

# CALGreen Embodied Carbon Series: Understanding the 2023 Embodied Carbon Amendments

Amie Lewis  
Senior Project Manager in  
Codes and Policy, NBI

Anish Tilak  
Manager with the Carbon-Free  
Buildings Program, RMI

Made in partnership with the SEAOC Sustainable Design Committee

1 LU | HSW / 1hr ZNCD MCE

# Learning Objectives



Clarify the concept of embodied carbon and its impact on climate change through building materials.



Trace the evolution of embodied carbon policies leading to state-level code adoption.

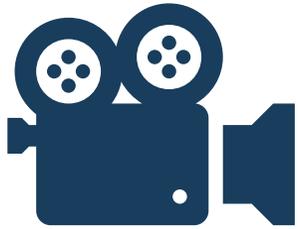


Gain a comprehensive understanding of the 2022 California Green Building Standards Code amendments.



Develop actionable strategies to comply with and excel in these new standards in your projects.

# Housekeeping Reminders



Access to today's recording will be made available on our website



Today's session qualifies for 1 AIA HSW/LU & 1hr of ZNCD



Please use the Q&A function to ask questions for today's presenters



Cultivate a positive learning environment



Luke Lombardi  
Sr. Sustainability  
Consultant, Buro Happold



Avideh Haghighi, AIA  
Architect & Sustainability  
Specialist, ZGF

# CALGreen Embodied Carbon Series

**4-part series** made in partnership with SEAOC's Sustainable Design Committee

Feb. 21, 2024	Understanding the 2023 Embodied Carbon Amendments
Mar. 13, 2024	WBLCA for Code Compliance <i>(registration open!)</i>
Apr. 10, 2024	Implications of Material Procurement for Design Professionals
June 2024 [TBD!]	Building Reuse for Decarbonization and Compliance



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Manager with the Carbon-  
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RMI



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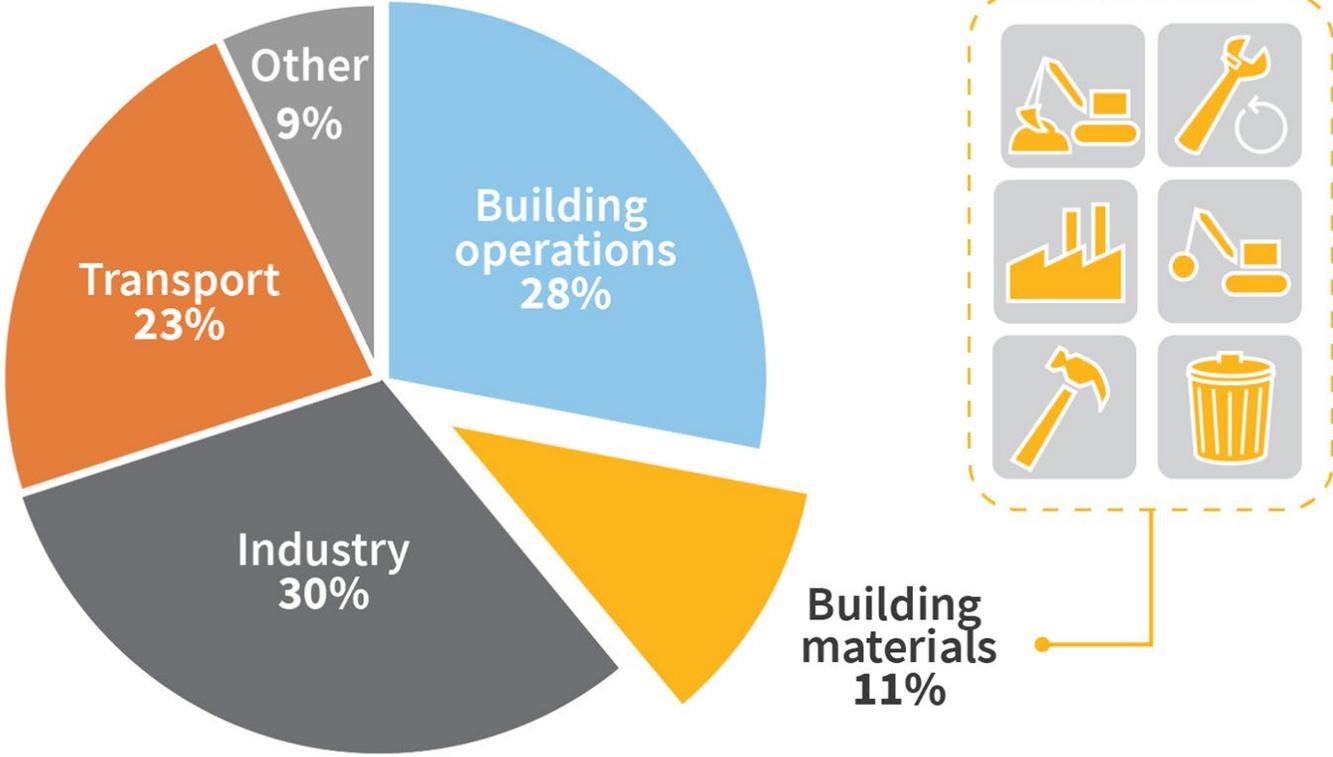
Embodied Carbon in  
*CAL* Green®



# Agenda

- Embodied carbon policy landscape summary
- Introduction to CALGreen Embodied Carbon Measure
- CALGreen Embodied Carbon Compliance Pathways
- Compliance & enforcement
- Q&A & Discussion

# Embodied Carbon is 11% of Worldwide GHG Emissions



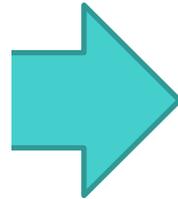
*Global energy-related CO<sub>2</sub> emissions.  
Adapted from the UNEP 2019 Global Status Report*

# Policy & Market Development Framework

## Emerging Solutions

### Demonstrations

- **Funds for pilot projects (private & public)**
- **Funds for testing labs**
- **Economic & business development support**

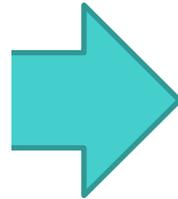


# Policy & Market Development Framework

## Emerging Solutions

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- Funds for pilot projects (private & public)
- Funds for testing labs
- Economic & business development support



## Market Ready Tech, Industry Capacity Building Needed

### Incentives

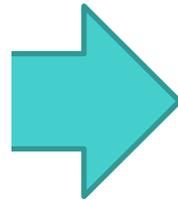
- Buy Clean – Incentive approach
- Financial grants
- Performance bonuses
- Planning / zoning incentives

# Policy & Market Development Framework

## Emerging Solutions

### Demonstrations

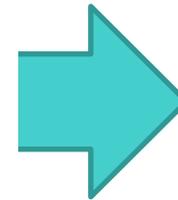
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## Market Ready Tech, Industry Capacity Building Needed

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## Mass Market

### Codes & Standards

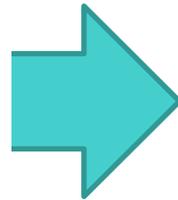
- Buy Clean – minimum standards
- Building Codes & Standards

# Policy & Market Development Framework

## Emerging Solutions

### Demonstrations

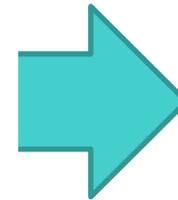
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## Market Ready Tech, Industry Capacity Building Needed

### Incentives

- Buy Clean – Incentive approach
- Financial grants
- Performance bonuses
- Permitting /planning / zoning incentives



## Mass Market

### Codes & Standards

- Buy Clean – minimum standards
- Building Codes & Standards

# What is CALGreen?

The California Green Building Standards Code—Part 11, Title 24, California Code of Regulations—known as CALGreen, is the **first-in-the-nation mandatory green building standards code. In effect since 2007.**

## Covered projects

- All new construction.
- Residential additions/alterations that increase the building's conditioned area.
- Non-residential additions greater than 1,000 square feet.
- Non-residential alterations valued at \$200,000 and more.

# Code organized by environmental categories

- Planning & Design (Ex: site)
- Energy Efficiency – *defers to CEC Title 24 Part 6*
- Water Efficiency
- **Material Conservation & Resource Efficiency**
- Environmental Quality

Source: [\[RMI\] Roadmap to Reaching Zero Embodied Carbon in Federal Building Projects](#)

A teal-colored map of California is positioned on the left side of the slide, partially overlapping the blue header and the light blue body. The map shows the state's outline with some internal details like the San Francisco Bay Area and the Central Valley.

# California adopts first statewide embodied carbon building code requirement in the U.S.

Starting July 2024, **the California Green Building Code (CALGreen)** will require non-residential building projects exceeding 100,000 sf and school projects exceeding 50,000 sf to **address the climate impact of building materials**

# Is my project covered by the measure?

## Covered

Public Schools (K-12), Community College  
>50,000 sf

Building types covered by *CALGreen Non-residential Provisions* and >100,000 sf

- Industrial
- Commercial Office
- Retail
- Lab
- Private School (K-12)
- University Academic (Public & Private)
- Hospital - **pending OSHPD approval**

## Not Covered

Public Schools (K-12), Community College  
<50,000 sf

Building types covered by *CALGreen Non-residential Provisions* and <100,000 sf

Building types covered by *CALGreen Residential Provisions*

- Single Family Residential
- Multifamily Residential
- Hotel / Motel / Lodging
- University Housing (*Note that Public University Housing IS covered by Buy Clean CA*)

# Clarifications

## CA Public Buildings

- **Buildings covered by Buy Clean California Act (BCCA) will need to meet BCCA GWP limits**
- **In addition, mandatory CALGreen GWP limits required for concrete materials**

## Mixed Use Buildings

- **The residential and non-residential portions must comply with provisions from respective CALGreen sections**
- **If project has non-residential floor area exceeding 100,000 sf, this measure is required**

# CALGreen Embodied Carbon Measure

3 possible paths that enable a wide range of embodied carbon choices

## Prescriptive

Source **Environmental Product Declarations (EPDs)** and meet **maximum GHG emissions targets** for all **concrete & Buy Clean California Act covered materials**

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## Performance

Demonstrate a **10% GHG emissions reduction** through **Whole Building Life Cycle Assessment (WBLCA)**

---

## Alternative

**Reuse** more than **45% of an existing building** structure & enclosure

# CALGreen Embodied Carbon Measure

3 possible paths that enable a wide range of embodied carbon choices

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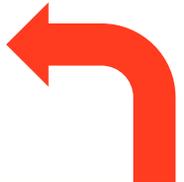
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Demonstrate a **10% GHG emissions reduction** through **Whole Building Life Cycle Assessment (WBLCA)**

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## Alternative

**Reuse** more than **45% of an existing building** structure & enclosure



**Streamlined pathway for adaptive reuse projects**

# CALGreen Embodied Carbon Measure

A prescriptive and performance pathway enable flexibility for project teams

## Prescriptive

Source **Environmental Product Declarations (EPDs)** and meet **maximum GHG emissions targets** for all **concrete & Buy Clean California Act covered materials**

---

## Performance

Demonstrate a **10% GHG emissions reduction** through **Whole Building Life Cycle Assessment (WBLCA)**

.....

# CALGreen Embodied Carbon Measure

## Prescriptive

**Specify and source EPDs meeting maximum GWP limits for the following materials**

- Ready-mix Concrete
- Structural Steel
- Concrete Reinforcing Steel
- Flat glass
- Mineral wool

## Performance

**Develop a baseline whole building model**

**Demonstrate embodied carbon optimizations**

- Material efficiency
- Alternative materials
- Low carbon materials procurement
- Reuse

# CALGreen Embodied Carbon Measure

## Prescriptive

**Specify and source EPDs meeting maximum GWP limits for the following materials**

- Ready-mix Concrete
- Structural Steel
- Concrete Reinforcing Steel
- Flat glass
- Mineral wool

**Construction administration & procurement focused optimization**

## Performance

**Develop a baseline whole building model**

**Demonstrate embodied carbon optimizations**

- Material efficiency
- Alternative materials
- Low carbon materials procurement
- Reuse

**Supports upfront integrated design to capture a broader suite of EC reduction strategies**

# What does this mean for project budgets?

## Prescriptive

- **Cost neutral to project**
- EPDs submitted by contractor as part of construction administration submittal process

## Performance

- **Small additional upfront cost for WBLCA analysis** conducted during design phase
- Offers opportunity for material optimization and efficiency, which can save upfront cost
- Provides more robust, holistic embodied carbon optimization

# CALGreen includes Tier 1 and Tier 2 Voluntary Measures

- CALGreen Tiers set stage for local reach codes and future mandatory standards
- For prescriptive pathway - Tier 2 aligns with Buy Clean & NRMCA regional benchmarks
- A number of local jurisdictions require Tier 1 or Tier 2:
  - Santa Clara County requires Tier 1 for larger projects
  - Palo Alto requires Tier 2 for larger projects

# CALGreen Embodied Carbon Options

## Lifecycle Analysis

**Scope:** 60-year cradle-to-grave WB LCA (ISO 14044), excluding operating energy. Show GWP analysis.

**Components:** Primary and secondary structural members, glazing, insulation, exterior finishes.

## Prescriptive Path

**Components:** Structural steel, rebar, flat glass, light and heavy duty mineral wool insulation, and ready mix concrete

**Exception:** Concrete mixes can use a weighted average for all mixes

## Building Reuse

**Components:** Existing primary structural elements, enclosure, window assemblies, and insulation.

**Exceptions:** Additions 2x+ the area of existing building

**Exclude:** Windows, insulation, portions structurally unsound or hazardous, and hazardous materials that are remediated as part of the project shall not be included in the calculation.

Choose one:

	Lifecycle Analysis	Prescriptive Path	Building Reuse
Mandatory	10% reduction from baseline	175% of IW-EPD GWP Limits	45% of the structure and enclosure to be reused
Tier 1	15% reduction from baseline	150% of IW-EPD GWP Limits	75% of the structure and enclosure to be reused
Tier 2	20% reduction from baseline	IW-EPD GWP Limits	75% of the structure and enclosure to be reused AND 30% of interior non-structural elements to be reused

# Whole Building LCA

- Conduct a cradle to grave building LCA
  - Baseline of a similar profile
  - Design (10% better)
- Add LCA summary to the CDs

Software requirements: must have a data set compliant with ISO-14044, and ISO 21930-2017 or EN 15804

The reference study period of the proposed building shall be equal to the reference baseline building and shall be 60 years.

## WORKSHEET (WS-9) Section 5.409.2 and Section A5.409.2 WHOLE BUILDING LIFE CYCLE ASSESSMENT

**CalGreen Whole Building LCA Reporting Template**

LCA model run

User input	Units	Overall scope included (select all that apply)
LCA Modeler (company) [private]		Structure (required) <input type="checkbox"/>
Date of Model Run (mm/yyyy)		Enclosure (required) <input type="checkbox"/>
Project Phase at Model Run		Interiors (optional) <input type="checkbox"/>
Reference Study Period (years)		MEP (optional) <input type="checkbox"/>
Software and Version Used*		Site/Landscaping (optional) <input type="checkbox"/>
Biogenic Carbon Included* (y/n)		FFE (optional) <input type="checkbox"/>
Model Floor Area	m2	

**Mandatory Scope Items**

Please break out the following in per element emissions by life cycle in kgCO<sub>2</sub>e. Leave blank any sections that were not calculated separately from Whole Building GWP

	Upfront Carbon			Use Phase	End of Life	Total
	A1-3	A4	A5	B1-5	C1-4	
Baseline Structure GWP (kgCO <sub>2</sub> e)						4.00
Baseline Enclosure GWP (kgCO <sub>2</sub> e)						4.00
<b>Baseline Whole Building GWP (kgCO<sub>2</sub>e)</b>						<b>4.00</b>
Proposed Structure GWP (kgCO <sub>2</sub> e)						4.00
Proposed Enclosure GWP (kgCO <sub>2</sub> e)						4.00
<b>Proposed Whole Building GWP (kgCO<sub>2</sub>e)</b>						<b>4.00</b>

Percent Reduction

**A1-A3\***  
(A1) Raw Material Supply, (A2) Transport to Factory, and (A3) Manufacturing

**A4\***  
(A4) Transportation to site

**A5\***  
(A5) Construction installation or "on-site energy use". Leave blank if unknown

**B1-B5\***  
(B1) Use, (B2) Maintenance, (B3) Repair, (B4) Replacement, (B5) Refurbishment

**C1-C4\***  
(C1) Deconstruction/Demolition, (C2) Transport to Waste Processing/Disposal, (C3) Waste Processing, (C4) Disposal of Waste

**D\***  
(D) Reuse-Recovery & Recycling Potential

**Optional Items - Proposed Design ONLY**

Please break out the following in per element emissions by life cycle in kgCO<sub>2</sub>e. Leave blank any sections that were not calculated separately from Whole Building GWP

	Upfront Carbon			Use Phase	End of Life	Total
	A1-3	A4	A5	B1-5	C1-4	
Interiors GWP (kgCO <sub>2</sub> e)						
MEP GWP (kgCO <sub>2</sub> e)						
Site/Landscaping GWP (kgCO <sub>2</sub> e)						
FF&E GWP (kgCO <sub>2</sub> e)						

# Incorporate WB LCA Requirements in Design and Construction Process

- **Specs:** Incorporate requirements in Div 1 and in each section
- **CDs:** Architect to include and sign Worksheet WS-4
- **Bid documents:** Indicate the intent for lower carbon products
- **Submittal review:** GC to provide EPD, Architect to confirm GWP meets the WB LCA design
- **Close out:** Consider providing updated WBLCA to the owner (not required)
- **Enforcement entity:** Provide WB LCA upon request.



# Prescriptive Path

Aligned with Buy Clean California, plus concrete

Product-specific or factory-specific Type III EPD.

**TABLE 5.409.3  
PRODUCT GWP LIMITS**

Buy Clean California Materials Product Category <sup>1</sup>	Maximum acceptable GWP value (unfabricated) (GWP <sub>allowed</sub> )	Unit of Measurement
Hot-rolled structural steel sections	1.77	MT CO <sub>2e</sub> /MT
Hollow structural sections	3.00	MT CO <sub>2e</sub> /MT
Steel plate	2.61	MT CO <sub>2e</sub> /MT
Concrete reinforcing steel	1.56	MT CO <sub>2e</sub> /MT
Flat glass	2.50	kg CO <sub>2e</sub> /MT
Light-density mineral wool board insulation	5.83	kg CO <sub>2e</sub> /1 m <sup>2</sup>
Heavy-density mineral wool board insulation	14.28	kg CO <sub>2e</sub> /1 m <sup>2</sup>

## Concrete, Ready-Mixed <sup>2, 3</sup>

Concrete Product Category	Maximum GWP allowed value (GWP <sub>allowed</sub> )	Unit of Measurement
up to 2499 psi	450	kg CO <sub>2e</sub> /m <sup>3</sup>
2500-3499 psi	489	kg CO <sub>2e</sub> /m <sup>3</sup>
3500-4499 psi	566	kg CO <sub>2e</sub> /m <sup>3</sup>
4500-5499 psi	661	kg CO <sub>2e</sub> /m <sup>3</sup>
5500-6499 psi	701	kg CO <sub>2e</sub> /m <sup>3</sup>
6500 psi and greater	799	kg CO <sub>2e</sub> /m <sup>3</sup>

## Concrete, Lightweight Ready-Mixed <sup>2</sup>

Concrete Product Category	Maximum GWP allowed value (GWP <sub>allowed</sub> )	Unit of Measurement
up to 2499 psi	875	kg CO <sub>2e</sub> /m <sup>3</sup>
2500-3499 psi	956	kg CO <sub>2e</sub> /m <sup>3</sup>
3500-4499 psi	1,039	kg CO <sub>2e</sub> /m <sup>3</sup>

### Footnotes:

1. The GWP values of the products listed in Table 5.409.3 are based on 175 percent of Buy Clean California Act (BCCA) GWP values, except for concrete products which are not included in BCCA.
2. For concrete, 175 percent of the National Ready Mix Concrete Association (NRMCA) 2022 version 3 Pacific Southwest regional benchmark values are used for the GWP allowed, except for High Early strength.
3. Concrete High Early Strength ready-mixed shall be calculated at 130 percent of the Ready mixed concrete GWP allowed values for each product category.

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# Prescriptive Concrete Exception

- Concrete may be considered one product category to meet compliance with this section.
- A weighted average of the maximum GWP for all concrete mixes installed in the project shall be less than the weighted average maximum GWP.
- Verification of compliance:
  - Calculations to demonstrate compliance
  - Type III EPDs for products required to comply
  - Worksheet WS-5 signed by the design professional of record
  - EPDs to be provided to the owner at the close of construction and to the enforcing entity upon request.

## Equation:

$$GWP_n < GWP_{\text{allowed}}$$

where

$$GWP_n = \sum (GWP_n)(v_n) \quad \text{and}$$

$$GWP_{\text{allowed}} = \sum (GWP_{\text{allowed}})(v_n)$$

and

$n$  = each concrete mix installed in the project

$GWP_n$  = the GWP for concrete mix  $n$  per concrete mix EPD, in kg CO<sub>2</sub>e /m<sup>3</sup>

$GWP_{\text{allowed}}$  = the GWP potential allowed for concrete mix  $n$  per Table 5.409.3

$v_n$  = the volume of concrete mix  $n$  installed in the project, in m<sup>3</sup>

# Prescriptive Path - Worksheet WS-5

- Add the worksheet to the CDs

STATE OF CALIFORNIA  
BUILDING STANDARDS COMMISSION

## WORKSHEET (WS-4)

### Section 5.409.2 WHOLE BUILDING LIFE CYCLE ASSESSMENT

Responsible Designer's Declaration Statement:

I attest that the Whole Building Life Cycle Analysis has been performed according to the requirements of Section 5.409.2 and has met the minimum 10 percent reduction in global warming potential as compared to a reference baseline building of similar size, function, complexity, type of construction, material specification, and location that meets the requirements of the California Energy Code currently in effect. Furthermore, I will ensure during construction that the material specifications will be reviewed for substantial conformance with the life cycle assessment indicated on the approved plans so at the close of construction the minimum 10 percent reduction in global warming potential is thereby secured.

Signature:	
Company:	Date:
Address:	License:
City/State/Zip:	Phone:

# Incorporate EPD/GWP Requirements in Design and Construction Process

- **Specs:** Incorporate GWP limits and EPD requirements in Div 1 and in each section.
- **CDs:** Architect to include and sign Worksheet WS-5
- **Bid documents:** Indicate the contractor's tracking requirements.
- **Submittal review:** GC to provide EPD, Architect to confirm GWP.
- **Close out:** Provide EPDs to the owner
- **Enforcement entity:** Provide EPDs upon request.

The enforcing agency may require inspection and inspection reports in accordance with Sections 702.2 and 703.1 during and at completion of construction to demonstrate substantial conformance. Inspection shall be performed by the design professional of record or third party acceptable to the enforcing agency.



Lovejoy Office Building | Portland, OR  
Credit: Opsis Architecture

# Building Reuse



Lofts on Laurel | San Diego, CA. Credit: H2 Architects

## Include:

45% of existing primary structural elements, enclosure, window assemblies, and insulation (assuming it is viable)

## Exclude:

Windows, insulation, portions structurally unsound or hazardous, and hazardous materials that are remediated

**Exceptions:** Additions 2x+ the area of existing building will be considered new construction

# Worksheet WS-3

- Add the reuse worksheet to CDs
- CDs to express the importance of retaining specific walls

WORKSHEET (WS-3)  
Section 5.105.2 BUILDING REUSE

DOCUMENTATION OF COMPLIANCE OF EXISTING BUILDING REUSE

Area of Existing Building(s) \_\_\_\_\_ SF

Area of Aggregate Addition(s) (if applicable) \_\_\_\_\_ SF

	Existing Total Area (A)	Retained Total Area (B)	% of Retained Structure (B)/(A)
<b>Primary Structural Elements of Existing Building(s)</b>  (foundations; columns, beams, walls, and floors; and lateral elements)	_____ SF	_____ SF	_____ %
<b>Building Enclosure of Existing Building(s)</b>  (roof framing, wall framing and exterior finishes only)	_____ SF	_____ SF	_____ %

Total % Reuse of Required Elements =  $\geq 45\%$  \_\_\_\_\_ %

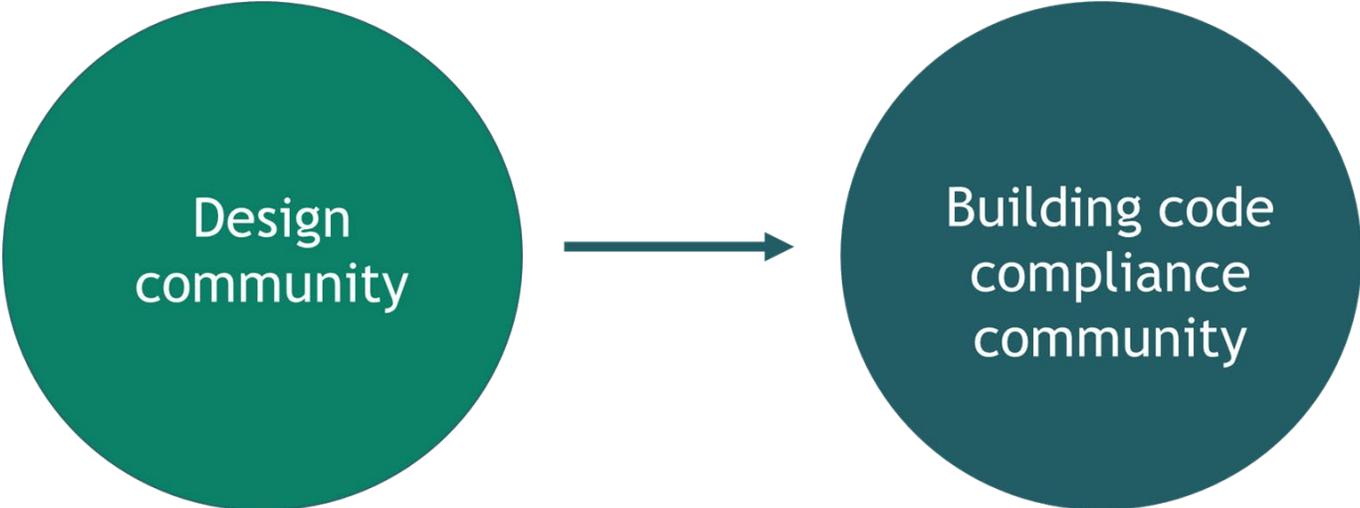
# Incorporate Reuse Requirements in Design and Construction Process

- **Specs:** Incorporate building component preservation requirements in Div 1
- **CDs:** Drawings to indicate the existing building components in plan and Architect to include and sign Worksheet WS-3
- **Bid documents:** Indicate the contractor's requirements for preserving the building
- **Construction:** During construction site visits, confirm preserved components remain
- **Close out:** Provide any update to unpreserved building component
- **Enforcement entity:** Provide updated worksheet upon request.



Lovejoy Office Building | Portland, OR  
Credit: Opsis Architecture

# Compliance and Enforcement



Toyota Research Institute | Los Altos, CA

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# What Code Officials Might Look for in Plan Review

- Worksheets
  - Values from EPDs, LCA, or reuse calc are referenced
- LCA reports from acceptable reporting tools
  - Enforcing agency can require reports be provided
- Specifications
- Signatures

*Include CALGreen considerations in your regular communications with the building department.*



# What Code Officials Might Look for in Field Inspection

- Verify conditions on site match documentation
  - Demo plans
  - Specifications
- Collect additional documentation
  - EPDs are valid
  - Invoices
  - Change orders
  - Products in packaging (especially during construction)
- Interview team members
- Take photos
- Write inspection notice



# Set Up for Success in Compliance

- Start Early! Invite vendors to the conversation
- Interview Structural Engineer
- Include EC goals in Owner's Requirements
- Coordinate & Collaborate
- Construction Administration
- Frontload (can benefit the Field Inspection)
- Ask Questions



# Q & A

# Resources

## California Building Standards Commission Approves Landmark Embodied Carbon Requirement

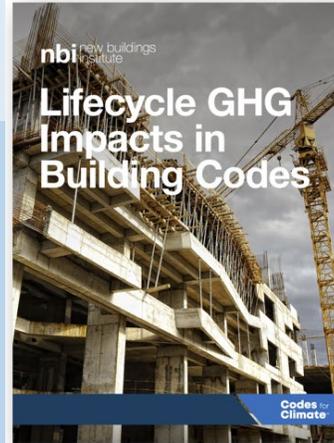
August 9, 2023 / [Codes And Policy](#)



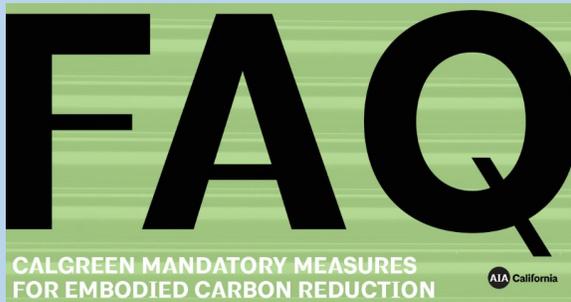
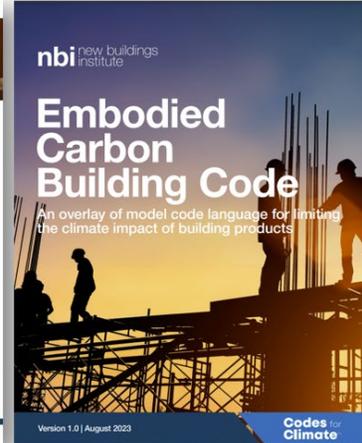
# Carbon-Free Buildings



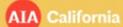
## NBI's Lifecycle Impacts Resources



[newbuildings.org/code\\_policy/embodied-carbon/](http://newbuildings.org/code_policy/embodied-carbon/)



California becomes first State to Adopt Mandatory Measures in Building Code to Reduce Embodied Carbon



## Lifecycle Impacts Resources



[localenergycodes.com/content/resources](http://localenergycodes.com/content/resources)

[newbuildings.org/code\\_policy/embodied-carbon/](http://newbuildings.org/code_policy/embodied-carbon/)

# Thank you



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Amie Lewis  
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## Next in the CALGreen Series:

Mar. 13, 2024

WBLCA for Code Compliance  
*(registration open!)*

AIA members should receive today's course credit on your transcript within 1-2 weeks.

ZNCD certificates for members and non-members will be sent via email to those who qualify.