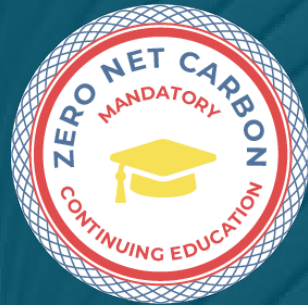


CLIMATE  
ACTION  
WEBINAR

04.20.23

CARBON PT. 3

## CARBON ACCOUNTING: DECARBONIZATION CASE STUDIES



### MODERATOR:

**BRAD BENKE, AIA**

RESEARCH SCIENTIST, CLF

### SPEAKERS:

**JESSICA MARTINEZ**

PE, LEED AP  
SUSTAINABILITY SPECIALIST,  
DCI ENGINEERS

**JACOB DAVIS, AIA**

LEED AP  
SR. ASSOCIATE, archimania

**KATE DIAMOND, FAIA**

LEED AP  
CIVIC DESIGN DIRECTOR, HDRINC

**YUNNAN ALLEN**

RA, NCARB, LEED AP  
SR. PROJECT ARCHITECT, HDRINC

**MATT CUNHA-RIGBY**

RA, LEED AP, LFA  
SUSTAINABLE LEADER, HDRINC



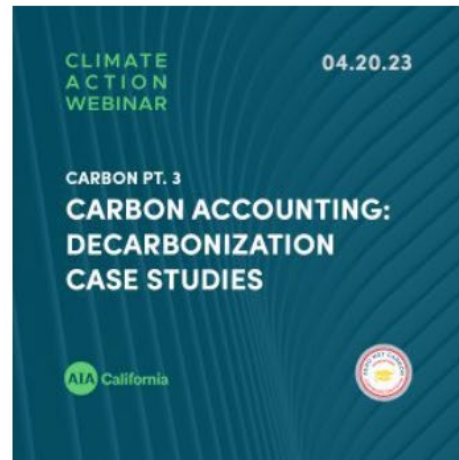


# CLIMATE ACTION WEBINARS

[2022 Climate Action Webinar Archive](#)

[2021 Climate Action Webinar Archive](#)

[View our Practice Webinars](#)



**Check the Chat Box  
at the bottom of  
your screen for links  
to our AIA CA  
Climate Action  
Webinars and for  
free ZNCD courses  
on-demand!**

# Learning Objectives

## Carbon Pt. 3 | Carbon Accounting: Decarbonization Case Studies



Name 3 real-world building projects that were able to achieve dramatic carbon reductions from typical industry practices



Be able to apply lessons learned by presenters on carbon goal setting, design strategies, measurement and verification methods

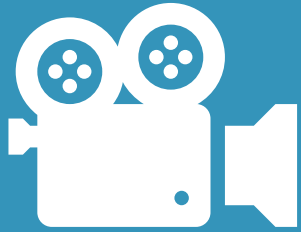


Understand the technical, social, and economic challenges of designing and constructing low-carbon buildings



Learn best practices for integrating zero and low-carbon design strategies at firm-wide scales

# Housekeeping Reminders



A recording of today's presentation will be made available on our website



Today's session qualifies for 1.5 AIA HSW/LU and 1.5hr ZNCD MCE



Please use the Q&A function to ask questions for today's presenters



Cultivate a positive learning environment

*MODERATOR*



**BRAD BENKE, AIA**  
RESEARCH SCIENTIST, CLF

***SPEAKERS***



**JESSICA MARTINEZ**

PE, LEED AP

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SR. PROJECT ARCHITECT  
HDRINC



**MATT CUNHA-RIGBY**

RA, LEED AP, LFA  
SUSTAINABLE LEADER  
HDRINC





# Aiming for Net Zero Carbon

104%

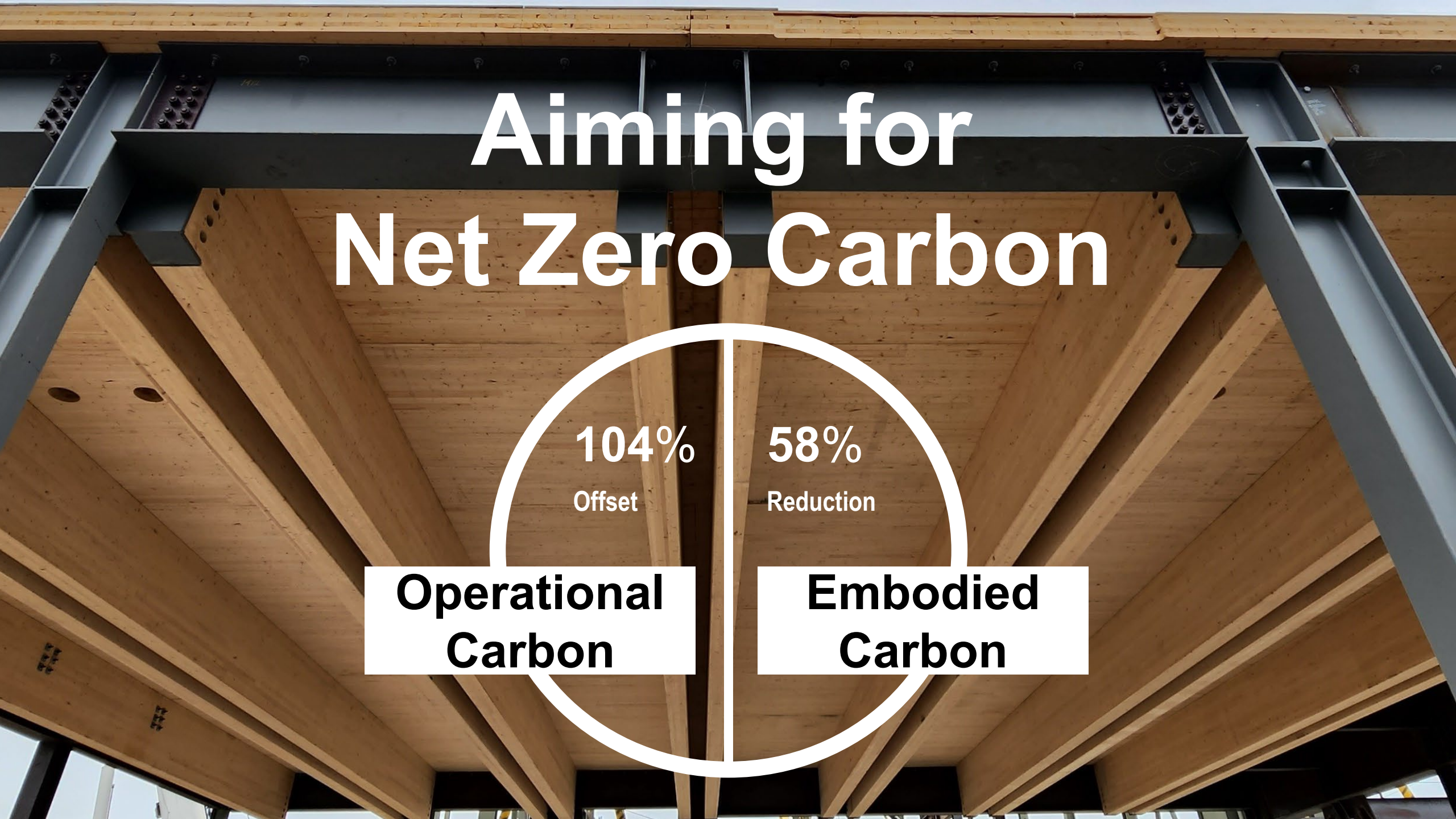
Offset

**Operational  
Carbon**

58%

Reduction

**Embodied  
Carbon**





## OUR MISSION

“To protect public health and the environment by providing effective wastewater collection, treatment, and recycling.”

## OUR VISION

ORANGE COUNTY SANITATION DISTRICT WILL BE A LEADER IN:

- Providing reliable, responsive and affordable services in line with customer needs and expectations.
- Protecting public health and the environment, utilizing all practical and effective means for wastewater, energy, and solids resource recovery.
- Continually seeking efficiencies to ensure that the public's money is wisely spent.
- Communicating our mission and strategies with those we serve and all other stakeholders.
- Partnering with others to benefit our customers, this region, and our industry.
- Creating the best possible workforce in terms of safety, productivity, customer service, and training.

# Orange County Sanitation District Administrative Headquarters



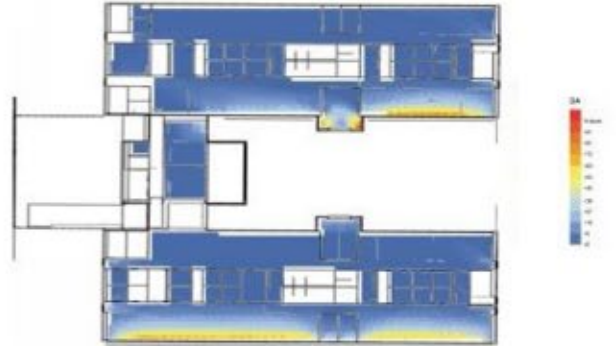
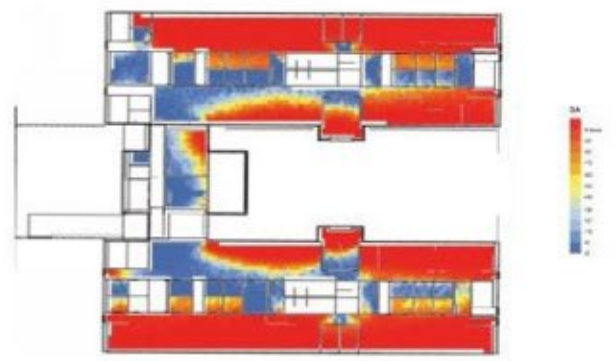
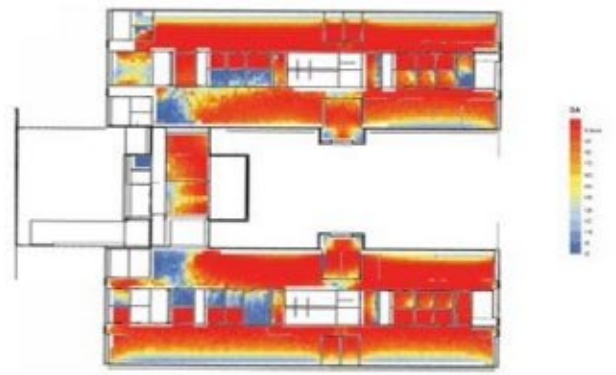
UDI



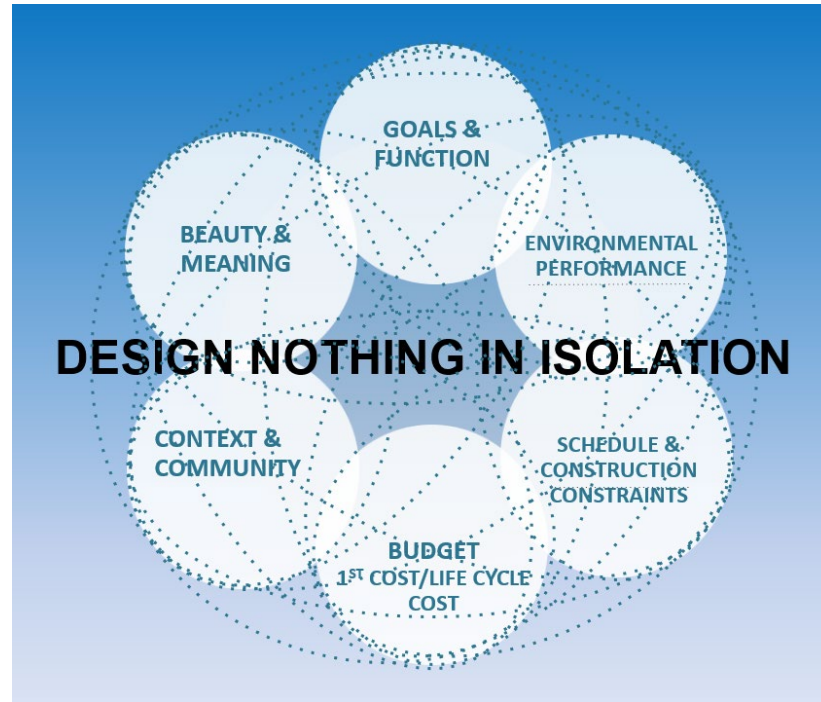
sDA



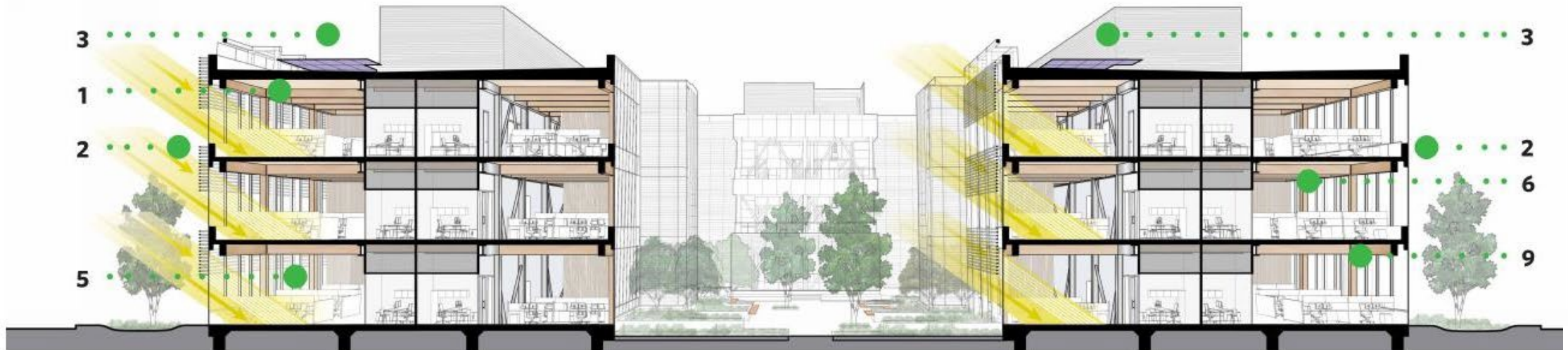
ASE



- 1 Mass-timber structure reduces embodied energy and provides carbon sequestration within the building. The Mass-timber will be sourced from within California to encourage sustainable forest management practices and support the local economy.
- 2 Narrow floor plates combined with optimum building orientation help provide effective daylight for 66+% of the occupied space. While effective, exterior passive shading keeps glare at 9%.
- 3 Capture of the bio-gas produced by the Sewage Plant combined with on-site photovoltaics achieve a Net Zero Energy project.

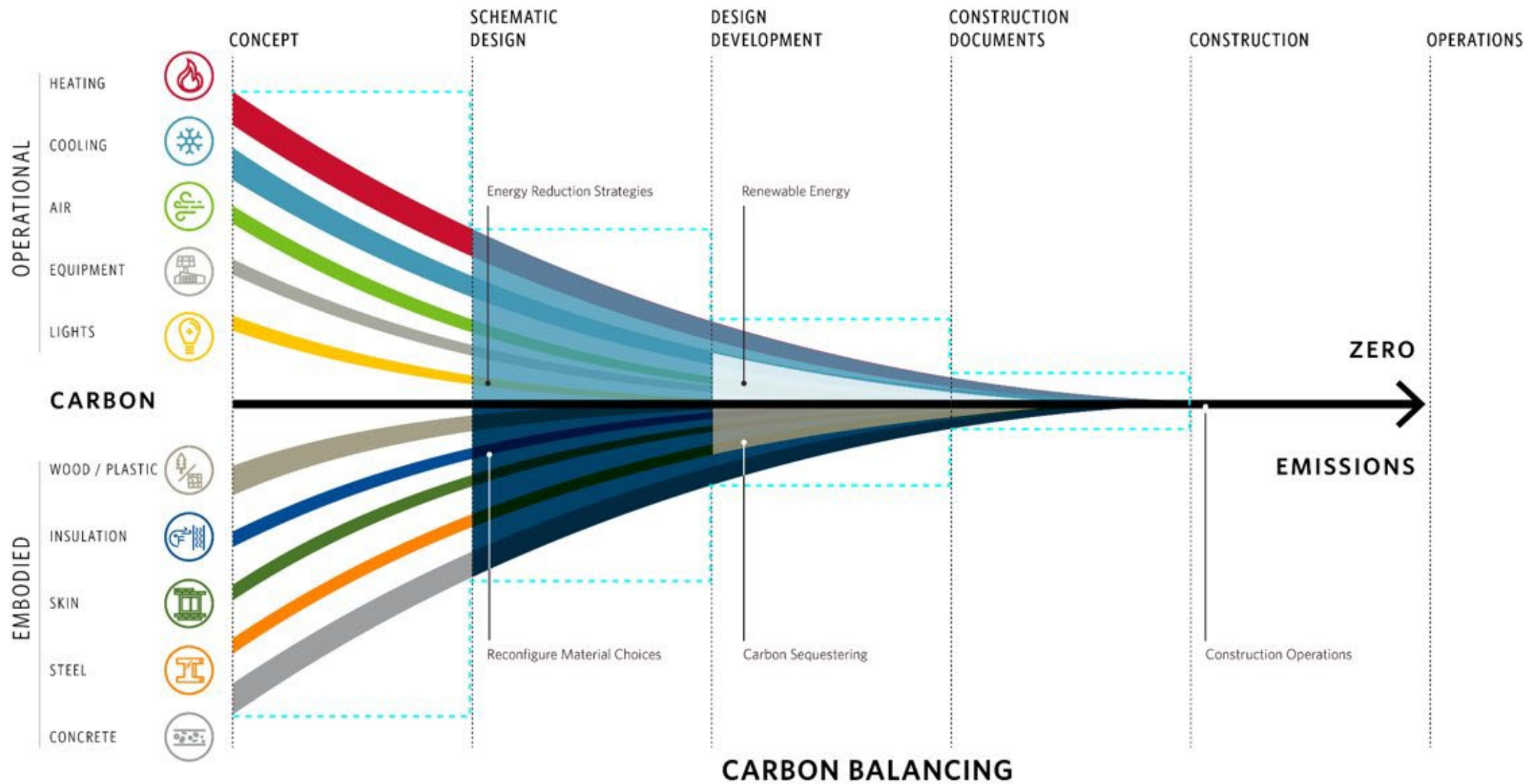


- 8 Site design manages 68,000 gallons of rainwater (85th percentile event) and the 25 year, 24 hour peak underground system flows.
- 9 The exposed mass-timber structure, natural lighting design, and views to nature for all occupied spaces support biophilic design and human well-being.
- 10 Sustainable design combined with high-performance, sustainable operations of the Sewage Plant will be featured in exhibits and tours open to the public.

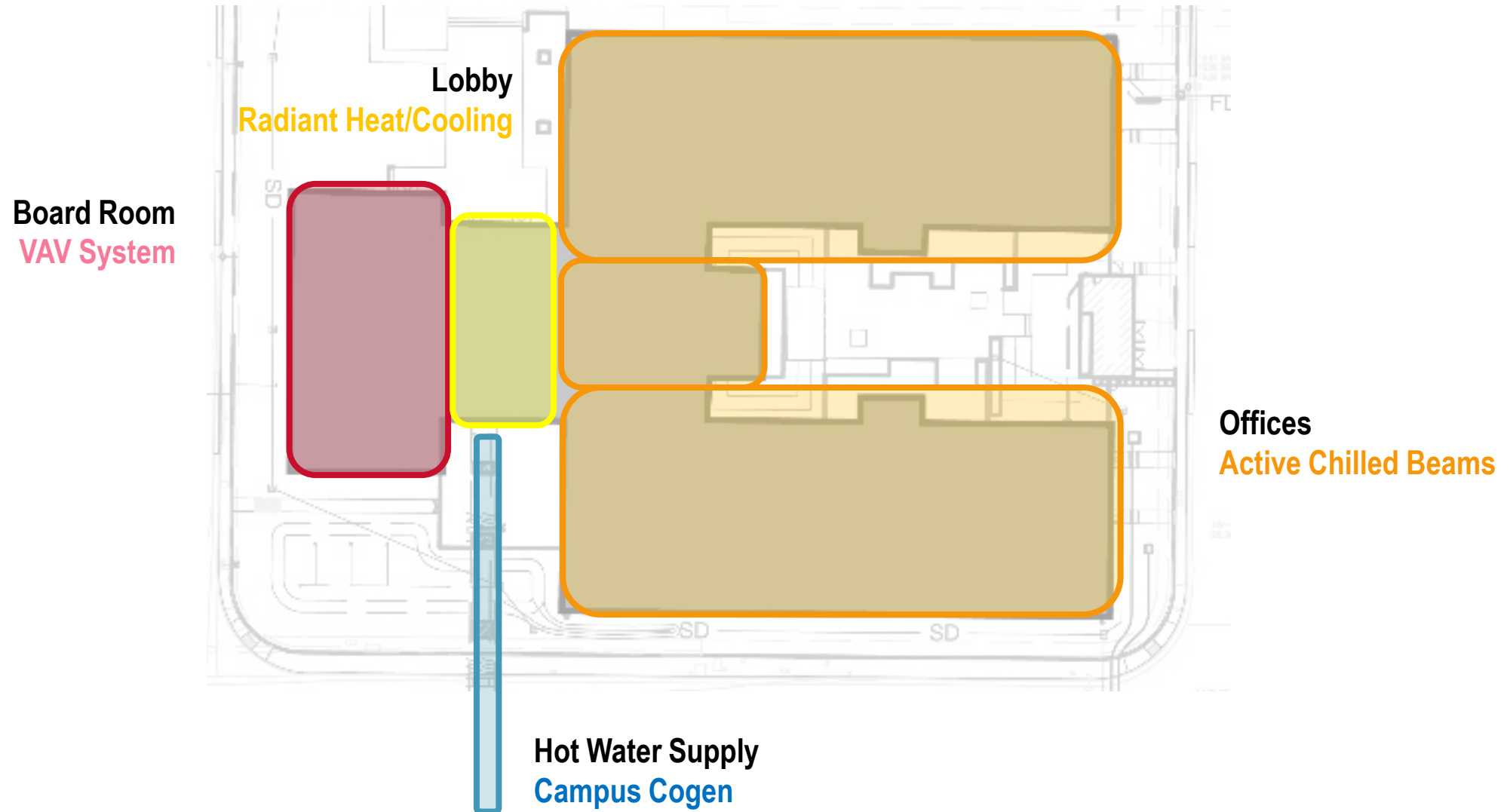




Orange County Sanitation District

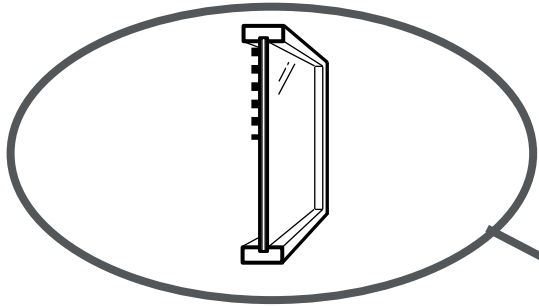


# OCSD – Path to Net Zero Operational Carbon

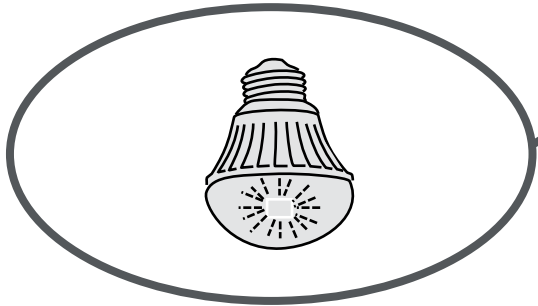


# OCSD – Path to Net Zero Operational Carbon

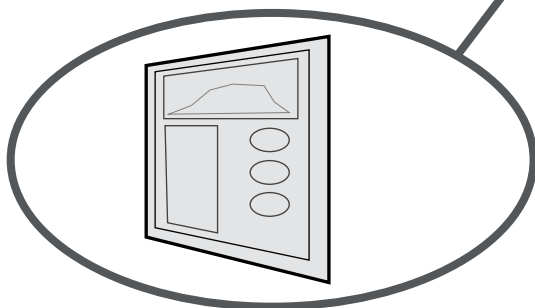
BUILDING ENVELOPE – HIGH PERF.



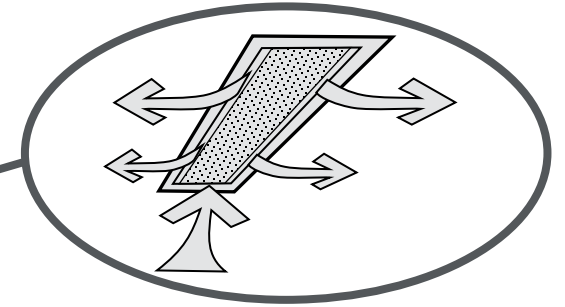
LIGHTING – HIGH PERF. LPD



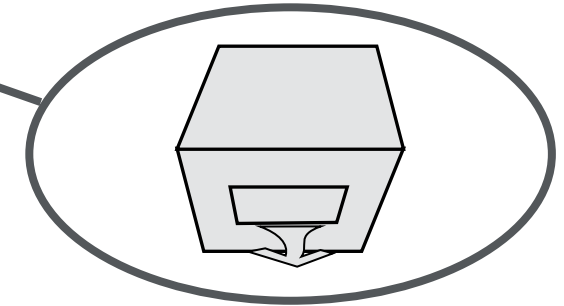
DIMMING CONTROLS



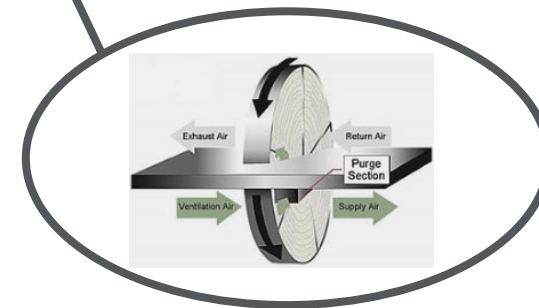
ACTIVE CHILLED BEAMS (ACB)



DEDICATED OUTDOOR AIR SYSTEM (DOAS)

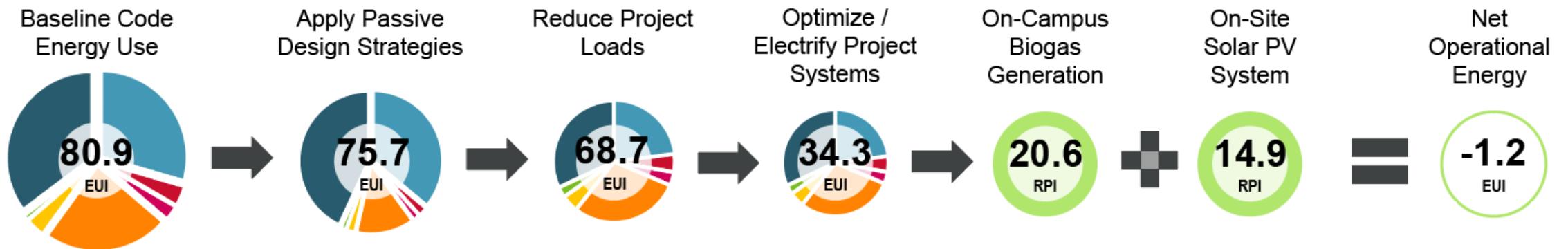


ENTHALPY WHEEL

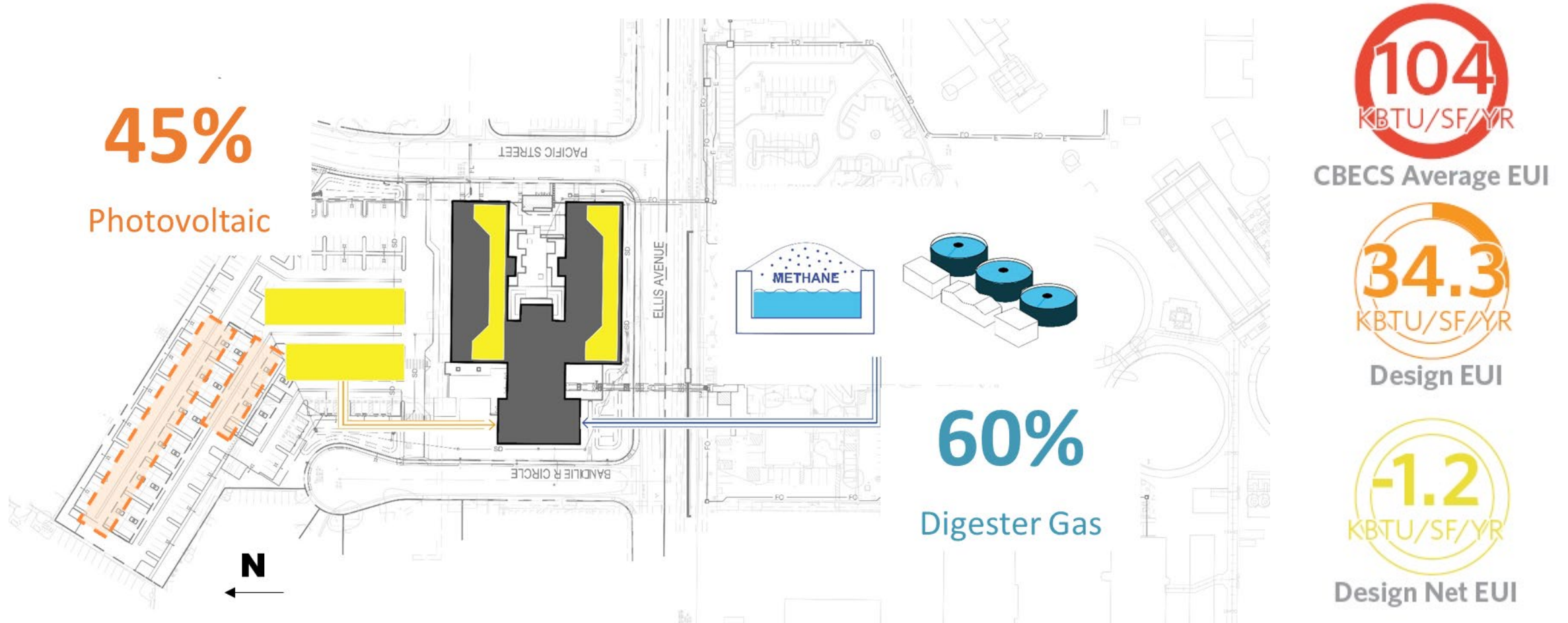




# OCSD – Path to Net Zero Operational Carbon



# OCSD – Path to Net Zero Operational Carbon



# OCSD – Biofuel Energy

**CO2e**  
**Baseline Case**

**1,616.6**

Metric Tons of CO2e

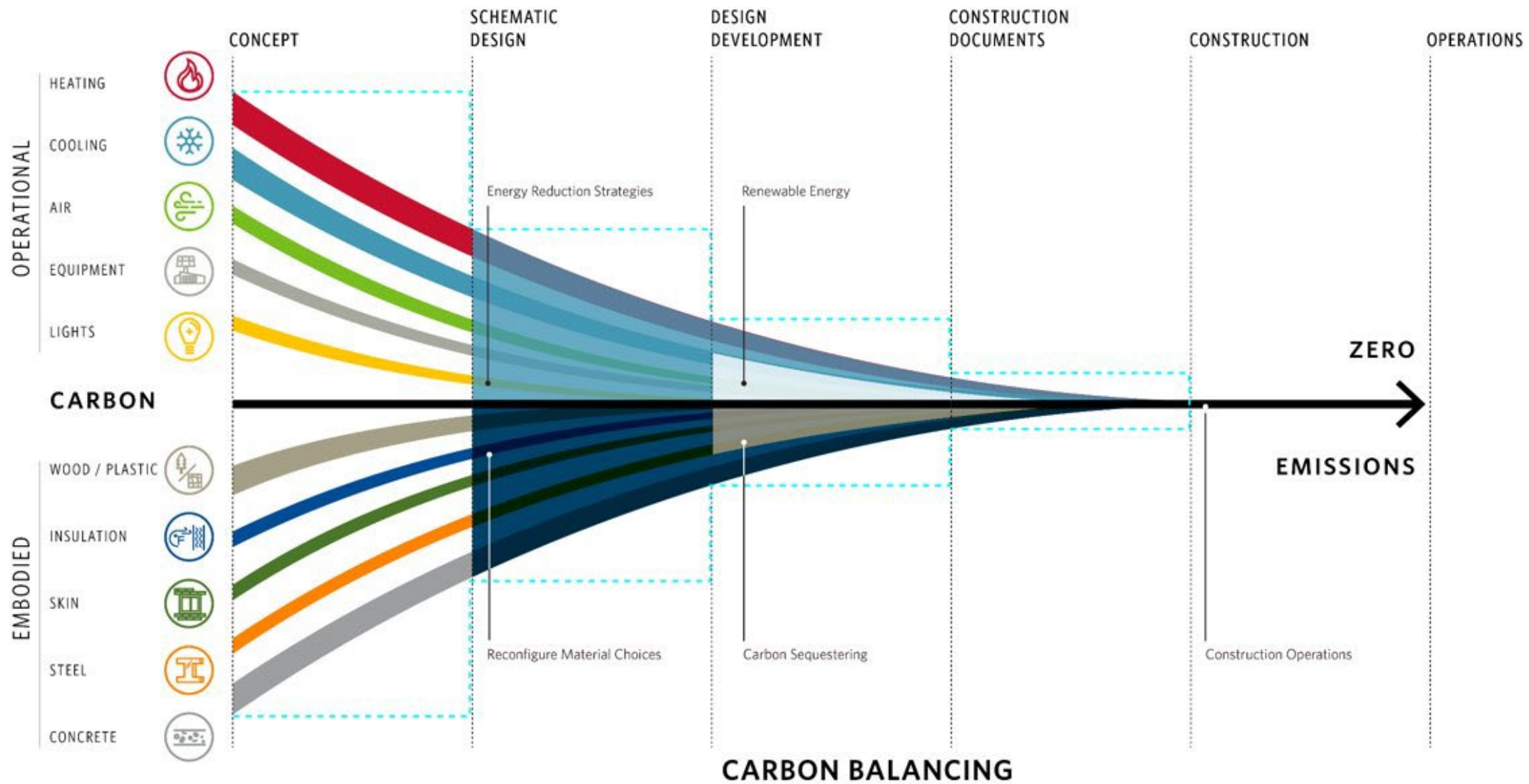
**CO2e**  
**Digester Gas Energy**

**76.8**

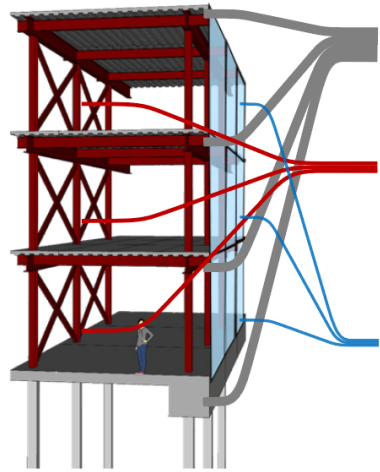
Metric Tons of CO2e

**CO2e**  
**Reduction**

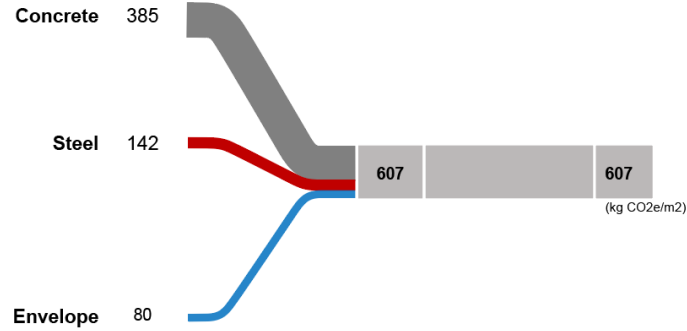
**95.2%**



# Studied Steel vs Hybrid Mass Timber



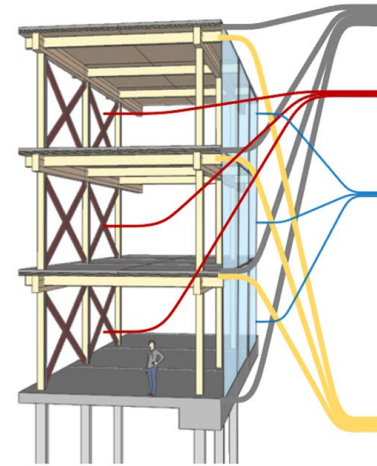
**Building Section**  
Structure / Core / Envelope



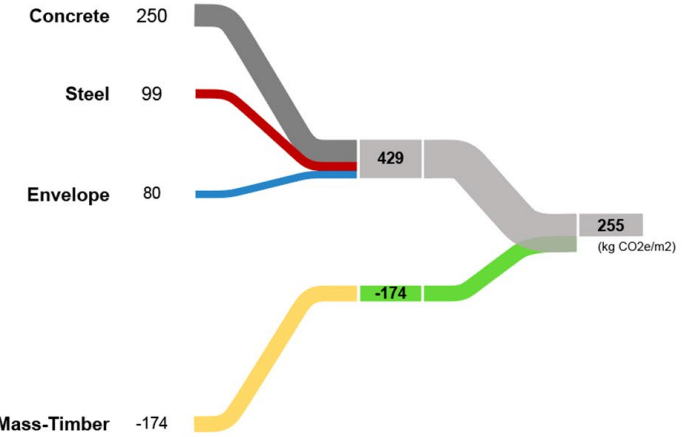
**Durable Building Materials**

**Subtotals**

**Net-Carbon Balance Baseline**




**Building Section**  
Structure / Core / Envelope



**Durable Building Materials**

**Subtotals**

**Net-Carbon Balance**  
58.0% Reduction


 Winner of the CA Mass Timber Building Competition. Recognized as a demonstration project and awarded a grant to source mass-timber wood products from within CA.

A MASS TIMBER SOLUTION



Sanitation District

NEWS

- 1. COVID-19 Annual Report
- 2. ...
- 3. ...

MEETINGS & EVENTS

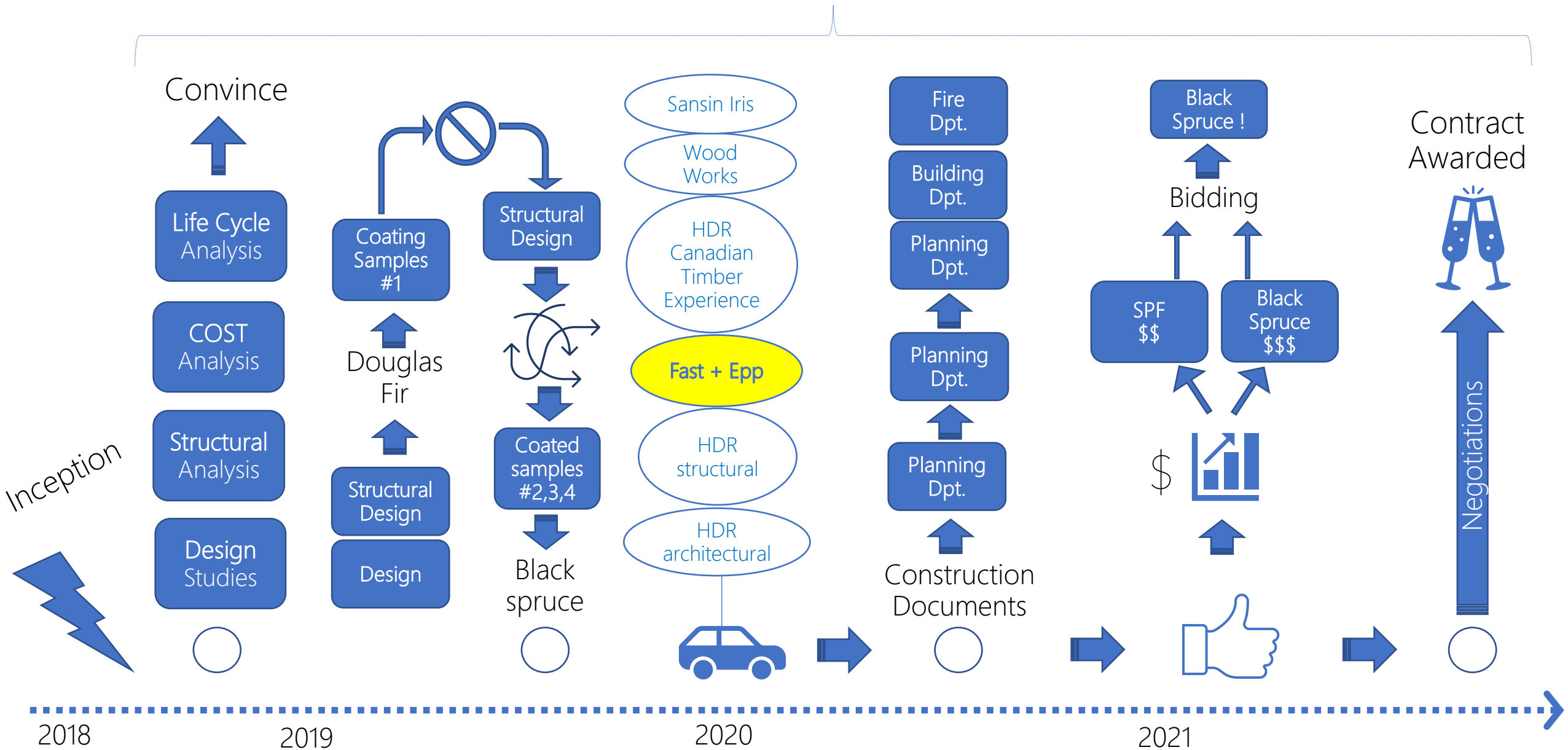
- 1. Legislative & Public Affairs Committee Meeting
- 2. Board of Directors Meeting
- 3. Board of Directors Meeting
- 4. Legislative & Public Affairs Committee Meeting

Water Cycle

The cycle of water in a city...

# Mass Timber Road Map

## Design Execution



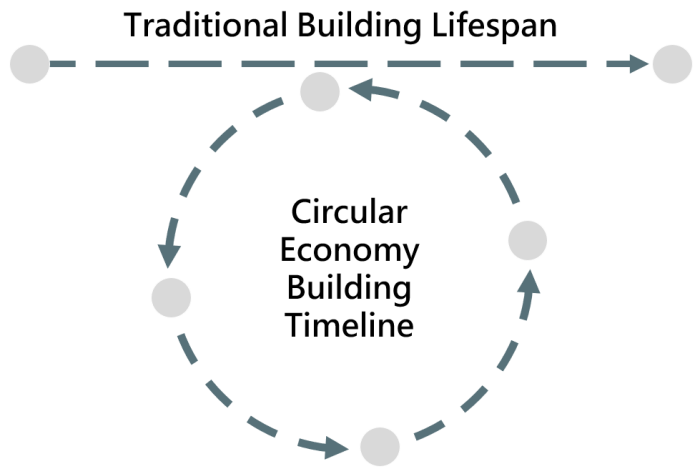
# Wood Coating <working with organic material>

**Traditional Wood Stains**

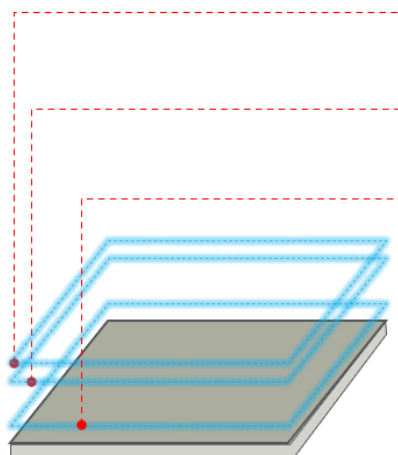
- The Worst of the Worst VOCs

**High Performance "Coating"**

- Water based
- Breathable
- Low VOC
  - (Actual 50, Regulatory 210)
- UV stable & UV resistant
- Multi-coat – Durablilty.
- Color:
  - Help UV stability
- Rigorous testing
  - (accelerated UV aging in lab)
- Support: Sansin Iris
- Maintenance: Sansin-Care



Chemical Facts			
Sample Size 10 oz. (85g)			
Sample Per Batch 3			
Amount Per Serving			
<b>VOC</b>	200	Industrial VOC	200
% Allowable Value*			
<b>Total VOC</b>	200		<b>20%</b>
Digoxin			<b>28%</b>
Sodium Cyanide			
<b>Formaldehyde</b>	30 mg		<b>10%</b>
<b>Solvents</b>	65 mg		<b>14%</b>
<b>Total Toxic Gas</b>	30 mg		<b>10%</b>
Ethylene Glycol			<b>0%</b>
Strychnine			
Heavy Metals 60 mg			
Lead	0.01%	Mercury	0.03%
Cadmium	0.03%	Chromium	0%
*Percent Daily Values are based on a 2,000 calorie diet. Your Daily Values may be higher or lower depending on your calorie needs.			
		Calories	2,000
Total Fat	Less than	65g	80g
Sat Fat	Less than	20g	25g
Cholesterol	Less than	300mg	300mg
Sodium	Less than	2,400mg	2,400mg
Total Carbohydrate		300mg	375mg
Dietary Fiber		25g	30g



**2nd Field coat**  
5 to 6 wet mils (400 to 500SF per US gallon)  
Precision Coat Purity Interior Glacier - **Low Luster**

**1st Field coat**  
6 mils (400 to 500 SF per US gallon)  
Precision Coat Purity Interior Glacier - **Gloss**

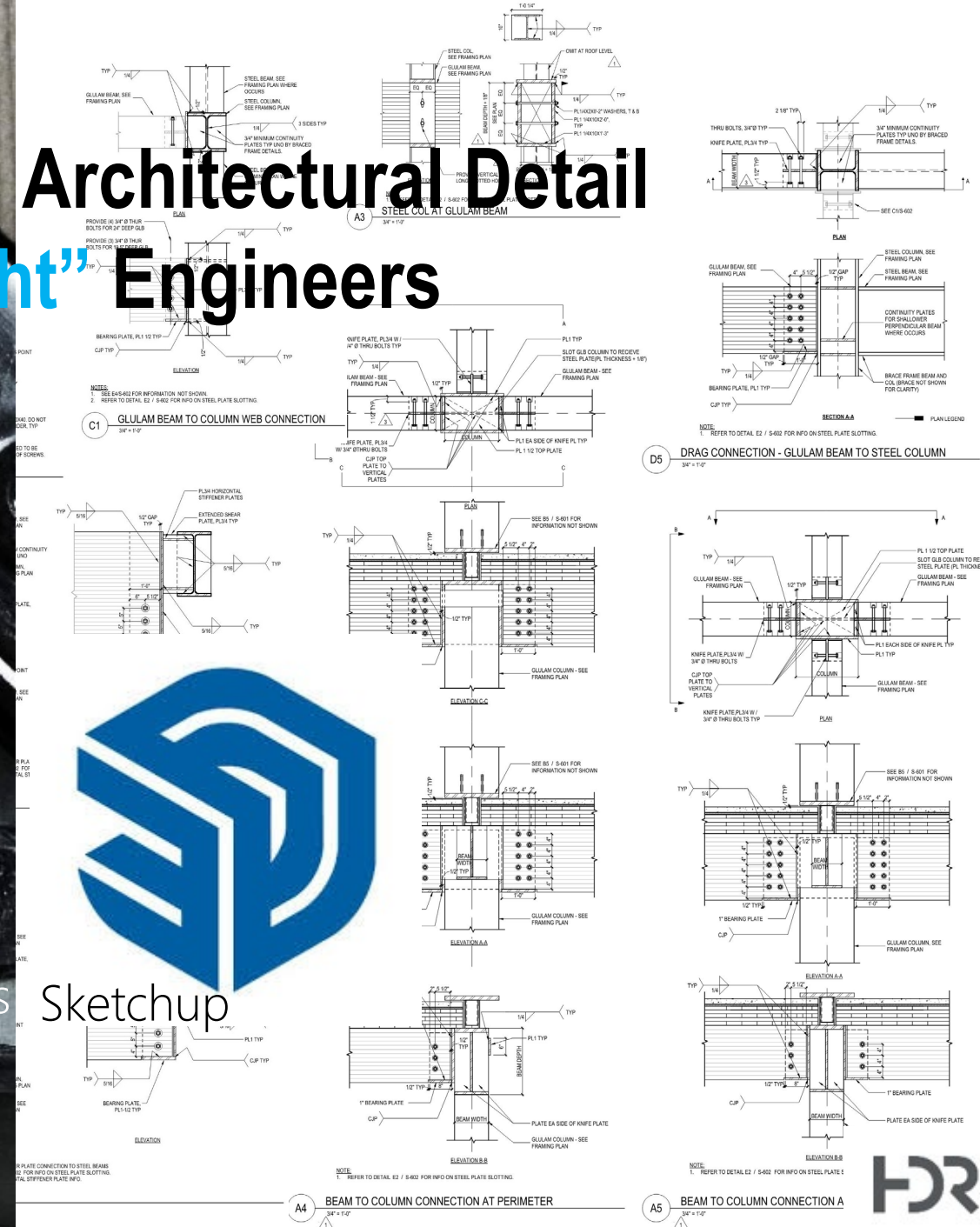
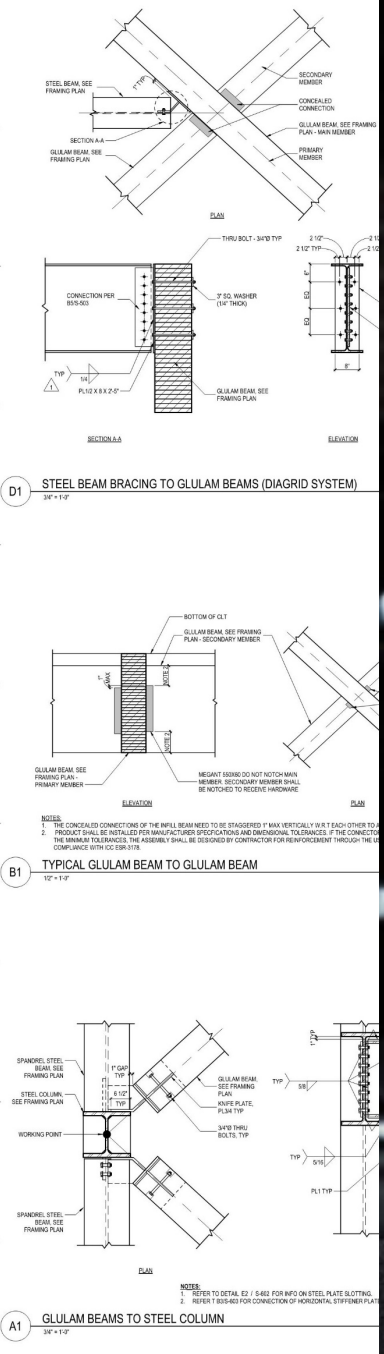
**Base / Factory Coat**  
6 wet mils (270 SF per US gallon)  
KP-12UVW

Interior Timber Coating spec



# Exposed Structure is the Architectural Detail

## Work with the “right” Engineers



Rothoblaas Sketchup




Pre-Construction

Production

Construction




Naviswork Models 

Design Models 

Drawings 

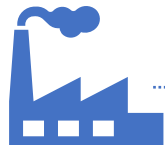
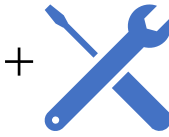
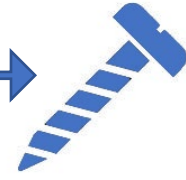
Shop LOD 350 

Mockup 

Shop LOD 400 

Order Long Lead

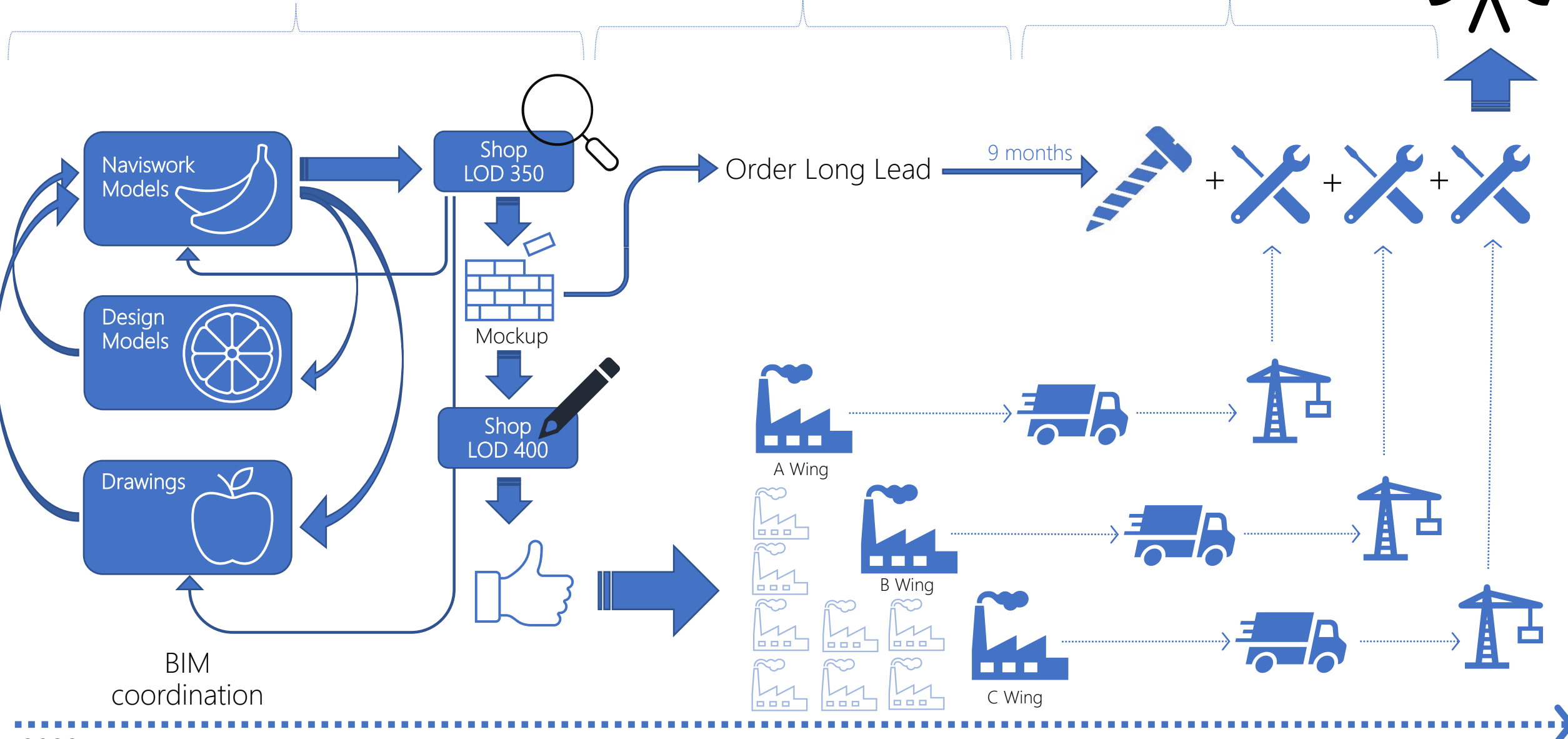
9 months



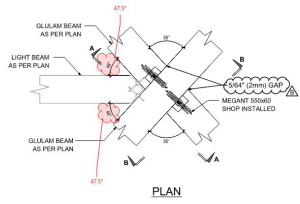
BIM coordination

2022

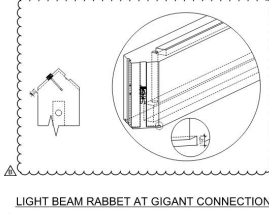
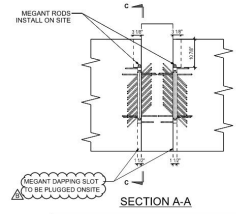
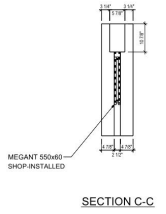
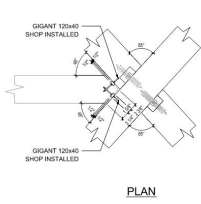
December 2023



**FIRST STEP**

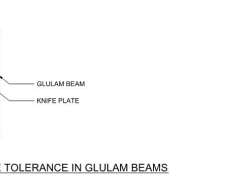
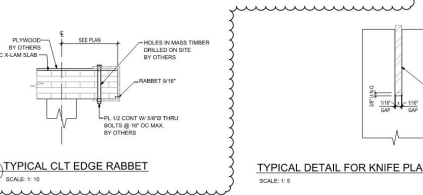
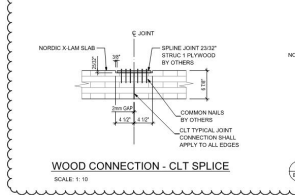
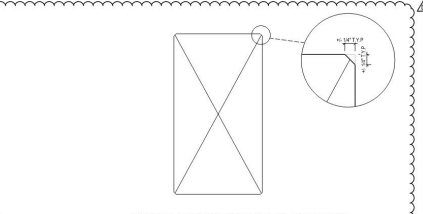
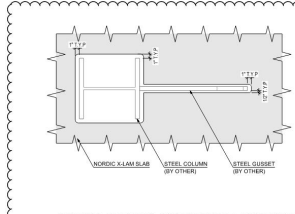
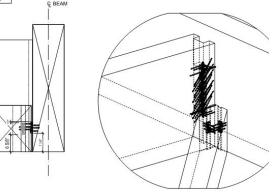
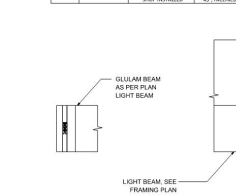
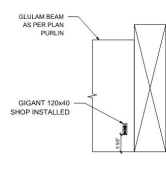
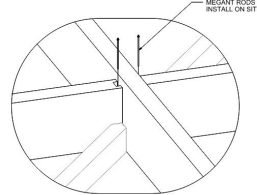
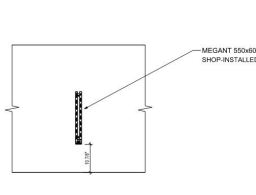


**SECOND STEP**

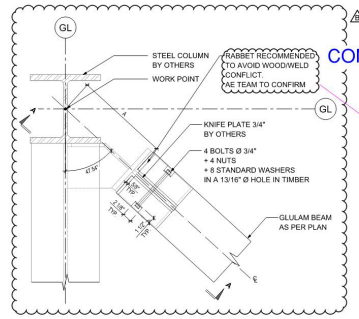


MEGANT CONNECTION SCHEDULE

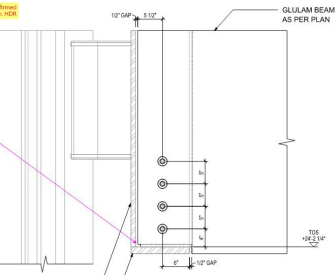
MARK	TYPE	SCREW TYPE	ORIENTATION	QUANTITY
MEGANT 120x40	10	PK 10x 1 1/2"	90° CONCENTRIC	10
		PK 10x 1 1/2"	45° INCLINED	10



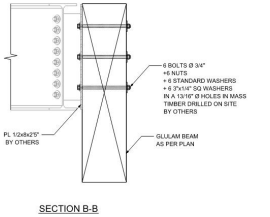
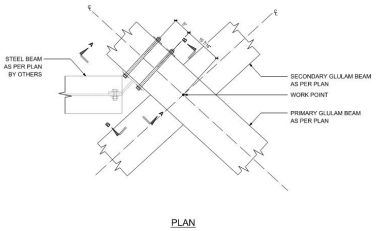
**11 DIAGRID ROOF - PURLIN TO MAIN GLULAM BEAM CONNECTION AND LIGHT BEAM CONNECTION**  
REF: 81025-513



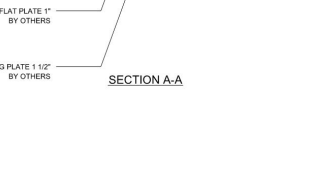
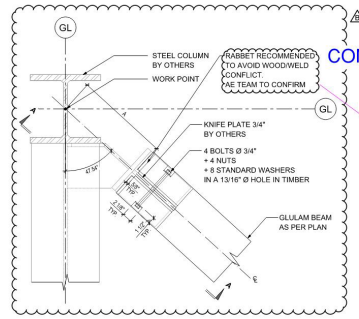
**CONFIRMED**



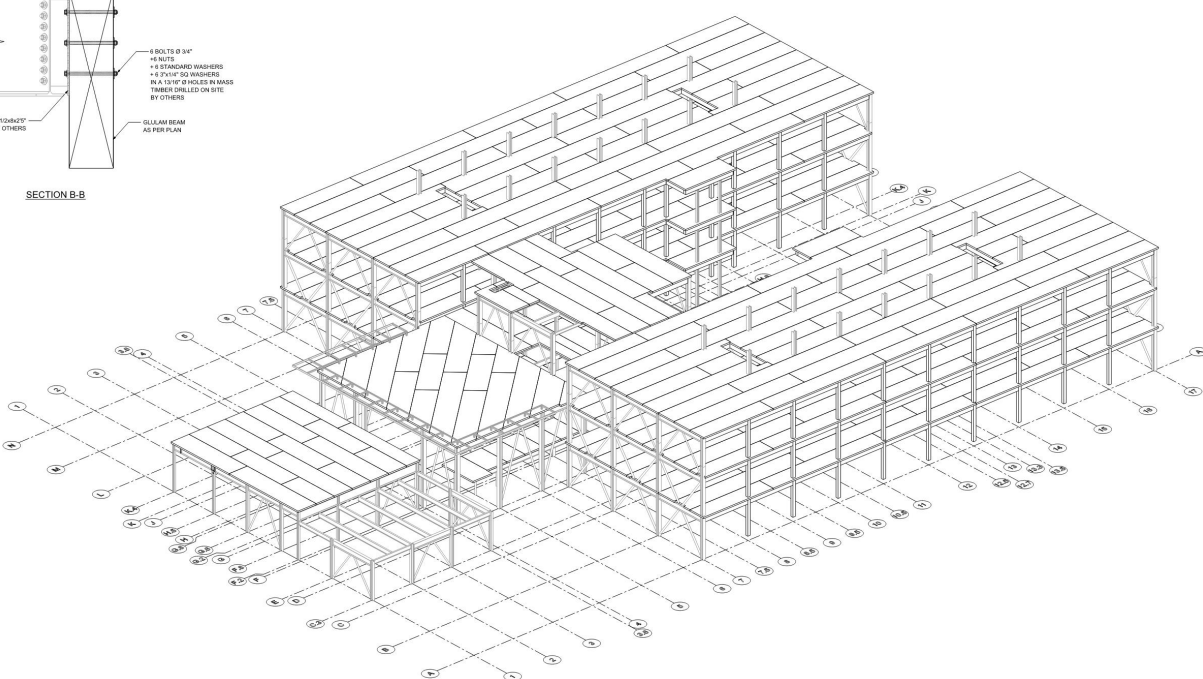
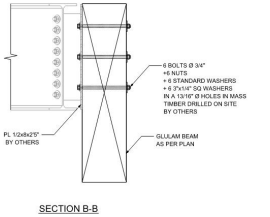
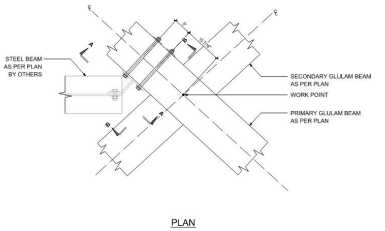
GL	A
GL4	21
GL4K	18 1/2"
GL4	18 1/2"
F-GL4	18 1/2"
ES	21
ES	21
E7.5	21
E7.5	17 5/8"
Q7.5	17 5/8"
Q7.5	17 5/8"
JS	21
JS	21



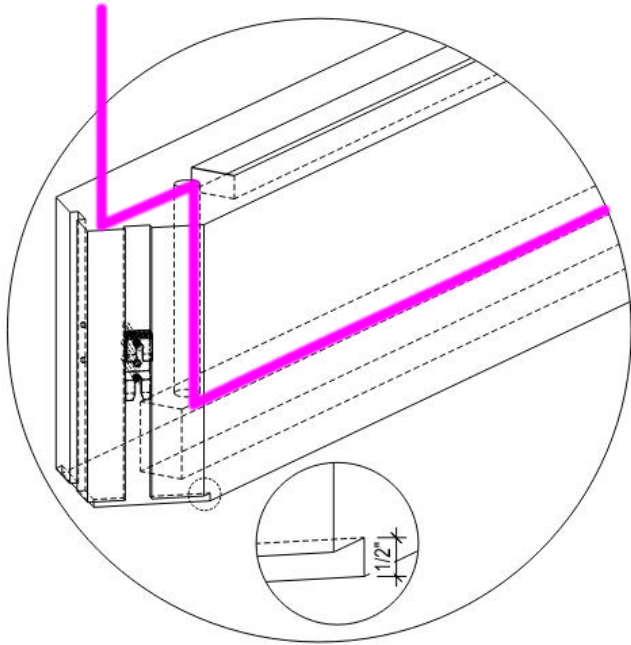
**9 DIAGRID ROOF - MAIN GLULAM BEAM TO STEEL STRUCTURE CONNECTION**  
SCALE: 1:10  
REF: 81030-603



**12 STEEL BEAM BRACING TO GLULAM BEAMS (DIAGRID SYSTEM)**  
SCALE: 1:10  
REF: 81030-603



# + Electrical



## Round 1



## Round 2





Nice Timber ceiling, where did you hide the mechanical diffusers?

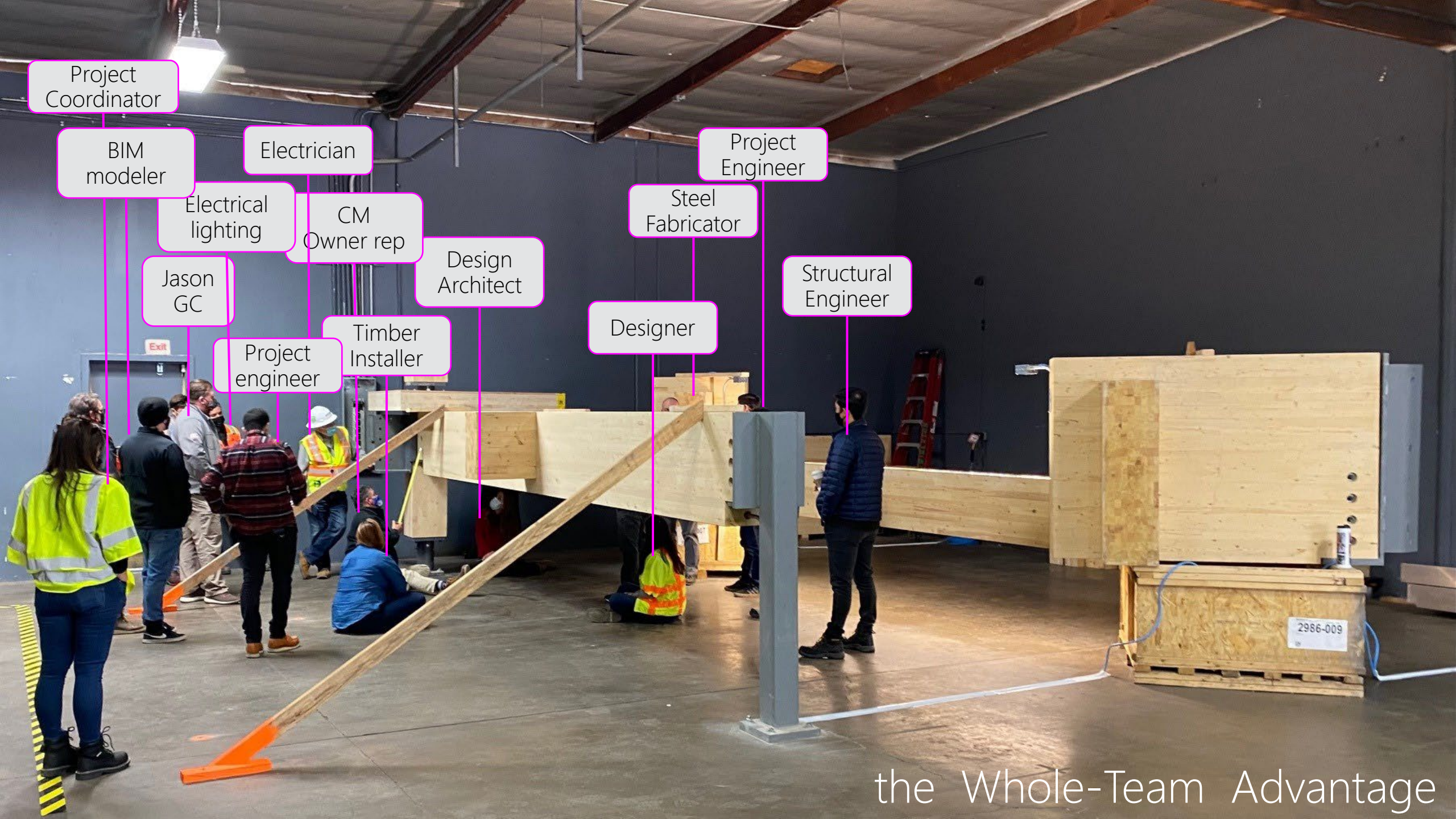


There are no diffusers in the ceiling. Lobby is conditioned via radiant floor. And.... net zero...



Did you check control joint depth and confirm insulation bearing capacity?

Orange County Sanitation District



Project Coordinator

BIM modeler

Electrician

Electrical lighting

CM Owner rep

Jason GC

Project engineer

Timber Installer

Design Architect

Designer

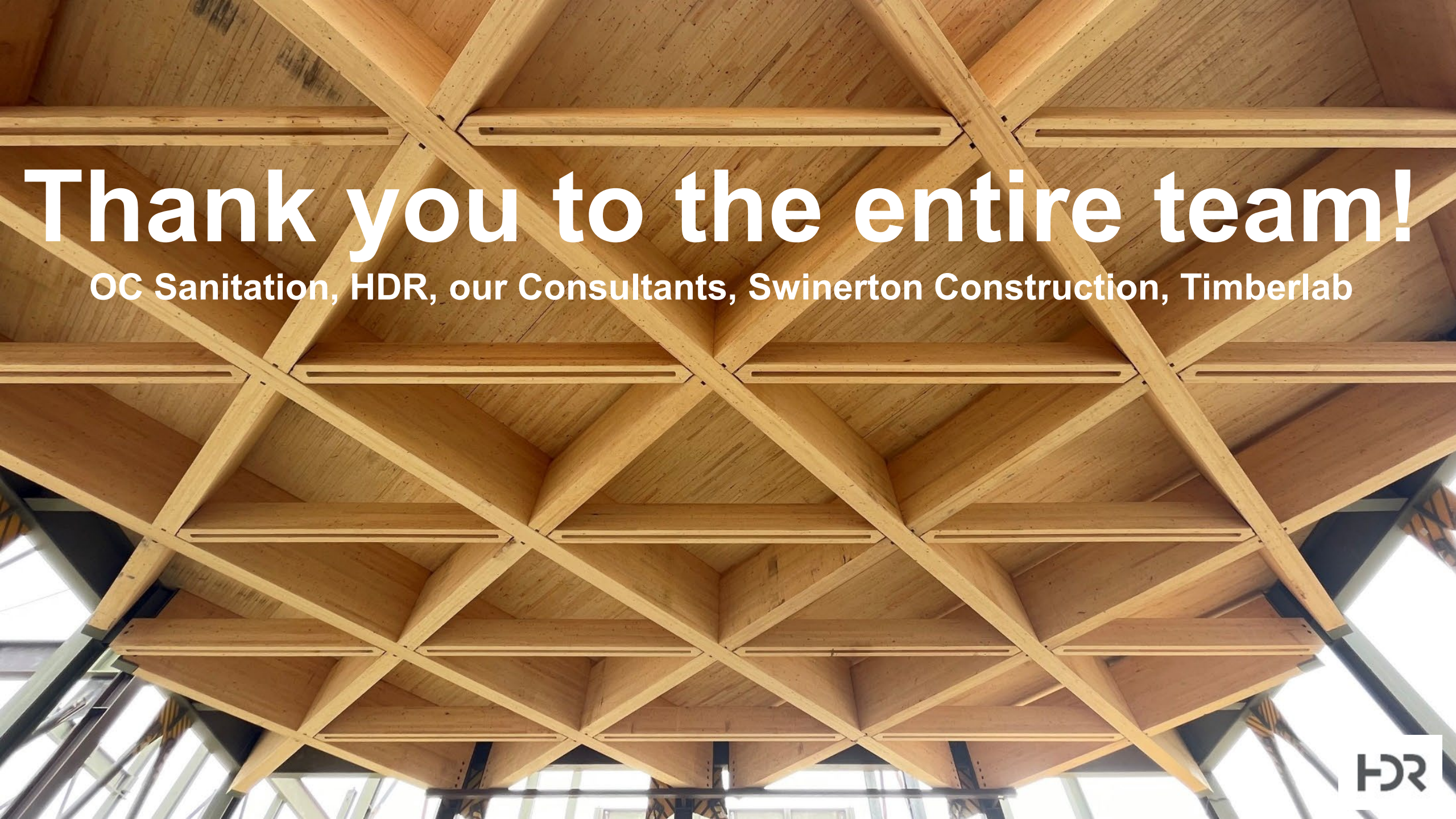
Steel Fabricator

Project Engineer

Structural Engineer

2986-009

the Whole-Team Advantage



# Thank you to the entire team!

OC Sanitation, HDR, our Consultants, Swinerton Construction, Timberlab



## How can an architecture practice use their own building and site as a case study for climate action?

### Myths we sought to disprove

1. A net zero energy building cannot be achieved in the hot-humid south on a budget.
2. Sustainability is an expense that cannot be justified.
3. Our aging building stock cannot feasibly become high performance.







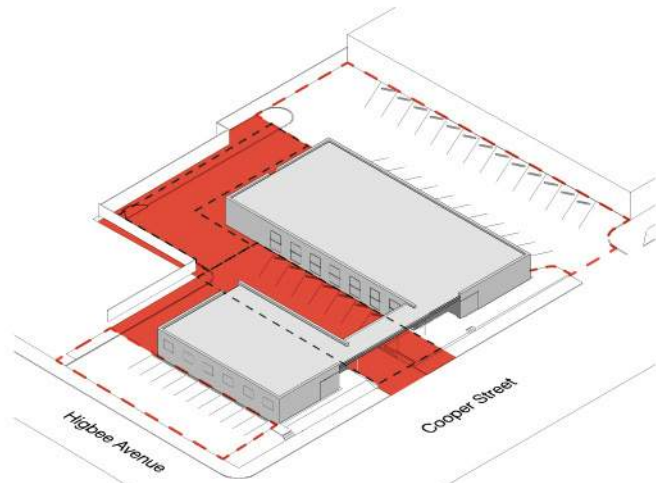


## UNDERSTANDING IMPACT

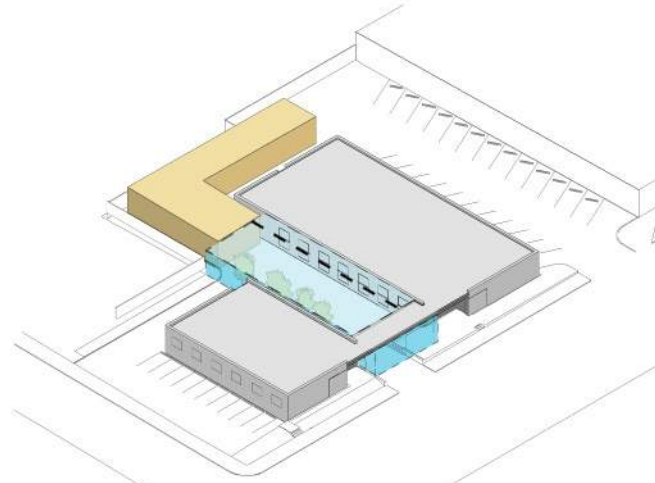
Population growth in the southeast has outpaced the rest of the country by nearly 40% over the past 60 years making it a critical contributor to our climate crisis.

Long considered the region with the most difficult climate and economy to achieve high performance design, our research and advancements have led us to discover strategies to meet these challenges.

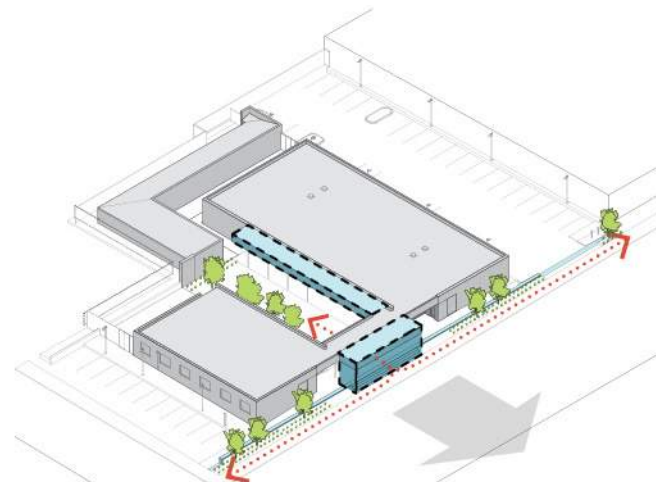
# DESIGN PERFORMANCE



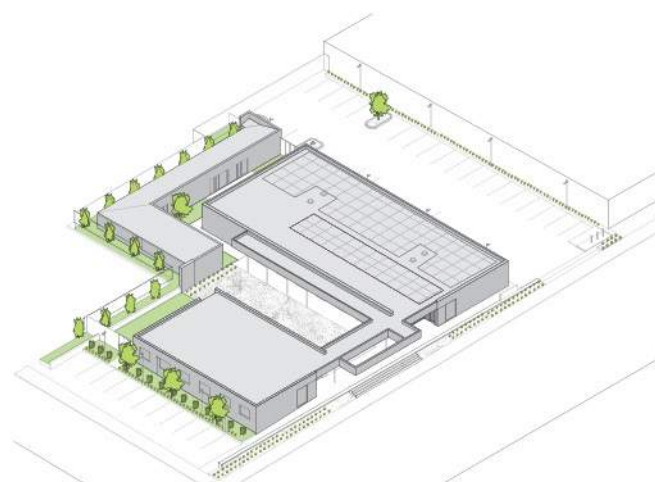
**1 RECLAIM INTERIOR SPACE FOR PEOPLE**



**2 DEFINE AN INTERNAL COURTYARD**



**3 EXTEND TO THE STREET TO ENGAGE PUBLIC**



**4 WEAVE LANDSCAPE THROUGHOUT VILLAGE**

## INTEGRATION

leveraging the best assets of the existing structure with strategic interventions to be expressed as architecture

## COMMUNITY

250-ft long enhanced street scape and 2,488 sf community courtyard and 31 space parking plaza (that can also be programmed for events)

## ECOLOGY

43% landscaping design to balance ecosystem by providing food, shelter, and nesting site for many different pollinators and birds

## WATER

37% of site transformed to pervious surface resulting in more than 20% increase in stormwater managed on site through bioswales and gravel courtyard

## ECONOMY

100% of cooling/heating/hot water via geothermal with shallow loops to 29 feet protect the sand aquifer

## ENERGY

107% of electricity offset by solar pv array

## WELLNESS

89% quality views & natural day lighting with a 18% glass to facade ratio

## RESOURCES

67% reduction in embodied carbon by up-cycling concrete, steel, masonry and designing with carbon smart materials

## CHANGE

100% of interior walls are non-loadbearing and reconfigurable while 80% of exterior walls were seismically upgraded

## DISCOVERY

100% transparency to share design strategies for this project as model for the integration of connectivity, design, and sustainability for similar buildings across Middle America



## LOW IMPACT DESIGN

Linear bioswales introduced along hardscape surfaces to provide filtered runoff through native plantings

**100%**  
new habitat to to balance ecosystem  
by providing food, shelter, and nesting  
site for many different pollinators and  
birds

**20% increase**  
in pervious surfaces with vegetation,  
lawn, and linear bioswales

Raymond Skinner  
(Recreation) Center

Higbee Avenue

Cowden Avenue

East Midtown  
Neighborhood

Peabody Park

South Cooper Street

## ENRICHING COMMUNITIES

by integrating design, sustainability, and connectivity through resources new and renovated.

Enhancements to the public realm invite the tenants and neighbors to actively engage and participate in a holistic community-oriented experiences.

### **FUTURE RESIDENTIAL APARTMENTS**

[4] apartment units integrated as mixed-use

### **SHARED PARKING PLAZA**

with adjacent church; also for events

### **SHARED COMMUNITY COURTYARD**

reclaimed as a social and recreation space for tenants and neighbors [previously asphalt parking]

### **ENHANCED STREETScape**

architectural lighting  
concrete threshold, bench, step  
low impact design bioswale  
40'-wide courtyard entry steps  
100% new pollinator habitat  
[educational sustainability sign]



**Legend**

- 1 open office
- 2 conference
- 3 meeting room
- 4 office
- 5 mechanical room
- 6 server room
- 7 supply / plot room
- 8 client prefunction
- 9 gallery
- 10 materials library
- 11 restroom
- 12 break room



**FLEXIBLE INTERIOR**

perimeter load bearing structure, open spans with single interior columns aligned

**100%**

non-load bearing interior walls provide extended life expectancy for building to be reconfigured through multiple iterations



## With an integrated approach to design and sustainability, how might a cost vs. performance model inform return-on-investment?

### Discoveries

1. At \$298 per square foot, this project became the first dual-certified Zero Energy and Zero Carbon renovation project by the International Living Future Institute (2021).
2. The energy saving strategies implemented in this project prove a return-on-investment in less than 10 years (compared to conventional baseline standards).
3. A 67% embodied carbon reduction was achieved through adaptive reuse of major systems (as final finishes) and smart carbon materials, assemblies, and products.

# GOALS, TARGETS, & MEASURING STICKS

## Zero Tool

### ABOUT YOUR BUILDING

Building Name: 663

Country: United States

City | State/Prov.: Memphis, Tennessee

Postal Code: 38104

Degree Days: HDD 3302, CDD 1969

New construction  Existing Building

### RESULTS

Target EUI is 26 based on a 60% reduction

BASELINE: 64 EUI, 100 Zero Score  
TARGET: 26 EUI, 40 Zero Score  
YOUR BUILDING: 26 EUI

### BUILDING USE DETAILS

In order to provide you with an appropriate comparison for your building, we need to know how spaces in this building will be used. If your building has multiple uses, add them below.

Commercial  Residential

Add Another Use:

Selected Use Type(s): Office

### BUILDING SUMMARY

LOCATION	Memphis, TN	38104
USES	Office	7,444 sq.ft (100.0%)

RESULTS	BASELINE	TARGET	YOUR BUILDING
EUI % Reduction from Baseline	0%	60%	N/A
Zero Score	100	40	N/A
Site EUI (kBTu/ft²/yr)	64	26	N/A
Source EUI (kBTu/ft²/yr)	165	66	N/A
Total GHG Emissions (metric tons CO <sub>2</sub> e/yr)	72	29	N/A

imperial  metric print

## Sefaira Energy Model Final Dashboard Export

08/15/2018

Office in Memphis, TN, USA

Properties

Total Floor Area: 7,444 ft<sup>2</sup>

26  
kBTU/ft²/yr

EQUIPMENT DOMINATED

MOSTLY UNDERLIT

Gains & Losses | Guidance

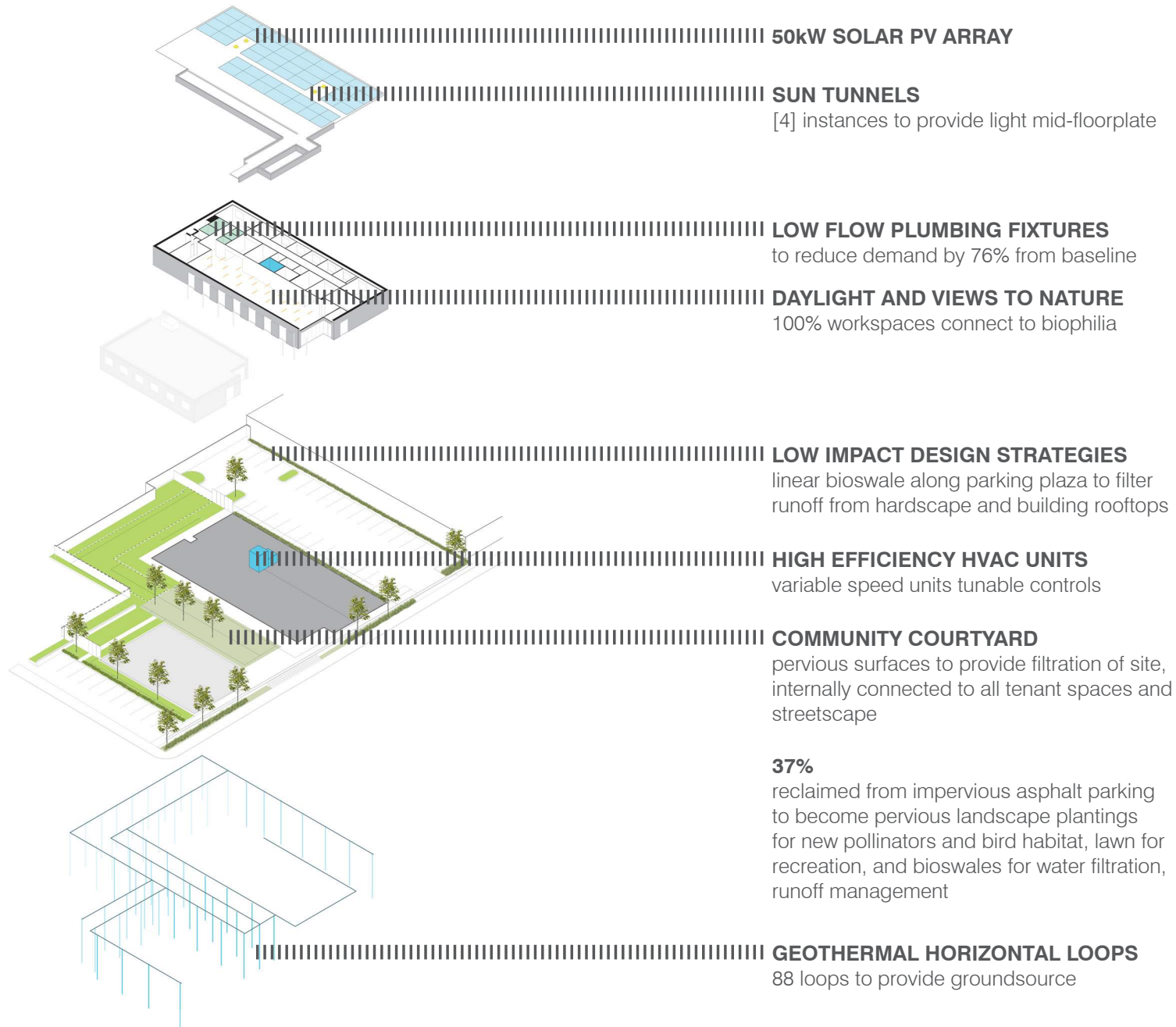
Impact on Heating

Impact on Cooling

- South Solar
- North Solar
- West Solar
- Floor Conduction
- East Solar
- Wall Conduction
- Roof Conduction
- Infiltration
- Glazing Conduction



# SUSTAINABLE SYSTEMS







2022 AIA COTE Top Ten Award

# SUSTAINABLE STRATEGIES

EUI  
(kbtu/SF/yr)

**-1.3**

## SUN PROTECTION

50 kW PV arrays shade roof overhang at south/east porch

## SUN COLLECTION

light tunnels mid-floorplate  
deep recessed windows

## ENERGY REDUCTION

strategic daylighting, enhanced thermal envelope, Energy Star appliances, high efficiency variable speed unit with geothermal system (Automated Logic), programmable lighting and plug load controls (Crestron) including daylight harvesting and occupancy sensors

## ENERGY PRODUCTION

rooftop 50kW solar pv array (Fronius) and geothermal heat pump [49 SEER]

## ENERGY MONITORING

Energy Reporting System (eGauge) tracks consumption and production data realtime

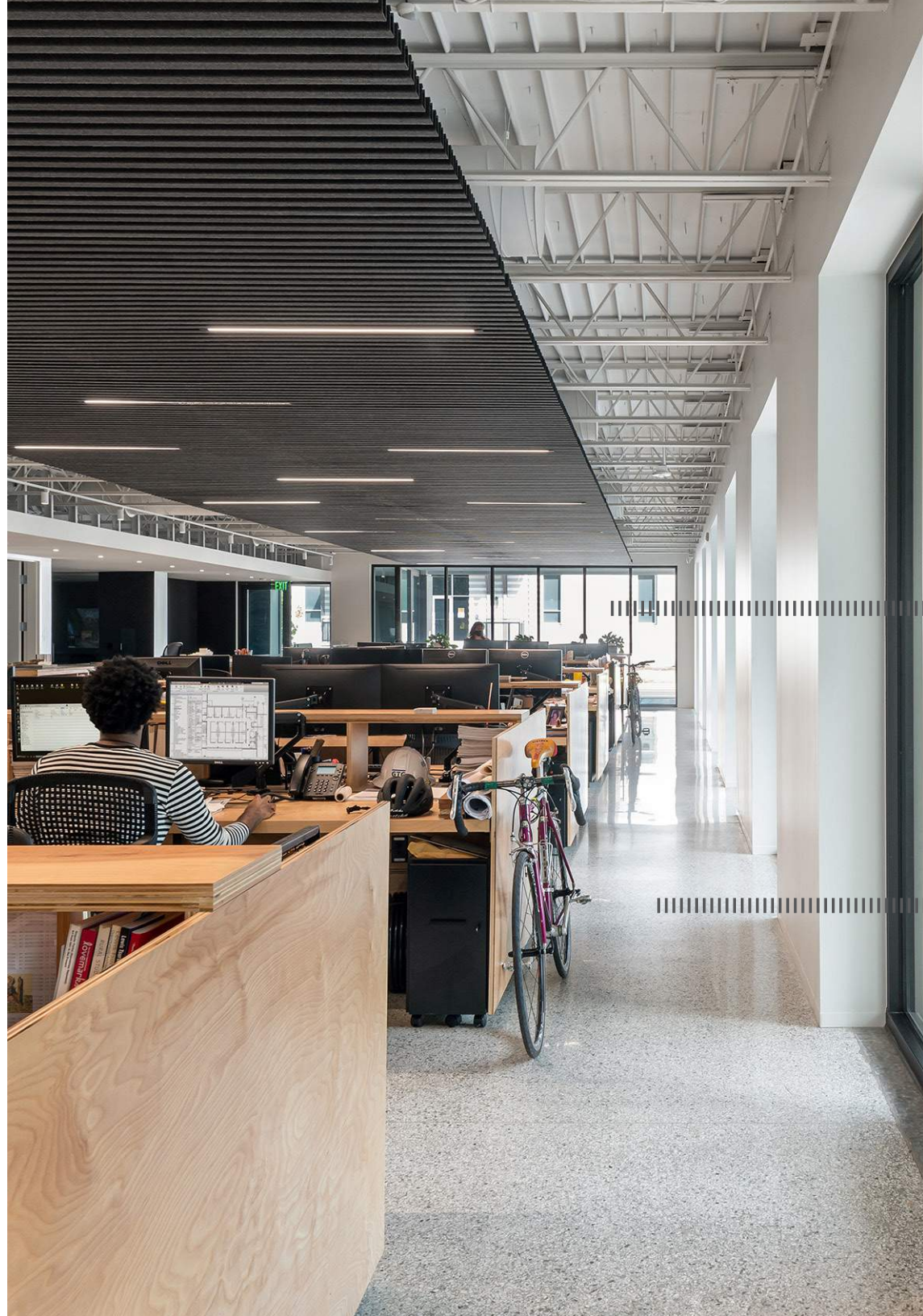


# CARBON SMART

demonstrated by a simple, yet rigorously organized, palette of locally sourced products and high recycled materials.

## 67% LESS EMBODIED CARBON

by up-cycling existing concrete & terrazzo floors, structural steel and decking, and exterior masonry and brick veneer, along with new construction low carbon materials and products



# STRATEGIC ECONOMY

is achieved by: upcycling existing primary structural and resilient finishes, maximizing daylight with views to nature and streetscape, introducing a refined articulation of common interior materials.

||||| **\$34,500**

heavy gauge metal stud framing and structural braces for seismic retrofit

add to existing unreinforced load bearing cmu block wall with brick veneer

||||| **\$43,000**

low-e IGU with thermally-broken storefront system

existing openings extend to grade to maximize daylight and connectivity to streetscape

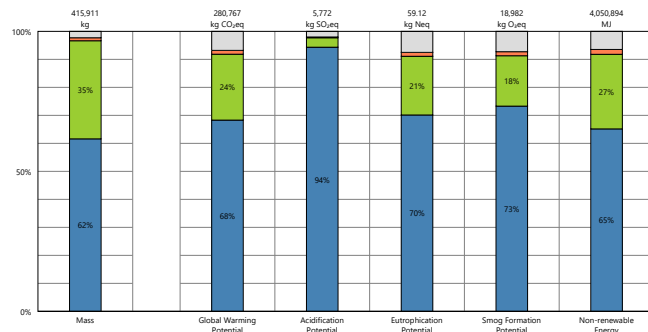
||||| **\$18,340**

refinish existing terrazzo flooring

savings avoid new concrete slab and floor finish with low maintenance and beautiful solution

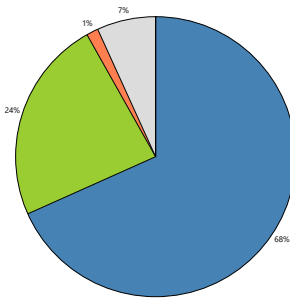
## FULL BUILDING SUMMARY - BASELINE

Results per Building Element



Legend

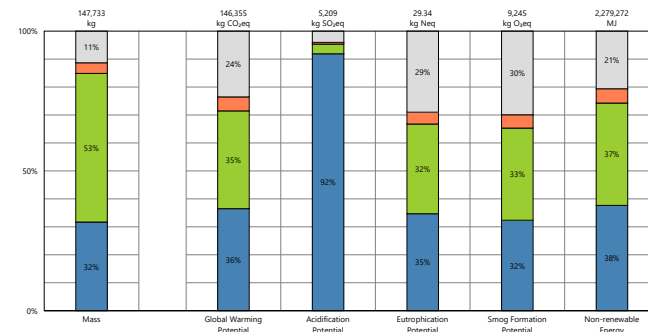
Building Elements  
 Superstructure  
 Enclosure  
 Interiors  
 Undefined



Global Warming Potential

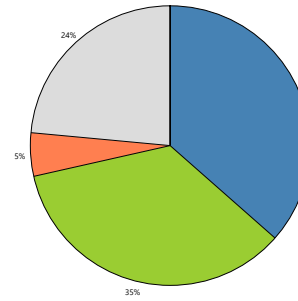
## FULL BUILDING SUMMARY - DESIGN

Results per Building Element



Legend

Building Elements  
 Superstructure  
 Enclosure  
 Interiors  
 Undefined



Global Warming Potential

# LIFE CYCLE ANALYSIS



PRIMARY MATERIALS EMBODIED CARBON BASELINE

346 tCO<sub>2</sub>e

PRMIARY MATERAILS EMBODIED CARBON AFTER REDUCTIONS

115 tCO<sub>2</sub>e

EMBODIED CARBON OF MATERAILS + CONSTRUCTION (A1-A5)

82 tCO<sub>2</sub>e

QUANTITY OF CARBON OFFSET PURCHASED

100 tCO<sub>2</sub>3 (domestic, wind power)

CARBON INTENSITY

117.6 kgCO/m<sup>2</sup>

# EMBODIED CARBON REDUCTION

# 67% LESS



## POROSITY AND CONNECTION

Two hinging screen panels pivot to provide 4 configurations for multiple means of access, transparency, and occupancy within courtyard.





## OUTDOOR GATHERING

The 3,000 square foot courtyard offers a supplemental environment to connect with nature for engagement and events, as well as meetings, phone calls, and independent working.

The southern porch offers a semi-private space for refuge and canopy from direct sun and rain.





# archimania energy monitor

View | LAN Access | Tools | Settings | Help

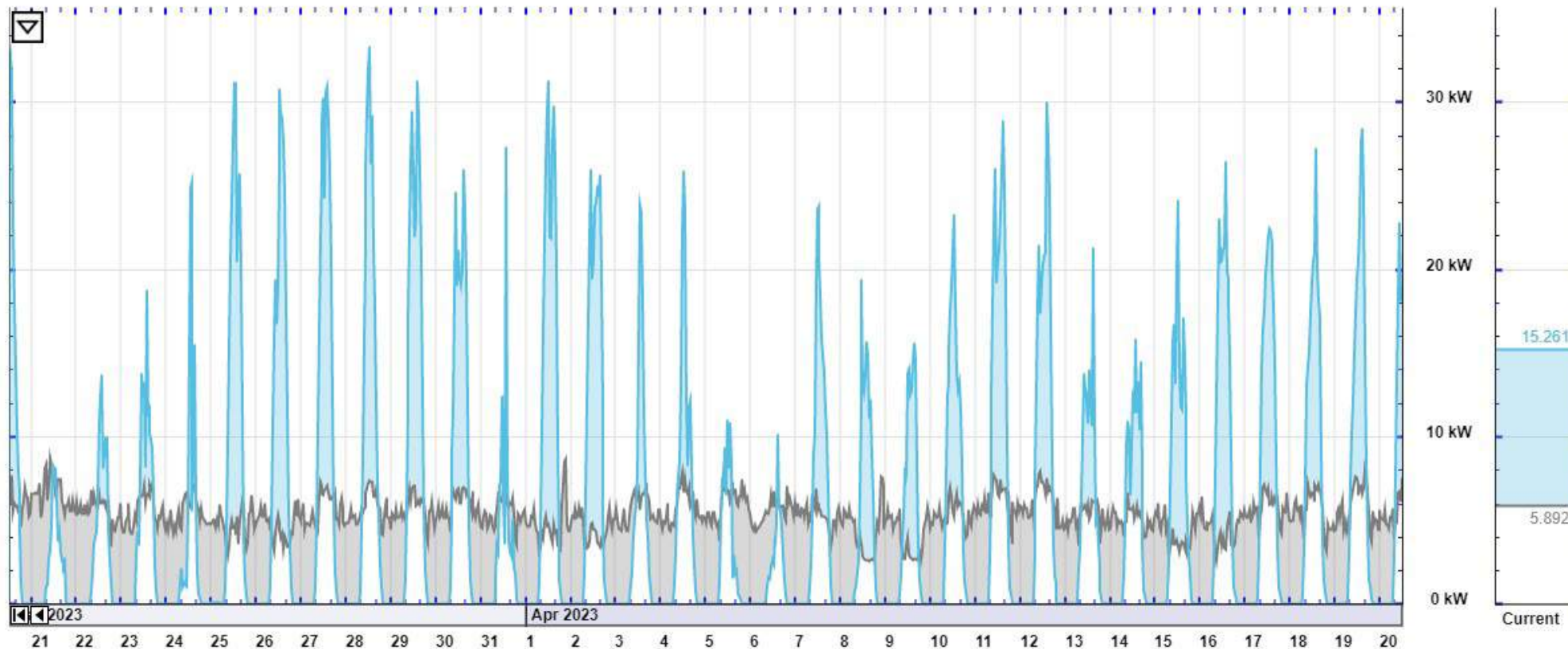
3/20/2023 12:18pm - 4/20/2023 12:18pm

### Summary for time-period shown in graph

Energy Used	4.00 MWh	(approx. \$279.84 used)
Energy Generated	4.33 MWh	(approx. \$325.04 saved)
Net	336 kWh sold	(approx. \$45.20 earned)

### Summary over last 30 days

Energy Used	3.84 MWh	(approx. \$268.99 used)
Energy Generated	4.21 MWh	(approx. \$316.08 saved)
Net	372 kWh sold	(approx. \$47.09 earned)



<input checked="" type="checkbox"/> Power used	<input checked="" type="checkbox"/> Energy from grid	<input checked="" type="checkbox"/> Power generated	<input checked="" type="checkbox"/> Energy to grid
<input type="checkbox"/> MECHANICAL gen./use	<input type="checkbox"/> WORKSTATION  gen./use	<input type="checkbox"/> RECEPTACLES  gen./use	<input type="checkbox"/> LIGHTING  gen./use
<input type="checkbox"/> SOLAR gen./use	<input type="checkbox"/> SOLAR+ gen./use	<input type="checkbox"/> Toggle all/none	

# POST OCCUPANCY AS A TEACHING TOOL

## SUSTAINABILITY ACTION PLAN

- . GREEN CLEANING POLICY
- . ENERGY MONITORING
- . OUTDOOR WORKING SPACES
- . VARIETY OF WORKSPACES
- . LIGHTING CONTROLS
- . RECYCLING PROGRAM
- . COMPOSTING
- . FLEXIBLE STAFFING
- . HEALTHY PRODUCT PURCHASING
- . REGULAR EMPLOYEE SURVEYS

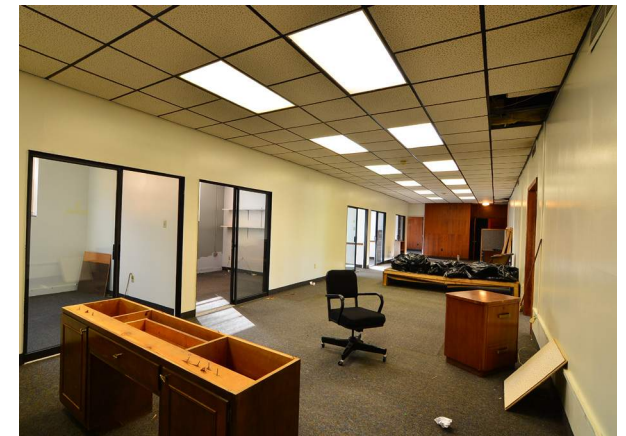


# WASTE DIVERSION

96% Repurposed and Reused Substructure, Superstructure and Enclosure

61% Existing Interior Partitions, Systems, and Finishes diverted from landfill

[before]



[before]



## **We have expanded the vision from our project/site as a model and proof-of-concept to reinvent aging mid-century commercial corridors across Middle America.**

### **Integrated Design Research**

Our research seeks to provide a Carbon Neutral Corridor model for reimagining aging commercial and residential corridors into locally authentic, resilient, equitable and inclusive solutions to rising energy use and carbon emissions. This will be a focused study of lower-carbon streetscapes, carbon neutral building strategies, and engagement with public/private partnerships.

This research will explore actionable and incremental steps for current property owners to leverage existing building stock for upcycling before considering steps for improvements using sustainable new construction methods. Additionally, the effort will explore how qualitative and measurable urban design strategies can reduce carbon impact comprehensively at the district scale.

# CARBON NEUTRAL CORRIDORS

imagines the opportunity to consider this project as model to demonstrate how change agents can re-frame community investment through the transformation of our existing building stock with the integration of design and sustainability.



663  
SOUTH  
COOPER

**Scale:**  
1.8 miles

**Opportunity**  
565,441 sf across 88 buildings

**Impact:**  
Carbon Reduction Savings  
from Zero Carbon Upcycling

**21,701,199**

lbs of CO2

or

[which is equal to]

**36,093**

Metric Tons

**Green house gas emissions from**

**7,798**

Passenger vehicles  
driven for one year

**CO2 Emissions from**

**4,165**

Homes' energy use  
for one year

**Green house gas emissions avoided by**

**1,535,734**

trash bags of waste recycled  
instead of landfilled

**Carbon Sequestered by**

**47,136**

acres of U.S. forests  
in one year

