Healthy for People and Planet

Why Healthier Materials Are Essential to High Performing Building Designs

Lisa Carey Moore and Jacob Deva Racusin
Learning Objectives

1. Identify where chemicals of concern exist using six classes approach

2. Explore the relationship/overlap between materials that support healthy indoor environments, and materials that have low embodied carbon values

3. Understand the importance of material selection in high performance buildings, as evidenced in impacts on both occupant and environmental health and carbon footprint

4. Identify processes and goals for healthy buildings and for low carbon construction practices, and identify which material solutions best support these goals
Who are you?
GOAL

Over time, all harms eliminated
Split of Global Building-related Emissions & Emissions Reduction Potential

4 Key global policy priorities for <2 °C Scenario

1. Near / Zero Energy Buildings
2. Deep Renovations
3. Low-GHG Energy Supply
4. Low-GHG Materials

Source: IEA Energy Technology Perspectives 2016
“Embodied Carbon (eCO2e) is the sum impact of all the greenhouse gas emissions attributed to the MATERIALS throughout their life cycle.”

http://carbonleadershipforum.org/
86,000 Chemicals Made in USA

Chemicals Tested in USA
THE SIX CLASSES OF CHEMICALS OF CONCERN

1. Highly Fluorinated
2. Antimicrobials
3. Flame Retardants
4. Bisphenols + Phthalates
5. Some Solvents
6. Certain Metals

How to reduce your exposure to harmful chemicals
SixClasses.org
Health Impacts

Highly Fluorinated: Kidney and testicular cancer; elevated cholesterol; decreased fertility; thyroid disease; interference with hormone function. **Antimicrobial:** Developmental; hormonal; reproductive problems; antibiotic resistance. **Flame Retardants:** Lowered IQ and hyperactivity in children; cancer; hormone disruption; decreased fertility; **Bisphenols & Phthalates:** Mimic or block hormones disrupting vital body systems; asthma; neuro-developmental problems; allergies; cognitive problems; obesity; type II diabetes; heart disease; decreased fertility; prostate cancer; reduced fertility. **Solvents:** Neurological problems and increased cancer risks. **Certain Metals:** Mercury/Arsenic/Cadmium and Lead exposure can cause brain development to be impacted; increase risk of cancer; neurological and cardiovascular effects; lung and kidney damage.

http://greensciencepolicy.org/topics/six-classes/
1. Highly Fluorinated

Where are they?

**Stain & Water Repellents**
- Furniture upholstery
- Carpets
- Drapery

FEP/teflon insulated Wire and Cable
Metal coatings “PVDF” type

**Health + Carbon:**

Ask manufacturer to remove stain and water repellants in finishes.

Eliminate products that need water and stain repellents.
2. Antimicrobials

Where are they?

Wall and window finishes
Flooring
Surfaces in lav & kitchen areas
Acoustical ceiling comp. & panels
Polyurethane adhesives

Foam and cellulose insulation

Health + Carbon:

Ask manufacturers to eliminate Antimicrobials.

See: Building Green “Antimicrobial Chemicals in Buildings—Hygiene or Harm?”
3. Flame Retardants

Where are they?

- Furniture Foam
- **Building Insulation**
- Textiles
- Fabric blinds and drapes
- Paints and coatings
- Wire and Cable sheathing
- Electronic Cases**

Health + Carbon:

Ask manufacturers to eliminate FRs.

Design/Build without foam insulation and products that contain these harmful chemicals.

TB 117-2013 for Furniture = meet flammability standards without chemical flame retardants
4. Bisphenols & Phthalates

**Where are they?**

**Bis:** Polycarbonates used for electrical enclosures, luminaire lenses, furniture/cabinets, epoxy products (paints, grouts, surfaces)

**Phthalates:** Vinyl Flooring, plastic divider curtains, plastic filters and screens, glues, caulks, paints.

See: Healthy Building Network’s DataCommons: https://commons.healthymaterials.net/home

LBC’s Red List: https://living-future.org/declare/declare-about/red-list/#red-list-cas-guide
Plastics that are “better” for Health

1. PET (#1 recycled) is recycled into new PET products, spun into polyester fiber (carpets, stuffing for furniture, small pieces in light fixtures & plumbing components).

2. LDPE/HDPE (#2) simple to recycle, can be used to make everything from wastewater pipe to baby changing stations. Durable when exposed to the elements. Substitute for PVC where code allows.

3. Polyolefins, Modified Polyphenylene (mPPE). Highly recyclable and less material needs to be used. Growth in electrical cable/wire.
5. Solvents

Where are they?

They disperse or dissolve...

- Oil based paints
- Adhesives
- Sealants
- Blowing Agents for foam

Health + Carbon:

Eliminate CA Class II Banned list.
Water based products.
Mechanical fasteners (better for adaptation/deconstruction)

https://www.arb.ca.gov/db/solvents/solvents.htm
6. Certain Metals

Mercury, Arsenic, Cadmium, Hexavalent Chromium and Lead

Where are they?
- MEP
- Drywall
- Electronic products
- Paints, metal coatings
- CRVI in galvanization & chrome plate

Health + Carbon:
- Lead Free
- Recycled content gyp board has trace mercury but best for eCO2!
- Electronics that have RoHS & WEEE recycling;
- CRIII for galvanizing and plating.
Our Scorecard

PRODUCT NAME
Company Name
Protocol Version

GOLD

BASIC BRONZE SILVER GOLD PLATINUM

MATERIAL REUTILIZATION ✓

MATERIAL HEALTH ✓

RENEWABLE ENERGY ✓

WATER STEWARDSHIP ✓

SOCIAL FAIRNESS ✓
<table>
<thead>
<tr>
<th>COMPONENT</th>
<th>INGREDIENT NAME</th>
<th>CAS#</th>
<th>%</th>
<th>SOURCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>All colors except Rose Quartz, Red Rock, Painted Desert</td>
<td>Water</td>
<td>7732-18-5</td>
<td>75-85%</td>
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</tr>
<tr>
<td><em>empty</em></td>
<td>Lithium silicate</td>
<td>12627-14-4</td>
<td>10-15%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Titanium dioxide</td>
<td>13463-67-7</td>
<td>5-10%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ferric oxide yellow</td>
<td>51274-00-1</td>
<td>1-5%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Iron Oxide Red</td>
<td>1309-37-1</td>
<td>1-5%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Iron oxide</td>
<td>1317-61-9</td>
<td>1-5%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Potassium siliconate</td>
<td>31795-24-1</td>
<td>1-5%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ethylene glycol</td>
<td>107-21-1</td>
<td>1-3%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Silicon hydroxide</td>
<td>21645-51-2</td>
<td>&lt; 1%</td>
<td></td>
</tr>
</tbody>
</table>
CONTENT IN DESCENDING ORDER OF QUANTITY
Summary of product contents and results from screening individual chemical substances against HPD Priority Hazard Lists and the GreenScreen for Safer Chemicals®. The HPD does not assess whether using or handling this product will expose individuals to its chemical substances or any health risk. Refer to Section 2 for further details.

<table>
<thead>
<tr>
<th>MATERIAL</th>
<th>SUBSTANCE</th>
<th>RESIDUAL OR IMPURITY</th>
<th>GREENSCREEN SCORE</th>
<th>HAZARD TYPE</th>
</tr>
</thead>
<tbody>
<tr>
<td>TECTUM WALL &amp; CEILING PANELS</td>
<td>AMERICAN ASPEN</td>
<td>NoGS</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>MAGNESIUM OXIDE</td>
<td>LT-UNK</td>
<td>SODIUM SILICATE</td>
<td>LT-P1</td>
</tr>
<tr>
<td></td>
<td>MAGNESIUM SULFATE, ANHYDROUS</td>
<td>LT-UNK</td>
<td>CALCIUM CARBONATE</td>
<td>BM-3</td>
</tr>
<tr>
<td></td>
<td>QUARTZ</td>
<td>LT-1</td>
<td>CAN</td>
<td>TITANIUM DIOXIDE</td>
</tr>
</tbody>
</table>

INVENTORY AND SCREENING NOTES:
Residuals / impurities in select raw materials are quantitatively measured and are displayed in the HPD when greater than 1000ppm.
Questions?
Why does embodied carbon (eCO2e) matter?

1. Cannot reach WGBC “zero by 2050” goal without addressing eCO2e.
2. Embodied emissions are large, and immediate - timing is critical, cannot be offset.
3. As grid “de-carbonizes”, operational CO2e reduces.
4. High eCO2e insulation could yield more total CO2e than less insulation.

5. Carbon-storing materials can help reverse atmospheric CO2e load.


7. Plant-based materials can support carbon-smart economies.
We know we can get to net zero.....
Carbon Databases
- eCO2e values for various materials
- not normalized to common units
- not directly comparable between different materials.
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Environmental Product Declaration (EPD)
- document providing independently-verified, transparent data
- info about multiple life-cycle environmental impact of products
- units and methodologies may vary widely!
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Environmental Product Declaration (EPD)
- document providing independently-verified, transparent data
- info about multiple life-cycle environmental impact of products
- units and methodologies may vary widely!

Whole Building Life Cycle Analysis (WBLCA)
- technique that identifies, quantifies and evaluates the environmental impacts (inputs and outputs) of a building from cradle to grave/cradle
- comprehensive, thorough, comparable
Example: Expanded PolyStyrene (EPS)

Source: industry EPD
Example: Expanded PolyStyrene (EPS)

Source: industry EPD
Figure 7: Normalized Results for EPS Insulation
Materials and Methods [15-20 min]
Health + Carbon: Material “Sweet Spot”

- Non-Formaldehyde Mineral Insulation
- MgO Cement Board
- PET, LDPE/HDPE, PE
- Cotton/Wool

- Cellulose Insulation
- FSC Wood w/Non-Toxic Finishes
- Lime/Clay Paints
- Ag Fiber Insulations

- Fly Ash in Concrete, Boral Wood
- Cork with High-VOC Finishes
- HFO-Based ccSPF
**Structure**

<table>
<thead>
<tr>
<th>Material Type</th>
<th>Baseline</th>
<th>Better</th>
<th>Best</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard Portland Cement, virgin steel</td>
<td>Fly-ash concrete, recycled steel</td>
<td>CO₂-cured concrete/reduction strategies, wood*</td>
<td></td>
</tr>
<tr>
<td><strong>Impact</strong></td>
<td>High eCO₂e, toxic treatments (CR6 or PFOAs), emissions (i.e. mercury)</td>
<td>Lower eCO₂e, toxins in fly ash and treatments</td>
<td>Lowest carbon/carbon storing, non/low toxic**</td>
</tr>
</tbody>
</table>

*FSC or comparable management practices must be applied. Use reclaimed wood where feasible.

**Avoid Phenol formaldehyde in adhesives used for laminated timbers, MDF; toxins in wood treatments*
## Insulation - Rigid

<table>
<thead>
<tr>
<th>Material Type</th>
<th>Baseline</th>
<th>Better</th>
<th>Best</th>
</tr>
</thead>
<tbody>
<tr>
<td>XPS</td>
<td></td>
<td>Mineral Board Polyisocyanurate (PIR)</td>
<td>Fiber Board Hempcrete++</td>
</tr>
<tr>
<td>High eCO2e, Flame Retardants</td>
<td>Less toxic, high carbon PIR is lower carbon, moderately toxic</td>
<td>Lowest carbon/carbon storing, non/low toxic**</td>
<td></td>
</tr>
</tbody>
</table>

++ While not a rigid board, a rigid insulation once it cures

**Avoid Phenol formaldehyde in adhesives used for the fiber board products
CARBON IMPACTS OF INSULATION

CO₂ per 4’x8’ wall panel at R-28 1040.60 lb CO₂ emitted
HIGH DENSITY SPRAY FOAM
MED. DENSITY SPRAY FOAM
EXTRUDED POLYSTYRENE (XPS)
EXPANDED POLYSTYRENE (EPS)
MINERAL WOOL BATT
FIBERGLASS BATT
DENIM BATT
WOOL
DENSE PACK CELLULOSE
CORK
HEMPCRETE
STRAW BALE

EMISSIONS INFLUENCED LARGELY BY SOURCE ENERGY TYPE

INGREDIENTS VARY

1. MATERIAL EXTRACTION
2. MANUFACTURING
3. TRANSIT
4. USE
5. END OF LIFE

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Example: Carpet Tile (Interface)

Total Life Cycle Global Warming Potential of a Carpet Tile (%)

- Raw materials: 68%
- Yarn: 45%
- Backing Compound: 11%
- Glasfleece and Tufting Carrier: 6%
- Precoat Bonding Layer: 4%
- Packing: 1%
- Raw Material Transport: 1%
- Production: 9%
- Transport: 8%
- Customer use: 8%
- End of life: 7%

Image Source: thinkstep assessment of Interface via GaBI software
Elimination or reduction of raw materials leads to more optimal solutions....

<table>
<thead>
<tr>
<th>New products</th>
<th>Microtuft reduction of yarn by</th>
<th>Biosfera amount of recycled material</th>
<th>TacTiles reduction of liquid adhesives</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>50%</td>
<td>100%</td>
<td>100%</td>
</tr>
</tbody>
</table>

Where are these opportunities in ANY of the products you specify?

Image Source: thinkstep
Embodied CO2e Emissions by Flooring Type, kg CO2e per 100 m² flooring

- Engineered wood: Total eCO2e Emissions = 660, eCO2e Storage = 150, eCO2e Emissions = 510
- Cork plank/tile: Total eCO2e Emissions = 1300, eCO2e Storage = 230, eCO2e Emissions = 1070
- Carpet: Total eCO2e Emissions = 1300, eCO2e Storage = 1300, eCO2e Emissions = 0
- Vinyl tile flooring: Total eCO2e Emissions = 980, eCO2e Storage = 980, eCO2e Emissions = 0
- Softwood FSC: Total eCO2e Emissions = -1400, eCO2e Storage = -1400, eCO2e Emissions = 0
- Softwood: Total eCO2e Emissions = 140, eCO2e Storage = 140, eCO2e Emissions = 0
- Hardwood FSC: Total eCO2e Emissions = -800, eCO2e Storage = -800, eCO2e Emissions = 0
- Hardwood: Total eCO2e Emissions = 1200, eCO2e Storage = 1200, eCO2e Emissions = 0
Product Certifications: Example Gypsum Board

- 37+ Declare Labels
- 61 HPDs
- 200+ Emissions Tested
- 16 EPDs
Approach:

ASK: What do I need?

Material Health Assessed!
How will you do this? What criteria?

Embodied Carbon Considered!
Find companies that have completed EPD’s, or done some level of LCA.

AT THE VERY LEAST
Recyclable? Reusable? End of life?
Questions?
Strategies and Practices [25’ min]

Group Think!

Address how we can get to healthier materials and better carbon outcomes via:

- Process/Project organization
- Design strategies
- Tools/metrics
- Other?
Project Organization

- Engage the whole team - importance of IPD and/or stakeholder buy-in
- **Goal setting and evaluation** during conceptual/schematic design
- Partner with vendors and manufacturers and OTHER projects in order to achieve economies of scale for preferential products.
- Make project material goals public: commitment to exceed 2030; Commitment to AIA’s 2050 Materials Pledge, Paris agreement.....
- Establish the metrics (see below) and framework for tracking progress
Design

- Ask: **Do I need it?** If so, how can it adapt over time to serve multiple functions?
- **Design to deconstruct!**
- **Simplify palette;** Architecture 2030 Carbon Smart Materials Pallet
- What are your **goalposts** (see previous)?
- Pick a **CSI section** and begin there!
- **Residential vs. non-residential** projects and approaches
- **Collaboration/organizations** that pull projects together
Metrics

- Look at whole buildings to identify “hot spots”, or look at comparative analysis to make specific choices.
- Don’t get stuck on absolute values of carbon, look for patterns within margins of error (i.e. build with plants whenever possible).
- Look at whole embodied carbon: emissions, storage, recycled materials, offset impacts.
Tools: Carbon

Autodesk “Tally”, One Click: Powerful WBLCA tools

Athena Impact Estimator: Free WBLCA tool

Bath Inventory of Carbon and Energy (ICE): + tried and true/ - new version coming Q1 ‘19

Building for Environmental and Economic Sustainability (BEES): + North American data

EPDs: + data sheet featuring verified life cycle data, including GWP / - units and methodologies will vary, use with caution especially in comparative analysis!
Tools: Health

Declare - Future labels to include eCO2e!

Living Product Challenge - “Handprinting” Full LCA + social justice component.

HPD - All Materials considered + Third Party verified + 100 PPM is best!

C2C Certified Product Standard 3.1 - with Material Health Score Gold/Platinum. IF Platinum for Renewable Energy / CO2 Mgmt, some benefits for carbon!

Visit MindfulMaterials for all of these.....
Commit Yourself to be part of the solution

THE 2030 CHALLENGE FOR PRODUCTS

35% TODAY
40% 2020
45% 2025
50% 2030
75% 2040
ZERO EMBODIED CARBON 2050

REDUCTION
EMBODIED CARBON EMISSIONS

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Parting thoughts…..

Transparency IS here to stay. Educate yourself, and start with the products that are most prevalent in your building.

Energy is not a proxy for carbon, and carbon is what matters to the climate! We can’t get there by reducing energy alone! Set carbon goals and a process for design and evaluation to meet these goals.

We need better metrics and data for assessing both ingredients and carbon! Advocate to manufactures that we need this info.

We can’t afford to do nothing!
Let’s Talk Again.....

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