Circularity in the Built Environment

Embodied Carbon Network Webinar
Sept 20, 2019
A More Circular Materials Management Hierarchy

- Rethink/Redesign
- Reduce
- Reuse/Share
- Remanufacture / Repair
- Recycle
- Dispose
Reducing Embodied Carbon: Circular Economy

Extract | Produce | Consume | Dispose

Avoided embodied emissions

Recycle
Greater avoided embodied emissions

- Extract
- Produce
- Consume
- Dispose
Current Building Materials Flow
Circular Building Materials Flow
Circular Building Materials Flow
At Each Scale Optimize...

a) Use of what’s existing, already in-place

b) Design of new construction’s material efficiency and end-of-life
Community
Optimize Utilization of City Infrastructure

- Community-scale planning
- Infill development
- Accessory dwelling units
- Smaller units
Buildings
Optimize Utilization of Existing Buildings

• Sharing / increasing occupancy rates
• Retrofit existing buildings
• Adaptive reuse
Components/Parts & Materials
Extract Existing Components for Reuse & Recycling

- Deconstruction
- Salvaged materials
- C&D recycling
Thank You!

Circularity in Built Environment Primer for Local Governments:

StopWaste.org/BE

Miya Kitahara, Program Manager | miya@stopwaste.org

StopWaste.org
According to “Architecture 2030”

“approximately two-thirds of the building area that exists today will still exist in 2050.”

So, what about the other third?
“Global building stock will double in area by 2060”...
“This is the equivalent of adding an entire New York City every month for 40 years”.
So, where will all the materials required for this come from?
There is little doubt that how we deal with these issues is the biggest question of our time.
Whatever happened to reduce, reuse, recycle?

**Reduce**
- No one wants to talk about this really
- Consumption is our economic driver
- But we are looking at ways to at least reduce waste and increase efficiencies

**Recycle**
- Recycling allowed us all to continue consuming in the same way.
- And feel good about it
- But it has never been a long term solution
- Because it is still linear
What is missing?

Reuse

Let's talk about that 1/3 of buildings!

- What is a circular economy in regards to buildings?
- Why aren't buildings part of these conversations?
- How do we start including buildings an create an economic model that is not based on wasting our resources.
Deconstruction

“The systematic dismantling of a structure in order to preserve the building materials for reuse”.

[Image of a deconstructed building]
The reuse and recycling industry produces 7 jobs per 1000 lbs of MSW.
Compared to less than 1 job per 1,000 lbs of waste landfilled.

"More Jobs, Less Pollution: Growing the Recycling Economy in the U.S."
Prepared by the Tellus Institute November, 2011
Additional jobs

Not yet measured are the thousands of jobs in reuse retail operations across the country...
What’s up in our Industry?

We are talking about deconstruction with:

- Atlanta
- St. Louis
- Pittsburg
- San Francisco
- Vancouver B.C.
- Seattle
- D.C.
- And more...
Industry challenges

- The reuse industry lacks serious investment
- The industry tends to be scattered group of hands on folks that lack an organized sharing of resources, knowledge, and passion to drive our market.
- Our industry is built on word of mouth to grow our businesses.
- We are where recycling was 25 years ago!
So, if this interests you, then you need to come to the only national conference that focuses on these questions!

October 28-30 - 2019
Building Material Reuse in Commercial Settings

Andrew Ellsworth, LEED AP
Doors Unhinged, LLC
ABOUT DOORS UNHINGED

We reclaim and resell commercial doors, frames and hardware.
COMMERCIAL WASTE CHARACTERIZATION

Municipal Solid Waste --- 262 Million Tons
Construction & Demolition Waste --- 169 Million Tons
Demolition waste = core & shell waste + latest interiors
Core & shell waste = concrete, masonry, steel and glass
Tenant interior waste is different:
  - Lighter, easily handled finish materials
  - Some materials are brand new!
  - Mass-produced products with limited customization
  - Standardized construction and dimensions
  - Are about the same as new materials being specified today!

32 MILLION TONS
Commercial Renovation Waste
Generated Annually
COMMERCIAL REUSE POTENTIAL

• Commercial reuse = building materials recovered from commercial buildings and reinstalled in commercial buildings.

• Common materials from commercial interiors
  
  • Drywall & steel studs
  • Insulation
  • Ceiling tile & grid
  • Doors, frames & hardware
  • Interior glazing
  • Carpeting & flooring
  • Casework
  • Furniture
  • Light fixtures & small electrical
  • Small mechanical
CARBON POTENTIAL

- Embodied carbon of TI materials is a fraction of whole building
- HOWEVER, tenant spaces turn over every 10-20 years, or less

Data approximated using results of Carbon Leadership Forum’s Benchmark, TI & MEP Studies
EMBODIED CARBON OF INTERIOR MATERIALS

Measuring “carbon density” vs. quantity of materials installed

Based on data sets from Carbon Leadership Forum’s TI Study; Huang, M., Simonen, K., Ditto, J. (2018) Life Cycle Assessment (LCA) for Low Carbon Construction: Tenant Improvements in Commercial Office Buildings
**COMPARATIVE EMBODIED CARBON**

Normalized by mass

- Batt Insulation
- Interior Glazing (1/4")
- Shaw Carpet Tile
- Interface Carpet Tile
- Acoustic Ceiling Tile
- Mortise Lockset
- Door Closer
- Hinges (3)
- Metal Frame
- Metal Door
- Wood Door
- Redaimed Materials

**Um, reuse is kicking butt!**

0.0045 kg CO2e per

kg CO2e / kg material
RESIDENTIAL VS. COMMERCIAL

• Residential
  • homeowners, hobbyists & small contractors
  • Go for uniqueness and bargains
  • Reuse centers ≈ Home Depot
  • Materials quantities ebb and flow

• Commercial
  • Uniform materials, larger quantities
  • B2B/Wholesale business
  • Material suppliers are focused
  • Projects can take 3-18 months
## COMMERCIAL REUSE

<table>
<thead>
<tr>
<th>Challenges</th>
<th>Opportunities</th>
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<tbody>
<tr>
<td>• Lots of materials!</td>
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<tr>
<td>• Lack of flexibility by designers</td>
<td>• New materials are $$$</td>
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<tr>
<td>• Desire for new appearance &amp; match</td>
<td>• Similarity &amp; uniformity</td>
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<tr>
<td>• Perceptions of inferiority</td>
<td>• Quick turnover</td>
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<td>• Storage and inventory</td>
<td>• Room to specialize</td>
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<td>• Must service clients professionally</td>
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<td>• Unfavorable payment terms</td>
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GETTING TO SCALE

- Moving large volume of materials
- Process has to be easy
- More materials, more matches
- Repurposing is NOT scalable
GETTING TO SCALE

400 MSF of commercial office space constructed/year in US

$$3.67 \times 10^7 \text{ m}^2 \times 75 \text{ kg/ m}^2 \text{ CO}_2\text{e} = 2.75 \text{ Megatonnes CO}_2\text{e}$$

If 50% of TI project SF used 50% reclaimed materials

$$2.75 \text{ MT} \times 0.5 \times 0.5 = 0.7 \text{ MT CO}_2\text{e avoided/yr}$$

20.7 MT CO$_2$e avoided by year 2050, just in US

WARNING: Lots of approximations within these calculations; meant for scale purposes only
HOW DO WE GET TO 50% REUSE?
CIRCULAR ECONOMY MEETS MULTI-LISTING SERVICE

• Connecting Assets
• Foster New Enterprises
• Create Jobs
SUMMARY

1. There’s a seemingly endless supply of materials available
2. The carbon benefits of reuse are real and substantial
3. The industry is challenging but the need is compelling
4. We need regional/nationwide infrastructure like MLS to source and sell materials

5. THANK YOU!

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Reducing GHG 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

Larry Strain, FAIA, LEED AP
Siegel & Strain Architects
Carbon Leadership Forum
AIA Materials Knowledge Working Group
• Build New Net Zero Buildings
• Reduce Embodied Emissions
• Upgrade Existing Buildings
Total Carbon Emissions of All Global New Construction from 2020-2050

Business as Usual Projection

Embodied Carbon
80%
By time value @2030

Operational Carbon
20%

Operational carbon and embodied carbon projections from 2020 to 2050.
New buildings
5.5 billion m² / year

3.9 gt/yr

0.20 gt/yr
(or less)

Operating

Embodied
New + Renovation

Emissions
New buildings
5.5 billion m²/year

Existing buildings
235 billion m²

Emissions

.20 gt/yr
(or less)
Operating

3.9 gt/yr
Embodied
New + Renovation

10 gt/yr
Operating

11% GHG

28% GHG
UN Global Status Report - 2017

FIGURE 3  Floor area additions to 2060 by key regions

Deep energy renovations of existing buildings (e.g. 50% to 70% energy intensity improvements, with the objective of moving towards high-performance and low-carbon buildings, such as near-zero energy buildings [nZEBs]), are another priority over the coming decades. This is especially true for Organisation for Economic Co-operation and Development (OECD) countries, where roughly 65% of the total expected buildings stock in 2060 is already built today.

From the Report
Concrete 25 - 50%
Wood 10 - 20%
Cladding 10 - 20%
MEP 10 - 15%
Other 10 - 15%

Concrete 25 - 80%
Steel 25 - 60%

Large, Heavy Buildings
100 lbs / sf

New Buildings

Existing Buildings

Embodied CO₂ by Construction Type & Material

Aluminum Glass Stucco, etc

Brick Vinyl, wood Stucco

Large, Heavy Buildings
100 lbs / sf

Small, Light Buildings
50 lbs / sf

Renovation + Upgrade
25 lbs / sf

Large, Heavy Buildings
100 lbs / sf
• Upgrade Existing Buildings to Net Zero

• Reduce Embodied Emissions

• Build New Net Zero Buildings
Reuse + upgrade is a complete GHG reduction strategy

- DPR offices SF – net zero remodel
- Total Carbon Study - Siegel & Strain, Integral Group, EBNet, StopWaste
70% Reduction in CO₂e Emissions
Embodied emissions per assembly (Tons of CO₂)
Total Carbon Reductions over 20 years (Tons)

- Energy Upgrades + PV’s: (4,170)
- Material Reuse: (650)
- Embodied carbon savings (compared to a new building)
- Total CO2 Reduction: (5,850)

No Gas: (1,160)
Small, Lightweight, Wood Frame Building

Total Emissions - e & o

Total Emissions - combined

New Building + 225 metric tons

Emission Totals – Range over 10 years

Existing Retrofit – 150 metric tons
Large, Concrete / Steel Frame Building

Total Emissions - e & o

- Existing As-is.
- New Efficient
- New Electric
- New ZNE
- Retrofit 50%
- Retrofit ZNE

Embodied
Operating
Combined

Emission Totals – Range over 10 years

New Building + 3500 metric tons

Existing Retrofit – 1250 metric tons
Improving what we have

- Reuse compared to new  - lower embodied CO2
- Energy upgrades   - lower operating CO2