

# Northeast Regional Biomaterials Summit

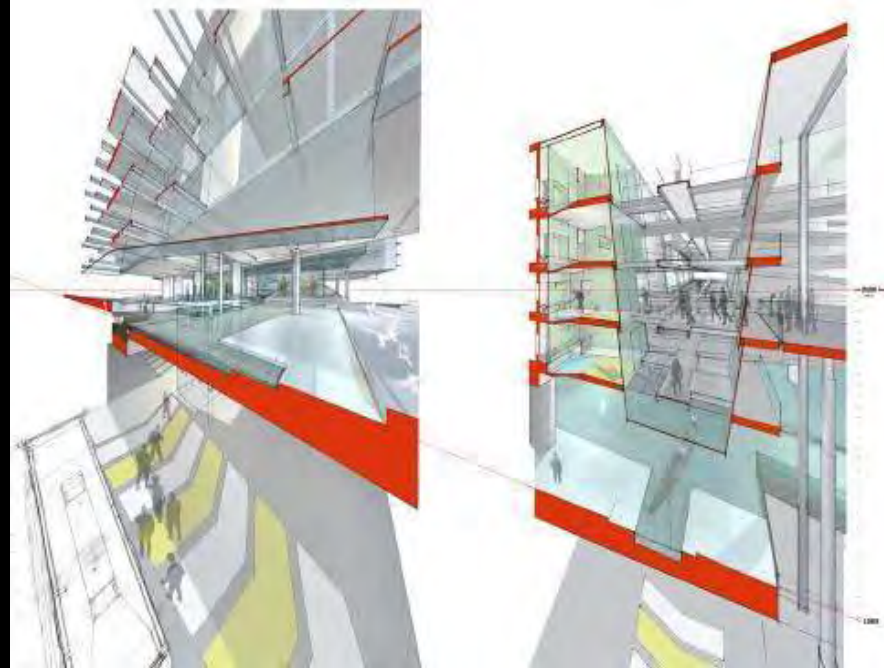
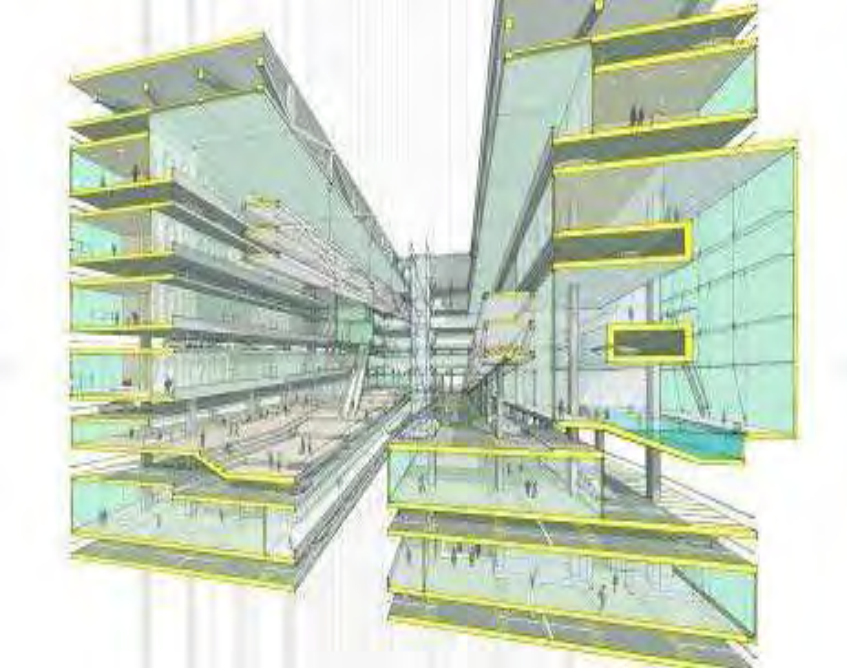
**David J. Lewis**

Principal, LTL Architects, New York, NY

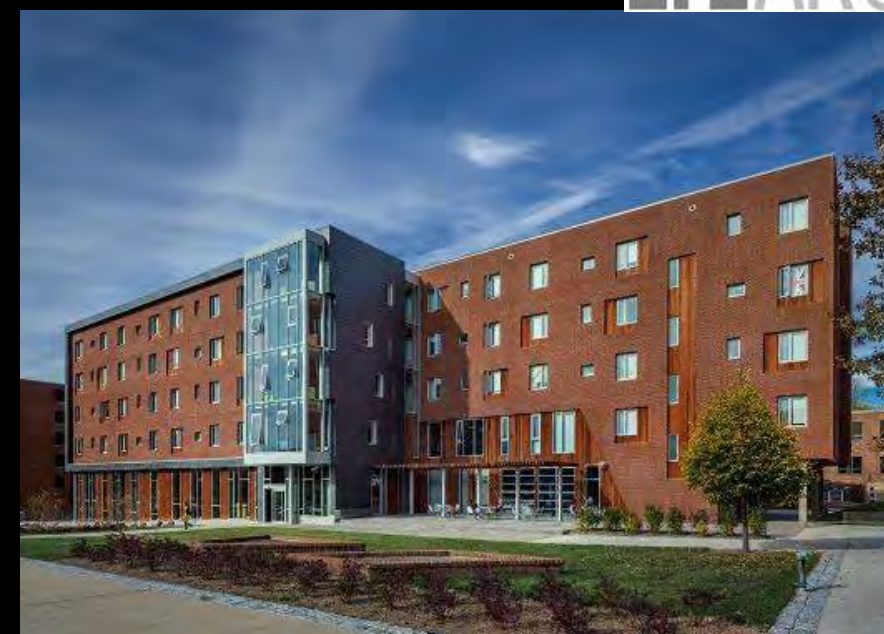
Professor and Dean Parsons School of Constructed Environments

November 15, 2023

**LTL**ARCHITECTS



LTLARCHITECTS



**Mission:** Encompassing a unique confluence of disciplines, Parsons' School of Constructed Environments nurtures tomorrow's practitioners and guides them in designing **socially just, environmentally regenerative, and innovative cities, buildings, interiors, lighting, and products.** We foster the skills, values, and vision vital to creating more integrated, equitable, and delightful worlds.

---

## Parsons School of Constructed Environments: **926** Students

### **SCE**

#### **Architecture**

BFA  
Architectural  
Design

Master of  
Architecture

#### **Lighting Design**

MFA Lighting  
Design

#### **Interior Design**

BFA Interior  
Design

AAS Interior  
Design

MFA Interior  
Design

#### **Product + Industrial Design**

BFA Product  
Design

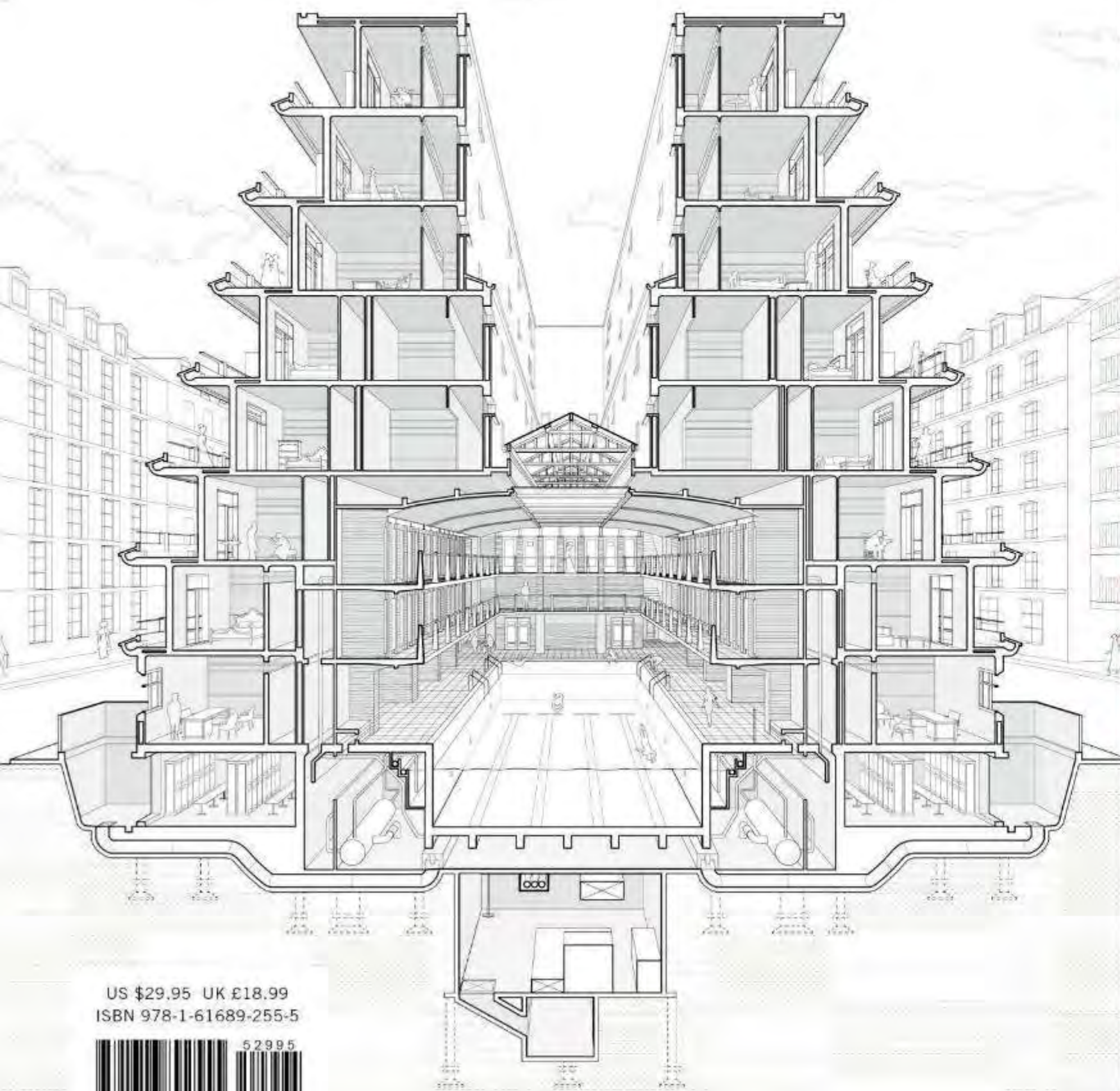
MFA Industrial  
Design

Master of  
Architecture  
+  
MFA Lighting  
Design

MFA Interior  
Design  
+  
MFA Lighting  
Design

An essential history, guide, and reference to section in architecture — the first comprehensive analysis of what it is and what it does.

Princeton Architectural Press  
www.papress.com



US \$29.95 UK £18.99  
ISBN 978-1-61689-255-5



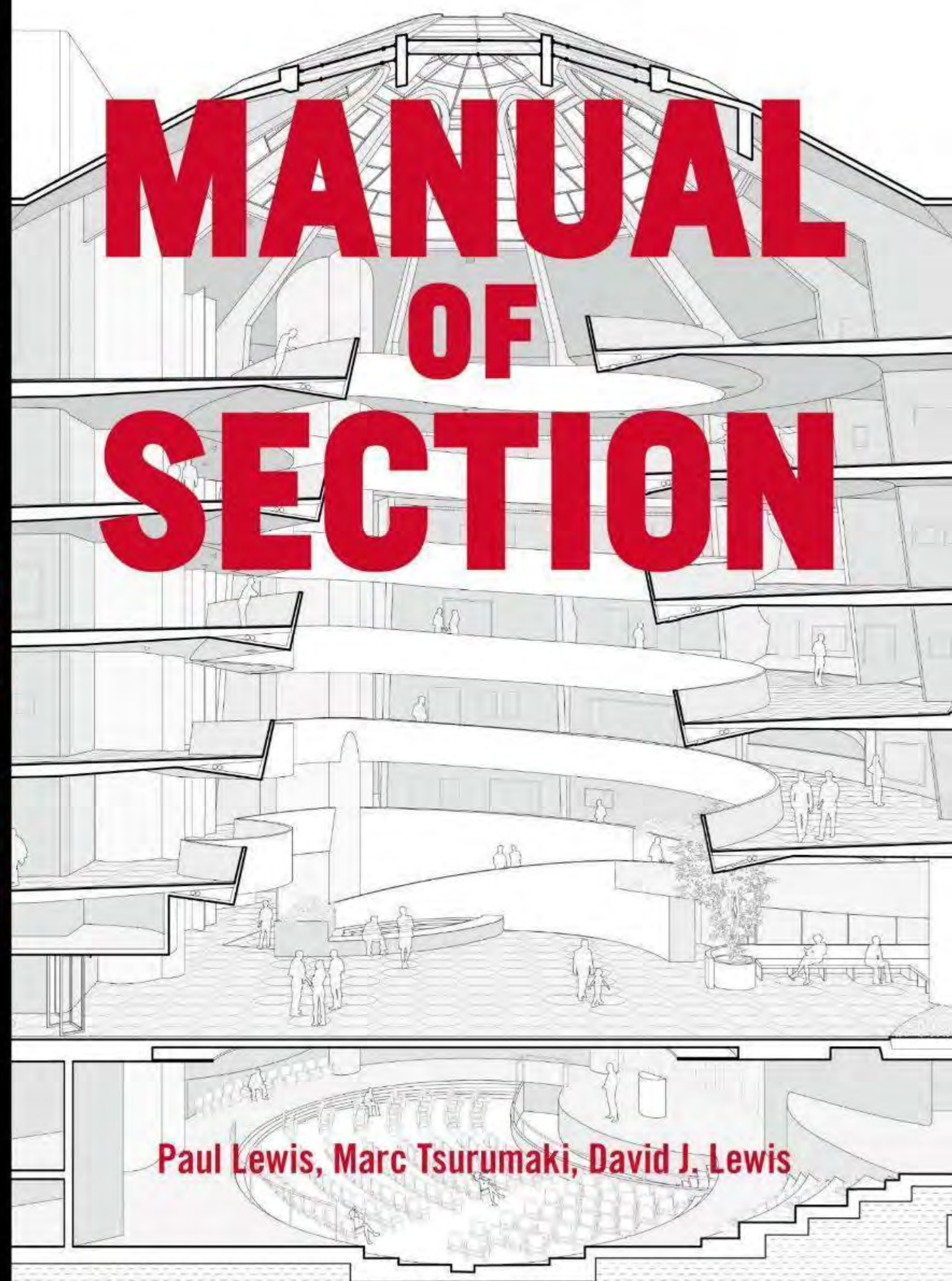
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Lewis, Tsurumaki, Lewis

MANUAL OF SECTION



# MANUAL OF SECTION



Paul Lewis, Marc Tsurumaki, David J. Lewis

The direct extrusion of a plan to a height  
sufficient for the intended use

# EXTRUSION 42

The layering of floors directly on top of one another; an extruded  
section, repeated with or without variations

# STACK 50

The deformation of one or more of the primary horizontal  
surfaces of a building to sculpt space

# SHAPE 64

The use of a rift or cut along either the horizontal or vertical axis  
of a building to generate sectional difference

# SHEAR 84

The deployment of any number or scale of penetrations through  
a slab, exchanging lost floor area for benefits in section

# HOLE 100

The manipulation of the angle of an occupiable horizontal  
plane, which tilts the plan into section

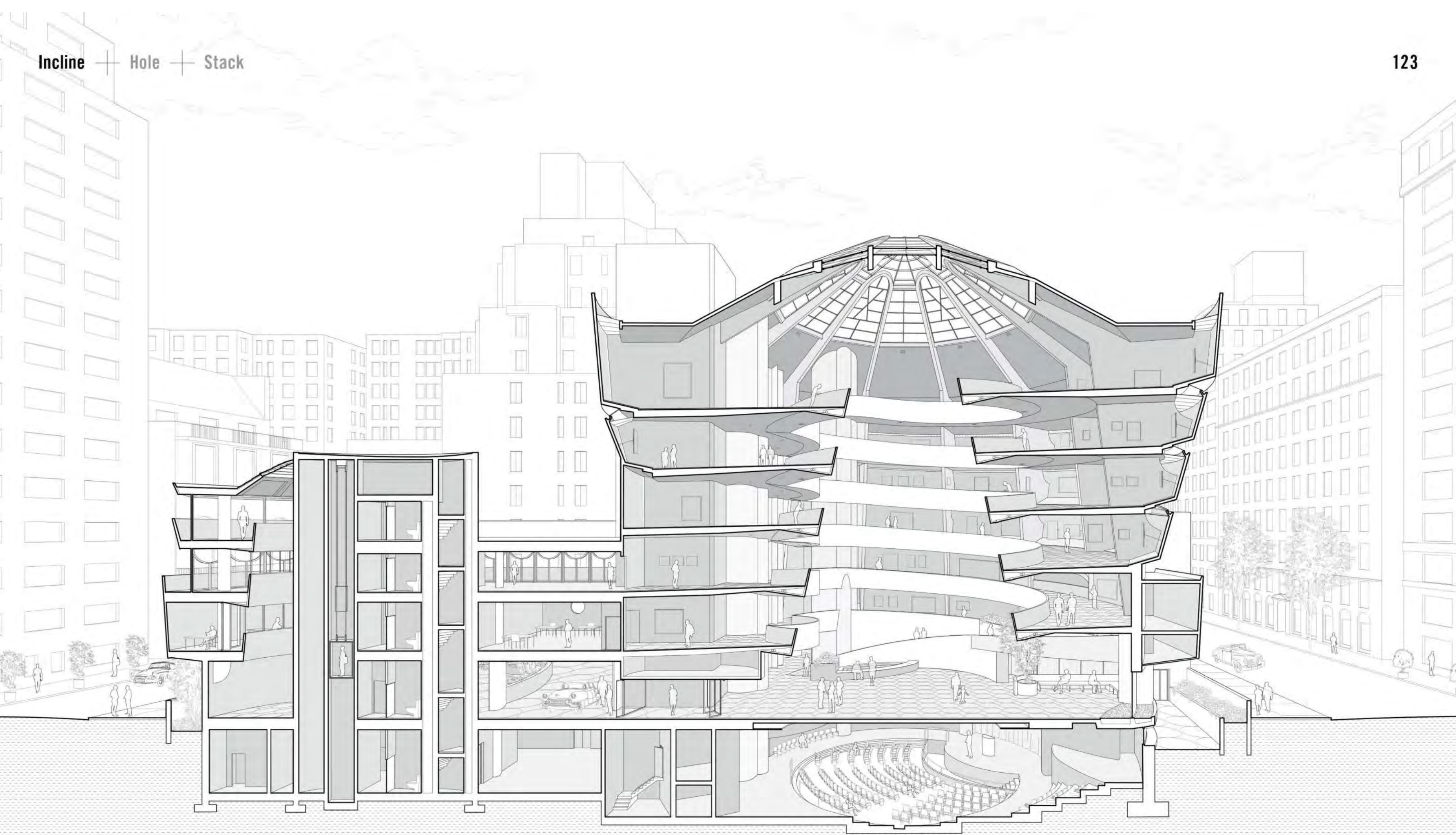
# INCLINE 116

The creation of sectional consequences through  
an interplay or overlap of legible volumes

# NEST 130

Any combination of Stack, Extrusion, Shape, Shear, Hole, Incline,  
and Nest; buildings rarely exhibit section types in isolation

# HYBRIDS 154



## The Solomon R. Guggenheim Museum | New York, New York, USA

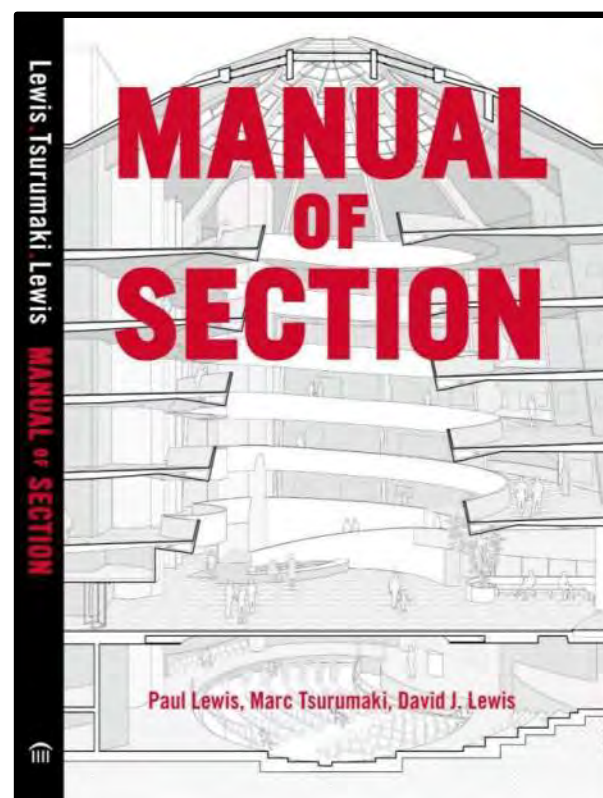
Frank Lloyd Wright | 1959

The main gallery of the Guggenheim Museum is an exemplary demonstration of an inclined section defining an entire building. Rising at a 3 percent grade and stretching more than 1/4 mi (0.4 km) in length, the continuous path expands in width as it moves upward, producing a conical void at the center of the museum

and an inverted conical form on the exterior. A skylight supported by concrete ribs fills the 92-ft-high (28 m) atrium with daylight, while the continuous perimeter skylight enabled by recessions in the exterior profile was intended to backlight paintings to make them appear to float. The tapered concrete balcony and integral soffit conceal

the air supply duct. The primary point of tension between the incline and level floor is at the bottom, where Wright folded the ramp up against itself to form a base. An exterior porte cochere separates the main gallery from the administrative wing. While the administrative wing echoes the circular form of the main gallery, the inclined

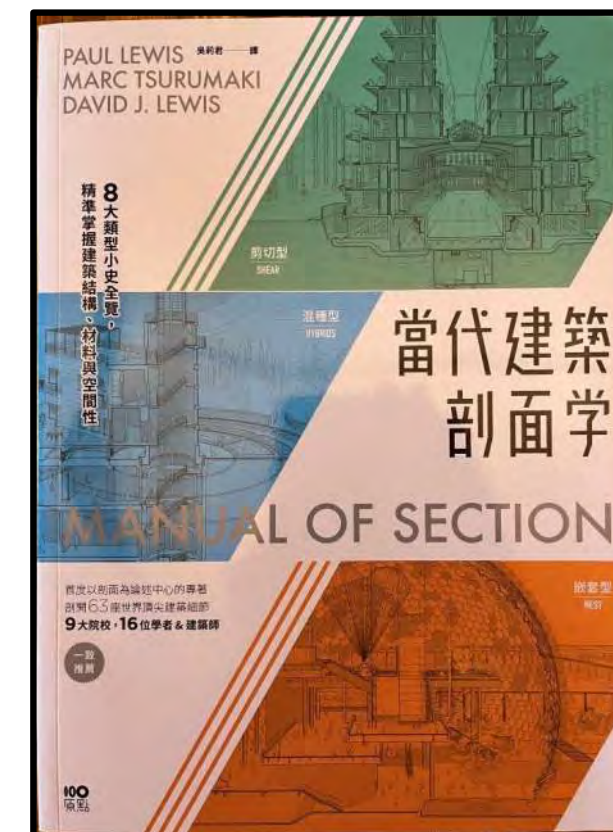
section is confined to the gallery, as connection among the flat administrative floors is made through a service core, with a small atrium providing limited visible continuity. In the main gallery, the inclined section's physical continuity is complemented by the visual connectivity of the large atrium.



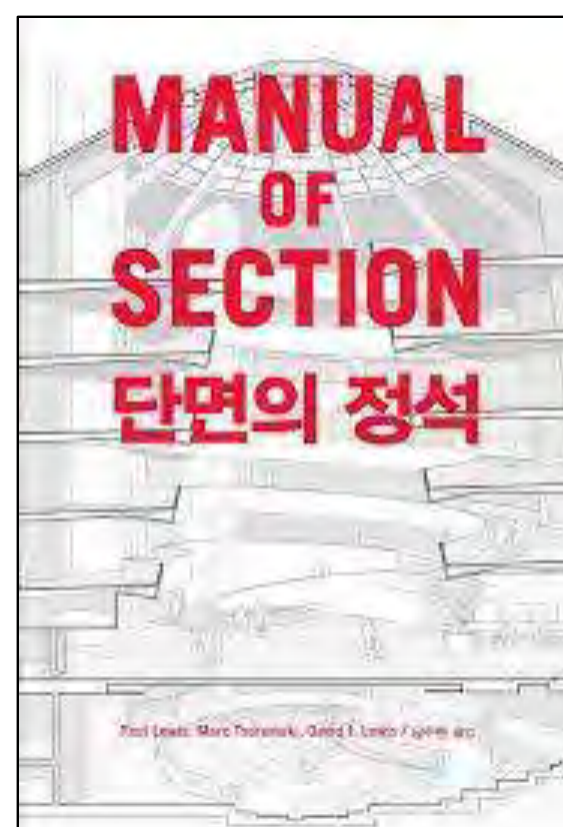
English



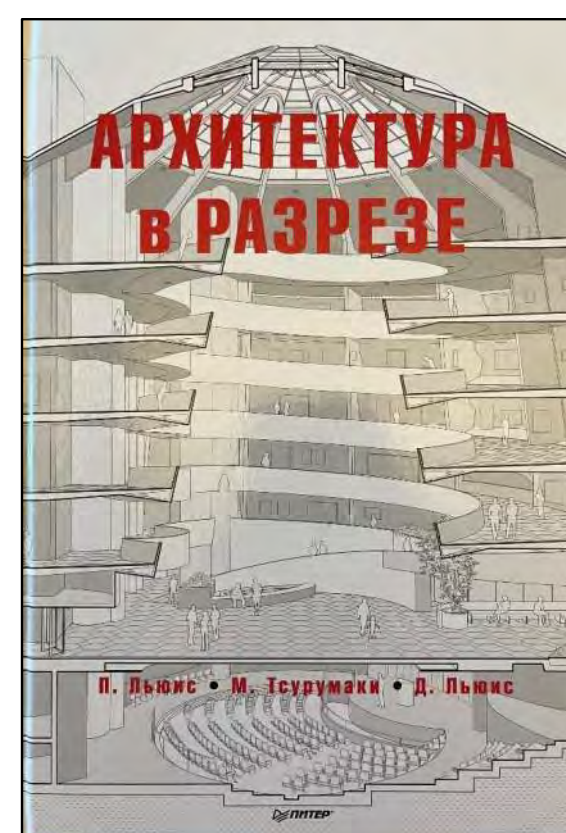
German



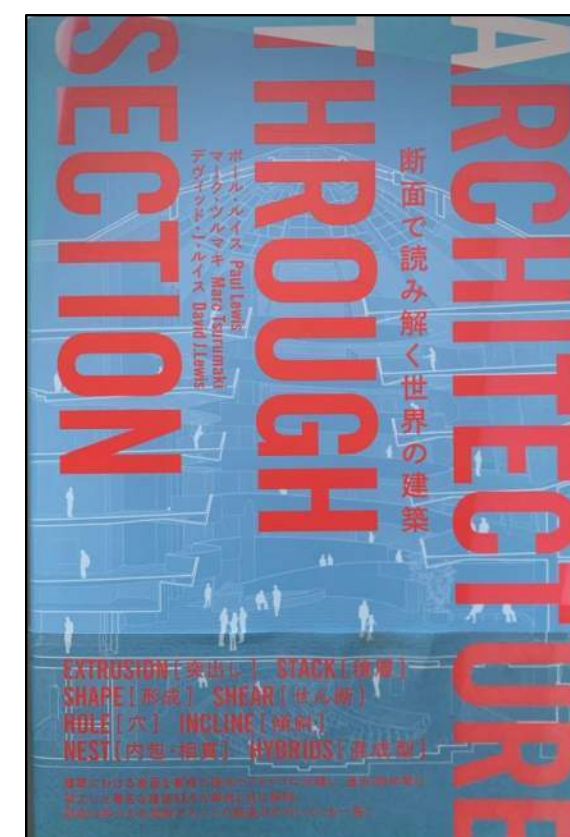
Taiwanese



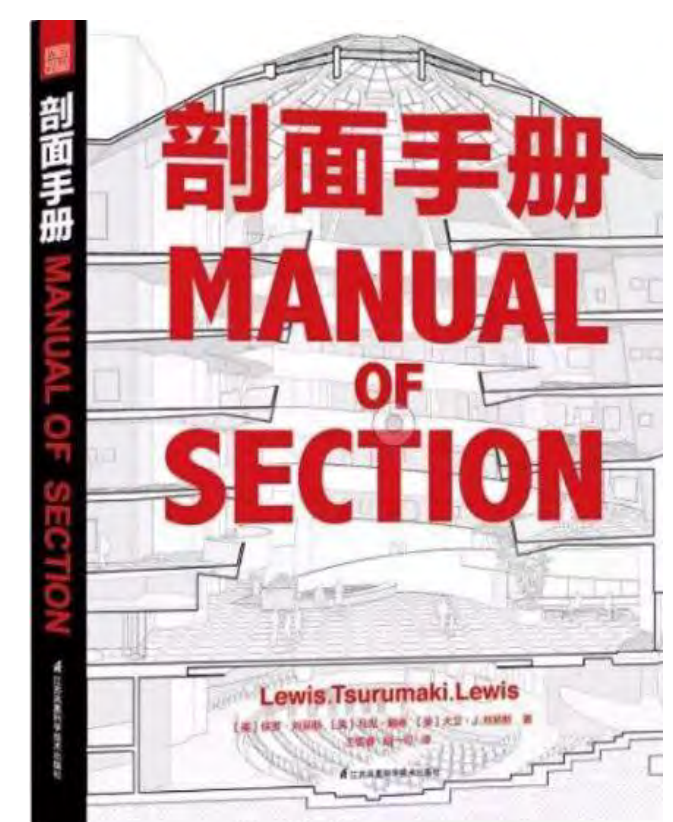
Korean



Russian

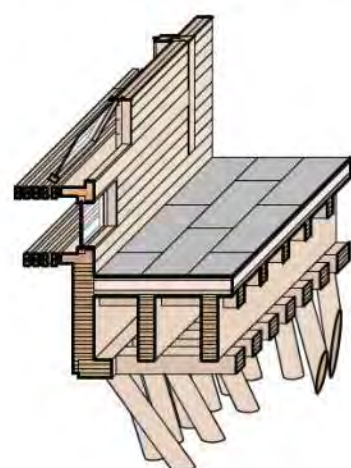


Japanese

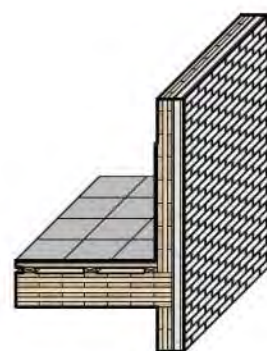


Chinese

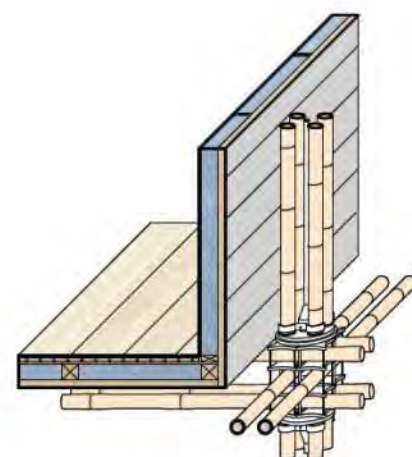
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Wood Frame



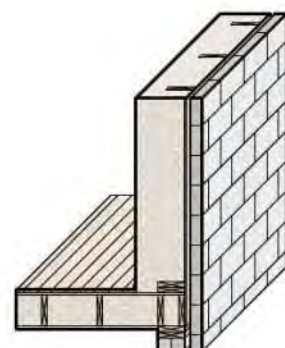
Mass Timber



Bamboo



Straw



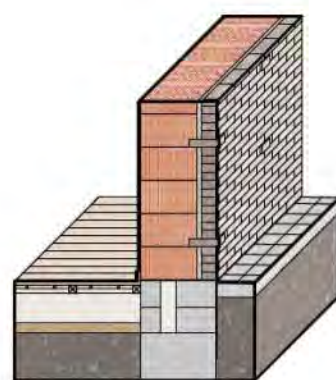
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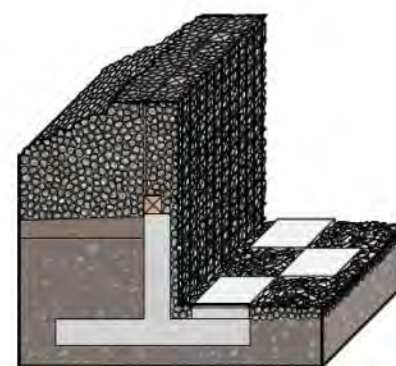
Cork



Earth



Brick



Stone

ISBN 978-1-957183-09-1

USD 39.95

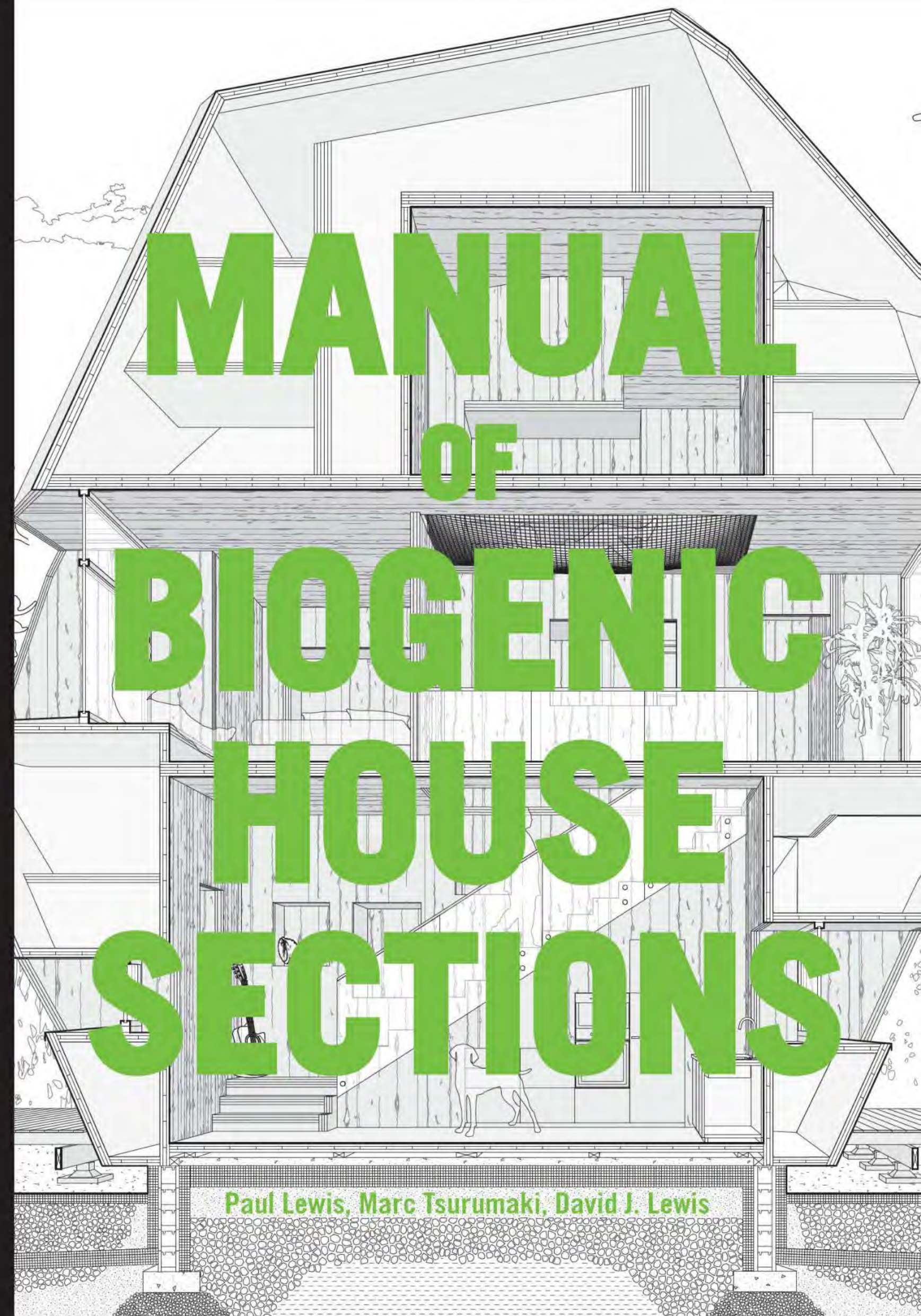


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Lewis.Tsurumaki.Lewis

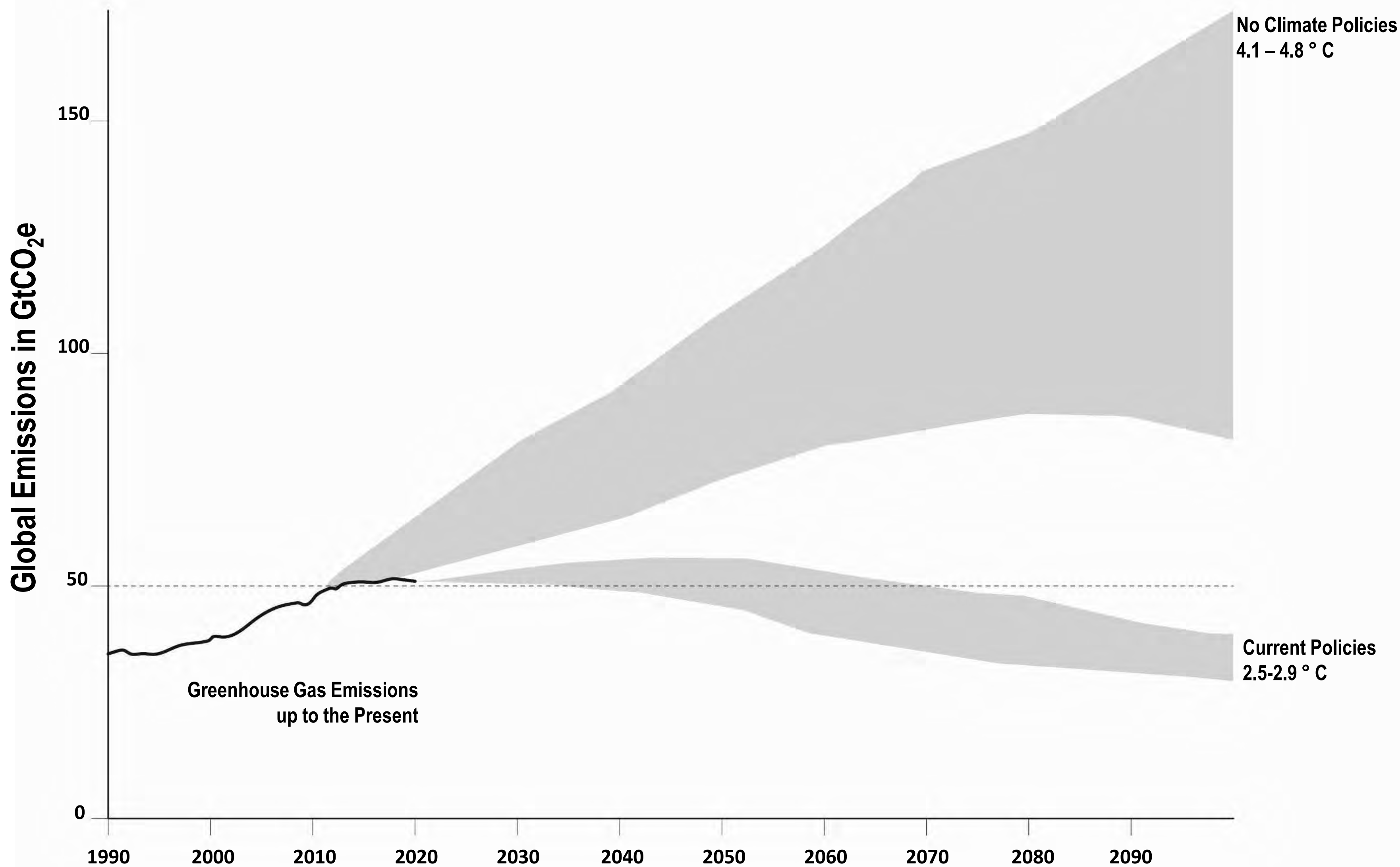
MANUAL OF BIOGENIC HOUSE SECTIONS



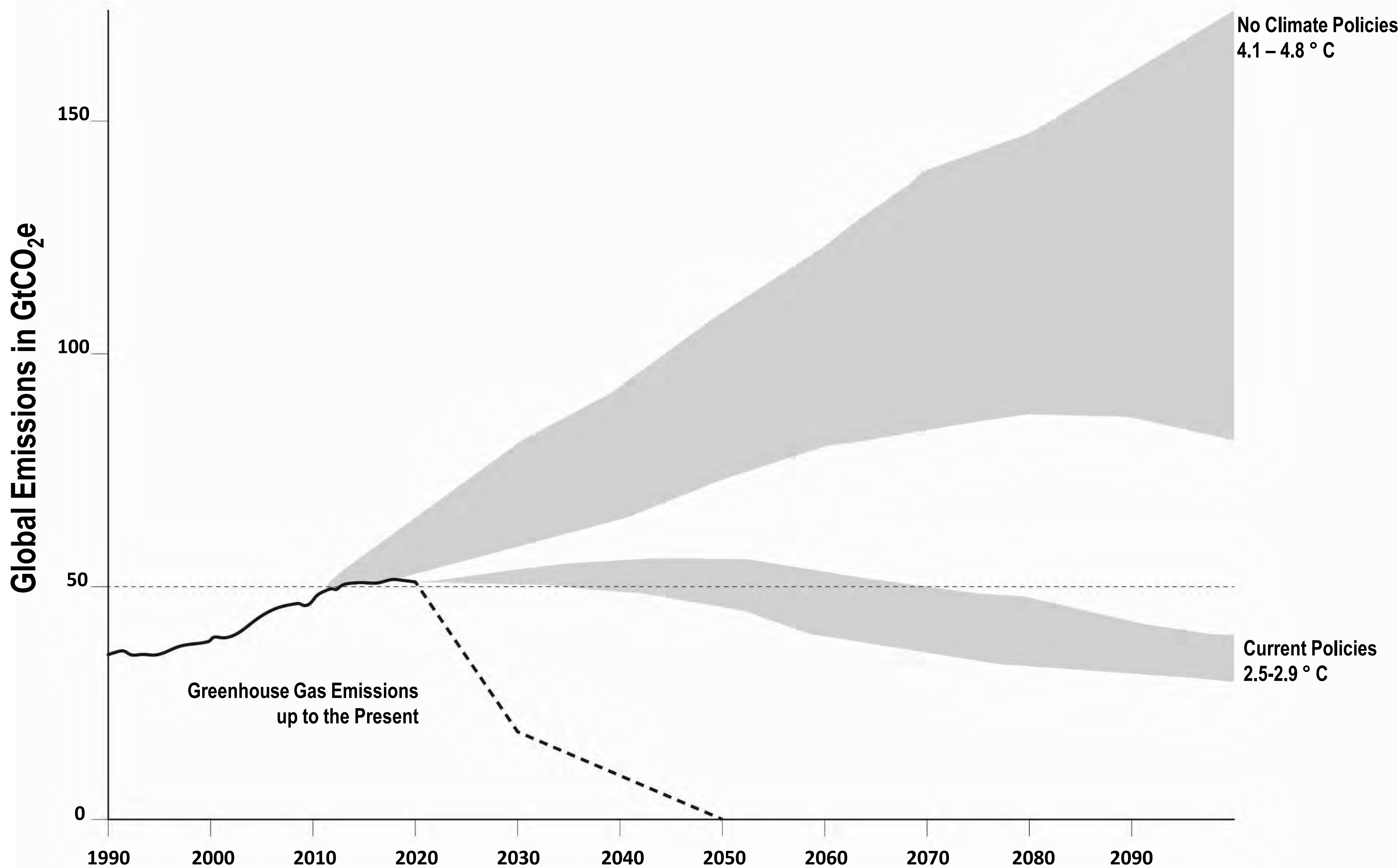
Paul Lewis, Marc Tsurumaki, David J. Lewis

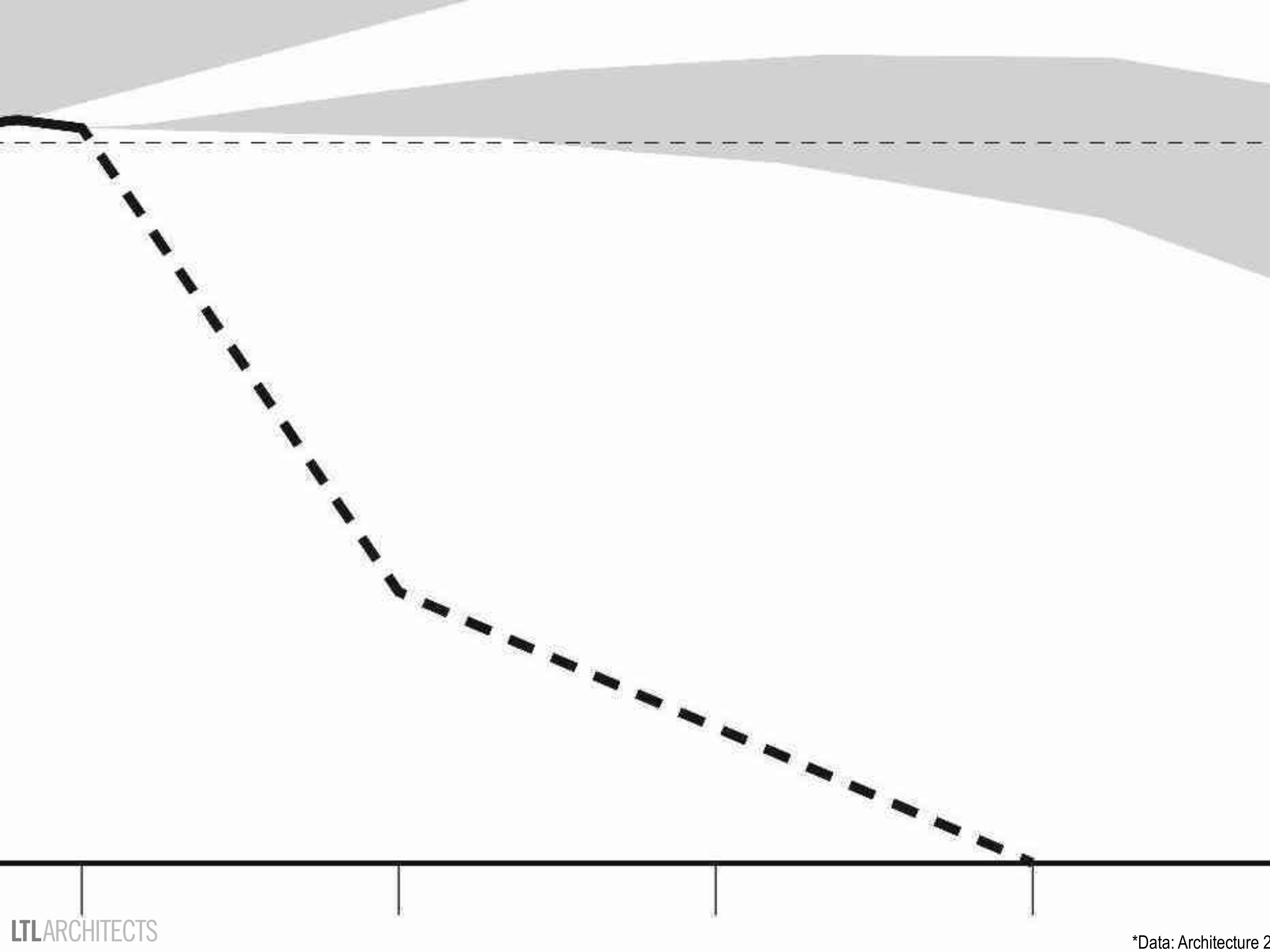


# Global Greenhouse Gas Emissions and Warming Scenarios

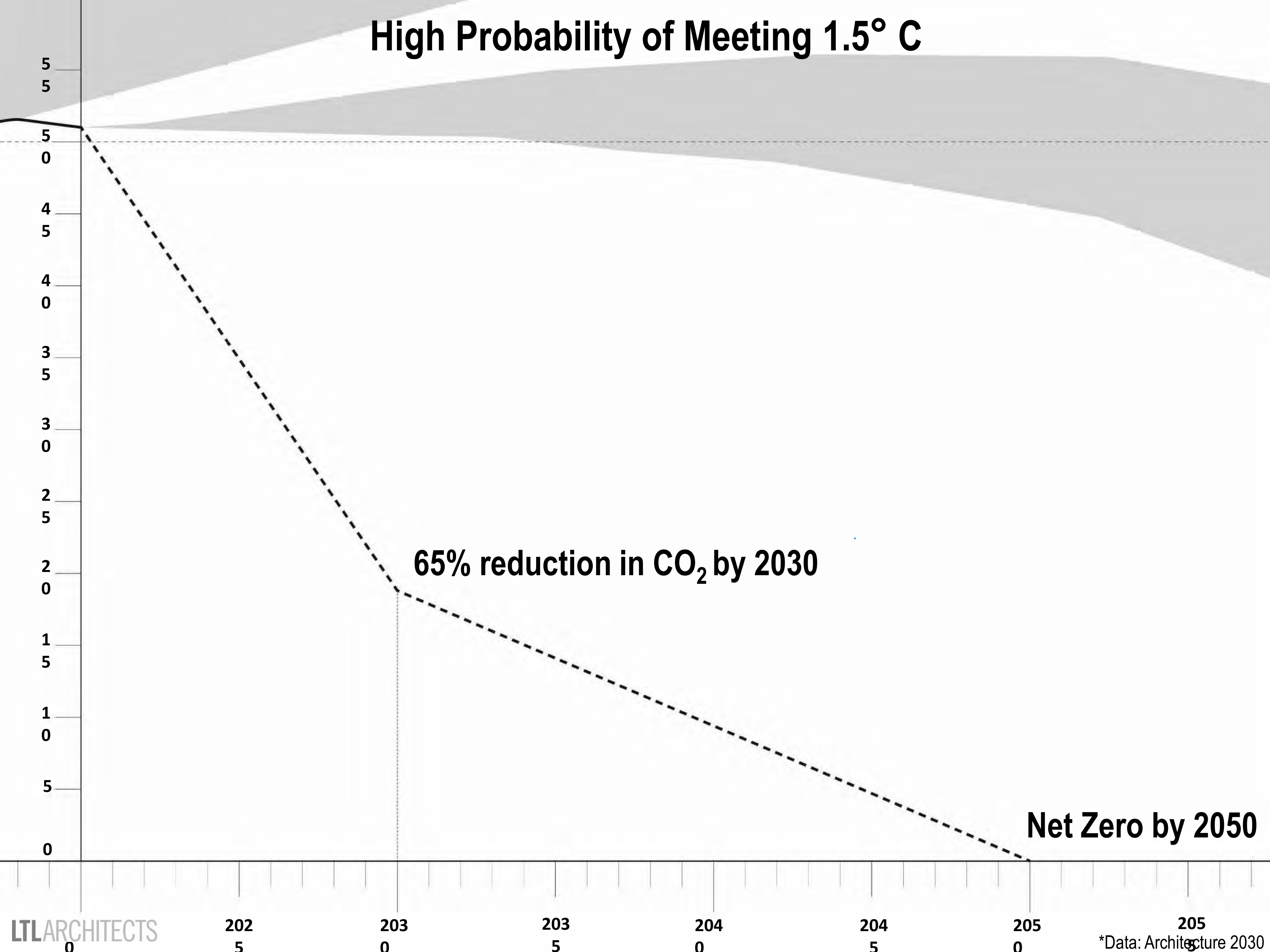


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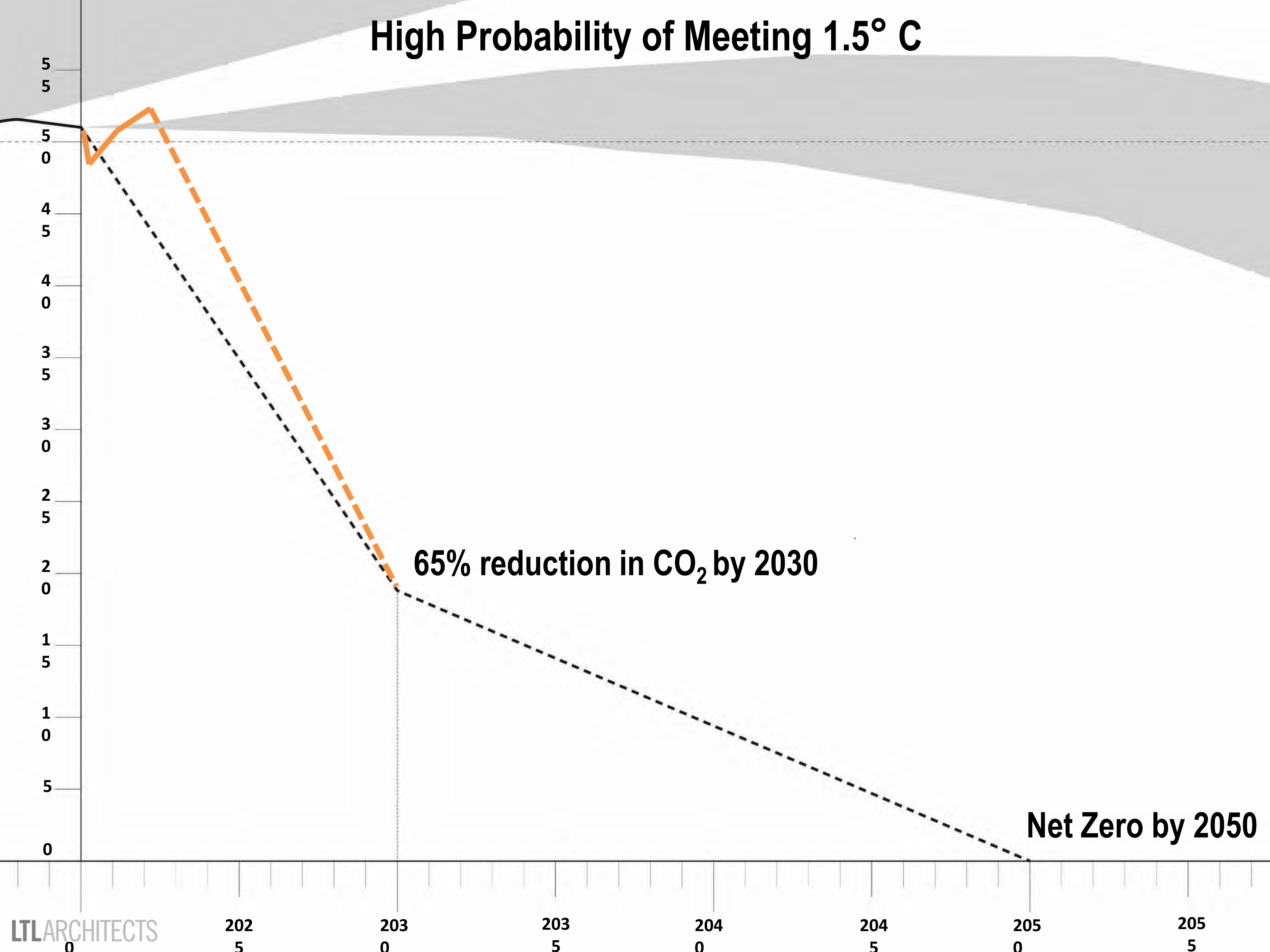
# High Probability of Meeting 1.5° C



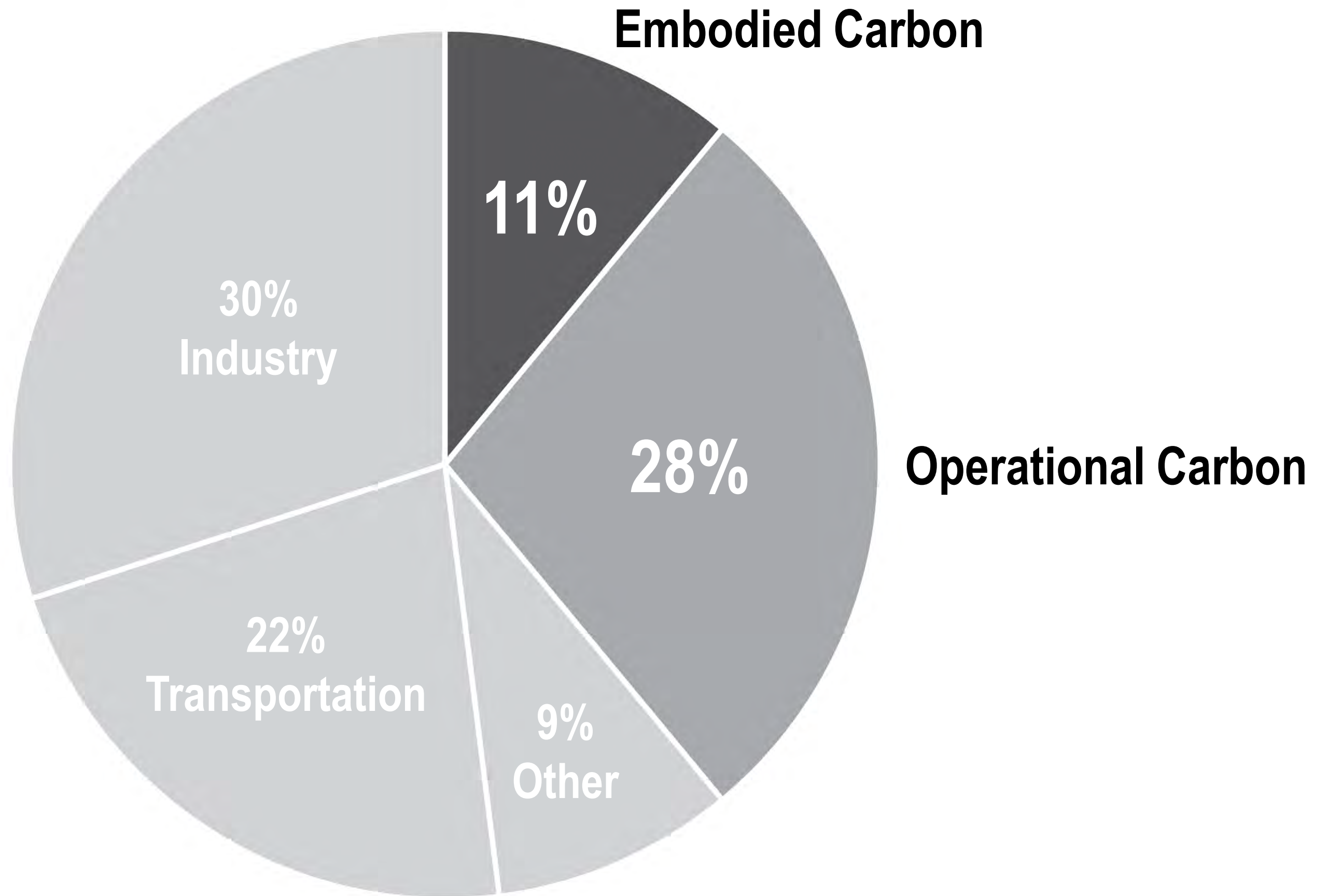
65% reduction in CO<sub>2</sub> by 2030

Net Zero by 2050

# High Probability of Meeting 1.5° C

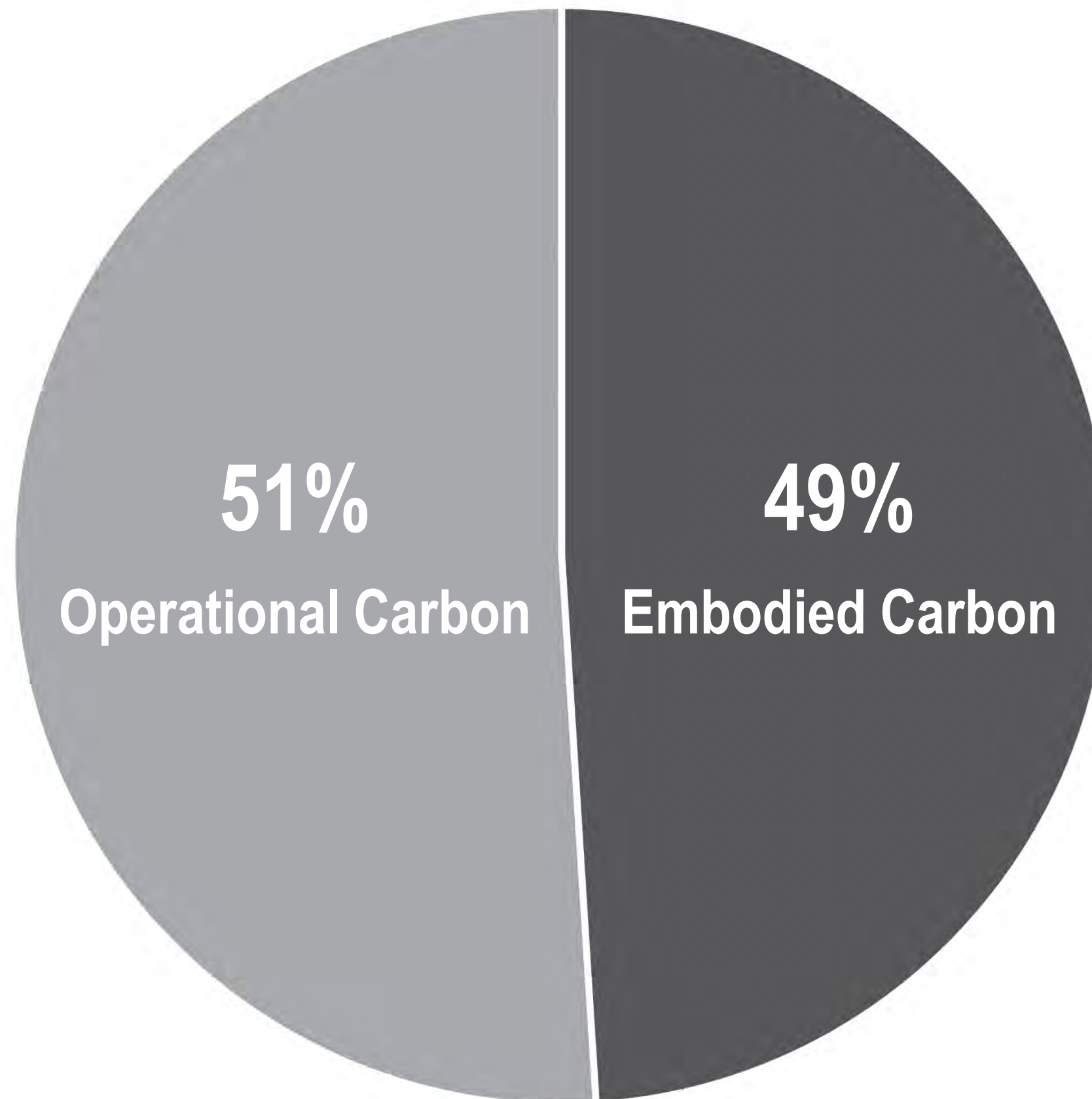


# Buildings = 39% of Global Carbon Emissions



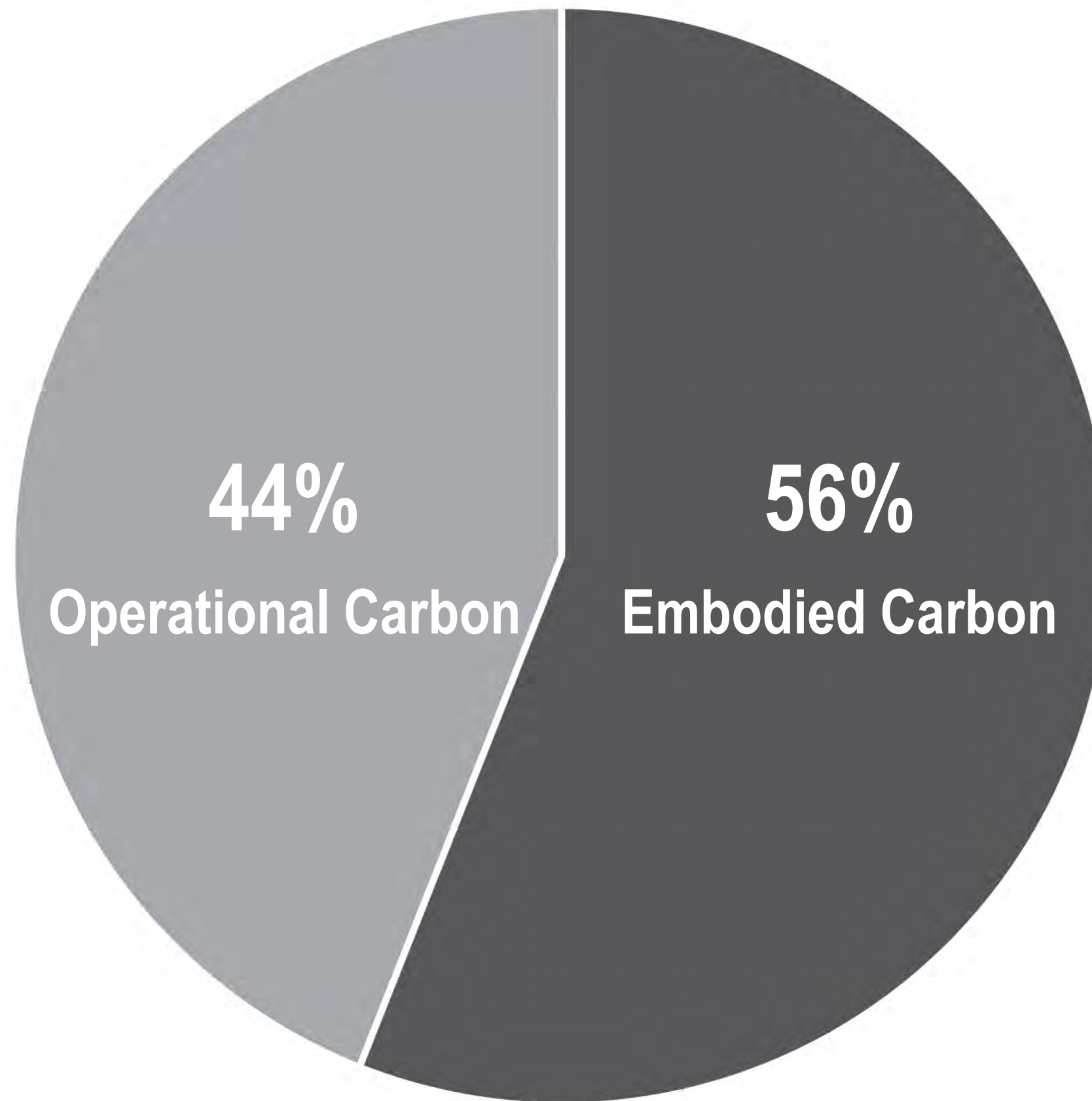
**Global CO<sub>2</sub>e Emissions by Sector**

# Total Carbon Emissions of Global New Construction 2020-2050



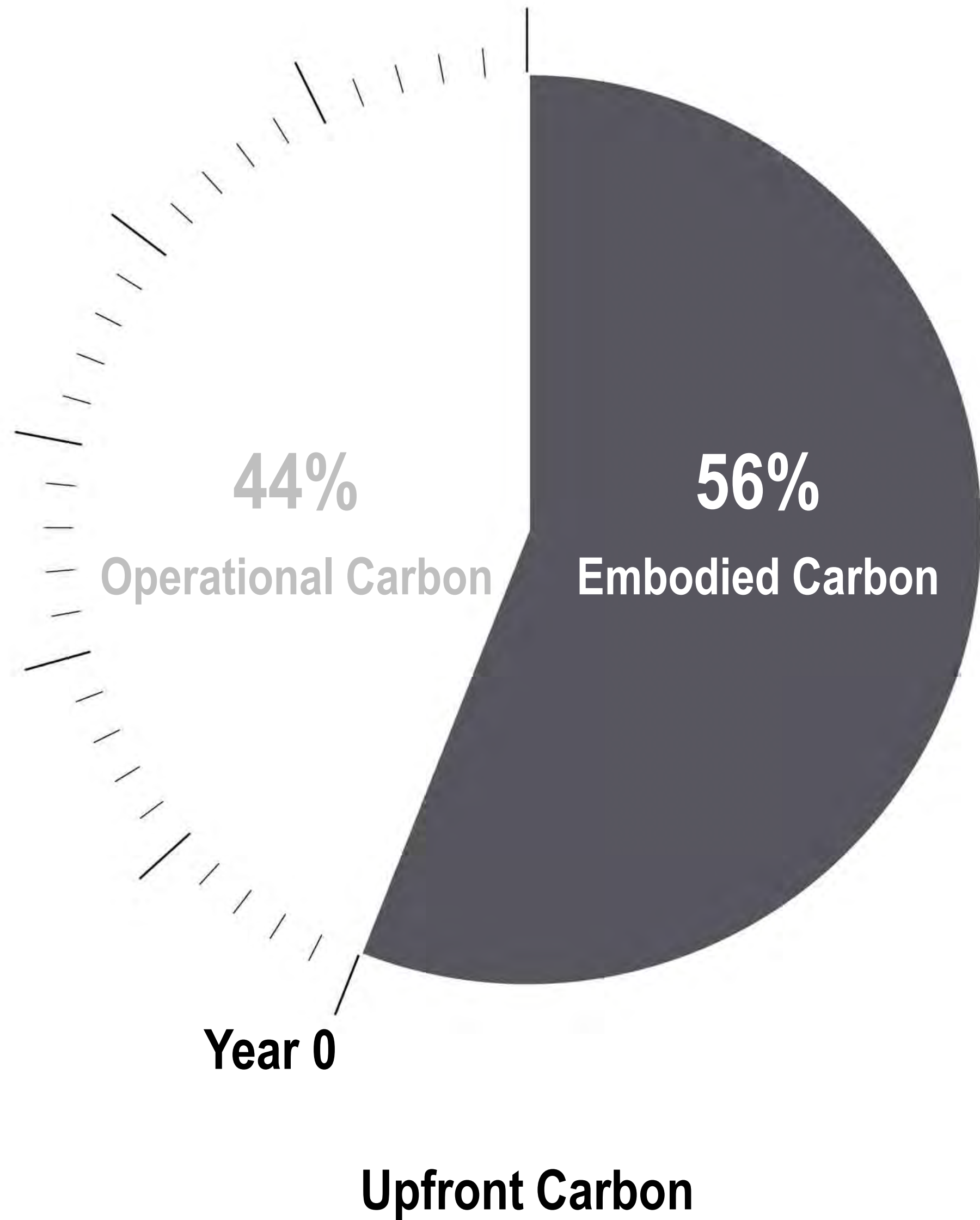
**Business as Usual**

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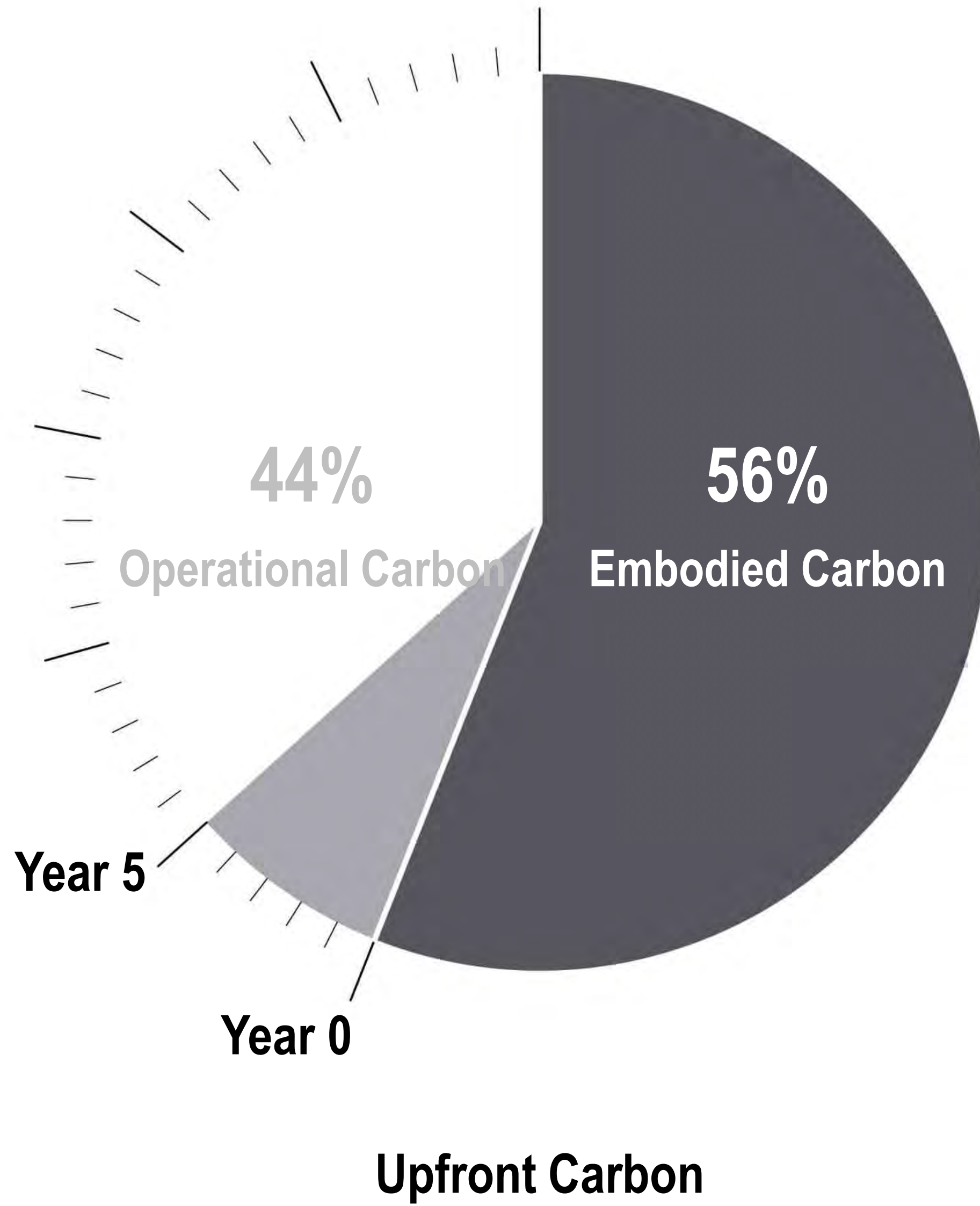


**High Performance Building**

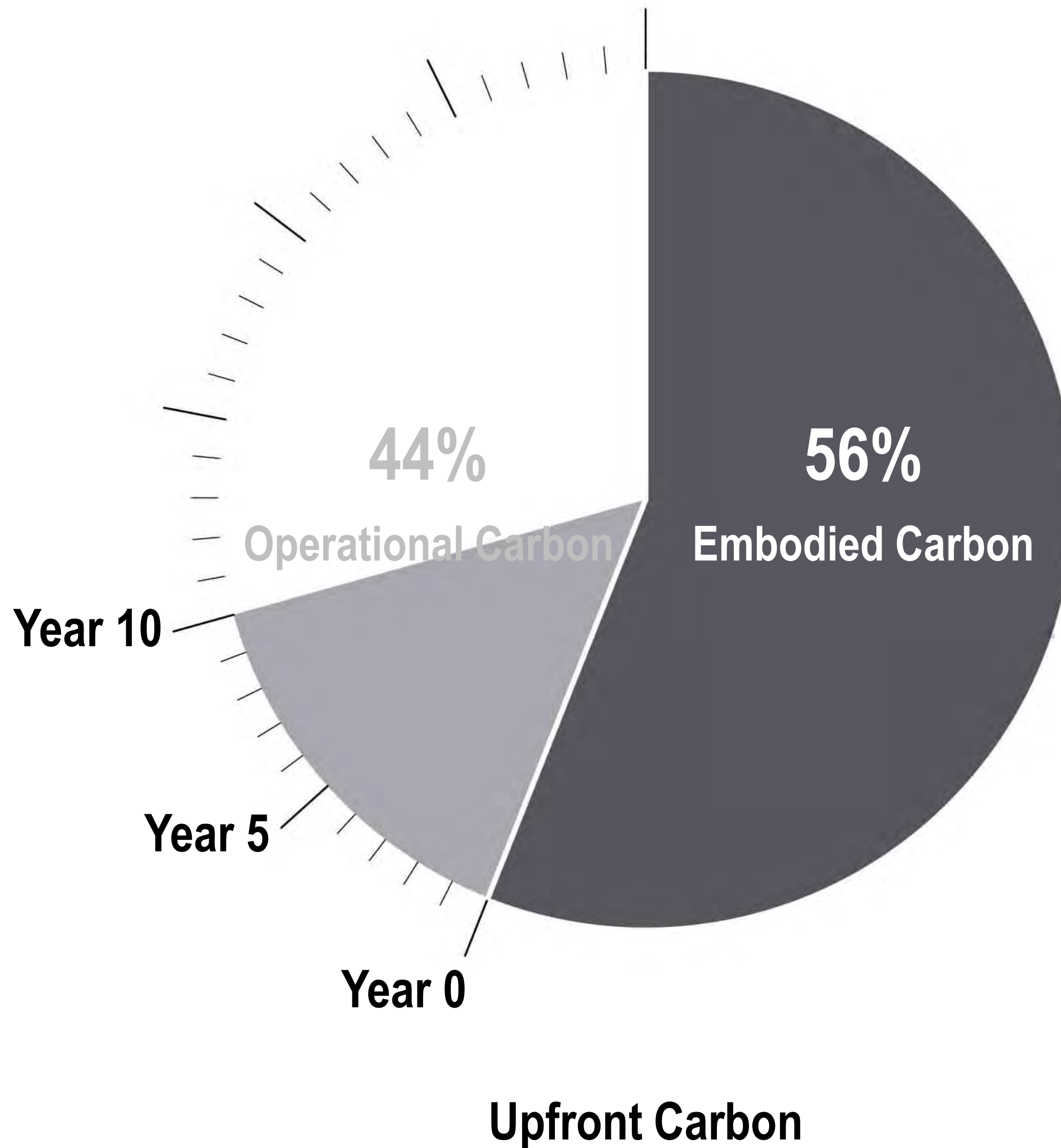
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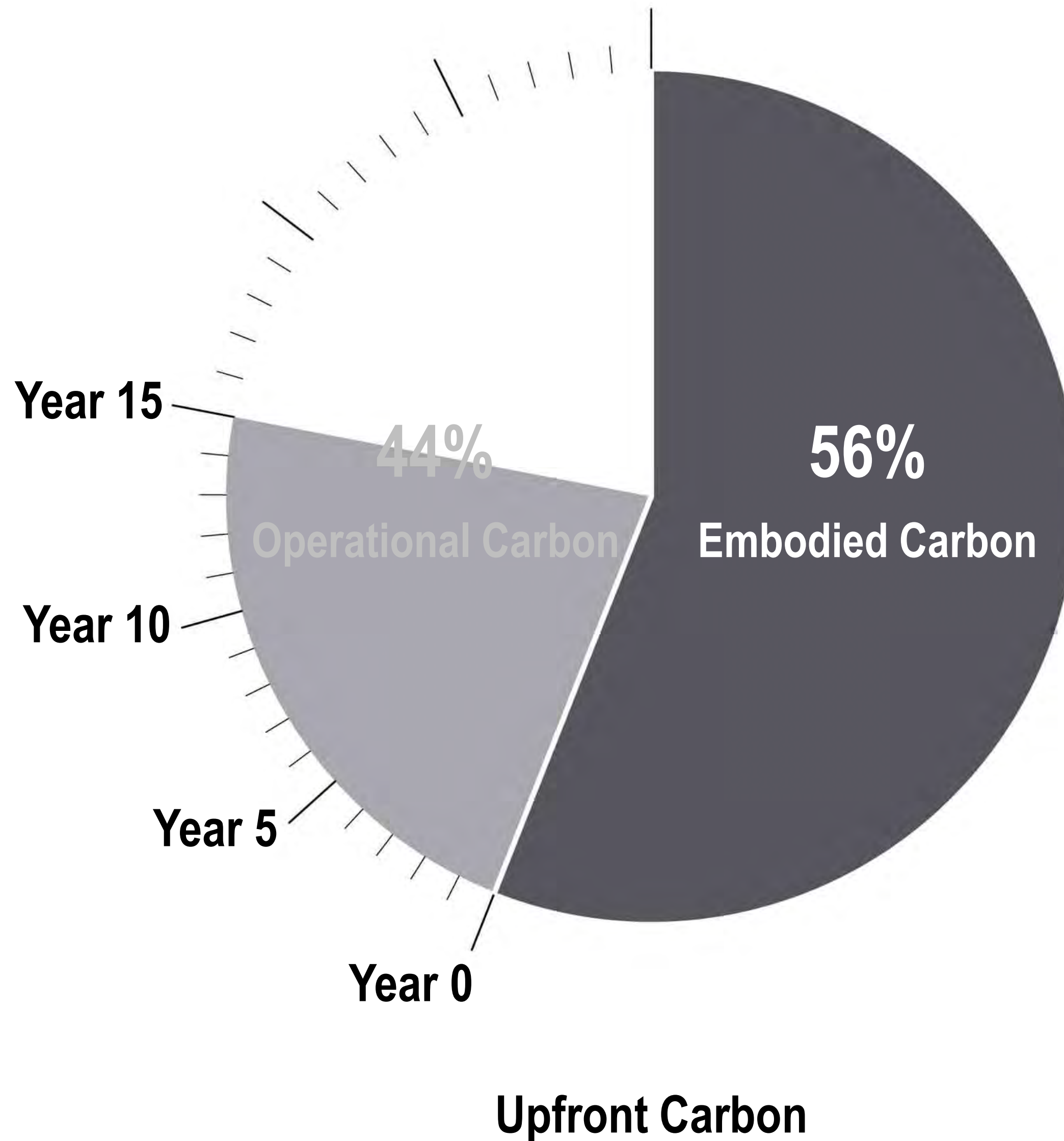
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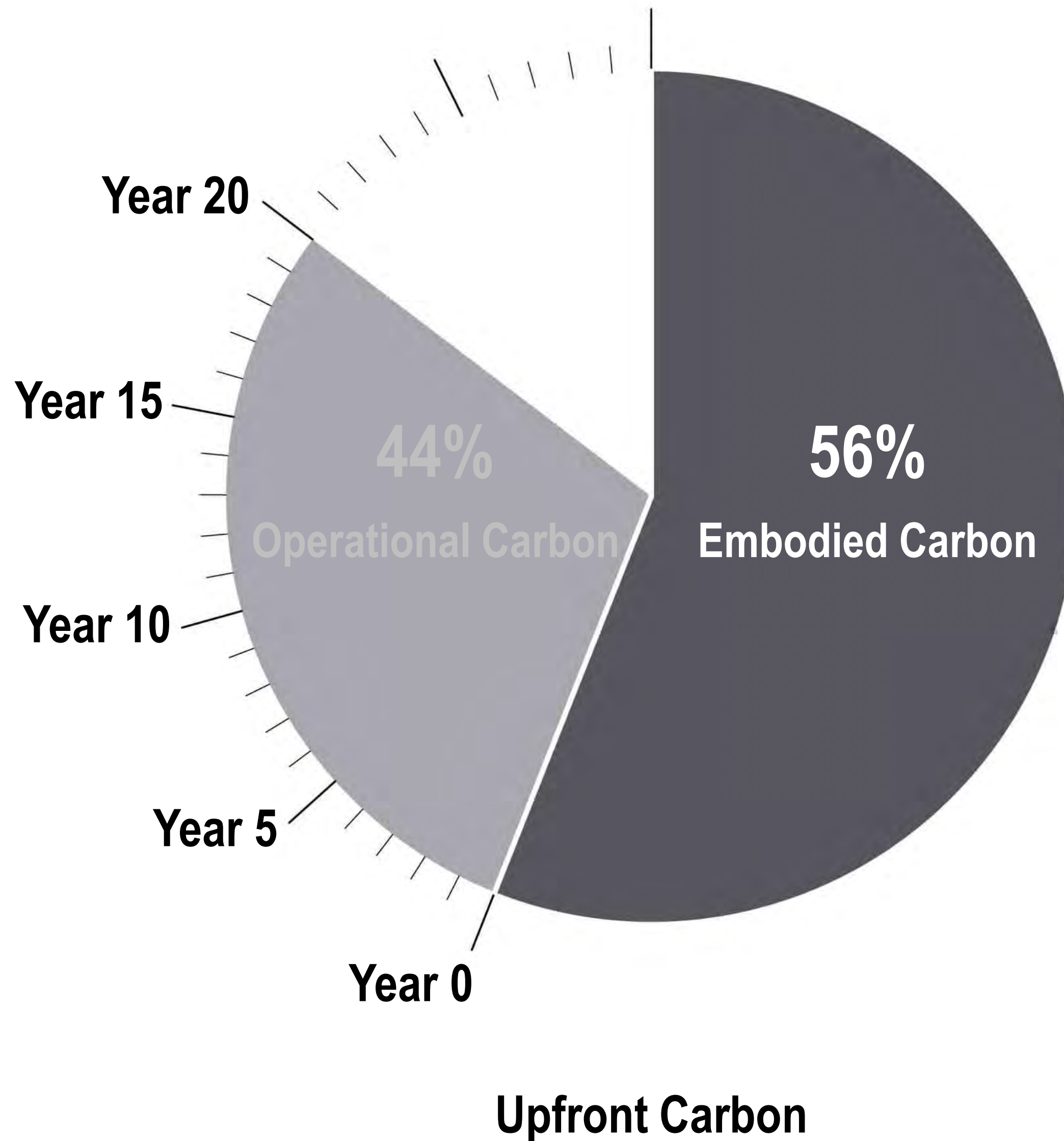
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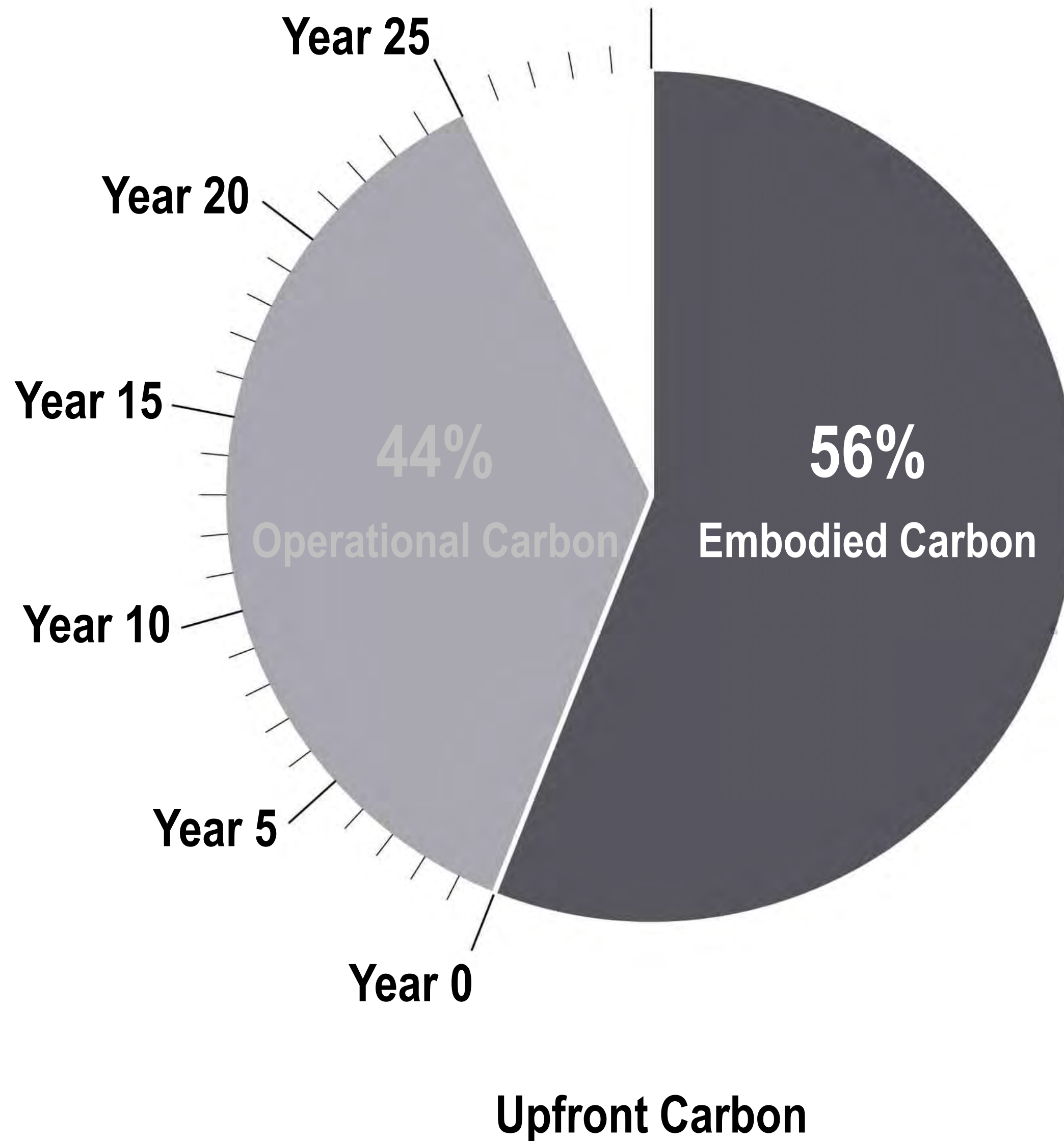
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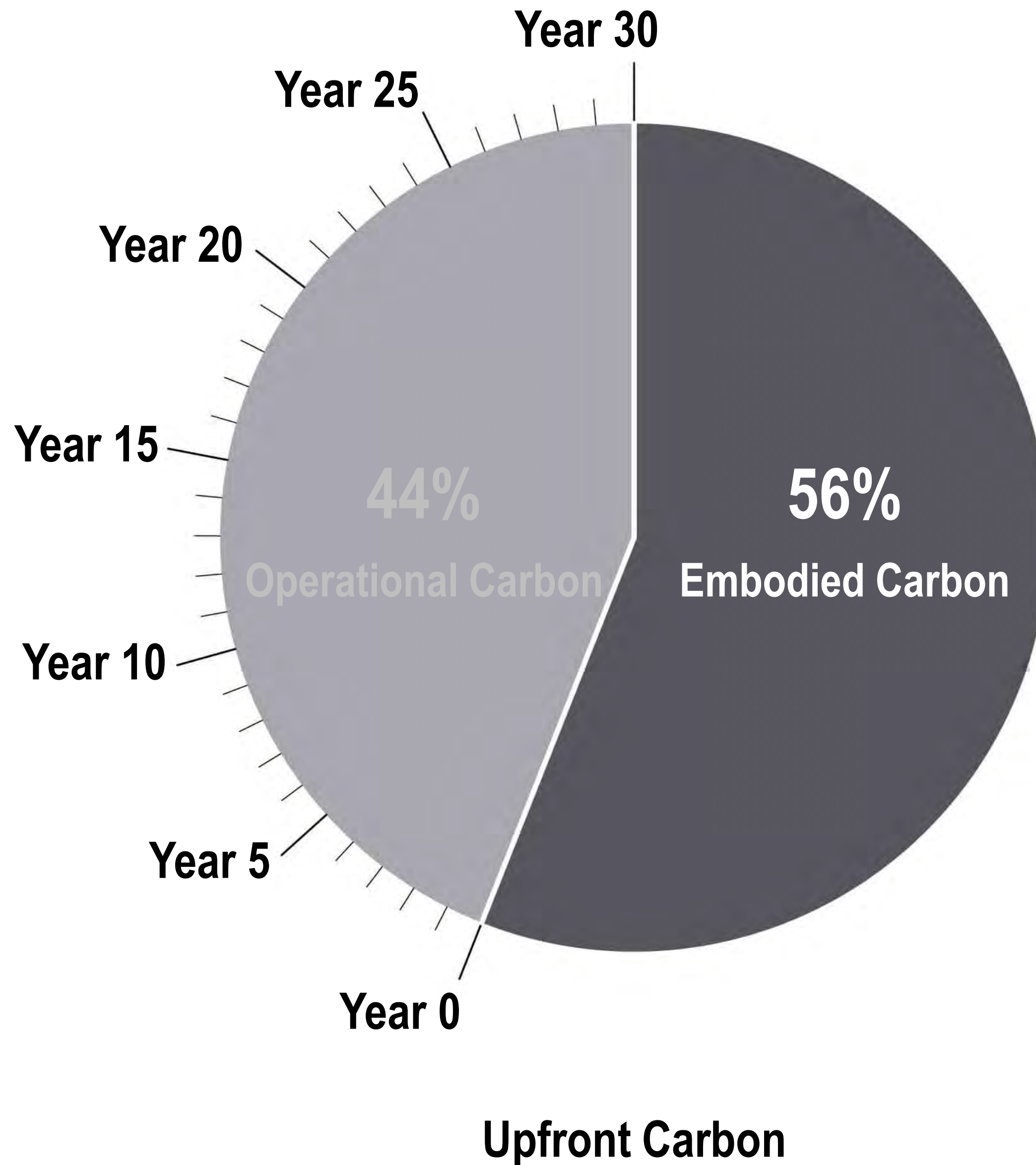
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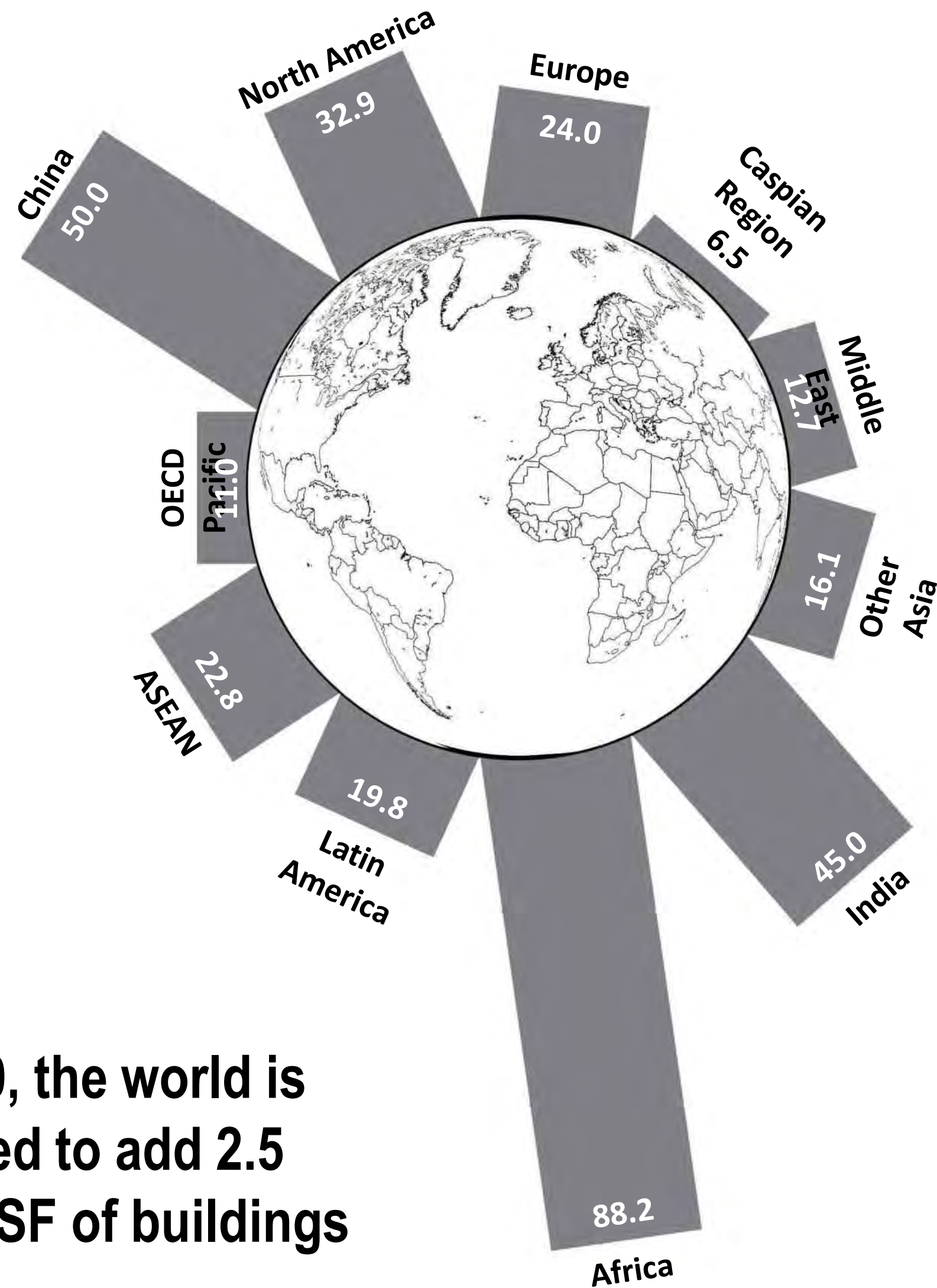




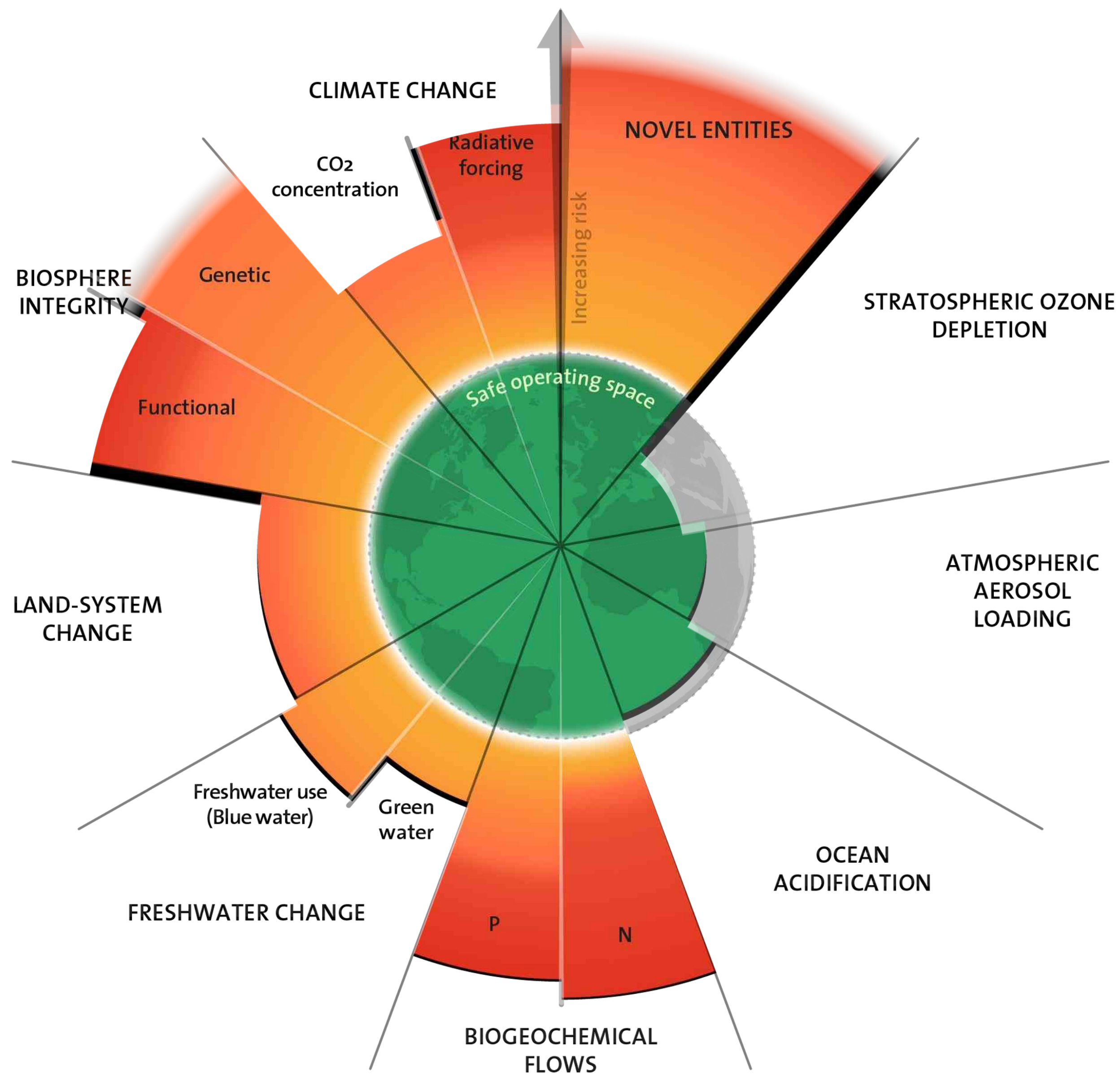
# Building Floor Area Additions by 2060 in Billions M<sup>2</sup>



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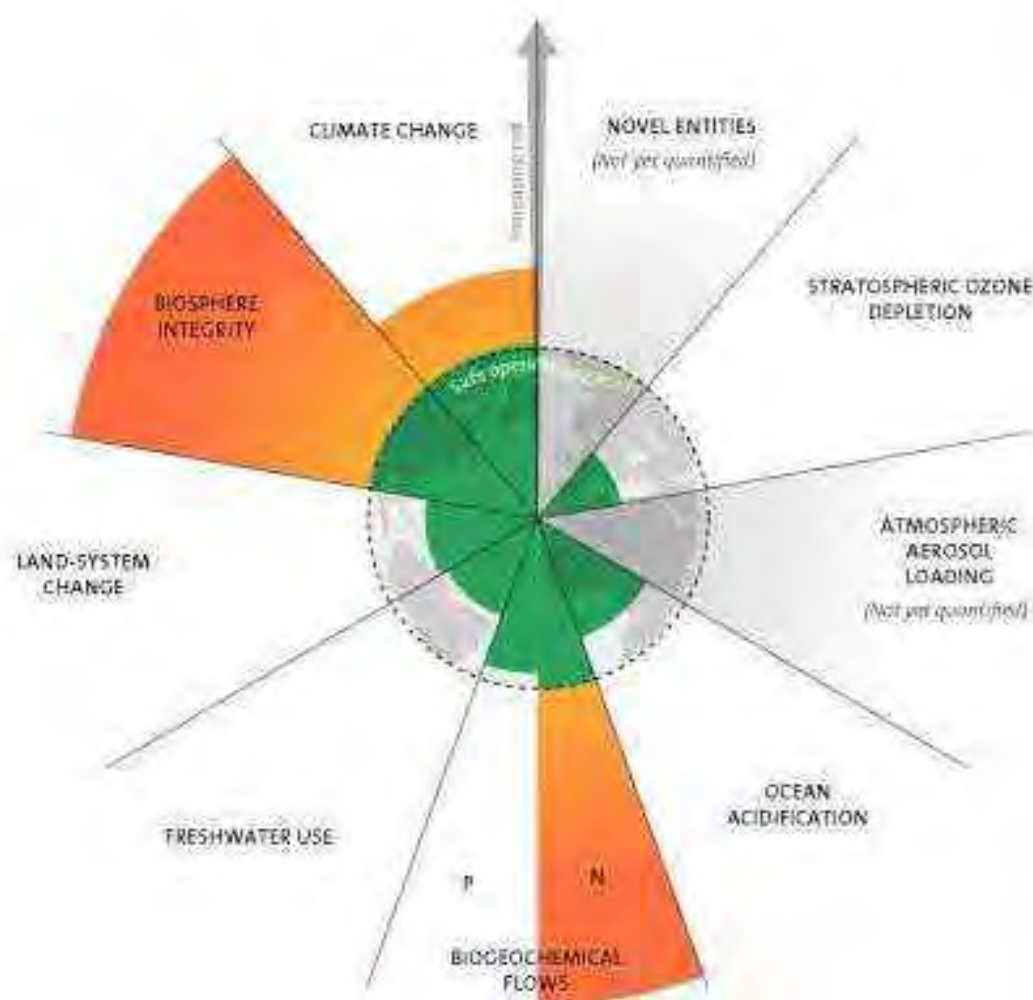


**By 2060, the world is projected to add 2.5 Trillion SF of buildings**



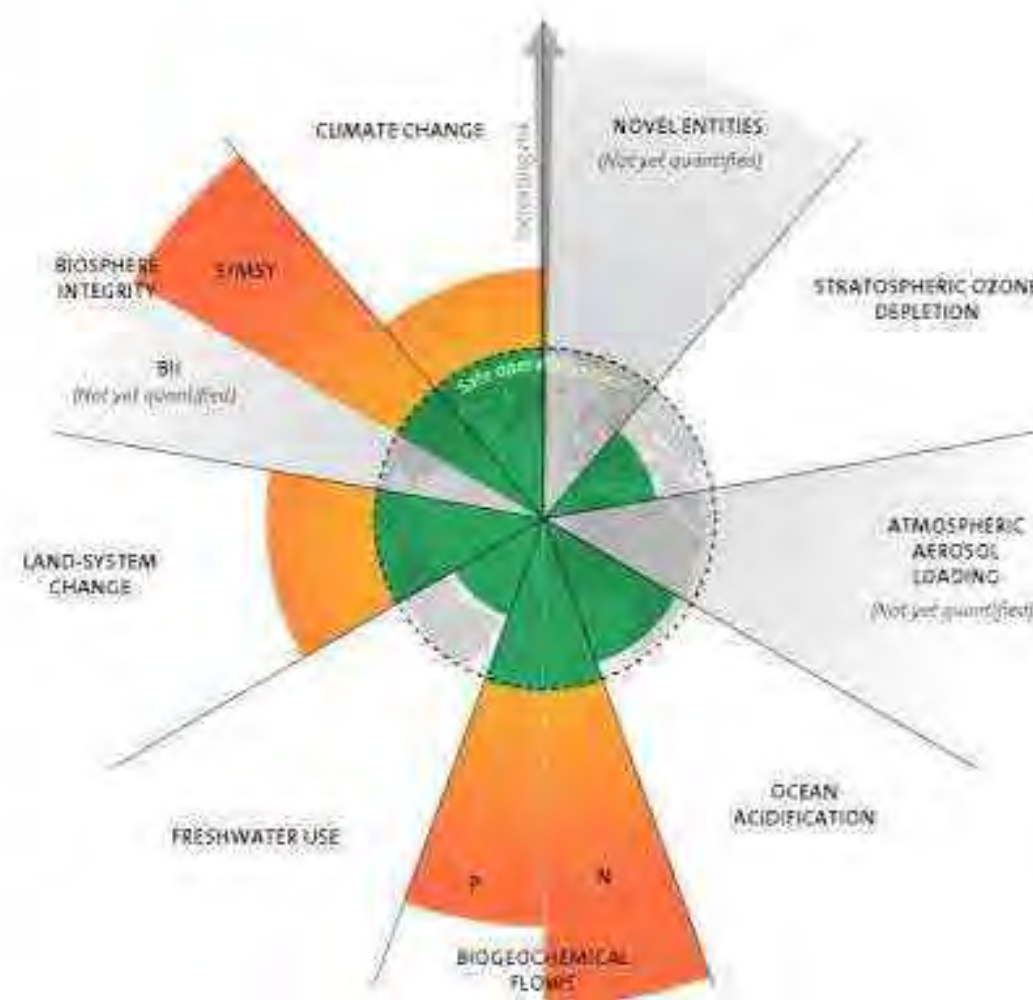
## The 2023 update to the Planetary Boundaries

# 2009



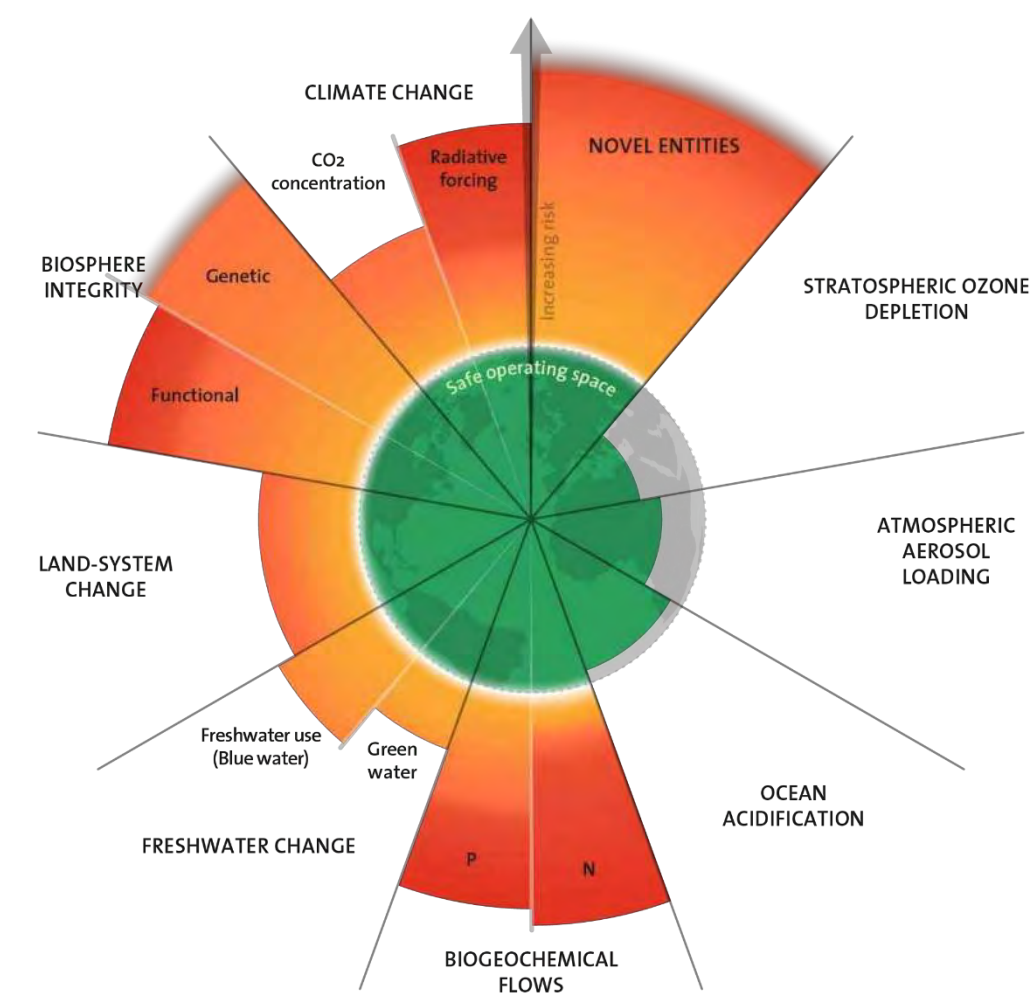
3 boundaries crossed

# 2015



4 boundaries crossed

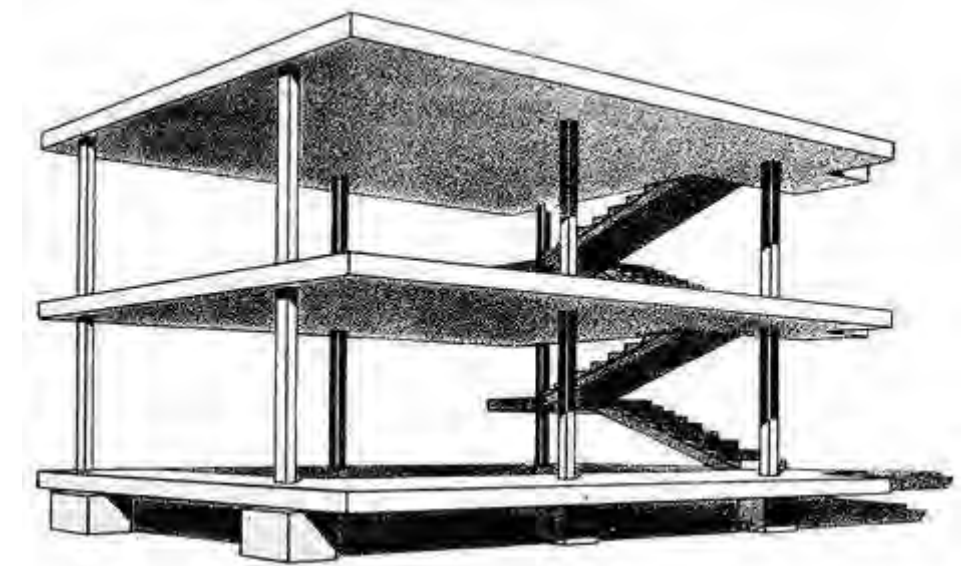
# 2023



6 boundaries crossed

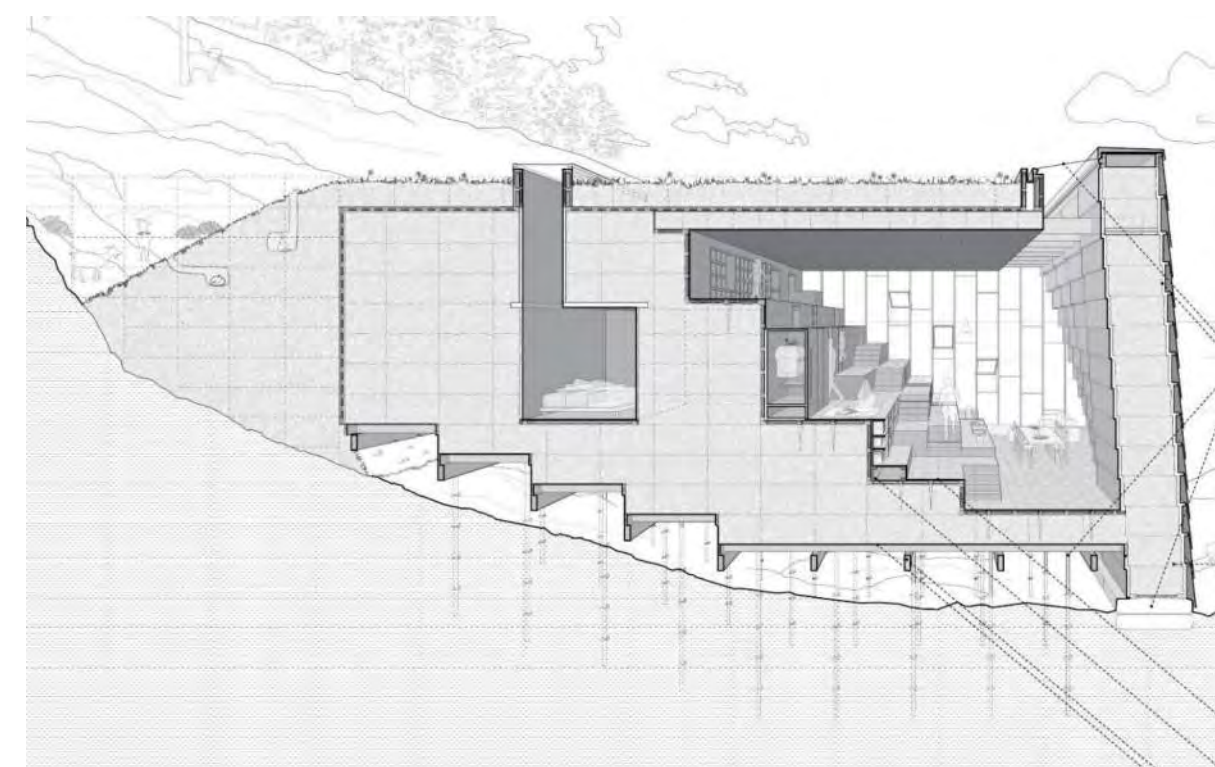
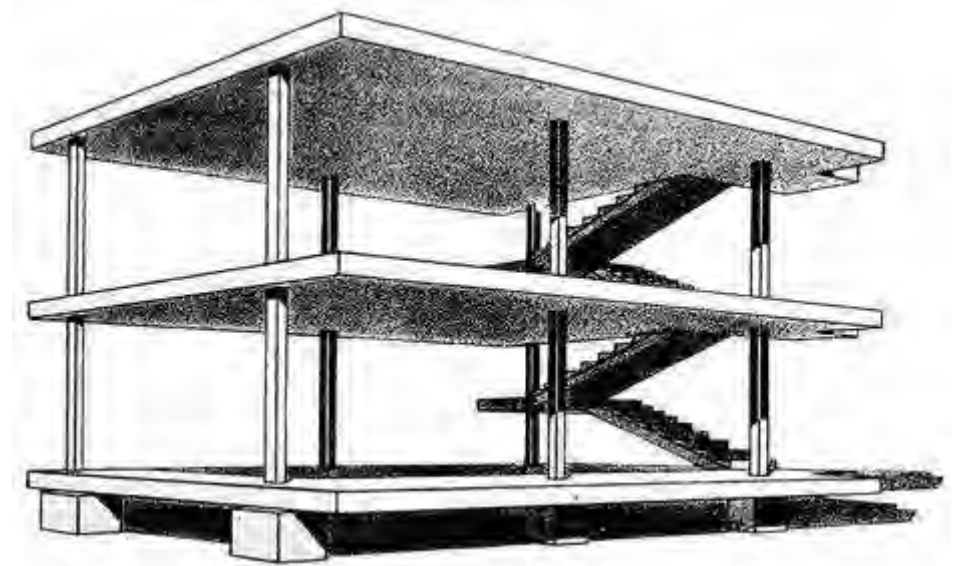
## **Legacy of Modernism**

- **Concrete, Steel, and Glass**
- **Carbon Intensive**
- **Linear / Extractive**
- **Global**
- **Environmental and Human Health Impacts**
- **Architect as Consumer**



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## **Biogenic and Geogenic Materials**

- **Plant and Earth Based Materials**
- **Low Carbon or Carbon Sequestering**
- **Renewable / Circular Life Cycles**
- **Local**
- **Regenerative and Healthful**
- **Architect Engaged in Material Cycles**

**Notes** All of the total embodied carbon numbers listed only represent life cycle assessment stages A1-A3, cradle to gate.

These numbers are estimates and reflect the best available published information as of May 2022. The use of a single number is for clarity of comparison, and should nevertheless be understood as an approximation, as specific material carbon data is subject to many variables.

The values given are drawn from publicly available carbon databases and EPDs as identified in the footnotes listed below. To be as consistent as possible, embodied carbon data was sourced from databases in the following order: Inventory of Carbon and Energy, version 3.0 2019, then Ökobaumat, then BEAM Estimator. Specific materials not contained in those databases were sourced from individual EPDs as noted.

**Databases** <sup>1</sup> Inventory of Carbon and Energy, version 3.0, 2019  
<https://circularecology.com>  
<sup>2</sup> Ökobaumat  
<https://www.oekobaumat.de>  
<sup>3</sup> BEAM Estimator  
<https://www.buildersforclimateaction.org>

**Individual EPDs** <sup>4</sup> INBAR, Technical Report #35  
<https://www.inbar.int>  
<sup>5</sup> Herrljunga Terrazzo  
<https://www.epd-norge.no>  
<sup>6</sup> Sikalastic©-618  
<https://www.igbc.ie>  
<sup>7</sup> Vinyl Siding Institute - Industry Average  
<https://www.vinylsiding.org>  
<sup>8</sup> Asphalt Roofing Manufacturer's Association - Industry Average  
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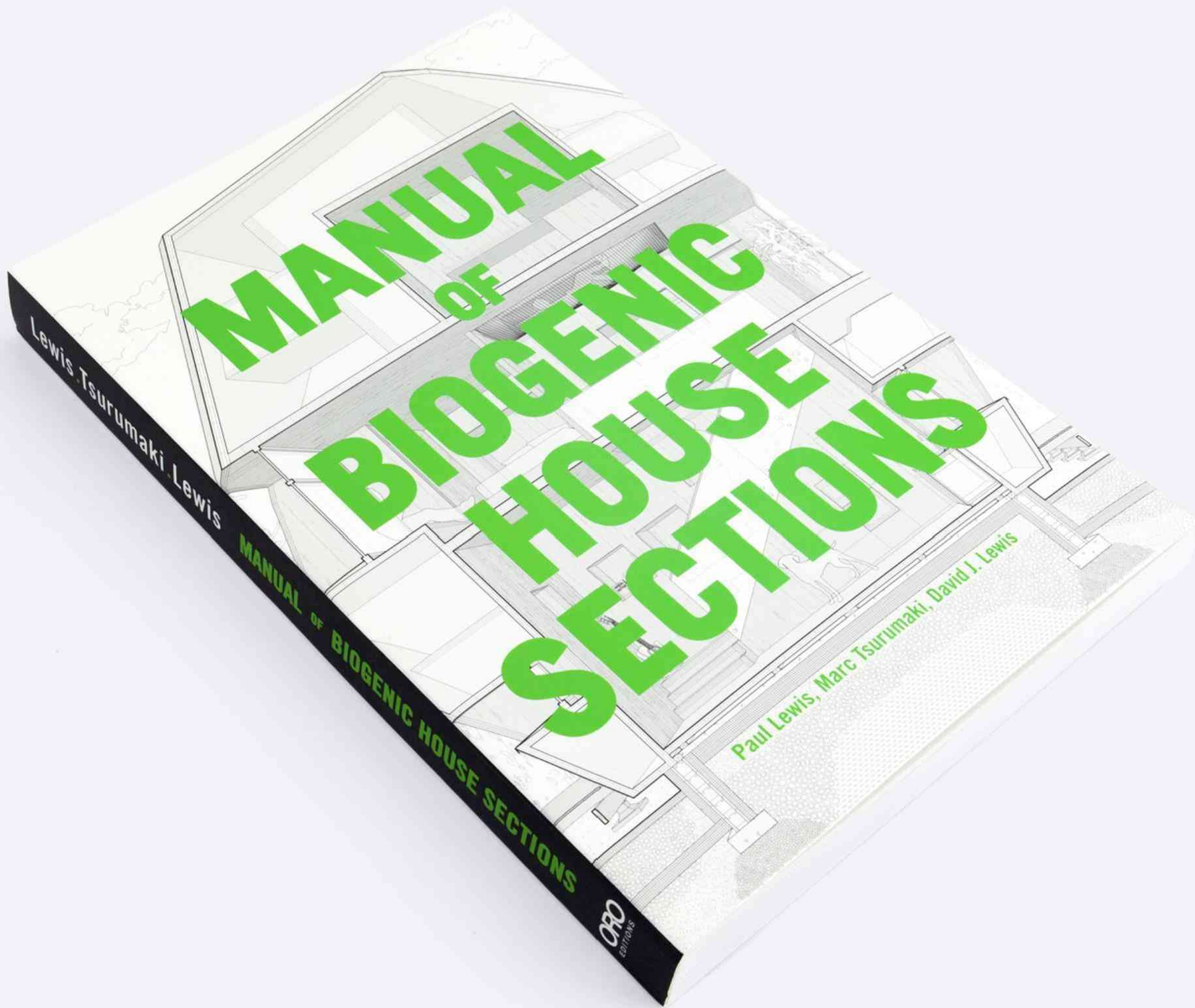
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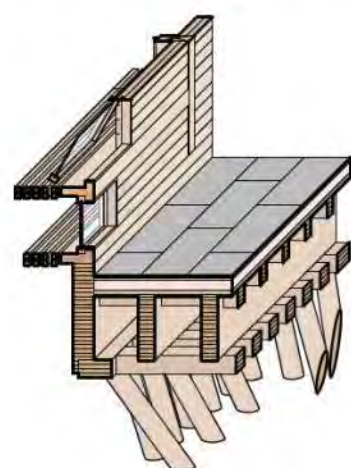
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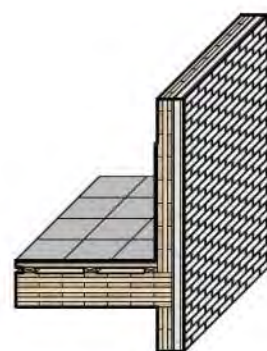
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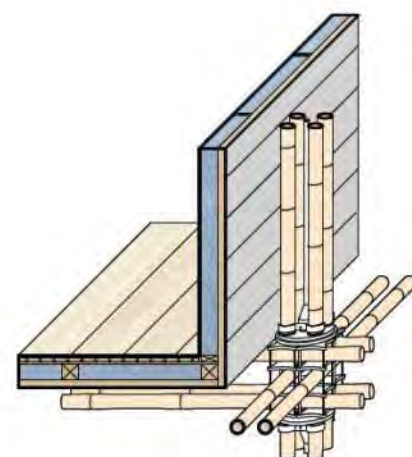
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Wood Frame



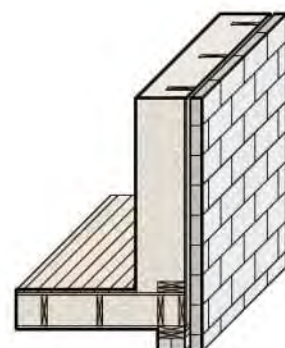
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Bamboo



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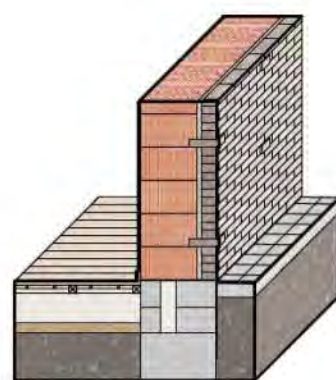
Hemp



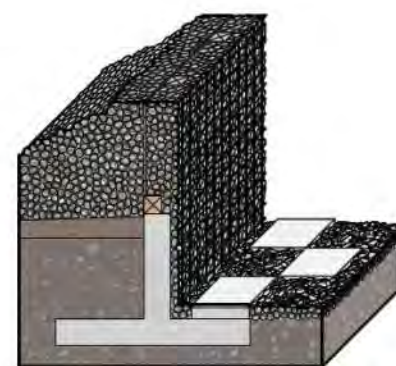
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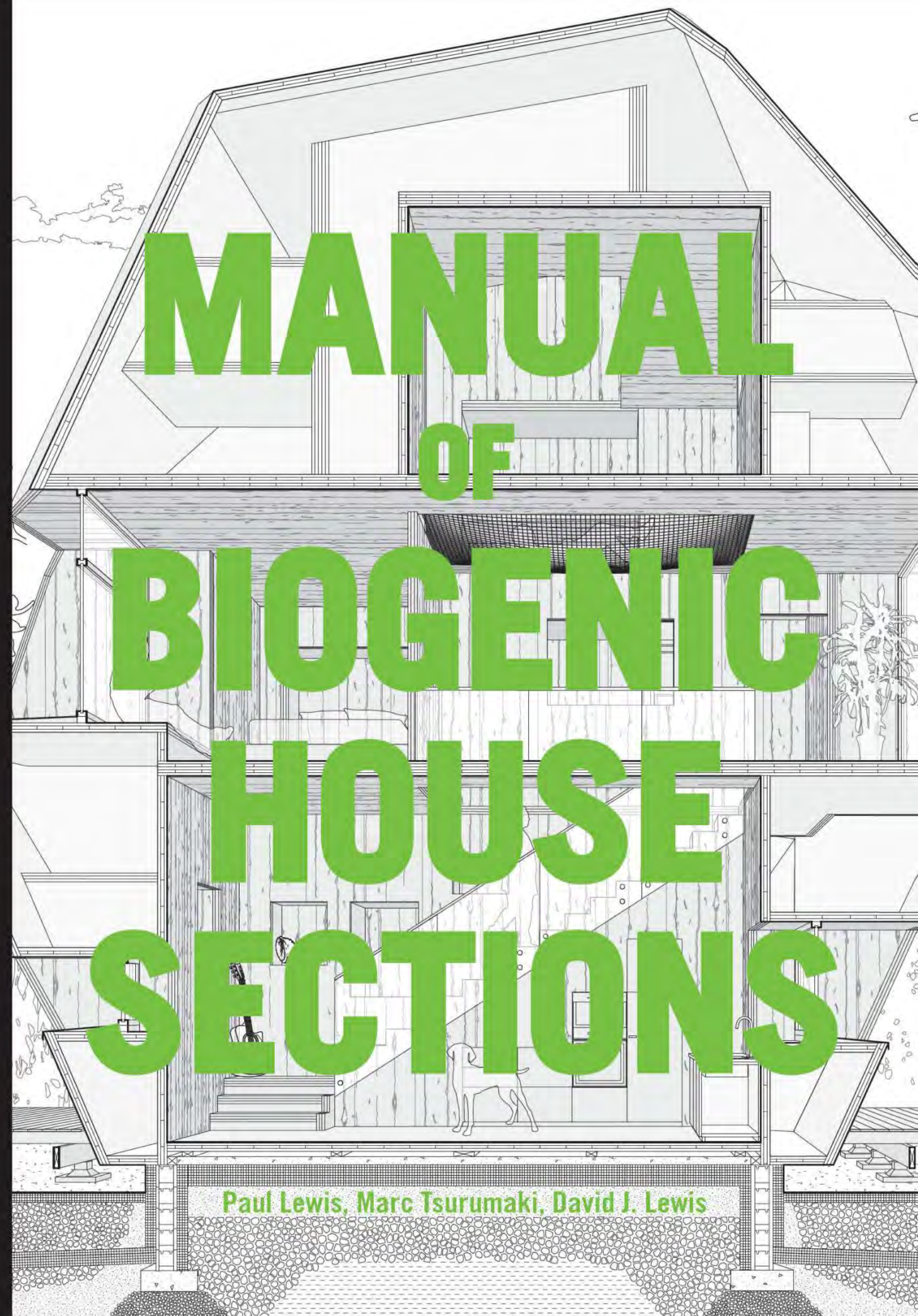


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Lewis.Tsurumaki.Lewis

MANUAL OF BIOGENIC HOUSE SECTIONS



Paul Lewis, Marc Tsurumaki, David J. Lewis

## EMBODIED CARBON

60.8k  
emittedAsphalt Shingles 1.4k  
Bitumen 0.7k  
Membrane 0.7kSpray Polyurethane  
Insulation 28.5kFiberglass Batt  
Insulation 9.5k

Polyiso 0.8k

Gypsum Board 4.9k

Glass 0.9k

Aluminum 1.8k

Steel 0.3k

Carpet 2.4k

Vinyl Tile 0.5k

Vinyl Siding 1.9k

Vapor Barrier 0.1k

Concrete 14.9k

Brick 0.3k

XPS 0.8k

Dimensional Lumber -18.5k

Oriented Strand Board -9.7k

Laminated Veneer Lumber -0.9k

-29.2k  
stored

-35k

-40k

-45k

2022

United States of America

## Standard Single-Family House

The standard single-family house, particularly in the United States, is characterized by three interlinked problems. First, they are mostly constructed of multiple, thin, lightweight layers of inexpensive material, many only doing one thing within the building assembly. Only the very thin veneers of exterior cladding and interior paint are visible, hiding these

multiple layers. Second, with the exception of the wood frame, many of those materials are petroleum based, have high levels of embodied carbon, and similar levels of toxicity. Third, the average house has increased in size from 1,000 sq ft (93 sq m) in 1950 to 2,500 sq ft (232 sq m) in 2021. The embodied carbon of this illustrated standard single-family house is

31,600 kgCO<sub>2</sub>e. The quantity is driven by the substantial use of concrete in the foundation and basement; by the insulation made from plastics (XPS, EPS, Polyiso), fiberglass and mineral wool; by the exterior cladding such as fired brick, vinyl siding and asphalt shingles; and by the plastic interior finishes, synthetic carpets, and vinyl floors. These materials are often

difficult to reuse and usually end up in a landfill. The short-term economic benefits of these inexpensive materials is countered by the longer-term health consequence of the poor interior air quality and the global environmental impacts, of which global warming is just one problem.

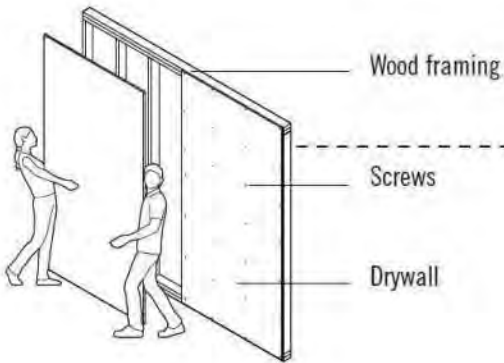


**1000 sf in 1950**

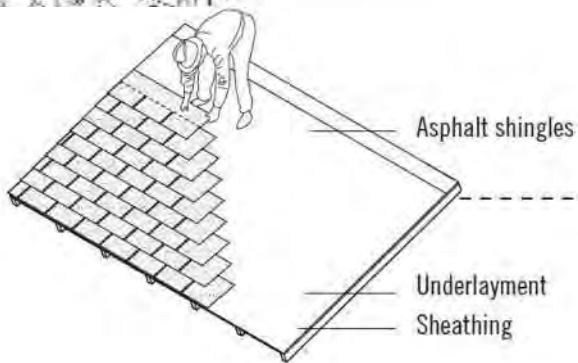


**2500 sf in 2020**

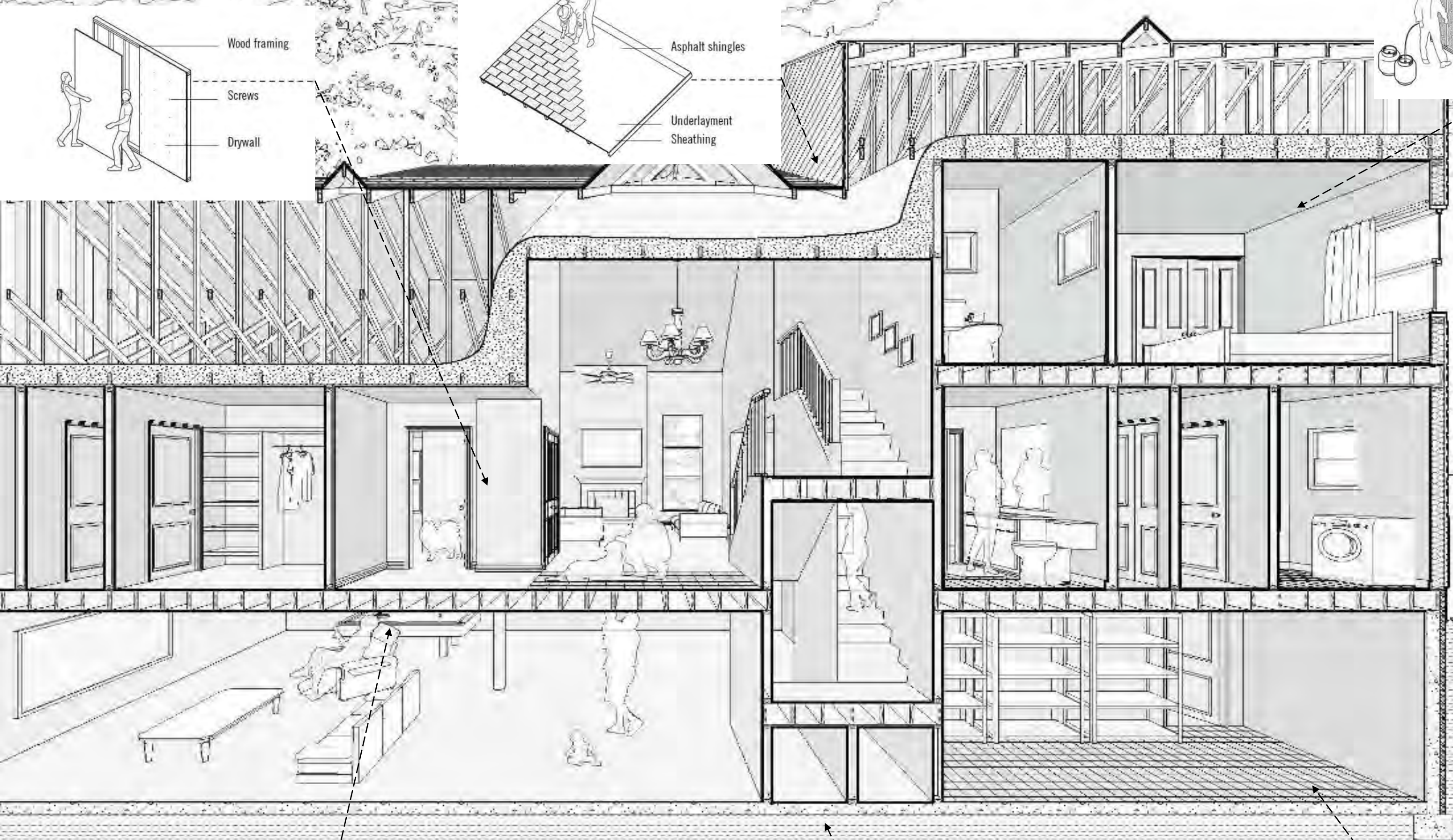
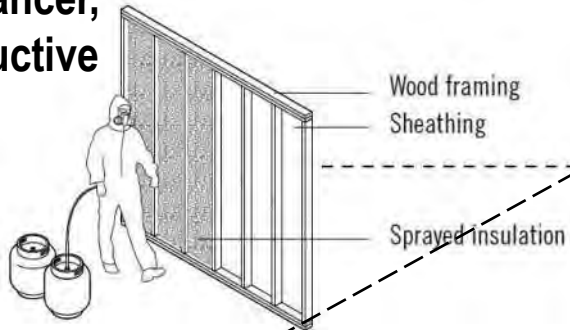
**Gypsum Board**  
Heavy metals and toxic antimicrobials



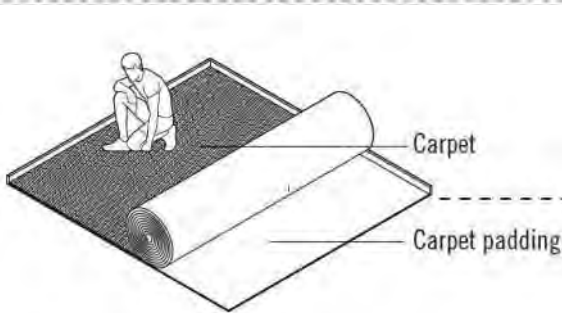
**Asphalt Shingles**  
Petroleum derivatives, respiratory effects, skin cancer



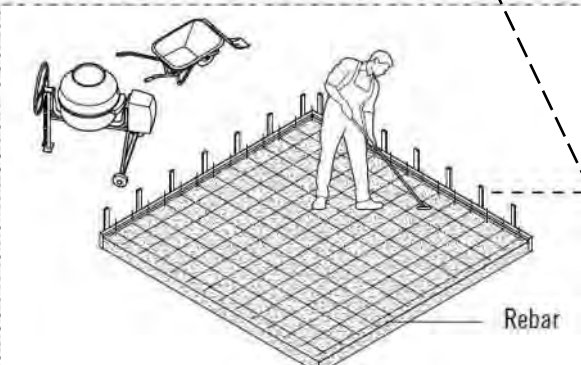
**Spray Foam Insulation**  
Isocyanates – asthma, cancer, neurological and reproductive effects



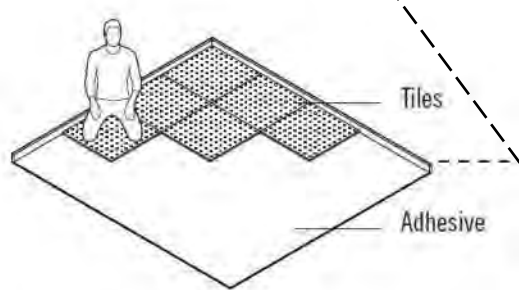
**Carpeting**  
Organotins and phthalates  
cancer, thyroid disease

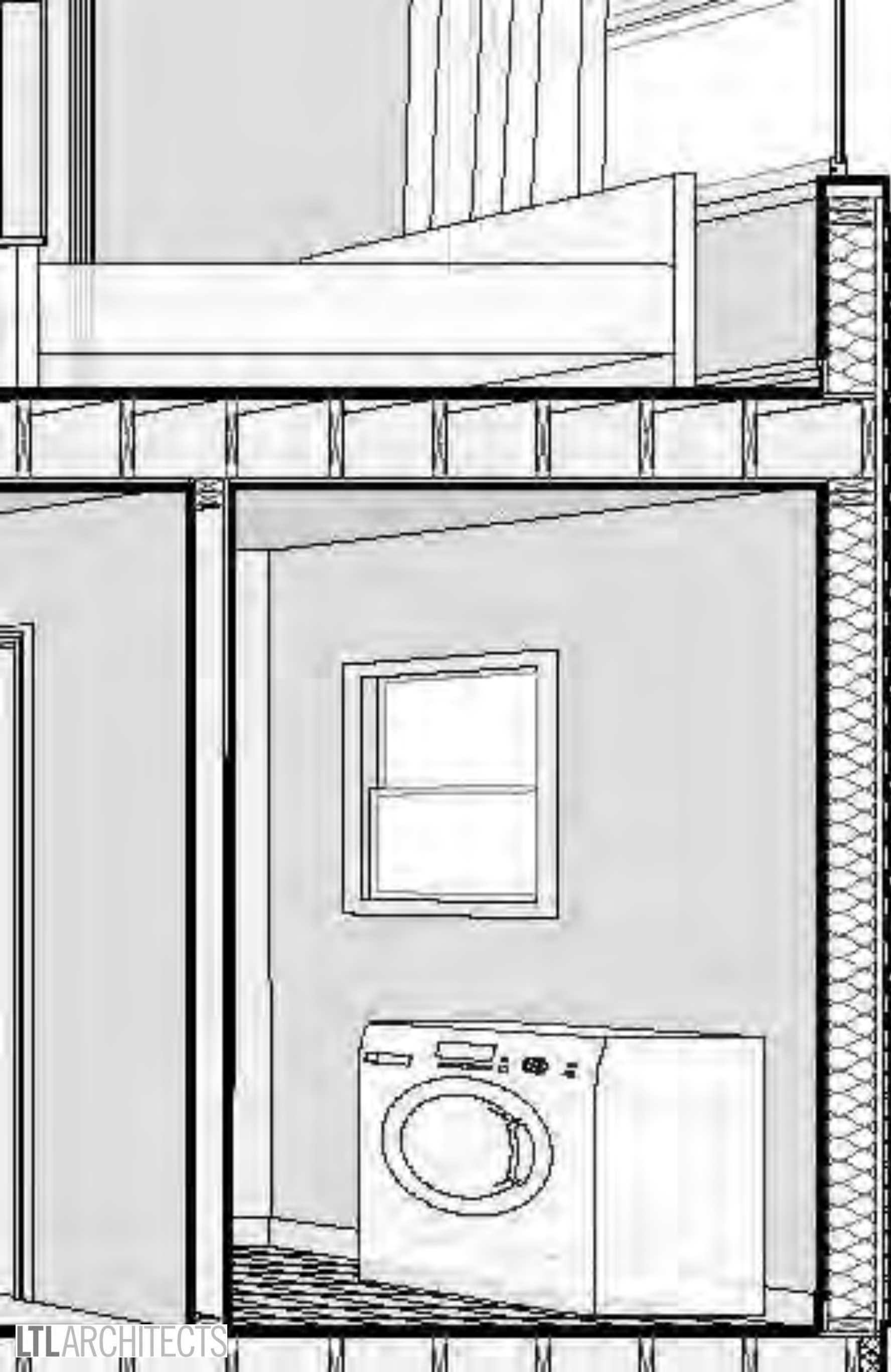


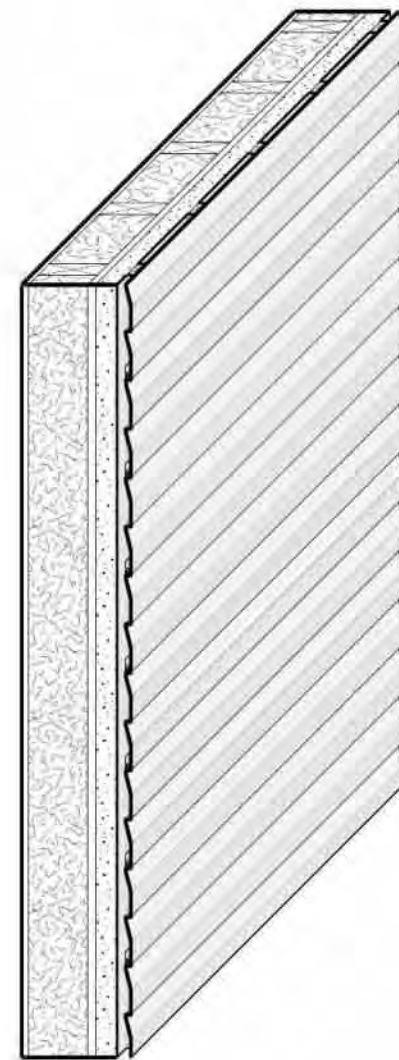
**Concrete**  
Fly ash, heavy metals  
Respiratory effects

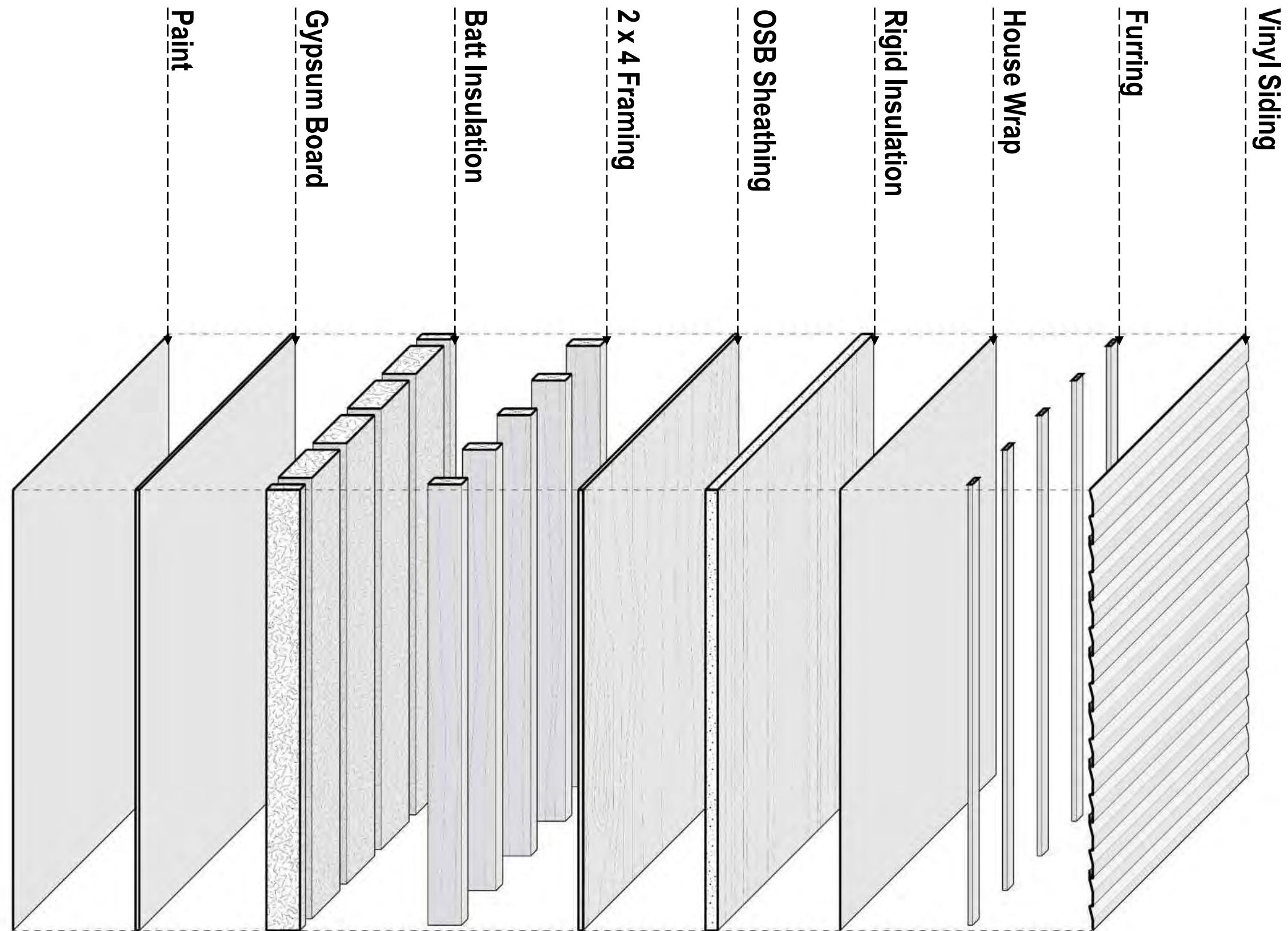


**Vinyl Tiles**  
Chlorine, mercury,  
asbestos, pvc's, lead,  
and arsenic

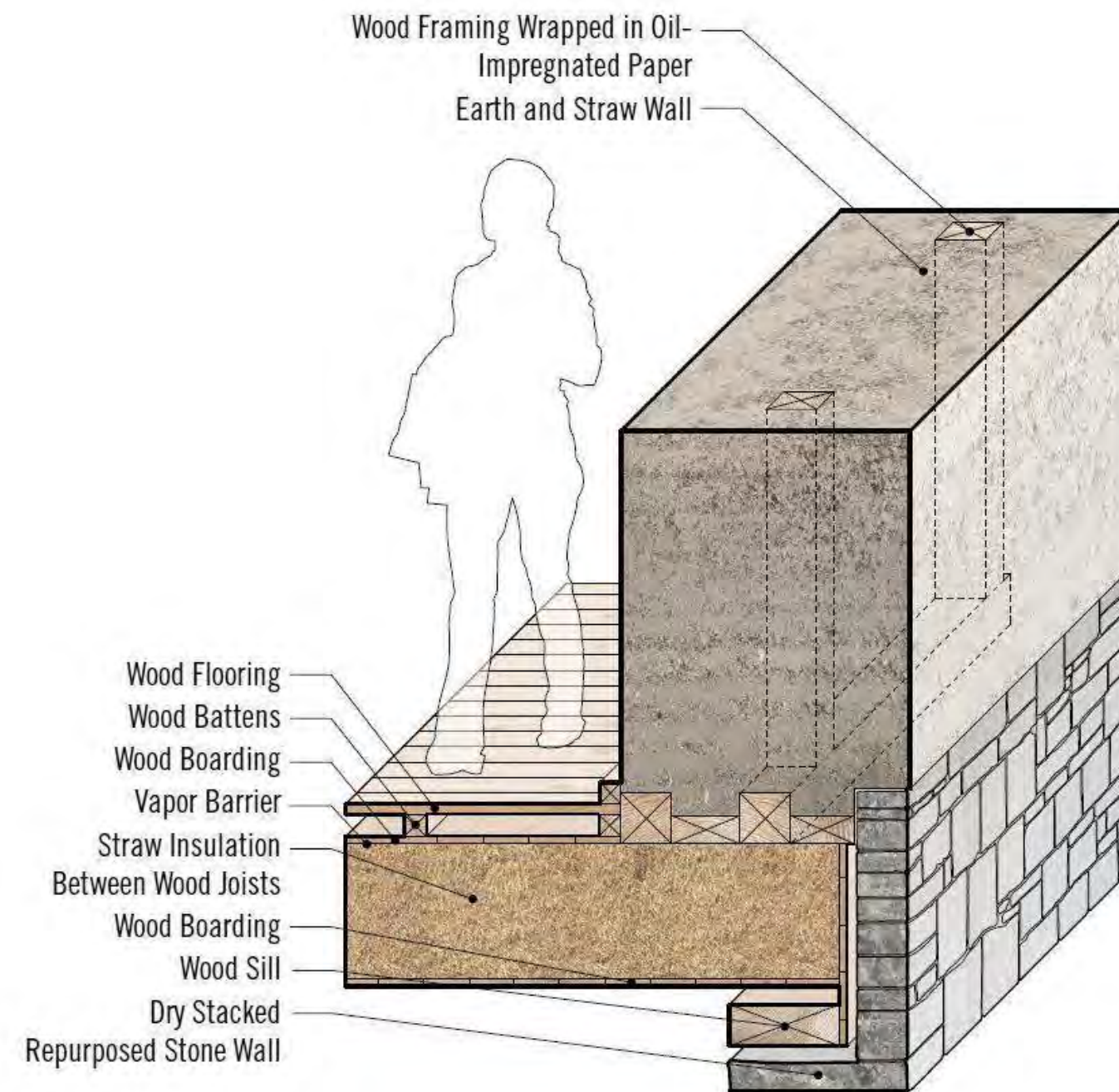






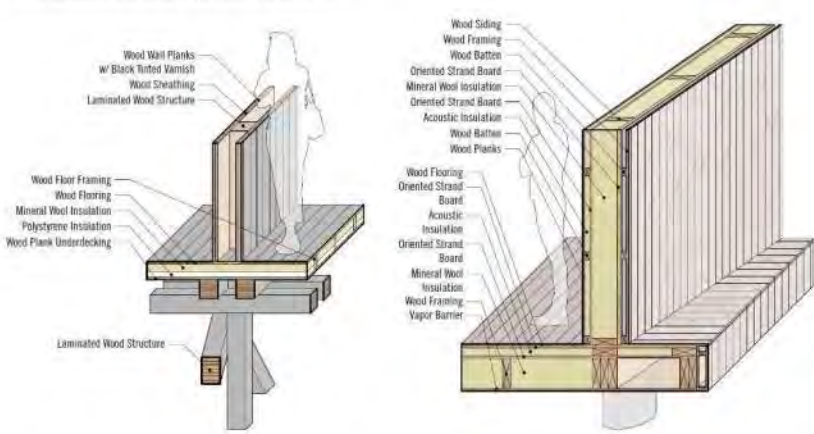


**Lightweight, thin, single-performing, multiple, hygienic layers  
producing a strict binary between interior and exterior.**



Material Assemblies

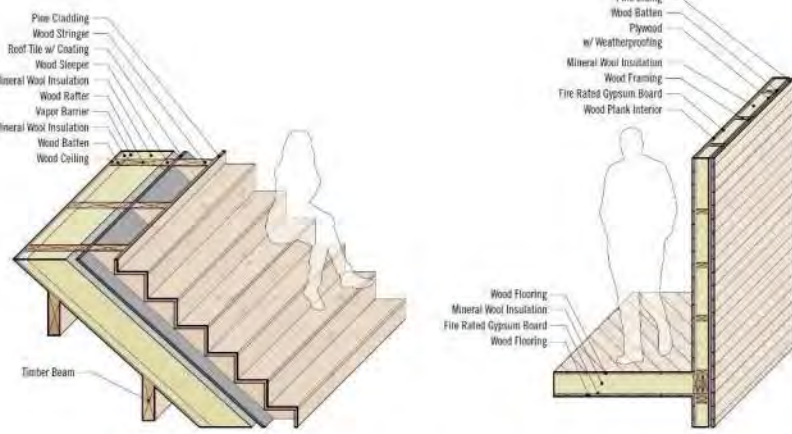
Section anatomies of the salient material techniques of each house



Wood Frame

Wood House  
Smiljan Radic

Zilvar House  
ASGA Design

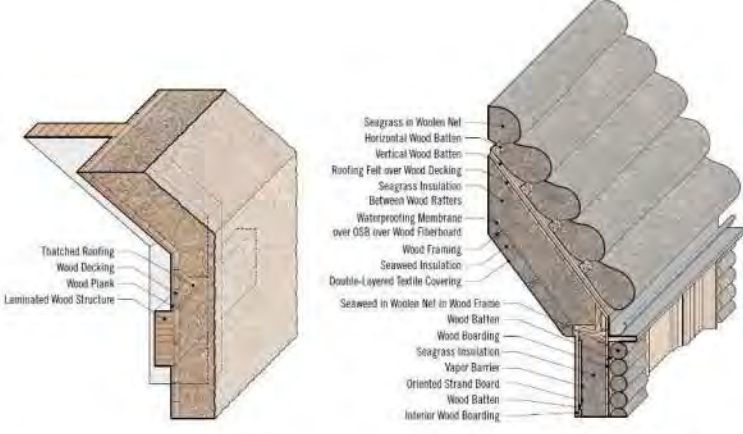


Thunder Top Cabin

Gartnertuglen Arkitekt

Gago House  
Pezo von Ellrichshausen

Straw (cont.)



Dune House

Archispektras

Modern Seagrass House

Vandkunsten Architects

Hemp

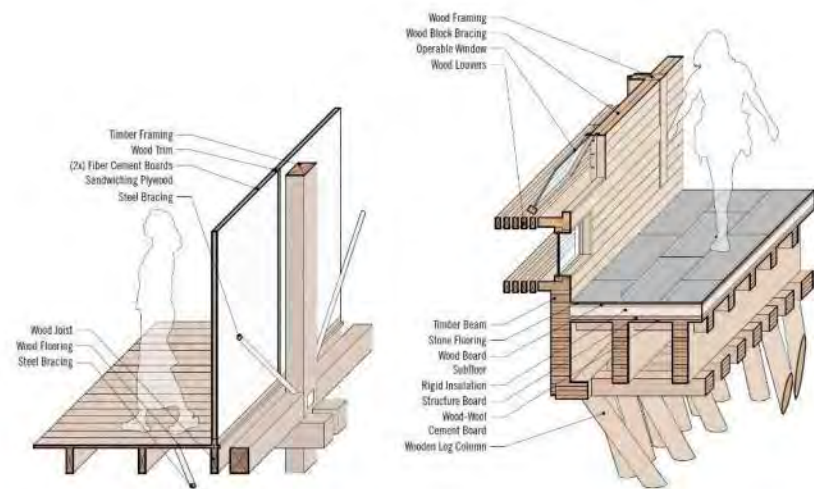
Riches Hawley Mikhail Architects

Flat House

Practice Architecture

Clay Field

Riches Hawley Mikhail Architects

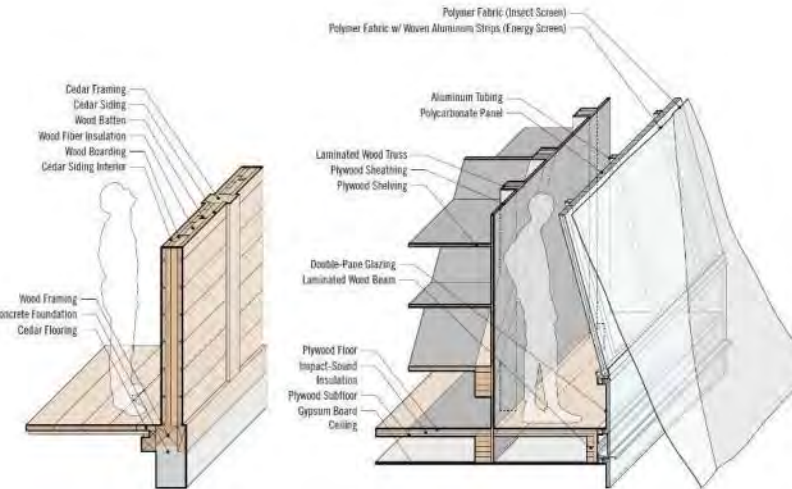


Helio Olga House

Marcos Acayaba Arquitectos

House in Itsuura

ADX

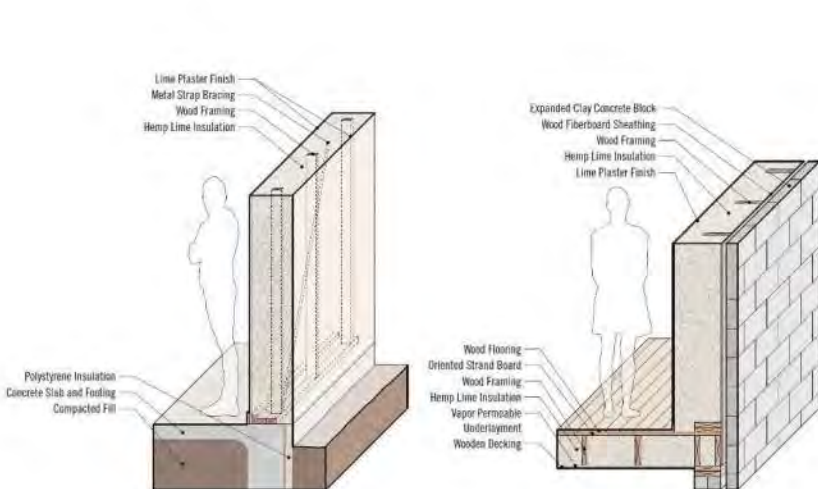


Oigachi House

Tomoaki Uno Architects

Wall House

FAR Irwin & Rojas

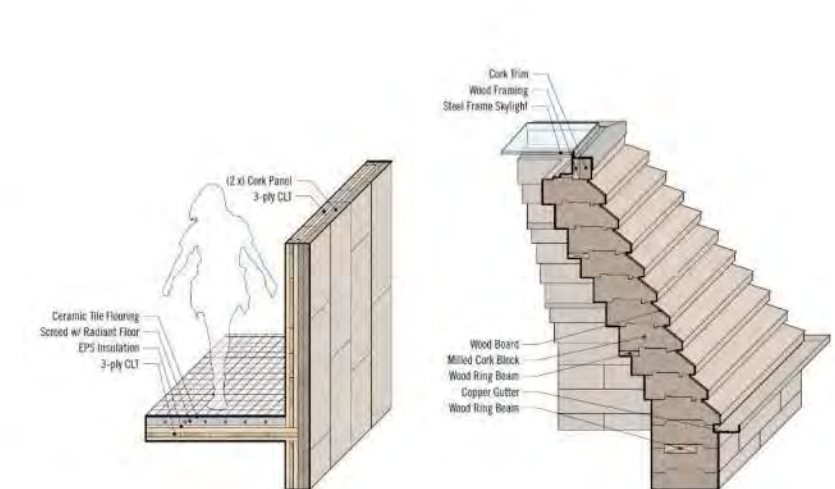


Mudjee Hempcrete House 2

Enviroecture

Low Energy House in Uccle

Karbon Architecture et Urbanisme



Cork

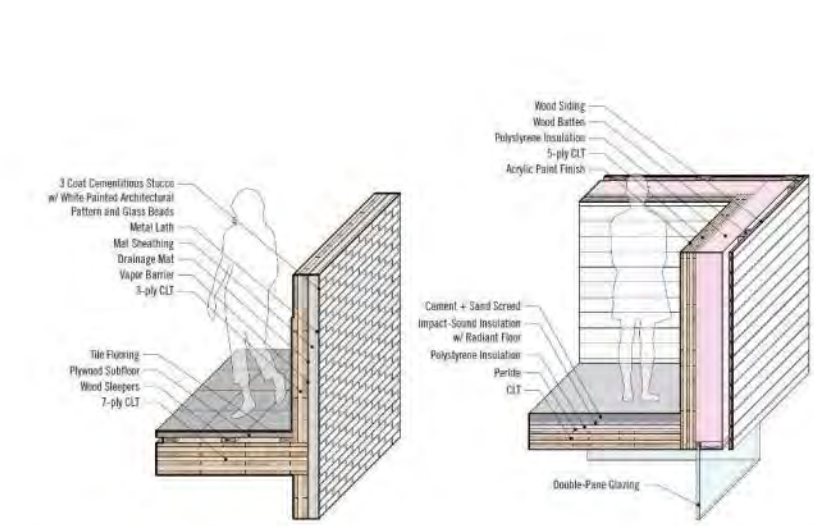
Emiliano López Mónica Rivera Arquitectos

Two Cork Houses

Emiliano López Mónica Rivera Arquitectos

Cork House

Matthew Barnett Howland with Dido Milne and Oliver Wilton



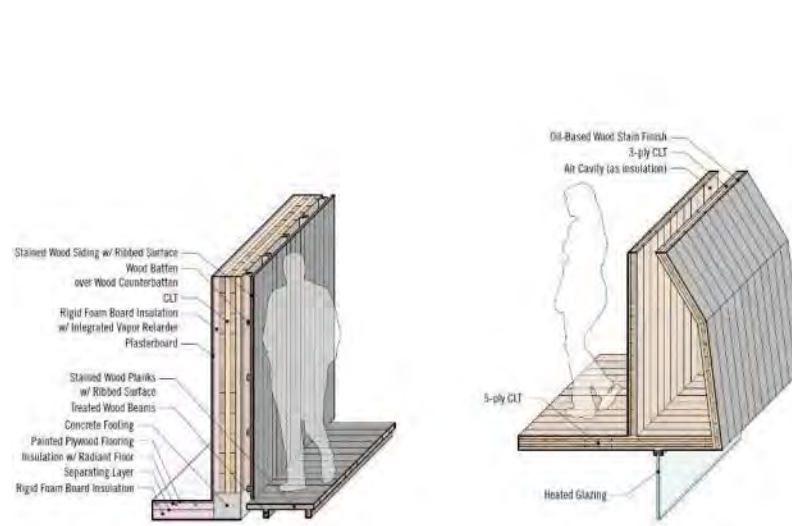
Mass Timber

Haus Gables

Jennifer Bonner / MALL

House W

Kraus Schönberg Architects

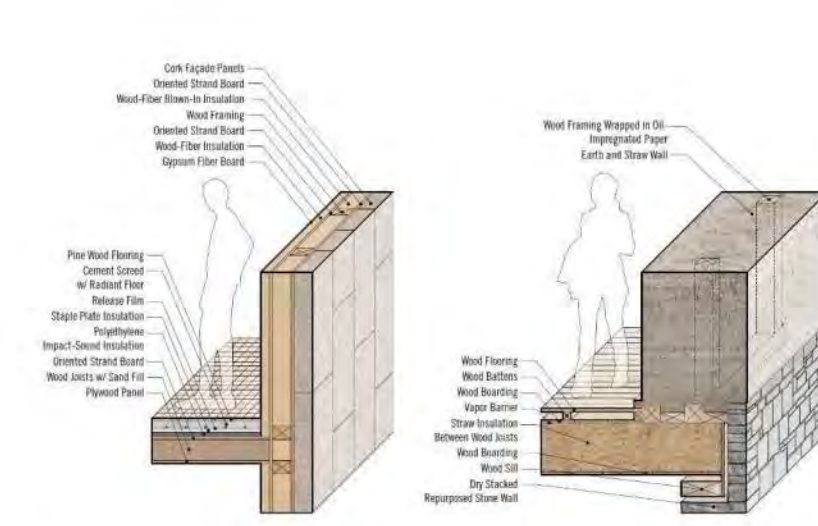


Sunken House

Adjaye Associates

Meteorite

Atefja Sotomay



Cork (cont.)

Cork Screw House

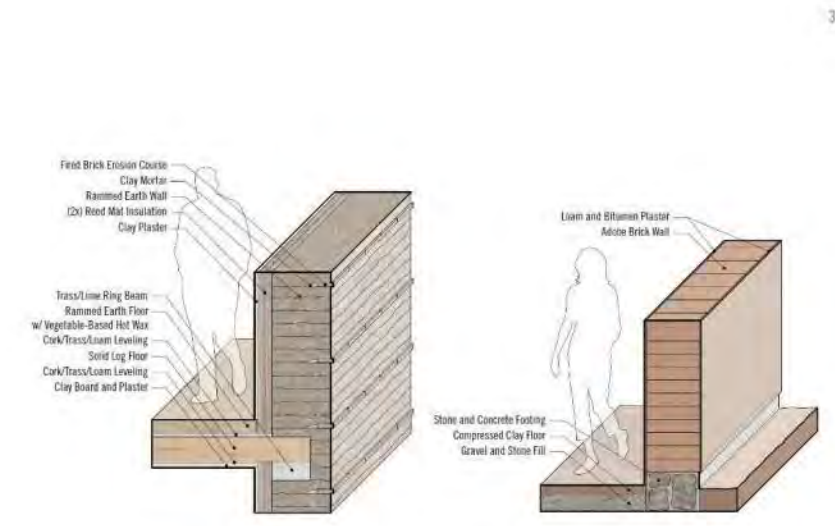
rundziwi Architekten



Earth

Wohnhaus Flury

spaceshop Architects

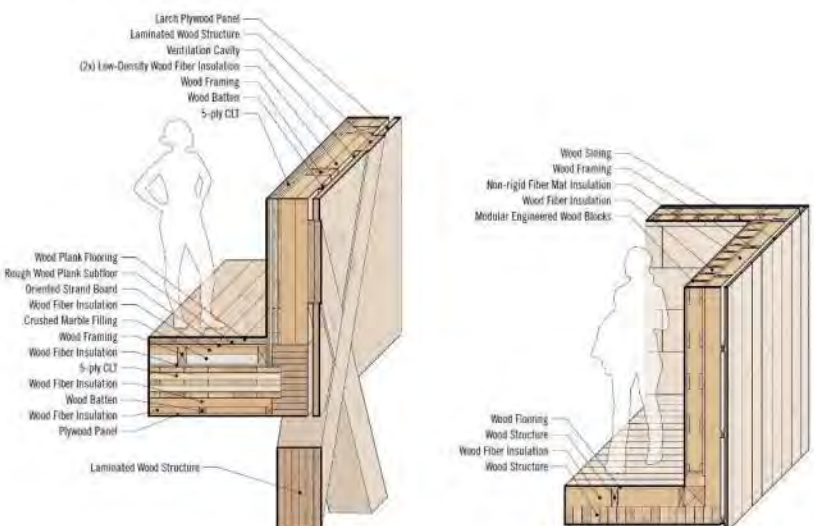


House Rauch

Bollshauer Architects, Lehm Ton Erde Baukunst

Gando Teachers' Housing

Kéré Architecture

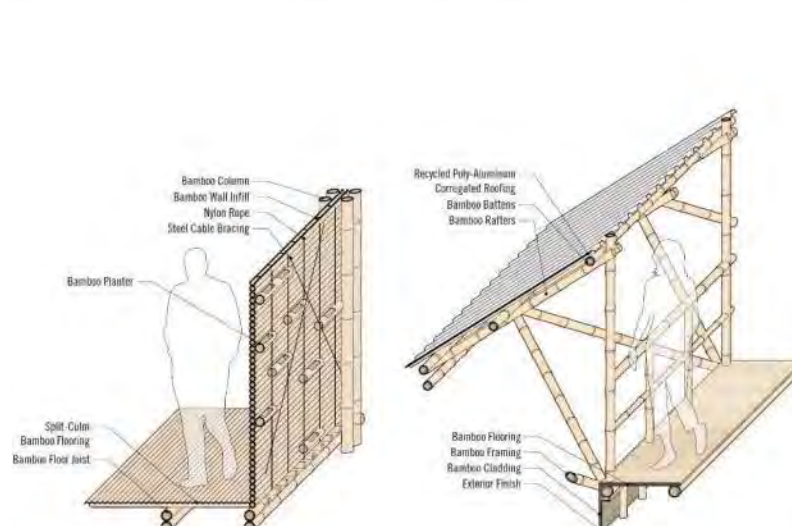


Kostner House and Studio

MoBus Architects

House Körös

Zeller & Moya



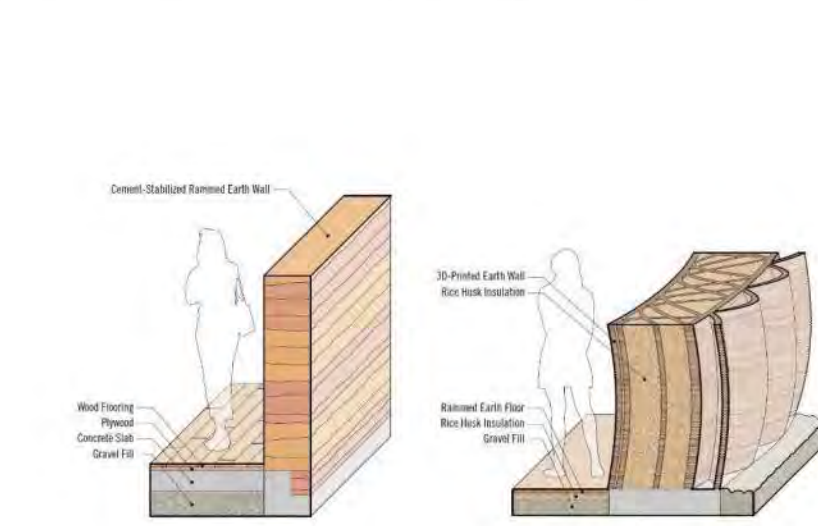
Bamboo

Blooming Bamboo Home

N&P Architects

From the Territory to the Dweller

Rozana Montiel Estudio de Arquitectura

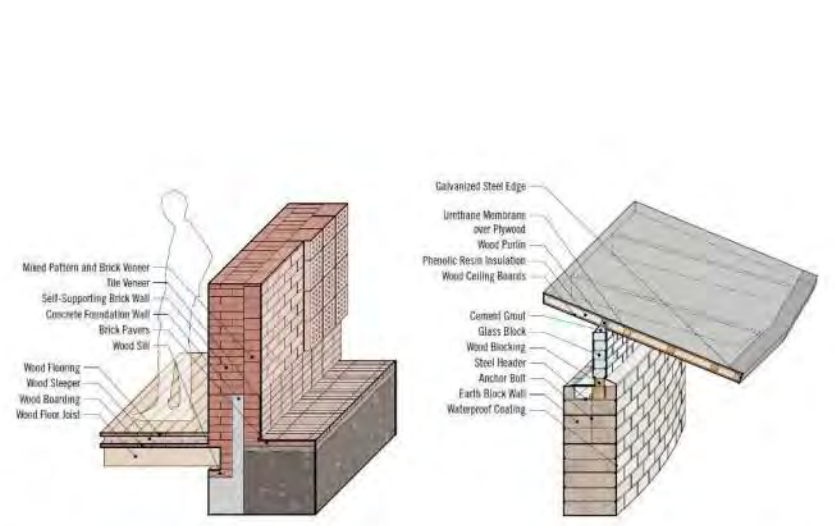


Dong Anh House

Vo Trong Nghia Architects

TECLA - Technology and Clay

Mario Cucinella Architects



Brick

Muuratsalo Experimental House

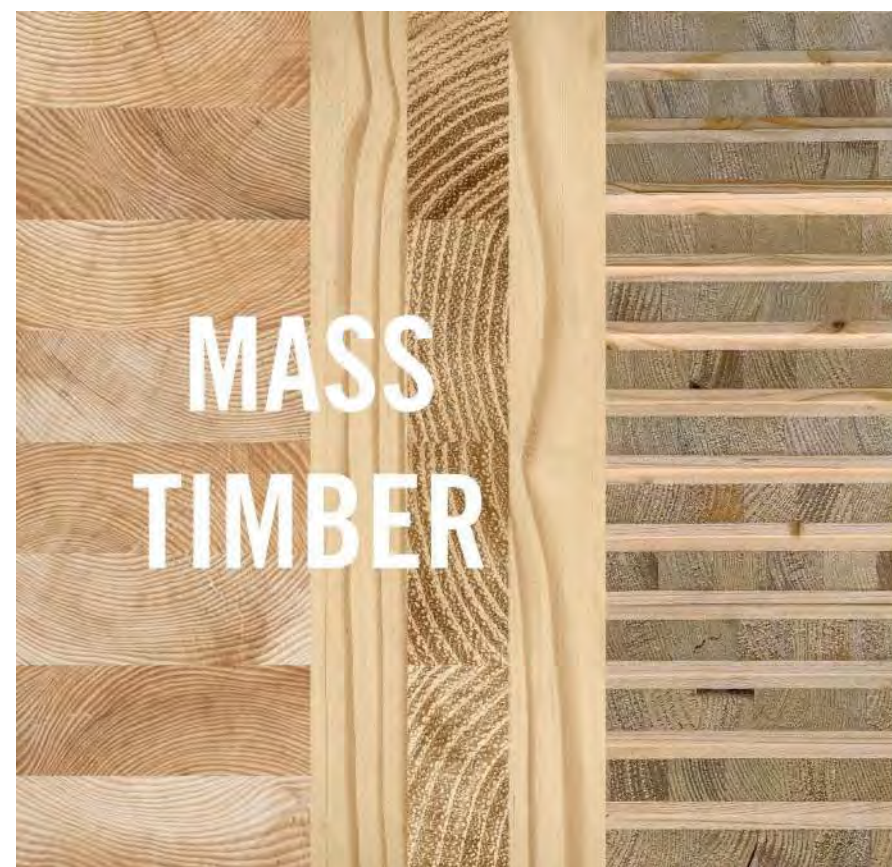
Alvar Aalto

Earth Bricks

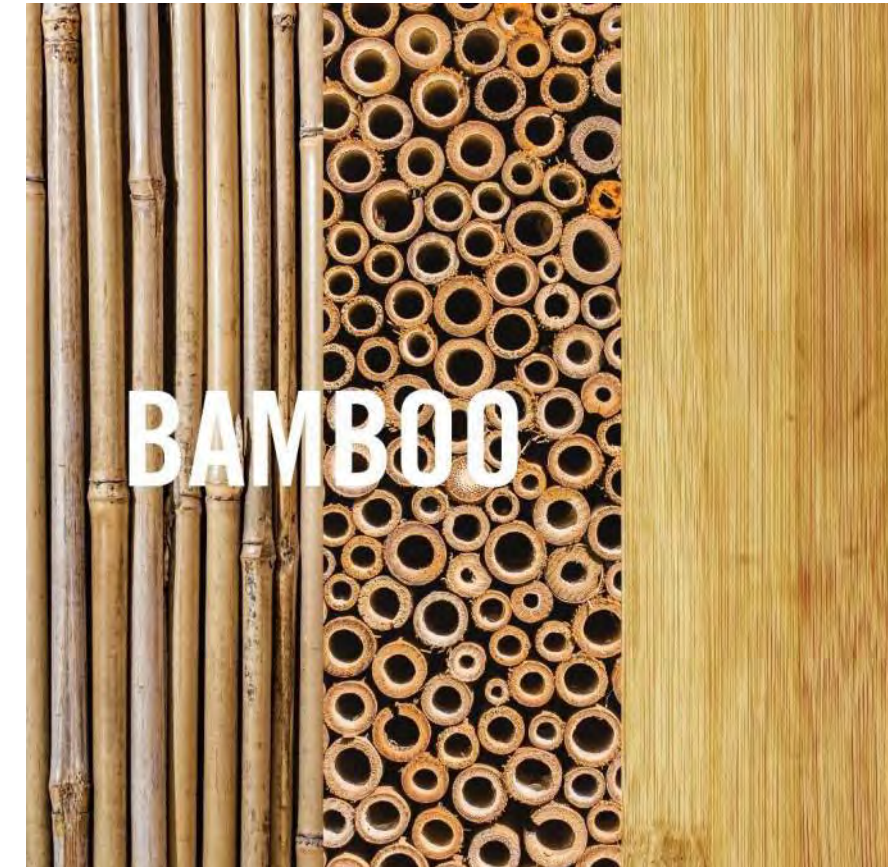
Atelier Tekuto



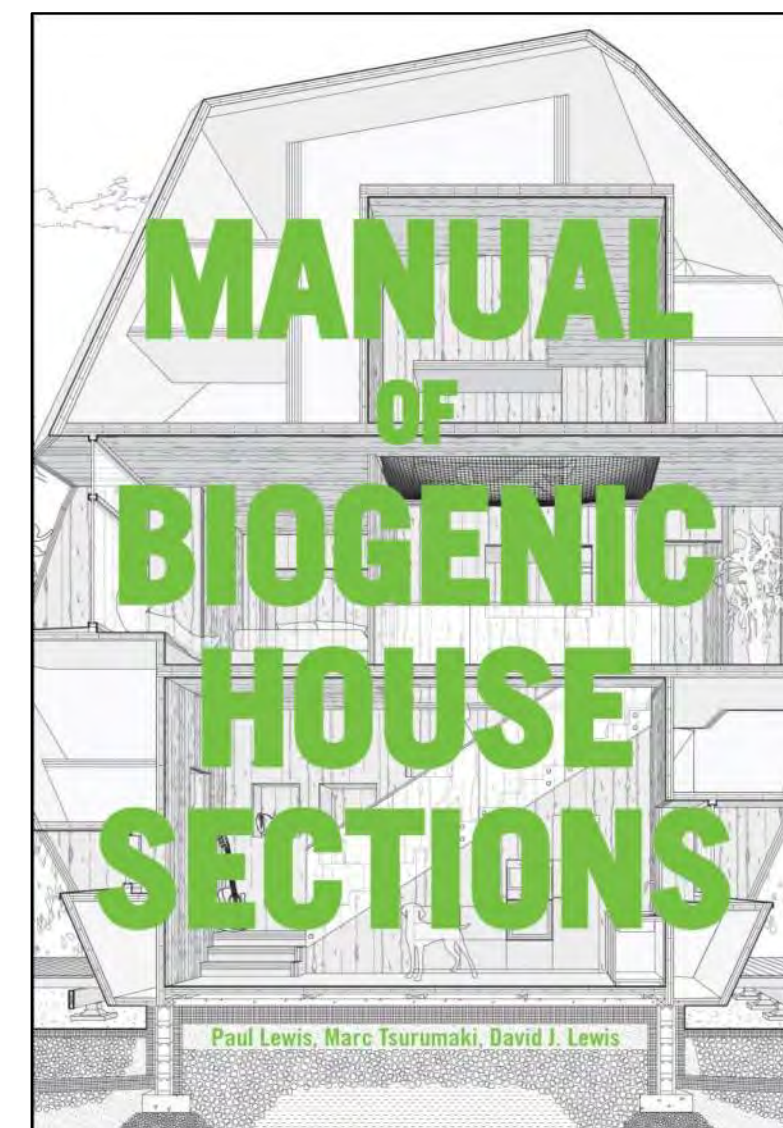
WOOD  
FRAME



MASS  
TIMBER



BAMBOO



CORK



HEMP



STRAW



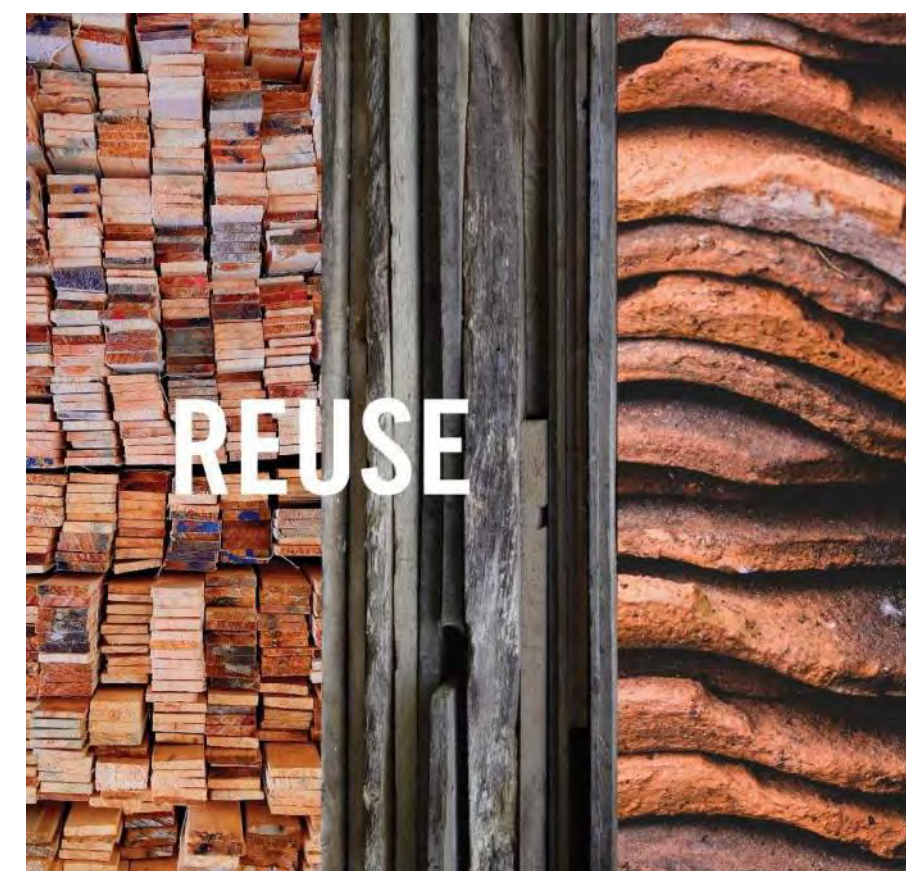
EARTH



BRICK

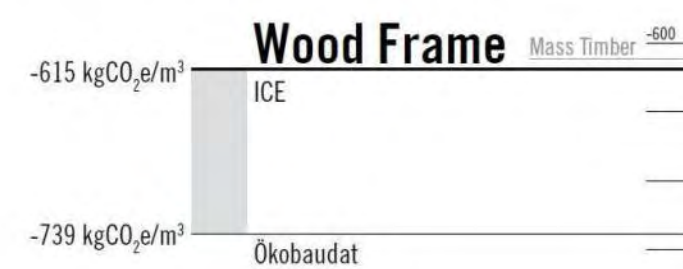


STONE



REUSE

# WOOD FRAME



# WOOD FRAME

Wood frames are the most common form of North American house construction, using standardized lumber dimensions and conventional 16 in to 24 in stud spacing. Although most wood frame construction is based on platform framing, with each floor resting on the walls below, other approaches include continuous vertical balloon framing and heavy timber post and beam. In each type, the stick construction is combined with lateral bracing, typically a stress skin of plywood or oriented-strand board. Although trees sequester carbon during their growth with about 50% of the dry weight of wood composed of carbon, lumber's value as a carbon sink is qualified by industrial harvesting, potential damage to forests, and the release of carbon stored in its soils and ecosystems. Responsible forest stewardship is a critical factor in lumber's net carbon benefits.

## GROWTH

Trees take decades to grow. Responsibly managed forests, such as those certified by the Forest Stewardship Council, are critical to wood's overall carbon impact.

## HARVEST

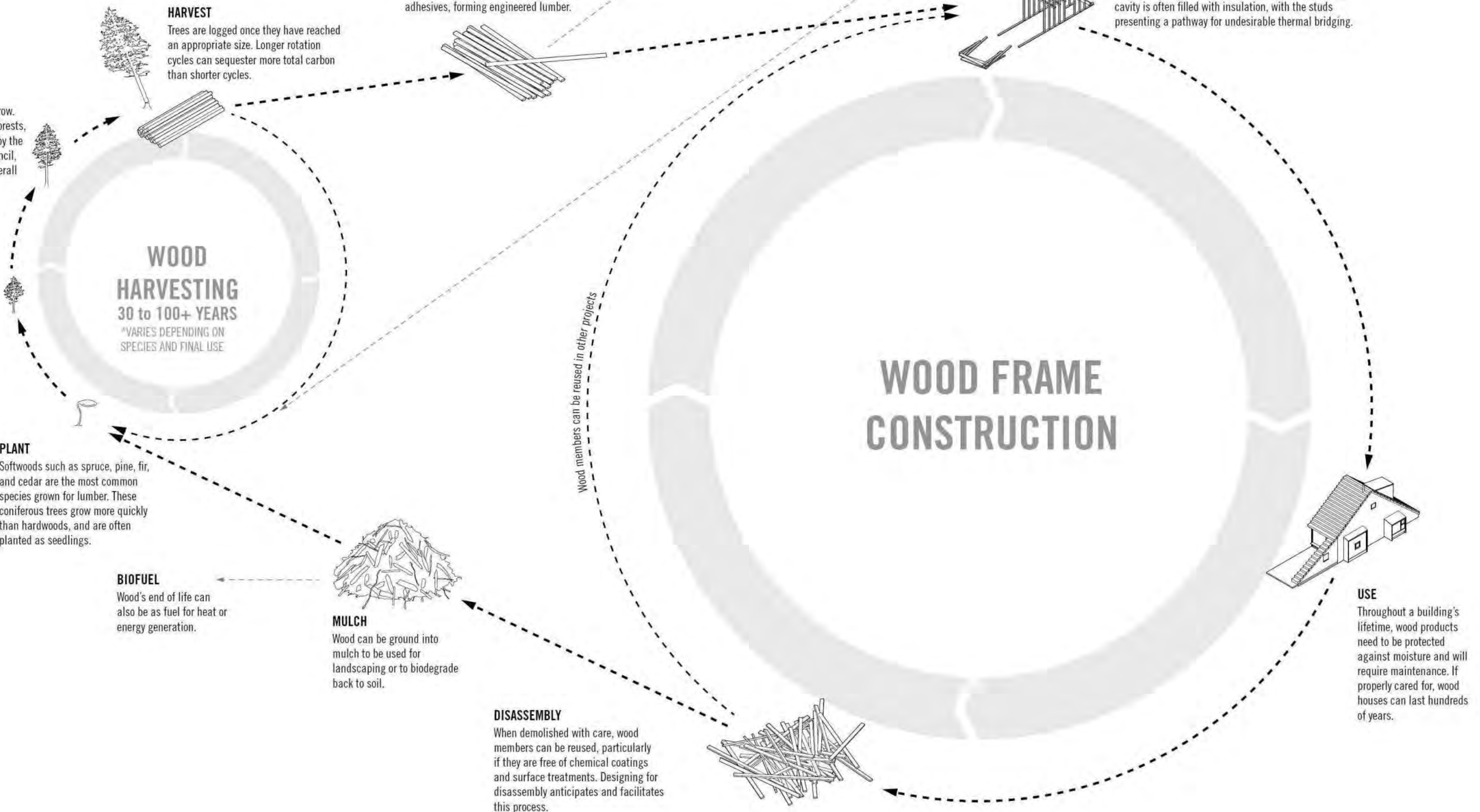
Trees are logged once they have reached an appropriate size. Longer rotation cycles can sequester more total carbon than shorter cycles.

## MANUFACTURING

Lumber can be manufactured via sawing and milling operations, and by the use of adhesives, forming engineered lumber.

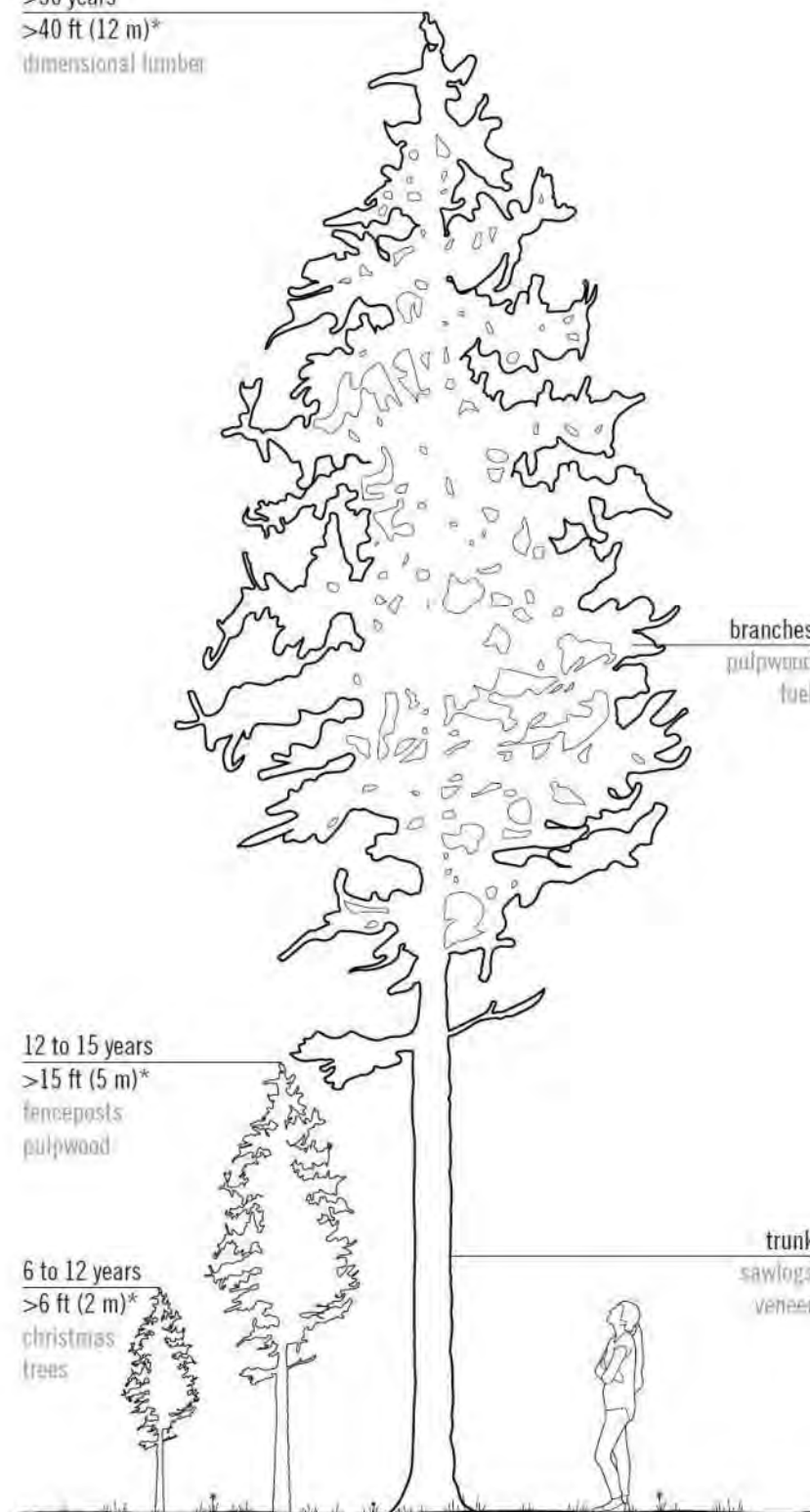
## CONSTRUCTION

Lumber's range of sizes allows it to be used in a wide variety of building assemblies. Yet, almost all combine stick framing with lateral bracing or skins. The hollow cavity is often filled with insulation, with the studs presenting a pathway for undesirable thermal bridging.



# WOOD FRAME

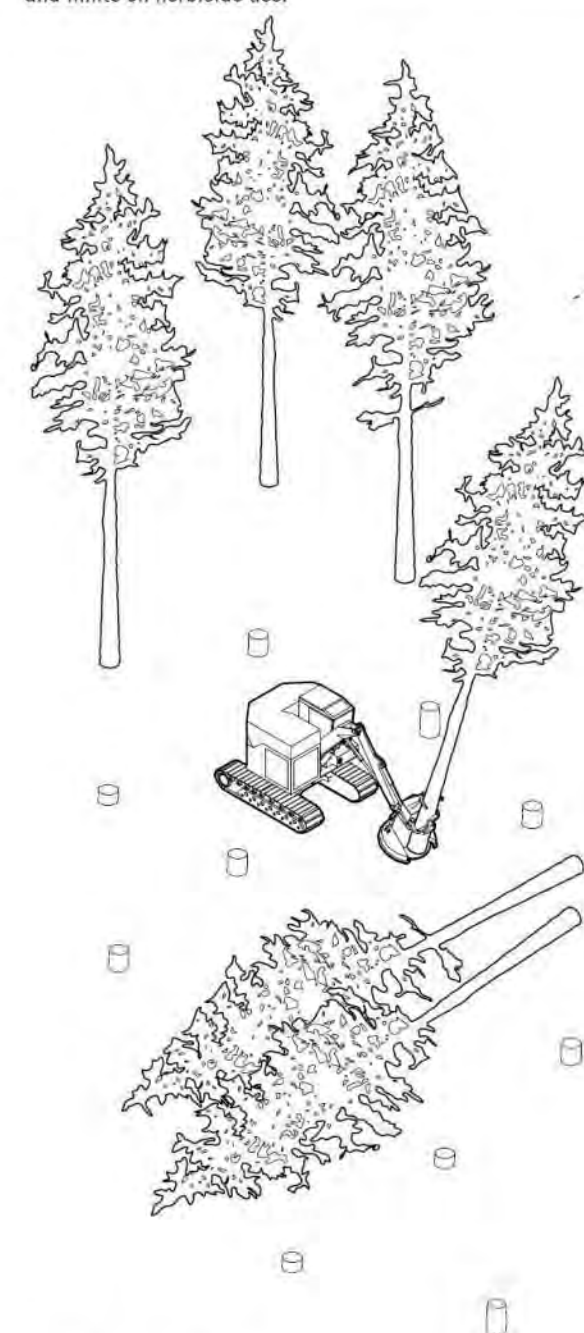
>30 years  
>40 ft (12 m)\*  
dimensional lumber



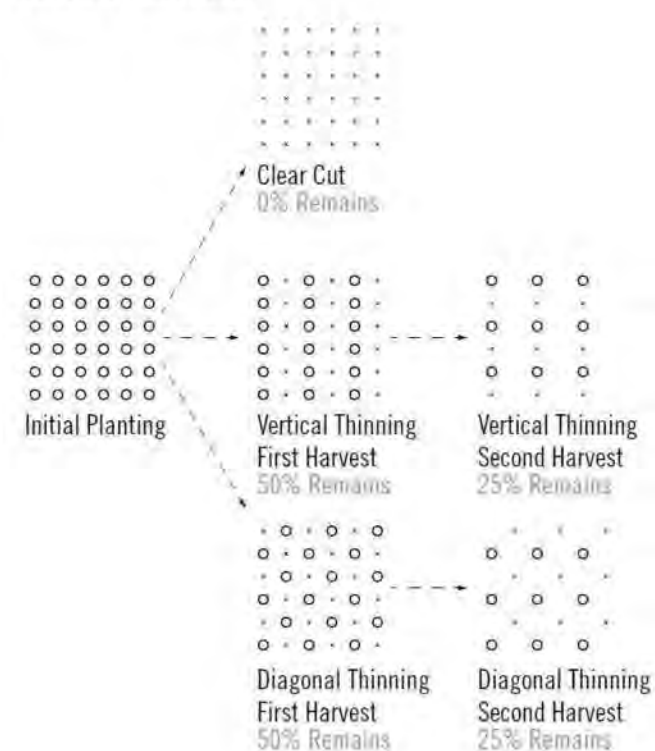
\*height and timeframe are averages; actual values vary by species and environmental factors

## LOGGING

Essential to wood's overall carbon and environmental impact, forest stewardship standards include longer growth cycles and time between harvest, smaller clear cuts, wider waterway buffers, and limits on herbicide use.

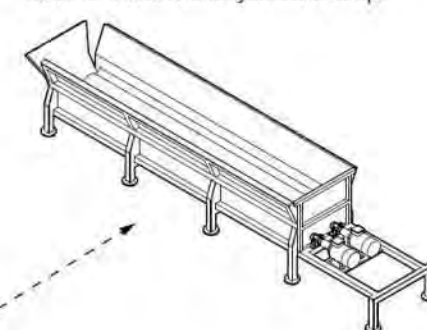


## LOGGING STRATEGIES



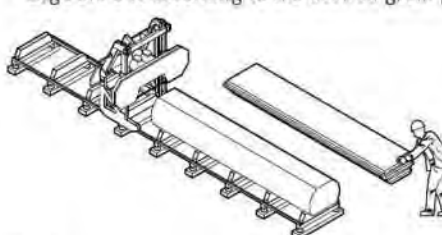
## DEBARKING

The tree trunk is stripped of its bark to achieve a consistent cylindrical shape.

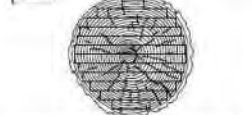


## CUTTING

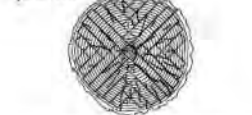
Logs are cut according to the desired grain pattern.



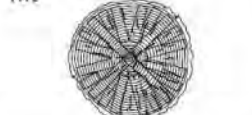
plain



quarter

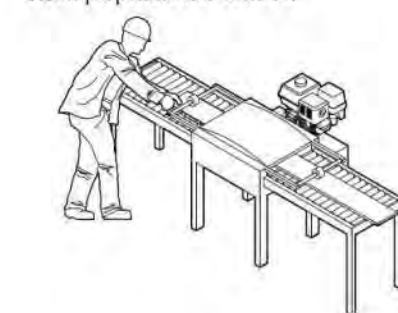


rift



## EDGING

The edges of boards are trimmed leaving clean perpendicular corners.

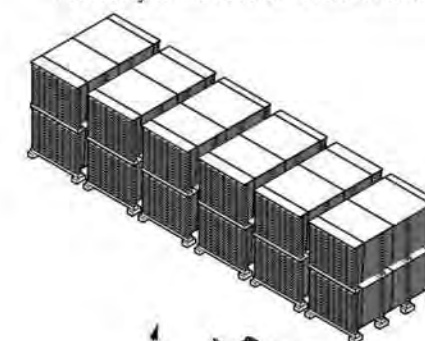


## INSULATING

Wood framed walls leave a void between the studs which is often filled with insulation. More insulation can be added as a continuous layer outside of the studs which also provides a thermal break to the studs. Biogenic insulation includes cellulose, wood fiber, hemp, straw, wool, denim, and seagrass.

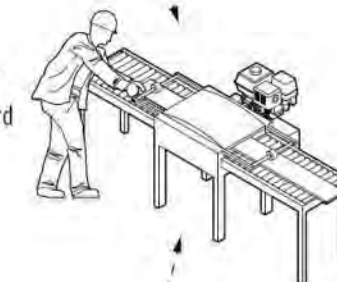
## AIR DRYING

Boards are left to dry via natural means, which may take a year or longer. Drying is necessary to increase dimensional stability.



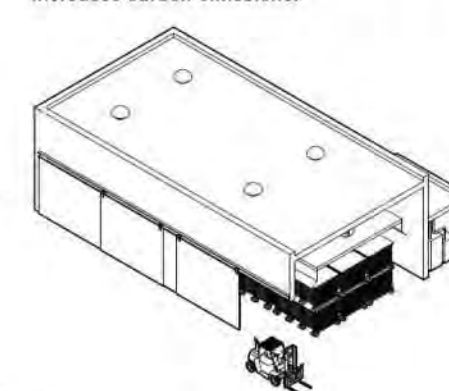
## FINISHING

Planing and routing of the edges of each board produces their final dimensional profile.



## KILN DRYING

Large buildings dry the lumber via mechanical means. Drying is necessary to increase dimensional stability. Although much faster than air drying, kiln drying increases carbon emissions.



## HALF TIMBER



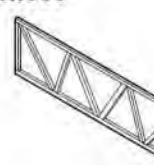
## MOMENT FRAME



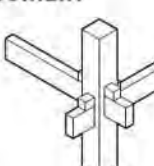
## LIGHT FRAMING

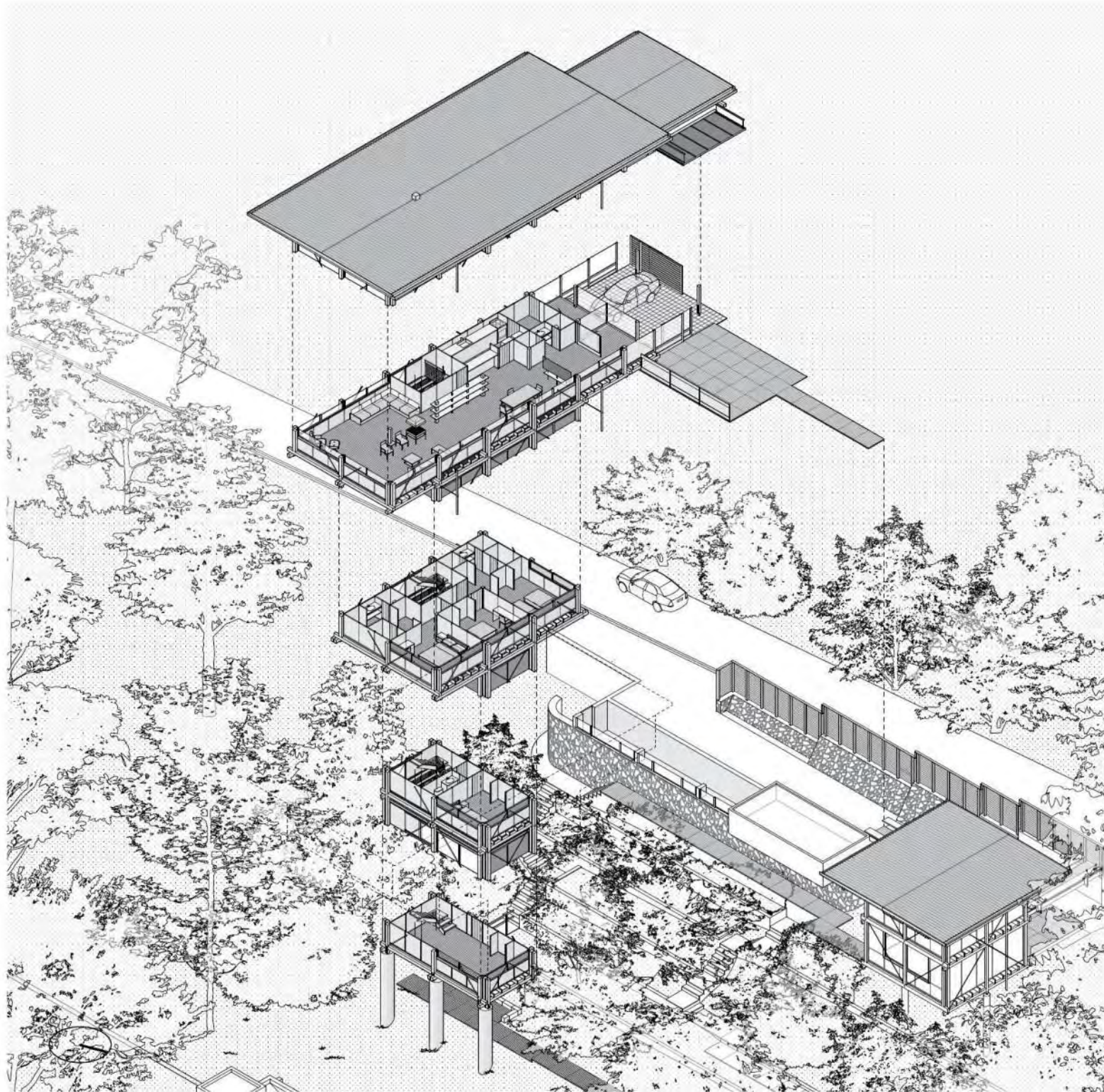


## TRUSS



## JOINERY





## Helio Olga House | Marcos Acayaba Arquitetos

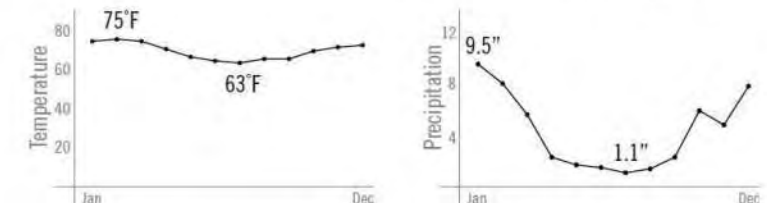
Built as a more efficient and less expensive way to inhabit a steep slope, this house is constructed from a wood frame in an inverted stepped pyramidal section. As such, the house is supported by only six slender concrete piers at its base, but expands to a large living area on the

top level contiguous with the upper elevation of the site. With its wood structure positioned on the exterior, the interior of the house comprises 20 cubes of space, with 10 forming the main living, kitchen, and dining floor; six on the floor below housing three bedrooms; and two additional levels



of two volumes containing a guest bedroom and den. A single stair on the southern side connects vertically between all the levels. Continuous ribbon windows on each level provide panoramic views of the city to the east.

## São Paulo, Brazil | 1990





## Helio Olga House

The house was constructed with prefabricated components, and its wood frame used as an exoskeletal structure. The corner joints were designed with intricate wood joinery, with as many as 10 separate wood members connecting through an interlocking array of bridal, mortise and tenon

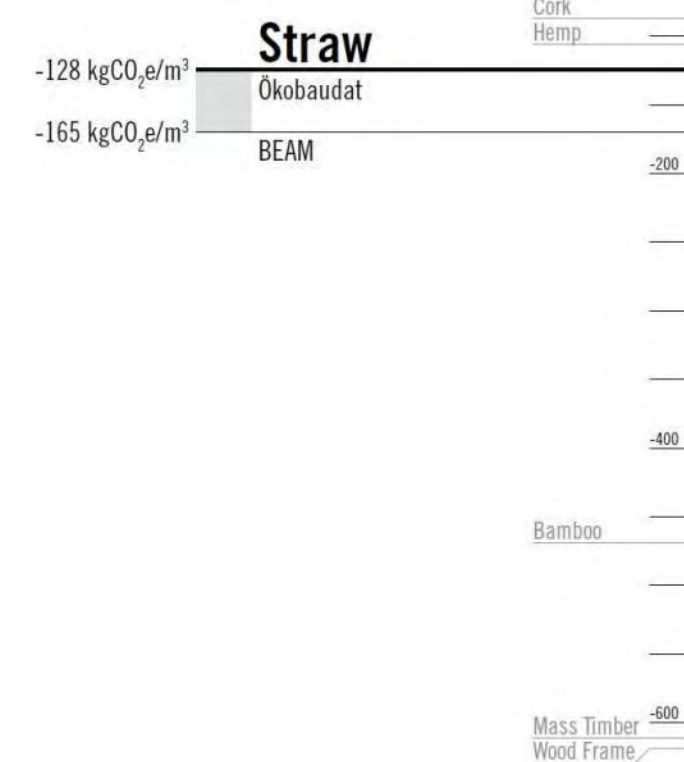
joints. The system allows additional posts to be added to the central columns without changing the thin profile of the grid. Wood members extend slightly beyond the joint, emphasizing the autonomy of the parts, while diagonal steel struts reinforce and visually register the structural

cantilevers. The beams under the upper floor anchor to the top surface of the driveway, additionally securing the top portion of the house to the hill. Lighter-weight joists span above and below the frames, supporting smooth surfaces of wood floors and ceilings, and the gap between provides

a ventilated cavity above and below each room. Lightweight walls internal to the frame produce a smooth, gossamer surface, much of which is glass. Wide roof overhangs shade the building, and continue the cascading form of this distinctive and tectonically explicit house.



# STRAW



# STRAW

Straw is a byproduct of critical food sources (wheat, rice, oats, barley, rye) and can be found throughout the world. After the seeds have been harvested, straw is the residual stock and not to be confused with hay, which is feedstock. Straw is about 40% carbon, and is transformed into a more useful form for construction by baling machines. Although globally it absorbs a massive amount of carbon dioxide each year, straw is left to decompose or is burned returning the CO<sub>2</sub> to the atmosphere. As a fast growing, inexpensive, ubiquitous, minimally processed, agricultural byproduct, straw has enormous capacity to sequester carbon as a building material. Primarily used as insulation with an R-value of 1.5 to 2 per inch, it can also be a load bearing material. In either condition, its clay, lime, or cementitious plaster skin is critical to its performance and aesthetic, and the source of much of its labor and cost as a building system.

## HARVEST

Cut close to the ground, straw is the stock remnant after the seeds have been removed by harvesting equipment. Mechanical hay baling machines compress and strap straw into rectangular or circular units for easier distribution and use.

## GROWTH

The growth cycle of all cereal grains is less than a year, significantly shorter than any other plant used in building. More importantly, straw is the waste product of these food grains.

## PLANT

The impact of straw is directly related to its place in larger agricultural practices, and their impacts. The industrial farming of wheat and other cereal grains often involves the use of fertilizers, herbicides, and pesticides.

## BIOFUEL

Straw's end of life can also be as fuel for heat or energy generation.

## MULCH

Straw can be ground into mulch, to be used for landscaping or to biodegrade back to soil.

## BALING

The size of the bales is contingent on the type of baler. These can range in size from a two-string rectangle weighing about 50 lbs (22 kg), to large round bales that can weigh over a ton. Larger bales can be compressed to much higher density, beneficial to being used as a load bearing structure.

## PREFABRICATION

Straw as insulation can be combined with wood frames into prefabricated units in more controlled off-site factories. This avoids some of the moisture challenges of on-site construction with straw. Dry or wet skins can be applied off-site.

## PLASTERING

Clay, lime, and/or cement is frequently used as a plaster skin, applied directly to the rough surface of both sides of straw-bales. Plaster skins are typically the air, water, and vapor controls of the assembly, as well as integral to the structural capacity of the straw wall.

## CONSTRUCTION

Straw can be used as a load bearing structure, as infill to a structural frame, or within prefabricated units. The size and type of bale or prefabricated cassette has a significant impact on the geometry of the building.

## USE

Given their thickness, straw-bale walls have excellent thermal values (approximately R-25 to 35), while their hygroscopic attributes helps balance interior humidity. With careful selection of the material for their skins, straw-bale walls can improve indoor air quality, and can have many times the thermal mass of a conventional stick framed wall.

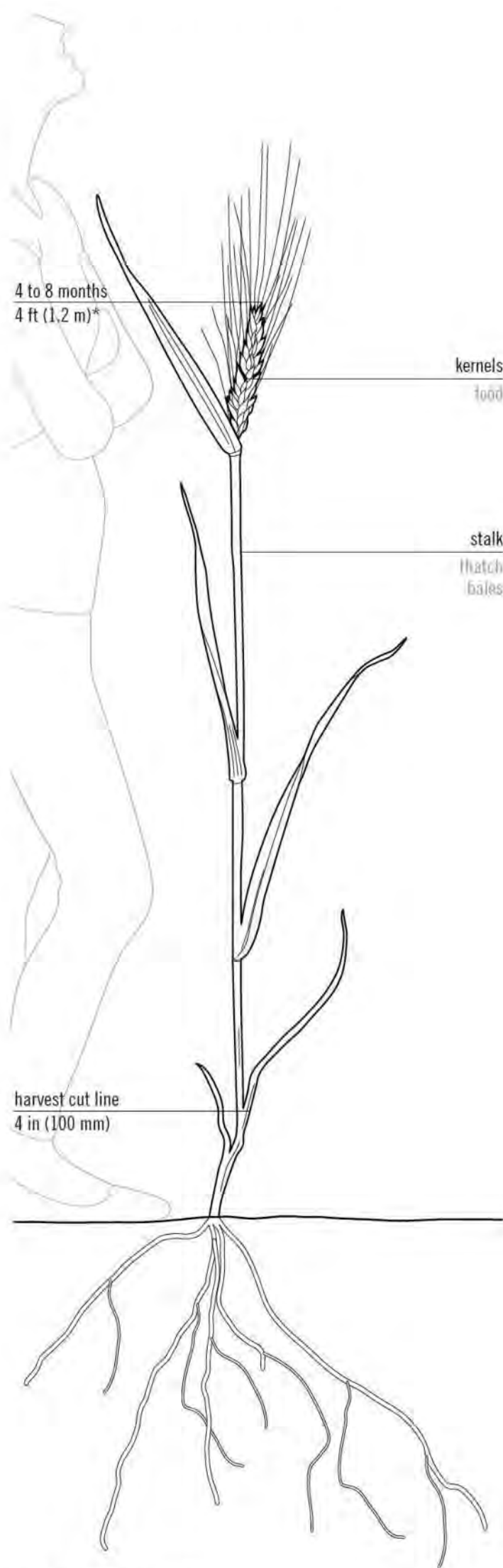
## DISASSEMBLY

Prefabricated panels can be designed to be detachable and reused. Straw-bale walls can decompose, particularly if their skins are clay-based or removable.

Prefabricated panels can be reused in other projects

# STRAW CONSTRUCTION

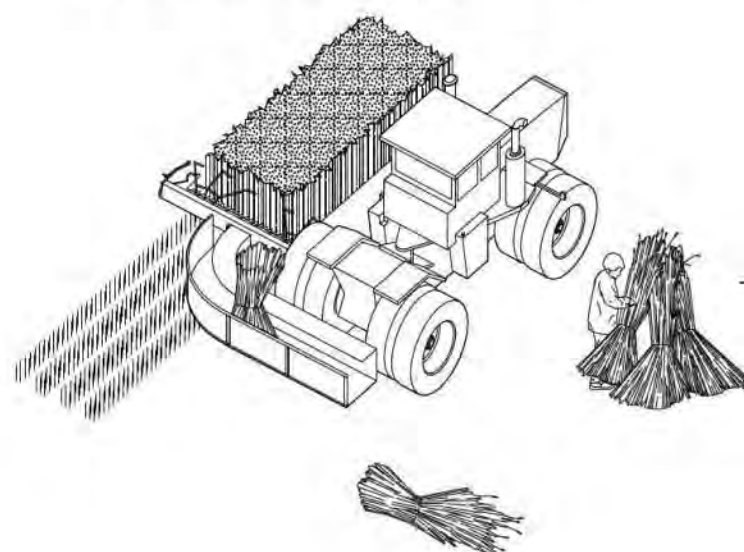
# STRAW



\*height and timeframe are averages;  
actual values vary by planting  
season and environmental factors

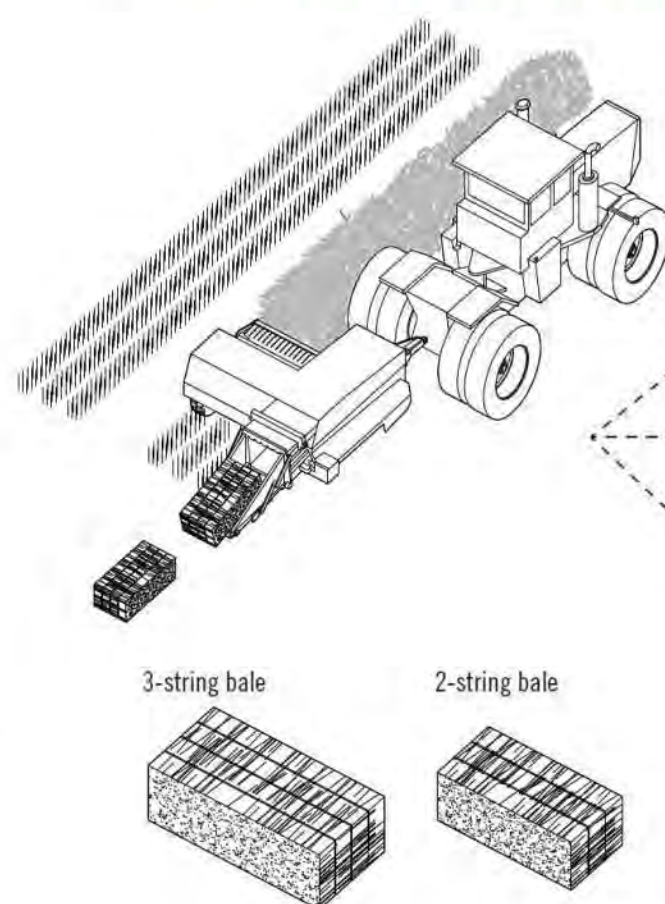
## HARVESTING

Reeds for thatching are harvested into carefully formed bundles, while sea grasses are gathered from the shoreline. Straw is typically gleaned from fields after the cereal grains have been removed.



## BALING

The most common grains used to make straw-bales are wheat and rice. Both are harvested and formed into bales after the seed kernels have been extracted and the stocks are sufficiently dry. Although bale sizes vary depending on the baling equipment, two-string bales are roughly 14 by 18 by 36 in (360 by 460 by 910 mm) while three-string bales are roughly 16 by 23 by 46 in (410 by 580 by 1170 mm). Jumbo rectangular and circular bales can also be used. Most commonly, the bales are positioned flat with the strings within the walls, allowing the outer sides to be notched for posts.



## PLASTERING

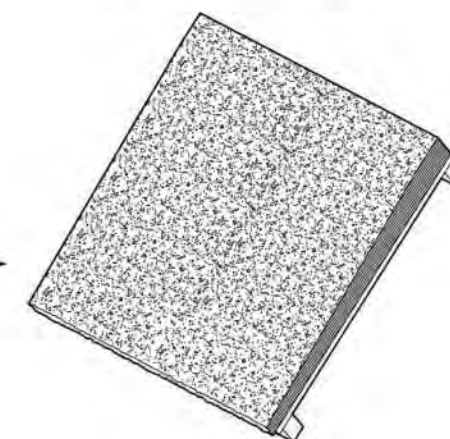
The plaster skin is a crucial component of straw-bale construction, contributing significantly to its structural capacity, and its resistance to fire, moisture, and vermin. Although slower drying, clay and lime plasters avoid the higher carbon emissions of portland cement-based plasters.

## THATCH

Tightly-packed long reeds or straw are fastened in overlapping bundles to a steeply pitched roof with horizontal straps producing a thickness that sheds water and can serve as insulation.



## THATCHED ROOF

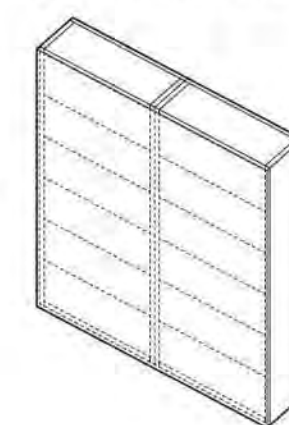


## PRE-FABRICATED PANELS

Straw-bales can be inserted into structural wooden frames to make pre-fabricated panels, increasing moisture control and construction precision. Skins can be added off-site or on-site.

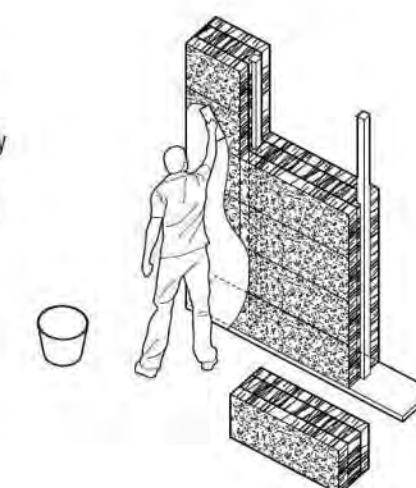


## PREFABRICATED ASSEMBLY

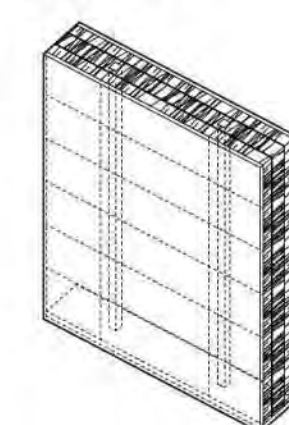


## WOOD FRAME INFILL

The most common approach, straw-bales are stacked around or within a structural wood frame, serving primarily as insulation. With proper treatment of the skin, the straw-bale walls can also provide lateral bracing.



## INFILL WALL

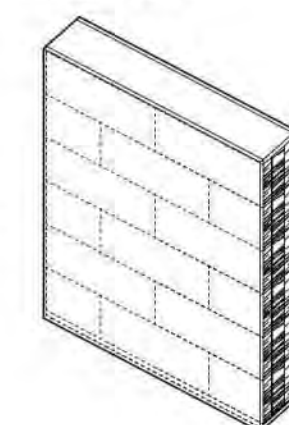


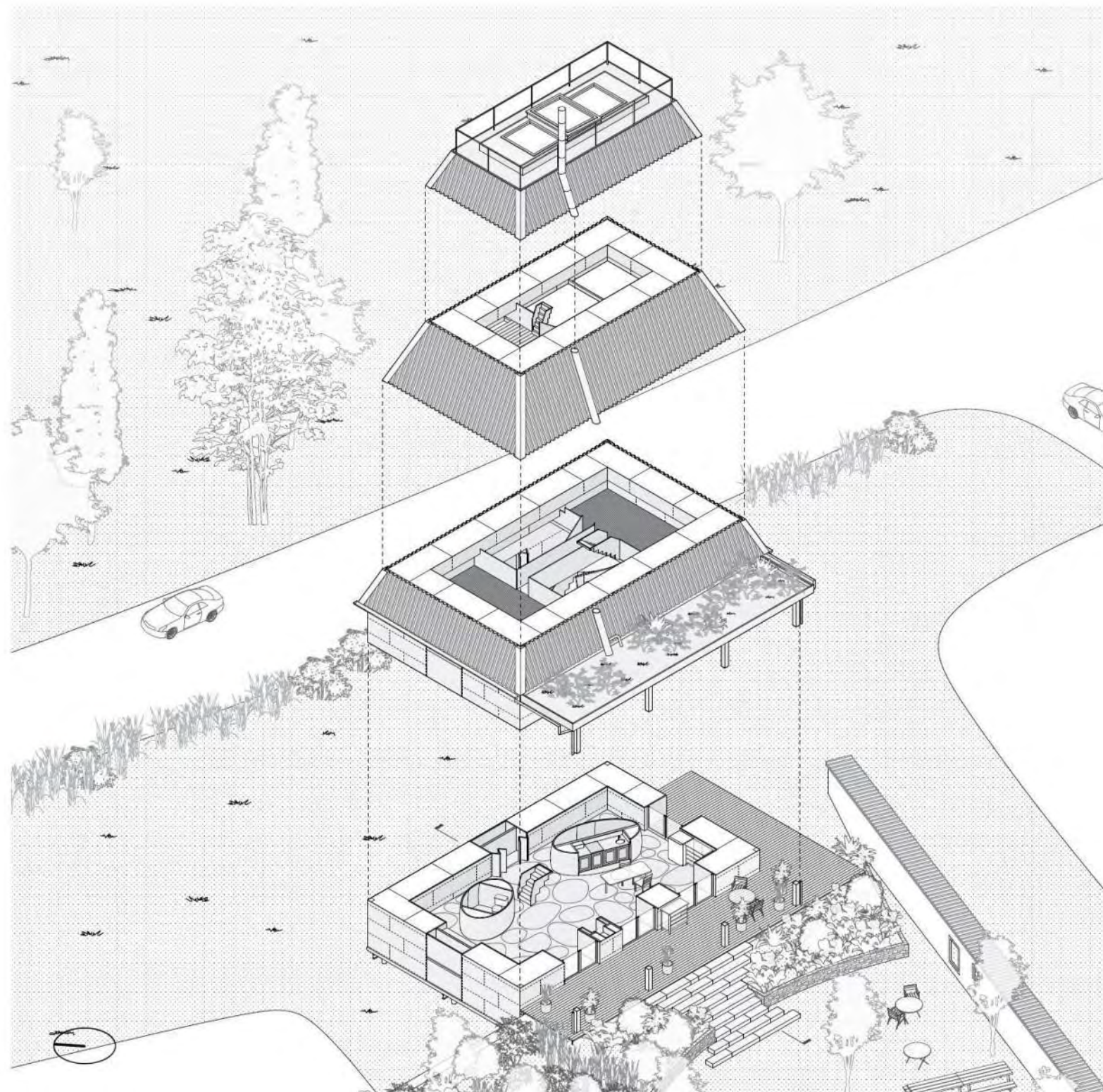
## NEBRASKA LOAD-BEARING

Referencing the location of its first use in the late 1800s, Nebraska-style walls use the combined sandwich of thick plaster skins and straw-bales to be the load bearing structure. Typically just a single story, the straw-bale walls are compressed before the plaster is applied. A wooden top plate or ring beam transfers the roof load to the plaster skins which carry it to the foundations.



## STACKED WALL





## Gartist GmbH House | Atelier Werner Schmidt

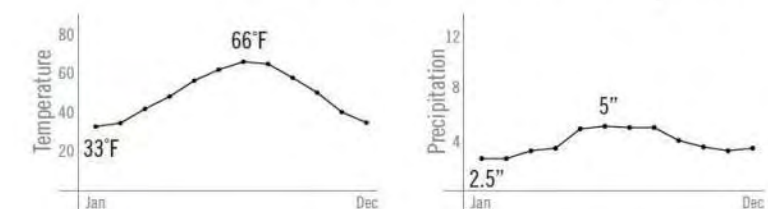
This pavilion is an ingeniously simple and consequential use of straw-bales as a building material, taking full advantage of their thermal, structural, volumetric, material, and ecological qualities. The floor, walls, and roof of this house are all constructed of very large and heavily compacted straw-bales. They are the load-bearing structure in the walls and

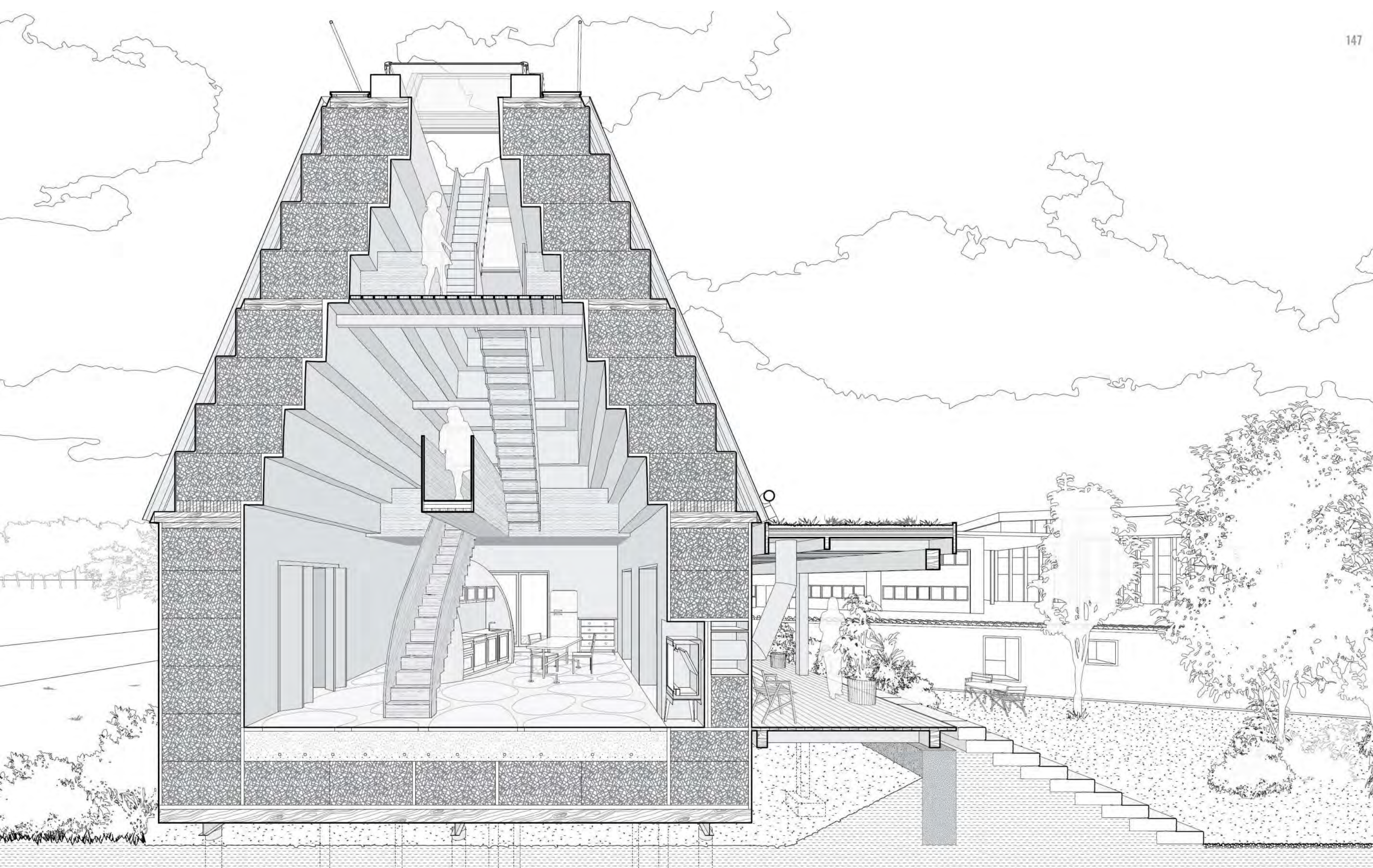
the corbeled roof, augmented only through selective planes of larch wood that frame the windows and form horizontal ring beams in the roof. Lime plaster on the outside and white clay plaster on the inside of the straw adds to the bales' structural capacity and protects against water, fire, and vermin. The thickness of the straw achieves high thermal resistance,



while also absorbing excess humidity. A small wood burning stove is rarely used. Bathroom and kitchen services are contained in lime-coated pods independent from the structural walls.

## Zurich, Switzerland | 2016





## Gartist GmbH House

Raised on stilt piles and a solid wood raft above the damp ground, the thick floor is made from a grid of timber panels infilled with straw and topped with gravel, a radiant heating system, and 2.4 in (60 mm) slices of moraine stones. The load-bearing walls are comprised of 30 by 47 by 98 in (750 by 1200 by 2500 mm) bales, each weighing 661 lb (300 kg),

erected by crane in about a week. These extremely thick walls allow the shape of the roof to be made by offsetting the upper eight rows of bales about 1 ft (300 mm) each, forming a corbeled structure. The keystone is a large skylight, filtering light down through the cascading thickness of this distinctive section. Stairs connect to lofted lounge areas nested inside

the inverted ziggurat and permit roof access. The surface of the straw is enhanced by the smooth undulations of the interior clay plaster, allowing the different edges of the bales to be visible. Corrugated metal attached to vertical wood battens, and a layer of clay protects the outside of the staggered roof bales. This house pavilion celebrates the thickness of an

inexpensive and minimally processed natural material and in the process stores the carbon contained in 75 metric tons of an agricultural residue within its envelope.

Gartist GmbH House  
Atelier Werner Schmidt

Straw

| Location | Material | Quantity | kgCO <sub>2</sub> e/unit | Total kgCO <sub>2</sub> e |
|----------|----------|----------|--------------------------|---------------------------|
|----------|----------|----------|--------------------------|---------------------------|

Interior -10198

|                    |                      |      |        |
|--------------------|----------------------|------|--------|
| Lime Plaster       | 1.52 m <sup>3</sup>  | 190  | 289    |
| Dimensional Lumber | 17.06 m <sup>3</sup> | -615 | -10486 |

Foundation -14290

|                    |                      |       |        |
|--------------------|----------------------|-------|--------|
| Steel              | 0.16 m <sup>3</sup>  | 17898 | 2850   |
| Concrete           | 9.82 m <sup>3</sup>  | 246   | 2417   |
| Stone Flooring     | 2.42 m <sup>3</sup>  | 746   | 1803   |
| Gravel             | 27.26 m <sup>3</sup> | 62    | 1677   |
| Cement Topping     | 2.30 m <sup>3</sup>  | 438   | 1004   |
| Vapor Barrier      | 58.42 m <sup>2</sup> | 0.4   | 23     |
| Straw              | 46.09 m <sup>3</sup> | -128  | -5908  |
| Dimensional Lumber | 29.54 m <sup>3</sup> | -615  | -18157 |

Exterior -25730

|                    |                       |      |        |
|--------------------|-----------------------|------|--------|
| Lime Plaster       | 12.34 m <sup>3</sup>  | 190  | 2345   |
| Clay Plaster       | 15.01 m <sup>3</sup>  | 93   | 1398   |
| Glass              | 0.12 m <sup>3</sup>   | 3593 | 443    |
| Dimensional Lumber | 18.61 m <sup>3</sup>  | -615 | -11439 |
| Straw              | 144.13 m <sup>3</sup> | -128 | -18478 |

Roof -33320

|                    |                       |       |        |
|--------------------|-----------------------|-------|--------|
| Galvanized Steel   | 0.14 m <sup>3</sup>   | 21666 | 2956   |
| Lime Plaster       | 9.69 m <sup>3</sup>   | 190   | 1841   |
| Aluminum           | 0.03 m <sup>3</sup>   | 18373 | 498    |
| EPDM Membrane      | 39.89 m <sup>2</sup>  | 9     | 361    |
| Glass              | 0.06 m <sup>3</sup>   | 3593  | 233    |
| Bitumen Membrane   | 25.62 m <sup>2</sup>  | 2     | 59     |
| Dimensional Lumber | 20.52 m <sup>3</sup>  | -615  | -12615 |
| Straw              | 207.91 m <sup>3</sup> | -128  | -26654 |

Total -83,538 kgCO<sub>2</sub>e

Area 171 m<sup>2</sup>

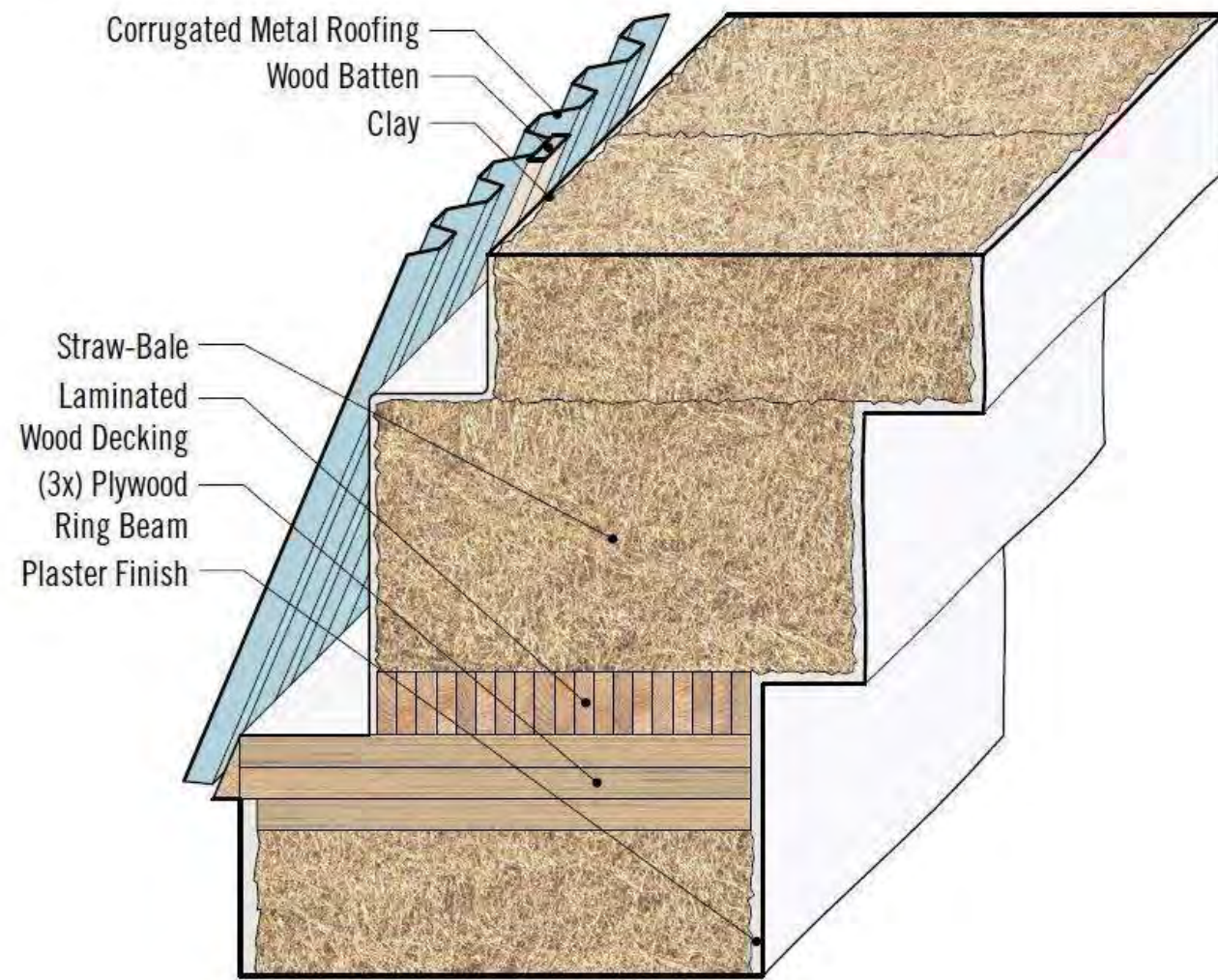
Total per Area -488 kgCO<sub>2</sub>e/m<sup>2</sup>

Assumptions:

Skylight and doors are double pane glass, 4 + 4 mm  
Aluminum skylight frames are calculated as 20% of simplified frame volume  
Metal roofing is 29 gauge galvanized steel  
Aluminum skylight edge is 16 gauge  
Windows and skylights are triple pane glass, 4 + 4 + 4 mm  
Lime plaster on interior and exterior surfaces is 5 cm thick  
Roof deck railing is 10 gauge galvanized steel  
"Stone Flooring" value is used for stone in ground floor  
Skylight opening is framed with lumber  
Wood-framed partitions in bathroom and kitchen volumes  
Clay sprayed on exterior of straw-bales is 5 cm thick  
EPDM roofing membrane is used on green roof

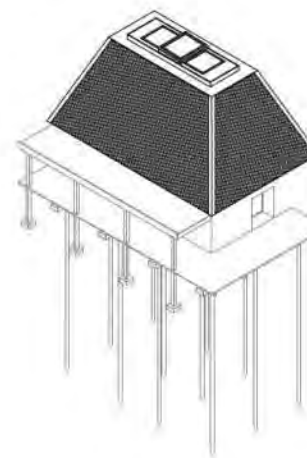
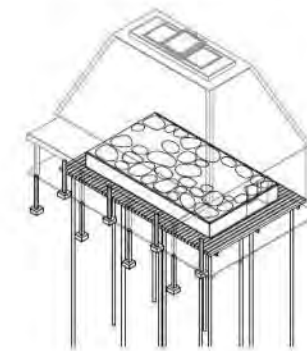
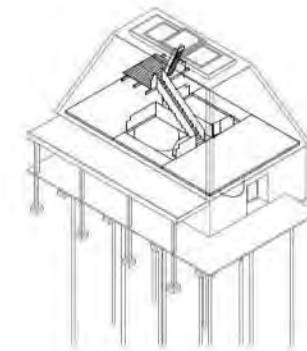
Exclusions:

Metal lath in kitchen and bathroom walls  
Stone steps and gabion wall  
Green roof soil and plantings  
Uncovered portion of deck  
Fasteners  
MEP  
Fixtures  
Concrete reinforcement  
Flashing  
Gutters and downspouts  
Stove and stove pipe  
Counters and casework



Straw

Gartist GmbH House  
Atelier Werner Schmidt





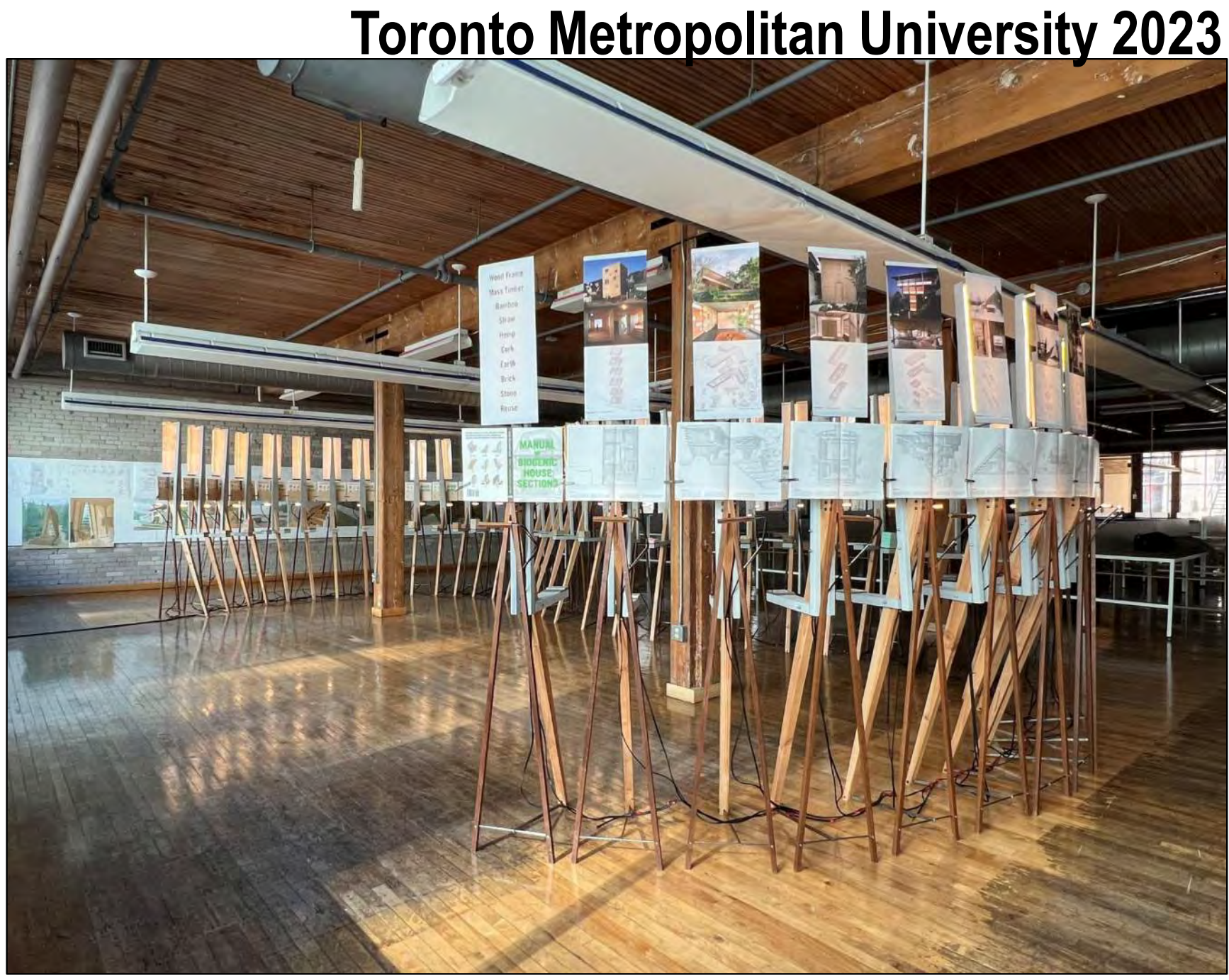
Princeton University 2022



RISD 2023



Ohio State University 2023



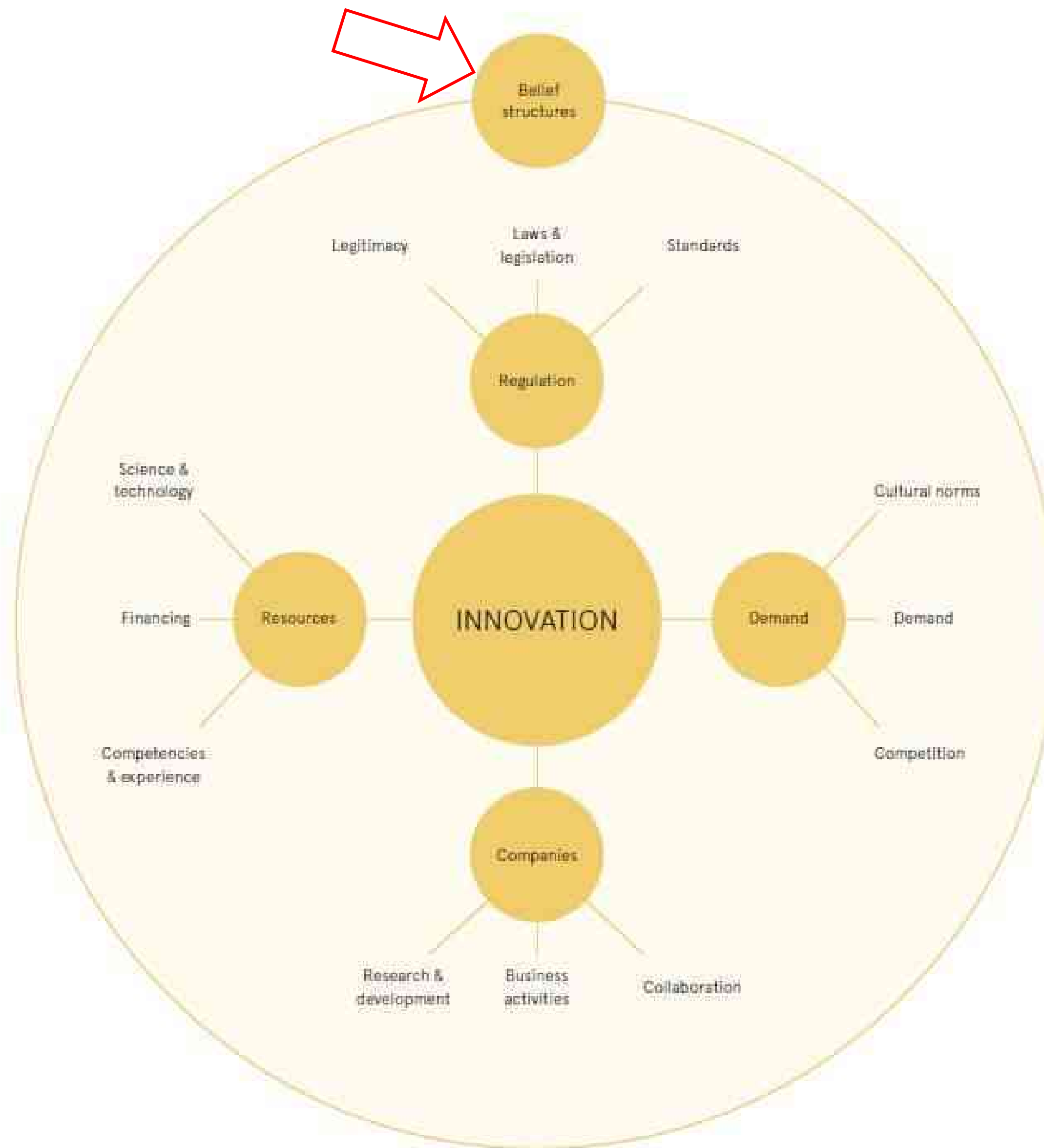
Toronto Metropolitan University 2023



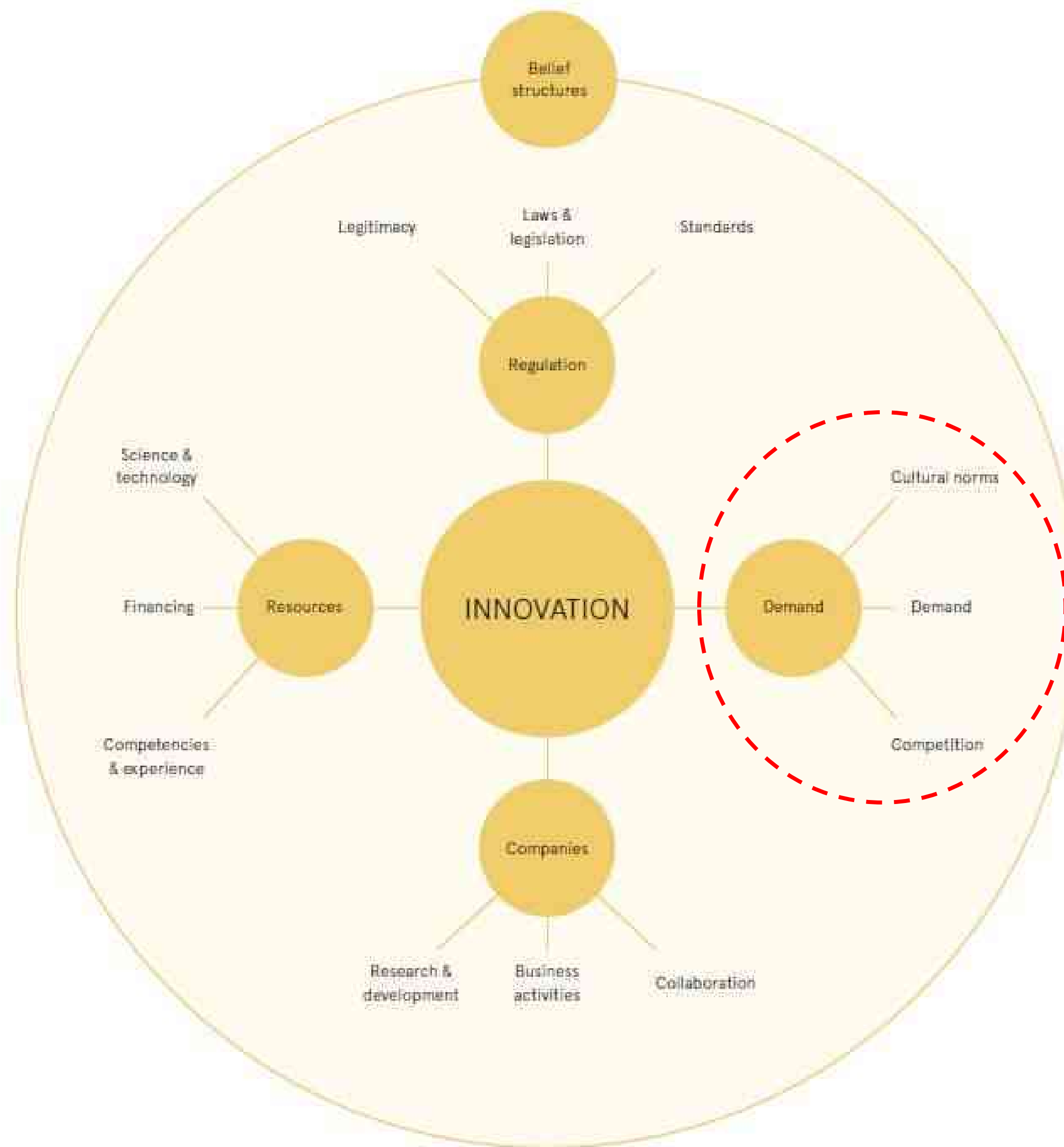
LTLARCHITECTS



LTLARCHITECTS

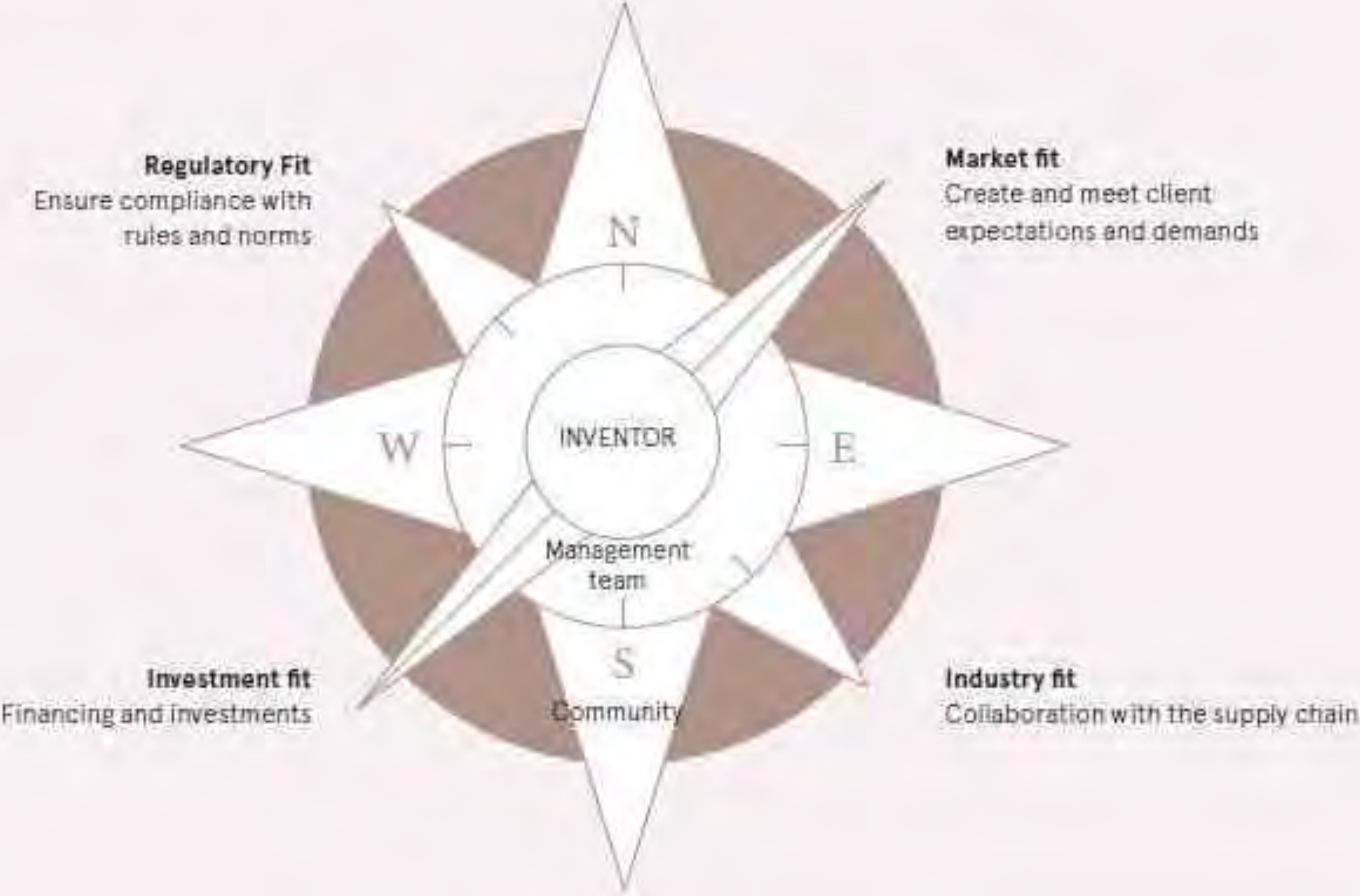


The institutional context of innovation. Innovation opportunities and barriers are shaped by four factors: regulation, available resources, demand and the commercial activities of companies. The inventor has to take these factors into account – adapt to them or change them – to make innovation happen. Figure is based on Van de Ven 1999.<sup>4</sup>



The institutional context of innovation. Innovation opportunities and barriers are shaped by four factors: regulation, available resources, demand and the commercial activities of companies. The inventor has to take these factors into account – adapt to them or change them – to make innovation happen. Figure is based on Van de Ven 1999.<sup>6</sup>

Four dimensions that needs to be handled by persons, companies and communities in order to make innovation take place





The various roles in sustainable innovation are especially relevant in different stages of the innovation process

# INNOVATION OF NOTHING

THE CAPABILITIES NEEDED  
TO LEAD SUSTAINABLE CHANGE  
IN THE BUILT ENVIRONMENT



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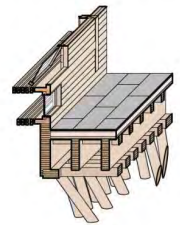


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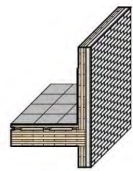


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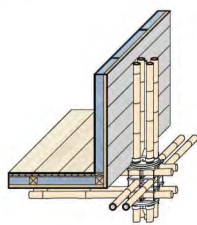
Building on *Manual of Section*, this book articulates how plant-based and low-carbon materials can produce a profound rethinking of section in houses.



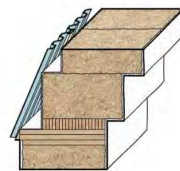
Wood Frame



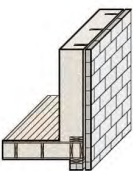
Mass Timber



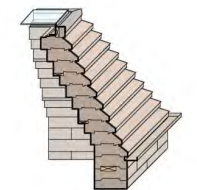
Bamboo



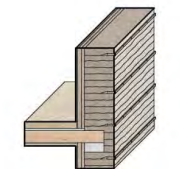
Straw



Hemp



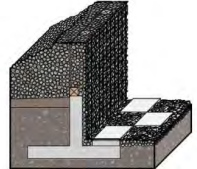
Cork



Earth



Brick



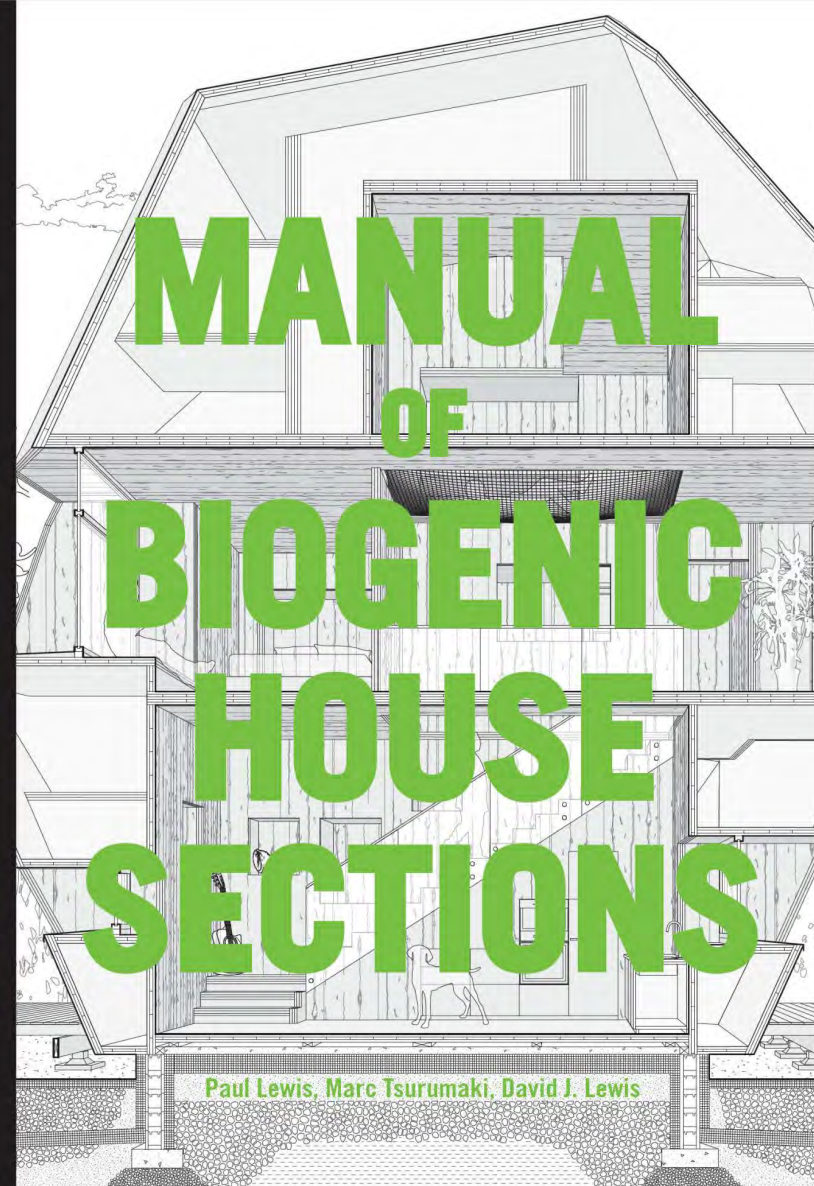
Stone



ISBN 978-1-957183-09-1  
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5 3 9 9 5  
9 781957 183091

Lewis, Tsurumaki, Lewis

MANUAL OF BIOGENIC HOUSE SECTIONS



Paul Lewis, Marc Tsurumaki, David J. Lewis

# FIVE BIOGENIC HOUSES



Princeton School of Architecture

Paul Lewis, Marc Tsurumaki, David J. Lewis



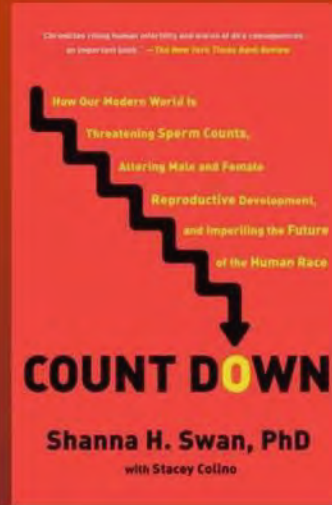
**Biomaterials Summit**  
15 November 2023



# Designing with Material Health

**Jonsara Ruth** Associate Professor of Interior Design  
Co\_Founder Design Director, Parsons Healthy Materials Lab

**“In some ways,  
the sperm-  
count decline is  
akin to where  
global warming  
was forty years  
ago - reported  
upon but denied  
or ignored.”**



Environmental Threats  
To Reproduction

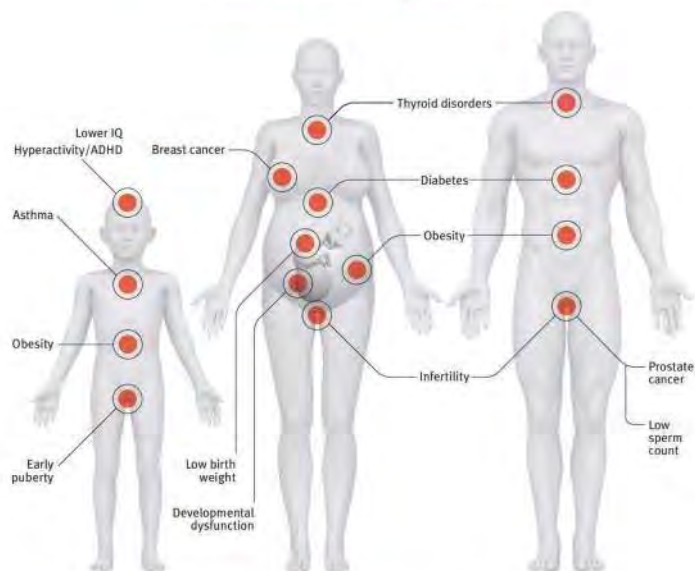
Shanna Swan, PhD

Professor, Environmental Medicine and Public Health  
Icahn School of Medicine at Mount Sinai



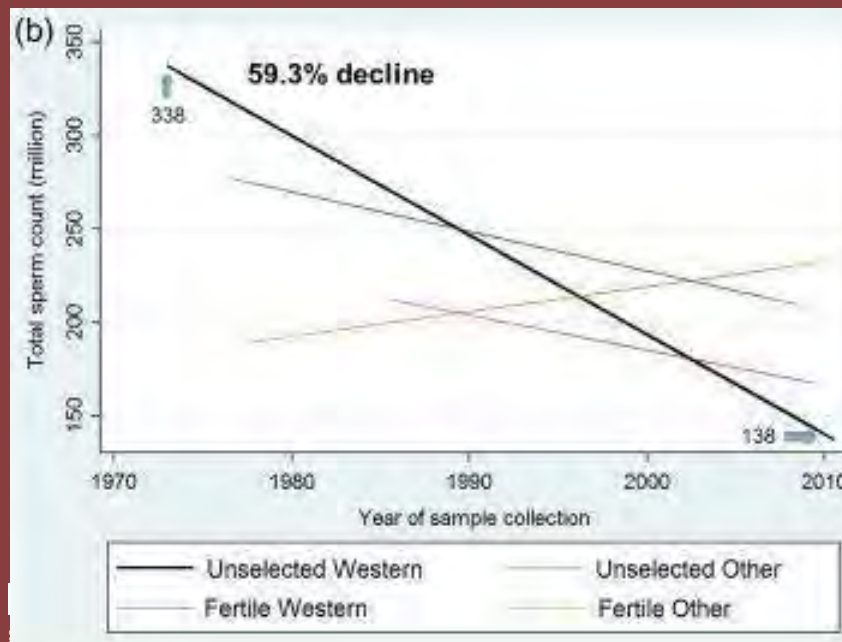
# Low Doses Matter

Everyday exposures to EDCs contribute to modern health epidemics.



## How are people exposed?

- |                                                         |                                                          |
|---------------------------------------------------------|----------------------------------------------------------|
| Children's toys (phthalates)                            | Fragrances (phthalates)                                  |
| Plastic drinking bottles (BPA, BPS, BPF)                | Food (pesticides like chlorpyrifos)                      |
| Cleaning products (phthalates, triclosan)               | Food packaging (BPA, PFAS, phthalates)                   |
| House dust (flame retardants, pesticides)               | Thermal cash register receipts (BPA, BPS)                |
| Home furniture/electronics (flame retardants, PFAS)     | Drinking water (arsenic, lead, perchlorate)              |
| Building materials (flame retardants, phthalates, PFAS) | Personal care products (parabens, phthalates, triclosan) |



(b) Meta-regression model for mean total sperm count by fertility and geographic groups, adjusted for potential confounders.

Levine, Hagai et al. "Temporal trends in sperm count: a systematic review and meta-regression analysis." *Human reproduction update* vol. 23,6 (2017): 646-659. doi:10.1093/humupd/dmx022



vinyl



polycarbonate

# Climate Change, Toxic Burden, Loss of Biodiversity

## Interconnected Triple Planetary Crisis

**“These issues are inseparable....  
to solve one, all of them must be addressed.”**

chemsec.org 15 Nov 2022



*Winona Laduke, White Earth Reservation, USA*



Louisville, Kentucky



Petrochemical Plants, Baytown, Texas, USA, 2017, photo by Edward Burtynsky.

What if raw materials for future building products looked like this (field) instead of this (fuel refining plant)?



New Castle, Pennsylvania



What if new jobs and working conditions to make building materials involved agriculture?



Isohemp, Fernelmont, Belgium



What if building materials were regenerative and circular instead of business as usual?



What if the renovation of affordable, healthy, energy efficient homes look like this?



And what if the waste from building materials was 100% biodegradable and recyclable instead of filling our land with waste?



# Parsons Healthy Materials Lab

The path to healthier people and planet begins with healthy affordable homes.

Centering human health in design and construction will change the future for everyone.

Established May 2015  
Parsons School of Design | The New School | New York City

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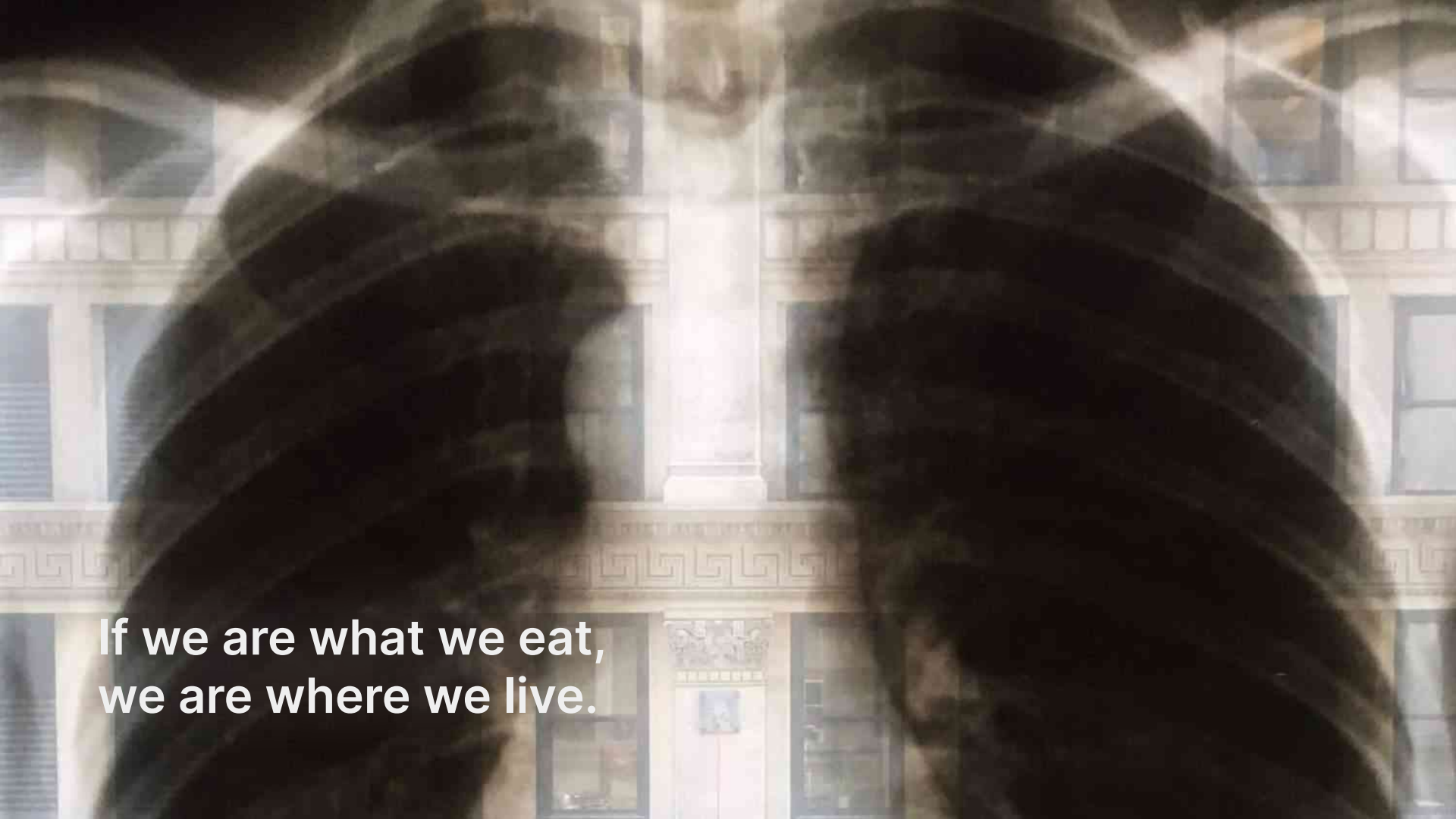
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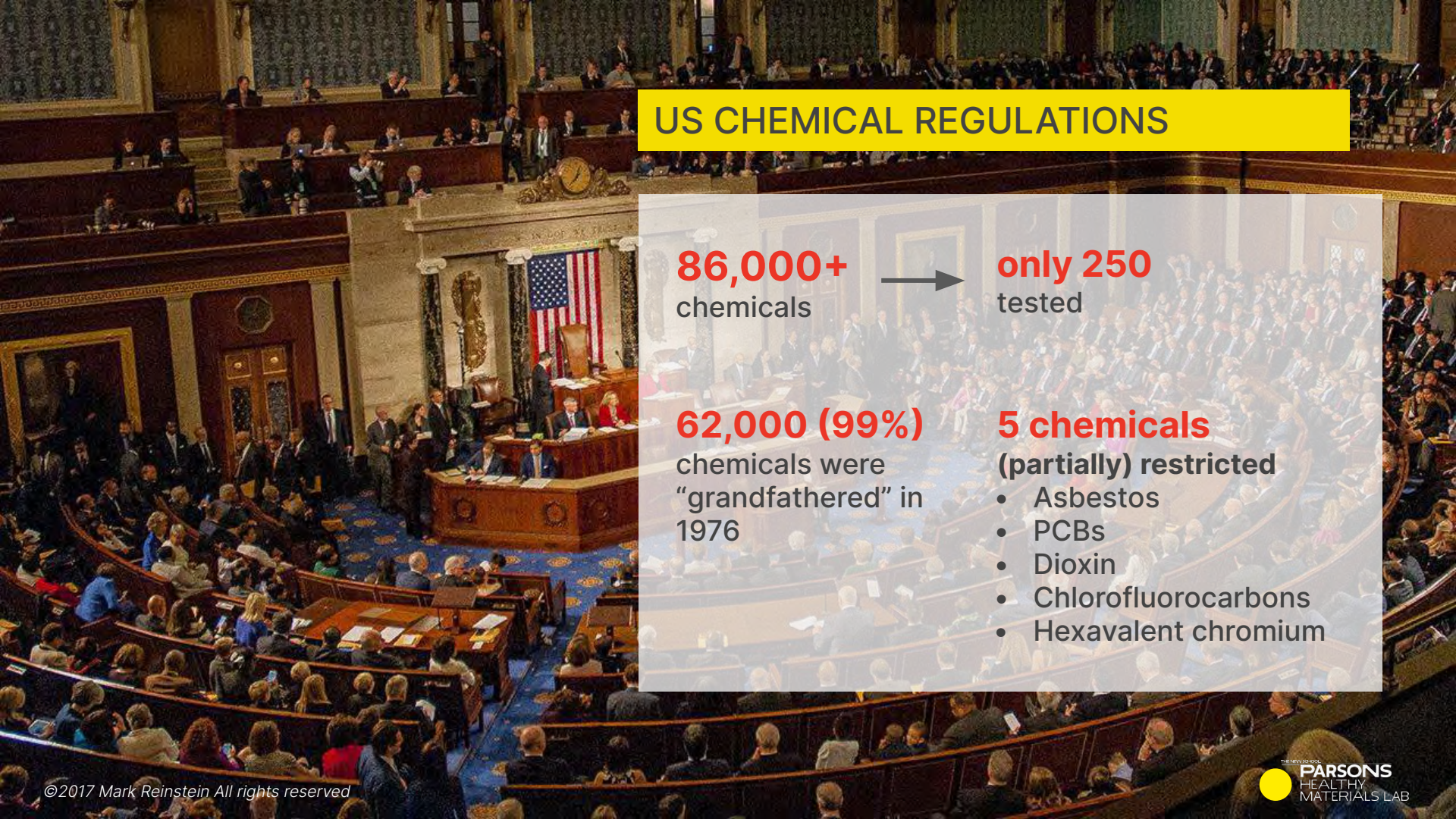
**Lucille Tenazas**  
Henry Wolf Professor of Communication Design, Parsons School of Design  
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**Building healthy affordable housing  
reduces toxics and embodied carbon  
+ creates healthier lives for everyone.**

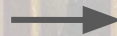


If we are what we eat,  
we are where we live.



## US CHEMICAL REGULATIONS

**86,000+**  
chemicals



**only 250**  
tested

**62,000 (99%)**  
chemicals were  
“grandfathered” in  
1976

**5 chemicals**  
(partially) restricted

- Asbestos
- PCBs
- Dioxin
- Chlorofluorocarbons
- Hexavalent chromium



What's in our walls?



A lot is invisible.

?

?

?

?

?

?



VOCs, APEs

Bisphenols

A lot is invisible.

PFAS

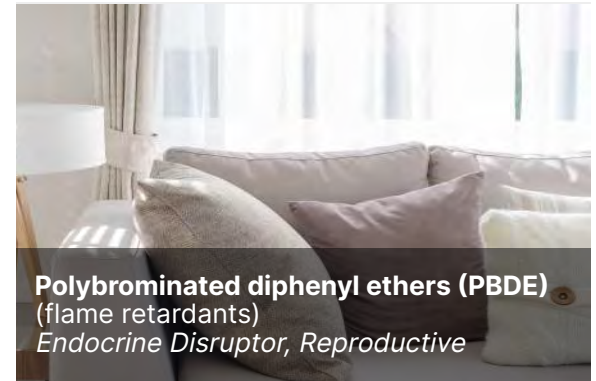
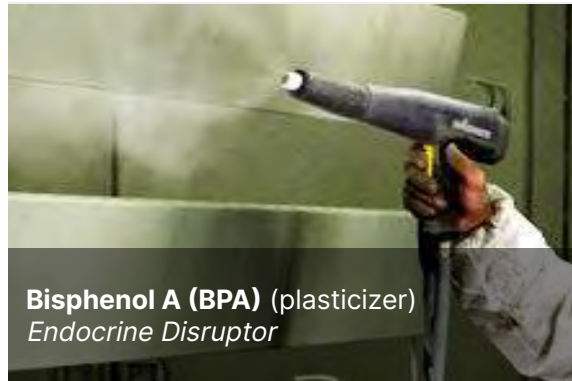
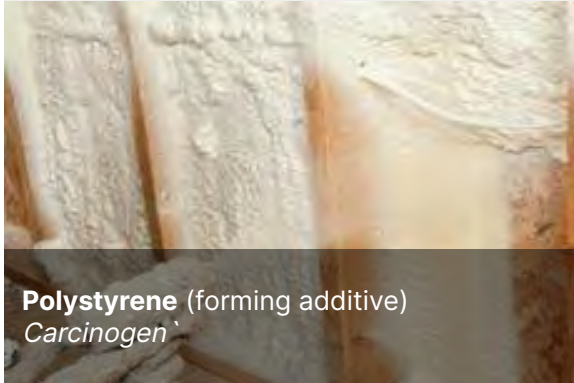
Isocyanates

Formaldehyde

Flame  
Retardants

PARSONS  
HEALTHY  
MATERIALS LAB

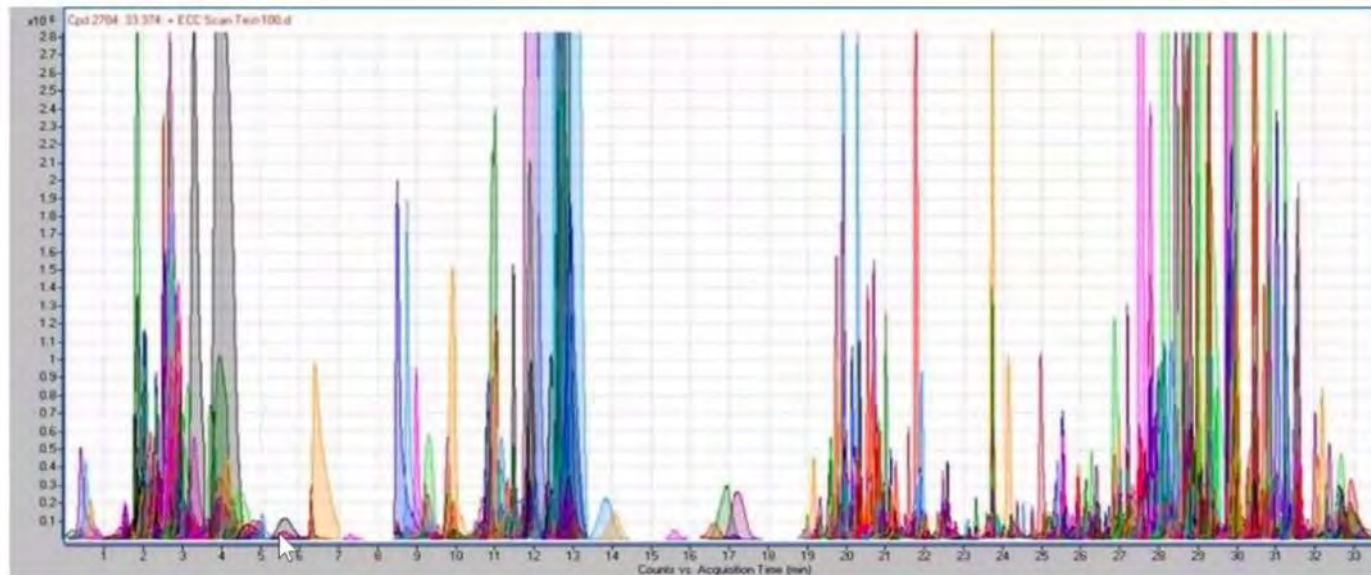
# PROBLEMATIC CHEMICALS IN BUILDING MATERIALS



# PETROCHEMICAL BASED PLASTICS IN CONTEMPORARY CONSTRUCTION



# MILLIONS OF INDUSTRIAL CHEMICALS IN OUR BODIES



A Chromatogram measures thousands (eventually millions) of chemicals in our body: nutrients, consumer products, air, water, etc.

**Internal Exposome:  
Measure of Blood +  
Urine**

**Will Aid In Diagnostics:**

- Early diagnosis or identify disease
- Predict speed of disease progression

## QUESTIONS TO ASK:

What is it made of?

How is it made?

Where is it made?

Does it require finishes?

How will it be installed?

Who will be exposed in use?

Where does it go at the end of its useful life?

Who is impacted throughout the lifecycle?



**Material  
Health  
Thinking**

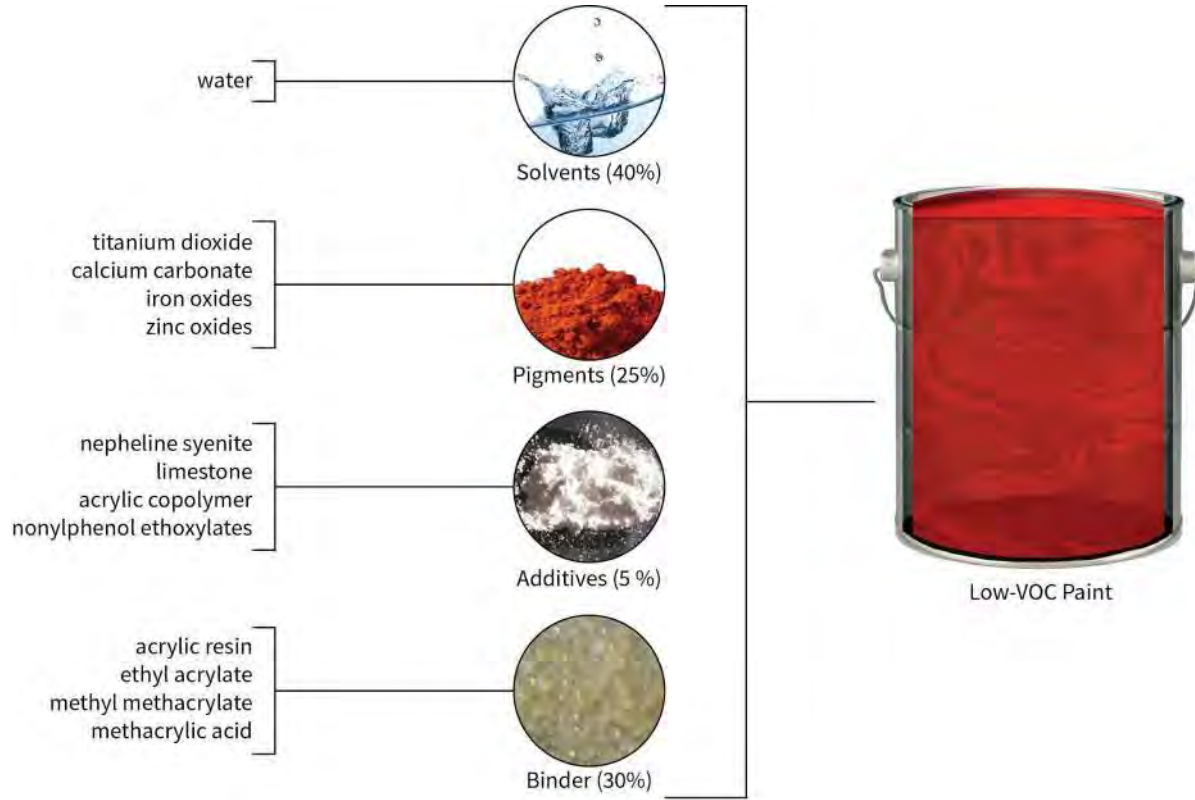


Paints Cover Most Interior Surfaces

# Common Acrylic Latex Paint Begins as Fossil Fuels



# What is in acrylic latex paint?



**Plastic paints contain chemicals that are harmful to human health such as VOCs, APEs + PFAS.**



# PLASTICS EMISSIONS WILL OUTPACE COAL BY 2030

<https://www.beyondplastics.org/plastics-and-climate>

# PLASTIC PAINT

# PLASTICS ARE NOW FOUND IN HUMAN BLOOD



# Comparison: Modern Acrylic Paint vs. Historic Limewash

## Low VOC Flat Acrylic Paint\*



### INGREDIENTS:

Water (solvent)

Limestone; Calcium Carbonate (extender)

Vinyl Acetate, Polymer w/ N-Butyl Acrylate (binder) *carcinogen*

Titanium Dioxide (pigment) *carcinogen*

Kaolin Clay (extender)

Propylene Glycol (freeze/thaw stabilizer) *endocrine disruptor*

1,3-Pentenediol, 2,2,4-Trimethyl-Monoisobutyrate (coalescent) *carcinogen*

Hydroxyethyl Cellulose (thickener) *endocrine disruptor*

Polyethylene Glycol Nonylphenyl Ether (surfactant) *persistent bioaccumulative toxicant (PBT)*

Polysiloxanes (defoamer)

Methylchloroisothiazolinone (preservative) *mammalian toxicant*

Polycarboxylic Acid, Sodium Salt (dispersant)

Polyurethane Based Associative Thickener (rheology modifier) *carcinogen*

2-(2-Butoxyethoxy)Ethanol (rheology modifier) *developmental toxicant*

Ammonium Hydroxide (pH buffer) *respiratory toxicant*

## Italian Limewash, circa 600 AD\*



### INGREDIENTS:

Water (solvent)

Limestone; Calcium Carbonate (binder)

Polycarboxylic Acid, Sodium Salt (dispersant)

Iron Oxide (pigments, optional)

\*Content based on Pharos Common Product Profile

# Material Collections

## Interior Paints 21 products

CATEGORY ▲

SUB-CATEGORY ▲

Paint / Biobased Cellulose Resin

Paint / Biobased Linseed Oil

Paint / Biobased Soy

Paint / Mineral Lime

Paint / Mineral Lime

Paint / Mineral Lime

Paint / Mineral Lime Cassein

Paint / Mineral Potassium Silicate

Paint / Mineral Potassium Silicate

|                   |                    |                     |                      |     |         |     |     |
|-------------------|--------------------|---------------------|----------------------|-----|---------|-----|-----|
| Paint / Mineral   | Potassium Silicate | Romabio             | Isourip Primer       | HPD | Declare | EPD | SDS |
| Paint / Mineral   | Potassium Silicate | Romabio             | Classico Limewash    | HPD | Declare | EPD | SDS |
| Paint / Mineral   | Potassium Silicate | Romabio             | EcoDomus             | HPD | Declare | EPD | SDS |
| Paint / Synthetic | Acrylic Latex      | Benjamin Moore      | Aura                 | HPD | Declare | EPD | SDS |
| Paint / Synthetic | Acrylic Latex      | Benjamin Moore      | EcoSpec Paint        | HPD | Declare | EPD | SDS |
| Paint / Synthetic | Acrylic Latex      | Benjamin Moore      | EcoSpec Primer       | HPD | Declare | EPD | SDS |
| Paint / Synthetic | Acrylic Latex      | Benjamin Moore      | Ultra Spec 500       | HPD | Declare | EPD | SDS |
| Paint / Synthetic | Acrylic Latex      | Imperial Paints LLC | Ecos Paint           | HPD | Declare | EPD | SDS |
| Paint / Synthetic | Acrylic Latex      | Sherwin Williams    | ProMar® 200 Zero VOC | HPD | Declare | EPD | SDS |
| Surface Coating   | Plaster            | Clayworks           | Clay Plasters        | HPD | Declare | EPD | SDS |
| Surface Coating   | Plaster            | Earthaus Plaster    | Lime Plaster         | HPD | Declare | EPD | SDS |

### Lime Plaster

AVAILABLE AT THE DODDIA MATERIALS LIBRARY

Limestrong's Artisan lime plasters are a healthier alternative to traditional wall finishes like paint. This plaster is made of lime, pumice, and a plant-based binder, all sourced from within the US. It is available in 3 finishes of varying levels of shine - Marble, Stone, and Sand. Limestrong uses natural pigments only and has created a palette of 98 colors using a combination of 8 naturally occurring minerals. These plasters are petrochemical and fragrance-free.

CATEGORY: Surface Coating, Plaster  
MANUFACTURER: Earthaus Plaster

PRODUCT WEBSITE

#### MATERIAL COMPOSITION\*

Calcium Hydroxide 50-75%, Amorphous Aluminum Silicate (Pumice) 25-50%, Crystalline silica, respirable powder 0.0001-1%

\*as reported by the manufacturer

#### COLORS

98 colors

#### CERTIFICATIONS & DISCLOSURES

Health Product Declaration (HPD)

Declare label

GreenScreen Gold Plus

✓ Safety Data Sheet (SDS)

#### LAST UPDATED

November 04, 2021





Healthy Materials Lab

PDF Generated: Nov 12, 2023

## Lime Plaster

Heritage's Natural Hydraulic lime plaster is a traditional recipe from hydraulic lime and silica sand only. It can be used for repairs of plaster and stucco for buildings originally constructed without Portland Cement. It is breathable, allowing for increased moisture ventilation. Hydraulic lime can cure even in damp/wet conditions and is most suitable as plaster on porous construction materials such as brick, or stone. The Lime Stucco/Plaster comes as a dry material, water is mixed in on-site.

|                          |                   |
|--------------------------|-------------------|
| CATEGORY                 | MANUFACTURER      |
| Surface Coating, Plaster | US Heritage Group |

MATERIAL COMPOSITION\*

50-75% silica sand, 25-50% Hydraulic lime  
\*as reported by the manufacturer



CERTIFICATIONS & DISCLOSURES

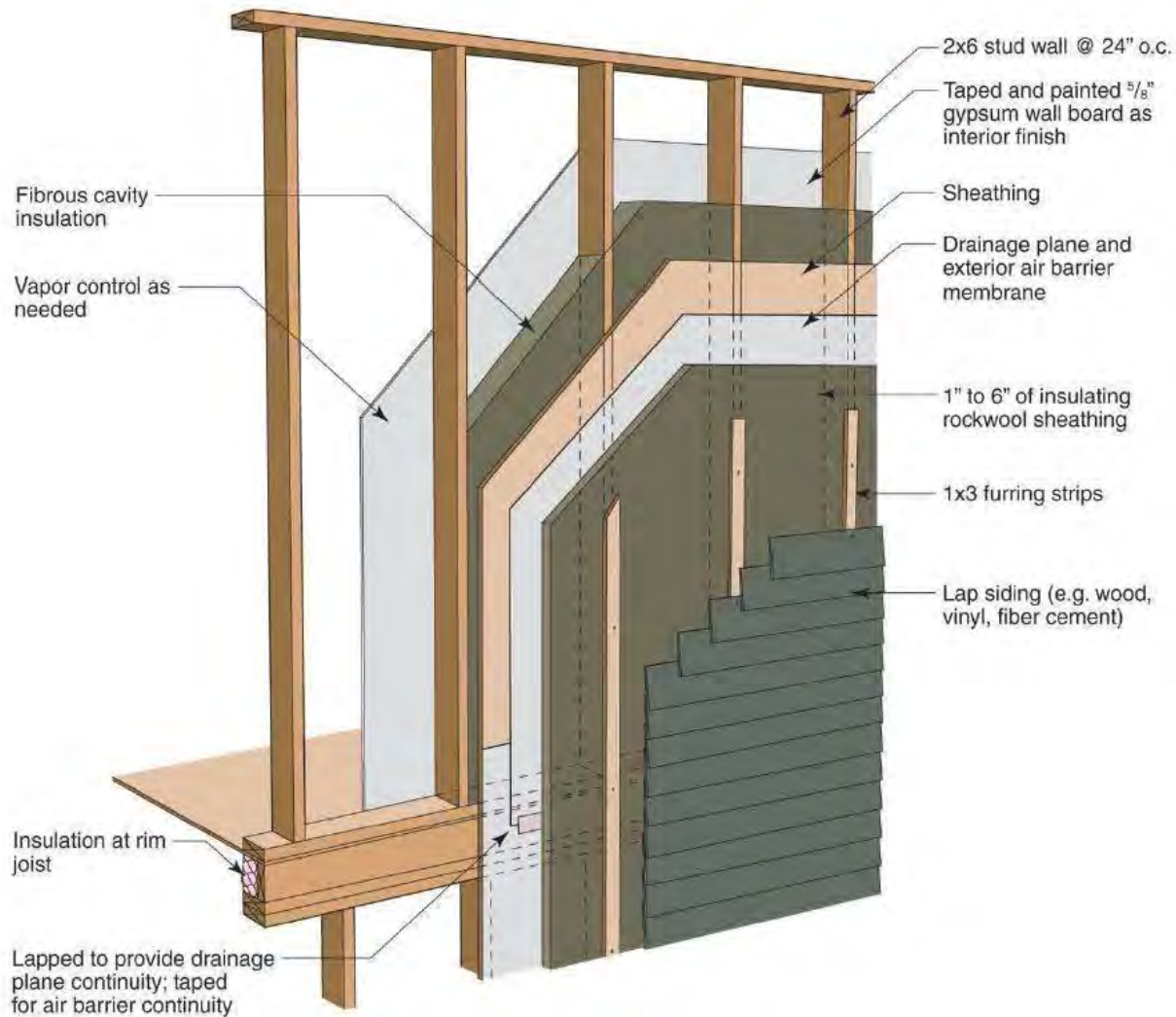
- ~~Health Product Declaration (HPD)~~
- ~~Declare label~~
- ~~Environmental Product Declaration (EPD)~~
- ✓ Safety Data Sheet (SDS)
- ~~Other~~

LAST UPDATED  
May 31, 2023

THE NEW SCHOOL

PARSONS







HempLime



# HEMP+LIME

100% Recyclable + Biodegradable

Regulates Indoor Humidity + Climate

Carbon Sink-Net Carbon Sequestering

Energy Efficient Insulation

Naturally Fire Resistant

Mold and Pest Resistant

100 years certified



HempLime Insulation  
PA Hemp Home  
New Castle, PA

## Hemp Fiber Test Acres Program



DON Services, New Castle, PA  
2019 Harvest



# PA HEMP HOME



PENNSYLVANIA HOUSING  
RESEARCH CENTER



HempLime Insulation  
PA Hemp Home  
New Castle, PA





Cameron McIntosh of Americhanvre  
filling small cavities by hand

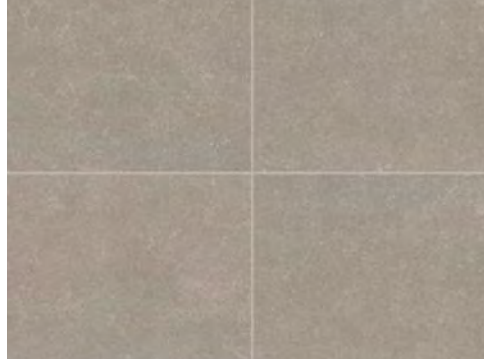
# MATERIAL PALETTE



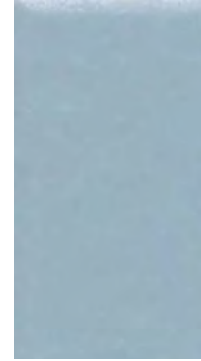
**Formaldehyde Free Plywood**  
Columbia Forest Products



**Engineered Wood Floors**  
HempWood



**Unglazed Colorbody Porcelain Tile**  
Daltile



**Lime Plaster with Lime Wash**  
Limeworks.us



**Linseed Oil Paint**  
Ottosson - Earth + Flax

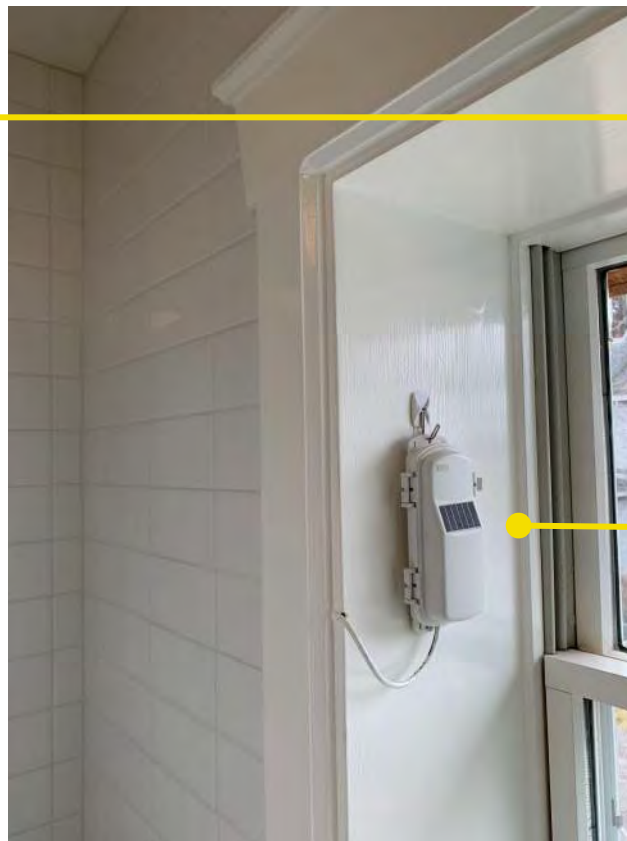


**Wool Carpet**  
Aronson's Floor Coverings



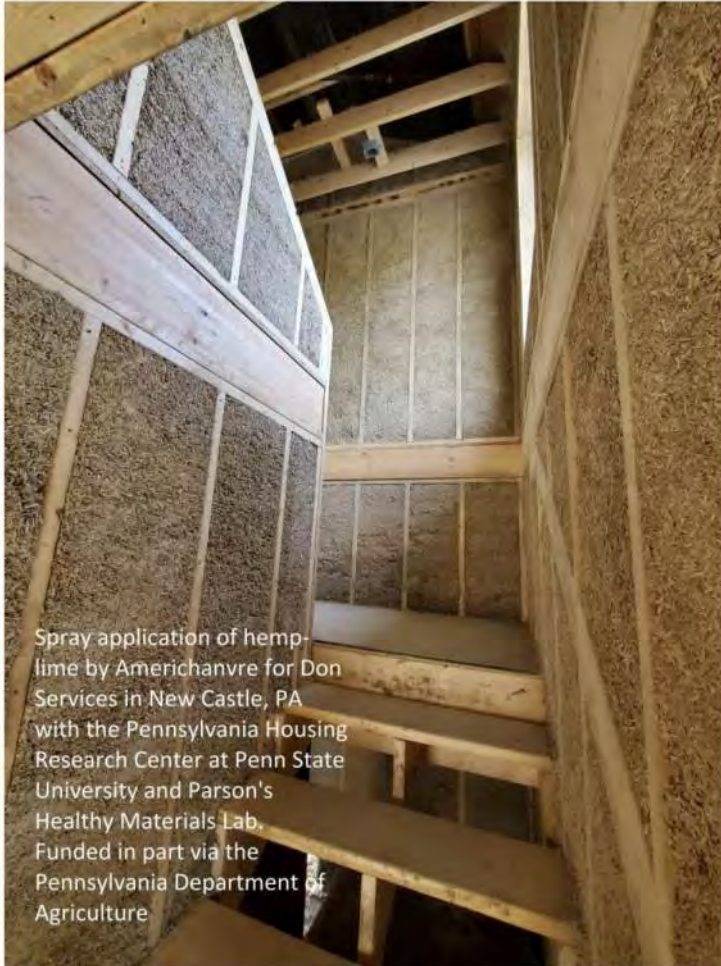
**Solid Granite**  
Precision Countertops

# TESTING HEMP + HEALTHIER MATERIALS' IMPACT



Testing the Indoor Air Quality for VOCs, Formaldehyde, PFAS and other toxics

Sensors were installed to test the energy efficiency of the HempLime wall system



Spray application of hemp-lime by Americhanvre for Don Services in New Castle, PA with the Pennsylvania Housing Research Center at Penn State University and Parson's Healthy Materials Lab. Funded in part via the Pennsylvania Department of Agriculture

New Castle stairs photo courtesy of Cameron McIntosh

## **RATIONALE FOR SPECIFIC SECTIONS OF PROPOSED APPENDIX Y – HEMP-LIME (HEMPCRETE) CONSTRUCTION**

**SECTION AY101 - GENERAL:** Hemp-lime is limited to use as a nonbearing, wall infill material. It primarily functions as insulation and a substrate for finish. Until further seismic testing is done, hemp-lime construction is restricted to use in Seismic Design Categories (SDCs) A, B, and C, except with an approved engineered design. Engineering analysis based on structural and materials tests and accepted engineering practice have determined hemp-lime's safe prescriptive use in SDCs A, B, and C, within the limits of the IRC's structural provisions and this appendix. Testing reports, structural analysis, and other supporting documents are available at: <https://ushba.org/icc-supporting-documents/>

**SECTION AY102 - DEFINITIONS:** Hemp-lime specific terms not found in the IRC are defined. Some definitions are consistent with identical or related terms defined in IRC appendices AR – Light Straw-Clay Construction, AS – Strawbale Construction, and AU – Cob Construction.

**SECTION AY103 - HEMP-LIME CONSTRUCTION:** Hemp-lime as a non-structural infill must comply with the Figures in Section AY103 or an approved alternative. The four Figures show different locations of the structural stud wall framing; interior, center, exterior, or double (interior and exterior). These Figures indicate the IRC sections that the foundation, wall framing, floor, and roof/ceiling assembly must comply with, unless otherwise stated in the appendix. They also identify code sections for other elements of a hemp-lime wall. Hemp-lime infill is limited to densities within a range of 12.5 to 25 pcf. This range encompasses the practical and commonly used hemp-lime densities.

**SECTION AY104 - FINISHES:** Hemp-lime infill requires vapor permeable finishes on the interior and exterior of the wall. The finish is necessary to create an air barrier and the high vapor permeability is required to allow vapor to move through the wall. As with many other building materials, hemp-lime infill must be sufficiently dry before finishes are applied. Hemp-lime is most commonly finished with plaster. Plaster is best applied directly to the hemp-lime infill.

**SECTION AY105 - FIRE RESISTANCE:** Hemp-lime is known for its fire-resistive properties through tests in Europe. When structural members are surrounded by hemp-lime infill, it can protect them from fire. However because ASTM E119 or UL263 tests have not yet been performed, a fire-resistance rating is not included in this proposal.

**SECTION AY106 - THERMAL PERFORMANCE:** Hemp-lime walls provide excellent thermal performance, with a combination of low thermal conductivity, thermal mass, and hygrothermal effects. Hemp-lime walls in this appendix are classified as masonry walls per Section 1410.2.5, if the thickness is greater than 8 inches.



# Introduction

- 1 Air and toxicity
- 2 Carbon
- 3 Equity
- 4 Waste and circular economies
- 5 Ecosystems
- 6 Futuring Materials





healthymaterialslab.org  
@healthymaterialslab

*Healthy Materials Lab centers  
human health in design, construction,  
and the production of materials  
to change the future for everyone.*

# Online Material Health Education

coursera



Free  
Material Health  
Courses



New

Parsons School of Design, The New School  
**Healthier Materials and Sustainable Building**

Intermediate · Specialization · 1 - 3 Months

Skills you'll gain

Environmental Impacts of Design Sustainability Green Design Materials  
Health Transparency and Disclosures



New

Parsons School of Design, The New School  
**Sustainable Building: Design and Specification**

Intermediate · Course · 1 - 4 Weeks

Skills you'll gain

Materials Research Public Health Green Design  
Health Transparency and Disclosures Materials Planning

Subtopics & Chemistry

**1.1**

**Pediatrician explains how chemicals get into our bodies**

Dr. Maria Graham, MD, MPH  
Professor of Environmental Medicine and Public Health & Pediatrics,  
Boston School of Health and Human Sciences

Environmental Health

**3.1**

**Are hazards hiding in building products?**

John Hartz  
Materials Principal  
Rena Architects

Product Development

**6.1**

**What manufacturers may not be telling you**

Heidi Vetter  
Principal Designer  
Health & Safety Consultants (HSC)

Material Chemistry

**2.1**

**Why should designers know about chemistry?**

Michael Weinbaum  
Associate Professor of Chemistry,  
The New School

Material Health

**4.1**

**How maintenance impacts material health**

Rebecca Drake  
Senior Designer  
Health & Safety Consultants (HSC)

Material Health

**7.1**

**How does the EPA evaluate chemicals?**

Heidi Vetter  
Principal Designer  
Health & Safety Consultants (HSC)

Material Health

**5.1**

**Working with communities to create affordable housing**

Edgardo Torres-Narvaez  
Senior Program Officer, Environmental Programs,  
The New School

Material Health

**8.1**

**What will future buildings be made of?**

Heidi Vetter  
Principal Designer  
Health & Safety Consultants (HSC)

# Healthier Material Collections

## Material Collections

Looking for a healthier material or building product? Specify healthier, sustainable, low-carbon choices starting with these examples.

[Healthier Building Products](#) ↓ [Healthier Design Alternatives](#) ↓ [Natural and Healthy](#) ↓ [Databases of Certified Products](#) ↓ [Design-Forward Product Libraries](#) ↓

### Featured Collections



Interior Paints



Low Embodied Carbon Materials



Flooring

### Healthier Building Products Collections [See all 12 Collections](#) →

These collections contain examples of healthier options, which disclose a minimum of 75% of ingredients by weight and avoid the most significant health concerns. Critical to our evaluation process is the impact of materials on human and environmental health throughout their lifecycle.



Composite Wood Products



Countertops



Insulation



Wallboard

#### 12 Healthier Building Products



Composite Wood Products



Flooring



Countertops



Interior Paints



Insulation



Healthier Finishes



Wallboard



Exterior & Structural



Carpet



Wall Coverings



Tile



Adhesives, Mortars, Grouts, and Sealants

# TRACE MATERIAL

A materials podcast



Season 1  
**Hemp**

Season 2  
**Plastic**

Season 3  
**Fungi**

# Consultation + Demonstration Projects



NYCHA = 170,000 Homes | Eliminate High VOC Paint



PA Hemp Home used as Supportive documentation for the proposed Hemp-lime Construction appendix for IRC



Determined By Design works with DCHA and others to create elevated healthy interiors and healthier guidelines for all homes

# Free Public Events

## Repair Workshop

with Healthy Materials Lab

SEP 6  
6PM ET

## mindful MATERIALS Pop-up

for Healthier Affordable Housing

OCT 10  
5:30PM ET

## Sustainable and Equitable Manufacturing with IKEA

OCT 25  
12PM ET

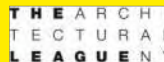
## From Field to Form: Hemp

with The Architectural League of New York

NOV 8  
7PM ET

Fall for  
Material  
Health

NYTM



**healthymaterialslab.org**  
**@healthymaterialslab**

# Supply, Production, Distribution: Biomaterials

One Story

Setting the table

Ace McArleton (he/him), Co-CEO New Frameworks



New Frameworks

*Low Impact. High Performance.*

# The Plant: Heirloom Organic Wheat



# The Farm: Aurora Farms



David and  
Tom Kenyon,  
6th & 7th  
Generation  
Settler  
Farmers in  
Charlotte, VT

# The Food: Nitty Gritty Grains & Red Hen Baking



# The Panels Team: Farm to Building



# The Design Process: Panelization



# The Custom Buildings: Panel-only



Image credit: Paul Lavold  
(photographer)  
Love|Schack (architect)

# The Kit Buildings: Casitas



# The Kit Buildings: Casitas



# The People: Joy, Justice, Innovation, Creativity, Together



# Drawdown Systems Solution

