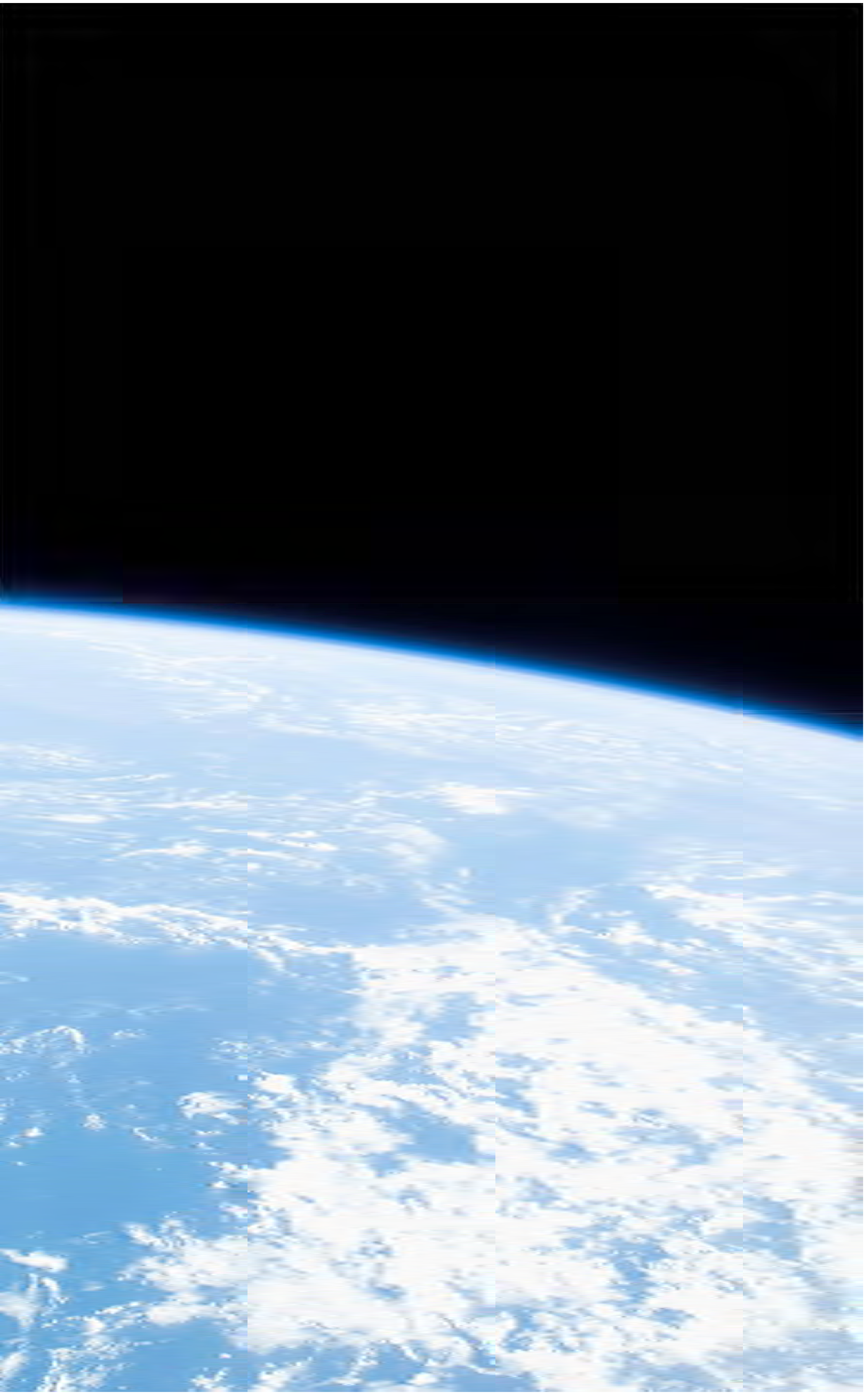


How Designers Can Curb Risk with Performance-Based Modeling

Eric McDaniel, AIA, BEMP, LEED AP

Principal

February 20, 2019

SORA DESIGN GROUP LLC

Learning Objectives

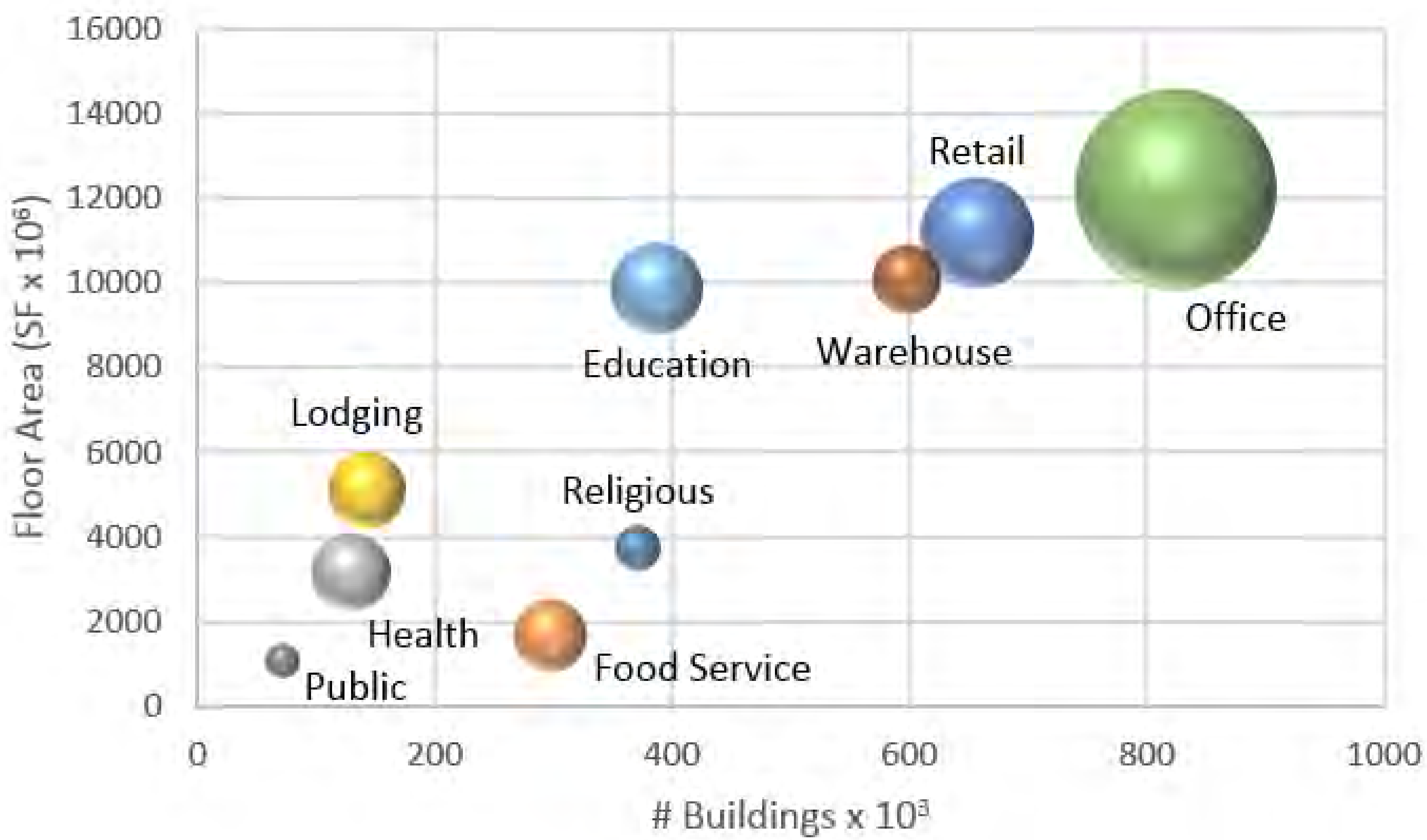
Today We Will Discuss:

- Energy & Building Design
- Value Proposition
- Managing Risk through Modeling
- Case Studies

“ Design is not just what it looks like and feels like. Design is how it works. “

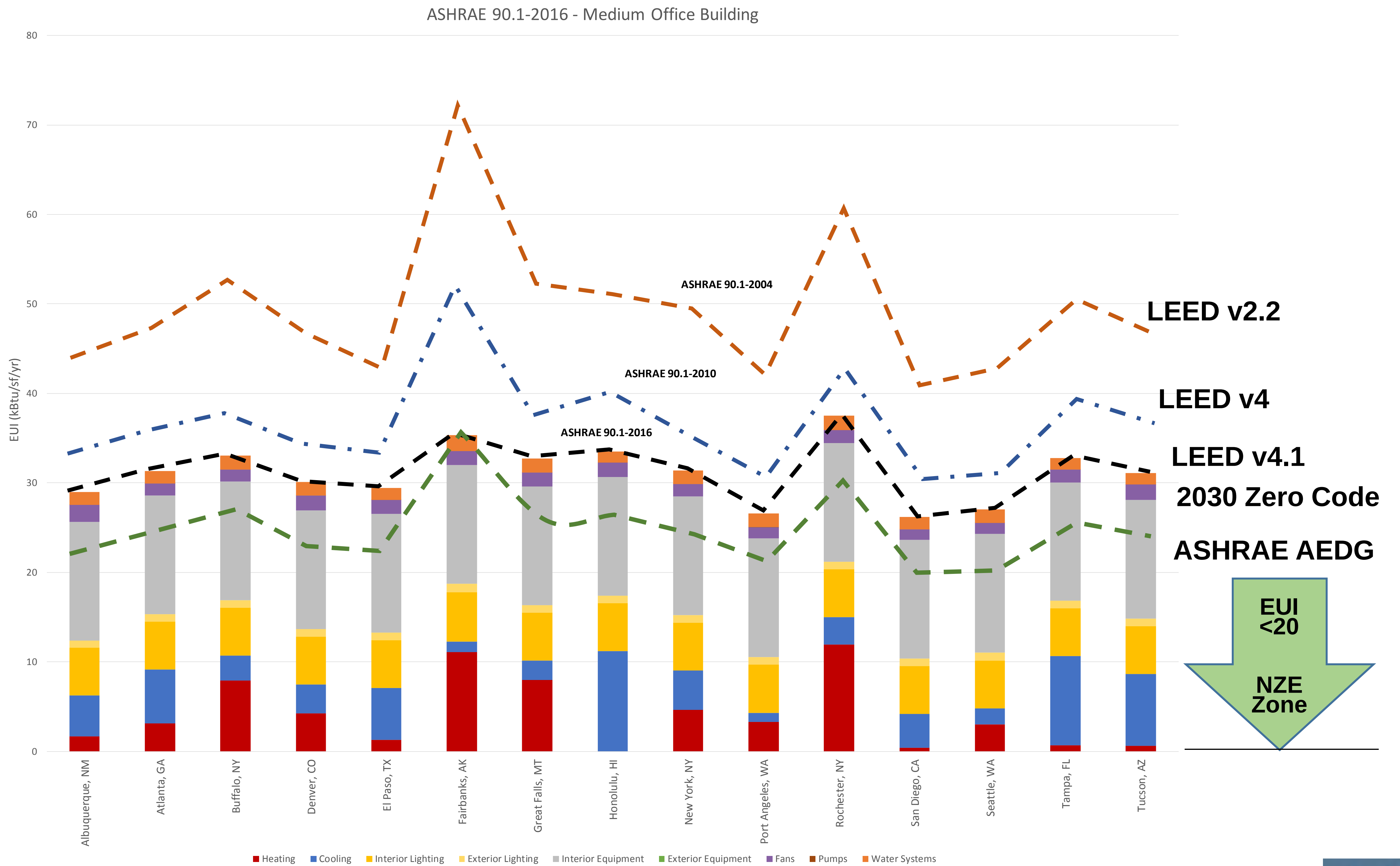
Steve Jobs

Energy & Buildings – Big Picture

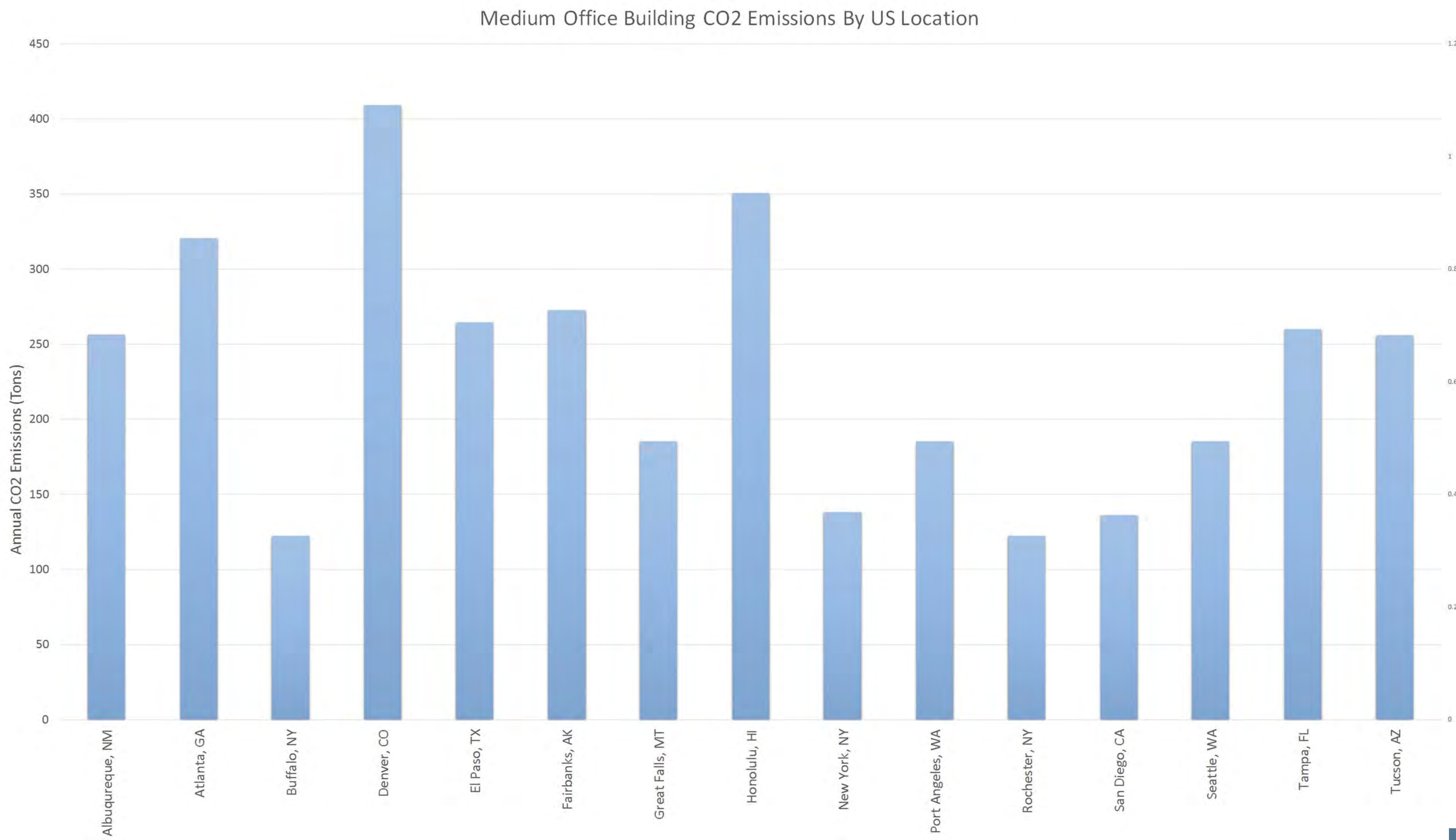


Data Source: CBECS 2003 Dataset

Energy & Buildings – Big Picture



Energy & Buildings – Big Picture



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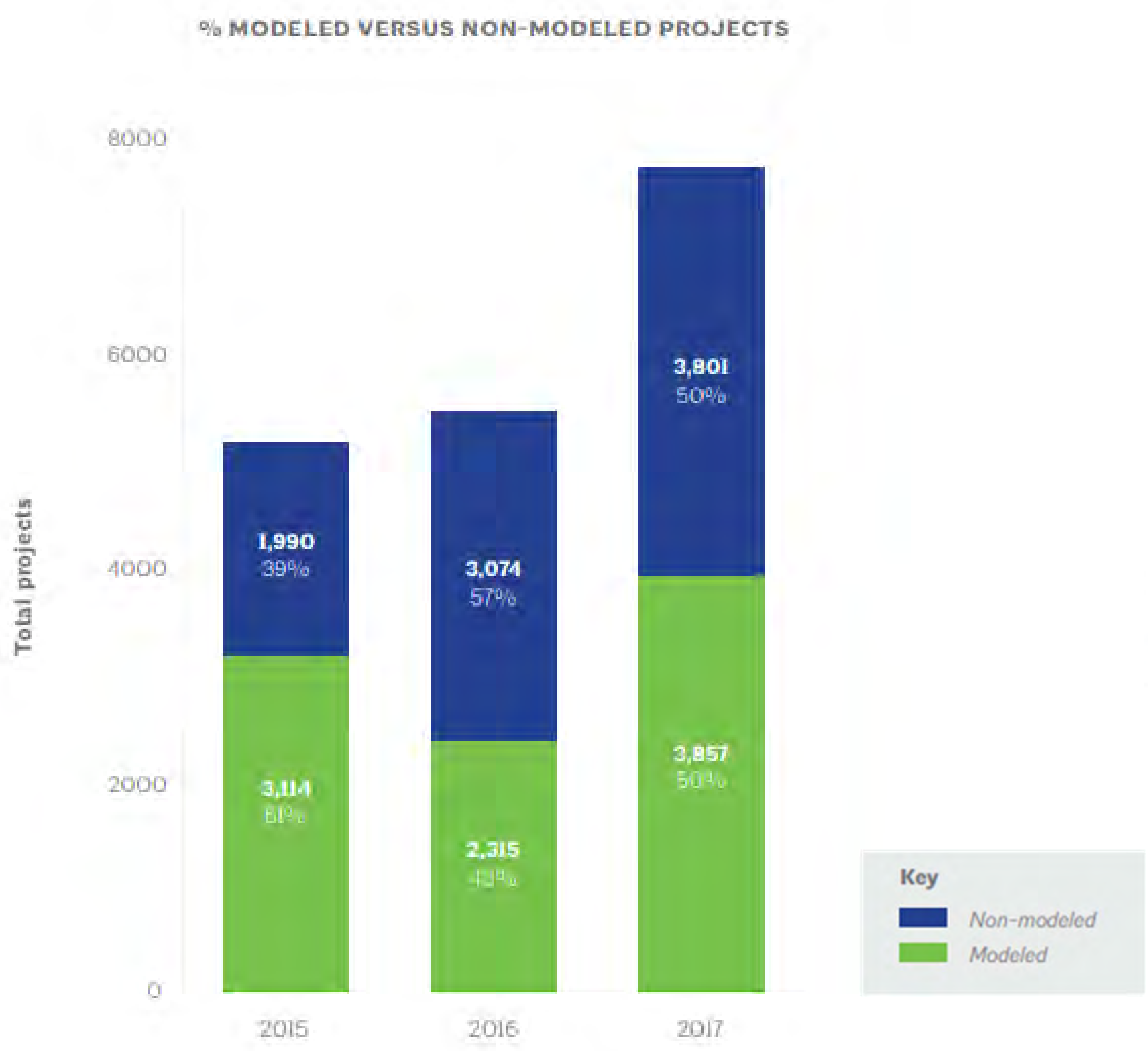
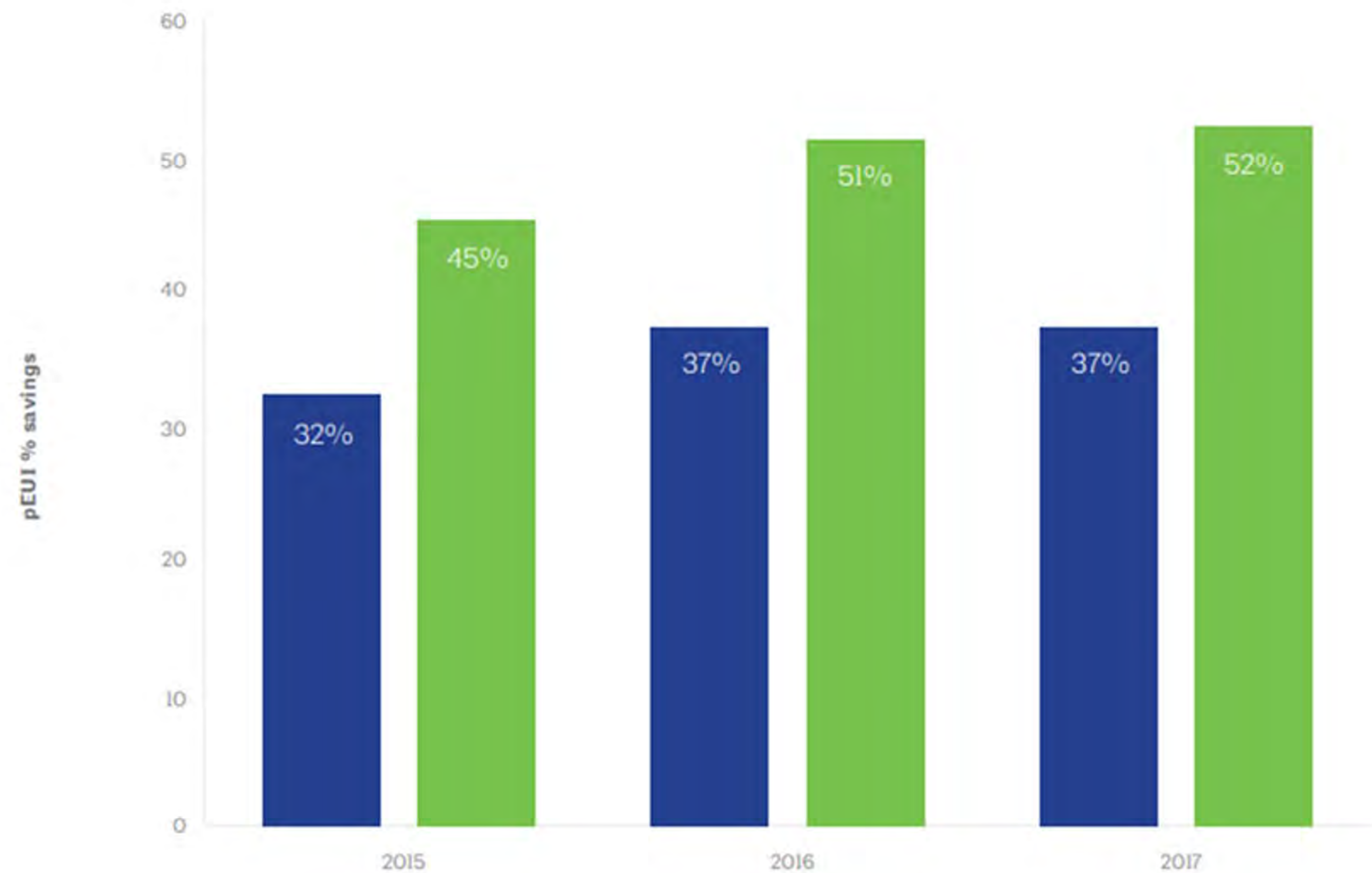
Energy & Buildings – Big Picture

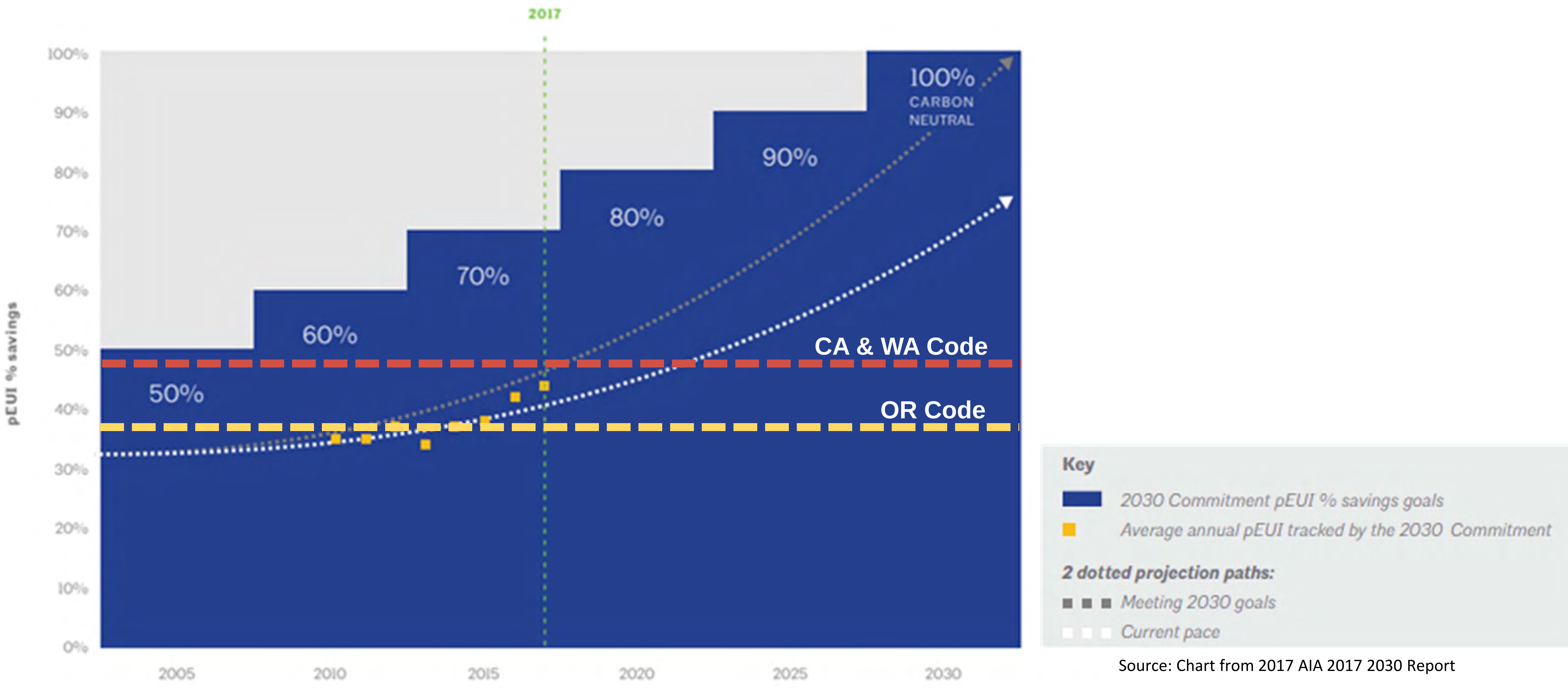


Modeled Projects are showing 40% better energy performance than non-modeled



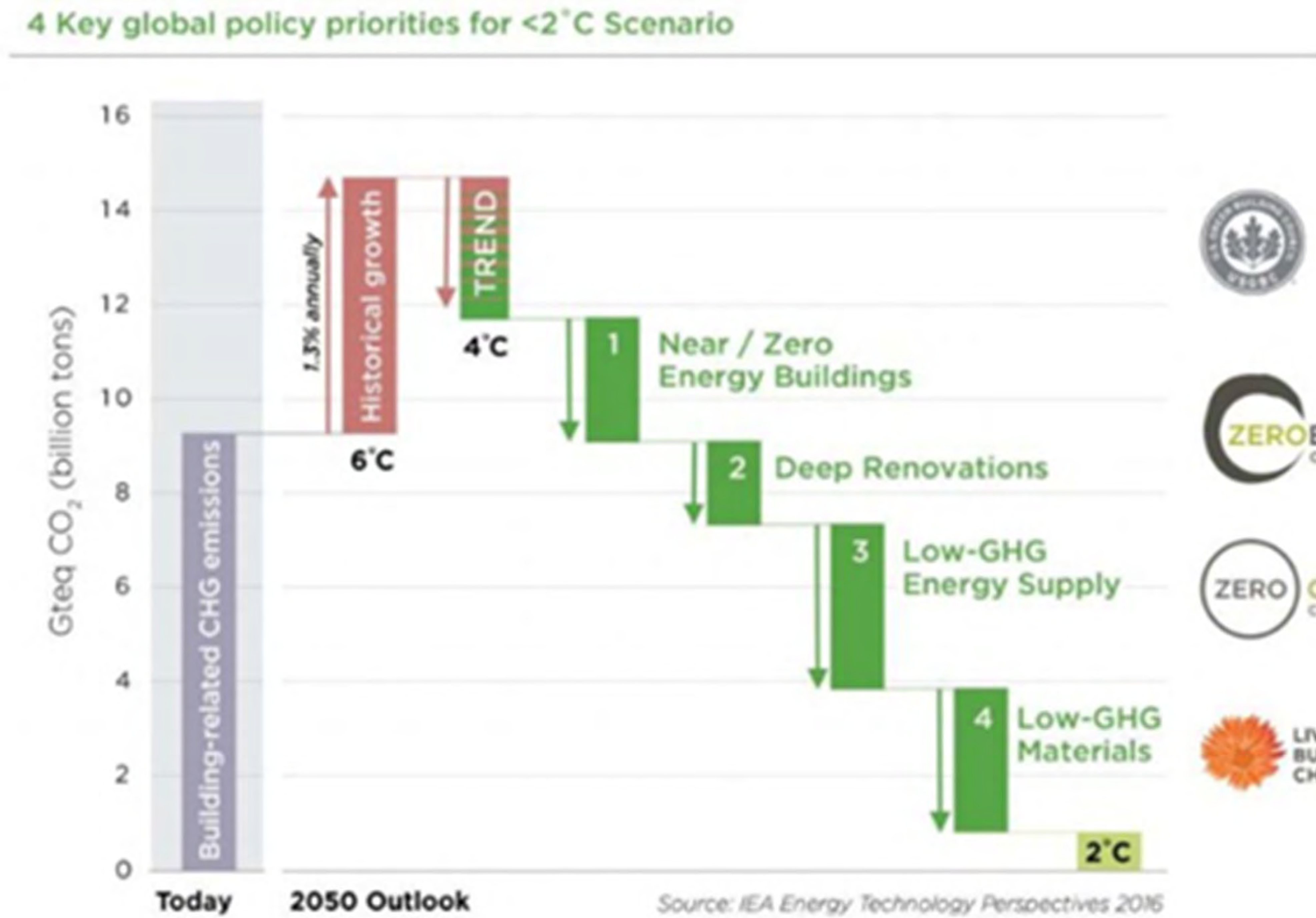
Source: Charts from 2017 AIA 2017 2030 Report

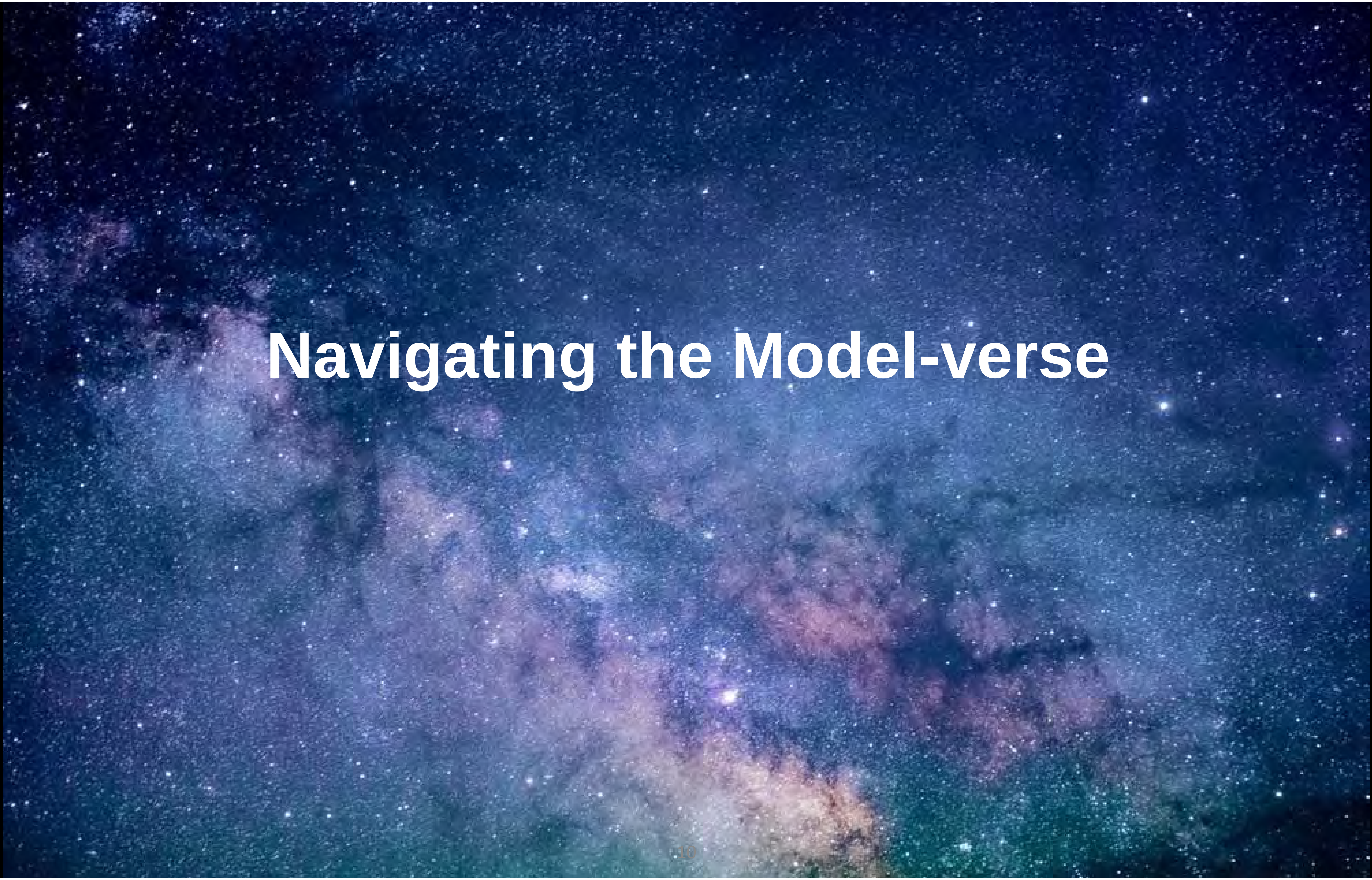
Energy & Buildings – Big Picture



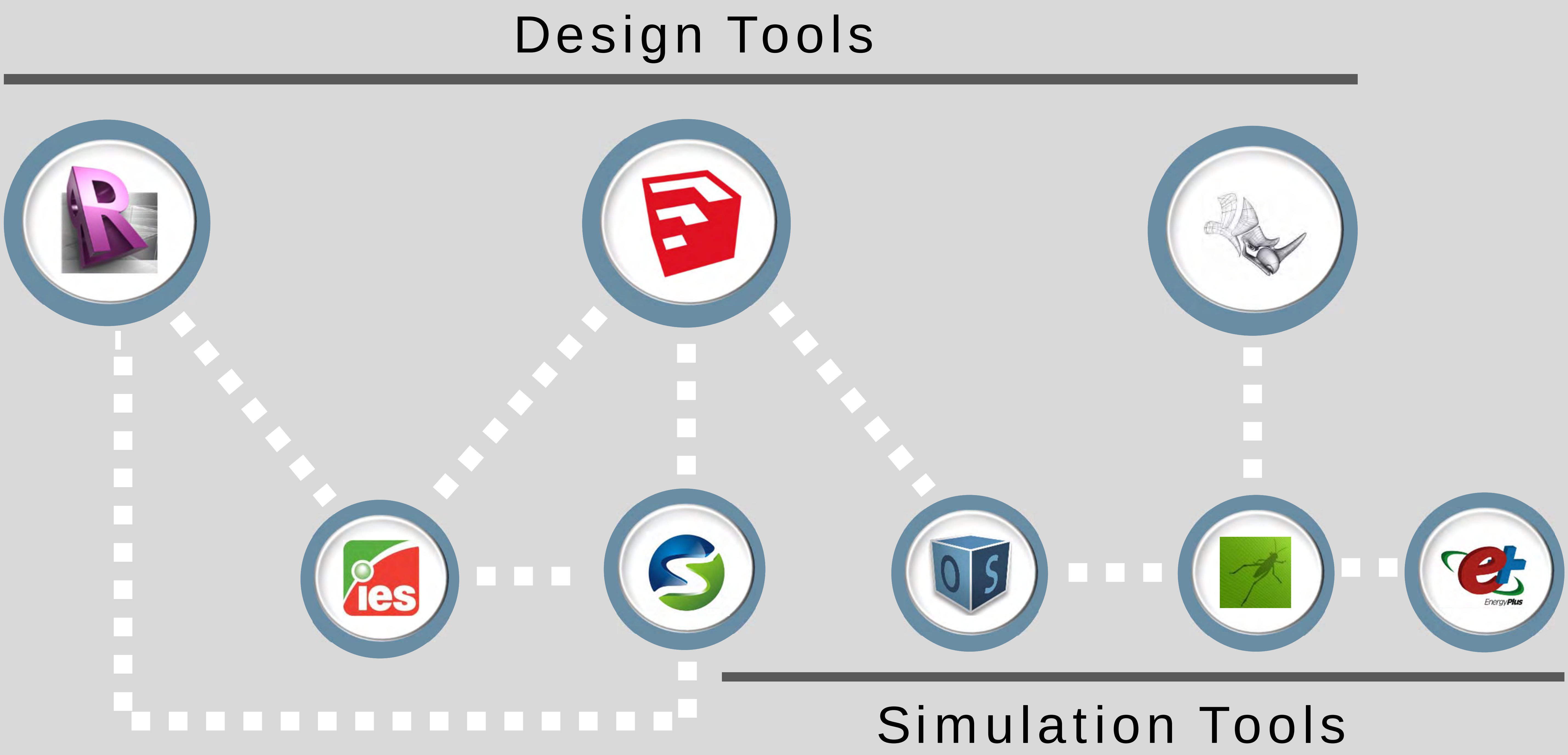
Source: Chart from 2017 AIA 2017 2030 Report

Low-Energy Pathway



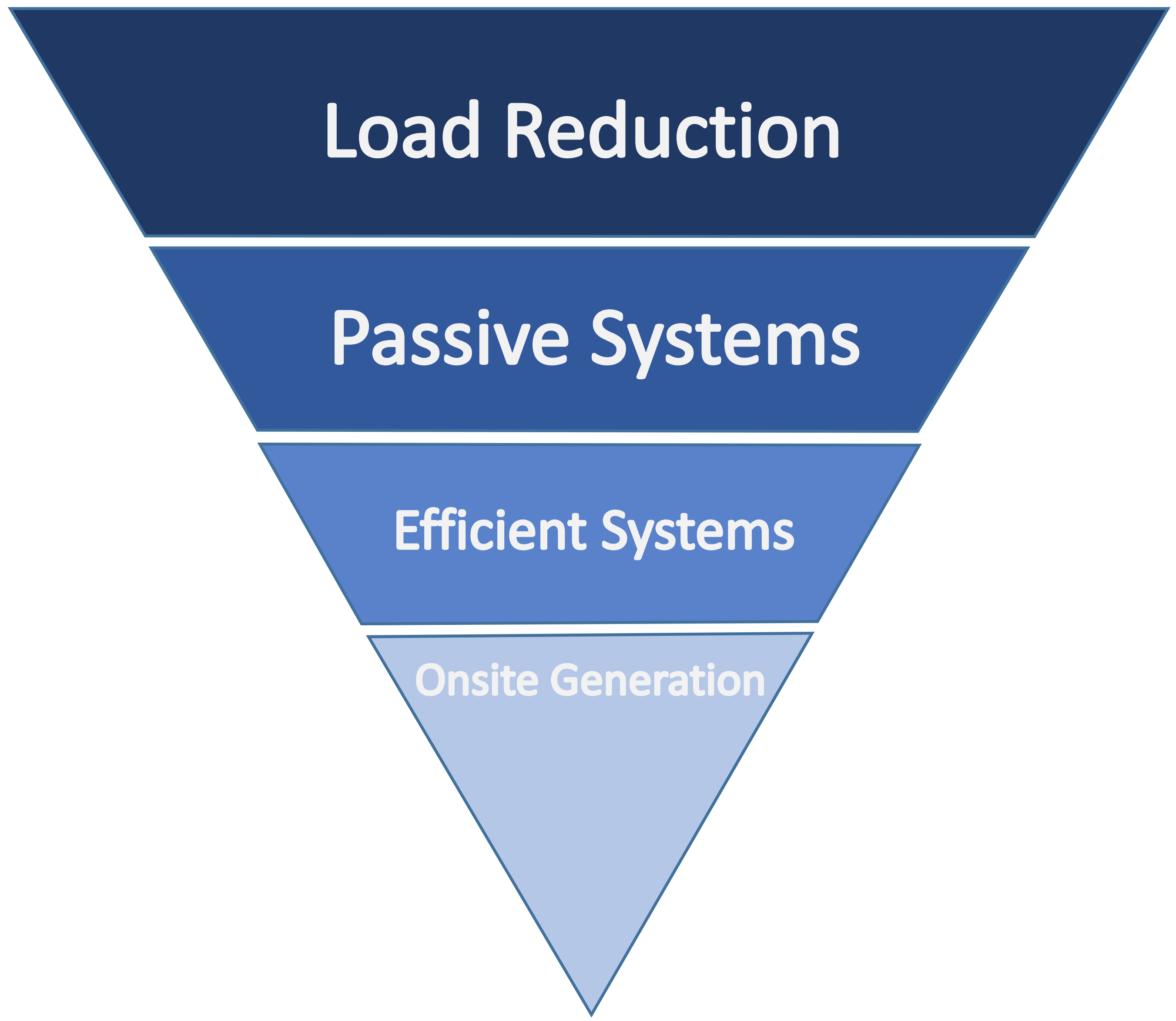

Navigating the Model-verse

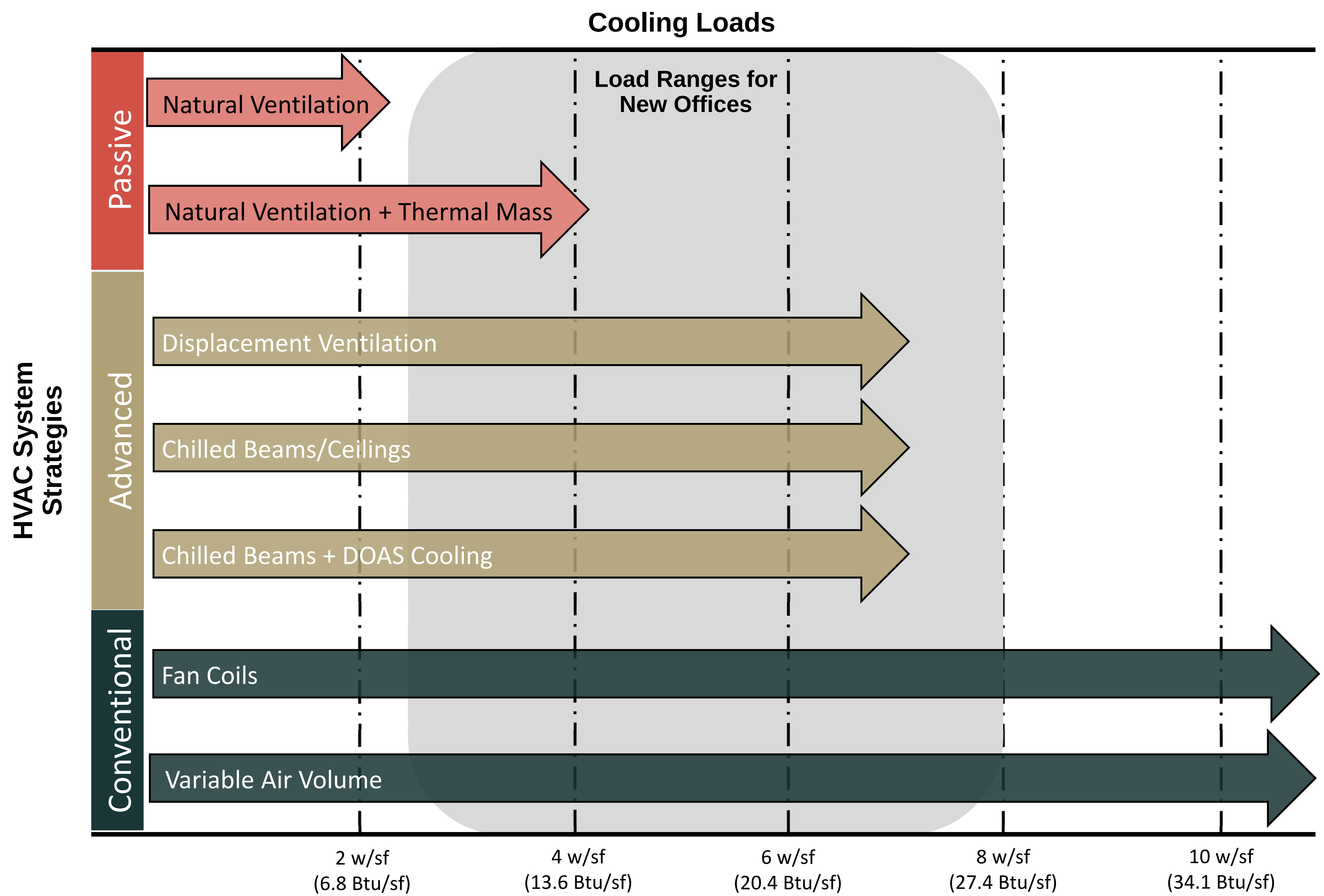
Tools – Interoperability



Energy & Design

- Develop a game plan for reducing loads
- Load Reduction = Design Opportunities
- Load reduction is the lowest cost strategy
- Efficient systems can be complex & $$$
- Onsite generation is a utility concept most expensive





Source: Chart derived from "Design Professional Guide to Zero Net Energy Buildings"

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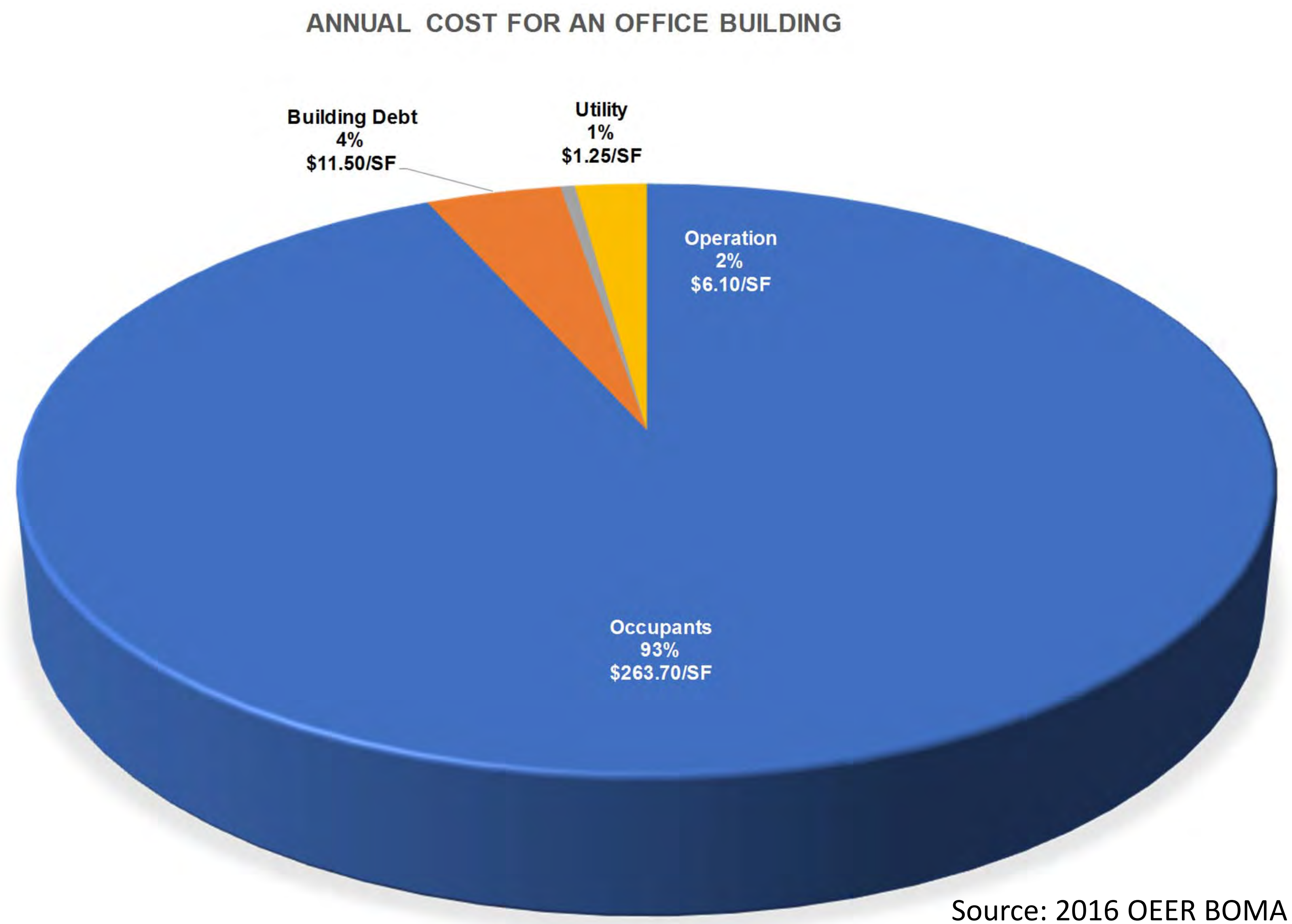
Value Proposition



Source: 2016 OEER BOMA

Making the Case:

- ❑ Energy cost is < 1% of overall cost.
- ❑ Concentrate on building and occupant savings.
- ❑ Apply societal cost to help inform decisions, e.g. cost of carbon
  - ❑ Oregon is implementing cap and trade policy
  - ❑ Cost of carbon may exceed energy cost

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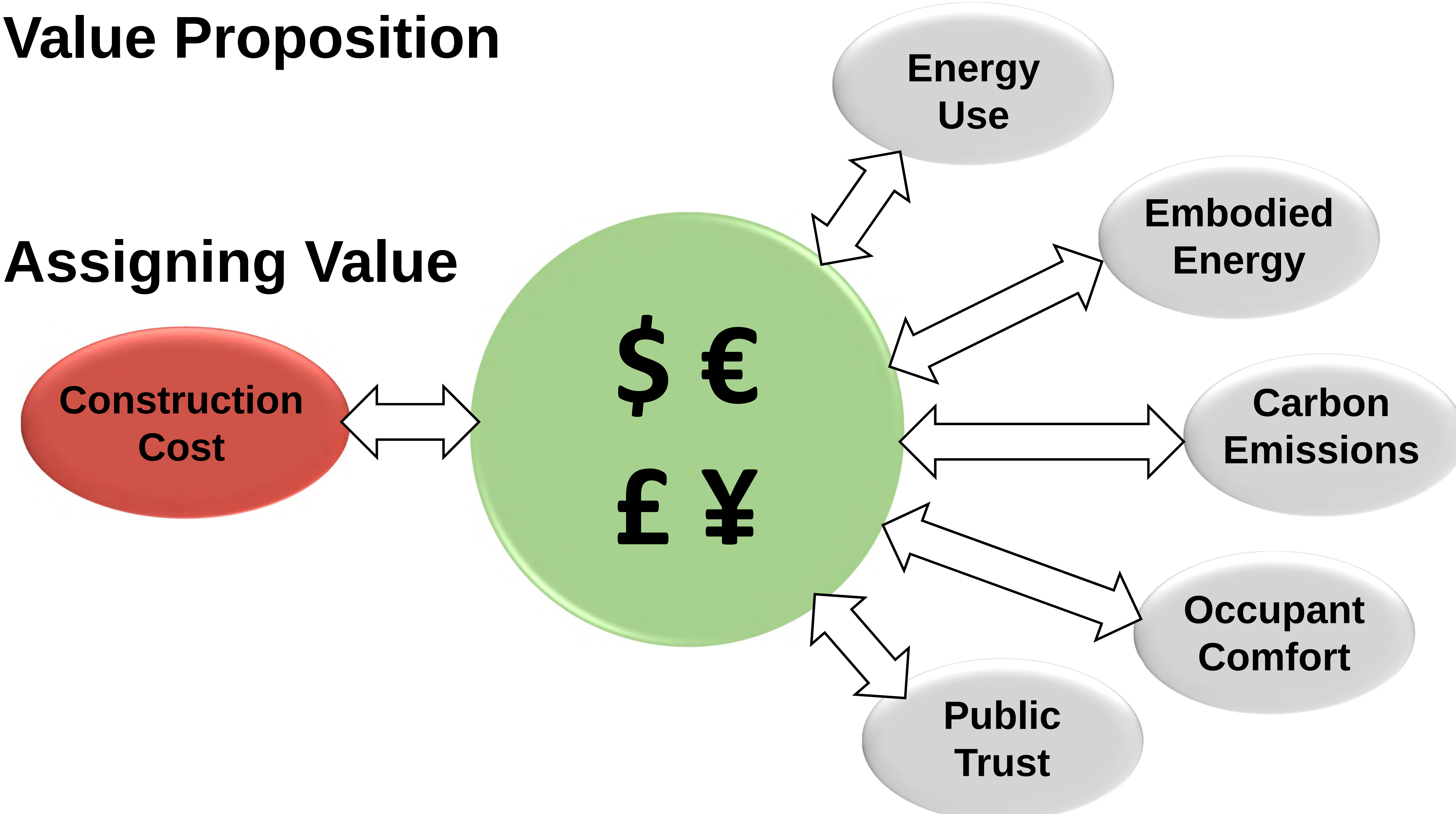
Value Proposition

Assigning Value



What is Risk?

What is Risk?


Hazard
Jeopardy
Exposedness
Gamble
Speculation
Uncertainty
Jeopardy
Exposure
Uncertainty
Openness
Plunge
Prospect
Hazard
Peril
Liableness
Hazard
Opportunity
Exposedness
Fortuity
Liableness
Jeopardy
Danger
Fortune
Hazard
Accident
Gamble
Fortuity
Fortune
Peril
Danger
Plunge
Luck
Prospect
Liability
Danger
Gamble
Contingency
Contingency
Fortuity
Wager
Opportunity
Possibility
Wager
Venture
Danger
Danger
Possibility
Liability
Venture
Liableness
Fortune
Exposure
Wager
Fortune
Peril
Opportunity
Accident
Openness
Prospect
Plunge
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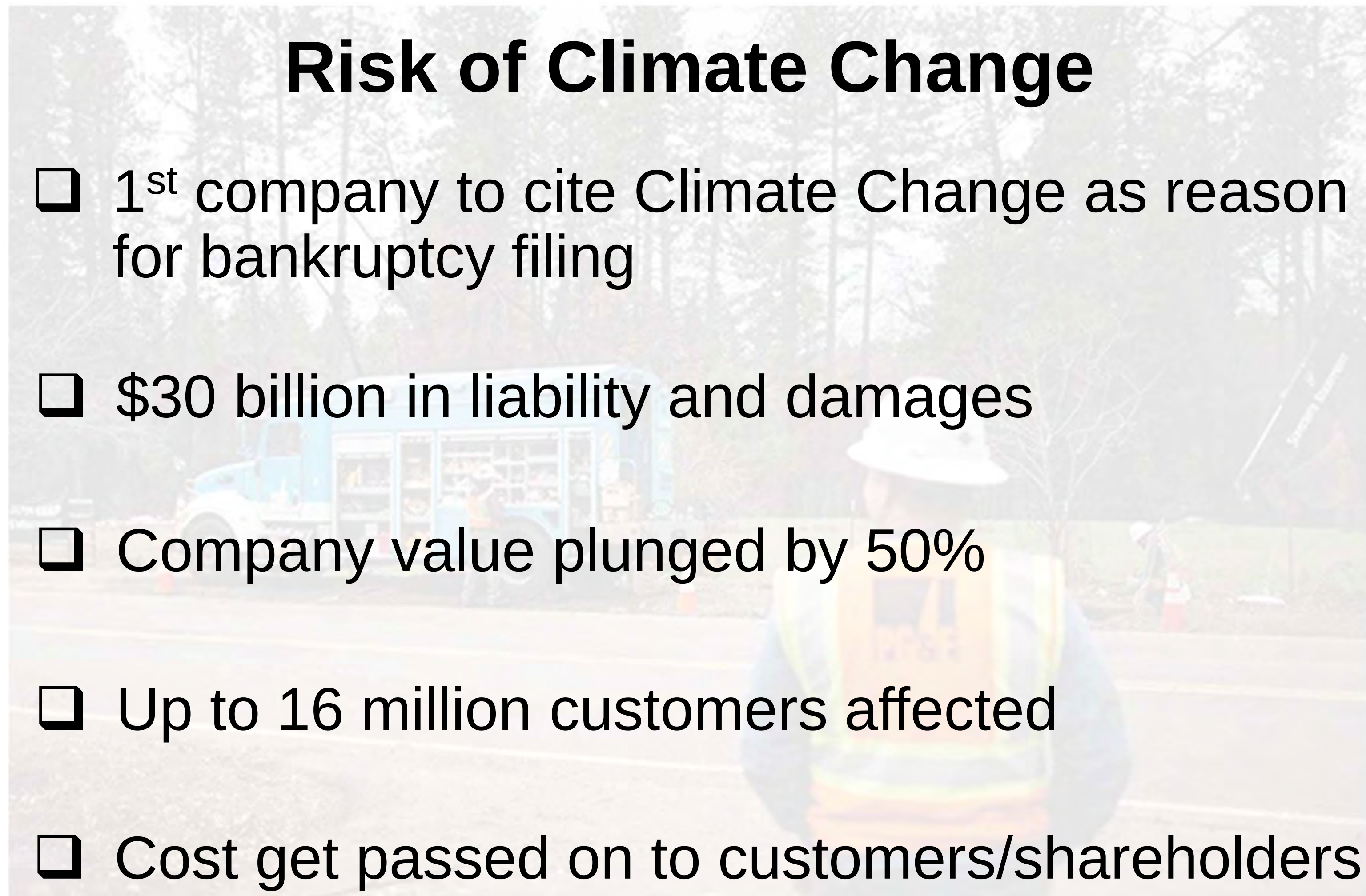
Peril
Liability
Exposure
Prospect
Accident
Exposure
Liability
Openness
Luck
Venture
Possibility

Identifying Risk

Identifying Risk

January 29, 2019

PG&E Bankruptcy Tests Who Will Pay for California Wildfires

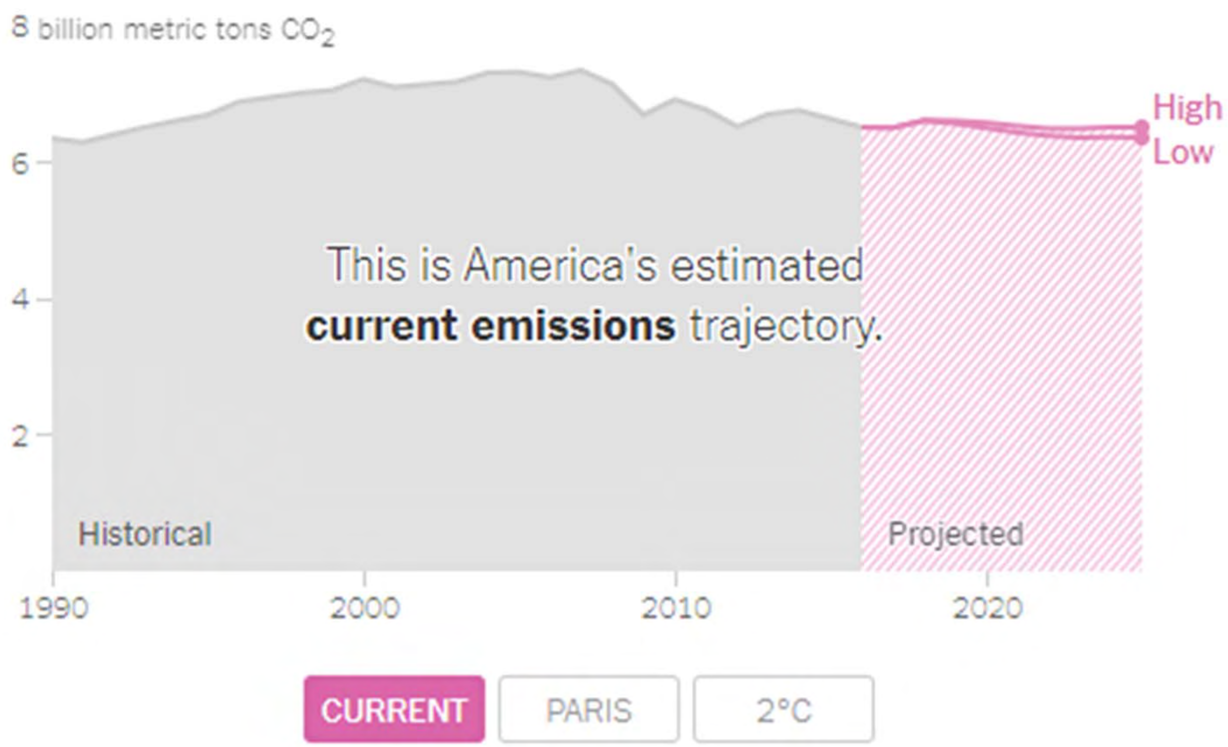


Risk of Climate Change

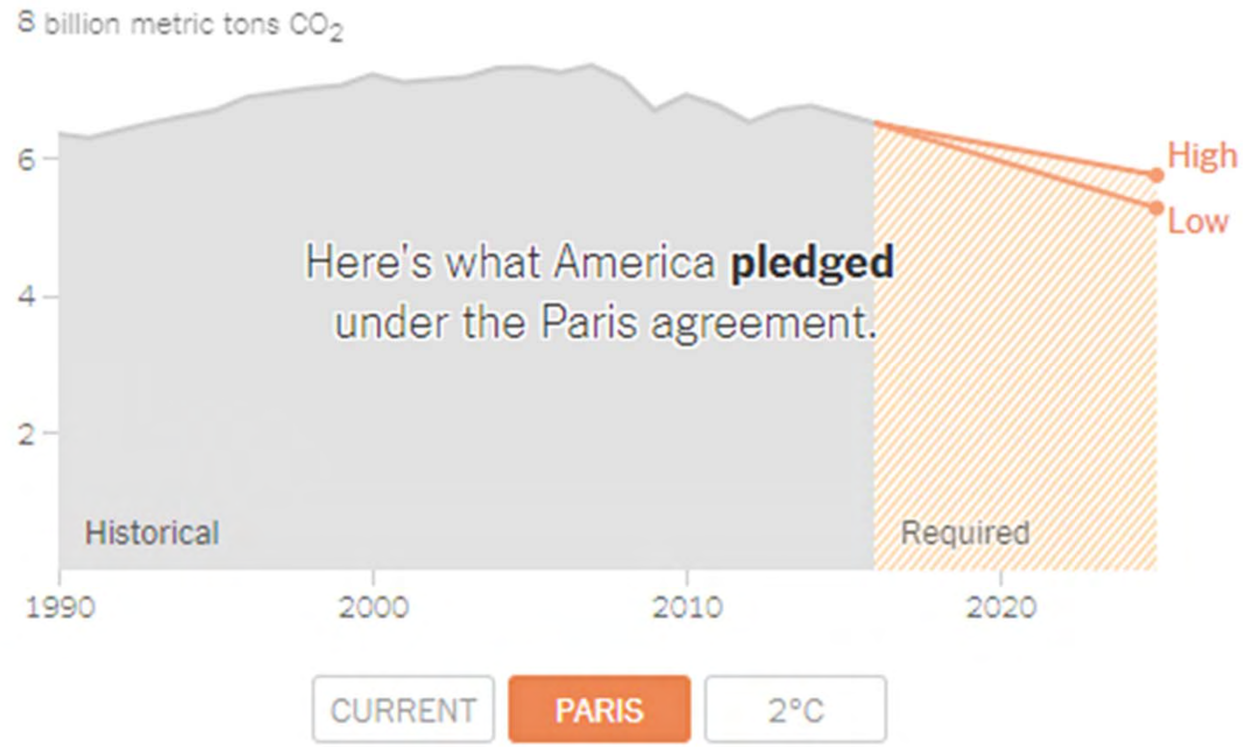
- 1st company to cite Climate Change as reason for bankruptcy filing
- $30 billion in liability and damages
- Company value plunged by 50%
- Up to 16 million customers affected
- Cost get passed on to customers/shareholders

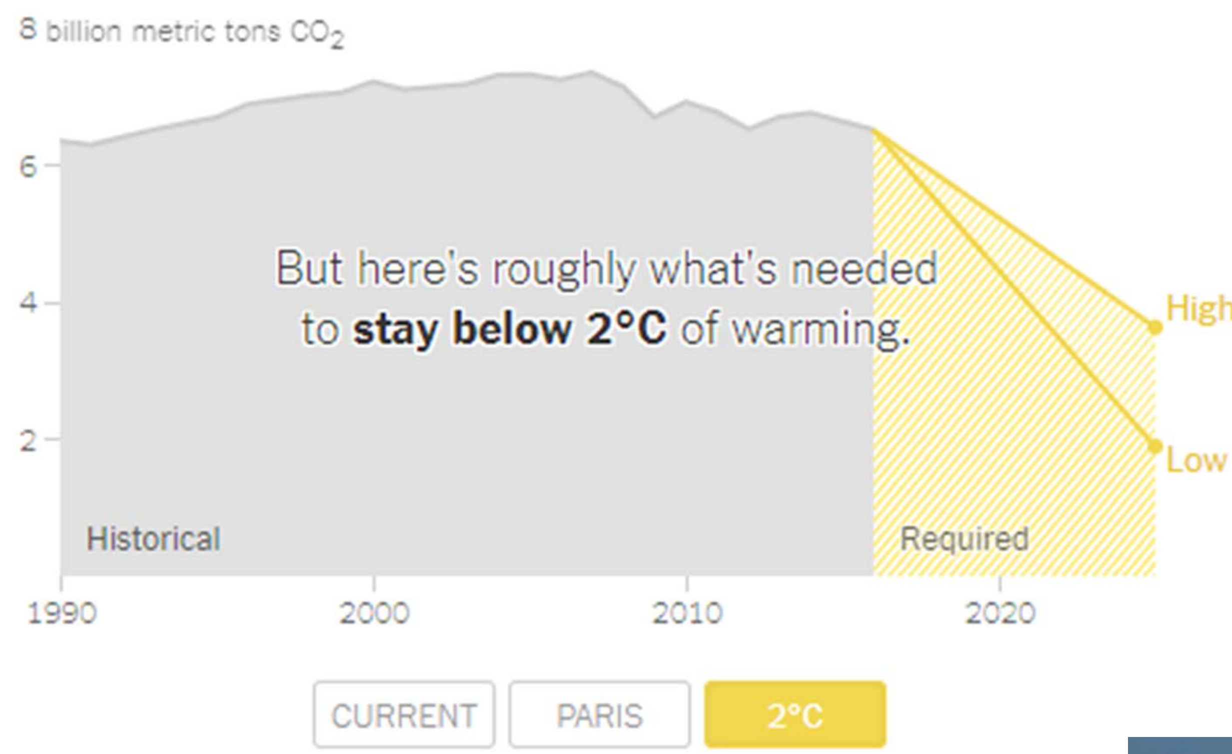
Image Credit: New York Times

Risk of Climate Change

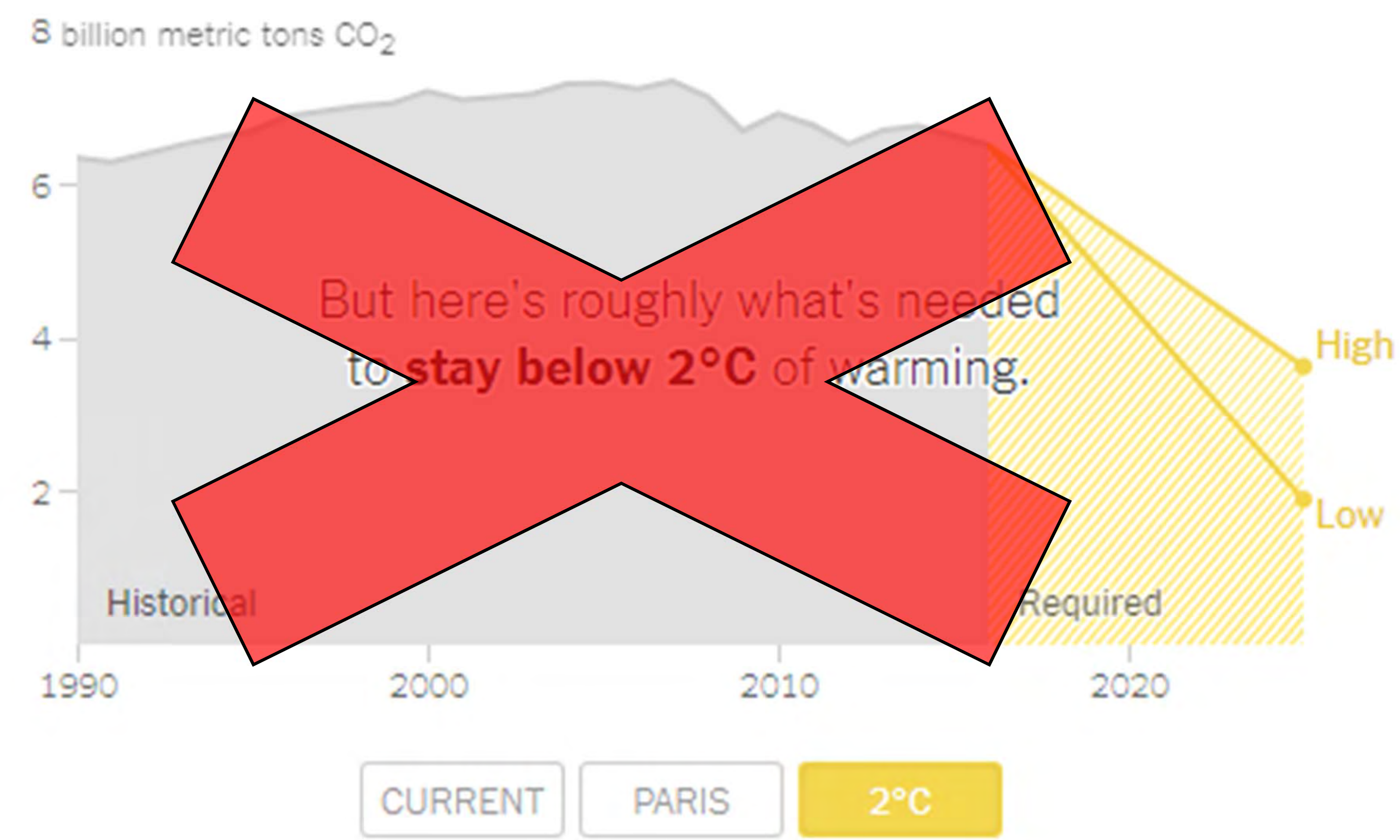


Source: NYT Article "The World Still Isn't Meeting Its Climate Goals"





Risk of Climate Change



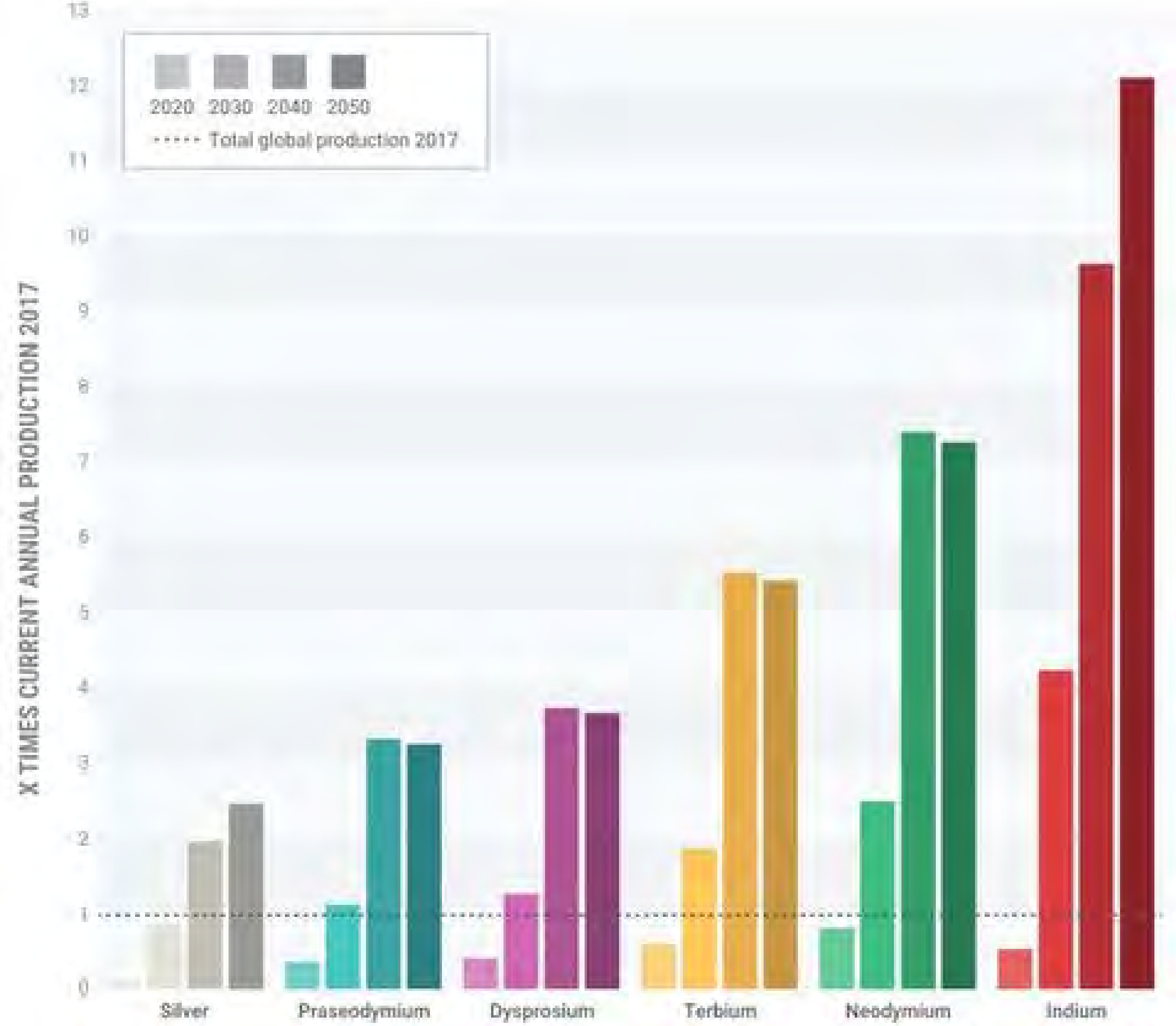
Source: NYT Article "The World Still Isn't Meeting Its Climate Goals"

Impacts of Climate Change

- ❑ 2°C ceiling is woefully short of what is needed.
- ❑ U.N. study predicts we have less than 13yrs to curb irreversible impacts
- ❑ Need to strive for 1.5oC difference (already at 1oC)
- ❑ **Difference of 0.5oC could mean**:
  - Marine life diminished by 50%.
  - 50% less fresh water supply.
  - 40-70% insect & pollinator loss.
  - Extinction of 25% of plants & animals.
  - 99% coral destruction
  - 60% of World's coffee supply vanishes
  - Economic losses ranging from 700B-1.3T/yr.

Understanding Risk

Rare Metals in Solar Panels



Source: Popular Mechanics Article 'We Might Not Have Enough materials for All the Solar Panels and Wind Turbines We Need"

Upstream Impacts

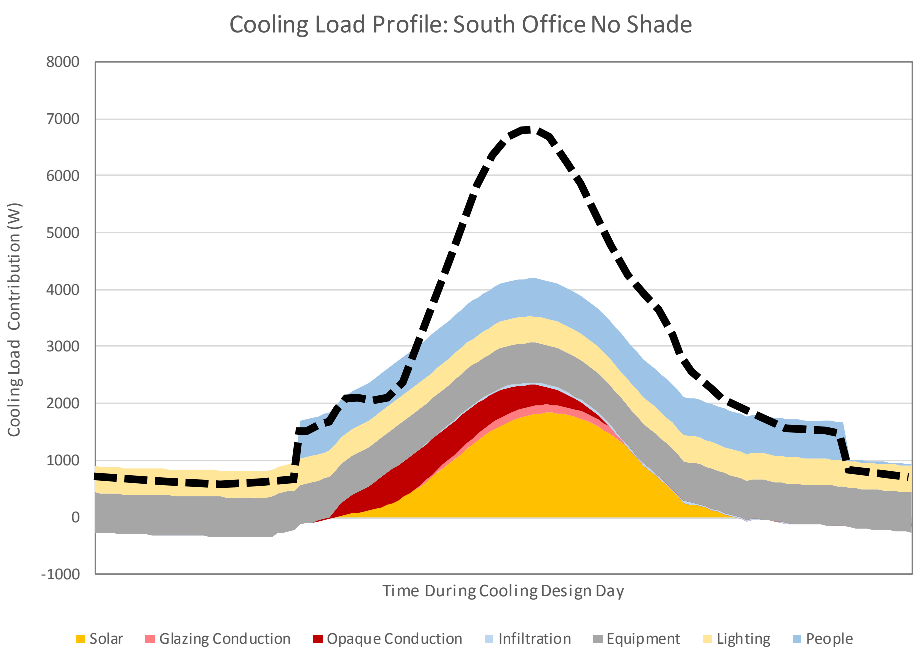
- ❑ Need significant more rare metals than currently supplied/available.
- ❑ Need 12 times indium by 2050.
- ❑ More mining needed to come on-line.

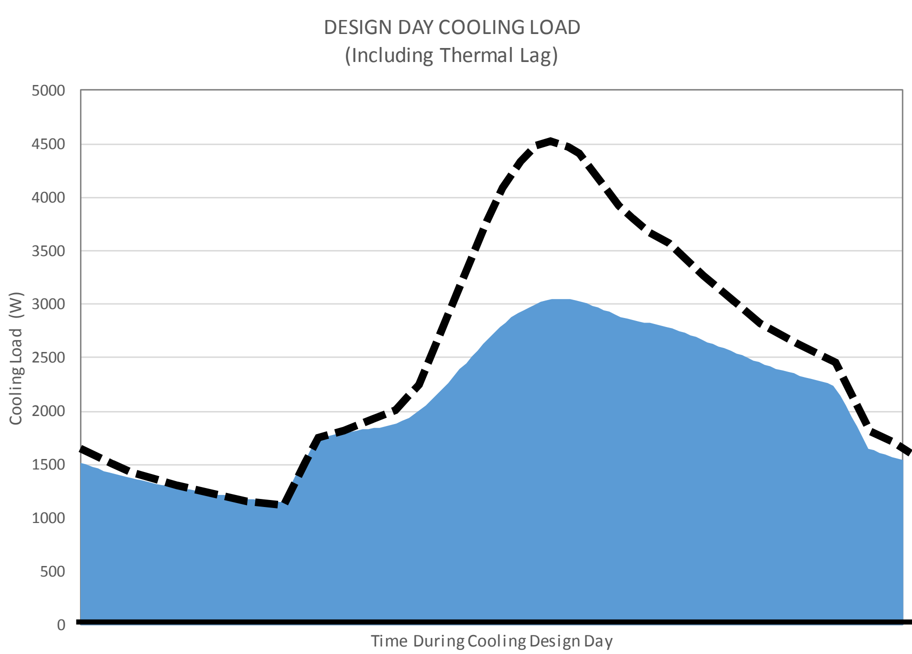
Downstream Impacts

- ❑ Need significant efforts to recycle electronic devices.
- ❑ Geo-economic implications from sourcing.
- ❑ Supply shortage to meet demands for rare metals. Cost uncertainty.

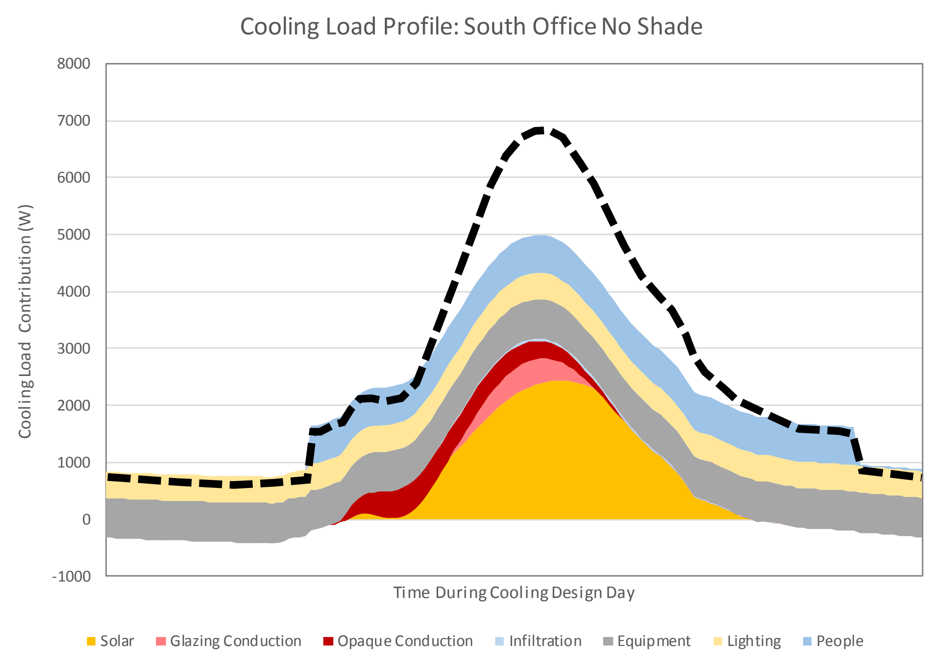
Designing for Loads

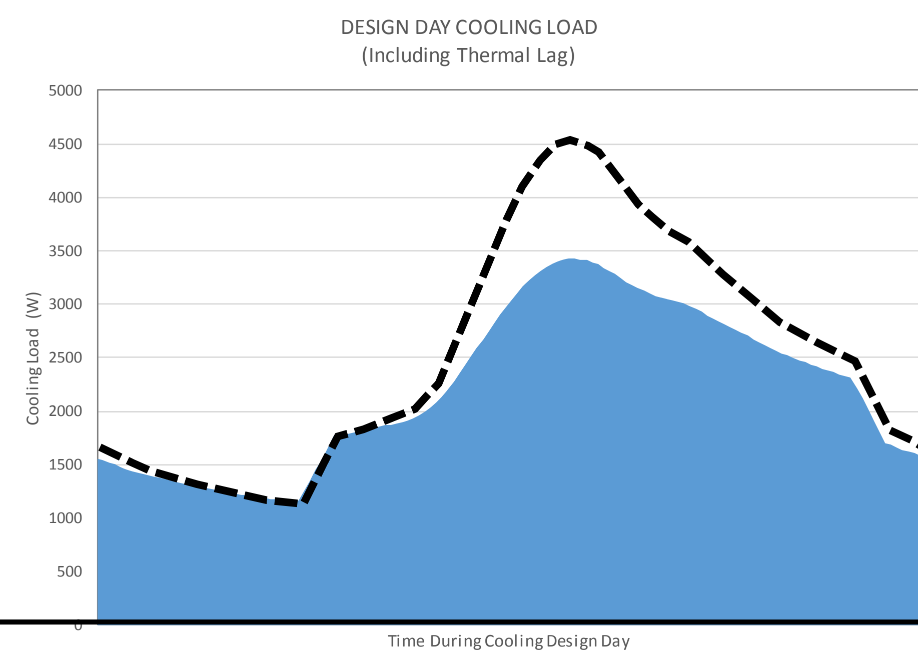
30% WWR – South Facade



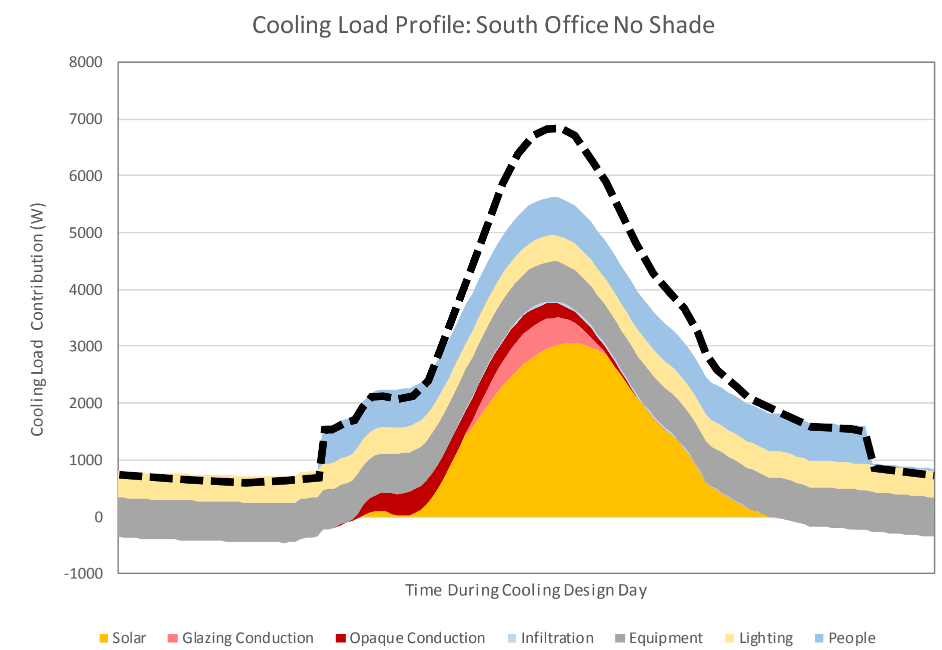


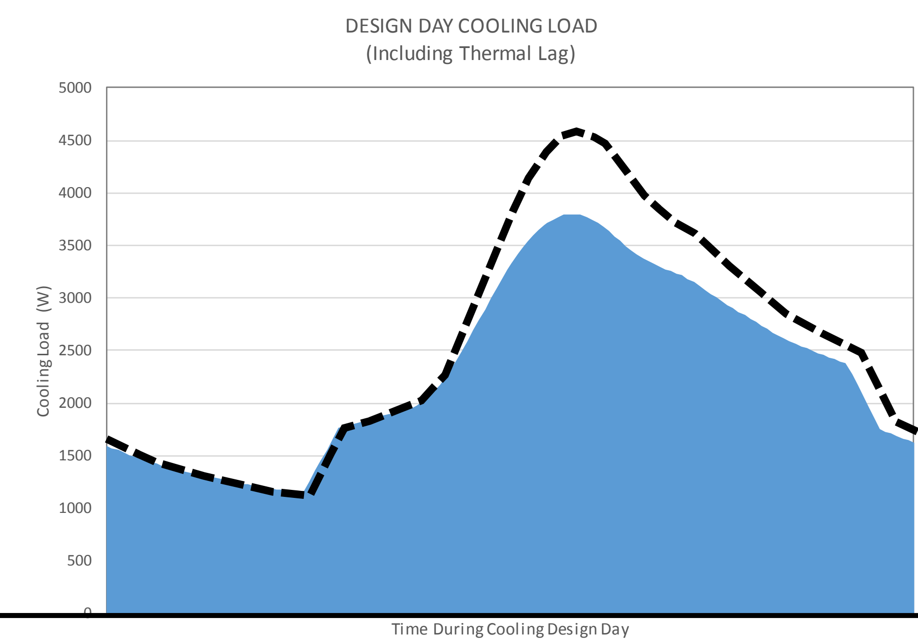
40% WWR – South Facade





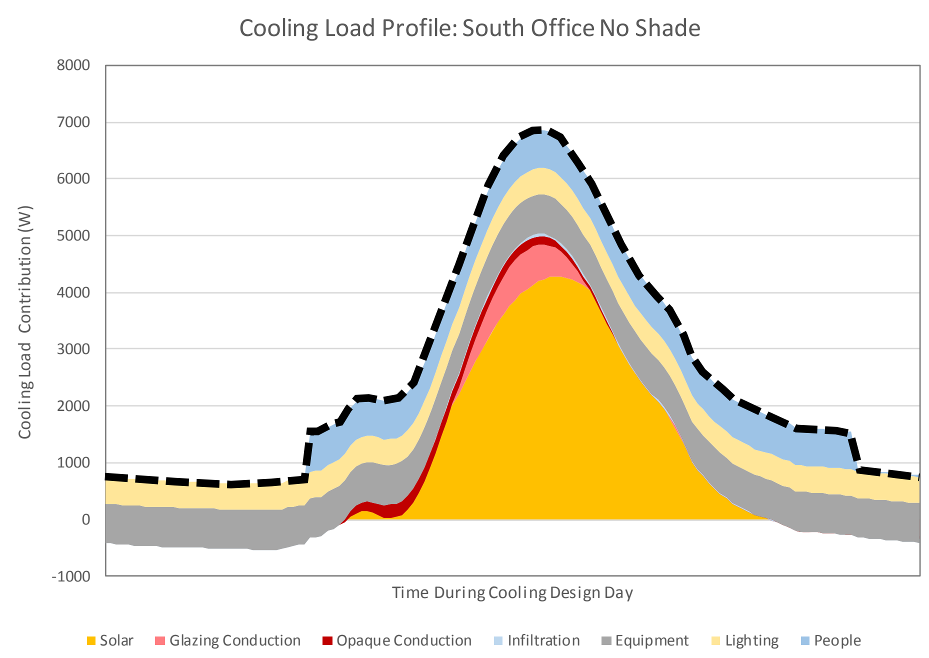
50% WWR – South Facade

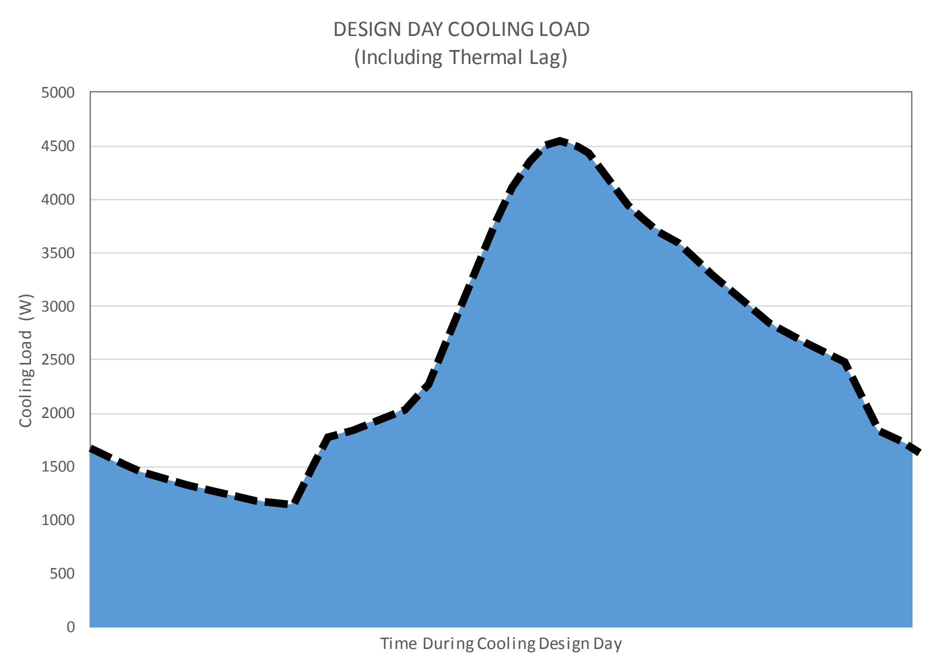




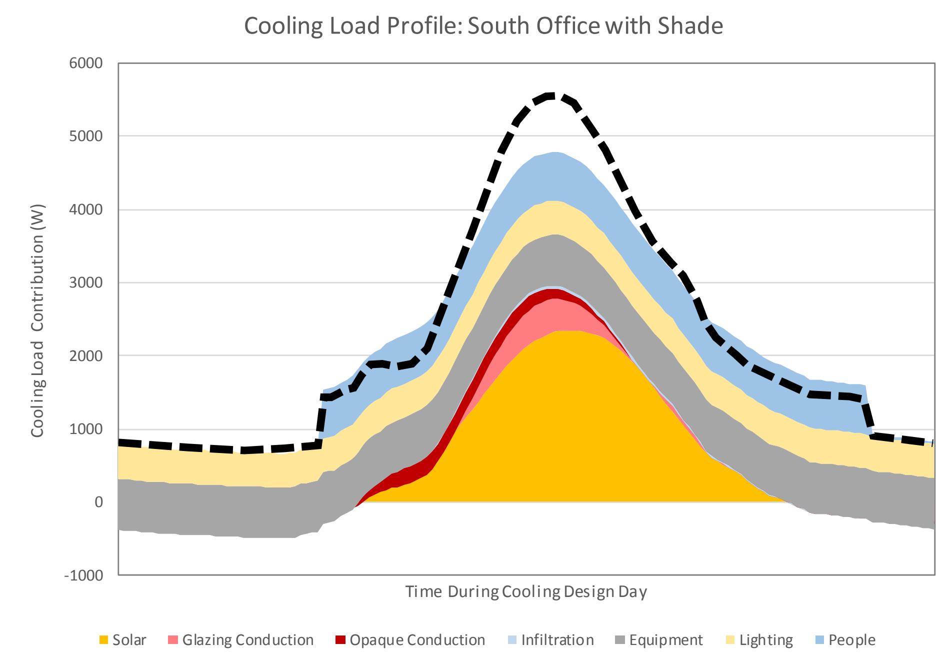
Designing for Loads

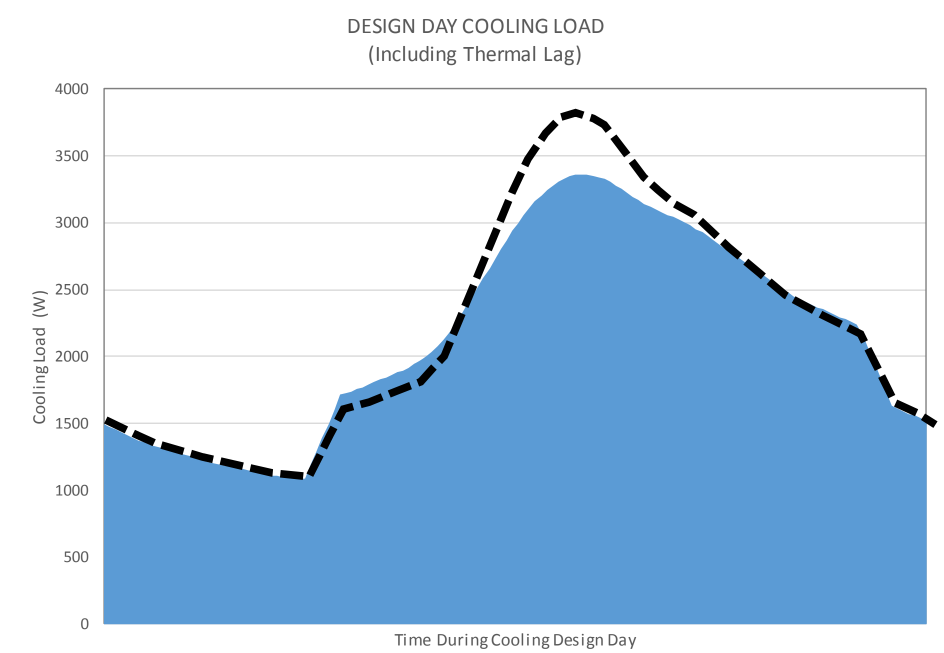
70% WWR – South Façade No Shade





70% WWR – South Façade With Shade

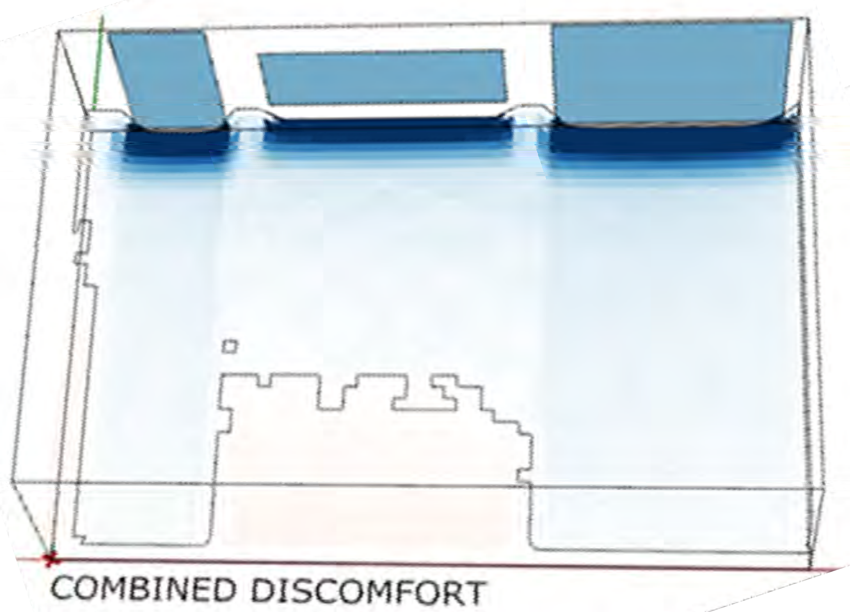




Occupant Comfort

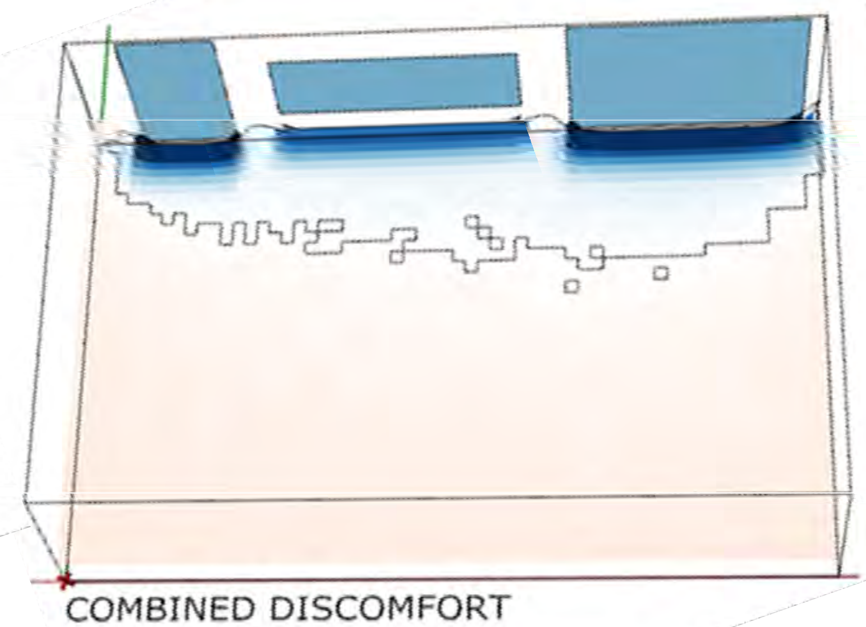
Winter Design Condition

Spatial Mapping – Percentage Persons Dissatisfied



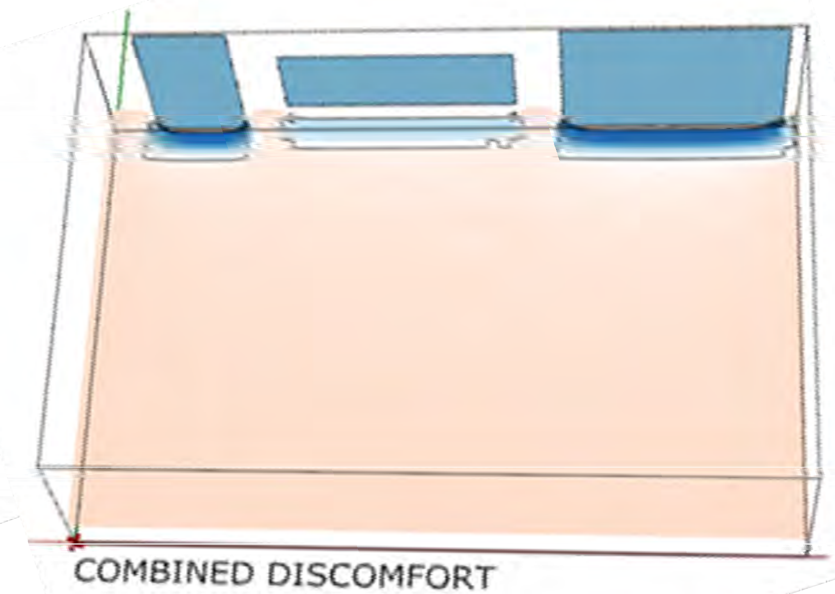
ASHRAE 90.1 Code Envelope

- **Reff 15.6 Opaque Walls**
- **Reff 2.5 Fenestration**



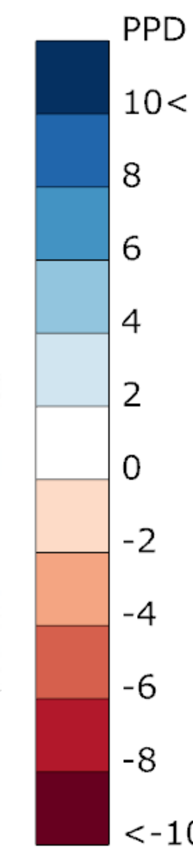
Enhanced Envelope

- **Reff 19.3 Opaque Walls**
- **Reff 3.0 Fenestration**

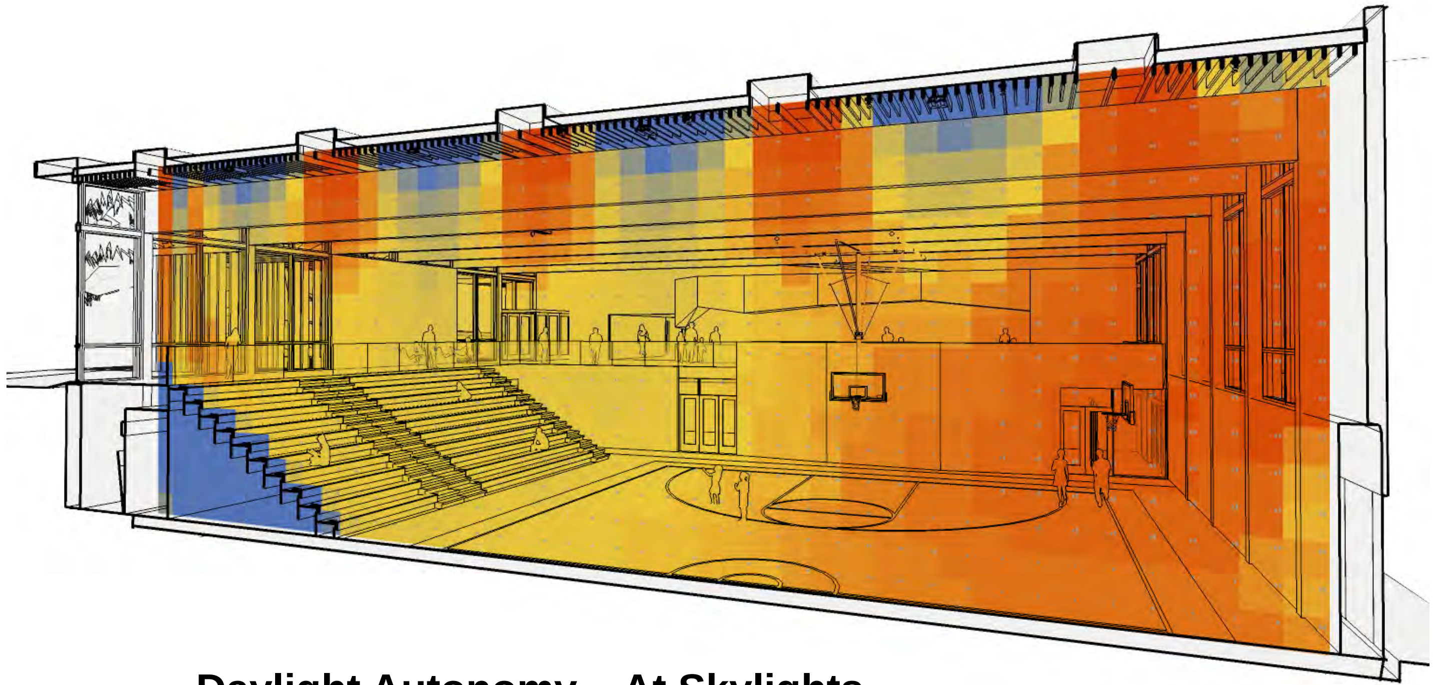


Passivhaus Envelope

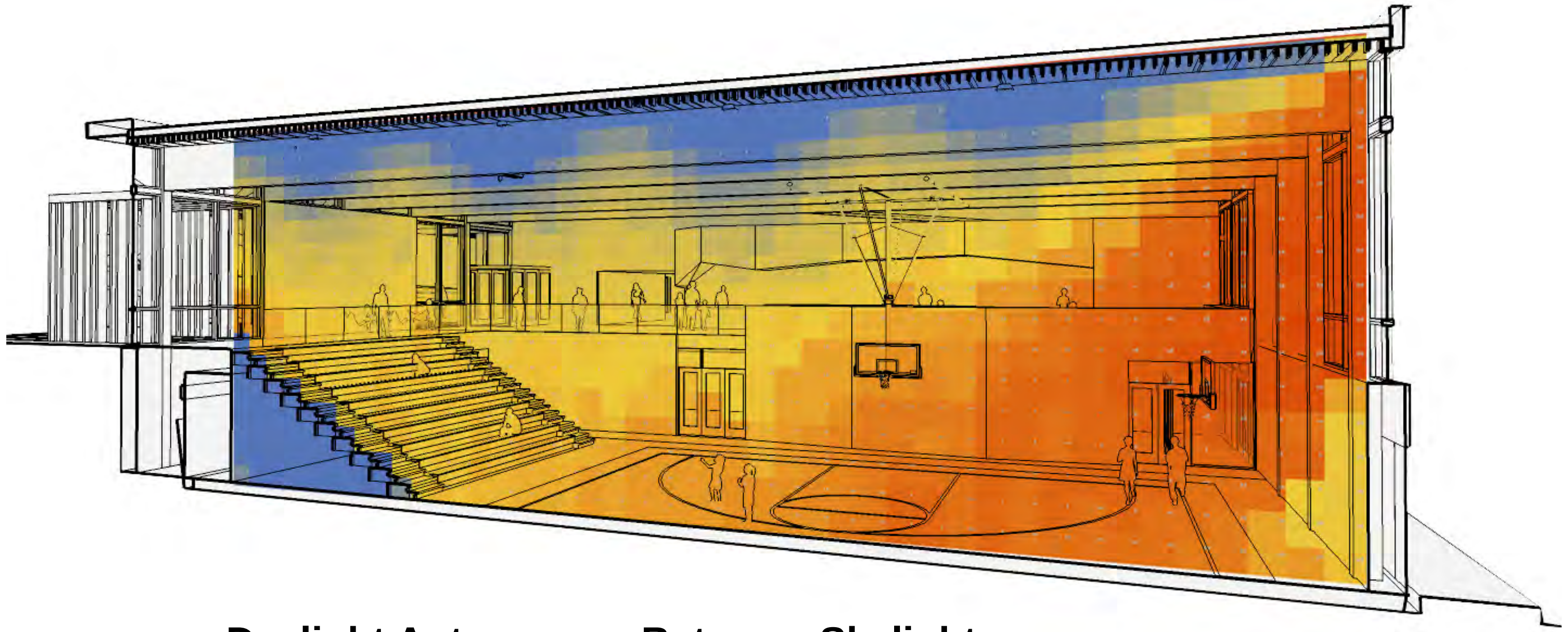
- **Reff 39 Opaque Walls**
- **Reff 5 Fenestration**



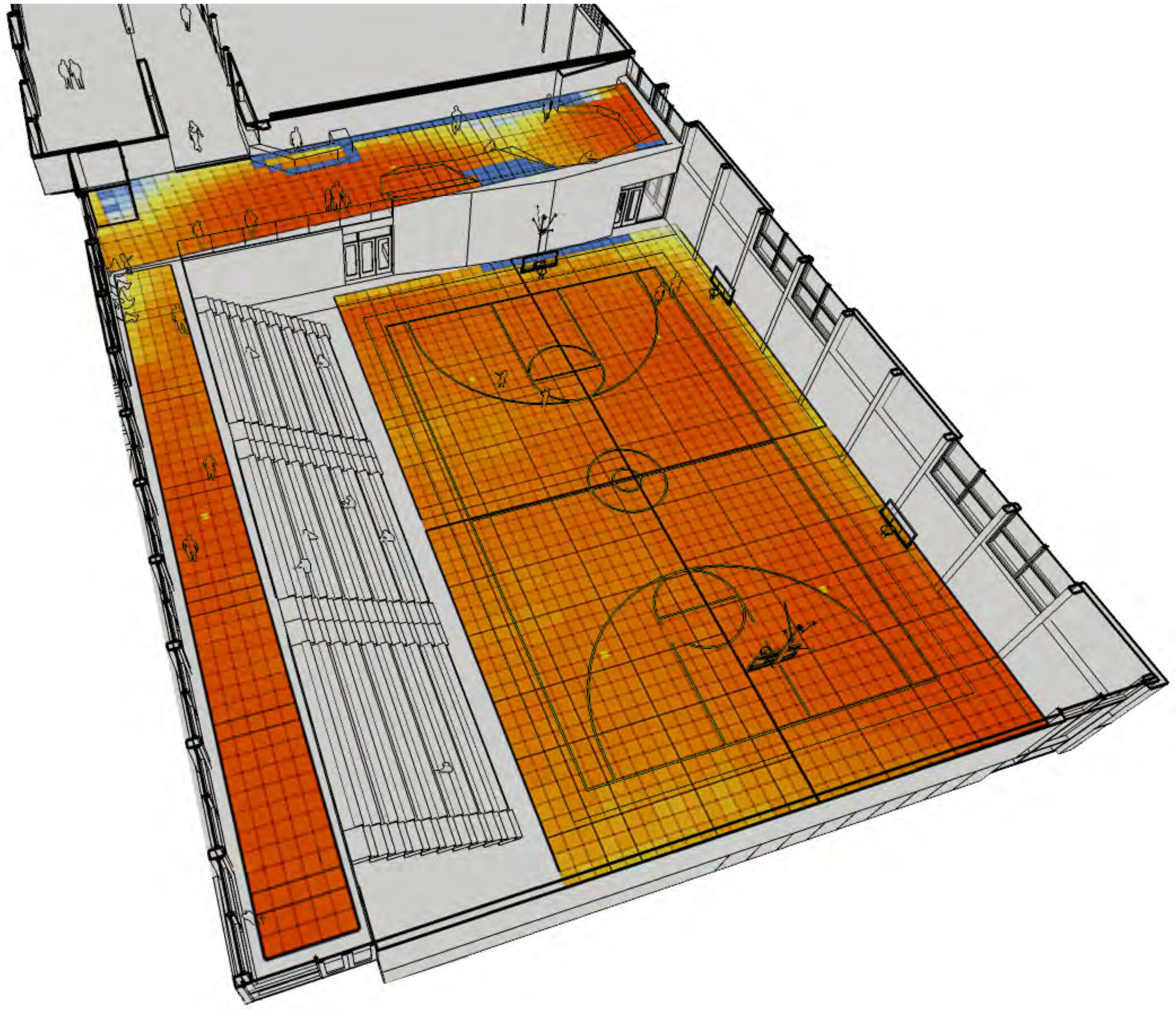
Visual Comfort



Daylight Autonomy – At Skylights

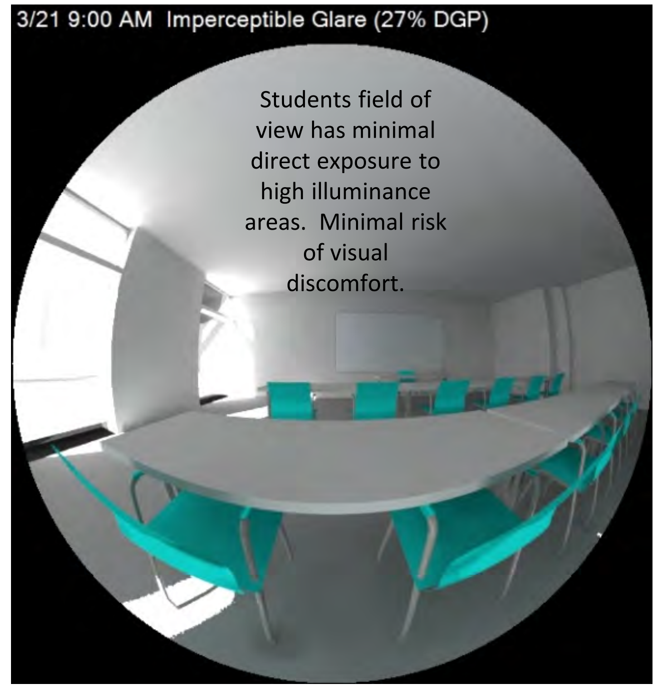


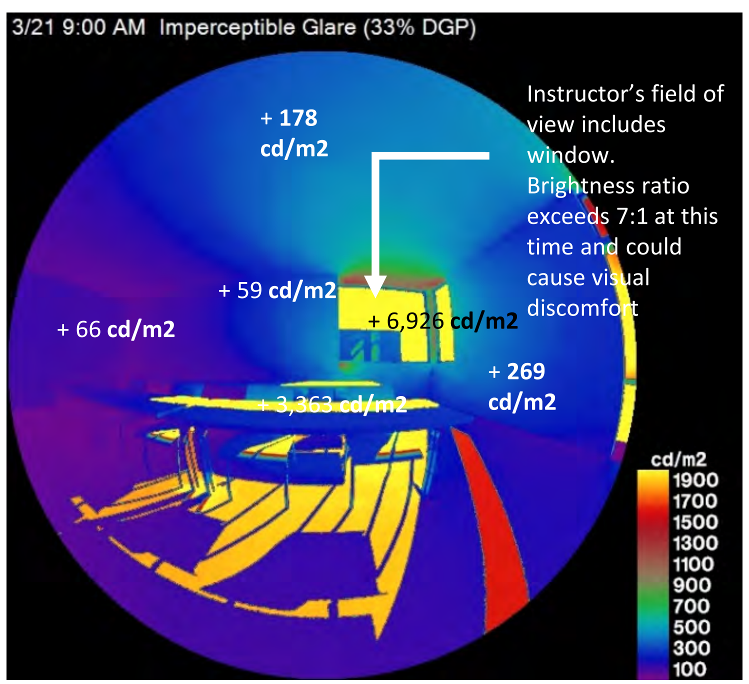
Daylight Autonomy – Between Skylights

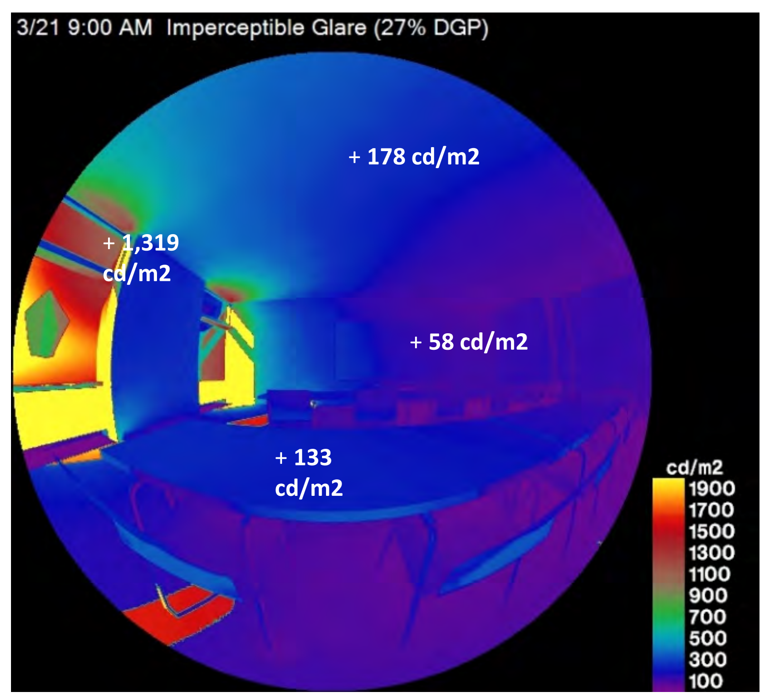


Daylight Autonomy

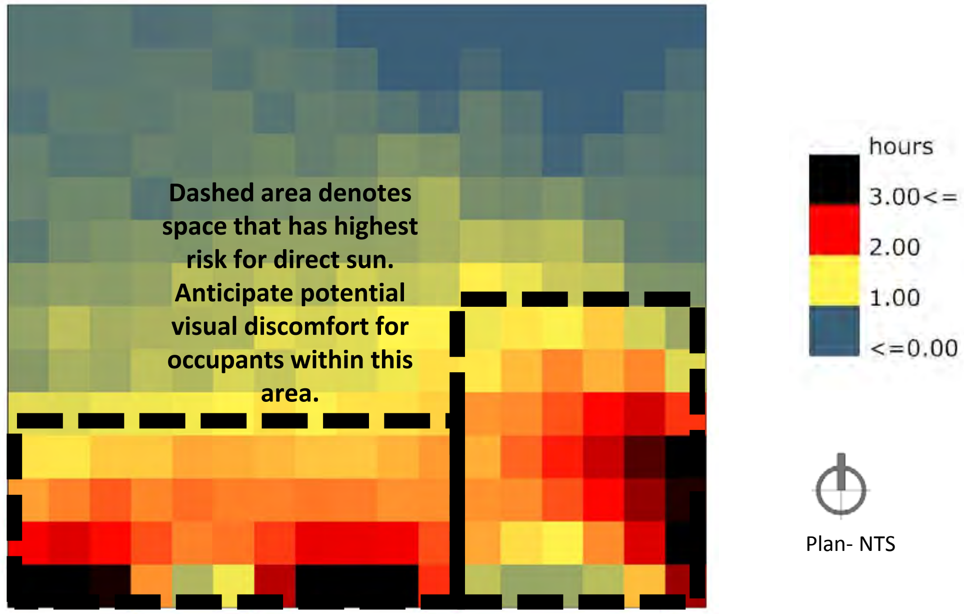
Visual Comfort



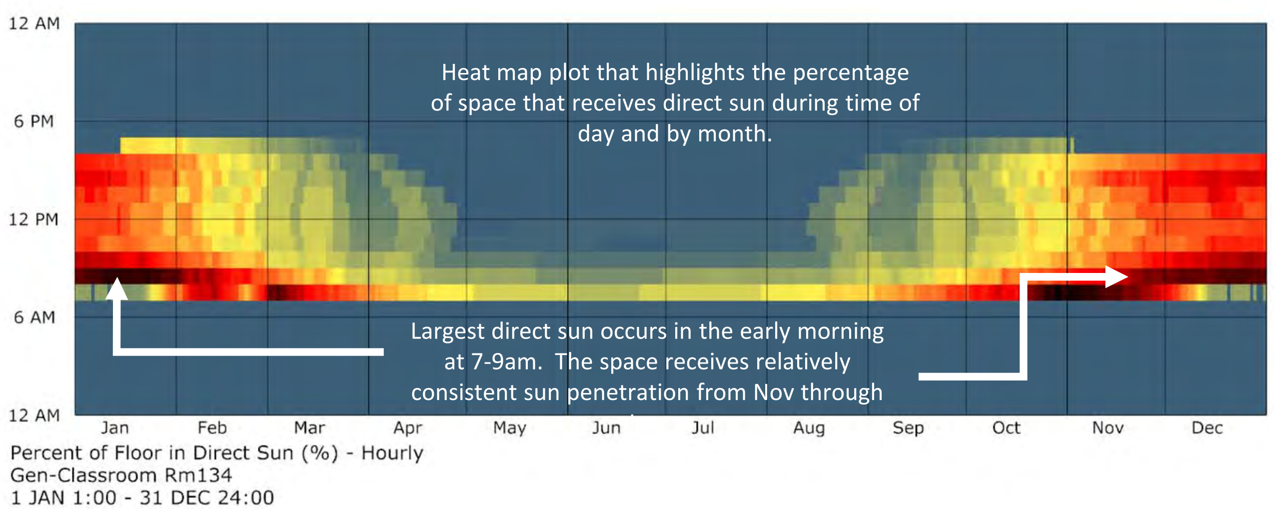




Hours of Sun Light > 4,000 Lux

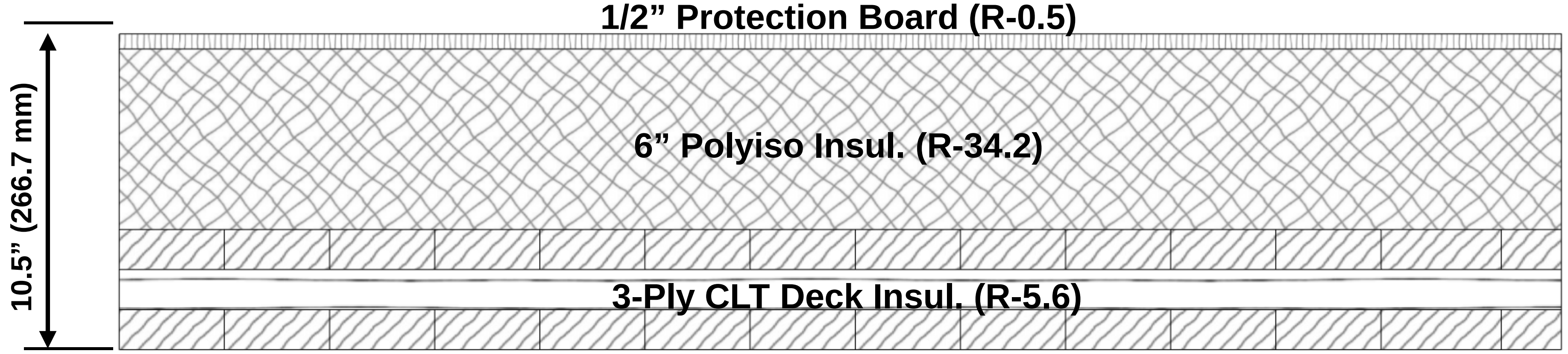


Plan – Window Shades Up



Direct Sun Temporal Map - Window Shades Up

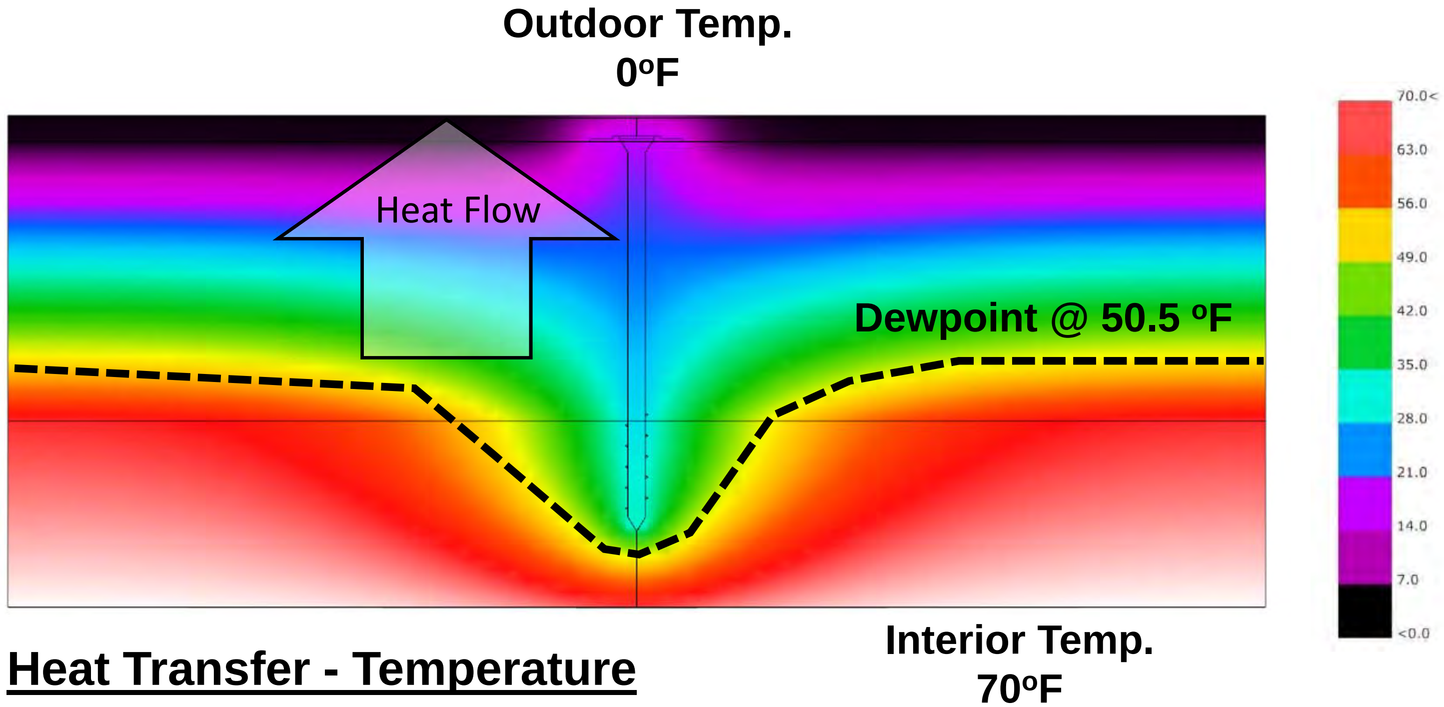
Envelope Performance



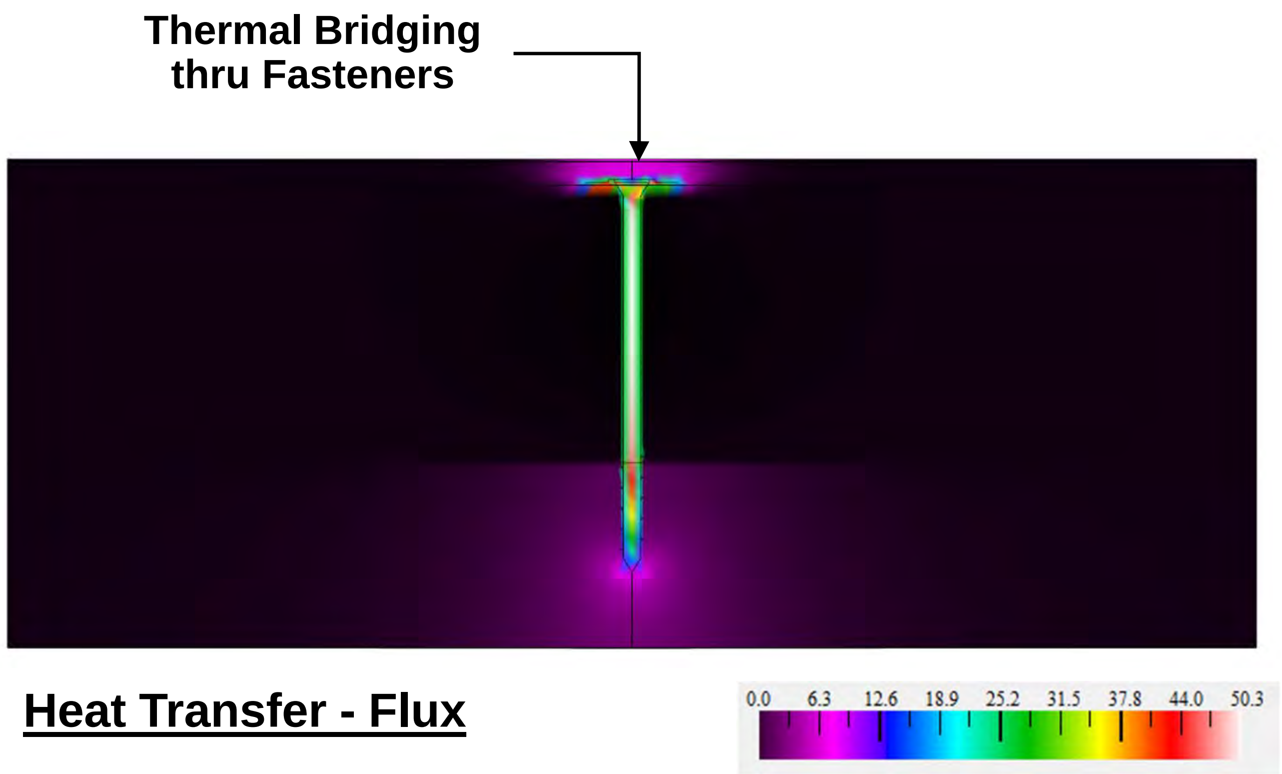
CLT Roof Assembly

Estimated Assembly R-Value

39.5



Heat Transfer - Temperature



Heat Transfer - Flux

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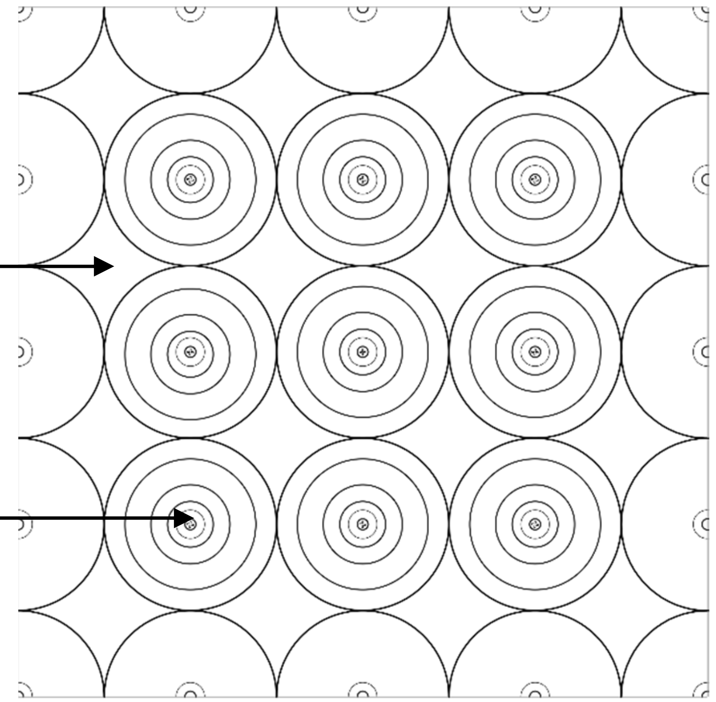
Envelope Performance

Adjusted Assembly R-Value

20.4

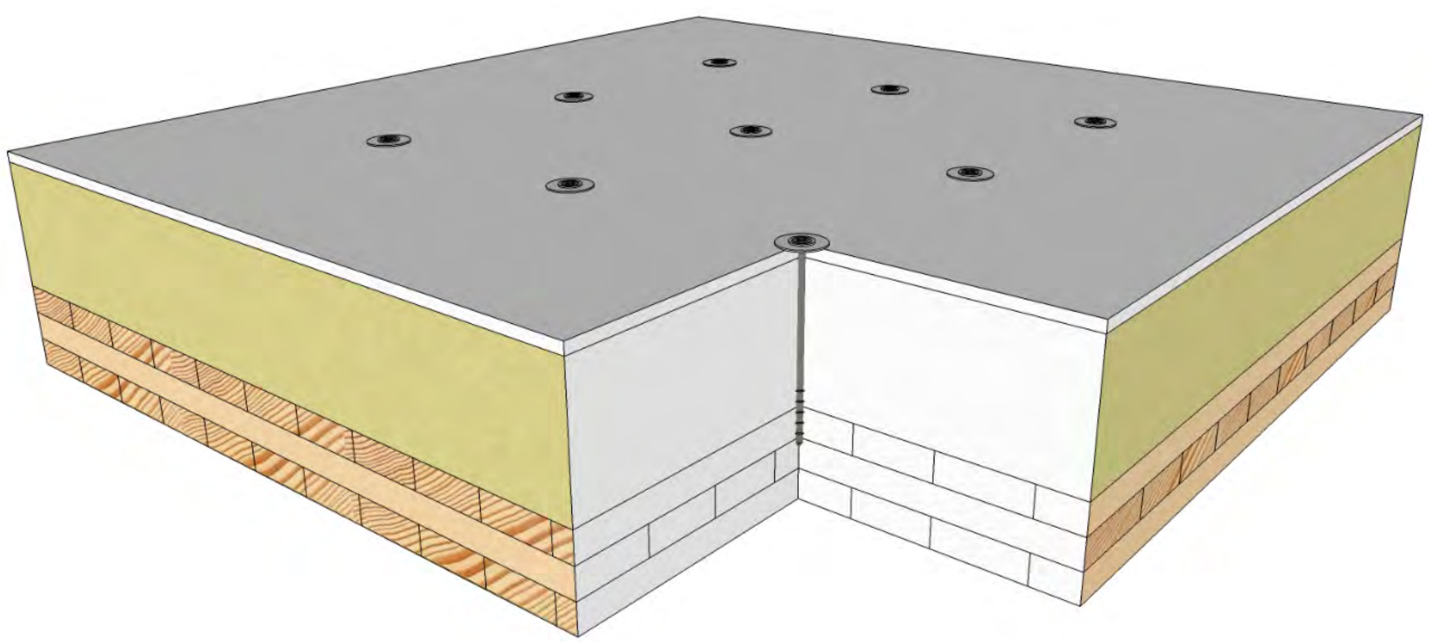
Homogeneous Tributary Area
21.5%

Thermal Bridging Tributary Area
78.5%

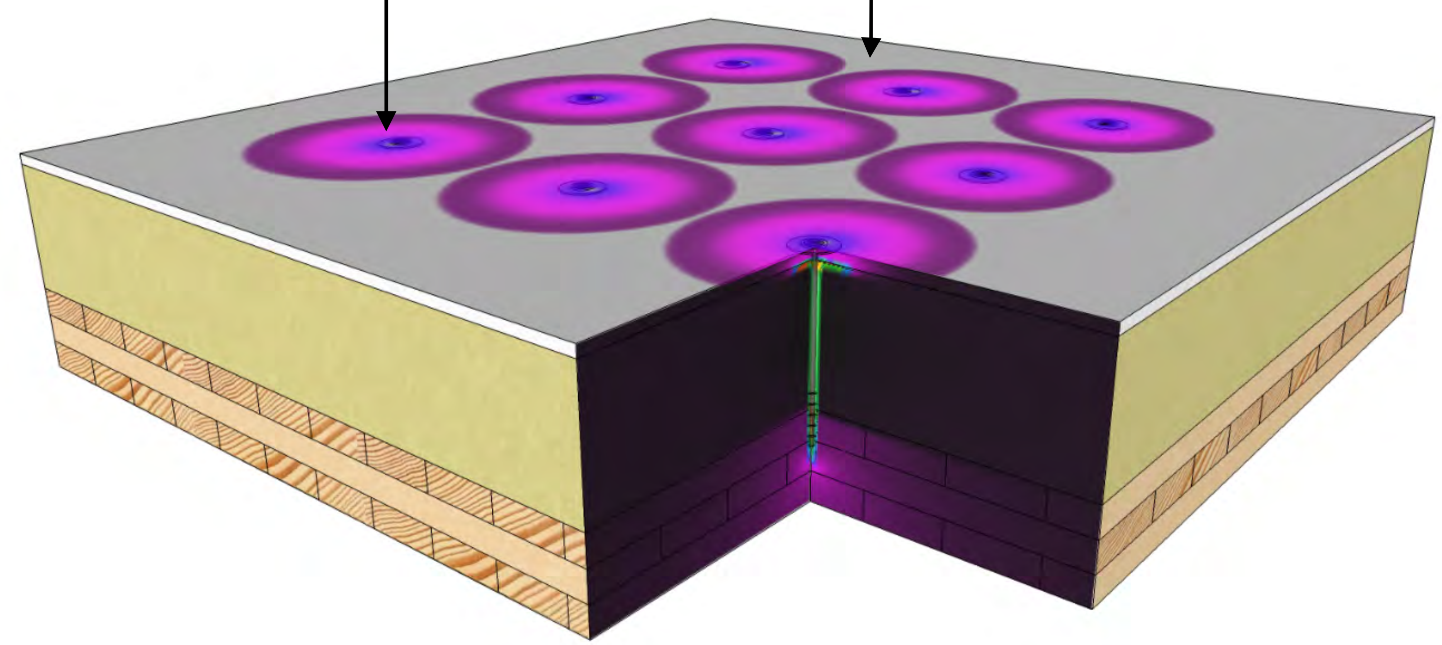


Eff R-Value of Region: 15.2

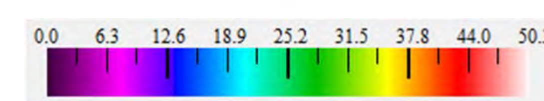
Eff R-Value of Region: 39.5



Roof Assembly Axon



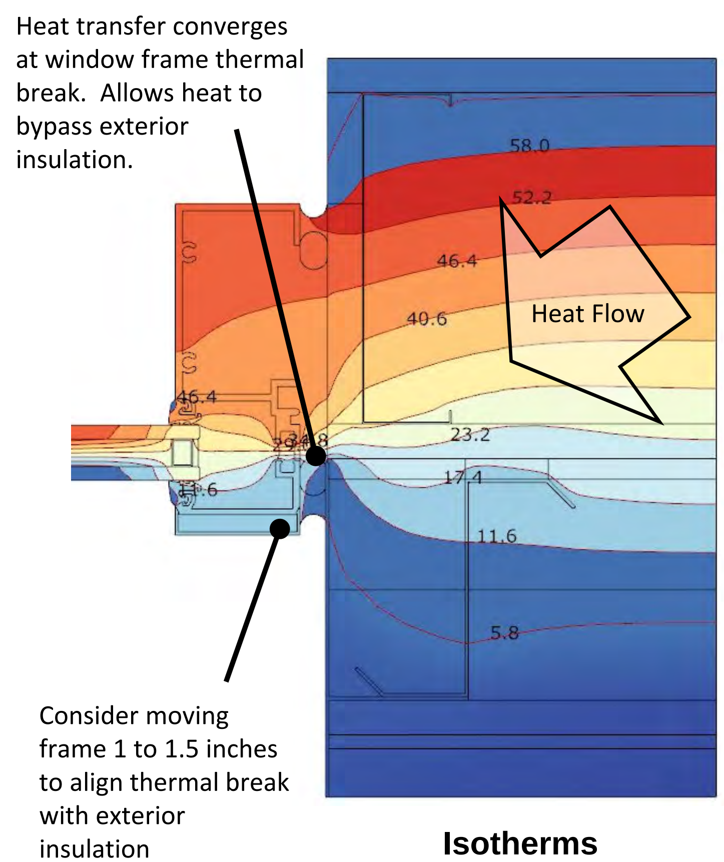
Heat Flux Overlay



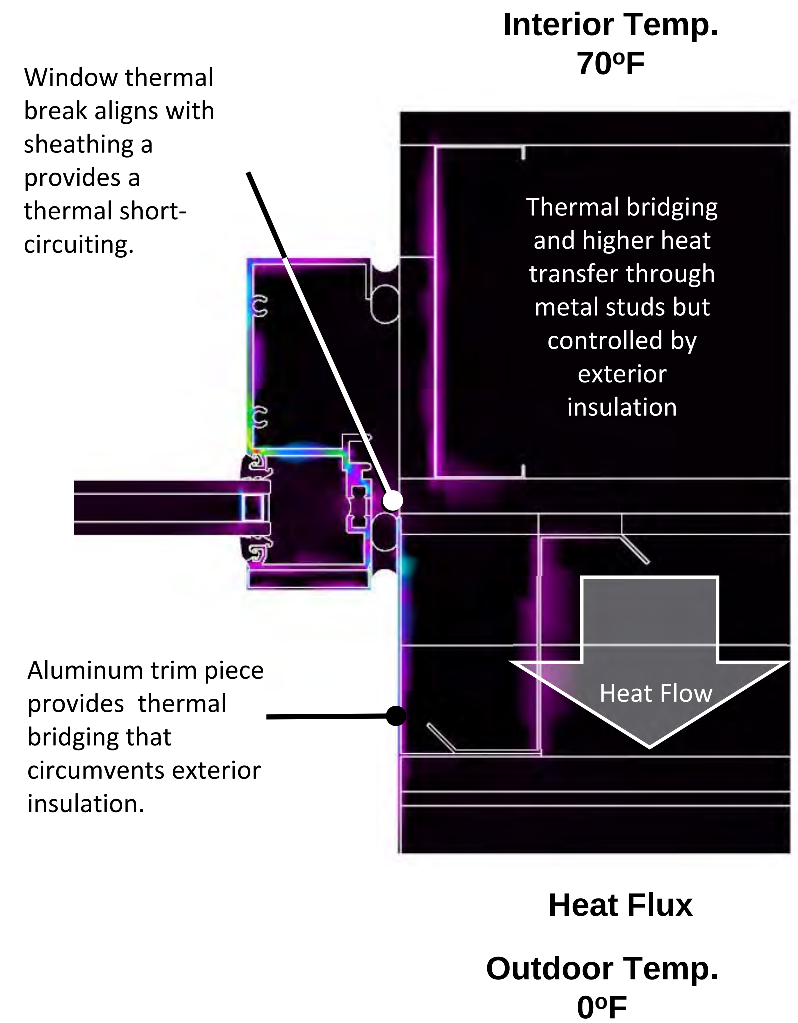
Envelope Performance

Window Jamb Detail

As Designed - Detail



Isotherms



Heat Flux

Case Study 1

View of West Facade

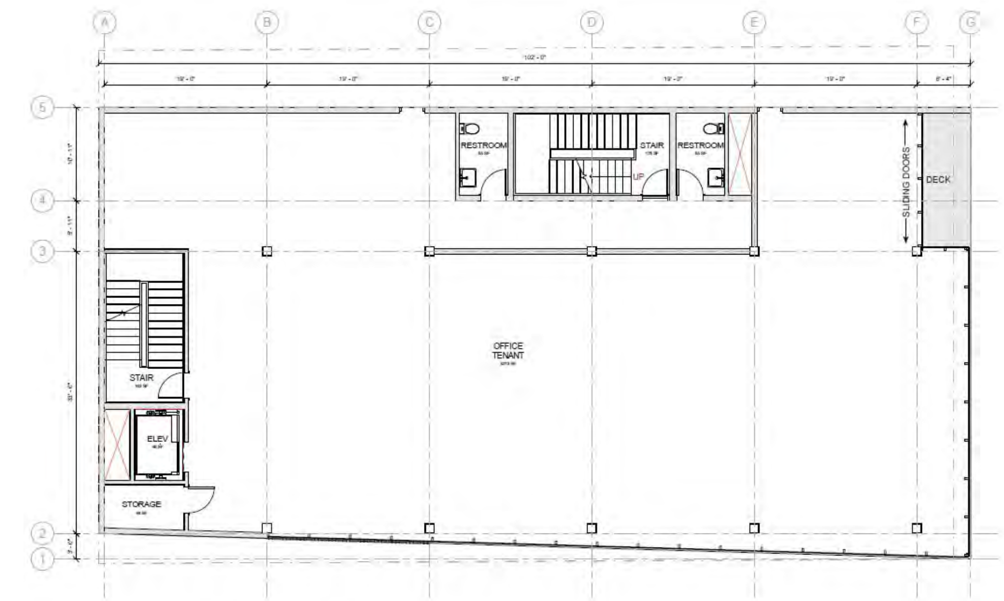
Image Credit: FWD Architecture

Project: N Beech Office Building

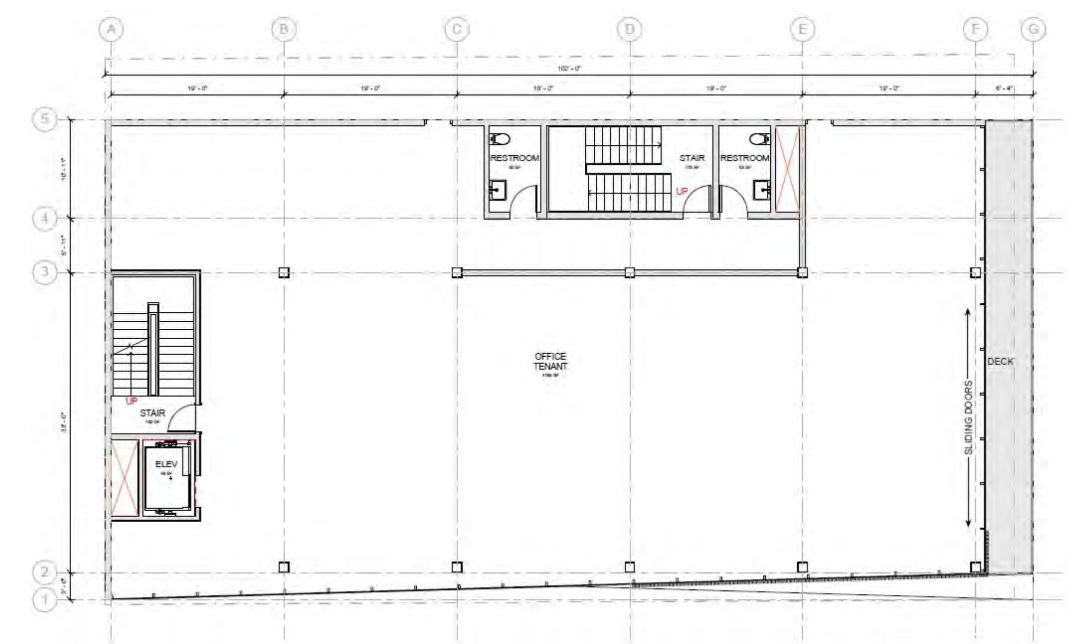
Building Type: Speculative Office

Size: 4 Stories, 20,036 sf (Gross)

Client: Willamette Stone



2nd & 4th Floor Plan



3rd Floor Plan

Plan- NTS

FWD// FIELDWORK DESIGN & ARCHITECTURE

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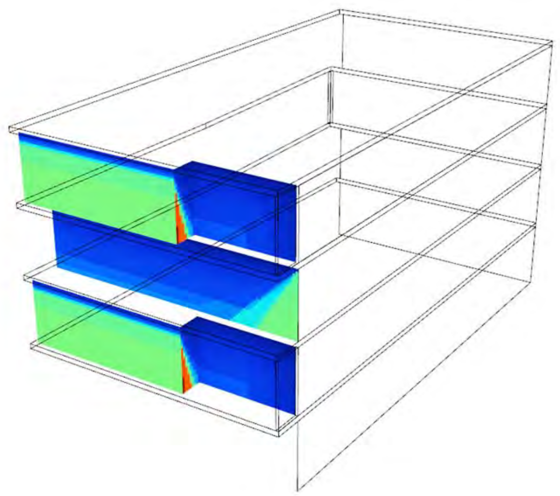
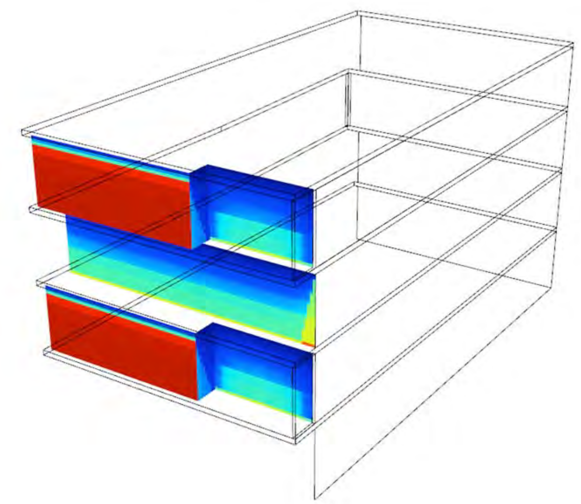
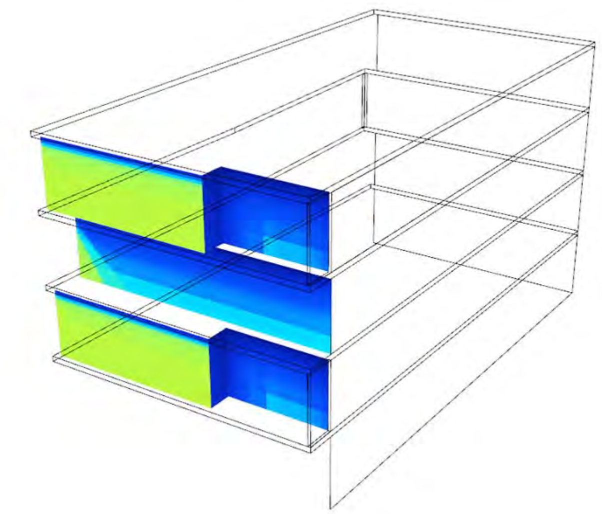
Solar Analysis – South Facade

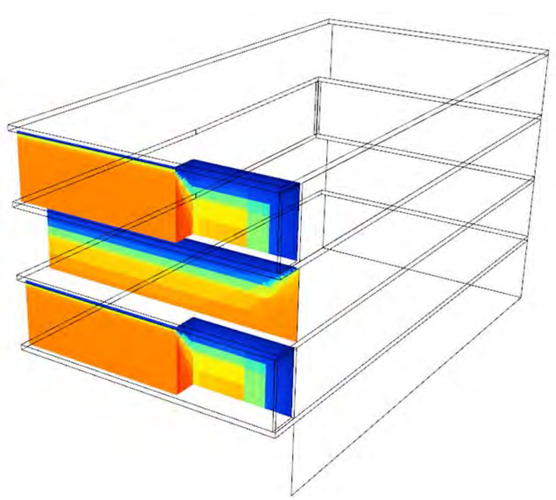
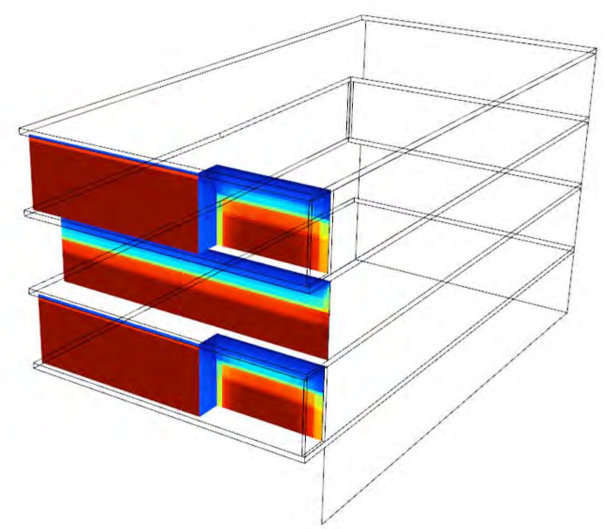
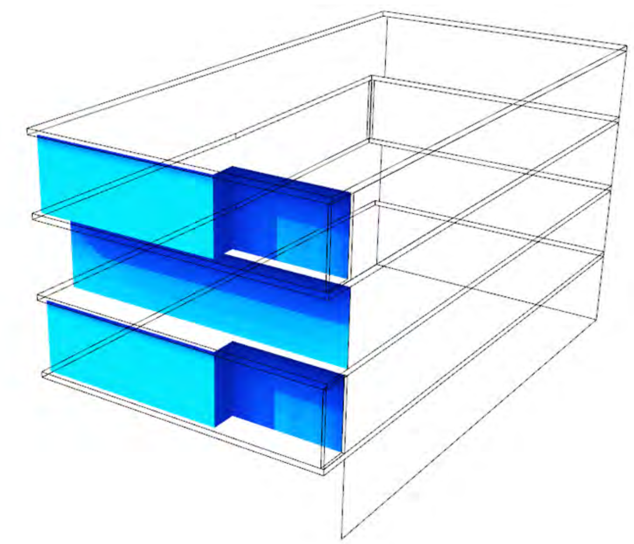
Summer Solstice

9am **12pm** **3pm**

View from SE

Fall Equinox

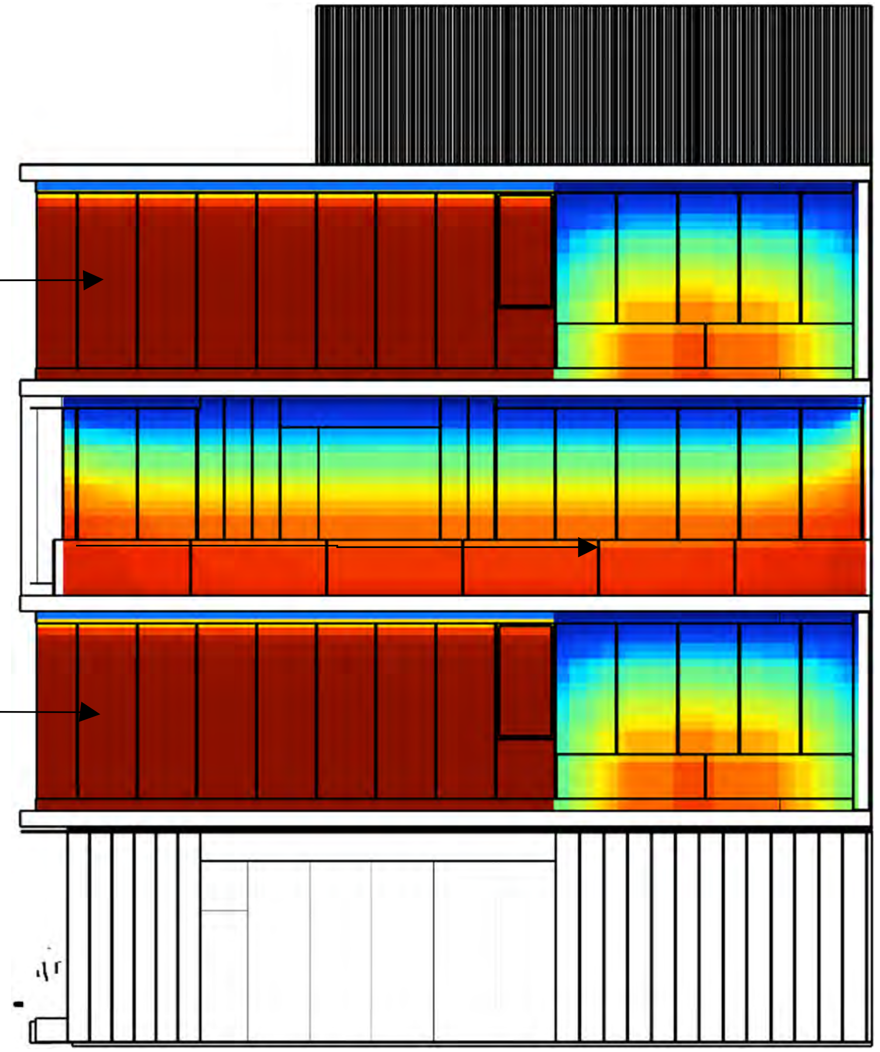
Solar Analysis – South Facade

No Panel Scenario

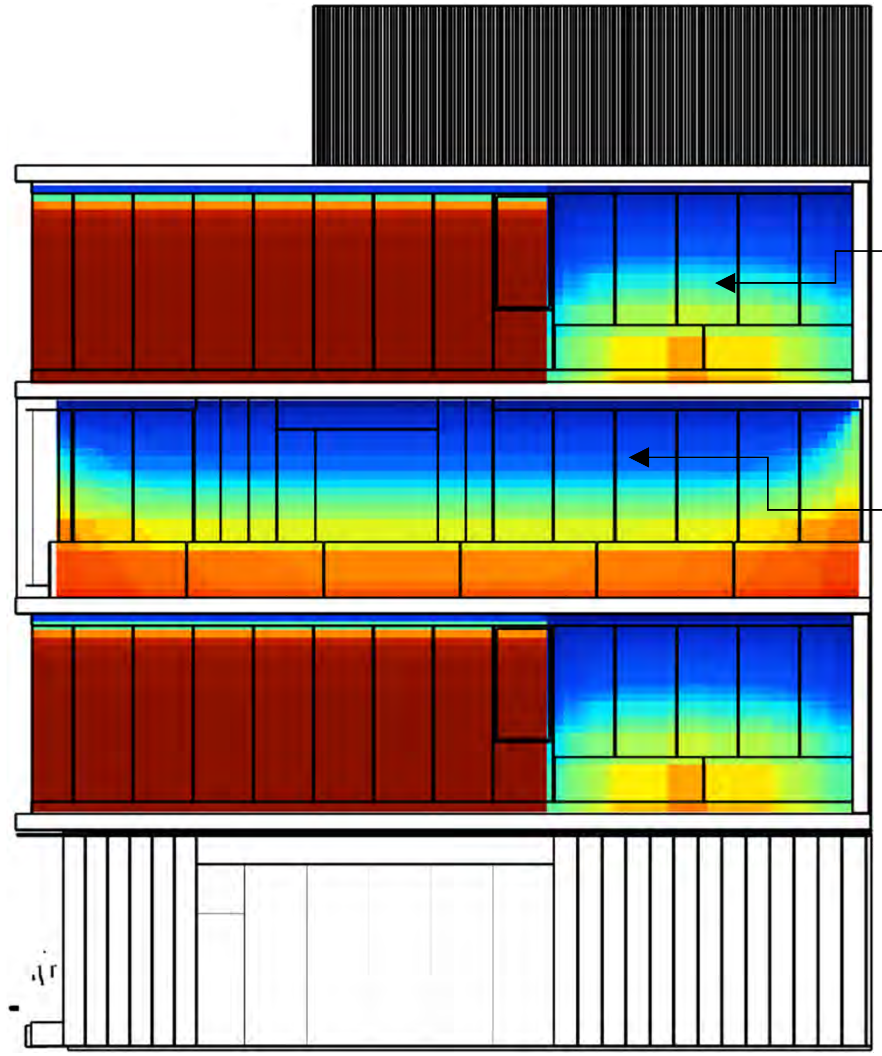
Approx. 94% of south façade are windows. Reducing window area is recommended.

This area of the façade receives the highest amount of solar heat gain due to the limited overhang projections at roof & balcony level. Using vertical screen panel or strategically eliminating windows need to be considered.

Annual Solar Radiation: 9am-6pm



Summer Solar Radiation: 9am-6pm



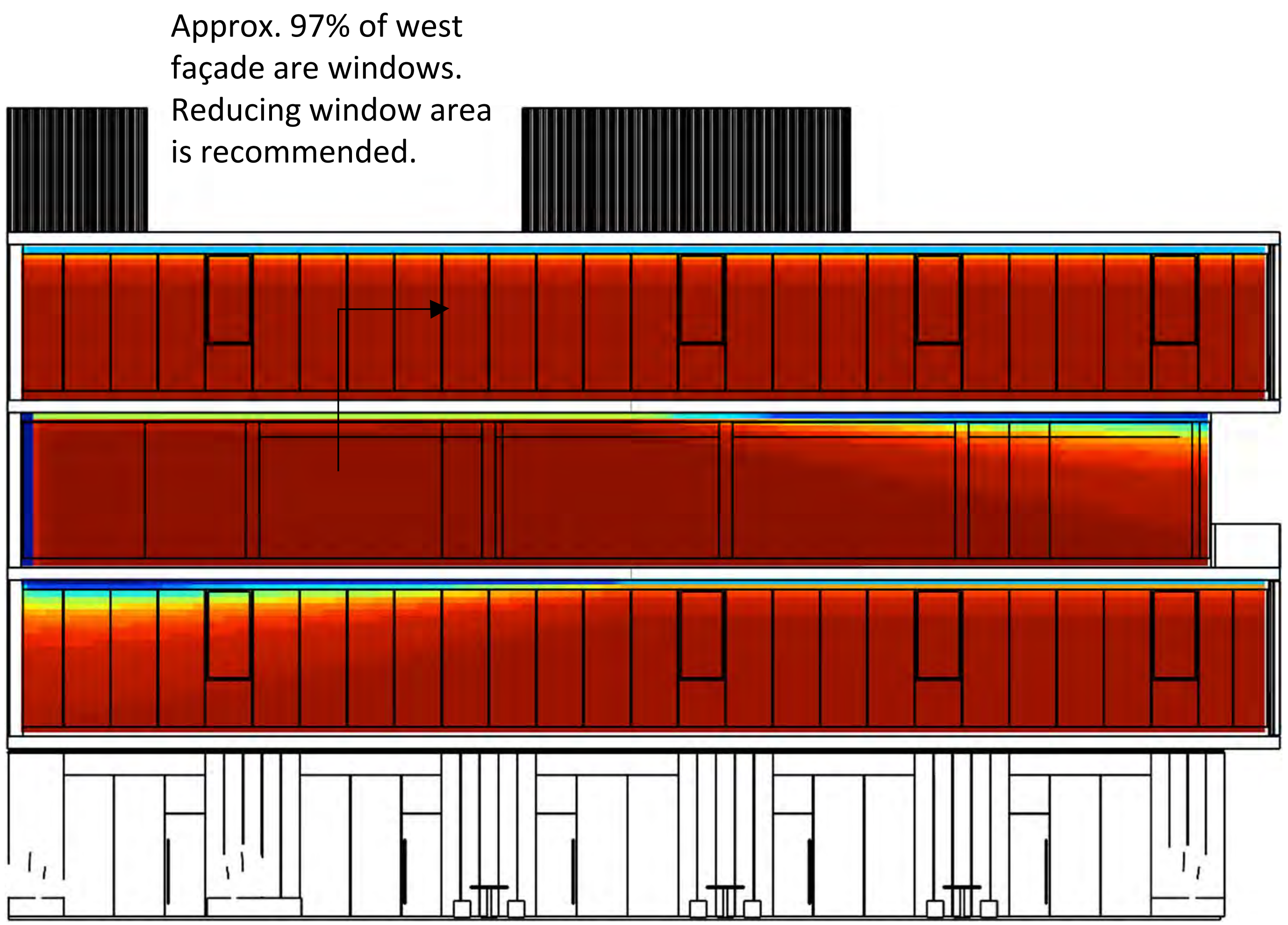
Setback of façade for balcony provides adequate shading of solar radiation in summer. Approx. 70% of solar radiation is controlled at this location.

Cantilevered floor above acts as a shading device and reduces approximately 60% solar radiation on this region of façade from June-Sept.

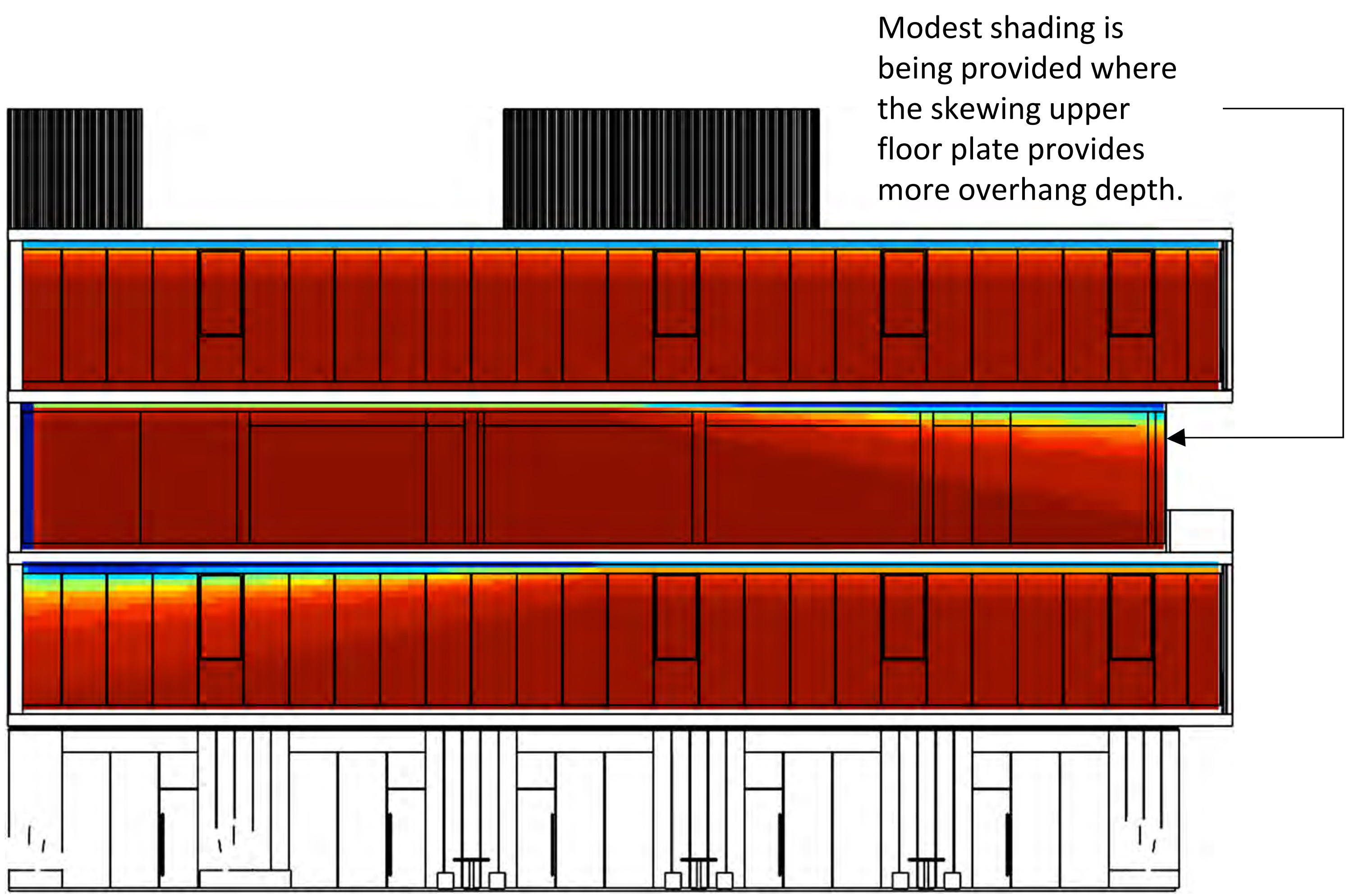
Solar Analysis – West Facade

No Panel Scenario

Annual Solar Radiation: 9am-6pm



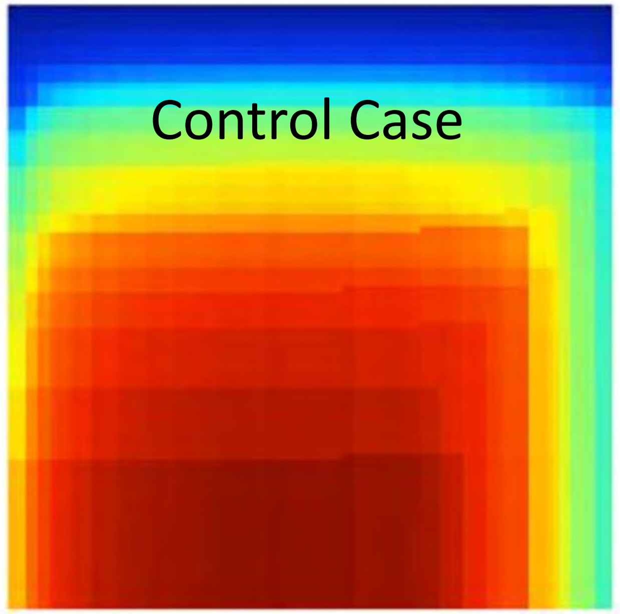
Summer Solar Radiation: 9am-6pm

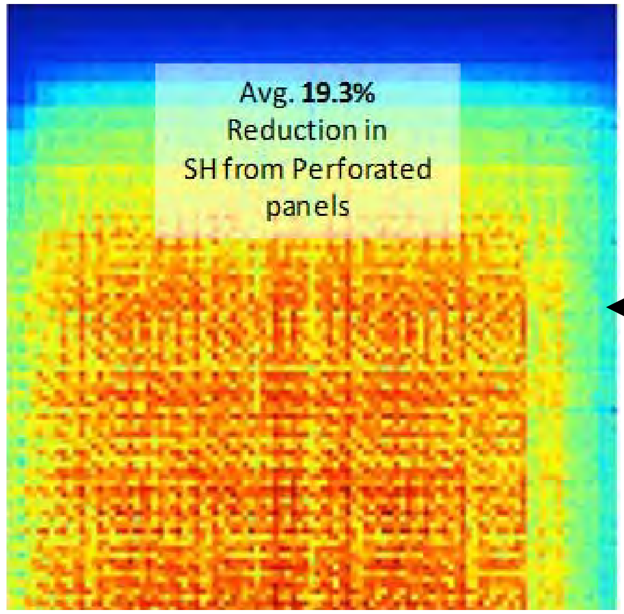


West façade receives approximately 30% more solar radiation on a unit basis (SHG/Area) than the south façade. Since the west façade has the most surface area it also has the largest solar heat gain. Strategic reduction of window area with high performance glazing and shading will be key in reducing space overheating and glare along the perimeter.

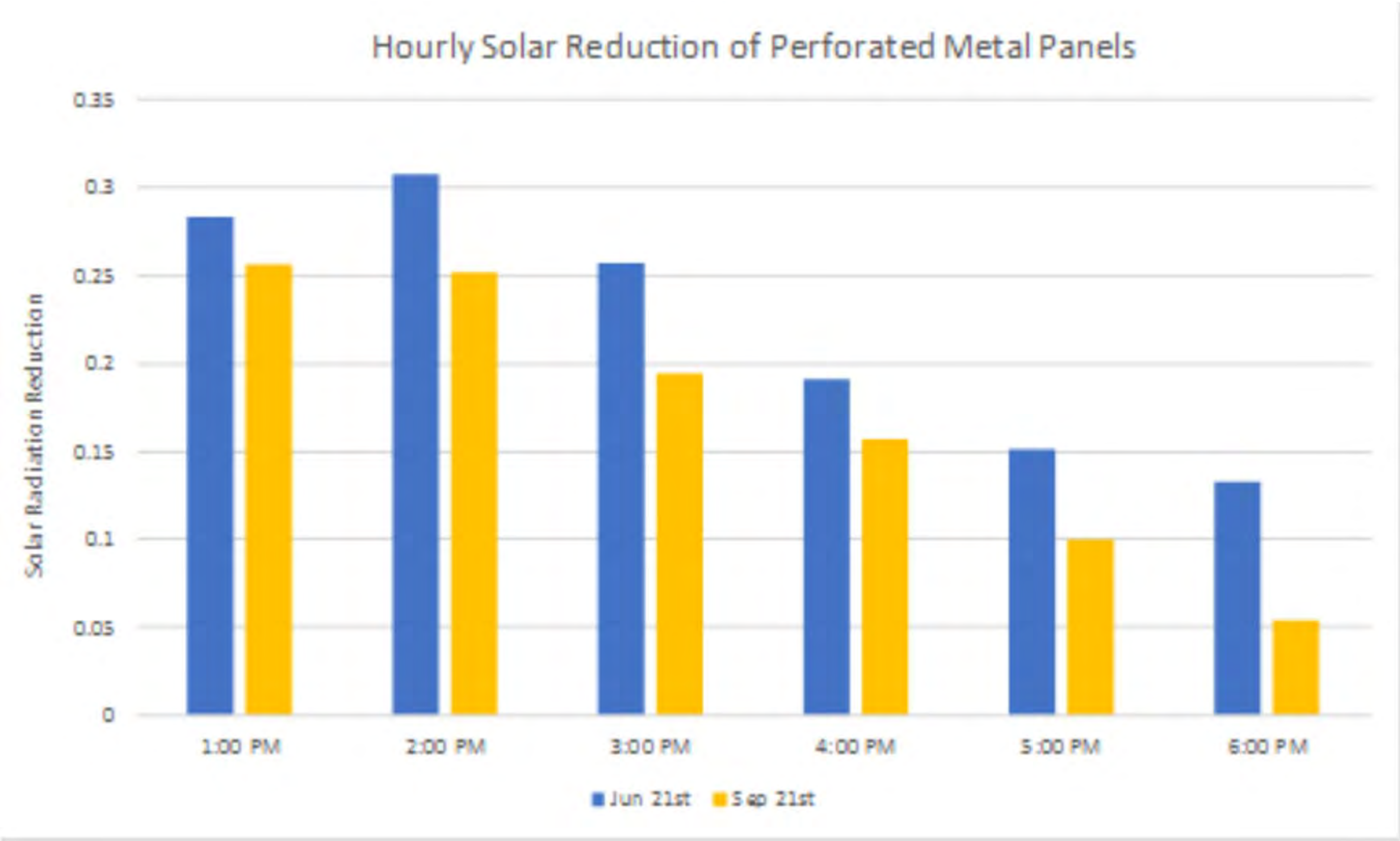
Solar Analysis – Panels

Annual Solar Radiation: 9am-6pm





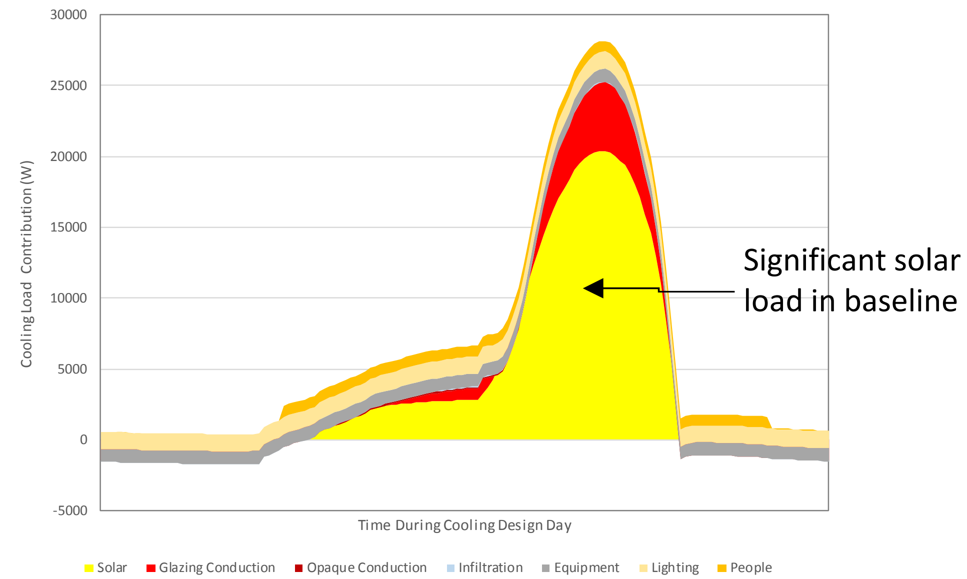
Panels have limited capability to shade global radiation

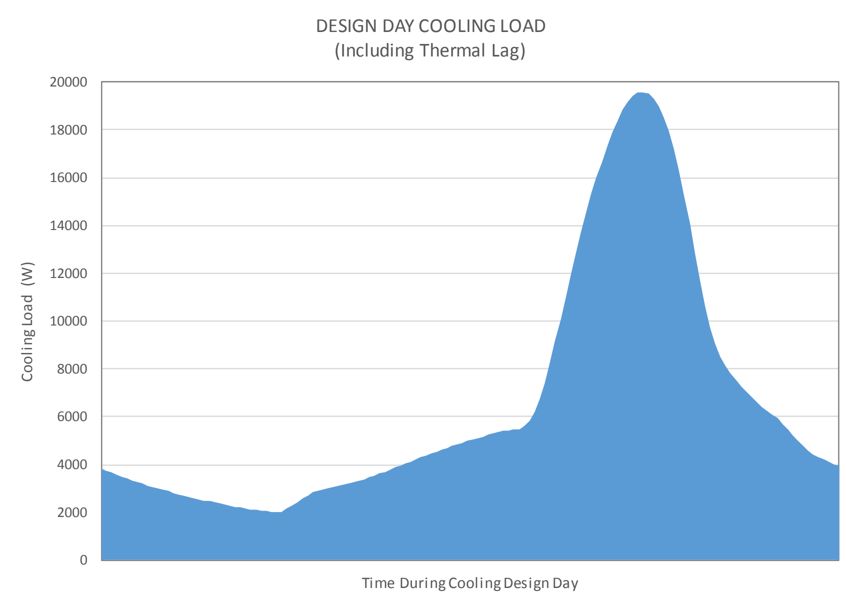


Solar Analysis – West Facade

No Shade Scenario

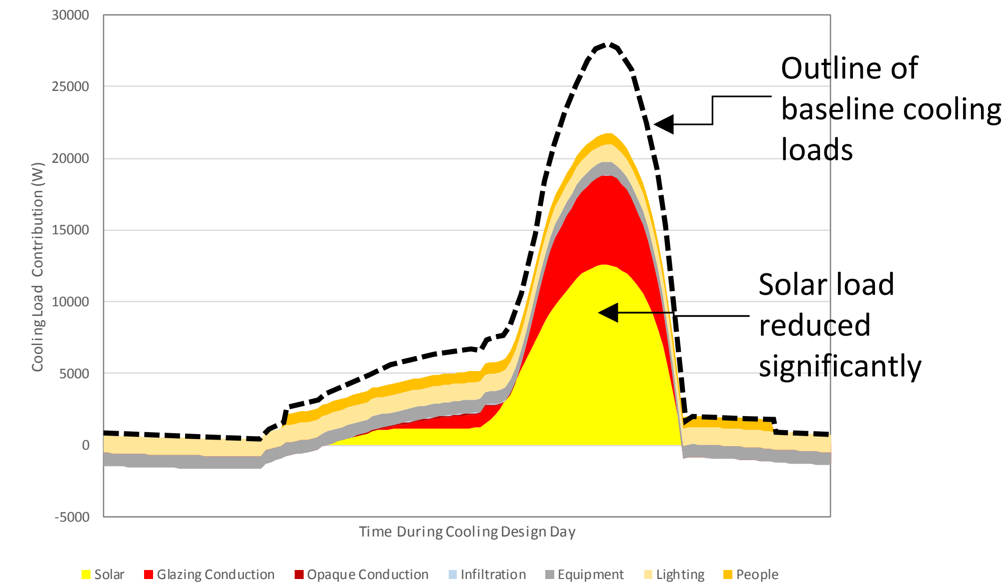
Figure 1 – Component Cooling Load Profile

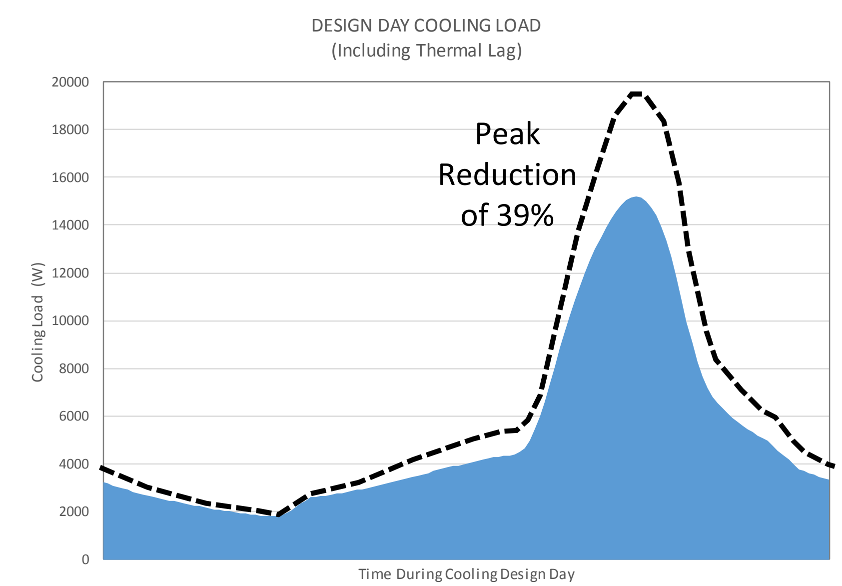




Design Alt 4

Figure 2 – Component Cooling Load Profile

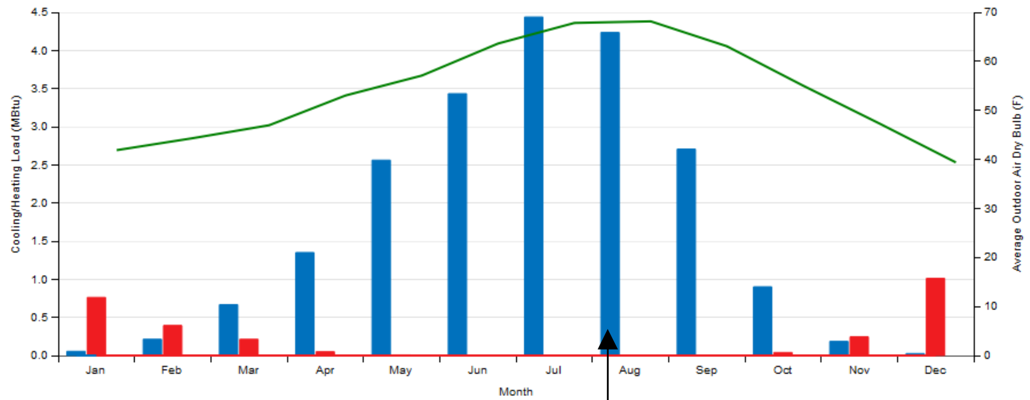




Facade Analysis

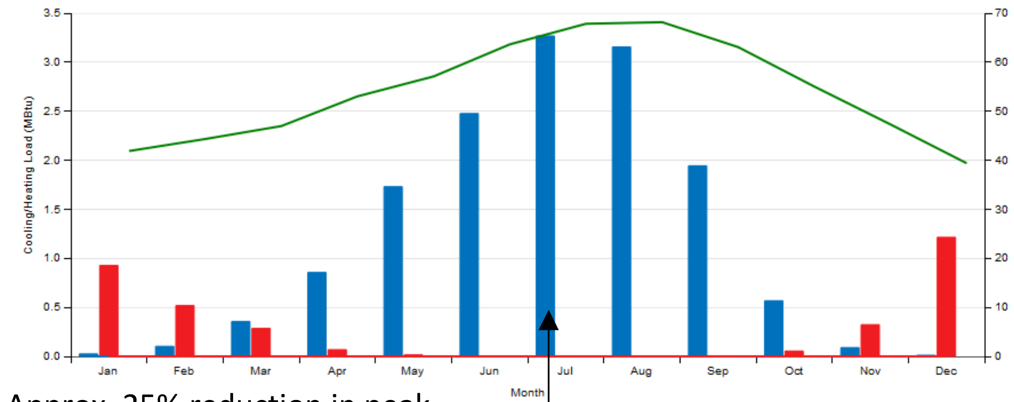
West Facade

***Figure 9*– HVAC Load Profiles with OEESC Code Glazing**



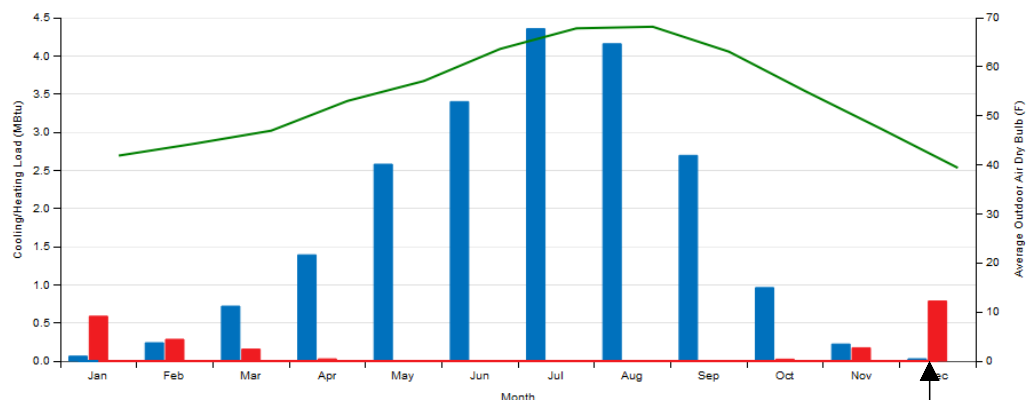
Cooling use is approx. 3 times higher on west façade vs. south façade.

***Figure 11* – HVAC Load Profiles with Solarban 70XL Glazing**



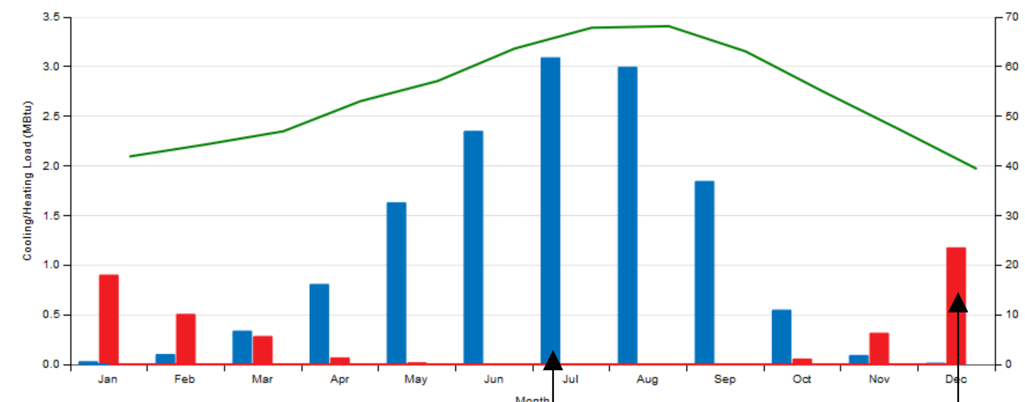
Approx. 25% reduction in peak HVAC cooling use (Jul), as compared to baseline.

***Figure 10* – HVAC Load Profiles with Solarban 60 Glazing**



Slight reduction in HVAC heating due to the increased thermal performance from the argon gas in IGU air gap.

***Figure 12* – HVAC Load Profiles with Solarban 90 Glazing**



Approx. 25% reduction in peak HVAC cooling use (Jul), as compared to baseline.

Approx. 20% increase in heating load due to the glazing's lower SHGC.

Facade Analysis

Figure 3 – South Façade Design Alternate Heat Gain Comparison

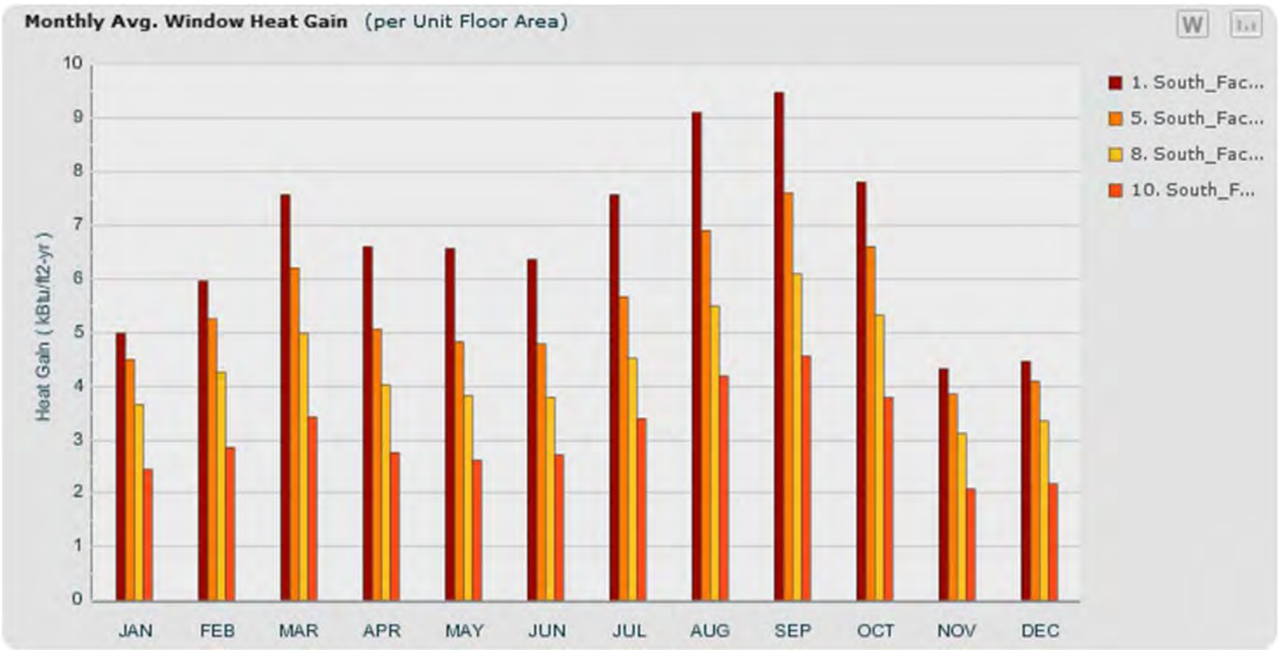
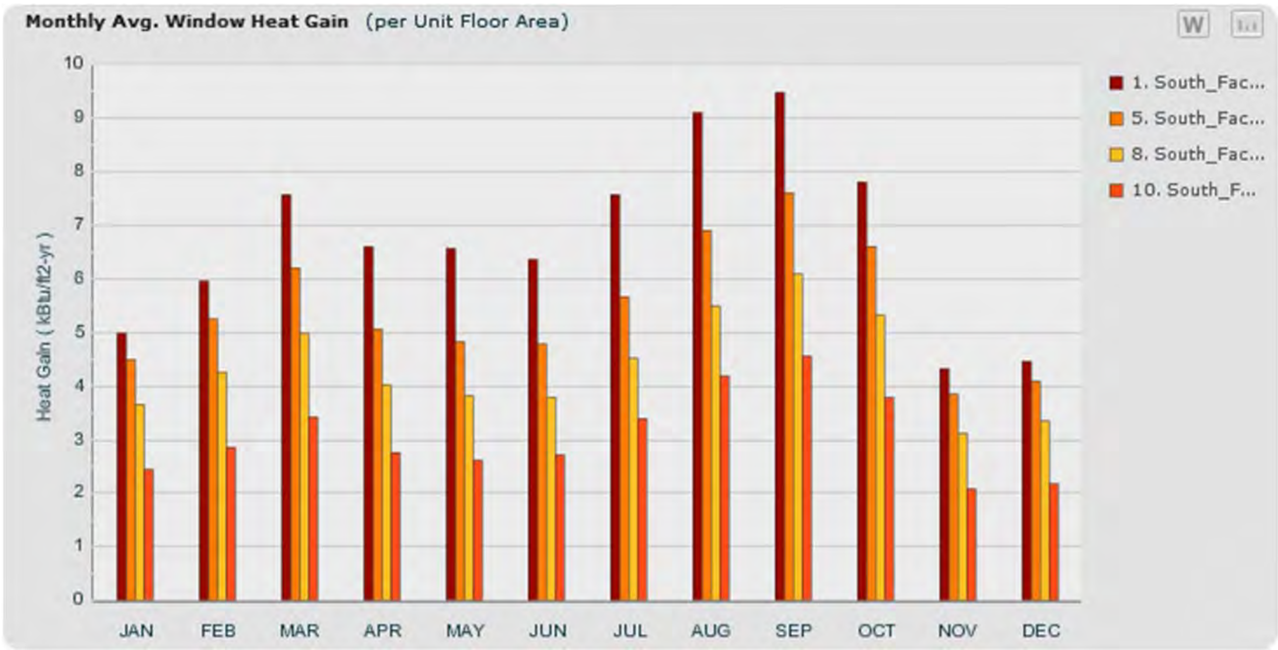


Figure 4 – West Façade Design Alternate Heat Gain Comparison



- Baseline (#1)
- Architectural Shading/Overhangs (#5)
- 17% Window Area Reduction (#8)
- Solarban 70XL Glazing (#10)

Façade Analysis

Table 1 – West Façade Cooling Load Performance Comparison

West Façade

Cooling Loads Summary

ID	Option Description	Peak Cooling Load[2]	Peak Cooling Load	Cooling Load Reduction	Cooling Load Savings		Estimated Energy Reduction
		Watts	Btu	Btu	%	**EUI**	%
	Baseline - No-Shade	27,181	92,742	--	--	69.01	--
Alt 1	SB 60 + Perforated Panels w/ 50% Open Factor	20,038	68,370	24,372	26.3%	59.40	13.9%
Alt 2	SB 70 XL + Perforated Panels w/ 50% Open Factor	16,213	55,319	37,423	40.4%	54.63	20.8%
Alt 3	SB 70 XL + Perforated Panels w/ 60% Open Factor	16,492	56,271	36,471	39.3%	54.90	20.4%

Notes:

1) Sensible cooling load values are based on a west facing perimeter zone with a depth of 15'-0".

2) Peak cooling load includes a 15% safety sizing factor per ASHRAE 90.1.

3) Baseline includes glazing that conforms to Oregon Energy Code 2014 version.

Table 2 – South Façade Cooling Load Performance Comparison

South Façade

Cooling Loads Summary

ID	Option Description	Peak Cooling Load	Peak Cooling Load	Cooling Load Reduction	Cooling Load Savings		Estimated Energy Reduction
		Watts	Btu	Btu	%	**EUI**	%
	Baseline - No-Shade or Overhangs	10,065	34,342	--	--	64.40	--
Alt 1	Current Design w/ Overhangs + Balconies	8,078	27,562	6,780	19.7%	57.77	16.3%
Alt 2	SB 60 + Perforated Panels w/ 50% Open Factor	7,218	24,628	9,714	28.3%	53.90	21.9%
Alt 3	SB 70 XL + Perforated Panels w/ 50% Open Factor	6,190	21,120	13,222	38.5%	49.32	28.5%
Alt 4	SB 70 XL + Perforated Panels w/ 60% Open Factor	6,256	21,345	12,996	37.8%	49.54	28.2%

Notes:

1) Sensible cooling load values are based on a south facing perimeter zone with a depth of 15'-0".

2) Peak cooling load includes a 15% safety sizing factor per ASHRAE 90.1.

Facade Analysis

Table 4 – Design Alternate Capital Cost Savings Summary

ID	Option Description	Initial Investment Cost	Operational Cost	Total Cost	Cost Savings
Base	Baseline - Code Glazing + No-Shade Devices	$148,456	$56,747	$205,204	--
Alt 1	SB 60 + Perforated Panels w/ 50% Open Factor	$182,888	$48,385	$231,273	-$26,069
Alt 2	SB 70 XL + Perforated Panels w/ 50% Open Factor	$178,387	$44,424	$222,811	-$17,607
Alt 3	SB 70 XL + Perforated Panels w/ 60% Open Factor	$178,945	$44,636	$223,581	-$18,377

Notes:

1) Initial capital construction cost accounts for estimated HVAC system, glazing and exterior metal screens.

2) Operational cost includes electricity energy cost of $0.08/kWh over 15 years. No adjustments for cost inflation are included in the calculations.

3) Construction cost used were derived from cost estimates developed by Seabold Construction Co., dated April 17, 2018.

Table 5 – Design Alternate Capital Cost Savings Summary

ID	Option Description	Initial Investment Cost	Operational Cost	Total Cost	Cost Savings
Base	Baseline - Code Glazing + No-Shade Devices	$136,129	$226,266	$362,395	--
Alt 1	SB 60 Argon	$141,950	$218,865	$360,814	$1,581
Alt 2	SB 60 Argon + 30% Frit	$144,210	$214,974	$359,184	$3,212
Alt 3	SB 60 Argon + 40% Frit	$145,232	$213,692	$358,924	$3,471
Alt 4	SB 70 XL Argon	$139,211	$198,471	$337,682	$24,714
Alt 5	SB 70XL Argon + 30% Frit	$142,259	$197,032	$339,291	$23,105
Alt 6	SB 70XL Argon + 40% Frit	$143,559	$196,852	$340,411	$21,985
Alt 7	SB 90 Argon	$144,246	$194,333	$338,579	$23,816
Alt 8	SB 90 Argon + 30% Frit	$147,270	$192,354	$339,625	$22,771
Alt 9	SB 90 Argon + 40% Frit	$148,548	$191,725	$340,273	$22,122

Notes:

1) Initial capital construction cost accounts for estimated HVAC system, glazing and exterior metal screens.

2) Operational cost includes electricity energy cost of $0.08/kWh over 15 years. No adjustments for cost inflation are included in the calculations.

3) Construction cost used were derived from cost estimates developed by Seabold Construction Co., dated April 17, 2018.

SORA DESIGN GROUP LLC

Case Study 2

Image Credit: YGH Architecture

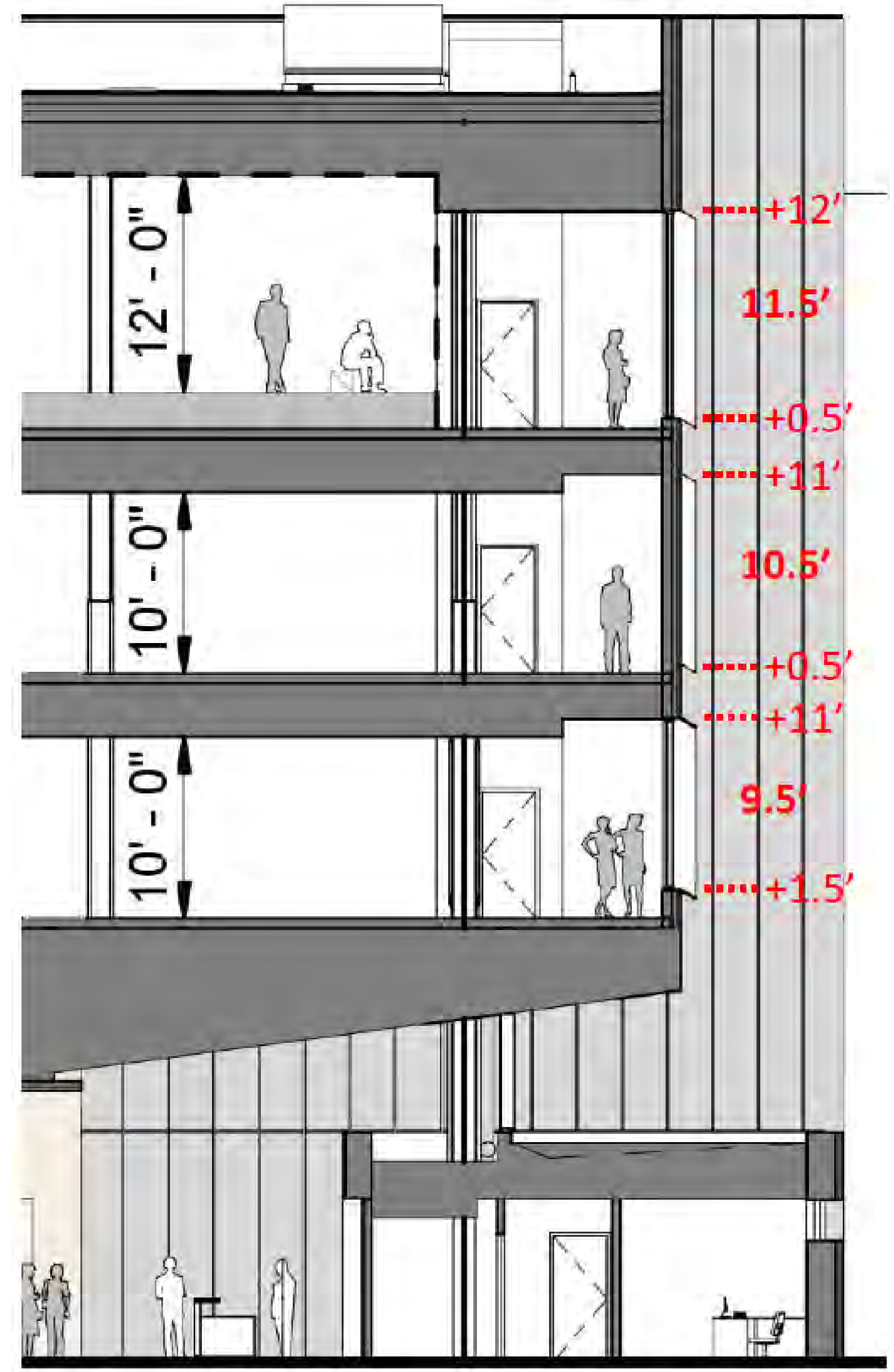
View of Southwest Facade

Project: RCC Office Building – Portland International Airport

Building Type: Mixed Use

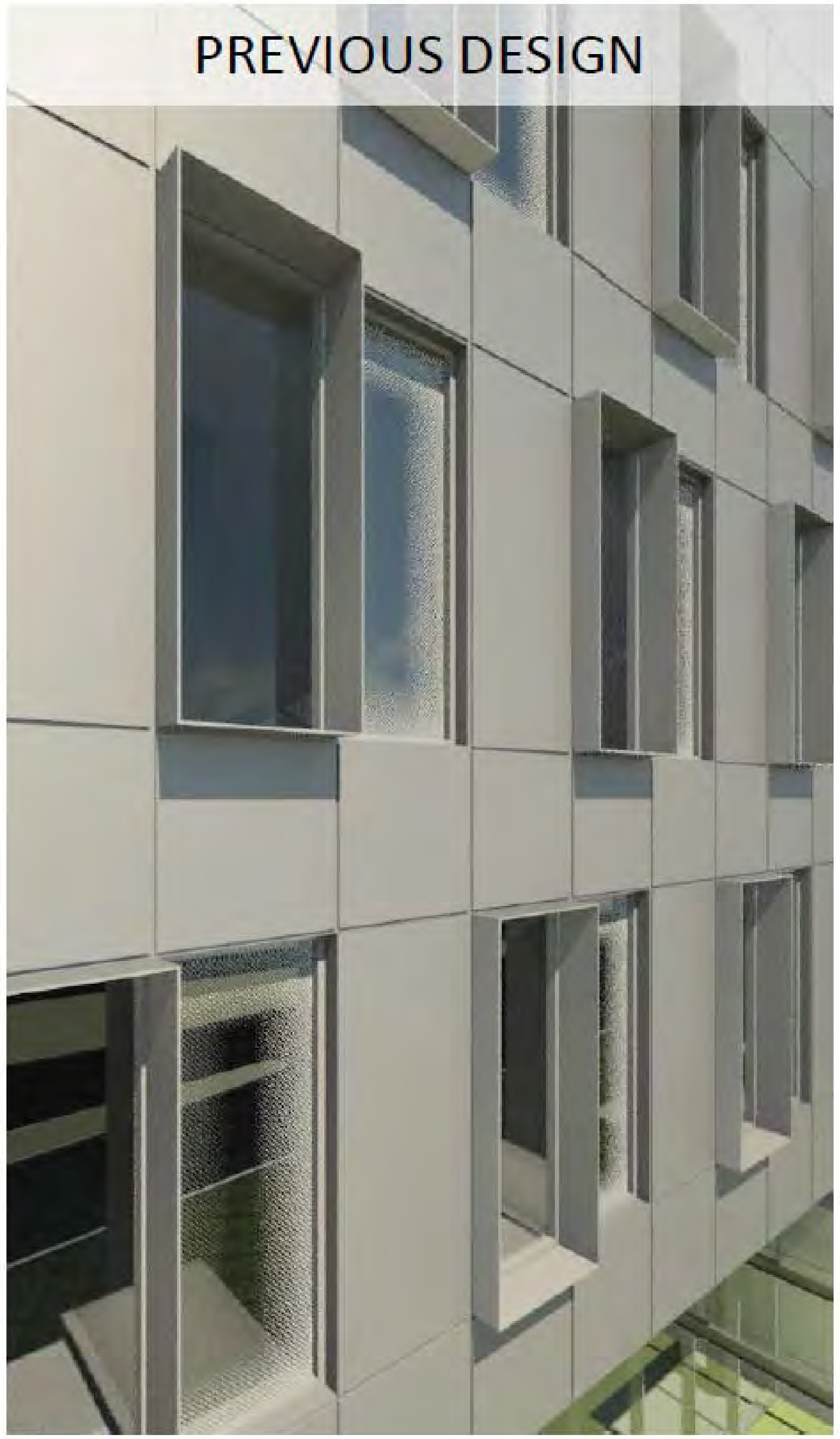
Size: 4 Stories, 91,000 sf (Gross)

Client: Port of Portland

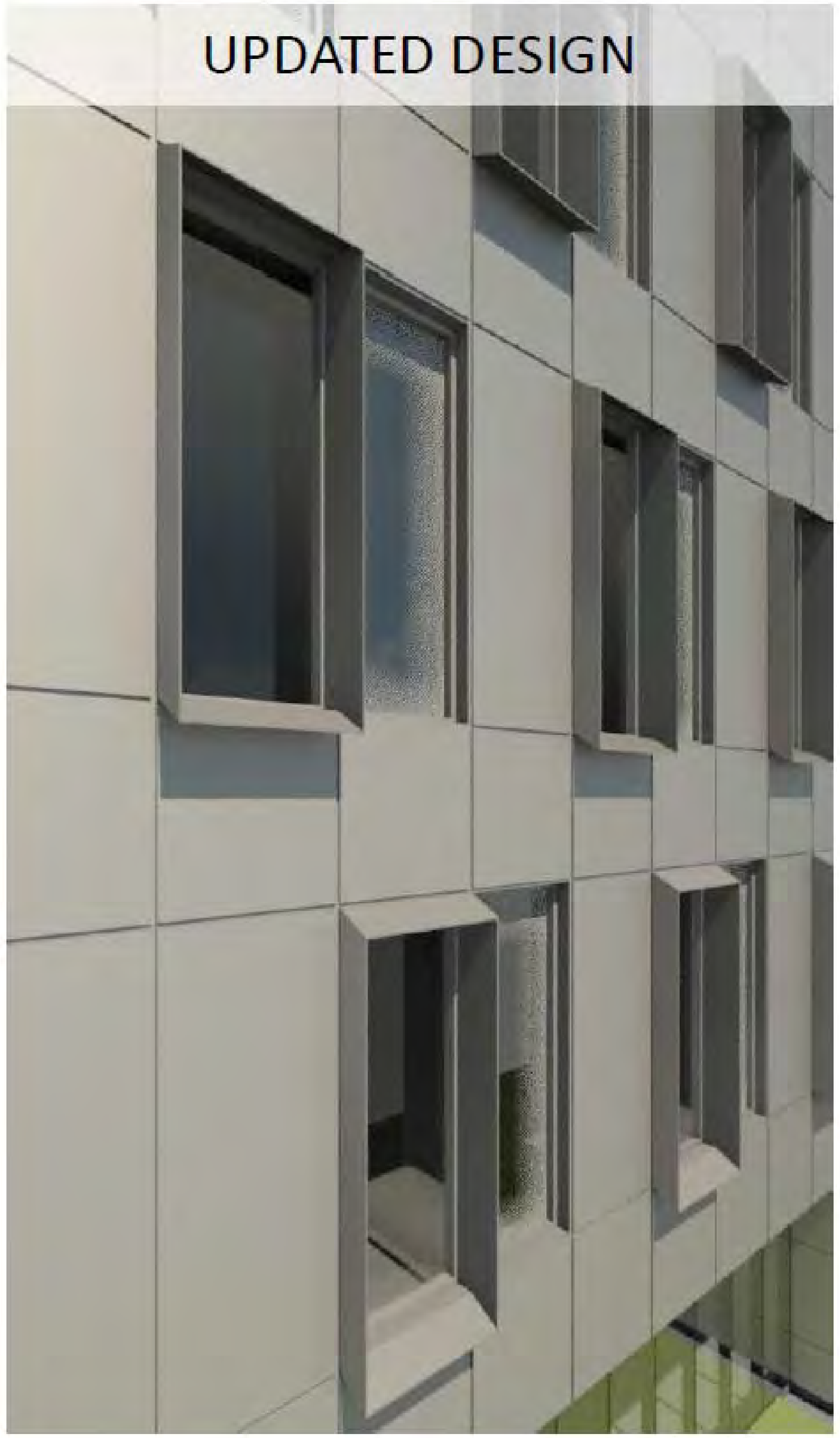


Partial Section – SW Facade

YOST GRUBE HALL ARCHITECTURE



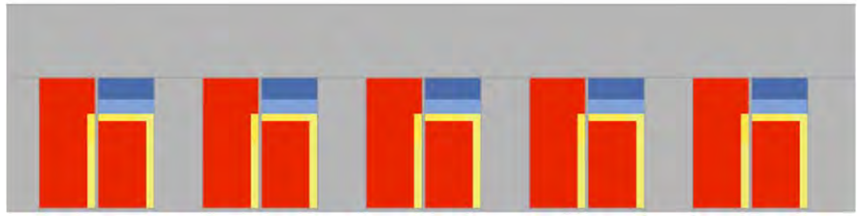
Shadow Frame – Initial Design



Shadow Frame – Updated Design

Shading Benefit of Shadow Frame – Summer Solstice

9 AM



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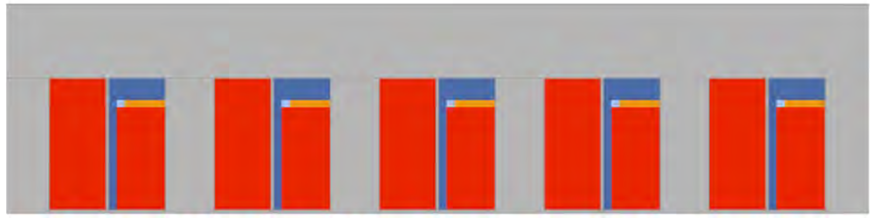

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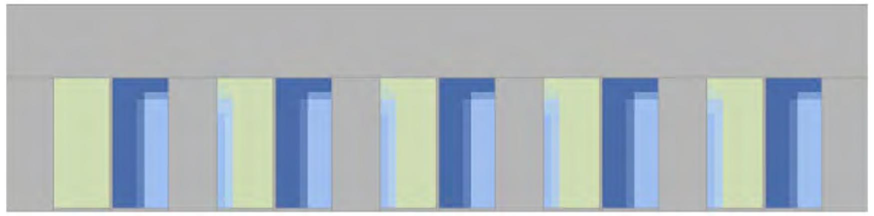

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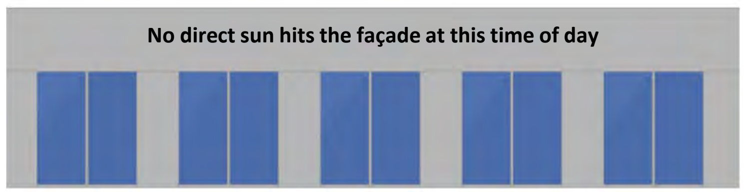
Shading Benefit of Shadow Frame – Summer Solstice



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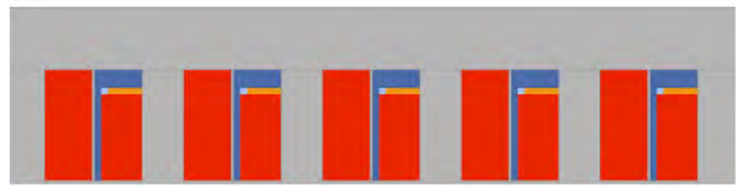

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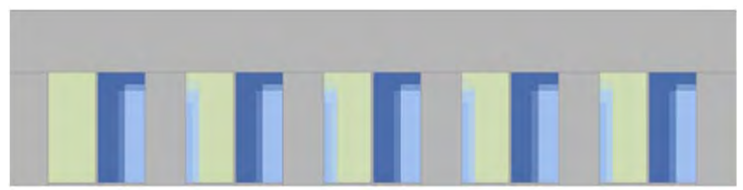

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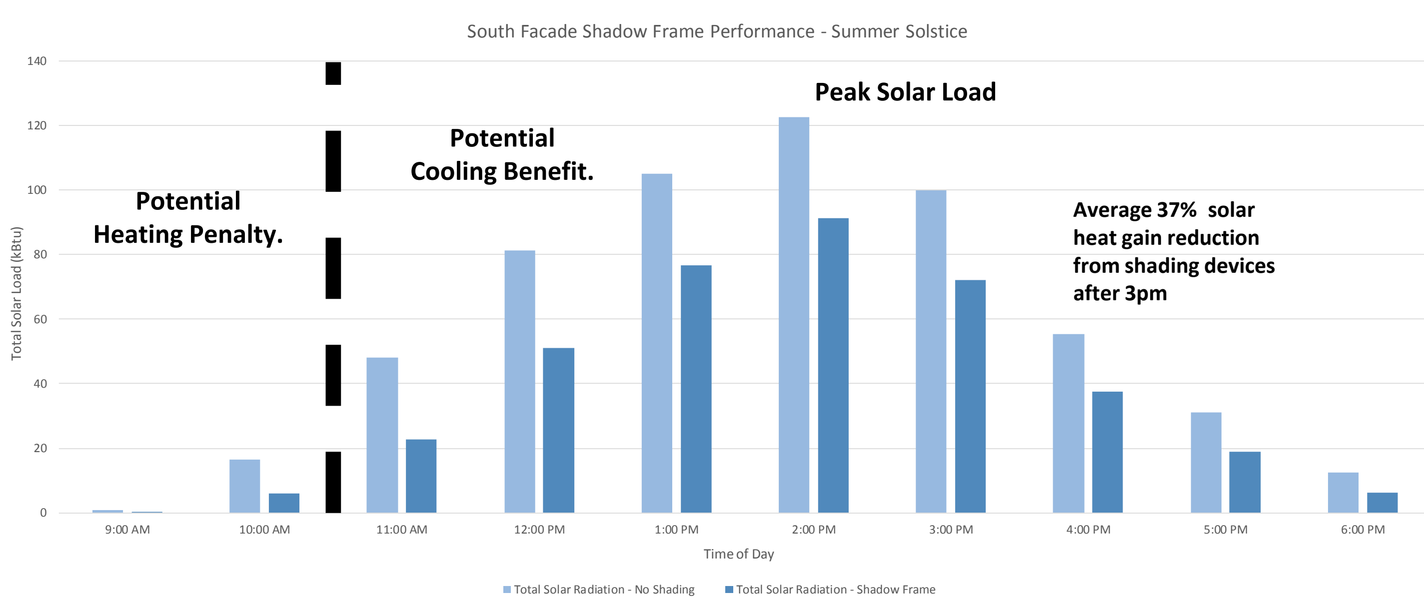
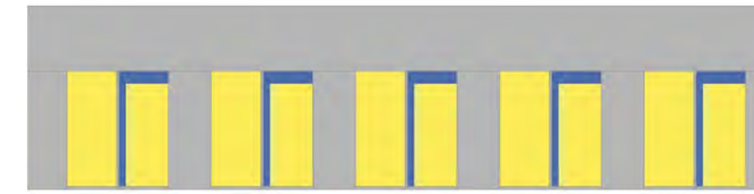


Shading Benefit of Shadow Frame – Fall Equinox

9 AM



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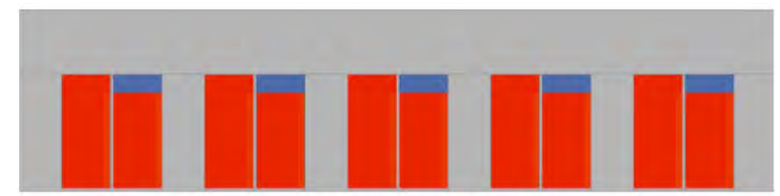

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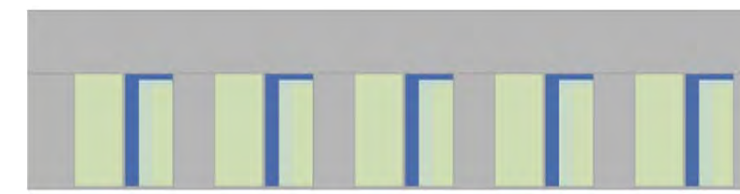

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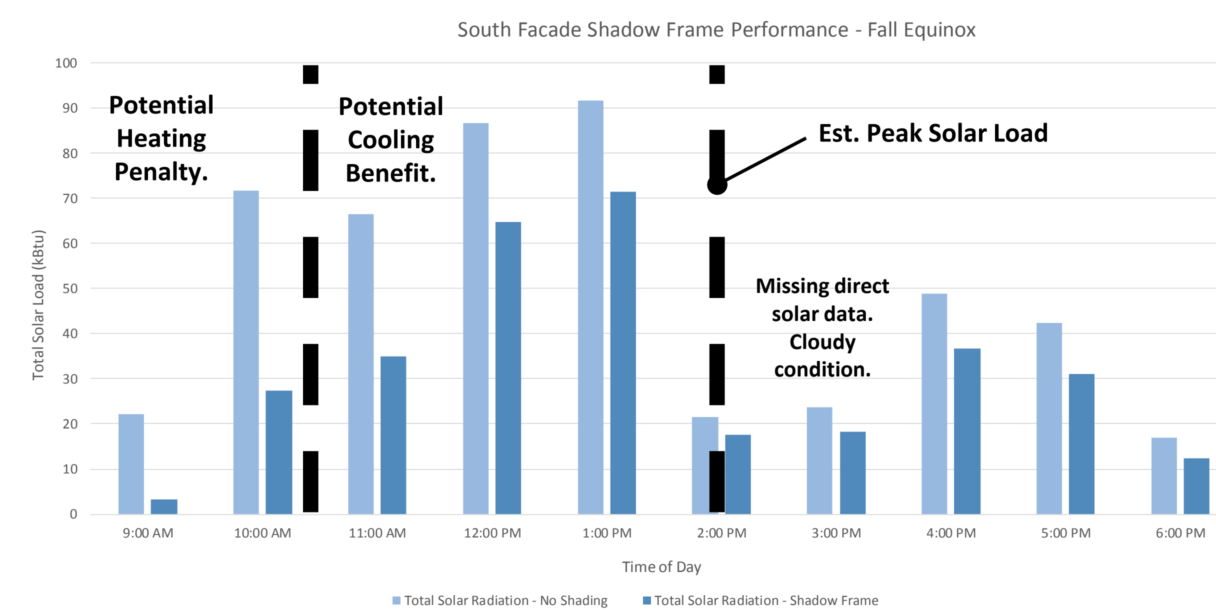
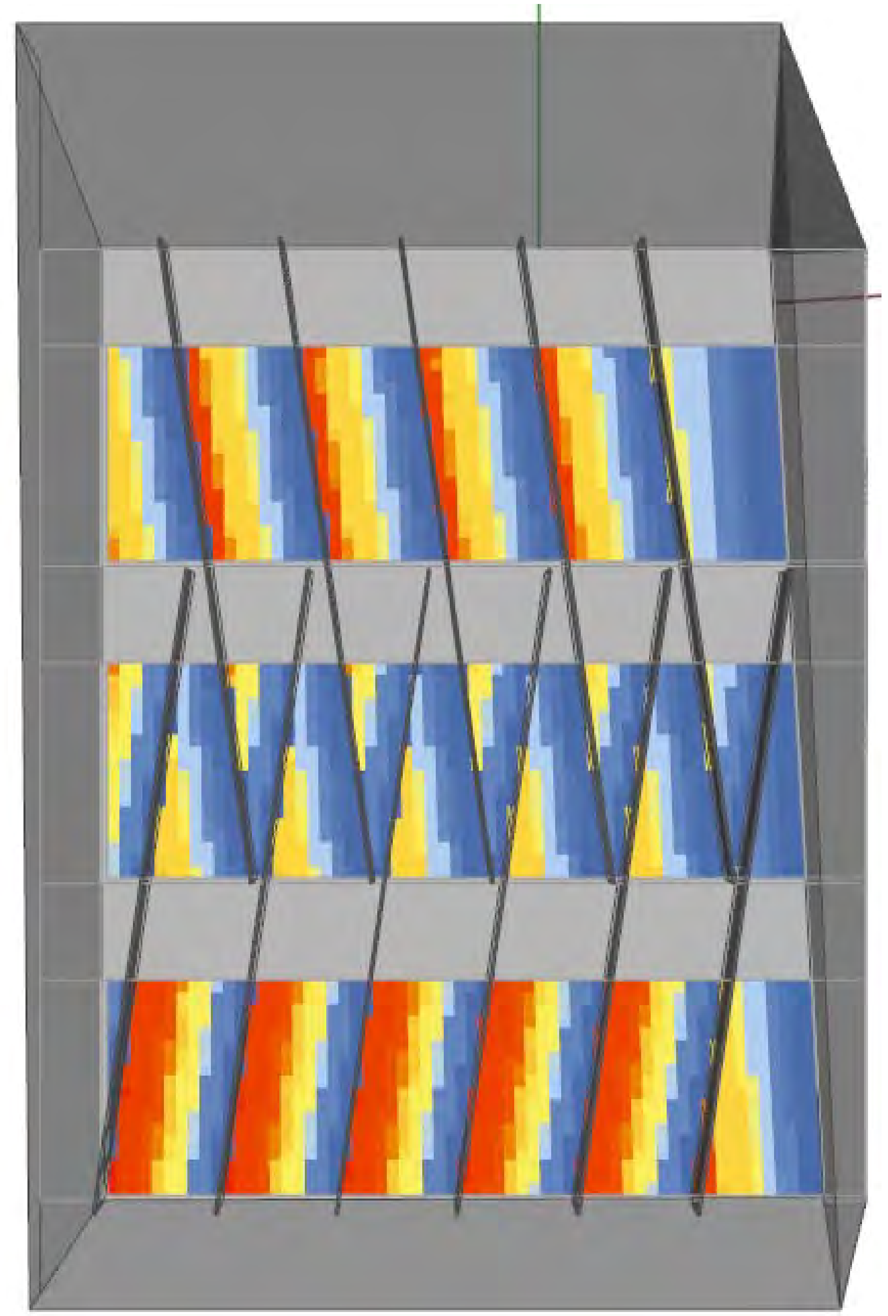


Vertical Fin Design Option 1

Vertical Fin Design Option 2

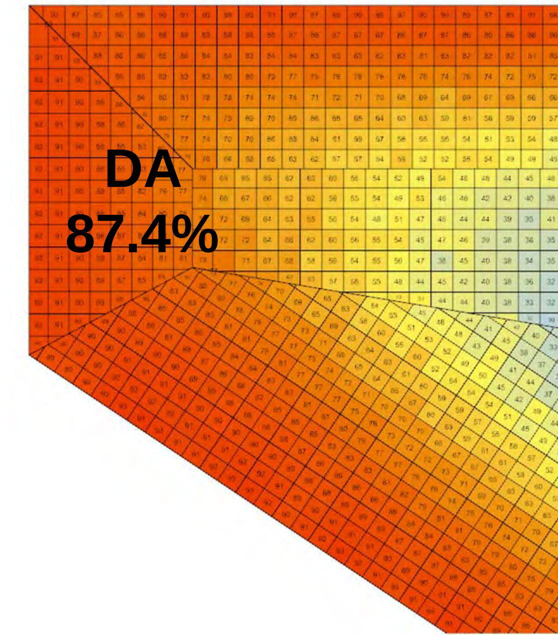
Vertical Fin Design Option 3

Vertical Fin Design Option 4

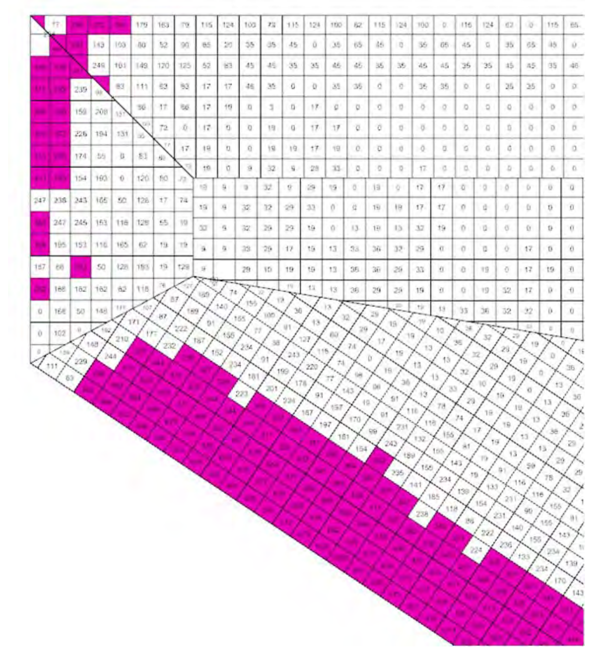


West Elevation – Solar Radiation (Jun-Sep)

Daylight Autonomy sDA 29.7%

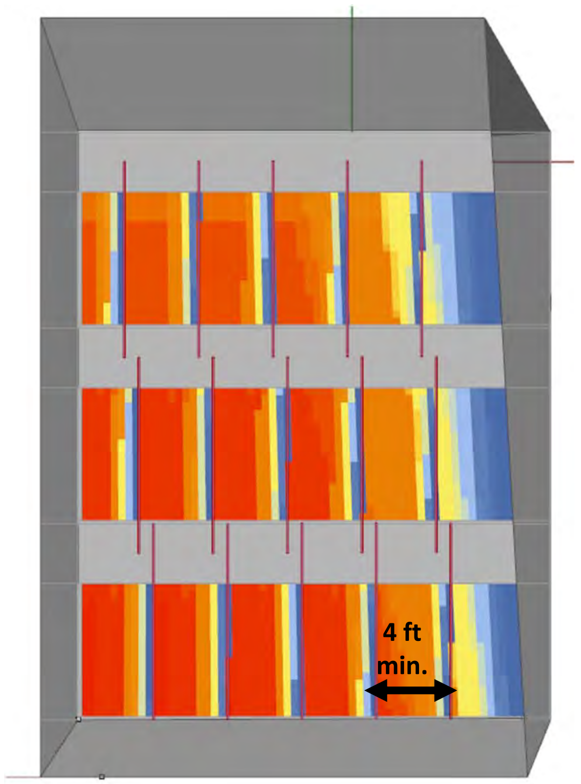


ASE 10.2%

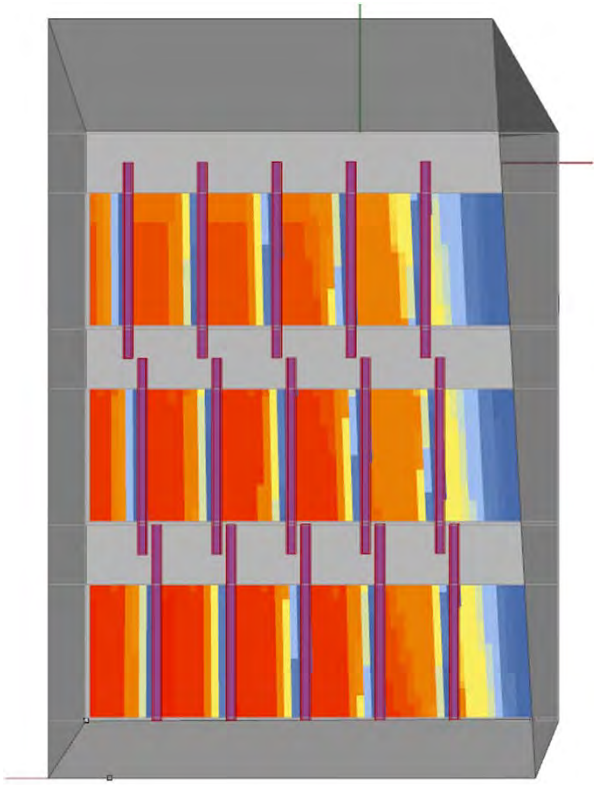


February 20, 2019

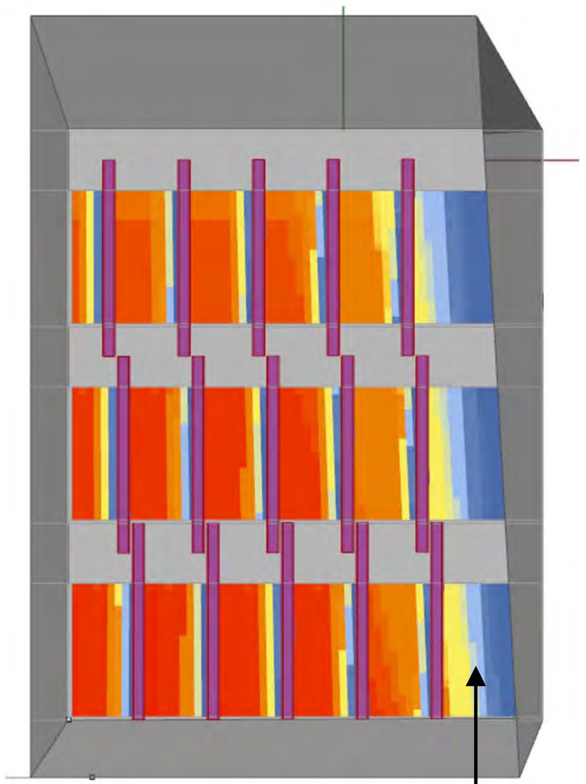
Vertical Fin Option Comparison – Jun-Sep



Option A – 5 Fins at 0 deg



Option B – 5 Fins at 22.5 deg



Option C – 5 Fins at 30 deg

Shroud provides relatively consistent shading of this region of façade.

Scenario	# Vert Fins	Rotation Angle	Solar Load Reduction %	Daylight Performance DA -300	Daylight Performance ASE
Baseline[1]	0	0	--	29.6	10.4
Option A	5	0	20.1%	29.4	10.3
Option B	5	22.5	27.4%	29.7	10.2
Option C	5	30	29.1%	30.6	10.2
Option D	7	30	37.0%	31.9	10.0
Option E	9	30	44.5%	29.9	9.9

Notes:

1) Baseline scenario includes extended shroud on west façade - no vertical fins.

February 20, 2019

DISCUSS

Thank You