Climate Positive Enclosures

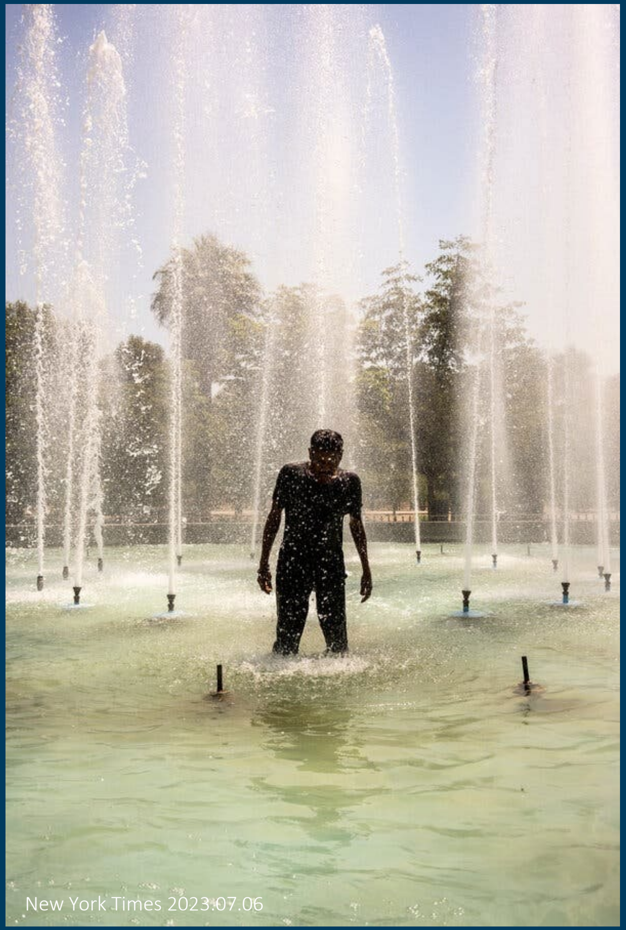
Priorities & Process

Agenda

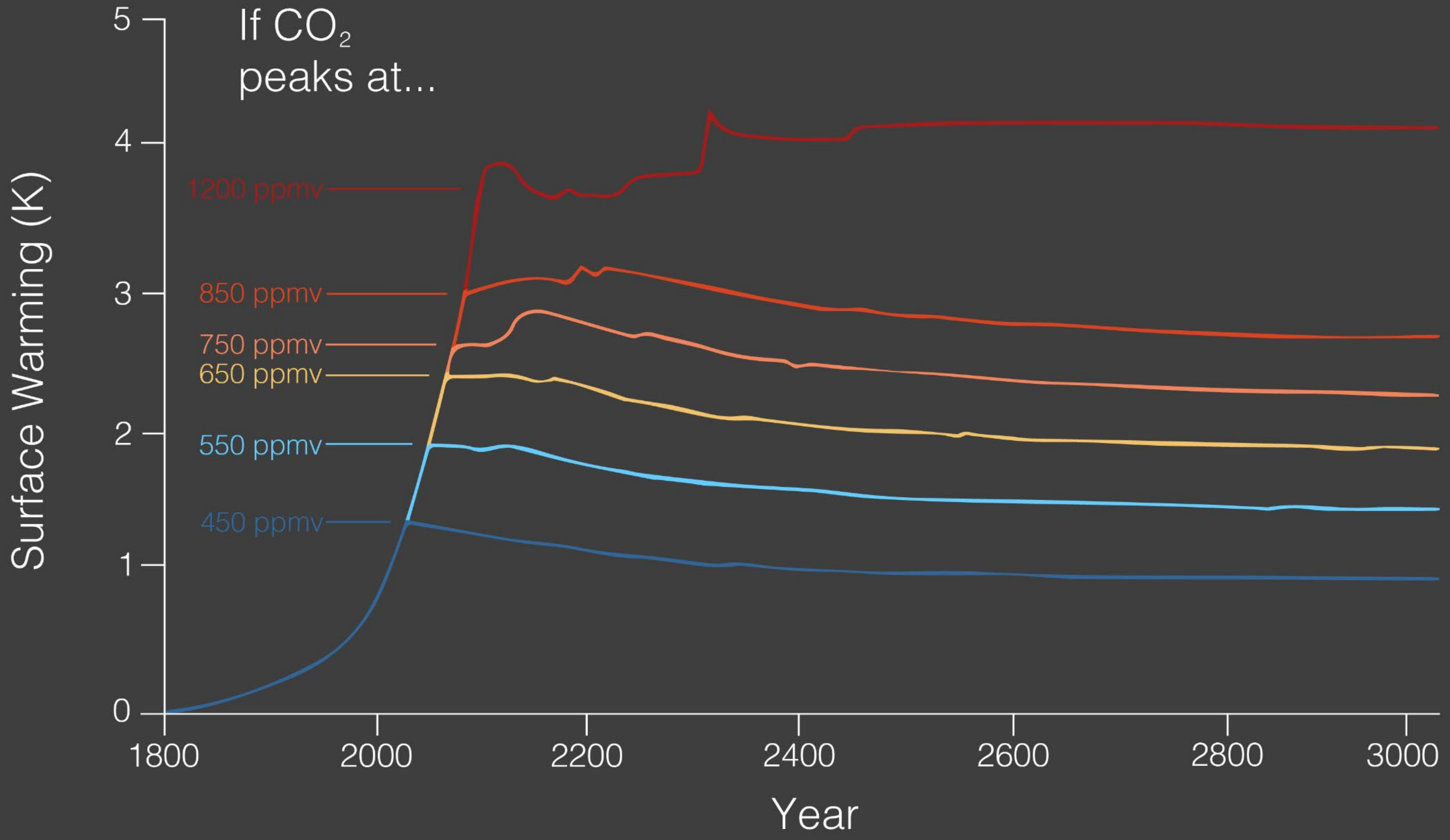
1. Buildings, climate, and the enclosure role
2. Mitigating dynamic conditions—exterior and interior
3. Climate impacts—operational and embodied carbon emissions
4. Enclosure performance
5. High performance and collaboration
6. What's next?
7. Call to action!

01 Buildings, Climate, & the Enclosure Role

- Climate change and impacts
- Current weather and trends
- Role of the built environment
  - mitigation
  - adaptation



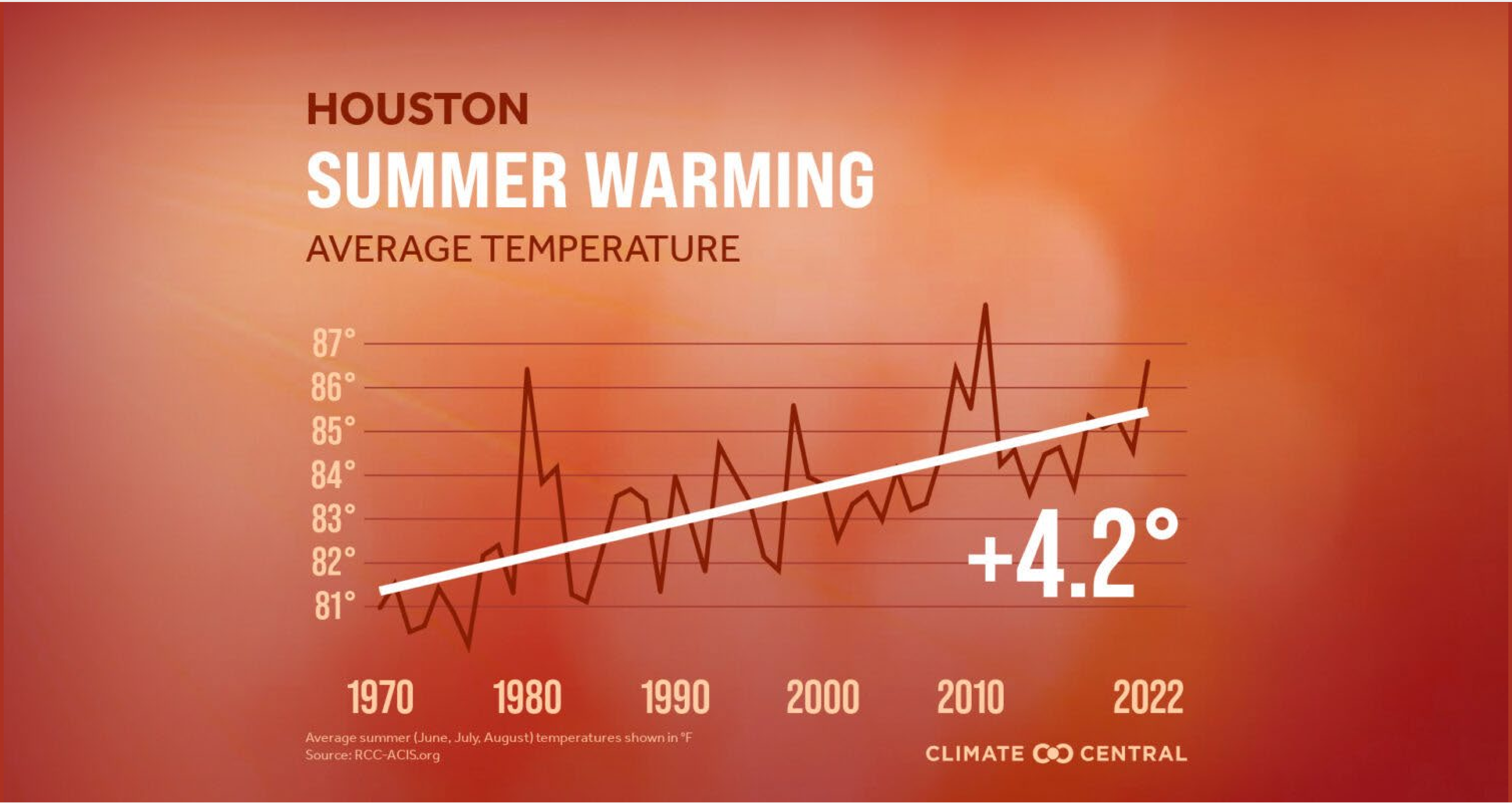
Climate Change—CO_2 Scenarios



climate.nasa.gov

*Data via Solomon et al., PNAS, 2009.

Climate Change—Local Effects



TAKEAWAY: THE CLIMATE HAS CHANGED

Buildings must adapt to a changing climate

At only 1.1°C of global warming:

→ Extreme storms with more water

→ Overland flooding

→ Sea level rise

→ Overheating buildings

→ Smoke-filled skies affect indoor air

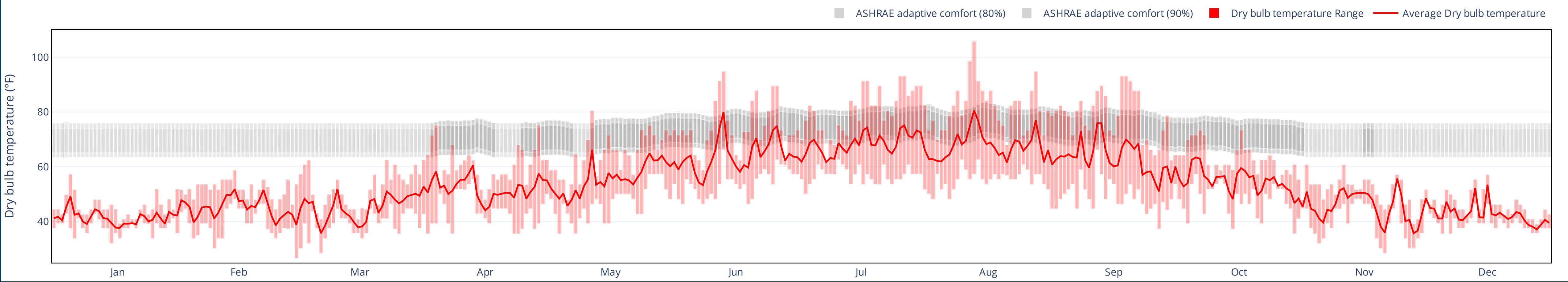
Every building needs a plan.

Lytton, B.C., on July 9, 2021.
Photo by Darryl Dyck, The Canadian Press.

RDH

02 Mitigating Dynamic Conditions

- Building enclosures play a crucial role in mitigating dynamic exterior and interior (climate) conditions
- This role also provide significant opportunities for global climate benefits



03 Climate Impacts

EMBODIED CARBON is the carbon footprint of all the materials & effort associated with construction.

OPERATIONAL CARBON is the carbon footprint from the operations of the building post construction.

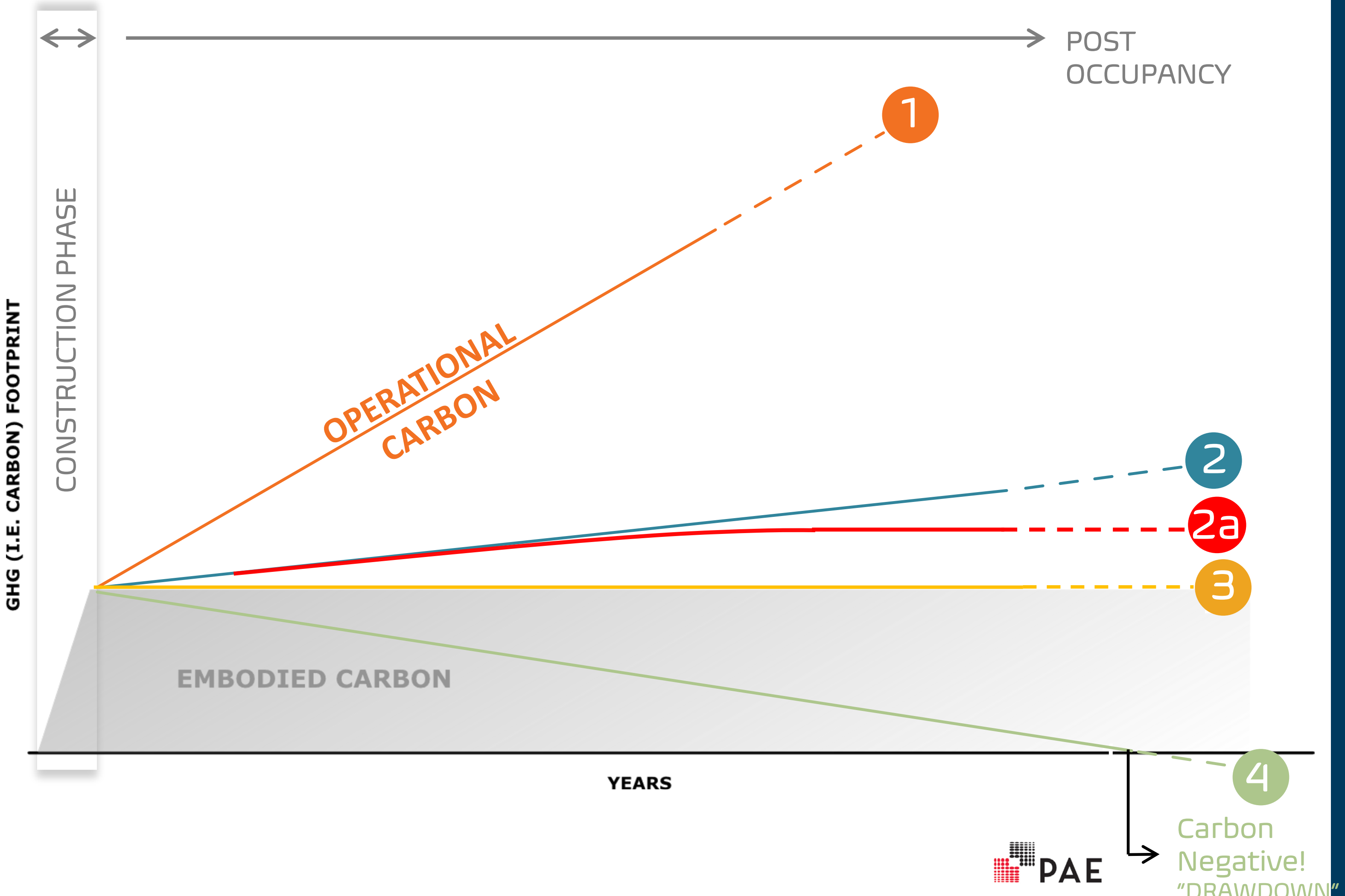
1 Energy Code Compliant - Operational Carbon Footprint Trajectory (Uses fossil fuels for heating)

2 15 to 25% better than Code (all electric building)

2a Transition to a Green Grid (all electric building)

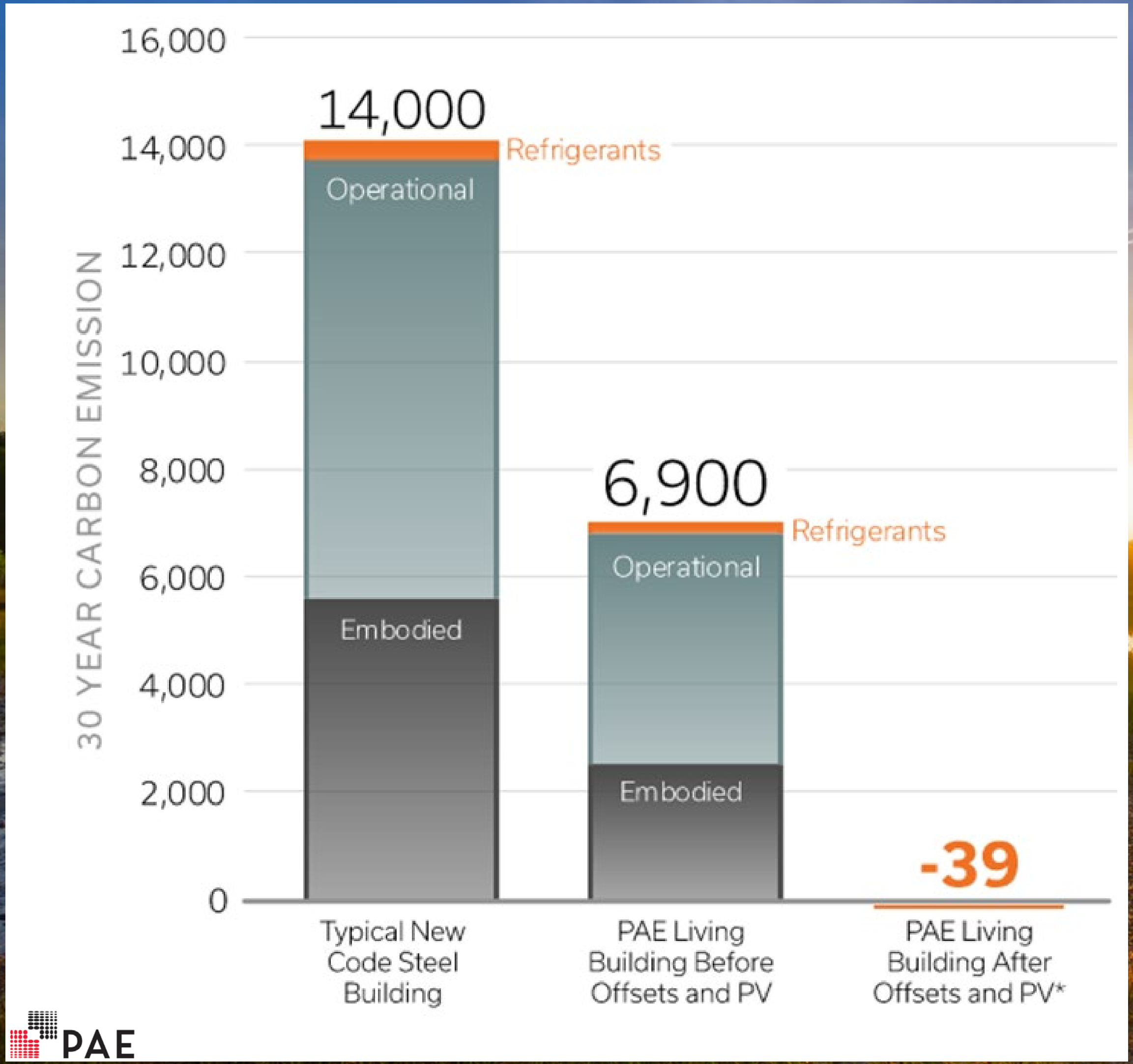
3 Net Zero Energy (NZE) (all electric building)

4 Positive Renewable Energy – producing more renewable energy annually than used on site (all electric building)



PAE

Carbon Reduction Case Study



50% REFRIGERANT EMISSIONS SAVINGS

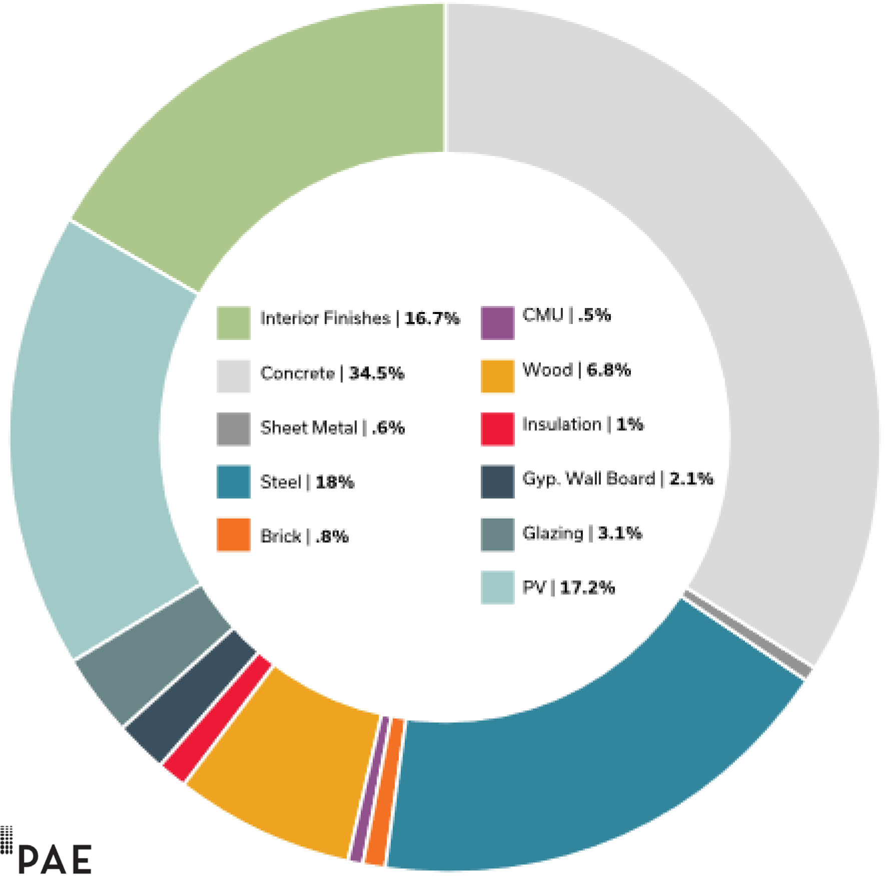
52% OPERATIONAL EMISSIONS SAVINGS

45% EMBODIED EMISSIONS SAVINGS

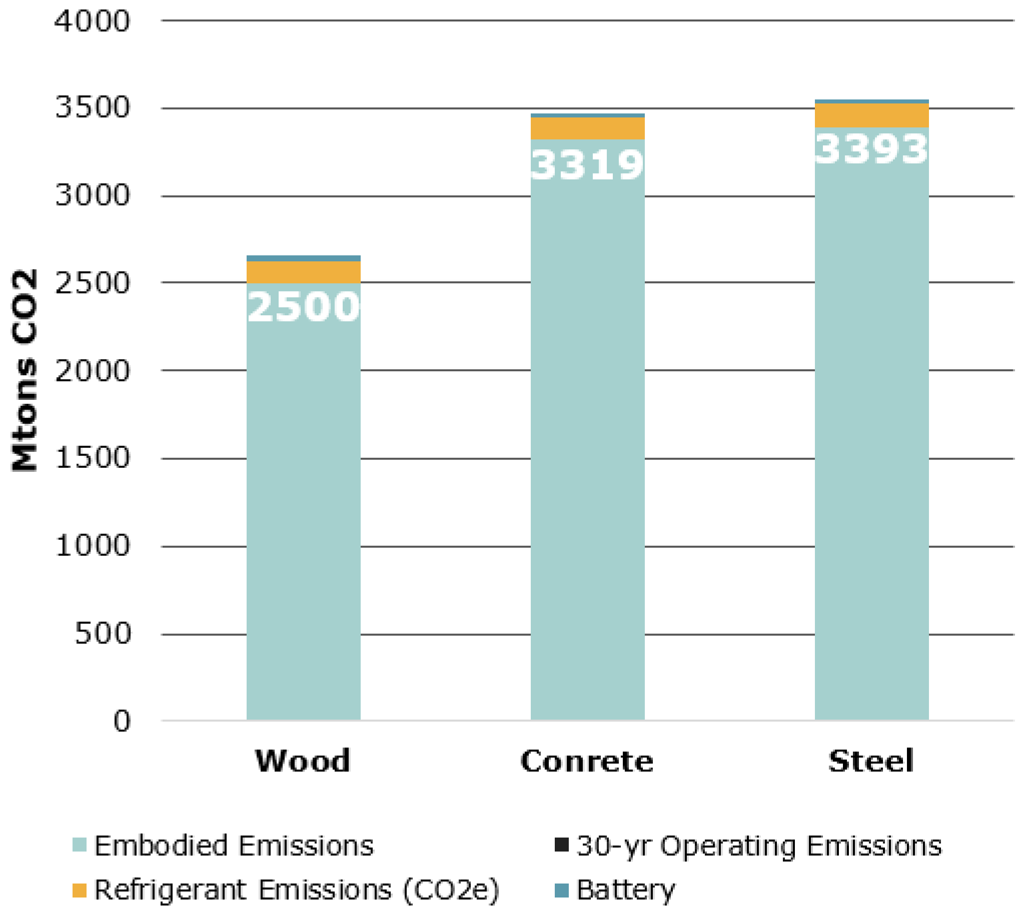
101% TOTAL CARBON EMISSION SAVING

Embodied Carbon Breakdown for a NZE Building

Embodied Emissions Cradle through Construction



30 Year Emissions



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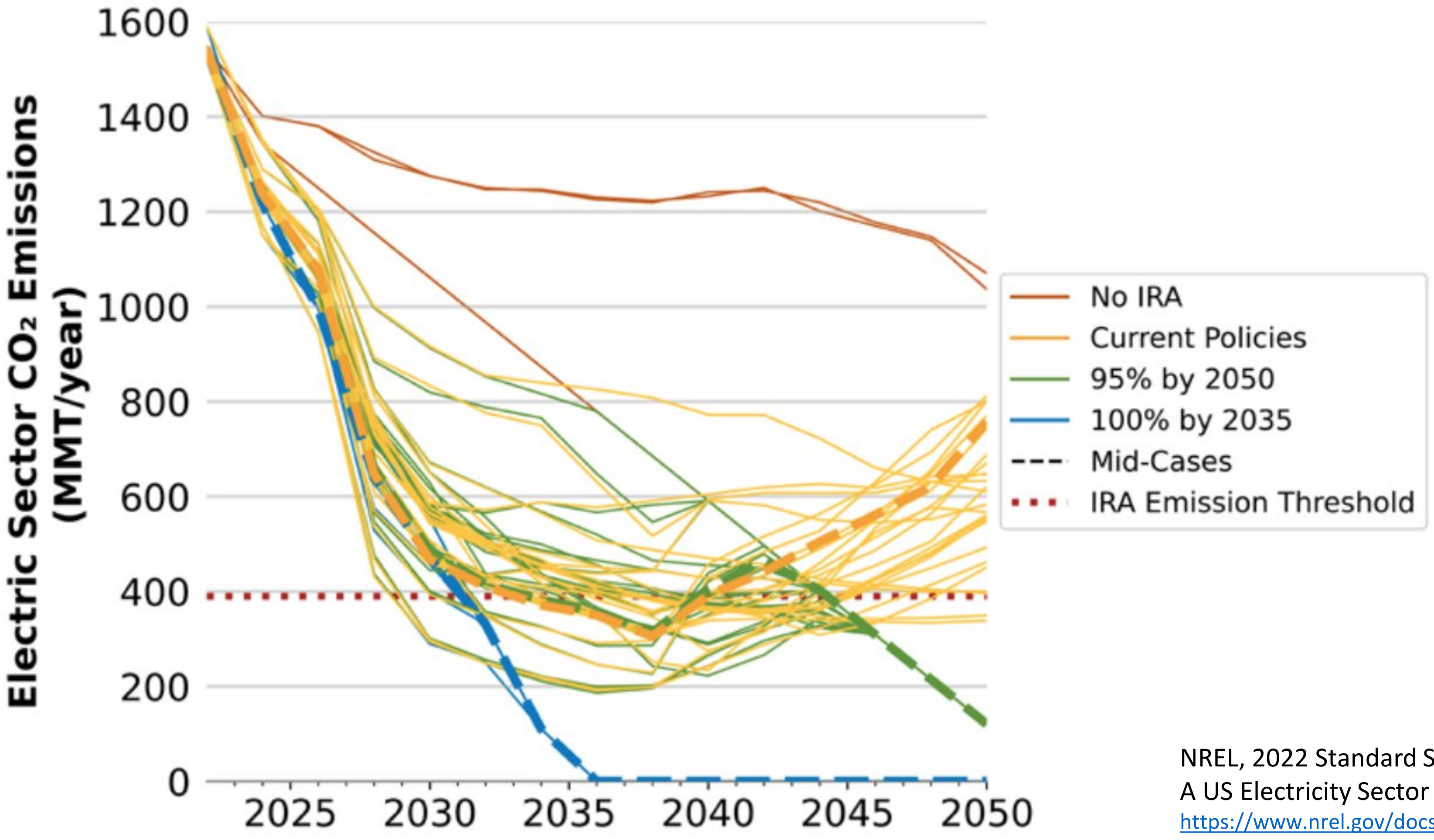
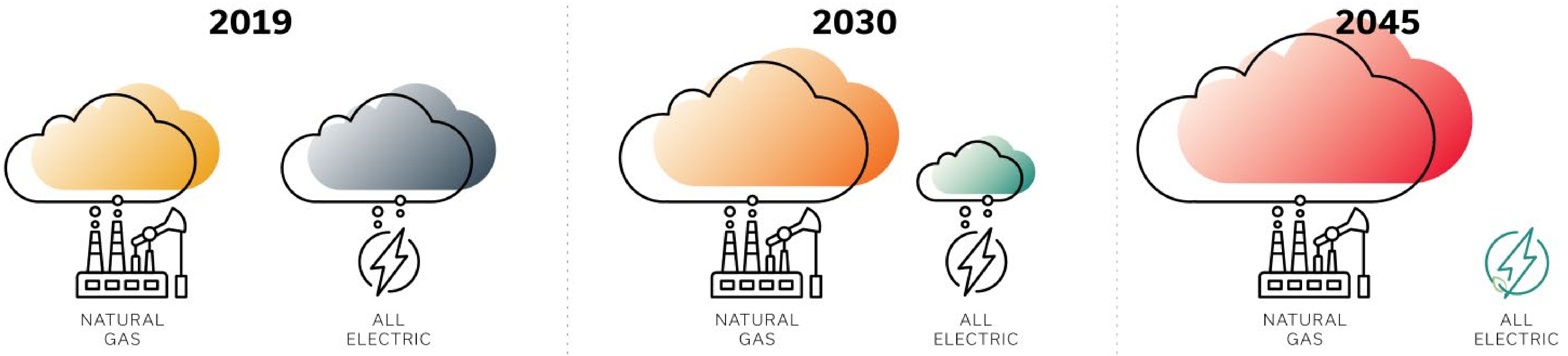
Electric grid trends



NREL, 2022 Standard Scenarios Report: A US Electricity Sector Outlook
https://www.nrel.gov/docs/fy23osti/84327.pdf

Grids are getting cleaner, faster!



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PATH TO NET ZERO CARBON

PAE

All-electric
No Fossil Fuels
Low Global Warming Potential (GWP) Refrigerants
Low embodied carbon building materials
Material carbon sequestration

MINIMIZE

DECARBONIZE

REVITALIZE
CARBON OFFSETTING

Right size construction
Limited Development
Energy Recovery + Sharing
Resource re-use
Water Conservation + re-use
Geothermal heating/cooling Technology
Refrigerants

On or offsite renewable energy
Renewable Energy Credits
Carbon Solution Investments
Reforestation

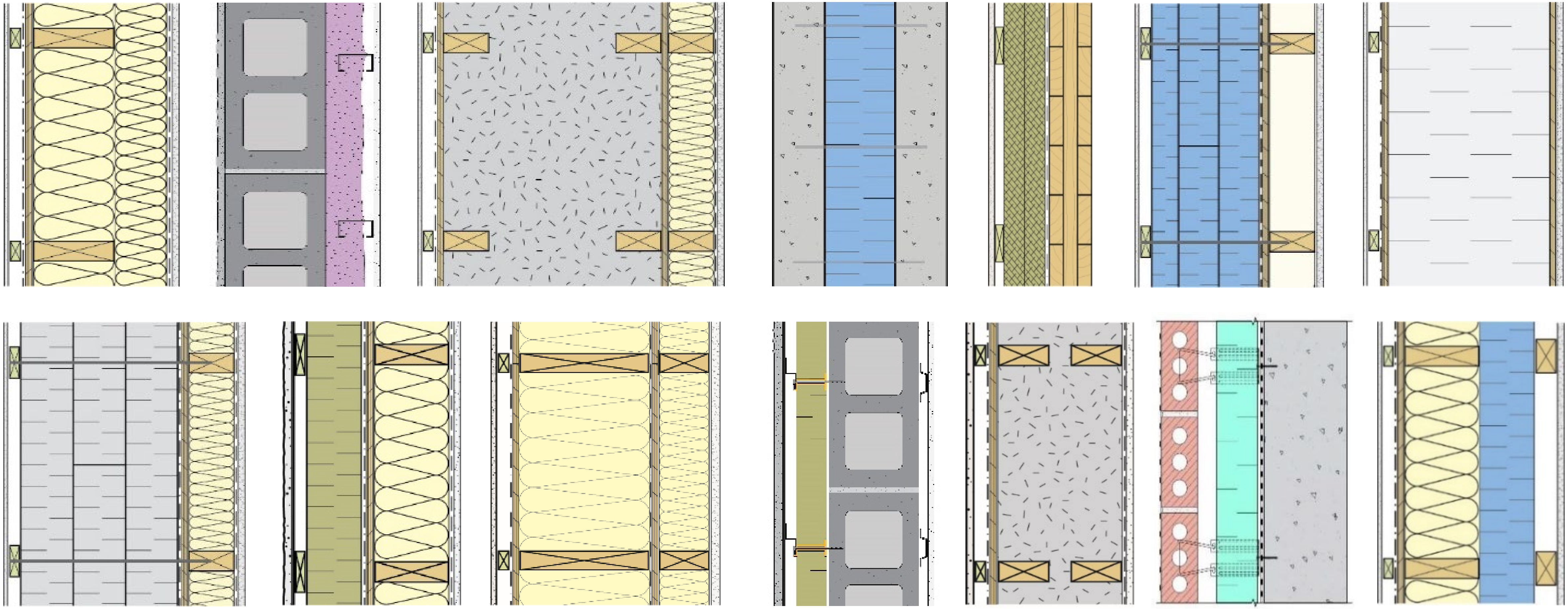
NET ZERO CARBON
THEN CARBON DRAWDOWN

EMBODIED
TRANSPORATION
WATER
BIOGENIC
REFRIGERANTS
OPERATIONAL

04 What Is a High-Performance Enclosure?

- High levels of control (heat, air, moisture)
- And…
- Mitigates climate change (energy efficient, low carbon)
- Adapts to climate change (wildfire resistant, airtight, resilient to storms)
- Comfortable for occupants
- And…
- Cost effectiveness, constructability, durability, etc…

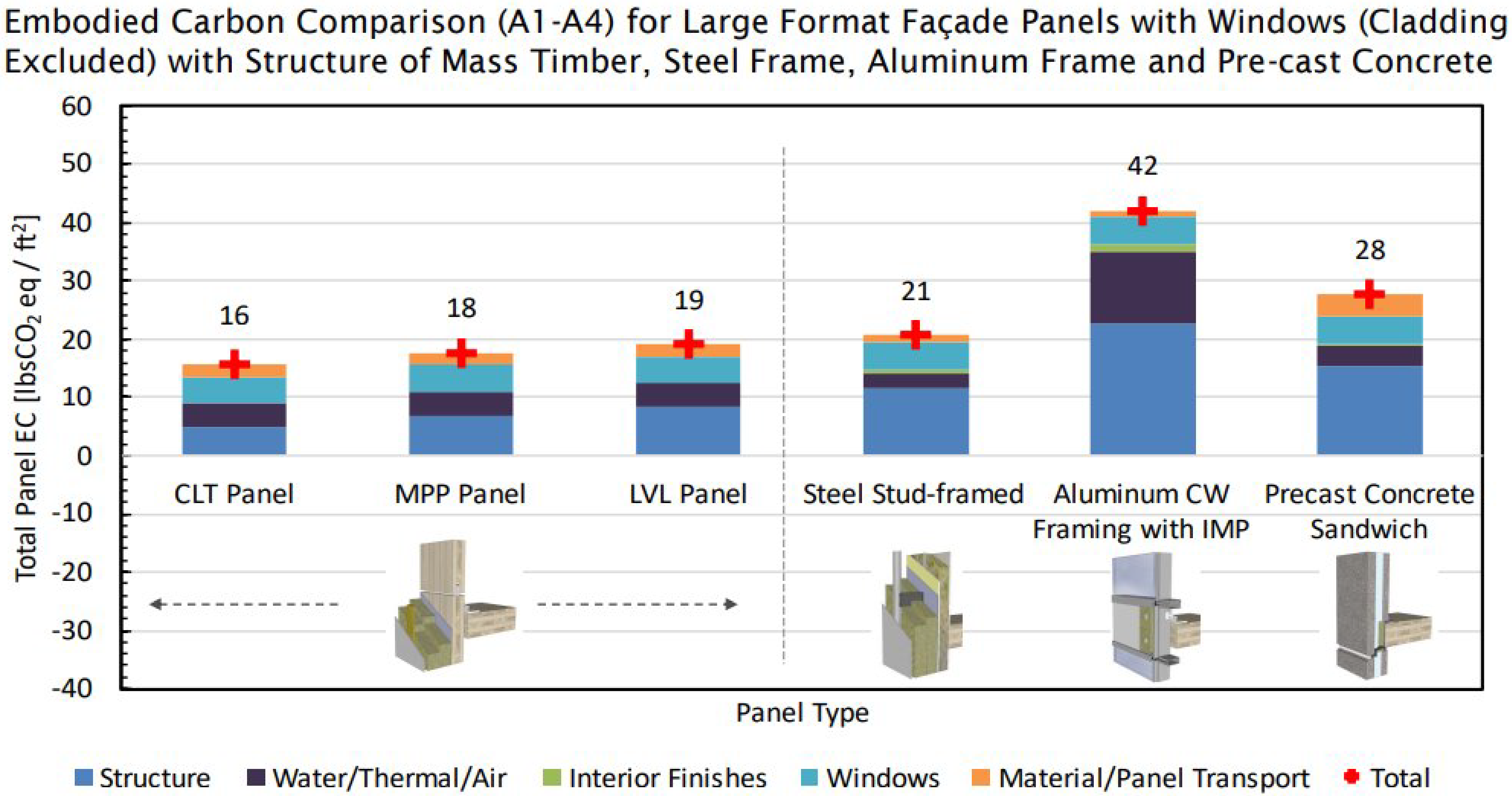
High Performance Enclosures



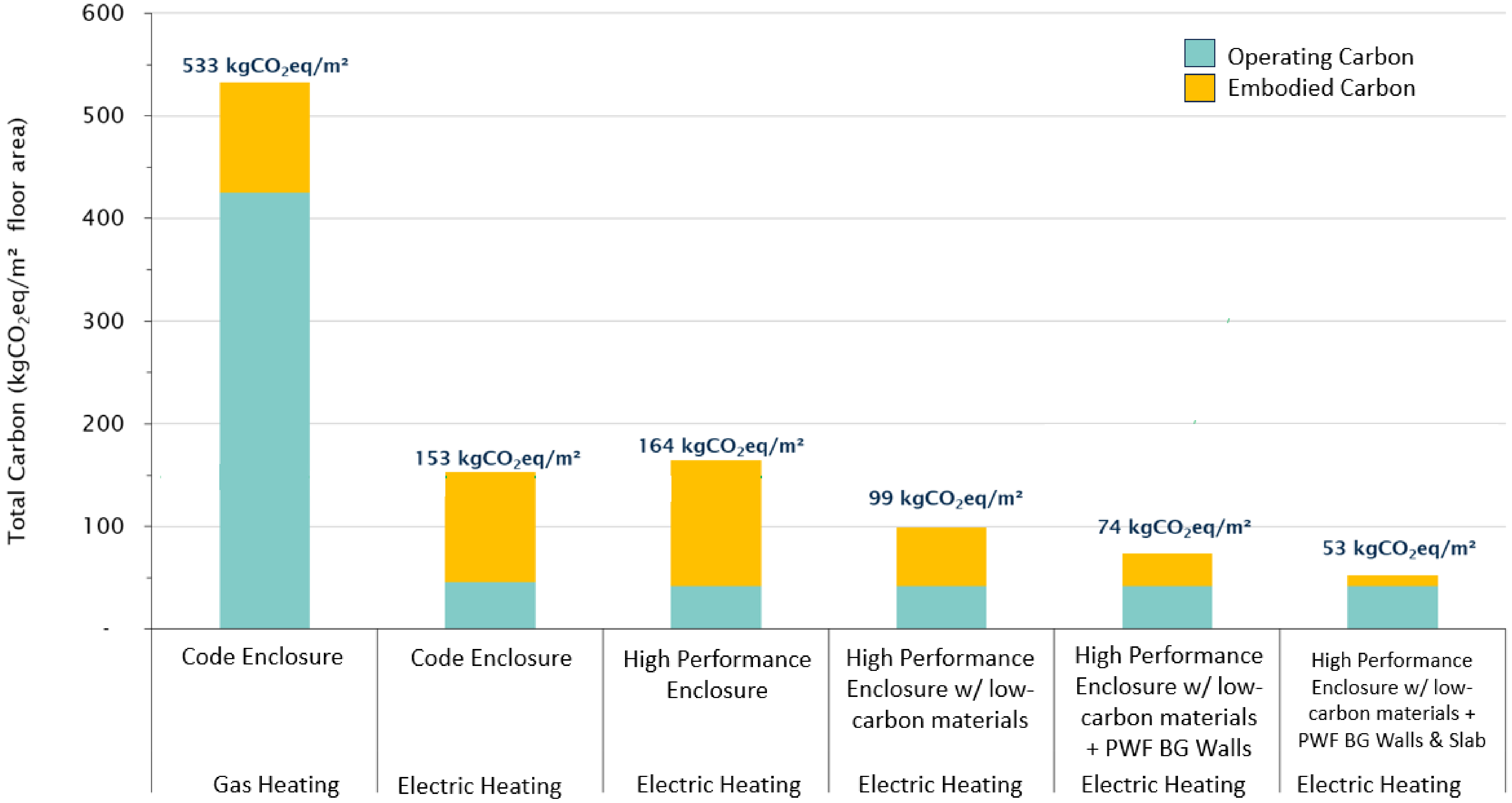
More than one way to get there…

Embodied Carbon Comparison of Facade Panels

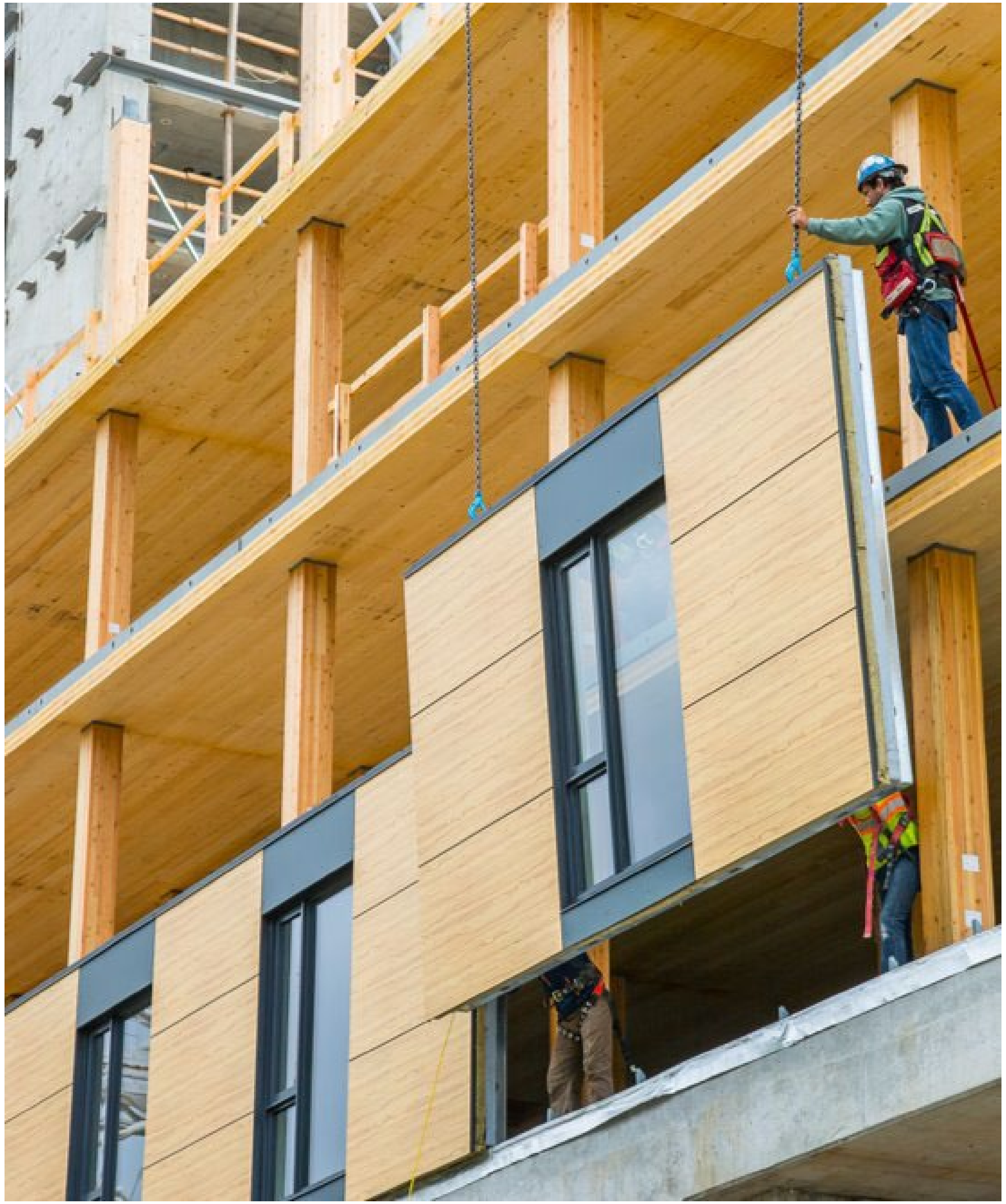
without biogenic carbon



Reducing Operational & Embodied Carbon

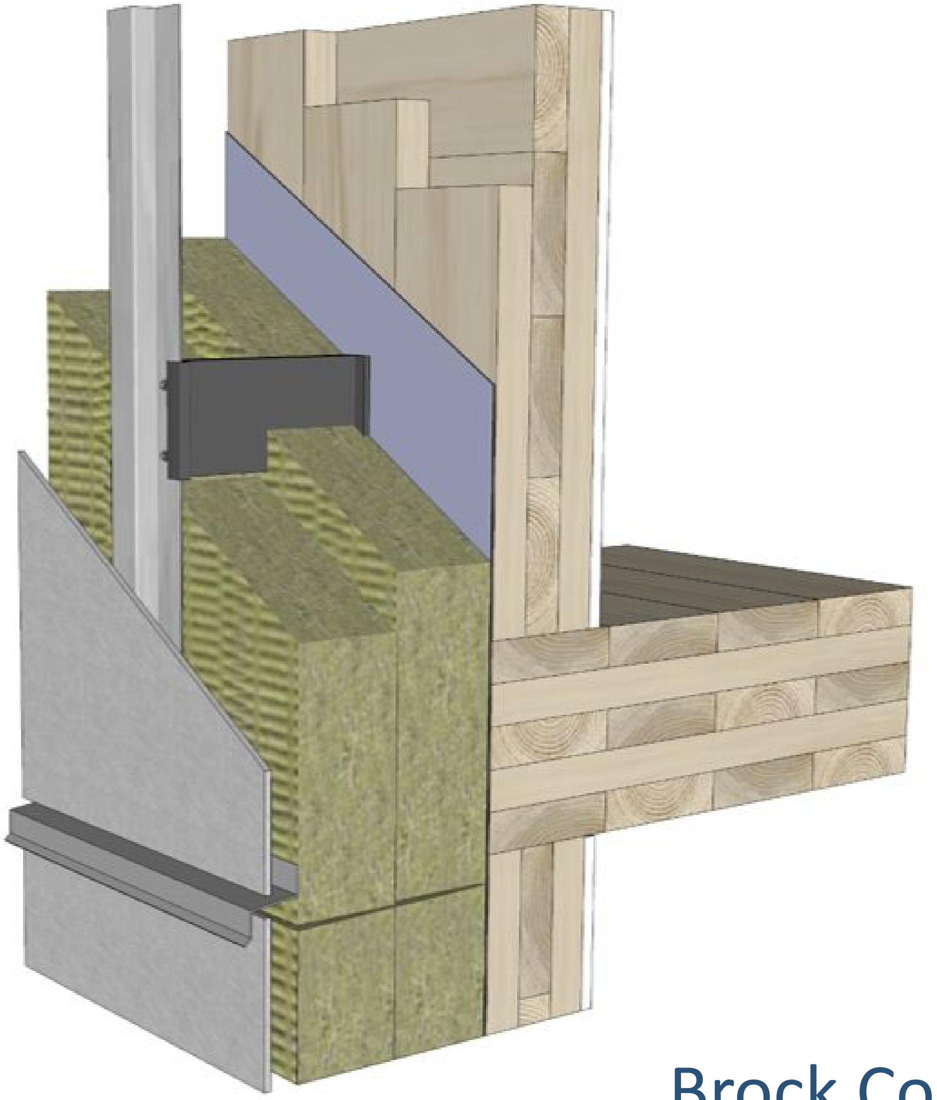


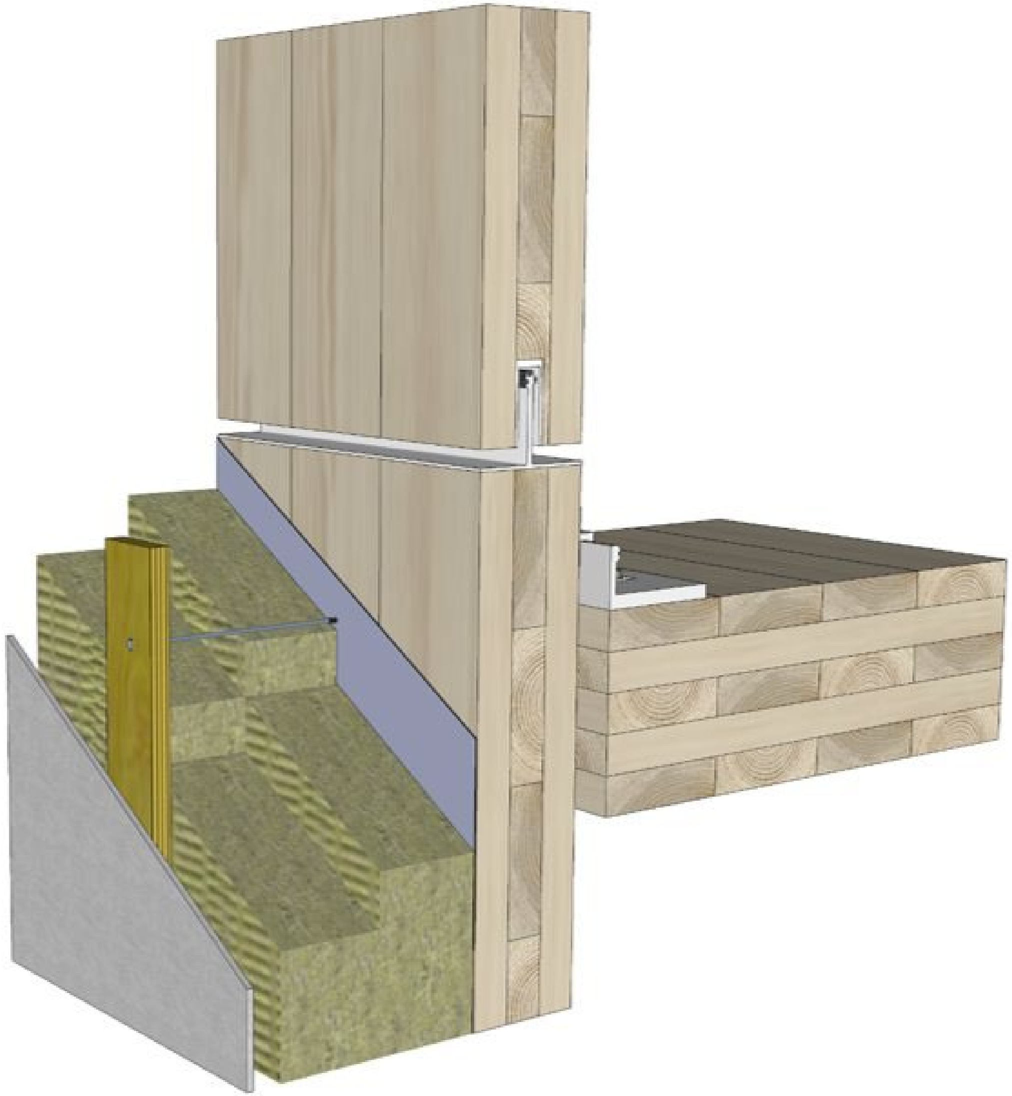
*Assuming a clean electricity grid



Building: UBC Brock Commons Architect: Acton Ostry Architects Photo Credit: UBC

Facade Systems—Load Bearing vs. Curtain Wall





Brock Commons

Building: Doig River Cultural Centre Architect: Iredale Architecture Photo Credit: Iredale Architecture


SOPREMA

Building: CURV Architect: WKK Architecture and Arcadis IBI Group

High window-wall ratio
Market condos

CURVed
Curves in plan and in elevation

60-storeys tall
Tallest Passive House in the world

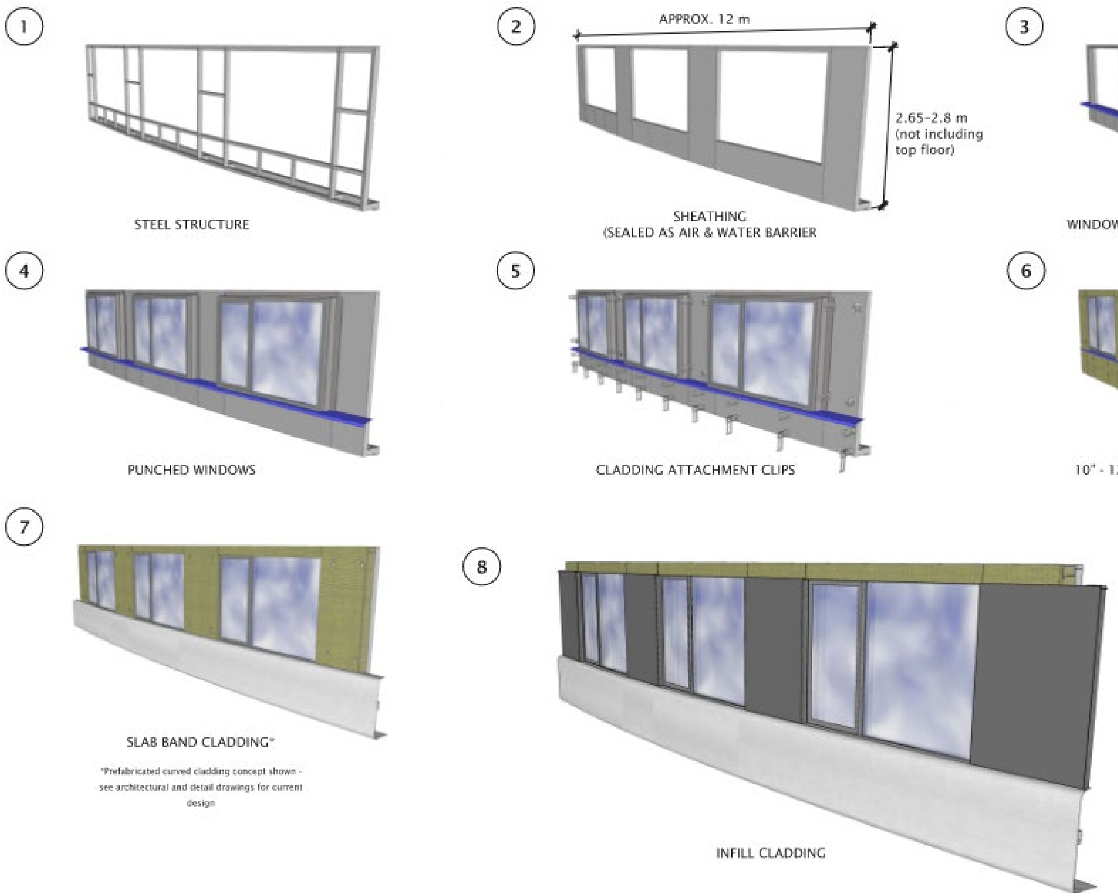
"Look like curtain wall"
Systems are not readily available that achieve required performance

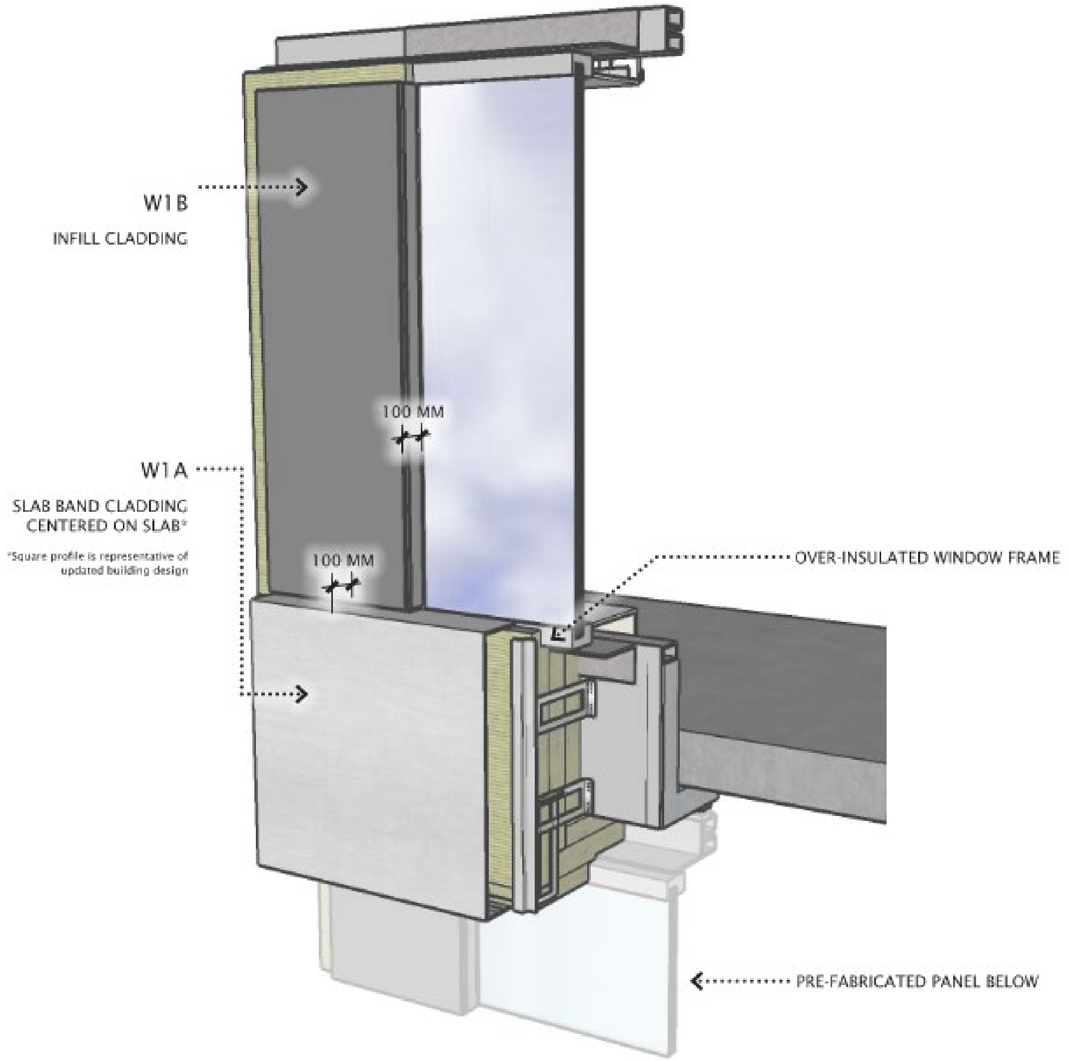
Extensive balconies
Balconies on every floor

CURV

1075 Nelson Street, Vancouver, BC.

Façade Panels with Punched Windows



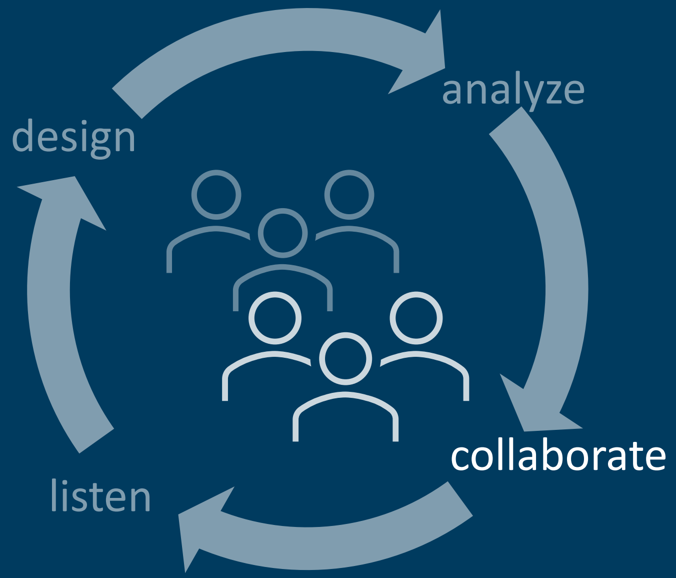


CURV

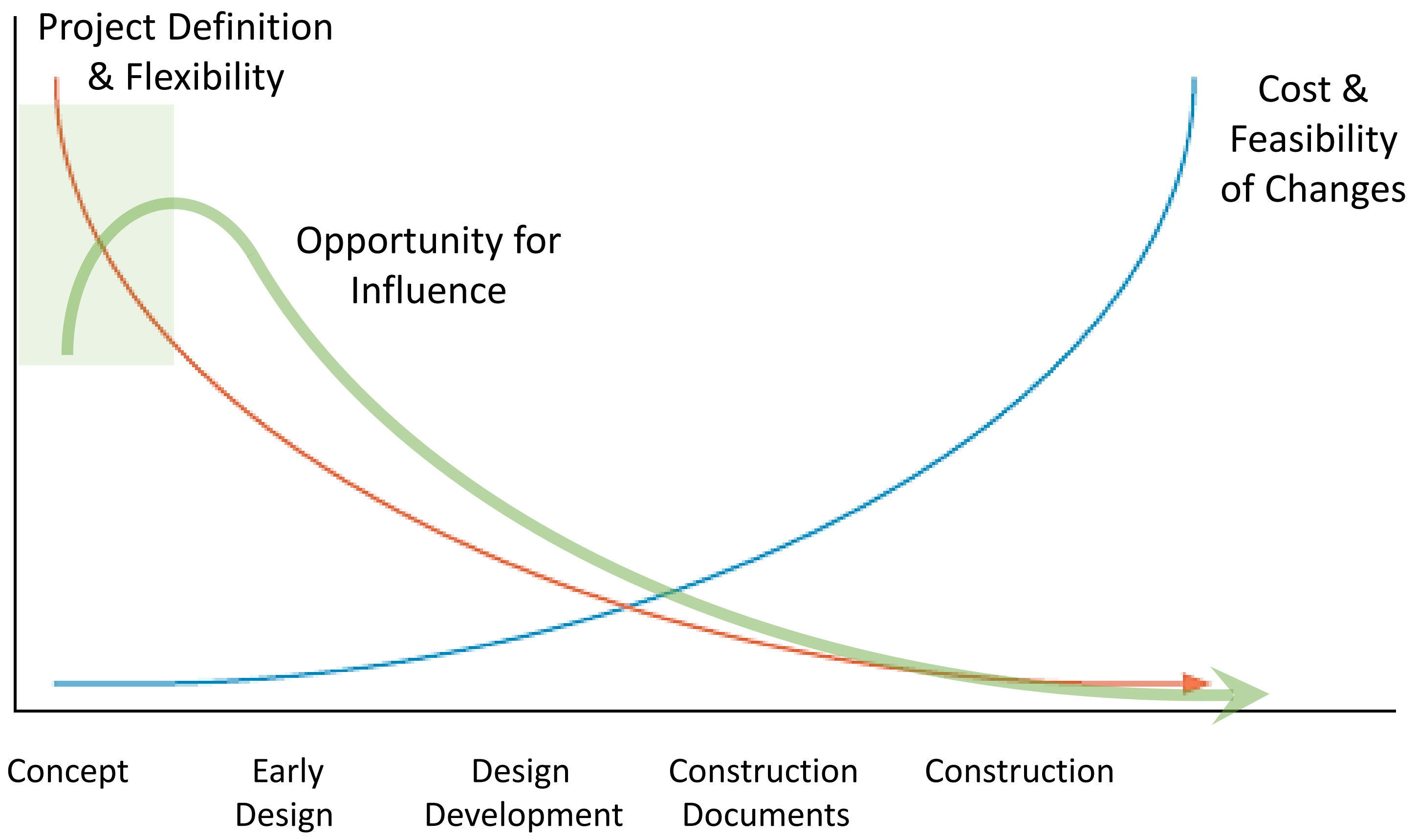
BRIVIA GROUP WKK IBI RDH

05 High Performance and Collaboration

- High performance depends on close collaboration within the design team
- True collaboration start with listening



Front-Loaded Design Process



Most cost-effective approach to delivering buildings =

make the right decisions early

Applies to high-performance buildings

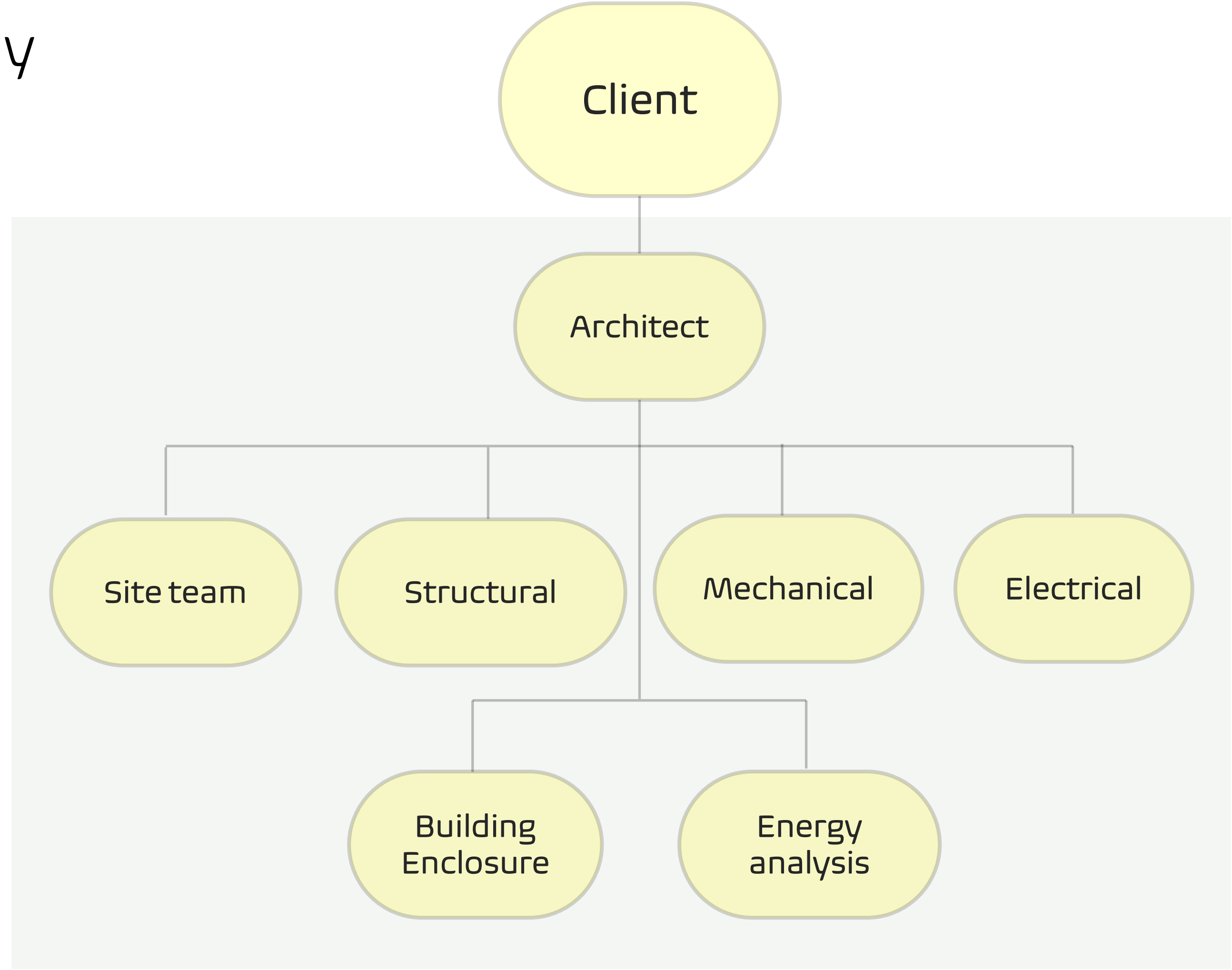
Milestones to Match the Metrics

PRE-DESIGN	SCHEMATIC DESIGN	DESIGN DEVELOPMENT	CONSTRUCTION DOCS	PRE-CONSTRUCTION	CONSTRUCTION	OCCUPANCY
Owner's Project Requirements	**Integrated Design Charette**	**Focus on design that impacts performance**	**Full modeling (BIM), details, and specs**	**Construction kickoff**	**Site visits & testing**	**Commissioning, training & feedback**
Articulate performance vision & goals	Develop design concepts in conjunction with performance concepts	Primary wall and roof assemblies	Review drawings and spec for consistency	Preconstruction meetings	Enclosure & mechanical reviews	Finalize commissioning
Hire experienced consultants & builder	1st energy model to test vision & goals	Identify windows & ventilation systems	Training for site supervisors	Construction mock-ups, train site workers	Ventilation commissioning	Train building operators and key users
Establish process with milestones to align with performance metrics	Identify ventilation and HVAC strategy	Thermal models of key junctions	VE process based on program and actual value	Comprehensive QA/QC plans	Field testing: window assemblies, air barrier (blower door)	Debrief on lessons learned
	Identify assembly strategy	2nd energy model includes critical details		Model updates		Plan post-occupancy evaluation (POE), including occupant satisfaction & performance
		Cost estimates: program & goal alignment				

Process: Business as Usual

Top-Down Hierarchy

- Linear structure
- Design first
- Engineering to support design
- Code compliant performance



Program

Design

Engineering

Site & context

Climate

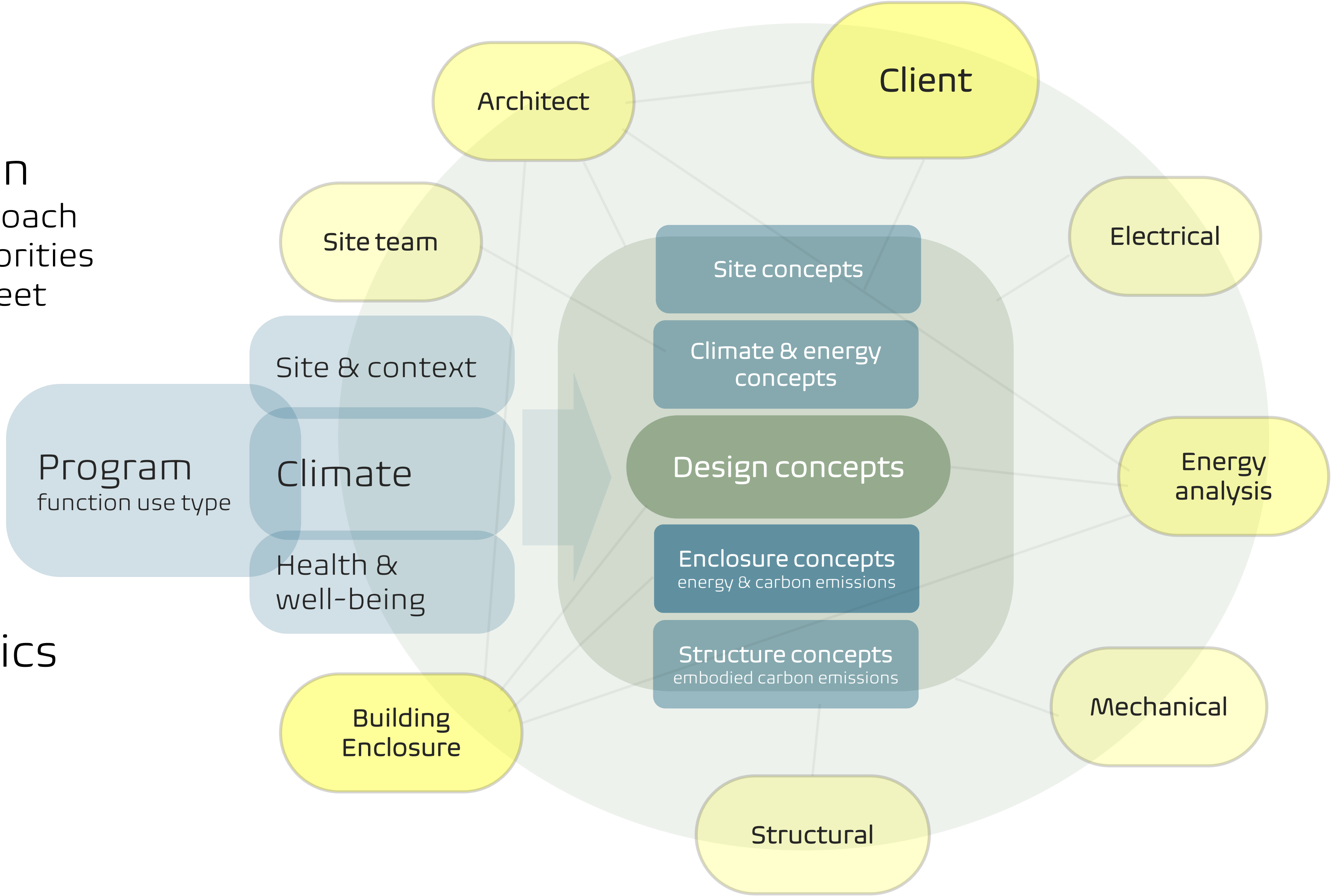
Process: High Performance Buildings

Early collaboration

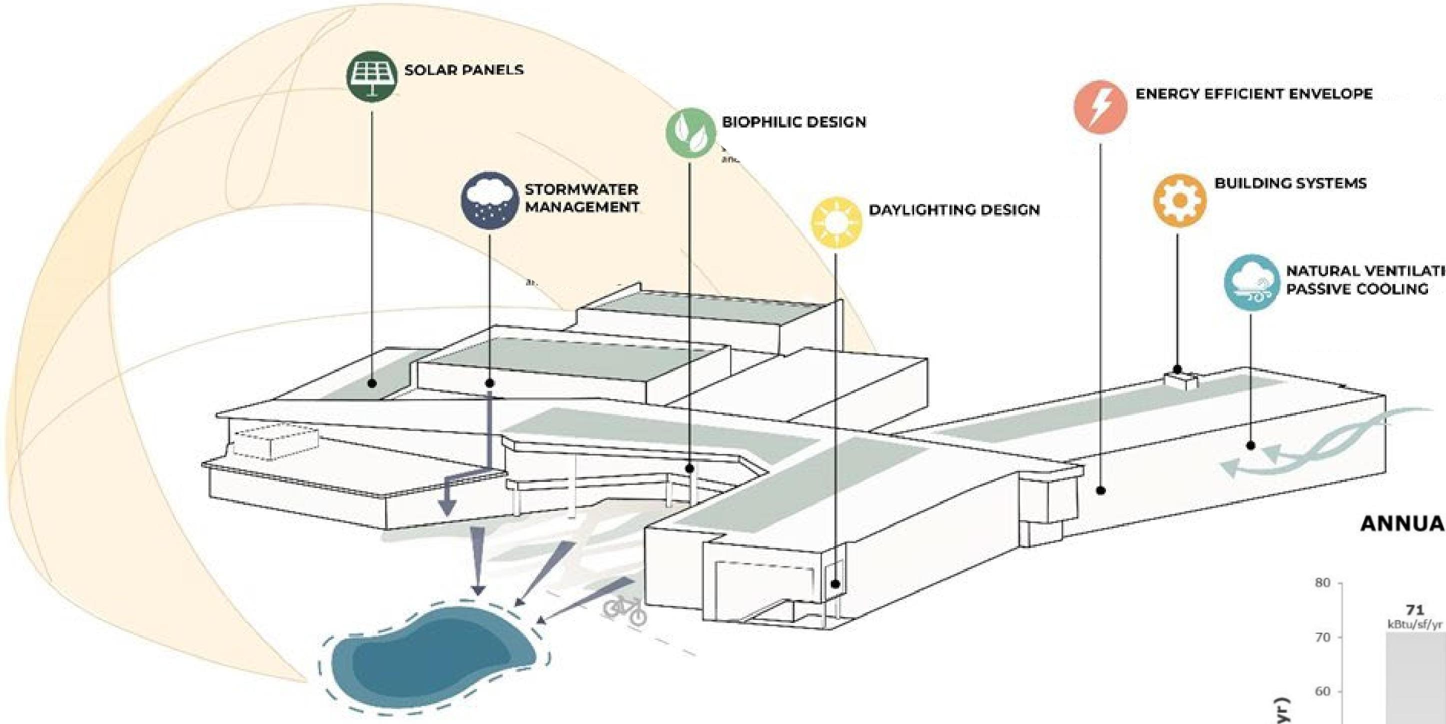
- Interconnected approach
- Set performance priorities design building to meet targets

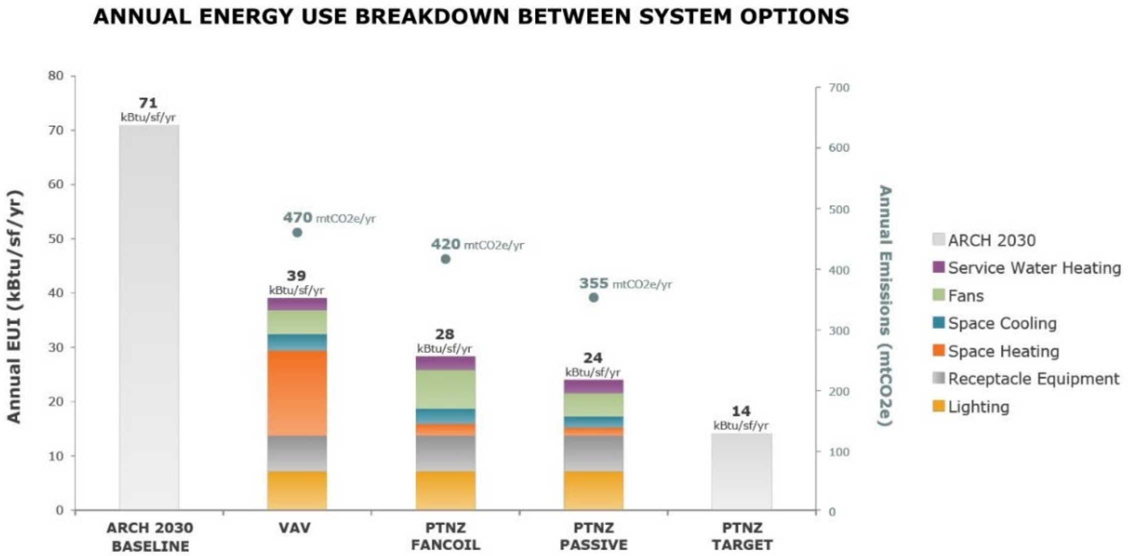
New Characteristics

- Communication
- Quality Assurance



Case Study—High Performance School

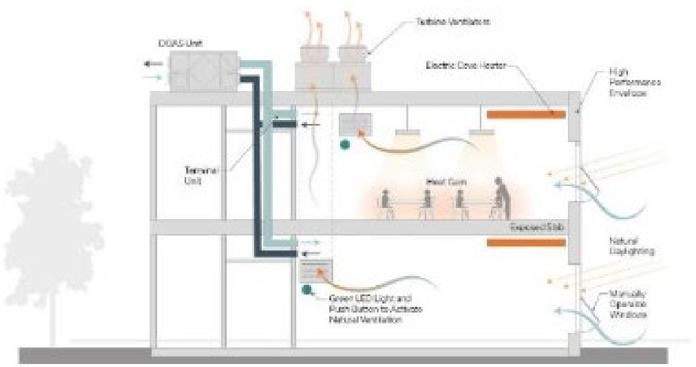




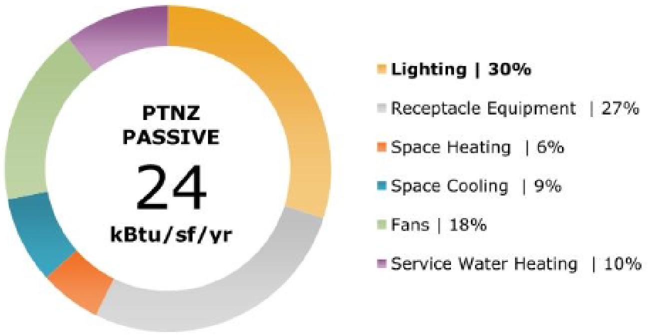
Case Study—High Performance School

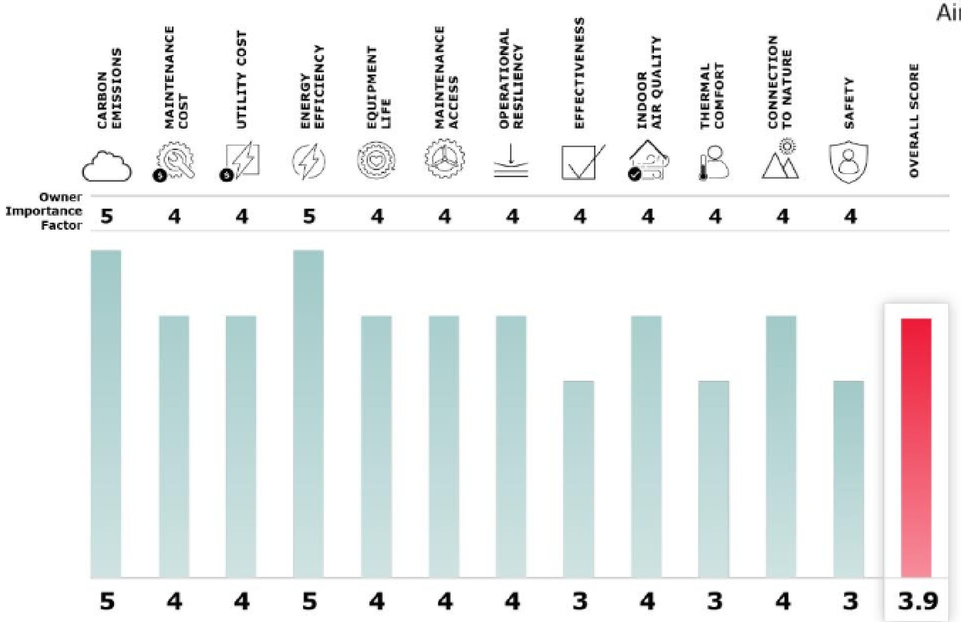
Enhanced Envelope with Systems Optimized for Passive Cooling

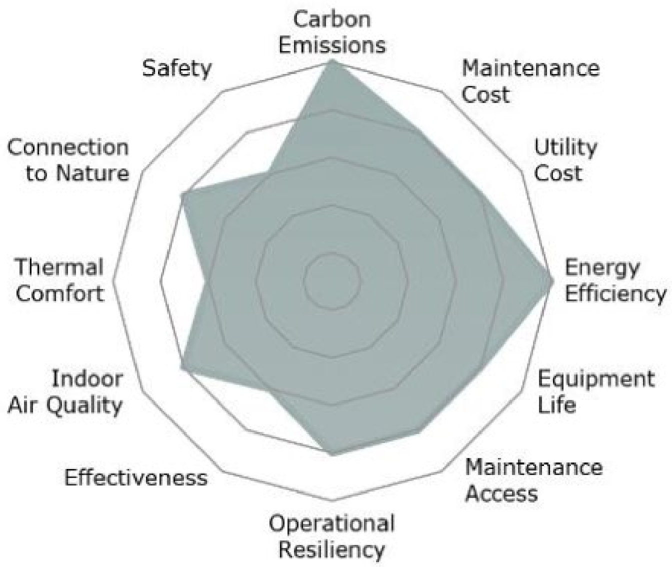
Design Options	EUI (kBtu/sf/yr)	NATURAL GAS (THERM)	ELECTRIC ENERGY (kWh)	ENERGY COST	EMISSIONS IMPACT (mt CO2e/yr)
Option 1	24	0	993,000	$88,000	355



Option 1: PTNZ - DOAS with Hybrid Passive Cooling



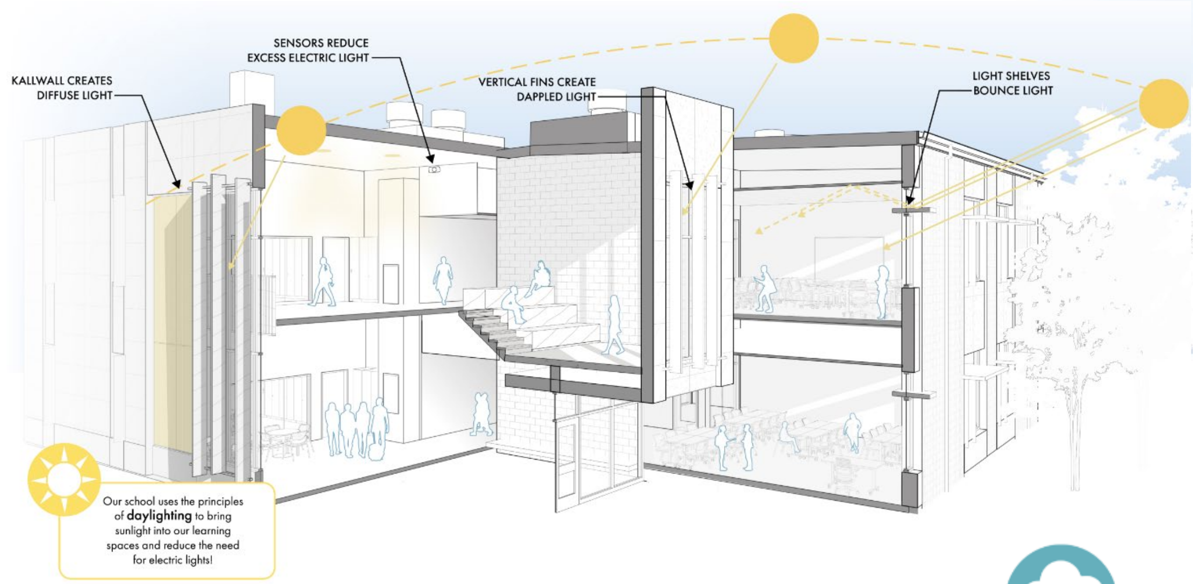


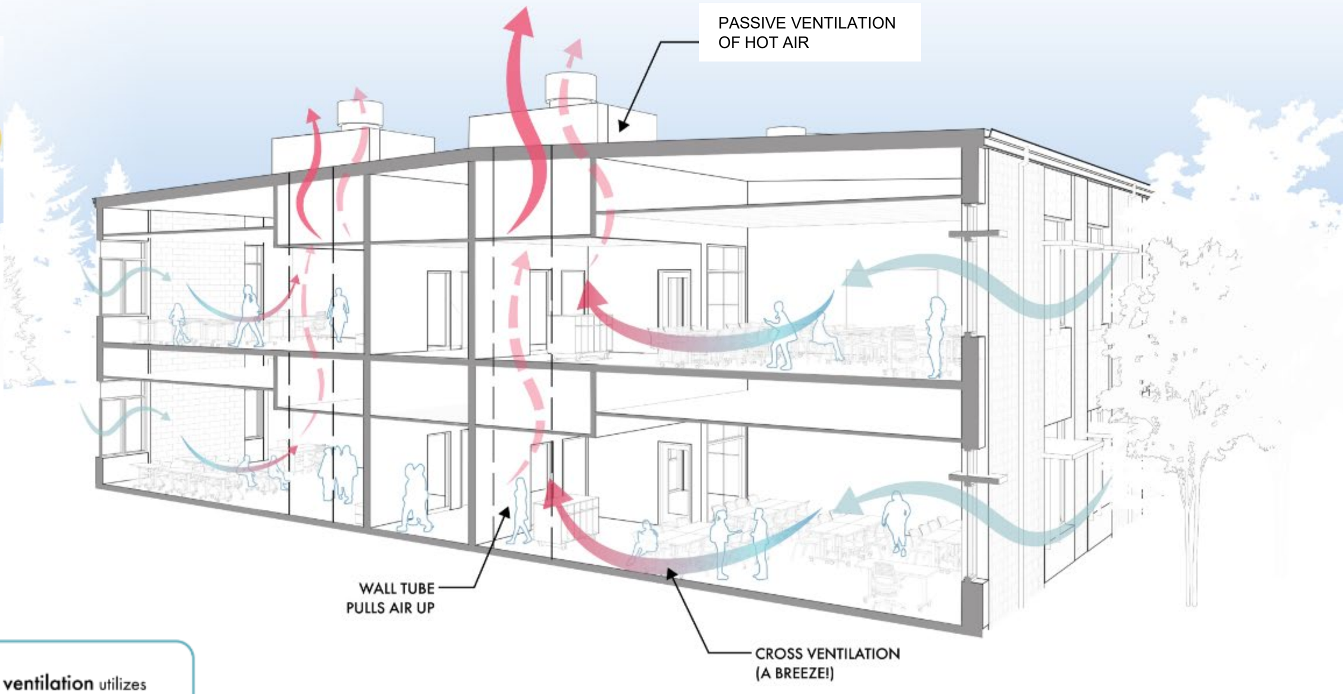


Case Study—High Performance School

Passive strategies & building enclosure

- Passive cooling / natural ventilation
- Ventilation stacks with turbine ventilators
- Exposed mass to manage temperature swings
- Strategic use of glazing
- Interior & exterior shading / daylight redirection





Natural ventilation utilizes the wind to help cool our learning spaces which reduces energy consumption.

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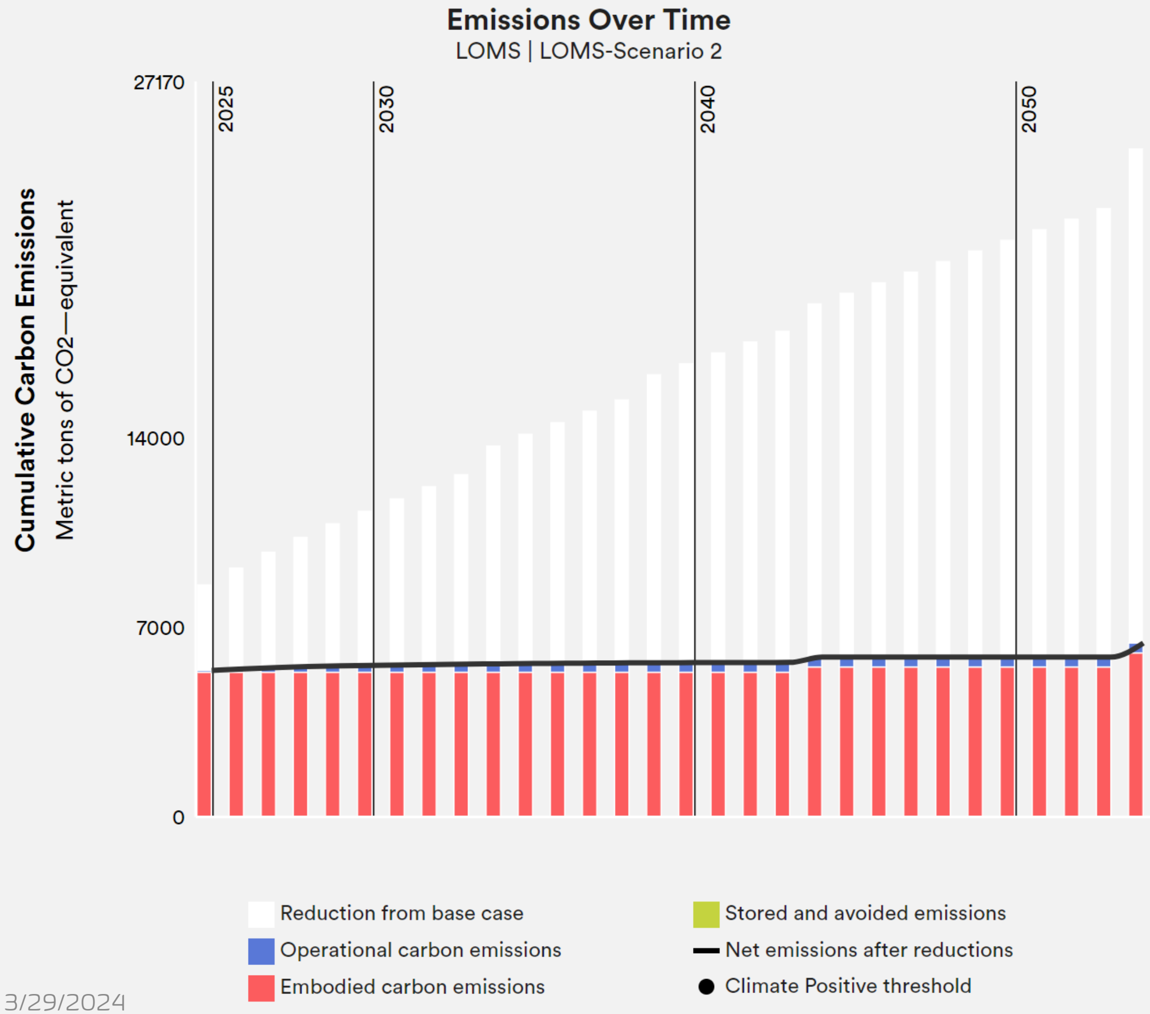
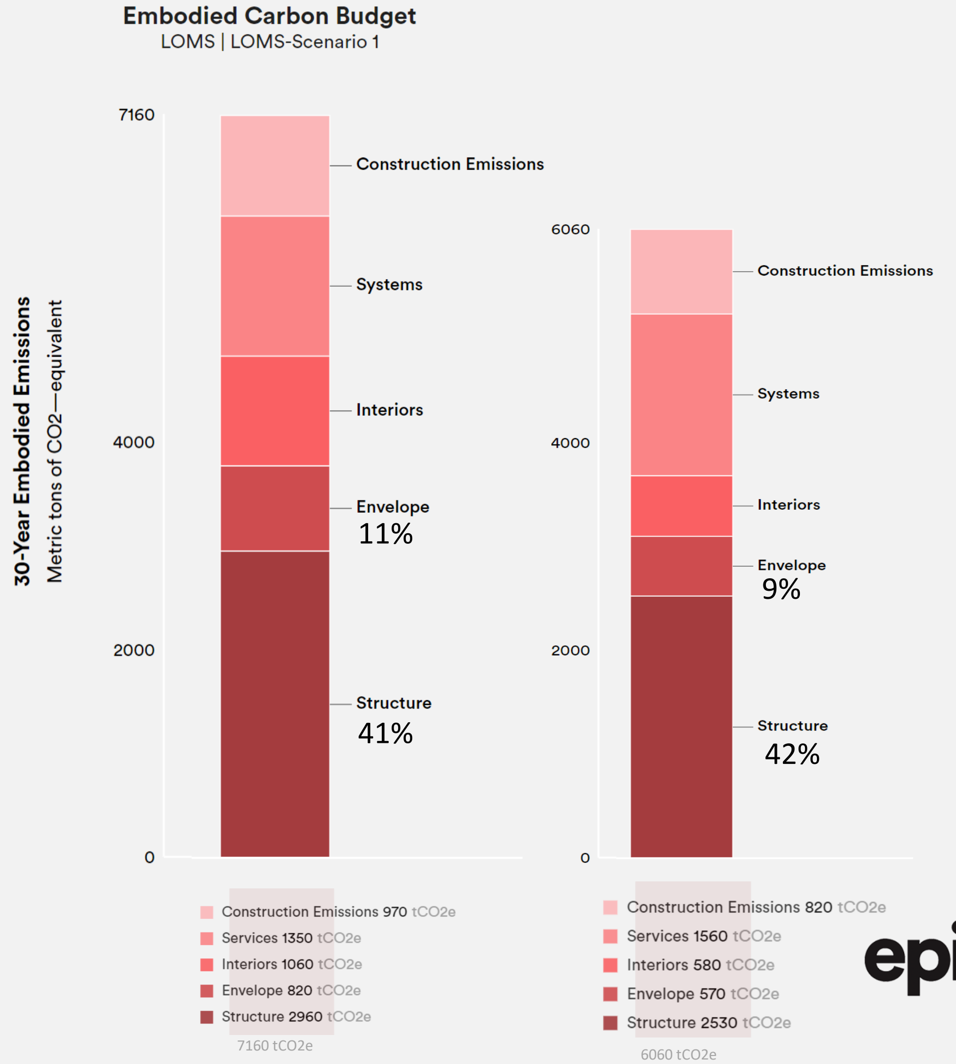
Case Study—High Performance School

Embodied carbon emissions





epic.

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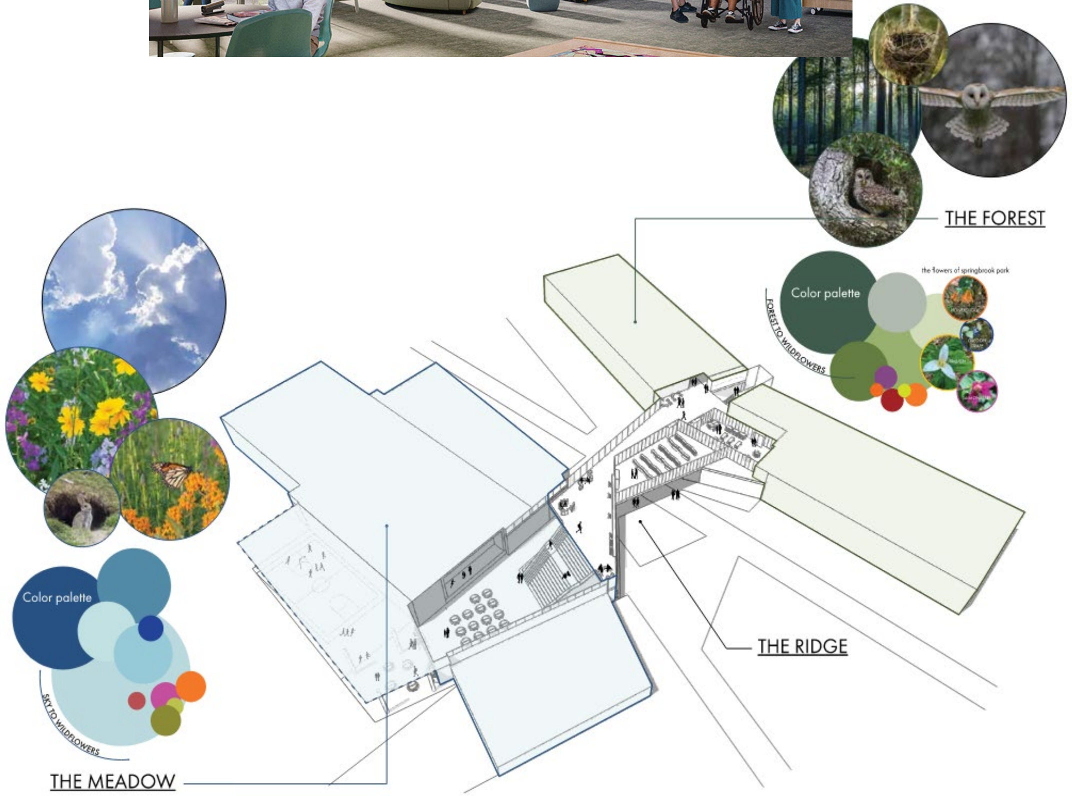
Case Study—High Performance School



Integrated performance—
includes the occupants!

06

What's next?

- Performance based codes
- Resilience strategies for multiple disruptions, including extreme weather

Image credits

The Performance Gap: Modelled vs. Measured

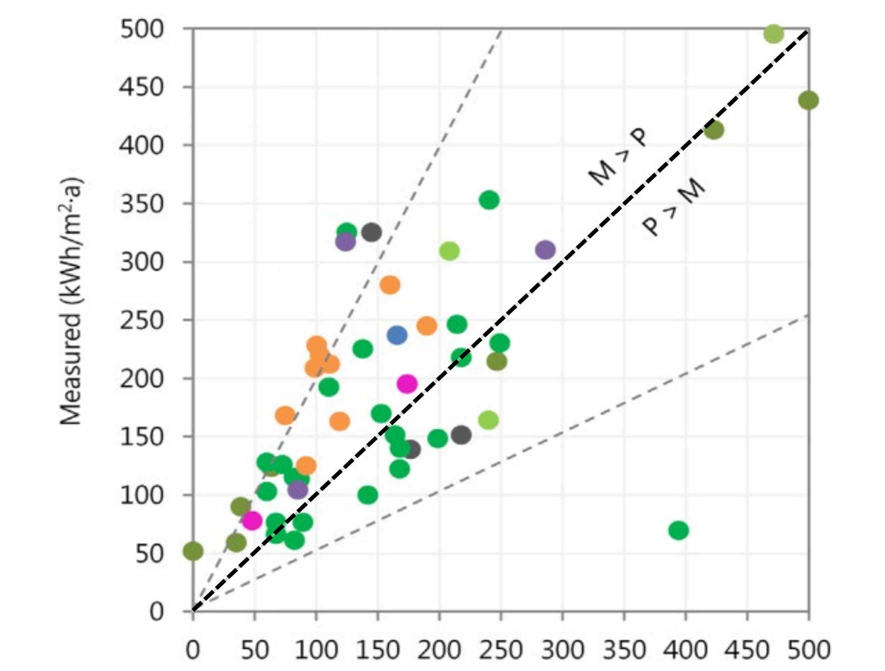


FIGURE 2 | Predicted and measured energy use intensities of reviewed case studies for different building functions.

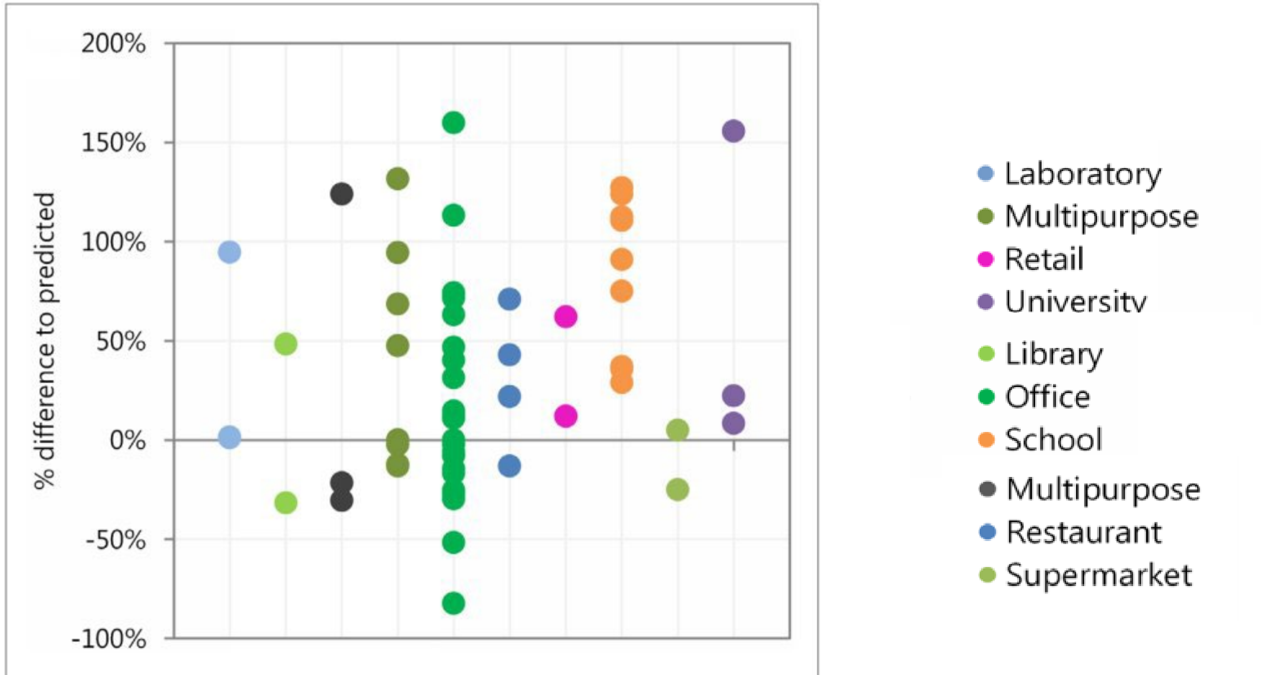


FIGURE 3 | Difference in percentages of measured to predicted energy use of reviewed case studies for different building functions.

----- Line representing Measured (M) = Predicted data (P)

<u>Source</u>: A review of the Energy Performance Gap and its Underlying Causes in Non-Domestic Buildings, Van Dronkelaar et al. 2016

Approaches to Building Energy Performance

PRESCRIPTIVE	PERFORMANCE	
Lists design requirements for mechanical, electrical and envelope systems	Focuses on the overall building performance	
Prescriptive Approach	Reference Building Approach	Absolute Performance Target Approach
e.g. ASHRAE 90.1	e.g. ASHRAE 90.1	e.g. Passive House, Massachusetts Stretch Code
✗	✗	✓

HAZARD
WARMING AND EXTREME HEAT EVENTS
WILDFIRES
FLOODING
EXTREME STORMS
DROUGHTS

07 Discussion

Call to action!
What is your role?