

**Maryland Commission on
Climate Change
Buildings Work Group**

8/24/21

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The carbon balance of the built environment

Buildings, Site Design, Land Use





About myself

Architect and Urban designer

- Founding Member of the 1000 Friends of MD
- Former Member of the MD Growth Commission Subcommittee on Planning Techniques
- Founder of ArchPlan Inc. and architecture and planning firm at the intersection of building and city
- Specialty work in community revitalization, brownfield reuse, preservation, and public transportation

Topics of today's discussion:

- Carbon in buildings: Embodied and operational carbon
- Carbon balance of site design
- Carbon balance of land use on the regional level



Rating systems galore

LEED certifications

Net Zero/ Net Positive buildings – Zero Energy Buildings,

Passive House

BREEAM (the Building Research Establishment Environmental Assessment Method)

Green Building Initiative

The WELL Building Standard

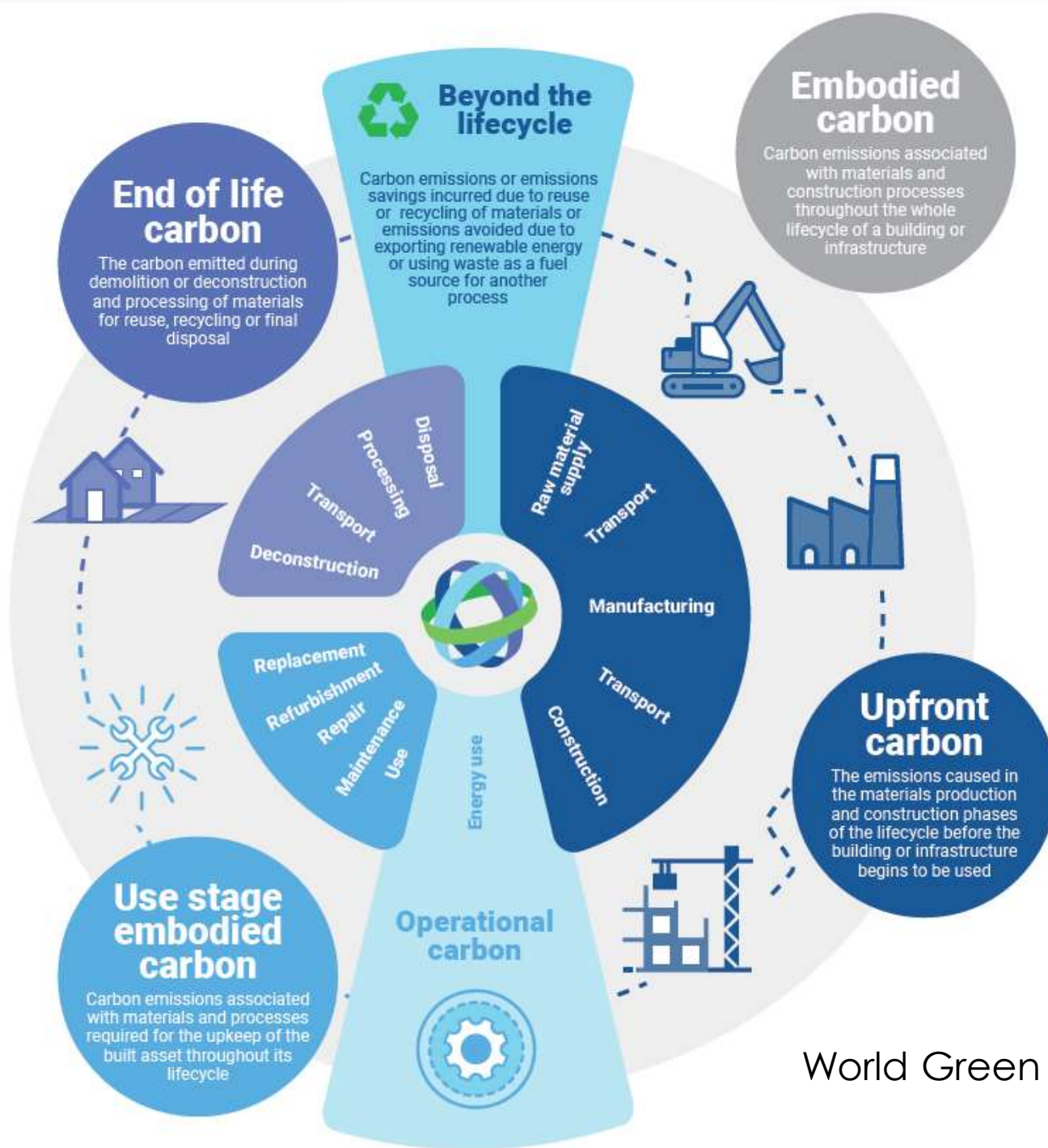
Living Building Challenge

Total Carbon Footprint of Buildings

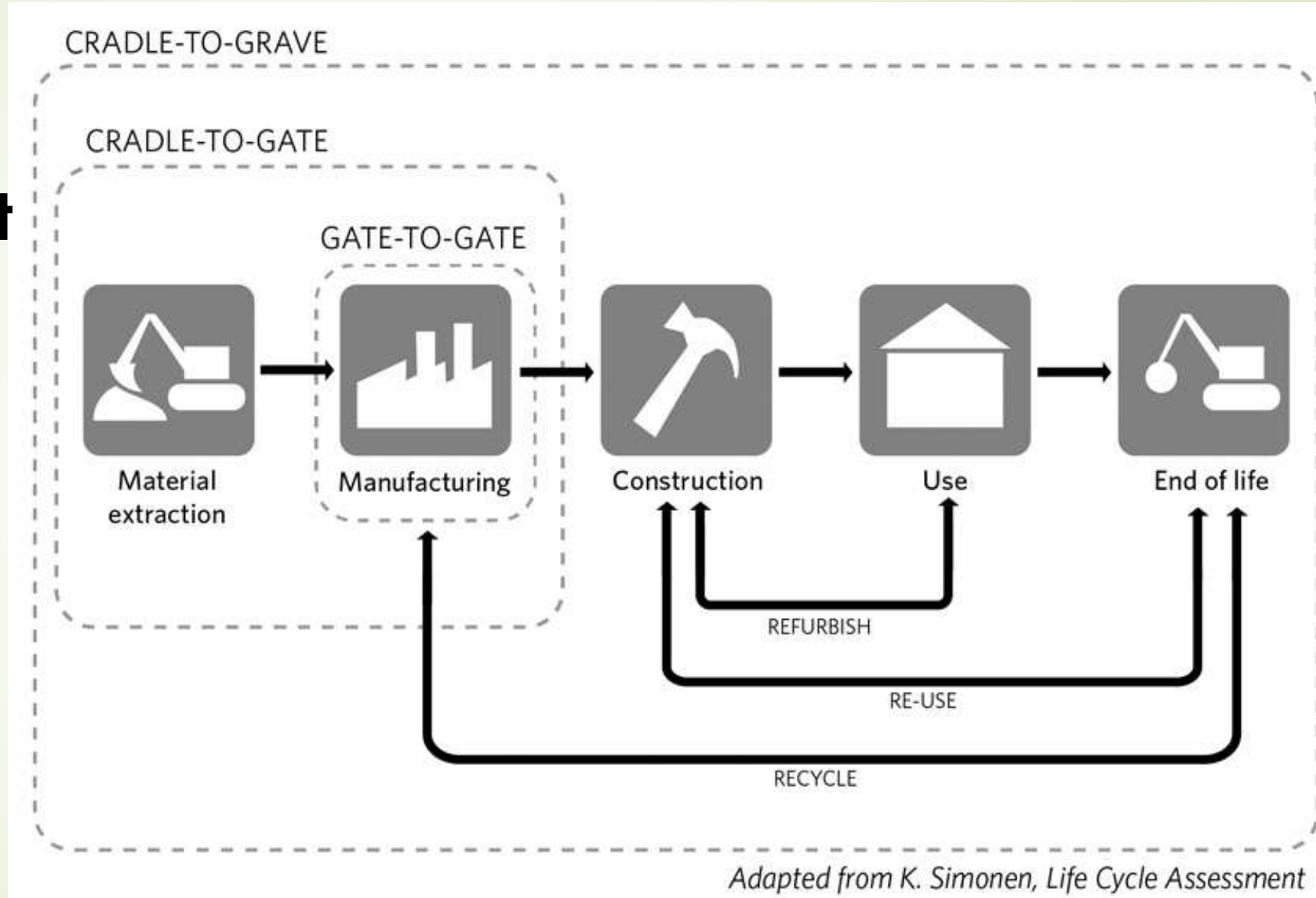
Building floor space has expanded 65% since 2000, while energy use per m2 has improved by only 25%



Buildings contribute around 40 percent of greenhouse gas (GHG) emissions worldwide



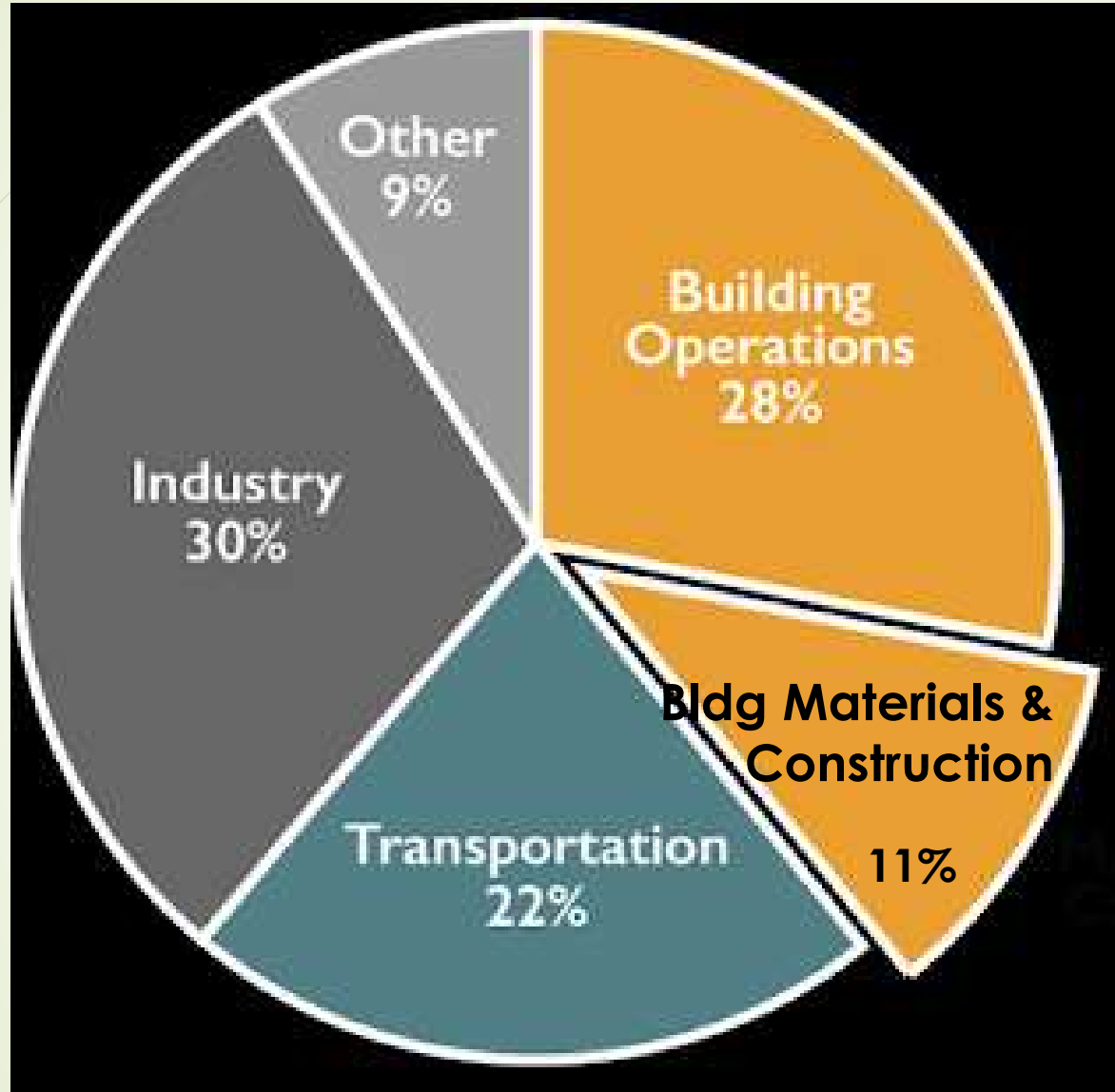
Life Cycle Assessment LCA



Adapted from K. Simonen, Life Cycle Assessment

Embodied Carbon

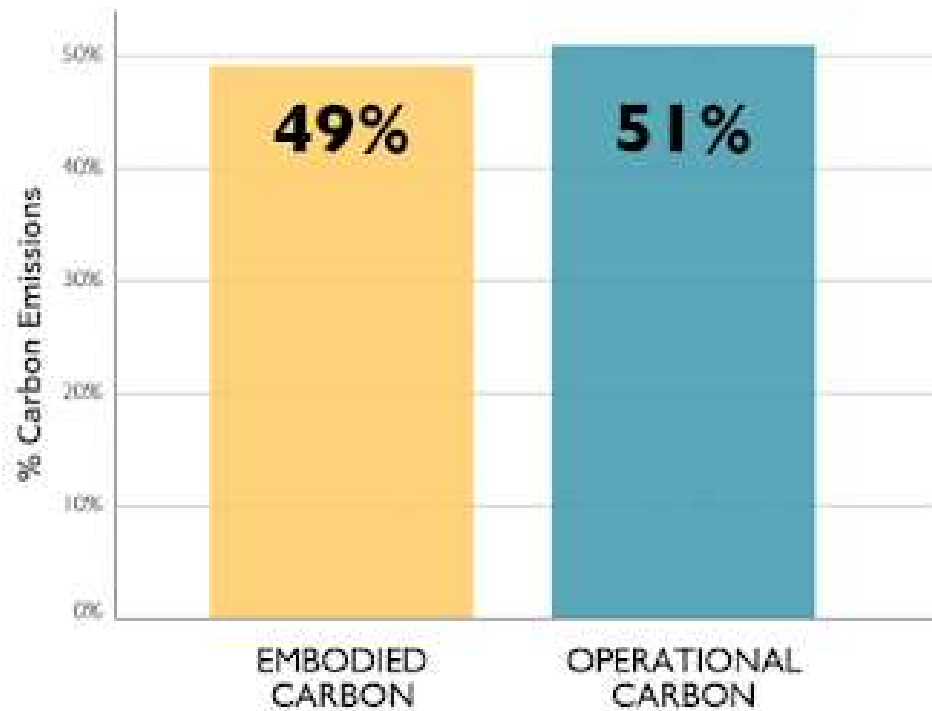




By 2060, the world is projected to add 230 billion m² (2.5 trillion ft²) of buildings, or an area equal to the entire current global building stock*.

This is the equivalent of adding an entire New York City to the planet every 34 days for the next 40 years.

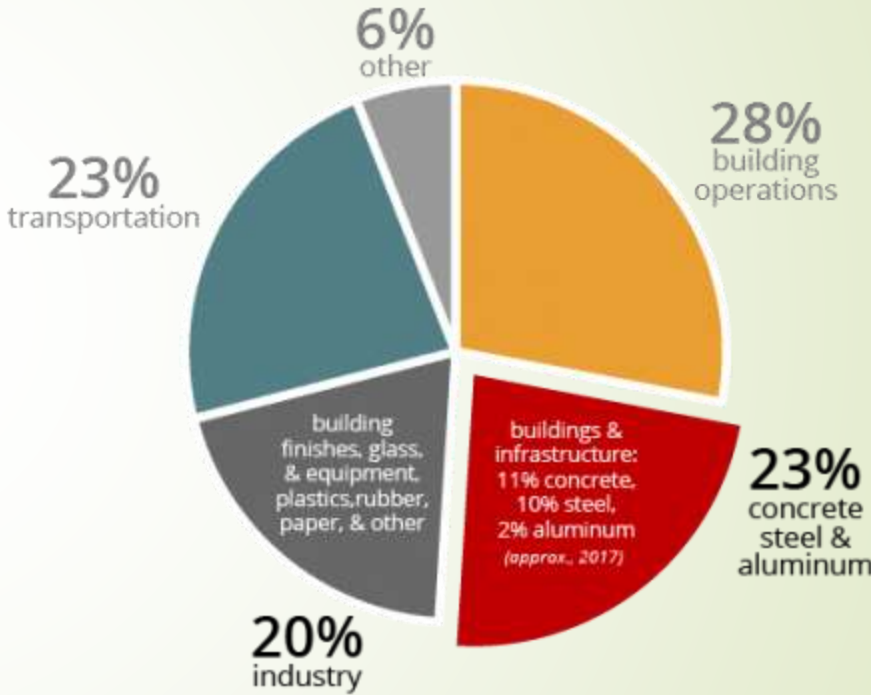
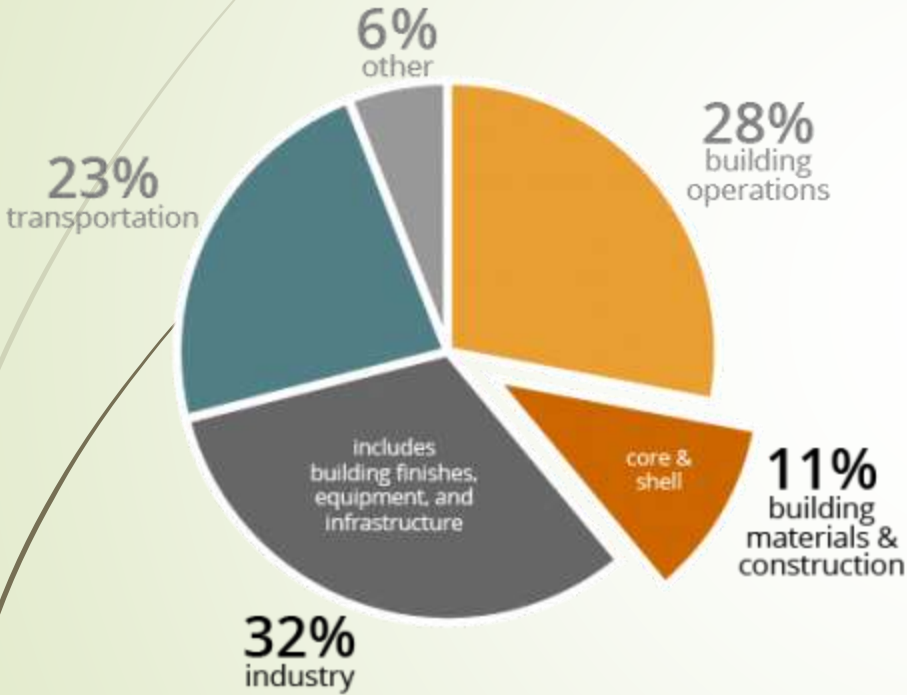
Total Carbon Emissions of Global New Construction from 2020-2050 Business as Usual Projection



© 2018 2030, Inc. / Architecture 2030. All Rights Reserved. Data Sources: UN Environment Global Status Report 2017; IEA International Energy Outlook 2017

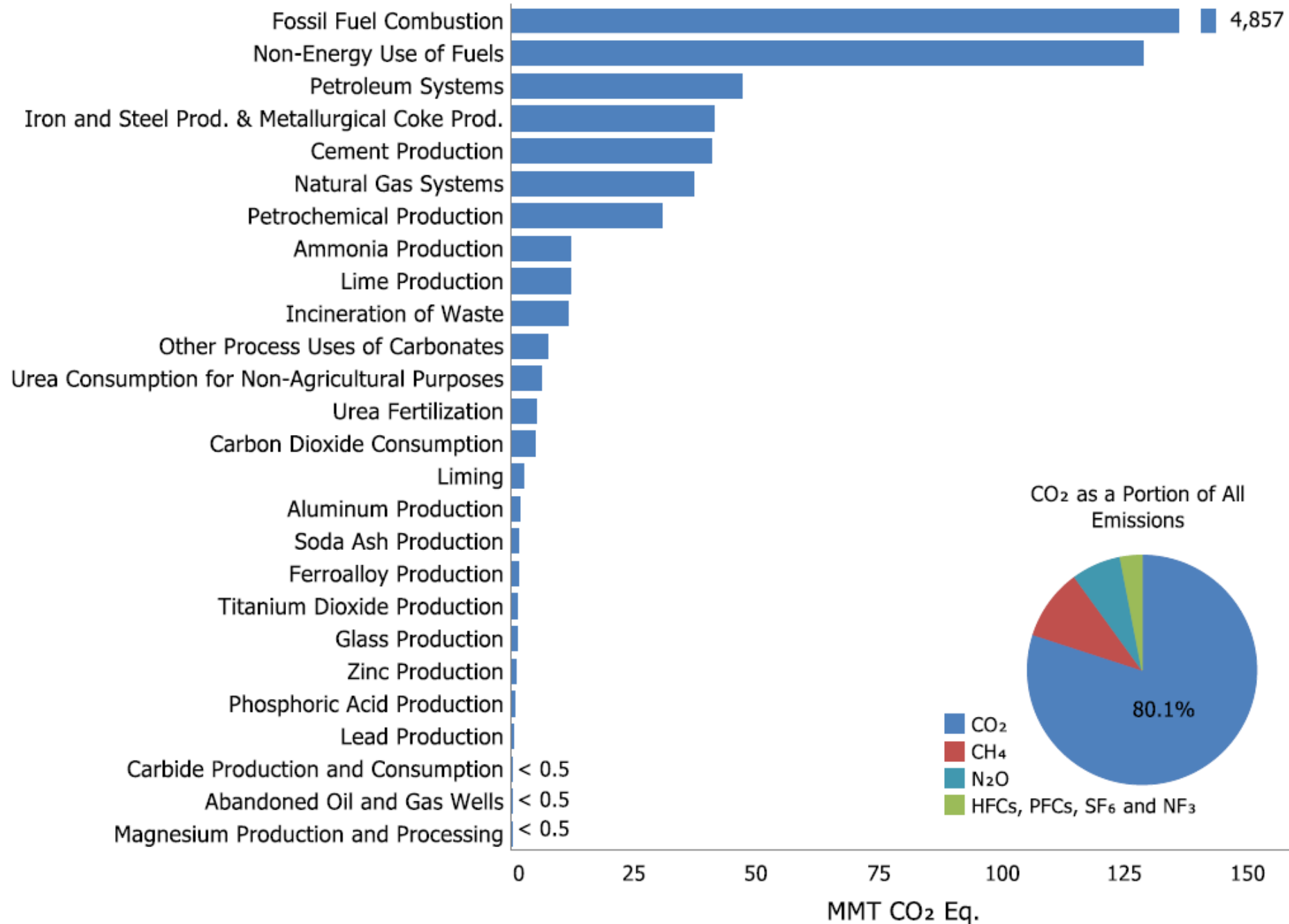
Embodied carbon consists of all the GHG emissions associated with building construction, including those that arise from extracting, transporting, manufacturing, and installing building materials on site, as well as the operational and end-of-life emissions associated with those materials. “Cradle to gate” embodied carbon refers to the emissions associated with only the production of building materials, from raw material extraction to the manufacturing of finished products; it can be thought of as supply-chain carbon, and it accounts for the vast majority of a building’s total embodied carbon.

GLOBAL CO₂ EMISSIONS BY SECTOR

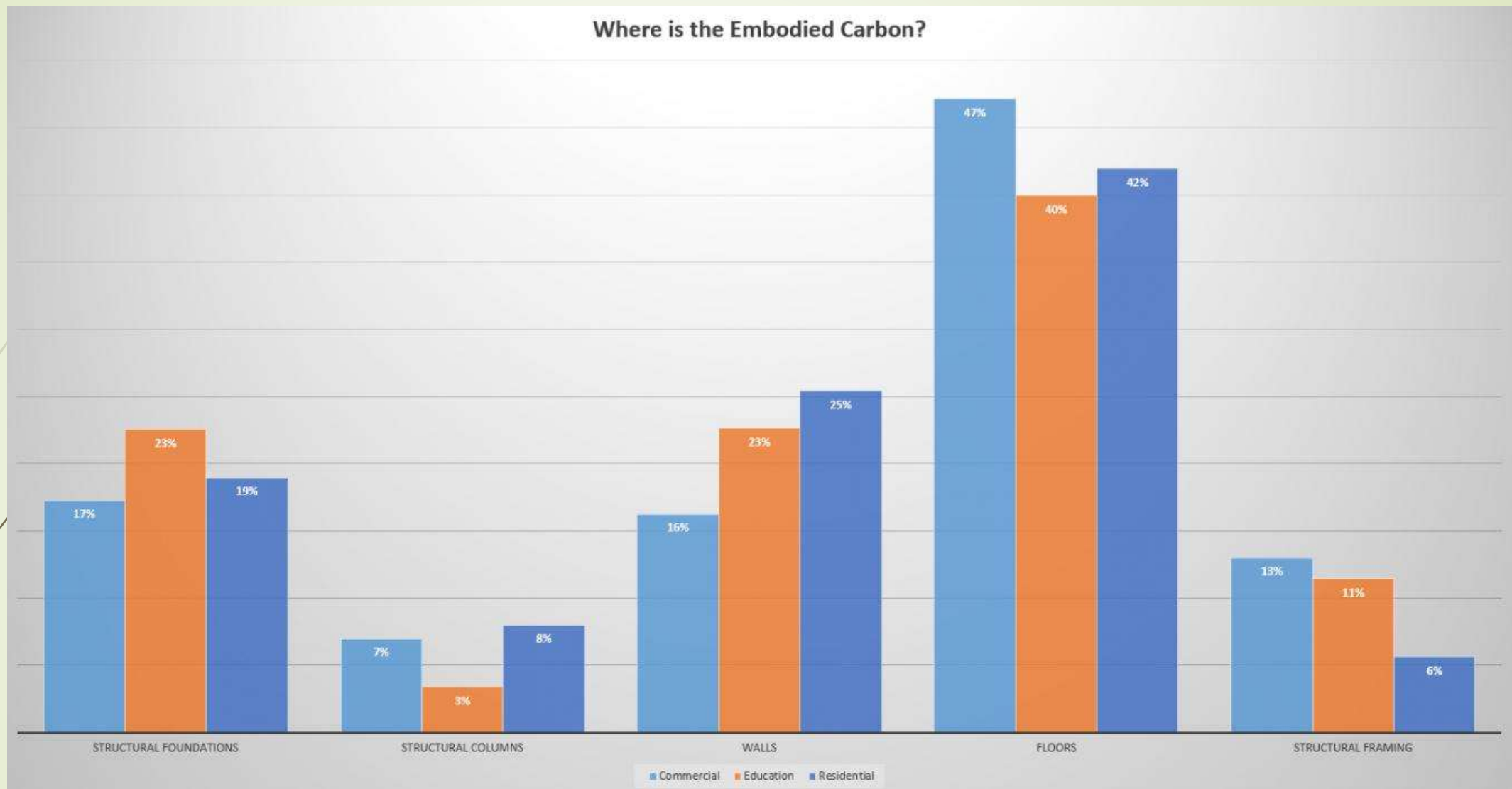


Data Sources: Global Alliance for Buildings and Construction, 2018 Global Status Report; IEA.


Figure ES-5: 2019 Sources of CO₂ Emissions



Where is the Embodied Carbon?



<https://www.thorntontomasetti.com/news/embodied-carbon-measurement-study>

- 
- **Steel has a bigger footprint than concrete**
 - **Both are much higher than engineered wood**
 - **The lowest footprint is the reuse of old buildings**

Embodied Carbon

Carbon Leadership Forum

<https://carbonleadershipforum.org/>

AIA Materials Palette: <https://materialspalette.org/>

Better Buildings.

<https://betterbuildingsolutioncenter.energy.gov/special-initiatives/waste-reduction-pilot>

EC3: Embodied Carbon Calculator

<https://www.buildingtransparency.org/>



Lessons and potential Policies

- Require manufacturers to take their products back after lifecycle use
- Require manufacturers to produce carbon emission reports and tax them accordingly
- Require minimum recycled content in many construction products
- Tax carbon
- Charge more for waste
- Provide incentives for low carbon products or carbon neutral products
- Require public projects to meet low carbon standards with the goal to be carbon neutral by the State provided deadlines
- Require deconstruction for all building demolitions

Site Design





Site Design

PREREQUISITES

- Smart Location
- Water body conservation
- Imperiled Species
- Wetland protection
- Ag. Land conservation
- Floodplain avoidance
- Connected community
- Compact community
- Walkable streets

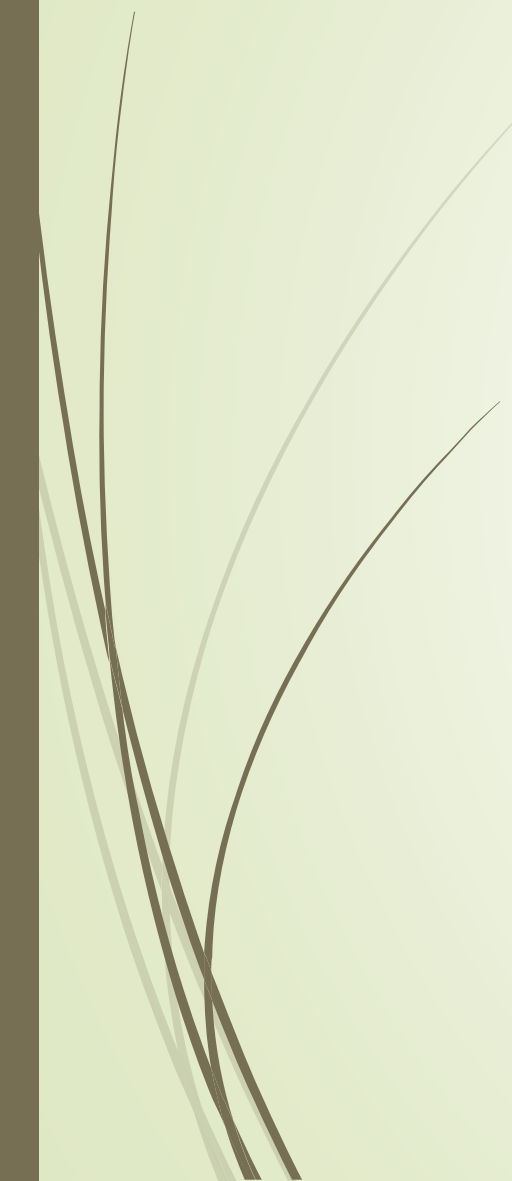
MAJOR CREDITS

- **Solar Orientation**
- **Renewable Energy Production**
- Rainwater Management
- Outdoor water use reduction
- **Minimized site disturbance**
- Heat Island Reduction
- **Building Reuse, Preservation**
- Infill Redevelopment
- Transit
- **Recycled Infrastructure**
- Water-Efficient Landscaping
- **Compact Development** (>38 DUs/acre)
- **Reduced Parking Footprint**
- Transportation Demand Management
- Bicycle Network and Storage
- Light Pollution reduction

<https://www.usgbc.org/guide/nd>

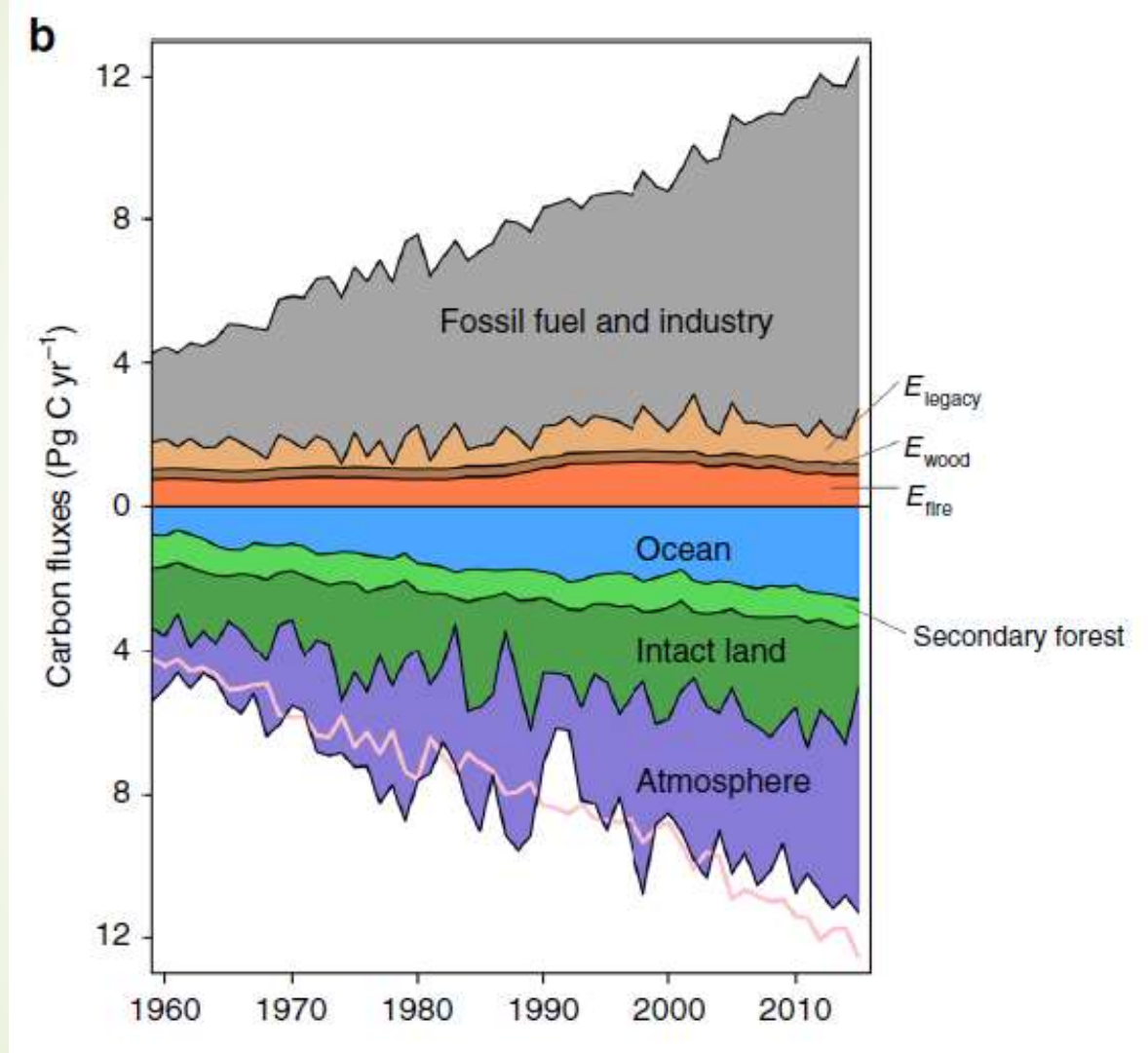


Site: Lessons and potential Policies

- Require a site design that is carbon neutral relative to the site before development (for greenfield development only)
 - On large commercial projects (warehouses and the like) require solar roof installations as a mitigation strategy and as part of a potential carbon trading system
 - Require zero impact urban heat island strategies
 - As on buildings, a already developed site performs better under the carbon needed for construction than a site that needs to be fully constructed
- 

Land Use





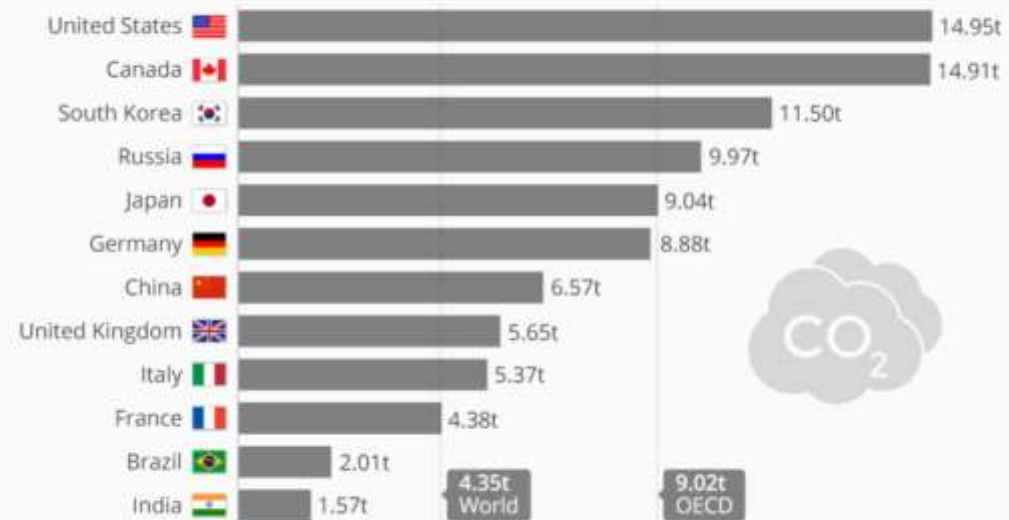
<https://www.nature.com/articles/s41467-020-16953-8>

Land Use

- ▶ Human use directly affects more than 70% of the global, ice-free land surface. Land plays an important role in the climate system.
- ▶ Since the pre-industrial period, the land surface air temperature has risen nearly twice as much as the global average temperature (Intergovernmental Panel on Climate Change)
- ▶ US loss of forest and farmland for development is significant: **Between 1982 and 2001, approximately 34 million acres of open space (an area the size of Illinois) were lost to development – approximately 4 acres per minute or 6,000 acres a day and 26 million acres more are projected to be developed by 2030. (US Forest Service)**

The Global Disparity in Carbon Footprints

Per capita CO₂ emissions in the world's largest economies in 2016* (in metric tons)



Land Use

The share of managed land in the U.S. is approximately 95 percent of total land included in the Inventory.

The LULUCF sector in 2019 resulted in a net CO₂ removal of 812.7 MMT CO₂Eq.

This represents an offset of 12.3 percent of total (i.e., gross) greenhouse gas emissions in 2019.

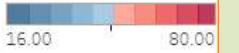
Emissions of CH₄ and N₂O from LULUCF activities in 2019 were 23.5 MMT CO₂Eq. and represent 0.4 percent of total greenhouse gas emissions.

Between 1990 and 2019, total C sequestration in the LULUCF sector decreased by 10.6 percent, primarily due to a decrease in *Remaining Cropland*, as well as an increase in CO₂ emissions from *Land Converted to Settlements*.

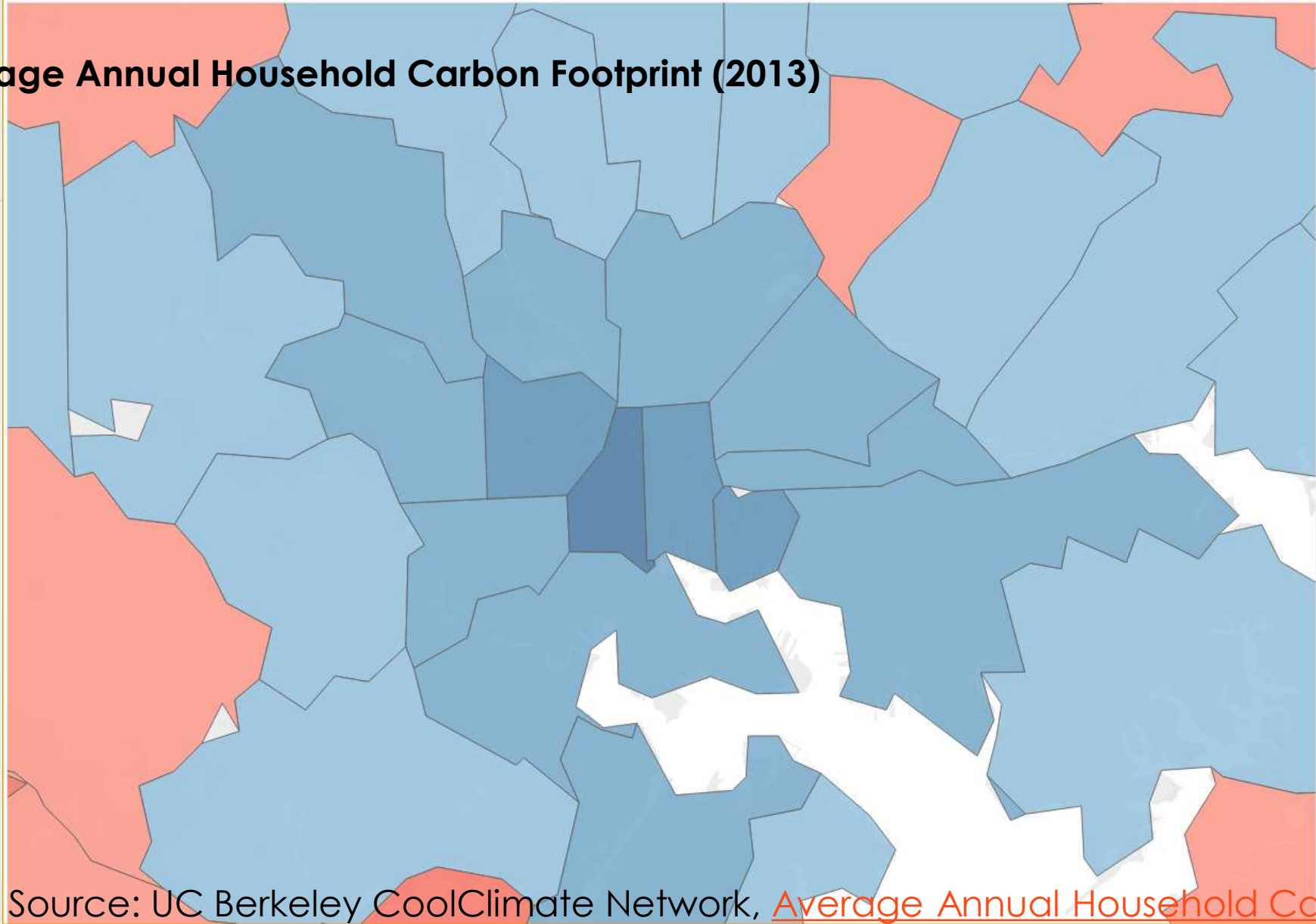
<https://www.epa.gov/sites/default/files/2019-04/documents/us-ghg-inventory-2019-chapter-6-land-use-land-use-change-and-forestry.pdf>

Average U.S. Household Carbon Footprint by Zip Code

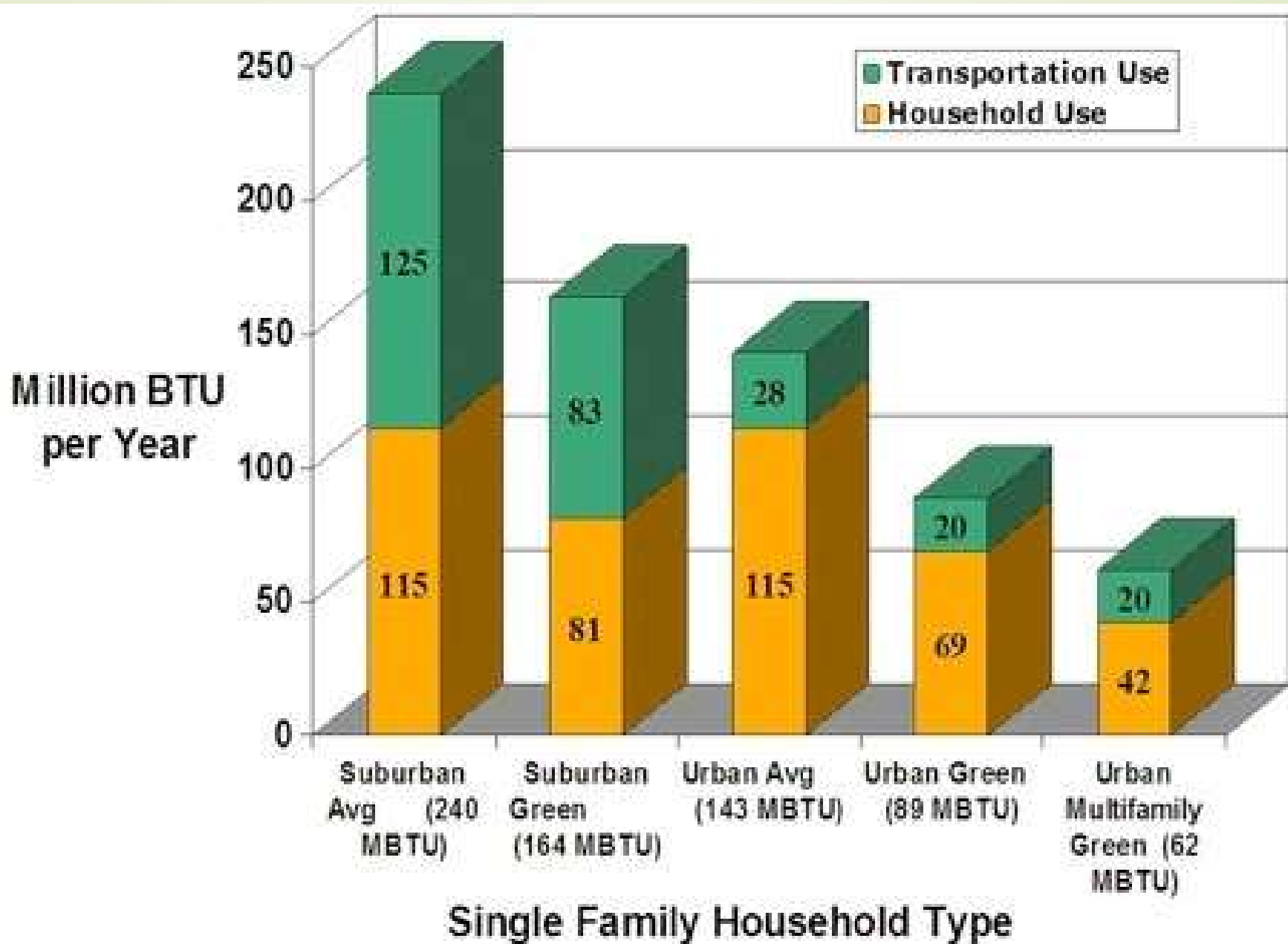
Total Household Carbon F...



Average Annual Household Carbon Footprint (2013)



Source: UC Berkeley CoolClimate Network, [Average Annual Household Carbon Footprint \(2013\)](https://coolclimate.org/maps) <https://coolclimate.org/maps>



Source: Jonathan Rose Companies, LLC for the EPA



Land Use: Lessons and potential Policies

- Promote density
- No net loss of open spaces (carbon capture lands)
- Include carbon balance consideration into the MD Sustainability Community palette
- Revision of the local tax rates based on carbon footprint of development
- **Binding commitment that emissions from land use are entirely compensated** by an equivalent accounted removal of CO₂ from the atmosphere



Resources and Tools



Land Use

EPA Carbon Stock Change:
<https://www.epa.gov/sites/default/files/2019-04/documents/us-ghg-inventory-2019-chapter-6-land-use-land-use-change-and-forestry.pdf>

Site Design

LEED Neighborhood Development <https://www.usgbc.org/guide/nd>
https://build.usgbc.org/l/413862/2019-01-17/nf5p2m/413862/152994/LEED_v4_ND.pdf
<http://urban-forests.com/wp-content/uploads/2020/05/Urban-Forests-report-The-Miyawaki-method-%E2%80%93-Data-concepts.pdf>

Embodied Carbon

Carbon Leadership Forum
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Resources and Tools



Embodied Carbon

EC3: Embodied Carbon Calculator

[https://www.buildingtransparency.org/
How LEED v4.1 addresses embodied carbon](https://www.buildingtransparency.org/How-LEED-v4.1-addresses-embodied-carbon)

AIA Materials Palette: <https://materialspalette.org/>

Better Buildings.

[https://betterbuildingsolutioncenter.energy.gov/spe
cial-initiatives/waste-reduction-pilot](https://betterbuildingsolutioncenter.energy.gov/special-initiatives/waste-reduction-pilot)

[Promoting Sustainable Design Through Life-Cycle Assessment
Applications](#)

Blogs

[https://archplanbaltimore.blogspot.com/2021/05/wh
at-does-it-take-to-make-sustainable.html](https://archplanbaltimore.blogspot.com/2021/05/what-does-it-take-to-make-sustainable.html)

[https://archplanbaltimore.blogspot.com/2021/06/bui
ldings-with-less-embodied-carbon.html](https://archplanbaltimore.blogspot.com/2021/06/buildings-with-less-embodied-carbon.html)



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