Carbon Leadership Forum

Regional Hub Policy Series

Embodied Carbon & Building Codes

Overview

This Presentation

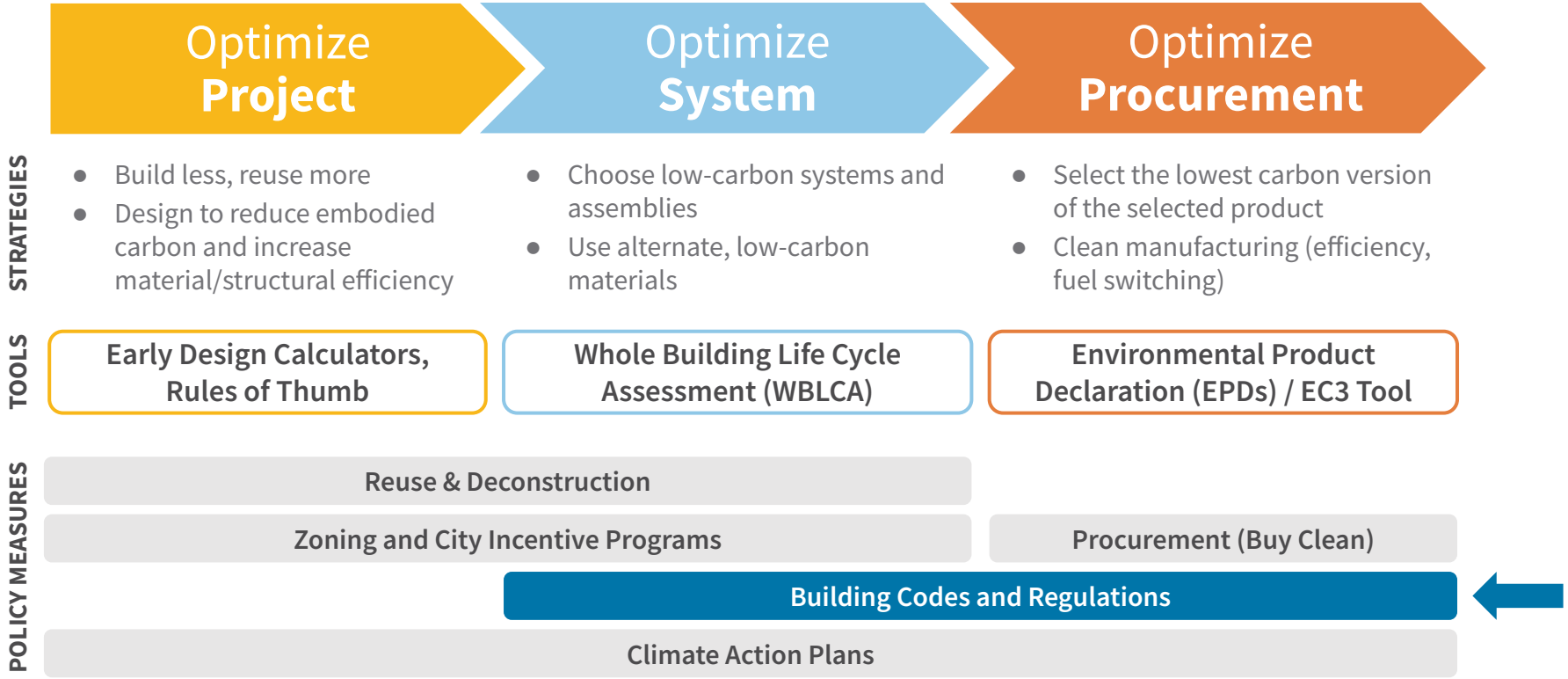
1. Development Process and Stakeholders
2. Materials: Code Pathways and Case Studies
3. Buildings: Code Pathways

Policy Introductory Series

1. Introduction to the Embodied Carbon Policy Landscape
2. Climate Action Plans
3. Procurement Policy
4. **Building Codes**
5. City Zoning and Incentive Programs
6. Reuse and Deconstruction

Thanks to the CLF Regional Hub Policy Leads and our partners at the New Building Institute for feedback and review.

Matching Policy Opportunities with Embodied Carbon Reduction Strategies



Building Codes Overview

Comprehensive set of interconnected regulations that are designed to govern new construction, renovations/remodels, repairs and demolitions.

- Adopted by state/province and local jurisdictions
- Enforceable by law
- Provide **minimum requirements** for the design and construction of buildings to protect the health and safety of building occupants.

Pexels, 2019

Building Codes and Embodied Carbon

Building codes allow setting requirements that reduce carbon impacts to projects

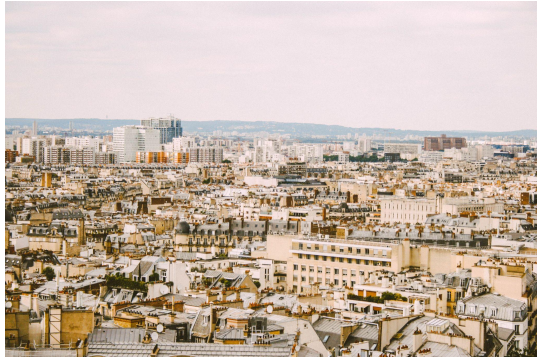
Benefits

- Largest number of projects covered (compared to other policy types)
  - Largest emissions reduction potential
- Clear market signals to manufacturers to meet future market demands

Challenges

- Complexity of the code-development process
- Need more standardized methodologies/tools to implement
- Increased need for training and building capacity (large number of stakeholders)
- Not all cities have authority to implement local building code requirements on top of state building code adoption

Geographic Variation



European Union

Building codes are written at a state or national level

Cities often granted the right to enforce them by building supervision.

Supplementary requirements by city

United States

Many cities can set their own codes

Some states prohibit cities from setting a more stringent standard

Varies between commercial and residential construction.

International Building Codes

Australia

Australian municipalities base their building codes on the National Construction Code

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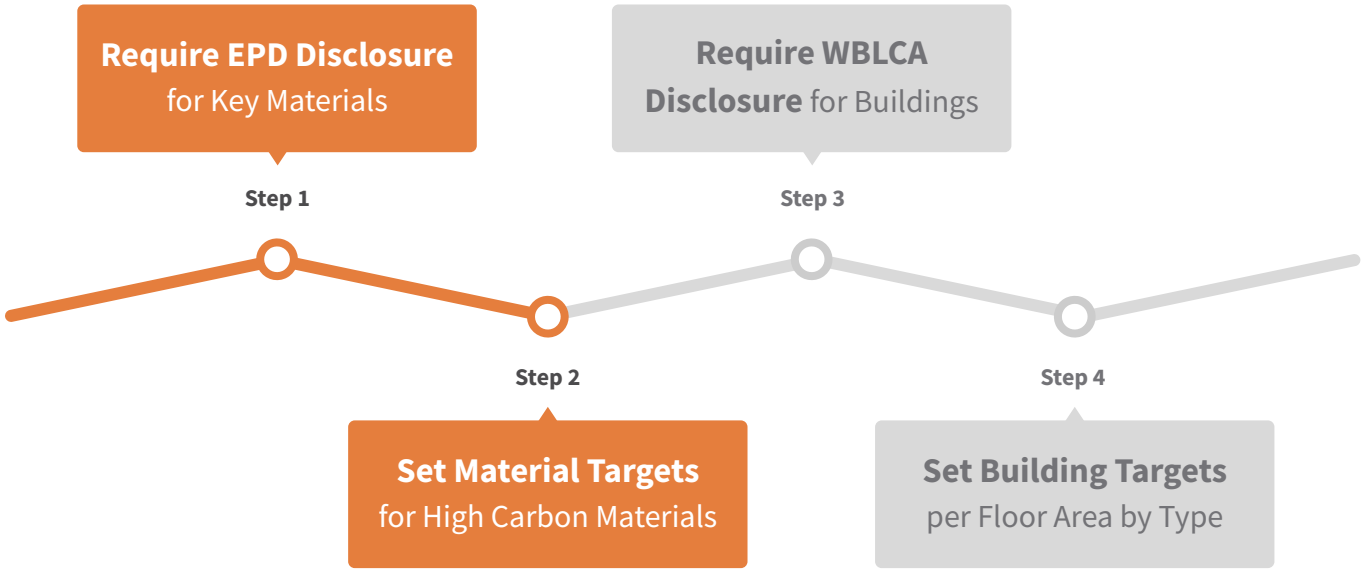
Development Process

Code Development Process

- Code committees are convened
  - US: International Code Council develops construction codes through a governmental consensus process
  - WA: State Building Council
- Proposed language is developed, submitted, and vetted
- Public comment period
- Proposals finalized and voted on
- New editions published *(cadence depends on jurisdiction)*

Embodied Carbon in the Code: Materials and Buildings



Regulating Building Materials → ***Regulating Whole Buildings***

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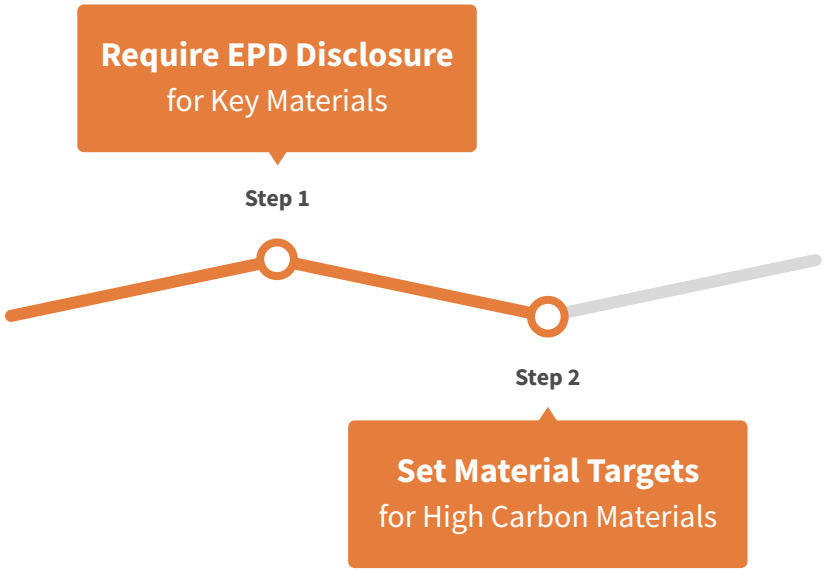
Materials: Code Pathways and Case Studies

Embodied Carbon in the Code: Materials



Benefits (Materials Approach)

- Transparency
- Market for cleaner products

Captures carbon reduction strategies like:

- Plant efficiency and fuel choices
- Sustainable ingredient sourcing (recycled content, alternative cements, etc.)

Regulating Material GHG Emissions in the Code

- Precedent to limit material GHG emissions already set in the code

Example: High Emitting Materials

- Codes prohibit use of specific materials with extremely high GHG emissions
  - Ex. spray foams with hydrofluorocarbon blowing agents used in insulation

- Most often implemented by local ordinance and may also be implemented by through building code.

Source: Sprayfoam.com, 2021

Which Code?

- Energy code has been regulatory focus for **operational** carbon
- Other codes are more applicable for **embodied** carbon

TABLE B: MATERIAL MAPPING OF BUILDING CODES

	Building Code	Residential Code	Mechanical Code	Plumbing Code	Electrical Code	Green Code	Energy Code
Primary Systems							
	Structural, envelope	All	Air supply, distribution, conditioning	Water supply, disposal, hot water	Electrical service, wiring, and systems	Site, Materials, Energy, IAQ,	
Materials Covered							
Concrete	X	X	X	X		X	
Steel	X	X	X	X			
Glass	X	X					
Aluminum	X		X				
Wood	X	X					
Copper			X	X	X		
Plastic	X	X	X	X			
Insulation	X	X	X				
Refrigerants			X			X	

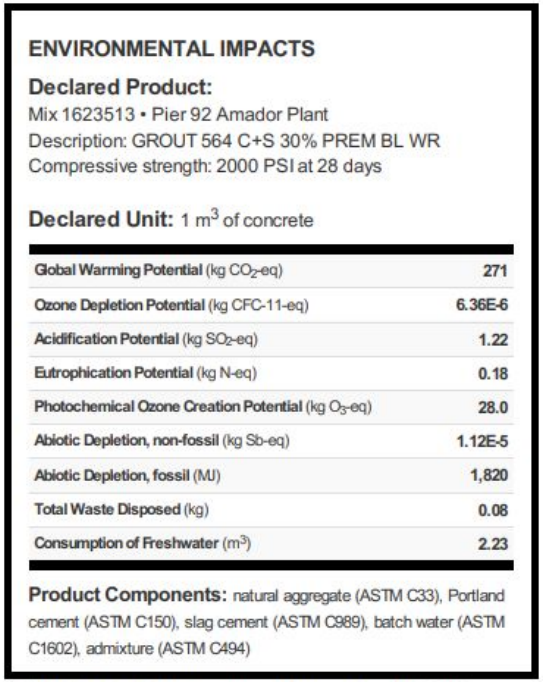
Source: New Buildings Institute, Lifecycle GHG Impacts in Codes, January 2022

Step 1: EPD Disclosure

- EPDs are **third party verified** disclosures of a material's environmental impacts based on a product LCA
- Must follow international LCA/EPD standards (**ISO**) and industry-specific rules (**PCRs**)

Example language (New Buildings Institute):

- *Product-specific Type III EPDs shall be submitted for 75% of steel products.*
- *EPDs shall be certified as complying with the goal and scope for the cradle-to-gate requirements in accordance with ISO Standards 14025 and 21930 and be available in a publicly accessible database.*



ENVIRONMENTAL IMPACTS

Declared Product:
Mix 1623513 • Pier 92 Amador Plant
Description: GROUT 564 C+S 30% PREM BL WR
Compressive strength: 2000 PSI at 28 days

Declared Unit: 1 m^3 of concrete

Global Warming Potential (kg CO_2-eq)	271
Ozone Depletion Potential (kg CFC-11-eq)	6.36E-6
Acidification Potential (kg SO_2-eq)	1.22
Eutrophication Potential (kg N-eq)	0.18
Photochemical Ozone Creation Potential (kg O_3-eq)	28.0
Abiotic Depletion, non-fossil (kg Sb-eq)	1.12E-5
Abiotic Depletion, fossil (MJ)	1,820
Total Waste Disposed (kg)	0.08
Consumption of Freshwater (m^3)	2.23

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

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

Step 2: Targets for High Embodied Carbon Materials

- Setting global warming potential targets *(kgCO2e/unit)*
- Require verification that a product met the target via product-specific Type III EPD

Example language (New Buildings Institute):

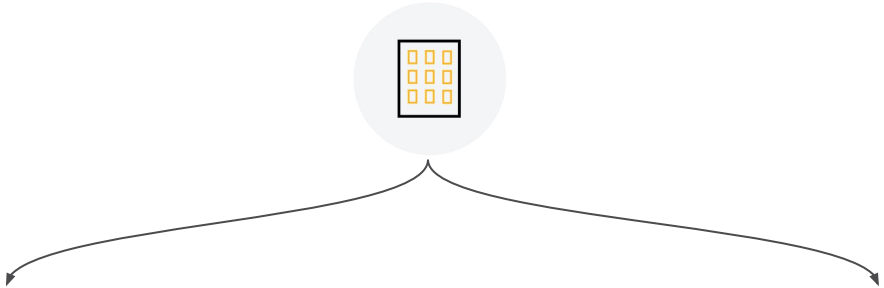
- *The total CO2e of the concrete mixes used in the project shall not exceed the value given in Table 1903.5.1 based on the compressive strength of the product.*
- *CO2e content shall be documented by a product-specific Type III EPD for each product.*

Table 1903.5.1 CO2e Limits in Mixture

Specified compressive strength f'_c, psi	Maximum kg/m³(SI)	High-early strength Maximum kg/m3 (SI)	Lightweight concrete Maximum kg/m3 (SI)
up to 2499	302	408	578
2500-3499	382	516	578
3500-4499	432	583	626
4500-5499	481	649	675
5500-6499	505	682	N/A
6500 and greater	518	680	N/A

Compliance by Mix or by Project

Both paths require EPDs to be collected for all applicable mixes on project



Compliance Option 1: Mixture Limit

Each concrete mix is below the maximum kgCO2e/m3 of ready mix concrete *(by compressive strength class)*

Compliance Option 2: Total Project Limit

Project total CO2e for all concrete placed at the building project must not exceed the total project limit CO2e.

Allows for low carbon mixes to balance high carbon mixes

Case Study Marin County, CA Low Carbon Concrete Code

(2019) Amendment to the International Building Code

- Establishes **limits on carbon from concrete** for residential and commercial construction
- Projects can meet either **cement or embodied carbon limits** (by strength class)
- Can meet limits at the scale of the **concrete mix or the entire project**

Table 19.07.050 Cement and Embodied Carbon Limit Pathways

	Cement limits for use with any compliance method 19.07.050.2 through 19.07.050.5	**Embodied Carbon limits** for use with any compliance method 19.07.050.2 through 19.07.050.5
Minimum specified compressive strength f'_c, psi (1)	Maximum ordinary Portland cement content, lbs/yd³ (2)	Maximum embodied carbon kg CO_2e/m^3, per EPD
up to 2500	362	260
3000	410	289
4000	456	313
5000	503	338
6000	531	356
7000	594	394
7001 and higher	657	433
up to 3000 light weight	512	578
4000 light weight	571	626
5000 light weight	629	675

Notes
(1) For concrete strengths between the stated values, use linear interpolation to determine cement and/or embodied carbon limits.
(2) Portland cement of any type per ASTM C150.

The GWP limits published in Marin's code were developed with an advisory committee who evaluated cement and embodied carbon (GWP) impacts of different design mixes in Northern California using data from NRMCA, Climate Earth, and the Structural Engineer's Association of Northern California (SEAONC)

Case Study **Denver Green Code**

Concrete *(excludes precast and concrete masonry units; projects with < 50 yd^3 concrete)*

- **Disclosure:** Product-specific Type III EPDs required to verify compliance
- **Targets:** Sets CO2e Limits by compressive strength

Steel *(structural sections, hollow structural sections, plate, concrete reinforcing steel bars)*

- **Also sets disclosure and targets**

OR

- **Facility Renewable Energy:**
  - Must be part **Green Power Partner** in the US EPA program or equivalent registry
  - 50% or more **renewable energy sourcing** for production, as documented by:
    - *On-site renewable energy system*
    - *Off-site renewable energy system owned by the production facility owner*
    - *Community renewable energy facility*
    - *Physical Renewable Energy PPA*
    - *Financial Renewable Energy PPA*

Additional Code Considerations

- Adjusting to allow for use of new materials
  - Carbon-storing materials
  - Alternative cements, etc.

Case Study: NYC Building Code

Proposed adoption of the 2021 International Building Code and International Fire Code

- Allows for mass timber buildings up to 18 stories

Case Study: Oregon Code

- Material efficiency and wood reuse
- Allows for wood to be reused but it is only considered to be rated #2 unless each member is tested.

Image Source: Pexels

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Buildings: Code Pathways

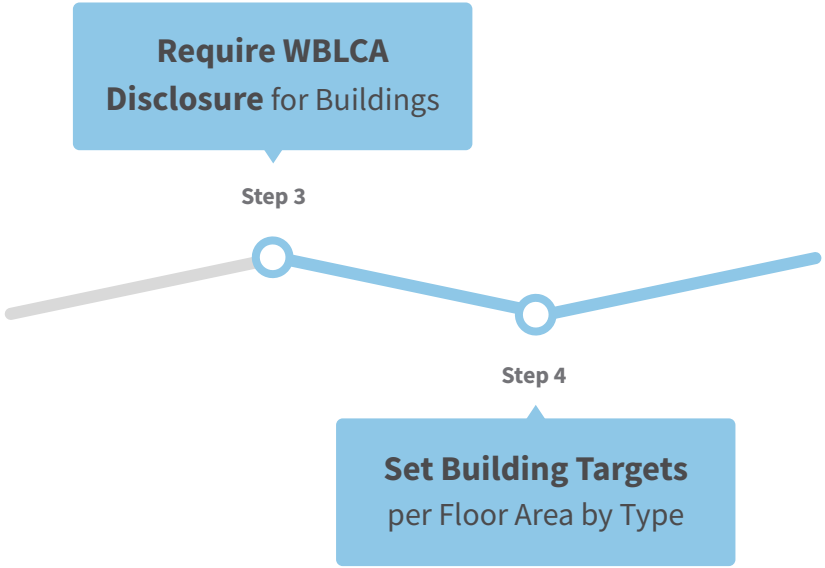
Embodied Carbon in the Code: Buildings

Benefits (Buildings Approach)

- Transparency
- Broadest range of strategies available

Captures carbon reduction strategies like:

- Building/material reuse
- Use of carbon-storing materials
- Efficient structural design



Next Step: Whole Building LCA Disclosure

- Precedents for **WBLCA disclosure** in green building certifications, zoning regulations, and other policy contexts (not yet in building code)
  - Requires alignment and guidance on WBLCA scope and methodology
    - Building scope (structure, envelope, finishes, etc.)
    - Life cycle stages to be included (A-C vs. A-D, etc.)
    - Materials to be included
    - Which tools are allowed for compliance
  - WBLCA are not typically third party verified *(as is typical with Type III EPDs)*
- Prescriptive strategies to reduce embodied carbon are **less defined and studied** than operational energy reductions: performance-based pathways currently more viable

Regulating Building GHG Emissions in the Code

- Already precedent of setting project **energy budgets** for buildings (for operational energy)
- Code could set **carbon budgets** for buildings to reduce embodied carbon, operational carbon, or total carbon
  - Absolute GWP value (Total)
  - CO2e per floor area
  - % better than baseline

Table: Energy budgets

Building category	**Total net energy requirement [kWh/m² heated gross internal area per year]**
Small houses and leisure homes with more than 150 m² of heated gross internal area	100 + 1,600/m² heated gross internal area
Block of flats	95
Kindergarten	135
Office building	115
School building	110
University/university college	125
Hospital	225 (265)
Nursing home	195 (230)
Hotel building	170
Sports building	145
Commercial building	180
Cultural building	130
Light industry/workshop	140 (160)

Source: Trondheim, Norway Building and Construction Regulations

Takeaways

Every new building or retrofit presents an opportunity to drive significant upfront embodied carbon reductions

- Decrease carbon impact, support local economic development, and **meet the international climate goals**
- Incorporating **EPD reporting and material embodied carbon limits** in building code illustrates materials important role in reducing global GHG emissions
- Addressing embodied carbon in code will **occur over time** and seek improved efficiency as the industry evolves
- Advancement depends on **trusted data, collaboration with industry, and education**
- Next step will be to move beyond individual materials and consider the **whole building life cycle analysis**

Pexels, 2019

Thank you!

Case Study **Denver Green Code**

Concrete *(excludes precast and concrete masonry units; projects with < 50 yd^3 concrete)*

- **Disclosure:** Product-specific Type III EPDs required to verify compliance
  - ***Exception:*** *"Projects where no concrete suppliers with product-specific EPDs for concrete are located within 100 miles of the project site, shall use Type III industry-wide EPDs in accordance with Section 901.4.1.4 for compliance with this section and provide an inventory of CO2e values for all concrete mixes to the AHJ."*
- **Targets:** Sets CO2e Limits by compressive strength
  - Allows for both compliance paths (by mixture or by project total)

Steel *(structural sections, hollow structural sections, plate, concrete reinforcing steel bars)*

- **Disclosure:** Product-specific Type III EPDs required for 75% of steel by cost or weight
- **Targets:** Sets CO2e limits by product type *(structural section, HSS, plate, rebar)*
- **Facility Renewable Energy:**
  - Must be part **Green Power Partner** in the US EPA program or equivalent registry
  - 50% or more **renewable energy sourcing** for production, as documented by:
    - *On-site renewable energy system*
    - *Off-site renewable energy system owned by the production facility owner*
    - *Community renewable energy facility*
    - *Physical Renewable Energy PPA*
    - *Financial Renewable Energy PPA*

Example Policies

Certified Wood Requirement

- Requires the use of certified wood products when appropriate
- Applied in building code, municipal procurement, or also non-municipal projects
- Certification system determined by the jurisdiction
  - Standards specifying wood with a lower embodied carbon footprint.
- 2021 IBC

Pexels, 2019

Resources

https://gettingtozeroforum.org/wp-content/uploads/sites/2/2022/01/NBI_Lifecycle-GHG-Impacts-in-Codes_Jan2022.pdf

https://www.aceee.org/white-paper/2021/12/knowledge-infrastructure-critical-path-advance-embodied-carbon-building-codes

Example Policies

Concrete Requirements

- Data availability
- Material-specific requirements
- Market-ready option to achieve meaningful embodied carbon savings
  In acknowledgement of the importance of concrete or steel, the industry aims to achieve practical climate impact reductions