



Addressing Embodied Carbon in Building Codes

Building codes have been one of the most influential tools to address climate change: The energy code addresses operational emissions and the building code address resiliency. The codes needs to continue protecting the public by addressing embodied carbon as we aim to reduce national GHG emissions 50% by 2030.

Worldwide, emissions associated with the most common building products and practices account for 15% of greenhouse gas (GHG) impact, and 28% of the carbon dioxide (CO₂) impact of buildings.¹

Emissions from building products, also known as embodied carbon, will become a larger part of a building's total carbon footprint as operational emissions decrease. To minimize the impacts of these products, policymakers are using all the tools available, including using existing code structures to incorporate global warming potential (GWP) limits on the most common building products and those with the highest GHG emissions.



What is GWP?

Global warming potential (GWP) is the most common metric for measuring and evaluating products' GHG emissions, represented as carbon dioxide equivalent (CO₂e). Eliminating or lowering the amount of CO₂e released can cap global warming past the 1.5 degrees Celsius goal.

Six of the 15% of construction carbon emissions come are related to the most widely used building products: steel, concrete, and aluminum. The environmental impacts of the three products typically account for over 50% of total product emissions in commercial projects. Steel is one of the most widely used products in building construction and a primary contributor to embodied carbon in buildings. The U.S. steel industry alone makes up 2% of total U.S. GHG emissions, with half of those emissions being steel for the built environment.²

¹ [2022 Global Status Report](#), International Energy Agency (IEA) with the Global Alliance for Buildings and Construction, 2022.

² [Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2018](#), US Environmental Protection Agency, 2020.

Industry Readiness

Manufacturer trade associations have already started to adapt to product-level low GWP regulations. The Global Cement and Concrete Association aims to reduce emissions by 50% by 2030 and achieve net zero by 2050.³ However, to meet climate goals, immediate implementation is needed. In response, several states and federal agencies (California, Colorado, Oregon, New York, U.S. General Services Administration (GSA)) are adopting procurement policies, like Buy Clean, changing how industries provide and respond to product GHG emissions requirements, specifically concrete and steel.

As jurisdictions adopt Buy Clean policies, proving the viability of procuring low carbon products, they should consider similar requirements for all private projects. [GSA research](#) shows that over 80% of concrete producers already provide concrete that complies with their low carbon concrete standard.

Cost Considerations

There are two major cost considerations for embodied carbon regulation, the cost to produce an EPD and the potential incremental cost for lower GWP products. For manufacturers, the primary cost is associated with creating EPDs for all of their products. Luckily, new funding from the [Inflation Reduction Act](#) will support EPD development and the cost premium for individual building projects that purchase low embodied carbon is negligible at 1% due to the scale of product development.⁴ Additionally, an [RMI study](#) has shown that low embodied carbon concrete is cost neutral and therefore does not increase the cost of the project. The same applies to rebar and insulation products. It is important to note that not all product manufacturers must comply with codes and policies since they will first impact government-funded and larger private projects.

Approaches to Regulation

Codes and policies can adopt product-focused prescriptive or whole building-focused performance approaches to embodied carbon regulation for building and construction projects. The approaches could be standalone options or provided as a choice under one requirement. Exceptions can be used to excuse projects by size or construction value, those that use a limited amount of a product, or other considerations important to the adopting jurisdiction.

Prescriptive

A product-focused prescriptive approach sets GWP limits for each target product and requires verification through an EPD. GWP limits could be a static value, as done in [Marin County](#) and in many Buy-Clean policies, including GSA, or pegging to a percentile of IW-EPD, or average, values, as done in ASHRAE's 189.1.⁵

The Marin code requires that all new building projects use low-embodied carbon concrete, allowing two different prescriptive pathways: a cement limit or a GWP limit (as stated in a certified EPD) for each strength category.



What are EPDs?

Environmental product declarations (EPDs) are third-party verified documents that summarize a product's lifecycle analysis and disclose the environmental impacts of materials, including the product's GWP, represented as CO₂e. Industry-wide EPDs (IW-EPDs) are similar third-party verified documents issued by a group of manufacturers or trade associations to publish the average footprint of the entire industry.

³ [Concrete Future: The GCCA 2050 Cement and Concrete Industry Roadmap for Net Zero Concrete](#), Global Cement and Concrete Association, 2021.

⁴ [Mission Possible: Reaching Net Zero Carbon Emissions from Harder-to-Abate Sectors](#), Energy Transitions Commission, 2018.

⁵ [Issuance of Low Embodied Carbon Concrete and Environmentally Preferable Asphalt Standards](#), US General Services Administration, 2022.

Marin County currently only regulates concrete, as one of the largest impact building materials.

ASHRAE 189.1, adopted as the International Green Construction Code, has proposed two new prescriptive embodied carbon amendments: a requirement for a specific percentage of products (by cost) to have EPDs and a separate percentage of products to meet specific GWP limits at 125% lower than the product’s IW-EPD. Unlike most Buy-Clean policies, the language does not state which products need to comply; it allows project teams some flexibility to select which products will meet GWP limits, but with some limitations. Projects are required to select a minimum of 20 products from 10 different manufacturers, and include big ticket items: products and materials meet or exceed 5% of the total cost of building materials.

Performance

The most common performance approach is through a whole building lifecycle analysis (WB LCA). Like an energy model, WB LCA compares the proposed design to a modeled baseline. A total GWP limit per building or square footage or a GWP percentage reduction would need to be set as the requirement.

The City of Vancouver, British Columbia, requires project teams interested in a rezoning permit to align their goals with City plans such as the [Green Buildings Policy for Rezonings](#). Projects must complete a WB LCA and demonstrate that they meet embodied carbon limits calculated in kgCO_{2e}/m². The Vancouver Embodied Carbon Guidelines set the standards and assumptions that teams must follow.

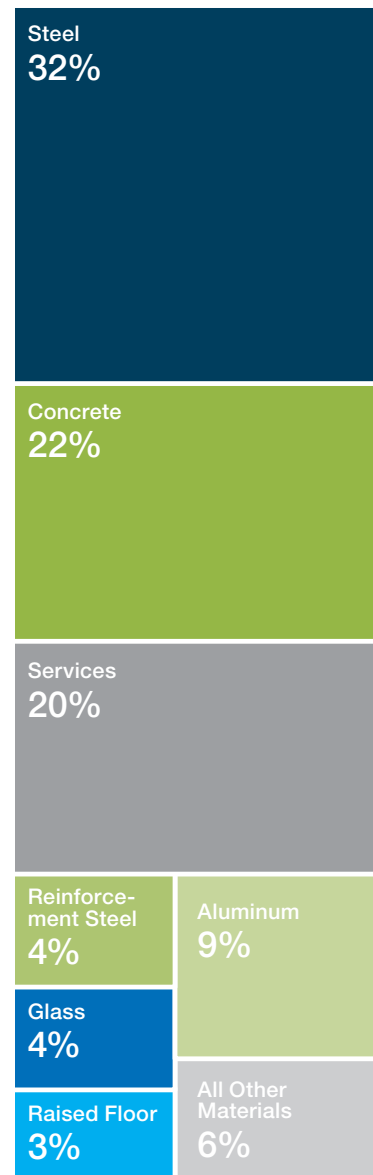
The main limitations of the performance approach in regulation are that the comprehensive material and product data, calculation tools and market expertise necessary to implement WB LCAs in code are not yet sufficiently available to create a standardized model for comparison or enforcement. Material-specific regulations, like those under a prescriptive policy approach, constraining embodied carbon are easy to write and enforce and offer the best, market-ready option to achieve meaningful embodied carbon savings in building codes today.

Enforcement

Authorities having jurisdiction (AHJ) will determine compliance, but there’s a clear path to support local goals and continue to use existing procedures. Plan reviewers can confirm that the EPD and GWP requirements are in the project specifications and that Division 1 indicates that EPDs will be part of the submittal review process. A letter signed by the architect, engineer, or contractor can confirm that the products’ EPDs comply. Most proposed embodied carbon code requirements target large buildings, and these projects include submittal reviews where designers and contractors sign off on the products before installation. Site inspectors can request to see EPDs when on the construction site, just as they may look at concrete strength testing reports or NFRC certificates for site-built windows.

If a project’s documentation isn’t compliant, most AHJs have non-compliance fee structures for non-life safety code violations in place already. For example, if a site-built window doesn’t have an NFRC certificate—the AHJ may fine the project instead of requiring window removal. Adopting jurisdictions should review their non-compliance violation structures when adopting embodied carbon regulations.

FIGURE 1: TOTAL CO₂E PER MATERIALS ACROSS FIVE ARUP CASE STUDIES



Source: Net-zero Buildings Where do we Stand

Picking the Right Code: Building, Energy, or Green?

The intent of the International Building Code (IBC) is to protect the public, structuring the chapters on the major products—concrete, aluminum, masonry, steel, wood, glass and glazing, gypsum board, plastic, and so on. The International Energy Conservation Code (IECC) is structured differently to address energy efficiency to conserve natural resources. The IECC requires energy efficiency measures to address operational energy and provide cost savings while considering the impact of energy usage on the environment. Avoiding embodied carbon emissions is not an energy efficiency measure and, therefore should not be regulated by the energy code.

The materials chapters of the IBC have been in place and used by the design and construction industry to ensure that the materials that make up our built environment preserve public health and safety. Addressing embodied carbon in the IBC expands its

impact to further safeguard the public from the hazards associated with the creation of building products.

The main opposition to adopting embodied carbon code language has been code councils' familiarity with the topic and code officials' concern about enforcing a non-fire life safety code. This hasn't stopped leadership in the code space. Beyond Marin County, the City and County of Denver adopted GWP limits for **concrete** and **steel** in their Green Code, and CALGreen, along with many other jurisdictions, is considering embodied carbon code requirements. As the IgCC adopts the latest ASHRAE 189.1 technical content, embodied carbon will be prevalent in green codes, a meaningful first step. As regulation continues to become more mainstream, the language will need to find its way out of green codes, which are largely considered "above code" and into the main body of the IBC.

Learn more:

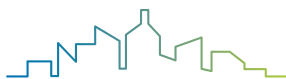
newbuildings.org/code-policy/embodied-carbon/

For questions, technical assistance, and more information:

Contact Webly Bowles webly@newbuildings.org

Codes for Climate™

Codes for Climate is an initiative of NBI to deliver the climate-aligned building codes and standards needed by U.S. states and cities in the face of the pressing demands of policy goals. To scale greenhouse gas reductions in the buildings sector to be in step with a 1.5°C future, the initiative works to support policy makers at multiple levels to move codes and standards forward, making significant reductions in energy consumption and GHG emissions from buildings possible and effective.



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New Buildings Institute (NBI) is a nonprofit organization working to advance best practice energy efficiency and decarbonization of the built environment. Our efforts are imperative to keeping energy costs affordable, cutting carbon emissions that are fueling climate change, and delivering on improved health, safety, and resiliency for all. We work collaboratively with industry market players—governments, utilities, advocates, AEC professionals, and others—to drive leading-edge design, innovative technologies, and public policies and programs for scale. Throughout its 25-year history, NBI has become a trusted and independent resource helping to create buildings that are better for people, communities, and the planet.

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