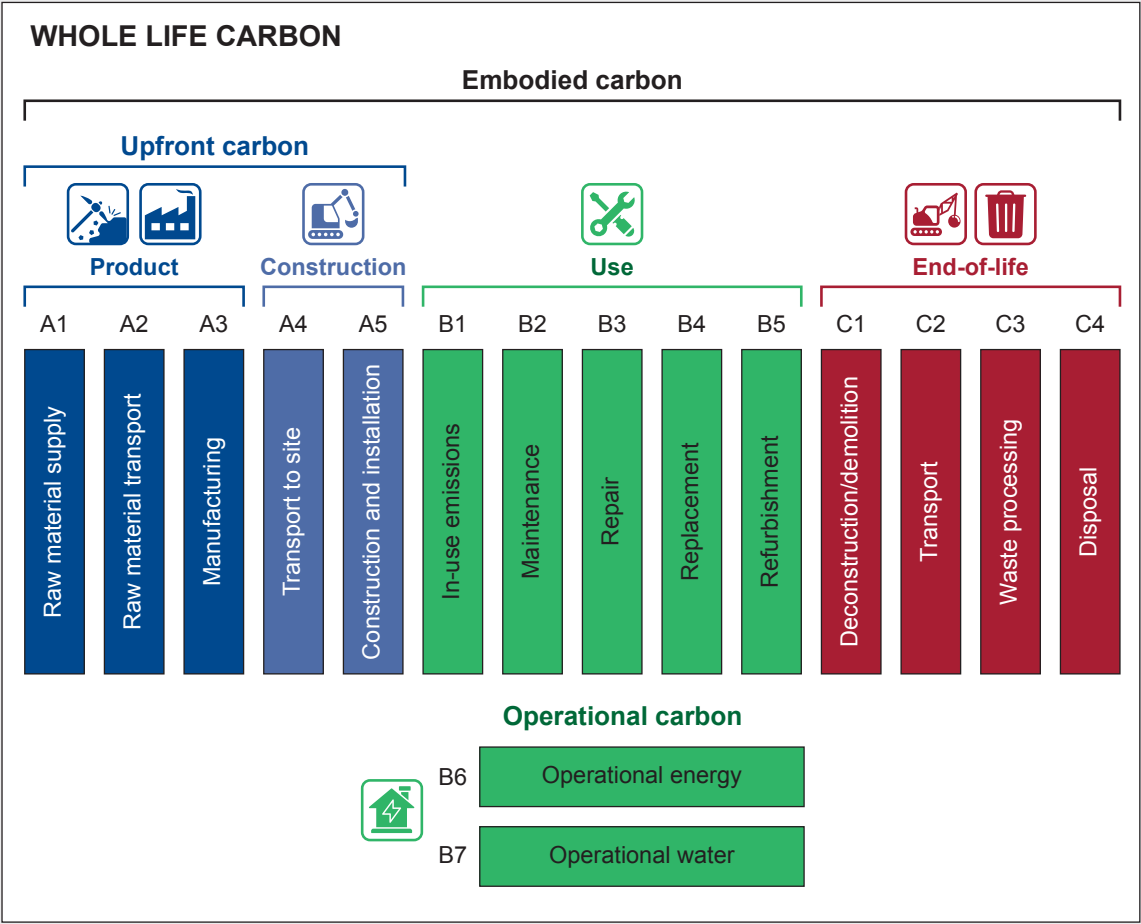


# International Survey of Mandatory Whole Life/Embodied Carbon Requirements in Building Codes and Regulations

June 2025



## Acronyms

<b>BECWG</b>	Building Energy Codes Working Group (IEA EBC Working Group)
<b>CLF</b>	Carbon Leadership Forum
<b>CO<sub>2e</sub></b>	Carbon Dioxide Equivalent
<b>EBC</b>	Energy in Buildings and Communities (IEA Technology Collaboration Program)
<b>EPBD</b>	Energy Performance of Buildings Directive (Europe)
<b>EPD</b>	Environmental Product Declaration
<b>EU</b>	European Union
<b>GHG</b>	Greenhouse Gases
<b>GWP</b>	Global Warming Potential
<b>IEA</b>	International Energy Agency
<b>ISO</b>	International Organization for Standardization
<b>LCA</b>	Life Cycle Assessment
<b>LCI</b>	Life Cycle Inventory
<b>LCIA</b>	Life Cycle Impact Assessment
<b>m<sup>2</sup></b>	square meters
<b>MEP</b>	Mechanical Electrical Plumbing
<b>PCR</b>	Product Category Rules
<b>WLCA</b>	Whole Life Carbon Assessment

Prepared for the Building Energy Codes Working Group, a Working Group of the International Energy Agency's Technical Collaboration Program on Energy in Buildings and Communities, by Adam Hinge of Sustainable Energy Partnerships, Tarrytown, New York USA, for the Australian Department of Climate Change, Energy, the Environment and Water.

June 2025

Cover graphic adapted from *Carbon Leadership Forum Building LCA 101: Embodied Carbon Accounting for Buildings*

# Table of Contents

<b>Executive Summary</b>	<b>4</b>
<b>Introduction</b>	<b>6</b>
What Are Embodied Emissions?	6
Terminology—Embodied Carbon, Whole Life Carbon, and Life Cycle Assessment	7
Embodied Emissions Vary by Building Type	10
<b>Example leading policies</b>	<b>11</b>
Mandatory Carbon Limits	11
<i>Netherlands</i>	11
<i>France</i>	12
<i>Denmark</i>	13
<i>Sweden</i>	14
<i>Finland</i>	15
<i>European Union</i>	16
Other Mandatory Embodied Carbon Requirements	17
<i>London</i>	17
<i>Vancouver</i>	18
<i>California</i>	18
<b>Comparing the different policies</b>	<b>20</b>
Overview of the Policies	20
Scope of Coverage of Policies (Life Cycle Modules)	20
Building Element Coverage	20
<b>Discussion</b>	<b>24</b>
Lessons Learned in Leading Countries/Regions	24
<i>Selection of Initial Buildings Covered by Whole Life Policies</i>	24
<i>Early Industry Reactions and Progress</i>	25
Data Quality and Comparability Challenges	25
Calculation Tools, Generic Data & Standard Values Critical	28
Key Design Features for Whole Life Carbon Regulations	28
Creating Regulations: Key Steps to Consider	29
Issues and Potential Policy Concerns	31
<b>Conclusions</b>	<b>33</b>
<b>References</b>	<b>34</b>
<b>Acknowledgements</b>	<b>36</b>

# Executive Summary

With building energy consumption and the resulting operating emissions from the ongoing energy consumption in buildings going steadily down in many advanced economies, there is increased focus on a building's embodied emissions from the construction sector to cut total GHG emissions from the buildings sector.

Embodied carbon, or whole-building embodied carbon impacts, refer to the greenhouse gas emissions (and impacts) associated with materials and construction processes throughout the life cycle of a building, except emissions from building energy and water use. This can include emissions from material extraction, manufacture, transportation, construction, replacement, refurbishment, demolition, removal, and other processes. The majority of these embodied emissions usually occur upfront during the initial construction of the building and the manufacturing of its materials.

The manufacture of construction products, and construction of buildings, are responsible for approximately 10% of total global energy and process emissions, with a significant portion of those emissions coming from a handful of key materials including concrete, steel, aluminum, bricks, glass, insulation and timber. The bulk of embodied emissions (generally 70–90%) happens upfront before the building is occupied. The IEA has calculated that buildings and construction are responsible for approximately 37% of total global energy and process emissions in 2022, with 27% currently coming from operational energy emissions, and 10% from buildings construction.

While significant policy activity has evolved since the 1970s on regulating building energy use and performance, most regulations have not addressed the large carbon impact associated with the construction of buildings. The traditional scope of building energy codes has focused on reducing the energy used in buildings and the resulting emissions, known as the “operational carbon”, or the emissions associated with energy used to operate a building. The focus of this report is on other emissions across the building's life cycle, generally referred to as “embodied carbon”.

A growing number of countries or subnational jurisdictions are adopting policies to regulate whole life or embodied carbon emissions. Over the past three years, there has been an explosion of interest in embodied carbon policy development, on nearly all continents, with the most significant policy activity to date happening in Europe.

Initial policies have been developed in the Netherlands, France and Denmark, and most recently adopted Europe-wide as part of a 2024 update to the European Energy Performance of Buildings Directive (EPBD). In the report, we present a short summary of the mandatory policies in place in these leading jurisdictions. We separate the policies by type: mandatory carbon limits and other mandatory embodied carbon requirements.

Most jurisdictions begin with some type of calculation and reporting requirement to build industry knowledge and capacity. Many countries begin with a voluntary scheme to build industry knowledge and capacity. Then, after a baseline and collection of life cycle assessment (LCA) benchmarks have been established, it is easier to set carbon limits and be able to enforce these limits.

Publicly available calculation tools are a critical need for comparability of LCA impacts, and valid data on commonly used construction materials and products is absolutely necessary to use these tools. In the jurisdictions with embodied carbon policies, all have had calculation tools that were available and being used by construction professionals well in advance of any mandatory policy taking effect.

More information and data are needed to understand the costs and benefits of deep cuts to embodied and whole life carbon. While ambitious policies that regularly reduce whole life limits to drive innovation are helpful in establishing targets for industry to drive toward, not enough is yet known about the costs of getting to very deep embodied carbon reduction.

While there has been a big rush of whole life and embodied policy development in the past two to three years, we are still in very early days with these policies, with many of them just coming into force and no time for real evaluation of policy effectiveness. There is not yet much actual experience with implementation issues and success of policies.

Leading jurisdictions are reporting better data collection and consistency in reporting, though not yet any drastic changes to construction practices.

The current activity in the European Union, with the EU wide mandate but individual member states transposing the EPBD directive language into national regulations, will be very interesting to watch in the coming one to three years. The individual EU Member State Roadmaps to be developed by 2027 will give more sense about how

much harmonization is realistic, even among the EU countries where there are many other consistent rules and reporting practices.

Some big picture takeaways from this research:

- There is lots of variation in current policy approaches
- There is a need to improve data availability, calculation methodologies, and the ability to directly compare results
- And more international coordination and collaboration is needed

Best practices include:

- Building capacity of regulators and the construction industry before implementing mandatory requirements
- Early engagement with building owners and other key stakeholders
- Starting small to gain experience; smaller scope and number of buildings to start, and reasonably achievable limit values

It is expected that a variety of new embodied and whole life carbon policy initiatives will be introduced in the coming years, learning from the experience of the leaders highlighted in this report. These types of regulations take years to implement and develop capacity among all stakeholders. The experience in France, where the voluntary whole life carbon label was introduced in 2016, and then the initial mandatory limits took effect in 2022 is a good example of the time required.

Starting with some simplified approach, initially with just a subset of buildings where data are available, or a voluntary scheme to build capacity, may be more practical than rushing to set mandatory limits. There will likely be more new approaches found as well, as more policy experts move into this rapidly evolving space.

# Introduction

Historically, building energy and environmental codes have focused on reducing energy use and waste, though with growing interest in the greenhouse gas (GHG) emissions reduction impacts of reduced energy use. A variety of policies such as building energy codes are driving down the energy usage of both new and existing buildings, with existing building performance being improved by a range of different existing building performance standards, or minimum energy performance standards for buildings. With building energy consumption and the resulting “operating emissions” from the ongoing energy consumption in the building going steadily down in many advanced economies, there is increased focus on a building’s embodied emissions (or embodied carbon) from the construction sector to cut total GHG emissions from the buildings sector. The majority of these embodied emissions usually occur upfront during the initial construction of the building and the manufacturing of its materials.

Because many countries or sub-national governments have set policies for zero operational energy or carbon in the coming decade or two, the shift toward the increased priority on embodied carbon relative to operating carbon is demonstrated in Figure 1. As building operational emissions decrease over time, embodied emissions make up a greater proportion of emissions over the whole life of the building.

A growing number of countries or subnational jurisdictions are adopting policies to regulate whole life or embodied carbon emissions<sup>1</sup>. Over the past three years, there has been an explosion of interest in embodied carbon policy development, on nearly all continents, with the most significant policy activity to date happening in Europe.

This report focuses on examples of mandatory requirements covering whole life and embodied carbon in building codes, where countries or sub-national governments have developed and are implementing policies that regulate and limit the total life-cycle carbon emissions of buildings, going beyond operational energy carbon emissions and including the carbon in the building materials, the construction process and end of building life. The report summarizes how different jurisdictions are addressing mandatory requirements for whole of life and embodied

carbon in building codes in economies that are part of the International Energy Agency’s Building Energy Codes Working Group (IEA BECWG), a Working Group of the IEA Energy in Buildings and Communities (EBC) Technology Collaboration Program.

In addition to this report from the BECWG, a related IEA EBC technical collaboration effort, Annex 89: Ways to Implement Net-zero Whole Life Carbon Buildings, is underway 2023 through 2027. Annex 89 includes a Subtask on enabling tools and instruments to increase net zero whole life building implementation at national and regional levels.<sup>2</sup>

## What Are Embodied Emissions?

The traditional scope of building energy codes has focused on reducing the energy used in buildings and the resulting emissions, known as the “operational carbon”, or the emissions associated with energy used to operate a building. The focus of this report is on other emissions across the building’s life cycle, generally referred to as “embodied carbon”.

While significant policy activity has evolved since the 1970s on regulating building energy use and performance, most regulations have not addressed the large carbon impact associated with the construction of buildings. The manufacture of construction products, and construction of buildings, are responsible for approximately 10% of total global energy and process emissions, with a significant portion of those emissions coming from a handful of key materials including concrete, steel, aluminum, bricks, glass, insulation and timber. The bulk of embodied emissions (generally 70–90%) happens upfront before the building is occupied (Zizzo & Doran 2022).

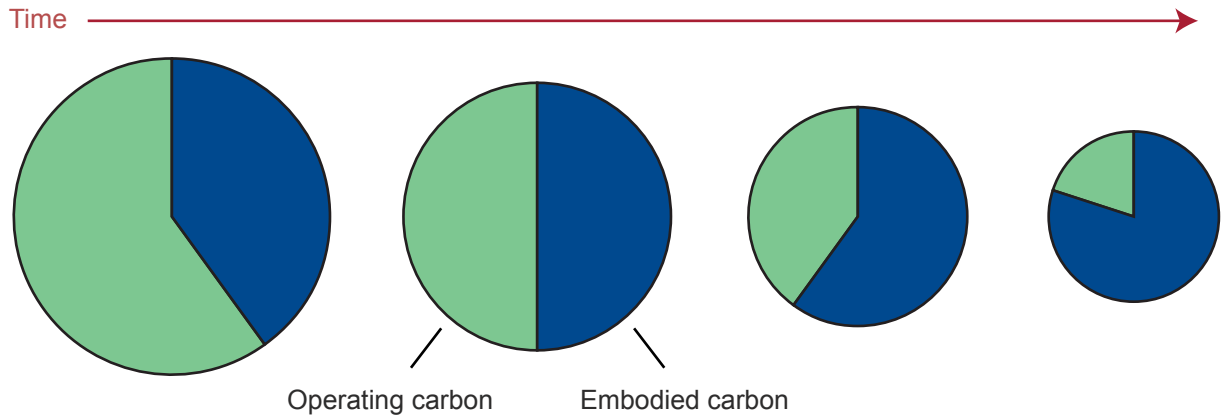
The IEA has calculated that buildings and construction are responsible for approximately 37% of total global energy and process emissions in 2022, with 17% currently coming from residential operational emissions<sup>3</sup>, 10% from non-residential buildings operational emissions, and 10% from buildings construction as shown in Figure 2.

Interestingly, building construction and materials carbon emissions represent a higher portion of the global total

<sup>1</sup> “Whole Life” carbon can refer to either “whole life cycle,” or “whole building life cycle,” and while we use the term whole life as a broader term, we attempt throughout the report to be careful about the usage. We use the shorthand of “carbon emissions” to generally refer to all greenhouse gases (GHG), usually represented as CO<sub>2</sub>e, or Carbon Dioxide Equivalent.

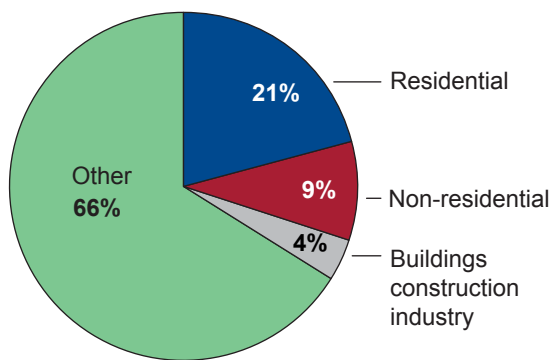
<sup>2</sup> More information on Annex 89 at: <https://annex89.iea-ebc.org>.

<sup>3</sup> “Direct” emissions are what a building creates directly, such as on-site combustion of fossil fuels, while “Indirect” emissions are those that occur at sources owned or controlled by a different entity, such as the electricity or district energy supplier.

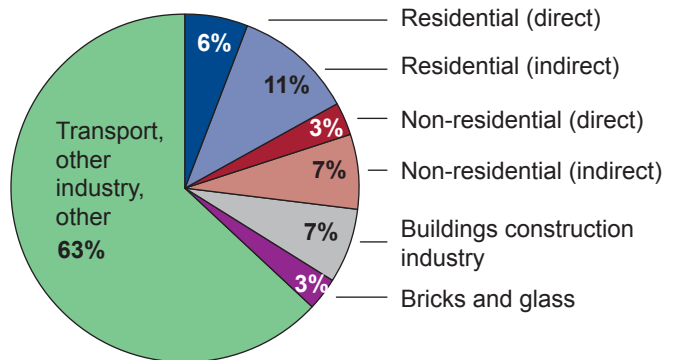


**Figure 1.** Embodied emissions make up a larger portion of total emissions as building operating carbon goes down. (Source: NZ MBIE 2020)

**Energy demand by sector 2022**



**Emissions by sector 2022**



**Figure 2.** Share of buildings in total final energy consumption and share of buildings in global energy and process emissions. (Adapted from UNEP 2024).

than energy demand by sector, as shown above. With operational energy use and resulting emissions in advanced economies beginning to decrease, and the tremendous amount of construction activity projected to take place in the coming 20–30 years, it is clear that more focus is needed to address the growing portion of construction-related embodied emissions.

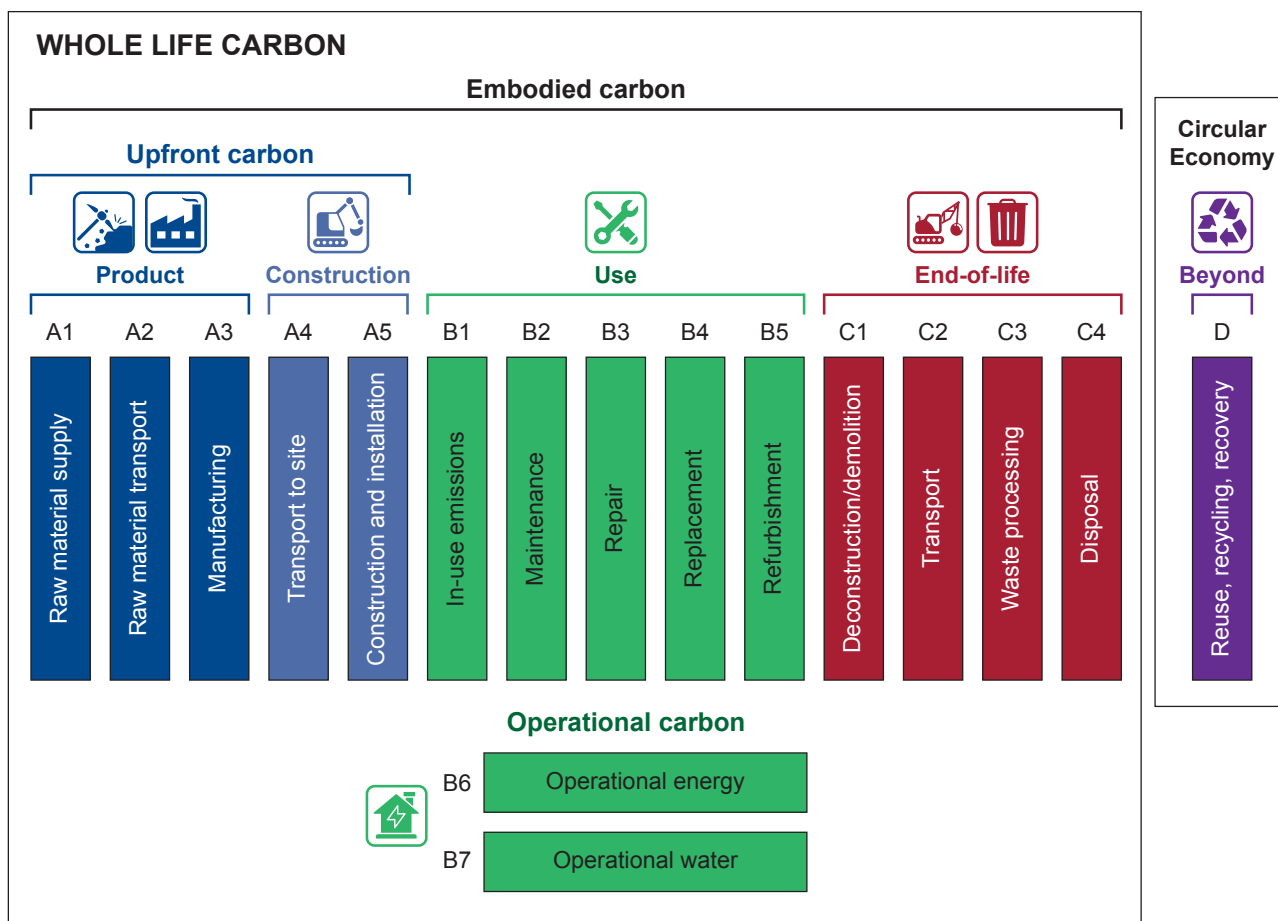
### Terminology—Embodied Carbon, Whole Life Carbon, and Life Cycle Assessment

There are different types of policies emerging to address embodied and whole life carbon. In many cases, an initial policy is launched requiring calculation and disclosure or reporting (“declarations”) of whole building embodied carbon emissions. These follow development of consistent methodologies for calculating and reporting Life

Cycle Assessment (LCA), an agreed upon methodology for measuring embodied carbon. LCA is a systematic approach to evaluate the environmental impacts of a building, product, or process over its full life cycle, from raw material extraction through end-of-life and disposal.

LCA can provide an estimate of GHG emissions over the building’s entire life cycle, generally reported as global warming potential (GWP), as well as other environmental and human health impacts, including acidification, eutrophication, and smog formation.

Building life cycle stages (product, construction, use, end-of-life) and modules, categorized through international standards such as European Standard EN 15978:2011 and ISO 21931-1:2022, subcategorize the life cycle of a building and help communicate when environmental



**Figure 3.** Life cycle stages and modules that subcategorize the full life cycle of a building. (Adapted from Carbon Leadership Forum 2024)

impacts occur as shown in Figure 3. Some of these international standards are currently in the midst of being updated, which is creating some confusion in the industry.<sup>4</sup>

In Europe, there is more focus on “whole life” carbon (also called “cradle to grave”) regulation, though currently not consistently among the different evolving regulations. Some European Member State whole life carbon regulations do not address operational carbon—B6, or sometimes B7, or address only upfront emissions, though there will likely be moves to harmonize EU level regulations in the coming years due to 2024 changes to the EU Energy Performance of Buildings Directive (more information in Example Leading Policies section below).

In the U.S. and Australia, there has been more focus on “embodied carbon” as the term of art, as the operational

carbon is already being addressed through energy codes and other policies.

Current and emerging mandatory policies can address different building types and sizes, building elements, different life cycle stages, different whole-life carbon metrics, and varied LCA calculation methodologies, data requirements, and benchmark methods.

For the purposes of this report, we define the following key terms that are used throughout this report:

**Embodied Carbon, Embodied Carbon Impacts, Whole-building Embodied Carbon, and Whole-building Embodied Carbon Impacts** refer to the greenhouse gas emissions (and impacts) associated with materials and construction processes throughout the life cycle of a

<sup>4</sup> There are additional modules that were adopted as part of the updates to European Standard EN 15643:2021 (Sustainability of construction works) and are planned to be added to other European and ISO Standards in the coming years. For example, in the current proposed revision to European Standard EN 15978, expected to be published as final later in 2025 there will be new modules A0 (Preconstruction) and B8 (Building related users’ activities not included in B1-B7) added, as well as breaking module D into D1 (Potential net benefits from reuse, recycling; Energy recovery and/or other recovery) and D2 (Potential benefits and loads from exported utilities). These additional modules have already been adopted as part of European Standard 15643:2021.

building, except emissions from building energy and water use. This can include emissions from material extraction, manufacture, transportation, construction, replacement, refurbishment, demolition, removal, and other processes. Embodied carbon and these related terms are the total calculated global warming potential (GWP) impact. Embodied carbon is usually measured in kilograms of carbon dioxide equivalent (kgCO<sub>2</sub>e), and often normalized to the building floor area.

An **Embodied Carbon Limit** is the embodied carbon impact that shall not be exceeded by the proposed design to comply with an embodied carbon requirement, such as 12 kgCO<sub>2</sub>e/m<sup>2</sup> per year, or 640 kgCO<sub>2</sub>e/m<sup>2</sup> over the reference study period. It is the highest embodied carbon impact, and the minimum performance level, allowed.

**Embodied Carbon Requirement** refers to a requirement to consider embodied carbon during building design or construction and may include a requirement to achieve relative embodied carbon performance (i.e., a percent improvement) over an established benchmark.

**Circular Economy** is an economy that is restorative and regenerative by design, and that aims to keep products, components, and materials at their highest utility and value at all times (and is represented by the “D” life cycle modules).

**Environmental Product Declaration (EPD)** is a third-party verified document written in conformance with international standards that reports the environmental impacts of a product, including its global warming potential (GWP), based on life cycle assessment (LCA) models. EPDs currently generally cover the product stages A1-A3 (cradle to gate, though sometimes other modules), and are widely accepted as the international best practice for LCA reporting at the product level.

**Global Warming Potential (GWP)** is an environmental indicator used to describe the climate-related environmental impacts of a product or building. It is a result and output of life cycle assessment (LCA) and expressed in terms of tonnes or kilograms of carbon dioxide equivalent (tCO<sub>2</sub>e or kgCO<sub>2</sub>e). In this context it is often has the same meaning as embodied carbon. **Note:** Global Warming Potential is also the term used for factors that allow comparisons of the global warming impacts of different gases. They are among many factors used in life cycle impact assessment and used in creating emissions inventories of organizations and nations. In this context, the larger the GWP, the more that a given gas warms the Earth compared to CO<sub>2</sub> over a given time period.

**Life Cycle Assessment (LCA)** is the process of evaluating a system, component, product, assembly, or building, from the moment of extraction of raw materials to transportation, processing, manufacturing, use, recyclability, and disposal. Through this methodology, the cumulative and ultimate environmental benefits and impacts are assessed.

**Life Cycle Inventory (LCI)** is a list of input and output flows for a particular process. The flows are resource use, such as materials, energy, and water, as well as emissions to air, land, and water. It is the data collection step of life cycle assessment.

**Life Cycle Impact Assessment (LCIA)** is a set of characterization factors that are applied to an LCI to arrive at environmental indicator results. These results may estimate “end-point” impacts, such as damage to human health, or “mid-point” impacts, such as global warming potential. It is the “what does it mean” step of life cycle assessment, where the inventory is analyzed for environmental impact.

**Limit Values** are the maximum amount of emissions allowed across a building’s lifecycle (such as 12 kgCO<sub>2</sub>e/m<sup>2</sup> per year), more specifically defined by the regulation or policy that establishes the limit value.

**Product Category Rules (PCRs)** are a set of guidelines, requirements, and rules for developing environmental product declarations for specific product categories.

**Reference Study Period** is the period under consideration for the building, in years, that will be assumed for the life cycle assessment. Most policies use reference study period of 50 or 60 years, sometimes with variation by building type.

**System Boundary** is the physical, geographical, and temporal scope of the assessment, including life cycle stages, building elements, processes, flows, and activities included or excluded from the life cycle assessment.

**Upfront (embodied) carbon** is the emissions associated with materials and construction processes up to practical completion (modules A1 to A5).

**Whole-building Life Cycle Assessment** is the process of conducting an LCA for a building as opposed to the building products and elements.

**Whole Life Carbon Assessment (WLCA)** expands the assessment to the entire life cycle. This is often referred to as a **cradle-to-grave assessment** if product, use, and end-of-life stages are included. If benefits and load beyond the building life (Module D) are added, the assessment is referred to as **cradle-to-cradle assessment**.

## Embodied Emissions Vary by Building Type

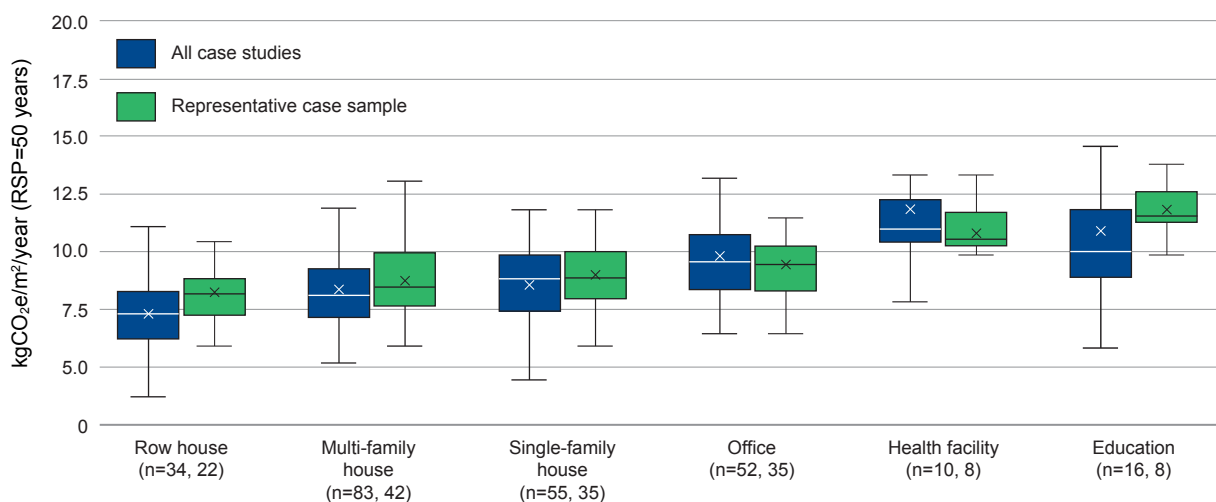
Different types of buildings may utilize quite different materials and practices in their construction, so there can be quite significant variation in the embodied carbon by building type. There are different types of materials most commonly used in different building use types that can lead to very different upfront and embodied carbon emissions from these building types.

An example of this variation is shown in Figure 4, comparing the relative life cycle emissions of a representative sample of buildings in Denmark, cleaned from a larger number of available case studies. The LCA impact of the buildings, including modules A1–3, B4, B6, and C3–4,

vary from 8.3 to 11.8 kg CO<sub>2</sub>e/m<sup>2</sup>/year, with row houses having the lowest mean GHGe, and education buildings the highest (Tozan, Hoxha et.al. 2024).

A study of over 500 buildings in Ontario, Canada found similar results of a fairly wide variation between building types, with small residential buildings having less than half the embodied emissions of large residential buildings, and commercial office/retail buildings having embodied emissions closer to those of the large residential buildings (Zizzo and Doran 2022).

Because of these variations by building type, most whole-life carbon policies give differentiated requirements on the limits depending on the building type.



**Figure 4.** Comparing the life cycle GHGe by building type of Danish case studies and the representative sample of the case studies (Adapted from Tozan, Hoxha et.al. 2024)

# Example leading policies

As noted earlier, there has been a dramatic increase in whole life/embodied carbon policy development in the past two to three years. Much of the leading activity has been happening in Europe, with initial policies developed in the Netherlands, then France and Denmark, and most recently adopted Europe-wide as part of a 2024 update to the European Energy Performance of Buildings Directive (EPBD).

In this section, we present a short summary of the mandatory policies in place in these leading jurisdictions. We separate the policies by type: mandatory carbon limits and other mandatory embodied carbon requirements.

In addition to the leading policies highlighted here, a variety of governments around the world have mandated clean material purchasing requirements that set environmental limits or targets for some of the construction materials with the most significant embodied carbon impacts.

Content in this section is not intended to be an exhaustive list of jurisdictions that have mandatory policies currently in place, but a summary of the leading jurisdictions, based on information gathered through March 2025. Regulation of embodied carbon is evolving very rapidly, with several quite recent reports summarizing policies acknowledging that information reported just several months earlier is already out of date.

Beyond the jurisdictions summarized in this report, a range of other IEA BECWG countries, including Australia and Canada, have made commitments to adopt new embodied or whole-life carbon policies in their building codes in the coming years. India is also considering addressing embodied carbon in their National Building Code.

## Mandatory Carbon Limits

The strictest type of embodied carbon regulation establishes mandatory limits, though these specific country limits are often based on the inclusion of emissions from different building life cycle modules.

### Netherlands

The Netherlands was the first country to introduce limits including embodied carbon as a part of the environmental impact of new buildings through its building regulations. New legislation came into force in January 2018 for calculating the Environmental Performance of Buildings (“*Milieu Prestatie Berekening*”, or “MPG” in Dutch) that set limit

values for buildings based on a calculated environmental cost or damage estimate for the building, expressed as a shadow cost for the building.

The MPG legislation sets a standardized maximum limit value for the building as a product, addressing embodied carbon emissions in the limit while operational emissions are regulated through other policy measures.

### Summary of Coverage

Construction in the Netherlands is regulated by the Dutch Building Decree that is mandatory for all office buildings over 100 m<sup>2</sup> and residential buildings.

The MPG legislation is tightly linked with separate legislation that established an Environmental Cost Indicator (MKI as the Dutch acronym) that translates the outcome of an LCA into a monetary unit, the Euro (€). The MKI is calculated by assigning a monetary value to 11 different environmental impact categories of the LCA (including GWP, Ozone Depletion Potential, Acidification, etc.), and the cost factors for each impact category are determined from the estimated damage costs by a certain type of emission. The cost indicator is referred to as the shadow cost for the building (e.g., 1 kgCO<sub>2</sub>e has a shadow price of 0.05 €). The main MKI result is expressed as €/m<sup>2</sup>/year.

The MPG is mandatory for all office buildings over 100 m<sup>2</sup> and residential buildings. The initial limit for all buildings since January 2018 was 1.0 €/m<sup>2</sup>/year and was tightened in July 2021 for residential buildings to 0.8 €/m<sup>2</sup>/year, while the value remained at 1.0 €/m<sup>2</sup>/year for office buildings.

The assessment includes the whole life cycle of the building, excluding operational energy (B6) and water (B7) usage. These operational emissions are regulated separately through a different policy, the Nearly Zero Energy Building (or “BENG” as the Dutch acronym) covering all residential and non-residential new construction, essentially the Dutch implementation of the European Energy Performance of Buildings Directive.

There are national environmental and cost databases that support the MPG calculation process, known as The Environmental Performance Assessment Method for Construction Works. The Assessment Method is performance-oriented, not solution-oriented and therefore sets no requirements on construction method or technology. The Method contains requirements including product

category rules (PCRs) for all construction products and installations; the verification protocol for assessing environmental data for including in the National Environmental Database (“NMD” in Dutch), and rules for calculating the environmental performance of construction works. Specific links to all of these requirements, as well as regular updates, are included at The Assessment Method link below.

As there were concerns identified about availability of EPDs for certain product categories, an effort was launched in 2022 to increase the number of environmental statements. Under the “Filling the Gaps Compensation Scheme,” producers of construction products and materials can apply for compensation from the NMD administrator for commissioning an LCA for their products.

Some practitioners have expressed concerns that the “cost-cap” approach to the limits could be said to conceal carbon emissions, though it translates the emissions into a language that designers, clients, and the public at large can more easily understand (RICS 2021).

#### *Specific Scope Requirements*

**Building types covered and size threshold:**

All residential buildings, and office buildings over 100m<sup>2</sup>

**Modules included:** A1–5, B1–4 (B6 regulated through other policy measures), C1–4, and D

**Reference study period:** 50 years for offices; 75 years for homes

**Data source/databases utilized:** The Dutch National Environmental Database (NMD in Dutch)

**Building components included:** substructure, superstructure, enclosure, interiors, services (mechanical, electrical, and plumbing)

**LCA method particulars:** The detailed LCA process includes 11 different environmental impact categories

#### *Sources and Additional Information*

- [Milieu Prestatie Berekening \(MPG\)](#), the national Environmental Performance of Buildings Regulation
- [Environmental Cost Indicator \(MKI\) Overview](#)

- [The Environmental Performance Assessment Method for Construction Works](#)
- [Whole Life Carbon Position Paper](#) (from Dutch Green Building Council, September 2021)

#### **France**

France began the process toward regulation of whole life carbon with a voluntary sustainability label “E + C-” (Energy + Carbon -), introduced by the Ministry of Housing in November 2016. The label was explicitly introduced to prepare for the introduction of a mandatory declaration of whole-life carbon impact. The voluntary label provided an opportunity to test an LCA methodology and build capacity among the building industry and regulatory authorities.

Following an extensive stakeholder consultation process, the LCA methodology and metrics were revised and turned into a mandatory environmental declaration with threshold values, RE2020 (“*Réglementation environnementale 2020*”) that was adopted in 2021, that sets limits designed to be reduced every three years through 2031.

#### *Summary of Coverage*

RE2020 is a national law that initially applied to new housing projects when introduced in 2022 but has since been extended to office buildings and educational buildings. The law covers life cycle scopes A-D and requires that owners must file declarations that the buildings comply with the limits defined by the government as part of a building permit application, and then generate a form containing the actual constructed value on completion of the building.

The embodied carbon limits are based on a dynamic LCA, which weights future emissions less than current emissions, as part of a plan to reduce carbon emissions from the building sector in half by 2030 (compared with a 2015 base) on the path to a fully net-zero building sector by 2050. The threshold limits for residential buildings over the 50 year building life cycle are shown below.

Base thresholds under France’s RE2020 regulations (not including operational emissions that are reported separately) are shown in Table 1.

The RE2020 regulations rely heavily on the French INIES national reference database for environmental and health data on construction products and equipment, that is composed of two primary programs that provide verified Environmental and Health Declaration Sheets for construction products (*Fiches de Déclaration Environnementale*

et Sanitaire – FDES) and Environmental Profiles (*Profils Environnementaux Produits* – PEP ecopassport) for electrical, electronic and climate engineering equipment.

#### Specific Scope Requirements

**Building types covered and size threshold:** New residential, office, and educational buildings

**Modules included:** A1–5, B1–7, C1–4, D

**Reference study period:** 50 years

**Building components included:** foundations, infrastructure, superstructure, masonry, roof covering, waterproofing, framework, zincwork, interior and exterior joinery, floor/wall/ceiling covering, paint, heating, ventilation, air conditioning, domestic hot water, plumbing, elevator, solar panel

**LCA method particulars:** Uses dynamic LCA calculation accounting for biogenic carbon storage; includes penalizing factors if using default values instead of specific EPDs

#### Supporting Policies

The French government has supported an investment of 100 million € for 2022–2026 to support bio-sourced materials, through industrial investments. The government has also set up funding for production of environmental declarations, their verification and the definition of product category rules.

#### Sources and Additional Information

- [Decree No. 2021-1004](#) of July 29, 2021 relating to the energy and environmental performance requirements of building construction in metropolitan France
- [How Green Building Regulations Are Shaking Up the French Construction Industry](#)
- [French INIES national reference database](#)

## Denmark

Denmark was the first Nordic country to introduce limit values, with relatively generous limit values taking effect in 2023, but an ambitious plan for revising and tightening the limits on a regular basis (in 2025, 2027, and 2029). The development of the legislation began in 2014 with different limits for voluntary sustainability classes, as the Danish Green Building Council had already created a national version of the DNGB certification system (created by the German Sustainable Building Council) that started the regular practice of LCA calculations in Denmark.

The Danish Building Regulation, BR18 (*Bygningsreglementet* 18), sets national life-cycle carbon limits on new buildings. When applying for a building permit and when completing a building, an initial LCA (applying for permit) and final LCA (at completion) assessing the building's overall climate impact must be documented and complied. The Danish *Bæredygtighedsklassen* ("The Sustainability Class") is a related voluntary assessment that includes indicators other than GWP.

#### Summary of Coverage

The Danish requirements provide that construction companies must create a LCA showing the environmental impact of a new building over a 50-year period. New buildings above 1,000 m<sup>2</sup> must comply with a carbon emissions limit of 12 kgCO<sub>2</sub>e/m<sup>2</sup>/year starting in 2023, though with new information coming in from early experience that limit is already being tightened down to 7.1 kgCO<sub>2</sub>e/m<sup>2</sup>/year on average, differentiated by building type, as of July 2025.

From January 2023, all new buildings larger than 1,000 m<sup>2</sup> are subject to the limits, and buildings 1,000 m<sup>2</sup> or less must still calculate the LCA but are not subject to limits. The building size threshold starting in July 2025 will shrink from 1,000m<sup>2</sup> to greater than 50m<sup>2</sup>, and summer holiday cottages and some building extension/expansion projects will be subject to the reduced limits.

The required LCA reports on all phases of the building's construction, from the emissions embodied in raw materials to transport, through to the construction and operation (modules A1–A3, B4, B6, and C3&4; module

**Table 1.** French embodied carbon limits (Scopes A–D) over the 50-year reference period

kgCO <sub>2</sub> e/m <sup>2</sup>	2022–2024	2025–2027	2028–2030	2031 and beyond
<b>Individual and terraced housing</b>	640	530	475	415
<b>Apartments</b>	740	650	580	490

D1 is reported as a separate value, with modules A4 & 5 previously included in a voluntary sustainability class, though added as mandatory with a separate uniform limit value starting July 2025). Denmark is closely watching the broader European developments and may extend the limits to include additional modules by mid-2027.

### Specific Scope Requirements

**Building types covered and size threshold:** All new buildings over 1,000m<sup>2</sup> (over 50m<sup>2</sup>, including extensions, from mid-2025)

**Modules included:** A1–3, (A4–5 from mid-2025), B4, B6, C3–4 (and D1 reported separately)

**Reference study period:** 50 years

**Data source/databases utilized:** For materials/product impact factors national EPD database (link below), and generic data based on Danish industry EPDs and in some cases German Okobaudat data

**Building components included:** substructure, superstructure, enclosure, interiors, and sitework

**LCA method particulars:** Buildings where special functional requirements impact material use can be allowed to exceed limit values per specified procedure. The method applies future decarbonization scenarios for the operational energy use (B6), and life cycle impacts of reused products are taken as zero.

### Sources and Additional Information

- [Building Act \(BR18\)](#), with climate act scope and GWP calculations in sections 297 & 298
- [Whole Life Carbon Requirements in Building Regulations – Experiences from Denmark](#) (presentation from Building Energy Codes Working Group Symposium, November 2024): to be posted
- [National EPD database](#)

### Sweden

Sweden was the first Nordic country to mandate carbon declarations, starting in 2022. It initially planned mandatory carbon limits to come into effect in 2027, which was advanced forward to 2025. However, following the update to the EU EPBD in 2024 (more information below), Sweden

will now follow the EPBD timeline, meaning an extended climate declaration for new buildings that will come into force no later than January 2028 and the limit values for the climate impact of buildings will come into force no later than January 2030.

In December 2024, the Swedish National Board of Housing, Building and Planning (*Boverket*) was commissioned by the government to submit a legislative proposal on the implementation of EPBD requirements.

The climate declaration requirements that came into force in 2022 resulted in 724 declarations registered with Boverket during 2022 and 2023, most of which were for single-family houses.

### Summary of Coverage

The Swedish regulation is expected to cover all building types, and the limits (over the 50 year reference study period) that had been proposed to take effect in July 2025 were as presented in Table 2.

These limit values will now be reviewed as part of the coming governmental activity to study implementation of the EPBD requirements

To support the ongoing declarations and calculation methodologies for the limits, the Swedish Board of Housing, Building and Planning has created a digital handbook that provides guidance on the rules for climate declarations (Climate Declaration guidance, in the link below).

The Swedish Environmental Research Institute (IVL), an independent non-profit research institute owned jointly by the Swedish Government and Swedish industry,

**Table 2.** Initially proposed Swedish limit values (being reconsidered following the EU EPBD revision)

Building type	Limit value (kgCO <sub>2</sub> e/m <sup>2</sup> ) <sup>1</sup>
<b>Office buildings</b>	385
<b>Special housing</b>	385
<b>Residential buildings</b>	375
<b>Pre-schools</b>	330
<b>Other educational buildings</b>	380
<b>One- or two-family homes</b>	180
<b>Other buildings</b>	460

<sup>1</sup> Limits addressing just upfront carbon (A1–5), over 50-year reference study period

administers the world's leading global program for Environmental Product Declarations (the International EPD System, operated by EPD International AB, a subsidiary of IVL). This Swedish based program is a strong motivator for LCA declarations in Sweden, the Nordic region, and beyond.

#### *Specific Scope Requirements*

**Building types covered and size threshold:**

Nearly all buildings over 100m<sup>2</sup>, though some temporary structures, public authorities, and others are exempt

**Modules included:** Only upfront carbon (A1–5); B6 regulated through other policy measures

**Reference study period:** 50 years

**Data source/databases utilized:** Strong source of EPDs and PCRs supported by EPD International, a subsidiary of the Swedish Environmental Research Institute

**Building components included:** substructure, superstructure, enclosure, interiors, and sitework

#### *Sources and Additional Information*

- [Klimatdeklarationen](#) (Climate Declaration)
- [The International EPD System](#)

#### **Finland**

In 2023 Finland adopted a new Construction Act (751/2023) that came into force at the beginning of 2025, that establishes new essential technical requirements, including measures for carbon reduction of buildings throughout the building's lifecycle. It was then amended (897/2024) in 2024 before it entered into force. The Construction Act sets new essential technical requirements coming into force January 2026 for low carbon buildings over their life cycle: climate declaration (Section 38) and limit values (Section 38 a). The carbon footprint and carbon handprint of the building and the construction site must be reported in the climate declaration for the final inspection (as built phase). During planning and construction, the building's carbon footprint must fall below the limit value. The application of the policies will start from the beginning of 2026, in accordance with the amendment to the Construction Act (897/2024).

#### *Summary of Coverage*

The Construction Act lays out specific technical requirements for low-carbon buildings over their life cycle. The Act includes authorization to issue decrees concerning climate and construction product declarations and limit values for the overall carbon footprint. The relevant decree on climate declaration and construction product declaration has already been given, and the decree on limit values is currently being prepared. The consultation round of the decree will be organized in the spring of 2025. These regulations will be published in the National Building Code of Finland after completion.

The Finnish Ministry of the Environment published a methodology for the whole life carbon assessment of buildings in 2019 (link below), leading to better standardization for how LCA is calculated and reported (see link below).

The OneClickLCA tool has been very influential in the development and adoption of building LCA in Finland, both as a tool and as a private consulting company (OneClick-LCA was initially commissioned by the Finnish Ministry of the Environment to compile reports and other data on reference and limit values for building LCA, and has grown to be a substantial global resource).

#### *Specific Scope Requirements*

**Building types covered and size threshold:**

Nearly all buildings with no size threshold, though certain building types (warehouses, transport & communications buildings, and indoor swimming pools & ice rinks) only over 1,000 m<sup>2</sup>. Small residential buildings are excluded from the scope as well as buildings that do not require an energy certificate.

**Modules included:** A1–5, B4, B6, C1–4, and D1

**Data source/databases utilized:** [National emission database](#)

**Reference study period:** 50 years

**Building components included:** Limits apply to building components including frame, roof structures, façade; interior walls, stairs, ceilings and floor; and building services. Climate declarations are prepared for building and building site separately.

## Supporting Policies

The Finnish government has worked closely with the construction industry, including commissioning OneClickLCA to compile reference data and limit values. This resource has been invaluable as the policies have evolved. Cooperation with stakeholders has been important. Finland has good capabilities and know-how to transition to regulation.

### Sources and Additional Information

- [Finnish Ministry of the Environment](#)—Circular economy in the construction sector, includes information and links to requirements
- [Finnish Low-carbon construction roadmap](#)
- [Ilmastaselvitys](#) (Method for the whole life carbon assessment of buildings)
- [New Construction Act \(751/2023\)](#), amended in 2024 (897/2024). New essential technical requirement, climate declaration in §38 and limit values in §38a.
- [Decree on climate declaration, national assessment method, 1027/2024](#) (*Ympäristöministeriön asetusrakennuksenilmastaselvityksestä jarakennustuoteluettelosta*)

## European Union

In May 2024 the European Parliament and the Council of the European Union (EU) published amendments to the Energy Performance of Buildings Directive (EPBD), introducing requirements for the reduction of whole-life-cycle emissions. The EPBD was first adopted in 2010, with the 2018 revision the latest before the 2024 amendments.

The 2024 changes require that EU *“Member States shall ensure that the life-cycle GWP is calculated ... and disclosed in the energy performance certificate of the building from January 2028 for new buildings with a useful floor area larger than 1,000 m<sup>2</sup>, and for all new buildings from January 2030”* (Article 7(2)). The Directive also requires that by January 2027 *“Member States shall publish and notify the Commission of a roadmap detailing the introduction of limit values on the total cumulative life-cycle GWP of all new buildings and set targets for new buildings from 2030, considering a progressive downward trend, as well as maximum limit values, detailed for different climatic zones and building typologies”* (Article 7(5)).

## Summary of Coverage

The 2024 amendment to the EPBD directs that EU Member States require the calculation and reporting of the whole-life GWP for all new buildings by 2030 (and buildings over 1,000 m<sup>2</sup> by 2028), and by 2027 publish roadmaps for introducing limit values for all new buildings. Each member state is required to “transpose” these new EPBD requirements into national regulations, as has been the case for all other EPBD requirements since 2010.

Currently, some specific instructions are given in Annex III to the Directive: *“Annex III—Calculation of life-cycle GWP of new buildings pursuant to Article 7(2):*

*“For the calculation of the life-cycle GWP of new buildings pursuant to Article 7(2), the total life-cycle GWP is communicated as a numeric indicator for each life-cycle stage expressed as kgCO<sub>2</sub>e/(m<sup>2</sup>) (of useful floor area) calculated over a reference study period of 50 years. The data selection, scenario definition and calculations shall be carried out in accordance with EN 15978 (EN 15978:2011 Sustainability of construction works. Assessment of environmental performance of buildings. Calculation method) and taking into account any subsequent standard relating to the sustainability of construction works and the calculation method for the assessment of environmental performance of buildings. The scope of building elements and technical equipment is as defined in the Level(s) common EU framework for indicator 1.2. Where a national calculation tool or method exists, or is required for making disclosures or for obtaining building permits, that tool or method may be used to provide the required disclosure. Other calculation tools or methods may be used if they fulfil the minimum criteria established by the Level(s) common EU framework.”*

Article 7(3) of the recast EPBD empowers the European Commission to adopt “delegated acts” to amend the current Annex III and set out a Union framework for the national calculation of life-cycle GWP.

The EPBD is linked to a broader framework of carbon and construction regulations and directives from the European Commission. In November 2024, the European Council adopted the updated Construction Products Regulation to harmonize the EU’s rules for trading construction products around the EU. The Construction Products Regulation sets standardized environmental reporting standards for construction products across the EU and aligns with the European standards around creating Environmental Product Declarations (EPDs).

The European Commission has established a process to coordinate with member states and other interested

parties as the whole life-cycle GWP requirements are being considered in the EU. This process, Whole Life-Cycle Global Warming Potential reporting for buildings, has established a website (listed below) where a range of relevant materials are published, including presentations from meetings where key issues around Life-Cycle GWP methodology and other important potential clarifications on issues like scope of life-cycle stage, scope of building components, reference study period, floor area definition, and other issues are being addressed.

#### *Sources and Additional Information*

- [DIRECTIVE \(EU\) 2024/1275 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL](#) of 24 April 2024 on the energy performance of buildings (recast)
- [Whole Life-Cycle Global Warming Potential reporting for buildings process](#)
- [Lessons learned from leading jurisdictions for EU Accession Countries](#)—How to establish Whole Life Carbon benchmarks: Insights and lessons learned from emerging approaches in Ireland, Czechia and Spain

## Other Mandatory Embodied Carbon Requirements

Some of the initial policy concepts that have eventually ended up in national regulations were first considered at subnational levels. In this section we highlight several leading subnational current policies that have advanced different regulatory concepts.

### London

The 2021 version of The London Plan implemented a mandatory requirement for the assessment and reporting of whole life cycle carbon emissions of buildings. The London Plan, first published in 2004, and regularly updated, is the statutory spatial development plan for Greater London.

The March 2021 London Plan includes Policy SI 2: Minimizing greenhouse gas emissions as part of the Chapter on Sustainable Infrastructure, requiring that all major development be net zero carbon. Provision F of the Plan requires that development proposals referable to the mayor should calculate whole life cycle carbon emissions and demonstrate actions taken to reduce life cycle carbon emissions.

#### *Summary of Coverage*

The policy requires submission of detailed reporting of whole life carbon (WLC) emissions of buildings at three

distinct phases: pre-application stage, planning application submission stage, and post-construction stage, all to be submitted on a standardized reporting template issued by the Greater London Authority (GLA). The GLA has prepared a guidance document detailing how to prepare a WLC assessment in line with Policy SI 2 using the WLC assessment template (links below).

The most recent monitoring report published on progress towards a net zero carbon London (published October 2024, link below) found that in 2023, 93 referable planning applications were granted provisional approval by their local planning authority and were subsequently approved by the Mayor. In 2023, 72 applications for development conducted whole life cycle carbon assessments. The monitoring report found that in general, the development performance improved compared to the benchmarks, and performance against aspirational benchmarks also improved but are still proving more challenging to meet.

#### *Specific Scope Requirements*

##### **Building types covered and size threshold:**

Buildings or development projects that are “referable to the Mayor” for approval, as defined in The London Plan. This generally includes projects with development of more than 150 residential units, development over 30 meters in height (outside the City of London), or development on London’s Green Belt or Metropolitan Open Land.

**Modules included:** A1–5, B1–7, C1–C4, and D

**Reference study period:** 60 years

**Data source/databases utilized:** [The Built Environment Carbon Database](#), a free-to-use repository of WLC assessments of built assets and product LCA data

**Building components included:** all building elements, as detailed in the Guidance document link below (based on the Royal Institute of Chartered Surveyors/RICS Professional Statement on Whole Life Carbon assessment for the built environment).

#### *Sources and Additional Information*

- [The London Plan: The Spatial Development Strategy for Greater London](#), March 2021
- [London Plan Guidance: Whole Life-Cycle Carbon Assessments](#), March 2022

- [London Plan reporting template for whole life carbon of buildings](#)
- [Towards a net zero carbon London: Energy Monitoring Report 2023](#) (published October 2024)

## Vancouver

Vancouver’s Climate Emergency Action Plan, approved by City Council in November 2020, sets a goal of reducing embodied carbon in construction by 40% by 2030. In May 2022, City Council approved changes to the Vancouver Building By-law (VBBL) to require designers to calculate, limit, and later reduce, embodied carbon in new Part 3 buildings (commercial and residential buildings above 600 m<sup>2</sup>).

Guidelines have been developed as part of the by-law to provide technical guidance on modelling embodied carbon emissions and demonstrating compliance with the requirements in the VBBL. The guidelines may also be used for requirements in policies or programs to report or reduce embodied carbon in construction, such as rezoning policies or owner’s project requirements.

Compliance with the embodied carbon requirements can be demonstrated in two different ways: an absolute path (not exceeding an established limit) or a baseline path, requiring a percentage reduction below a baseline.

### *Specific Scope Requirements*

**Building types covered and size threshold:** “Part 3 buildings” under the British Columbia building code, including commercial buildings and large apartment complexes, exceeding either three stories in height or 600 m<sup>2</sup>.

**Modules included:** A1–5, B1–5, and C1–C4, wherever data is available (B6 & 7 regulated through other policy measures)

**Reference study period:** 60 years

**Data source/databases utilized:** Various data sources specified in the Guidelines (Section 4).

**Building components included:** building sub-structure and shell required; optional scope to include interiors, services, equipment & furnishings, special construction & demolition, and sitework (Guidelines, section 3.3).

### *Supporting Policies*

Vancouver has an ambitious program to support mass timber buildings, including a variety of tools and incentives to encourage mass timber construction, as well as zoning policies that have allowed height relaxation for tall mass timber buildings.

### *Sources and Additional Information*

- [Green Vancouver Climate Emergency Action Plan, Zero Energy Buildings](#)
- [Vancouver Embodied Carbon Guidelines, Version 1.0](#), last Amended October 18, 2023
- [Embodied Carbon in Vancouver Building By-Law](#)
- [Vancouver mass timber buildings](#)

## California

In August 2023, California became the first state in the United States to make embodied carbon emission control a mandatory part of its building code. The California Green Building Standards Code (“CALGreen”) was amended in its 2022 revision cycle to include embodied carbon requirements, with a supplement effective July 1, 2024 that addresses embodied carbon requirements in large buildings.

The CALGreen Embodied Carbon requirements followed earlier California “buy clean” procurement policies, including the 2017 Buy Clean California Act that was enacted by the State Legislature, and required the California Department of General Services (DGS) to create GWP limits for four materials used in public works projects: structural steel, concrete reinforcing steel, flat glass, and mineral wool board insulation.

### *Summary of Coverage*

Updates to the California Green Building Standards Code (CALGreen) Part 11, Title 24, became effective July 1, 2024 statewide. Nonresidential commercial building projects over 100,000 square feet and school building projects over 50,000 square feet are required to comply with one of three compliance pathways:

- **Building Reuse:** Reuse at least 45% of an existing structure and exterior. When reuse is combined with new construction, the total addition area using this pathway is limited to double the area of the existing structure. (Section 5.105.2)

- **Performance:** Complete a whole building lifecycle assessment demonstrating 10% lower embodied carbon emission than a baseline project design. (Section 5.409.2)
- **Prescriptive:** Document environmental product declarations for listed materials (steel, glass, mineral wool, concrete) that are on average lower than a specified threshold of global warming potential. (Section 5.409.3)

Specific requirements of these CALGreen optional pathways are shown in Table 3.

#### *Specific Scope Requirements*

**Building types covered and size threshold:** All non-residential buildings, with a size threshold of 9,300 m<sup>2</sup> (100,000 ft<sup>2</sup>) for all types except schools, where the threshold is cut in half (4,650 m<sup>2</sup>/50,000 ft<sup>2</sup>)

**Modules included:** A1–5, B1–7, and C1–4

**Reference study period:** 60 years

**Building components included:** substructure, superstructure, enclosure, and interiors

#### *Supporting Policies*

Some cities in California have climate action plans and have signed the C40 Cities Clean Construction Declaration, which aims to reduce embodied emissions by at least 50% for all new buildings, major retrofits, and all infrastructure projects by 2030.

In addition, there are some clean procurement rules for any US Federal buildings constructed in California, and the US Inflation Reduction Act of 2022 includes significant funding for embodied carbon programs, including a large budget allocated to develop and standardize EPDs for construction materials.

#### *Sources and Additional Information*

- [California Green Building Standards Code \(CALGreen\) Part 11, Title 24](#)
- [CALGreen Sections added effective July 2024 regarding Embodied Carbon Requirements](#)
- [Embodied Carbon and CALGreen Embodied Carbon Requirements](#)

**Table 3.** CALGreen Optional Pathways

Building Reuse	Performance	Prescriptive Path
<i>Section 5.105, Deconstruction and Reuse of Existing Structures</i>	<i>Section 5.409, Life Cycle Assessment</i>	<i>Section 5.409.3, Product GWP Compliance</i>
<p><b>Components:</b> Existing primary structural elements, enclosure (roof framing, wall framing, and exterior finishes).</p> <p><b>Exceptions:</b> Additions 2x the area or more of the existing building.</p> <p><b>Exclude:</b> Window assemblies, insulation, portions structurally unsound or hazardous, and hazardous materials that are remediated as part of the project shall not be included in the calculation.</p>	<p><b>Scope:</b> 60-year cradle-to-grave WB LCA (ISO 14044), excluding operating energy. Show GWP analysis.</p> <p><b>Components:</b> Primary and secondary structural members, glazing insulation, exterior finishes.</p>	<p><b>Components:</b> Structural steel, rebar, flat glass, light and heavy-duty mineral wool insulation, and ready mix concrete.</p> <p><b>Exception:</b> Concrete mixes can use a weighted average for all mixes.</p>

# Comparing the different policies

Some important lessons can be learned from the early adopters of these policies, and it is useful to compare the various policies.

## Overview of the Policies

Table 4 summarizes the key provisions of the various policies, showing dates of adoption and first compliance requirements, building types covered and size thresholds for the coverage, along with the metric for the policy and reference study period.

There is consistency in that most of the policies are applied at the building permit stage, though several of those also require submission of as built reporting. There are significant variation among the minimum building size covered, and the timeframe for implementation.

## Scope of Coverage of Policies (Life Cycle Modules)

There can be quite wide variations among the different jurisdictions of the scope of the whole life coverage, as expressed by the different life cycle modules (A1 through A5, B1 to B5, etc.). Table 5 maps the different policies with the life cycle modules included in the policy.

Most notably, several jurisdictions with advanced policies do not include operational energy and water impacts in their LCA analyses, as those operational carbon emissions are often covered by other building performance regulations, in many cases standards that have been in place through building energy codes or other regulations. There can be more variability by building type and space usage operational impacts, and operational energy impacts are often addressed in separate regulations as operational emissions over a 50- or 60-year reference study period require making estimates of energy grid emissions and fossil fuel use for that extended period.

## Building Element Coverage

The coverage of building elements by different policies is shown in Table 6. The various policies differ by the building elements covered, in some cases leaving out substantial elements in comparison with other nearby countries. This difference in what building elements are included is shown later in this report (in the section on Data Quality and Comparability Challenges) in a comparison between calculated values for Denmark and Sweden.

**Table 4.** Overview of Whole Life Carbon Policies

### Mandatory limit policies

Jurisdiction	Netherlands (NL)	Denmark (DK)	France (FR)	Sweden (SE)	Finland (FI)	European Union (EU)
<b>Name of regulation</b>	Milieu Prestatie Berekening/ MPG	Bygnings-reglementet/ BR18	Reglementation Environnementale (RE 2020)	Klimatdeklarationen	Ilmastoselvitys	2024 Amendment—EPBD
<b>Year initially adopted</b>	2013	2020	2021	2022	2023	2024
<b>Initial date for reporting/ declaration</b>	2018	2023	2022	2022	2025	2028
<b>Initial date for limit values</b>	2018	2023	2022	2025	2026	2030
<b>Building types covered</b>	Residential and office	All	Residential, office and educational	All (some exceptions <sup>1</sup> )	Nearly all	All
<b>Initial building size threshold (m<sup>2</sup>)</b>	100	1,000	none	100	none <sup>2</sup>	1,000
<b>Floor area definition<sup>3</sup></b>	GFA	GFA/HFA	LA/UA	GFA	NHA	UFA
<b>Design-level (at permit application) or as-built?</b>	Permit	As-built	Permit + as-built	As-built	Permit + as-built	TBD
<b>Reference study period (years)</b>	50/75 <sup>4</sup>	50	50	50	50	50

### Other mandatory policies

Jurisdiction	London	Vancouver	California
<b>Name of regulation</b>	London Plan Policy SI 2 (Minimizing GHG emissions)	Building Bylaw Embodied Carbon Guidelines	CALGreen 2022
<b>Year initially adopted</b>	2021	2022	2022
<b>Initial compliance year</b>	2022	2023	2025
<b>Building types covered</b>	Large development projects “referable to the mayor”	Large buildings, including most >3 stories	All Non-residential
<b>Initial building size threshold (m<sup>2</sup>)</b>	varies	600	9,300 (4,650 for schools)
<b>Floor area definition</b>	GIA	GFA	GFA
<b>Design-level (at permit application) or as-built?</b>	Planning/permit, and post-construction	Permit	Permit
<b>Reference study period (years)</b>	60	60	60

<sup>1</sup> Some temporary structures, public authorities, and others exempt

<sup>2</sup> Certain building types (warehouses, transport & communications buildings, and indoor swimming pools & ice rinks) only over 1,000 m<sup>2</sup>

<sup>3</sup> GFA: Gross Floor Area; GIA: Gross Internal Area; HFA: Heated Floor Area; NHA: Net Heated Area; LA/UA: Liveable Area/Usable Area; UFA: Useful Floor Area

<sup>4</sup> 50 years for offices; 75 years for homes

Table 5. Scope of Coverage of Policies by Life Cycle Module

		Mandatory limit policies					Other mandatory policies				
Life Cycle Stages Included		Netherlands (NL)	Denmark (DK)	France (FR)	Sweden (SE)	Finland (FI)	European Union (EU) <sup>1</sup>	London	Vancouver	California	
Stage	Name of regulation	Milieu Prestatie Berekening/ MPG	Bygnings-reglementet/ BR18	Reglementation Environnementale (RE 2020)	Klimatdeklarationen	Ilmastaselvitys	2024 Amendment—EPBD	The London Plan	Building Bylaw Embodied Carbon Guidelines	CALGreen 2022	
Product stage	A1. Raw material supply	●	●	●	●	●	●	●	●	●	Cradle to gate
	A2. Transport	●	●	●	●	●	●	●	●	●	
	A3. Manufacturing	●	●	●	●	●	●	●	●	●	
Construction stage	A4. Transport	●	■	●	●	●	●	●	●	●	Upfront carbon
	A5. Construction & installation process	●	■	●	●	●	●	●	●	●	
Use stage	B1. Use	●		●			●	●	●	●	Cradle to grave
	B2. Maintenance	●		●			●	●	●	●	
	B3. Repair	●		●			▲	●	●	●	
	B4. Replacement	●	●	●		●	●	●	●	●	
	B5. Refurbishment			●			▲	●	●	●	
Operational energy	B6. Operational energy	○	●	●	○	●	●	●	○	●	Cradle to cradle
	B7. Operational water	○		●			▲	●	○	●	
End of life stage	C1. Deconstruction & demolition			●		●	●	●	●	●	Cradle to cradle
	C2. Transport			●		●	●	●	●	●	
	C3. Waste processing		●	●		●	●	●	●	●	
	C4. Disposal		●	●		●	●	●	●	●	
Beyond building life cycle	D1. Reuse, recovery, recycling potential		■	●		●	●	●	■		Cradle to cradle
	D2. Exported utilities potential		■	●		●	●	●	■		

<sup>1</sup> EU: Modules shown based on current EN15978; there are proposed amendments to be resolved

- Required by Legislation/Regulation
- Regulated in other policy measure
- Reported as separate value
- ▲ Optional

**Table 6.** Building Elements Covered in Different Policies

### Mandatory limit policies

Jurisdiction	Netherlands (NL)	Denmark (DK)	France (FR)	Sweden (SE)	Finland (FI)	European Union (EU) <sup>1</sup>
Name of regulation	Milieu Prestatie Berekening/ MPG	Bygningsreglementet/ BR18	Reglementation Environnementale (RE 2020)	Klimatdeklarationen	Ilmastoselvitys	2024 Amendment—EPBD
Substructure	●	●	●	●	●	●
Superstructure	●	●	●	●	●	●
Enclosure	●	●	●	●	●	●
Interiors	●	●	●	●	●	●
Services (MEP)	●	■	●	⊖	■	●
Equipment and Furnishings	⊖	■	●	⊖	■	●
Sitework (including landscape)	⊖	⊖	●	●	●	▲

### Other mandatory policies

Jurisdiction	London	Vancouver	California
Name of regulation	London Plan Policy SI 2 (Minimizing GHG emissions)	Building Bylaw Embodied Carbon Guidelines	CALGreen 2022
Substructure	●	●	●
Superstructure	●	●	●
Enclosure	●	●	●
Interiors	●	⊖	▲
Services (MEP)	●	⊖	▲
Equipment and Furnishings	●	⊖	▲
Sitework (including landscape)	●	⊖	▲

<sup>1</sup> All EU elements as currently proposed but subject to change

- Required
- Required via proxy values
- ▲ Optional
- ⊖ Not required

# Discussion

## Lessons Learned in Leading Countries/Regions

While it is still relatively early days in policy implementation, some key lessons can be learned from the jurisdictions that have been leading the way.

**Initial Reporting Focus.** Most jurisdictions begin with some type of calculation and reporting requirement to build industry knowledge and capacity. Many countries begin with a voluntary scheme to build industry knowledge and capacity. Then, after a baseline and collection of LCA benchmarks have been established, it is easier to set carbon limits and be able to enforce these limits.

**Building Size.** There may be value to starting with just the largest, more complex projects where there are more design disciplines and experts involved to be able to understand new requirements, and then have smaller, less complex buildings meet these requirements after an initial learning period with the smaller number of buildings. In many jurisdictions a relatively small number of very large buildings with quite sophisticated design teams can represent a substantial proportion of the new construction (by floor area or construction value) that may be impacted by these policies, and having the policies begin with those large projects allows for capacity to be built without extending the regulatory burden to smaller projects.

**When to Limit.** Different distinct approaches can be considered to facilitate the adoption of climate declarations and limit values at the time of their introduction. The Swedish plan has been to introduce a declaration without limit value and then introduce a somewhat ambitious limit value a few years later (now delayed with the EU EPBD timeline). In contrast, the Danish approach was to introduce a limit value from the beginning alongside the climate declaration but ensure that the limit value initially can be met by most “regular” building projects without special effort. Then there can be a gradual tightening of the limit value over time (Nordic Innovation 2024a).

**Scope.** There is not yet consensus on the scope of different requirements, from the life cycle modules included through what building components need to be included. The extensive Nordic harmonization efforts currently underway are an attempt to resolve this wide variation, and the coming process for European countries to develop their roadmaps will provide an important lesson and will likely lead to increased harmonization.

**Method and Data Foundation.** There is a critical need for supporting policies and resources, including databases, procurement policies, certification pathways, etc. as a precursor to mandatory carbon limits. Developing mandatory regulations without established, consistent methodologies and processes for calculating and reporting LCA will not advance industry practices. It is critical to develop high-quality data and tools for comparison benchmarking and to develop valid reduction strategies. There is a very big need for adequate resources to develop and maintain these methodologies, particularly development of reliable data for use by construction practitioners.

**Product Specific Policy.** If the consistent methodologies and policies, along with data and supporting systems, are not already in place, there are likely opportunities to implement policies aimed at specific construction products, including concrete, steel, insulation, timber and a few others that contain a large portion of the embodied emissions from construction materials. Several leading jurisdictions began their policies with “buy green” requirements for these products in public facility construction processes, which led to better data collection and availability of lower carbon products in those regions.

**New Buildings First.** Finally, all of the leading regions start their embodied carbon policies with a focus on new construction. New construction, where the materials going into the building are known and should have key specifications and at least some life cycle impact data available, are much simpler than trying to understand the LCA impacts of existing buildings.

The most valuable policy for embodied carbon reduction in existing buildings is to preserve the existing building through retrofit and renovation instead of demolition and new construction, even if the building needs to go through a change of use (e.g., obsolete office converted to housing). Figure 5 shows how the embodied carbon reduction potential drops the further along a building is in the project cycle.

Some specific lessons noted by early adopters:

### Selection of Initial Buildings Covered by Whole Life Policies

Some European leaders noted that the selection of buildings to be covered by initial climate declaration or limit value requirements was closely linked with other EU buildings regulations, particularly addressing the buildings that

## DECARBONISATION

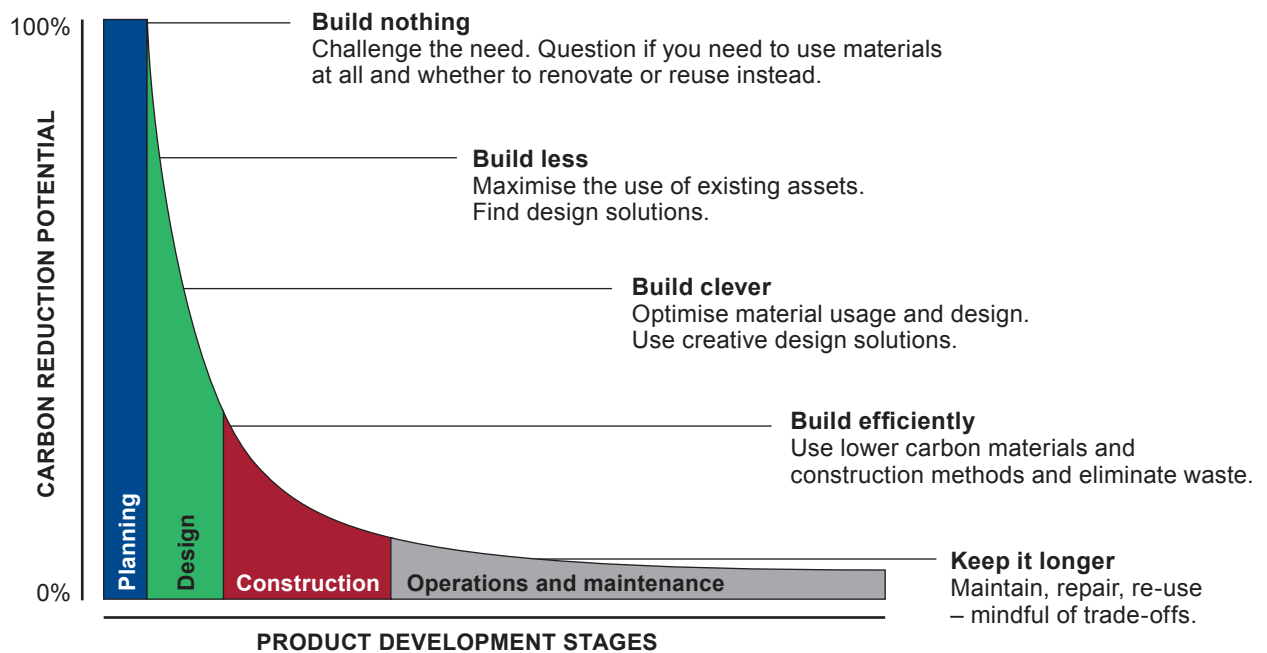


Figure 5. Opportunities to reduce embodied carbon by stages in the project cycle. (Source: ASBEC et al 2024)

are required to develop an Energy Performance Certificate. In some cases, smaller buildings or renovation projects were removed from coverage due to concerns about regulatory burden.

France chose their first three building categories (housing, offices, and education) as those were the categories where they had the most information and industry feedback that LCA performance was achievable at an economically sustainable cost. These building typologies also represented the greatest number of buildings that had voluntarily carried out LCAs during the voluntary “Energy + Carbon –” sustainability label initiative introduced in 2016.

### Early Industry Reactions and Progress

In most of the European leading countries, government regulators worked very closely with building trade organizations and industry in development of the policies, tools, and any complementary or supportive programs to build industry awareness and capacity. While there had been initial opposition from some construction industry stakeholders to the regulations, that has mostly been overcome as industry sees this as part of the regular, periodic tightening of environmental regulations.

The most common industry response has been much more awareness of LCA and EPDs. The feeling among

leading Nordic countries is that now “everyone knows what an EPD is,” especially with government and other support for developing product and whole building declarations. The ever-growing number and availability of EPDs, as well as new and evolving tools, is making it easier for designers and other construction professionals to comply with the new regulations.

It was also noted by leaders that the introduction of environmental declarations has led product manufacturers to adopt an eco-design approach, including measures such as decarbonizing the production plant’s energy source and optimizing recyclability.

### Data Quality and Comparability Challenges

The current situation around data for EPDs and PCRs is relatively immature, leading to large potential variations in the total LCA (and calculated impact to show compliance with a carbon limit). European countries have more mature data systems, with certification programs that provide some more consistency in calculation and reporting of LCA through validation of EPDs and PCRs.

It is also important to note that most LCA tools are designed around certain datasets, so it is critical to understand whether the EPD and PCR data is intended to be used with a specific tool. Having clarity and transparency

in reporting datasets and results is necessary to have confidence in the reported data.

The lack of EPD data can be a major challenge in early stages of policy implementation, and it is crucial to have a sufficient volume of EPD data for accurate assessment. In France, for example, the number of standardized documents like EPDs has more than doubled from around 2,000 in the year 2019, to over 4,500 in 2023 (OECD 2025).

When LCAs are based on design calculations there is a lot more uncertainty in the data, relative to calculating the LCA based on as-built information. Different jurisdictions have taken different approaches on requiring building emission assessments at both, or one of two, main stages: design stage, and post construction stage. Requiring submissions at the design stage can have greater impact on promoting low-carbon construction design, but is also less reliable as materials are not yet final at that point. Collecting data post-construction allows for more accurate data from building material actually used, but less influence on the design (OECD 2025).

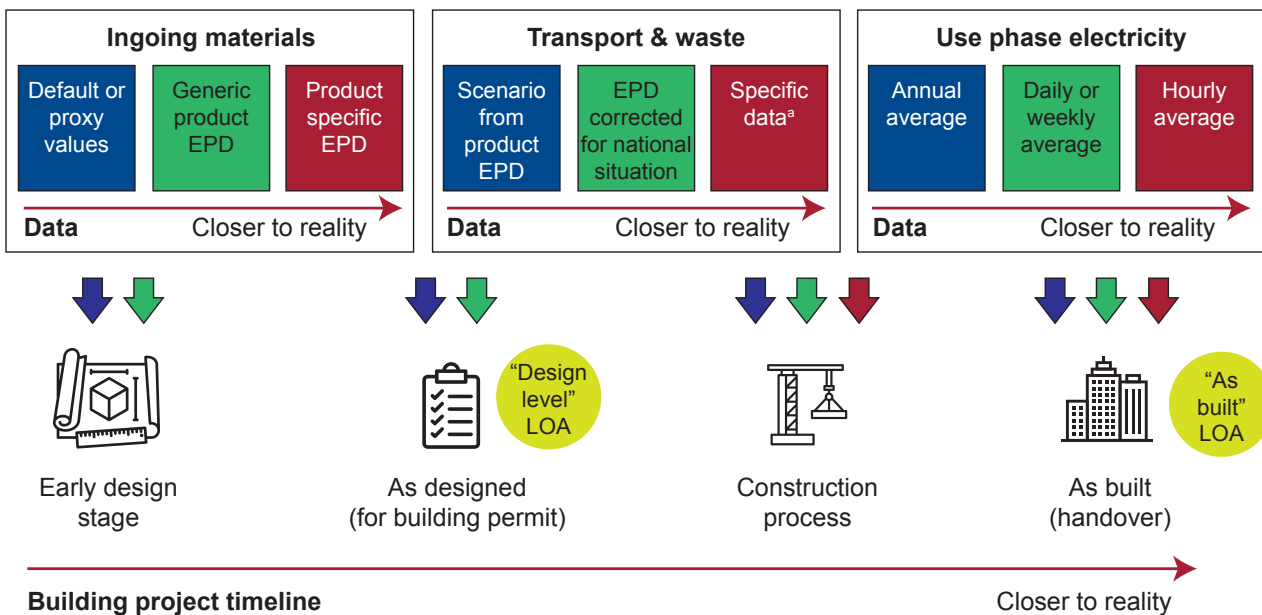
The variation in data quality levels depending on progress of the project is shown in Figure 6.

As an example, much of the reporting in North America is reported and calculated through the Embodied Carbon

in Construction Calculator, a free software tool that gives digital access to EPDs along with other information on environmental impacts (Carbon Leadership Forum 2025). Often factors used are based on modeled estimates, with some more accurate than others, requiring that the calculator includes uncertainty factors in its search results and comparisons.

Data quality appears to be more advanced in Europe, particularly in the Nordic region, through efforts like the Swedish International EPD system, originally established in 1998 as a joint initiative between the Swedish Environmental Protection Agency and the construction industry. This model, with a global service network including exclusive representations in a variety of economies including Oceania, South America, and part of Asia, may be something that can be replicated or expanded in regions where data are clearly lacking.

There can be very substantial differences between how the LCA is calculated, particularly from variations in which life cycle modules are included in the assessment. An example was presented in recent Nordic harmonization studies, showing extremely different results for the overall carbon impact and the resulting carbon intensity per floor area for the same 3,000 m<sup>2</sup> office building, as shown in Table 7. Indeed, the Danish system calculated result was about 2.5 times the footprint of the Swedish calculated footprint.



a Actual site and national environmental data used

**Figure 6.** Data quality levels and how they can improve as the project progresses (Source: EU Whole Life-Cycle Global Warming Potential reporting for buildings 2024)

**Table 7.** Comparison of GWP calculated using Danish and Swedish LCA regulations for a 3,000m<sup>2</sup> office building (Source: Ramboll 2023)

**Denmark: Global warming potential (kg CO<sub>2</sub>e)**

Building elements	A1-A3 (including biogenic carbon)	B4 (50 years)	B6 (50 years)	C3	C4
<b>Substructure</b>	183,495	0	0	2,924	15,381
<b>Superstructure (frame)</b>	-65,594	0	0	138,337	1,288
<b>Superstructure (envelope)</b>	32,233	33,512	0	52,338	1,250
<b>Superstructure (internal elements)</b>	133,603	0	0	17,621	1,049
<b>Finishes</b>	53,118	159,991	0	13,179	9,309
<b>Building services</b>	118,260	0	0	22,740	0
<b>External works</b>	0	0	0	0	0
<b>Operational energy</b>			345,000		
<b>Totals</b>	<b>455,115</b>	<b>193,503</b>	<b>345,000</b>	<b>247,139</b>	<b>28,278</b>
<b>Per m<sup>2</sup></b>	<b>152</b>	<b>65</b>	<b>115</b>	<b>82</b>	<b>9</b>
<b>Total: 1,269,035</b>					
<b>Per m<sup>2</sup>: 423</b>					

**Sweden: Global warming potential (kg CO<sub>2</sub>e)**

Building elements	A1-A3	A4 (50 years)	A5
<b>Substructure</b>	218,915	10,470	10,181
<b>Superstructure (frame)</b>	50,918	6,217	4,295
<b>Superstructure (envelope)</b>	101,664	3,318	4,405
<b>Superstructure (internal elements)</b>	81,158	3,445	4,004
<b>Finishes</b>	Not Included	Not Included	Not included
<b>Building services</b>	Not Included	Not Included	Not included
<b>External works</b>	Not Included	Not Included	Not included
<b>Operational energy</b>	Not Included	Not Included	Not included
<b>Totals</b>	<b>452,656</b>	<b>23,450</b>	<b>22,886</b>
<b>Per m<sup>2</sup></b>	<b>151</b>	<b>8</b>	<b>8</b>
<b>Total: 498,992</b>			
<b>Per m<sup>2</sup>: 166</b>			

Figure 7 shows the same comparison of the two countries' reporting systems, but adjusting the scope so it is easier to see what causes the wide variation.

There is clearly a need for more standardization among different embodied carbon regulations, which beyond the Nordic and European efforts, is not yet happening. The current relevant International Standards (EN 15978:2011 and ISO 21931-1:2022) are generally based on earlier versions of European CEN Standards. The coverage of the relevant international standards is shown in Table 8.

There is an effort in North America for ASHRAE, along with the International Code Council, to develop a new Standard on Quantification of Life Cycle Greenhouse Gas Emissions of Buildings (Standard 240P, that had been out for public review in early 2024). A second public review of that draft Standard is expected later in 2025.

In reality, though, the new ASHRAE/ICC Standard and the current ISO Standards are more for calculation of LCA, and do not give specific direction about what modules to include, and other critical criteria to improve the comparability of LCA assessments. Eventually, there will need to be more international standardization for more consistency of whole life carbon reporting globally.

In order to advance comparability and consistency in reporting LCA whole building LCA, several leading organizations in North America have been collaborating through the Embodied Carbon Harmonization & Optimization ("ECHO") Project. Leaders across rating systems, industry membership organizations, embodied carbon subject matter expert organizations, and industry commitment leaders have convened to develop recommendations for

alignment, and issued a first set of recommendations in October 2024 (Lewis et. al. 2024)

### Calculation Tools, Generic Data & Standard Values Critical

Publicly available calculation tools are a critical need for comparability of LCA impacts, and valid data on commonly used construction materials and products is absolutely necessary to use these tools. In the jurisdictions with embodied carbon policies, all have had calculation tools that were available and being used by construction professionals well in advance of any mandatory policy taking effect.

The data on emissions factors is an extremely complicated topic. In many places, to get started, the calculation tools use default values (often based on the worst in class products) to allow for some initial population of values for the tools. Over time, though, development of real, actual emissions factors for the products being used is necessary to start to drive professionals to lower emission products.

Much more widespread building product certification initiatives that support broader development of EPDs, PCRs, and other necessary reliable data for LCA calculation are critical. Some of the early experience in the Nordic region and other European countries can likely be expanded around the world, building on the good work that has started in leading countries.

### Key Design Features for Whole Life Carbon Regulations

There are a number of critical policy design decisions that need to be made early on when considering development

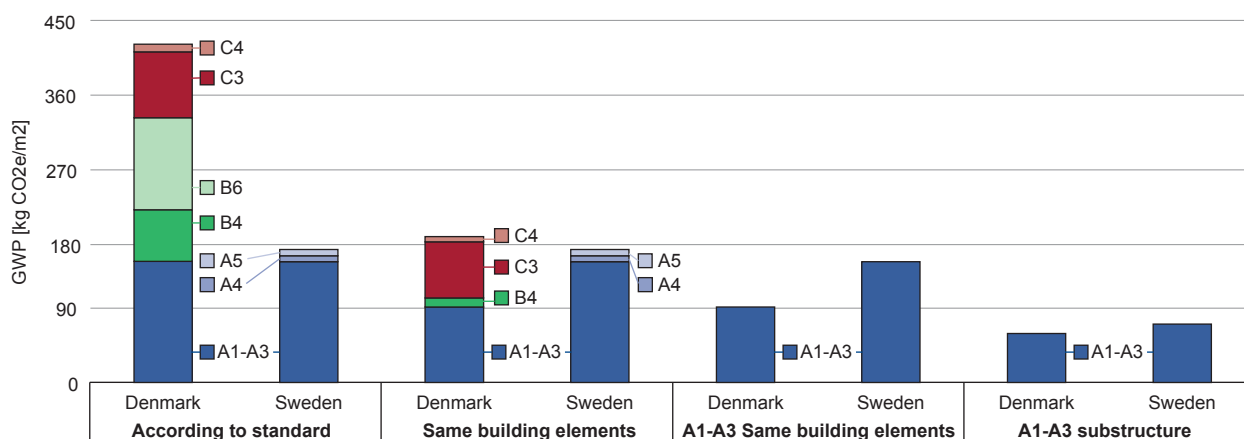


Figure 7. The same 3,000 m<sup>2</sup> building, adjusting scope to make buildings more comparable (Source: Ramboll 2023)

**Table 8.** International & European Standards for LCA and EPDs (source: Waters 2024)

Standard	What it Governs	Other Information	
<b>International Organization for Standardization (ISO)</b>	<b>ISO 14040, 14044</b>	Life-cycle assessment (LCA) principles, methodologies, and requirements	
	<b>ISO 14025</b>	Type III environmental product declaration (EPD) development and presentation	Aligns with ISO 14040/44
	<b>ISO 14027</b>	Product category rule (PCR) development (not construction specific)	Aligns with ISO 14040/44/25
	<b>ISO 21930</b>	EPD development for construction-related products and services	Mirrors EN 15804+A1; Not fully compatible with 15804+A2
<b>European Committee for Standardization (CEN)</b>	<b>EN 15978</b>	Building-level LCA; Building life-cycle stages A–D	Aligns with ISO 14040/44. Currently in revision with new version expected later in 2025
	<b>EN 15804+A1</b>	Product category rules (PCRs) for construction-related EPDs	Includes seven environmental impact categories. Aligns with ISO 14040/44/25 and 21930.
	<b>EN 15804+A2</b>	2019 amendment to EN 15804 that supersedes A1 in the European Union	Compared with the A1 version, the more recent standard. No longer fully compatible with ISO 21930, changes include: Triple the number of impact categories; New approach to biogenic carbon emissions and storage; Expanded scope that includes a product’s end-of-use impacts

of a new whole-life carbon regulation. The Building Performance Institute Europe prepared a report in 2024 looking at insights and lessons learned from emerging approaches in some European countries and found the following key design features that need to be decided as part of any whole life carbon policy are shown in Figure 8 (BPIE 2024).

One area where there is not yet consistency, or agreement on the most effective path, is whether to use static or dynamic approaches for the LCA methodology. A static approach is essentially a time-independent LCA method that aggregates environmental impacts over the building’s life cycle without considering when they occur. A dynamic approach (as used in the French regulation) is a more complex, time-sensitive methodology, accounting for the relative impacts over time, taking into account likely changes in the future (to electric grids, and other important parameters).

Closely related to this is the time value of carbon, where carbon savings today could be valued more highly than carbon savings promised in the future (Wild, Lau and Allwood 2024). In the French case, utilizing a dynamic approach recognizing higher value for early reductions, embodied carbon has a higher priority.

The timing of operational and embodied carbon emissions over the life cycle of a building is illustrated in Figure 9.

**Creating Regulations: Key Steps to Consider**

As part of the Nordic Innovation harmonization effort, there has been significant activity trying to understand the various steps that are needed to build the capacity among regulators and all stakeholders, and have successful regulations related to whole building carbon limits.

### 1 Scope: Building type and size

- What building types?
- Initially cover >1,000m<sup>2</sup>? 100m<sup>2</sup>?

### 2 Reference study period

- Usually 50 years
- NL 75 years for residential buildings

### 3 WLC metric

- Often total life cycle GHG emissions (generally either kgCO<sub>2</sub>e/m<sup>2</sup> for the full reference study period, or kgCO<sub>2</sub>e/m<sup>2</sup>/yr)

### 4 Building elements

- Include substructure?
- What other elements?

### 5 Life cycle modules

- Just A1-A3?
- Include A4-A5, B1-B7, C1-C4?

### 6 Reporting templates

- Specify reporting template?
- Part of construction permitting process?

### 7 Scenario assumptions: grid decarbonization, biogenic carbon, exported energy

- Planned decarbonization of electric grid?
- Static vs dynamic (include LULUC impacts & carbon storage benefits)?

### 8 Calculation tools

- What tools allowed/required?

### 9 Data sources and default values

Figure 8. Key design features that need to be decided as part of any whole life carbon policy

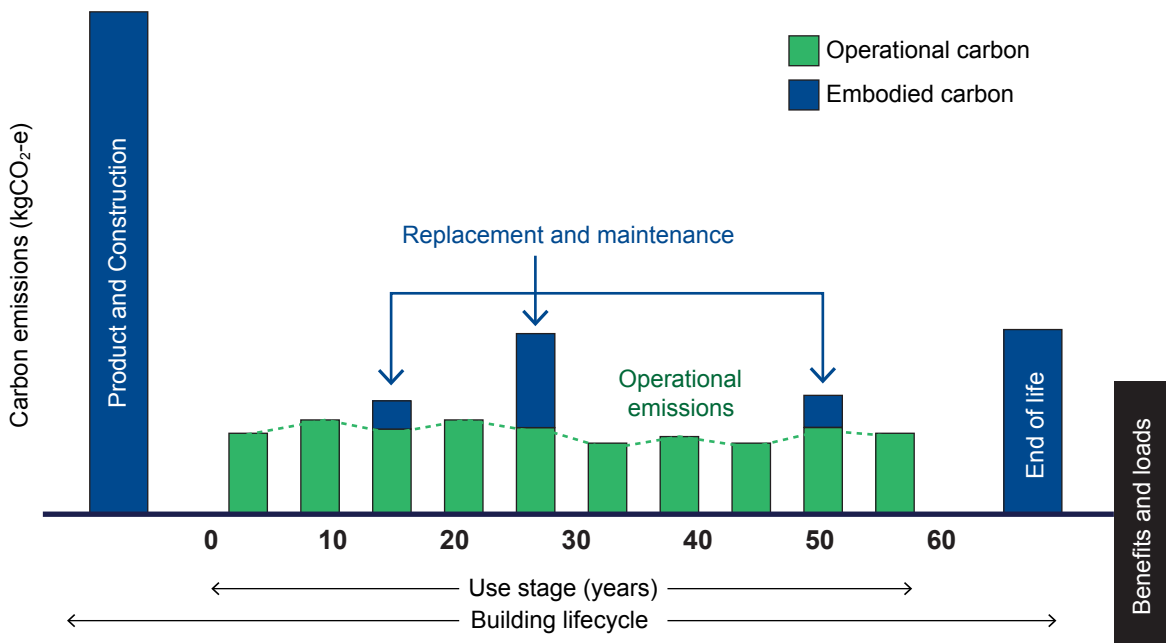


Figure 9. Operational and embodied carbon emissions over the life cycle of a building (Source: NZ MBIE 2020)

Figure 10 shows what the Nordic experience has found to be eight key steps that need to be carefully considered in order for a policy to be accepted by stakeholders and lead to successful implementation, along with the types of stakeholders (government authorities, industry, academia, etc.) that need to be included for each step.

Experts consulted during the preparation of this report stressed the need for careful and thoughtful development of national whole life carbon accounting methods, which can take significant time. While accepted accounting methods are in place in some leading European countries, much of the rest of the world currently relies on voluntary accounting procedures. In some cases there are multiple voluntary methods that can give quite different results for the reasons noted earlier. These accounting methods are critical to have in place as a first step, before work toward data collection, benchmarking and consideration of limit values can take place.

A step that has not been part of the process to date in Europe is quantification of the costs and benefits of embodied carbon policies. Some jurisdictions (including Australia and many U.S. states) require a cost/benefit analysis to justify any new energy or building code additions, and both cost and benefit data for many whole life carbon improvements are just beginning to be calculated and tracked.

## Issues and Potential Policy Concerns

As noted earlier, whole life carbon policies rely heavily on appropriate tools, data availability, and data quality and consistency. Without more consensus on the reliability of LCA data, including verified EPDs through more widespread certification programs, there are risks of serious problems with invalid embodied carbon reporting, and potential greenwashing and gaming of the systems and regulations. There is a strong need for better tools and reliable, verified data.

### 1 Build up competence

- Learning resources adapted to national contexts
- Certification schemes to foster competition
- **Stakeholders: Academia, Industry**

### 2 Secure stakeholder involvement

- Balance current readiness with future requirements
- Monitoring and revisiting regulation
- **Stakeholders: Authorities, Policymakers, Industry**

### 3 Ensure access to generic data and standard values

- Phasing out of the conservativity factor in generic data
- Use of standard component values for as-built reporting
- **Stakeholders: Authorities, Academia, Industry**

### 4 Improve availability and digitalization of EPDs

- Alignment of structure and content of databases
- Subsidies or automated tools designed to generate EPDs
- **Stakeholders: Authorities, EPD Operators**

### 5 Create a case basis and structure for the limit values

- Real cases sample for feasible limit values (archetypes for potentials)
- Need for differentiation of limit values
- **Stakeholders: Academia, Authorities**

### 6 Determine the initial scope and method

- Start with a limited scope (size and type, modules, building model)
- Need to highlight upfront carbon reduction (several options)
- **Stakeholders: Policymakers, Authorities, Academia**

### 7 Establish a suggested limit value pathway

- Incremental implementation of methods and limit value levels (long-term roadmap)
- Impact assessments to support gradual expansion (scope/ projects)
- **Stakeholders: Authorities, Policymakers, Industry**

### 8 Expand the regulation to renovations

- Avoid creating burdens for renovations with environ. benefits
- Develop a harmonised approach (start with deep renovations)
- **Stakeholders: Authorities, Academia, Industry**

**Figure 10.** Key Steps to consider in developing and implementing whole life carbon limits (Source: Nordic Sustainable Construction 2024)

There is a need for a skilled workforce to understand and implement these policies, particularly many more whole life carbon assessors to build capacity to deliver projects under the new regulations, and potentially including accreditation programs to validate the quality of assessors. Like calculation tools and data availability and quality, building up the number, and the quality, of assessors is critical for capacity building and development for the industry to deliver on these policies.

And because most LCA calculations are based on a building design, and there can often be differences between the building design and the built structure, there is a risk of performance gap issues as have been noted for operational building energy performance. There will be an ongoing tension between wanting to update LCA information as a building is constructed to have the most valid information about the construction, vs just submitting paperwork and keeping bureaucratic oversight to a reasonable level.

There are potential issues with traded and imported products, and the reliability of EPD and other reporting data for imported products. With the emerging carbon tax situation in some regions there are also potential issues around Carbon Border Adjustment Mechanisms that will need to be closely linked to other regulations regarding imported products.

Some experts consulted during the preparation of this report expressed concerns about rushing too quickly into specific whole life carbon limits given some of the

uncertainties around LCA and EPD data quality, and the various complexities of calculating whole life and embodied impacts. With a large percentage of embodied emissions coming from the upfront carbon with a relatively small number of key construction products, as noted in the introduction, these experts suggest a longer period of phase in for mandatory policies, perhaps with more focus on just the key products, or starting with a subset of buildings to be regulated to give time to build capacity among design and construction practitioners. There may be opportunities to change the balance of technical complexity with lower regulatory burden, particularly for smaller, less complex buildings.

Experts outside of Europe noted significant challenges with the lack of incentives and educational resources to support the industry on the path to mandatory whole life carbon requirements, where there can often be resistance from building practitioners and product manufacturers to report and publish needed data.

Finally, more information and data are needed to understand the costs and benefits of deep cuts to embodied and whole life carbon. While ambitious policies that regularly reduce whole life limits to drive innovation are helpful in establishing targets for industry to drive toward, not enough is yet known about the costs of getting to very deep embodied carbon reduction. Recent research has shown that upfront embodied reductions of 17% to 45% are achievable with ambitious design and material changes, but getting beyond 45% reductions can be technically challenging (Craft, Oldfield, et.al. 2024).

# Conclusions

While there has been a big rush of whole life and embodied policy development in the past two to three years, we are still in very early days with these policies, with many of them just coming into force and no time for real evaluation of policy effectiveness. There is not yet much actual experience with implementation issues and success of policies.

Leading jurisdictions are reporting better data collection and consistency in reporting, though not yet any drastic changes to construction practices.

The current activity in the European Union, with the EU wide mandate but individual member states transposing the EPBD directive language into national regulations, will be very interesting to watch in the coming one to three years. The individual EU Member State Roadmaps to be developed by 2027 will give more sense about how much harmonization is realistic, even among the EU countries where there are many other consistent rules and reporting practices.

Some big picture takeaways from this research:

- There is lots of variation in current policy approaches
- There is a need to improve data availability, calculation methodologies, and the ability to directly compare results
- And more international coordination and collaboration is needed

Best practices include:

- Building capacity of regulators and the construction industry before implementing mandatory requirements
- Early engagement with building owners and other key stakeholders
- Starting small to gain experience; smaller scope and number of buildings to start, and reasonably achievable limit values

It is expected that a variety of new embodied and whole life carbon policy initiatives will be introduced in the coming years, learning from the experience of the leaders highlighted in this report. These types of regulations take years to implement and develop capacity among all stakeholders. The experience in France, where the voluntary whole life carbon label was introduced in 2016, and then the initial mandatory limits took effect in 2022 is a good example of the time required.

With this in mind, starting with some simplified approach, initially with just a subset of buildings where data are available, or a voluntary scheme to build capacity, may be more practical than rushing to set mandatory limits. There will likely be more new approaches found as well, as more policy experts move into this rapidly evolving space.

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**Adam Hinge, Sustainable Energy Partnerships**

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