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TO: ANNA RUTH KIMBROUGH

FROM: ALEXANDER SKILLMAN // ENERGY STUDIO

SUBJECT: FRANKLIN CITY HALL: LEED CHARETTE SESSION #1 MEETING NOTES

DATE: NOVEMBER 13, 2020

CC: KEN SCALF

LEED Charette Session #1 Summary

This memorandum serves to provide the meeting notes from the November 10, 2020 LEED charette session. This session focused on the broader purpose of the project and sustainability goals, initial energy performance results, and generating ideas for energy conservation and water conservation measures to examine as the design process continues.

Project Purpose Concepts

Participants provided insight into areas of broad project purpose that are critical for success. These key areas are summarized below:

- Flexibility in facility use and future growth potential
- Durable facility for long useful life
- Inviting for the public to use both interior building and site amenities
- Must be historically appropriate and connect with the heart of downtown Franklin
- Serve as a benchmark for sustainable development
- Educate public on meaningful sustainability measures

Sustainability Key Concepts

Participants provided insight into areas of project sustainability that are critical for success. These items are summarized below:

- Focus on staff thermal comfort and higher level of system controllability
- Enhance natural lighting and views to outdoors
- Encourage connection to exterior environment (green roof, courtyards, etc.)
- Focus on maintainability of all building systems and materials
- Providing ventilation rates to support occupant health and building resiliency
- Re-use water in appropriate applications; reduce reliance on exterior utilities
- Educate public and demonstrate incorporated sustainable measures
- Avoid green washing; visible measures are good but meaningful is critical

Simple Block Model: Initial Results

A discussion of local climate characteristics based on historical weather data and initial results from the simple block model were presented to the group. The simple block model shows substantial end-uses from interior lighting and cooling-related systems. Additionally, various envelope performance parameters were tested for window area, roofs, walls, windows, shading/solar control, and interior lighting power; the sensitivity of the building to these tested parameters was presented. Please see the attached presentation document for detail.

Energy Conservation Measure Discussion

During the afternoon, participants discussed energy conservation measures in two groups. The first group focused on site, envelope, and passive systems; the second group focused on lighting/electrical, mechanical systems, and other active systems. The following summarizes the list of ideas that were generated across both groups. Note that similar ideas are grouped together below for brevity.

- Site conditions, massing, and orientation
    - Orientation is governed by site constraints
    - Utilize trees or other shading along street side such as colonnade
    - Continue to develop massing concepts with more detail: courtyards, setbacks, etc
    - Consolidate breakrooms by level instead of more breakrooms per department; dual purpose as gathering areas for employees
- Building envelope
    - Incorporate skylights, atriums, or courtyards to increase daylight & view potential
    - Tinted glass is not allowed (understood due to historic considerations)
    - Integrate shading devices as decorative precast, lintels, or required building setbacks via thickness of wall; set window to interior of opening
    - Examine green roof
    - Implement light shelves to increase daylight effectiveness
- Lighting
    - Daylighting is required by code; examine expanded use beyond code
    - Occupant/vacancy controls are mandatory under code; examine expanded use
    - LED luminaires likely basis for primary lighting; LED also work well with controls (e.g. daylight dimming)
- Mechanical systems
    - Operable windows and natural ventilation; requires careful integration with building systems to ensure security; further consideration required related to potential maintenance costs or issues
    - Air-side systems
    - Plant-side systems (can be combined with various air-side systems)
        - Ground source / "geothermal"
    - Implement dedicated outside air systems where appropriate
    - Consider waterside economizers where system permits
    - Natural gas likely used for emergency generator; consider heating systems with natural gas as alternative to electricity

Water Conservation Measure Discussion

During the afternoon, the first group of participants also included water conservation measures in the discussion. The following summarizes the list of ideas that were generated. Note that similar ideas are grouped together below for brevity.

- Cistern for rain water capture
  - Northern quadrant location
- Reclaimed water line nearby
  - Costly to run a line through downtown
- Stormwater discharge to river
  - Green infrastructure - pervious paving
  - Green roof

Miscellaneous Notes

Additional ideas and commentary were discussed related to broader project themes beyond water and energy conservation. These comments are summarized here but were also captured in the attached notes.

- General
  - Public needs to see a building that is both efficient and meets the intent of historic guidelines
  - Focus on proven technologies that have demonstrable effectiveness and reliability
  - Avoid systems that greatly increase maintenance cost or complexity
    - Ensure adequate area and access to maintain systems
  - Will new facility continue to use current MTECC rate schedule or fall under tariff with demand charge? Could natural gas heating avoid this in cost-effective way
- Site
  - Engagement of streetscape to be open and inviting
  - Complement with civic presence but do not compete with courthouse; utilize steps up to Public Square entrance as another gathering opportunity
  - Select vegetation on site beyond rain gardens
  - Develop deeper streetscape than 12' on Main Street, targeting 20'
- Envelope
  - Incorporate brickwork similar to 231 building with precast
  - Envelope thickness should look relevant
  - Provide outdoor opportunities via courtyards and/or on upper levels
  - Steel stud cavity wall with brick veneer and 6" composite floor slabs
- Lighting/Electrical
  - Utilize task lighting to increase individual control and reduce frequency of lighting related complaints
  - Consider how to integrate access control systems with IT
  - Identify areas/departments requiring emergency power backup
  - Surge protection for systems
- Mechanical systems

- Discussed centralized vs decentralized systems
  - Centralized tend to have better control and flexibility
- Good experience with current Trane VRF for reliability and customer service
- Good experience with existing ground source systems
  - Low maintenance costs: approx.. $1,000 per year for water treatment
- Improve indoor air quality for occupant wellness
- Rooftop mounted equipment will need to be screened for visual and noise control; focus on systems that can be placed on ground level or have small roof footprint

Attachments

- Original meeting agenda
- Presentation used during session
- Original notes from afternoon discussion sessions

Optimized Design Solutions

Energy Studio

Integrated Design Charrette Agenda
City of Franklin, City Hall

Date: November 10, 2020
Time: 10:00 am-3:00 pm CST
Location: Zoom Meeting

Objectives:

- Team understanding of the Integrative Design process and requirements.
- Establish charrette goals and anticipated outcomes.
- Identify tasks/action items and responsible parties.

1. **Welcome, Introductions, and Agenda (0:10 min., 10:00 am) – ODS/ES**
   a. This is a time for everyone to get online and get to know one another.
   b. The team will introduce themselves (name and role in the project).

2. **Workshop Goals (0:10 min.) – ODS/ES**
   a. Anticipated outcomes – we want to walk away from this charrette with aspirational performance goals. The goals can pertain to all aspects of the building: energy, emissions, water, site, materials, waste, IAQ, O&M, etc.
   b. Identify performance goals and definitions.
   c. Ground rules for the meeting to be successful.

3. **Project Overview (0:20 min.) – Owner and Project Manager**
   a. During this time, the project leaders (Owner/Representative, Architect, etc.) will provide a brief overview of the project and project status. The leadership team should present an overview of the following items:
      - Project Description – A brief overview of project with drawings.
      - Project Status – What decisions have been made already and what work has been performed? What are the criteria and process for making sustainability related decisions?
      - Review of previously established overall project critical success factors and project vision statement.
      - Issues or Concerns – Are there any barriers or problems that affect the project?

b. It is valuable that any plans (site plan, programming sketches, conceptual plans, etc.) that have already been created are brought to the charrette for discussion or reviewing during the meeting.

4. Project Purpose (0:20 min.) – ODS/ES

a. What will make this project successful in the big picture? ODS/ES to lead group discussion. Each person takes 5 minutes to reflect on what will make this project successful and write them down. Focus on things like:

- Why does this project matter in the big picture?
- To whom does it, or will it, matter? Who will it impact?
- What is the transformative potential of this project?
- Building/energy performance.
- User experience.
- Maintenance, Operations and anticipated operational cost.
- Education

b. We will then synthesize and discuss as a group to identify top 5 to 6 measures of success.

c. Owner's Project Requirements – Discuss/review key success measures.

5. Sustainability and Performance Goals (0:45 min.) – ODS/ES

a. This portion will begin to focus in on the specific performance goals for the project. We will continue from the last activity into the following areas:

- Energy benchmarks and energy targets: Energy Studio will provide a technical presentation that describes project climate and simple box energy modeling results
- Historical utility bill analysis.
- Project climate.
- Simple box model serves to inform building operational energy use.

b. Discuss potential range for reductions of new facility over benchmark buildings.

6. Break/Lunch (1:00 hr., noon)

7. Breakout Groups (1:00 hr., 1:00 pm) – ODS/ES

a. The purpose and set-up of the two breakout groups will be explained briefly and participants will be asked to move to one of the pre-set group web meeting session. Worksheets will be provided to each group and they will work in one of the following two breakout groups:

- Envelope/Passive design/Site (including site/orientation, building systems, materials, daylighting, passive ventilation, infiltration control, on-site renewables etc.)

- HVAC/Energy systems/Lighting (including primary systems, ventilation, controls, sub-metering, regulated and unregulated electric loads (e.g. elevators, material moving systems, manufacturing equipment), light levels, task lighting, lights sensors, exterior site lighting, technology, combined heat and power, etc.).

b. Each group will need to first establish the following roles (different roles may be filled by the same person, but all should participate).

- Facilitator: Keeps the group on-track, on-time, and makes sure everyone participates.
- Record Keeper: Captures the group discussion and information on the worksheet and makes sure that all the areas of the worksheet are being discussed.
- Reporter: Makes sure they can read and summarize the group discussion and the information captured on the worksheet.

8. Report Out and Discussion (0:30 min.) – ODS/ES

a. The two groups will each have ~ 10 minutes to report out the goals, measures, and strategies that they discussed during their breakout session. These will be captured as they presented. All notes will be kept for the project record, even those that are not presented verbally during the discussion.

b. We will then discuss as a group how the goals, measures, and strategies connect with each other and create a list of the goals for the project. These will be captured as they are presented.

9. Next Steps (0:15 min., 3:00 pm) – Energy Studio

a. We will go over the next steps in the process and decide on the dates for:

- Distribute draft charrette meeting minutes
- Distribute preliminary energy modeling report
- Reviews and comments on preliminary energy modeling report

b. We will review what to expect after preliminary energy modeling is complete

- SD drawings, date anticipated to be available
- SD energy modeling report, date anticipated to be available

Daylighting
Ventilation
Sunshading
Climate

DESIGN STRATEGY BREAKOUT

ENVELOPE AND PASSIVE DESIGN

Daylighting - Kelly works in our favor Historic.

Group Members:

Annette D
Gary V
Keith Holz
Kelly D
Ken Scalf
Amanda R.
Malec Cherry
Mark Hilty
Russell Vernon
Keith Holz
Matt Edwards

Date:

Daylighting:

Sunshading: windows
Not Allowed: Tinted-Glass
Thickness of Walls - Look more relevant.
Public - needs to see a bldg efficient / meet intent of Historic Guidelines.
Shading Devices - Decorative Precast - Lintels.

Site & Orientation:

Sun orientation - Not a lot

Shading - Trees along the street for shading or colonnade for shading 1st Floor

Engagement of Streetscape to open & Inviting.

Prominance - to the bldg. 231 Courthouse.

Passive Ventilation:

Operable Windows - Acceptable ~~abominable~~ more traditional window configuration

Office Bldg → 200-300 employees - maintenance concern / security concern.
Lower floors - tenant spaces - open for walking by.
Appearance - of an operable one over one buiding.
liability issue

Agreement. - policy control

Building Envelope Systems:

Prominance & Welcoming.

Courtyard

Brickwork on 231

Inviting - 231 Public
Civic - Presence like Courthouse.
Outdoors - Upstairs.-

Skylights / Atriums / courtyards.

Other:

Security - 2nd Floor.

Do not compete w/ Courthouse

% Usage
2/5 or 1/3
Happpchin River

DESIGN STRATEGY BREAKOUT

ENVELOPE AND PASSIVE DESIGN

Key Factors:

Cistern - Rain H_2O capture
reclaimed H_2O line -
Main Street - 1200' fr City Hall
New line - hang on TDOT bridge

Brainstorm:

Cistern on Square Northern Quadrant
Roof - Green Roof.
→ costly to run a line thru downtown.
COF Maintenance Crew

Stormwater discharge to river
- Stormwater requmts. -
- Green Infrastructure - BOZO TSC pervious

other than rain gardens

Goals:

3rd

Nice Vegetation ~~on~~ on site
Streetscape along 3rd Ave.
Deeper Streetscape than 12' on Main Street - 20'

Options to Model (3+ Options):

Composite Steel - 6" Floor slab.
Conc. Walls @ Elev. & Stair Cores

Brick w/ Precast.

Civic Architecture → Steps, Gathering.
traditional character. Civic →

Tank - domestic attached.

Pushes & Pulls in Elevation along 3rd - Shading.

BREAKOUT

HVAC, LIGHTING, AND CONTROLS

Group Members:

Alex (Moderator)
- Victoria Estabrook
- Andrew Orr
- Dan Schaefer
- Boyd Wilson
- MEI
- Randall Losh
- Jim Maxwell

Date:

11-10-20

HVAC System Types:

- Rooftop - 30-40 Condensing Units (Packaged Units).
  - Maint. Issues
- Elec Bills have not been that bad.
- Cooling Tower? Appropriate?
- VRF System? - Ea Unit has shut off.
- How to pack tube - exterior area (Maint + Screening)
- Refrigerant - Both system preferred
- Geothermal @ FPD - Worked well. Had a few lines leak, but overall very happy.
  - Good energy bill returns.

Decentralized vs Centralized → Boiler Controls, VRF / Cooling Tower

Lighting Systems:

- More daylight / windows
- LED
- Occ. Sensors (IR / Ultrasonic)
  - Less concern over movement.
- Daylight Controls
- Don't over complicate controls.
- Light Shades / Controls
- A lot of anxiety about lighting controls / daylight harvesting.

Consistency of controls

If different, have a reason, but is consistent for users is positive.

Ventilation:

- Need fresh air recovery / intake @ every unit.
- Humidity control
- Water-side economizer may work better than Air-side
- DOAS may make sense
  - Central Air - Dedicated Outside Air Sys.
  - Allows for add'l Cent. Air / Better IAQ.

Control Strategies:

- Need Surge Protection on Equip.
- Sub-metering / BAS to track energy demands & usage.
- Access Controls (Security) - IT money to sensors on hardware. - No wall mounted reader readers.
  - Remote capability / Scheduling for security locking, etc!

Other: Case based system.

Natural gas likely for emergencies
- Think about the water - Nat Gas.
- Specific zones on generator - TBD - as needed for emerg. response.

- Multiple Elec Meters from old Mall setup
- MYEMC - Currently no demand charge
  - May be w/ new bldg.
- Generator - Screening - roof or rooftop
  - Use bldg placement to create utility courtyard for screening
  - Geothermal below ground as Cooling Tower visible - too big for roof.

BREAKOUT

HVAC, LIGHTING, AND CONTROLS

Key Factors:

Brainstorm:

- Operable windows? On the table
  - Impact on HVAC?
  - What bldg to be inviting.
  - Leads itself to historic bldgs.
  - Sensors on windows tied to HVAC
- Cool HVAC Filtration Plant w/ Fire Sprinkler Issue (avoid conflicts).
- Ventilation @ Food Areas
  - Get away from multiple breaks areas in ea. Dept.
  - More centralized for
- VRF - GT has had great luck w/ Trane systems.

Goals:

- Keep bldg uncomplicated.
- Proven technology - no bleeding edge
- Don't overcomplicate it.
- FDD - A lot of talk about ceiling
  - Kind of a pain to maintain because so many

Options to Model (3+ Options):

CITY OF FRANKLIN: NEW CITY HALL

INTEGRATIVE DESIGN PROCESS CHARETTE

NOVEMBER 10, 2020

Energy studio / Optimized Design Solutions

Welcome & Introductions

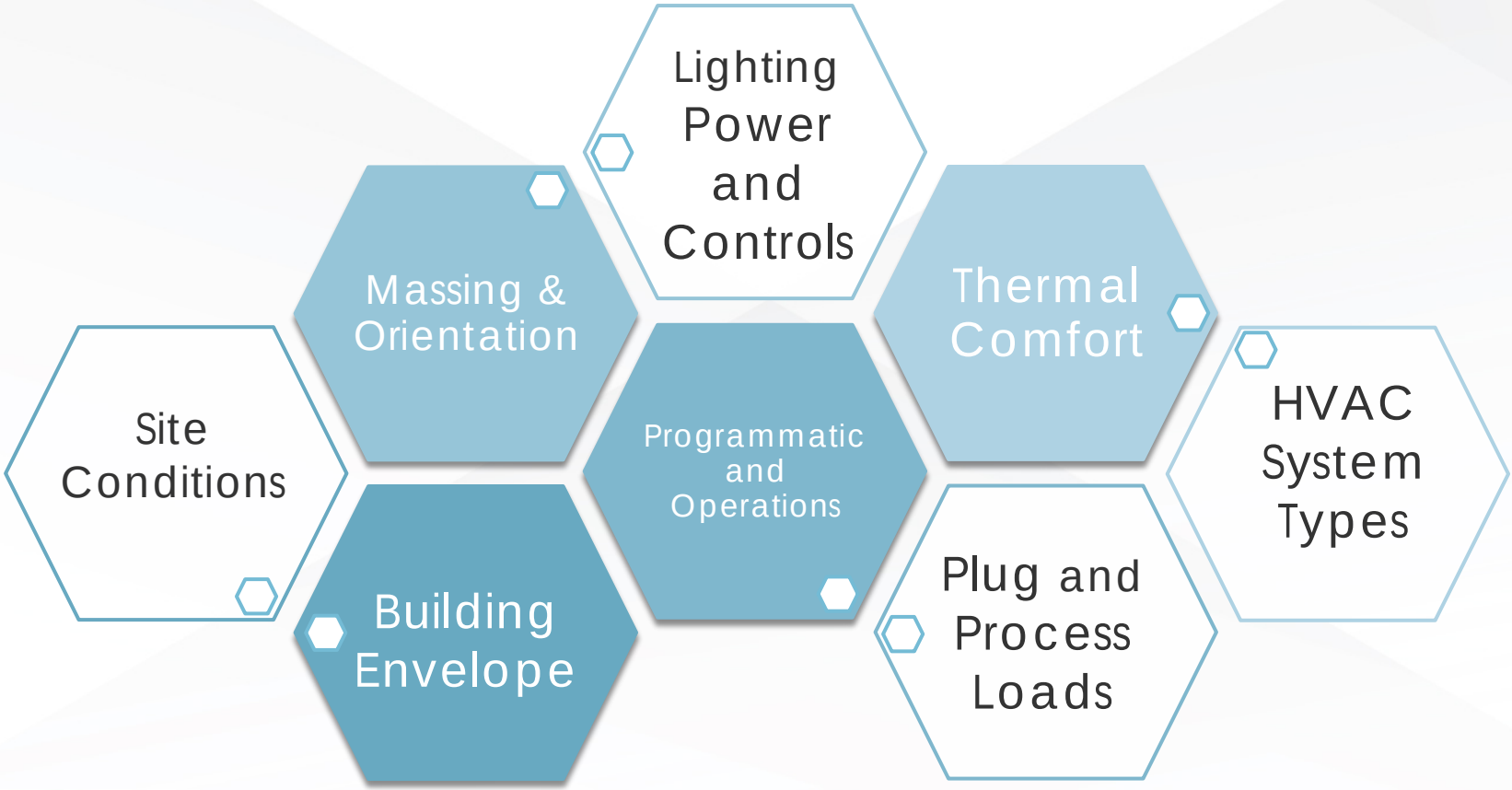
Workshop Goals

Integrative Process Agenda

- Set project goals
- Climate analysis
- Operational carbon findings
- Schematic energy model results
- Evaluate and discuss possible energy conservation strategies
- Evaluate and discuss possible water conservation strategies

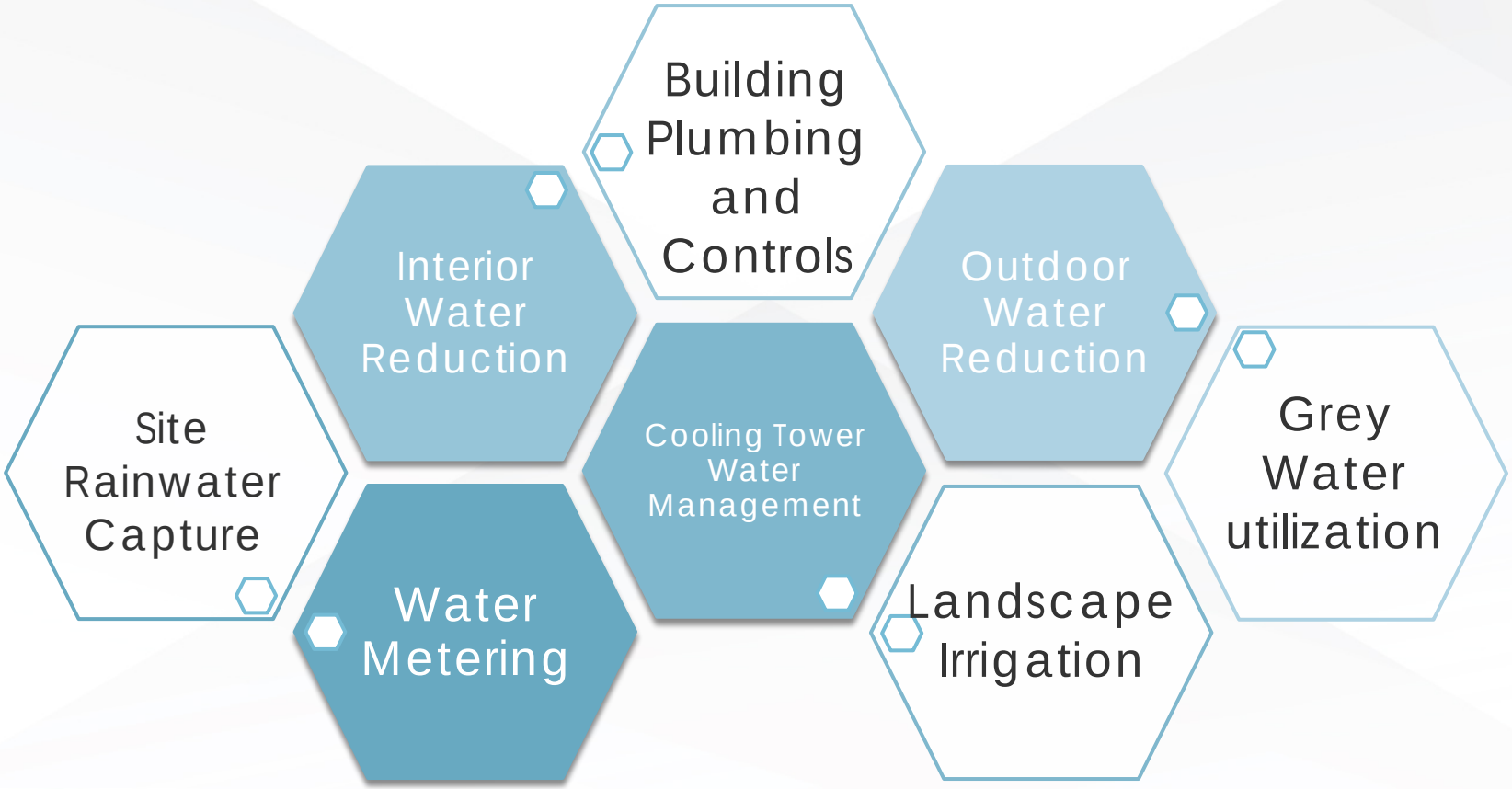
Integrative Process

- Energy-Related Systems



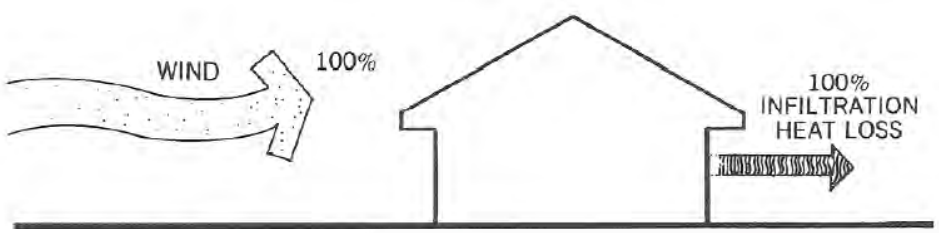
Integrative Process

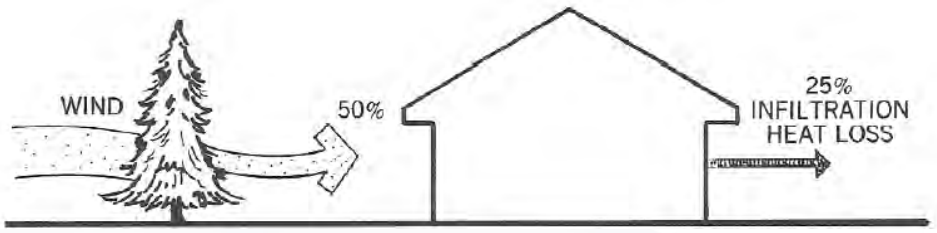
- Water-Related Systems



Site Conditions

- Shading strategies
- Landscaping (wind break, amphitheater location)
- Adjacent site conditions





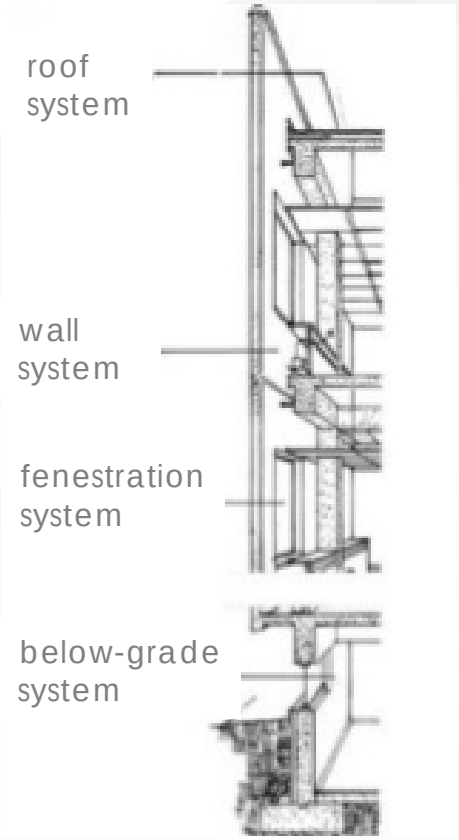
Source: Heating, Cooling, Lighting: Sustainable Design Methods for Architects, Third Ed.

Massing and Orientation

- Assess how massing and orientation affect the following:
  - HVAC equipment sizing
  - Daylighting potential
  - Renewable energy opportunities

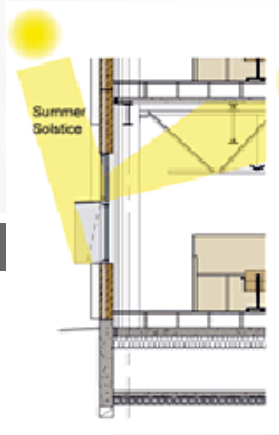
Building Envelope

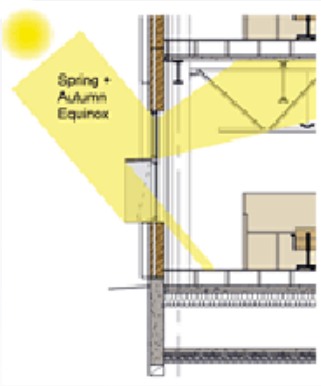
- Insulation types and thicknesses
- Window-to-wall ratio
- Glazing characteristics
- Window operability



Lighting Levels

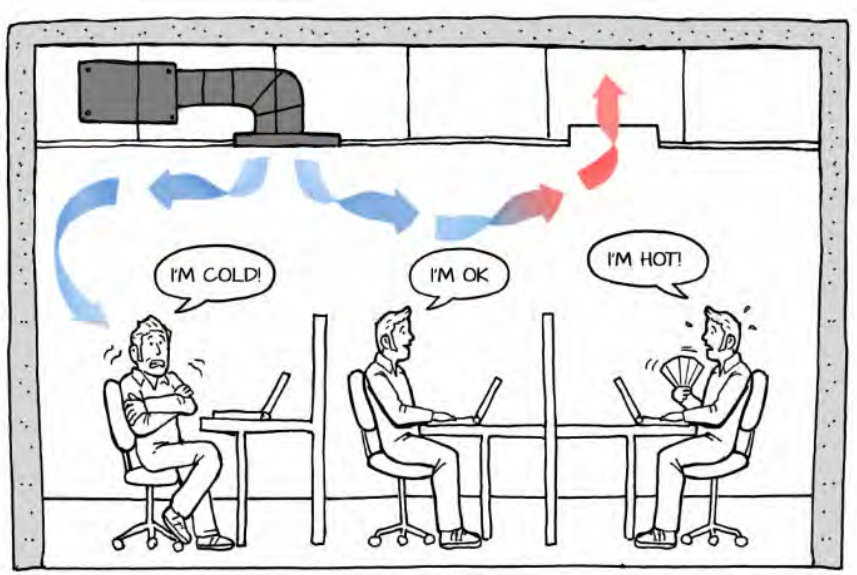
- Control strategies
  - Daylighting
  - Occupancy/vacancy sensor
  - Time-delay to vacancy
- Lighting fixture types
- Interior surface reflectance





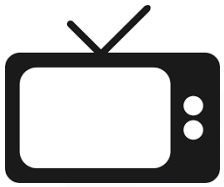
Thermal Comfort Ranges

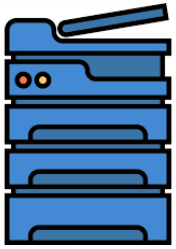
- Air Temperature
- Humidity
- Air speed and draft
- Radiant temperature

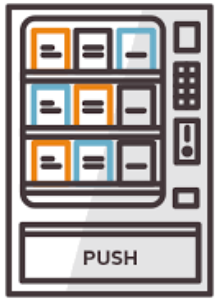


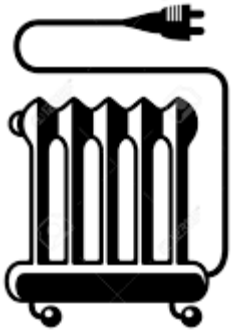
Plug and Process Load Needs

- Assess reducing the plug and process loads through programmatic solutions
  - Plug load controls
  - Equipment and purchasing policies
  - Layout options
  - Thin client computing









Water Use Reduction

- Landscape/irrigation optimization
  - Native landscape, drought tolerant
  - Rainwater capture for irrigation
  - Greywater utilization for irrigation
- Building related conservation
  - Grey/rainwater utilization for toilets
  - Efficient plumbing fixtures
  - Cooling tower water management
  - Building level water metering

Programmatic and Operational Parameters

- Assess space optimization
  - Multifunctioning space
  - Space allotment per person
  - Reduction of building area

- Assess operating parameters
  - Operating schedules
  - Night temperature setback
  - Occupied setpoint temperature

Anticipated Outcomes

- We want to walk away from this workshop with aspirational goals
- These goals can pertain to
  - Energy
  - Water
  - Site
  - Materials and waste,
  - Indoor environmental quality
  - Operations and maintenance

Ground Rules

What guidelines can we set to foster the most effective brainstorming today?

Defer judgement.

Stay on topic.

Go for quantity of ideas.

Silly is important. Wild is welcome.

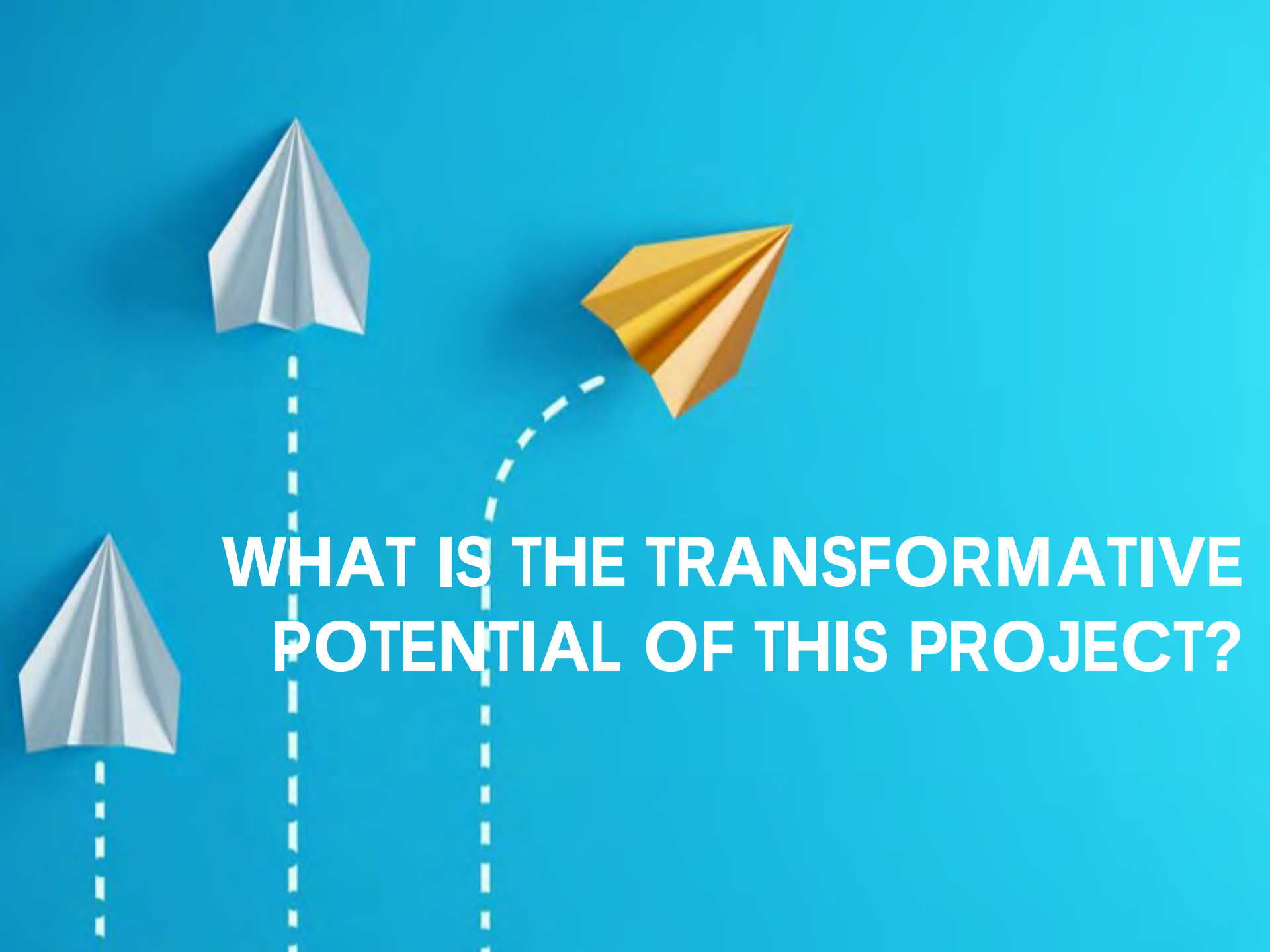
One idea per turn / webinar comment.

Project Overview

Project Purpose

WHY DOES THIS PROJECT MATTER IN THE BIG PICTURE?


TO WHOM DOES IT, OR WILL IT, MATTER? WHO WILL IT IMPACT?


WHAT IS THE TRANSFORMATIVE POTENTIAL OF THIS PROJECT?

Project Purpose

- Share, discuss, and summarize
  - Flexibility and future growth potential
  - Public use and invitation for both inside and out; and site
    - Public access beyond just typical meeting rooms; it's public's building
  - Historically appropriate; heart of downtown Franklin
    - Benchmark for sustainable development in area (educational and aspirational)
    - Education: sustainable development that compliments historic AND judicious use of city (taxpayer) capital
  - Facility that public embraces
  - Long term owner: systems should facilitate this
  - Visibility and recognizable strategies that public can see
  - Infrastructure improvements (brownfield site)
  - Staff and visitors feeling safe and secure
  - Integrating with pedestrian activity in downtown area

Sustainability & Performance Goals

WHAT ARE THE SPECIFIC CONDITIONS OF SATISFACTION FOR BUILDING PERFORMANCE?

Building Performance

- Group Discussion:
  - What are the specific conditions of satisfaction for the building performance of the project?
  - What do users need this building to do?

Maintenance
& Operation

Energy
Performance

What will make this project successful in the big picture?

Education

User
Experience

Others?

Sustainability

- Determine Top 5 measures of success
  - Staff thermal comfort (heating and cooling); controllability of systems
  - Natural lighting / views to outside / engage outdoors in building (nice view from rooftop; overlooks, courtyard, etc)
    - Few existing spaces with these
  - Maintenance concerns: luminaires (long lasting, reliable sources); maintainable systems
    - Design to skillset of staff
    - Measurement for success: implement proven technologies; validation available and not untested (5 year benchmark)
    - Wide operation hours for office and public areas – efficiency during unoccupied periods (control)
  - Adequate ventilation / resiliency (pandemic avoidance)
    - Specific LEED related credits
  - Building materials selected for longevity and maintenance over time considerations
  - Non-potable water use; reduction of reliance on exterior utilities
  - Historic structure lessons learned
  - How can all of these be shown to public? Leading by example
    - Some are hidden to general public
    - Signage, etc; illustrate best and meaningful practices (common/public areas in particular)
    - Prove that historic building districts can be made sustainable: info kiosks, exterior info stations explaining
  - Avoiding green washing / "green bling"; visible is good but meaningful is critical
    - Value added strategies: enhance occ experience and/or reduce operating costs

Project Climate Summary

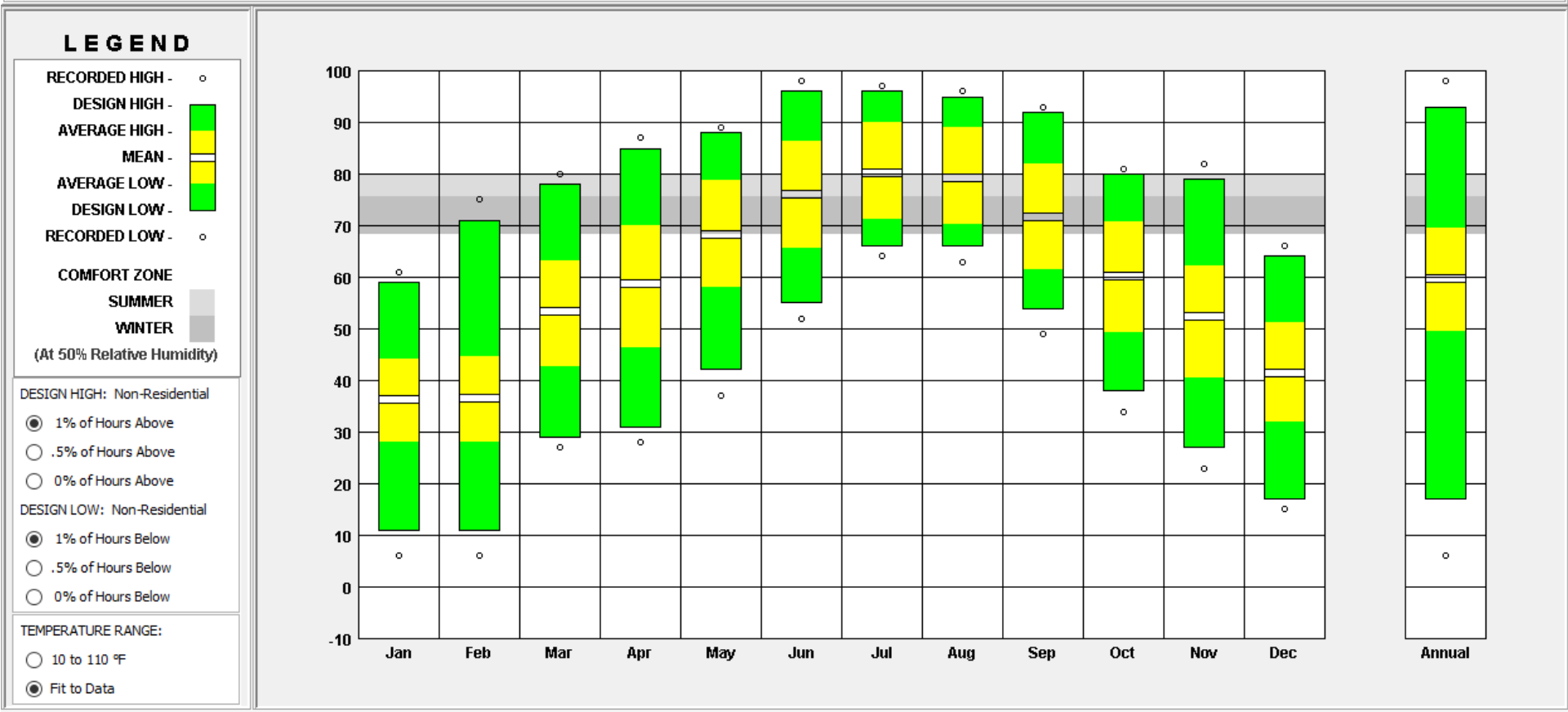
General Climate

- ASHRAE Climate
  - Zone 4A
    - Mixed-humid (lower number = warmer)
    - A = “moist”: not marine or dry
    - Close to Zone 3A
- Köppen Climate Classification
  - Cfa: humid subtropical (temperate)
    - Hot summer
    - Humid year-round
- Degree Days – ASHRAE Design Data
  - CDD50: 4,689
  - HDD65: 3,729

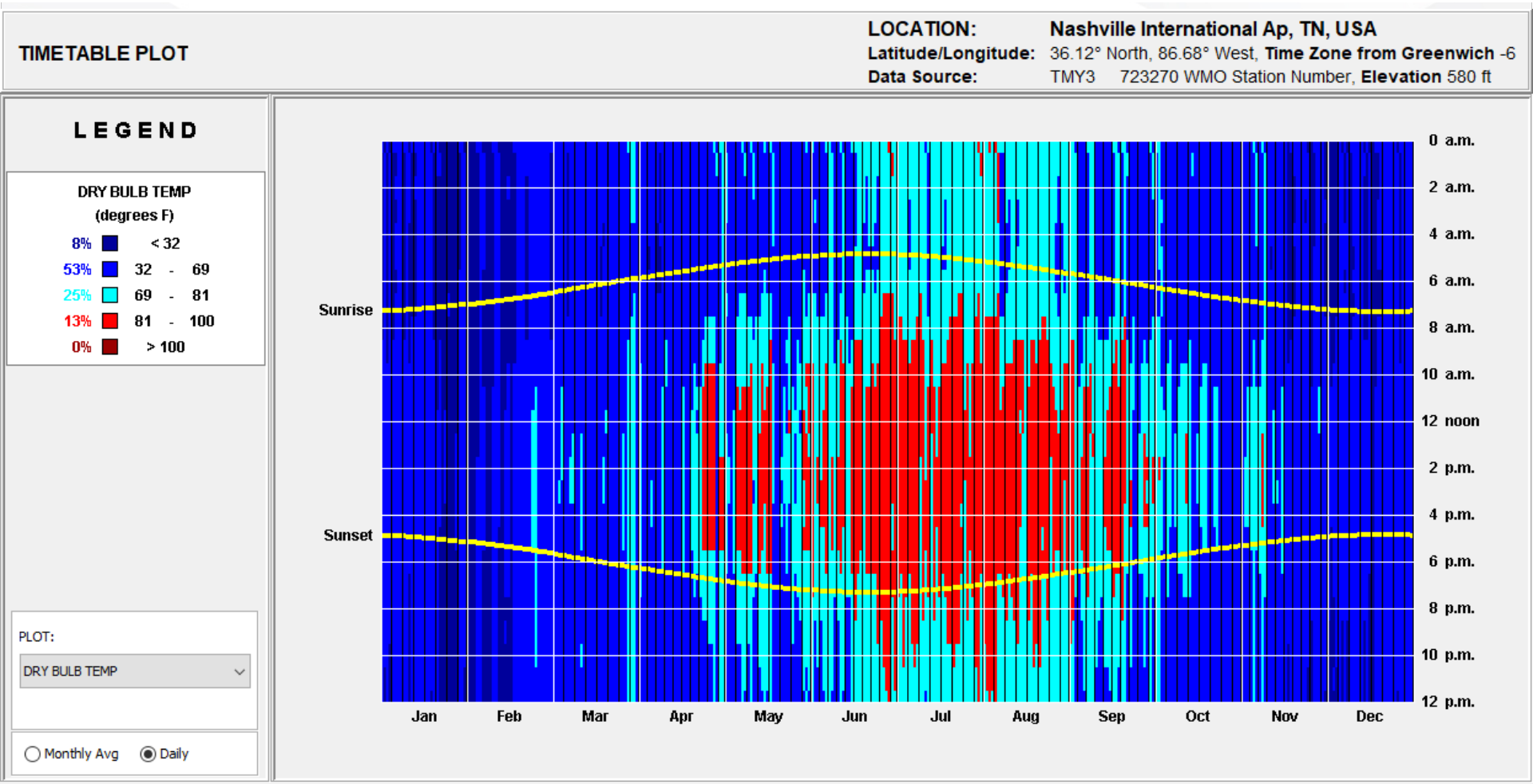
Air Temperature Range

TEMPERATURE RANGE
ASHRAE Standard 55-2004 using PMV

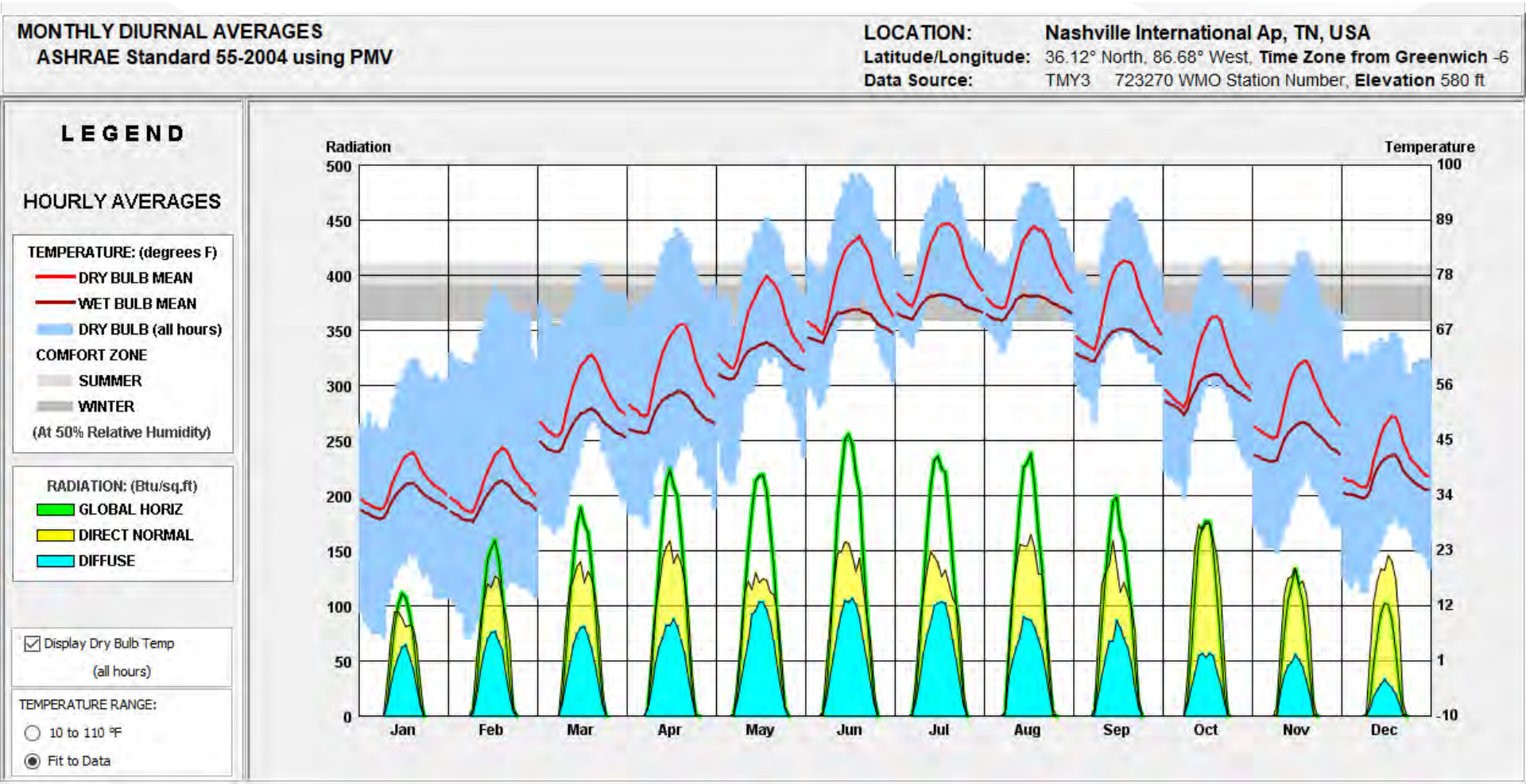
LOCATION: **Nashville International Ap, TN, USA**
Latitude/Longitude: 36.12° North, 86.68° West, **Time Zone from Greenwich** -6
Data Source: TMY3 723270 WMO Station Number, **Elevation** 580 ft



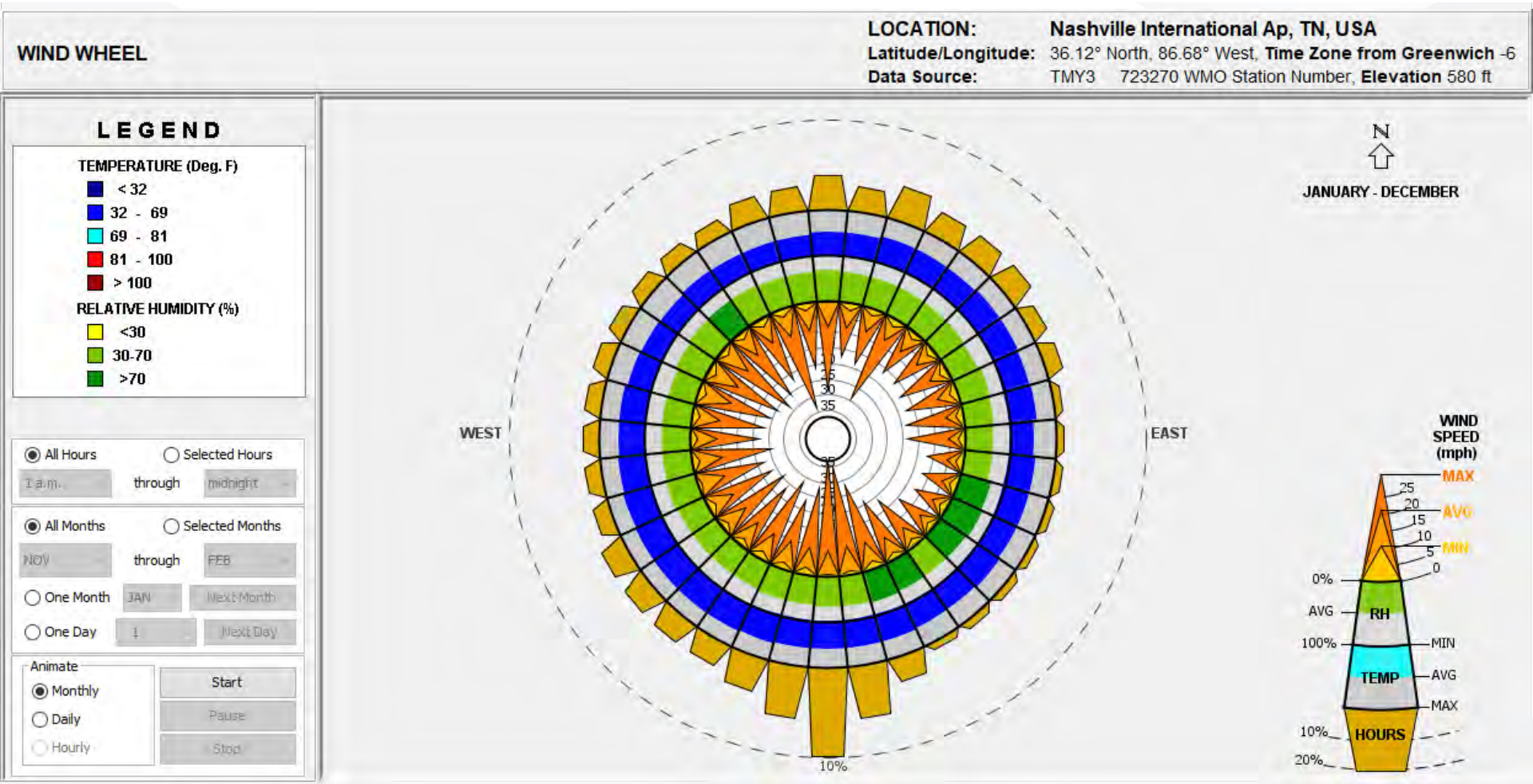
Climate Analysis: Drybulb Temp



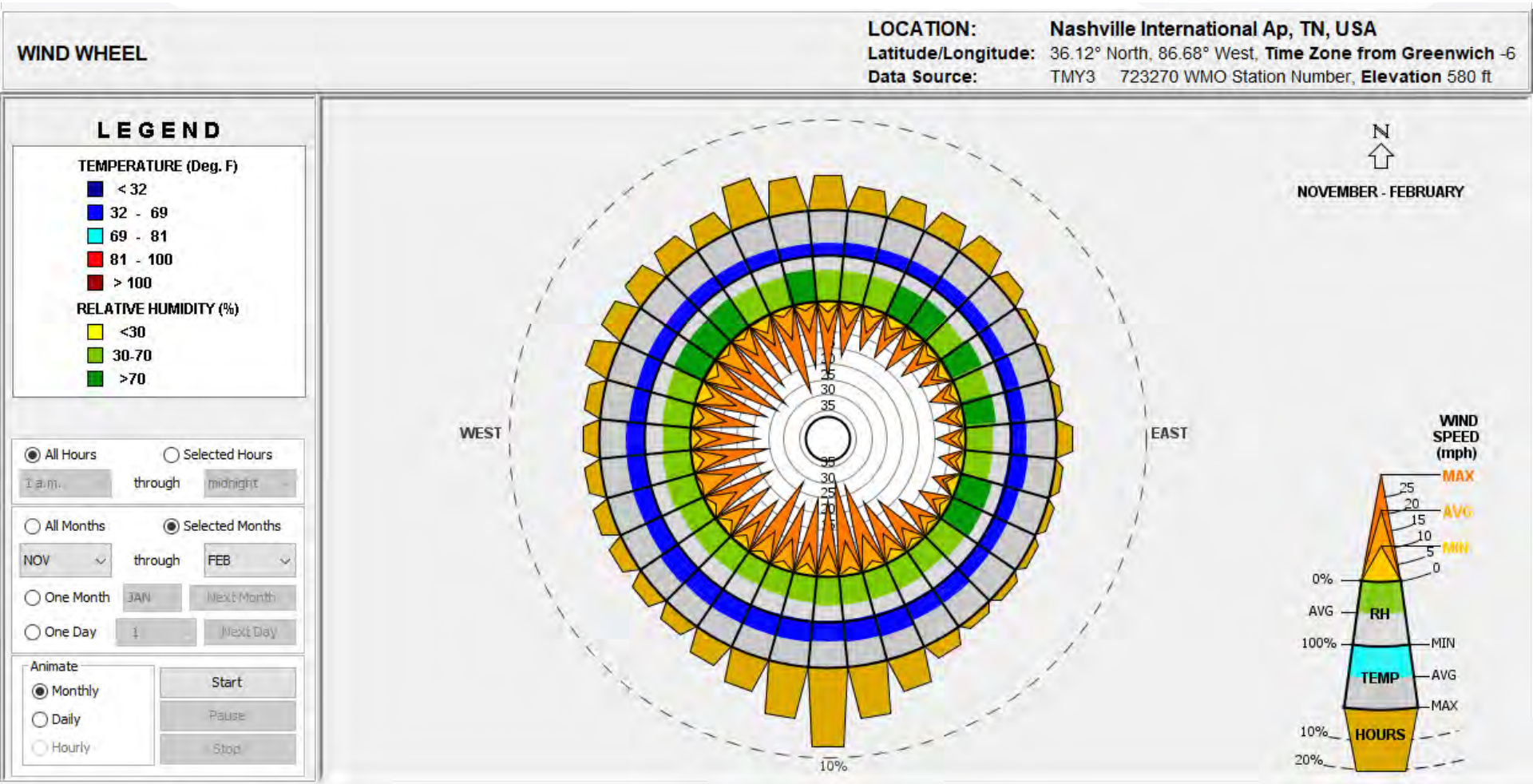
Climate Analysis: Diurnal Temp



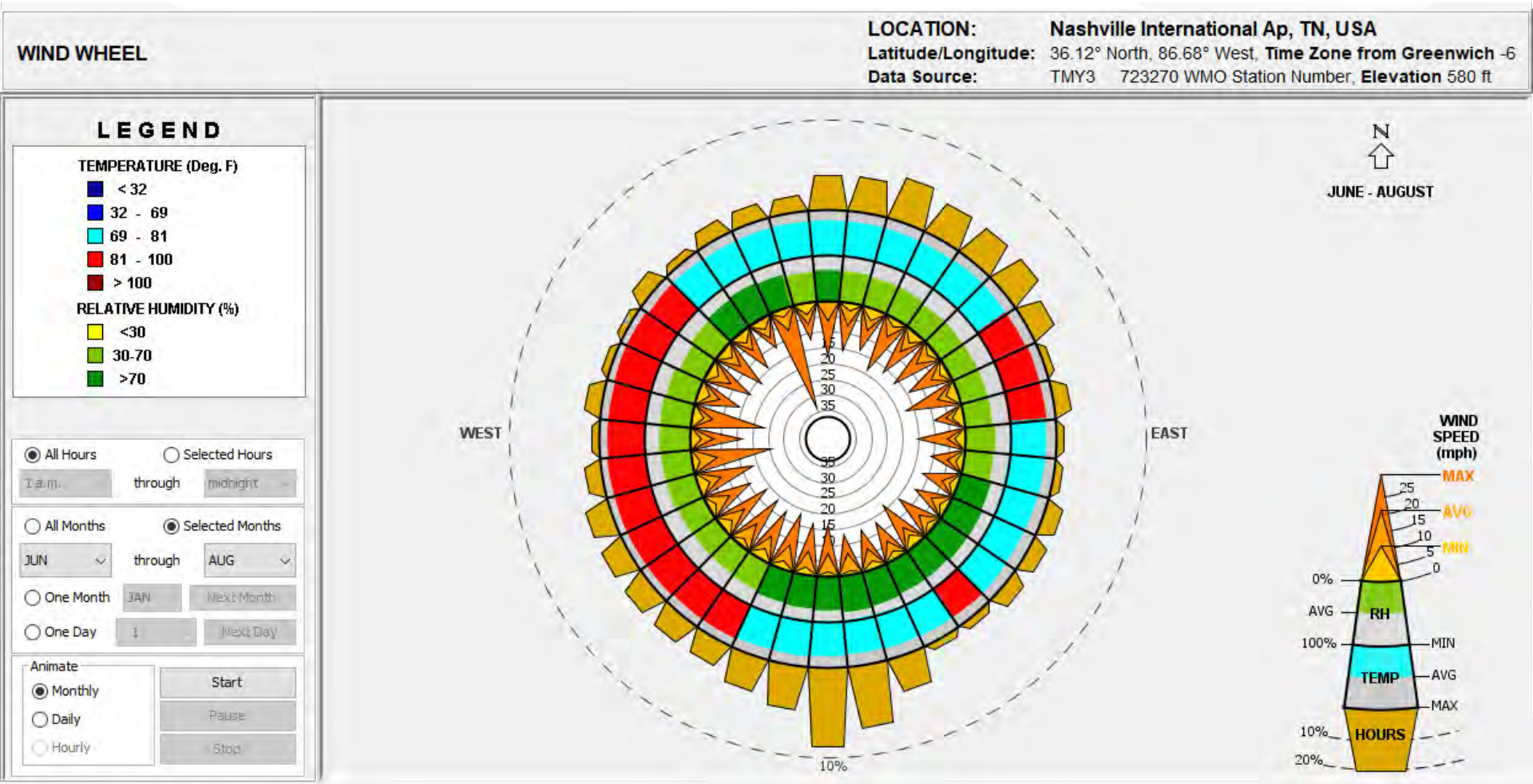
Climate Analysis: Wind Wheel



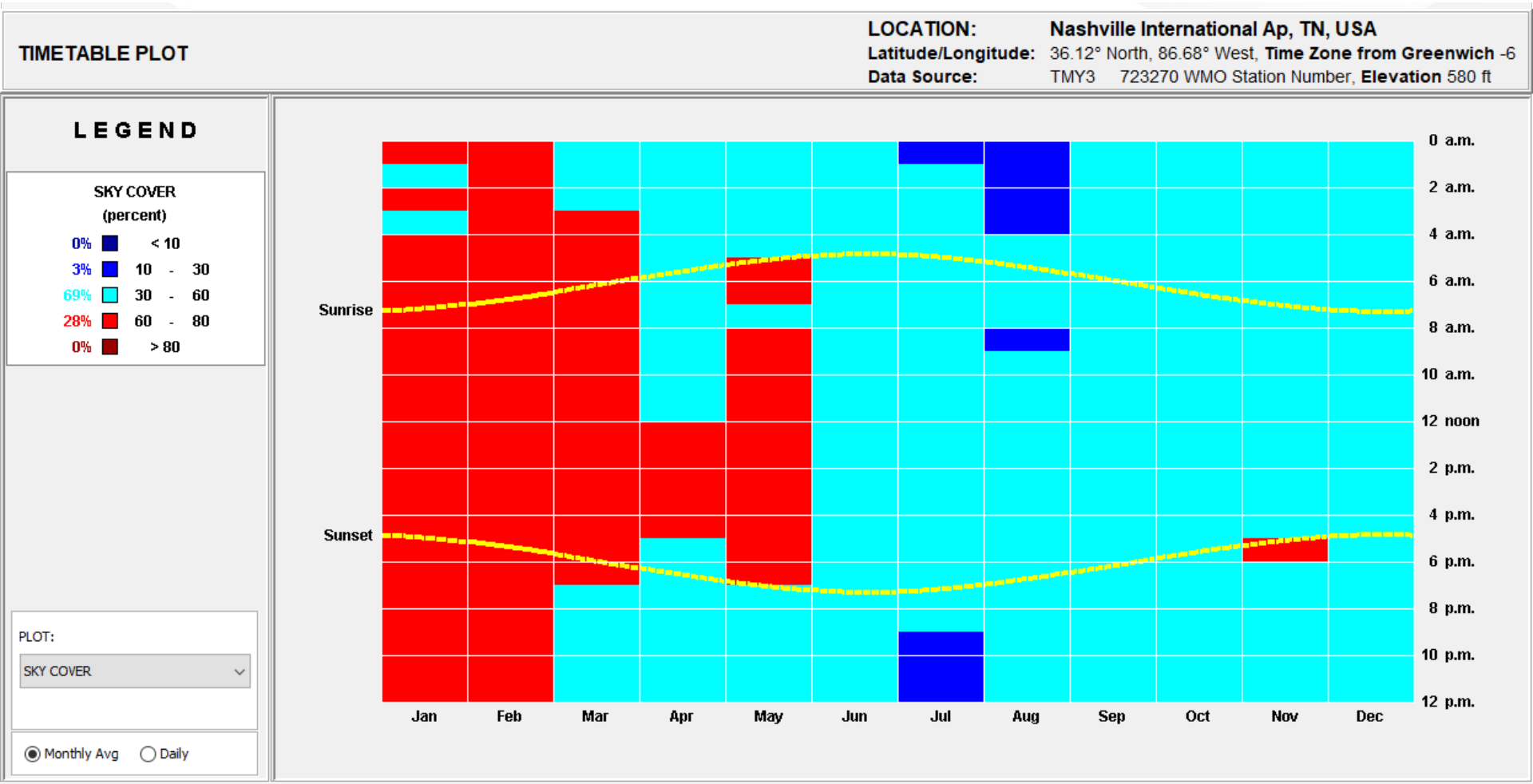
Climate Analysis: Winter Wind Wheel



Climate Analysis: Summer Wind Wheel



Climate Analysis: Skycover



Climate Analysis: Annual Solar Radiation

TIMETABLE PLOT

LOCATION: Nashville International Ap, TN, USA
Latitude/Longitude: 36.12° North, 86.68° West, **Time Zone from Greenwich** -6
Data Source: TMY3 723270 WMO Station Number, **Elevation** 580 ft

LEGEND

TILTED SURFACE RADIATION (Btu/sq.ft)

49%		Night Time
17%	1	- 50
10%	50	- 100
6%	100	- 150
18%	> 150	

Tilted Surface Radiation:

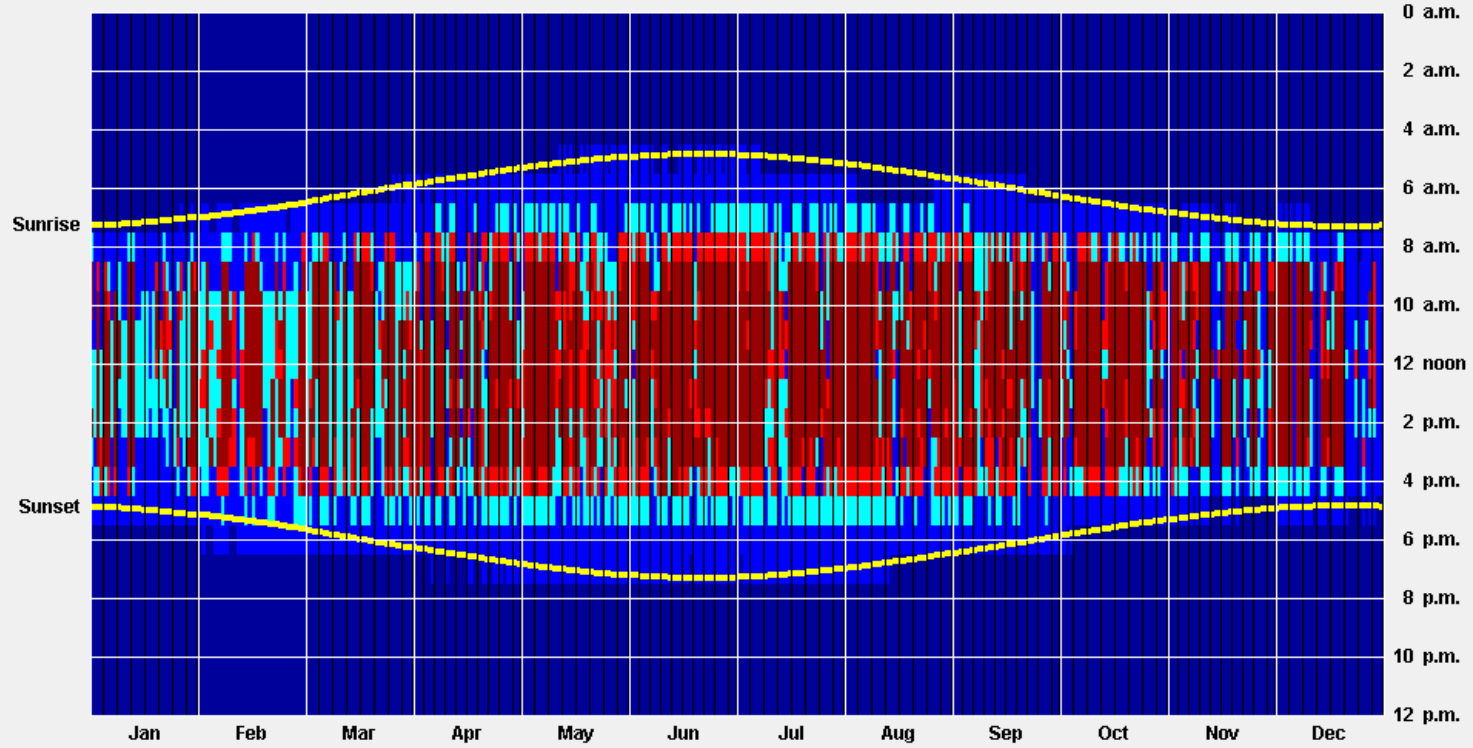
37.0 Tilt degrees from Horizontal (Vertical = 90°)

0.0 Bearing degrees from South (South = 0°,West = +90°)

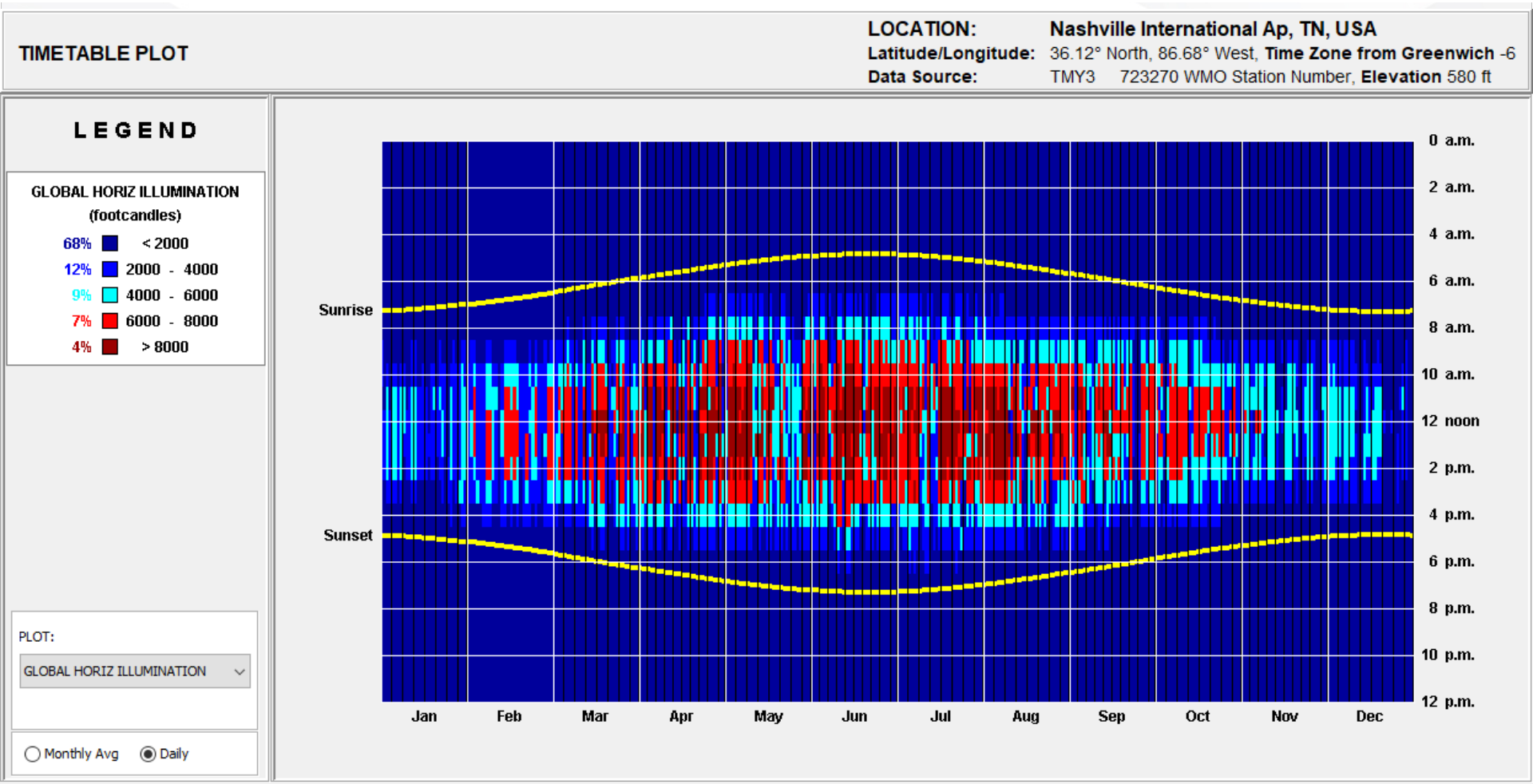
20.0 % Ground Reflectance (20% = grass)

PLOT: TILTED SURFACE RADIATION

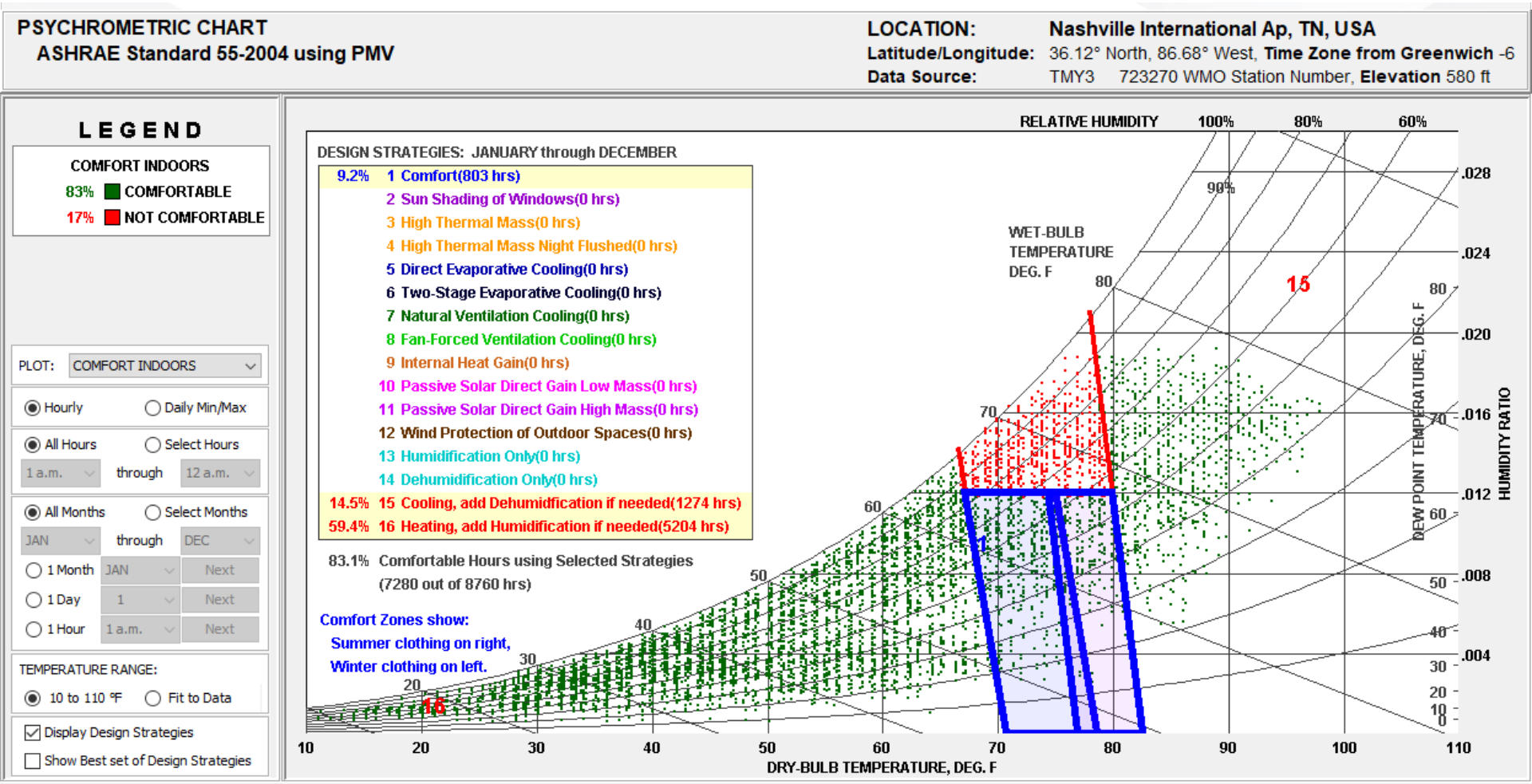
○ Monthly Avg ◉ Daily



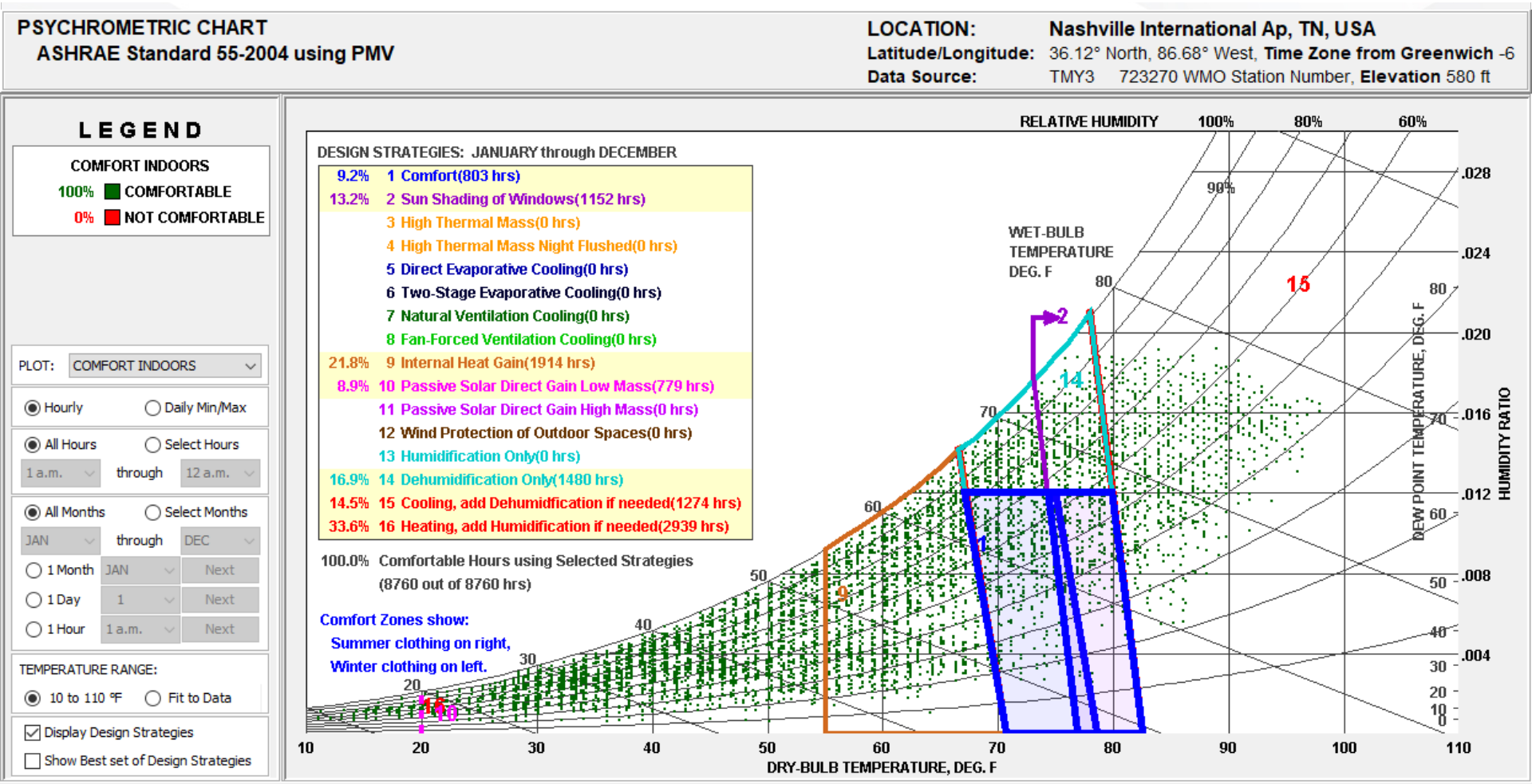
Climate Analysis: Illumination



Climate Analysis



Climate Analysis



Energy & Operational Carbon

Benchmark Estimates

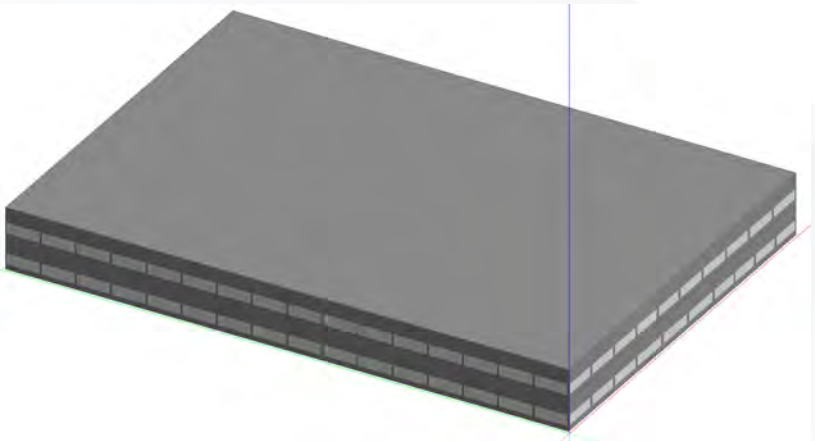
EnergyStar Target Finder

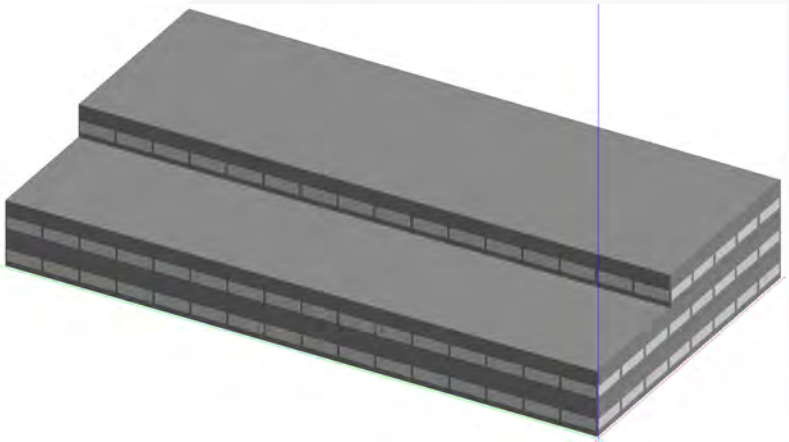
Metrics Comparison for Your Design and/or Target

Metric	Design Project	Design Target*	Median Property*
ENERGY STAR score (1-100)	78	75	50
Source EUI (kBtu/ft²)	123.6	133.2	191.7
Site EUI (kBtu/ft²)	44.1	47.6	68.5
Source Energy Use (kBtu)	12,856,279.7	13,847,994.0	19,936,435.1
Site Energy Use (kBtu)	4,591,528.4	4,945,712.8	7,120,156.2
Energy Cost ($)	128,743.27	138,674.40	199,644.26
Total GHG Emissions (Metric Tons CO2e)	633.6	682.5	982.6

- Comparison to peer building set
  - Similar location & climate
  - Similar space uses & building size

Simple Block Energy Model





Simple Block Model

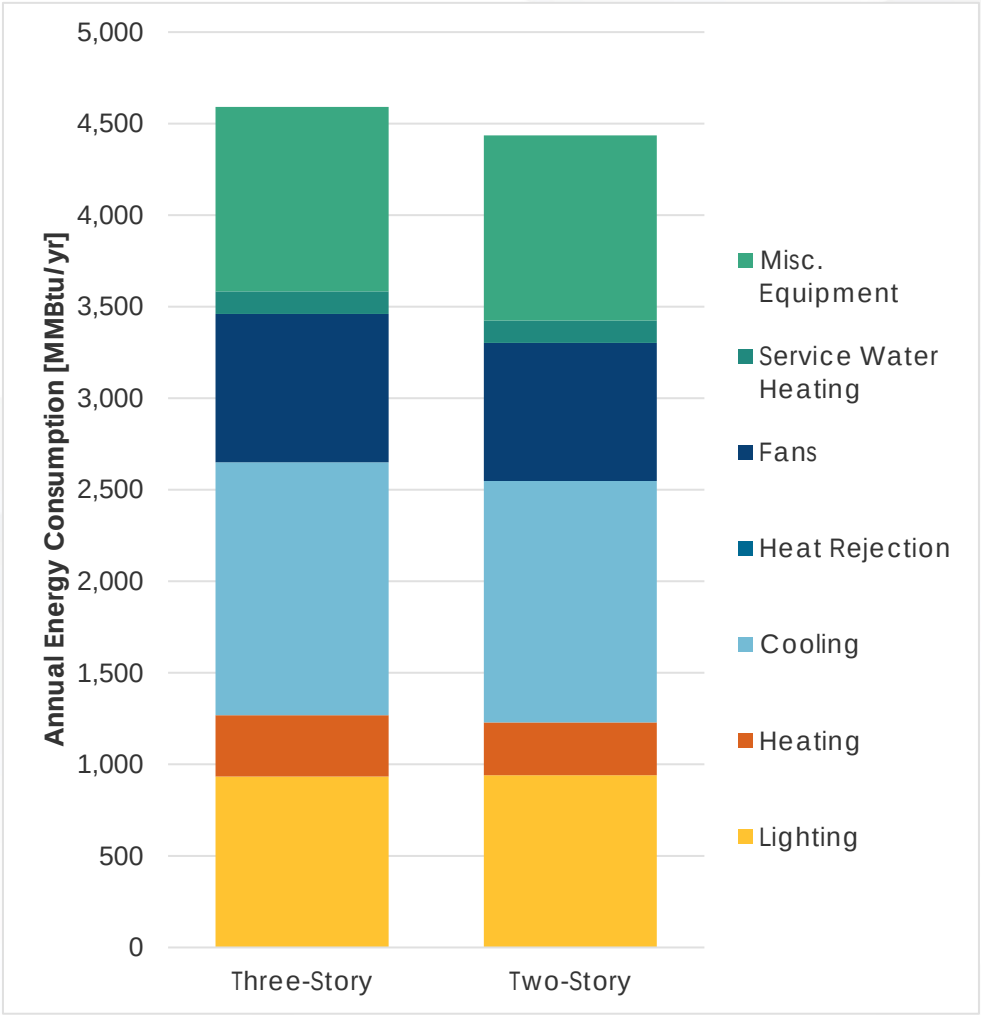
- Included in model?
  - Current massing & orientation
  - Basic HVAC zoning
  - High-level HVAC assumptions
  - Internal process load assumptions
    - Plug loads: 0.75 W/sf average
    - Elevator: 15 kW
- Full-year simulation
  - Typical year weather file

Simple Block Model

- Not included in model?
  - Specific HVAC equipment performance
  - Detailed operational schedules
- Not calibrated to historical utility data
  - Annual weather differs from typical year file

Simple Block Model

- Simple models
  - EUI: 42.6 – 44.1
  - Annual energy cost: $1.16-$1.22
- Relevant baselines
  - LEED: ASHRAE 90.1-2010
  - Code: 2018 IECC

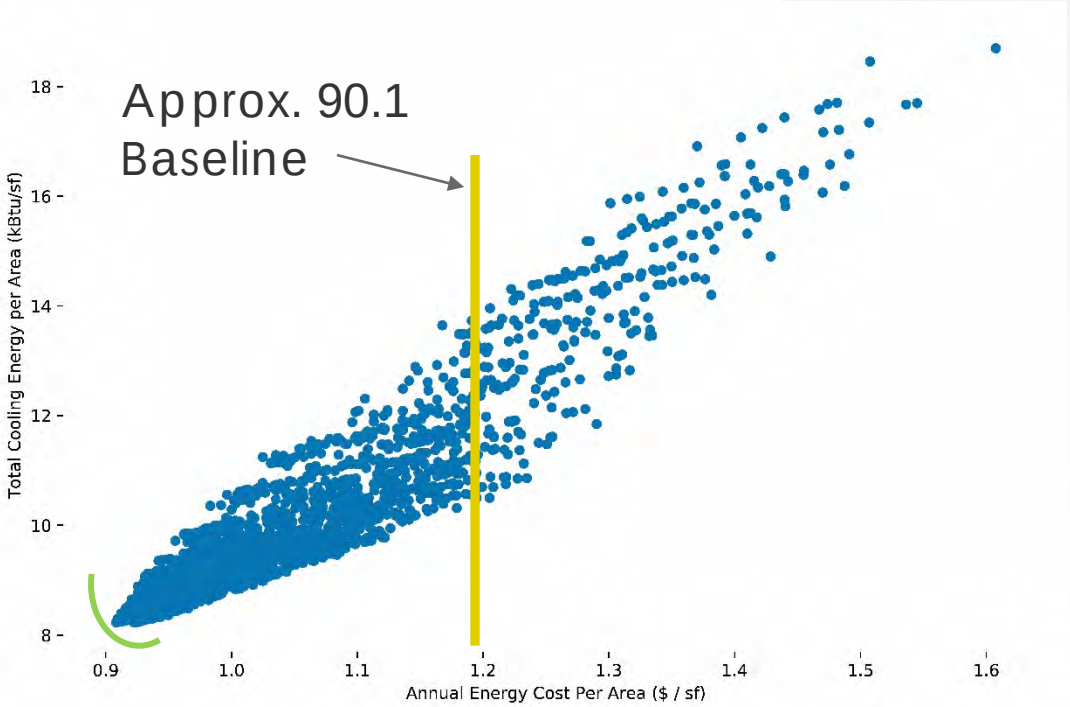


Priority Areas

- Massing options
  - Three story approx. 4% higher energy use
    - Increased envelope area
- Reduce electricity consumption
  - Lighting
  - Cooling and related systems
- Control process/plug loads
  - Efficient buildings have higher ratio

Schematic Model: Genetic Algorithm Testing

- Simultaneously test multiple ECMs
- Potentially thousands of combinations
- Searches for combinations on pareto curve

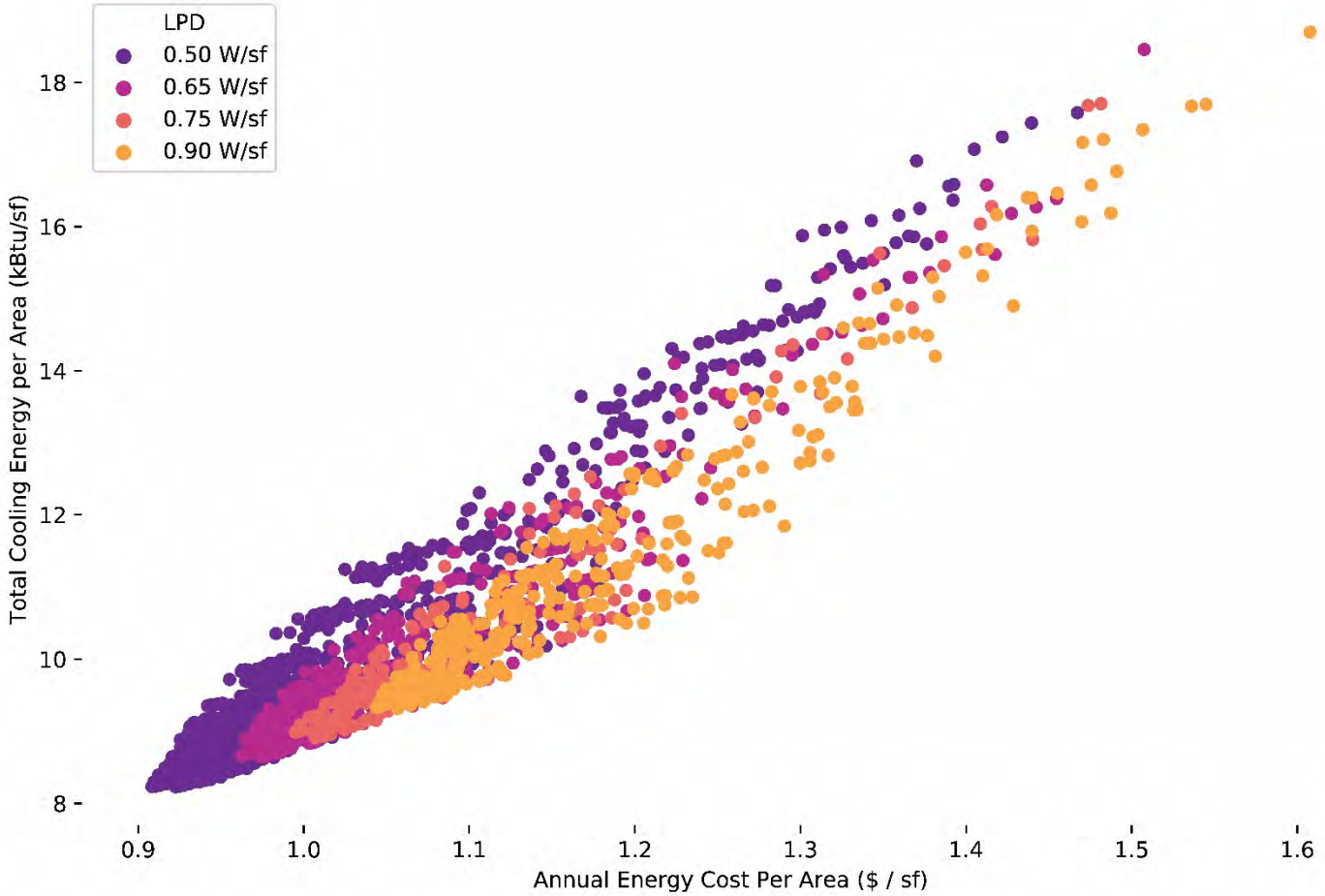


Schematic Energy Model: Tested Parameters

Parameter	Minimum	Maximum	Step
Window to wall ratio	10%	90%	10%
Exterior wall insulation	Steel-frame: R-13 + 4 ci Mass wall: R-10 ci	Steel-frame: R-13 + 19 ci Mass wall: R-25 ci	5 levels of insulation
Roof Insulation	R-20	R-60	9 levels of insulation
Fenestration SHGC	0.20	0.60	0.1
Fenestration U-value	0.3	0.5	0.1
Fenestration shading	No overhang	6.0 ft overhang	1.5 ft
Lighting power density (W/sf)	0.50, with daylight control	0.90, with daylight control	4 levels

Thermal Bridging

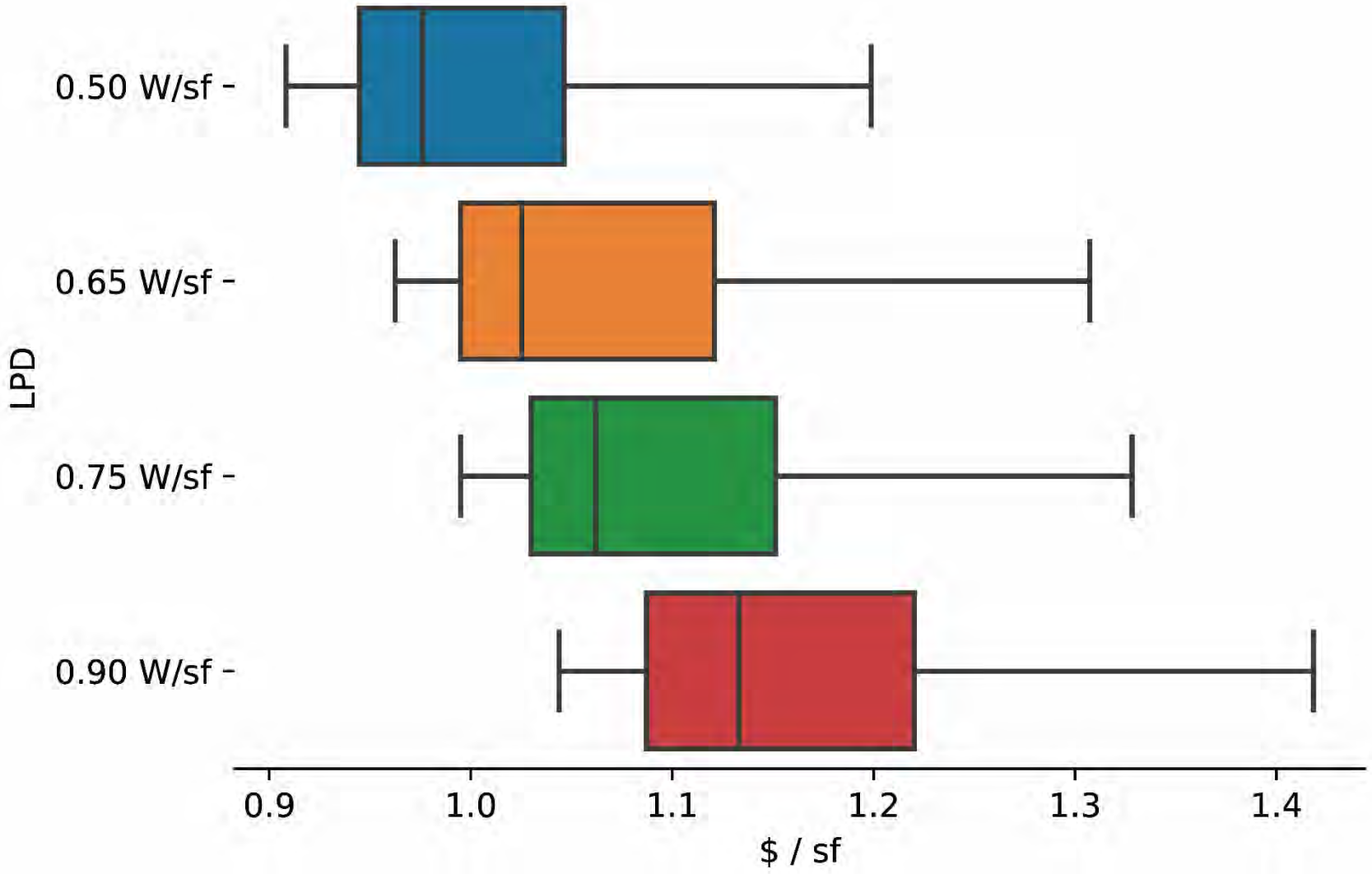
- Focus is on assembly performance
  - Must account for total energy transfer
  - Penetrations act as conduits for energy
- Steel-frame wall
  - Cavity insulation
  - R-13 @ 16” o.c. = R-6.0 effective
  - R-19 @ 16” o.c. = R-7.1 effective
- Fenestration
  - Not just center-of-glass performance
  - Must account for frame



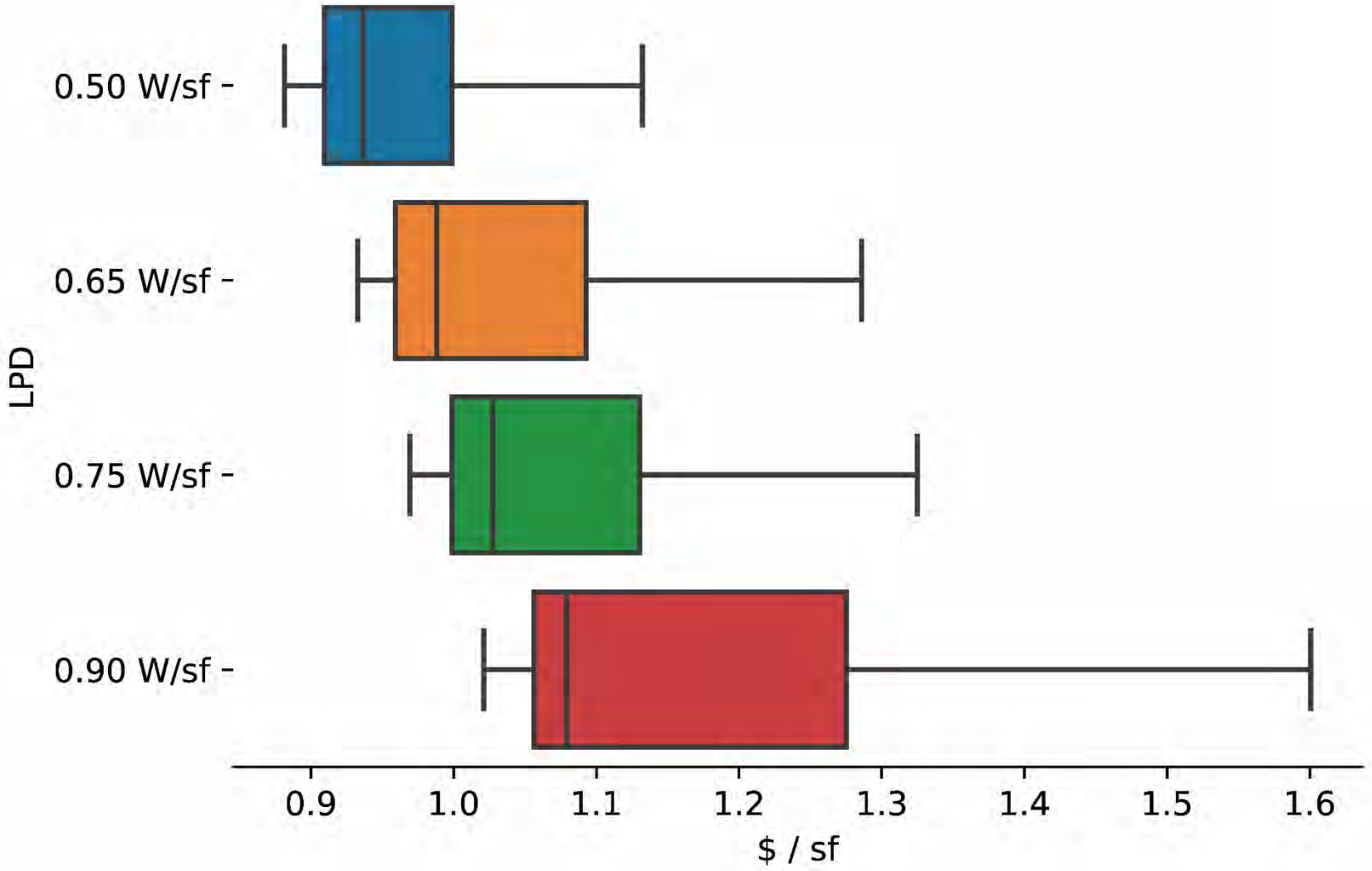
LIGHTING POWER DENSITY

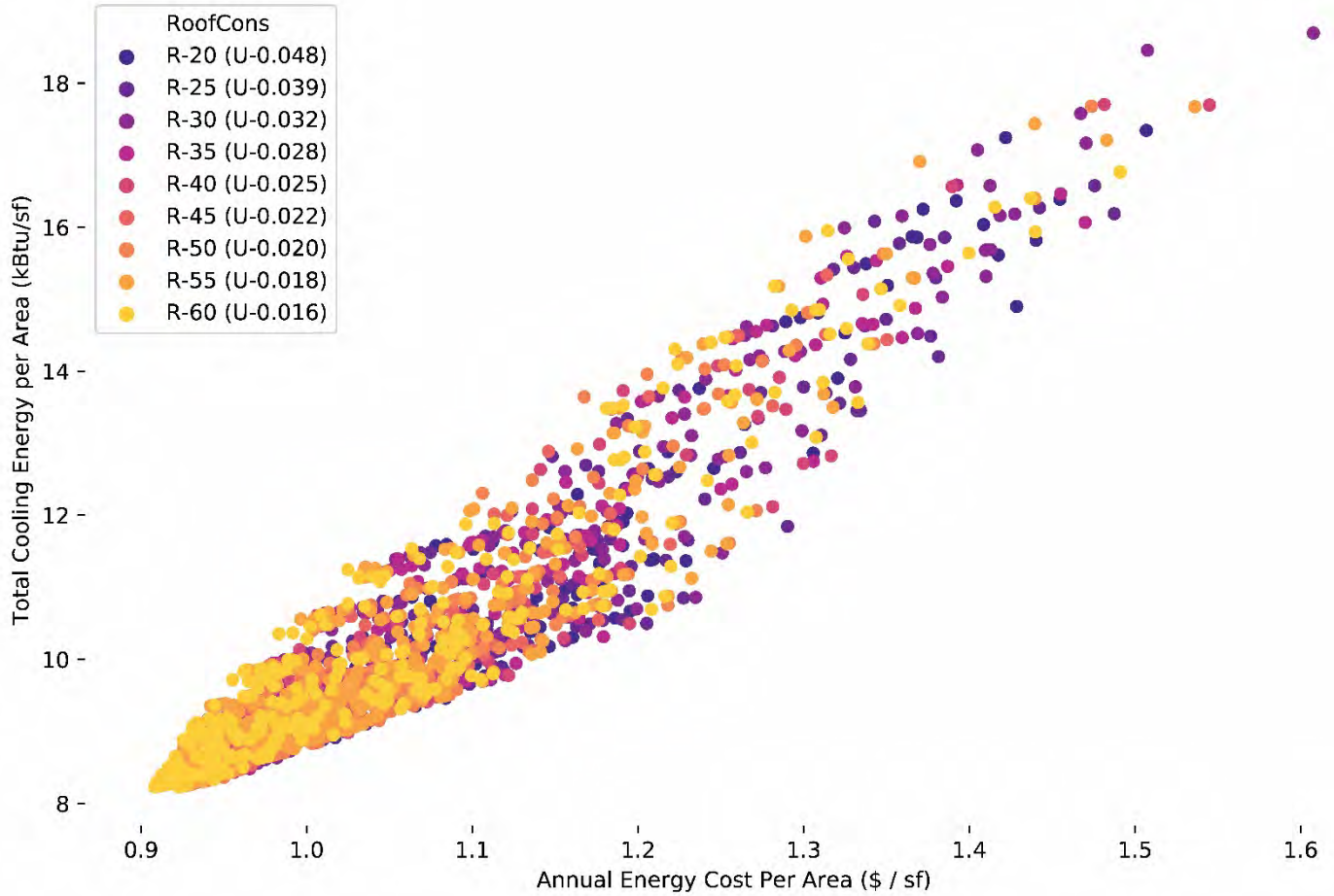
Strong correlation to lower installed lighting power density with reduced energy and operational carbon emissions.

Two-Story



Three-Story





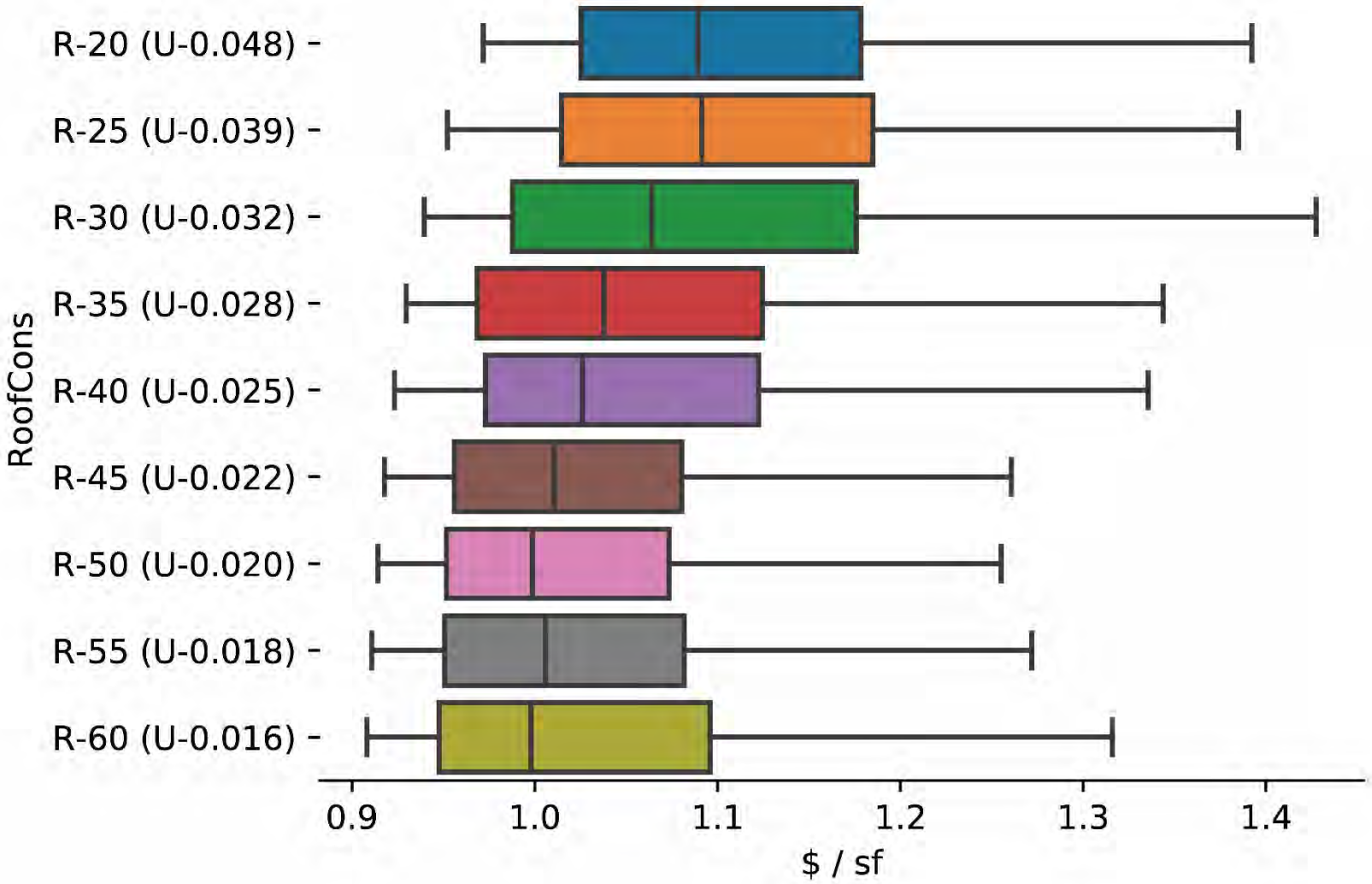
55

ROOF INSULATION

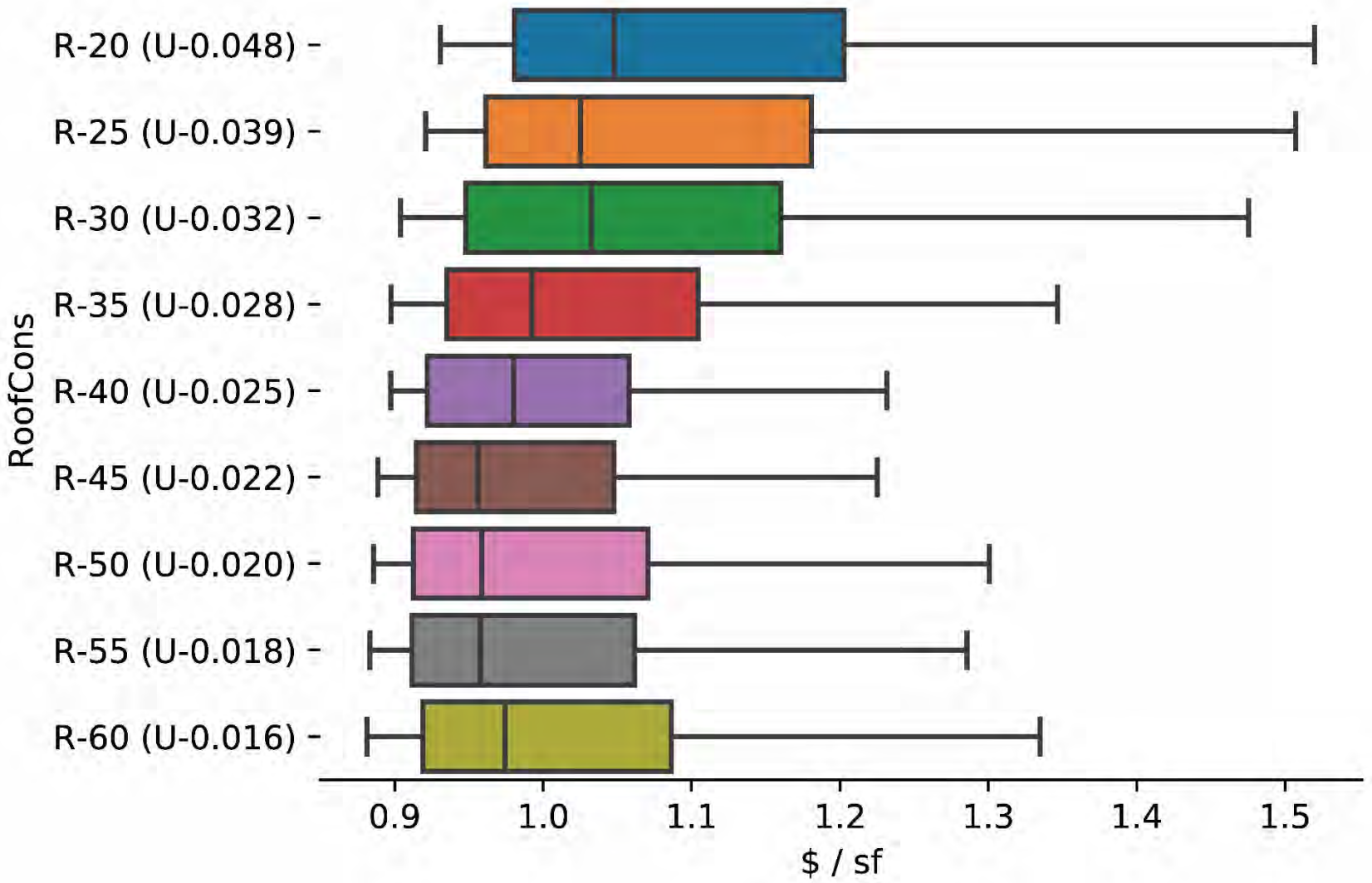
Despite large roof area compared to internal volume roof insulation above R-35 is not strongly correlated to overall performance.

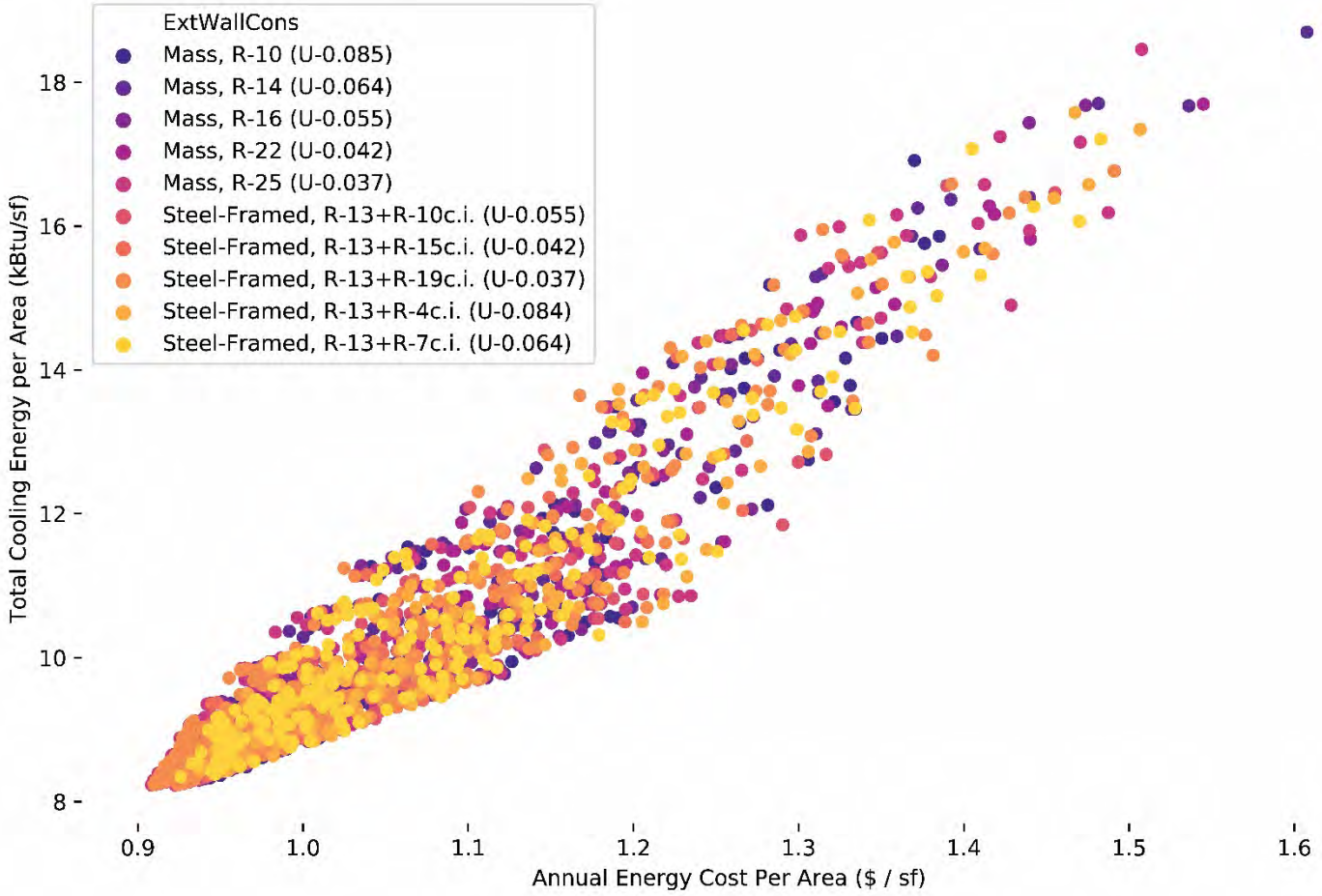
Ultra-high insulation results in higher energy consumption

Two-Story


R-20 (U-0.048)
R-25 (U-0.039)
R-30 (U-0.032)
R-35 (U-0.028)
R-40 (U-0.025)
R-45 (U-0.022)
R-50 (U-0.020)
R-55 (U-0.018)
R-60 (U-0.016)
RoofCons
0.9
1.0
1.1
1.2
1.3
1.4
$ / sf

Three-Story


R-20 (U-0.048)
R-25 (U-0.039)
R-30 (U-0.032)
R-35 (U-0.028)
R-40 (U-0.025)
R-45 (U-0.022)
R-50 (U-0.020)
R-55 (U-0.018)
R-60 (U-0.016)
RoofCons
0.9
1.0
1.1
1.2
1.3
1.4
1.5
$ / sf

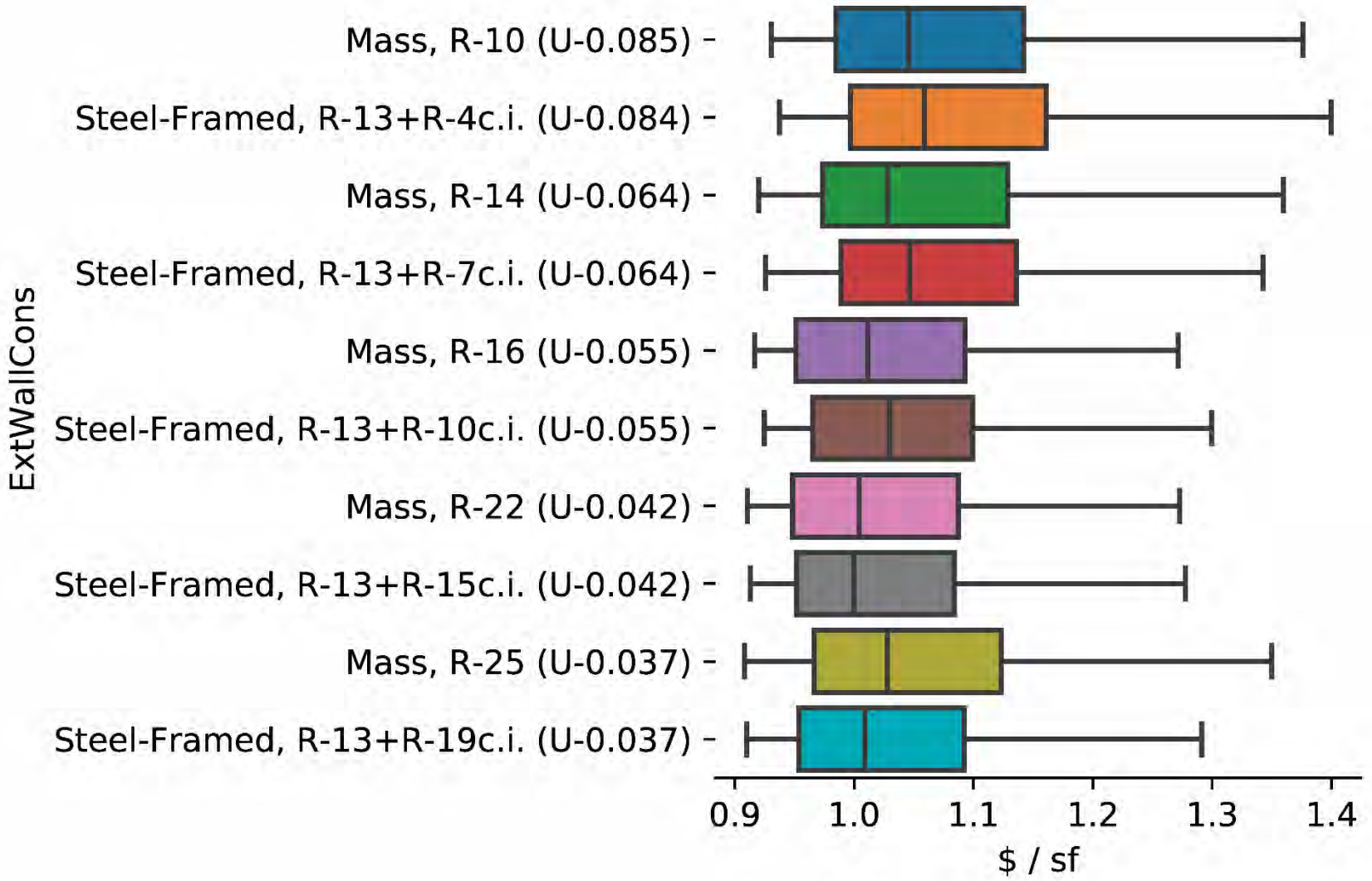


WALL INSULATION

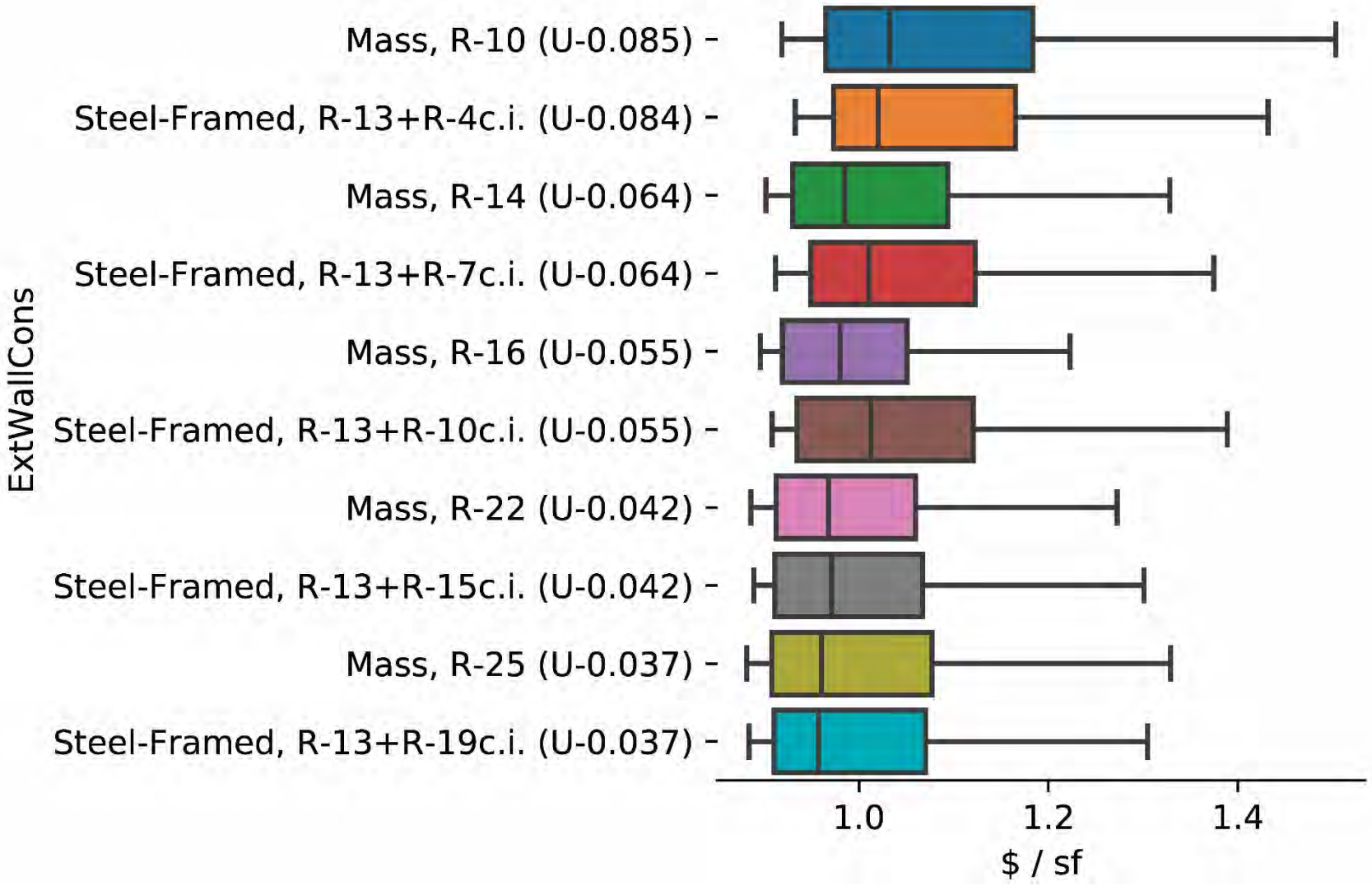
Minor impact of wall insulation increases above U-0.064

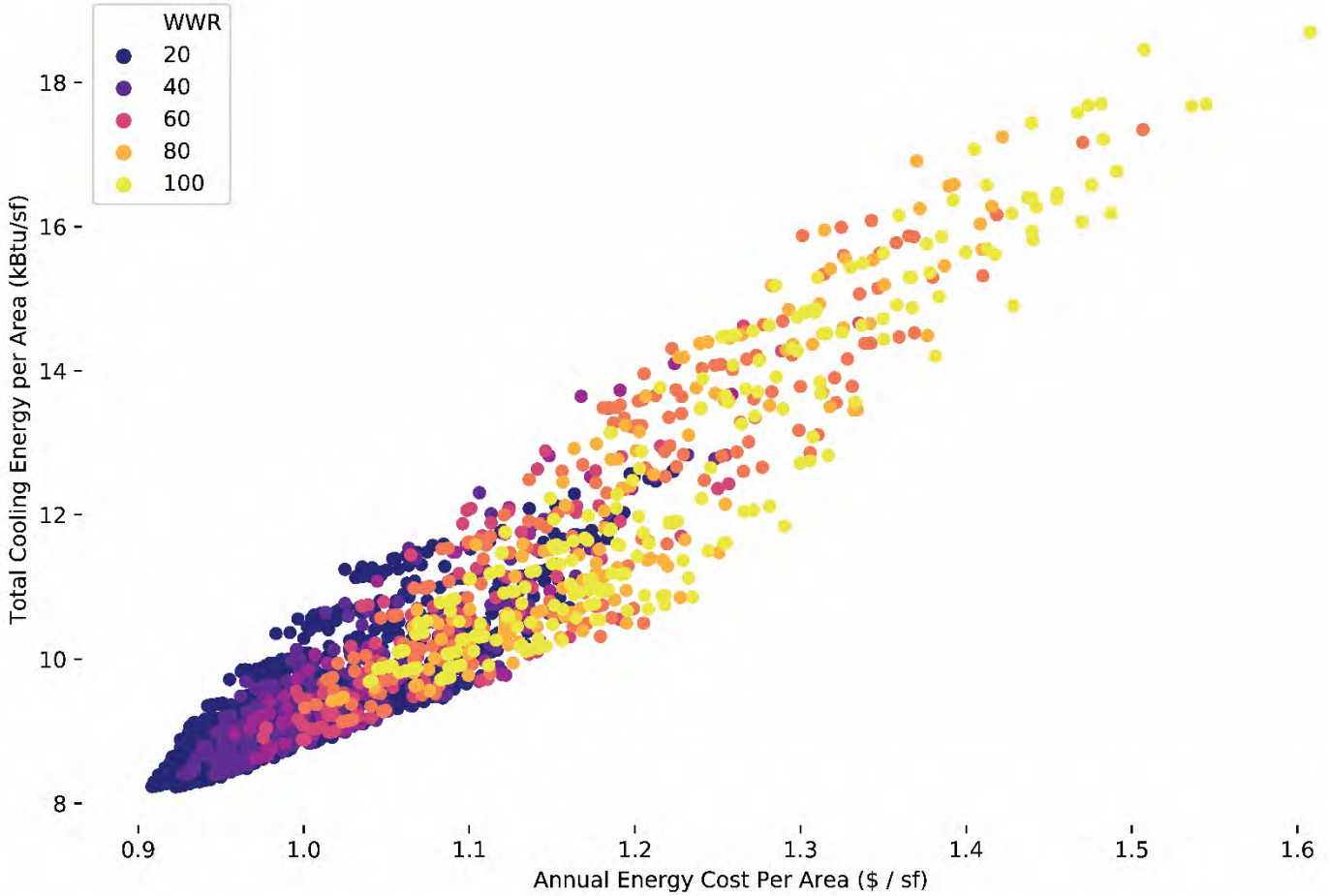
Mass walls are slightly better at lower insulation levels

Two-Story


ExtWallCons
Mass, R-10 (U-0.085)
Steel-Framed, R-13+R-4c.i. (U-0.084)
Mass, R-14 (U-0.064)
Steel-Framed, R-13+R-7c.i. (U-0.064)
Mass, R-16 (U-0.055)
Steel-Framed, R-13+R-10c.i. (U-0.055)
Mass, R-22 (U-0.042)
Steel-Framed, R-13+R-15c.i. (U-0.042)
Mass, R-25 (U-0.037)
Steel-Framed, R-13+R-19c.i. (U-0.037)
0.9
1.0
1.1
1.2
1.3
1.4
$ / sf

Three-Story

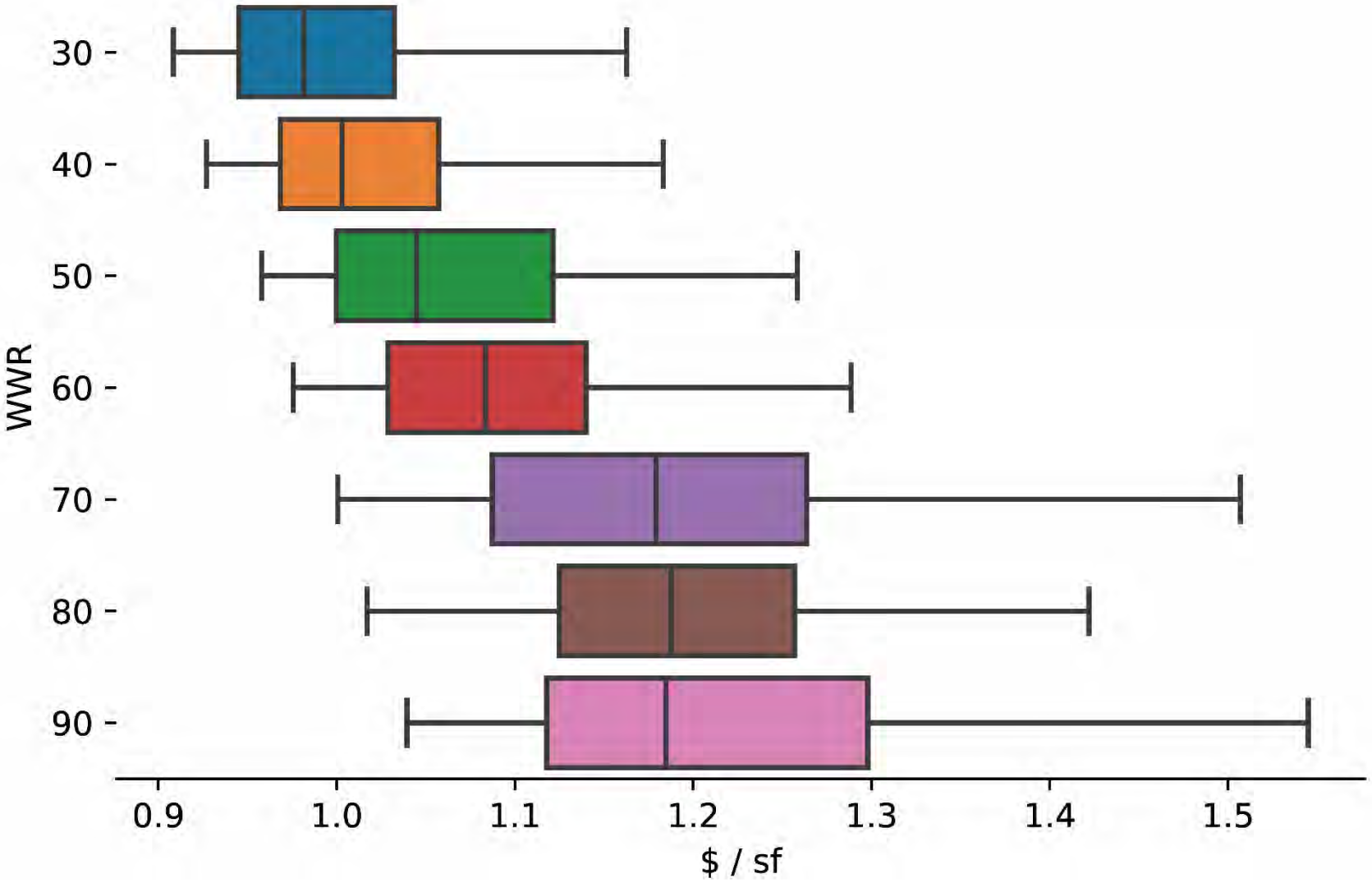

ExtWallCons
Mass, R-10 (U-0.085)
Steel-Framed, R-13+R-4c.i. (U-0.084)
Mass, R-14 (U-0.064)
Steel-Framed, R-13+R-7c.i. (U-0.064)
Mass, R-16 (U-0.055)
Steel-Framed, R-13+R-10c.i. (U-0.055)
Mass, R-22 (U-0.042)
Steel-Framed, R-13+R-15c.i. (U-0.042)
Mass, R-25 (U-0.037)
Steel-Framed, R-13+R-19c.i. (U-0.037)
1.0
1.2
1.4
$ / sf



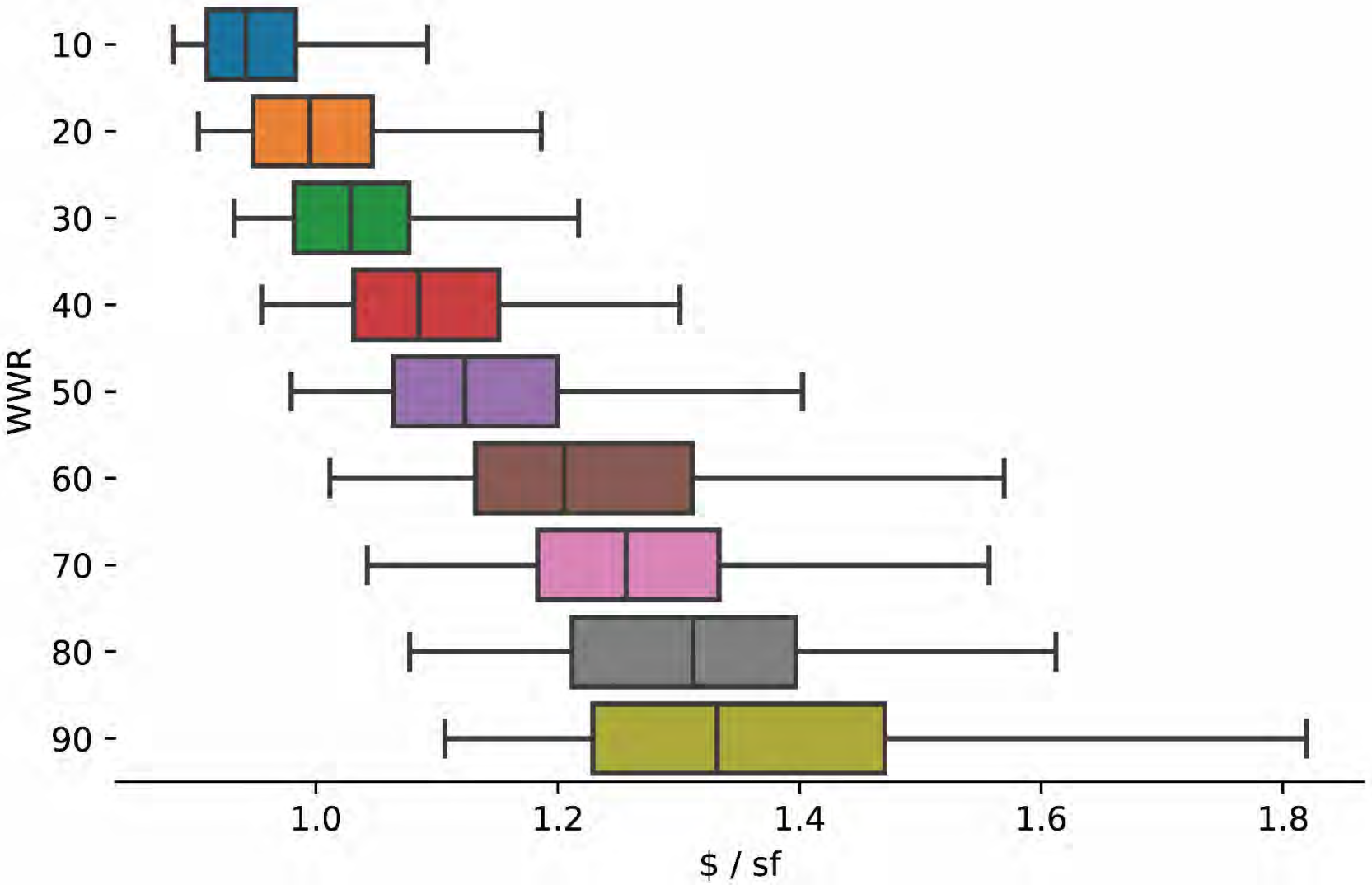
61 WINDOW-TO-WALL RATIO

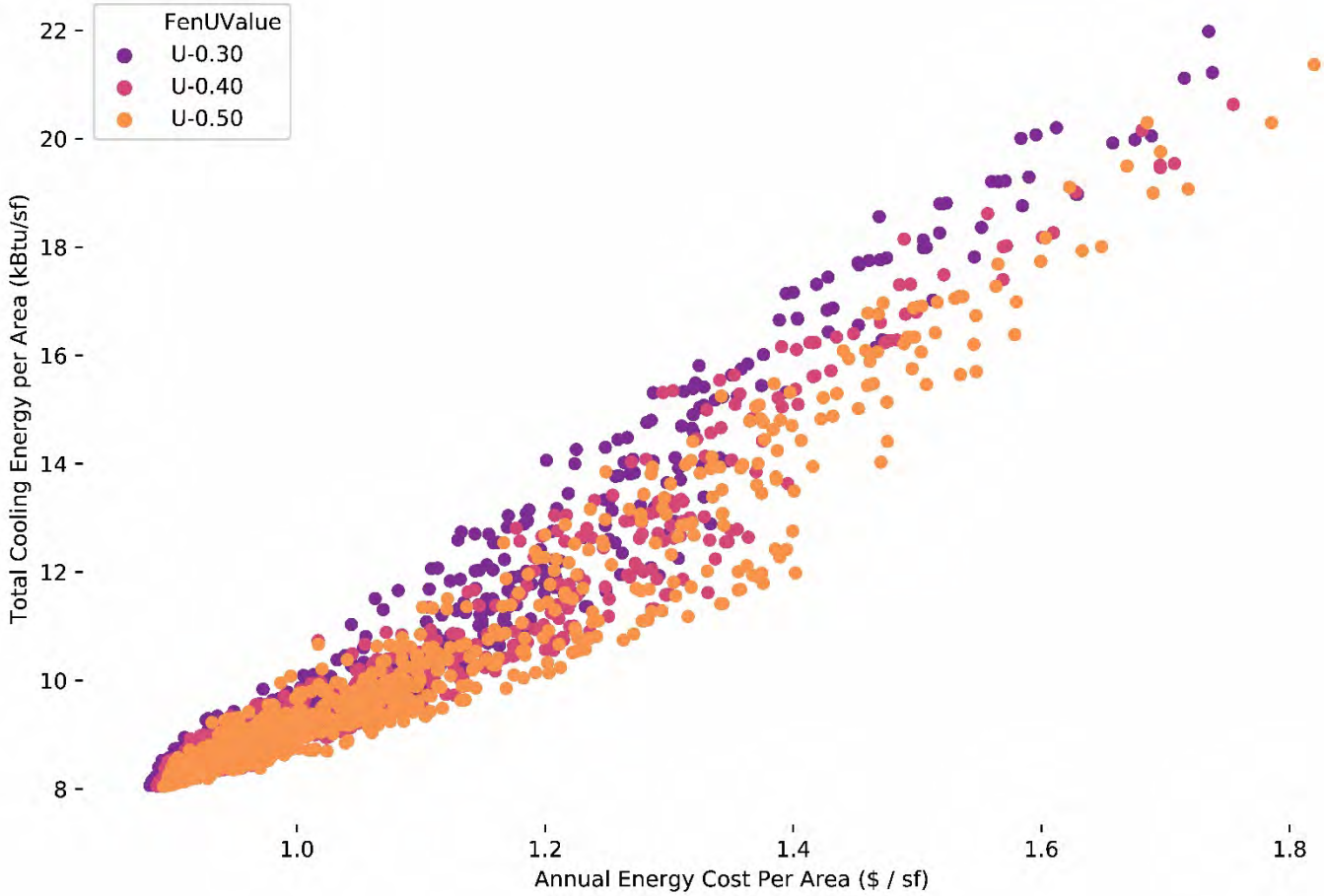
Lower office window-to-wall ratio results in lower total energy and annual operational carbon emissions.

Two-Story



Three-Story



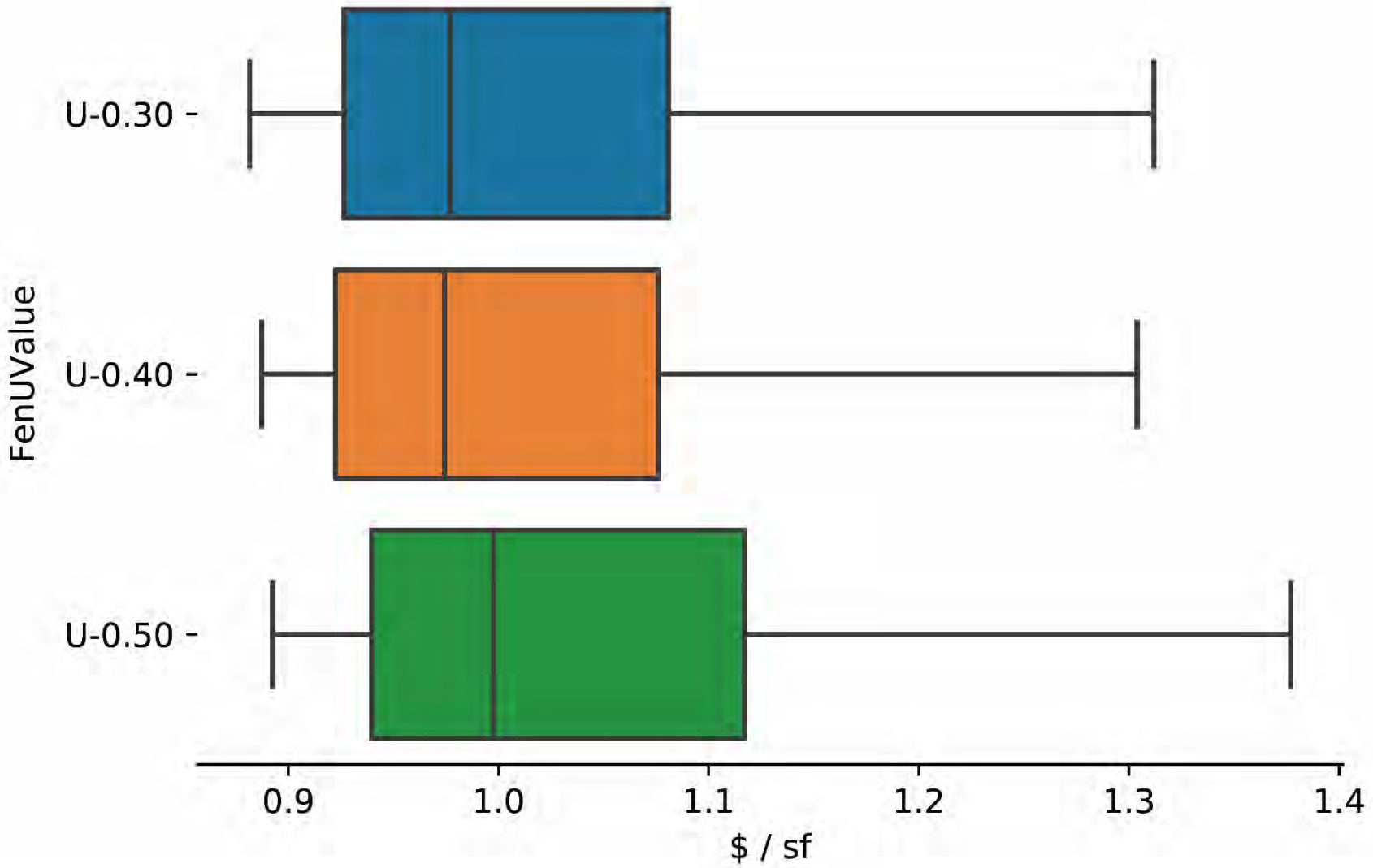


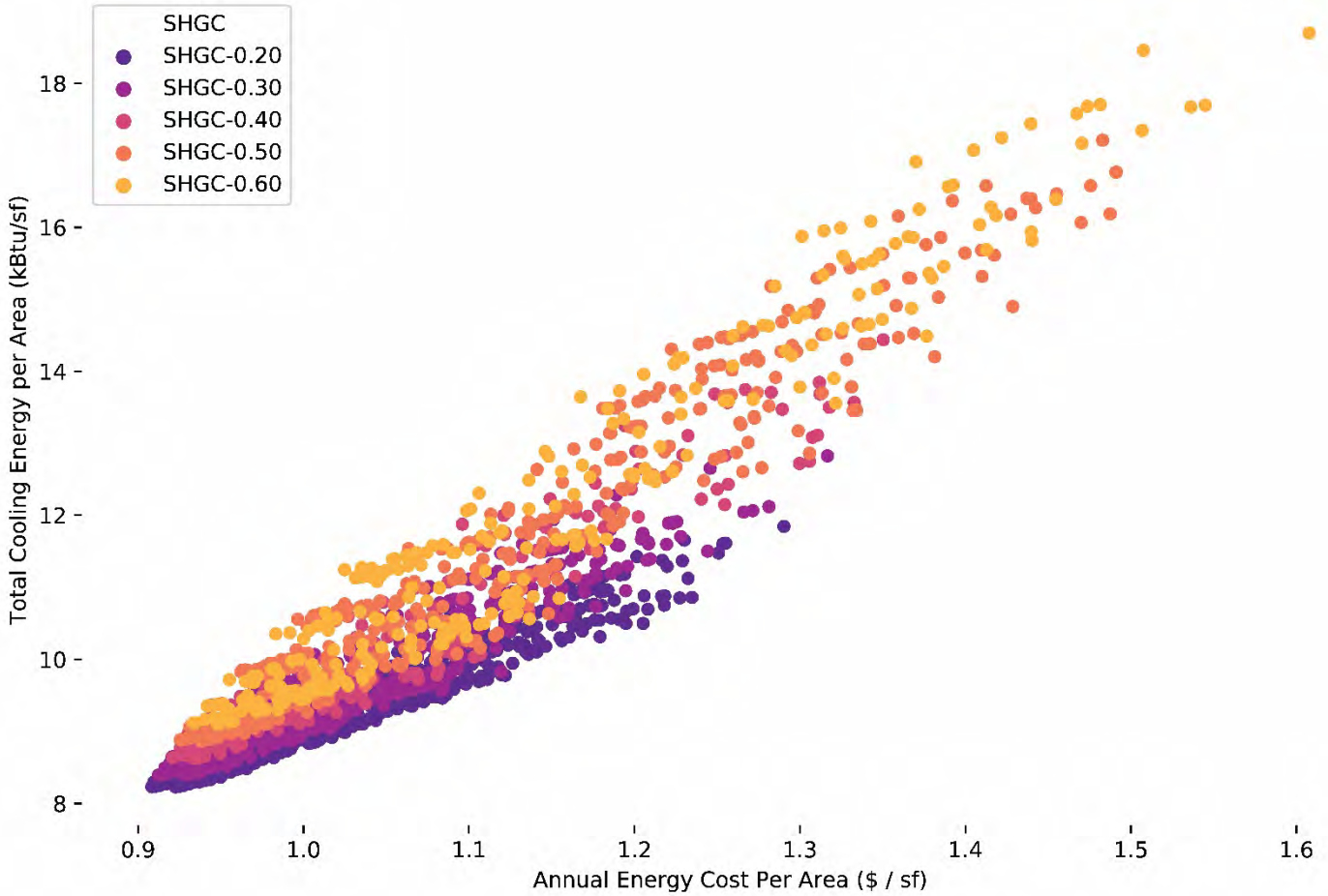
FENESTRATION U-VALUE

Slight improvement at U-0.40

Minimal improvement below U-0.40

Two-Story/Three-Story

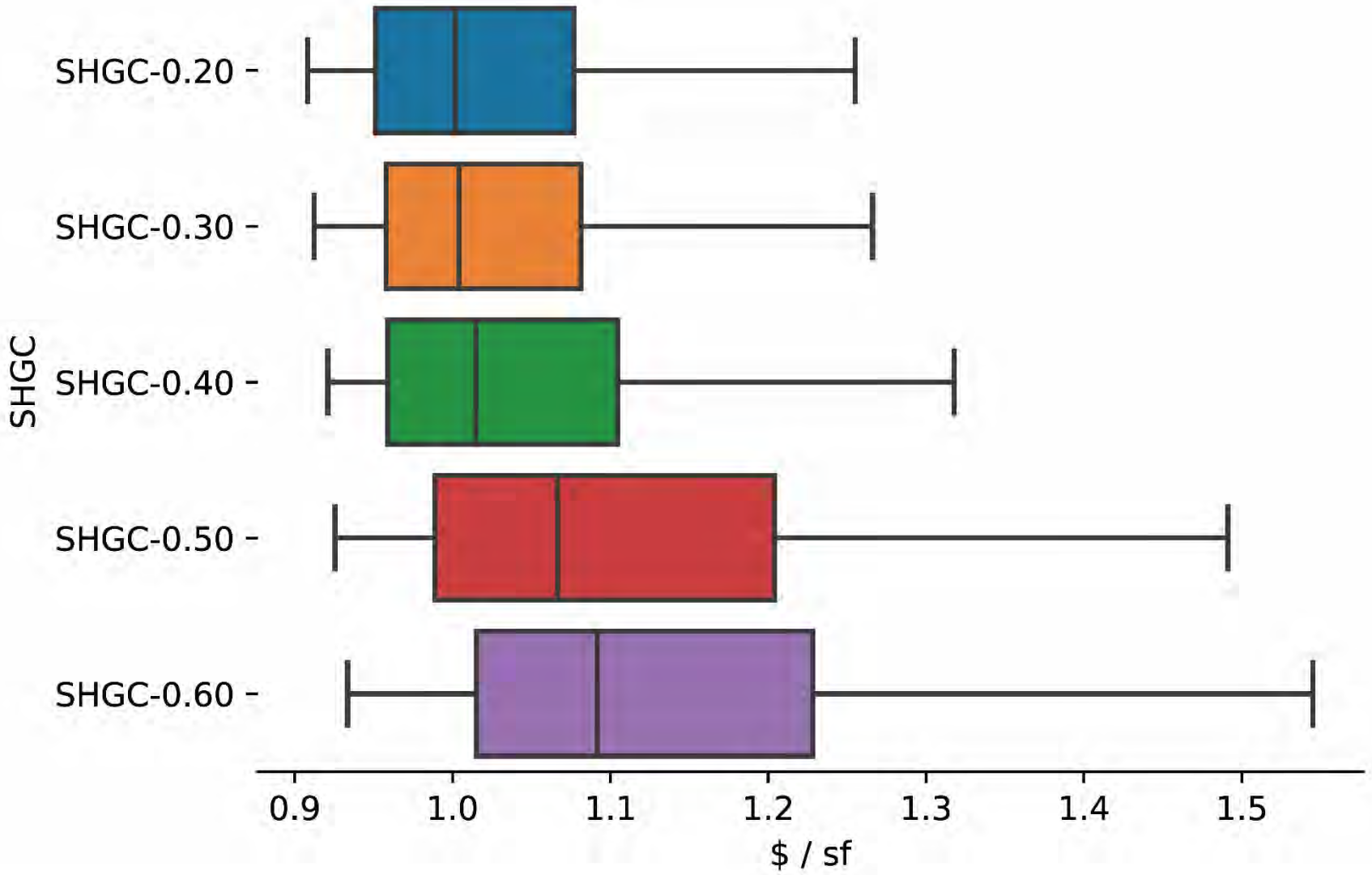




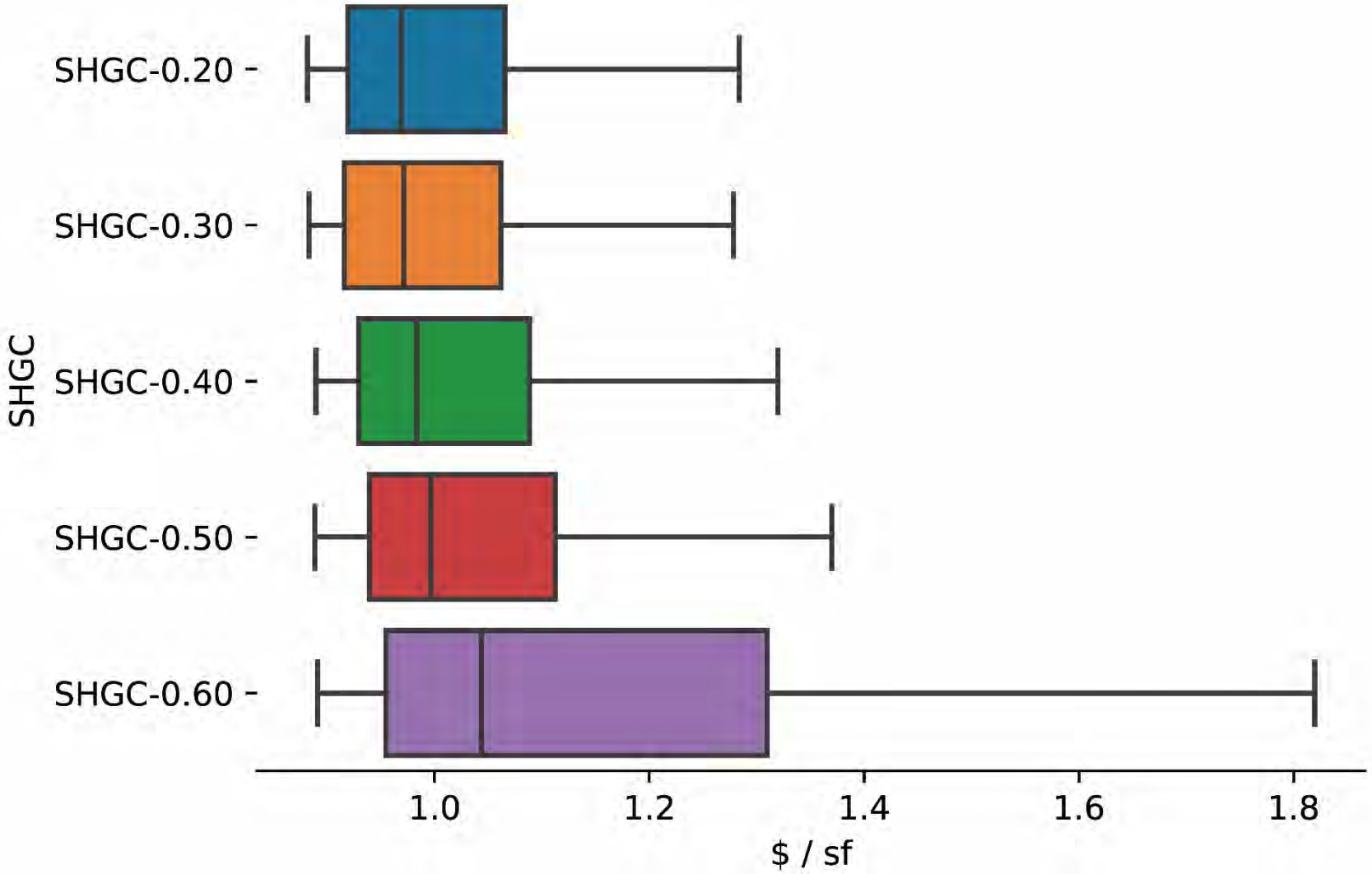
SOLAR HEAT GAIN COEFFICIENT (SHGC)

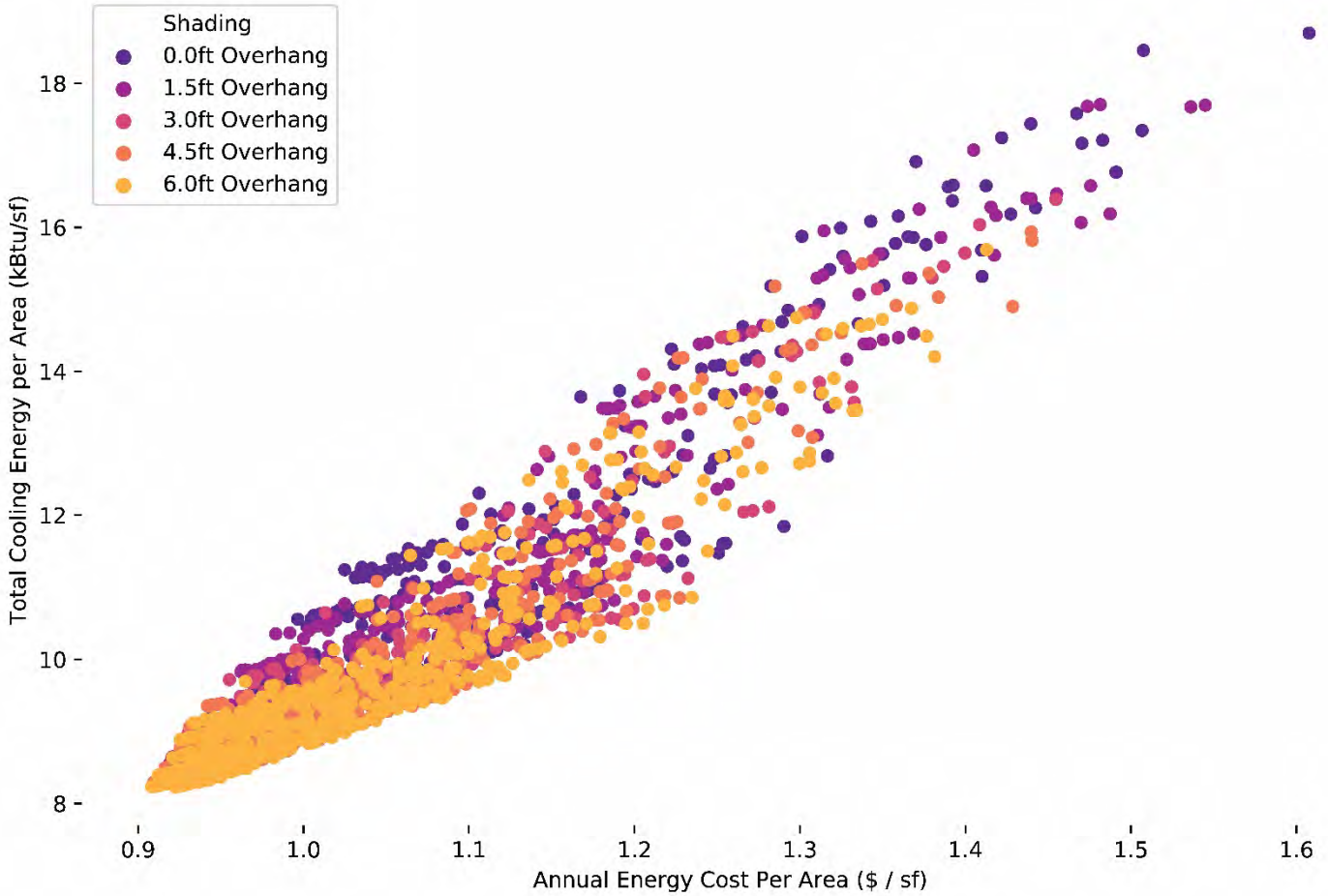
Moderate SHGC values, between 0.20 and 0.40 result in the better performing combinations

Two-Story


SHGC-0.20
SHGC-0.30
SHGC-0.40
SHGC-0.50
SHGC-0.60
SHGC
0.9
1.0
1.1
1.2
1.3
1.4
1.5
$ / sf

Three-Story


SHGC-0.20
SHGC-0.30
SHGC-0.40
SHGC-0.50
SHGC-0.60
SHGC
1.0
1.2
1.4
1.6
1.8
$ / sf

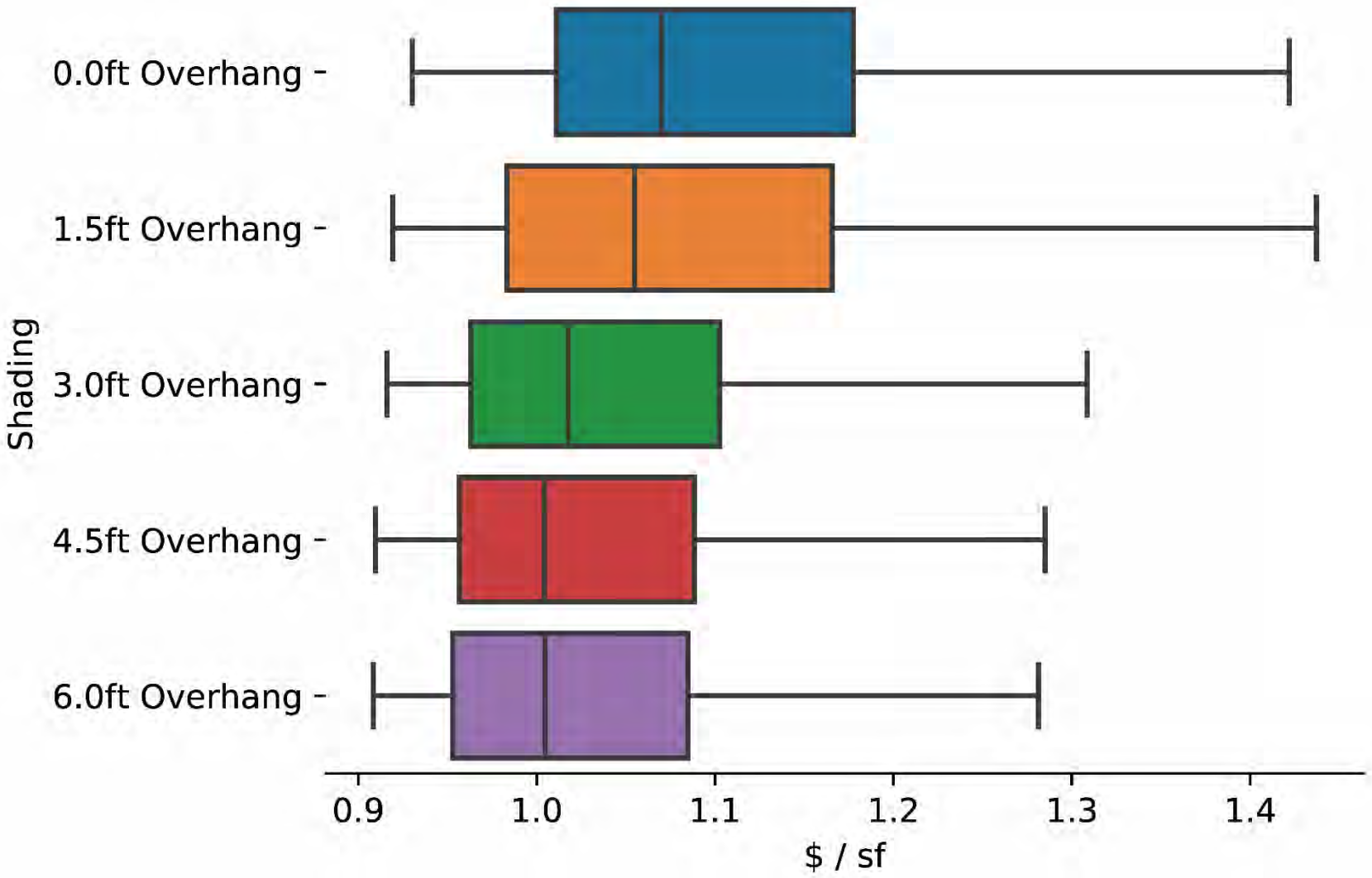


EXTERIOR SHADING

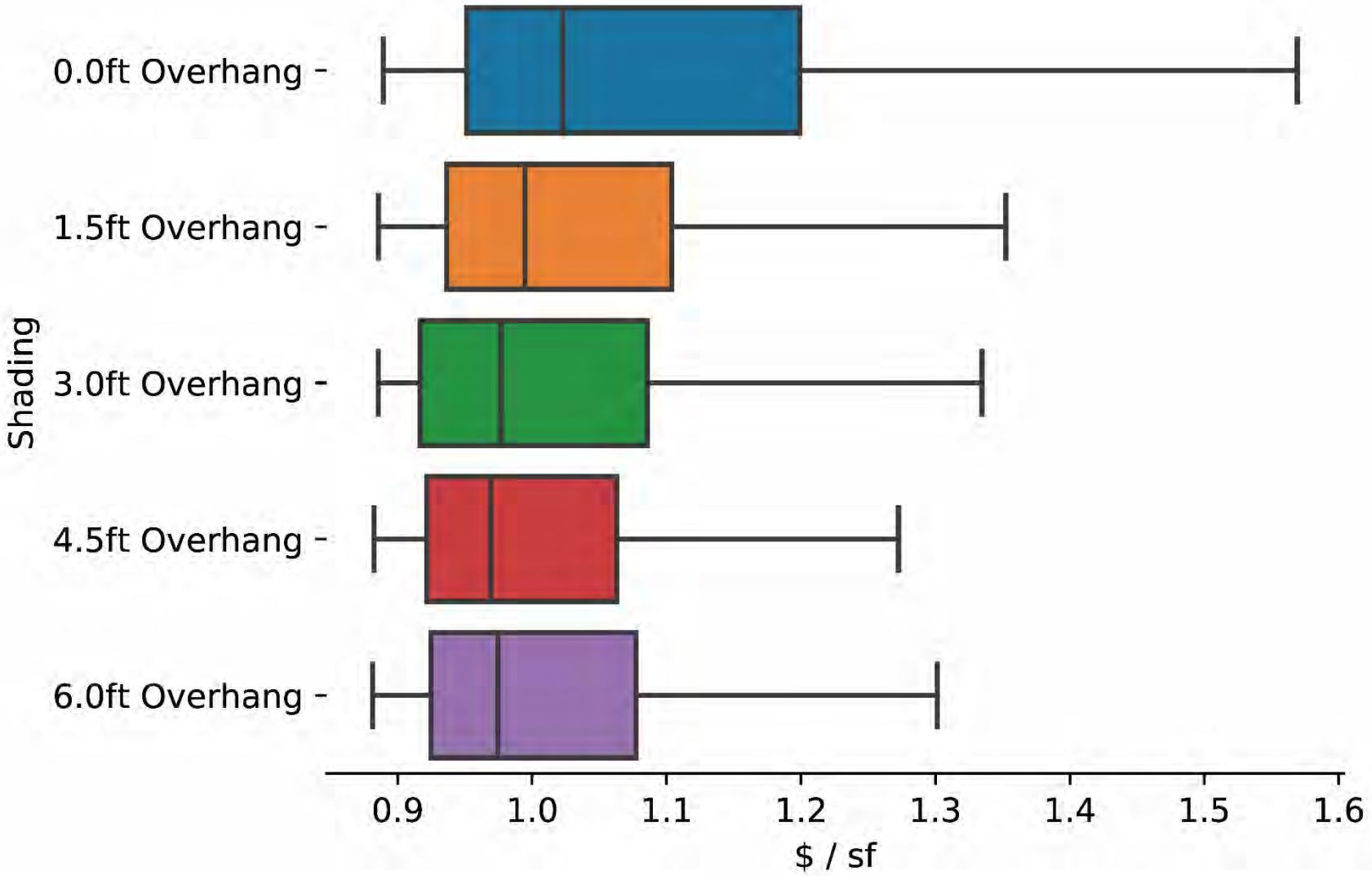
Moderate overhang depths perform better than no overhang or very deep overhang

Could also be achieved via setback

Two-Story


0.0ft Overhang
1.5ft Overhang
3.0ft Overhang
4.5ft Overhang
6.0ft Overhang
Shading
0.9
1.0
1.1
1.2
1.3
1.4
$ / sf

Three-Story


0.0ft Overhang
1.5ft Overhang
3.0ft Overhang
4.5ft Overhang
6.0ft Overhang
Shading
0.9
1.0
1.1
1.2
1.3
1.4
1.5
1.6
$ / sf

Summary: Impactful Parameters

Parameter	Minimum	Maximum
Lighting power density: (W/sf)	Low as feasible	
Roof insulation	R-30	R-35
Window to wall ratio:	Low as feasible	
Fenestration U-value	0.30	0.40
Solar heat gain coefficient	0.20	0.40
Shading	1.5ft	3.0ft

- Higher roof insulation capital and carbon costs become unattractive
- No substantial difference between mass wall and steel framed wall at recommended insulation
- Does not account for indoor environment quality or occupant comfort impact

LUNCH BREAK

Breakout Groups

Design Strategies

- Brainstorming Session
  - Group 1: Envelope/Passive Design/Water
  - Group 2: HVAC/Energy Systems/Lighting
- Group Member Roles
  - Facilitator: Keeps group on-track, on-time, and makes sure everyone participates
  - Recordkeeper: Fills out worksheet and confirms all topics are being discussed
  - Reporter: Summaries group discussion and worksheet contents at end of activity

Report & Discussion

- Each group shares goals and design strategies discussed during their breakout session
- Let's consolidate the highlights of each group and create master strategy list
- Which of these should be tested in the energy model?

Next Steps

- Compile today's ideas and share with whole project team via meeting minutes
- Determine important upcoming dates
  - Preliminary Energy Modeling report
  - Future phase drawings issued
  - Future energy modeling report