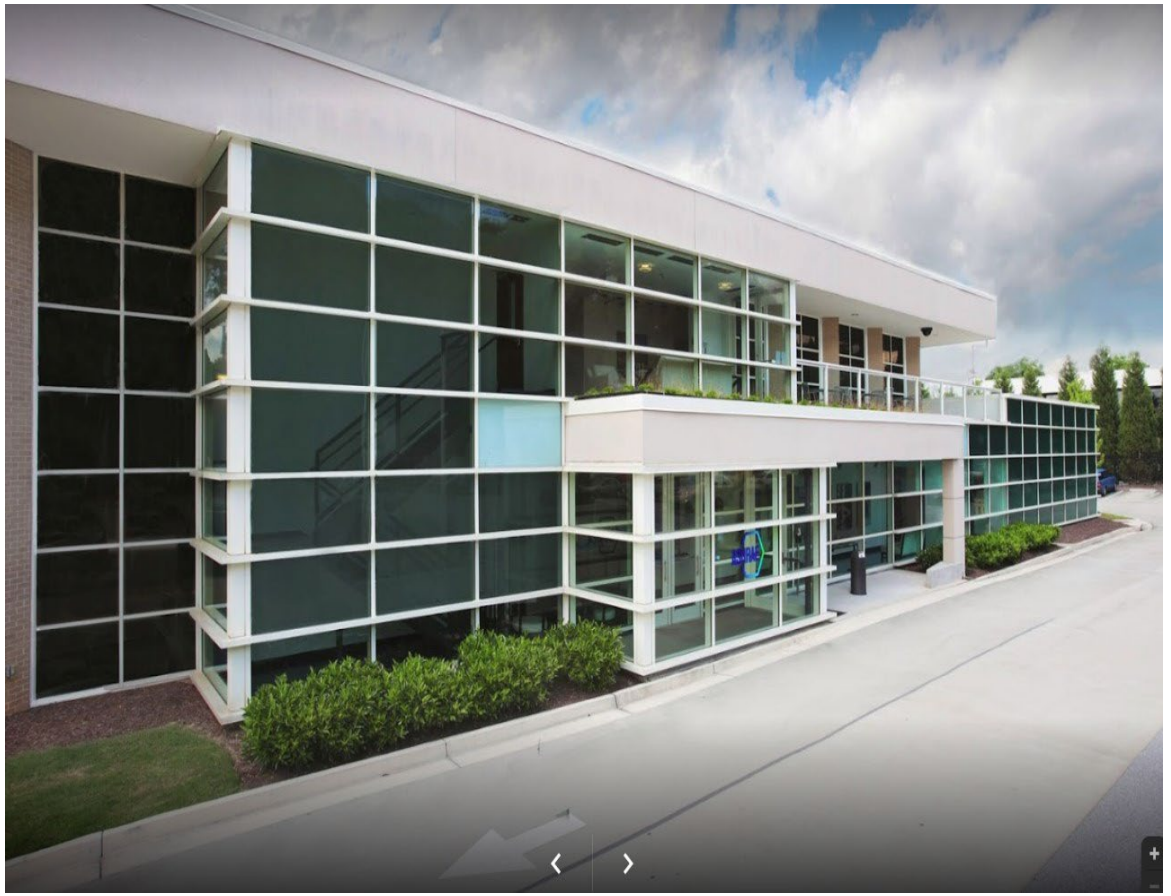
ASHRAE's New Headquarters: Applying Sustainable Development Principles in the Real World

Darryl K. Boyce, P.Eng.
2019-20 ASHRAE President

About

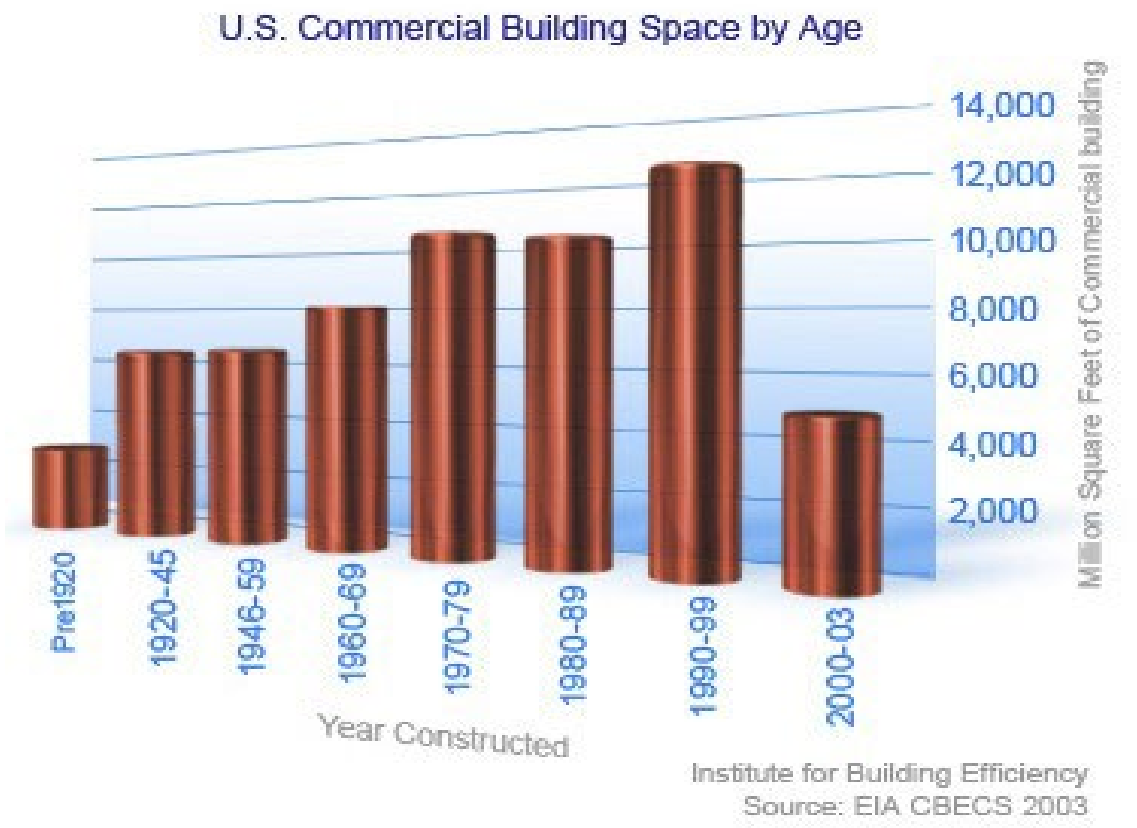
ASHRAE Headquarters Building Ad Hoc Committee: (L to R) Jeff Littleton, Michael Cooper, Blake Ellis, Ginger Scoggins (Chair), Darryl Boyce, Don Brant, Tim McGinn (Technical Advisory Subcommittee Chair), Kent Peterson

Legacy ASHRAE Headquarters



- *1791 Tullie Circle NE, Atlanta, GA*
- *35,000 sq. ft. building – 2 stories with learning center on 1st level*
- *Renovated in 2010 to LEED Platinum level*

Project Goal



In developed economies, at least half of the buildings that will be in use in 2050 *have already been built.*[4][5] According to a recent survey by the U.S. Energy Information Agency, 72 percent of floorstock in the U.S., or 46 billion square feet, belongs to buildings over twenty years old.[6]

Project Goal:

To renovate a 1970's building into a high-performing net-zero-ready facility in a cost-effective method that can be replicated in the industry.

What is our Story?

"Our organization relies on harvesting the technical knowledge, volunteer energy, and expertise of our members. We want this space to inspire visitors to participate and honor them for their volunteer service and commitment."

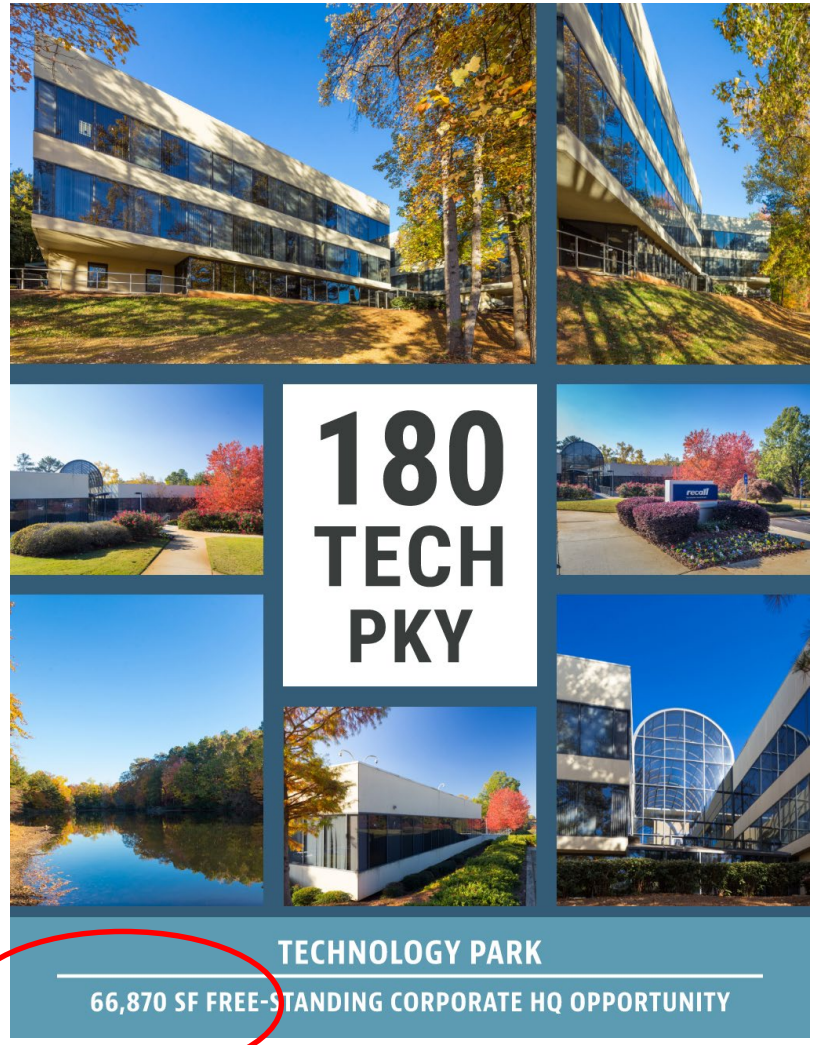
- Jeff Littleton, Executive VP for ASHRAE

Program Summary

Initial Program (areas in NSF):

Departmental Areas:

Administrative Staff:	1,044
Marketing:	2,055
Development:	633
Member Services:	1,137
Technology:	1,089
Finance & Admin Services:	1,713
Publications & Education:	2,383
Shared Conference/Meeting:	4,500
Service Spaces:	7,961
Conference Center:	6,180
Total Net Program Area:	28,725
Gross Program Area:	**44,000 gsf (approx.)**



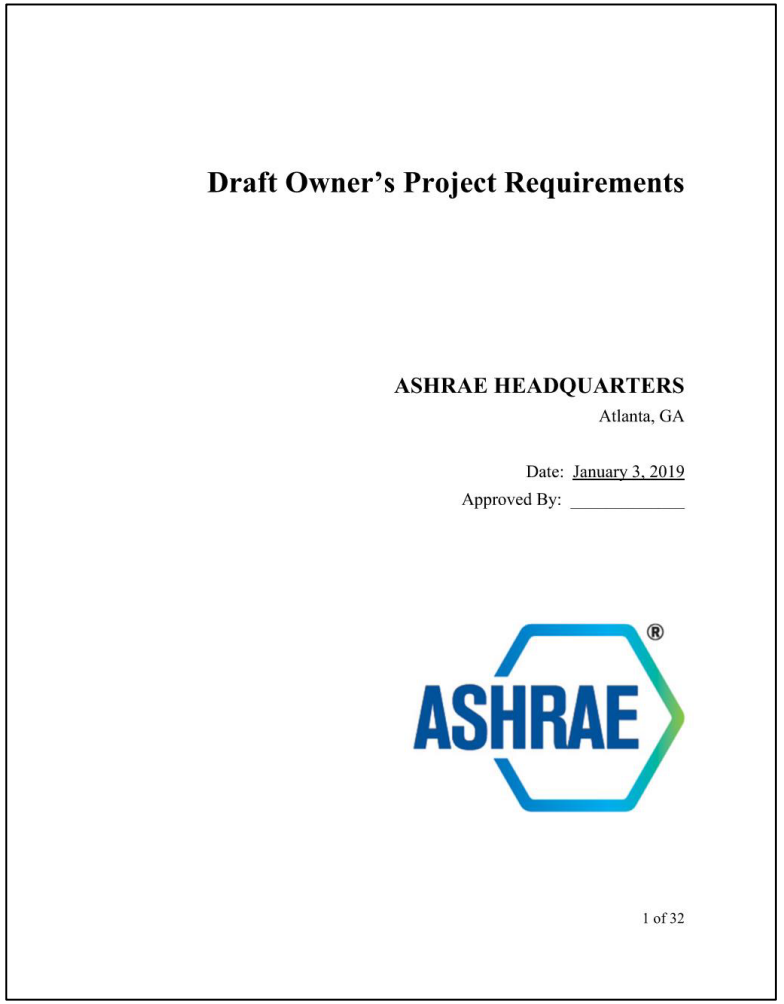
New ASHRAE Headquarters

- *180 Technology Parkway, Peachtree Corners, GA*
- *66,000 sq. ft. building – 3 stories*
- *Built in 1970's*
- *Purchased by ASHRAE in December 2018*

Owner’s Project Requirements

- Owner’s Project Requirements (OPR) document establishes owner goals:

- Mission Critical Items:
  - **SAFETY** – Safe work environment and construction
  - **AFFORDABLE** – Constructed within the available funding
  - **ASHRAE STANDARDS** – Exceed applicable ASHRAE Standards
  - **ACCOUSTICS** – Exceed Acoustical levels for Office Environments
  - **NET ZERO ENERGY READY** – Requires low EUI levels


Draft Owner’s Project Requirements

ASHRAE HEADQUARTERS

Atlanta, GA

Date: January 3, 2019

Approved By: _____

ASHRAE®

1 of 32

Owner's Project Requirements (OPR)

Item	OPR
ASHRAE 189.1-2017	Exceed Requirements
Site Energy Consumption	21.4 kBTU/SF/year 15 kBTU/SF/year (stretch)
Water Efficiency	Obtain 11 of 11 LEED Water Use Efficiency Points
Daytime Plug Load	0.04 W/SF
Acoustics	Exceed requirements by 3-5 NC/RNC
Outside Air Supply	1.3 times ASHRAE 62.1
Outside Air Control	Demand Control Ventilation (DCV) for high occupancy spaces
Daylighting	Majority of Occupants achieve generous daylighting 55% of the time
Resiliency	Achieve resiliency in OPR

Schedule Constraints

January 2019: Design Team Selection

February 2019: Construction Manager Selection

April 1, 2019: Schematic Design Complete

May 15, 2019: Design Development Complete

August 1, 2019: Construction Documents Complete

September 15, 2019 – Start Construction Phase

August 15, 2020 – Construction Complete

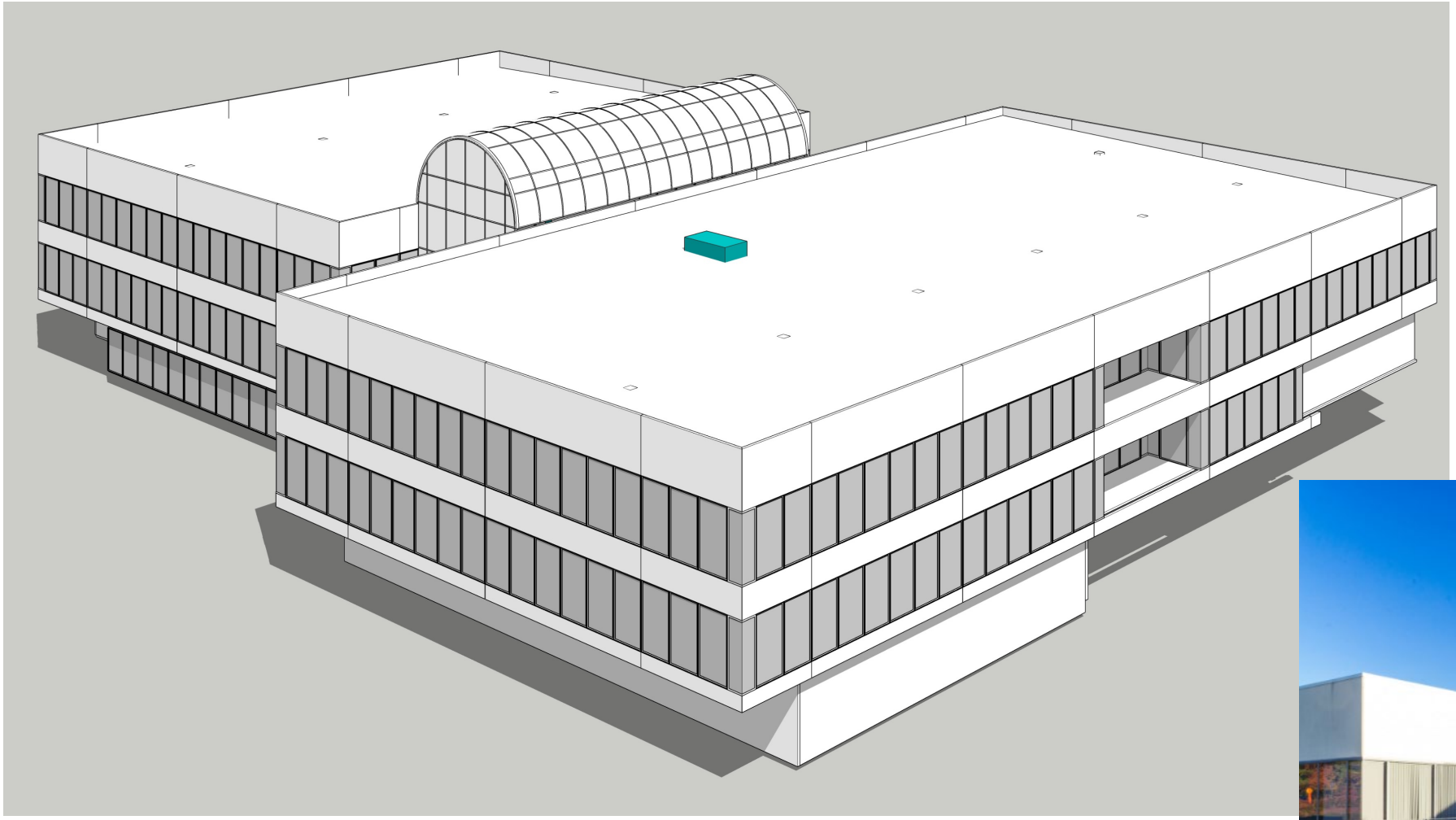
August – September 2020 – Commissioning Efforts

October 2020 – Ready for Full Occupancy

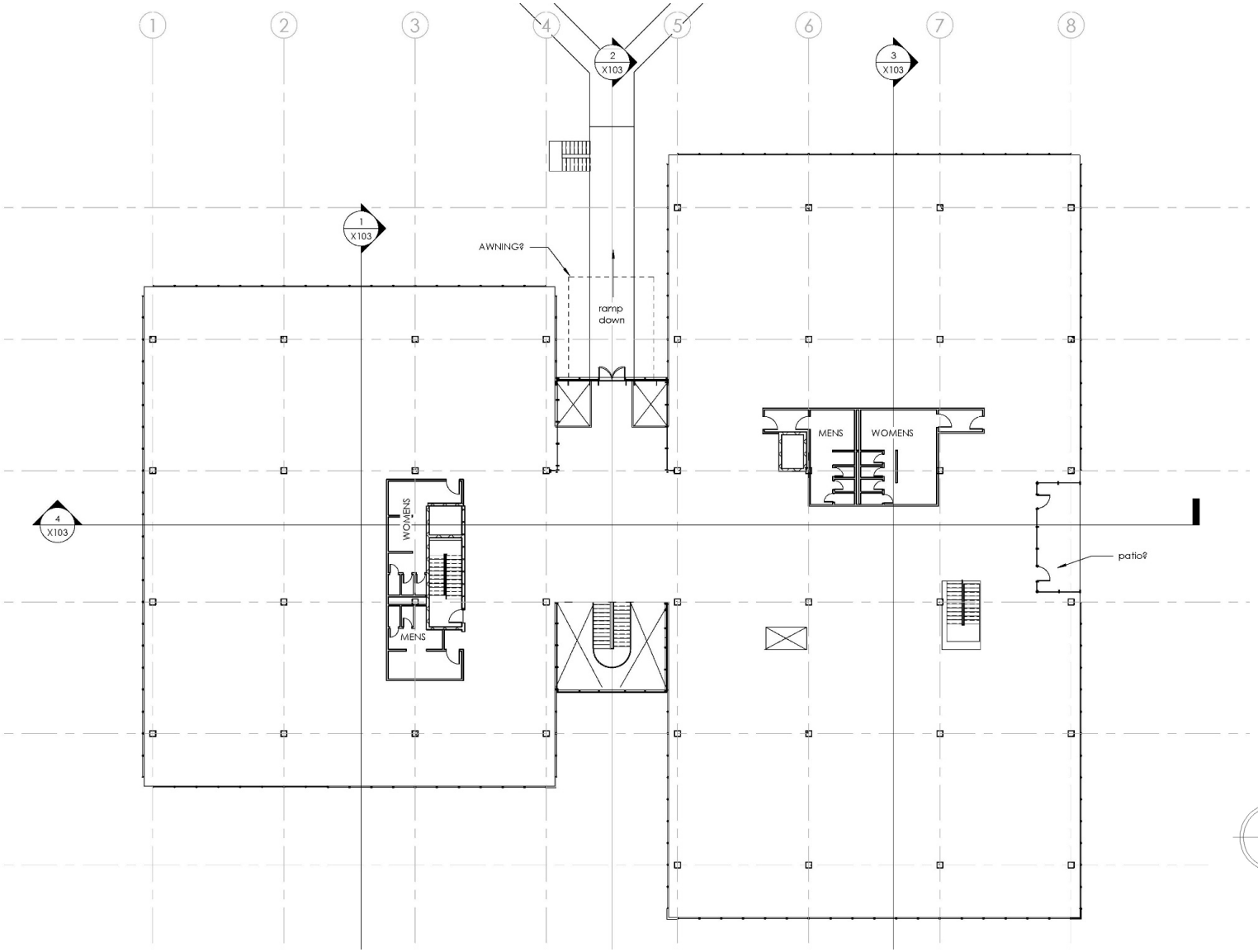
Project Execution Method

- *Decision #1:* Utilize a Project Manager
  - ASHRAE doesn't have Project Managers on staff
  - Needed to have day to day management of design team and contractor team
  - Ad Hoc developed an RFQ for a Project Manager
- *Decision #2:* Utilize Construction Manager at Risk
  - Wanted early contractor involvement
  - Atlanta market not familiar with Integrated Project Delivery
- *Decision #3:* Hire Project Team
  - Contracted Project Manager helped manage RFP's and select Design, Commissioning and Construction Manager

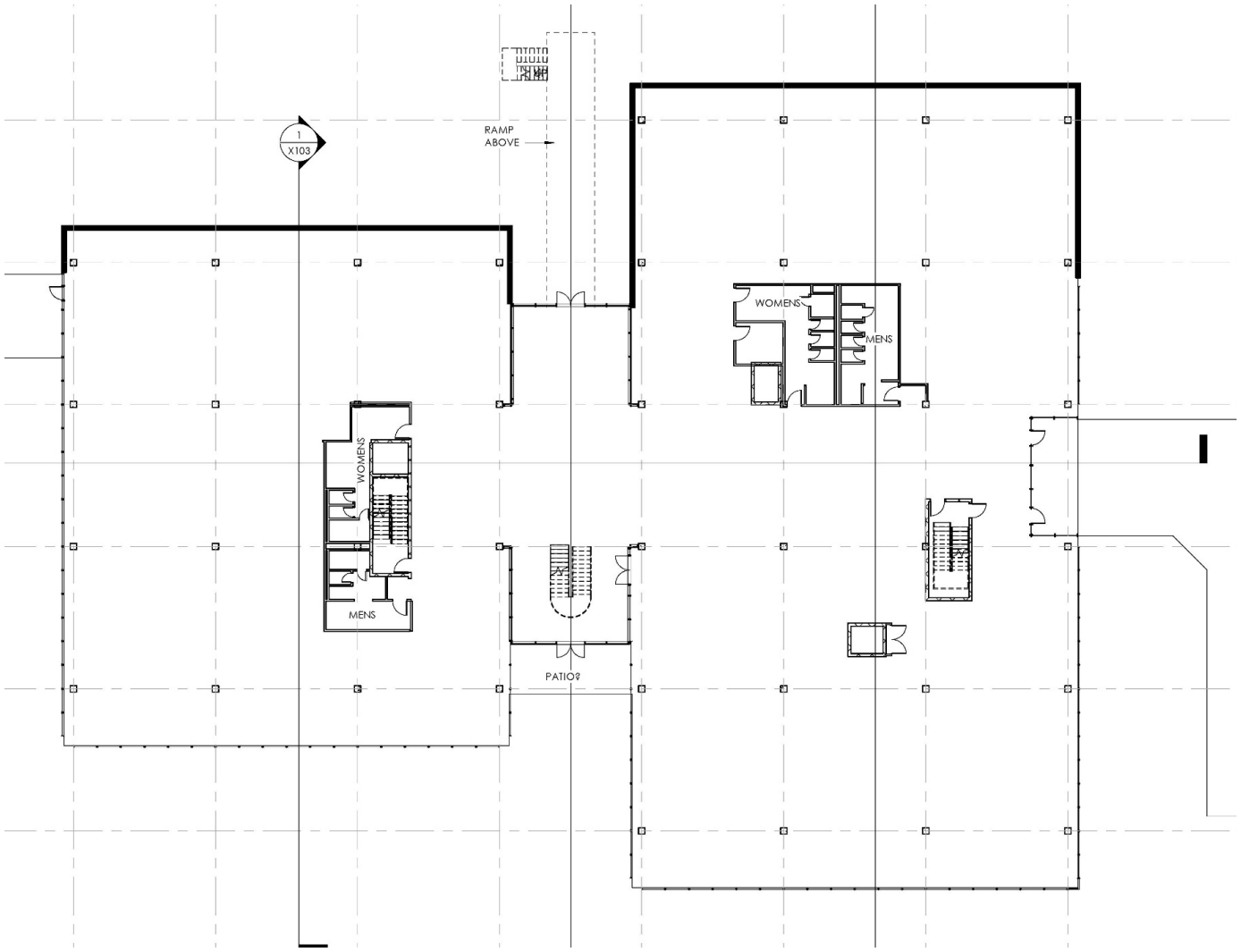
Existing Structure

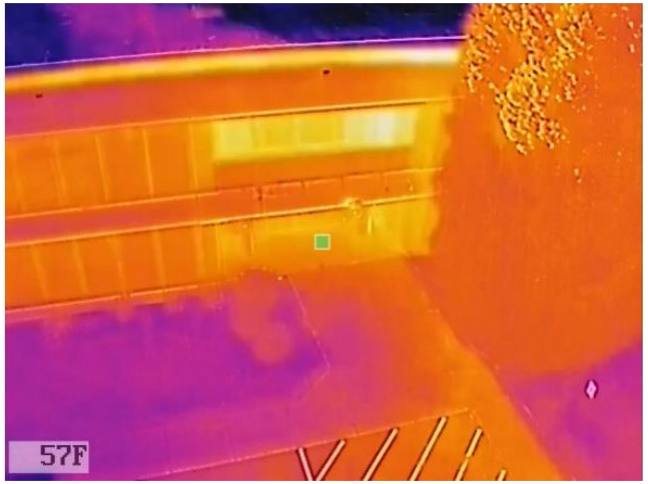


Existing Upper Level Floor Plan



Existing Middle Level Floor Plan





Primary Envelope Factors

Window to Wall Ratios (WWR)

- Important to define the optimum area of openings relative to achieving daylighting goals, as well as maximize the thermal efficiency of the wall.

Air Infiltration and Insulation

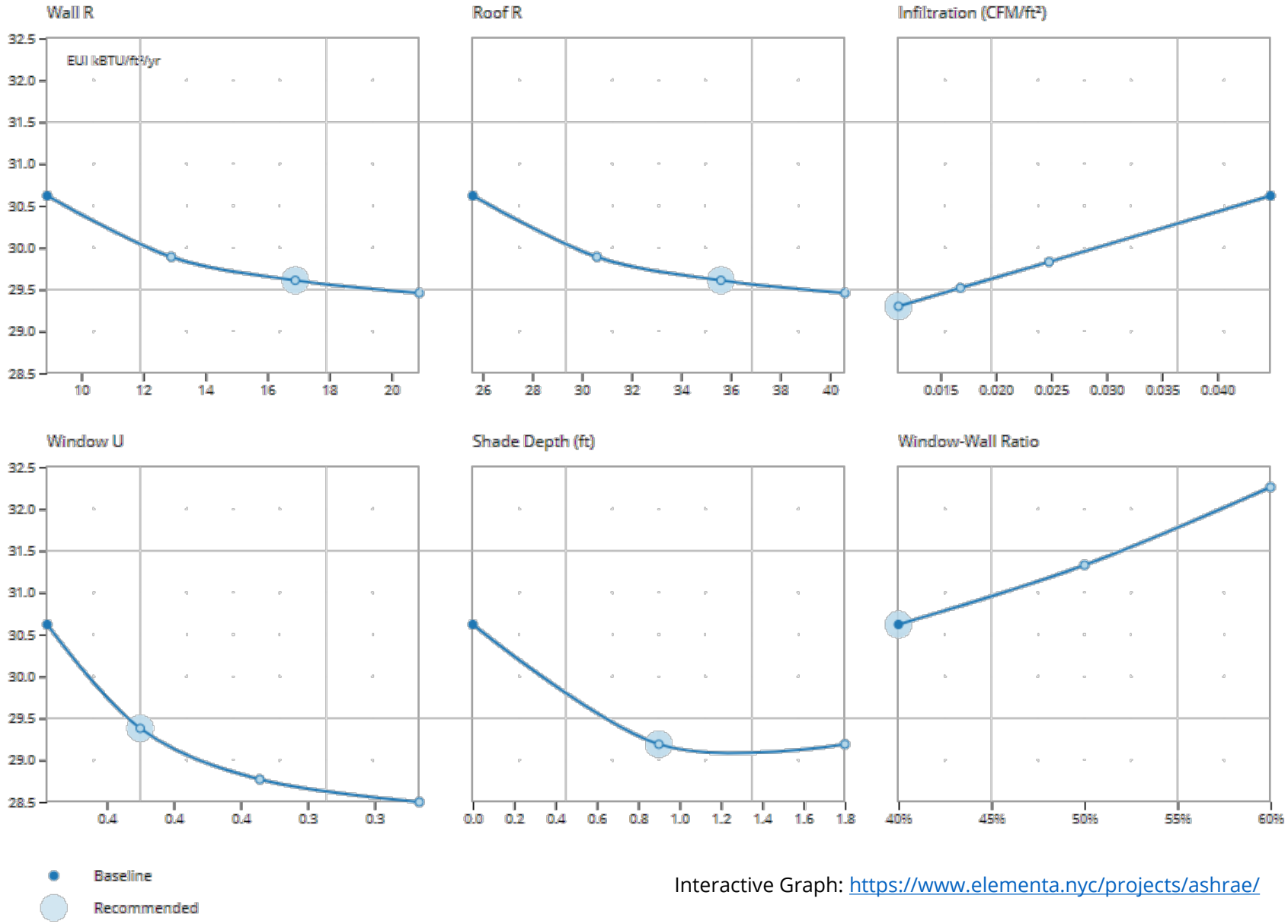
- Determining the optimal R-Value for each part of the exterior envelope and how to reduce air infiltration.

Envelope Sensitivity Analysis

Preliminary envelope performance targets based on point of diminishing Energy Use Intensity (EUI) savings shown at right:

Parameter	Existing Performance	ASHRAE 90.1-2016	Recommended
Wall Assembly	U-0.3 (R-3.0)	U-0.122 (R-8.0)	**U-0.058 (R-17)**
Roof Assembly	U0.047 (R-21)	U-0.039 (R-25)	**U-0.028 (R-35)**
Window Assembly	U-0.59 SHGC-0.52	U-0.45 SHGC-0.25	**U-0.40 SHGC-0.25**
Window to Wall Ratio	~50%	40%	**40%**
External Shade Depth	N/A	N/A	**1'** (to be further optimized for visual, thermal comfort)
Infiltration	0.025 cfm/ft²	0.045 cfm/ft²	**0.011 cfm/ft²**

ASHRAE NZE AEDG recommends R-15.6 wall for Climate Zone 3!



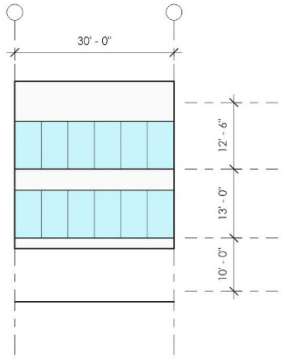
Interactive Graph: https://www.elementa.nyc/projects/ashrae/

Final Window Wall Ratios

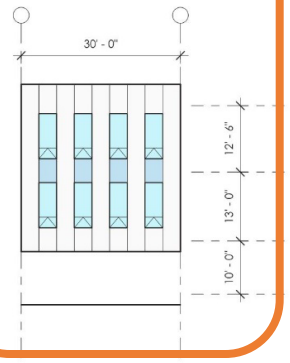
East and West

North and South

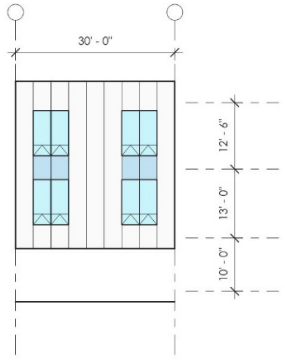
EXISTING
WWR 79.9%



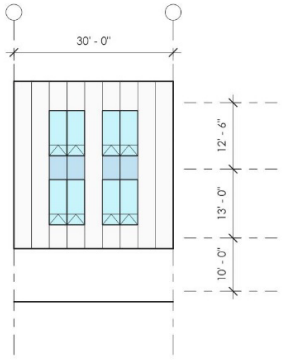
WWR 33.5%



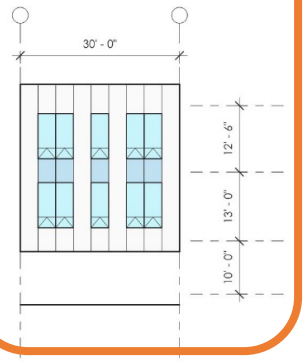
WWR 33.5%



WWR 33.5%

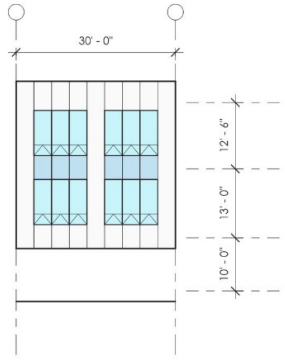


WWR 41.9%

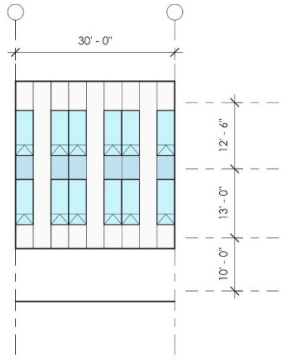


Optimo Panel Widths: 24, 30, 36, 40
Karrier Panel Widths: 24, 30, 36, 40, 42

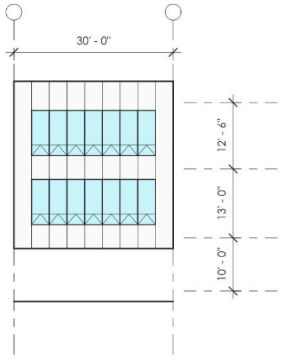
WWR 50.3%



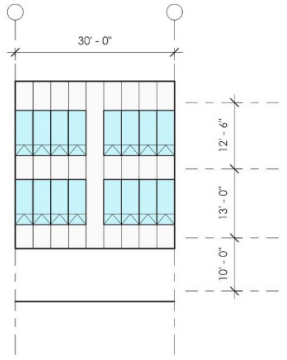
WWR 50.3%



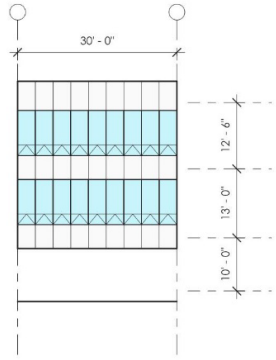
WWR 58.7%



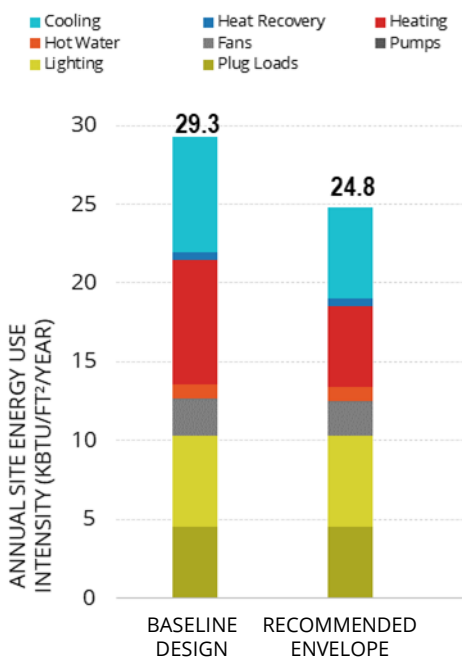
WWR 67.1%

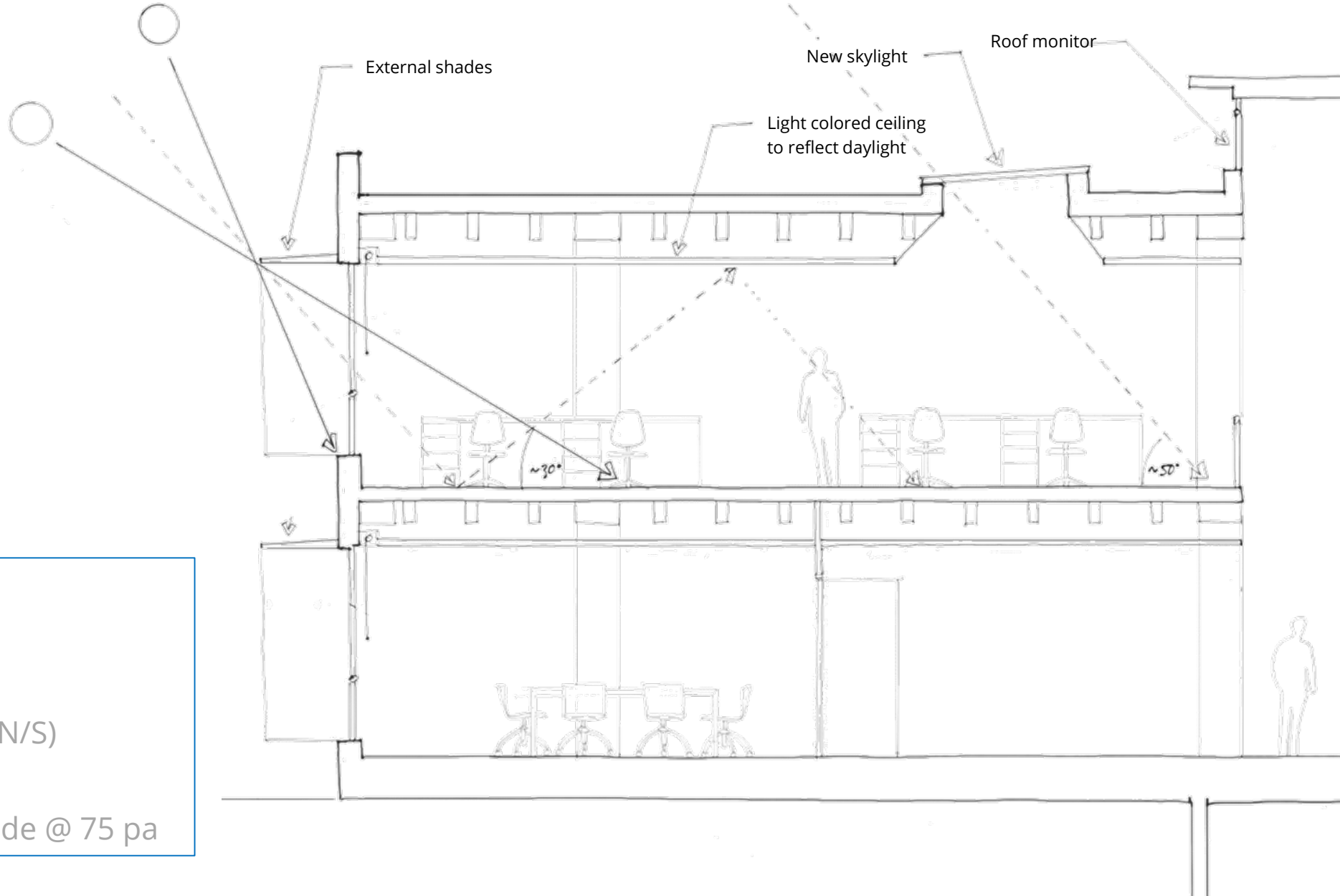


WWR 75.4%



High Performance Envelope





Recommended Envelope

R17 Walls | R35 Roof

U-0.4 | SHGC-0.25

~32% WWR (30% E/W, 40% N/S)

Minimum 1’ overhangs

Infiltration < 0.1 cfm/sf façade @ 75 pa

Daylight Strategies

Skylights

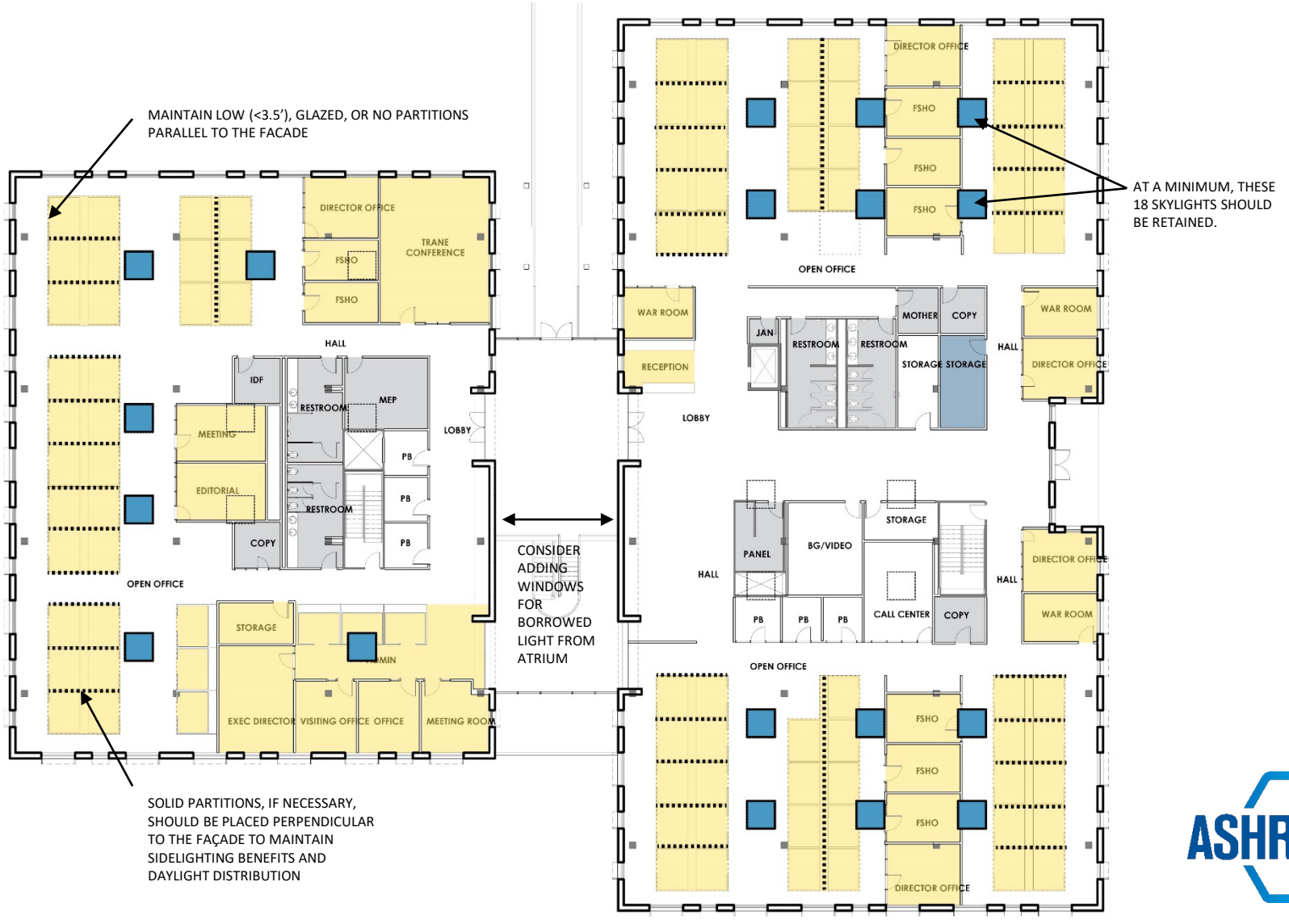
- Double the daylit floor area on the upper floor
- Provides useful daylight illuminance to 70% of work areas
- Offers significant opportunity for electric light dimming.
- The 18 skylights shown at right (in blue) provided the best impact according to ASHARE's consultant

Raised Windows

- Raising the window height increases the daylit floor area percentage from 36-46%.

Interior Desk Layout

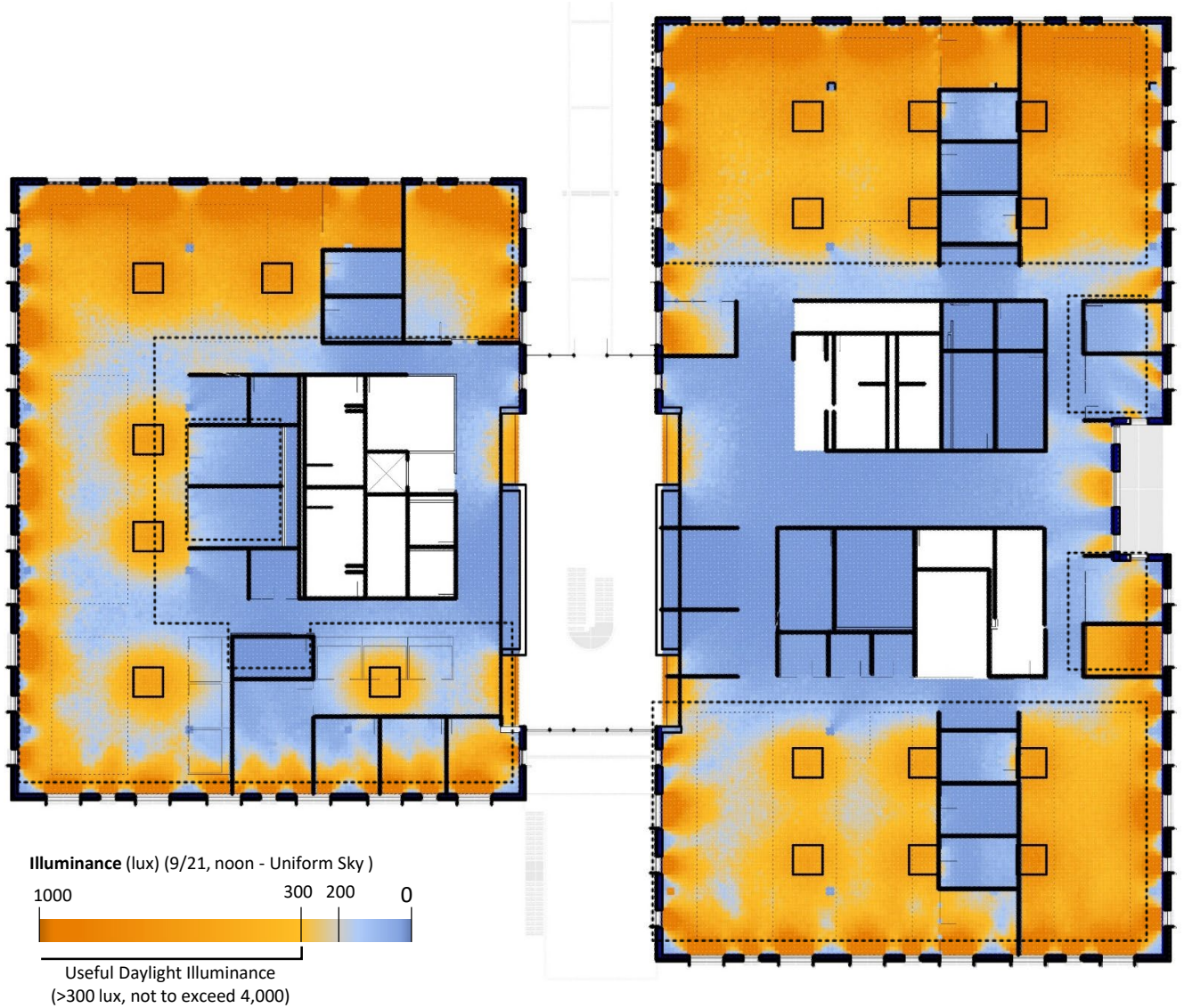
- Tall and/or opaque desk partitions running parallel to the façade must be avoided in order to maintain side-lighting benefits.



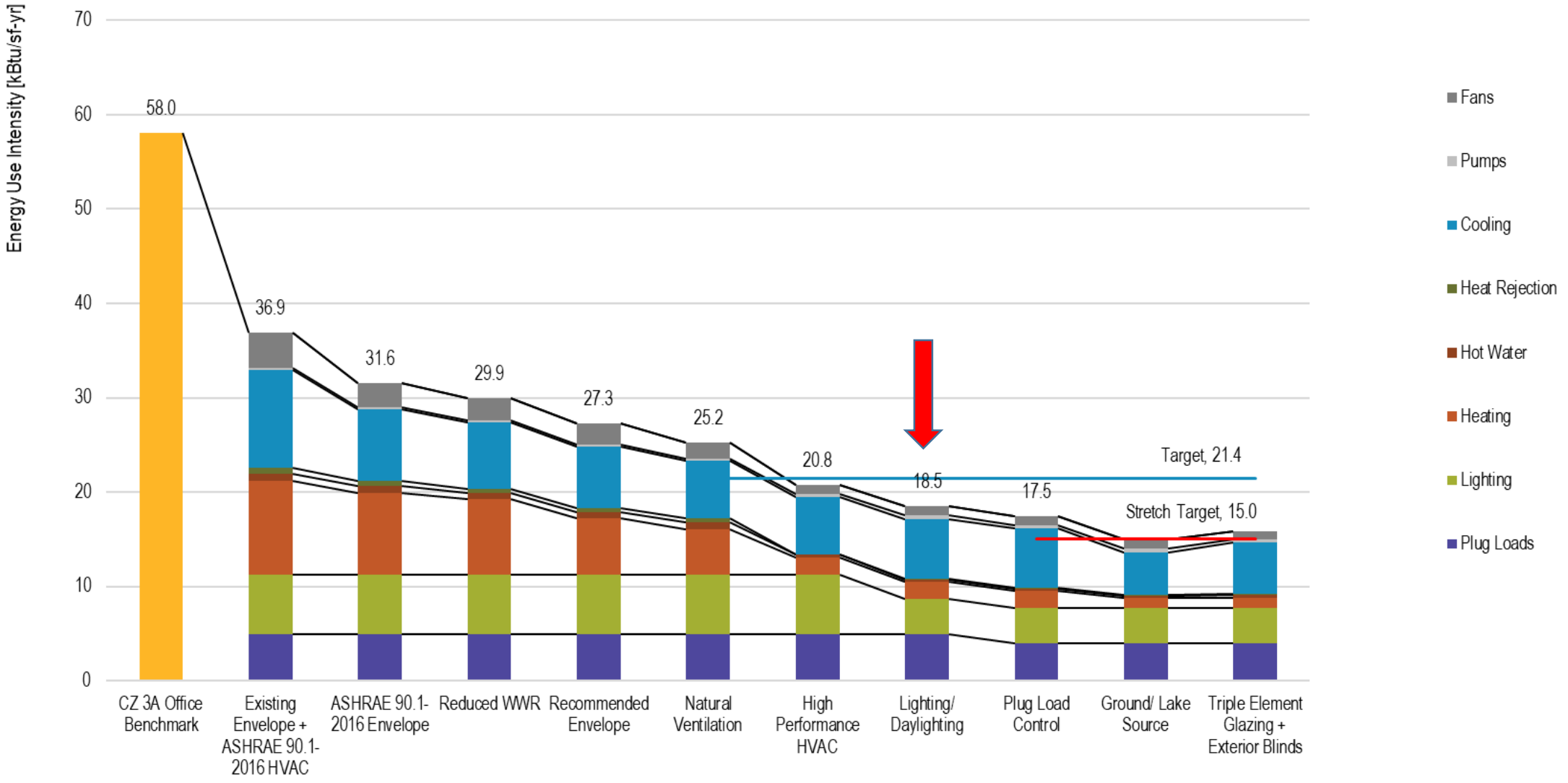
Daylight Strategies – 18 Skylights

57%

Percentage of regularly occupied workspaces on the upper level with useful daylight illuminance (>300 lux) at the work plane



Path to Net Zero



HVAC Solution : Hydronic Systems

DOAS

With enthalpy heat recovery and DCV

Option 1A: Add desiccant wheel

Option 1B: Add DX Trim Coil

CW Terminal Unit Options

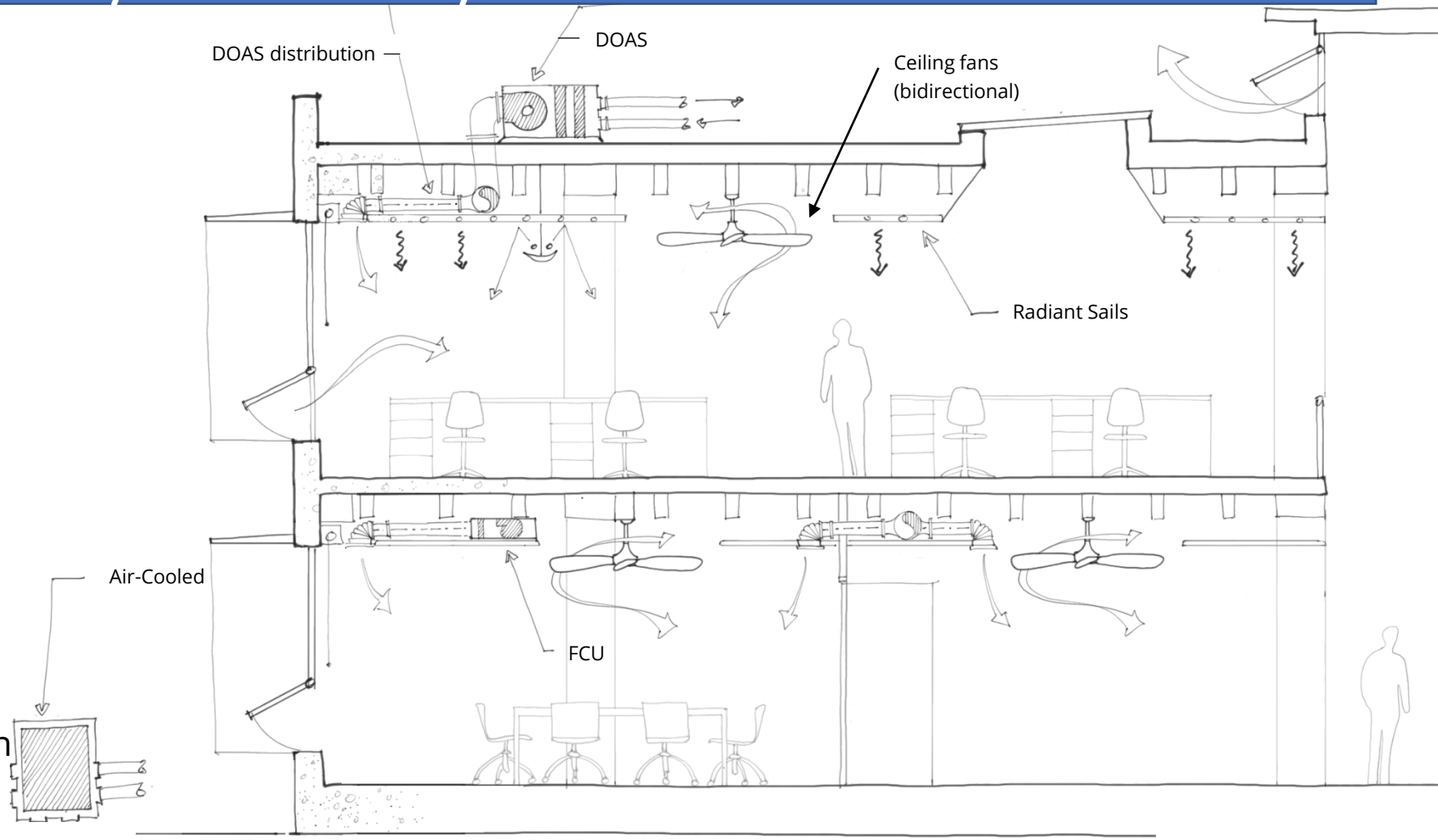
Radiant Ceiling Panels

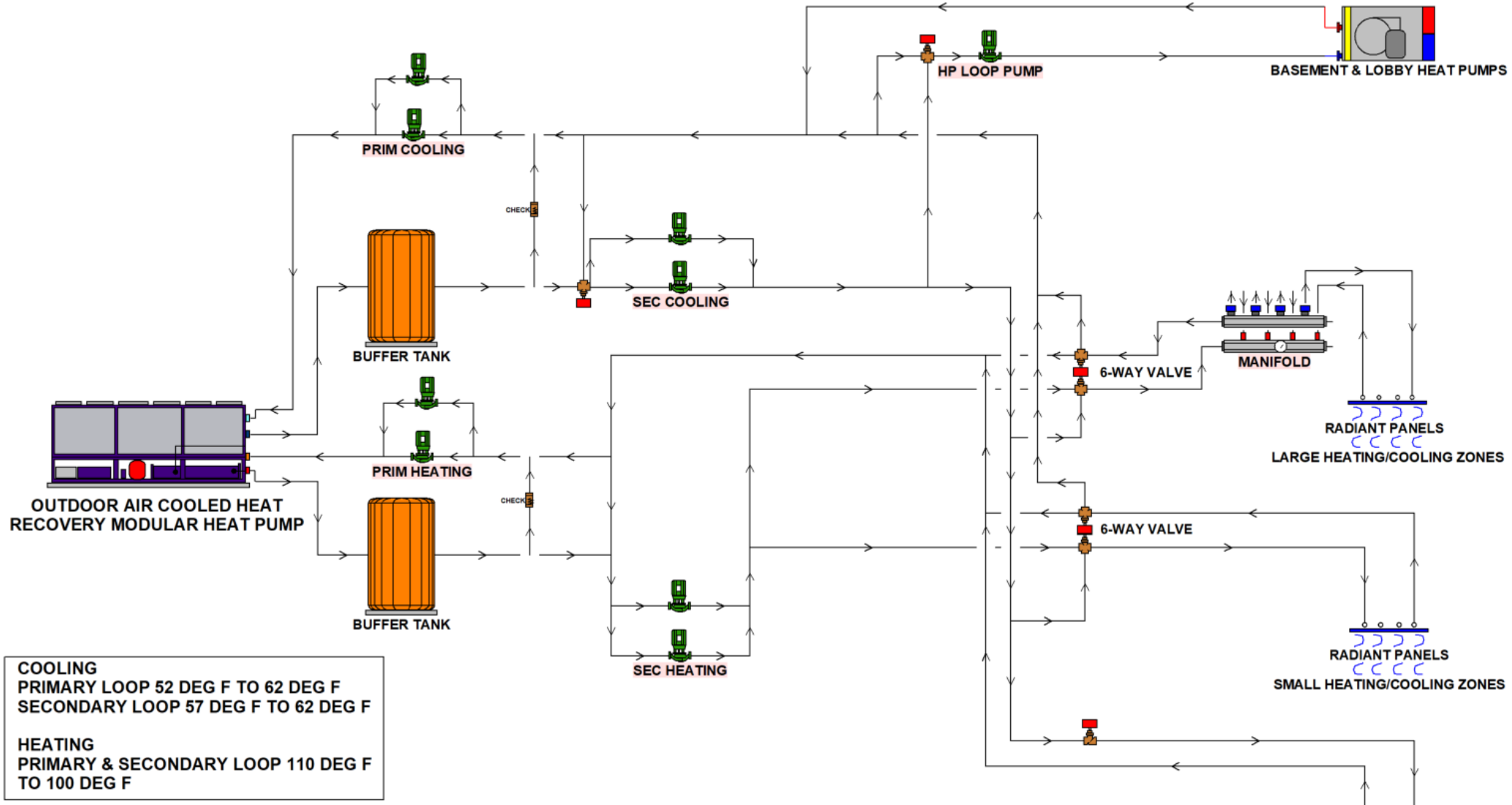
Sensible Fan Terminal Units

Heat Pump Options

Air-Cooled HP

Night-Flush & Mixed-Mode Ventilation

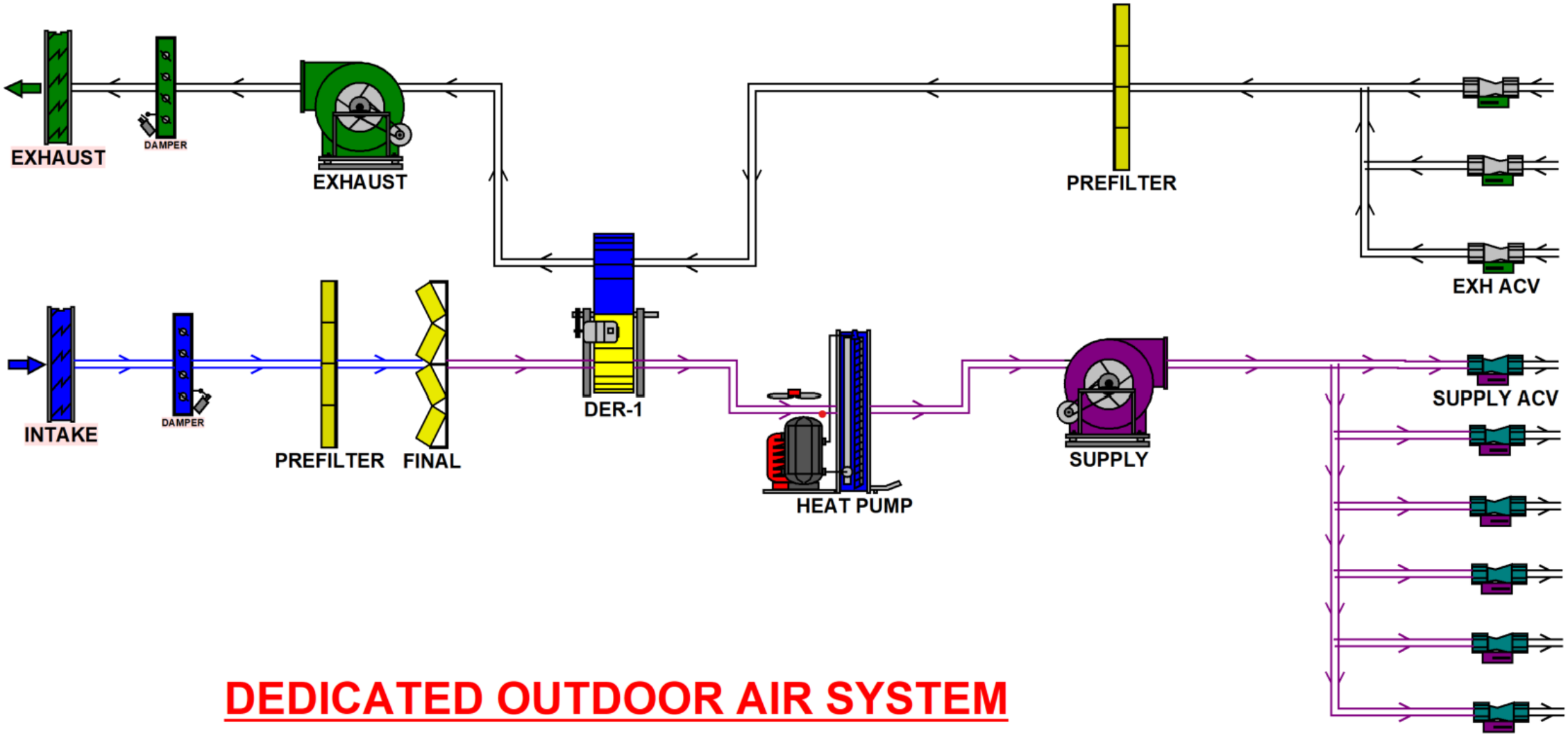




COOLING
PRIMARY LOOP 52 DEG F TO 62 DEG F
SECONDARY LOOP 57 DEG F TO 62 DEG F

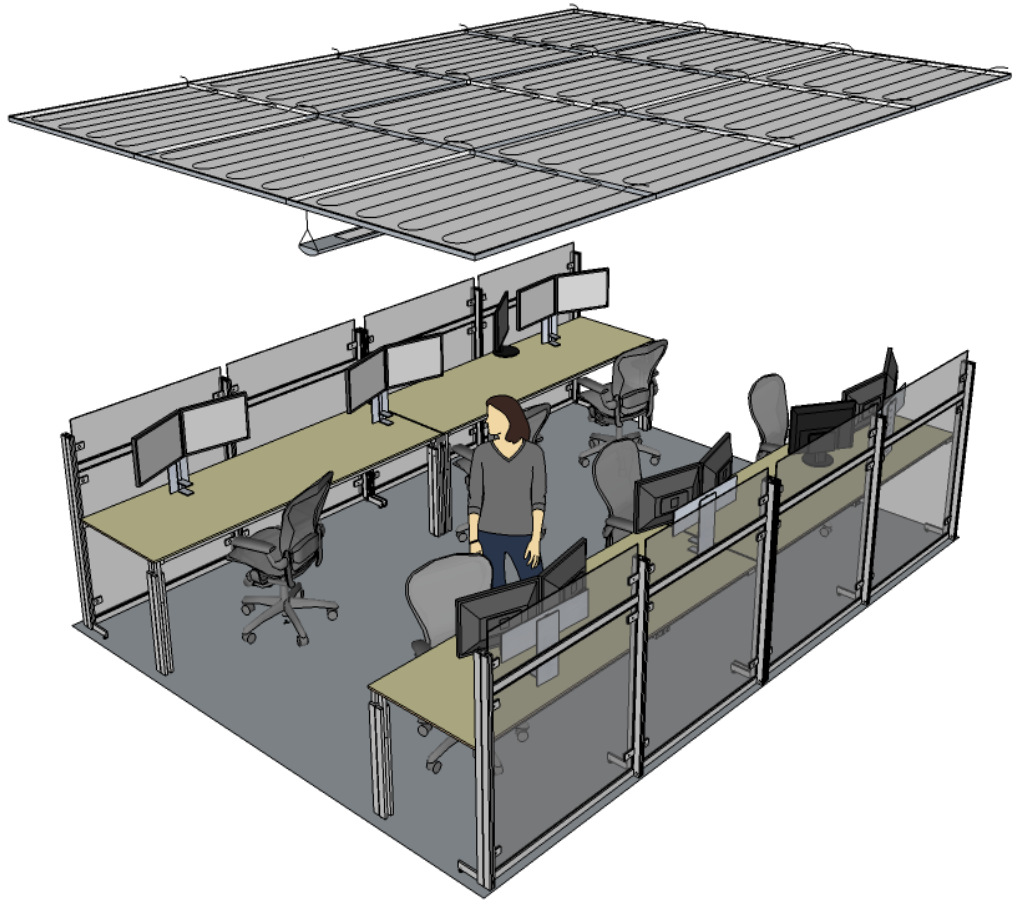
HEATING
PRIMARY & SECONDARY LOOP 110 DEG F TO 100 DEG F

HEATING & COOLING SYSTEM



DEDICATED OUTDOOR AIR SYSTEM

Overhead Radiant Systems



- Radiant Panels form clouds above the occupied spaces
- Primary heating and cooling in these spaces is provided by the panels.
- Ventilation is cool/neutral temperature air delivered directly to the space and not directly responsible for temperature control within the zone.

Upper Level

(1) Large Conference Room

(3) Medium Conference Room

(1) Small Conference Room

(7) FSHO

(2) WAR Room (Small Conference)

Middle Level

(7) Medium Conference Room

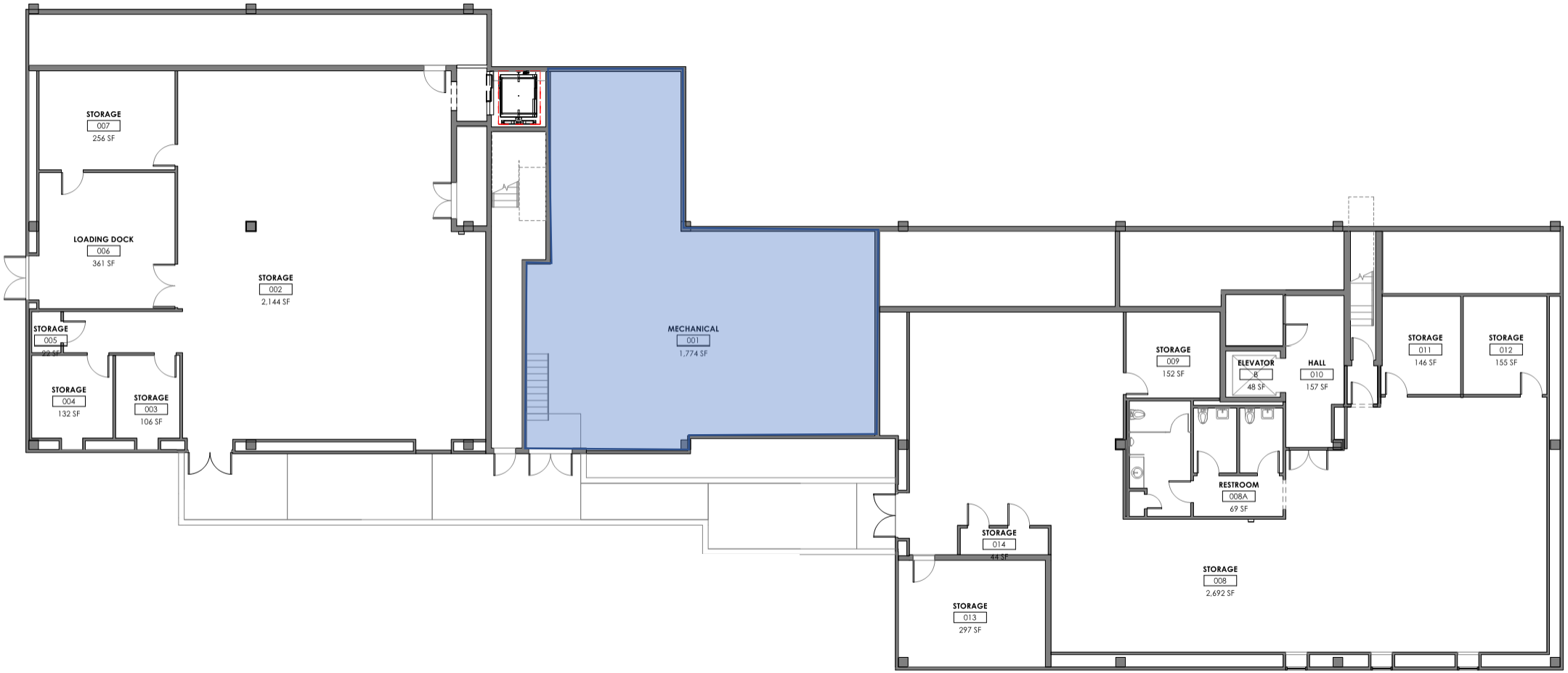
(1) Small Conference Room

(1) Large Training Room

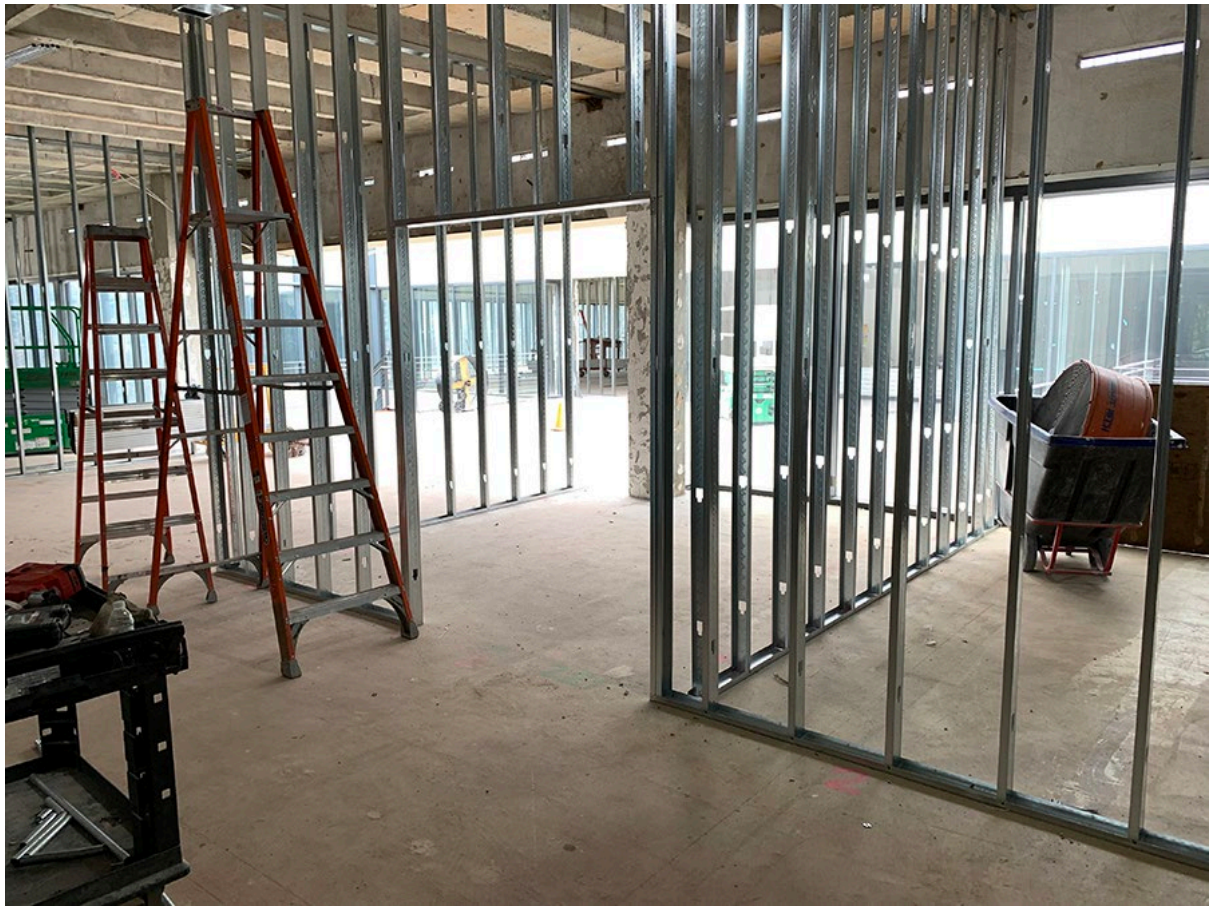
(1) Standard Training Room

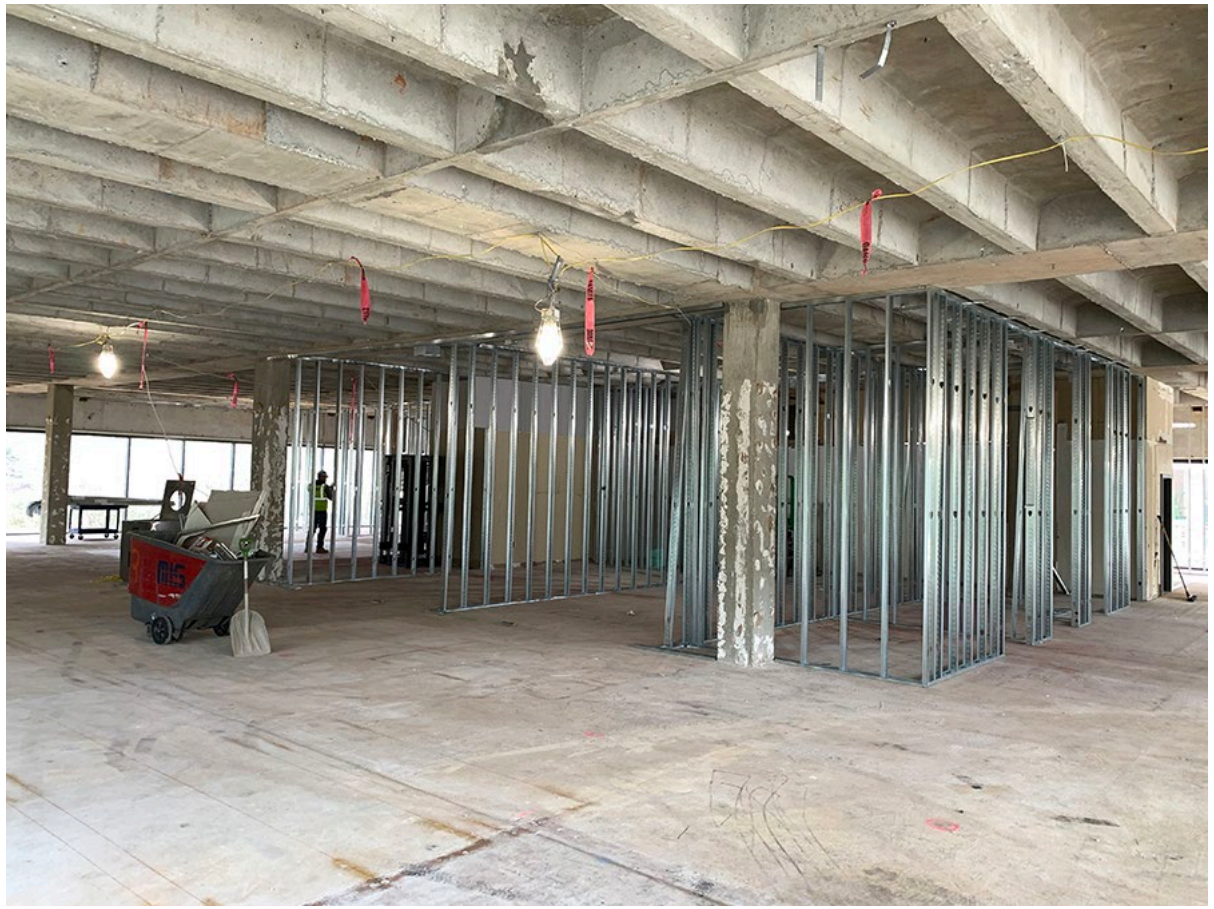
(2) Simple Training Room

Lower Level

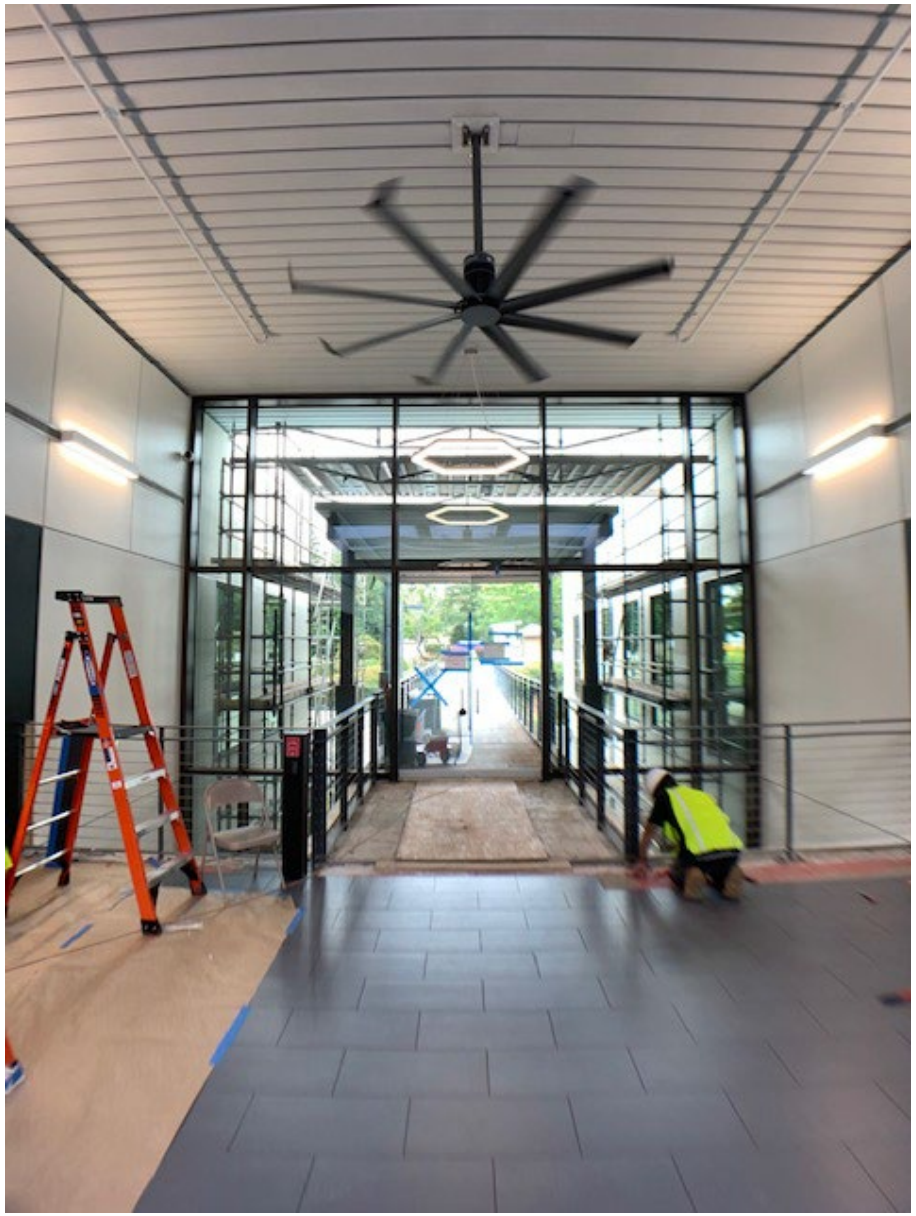

STORAGE
007
256 SF
LOADING DOCK
006
361 SF
STORAGE
002
2,144 SF
STORAGE
005
STORAGE
004
132 SF
STORAGE
003
106 SF
MECHANICAL
001
1,774 SF
STORAGE
009
152 SF
ELEVATOR
48 SF
HALL
010
157 SF
STORAGE
011
146 SF
STORAGE
012
155 SF
RESTROOM
008A
69 SF
STORAGE
014
STORAGE
008
2,692 SF
STORAGE
013
297 SF

Construction Photos – January 2020





Construction Photos – July 2020



Construction Photos – August 2020

Construction Photos – August 2020

Final finishes in the office areas

Construction – Adding Solar PV

System Size **331.88 kW DC**

Estimated Energy Production (Year 1): 457,713 kWh

Capacity:

- 250kW AC
- Capped by Georgia Power Net Metering

Costs:

- PV $500,000
- Site $50,000
- Total $550,000

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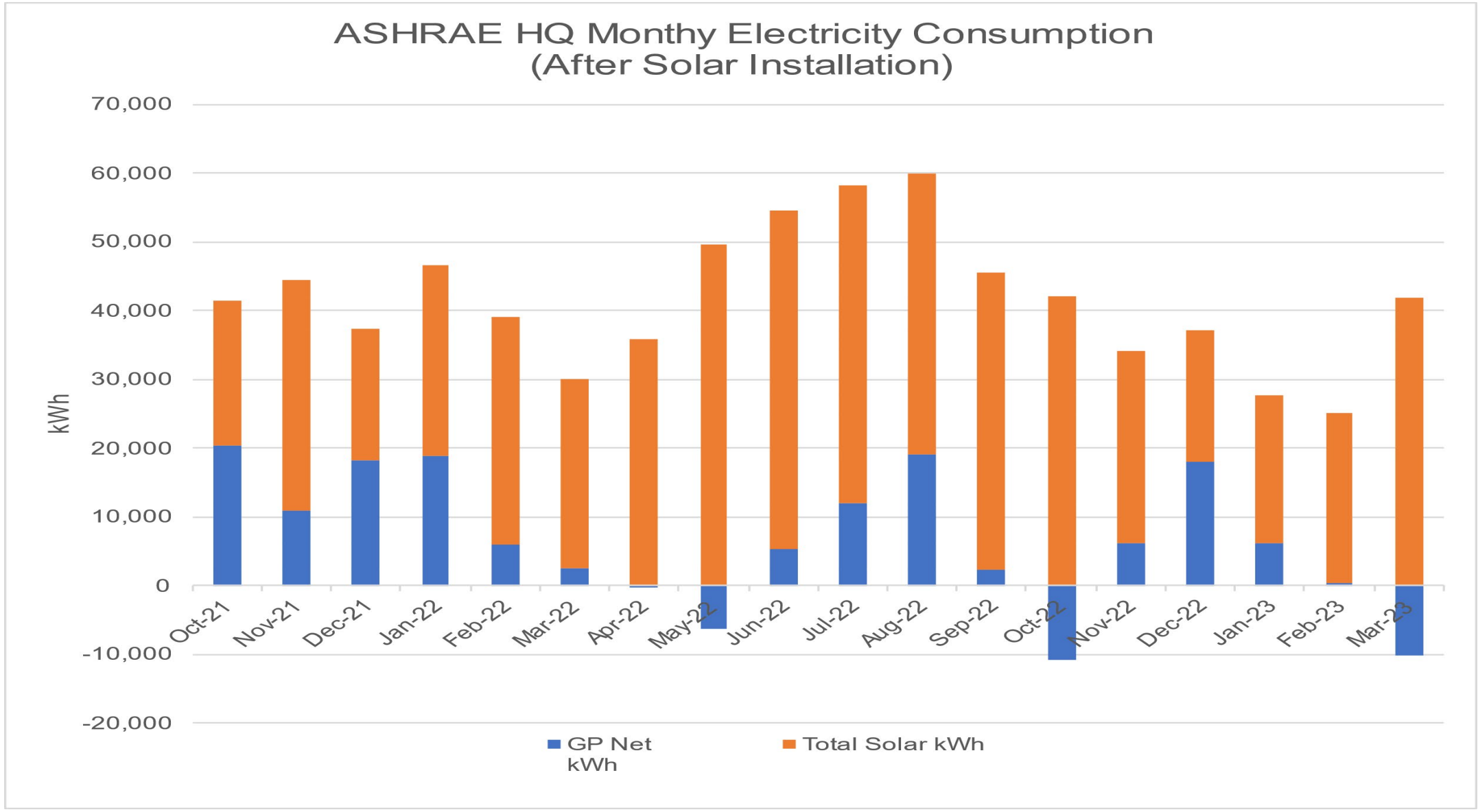
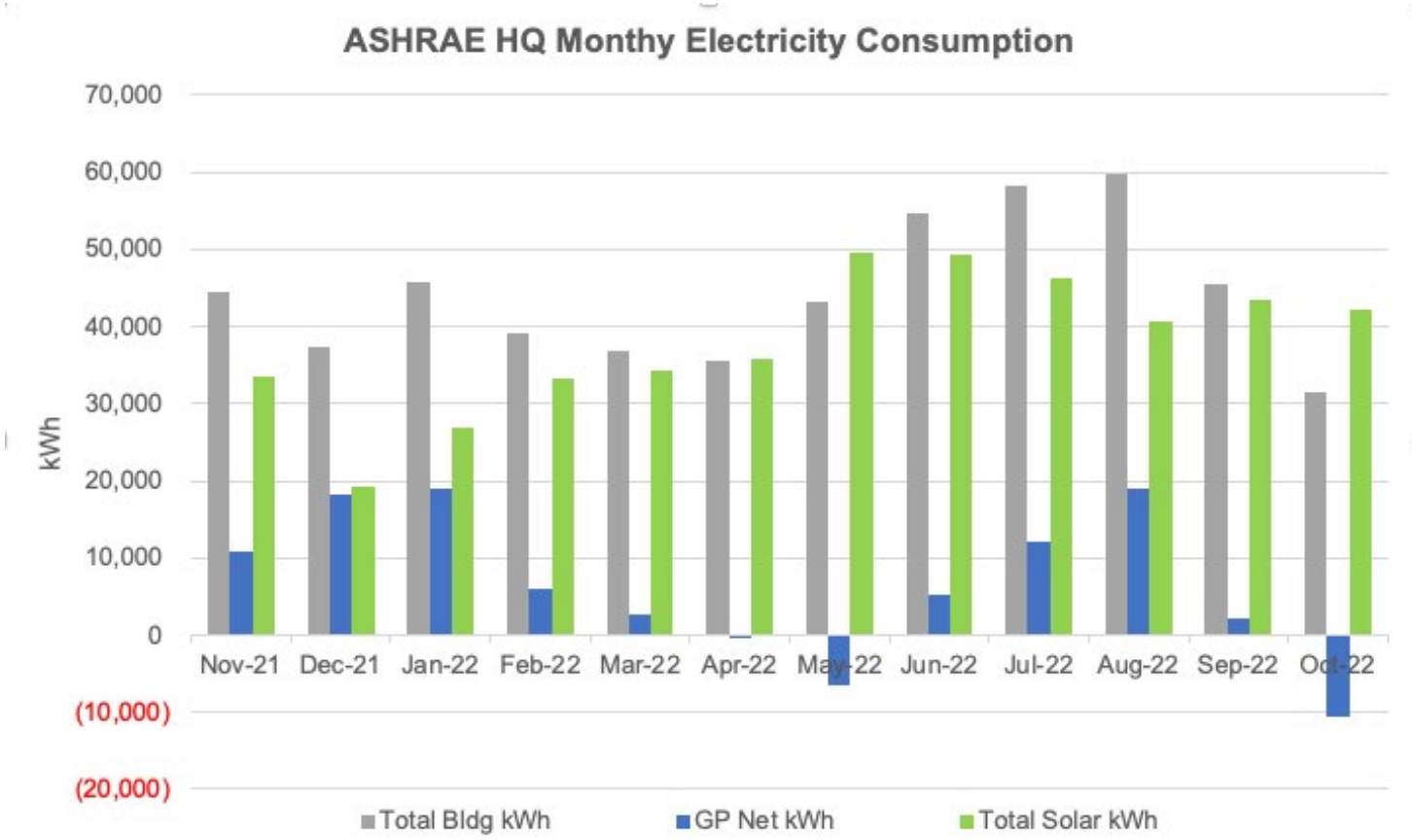
Net Operating



Actual Operating

The building has operated at 23.2 kBtu/SF-yr in the past 12 months without the solar PV. The solar PV brought it down to 4 kBtu/SF-yr.



Project Budget

	Pre-Design November 2018	Mid-Design July 2019	GMP November 2019
Pre-Development Costs	$4,750,000	$4,750,000	$4,733,950
Consulting Services	$1,375,000	$1,375,000	$1,551,780
Construction*	$7,800,000	$10,155,000	$12,349,837
FF&E	$675,000	$675,000	$904,682
Admin & Misc	$50,000	$50,000	$30,000
Contingency	$1,100,000	$1,100,000	$429,751
Total	**$15,750,000**	**$18,105,000**	**$20,000,000**

* Less donated equipment

Note: Solar PV not included in project scope

Key Design Features

- 18 new skylights and reconfigured window/wall ratio.
- Radiant ceiling panel system: This is used for heating and cooling & dedicated outdoor air system for outdoor air ventilation with enthalpy heat recovery.
- Overhead fresh air distribution system augmented with reversible ceiling fans in the open office areas and displacement distribution in the learning center.
- Six water source-heat pumps (WSHPs): There are four on basement level and two on upper level atrium that will be used to condition these spaces.
- A Building Automation System with remote access.
- A robust IT backbone network
- Demand Control Ventilation (DCV): This will be used for high occupancy spaces in the meeting and learning center.
- On-site electric vehicle charging stations available for guests and staff.

Building Operations

- Smart Buildings
- Building analytics and fault detection
- Building intelligence evaluation using Building IQ
- Demonstration of the use of Automated System Optimization
- Building EQ evaluation
- IEQ monitoring

Smart Buildings

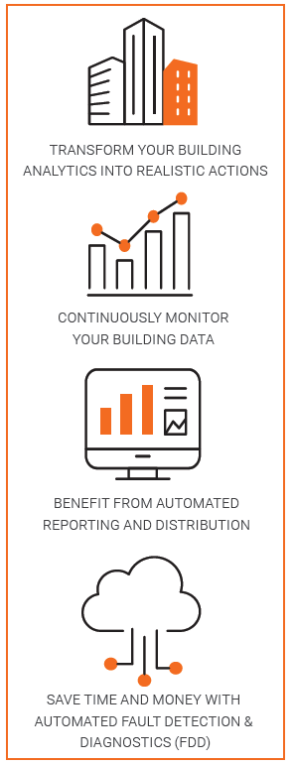
- Affectively maximizing and assessing sustainability in a smart building requires actionable insights that can only come from data this requires technologies and solutions that collect and analyze real-time data about the building performance and the environment in which the buildings operate to continually make adjustments that improve sustainable operations throughout the building lifecycle
- Smart buildings generate data and in turn we need that data to optimize functionality and deliver on sustainability it's the number one focus we can't measure or know that we're moving forward without accurate data

Building Analytics

- Use of analytics in the built environment creates a shift from a reactive to proactive maintenance mindset. One benefit is to reduce the amount of time it takes to diagnose issues and shift that time to fixing the things that are broken. The application of analytics does not reduced maintenance hours it shifts where the labour is used for low value activities like searching for issues to high value activities like fixing issues Analytics often offers to reduce energy consumption by 5% with simple payback within one year part of energy study deal comes with facilities managers implement analytics solutions in their buildings in 2017 the study yielded highly promising results campaign particularly made improvements to the buildings achieving immediate median energy savings of 5% was less than one year payback.
- Analytics also makes it possible to understand if I previously unknown energy saving opportunities the solutions also tracked previously energy saving initiatives and verified through energy savings plus achieved in addition analytics enables monitoring based commissioning and measurement and verification

BUILDING & ENERGY ANALYTICS GOALS

- ✓ Increase Energy Efficiency Reporting
- ✓ Improve Occupant Comfort/Safety
- ✓ Reduce Maintenance Costs ($/Sqft & Sqm)
- ✓ Prolong Equipment & Plan Capital Upgrades



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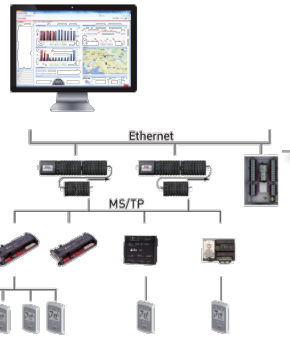
HOW DOES IT WORK?

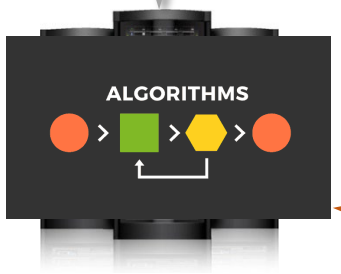
Weather Data

Existing Metering & HVAC Control System



CopperTree Edge Device

HVAC Zone, Plant & Auxiliary Equip.



Analytics Server

Alerts & Reports

Mobile & PC

ONSITE DEVICE ACQUIRES AND PREPARES DATA FOR DELIVERY

CLOUD SERVER ANALYZES THE DATA & GIVES ACCESS TO ANALYTICS, CHARTS AND REPORTS.

NOTIFICATIONS ARE DELIVERED VIA THE WEB AND MOBILE

What is Building EQ

- Free Web-based Portal
- Benchmarks energy performance
- Calculates building EUI based on Climate Zone
- Includes Operational Carbon Metrics
- Integrates with ASHRAE Level 1 Energy Audit
- Provides data to improve energy performance

Building EQ Works with Level 1 Energy Audit

- In Operation Assessment
- Uses metered energy bills for energy usage
- Reflects how the building is designed, used, and operated
- Most common application
- Rating from 0 (zero net energy) to 200 (energy inefficient)
- Allows for tracking of improvements and comparing building to itself over time Building EQ Complies with Standard 21

Building EQ Complies with Standard 211

- In Operation aligned with ASHRAE Standard 211 Level 1 Audit reporting requirements
- Site visit required for both, with field data almost being the same
- Building EQ delivers a Level 1 Energy Audit Report aligned with ASHRAE Standard 211
- Customer gets understanding of how building ranks against similar buildings AND the initial evaluation on how to improve the building
- Building EQ Spreadsheet Audit Report auto populates Standard 211 spreadsheets Using Building EQ Celebrate good scor

Building EQ Scores for ASHRAE Headquarters

- Building EQ Energy Performance Score: 3
- Source EUI: 7
- Media EUI: 223
- Building EQ Carbon Performance Score: 3.2
- Total Annual GHG Emissions per Conditioned Space: 3.46 lbs/yr-sf

ASHRAE®

Building IQ

- The Continental Automated Buildings Association (CABA) has developed the building intelligence quotient BIQ an online rating tool that will enable facility executives that have existing facilities to gauge the building's intelligence and identify ways to increase it. The BIQ rating generates an online report that not only assigns the rating but also provides recommendations about ways to improve the score.
  - Sample of Findings:
    - 2.1.2 b. Training on a new system or training a new operator when they are hired is critical to get the most out of the BAS. This saves time and money.
    - 2.3.1 c. The values such as response times to user inputs, thermostat or humidistat changes, changes to the environment in response to opening or closing a building or room etc. should be data logged to ensure that existing and/or future equipment is tailored to the precise needs of the building.
    - 5.1.6 There should be a schedule to regularly update and maintain data resources and control data quality. A data dictionary, or metadata repository is a "centralized repository of information about the data such as meaning, relationships to other data, origin, usage, and format. The data dictionary should be regularly updated and maintained to effectively improve the data quality.

Automated Systems Optimization

Automated System Optimization (ASO)

"Tools used to dynamically modify Building Automation System (BAS) control settings to optimize HVAC system energy usage while maintaining occupant comfort."

"Two-way communication with the BAS is the distinguishing feature of ASO solutions. ASO technologies are the newest in the EMIS family…"

- From: "A Primer on Organizational Use of Energy Management and Information Systems (EMIS)",
- Lawrence Berkeley National Laboratory, U.S. Department of Energy, Better Buildings Initiative

ASO Benefits:

- Achieve consistent operational and energy cost savings from tighter action-loop workflow.
- Establish ongoing commissioning processes. Revert overridden setpoint values to commissioned values by operator-initiated action.
- Implement continuous control optimization with/without operator supervision to:
  - Determine dependent-system requests and rogue-system suppression as per ASHRAE Guideline 36 for integration into BAS controls
  - Energy consumption tracking against modelled baseline and variation notification via BAS
  - Demand response strategy implementation based on the utility operator's projected peak demand period
  - Automate system verification events by exercising equipment and generating system report cards.

Other Programs Being Considered

- Building Owners and Managers Association (BOMA) 360
- Green Globes Existing Building (EB)
- LEED Existing Building Operation and Maintenance (EBOM)

OPR Goal Comparison

Thank You