OECD Urban Studies

Zero-Carbon Buildings in Cities

A Whole Life-Cycle Approach

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OECD
BETTER POLICIES FOR BETTER LIVES

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Foreword

Buildings are among the largest contributors to greenhouse gas emissions, accounting for nearly 40% of energy-related CO_2 emissions. These reflect emissions from operational use, but also emissions related to energy used in the construction of buildings, as well as significant indirect emissions related to the upstream production of construction materials. Indeed, in part because of progress made in improving the energy efficiency of buildings, by 2050, these non-operational emissions, including those related to demolition, referred to collectively as embodied carbon or embodied emissions, are projected to account for half of the carbon footprint of new buildings.

Operational carbon, i.e., emissions related to the use phase of a building (e.g., heating, cooling and powering), has traditionally been the focus of decarbonisation efforts. In a recent OECD survey, close to 90% of responding countries had introduced mandatory energy efficiency codes and over 60% had introduced Energy Performance Certificate. However, by comparison, only 21% of countries had introduced regulations addressing whole life carbon, despite the significant scale of embodied carbon and its impact on climate change, and despite the fact that much of the progress made on reducing operational emissions has been through the construction of new energy efficient buildings. In other words, a whole life carbon approach that ensures buildings remain sustainable throughout their entire life-cycle, from construction to demolition, is needed.

The OECD's *Global Monitoring of Policies for Decarbonising Buildings: A Multi-level Approach (2024)* revealed that while countries have predominantly focused on energy-related measures to reduce emissions, whole life carbon policies are gaining momentum. According to the report, 43% of responding countries are expected to prioritise these in the future compared to only 14% today. Similarly, policies to increase the circularity of materials, a crucial element in reducing embodied carbon, are also expected to see greater uptake. Currently, only 11% of responding countries set circularity as one of their priorities, but this is expected to increase to 68%.

In response to this growing challenge, the OECD has carried out a *Global Survey on Whole Life Carbon of Buildings (2024).* This survey gathers advanced data from 15 countries and cities, representing diverse economic contexts, geographic conditions, and governance structures. By providing a common framework for comparison and policy analysis, this report, entitled *Zero-Carbon Buildings in Cities: A Whole Life-Cycle Approach,* highlights best practices and successful strategies, enabling countries and cities to gain insights into developing whole life carbon policies.

As part of the OECD Programme on Decarbonising Buildings in Cities and Regions, this report addresses a critical gap in global decarbonisation strategies by placing whole life carbon at the forefront of the conversation. It equips policy makers both at national and subnational level with actionable insights, practical tools, and proven examples to accelerate the adoption of comprehensive building decarbonisation policies.

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The project was led by Takeshi Miyamori, Senior Manager of the Sustainable Buildings Unit, with the support of Marie Hanagata and Ji Soo Yoon, Policy Analysts, under the supervision of Aziza Akhmouch, Head of the Cities, Urban Policies and Sustainable Development (CITY) Division in the CFE.

The report was drafted by Marie Hanagata and Ji Soo Yoon under the guidance of Takeshi Miyamori. Additional contributions were provided by Connaught Lee and Matylda Strand, with desk research support from Andres Rocha Zarate and Gunes Ozcoban (all CFE). The report benefited from comments and suggestions from Nadim Ahmad, Deputy Director, and Soo-Jin Kim, Deputy Head of the Cities, Urban Policies and Sustainable Development Division in the CFE.

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Table of contents

FIGURES

TABLES

BOXES

Abbreviations and acronyms

3D	Three-dimensional
ADEME	*Agence de la transition écologique*, French Agency for Ecological Transition
AGEC	*Anti-gaspillage pour une économie circulaire* (Anti-Waste for a Circular Economy)
BBR	*Bundesamt für Bauwesen und Raumordnung*, Federal Office for Building and Regional Planning of Germany
BBSR	*Bundesinstitut für Bau-, Stadt- und Raumforschung*, Federal Institute for Research on Building, Urban Affairs, and Spatial Development of Germany
BCIT	British Columbia Institute of Technology
BECD	The *Built Environment Carbon Database* of United Kingdom
BilanBEPOS	*Bilan énergétique du bâtiment à énergie positive*, Energy assessment of the energy positive building
BIM	Building Information Modelling
BM	*Byggsektorns Miljöberäkningsplattform*, Building Sector Environmental Calculation Tool of Sweden
BMNL	*Beleidscommissie Milieuprestatie Nederland*, Netherlands Policy Committee on Environmental Performance
BMUV	*Bundesministerium für Umwelt, Naturschutz, nukleare Sicherheit und Verbraucherschutz,* German Ministry of Environment, Nature Conservation, Nuclear Safety and Consumer Protection
BMWSB	*Bundesministerium für Wohnen, Stadtentwicklung und Bauwesen,* Federal Ministry for Housing, Urban Development, and Building of Germany
BNB	*Bewertungssystem Nachhaltiges Bauen*, Assessment System for Sustainable Building
Boverket	Swedish National Board of Housing, Building and Planning
BR18	Denmark Building Regulations 2018
BUILD	Department of the Built Environment of Aalborg University
CAD	Canadian Dollar
CBAM	Carbon Border Adjustment Mechanism of the European Union
CBCS	*Conselho Brasileiro de Construção Sustentável*, Brazilian Council for Sustainable Construction
Cerema	*Centre d'études et d'expertise sur les risques, l'environnement, la mobilité et l'aménagement,* Centre for Studies on Risks, the Environment, Mobility and Urban Planning
CIEC	*Centro de Innovación y Economía Circular* ,Intersectoral Committee for Circular Economy

CO_2	Carbon dioxide
COP28	28th United Nations climate change conference
CoPIL	Steering Committee of E+C- project
CoTec	Technical Committee E+C- project
CPR	Construction Products Regulation of the EU
CRF	Cumulative radiative forcing
CTCN	United Nations Climate Technology Centre & Network
DGNB	*Deutsche Gesellschaft für Nachhaltiges Bauen*, German Sustainable Building Council
DKK	Danish Krone
DPP	Digital Product Passport
E+C-	Positive Energy, Carbon Reduction Project of France
Eges	*Émissions de Gaz à Effet de Serre sur l'ensemble du cycle de vie*
EgesPCE	*Émissions de Gaz à Effet de Serre de produits de construction et des équipements utilisés*
ELAN	*Évolution du logement, de l'aménagement et du numérique,* Evolution of housing, development and digital technology
EN	European standard
ENEC	*La Estrategia Nacional*, National Circular Economy Strategy of Costa Rica
EPBD	Energy Performance of Buildings Directive of European Union
EPC	Energy Performance Certificate
EPD	Environmental Product Declaration
EU	European Union
EUDP	*Det Energiteknologiske Udviklings- og Demonstrationsprogram*, The Energy Technology Development and Demonstration Programme of Denmark
EUR	Euro
G7	The Group of Seven
GHG	Greenhouse gas
GIZ	*Deutsche Gesellschaft für Internationale Zusammenarbeit*, German International Cooperation Agency
GLA	Greater London Authority
GWP	Global Warming Potential
IBECS	The Institute for Built Environment and Carbon Neutral for SDGs of Japan
ILCD	International Life-Cycle Data System
INIES	Environmental and health benchmarks for buildings of France

J-CAT	Japan Carbon Assessment Tool for Building Lifecycle
kg	*Kilogram*
LCA	Life-Cycle Assessment
LCC	Life-Cycle Cost
LFM30	Local Roadmap for a Climate Neutral Building & Construction Industry in Malmö 2030
LPG	Greater London Plan Guidance
MDPE	Products, Equipment, Materials and Waste
MLIT	Ministry of Land, Infrastructure, Transport and Tourism of Japan
NGOs	Non-governmental organizations
NMD	Netherlands' Nationale Milieudatabase
NZEB	Nearly Zero-Energy Building
OECD	Organisation for Economic Co-operation and Development
PPPs	Public-private partnerships
PTNB	*Plan Transition Numérique dans le Bâtiment*, Digital Transition Plan in the Building Industry of France
QNG	*Qualitätssiegel Nachhaltiges Gebäude*, The Sustainable Building Quality Seal
RE2020	*Réglementation environnementale*
SDGs	Sustainable Development Goals
SIDAC	Brazil's Information System for Environmental Performance in Construction
SMEs	Small- and medium-sized enterprises
SPIPA	Strategic Partnerships for the Implementation of the Paris Agreement
SYKE	*Suomen ympäristökeskus,* Finnish Environment Institute
TIC	Technical Committee of the Policy Committee on Environmental Performance of Netherlands
UK	United Kingdom
UNEP	United Nations Environment Programme
US	United States
VBBL	Vancouver Building By-law
VCBK	*Videncenter om Bygningers Klimapåvirkninger,* Knowledge Centre on Climate Impacts of Buildings
WBCSD	The World Business Council for Sustainable Development
WLC	Whole life carbon

Executive summary

The day-to-day use of buildings generates significant operational emissions (e.g. through lighting, heating and cooling) and recent decades have seen an acceleration in efforts to reduce these, notably as a response to climate change and more recently to the energy and cost of living crisis. However, these are not the only emissions to account for when calculating the overall carbon footprint of buildings. The production and the eventual demolition of buildings are also significant sources of emissions. These emissions, typically referred to as embodied carbon or embodied emissions, are expected to account for around half of the total carbon footprint of new buildings by 2050 if left unaddressed.

To achieve net-zero emission buildings, governments need to adopt a whole life-cycle approach, which addresses both operational and embodied carbon to reduce a building's overall footprint. Whole life carbon, however, has, at least until recently, been a blind spot in global climate policy, despite the fact that much of the progress made on reducing operational emissions has arisen through the construction of newer, more energy-efficient buildings. Indeed, reducing embodied emissions can also enhance resource efficiency, promote material circularity, and drive innovation in construction practices.

The new OECD Global Survey on Whole Life Carbon of Buildings aims to accelerate progress on embodied emissions by providing in-depth insights on how to integrate whole life carbon approaches into regulatory frameworks and sustainable development strategies.

Key findings from the survey

Numerous national and subnational policy measures are already in place. **Key regulatory approaches** include mandatory whole life carbon assessments and reporting, as well as the establishment of limit values for carbon emissions. Mandatory reporting frameworks, such as those in Germany, Sweden, and Greater London (UK), provide a foundation for compliance on and oversight of carbon emissions across all the different construction stages. Limit values, adopted by Denmark and France, for example, set clear maximum thresholds for emissions, encouraging innovation in low-carbon construction practices that can accelerate progress on climate goals.

At the same time, the effective implementation of these measures depends on **several enabling factors**. These include the development of standardised methodologies to ensure consistency and accuracy in carbon assessments, alongside the adoption of digital tools to support data collection and analysis. For example, Sweden's climate declarations provide a standardised format for reporting climate data on upfront emissions (A1-A5 stages), while Singapore has a Green Mark certification to assess both operational and embodied carbon.

In addition, **training and education programmes** are crucial for building stakeholder capacity and raising awareness. For instance, France's Massive Open Online Course (MOOC) on Sustainable Building platform trains project managers on RE2020 regulations (France's standard for energy and environmental impact of buildings). **Financial incentives** can also help foster compliance and stimulate innovation. For example, Vancouver (Canada)'s NearZero programme, launched in 2018, provides subsidies to incentivise embodied carbon reduction and high-performance construction.

Complementary initiatives, such as voluntary certifications, are used in some countries to test industry readiness and establish benchmarks for sustainability before implementing regulations. For example, Germany's Sustainable Building Quality Seal (QNG) is voluntary standards for greenhouse gas (GHG) emissions throughout a building's life cycle. The QNG is verified by the Quality Assurance Association for Life-Cycle Assessment (LCA) Tools for Buildings e.V., whose aim is to test and confirm the quality of tools for standard-compliant and QNG-compliant LCAs for buildings using scientific methods. Circular economy approaches, like Malmö's LFM30 platform in Sweden and Oslo's guidelines for real estate developers in Norway, emphasise material reuse and waste reduction, integrating practices that lower embodied carbon and support sustainable construction goals.

However, several barriers persist, slowing the implementation of whole life carbon policies. This report outlines those barriers and provides targeted recommendations to overcome them.

Key challenges

1. **Limited adoption of whole life carbon policies**: Only 21% of countries that responded to the OECD Global Survey on Buildings and Climate currently implement policies that specifically target whole life carbon.
2. **High complexity of setting reference and limit values**: Developing whole life carbon benchmarks for diverse types of buildings is a complex task due to variations in building size, energy intensity and stock composition. This process requires extensive research and can be time-consuming.
3. **Limited Environmental Product Declaration data**: Limited availability of Environmental Product Declaration (EPD) data, which provide standardised information on the environmental impact of products, can lead to inaccurate whole life carbon assessment results. Construction product and material manufacturers can be reluctant to invest in environmental product declarations, largely because the expected return on investment is uncertain or low.
4. **Stakeholder burden**: Because buildings are composed of tens of thousands of parts, calculating whole life carbon can impose an onerous burden on developers, architects, and construction companies, especially in firms with limited expertise or human resources.
5. **Resource and expertise constraints at the local level**: Subnational governments, particularly municipalities and smaller cities, face significant institutional and capacity barriers in terms of implementing whole life carbon policies due to misaligned policies, workload pressures, and a shortage of experts within local authorities.
6. **Absence of immediate direct co-benefit for end users in embodied carbon policies**: Operational energy efficiency measures provide clear, direct advantages, including energy cost savings, improved health outcomes, and enhanced comfort for occupants. In contrast, addressing embodied carbon often imposes higher costs on construction stakeholders while offering limited tangible benefits for building owners and tenants. This economic imbalance can make whole life carbon initiatives less appealing compared to operational energy efficiency measures, as they lack the immediate co-benefits that drive stakeholder engagement and support. Consequently, these policies are unlikely to gain traction if left solely to market dynamics or public regulations alone.

Policy recommendations

1. **Apply a whole life-cycle approach to shift focus from only operational carbon to also address energy efficiency and embodied carbon**: Decarbonisation policies for buildings need to consider all aspects of construction – whether planning new buildings, undertaking renovations, or managing demolition and reconstruction. Tackling embodied carbon is particularly important for achieving immediate CO_2 reductions critical to achieve mid-term goals (e.g. those set for 2030), while also laying the foundation for achieving long-term targets such as net-zero emissions by 2050. Notably, embodied emissions are projected to represent approximately half of the total carbon footprint of buildings by 2050 if left unaddressed.
2. **Adopt a step-by-step approach to the implementation of whole life carbon policies**: Long-term roadmaps should establish measurable goals and phased milestones, starting with relatively simpler measures such as mandatory climate impact reporting, which not only fosters stakeholder "buy-in" and engagement but also serve as a testing ground for more complex interventions. Over time, governments can introduce stricter emission limits and more complex interventions. Categorising buildings into different types (e.g., residential, commercial) allows for tailored benchmarks that reflect varying emission reduction potentials, as seen in France's RE2020 regulation and Sweden's phased whole life carbon strategy. Stakeholder engagement and public-private partnerships, exemplified by Denmark's collaborative climate roadmaps and carbon limit regulations, are crucial to align efforts, mobilise resources, and ensure flexibility. This incremental approach balances ambition with practicality, fostering innovation and ensuring progress toward decarbonising diverse building stocks.
3. **Develop strategies for data collection**: Incentivising Environmental Product Declaration (EPD) acquisition and developing a digital platform for data sharing can help enable the creation of a national database. By consolidating accurate and standardised data, such a database helps inform decision-making, facilitate benchmarking, set clear reduction targets, and monitor progress. It can also promote transparency and collaboration across sectors, driving more effective and cohesive emissions reduction efforts. To overcome limited industry capacity for generating EPDs, countries such as the Netherlands and Denmark have introduced financial support programmes to incentivise manufacturers, while Denmark, France, Finland and Sweden have encouraged EPD use by setting more conservative generic emission data. This approach ensures that products without EPDs are assigned higher emissions values, effectively making EPD-certified products more advantageous.
4. **Deploy digital tools to reduce workload**: Developing comprehensive databases and standardised assessment tools such as the Netherlands' Nationale Milieudatabase, enables firms to conduct accurate and efficient whole life carbon assessment. Building Information Modelling (BIM) is critical for centralising data and automating whole life carbon assessments, but its adoption —especially among SMEs—remains limited. Initiatives like France's Plan BIM and Japan's BIM Acceleration Project demonstrate how financial support, training, and standardisation can promote widespread BIM use.
5. **Enhance vertical co-ordination to empower city-led initiatives**: Cities are uniquely positioned to lead ambitious initiatives that can drive significant emission reductions with their regulatory authority, proximity with stakeholders and ability to act as innovation hubs. For instance, cities like Tampere, Helsinki, and Vancouver have implemented stricter standards than national regulations and adopted innovative practices. To maximise their potential, national governments should establish coherent frameworks with standardised methodologies, accessible tools, and national databases, while creating platforms for regular information exchange with cities. Disparities in capacity, particularly in smaller cities, highlight the need for national support through funding, training, and tailored guidance. Effective national/local co-ordination is essential to scale up

individual cities' successes nationally, fostering impactful whole life carbon policy implementation across all regions.

6. **Strengthen horizontal collaboration and public-private-academic partnerships**: Horizontal collaboration, such as Sweden's inter-municipal and Japan's inter-ministerial initiatives, promotes knowledge-sharing, aligns policies, and breaks down silos to advance coherent national roadmaps. Public-private-academic partnerships mobilise expertise for developing methodologies, databases, and pilot projects (e.g., Brazil's SIDAC, Japan's J-CAT) while addressing skill gaps through training programmes like Nordic Skills4Reuse. Early stakeholder mapping, as in the Netherlands' NMD model, ensures clear roles and responsibilities, minimising conflicts and enabling efficient whole life carbon policy implementation.

1 Setting the scene: Why is it critical to reduce carbon across the entire life of a building?

This chapter establishes the rationale for the report by explaining why addressing whole life carbon is essential for decarbonising buildings. It outlines key global initiatives aimed at reducing whole life carbon emissions, reflecting global momentum toward comprehensive carbon reduction strategies in the building sector. The chapter introduces the OECD Global Survey on Whole Life Carbon, which serves as the main data collection method for this report.

Introduction

Why is it essential to decarbonise buildings to achieve net-zero targets?

Buildings are responsible for 37% of energy-related CO_2 emissions, making them a critical lever to reduce GHG emissions worldwide (UNEP, 2022[1]). Although the energy consumed per square meter in buildings has steadily decreased, the pace of reduction needs to accelerate significantly – nearly fivefold – over the next decade (IEA, n.d.[2]). Between 2010 and 2020, the new built-up areas across the globe consumed an area as big as Austria (OECD, 2024[3]). By 2030, global floor area is expected to increase by around 15%, meaning that every week, a new area the size of Paris is built around the globe (United Nations, 2023[4]).

Moreover, the demand for new buildings is poised to surge in the future. In Africa, where the population is forecast to rise to at least 2.4 billion by 2050 (African Development Bank, n.d.[5]), the residential building stock is projected to double to almost 50 billion m^2 over the same period (IEA, 2023[6]), with 80% of new construction taking place in cities, especially slums (Muggah and Kilcullen, 2016[7]). Similarly, Asia will see a substantial rise in construction as another 65% of the current floor area is projected to be built between 2020 and 2050 (IEA, 2022[8]). Most of the growth will take place in the residential sector due to population growth and the increasing number of households, linked to increasing income (GlobalABC/IEA/UNEP, 2020[9]).

Decarbonising the urban built environment is a complex task, involving many different stakeholders and interests across multiple levels. On the one hand, buildings are inherently local infrastructure subject to different climate zones, historical contexts, and social conditions. Decarbonisation solutions should therefore be tailored to local needs. For instance, there are varying decarbonisation needs of existing buildings with respect to energy use between rural and urban areas in OECD countries (OECD, 2024[3]). On the other hand, decarbonising buildings requires global co-ordination of efforts and innovation in terms of materials, design, and energy use. By sharing research, technology, and strategies that have proven effective, countries can avoid duplication of effort, speed up the adoption of sustainable practices, and make more efficient use of resources.

In response to the multifaceted challenge of decarbonising the urban built environment, governments around the world are taking action at supranational, national and local levels. On a supranational level, for example, the European Union's (EU) Energy Performance of Buildings Directive (EPBD), updated in 2024, sets decarbonisation milestones for member states. Nationally, many countries are setting their own standards for energy efficiency in buildings, such as Norway's TEK17, Denmark's BR18, and France's RE2020. At the local level, cities such as Vancouver (Canada) and New York (US) have implemented local carbon limits for large buildings, striving for impactful measures.

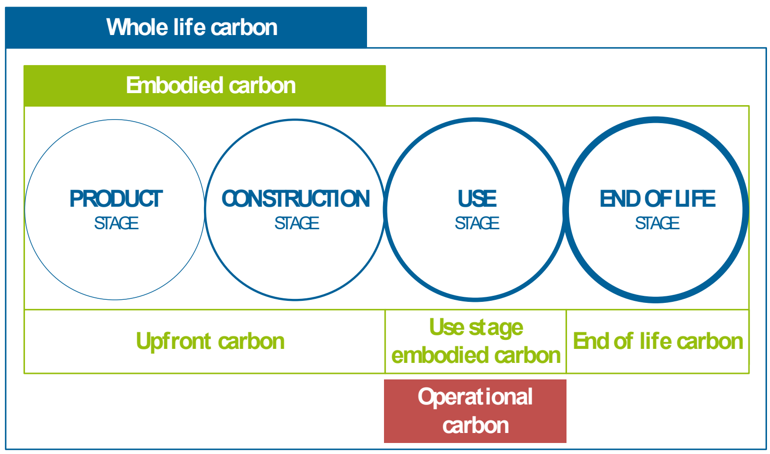
Why address whole life carbon in buildings?

To mitigate climate change, emissions have to be reduced across the entire life-cycle of a building, from its construction to its demolition. As shown in Figure 1.1, whole life carbon (WLC) encompasses both *operational* and *embodied* carbon:

- **Operational carbon** refers to the emissions produced during a building's in-use phase, primarily from energy consumption for heating, cooling, lighting, and powering appliances. Technological advancements and increased use of renewable energy have started to reduce these emissions. In 2021, operational carbon represented 75% of emissions in the building sector. Improving energy efficiency, including by enhancing the bioclimatic performance of buildings as well as scaling up renewable energy capacity, should remain a priority, as reiterated during COP28 (COP28, 2023[10]).

- **Embodied carbon** includes emissions from the extraction, manufacturing, transportation, and installation of building materials, as well as those arising from maintenance and end of life. As buildings become more energy-efficient, embodied carbon must also be reduced to move closer to a net-zero built environment. At the global level, addressing embodied carbon is now recognised as critical for achieving comprehensive carbon reduction in the built environment (World Green Building Council, 2019[11]). Embodied carbon currently contributes about 13% of global annual GHG emissions, stemming from materials manufacturing and construction activities (Carbon Leadership Forum, n.d.[12]).

Figure 1.1. Reducing carbon emissions in each life-cycle stage

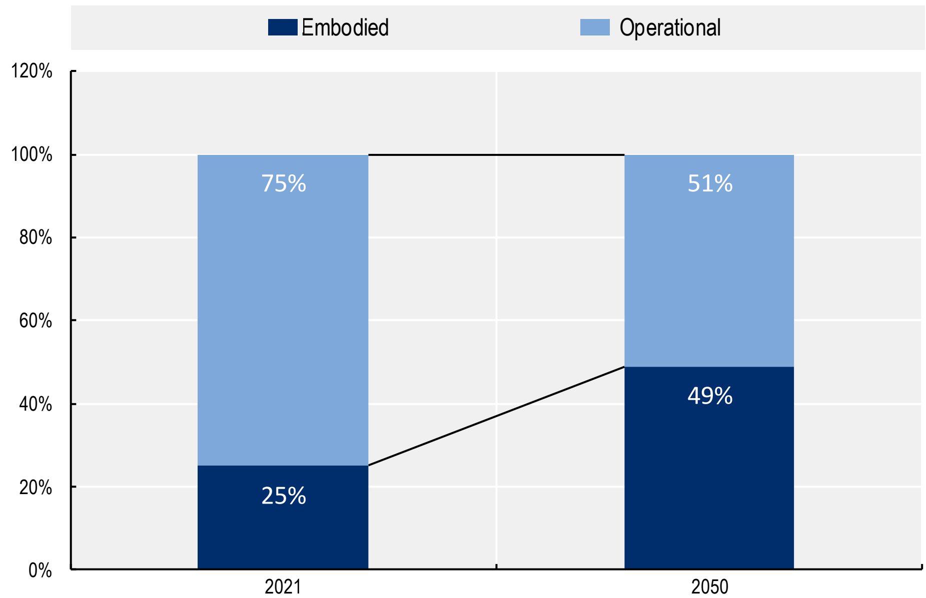


Source: Author's elaboration based on European standard EN 15978.

Furthermore, it is essential to implement circularity principles in the built environment to reduce embodied carbon. Embracing a circular approach entails maximising resource utilisation and minimising waste across a building's entire lifespan. A circular economy approach entails both the construction stage, by utilising recycled materials, and the demolition stage, by salvaging materials that can be used in the future.

If no action is taken, half of the carbon footprint of new buildings will stem from embodied carbon emissions by 2050 (Figure 1.2). Given the complexity of supply chains, reducing embodied carbon will be a lengthy process, emphasising the importance of initiating reductions immediately (World Green Building Council, 2019[11]).

Figure 1.2. Projected contributions from embodied and operational carbon within the building sector



Source: UNEP (2023), "Building Materials and the Climate: Constructing a New Future" https://wedocs.unep.org/handle/20.500.11822/43293

A global momentum towards reducing whole life carbon

As the share of embodied carbon is projected to increase in the coming decades, global efforts to achieve net-zero buildings are gaining momentum.

G7 Sustainable Urban Development Ministers' Communiqué in 2024

In November 2024, G7 Ministers came together in Rome (Italy) to hold a third Ministerial meeting on Sustainable Urban Development. The first Ministerial meeting was held under the German presidency, while the second meeting took place in Japan. Building on the 2023 G7 Sustainable Urban Development Ministers' Communiqué, which underlines the importance of pursuing net-zero building life-cycles from design and construction through operation, management, and demolition (Ministry of Land, Infrastructure, Transport and Tourism of Japan, 2023[13]), the 2024 Communiqué highlights the use of low-carbon materials in construction and consideration of their entire life-cycle (G7, 2024[14]). This continued commitment reflects a growing international consensus on the need for enhanced co-operation to achieve net-zero buildings.

EU climate ambitions

EU Taxonomy

The EU Taxonomy, which entered into force on 12 July 2020, is a tool to help investors, companies, issuers of financial products, and project promoters navigate the transition to a low-carbon, resilient and resource-efficient economy. The Taxonomy sets performance thresholds, referred to as "technical screening criteria", for economic activities (EU Technical Expert Group on Sustainable Finance, 2020[15]). Established as part of the EU's sustainable finance framework, it aims to direct financial flows toward projects and activities that support environmental objectives, such as reducing GHG emissions and promoting biodiversity. This helps align investments with the EU's climate and environmental goals, particularly the target of achieving net-zero emissions by 2050 as outlined in the European Green Deal (European Commission, n.d.[16]).

Some of the technical screening criteria set for the building sector, closely related to WLC of buildings, are summarised in Table 1.1. In 2023, the updated Delegated Act, an integral part of the EU Taxonomy, specifies the screening criteria under which economic activities can be qualified as contributing substantially to the environmental objectives. The Act highlights the importance of a WLC approach, by encompassing life-cycle Global Warming Potential (GWP) calculations for all renovation projects. It also puts greater emphasis on the circularity of materials and building components by setting an upper limit for the proportion of primary materials used in a building. These criteria contribute to a holistic, life-cycle approach to carbon reduction, covering both construction materials and long-term energy performance (European Commission, 2021[17]; European Commission, 2023[18]).

Table 1.1. Implications of the EU Taxonomy for the building sector

Type of economic activity	Technical screening criteria
New constructions	• For buildings > 5000m^2: The **life-cycle global warming potential of the building is calculated** for each stage and is disclosed to investors and clients on demand. • Compliance with maximum total amounts of primary raw materials used: e.g. 70% for the combined total of concrete, natural or agglomerated stone, 80% for bio-based product, and 65% for gypsum. • At least 90% (by weight) of the non-hazardous construction and demolition waste generated on the construction site is prepared for reuse or recycling.
Renovation of existing buildings	• The **life-cycle global warming potential of the building's renovation works** has been calculated for each stage in the life cycle, from the point of renovation, and is disclosed to investors and clients on demand. • At least 50% of the original building is retained, based on the gross external floor area. • At least 70% (by weight) of the non-hazardous construction and demolition waste generated on the construction site is prepared for reuse or recycling.

Source: European Union (2021), "COMMISSION DELEGATED REGULATION (EU) 2021/2139" https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32021R2139 ; European Union (2023), "COMMISSION DELEGATED REGULATION (EU) 2023/248" https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=OJ:L_202302486

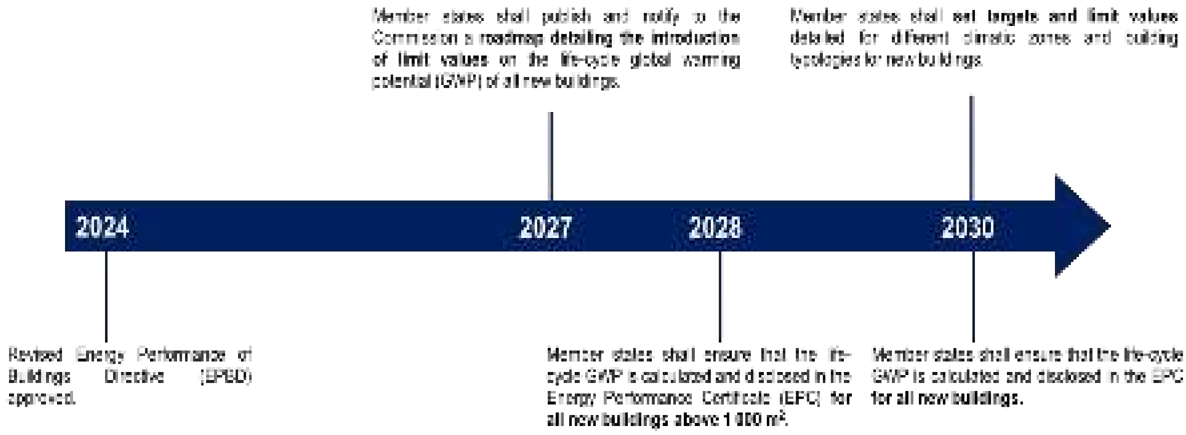
Revision of the EU Energy Performance of Buildings Directive (EPBD)

The EU's 2024 revision of the Energy Performance of Buildings Directive (EPBD) represents a major step forward in global efforts to reduce climate change impacts within the building sector. As part of the EU's Green Deal, the directive aims to cut both operational and embodied carbon emissions, setting a new benchmark for sustainable construction (European Commission, 2021[19]).

The 2010 EPBD introduced Nearly Zero-Energy Buildings (NZEBs), primarily focusing on operational energy efficiency. The 2024 update significantly expands the directive's scope to include WLC reduction, aligning with the EU's climate neutrality goals. It requires member states to publish a roadmap detailing the introduction of limit values on total cumulative life-cycle GWP for all new buildings by 2027 and mandates carbon assessments to be disclosed through Energy Performance Certificates (EPCs) for large buildings from 2028 onwards (Figure 1.3).

Additionally, the directive places a strong emphasis on social fairness, ensuring that vulnerable populations receive financial and technical assistance. This approach aligns with the EU's broader commitment to social equity under the Green Deal. By addressing both operational and embodied carbon throughout a building's entire life-cycle, the 2024 EPBD sets a new international standard for sustainable construction. It supports climate action while fostering social inclusivity, offering a forward-thinking model for other regions to emulate (European Commission, 2024[20]).

Figure 1.3. Roadmap of the EU's revised Energy Performance of Buildings Directive (EPBD) related to whole life carbon



Source: EU (2024), "DIRECTIVE (EU) 2024/1275 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 24 April 2024 on the energy performance of buildings (recast)" https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32024L1275

Chaillot Declaration in 2024

In 2024, the Buildings and Climate Global Forum, led by the French government, brought together ministers and high-level representatives from over 40 organisations in an unprecedented effort to enhance the decarbonisation and resilience of the building sector. The forum included the first ever global ministerial meeting on buildings and construction, as well as thematic roundtables. During the ministerial meeting, 64 governments endorsed a framework called the Chaillot Declaration for global efforts to achieve decarbonisation and climate change resilience in the building sector through a whole life-cycle approach (Box 1.1).

Box 1.1. Chaillot Declaration commitments for decarbonising buildings and enhancing climate resilience

The Chaillot Declaration, signed by 64 countries around the world in March 2024, includes 10 policy commitments for decarbonising buildings and enhancing climate resilience. Signatory governments committed to establishing inclusive decarbonisation and resilient pathways for buildings at all levels, with adjustments to actions based on each country's specific context.

In particular, objective 5.2 "Construction/Retrofitting" addresses WLC of buildings. Signatory countries committed to "plan, design, build, operate and manage all-round sustainable, culturally, functionally, socially, and economically climate adapted, resource efficient, zero-emission, healthy, safe, flexible and resilient buildings through a **whole life-cycle approach**". For both new construction and retrofitting, sustainability of building projects is to be achieved notably by prioritising on-site assets, recycled and end-of-life use, local, sustainable, bio/geo-sourced, low carbon, energy efficient materials. This is expected to ensure easy maintenance and repair for life extension, aligned with circular economy, eco-design, sufficiency and waste prevention principles. Moreover, carbon balance should be enhanced through storage and absorption in building materials (5.2.4).

In addition, signatories of the Declaration committed to promoting the production, development and use of low-carbon and sustainably sourced construction materials at affordable costs (6.5).

Source: Ministry of Ecological Transition and Territorial Cohesion (2024), Déclaration de Chaillot, https://www.ecologie.gouv.fr/rendez-vous/forum-mondial-batiments-climat/declaration-chaillot

Disclosure of Scope 3 emissions in sustainable finance

As mentioned above, operational carbon refers to emissions produced during a building's use, while embodied carbon encompasses emissions from the materials and processes used in its construction. In contrast, Scope 1, 2, and 3 emissions are classified as such on the basis of ownership and control, distinguishing between direct and indirect sources.

Scope 1 covers direct emissions from sources that are owned or controlled by a company, while Scope 2 refers to indirect emissions from the purchase and use of electricity, steam, heating and cooling. In contrast, Scope 3 includes all other indirect emissions that occur in the upstream and downstream activities of an organisation. If a company or an individual acquires a real estate asset, embodied carbon will be associated with Scope 3 emissions (GHG Protocol, 2024[21]).

The financial sector is increasingly acknowledging the need to take into account Scope 3 emissions. The focus on Scope 3 is driven by new regulatory requirements and growing investor demand for comprehensive carbon reporting, particularly in countries such as the United States or New Zealand where emerging rules mandate disclosure of Scope 3 emissions (GHG Protocol, 2024[21]). Despite this shift, many companies are still unprepared to tackle the complexities of Scope 3 reporting, facing significant barriers such as data quality issues, complex value chains, and inconsistent standards.

The Investor Group on Climate Change (IGCC), a network for Australian and New Zealander investors to understand and respond to climate risks and opportunities that also functions at a global scale through various projects such as Climate Action 100+, underscores the role of Scope 3 reporting in reshaping investment strategies and emphasises the need for the financial sector to support improved carbon disclosures. This focus is further reinforced by the growing importance of WLC assessments, which take into account all emissions over a building's life-cycle, providing a more comprehensive view of their environmental impact and aligning with sustainable finance objectives (IGCC, 2024[22]). The emphasis on

Scope 3 emissions and WLC assessments reflects a broader trend towards holistic carbon accounting. As the financial sector continues to evolve, robust Scope 3 reporting will be crucial for companies to maintain regulatory compliance, investor trust, and market competitiveness, reinforcing the link between sustainability and financial performance.

Overview of the OECD Global Survey on Whole Life Carbon of Buildings

According to *the OECD Global Monitoring of Policies for Decarbonising Buildings: A Multi-level Approach* (2024), respondent countries currently focus primarily on energy-related measures, whereas WLC receives comparatively less attention. Looking ahead, respondent countries anticipated a significant shift regarding WLC policies. Embodied carbon will increase from 14% (of responding countries) in current priorities to 43% in future priorities, and the circularity of materials from 11% to 68% (OECD, 2024[23]).

Similarly, the Global Monitoring showed that while many countries have established policy measures for operational carbon, such as mandatory energy efficiency codes (89%) and mandatory Energy Performance Certificates (EPCs) (61%), only a few (21%) respondent countries have implemented regulations tackling WLC.

In light of the increasing importance of embodied carbon, the OECD has conducted a Global Survey on Whole Life Carbon of Buildings (2024) (Box 1.2). The survey has collected cutting-edge data and information across 15 countries and cities, while accounting for their varying economic sizes, geographical characteristics, and governance structures.

While methodologies and definitions differ across countries and cities, the survey has set a common framework that enables comparison. The survey has also identified best practices, allowing countries and cities to draw insights from successful approaches and identify relevant policy areas when developing WLC policies.

Box 1.2. The OECD Global Survey on Whole Life Carbon of Buildings

To gain a granular understanding of WLC policy development around the world, the OECD conducted an online survey from August to November 2024. The survey targeted countries who reported having a national methodology for WLC assessment in the OECD Global Survey on Buildings and Climate (2024), as well as cities that developed WLC initiatives. While policy makers increasingly recognise the importance of decarbonising buildings throughout their entire life-cycle, only a limited number of countries and cities have introduced WLC calculation and reduction as a policy. Consequently, the survey collected data and information not only on implemented policies, but also on policies currently being developed. The survey consisted of five sections: i) goals and strategies of WLC policies; ii) policy instruments for WLC policies; iii) enabling factors for WLC policies; iv) multi-level approaches for WLC policies; and v) challenges and countermeasures in WLC policies.

To map out the status of WLC policies, the survey was disseminated both to countries and cities that have implemented WLC policies and to those where policy development is currently underway. This interim report is based on responses received from 11 countries and 7 cities as of 29 November 2024 (Table 1.2).

Table 1.2. List of countries and cities that responded to the OECD Global Survey on Whole Life Carbon of Buildings

	Respondents
Countries (11)	Brazil, Costa Rica, Denmark, Finland, France, Germany, Israel, Japan, the Netherlands, Singapore (city-state), Sweden
Cities (7)	Espoo (Finland), Helsinki (Finland), Greater London (UK), Malmö (Sweden), Oslo (Norway), Tokyo (Japan), Vancouver (Canada)

Source: OECD Global Survey on Whole Life Carbon of Buildings (2024)

References

African Development Bank (n.d.), *Human Development*, https://www.afdb.org/en/knowledge/publications/tracking-africa%E2%80%99s-progress-in-figures/human-development#:~:text=By%202050%2C%20the%20African%20population,by%20more%20than%20fertility%20rates. [5]

Carbon Leadership Forum (n.d.), *The Embodied Carbon Challenge,*, https://carbonleadershipforum.org/carbon-challenge/. [12]

COP28 (2023), *Letter to Parties*, https://www.cop28.com/en/letter-to-parties. [10]

EU Technical Expert Group on Sustainable Finance (2020), *Taxonomy: Final report of the Technical Expert Group on Sustainable Finance*, https://finance.ec.europa.eu/system/files/2020-03/200309-sustainable-finance-teg-final-report-taxonomy_en.pdf. [15]

European Commission (2024), *Energy Performance of Buildings Directive adopted to bring down energy bills and reduce emissions*, https://ec.europa.eu/commission/presscorner/detail/en/IP_24_1965. [20]

European Commission (2023), *COMMISSION DELEGATED REGULATION (EU) 2023/2486 of 27 June 2023*, https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=OJ:L_202302486. [18]

European Commission (2021), *COMMISSION DELEGATED REGULATION (EU) 2021/2139 of 4 June 2021*, https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32021R2139. [17]

European Commission (2021), *DIRECTIVE OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL on the energy performance of buildings (recast)*, https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:52021PC0802. [19]

European Commission (n.d.), *EU taxonomy for sustainable activities*, https://finance.ec.europa.eu/sustainable-finance/tools-and-standards/eu-taxonomy-sustainable-activities_en. [16]

G7 (2024), *G7 Sustainable Urban Development Mnisters' Communiqué*, https://www.g7italy.it/wp-content/uploads/Communique_Sustainable-Urban-Development-G7.pdf. [14]

GHG Protocol (2024), *Trends Show Companies Are Ready for Scope 3 Reporting with U.S. Climate Disclosure Rule*, https://ghgprotocol.org/sites/default/files/Trends%20Show%20Companies%20Are%20Ready%20for%20Scope%203%20Reporting%20with%20U.S.%20Climate%20Disclosure%20Rule.pdf. [21]

GlobalABC/IEA/UNEP (2020), *GlobalABC Regional Roadmap for Buildings and Construction in Asia 2020-2050*, https://globalabc.org/sites/default/files/inline-files/Asia_Buildings%20Roadmap_FINAL.pdf. [9]

IEA (2023), *Energy Efficiency for Affordability: Improving people's lives through delivery of a modern sustainable energy system in Kenya*, https://iea.blob.core.windows.net/assets/e283fa7f-9c09-4248-a4da-6b14124ded93/EnergyEfficiencyforAffordability.pdf. [6]

IEA (2022), *Roadmap for Energy-Efficient Buildings and Construction in the Association of Southeast Asian Nations*, https://www.iea.org/reports/roadmap-for-energy-efficient-buildings-and-construction-in-the-association-of-southeast-asian-nations. [8]

IEA (n.d.), , https://www.iea.org/energy-system/buildings (accessed on 14 November 2024). [2]

IGCC (2024), *cope 3 Emissions: A Necessary Frontier for Decarbonisation*, https://igcc.org.au/wp-content/uploads/2024/03/2024-IGCC-Scope-3-Emissions-Paper.pdf. [22]

Ministry of Land, Infrastructure, Transport and Tourism of Japan (2023), *G7 Sustainable Urban Development Ministers' Communiqué*, https://www.mlit.go.jp/g7sud2023-takamatsu-kagawa/assets/images/pdf/G7_SUD_Ministers_Communique.pdf (accessed on 29 October 2024). [13]

Muggah, R. and D. Kilcullen (2016), *These are Africa's fastest-growing cities – and they'll make or break the continent*, World Economic Forum, https://www.weforum.org/agenda/2016/05/africa-biggest-cities-fragility/. [7]

OECD (2024), *Global Monitoring of Policies for Decarbonising Buildings: A Multi-level Approach*, https://www.oecd.org/en/publications/global-monitoring-of-policies-for-decarbonising-buildings_d662fdcb-en.html. [23]

OECD (2024), *OECD Regions and Cities at a Glance 2024*, OECD Publishing, Paris, https://doi.org/10.1787/f42db3bf-en. [3]

UNEP (2022), *2022 Global Status Report for Buildings and Construction*, https://www.unep.org/resources/publication/2022-global-status-report-buildings-and-construction. [1]

United Nations (2023), *Building Paris every week: Urgent need to cut emissions in construction sector*, https://news.un.org/en/story/2023/09/1140677. [4]

World Green Building Council (2019), *Bringing embodied carbon upfront*, https://worldgbc.org/advancing-net-zero/embodied-carbon/. [11]

2 Regulatory measures and an enabling environment to reduce whole life carbon in buildings

This chapter presents regulatory measures - such as mandatory reporting and carbon emissions limits - to reduce whole life carbon emissions in the building sector. It discusses how governments can create an enabling environment to facilitate low-carbon initiatives. This includes notably adopting standardised methodologies for carbon assessment, utilising digital tools, supporting training and capacity building, providing financial incentives, encouraging voluntary certifications and promoting circularity principles.

Introduction

Governments play a crucial role in reducing WLC emissions of buildings, by creating an enabling environment and implementing regulatory measures. Indeed, some of the leading countries and cities in WLC policies have already introduced mandatory reporting or limit values as effective regulatory measures. However, implementation of such regulations must come after sufficient preparations.

This chapter will examine what kind of regulatory measures – such as mandatory reporting and carbon emission limits – have been introduced and implemented in leading countries and cities, as well as how governments are leveraging key elements of an enabling environment to make the introduction of these regulations feasible and effective. The following analysis draws on results from the 2024 OECD Global Survey on Whole Life Carbon of Buildings.

Regarding WLC policy development, respondents of the 2024 OECD Global Survey on Whole Life Carbon of Buildings reported the following main challenges: setting reference and limit values (9 out of 16 respondents), the development of a database, co-operation with developers and construction companies, and alignment with international policies (Figure 2.1).

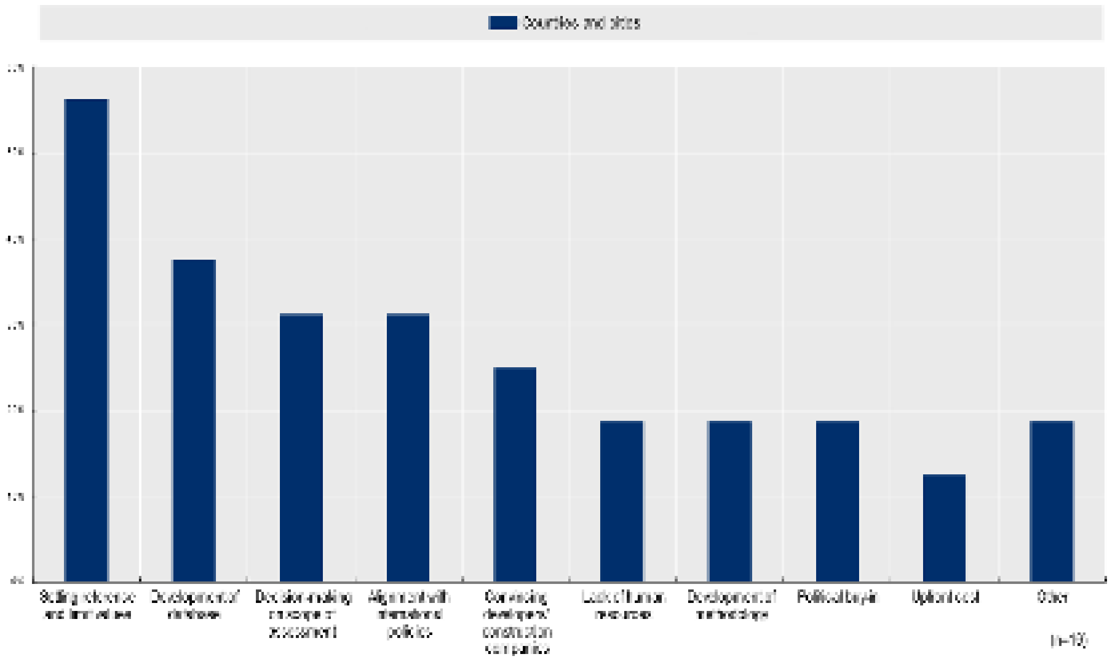
One of the reasons that explain these difficulties is the wide variation in building types. Indeed, buildings differ in aspects such energy intensity, size as well as the proportion of a given type in the building stock. This diversity calls for a detailed analysis to categorise building types and differentiate between them in a meaningful way. To effectively reduce emissions, limit values must be tailored to each building type, as their potential for emission reductions varies significantly.

As for WLC policy implementation, a major challenge identified by survey respondents is the additional workload imposed on industry stakeholders for WLC assessment (13 out of 18 respondents), followed by the lack of EPD data, the shortage of WLC experts in the private sector, and the workload imposed on local authorities (Figure 2.2).

These challenges arise mainly because WLC is a relatively new approach in decarbonising buildings, which many stakeholders are unfamiliar with. To comply with WLC policies, the industry must invest time and human resources in gaining expertise, collecting data, and conducting assessments, which adds to their workload.

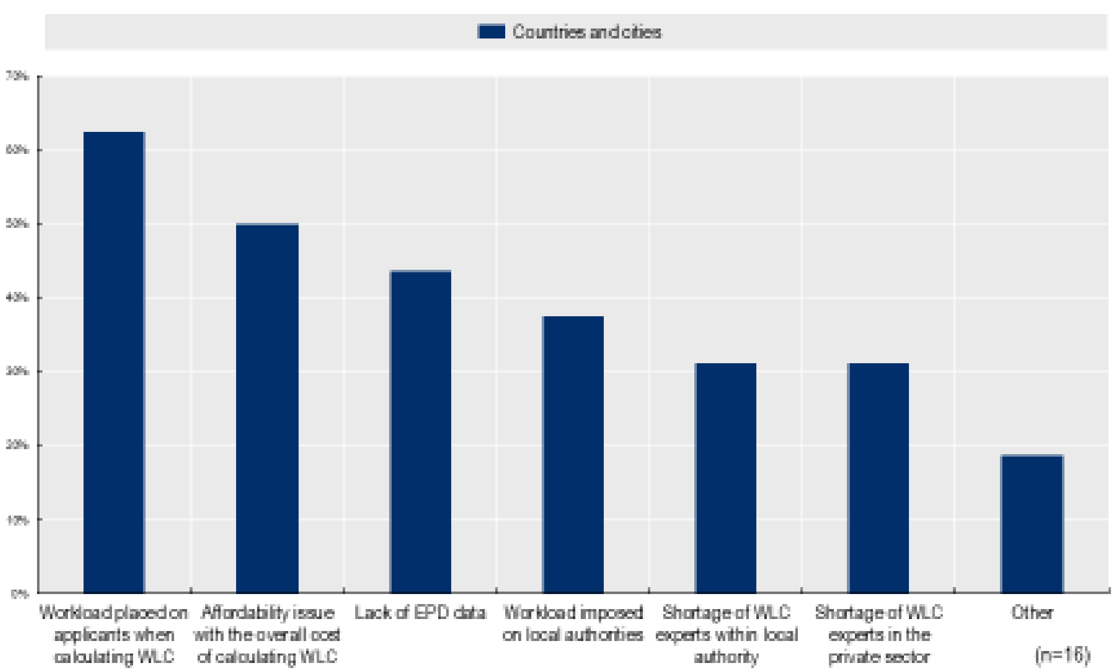
This chapter provides a comparative analysis of regulatory measures – such as mandatory reporting, and limit values – in the countries and cities that responded to the survey and discusses how these measures address the above-mentioned challenges and help foster an enabling environment.

Figure 2.1. Main challenges at the policy development stage



Note: Question from the survey: "Main challenges at the policy development stage" The responding countries and cities could select all applicable options.
Source: OECD Global Survey on Whole Life Carbon of Buildings (2024)

Figure 2.2. Main challenges at the policy implementation stage



Note: Question from the survey: "Main challenges at the policy implementation stage" The responding countries and cities could select all applicable options.
Source: OECD Global Survey on Whole Life Carbon of Buildings (2024)

Regulatory measures for reducing whole life carbon emissions

Mandatory whole life carbon assessment and reporting

A mandatory climate report is a document used to report the environmental performance of a building, often serving as a preliminary step toward the implementation of limit values. In leading countries, mandatory climate reporting is either already in use or being developed alongside or ahead of limit value regulations. However, the specific requirements for what, how, and when information should be reported vary across countries. This inconsistency influences how reporting systems are implemented and the mechanisms required to ensure compliance. The need for verification and potential sanctions depends on the stage of intervention – whether during the building permission phase or post-handover – as well as on the clarity of reporting requirements and the authority designated to review them. Key elements requiring verification in the report include inventory data, projected scenarios, environmental data, and calculation methodologies (Nordic Sustainable Construction, 2024[1]).

In **Sweden**, developers must submit a climate declaration (mandatory reporting) to the National Board of Housing, Building and Planning (Boverket) through its online platform, which reports carbon emissions from product stage and construction stage, i.e. upfront carbon (A1-A5), in order to receive a final approval, with a few exceptions such as buildings smaller than 100 m^2 or industrial buildings. The provisions apply to buildings where a building permit application was submitted on or after 1 January 2022 (Boverket, n.d.[2]) (Boverket, 2023[3]). Upon submission, Boverket issues a confirmation of receipt, which must in turn be sent to the local authority to obtain final approval. If a confirmation document for the climate declaration is not submitted to the local authority during the final approval phase, the authority may issue a provisional approval, specifying a deadline by which the confirmation must be submitted. This allows the building to be used temporarily before final approval (Boverket, 2024[4]).

Greater London (UK) has also implemented a mandatory requirement for the assessment and reporting of WLC emissions of buildings as part of the London Plan. This process requires report submission in three distinct phases: pre-application stage, planning application submission stage, and post-construction stage. The Greater London Authority (GLA) provides a standardised reporting template on its website. This template, developed as an Excel document, includes separate tabs corresponding to each submission stage – pre-application stage, planning application submission stage, and post-construction stage (Figure 2.3). The template is designed to guide applicants in understanding the information required at each submission stage and assist them in completing the necessary documentation. Alongside the template, London Plan Guidance outlines the basic information to fulfil the requirement as well as necessary steps for the application and submission procedure. The guidance also includes WLC benchmarks for the most common building types. At the pre-application stage, applicants are required to provide a baseline estimate of their project's WLC emissions. Following project completion, the applicants must compare the actual post-construction WLC emissions with these benchmark and baseline emissions, and any discrepancies must be explained within the reporting document. Box 2.1 showcases the content of required information at each submission stage (Greater London Authority, 2022[5]).

Figure 2.3. Greater London's reporting template for whole life carbon of buildings

Note: This is an image of climate reporting template provided by GLA, which is available online.
Source: Mayor of London, https://www.london.gov.uk/programmes-strategies/planning/planning-applications-and-decisions

Box 2.1. Information requirements of the London Plan for each submission stage

Pre-application stage

1. A description of the proposed development.
2. Confirmation that options for retaining existing buildings and structures have been fully explored before considering substantial demolition, including incorporating the fabric of existing buildings into the new development.
3. The carbon emissions associated with pre-construction demolition.
4. An estimate of the percentage of the new build development which will be made up of existing facades, structures, buildings.
5. The WLC principles that are informing the development of the site.

Planning application submission stage

1. Project and assessment details e.g. brief description of the project, software tool used, type of environmental product declarations (EPDs) used.
2. Confirmation that the assessment accounts for a minimum of 95% of the capital cost allocated to each building element category.
3. An explanation of the third-party mechanisms that have been adopted to assure the quality of the submission.

4. Estimated total WLC emissions ($kgCO_2e$ and $kgCO_2e/m^2$ GIA) for each life-cycle module, which will form the baseline for the development.
5. Confirmation that options for retaining existing buildings and structures have been fully explored before considering substantial demolition.
6. The carbon emissions associated with pre-construction demolition.
7. The percentage of the new build development that will be made up of existing façades, structures, buildings.
8. Summary of key actions to achieve the WLC emissions reported and the emission reductions they are expected to achieve.
9. Opportunities to reduce the development's WLC emissions further.
10. Completion of the 'material quantities and end-of-life scenarios' table covering all building element categories, in line with the Bill of Materials.
11. Completion of the "GWP of all life-cycle modules" table.

Post-construction stage

1. An update of the information provided at planning submission stage using the actual WLC emission figures.
2. A comparison of the post-construction results with the WLC emissions baseline reported at planning submission stage and an explanation for the difference.
3. A comparison of the post-construction results with the WLC benchmarks with an explanation for the difference.
4. A summary of the lessons learnt that will inform future projects.
5. To support the results provided in the template, the following minimum evidence requirements should be submitted at the same time:
   a. Site energy (including fuel) use record,
   b. Contractor confirmation of as-built material quantities and specifications,
   c. Record of material delivery including distance travelled and transportation mode,
   d. Waste transportation record including waste quantity, distance travelled, and transportation mode broken down into material categories used in the assessment,
   e. A list of product-specific EPDs for the products that have been installed.

Source: Mayor of London (2022), https://www.london.gov.uk/sites/default/files/lpg_-_wlca_guidance.pdf

Mandatory whole life carbon assessment and reporting with target values

In **Germany,** mandatory assessment of WLC of buildings was first introduced in 2011 for certain federal construction projects – office, administrative, educational and laboratory buildings – in the form of an Assessment System for Sustainable Building (BNB: Bewertungssystem Nachhaltiges Bauen in German). The obligation was extended to all major civil federal construction measures in 2013.

The core criteria of the BNB system were developed by the former Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB), with scientific support from the Federal Institute for Research on Building, Urban Affairs and Spatial Development (BBSR), in a two-year co-operative collaboration with the German Sustainable Building Council (DGNB). In the BNB system, five evaluation groups - ecological, economic, sociocultural, technical and process qualities – and location profiles are examined, with WLC assessment results falling under the ecological section. The building is assessed by individual criteria, described in criteria profiles. These include objectives, relevance and evaluation methodology, the evaluation standard and, if necessary, explanatory annexes.

The evaluation standard defines a target value (maximum 100 points), a reference value (50 points) and a threshold value (10 points) for each profile, whereby in the minimum, compliance with the threshold value must be demonstrated for certification. All federal buildings must therefore conduct a WLC assessment and register the results to obtain a BNB certification. The evaluation standards for WLC emissions are defined for each building type: office buildings, educational buildings, laboratory buildings, and outdoor facilities. Table 2.1 shows the standard values set by BNB for office buildings.

The degree of fulfilment in the criteria groups is calculated from the individual results of the criteria profiles. The final score is determined based on overall fulfilment of criteria in the five evaluation groups, which take into account the defined weighting factors. The degree of fulfilment is then used to assign the gold, silver or bronze quality standard. Civil federal construction projects must achieve at least the BNB's "silver" quality standard. While Germany has not yet introduced limit values of climate impacts from buildings yet, federal construction projects are encouraged to lower the WLC emissions. This is achieved through a minimum requirement of attaining a silver standard, with further incentives for striving toward achieving the gold standard (Federal Ministry of the Interior, Building and Community, 2019[6]).

Table 2.1. Evaluation standard for whole life carbon emissions defined in Germany's Assessment System for Sustainable Building (BNB: Bewertungssystem Nachhaltiges Bauen in German)

Evaluation standard values of GWP for office buildings

Standard values	Requirement level
Target value: 100 points	≤ 24 kg CO_2eq / m² / year
Reference value: 50 points	= 37 kg CO_2 eq / m² / year
Threshold value: 10 points	≥ 66 kg CO_2 eq / m² / year
0	No GWP assessment has been done

Source: Bundesministerium für Wohnen, Stadtentwicklung und Bauwesen; https://www.bnb-nachhaltigesbauen.de/fileadmin/steckbriefe/verwaltungsgebaeude/neubau/v_2015/BNB_BN2015_111.pdf

Limit values of carbon emissions from buildings

A limit value sets out the upper limit of emissions from a building, usually in $kgCO_2e/m^2$ or in $kgCO_2e/m^2$/year. It can act as a strong driver for innovation in low-carbon products and designs, making it one of the most effective policy instruments for reducing embodied carbon. However, the successful implementation of limit values requires comprehensive feasibility studies and capacity building within the industry to ensure readiness and efficacy.

In Denmark, limit values were initially introduced in 2023 for buildings larger than 1 000 m². In May 2024, the Danish government agreed to tighten these limits, with new regulation taking effect from July 2025 onwards (Table 2.2) (Danish Authority of Social Services and Housing, 2024[7]). The agreement does not only tighten limit values but also expands the scope to cover a broader range of building types. A preliminary study conducted by the Danish Authority of Social Services and Housing has revealed that nearly 90% of construction projects in Denmark do not comply with the upcoming limit values, implying a change in practices for the majority of construction projects to comply with the new limit values (Figure 2.4) (Danish Authority of Social Services and Housing, 2024[7]).

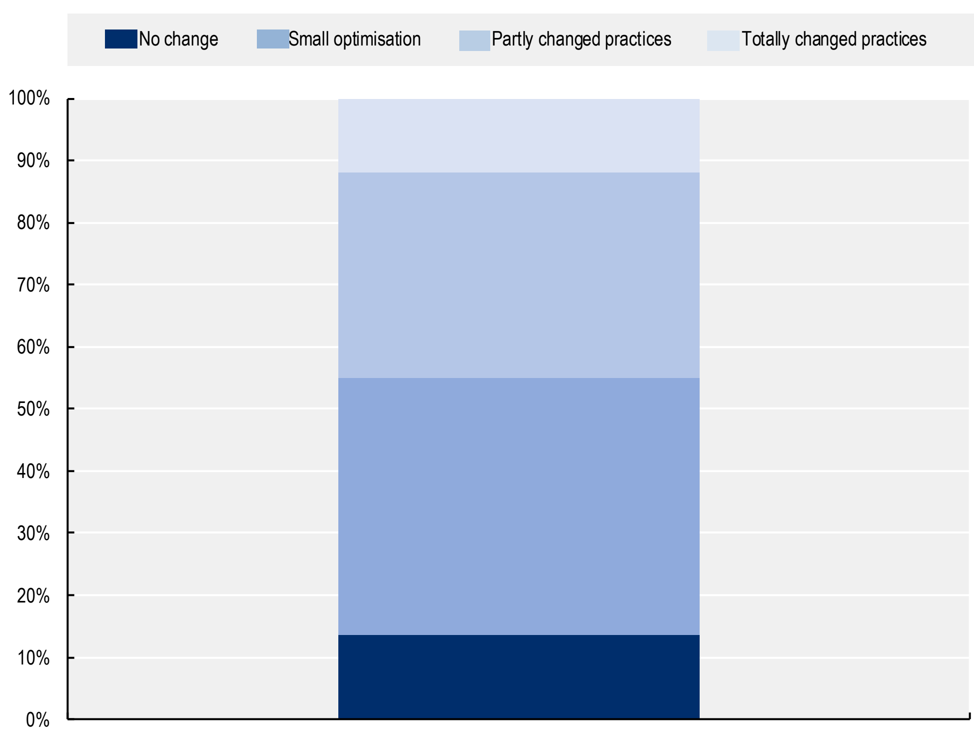
Table 2.2. Denmark's tightened limit values applied from 2025 onwards

	Kg $CO_2e/m^2/year$
Holiday homes under 150m²	4.0
Single-family houses, row houses, tiny houses, and holiday homes above 150 m²*	6.7
Apartment buildings	7.5
Office buildings	7.5
Institutions	8.0
Other new constructions	8.0
Average limit value of m² excluding A4 and A5	7.1
Independent limit value for the construction process	1.5
Total limit including construction process	8.6

Note: The 150 m² limit only applies to holiday homes.
Source: Danish Authority of Social Services and Housing (2024), https://www.sm.dk/nyheder/nyhedsarkiv/2024/maj/ny-aftale-stiller-ambitioese-klimakrav-til-nyt-byggeri

Figure 2.4. Denmark's preliminary research for limit values

Share of new constructions that need to change construction practices



Source: Danish Authority of Social Services and Housing (2024)

France is taking a similar approach to Denmark. RE2020, the current regulatory standard for energy and environmental impact of buildings, calls for reducing the carbon impact of new constructions by 2031 by a gradual implementation of limit values (Ministry of Ecological Transition and Territorial Cohesion, 2022[8]). When the limit value requirement was first introduced in January 2022, it covered only residential buildings.

However, the requirement has been since expanded to include offices, primary and secondary educational buildings, and small projects (Table 2.3). Studies are currently underway to expand the scope further to cover other tertiary buildings, such as commercial buildings, restaurants, and nurseries.

Table 2.3. France's current limit values in RE2020 (as of 2024)

	$kgCO_2e/m_2$
Individual or semi-detached houses	530
Apartment buildings	650
Office buildings	810
Primary or secondary schools	770

Source: Ministry of Ecological Transition and Territorial Cohesion (2024), *Guide RE2020*, https://www.ecologie.gouv.fr/sites/default/files/documents/guide_re2020_version_janvier_2024.pdf

Controlling compliance at the early-stage versus at after-completion stage

Ensuring compliance with climate reporting and limit value regulations is key for effectively reducing emissions. Some countries and cities require stakeholders to submit building emission assessments at both or one of two main stages: design stage and after-completion stage. Requiring submission at design stage can yield stronger impact on promoting low-carbon construction design, but also potentially inaccurate results due to insufficient information on materials and quantities thereof. By contrast, controlling emissions at the after-completion stage allows for accurate measurement and reduction of emissions from the actual building material data. However, this will require closer collaboration across the entire value chain and the co-ordination of voluntary assessments to ensure that buildings comply with regulations.

Denmark, **France** and **Sweden** only mandate submission of assessment results at after-completion stage, while **Helsinki** (Finland) mandates both at design stage and after-completion stage and **Greater London** (UK) at the pre-application, application and after-completion stage (Table 2.4).

Table 2.4. Overview of current LCA regulation and compliance control regimes

	Denmark	France	Sweden	Helsinki (Finland)	Greater London (UK)
Authority in charge	Danish Authority of Social Services and Housing	Ministry of Ecological Transition	Swedish National Board of Housing, Building and Climate	City of Helsinki	Greater London Authority
Climate reporting	In use	In use	In use	In use	In use
Limit value(s)	In use	In use	Proposed	In use	N/A
Compliance control	10% of cases checked	-	10% of cases checked	-	-
Reporting stage(s), *when applicable	After-completion stage	After-completion stage	After-completion stage	Both at design stage and after-completion stage	Pre-application stage*, application stage, and after-completion stage
Sanction for non-compliance	Fine	-	Fine	-	-

Note: Adapted from "Harmonised Carbon Limit Values for Buildings in Nordic Countries" by Nordic Sustainable Construction
Source: Nordic Sustainable Construction (2024), *Harmonised Carbon Limit Values for Buildings in Nordic Countries*, https://pub.norden.org/us2024-415/us2024-415.pdf, OECD Global Survey on Whole Life Carbon of Buildings (2024)

Key elements of an enabling environment for introducing regulations

Methodology

Before implementing comprehensive policies for WLC of buildings, it is crucial to refine the methodology to assess the energy and environmental performance of buildings. According to the OECD *Global Monitoring of Policies for Decarbonising Buildings* (2024), 61% (17 out of 28) of respondent countries have developed WLC assessment methodologies (OECD, 2024[9]). Governments often begin by initiating pilot projects involving various stakeholders to develop a methodology that is suitable for subsequent national application. This step-by-step approach enables iterative enhancements, integrating feedback and expertise from pilot initiatives and expert consultations.

In all surveyed countries and cities, the development of methodologies for building life-cycle assessment (LCA) is grounded in either ISO 21930, an international standard, or EN 15978, a European standard. As this process includes defining system boundaries, identifying targeted building components, and determining the approach to biogenic carbon – carbon sequestered from the atmosphere into biological materials – within the assessment, governments need to co-operate with academia and private companies. These methodological choices are shaped by each country's specific priorities or industry requirements.

For example, J-CAT, a **Japanese** WLC assessment tool, was launched in 2024 by a consortium organised through a public-private partnership, building on the basis of a decade of academic work (IBECs, n.d.[10]). In **Sweden**, the Swedish National Board of Housing, Building, and Planning (Boverket) oversees the development and implementation of national regulations and guidelines for buildings and urban planning. Boverket, which sits under the Ministry of Rural Affairs and Infrastructure, can make suggestions for further policy advancements targeting WLC reduction in the building sector. As part of its role, Boverket collaborates with experts, academia, and other key stakeholders to develop and refine methodologies for assessing the climate impact of buildings. This collaborative approach ensures that the guidelines are grounded in scientific research and practical expertise, promoting consistent and reliable life-cycle approach (LCA) practices across the industry (Boverket, 2023[11]).

Boverket's LCA guidance assesses a building's climate impact in a standardised way by establishing specific methodologies, reference values, and calculation frameworks. This guidance includes the selection of system boundaries, such as which building elements to include in the assessment, and how to account for different stages of a building's life-cycle. The guidelines also address how to consider biogenic carbon, reflecting Sweden's priorities and industry demands (Boverket, 2023[11]).

System boundaries

System boundaries are a framework that specifies which processes and flows will be included in the assessment. Setting system boundaries for LCA is critical, as it determines the scope of the LCA by including or excluding certain life-cycle stages, flows, and impacts. System boundaries can be divided into five categories: i) A1-A3 product stage, ii) A4-A5 construction stage, iii) B1-B8 use stage, iv) C1-C4 end-of-life stage, and v) D benefits and loads beyond the system boundaries.

Table 2.5 highlights the range of system boundaries covered by WLC policies in various respondent countries and cities. The system boundaries applied give a clear indication on the strategies of individual countries and cities, notably which scope is prioritised for carbon reductions. These strategies may vary depending on a number of factors, such as industry capacity and the maturity of the assessment methodology.

Among surveyed countries and cities, the system boundaries applied in **Sweden**'s mandatory climate declaration put greater emphasis on reducing upfront emissions, i.e. A1-A5 product and construction stages. Limit values, which are expected to be implemented in 2027 at the earliest, will also apply exclusively to these stages due to several factors. First, mandating an assessment of A1-A5 will steer more focus on decreasing emissions that occur today, resulting in immediate reduction. Second, A1-A5 stages account for a high proportion of emissions over the life-cycle of a building. What's more, there is no established methodology for stages beyond A1-A5 (Boverket, 2023[3]).

In **Singapore**, where the lifespans of buildings tend to be shorter due to urban renewal, the embodied carbon emissions of buildings can constitute up to 40% of emissions over the lifespan of the building (Singapore Green Building Council, n.d.[12]). Due to the large share of embodied carbon emissions, Singapore developed the BCA Green Mark 2021, which is a green buildings certification scheme tailored to Singapore's climate conditions. Launched in 2021 and revised in 2024, the scheme provides one standardised methodology for all buildings and emphasises sustainability outcomes beyond energy efficiency (building intelligence, health and wellbeing of the occupants, WLC, design for maintainability, resilience). The methodology therefore allows scoring of buildings on their WLC performance, including embodied carbon. The carbon section of BCA Green Mark guides project teams on accounting for carbon over the lifetime of a building. The voluntary climate declarations are made both at the design and after-completion stage, to reflect reality as precisely as possible. The minimum scope requirement of a WLC assessment consists in considering modules A1-A3 (product stage), A4-A5 (construction stage), B2 (maintenance), B4 (replacement) and B6 (operational energy). The life-cycle analysis, which remains voluntary, is applicable to both new construction projects and major retrofits as its purpose is to recognise the effort of forerunning developers (Building and Construction Authority, 2024[13]).

Reference unit and reference study period

Reference study period (RSP) is a critical factor in ensuring the comparability of results in WLC assessment of buildings, particularly for comparable quantification of impacts associated with the use stage of a building (module B). It defines the number of years over which the environmental impacts of a building are assessed. The RSP allows for consistent benchmarking by aligning assessment periods across different projects and scenarios, ensuring that life-cycle stages and associated emissions are analysed over a uniform timeframe.

Among the surveyed countries, **Denmark** and **France** currently adhere to a fixed RSP of 50 years, which aligns with the standard established in Level(s) – a European assessment and reporting framework for sustainability performance of buildings – and is the most commonly applied time frame at the international level. Currently, **Sweden** does not require RSP in its climate declaration, as it only addresses upfront impacts. However, the planned extension of the declaration to include operational stages in 2027, proposed by Boverket, will also adopt an RSP of 50 years (Boverket, 2023[11]). In contrast, **Greater London (UK)** and **Vancouver** adopt a 60-year RSP, aligning with the standards set by BREEAM and LEED, two globally recognised certification schemes for building sustainability assessment (Mayor of London, 2023[14]; City of Vancouver, 2023[15])

While longer building lifespans significantly reduce overall climate impacts, current regulations in the surveyed countries or cities rely on assumed fixed lifespans for WLC assessments. This approach prioritises comparability of results but fails to recognise the potential for greater climate benefits from buildings that last beyond the assumed lifespan. For example, the guidelines provided by the Royal Institution of Chartered Surveyors (RICS) for WLC assessments, which form the basis of Greater London's regulatory framework, allow for assessing climate impacts against optional service life, but the result has to be reported as an additional information to the assessment result based on the mandatory RSP of 60 years for comparability (RICS, 2023[16]). Similarly, Denmark recognises that a fixed RSP is essential, regardless of whether a building's actual lifespan is shorter or longer, to ensure comparability and effectiveness of the introduced limit values (VCBK, 2022[17]).

Reference unit is another important concept in WLC assessment to ensure the comparability of results. For example, climate impact calculated per gross floor area (GFA) and climate impact calculated per heated floor area (HFA) will give different results and therefore cannot be compared. In **Sweden**, where only upfront carbon emissions (modules A1-A5) are taken into account, GFA is used as the reference unit. A reference value study conducted in Sweden examined whether buildings with underground storeys and those without would exhibit differences in climate impact when assessed per square meter of GFA and per square meter of HFA. The findings indicated no significant differences in the results when calculated using GFA. However, the study noted a tendency for buildings with storeys below ground level to be disadvantaged if HFA were used as the reference unit. This suggests that GFA provides a more equitable basis for comparison across building types under the current scope of the climate declaration regulation (Boverket, 2023[11]).

Denmark employs two distinct area metrics to assess the total climate impact of buildings: GFA for embodied carbon emissions and HFA for operational carbon emissions (module B6). This differentiation is based on the specific nature of the emissions being evaluated. Operational carbon emissions are primarily driven by energy used for heating, cooling, and maintaining comfortable indoor conditions. Heated floor area directly correlates with these energy demands, providing a more precise basis for calculating emissions in this category. In contrast, gross floor area encompasses the total built-up area and is better suited for embodied carbon assessments, which include materials and construction processes irrespective of energy consumption during operation (Nordic Sustainable Construction, 2024[1]).

Unlike Sweden or Denmark, **France's** RE2020 employs distinct area measurement units tailored to building types: habitable surface (French: surface habitable, SHAB) for residential buildings and usable surface (French: surface utile, SU) for non-residential buildings. SHAB emphasises core living spaces, excluding areas such as walls, partitions, staircases, and spaces with a ceiling height below 1.8 meter. In contrast, SU encompasses the habitable area plus additional usable spaces, such as storage rooms, provided they meet specific criteria, such as a minimum ceiling height or temperature control (Ministry of Ecological Transition and Territorial Cohesion, 2024[18]).

However, in the **EU**, the revised EPBD introduces the possibility of mandating the use of useful floor area (UFA) by referencing Level(s), a European framework that standardises the assessment and reporting of building sustainability performance. The UFA definition is aligned with the International Property Measurement Standards (IPMS). As Level(s), the EU Taxonomy, and the EPBD evolve, regulatory frameworks in European countries that currently use different reference units may need to adapt their standards to comply with EU regulations (EU, 2024[19]; Nordic Sustainable Construction, 2024[1]).

Building components

The selection of targeted building components is critical in WLC assessment, as different components contribute varying levels of embodied and operational carbon throughout a building's life-cycle. Focusing on high-impact components, such as structural elements, façades, and energy systems, allows for identifying significant carbon reduction opportunities. Early design choices, material efficiency, and consideration of durability and end-of-life impacts play a key role in minimising emissions. By starting with components with the greatest carbon footprint, WLC assessments can more effectively guide sustainable design strategies and optimise carbon performance across the building's lifespan.

For example, the climate declaration introduced in **Sweden** in 2022 focuses on building components that typically have higher climate impacts, mandating the inclusion of the building's envelope, load-bearing structures, and interior walls, while excluding technical equipment. According to Boverket's proposal, the limit values expected to be introduced in 2027 will expand to cover all building components, from the building's foundations and its insulation, but will continue to exclude solar cells and fixed equipment. However, the climate impact of solar cells, whether integrated into construction products or surface-mounted, still must be reported in the climate declaration.

Table 2.5. Examples of system boundaries covered by whole life carbon policies (as of December 2024)

	Studied period (years)	Floor area definition	Product stage			Construction stage		Use-stage embodied carbon					Operational carbon			Demolition stage (End of life)				Beyond boundary	
			A1	**A2**	**A3**	**A4**	**A5**	**B1**	**B2**	**B3**	**B4**	**B5**	**B6**	**B7**	**B8**	**C1**	**C2**	**C3**	**C4**	**D1**	**D2**
Denmark (BR18)	50	GFA HFA	✓	✓	✓	TBI, July 2025	TBI, July 2025	N/A	N/A	N/A	✓	N/A	✓	N/A	N/A	N/A	N/A	✓	✓	✓	✓
France (RE2020)	50	SRT SU	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	N/A	✓	✓	✓	✓	✓	✓
The Netherlands (Building Decree 2012)	Housing 75 Other buildings 50	GFA	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	N/A	N/A	N/A	✓	✓	✓	✓	✓	✓
Sweden (Climate declaration)	50	GFA	✓	✓	✓	✓	✓	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Greater London (London Plan)	60	GIA	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Vancouver (VBBL)	60	GFA	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	N/A	N/A	N/A	✓	✓	✓	✓	✓	✓

Note: ✓ = covered, N/A = not applicable, TBI = to be introduced, Green = limit values, Blue = mandatory declaration; Adapted from Nordic Sustainable Construction (2024);
A1 Raw materials procurement, A2 Transport, A3 Manufacturing, A4 Transport, A5 Construction and installation, B1 Use, B2 Maintenance, B3 Repair, B4 Replacement, B5 Refurbishment, B6 Operational Energy, B7 Operational Water, B8 Other activities C1 Demolition, C2 Transport, C3 Waste processing, C4 Disposal, D1 Net flows from reuse, recycling, energy recovery, other recovery, and D2 Exported utilities: e.g. electric energy.
Source: OECD Global Survey on Whole Life Carbon of Buildings (2024); Nordic Sustainable Construction (2024), https://pub.norden.org/us2024-415/us2024-415.pdf

Biogenic carbon

Inclusion of biogenic carbon in WLC of buildings can have a big impact on the outcome of the assessment and subsequently, influence the decisions of industry stakeholders. These implications are significant because competition between biogenic construction materials and mineral-based products impacts influential industrial and economic players, such as the forestry industry and the concrete sector (Nordic Sustainable Construction, 2024[1]).

According to EN15804+A2, the European standard for producing EPDs for construction products, there are three approaches to biogenic carbon consideration in LCA: i) the 0/0 approach, ii) the -1/+1 approach, and iii) the "dynamic" approach. The 0/0 approach considers neither fixation nor releases of biogenic carbon, whilst the -1/+1 method, recommended by EN15804+A2, accounts for the fixation of biogenic carbon in the production stage and its release at the end of life (Table 2.6. Overview of biogenic carbon calculation methods). There are also variants of these two approaches depending on end-of-life scenarios. For example, in the case of recycling or landfill at the end of life, sequestered biogenic carbon is considered at the production stage, but no (or not all) biogenic carbon is considered as an emission at the end of life. This third approach, called the dynamic approach, considers time-dependency of climate impacts according to the time of emissions, discounting future emissions (Ouellet-Plamondon et al., 2023[20]).

Table 2.6. Overview of biogenic carbon calculation methods

	0/0	-1/+1	Dynamic
Description of method	This approach considers neither fixation nor releases	This approach accounts for the fixation of biogenic carbon in the product stage and its release in the demolition stage.	This approach takes into account time-dependency of the climate impacts.
Biogenic carbon reporting	N/A	Separately reported from GWP-total	Subtracted from GWP-total
Countries applied	Sweden	Denmark, Finland and Greater London	France

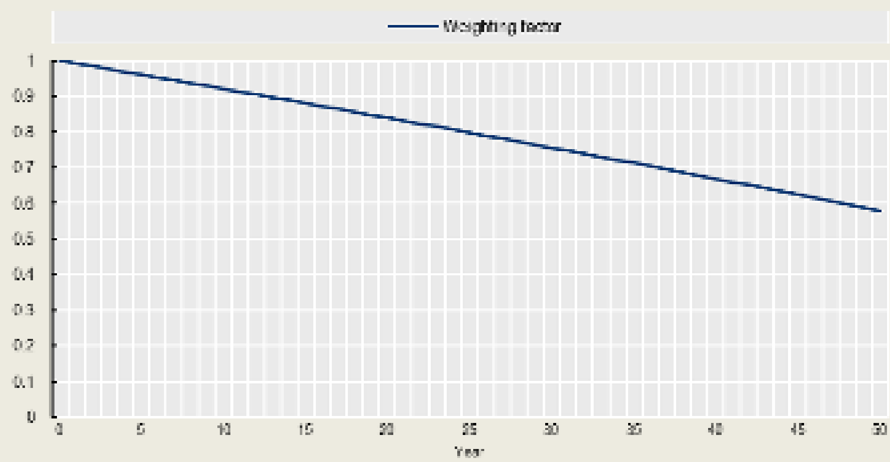
Source: Nordic Innovation (2024), *Harmonised Carbon Limit Values for Buildings in Nordic Countries*, https://pub.norden.org/us2024-415/us2024-415.pdf;; Ouellet-Plamondon, C. et al. (2023), *Carbon footprint assessment of a wood multi-residential buidling considering biogenic carbon*, https://pdf.sciencedirectassets.com/271750/1-s2.0-S0959652623X00201/1-s2.0-S0959652623009927/main.pdf?X-Amz-SecurityToken=IQoJb3JpZ2luX2VjENL%2F%2F%2F%2F%2F%2F%2F%2F%2F%2FwEaCXVzLWVhc3QtMSJHMEUCIQDdKUAgiSCPgkGQnCKHyCICiXgG%2FcKJfy%2Bziv7KHo%2BURQIgAI9LGn

France's RE2020 has introduced a unique methodology of "dynamic LCA" where climate impacts are weighted according to the time of emission release (Box 2.2) (Ministry of Ecological Transition and Territorial Cohesion, 2023[21]). France's dynamic LCA is based on the idea that the same consumption or the same emission can have a different impact depending on the date on which it takes place. The rationale is that early emissions are considered more harmful than future emissions, considering the climate urgency and the increased cumulative impact due to the persistence of CO_2 in the atmosphere (Ministry of Ecological Transition and Territorial Cohesion, 2024[18]). This perspective also encourages the storage of biogenic carbon within buildings, promoting designs that incorporate materials capable of sequestering carbon, thereby reducing immediate emissions and contributing to long-term carbon storage (Guldner, 2019[22]).

Box 2.2. France's dynamic life-cycle assessment approach: RE2020

The Dynamic LCA approach in RE2020 (Régulation Environnementale 2020) includes the assessment of the environmental impacts of buildings over time. The values correspond to the cumulative radiative forcing (CRF) over a fixed 100-year horizon of 1 kg of CO_2 emitted in a given year, with emissions in the current year assigned a coefficient of 1. Under this approach, emissions occurring after the building's construction have a reduced climate impact, reflected by a lower coefficient (e.g., coefficient of 0.578 for 50 years after completion) (Figure 2.5).

Figure 2.5. Weighting factor used for RE2020 dynamic LCA



Note: Adapted from "Guide RE2020" Ministry of Ecological Transition and Territorial Cohesion (2024)
Source: Ministry of Ecological Transition and Territorial Cohesion (2024), Guide RE2020, https://www.ecologie.gouv.fr/sites/default/files/documents/guide_re2020_version_janvier_2024.pdf

Table 2.7 takes the example of a laminated timber beam to show the difference between static LCA and dynamic LCA. As a dynamic LCA approach considers future emissions as less impactful, carbon sequestration in biobased materials can be considered beneficial in the assessment.

Table 2.7. Example of calculation in dynamic life-cycle approach

Example of a laminated timber beam

"Static" LCA	$kgCO_2eq$	"Dynamic" LCA	$kgCO_2eq2$
Life-Cycle Stages		Dynamic modulation factor: f	
Product stage	-34.1	Year 0 : f = 1, 1 x -34.1	-34.1
Construction process stage	1.5	Year 0 : f = 1, 1 x 1.5	1.5
Use stage	0	Year 1 to 49 : f = 0.992 to 0.578, f x 0	0
End-of-life stage	**38.9**	**Year 50 : f = 0.578 x 38.9**	**22.5**
Module D: Beyond the system boundary	**-7.8**	**Year 50 : f = 0.578 x -7.8**	**-4.5**
Total life-cycle	-1.5		-14.6

Source: Ministry of Ecological Transition and Territorial Cohesion (2024), *Guide RE2020*, https://www.ecologie.gouv.fr/sites/default/files/documents/guide_re2020_version_janvier_2024.pdf

Digital tools for life-cycle approach

Database for whole life-cycle carbon assessment

Developing a national database is one of the most effective ways to ensure consistency and comparability of LCA throughout the country. Life-cycle carbon of buildings is usually assessed by using two broad types of environmental data: EPD and generic emission data. An **EPD** is a standardised document aligning with ISO 14025, the international standard on EPDs. Based on quantitative data from the LCA of a specific product, ISO 14025 communicates the environmental performance of a product throughout its life-cycle (Ecochain, n.d.[23]). Generic emission data are based on the average of typical products and are therefore less accurate compared to EPD data. Generic data are used only when EPD data is not available for a specific product.

While several countries have already developed a national database for WLC assessment, their approaches vary. Table 2.8 provides a detailed overview of databases developed by respondent countries. Among them, **France** and **the Netherlands** have more stringent standardised databases compared to others. Both countries run their own national EPD programmes integrated into these databases, which restricts the inclusion of international EPDs. In the Netherlands, EPDs are based on the European standard EN 15804, and in line with the development of Construction Product Regulation (CPR). In principle, assessors are not able to use other data sources than this national database. **Germany** maintains a dedicated national database called ÖKOBAUDAT, developed and operated by the Federal Ministry for Housing, Urban Development, and Building (BMWSB). This database adheres to its own rigorous standards based on EN 15804+A2, and serves as a mandatory resource for BNB, the above-mentioned nationwide certification system for sustainable building (Bundesministerium für Wohnen, Stadtentwicklung und Bauwesen, n.d.[24]). In contrast, the database in **Finland** primarily consist of generic emission data and do not include EPD data.

Table 2.8. Examples of nationally-developed environmental database

	Finland	France	Germany	Netherlands
Name of database	CO2data.fi	INIES	ÖKOBAUDAT	NMD
Provided by	Finnish Environment Institute (SYKE)	HQE-GBC	Federal Ministry for Housing, Urban Development, and Building (BMWSB)	Nationale Milieudatabase
Total number of data			1 563	4 335
Type of data [*] *approx. # or % of data	Generic data [319] EPD [N/A] Others [N/A]	Generic data [1733] EPD [5 840] Others [N/A]	Generic data [571] EPD [671] Others [321]	Generic data [abt. 50%] EPD [abt. 50%] Others [N/A]
Acceptance of International EPDs in the database	Accepted	Accepted with conditions	Accepted with conditions	Not accepted
Number of data as of	12 December 2024	12 December 2024	19 December 2024	12 December 2024

Note: Number of generic data in French INIES database is as of 31 December 2023
Sources: Bygningsreglementet, https://bygningsreglementet.dk/Bilag/B2/Bilag_2; Finnish Environment Institute SYKE, *CO2data*, https://co2data.fi/rakentaminen/, HQE-GBC, *INIES*, https://www.inies.fr/; BMWSB, https://www.oekobaudat.de/no_cache/en/database/search.html; Nationale Milieudatabase, https://milieudatabase.nl/en/database/

Restricting data sources for LCA enhances the comparability and consistency of assessment results, but may limit openness to the global market

Accepted data sources for LCA vary across countries and cities. For example, **France** and **the Netherlands** only allow the use of data from their national databases. This approach enhances coherence and comparability of LCA results within each country, but may limit openness to the global market, as these databases exclude international EPDs. In contrast, **Denmark**, **Finland**, and **Greater London (UK)** allow the use of international EPD data for LCA, supporting global market integration but potentially reducing coherence and comparability in LCA results.

The lack of EPD data is a major challenge at the early stage in many countries and cities

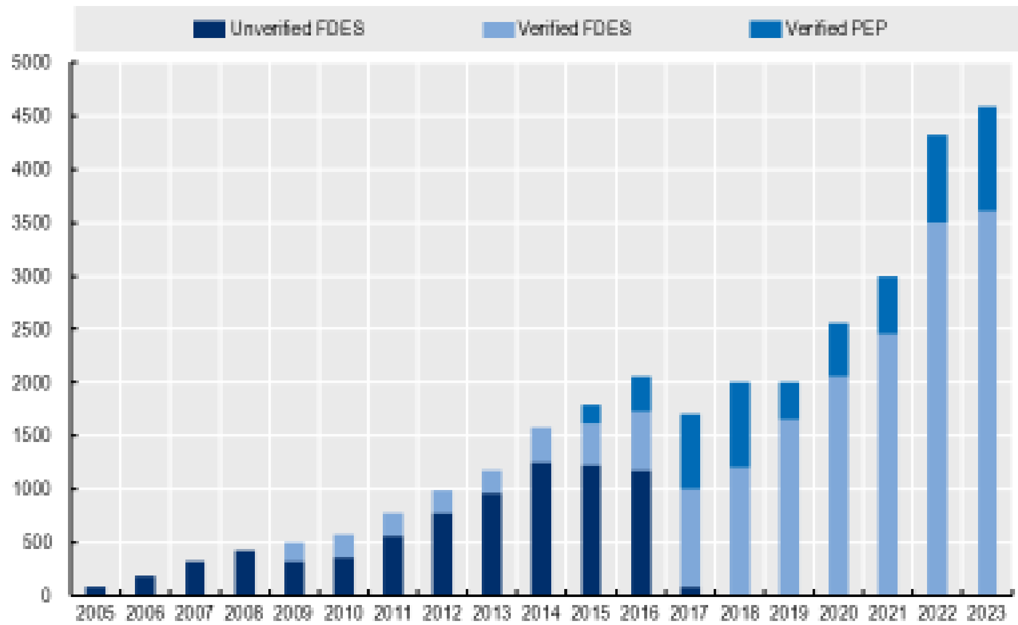
As WLC of a building is assessed by multiplying environmental data of each material or product by its quantity, the accuracy hugely relies on the availability of products-specific environmental data. Therefore, it is crucial to have a sufficient volume of EPD data to facilitate more accurate assessment. According to the OECD Survey on Whole Life Carbon of Buildings (2024), most respondent countries and cities have stated that the lack of EPDs has been a major challenge at the early stage of policy implementation. **Denmark**, **Finland**, **France**, and **Sweden** establish national generic emission data in a more conservative way than average emission values. For instance, Finland's generic emission data includes an additional 20% (Nordic Sustainable Construction, 2023[25]). Similarly, Nationale Milieudatabase (NMD) puts a 30% surcharge on category 3 datapoints that are unspecific and based on the international database (Box 2.3). This is expected to encourage developers to utilise more materials with EPDs in their buildings, prompting manufacturers to pursue EPD certification as well.

Figure 2.6 illustrates the steady rise in French EPDs within the INIES (Information sur les Impacts Environnementaux et Sanitaires) database over time. A significant increase in verified EPDs occurred between 2016 and 2017, coinciding with the introduction of the E+C- certification label, a state-funded certification scheme aimed at trialling LCA. Another sharp increase appeared between 2021 and 2022, aligning with the implementation of RE2020, a new regulation that introduced specific limit values for WLC emissions of buildings.

Costa Rica, which is in an initial stage of developing a WLC approach, is working to promote EPD acquisition through public procurement. In January 2015, Costa Rica became the first country in Latin America to publish a National Policy on Sustainable Public Procurement, aiming at improving the economic, environmental and social performance of services and goods, taking into account the participation of SMEs (MINAE, MIDEPLAN and MREC, 2018[26]). As part of the implementation of this policy, an Agreement was issued in 2019 called "National Environmental Labelling and Energy Efficiency Programme of Costa Rica and Creation of the Technical Committee on Environmental and Energy Labelling". It aims to establish a national EPD programme, operated by an accredited public body, to promote public procurement as a tool for consumers to select better environmental and energy performance products and services. The Sustainable Public Procurement Guide 2022 explicitly refers to type III environmental labels, i.e. EPDs, as a reliable verification method for the implementation of sustainable public procurement (DIGECA, 2022[27]).

Figure 2.6 Evolution of the number of EPDs in France

Increase in the number of standardised documents equivalent to EPD for construction products in France



Note: FDES (Fiche de Déclaration Environnementale et Sanitaire) is an environmental and health declaration applied to construction products. PEP (Profil Environnemental Produit) is an environmental product profile applied to electrical, electronic and HVAC (heating, ventilation, and air conditioning) equipment. Both are equivalent to EPD.
Source: INIES (2024), Les chiffres clé 2023, https://www.inies.fr/les-chiffres-cles-inies-2023/

Box 2.3. Netherlands' Nationale Milieudatabase (NMD)

In the Netherlands, the NMD contains environmental data that are used to calculate the environmental performance of construction works, including embodied carbon of buildings. The environmental data are based on the European standard EN 15804, and in line with the development of EU standards and regulations. The data are divided into three categories:

Table 2.9. Categories of environmental data in the Netherlands' Nationale Milieudatabase

Category 1	Category 2	Category 3
Proprietary data from manufacturers and suppliers. The data are verified by an independent, qualified third party in accordance with the NMD verification protocol (e.g. product-specific EPD).	Non-proprietary data from groups of manufacturers and/or suppliers and sectors. The data are verified by an independent, qualified third party in accordance with the verification protocol, stating how representative it is (e.g., sector EPD).	Non-proprietary data from NMD. The data are drafted by LCA experts under the responsibility of NMD, but not verified according to the verification protocol. It is used in the absence of category 1 and category 2 data.

Source: Nationale Milieudatabase, https://milieudatabase.nl/en/

The NMD sets their own verification protocol for EPDs, and only incorporates EPDs that meet this requirement. This results in difficulty for international producers to include their product data in the NMD. In the Netherlands, WLC assessment must be done by using national database only.

Along with environmental databases, the development of a national assessment tool facilitates the implementation of WLC assessment, enhances the quality of the assessment and ensures comparability among different results. Table 2.10 shows in which countries a national assessment tool is available, i.e. a tool developed by a governmental body or a commissioned organisation, and which types of approved tools exist in terms of regulatory compliance in different countries.

The LCAbyg, a freely available national LCA tool in **Denmark**, has been developed by the Department of the Built Environment (BUILD) at Aalborg University since 2014, with the financial support of the Danish Authority of Social Services and Housing. The LCAbyg library incorporates a generic emission database, which is in accordance with a Danish building regulation called BR18, as well as with Danish and Norwegian EPDs. The tool also allows for importing other EPDs in ILCD+EPD format, a widely used data format developed by the European Commission with ILCD indicates (instead of users having to input the data manually). ILCD refers to the International Reference Life-Cycle Data System. Based on the information about the building and the building's components, waste, transportations, construction works as well as the building's energy use, LCAbyg will conduct an LCA, and compile the results in a document that is in accordance with BR18. The generated LCA document can be downloaded as a pdf file. Despite the availability of a national LCA tool, Denmark does not restrict the use of other assessment tools in the market, if the results are aligned with the requirements of BR18 (BUILD - Institut for Byggeri, By og Miljø, Aalborg Universitet, 2023[28]).

Similarly, the **Swedish** Environmental Research Institute (IVL), a non-profit organisation, has developed a tool called Byggsektorns Miljöberäkningsplattform (BM – Building Sector Environmental Calculation Tool), which is fully compliant with the Swedish climate declaration regulations (Nordic Sustainable Construction, 2023[25]). However, building owners remain free to select any tool available in the market, provided it can generate the required data for the climate declaration, with calculations based on either Boverket's generic data or EPD data (Boverket, 2024[29]).

In **Germany**, a national eLCA tool has been developed by the Federal Institute for Research on Building, Urban Affairs, and Spatial Development (BBSR), which operates under the Federal Ministry for Housing, Urban Development, and Building (BMWSB). All public construction projects are mandated to conduct an LCA to comply with the Assessment System for Sustainable Building (BNB). The assessments have to be carried out using the eLCA tool and have to be based on ÖKOBAUDAT, the federal EPD database (Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety, 2014[30]; BBSR, 2019[31]). While BNB mandates the use of eLCA, QNG – a voluntary nation-wide quality seal for buildings – allows the use of other assessment tools that are verified by the Quality Assurance Association for LCA Tools for Buildings e.V., a certification body accredited for the QNG (Nachhaltige Gebäude, 2023[32]). The Association was founded in 2023 with the aim of testing and confirming the quality of tools for the preparation of standard-compliant and QNG-compliant LCAs for buildings using scientific methods for validation. Currently, two LCA softwares developed by the private sector are deemed conform with QNG standards (Güte- und Qualitätsgemeinschaft Ökobilanzierungswerkzeuge für Gebäude e.V., n.d.[33]).

While Denmark and Germany have developed national assessment tools, **France** does not possess a specific national tool. Instead, RE2020 mandates the use of assessment tools that have been pre-approved by the relevant ministries to ensure regulatory compliance. This approval can be obtained on the basis of an assessment by the Centre for Studies on Risks, the Environment, Mobility and Urban Planning (Cerema), a public institution dedicated to supporting policies, under the supervision of the Ministry for Ecological Transition and Regional Cohesion. The objective of this evaluation is to improve the quality of the assessment and to ensure that the results are in accordance with RE2020 standards. The evaluation procedure is composed of a self-check followed by additional checks by Cerema, allowing publishers to obtain an opinion on the technical quality of their software. The first approval is valid for two years, followed by a periodic review that may result in renewing the approval with an extended validity period between two to five years. If the software largely deviates from RE2020 standards, the approval can be withdrawn (Ministry of Ecological Transition and Territorial Cohesion, 2024[34]).

Table 2.10. Availability of a national whole life carbon assessment tool, and approved tools for regulatory compliance

	Availability of the national LCA tool	Available LCA tools for regulatory compliance		
		National tool only	Approved tools	Any tools are allowed
Denmark	✓			✓
France			✓	
Germany	✓		✓	
Sweden				✓

Note: National LCA tool here indicates a tool that has been developed by the government or with any relevant public body's involvement in some way (e.g. via funding). Question from the survey: "What assessment tools are/will be allowed in your country for assessing whole life carbon of buildings?"
Source: OECD Global Survey on Whole Life Carbon of Buildings (2024)

Building Information Modeling

Building Information Modelling (BIM) is a digital technology that creates detailed 3D representations of buildings, enhancing the construction, maintenance, and management phases of building life-cycles. These software tools enable precise architectural design, simulations, and evaluations, optimising both design and construction processes. BIM is more than a tool for initial planning; it plays a crucial role in addressing sustainability challenges in the construction industry, particularly through its contributions to the LCA (OECD, 2024[9]). However, BIM models are currently not as fully utilised in the LCAs as they could be. Data required for LCA may either be missing from the models or modelled in a non-standardised way, limiting their comprehensiveness and coherence (Lavikka et al., 2024[35]).

Overall, the use of BIM in most respondent countries and cities is driven by the industry. However, there is a spectrum of national strategies to further integrate the use of BIM in national policies. In **Japan**, the Ministry of Land, Infrastructure, Transport, and Tourism (MLIT) actively promotes BIM implementation by offering incentives, particularly targeting small- and medium-sized enterprises. Recognising BIM's potential to enhance efficiency and quality in construction, the Japanese government provides substantial economic support through its BIM Acceleration Projects, reflecting a strong commitment to expanding BIM use throughout the construction sector (Ministry of Land, Infrastructure, Transport and Tourism, 2021[36]). BIM in Japan focuses on optimising the entire building life-cycle, enhancing data management and operational efficiency (Ministry of Land, Infrastructure, Transport and Tourism, 2019[37]; OECD, 2024[9]). Japan is particularly focused on BIM's usability for LCA at the planning and designing stage; and the ability of BIM to facilitate architects' revisions of designs depending on climate impacts. This approach reduces long-term costs and environmental impacts while promoting better regulatory compliance (OECD, 2024[9]).

In **Finland**, an open data model, called IFC file format, has been designed to facilitate the exchange of BIM content across different software programmes, and will become compulsory for building permits with the new Building Act that will come into force at the beginning of 2025. This is made possible by the model specifications and inspection rules set out by RAVA3Pro project, a collaborative project with building control authorities and Solibri, a Finnish BIM software company (SOLIBRI, n.d.[38]). This approach entails strong enforcement for stakeholders to move towards BIM-based design and modelling in a standardised manner. This unified format of building permit is expected to simplify data collection as well as monitoring processes once limit values have been implemented.

France’s BIM Plan (Plan BIM) was created at the beginning of 2022 to support the digital transition of SMEs by generalising the use of digital technology in the building industry and promoting the development of professionals’ skills. The Plan is in line with PTNB (Plan Transition Numérique dans le Bâtiment), a guideline set by public authorities to promote the digital transition of the construction sector through BIM utilisation. The BIM Plan provides concrete methods and tools to expand the use of digital practices around two priority areas. First, the use of BIM should be generalised across all construction projects by standardising practices and stakeholders should have clear and balanced definitions of each party’s expectations and responsibilities. Second, BIM is to be deployed across all regions and made accessible to everyone through appropriate tools (Ministères Territoires Ecologie Logement, 2024[39]).

Training and education for capacity building

Training and education for both industry stakeholders and regulatory authorities are critical for building the capacity needed to effectively implement whole life-cycle carbon regulations for buildings. However, few governments provide direct support to the industry, such as on-site technical assistance, grants, incentives, or certification programmes, to help these groups acquire the necessary knowledge and skills for conducting WLC assessments. Instead, governments are more focused on indirect support, such as publishing educational materials or guidance on their platforms, as well as providing financial support to commissioned organisations for them to support industry on behalf of governments (Figure 2.7).

In **Denmark**, a sum of DKK 50 million was allocated to advancing sustainable construction between 2021 and 2024. The Knowledge Centre on Climate Impacts of Buildings (VCBK: Videncenter om Bygningers Klimapåvirkninger) received DKK 11.4 million from this funding in order to spread information about buildings’ carbon footprint and educate industry stakeholders. While the VCBK is under the Danish Authority of Social Services and Housing, it is a politically impartial body. To ensure the organisation’s independence, the VCBK is presided by a consortium consisting of the Danish Technological Institute, BUILD (Aalborg University), as well as private companies (VCBK, n.d.[40]). The VCBK platform provides various materials free of charge, including guidelines for LCA and the climate requirements of BR18, the latest Danish building regulation, in the form of publications, webinars, and short videos. It also provides a comprehensive set of teaching materials, including a PowerPoint presentation, Excel-based exercises, exercises using LCAbyg (a Danish LCA tool), and a selection of EPDs used in the exercises. These resources are designed for educational institutions or companies to utilise in delivering both internal and external courses for educational purposes (VCBK, n.d.[41]).

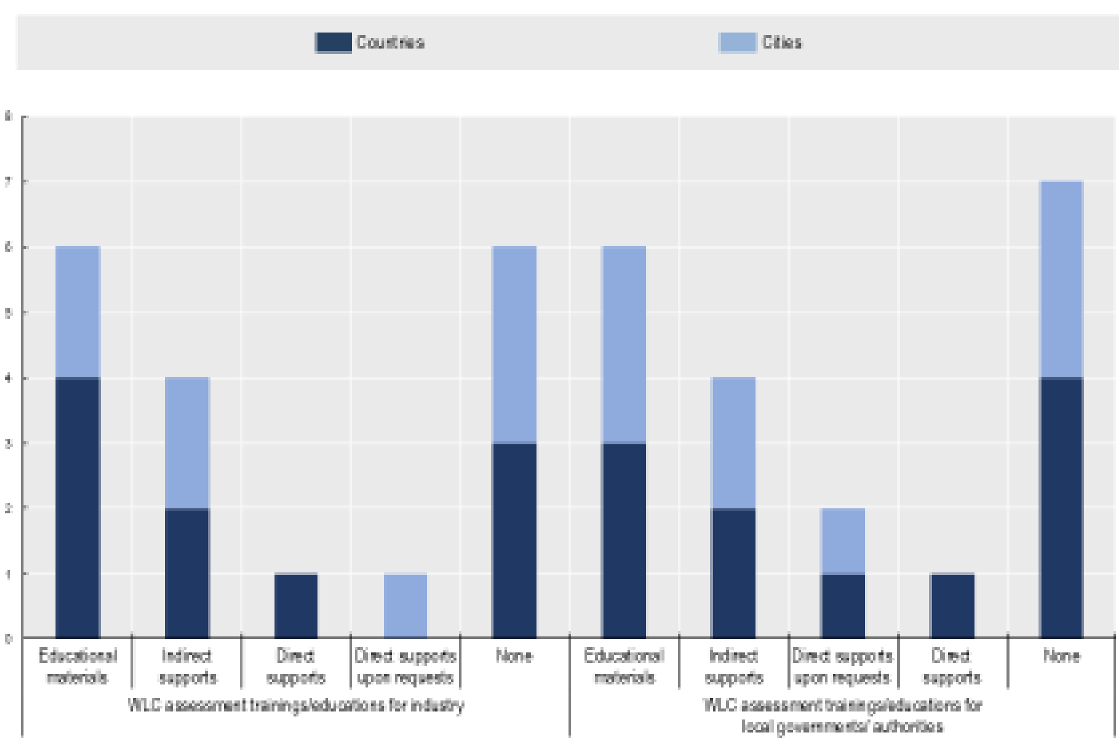
Similarly, Boverket in **Sweden** provides an online training platform, which offers digital handbooks, visuals, videos, training courses, as well as a national climate database, primarily aiming at helping developers and contractors apply regulation on climate declaration for buildings. The learning content for climate declarations is estimated to take about two hours and consists of three parts: i) introduction to climate declarations; ii) details of climate calculations; and iii) template for climate calculations and processes of Boverket’s supervision of the submitted declarations. Following the completion of the training on the platform, Boverket issues a certificate to the individual (Boverket, 2024[4]).

In **France**, the MOOC Sustainable Building platform (MOOC Bâtiment Durable) was launched as the result of a collaborative project of professionals in the building sector, the Sustainable Building Plan (Plan Bâtiment Durable) and the French Agency for Ecological Transition (ADEME). The MOOC serves as a training platform dedicated to sustainable building and real estate (MOOC Bâtiment Durable, n.d.[42]). The platform provided several RE2020 training sessions in 2021 and 2024, with financial support from the Ministry of Ecological Transition and Territorial Cohesion. The training course is structured over four weeks, with an estimated time commitment of one and a half hour per week, plus an additional week for completing all learning modules. This programme is specifically tailored for project managers, equipping them with a comprehensive understanding of the context and challenges of RE2020. Participants gain insights into the new regulations across three key dimensions: energy, carbon, and summer comfort.

Additionally, the training clarifies the responsibilities at each phase of a project and provides guidance on making informed decisions as a project manager. Participants are evaluated on the basis of their responses to a quiz and receive a certificate of successful completion of the course if they achieve an average score of 60% or more (MOOC Bâtiment Durable, n.d.[43]).

Unlike Denmark, Sweden, and France, the British Columbia Institute of Technology (BCIT) in **Canada** – a public post-secondary institution funded by the Province of British Columbia – offers a programme focused on LCA of buildings. The programme is offered as a micro-credential that certifies mastery in a specialised area, and requires the payment of tuition fees, aiming at upskilling industry professionals and recent graduates (BCIT, n.d.[44]; BCIT, 2022[45]). Developed in partnership with the Athena Sustainable Materials Institute, a membership-based non-profit research organisation based in North America, the micro-credential consists of four courses delivered online by experienced LCA professionals through a combination of self-paced work and virtual live lectures. Through the programme, students gain foundational knowledge of life-cycle assessment, as well as methods to calculate the carbon impact of building materials using Athena's free LCA software. Participants are expected to complete the micro-credential with a final project in which they have to undertake a thorough WLC assessment of a building and produce a comprehensive report in compliance with the National Whole-Building Life-Cycle Assessment Practitioner's Guide, federal document adapted from Vancouver's Embodied Carbon Guidelines (National Research Council of Canada, 2024[46]).

Figure 2.7. Training and education provided by national and subnational governments for capacity building



Note: Question from the survey: "Does the national/local government provide any training or education for SMEs regarding whole life carbon assessment of buildings in your country/city?"; "Does the national government provide any training or education for local governments regarding whole life carbon assessment of buildings?"
Source: OECD Global Survey on Whole Life Carbon of Buildings (2024)

Financial incentives

As WLC assessment of buildings is a relatively new concept, it requires effective financing mechanisms to incentivise investment. Existing financing mechanisms range from the development of assessment tools to innovation in low carbon products. Stable financial incentives designed and implemented by governments can also ensure policy stability, which is key for actors on both the supply and the demand side (Kerr and Winskel, 2020[47]).

Unlike improvements in building energy efficiency, which deliver direct benefits to residents (such as lower utility costs and enhanced comfort), efforts to reduce embodied carbon offer no obvious immediate co-benefits for occupants. Consequently, assessing and reducing embodied carbon often represents a direct cost increase for stakeholders in the construction sector, with limited direct returns for end users. However, according to a report by the Rocky Mountain Institute (RMI), mid-sized commercial building projects can achieve reductions in embodied carbon of up to 46% at a cost premium of less than 1% by replacing conventional materials with low-emission alternatives (Esau et al., 2021[48]). This finding suggests that significant reductions in embodied carbon can be accomplished in an affordable way, making it more feasible for developers committed to sustainable building practices. However, this can only be possible when companies have enough capacity to conduct assessments and comparisons of different designs, which typically lack in SMEs in terms of human and financial resources. This challenge is evident in the limited availability of EPD data that countries are typically suffering from during the early stages of LCA policy implementation. Obtaining EPDs can be costly, time-consuming, and requires specialised expertise, making it particularly challenging for SMEs to pursue.

The OECD Global Survey on Whole Life Carbon of Buildings (2024) shows that the majority of the countries and cities that have already implemented LCA policies have not used financial incentives. Among respondent countries and cities, the **Netherlands** is one of the few countries that has a financial aid scheme for SMEs to obtain EPDs. Through the “Filling the Gaps” compensation scheme (in Dutch: *Witte Vlekken vergoedingsregeling*), the Netherlands incentivises life-cycle analysis. The scheme offers EUR 2 500 to producers of construction products and materials for the development of an LCA. The main aim of the project is to increase the number of category 1 and 2 environmental statements in the Nationale Milieudatabase (see earlier Box 2.3). While the compensation scheme is a financial incentive for manufacturers to pursue EPDs, the 30% surcharge on category 3 data works as a means to incentivise manufacturers to differentiate their product from generic data by acquiring EPDs (Nationale Milieudatabase, n.d.[49]). Similarly, **Denmark** has implemented a subsidy scheme to support EPDs, although it was available only for a limited period during the initial phase, from 1 January 2022 until 30 September 2022 (Social- og Boligstyrelsen, 2022[50]). In France, to support the integration of LCA in the building sector, the French Environment and Energy Management Agency (ADEME) has been subsidising the development of French EPDs (Fiches de Déclaration Environnementale et Sanitaire, FDES) since 2019 through targeted calls for projects. The first three funding rounds facilitated 26 projects, leading to the creation of 42 environmental declarations and configurators, as well as three Product-Specific Rules (PSRs), which serve as standardised reference frameworks for producing Product Environmental Profiles (PEPs) within specific equipment categories.

Another possible financial incentive is a subsidy for low carbon constructions. **Vancouver**’s **(Canada)** NearZero programme, launched in 2018, offers a financial incentive for low-rise houses that achieve 30%+ embodied carbon reduction, aiming at helping inform policy and building industry capacity. The programme was originally developed to support high-performance construction, including in terms of energy efficiency. Following the success of this initial stream, the programme has grown both in geographic range and in scope (Zero Emissions Innovation Centre, n.d.[51]):

- Stream 1: high performance homes/low operational carbon (2018-2021, province-wide)
- Stream 2: low embodied carbon home construction (2023-present, City of Vancouver)

- Stream 3: fuel switching gas fired domestic hot water equipment to electric (2023-2024, City of Vancouver)
- Stream 4: assessing energy usage of high-performance homes and dual fuel heat pump retrofits (2023-present, province wide).

Voluntary certifications

Six out of fifteen surveyed countries and cities have started or will start with voluntary certification prior to the implementation of regulatory measures, often as a preparatory phase to collect data or test industry's readiness.

In **Denmark**, a "sustainability class" (Bæredygtighedsklasse) was launched for specific new buildings and renovation projects in May 2020. It functioned as a test phase to gather experience that can form the basis for introducing sustainability requirements in the building regulations, ending in November 2023. The requirements in the sustainability class include mandatory reporting of LCA, life-cycle cost (LCC) analysis, as well as requirements on indoor climate and daylight levels. When applying for a building permit and reporting the completion of a building, participating developers must submit both initial and final results of the assessment of overall climate impacts of a building. During the test phase, 73 construction projects were registered across various types of buildings, including residential buildings, commercial buildings, office buildings, single-family houses, as well as institutions and other types of buildings (Social- og Boligstyrelsen, n.d.[52]).

The Sustainable Building Quality Seal (QNG: Qualitätssiegel Nachhaltiges Gebäude), developed by the **German** Federal Ministry of Housing, Urban Development and Building (BMWSB), promotes a uniform understanding of sustainability, and at the same time, creates a legally secure basis for the allocation of subsidies. The basic requirement for the quality seal is proof of compliance with general and special requirements in terms of the ecological, socio-cultural and economic quality of buildings. The QNG is awarded in two quality levels – above-average quality (QNG-PLUS) and significantly above-average quality (QNG-PREMIUM) – on the condition of certification with a registered assessment system for sustainable construction which includes a requirement on GHG emissions in the whole life-cycle of the buildings. It sets out a benchmark of the GHG emissions in the building life-cycle for residential buildings to achieve QNG-PLUS and QNG-PREMIUM, respectively. For non-residential buildings, considering the wide range of building types and significant differences among them, the benchmark is determined at a project-specific level (BMWSB, 2023[53]).

In **France**, the Low Carbon Building Initiative (LCBI) was established as a voluntary certification to address the lack of a unified European methodology for assessing and comparing the carbon footprints of buildings. Recognising this gap, LCBI developed a comprehensive life-cycle assessment methodology with defined limit values to measure carbon emissions across all phases of a building. By acting as a common language, LCBI simplifies the quantification, comparison, and benchmarking of buildings' carbon footprints, ensuring greater transparency and consistency across the sector. The harmonisation of carbon assessment methods sends a strong market signal, encouraging real estate stakeholders to adopt sustainable practices and unlocking greater private sector investment in low-carbon buildings (Low Carbon Building Initiatitve, 2024[54]).

A circular economy approach for buildings

Adopting a circular economy approach is crucial for whole life carbon policies as it directly tackles the environmental impact of the construction sector. The circular economy can be defined as a guiding framework whereby: services (e.g. from water to waste and energy) are provided making efficient use of natural resources as primary materials and optimising their reuse; economic activities are planned and carried out in a way to close, slow and narrow loops across value chains; and infrastructures are designed and built to avoid linear lock-in (e.g. district heating, smart grid, etc.) (OECD, 2020[55]).

As highlighted in the OECD *Circular Economy in Cities and Regions: Synthesis Report* (2020[55]) (Box 2.4), adopting a circular approach presents multifaceted advantages. It provides an opportunity to “do more with less” by better using available natural resources and transforming waste into new resources. In addition, it can help promote new job opportunities and tackle inequalities. Governments are therefore increasingly adopting a circular approach, with the built environment pinpointed as one of the key sectors. In fact, 75% of respondents to the OECD Survey on the Circular Economy in Cities and Regions (2020[55]) indicated that their initiative includes the built environment.

Applying circular principles in the building sector implies rethinking the whole value chain: both upstream and downstream emissions. Upstream emissions come from construction, while downstream emissions are linked to the use and demolition of a building. Adopting circular practices in the building sector can help significantly lower embodied carbon – CO_2 emissions produced during material production, transportation, and construction processes. Reusing materials helps eliminate emissions associated with extracting raw materials and manufacturing new ones. Indeed, the construction sector is a major contributor to waste, generating 37% of the total waste in the EU alone (European Union, 2023[56]). Adopting a circular approach in the building sector also implies new forms of collaboration amongst designers, constructors, contractors, real estate investors, suppliers of building materials and owners, while looking at the life-cycle from construction to end of life. Circular economy approaches in the building sector can be divided in the following manner: i) strategies that promote a holistic approach to building circularity; ii) policies addressing retrofit and idle capacity of buildings; iii) policies targeting design, planning and construction; and iv) policies focusing on end of life of buildings.

Box 2.4. Guiding principles for a circular economy in cities and regions: highlights from the OECD Synthesis Report

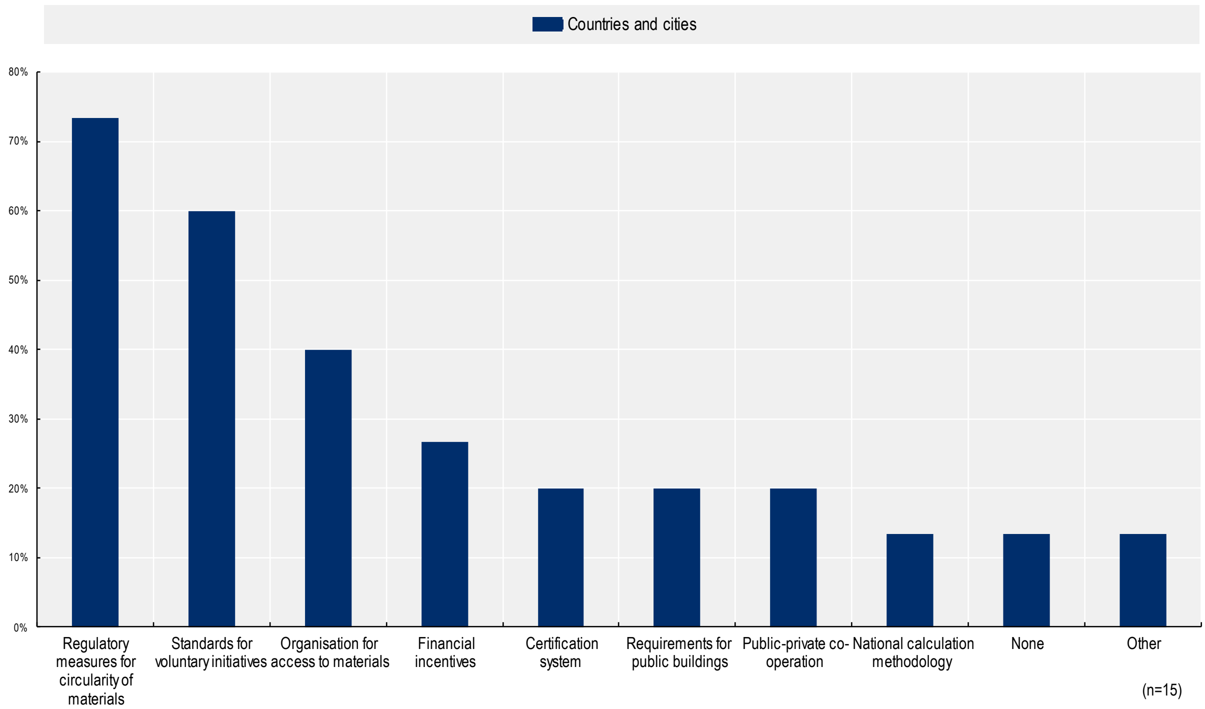
The OECD Circular Economy in Cities and Regions: Synthesis Report (2020[55]) outlines the guiding principles for a circular economy moving forward and maps existing measures and initiatives. The circular economy is an opportunity to rethink economic functioning to increase resilience in the face of future crises. The report highlights three key principles of the circular economy: i) design out waste and pollution; ii) keep products and materials in use; and iii) regenerate natural systems.

To gain a detailed understanding of the initiatives in place and challenges faced by municipal and regional governments, the OECD conducted a survey to identify policies addressing circular economy in cities and regions. The report is based on responses provided by 44 cities and 2 regions. It is complemented by 8 in-depth case studies, highlighting the need for place-based policies.

Source: Author’s elaboration based on OECD (2020), The Circular Economy in Cities and Regions: Synthesis Report. https://doi.org/10.1787/10ac6ae4-en.

Figure 2.8 shows the types of measures that national and local governments are implementing to promote and enhance circularity in the built environment. Most respondent countries and cities are aware of the importance of adopting a circular approach in the building sector and are adopting diverse measures in this respect. Surveyed countries and cities are overwhelmingly privileging regulation that mandates circularity of building materials: 11 out of 15 (73%) responding governments state that they implemented a regulatory measure concerning reuse of existing materials, and 9 out of 15 (60%) responding cities and countries introduced standards for voluntary initiatives.

Figure 2.8. Building circularity measures in place in countries and cities



Note: Question from the survey: "Building circularity measures in place". The responding countries and cities could select all applicable options.
Source: OECD Global Survey on Whole Life Carbon of Buildings (2024)

Circularity roadmap

Circularity roadmaps can be implemented both at the national level and at the city level to address local conditions more efficiently. At the national level, for example, **Costa Rica** promotes circularity through the National Circular Economy Strategy (ENEC), which serves as a guideline for voluntary initiatives. The ENEC was developed by the Intersectoral Committee for Circular Economy (CIEC) with the co-ordination of the Ministry of Environment and Energy (MINAE), and with the support of the Climate Technology Centre & Network (CTCN) of the United Nations and of different public, private and industrial entities. Under the section on circular construction and resilient infrastructure, it seeks to promote the adoption of a circular economy throughout the entire construction and infrastructure industry, from the extraction of raw materials to operational management, maintenance and subsequent demolition of buildings. Their strategic component considers action plans that gradually transform the construction industry at all stages, incorporating design strategies, clean technologies and sustainable construction processes. Strategic actions include enhancing the circularity of both public and private works, establishing revaluation mechanisms for construction and demolition waste, as well as incorporating sustainable design and construction principles into architecture and engineering degrees (Intersectoral Committee for Circular Economy, 2023[57]).

At the city level, **Malmö**'s **(Sweden)** LFM30 platform functions as a local roadmap for a climate-neutral construction sector. Initiated by the city government and bringing together over 200 stakeholders from the construction sector, LFM30 covers six priority areas of work. Area 2 "Circular economy and resource efficiency" strives to enhance circularity in the construction sector. Malmö's goal is to be climate-neutral by 2030 and the transition to a circular economy is seen as crucial to achieving this goal. Malmö sees its role as going beyond a local initiative: it strives to be a testbed for policies that could later be implemented on the national level. While Sweden's economy is not emission-heavy, only 3.4% of the resources used within the country are cycled back into the economy after use. Sweden's extraction rates per capita are the fourth largest in the world (Circle Economy, 2024[58]), highlighting the need to adopt a circular economy approach. Malmö's LFM30 platform serves as a pilot project that has the potential to be upscaled to the national level.

To make progress within the six priority areas, LFM30 set up a working group for each area. Working Group 2 focuses on introducing a circular approach in the construction sector the local reuse market, inventories of reused materials as well as circular procurement requirements. To help both companies and private individuals in implementing principles outlined in Malmö's roadmap**,** the city has made available a compilation of guidelines that focus on reuse and circularity. The guidelines address four different areas (LFM30, n.d.[59]):

- Working methods for circular construction,
- Procurement and public activities,
- Dismantling for reuse,
- The effects of reuse

Retrofit and idle capacity of buildings

Doing more with less is a key principle of a circular economy. This implies thorough investigation in early phases of projects to find out whether new construction is needed, in accordance with the principle of sufficiency. Sufficiency aims to optimise the use of existing buildings to create a built environment that is attractive, affordable, and aligned with the actual space and the accessibility needs of occupants, while abiding by planetary boundaries. In cities, a number of dismissed buildings can have a second life, avoiding new constructions (OECD, 2020[60]).

Greater London (UK) encourages developers to reuse and retrofit as a first principle, focusing on optimising the use of existing buildings before considering any new construction. The London Plan includes a section entitled Policy D3 "Optimising site capacity through the design-led approach", which sets the order in which actions should be considered. Policy D3 lays out a Circular Economy Hierarchy for Building Purposes, which orders actions as follows: developers should first retain existing buildings, then consider refitting, refurbishing, reclaiming and only after that, remanufacturing, and recycling (Greater London Authority, 2021[61]).

Similarly to Greater London, **Oslo**'s **(Norway)** Guidelines for Real Estate Developers, first introduced in 2020 and updated in 2024, prioritise retaining and retrofitting existing buildings. The Guidelines serve simultaneously as a recommendation for developers and as a tool for city officials to evaluate planning projects. Each new building project must be justified: the Guidelines require carrying out calculations on whether emissions from demolishing and building anew are lower than retaining and renovating the existing building (City of Oslo, 2024[62]).

Repurposing properties is also a priority for the city of **Glasgow (United Kingdom).** City Property Glasgow, a dedicated arm's length external organisation (ALEO) of Glasgow City Council, oversees the management of all 800 properties that belong to the city. Glasgow City Council sees the possibility of maximising the use and making profitability from its estate in order to provide hubs, workspaces and premises for circular economy actors (OECD, 2021[63]).

Planning, design, and construction

While circular economy initiatives are devoting attention to sustainable waste management (OECD, 2020[55]), well-designed building components can reduce waste generation in the first place.

In the **EU**, the newly adopted Construction Products Regulation (CPR) supports building circularity and whole life carbon (WLC) policies by mandating life-cycle data reporting, integrating digital tools such as the Digital Product Passport (DPP), and harmonising sustainability requirements across the EU. In November 2024, the Council of the EU approved a revised CPR, establishing harmonised rules for the marketing and use of construction products. The revision comes into effect by the end of 2024 (European Commission, 2024[64]).

This revision ensures the smooth circulation of construction products within the EU single market while upholding stringent standards in terms of safety, sustainability, and environmental performance. These updates enhance the CPR's role in advancing the EU's green and digital transition, contributing to the development of a resource-efficient, circular economy. Furthermore, the CPR aligns with the principles of the EU Circular Economy Action Plan to reduce the environmental footprint of the construction sector (European Union, 2024[65]).

A cornerstone of the revised CPR is the declaration of performance and conformity, which has been expanded to include the environmental sustainability performance of construction products. This declaration now addresses the life-cycle impacts of products, including packaging, as outlined in Article 15. The phased implementation of Annex II's essential characteristics ensures a structured approach, starting with the immediate inclusion of characteristics such as climate change effects, with additional criteria to be added over the coming years. Accessible electronically or through the Digital Product Passport, the declaration promotes transparency by providing readily available life-cycle performance data. This accessibility supports regulatory compliance while incentivising manufacturers to design lower-carbon, resource-efficient products. The integration of life-cycle sustainability data into the declaration enhances accountability, ensuring alignment between manufacturers' practices and WLC reduction objectives (European Union, 2024[65]).

The introduction of the Digital Product Passport marks a transformative development in managing life-cycle and product information. The DPP consolidates essential data, including the declaration of performance, technical documentation, safety information, and unique product identifiers, giving stakeholders comprehensive access to product details. By enabling real-time updates and dynamic accessibility, the DPP ensures that life-cycle and environmental performance data remain accurate and up-to-date. It also supports circular economy principles by facilitating the sharing of data that are crucial for reuse, recycling, and remanufacturing. This system fosters product designs that prioritise circularity, encouraging recyclability, ease of deconstruction, and the minimisation of mixed materials. The DPP increases transparency throughout the value chain, supporting informed decision-making and traceability of environmental impacts (European Union, 2024[65]).

In addition to these individual contributions, the CPR creates significant synergies with the Energy Performance of Buildings Directive (EPBD), which aims to reduce life-cycle GWP and improve operational energy efficiency at the building level. The CPR's declarations of performance and conformity provide essential product-level data required for the EPBD's building-level WLC assessments, ensuring accurate accounting of embodied carbon in construction materials. Furthermore, the alignment of digital tools – such as the integration of the Union Construction Products Database with the DPP – streamlines life-cycle GWP calculations, enabling buildings to comply more efficiently with EPBD requirements. By 2030, the mandatory disclosure of life-cycle GWP under both the EPBD and CPR will establish a cohesive regulatory framework, ensuring that both construction products and buildings meet net-zero targets. This alignment bridges the gap between material-level sustainability and building-level performance, creating a unified approach that advances consistent sustainability goals across the construction sector (BPIE, 2024[66]).

Oslo (Norway) has set a target of reducing emissions that physically occur within the city by 95% by 2030 compared to 2009 levels (City of Oslo, 2024[67]). A key aspect of this strategy is the emphasis on reuse and sustainable material choices in construction, designed to lower emissions across buildings' whole life-cycle. These policies prioritise a holistic approach, from planning to construction and operation, aligning with the broader goal of reducing the city's overall climate footprint. Oslo's Guidelines for Real Estate Developers encourage the reduction of a building's climate and environmental impact over the life-cycle through the use of more sustainable materials, such as reused materials and the use of wood, biomass-based or wood-based products, low-carbon concrete and recycled metals. Chosen materials should have a long lifespan to withstand future climate change (increased precipitation, temperature increase, drought etc.) (City of Oslo, 2024[62]).

In 2010, Oslo along with Bergen, Trondheim and Stavanger launched the FutureBuilt programme to support climate friendly urban development. The goal of the programme is to complete 100 pilot projects that fulfil the standards set by FutureBuilt. As of October 2024, 77 projects are part of the programme, including 44 that have been completed. FutureBuilt projects have to cut emissions from transport, energy and materials by at least 50% compared to the regulatory requirements and common practice, adopt a circular approach as well as implement sustainable water management. The programme includes two sets of criteria: i) FutureBuilt ZERO, pertaining to emission reduction; and ii) FutureBuilt Circular, aimed at addressing the problem of material reuse. FutureBuilt Circular states that pilot projects that are part of the programme should facilitate resource utilisation at the highest possible level and aim for a minimum of 50% circularity. In order to quantify the requirements, FutureBuilt has developed a circularity index, which applies to both new construction and retrofit. It is a comprehensive set of criteria that addresses all stages of the construction process, from choosing monomaterials and components easy to dismantle to making material passports. Decisions on conservation, demolition, or rehabilitation of existing buildings are based on an assessment to determine what the best environmental option is in terms of conservation, degree of transformation, rehabilitation, or demolition (FutureBuilt, 2024[68]).

In **Vancouver (Canada)**, the city's WLC policy aims to enhance circularity in construction. The Embodied Carbon Guidelines, introduced in 2023, are aligned with the 2022 revision of the Vancouver Building By-law (VBBL), which requires designers to calculate, limit, and report embodied carbon in new buildings. This applies to large buildings (>600 m^2 of building area and more than 3 floors) and those in which care, treatment and essential services are provided. The Guidelines build on the VBBL, providing detailed information on modelling embodied carbon emissions. To reward circular solutions, the Embodied Carbon Guidelines allow for assuming zero-embodied-carbon emissions for reused elements and 50% reduction of end-of-life emissions for design for disassembly/adaptability. The possibility of offering embodied carbon reduction credits for salvaging materials and designing for deconstruction is under discussion as part of embodied carbon requirements for 2025 (City of Vancouver, 2024[69]).

In **Flanders (Belgium)**, the Public Waste Agency (OVAM), in collaboration with the Walloon Public Service (SPW) and the Brussels Environment Agency (Brussels Environment), has developed an online open-access calculation tool called "Tool to Optimise the Total Environmental Impact of Materials" (TOTEM). The TOTEM helps architects, designers and builders assess the environmental impact of building materials to increase the material and energy performance of buildings. **Amsterdam (Netherlands)** applies smart design for buildings more suitable for the repurposing and reuse of materials and improves efficiency in the dismantling and separation of waste streams to enable high-value reuse and create a resource bank and marketplace where materials can be exchanged between market players. **Paris (France)** has established a circular economy certification for the construction sector. To obtain the certification, construction projects have to reach at least 40% of the points established in a "circular economy profile" (e.g. inclusion of a waste management plan, use of recycled materials, development of life-analysis calculations, eco-certification of wood, considering deconstruction processes, establishing synergies with local actors in the surrounding areas, among others) (OECD, 2020[60]).

End of life

In a circular economy, the end of life of a building creates a new use for the waste material produced. Different levels of circularity can be identified: sometimes the existing asset, its components and materials are repurposed with no major transformations and in the same location, whereas at other times, components and materials from a building are used in a different location (OECD, 2020[60]). As evidenced by Figure 2.8 above, both local and national governments are prioritising regulation that mandates the reuse of existing building materials, thus minimising waste.

In the **EU**, the EU Taxonomy promotes circularity in the building sector to reduce waste and enhance sustainability. It established a set of technical screening criteria to ensure that the industry transitions towards a circular economy. For demolition activities, the EU Taxonomy requires thorough pre-demolition planning, including audits and waste management plans that prioritise selective deconstruction and sorting of waste streams. Operators must ensure that at least 90% of demolition waste is reused or recycled, with separate collection and preparation processes for different material types. Compliance with these requirements is tracked through standardised reporting using EU Level(s), the framework for assessing and reporting on the sustainability performance of buildings (European Commission, n.d.[70]).

Greater London (UK) has taken a similar approach to the EU. The London Plan sets targets to minimise waste and promotes waste prevention by reusing components and materials. . Large developments, which are referable to the Mayor of London, are mandated to submit a Circular Economy Statement. Particular attention is paid to waste management of the projects. Construction, demolition and excavation works account for 9.7 million tonnes of waste in London annually, representing 54% of all waste generated in the city. To address this problem, the London Plan requires referable applications to recycle at least 95% of construction and demolition waste, thus ensuring that materials are managed at their highest value (Greater London Authority, 2021[61]).

In **Helsinki (Finland),** the transport of materials and waste at different stages of the life-cycle, the energy consumption of the construction site, and the demolition of the building and the treatment of demolition waste typically account for approximately 15% of the carbon footprint of the entire life-cycle of a residential building. The city therefore encourages developers to minimise construction site waste and improve recycling and recovery rates. Reducing waste is not only beneficial from the perspective of use of resources, but it also decreases transport emissions (City of Helsinki, 2024[71]).

In **France**, the building sector generates approximately 42 million tonnes of waste each year, which is more than households' combined waste (30 million tonnes). More than 90% of building waste comes from demolition or rehabilitation work (INIES, n.d.[72]). The Anti-Waste for a Circular Economy (AGEC) law, enacted in 2020, set up the Products, Equipment, Materials and Waste (MDPE) diagnosis. The aim is to support the principle of the AGEC law by promoting sustainability and responsible management of resources, reducing waste produced by the building sector by encouraging reuse. The MDPE tool provides information on the products, equipment, materials and waste expected from demolition or significant renovation operations. The priority is to reuse building materials, but if that is not possible, they can be recycled. MDPE therefore also indicates reuse or management, and recovery channels and recommends additional analysis to ensure the reusability of these products, equipment and materials. The diagnosis applies to the demolition or significant renovation of buildings: i) with a cumulative floor area of more than 1 000m^2; ii) where an agricultural, industrial or commercial activity took place; and iii) where dangerous substances were stored, manufactured or distributed.

The project owner is subject to the regulatory obligation to carry out the MDPE diagnosis prior to the submission of an application for a planning permission, and at the end of the demolition or renovation work. The project owner is then required to document the nature and quantities of the products, equipment and materials reused or intended to be reused and those of the waste, effectively reused, recycled, recovered or disposed of (Ministères Territoires Écologie Logement, 2024[73]).

The 2024 Paris Olympic and Paralympic Games serve as an example of sustainable construction practices, particularly in terms of recycling and reusing building materials. Developed on a reclaimed industrial site, the Olympic Village's initial phase prioritised deconstruction over traditional demolition, ensuring maximum material recovery in line with circular economy principles. Unlike conventional demolition, deconstruction enables the systematic recovery and reuse of materials, reducing waste and minimising environmental impact. As a result, over 860 tonnes of materials were salvaged and repurposed.

A target of 90% reuse and recovery of waste from the Olympic and Paralympic construction sites was set and achieved, demonstrating a strong commitment to resource efficiency and sustainability. Moreover, timber was used extensively in the Athletes' Village, especially in structures under 28 meters in height, where it was used as a primary structural material. By mandating at least 30% of the wood be sourced from French eco-managed forests, the initiative not only advanced the use of sustainable construction practices but also supported the local timber industry (SOLIDEO, 2024[74]).

In addition, the Aquatics Centre, the only permanent sports facility built specifically for the Paris 2024 Games, exemplifies low-carbon, bio-based construction. The Centre features a structure made from bio-sourced materials, a timber frame that complements the future green spaces of the area, and a 5,000 m² roof equipped with photovoltaic panels. This makes it one of the largest urban solar farms in France. Its interiors have been crafted from recycled materials (SOLIDEO, 2022[75]).

While Greater London (UK), Helsinki (Finland) and France mandate the reduction of construction waste and only account for the negative externalities of the construction and demolition process, **Finland** also considers these processes as an opportunity. To take into account the positive climate impacts that would not arise without the construction project, Finland proposes the "carbon handprint" concept. Contrary to the notion of carbon footprint, carbon handprint refers to module D elements. Module D consists of all potential benefits and loads occurring beyond the system boundaries: recycling (D1), energy recovery (D2) and surplus energy generation (D3). These elements are supplemented with other benefits such as biogenic carbon storage (D4) and cement carbonation beyond system boundaries (D5). This incentivises developers to introduce innovative solutions, for instance by using the excess energy generated by construction (Nordic Sustainable Construction, 2024[1]).

In **Vancouver (Canada)**, the Green Demolition Bylaw differentiates buildings on the basis of their age and sets different requirements regarding the salvage of materials. The Bylaw mandates recuperating 3 tonnes of wood from heritage-listed or pre-1910 houses, and requires 75% recycling for pre-1950 houses, and 90% recycling for pre-1950-character houses (City of Vancouver, 2023[76]). In addition, the Rebuild Hub run by the Vancouver branch of Habitat for Humanity offers a place to donate and source high quality salvaged materials, facilitating the co-ordination between construction companies. Habitat for Humanity helps individuals and companies navigate the deconstruction process. Donors receive a tax receipt for the value of the salvaged goods to mitigate additional costs involved with deconstruction as opposed to demolition (Habitat for Humanity, n.d.[77]). Similarly, in **Malmö (Sweden)**, the local government in co-operation with the private sector has founded the Malmö Reconstruction Depot to increase reuse of building materials. The Depot receives and sells used building materials, such as roof tiles, bricks, windows, doors, cabinets, insulation, timber and others. From 2024 onwards, some of the Depot's products can also be purchased online to increase the Depot's attractiveness and convenience (Malmö Återbyggdepå, n.d.[78]).

References

BBSR (2019), *ÖKOBAUDAT Basis for the building life cycle assessment*, https://www.oekobaudat.de/fileadmin/downloads/0068G_en_BF_200106ms.pdf. [31]

BCIT (2022), *What are microcredentials and who are they for?*, https://commons.bcit.ca/news/2022/05/what-are-microcredentials/. [45]

BCIT (n.d.), *Governance*, https://www.bcit.ca/about/leadership-vision/governance/. [44]

BMWSB (2023), *Qualitätssiegel Nachhaltiges Gebäude (QNG)*, https://www.bmwsb.bund.de/SharedDocs/downloads/Webs/BMWSB/DE/publikationen/bauen/qng-neubau-und-modernisierung-von-wohn-und-nichtwohngebaeuden.html. [53]

Boverket (2024), *Online training on climate declarations*, https://www.boverket.se/sv/klimatdeklaration/utbilda/webbutbildning/. [4]

Boverket (2024), *Questions and answers about climate declarations*, https://www.boverket.se/en/start/building-in-sweden/developer/rfq-documentation/climate-declaration/questions/. [29]

Boverket (2023), *Limit values for climate impact from buildings and an expanded climate declaration*, https://www.boverket.se/globalassets/engelska/limit-values-for-climate-impact-from-buildings-and-an-expanded-climate-declaration.pdf (accessed on 24 October 2024). [3]

Boverket (2023), *Limit values for climate impact from buildings and an expanded climate declaration*, https://www.boverket.se/globalassets/engelska/limit-values-for-climate-impact-from-buildings-and-an-expanded-climate-declaration.pdf. [11]

Boverket (n.d.), *PBL and climate declarations*, https://www.boverket.se/sv/klimatdeklaration/om-klimatdeklaration/pbl-och-klimatdeklarationer/. [2]

BPIE (2024), *How to establish Whole Life Carbon benchmarks: Insights and lessons learned from emerging approaches in Ireland, Czechia and Spain*, https://www.bpie.eu/publication/how-to-establish-whole-life-carbon-benchmarks-insights-and-lessons-learned-from-emerging-approaches-in-ireland-czechia-and-spain/ (accessed on 22 November 2024). [66]

BUILD - Institut for Byggeri, By og Miljø, Aalborg Universitet (2023), *LCAbyg User Guide*. [28]

Building and Construction Authority (2024), *Green Mark 2021 Technical Guide*, https://www1.bca.gov.sg/docs/default-source/docs-corp-buildsg/sustainability/20240101_wholelifecarbon_technical_guide_r2.pdf?sfvrsn=8b82a43b_0. [13]

Bundesministerium für Wohnen, Stadtentwicklung und Bauwesen (n.d.), *ÖKOBAUDAT*, https://www.oekobaudat.de/en.html. [24]

Circle Economy (2024), *The Circularity Gap Report: Sweden*, https://www.circularity-gap.world/sweden#download. [58]

City of Helsinki (2024), *Vähähiilisyysopas suunnittelijoille ja rakennus-hankkeeseen ryhtyville*, https://www.hel.fi/static/att/helsingin-ohje-elinkaaren-hiilijalanjalkilaskelmiin.pdf. [71]

City of Oslo (2024), *Climate Budget 2024*, https://www.klimaoslo.no/wp-content/uploads/sites/2/2024/08/Climate-budget-2024.pdf. [67]

City of Oslo (2024), *Kriterier for vurdering av klimakonsekvenser iplanprosessen*, https://www.oslo.kommune.no/getfile.php/13372564-1712062712/Tjenester%20og%20tilbud/Plan%2C%20bygg%20og%20eiendom/Byggesaksveiledere%2C%20normer%20og%20skjemaer/Klimakriterier%20%E2%80%93%20veileder.pdf. [62]

City of Vancouver (2024), *Embodied Carbon in Vancouver Building Bylaw 2025*, https://vancouver.ca/files/cov/proposed-embodied-carbon-requirements-vancouver-building-by-law-2025.pdf. [69]

City of Vancouver (2023), *Embodied Carbon Guidelines*, https://vancouver.ca/files/cov/embodied-carbon-guidelines.pdf. [15]

City of Vancouver (2023), *Green Demolition By-law*, https://bylaws.vancouver.ca/11023c.pdf. [76]

Danish Authority of Social Services and Housing (2024), *Ny aftale stiller ambitiøse klimakrav til nyt byggeri*, https://www.sm.dk/nyheder/nyhedsarkiv/2024/maj/ny-aftale-stiller-ambitioese-klimakrav-til-nyt-byggeri. [7]

DIGECA (2022), *Guía de Compras Públicas Sostenibles*, Dirección de Gestión de Calidad Ambiental, http://www.digeca.go.cr/sites/default/files/documentos/guia_compras_publicas_sostenibles_2022.pdf. [27]

Ecochain (n.d.), *Environmental Product Declaration (EPD) - The complete guide*, https://ecochain.com/blog/environmental-product-declaration-epd-basics/#:~:text=EPD%20reports%20are%20standardized%2C%20verified,comparison%2C%20and%20decision%2Dmaking. [23]

Esau, R. et al. (2021), *Reducing Embodied Carbon in Buildings: Low-Cost, High Value Opportunities*, RMI, https://rmi.org/wp-content/uploads/dlm_uploads/2021/08/Embodied_Carbon_full_report.pdf. [48]

EU (2024), *DIRECTIVE (EU) 2024/1275 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 24 April 2024 on the energy performance of buildings (recast)*, https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=OJ:L_202401275. [19]

European Commission (2024), *Conference on the new Construction Products Regulation 2024*, https://single-market-economy.ec.europa.eu/sectors/construction/construction-products-regulation-cpr/review/conference-new-construction-products-regulation-2024_en. [64]

European Commission (n.d.), *Demolition and wrecking of buildings and other structures*, https://ec.europa.eu/sustainable-finance-taxonomy/activities/activity/396/view (accessed on 19 November 2024). [70]

European Union (2024), *Regulation of the European Parliament and of the Council laying down harmonised rules for the marketing of construction products and repealing Regulation (EU) No 305/2011*. [65]

European Union (2023), *COMMISSION DELEGATED REGULATION (EU) 2023/2486 of 27 June 2023*, https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32023R2486 (accessed on 19 November 2024). [56]

Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (2014), *Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety*, https://www.nachhaltigesbauen.de/fileadmin/pdf/Systainable_Building/LFNB_E_160309.pdf. [30]

Federal Ministry of the Interior, Building and Community (2019), *Guideline for Sustainable Building*, https://www.bnb-nachhaltigesbauen.de/fileadmin/publikationen/BBSR_LFNB_E_komplett_KOR1_190503.pdf. [6]

FutureBuilt (2024), *What is FutureBuilt*, https://www.futurebuilt.no/English. [68]

Greater London Authority (2022), *London Plan Guidance Whole Life-Cycle Carbon Assessments*, https://www.london.gov.uk/sites/default/files/lpg_-_wlca_consultation_report.pdf. [5]

Greater London Authority (2021), *The London Plan*, https://www.london.gov.uk/sites/default/files/the_london_plan_2021.pdf (accessed on 28 October 2024). [61]

Guldner, L. (2019), *GE3: Stockage temporaire du carbone Rapport du groupe d'expertise*, http://www.batiment-energiecarbone.fr/IMG/pdf/ge3_stockage_temporaire_carbone_rapport_final.pdf. [22]

Güte- und Qualitätsgemeinschaft Ökobilanzierungswerkzeuge für Gebäude e.V. (n.d.), *Test bestanden: Gütegemeinschaft Ökobilanzierungswerkzeuge e.V. validiert mit CAALA und LEGEP erste Software-Lösungen*, https://guetegemeinschaft-lca.de/test-bestanden-guetegemeinschaft-oekobilanzierungswerkzeuge-e-v-validiert-mit-caala-und-legep-erste-software-loesungen/. [33]

Habitat for Humanity (n.d.), *The Rebuild Hub*, https://www.habitatgv.ca/rebuildhub. [77]

IBECs (n.d.), *J-CAT/Japan Carbon Assessment Tool for Building Lifecycle*, https://www.ibecs.or.jp/english/JCAT/index.html. [10]

INIES (n.d.), *The circular economy*. [72]

Intersectoral Committee for Circular Economy (2023), *National Circular Economy Strategy*, https://minae.go.cr/organizacion/vicegestionestrategica/SEPLASA/Documentos/Estrategia%20National%20Economia%20Circular.pdf. [57]

Kerr, N. and M. Winskel (2020), "Household investment in home energy retrofit: A review of the evidence on effective public policy design for privately owned homes", *Renewable and Sustainable Energy Reviews*, Vol. 123, p. 109778, https://doi.org/10.1016/J.RSER.2020.109778. [47]

Lavikka, R. et al. (2024), *BIM for Building, Enhancing Nordic Sustainable Construction through Digitalisation*, Nordic Sustainable Construction, https://www.nordicsustainableconstruction.com/Media/638616414274636915/BIM%20for%20Building%20LCA_Enhancing%20Nordic%20Sustainable%20Construction%20Through%20Digitalisation.pdf. [35]

LFM30 (n.d.), *Cirkulär ekonomi och resurseffektivitet*, https://lfm30.se/cirkular-ekonomi-och-resurseffektivitet/. [59]

Low Carbon Building Initiatitve (2024), *Low Carbon Building Initiatitve New Construction Scheme*, https://www.lowcarbonbuilding.com/wp-content/uploads/2024/03/2024-01-25-lcbi-certification-scheme-new-construction-v10-a.pdf (accessed on 4 February 2025). [54]

Malmö Återbyggdepå (n.d.), , https://aterbygg.nu/. [78]

Mayor of London (2023), *Whole life-cycle carbon (WLC), Circular Economy (CE) and retrofit*, https://consult.london.gov.uk/pflp-stakeholder/brainstormers/whole-life-cycle-carbon-wlc-circular-economy-ce-and-retrofit. [14]

MINAE, MIDEPLAN and MREC (2018), *Política Nacional de Producción y Consumo Sostenibles 2018 -2030*, https://cdn.climatepolicyradar.org/navigator/CRI/2018/national-policy-of-sustainable-production-and-consumption-2018-2030_7ee0a623a48631c13b239c8bb8a51d79.pdf. [26]

Ministères Territoires Ecologie Logement (2024), *Bâtiment et numérique*, https://www.ecologie.gouv.fr/politiques-publiques/batiment-numerique. [39]

Ministères Territoires Écologie Logement (2024), *Le diagnostic « produits, équipements, matériaux et déchets » (PEMD)*, https://www.ecologie.gouv.fr/politiques-publiques/diagnostic-produits-equipements-materiaux-dechets-pemd. [73]

Ministry of Ecological Transition and Territorial Cohesion (2024), *Evaluation des logiciels*, https://rt-re-batiment.developpement-durable.gouv.fr/evaluation-des-logiciels-a619.html?lang=fr (accessed on 2024). [34]

Ministry of Ecological Transition and Territorial Cohesion (2024), *Guide RE2020*, https://www.ecologie.gouv.fr/sites/default/files/documents/guide_re2020_version_janvier_2024.pdf (accessed on 25 October 2024). [18]

Ministry of Ecological Transition and Territorial Cohesion (2023), , https://www.ecologie.gouv.fr/experimenter-construction-du-batiment-performant-demain-0 (accessed on 17 April 2024). [21]

Ministry of Ecological Transition and Territorial Cohesion (2022), *GUIDE RE2020 Réglementation Environnementale*, Centre d'études et d'expertise sur les risques l'environnement la mobilité et l'aménagement (Cerema), https://www.ecologie.gouv.fr/sites/default/files/documents/guide_re2020_version_janvier_2024.pdf. [8]

Ministry of Land, Infrastructure, Transport and Tourism (2021), *BIM/CIM related standards and guidelines*, https://www.mlit.go.jp/tec/tec_fr_000079.html. [36]

Ministry of Land, Infrastructure, Transport and Tourism (2019), *Vision for the Future and Roadmap to BIM*, https://www.mlit.go.jp/jutakukentiku/content/001351970.pdf. [37]

MOOC Bâtiment Durable (n.d.), *About us*, https://www.mooc-batiment-durable.fr/fr/annexe/a-propos/. [42]

MOOC Bâtiment Durable (n.d.), *RE2020: Prepare for the new environmental regulations*, https://www.mooc-batiment-durable.fr/fr/formations/re2020-preparez-vous-la-nouvelle-reglementation-environnementale/. [43]

Nachhaltige Gebäude (2023), *Anhang 3.2.1.1 zur ANLAGE 3 Bilanzierungsregeln des QNG für Nichtwohngebäude, Stand 01.03.2023*, https://www.qng.info/app/uploads/2023/03/QNG_Handbuch_Anlage-3_Anhang-3211_LCA_Bilanzregeln-NW_v1-3.pdf. [32]

National Research Council of Canada (2024), *National whole-building life cycle assessment practitioner's guide*, https://nrc-publications.canada.ca/eng/view/object/?id=533906ca-65eb-4118-865d-855030d91ef2. [46]

Nationale Milieudatabase (n.d.), *Filling the Gaps Compensation Scheme*, https://milieudatabase.nl/en/database/project-blanc-spots-in-the-nmd/. [49]

Nordic Sustainable Construction (2024), *Harmonised Carbon Limit Values for Buildings in Nordic Countries*, https://pub.norden.org/us2024-415/us2024-415.pdf. [1]

Nordic Sustainable Construction (2023), *Roadmap: Harmonising Nordic Building Regulations concerning Climate Emissions*, https://www.nordicsustainableconstruction.com/Media/638302229397775948/Roadmap%20for%20harmonising%20Nordic%20Building%20Regulations%20concerning%20Climate%20Emissions.pdf. [25]

OECD (2024), *Global Monitoring of Policies for Decarbonising Buildings: A Multi-level Approach*, https://www.oecd.org/en/publications/global-monitoring-of-policies-for-decarbonising-buildings_d662fdcb-en.html. [9]

OECD (2021), *The Circular Economy in Glasgow, United Kingdom*, OECD Urban Studies, OECD Publishing, Paris, https://doi.org/10.1787/7717a310-en. [63]

OECD (2020), *The Circular Economy in Cities and Regions: Synthesis Report*, https://www.oecd.org/en/publications/the-circular-economy-in-cities-and-regions_10ac6ae4-en.html. [55]

OECD (2020), *The Circular Economy in Cities and Regions: Synthesis Report*, OECD Urban Studies, OECD Publishing, Paris, https://doi.org/10.1787/10ac6ae4-en. [60]

Ouellet-Plamondon, C. et al. (2023), *Carbon footprint assessment of a wood multi-residential buidling considering biogenic carbon*, https://pdf.sciencedirectassets.com/271750/1-s2.0-S0959652623X00201/1-s2.0-S0959652623009927/main.pdf?X-Amz-Security-Token=IQoJb3JpZ2luX2VjENL%2F%2F%2F%2F%2F%2F%2F%2F%2FwEaCXVzLWVhc3QtMSJHMEUCIQDdKUAgiSCPgkGQnCKHyCICiXgG%2FcKJfy%2Bziv7KHo%2BURQIgAI9LGn. [20]

RICS (2023), *Whole life carbon assessment for the built environment*, https://www.rics.org/content/dam/ricsglobal/documents/standards/Whole_life_carbon_assessment_PS_Sept23.pdf. [16]

Singapore Green Building Council (n.d.), *Bringing Embodied Carbon Upfront*, https://www.sgbc.sg/embodied-carbon/. [12]

Social- og Boligstyrelsen (2022), *Tilskud til udvikling af miljøvaredeklarationer af byggevarer (EPD'er)*, https://www.sbst.dk/nyheder/2022/tilskud-til-udvikling-af-miljoevaredeklarationer-af-byggevarer-epder. [50]

Social- og Boligstyrelsen (n.d.), *Den frivillige bæredygtighedsklasse*, https://www.xn--bredygtighedsklasse-lxb.dk/. [52]

SOLIBRI (n.d.), *RAVA3Pro and Solibri collaborate toward digital building permitting process in Finland*, https://www.solibri.com/articles/rava3pro-and-solibri-collaborate-toward-a-digital-building-permitting-process-in-finland. [38]

SOLIDEO (2024), *Le Village des Athlètes, un nouveau quartier durable et confortable*, https://www.ouvrages-olympiques.fr/village-athletes-nouveau-quartier-durable-confortable (accessed on 7 February 2025). [74]

SOLIDEO (2022), *EXCELLENCE ENVIRONNEMENTALE*, https://www.ouvrages-olympiques.fr/sites/default/files/fichiers/SOLIDEO_RAPPORT_ENVIRONNEMENTALE_VDEF-complet-BD.pdf (accessed on 4 February 2025). [75]

VCBK (2022), *LCA ifølge klimakravene*, https://byggeriogklima.dk/media/04pnc2uj/vcbk_2022_lca-publikation.pdf. [17]

VCBK (n.d.), *About VCBK*, https://byggeriogklima.dk/om/. [40]

VCBK (n.d.), *Knowledge*, https://byggeriogklima.dk/viden/. [41]

Zero Emissions Innovation Centre (n.d.), *NearZero research and incentive programs for BC residents*, https://zeic.ca/programs/near-zero/. [51]

3 Spotlight on step-by-step whole life carbon policies at national level

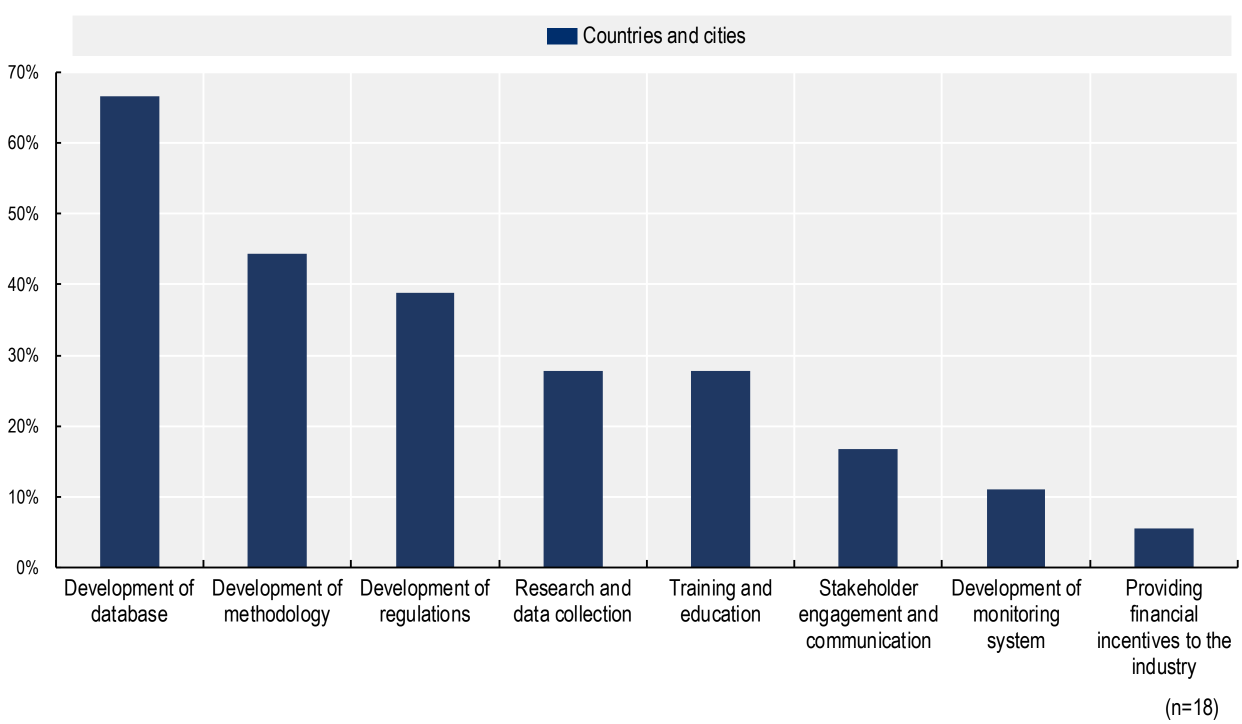
This chapter takes a deep dive into four countries that have adopted a step-by-step approach to address whole life carbon of buildings: Denmark, Finland, France, and Sweden. It highlights lessons from each country's strategy in terms of system boundaries, types of regulated buildings, and policy instruments. A common pattern includes the fact that each country set the reduction of whole life carbon as a priority, considered the degree of feasibility in light of its specific conditions, and supported these regulatory changes through overarching climate acts.

Introduction

As highlighted in the OECD report *Global Monitoring of Policies for Decarbonising Buildings: A Multi-level Approach* (2024), a step-by-step approach to decarbonising buildings consists in pursuing long-term transformations by breaking down complex challenges into manageable steps. As opposed to sudden overhauls or inaction, this incremental approach offers the flexibility to adapt to new developments and introduces regulatory measures progressively, allowing each phase to build momentum, refine strategies, and expand efforts. Clear, ambitious goals with measurable targets should guide this process, starting with simpler tasks.

The OECD Global Survey on Whole Life Carbon of Buildings identified the development of databases as the most resource-intensive task in implementing whole life carbon policies, followed by the development of methodologies, development of regulations, as well as research and data collection, as shown in Figure 3.1. This suggests that the primary challenges associated with whole life carbon policies are concentrated in the preparatory phase, particularly during the policy development stage. For example, **France** required approximately six years to implement limit value regulations after initiating the preparatory phase with **E+C- in 2016**, a state-funded voluntary certification label that marked the first introduction of LCA. Similarly, **Finland**'s initial step began in 2019 by drafting LCA methodology, and it plans to introduce mandatory reporting and limit value regulations by 2025, marking a preparatory phase of approximately six years (Nordic Sustainable Construction, 2024[1]). The duration of the preparatory phase varies by country, however, the majority require several years before the implementation of regulatory measures to develop methodologies and database, collect necessary data for assessment, as well as test industry's capacity for the coming regulations.

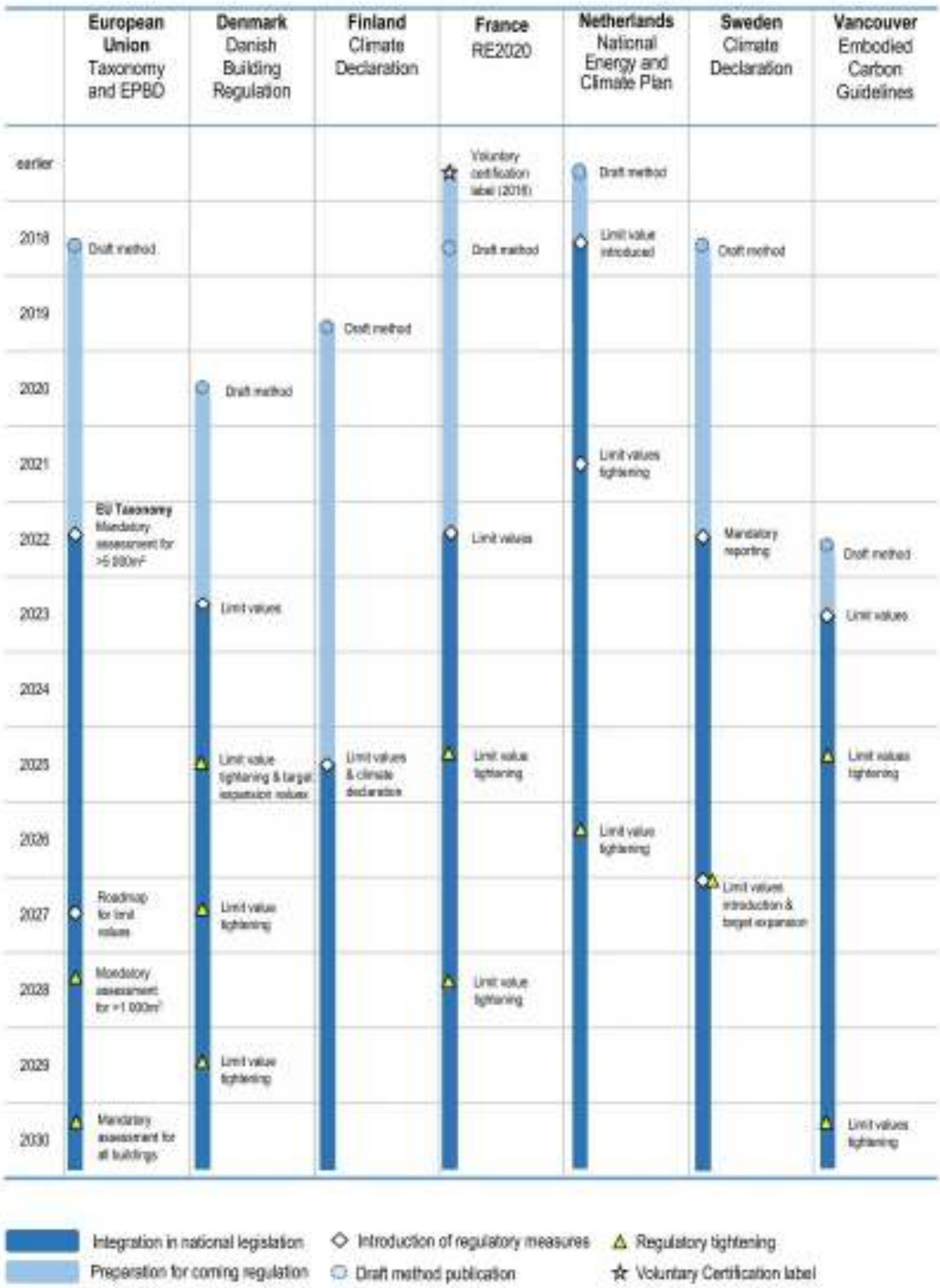
Figure 3.1. Resource-intensive tasks in WLC policy development and implementation



Note: Question from the survey: "Which of the following do you think would be the essential tasks in the development and implementation of whole life carbon policies for buildings that requires more resources (e.g. cost, time and efforts)?" The responding countries and cities could select three applicable options.
Source: OECD Global Survey on Whole Life Carbon of Buildings (2024)

A long-term roadmap with milestones, timelines, and monitoring mechanisms ensures that progress is tracked, and adjustments are made as needed. This approach also fosters more effective stakeholder engagement by delivering tangible results and incorporating feedback at each stage. By setting measurable benchmarks and timelines for implementing regulations such as climate reporting and emissions limits, the roadmap fosters co-ordinated action and accountability among stakeholders, reduces uncertainty, and encourages investment in sustainable practices. It serves as a clear guide for policy makers, developers, architects, contractors, and suppliers, aligning industry efforts and building confidence to achieve WLC reduction in buildings. Its adaptability allows stakeholders to respond to new challenges and innovations, making it an effective tool for aligning industry efforts toward achieving long-term carbon reduction goals in buildings. This is why several countries have been developing a roadmap for WLC policies, as illustrated in Figure 3.2.

Figure 3.2. Roadmaps to reduce whole life carbon in leading countries and cities



Note: Adapted from "Timeline of climate declaration and limit values integration (as of June 2024)" by Nordic Sustainable Construction. 'Leading countries' are defined as countries and cities that have already implemented whole life carbon regulations, drawn from the OECD report on Global Monitoring of Policies for Decarbonising Buildings.

Source: OECD Global Survey on Whole Life Carbon of Buildings (2024); OECD Global Monitoring of Policies for Decarbonising Buildings, https://www.oecd.org/en/publications/global-monitoring-of-policies-for-decarbonising-buildings_d662fdcb-en.html; Nordic Sustainable Construction (2024), https://www.nordicsustainableconstruction.com/Media/638530156105505088/Nordic%20Timeline%20regulations%20updated.pdf

The benefits of such a stepbystep approach apply directly to policies addressing WLC of buildings. When adopting a roadmap to tackle emissions across a building's entire life-cycle, identifying the first step is an essential foundational decision that shapes the rest of the decarbonisation journey.

The OECD Global Survey on Whole Life Carbon suggests that three key elements are critical in defining the first step of WLC policies: system boundaries, types of regulated buildings, and policy instruments. Table 3.1 categorises various step-by-step approaches into four distinct groups and provides a mapping of associated countries and cities.

- **System boundaries** refer to each phase of a building's life-cycle, including raw material extraction (A1-A3), transportation (A4), construction (A5), operation (B1-B7) and eventual demolition and disposal (C1-C4).
- **Types of regulated buildings** categorise buildings into groups such as residential, commercial, office, public buildings, etc.
- **Policy instruments** include measures such as climate declarations (climate impact reporting) and limit values for carbon emissions.

Table 3.1. Categorisation of the first step in step-by-step WLC approaches

Country/City	**Denmark**	**France**	**Greater London (the United Kingdom)**	**Sweden**
System boundaries	Whole life carbon	Whole life carbon	Whole life carbon	Upfront carbon only
Policy instruments	Mandatory reporting + limit values	Mandatory reporting + limit values	Mandatory reporting only	Mandatory reporting only
Types of regulated buildings	Limit values for buildings **above 1 000m²** and mandatory reporting for buildings **below 1 000m²** were introduced in 2022,	Limit values were first introduced for **housing**, **office and school buildings** in 2022.	The Greater London Authority introduced mandatory reporting on the **mayor's referable development projects** since 2021.	Mandatory climate reporting was introduced in 2022 for **all new buildings**, excluding industrial facilities and workshops, agricultural buildings for farming, forestry or other similar enterprises, buildings that do not have a gross floor area larger than 100 square metres.
Countries and cities with similar approaches	Finland	Helsinki (Finland), Vancouver (Canada)		

Source: Boverket (2020), "Regulation on climate declarations for buildings", https://www.boverket.se/globalassets/publikationer/dokument/2020/regulation-on-climate-declarations-for-buildings.pdf; Danish Authority of Social Services and Housing (2024), "National strategi for bæredygtigt byggeri", https://www.sbst.dk/byggeri/baeredygtigt-byggeri/national-strategi-for-baeredygtigt-byggeri; Greater London Authority (2022), https://www.london.gov.uk/sites/default/files/lpg_-_wlca_guidance.pdf; Ministry of Ecological Transition and Territorial Cohesion (2021), "Règles générales pour le calcul de la performance", https://rt-re-batiment.developpement-durable.gouv.fr/IMG/pdf/annexeii_arrete_4_aout_2021.pdf; Ministry of the Environment of Finland (2019) Method for the whole life carbon assessment of buildings; City of Vancouver (2023), https://vancouver.ca/files/cov/embodied-carbon-guidelines.pdf

This chapter takes a deep dive into four countries that have adopted a step-by-step approach to address WLC of buildings: Denmark, Finland, France, and Sweden. It highlights how each country's unique context, including existing laws and available resources, has shaped its strategy to reduce the environmental impact of the building sector (Table 3.2). In each case, an overarching climate act has served as a critical foundation for implementing new regulations. Each country has then identified feasible, high-impact first steps and established phased plans for continued progress.

Table 3.2. Overview of step-by-step whole life carbon policies in Denmark, Finland, France, and Sweden

	Denmark	Finland	France	Sweden
System boundaries	A1-A3, B4, B6, C3, C4 and D	A1-A5, B3-B4, B6, C1-C4, D (handprint separately)	Entire module except for B8	Upfront carbon (A1-A5) only
Types of regulated buildings	All new buildings	New buildings of the following: (1) terraced houses; (2) apartment blocks; (3) office buildings and health centres; (4) commercial buildings, department stores, shopping centres, wholesale and retail trade buildings, market halls, theatres, opera, concert and conference buildings, cinemas, libraries, archives, museums, art galleries and exhibition venues; (5) tourist accommodation buildings, hotels, residential homes, senior housing, residential care homes and medical care institutions; (6) educational buildings and kindergartens; (7) sports halls; (8) hospitals; (9) storage buildings, transport buildings, swimming pools and ice rinks with a net heated area of more than 1 000 square metres.	New Housing, office and school buildings	All new buildings excluding: (1) buildings with temporary building permits (2) buildings used for industrial facilities and workshops (3) agricultural buildings for farming, forestry, or similar enterprises (4) buildings with a gross floor area not exceeding 100 square metres (5) buildings intended for total defense purposes and those critical to Swedish security (6) buildings developed by private individuals not constructing as part of a business (7) buildings where the developer is a designated public authority
Policy instruments	1,000 m²<: limit values (2022~), <1,000 m²: mandatory reporting (2022) *limit values in 2025	Climate reporting, limit value (2026 ~)	Limit values (2022~)	Mandatory reporting (2022~) *limit values planned in 2027

Source: Boverket (2020), "Regulation on climate declarations for buildings", https://www.boverket.se/globalassets/publikationer/dokument/2020/regulation-on-climate-declarations-for-buildings.pdf; Danish Authority of Social Services and Housing (2024), "National strategi for bæredygtigt byggeri", https://www.sbst.dk/byggeri/baeredygtigt-byggeri/national-strategi-for-baeredygtigt-byggeri; Ministry of Ecological Transition and Territorial Cohesion (2021), "Règles générales pour le calcul de la performance", https://rt-re-batiment.developpement-durable.gouv.fr/IMG/pdf/annexeii_arrete_4_aout_2021.pdf; Ministry of the Environment of Finland (2019) Method for the whole life carbon assessment of buildings; EDUSKUNTA RIKSDAGEN (2024) https://www.eduskunta.fi/FI/vaski/HallituksenEsitys/Sivut/HE_101+2024.aspx;

A shared vision: Denmark's multi-stakeholder model

Relevant law

In 2019, the Danish parliament passed a new climate law, which came into effect in 2020 and set an ambitious goal of reducing GHG emissions by 70 % from 1990 levels by 2030, with the broader aim of reaching carbon neutrality by 2050 (Danish Ministry of Climate, Energy and Utilities, n.d.[2]). The law mandates regular updates to achieve this target. This includes notably setting legally binding emission reduction targets every five years, with each new target looking ahead to the next ten years. Moreover, each new target must be at least as ambitious as the previous one, ensuring a continuous push towards lower emissions. These targets will be advised by the Danish Council on Climate Change, an independent body of experts from fields relevant to climate policy, including energy, transport, agriculture, environmental sciences, and behavioural research. This Council provides impartial, expert recommendations to guide Denmark's ongoing climate efforts and ensure compliance with its long-term climate objectives (Danish Ministry of Climate, Energy and Utilities, 2020[3]).

In response to the targets, the Danish government has to develop annual Climate Action Plans that outline concrete policies to reduce emissions for each sector: energy, housing, industry, transportation, energy efficiency, agriculture and land use change and forestry (Danish Ministry of Climate, Energy and Utilities, n.d.[2]).

Public-private climate partnerships

In spring 2020, 13 climate partnerships, each composed of companies within a specific sector in Denmark, submitted reports outlining their ambitions for a green transition. The reports also included recommendations for political actions to support companies in their efforts to mitigate climate change. The government has then worked with businesses to develop sectoral roadmaps for each climate partnership, combining government initiatives and private sector strategies into a unified plan.

In 2021, the climate partnership for building and construction released a sector-specific proposal to reduce CO_2 emissions by 2030. Among its recommendations, the report notably proposed mandatory CO_2 accounting for buildings. All new buildings should have a calculated CO_2 footprint per square meter, with specific requirements introduced in the building regulations by 2023 and regularly updated until 2030. Additionally, it suggests a voluntary, more ambitious standard for construction companies that wish to exceed the regulatory requirement set for 2023 (Regeringens Klimapartnerskaber, 2021[4]).

Reference value study

The Danish Department of the Built Environment (BUILD) prepared a study report in 2019 as it was commissioned by the Danish Transport, Construction, and Housing Authority to research WLC assessments of buildings. The goal of the study was to establish a knowledge base to set benchmark values for building emissions. The research analysed 60 buildings constructed between 2013 and 2021 from DGNB-certified projects – buildings that met rigorous sustainability standards set by the Deutsche Gesellschaft für Nachhaltiges Bauen (DGNB), or German Sustainable Building Council – as well as LCAs conducted by BUILD. The study examined reference lifespans of 50 years and 80 years.

For the 50-year period, the analysis revealed significant variation in Danish buildings' GWP, with impacts ranging from 6.45 to 14.52 kg CO_2 eq/m²/year, as some buildings had up to 2.25 times greater emissions than others. Construction material impacts were consistently higher than operational energy impacts. While material emissions ranged from 3.67 to 10.84 kg CO_2 eq/m²/year, operational emissions were typically 2-4 times lower, ranging from 0.22 to 4.58 kg CO_2 eq/m²/year. Actual energy use may be higher than estimates, as the energy performance calculations used standard assumptions and did not capture all consumption.

For the 80-year period, the findings were similar, with GWP values ranging from 4.92 to 12.39 kg CO2 eq/m²/year – some buildings had up to 2.5 times higher impacts than others. Material impacts again exceeded operational impacts, with material emissions ranging from 3.11 to 9.50 kg CO2 eq/m²/year and operational emissions from 0.17 to 4.30 kg CO2 eq/m²/year (Zimmermann et al., 2021[5])

This research contributed to setting an initial carbon limit of 12 kg CO_2 per m² per year for buildings over 1 000 m² in Denmark (Bolig og planstyrelsen, 2022[6]; Nordic Sustainable Construction, 2024[7])

Regulatory response

In 2021, Denmark introduced a National Strategy for Sustainable Construction, which established limit values for new constructions. The initial carbon limit was set at 12 kg CO_2e/m^2/year and applied to buildings over 1 000 m². The limit value was set based on **feasibility** as it was estimated that approximately 90% of buildings could meet the limit without needing substantial modifications. As a result, carbon limit values for new buildings came into effect in January 2023, making Denmark the first country among the Nordics to introduce such a requirement (Nordic Sustainable Construction, 2024[1]).

The Danish approach consisted in implementing a starting limit value alongside the mandatory climate declaration, ensuring that typical building projects could initially comply without significant additional effort. An additional defining feature of the Danish approach is the frequency of adjustments: regulations are reviewed and updated every two years to ensure that they stay aligned with climate goals (Nordic Sustainable Construction, 2024[7]).

In 2024, the Danish government and a broad political coalition agreed to tighten CO_2 emission limits for new buildings starting from July 2025. The new agreement aims to tighten the CO_2e limit value to reduce the climate impact of buildings, setting differentiated limits based on building type to expand the range of new construction subject to these standards. With an average limit of 7.1 kg CO_2e/m²/year, this target exceeds those outlined in the 2021 National Strategy for Sustainable Construction. The parties to the agreement have also committed to raising the ambition by broadening the scope of buildings covered under the CO_2e limit, including holiday homes and unheated buildings over 50 m² starting in 2025 (Table 3.3) (Nordic Sustainable Construction, 2024[7]).

Table 3.3. Timeline of limit values in Denmark

Kg CO_2e/m^2/year

	2025	2027	2029
Average limit value of m² excuding A4 and A5	7.1	6.4	5.8
Holiday homes under 150 m²	4.0	3.6	3.2
Single-family houses, row houses, tiny houses, and holiday homes above 150 m²*	6.7	6.0	5.4
Apartment buildings	7.5	6.8	6.1
Office buildings	7.5	6.8	6.1
Institutions	8.0	7.2	6.4
Other new constructions	8.0	7.2	6.4
Independent limit value for the construction process	1.5	1.3	1.1
Total limit including construction process	8.6	7.7	6.9

Note: *The 150 m² limit only applies to holiday homes.
Source: (Danish Authority of Social Services and Housing, 2024[8])

Expansion of limit values to further system boundaries

Under Denmark's 2023 limit value, climate impacts from production, parts of the use phase, and waste management and disposal (modules A1-A3, B4, B6, C3, C4) were included. In addition, as of 1 January 2024, reused building materials are assigned a value of 0 kg CO_2 in climate impact calculations to encourage the use of reused components and materials (Social- og Boligstyrelsen, 2024[9]).

With the 2025 adjustment, the limit value requirements will expand to cover climate impacts from the construction process itself (modules A4 and A5) to reduce energy and fuel use from transporting building materials to the site, on-site transportation, and material waste. A specific limit of 1.5 kg CO_2e/m^2/year has been introduced for emissions from transport and energy use on construction sites, aiming to set standards so that around half of construction sites will need to improve upon the 2021 baseline (Nordic Sustainable Construction, 2024[1]).

Adjusting for success: Finland's flexible approach to progress

Relevant law

In 2017, the Finnish Ministry of Environment developed a comprehensive roadmap to reduce the carbon footprint of construction, with a particular focus on building materials. This roadmap aligned the building sector with national climate goals and outlined measures such as assessing the emissions and carbon stocks of existing building stock, exploring economic incentives for low-carbon construction, and identifying information gaps and timelines necessary for implementation. The roadmap was created under the guidance of the Ministry of Environment and a steering group that included broad industry representation. To gather input, three industry workshops were organised with approximately 100 participants, alongside a competence survey that received about 60 responses. The initial roadmap set ambitious targets, including the introduction of carbon footprint limit values for apartment buildings by 2022 and for all building types by 2024 (Bionova, 2017[10]).

These efforts culminated in the enactment of the Construction Act in 2023, which marked a significant step forward by integrating climate change mitigation into regulatory guidance for the construction sector. This new law mandated climate declarations and CO_2 limit values for buildings, reflecting Finland's commitment to embedding sustainability in construction practices. It required that the main designer, building designer, or special designer prepare climate and material statements in two stages, including small houses and large-scale repairs for these requirements (Eduskunta Riksdagen, 2024[11]).

Before the Construction Act took effect, however, the Finnish Government, formed in June 2023, proposed key amendments to refine its provisions. These amendments, outlined in a government proposal published on 19 September 2024, aim to ease some of the requirements and postpone their enforcement until 2026. For example, unlike the original plan, the revised Act exempts small houses and large-scale repair sites from preparing climate reports. This adjustment reflects Finland's flexible and adaptive approach to balancing regulatory ambitions with practical considerations for implementation (Eduskunta Riksdagen, 2024[11]).

Building a national database

An essential milestone in Finland's efforts to reduce the carbon footprint of buildings was the development of a national assessment method. The Ministry of Environment, in collaboration with industry experts, researchers, and LCA professionals, created a Finnish method for assessing the low-carbon performance of buildings. The first draft of this method was published in 2018 and has been refined over time. It has also undergone practical testing within the construction industry to ensure its applicability and effectiveness (Ministry of the Environment of Finland, 2019[12]).

Simultaneously, close co-operation with the European Commission was initiated, integrating the Nordic ministers' goal of harmonising low-carbon assessment methods for buildings. These efforts are aligned with key European standards, further enhancing the method's credibility and consistency. In 2019, the Ministry of the Environment released an updated draft of the low-carbon assessment method. This revision incorporated feedback from the 2018 review, trial results, Level(s) testing, and Nordic collaboration experiences (Ministry of the Environment of Finland, 2019[12]). The updated method was tested in over 40 construction projects between 2019 and 2020, culminating in a public feedback round in 2020 (Kuittinen and Hakkinen, 2020[13]).

Building on these experiences, draft regulations for the climate assessment of buildings were prepared in 2021 and circulated for feedback during the summer of 2021 and again in 2022. Stakeholders continued to contribute to refining the assessment method in 2023–2024 (Valtionevusto Statsradet, 2024[14]).

Regulatory response

Starting 1 January 2026, Finland will require a climate report and a list of construction products for new buildings under Section 38 of the Construction Act, as per a decree by the Ministry of the Environment. The climate report evaluates a building's carbon footprint across its life-cycle, ensuring it meets forthcoming limit values. A climate report will be used to demonstrate that the carbon footprint of a new building is below the limit value during the final inspection phase. The list of construction products will be required when applying for a building permit and will be updated for any significant changes after the project is completed. The limit value regulation is under preparation and will be open for comment in spring 2025 (Ministry of the Environment of Finland, 2024[15]).

The new rules exempt certain types of buildings, such as small, detached houses, large-scale repairs, and minor alterations or extensions, from the obligation to prepare a climate report. Instead of a material statement, a construction product list will be required, which will be prepared during the construction permit phase and updated for the building's final inspection. Climate assessments and carbon footprint limit values will only apply to specific building categories, including apartment buildings, commercial facilities, health centers, hotels, theaters, hospitals, and sports facilities. Exemptions are provided for small houses, movable buildings, and storage buildings under 1 000 m².

Climate reporting is no longer required at the construction permit stage but will be reviewed during the final inspection. Similarly, the carbon footprint limit values will be verified at the project's completion rather than during the permit application phase. Adjustments to limit values may be allowed for special cases where achieving compliance is particularly challenging due to the building's characteristics, purpose, or location. These refinements aim to reduce costs and streamline the permit process, benefiting both project initiators and building control authorities (Eduskunta Riksdagen, 2024[11]).

As demonstrated by the Finnish example, a step-by-step approach offers flexibility, allowing governments to adapt over time to changing conditions and circumstances.

Testing and scaling: France's pilot project approach

France's environmental regulation for new construction (RE2020) came into force on 1 January 2022, gradually replacing the RT2012 thermal regulation. RT2012 aimed to make low-energy buildings the standard by setting strict requirements to manage energy demand and consumption, as well as establishing performance targets to ensure comfort during the summer. Additionally, RT2012 mandated the use of renewable energy in single-family homes and focused primarily on energy use, not taking into account the entire life-cycle of a building. As a new regulation succeeding RT2012, RE2020 expands the focus to include energy efficiency, carbon footprint reduction, and overall environmental impact including life-cycle considerations of buildings (Ministry of Ecological Transition and Territorial Cohesion, 2024[16]).

Pilot projects

In November 2016, France launched the "Positive Energy, Carbon Reduction" (E+C-) experiment to help the construction sector prepare for future regulation. The government has used this pilot project to calibrate between establishing ambitious policies and maintaining the construction industry's competitiveness. Co-led by the French Construction Council, the initiative aimed to assess high-performance buildings with higher standards of energy efficiency and reduction of GHG emissions.

The E+C- pilot project was based on a collaborative governance model, bringing together key stakeholders from the construction industry. It was organised around two main committees: the Steering Committee (CoPIL), overseeing the experiment, and the Technical Committee (CoTec), responsible for support and monitoring. The two committees also worked on the gradual development of the E+C- pilot project.

The main output of the E+C- project consisted in the development and implementation of a standardised method for calculating a building's environmental impact. As part of the project, the "Energy-Carbon Reference Model" was introduced, detailing key energy and environmental indicators, calculation methods, required data, and relevant life-cycle stages for a comprehensive LCA. The model set performance benchmarks in two primary areas:

- **The Energy** indicator (Bilan BEPOS), measuring the balance between energy consumption and production.
- **The Carbon** indicators (EgesPCE and Eges) focusing respectively on emissions from construction products, and on emissions from both construction products and building operation.

This model has established a framework for advancing sustainable practices and performance standards across France's construction sector.

To draft environmental regulations for new buildings, a major consultation with construction industry stakeholders began in January 2019. Guided by 16 expert groups and insights from the 2016 E+C- trial, this phase has helped unify industry perspectives, highlighting points of agreement and contention to shape RE2020. This collaborative effort resulting in the government setting objectives was supported by the industry (Ministry of Ecological Transition and Territorial Cohesion, 2024[16]).

Relevant law

RE2020 aligns both with France's Energy Transition for Green Growth Law from 2015 (in French: loi de transition énergétique pour la croissance verte) and the 2018 ELAN Law (in French: loi Évolution du logement, de l'aménagement et du numérique). RE2020 strives to reduce the impact of buildings on climate, taking into account GHG emissions across the entire life-cycle of a building. Moreover, RE2020 emphasises the need to prepare the building stock for changes in climate, notably the rise of temperatures during summer (Ministry of Ecological Transition and Territorial Cohesion, 2024[16]).

The ELAN Law (2018), although primarily tackling the housing crisis, emphasises the importance of conducting life-cycle analysis for new buildings. The law mandates construction regulations to account for a building's environmental performance throughout its life-cycle. The environmental impact of construction products and equipment must be assessed through metrics such as GHG emissions, atmospheric carbon storage, and the proportion of recycled materials used. The ELAN Law also requires that these metrics be made public and verified by independent, qualified professionals. According to the law, both environmental and thermal regulations should be integrated in building standards to ensure greater comprehensiveness.

The ELAN Law addresses both the need to improve the environmental performance of the building stock to mitigate climate change and the need for high-quality and affordable housing. To improve occupants' comfort, the law introduces notably stringent air quality standards. The level of comfort a building provides to its occupant must meet climate-change objectives (Legifrance, n.d.[17]).

Regulatory response

RE2020 is the first French regulation, and one of the first worldwide, to introduce environmental performance into new construction through life-cycle analysis. The regulation was designed to pursue three major government objectives: i) energy sobriety and energy decarbonisation; ii) reduction of the carbon impact of buildings; and iii) indoor comfort during extreme heat (Ministry of Ecological Transition and Territorial Cohesion, 2023[18]).

Starting from 1 January 2022, RE2020 regulations were phased in gradually by building type, beginning with residential buildings due to their significant **impact** on climate and the availability of reliable data. Residential buildings alone contribute roughly 60% of operational carbon emissions in the building sector, making them a priority target for emissions reductions (Ministry of Ecological Transition and Territorial Cohesion, 2023[18]).

In terms of **feasibility**, the residential sector has also represented a more practical starting point. Residential building permits are issued in far greater numbers each year than for other building categories, reflecting the scale and uniformity of available data. For instance, 98 300 residential building permits were issued in France in 2023, compared to 40 253 non-residential building permits (Ministry of Ecological Transition and Territorial Cohesion, n.d.[19]). Additionally, the non-residential sector comprises a wide variety of building types, each with unique characteristics and limited data availability, making it more challenging to establish accurate emission limits across the board. By focusing first on the residential sector, RE2020 regulations have implemented meaningful emissions targets supported by sufficient data, setting a strong foundation for gradually expanding to other building types.

A key distinction between RE2020 and its predecessor, RT2012, is the introduction of a limit on carbon emissions specifically for building construction. This approach to controlling and reducing the environmental impact of construction is structured in a phased, step-by-step manner, with limit thresholds that account for diverse building characteristics and constraints. As shown in Table 3.4, each building's construction carbon emissions must remain below a given maximum threshold to achieve compliance.

Table 3.4. RE2020 application dates for different types of buildings

Type of building	Application date (RE2020)
Residential buildings	1 January 2022
Offices, primary and secondary schools	1 July 2022
Small residential extensions/buildings, small offices, small schools	1 January 2023
Recreational light housing (HLL) < 50m² (subject to urban planning)	1 January 2023
Temporary residential buildings, offices, primary/secondary schools	1 July 2023
Recreational light housing (HLL) < 35m² (exempt from urban planning)	1 July 2023

Source: Ministry of Ecological Transition and territorial Cohesion (2024), *Réglementation Environnementale Des Bâtiments Neufs (RE2020)* https://www.ecologie.gouv.fr/sites/default/files/documents/guide_re2020_version_janvier_2024.pdf

These thresholds will be progressively tightened over time, enabling the construction industry to adapt gradually, reduce emissions, and incorporate the LCA methodology into their practices (Table 3.5).

Table 3.5. France's limit values for construction emissions (excluding operational carbon) in RE2020

$kgCO_2e/m_2$

	2022-2024	2024-2027	2028-2030	2031 onwards
Individual or semi-detached houses	640	530	475	415
Apartment buildings	740	650	580	490
Office buildings	980	810	710	600
Primary or secondary schools	900	770	680	590

Source: Ministry of Ecological Transition and Territorial Cohesion (2022)

Focusing on feasibility: Sweden's initial steps on upfront carbon

Relevant law

Sweden's WLC strategy is aimed at achieving both a significant and immediate impact. The initial step in this strategy focuses heavily on learning and stakeholder engagement. The Swedish government aimed to involve all relevant stakeholders early on to prepare them for future regulatory changes. Sweden's Climate Act (2017:20), which came into effect on 1 January 2018, has played a pivotal role in this process. The Act requires the government to work toward reducing GHG emissions, aligning with Sweden's long-term goal of achieving net-zero emissions by 2045. All sectors, including construction and real estate, must contribute to this national target.

The construction and real estate sector in 2022 accounts for approximately 17.7 million tonnes of CO_2 equivalents annually, i.e. about 21 % of Sweden's total climate impact. Around a third of these emissions stem from the construction of new buildings and demolition of old ones. From a life-cycle perspective, the most significant climate impacts come from material used during construction (modules A1-A3) and energy use during building operation (module B6) (Boverket, 2025[20]).

Regulatory response

Recognising the substantial environmental impact of building construction, the Swedish government saw the need for stronger regulations to drive a faster transition toward lower emissions. As part of this effort, climate declarations were introduced, focusing specifically on upfront carbon, i.e. the emissions tied to material production and use in the early stages of construction (system boundaries A1 to A5). This measure aimed to raise awareness among stakeholders in the construction sector about their contributions to upfront carbon emissions and prompt them to begin calculating and managing their climate impacts (Boverket, 2020[21]).

Sweden's first step – starting with upfront carbon – was strongly influenced by considerations of its **impact**, while subsequent steps were gradually planned with added focus on **feasibility** and **international harmonisation**. In 2020, Boverket proposed including additional modules in mandatory carbon declarations starting in 2027. These include modules B2, B4 and B6 (use stage), C1 to C4 (end-of-life stage), as well as supplementary environmental information such as biogenic carbon storage and net exports of locally produced electricity.

The inclusion of module B was based on considerations of both feasibility and impact. According to Boverket (2020[21]), the SS-EN 15978 standard – Swedish adaptation of the European standard (EN) for assessing the environmental impact of buildings throughout their life-cycle – does not provide clear distinctions between the modules in the B stage (Use).

The B module (Use) covers impacts associated with the building's use, including maintenance, repair, and replacement activities, but the boundaries between these activities are often blurry. As a result, this ambiguity has led to varying interpretations in LCA studies and methods across different countries, prompting the exclusion of certain modules (B1, B3, and B5) from mandatory requirements.

- Module B1 addresses the environmental impact associated with building use, such as climate emissions from refrigerants in installations or from painted surfaces. However, its inclusion in building LCAs has been limited, both in academia and in industry.
- Module B3 pertains to repairing damaged components to restore them to expected performance levels, which is often conflated with maintenance covered in B2. Additionally, creating realistic scenarios for B3 is challenging due to the difficulty of predicting future repair needs.
- Module B5 concerns major renovations and refurbishments. Boverket assumes that significant performance-enhancing renovations will take place after the building's reference study period, initiating a new life-cycle. Predicting the need for other types of refurbishments at the construction stage is equally challenging.

Module C, covering the end-of-life stage, was included to promote circularity in construction and align Sweden's regulations with those of other Nordic countries and developments across Europe, despite the relatively small share of climate impact attributed to this stage (Boverket, 2020[21]).

Introducing limit values

Sweden is planning to introduce limit values for climate emissions from buildings, balancing both impact and feasibility considerations. In 2020, Boverket proposed to the government that limits for carbon emissions during the construction phase (modules A1 to A5) be implemented in 2027, with subsequent reductions in two phases, in 2035 and 2043. The rationale for focusing on upfront carbon emissions is threefold: i) it directly addresses immediate carbon output; ii) upfront emissions are easier to verify compared to future emissions; and iii) they represent the largest share of climate-impacting emissions over a building's life-cycle (Boverket, 2020[21]).

In 2023, Boverket further suggested that limit values could be introduced as early as 1 July 2025 for modules A1 to A5. This proposal follows a year of implementing climate declarations for buildings and reflects the urgency of reducing the carbon footprint in the building sector as soon as possible. In addition, Boverket proposed reducing limit values every five years (Boverket, 2023[22]). Table 3.6 summarises the current state of play of WLC policy in Sweden and its next steps.

Table 3.6. Step-by-step whole life carbon policy in Sweden

Year	2022	2027
Limit value	No limit value	Limit value covering A1-A5 **(2025 was proposed by Boverket)**
Modules to be declared	A1-A5	A1-A5, B2, B4, B6, C1-4, supplementary environmental information – biogenic carbon storage and net export of locally produced electricity
Building elements	- Load-bearing structures - Building envelope - Interior Walls	- Load-bearing structures - Building envelopes - Interior walls - Installations - Interior surface finishes - Room fittings
Reference study period		50 years

Notes: Boverket's initial proposal sets carbon limits in 2027, with subsequent reductions in two phases, in 2035 and 2043.
Source: (Boverket, 2020[21])

References

Bionova (2017), *Tiekartta rakennuksen elinkaaren hiilijalanjäljen huomioimiseksi rakentamisen ohjauksessa*, https://ym.fi/documents/1410903/38439968/Tiekartta-rakennuksen-elinkaaren-hiilijalanjaljen-huomioonottamiseksi-rakentamisen-ohjauksessa-4B3172BC_4F20_43AB_AA62_A09DA890AE6D-129197.pdf/1f3642e1-5d58-8265-40c1-337deeab782d/Tiekartta-rakennuksen-elinkaaren-h (accessed on 28 November 2024). [10]

Bolig og planstyrelsen (2022), *Development of limit values for CO2-emissions in buildings in Denmark*, https://www.nordicsustainableconstruction.com/Media/637985265579506749/NCFC_2022_Limit%20values%20Denmark.pdf (accessed on 28 October 2024). [6]

Boverket (2025), *Utsläpp av växthusgaser från bygg- och fastighetssektorn*, https://www.boverket.se/sv/byggande/hallbart-byggande-och-forvaltning/miljoindikatorer---aktuell-status/vaxthusgaser/. [20]

Boverket (2023), *Limit values for climate impact from buildings and an expanded climate declaration*, https://www.boverket.se/globalassets/engelska/limit-values-for-climate-impact-from-buildings-and-an-expanded-climate-declaration.pdf (accessed on 24 October 2024). [22]

Boverket (2020), *Regulation on climate declarations for buildings*, https://www.boverket.se/globalassets/publikationer/dokument/2020/regulation-on-climate-declarations-for-buildings.pdf (accessed on 22 October 2024). [21]

Danish Authority of Social Services and Housing (2024), *Ny aftale stiller ambitiøse klimakrav til nyt byggeri*, https://www.sm.dk/nyheder/nyhedsarkiv/2024/maj/ny-aftale-stiller-ambitioese-klimakrav-til-nyt-byggeri. [8]

Danish Ministry of Climate, Energy and Utilities (2020), , https://www.en.kefm.dk/Media/1/B/Climate%20Act_Denmark%20-%20WEBTILG%C3%86NGELIG-A.pdf (accessed on 28 October 2024). [3]

Danish Ministry of Climate, Energy and Utilities (n.d.), , https://www.en.kefm.dk/Media/6/4/Climate%20act%20fact-sheet%20FINAL-a-webtilg%C3%A6ngelig.pdf (accessed on 28 October 2024). [2]

Eduskunta Riksdagen (2024), *Board proposal HE 101 /2024 vp*, https://www.eduskunta.fi/FI/vaski/HallituksenEsitys/Sivut/HE_101+2024.aspx (accessed on 28 November 2024). [11]

Kuittinen, M. and T. Hakkinen (2020), *Reduced carbon footprints of buildings: new Finnish standards and assessments*, https://journal-buildingscities.org/articles/30/files/submission/proof/30-1-1541-1-10-20200603.pdf (accessed on 29 November 2024). [13]

Legifrance (n.d.), , https://www.legifrance.gouv.fr/jorf/id/JORFTEXT000037639478 (accessed on 25 October 2024). [17]

Ministry of Ecological Transition and Territorial Cohesion (2024), *Guide RE2020*, https://www.ecologie.gouv.fr/sites/default/files/documents/guide_re2020_version_janvier_2024.pdf (accessed on 25 October 2024). [16]

Ministry of Ecological Transition and Territorial Cohesion (2023), , https://www.ecologie.gouv.fr/sites/default/files/documents/Proposition%20de%20feuille%20de%20route%20de%20decarbonation%20du%20batiment.pdf (accessed on 28 October 2024). [18]

Ministry of Ecological Transition and Territorial Cohesion (n.d.), , https://www.statistiques.developpement-durable.gouv.fr/catalogue?page=dataset&datasetId=6513f0189d7d312c80ec5b5b (accessed on 29 October 2024). [19]

Ministry of the Environment of Finland (2024), , https://ym.fi/-/ilmastoselvitys-ja-rakennustuoteluettelo-luovat-uusia-edellytyksia-rakennuksen-vahahiilisyyden-arvioinnille (accessed on 3 January 2025). [15]

Ministry of the Environment of Finland (2019), *Method for the whole life carbon assessment of buildings*, https://julkaisut.valtioneuvosto.fi/bitstream/handle/10024/161796/YM_2019_23_Method_for_the_whole_life_carbon_assessment_of_buildings.pdf?sequence=1&isAllowed=y (accessed on 28 November 2024). [12]

Nordic Sustainable Construction (2024), *Harmonised Carbon Limit Values for Buildings in Nordic Countries*, https://pub.norden.org/us2024-415/us2024-415.pdf. [7]

Nordic Sustainable Construction (2024), *Update on whole life carbon regulation of constructions in Denmark*, https://www.nordicsustainableconstruction.com/news/2024/june/tillaegsaftale-paa-engelsk (accessed on 29 October 2024). [1]

Regeringens Klimapartnerskaber (2021), *Klimapartnerskab for bygge og anlaeg*, https://www.em.dk/Media/638252007355613356/sektorkoereplan-for-klimapartnerskab-for-bygge-og-anlaeg.pdf (accessed on 28 October 2024). [4]

Social- og Boligstyrelsen (2024), *Nu regnes genbrugte byggematerialer for 0 kg CO2 i bygningers klimaregnskab*, https://www.sbst.dk/nyheder/2024/-genbrugte-byggematerialer-for-0-kg-co2-i-bygningers-klimaregnskab (accessed on 17 December 2024). [9]

Valtionevusto Statsradet (2024), *Preparation of regulatory guidance for low-carbon construction progresses*, https://valtioneuvosto.fi/-/1410903/vahahiilisen-rakentamisen-saadosohjauksen-valmistelu-etenee (accessed on 29 November 2024). [14]

Zimmermann, R. et al. (2021), *Whole Life Carbon Assessment of 60 buildings: Possibilities to develop benchmark values for LCA of buildings*, https://vbn.aau.dk/ws/portalfiles/portal/414195632/BUILD_Report_2021_12.pdf (accessed on 28 October 2024). [5]

4 Spotlight on whole life carbon policies at city level

This chapter sheds light on the role of cities in driving whole life carbon policies for buildings. It looks into how cities can leverage local resources such as public buildings and land, local networks with the private sector and local regulations to promote whole life carbon reduction in buildings, drawing lessons from Helsinki (Finland), Greater London (UK), Malmö (Sweden), Tampere (Finland) and Vancouver (Canada). The chapter concludes by emphasising the importance of further collaboration with the national government for wider adoption of whole life carbon policies for buildings.

Introduction

Cities play a key role in WLC policies for buildings. The OECD report *Decarbonising Buildings in Cities and Regions* (2022) highlighted four major advantages of cities in terms of decarbonising buildings: i) cities own public buildings themselves; ii) cities are responsible for building and zoning regulations; iii) cities are close to citizens and local businesses; and iv) cities are familiar with the local building stock (OECD, 2022[1]). These structural advantages enable cities to take the lead in pursuing their own initiatives, rather than just following national regulation. Drawing from the OECD Global Survey on Whole Life Carbon of Buildings (2024), this chapter delves into examples of WLC policies led at city level, often ahead of national governments.

While many national governments (as discussed in Chapter 3) and cities (as highlighted in Chapter 4) are implementing WLC policies for buildings, challenges in aligning efforts across levels of government, across sectoral entities, and across public-private sectors can create inefficiencies and slow down progress towards zero-carbon buildings.

First, a lack of vertical co-ordination between national and subnational governments can inhibit effective local implementation of WLC policies. Without support from the national level, subnational governments, particularly in small- and medium-sized cities, struggle in developing WLC policy instruments due to limited financial resources and technical capacity. National governments would also miss out on the opportunity to scale up innovative and ambitious local efforts if national and local policies are not aligned. Furthermore, disparities in WLC policy frameworks and calculation methodologies across different levels of government create regulatory uncertainty, hindering private sector investment and potentially affecting overall market efficiency in the construction and real estate sector.

Second, the responsibility of developing WLC policies for buildings is often distributed across different government agencies or different sectoral entities. In a fragmented policy landscape, WLC measures for buildings cannot be implemented effectively unless horizontal collaboration mechanisms are put in place to help overcome siloes across ministries at the national level and across sectoral entities at the city level, as well as achieve harmonisation of policies and standards across countries.

Third, the private sector and academia can play a pivotal role in knowledge co-creation for sustainable construction alongside the public sector. Unlike urban planning and public infrastructure carried out by the government, buildings are largely owned and financed by the private sector, involving various actors such as developers, architects, construction companies, housing companies, building material suppliers, and equipment (i.e. heat pump and solar panel) companies. Private sector engagement is therefore essential – not only because governments' WLC policies have a full range of consequences on the construction and real estate industry, but also because the construction industry and LCA experts can bring critical technical and market insights. Similarly, universities and research institutes can provide specialised technical knowledge to help governments develop a sound methodology for WLC of buildings.

Furthermore, a WLC approach requires a broader, more holistic engagement of stakeholders across the entire construction value chain as well as the building policy arena. As opposed to operational carbon, where stakeholder networks focus on energy efficiency at the use stage of a building, WLC approaches engage stakeholders throughout all life-cycle stages. Recent studies on WLC of buildings reveal a complex landscape involving numerous stakeholders with competing interests. For example, a systematic literature review of 40 quality academic publications has identified 32 key stakeholders and 47 distinct roles in WLC of buildings, including construction professionals, property owners, building users, policy makers, manufacturers, building material and equipment suppliers (Falana, Osei-Kyei and Tam, 2024[2]). Consequently, the wide range of stakeholders complicates co-ordinated action, slowing down the development and implementation of WLC policies. Fragmented collaboration among stakeholders underscores the crucial need for multi-stakeholder collaboration across public and private sectors. Effective WLC policy development and implementation depends on early identification and engagement of private sector stakeholders to avoid ambiguity in roles, prevent conflicts, and ensure effective communication.

Moreover, it is often challenging to demonstrate any immediate and tangible co-benefits of WLC policies for occupants, such as energy cost savings, improved health, or enhanced comfort, which are typically associated with operational energy efficiency measures. Without these direct advantages, WLC policies are unlikely to gain traction if left solely to market forces. Assessing and reducing embodied carbon usually entails higher costs for construction stakeholders, with limited direct returns for end users. This economic imbalance makes WLC initiatives less attractive compared to energy efficiency policies.

This chapter will examine governance challenges and opportunities related to WLC policies for buildings around three axes: i) vertical co-ordination, ii) horizontal collaboration, and iii) public-private-academic partnerships (OECD, 2010[3]; OECD, 2024[4]).

Cities leveraging local advantages to drive whole life carbon initiatives

Table 4.1 categorises city-led WLC initiatives into three groups, drawing on the three advantages outlined in the above-mentioned OECD report (OECD, 2022[1]): i) ownership of public buildings; ii) responsibility for local regulations and knowledge of the local building stock; and iii) proximity to citizens and local businesses. Even if cities are not authorised to have their own building or zoning regulations, they can implement a WLC approach by leveraging their unique characteristics.

Table 4.1. City-led initiatives on whole life carbon of buildings

	Cities own public buildings/land	Cities are responsible for local regulations	Strong public-private partnership (PPP) and highly motivated local industry
Helsinki (Finland)	✓	✓	
London (United Kingdom)		✓	
Malmö (Sweden)	✓		✓
Oslo (Norway)	✓		✓
Vancouver (Canada)		✓	✓

Source: OECD Global Survey on Whole Life Carbon of Buildings (2024); LFM30 (2019), "How We Collectively Develop A Climate Neutral Building and Construction Industry", https://lfm30.se/wp-content/uploads/2021/01/Local-Roadmap-LFM30-English.pdf; Greater London Authority (2022), "Whole Life-Cycle Carbon Assessments LPG Consultation summary report", https://www.london.gov.uk/sites/default/files/lpg_-_wlca_consultation_report.pdf ; City of Vancouver (2023) "Embodied Carbon Guidelines", https://vancouver.ca/files/cov/embodied-carbon-guidelines.pdf

Local public buildings

In **Tampere (Finland)**, developers are required to submit a climate declaration, including energy class A certification and carbon calculations, before leasing public land. As the city owns 70% of the inner-city land, this requirement has a significant influence on most construction projects (Tampereen kaupunk, 2022[5]). For public construction projects, a carbon footprint assessment must be submitted to the City Council, along with life-cycle and investment cost analysis for each design option (Box 4.1). Building design decisions are then based on these three parameters, with the Council typically prioritising lower-carbon designs over the least expensive options.

Similarly, in **Helsinki (Finland)**, the city can set carbon footprint as a criterion, for example, in plot competitions and plot transfer terms. For example, the quality competition for residential plots in Verkkosaari, a residential area in eastern Helsinki, aimed at producing a green block of high architectural quality that would form a unique and feasible design for residential and commercial construction complex in terms of the cityscape. This competition holds significant importance for the construction industry, highlighting the Finnish sector's readiness to adopt and implement low-carbon solutions that are both aesthetically pleasing and economically sustainable. The high quality of the proposals demonstrates that Finnish construction industry is equipped to incorporate energy-efficient, low-carbon innovations across a wide range of projects. In the winning proposal, out of twelve approved proposals, the carbon footprint was 25% lower than the average of competition entries, and emissions from product stage A1-A3 are about 20% lower than the carbon benchmark of common building types (City of Helsinki, 2021[6]).

Box 4.1 Balancing investment costs and life-cycle carbon footprint in new building projects: the example of the Hiedanrannan School and Daycare Centre Initiative in Tampere (Finland)

The city of Tampere (Finland) is placing equal emphasis on life-cycle carbon footprint and investment costs when constructing new buildings, such as the Hiedanrannan school and daycare centre.

The construction is planned in two phases: phase 1 from June 2026 to May 2028 and phase 2 from 2031 to 2033. Prior to this, a preliminary study has been submitted to the City council that contains detailed comparisons of three scenarios in terms of costs and carbon footprints: baseline, Option 1, and Option 2.

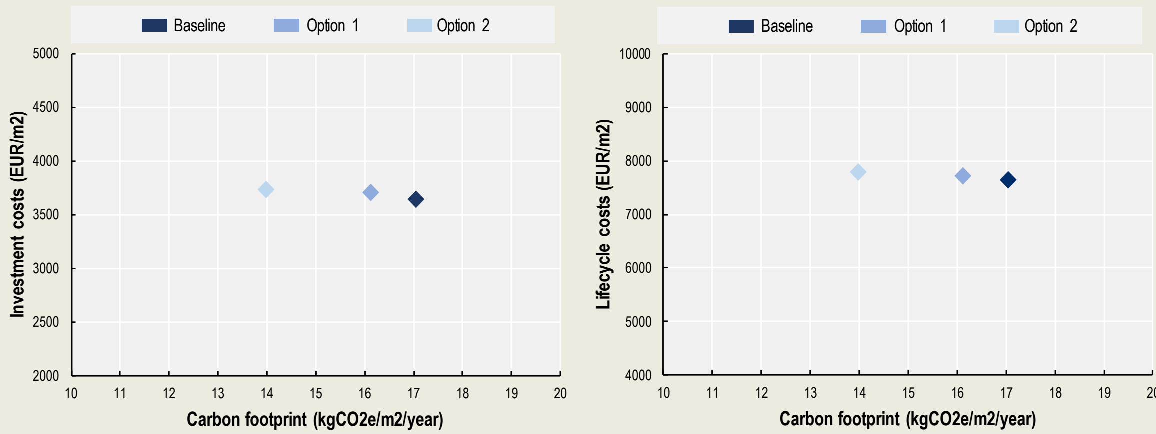
The study advocates for implementing the project according to Option 2, which focuses on achieving the lowest carbon footprint. This approach is based on the expectation that low-carbon building materials will become more prevalent and competitively priced in the market (Tampere City Council, 2023[7]).

Table 4.2. Overall assessment of life-cycle impacts, by scenario

Scenario	Life-cycle carbon footprint ($kgCO2e/m^2/year$)	Investment costs	Life-cycle costs
Baseline	17.06	EUR 52 322 000 (3 640 EUR/m^2)	EUR 109 879 000 (7 643 EUR/m^2)
Option 1 %: change rate from baseline	16.13 -5.4%	EUR 53 161 000 (3 698 EUR/m^2) +1.6%	EUR 110 865 000 (7 712 EUR/m^2) +0.9%
Option 2 %: change rate from baseline	13.98 **-18%**	EUR 53 584 000 (3 727 EUR/m^2) **+2.4%**	EUR 111 948 000 (7 787 EUR/m^2) **+1.9%**

Source: Tampere City Council (2023),
https://tampere.cloudnc.fi/fi-FI/Toimielimet/Kaupunginhallitus/Kokous_562023/Hiedanrannan_koulun_ja_paivakodin_uudisr(335397)

Figure 4.1. Comparison of costs and carbon footprint, by scenario



Source: Tampere City Council (2023), https://tampere.cloudnc.fi/fi-FI/Toimielimet/Kaupunginhallitus/Kokous_562023/Hiedanrannan_koulun_ja_paivakodin_uudisr(335397)

Proximity to local businesses, citizens, and knowledge of the local building stock

Cities can leverage their close relationships with local businesses to accelerate innovation in the industry and create initiatives to implement WLC policies for buildings. For example, **Malmö (Sweden)**'s experience shows how public-private partnership can drive local climate action to achieve ambitious goals. The city's LFM30 platform unites over 200 stakeholders from the construction sector under six focus groups, and promotes climate-neutral construction practices, fostering innovation and collaboration throughout the construction chain (LFM30, n.d.[8]) (Box 4.2).

With regards to WLC requirements on buildings, developers in the collaborative LFM30 platform mandate the use of environmentally friendly electricity and prohibit fossil fuel energy in all new and existing buildings starting in 2025. In addition, all their building sites are expected to achieve climate neutrality throughout the construction process (A1-A5), operational phases (B1-B7), and final stages (C1-C4) from 2030 and onwards (LFM30, 2019[9]). This approach is more ambitious than its national counterpart, since Sweden only requires the upfront carbon (A1-A5) climate declaration since 2022 (Boverket, 2020[10]).

Greater London (UK) is advancing WLC policies through extensive stakeholder engagement. The GLA's consultation on the draft WLC assessment guidance has engaged a diverse array of stakeholders, including 50 formal survey responses, with 54% of identified respondents coming from the business sector and 243 individuals participating in an online seminar. The process also involved technical meetings with Greater London boroughs and industry experts, facilitating valuable insights on WLC methodologies (Greater London Authority, 2022[11]). Additionally, the Planning for Greater London Programme fostered stakeholder engagement on WLC assessment policies through deliberative events and roundtables, involving citizens, NGOs and developers (Mayor of London, 2023[12]) (Box 4.3).

Box 4.2. Example of public-private partnership for climate-neutral construction: the LFM30 platform in Malmö (Sweden)

Malmö’s LFM30 platform serves as an example of how local climate action can be propelled by robust collaboration between the city government and the construction sector. A preliminary study was conducted in 2018, leading to the initiation of the LFM30 roadmap. As Sweden’s first local roadmap for a climate-neutral construction sector, LFM30 sets forth an ambitious timeline, demanding affiliated construction companies to reduce GHG emissions by 50% and developers to have at least one climate-neutral project by 2025, as well as achieving a climate-neutral building and construction industry in the city by 2030 and a climate-positive building and construction industry by 2035.

To achieve these goals, the LFM30 roadmap has created a joint platform under the same name to support mutual learning, innovation and the implementation of climate-neutral building and construction practices. The City of Malmö has played a key role in the initiation of the LFM30 platform. The city government has engaged in early dialogues with developers on the conditions and opportunities of new construction, considering energy solutions and the use of resources and climate-neutral building materials with regards to the location and time. Launched by seven entities including the City of Malmö, the LFM30 platform includes a broad representation of actors throughout the construction chain. The LFM30 platform brings together over 200 stakeholders from the construction sector, including 46 construction companies/organisations, one bank, 29 contractors, 65 consultancies, 49 material suppliers, one law firm, two transport companies, six circularity and energy companies, six organisations and authorities, and five research institutions. The LFM30 platform covers six areas of work, each led by an industry leader alongside a scientist:

- Business models, incentives, and collaboration
- Circular economy and resource efficiency
- Design, processes and calculation
- Climate neutral construction materials
- Operations, maintenance and management
- Climate neutral construction sites and transports

Source: Carbon Disclosure Project, “Malmö” https://www.cdp.net/en/articles/cities/malmo; ICLEI – Local Governments for Sustainability (2021), “LFM30: a climate-neutral construction sector in Malmö by 2030’’, https://talkofthecities.iclei.org/lfm30-a-climate-neutral-construction-sector-in-malmo-by-2030/; LFM30 (2022), “LFM30:s metod för klimatbudget”, https://lfm30.se/wp-content/uploads/2022/03/LFM30-Metod-Klimatbudget-version-1.6.pdf ; LFM30 (2019), “How We Collectively Develop A Climate Neutral Building and Construction Industry” https://lfm30.se/wp-content/uploads/2021/01/Local-Roadmap-LFM30-English.pdf

Box 4.3. Stakeholder engagement strategies in Greater London (UK)

Greater London Plan Guidance (LPG) Consultation

In 2020, the GLA launched a consultation on the Mayor's draft Whole Life-Cycle Carbon (WLC) Assessment LPG and WLC assessment template. To facilitate stakeholder discussions, the consultation included:

- a formal consultation survey with 50 responses received;
- an online seminar attended by 243 participants;
- technical meetings with Greater London boroughs;
- technical meetings with industry representatives;
- a technical seminar with planning inspectors and members of the public.

The formal consultation survey has identified 43 respondents from six different groups (individuals, business, campaign group, government body or agency, Greater London borough, and professional body) with 54% of respondents from the business sector. These stakeholders provided insights on the WLC methodology, grid decarbonisation, WLC assessment template, and benchmarks. Furthermore, the GLA has leveraged technical expertise from sustainable engineering consultancies and industry experts in preparing the LPG and WLC assessment template through organising technical meetings prior to the formal consultation.

Planning for Greater London stakeholder events

The Planning for Greater London Programme engages stakeholders through various collaborative initiatives by partnering with organisations such as the Greater London Sustainable Development Commission. Moreover, deliberative events were held in 2023 to gather insights from a diverse and representative group of Londoners. This was followed by topic-specific roundtable discussions, engaging stakeholders including boroughs, NGOs, environmental groups, developers, and residents. One of the roundtables featured WLC topics (i.e. WLC assessment benchmarks, circular economy, heritage and retrofit strategies), advancing future policy development. These events were held to inform the development of the next version of the London Plan, due to be published in the upcoming few years.

Source: Greater London Authority (2022), "Whole Life-Cycle Carbon Assessments LPG Consultation summary report" https://www.GreaterLondon.gov.uk/sites/default/files/lpg_-_wlca_consultation_report.pdf

Building and zoning regulations

Vancouver (Canada)'s Climate Emergency Action Plan, approved by the City Council in November 2020, aims to reduce embodied carbon in construction by 40% by 2030. In May 2022, the City Council approved changes to the Vancouver Building By-law (VBBL) to require designers to calculate, limit, and reduce embodied carbon in new Part 3 buildings, which refer to large buildings (>600 m^2 of building area and more than 3 floors) and where care, treatment and essential services are provided or assemblies are held (City of Vancouver, 2023[13]). Vancouver's unique ability to adopt its own Building By-law is one of the success factors behind the city's ambitious WLC policies. The Vancouver Charter enables the city to adopt by-laws to regulate the design and construction of buildings as well as the administrative provisions related to permitting, inspections, and the enforcement of these requirements (City of Vancouver, 2024[14]). This allows Vancouver to put in place embodied carbon requirements in the Building By-law before the provincial code or national model building code.

Helsinki (Finland) leverages its authority over city planning to set its own requirements. Although Helsinki does not have authority to set its own building codes, the city has established a planning monopoly through its “local detailed plan”, which enables it to adopt WLC policies ahead of the national government. In June 2023, the city first introduced a limit value of 16 kgCO_2e/m²/year on carbon footprint, calculated per 50 years of use. As a rule, the total carbon footprint requirement will be imposed on all building permits for apartment buildings (City of Helsinki, 2023[15]). In this way, although Helsinki cannot establish its own building codes, it can impose carbon limit values on all residential buildings within the city – not only those on city-owned land but also on private-owned land through its monopolistic power in city planning.

Greater London (UK) mandates WLC assessments for strategic developments, making it the first city in the United Kingdom to impose such a policy. The London Plan, introduced in March 2021, requires development proposals referable to the Mayor to calculate whole life-cycle carbon emissions through a nationally recognised WLC assessment and demonstrate actions taken to reduce life-cycle carbon emissions (Greater London Authority, 2021[16]). Most applications for new development are submitted to Greater London’s boroughs, but strategic projects need approval from the GLA. While only a small number of applications are under the jurisdiction of the Mayor, they represent a significant proportion of total new development in the city: in 2022, 63,700 residential units were given permission in London, and around 73% of them (46,844) were part of a Stage 2 application, which is required to refer to the Mayor of London (UK Government, 2023[17]). The GLA thus emphasises the need to tackle big projects first, as they have the most substantial impact. Greater London has adopted a multi-level planning approach, spearheading WLC policies while letting the boroughs decide on smaller development projects within their limits (Greater London Authority, n.d.[18]). To this day, there is no WLC policy on the national level in the United Kingdom.

Tokyo (Japan)’s Green Building Programme – the green building plan submission and publication scheme – requires building owners to submit environmental documentation, with a summary published on the Tokyo Metropolitan Government’s website. This approach encourages building owners to pursue environmental targets. Currently, the programme focuses on reducing operational carbon, but starting in April 2025, its scope will expand to encompass embodied carbon reduction. Under this revision, new buildings larger than 2 000 m² will be encouraged to assess upfront carbon emissions and prioritise low-carbon materials by a grading system. When a building owner conducts a WLC assessment and publishes the results, the highest grade will be awarded in the “Appropriate Use of Resources”’ category. However, the assessment is not mandatory. Rather, it is intended to serve as an incentive for building owners to conduct LCA in order to enhance market competitiveness. This step is projected to have a significant impact: although new buildings over 2 000 m² make up only around 2% of all new constructions, they represent approximately 50% of the total gross floor area being built. The implementation of WLC policy in Tokyo is ahead of national regulations, as the Japanese government does not yet have a concrete plan to implement WLC regulations (Tokyo Metropolitan Government, 2024[19]).

Cities advancing carbon policies ahead of national rules

By leveraging their local strengths and adopting tailored approaches, cities can often act faster and set more ambitious WLC standards than national governments. Table 4.3 categorises city-led initiatives according to three characteristics: faster pace, more ambitious targets, and unique approaches compared to national policies.

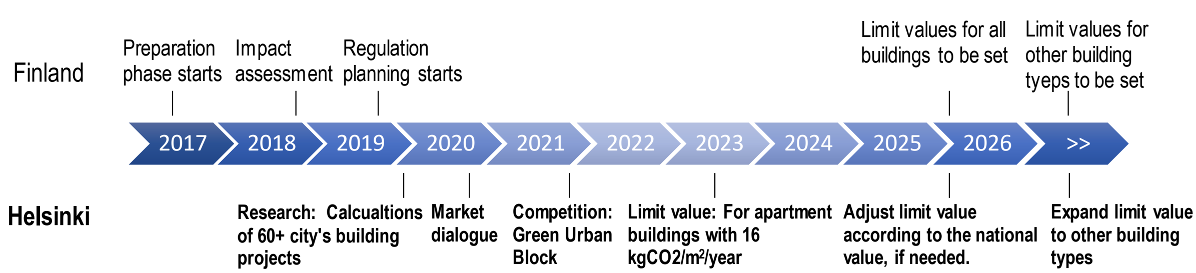
Table 4.3. Overview of city-led initiatives on whole life carbon of buildings

Cities with faster implementation of policies than national policies	Cities with more ambitious targets than national targets	Cities with unique approaches in the national context
Greater London (UK) – Faster implementation of mandatory reporting **Helsinki** (Finland), **Vancouver** (Canada) – Faster implementation of limit values **Malmö** (Sweden) – Faster extension of system boundaries beyond A1-A5	**Malmö** (Sweden) – Targets climate neutral construction industry by 2030 (National target by 2045) **Helsinki** (Finland), **Malmö** (Sweden) – Requires submission of LCA results both at planning stage and after completion	**Malmö** (Sweden) – Mandates use of environmentally friendly energy sources at construction site and existing buildings from 2025 **Tampere** (Finland) – Sets carbon footprint as a criterion for design selection

Source: OECD Global Survey on Whole Life Carbon of Buildings (2024); LFM30(2019), "How We Collectively Develop A Climate Neutral Building and Construction Industry", https://lfm30.se/wp-content/uploads/2021/01/Local-Roadmap-LFM30-English.pdf; Greater London Authority (2022), "Whole Life-Cycle Carbon Assessments LPG Consultation summary report", https://www.london.gov.uk/sites/default/files/lpg_-_wlca_consultation_report.pdf

Helsinki (Finland), for instance, has implemented a limit value requirement for new apartment buildings ahead of national mandates from the Finnish government, pushing for more ambitious reductions in building-related emissions. Figure 4.2 illustrates the timeline for establishing limit values in Helsinki, in comparison with the national timeline. The city started by conducting case studies of over 60 buildings and thoroughly calculating their emissions. This allowed Helsinki to gain knowledge on the carbon intensity of its building stock. Helsinki's initiative is particularly noteworthy because it leveraged the calculation method developed by the national government, serving as a practical demonstration of the method before its broader application at the national level. Helsinki has communicated with the national government and shared information on its experience about limit values (City of Helsinki, n.d.[20]). This approach therefore underscores the effectiveness of sharing resources and expertise for driving impactful change.

Figure 4.2. Timeline of whole life carbon policies in Helsinki and Finland



Source: City of Helsinki (n.d.), https://www.hel.fi/en/urban-environment-and-traffic/plots-and-building-permits/applying-for-a-building-permit/carbon-footprint-limit-value#:~:text=Current%20limit%20value&text=The%20total%20carbon%20footprint%20of,per%2050%20years%20of%20use;
Ministry of the Environment of Finland (2019),
https://julkaisut.valtioneuvosto.fi/bitstream/handle/10024/161796/YM_2019_23_Method_for_the_whole_life_carbon_assessment_of_buildings.pdf?sequence=1&isAllowed=y

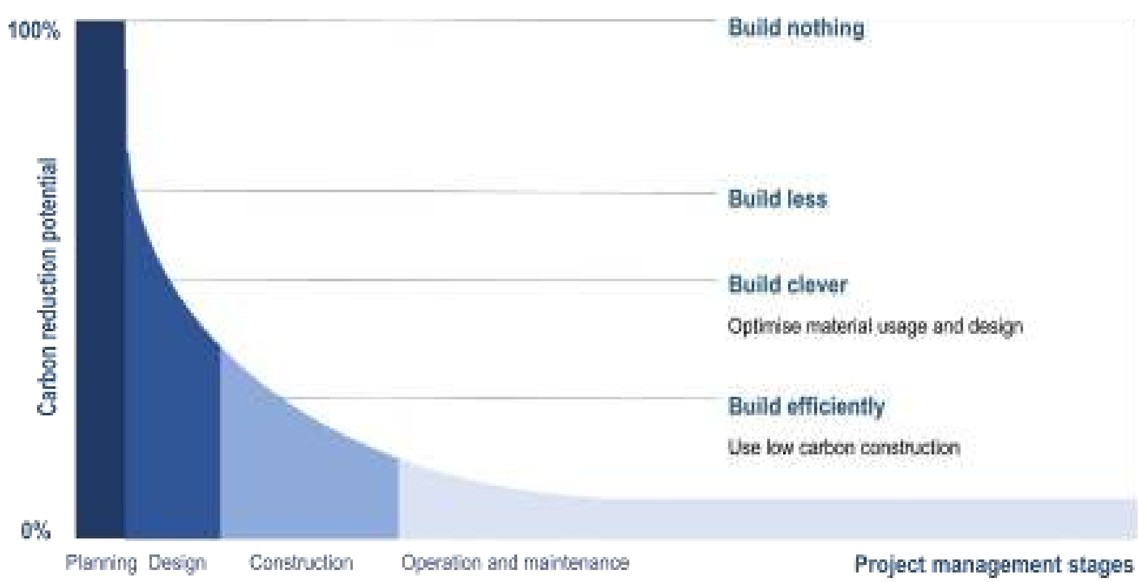
Similarly, **Tampere (Finland)** promotes the implementation of LCA by incorporating carbon footprint as a key criterion to select public building projects (Tampereen kaupunk, 2022[5]). Although neither Helsinki nor Tampere has the power to enact independent building codes, both cities leverage their planning monopolies and public project competitions, respectively, to encourage WLC reduction in their building projects.

Malmö (Sweden) has adopted an ambitious approach by expanding system boundaries for carbon assessment in construction to include the B module (use) (LFM30, 2019[9]). This stage accounts for emissions produced during a building's operational phase, such as maintenance and repair, which go beyond the Swedish government's current national requirement. Nationally, Sweden mandates the assessment of upfront carbon emissions (stages A1–A5), which focus on emissions from raw material extraction, transport, and construction processes (Boverket, 2020[10]). Malmö's approach does not only support its ambitious goal of climate neutrality by 2030, but also ensures that the city captures a more comprehensive picture of a building's carbon footprint throughout its life-cycle.

Moreover, unlike any national regulations, **Helsinki (Finland)** and **Malmö (Sweden)** require compliance with, and submission of the limit value both at the planning stage and at the after-completion stage, reflecting all the as-built information. In this way, cities can control that low-carbon design is carefully considered at the designing phase, and that the building is constructed appropriately to meet the limit value.

While some cities control both at the design and at the completion stages, national governments that have adopted WLC policies – such as France, Denmark, and Sweden – require compliance only at the after-completion stage. This suggests that national governments tend to take a simpler, lower-workload regulatory approach, whereas some cities have the capacity to adopt more ambitious, multi-stage controls, indicating further potential for cities to accelerate carbon reduction efforts. The World Business Council for Sustainable Development (WBCSD) also underscores the importance of addressing embodied carbon reduction at the earlier stages of a project, as the potential for carbon reduction is highest at the outset and decreases as the project advances (Figure 4.3).

Figure 4.3. Opportunity to reduce embodied carbon as the project progress



Source: GlobalABC(2021), "Decarbonizing construction: Guidance for investors and developers to reduce embodied carbon", https://globalabc.org/sites/default/files/2021-07/Decarbonizing_construction_Guidance_for_investors_and_developers_to_reduce_embodied_carbon.pdf

Given their unique characteristics and agility for change, cities can serve as dynamic testbeds for new policies, offering a fertile environment for experimentation, feedback, and innovation. Pilot-testing solutions to complex challenges in cities can help inform broader scale policy frameworks and contribute to shaping more resilient and sustainable communities. However, challenges remain in terms of collaboration across levels of government as well as alignment of local initiatives with national regulations. Co-ordination between different levels of government is further discussed in Chapter 5.

References

Boverket (2020), *Regulation on climate declarations for buildings*, https://www.boverket.se/globalassets/publikationer/dokument/2020/regulation-on-climate-declarations-for-buildings.pdf (accessed on 22 October 2024). [10]

City of Helsinki (2023), *Hiilijalanjäljen raja-arvo talonrakentamisen ohjauksessa*, https://ahjojulkaisu.hel.fi/712749CF-D40E-CD43-9541-88FBB070000D.pdf. [15]

City of Helsinki (2021), *Verkkosaareen rakennetaan vähähiilinen ja erittäin energiatehokas kortteli – kilpailulla suuri merkitys rakennusalalle*, https://kestavyys.hel.fi/verkkosaareen-rakennetaan-vahahiilinen-ja-erittain-energiatehokas-kortteli-kilpailulla-suuri-merkitys-rakennusalalle/. [6]

City of Helsinki (n.d.), *Carbon Footprint Limit Value*, https://www.hel.fi/en/urban-environment-and-traffic/plots-and-building-permits/applying-for-a-building-permit/carbon-footprint-limit-value (accessed on 28 October 2024). [20]

City of Vancouver (2024), *Vancouver Building By-law (CBO)*, https://vancouver.ca/your-government/vancouver-building-bylaw.aspx. [14]

City of Vancouver (2023), *Embodied Carbon Guidelines*, https://vancouver.ca/files/cov/embodied-carbon-guidelines.pdf. [13]

Falana, J., R. Osei-Kyei and V. Tam (2024), "Towards achieving a net zero carbon building: A review of key stakeholders and their roles in net zero carbon building whole life cycle", *Journal of Building Engineering*, Vol. 82, https://doi.org/10.1016/j.jobe.2023.108223. [2]

Greater London Authority (2022), *Whole Life-Cycle Carbon Assessments LPG Consultation summary*, https://www.london.gov.uk/sites/default/files/lpg_-_wlca_consultation_report.pdf. [11]

Greater London Authority (2021), *The London Plan*, https://www.london.gov.uk/sites/default/files/the_london_plan_2021.pdf (accessed on 28 October 2024). [16]

Greater London Authority (n.d.), *Referral process for LPAs*, https://www.london.gov.uk/programmes-strategies/planning/planning-applications-and-decisions/referral-process-lpas (accessed on 28 October 2024). [18]

LFM30 (2019), *How we collectively develop a Climate Neutral Building and Construction Industry*, https://lfm30.se/wp-content/uploads/2021/01/Local-Roadmap-LFM30-English.pdf. [9]

LFM30 (n.d.), *Vi lovar att implementera Malmös färdplan & målsättningar för en klimatneutral bygg- & anläggningssektor i vår egen verksamhet*, https://lfm30.se/bakgrund/. [8]

Mayor of London (2023), *Whole life-cycle carbon (WLC), Circular Economy (CE) and retrofit*, https://consult.london.gov.uk/pflp-stakeholder/brainstormers/whole-life-cycle-carbon-wlc-circular-economy-ce-and-retrofit. [12]

OECD (2024), *Global Monitoring of Policies for Decarbonising Buildings: A Multi-level Approach*, https://www.oecd.org/en/publications/global-monitoring-of-policies-for-decarbonising-buildings_d662fdcb-en.html. [4]

OECD (2022), *Decarbonising Buildings in Cities and Regions*, https://doi.org/10.1787/a48ce566-en. [1]

OECD (2010), *Cities and Climate Change*, OECD Publishing, Paris, https://doi.org/10.1787/9789264091375-en. [3]

Tampere City Council (2023), *Kaupunginhallitus, kokous 5.6.2023*, https://tampere.cloudnc.fi/fi-FI/Toimielimet/Kaupunginhallitus/Kokous_562023/Hiedanrannan_koulun_ja_paivakodin_uudisr(335397). [7]

Tampereen kaupunk (2022), *Kiinteistöt, tilat ja asuntopolitiikka 2022-2025*, https://www.tampere.fi/sites/default/files/2022-09/Tampereen%20kaupungin%20asunto-%20ja%20maapolitiikan%20linjaukset%202022-2025_web%20%281%29_0.pdf. [5]

Tokyo Metropolitan Government (2024), *建築物環境計画書制度の改正概要について*, https://www7.kankyo.metro.tokyo.lg.jp/building/240221_briefing.pdf. [19]

UK Government (2023), *Planning applications in England: October to December 2022*, https://www.gov.uk/government/statistics/planning-applications-in-england-october-to-december-2022/planning-applications-in-england-october-to-december-2022#:~:text=During%20October%20to%20December%202022%2C%20authorities%20granted%2079%2C500%20decisions%. [17]

5 A multi-level approach to whole life carbon policies for buildings

Reducing whole life carbon of buildings requires vertical co-ordination of efforts across levels of government, as well as horizontal collaboration across municipalities, ministries, and countries by pooling knowledge and resources for greater impact. Public-private-academic partnerships are also critical to leverage industry insights and technical knowledge from the private sector throughout the construction value chain as well as universities and research institutes.

Vertical co-ordination

Cities possess a range of strengths in advancing WLC policies for buildings. As discussed in Chapter 4, some city governments are leveraging their unique advantages to pioneer ambitious policies. However, effective policy implementation cannot be achieved without robust vertical co-ordination mechanisms. While city-level policies determine specific details of land use, building and planning regulations, WLC standards are usually subject to national policies. This highlights a two-way relationship between local and national actions on climate change, as action at local scale may enable or constrain what is possible at the national level and *vice versa* (OECD, 2010[1]). Therefore, vertical co-ordination is essential to overcome institutional constraints and narrow the policy gaps across levels of government that hamper the effectiveness of local actions.

The OECD Global Survey on Decarbonising Buildings in Cities and Regions (2022) has shown that 74% of surveyed cities and regions stated they do not receive enough support from the national government for decarbonising buildings (OECD, 2022[2]). In addition, the OECD Global Survey on Whole Life Carbon of Buildings (2024) has revealed that disparities between local and national WLC measures, alongside inconsistent methodologies, pose challenges to ambitious city-led initiatives, potentially expose subnational authorities to legal risks, and strain local government capacity.

Strengthen policy coherence across levels of government

The OECD Global Survey on Whole Life Carbon of Buildings (2024) shows that in most of the surveyed countries that have implemented WLC policies (Denmark, France, and Sweden), local governments are required to follow the national government's policy decisions without a subnational breakdown of quantitative targets or the autonomy to adjust building policies or regulations locally.

In some cases, local governments are implementing stricter policies than the national government (i.e. Espoo and Helsinki, Finland) and the national government adopted local guidelines at the national level (i.e. Vancouver, Canada). In the absence of national policies, some local governments must follow the regional government's WLC standards (i.e. Greater London, UK). The variability across different levels of government underscores the need for enhanced policy coherence to align mandates, policies, and sectoral objectives across government institutions, ensuring consistent and effective implementation of WLC policies for buildings.

Disparities in whole life carbon policies and methodologies hamper local implementation

While cities and regions often have competencies over local building regulations and building energy efficiency measures, discrepancies can arise between subnational and national policy frameworks, particularly when city governments are pursuing more ambitious objectives than those set at the national level. As revealed by responses to the OECD Global Survey on Whole Life Carbon of Buildings (2024), a city government actively pursuing ambitious climate goals in the building sector can encounter significant obstacles in implementing local building and urban planning regulations if the national government challenges the legality of such measures. Without a coherent policy framework that aligns national and local legislations, countries could miss out on the opportunity to leverage effective city-level initiatives for scalable national policies.

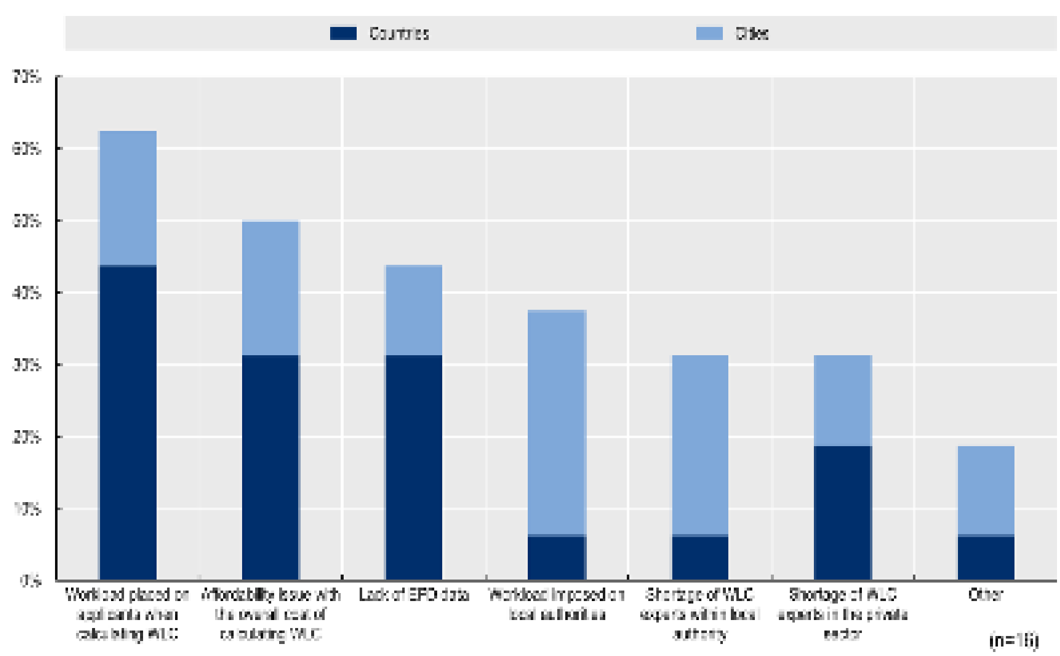
Cities that have already implemented WLC policies may lose motivation to advance their initiatives if national policies are scheduled for implementation several years later. This scenario underscores the need for flexibility in national policy frameworks to accommodate local contexts and recognise existing progress. Inflexible national policies risk discouraging cities from pursuing ambitious WLC standards. Concerns about future adjustments to align with national standards might deter cities from pioneering these standards, potentially hindering progress towards global sustainability goals.

Furthermore, the lack of a coherent, standardised WLC calculation methodology throughout a country increases the cost for capacity building at the local level. Given the technical nature of WLC assessment, city governments can face difficulties in implementing emission limit values and tender award criteria based on life-cycle emissions from buildings. Inconsistencies in WLC methodology and assessment tools across different cities and regions within a country further complicate policy development, leading to higher costs both for local governments and for companies to build technical capacity. In addition, disparities across WLC methods may complicate LCA application process, disrupt market performance, and even expose subnational governments to legal risks, including potential litigation challenges from construction companies, as indicated by survey responses.

Divergent challenges between national and local governments

The OECD Global Survey on Whole Life Carbon of Buildings (2024) reveals that national and local governments face distinct challenges regarding the implementation of WLC policies. While the top three challenges identified by survey respondents are the workload placed on developers, construction companies, and/or architects when calculating WLC, the lack of EPD data, and the affordability of WLC calculation, the capacity constraints of local authorities are often overlooked. Five out of seven local government respondents considered workload imposed on local authorities as a main challenge during policy implementation, while four out of seven local government respondents indicated the shortage of WLC experts within their local authority. By contrast, only one national government respondent saw these issues as main challenges (Figure 5.1). The disparity in perceived challenges underscores the need for effective vertical co-ordination mechanisms across levels of government that are essential for ensuring that local challenges can be effectively communicated to the national government. It is crucial for national governments to identify and understand capacity constraints (i.e. lack of technical expertise) at subnational level when developing national policies. Such understanding is key for formulating feasible policies that account for diverse contexts and support targeted capacity building initiatives tailored to local needs.

Figure 5.1. Main challenges at the policy implementation stage



Note: Question from the survey: "Main challenges at the policy implementation stage" The responding countries and cities could select all applicable options.
Source: OECD Global Survey on Whole Life Carbon of Buildings (2024)

In addition, the survey indicates a lack of vertical co-ordination mechanisms regarding WLC policies in the surveyed countries. Only 4 (Denmark, France, Germany, and Japan) out of 11 national governments that participated in the survey have platforms or mechanisms in place to discuss and co-ordinate with subnational governments on WLC policies for buildings. These platforms and mechanisms include regular meetings or committees, dedicated task forces or working groups, online collaboration platforms or forums, and joint projects or initiatives. Such mechanisms play a crucial role in facilitating communication and dialogue between national and subnational governments regarding buildings policies.

For instance, Germany's annual Conference of Building Ministers convenes the ministers and senators responsible for urban development, construction, and housing from the country's 16 states, with regular attendance by the Federal Minister for Housing, Urban Development and Building. This vertical co-ordination platform ensures the uniform application of building and construction regulations across the states and makes key policy decisions, such as determining the model building code, which forms the basis for state building codes (Bayerisches Staatsministerium für Wohnen, Bau und Verkehr, n.d.[3]). In 2024, the Conference passed a resolution on Germany's Building Energy Act, emphasising the importance of considering life-cycle GHG emissions when implementing the EPBD (Bayerisches Staatsministerium für Wohnen, Bau und Verkehr, 2024[4]).

Scale up city-led initiatives for whole life carbon of buildings

Leveraging cities as testbeds can enable national governments to implement ambitious policies and identify scalable measures (OECD, 2024[5]). Successful city-led initiatives often generate valuable data and insights that can facilitate policy making at the national level. However, scaling up successful local WLC measures requires effective vertical co-ordination between national and subnational governments.

Canada's federal government demonstrates the potential of harnessing local initiatives by adapting city-level guidelines on embodied carbon for nation-wide use. In 2024, the National Research Council Canada and the Construction Research Centre published the National Whole-Building Life-Cycle Assessment Practitioner's Guide, which was adapted from the City of Vancouver's Embodied Carbon Guidelines. The new National Guide complements the existing National Guidelines for Whole-Building Life-Cycle Assessment with additional guidance on embodied carbon assessments of new buildings and renovation of buildings and has been referenced by Canada Green Building Council (CAGBC)'s standard. It is also intended to support the compliance with the Standard on Embodied Carbon in Construction for major federal government construction projects. The federal government encourages local governments to adopt the same guides (National Research Council of Canada, 2024[6]).

Providing financial aid to subnational governments is another effective policy instrument to boost local efforts for WLC of buildings. Launched in January 2023 by Natural Resources Canada, the Codes Acceleration Fund is designed to assist subnational governments in adopting the highest feasible energy performance tiers within building codes to reduce GHG emissions and energy use (Natural Resources Canada, 2023[7]). The Code Acceleration Fund targets Canadian provinces, territories, municipalities, as well as Indigenous governments and communities that have the authority to adopt energy codes, addressing gaps in code compliance and enforcement at the local level (Natural Resources Canada, 2024[8]). For instance, the City of Vancouver received CAD 2.98 million in funding through the Codes Acceleration Fund for the adoption and implementation of Canada's first embodied carbon code and existing building GHG emission regulations (Government of Canada, 2024[9]).

Support local governments through capacity building

Support from the national government is essential to build the capacity of local authorities, particularly municipalities and smaller cities, to implement WLC policies for buildings. The OECD Global Survey on Whole Life Carbon of Buildings (2024) shows that supervision and monitoring are the most prevalent capacity building support from national governments to local governments, in four out of seven respondent countries (Table 5.1).

Table 5.1. Countries providing capacity building support to local governments

	Provide education and capacity building for the local industry	Conduct pilot projects to collect data and knowledge and leverage it for national policies	Adjust national policies or regulations to local scale	Ensure supervision and monitoring
Countries	Israel	Israel, Japan	Brazil, Germany, Israel	Denmark, France, Germany, Japan, Sweden*

Note: Question from the survey: “National government support of capacity building and technical assistance to local governments for implementing WLC policies for buildings” The responding countries and cities could select all applicable options. (n=6)
Sweden*: The national government only supervises/monitors when a climate declaration is submitted for a new building.
Source: OECD Global Survey on Whole Life Carbon of Buildings (2024)

At the same time, supervision and monitoring alone are insufficient to unlock the potential of cities to implement WLC policies. National governments can provide support to local authorities through an array of policy instruments, including education and capacity building for the local industry, pilot projects, and adjustment of national policies or regulations to local scale. However, the survey reveals that only two out of seven city respondents (Espoo, Finland, and Vancouver, Canada) receive support for capacity building and technical assistance from the national government.

A wider range of support from the national level can bolster local governments’ capacity to implement WLC policies. The survey finds that in the case of **Espoo (Finland)**, which has implemented more stringent policies than the national government, the national level provides the city with various types of support, including funding for training programmes and workshops, hosting annual conferences focused on WLC policy implementation, and distributing toolkits and guidelines tailored to local government needs. Furthermore, according to the survey, all three countries that have implemented WLC policies for buildings (Denmark, France, and Sweden) offer training programmes for local governments on WLC of buildings (Table 5.2). This shows that support from the national level is a key enabler for effective implementation of WLC policies across regions within a country.

Table 5.2. Types of training on WLC assessment of buildings for local governments

	Direct	Indirect	Upon request	Educational materials
Countries	France	Denmark, France	France	France, Germany, Sweden

Note: Question from the survey: “Training/education for local governments regarding WLC assessment of buildings” The responding countries could select all applicable options. (n=6)
Source: OECD Survey on Whole Life Carbon of Buildings (2024)

Horizontal collaboration

Horizontal collaboration across ministries and government agencies is key to overcome potential discrepancies regarding WLC policies for buildings. According to the OECD Global Survey on Buildings and Climate (2024), 93% of respondent countries have at least three ministries involved in decarbonising buildings (OECD, 2024[5]). The fragmentation of buildings policy making and implementation responsibilities across different branches within a subnational government unit also hampers the effectiveness of WLC policies for buildings at the local level. There is a critical need for horizontal co-ordination among ministries and government agencies at the national, as well as at the subnational level to break siloes and develop coherent strategies. The OECD Global Survey on Whole Life Carbon of Buildings (2024) shows that subnational governments can create political momentum to influence national policy through inter-municipal collaboration, while inter-ministerial collaboration can facilitate an effective dialogue across the government agencies and greater access to information, and countries can benefit from inter-governmental collaboration by sharing knowledge and resources.

Inter-municipal collaboration

The OECD Global Survey on Whole Life Carbon of Buildings (2024) shows that six out of seven surveyed cities (Helsinki, Greater London, Malmö, Oslo, Tokyo, and Vancouver) take part in horizontal collaboration mechanisms involving subnational governments.

Sweden's "Climate Municipalities" (Klimatkommunerna) show how inter-municipal collaboration can leverage synergies at the local level to promote WLC policies for buildings. This association brings together 54 subnational governments for regular meetings, engaging them in policy dialogues with the national government, and facilitating knowledge-sharing on local climate action (Klimatkommunerna, 2024[10]). The association also leverages the political momentum at the local level to advocate for emission limit values that are stricter than those set forth by the national government (Klimatkommunerna, 2024[11]) (Box 5.1).

Box 5.1. Sweden's "Climate Municipalities"

Sweden's "Climate Municipalities" (Klimatkommunerna) is an association of cities and regions dedicated to accelerating Sweden's climate transition. Its primary goal is to support municipalities and regions to reduce carbon emissions, exchange experiences, influence national policymaking, and showcase successful climate actions to inspire other municipalities and regions across Sweden. It brings together 52 municipalities and two counties for regular networking meetings to foster collaboration and knowledge sharing among members. The association's pillars of work include reducing carbon emissions from the construction and real estate sector and promoting sustainable building practices throughout Sweden.

The association exemplifies how effective horizontal co-ordination across subnational governments can leverage synergies at the local level to promote WLC policies for buildings. The Climate Municipalities' collaborative efforts include:

- **Dialogue with national government**: It engages in active discussions with various national-level agencies, including Fossil Free Sweden, the Swedish Environmental Protection Agency, and the Swedish Climate Policy Council. This engagement helps shape national policies and ensures municipal perspectives are represented.
- **Disseminating best practices**: It highlights inspiring examples of effective local climate actions and success factors. The association also provides local politicians and leaders with tips and

guide for achieving climate goals at the municipal level. The "Climate knowledge for local leaders" is a set of self-study training material, which provides basic knowledge about what the climate transition means and concrete tips on measures and working methods.

- **Gathering expertise**: It collects members' expertise and experiences to identify gaps in national climate policy and suggest improvements. Member municipalities and regions present their views regularly through articles and consultation processes mediated by the association. A climate situation report is published every year to evaluate the member municipalities' measures and emission levels.

Promoting stricter emission limit values in new buildings and renovations

The Climate Municipalities advocates for stricter emission limit values in new buildings and renovations compared to the proposal by the Swedish National Board of Housing, Building and Planning. The association supports setting limit values that are lower than those proposed by the national agency (Boverket) and tightening them over time. The rationale is that many actors in the construction industry find the current requirements too lenient, as most of the existing building stock is already below the limit values proposed for 2025. In addition, the association calls for measuring and reporting emissions through climate declarations and limit values for new buildings at the construction phase. The association also promotes the application of EPDs of recycled building materials to indicate the climate impact of a reused building product throughout the circular material flow.

Source: Klimatkommunerna, https://klimatkommunerna.se/

Inter-ministerial collaboration

The OECD Global Survey on Whole Life Carbon of Buildings (2024) showed that the number of ministries and agencies at the national level involved in WLC of buildings ranges from three to seven (Table 5.3). Considering this large number of entities involved in the decarbonisation agenda, horizontal collaboration across ministries and agencies within the government structure is crucial in delineating a coherent long-term vision and mobilising resources to assist various government agencies. Countries can deploy a range of mechanisms to strengthen horizontal collaboration across ministries, such as inter-ministerial platforms. For instance, **Japan** has established an Inter-Ministerial Liaison Meeting for Building Life-cycle carbon Reduction to develop WLC assessment roadmaps involving related ministries and agencies, with the Cabinet Secretariat and the Ministry of Land, Infrastructure, Transport and Tourism serving as a joint secretariat (Box 5.2). This demonstrates a robust political ambition to break down ministerial siloes and integrate existing work streams distributed across government agencies at the national level. The Inter-Ministerial Liaison Meeting also facilitates collaboration with other stakeholder engagement platforms, such as the Zero Carbon Buildings Promotion Council and the EPD Promotion Council.

Table 5.3. Ministries and agencies involved in whole life carbon related regulations and standards

	Denmark	Japan	Sweden
Number of ministries/agencies working on whole life carbon of buildings	6	7	4
Building code	The Danish Authority of Social Services and Housing	Ministry of Land, Infrastructure, Transport and Tourism	Ministry of Infrastructure, *Boverket*
Building permit	Municipalities	Building officials; Designated confirmation and inspection bodies	Municipalities
Climate declaration	The Danish Authority of Social Services and Housing	Ministry of Environment	Ministry of Infrastructure, *Boverket*
Energy efficiency standards	The Danish Authority of Social Services and Housing, the Danish Energy Agency	Ministry of Land, Infrastructure, Transport and Tourism, *Ministry of Economy, Trade and Industry*	Minimum energy efficiency standards: Ministry of Rural Affairs and Infrastructure; Boverket. Voluntary standards: Ministry of Climate and Enterprise, *Energimyndigheten*
WLC standards	The Danish Authority of Social Services and Housing	Ministry of Land, Infrastructure, Transport and Tourism, *Ministry of Economy, Trade and Industry*	Ministry of Infrastructure, Ministry of Climate and Enterprise, *Boverket*
EPD related		Ministry of Economy, Trade and Industry	Boverket
Innovation of low carbon materials	The Energy Technology Development and Demonstration Programme (EUDP), The Danish Eco-Innovation Programme (MUDP)	Ministry of Economy, Trade and Industry	
Database	The Danish Authority of Social Services and Housing	Ministry of Land, Infrastructure, Transport and Tourism	Boverket
Assessment tools	The Danish Authority of Social Services and Housing, *Department of the Built Environment – Aalborg university*	Ministry of Land, Infrastructure, Transport and Tourism	
Training and education	VCBK, Videnscenter	Ministry of Land, Infrastructure, Transport and Tourism	Boverket
Capacity buildings for SMEs		Ministry of Land, Infrastructure, Transport and Tourism	Boverket
Circularity of building	Danish Ministry of Environment and Gender Equality, *The Danish Authority of Social Services and Housing*		Ministry of Infrastructure, *Boverket*

Note: Ministries/agencies that are in italics are contributing to work on the given topics, but they are not the leading institution.
Source: The OECD Global Survey on Whole Life Carbon of Buildings

Box 5.2. Japan's Inter-Ministerial Liaison Meeting

In November 2024, Japan established an Inter-Ministerial Liaison Meeting for Building Life-cycle Carbon Reduction to foster collaboration across related ministries and agencies, including:

- Cabinet Secretariat
- Ministry of Land, Infrastructure, Transport and Tourism (MLIT)
- Ministry of Economy, Trade and Industry (METI)
- Ministry of the Environment (MOE)
- Ministry of Education, Culture, Sports, Science and Technology (MEXT)
- Financial Services Agency (FSA)
- Forestry Agency

The Inter-Ministerial Liaison Meeting is co-ordinated at a high-level with the Cabinet Secretariat and MLIT as its secretariat, demonstrating the political will of the Japanese government to promote WLC assessment. The Inter-Ministerial Liaison Meeting is tasked with the development of coherent national roadmaps for introducing whole LCA and the development of policies for environmental product declaration. It also collaborates with other stakeholder engagement platforms. For instance, the Inter-Ministerial Liaison Meeting discusses issues raised by the Zero Carbon Buildings Promotion Council, composed of academics, major construction companies, major real estate companies, as well as design offices and financial institutions. It also helps building material and equipment companies as well as industry associations to join the EPD Promotion Council, which provides capacity building opportunities, disseminates best practices, and assists companies to develop EPDs.

Source: Cabinet Secretariat of Japan, https://www.cas.go.jp/jp/seisaku/building_lifecycle/index.html

Inter-governmental collaboration

International collaboration offers valuable opportunities for knowledge exchange and regional harmonisation of WLC measures for buildings. On the one hand, national governments can leverage the experience and resources of countries that share a common political ambition through structured dialogue and information sharing to develop WLC calculation methodologies, databases, and digital tools. On the other hand, horizontal collaboration mechanisms, such as inter-governmental platforms, inter-ministerial fora, and joint research programmes, create political momentum and commitments for harmonising legislation, methodologies, and policies on the built environment across countries.

Nordic Sustainable Construction is an example of horizontal collaboration across Nordic countries (Box 5.3). This collaborative programme, under the Nordic Council of Ministers, works towards the harmonisation of LCA policies, methodologies, limit values, and BIM-based LCA across Nordic countries, supporting shared goals under the Nordic Vision 2030 (Nordic Sustainable Construction, 2024[12]). The 2023 Nordic Ministerial Declaration further strengthens this commitment to low-carbon construction by pledging to align policies, tools, and data across Nordic countries (Nordic Sustainable Construction, 2023[13]). Effective inter-governmental collaboration can leverage the collective knowledge and experience in implementing methods and legislation for WLC of buildings, while identifying opportunities for more efficient division of work and shared pathways for future development (Nordic Sustainable Construction, 2023[14]).

By addressing discrepancies and similarities across countries, horizontal collaboration mechanisms across countries pave the way for harmonising WLC policies across countries, aligning limit values, and enhancing consistency of LCA. This allows the construction industry to evaluate limit values and LCA calculation across countries efficiently, accelerating the market transition towards a low carbon-built environment.

Box 5.3. Nordic Sustainable Construction

Nordic Sustainable Construction is a collaborative programme funded by Nordic Innovation, an organisation under the Nordic Council of Ministers, focusing on improving the sustainability of buildings and construction processes across the Nordic countries. The programme supports Nordic countries in implementing the Nordic Vision 2030, establishing the Nordics as the world's leading region in sustainable and competitive constriction with minimised environmental and climate impact.

Nordic Ministerial Declaration on Commitment to Low Carbon Construction

In September 2023, the Nordic Ministers of Housing and Construction committed to a common effort on reducing climate impact from construction through a declaration on low carbon construction. This ministerial declaration aims to reduce GHG emissions from buildings, with a focus on building materials, waste, construction sites, the existing building stock, and construction processes. Another key commitment is the harmonisation of policies, legislations, tools, data, and assessment methods for achieving carbon neutrality in the built environment across the Nordic countries.

Work package on LCA in the Nordics

Nordic Sustainable Construction promotes the harmonisation of LCA assessment across the Nordic countries through one of five work packages. Key milestones include developing a roadmap for LCA harmonisation, presented at the Nordic Climate Forum for Construction 2023. Nordic Sustainable Construction published reports and hosted webinars to disseminate research findings on topics such as the creation and maintenance of LCA databases in the Nordics, BIM-based LCA, a common Nordic approach to GWP data and life-cycle scenarios, and harmonised CO2eq limit values for buildings. A BIM-to-LCA tool was developed, accompanied by YouTube training videos on LCA digitalisation.

Additionally, in 2023, Nordic Sustainable Construction launched the "Roadmap: Harmonising Nordic Building Regulations concerning Climate Emissions", which lays out three strategic aims:

- **Harmonisation and implementation of climate declarations:** Nordic countries collaborate in future methodological development regarding the scope and level of detail based on the European LCA standards, translatability of results and methods across countries, limit values, digitalised and BIM-based LCA, and the reporting on the decarbonisation of the Nordic building stock. This will also be supported by pooling resources for capacity building in the markets and stakeholder dialogue.
- **European collaboration:** Collaboration across the Nordic countries includes initiatives such as the mapping of and contribution to EU climate policies, regulations, methods, and initiatives (i.e. EPBD, CPR, WLC, EU Sustainable Finance Taxonomy Regulation, CBAM, Ecodesign Directive, and EU Green Public Procurement Criteria).
- **Strengthened authority co-operation:** The continuation and strengthening of the existing Nordic inter-governmental network is key to the accumulation of knowledge and sharing of

experience in implementing methods and legislation. This also includes enhancing collaboration with researchers and creating a common digital co-working platform.

Source: Nordic Sustainable Construction, https://www.nordicsustainableconstruction.com/work-packages; Nordic Sustainable Construction (2023), "Nordic Ministerial Declaration on Commitment to Low Carbon Construction", https://www.nordicsustainableconstruction.com/knowledge/2023/november/nordic-ministerial-declaration-on-commitment-to-low-carbon-construction; Nordic Sustainable Construction (2023), "Roadmap: Harmonising Nordic Building Regulations concerning Climate Emissions", https://www.nordicsustainableconstruction.com/knowledge/2023/september/roadmap-for-harmonisation; Nordic Sustainable Construction (2023), "Roadmap: Harmonising Nordic Building Regulations concerning Climate Emissions", https://www.nordicsustainableconstruction.com/Media/638302229397775948/Roadmap%20for%20harmonising%20Nordic%20Building%20Regulations%20concerning%20Climate%20Emissions.pdf

Public-private-academic partnership

Engaging the private sector and research institutes is crucial in creating an enabling environment for WLC policies. Given the varying technical capacity and resources of different levels of government, support from the private sector and the academia is an important success factor in effective WLC policy development. Public-private-academic partnerships play an instrumental role in developing digital tools and methodologies for WLC calculation, while providing resources to train and upskill workers in the construction industry. In addition, these partnerships can help clarify roles and responsibilities for various stakeholders.

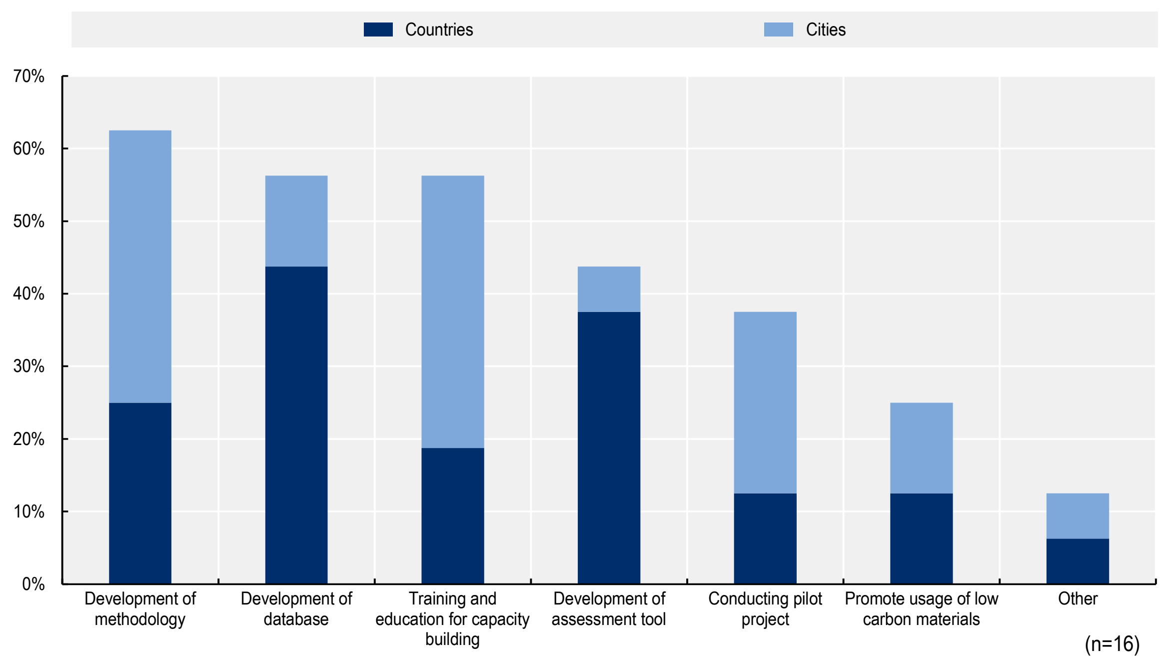
Public-private-academic partnerships can harness the potential of multi-stakeholder knowledge co-creation and generate impact on innovation for sustainable building practices. According to the OECD (2013[15]), public-private partnerships (PPPs) are long-term contractual agreements between the government and a private partner whereby the latter typically finances and delivers public services using a capital asset (e.g. transport or energy infrastructure, hospital or school buildings). The private party may be tasked with the design, construction, financing, operation, management, and delivery of the service for a pre-determined period of time, receiving its compensation from fixed unitary payments or tolls charged to users. Public-private partnerships blend the regulatory guidance and policy support from the public sector with the innovation, resources, and execution capabilities of the private sector (OECD, 2024[5]). Governments expect private sector engagement to bolster government capacity to achieve its objectives by mobilising the resources (money, technology, and knowledge) of the private sector (OECD, 2018[16]). Furthermore, the OECD finds that public support for science-industry collaboration is shifting towards a more interactive, long-term model of knowledge co-creation that involves stakeholders from industry, civil society, research and government (OECD, 2019[17]).

The complex nature of building policies underscores the relevance of multi-stakeholder partnerships. Real estate developers, investors, and financial institutions are crucial in addressing WLC of buildings, given that the majority of the building stock is owned by the private sector and the construction of net-zero carbon buildings relies on private funds. Besides, universities, research institutes, and the scientific community contribute to the development of calculation methodologies for carbon emission of buildings, while conducting studies on the environmental, socio-economic, and technical practices for low-carbon buildings. Stakeholders such as manufacturers and suppliers play an essential role in developing and producing low-carbon building materials. By contrast, professionals such as architects, contractors, designers, engineers, green building and energy consultants, and procurement professionals are responsible for planning and implementing the WLC approach in the construction process. They do so by providing building specifications, integrating low-carbon and energy-efficient design elements, ensuring quality control and effective logistics, estimating LCC, and conducting site investigations and analyses (Falana, Osei-Kyei and Tam, 2024[18]). Public-private-academic partnerships create formal channels for knowledge co-creation by leveraging private sector's technical expertise and research institutes' capacity to develop WLC calculation methodologies.

However, the wide range of stakeholders with varying levels of engagement throughout the long span of the building life-cycle implies potential conflicts and confusion due to competing interests (Falana, Osei-Kyei and Tam, 2024[18]). This complex policy landscape highlights the need for robust public-private-academic partnerships to gather different stakeholders and facilitate effective collaboration across various sectors, clarifying roles and responsibilities in developing and implementing WLC policies.

The OECD Global Survey on Whole Life Carbon of Buildings (2024) reveals that national and city governments consider the development of methodologies and databases, training and capacity building, as well as the development of assessment tools as the three most important aspects of public-private-academic partnerships (Figure 5.2).

Figure 5.2. Key elements of public-private-academic partnerships for whole life carbon of buildings



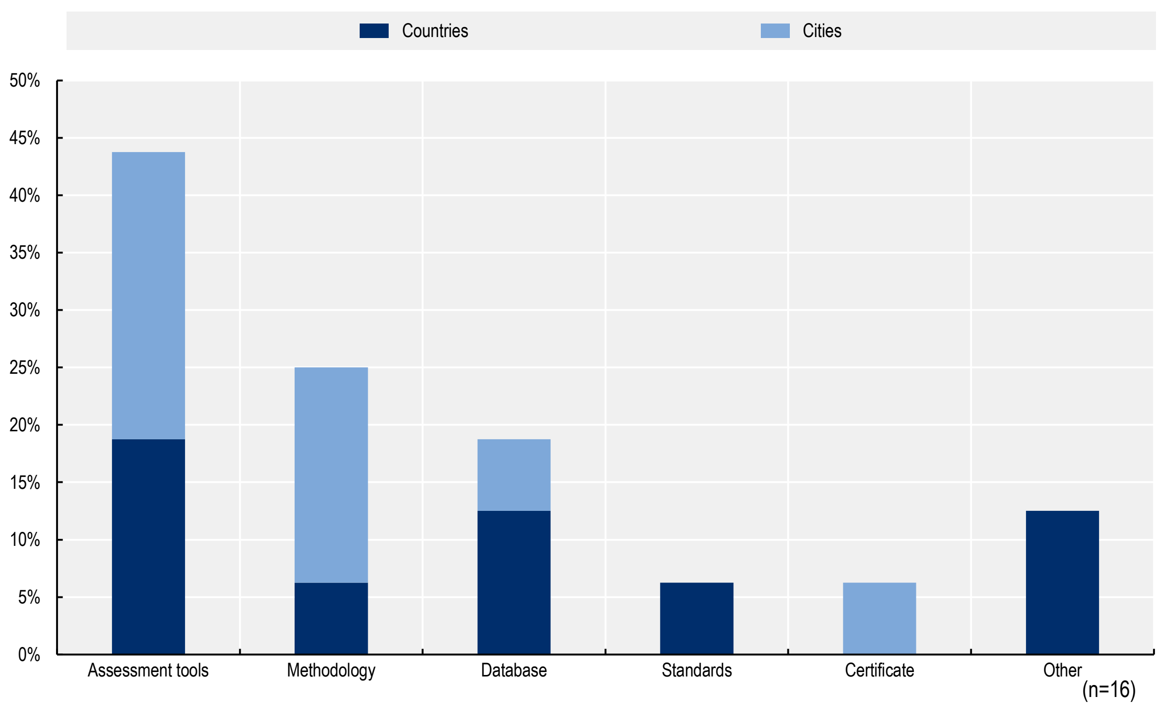
Note: Question from the survey: "Tasks where the public-private-academia partnership is important" The responding countries and cities could select all applicable options.
Source: OECD Survey on Whole Life Carbon of Buildings (2024)

The evidence drawn from the survey also shows that private sector engagement cannot be overlooked when governments pursue ambitious WLC policies. Premature implementation of WLC policies without a without a clearly defined and consolidated methodology will send conflicting signals to the private sector and risks distorting market performance. In contrast, governments can benefit from a proactive buildings and construction sector to pioneer successful policies. For instance, **Vancouver (Canada)** indicated in the survey that the backing of local and international industry leaders and experts is one of the reasons the city was able to take action ahead of the federal government in Canada, as these stakeholders provided critical insights informing the city's WLC policies for buildings. The city also emphasised the importance of public-private-academic partnerships for advancing research into innovative low-embodied carbon materials and solutions.

Develop methodologies, databases, and assessment tools

The OECD Global Survey on Whole Life Carbon of Buildings (2024) provides evidence on how joint efforts involving private sector actors can advance WLC policies instruments. Indeed, including diverse actors throughout the construction value chain, such as construction companies, architectural firms, and building material providers, as well as research institutes helps enhance an enabling environment for WLC policies. The survey shows that governments are mobilising resources from the private sector to develop WLC assessment tools, methodologies, and database (Figure 5.3). This approach combines the regulatory guidance and policy support from the government with the innovative and technical capabilities of various stakeholders.

Figure 5.3. Types of policy instruments based on private sector initiatives



Note: Question from the survey: "Policy instruments based on the initiatives that have been fully developed by the private sector" The responding countries and cities could select all applicable options.
Source: OECD Survey on Whole Life Carbon of Buildings (2024)

For instance, **Brazil**'s Information System for Environmental Performance in Construction (SIDAC) shows that partnerships involving public agencies, private companies, and researchers are key to develop a national database on EPDs and LCA (Box 5.4). SIDAC's development is co-ordinated by the Brazilian Council for Sustainable Construction (CBCS), a nationwide civil society organisation comprising academia, construction companies, manufacturers, government representatives, and other stakeholders in the construction industry. Major public utilities companies, associations of construction companies, and research institutions play an important role in the development process to refine methodologies, gather stakeholder feedback on prototypes, and develop assessment tools, such as the CECarbon (SIDAC, 2024[19]; Fernanda Belizario-Silva, 2023[20]; CECarbon, 2020[21]; SIDAC, 2024[22]).

Box 5.4. Brazil's Information System for Environmental Performance in Construction (SIDAC)

Brazil's Information System for Environmental Performance in Construction (SIDAC) shows that public-private-academic partnership is one of the success factors for developing a national database on EPD and LCA. SIDAC is an outcome of the Strategic Partnerships for the Implementation of the Paris Agreement (SPIPA) programme, co-ordinated by the Brazilian Ministry of Mines and Energy (MME), funded by the EU's Partnership Instrument and the German Ministry of Environment, Nature Conservation, Nuclear Safety and Consumer Protection (BMUV) and implemented by the German International Cooperation Agency (GIZ).

The development of SIDAC exemplifies the merits of involving public enterprises, the private sector, and industry experts in refining the methodology, collecting data, and gathering feedback on system prototypes. The administrative co-ordination of SIDAC's development is undertaken by the Brazilian Council for Sustainable Construction (CBCS), a nationwide civil society organisation comprising academia, construction companies, manufacturers, government representatives, and other stakeholders in the construction industry. Notably, the development process was supported by collaboration among various public and private stakeholders, including the Brazilian Ministry of Regional Development (MDR), the major public electric utilities company Eletrobras, the national energy efficiency programme Procel, the state-owned Energy Research Office (EPE), and associations of material manufacturers, designers, life-cycle assessment experts, and local software companies. Prototypes of the system were presented during meetings with stakeholders for feedback and suggestions. The system methodology was examined by a scientific committee composed of researchers specialised in life-cycle assessment from nine universities, resulting in two methodological revisions. Furthermore, a technical committee was established within the governance structure to ensure the technical and methodological integrity of the system, alongside reviewers and specialists in life-cycle assessment of buildings.

In addition, Brazil taps into the resources and executive capabilities of the private sector in developing assessment tools for carbon emissions in the construction of new buildings. SindusCon-SP, a major association of companies in the construction industry in the State of São Paulo, launched the CECarbon tool in 2021 for calculating GHG emissions and energy consumption of each of the construction stages. CECarbon results from a partnership between SindusCon-SP, GIZ, and the National Housing Secretariat of the Ministry of Regional Development.

Source: Sidac, https://sidac.org.br/quem_somos/desenvolvimento; Belizario-Silva, et al. (2023), "The Sidac system: Streamlining the assessment of the embodied energy and CO2 of Brazilian construction products" https://doi.org/10.1016/j.jclepro.2023.138461; Sidac, https://sidac.org.br/quem_somos/governanca; CECarbon, "Sobre a CECarbon", https://cecarbon.com.br/about

Japan's public-private-academic partnership demonstrates effective collaboration in developing WLC calculation tools (Box 5.5. Japan's Zero Carbon Building Promotion Committee. The Institute for Built Environment and Carbon Neutral for SDGs (IBECs) serves as a platform for research and technological development related to housing, architecture, and cities, including the built environment and energy conservation (IBECs, 2024[23]). The Zero Carbon Building Promotion Committee, established with the IBECs in 2022, engages a full range of stakeholders including local governments, universities, four associations of construction, architecture, and real estate companies, and several ministries (IBECs, 2024[24]). The Committee launched the J-CAT, a Japanese WLC assessment tool for calculating GHG emissions throughout the entire building life-cycle, in 2024 (IBECs, 2024[25]; Ministry of Land, Infrastructure, Transport and Tourism, 2024[26]).

Box 5.5. Japan's Zero Carbon Building Promotion Committee

Japan leverages public-private-academic partnership to develop WLC calculation tools. The Institute for Built Environment and Carbon Neutral for SDGs (IBECs) serves as a platform for research, technological development and outreach activities related to housing, architecture and cities, including the built environment and energy conservation. The Zero Carbon Building Promotion Committee was established in December 2022, with IBECs and the Japan Sustainable Building Consortium (JSBC) serving as a joint secretariat. The Committee aims to develop WLC evaluation methods, study issues related to databases on materials and equipment, and collect information from overseas, promoting zero-carbon buildings through collaboration between industry, government, and academia.

The Zero Carbon Building Promotion Committee comprises representatives from two local governments, eight universities, a federation of construction contractors, an association of architectural firms, an association of real estate companies, a national research and development agency, a public interest incorporated foundation, a leading architectural agency, and an investment consultancy, with government officials from the Cabinet Secretariat and four Ministries as observers. One of the main outputs of the Zero Carbon Buildings Promotion Committee is the J-CAT launched in 2024. J-CAT offers a free software and a manual to calculate GHG emissions throughout the entire building life-cycle, based on the revised LCA guidelines defined by the Architectural Institute of Japan.

Source: Institute for Built Environment and Carbon Neutral for SDGs, https://www.ibecs.or.jp/english/index.html; Institute for Built Environment and Carbon Neutral for SDGs, "Zero Carbon Buildings (LCCO2 Net Zero) Promotion Council", https://www.ibecs.or.jp/zero-carbon_building/; Institute for Built Environment and Carbon Neutral for SDGs, https://www.ibecs.or.jp/zero-carbon_building/files/ZeroCarbonBuildingPC_member240701.pdf; Ministry of Land, Infrastructure, Transport and Tourism of Japan, https://www.mlit.go.jp/report/press/house04_hh_001226.html

Provide training and education to the construction industry

The OECD Global Survey on Whole Life Carbon of Buildings (2024) reveals that only two national and one local government respondents have introduced WLC training programmes based on public-private partnership. However, these examples demonstrate the potential of public-private-academic partnerships in providing training programmes on WLC. As labour shortages and upskilling in the construction sector become more pressing issues, governments can tap into the sector's resources to address skill gaps and ensure long-term competitiveness of the construction industry.

For instance, the Nordic Sustainable Construction offers an example of effective public-private-academic collaboration, leveraging expertise from Nordic countries' sustainability consulting firms and Denmark's national Knowledge Centre for Crafts and Sustainability to develop educational materials on sustainable building practices. Skills4Reuse is an online platform that provides comprehensive introductory courses on the reuse and recycling of wood and brick (Skills4Reuse, n.d.[27]). This initiative contributes to a collective effort in the Nordic region towards enhancing the circularity of building materials, as well as upskilling current and future workers in sustainable building practices.

The **Singapore** Green Building Council (SGBC) Digital Academy provides built environment and sustainability professionals and practitioners with on-demand access to over 30 webinars on green buildings. The online platform offers webinars on whole life carbon (Singapore Green Building Council, n.d.[28]). The SGBC is a non-profit industry-led organisation that facilitates public-private partnerships and fosters innovative industry solutions across the entire building and construction value chain (Singapore Green Building Council, n.d.[29]). Similarly, the **Israeli** Green Building Council (ILGBC) provides professional courses on LCA and the revision of the Green Building Standard in collaboration with the country's Ministry of Environmental Protection (Israeli Green Building Council, 2024[30]). The ILGBC serves as a non-profit platform for public-private-academic partnership by bringing together more than 270 member organisations from the construction industry, local and central governments, professional community, academia, and NGOs (Israeli Green Building Council, n.d.[31]).Clarify roles and responsibilities through multi-stakeholder engagement.

The vast number of stakeholders involved in the entire life-cycle of buildings creates a complex policy landscape that requires clearly defined roles and responsibilities for various stakeholders. Some countries have adopted a multi-stakeholder approach to allow for the identification and clarification of roles and responsibilities in setting life-cycle assessment methodologies.

The Netherlands has developed a public-private partnership model to delineate the roles of various stakeholders. The Nationale Milieudatabase (NMD) is an independent organisation managing the Environmental Performance Assessment Method for Construction Works and its database (Nationale Milieudatabase, 2024[32]) (Box 5.6. The Netherlands' National Environmental Database). The NMD is overseen by the Netherlands Policy Committee on Environmental Performance (BMNL), which brings together 18 stakeholder parties including public and private clients, data suppliers, and users. In parallel, there is a Technical Committee engaging experts from the construction sector, allowing them to share knowledge and industry perspectives (Nationale Milieudatabase, 2024[33]). By collaborating with the industry, this governance structure clarifies roles and responsibilities in setting methodologies on LCA that are separate from policy making and political decisions on regulations. The BMNL's governance framework also safeguards the independence of the NMD, ensuring that it remains impartial and resilient to commercial or political influence while meeting the evolving energy and environmental standards.

Box 5.6. The Netherlands' National Environmental Database

The Nationale Milieudatabase (NMD) is an independent non-profit organisation in the Netherlands that manages and maintains the Environmental Performance Assessment Method for Construction Works (Assessment Method) as well as the construction carbon database. The NMD also validates privately developed calculation tools based on the assessment method and EPDs for building products for the database.

The NMD exemplifies a robust public-private partnership model that convenes a wide range of stakeholders to assess energy performance of buildings or civil engineering structures in the construction sector. The NMD is overseen by the Netherlands Policy Committee on Environmental performance (BMNL), which brings together 18 stakeholder parties including public and private clients, data suppliers from the industry, and data users – including architects, engineers, and software providers. Representing stakeholders' interests, the BMNL decides on rates, the annual plan, and licences. The BMNL advises on the Assessment Method and the database following consultation with the relevant Ministry and the advisory committees. A key aspect of this collaboration is the Technical Committee (TIC), which comprises 8-10 sector experts who bring technical knowledge and industry perspectives to the table. The TIC has a balanced membership of 60% LCA experts and 40% construction sector representatives. BMNL and TIC members are appointed for three-year terms.

The BMNL's collaborative governance structure enables stakeholders to share knowledge and align on sustainability goals, benefiting from exchanges of insights and experience. Through establishing an independent foundation, the Netherlands has developed a public-private partnership model that does not only raise environmental standards in buildings, but also empowers stakeholders from the construction industry by recognising and leveraging their technical expertise. More importantly, this structure clarifies roles and responsibilities in setting methodologies on LCA that are separate from policy making and political decisions on regulations. The BMNL's governance framework also safeguards the independence of the NMD, ensuring that it remains immune to commercial or political influence while meeting the evolving energy and environmental standards.

Source: Nationale Milieudatabase, "Organisation NMD" https://milieudatabase.nl/en/about-us/organisation/; Nationale Milieudatabase, "An introduction to the NMD", https://milieudatabase.nl/en/an-introduction-to-the-nmd/

References

Bayerisches Staatsministerium für Wohnen, Bau und Verkehr (2024), *Pressemitteilung der 145. Bauministerkonferenz*, https://www.bauministerkonferenz.de/IndexSearch.aspx?method=get&File=bya892ba82y1b9bbba8a4a8yb9bb92b8y9ya8ayyb9y884b992a2a0a1a0a2a3a1aa4b80b8y0epqcvcjbjukyvsxvhkprftyg. [4]

Bayerisches Staatsministerium für Wohnen, Bau und Verkehr (n.d.), *STRUKTUR UND AUFGABEN*, https://www.bauministerkonferenz.de/verzeichnis.aspx?id=762&o=759O762. [3]

CECarbon (2020), *Sobre a CECarbon*, https://cecarbon.com.br/about. [21]

Falana, J., R. Osei-Kyei and V. Tam (2024), "Towards achieving a net zero carbon building: A review of key stakeholders and their roles in net zero carbon building whole life cycle", *Journal of Building Engineering*, Vol. 82, https://doi.org/10.1016/j.jobe.2023.108223. [18]

Fernanda Belizario-Silva, L. (2023), "The Sidac system: Streamlining the assessment of the embodied energy and CO2 of Brazilian construction products", *Journal of Cleaner Production*, Vol. 421, https://doi.org/10.1016/j.jclepro.2023.138461. [20]

Government of Canada (2024), *Funded initiatives announced with the Canada Green Buildings Strategy*, https://www.canada.ca/en/natural-resources-canada/news/2024/07/funded-initiatives-announced-with-the-canada-green-buildings-strategy.html. [9]

IBECs (2024), *About us*, https://www.ibecs.or.jp/english/index.html. [23]

IBECs (2024), *J-CAT／Japan Carbon Assessment Tool for Building Lifecycle*, https://www.ibecs.or.jp/english/JCAT/index.html. [25]

IBECs (2024), *ゼロカーボンビル（LCCO2 ネットゼロ）推進会議 委員名簿*, https://www.ibecs.or.jp/zero-carbon_building/files/ZeroCarbonBuildingPC_member240701.pdf. [24]

Israeli Green Building Council (2024), *WBLCA Professional Webinar*, https://ilgbc.org/course/wblca/. [30]

Israeli Green Building Council (n.d.), *About the Israeli Green Building Council (ILGBC)*, https://ilgbc.org/about/about-ilgbc/. [31]

Klimatkommunerna (2024), *Our mission*, https://klimatkommunerna.se/in-english/. [10]

Klimatkommunerna (2024), *Premiera hållbart byggande*, https://klimatkommunerna.se/vad-vi-vill/vad-vi-vill-bygg/. [11]

Ministry of Land, Infrastructure, Transport and Tourism (2024), *建築物のライフサイクルカーボン算定ツール試行版を公開しました！*, https://www.mlit.go.jp/report/press/house04_hh_001226.html. [26]

National Research Council of Canada (2024), *National whole-building life cycle assessment practitioner's guide*, https://nrc-publications.canada.ca/eng/view/object/?id=533906ca-65eb-4118-865d-855030d91ef2. [6]

Nationale Milieudatabase (2024), *An introduction to the NMD*, https://milieudatabase.nl/en/an-introduction-to-the-nmd/. [32]

Nationale Milieudatabase (2024), *Organisation NMD*, https://milieudatabase.nl/en/about-us/organisation/. [33]

Natural Resources Canada (2024), *Codes Acceleration Fund*, https://natural-resources.canada.ca/energy-efficiency/buildings/codes-acceleration-fund/24794. [8]

Natural Resources Canada (2023), *Natural Resources Canada Launches Call for Proposals for the Delivery of the Codes Acceleration Fund*, https://www.canada.ca/en/natural-resources-canada/news/2023/01/natural-resources-canada-launches-call-for-proposals-for-the-delivery-of-the-codes-acceleration-fund.html. [7]

Nordic Sustainable Construction (2024), *Work Packages*, https://www.nordicsustainableconstruction.com/work-packages. [12]

Nordic Sustainable Construction (2023), *Nordic Ministerial Declaration on Commitment to Low Carbon Construction*, https://www.nordicsustainableconstruction.com/knowledge/2023/november/nordic-ministerial-declaration-on-commitment-to-low-carbon-construction. [13]

Nordic Sustainable Construction (2023), *Roadmap: Harmonising Nordic Building Regulations concerning Climate Emissions*, https://www.nordicsustainableconstruction.com/Media/638302229397775948/Roadmap%20for%20harmonising%20Nordic%20Building%20Regulations%20concerning%20Climate%20Emissions.pdf. [14]

OECD (2024), *Global Monitoring of Policies for Decarbonising Buildings: A Multi-level Approach*, https://www.oecd.org/en/publications/global-monitoring-of-policies-for-decarbonising-buildings_d662fdcb-en.html. [5]

OECD (2022), *Decarbonising Buildings in Cities and Regions*, https://doi.org/10.1787/a48ce566-en. [2]

OECD (2019), *University-Industry Collaboration : New Evidence and Policy Options*, OECD Publishing, https://doi.org/10.1787/e9c1e648-en. [17]

OECD (2018), *Subnational Public-Private Partnerships: Meeting Infrastructure Challenges*, OECD Publishing, https://doi.org/10.1787/9789264304864-en. [16]

OECD (2013), *Government at a Glance 2013*, OECD Publishing, https://doi.org/10.1787/gov_glance-2013-en. [15]

OECD (2010), *Cities and Climate Change*, OECD Publishing, Paris, https://doi.org/10.1787/9789264091375-en. [1]

SIDAC (2024), *About Us - Development of SIDAC*, https://sidac.org.br/quem_somos/desenvolvimento. [19]

SIDAC (2024), *About Us - Governance of Sidac*, https://sidac.org.br/quem_somos/governanca. [22]

Singapore Green Building Council (n.d.), *About Us*, https://www.sgbc.sg/about-us/. [29]

Singapore Green Building Council (n.d.), *Unpacking Green Mark: 2021 Sustainability Sections:*, https://digitalacademy.sgbc.sg/course/unpacking-green-mark-2021-sustainability-sections-whole-life-carbon-cn-and-intelligence-in. [28]

Skills4Reuse (n.d.), *About Skills4Reuse*, https://www.en.skills4reuse.com/about-us. [27]

6 Policy recommendations

This chapter provides six main policy recommendations to accelerate the effective design and implementation of decarbonisation policies for buildings: i) expand policy focus to whole life carbon of buildings; ii) customise step-by-step approaches in developing whole life carbon policies; iii) develop data collection strategies; iv) utilise digital tools for more effective whole life carbon policies; v) enhance vertical co-ordination to empower city-led actions; and vi) strengthen horizontal collaboration and public-private-academic partnerships.

Introduction

Whole life carbon (WLC) policies are critical for reducing emissions across the life-cycle of buildings and achieving a sustainable built environment. Despite their growing importance, WLC policies remain underutilised and face numerous implementation barriers. To support policy makers in overcoming these obstacles, this chapter provides targeted recommendations to address six key challenges identified by the OECD Global Survey on Whole Life Carbon of Buildings (2024):

- The first challenge is the lack of regulatory frameworks in most countries that explicitly address whole life carbon. This leaves the critical aspects of embodied carbon and circularity inadequately addressed.
- Second, setting reference and limit values for WLC is a complex task. Variations in building type, size, and energy intensity require extensive research and tailored benchmarks, delaying implementation.
- Third, insufficient Environmental Product Declaration (EPD) data undermines the accuracy of WLC assessments. Many manufacturers hesitate to invest in EPDs, particularly during the early stages of policy adoption, due to unclear economic incentives.
- Fourth, stakeholder burden and fragmented efforts present a major hurdle. Developers, architects, and construction firms often lack the expertise, resources, and time to conduct WLC assessments, which involve compiling data on tens of thousands of building components.
- Fifth, resource and expertise constraints at the local level hinder local governments from implementing WLC policies effectively. Misaligned policies, limited capacity, and institutional barriers exacerbate these challenges.
- Lastly, operational energy efficiency measures offer immediate advantages like cost savings and improved comfort, whereas addressing embodied carbon entails higher costs with minimal direct benefits for tenants or owners. This economic disparity reduces the appeal of whole life carbon initiatives, making them unlikely to succeed without strong collaboration beyond market forces or regulations.

This chapter lays out concrete policy recommendations to address each of these challenges. By tackling these barriers, governments can accelerate the adoption of WLC policies, align incentives and tools more effectively, and ensure a holistic approach to decarbonising the built environment.

Expand policy focus to whole life carbon of buildings from operational carbon

Despite the critical importance of addressing WLC – which includes embodied carbon from construction materials and processes, as well as operational carbon from energy use – only a small fraction of countries have implemented comprehensive policies to tackle this issue. Current regulatory frameworks predominantly focus on operational carbon, largely overlooking issues of embodied carbon and material circularity.

This policy gap is evident in the findings of the OECD report *Global Monitoring of Policies for Decarbonising Buildings: A Multi-level Approach* (2024). The report highlights that while 89% of countries have established mandatory energy efficiency codes and 61% have adopted an Energy Performance Certificate (EPC), only 21% have implemented regulations addressing WLC. This imbalance underscores the limited attention given to embodied carbon and circularity of materials. However, respondent countries anticipate a shift in priorities. While only 14% of countries currently consider embodied carbon as a key focus in the present, this figure is expected to rise to 43% in the future. Similarly, the prioritisation of material circularity is projected to increase dramatically, from 11% to 68% in the future. These trends indicate growing awareness of WLC but also highlight the urgent need for accelerated action (OECD, 2024[1]).

The urgency is particularly pronounced in rapidly urbanising regions in Africa and Asia, where the construction boom presents both a significant opportunity and a major risk. In Africa, the population is expected to grow to 2.4 billion by 2050 (African Development Bank, n.d.[2]), with the residential building stock projected to double to nearly 50 billion m^2 during the same period (IEA, 2023[3]). A staggering 80% of this new construction is anticipated to occur in urban areas, particularly in slums, where sustainable construction practices are often absent (Muggah and Kilcullen, 2016[4]). Similarly, Asia is poised to experience a dramatic rise in construction activity, with 65% of the current floor area projected to be built between 2020 and 2050 (IEA, 2022[5]). Much of this growth will occur in the residential sector, driven by population increases, rising incomes, and the expansion of household and appliance ownership (GlobalABC/IEA/UNEP, 2020[6]).

The risks of failing to address WLC in these regions are immense. Buildings have long lifespans, and decisions made during the design stage – such as the choice of materials and construction methods – can lock in carbon-intensive practices for decades. If projects continue to rely on carbon-intensive approaches, the cumulative emissions from these buildings could severely delay or even derail the global transition to low-carbon pathway.

Expanding the policy focus to WLC of buildings is crucial for achieving both immediate and long-term climate objectives. Reducing embodied carbon – emissions from materials and construction – delivers immediate CO_2 reductions, making it indispensable for meeting 2030 targets. In contrast, energy efficiency measures, such as improved insulation, are critically important for the medium to long term, particularly for buildings with lifespans of 50 years or more.

A comprehensive WLC approach addresses emissions across all stages of a buildings' life-cycle, ensuring a balanced and effective decarbonisation strategy. This focus not only accelerates the transition to low-carbon construction but also fosters innovation in sustainable materials, and advances circularity. By taking into account emissions across buildings' entire life-cycles, policy makers can deliver immediate climate benefits while paving the way for a sustainable and resilient future.

Customise step-by-step approaches in developing whole life carbon policies

Most responding countries (8 out of 15) identify the task of setting reference and limit values for different building types as the most significant challenge in implementing WLC policies. The diversity of building stocks, which vary in size, energy intensity, and proportion within the overall stock, exacerbates the difficulty of the task. Developing differentiated reference and limit values requires extensive research to ensure that these benchmarks reflect the specific emission reduction potential of various building types, making the process both intricate and time-consuming. The OECD Global Survey on Whole Life Carbon of Buildings (2024) indicated that developing databases, methodologies, and regulations requires the most resources in WLC policy development and implementation. The necessary cost, time, and effort pose a significant challenge to government capacity.

To address this challenge, it is essential to adopt a step-by-step approach. A step-by-step approach begins with the creation of a long-term roadmap that establishes clear, measurable goals and phased milestones, ensuring progress is tracked and adjustments can be made as necessary. This roadmap should establish a timeline for implementing key measures such as mandatory WLC declarations, requiring developers to disclose embodied carbon emissions for all new construction projects.

As the framework evolves, it should include the gradual adoption of carbon limit values, setting thresholds for embodied carbon emissions that tighten progressively over time to encourage innovation and reduce emissions. Furthermore, the roadmap must progressively expand targeted building types, encompassing a broader range of residential, commercial, and public buildings. Over time, these limit values should be strengthened in line with advancements in technology and industry practices, ensuring continuous progress toward decarbonisation.

Incorporating specific timelines and measurable goals within the roadmap is vital for ensuring accountability and providing stakeholders with the clarity needed to prepare for upcoming requirements. This approach enables policy makers, developers, and the construction industry to align their efforts, invest in capacity building, and adopt sustainable practices proactively.

For instance, starting with a 2017 roadmap, **Finland** set clear targets, such as carbon footprint limits for buildings, and introduced a WLC assessment method. Testing and feedback refined the assessment, while regulatory adjustments, including exemptions and delayed enforcement, balanced ambition with practicality. This adaptive strategy ensured progress while addressing implementation challenges, demonstrating that incremental, well-planned steps can effectively align policy with industry capacity and stakeholder needs (Bionova, 2017[7]; Eduskunta Riksdagen, 2024[8]).

Given the complexity of building stocks, categorisation is critical. Buildings should be grouped into types such as residential, commercial, and public, with reference and limit values tailored to reflect the varying potential for emission reductions. Initial efforts should focus on high-impact actions, such as climate reporting and emissions limit values, which can generate momentum and confidence. **France**'s RE2020 regulation illustrates the critical role of building stock categorisation in implementing WLC policies. Recognising the complexity of the building sector, France prioritised residential buildings as the initial focus due to their substantial climate impact (60% of operational carbon emissions) and the availability of reliable data. The phased introduction of RE2020, beginning with residential buildings, allowed for meaningful emissions targets to be implemented where data and feasibility supported immediate action (Ministry of Ecological Transition and Territorial Cohesion, 2023[9]; Ministry of Ecological Transition and Territorial Cohesion, n.d.[10]).

In addition, countries can start with simpler regulatory measures such as climate impact reporting, which allows incremental progress before moving towards stricter emission limits as data and enforcement capacities improve. **Sweden**'s approach to WLC policies began with mandatory climate declarations in 2022, focusing on upfront carbon emissions (A1 to A5) for their immediate impact and feasibility. Plans to expand system boundaries to later life-cycle stages by 2027 reflect a phased strategy, balancing complexity with readiness (Boverket, 2020[11]; Boverket, 2023[12]).

Stakeholder engagement is another vital element of this approach. Policy makers, developers, architects, contractors, and suppliers must be actively involved to align efforts, foster trust, and reduce uncertainty. Public-private partnerships can play a crucial role in mobilising resources and expertise. Embedding flexibility into the process ensures policies can adapt to innovations and address unforeseen challenges, maintaining their relevance and impact over time.

Denmark exemplifies effective public-private partnership. Denmark's WLC policies highlight the central role of public-private partnerships in driving the green transition. In 2020, climate partnerships across 13 sectors, including construction, brought together businesses and the government to develop unified roadmaps. The construction sector's roadmap, proposed in 2021, included mandatory CO_2 accounting for buildings and phased regulations starting in 2023, ensuring early compliance with minimal disruption (Regeringens Klimapartnerskaber, 2021[13]).

Public-private collaboration has also informed Denmark's carbon limits for new buildings, set at 12 kg CO_2e/m^2/year in 2023. This limit applies to buildings over 1 000 m², with plans for stricter limits and expanded coverage in 2025. Denmark's collaborative approach ensured practical, phased regulations that align industry goals with ambitious climate targets (Nordic Sustainable Construction, 2024[14]).

By adopting this structured, step-by-step approach, countries can effectively navigate the complexities of introducing WLC policies. This method addresses the diversity of building stocks, fosters collaboration, and provides a sustainable pathway to decarbonising buildings while overcoming the challenges associated with setting reference and limit values.

Develop data collection strategies

The survey revealed two major challenges affecting the effectiveness of WLC policies. Setting limit values emerged as the primary challenge during policy development, whereas the lack of EPDs is a significant challenge during policy implementation pointed out by 7 out of 16 respondent countries and cities. These findings underscore the importance of ensuring the availability of both EPD data and assessment results. Developing strategies to collect such data is essential for successful policy implementation.

EPD data plays a pivotal role in enhancing the quality of WLC assessment. However, the lack of EPDs remains a significant bottleneck in many surveyed countries and cities, primarily due to limited capacity within the industry. This trend is most pronounced in the early stages of WLC policies, as manufacturers often cannot expect enough return on investment for pursuing EPDs.

To address this challenge, the **Netherlands** introduced a financial aid programme called "Filling the Gaps", which incentivises SMEs to obtain EPDs by offering a financial support of EUR 2 500 (Nationale Milieudatabase, n.d.[15]). Similarly, **Denmark** implemented a subsidy programme to support EPD acquisition for a limited period from 1 January 2022 until 30 September 2022. Denmark's approach focused on supporting manufacturers during the early stages of WLC policies (Social- og Boligstyrelsen, 2022[16]). Now, with the successful implementation of WLC policies in the country, manufacturers are proactively pursuing EPDs without needing financial support.

Another approach to incentivise manufacturers is to set national generic emission data at a more conservative level than the average emission values. This approach is used in **Denmark, Finland, France**, and **Sweden**. For instance, **Finland**'s generic emission data is 20% more conservative than the actual emission data. This means that there is an advantage of using EPDs to have lower emission calculations (Nordic Sustainable Construction, 2023[17]). Similarly, in the **Netherlands**, the Nationale Milieudatabase puts a 30% surcharge on category 3 datapoints that are unspecific and based on the international database. This is expected to encourage developers to utilise more materials with EPDs in their buildings, prompting manufacturers to pursue EPD certification as well.

As the number of EPD-declared products increases in the market, it will become increasingly important for manufacturers to obtain EPDs to maintain competitiveness. Furthermore, if the calculation and reporting of WLC are mandated by regulation, developers will have a natural incentive to adopt products with EPDs. To support this environmental shift in the market, governments may need to develop strategies that facilitate this transition.

Collecting assessment results is equally crucial, as it enables the monitoring of policy effectiveness and helps identify optimal reference or limit values for building carbon emissions that are both ambitious and achievable.

The **Greater London Authority (UK)** has developed a standardised template for its mandatory reporting system, provided in Excel format. This template includes information sheets where applicants can input the required data and submit it via an online platform. Boverket in **Sweden** has also launched a digital platform with an automatic import function for XML files, allowing developers to register climate declarations. Similar to the Greater London Authority, Boverket provides an Excel template for applicants to input the required information, which can then be imported directly into the system for registration. The standardised template for mandatory reporting not only simplifies the process for applicants, but also enables the authority to efficiently compile the submissions and leverage the data for analytical purposes to support further policy development.

Use digital tools for more effective development of WLC policies

To enable a smooth introduction and an effective implementation of WLC policies towards achieving zero-carbon buildings, governments should develop digital tools that enable more efficient and precise WLC assessment of buildings. WLC assessments place substantial workload on stakeholders: a single detached house typically consists of over ten thousand individual building components, sourced from approximately 20 to 30 different manufacturers (NEC Corporation and Home Eco Logistics Co., Ltd., 2014[18]; Daiwa House Group, n.d.[19]).

The OECD Global Survey on Whole Life Carbon of Buildings (2024) identifies workload placed on stakeholders to conduct WLC assessments as the most common challenge at the policy implementation stage. Leveraging digital assessment tools is crucial to overcome this challenge.

Enhance collaborative partnership for database and tool development

The development of a comprehensive database is essential for conducting WLC assessments of buildings in a standardised and comparable manner, but the respondents of the OECD Global Survey on Whole Life Carbon of Buildings (2024) report it as the second most pressing challenge at the policy development stage. In addition to the database, the availability of assessment tools is another key enabler for the industry, as it can significantly reduce the workload associated with WLC assessments.

Public-private-academic partnership is key to addressing these challenges as the partnership fosters collaboration among diverse stakeholders. By pooling resources, expertise, and perspectives, these partnerships drive innovative solutions to complex issues. The **Netherlands**' Nationale Milieudatabase serves as an example of a database developed through a strong public-private partnership, bringing together a diverse range of stakeholders to assess the energy performance of buildings and civil engineering structures within the construction sector. The NMD is managed by the Netherlands Policy Committee on Environmental Performance (BMNL), which comprises 18 stakeholder organisations, including public and private players, industry data suppliers, and data users such as architects, engineers, and software providers. Through this collaborative governance structure, the NMD has been developed as a nationwide database, which is set to be mandated for use in WLC assessments of buildings for regulatory purposes across the country (Nationale Milieudatabase, 2024[20]).

A similar approach is observed in the **French** INIES database, which is managed by the non-profit organisation HQE (Haute Qualité Environnementale). HQE receives funding both from public and private sectors, including from key actors within the construction and environmental sector. What the Dutch NMD and the French INIES examples have in common is that their websites do not only function as simple databases but also as knowledge-sharing platforms for all stakeholders (INIES, n.d.[21]).

Effectively engaging stakeholders from various sectors throughout and beyond the buildings and construction sector in a collaborative initiative can foster knowledge exchange, increase resource efficiency, and bring better solutions. This collaboration, in turn, will enable the development of more efficient, effective, and user-friendly digital platforms.

Incentivise industry to accelerate the digital transition

To reduce workload and improve efficiency, it is also crucial to support industry towards the digital transition. Utilising Building Information Modelling (BIM) in WLC assessment is being mainstreamed worldwide, as it centralises data, automates calculations, and enables real-time collaboration among stakeholders. However, the low adoption rate of BIM, particularly among SMEs, presents a challenge in utilising it for WLC assessments, especially in countries that have not yet implemented WLC policies.

France's BIM Plan (Plan BIM) was launched at the beginning of 2022 to support the digital transition of SMEs by expanding the use of digital technology in the construction industry and promoting the development of professionals' skills. BIM should be used across all construction projects by standardising practices and stakeholders should have clear and balanced definitions of each party's expectations and responsibilities. Accessibility is key for the French approach: BIM is to be deployed across all regions and made accessible to everyone through appropriate tools (Ministères Territoires Ecologie Logement, 2024[22]).

Japan exemplifies another approach for promoting BIM utilisation. The BIM Acceleration Project by the Ministry of Land, Infrastructure, Transport, and Tourism (MLIT) offers financial support to companies, targeting SMEs in particular. Through this project, the government provides subsidies for BIM implementation costs for building projects that meet specific criteria, such as when multiple organisations collaborate to generate architectural BIM data (Ministry of Land, Infrastructure, Transport and Tourism, 2021[23]). In particular, Japan focuses on BIM's usability for LCA at the planning and designing stage; and on the ability of BIM to facilitate architects' revisions of designs depending on climate impacts. This approach reduces long-term costs and environmental impacts while promoting better regulatory compliance (OECD, 2024[1]).

Countries such as **Denmark** require the use of BIM to strengthen their construction industries' adherence to environmental regulations. The national building regulation BR18 serves as the cornerstone of Denmark's BIM framework, which includes rigorous LCAs and mandatory documentation of the climate impact of new buildings. To comply with these requirements, the architecture, engineering and construction industries use software tools that ensure data accuracy and support interoperability through open standards such as the Industry Foundation Classes (IFC) format, enabling seamless data exchange between different BIM software systems (OECD, 2024[1]).

Standardising BIM protocols across all stakeholders at the national level, coupled with financial or capacity building support, will accelerate BIM adoption within the industry. Widespread BIM adoption across the supply chain will allow seamless data exchange among different levels of stakeholders, leading to more efficient and accurate WLC assessments.

Enhance vertical co-ordination to empower city-led actions

Cities possess a range of strengths in advancing WLC policies for buildings, presenting an opportunity to pioneer ambitious initiatives. However, effective policy implementation cannot be achieved without robust vertical co-ordination mechanisms. Therefore, national governments should i) establish a coherent national policy framework, combined with a standardised methodology, assessment tool, and database; ii) establish platforms to exchange information and data with subnational governments; and iii) support local governments' capacity building.

Leverage cities' unique advantages

Cities should leverage their specific local advantages to drive WLC initiatives. These enabling factors allow municipal governments to adopt place-based policies, leveraging local strengths to drive innovation and address local challenges effectively. These structural advantages include: i) ownership of public buildings; ii) responsibility for local regulations and knowledge of the local building stock; and iii) proximity to citizens and local businesses.

As a result, cities' structural advantages enable them to take the lead in pursuing initiatives, often setting more ambitious WLC standards than national guidelines. Chapter 5 highlighted three types of pioneering city-led initiatives: innovative approaches, faster policy implementation, and more ambitious targets. These initiatives have driven stricter limit values and expanded carbon assessment boundaries in construction, outpacing national governments. **Tampere (Finland)** undertook a unique approach by setting carbon footprint as a criterion for design selection of public projects. One of the enabling factors was the city's ownership of 70% of the inner-city land, which has a significant influence on most construction projects (Tampereen kaupunk, 2022[24]). **Helsinki (Finland)** and **Vancouver (Canada)** implemented limit values earlier than their national governments, given the former's authority over city planning through its "local detailed plan" and the latter's ability to adopt its own Building By-law (City of Helsinki, 2023[25]; City of Vancouver, 2023[26]; City of Vancouver, 2024[27]). Similarly, **Greater London (UK)** implemented mandatory reporting ahead of its national government through its Greater London Plan (Greater London Authority, 2021[28]; Greater London Authority, n.d.[29]). The survey also shows that **Malmö (Sweden)** implemented requirements of mandating assessment both at building permit stage and after completion that are more ambitious than at national level, driven by the strong relationship with local stakeholders (LFM30, 2019[30]; Boverket, 2020[11]).

As cities are pioneering whole life carbon initiatives, national governments can amplify successful local practices to achieve broader impact. For instance, **Canada**'s federal government demonstrates the potential of harnessing local initiatives by adopting city-level guidelines on embodied carbon for federal buildings (National Research Council of Canada, 2024[31]).

Provide support to cities

Leveraging cities as testbeds can enable national governments to implement ambitious decarbonisation policies for buildings and identify scalable measures (OECD, 2024[1]). However, the OECD Global Survey on Whole Life Carbon of Buildings (2024) shows that incoherent policies, the lack of vertical co-ordination mechanisms, and limited capacity of subnational governments hinder effective implementation of WLC policies.

To fully leverage the potential of cities, national governments need to establish a coherent national policy framework for WLC of buildings. Simple and accessible assessment tools, combined with a standardised methodology and a national database, should be the key components of a comprehensive national policy framework. These elements are essential to avoid confusion among private stakeholders and improve market efficiency. As indicated by the survey, disparities across WLC assessment methods may disrupt market performance and even expose subnational governments to legal risks, including potential litigation challenges from construction companies. National governments can provide cities with clear guidelines and tools to ensure efficient policy implementation and avoid duplicative efforts. **Tokyo (Japan)** demonstrates how co-ordinated efforts between different levels of government can minimise inefficiencies and duplicative efforts in policy development and implementation. The Tokyo Metropolitan Government has been actively preparing for the rollout of a national WLC policy, expecting the national government to develop comprehensive calculation guidelines and establish a robust data collection system. In line with this preparatory effort, Tokyo has adopted the Japan Carbon Assessment Tool for Building Lifecycle (J-CAT), which was launched by the Ministry of Land, Infrastructure, Transport, and Tourism and the Zero Carbon Building Promotion Committee in 2024 (IBECs, 2024[32]; Ministry of Land, Infrastructure, Transport and Tourism, 2024[33]), to implement city-level measures.

The availability of a national WLC methodology can drive impactful change at the local level. **Helsinki (Finland)** leveraged the calculation method developed by the national government, which served as a practical demonstration of the method before its broader application at the national level. The City of Helsinki has communicated with the national government and shared information on its experience about limit values (City of Helsinki, n.d.[34]), showcasing the effectiveness of sharing national resources and expertise to bolster local WLC initiatives.

Furthermore, effective vertical co-ordination mechanisms are essential for communicating local experience and challenges to the national government, as the survey shows that local governments face distinct obstacles regarding workload and shortage of WLC experts but only one-third of surveyed countries have implemented vertical co-ordination mechanisms to engage with subnational governments.

To address this challenge, national governments should establish platforms to foster exchanges of information and data across levels of government. Regular dialogues enable national governments to identify and acknowledge the distinct challenges faced by subnational authorities, facilitating more effective designation of roles and responsibilities across levels of government. Surveyed countries have put in place the following mechanisms to discuss and co-ordinate actions with subnational governments: i) regular meetings or committees; ii) dedicated taskforces or working groups; iii) online collaboration platforms or fora; and iv) joint projects or initiatives.

It is equally important to build the institutional, technical, and operational capacity of subnational governments. While the survey finds that supervision and monitoring are the most prevalent capacity building support that national governments provide to local governments, these measures alone are insufficient to unlock the potential of cities to implement WLC policies. Moreover, the survey reveals that only two out of seven city respondents – **Espoo (Finland)** and **Vancouver (Canada)** – receive support for capacity building and technical assistance from the national government.

Providing financial aid to subnational governments is another effective policy instrument to boost local efforts for WLC assessment of buildings. For instance, the City of **Vancouver (Canada)** received CAD 2.98 million in funding through the Codes Acceleration Fund from the federal government for the adoption and implementation of Canada's first embodied carbon code and existing building GHG emission regulations (Government of Canada, 2024[35]). This support addresses gaps in energy code compliance through assisting subnational governments in adopting the highest feasible energy performance tiers within building codes to reduce GHG emissions and energy use.

National governments can also provide education and training to subnational governments. The survey shows that **Espoo (Finland)**, which has implemented more stringent policies than the national government, has received various types of support from the national level. These include funding for training programmes and workshops, annual conferences on WLC policy implementation, as well as toolkits and guidelines tailored to local government needs. In addition, all three surveyed countries that have implemented WLC policies for buildings (**Denmark**, **France**, and **Sweden**) offer WLC training programmes for local governments on buildings. This shows that support from the national level is a key enabler for effective implementation of WLC policies across regions within a country.

Finally, national governments should also channel resources to support small- and medium-sized cities in adopting WLC policies. Although the survey shows that cities are leading the way with ambitious WLC policies, these initiatives are often spearheaded by larger cities that have the necessary financial resources and technical expertise. In contrast, smaller cities often lack the capacity to develop and implement comprehensive WLC policies.

Strengthen horizontal collaboration and public-private-academic partnerships

The OECD Global Survey on Whole Life Carbon of Buildings (2024) showed that three to seven ministries and agencies are involved in WLC assessment of buildings in the surveyed countries, making the WLC policy arena complex and fragmented. A recent study shows that WLC of buildings involves 32 key stakeholders and 47 distinct roles with competing interests (Falana, Osei-Kyei and Tam, 2024[36]). Given the complexity of the policy landscape, robust public-private-academic partnerships are required to gather different stakeholders and facilitate effective collaboration across various sectors, clarifying roles and responsibilities in developing and implementing whole life carbon policies.

Further complicating the issue is the economic disparity between operational energy efficiency measures and WLC initiatives. While operational energy measures provide immediate benefits such as cost savings and enhanced comfort for occupants, addressing embodied carbon involves higher costs and offers limited direct benefits for tenants or building owners. This imbalance diminishes the appeal of WLC policies, making them unlikely to succeed without strong, coordinated efforts that extend beyond market forces or standalone regulations.

Facilitate horizontal collaboration

City governments can engage in inter-municipal partnerships to promote their perspectives and advance their policy goals. As demonstrated by **Sweden**'s "Climate Municipalities", inter-municipal collaboration facilitates knowledge-sharing and can create political momentum at the national level, ultimately driving more effective WLC initiatives across different subnational governments (Klimatkommunerna, 2024[37]).

National governments can also establish inter-ministerial collaboration mechanisms. Horizontal collaboration across ministries and agencies within the government structure is crucial for delineating a coherent long-term vision, breaking down ministerial siloes, and engaging a wider range of stakeholders. **Japan**'s Inter-Ministerial Liaison Meeting for Building Life-cycle Carbon Reduction demonstrates that political will and inter-ministerial co-operation is essential for achieving coherent national roadmaps (Cabinet Secretariat, 2024[38]). In addition, different ministries and government agencies can demonstrate their collective ambition to achieve a low-carbon built environment by working collaboratively.

National governments can collaborate to align WLC policies for buildings. Initiatives like the Nordic Sustainable Construction show that sharing expertise accelerates policy development, standardises methodologies, and fosters consistent legislation (Nordic Sustainable Construction, 2023[17]). Inter-governmental platforms and joint programmes streamline efforts and create political momentum for harmonised approaches.

Leverage public-private-academic partnerships

Governments should leverage public-private-academic partnerships to develop various policy instruments for a successful implementation of WLC policies. Governments can mobilise resources and technical knowledge from private sector and academia particularly for: i) developing calculation methodologies; ii) developing a standardised, national database; iii) developing LCA tools; and iv) conducting pilot projects.

The example of **Vancouver (Canada)** demonstrates that one of the success factors of city-led initiatives in WLC of buildings is the strong support of local and international industry leaders, as well as the involvement of private sector and research institutes in developing methodologies. Public-private-academic partnerships have the potential to facilitate the development of WLC databases, assessment tools, and conducting pilot projects. **Brazil**'s Information System for Environmental Performance in Construction (SIDAC) shows that partnerships involving public agencies, private companies, and researchers are key to develop a national database on EPDs and life-cycle assessment (SIDAC, 2024[39]; Fernanda Belizario-Silva, 2023[40]; CECarbon, 2020[41]). Additionally, **Japan's** public-private-academic partnership demonstrates effective collaboration in developing WLC calculation tools, such as J-CAT (IBECs, 2024[32]; Ministry of Land, Infrastructure, Transport and Tourism, 2024[33]).

Governments should also leverage industry knowledge and expertise to provide training and upskill the construction sector. By making use of the industry's expertise, governments can develop training programmes that address specific skill gaps. This collaborative approach enhances the long-term competitiveness of the construction industry while fostering a culture of continuous improvement and innovation. As revealed by the survey, the buildings and construction industry can offer resources and demonstrates eagerness to provide training to its members.

For instance, industry stakeholders in the Nordic countries have developed educational materials on sustainable building practices for vocational schools through Skills4Reuse, an online platform which provides comprehensive introductory courses on the reuse and recycling of wood and brick (Skills4Reuse, n.d.[42]). Available industry knowledge and expertise present a valuable opportunity for governments to address critical issues in the sector, particularly labour shortages and upskilling challenges.

Governments should identify and involve stakeholders at the early stage of policy development and implementation to allocate clear roles and responsibilities throughout the building life-cycle. The complex landscape of stakeholders involved in the entire life-cycle of buildings creates a multifaceted policy environment that requires clearly defined roles and responsibilities for various actors. A mapping of stakeholders across the buildings policy arena prior to policy development and implementation will be instrumental in minimising competing interests as well as obstacles due to miscommunication and unclear roles.

For instance, **the Netherlands** has successfully implemented multi-stakeholder institutions to identify and clarify these roles, particularly in setting life-cycle assessment methodologies. The Netherlands' NMD exemplifies the benefits of a multi-stakeholder governance structure with clear roles and responsibilities in setting methodologies on life-cycle assessment in maintaining independence from policy making and political decisions on regulations (Nationale Milieudatabase, 2024[20]). Stakeholder participation in the development of whole life-cycle methodologies and databases contributes to a more coherent policy framework and efficient resource allocation across different stages of the building life-cycle.

References

African Development Bank (n.d.), *Human Development*, https://www.afdb.org/en/knowledge/publications/tracking-africa%E2%80%99s-progress-in-figures/human-development#:~:text=By%202050%2C%20the%20African%20population,by%20more%20than%20fertility%20rates. [2]

Bionova (2017), *Tiekartta rakennuksen elinkaaren hiilijalanjäljen huomioimiseksi rakentamisen ohjauksessa*, https://ym.fi/documents/1410903/38439968/Tiekartta-rakennuksen-elinkaaren-hiilijalanjaljen-huomioonottamiseksi-rakentamisen-ohjauksessa-4B3172BC_4F20_43AB_AA62_A09DA890AE6D-129197.pdf/1f3642e1-5d58-8265-40c1-337deeab782d/Tiekartta-rakennuksen-elinkaaren-h (accessed on 28 November 2024). [7]

Boverket (2023), *Limit values for climate impact from buildings and an expanded climate declaration*, https://www.boverket.se/globalassets/engelska/limit-values-for-climate-impact-from-buildings-and-an-expanded-climate-declaration.pdf (accessed on 24 October 2024). [12]

Boverket (2020), *Regulation on climate declarations for buildings*, https://www.boverket.se/globalassets/publikationer/dokument/2020/regulation-on-climate-declarations-for-buildings.pdf (accessed on 22 October 2024). [11]

Cabinet Secretariat (2024), *建築物のライフサイクルカーボン削減に関する関係省庁連絡会議*, https://www.cas.go.jp/jp/seisaku/building_lifecycle/index.html. [38]

CECarbon (2020), *Sobre a CECarbon*, https://cecarbon.com.br/about. [41]

City of Helsinki (2023), *Hiilijalanjäljen raja-arvo talonrakentamisen ohjauksessa*, https://ahjojulkaisu.hel.fi/712749CF-D40E-CD43-9541-88FBB070000D.pdf. [25]

City of Helsinki (n.d.), *Carbon Footprint Limit Value*, https://www.hel.fi/en/urban-environment-and-traffic/plots-and-building-permits/applying-for-a-building-permit/carbon-footprint-limit-value (accessed on 28 October 2024). [34]

City of Vancouver (2024), *Vancouver Building By-law (CBO)*, https://vancouver.ca/your-government/vancouver-building-bylaw.aspx. [27]

City of Vancouver (2023), *Embodied Carbon Guidelines*, https://vancouver.ca/files/cov/embodied-carbon-guidelines.pdf. [26]

Daiwa House Group (n.d.), , https://www.daiwahouse.co.jp/factory/index.html. [19]

Eduskunta Riksdagen (2024), *Board proposal HE 101 /2024 vp*, https://www.eduskunta.fi/FI/vaski/HallituksenEsitys/Sivut/HE_101+2024.aspx (accessed on 28 November 2024). [8]

Falana, J., R. Osei-Kyei and V. Tam (2024), "Towards achieving a net zero carbon building: A review of key stakeholders and their roles in net zero carbon building whole life cycle", *Journal of Building Engineering*, Vol. 82, https://doi.org/10.1016/j.jobe.2023.108223. [36]

Fernanda Belizario-Silva, L. (2023), "The Sidac system: Streamlining the assessment of the embodied energy and CO2 of Brazilian construction products", *Journal of Cleaner Production*, Vol. 421, https://doi.org/10.1016/j.jclepro.2023.138461. [40]

GlobalABC/IEA/UNEP (2020), *GlobalABC Regional Roadmap for Buildings and Construction in Asia 2020-2050*, https://globalabc.org/sites/default/files/inline-files/Asia_Buildings%20Roadmap_FINAL.pdf. [6]

Government of Canada (2024), *Funded initiatives announced with the Canada Green Buildings Strategy*, https://www.canada.ca/en/natural-resources-canada/news/2024/07/funded-initiatives-announced-with-the-canada-green-buildings-strategy.html. [35]

Greater London Authority (2021), *The London Plan*, https://www.london.gov.uk/sites/default/files/the_london_plan_2021.pdf (accessed on 28 October 2024). [28]

Greater London Authority (n.d.), *Referral process for LPAs*, https://www.london.gov.uk/programmes-strategies/planning/planning-applications-and-decisions/referral-process-lpas (accessed on 28 October 2024). [29]

IBECs (2024), *J-CAT／Japan Carbon Assessment Tool for Building Lifecycle*, https://www.ibecs.or.jp/english/JCAT/index.html. [32]

IEA (2023), *Energy Efficiency for Affordability: Improving people's lives through delivery of a modern sustainable energy system in Kenya*, https://iea.blob.core.windows.net/assets/e283fa7f-9c09-4248-a4da-6b14124ded93/EnergyEfficiencyforAffordability.pdf. [3]

IEA (2022), *Roadmap for Energy-Efficient Buildings and Construction in the Association of Southeast Asian Nations*, https://www.iea.org/reports/roadmap-for-energy-efficient-buildings-and-construction-in-the-association-of-southeast-asian-nations. [5]

INIES (n.d.), *Who are we?*, https://www.inies.fr/en/inies-and-its-data/who-are-we/. [21]

Klimatkommunerna (2024), *Our mission*, https://klimatkommunerna.se/in-english/. [37]

LFM30 (2019), *How we collectively develop a Climate Neutral Building and Construction Industry*, https://lfm30.se/wp-content/uploads/2021/01/Local-Roadmap-LFM30-English.pdf. [30]

Ministères Territoires Ecologie Logement (2024), *Bâtiment et numérique*, https://www.ecologie.gouv.fr/politiques-publiques/batiment-numerique. [22]

Ministry of Ecological Transition and Territorial Cohesion (2023), , https://www.ecologie.gouv.fr/sites/default/files/documents/Proposition%20de%20feuille%20de%20route%20de%20decarbonation%20du%20batiment.pdf (accessed on 28 October 2024). [9]

Ministry of Ecological Transition and Territorial Cohesion (n.d.), , https://www.statistiques.developpement-durable.gouv.fr/catalogue?page=dataset&datasetId=6513f0189d7d312c80ec5b5b (accessed on 29 October 2024). [10]

Ministry of Land, Infrastructure, Transport and Tourism (2024), *建築物のライフサイクルカーボン算定ツール試行版を公開しました！*, https://www.mlit.go.jp/report/press/house04_hh_001226.html. [33]

Ministry of Land, Infrastructure, Transport and Tourism (2021), *BIM/CIM related standards and guidelines*, https://www.mlit.go.jp/tec/tec_fr_000079.html. [23]

Muggah, R. and D. Kilcullen (2016), *These are Africa's fastest-growing cities – and they'll make or break the continent*, World Economic Forum, https://www.weforum.org/agenda/2016/05/africa-biggest-cities-fragility/. [4]

National Research Council of Canada (2024), *National whole-building life cycle assessment practitioner's guide*, https://nrc-publications.canada.ca/eng/view/object/?id=533906ca-65eb-4118-865d-855030d91ef2. [31]

Nationale Milieudatabase (2024), *Organisation NMD*, https://milieudatabase.nl/en/about-us/organisation/. [20]

Nationale Milieudatabase (n.d.), *Filling the Gaps Compensation Scheme*, https://milieudatabase.nl/en/database/project-blanc-spots-in-the-nmd/. [15]

NEC Corporation and Home Eco Logistics Co., Ltd. (2014), *建材物流効率化の仕組みを実現するIT活用の検討と構築　事業報告書*, https://www.logistics.or.jp/jils_news/%E6%97%A5%E6%9C%AC%E9%9B%BB%E6%B0%97_%E3%83%9B%E3%83%BC%E3%83%A0%E3%82%A8%E3%82%B3%E3%83%BB%E3%83%AD%E3%82%B8%E3%82%B9%E3%83%86%E3%82%A3%E3%82%AF%E3%82%B9.pdf. [18]

Nordic Sustainable Construction (2024), *Harmonised Carbon Limit Values for Buildings in Nordic Countries*, https://pub.norden.org/us2024-415/us2024-415.pdf. [14]

Nordic Sustainable Construction (2023), *Roadmap: Harmonising Nordic Building Regulations concerning Climate Emissions*, https://www.nordicsustainableconstruction.com/Media/638302229397775948/Roadmap%20for%20harmonising%20Nordic%20Building%20Regulations%20concerning%20Climate%20Emissions.pdf. [17]

OECD (2024), *Global Monitoring of Policies for Decarbonising Buildings: A Multi-level Approach*, https://www.oecd.org/en/publications/global-monitoring-of-policies-for-decarbonising-buildings_d662fdcb-en.html. [1]

Regeringens Klimapartnerskaber (2021), *Klimapartnerskab for bygge og anlaeg*, https://www.em.dk/Media/638252007355613356/sektorkoereplan-for-klimapartnerskab-for-bygge-og-anlaeg.pdf (accessed on 28 October 2024). [13]

SIDAC (2024), *About Us - Development of SIDAC*, https://sidac.org.br/quem_somos/desenvolvimento. [39]

Skills4Reuse (n.d.), *About Skills4Reuse*, https://www.en.skills4reuse.com/about-us. [42]

Social- og Boligstyrelsen (2022), *Tilskud til udvikling af miljøvaredeklarationer af byggevarer (EPD'er)*, https://www.sbst.dk/nyheder/2022/tilskud-til-udvikling-af-miljoevaredeklarationer-af-byggevarer-epder. [16]

Tampereen kaupunk (2022), *Kiinteistöt, tilat ja asuntopolitiikka 2022-2025*, https://www.tampere.fi/sites/default/files/2022-09/Tampereen%20kaupungin%20asunto-%20ja%20maapolitiikan%20linjaukset%202022-2025_web%20%281%29_0.pdf. [24]

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