Clean Construction and Decarbonizing Public Infrastructure

Jen Muir, P.E. & Megan Coleman, ENV SP

JKMuir, LLC

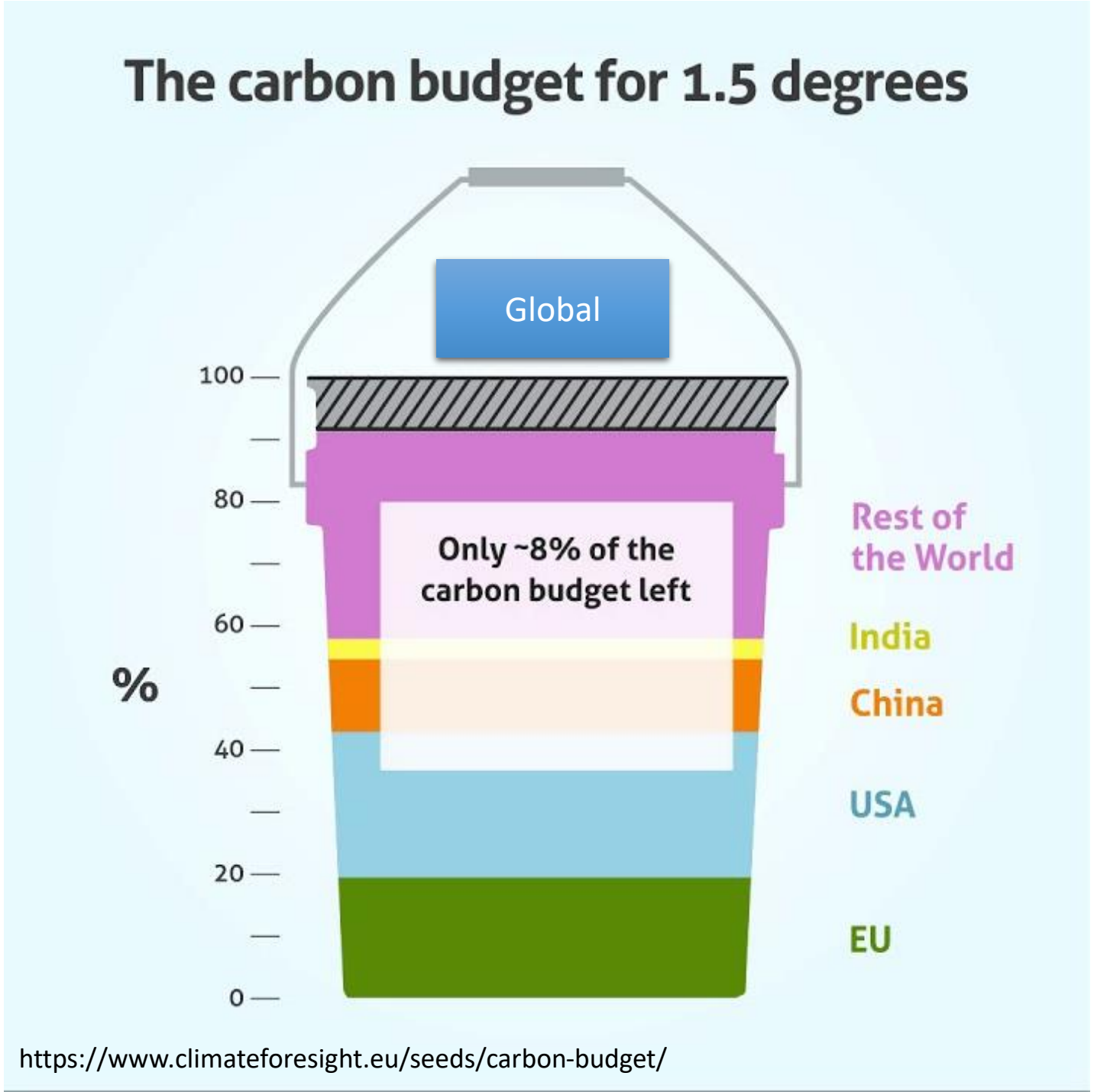
Agenda

The climate challenge & clean energy movement

Defining “Clean Construction”

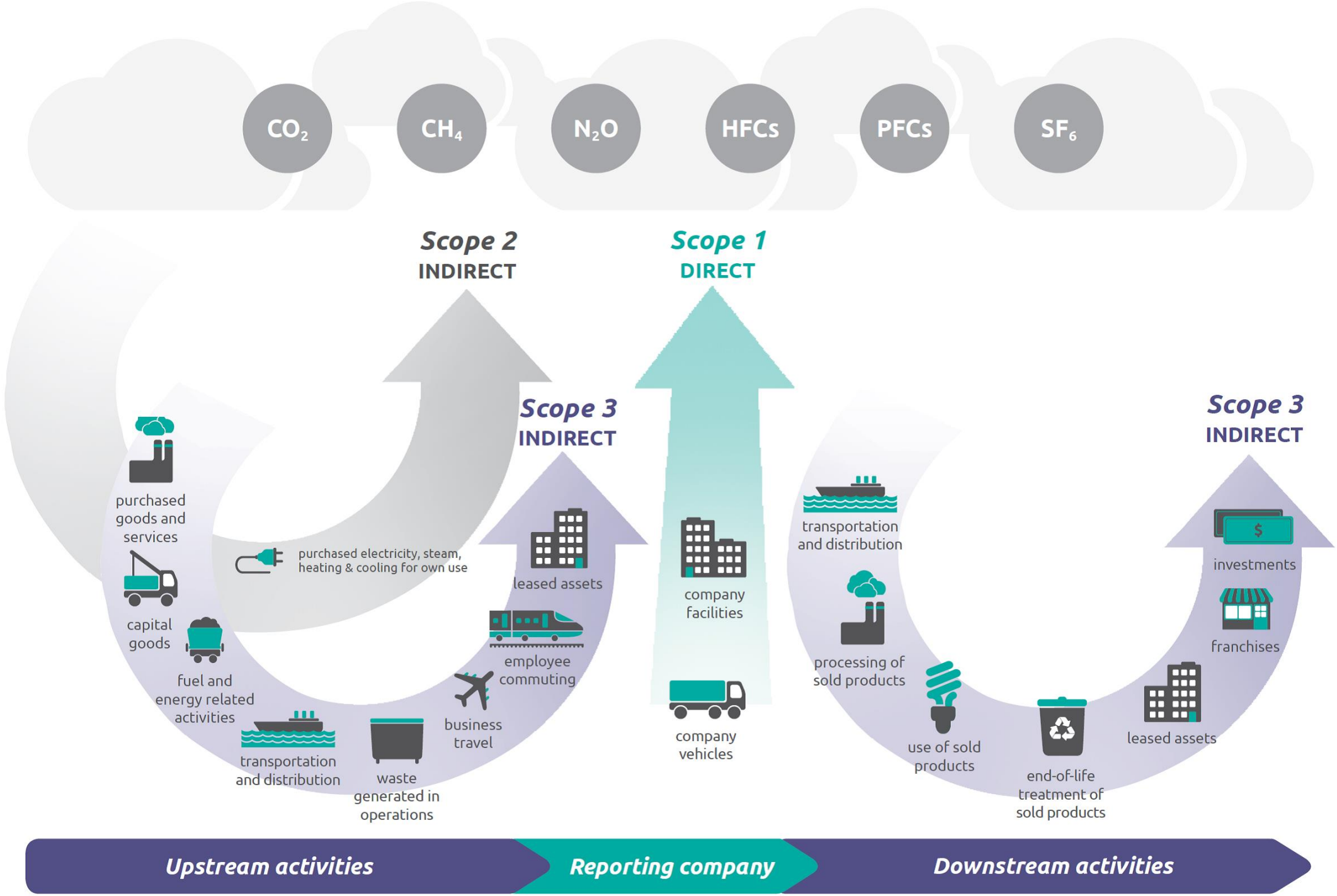
Implementation of metrics for water/wastewater utilities

A call to action

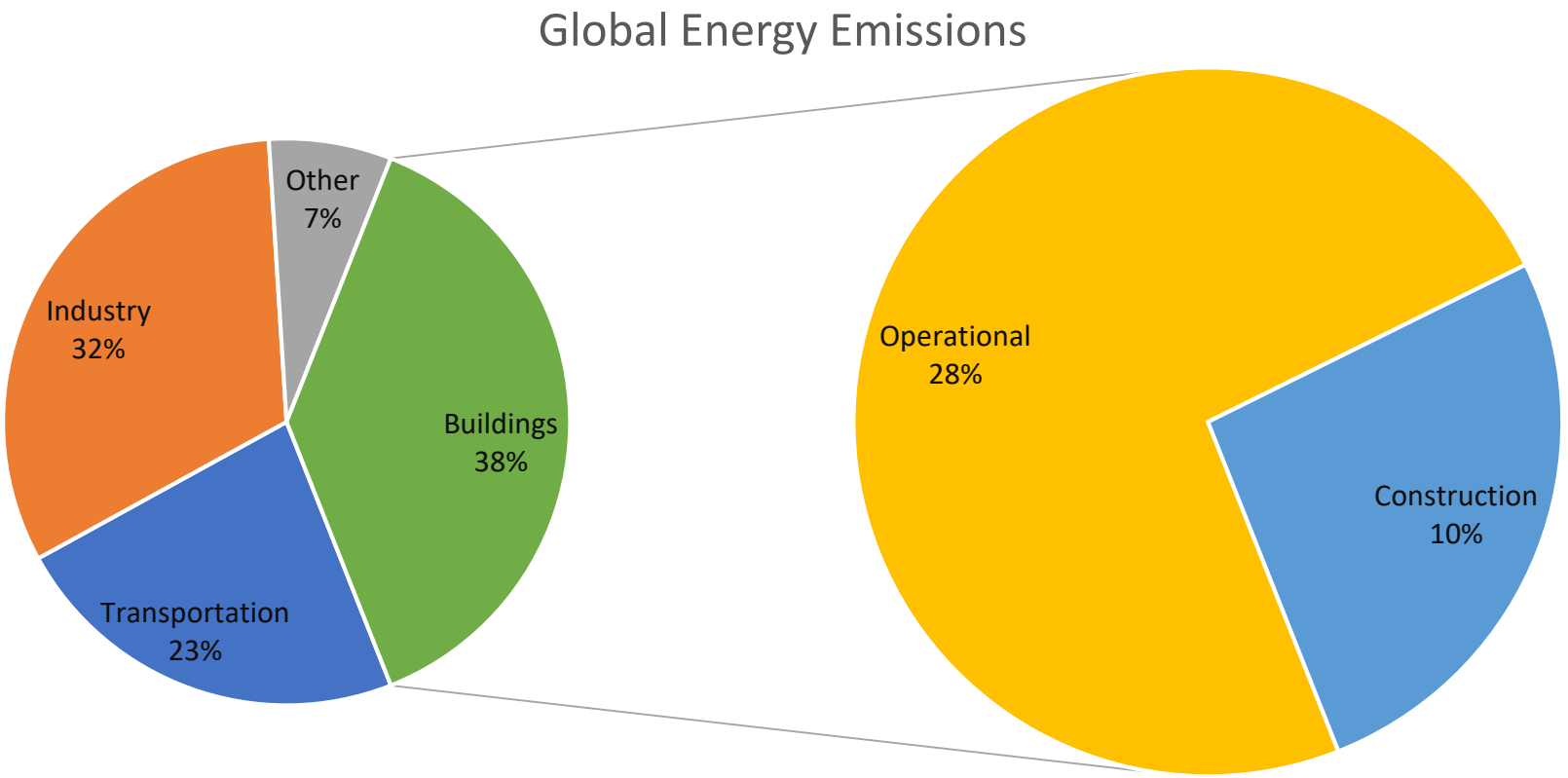


https://www.climateforesight.eu/seeds/carbon-budget/

Creating a sustainable built environment


CO_2
CH_4
N_2O
HFCs
PFCs
SF_6
Scope 2
INDIRECT
Scope 1
DIRECT
Scope 3
INDIRECT
Scope 3
INDIRECT
purchased goods and services
capital goods
fuel and energy related activities
transportation and distribution
waste generated in operations
business travel
employee commuting
leased assets
purchased electricity, steam, heating & cooling for own use
company facilities
company vehicles
transportation and distribution
processing of sold products
use of sold products
end-of-life treatment of sold products
leased assets
franchises
investments
Upstream activities
Reporting company
Downstream activities

The growing importance of embodied carbon emissions



As we decarbonize the operational side of the building sector's emissions, embodied carbon's share of buildings emissions will grow

Sustainability Policies

NYC Executive Order 23

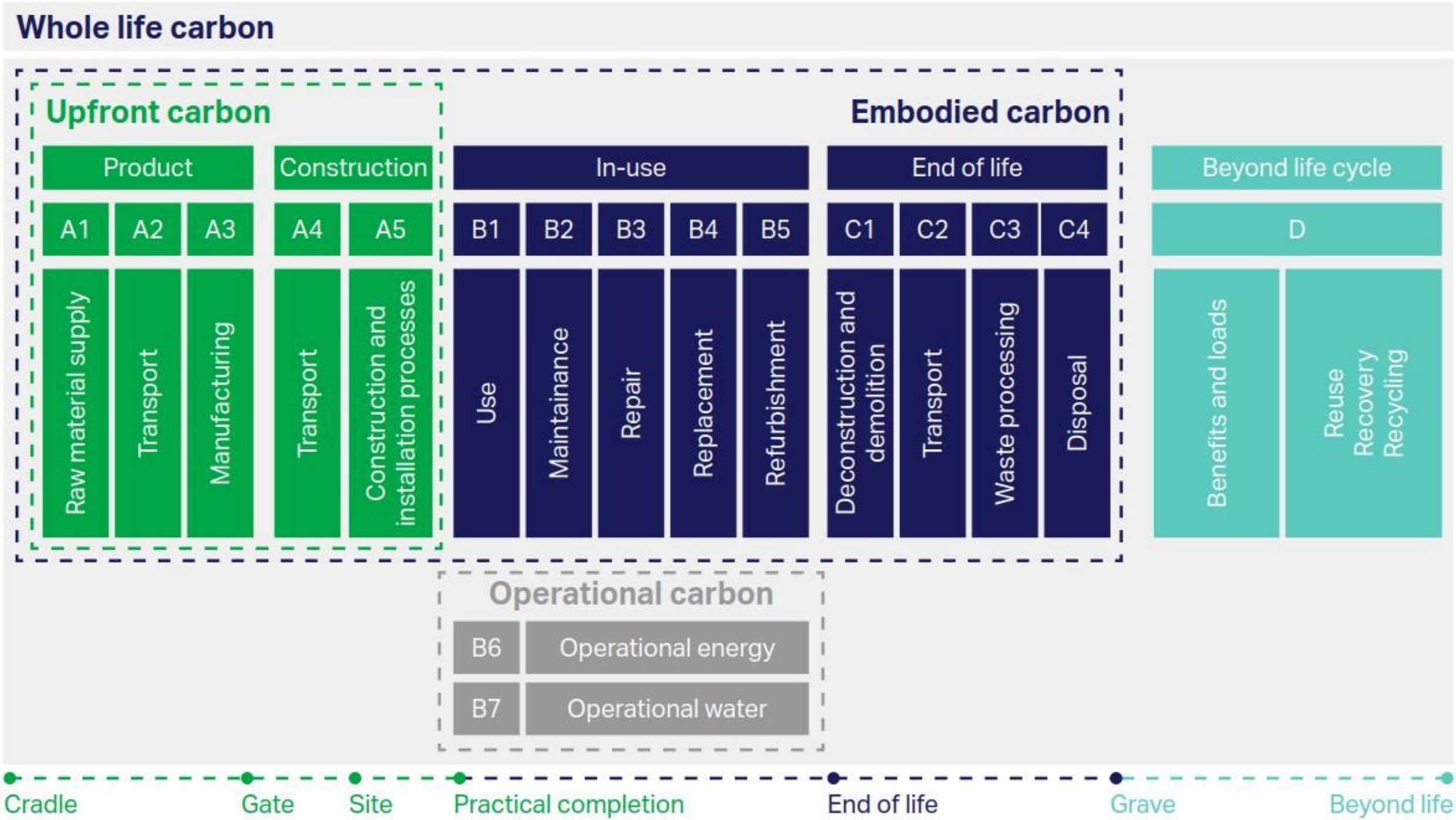
- **Life cycle assessments** applicable to new construction, additions, and substantial reconstruction on building envelope and when green building standards are applicable
- Specifications:
  - ***Low carbon concrete*** for ready-mix concrete and concrete sidewalks
  - ***Low-emission vehicles*** and equipment, with preference for all-electric
- ***Environmental Product Declarations*** (EPDs) submitted to Building Transparency database by capital project agency construction managers (EC3 - Login (buildingtransparency.org))

Source: Executive Order 23 | City of New York (nyc.gov)

Federal Executive Order

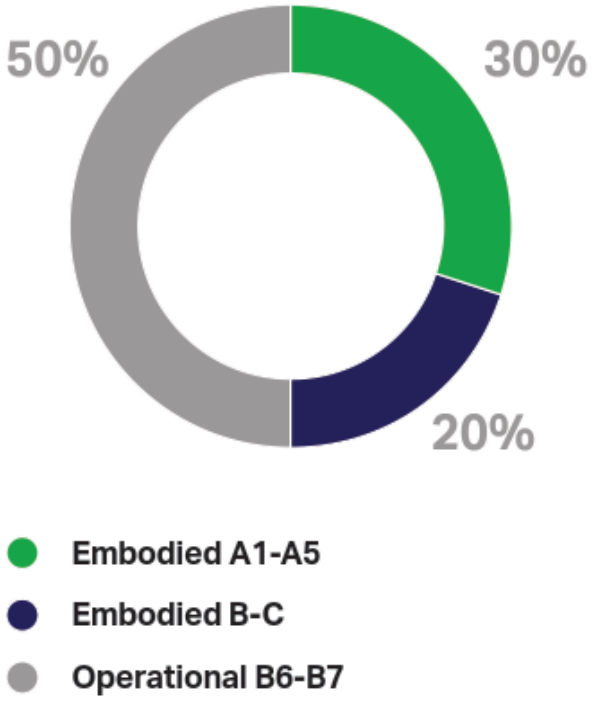
- 100% carbon pollution-free electricity (CFE) by 2030
- 100% percent zero-emission vehicle (ZEV) acquisitions by 2035
- Net-zero emissions from federal procurement no later than 2050
- A Buy Clean policy to promote use of construction materials with lower embodied emissions
- A net-zero emissions building portfolio by 2045, including 50% emissions reduction by 2032
- Net-zero emissions from overall federal operations by 2050, including 65% emissions reduction by 2030

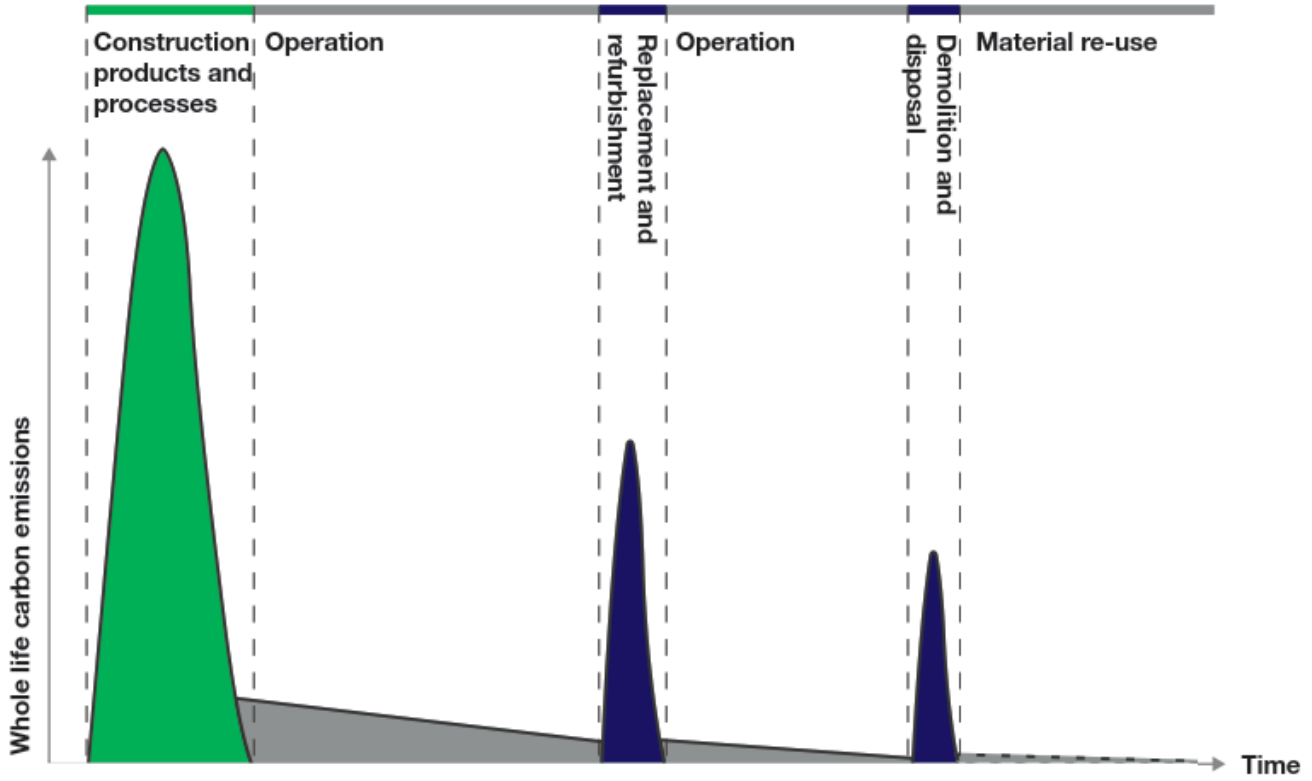
Source: FACT SHEET: President Biden Signs Executive Order Catalyzing America's Clean Energy Economy Through Federal Sustainability - The White House


Whole life carbon
Upfront carbon
Embodied carbon
Product
Construction
In-use
End of life
Beyond life cycle
A1
A2
A3
A4
A5
B1
B2
B3
B4
B5
C1
C2
C3
C4
D
Raw material supply
Transport
Manufacturing
Transport
Construction and installation processes
Use
Maintainance
Repair
Replacement
Refurbishment
Deconstruction and demolition
Transport
Waste processing
Disposal
Benefits and loads
Reuse
Recovery
Recycling
Operational carbon
B6
Operational energy
B7
Operational water
Cradle
Gate
Site
Practical completion
End of life
Grave
Beyond life

Whole life carbon

- Embodied carbon refers to a quantity of CO_2e associated with the materials used to construct and maintain the building throughout its lifespan
  - Material selection has largest impact for embodied carbon (A1 – A5)
- Operational carbon refers to the emissions associated with the heating, cooling, and energy use of the building (B6 – B7)





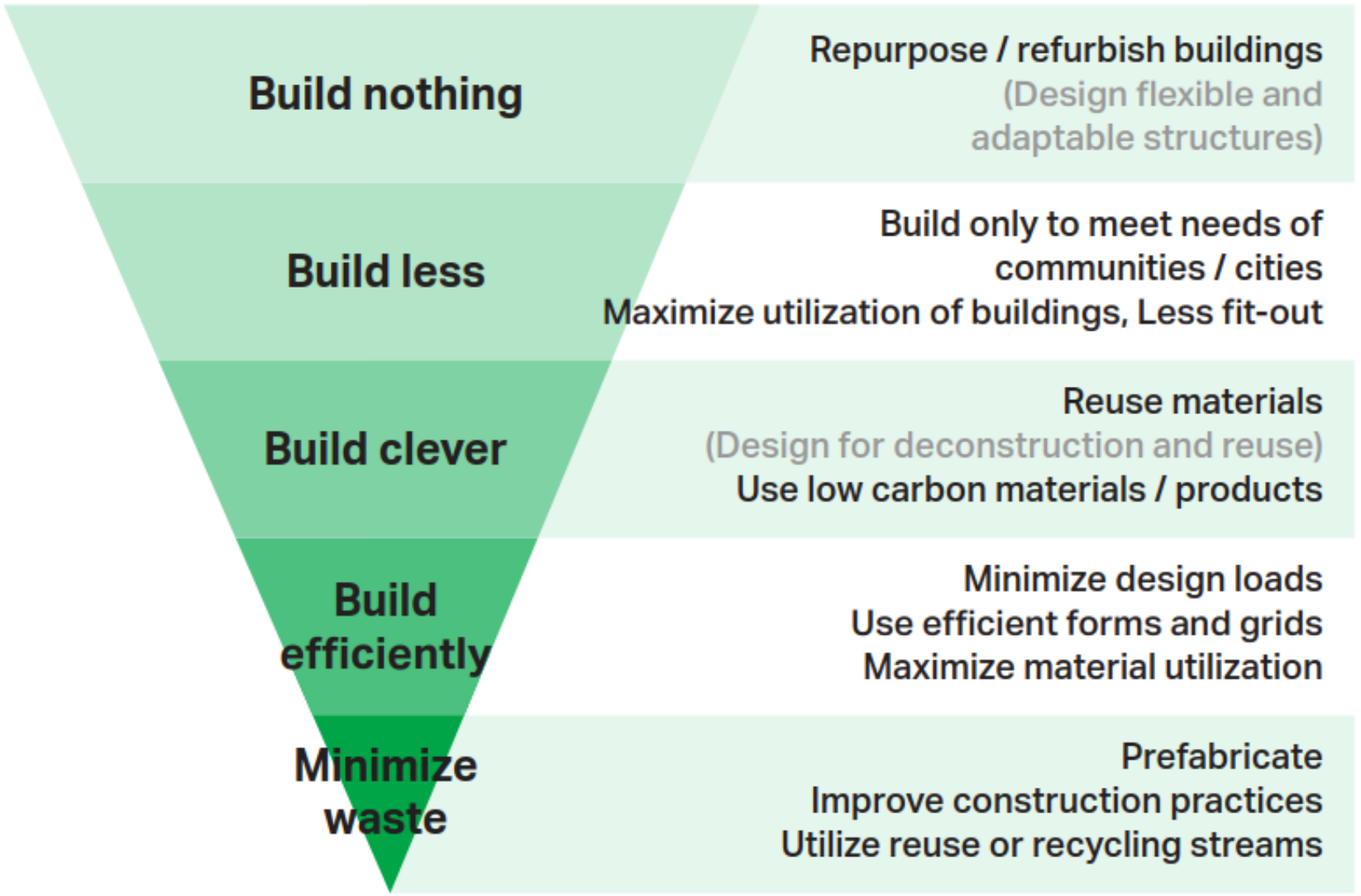
Strategies for reducing embodied carbon emissions

Source materials regionally

Recycle materials and infrastructure

Specify low to zero carbon materials

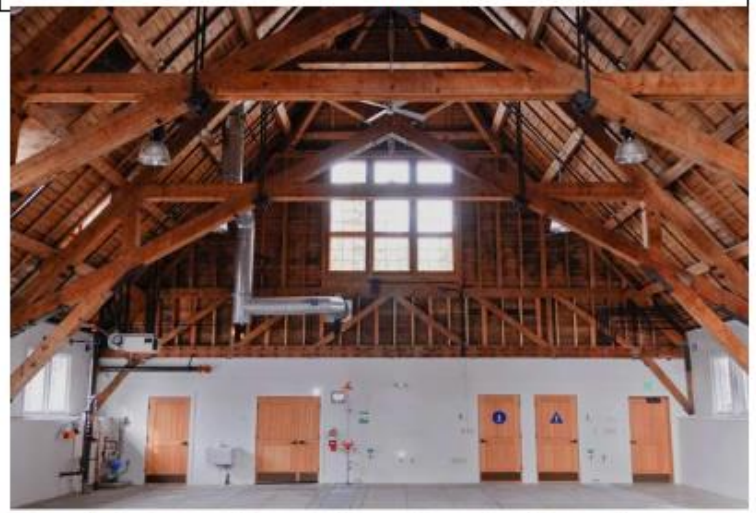
Use carbon sequestering materials


Build nothing
Repurpose / refurbish buildings
(Design flexible and adaptable structures)
Build less
Build only to meet needs of communities / cities
Maximize utilization of buildings, Less fit-out
Build clever
Reuse materials
(Design for deconstruction and reuse)
Use low carbon materials / products
Build efficiently
Minimize design loads
Use efficient forms and grids
Maximize material utilization
Minimize waste
Prefabricate
Improve construction practices
Utilize reuse or recycling streams

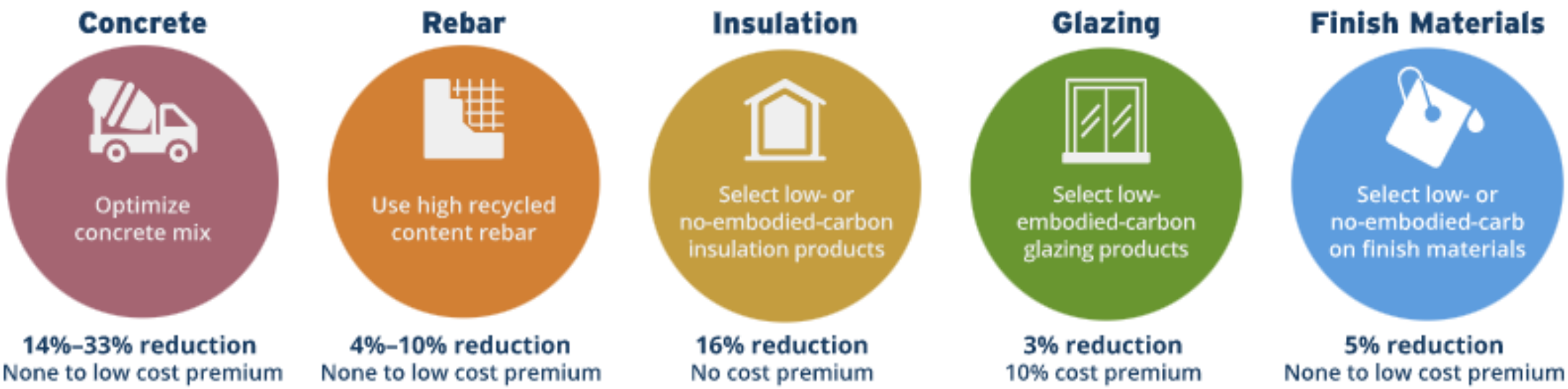
Embodied Carbon*

**mostly from CLF Embodied Carbon Benchmarking study.*

Heavy Building Concrete/Steel frame	Light Building Wood frame	Reuse Existing Building
80 lbs/sf (400 kg/m²)	40lbs/sf (200 kg/m²)	20lbs/sf (100 kg/m²)



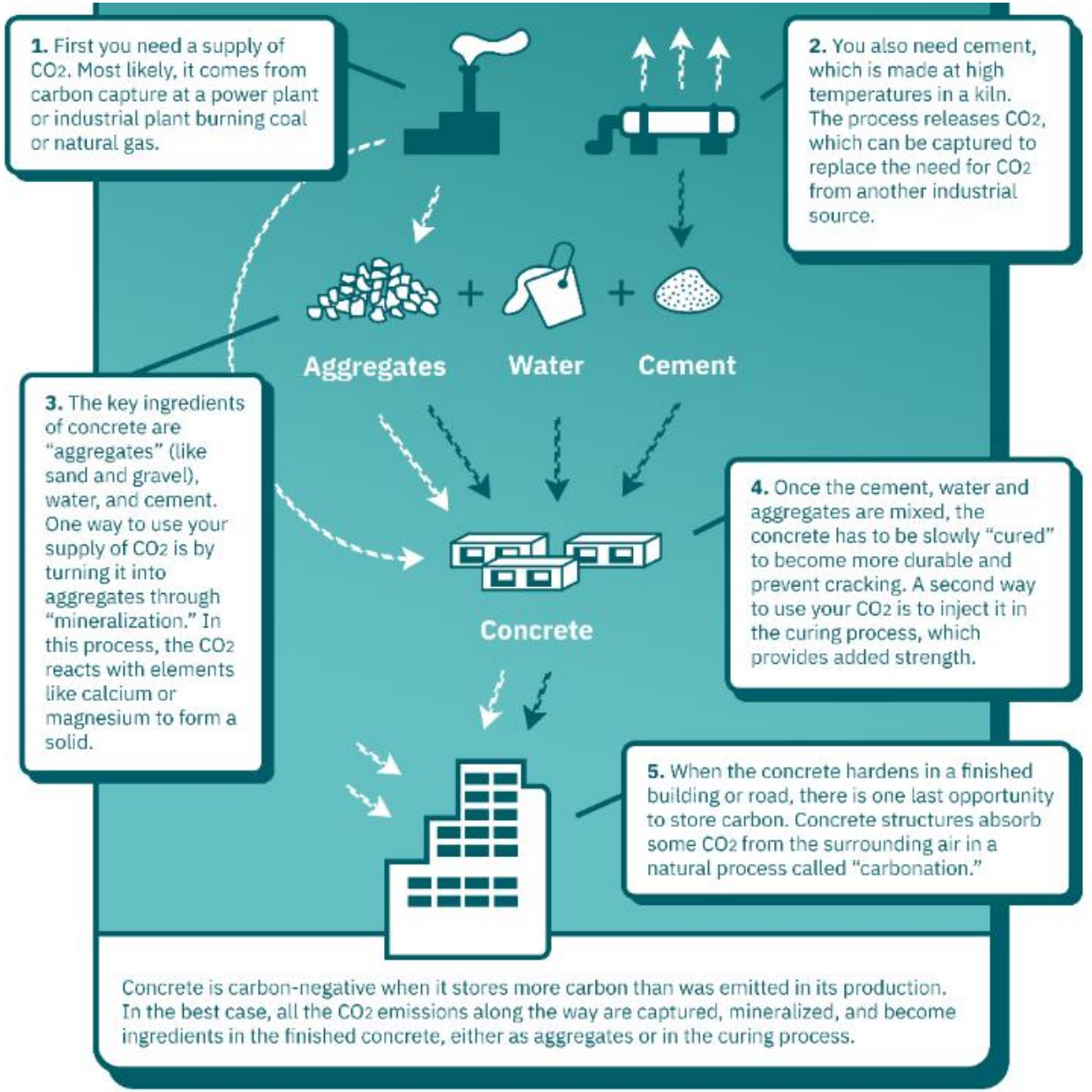
Embodied Carbon Reduction Strategies for Building Materials



Top categories of building materials for reducing embodied carbon.

Low Carbon Concrete

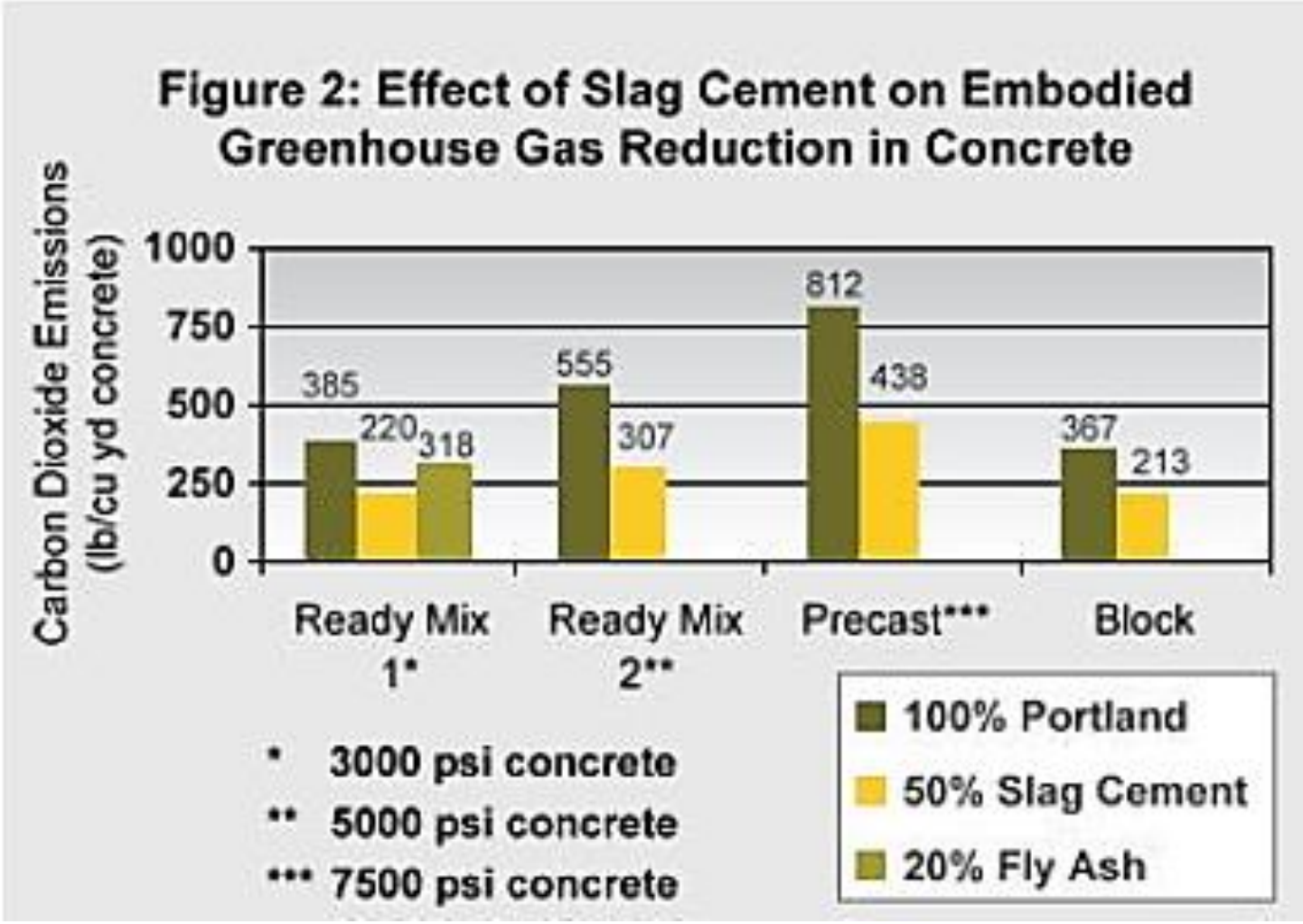
- Concrete production is a tangible opportunity for embodied carbon reduction



Source: [Concrete | MIT Climate Portal]

Alternate Cement Uses

- Supplementary cementitious materials (SCMs)
  - Fly ash
  - Slag cement
  - Ground glass pozzolans (GGP)



Source: [Low CO2 Concrete (us-concrete.com)]

Actual Project Reporting Example – Recycled, Regional, and Sustainable Sourcing Quantification

Relevant Scope Items:

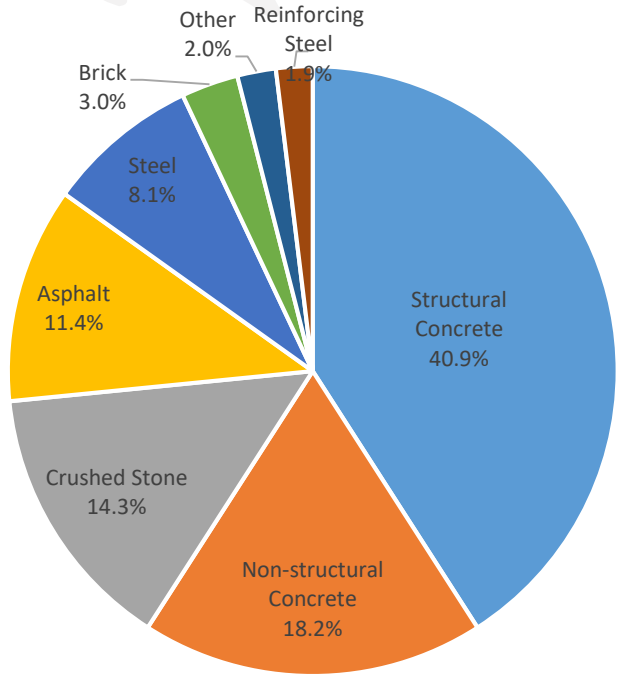
- Site/Civil – asphalt, crushed stone
- Architectural/Structural – brick, concrete, fiberglass, polystyrene foam, PVC, reinforcing steel, stainless steel, steel

KPI Goals:

- 25% Recycled Content
- 95% Regionally Sourced Content
- 25% Sustainably Sourced Content

Design Status:

- Total weight is 5,559.7 tons
- 44.7% Recycled Content
- 87.9% Regionally Sourced Content
- 81.7% Sustainably Sourced Content



Percentage by Weight of Total Construction Materials

Note:

1. Only materials with weights comprising greater than 1% of total weight are shown
2. Other includes: Fiberglass, Polystyrene foam, PVC, and Stainless Steel

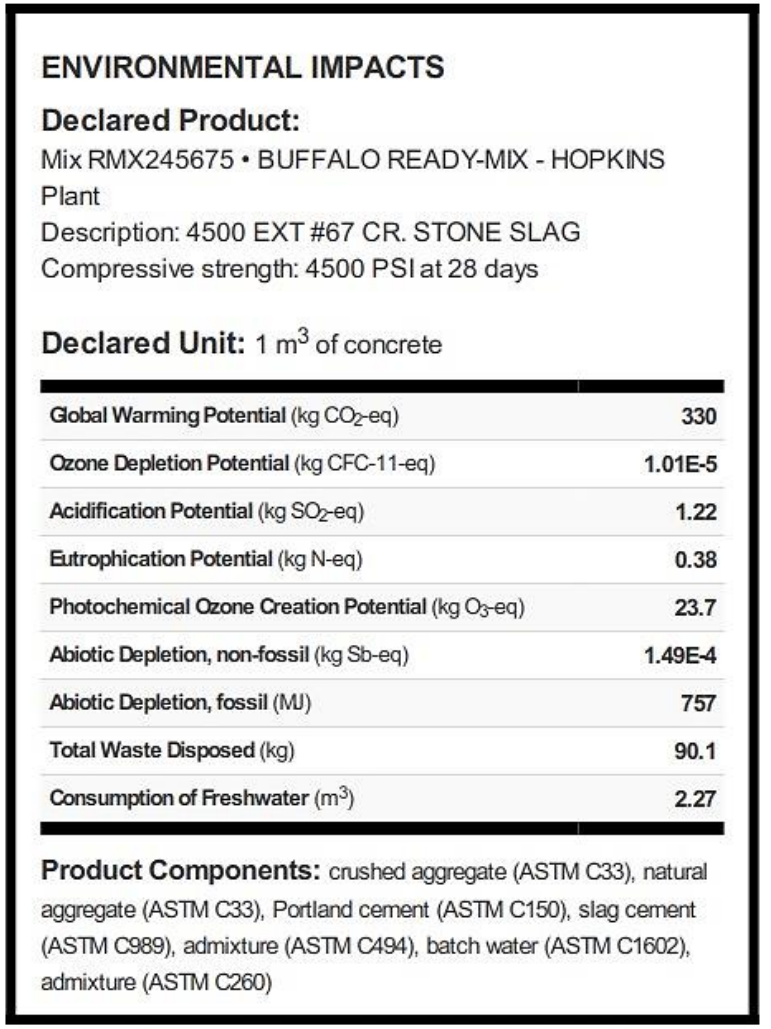
Sustainably Procured Material and Soil Reuse Quantities

Material	Quantity (Tons)	Sustainable Content (%)	Sustainable Content (Tons)	Percent of Total Weight (%)
Asphalt	636.5	100%	636.5	11.4%
Brick	168.5	100%	168.5	3.0%
Crushed Stone	796.3	0%	0	0%
Concrete (Non-Structural)	1,011.2	100%	1,011.2	18.2%
Concrete (Structural)	2,274.5	100%	2,274.5	40.9%
Fiberglass	25.0	0%	0.0	0.0%
Grout	46.6	0%	0.0	0.0%
Polystyrene	0.9	0%	0.0	0.0%
PVC	4.2	0%	0.0	0.0%
Reinforcing Steel	107.6	0%	0.0	0.0%
Stainless Steel	37.2			
Steel	451.3			
Total	**5,559.7**			

Excavated Soil Diversion							
Total Excavated (tons)	Reused Onsite (tons)	Reused Offsite (tons)	Disposal (tons)	Reused Onsite (%)	Reused Offsite (%)	Disposal (%)	Total Reuse Rate (%)
1,623	0	1,623	0	0%	100%	0%	100%

Environmental Production Declarations (EPDs)

- Provides product-specific environmental impact information about the life cycle of a product
- Data verified by a third-party and provides transparency in conformance with ISO 14025, 14044
  - Also called a Type III environmental declaration



ENVIRONMENTAL IMPACTS

Declared Product:
Mix RMX245675 • BUFFALO READY-MIX - HOPKINS Plant
Description: 4500 EXT #67 CR. STONE SLAG
Compressive strength: 4500 PSI at 28 days

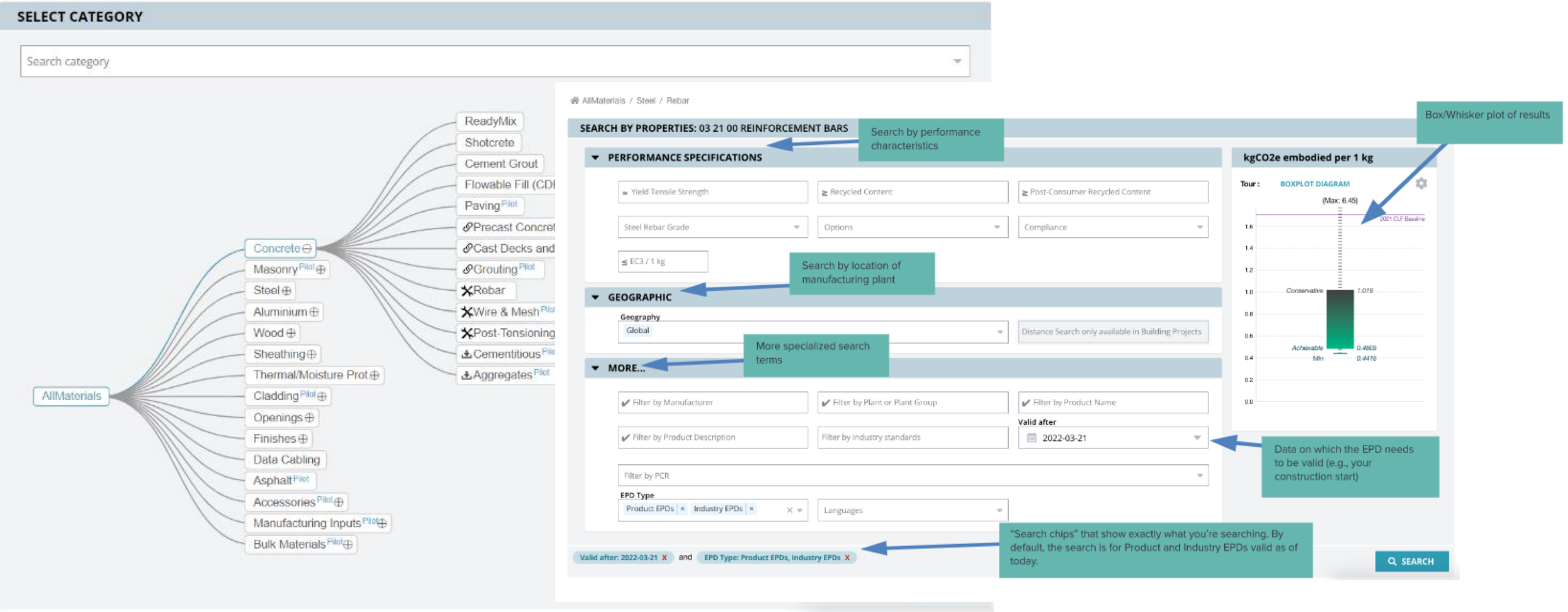
Declared Unit: 1 m^3 of concrete

Global Warming Potential (kg CO_2-eq)	**330**
Ozone Depletion Potential (kg CFC-11-eq)	**1.01E-5**
Acidification Potential (kg SO_2-eq)	**1.22**
Eutrophication Potential (kg N-eq)	**0.38**
Photochemical Ozone Creation Potential (kg O_3-eq)	**23.7**
Abiotic Depletion, non-fossil (kg Sb-eq)	**1.49E-4**
Abiotic Depletion, fossil (MJ)	**757**
Total Waste Disposed (kg)	**90.1**
Consumption of Freshwater (m^3)	**2.27**

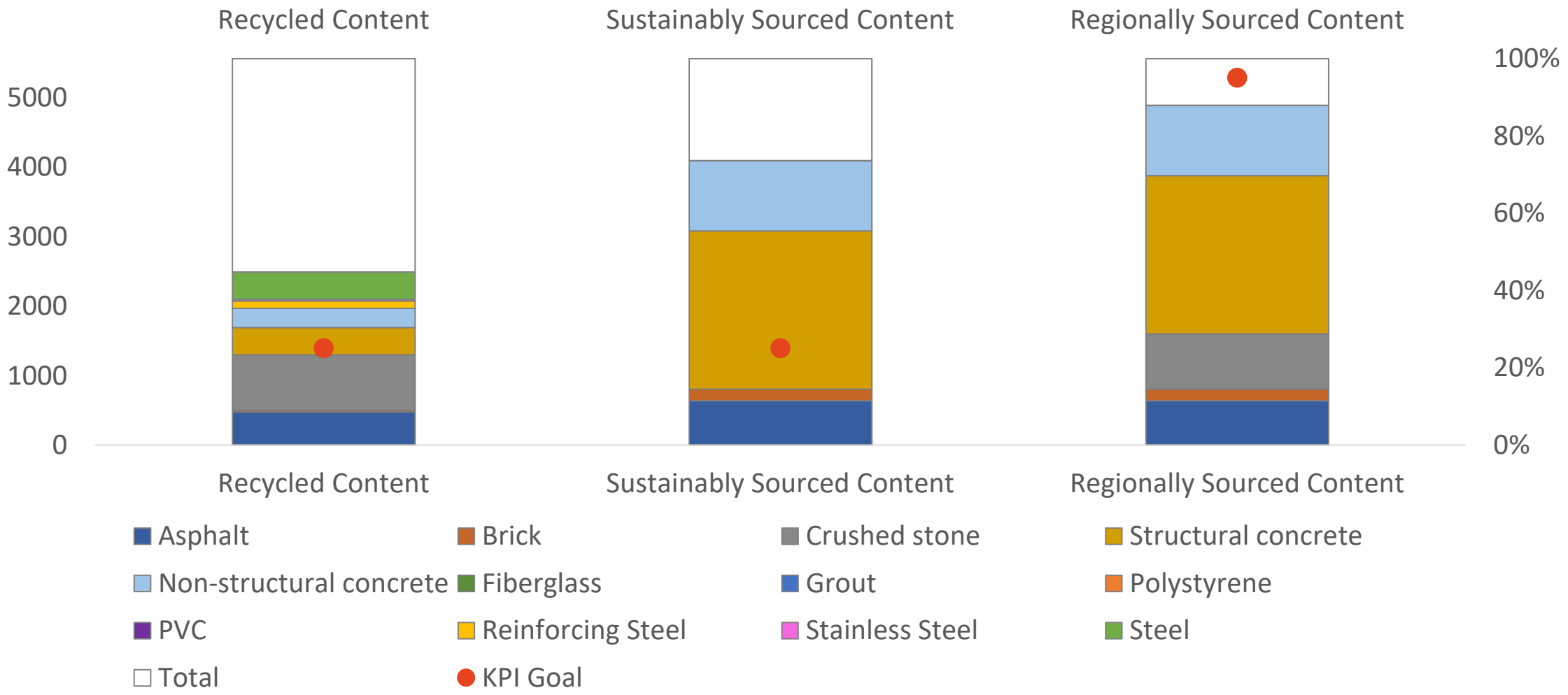
Product Components: crushed aggregate (ASTM C33), natural aggregate (ASTM C33), Portland cement (ASTM C150), slag cement (ASTM C989), admixture (ASTM C494), batch water (ASTM C1602), admixture (ASTM C260)

Additional detail and impacts are reported on page three of this EPD

Building Transparency – EC3 openEPD



Resource allocation and circular economy



ENVIRONMENTAL MATERIALS REPORTING FORM (provide cut sheets for the data below)

PROJECT NAME: _____ **CONTRACTOR:** _____

SPEC SECTION: _____

CONTACT NAME: TEL. NO: SUBMITTAL NO:

Product Name	Vendor or Manufacturer	**REQUIRED for ALL products identified in Specs** CSI 2004 Divisions 3–10, 31.60 Foundations, 32.10 Paving, 32.30 Site Improvements, and 32.90 Planting. *MEP excluded.* Total Material Cost (excl. labor & equipment)	Percentage of the product salvaged, refurbished or reused[1]	Recycled Content[2] (for concrete, use separate form)		Location and distances from manufacturing point to project site AND raw material harvesting point to project site (miles)[3]	Percentage of product that is rapidly renew-able[4]	For all wood-based products[5]			
				% post-consumer	% pre-consumer			% New wood	% Certified Wood	FSC Tracking: COC #	Urea formaldehyde in composites (Y/N)
1.						Harvest: Manufacture:					
2.						Harvest: Manufacture:					
3.						Harvest: Manufacture:					
4.						Harvest: Manufacture:					

CONTRACTOR CERTIFICATION:

I, _____ a duly authorized representative of _____ hereby certify that the material information contained herein is an accurate representation of the material qualifications to be provided by us, as components of the final building construction. Furthermore, I understand that any change in such qualifications during the purchasing period will require prior written approval from the Construction Manager and Owner.

SIGNATURE OF AUTHORIZED REPRESENTATIVE: _____ DATE: _____

[1] ***Salvaged***: Material or product which has been recovered from existing buildings or construction sites and reused in other buildings (e.g., structural beams, doors, brick).

[2] ***Post-Consumer Recycled Content***: Portion of material or product which derives from discarded consumer waste that has been recovered for use as a raw material (e.g., plastic bottles, newspaper).
Pre-Consumer Recycled Content: Portion of material or product which derives from recovered industrial and mfg. materials that are diverted from municipal solid waste for use in a *different* mfg. process, prior to use by a consumer (e.g., fly-ash in concrete or synthetic gypsum board, both of which are by-products of coal-burning power plants). Note that spills and scraps from the original mfg. process that are combined with other constituents after a minimal amount of reprocessing for use in further production of the same product do not qualify.

[3] ***Regional Materials:*** Materials are considered regional if harvested AND manufactured within 500 miles of the project site. Materials can travel more than 500 miles, provided materials always remain within a 500 mile radius of project site. For salvaged/recycled materials such as steel, you do not need to provide the original harvesting location, but rather the location the steel was sourced from. Distances are as the crow flies, not actual miles traveled via surface transport.

[4] ***Rapidly Renewable***: Materials and products made from raw materials that are harvested within a 10-year cycle (e.g., bamboo, cork, linoleum, fast-growing poplar, wheatboard, wool carpet)

[5] ***FSC Certified***: Wood-based products which are certified by the Forest Stewardship Council and carry a Chain-of-Custody certificate number from the vendor or manufacturing.
Composite Wood & Agrifiber Products: Any wood based products must not contain added urea-formaldehyde.

Zero waste and use of resources – landfill diversion opportunities

Agency Highlight: Port Authority of New York and New Jersey – Clean Construction Group

- Construction Waste Matching Tool Program
  - Creation of an internal marketplace to facilitate systematic exchange of construction debris between Port Authority facilities. Tool helps connect “suppliers” and “requesters” early on, enhancing opportunities for reuse of materials like concrete, asphalt, and soil. Program reduces GHG emissions while also reducing material costs
- Program is a way to promote circular resource economy internally, with information about:
  - Available material and material type
  - Anticipated construction schedule
  - Estimated material quantities
  - Distance to next project site and/or nearest available manufacturing plant

Actual Project Reporting Example – Material Diversion Quantification

Relevant Scope Items:

- Demolition of existing FRP tanks
- Removal of asphalt and concrete

KPI Goals:

- 100% diversion of construction waste from landfills
- 100% diversion of soil from landfills

Design Status

- No demolition material is currently anticipated to require landfilling
- Additional construction/demolition waste details will be evaluated during later phases of design

Estimated New Construction and Demolition Waste Diversion

Material	Construction Waste (tons)	Demolition Waste (tons)	Total Waste (tons)	% of Total Waste	% Diversion	Diversion Waste Weight (tons)
Asphalt	25.5	364.1	390.0	68.17%	100%	389.6
Brick	6.7	0.00	6.7	1.18%	100%	6.7
Structural/Non-Structural Concrete	107.5	59.4	166.8	29.20%	100%	166.8
Fiberglass	0.00	2.8	2.8	0.49%	100%	2.8
Polystyrene	0.1	0.00	0.0	0.01%	100%	0.1
PVC	0.1	0.00	0.1	0.01%	100%	0.1
Reinforced Steel	5.4	0.00	5.4	0.94%	100%	5.4
Total	145.2	426.3	571.4	100%	100%	571.4

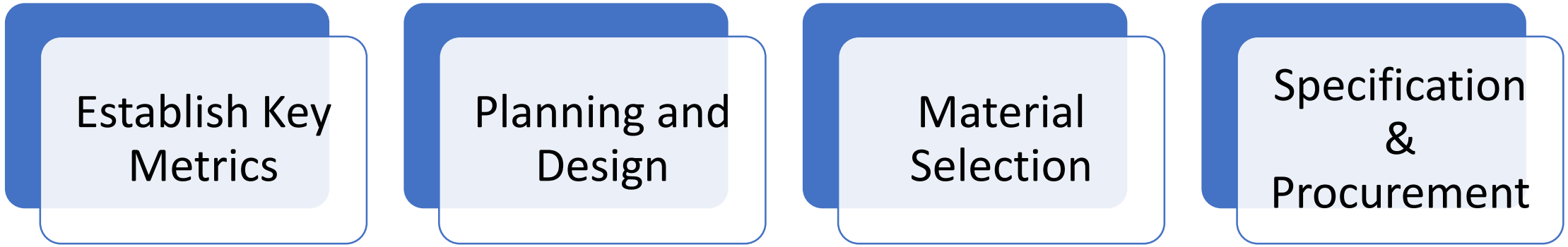
Site Excavated Soil Diversion

Total Excavated (tons)	Reused Onsite (tons)	Reused Offsite (tons)	Disposal (tons)	Reused Onsite (%)	Reused Offsite (%)	Disposal (%)	Total Reuse Rate (%)
1,722	720	1,002	0	42%	58%	0%	100%

Clean Construction – Beyond Materials

- Reduce equipment vehicle emissions
- Minimize night light pollution
- Consider optimization of bypass pumping strategies
- Reduce use of potable water in dewatering

“Clean Construction” Summary



Thank You!

Special thanks to:

- **NEWEA-NYWEA organization and sustainability committee for hosting and organizing**
- **JKMuir staff: Molly Keleher, Paul Campbell, & Chelsea Conlon**
- **Ongoing collaboration with consulting engineers, vendors/suppliers, and government agencies**

Jen Muir, P.E.
jenmuir@jkmuir.com
(860)-249-0989
jkmuir.com

Megan Coleman, ENV SP
MColeman@jkmuir.com
(860)-249-0989
jkmuir.com