Embodied Carbon Network | 2018 Webinar Series

EMBODIED CARBON IN THE BUILT ENVIRONMENT:
SESSION 5 - REUSE

August 17, 2018
This session is provided as part of the Embodied Carbon Network 2018 Webinar Series. The Network is a collaboration of building sector practitioners, researchers, advocates, and government professionals. We invite guest speakers to share their knowledge and insight on carbon emission topics to get participants thinking and talking about new strategies to achieve climate change goals. Mention of trade names or commercial products does not constitute endorsement or recommendation for use. Please note the opinions, ideas, or data presented by speakers in this series do not represent Embodied Carbon Network members policy or constitute endorsement by the Network.
Communication & knowledge building platform:
• Share and build resources
• Align projects and goals
• Increase awareness of current & emerging embodied carbon initiatives

Common mission to track, quantify, and eliminate building carbon emissions
• 300 members from industry, nonprofit, government

Mobilizing a force of individuals to work together to develop a roadmap for eliminating building sector carbon emissions by 2050
Embodied Carbon Network

Academic
Melissa Bilec
University of Pittsburgh

Buildings
Ryan Zizzo
Zizzo Strategy

Construction
Stacy Smedley
Skanska Sustainability

LCA Data/Tools
Megan White
Integral Group

Materials
Dave Walsh
Sellen Construction

Outreach
Nodo Hispano

Policy

Renewables
Barbara Rodriguez
Carbon Leadership Forum

Tina Dilegge
Carbon Leadership Forum

David Arkin
Arkin Tilt

Reuse
Larry Strain
Siegel & Strain
CARBON LEADERSHIP FORUM
Advancing low carbon construction through research, education and outreach

DIAMOND
MITHUN
STOPWASTE
Carbon Innovations
THE RUSSELL FAMILY FOUNDATION

PLATINUM
ARUP
Orca
Interface
Thornton Tomasetti
CENTRAL
SKANSKA

GOLD
climate earth
MAGNUSSON KLEMCENIC
OWENS CORNING
SIMPSON GUMPertz & HEGEr
thinkstep
URBAN
FABRICK
WALTER P MOORE

SILVER
KIERAN TIMBERLAKE
ADRIAN SMITH + GORDON GILL | ARKIN TILT | CARBONCURE | KATERRA | LMN ARCHITECTS | LUND OPSAHL | NATIONAL READY MIXED CONCRETE CO. | NRMCA | SELLen | SHKS | SIEGEL & STRAIN ARCHITECTS | WRNS STUDIO

SUPPORTERS
ARCHITECTURE 2030 | ATHENA SMI | CASBA | C-CHANGE LABS | COALITION TO PRESERVE LA | CORRIM | ECOLOGICAL BUILDING NETWORK | ENDEAVOUR CENTRE | NET ZERO ENERGY COALITION

Embodied Carbon Network

New Member Introduction
Knowledge/strategies for reducing carbon emissions caused by building materials

Eight online sessions throughout 2018
Subject matter experts From ECN Taskforces
AIA Continuing Education Credits
Webinar Overview

Why Reuse Matters – the Big, Global Picture
Larry Strain
Principal, Siegel & Strain

Materials Reuse – Avoided Impacts from Reuse Compared to Making New Materials
Dave Bennink
Owner, RE-USE Consulting

Lessons Learned and Tools: Measuring Impacts / Benefits of Reuse
Brad Guy
Associate Professor
The Catholic University of America

Embodied Carbon Network

2018 Webinar Series
Saving the World through Reuse

Larry Strain, FAIA, LEED AP
Siegel & Strain Architects
Carbon Leadership Forum
AIA Materials Knowledge Working Group
This is what we’re trying to save
But we also need to save this
Saving the World through Reuse

We have a lot of buildings
They contain a lot of materials
They are not very efficient
We can’t afford to replace them all
Here’s what we need to do:

To keep the global warming under 2° C

Emissions need to peak by 2020
Stop burning fossil fuels by 2050
Start sequestering GHG now

Source: IPCC 2013, Representative Concentration Pathways (RCP); Stockholm Environment Institute (SEI), 2013; Climate Analytics and ECOFYS, 2014.
Note: Emissions peaks are for fossil fuel CO2–only emissions.
We need strategies that can save a lot of carbon

We need strategies that can save it now

**Time Value of Carbon**

- Start slow - increase rate of reduction
- Start fast - decrease rate of reduction

![Graph showing carbon emissions over time with different strategies]
11% - 4 gt
embodied emissions

28% - 10gt
operating emissions

New Buildings (5.5 billion m² / year)

Existing Buildings (230 billion m²)
Global floor area is projected to double by 2060

Existing floor area
230 billion m²

Projected Floor Area
- 2017 - 2030
- 2030 - 2040
- 2040 - 2050
- 2050 - 2060

The UN Environment Status Report 2017
Reuse & Retrofit more – Build Less

The UN Environment Status Report 2017
Energy consumption - Key contributors

The UN Environment Status Report 2017

Consumption increases Efficiency Improvements

Increased Energy Demand

- Population
- Floor Area/person
- Energy Services
- Envelope
- Other improvements
- Technology Performance
- Technology Choice

Consumption increases Efficiency Improvements
CO2 Emission Reductions - Key contributors

The UN Environment Status Report 2017

Decarbonization of the grid
Energy savings - Key contributors
Adapted from - The UN Environment Status Report 2017
New buildings
5.5 billion m² / year

Existing buildings
235 billion m²

GHG emissions (giga tons)

Operating Embodied ZNE Reuse Upgrade

0.25 gt/yr (or less)

4 gt/yr

10 gt/yr
The Character Score tells the story of building age and size on a 200-by-200 meter grid. Aimed at finding the older, diverse fabric that has proven to be valuable in urban areas, it is a composite of three datasets:

- **Median year built** - Where are the oldest and newest buildings?
- **Diversity of building age** - Where are the blocks where old and new buildings co-exist?
- **Granularity of building size** - How many buildings exist together in the same space?

**How to Read the Character Score**

- **Red areas** represent blocks of older, smaller, and mixed-aged buildings.
- **Blue areas** represent the opposite: newer, large.
Increasing the rate of retrofits

1. Portfolio optimization through Mass Customization
2. The “Deep over Time” approach
3. Point of Sale and Green Lease based policy incentives
4. Time based consumption approaches
5. District based grid greening

Resources

National Trust for Historic Preservation
https://savingplaces.org/reurbanism#.W3T5RS2ZPyI
Atlas of Reurbanism – Preservation Green Lab - 2016

Rocky Mountain Institute
How to Calculate and Present Deep Retrofit Value - 2014

UN Environment – Global Alliance for Buildings and Construction
http://www.worldgbc.org/sites/default/files/UNEP%20188_GABC_en%2028web%29.pdf
Global Status Report 2017
Reuse + upgrade is a complete GHG reduction strategy

- DPR offices SF – net zero remodel
- Total Carbon Study - Siegel & Strain, Integral Group, EBNet, StopWaste
Embodied emissions per assembly (Tons of CO$_2$)

70% Reduction in CO$_2$e Emissions
Embodied emissions per assembly (Tons of CO₂)
Total Carbon Reductions over 20 years (Tons)

- No Gas: -(1,160)
- Energy Upgrades + PV’s: (4,170)
- Material Reuse: (650)

Total CO2 Reduction: (5,850)
Materials 70 - 85%
Transport 6 - 10%
Construction 6 - 13%
Site 5 - 10%
Materials Reuse
Residential – Commercial – Institutional
Agricultural – Sports Stadium - Industrial
Demolition
We have found that the **single most wasteful decision** many people will make in their lifetime is to decide to demolish their building
Time/Cost: Hybrid Deconstruction
Hierarchy of Reuse:

1. Reuse Building in place
2. Move Building
3. Reuse Assemblies
4. Reuse Materials

Recycle
Down cycle

Current structures are ‘paid for’
Disturbing Trends
-new materials lack durability
-possible 3 to 1 replacement ratio
-the rate of waste is accelerating
Avoided Impacts from Reuse vs. New

- Materials already ‘paid for’
- Lower carbon emissions
- Embodied energy vs. new
- Forests/resources saved
- Landfill life extended
- Forest Products Lab study

Sourcing/Selling Reuse Materials
State of the Reuse Marketplace
Sourcing/Selling Reuse Materials
State of the Reuse Marketplace
Sourcing/Selling Reuse Materials
State of the Reuse Marketplace

Demolition:
(cost of demolition + cost of full disposal + cost to repurchase everything you just threw away)

Deconstruction/reuse:
(cost of deconstruction + partial recycling /disposal cost )-( benefit of having your materials returned to you as part of the deconstruction bid)
Reusing Whole Assemblies
Zero Waste, Recycling, Denailing, Rebuilding

‘Post-Fabs’
Reuse: Partial Deconstruction
Portland, OR Decon Ordinance
-Historic Preservation
-Environment
- Milwaukee, other cities following
Achieving Material Reuse/ Barriers

Success:
- Time allowed
- Costs controlled
- Supply managed
- Demand built up
- Better quality materials

Failure:
- Time not allowed
- Costs too high
- Supply mismanaged
- Demand not tracked
- Lower quality materials
Creative Solutions: EPDM Roofing
Materials Reuse

Residential – Commercial – Institutional

Agricultural – Sports Stadium - Industrial
Reuse: measure what we value

- The glass is half-full
- Location and transportation are relevant
- Largest effects from avoidance of new materials
- Reuse is holistic

Brad Guy, Assoc AIA, LEED AP BD+C, SEED
ISO/TC 59/SC 17/WG1 Design for Adaptability and Disassembly
AIA Materials Knowledge Working Group
USGBC LEED Social Equity Working Group
Continuum of reuse

- **THINK**
  - Building-scale reuse
  - Reuse materials supply
  - Deconstruction
  - *(future design for reuse)*

- **ACT**
  - Deconstruction
  - Reuse materials supply
  - Building-scale reuse
Sustainability benefits of reuse

• Economic assessment
  • Economic multipliers
  • Labor intensity

• Social and health assessment
  • Local
  • Public health

• Environmental assessment
  • Carbon footprint
  • Life cycle assessment
3 studies

• Life cycle assessment (LCA) of demolition versus deconstruction
• Carbon footprint of reuse operation
• Building reuse vs non-reuse via LEED metrics
LCA of deconstruction vs demolition

- Impacts of process via time, mass, environmental effects?
- Trade-offs between deconstruction and demolition?
- Greenhouse gas (GHG) impacts of deconstruction vs demolition?
- Environmental “break-even” for deconstruction?
TIME

Deconstruction | Demolition

LABOR DAYS
- Deconstruction: 13.6
- Demolition: 15

MACHINE DAYS
- Deconstruction: 10
- Demolition: 3

Ft. McClellan LCA
CO\textsuperscript{2} G/PER SF

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<thead>
<tr>
<th>Category</th>
<th>Deconstruction</th>
<th>Demolition</th>
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<td>Equipment</td>
<td>386</td>
<td>179</td>
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<tr>
<td>Transport</td>
<td>111</td>
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<td>1990</td>
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Ft. McClellan LCA
CO$_2$ G/PER SF

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Ft. McClellan LCA
CO$^2$ G/PER SF (43% REUSE)

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Ft. McClellan LCA
CO2E G/SF (WHAT IF 55% REUSE)

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Carbon footprint of reuse operation

- Environmental (GHG) benefit to reuse facilities?
- GHG consumer marketing message?
- Internal knowledge of environmental impacts?
New Brick CO2e Lifecycle

Production

+ 

0 

- 

Deconstruction  Transport  Processing  Recycle Benefit?
Reuse Operation

Production

+ Reuse Benefit

- Deconstruction

Transport

Processing
ANNUAL MT CO2-E

<table>
<thead>
<tr>
<th>Category</th>
<th>CF (carbon footprint) MT CO2-E</th>
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<tr>
<td>RECYCLING TRANSPORT</td>
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<tr>
<td>CF EMPLOYEE COMMUTE</td>
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<td>ELECTRICITY</td>
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<tr>
<td>DONOR TRANSPORT</td>
<td>60.4</td>
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<tr>
<td>HEATING (GAS)</td>
<td>68</td>
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<tr>
<td>WASTE LANDFILL</td>
<td>127</td>
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<td>TOTAL ANNUAL CO2-E</td>
<td>-309.3</td>
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CF Carbon Footprint
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<th>Activity</th>
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<tbody>
<tr>
<td>Recycling Transport</td>
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**ANNUAL MT CO2-E**
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CF: Carbon Footprint
309 MT CO2-E =

66.2
Passenger vehicles driven for one year

33.4
homes' energy use for one year

Avoided

https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator
309 MT CO2-E

Avoided

- 66.2 passengers vehicles driven for one year
- 33.4 homes' energy use for one year

Sequestered

- 8,008 tree seedlings grown for 10 years
- 364 acres of U.S. forests in one year

https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator
LEED v2 & 3 building reuse vs new

• Energy performance of building reuse vs new construction?
• Is building reuse “sustainable design”?
• Holistic comparison between building reuse and new construction?
Building stock available for reuse

- 60% older than 25 years
- 22% older than 50 years
- 2.2% vacant as of 2012 (NGO)
- 2 billion SF (NGO)
- THE GLASS IS HALF-FULL

YEAR BUILT BY SF

---|---|---|---|---|---|---
11.49% | 8.47% | 11.90% | 12.45% | 17.49% | 15.85% | 22.35%
LEED MRC1 PROJECTS REUSE %

| Reuse % | Value  
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<tbody>
<tr>
<td>33%</td>
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<td>111.0</td>
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<td>25%</td>
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<td>50%</td>
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<td>55%</td>
<td>983.0</td>
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<td>75%</td>
<td>505.0</td>
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<td>95%</td>
<td>42%</td>
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CS ENERGY-USE

- Adaptive Reuse
- New Construction

V2 EA1 OPTIMIZE ENERGY PERFORMANCE
- Adaptive Reuse: 24%
- New Construction: 18%

V3 EA1 OPTIMIZE ENERGY PERFORMANCE
- Adaptive Reuse: 25%
- New Construction: 25%
CS SITE & IEQ

- **SS2 Density and Connectivity**
  - Adaptive Reuse: 87%
  - New Construction: 64%

- **SS4.1 Public Transit Access**
  - Adaptive Reuse: 90%
  - New Construction: 71%

- **EQ8.1 Daylight**
  - Adaptive Reuse: 19%
  - New Construction: 33%

LEED Building Reuse
Themes and findings

• Manual deconstruction more time reduces environmental impacts
• Reuse substitutes for new materials – CARBON SINK
• Location and transportation are major factors for reuse – THINK LOCAL
• Building reuse energy-performance comparable to new construction
• More to reuse than just the building
Future

- Carbon offsets for reuse of materials and buildings
- Scope of reuse in US
- PCR and EPDs for reclaimed materials
- Buildings as invested materials banks for the future (return)
- DESIGN FOR ADAPTABILITY AND DISASSEMBLY (ISO 20887)
• Stick around for Q & A

• Next webinar: LCA Data and Tools | Sept. 21 – Register today @
  https://attendee.gotowebinar.com/register/1520279727334552322

• Learn more about the Embodied Carbon Network at
  www.embodiedcarbonnetwork.org

• To receive AIA continuing education credit send your AIA member
  number to info@embodiedcarbonnetwork.org
Thank you!

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