Facades– What else is there?

Façade Tectonics Forum: Simulation vs. Reality

Session 2 - Tools

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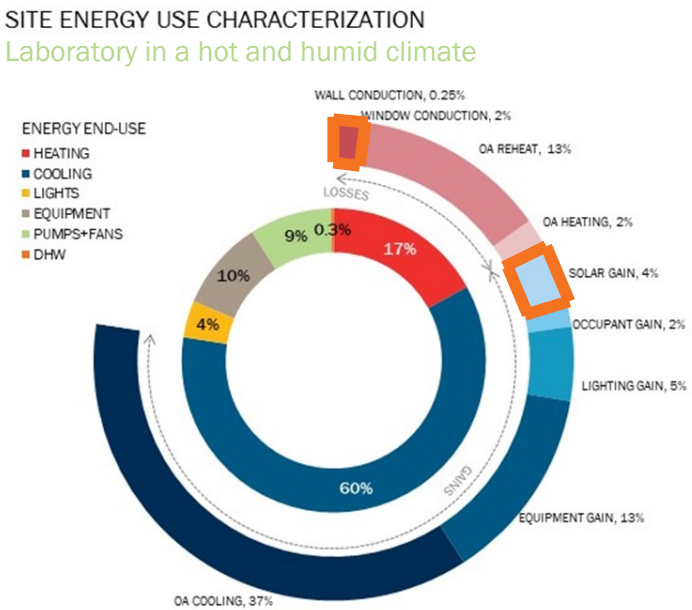
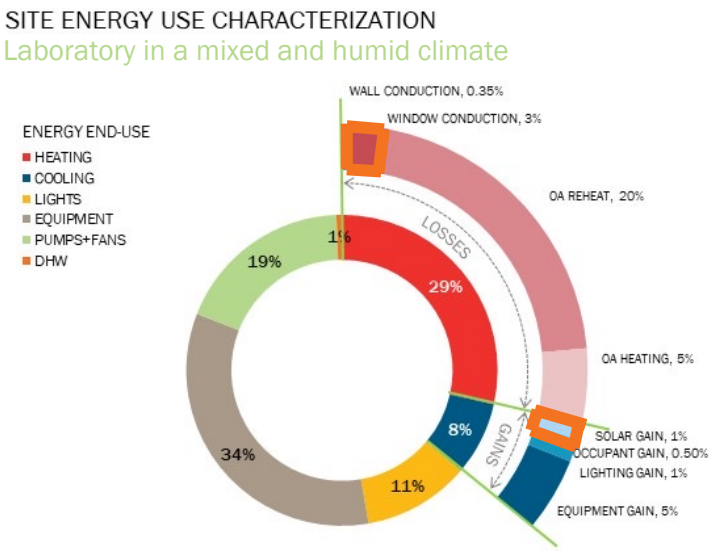
Energy matters, but what else should we think about?





Facades as part of a passive comfort system

Optimizing for quality daylight

Where does all the rejected solar energy go?

Facades and embodied energy

Apples & Oranges

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Facades as part of a passive comfort system

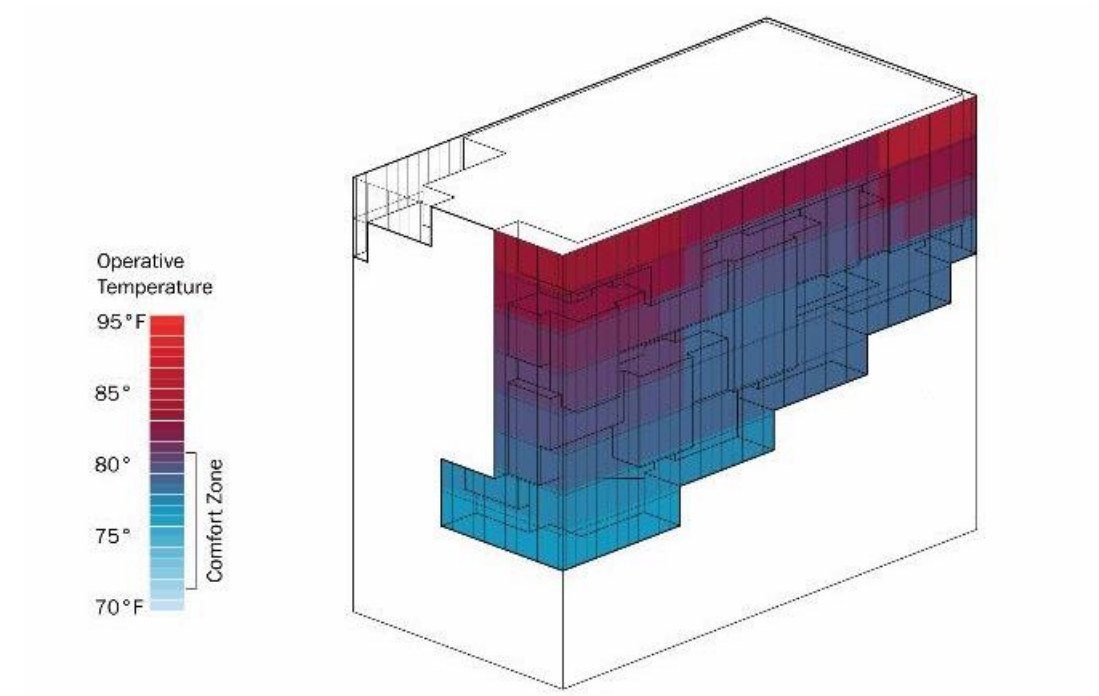
Facades as part of a passive comfort system

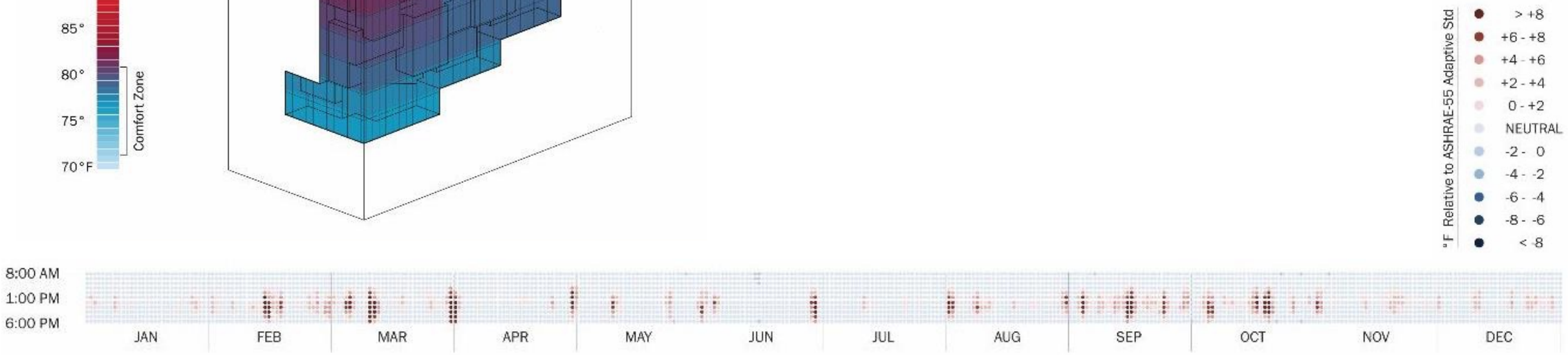
Thermal comfort of occupant in shade

Topic: **Thermal Comfort**

Metric: **Operative Temperature (°F)**

Analysis Tool: **E+ Outputs**





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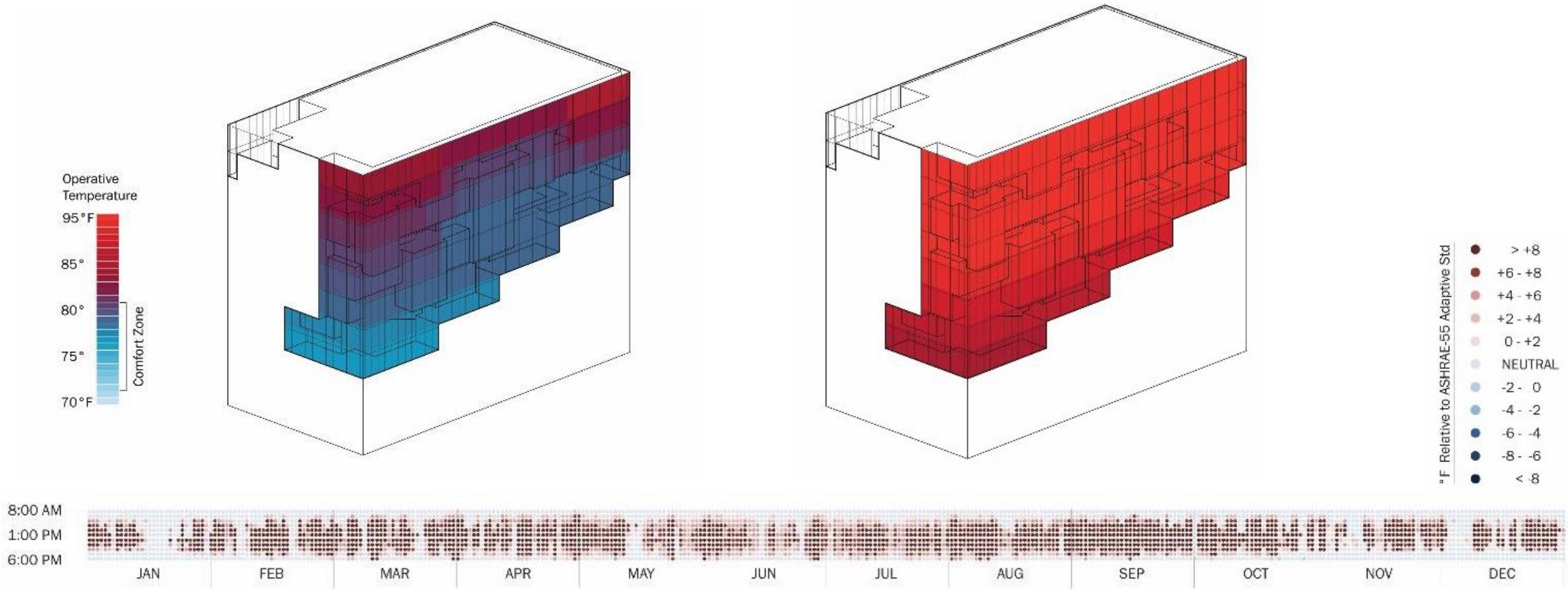
Facades as part of a passive comfort system

Thermal comfort of occupant with direct solar

Topic: **Thermal Comfort + Direct Solar**

Metric: **Operative Temperature (°F)**

Analysis Tool: **E+ Outputs + Excel (Method 1 Post Processing)**



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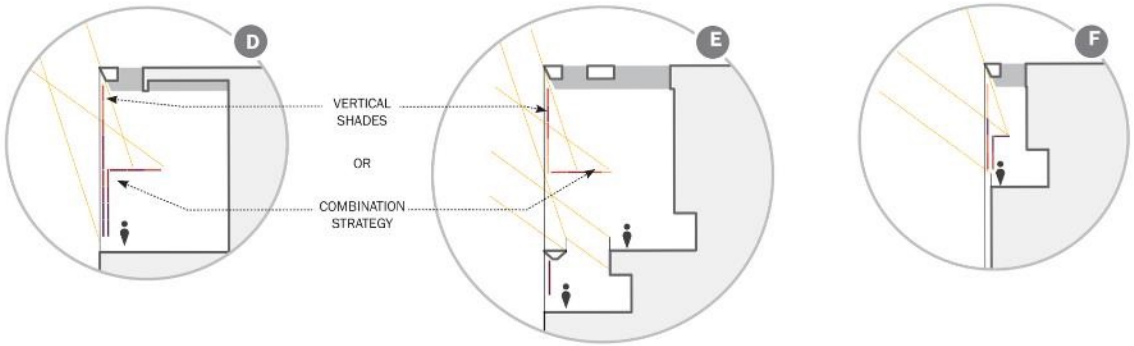
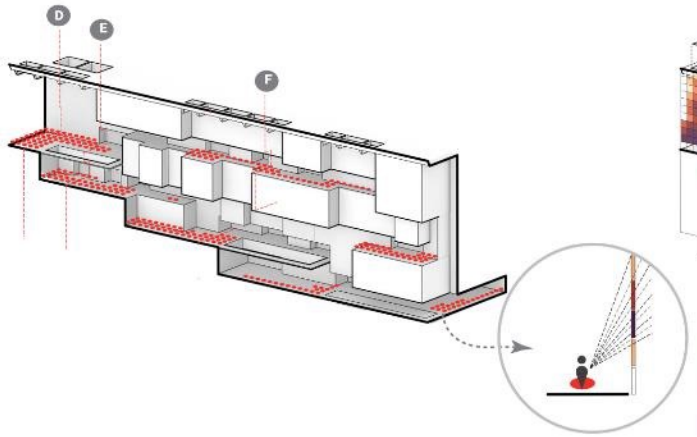
Facades as part of a passive comfort system

Layering façade strategies with additional local shading strategies



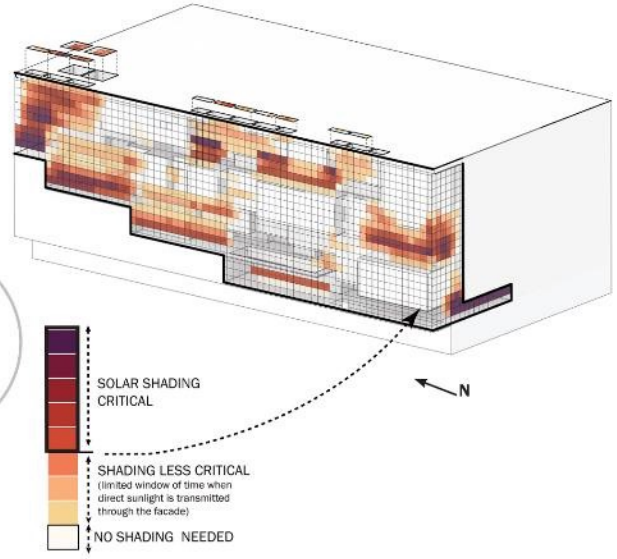
COMMON AREAS RECEIVING DIRECT SUNLIGHT

REGULARLY OCCUPIED AREAS OF THE WEST SOLARIUM RECEIVING DIRECT SOLAR RADIATION DURING THE SUMMER.



SOLAR SHADING MAP

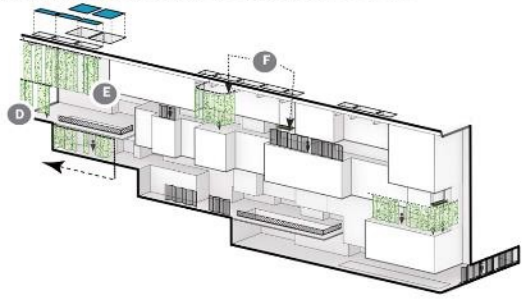
RED AND PURPLE GRID CELLS INDICATE LOCATIONS OF THE FACADE WHERE INTERNAL SHADING IS MOST CRITICAL FOR THE THERMAL COMFORT OF OCCUPANTS WITHIN THE COMMON AREAS. (EACH GRID MEASURES 4' X 4')

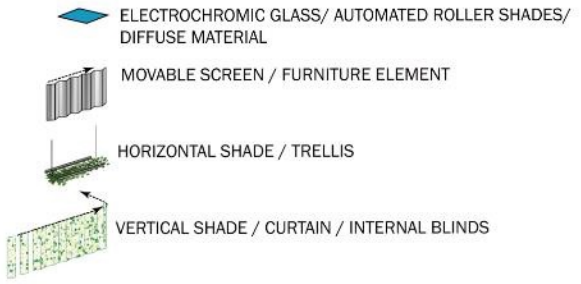


OVERSHADOWING OF THE WEST SOLARIUM FACADE BY ADJACENT CONTEXT BUILDINGS REDUCES THE NEED FOR SOLAR SHADING ON THE LOWER FLOORS AND MIDDLE ZONES. SHADING WILL BE MOST CRITICAL AT THE NORTH AND SOUTH CORNERS WHICH ARE EXPOSED TO DIRECT SOLAR RADIATION FOR OVER 4 HOURS PER DAY IN THE SUMMER.

POTENTIAL SOLAR SHADING STRATEGIES

SIMILAR TO THE SOUTH FACADE, VERTICAL SHADING DEVICES SUCH AS CURTAINS, SHUTTERS, LOUVERS, PLANTED SCREENS, OR TREES WILL BE EFFECTIVE STRATEGIES FOR CONTROLLING OCCUPANT EXPOSURE TO DIRECT SUNLIGHT IN THE COMMON AREAS OF THE SOLARIUM. COMBINING HORIZONTAL SHADING ELEMENTS WITH VERTICAL SHADES IS A VIABLE ALTERNATIVE AS SHOWN IN THE SECTIONS ABOVE. MOVABLE SHADES (EITHER OCCUPANT CONTROLLED OR AUTOMATED) ARE RECOMMENDED FOR VERTICAL SHADING DEVICES TO ALLOW SEASONAL FLEXIBILITY.





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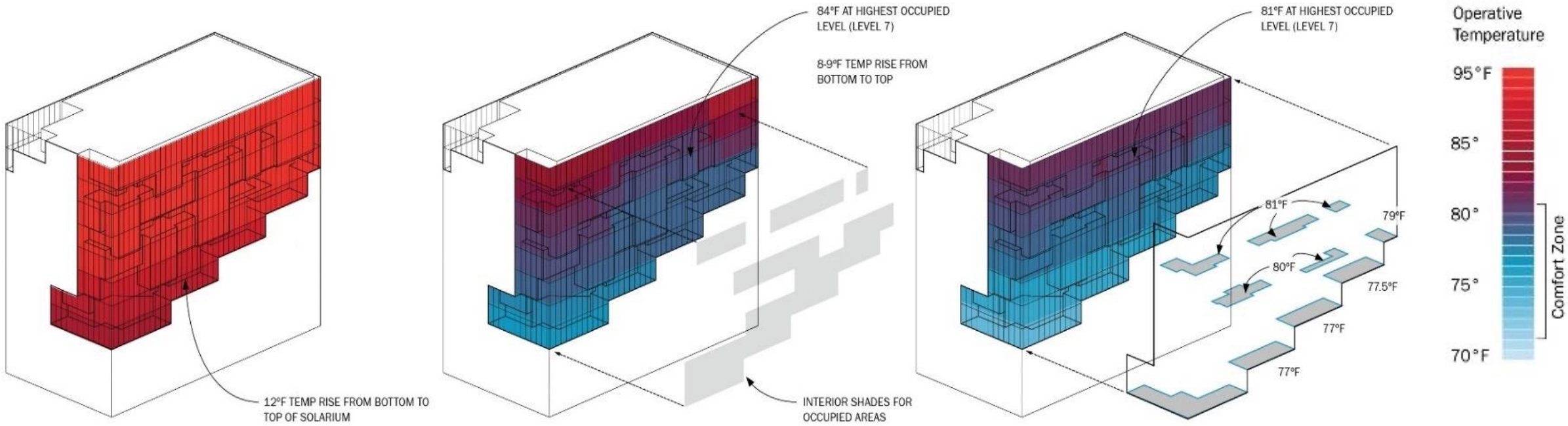
Facades as part of a passive comfort system

Adding natural ventilation via the façade to further improve comfort



Operable Windows & Shading

In areas where staff will work, using planters, furniture, and trellises

+ Supplemental Active Cooling

Located to induce airflow at terrace levels, controlled by BMS, with backup fan exhaust at top of solarium

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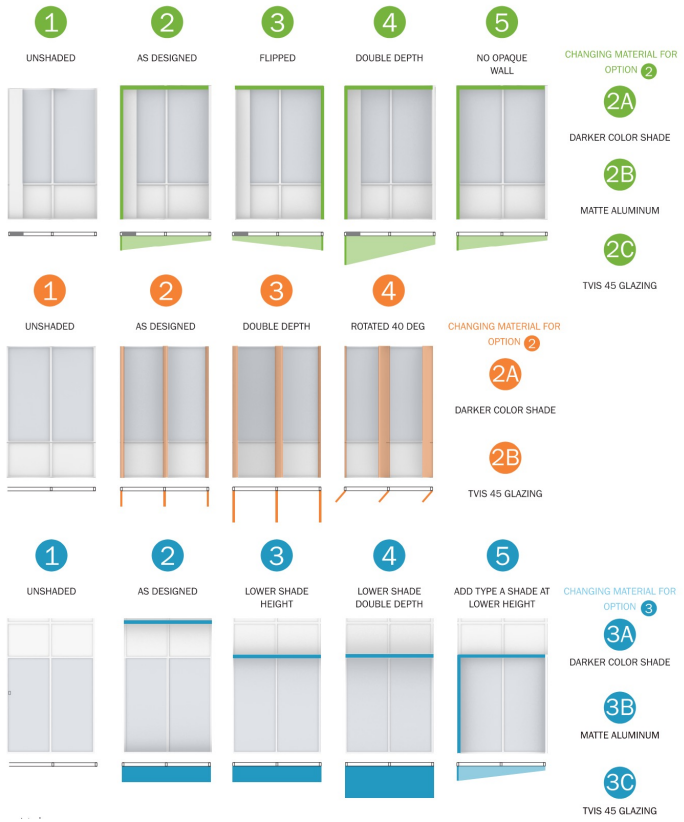
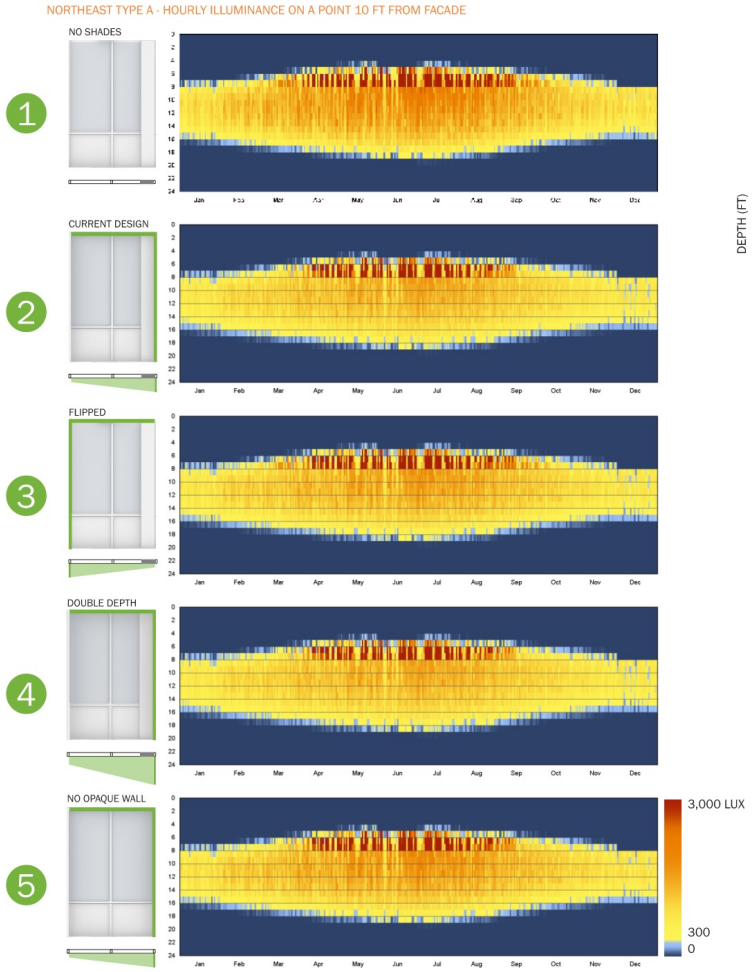
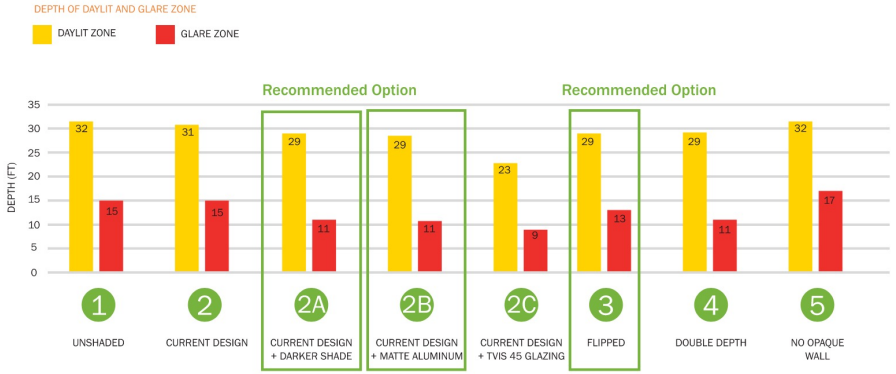
Optimizing for quality daylight

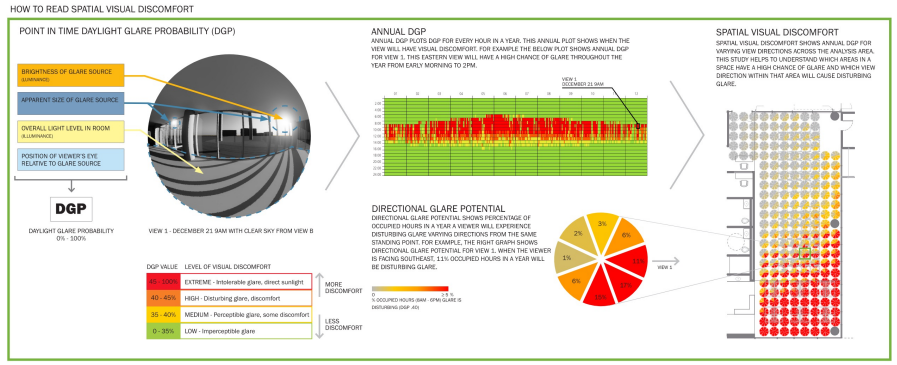
Optimizing for quality daylight

Ability to look quickly across many design options









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Optimizing shading for quality daylight

Spatial and temporal distribution of quality daylight

% AREA ABOVE 300 LUX FOR MORE THAN 50% OF OCCUPIED HOURS

% OF OCCUPIED HOURS ABOVE 300 LUX

0 — 50 — 100 %

RECOMMENDED

% AREA ABOVE 1,000 LUX FOR MORE THAN 250 HOURS

OCCUPIED HOURS ABOVE 1,000 LUX

0 — 250

RECOMMENDED

% SPACE WITH DISTURBING GLARE AT LEAST 5% OF OCCUPIED HOURS

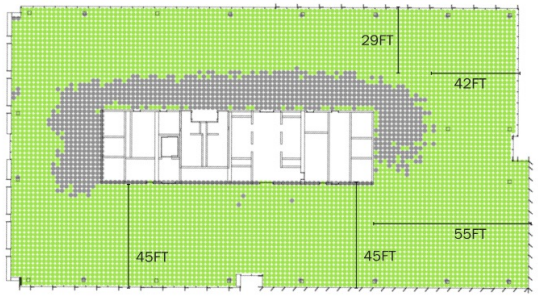
% OCCUPIED HOURS (8AM - 6PM)
GLARE IS DISTURBING (DGP .40)

≥ 5 %

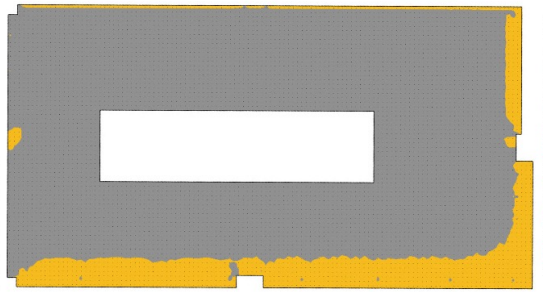
OPTIMIZED DESIGN

TYPE A - FLIPPED + MATTE ALUMINUM
TYPE B - ROTATED + DARKER COLOR
TYPE C - LOWERED SHADE + MATTE ALUMINUM

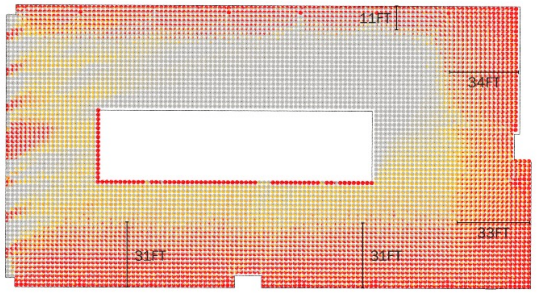
3 4 3B
2B 2A



sDA 85%



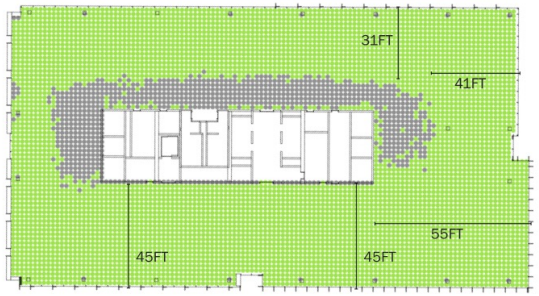
ASE 14%



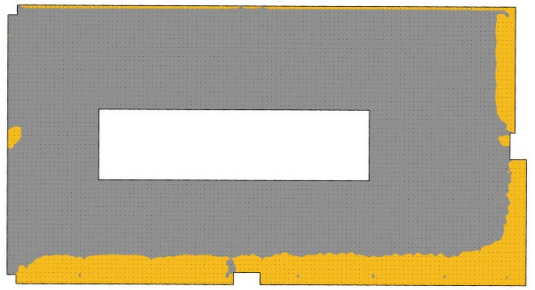
23%

CURRENT DESIGN

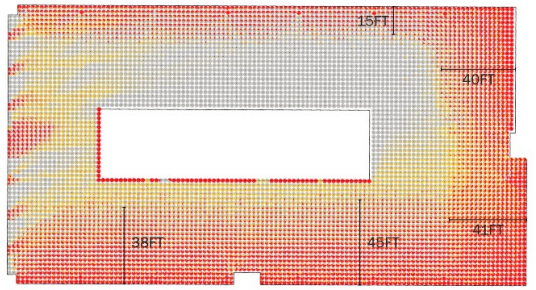
2 2 2



sDA 86%



ASE 15%

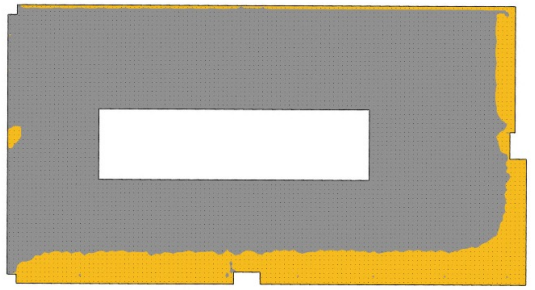


27%

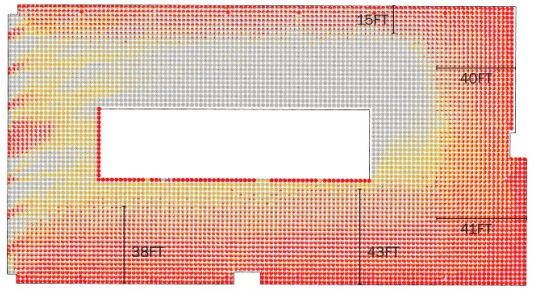
UNSHADED DESIGN

1 1 1

sDA 87%



ASE 17%



30%

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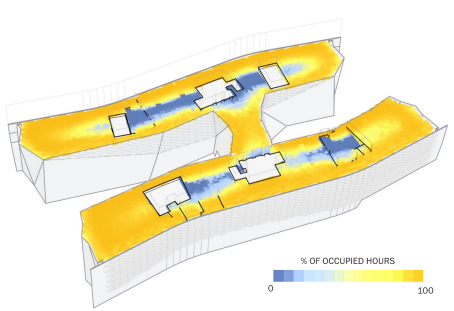
Optimizing for quality daylight

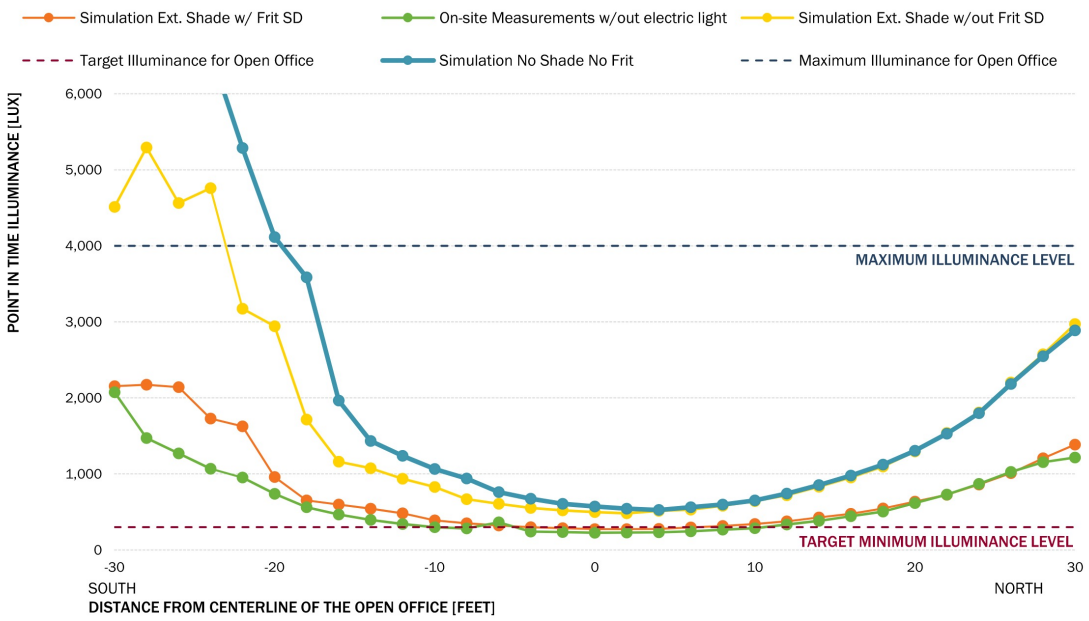
Verification and visualization is key to drive acceptance

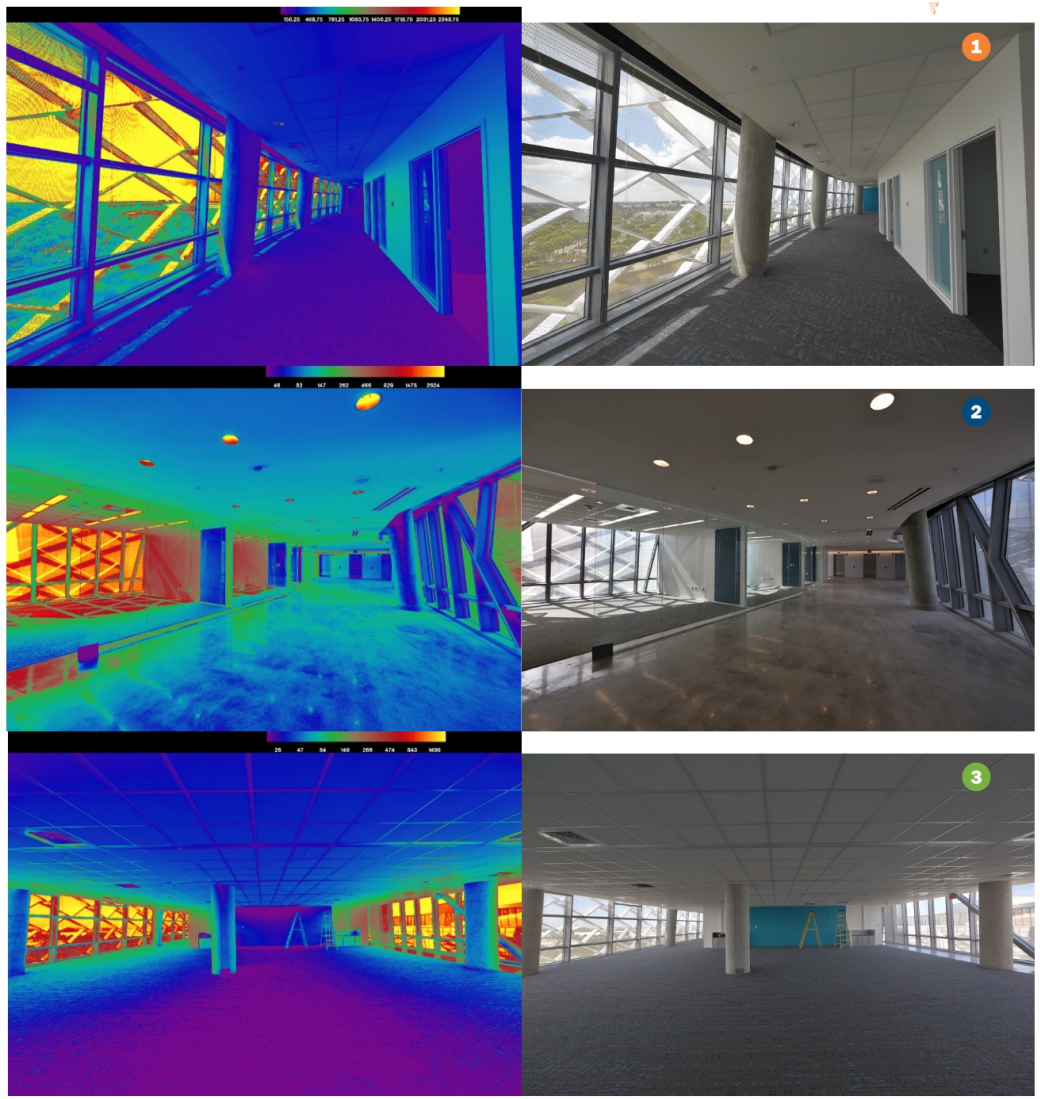


DAYLIGHT AUTONOMY FOR 200 LUX IN TYPICAL FLOOR MODEL

DAYLIGHT ANALYSIS, MEASUREMENT AND VERIFICATION

GENERAL SERVICES ADMINISTRATION - MIRAMAR, FL





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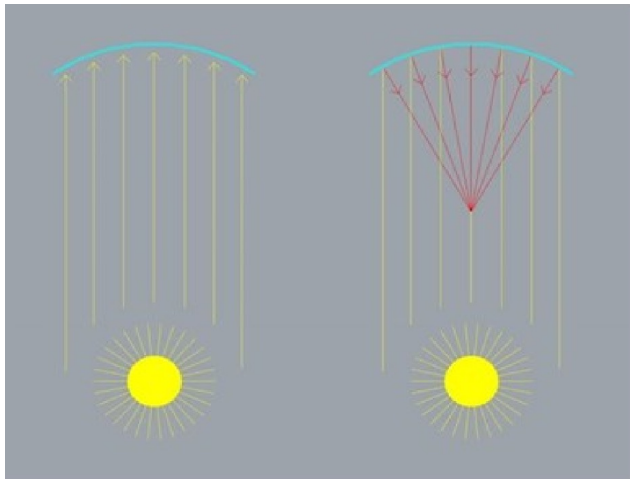
Where does all the solar energy go?

Where does all the solar energy go? Look out for convergence!

Energy that doesn't enter the building gets rejected back into the environment

Parallel rays of the sun can strike a concave specular object and converge to a common point.



20 Fenchurch in London is a high-profile example of a problematic solar convergence from reflections off the curved glass façade.

Intensity metrics established by the City of London

Intensity (kW/m^2)	Description	Recommendation
0.5	Common direct summer solar irradiance in London.	
1.0	Maximum direct solar irradiance in London.	
1.0 – 1.5	Damage to the eyes can occur when looking at reflecting building. Low melting point materials can be softened.	
2.5	Above this level can give rise to skin damage and burns within 30 seconds of exposure	Areas where people are likely to be present should not receive this level for more than 30 seconds
10	Timber, plastic, fabrics and paper can catch fire above this level	No area, even at roof level, should receive this level of irradiance
1.5		Reflected irradiances above this level should be minimised.
1.0		Reflected irradiances above this level should preferably be minimised.

Where does all the solar energy go? Look out for convergence!

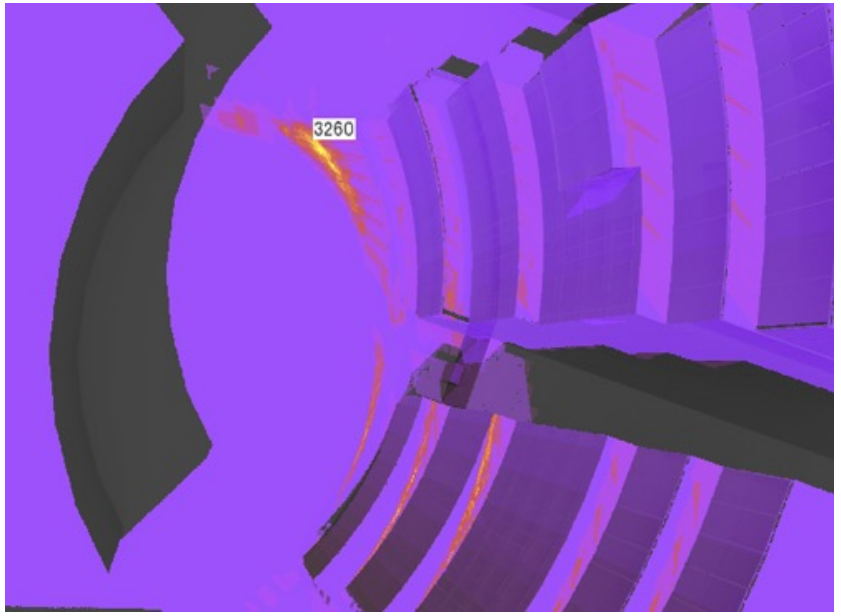
Convergence patterns with high performance glass and no shading

Pattern 1:
Wintertime at midday, grazing sun across the curved skin forms a local convergence on the north mass of the building itself.

Pattern Duration per Day

40 mins	60 mins	80 mins	80 mins	50 mins	40 mins	20 mins
Dec	**Jan Nov**	**Feb Oct**	**Mar Sep**	**Apr Aug**	**May Jul**	**June**

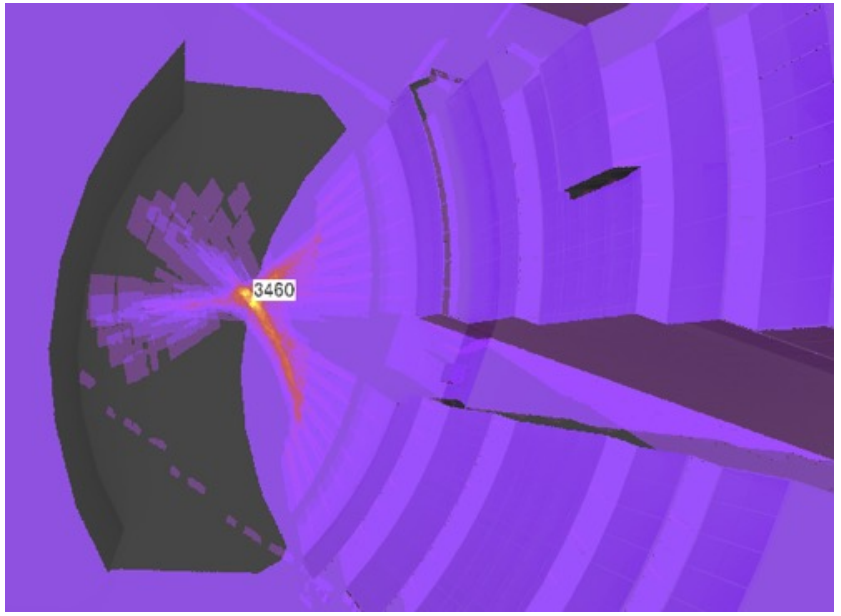
Pattern 2:
Spring and fall in the early afternoon, the north mass casts a convergence to the ground plane.



Pattern Duration per Day

-- mins	-- mins	100 mins	100 mins	110 mins	120 mins	90 mins
Dec	**Jan Nov**	**Feb Oct**	**Mar Sep**	**Apr Aug**	**May Jul**	**June**

Pattern 3:
Summer months in the afternoon, both tower masses create two convergence patterns that join together on the ground plane.



Pattern Duration per Day

-- mins	-- mins	-- mins	-- mins	40 mins	110 mins	100 mins
Dec	**Jan Nov**	**Feb Oct**	**Mar Sep**	**Apr Aug**	**May Jul**	**June**

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IRRADIANCE w/m²

Goal

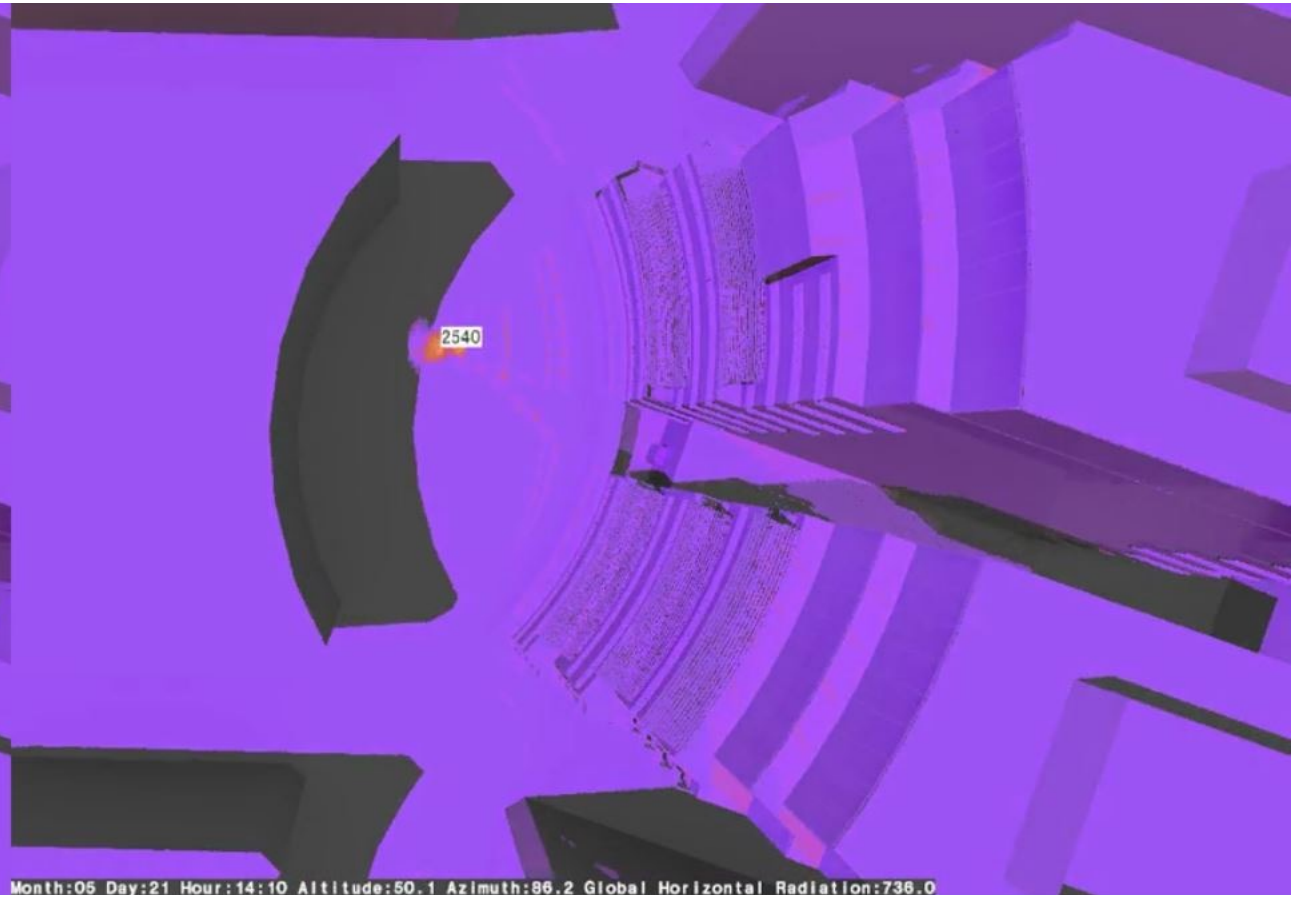
3000 2700 2400 2100 1800 1500 1200 900 600 300 0

Where does all the solar energy go? Look out for convergence!

Shading not to reduce building solar gain but disrupt convergence patterns.

ORIGINAL BASELINE WITHOUT FRIT OR SHADES

WITH SHADE CANOPIES AND THREE HORIZONTAL SHADES AT WEST GLASS



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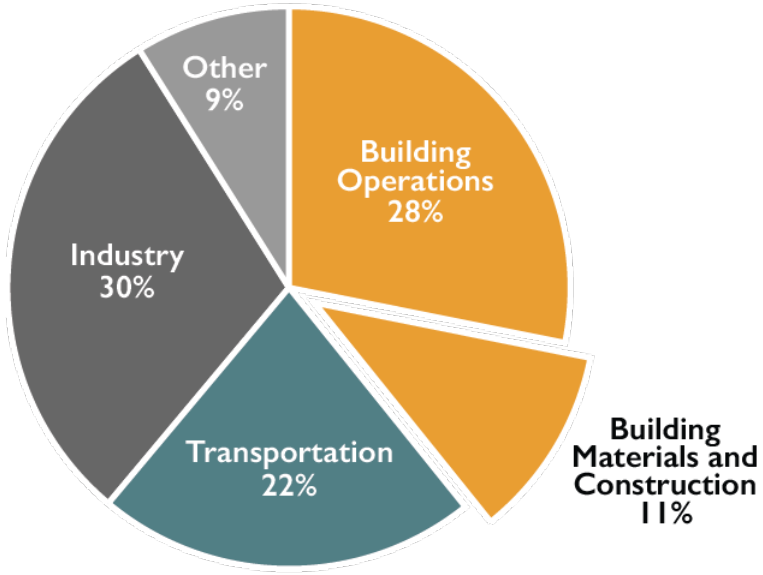
Facades and embodied energy

Facades and embodied energy

As operational emissions reduce, embodied carbon importance increases



Source: Architecture 2030

By 2060, the world is projected to add 230 billion m² (2.5 trillion ft²) of buildings, or an area equal to the entire current global building stock.

This is the equivalent of adding an entire New York City to the planet every 34 days for the next 40 years.

- UN Environment, Global Status Report 2017

Embodied & Operational Carbon: short term and long term

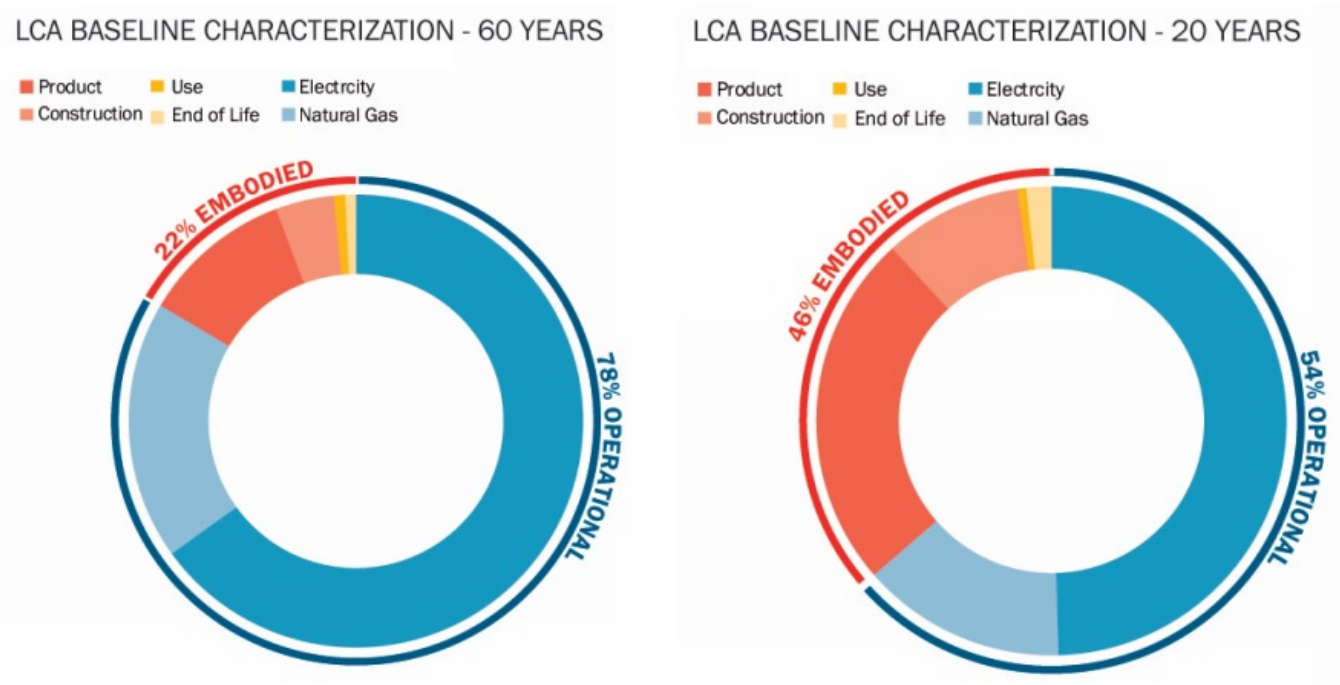


Figure 3: Life-Cycle Carbon Characterization – Baseline Case

Carbon reductions now have more value than carbon reductions in the future as we strive to stay under 1.5°C

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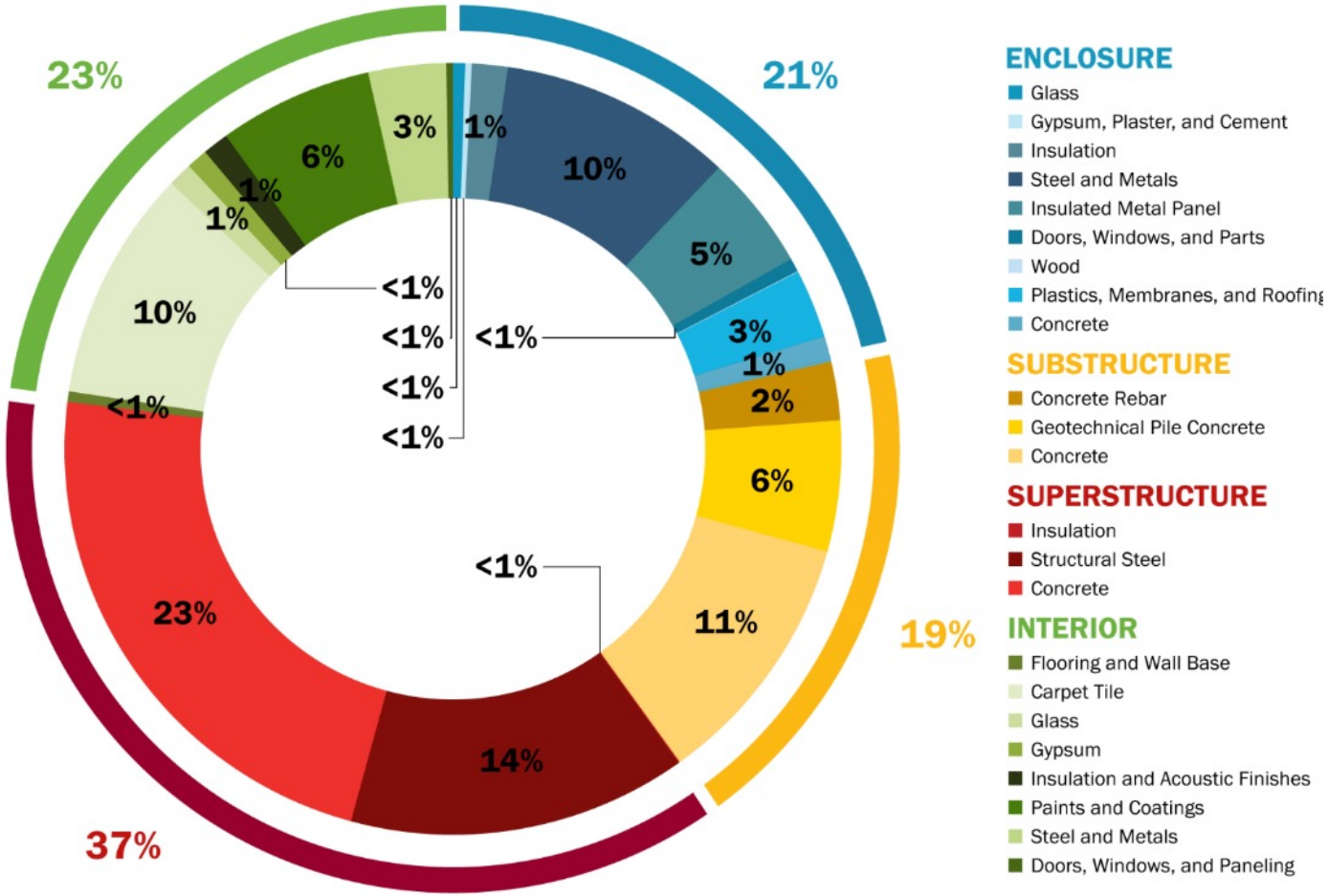
Facades and embodied energy

Typical break down of new projects in the Bay Area



ENCLOSURE
- Glass
- Gypsum, Plaster, and Cement
- Insulation
- Steel and Metals
- Insulated Metal Panel
- Doors, Windows, and Parts
- Wood
- Plastics, Membranes, and Roofing
- Concrete

SUBSTRUCTURE
- Concrete Rebar
- Geotechnical Pile Concrete
- Concrete

SUPERSTRUCTURE
- Insulation
- Structural Steel
- Concrete

INTERIOR
- Flooring and Wall Base
- Carpet Tile
- Glass
- Gypsum
- Insulation and Acoustic Finishes
- Paints and Coatings
- Steel and Metals
- Doors, Windows, and Paneling

20-30%
Enclosure

45-60%
Structure

20-30%
Interiors

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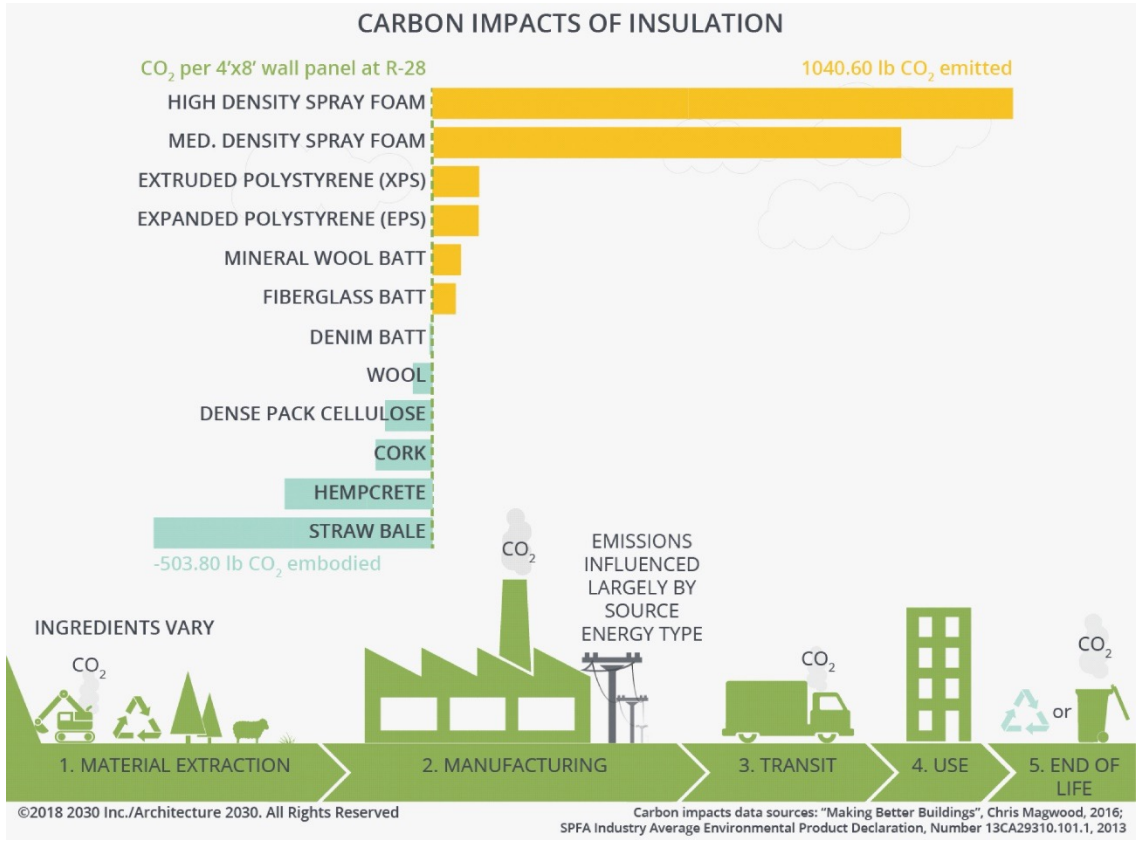
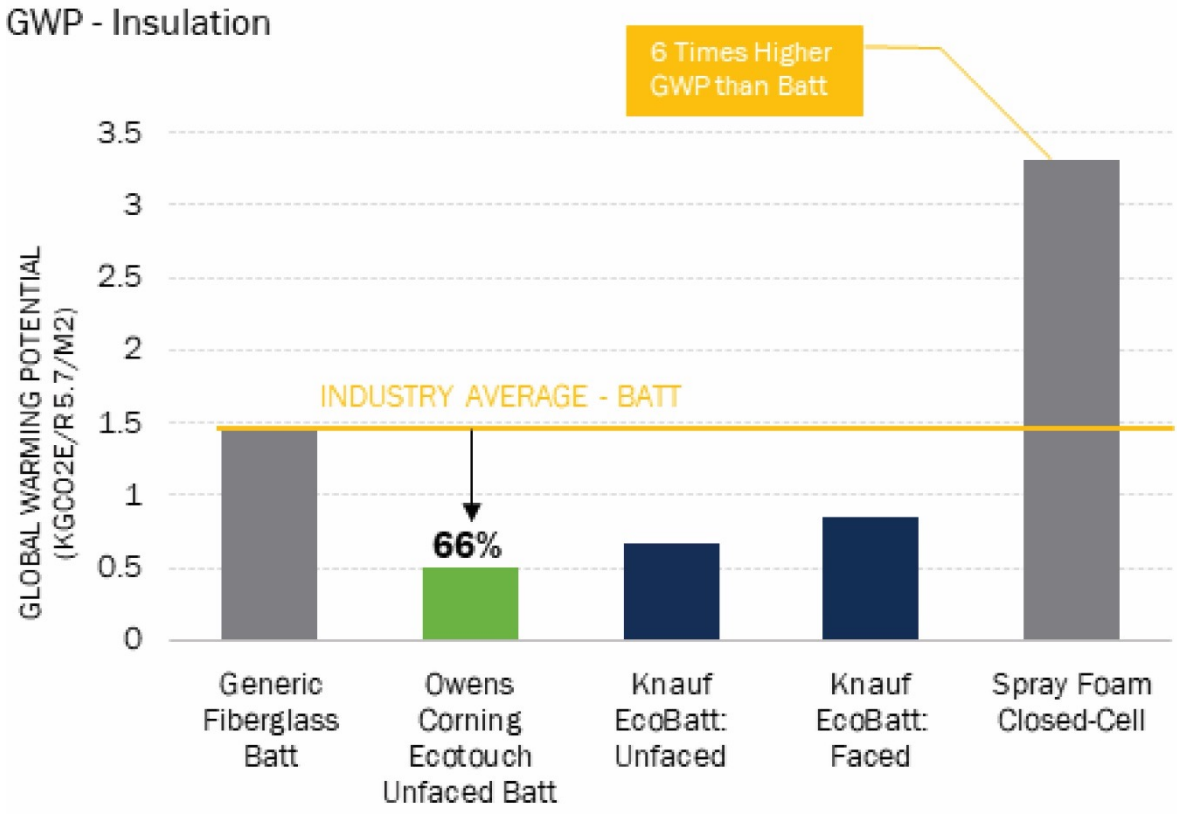
Facades and embodied energy

Materials perform surprisingly different for the same functional contribution





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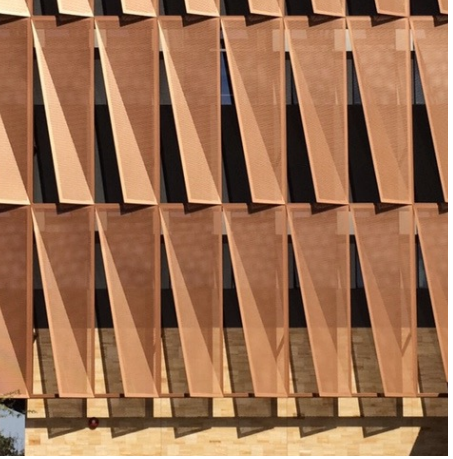

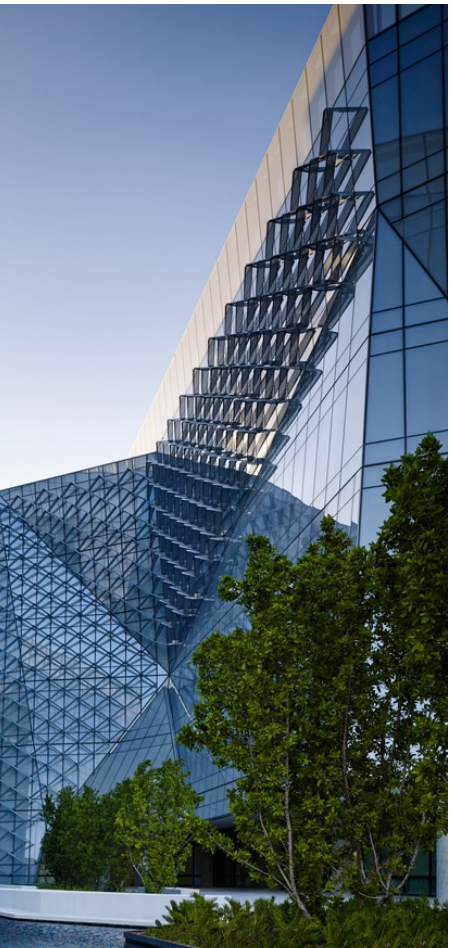

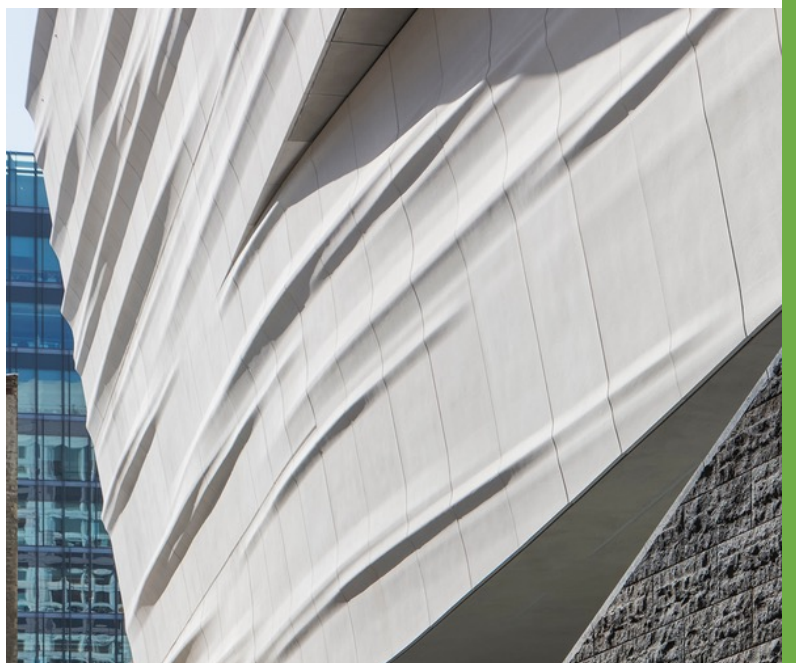

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East Coast

NEW YORK
45 East 20th Street, 4th Fl
New York NY 10003
T +1 (212) 254 450011

NEW HAVEN
798 Chapel Street
New Haven CT 06510
T +1 (203) 777 1400

SAN FRANCISCO
443 Tehama Street, 1st Fl
San Francisco CA 94103
T +1 (415) 351 2100

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