ASHRAE's LowDown Showdown

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Overview

Project Approach

Existing Building Modeling/Calibration

Proposed Design

Proposed Building Modeling

Renewables

Results/Outcomes

Lessons Learned

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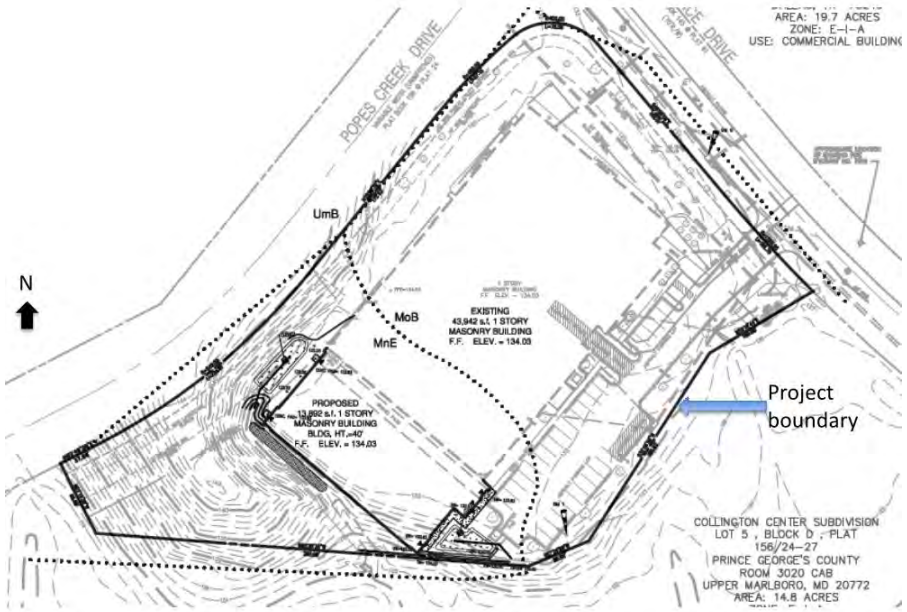
ASHRAE "Lowdown Showdown"

Conceptual retrofit of existing library archival facility

- Energy consumption comparable to coffee shop
- Required 24/7/365 setpoint control to 60°F and 40% RH
- Issues with project documents did not match building
- Limitation on renewables capacity



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Six-Step Design Approach

Set Aggressive Goals

Analyze the Climate

Reduce Loads

Choose Efficient Systems

Opt for Renewables

Verify Performance

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Lowdown Showdown - Approach

- Model existing building, calibrate to electric bill data
- Identify main sources of energy consumption
- Create energy reduction strategies
- Judging criteria: feasibility, cost effectiveness, energy performance

Design Goals

- Understand main consumers of energy in existing building
- Focus efforts on making archival bays as efficient as possible
- Develop an innovative, interactive design
- Apply renewables to approach Net Zero Energy

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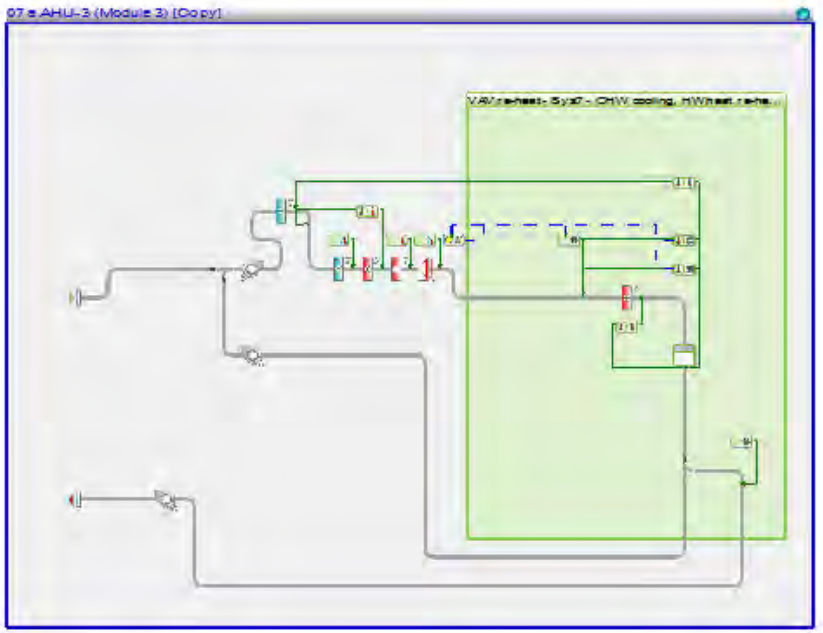
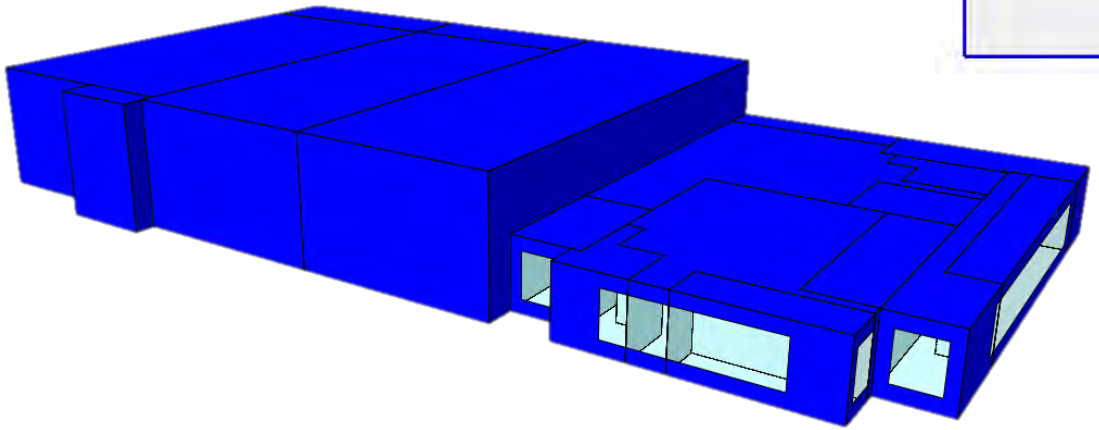
Modeling Baseline

- Drafted from design documents
- Large amount of airflow through AHUs
- Workaround required for modeling desiccant wheel





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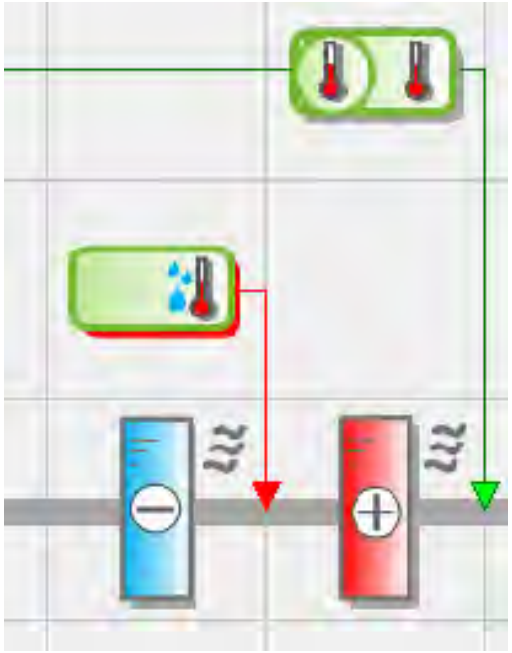
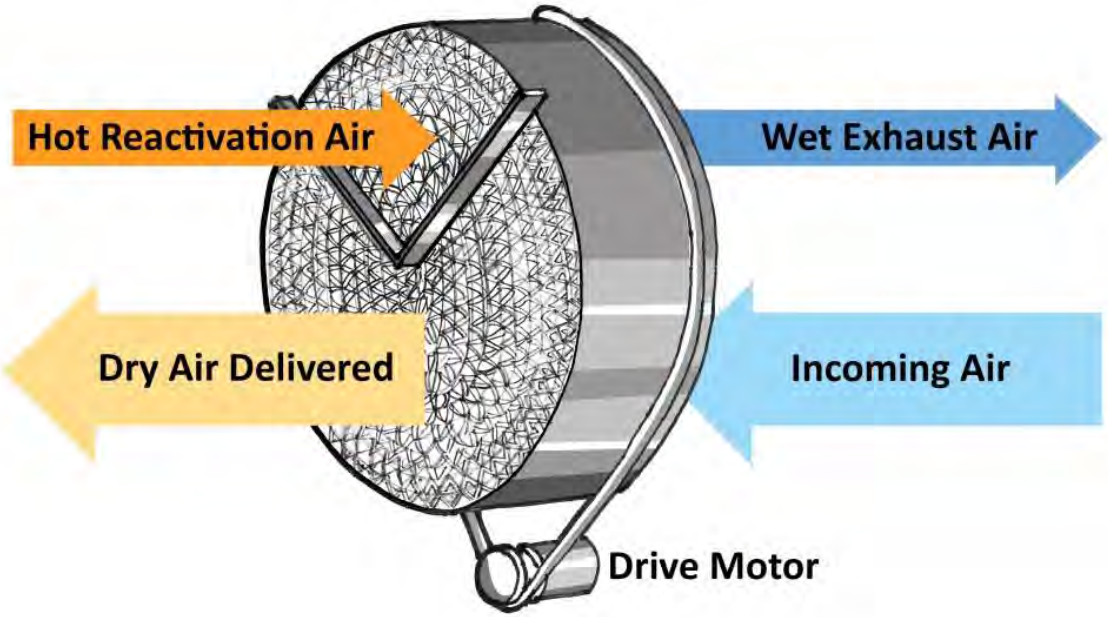
Desiccant Wheel

- Not modeled directly with IES
- Modeled with additional cooling + heating coil
- Overestimates energy usage





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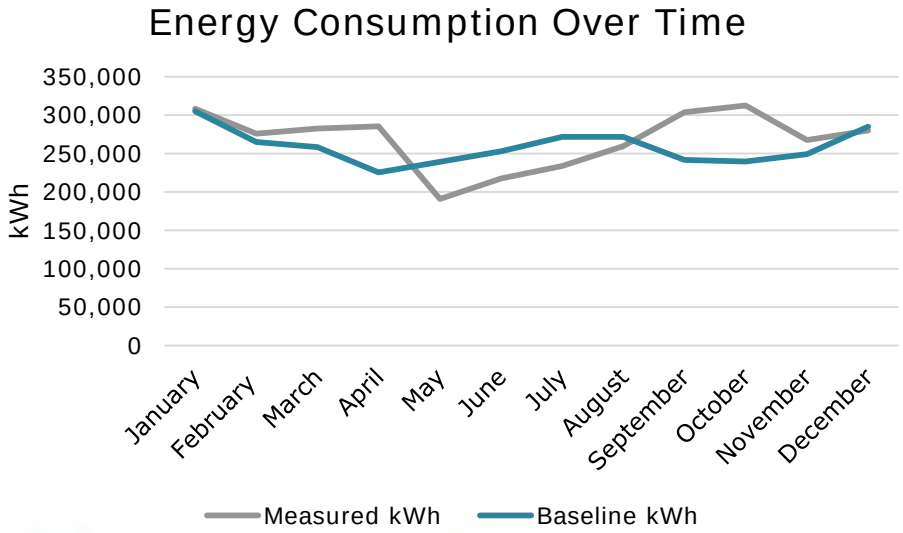
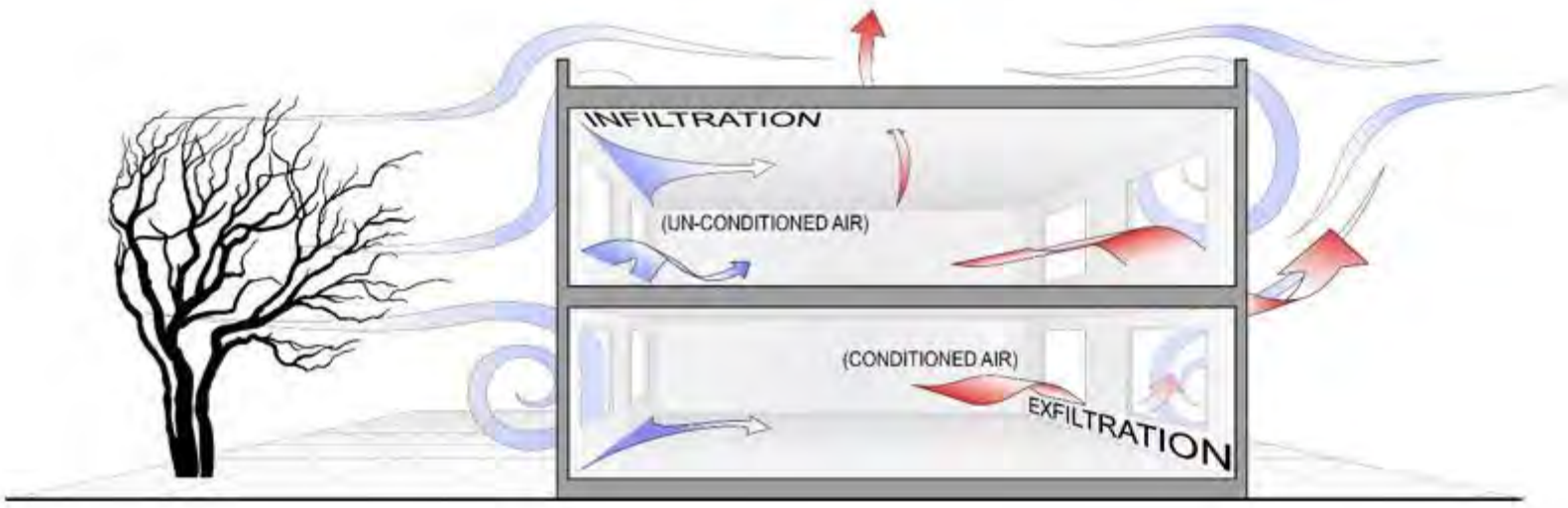
Calibration

- Limited variables we could change
- Infiltration unknown and often underestimated
- Fan static pressure
- Chiller efficiency





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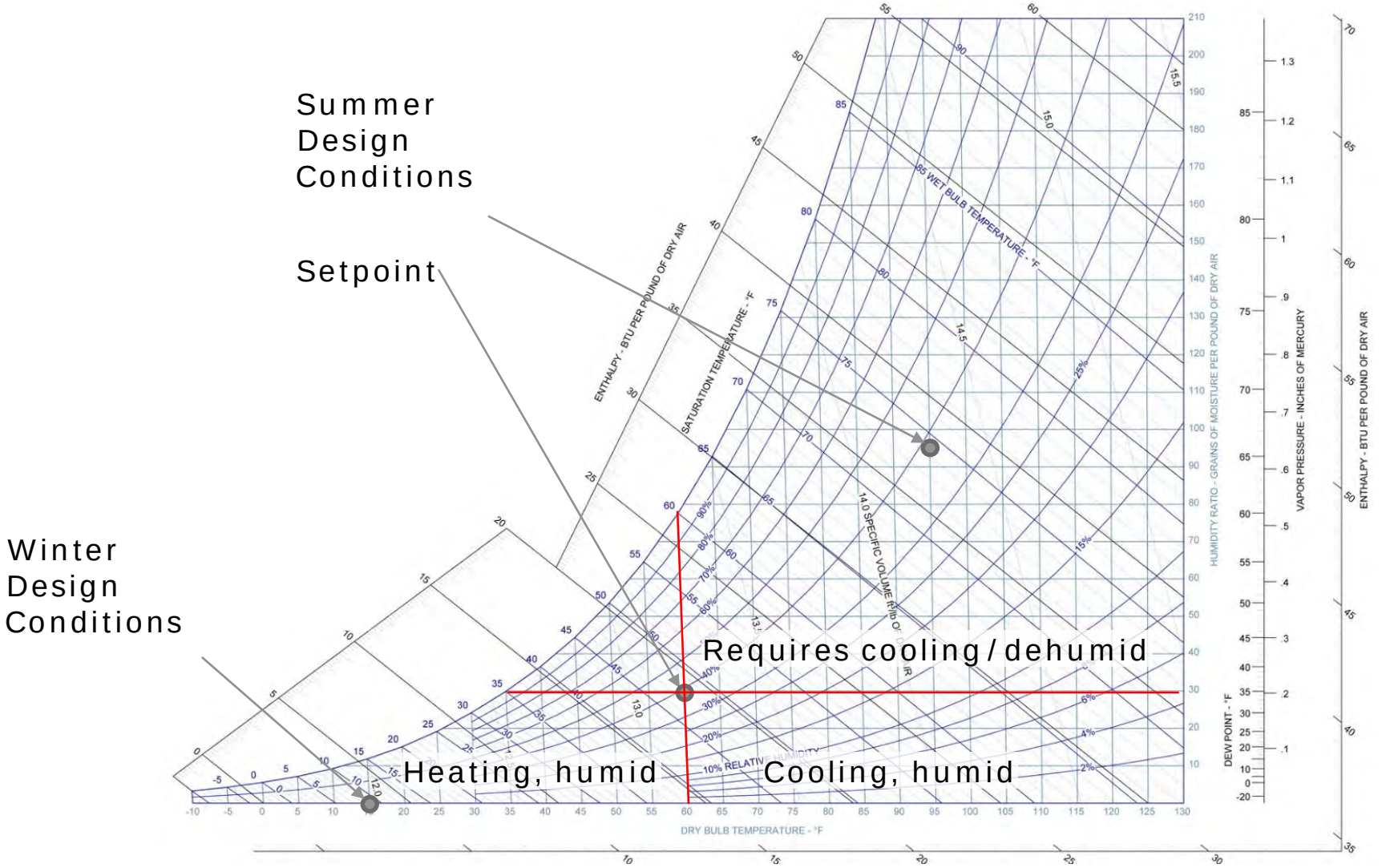
Building Loads



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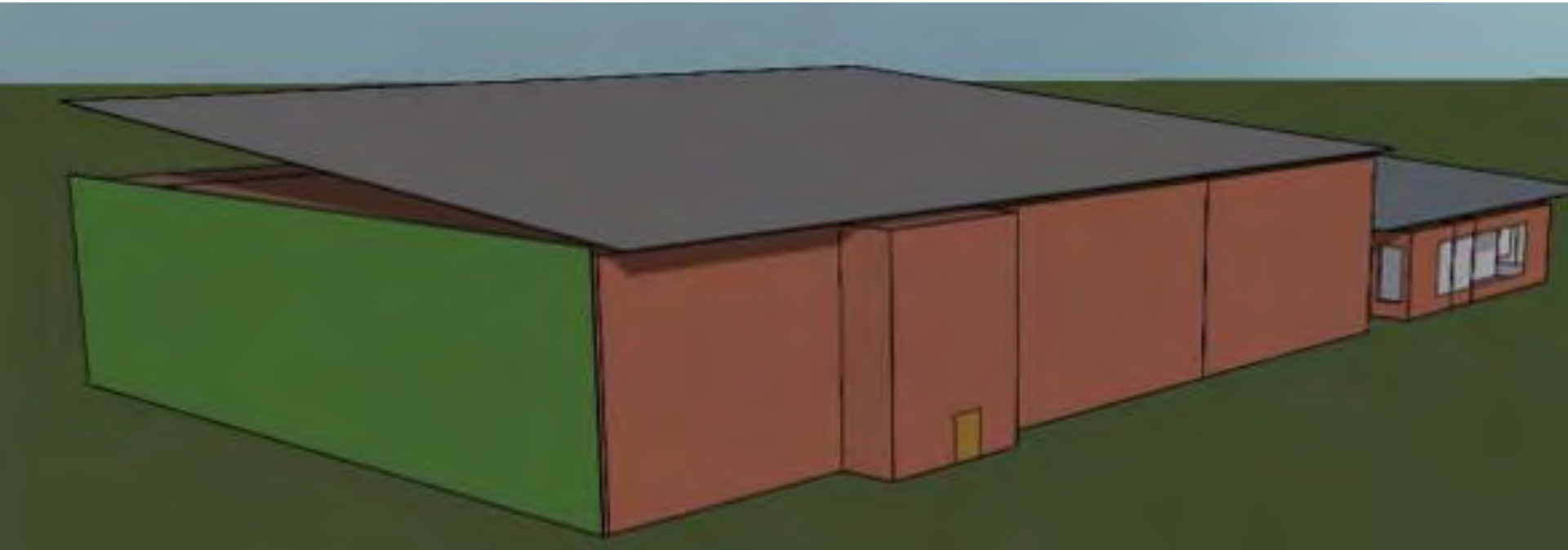
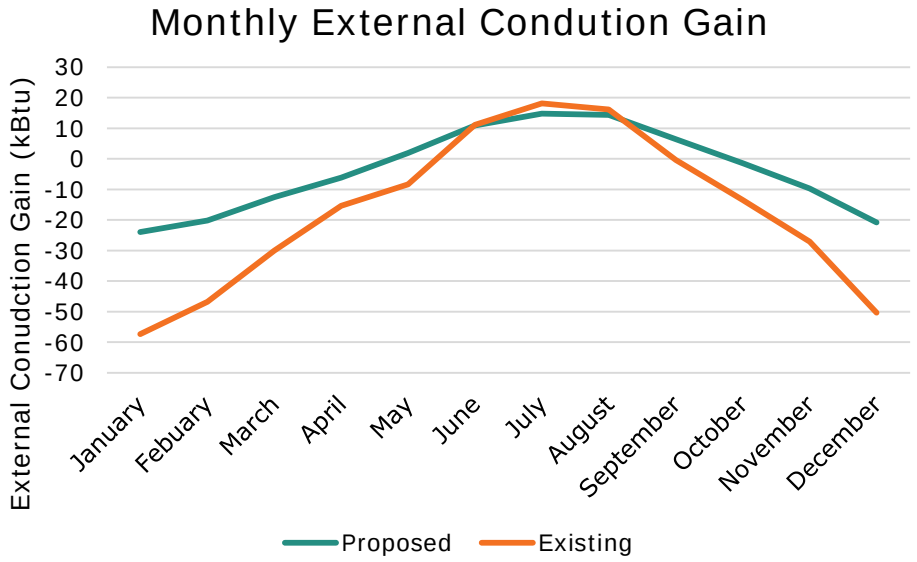
LowDown Showdown – Efficiency Measures

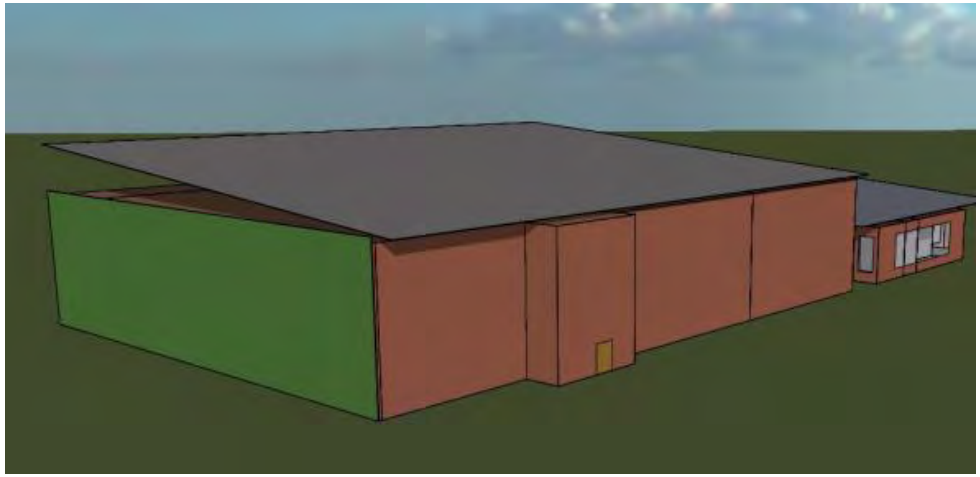
- Insulate vertical walls + green west wall
- Roof canopy shades from direct solar, provides platform for PV
- Operational awareness to reduce infiltration
- Lighting inspired by data centers ("follow-me" style)



Envelope Gains

- Add insulation on vertical walls
- Fly roof shades building from overhead direct solar gain and provides PV platform
- Reduced infiltration via verifying building tightness
- Increased operational awareness to minimize doors opening





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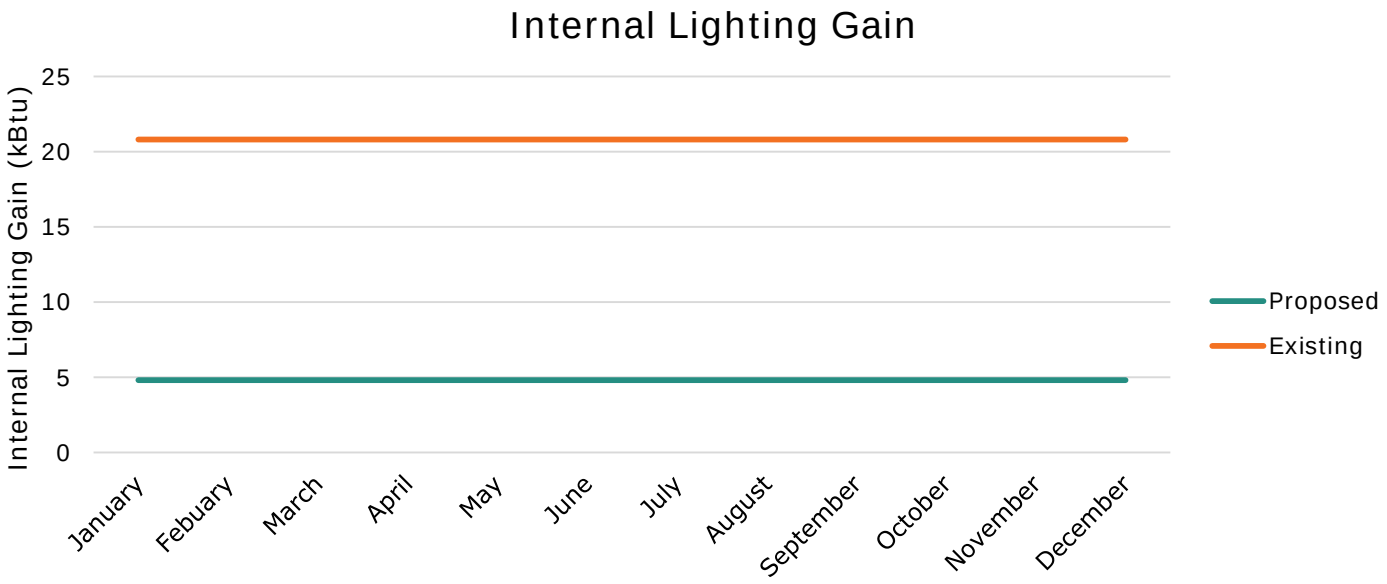
Reduced Lighting

- Existing lighting power density = 1.5 W/sf
- Proposed lighting power density = 0.6 W/sf
- "Follow Me" style occupancy controls
  - Large floor plate
  - Only a small fraction of space needs lit at any given instant—where the workers are
- Resultant ~75% decrease in lighting energy



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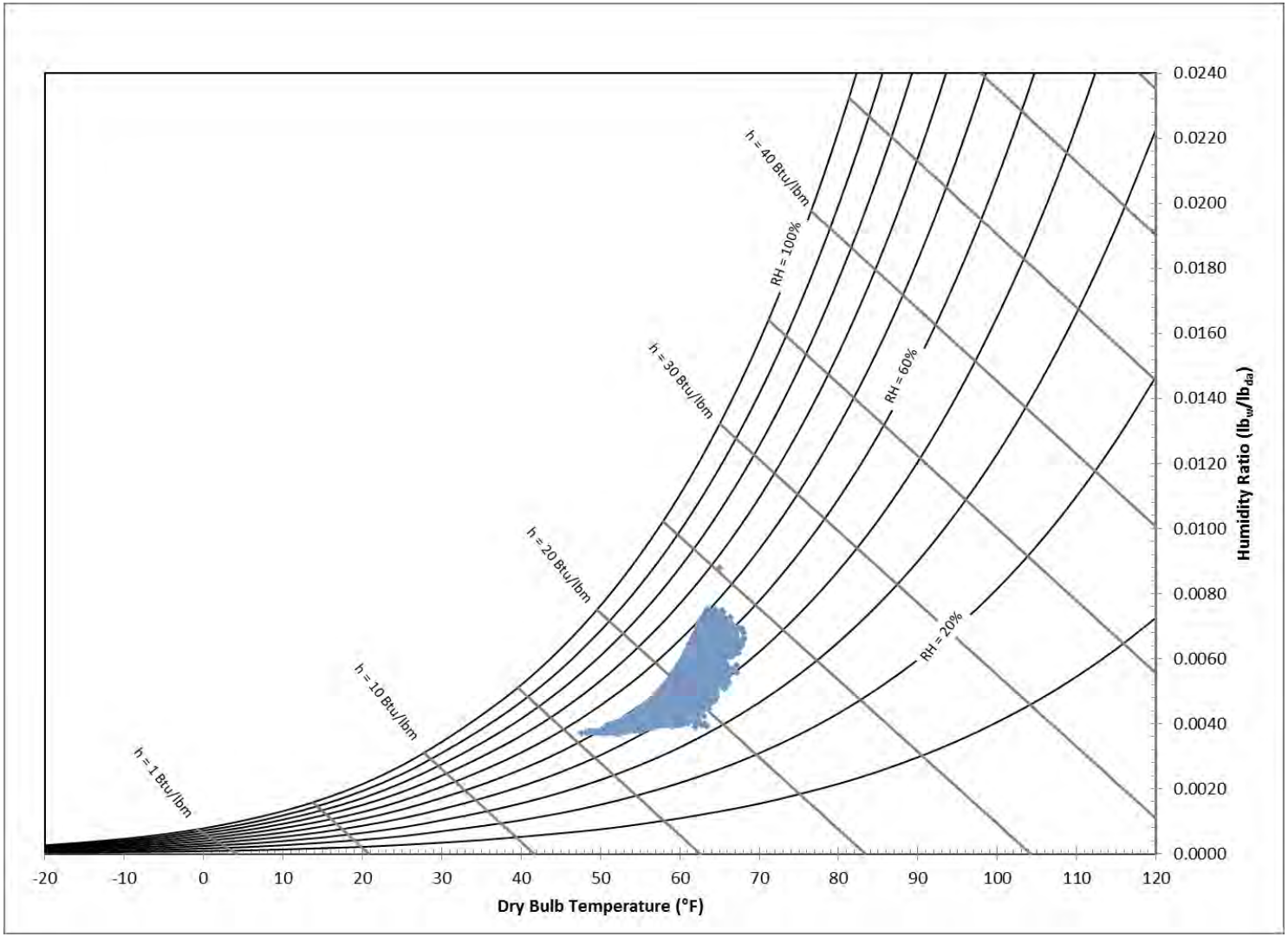
Heat Recovery



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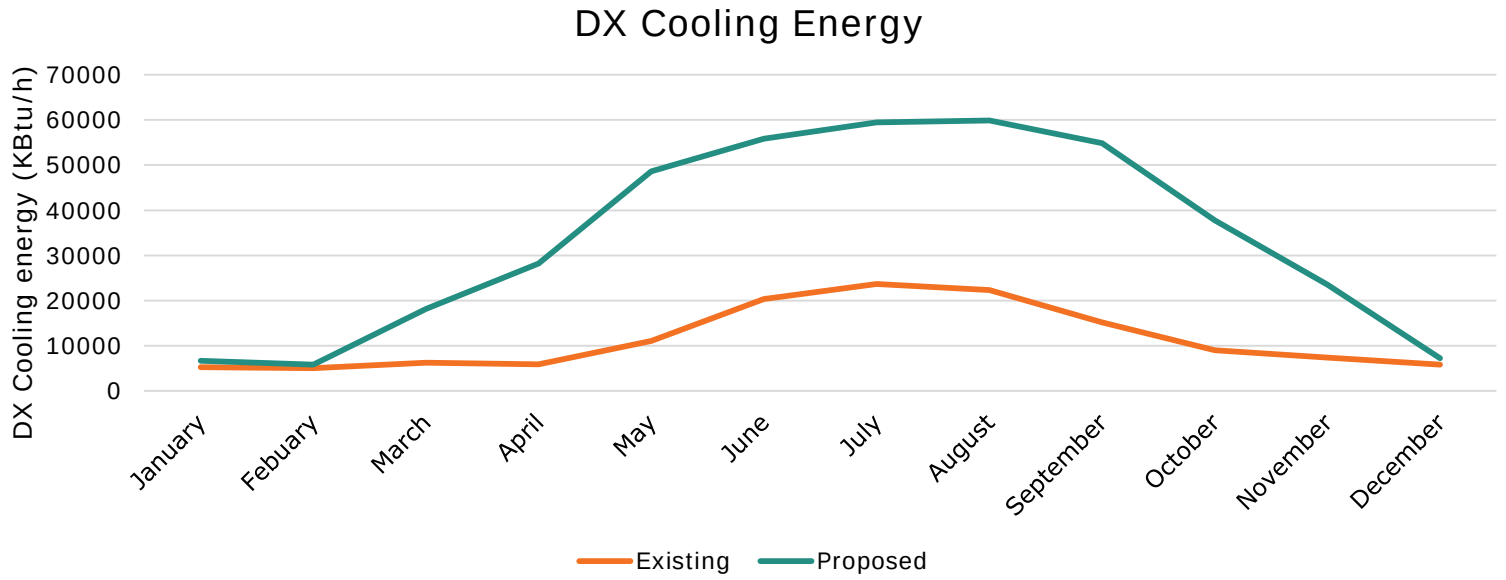
Isolating Ventilation

- Reducing loads means ventilation can be decoupled from other space conditioning
- Deliver code-required outside air (600 CFM per bay) at interior design conditions
- Low-RPM large-diameter ceiling fans for destratification
- Utilize efficient secondary system to handle envelope and internal loads



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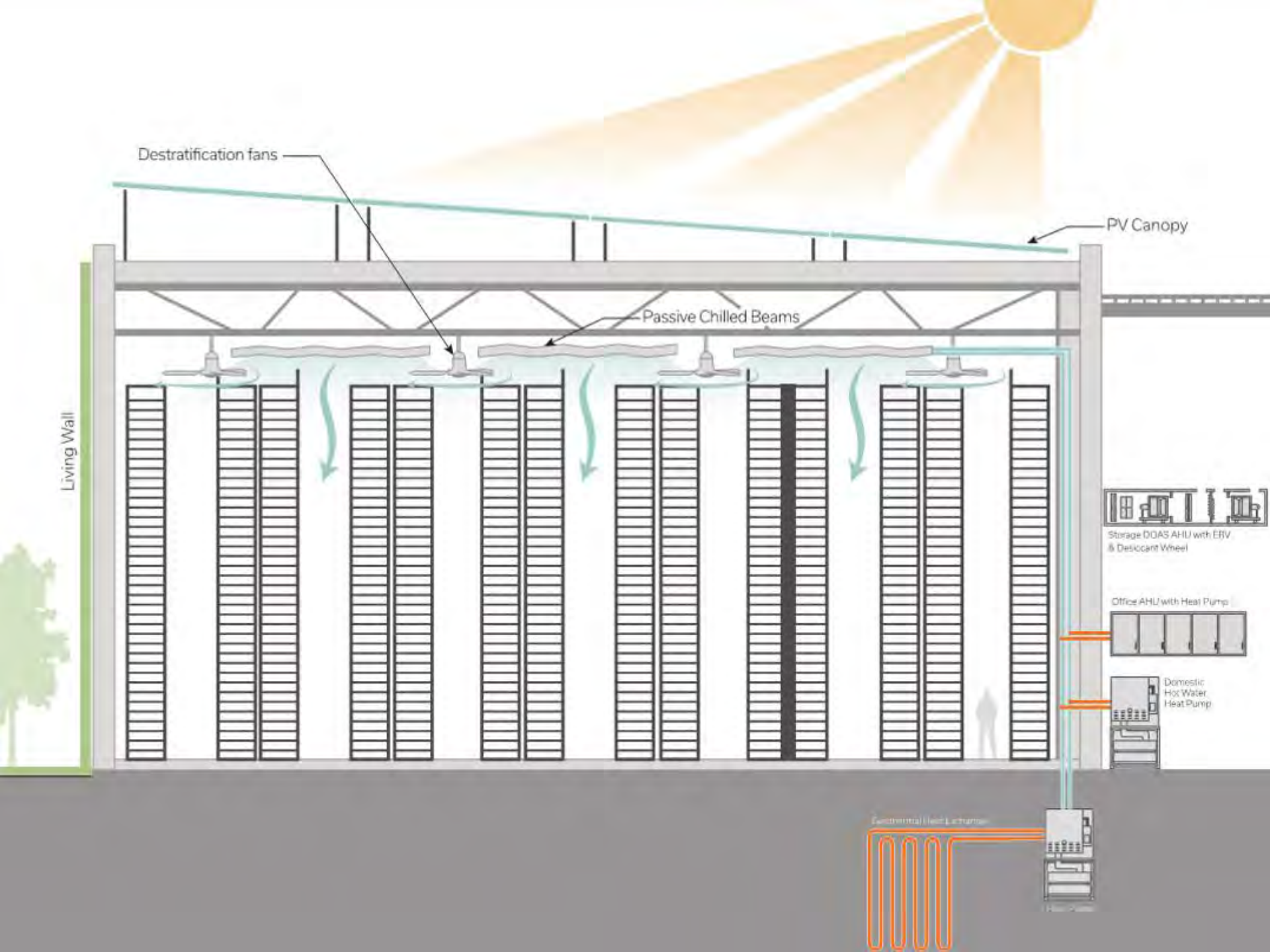
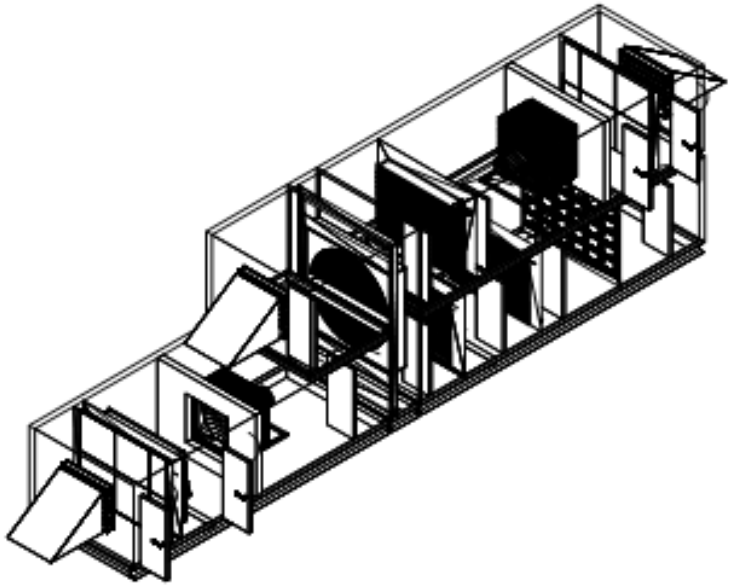
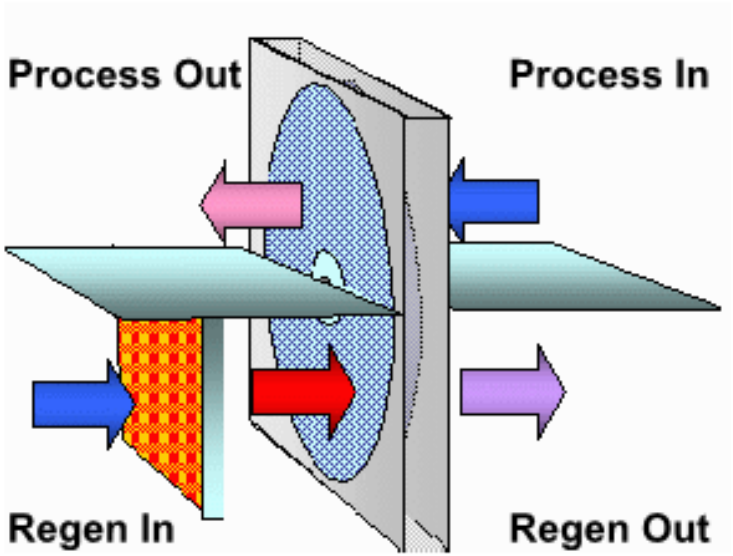

Destratification fans
PV Canopy
Passive Chilled Beams
Living Wall
Storage DOAS AHU with ERV & Desiccant Wheel
Office AHU with Heat Pump
Domestic Hot Water Heat Pump

Custom AHU for Storage Bays

- Hydronic preheat
- Desiccant dehumidification with hot gas regeneration
- DX coil
- Evaporative pad humidifier
- Powered exhaust with 80% effective total heat recovery wheel





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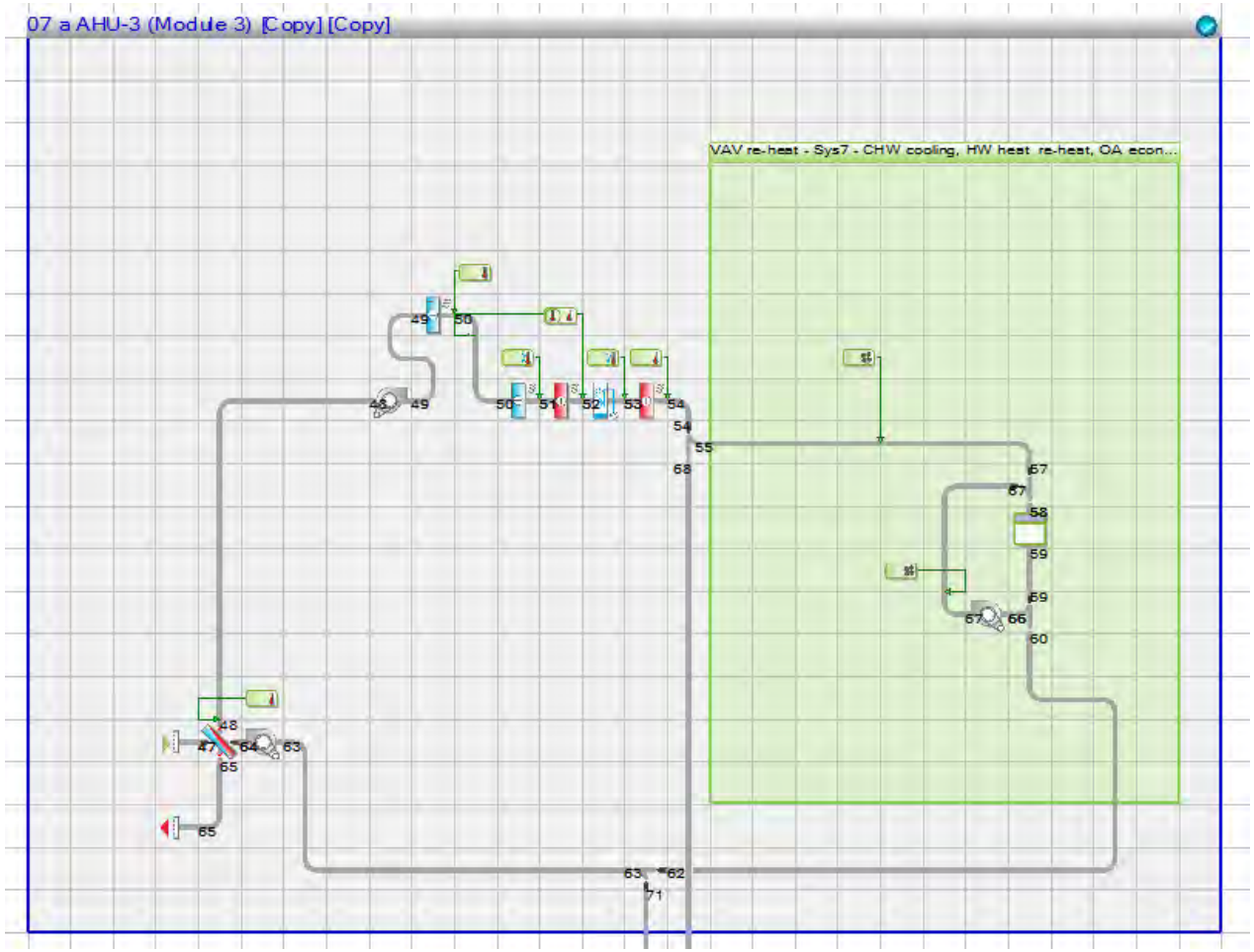
Modeling Proposed

Challenges:

- Heat Recovery
- Desiccant Wheel
- Chilled Beams
- Ceiling Fans
- Geo Loop



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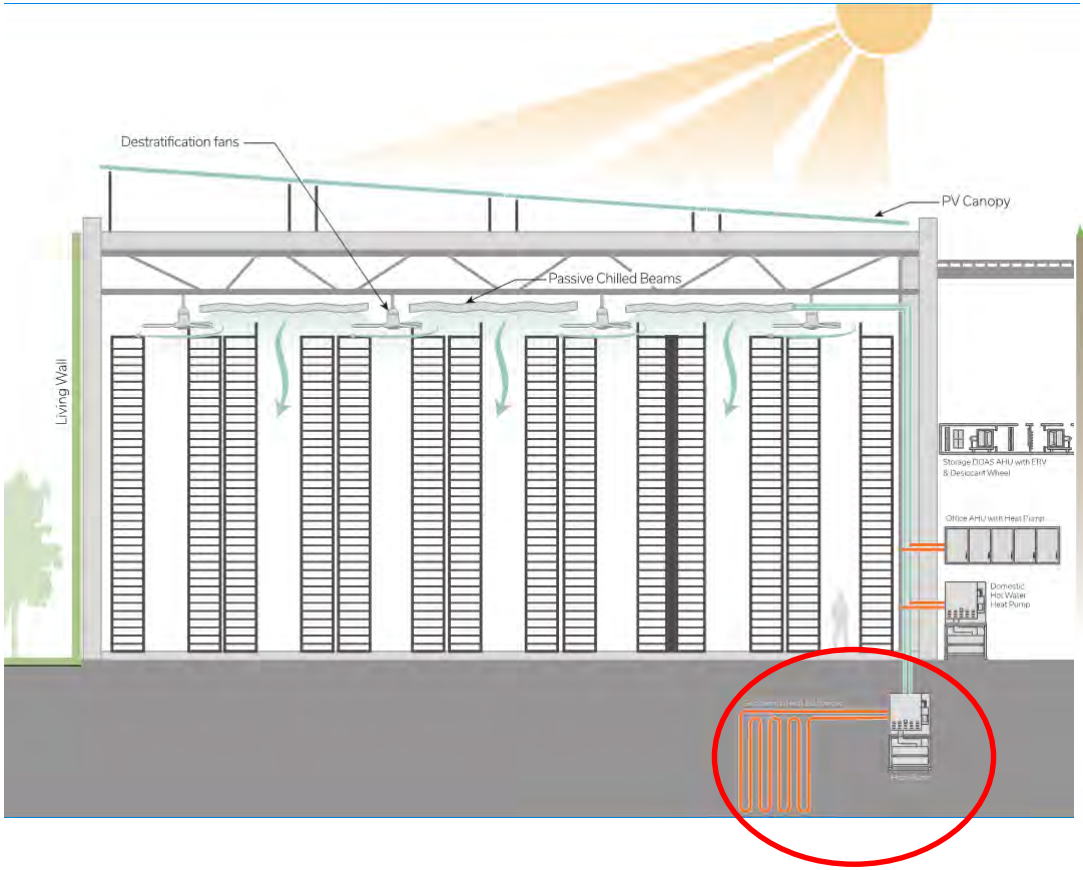
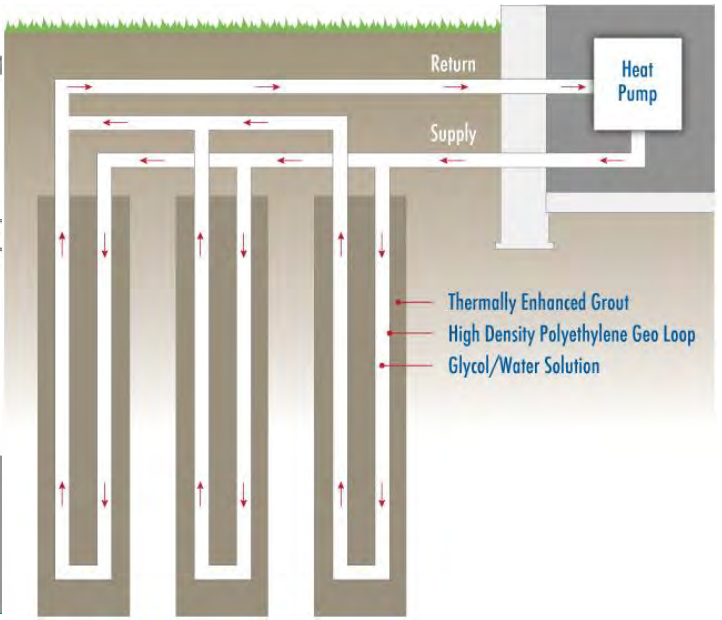
Modeling Proposed





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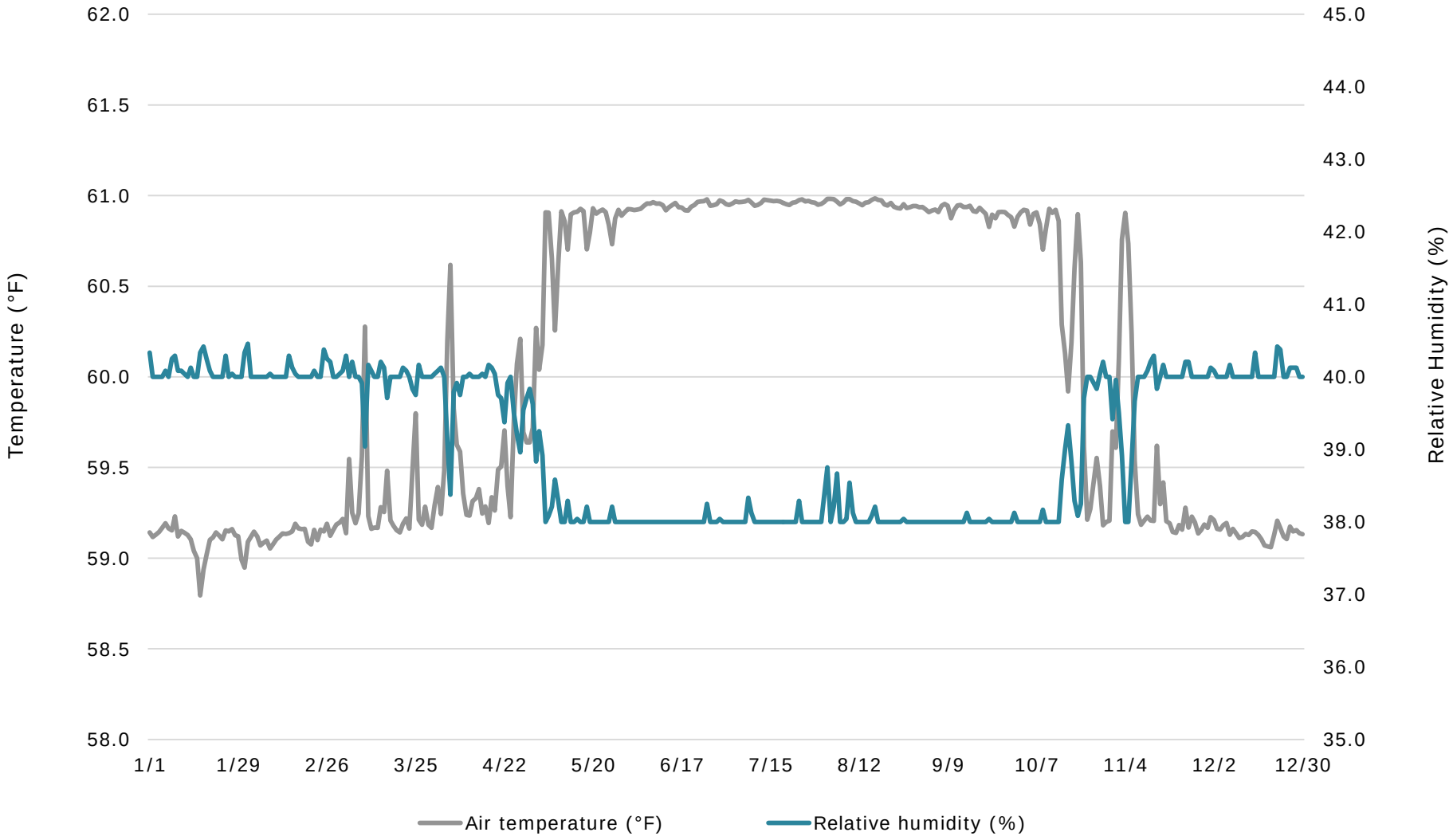
Holding Set Point



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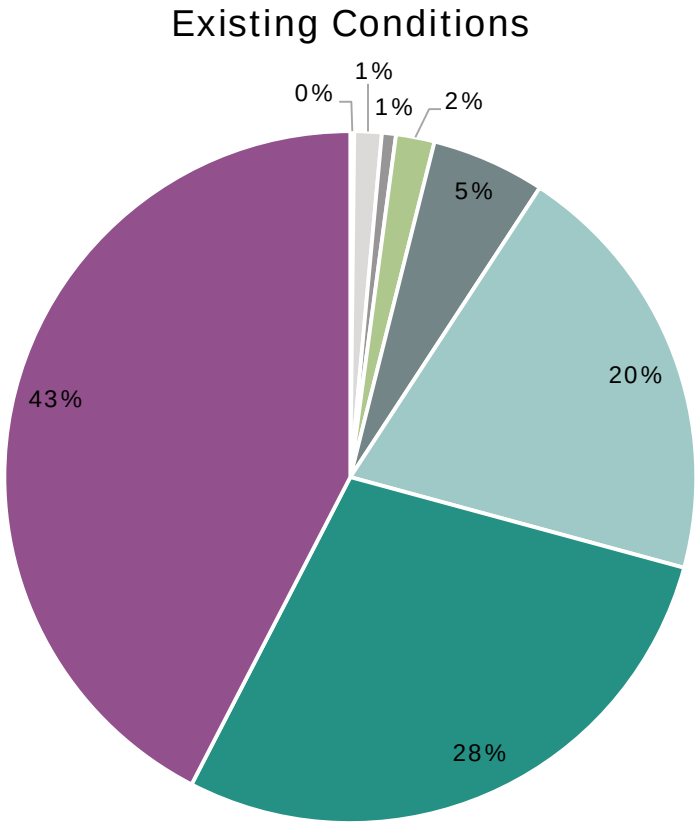
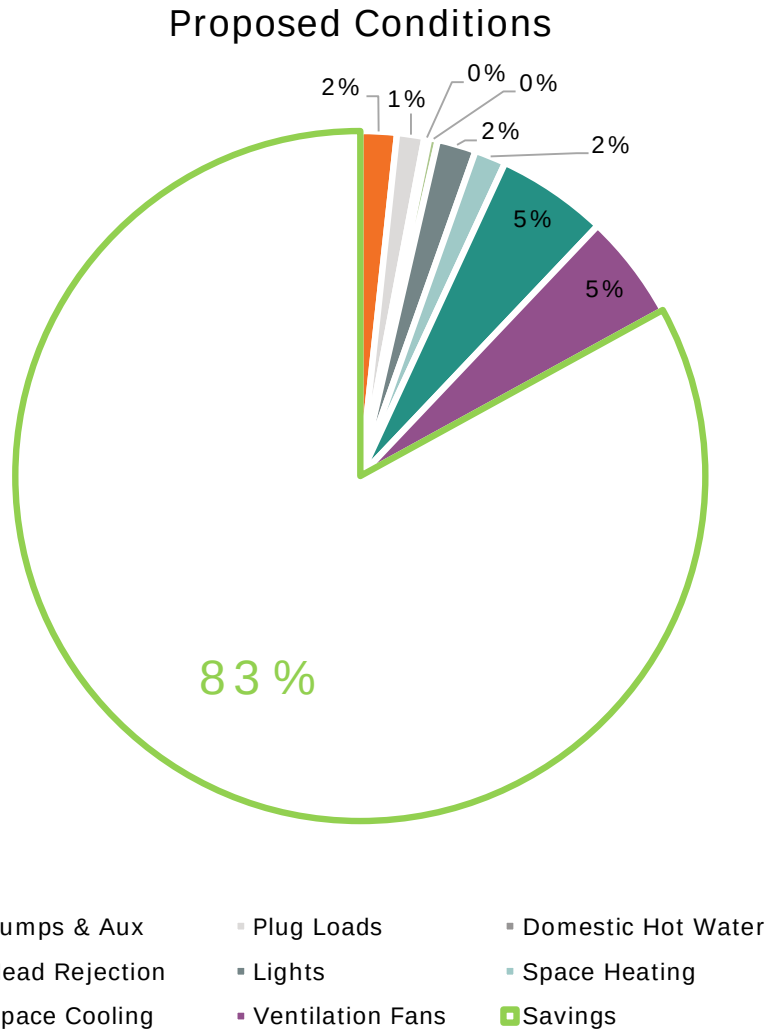
Renewables

- Use 10,000sf of roof canopy for PV
- Analysis with NREL's PVWatts tool estimates 1,179 kWh/kW of installed PV
- Panel density of 18 W/sf -> 180kW array
- Provides EUI offset of 11 kBtu/sf/yr

Energy Breakdown





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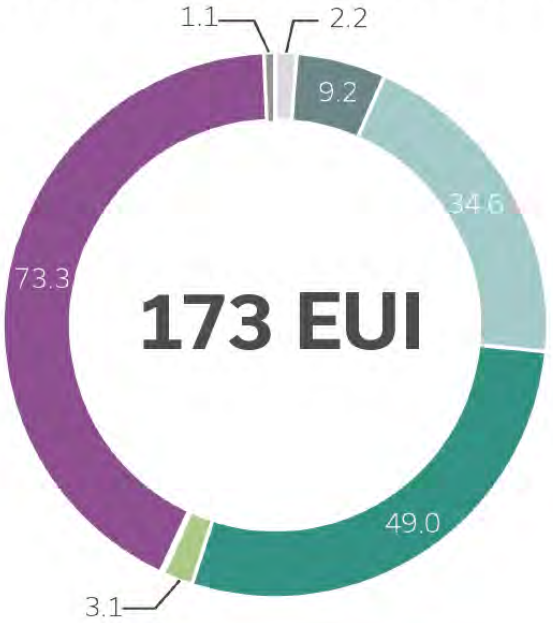
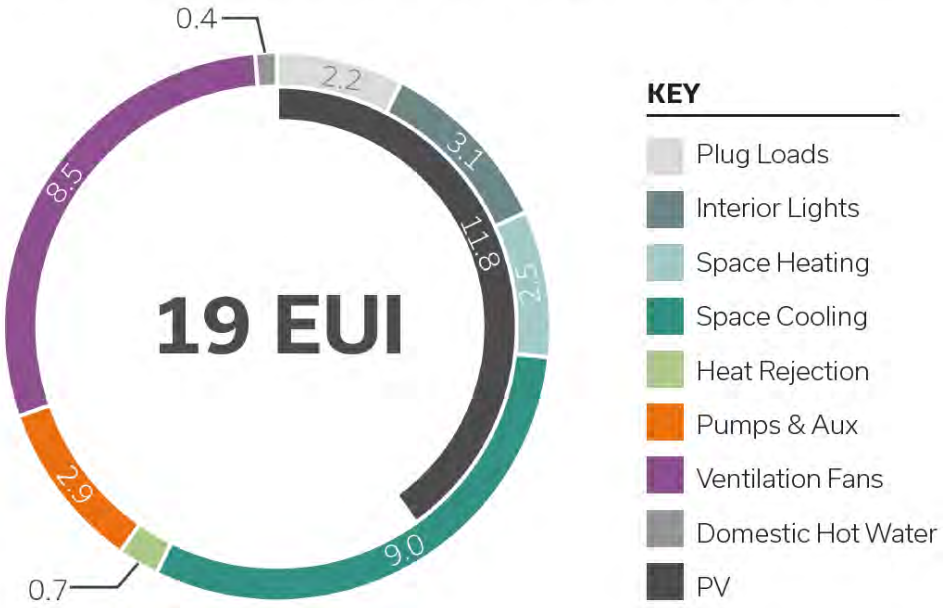
Lowdown Showdown - Outcomes

- 82% energy savings prior to inclusion of PV
- Savings in ventilation key – only deliver the air you need
- $1.2M estimated cost, but payback in 5 years

EUI Breakdown for the Baseline



EUI Breakdown for the Proposed Design



Results Summary

LDSD RESULTS SUMMARY	BASELINE	SUSTAINABILITY SAVANTS	
Total Energy Usage (kBtu)	10,600,000	1,800,000	
Site EUI (kBtu/sf/year)	173	18.6	
Source EUI (kBtu/sf/year)	535	55.3	
Annual Electricity Usage (kWh)	3,105,000	528,000	
Annual Water Usage (gal)	12,500	12,500	
Annual Electricity Cost	$250,900	$25,500	
Annual Water Cost	$500	$500	
Total Annual Costs	$251,400	$26,000	
Cost Per Square Foot	$4.10	$0.42	
Total Energy Generation (kBtu)	0	724,000	
Net Energy (kBtu)	10,594,000	1,078,000	
Carbon Equivalent (tons CO_2/year)	2,160	220	

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Lessons Learned

- Calibrating a model with limited design data requires setting a "good enough" criteria
- Still uncertainty when actual site conditions can't be known due to project constraints
- Workaround necessary for reasonable modeling of desiccant wheel
- Load reduction was key in creating a highly efficient design

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Creating a better environment

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