



EMBODIED CARBON PRIMER

AIA COTE, MAY 2ND, 2023

1

Founders Hall
Get to know Founders Hall with this self-guided walking tour
SCAN ME

FOSTER
SCHOOL OF BUSINESS
UNIVERSITY OF WASHINGTON

HAMMER CLASSROOM



Justin Schwartzhoff

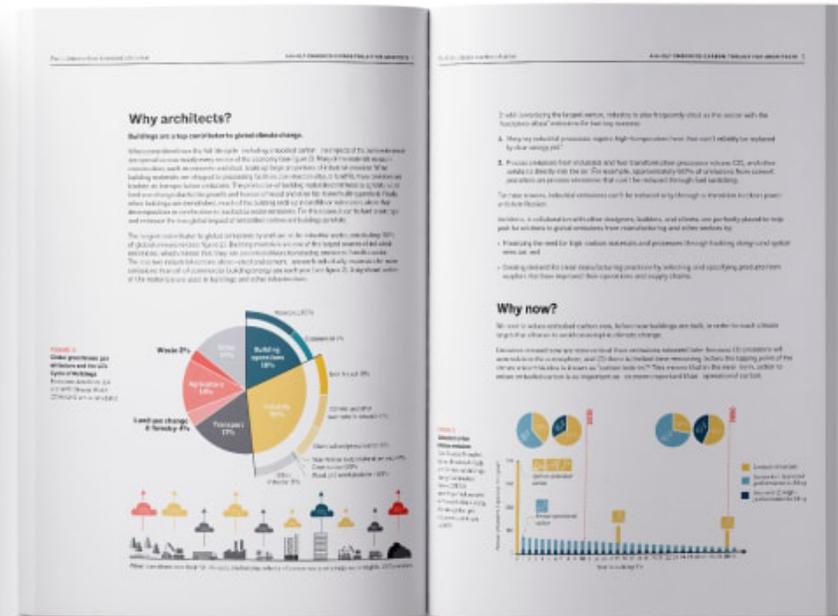
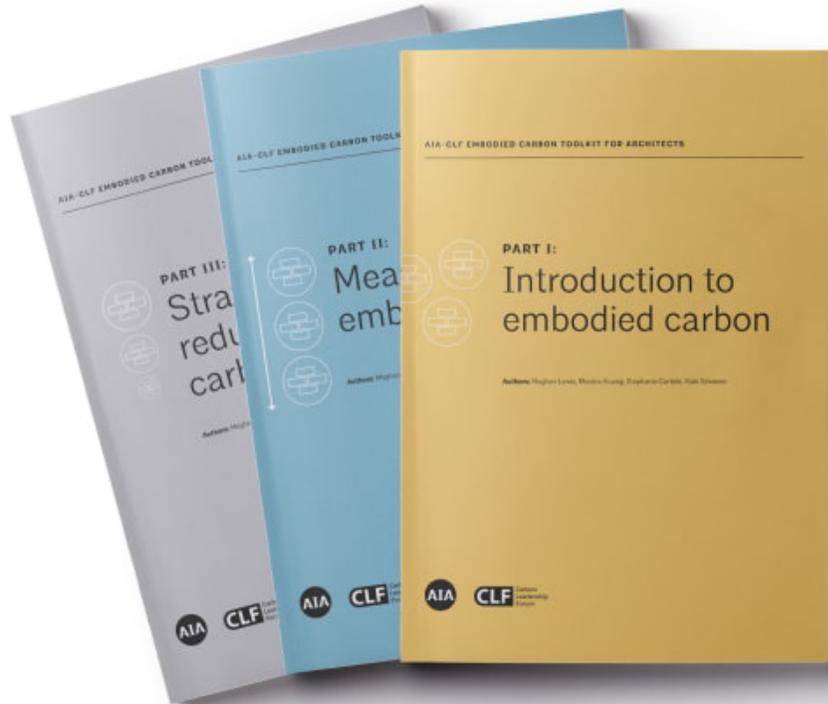
Architect and Embodied Carbon Lead
jschwartzhoff@lmmarchitects.com

EMBODIED CARBON PRIMER

AIA COTE, MAY 2ND, 2023

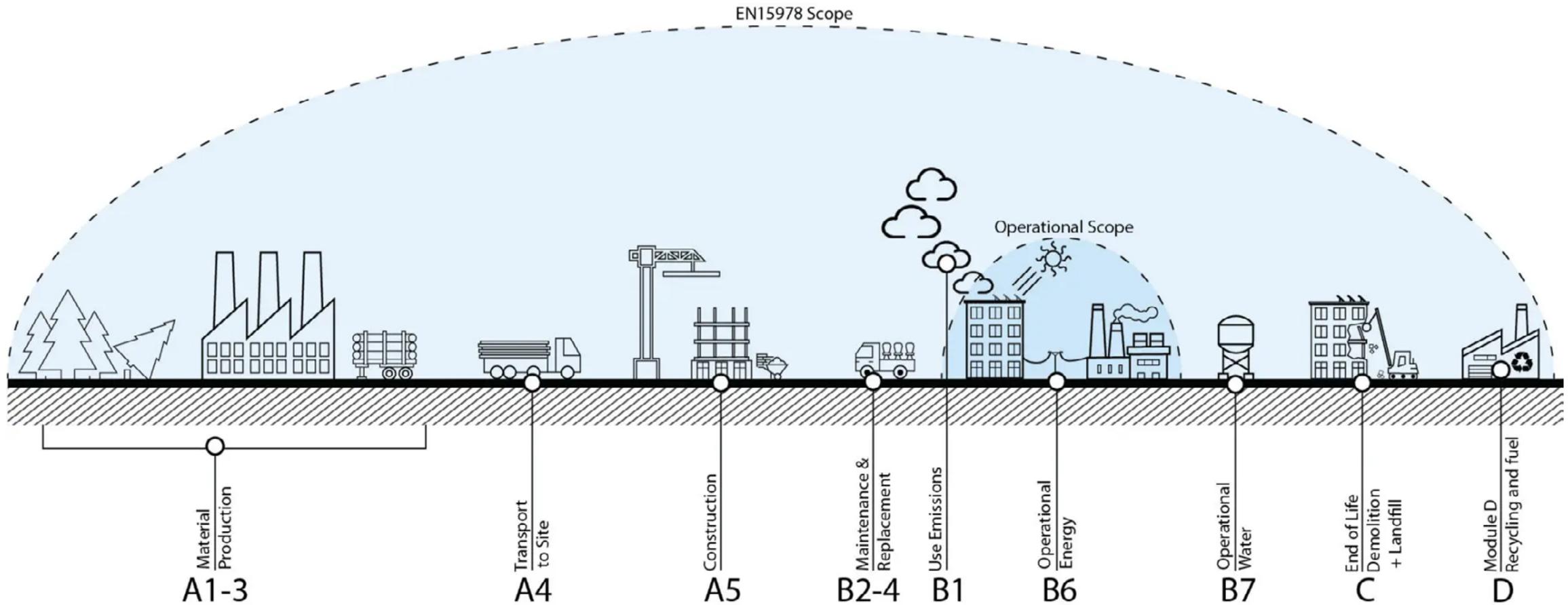


EMBODIED CARBON 101



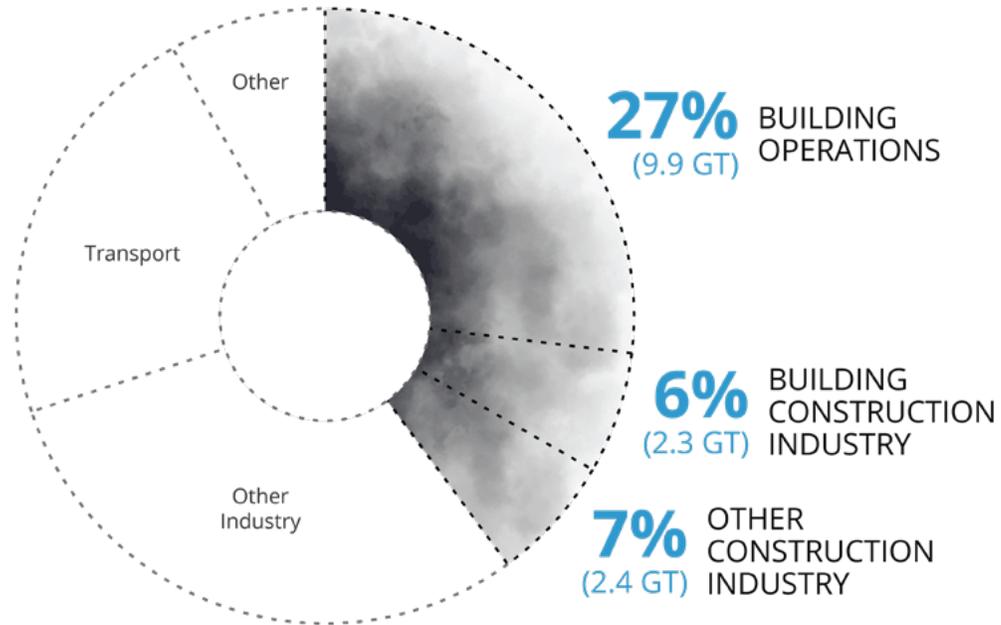
<https://carbonleadershipforum.org/clf-architect-toolkit/>

EMBODIED CARBON WHAT IS IT?

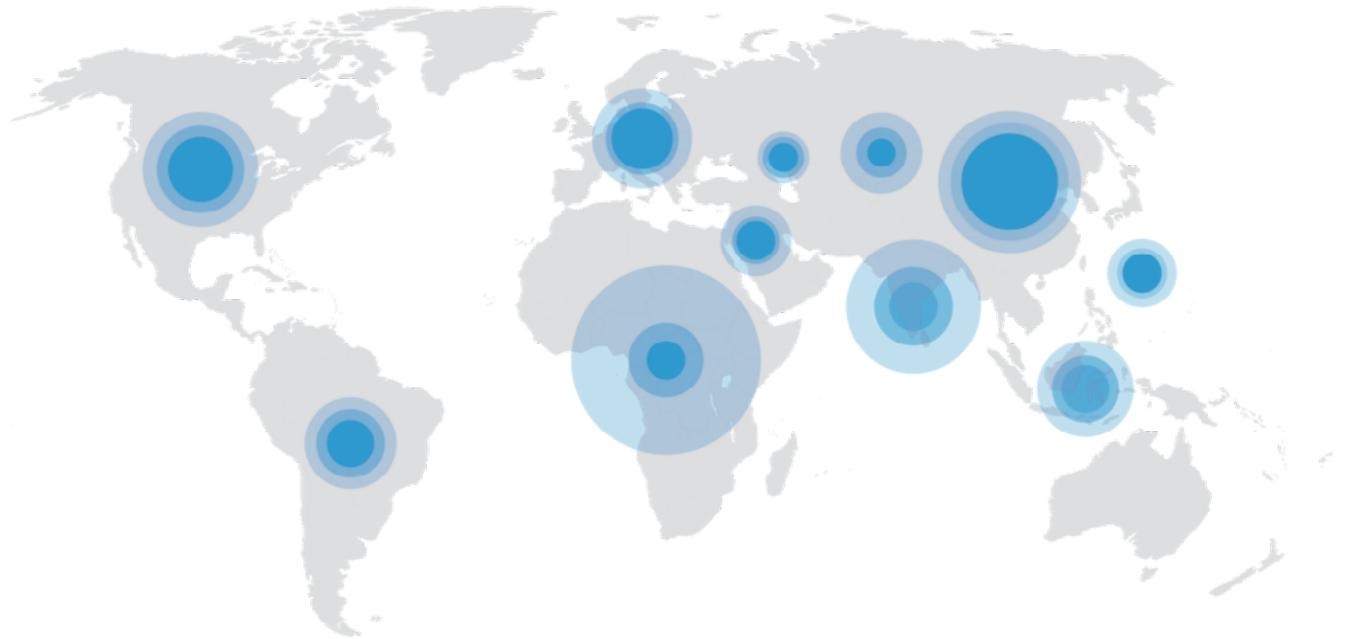


EMBODIED CARBON WHY WE CARE

Annual Global CO₂ Emissions



Global building floor area is expected to **double** by 2060.

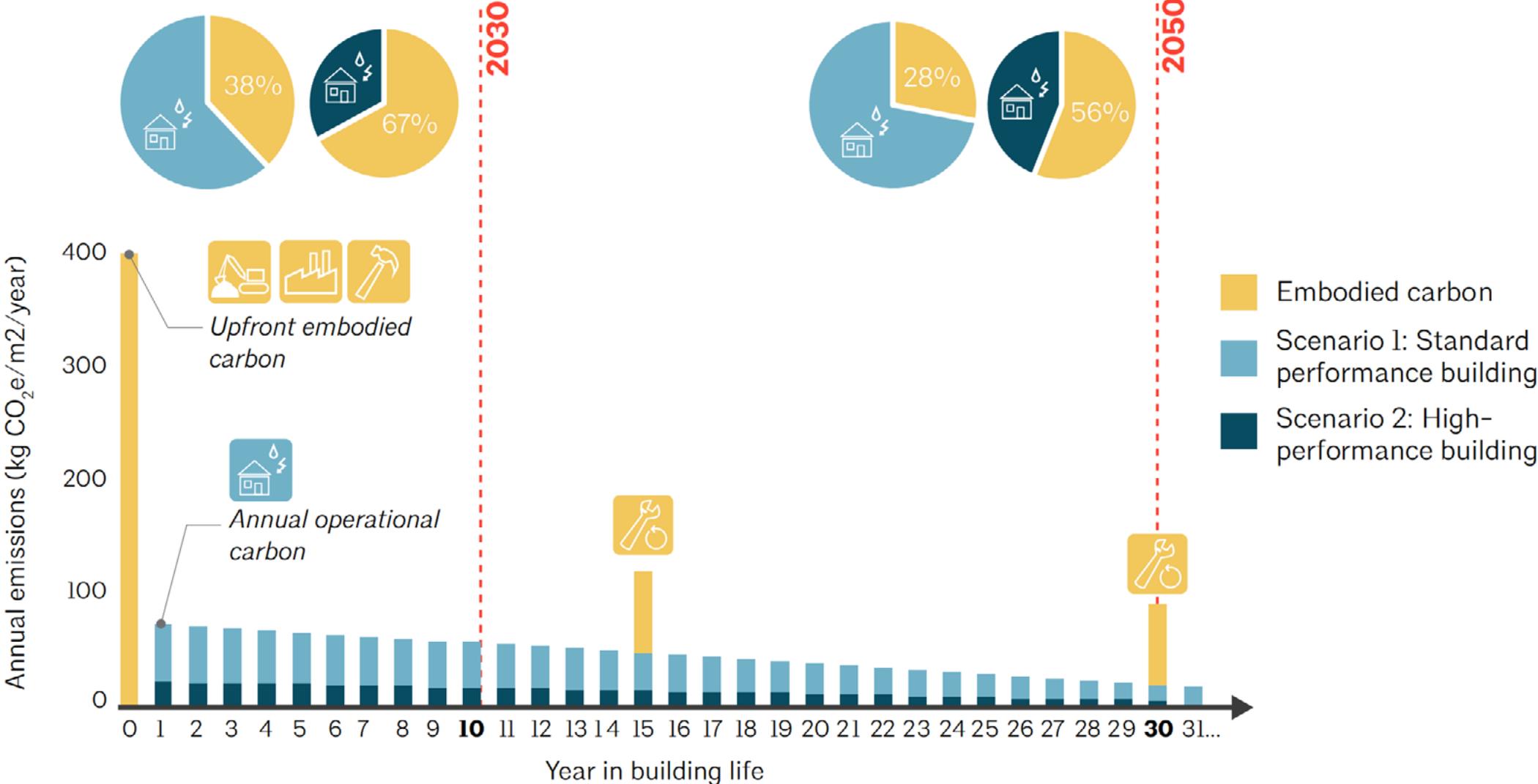


© Architecture 2030. All Rights Reserved. Data Source: IEA (2022), Buildings, IEA, Paris

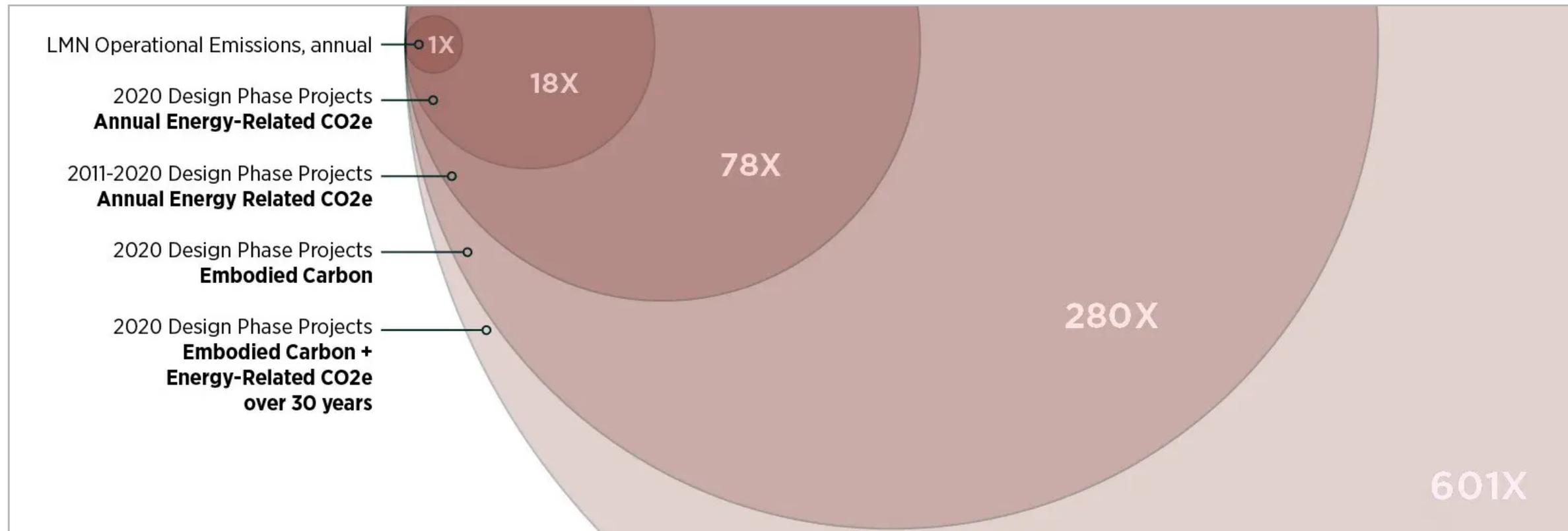
Building Construction Industry and Other Construction Industry represent emissions from concrete, steel, and aluminum for buildings and infrastructure respectively.

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Data Sources: Global ABC, Global Status Report 2017

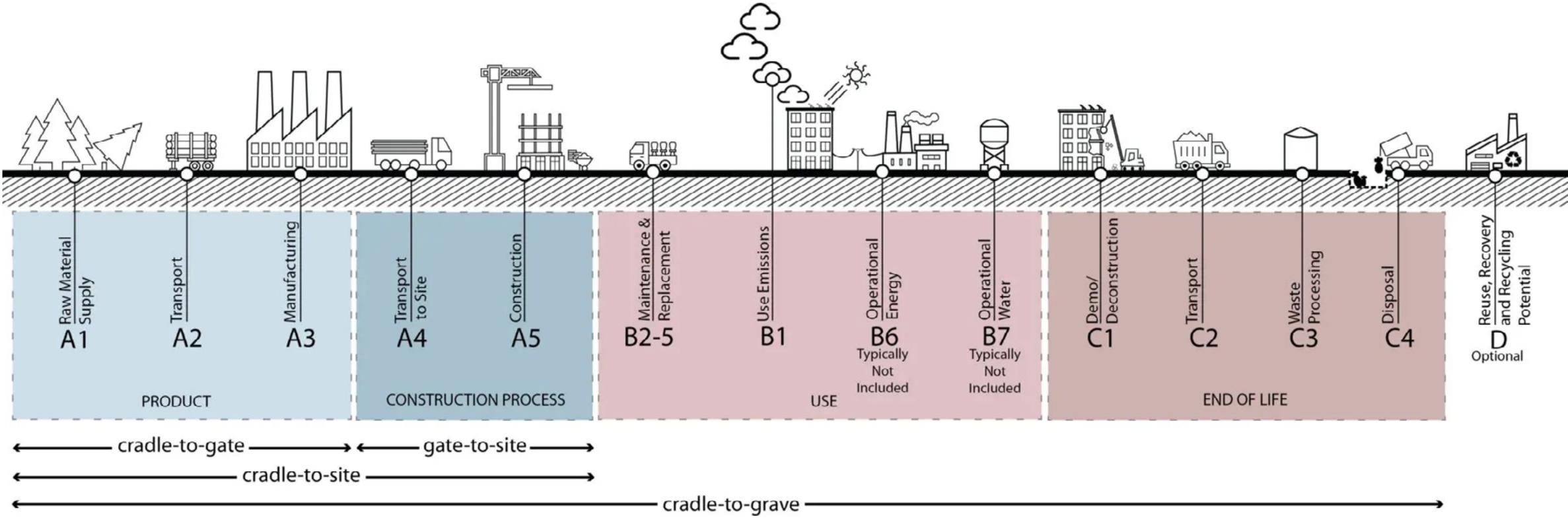
EMBODIED CARBON WHY WE CARE



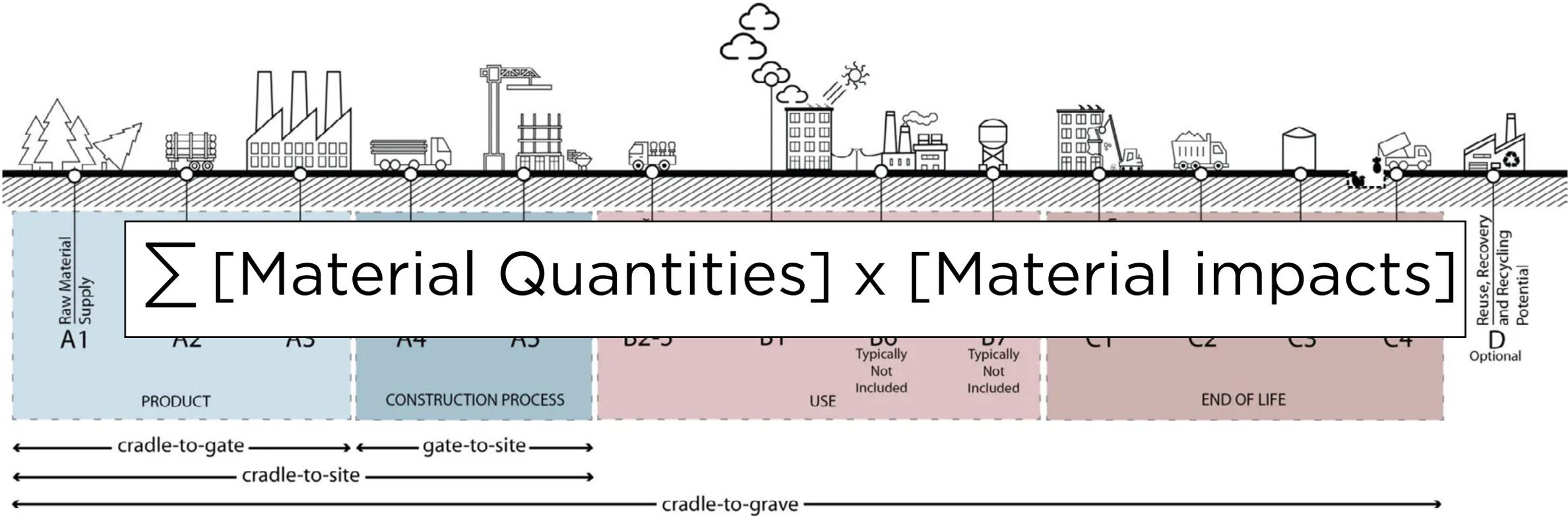
EMBODIED CARBON WHY WE CARE



EMBODIED CARBON TERMS: LCA + STAGES



EMBODIED CARBON TERMS: LCA + STAGES



EMBODIED CARBON TERMS: EPD

ENVIRONMENTAL PRODUCT DECLARATION

STEEL REINFORCING BAR AND MERCHANT BAR PRODUCTS

NUCOR STEEL SEATTLE, INC.
2424 SW ANDOVER ST. SEATTLE, WA 98106



NUCOR®

Nucor Steel Seattle, Inc. is the state of Washington's largest recycler, with the capacity to process over a million tons of scrap steel each year. Using an electric arc furnace, a steel recycling technology we helped to pioneer, we produce high-quality steel with 99.4% recycled content.

We recognize our role in protecting the environment and have demonstrated a long-standing commitment to do so. We have invested tens of millions of dollars in our Seattle facility to make it among the most efficient and environmentally responsible steel plants in the world.

In addition to being ISO14001 certified, we operate on an electric grid that is nearly carbon free.



ENVIRONMENTAL PRODUCT DECLARATION

NUCOR®

Steel Reinforcing Bar and Merchant Bar
Designated Steel Construction Product



According to ISO 14025,
EN 15804 and ISO 21930:2017

EPD PROGRAM AND PROGRAM OPERATOR NAME, ADDRESS, LOGO, AND WEBSITE	UL ENVIRONMENT 333 PFINGSTEN ROAD, NORTHBROOK, IL 60011
GENERAL PROGRAM INSTRUCTIONS AND VERSION NUMBER	General Program Instructions v2.7 2022
MANUFACTURER NAME AND ADDRESS	Nucor Steel Seattle, Inc., 2424 SW Andover Street, Seattle, WA 98106
DECLARATION NUMBER	4790291557.101.1
DECLARED PRODUCT & FUNCTIONAL UNIT OR DECLARED UNIT	Steel Reinforcing Bar and Merchant Bar, 1 metric ton
REFERENCE PCR AND VERSION NUMBER	Part A: Life Cycle Assessment Calculation Rules and Report Requirements (UL Environment, V3.2, 12.12.2018) and Part B: Designated Steel Construction Product EPD Requirements (UL Environment, V2.0, 08.26.2020).
DESCRIPTION OF PRODUCT APPLICATION/USE	Fabricated steel reinforcing bar and merchant bar used in construction
PRODUCT RSL DESCRIPTION (IF APPL.)	N/A
MARKETS OF APPLICABILITY	North America
DATE OF ISSUE	June 10, 2022
PERIOD OF VALIDITY	5 Years
EPD TYPE	Product-Specific
EPD SCOPE	Cradle to gate
YEAR(S) OF REPORTED PRIMARY DATA	2020
LCA SOFTWARE & VERSION NUMBER	GaBi v10.5.1.124
LCI DATABASE(S) & VERSION NUMBER	GaBi 2021.2
LCIA METHODOLOGY & VERSION NUMBER	TRACI 2.1, EN15804

The PCR review was conducted by:	UL Environment
	PCR Review Panel
	epd@ul.com

This declaration was independently verified in accordance with ISO 14025: 2006.
 INTERNAL EXTERNAL

Cooper McCollum
Cooper McCollum, UL Environment

This life cycle assessment was conducted in accordance with ISO 14044 and the reference PCR by:

Trinity Consultants

This life cycle assessment was independently verified in accordance with ISO 14044 and the reference PCR by:

Thomas P. Gloria
Thomas P. Gloria, Industrial Ecology Consultants

LIMITATIONS
Exclusions: EPDs do not indicate that any environmental or social performance benchmarks are met, and there may be impacts that they do not encompass. LCAs do not typically address the site-specific environmental impacts of raw material extraction, nor are they meant to assess human health toxicity. EPDs can complement but cannot replace tools and certifications that are designed to address these impacts and/or set performance thresholds – e.g. Type 1 certifications, health assessments and declarations, environmental impact assessments, etc.

Accuracy of Results: EPDs regularly rely on estimations of impacts; the level of accuracy in estimation of effect differs for any particular product line and reported impact.

Comparability: EPDs from different programs may not be comparable. Full conformance with a PCR allows EPD comparability only when all stages of a life cycle have been considered. However, variations and deviations are possible. Example of variations: Different LCA software and background LCI datasets may lead to differences results for upstream or downstream of the life cycle stages declared.

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3. LCA Results

LCIA results are relative expressions and do not predict actual impacts, the exceeding of thresholds, safety margins or risks.

Buy Clean California Act (BCCA) Results

The Buy Clean California Act (BCCA) allows for the exclusion of emissions that occur during the fabrication stages in reporting total Global Warming Potential (GWP) results. Therefore, this LCA report provides separate, pre-fabrication GWP results for BCCA compliance.

Table 2. BCCA Results, per 1 metric ton (unfabricated)

PARAMETER	UNIT	A1	A2	A3	Total
GWP 100 (excl. biogenic carbon)	kg CO ₂ eq.	177	12	224	413
GWP 100 (incl. biogenic carbon)	kg CO ₂ eq.	176	12	224	412

Fabricated Bar Results

Fabrication requires 1.08 metric tons of bar per 1 metric ton of fabricated product. Module A1 includes production of all 1.08 metric tons of bar.

Table 3. LCIA results, per 1 metric ton (fabricated)

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GWP 100 (excl. biogenic carbon)	kg CO ₂ eq.	191	13	329	532
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ODP	kg CFC 11 eq.	5.0E-13	6.7E-15	2.0E-05	2.0E-05
AP	kg SO ₂ eq.	9.3E-01	5.2E-02	9.1E-01	1.9
EP	kg N eq.	2.3E-02	4.7E-03	6.9E-02	9.7E-02
SFP	kg O ₃ eq.	10.6	1.4	22.8	34.8
ADP _{total}	MJ surplus	367	19	159	546

EMBODIED CARBON TERMS: EPD

ENVIRONMENTAL PRODUCT DECLARATION




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The PCR review was conducted by:	UL Environment PCR Review Panel epd@ul.com
This declaration was independently verified in accordance with ISO 14025: 2006. <input type="checkbox"/> INTERNAL <input checked="" type="checkbox"/> EXTERNAL	<i>Cooper McC</i> Cooper McCollum, UL Environment
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EMBODIED CARBON TERMS: BIOGENIC CARBON



EMBODIED CARBON TERMS: OFFSETS

Some Common Examples of Carbon Offset Projects

Avoided emissions, or emission reduction without storage		Emissions reduction with short-lived storage	Emissions reduction with long-lived storage	Carbon removal with short-lived storage	Carbon removal with long-lived storage
Counterfactual Baseline	Retrospective Baseline				
<p>Renewable Energy Biomass/Biogass Example:</p>  <p>Engro Biomass CDM Project</p>	<p>Methane Abatement Landfill Gas Example:</p>  <p>Richeast WWT Methane Recovery Project</p>	<p>Forestry Avoided Conversion Example:</p>  <p>Pungo River Forest Conservation Project</p>	<p>Carbon Capture and Sequestration Facility Example:</p>  <p>Century Plant</p>	<p>Improved Forest Management Example:</p>  <p>Noles Farms</p>	<p>Direct Air Capture and storage Example:</p>  <p>Orca Project</p>
<p>Renewable Energy Solar/Wind/Small-hydro Example:</p>  <p>Sapphire 49.5 MW Wind Park CDM Project</p>	<p>N₂O Abatement Landfill Gas Example:</p>  <p>Luohe Landfill Gas CDM Project</p>				<p>Bioenergy and CCS Example:</p>  <p>Illinois Industrial Carbon Capture & Storage Project</p>
<p>Improved Cookstove Example:</p>  <p>Sichuan Rural Poor-Household Biogas Programme</p>					

Source: Adapted from The Oxford Principles for Net Zero Aligned Carbon Offsetting

EMBODIED CARBON TERMS: "NET ZERO"



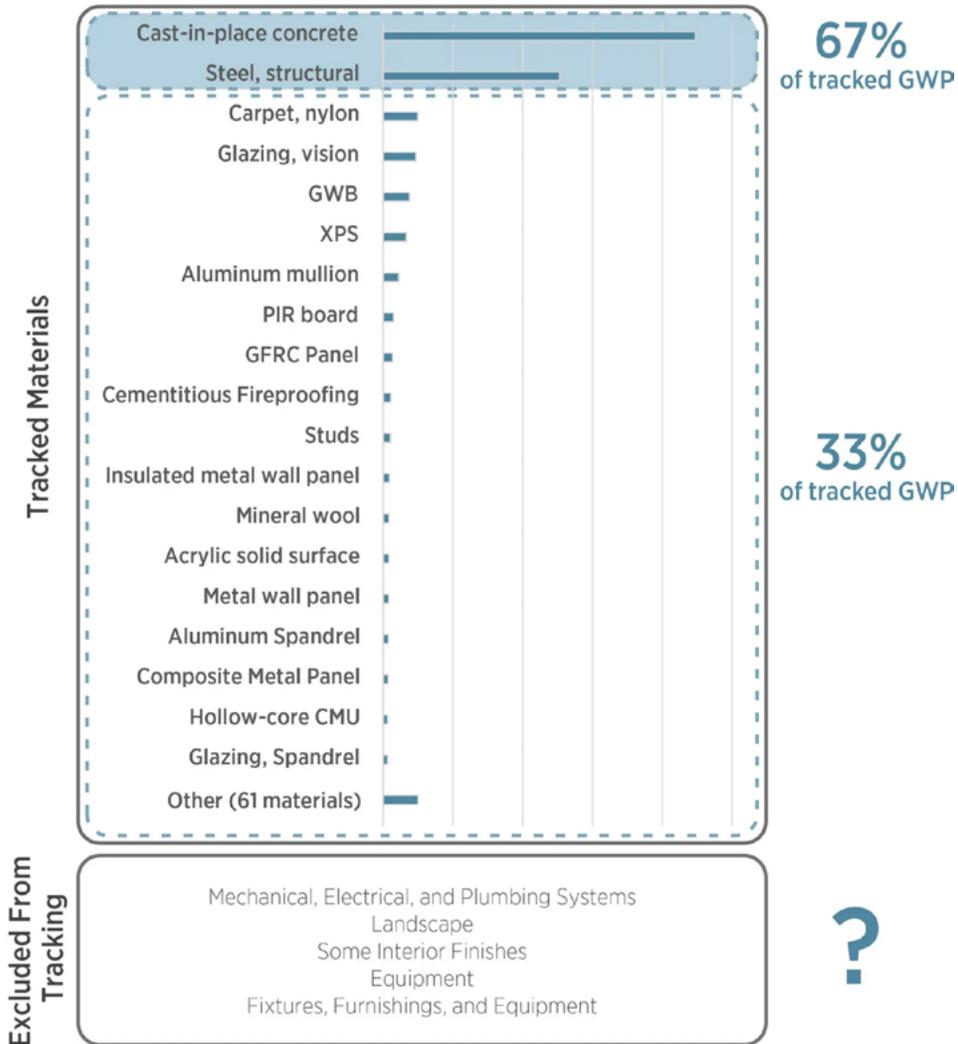
Scope Comparison of Frameworks, Certifications/Standards, and Some Research That Include CO₂e Calculations

			YES	NO	OPTIONAL	EN 15978 FRAMEWORK	LEED V4.1	ILFI ZERO CARBON	LEED ZERO CARBON	ASHRAE 228P	ENVISION	MEP 2040	SE 2050	NREL CAMBIUM	
INITIAL CARBON	DESIGN TEAM	Travel, printing, office, etc.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	EMBODIED	Structure	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
		Envelope	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
		Interiors	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
		FF+E or furniture	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
		Landscape/Site	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
		MPE + Systems	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
		Renewables	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	CONSTRUCTION	Transportation distance	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
		Construction carbon, incl water	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
EXISTING BUILDING	Recycling, reuse, and demo	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
OPERATIONAL CARBON	ENERGY	Annual energy use	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
		Energy time of use	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	
		Refrigerants	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	WATERGY	Water-related energy use	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	MAINTENANCE/REPLACEMENT	Interiors, MEP systems, etc.	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	LANDSCAPE	Maintenance and sequestration	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	TRANSPORTATION	Transportation impact of project	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	



EMBODIED CARBON IDENTIFYING IMPACTS

Firm Wide Material Impacts



Concrete

- SCM Limits and Cure Times
- Type 1L Concrete

Steel

- EAF Production vs Others

Mass Timber

- Sustainable Sourcing

EMBODIED CARBON TOOLS

EARLY DESIGN GUIDANCE



caretool.org

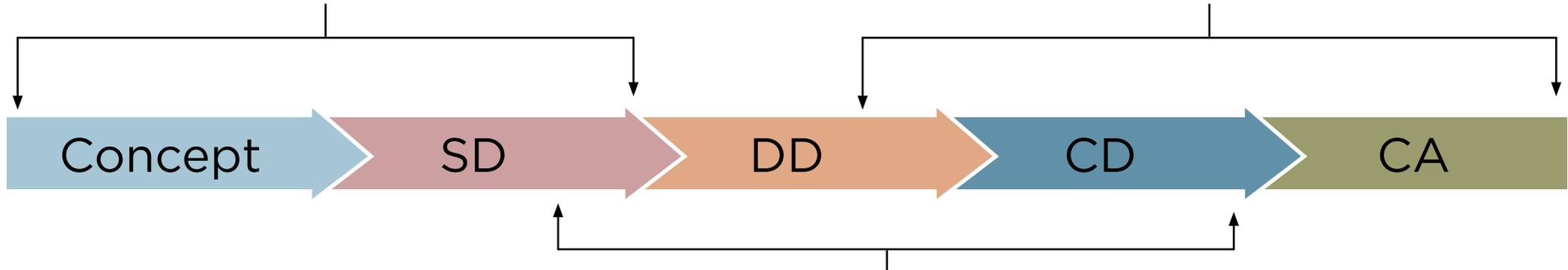


epic.ehdd.com

MATERIAL SELECTION



buildingtransparency.org



oneclicklca.com



buildingtransparency.org/tally/tallycat
choosetally.com

WHOLE BUILDING LCA

EMBODIED CARBON ENGAGEMENT

CARBON CURIOUS:

- AIM FOR THE BIG IMPACTS - CONCRETE, STEEL, INSULATION
- ASK FOR EPDS
- REUSE, REDUCE, THEN BUILD WELL

CARBON WRANGLERS:

- RUN MODELS
- IDENTIFY YOUR OWN HOTSPOTS

CARBON CHAMPIONS:

- IDENTIFY AND FILL THE DATA GAPS
- HELP DRIVE POLICY

EVERYONE:

- GET INVOLVED - CLF HUBS
- GET YOUR CONSULTANTS INVOLVED - SE 2050, MEP 2040

EMBODIED CARBON RESOURCES

AIA CLF EMBODIED CARBON TOOLKIT [HTTPS://CARBONLEADERSHIPFORUM.ORG/CLF-ARCHITECT-TOOLKIT/](https://carbonleadershipforum.org/clf-architect-toolkit/)

LMN'S PATH TO ZERO CARBON [HTTPS://LMNARCHITECTS.COM/LMN-RESEARCH/PATH-TO-ZERO-CARBON-SERIES](https://lmnarchitects.com/lmn-research/path-to-zero-carbon-series)

CARBON LEADERSHIP FORUM [HTTPS://CARBONLEADERSHIPFORUM.ORG/](https://carbonleadershipforum.org/)

CLF LOCAL HUBS [HTTPS://CARBONLEADERSHIPFORUM.ORG/REGIONAL-HUBS-2/](https://carbonleadershipforum.org/regional-hubs-2/)

CLF YOUTUBE [HTTPS://WWW.YOUTUBE.COM/@CARBONLEADERSHIPFORUM](https://www.youtube.com/@carbonleadershipforum)

EMBODIED CARBON RESOURCES

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LMN'S PATH TO ZERO CARBON [HTTPS://LMNARCHITECTS.COM/LMN-RESEARCH/PATH-TO-ZERO-CARBON-SERIES](https://lmnarchitects.com/lmn-research/path-to-zero-carbon-series)

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JOIN US @ A'23!



Carbon Crash Course Charrette

WE303
Wednesday, June 7, 1:00 PM – 3:30 PM
2.50 LUs/HSW/RIBA



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Efrie Escott, AIA

Sustainability Transformation Leader, *Schneider Electric*

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