BUILDINGENERGY BOSTON

# Biomaterials: A Regional and Global Movement for Climate Justice and Resilience


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Northeast Sustainable Energy Association (NESEA) | March 19, 2024

# Building Materials and Climate

## UN Report

**1. AVOID** the extraction and production of raw materials by galvanizing a circular economy.

**2. SHIFT** to regenerative material practices whenever possible by using ethically-produced low carbon earth- and bio-based building materials.

**3. IMPROVE** methods to radically decarbonize conventional materials such as concrete, steel and aluminum, and only use these non-renewable, carbon-intensive, extractive materials when absolutely necessary.

# Intersectoral Approach

**“Bio-based materials may represent our best hope for radical decarbonization** through the responsible management of carbon cycles. The shift towards properly managed bio-based materials could lead to compounded emission savings in the sector of up to **40% by 2050**.

Renewable, bio-based building materials have a **unique capacity to drive reductions in atmospheric carbon**, if they are sustainably sourced and managed.

However, a key prerequisite is that **intersectoral approaches to renewable resource and land management** are urgently required to transition away from the high carbon impacts of much “business-as-usual” forestry and agriculture.”

# Intersectoral Approach

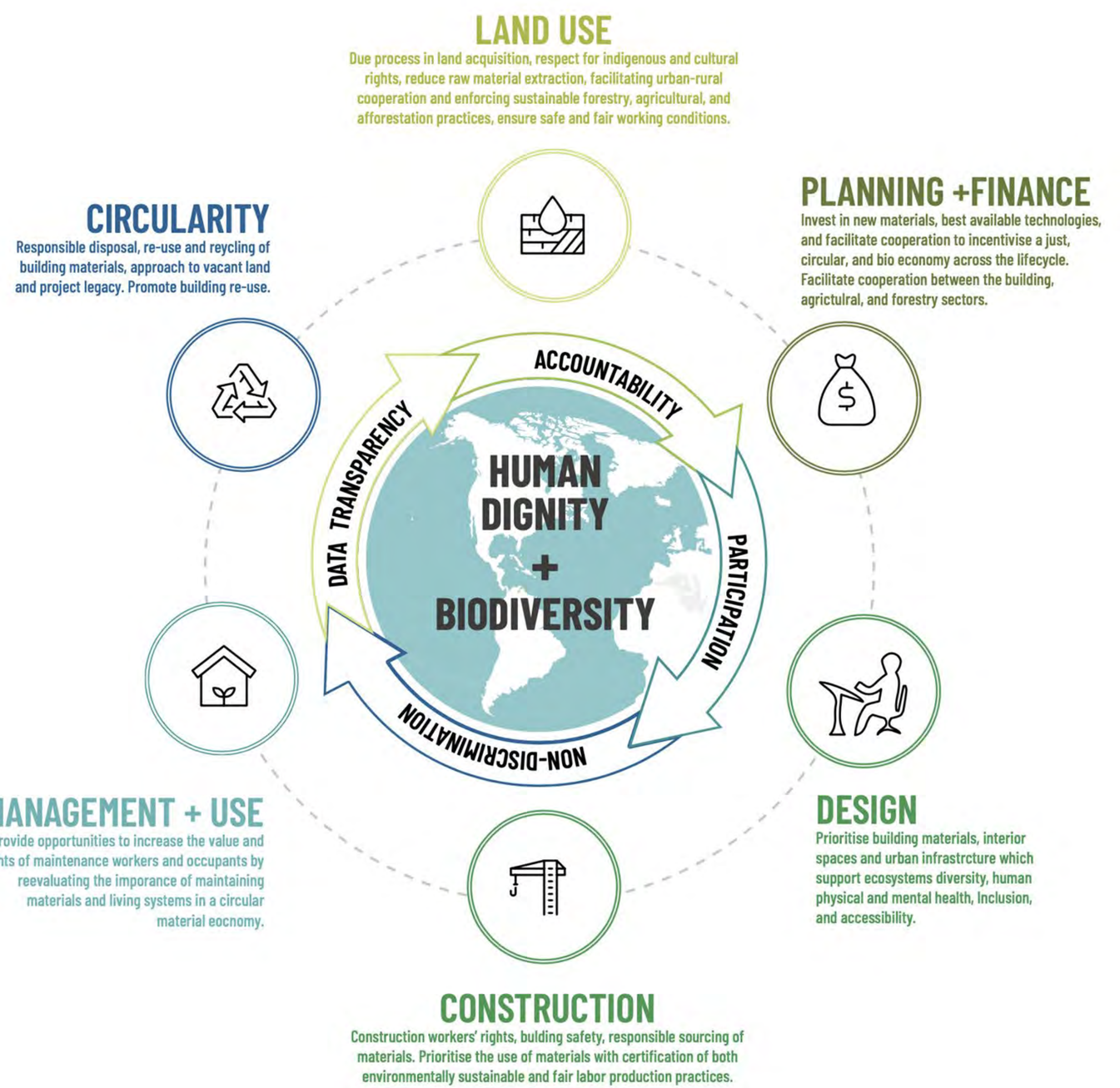
“One of the most important opportunities for synergistic potential to decarbonize the [building] sector lies with the ability to **link the production of building materials with the management of carbon cycles of forests and agricultural lands**...

…[and increasing] the capacity to store carbon within building materials and products, thereby **reducing climate change emissions from decaying matter, forest fires and the burning of crop waste.**

Further, major carbon sequestration benefits could come from new **cooperative approaches** between builders and forest managers to **increase the biodiversity of forests** through the selection of functional attributes for building materials according to species.”

# Human Dignity and Biodiversity

"In the shift towards bio-based materials, critical attention should be placed on **protecting ecosystems and workers from toxicity and environmental degradation** from unsound agricultural and forestry practices."




Source: Partially adapted from Institute for Human Rights and Business (2022).

Source: United Nations Environment Programme (2023). Building Materials and the Climate: Constructing a New Future. Nairobi

# Drawdown Solutions

**Women’s education and reproductive rights are climate action solutions**

**Indigenous land management is a climate action solution.**

**Social and ecological justice are climate action solutions**

**Humans are nature; ecological and social issues are deeply interconnected.**

## FAMILY PLANNING AND EDUCATION

IMPROVE SOCIETY › Health and Education

Rights-based, voluntary family planning and universal, high-quality education are essential human rights. They generate numerous direct benefits for gender equality, improved health and well-being, economic development, and more. Slower global population growth, a cascading outcome of increased family planning and rising education levels, contributes to reduced greenhouse gas emissions.

**68.9**
**GIGATONS**
$CO_2$ EQUIVALENT
REDUCED/SEQUESTERED
2020–2050

## INDIGENOUS PEOPLES’ FOREST TENURE

REDUCE SOURCES › Food, Agriculture, and Land Use › *Protect Ecosystems*
SUPPORT SINKS › Land Sinks

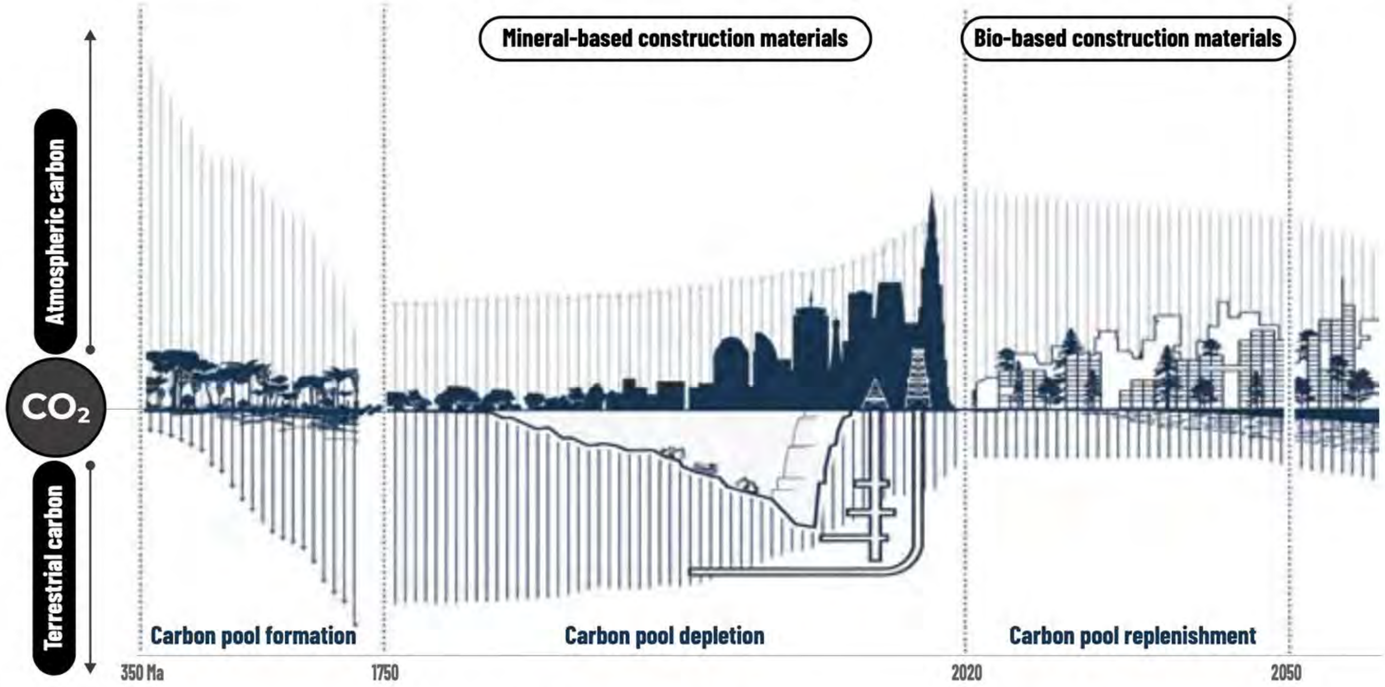
Secure land tenure protects Indigenous peoples’ rights. With sovereignty, traditional practices can continue—in turn protecting ecosystems and carbon sinks and preventing emissions from deforestation.

**8.69 to 12.51**
**GIGATONS**
$CO_2$ EQUIVALENT
REDUCED/SEQUESTERED
2020–2050

Source: Project Drawdown, http://www.projectdrawdown.org

# Returning to Balance

**4.1 Historical development of atmospheric carbon patterns**




A shift to bio-based building materials by 2060 can replenish the carbon pool and reduce atmospheric carbon

Note: The figure shows the historical transition in the terrestrial carbon pool from formation (left) to depletion (middle) to gradual replenishment (right, with simultaneous reduction in atmospheric carbon). Adapted from Churkina *et al.* 2020.

Source: United Nations Environment Programme (2023). Building Materials and the Climate: Constructing a New Future. Nairobi

# Data, Transparency, Justice

“ **Key recommendations for bio-based materials include:**

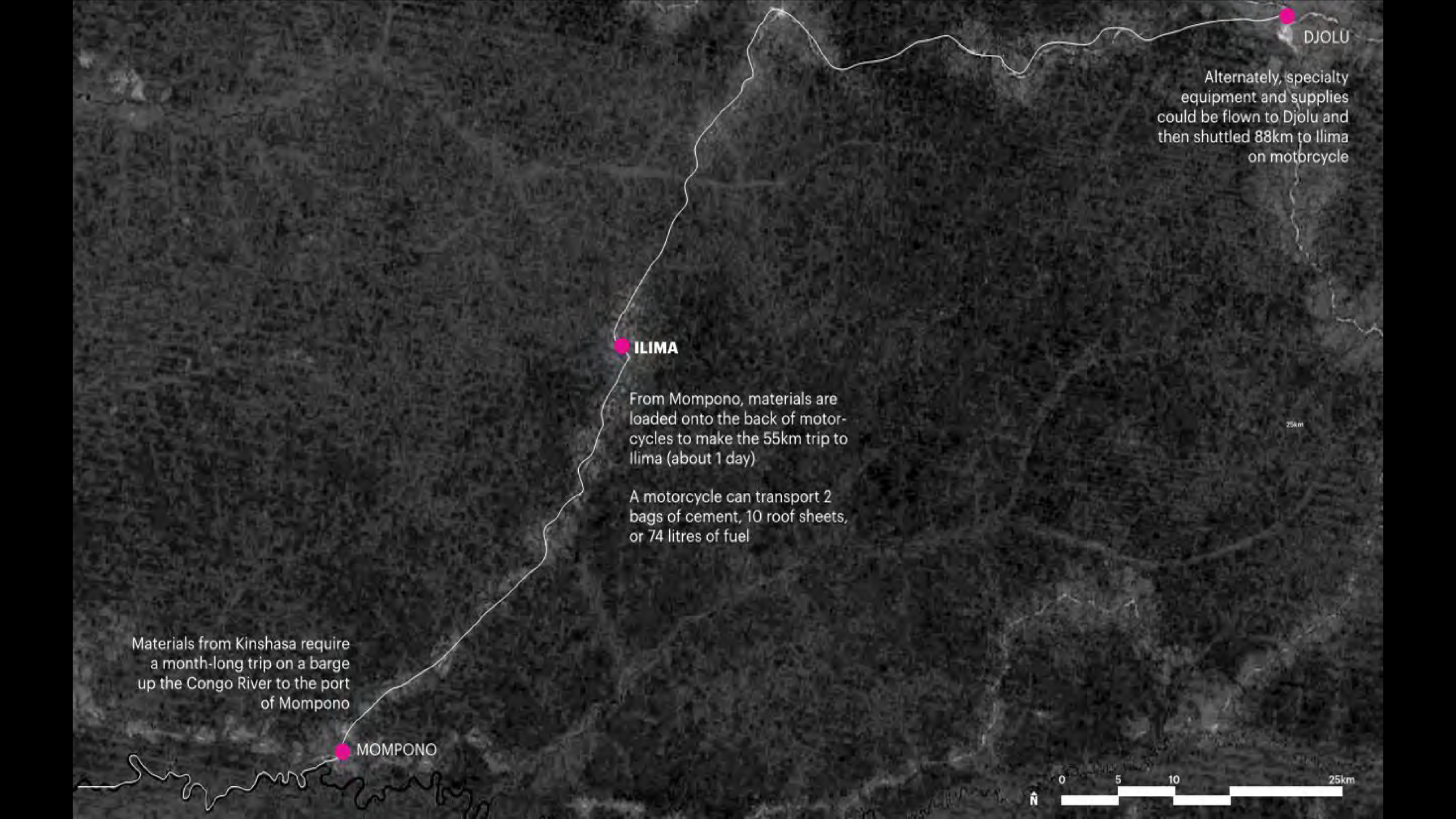
1. Standardization of performance
2. Integration into building codes
3. Broad industry upskilling
4. Marketing and financial incentivization
5. Regulated cooperation in sustainable land-use techniques.”

- Building Materials and the Climate: Constructing a New Future, UN Environment Programme (2023), Nairobi

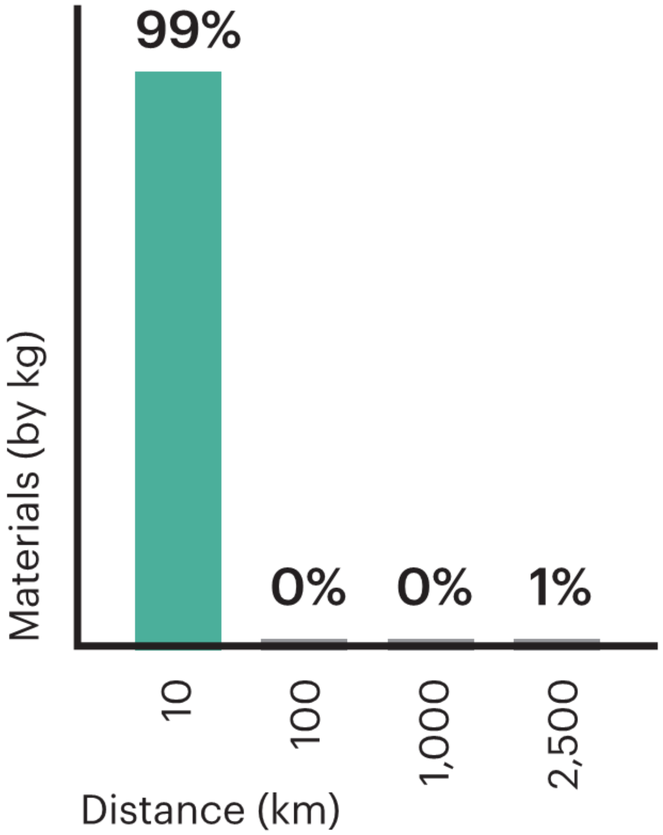

Footprint

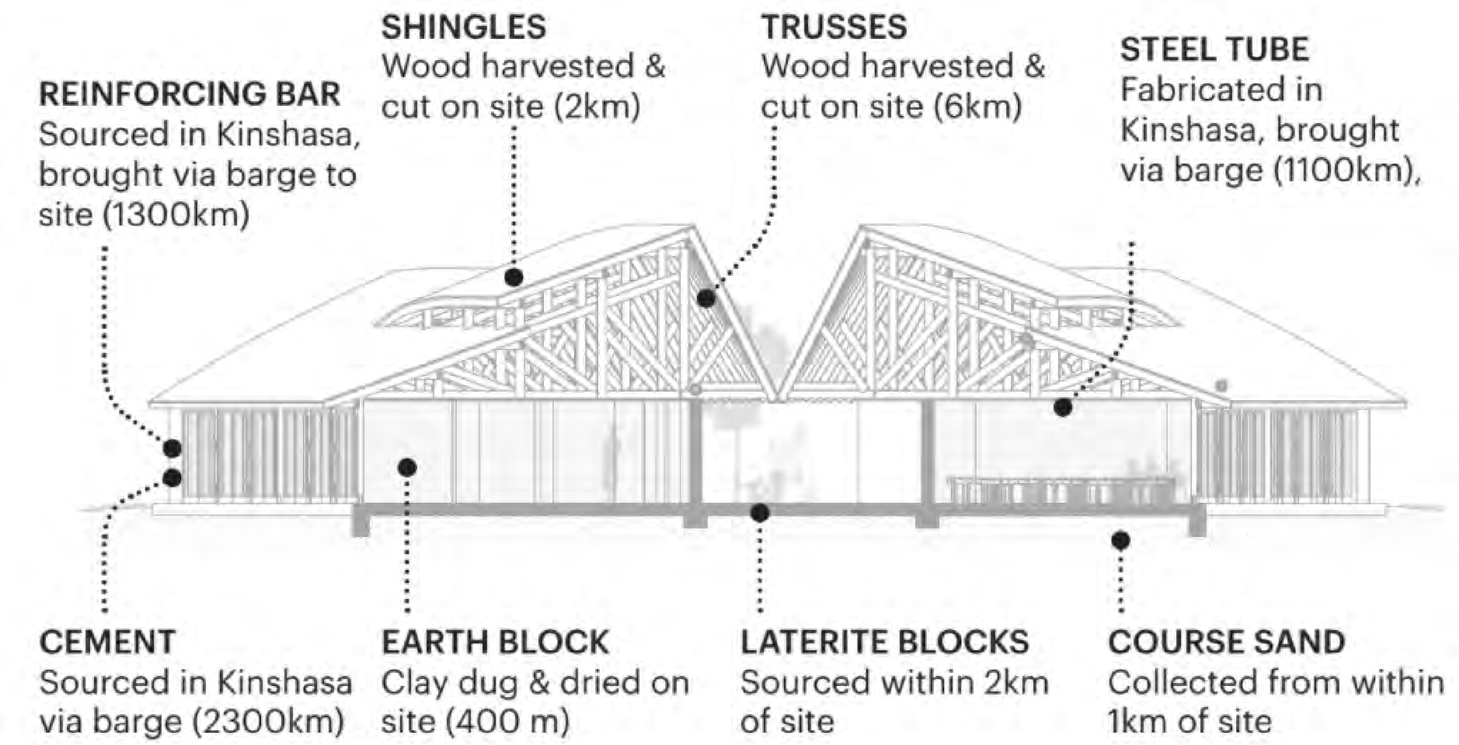

Handprint

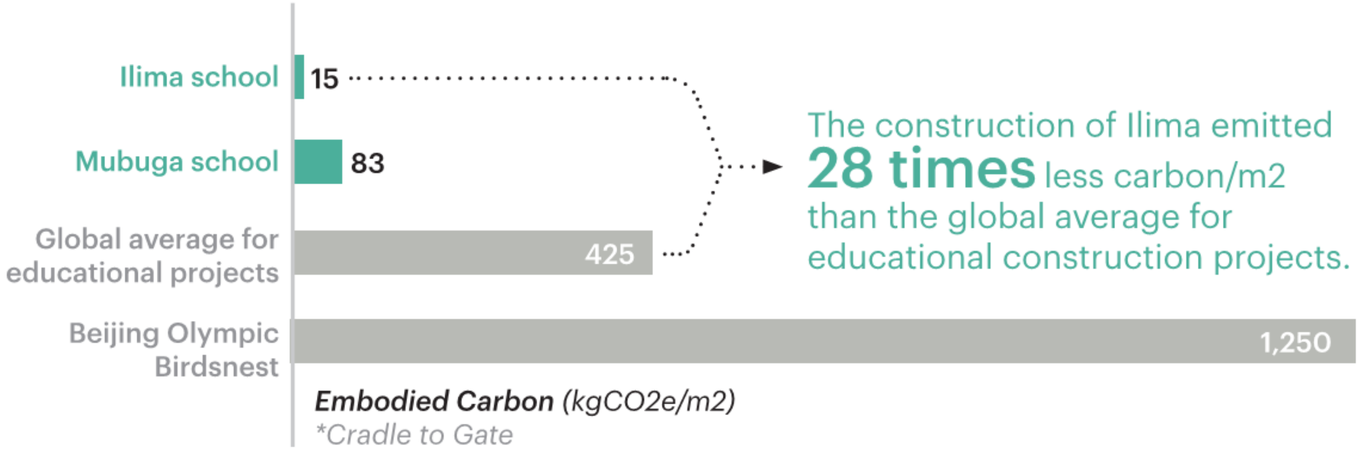
**Ilima Primary School**
*Ilima, Democratic Republic of Congo*


DJOLU
Alternately, specialty equipment and supplies could be flown to Djolu and then shuttled 88km to Ilima on motorcycle
ILIMA
From Mompono, materials are loaded onto the back of motor-cycles to make the 55km trip to Ilima (about 1 day)
A motorcycle can transport 2 bags of cement, 10 roof sheets, or 74 litres of fuel
Materials from Kinshasa require a month-long trip on a barge up the Congo River to the port of Mompono
MOMPONO
25km
0
5
10
25km
N

# Material Sourcing






The construction of Ilima emitted **28 times** less carbon/m2 than the global average for educational construction projects.


PROPOSED SITE
4
2
1
3
Lac Calmont

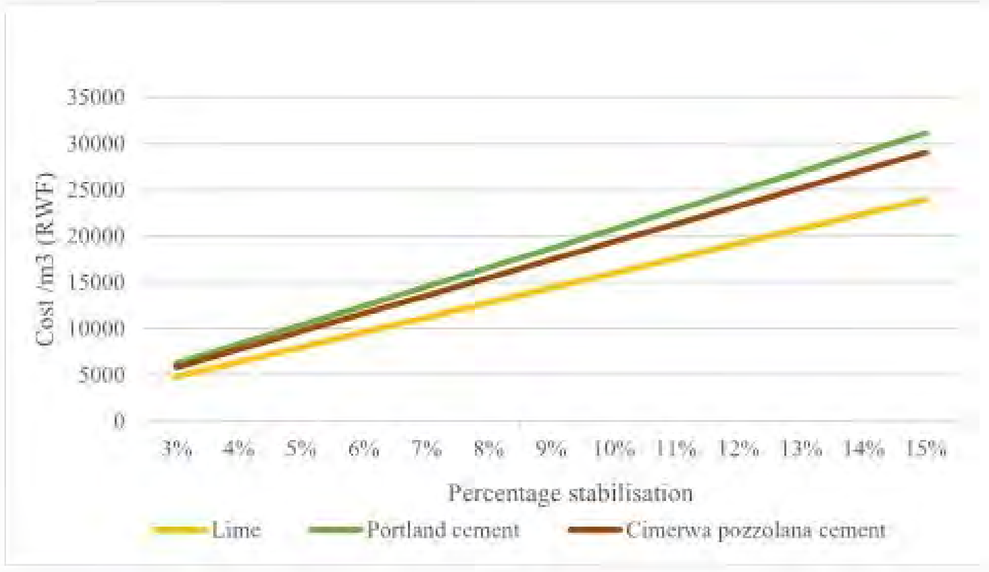



**Figure 5:** Cost comparison of stabilising CSEBs with lime or cement

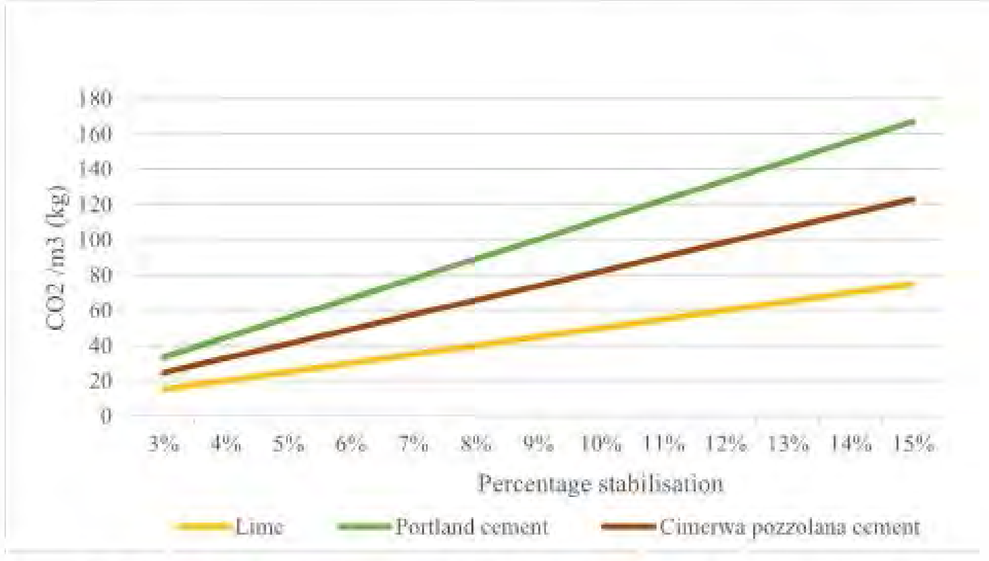



**Figure 6:** Sustainability comparison of stabilising CSEBs with lime or cement

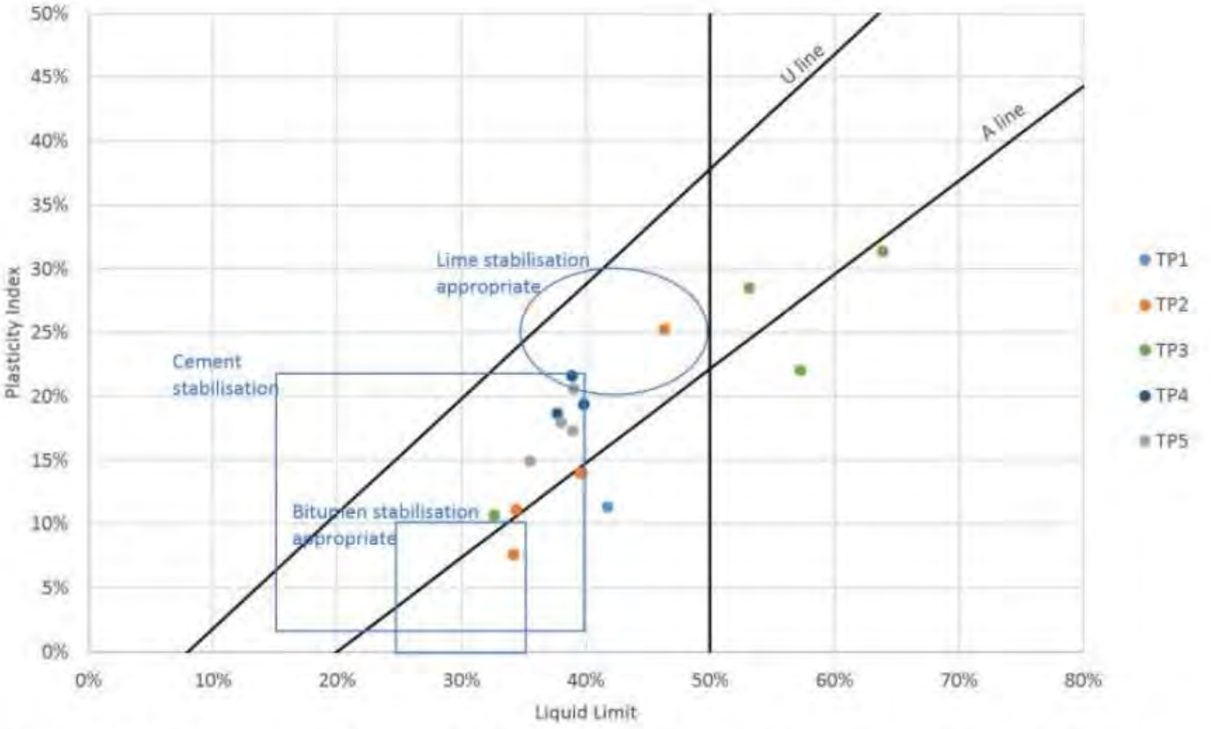
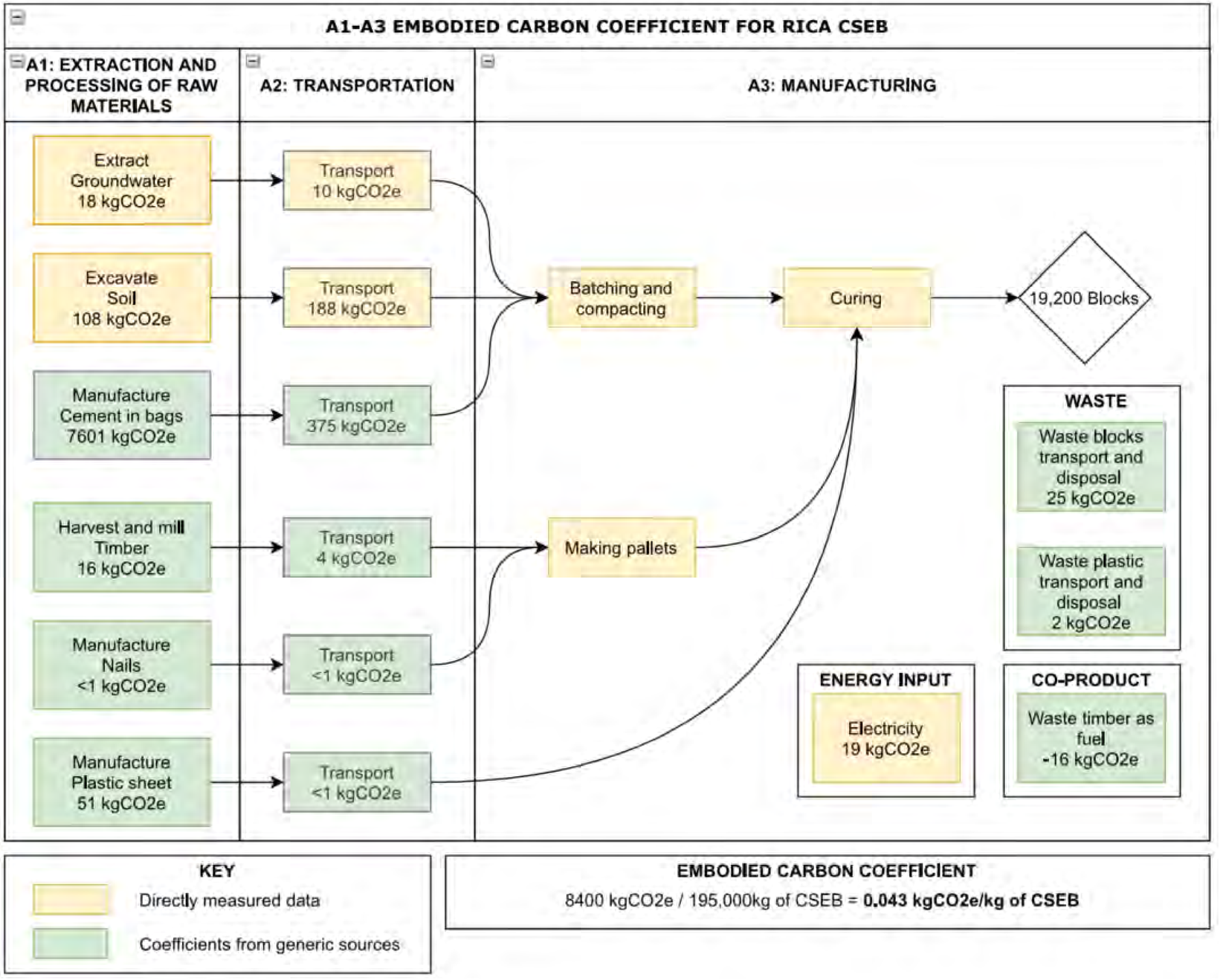



**Figure 2:** Laboratory test results for plasticity of materials from the five trial pits

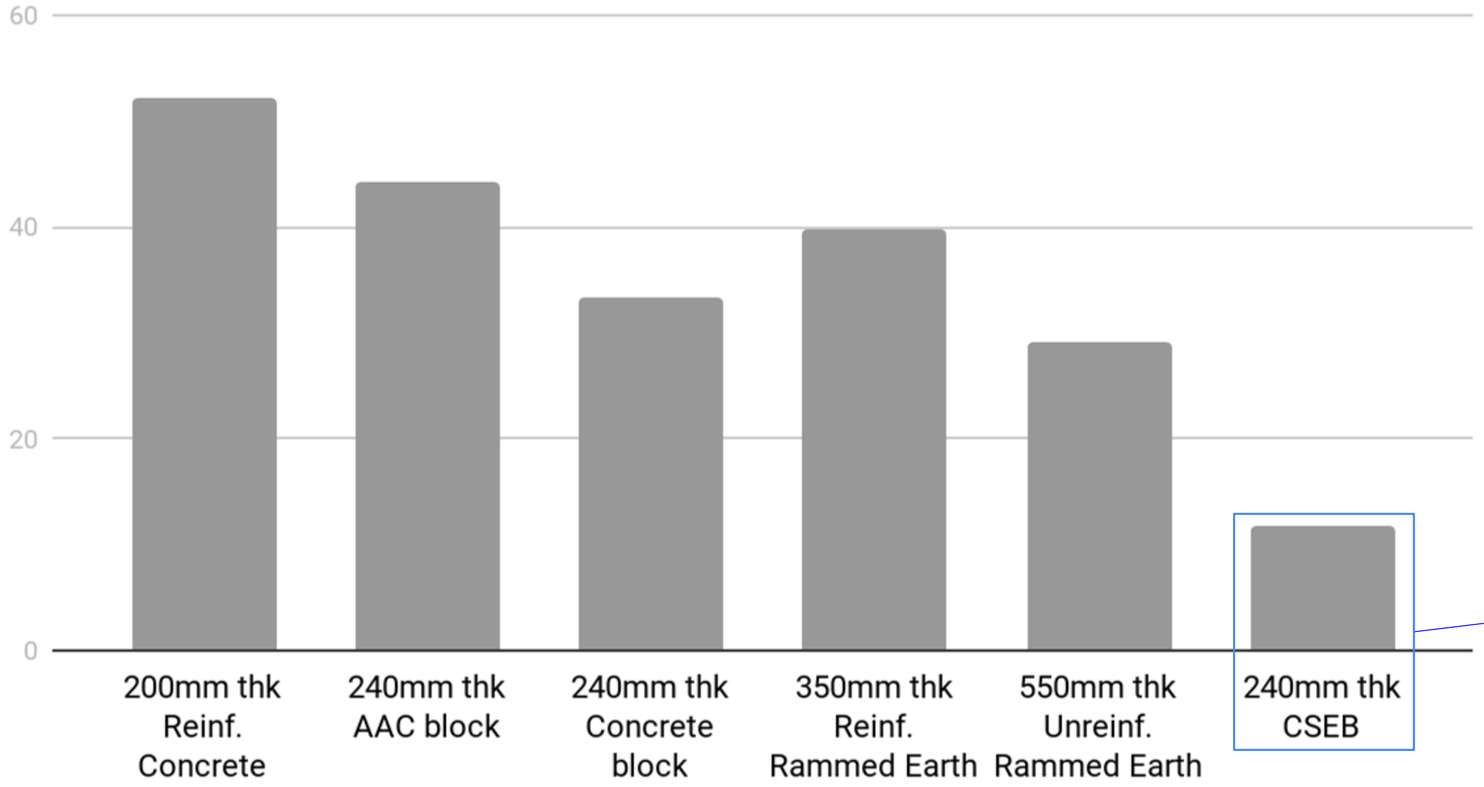
Earth

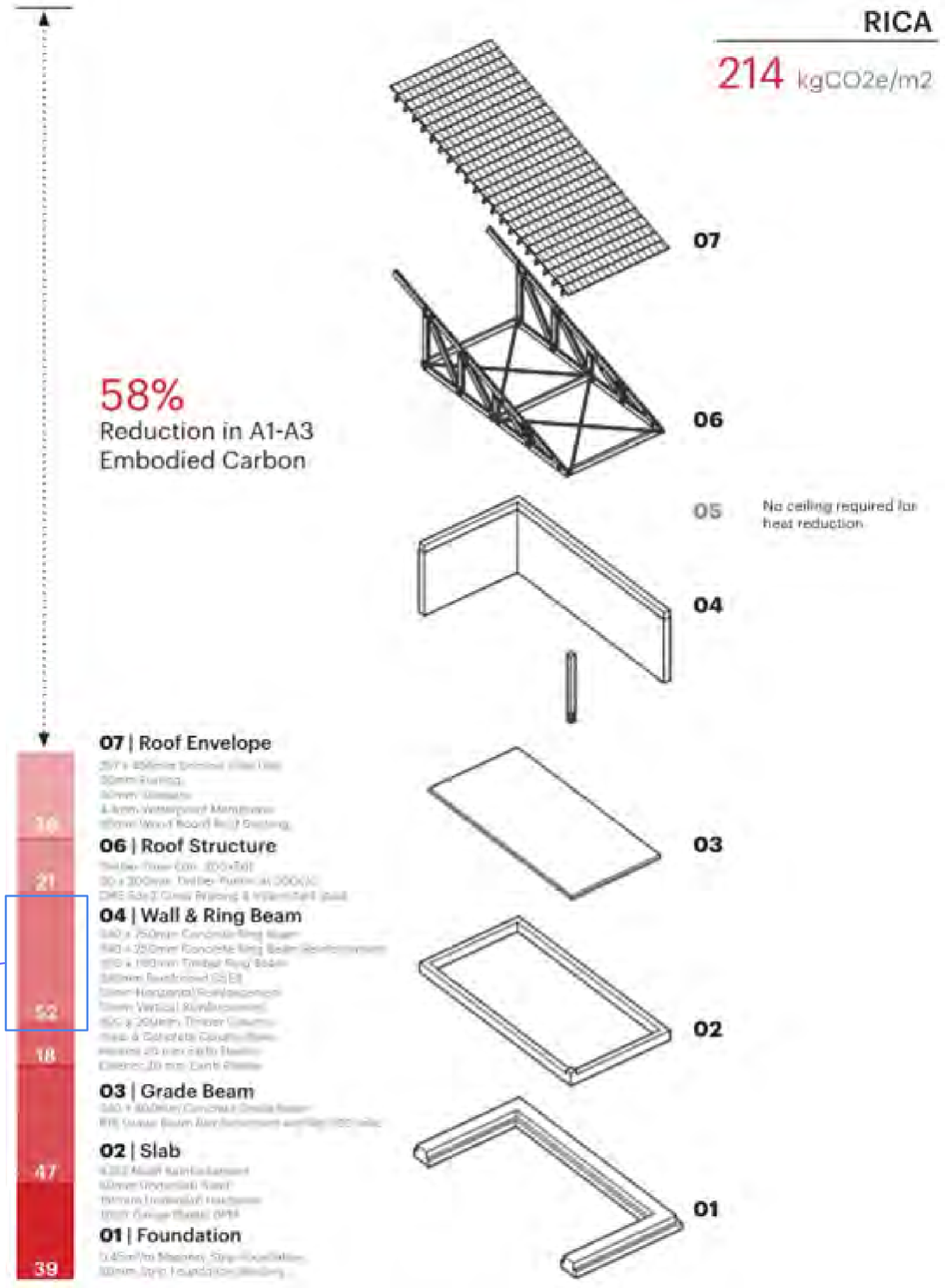
# Supply chain



# 1/2

## Embodied carbon of CSEBs vs other walling



**3,400** acres

**69** buildings on campus

**96%** of materials sourced within Rwanda

**500,000+** native plants propagated on-site

# RS 484:2021

# Adobe Blocks (Rukarakara) - Specification

RSB Rwanda Standards Board

**RWANDA STANDARD**

**DRS 484:2021**

First edition

2021-mm-dd

**Adobe blocks (Rukarakara)—Specification**

ICS 91.100.15

Reference number

DRS 484: 2021







**5.2.3.2** Protection from rain and surface water is extremely important throughout the curing period and also during construction when block is in the wall and not covered by a roof. A plastic sheet shall be used to protect the blocks from rain however it should not limit airflow or drying of blocks for long periods of time.

NOTE Other forms of rain protection such as banana leaves provide limited protection during large rainfall and do not allow the blocks to dry if placed directly against them. Raising the blocks off the ground and providing a bund around the curing area will help to protect them from surface water during large rainfalls.

**5.2.3.3** Following initial drying, the blocks shall be flipped onto their side when strong enough to turn, this exposes a larger surface area to air for efficient curing and then rotated every 3-4 days for even drying. Depending on the size of block and the weather, curing may take between 14 days and 2 months, and blocks shall not be used in construction before they are fully cured. When they are fully cured, the block has the same colour as the dry soil they were made from, and when tapped with a coin they produce a 'clear ring'.

**5.2.3.4** Dry blocks shall be stacked in rows not exceeding 7 number.

**5.2.3.5** Blocks stabilised with cement shall be damp cured for at least 1 week before being air dried. During damp curing the blocks are not allowed to dry.

## 6 Performance criteria

### 6.1 Strength

**6.1.1** If the compressive strength is carried out, it should be performed in accordance with BS EN 772-1:2011+A1:2015, but see 6.1.3 for other methods of strength testing.

**6.1.2** The minimum compressive strength shall be 0.5N/mm$^2$.

**6.1.3** The Block Drop Test may be used as an indicator of strength.

**6.1.4** At least 20 trial blocks should be made using the same materials and techniques expected to be used in the future manufacture of blocks. These trial blocks should be tested using the Block Drop Test and if 80% pass the blocks may be considered to have met the required minimum compressive strength as per Annex B .

**6.1.5** If any part of the mixture or manufacturing process changes during construction then the testing described in clause 6.1.4 shall be performed again. Any of the following would require testing to be performed again:

a) Soil from another location is used

b) The type of soil in the pit clearly changes, often indicated by changes in colour or particle size

c) Fibre type or quantity of fibre is changed

**6.1.6** If still suitable, the broken blocks from the test may be used in the building as half blocks at openings or wall ends.









*Figure 13: Small piece broken off block corner: Measure according to Figure 14*

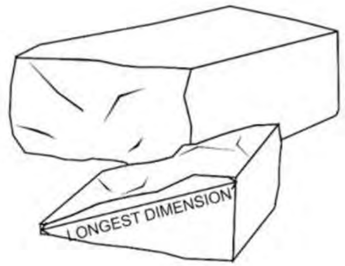



*Figure 14: How to measure broken piece - if less than* **150mm***: PASS*

**B.2.2** The following are recommendations based on the pass rate of at least 20 blocks.

a) > 80% pass rate: block performs well

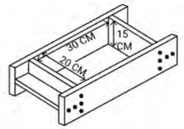
b) 60-80% pass rate: block is acceptable but recommend improvements, such as mixing with another soil to improve the properties and testing again

# Technical Guidelines on Adobe Block Construction in Rwanda

**Amabwiriza agenga imyubakishirize ya Rukarakara mu Rwanda**

**Technical Guidelines on Adobe Block Construction in Rwanda**






Igishushanyo 10. Ibipimo ntarengwa by'iforoma yifashishwa mu kubumba rukarakara

### 3.6 Ahabumbirwa amatafari

Ahabumbirwa amatafari hagomba kuba:

- Hatagerwa n'urumuri rw'izuba cyangwa ngo hanyagirwe.
- Haringaniye kandi humutse
- Hatunganyijwe ku buryo amazi atareka cyangwa ngo agire aho ahurira n'amatafari
- Amatafari agomba kwanikwa akuwe ku butaka mu gihe cy'imvura keretse iyo ahabumbirwa hasakaye

### 3.7 Kubumba

Mbere yo gutangira kubumba, ubutaka bugomba kuba buteguwe, bwakuwemo imyanda yose, ibintu bityaye ndetse na garaviye zose zifite umubyimba uri hejuru ya 2.5cm.

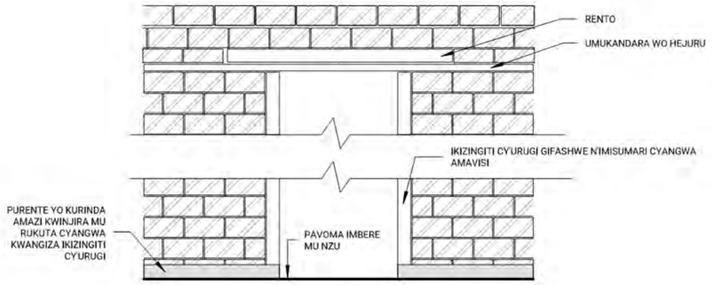
Ingano y'amazi isabwa iterwa n'ubwoko bw'igitaka cyangwa ibihe by'imvura n'izuba. Urwondo rugomba gukatwa neza kugira ngo itafari rivamo ribe ryujuje ibisabwa. Urwondo rukatwa nibura mbere y'amasaha 12 kugira ngo amazi akwiremo neza. Ibi ntibyubahirizwa mu gihe hifashishijwe sima cyangwa ishwagara mu kongera ubukomere bw'itafari.

Ingano y'amazi ari mu rwondo imenyekana iyo hafashwe urwondo mu kiganza, rugakandwa kugira ngo harebwe ingano y'uruca mu myanya y'intoki n'uburyo urusigaye mu ntoki rutose. Imbonerahamwe ikurikira igaragaza urwondo rutose cyane, urwumagaye ndetse n'ururimo ingano y'amazi ikwiriye.

| **Harimo amazi menshi** Iyo ukanze icyo gica mu myanya y'intoki kandi ibiganza bigakomeza kuba bitose. | **Harimo amazi make** Iyo ukanze urwondo mu biganza ntiruca mu myanya y'intoki kandi ibiganza ntibiba bitose. | **Amazi akwiriye** Iyo ukanze urwondo mu kiganza, urwondo ruke ruca mu myanya y'intoki kandi urwondo ruke rushobora gusigara mu biganza. |
|---|---|---|
|  |  |  |
|  |  |  |

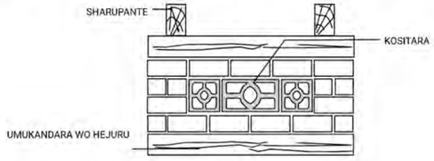
Imbonerahamwe 1. Uko hamenywa ingano y'amazi akwiye kuba mu rwondo rubumbwamo rukarakara



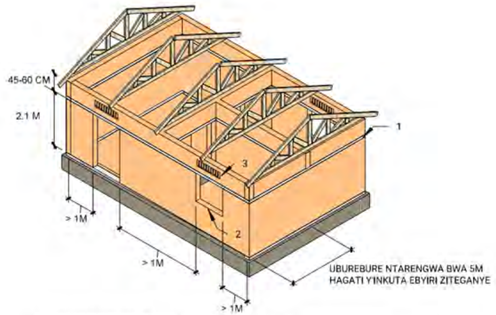



Igishushyanyo 32. Ikizingiti cy'umuryango

- Buri cyumba kigomba kugira idirishya rifunguka. Ubuso bw'idirishya bugomba kuba bufite nibura 5% by'ubuso bw'icyumba.
- Mu rwego rwo kurengera ubuzima, igikoni kigomba kugira idirishya rifunguka kandi rifite ubuso bungana nibura na 5% by'ubuso bwacyo.
- Amakositara cyangwa ruvazi (louvres) agomba gushyirwa hejuru y'umundara w'inzu; amakositara agomba kugira nibura 1m z'uburebure kuri buri cyumba cyangwa hejuru ya buriI dirishya.




Igishushanyo 33. Kositara




1. UMUKANDARA WO HEJURU
2. NIBURA IDIRISHYA RIMWE KURI BURI CYUMBA KANDI RIFITE UBUSO BUTO NTARENGWA BWA 5% BY'UBUSO BW'ICYUMBA
3. NIBURA 1M YA KOSITARA KURI BURI CYUMBA

Igishushanyo 34. Uburyo bwizewe bwo gusyira inzugi n'amadirishya ku nzu

# A Toolkit for Built Environment Practitioners to Measure and Reduce Embodied Carbon in Rwanda

Measuring and Reducing Embodied Carbon in Rwanda's Built Environment

MASS. ARUP

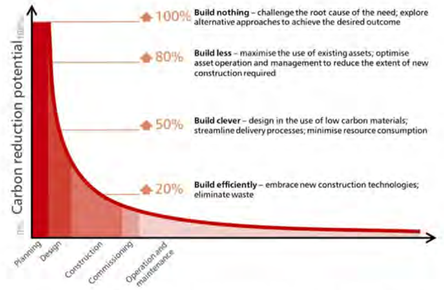



*Figure 8: Embodied carbon reduction potential over the life of a project [8]*

Understanding the relative proportion of embodied carbon by building part (substructure, roof, finishes etc.), through whole building assessments, helps to identify where the highest embodied carbon reduction potential is, and therefore where most effort should be spent. This is shown in the indicative building assessment in Figure 9.

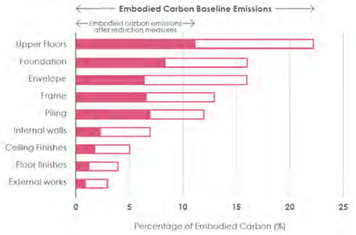
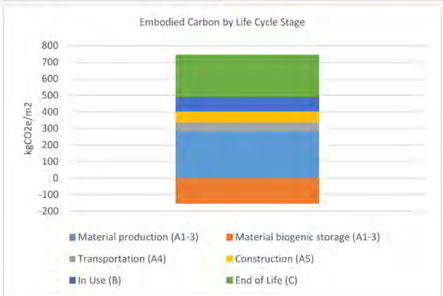


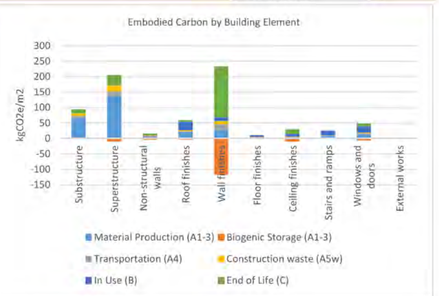

*Figure 9: Approximate embodied carbon breakdown by building category and reduction potential [9]*

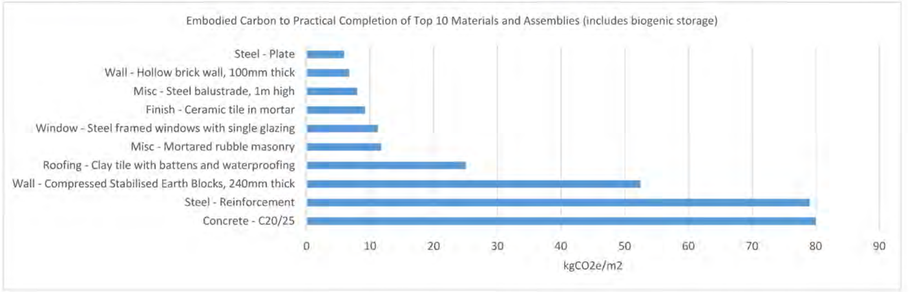
While the planning stage of a project offers the greatest opportunity for carbon reduction, built environment professionals, who are the primary audience of this guide, are more typically engaged at the start of the design process. Because of this, the top five embodied carbon reduction opportunities featured in this guide have been developed



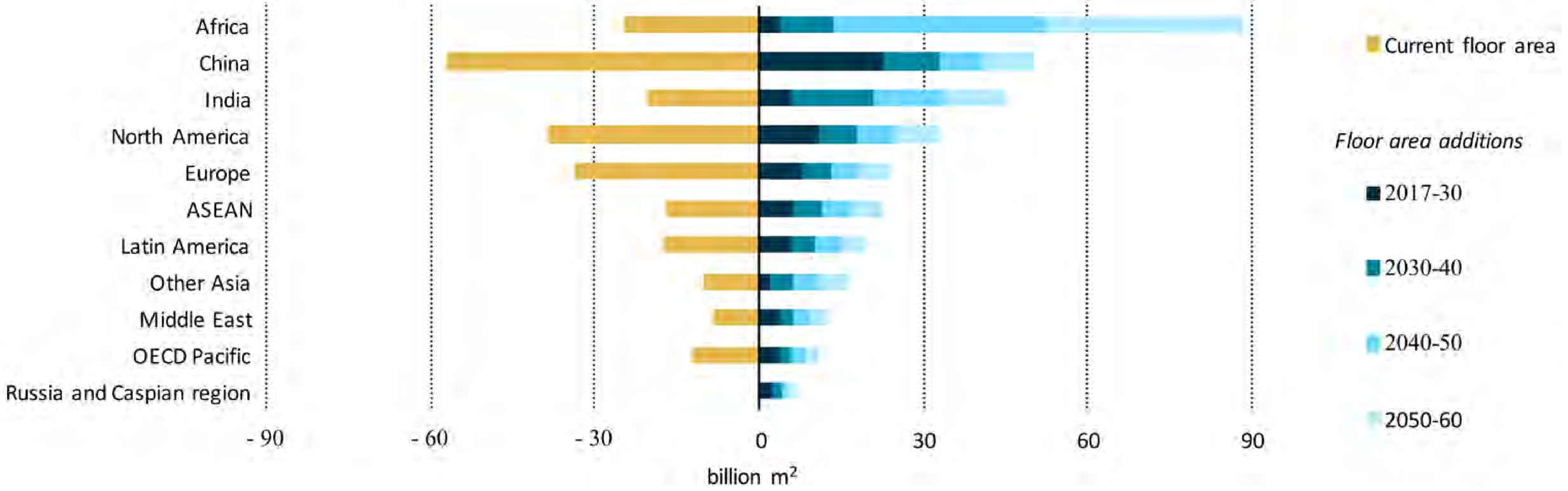
| Building information | | Life Cycle Stages | kgCO2e | kgCO2e/m² | kgCO2e/ m²/yr |
|---|---|---|---|---|---|
| Project name | RICA Y2+3 | Material production (A1-3) | 655298 | 285 | 4.7 |
| Project stage | In Use | Material biogenic storage (A1-3) | -353656 | -154 | -2.6 |
| Building classification | Educational | Transportation (A4) | 118897 | 52 | 0.9 |
| Building use | Residential building for 86 students at an agricultural university | Construction (A5) | 153422 | 67 | 1.1 |
| | | In Use (B) | 207133 | 90 | 1.5 |
| Date of practical completion | 01 August 2021 | End of Life (C) | 577104 | 251 | 4.2 |
| Project district | Bugasera | | Which building elements are included in the assessment? | | |
| Email contact | jkitchin@mass-group.org | Building Information | | | |
| Name of assessor and organisation | James Kitchin, MASS Design Group | Gross floor area (m²) | 2300 | Substructure | Yes |
| Assessment date | 27 May 2022 | Service life (years) | 60 | Superstructure | Yes |
| Assessment version | 1 | # of occpuants | 86 | Non-structural walls | Yes |
| Embodied carbon reduction importance | Very important to project success | # of above ground floors | 2 | Roof finishes | Yes |
| Structural systems | Rubble masonry foundations, CSEB walls, reinforced concrete floors and timber roof. | # of below ground floors | 0 | Wall finishes | Yes |
| | | | | Floor finishes | Yes |
| Building description | Two storey residential building with bedrooms, communal areas and service area. There are limited finishes in the building. | | | Ceiling finishes | Yes |
| | | | | Stairs and ramps | Yes |
| Notes on assumptions and limitations of assessment | External works are not included but will be included in Assessment Version 2. | | | Windows and doors | Yes |
| | | | | External works | No |



Africa will build more than any other
region in the world in the next 40 years.



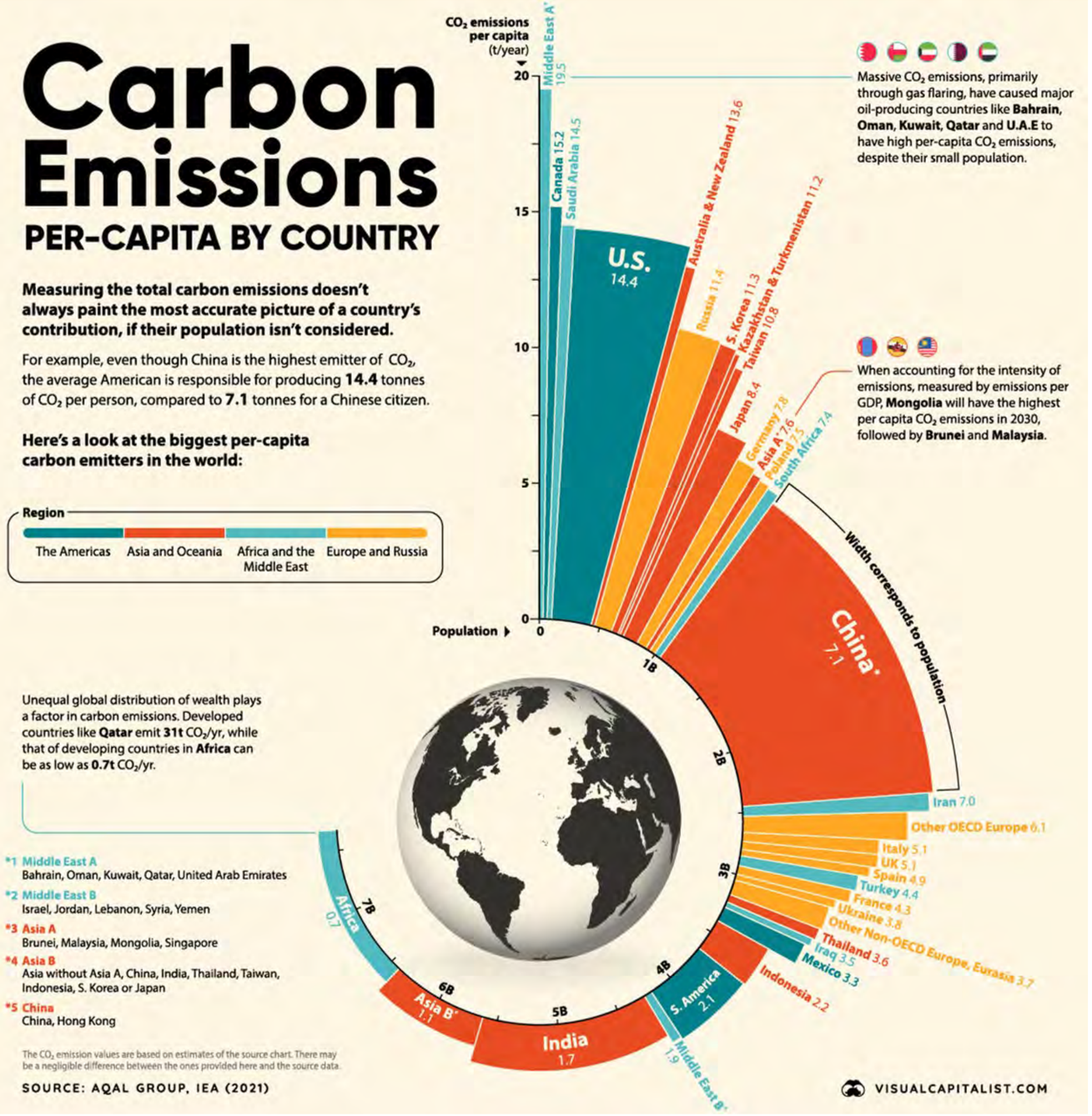
# Carbon Emissions

## PER-CAPITA BY COUNTRY

**Measuring the total carbon emissions doesn't always paint the most accurate picture of a country's contribution, if their population isn't considered.**

For example, even though China is the highest emitter of $CO_2$, the average American is responsible for producing **14.4** tonnes of $CO_2$ per person, compared to **7.1** tonnes for a Chinese citizen.

**Here's a look at the biggest per-capita carbon emitters in the world:**




Massive $CO_2$ emissions, primarily through gas flaring, have caused major oil-producing countries like **Bahrain**, **Oman**, **Kuwait**, **Qatar** and **U.A.E** to have high per-capita $CO_2$ emissions, despite their small population.

When accounting for the intensity of emissions, measured by emissions per GDP, **Mongolia** will have the highest per capita $CO_2$ emissions in 2030, followed by **Brunei** and **Malaysia**.

Unequal global distribution of wealth plays a factor in carbon emissions. Developed countries like **Qatar** emit **31t** $CO_2$/yr, while that of developing countries in **Africa** can be as low as **0.7t** $CO_2$/yr.

*1 **Middle East A**
Bahrain, Oman, Kuwait, Qatar, United Arab Emirates

*2 **Middle East B**
Israel, Jordan, Lebanon, Syria, Yemen

*3 **Asia A**
Brunei, Malaysia, Mongolia, Singapore

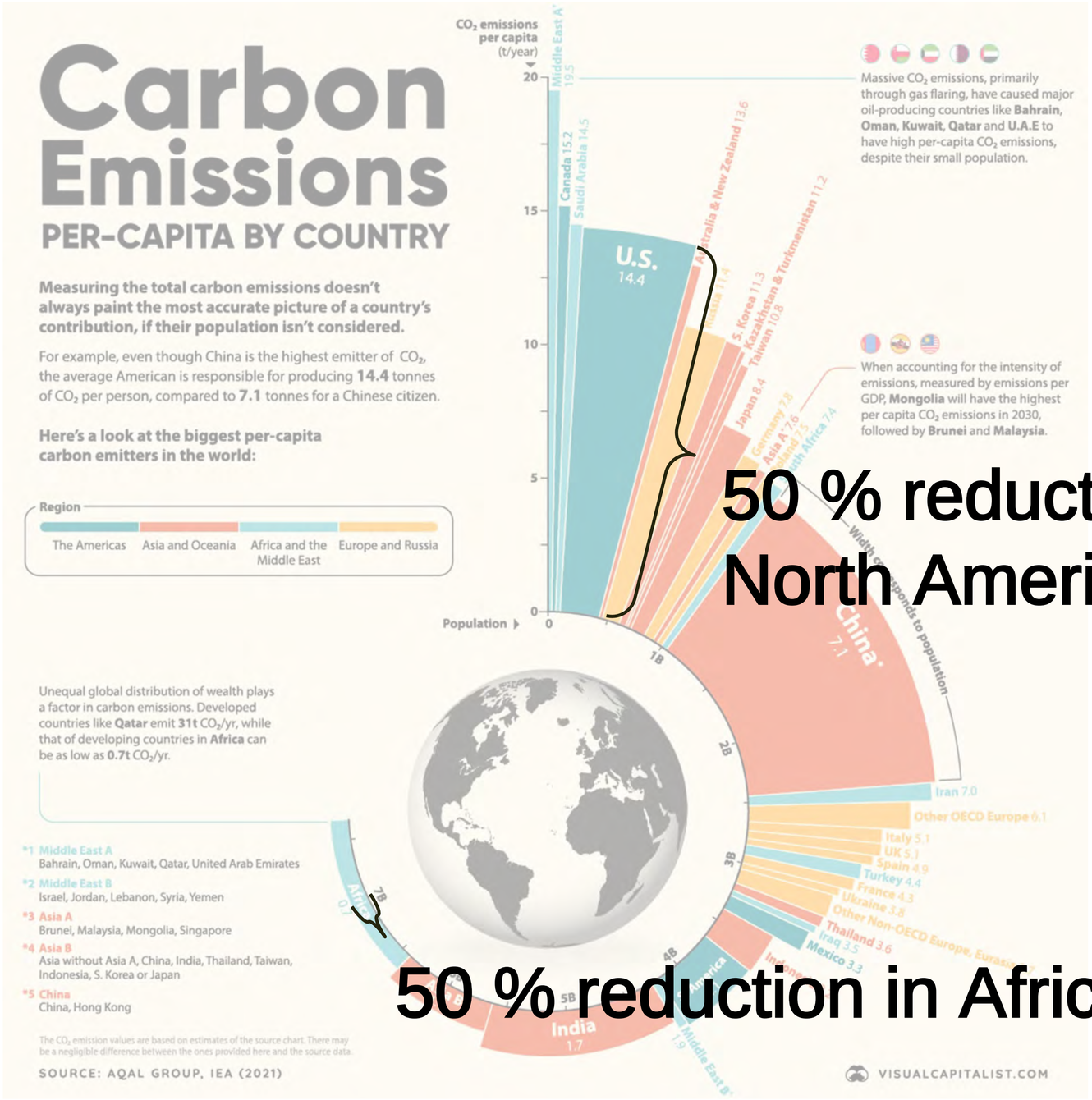
*4 **Asia B**
Asia without Asia A, China, India, Thailand, Taiwan, Indonesia, S. Korea or Japan

*5 **China**
China, Hong Kong

The $CO_2$ emission values are based on estimates of the source chart. There may be a negligible difference between the ones provided here and the source data.

SOURCE: AQAL GROUP, IEA (2021)

VISUALCAPITALIST.COM




50 % reduction in North America

50 % reduction in Africa

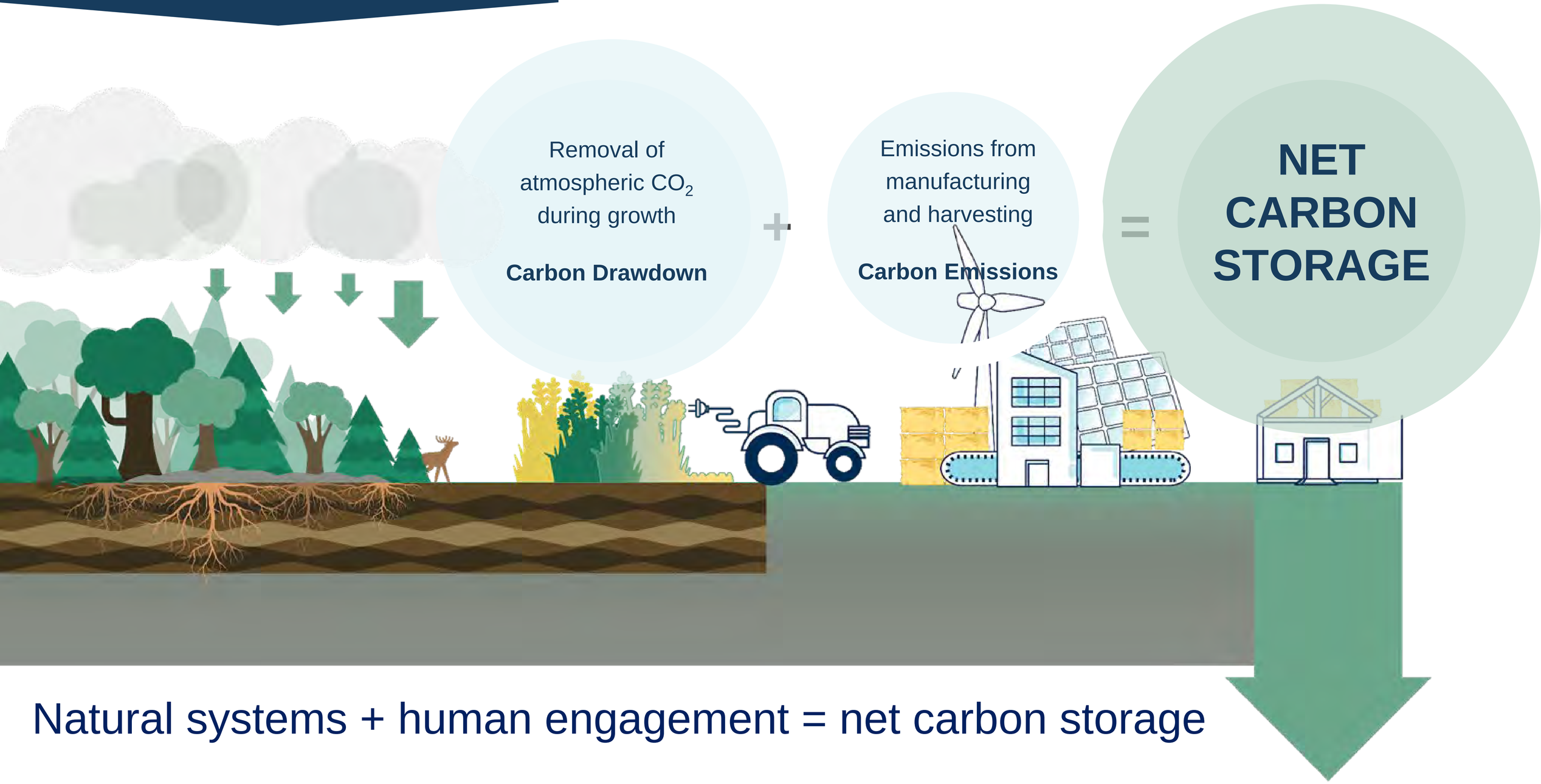

How can our work in the US reflect similar values, economic improvement, and regional focus?

Ohkay Owingeh
New Mexico
MASS and formerly AOS Architects


Stone Barns
New York


What is a regional approach to low embodied carbon construction in the Northeast?

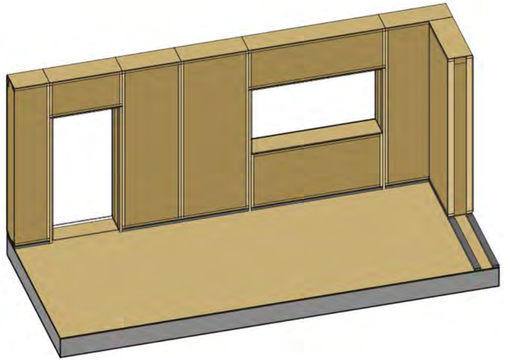
# Drawdown Systems Solution



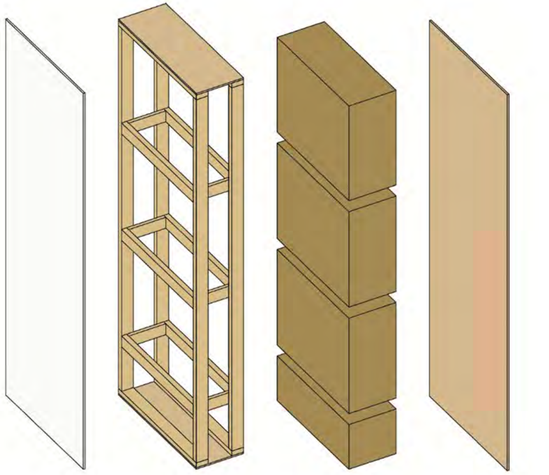

Natural systems + human engagement = net carbon storage

# New Frameworks Panels

New Frameworks



EXAMPLE PANEL LAYOUT



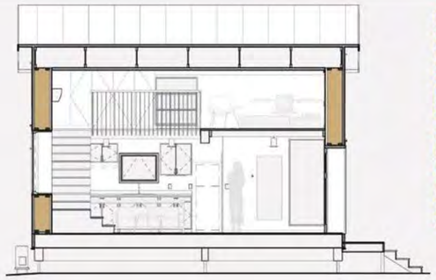

**Idaho Residence**

***Love Schack Architecture + New Frameworks Panels***

# Casitas

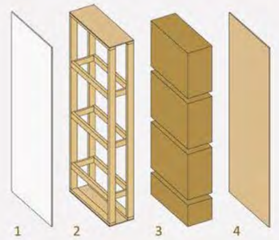
## CASITA LINE TERRA

PRE-FABRICATED STRAW PANEL ASSEMBLIES WITH FULL MEP SERVICES

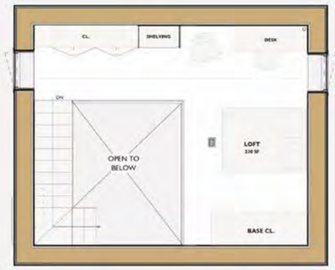


INSULATION STRAW PANEL

- **MATERIAL SOURCING:**
STRAW BALE INSULATION IS MADE FROM USDA ORGANIC GRASS FROM AURORA FARMS.FRAMING LUMBER TRAVELS 45MILES FROM FONTAINE SAWMILL - A ZERO WASTE YARD USING LOCALLY SOURCED AND SUSTAINABLY MANAGED TIMBER.
- **ECOLOGICAL AND ECONOMIC JUSTICE:**
**92%** OF PANEL VOLUME IS PLANT-BASED.
**75%** OF PANEL MATERIALS ARE GROWN AND SOURCED WITHIN 50 MILES OF FABRICATION.
**21.7KG** OF CO2 SEQUESTERED IN EACH PANEL.




1. AIR BARRIER
2. FRAMING
3. STRAW BALES
4. SHEATHING





A BEAUTIFUL, NATURAL, ACCESSORY UNIT, ADU, TINY HOUSE OR CABIN FOR YOUR BACKYARD OR PROPERTY. COZY IN THE WINTER AND COOL IN THE SUMMER, THIS ENERGY EFFICIENT CABIN IS READY TO BE YOUR STUDIO, OFFICE, VACATION RENTAL OR EXTRA SPACE FOR YOUR FAMILY. MADE IN VERMONT WITH ALL NATURAL AND NONTOXIC VERMONT PRODUCTS BY THE WORKER COOPERATIVE NEW FRAMEWORKS.

info@newframeworks.com

# Relationships Matter

**Cooperative business gives paths to ownership for all.**

**Equitable hiring, inclusive culture, and language justice build our workforce.**

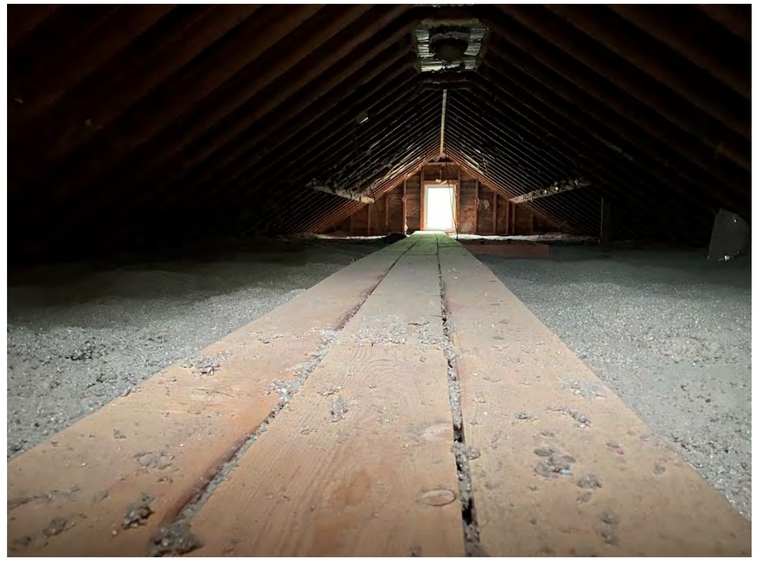
**Supporting local agriculture is an investment in community resilience across multiple sectors.**

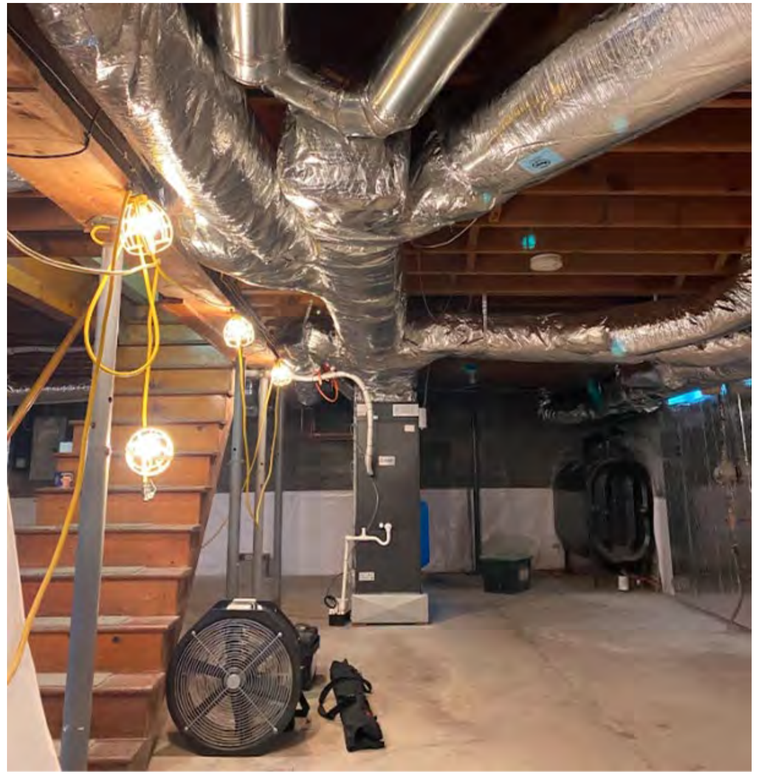

Dave Kenyon, Nitty Gritty Grain Company, Charlotte

# Retrofits Matter

**Decarbonizing existing buildings hits core goals for social and ecological impact.**

**Bio-based materials + healthy homes + electrification + renewable energy + community investment/economic empowerment + applied building science**





# Democratizing Data

**BUILDING EMISSIONS ACCOUNTING** FOR MATERIALS

BEAM : *A Tool For Climate Action!*

## EXTERIOR WALLS

SECTION COMPLETE? ☐

**SUBTOTAL (kg $CO_2e$)**

**-5,576**

| CATEGORY | MATERIAL | QUANTITY | UNITS | % | SELECT | NET EMISSIONS (kg $CO_2e$) | EMISSIONS (kg $CO_2e$) | STORAGE (kg $CO_2e$) | FOOTNOTE |
|---|---|---|---|---|---|---|---|---|---|
| | Fiberglass batt / Owens Corning / EcoTouch Pink batt and roll / R 3.6/inch | 4,101.0 | ft² | 100% | ☐ | 374 | 374 | 0 | |
| **HEMP FIBER WOOL INSULATION** | | | | | | | | | |
| | Hemp fiber batt / NaturFibre / Hemp Wool / R 3.7/inch | 4,101.0 | ft² | 100% | ☐ | -438 | 1,398 | 1,836 | |
| **CELLULOSE INSULATION** | | | | | | | | | |
| | **Cellulose / loose fill / R 3.7/inch / CIMA [Industry Avg \| US & CA]** | 4,101.0 | ft² | 100% | ☐ | -856 | 392 | 1,248 | |
| | Cellulose / batt / CMS / EcoCell / R 3.6/inch | 4,101.0 | ft² | 100% | ☐ | -1,436 | 392 | 1,828 | |
| | Cellulose / spray applied / R 3.75/inch / International Cellulose Corp. / K-13, ThermoCon | 4,101.0 | ft² | 100% | ☐ | -1,692 | 262 | 1,954 | |
| | **Cellulose / dense pack / R 3.7/inch / CIMA [Industry Avg \| US & CA]** | 4,101.0 | ft² | 100% | ☐ | -1,711 | 784 | 2,495 | |
| **WOOD FIBER INSULATION** | | | | | | | | | |
| | Wood fiber loose fill / GUTEX / ThermoFiber / R 3.6/inch | 4,101.0 | ft² | 100% | ☐ | -1,172 | 486 | 1,658 | Expired 2020 |
| | Wood fiber batt / GUTEX / ThermoFlex / R 4/inch [EU] | 4,101.0 | ft² | 100% | ☐ | -1,731 | 302 | 2,033 | |
| | Wood fiber batt / Steico / SteicoFlex / R 3.8/inch [EU] | 4,101.0 | ft² | 100% | ☐ | -1,897 | 352 | 2,249 | Expired 2021 |
| | **Wood fiber batt / [BEAM Avg \| EU]** | 4,101.0 | ft² | 100% | ☐ | -1,956 | 235 | 2,191 | |
| | Wood fiber batt / Pavatex / Pavaflex / R 3.8/inch [EU] | 4,101.0 | ft² | 100% | ☐ | -2,241 | 50 | 2,291 | Expired 2019 |
| **HEMPCRETE INSULATION** | | | | | | | | | |
| | Hempcrete / Cast in-situ / USA / R 2.1/inch, Avg. mix using NHL & PHL | 4,101.0 | ft² | 100% | ☐ | -2,417 | 7,133 | 9,551 | Peer-reviewed LCA, 2020 |
| | Hempcrete / Cast in-situ / Europe / R 2.1/inch, Avg. of 9 mixes | 4,101.0 | ft² | 100% | ☐ | -4,199 | 10,548 | 14,747 | Peer-reviewed LCA, 2017 |
| | Hempcrete / Cast in-situ / IsoHemp / Europe / R 2.1/inch | 4,101.0 | ft² | 100% | ☐ | -4,832 | 4,719 | 9,551 | LCA, 2018 |
| **STRAW BALE INSULATION** | | | | | | | | | |
| | Straw Bale / Wheat & barley straw / SNaB (UK) / R 2.8/inch | 4,101.0 | ft² | 100% | ☐ | -4,319 | 542 | 4,861 | |
| | Straw Bale / Wheat & rye straw / (Germany) / R 2.8/inch | 4,101.0 | ft² | 100% | ☑ | -6,162 | 326 | 6,488 | Expired 2019 |

# Democratizing Data

## MATERIAL CARBON
## PROJECT RESULTS

BUILDERS FOR CLIMATE ACTION

BEAM

Net total: -3,057 kg CO2e

Ext. walls: -5,922 kg CO2e

YAY!

### PROJECT INFORMATION

| | | | |
|---|---|---|---|
| **Project Name** | Terra | **Construction Year** | |
| **Design Firm(s)** | | **Number of Bedrooms** | |
| **Engineering Firm(s)** | | **Stories Above Grade** | 2 |
| **Builder / Developer** | | | |
| **Development Project** | | **CONDITIONED AREA** | |
| **Street Address** | | **Above Grade** | 770 ft² |
| **City** | | **Below Grade** | 0 ft² |
| **Province / State** | | **Total** | 770 ft² |
| **Country** | United States | | |
| | | **GROSS AREA** | |
| **Building Type** | Single Detached House | **Excluding Garage** | 770 ft² |
| **Construction Type** | New Construction | **Garage** | 0 ft² |
| **Project Stage** | Construction Documents | **Total** | 770 ft² |

### MATERIAL CARBON EMISSIONS BY SECTION

| | | |
|---|---|---|
| **Footings & Slabs** | **489** | kg $CO_2e$ |
| **Foundation Walls** | **0** | kg $CO_2e$ |
| **Structural Elements** | **176** | kg $CO_2e$ |
| **Exterior Walls** | **-5,922** | kg $CO_2e$ |
| **Party Walls** | **0** | kg $CO_2e$ |
| **Exterior Wall Cladding** | **493** | kg $CO_2e$ |
| **Windows** | **592** | kg $CO_2e$ |
| **Interior Walls** | **235** | kg $CO_2e$ |
| **Floors** | **119** | kg $CO_2e$ |
| **Ceilings** | **50** | kg $CO_2e$ |
| **Roof** | **711** | kg $CO_2e$ |
| **Garage** | **0** | kg $CO_2e$ |
| **NET TOTAL** | **-3,057** | kg $CO_2e$ |

# Movement Building

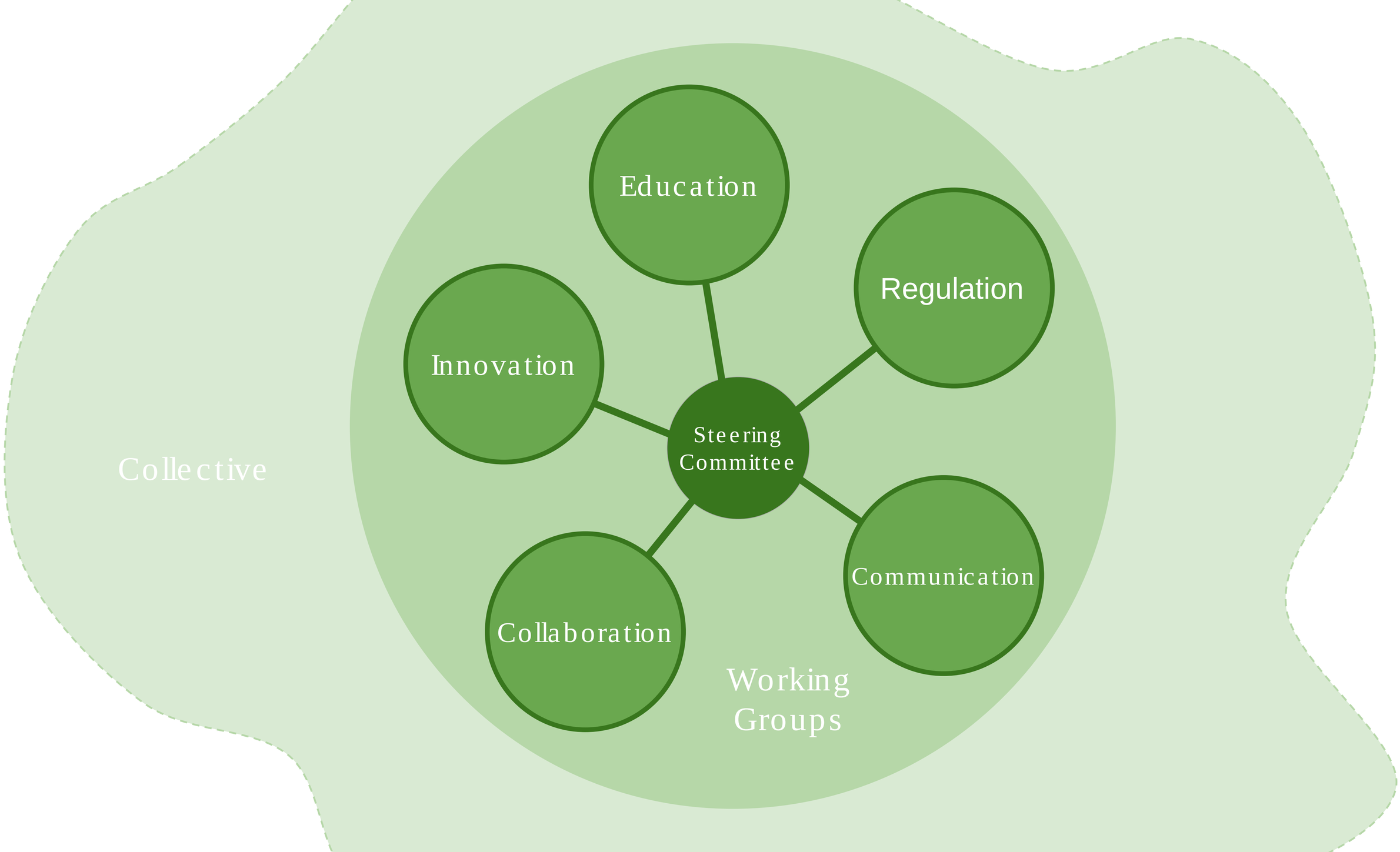
## Northeast Bio-Based Materials Collective

**How can regionally produced renewable building materials be brought to market, at scale, across the Northeast of North America?**

- **All work in the Northeast regional built environment is:**
  - **Good for Land = Regenerative**
    - Bio-based materials have demonstrated biogenic carbon storage.
    - Bio-based materials are demonstrated to be healthy for all humans, species, and ecologies.
    - Agricultural and forestry practices have enhanced productivity for generations to come through improved soil, water and ecosystem health.

- **All work in the Northeast regional built environment is:**
  - **Good for People = Abundant**
    - Economic, social and environmental welfare prospers due to a thriving bio-based materials industry using a cooperative economic model that benefits all.
    - Regional material suppliers and supply chains are resilient to economic, social, climatic, and technological hazards.
    - Everyone within the life cycle is educated in, and empowered to use, bio-based materials.

- **All work in the Northeast regional built environment is:**
  - **Good for All = Connected**
    - Cultures and communities are protected, respected, and better connected through regional supply chain collaboration.
    - Strong relationships exist across the life cycle from farmer to user, from rural to urban.
    - The relationships between harvesters, the land and all interconnected communities are mutually beneficial.

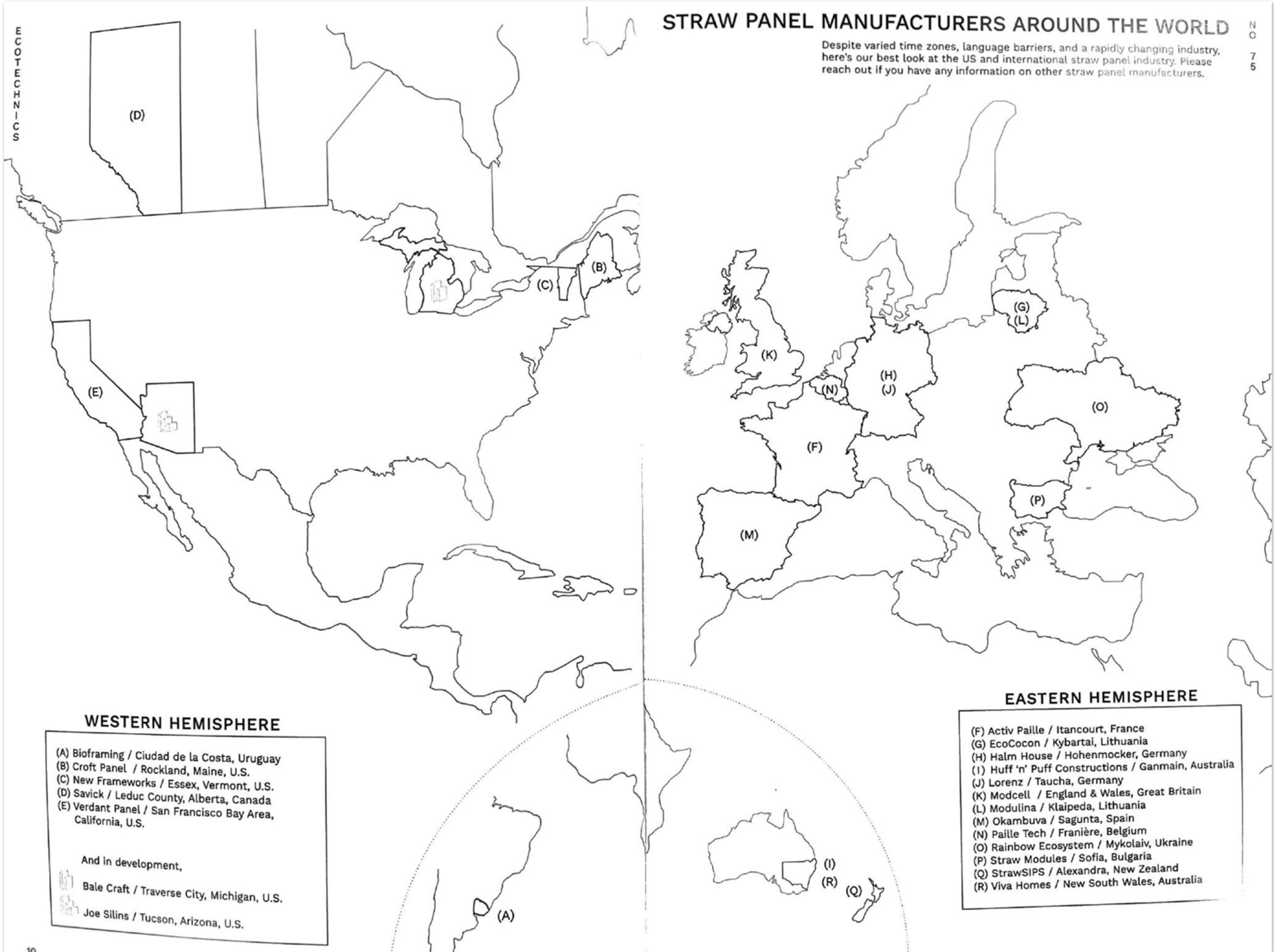

Collective
Education
Regulation
Innovation
Steering Committee
Communication
Collaboration
Working Groups

ECOTECHNICS

# STRAW PANEL MANUFACTURERS AROUND THE WORLD

NO 75

Despite varied time zones, language barriers, and a rapidly changing industry, here's our best look at the US and international straw panel industry. Please reach out if you have any information on other straw panel manufacturers.




## WESTERN HEMISPHERE

(A) Bioframing / Ciudad de la Costa, Uruguay
(B) Croft Panel / Rockland, Maine, U.S.
(C) New Frameworks / Essex, Vermont, U.S.
(D) Savick / Leduc County, Alberta, Canada
(E) Verdant Panel / San Francisco Bay Area, California, U.S.

And in development,

Bale Craft / Traverse City, Michigan, U.S.

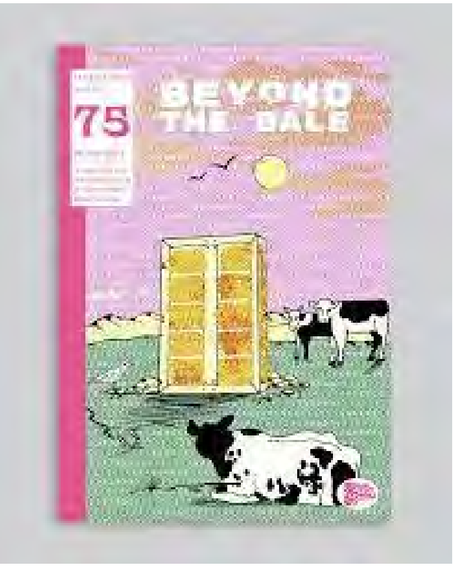
Joe Silins / Tucson, Arizona, U.S.

## EASTERN HEMISPHERE

(F) Activ Paille / Itancourt, France
(G) EcoCocon / Kybartai, Lithuania
(H) Halm House / Hohenmocker, Germany
(I) Huff 'n' Puff Constructions / Ganmain, Australia
(J) Lorenz / Taucha, Germany
(K) Modcell / England & Wales, Great Britain
(L) Modulina / Klaipeda, Lithuania
(M) Okambuva / Sagunta, Spain
(N) Paille Tech / Franière, Belgium
(O) Rainbow Ecosystem / Mykolaiv, Ukraine
(P) Straw Modules / Sofia, Bulgaria
(Q) StrawSIPS / Alexandra, New Zealand
(R) Viva Homes / New South Wales, Australia



Source: The Last Straw, Issue 75, Winter 2024




California Straw Bale Association,(CASBA)


# Where we’re going: Interconnected global work

European Straw Bale Building Association (EUSBBA)


ONTARIO NATURAL BUILDING COALITION

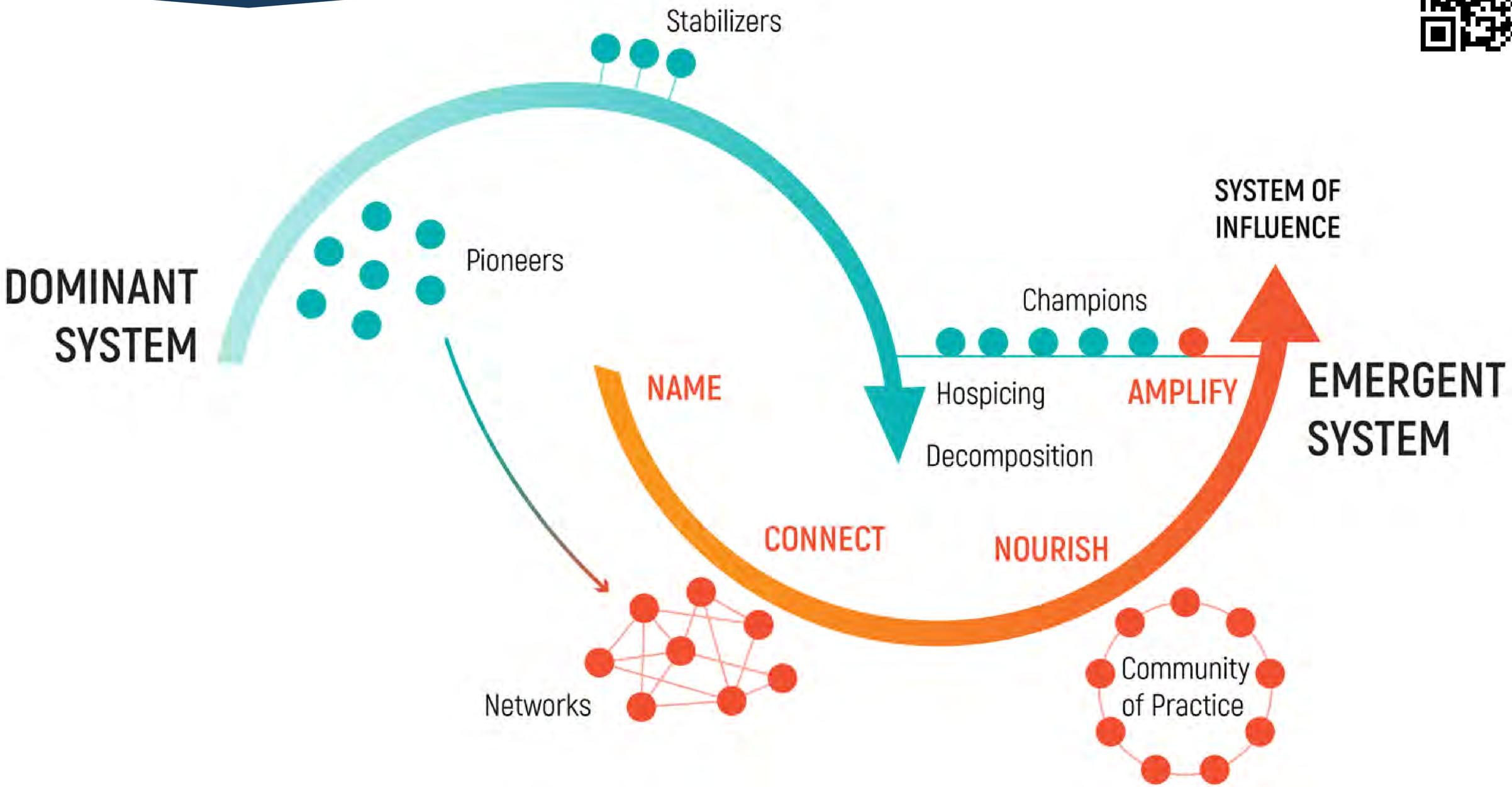
Rocky Mountain Natural Building Conference
Natural Building Alliance

Natural Building Alliance (Rocky Mountain Natural Building Conference)

# Biobased Cities

“**The trend [towards biobased materials]** is not limited to any specific region; it **is a global phenomenon**…To accelerate this transformation and make a meaningful impact on our built environment, we must continue to promote and **expand the use of these materials on a larger scale.”**

# Two Loops


Stabilizers
DOMINANT SYSTEM
Pioneers
SYSTEM OF INFLUENCE
Champions
NAME
Hospicing
AMPLIFY
EMERGENT SYSTEM
Decomposition
CONNECT
NOURISH
Networks
Community of Practice


*This could be you!*
Join the Northeast Bio-Based Materials Collective!
Online Meetings Commencing Soon - Stay Tuned!
Next Convening: CLF-Boston Embodied Carbon Summit 6/21/24

Interested in participating in the Northeast Bio-Based Materials Collective?

Reach out to us!

https://forms.gle/EbYWWf7tFFyACaVH6

CLIMATE SMART WOOD GROUP

CLF Carbon Leadership Forum Boston / New England Hub

BUILDERS FOR CLIMATE ACTION

BEAM

RMI

HomebuildersCAN CARBON ACTION NETWORK

MASS.

Chris Hardy - Design Director

Northeast Bio-Based Materials Collective

New Frameworks

Ace McArleton – Co-CEO
Jacob Racusin – Dir. Bldg Sci.

**Join the Biobased Materials Movement!**
**Thank You!**