Carbon Leadership Forum

Embodied Carbon Policy Factsheet

Building-Scale Embodied Carbon Performance Requirements

Building-scale ***embodied carbon*** performance requirements fill a current gap in building climate policies by targeting greenhouse gas (GHG) emissions from the materials and construction processes across the life cycle of buildings, referred to as embodied carbon. Reducing embodied emissions can also reduce environmental and human health impacts from pollution at manufacturing facilities, highways, construction sites, and landfills. Building policies engage design and construction teams to design more material-efficient and lower-carbon buildings and to specify lower-carbon products.

This document provides an overview of how *performance-based building policy requirements* can help address embodied carbon, why they should be a policy priority, and examples of existing policy paths. To read more about related policy strategies like Buy Clean, check out CLF's other Embodied Carbon Policy Toolkit factsheets.

Embodied carbon is a significant contributor to global emissions

Embodied carbon refers to the GHG emissions from the manufacturing, transportation, installation, maintenance, replacement, and disposal of construction materials used in buildings and infrastructure. In contrast, *operational carbon* refers to emissions from a building's energy consumption, including the burning of fossil fuels to heat, cool, and light the building. Decarbonizing buildings requires eliminating both embodied *and* operational carbon emissions.

The manufacturing impacts of construction materials used in buildings alone are responsible for approximately 10% of global energy-related greenhouse gas emissions.[1] When we look at new buildings, the urgency of embodied carbon is even more clear, as the majority of emissions between now and 2050 will be embodied emissions from manufacturing and building materials. For example, a 2024 CLF study found that for newly constructed buildings in California, embodied emissions would contribute approximately 80% of total emissions from 2024-2030 and 70% of total emissions from 2024-2045.[2]

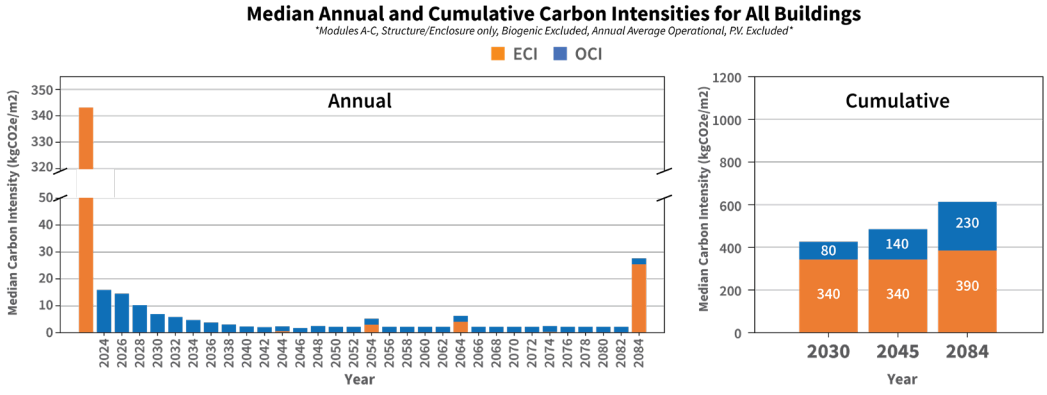

Figure 1. Median annual and cumulative **embodied carbon intensities (ECIs)** and **operational carbon intensities (OCIs)**. Modeling based on the embodied and operational emissions from life cycle modules A-C for the structure and enclosure of buildings in California.

Note that the y-axis for annual impacts (above) is shown with a break between 50 and 320 kg CO_2e/m^2). Adapted from Benke, B., Roberts, M., Lewis, M., Shen, Y., Carlisle, S., Chafart, M., and Simonen, K. (2024). The California Carbon Report: Six Key Takeaways for Policymakers. Carbon Leadership Forum, University of Washington. Seattle, WA.

KEY TERMS

Embodied carbon

GHG emissions generated by the manufacturing, transportation, installation, maintenance, and disposal of construction materials used in buildings, roads, and other infrastructure.

REFERENCES

1. IEA. (2021). Global energy use and energy-related CO2 emissions by sector, 2020.

2. Benke, B. et al. (2024). The California Carbon Report: Six Key Takeaways for Policymakers. Carbon Leadership Forum, University of Washington. Seattle, WA.

Policy opportunities

Low-carbon building requirements or incentives can be integrated into many different policies and programs. Examples of current pathways are:

- Building codes and building owner performance standards
- Government procurement requirements, incentives, and performance standards
- Urban design and zoning requirements or incentive programs
- Climate action plans, executive orders, and private sector commitments

Leading jurisdictions are paving the way

Performance-based low-carbon building policies have been introduced in Europe, Canada, and more recently in the United States. Examples of policies include:

- **International:** The Energy Performance of Buildings Directive Recast updated the overall framework for building energy performance standards in the European Union to now require calculations and targets to reduce embodied carbon, in line with the Level(s) Framework.[3]
- **National:** The Netherlands, Denmark, and France have all set embodied carbon intensity limits for both residential and non-residential buildings.[4] Sweden and Finland require reporting of the results of a building LCA but do not yet set limits.

  The U.S. General Services Administration (GSA) requires federal buildings to target a 20% reduction in the project's embodied carbon as compared to a baseline building of the same project type.[5]
- **State:** California's mandatory green building code, CALGreen, now requires certain new buildings to achieve a 10% reduction in embodied carbon, demonstrated by using results from a building LCA, as one of three pathways. See CLF Codes factsheet for more.
- **City**: Many leading cities now require building embodied carbon reporting and reduction requirements or limits, such as Toronto's Green Standard, Vancouver's Building by-laws, and London Plan 2021. Cities in the U.S. are also working towards the adoption and implementation of requirements, such as New York City (via Executive Order 23) and Cambridge, MA.

Low carbon building policies build on private sector leadership

In addition to policy leadership, the design community has stepped up to address both operational and embodied carbon building emissions. In the absence of regulations, professional organizations have put forward voluntary commitments for design and construction firms, such as:

- SE2050 Commitment Program for structural engineering firms targeting net zero embodied carbon by 2050;
- AIA Materials Pledge and 2030 Commitment for architecture firms, which began tracking embodied carbon alongside operational energy, in 2020;
- MEP2040 Commitment for mechanical, electrical, and plumbing (MEP) engineering and design firms committed to net zero embodied carbon by 2040;
- Climate Positive Design Challenge for landscape architects committed to being climate-positive by 2030;
- Contractor's Commitment to Sustainable Building Practices is a voluntary commitment for contractors started in 2018, focused on carbon, job-site wellness, waste, and more; and
- HomebuildersCAN is a community of practice to measure and reduce embodied carbon in home construction.

Green building certifications have long included embodied carbon-related credits, and they are often a standard part of green building consultants' and professionals' services. Embodied carbon has been a part of the USGBC LEED rating system since 2014, and a growing number of national and international certifications, from BREEAM to DGNB to Passive House and the Living Building Challenge, all now address embodied carbon. Broader policies will speed the process of shifting best practices to everyday norms on projects.

REFERENCES

3. Recast Energy Performance of Buildings Directive, www.eurovent.eu.

4. Buildings Performance Institute Europe (BPIE). (2022). A Life-Cycle Perspective On The Building Sector: Good Practice In Europe.

5. GSA. (2022). Facilities Standards for the Public Buildings Service (P100), Section 1.9.2.9. Decarbonization.

Learn More

Find out more about some of these policy case studies in:

- → *Pacific Coast Collaborative: Embodied Carbon Policy Case Studies* (CLF, 2023)
- → *Northeast U.S. & Canada Embodied Carbon Policy Case Studies* (CLF, 2024)
- → CLF Embodied Carbon Policy Tracking Map

Low-carbon building policies are a critical complement to industrial policies

Low-carbon building policies encourage the adoption of strategies that require early design and construction coordination or strategies. These can include things like material efficiency, substitution, and circularity that are not covered by Buy Clean and similar industrial policies that focus on the carbon intensity of specific construction materials. Strategies uniquely influenced by building-focused policies are:

- **Material Efficiency:** Building the same function and strength with less volume of materials, such as using voided slab systems, post-tensioned slabs, or composite design braced frames instead of moment frames.[6] This can also include reducing requirements and incentives for unnecessary parking and underground structures.
- **Circularity:** Minimizing new construction and reusing existing buildings or components, which can include reusing entire foundations or enclosures for individual salvaged materials.
- **Material & Assemblies Substitution**: Evaluating the environmental trade-offs between different components of a building, such as carbon-storing materials (climate-smart wood, hempcrete, bio-based insulation, etc.) or other alternatives in place of conventional materials.
- **Engaging designers**: Architects and engineers lead compliance with building LCA and performance standards and are key to maximizing reduction potential by coordinating early in the design and construction process, ensuring that changes make it into the specifications, and educating clients and contractors on potential changes.

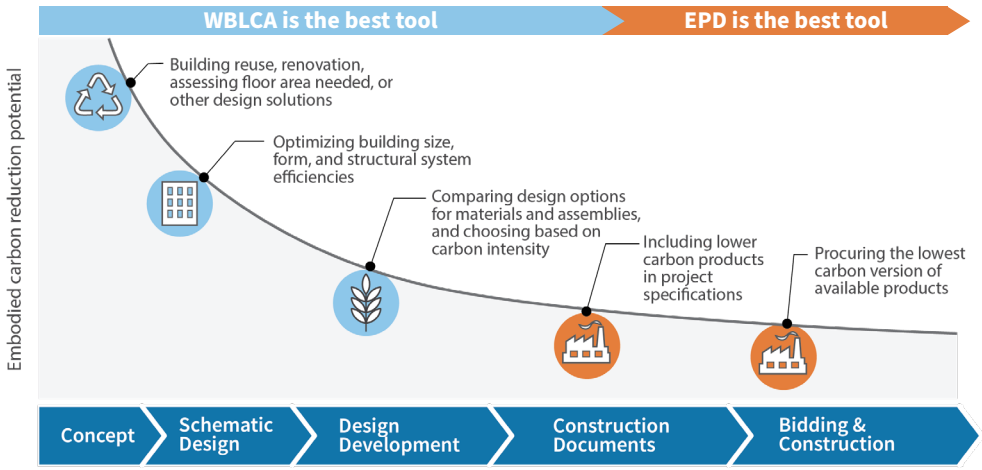

Figure 1. The availability of carbon reduction strategies changes across the design and construction timeline. Strategies like building reuse and material efficiency are only available earlier in the design process. Early coordination can unlock greater reductions in selecting and procuring the lowest carbon versions of products available.

Low embodied carbon building policies have the potential to result in large emissions reductions. Strategies to optimize buildings holistically may have a larger carbon reduction potential in the short term, whereas strategies to optimize procurement have a greater long-term potential when technological developments unlock greater industrial decarbonization.[7,8] In the long run, we need *both industrial and building* policies to reach global climate targets.

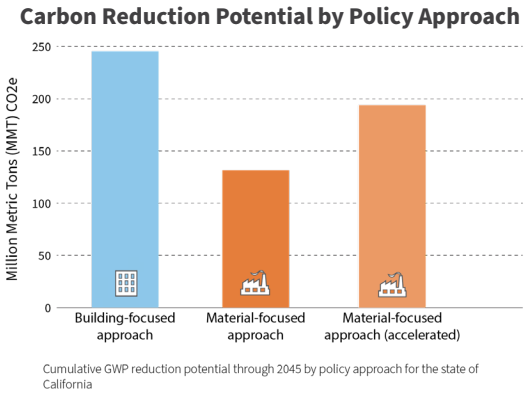

Figure 2. Cumulative global warming potential (GWP) reduction potential through 2045 in California, by policy approach. Source: Arup, NRDC. (2023). Embodied Carbon Reduction Roadmap: Strategies and Policies for the State of California.

REFERENCES

6. Webster, M. et al. (2020). *Achieving Net Zero Embodied Carbon in Structural Materials by 2050*. Structural Engineering Institute's Sustainability Committee Carbon Working Group. 10.13140/RG.2.2.28440.14085.

7. Arup, NRDC. (2023). *Embodied Carbon Reduction Roadmap: Strategies and Policies for the State of California*.

8. Benke, B., Lewis, M., Carlisle, S., Huang, M. & Simonen, K. (2022). *Developing an Embodied Carbon Policy Reduction Calculator.*

Basic elements of a low carbon building policy

Performance-based low-carbon building policies require two to three basic elements: (1) reporting (minimum), (2) limits/targets, and/or (3) incentives. Policies must also choose which projects are eligible, and when to implement each requirement. Requirements for limits are often phased in over several years to allow time for adoption.

Reporting

Policies *must* require reporting to verify compliance.

Measurement and reporting of embodied carbon for a building requires a building life cycle assessment (LCA), a methodology for accounting for GHG emissions and other impacts across the entire life cycle.

Possible outcomes:

- Availability of more building LCA results for informing targets and prescriptive approaches
- Increased capacity of the building sector to understand and track reductions in greenhouse gas emissions

Targets

Policies may require projects to meet performance targets *(read more on pg. 5)*. Embodied carbon intensity targets are flexible and technology-agnostic, enabling teams to select the decarbonization strategies that work best for their projects. Targets must be lowered or reviewed at regular intervals to result in reductions.

Possible outcomes:

- Encourage the use of available strategies for material efficiency and material substitutions
- Encourage building and material salvage and reuse strategies
- Use of available lower carbon product choices, especially in combination with Buy Clean requirements

Incentives

Policies can use incentives to encourage voluntary participation, support broader implementation, or reward high performance.

Examples of incentives include owner bid preferences, zoning incentives (e.g., expedited permitting, density bonuses), tax incentives, free technical assistance, and contract performance incentives.

Possible outcomes:

- Continued innovation
- Piloting cutting-edge solutions required to reach building and industrial sector climate targets
- Increased early, voluntary participation

Embodied Carbon Performance Requirements: Policy Variations

Policies typically use a combination of reduction targets and/or building carbon budgets to set building embodied carbon performance requirements. The variations described below can be used for either regulatory or incentive requirements.

Policy Variation A **% Reduction Targets**	Policy Variation B **Building Carbon Budgets**	Policy Variation C **Combined Approach**
Projects must reduce the building's embodied carbon by a certain percentage compared to a building-specific baseline. This is typically user-modeled. **Example:** The U.S. General Services Administration (GSA) requires certain federal buildings to achieve a 20% embodied carbon reduction compared to a baseline.[5]	The embodied carbon intensity per floor area (kg CO_2e/m^2) must be below a maximum value. **Example:** France's RE2020 requires new buildings to be below 640 - 740 kg CO_2e/m^2, depending on the type of building (single-family house, multi-family house, etc.) and climate zone.	Projects can comply with either variation A or B. Another option is to require a % reduction target (A) but *coupled with* a high maximum kg CO_2e/m^2 (B). **Example:** Beginning in 2025, the City of Vancouver will require projects (based on building type and height) to reduce 10-20% from either (a) 400 kg CO_2e/m^2 limit or (b) a baseline building modeled according to Vancouver's requirements.
Pros:		
+ **Flexible.** Reduction targets can be applied across building types and geographies. + **Familiar.** This approach has been implemented for multiple years in rating systems (e.g. LEED v4.1)	+ **Familiar.** A similar approach to requiring energy use intensity (EUI) targets for buildings. + **Lower administrative and compliance burdens.** Agencies do not have to create baseline building guidelines or review submissions in detail to identify whether requirements are being 'gamed'. Teams only have to model one building.	+ **Most flexible.** Teams can select the approach that is best for their project, and agencies do not have to establish limits for every type of building.
Cons:		
– **Administrative burden** on government agencies to provide adequate definition of a baseline building and review work of project teams. – **Compliance burden**. Requires design teams to define and model a baseline building in addition to the actual design, which can be a challenge if not enough guidance is provided by the jurisdiction.	– **Requires limit development**. Efforts to develop North American building-level benchmarks are advancing rapidly, but policy makers may need to lead data collection in the short-term, and/or have a phase-in period. – **Requires consistent tools and modeling requirements** to compare a building effectively to a kgCO_2e/m^2 target	– **High administrative burden**. The combined approach requires government agencies to both (1) provide additional guidance to define the baseline building and also (2) develop limits.

Building policies with embodied carbon performance requirements are important, are possible with existing tools and standards, and are growing rapidly in Europe and North America. To find more examples and learn about related policy approaches, check out the other CLF Embodied Carbon Policy Toolkit factsheets and resources.

Learn More

- → Embodied Carbon 101
- → EPD 101
- → Building LCA 101
- → Buy Clean: Overview and Implementation
- → Embodied Carbon and Building Codes
- → Deconstruction, Salvage, and Reuse Policies

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