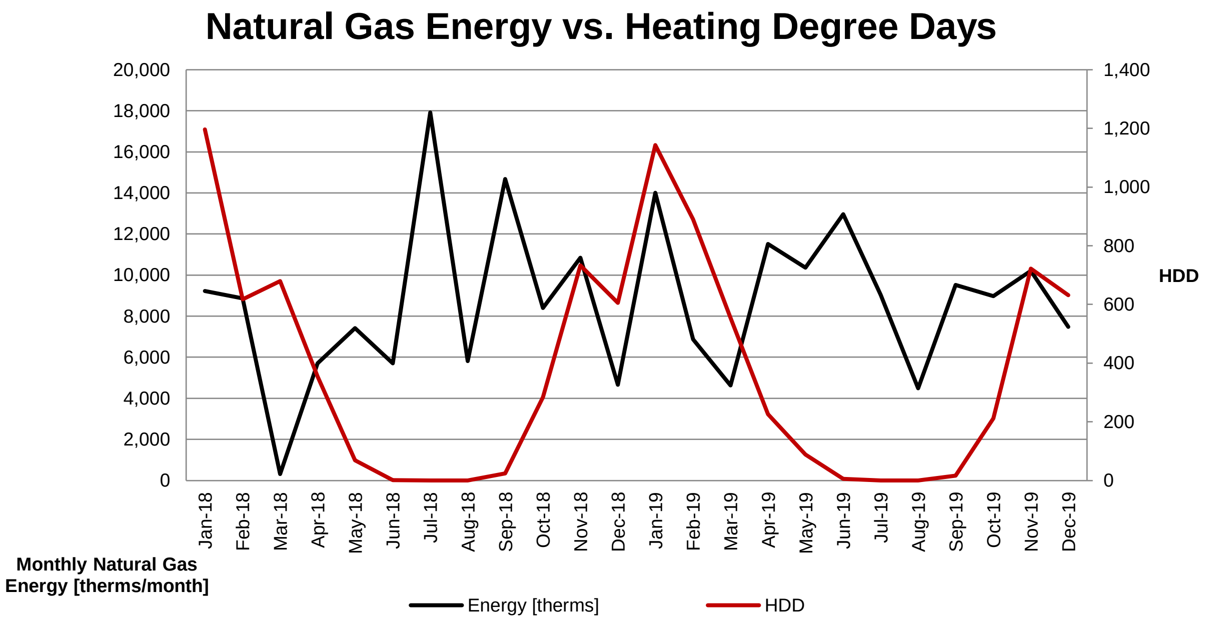
Final Reporting

- ☐ Final Report **(In Progress)**
- ☐ Case Study Documentation **(In Progress)**

BASELINE ENERGY MODEL

Natural Gas

Year	Month	Energy [therms]	Days	HDD
2018	January	9,219	36	1,196
2018	February	8,862	29	617
2018	March	308	28	680
2018	April	5,711	30	355
2018	May	7,421	29	69
2018	June	5,708	30	2
2018	July	17,922	30	0
2018	August	5,814	29	0
2018	September	14,684	28	24
2018	October	8,398	28	284
2018	November	10,850	33	734
2018	December	4,655	24	605
2019	January	14,007	36	1,143
2019	February	6,870	29	891
2019	March	4,630	30	554
2019	April	11,515	28	226
2019	May	10,355	29	89
2019	June	12,956	31	5
2019	July	9,039	28	0
2019	August	4,486	29	0
2019	September	9,520	28	16
2019	October	8,973	30	212
2019	November	10,209	31	723
2019	December	7,474	24	631



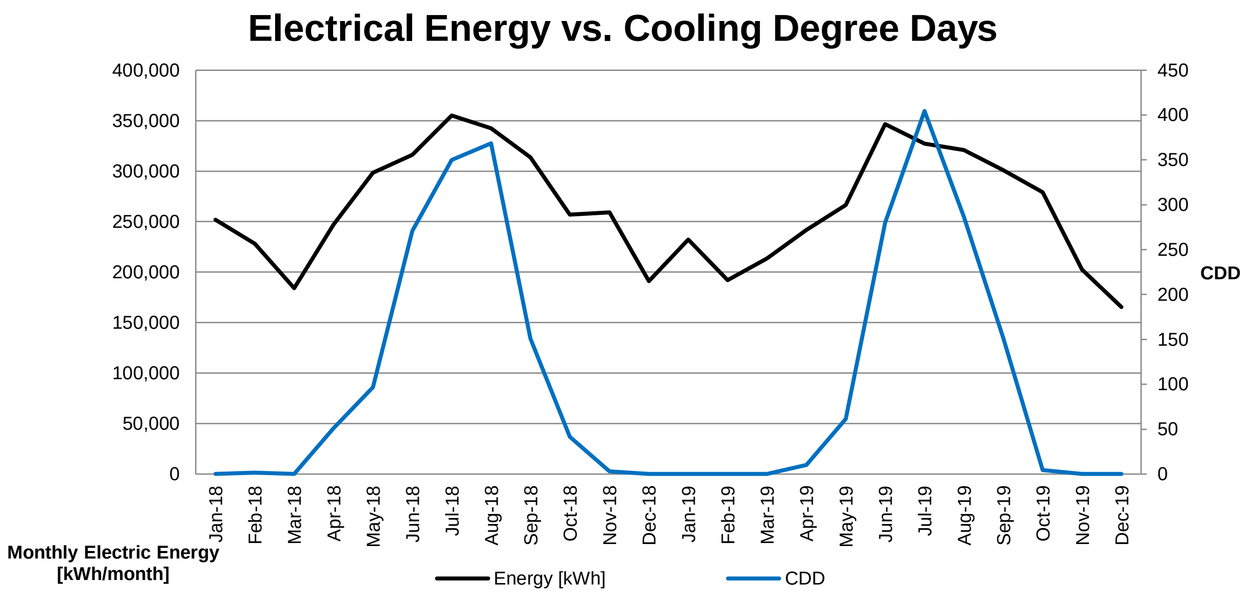
Notes:

1. A regression analysis was utilized to develop a simplified energy model for heating end uses in the building.
2. **Insight:** The regression analysis shows that MoMA QNS's heating energy profile follows a typical trajectory and is driven by outside air temperature. Additional investigation into peaks will be required. May need to run regression analysis based on OA RH instead of OA temp since NG is used to generate steam for humidification and space heating.

BASELINE ENERGY MODEL

Electricity

Year	Month	Energy [kWh]	Days	CDD
2018	January	251,819	35	0
2018	February	228,000	29	2
2018	March	184,000	28	0
2018	April	247,200	30	51
2018	May	298,400	29	97
2018	June	316,000	29	271
2018	July	355,200	30	350
2018	August	342,400	29	369
2018	September	313,600	28	151
2018	October	256,800	28	42
2018	November	259,200	33	3
2018	December	190,968	25	0
2019	January	232,232	35	0
2019	February	192,000	29	0
2019	March	213,600	31	0
2019	April	241,600	28	10
2019	May	266,400	29	62
2019	June	346,400	31	280
2019	July	327,200	28	405
2019	August	320,800	29	287
2019	September	300,800	28	152
2019	October	279,200	30	5
2019	November	202,400	31	0
2019	December	165,368	24	0



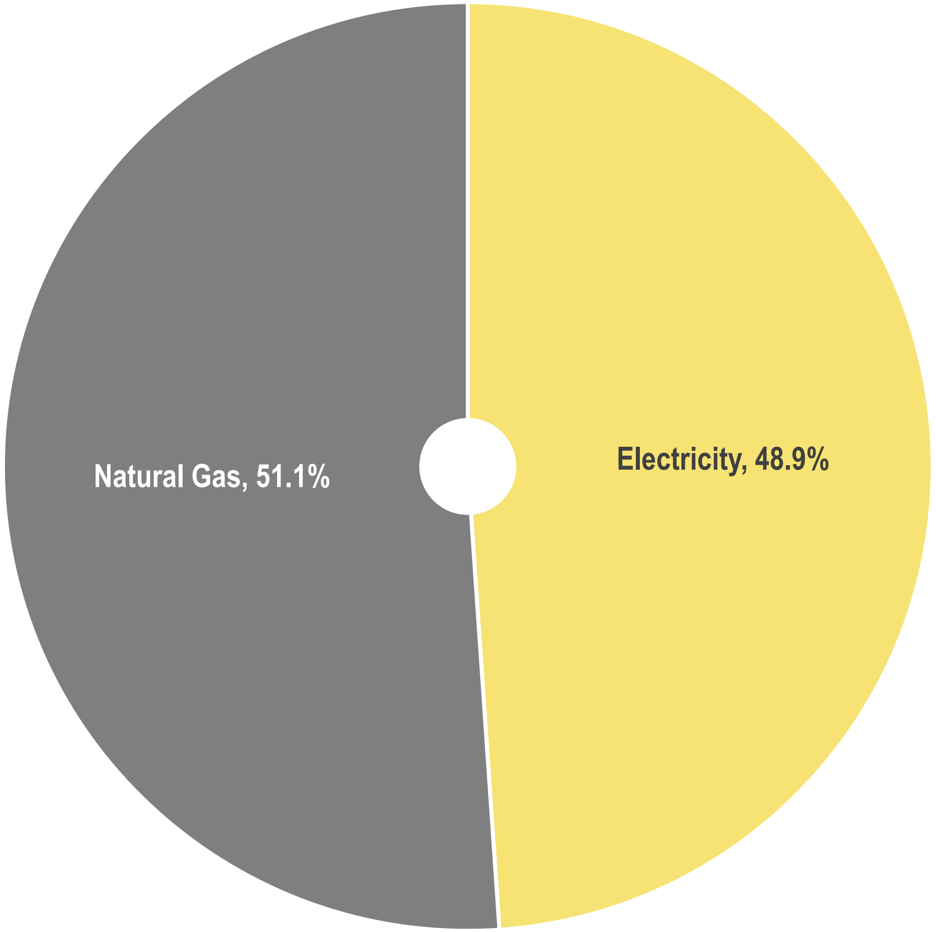
Notes:

1. A regression analysis was utilized to develop a baseline energy model for cooling end uses in the building.

2. **Insight:** The regression analysis shows that MoMA QNS cooling energy profile is consistent year-round due to the stringent temperature and humidity requirements for Museum gallery and art storage spaces.

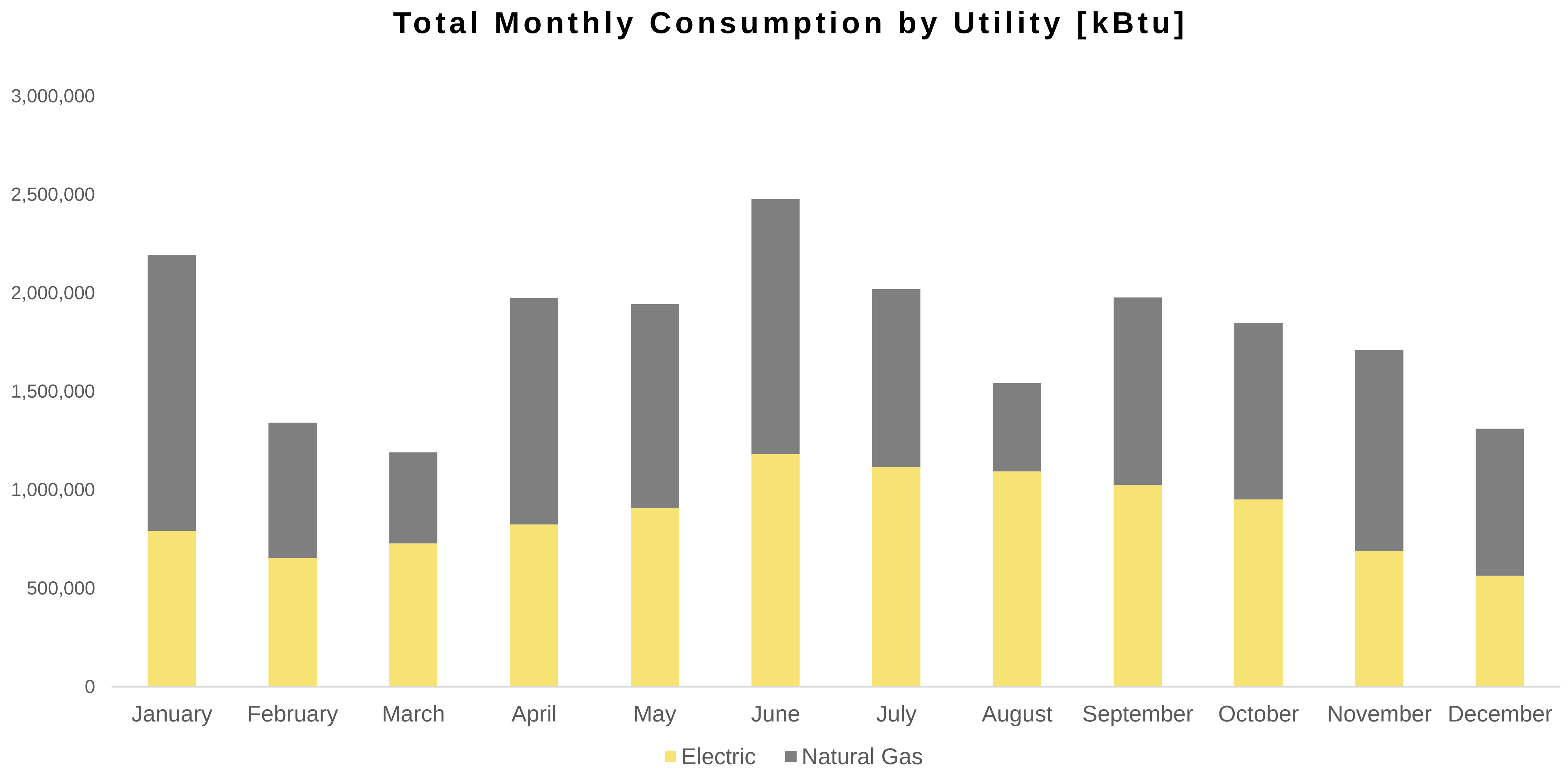
BASELINE ENERGY MODEL

Total Regression Based 2019 Consumption by Utility



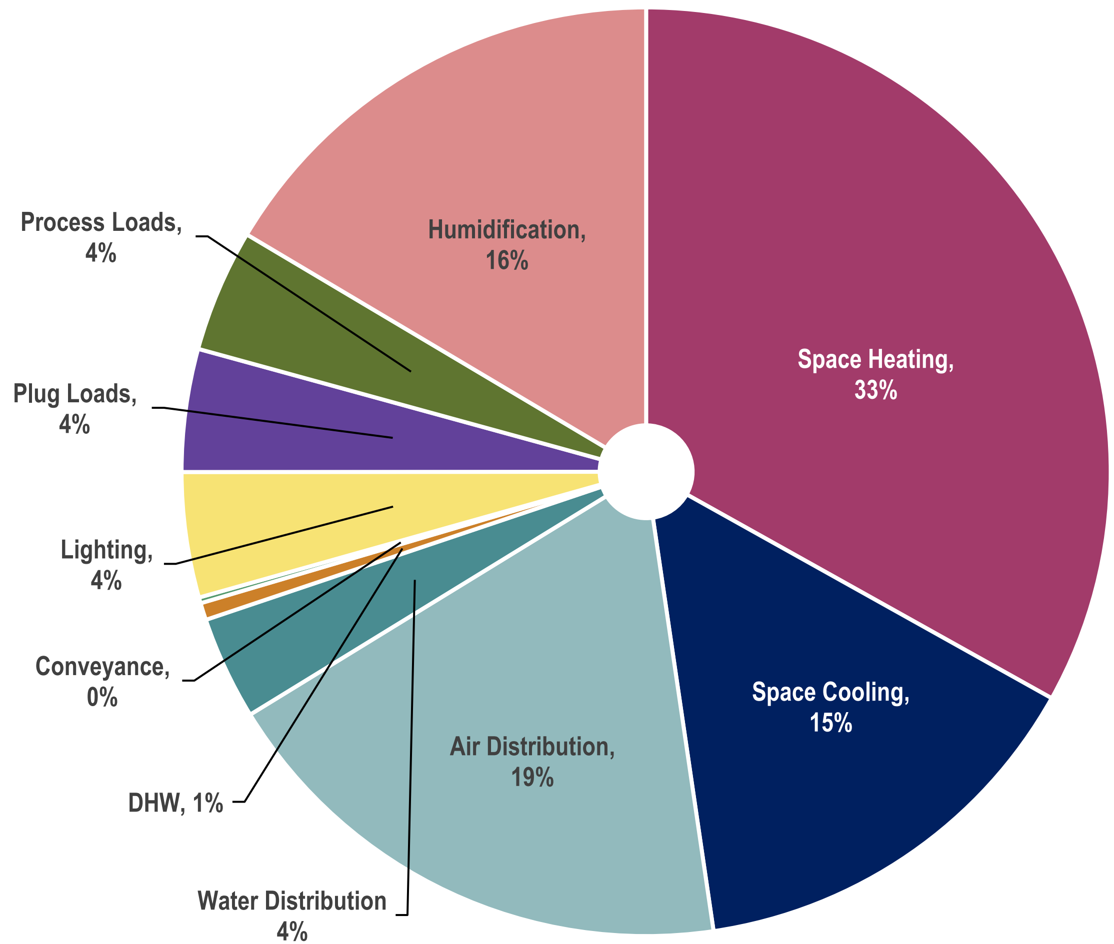
Energy Source	Energy Consumption [kBTUs]	% Energy Consumption
Electricity	10,536,256	48.9%
Natural Gas	11,003,594	51.1%

BASELINE ENERGY MODEL



Total 2019 Consumption: 21,539,850 kBtu

Total 2019 Consumption by End Use



End Use	Energy Consumption (kBtu)	% Energy Consumption
Space Heating	7,376,459	33.2%
Space Cooling	3,246,275	14.6%
Air Distribution	4,134,779	8.6%
Water Distribution	800,678	3.6%
Water Heating	133,000	0.6%
Conveyance	45,000	0.2%
Lighting	971,000	4.4%
Plug Loads	952,000	4.3%
Process Loads	952,000	4.3%
Humidification	3,667,867	16.5%

Notes:

1. The end use categories are based on ASHRAE Standard 211-2018 Guidelines.
2. Equipment runtimes are based on discussions with building staff and standard assumptions, along with a 2020 LL87 report, where applicable.

IAQ ONSITE SURVEY

AHU and Filtration Media Inventory

- Inventory includes fan data, coil data, pre & final filtration strategies, make and model of each SF & RF, duct dimensions, etc.
- Information will be used to determine feasibility of IAQ recommendations and to evaluate energy impact of IAQ measures.

Unit Number	Unit Model	Unit Serial	Fan Info									
			Service	Room	Type	VFD	Motor Manufacturer	Model Number Motor	ID Number Motor	Model Number Fan	Serial Number Fan	
AC-1L-1	Ventrol ITF VC22-74/102-I2	10277-01	Collection I	Sub-Cellar MER		Yes	Weg Nema Premium	025180T3E284TF2	06MAR2017 1035562622			
AC-1L-2	Ventrol ITF VCC22-74/102-I2	10277-02	Collection II	Sub-Cellar MER		Yes	Weg Nema Premium	025180P3E284T	135ET06 BY26056			
AC-1L-4	Ventrol ITF VC22-74/81-I2	10277-04	Shops	Cellar MER		Yes	Baldor SuperE	EM2515T	39K057W915			
AC-1L-5	Ventrol ITF VCC22-74/102-I2	10277-05	Office Area	Cellar MER		Yes	Nidec Motor Corporation	FP91	A 10 962454-0001 M 0004			
AC-2L-1	Ventrol ITF VC30-108/118-I2	10277-06	Exhibition Area	Cellar MER	Centrifugal	Yes	GE	5KE324AC220	7440150098	9V1223 120	ACF/PLR/FAN CLASS I-III	
AC-2L-2	Ventrol ITF VC30-105/129-I2	10277-07	Lobby/Safe Area	Sub-Cellar MER	Centrifugal	Yes	GE	5KE326AC220	7441250056	9V1223 130	ACF/PLR/FAN CLASS I-III	
AC-2L-3	Ventrol ITF VC27-87/107-I2	10277-08	Exhibition/Conservation	Cellar MER	Centrifugal	Yes	Baldor SuperE	EFM2539T	Z0104050239			
AC-2L-4	Ventrol ITF VCC22-72/78-I2	10277-09	Paper Collection	Cellar MER		Yes	Dayton	4GZC4	ASGH OG			
AC-C-1	Ventrol		Corridor	Roof		Yes	Hengshui Electric Motors	PB0254FB6	PB0254FBAPI27002			
AC-2L-5			Offices	Roof	Centrifugal	Yes	Baldor SuperE	EM3311T 37F614Y663	F0011080960			
AC-OA-1			AC Units	Roof	Centrifugal	Yes	Toshiba	24AW27	S65226110			
AC-LS-1	Purafil 000143 04	E01-3040	Library Stacks	Roof		Yes	No Access	No Access	No Access			

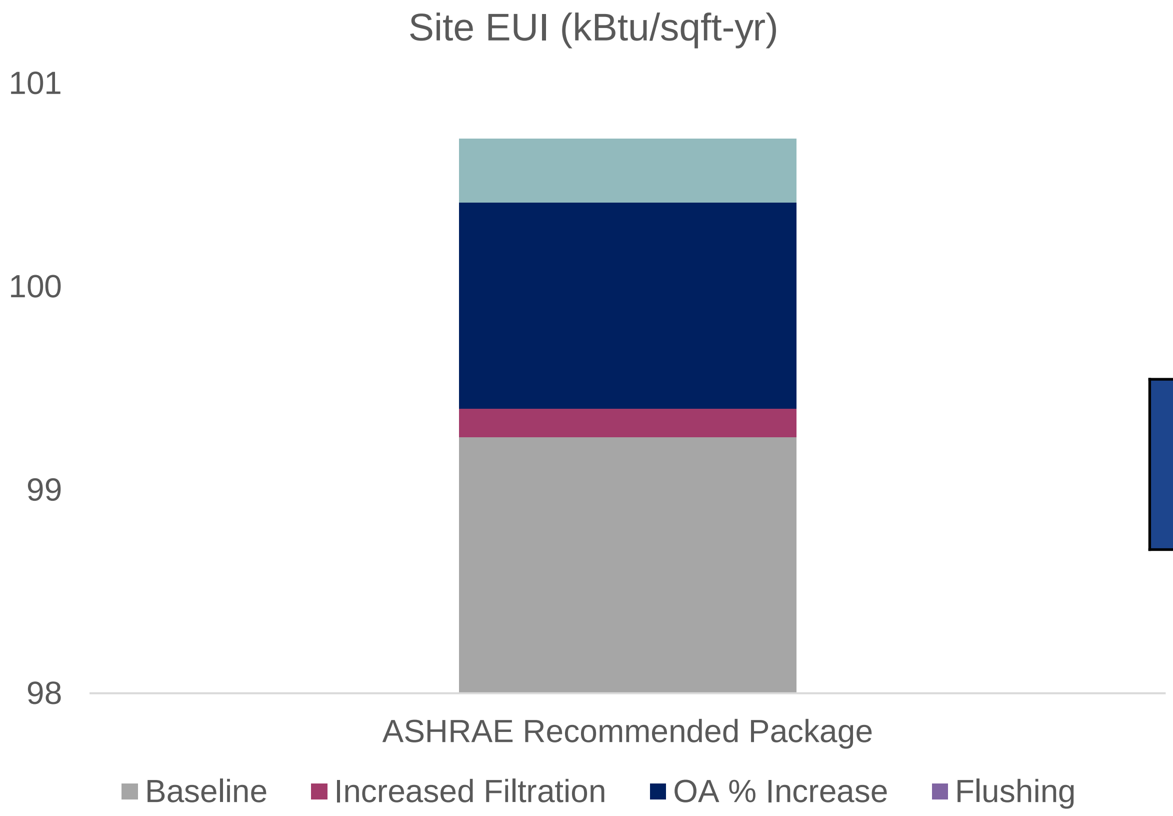
ASHRAE MINIMUM RECOMMENDATIONS

Overview

ASHRAE Minimum IAQ Recommendation	Feasible?	Notes and Comments
Increase in Air Filtration to minimum MERV-13	☑	• **Most airside systems at the facility already use a higher level of filtration (MERV-15) than the minimum recommendation due to art preservation requirements.** • AHUs already have the required final filtration rack assemblies within each unit (i.e. a 12" deep filter rack) to accommodate MERV-16 filtration where it does not already exist. • Fan systems can accept MERV-16 filters without increasing the motor size of the unit. • Filters are a Tier 1 upgrade as they directly remove particles within the airstream and are considered non-disruptive and cost efficient.
Increase in OA % to highest level possible during occupied hours without impacting interior comfort criteria	☑ (with limitations)	• **Due to the tight environmental control requirements of the museum space both in cooling and heating operation, there are limitations on increasing the outside air quantity of the AHU systems above current design levels.** • Museum spaces need a tightly controlled leaving air temperature setpoint from the AHUs in order to properly cool and dehumidify in the summer. • The heating season poses a similar issue with humidifying the airstream; increasing the outside air will strain the humidification capacity of the existing steam humidification and cause internal RH% to be depressed.
Disable Demand Controlled Ventilation (DCV)	☑	• Most airside systems have DCV capabilities which can be enabled and disabled from the Building Management system.
Flush building 2 hours before and 2 hours after occupancy	☑	• Programming may be implemented to "flush" the building 2 hours before and after occupancy.

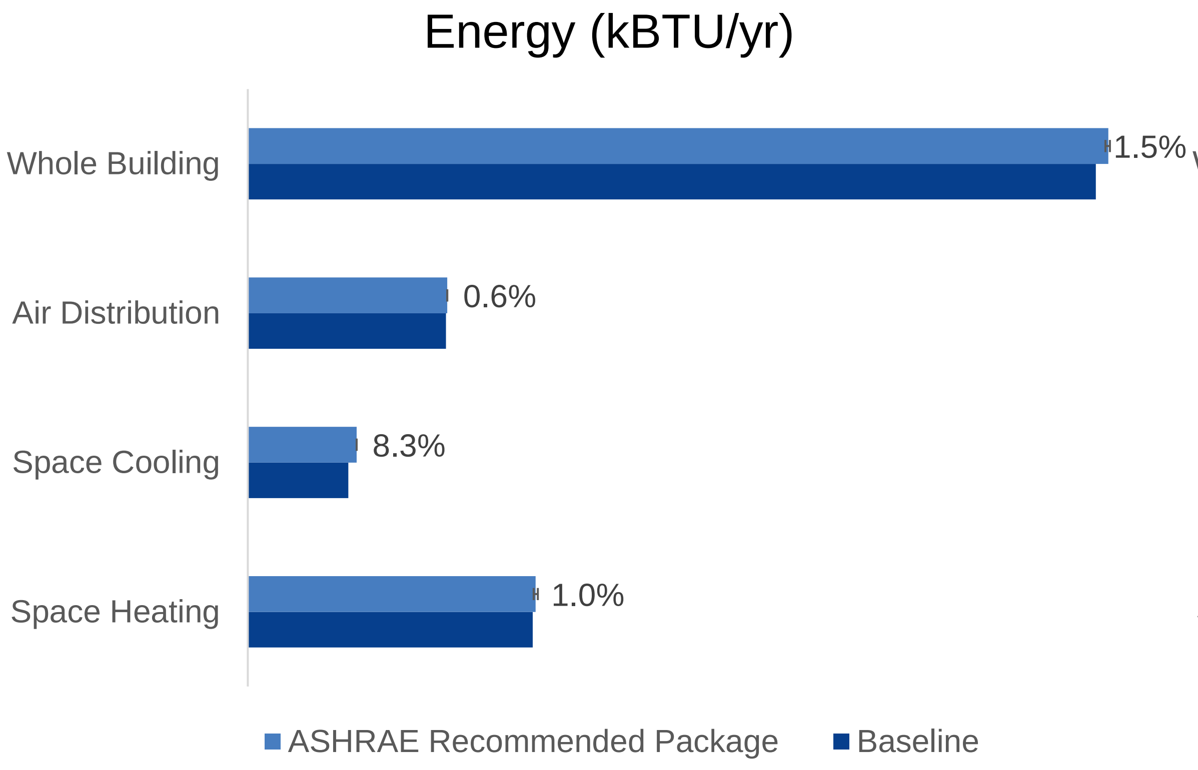
*Source: Azimi P, Stephens B. HVAC filtration for controlling infectious airborne disease transmission in indoor environments: Predicting risk reductions and operational costs. *Build Environ*. 2013;70:150-160. doi:10.1016/j.buildenv.2013.08.025

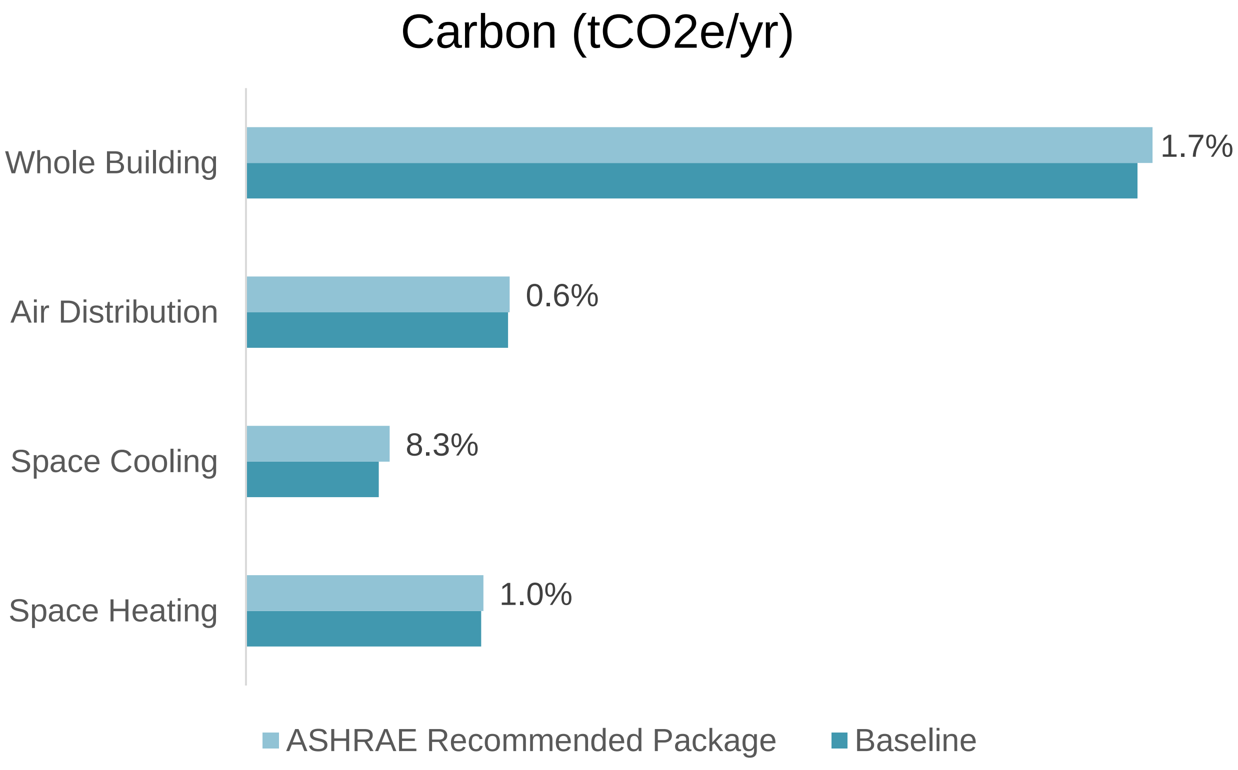
ASHRAE RECOMMENDED PACKAGE – ENERGY INCREASE BY EUI (NEW)



	Baseline	Projected Final
Site EUI	99.2	100.4 – 101.0

ASHRAE RECOMMENDED PACKAGE – INCREASES BY END USE (NEW)

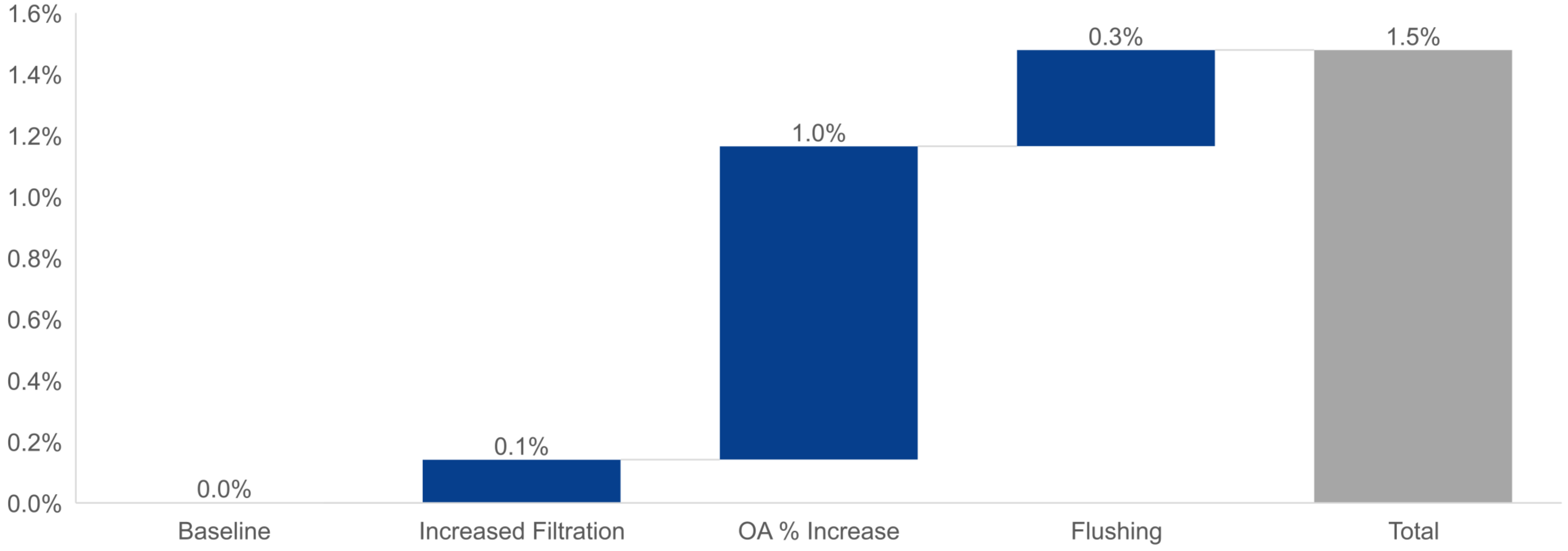




Whole Building	Space Heating	Space Cooling	Fans
+1.2% - 1.7%	+0.1% - 1.8%	+8.3%	+0.6%

Whole Building	Space Heating	Space Cooling	Fans
+1.7%	+1.0%	+8.3%	+0.6%

ASHRAE RECOMMENDED PACKAGE – AVERAGE ENERGY INCREASE BY MEASURE (NEW)



Increased Filtration	OA % Increase	Flushing	Total
+0.1%	+0.8% - 1.2%	+0.2% - 0.4%	+1.2% - 1.7%

ASHRAE RECOMMENDED PACKAGE – SUMMARY TABLE (NEW)

ASHRAE Recommendation Package	Whole Building	Notes
Increased Filtration	0.1%	MERV 13 Filtration
OA % Increase	0.8% - 1.2%	Average 7% to 11% OA increase **continuously reset** to maximize coil capacities.
Flushing	0.2% - 0.4%	2 hour flushing before and after occupancy
Disable DCV	N/A	No DCV in the building
Total	**1.2% - 1.7%**	
Existing Building EUI	**99.2**	
Post ASHRAE Recommended Package EUI	**100.4 - 101.0**	

ENERGY EFFICIENCY PACKAGES – OVERVIEW & PRELIM RESULTS (NEW)

Strategy	ASHRAE Recommended Package	Alternate Energy Efficient IAQ Enhancement Packages			
	Baseline	**EE Package 1**	**EE Package 2**	**EE Package 3**	**EE Package 4**
Filtration	MERV-13	MERV-16	MERV-13 (MERV-16, if UV-C is **NOT** feasible)	MERV-13	MERV-13
OA%	11%	Design OA	Design OA	Design OA	Design OA
Flushing	2 hours before and after occupancy	3 OACH	3 OACH	3 OACH	3 OACH
UV	N/A	N/A	Central AHU **OR** Upper Room	N/A	N/A
Portable HEPA Units	N/A	N/A	N/A	4-6 Additional ACH	N/A
DCV	N/A	N/A	N/A	N/A	N/A

ENERGY EFFICIENCY PACKAGE – OVERVIEW & PRELIM RESULTS (NEW)

Strategy	Energy/Carbon/Cost Impacts		
	Energy Increase	Carbon Increase	Utility Cost Increase
ASHRAE Recommended Package	+1.5%	+1.7%	+2.1%
EE Package 1	+2.2%	+2.7%	+3.9%
EE Package 2	+0.5%	+0.6%	+1.9%
EE Package 3	+1.2%	+1.4%	+6.2%
EE Package 4	+1.4%	+1.7%	+2.1%

NOTES, ASSUMPTIONS & RESOURCES

- Four (4) units are targeted for the additional filtration measure. All other observed units had MERV 13 and above.
- Eleven (11) of fifteen (15) units are targeted for the OA % Increase, Flushing, or Disable DCV measures. The other units are not targeted because they either: serve mechanical or unoccupied space; there was limited access available on-site to gather sufficient information; or, there was limited information regarding the original design conditions to compare with the observations identified on-site.
- To compare like units, they were bucketed into several categories to simplify calculations: Exhibits, Offices, Archives and Industrial Spaces
- The change in steam humidification was not calculated for the OA % Increase, Flushing, or Disable DCV measures.
- For the OA % Increase, Flushing, and DCV measures, constant year-round differences in supply and return temperatures were calculated for three different scenarios, which gives the range of potential energy increases.
  - The ranges are as follows: 74°F supply air and 68°F return air, 65°F supply air and 68°F return air, 65°F supply air and 70°F return air.
- During unoccupied periods, the units are assumed to resume their design OA %, rather than the increased OA % proposed in this study

NOTES, ASSUMPTIONS & RESOURCES

- Resource: ASHRAE Standard 211-2018
- Resource: ASHRAE Epidemic Task Force guidance
  - Building Readiness (05/21/2020)
  - Commercial (04/20/2020)
  - Filtration & Disinfection (05/27/2020)
- Resource: Airborne Infection Risk (AIRC) and Ventilation Increase Impact (VII) Calculator v1.0 (07/2020)
- Existing LL87 Report (Kohler Ronan 2018-2019) utilized as a check on JB&B analysis.
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NEXT STEPS (NEW)

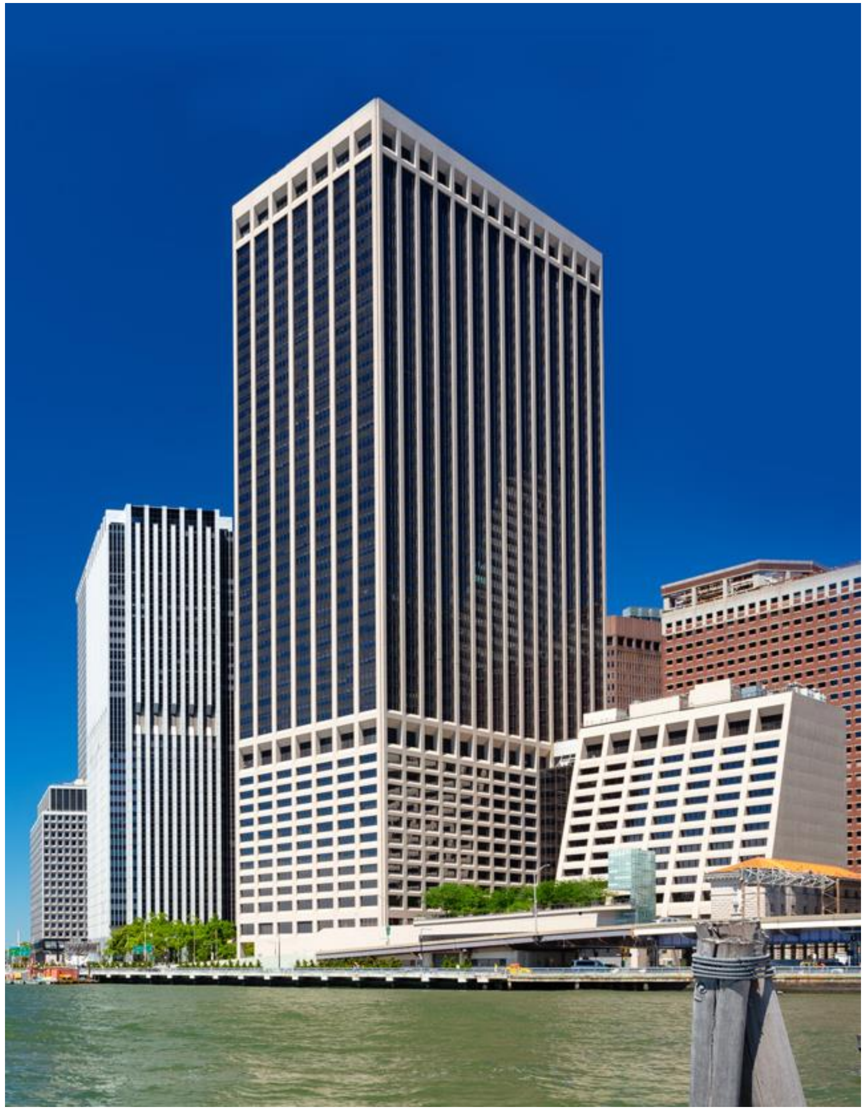
- Expected DRAFT for Final Report Delivery to MoMA QNS and NYSERDA by 11/15.
- Study at MoMA Main is substantially complete.

55 WATER STREET

55 WATER STREET

Overview

- Building Name: 55 Water Street
- Building Location: 55 Water Street, New York, NY
- Building Typology: Commercial Office
- Occupancy Types: Office, Retail, Cafeteria
- Size: 3.5 million sqft
- Operating Hours: 8:00 AM – 5:00 PM Monday through Friday | 8:00 AM – 12:00 PM Saturday
- Systems Impacting IAQ:
  - Variable Air Volume Central Air Handling Systems (various configurations & vintages)
  - Perimeter Induction Units
  - MERV 13/14 Filtration Strategy Upgraded to MERV 15/16
  - No Demand Control Ventilation
  - No Energy Recovery



55 WATER STREET TASK LIST STATUS

Data Collection & Review

- ☑ Minimum 12-Months Pre-COVID Utility Data
- ☑ Existing Building MEP Drawings
- ☑ BMS Sequence of Ops
- ☑ Conduct Preliminary Site Walkthrough
- ☑ Conduct Operator Interviews

Develop Baseline Energy Model

- ☑ Total Annual Energy Use Breakdown by End Use
- ☑ Benchmark Building
- ☑ Develop Preliminary ECMs

Site Survey & Energy Efficient IAQ Recommendations

- ☑ Conduct Detailed Site Visits
- ☑ Develop Filtration and Airside Equipment Operation Log
- ☑ Develop IAQ Recommendations
- ☑ Refine Preliminary ECMs

Energy Efficient IAQ Energy Analysis

- ☑ ASHRAE Recommendations Energy Model
- ☑ Energy Efficiency Model

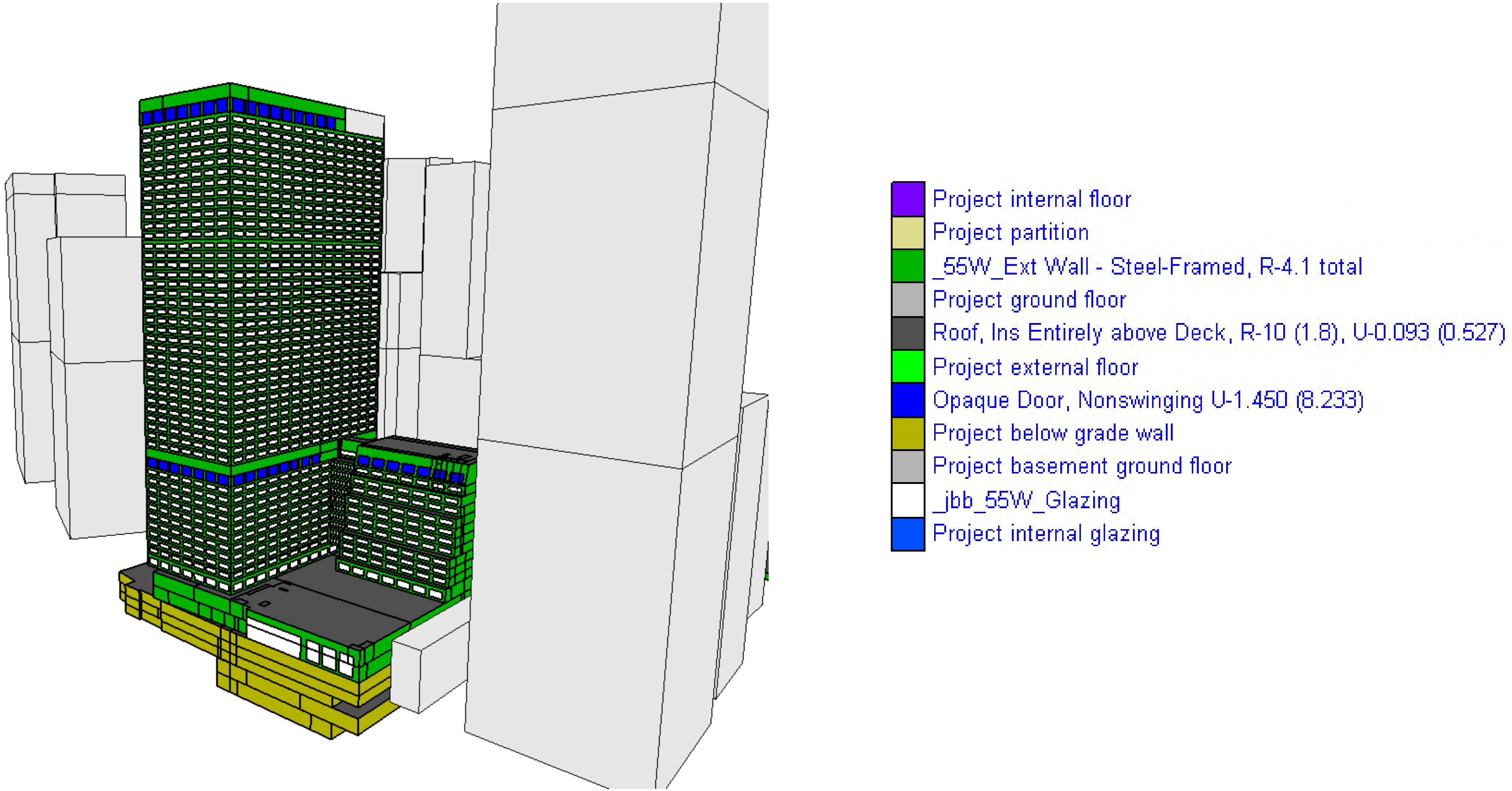
Economic Analysis

- ☑ Collect Cost Estimates
- ☑ Conduct Economic Analysis

Final Reporting

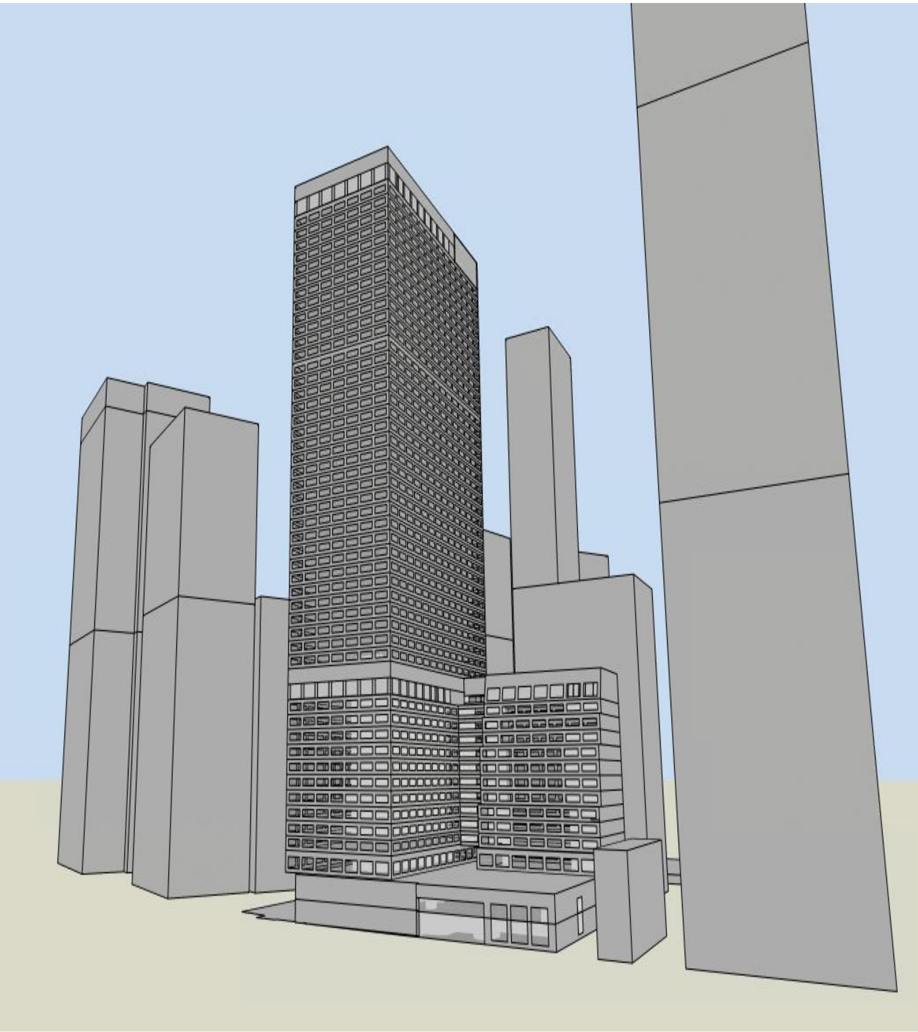
- ☐ Final Report **(In Progress)**
- ☐ Case Study Documentation

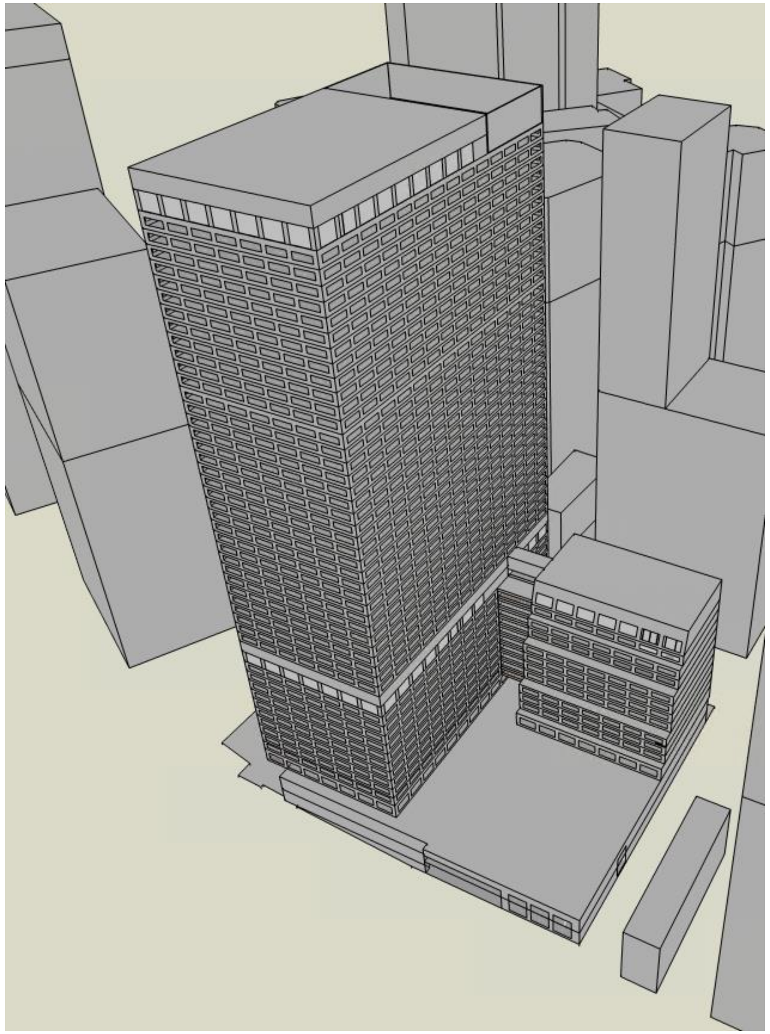
DESIGNBUILDER® MODEL

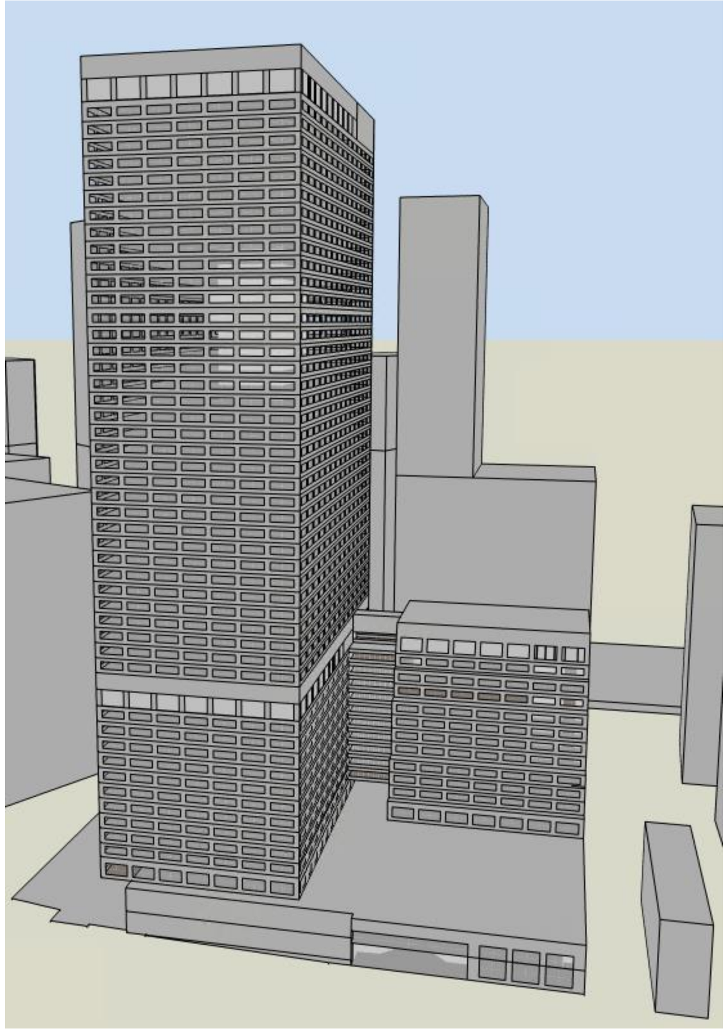


*Existing Calibrated Energy Model built in 2019 based on 2018 utility data. Weather file updated from 2018 to 2019.

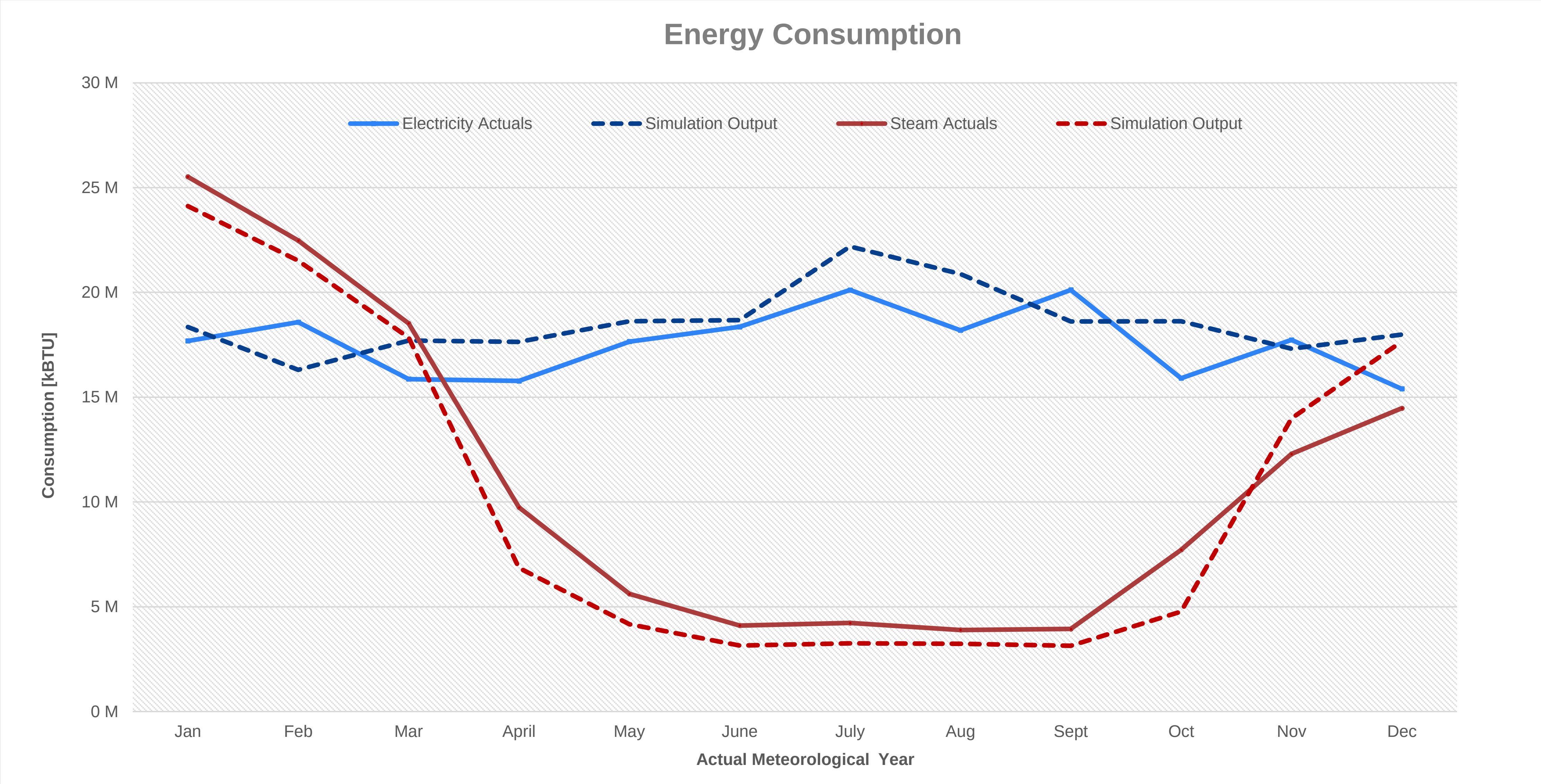
DESIGNBUILDER® RENDERINGS





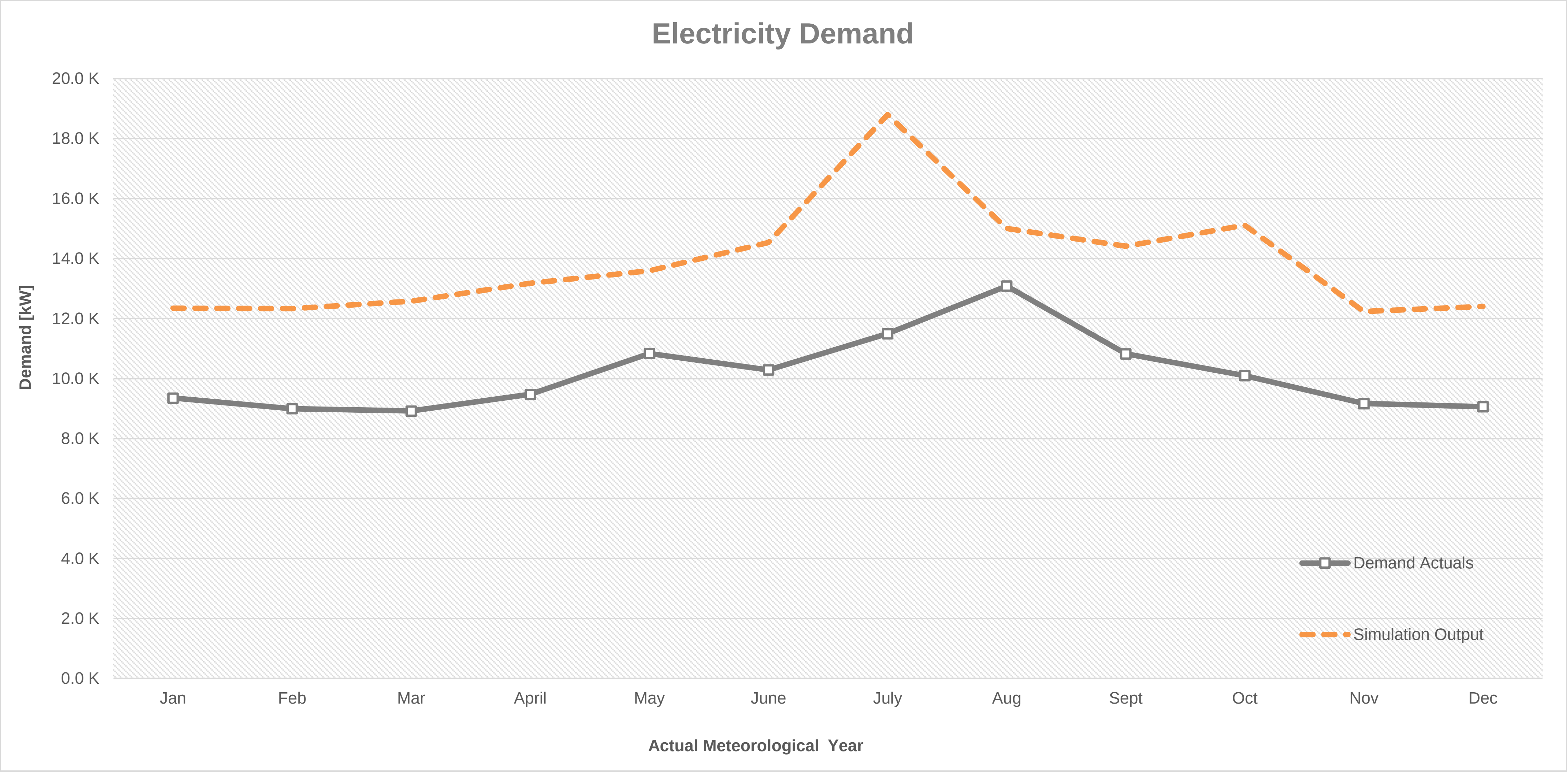


CALIBRATION OUTPUTS



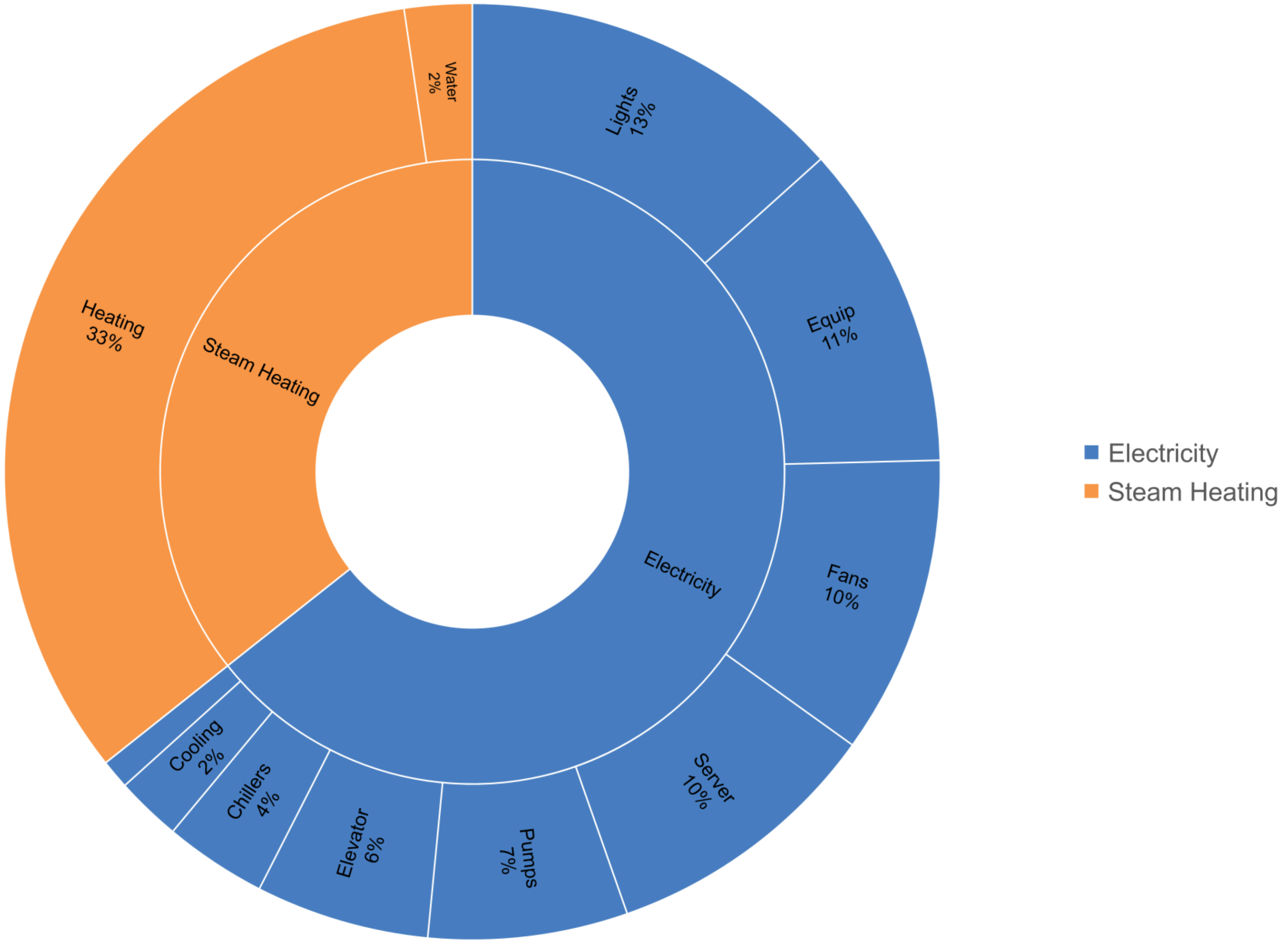
Total Actual 2019 Consumption: 343,841,233 kBtu
Total Calibrated 2019 Consumption: 346,710,322 kBtu
Margin of Error: +1%

CALIBRATION OUTPUTS



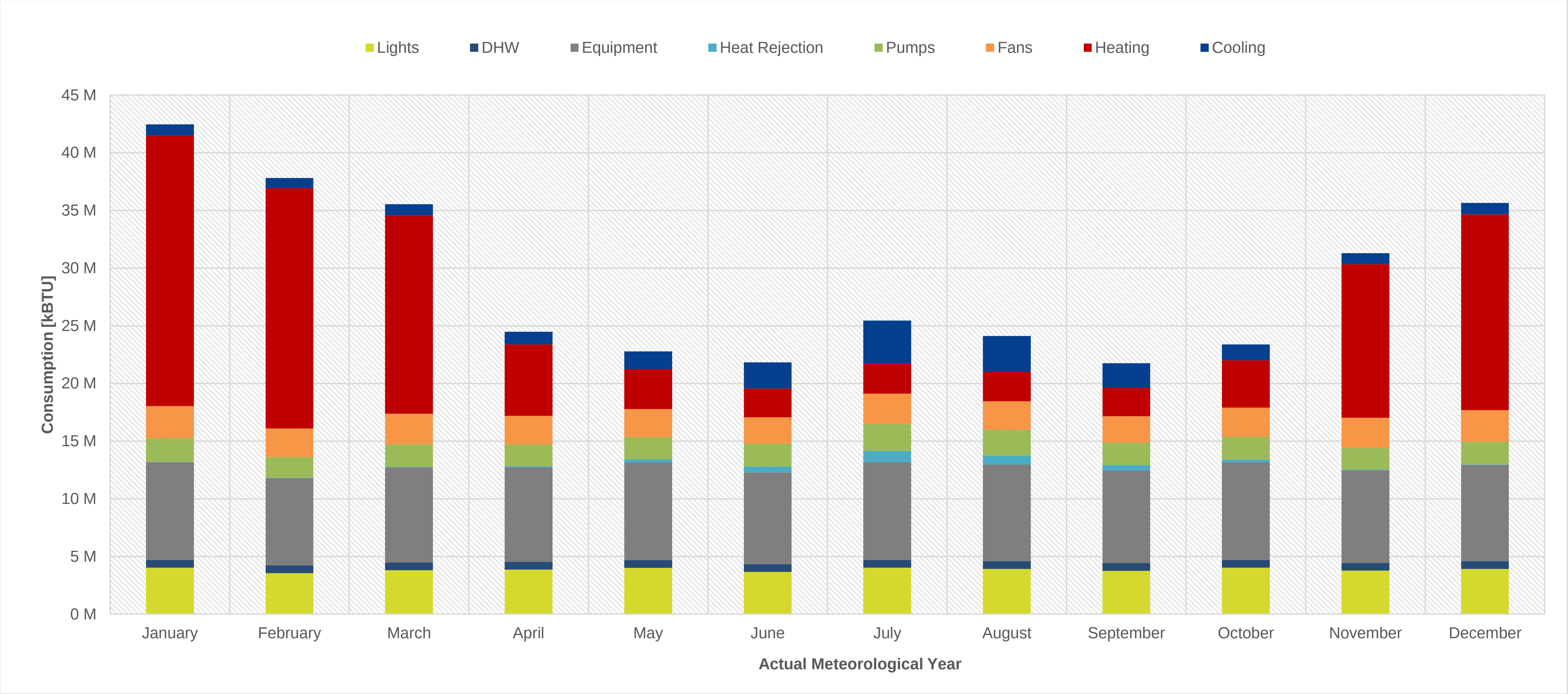
ENERGY BREAKDOWN

Total Annual Consumption by Utility



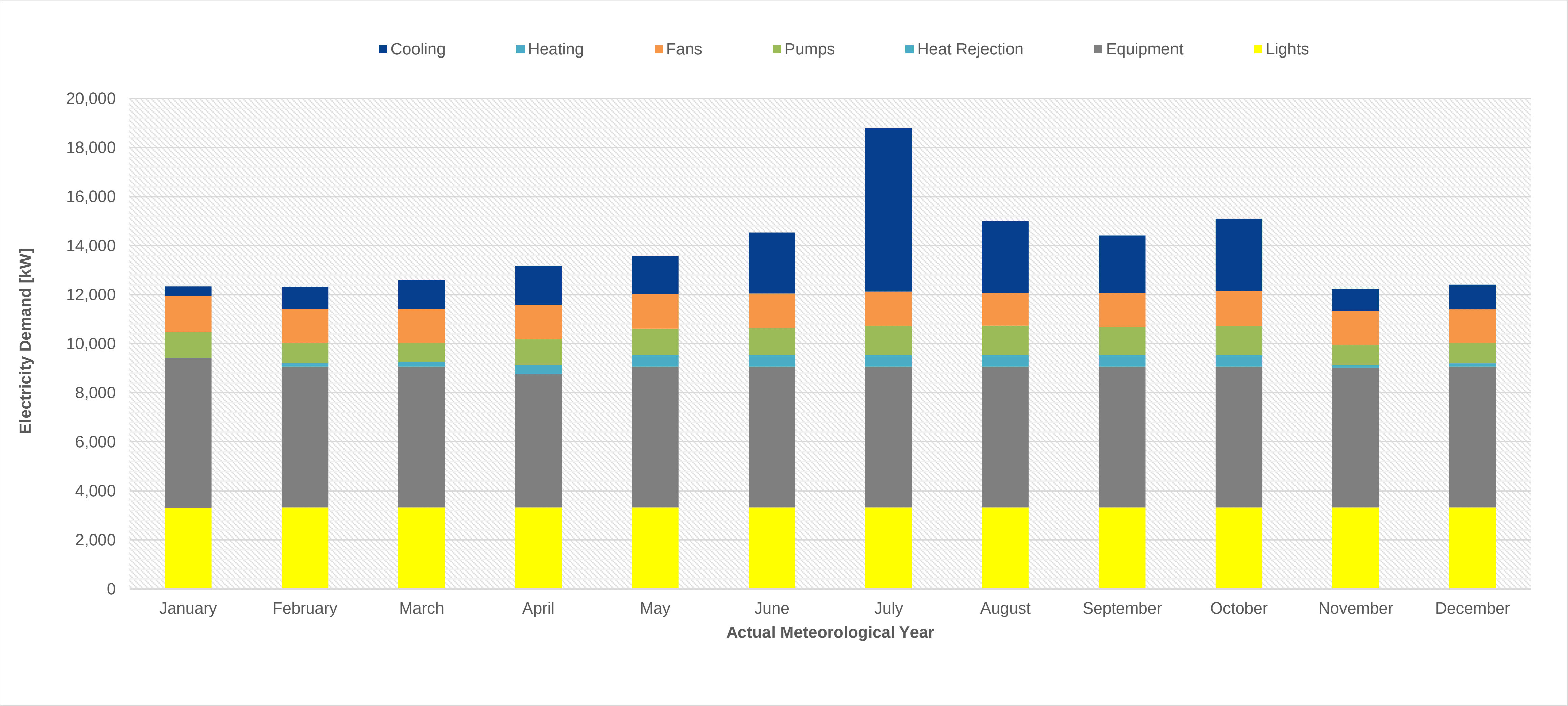
ENERGY BREAKDOWN

Total Monthly Consumption



ENERGY BREAKDOWN

Monthly Electrical Demand

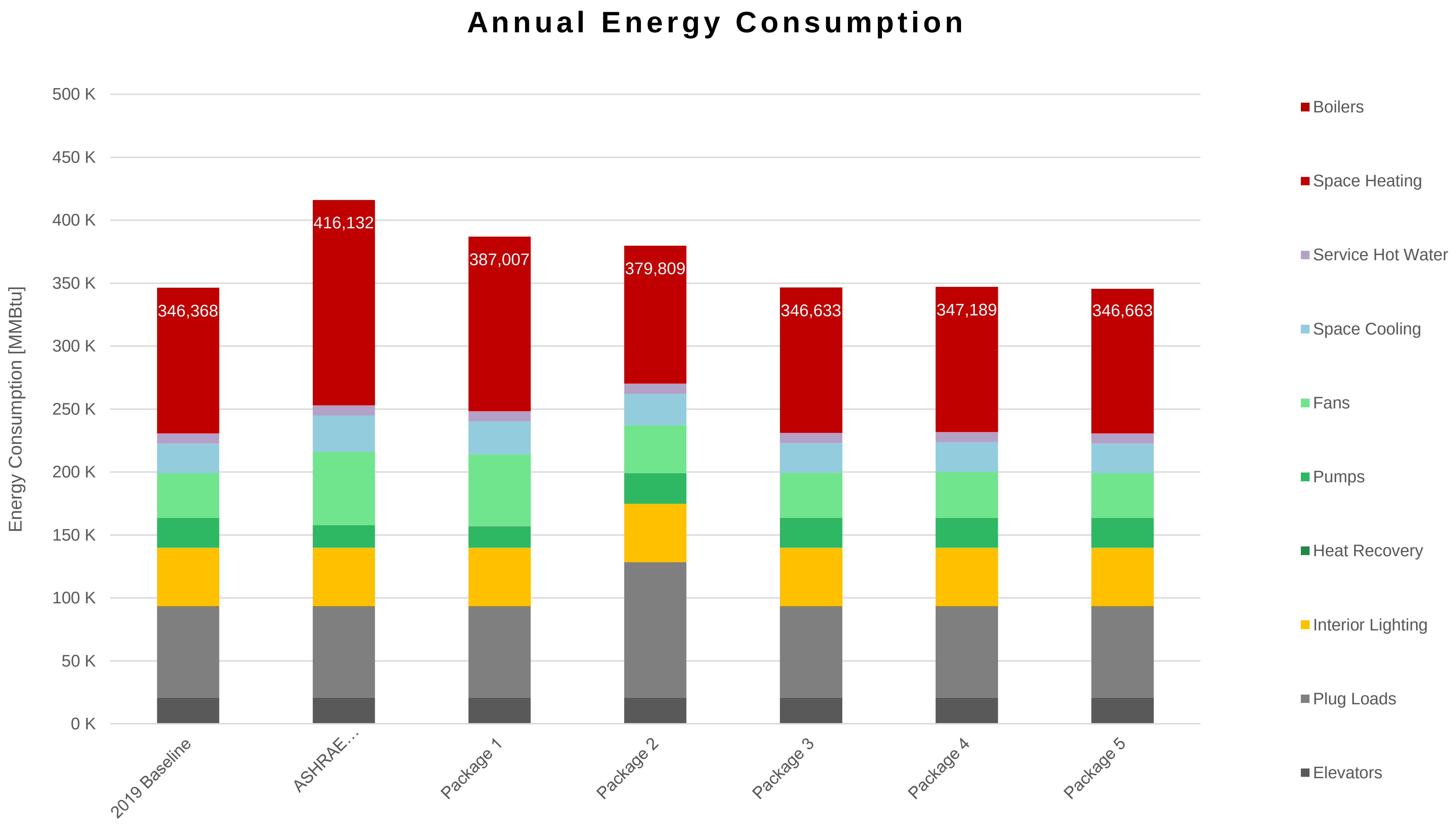


ASHRAE MINIMUM RECOMMENDATIONS (NEW)

Overview

ASHRAE Minimum IAQ Recommendation	Feasible?	Notes and Comments
Increase in Air Filtration to minimum MERV-13	☑	• Original filter strategy is MERV-13. Bag filters installed that are of the equivalent rating of a MERV-15 were installed in response to COVID. • The 36" deep filter rack assembly will allow for ample space to remove the bag filters and insert MERV filters if desired. • All but three fan systems can manage the increased pressure drop associated with a 6" MERV-16 filter.
Increase in OA % to highest level possible during occupied hours without impacting interior comfort criteria	☑	• The existing AHU's are sized on average to handle 35% outside air. • After looking at the duct size limitations and coil capacities all but 3 units could feasibly increase outside air intake to 50%.
Disable Demand Controlled Ventilation (DCV)	☑	• Most airside systems have DCV capabilities which can be enabled and disabled from the Building Management system.
Flush building 2 hours before and 2 hours after occupancy	☑	• Programming may be implemented to "flush" the building 2 hours before and after occupancy.

ALTERNATURE MEASURE ENERGY CONSUMPTION (NEW)



ALTENRATE PACKAGES – OVERVIEW & PRELIM RESULTS (NEW)

	Filtration	OA%	Flushing	UV-C	Portable HEPA Units
Alt. Package 1	MERV-13	50%	3 OACH		
Alt. Package 2	MERV-13	Design OA	3 OACH		4 - 6 Additional ACH
Alt. Package 3	MERV-13	Design OA	3 OACH	Inside Central AHUs	
Alt. Package 4	MERV-15	Design OA	3 OACH		
Alt. Package 5	MERV-16	Design OA	3 OACH		

ENERGY EFFICIENCY PACKAGE – OVERVIEW & PRELIM RESULTS (NEW)

Strategy	Energy/Carbon/Cost Impacts		
	Energy Increase	Carbon Increase	Utility Cost Increase
ASHRAE Recommended Package	20.1%	16.4%	16.8%
EE Package 1	11.7%	10.4%	10.5%
EE Package 2	9.7%	12.6%	12.3%
EE Package 3	0.1%	0.1%	0.1%
EE Package 4	0.2%	0.3%	0.3%
EE Package 5	0.1%	0.2%	0.2%

NEXT STEPS (NEW)

- Expected DRAFT for Final Report Delivery to 55 Water Street and NYSERDA by 11/15.
- Study at 55 Water is substantially complete.

80 PINE STREET

JB&B

80 PINE STREET

Overview

- Building Name: 80 Pine Street
- Building Location: 80 Pine Street, New York, NY
- Building Typology: Commercial Office
- Occupancy Types: Office, Retail
- Size: 1,080,000 sqft
- Operating Hours: 24 x 7 Operation
- Systems Impacting IAQ:
  - Central Constant Volume Air Handling Systems
  - Perimeter Induction Units
  - MERV-15 Filtration Strategy
- Other Notes/Information:
  - No Energy Recovery

JB&B

80 PINE STREET TASK LIST STATUS (NEW)

Data Collection & Review

- ☑ Minimum 12-Months Pre-COVID Utility Data
- ☑ Existing Building MEP Drawings
- ☑ BMS Sequence of Ops
- ☑ Conduct Preliminary Site Walkthrough
- ☑ Conduct Operator Interviews

Develop Baseline Energy Model

- ☑ Total Annual Energy Use Breakdown by End Use
- ☑ Benchmark Building
- ☑ Develop Preliminary ECMs

Site Survey & Energy Efficient IAQ Recommendations

- ☑ Conduct Detailed Site Visits **(Scheduled)**
- ☑ Develop Filtration and Airside Equipment Operation Log
- ☑ Develop IAQ Recommendations
- ☑ Refine Preliminary ECMs

Energy Efficient IAQ Energy Analysis

- ☐ ASHRAE Recommendations Energy Model **(In progress)**
- ☐ Energy Efficiency Model **(In progress)**

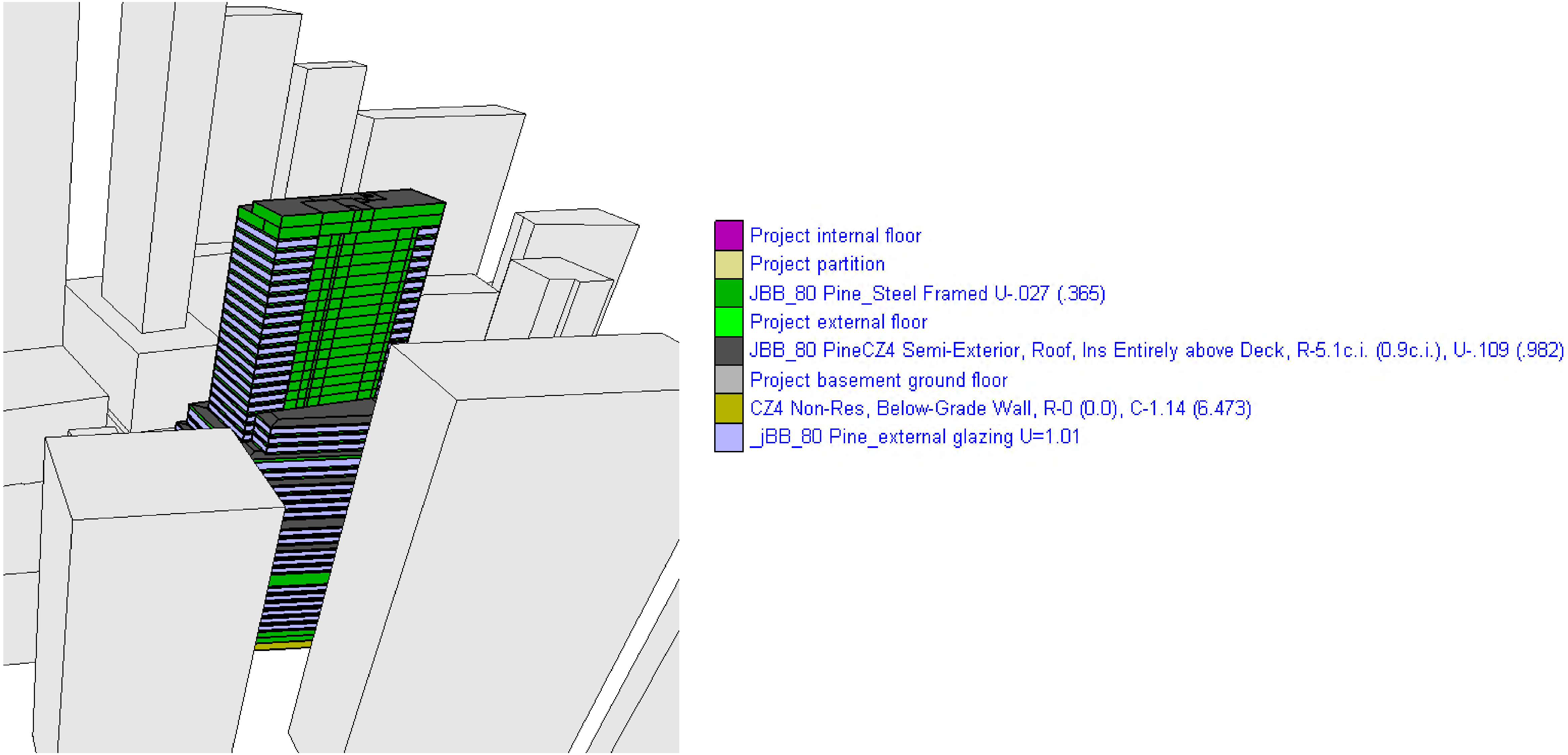
Economic Analysis

- ☐ Develop Design Document for Cost Estimator
- ☐ Collect Cost Estimates
- ☐ Conduct Economic Analysis

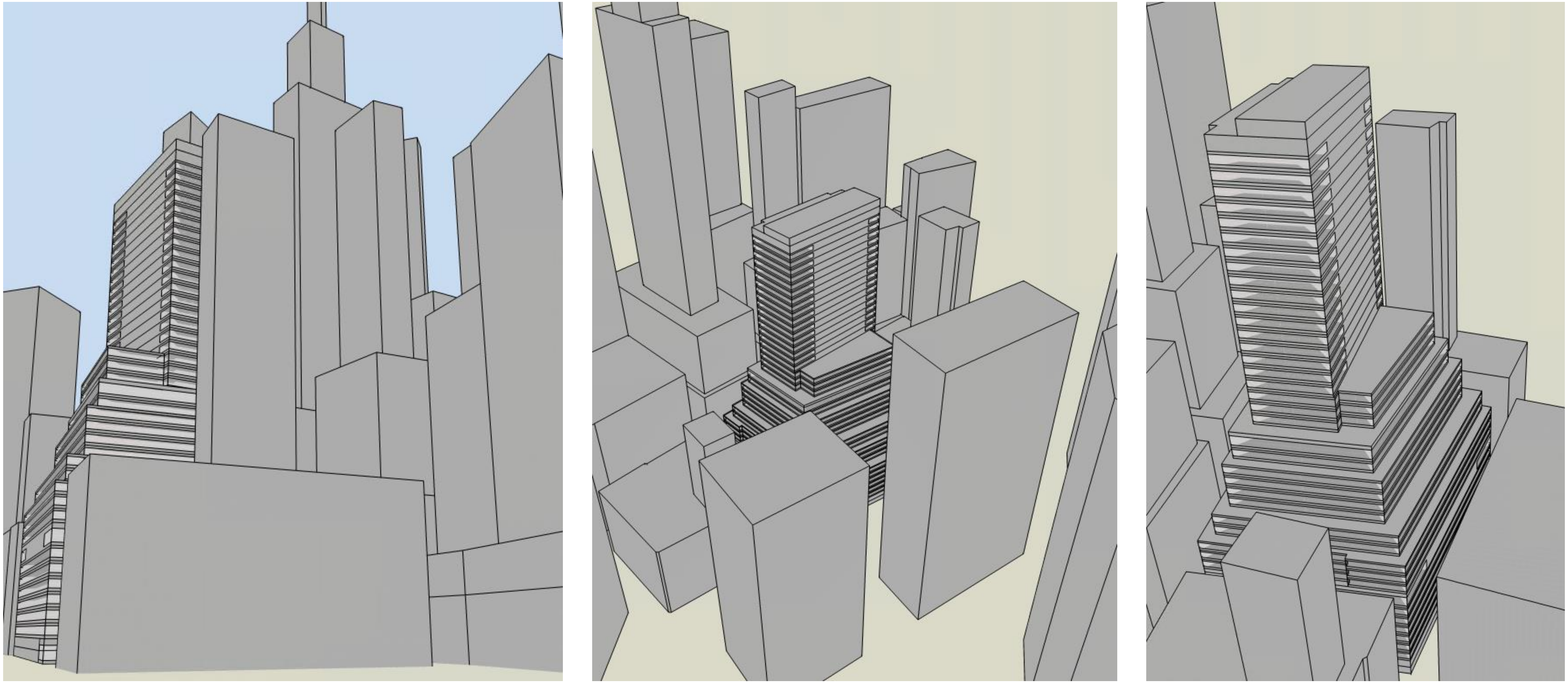
Final Reporting

- ☐ Final Report
- ☐ Case Study Documentation

DESIGNBUILDER® MODEL



DESIGNBUILDER® RENDERINGS



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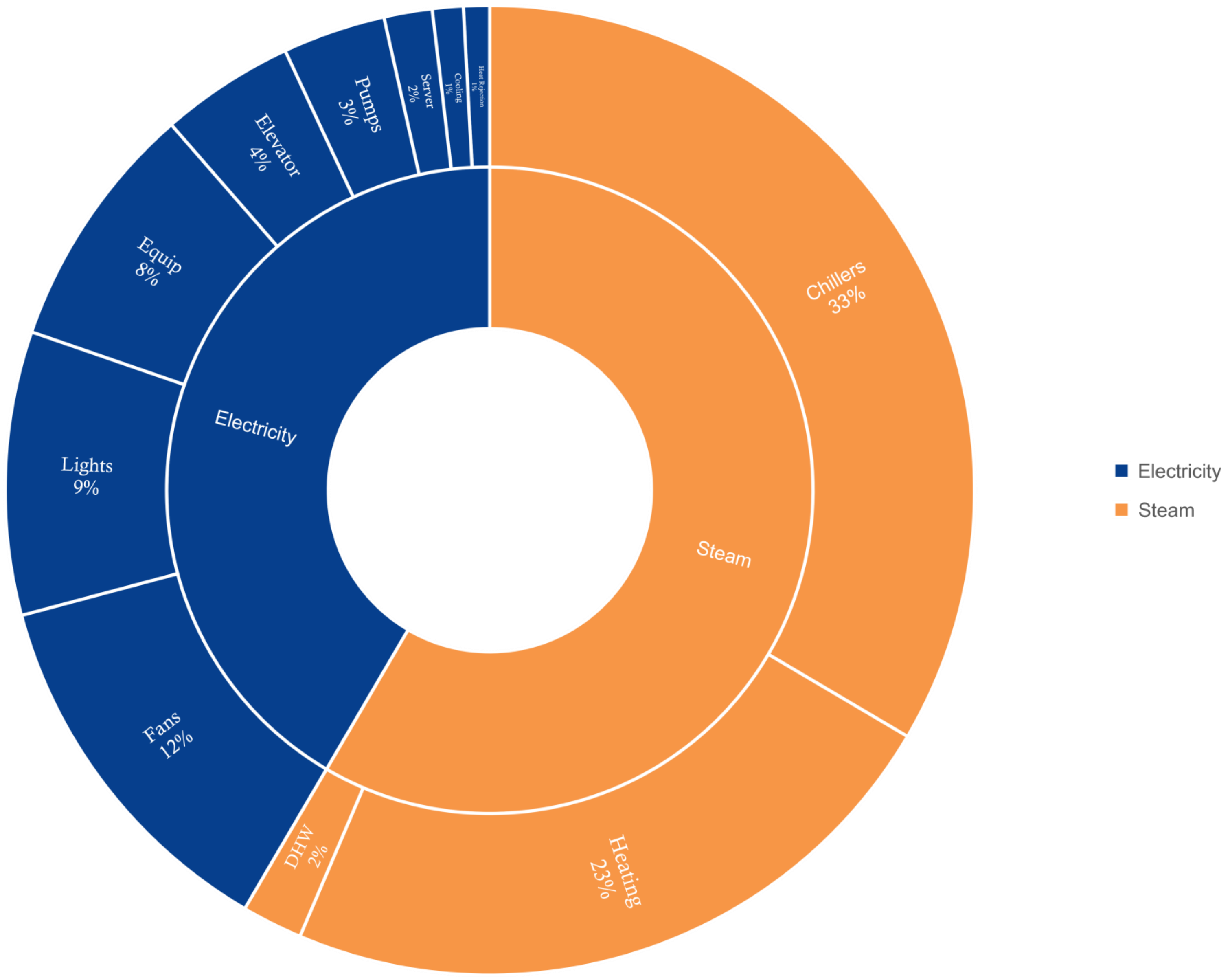
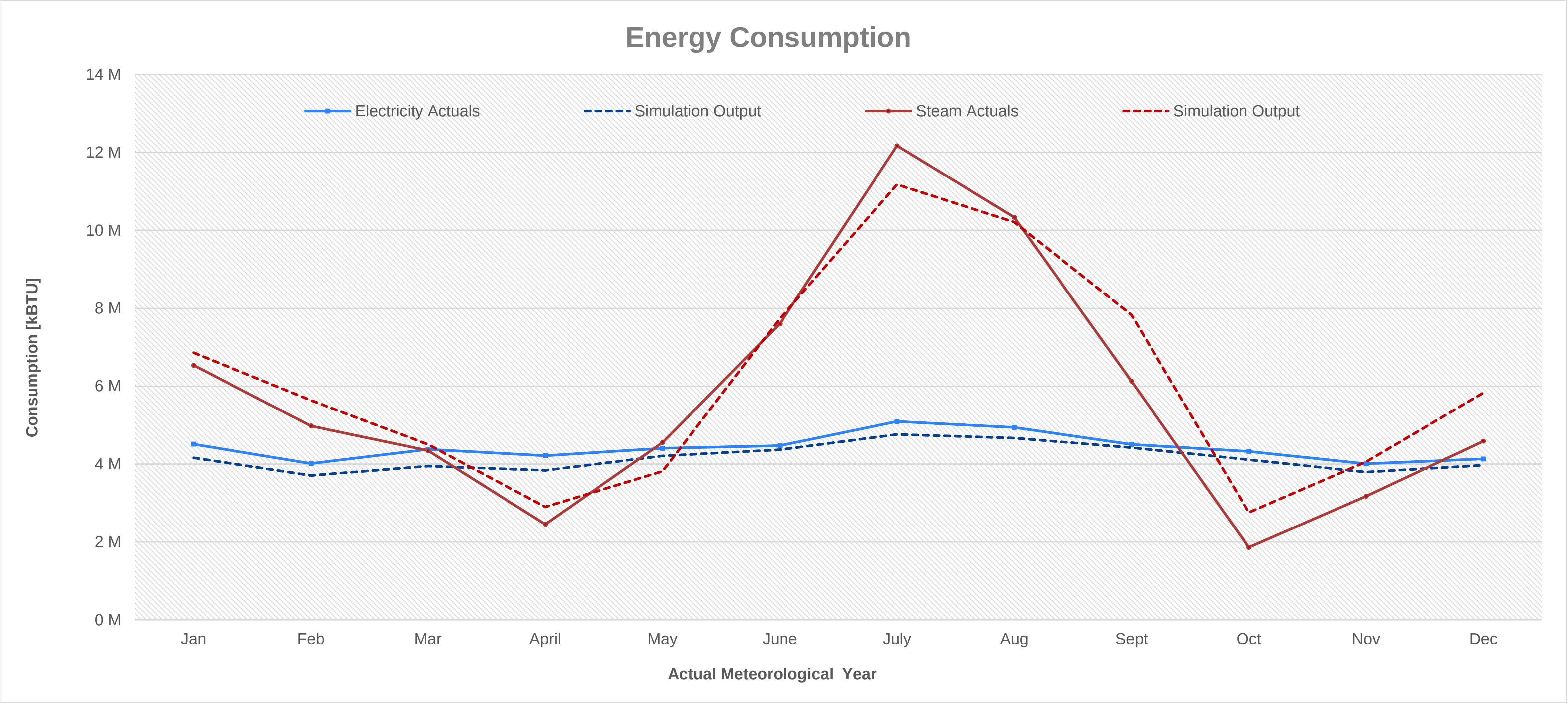
ENERGY BREAKDOWN

Total Annual Consumption by Utility

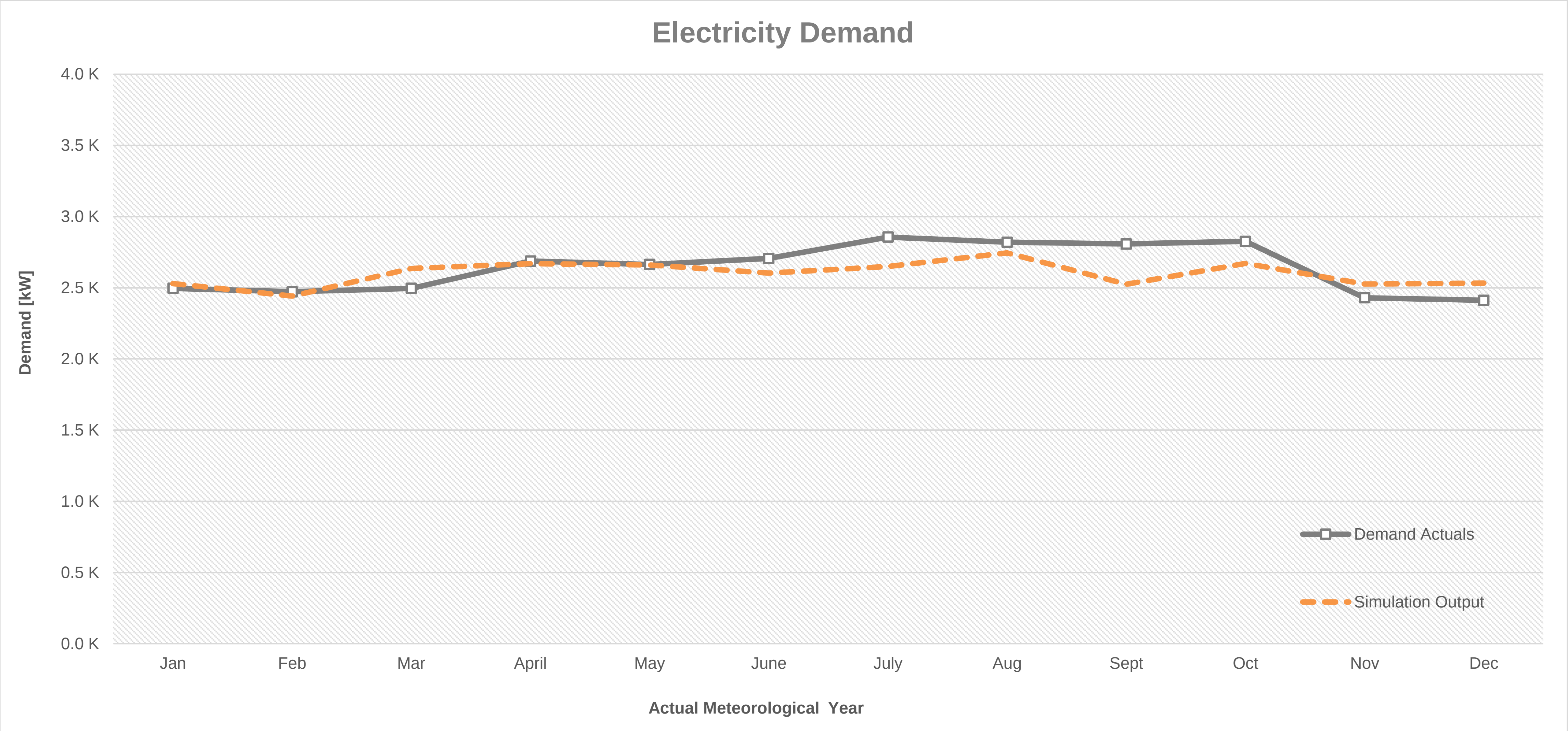


CALIBRATION OUTPUTS



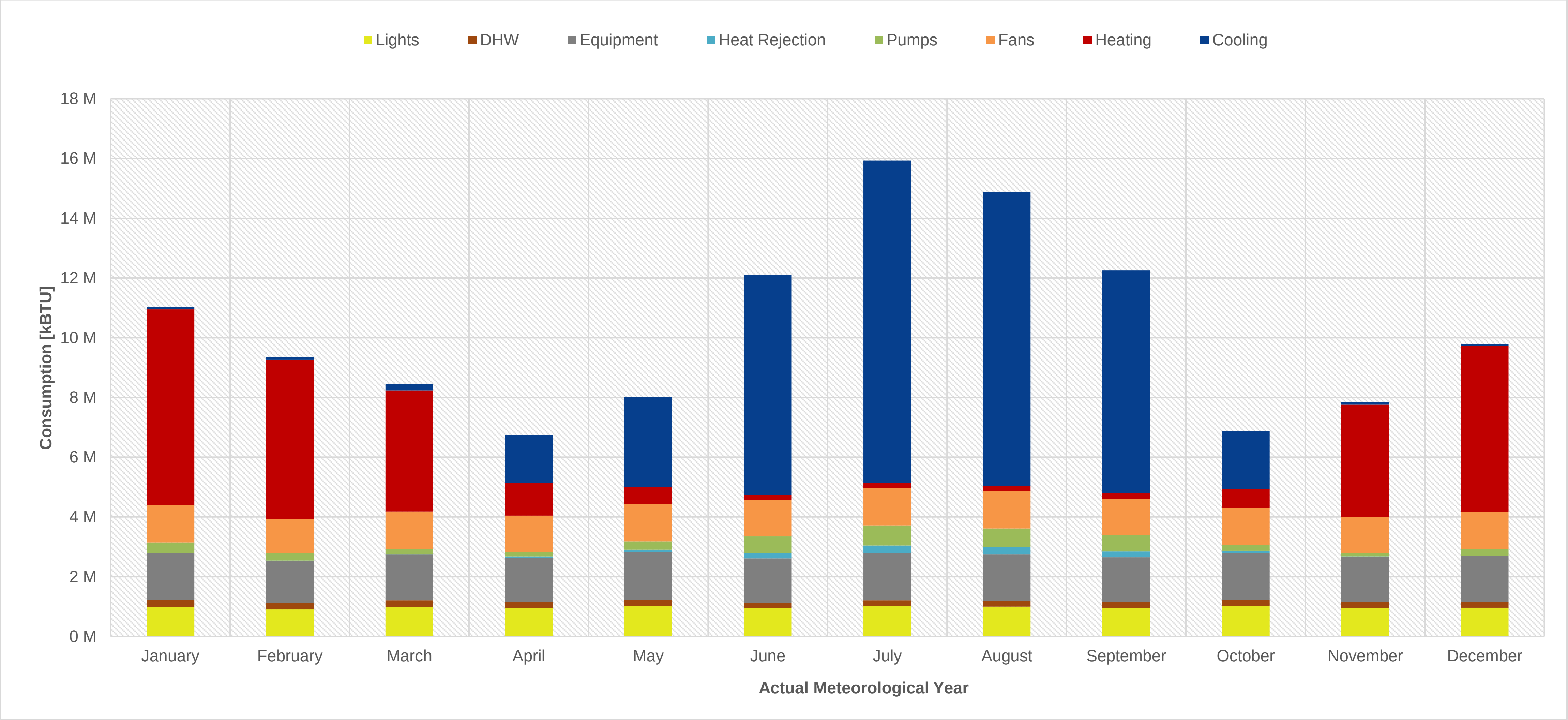
Total Actual 2019 Consumption: 121,730,237 kBtu
Total Calibrated 2019 Consumption: 123,268,295 kBtu
Margin of Error: +1%

CALIBRATION OUTPUTS



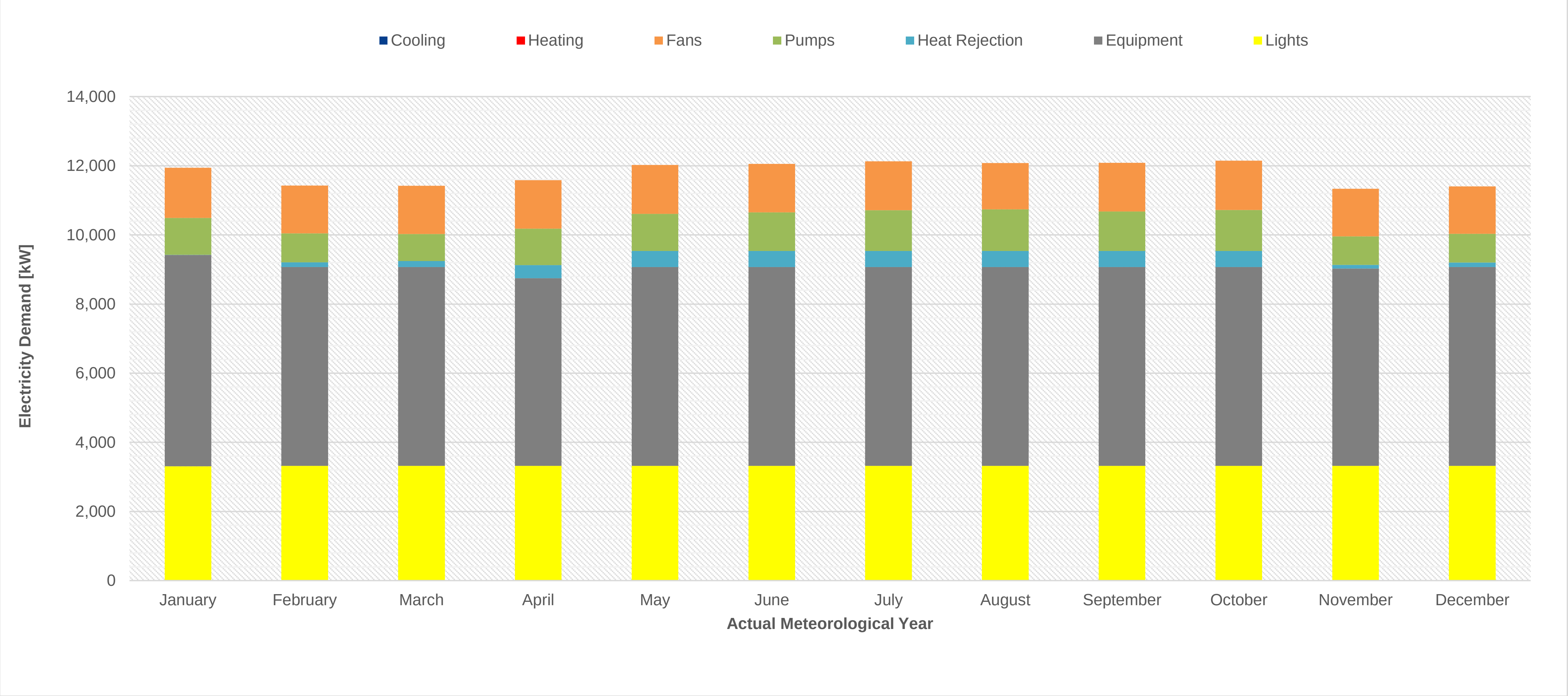
ENERGY BREAKDOWN

Total Monthly Consumption



ENERGY BREAKDOWN

Electric Components of Peak Demand



NEXT STEPS (NEW)

- Evaluate ASHRAE minimum recommendations in energy model
- Develop ECMs for IAQ systems
- Expected DRAFT for Final Report Delivery to 80 Pine and NYSERDA by 11/1

3 TIMES SQUARE

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3 TIMES SQUARE

Overview

- Building Name: 3 Times Square
- Building Location: 3 Times Square, New York, NY
- Building Typology: Commercial Office
- Occupancy Types: Office, Retail
- Size: 885,000 sqft
- Operating Hours: 7:00 AM – 7:00 PM Monday through Friday | 7:00 AM – 1:00 PM Saturday
- Systems Impacting IAQ:
  - Floor-by-floor Chilled Water Air Handling Units
  - MERV-15 Filtration Strategy
- Other Notes/Information:
  - Wrap around energy recovery coils
  - Demand controlled ventilation

3 TIMES SQUARE TASK LIST STATUS

Data Collection & Review

- ☑ Minimum 12-Months Pre-COVID Utility Data
- ☑ Existing Building MEP Drawings
- ☑ BMS Sequence of Ops
- ☑ Conduct Preliminary Site Walkthrough
- ☑ Conduct Operator Interviews

Develop Baseline Energy Model

- ☑ Total Annual Energy Use Breakdown by End Use
- ☑ Benchmark Building
- ☑ Develop Preliminary ECMs

Site Survey & Energy Efficient IAQ Recommendations

- ☑ Conduct Detailed Site Visits
- ☑ Develop Filtration and Airside Equipment Operation Log
- ☑ Develop IAQ Recommendations
- ☑ Refine Preliminary ECMs

Energy Efficient IAQ Energy Analysis

- ☐ ASHRAE Recommendations Energy Model **(In Progress)**
- ☐ Energy Efficiency Model **(In Progress)**

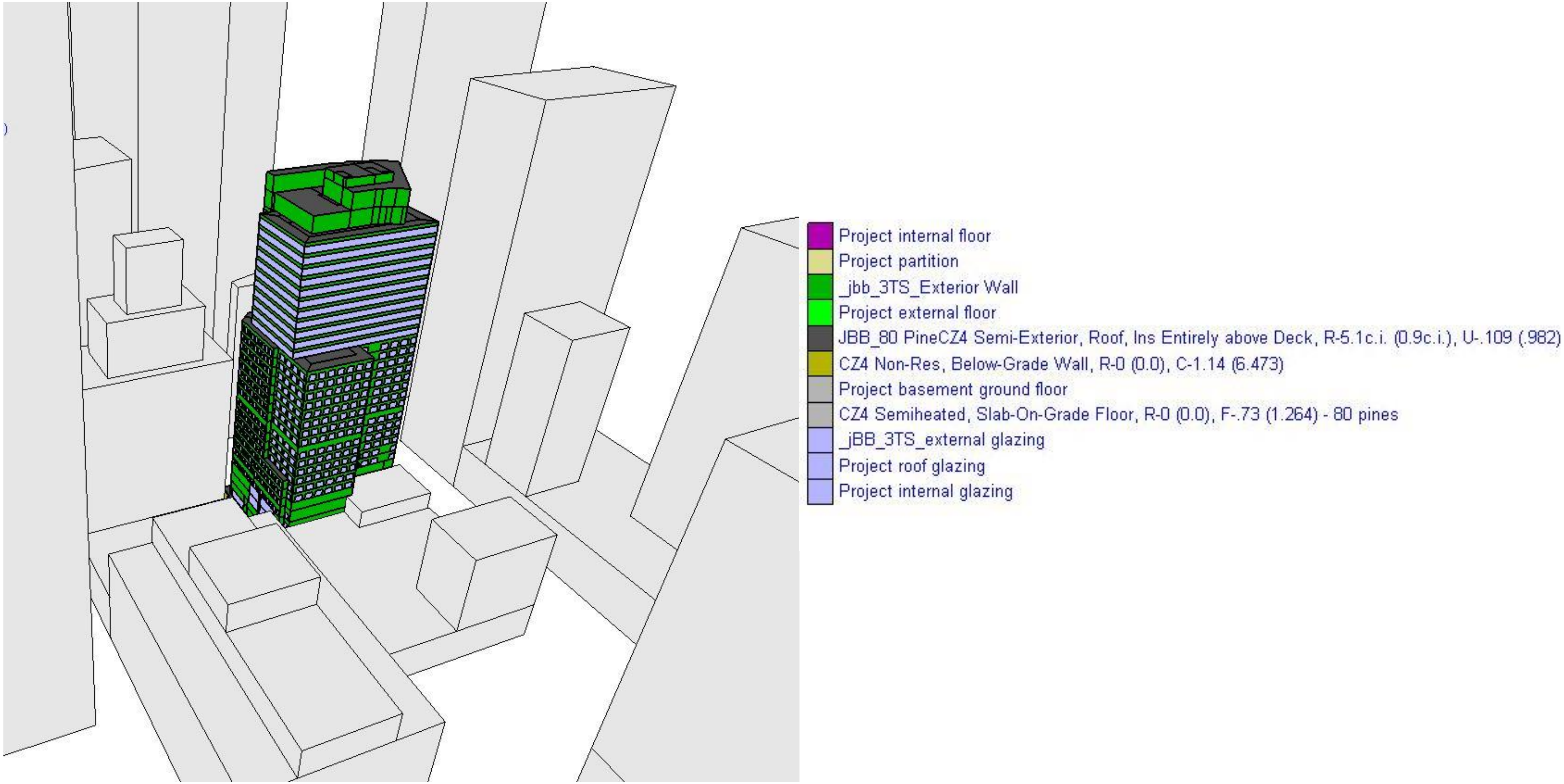
Economic Analysis

- ☐ Develop Design Document for Cost Estimator
- ☐ Collect Cost Estimates
- ☐ Conduct Economic Analysis

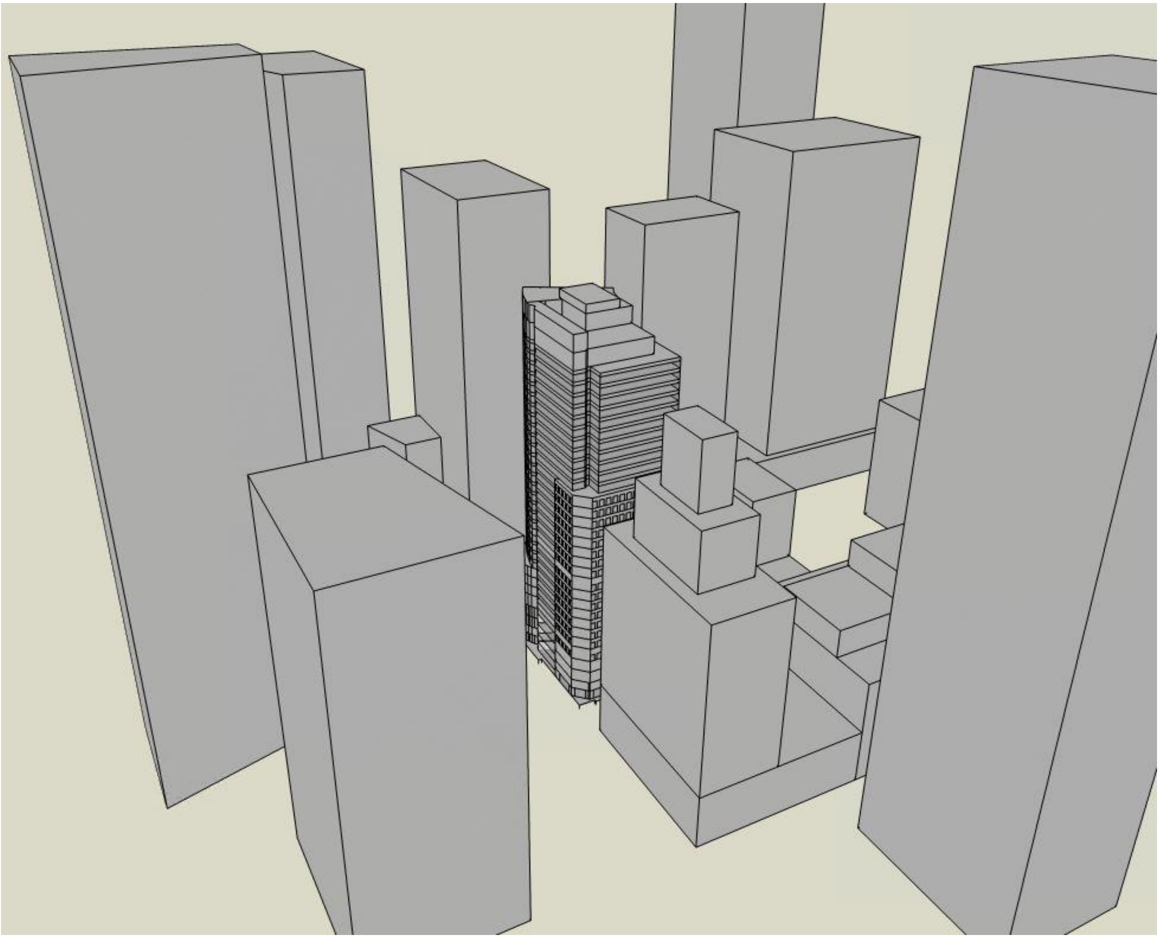
Final Reporting

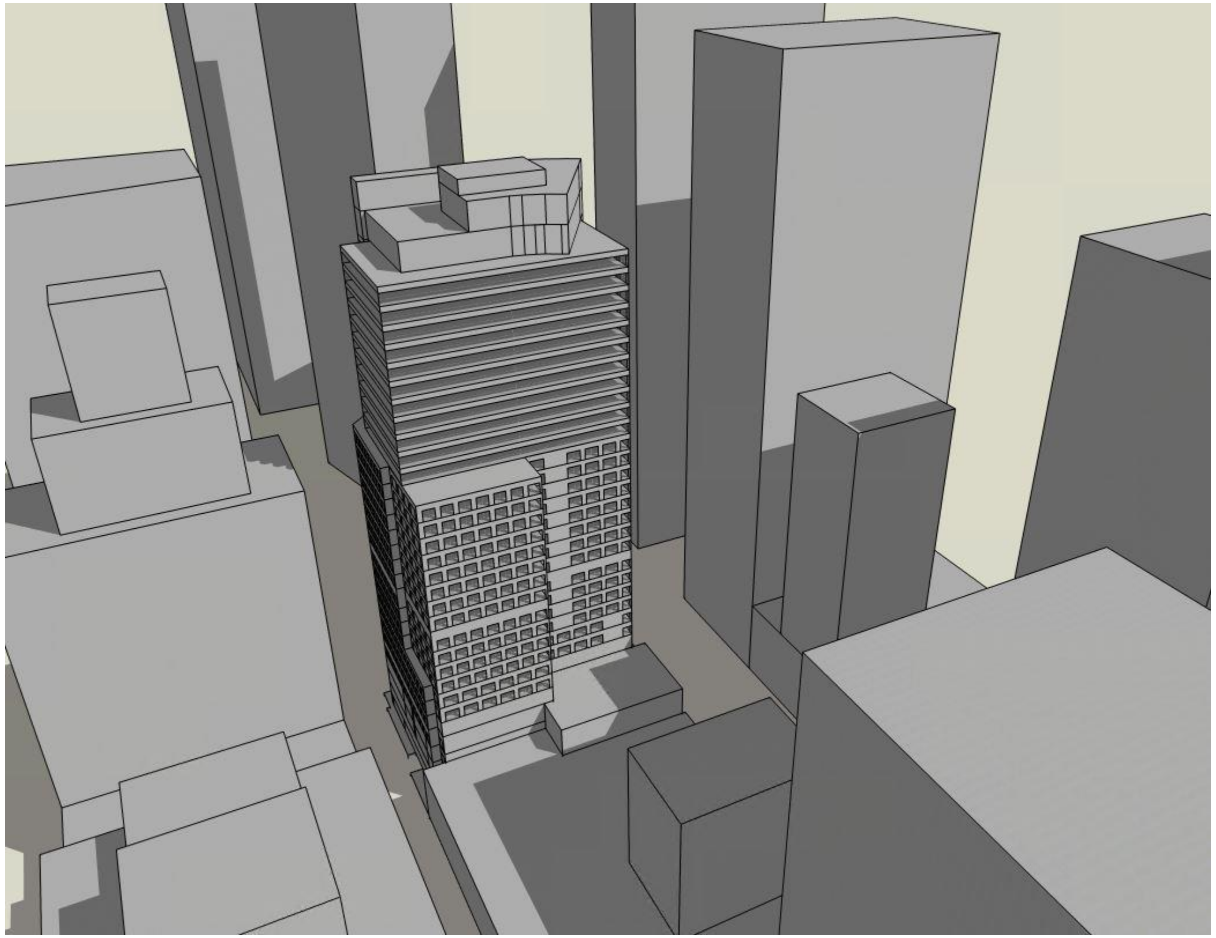
- ☐ Final Report
- ☐ Case Study Documentation

DESIGNBUILDER® MODEL



DESIGNBUILDER® RENDERINGS





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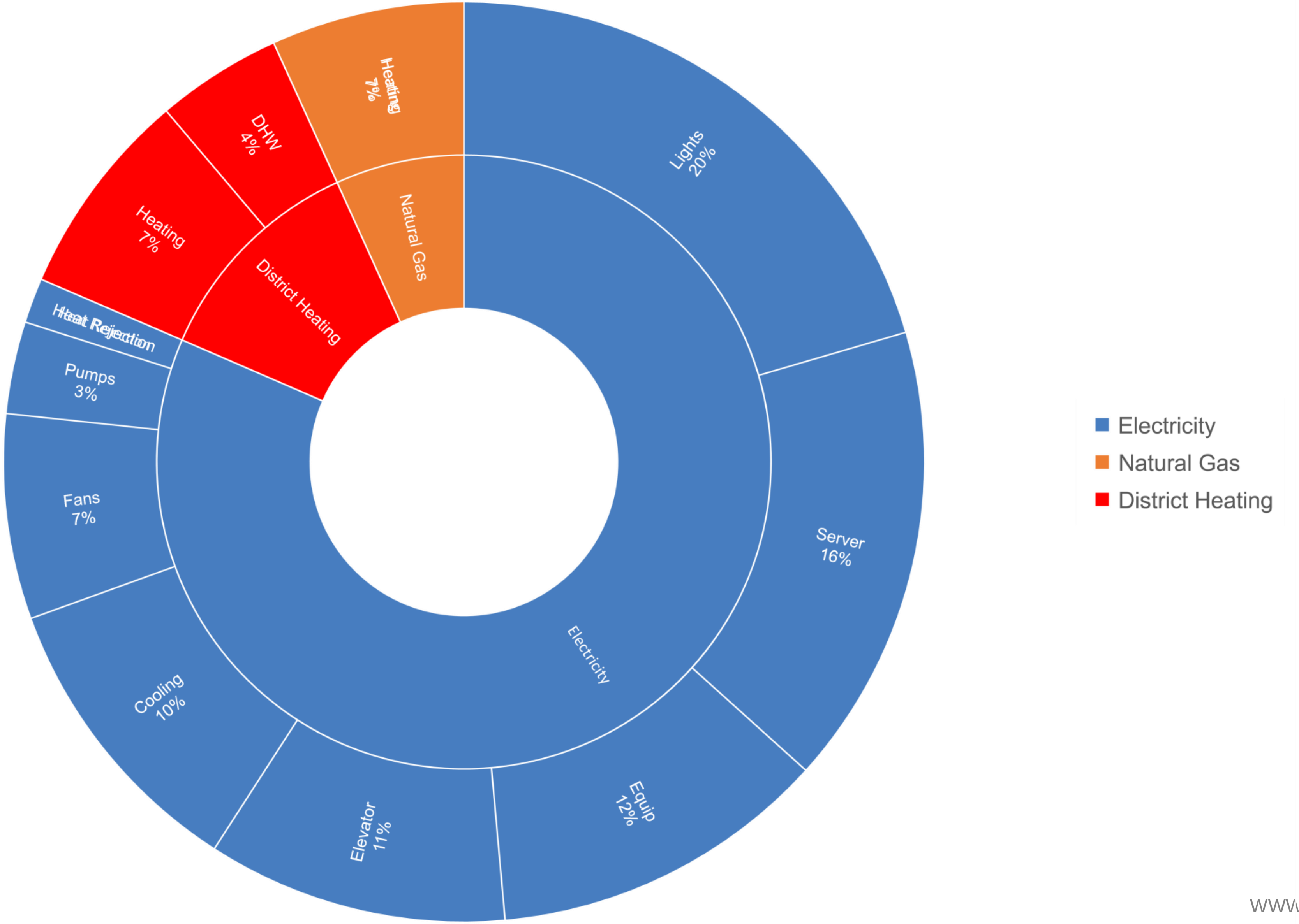
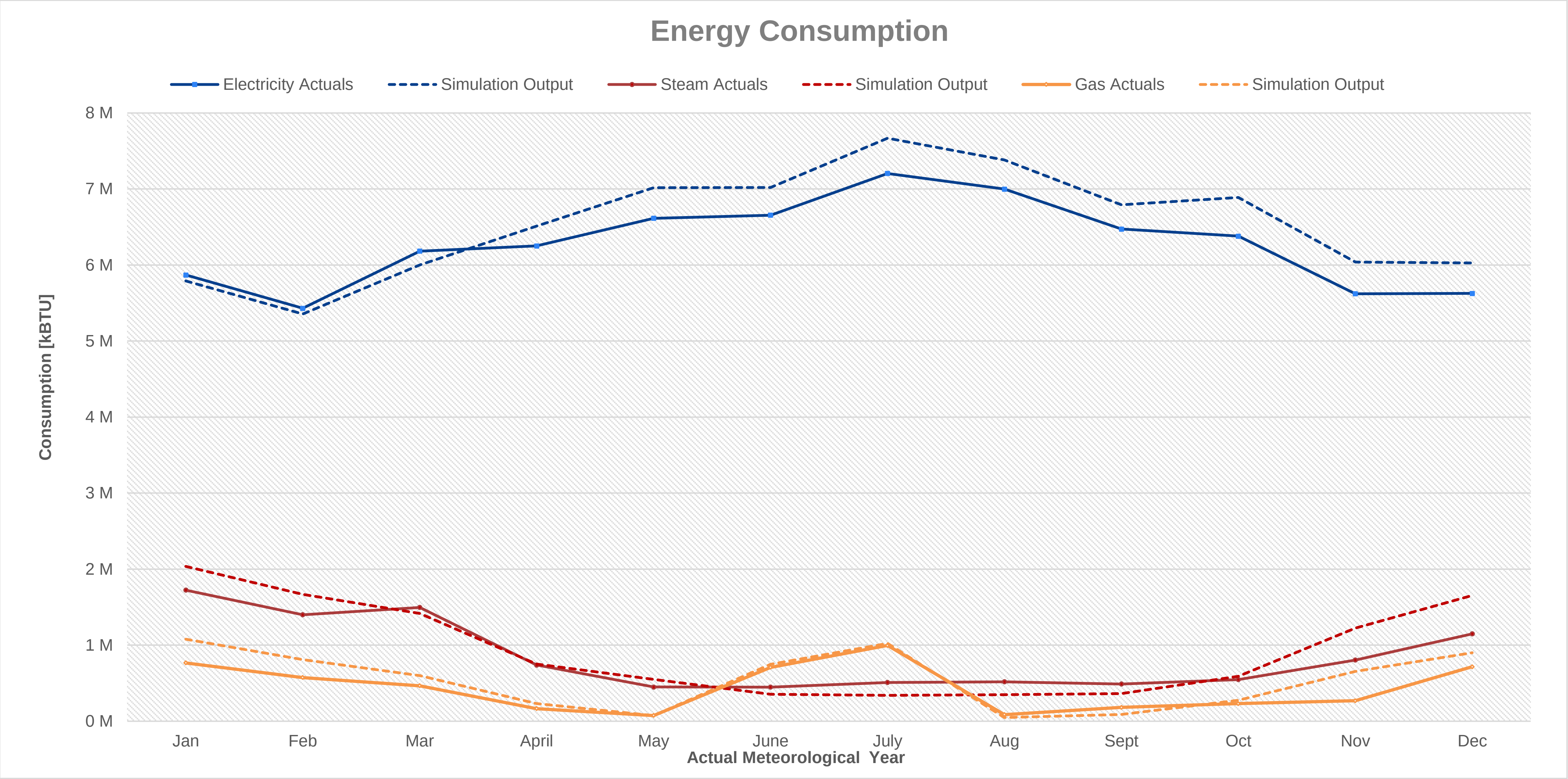
ENERGY BREAKDOWN

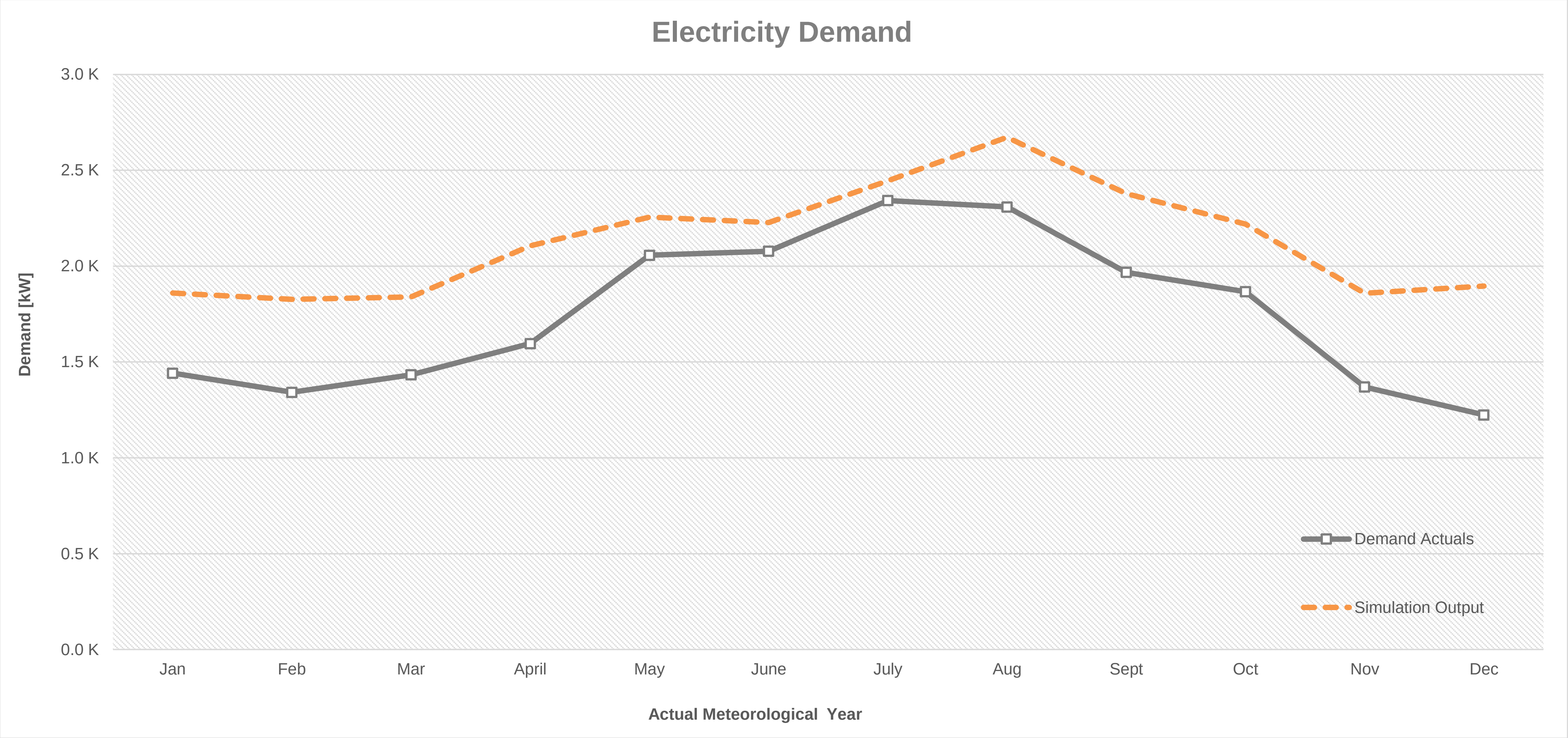
Total Annual Consumption by Utility



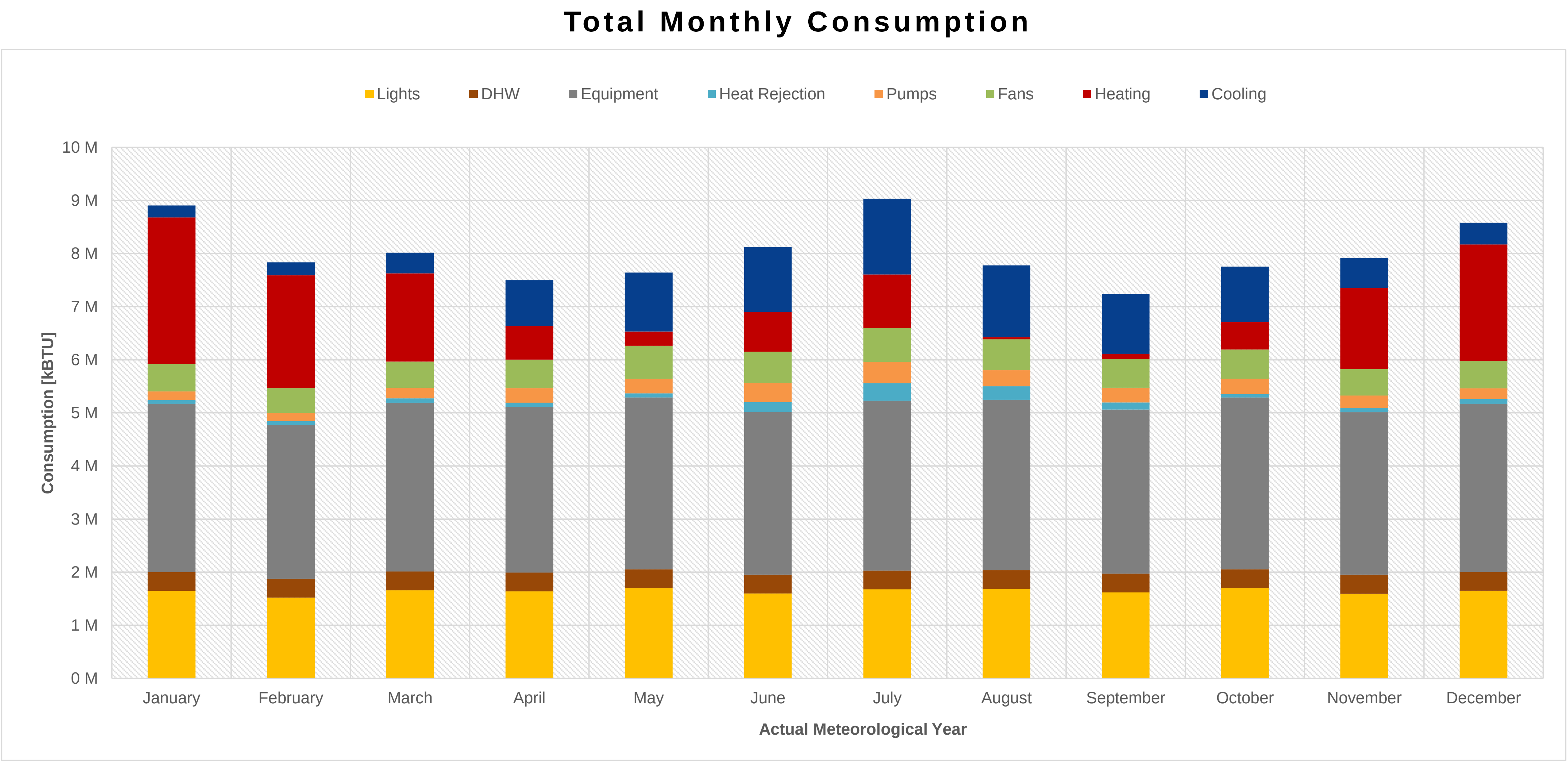
CALIBRATION OUTPUTS



CALIBRATION OUTPUTS

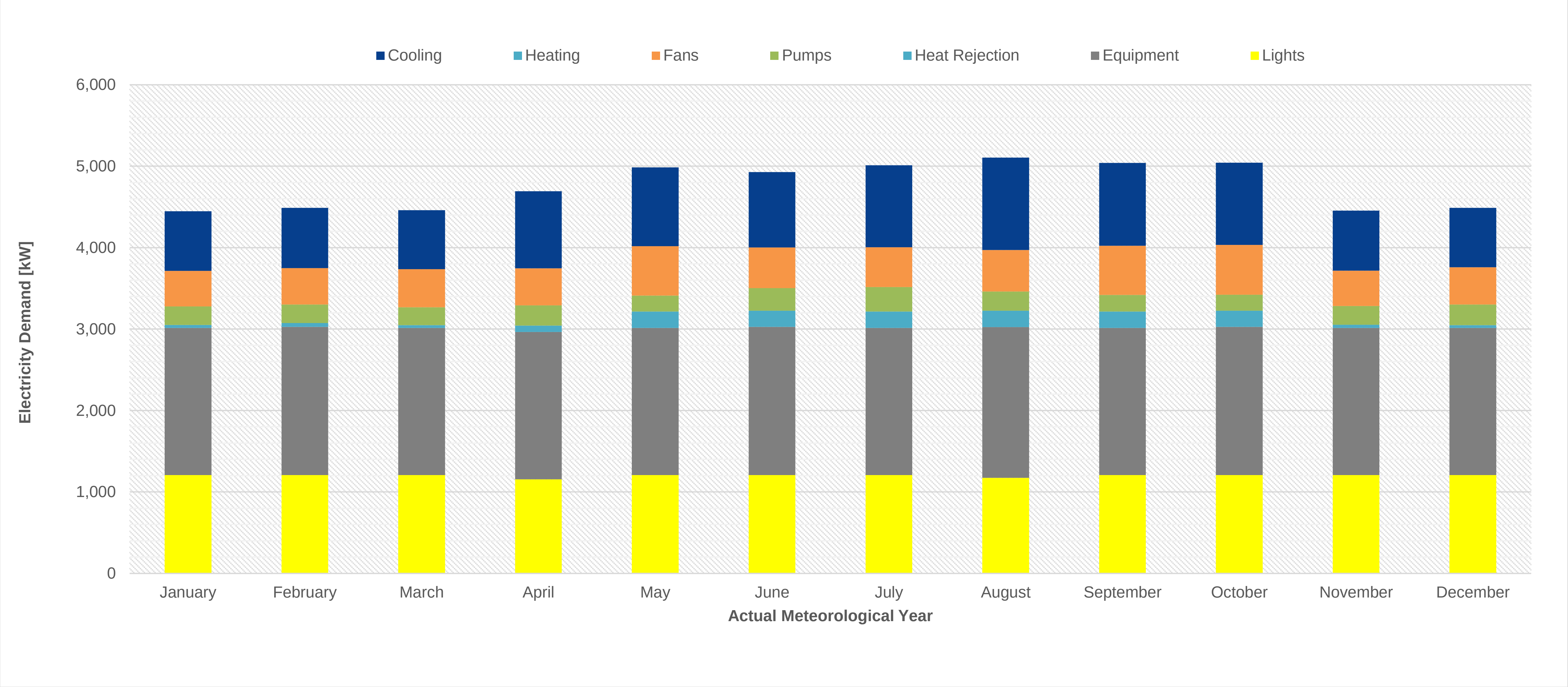


ENERGY BREAKDOWN



ENERGY BREAKDOWN

Electric Components of Peak Demand



345 PARK AVENUE

JB&B

345 PARK AVENUE

Overview

- Building Name: 345 Park Avenue
- Building Location: 345 Park Avenue, New York, NY
- Building Typology: Commercial Office
- Occupancy Types: Office, Retail
- Size: 1,900,000 sqft
- Operating Hours: Upper House 7:00 AM – 9:00 PM Monday through Friday | Lower House 7:00 AM – 7:00 PM Monday through Friday | All Floors 8:00 AM – 1:00 PM Saturday
- Systems Impacting IAQ:
  - Central Constant Volume Air Handling Systems
  - Perimeter Induction Units
  - MERV-14 to MERV-16 Filtration Strategy
- Other Notes/Information:
  - No energy recovery

345 PARK AVE. TASK LIST STATUS (NEW)

Data Collection & Review

- ☑ Minimum 12-Months Pre-COVID Utility Data
- ☑ Existing Building MEP Drawings
- ☑ BMS Sequence of Ops
- ☑ Conduct Preliminary Site Walkthrough
- ☑ Conduct Operator Interviews

Develop Baseline Energy Model

- ☑ Total Annual Energy Use Breakdown by End Use
- ☑ Benchmark Building
- ☑ Develop Preliminary ECMs

Site Survey & Energy Efficient IAQ Recommendations

- ☑ Conduct Detailed Site Visits
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Energy Efficient IAQ Energy Analysis

- ☐ ASHRAE Recommendations Energy Model
- ☐ Energy Efficiency Model

Economic Analysis

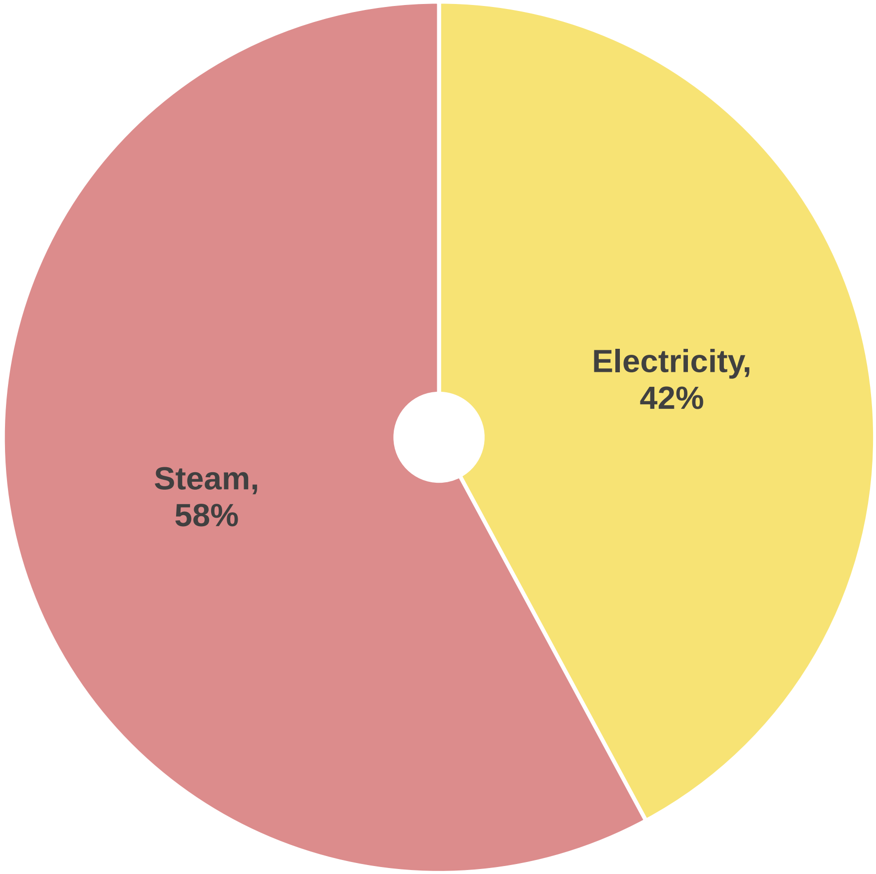
- ☐ Develop Design Document for Cost Estimator
- ☐ Collect Cost Estimates
- ☐ Conduct Economic Analysis

Final Reporting

- ☐ Final Report
- ☐ Case Study Documentation

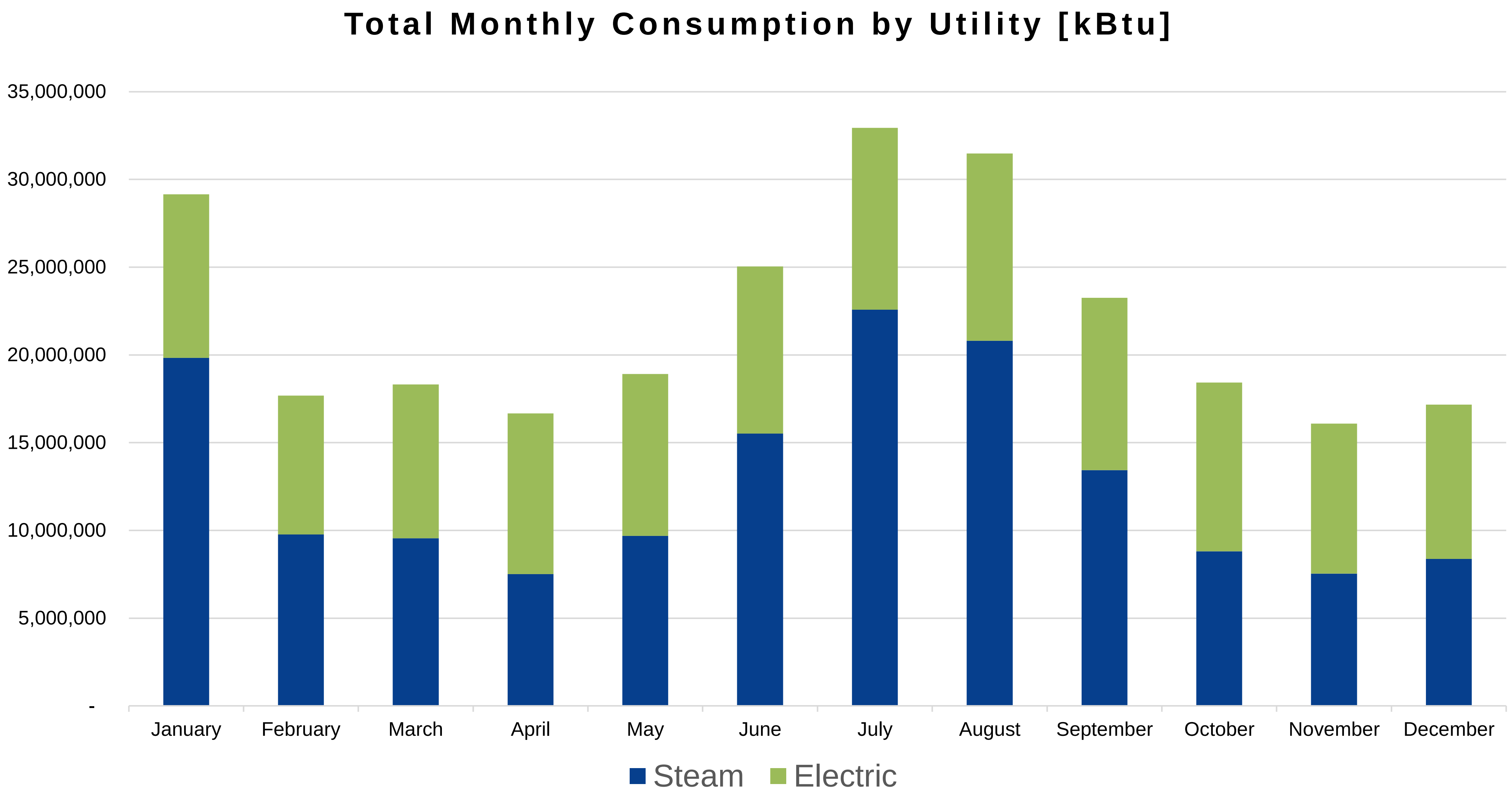
BASELINE ENERGY MODEL (NEW)

Total Consumption by Utility



Energy Source	Energy Consumption [kBTUs]	% Energy Consumption
Electricity	111,693,413	42%
Steam	153,421,836	58%

BASELINE ENERGY MODEL (NEW)

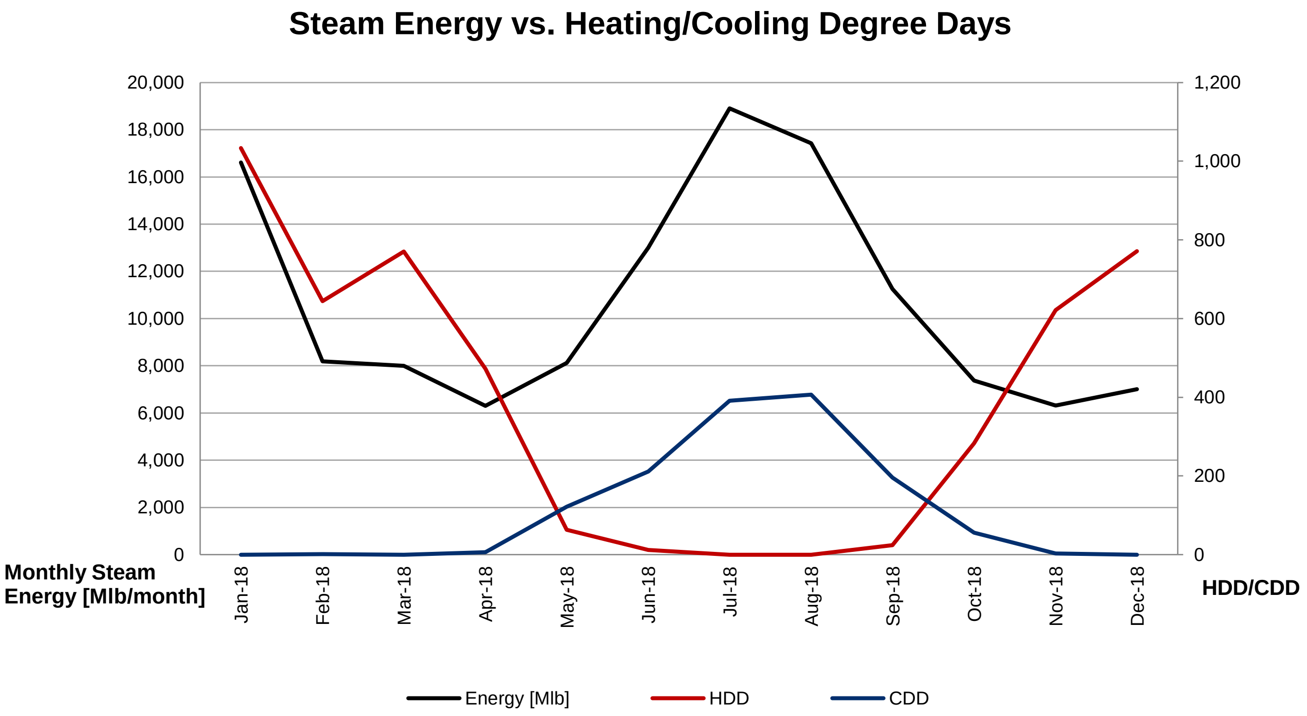


Total 2018 Consumption: 265,115,822 kBtu

BASELINE ENERGY MODEL (NEW)

Steam

Year	Month	Energy [Mlb]	Days	HDD	CDD
2018	January	16,609	31	1,033	0
2018	February	8,186	28	645	2
2018	March	8,004	31	771	0
2018	April	6,296	30	473	6
2018	May	8,117	31	64	122
2018	June	12,996	30	12	212
2018	July	18,907	31	0	392
2018	August	17,421	31	0	407
2018	September	11,254	30	24	196
2018	October	7,376	31	283	56
2018	November	6,317	30	622	3
2018	December	7,010	31	772	0



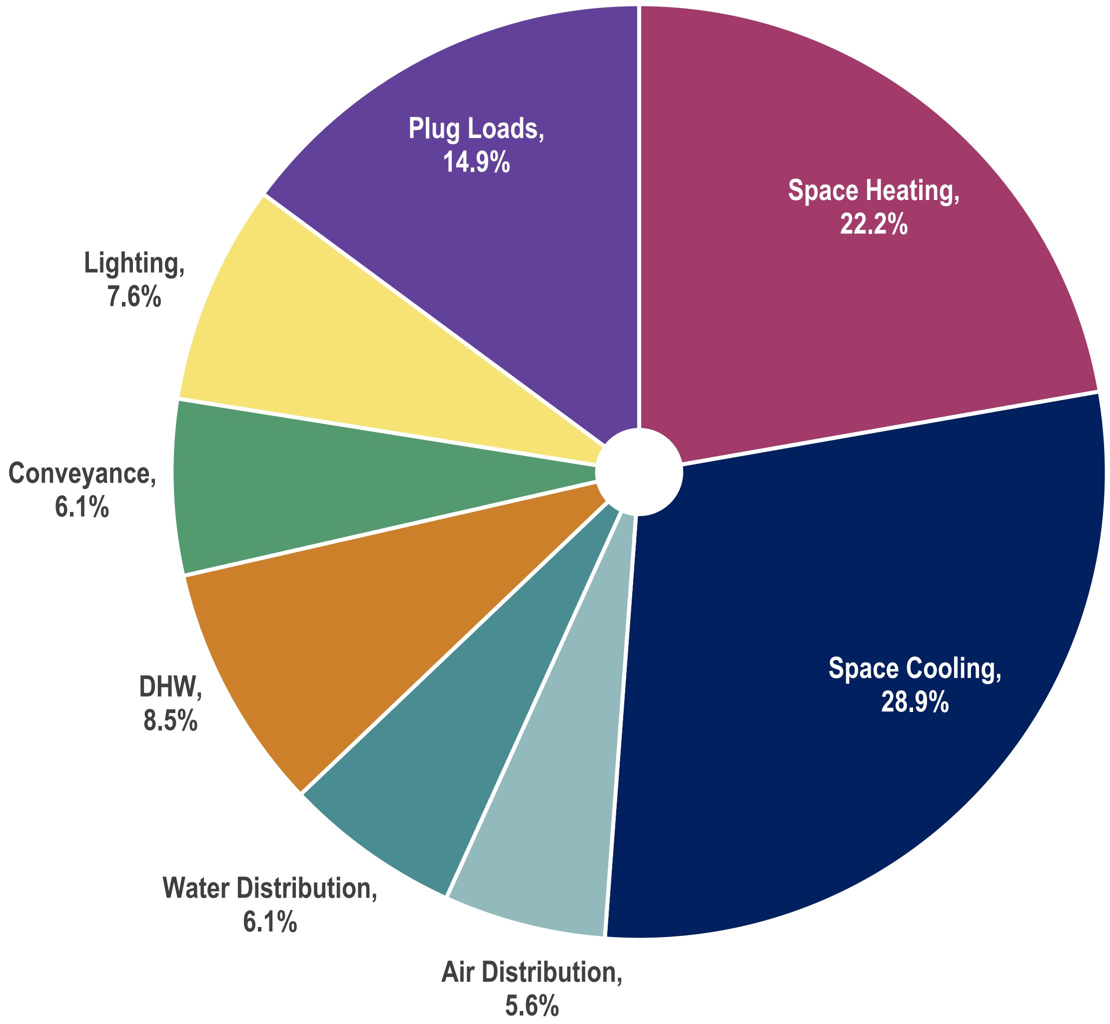
Notes:

1. A regression analysis was utilized to develop a simplified energy model for heating and cooling end uses in the building.

2. **Insight:** The regression analysis shows that 345 Park's steam profile approximately follows an expected trajectory, with steam usage driven by outside air temperature in the summer for cooling by steam chillers and in the winter for heating by steam to hot water heat exchangers.

UTILITY ANALYSIS (NEW)

Total 2018 Consumption by End Use



End Use	Energy Consumption (kBtu)	% Energy Consumption
Space Heating	58,338,840	22.1%
Space Cooling	75,853,853	28.7%
Air Distribution	15,896,525	6.0%
Water Distribution	17,006,113	6.4%
Domestic Water Heating	22,412,574	8.5%
Conveyance	15,640,190	5.9%
Lighting	19,983,279	7.6%
Plug Loads	38,991,763	14.8%

Notes:

1. The end use categories are based on ASHRAE Standard 211-2018 Guidelines.
2. Equipment runtimes are based on discussions with building staff and standard assumptions, where applicable.

HORACE MANN

HORACE MANN TASK LIST STATUS (NEW)

Data Collection & Review

- ☑ Minimum 12-Months Pre-COVID Utility Data
- ☑ Existing Building MEP Drawings
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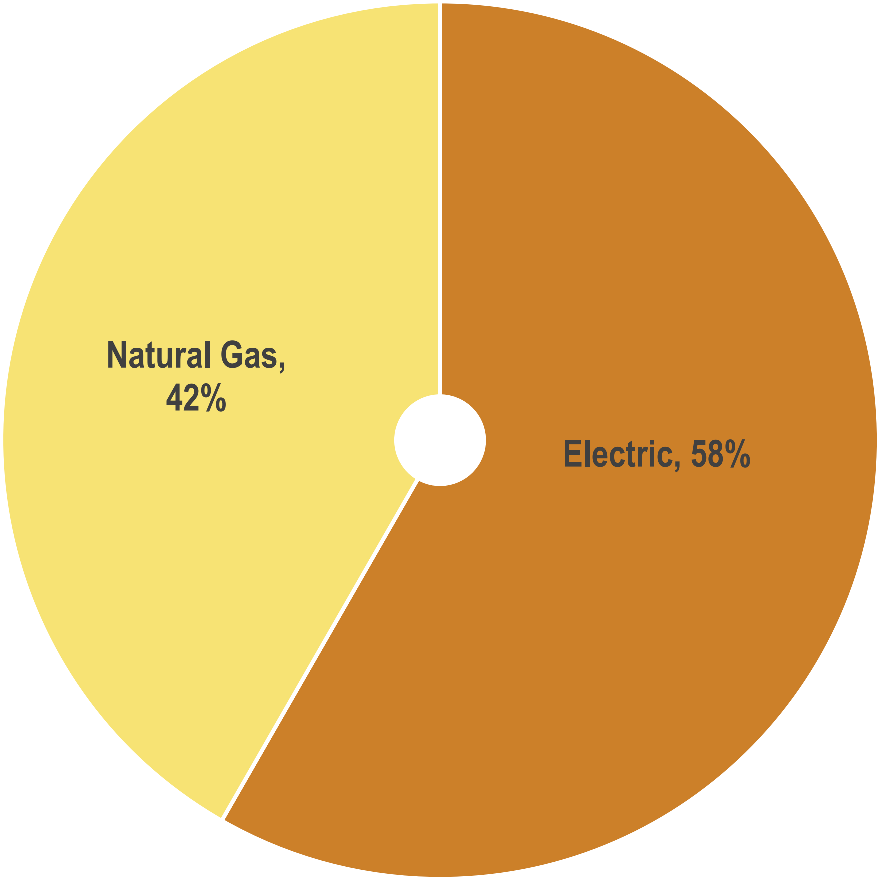
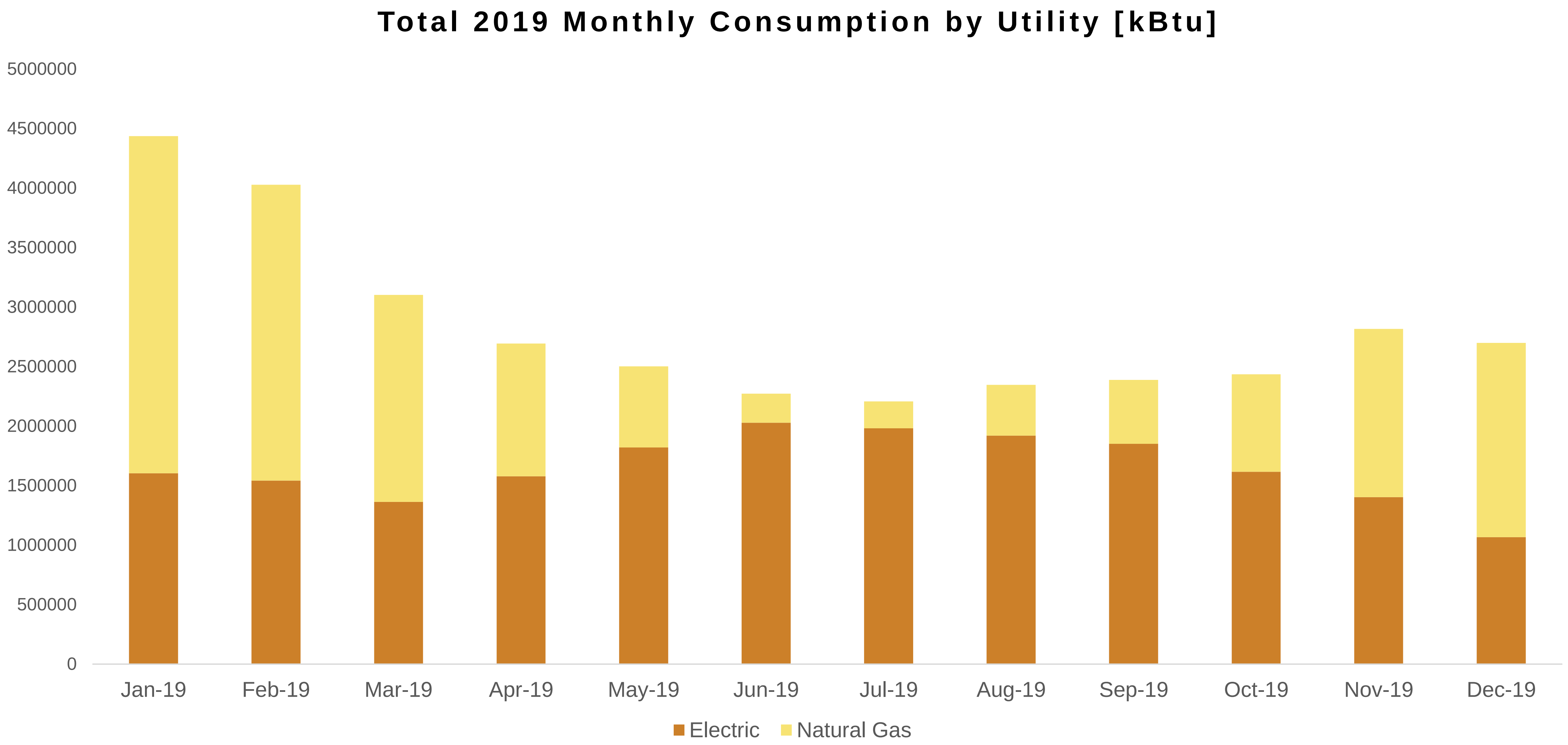
BASELINE ENERGY MODEL (NEW)

2019 Energy Consumption by Utility



Energy Source	Energy Consumption [kBTUs]	% Energy Consumption
Electricity	19,779,432	58%
Natural Gas	14,151,700	42%

BASELINE ENERGY MODEL (NEW)



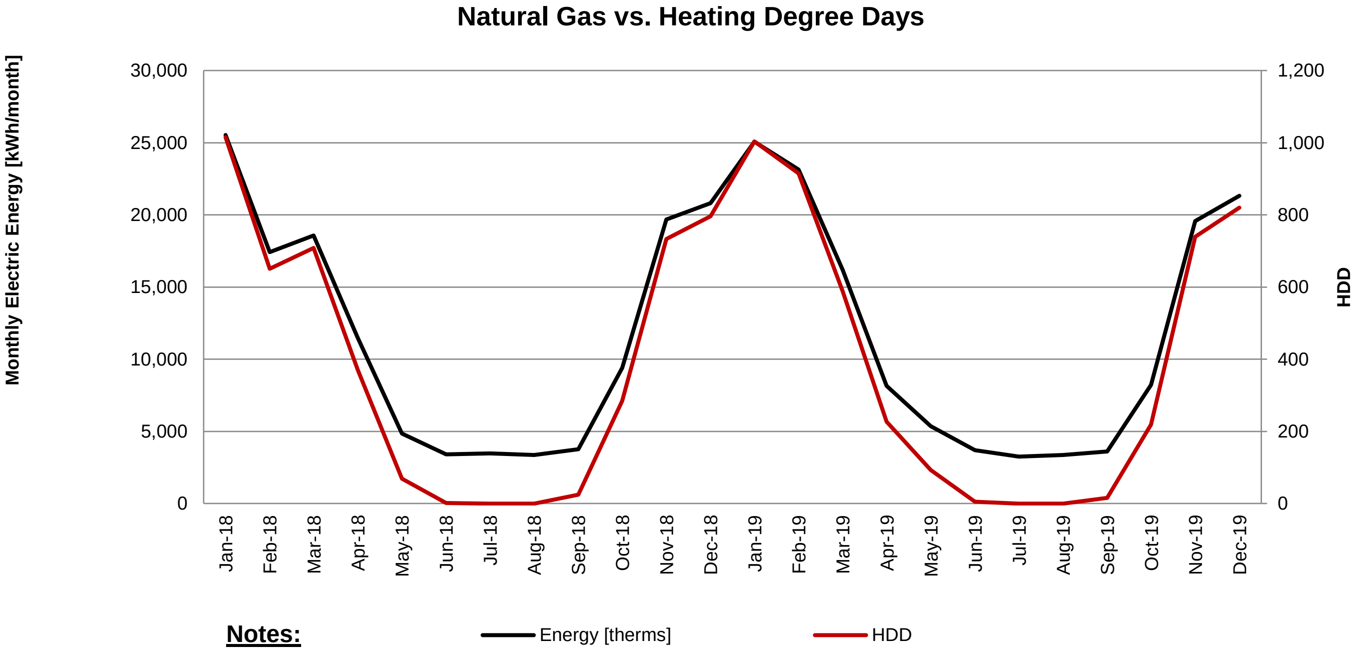
Total 2019 Consumption: 33,931,132 kBtu

JBB

BASELINE ENERGY MODEL (NEW)

Natural Gas

Year	Month	Energy [therms]	Days	HDD
2018	January	25,547	32	1,016
2018	February	17,430	30	651
2018	March	18,572	29	709
2018	April	11,486	31	371
2018	May	4,854	30	69
2018	June	3,394	30	2
2018	July	3,474	31	0
2018	August	3,362	30	0
2018	September	3,769	29	24
2018	October	9,392	29	284
2018	November	19,673	34	734
2018	December	20,811	32	797
2019	January	25,074	30	1,004
2019	February	23,150	30	915
2019	March	16,179	31	588
2019	April	8,159	29	227
2019	May	5,362	30	93
2019	June	3,694	32	5
2019	July	3,250	29	0
2019	August	3,362	30	0
2019	September	3,596	29	16
2019	October	8,210	31	219
2019	November	19,568	32	739
2019	December	21,330	32	821



Notes:

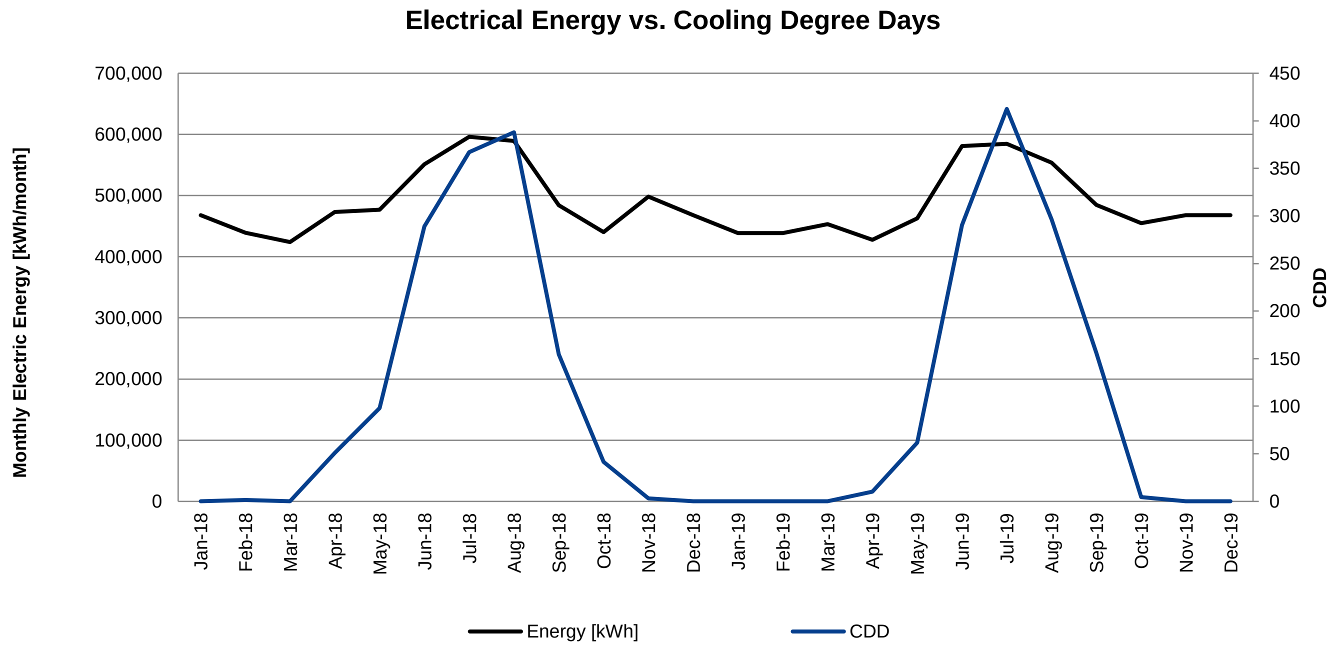
1. A regression analysis was utilized to develop a baseline energy model for heating end uses in the building. This analysis often allows the energy auditing team to better understand the facilities' heating energy profile and will form the analytical foundation for energy reduction analysis associated with ECMs impacting building heating loads.

2. **Insight:** The regression analysis shows that Horace Mann's natural gas profile follows an expected trajectory, with usage driven by outside air temperature in the winter.

BASELINE ENERGY MODEL (NEW)

Electricity

Year	Month	Energy [kWh]	Days	CDD
2018	January	467,828	32	0
2018	February	439,172	30	2
2018	March	423,969	29	0
2018	April	473,047	31	51
2018	May	476,709	30	98
2018	June	551,005	30	289
2018	July	595,966	31	367
2018	August	589,515	30	388
2018	September	484,067	29	155
2018	October	440,112	29	42
2018	November	498,234	34	3
2018	December	467,828	32	0
2019	January	438,589	30	0
2019	February	438,589	30	0
2019	March	453,208	31	0
2019	April	427,859	29	10
2019	May	462,511	30	62
2019	June	580,828	32	291
2019	July	584,425	29	413
2019	August	553,923	30	297
2019	September	484,651	29	156
2019	October	454,959	31	5
2019	November	467,828	32	0
2019	December	467,828	32	0



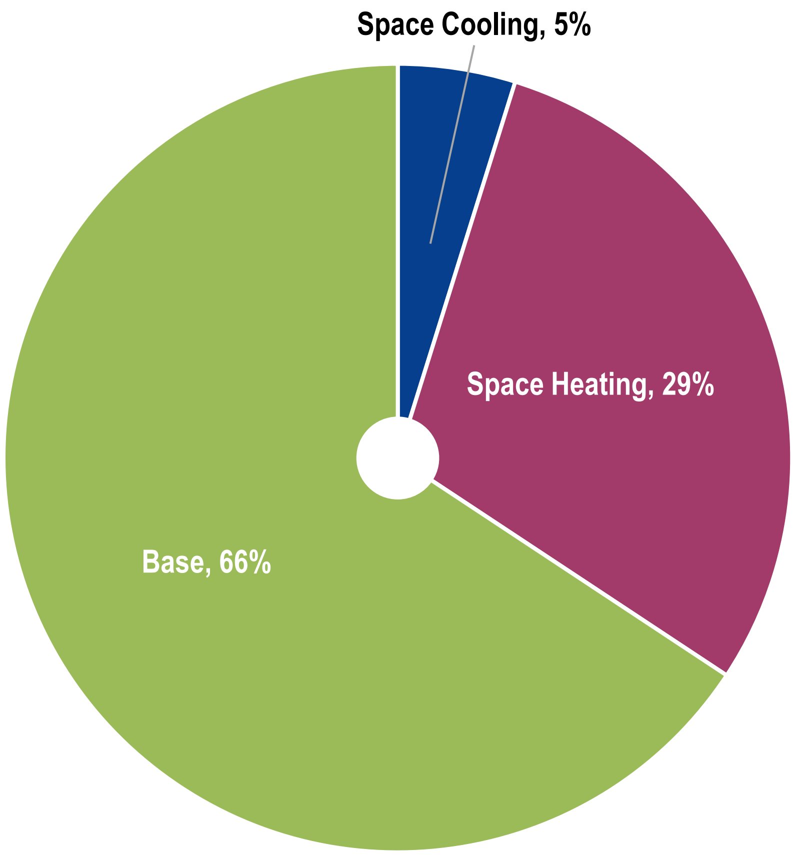
Notes:

1. A regression analysis was utilized to develop a baseline energy model for cooling end uses in the building. This analysis often allows the energy auditing team to better understand the facilities' cooling energy profile and will form the analytical foundation for energy reduction analysis associated with ECMs impacting building cooling loads.

2. **Insight:** The regression analysis shows that Horace Mann's electricity profile follows an expected trajectory, with usage driven by outside air temperature in the summer.

UTILITY ANALYSIS (NEW)

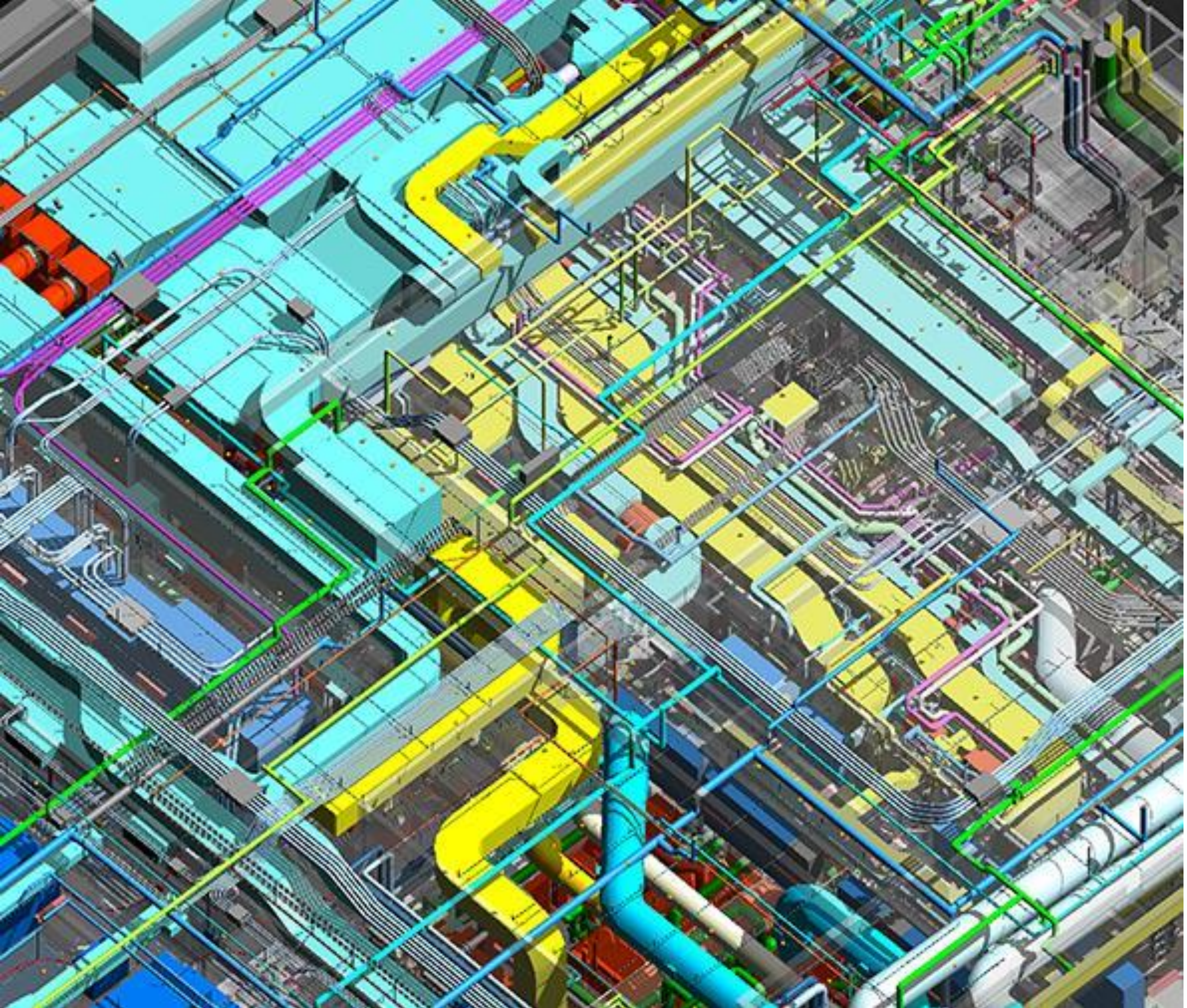
Total 2019 Consumption by End Use



End Use	Energy Consumption (kBtu)	EUI (kBtu/sq.ft)
Space Cooling	1,634,469	6.13
Space Heating	10,003,005	37.49
Base Building	22,297,382	83.57
Total	33,934,856	127.19

Notes:

1. The entire Horace Mann campus is metered together, which does not allow for breaking down the end uses beyond a linear regression of the utility information
2. Space heating and space cooling was determined from the linear regression of the electric and natural gas data based on the heating and cooling degree days in each period.



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