
A BETTER CITY
BUILT TO LEAD:
LESSONS IN BUILDING DECARBONIZATION
DECONSTRUCTION & EMBODIED CARBON
LEARN MORE HERE

BUILT TO LEAD: LESSONS IN BUILDING DECARBONIZATION AND RESILIENCE

1. September 24, 2025, Built to Lead: Lessons in Building Decarbonization in Existing Buildings

2. October 30, 2025, Built to Lead: Lessons in Building Decarbonization in New Construction

3. December 18, 2025, Built to Lead: Lessons in New Technologies and Opportunities

4. **February 3, 2026, Built to Lead: Lessons in Deconstruction and Embodied Carbon, @ 10-11.30AM**

5. Built to Lead: Lessons in Resilience, late March/early April, 2026

A BETTER CITY

AGENDA

10:00 AM	**Kate Dineen, A Better City**—Welcome
10:02 AM	**Yve Torrie, A Better City**—Introduction
10:06 AM	**Irmak Turan, Arup**—*Circularity and embodied carbon at airports*
10:22AM	**Dennis Carlberg, Boston University**—*Retrofit of BU's Warren Towers*
10:34 AM	**Caroline Murray, Turner Construction**—*Deconstruction and reuse of office space*
10:46 AM	**Andrew Thompson, Boston Building Resources**—*Material donation and reuse*
11.00 AM	**Q+A**
11:30 AM	**Event Concludes**

IRMAK TURAN, ARUP

A Better City
Material Circularity and Reuse at Airports

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Irmak Turan, Ph.D.
Associate | Climate and Sustainability
February 3, 2026

Image Credit: SFO

Circularity of Building Materials

Linear Material Flow

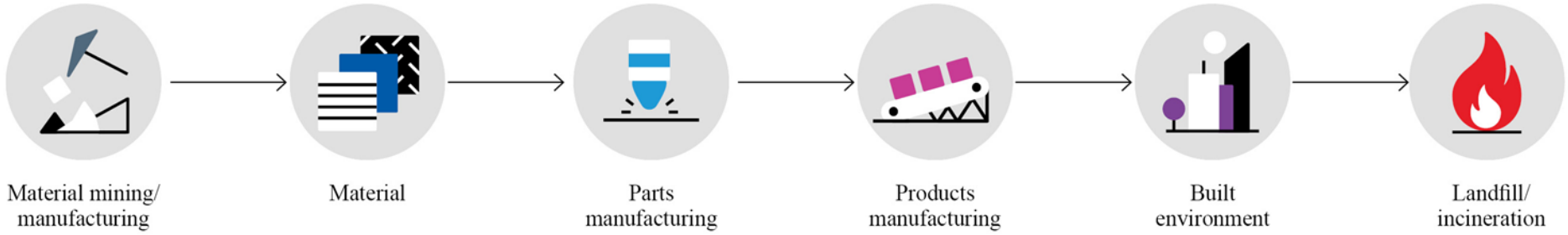

Image from Unlocking Value in Buildings: developing the business case for building circularity (Arup, 2025)

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Circularity of Building Materials

Circularity—in the context of building materials—refers to **designing, using, and managing materials in ways that maximize reuse, extend material life, and minimize waste,** thereby reducing overall environmental impact.

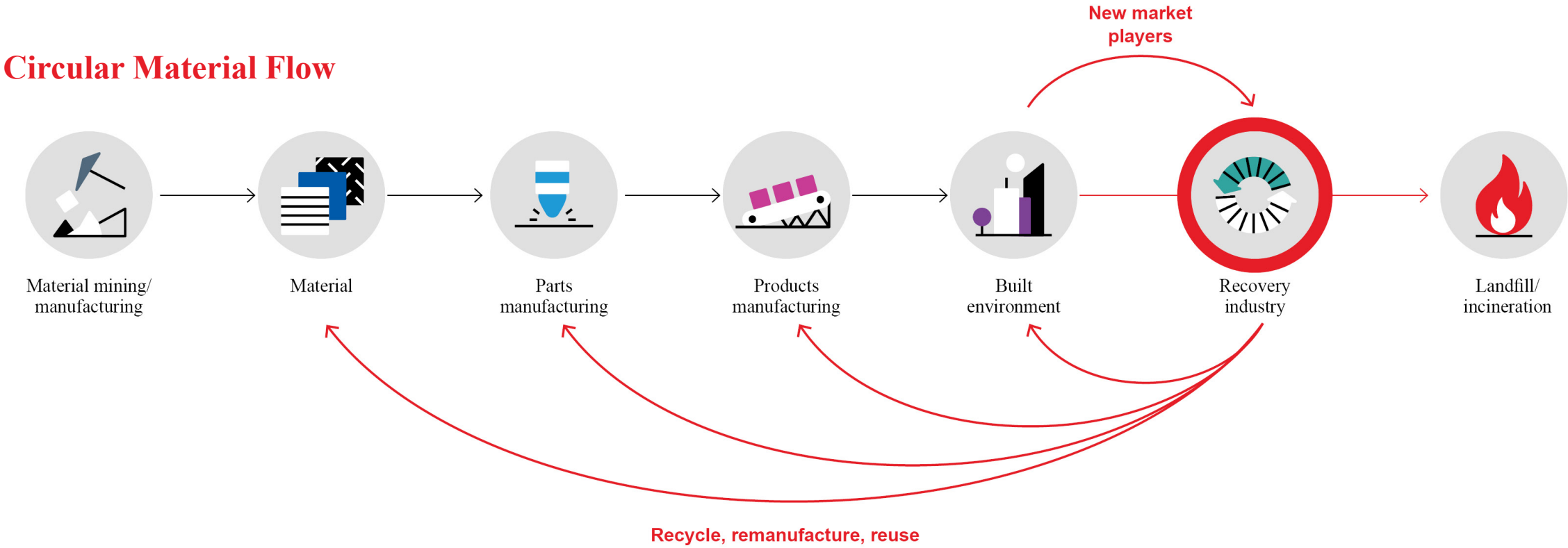

Image from Unlocking Value in Buildings: developing the business case for building circularity (Arup, 2025)

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A proposition…

Large portfolio owners—such as airport authorities, higher-ed campuses, and multi-facility organizations—are **uniquely positioned to benefit from circularity because they manage continuous, overlapping construction cycles**.

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Large Portfolio Owners & Campuses

Consideration	Opportunity
On larger campuses there is concurrent construction activity happening at any given time	Multiple sources for material input and output
Because construction is happening in/near/around operational buildings, deconstruction (vs demolition) is common	Deconstruction, rather than demolition, is business as usual

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San Francisco International Airport
Circularity Strategy for C&D Materials

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Study Goal: **Grow SFO's circularity strategy for C&D materials** in alignment with the Airport's zero waste goals and its vision of becoming a circular airport.

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Mapping Material Inputs & Outputs

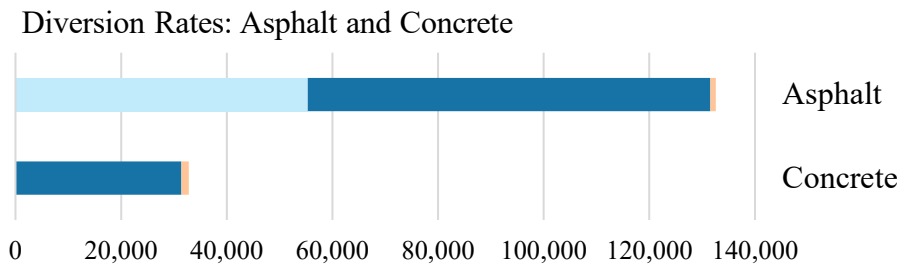
Inputs (Construction Material Use)

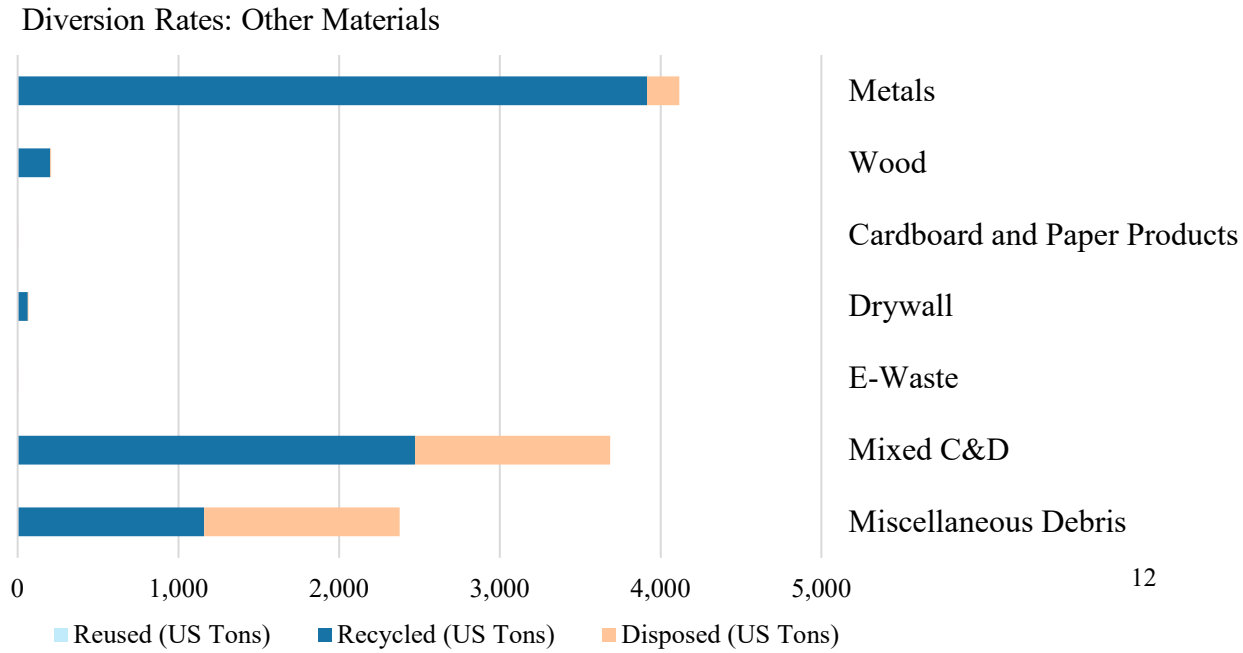
vs

Outputs (Demolition Waste)

	Infrastructure Projects	Capital Projects	Tenant Improvements	Maintenance Projects	Useful Life (Years)	Purchase Costs (FY23/24)
Asphalt*	X	X		X	10-20	$27M
Airfield and Construction Support Material	X			X	30	$48M
Building Structural Materials	X	X		X	60	$348M
Building Envelope Materials		X		X	40	$188M
MEP Equipment	X	X	X	X	30	$944M
Interior Construction		X	X	X	20	$210M
Interior Finishes		X	X	X	10	$158M
Fixtures, Furnishing and Equipment (FF&E)	X	X	X	X	10	$191M

* This is only for the asphalt cover. It does not include the runway structure.





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Identifying Laydown & Storage Areas

The study identified ~**672,000 ft²** **of total Laydown Area** spread across the Airport.

North Campus Laydown Spaces

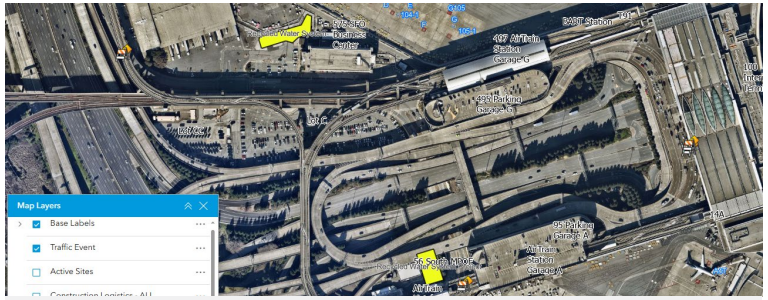
Total Spaces: 12

Total Area: ~335,000 ft²

Off Campus Laydown Spaces

Total Spaces: 1

Total Area: ~112,000 ft²



West Campus Laydown Spaces

Total Spaces: 2

Total Area: ~123,000 ft²

East Campus Laydown Spaces

Total Spaces: 3

Total Area: ~102,000 ft²

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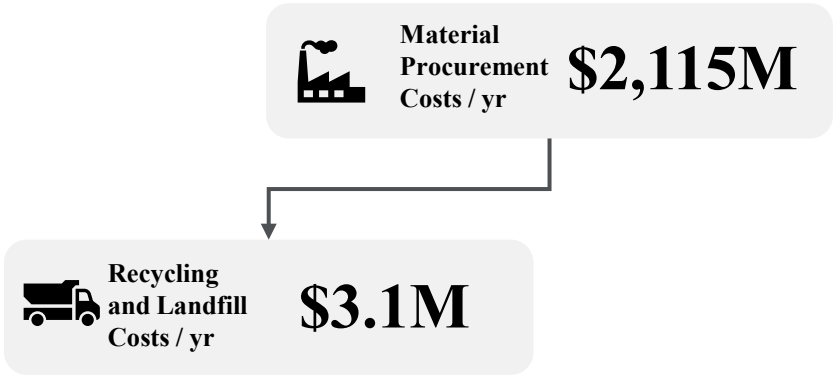
Potential Cost Savings

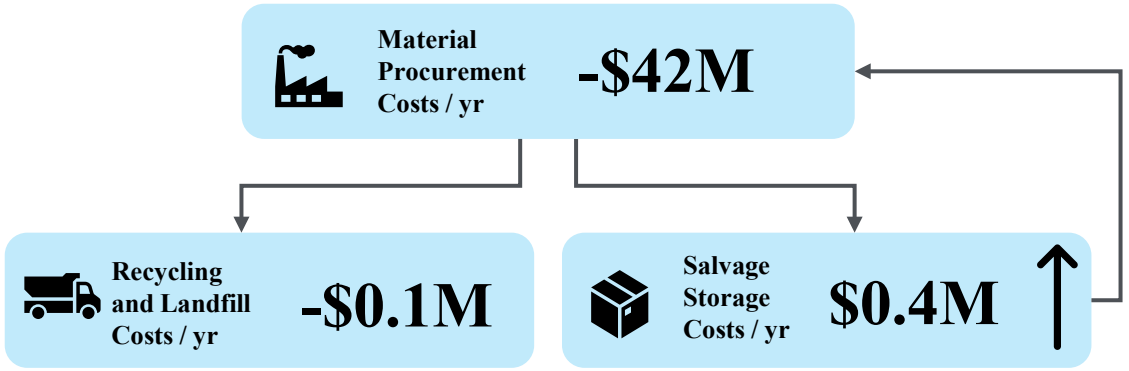
Business as Usual

annual material procurement costs for SFO
vs
annual demolition + hauling + tipping fees



Circular Model

reuse 2% of materials that have reached end-of-life
in order to…
reduce hauling & tipping fees +
to save on new material procurement



Net $41.7 Million in Estimated Savings

Recommendations

- Develop a **C&D Circularity Plan** with clear roles, goals, and material budgets.
- Establish a **Circularity Coordinator and department Circularity Champions** to lead implementation.
- Improve **storage and laydown space management** using asset-management tools and external partnerships.
- Define **material reuse criteria** and conduct early project team surveys to identify salvage opportunities.
- Track **KPIs, material costs, and savings**, aligning procurement and waste-tracking systems.

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Steps after a high-level study…

- **Pilot Project:** Test recommendations made in a pilot project. Include a detailed data collection process to verify reuse rates and costs associated with more circular methods.

- **Life Cycle Assessment:** A life cycle assessment based on data collected from the pilot project to verify the carbon and cost savings of reuse over recycling.

- **Standards and Specifications Updates:** Consider opportunities to update the standards and specifications to implement circularity practices in the future.

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Portland International Airport

Roof Truss Reuse

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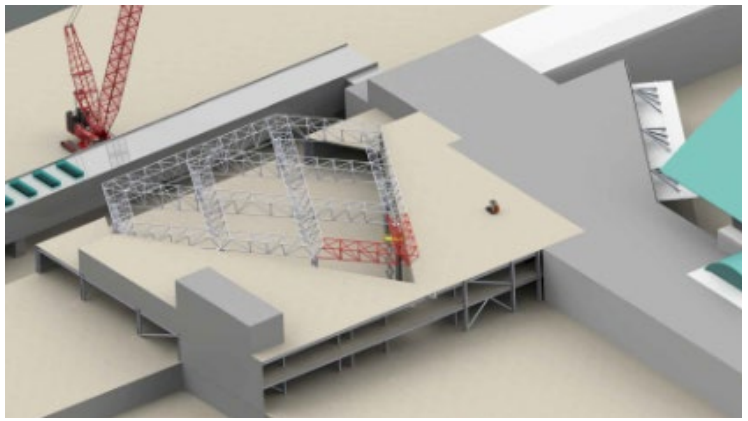
Steel Reuse Study at PDX

Savings of $2-3M possible



Proposed salvage & reuse of roof trusses in former security checkpoint

Client: Port of Portland
Team: Arup, Skanska, ZGF Architects

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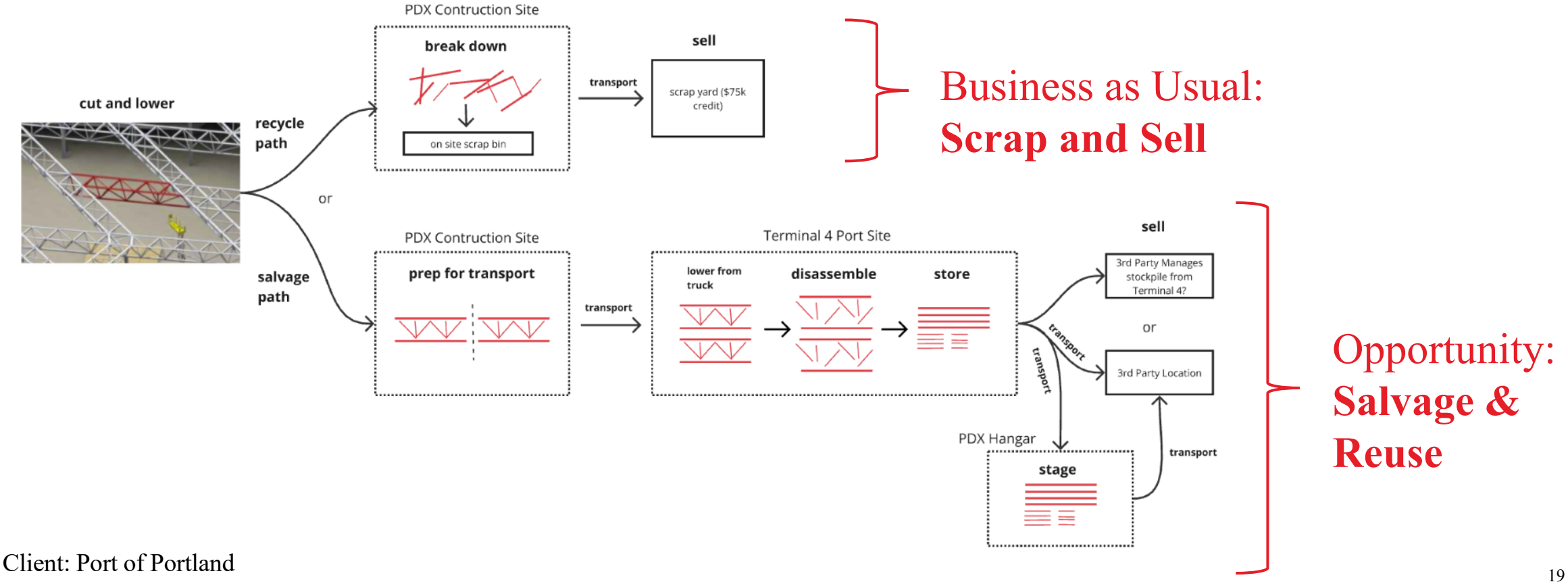
Deconstruction was already planned

Avoids a potential cost add for material recovery



Client: Port of Portland
Team: Arup, Skanska, ZGF Architects

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Findings

$1.5-2.7M in potential savings

Scenario	$ Debit	$ Credit	Total Cost Savings	Net Carbon Savings for reuse within 100mi (kgCO2e)	Steel Utilization Factor Assumed (%)
Scrap Steel	$ -324,000	$88,000	**$ -236,000**	(48,796)	100%
Tube Reuse	$ -389,000	$1,838,000	**$1,449,000**	413,607	70%
Truss Reuse	$ -124,000	$2,863,000	**$2,739,000**	104,975	50%

Tube Reuse: more potential reuse applications

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Truss Reuse: higher reuse value but fewer potential applications

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Lessons Learned

- Savings from reuse of structural materials can be large
- Plan early to realize savings
- Identify storage areas (marine terminal, in this case)
- Get all participants on board (e.g. demo subcontractors)

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Takeaways

Next Life Options for Reclaimed Materials

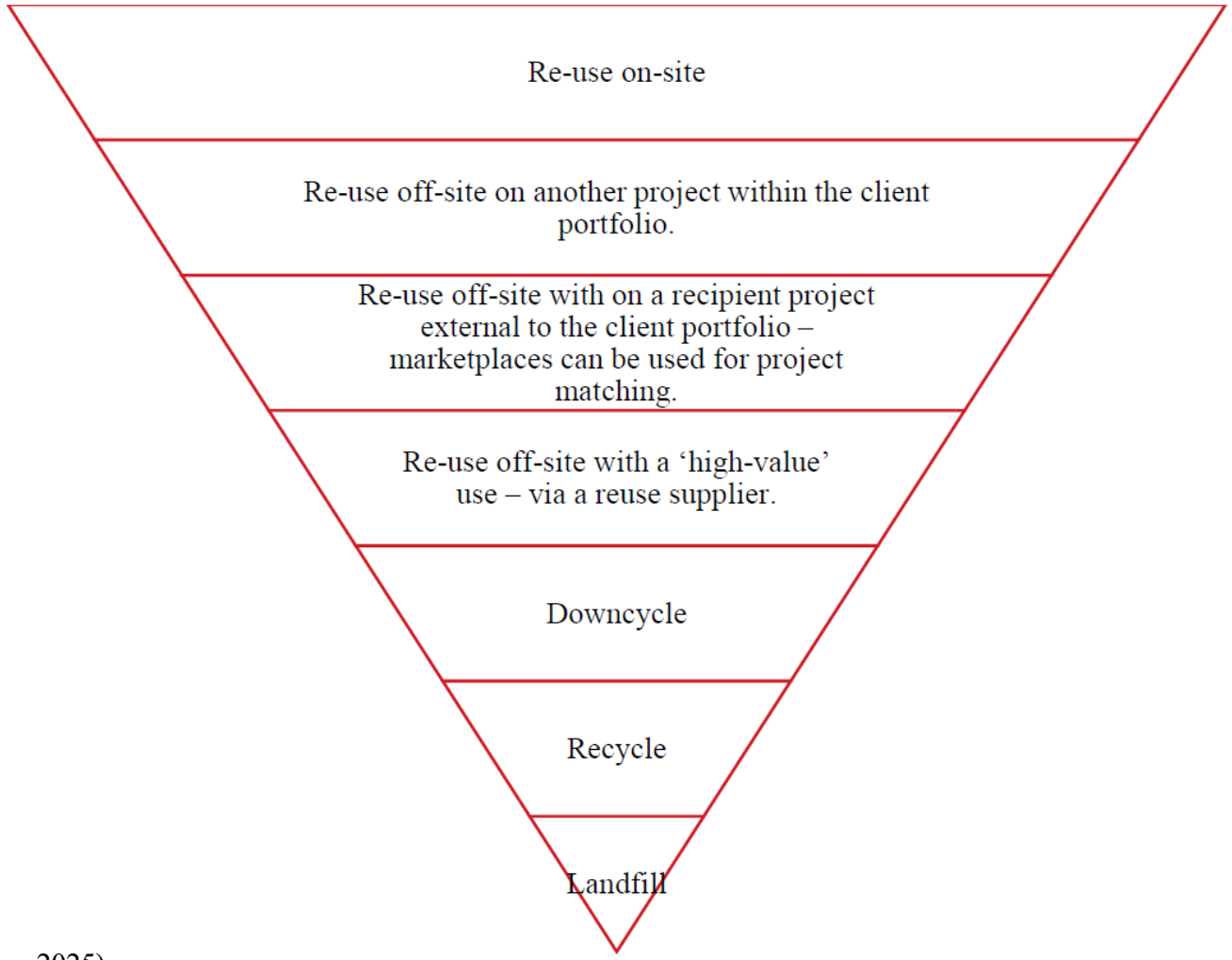

Image from The Reuse Playbook (Arup, 2025)

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Takeaways and Considerations

1. Circularity Delivers Real, Measurable Value
2. Early Planning is Essential
3. Deconstruction Enables Reuse
4. Storage and Space Are Critical Infrastructure
5. Pilot Projects Build Confidence

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We'd love to hear from you…

Irmak Turan, Ph.D.

Associate | Climate and Sustainability

irmak.turan@arup.com

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Arup's Circularity Resources:

- Circular Buildings Toolkit (online resource)
- The Reuse Playbook (Arup, 2025)
- Applying Circularity in the Life Cycle Assessment of Buildings (Arup, 2024)
- Unlocking Value in Buildings: Developing the business case for building circular (Arup, 2025)

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DENNIS CARLBERG, BOSTON UNIVERSITY

Climate Action

Acting on Indirect Emissions

Lessons in Building Deconstruction and Embodied Carbon Panel
A Better City

February 3, 2026

BOSTON UNIVERSITY

Rendering: Karen Nyberg,, NASA

Climate Action Plan - Goals

1

Prepare for Climate Change

2

Net Zero Direct Emissions by 2040

3

Act on Indirect Emissions

Photo: Loch & Key for ENGIE

Climate Action Plan - Actions

1

Prepare

Building above
Elevation of
Resilience

2

Net Zero

Reduced
emissions by 66%

BU Wind matches
100% of electricity

3

Indirect

Embodied Carbon
New construction
Adaptive Reuse
Sustainable
purchasing

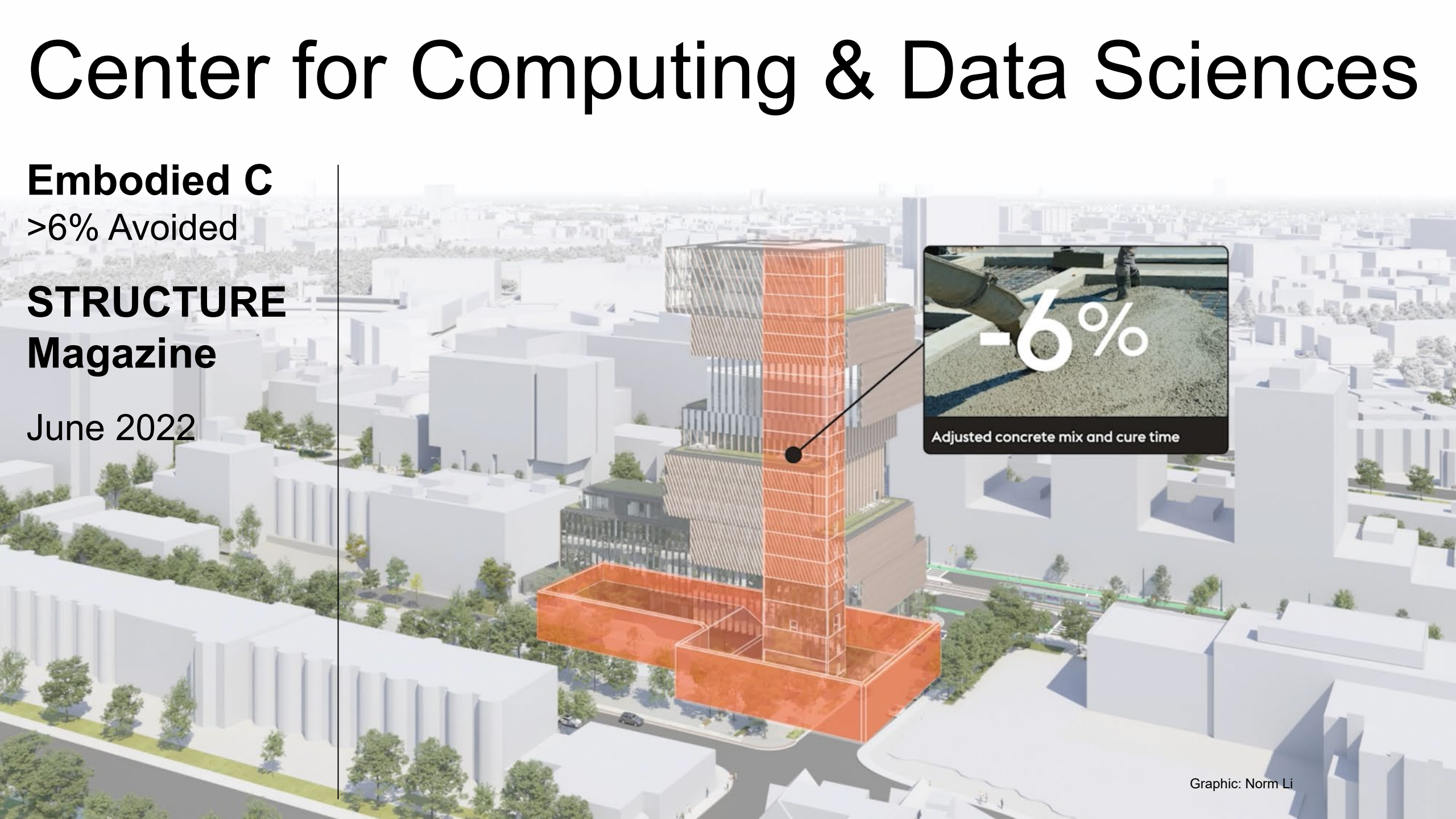
Photo: Loch & Key for ENGIE

Center for Computing & Data Sciences

Embodied C
>6% Avoided

STRUCTURE Magazine

June 2022



Graphic: Norm Li

Pardee School of Global Studies

Embodied C
>30% Avoided

Rendering: Diller Scofidio + Renfro

Warren Towers

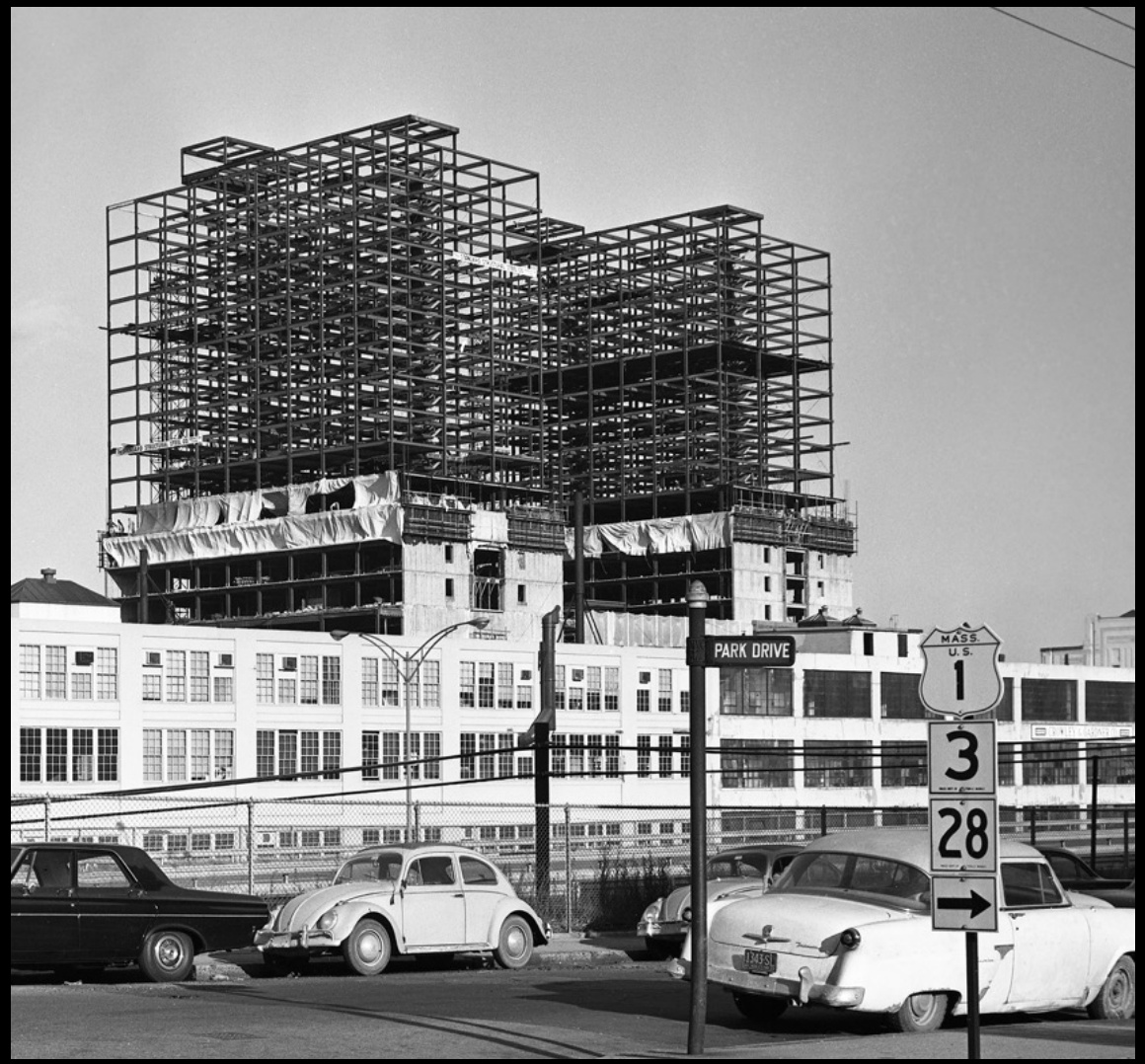
Area
380,000 sf

Beds
1,800

Emissions ‘24
2,780 $MTCO_2e$

Net Zero Operational Carbon

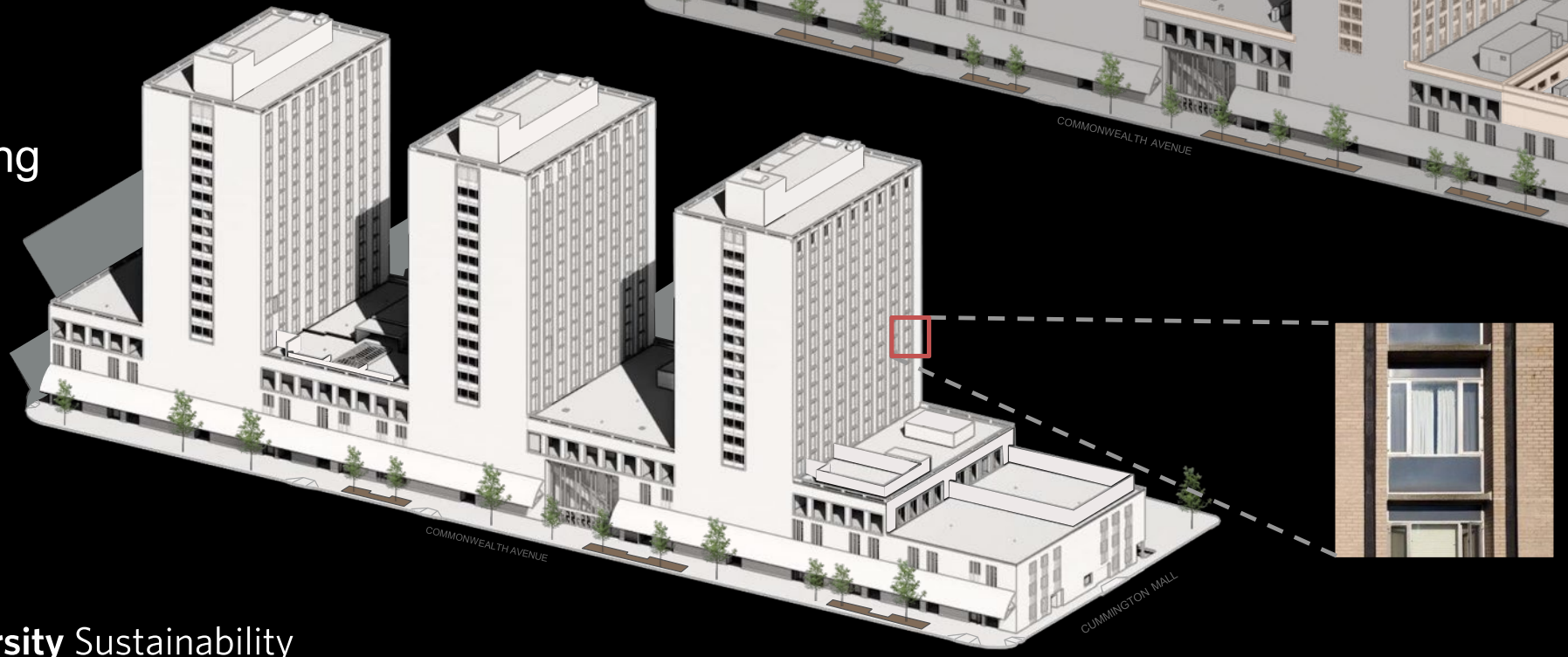
Embodied Carbon



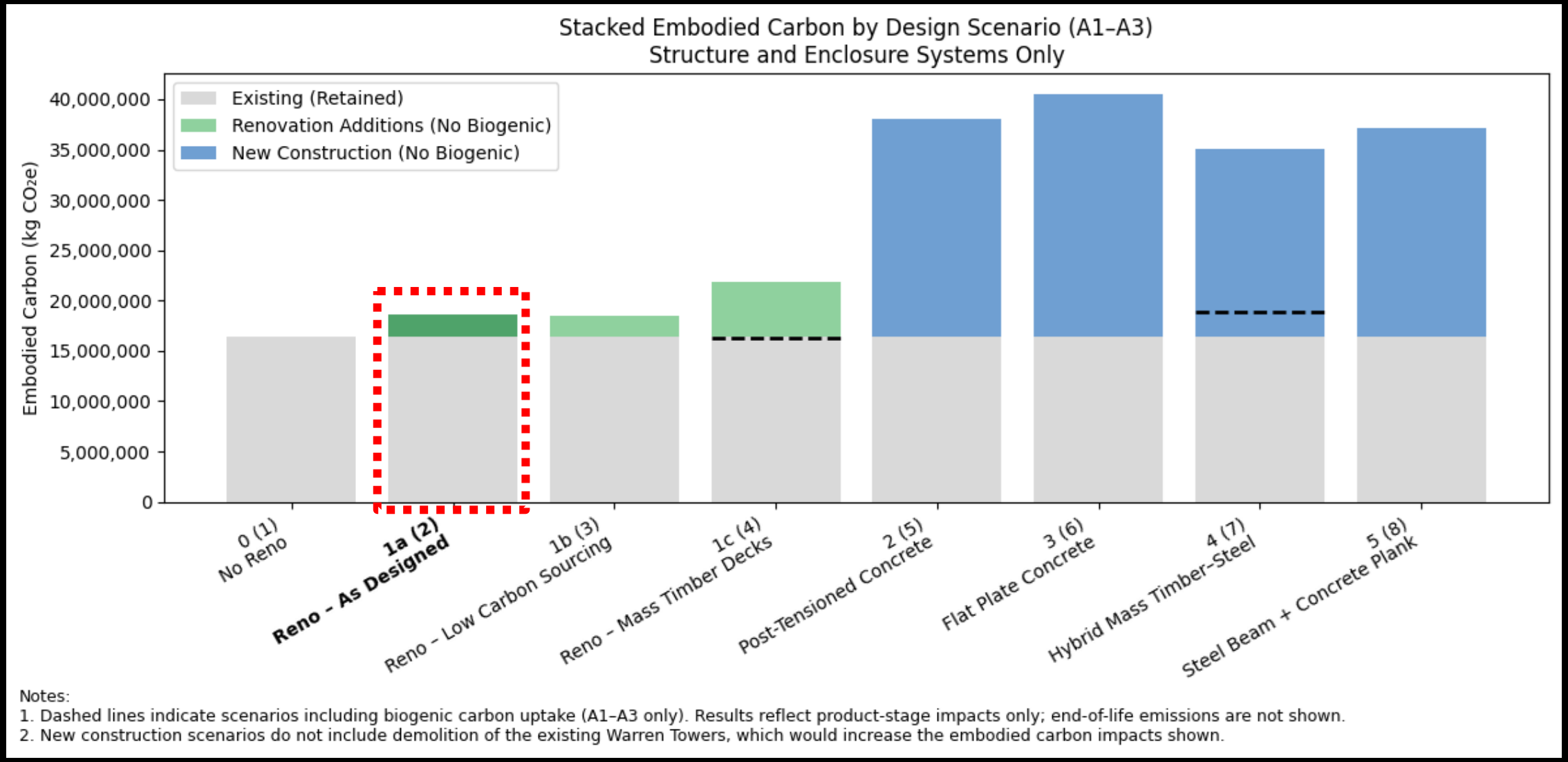
Embodied Carbon

Proposed

Existing

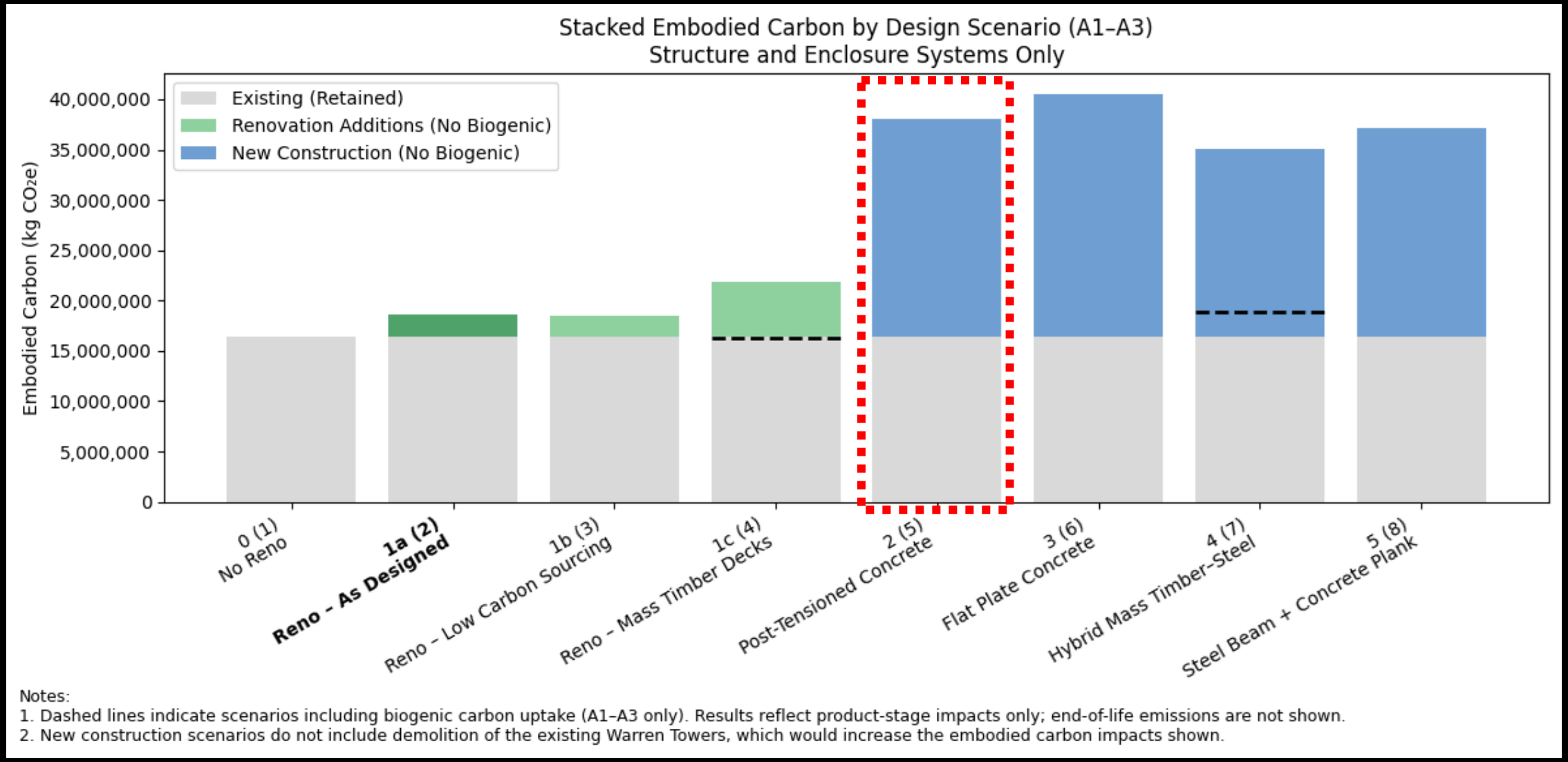


Embodied Carbon



Notes:
1. Dashed lines indicate scenarios including biogenic carbon uptake (A1–A3 only). Results reflect product-stage impacts only; end-of-life emissions are not shown.
2. New construction scenarios do not include demolition of the existing Warren Towers, which would increase the embodied carbon impacts shown.

Embodied Carbon



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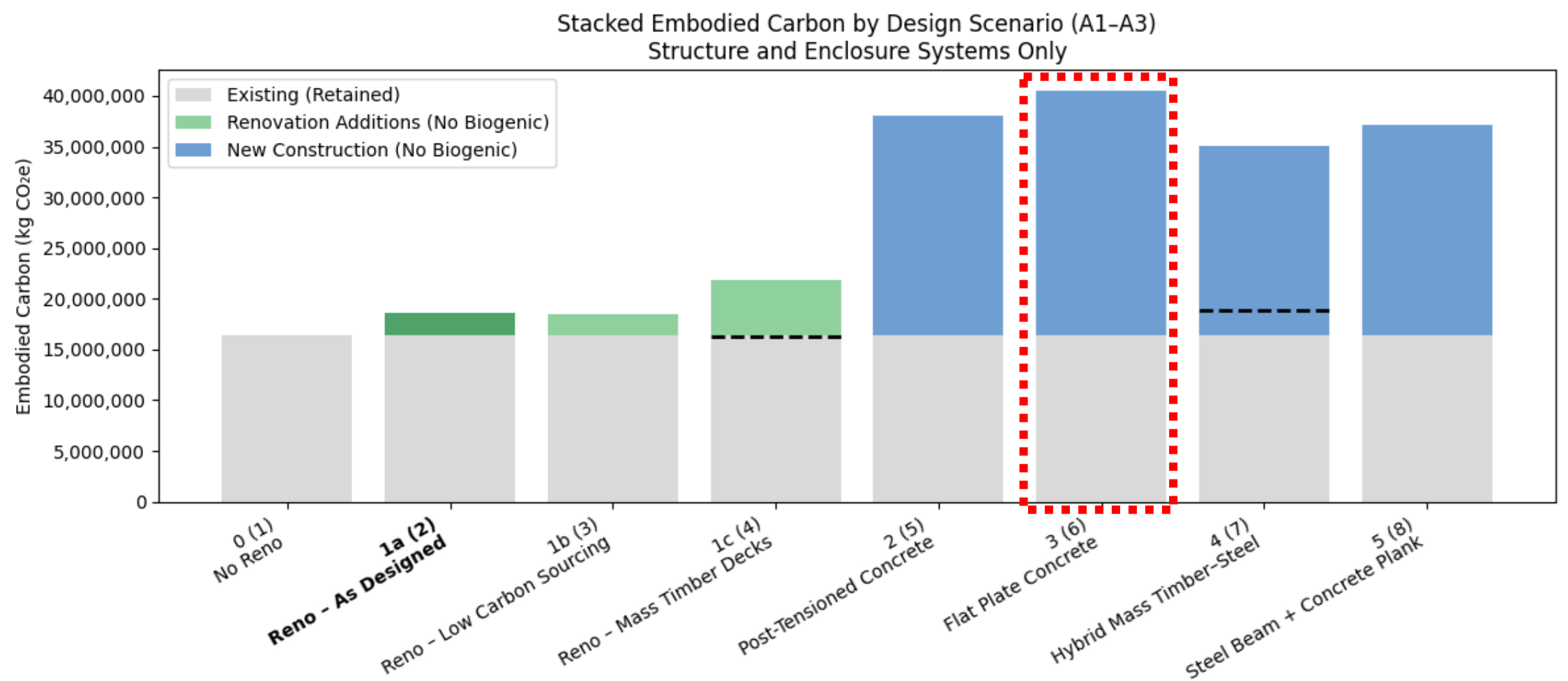

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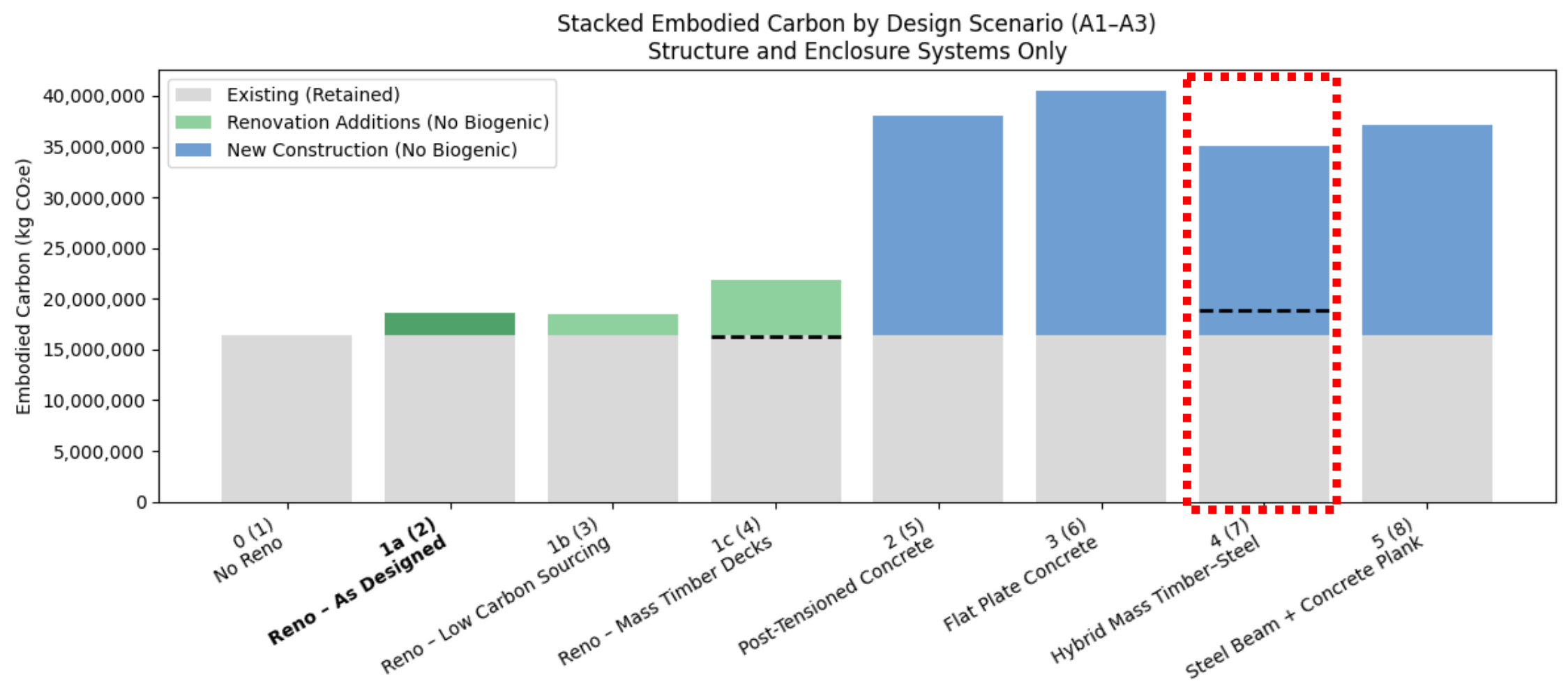

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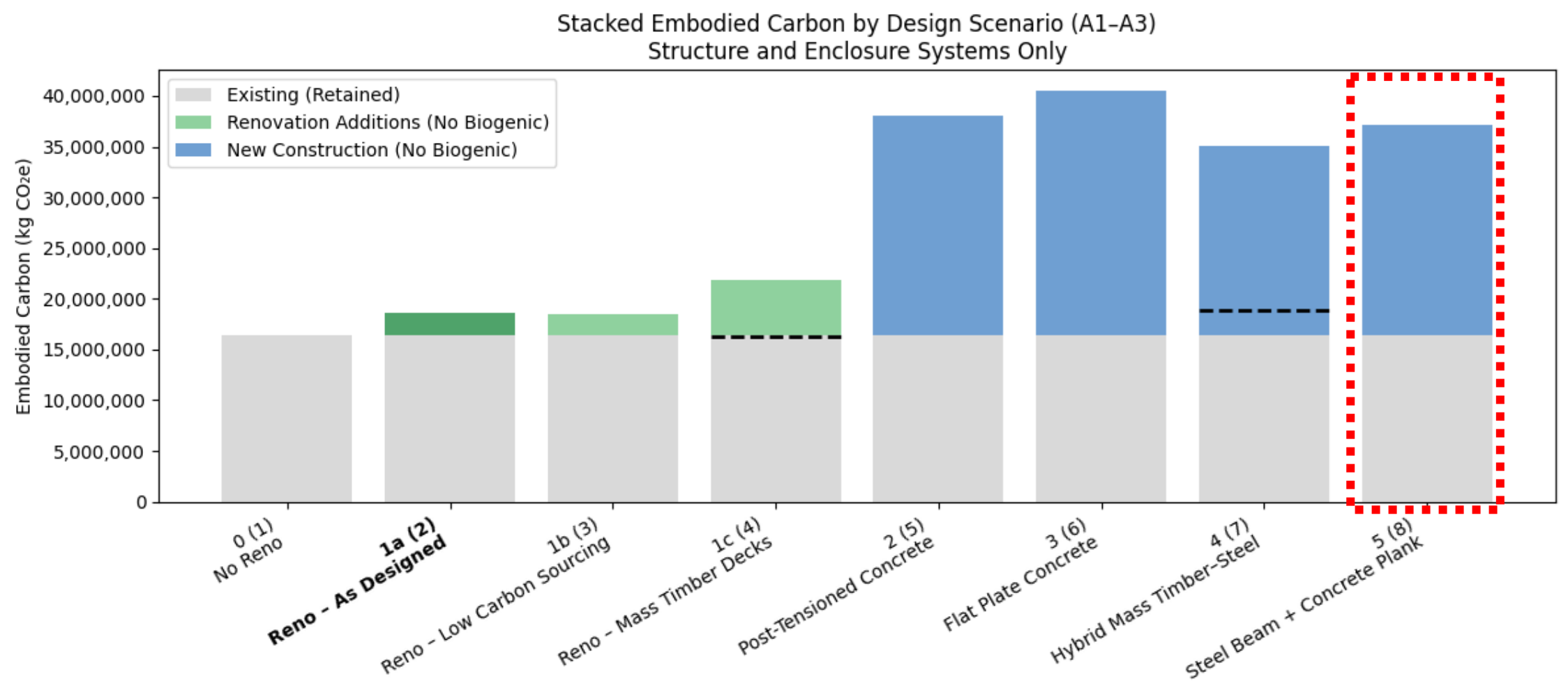

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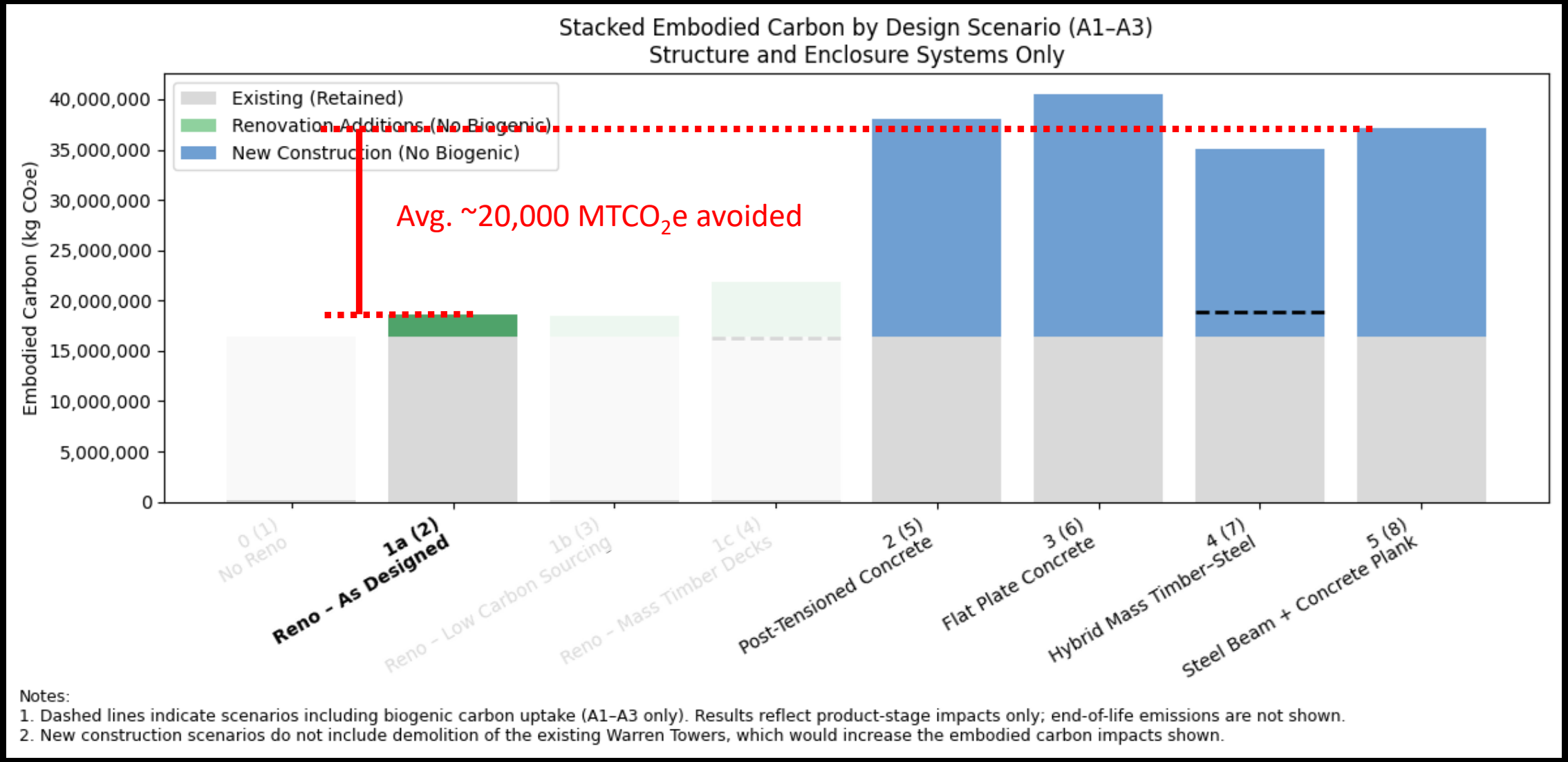

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Core Findings: Renovation Wins

- Renovation avoids ~20,000 metric tons CO2e
- Average new construction results in 6 - 10x more embodied carbon than renovation
- Even lower-carbon new buildings cannot easily outperform reuse
- The carbon cost is driven by new foundations, full material replacement, and larger building area

Time Matters: Carbon Payback

- Embodied carbon is emitted up front - before occupancy
- Renovation carbon typically is offset in ~1 year
- New construction typically requires 8 - 9 years to pay back
- The operational carbon for Warren will be net-zero –
  - All the emission from this building will be its embodied carbon

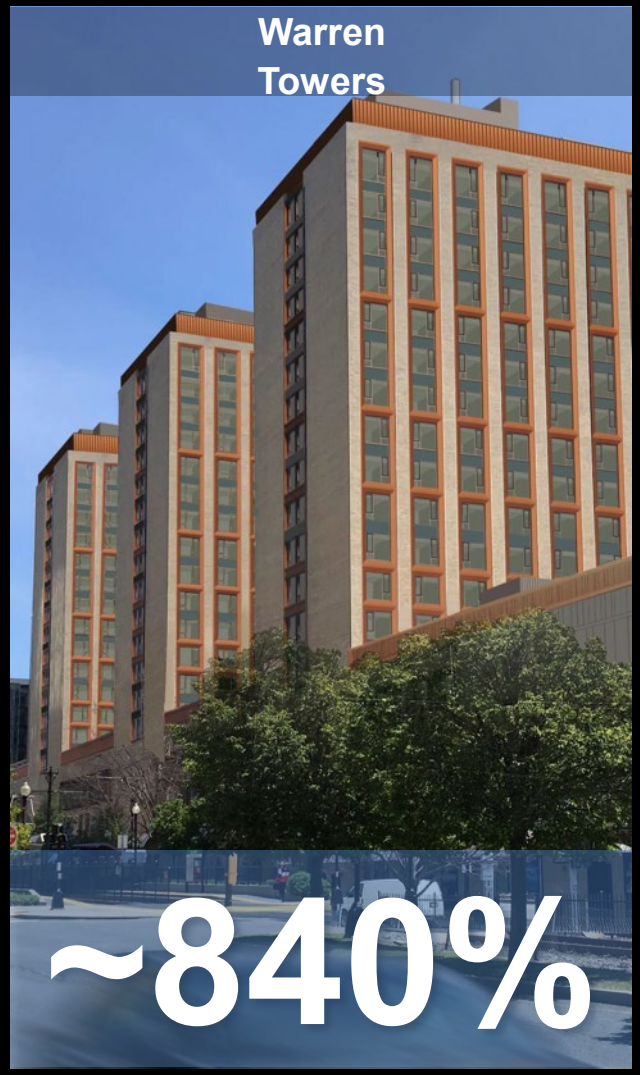
Warren Towers off Carbon

EC Avoided
~20,000 $MTCO_2e$
or
6 – 10 x new construction

Emissions ‘24
2,780 $MTCO_2e$

Emissions ‘29
Zero $MTCO_2e$

Embodied Carbon



Boston University Sustainability

All values shown as percent reduction relative to typical new construction (whole-building LCA)

Looking Ahead

BU Climate Action Plan update

- CAP 1.2 Working Group
- Exploring recommendations for Embodied Carbon:
  - Reduction targets (percent)
  - Time scales
  - Building types
  - Campus wide carbon budget ($kgCO_2e/sf$)
  - Integration with the planning process
  - Integration with construction standards for early decision-making
  - Track progress tied to operational emissions
  - Thoughtfully, transparently, and collaboratively contribute to help move the industry forward

Thank You.

BOSTON UNIVERSITY

Rendering: Karen Nyberg,, NASA

CAROLINE MURRAY, TURNER CONSTRUCTION COMPANY

Turner

Caroline Murray
Regional Sustainabi
Manager
She/her

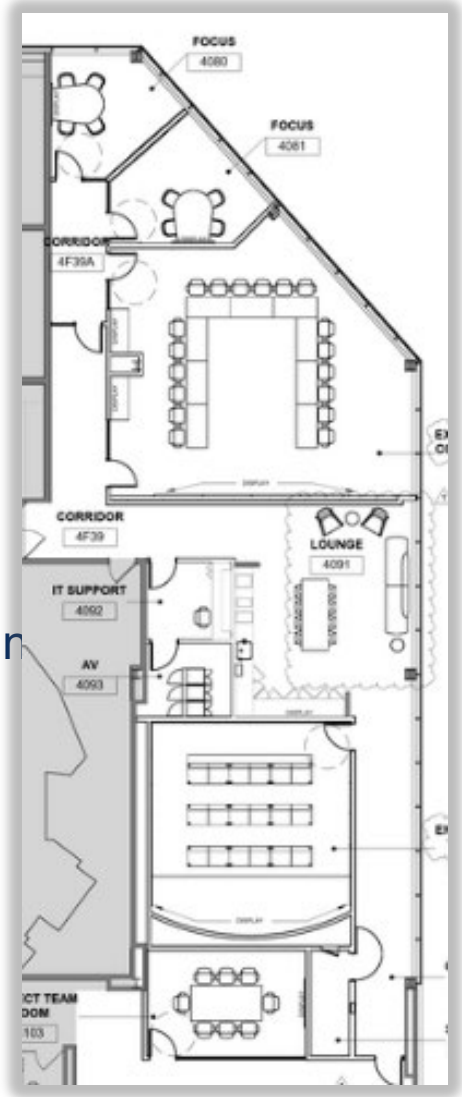
A Better City Panel: Deconstruction & Reuse Playbook

February 3rd, 2026

Confidential Project Description

BACKGROUND

- ~4,000 sq. ft.
- Located in Suburban Boston
- Tenant relocation from adjacent building
- Similar usage & headcount to former space
- Point-to-point move with no intermediate warehousin



Deconstructed / Reused

DEMOUNTALBE PARTITIONS

Win

- Material cost savings
- Zero lead time
- Plate glass is not recyclable in MA

Why it Worked

- System manufactured for reconfiguration
- Designer buy in for dimensional flexibility

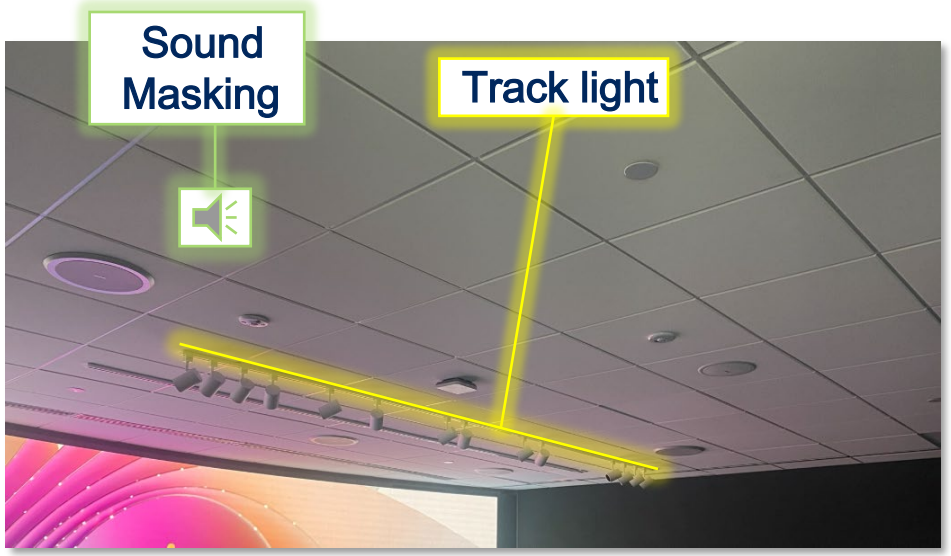
The Catch

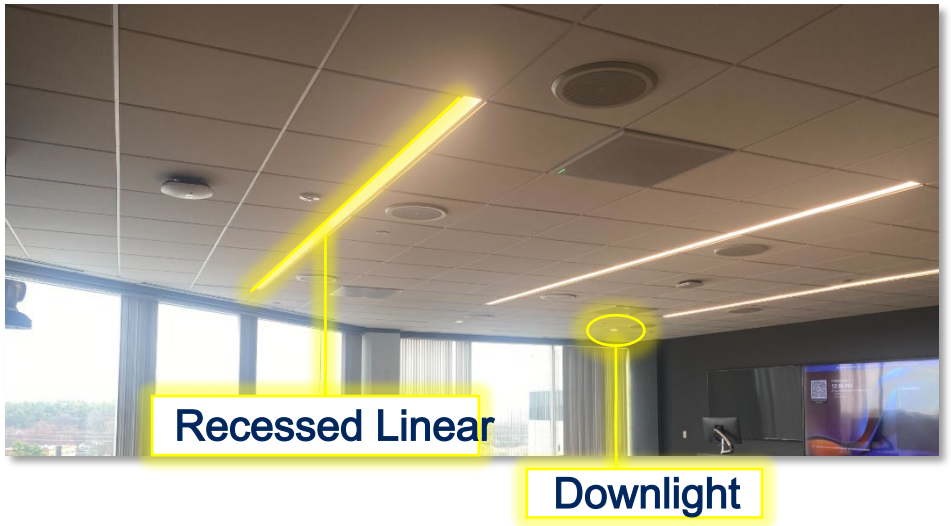
- Confirm components align with design intent

Turner Control Point

- Accurate audit of available components vs. final de
- On-site material storage, protection, & labeling

Deconstructed / Reused





LIGHT FIXTURES

Win

- Material cost savings
- Zero lead time
- Reuse of hard to recycle components

Why it Worked

- Salvaged fixtures met design intent
- Trims compatible with existing ceilings

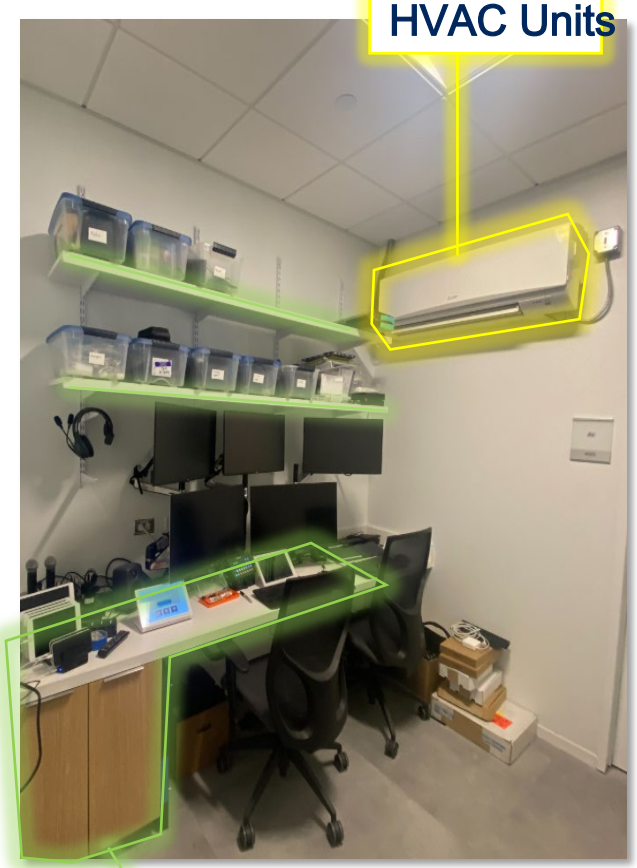
The Catch

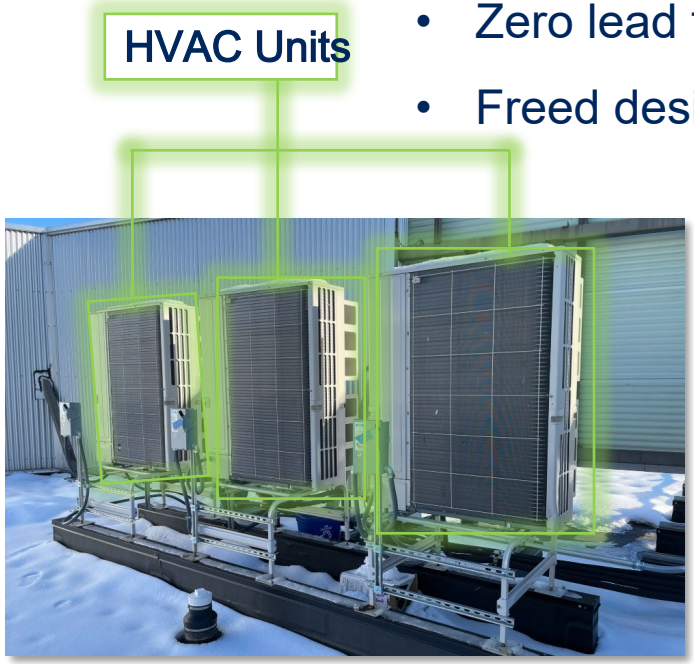
- Driver & controls incompatibility

Turner Control Point

- Cost for repairs, adjustment, & reconfiguration
- Cost for replacement fixtures at prior location

Deconstructed / Reused





BACK OF HOUSE & ROOFTOP

Win

- Material cost savings
- Zero lead time, new HVAC units would not have met schedule
- Freed design, engineering, & fabrication effort for higher work

Why it Worked

- Client & designer buy-in on finishes for non client facing area

The Catch

- Equipment warranty forfeited
- Obsolete refrigerants

Turner Control Point

- Coordination of dimensions & blocking
- Hygienist cleaning of reused equipment

Recovered / Reused

AV EQUIPMENT & CARPET

Win

- Material cost savings
- Zero lead time
- Reuse of hard to recycle AV equipment
- Use of attic stock frees up storage space

Why it Worked

- Client attic stock met design standards
- Designer sized layout to accommodate

The Catch

- None!

Turner Control Point

- Floor box sizing

Diverted / Manufacturer Takebacks

Existing Shaw Carpet Tiles (palletized after salvage)

Clean GWB Offcuts

CARPET & CLEAN GYPSUM

Win

- Circulatory: materials are back to the supply chain
- Dumpster cost savings

Why it Worked

- Massachusetts ban on landfill disposal of clean drywall
- Established carpet manufacturer takeback program

The Catch

- Labor cost for separation & palletizing
- Site separation can congest jobsite

Turner Control Point

- Staff coordination with manufacturers

Demolished

SPECIALITY FINISHES

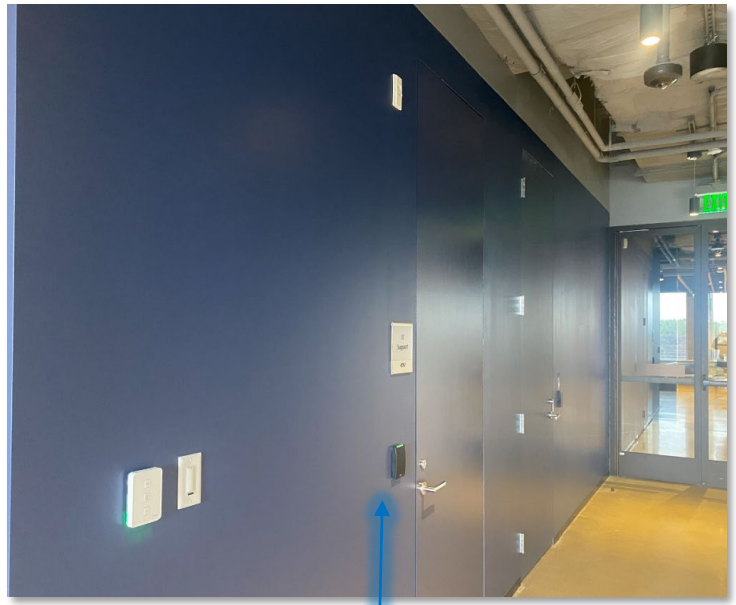
Why it didn't work

- Limited secondary use or resale market
  finishes with penetrations/cuts
- Not cost effective

Turner Control Point

- Assess quality & quantities early for pot
  reuse

Purchase New



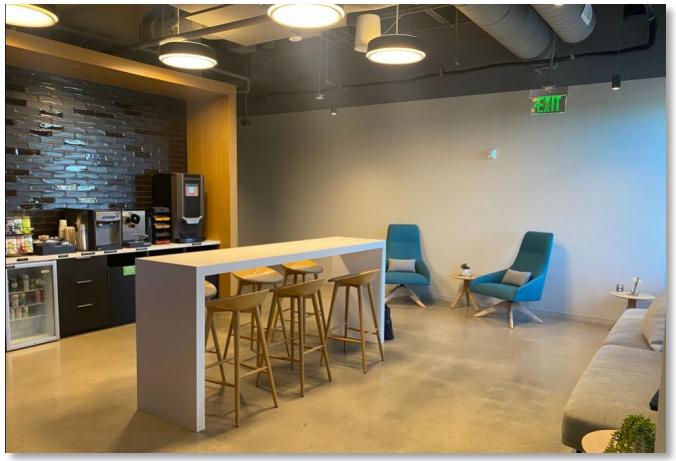
CLIENT FACING & SIGNATURE SPACES

Why it didn't work

- Salvaged or recovered products did not meet design intent

Turner Control Point

- Understand client use & expectations



Reuse Feasibility Matrix

Logistics & Schedule Friction

High

Low

Low

High

Design Flexibility

Lights in ACT

Clean gypsum

ACT takeback

Carpet takeback

Doors

Back-of-house casework

Wood trim

+Minimal buy
+Less dust
-Material management

+Cost savings
-Warranty Expiration
-Outdated components
-Multi-trade

Lighting Controls

HVAC Units

Lights in gyp

Specialty ceilings

Feature millwork

Fabric panels

Reuse of ACT

Sound Masking

AV Equipment

Attic stock reuse

+Schedule benefit
-Possible outdated design

+Reuse of hard to recycle materials
-Possible design concession

Demountable partitions

Pendant lights

ANDREW THOMPSON, BOSTON BUILDING RESOURCES

Boston Building Resources – Reuse Center

We empower people to build equitable, sustainable, and strong communities through material reuse and education.

Who are we?

- Nonprofit focused on building material reuse and education
- Founded in 1981, Reuse Center opened in 1993
- Over 5,000 customers, donors, workshop attendees, etc. in 2025
- Serving homeowners, renters, contractors, designers, etc.
- Store open to the public
  - Program for low-income customers to get deeper discount
- Deconstruction services and educational workshops
  - Home improvement skills and concepts, art making/creative reuse, intro to tools for women, etc.

New kitchens = a lot of saddle time

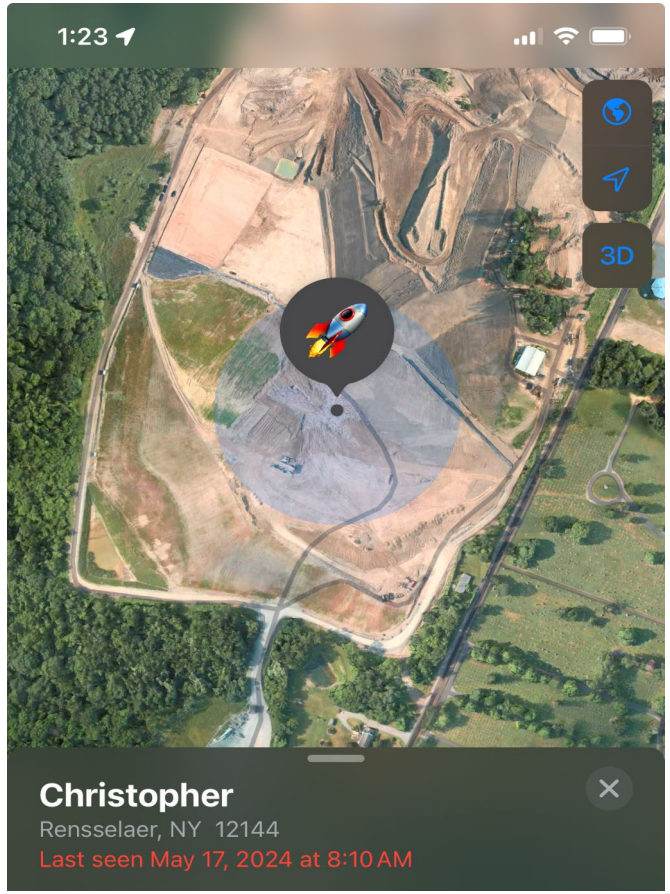
10 feet of upper & lower cabinets + solid surface manufactured countertop = **5 tons CO2**

5 tons CO2 =

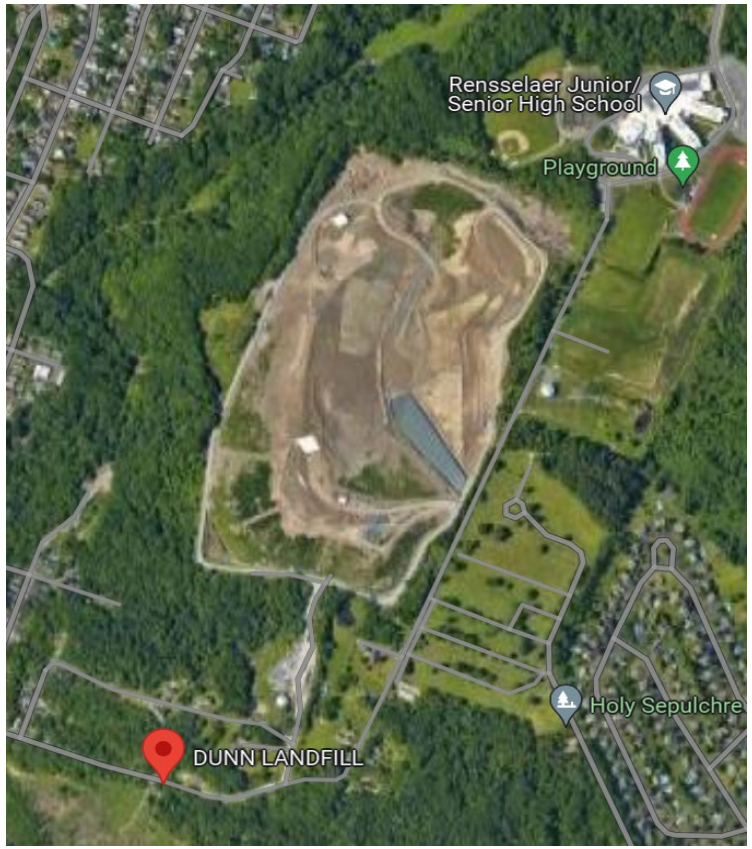
Bicycle 100 miles every day for a year CO2

or

Bicycle from Boston to Montreal and back 53 times.



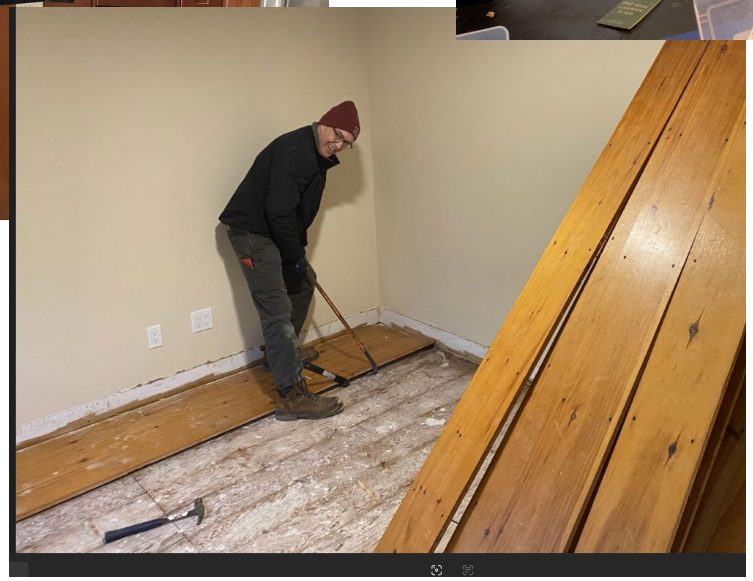
Location of "Christopher", the Apple GPS Tracker



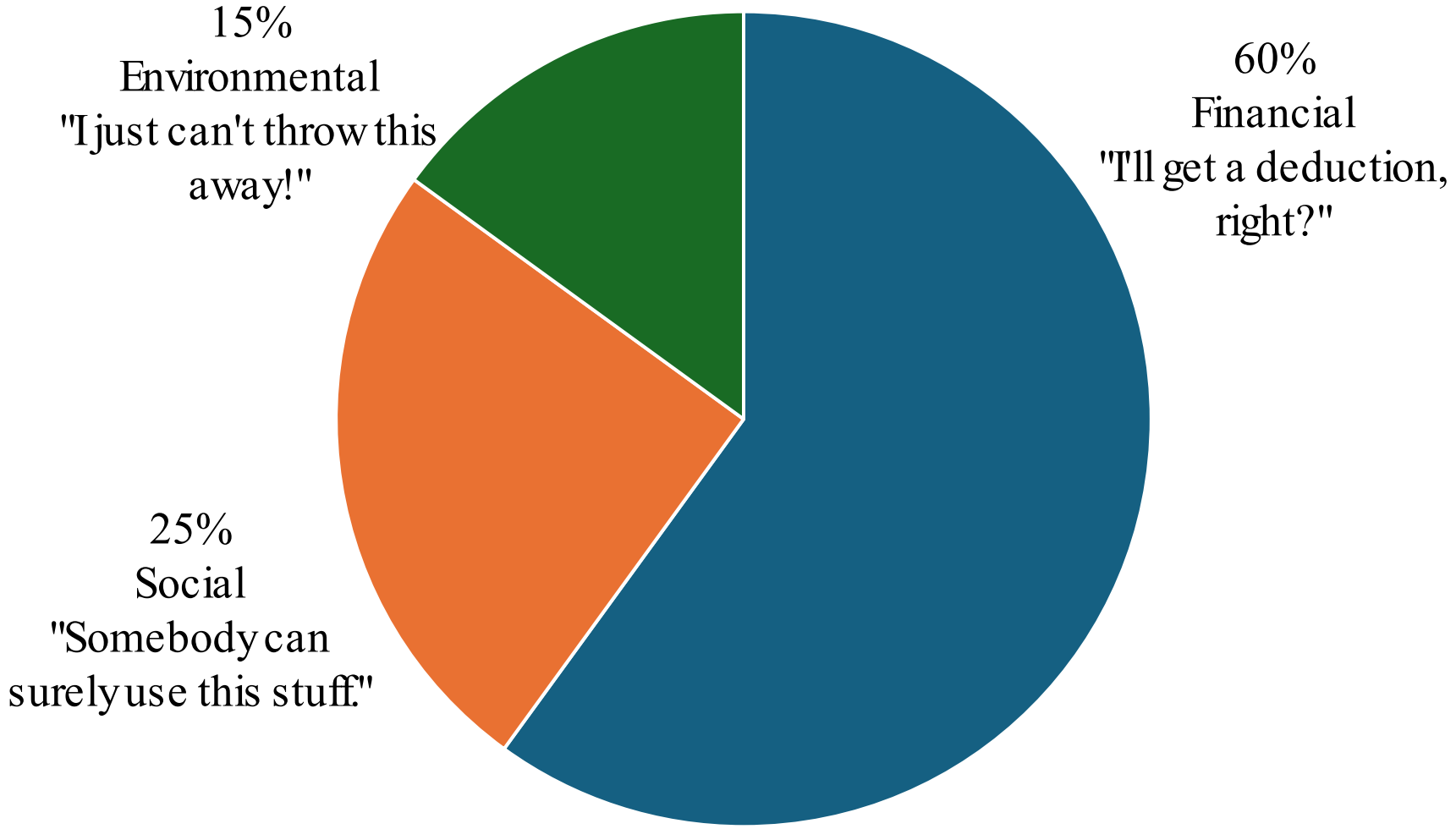
Google Maps

Since the landfill began operations in 2015, the residents of Rensselaer have been subjected to the rotten egg odors caused by hydrogen sulfide gas released from rotting drywall in the landfill. Dust from the dump frequently envelopes the school and surrounding homes. Each weekday, beginning around 6:40 AM, dozens of long-haul tractor trailer trucks coming from seven states roar up through residential areas of Rensselaer on their way to and from the dump, disturbing residents and exposing them to dust, loud noise, and diesel exhaust. ---- Dunn Landfill - Rensselaer Environmental Coalition

Deconstruction as a viable alternative to disposal



Motivations for Choosing Deconstruction



Desirable Materials

Condition

Quality

Utility / Alternatives

Architectural integrity

	% of BBR sales	Utility
Cabinets	15-20%	High
Appliances	10-15%	High
Windows	8-12%	Medium
Doors	8-10%	Medium
Plumbing	4-8%	High
Housewares	4-8%	Low
Lighting	1-3%	Low

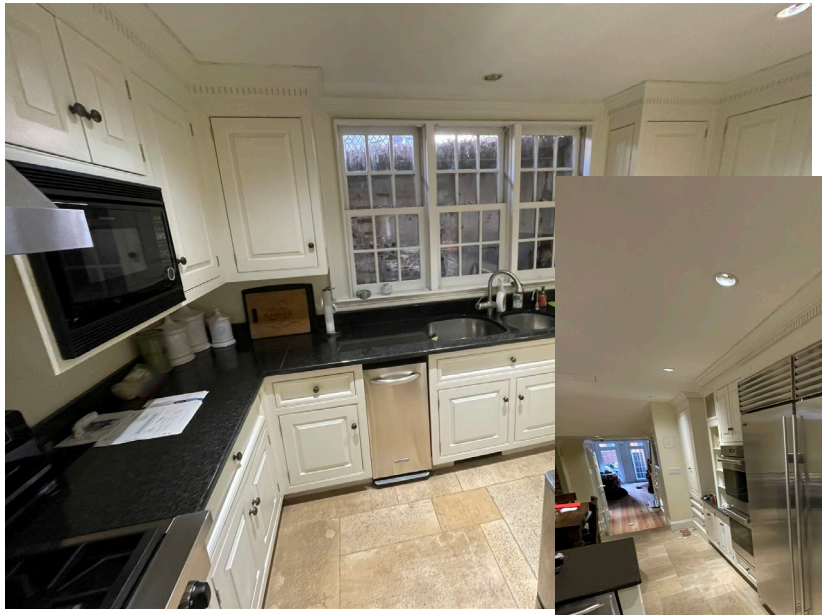
Challenges

- Lack of deconstruction contractors/reuse partners
- Developing market for secondhand building materials
- Project planning hurdles
- Storage and staging place for salvaged materials
- Complexity and long timelines in commercial building sector

Opportunities

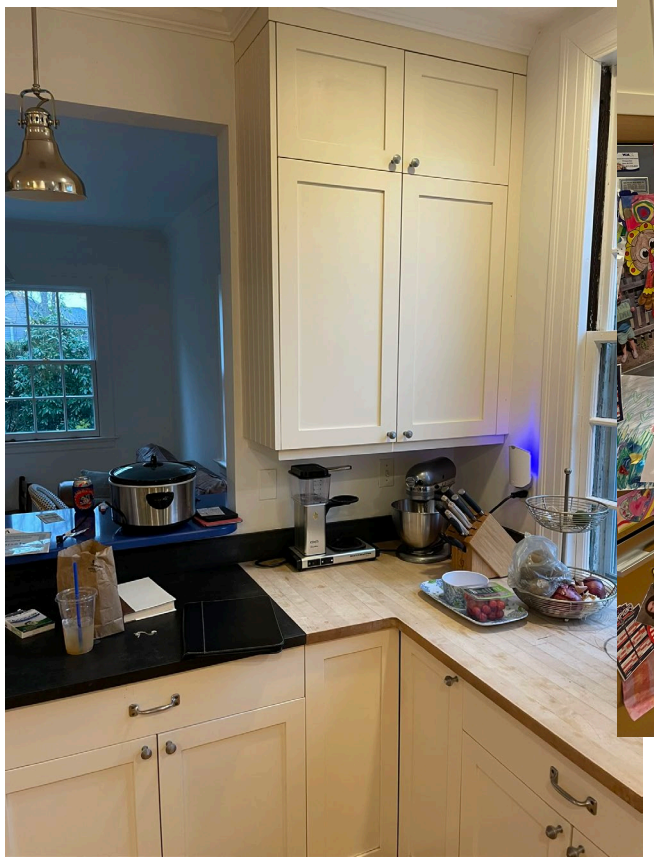
- Small victories are easy to come by and simple to execute
- Long planning process provides time to line up reuse partners
- Market differentiation—commitment to the basic sustainable practice of material reuse can help an organization stand out
- Develop an internal process—materials can be recirculated inside a portfolio or a network of projects
- Measure and publicize your sustainability gains from reuse and deconstruction
- Deconstruction and building material reuse has real world impact on housing affordability and provides a foundation for workforce development programs

Beacon Hill 5-story single family home



- 18 appliances
- Kitchen garden level
- Utilized 3rd party mover

Milton kitchen



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Q&A

COMING SOON:

Built to Lead: Lessons in Resilience

Date & Location TBA