



ASHRAE HQ NZE Renovation

Shreshth Nagpal



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02 Project

03 Baseline

04 Climate

05 Program

06 Envelope

07 Systems

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ASHRAE HQ NZE RENOVATION

Design Team

Houser Walker Architecture | McLennan Design | Integral Group

Integral Group

Committed to decarbonization & resilience in built environment

Design Analytics

Architects, building technologists, data scientists, UX designers

Energy Modeling

Deep-knowledge practice supports broad-knowledge practices

Architect of Record Interior Design: (SBE)

Houser Walker Architecture, LLC

Partner in Charge, Co-Lead Designer,
Overall Project Manager:
Gregory Walker, AIA, LEED AP

Project Architect:
(responsible for sub consultant
coordination, document production)
Tom Butler, LEED AP

Design Architect Lead Sustainability Designer: (SBE) McLennan Design

Partner in Charge, Co- Lead Designer,
Lead Sustainability Designer
Jason McLennan, LEED Fellow

Project Manager:
Dale Duncan, AIA LEED AP

Director of Regenerative Design:
(programming lead)
Phaedra Svec, AIA, LEED BD+C

Mechanical, Electrical, Plumbing, Fire Protection Engineering Lighting Consultant:

Integral Consulting Engineering
the Atlanta practice of Integral Group

Principal in Charge; Mechanical Principal:
Stanton Stafford, PE, LEED BD+C

Net Zero Advisor:
John Andary, PE, LEED AP

Electrical Principal:
Spencer Phillips PE, LEED AP BD+C

Plumbing and Fire Protection Team Lead:
Benjamin Byerson, CPD, CET

Lighting Design:
Kera Lagios, LEED AP BD + C, Assoc. IALD, MIES

Energy Modeling:
Shreshth Nagpal, HBDP, BEMP, CPHD, CEM,
LEED AP BD+C

Building Envelope Consulting:
Niall Byrne, P.Eng., Ph.D. CxA

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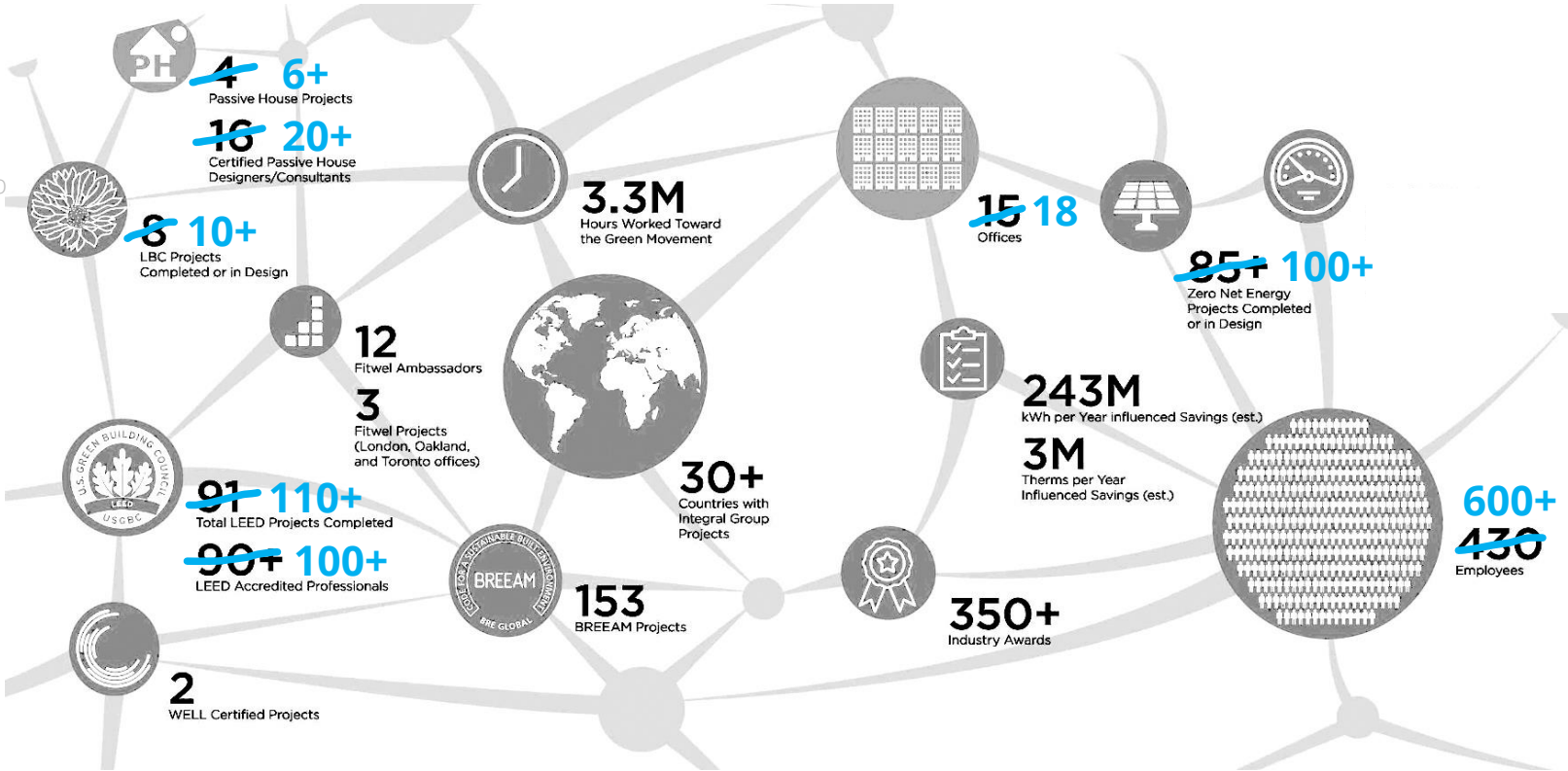
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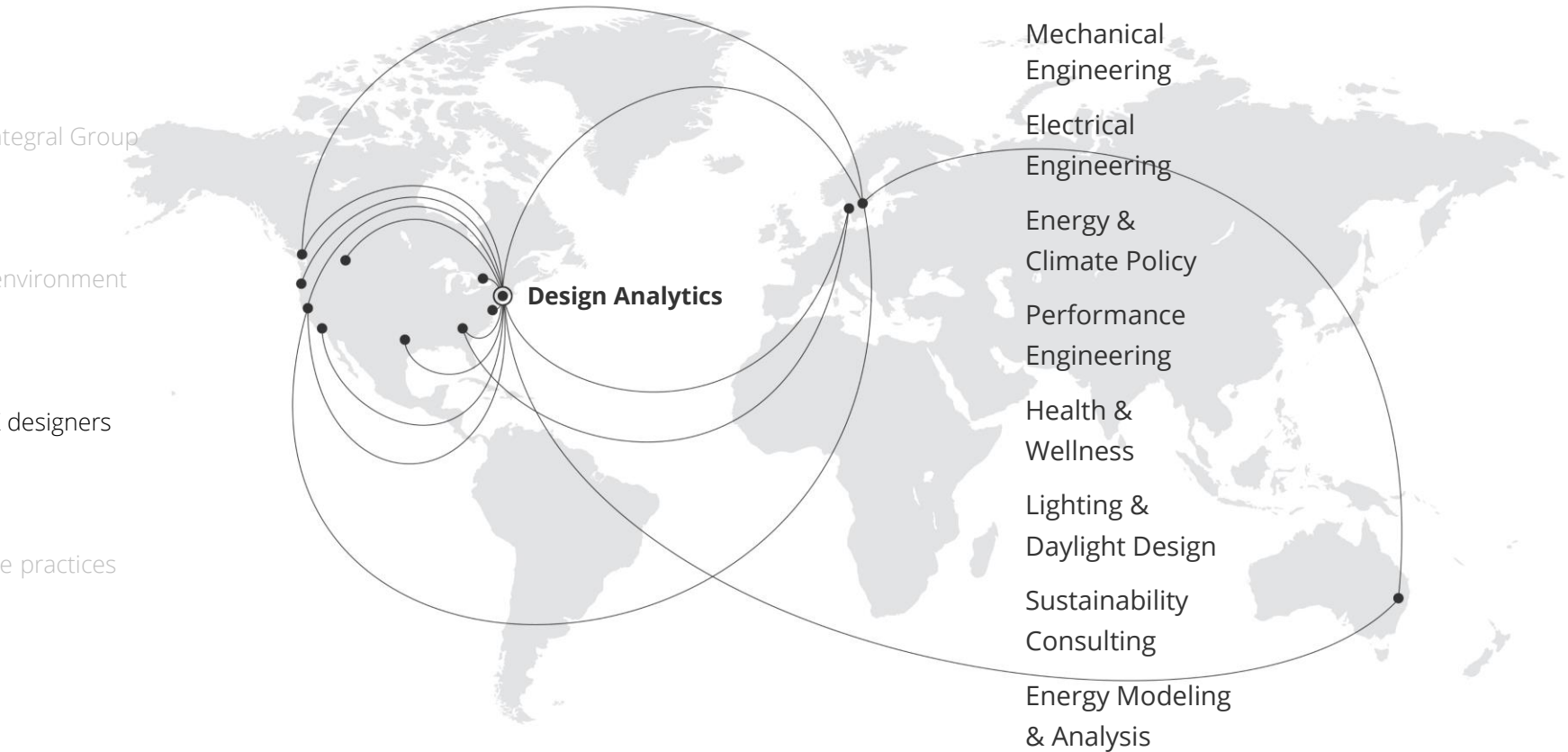
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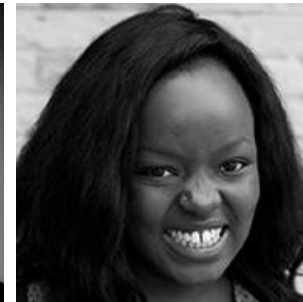
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CHALLENGE

ASHRAE future global headquarters

Renovating a 67,000 ft² building from 1978 near Atlanta, GA

Demonstrate a replicable process

For retrofitting a mid-century building

Achieve net-zero energy performance

While providing an exceptional workplace

Target maximum EUI 24.1 kBtu/ft²/yr

Before renewable energy. Aspirational target 15 kBtu/ft²/yr



VISION

Showcase for latest technology

Destination venue for industry visitors

Superior efficiency

While providing a healthy and comfortable environment

Represent sustainability values

That ASHRAE has long held

Have a net-zero energy operation

And a zero-carbon footprint



PRINCIPLES

Climate and place inform design

Envelope tailored to task and orientation

Daylight as primary lighting source

Minimal reliance on electric lighting

Expanded thermal comfort range

Natural ventilation when appropriate

Low energy use systems

Spaces zoned thermally and acoustically



PATH TO NET ZERO ENERGY



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SENSITIVITY ANALYSIS

Evaluate a series of envelope measures

To understand the sensitivity of individual characteristics

X-axes show incremental improvement

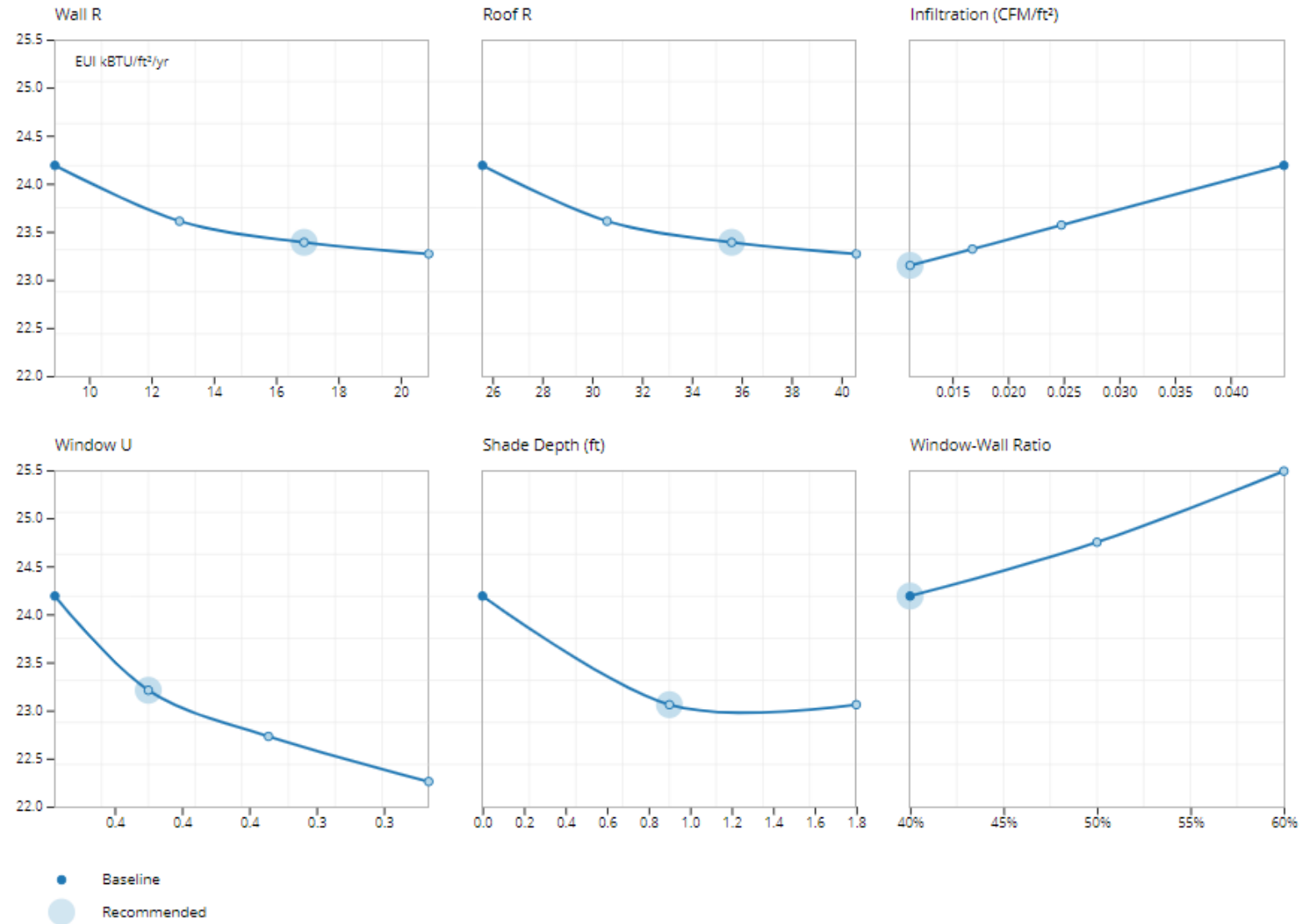
In the specific studied parameter over baseline values

Y-axes show associated impact

of improvement on annual energy use intensity

R-17 walls, R-35 roof, U-0.4 windows

Targets based in diminishing returns



PARAMETRIC STUDY

Parallel coordinates plot

To better understand the effect of different parameters

Left axes each represent a parameter

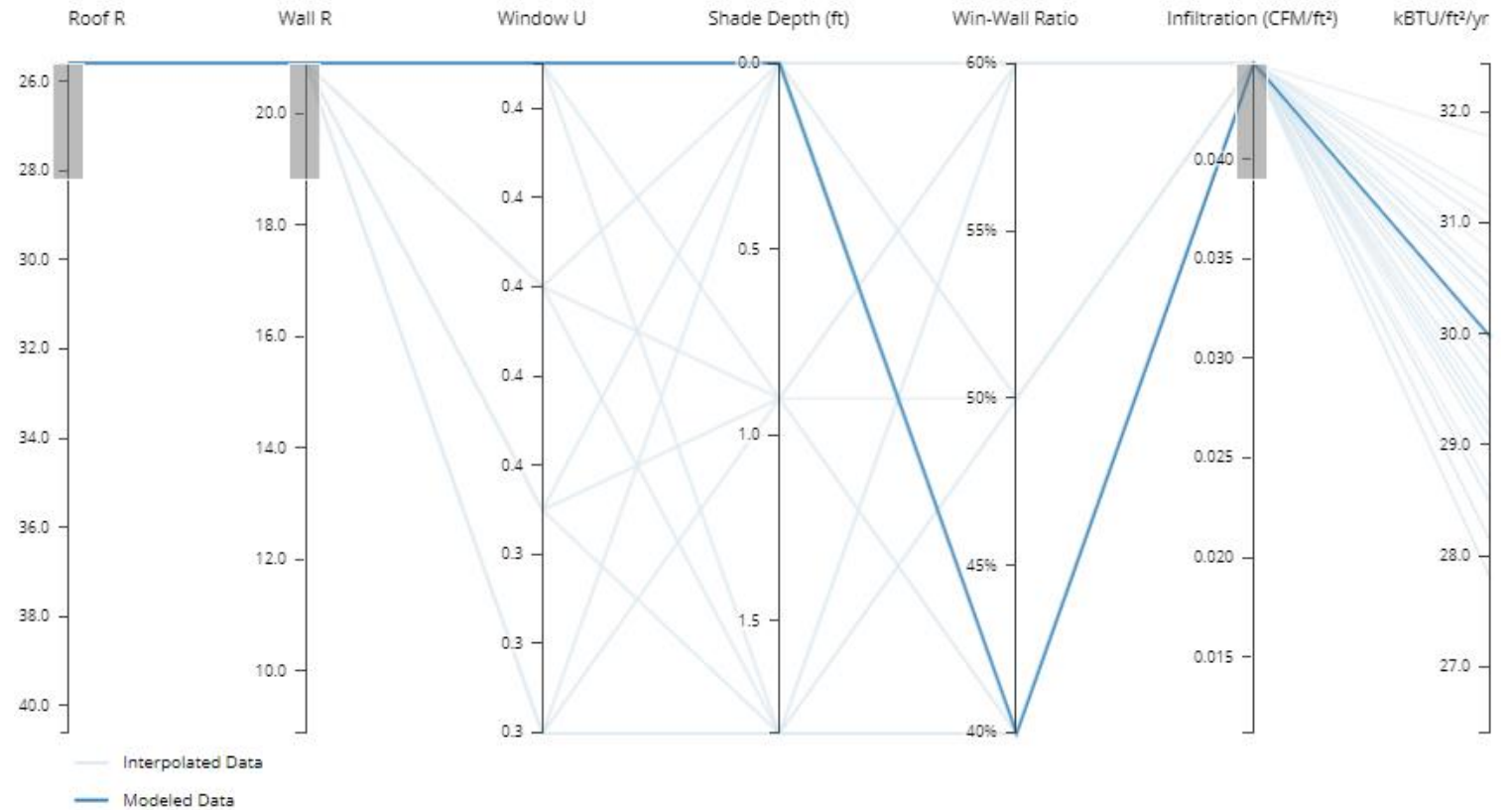
And the different evaluated properties

Right axis presents energy use intensity

Resulting from the selected parameter combination(s)

Energy and surrogate model results

Lighter lines are results from statistical surrogate models



ENERGY USE CHARACTERIZATION

Breakdown of energy by end use

To identify opportunities to improve overall performance

Windows largest heat loss component

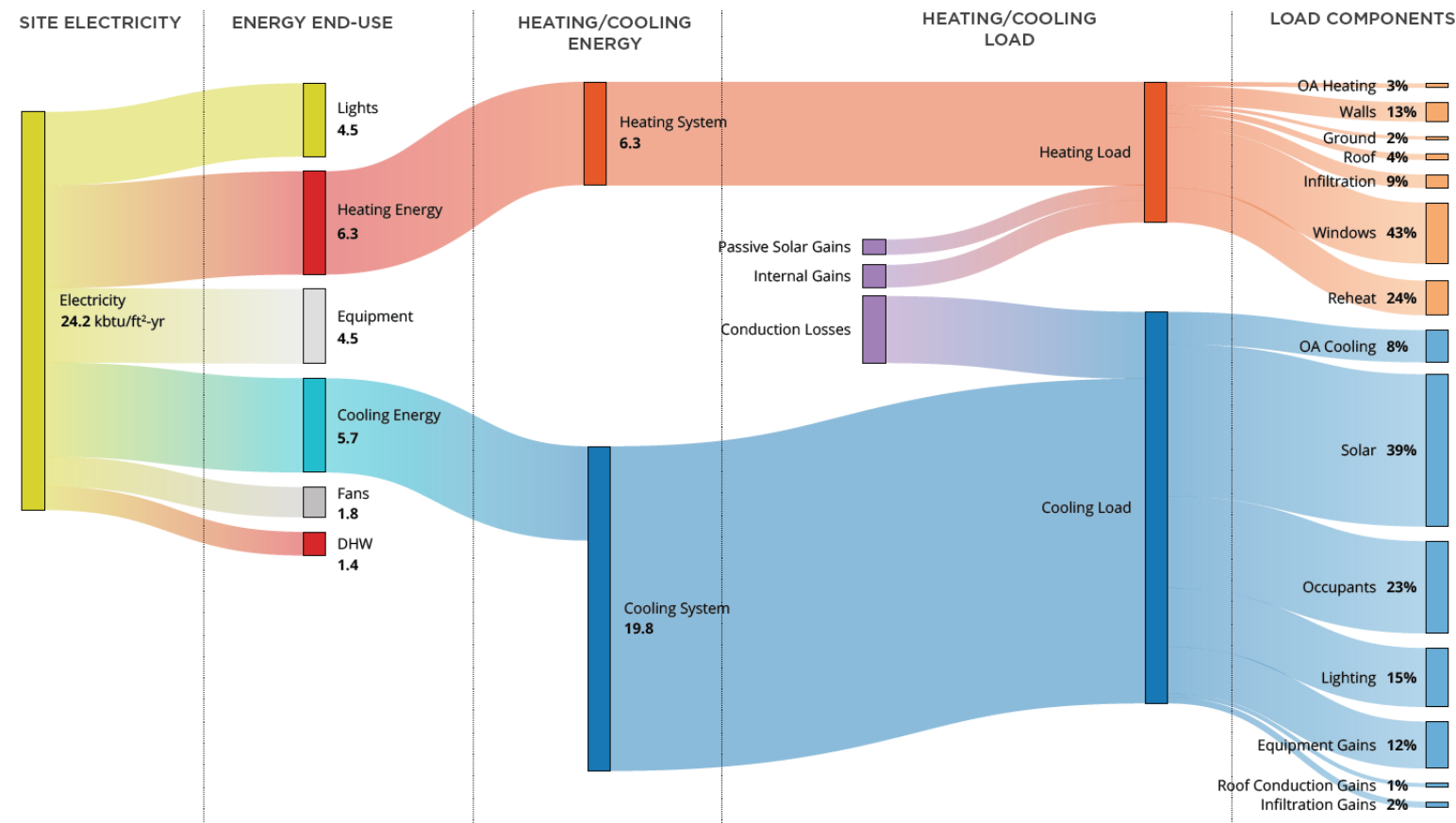
Heating ~25% of total energy use

Solar gains largest cooling component

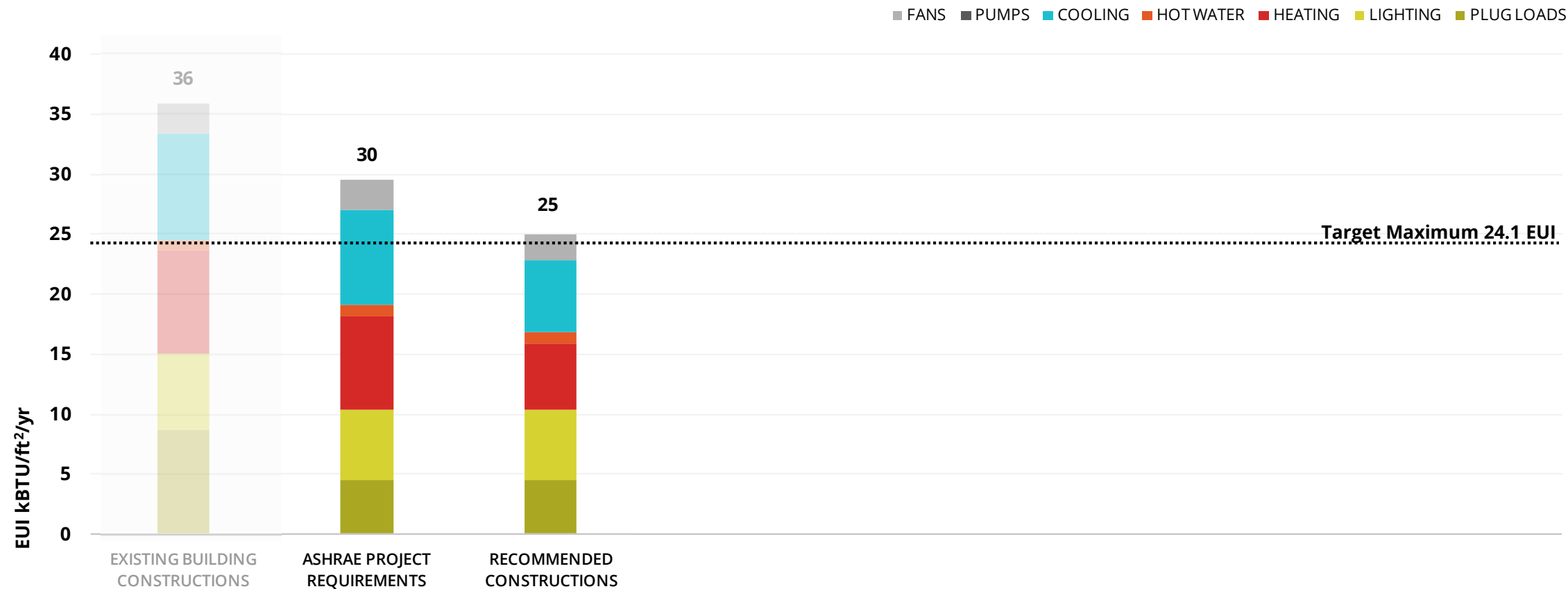
Cooling ~25% of total energy use

Fenestration offers largest opportunity

By further reducing conductive losses and solar gains



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SOLAR ORIENTATION

Summer: May to September

Extreme hot period: Jul 6-12 | Max Temp 98°F (37°C)

Winter: December to February

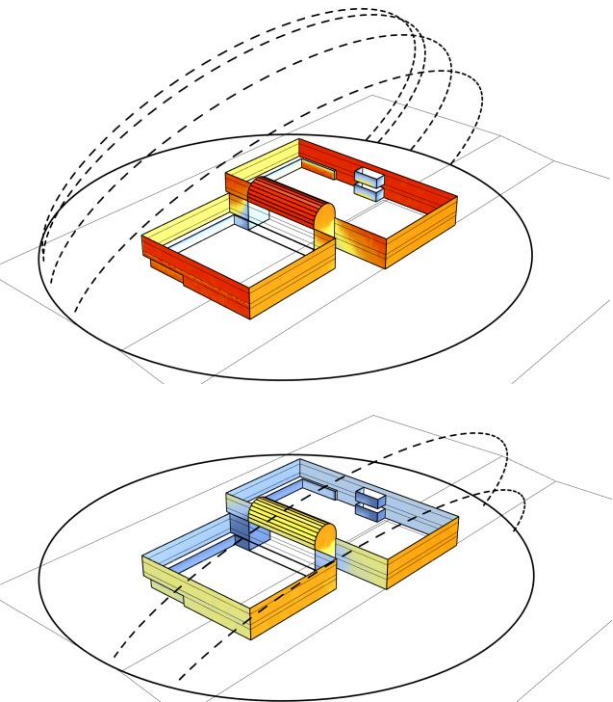
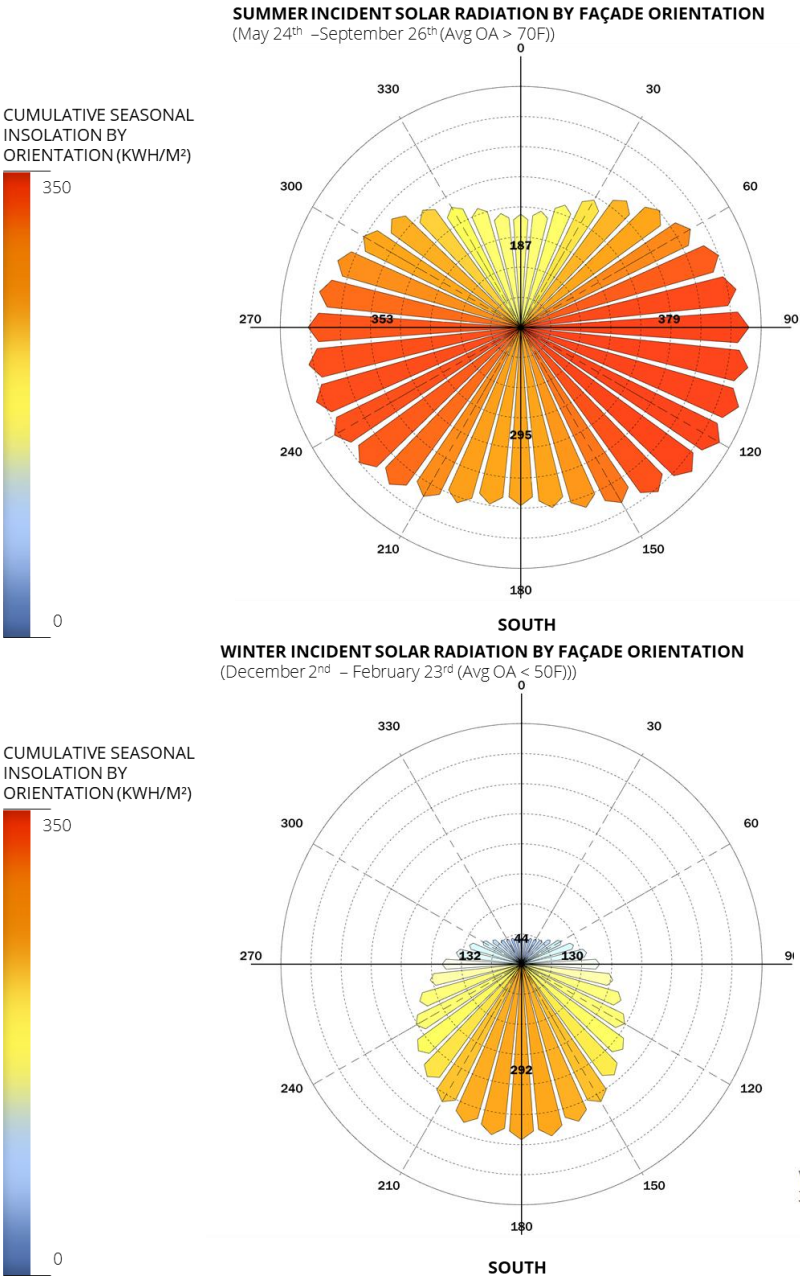
Extreme cold period: Jan 6-12 | Min Temp 9°F (-13°C)

Orientations to avoid: East/West

High summer solar exposure | Low solar angles

Windows to orient: North/South

Passive winter gains | Controllable summer exposure



30% - 40% WWR+SHADES
Based on Orientation



NATURAL VENTILATION

Natural ventilation alternates

Daytime | Night purge | RH limits

605 hours with 60% RH high limit

Indoor Air Temp > 70°F | Outdoor Air Temp < 81°F

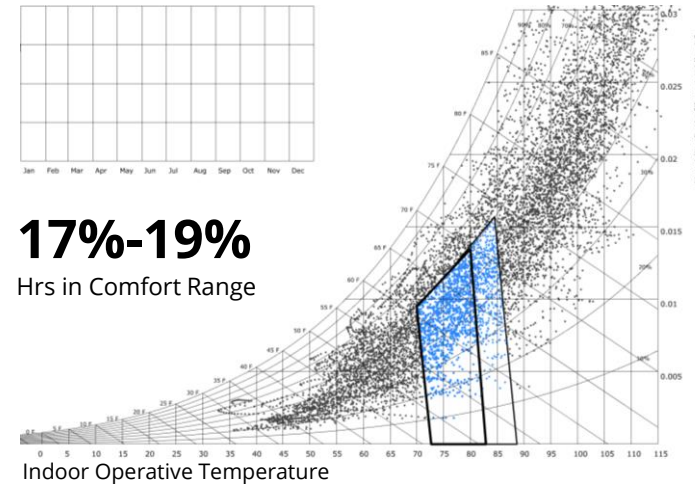
1264 hours without RH limit

Daytime operation only

3043 hours with night purge

Fan assisted nighttime economizer operation

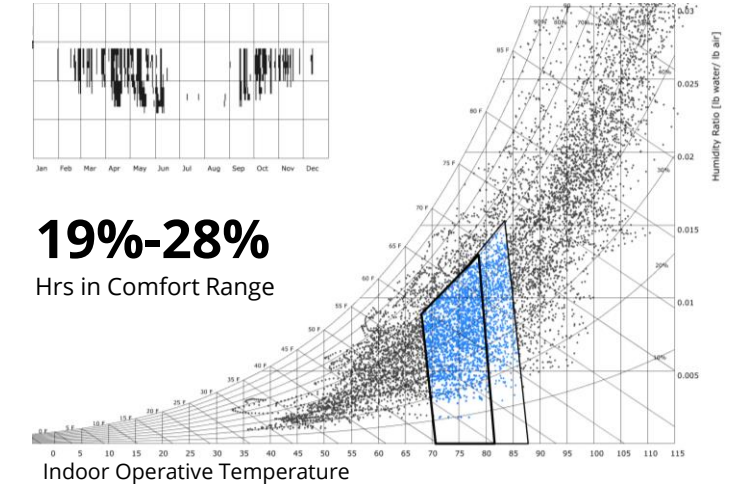
No Natural Ventilation



17%-19%

Hrs in Comfort Range

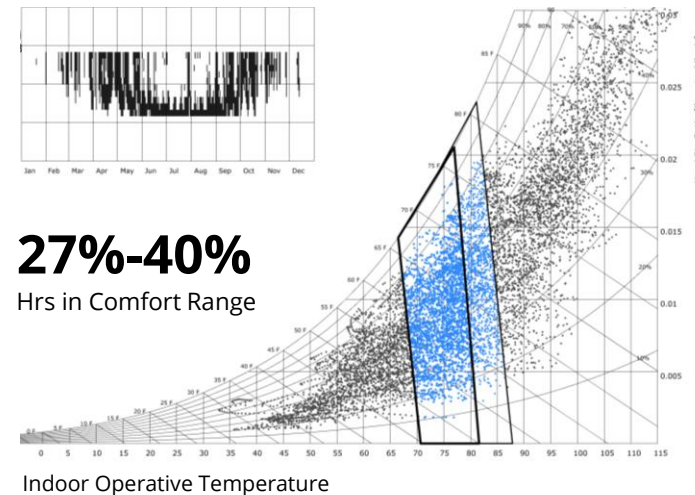
Daytime Ventilation / 60% RH Limit



19%-28%

Hrs in Comfort Range

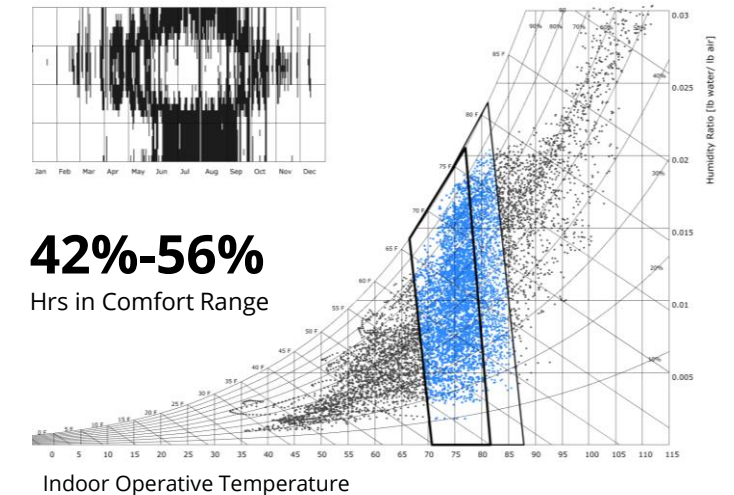
Daytime Ventilation / No RH Limit



27%-40%

Hrs in Comfort Range

Day & Night Ventilation / No RH Limit



42%-56%

Hrs in Comfort Range

ONSITE RENEWABLES

12,000-14,000 ft² rooftop PV area

Assuming ~50% of 28,000 ft² roof available for PV array

210-260 kW_p PV system capacity

Assuming 19.5% PV module efficiency

290-341 MWh annual energy generation

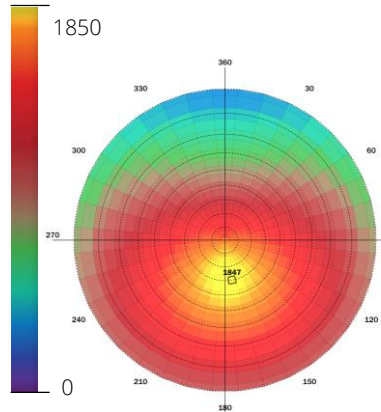
Assuming 15% inverter losses, 4% system losses

15-17 kBtu/ft²/yr potential EUI offset

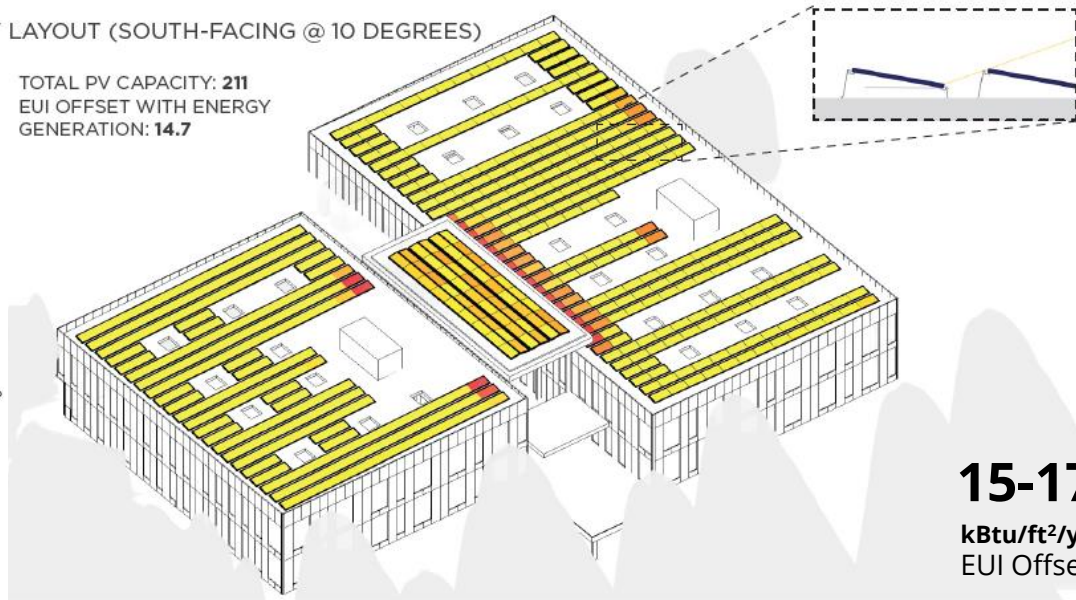
Assuming 68,000 ft² floor area for EUI calculations

PV CONFIGURATION 1: SINGLE-TILT LAYOUT (SOUTH-FACING @ 10 DEGREES)

CUMULATIVE ANNUAL
INSOLATION
(KWH/M²)



TOTAL PV CAPACITY: **211**
EUI OFFSET WITH ENERGY
GENERATION: **14.7**

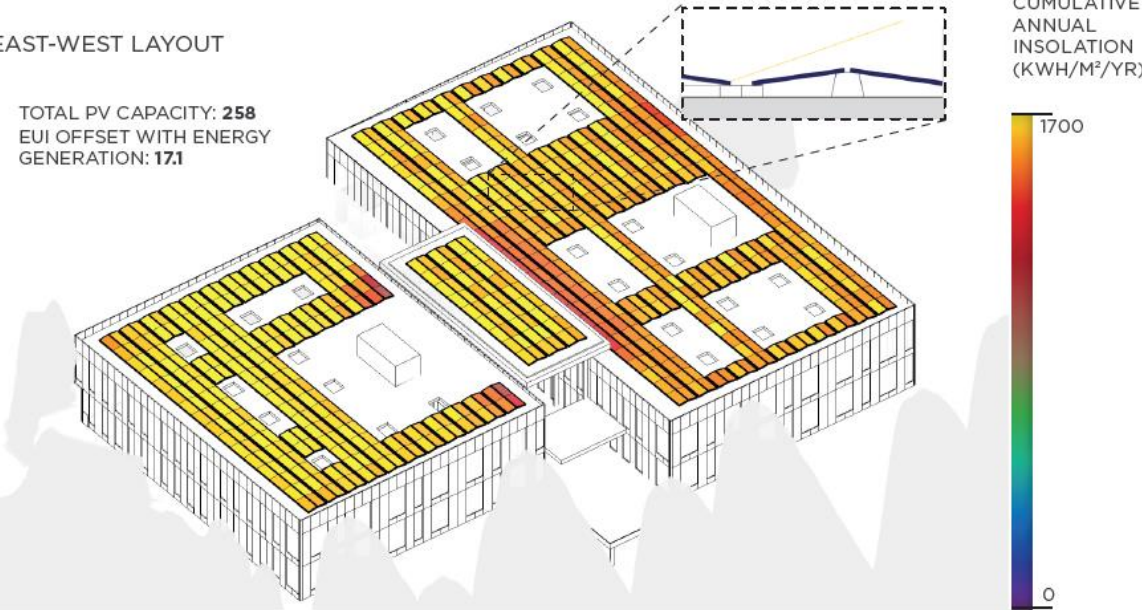


15-17
kBtu/ft²/yr
EUI Offset

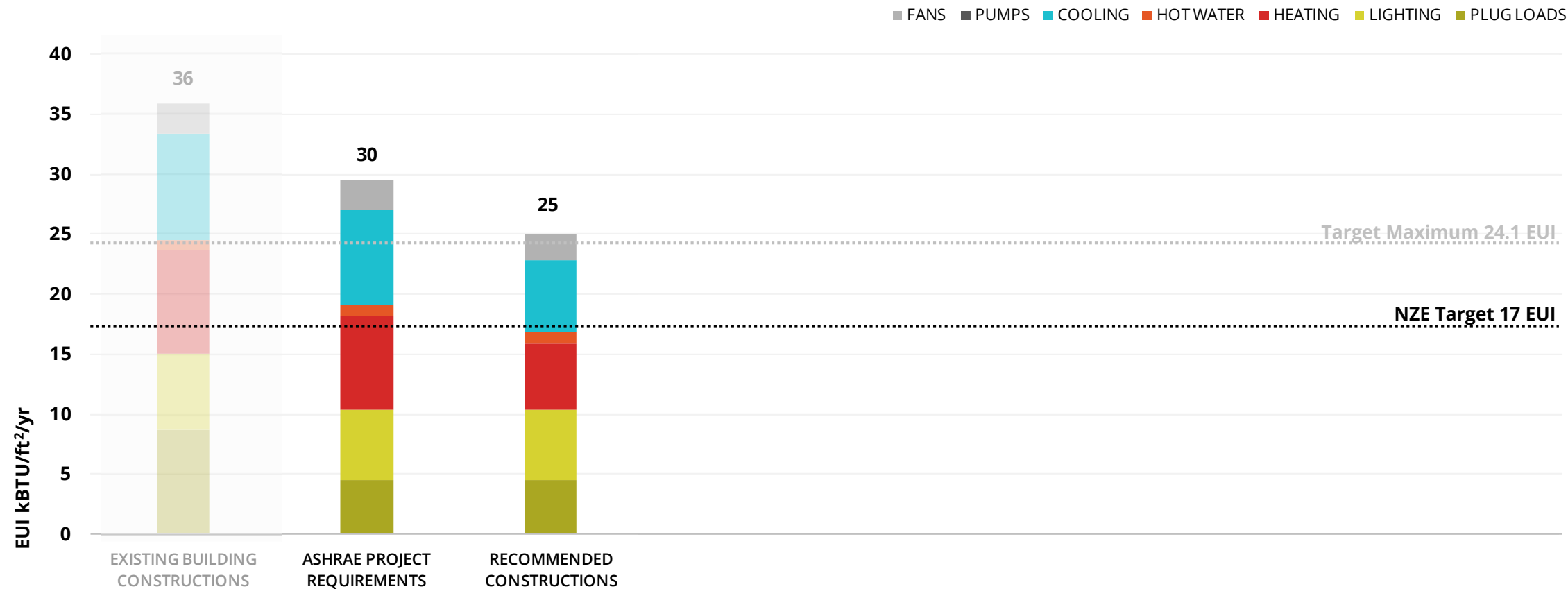
PV CONFIGURATION 2: DUAL-TILT, EAST-WEST LAYOUT

Annual Insolation	(kWh/m²/yr)	1,615
Array Altitude	Degrees	5
Array Azimuth	Degrees	80/260
PV Panel Efficiency	(%)	19.5%
System Losses	(%)	15%
Inverter Losses	(%)	4%
PV Panel Area	(m²)	1,323
Roof Utilization	(%)	49%
# 405W Panels*		638
DC System Size	(kW)	258
Annual PV Energy	(kWh)	341,000
Annual PV Generation Potential (EUI**)	(kBtu/ft²/yr)	17.1
Annual PV Generation Per m² Panel	kWh/m²	258

TOTAL PV CAPACITY: **258**
EUI OFFSET WITH ENERGY
GENERATION: **17.1**



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PROGRAM ORGANIZATION

First principles approach

Adapted to accommodate program criteria flexibility

A - Mixed

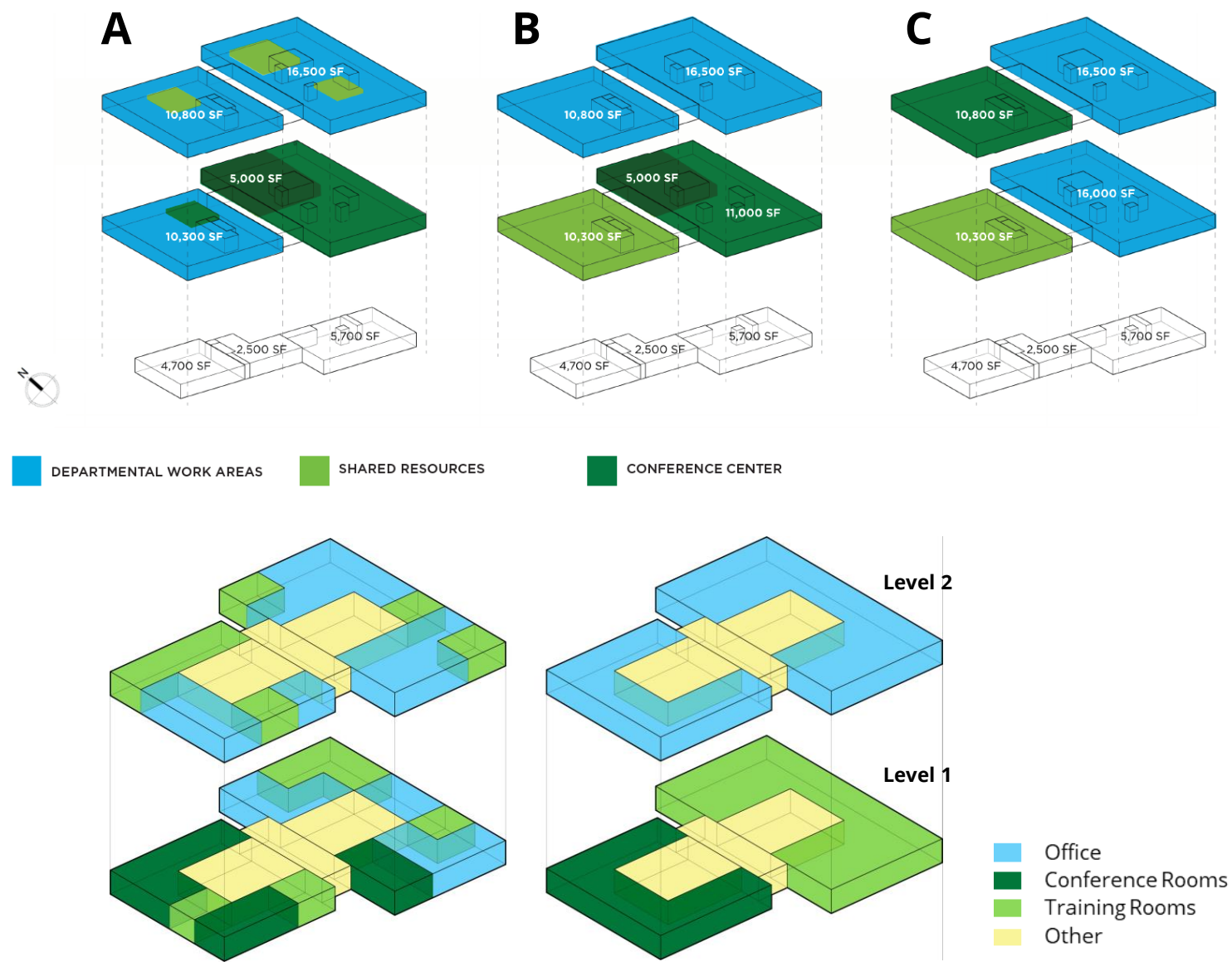
Good inter-department workflow

B - Stratified ✓

Best daylight | All staff on one level | Good thermal zoning

C - Stacked

Good thermal zoning | Better proportion of program areas



ATRIUM ENCLOSURE

Existing atrium is a greenhouse

Example of exactly what not to do

New opaque roof

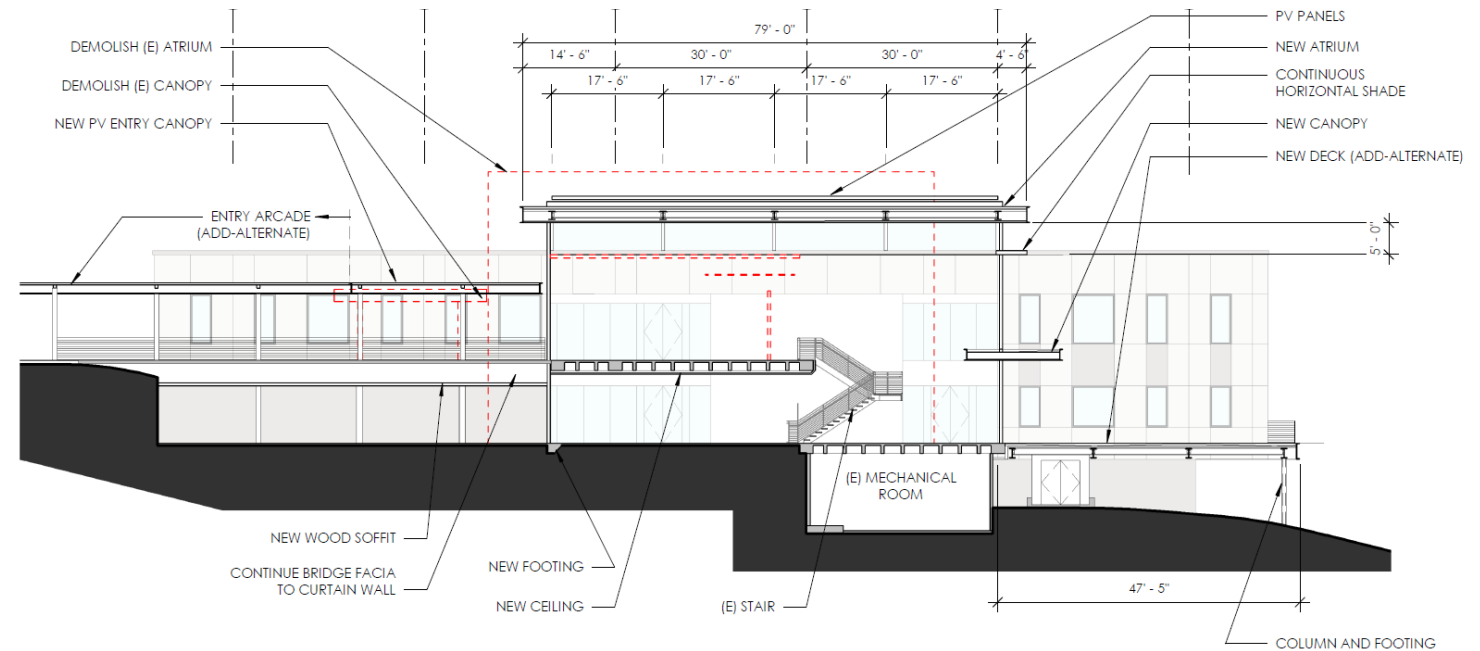
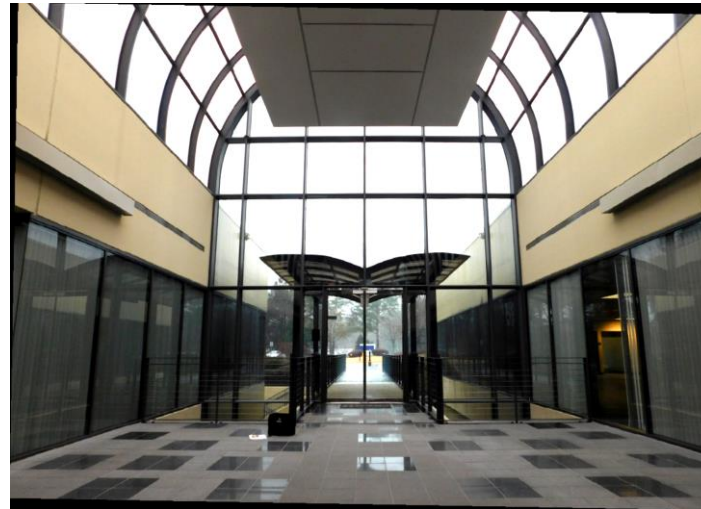
Provide area for additional photovoltaic panels

Deep shading on south

For optimal solar control

Insulated interior glass walls

Atrium to act as a thermal interstitial zone



EXPANDED COMFORT RANGE

Separate sensible load control

Hydronic radiant or chilled beam systems

Remove heat using convection

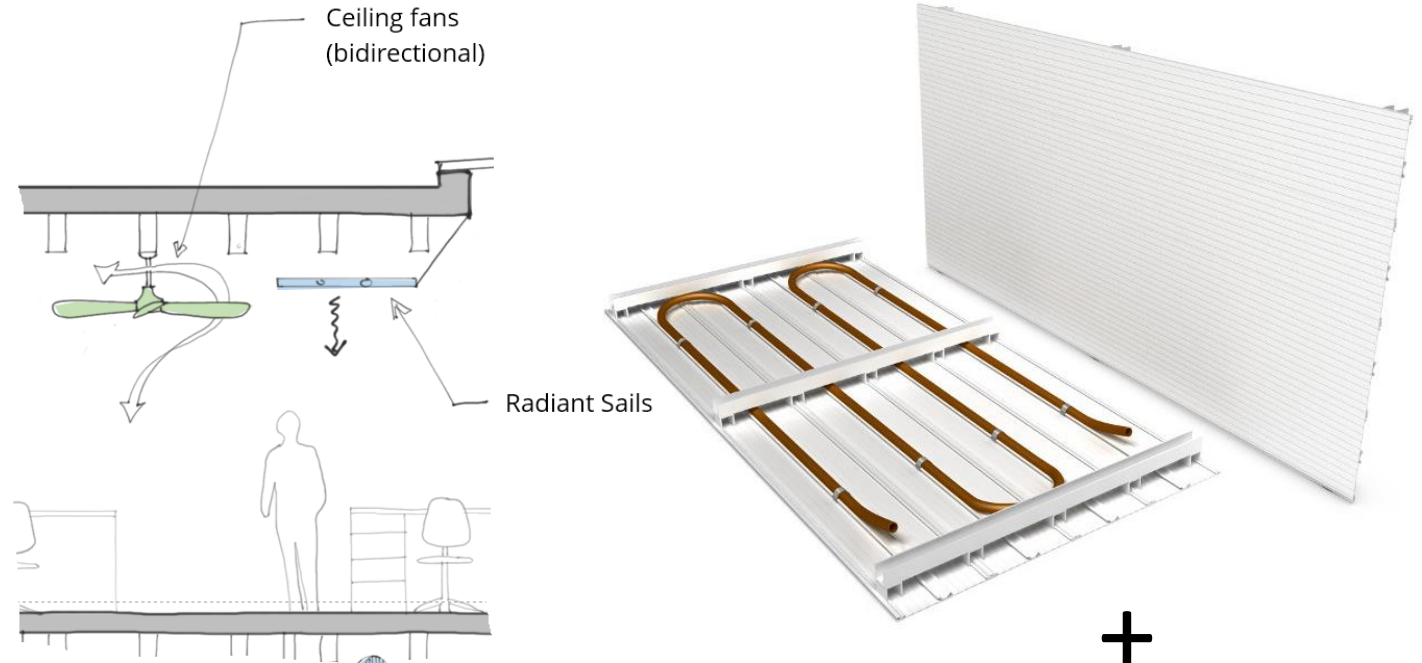
Using ceiling fans and natural ventilation

Maintain operative temperatures

Use higher air temperature setpoints

Higher chilled water temperature

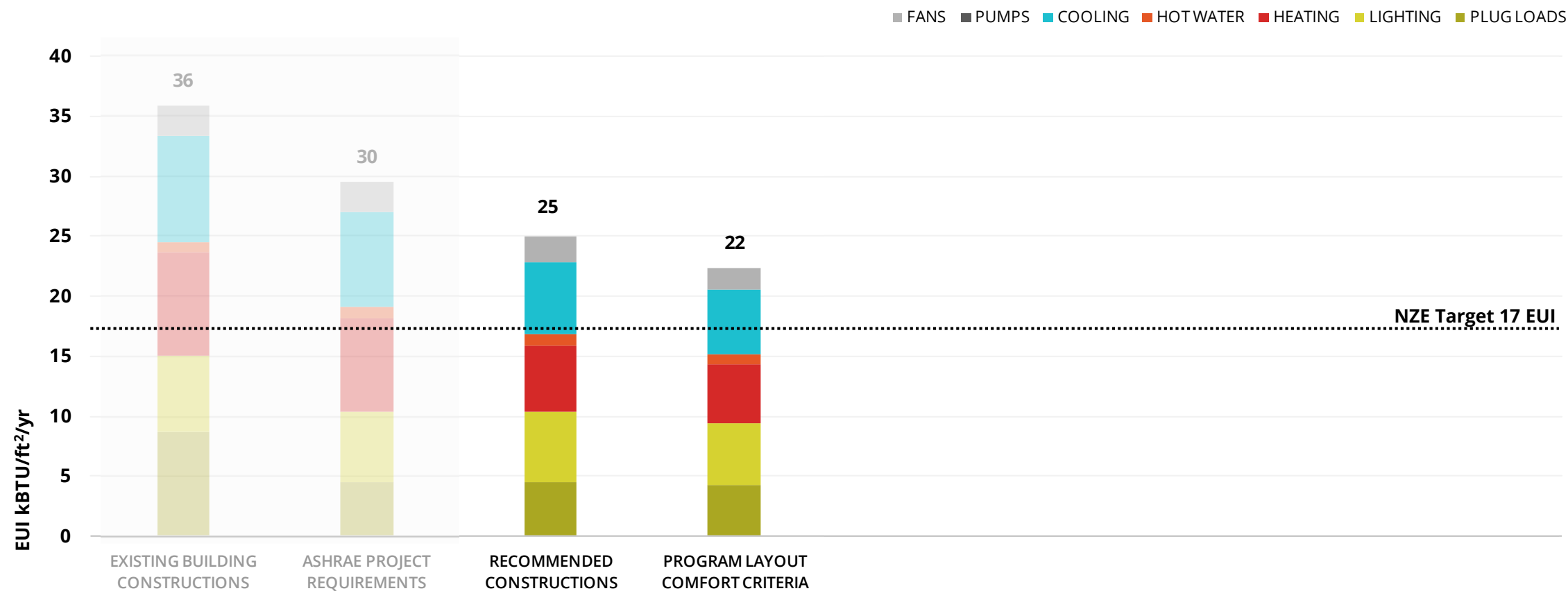
Allow improved energy efficiency at plant



OR



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FENESTRATION CONFIGURATION

Several window option studies

Location and sizes with respect to interior planning

IGUs in aluminum frame

Strategically designed to leave existing precast panels in place

Tuned to desired area ratios

30% on east and west | 40% on north and south

Exterior shading devices

Horizontal and vertical on east and west | Horizontal on south



SKYLIGHTS AND DAYLIGHT

Cloud ceilings over workstations

Host ceiling fans and radiant panels

Skylights over circulation zones

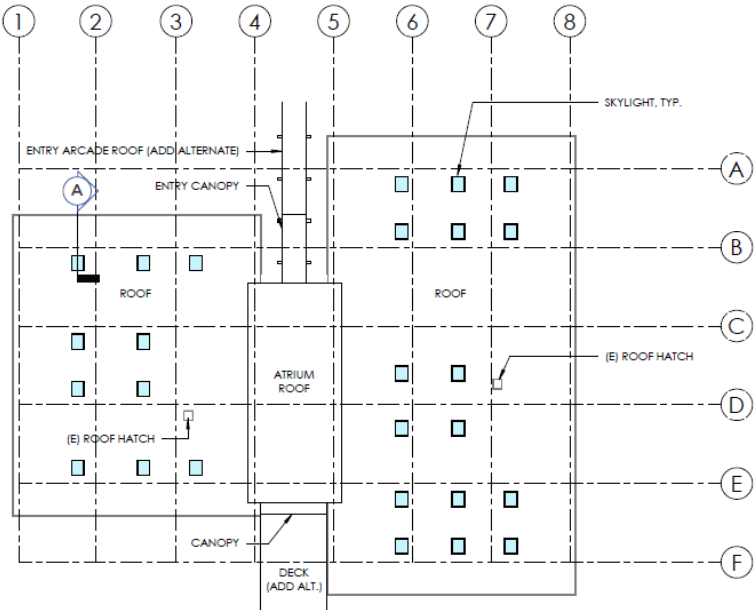
More ideal than having skylights directly over a workstation

Closed offices to be glass enclosed

Allow borrowed light to permeate with little obstruction

Centralized restrooms and storage

Opaque areas clustered in the center of floorplate



**Short Windows
No Skylights**

36%
Percentage of
regularly occupied
workspaces with
useful daylight
illuminance
(>300 lux)



**Tall Windows
18 Skylights**

67%
Percentage of
regularly occupied
workspaces with
useful daylight
illuminance
(>300 lux)

WALL AND ROOF INSULATION

Two-dimensional heat transfer model

LBNL THERM platform

Assess options for wall assembly

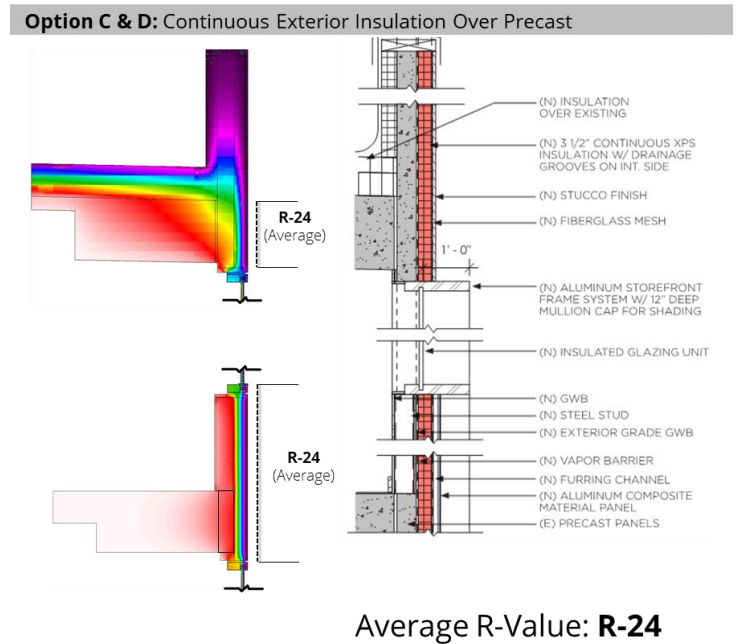
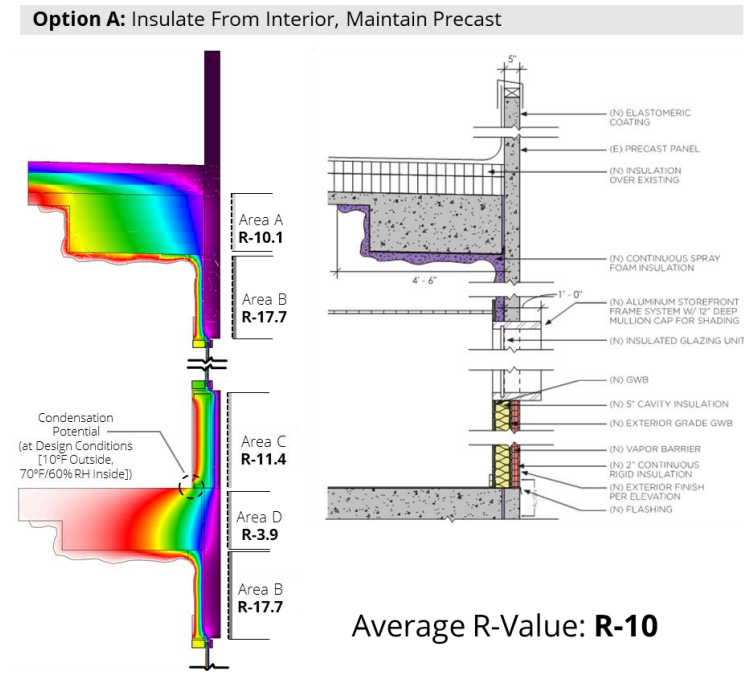
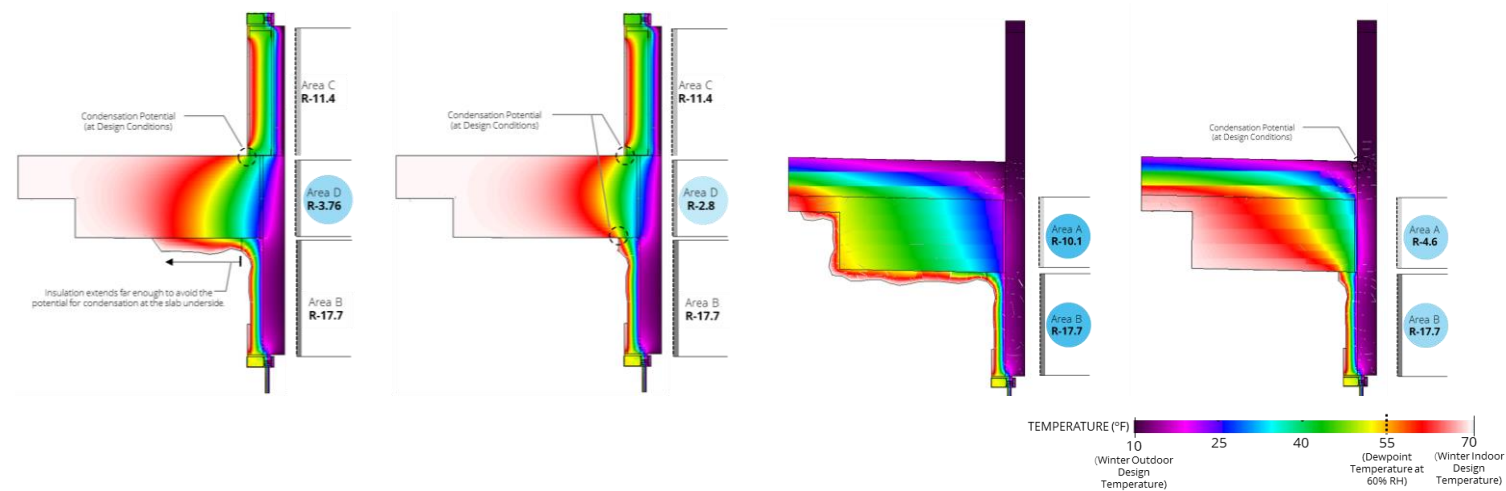
Target wall R value | Condensation potential

3.5" XPS added to interior: R-10

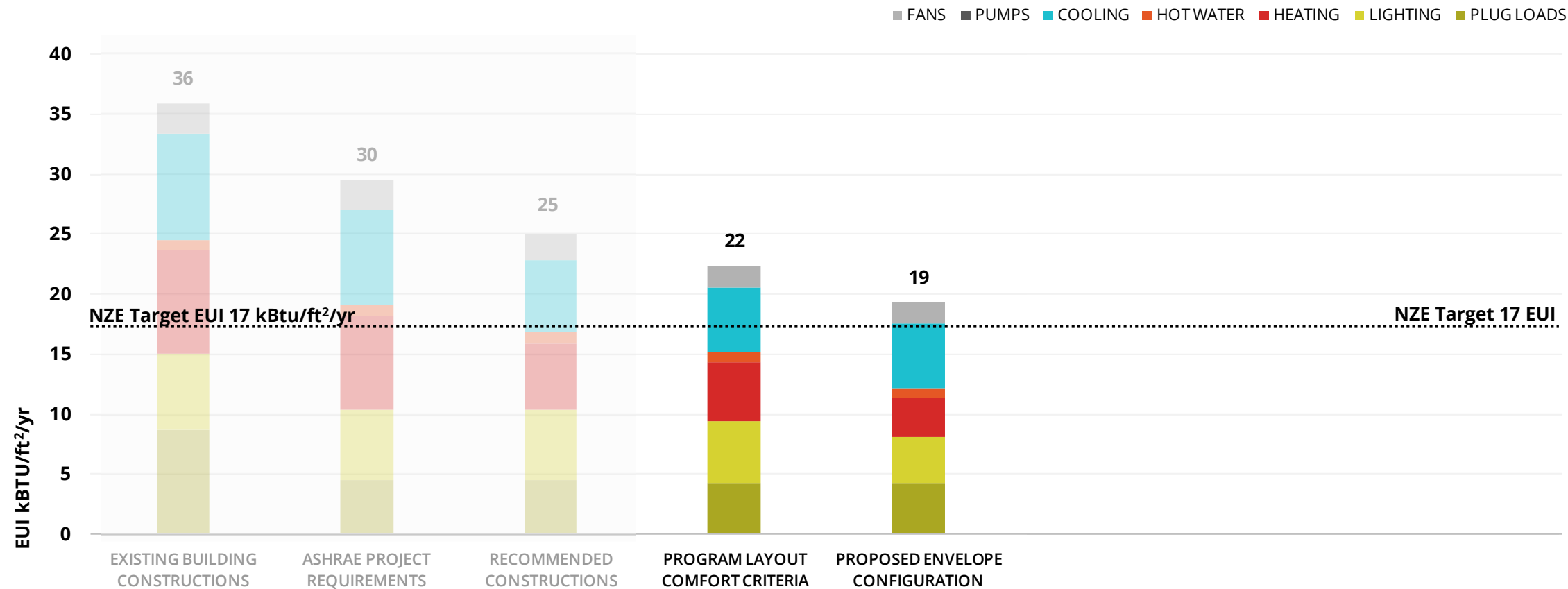
Thermal bridging | Condensation risk | Not recommended

3.5" XPS added to exterior: R-24

Exceeds target | Recommended



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REDUCED LOADS

Insulated Walls and Roofs

R-17 Walls | R-35 Roof

Optimized Fenestration

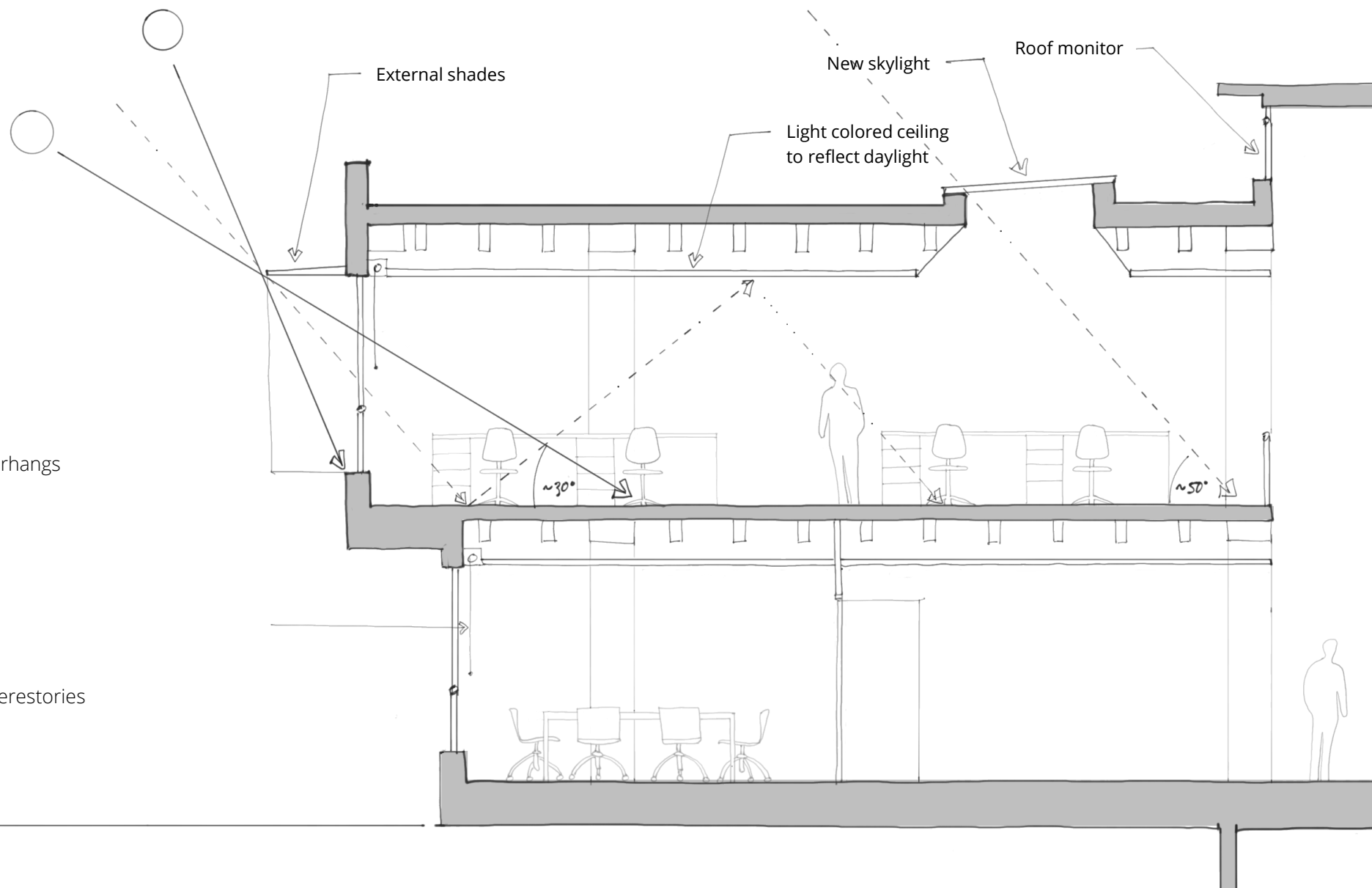
U-0.4 | SHGC-0.25 | ~32% WWR | Min 1' overhangs

Airtight Construction

0.1 cfm/ft² façade infiltration @ 75 pa

Maximized Daylight

High windows | Skylight monitors | Atrium clerestories



OPTIMIZED CONDITIONING

Mixed Mode System

Operable windows | Atrium exhaust | Ceiling fans

Night-flush Economizer

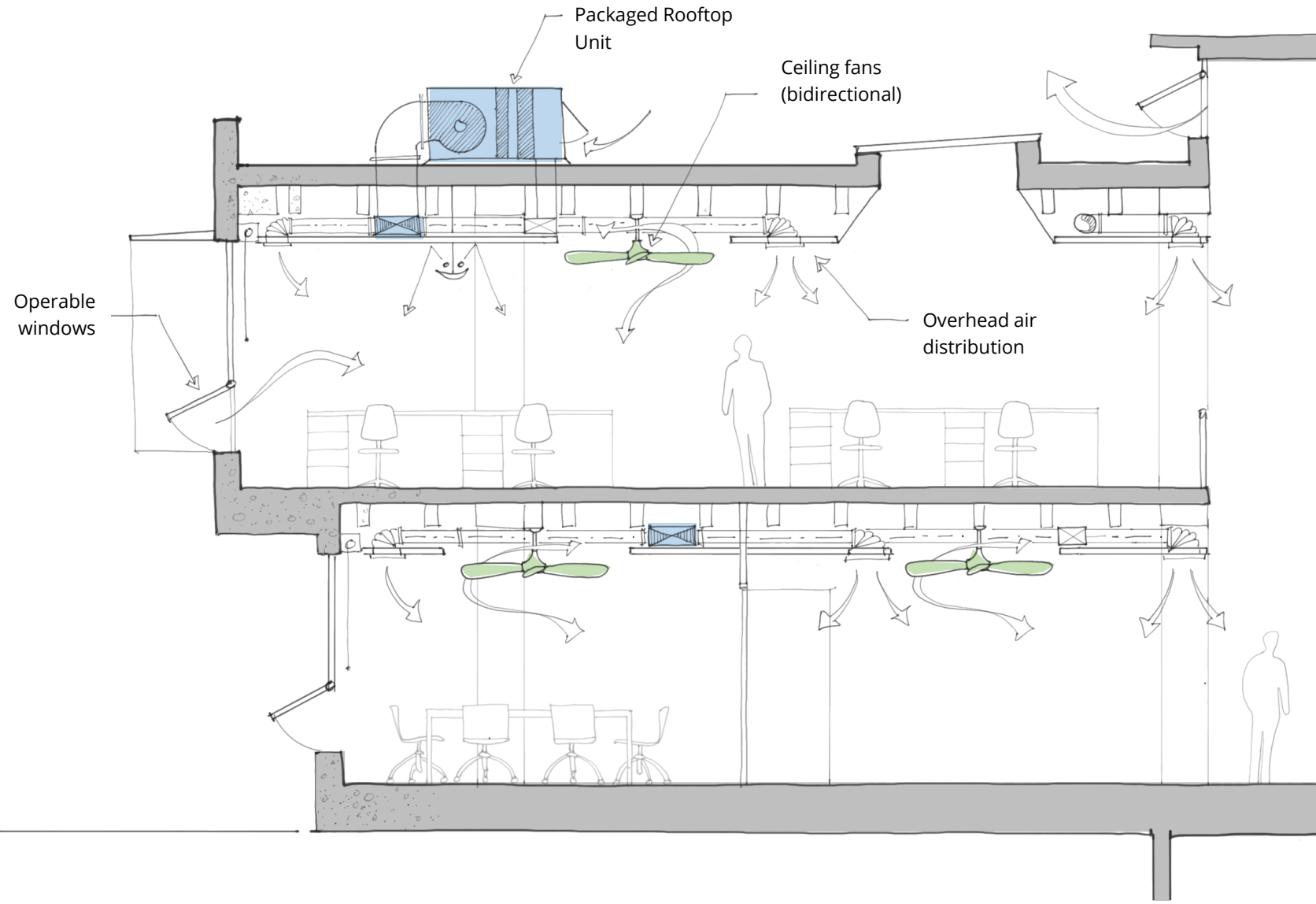
Precool building thermal mass

Effective Ventilation

Enthalpy heat recovery | Demand controlled ventilation

Optimized Air Distribution

Overhead mixed air | Overhead displacement



DECOUPLED SYSTEMS

Hydronic Terminal Units

Chilled beams | Radiant ceiling panels | DOAS boxes

Dedicated Outside Air System

Enthalpy heat recovery | Demand controlled ventilation

High Efficiency Plant

Air-to-water heat pumps | Water-to-water heat pumps

Potential Geo/Lake Exchange

Potential ground source heat exchange

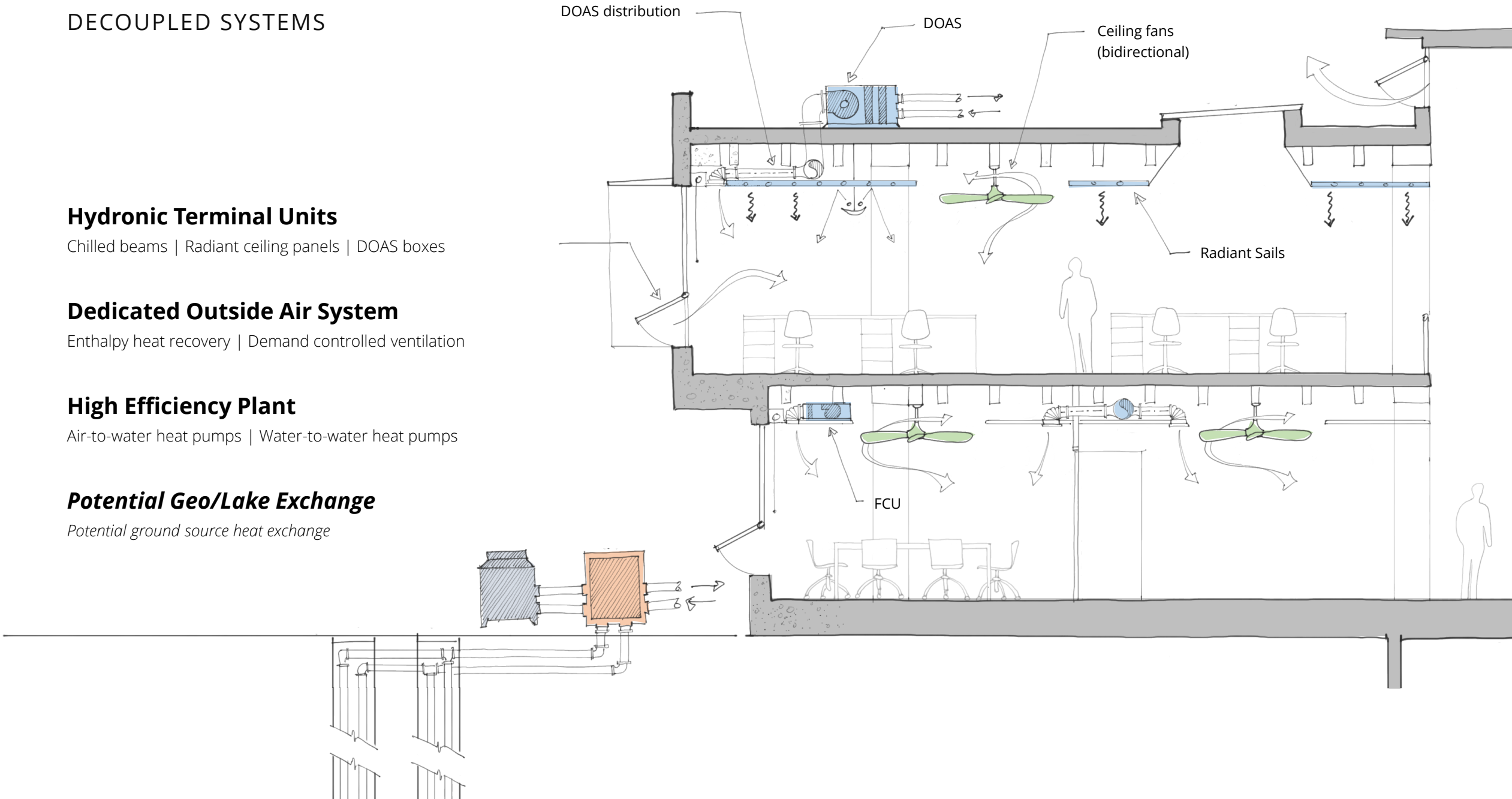
DOAS distribution

DOAS

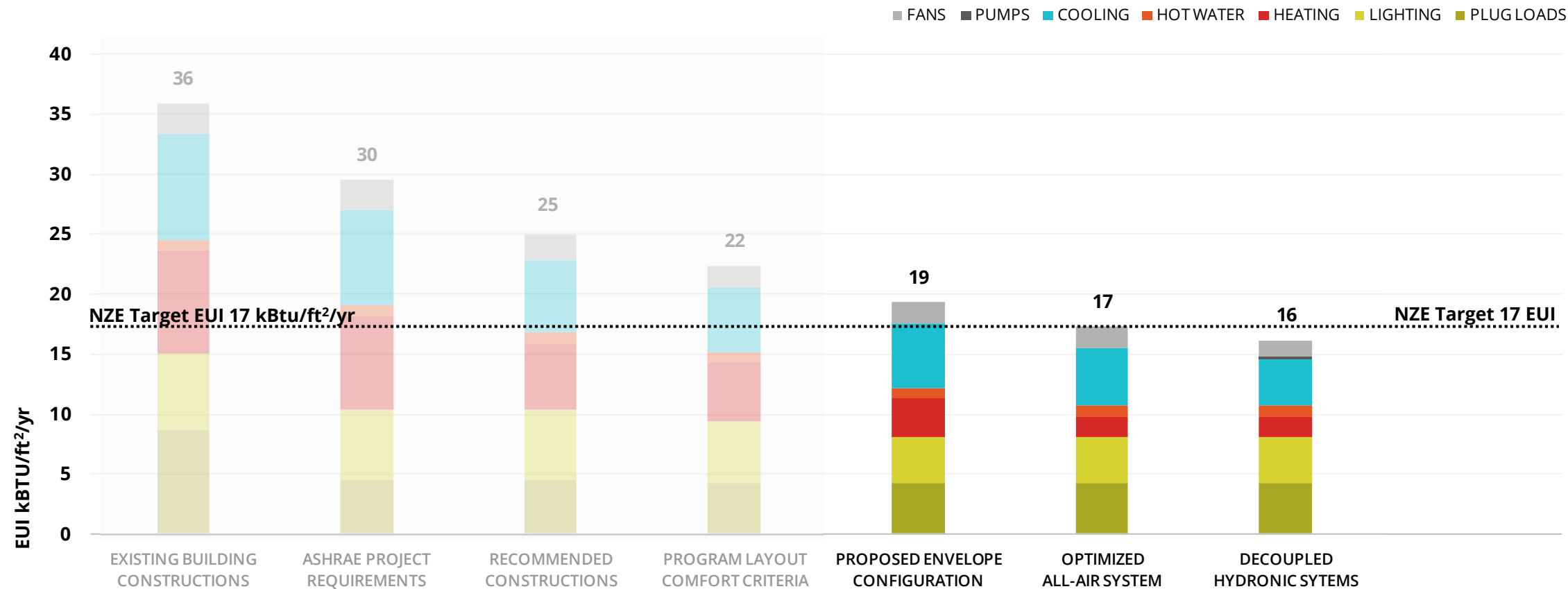
Ceiling fans
(bidirectional)

Radiant Sails

FCU



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20% SAFETY FACTOR

16,000
14,000 ft² rooftop PV area

Assuming ~50% of 28,000 ft² roof available for PV array

292
258 kW_p PV system capacity

Assuming 19.5% PV module efficiency

378
341 MWh annual energy generation

Assuming 15% inverter losses, 4% system losses

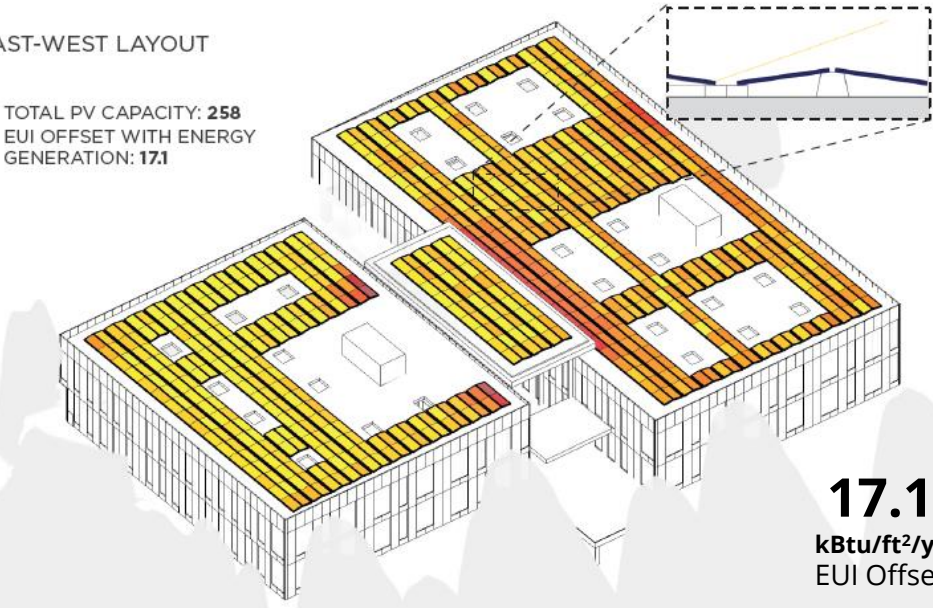
19.3
17.1 kBtu/ft²/yr potential EUI offset

Assuming 68,000 ft² floor area for EUI calculations

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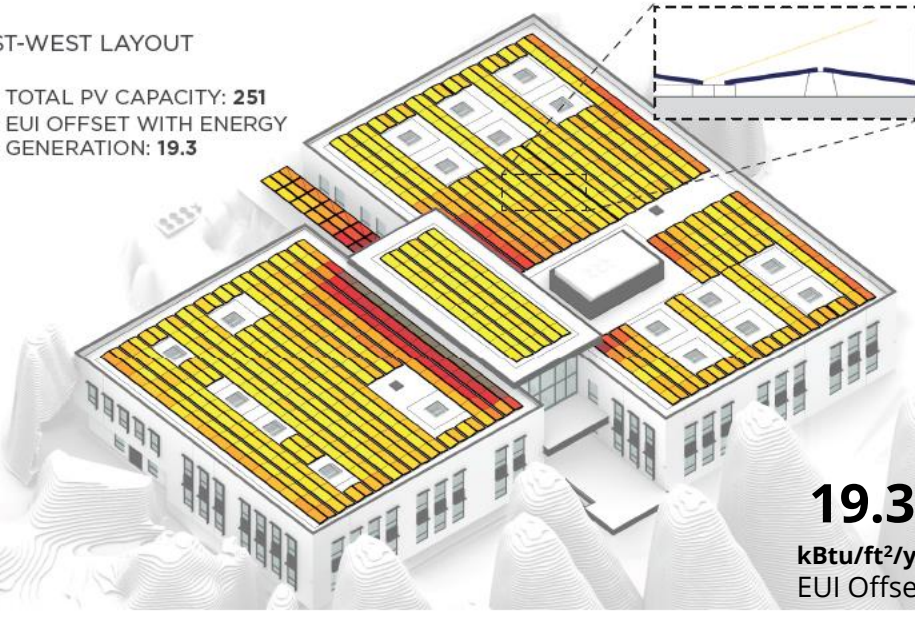
TOTAL PV CAPACITY: 258
EUI OFFSET WITH ENERGY GENERATION: 17.1



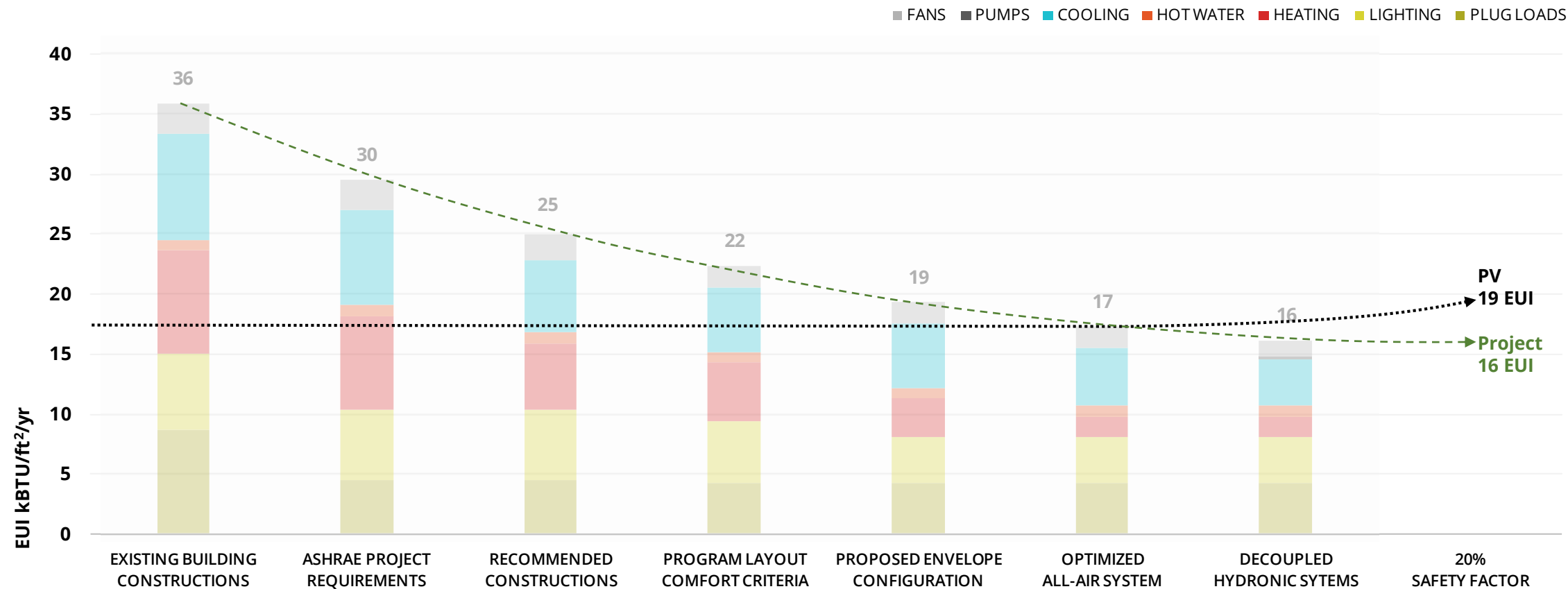
PV CONFIGURATION 2: DUAL-TILT, EAST-WEST LAYOUT

Annual Insolation	(kWh/m2/yr)	1,579
Array Altitude	Degrees	5
Array Azimuth	Degrees	80/260
PV Panel Efficiency	(%)	19.5%
System Losses	(%)	15%
Inverter Losses	(%)	4%
PV Panel Area	(ft2)	16,196
	(m2)	1,505
Roof Utilization	(%)	54%
# 405W Panels*	(#)	720
DC System Size	(kW)	292
Annual PV Energy	(kWh)	378,000
Annual PV Generation Potential (EUI**)	(kBtu/ft2/yr)	19.3
Annual PV Generation Per m² Panel	kWh/m²	251

TOTAL PV CAPACITY: 251
EUI OFFSET WITH ENERGY GENERATION: 19.3



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snagpal@elementaengineering.com

