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Designers Lighting Forum

Holistic Sustainable Design for Lighting

Alexandra Gadawski, HMFH Architects
Jaime McGavin, HMFH Architects
Christoph Reinhart, Solemma and Massachusetts Institute of Technology

March 8th, 2023

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Credit(s) earned on completion of this course will be reported to AIA CES for AIA members. Certificates of Completion for both AIA members and non-AIA members are available upon request.

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Questions related to specific materials, methods, and services will be addressed at the conclusion of this presentation.

Learning Objectives

At the end of this course, participants will be able to:

1. Discuss design goals through the lenses of human, climate and ecosystem health, social health and equity, and the circular economy to ensure that the health of building occupants, as well as the larger public, is prioritized.

2.Facilitate a visioning charrette, set concrete targets, determine tracking metrics, and convey goals to clients and the project team.

3. Implement a sustainable design workflow which incorporates quantitative analysis, starting at feasibility and continuing through construction administration.

4. Analyze design decisions through efficient workflow and describe analysis tools and simulation types that can be used to facilitate the sustainable design goals established by the team.

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SPEAKERS

Christoph Reinhart

PhD, MIT SA+P Educator

Head
Sustainable Design Lab (SDL)

Alexandra Gadawski

AIA, WELL AP, LEED AP BD+C

Associate
HMFH Architects

Jaime McGavin

LEED AP BD+C

Designer
HMFH Architects

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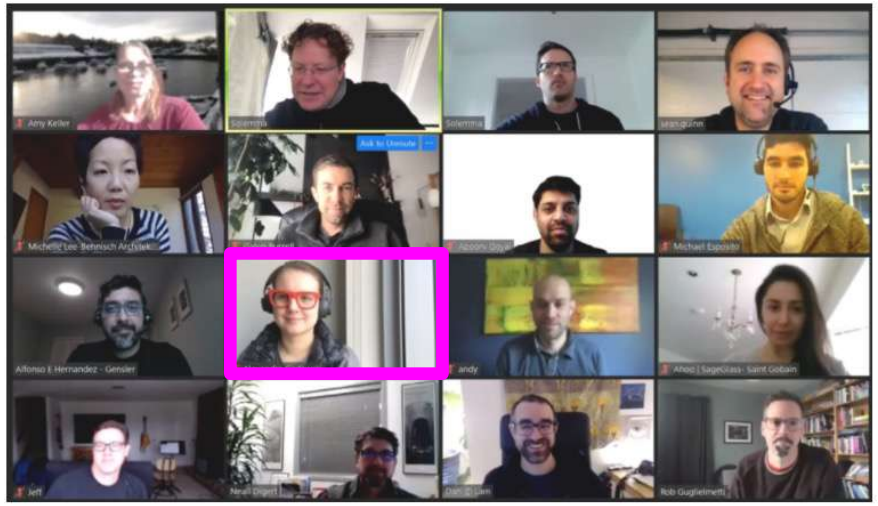
MIT SUSTAINABLE DESIGN LAB

SOLEMMA

Product Advisory Group



Research\Education ← Tools & Workflows → Practice

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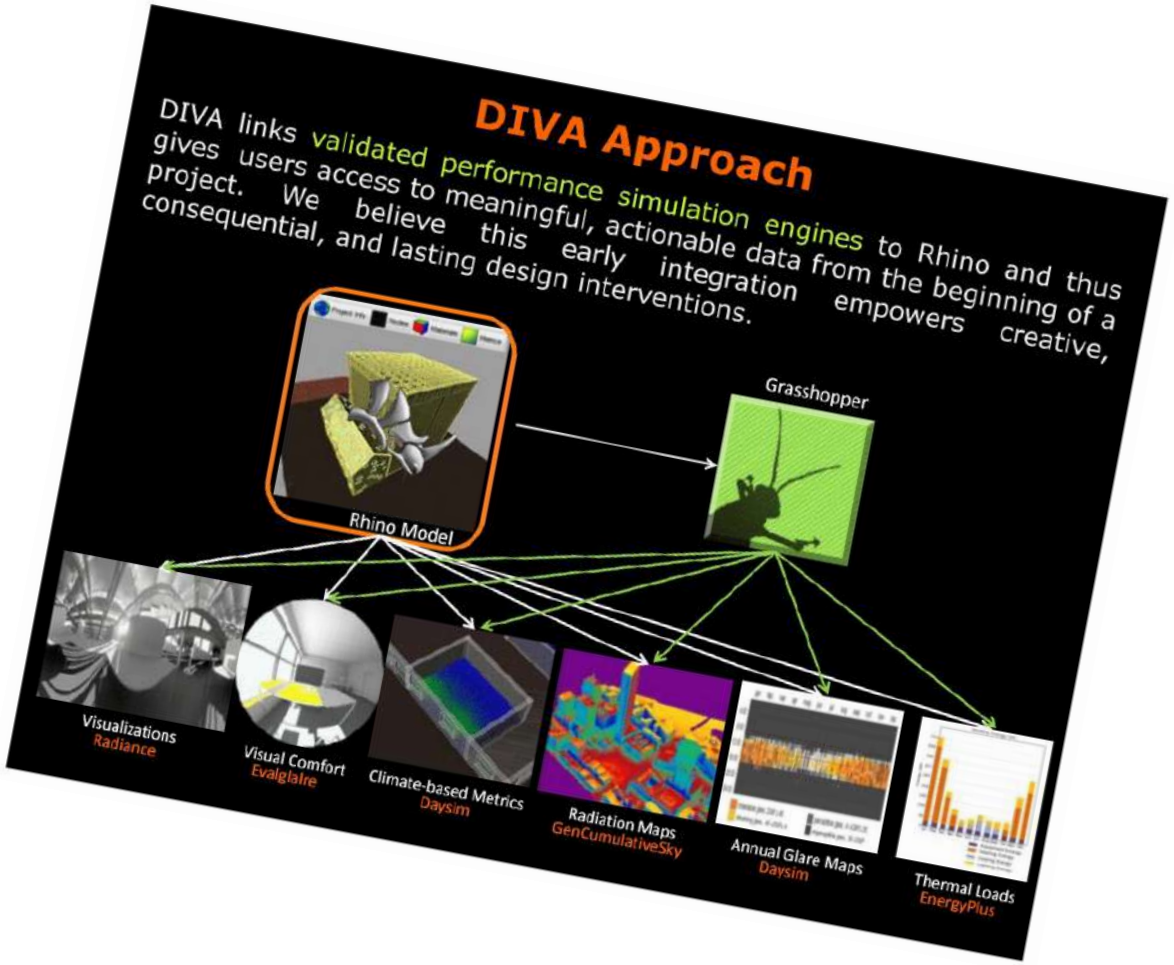
Combining Design and Environmental Modeling since 2012



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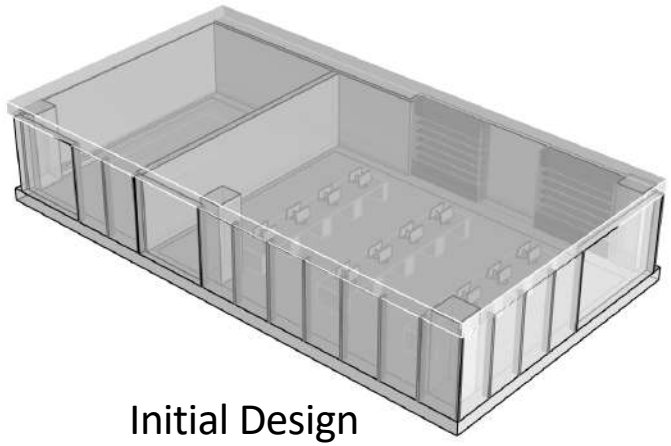
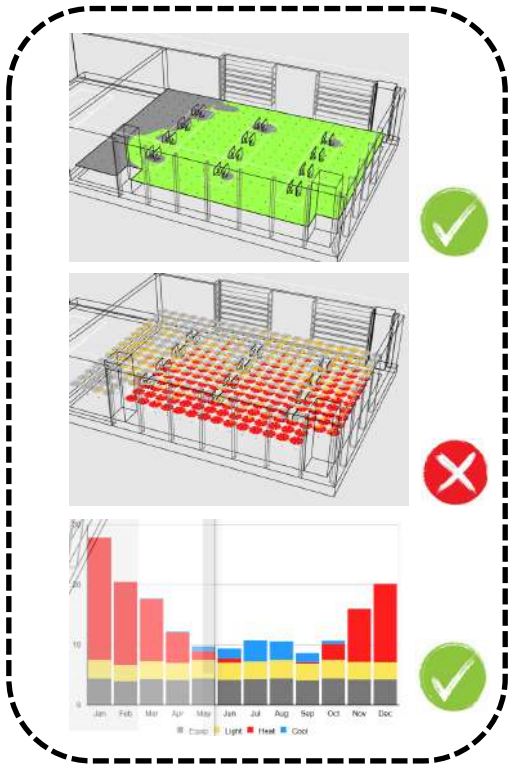
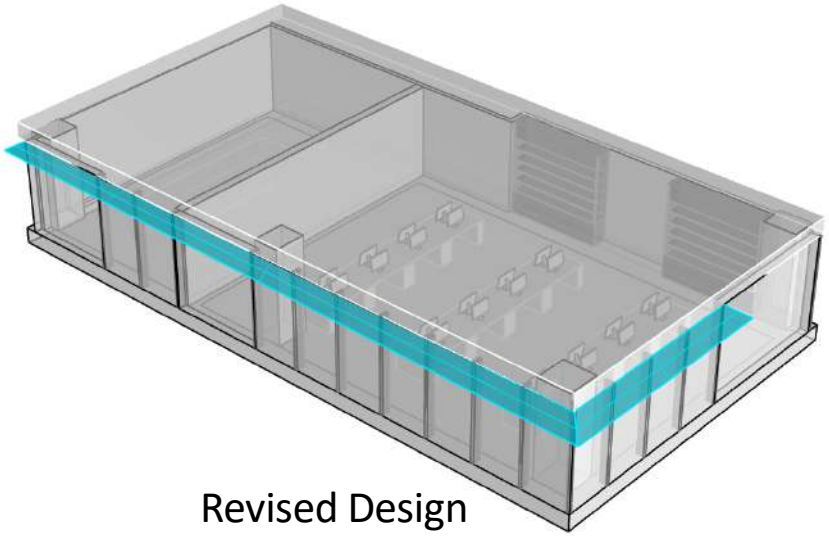
Environmental Performance Analysis in Design



Initial Design



Environmental Analysis



Revised Design

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How often does that happen?

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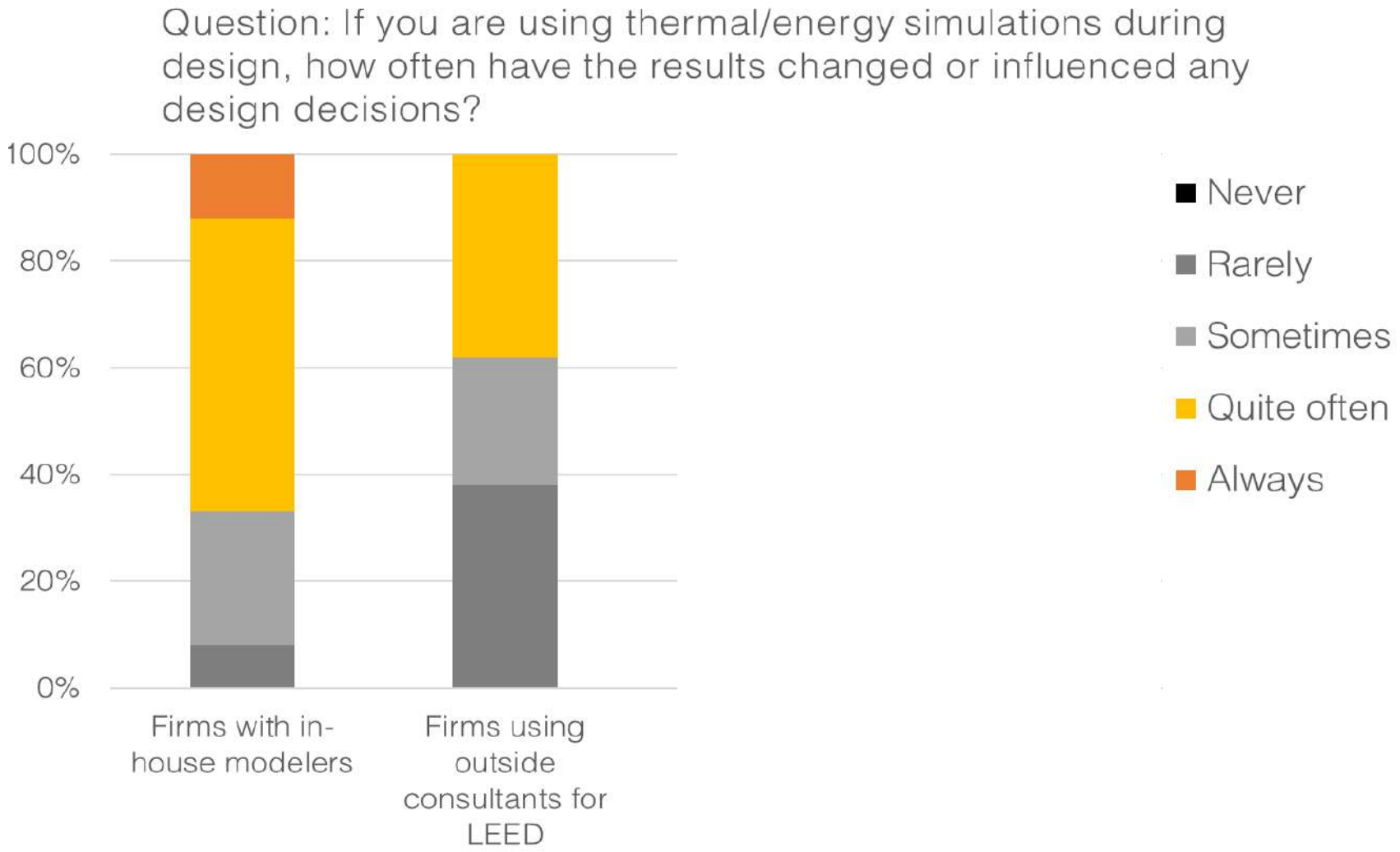
Two surveys: 2011 and 2018



H W Samuelson, A Lantz and C F Reinhart, "Non-technical barriers to energy model sharing and reuse", Building and Environment, 54, pp. 71-76, 2012.

Is there an interest in change?

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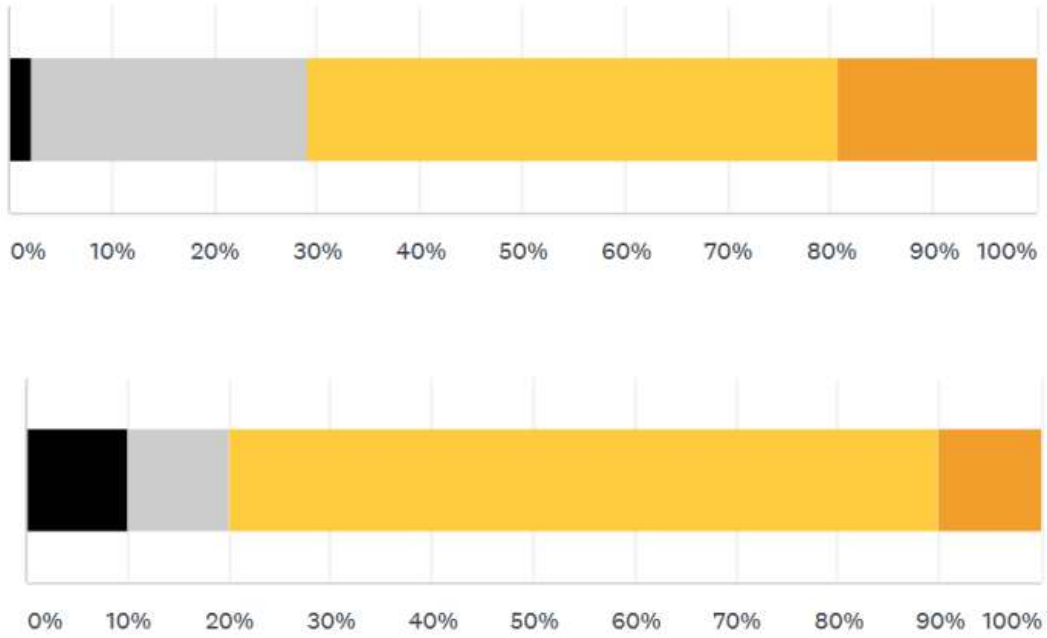
2018 survey: Daylighting – Attitude towards Simulations

What is your general attitude towards daylight simulations?



- I have not seen a case in which this type of analysis has helped us to design a better building.
- I appreciate insight gained from daylight simulations provided during design reviews by our sustainability consultants.
- I highly value insight gained from daylight simulations and believe that some of the simulations should be conducted by designers, if adequate training is provided.
- I highly value insight gained from daylight simulations and already use them during design.

- ❑ Positive attitude throughout.
- ❑ Broad consensus regarding interest into training designers in the use of simulations.

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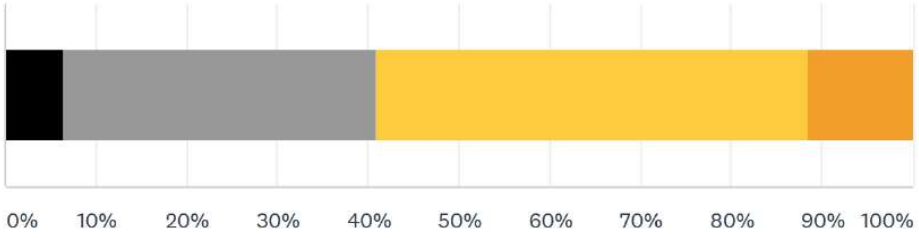
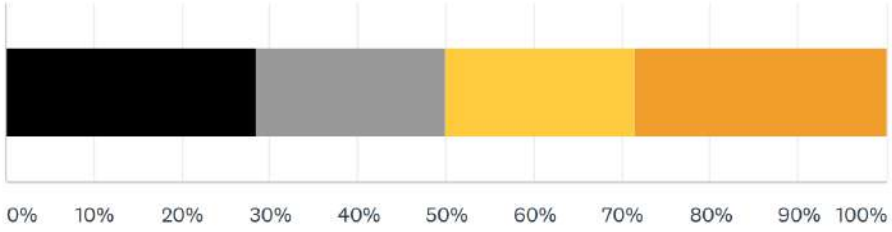
2018 survey: Thermal – Attitude towards Simulations

What is your general attitude towards thermal/energy simulations?

Designers



Experts



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❑ Less clear mandate to introduce designers to energy modeling

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Is there an interest in change?

Yes, and we have to act now!

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Solemma Product Advisory Group

KALWALL®
high performance translucent building systems

KPF

h+k

SHIMIZU CORPORATION
SHIMZ

PERKINS EASTMAN

TAKENAKA

atelier ten

STUDIO MA

view

Lam Partners

NIKKEN

INTEGRAL

Gensler

KINESTRAL

HM FH

SAINT-GOBAIN

BEHNISCH ARCHITEKTEN

SOLATUBE

Snøhetta

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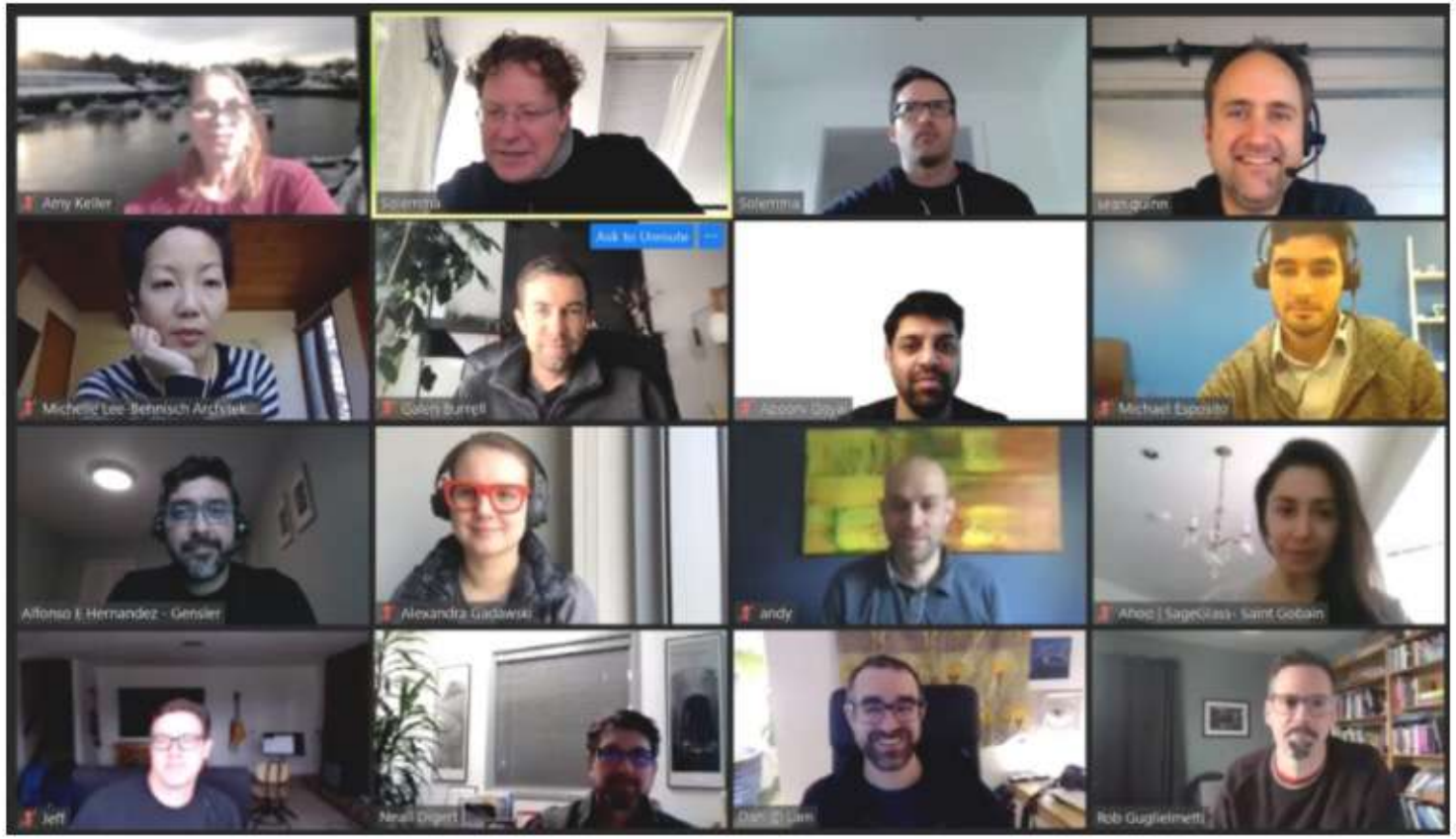

- ❑ Since 2019
- ❑ Bimonthly calls
- ❑ Present new concept ideas
- ❑ Share test installers
- ❑ Survey and respond to member interests

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ClimateStudio release in 2020 in LA

https://www.solemma.com/climatestudio

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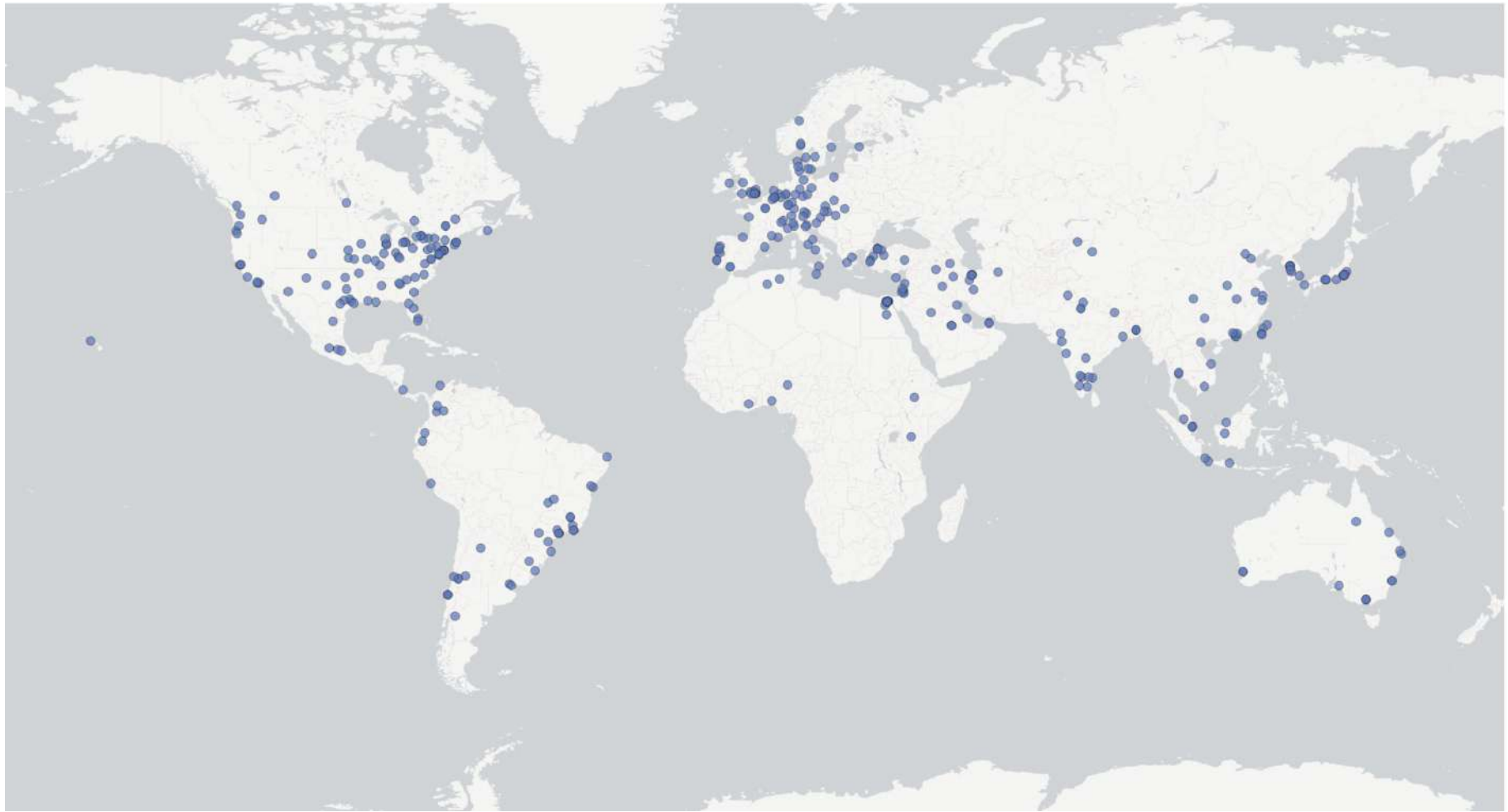
ClimateStudio Ambassador Program



- Over 500 Schools of Architecture teach over 30,000* students each year

*) Number estimate based on 2022 survey

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ClimateStudio in Ghana

Courage (Dzidula) Kpodo teaching CS at Kwame Nkrumah University of Science and Technology

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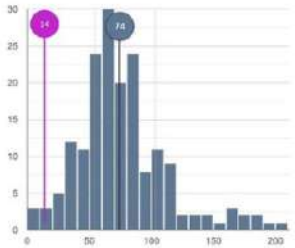
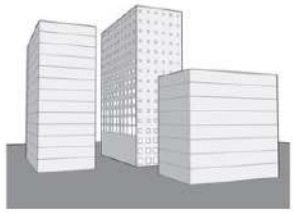
MIT SDL Net Zero Buildings in eight steps



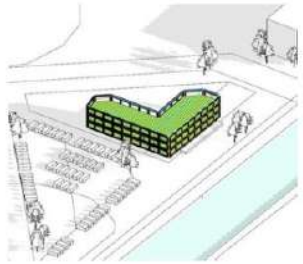
Climate, Benchmark & PV

Three initial environmental analysis steps for any net zero building project



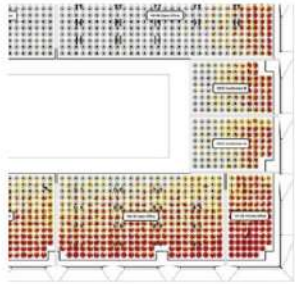
Daylight Precedence & Massing Study

Develop an initial daylight massing based on precedence and rules of thump



Daylight Availability Study

Refine daylight massing and set window-to-wall-ratio and glazing type

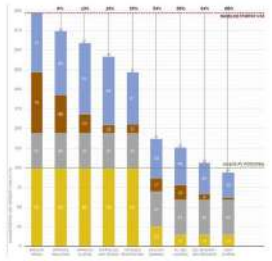


Visual Comfort

Develop a shading strategy by balancing glare, view and solar gains

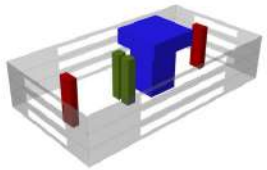
Electric Lighting

Explore the dynamic interactions between daylight and electric lighting



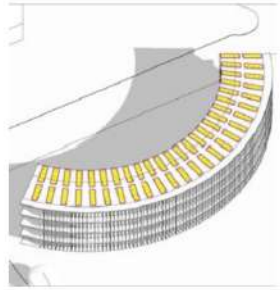
EUI Study

Reduce internal gains, upgrade the envelope and optimize ventilation



HVAC Selection and Layout

Select a system type and Description goes here locate system components



Finalize Onsite Renewables

Compare annual onsite energy generation to operational energy use

https://netzerobuildings.mit.edu

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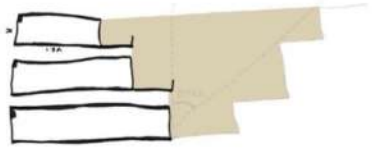
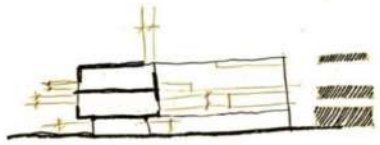
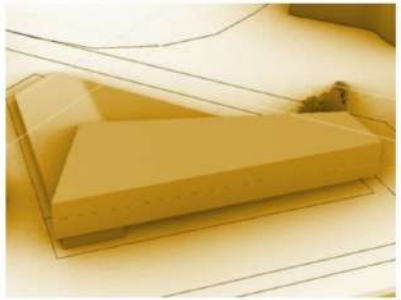
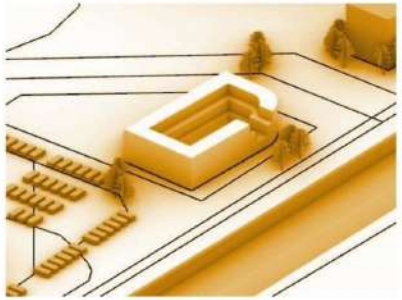
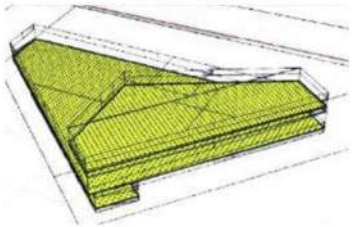
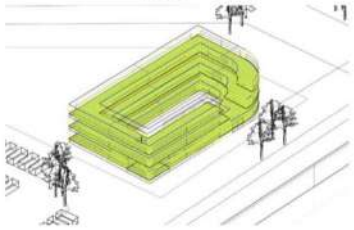
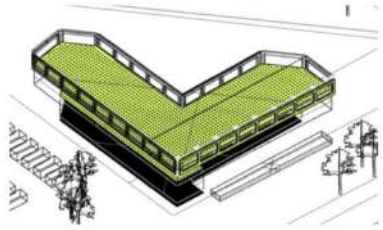
Daylight Massing

Rules of thumb

Simulation

	Skylights	Atrium	Fabric
Concept			
Massing			
sDA	sDA = 100% ASE = 70% 	sDA = 100% ASE = 66% 	sDA = 100& ASE = 43% 

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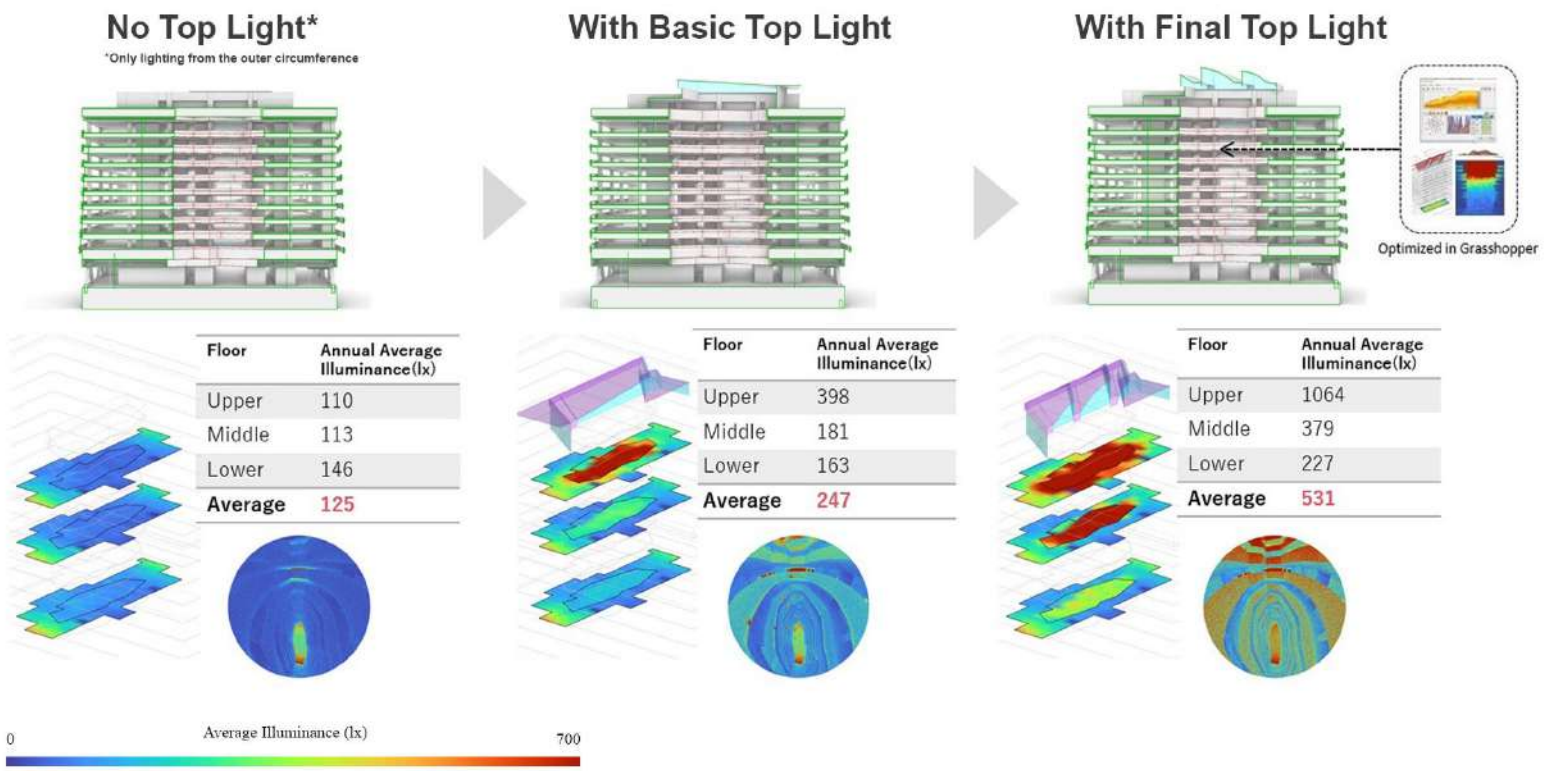
Case Study: MEBKS TOYOSU

MEBKS TOYOSU Shimizu Corporation, Tokyo



Images courtesy of Shimizu Cor
Blog post: https://www.solemma.com/blog/mebks-toyosu-atrium-case-study

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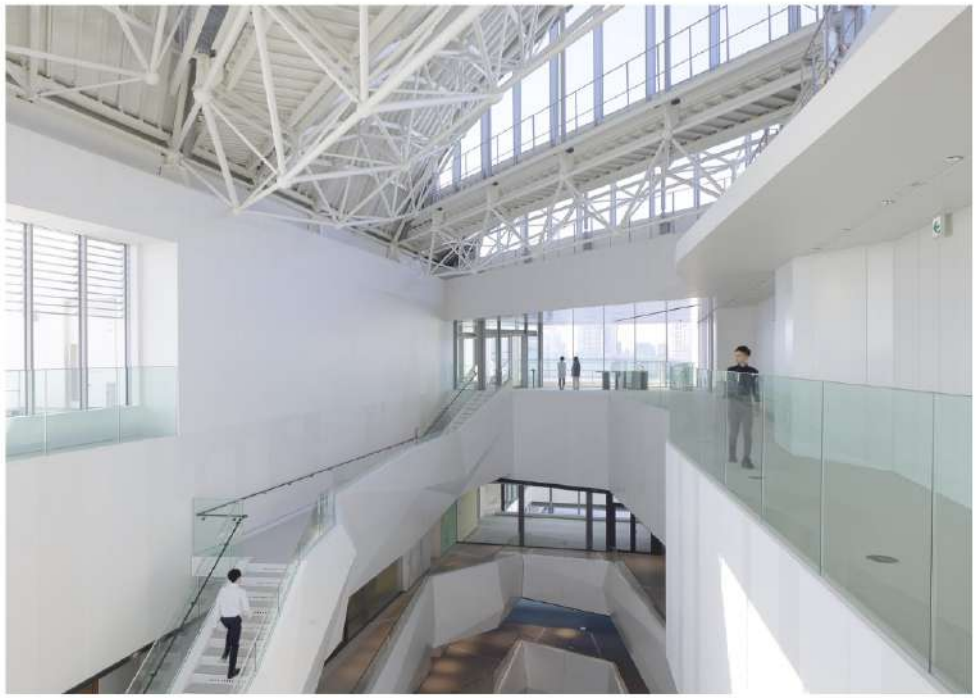
Case Study: MEBKS TOYOSU



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Images courtesy of Shimizu Cor
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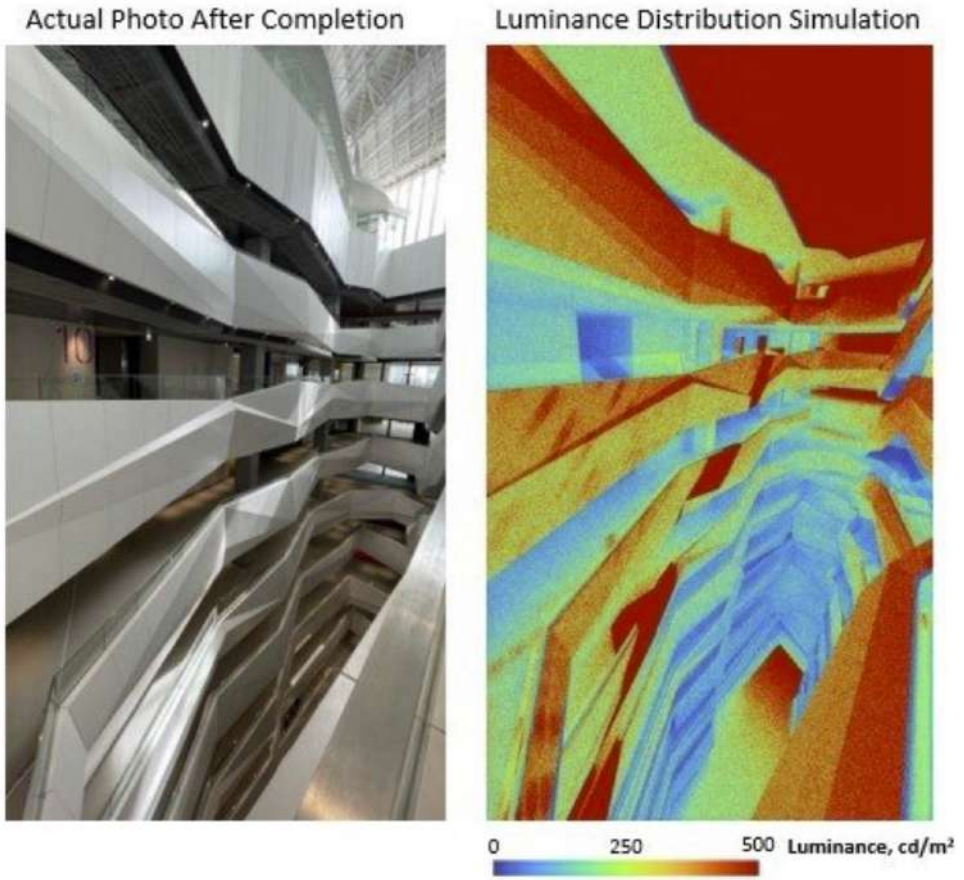
Case Study: MEBKS TOYOSU



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Images courtesy of Shimizu Cor
Blog post: https://www.solemma.com/blog/mebks-toyosu-atrium-case-study

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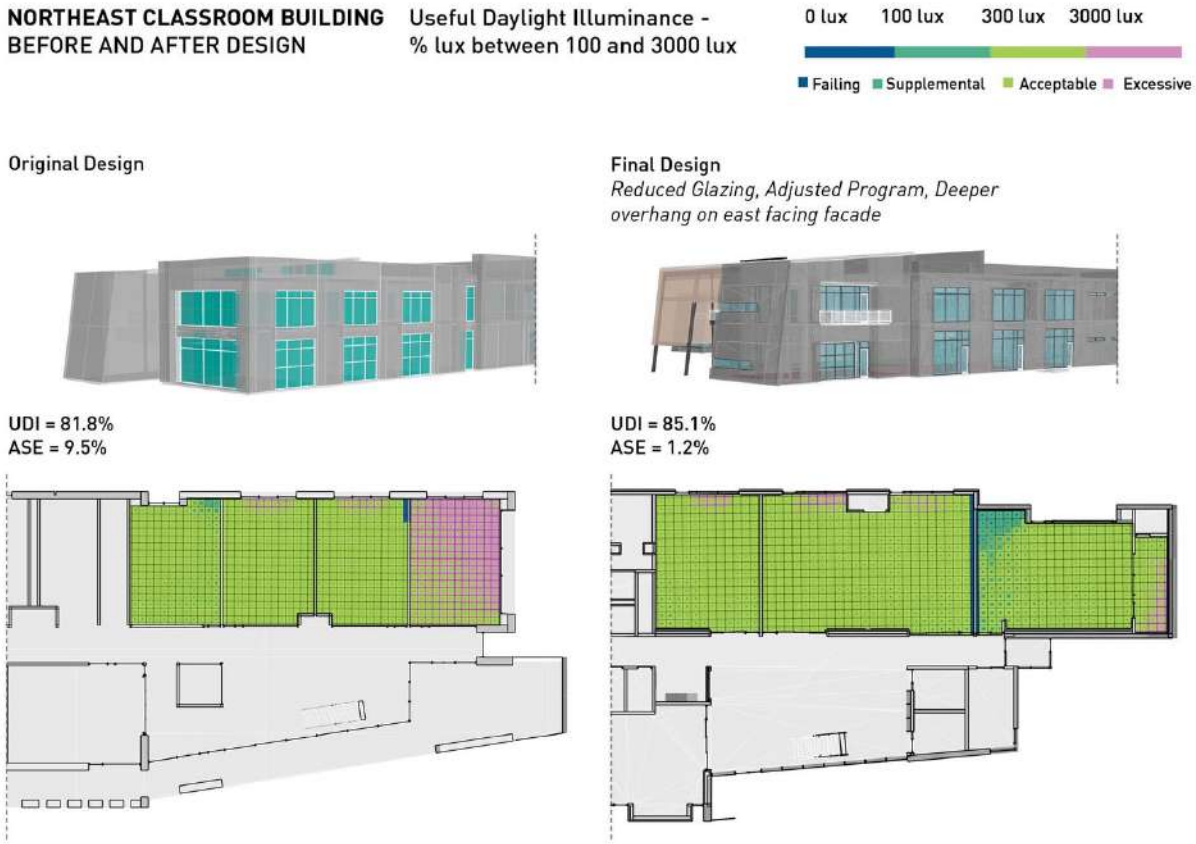
Case Study: Lake|Flato designs High-Performance School

Alamogordo Middle School in Alamogordo, NM



Images courtesy of Lake|Flato
Blog post: https://www.solemma.com/blog/lakeflato-alamogordo-middle-school-case-study

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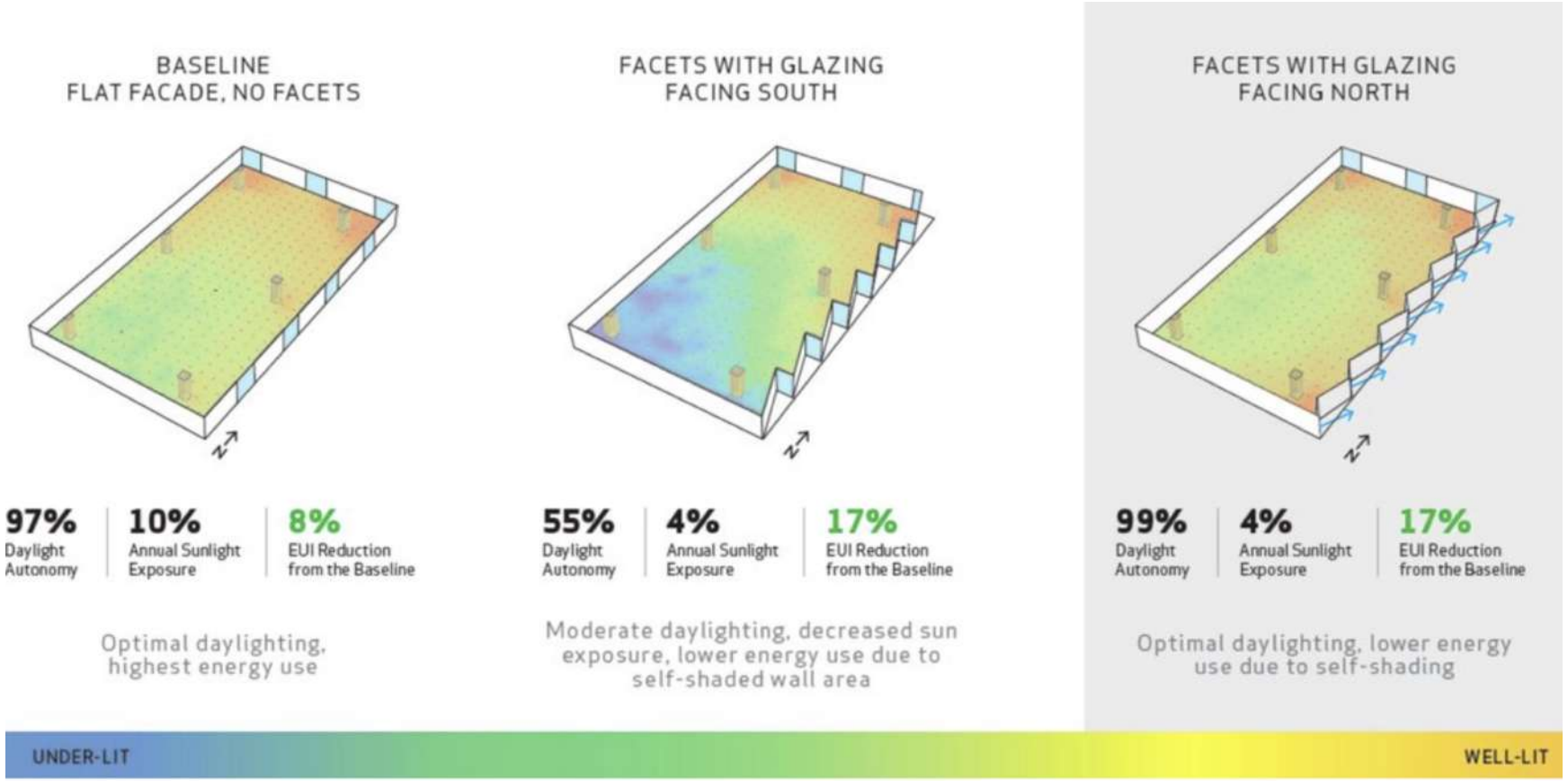
Case Study: Residence Hall for Arizona State University



Images courtesy of Studio MA
Blog post: https://www.solemma.com/blog/lakeflato-alamogordo-middle-school-case-study

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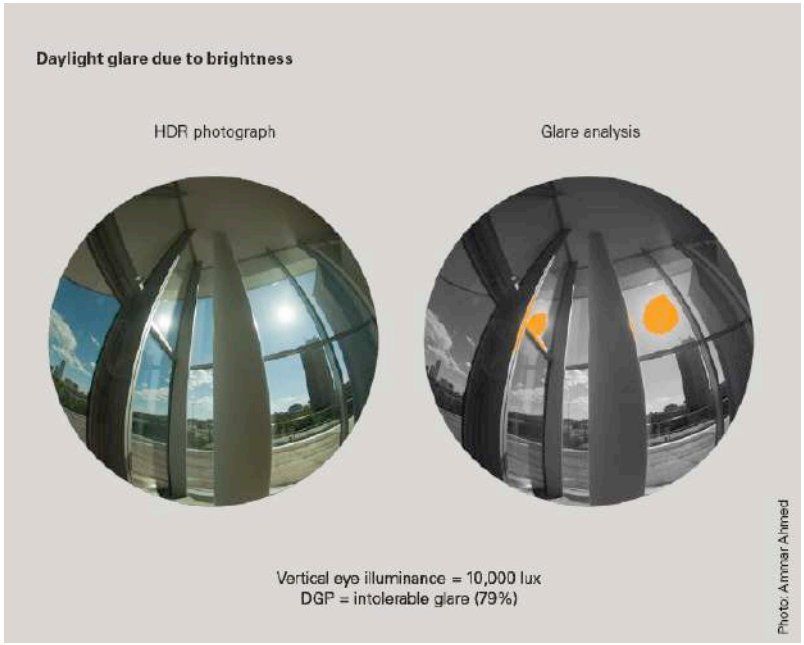
Discomfort Glare Analysis



Imperceptible glare	Perceptible glare	Disturbing glare	Intolerable glare
DGP ≤ 35%	35% < DGP ≤ 40%	40% < DGP ≤ 45%	45% < DGP

Source: Daylighting Handbook II

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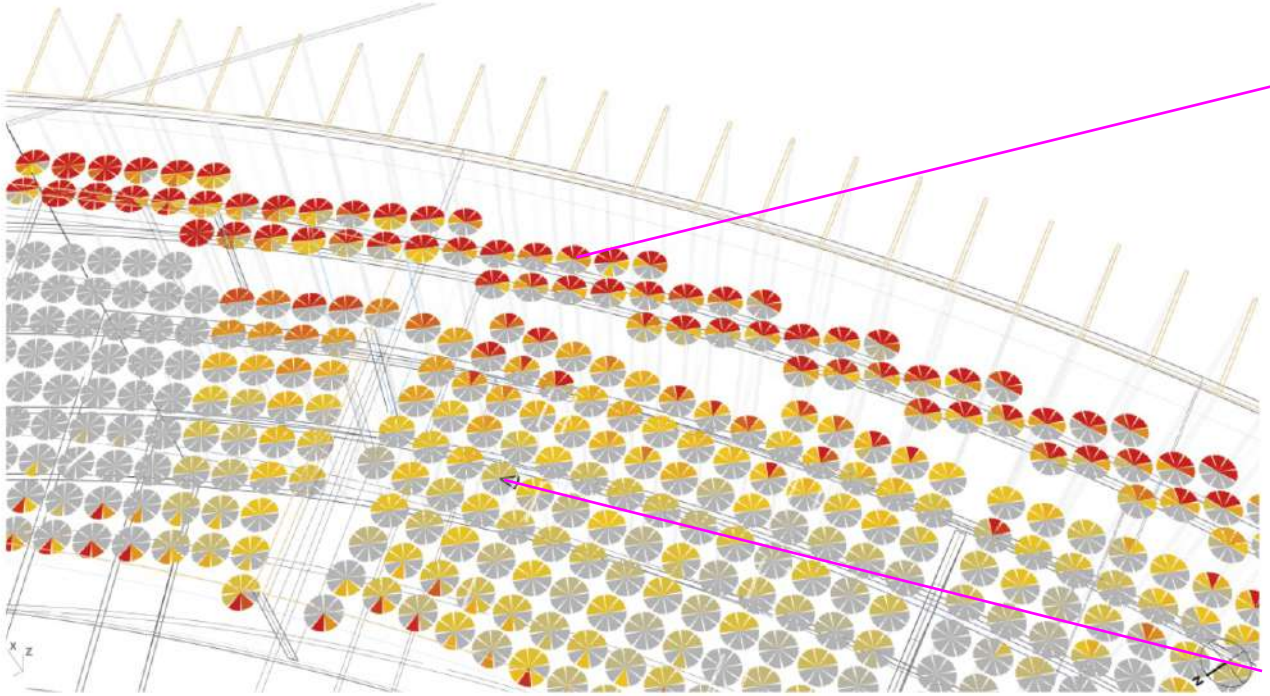
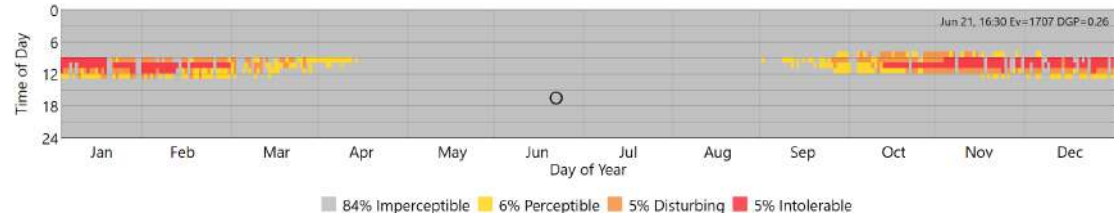
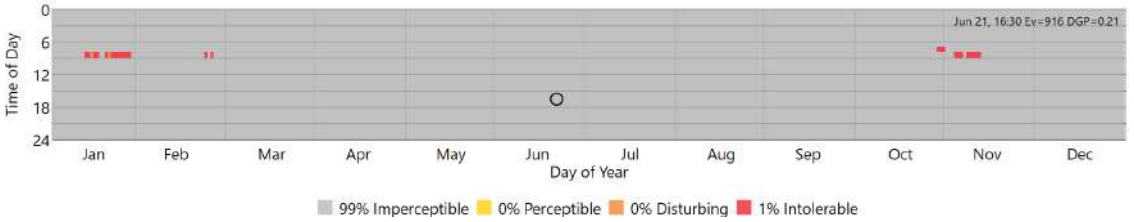
Annual Discomfort Glare Analysis







- Each slice corresponds to a give view direction within the scene
- The color of the slice depends on how often a spectator may experience discomfort glare throughout the year.

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Case Study: NVIDIA Endeavor Headquarters

Architecture: Gensler, Sustainability Consultant: Atelier Ten, Santa Clara, CA

Images courtesy of Gensler & A10
Solemma Symposium 2020: https://www.solemma.com/events-2020/#talks

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Case Study: NVIDIA Endeavor Headquarters

Photo: Jason O'Rear/Gensler

Images courtesy of Gensler & AIA

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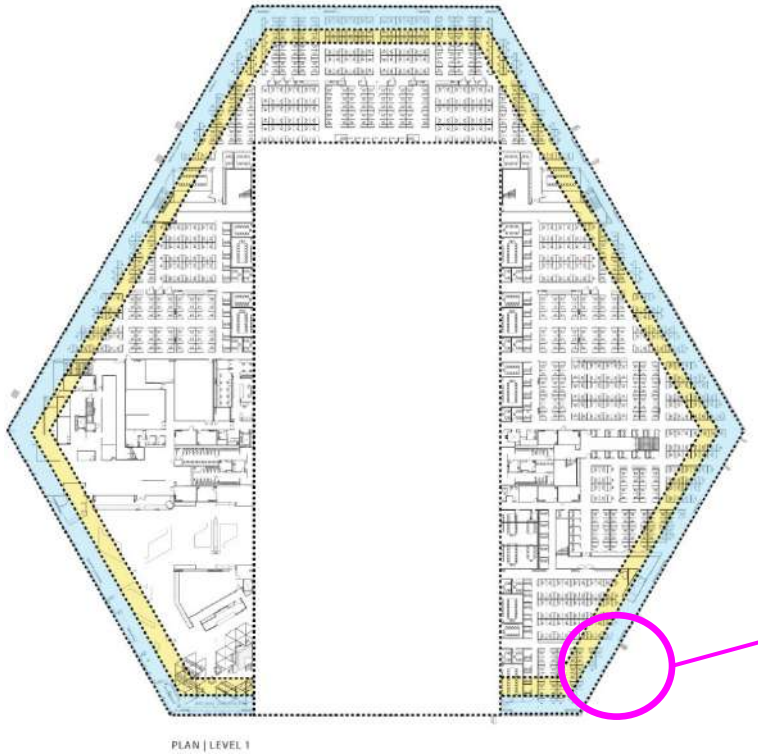
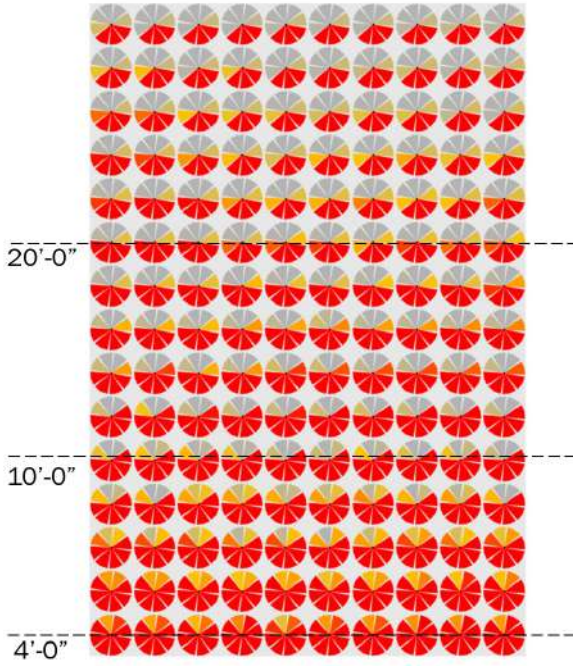
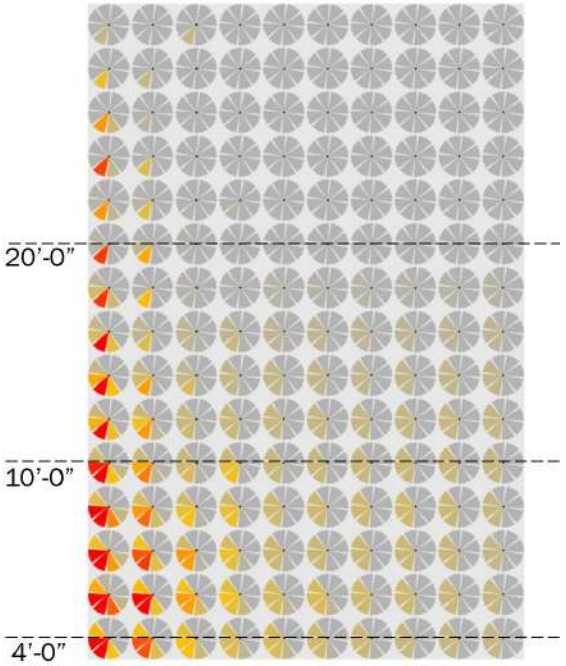
Case Study: NVIDIA Headquarters – Glare



No blinds



Blinds 100%



Simulation Atelier Ten

- Dynamic Thermal & Daylight Zone
- Brighter Daylight Zone
- Low risk of thermal and visual discomfort

Images courtesy of Gensler & A10
Solemma Symposium 2020: https://www.solemma.com/events-2020/#talks

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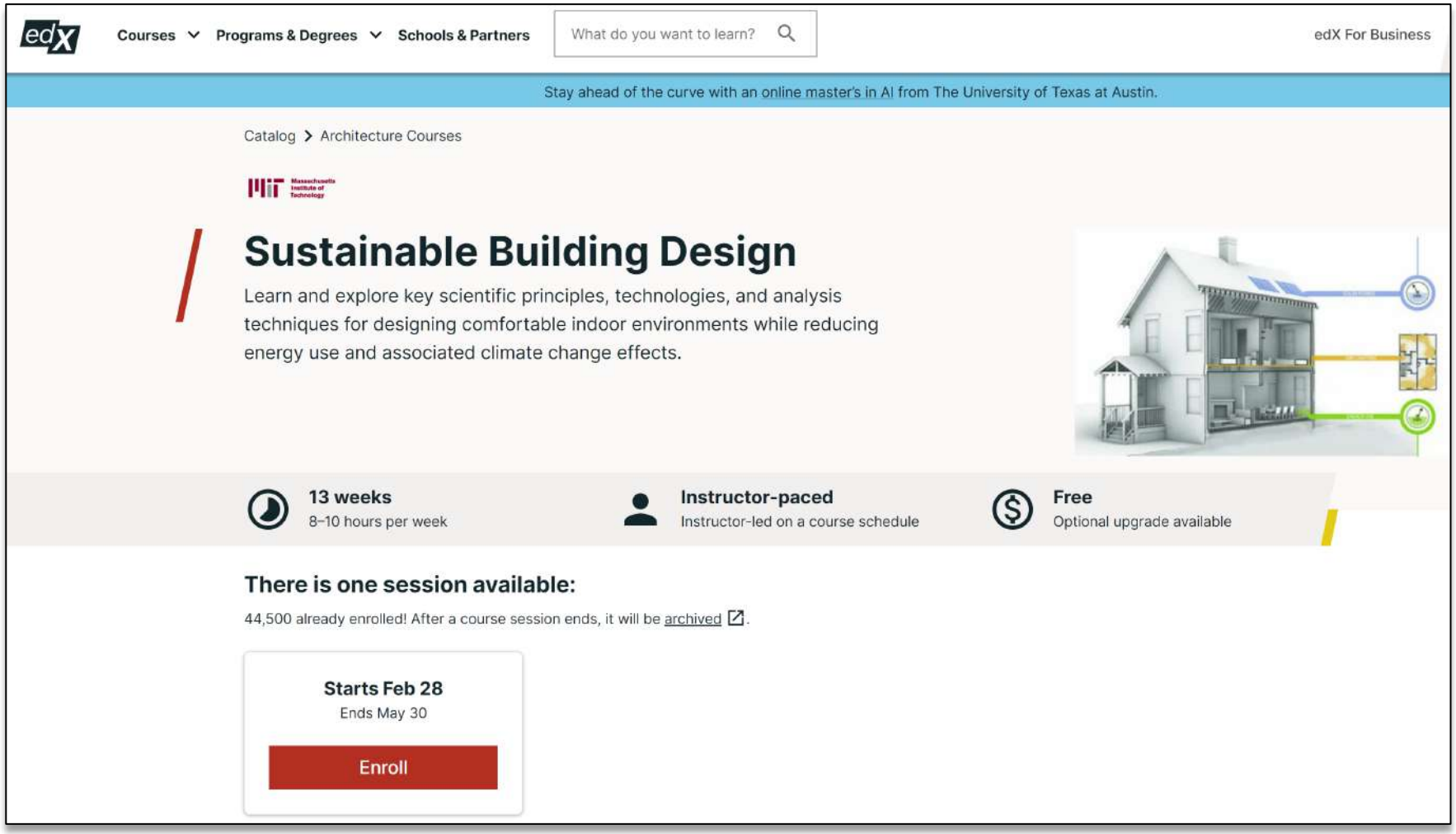

https://www.edx.org/course/environmental-technologies-in-buildings

Firm Values ...

Why is this important?

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HM
FH

BUILDING PERFORMANCE HEALTH + WELLBEING

Indoor Environment - COG FX STUDY

By the time a student graduates high school, they will have spent **more than 15,000 hours in a school,** which is the second longest indoor exposure time after their home. For more than 50 million K-12 students enrolled in fall of 2015, this is a time of critical physiological, social and emotional growth and development, which is susceptible to many indoor conditions including indoor air pollution, mold, elevated noise levels, radon, asbestos, inadequate lighting and more.

https://schools.forhealth.org/#relevant-research-sidebar

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BUILDING PERFORMANCE HEALTH + WELLBEING

HMFH Commitment - AIA Materials Pledge

support **human health** by preferring products that support and foster life throughout their life cycles and seek to eliminate the use of hazardous substances.

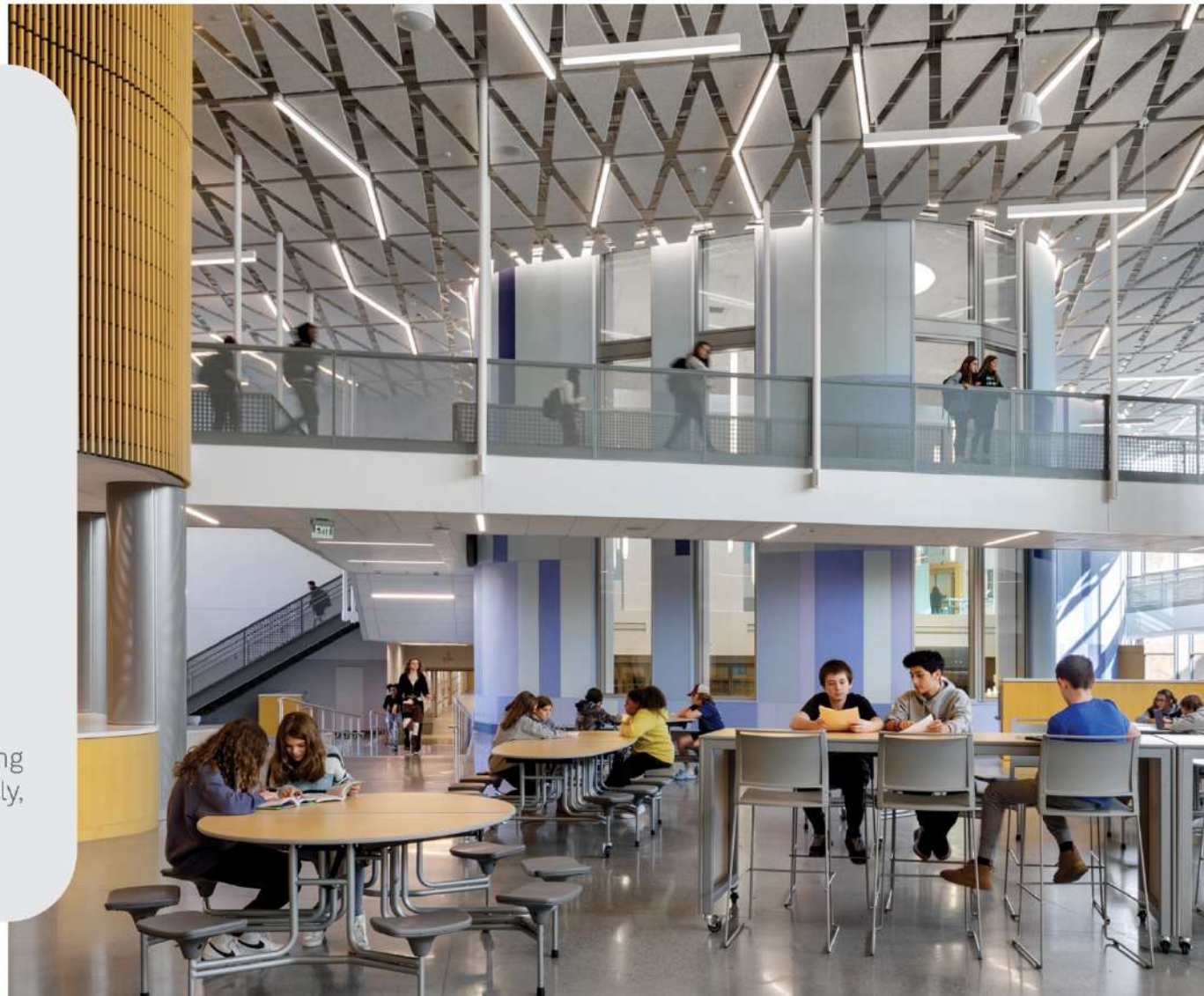
support **social health & equity** by preferring products from manufacturers that secure human rights in their own operations and in their supply chains, positively impacting their workers and the communities where they operate

support **ecosystem health** by preferring products that support and regenerate the natural air, water, and biological cycles of life through thoughtful supply chain management and restorative company practices

support **climate health** by preferring products that reduce carbon emissions and ultimately sequester more carbon than emitted.

support a **circular economy** by reusing and improving buildings and by designing for resiliency, adaptability, disassembly, and reuse, aspiring to a zero-waste goal for global construction activities.

https://www.aia.org/pages/6351155-materials-pledge



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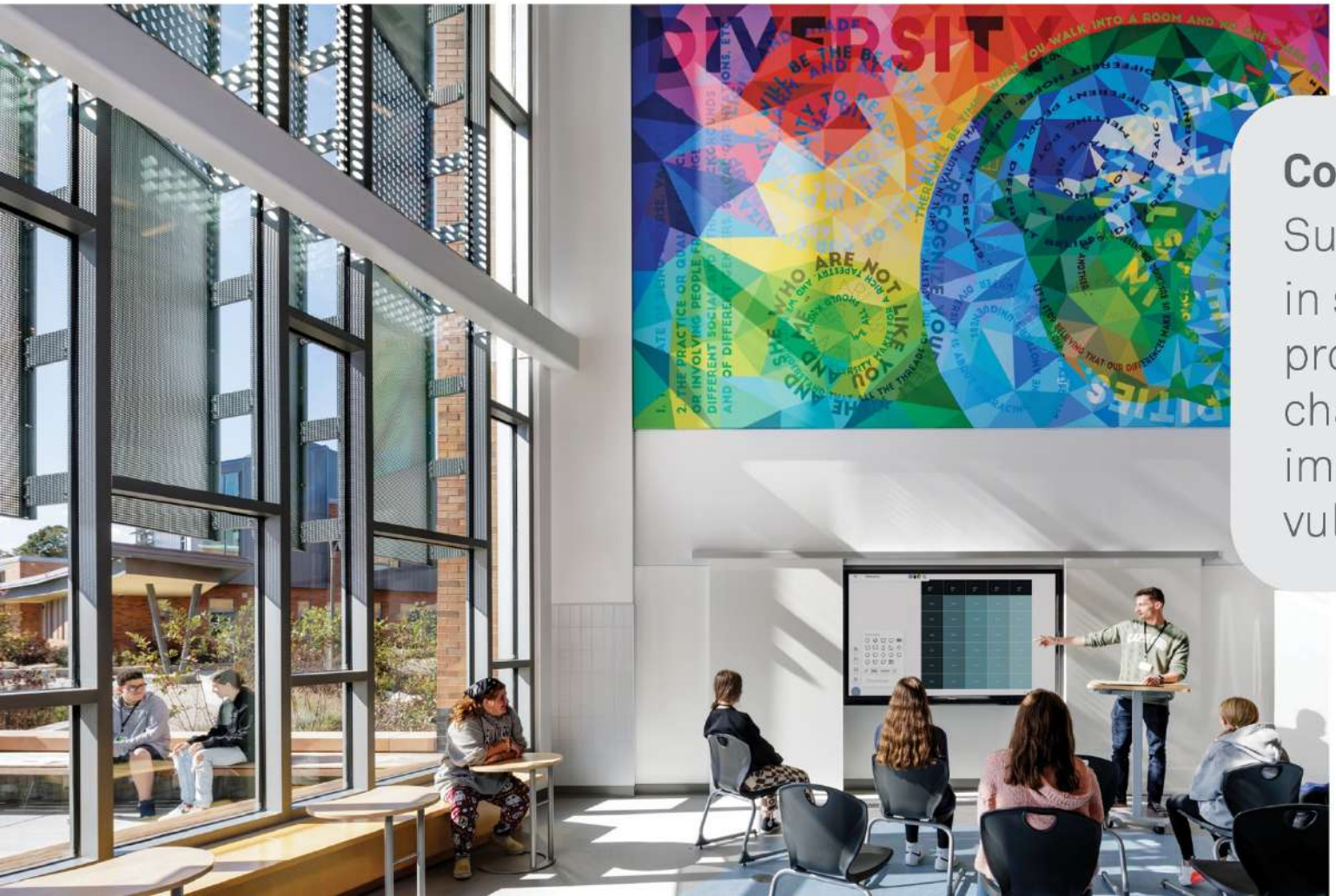
BUILDING PERFORMANCE HEALTH + WELLBEING

Material Transparency - Social Justice



Considering Social Justice

Sustainability work at its core is rooted in social justice because environmental problems, such as pollution and climate change, have disproportionately impacted low-income and other vulnerable populations.

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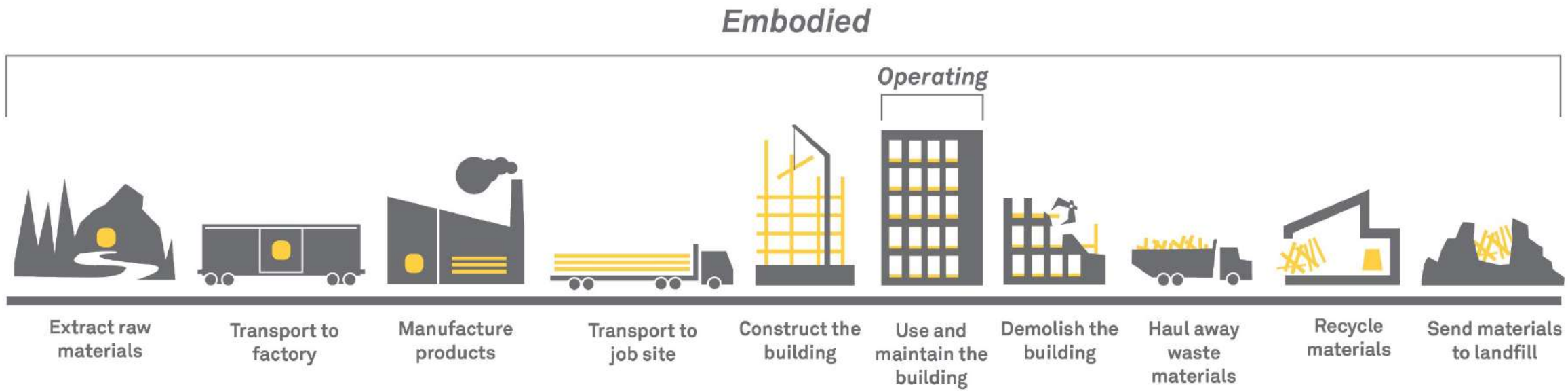
Thinking Beyond Building Occupants



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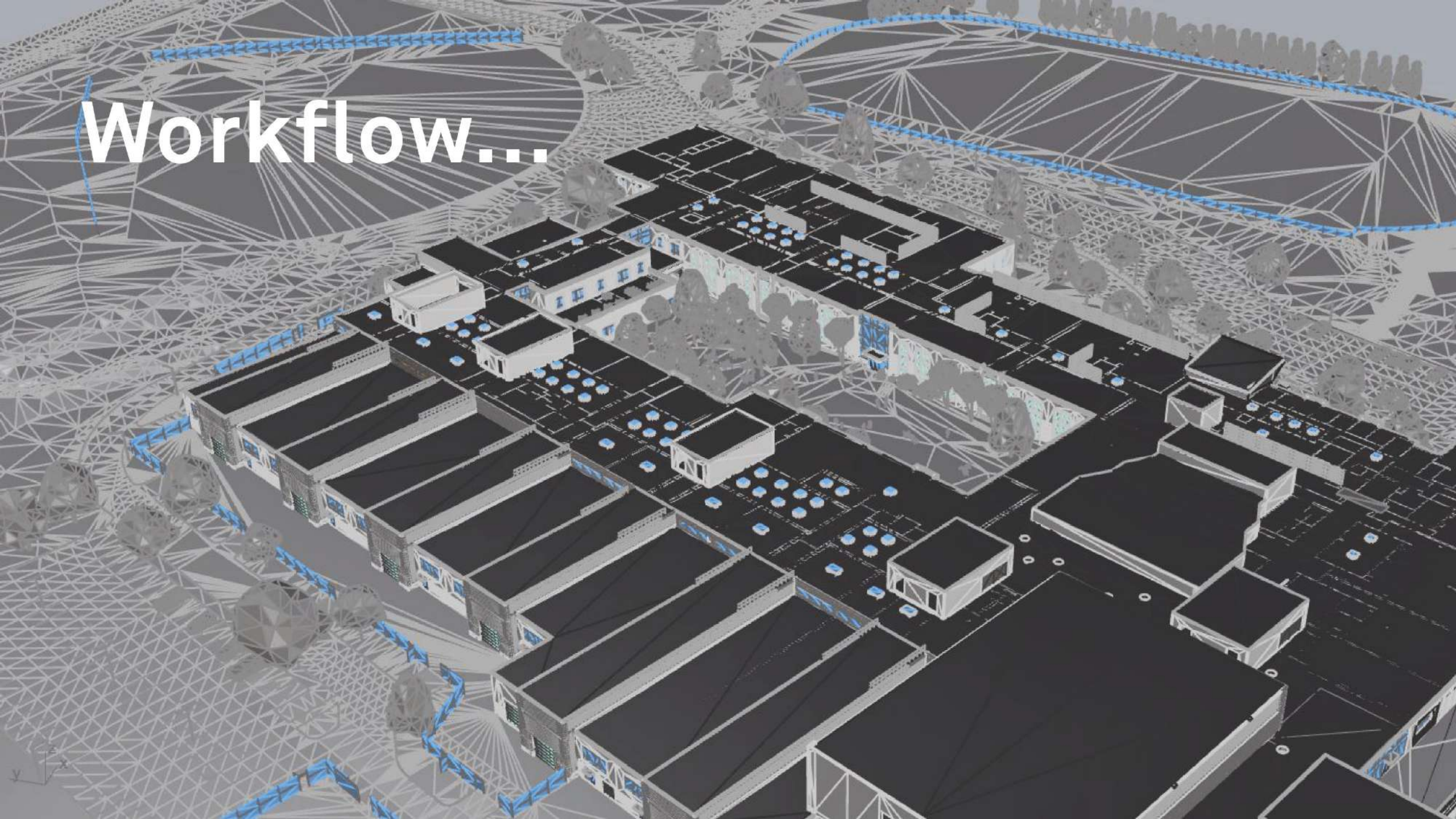
FIRM COMMITMENTS

AIA + architecture 2030 + mindful MATERIALS

Workflow...



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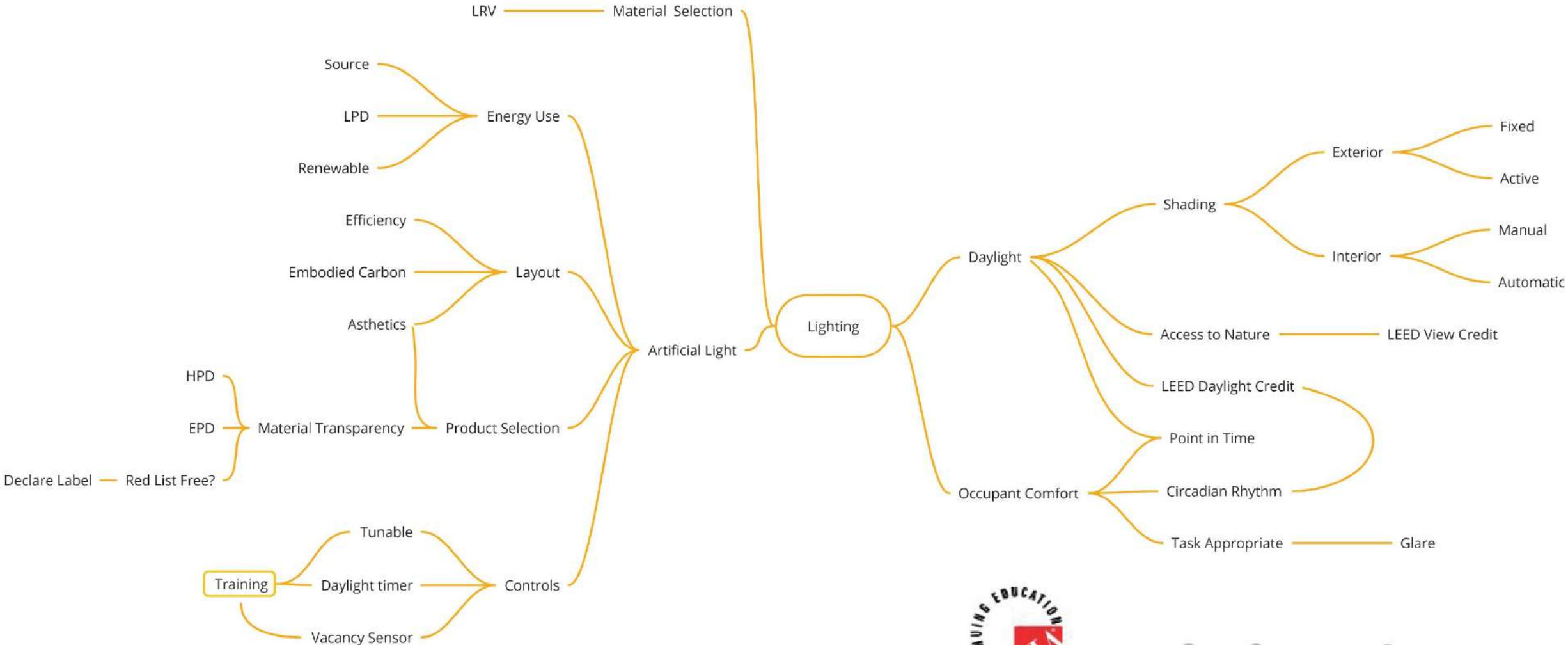
SYNERGIES AND OPPORTUNITIES



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Standardized Workflow

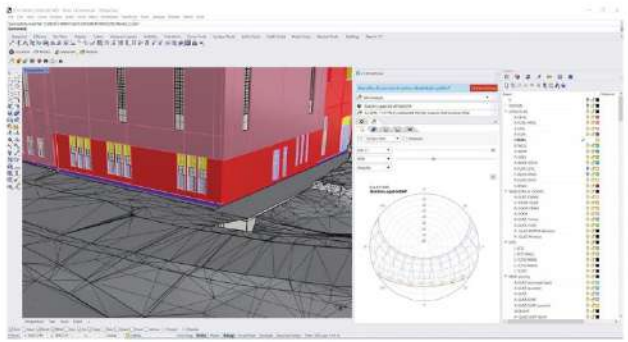
HMFH Workflow - Climate Studio

Table of Contents

HMFH

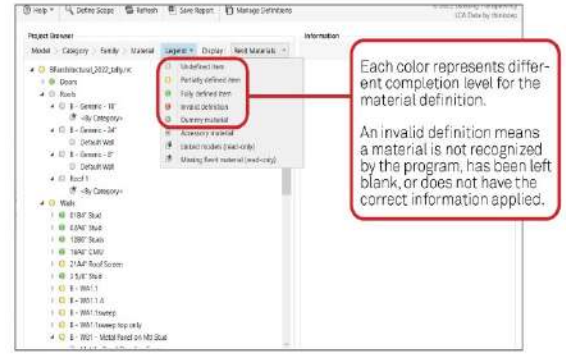
CLIMATE STUDIO: HMFH WORKFLOW

DRAFT

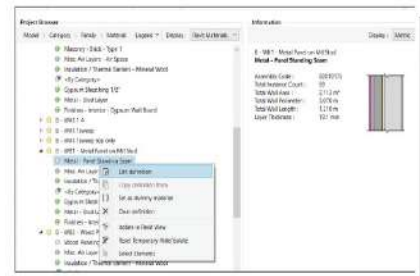


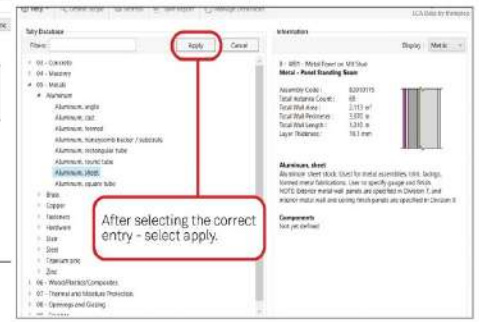
HMFH ARCHITECTS

Defining Materials in Tally



Right Click to Edit Definition





ARCHITECTS

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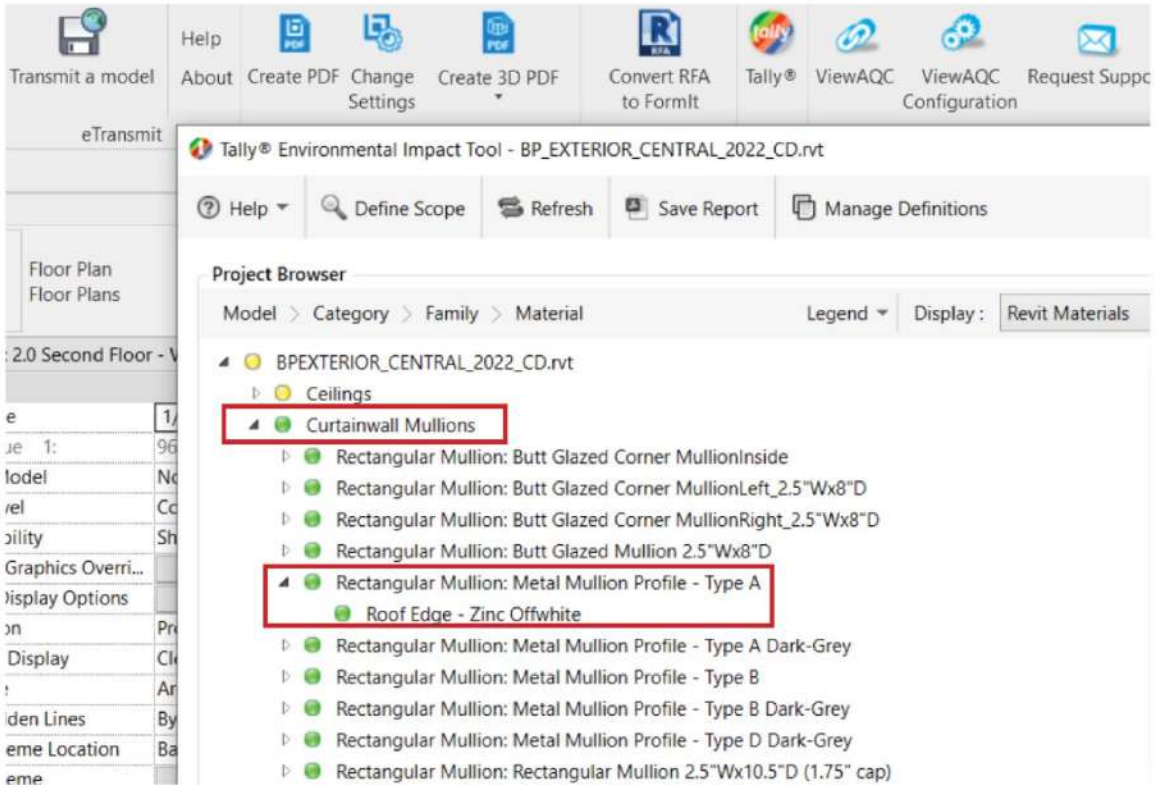
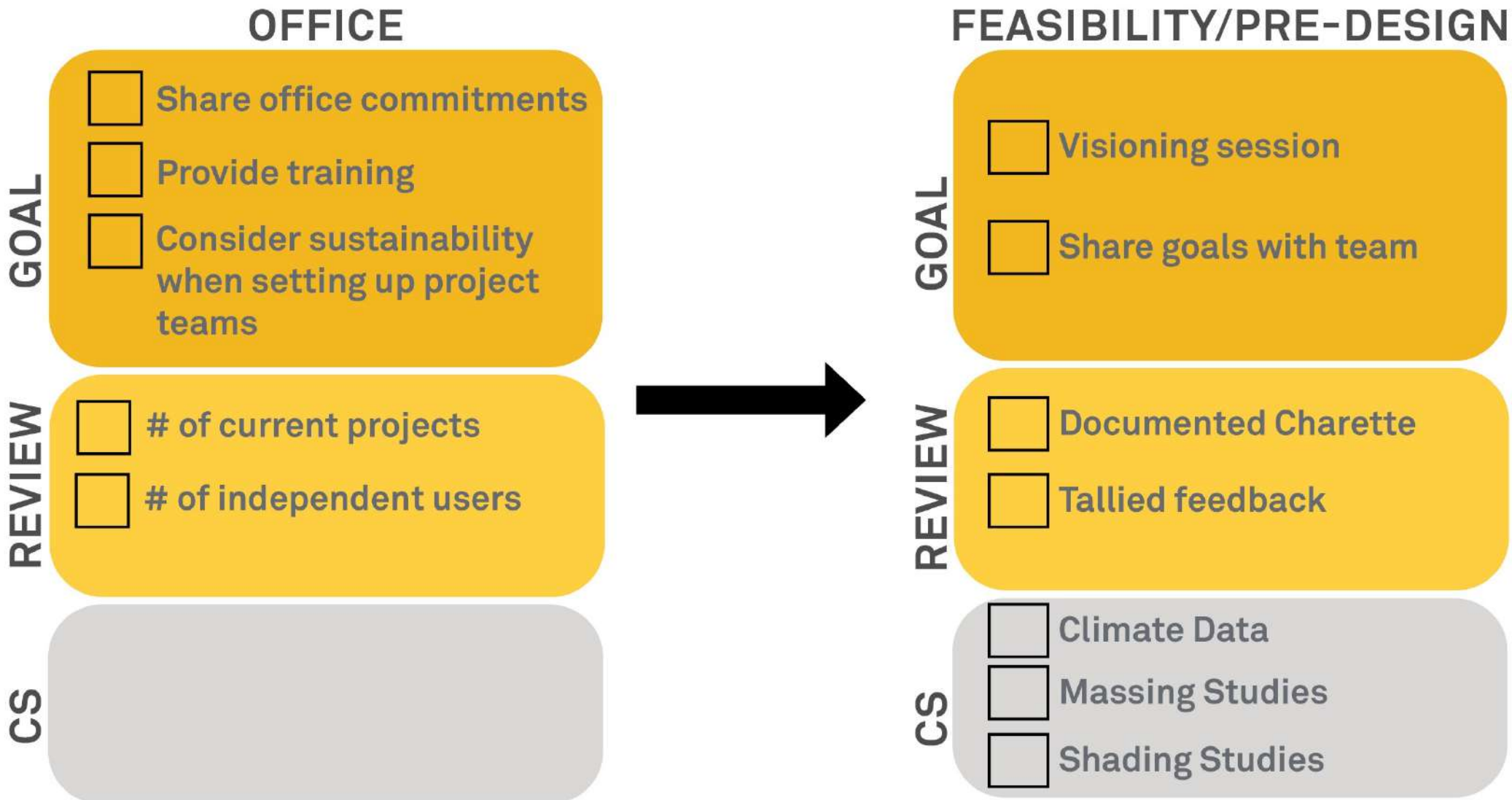
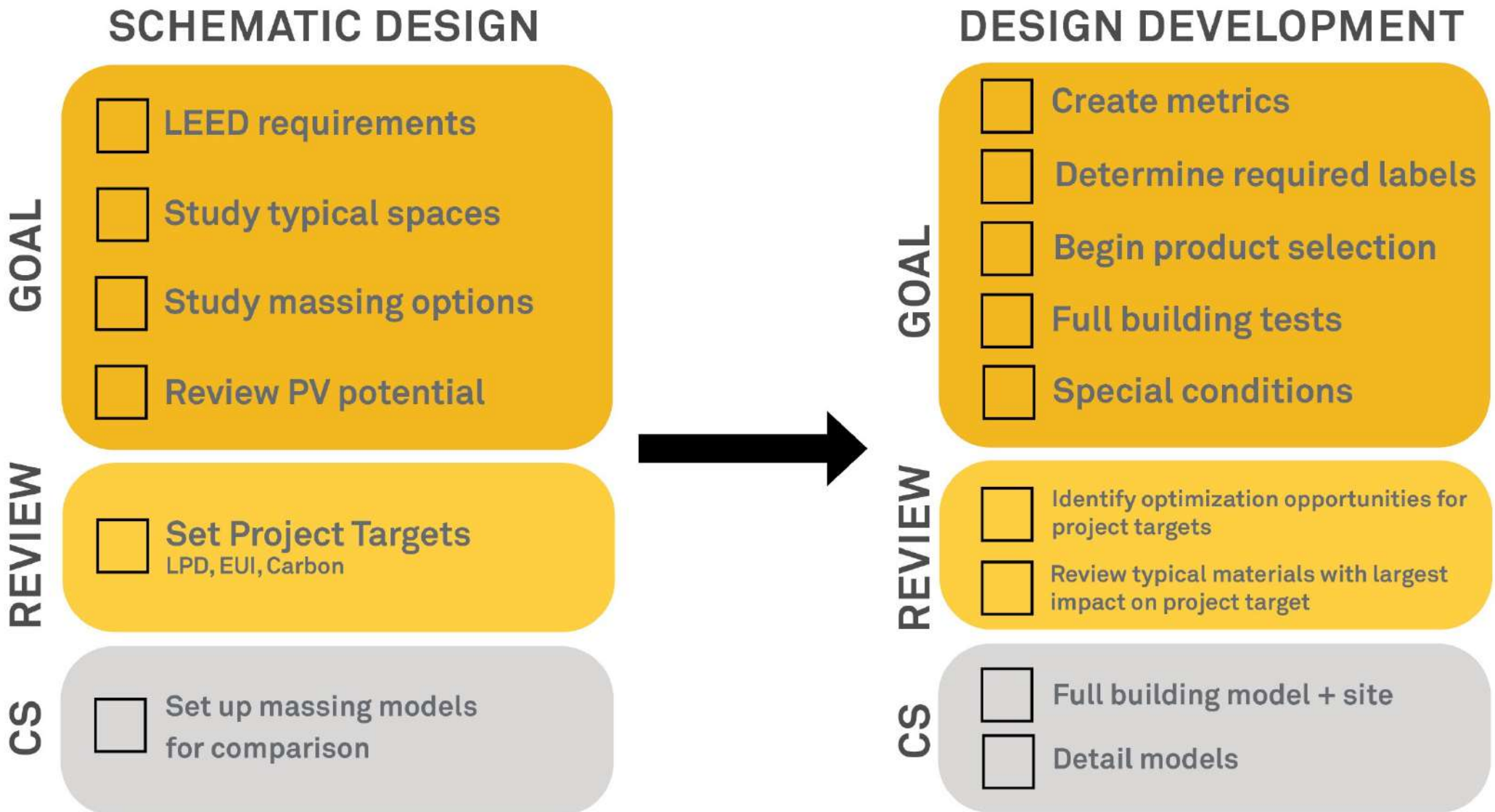
Revit Best Practices



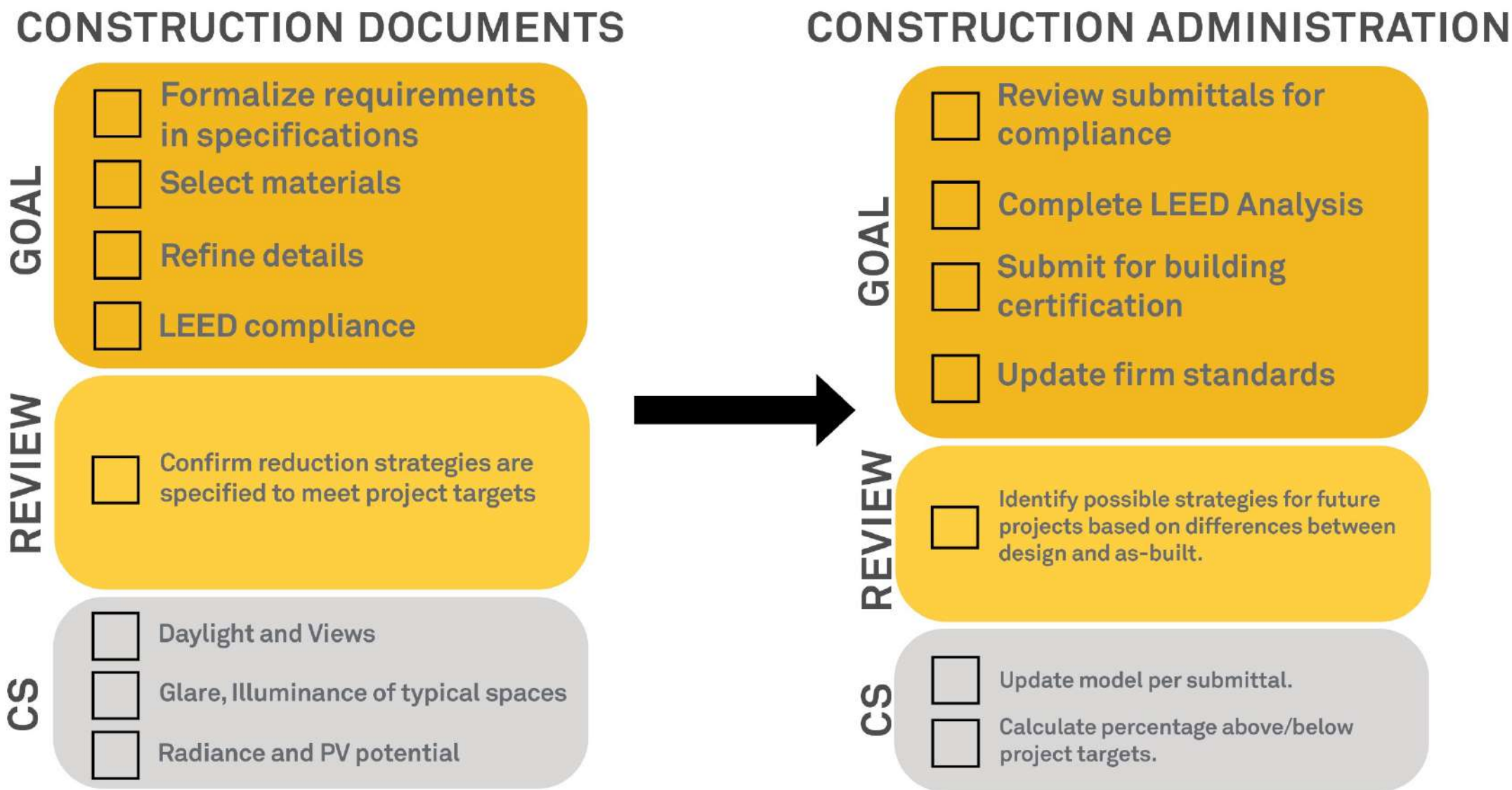
Standardized Workflow



Standardized Workflow



Standardized Workflow




Case Study...
VOCATIONAL SCHOOL, MA

BUILDING INFORMATION SUMMARY

Opens **2025**

Grades **9-12**

Enrollment **1434**

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GOAL SETTING

ENVIRONMENTAL

ECONOMIC

Site
Daylight
Future Proof
Efficient Design
Materials
Teaching Tool
Reduce Carbon

SOCIAL

EDUCATIONAL

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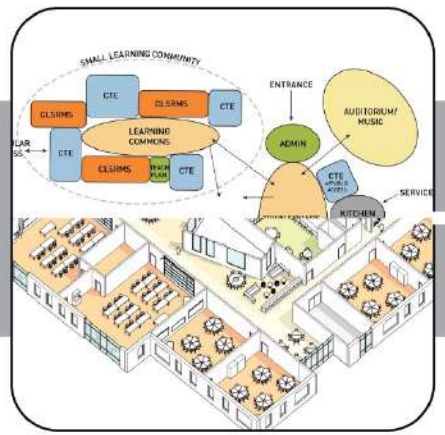
COMMUNICATE THE PROCESS

PRE-DESIGN



DESIGN
GOAL SETTING

CONSTRUCTION

OCCUPANCY

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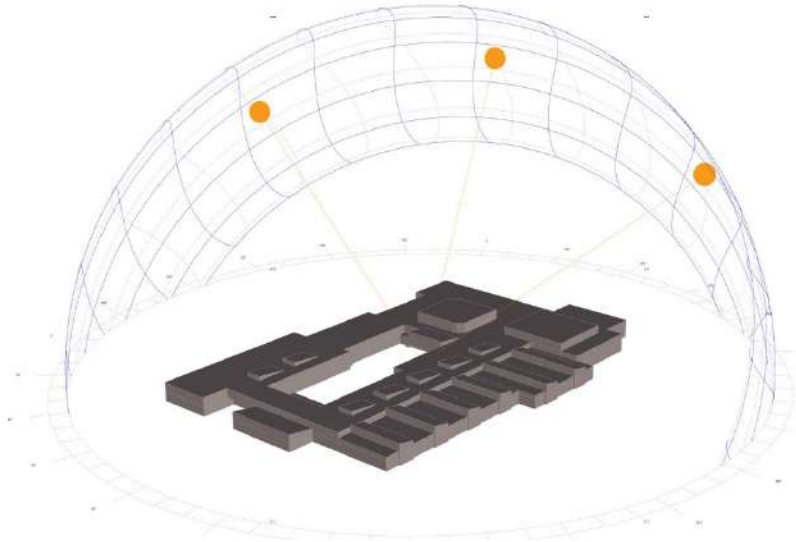
MASSING



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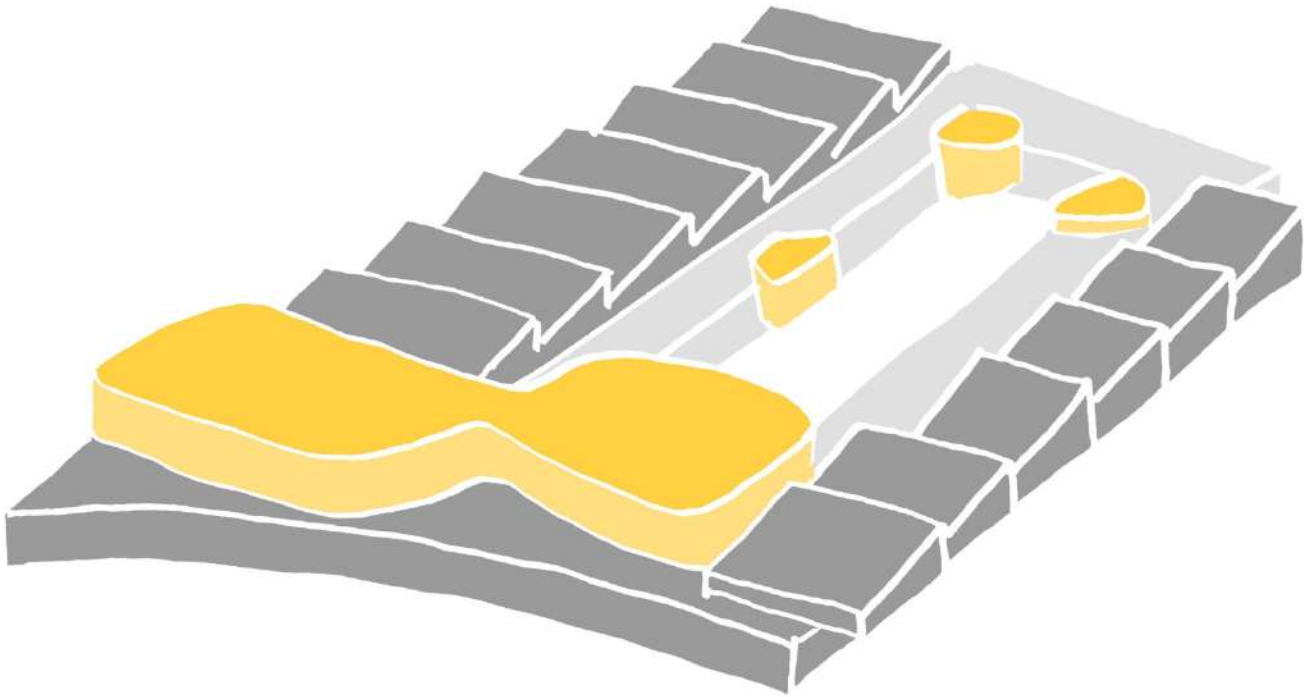
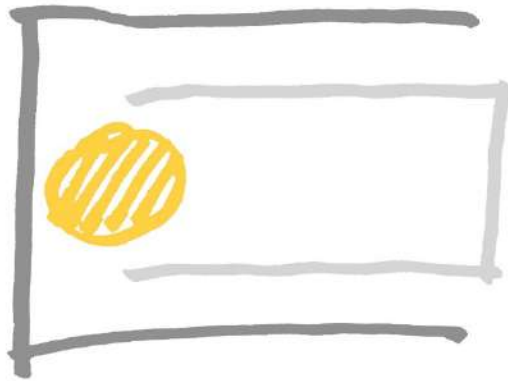
Building Organization





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CROSS SECTION

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BUILDING PERFORMANCE HEALTH + WELLBEING

HMFH Initiative - RED List Free Materials

HMFH's design approach creates buildings with the best possible environmental quality. We focus on standards that optimize human health without compromising the health of the natural environment. This is done by specifying non-toxic materials based on the best available information and data. Our priority is the surfaces we touch but aim for all materials on any given project.

https://www.aia.org/pages/6351155-materials-pledge

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PRODUCT TIERS

TIER 1	Red List Free, documented with Declare Label + Product Specific EPD
TIER 2	LBC Red List Approved, documented with Declare Label + Product Specific EPD
TIER 3	Cradle to Cradle Platinum + Product Specific EPD
TIER 4	Cradle to Cradle Gold + Product Specific EPD
TIER 5	Declared, documented with Declare Label + Product Specific EPD

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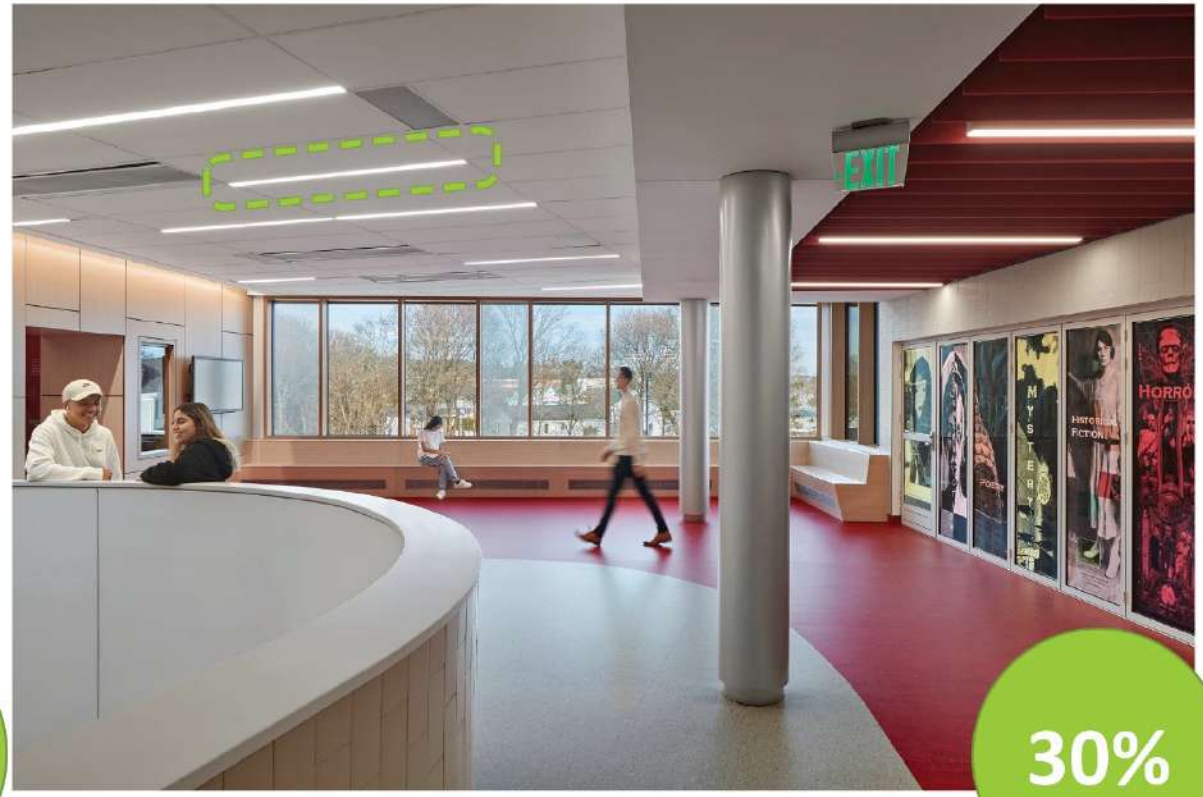
LIMITING THE PALETTE



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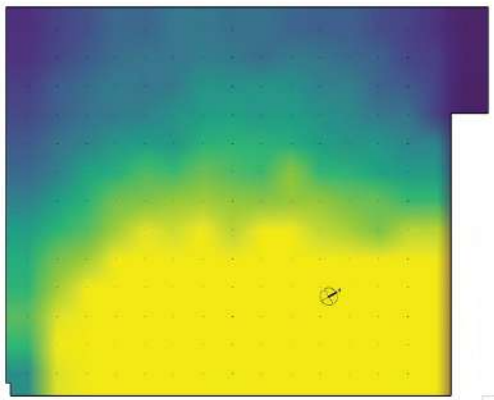
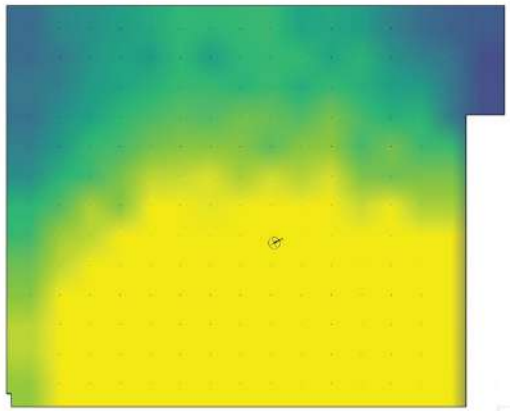
TYPICAL CLASSROOM





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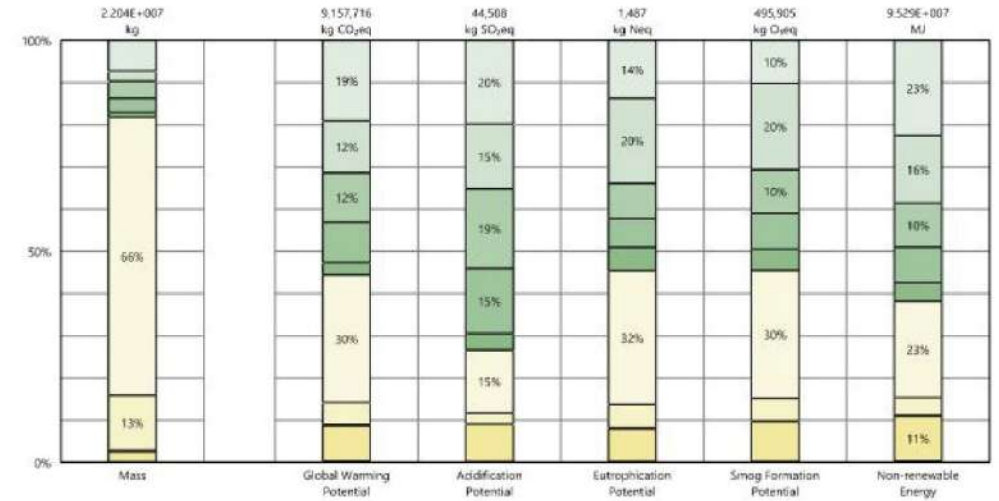
EMBODIED CARBON

Environmental Impact Totals	Product Stage [A1-A3]	Construction Stage [A4]	Use Stage [B2-B5]	End of Life Stage [C2-C4]	Module D [D]
Global Warming (kg CO_2eq)	8,926,919	107,477	0	792,033	-668,713
Acidification (kg SO_2eq)	43,231	498.0	0	2,006	-1,226
Eutrophication (kg Neq)	1,393	40.55	0	101.7	-48.1
Smog Formation (kg O_3eq)	453,875	16,456	0	39,876	-14,303
Ozone Depletion (kg CFC-11eq)	0.06123	3.681E-009	0	7.981E-008	0.004844
Primary Energy (MJ)	9.674E+007	1,562,946	0	7,433,808	-5,833,256
Non-renewable Energy (MJ)	9.304E+007	1,525,545	0	6,950,865	-6,218,014
Renewable Energy (MJ)	3,810,595	37,794	0	490,960	382,124
Environmental Impacts / Area					
Global Warming (kg CO_2eq/m²)	229.3	2.761	0	20.34	-17.2
Acidification (kg SO_2eq/m²)	1.110	0.01279	0	0.05152	-0.03149
Eutrophication (kg Neq/m²)	0.03579	0.001042	0	0.002613	-0.001235
Smog Formation (kg O_3eq/m²)	11.66	0.4227	0	1.024	-0.3674
Ozone Depletion (kg CFC-11eq/m²)	1.573E-006	9.455E-014	0	2.050E-012	1.244E-007
Primary Energy (MJ/m²)	2,485	40.15	0	190.9	-150
Non-renewable Energy (MJ/m²)	2,390	39.19	0	178.5	-160
Renewable Energy (MJ/m²)	97.88	0.9708	0	12.61	9.815

Results per Division, itemized by Material



Legend

03 - Concrete

- Steel, concrete reinforcing steel, CMC - EPD
- Steel, reinforcing rod
- Structural concrete, 3000 psi, 20% fly ash
- Structural concrete, 3000 psi, Eastern regional average
- Structural concrete, 4000 psi, Eastern regional average

05 - Metals

- Cold formed structural steel
- Fireproofing, cementitious
- Fireproofing, cementitious, by area
- Galvanized steel
- Galvanized steel decking
- Hot rolled structural steel, AISC - EPD

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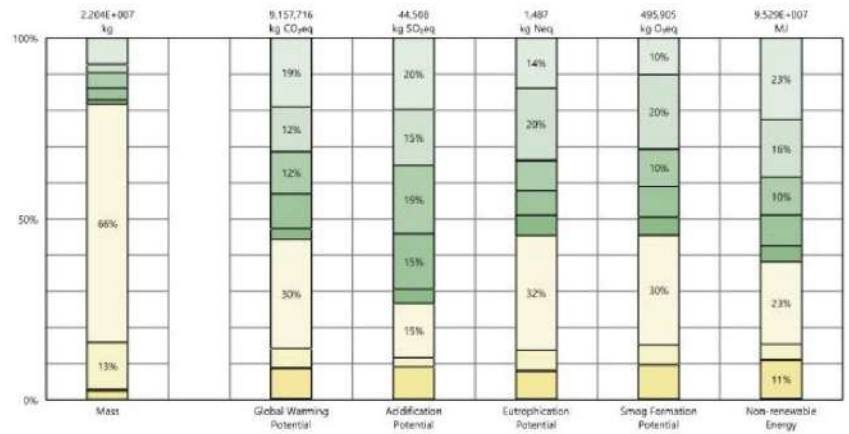
EMBODIED CARBON COMPARISON

Results per Division, itemized by Material

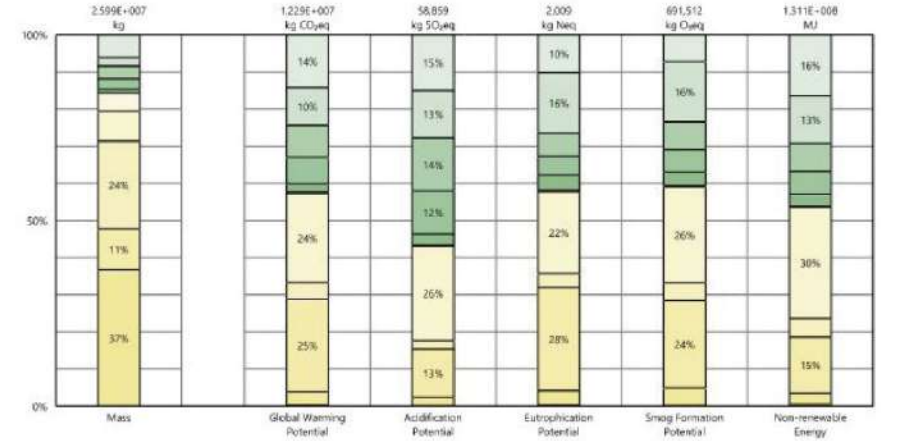


Legend

03 - Concrete
- Steel, concrete reinforcing steel, CMC - EPD
- Steel, reinforcing rod
- Structural concrete, 3000 psi, 20% fly ash
- Structural concrete, 3000 psi, Eastern regional average
- Structural concrete, 4000 psi, Eastern regional average

05 - Metals
- Cold formed structural steel
- Fireproofing, cementitious
- Fireproofing, cementitious, by area
- Galvanized steel
- Galvanized steel decking
- Hot rolled structural steel, AISC - EPD

Results per Division, itemized by Material



Legend

03 - Concrete
- Admixture
- Coarse aggregate
- Portland cement, PCA - EPD
- Sand
- Steel, reinforcing rod
- Water

05 - Metals
- Cold formed structural steel
- Fireproofing, cementitious
- Fireproofing, cementitious, by area
- Galvanized steel
- Galvanized steel decking
- Hot rolled structural steel, AISC - EPD

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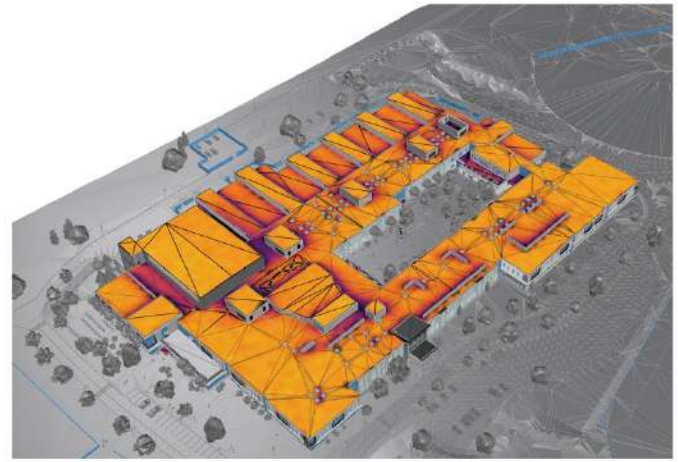
KEY

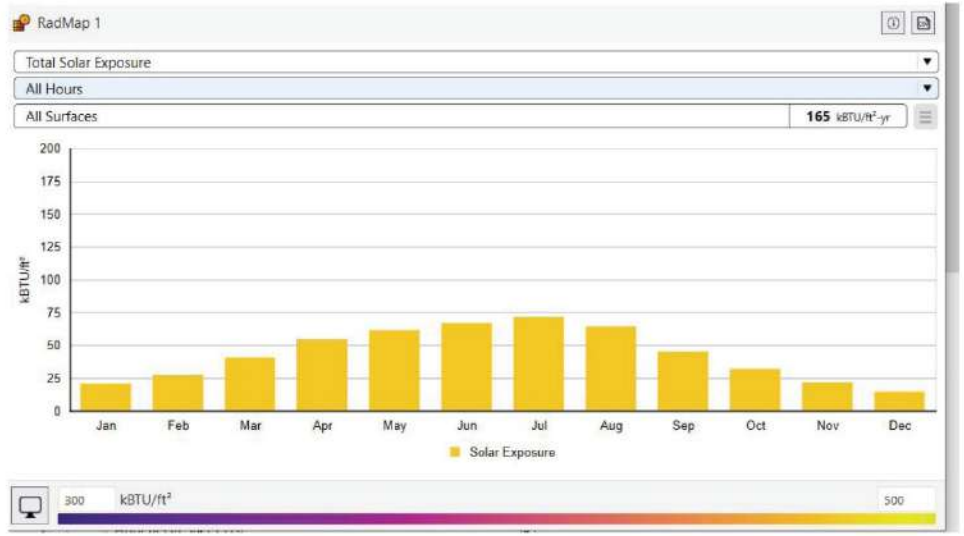
LEGEND - PV ROOF PLAN - NIC

(SEE SHEET A0.1 FOR ADDITIONAL ABBREVIATION DESIGNATIONS)

FUTURE PHOTOVOLTAIC PANEL ARRAYS (NIC)

	1% OF UTILITY COST	2,329 SF
	2% OF UTILITY COST	4,606 SF
	5% OF UTILITY COST	11,538 SF
	10% OF UTILITY COST	23,041 SF
	20% OF UTITLITY COST	46,067 SF
	40% OF UTILITY COST	92,134 SF
	50% OF UTILITY COST	115,168 SF





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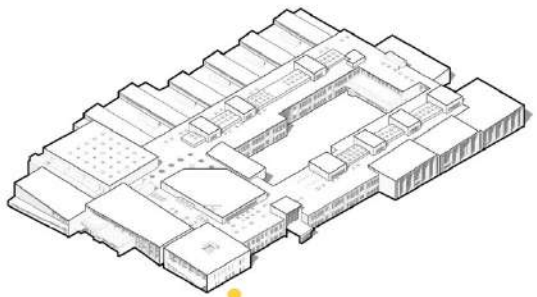
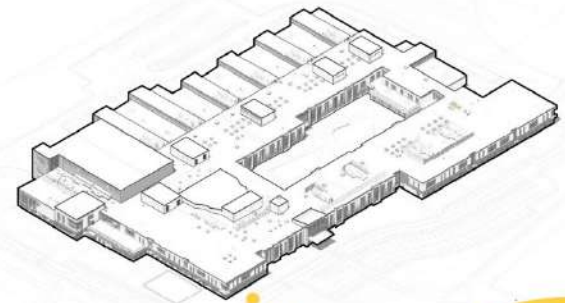
BUILDING TIMELINE

Schematic Design



Design Development

Construction Documents



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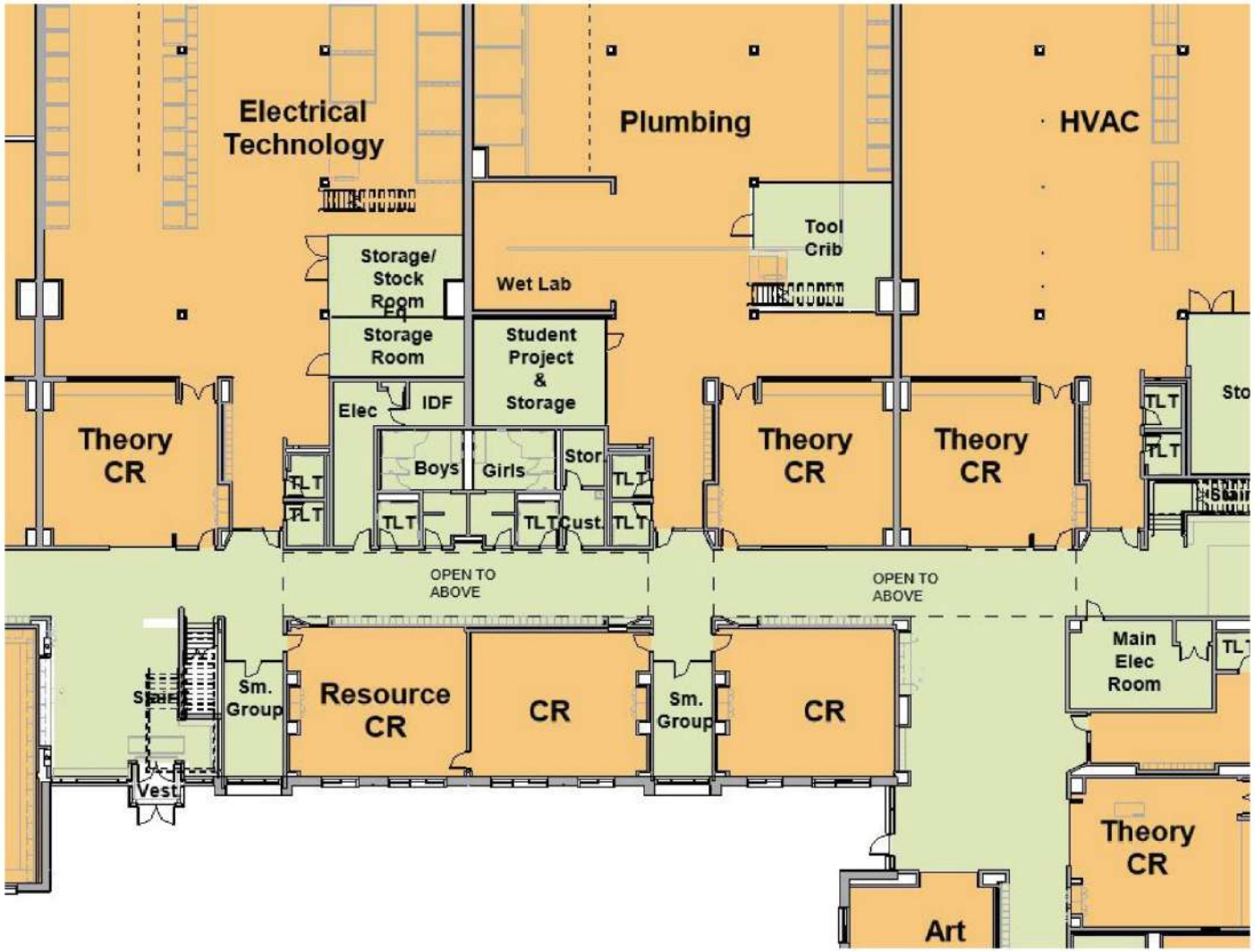
REGULARLY OCCUPIED SPACES



Not Regularly Occupied

Regularly Occupied

Single Occupant

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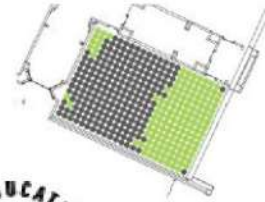
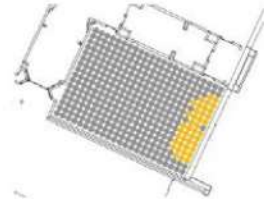
LEED DAYLIGHT ANALYSIS

118 1447 ft² 2.0 ft N



40.49%



11.14%

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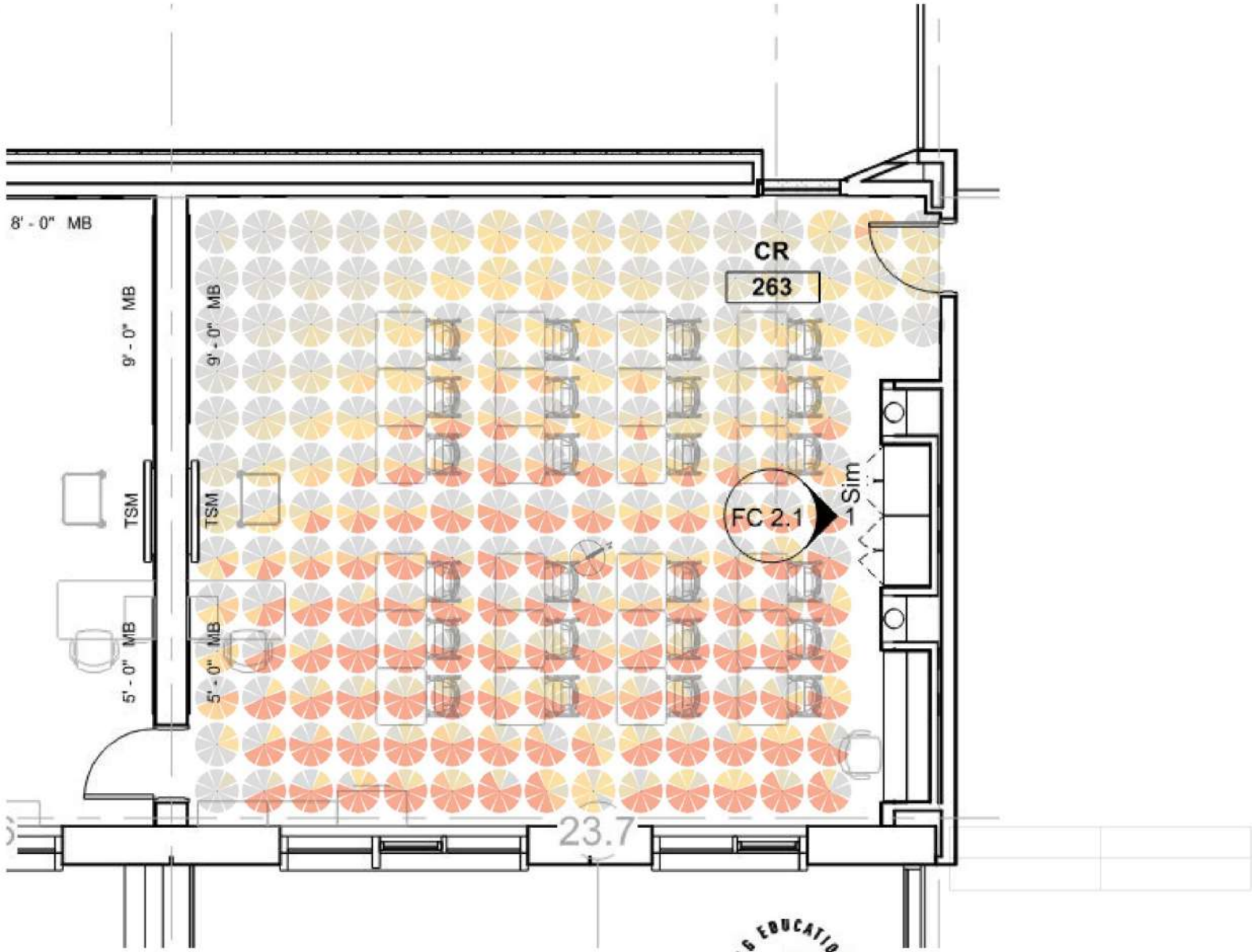
GLARE



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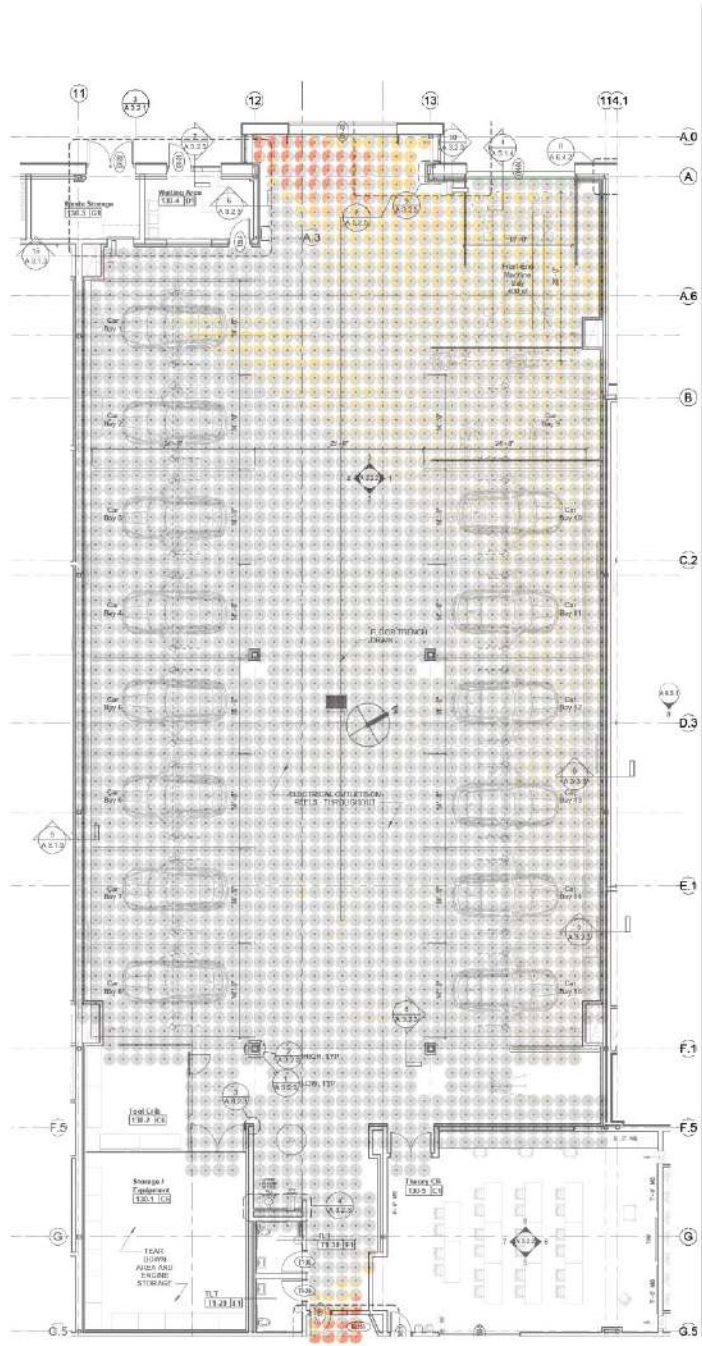
GLARE



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Increasing Adoption ...

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CLOSING THE LOOP

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HMFH ARCHITECTS

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Jaime McGavin
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This concludes The American Institute of Architects Continuing Education Systems Course

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