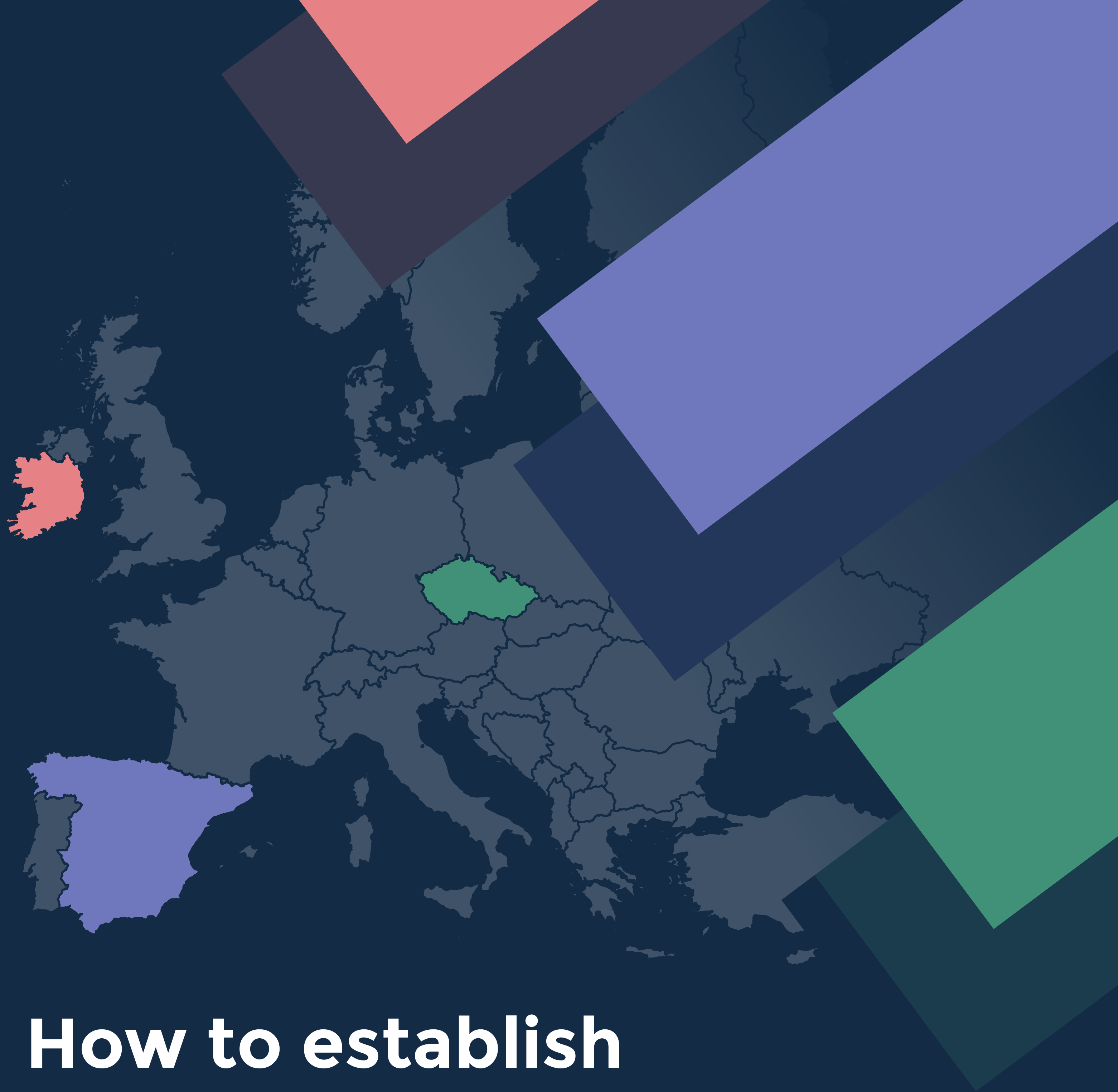

How to establish Whole Life Carbon benchmarks

Insights and lessons learned from emerging approaches in **Ireland**, **Czechia** and **Spain**

INDICATE

BPIE

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BPIE (Buildings Performance Institute Europe) is a leading independent think tank on climate mitigation and adaptation of buildings. Our vision is a net-zero carbon built environment, aligned with the ambition of the Paris Agreement, and in support of a fair and sustainable society. We provide data-driven and actionable policy analysis, advice, and implementation support to decision-makers in Europe and globally. www.bpie.eu

Executive Summary

Aligning the construction and real estate sector with climate neutrality goals is largely driven by the availability and transparency of operational and embodied carbon data across the industry. Recent EU regulations are poised to drive widespread adoption of whole life carbon assessment across the sector. These regulations are expected to drive data collection and analysis, enabling the creation of critical baseline values for buildings. In turn, this will help policymakers and industry leaders to pinpoint the source and scale of carbon emissions. By establishing benchmarks with progressively stricter targets, policymakers can steer the building sector toward near-zero emissions, offering clear guidance on how to reduce carbon emissions rapidly, and at the necessary scale.

This report is intended to support European and national policymakers prepare for the implementation of regulations aimed at reducing the whole life carbon (WLC) impact of buildings. While the Energy Performance of Buildings Directive (EPBD) mandates that life cycle Global Warming Potential (GWP) measurement begin in 2028, a framework for assessment and a roadmap introducing limit values must be established and published by the end of 2027. Some leading European countries are moving ahead more quickly, having already regulated embodied carbon emissions prior to the 2024 revision of the Directive. In these markets, the first critical step was to develop a measurement methodology and use it to establish baselines for current building design. This report summarises the experiences of Czechia, Ireland, and Spain in taking these initial steps toward the consistent and effective implementation of WLC regulations.

The EU framework represents an opportunity to enhance transparency and consistency of methodologies among Member States, which could improve the comparability of WLC reporting and benchmarks. Transparency of WLC methods and assumptions is an essential step towards a more harmonised EU WLC approach. This is crucial because existing WLC assessment methods diverge in scope and assumptions, complicating comparisons. A proliferation of different WLC approaches in different Member States could lead to confusion and increased costs for the construction industry. At worst, it could lock in the divergence of national methodologies for an extended period.

Developing WLC methodologies and benchmarks in support of future limit values and targets is a gradual process, requiring EU Member States to overcome common challenges. This report provides valuable insights into the key features of WLC regulations, focusing on three European countries - other than the well - researched Nordic countries, France, and the Netherlands. It sets out initial baseline values based on common data collection and analysis templates, which will need to be regularly updated as data quality improves, EU-level requirements evolve, and further clarifications on WLC assessments are made.

Early quantitative results indicate that the product stage is the largest source of embodied carbon across all three countries and all building types, highlighting that policymakers and industry should prioritise reducing upfront emissions for maximum impact. While these overall trends are consistent, specific values vary between countries due to differences in building practices, grid carbon intensity, assessment methodologies, and data sources.

More granular and representative national benchmarks, as required by the recast EPBD, will provide a clear reference point for understanding national averages and identifying best practices in construction. These benchmarks will help determine which buildings and portfolios align with climate neutrality goals and guide the level of policy ambition needed. The goal of the INDICATE project is to contribute to establishing these initial benchmarks in countries where such efforts are still in early stages and to share the lessons learned across Europe.

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Abbreviations

CPR	Construction Products Regulation
CZ	Czechia
CZGBC	Czech Green Building Council
EGBC	Spanish Green Building Council
EPBD	Energy Performance of Buildings Directive
EPD	Environmental Product Declaration
EoL	End of Life (EN15978 : life cycle module C)
EPC	Energy Performance Certificates
ES	Spain
ETS	EU Emissions Trading System
GHG	Greenhouse gases
GWP	Global Warming Potential
IE	Ireland
IGBC	Ireland Green Building Council
LCA	Life cycle assessment
RSP	Reference study period
WLC	Whole life carbon

About INDICATE

Climate change mitigation in the building sector necessitates a re-evaluation of design requirements for building construction and operation. Aligning the sector with climate neutrality goals requires robust data on the baseline (our starting point) as well as best practice examples to support policymaking and target setting.

Against this background, the INDICATE initiative brings together governments, industry, and academia to tackle one of the key barriers to decarbonising Europe's built environment: a lack of reliable and comprehensive emissions data for buildings. It seeks to accelerate policy developments by generating critical baseline data for buildings. This in turn will allow policymakers to set carbon limits that cover the full life cycle impact of buildings, from manufacture and construction through to deconstruction and waste processing or recycling.

INDICATE is an accelerator programme offering a project framework and co-funding to support efforts to generate much-needed building level whole life carbon data in Europe. This data must be generated now if industry and policy action on decarbonising buildings are to be brought in line with the 1.5° target of the Paris Agreement.

The accelerator is a collaboration of Smith Innovation as operator, BPIE, KU Leuven and the World Green Building Council delivering political and technical support, and Laudes Foundation as funding partner.

INDICATE is currently supporting three EU countries – Czechia, Ireland and Spain – to develop whole life carbon baselines for a variety of building typologies, including new-built and renovations, in anticipation of the implementation of the recently revised Energy Performance of Buildings Directive (EPBD). While some leading Member States already have considerable experience with regulating the whole life carbon impact of buildings, many others are just starting to explore how to effectively mitigate life cycle emissions from buildings. These Member States can benefit greatly from the lessons learned and experiences of the INDICATE countries.

For further information on INDICATE, please visit https://www.indicatedata.com/

About this report

This report has been drafted to support European and national level policymakers preparing the implementation of regulations aiming to drive down the whole life carbon (WLC) impact of buildings. While the EPBD requires life cycle Global Warming Potential (GWP) measurement to begin in 2028, a framework for assessment and a roadmap introducing limit values must be established and published by the end of 2027. Some leading European countries are moving ahead faster, having already regulated embodied carbon emissions before the 2024 revision of the Directive. In these markets, the first critical step was to develop a measurement methodology and use it to establish baselines associated with current building design. This report summarises the experience of Czechia, Ireland and Spain in taking these initial steps toward the consistent and effective implementation of WLC regulations.

The report starts with a review of the relevant EU legislation impacting the decarbonisation of buildings (Chapter 1), followed by an overview of the design features of effective WLC policy frameworks, based on an analysis of existing national WLC regulations (Chapter 2). Next, Chapter 3 presents an analysis of the INDICATE countries, offering insights into data collection efforts, WLC assessment methods, and quantitative results. Chapter 4 provides specific guidance for key actors on establishing baseline values, including stakeholder engagement and considering the benefits of adopting WLC assessments and low carbon strategies. Finally, Chapter 5 outlines policy recommendations for other Member States working on the design and implementation of similar WLC legislation.

[1] https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=OJ:L_202401275#d1e38-57-1
[2] The European Standard on the calculation methods for assessing the environmental performance of buildings. Soucre: CEN
[3] https://7520151.fs1.hubspotusercontent-na1.net/hubfs/7520151/RMC/Content/Whole-life-carbon-models-Review-of-national-legislative-measures.pdf

1.

EU Policy Context

The meaningful decarbonisation of the building sector requires addressing all sources of emissions during the entire life cycle of buildings. This involves simultaneous improvements of energy efficiency and reducing embodied carbon from materials and construction.

Over the past two decades, substantial improvements have been made to reduce operational carbon emissions of buildings through efficiency and the use of renewable energy. However, aligning the sector with climate neutrality goals calls for increased efforts to reduce the embodied carbon of buildings.

In the ‘Renovation Wave strategy’,[1] as part of the EU Green Deal,[2] the European Commission announced its intention to adopt “life cycle thinking and circularity” and provided a detailed outline of the necessary instruments for reducing energy consumption and greenhouse gas (GHG) emissions of the building stock.

Since the announcement in 2020, life cycle thinking and whole life carbon (WLC) considerations have been gradually integrated into several EU policy initiatives and EU legislation.

These recent policy developments pave the way for an **integrated value chain approach combining product- and building-level policies** to limit the WLC intensity of built assets.

A range of EU policies are already addressing the supply of low carbon materials. For example, the EU Emissions Trading System (ETS)[3] and the revised Construction Products Regulation (CPR)[4] incentivise transparency and availability of products made with lower carbon manufacturing practices. The recently recast Energy Performance of Buildings Directive (EPBD)[5] is significant as it introduces building level provisions for the first time. These requirements encourage low carbon building design and whole building strategies such as material and building reuse, material substitution, and material efficiency through building level life cycle assessment (LCA).

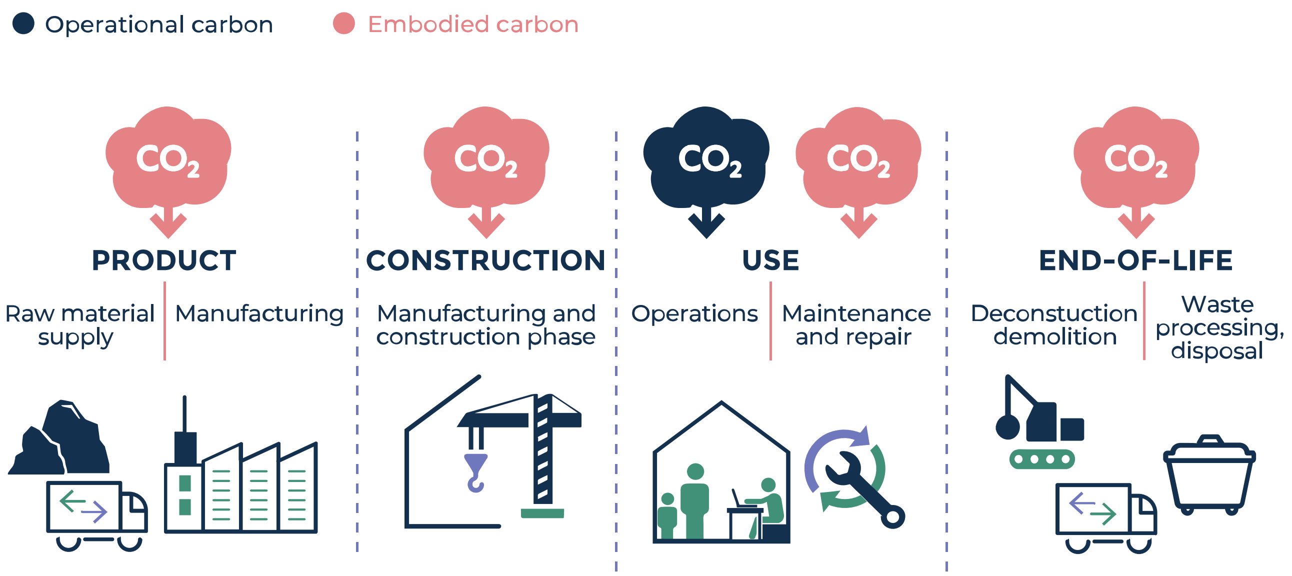

Figure 1 - Illustrative breakdown of embodied and operational carbon in buildings. Source: BPIE.

[1] European Commission. (COM(2020) 662 final). "A Renovation Wave for Europe - greening our buildings, creating jobs, improving lives". Accessible at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52020DC0662
[2] European Commission. (n.d.). ''The European Green Deal – Striving to be the first climate-neutral continent'. Accessible at: https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal_en
[3] European Commission. (n.d.). ''EU Emissions Trading System (EU ETS). Accessible at : https://climate.ec.europa.eu/eu-action/eu-emissions-trading-system-eu-ets_en
[4] European Commission. (n.d.). ''Review of the Construction Product Regulation''. Accessible at: https://single-market-economy.ec.europa.eu/sectors/construction/construction-products-regulation-cpr/review_en
[5] Directive 2024/1275. Directive (EU) 2024/1275 of the European Parliament and of the Council of 24 April 2024 on the energy performance of buildings (recast). Accessible at: https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=OJ:L_202401275#d1e38-57-1

1.1 EPBD recast: Whole life carbon disclosure and limit values

The EPBD recast is the key EU policy instrument to decarbonise the European building stock. It sets out a performance-based policy framework for measuring and reducing WLC emissions, **based on common standards and EU calculation framework**. As of 2028, Member States must ensure the life cycle global warming potential (GWP) for new buildings with a useful floor area >1,000m², and all buildings as of 2030, is calculated and disclosed through the energy performance certificate (EPC). The data selection, scenario definition and calculations must be carried out in accordance with the EN 15978 standard.[6] The building elements and technical equipment included in the assessment must align with the Level(s)[7] indicator 1.2 for life cycle GWP.[8]

Annex III of the Directive, which outlines the WLC assessment methodology, leaves room for various interpretations. In this sense, the Commission is empowered to adopt a Delegated Act to amend Annex III and establish a 'Union framework for the national calculation of life cycle GWP' by the end of 2025. This is expected to provide more clarity on the scope of the WLC calculation, including life cycle modules, data sources, and scenario definitions. The EU framework represents an **opportunity to enhance transparency and consistency of methodologies among Member States** and could be designed to improve the comparability of WLC reporting and benchmarks. Transparency of WLC methods and assumptions is an essential step towards a more harmonised EU WLC approach. This is crucial because existing WLC assessment methods diverge in scope and assumptions, complicating comparisons.[9] A proliferation of different WLC approaches in different Member States could lead to confusion and increased costs for the construction industry. At worst, it could lock in the divergence of national methodologies for an extended period.

The EPBD also requires Member States to develop national roadmaps towards the introduction of limit values on total cumulative life cycle GWP for all new buildings by the end of 2026. The roadmaps should detail how targets and limit values for new buildings will be introduced from 2030 onwards, while considering a progressive tightening of these limit values. The European Commission is expected to provide guidance to support Member States setting these minimum and aspirational WLC thresholds according to a science-based decarbonisation pathway with a net-zero carbon goal by 2050.

The transposition period of the EPBD started end of May 2024 and will last two years. This period is crucial to get policies right at the national level and clarify the manyfold technical aspects of WLC assessment methodologies, data availability and limit values. Recognising the need for further guidance, INDICATE aims to support national transposition efforts by building capacity and providing initial baseline values that drive both policy and industry action.

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[6] CEN EN15978:2011. "Sustainability of construction works - Assessment of environmental performance of buildings - Calculation method". Accessible at: https://standards.iteh.ai/catalog/standards/cen/62c22cef-5666-4719-91f9-c21cb6aa0ab3/en-15978-2011
[7] European Commission. (n.d.). "Level(s) – European Framework for sustainable buildings". Accessible at: https://environment.ec.europa.eu/topics/circular-economy/levels_en
[8] Dodd, Donatello & Cordella (2021). Level(s) indicator 1.2: Life cycle Global Warming Potential (GWP). European Commission, JRC technical reports. Accessible at : https://susproc.jrc.ec.europa.eu/product-bureau/sites/default/files/2021-01/UM3_Indicator_1.2_v1.1_37pp.pdf
[9] Steinmann, J., Röck, M., Lützkendorf, T., Allacker, K., Le Den, X. (2022). Whole life carbon models for the EU27 to bring down embodied carbon emissions from new buildings – Review of existing national legislative measures. Accessible at : https://7520151.fs1.hubspotusercontent-na1.net/hubfs/7520151/RMC/Content/Whole-life-carbon-models-Review-of-national-legislative-measures.pdf

By 31/12/2025

The Commission must adopt a Delegated Act to amend Annex III to set out a Union framework for the national calculation of life cycle global warming potential.

2027

Based on the Delegated Act, by 01/01/2027 Member States must publish a roadmap detailing the introduction of limit values on total cumulative life cycle global warming potential for all new buildings, and set targets and limit values for new buildings from 2030, aiming at a progressive downward trend.

There will also be Commission guidance to support this exercise.

2028

From 01/01/2028, Member States must ensure that the life cycle global warming potential is calculated in accordance with Annex III and disclosed through the energy performance certificate for all new large buildings (useful floor area >1,000m^2).

In calculating and setting cost-optimal levels, to be submitted by 30/06/2028, Member States may take into account life cycle global warming potential.

From 01/01/2030

All new buildings should comply with the ZEB standard, have their life cycle global warming potential calculated and disclosed through the EPC, and comply with the limit values on total cumulative life cycle global warming potential set at national level.

Figure 2 - EPBD timeline on implementation of life cycle global warming potential requirements. Source: BPIE.

1.2 Revised Construction Products Regulation: encouraging transparency and the availability of low carbon materials

The CPR is a legislation primarily intended to ensure a well-functioning EU market for construction products. Importantly, the regulation sets out harmonised assessment methods to provide reliable information about construction product performance related to basic product requirements and essential environmental characteristics.[10] By this feature alone, it is **a relevant supply-side, material-scale approach to reduce the embodied carbon impact of individual materials**. However, the CPR is also **an important driver of high-quality environmental data** for construction products that can feed into building level WLC assessments.

The CPR does not harmonise product design but ensures harmonised information and assessment methods for construction product performance based on eight categories of 'basic requirements'. To ensure that harmonised assessment methods including the updated essential environmental characteristics are available for all families of construction products, all EU standards are being updated in what is called the CPR Acquis process. This process prioritises high-density structural products and takes several years for each product family, with the replacement of all standards expected to be completed by the mid-2030s.[11] While the assessment methods and types of information to be declared are harmonised at the EU level, Member States may define national product requirements.

[10] European Parliament (2024) Legislative resolution on the proposal for a regulation laying down harmonised conditions for the marketing of construction products, amending Regulation (EU) 2019/1020 and repealing Regulation (EU) 305/2011 (COM(2022)0144 – C9-0129/2022 – 2022/0094(COD). Accessible at: https://www.europarl.europa.eu/doceo/document/TA-9-2024-0188_EN.html
[11] See the priority list here. Product families at the top of the priority list are also usually the most impactful in WLC measurement.

The new CPR mandates that four GWP indicators be reported in the 'declarations of performance'-total GWP, fossil fuels, biogenic, and land use/land use change-starting from mid-2025. Additional environmental indicators, such as ozone depletion, acidification potential, and abiotic depletion, will become mandatory 4 to 6 years later, which will facilitate more comprehensive building LCAs. Manufacturers will be obliged to provide product information through a Digital Product Passport which could help tracking of materials, circularity and integration with LCA tools.

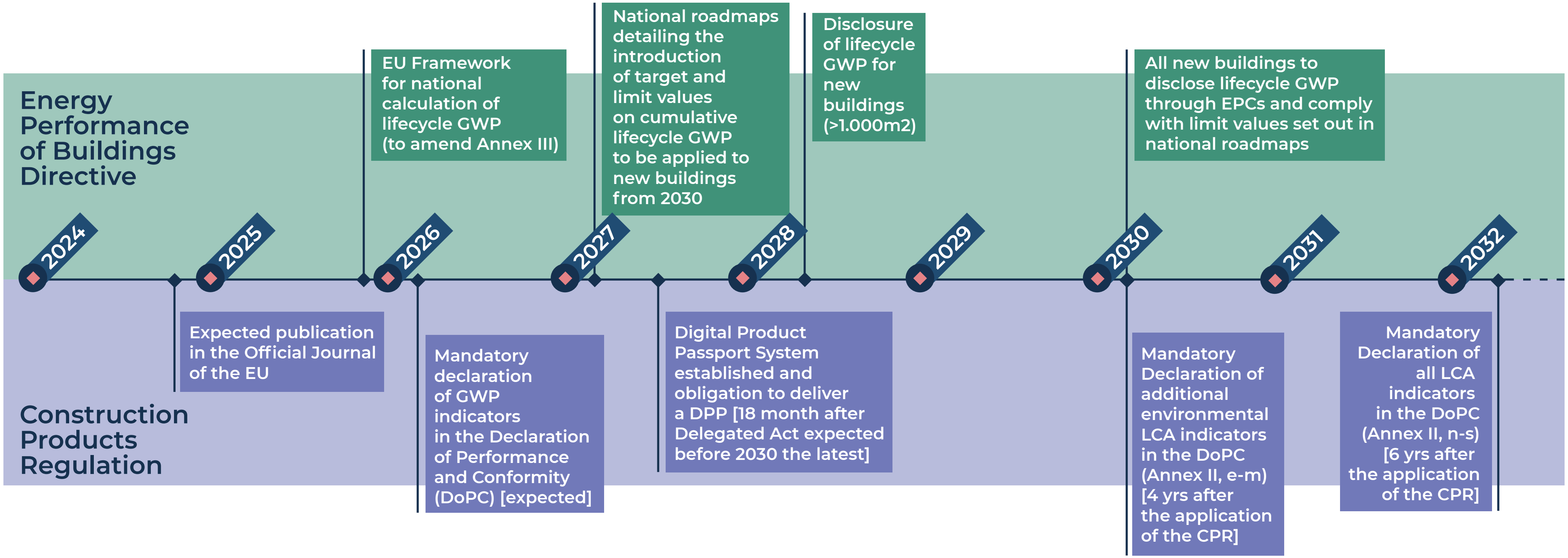


Figure 3 - Timeline of CPR and EPBD implementation. Source: BPIE.

The implementation of the CPR, and especially the reporting on essential environmental characteristics (GWP), is highly relevant for improving data availability for WLC assessments required by the EPBD recast. To avoid a mismatch between the timeline of fully transposing the CPR and updating all standards and the need to implement WLC assessments (see Figure 3), Member States can already start working without CPR compliant data. This is illustrated by the EPBD recast Annex III on life cycle GWP calculations, that specifies that "Data regarding specific construction products calculated in accordance with Regulation (EU) No 305/2011 [i.e. the CPR] of the European Parliament and of the Council shall be used when available".[12]

[12] Directive 2024/1275. Directive (EU) 2024/1275 of the European Parliament and of the Council of 24 April 2024 on the energy performance of buildings (recast).

1.3 Reporting obligations under the Sustainable Finance Disclosure Regulation and the Corporate Sustainability Reporting Directive: the link between carbon data and finance

While the EPBD remains the most important legislative driver for change in the buildings sector, the EU Sustainable Finance Strategy[13] is already playing an important role in accelerating WLC reductions by mobilising capital and influencing the design, construction, management and operation of buildings, as well as the disposal of assets. The Corporate Sustainability Reporting Directive (CSRD)[14] and Sustainable Finance Disclosure Regulation (SFDR),[15] backed up by the Corporate Sustainability Due Diligence Directive (CSDDD)[16] are now **linking all investment decisions to environmental reporting data**. Investors and banks are demanding more data on the emissions related to all their lending or investments including buildings.

Data is also being viewed through the lens of the EU Sustainable Finance Taxonomy.[17] For new buildings, the technical screening criteria is defined by the Level(s)[18] Indicator 1.2, Life cycle GWP.[19] This indicator forms the basis for developing any methodology for calculating life cycle GHG emissions for buildings in Europe. Tightening the climate change mitigation thresholds of the current taxonomy is crucial to align with the recast EPBD, emphasising renovations over new constructions and introducing WLC benchmarks and limit values.

The implementation of the taxonomy and reporting obligations is driving unprecedented transparency of climate impacts and is rendering data collection and disclosure increasingly more relevant than ever. Collecting sufficient data to measure against the EU taxonomy is considered valuable in anticipation of its future expansion, offering insights into the proportion of portfolios that already have a reduced WLC impact and the steps that can be taken to improve the more carbon-intensive assets. In other words, the EU's Sustainable Finance package is already playing a significant role in shaping investment decisions in the building sector – either through preferential financing conditions for better performing assets or limited access to for assets lacking data or alignment with climate neutrality goals. Finally, the Green Claims Directive will require companies to substantiate green claims made within the building sector, among others based on LCA methodologies.[20]

[13] European Commission. COM(2021) 390. "Communication from the Commission to the European Parliament, Council, the European Economic and Social Committee and the Committee of the Regions - Strategy for Financing the Transition to a Sustainable Economy" Accessible at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52021DC0390

[14] Starting in the 2024 financial year, companies must adhere to European Sustainability Reporting Standards (ESRS), developed by the European Financial Reporting Advisory Group (EFRAG). The first ESRS batch was published on December 22, 2023. Disclosure requirement E1 – 6 includes disclosure in metric tonnes of CO_2eq of scope 1, 2 and 3 GHG emissions for large companies. For more info see: Directive 2022/2464. Directive of the European Parliament and of the Council of 14 December 2022 amending Regulation (EU) No 537/2014, Directive 2004/109/EC, Directive 2006/43/EC and Directive 2013/34/EU, as regards corporate sustainability reporting. Accessible at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32022L2464

[15] To meet SFDR sustainable investment definitions, reporting of the full life cycle environmental impacts is required, including extraction of raw materials to the construction phase, use and finally demolition and disposal. For more info see: Regulation (EU) 2019/2088. "Regulation of the European Parliament and of the Council of 27 November 2019 on sustainability-related disclosures in the financial services sector". Accessible at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32019R2088

[16] Directive 2024/1760. Directive (EU) 2024/1760 of the European Parliament and of the Council of 13 June 2024 on corporate sustainability due diligence and amending Directive (EU) 2019/1937 and Regulation (EU) 2023/2859. Accessible at: https://eur-lex.europa.eu/eli/dir/2024/1760/oj

[17] The screening criteria for new construction to assess if an economic activity qualifies as contributing substantially to climate change mitigation requires the calculation and disclosure of the life cycle GWP of buildings exceeding 5000 m2.

[18] European Commission. (n.d.). "Level(s) – European Framework for sustainable buildings"

[19] Dodd, Donatello & Cordella (2021). Level(s) indicator 1.2: Life cycle Global Warming Potential (GWP). European Commission, JRC technical reports

[20] European Commission. (n.d.). ''Green Claims''. Accessible at: https://environment.ec.europa.eu/topics/circular-economy/green-claims_en

2.

Learning from frontrunner countries: design features of effective whole life carbon policy frameworks

Several Member States have already implemented or are developing WLC policies. This chapter examines the key design features of existing WLC policy and regulatory frameworks, drawing lessons from North and Western Europe countries.

By analysing their approaches, from assessment methodologies to regulatory frameworks, we can better understand how to create effective and scalable WLC strategies.

These lessons in turn served as a basis to start developing and piloting WLC strategies in INDICATE pilot countries, **Czechia**, **Ireland** and **Spain** (further detailed in chapters 3 and 4).

2.1 Design features of existing national whole life carbon policy frameworks

A number of Member States have already introduced legislative measures to ensure systematic and consistent measurement and disclosure of WLC of buildings. Other EU countries are in the process of setting up WLC measurement and benchmarking initiatives.

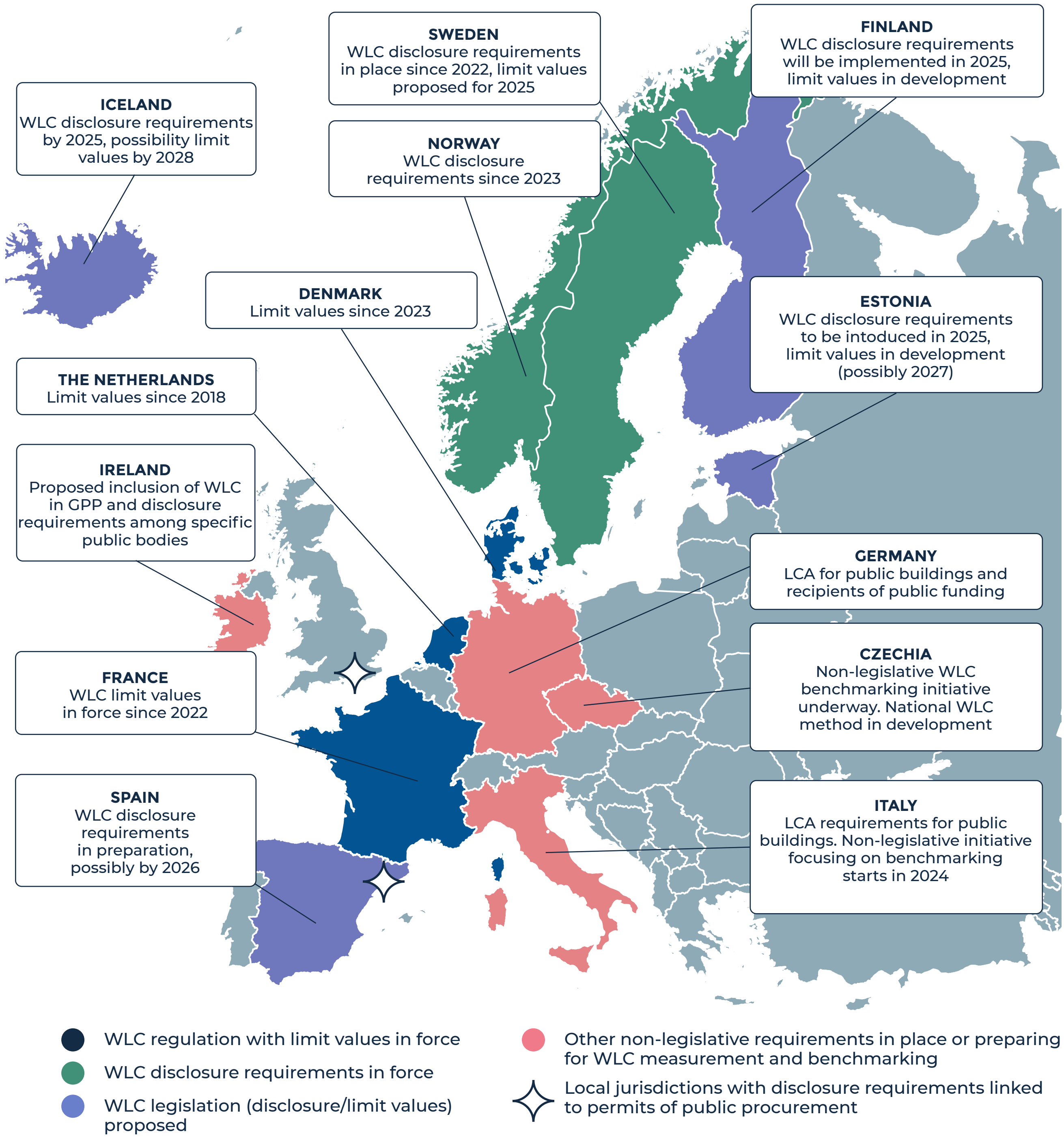


Figure 4 - Overview of WLC regulations and initiatives across Europe (Based on: Steinmann et al. 2022, Balouktsi, Francart & Kanafani. 2024, BPIE).

The analysis of existing WLC regulations and initiatives reveals commonalities in policy design but also differences in national approaches.

These design features can be categorised into four interconnected thematic areas (see Figure 5):

- WLC assessment methods, data and tools
- WLC regulatory framework and compliance regime
- Stakeholder engagement and policy development process
- Supportive policy measures (e.g., low carbon procurement, capacity building and upskilling programmes).

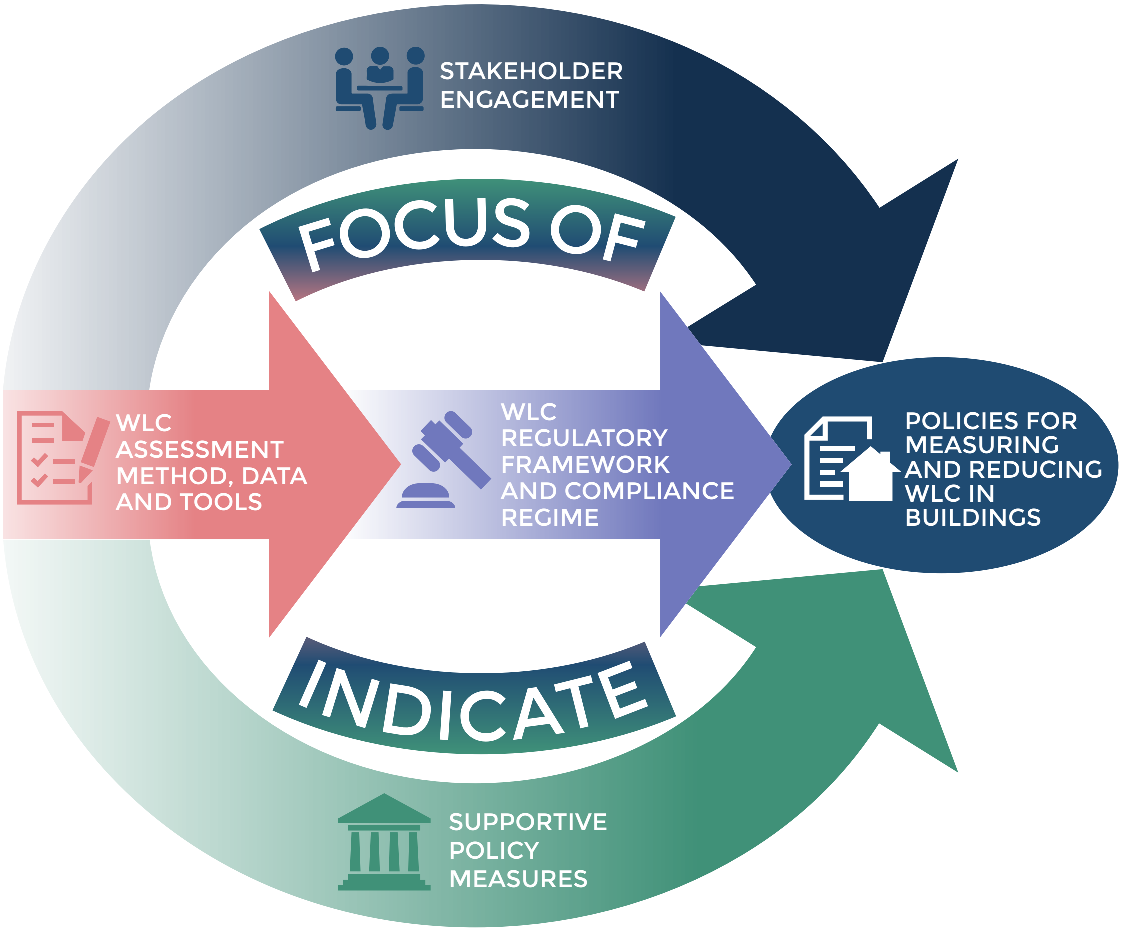


Figure 5 - Comprehensive WLC policy framework. Source: BPIE based on Nordic Cooperation and Ramboll (2023).

National WLC methodologies established, among others (see Table 1), the scope and system boundary, calculation and assessment method, as well as requirements related to input data.[21] The forthcoming EU Delegated Act pursuing Annex III of the EPBD recast is expected to set out minimum level of harmonisation, i.e. a common denominator of requirements for methodological aspects that define what the focus of the WLC assessment across Europe will be.

[21] Steinmann et al. (2023) Whole life carbon models for the EU27 to bring down embodied carbon emissions from new buildings. Towards a whole life carbon policy for the EU. Accessible at: link

WLC methodology aspects	Scope and system boundary	Assessment and calculation method	Data sources, default values, and assumptions	Calculation tools	Reporting and aggregation
Design features	Building typology RSP Functional unit (m² or capita) GWP metric Building elements	LCA modules Scenario assumptions Decarbonisation scenarios B6 / B/C embodied, biogenic carbon, exported energy)	Data sources (EPDs, generic data, conservative values, background data) Default values and assumptions (building elements, building services, life-cycle modules)	Calculation tools used	Reporting templates Aggregation

Table 1 - Overview of WLC methodological aspects.

The scope and system boundaries include:

- the building types to which the method applies, e.g. new or existing buildings, residential or non-residential
- reference study period, i.e. the assumed lifetime of the building
- normalisation for comparing different buildings or functional units, e.g., the definition of the floor area or per capita
- the metric in which results are expressed, e.g. the annual kg of CO_2 equivalents
- scope definition, such as clarification of building elements covered.

A WLC assessment method should also specify which LCA modules are assessed. It should define scenarios for electricity grid decarbonisation, treatment of biogenic carbon, and how on-site renewables are integrated into the life cycle model.[22] Specifications should be provided for which data to use (generic, product specific), whether any conservative weighting factors are applied, and what default values and assumptions underpin specific life cycle modules.

Such clarifications and practical guidance on the consistent implementation of existing and widely-accepted environmental performance assessment standards such as the EN 15978, EN 15804 and Level(s) are essential to increase the reliability and comparability of results. For practitioners it is furthermore important to understand which tools can be used to conduct WLC assessments. Additionally, common reporting templates and aggregation of results not only facilitate effective data collection but also promote greater transparency, engagement, and adoption within the built environment sector.

[22] Steinmann et al. (2023) Whole life carbon models for the EU27 to bring down embodied carbon emissions from new buildings. Towards a whole life carbon policy for the EU. Accessible at: link

2.2 Design features of existing whole life carbon regulations

Denmark, Finland, France, the Netherlands, and Sweden have already implemented or are planning to implement WLC regulations that include limit values. Meanwhile, Norway, Iceland, Estonia, and several other jurisdictions have established or are planning WLC disclosure requirements. All these Member States have closely aligned their methods for calculating life cycle assessments with the European Standard EN 15978 and, to varying degrees, with the voluntary European framework for sustainable buildings, Level(s).[23]

This section summarises the design features of established WLC regulations, drawing on a review of existing literature:[24][25]

Scope: building type and size

In all reviewed countries, WLC requirements apply to new buildings (residential and office buildings). In Denmark (DK) and the Netherlands (NL), threshold values apply only to buildings above a certain size (DK: >1.000 m²; NL: > 100m²). Certain building types are exempted in some countries, such as single family houses in Estonia, Finland and Norway, or holiday homes in Denmark, Estonia, Finland, Iceland.[25] Notably, Norway is the only country that also requires WLC disclosure also for renovation projects.

Reference study period (RSP)

In all countries except the Netherlands, the RSP is 50 years for both residential and non-residential. In the Netherlands, the RSP is 50 years for non-residential and 75 years for residential buildings.

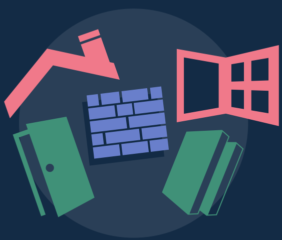
Building reference area

In most countries such as Denmark, the Netherlands, Norway and Sweden,[27] the floor area measurement used in WLC assessments is a variation of the gross floor area (GFA). However, there are differences in how GFA is applied. For example, Denmark excludes certain building parts like ramps or integrated garages, while the Netherlands considers the GFA of all indoor areas. In some cases, GFA includes the total building area, even spaces not used for residential or office purposes. Finland and Estonia, on the other hand, use the Heated Floor Area (HFA), while France applies the Liveable Area/Usable Area as the reference unit.

[23] Steinmann, J., Röck, M., Lützkendorf, T., Allacker, K., Le Den, X. (2022). Whole life carbon models for the EU27 to bring down embodied carbon emissions from new buildings – Review of existing national legislative measures.
[24] Idem.
[25] Balouktsi, M., Francart, N., Kanafani, K. (2024). "Harmonised Carbon Limit Values for Buildings in Nordic Countries: Analysis of the Different Regulatory Needs". Nordic Innovation. Accessible at: https://www.nordicsustainableconstruction.com/knowledge/2024/march/new-report-regulatory-needs-for-harmonising-carbon-limit-values
[26] Idem.
[27] Idem.

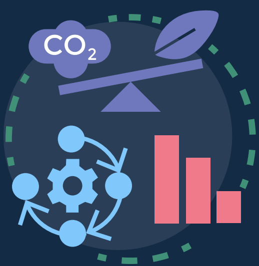
WLC metric

The Netherlands uses an aggregated environmental impact indicator expressed in EUR/m^2/year. In Denmark, the threshold is expressed in a metric for total life cycle GHG emissions (kgCO_2eq/m^2/year); Sweden reports only the embodied carbon for Modules A1-5 (kgCO_2eq/m^2). France, on the other hand, reports WLC emissions in a single value (kgCO_2eq/m^2 over the entire 50-year lifespan), with the total value supported by separate thresholds for the operational phase and the embodied impacts, ensuring both elements are adequately considered as part of the total amount.



Building elements

National regulations consistently include both the substructure and superstructure in WLC assessments. From a climate neutrality perspective, this is crucial, as these elements account for the majority of embodied carbon emissions. However, the inclusion of other building elements varies across different countries.



Life cycle modules[28]

While all regulations include upfront emissions (A1-A3), the inclusion of other modules, such as construction (A4-A5), use (B1-B7), and end-of-life (C1-C4), differs by country. The beyond-end-of-life phase (Module D) is also considered in some cases. Currently, Sweden requires disclosure only for upfront emissions, covering the production and construction phases (A1-A3, A4-A5), but plans to include additional modules in the future.[29] The use phase (Module B6) is included in Denmark and France, with France reporting these values separately.

Reporting templates

The results of WLC assessments must be presented in a specific format that provides insights into the environmental impact of different building parts or life cycle modules. The structure of the WLC reporting template is specified in environmental declarations in countries like Denmark, Sweden, and Finland, or through environmental performance calculations in the Netherlands. In some countries, these declarations are required to be submitted to local authorities as part of the construction permitting process.

[28] See Annex I for an overview of Life cycle modules covered in EN15978
[29] Boverket. (2023). "Limit values for climate impact from buildings. Report 2023:24. Swedish National Board of Housing, Building, and Planning. Accessible at: https://www.boverket.se/globalassets/engelska/limit-values-for-climate-impact-from-buildings-and-an-expanded-climate-declaration.pdf

Scenario assumptions: grid decarbonisation, biogenic carbon, exported energy

WLC assessment methodologies involve various assumptions about future scenarios, such as the decarbonisation rate of the electricity grid, which affects both embodied and operational carbon. Another critical assumption concerns biogenic carbon, referring to carbon sequestered and stored within construction products used in a building. Additionally, the treatment of renewable energy and the different carbon emissions associated with energy use within a built asset should also be accounted for.

A critical distinction in WLC assessments is between static and dynamic approaches. Most countries use a static LCA approach, which do not take into account land-use and land-use-change (LULUC) impacts and carbon-storage benefits. In contrast, France employs a dynamic LCA approach that uses dynamic emission factors to account for emissions and removals that occur earlier in the building's life cycle have greater weighting in the overall impact than those that occur later in the life cycle. This approach allows benefits of long-term carbon storage, and potentially the reuse and recycling of biomass at end of life to be quantified and reported, which in itself incentivises the use of CO_2-storing materials, but it also requires more complex calculations.

Finnish and Danish regulations require the reporting of GWP-total, which includes biogenic emissions as well as emissions from land use and fossil fuels. In contrast, Sweden and Norway use GWP-GHG, which accounts only for emissions from land use and fossil fuels. In Sweden, where only upfront carbon (A1-A3) is considered, biogenic carbon cannot be included because biogenic carbon calculations rely on complementary modules A1-3 and C3 for carbon calculation. Estonia suggests using either GWP-fossil or GWP-GHG for its assessments.

Calculation tools

A variety of calculation tools are generally available in national markets for conducting WLC assessments, ranging from freely accessible tools provided by public authorities to commercial LCA software. Member States typically indicate which tools have been verified and comply with national WLC methodologies and guidelines. For example, the Netherlands environmental database includes a list of verified tools.[30]

[30] Nationale Milieudatabase (n.d.) "Rekeninstrumenten". Accessible at: https://milieudatabase.nl/nl/milieuprestatie/rekeninstrumenten/

Data sources and default values

Typically, both product-specific data and generic datasets can be used in WLC assessments. Most countries have a national database that includes both types of data, though the approaches to developing these databases vary. Assessors are generally required to use data from these national databases when conducting WLC assessments. France developed a generic dataset covering all product families during the E+C- pilot programme, which ran from 2016 to 2020. It also collected building LCA case studies to establish WLC benchmarks. These case studies were published anonymously in a central database. Denmark adapted the German ÖKOBAUDAT for its generic dataset, while the Netherlands established its national environmental database before introducing limit values. Finland and Sweden collaborated on developing national environmental databases for buildings, which were published simultaneously in 2022. These "sister databases" are based on national data from both countries and are collected and provided in a consistent manner. The availability of coherent generic data facilitates WLC assessment, even when EPDs are not available. By subsidising the generation of EPDs for specific product categories, it is expected that over time, data quality and availability will improve. Additionally, for certain assumptions in LCA calculations, such as transport distances or waste disposal scenarios, specific data sources or assumptions are prescribed in national assessment methods.

2.3 Whole life carbon benchmarks and governance

The availability of assessment methodologies and benchmarks is an indispensable first step in the development of WLC regulations. By collecting WLC case studies from representative building typologies within the national building stock, benchmarks can be established to provide insights into the average WLC emissions of e.g. single-family houses, apartment buildings, offices, and schools. In leading countries, this benchmark data is typically gathered in collaboration with academic institutions or private entities, such as national Green Building Councils. A starting point for an initial WLC benchmark can be as few as 60 to 70 cases (e.g., Denmark: 60 cases,[31] Sweden 68: cases[32]). The representativeness and quality of these benchmarks are continually refined as new building LCA cases become available.

WLC regulatory frameworks tend to evolve from requirements for WLC disclosure in new construction projects, to ultimately steering the WLC performance of new construction and renovations.[33] These requirements can take different shapes and forms, like disclosure requirements and target or limit values (see Table 2).

[31] Zimmermann, R. K., Andersen, C. M. E., Kanafani, K., & Birgisdottir, H. (2021). Whole Life Carbon Assessment of 60 buildings: Possibilities to develop benchmark values for LCA of buildings. BUILD Report No. 2021:12. Accessible at: https://vbn.aau.dk/en/publications/whole-life-carbon-assessment-of-60-buildings-possibilities-to-dev
[32] See the report: Boverket. (2023). "Limit values for climate impact from buildings. Report 2023:24. Swedish National Board of Housing, Building, and Planning.
[33] Up to this point, regulations only focus on new construction, not yet on renovations.

WLC methodology aspects	WLC disclosure requirements and limit values	Compliance / governance regime	Link to policy instruments	Central collection/ public registry	Reporting and aggregation
Design features	Building typology covered Functional unit (per capita/ m², embodied/ operational separate or combined) Reduction pathways / timeline (optional, with limit	Reporting stage (permit, as-built) Compliance control regime (%checked) Third-party verification (yes/no)	Energy Performance Certificates Digital Building Logbooks	Central collection of cases Ability to statistically analyse WLC data Link WLC data with policymaking / evaluation	Timeline for revision and evaluation

Table 2 - Overview of WLC regulatory aspects.

Compliance regimes should ensure that quality standards are maintained and WLC assessment results fall within the limit values. The aggregation and transparency of assessment results to relevant stakeholders is essential to give policymakers, construction industry and financial sector stakeholders new insights to accelerate decarbonisation. Public authorities can leverage WLC data to inform policy decisions, monitor policy implementation and avoid greenwashing, which is facilitated by centrally storing WLC assessments and enabling statistical analysis, as done in France.

To continually improve data quality and align WLC requirements with technological advancement and best practices, establishing a regular revision and evaluation cycle is also required, including the systematic update of WLC limit/target values. The technical study 'Supporting the Development of a Roadmap for the Reduction of Whole Life Carbon of Buildings' developed an initial EU-wide trajectory of embodied carbon (see Table 3).[34] More granular and representative national benchmarks, as required by the recast EPBD, will offer a clear reference point for understanding national averages and best practices in construction. These benchmarks will help identify which buildings and portfolios align with climate neutrality goals and guide the level of policy ambition needed. The goal of the INDICATE project is to contribute to establishing these initial benchmarks in countries where such efforts have not yet been initiated.

[34] Le Den, X. Steinmann, J., Kovacs, A., Kockat, J., Toth, Z., Röck, M., Allacker, K., (2023) "Supporting a Roadmap for the Reduction Whole Life Carbon in Buildings". European Commission. DG Environment. Accessible at: https://op.europa.eu/en/publication-detail/-/publication/923706b7-8f41-11ee-8aa6-01aa75ed71a1/language-en

Year	2020	2025	2030	2035	2040	2045	2050
Upfront construction embodied carbon (A1-A5) ($kgCO_2e/m^2$UFA)							
Average*	**810.41**	**706.55**	**603.12**	**500.66**	**398.48**	**398.48**	**398.48**
Best practice*	344.21	296.27	248.54	201.26	154.10	154.10	154.10
Renovation embodied carbon (B5) ($kgCO_2e/m^2$UFA)							
Average*	**273.81**	**260.30**	**246.60**	**233.62**	**222.06**	**222.06**	**222.06**
Best practice*	46.81	44.51	41.93	39.49	37.32	37.32	37.32

***Average** represents the average across all new construction archetypes (all regions and building typologies) after implementing technological reduction measures. **Best practice** represents the lowest lowest value in individual archetypes.

Table 3 - Trajectory of building level upfront embodied carbon and renovations in $kgCO_2e/m^2$ of useful floor area (UFA) in TECH-Build scenario. Source: Ramboll, BPIE, KU Leuven, 2023.

3.

INDICATE country analysis: Ireland, Spain and Czechia

Chapter 3 offers an in-depth analysis of the whole life carbon (WLC) assessment approaches and market contexts in the three INDICATE countries, highlighting variations in national policies, regulatory frameworks, and data availability. It compares the WLC methodologies developed and tested across Czechia, Ireland, and Spain, focusing on differences in scope, system boundaries, calculation tools, and default values used in the assessments.

The collected data and analysis provide baseline benchmark values for embodied carbon and whole life carbon emissions, shedding light on primary actions that can be taken to bring down upfront embodied carbon.

While consistent patterns emerge, the values differ across countries due to variations in building practices, grid carbon intensity, assessment methods, and data sources. Expanding sample sizes, enhancing data collection standards, and developing open infrastructure for data and analytics will support ongoing monitoring, analysis, and benchmarking efforts.

3.1 Policy and market context

Market context

In countries without WLC legislation, WLC assessments and disclosures are driven by market initiatives such as green building certifications[35] and net-zero target commitments by real estate, construction, and building design sectors. Consequently, baselines in the INDICATE countries have been developed by collecting and analysing WLC data from existing projects and were influenced by the availability of LCA calculation tools and of environmental data on construction products and processes (See Annex II for an overview).

In all INDICATE countries, preliminary methods for calculating life cycle impacts at the building level had already been developed in previous projects. Although no official standard or national methodologies existed in any of the INDICATE countries, these pre-existing projects provided useful datasets and insights which were refined and validated later on via engagement with industry experts and stakeholders. Decarbonisation roadmaps and strategies also contributed to an enabling environment in Spain and Ireland by generating awareness around WLC and outlining priorities for establishing WLC regulations.

Green building certifications are potentially valuable sources of information for establishing WLC baselines. However, data collection takes time, and case studies require additional harmonisation to ensure comparability in terms of scope and background data sources. While WLC studies conducted in the context of green certification were considered less relevant in Czechia, they were deemed valuable sources of data in Ireland and Spain. Besides the more recognised certification schemes such as LEED and BREEAM, which are well established in INDICATE countries, other national certifications also play a role (e.g., Home Performance Index for residential buildings in Ireland and Verde in Spain). Given the absence of clear regulatory or market incentives to report WLC data, engaging with certification bodies and project owners, as well as the ability to financially remunerate data providers, was crucial to tapping into this potential data source.

Verified and accessible national LCA tools and databases collecting building level WLC case studies do not yet exist in INDICATE countries. Collaboration with LCA software providers could be beneficial when national standard methodologies are established. Transparency and accessibility concerns will need to be clarified and addressed by regulators.

Environmental Product Declarations (EPD) databases are available in all three INDICATE countries; however, they do not yet cover all relevant product families. In the absence of comprehensive national databases, preliminary databases have been developed within INDICATE to support calculations. Due to the lack of EPDs for certain construction products, generic carbon intensity data had to be developed for use in the absence of product-specific information.

[35] Bruce-Hyrkäs, T., Pasanen, P., Castro, R. (2018). "Overview of Whole Building Life Cycle Assessment for Green Building Certification and Ecodesign through Industry Surveys and Interviews". Procedia CIRP. Volume 69. 178-183. Accessible at: https://www.sciencedirect.com/science/article/pii/S2212827117309125?ref=cra_js_challenge&fr=RR-1

National policy background

WLC baselines are effective when embedded in the national policy framework. They are instrumental to set, track and monitor policy ambition and performance targets, reveal low carbon solutions, design choices and building types in the national stock which will deliver the greatest carbon savings. It is therefore essential to consider national political and policy priorities related to the building sector, and build upon existing WLC initiatives and existing national decarbonisation strategies (see Annex III for more information).

Political priorities like housing shortages and affordability of housing risk overshadowing the urgency to include WLC in national construction legislation. Although in Spain building decarbonisation is on the political agenda, in Ireland and Czechia, WLC risks being perceived as red tape that could increase the cost of housing and slow down construction. This highlights the necessity of awareness raising, a streamlined WLC calculation method and tools, and WLC capacity building. Most construction and real estate sector decision makers remain unaware of the benefits of addressing WLC emissions, which are largely unknown and insufficiently documented, and therefore do not request low-carbon solutions and products to begin with. Clarifying aspects in upskilling related to perceptions of high costs and lack of trust in low-carbon buildings and materials can help dispel and overcome these barriers (see section 4.3 on Benefits of implementing WLC assessments for buildings).

National strategies and action plans provide guidelines for stakeholder engagement and coordinating efforts to implement WLC regulations. National strategies for developing WLC baselines in INDICATE countries include Climate Action Plans (CZ, IE), State Energy Concepts (CZ), National Energy and Climate Plans (ES), and National Building Renovation Plans (ES). In Ireland, several actions related to WLC are already explicitly included in the Climate Action Plan, creating a conducive environment for engaging with public and private stakeholders. In Spain, the regional autonomous government of Barcelona has already included WLC requirements in public procurement. For a more detailed overview of the various national policy initiatives including WLC provisions, see Annex IV.

The EPBD recast transposition offers a critical policy opportunity to drive WLC action by public actors, with initiatives varying in focus and application. Examples in INDICATE countries include: the integration of WLC disclosure in the building code before EPBD requirements apply (ES); governments developing national LCA databases (CZ); governments adopting international standards, such as the International Cost Measurement Standards that include WLC (IE); social housing development agencies using WLC tools (IR); regional authorities leading the way by publishing freely accessible WLC tools (ES) and integrating WLC disclosure in project permitting procedures (ES).

3.2 Comparative overview of whole life carbon assessment methodologies and data collection

This section provides an overview of the WLC assessment methodologies and the various data sources used by the INDICATE teams.

3.2.1 Scope and system boundaries

INDICATE national WLC assessment methodologies comply with the minimum requirements set out in the EPBD recast, such as data selection and calculations according to the EN15978 standard and alignment with the Level(s) framework. The technical methodology applies to new buildings in all countries, and to renovations in some. The reference study period, WLC metric, and reference area are consistent across all INDICATE countries and compliant with Level(s). The building elements included in the assessments follow the structured approach of Level(s) indicator 1.2 (see Annex V for the Level(s) overview).

In Ireland and Czechia, the benchmarks are based on real construction projects. In Spain, both real cases and synthetic cases based on BIM modelling have been used to calculate the benchmarks. The Spanish approach of defining synthetic cases allows for generating a variety of case studies with slightly altered parameters, such as climatic conditions, building design, and materials used. Real cases offer the opportunity to include realistic scenarios, more specific construction product data, and collaboration with developers and industry stakeholders. The synthetic approach in Spain has the potential to be further developed into a tool that could support targeted WLC policymaking focusing on specific building materials or building elements (e.g. green public procurement requirements).

3.2.2 WLC assessment

There are variations in scope and system boundaries, despite compliance with the EN15978 standard. Tailoring the assumptions for calculations at the national level significantly influences the results of WLC assessments. The scope and system boundaries, particularly the life cycle modules covered by LCA studies, differ across national methodologies. Similar variations are also observed in the scope of WLC methodologies in other Member States with WLC regulation in place.[36] Key assumptions include operational energy use (life cycle module B6), accounting for on-site renewable energy (generation, use, and export), floor area definitions, and biogenic carbon accounting. In the INDICATE national methods, biogenic carbon was reported separately. Energy decarbonisation scenarios relevant to operational energy use were sourced from official public sources in Ireland and Spain. However, the export of renewable energy was not considered in any national method. Similarly, the likelihood of lower embodied carbon materials being available in the future for refurbishment was not considered.

3.2.3 Data sources, default values and assumptions

Given persistent data gaps, each INDICATE team developed national reference databases to ensure consistent calculations. These gaps existed due to the absence of national LCA databases and a lack of product-specific environmental data. The databases were populated with nationally available EPDs, LCA background data (e.g., from sources like Ecoinvent), and default values for products and processes, including transportation, when specific data was unavailable. Default values were also provided for some LCA assumptions and building elements.

[36] Steinmann, J., Röck, M., Lützkendorf, T., Allacker, K., Le Den, X. (2022). Whole life carbon models for the EU27 to bring down embodied carbon emissions from new buildings – Review of existing national legislative measures. Accessible at : link

Specific product data obtained from EPDs were used in the assessments when available, but due to the low availability of EPDs, default values were essential for obtaining results. In Ireland, to ensure consistency, default values were used unless product-specific EPDs were available and where particular manufacturers' products had been chosen. Default values and proxy data were tailored to specific life cycle modules in Spain and used for specific elements, such as technical building systems, in Czechia and Spain. In Ireland, a data quality tracker showed the share of generic versus product-specific data used. Although no default values were used for building elements, this could prove beneficial as such benchmarks would lead to time savings. Conservative weighting factors are applied in each method when using default values, to encourage the use of specific data.

3.2.4 Calculation tools

Tools used for the calculations were either excel sheets (ES/IR) or commercial LCA software (CZ). Spain used Excel sheets, importing data directly from BIM models. Ireland continues to use spreadsheets, although it recognises the benefit of making the calculations and default assumptions available to all commercial software developers so they can integrate the method into their market offerings. In Czechia, the calculations were conducted using the One-Click LCA software.

3.2.5 Reporting requirements

The reporting template used in INDICATE is based on work done by IEA EBC Annex 72[37] and the Towards Embodied Carbon Benchmarks for Buildings Across Europe project, providing clarity on the reporting requirements per building element and granularity.[38]

Table 4 provides an overview of the methodological choices used in INDICATE countries. It **highlights the critical need for a standardised national method alongside a streamlined and consistent data collection process.** The EPBD recast already sets some requirements related to i) the scope and system boundaries, ii) the calculation and assessment method, iii) the reporting templates and requirements, iv) the input data, and v) the tools used. These could be further specified in the forthcoming WLC Delegated Act to ensure transparent reporting by Member States regarding their methodological choices. This would facilitate WLC calculations using default values in instances where data gaps are inevitable.

[37] Röck, M., Ruschi Mendes Saade, M., Balouktsi, M., Nygaard Rasmussen, F. (2020). "Embodied GHG emissions of buildings – the hidden challenge for effective climate change mitigation". Applied Energy. Volume 258. Accessible at: https://www.sciencedirect.com/science/article/pii/S0306261919317945
[38] Röck, M., Sørensen, A., Steinmann, J., Hvid Horup, L., Tozan, B., Le Den, X., Birgisdottir, H. (2022). Towards embodied carbon benchmarks for buildings in Europe. All-in one report. Accessible at: https://fs.hubspotusercontent00.net/hubfs/7520151/RMC/Content/EU-ECB-5-all-in-one-report.pdf

	Feature	EPBD recast	Level(s)	Czechia	Ireland	Spain
Scope and system boundary	Applicability (building typology)[39]	New buildings >1000m² as of 2028 All new buildings as of 2030	New buildings Renovations	New residential and non-residential buildings Renovations	New residential and non-residential buildings Renovations	New residential and non-residential buildings
	Reference study perio	50 years	50 years	50 years	50 year	50 year
	Building Reference Area	Useful floor area (m²)	Useful floor area (m²)	Gross Floor Area (GFA) Useful floor area (m²)	Gross Floor Area (GFA) Useful floor area (m²)	Gross Floor Area (GFA) Useful floor area (m²)
	WLC-metric	$kgCO_2$/ m² /year	$kgCO_2$/ m² /year	$kgCO_2$/ m² /year	$kgCO_2$/ m² /year	$kgCO_2$/ m² /year
	Building physical characteristics (building elements)	Level(s) Indicator 1.2 GWP	Shell (sub/super structure), core (fittings, furnishing, services), external works (utilities, landscaping	Shell (sub/super structure), core (fittings, furnishing, services), external works (utilities, landscaping)	Shell (sub/super structure), core (fittings, furnishing, services), external works (utilities, landscaping)	Shell (sub/super structure), core (fittings, furnishing, services), external works (utilities, landscaping)
WLC assessment and calculation method	LCA modules	Comply with EN15978:2011	A1-5, B1-7, C1-4, D Simpl. 1: A1-3, B4-6 Simpl. 2: A1-3, B6, C3-4, D	A1-5, B4-B7, C2-4, B1-3 and C1 considered 0	A1-5, B1, B4, (B6, B7 optional), C1-4	A1-5, B1-7, C1-4
	Decarbonisation scenario B6	Comply with EN15978:201	Scenario quantifying primary energy consumed by building systems (heating, cooling, ventilation, h-water, lighting, control) – PRIMES model	Included, but unclear how its assessed	Emissions factors of fuels and forecast of grid emissions factors provided by the Sustainable Energy Authority Ireland (SEAI)	Future decarbonisation projections based on data from the National Energy and Climate Plan (NECP).
	Decarbonisation embodied carbon B/C[40]	n/a	n/a	No	No	No
	Exported energy (Module D)	No	Quantify exported energy and report under module D	No	No	No
	Biogenic carbon	-1/+1 method MS address carbon removals associated to carbon storage (Art 7) Temporary carbon storage may be reported (Annex V)	-1/+1 method Data should be aligned with EN 15804 Emissions from disposal processes of biogenic carbon shall be accounted for without time limit	-1/+1 method	-1/+1 method, biogenic carbon reported separatel	-1/+1 method

	Feature	EPBD recast	Level(s)	Czechia	Ireland	Spain
Data sources, default values and assumptions	Data requirements	Comply with EN15978:2011	Data quality according to EN15804/prEN15941 Generic data (<10y), specific data <5y) First: use specific data, then average data. Data quality index to be calculated	Generic data from internal database based on OCLCA, Ecoinvent, EU general high impact datasets , specific datasets (e.g., countries with similar energy mix, NL, PL, IT). Appropriate national EPDs used.	National generic database for construction products, specific EPDs can be included when product application is proved.	Internal database with generic data from Ecoinvent 3.10 and specific EPDs can be applied
	Conservative weighting factors	Not specified	Not specified	Not clear	n/a	n/a
	Standard/default values and assumptions for LCA modules	Not specified	Recommended scenarios: re-use compared to demolition, design specifications, service life planning, future electricity grid emissions, future climatic conditions, EoL circular infrastructure	Not clear	A4, B1, B4, B6, B7, C1-4.	A4, A5, B1, B2, B3, B5, B7, C1-4.
	Standard/ default values for elements[41]	Not specified	Not specified	Default baseline values for elements based on the averages of the sample	Default baseline values for elements based on the averages of the sample	Default baseline values for elements based on the averages of the sample
Calculation tools	Calculation tools	Fulfil minimum criteria Level(s) Indicator 1.2	Comprehensiveness Robustness, Operability Additional requisites[42]	One-click LCA, internal excel	Excel	Excel
Reporting requirements and templates for benchmarks	Reporting template	Not specified	Not specified	Template based on (Röck et al., 2020) and (Röck, Sørensen, Steinmann, et al., 2022; Röck, Sørensen, Tozan, et al., 2022)	Template based on (Röck et al., 2020) and (Röck, Sørensen, Steinmann, et al., 2022; Röck, Sørensen, Tozan, et al., 2022) RICS WLCA standard	Template based on (Röck et al., 2020) and (Röck, Sørensen, Steinmann, et al., 2022; Röck, Sørensen, Tozan, et al., 2022)
	Aggregation	Not specified	Not specified	Not clear	Building typologies, building elements (embodied) Level(s) aligned	Building typology, building element category, life cycle module grouping (A1-3, A4-5, B1-5, B6-7, C1-4.

Table 4 - Overview of WLC methodological aspects in INDICATE countries.

[39] For Czechia, Ireland and Spain, the applicability relates to building LCA cases included in the benchmark.
[40] Similar considerations can be observed in the DGNB method in Denmark. Here a 1% annual technological improvement factor is applied in reducing embodied emissions. Source: https://rfbb.dk/publikation/dgnb-renovering-og-nybyggeri-2025-pilot (SOURCE: pre-print Nordic Innovation – release September 2024)
[41] See INDICATE national reports for a more detailed overview of country specific default values and assumptions
[42] **Comprehensiveness**: Level(s) compliance-tick mark box, **Robustness**: Alignment of EPDs with EN 15804+A2, High-quality and industry-specific data), **Operability** (User-friendliness, the availability of training and flexible pricing), Interoperability: plug-in info, import/export interfaces for relevant data formats (e.g. to read in data from BIM and other CAD systems, and to exchange LCI data). **Additional requisites**: 'Official' approval and validation of tools by national authorities, external independent and qualified review of data.

3.3 Quantitative results – baseline values

Performance definition: background on benchmarks and targets

As preparatory steps for benchmarking, all INDICATE countries established their LCA methods and metrics, and generated or compiled quantitative data from a relevant sample of building cases. This data, collected through harmonised reporting requirements, is now ready for analysis. It serves to enhance understanding of current practices and to define indicative baseline benchmarks within each context. These steps are crucial for building a robust data foundation and advancing policies to measure and reduce WLC emissions of buildings.

Steps to advance policies for measuring and reducing Whole Life Carbon emissions of buildings

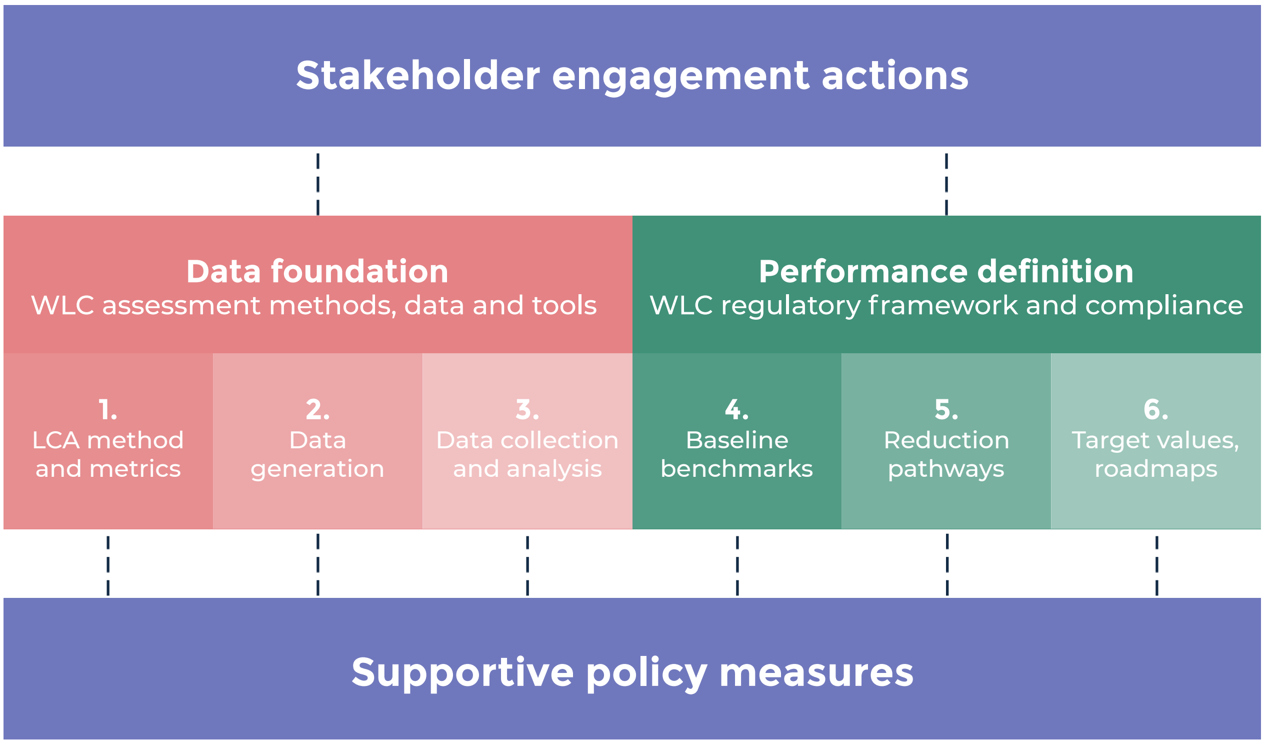


Figure 6 - Steps to advance policies for measuring and reducing whole life carbon (WLC) emissions of buildings. Based on: Tozan et al., 2022.

A benchmarking system defines reference values to measure and manage performance in relation to embodied carbon. In accordance with ISO 21678:2020, two types of reference systems are possible:

- **Bottom-up benchmarks** are based on the actual embodied carbon levels derived from empirical datasets. These benchmarks can be established by setting reference values that, for example, stay below the average for current buildings or do not exceed the emissions of best-in-class buildings.
- **Top-down benchmarks** are determined by external factors, such as the remaining global carbon budget, i.e. the maximum cumulative amount of greenhouse gases associated with the 1.5°C warming threshold. The purpose of top-down benchmarks is to limit embodied emissions to levels that align with the downscaled carbon budgets specifically allocated for the building sector.[43]

[37] For and illustration, see: https://reductionroadmap.dk/reduction-roadmap

Table 5 outlines the key terms for setting benchmarks that guide the industry on how quickly and significantly it should reduce carbon emissions.

Type of benchmark	Statistical analysis	Determination of reference level
Upper limit value	10th or 25th percentile	The upper acceptable performance level on a performance scale. 10% or 25% of all values are below this limit, respectively.
Reference values (baseline)	Median, mean, or modal value	The current state of the art based on relevant statistical information describing the performance of buildings.
Lower limit value	90^{th} or 75^{th} percentile	The minimum acceptable performance level on a performance scale. 90% or 75% of all values are above this value, respectively.
Best practice	-	The level representing the best available performance identified in real world cases.
Target value	-	The level set by decision makers, e.g., policymakers, to set targets for varying performance aspects.

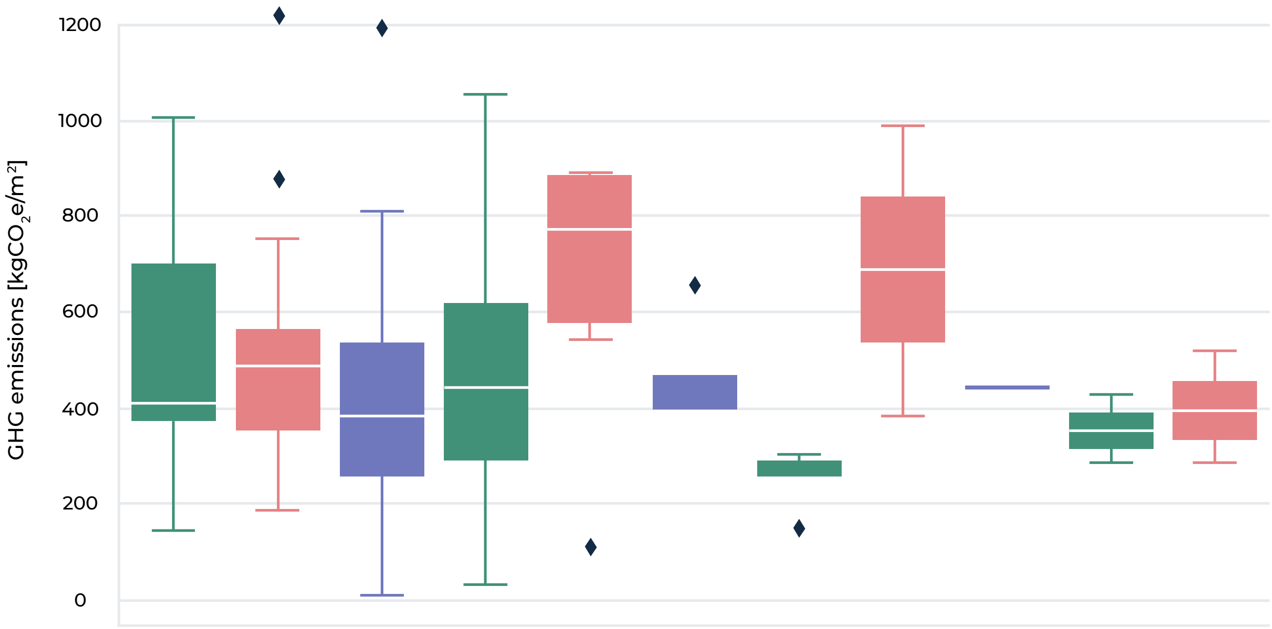
Table 5 - Elements of the performance system for embodied carbon (based on Tozan et al. 2022).

INDICATE baseline values: understanding the status-quo

Figure 7 shows the results of embodied carbon (EC) per square metre ($kgCO_2e/m^2$), highlighting the variation in emissions depending on the building types included in the dataset.

Embodied Carbon by Building Subtypes

a) Production embodied carbon (A1-A3; Cradle-to-gate*)



b) Whole life embodied carbon (A1-C4; Cradle-to-gave*)

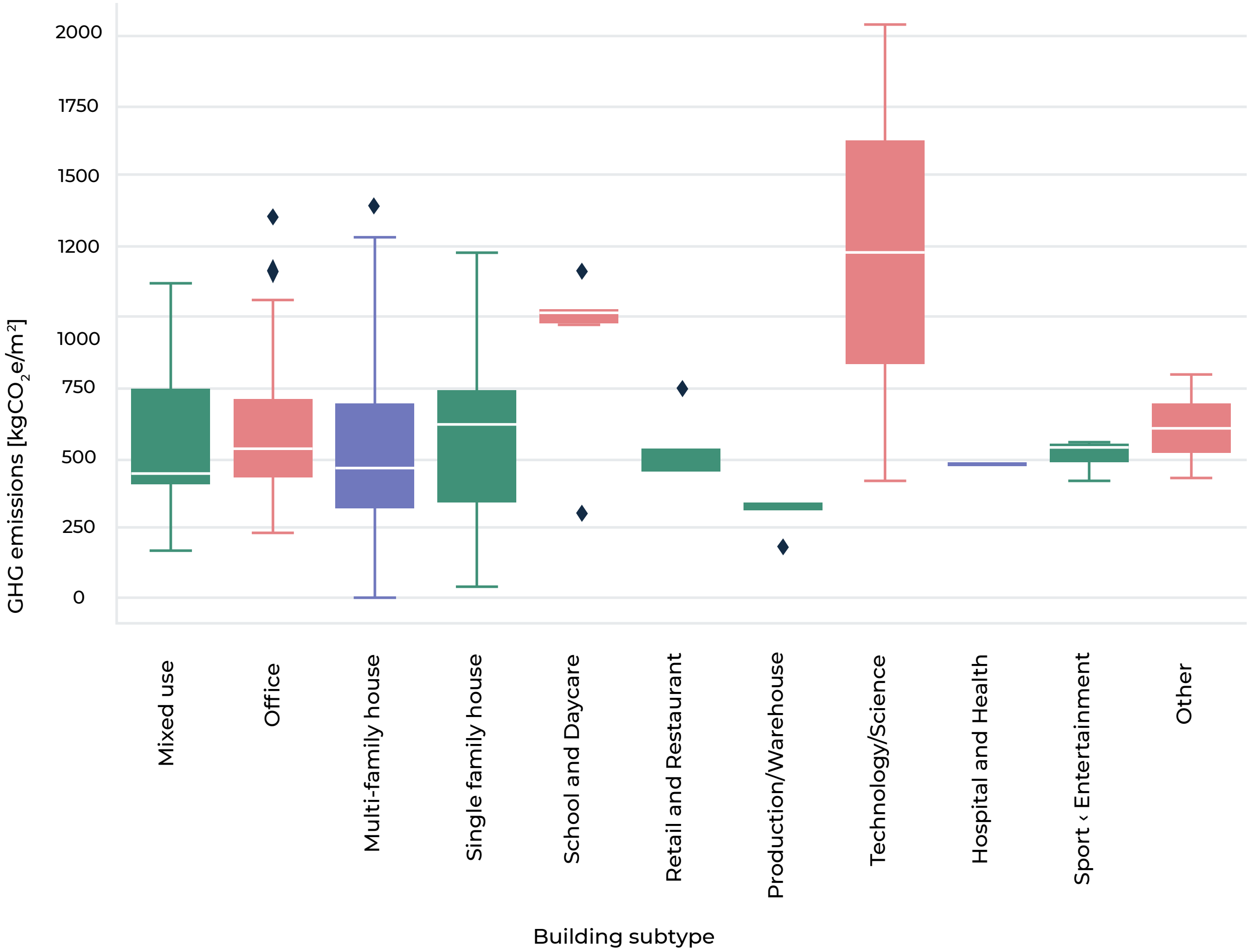


Figure 7 - Boxplots showing embodied carbon by building subtypes. a) Production embodied carbon (A1-A3), and b) Whole life embodied carbon (WLEC), combining the embodied carbon results from all life cycle stages (Production (A1-A3), Construction and installation process (A4-A5), use phase embodied carbon (B1-B4), deconstruction (C1-C2), as well as end of life (C3-C4). Additional information outside the system boundary, as reported in Module D, is not included. *) Note: The Embodied carbon results shown are based on a combined dataset that includes various cases from different countries, and not all life cycle stages are assessed or reported in every case. Additionally, not all building subtypes are represented in each of the countries.

The results indicate that the emissions released during the production stage of materials is the most significant life cycle stage in terms of carbon emissions before building construction and use. Production stage emissions are found to account for approximately 80% of the total embodied emissions over the entire building life cycle, making it the most significant source of emissions for new constructions. Production embodied carbon (A1-A3) of new buildings (Figure 7a) typically falls between 400 to 500 $kgCO_2e/m^2$ on average (median). The core values (representing 50% of the cases) range from 300 to 700 $kgCO_2e/m^2$ for most residential and non-residential buildings in this dataset. The boxes in the plot show the lower 25% and upper 75% of cases, while the whiskers represent the range of extreme cases, which can exceed 1,000 $kgCO_2e/m^2$—solely from building material production. Higher values are observed in schools, daycare centres, and technology and science sectors, with average values between 700 to 750 $kgCO_2e/m^2$ and a core range from approximately 550 to 900 $kgCO_2e/m^2$.

Embodied carbon intensity for selected key attributes

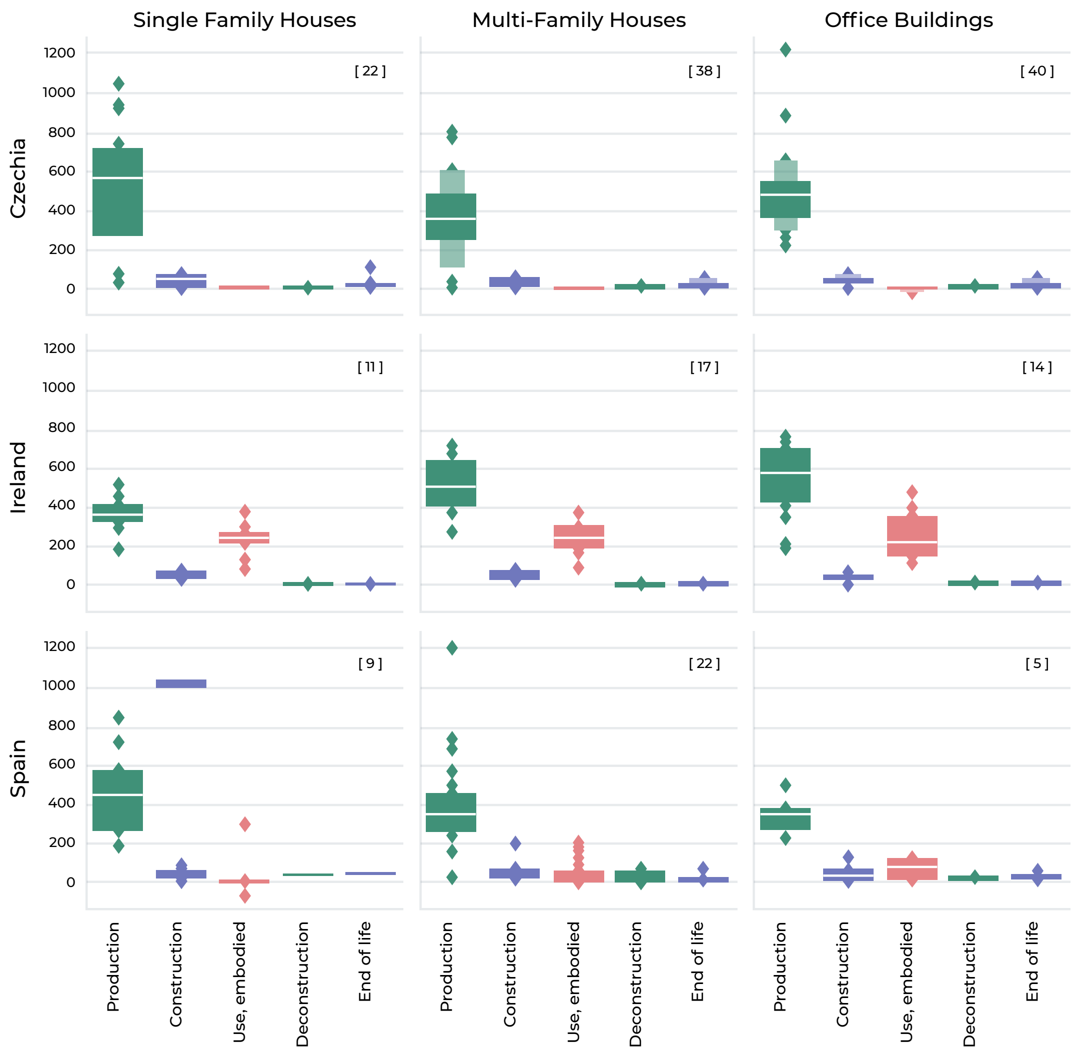


Figure 8 – Boxplots showing embodied carbon intensity per life cycle stage (acc. EN 15978) for single family houses, multi-family houses, and office buildings (columns) in Czechia, Ireland, and Spain (rows), respectively. The number of case studies behind each subplot is indicated in square brackets. The horizontal line within the central box indicates the median value, the upper and lower boxes indicate the 25th and 75th percentiles, respectively. The diamond shapes indicate extreme values outside of this core distribution, indicating the full range of current practice.

Figure 8 provides an overview of the embodied carbon values of the three most common building types featuring in all three INDICATE countries: single family houses (SFH), multi-family houses (MFH), and office buildings (offices). As above, the product stage is the largest source of embodied carbon across all countries and building types, which suggests that policymakers and industry should first focus on upfront emissions in order to bring about the greatest reductions. While the overall patterns are consistent, the values vary across countries. This is expected due to differences in building practices, carbon intensity of the grid, assessment methodologies, and data sources.

Challenges and next steps

Without statutory requirements to report WLC data, obtaining the quantity and quality of data needed to establish reliable benchmarks and target values remains a significant challenge. While all INDICATE countries successfully reached the goal of compiling 50 real-world building case studies, further expanding the datasets with more diverse and detailed information is crucial for improving the quality and robustness of future benchmarking efforts. Looking ahead, the next steps for INDICATE involve advancing data collection requirements and refining the associated templates. Additionally, creating an open infrastructure for data collection and analytics will help the ongoing monitoring, analysis and benchmarking process. The next iteration of INDICATE will broaden its geographical scope to include four additional countries - Austria, Croatia, Italy, and Luxembourg - and further advance benchmarking efforts by defining limit values and national reduction roadmaps.

4. Opportunities and strategies to deliver whole life carbon benchmarks

This chapter explores critical opportunities and strategies for delivering effective WLC policies and benchmarks. In each INDICATE country, stakeholders from industry, academia, and government played pivotal roles in supporting the development of methodologies, gathering data, and preparing for policy uptake.

Pilots also identified common challenges and solutions to establishing WLC benchmarks, and many other benefits beyond carbon reduction alone, that WLC assessments bring to a wide range of stakeholders, such as driving innovation, transparency, operational and material efficiency leading to reduced capital expenditure and life cycle costs.

The act of doing an assessment, regardless of method or result, gives building designers new perspectives and encourages them to consider long and short term efficiencies early in the design process.

While international best practices and ongoing efforts exist, significant work remains in addressing knowledge and data gaps for embodied carbon at the building, process, and product levels, as well as in designing data infrastructure and identifying training needs.

These strategies and benefits offer a clear pathway for other Member States to follow, accelerating decarbonisation in the construction sector.

4.1 Stakeholder engagement

Support, feedback and data contributions of stakeholders were pivotal to achieve INDICATE results. Industry representatives, technical experts and policymakers in particular played an important role. Each team involved relevant national ministries (e.g., Environment, Construction, Industry), academia (technical LCA expertise) and industry representatives (architects, construction product manufacturers, LCA consultants, industry associations, real estate developers, and software companies).

Stakeholder engagement objectives included:

- developing and validating the methodology
- collecting representative building LCA data
- preparing policy uptake of the WLC benchmarks

Stakeholder engagement objectives	Method development / validation	Case study and data collection	collection
Methods	Technical working group, mailings, recordings, meetings	Data working group, bilateral meetings	Bilateral meetings, mailing, conferences, roundtables

Table 6 - Stakeholder engagement objectives and methods.

Examples of stakeholder concerns and incentives

Concerns: How to deal with incomplete carbon data? How to deal with renovation embodied carbon? What will be the costs? How to ensure comparability and robustness of the results? How to build sufficient capacity to implement WLC assessments nation-wide?

Incentives: Building capacity and getting ahead of regulation, integration with carbon management and cost planning, long term and full life cycle overview of maintenance, repair and replacement requirements, reputational benefits, reporting of both own scope 1 and 2 emissions and scope 3 emissions of clients.

4.2 Challenges and solutions to establish whole life carbon benchmarks

During the development of WLC benchmarks, INDICATE national teams encountered similar challenges and devised mitigation strategies to address them. Member States preparing to implement the EPBD recast and develop their own WLC benchmarks can anticipate facing similar challenges and may benefit from adopting some of these approaches.

Time constraints were a significant challenge in developing the method, collecting data, and performing WLC calculations. This was partly due to the **lack of environmental and building level data repositories** at the national level, which necessitated the creation of default datasets for calculations. Additionally, setting up processes for screening, engaging, and guiding potential data providers added to the complexity. Since WLC calculations are still a market niche in the INDICATE countries, there was a **need for capacity building within calculation teams, among data providers, and public officials.**

The following strategies have been employed by the INDICATE teams:

- transparent method development and validation process proved crucial for ensuring the quality and accuracy of the calculation results
- to facilitate data collection, INDICATE teams actively engaged data providers and created guidance documents and reporting templates to streamline data submission in the correct format
- although many data providers expressed interest in contributing to WLC benchmarks, offering financial compensation was key to securing access to their data and covering their time investment
- capacity-building efforts included creating tailored guidance documents for the broader industry and policymakers, along with regular communication through emails, workshops, and bilateral meetings which underscored the importance of comprehensive stakeholder engagement.

	Challenges	Mitigation measures
Method development, calculations	• Time required to develop the WLC assessment method, identifying data sources • Time required to perform the WLC assessments	• Generate broad agreement and validation of method by LCA experts through collaboration in technical working groups • Method validation with support of international experts
Data collection & calculations	• Lacking building level data repositories / databases • Lacking specific product level environmental data • Time required to identify and select relevant data providers ensuring a representative sample underlying the benchmarks • Time required to define data needs and clarify the reporting template and format • Time required for data partners to provide the information in the required reporting templates – interest tends to be high, willingness to provide data much lower • Need for sufficient and representative cases to enable robust WLC benchmarks	• Develop a streamlined internal WLC calculation process, including guidance documents (default data sets, classification systems, import of bill of quantities, templates for the results, calculation guidelines, and sharing individual results with each partner) • Financially remunerate case study providers for time they invest in providing data. • Offering developers more in-depth calculations or WLC analytics in exchange for providing case studies for benchmarking
Capacity building	• Lacking technical capacity to make the WLC assessments and use calculation tools • Lacking capacity among data providers and industry to collect the input data for the WLC assessment (e.g., on all building elements and life cycle modules) • Lacking capacity and awareness among relevant civil servants responsible for building policy	• Capacity building among calculation teams (within INDICATE teams) • Development of support and guidance materials for practitioners and policymakers (e.g. compendium of case studies, policy briefs, white papers)
Stakeholder engagement	• Ensuring political support facing ambiguity around EU requirements and competing national political priorities • Addressing concerns among construction sector stakeholders (e.g., related to costs, time, energy intensity of the economy, red-taping, slowing down new construction).	• Comprehensive stakeholder engagement approach, a transparent method, and regular contact (mailings, meetings, surveys, conferences, roundtables).

Table 7 - Challenges and mitigation measures to establish whole life carbon benchmarks.

4.3 Benefits of implementing whole life carbon assessments for buildings

WLC assessments are essential for identifying carbon hotspots and decarbonising construction. However, they also offer numerous direct and indirect benefits, as highlighted by the INDICATE case studies, that are often overlooked due to concerns about potential costs and administrative burdens, patchy data and uncertainty related to assumptions and future projections. On a broader scale, building decarbonisation can minimise climate and transition risks inherent in both real estate and financial sectors, enhance energy security by decreasing reliance on fossil fuel imports, prepare for future regulations, achieve cost savings, demonstrate market leadership and boost industry competitiveness by fostering lead markets for green technology and innovation.

Other important benefits include:

Increasing awareness of carbon hotspots in buildings

Conducting WLC assessments provides designers, developers and manufacturers insights about carbon hotpots, allowing them to optimise design choices and the sourcing and processing of materials and products. WLC accounting also offers an understanding of long-term post-completion considerations, such as maintenance, durability, and the lifespan of materials and building elements.

Targeting rapid and deep carbon reductions that will last

WLC assessments highlight and provide evidence for the carbon value of retaining the existing building stock, prioritising renovation and the retention of materials and building elements over new construction. An integrated WLC approach offers significant flexibility to building sector stakeholders, allowing them to implement the most feasible and appropriate carbon reduction measures and compensate for carbon hotspots in certain building elements or life cycle stages with mitigation in others. **Pinpointing the source and scale of embodied carbon in buildings enables the industry and policymakers to focus on areas where carbon efficiencies are most needed.** Furthermore, rapid reductions of WLC emissions at the building level also mitigate the need for costly investments in energy infrastructure or reliance on uncertain offsets to achieve near-and long-term climate goals.

Driving innovation in low-carbon construction

Disclosing embodied carbon in construction secures Europe's role as a global industry leader in low-carbon markets, and increases competitiveness by encouraging substantial research and investment to scale up emerging low-carbon technologies, creating robust medium and long-term business cases for material and design innovation. By quantifying the impact of construction products at the end-of-life phase and their benefits and loads beyond the system boundary, WLC assessments support circularity solutions and industrially prefabricated construction.

Creating jobs and building skills for the green workforce

Increasing demand for zero life cycle carbon buildings translates to growth and job opportunities in low carbon construction projects and services. It also reflects a growing need for foundational skills, data and digital tools. Shifting from current mainstream construction practices to low embodied carbon- and energy-saving buildings that incorporate design innovations and smart technologies presents challenges, but also exciting opportunities for new skill sets, business models, workforce diversity, new entrants and careers. Additionally, implementing WLC approaches in the construction sector can positively impact local forestry, agriculture, and livestock sectors by providing sustainable construction materials and generating local circular jobs.

Cutting costs and building with long-term value in mind

Linking WLC assessments to life cycle costing can result in capital cost savings, operation and replacement cost optimisation which inherently incentivises long-term thinking and the use of durable materials and solutions. By considering future climate change and adaptation strategies during design, the construction sector can enhance resilience and minimise future carbon impacts and waste. Reducing WLC often correlates with resource savings, which can offset the higher costs associated with sustainable materials. Additionally, WLC disclosures are expected to increase the marketability of properties and provide opportunities for more advantageous access to financing. Finally, WLC assessments help quantify residual value after demolition, further enhancing financial planning and sustainability efforts.

Boosting health and well-being through sustainable materials

Using natural materials can enhance indoor climates and increase health, well-being, and productivity by emitting fewer harmful volatile organic compounds. Cities and citizens benefit from increased liveability, such as reduced acoustic, particulate and health-harming emissions associated with material production, construction processes and transport.[44]

[44] Carbon Neutral Cities Alliance & One Click LCA (2022) “City Policy Framework for Dramatically Reducing Embodied Carbon”. Accessible at: https://www.embodiedcarbonpolicies.com/

5. Conclusions and policy recommendations

Developing WLC methods and benchmarks in support of WLC legislation is a gradual process, requiring EU Member States to overcome common challenges.

This report has outlined the key features of WLC regulations and has demonstrated how Czechia, Ireland, and Spain have anticipated the EPBD recast transposition by developing WLC benchmarks and generating relevant insights and stakeholder support for establishing national WLC methodologies.

Other EU countries preparing for the EPBD recast transposition can learn from the lessons and experiences of the INDICATE project. This section is aimed primarily at EU and national policymakers, though it is clear that wholesale building sector decarbonisation and market transformation will not be possible without the engagement and support of the entire value chain.

5.1 Recommendations to establish a whole life carbon assessment methodology

Governments should start developing a national WLC methodology as soon as possible in consultation with relevant industry stakeholders and academia. This is a time-consuming but indispensable process for enabling the development of WLC benchmarks and regulations. Benchmarks can help identify carbon hotspots by analysing which building elements generate the most impact. Focusing on the most impactful materials and building elements allows assessments to be scaled and practitioners to start learning what is important and what is less impactful. Simplifying WLC assessments by establishing default values for less impactful building elements saves costs and time.

Instead of waiting for perfect data, policymakers should mandate WLC assessments early on, while simultaneously ensuring consistency in the methodologies and data used to establish WLC benchmarks. The same assumptions, reporting templates, and default data should apply to all projects. Prioritising consistency and transparency in the methodology in the starting phase is more important than directly achieving the ultimate accuracy of carbon data, which can be improved over time.

Other specific recommendations:

- Consider separate reporting of embodied and operational carbon to ensure neither category of emissions can be ignored entirely and some level of reduction must be achieved for each.
- Include both relative $kgCO_2e/m^2$ metrics (in order to align with other widely used metrics such as energy use intensity), and absolute value total emissions $kgCO_2e$ so that results can be normalised by e.g. $kgCO_2e$/occupants. Absolute values are particularly relevant if the floor area is larger than necessary.
- Collaborate and align with relevant WLC related international standards and initiatives (e.g. EN 15978, ICMS, IEA EBC Annex 72, and Nordic Cooperation) and consider using Level(s) indicator I.2 as a reference (e.g. for building elements).
- Consider requiring sensitivity analyses, data quality assessments, data completeness and confidence checks, as well as third-party verification for quality assurance purposes.
- Consider automated warning systems checking symmetry and proportionality between life cycle modules (A4 and C2 (transport), A5 and C1 (construction and demolition), and A1-A3 and C3-C4 (construction materials and waste processing and disposal). Another focus could be the consistency of biogenic carbon in A1-A3 and C3. This can reduce human errors in assessments.
- Link LCA datasets from the generic datasets to items in the bill of quantities.
- When adopting foreign EPD data, assess the data origin and assumptions (e.g. geographical, technological and temporal representativeness, carbon intensity of the energy grid).
- Collect official data from public bodies (e.g., energy, water, waste) to support scenario assumptions.
- Develop a methodology that allows different materials to reflect their intrinsic qualities and advantages (e.g. durability, repairability, recyclability, and maintenance) and that encourages the use of high-quality data (e.g., through applying conservative weighting factors when generic data

5.2 Recommendations for data collection

Establishing the data infrastructure for collecting, storing, and analysing WLC data could potentially include national WLC databases containing generic, default and product-specific data, building level WLC repositories, and WLC calculation tools. Tools and data exchange between different platforms should be linked to BIM and other commercial LCA software currently being used by the market. Furthermore, the recast EPBD requires the WLC footprint of new construction to be disclosed on EPCs, necessitating the integration of WLC assessments with existing EPC certification schemes and tools. Data collected for generating an EPC, such as material volumes and surface areas, can provide useful data points for WLC assessment. Therefore, it is crucial to link and realise these synergies and streamline WLC assessments.

Continuous monitoring and evaluation of data quality and robustness of benchmarks are paramount. Improving data quality improves the reliability of assessments, but also incentivises further data collection, generation and disclosures at product, building and company levels. Accurate benchmarks are essential to guide policymaking and help industry actors reduce carbon quickly, deeply, and effectively. High-quality data and a greater number of representative case studies across building typologies are therefore a priority.

Other specific recommendations:

- Start identifying and engaging data providers as early as possible. Data collection and processing takes time.
- Prepare precise data requirements and reporting formats for the case studies and share these with data providers to save time and ensure data is provided in the right format.
- Develop a clear calculation protocol and internal guidance documents to reduce time on calculations.
- Consider rewarding data providers (developers, investors, designers) by granting access to benchmarks and databases, allowing them to (1) benchmark their own datasets against the same data from other sources; (2) fill the existing gaps in their datasets; (3) obtain analytics on data samples that are either larger (i.e., with higher number of data points) or more detailed (e.g., with larger geographical coverage).
- Share generic databases with default values and calculation assumptions with LCA tool developers to make compliance easier for their clients.

5.3 Recommendations for stakeholder engagement

To deliver on EU climate goals, the construction and real estate sector needs to undertake a deep transformation of the building stock and associated value chain. This includes changes to the way buildings are currently produced, constructed, operated, maintained, renovated and demolished. **Given that life cycle stages in the built environment are closely connected, decisions need to be supported throughout the value chain.** This broadening of the involvement of relevant actors aligns with the principle that every actor in the value chain has to contribute to the net-zero transformation of the stock. It requires uniting diverse stakeholders across the construction value chain around a **shared vision, addressing the fragmentation within the sector**.

Governments should support capacity building through guidance, awareness raising and education. There is a pressing need for guidelines on data collection, material inventories and reporting templates for LCA practitioners. Moreover, policymakers, together with civil society, professional bodies and research community, should launch awareness campaigns on WLC and develop upskilling programmes and training materials for the different disciplines along the value chain on WLC assessment, material efficiency, new construction and renovation technologies and innovative materials, circularity and stakeholder collaboration.

Other specific recommendations:

- Consider publishing a call for expression of interest to relevant construction sector stakeholders and establish a technical working group (including LCA practitioners, designers, developers, manufacturers, academia) to exchange views on the method and data collection. These technical working groups proved indispensable for national INDICATE teams.
- Establish a working group specifically for data providers to discuss concerns, clarify data collection processes, and provide information on possible future WLC requirements
- Monitor and connect with relevant European and international WLC initiatives to ensure consistency and avoid reinventing the wheel.
- Engage policymakers and civil servants at all levels, invite them to working groups, and keep them informed on methodology and industry developments, while building cross-departmental support.
- Leverage networks of the national Green Building Councils.
- Communicate the co-benefits of WLC assessments to the industry and general public (see Section 4.3 above) before the assumption of costs and administrative burden.
- Encourage taking shared responsibility for carbon emissions and celebrate data sharing.

5.4 Recommendations for the definition of whole life carbon limit values and policies to support life cycle thinking

The baseline values developed by INDICATE serve as an initial reference point. To increase the confidence level of these baselines, they need to be enriched with additional case studies that cover a representative sample of the national building stock. It is crucial that these case studies are assessed using **consistent background data and assumptions to ensure comparability**. A common issue with existing LCAs is that they are often not comparable due to differences in carbon factors for materials, replacement rates, or deconstruction scenarios.

WLC assessments and benchmarks should be broadly integrated into national regulations and policy instruments, extending beyond building regulations to include low carbon procurement policies and decarbonisation roadmaps. By integrating WLC assessments into legislation, more reliable benchmarks can be developed that support the introduction of limit values.

Other specific recommendations:

- When defining WLC limit values, consider indicators reflecting kgCO_2e per user or capita besides kg CO_2e/m^2. Such indicators would support rewarding demand reduction and sufficiency strategies.
- When setting WLC limit values in regulation, ensure that decarbonisation efforts do not compromise quality of construction, including safety, health, structural integrity. Consider earthquake risks and local building traditions, in addition to climate region. Ensure the limit values tackle the worst-in-class buildings in terms of WLC footprint
- When setting WLC limit values, an initial focus on A1-A3 or A1-A5 modules could be considered due to limited data availability and the significant importance of reducing upfront carbon spike. Consider increasing additional life cycle modules to create WLC limit values based on comprehensive assessments including many or ideally all modules in the medium- to long-term.
- When setting WLC limit values, progressively include other LCA impact categories to avoid a carbon tunnel vision that focuses solely on climate change mitigation, while ignoring other sustainable development goals (e.g., resource use, toxicity, biodiversity impact).
- Focus on construction solutions rather than individual products, as on-site assembly affects decarbonisation benefits like recyclability and durability. Preferably, compare functional units with equivalent construction, acoustic, thermal, and seismic performance.
- Embed WLC criteria in public procurement requirements. For example, by incentivising buildings with a ''best-in-class'' WLC performance, or requiring EPDs for the structural materials to be provided so that the most impactful elements of the building are assessed using accurate data.
- Provide financial support for generating EPDs for specific product families to tackle data gaps.

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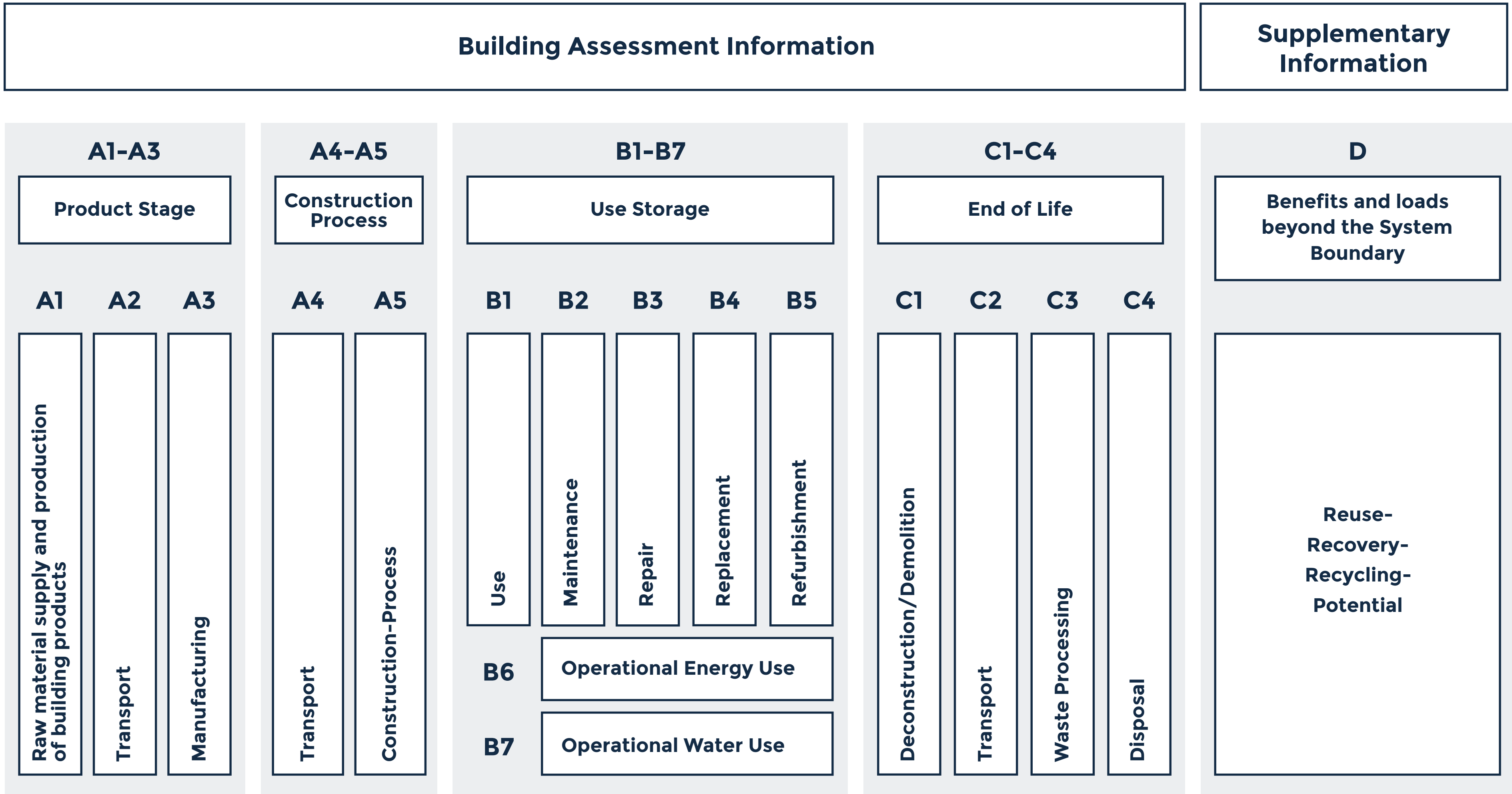
7. Annexes

Annex I – Life cycle modules in the EN15978



Annex II - Market context

Market context	Czechia	Ireland	Spain
Pre-existing WLC projects and methods	One previous WLC research project, resulting in a draft WLC methodology.	Several pre-existing research projects, including one project resulting in a detailed WLC methodology.	Many pre-existing research projects, but no harmonized method for calculating WLC has been developed in Spain.
Green certification (BREAAM, LEED, DGNB, ect).	BREEAM market leader (960+), followed by LEED (200+). LCAs performed for green certification at this stage seems a less relevant source of data.	Many certified buildings. LEED leading for non-residential (400+), home-performing index (HPI) for residential (21 000+ registered) LCAs performed for green certification are a relevant potential source of data, when scope and data divergence can be overcome.	Many certified buildings. BREAAM market leader (+2000), followed by LEED (800+) and Verde (340+). LCAs performed for green certification are a relevant potential source of data, when scope and data divergence can be overcome.
LCA tools	CBToolCZ is used for certifying buildings. No dedicated LCA tools or databases are available for LCA cases.	The HPI Tool used for WLC disclosure, private tools (e.g., one-click LCA – used for green certification), and the IGBC Carbon Designer Tool used for early stage assessments.	Five tools are provided by both private and public actors (TCQi-GMA from ITeC, Cype, Ecómetro-ACV, TURIA, and OneClick LCA).
Availability of environmental product data and LCA databases	EPDs are stored in the CENIA database, containing approximately 150 EPDs, not covering all product groups. The Czech Ministry of Environment manages the EPD programme. No database with generic LCA data available.	Over 200 EPDs are available on the data platform from programme operator EPD Ireland, not covering all product groups including many imported products. No database with generic LCA data available.	Two EPD programme operators are active in Spain (DAPcons, Global EOD). Over 400 EPDs are available, but not all product groups are equally covered. EPDs are collected in the OpenDAP database. No database with generic LCA data available.

Annex III - Policy context

Policy context	Czechia	Ireland	Spain
National political priorities related to buildings and WLC	High energy prices and housing costs are political priority in the Czechia, although key civil servants recognise the importance of WLC, sustainability in construction is no political priority.	High costs of housing, shortage of housing and ambitious energy renovation targets are political priorities. Although some policymakers are supportive, WLC risks being perceived as red taping that increases housing prices.	Building decarbonisation, alongside housing costs and availability, are political priorities in Spain. Due to water scarcity, initiatives consider including water indicators for housing.
Key national regulations and applicable policies:	- Energy Management Act (406/2000) and regulation (264/2020)	- Building Regulations TGD L. - Planning and Development Bill	- Spanish Building Code (Law 38/1999). - Catalonia's Ecoefficiency Decree (Decree 21/2006) - AMB/IMPSOL –procurement protocol for public tenders includes WLC limit values
Key national WLC initiatives and strategies	**Strategies** - The Climate Action Plan and The State Energy Concept are being updated, which offer an opportunity to engage policymakers on WLC. Policy initiatives - The Czech Ministry of Environment is developing a national LCA database, expected to be published in the coming years. - EPBD recast transposition is essential for WLC.	**Strategies** - Ireland Climate Action Plan 2024 includes objectives to reduce embodied carbon of construction products with 10% by 2025, and 30% by 2030. - Other WLC actions include the SEAI developing a GWP rating system, database, methodology and software. Policy initiatives - Adoption of the International cost management standard (ICMS) which includes LCA / embodied carbon method, and enable reporting as of 2025. Land Development Agency (large scale housing projects) is using the IGBCs HPI index, which requires WLC declaration. - EPBD recast transposition is essential for WLC.	**Strategies** - National Energy and Climate Plan -National building renovation plan Policy initiatives - Inclusion of mandatory GWP disclosure indicator in Spanish in the building code in anticipation of the EPBD recast. - The Catalonian Government plans to integrate a WLC indicators in project approval documentation. - Valencian Government published a free WLC tool for building projects (TURIA).

Annex IV - National whole life carbon policy initiatives

Although WLC regulations are not yet in place in Czechia, Spain, and Ireland, several policy initiatives are paving the way for future implementation of the recast EPBD.

In Ireland, various strategies and action plans emphasise WLC reductions. For instance, the Government's Housing Commission report calls for meeting emission targets for new buildings by implementing the IGBC WLC roadmap and introducing WLC targets for new constructions.[45] Additionally, the Department of Enterprise, Trade and Employment recommends reducing embodied carbon in cement and concrete through WLC assessments in public projects by 2024 and mandates carbon disclosure statements for all large public projects using concrete.[46] The updated Green Public Procurement Strategy includes several WLC-related actions[47] and the Irish Land Development Agency uses an IGBC-developed a Home Performance Index (HPI) that includes WLC assessments for new projects.[48]

In Spain, the autonomous community of Barcelona has integrated WLC limit values for life cycle modules A1-A5 into a sustainability protocol for green public procurement. These requirements apply to project and construction tenders for the Metropolitan Area of Barcelona (AMB) and the Metropolitan Institute for Land Promotion and Asset Management (IMPSOL).[49] Additionally, discussions are ongoing to include WLC disclosure in construction permits, although no specific date has been set for this. The Spanish government plans to implement a simple WLC disclosure requirement starting in 2026, with the responsibility for implementation lying with the autonomous communities/federal states, following a system similar to EPCs. The University of Sevilla, an INDICATE partner, is supporting the Ministry (CTE) with technical assistance for establishing default values to be used in the assessment.

In Czechia, the national government is preparing a public tender to develop a national WLC methodology, while the Ministry of Regional Development is considering integrating WLC requirements in the updated guidelines for green public procurement. The INDICATE consortium is actively participating in several working groups preparing for the implementation of the EPBD recast in Czechia. Additionally, WLC is a key focus during consultations for updating the national Climate Action Plan and the State Energy Concept.

[45] https://www.gov.ie/en/publication/f3551-report-of-the-housing-commission/
[46] https://enterprise.gov.ie/en/publications/publication-files/reducing-embodied-carbon-in-cement-and-concrete-through-public-procurement-in-ireland.pdf
[47] https://www.gov.ie/pdf/?file=https://assets.gov.ie/288344/3b6eece7-7d30-47c5-895e-0512a0e9b3f8.pdf#page=null
[48] https://lda.ie/uploads/documents/LDA-Sustainable-Development-Strategy-2024-2028.pdf
[49] https://protocolsostenibilitat.amb.cat/

Annex V - Level(s) minimum scope of building parts

Building parts	Related building elements	Expected lifespan
	Shell (substructure and superstructure)	
Load bearing structural frame	- Frame (beams, columns and slabs) - Upper floors - External walls - Balconies	60 years
Non-load bearing elements	- Ground floor slab - Internal walls, partitions and doors - Stairs and ramps	30 years
Facades	- External wall systems, cladding and shading devices - Façade openings (including windows and external doors)	30 years (35 years glazed) 30 years
Building parts	**Related building elements**	**Expected lifespan**
	- External paints, coatings and renders	10 years (paint), 30 years (render)
Roof	- Structure - Weatherproofing	30 years
Parking facilities	- Above ground and underground (within the curtilage of the building and servicing the building occupiers)	30 years
	Core (fittings, furnishings and services)	
Fittings and furnishings	- Sanitary fittings - Cupboards, wardrobes and worktops - Floor finishes, coverings and coatings - Skirting and trimming - Sockets and switches - Wall and ceiling finishes and coatings	20 years 10 years 30 years (finishes), 10 years (coatings) 30 years 30 years 20 years (finishes), 10 years (coatings)
In-built lighting system	- Light fittings - Control systems and sensors	15 yeras
Energy system	- Heating plant and distribution - Radiators - Cooling plani and distribution - Electricity generation - Electricity distribution	20 years 30 years 15 years 15 years 30 years
Ventilation system	- Air handling units - Ductwork and distribution	20 years 30 years
Sanitary systems	- Cold water distribution - Hot water distribution - Water treatment systems - Drainage system	25 years
Other systems	- Lifts and escalators - Firefighting installations - Comm unication and security installations - Telecoms and data installations	20 years 30 years 15 years 15 years
	External works	
Utilities	- Connections and diversions - Substations and equipment	30 years
Landscaping	- Paving and other hard surfacing - Fencing, railings and walls - Drainage systems	25 years 20 years 30 years

Table 8 - Default service lives for the minimum scope of building parts ond elements

Source: Level(s) indicator 1.2: Life cycle Global Warming Potential (GWP). Accessible at: https://susproc.jrc.ec.europa.eu/product-bureau/sites/default/files/2021-01/UM3_Indicator_1.2_v1.1_37pp.pdf

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