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

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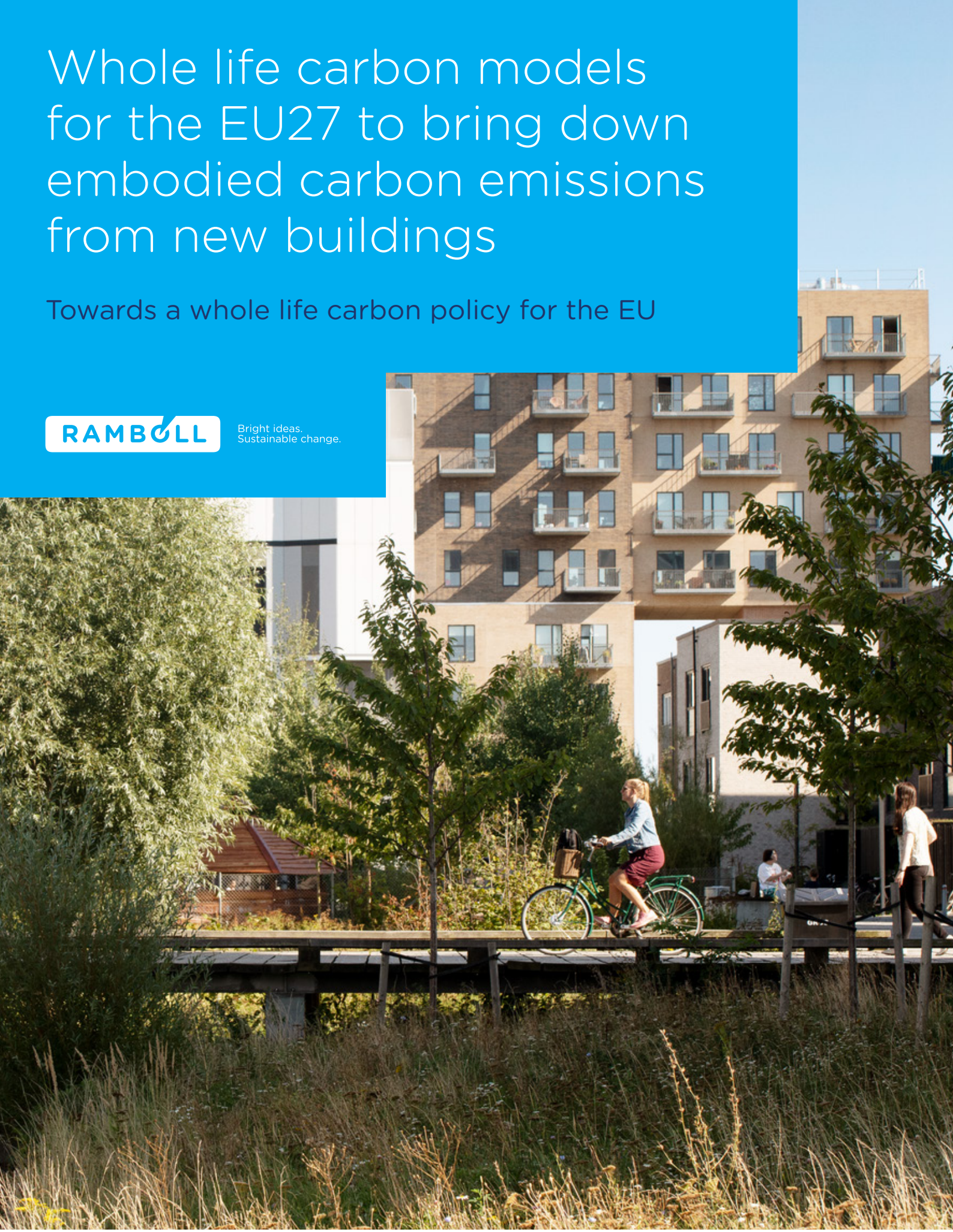

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Whole life carbon models for the EU27 to bring down embodied carbon emissions from new buildings
Towards a whole life carbon policy for the EU

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Description	This report proposes requirements for a process and elements to establish a policy model to reduce building sector emissions beyond operational emission from the use phase with the objective to reduce the whole-life carbon (WLC) impact of buildings in Europe.

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List of abbreviations

CPR	Construction Products Regulation
DBL	Digital Building Logbook
EN	European Standard
EPBD	Energy Performance of Buildings Directive
EPC	Energy Performance Certificate
EPD	Environmental Product Declaration
GHG	Greenhouse Gas (Emissions)
ISO	International Standardisation Organisation
LCA	Life Cycle Assessment
PEF	Product Environmental Footprint
WLC	Whole Life Carbon

Executive summary

Background and purpose

Operational greenhouse gas (GHG) emissions of buildings are regulated at the EU and national levels through energy efficiency and renewable energy requirements. In contrast to this, legal requirements on whole life carbon (WLC) which also includes the embodied GHG emissions (or embodied carbon) from construction products, processes, and end-of-life treatment exist in only a few EU countries. However, the ongoing negotiations of the Energy Performance of Buildings Directive (EPBD) include the introduction of WLC calculation, reporting, and reduction.

To realise European and international climate commitments, policy instruments are needed to govern and reduce building and real estate sector GHG emissions beyond operational ones are needed. Yet, clear, consistent and effective policy instruments are missing at the EU level and consequently also in most EU Member States. This in turn causes challenges for business activities across borders, as scopes, methods and limit value formulations vary for every country – if they are specified at all. A process to define the key features of an effective policy instrument has to be implemented quickly to respond to the urgent challenges posed by climate change as well as ensure the good functioning of the Internal Market.

This report proposes a policy model to introduce WLC reduction policies at the EU level in a way that ensures whole life climate impacts are monitored and governed across all 27 EU countries. The work is part of the project "Whole Life Carbon Models for EU27 to Bring Down Embodied Carbon Emissions from New Buildings", funded by the European Climate Foundation (ECF). It builds on a first report that reviews and compares existing national policy models in the EU for regulating and reducing embodied carbon emissions from new buildings.

Objectives for an EU WLC policy

The EU has a strong opportunity to overcome the challenges to ensure that embodied carbon as part of WLC is reduced in line with the EU Climate Law. These goals require aligning and enhancing efforts in policy and industry to reduce WLC emissions of buildings. Additionally, EU-level legislation provides the **opportunity to reduce the complexity for practitioners** in building design and construction through a certain degree of harmonisation across EU Member States. To support this, an initiative on reducing WLC should be accompanied by **instruments to support the capacity development** in Member States and value chain segments with the largest lack of awareness and skills. This will ensure rapid implementation – and reduction – in all countries.

More specifically, the policy instrument has to enable **the generation and sharing of data for measuring and reporting embodied emissions,** as part of the emissions over the whole life cycle.

This creates a basis for a **transparent and harmonised calculation method** for LCAs among other requirements and preconditions, which is necessary for reducing complexity, ensuring quality and enabling monitoring. This includes **generating product-level data on life cycle impacts** consistently and comparably (in line with EN 15804 A2) and **defining WLC reduction targets.** Reducing the complexity further benefits from **creating consistent rules across the building and construction regulations** in the EU and avoiding cross-border complexity in building design and material supply. Finally, the **necessary tools and resources for developing the capacity** in all of Europe need to be provided.

The proposed policy model for reducing WLC of buildings

Based on the previous considerations, an appropriate policy model should work around different tiers and stages that allow different speeds and complexities between frontrunner Member States and others which follow or have not yet started developing WLC awareness and capacity.

The principle of this option would be to lay a common foundation for WLC reduction by offering an EU method for calculating, assessing and reducing WLC as a basis for harmonisation over time. This would allow the EU to define a legal obligation for Member States to have a mitigation policy for the climate impact of buildings beyond operational GHG emissions in place. Existing policies that are based on comparable principles could be kept, while harmonisation is pursued.

The tiers of the policy models are the following:

1. EU-level legislation to define the elements necessary for WLC monitoring and governance in all EU countries, including those without existing WLC and LCA initiatives
2. Existing national policy models that are based on European standards and satisfy legal requirements for effective decarbonisation
3. Harmonisation process to form comparable approaches and results all across the EU

EU-level legislation represents the most immediate action point to enable a quick and simple implementation across the EU. Existing national policies can be maintained if they can show that they meet the requirements defined in EU legislation. Therefore, pioneers can continue to use and develop their policies and other countries are incentivised to start developing legislative measures as soon as possible. Through revision cycles in national and EU instruments as well as standardisation processes, the harmonisation towards largely standardised and comparable mechanisms should then be pursued.

At the EU level, the existing landscape of legislation and voluntary tools provides a relevant starting point. The revision processes of the Energy Performance of Buildings Directive (EPBD) and Construction Products Regulation (CPR), represent sectoral legislation that has a strong potential to form a legislative entry point. Particularly, the CPR and its current revision process have strong interlinkages with the ability to reliably quantify life cycle impacts. Therefore, the timeline of this legislation needs to speed up to prepare the ground for WLC instruments. The existing, voluntary Level(s) framework provides an operationalised calculation method for WLC in line with EN 15978 which the legislative framework can leverage for an obligatory system. Table 1 summarises the key features for which requirements need to be defined as indicated in more detail in the report.

Table 1: Key features for the policy elements for which requirements have to be defined

Life cycle assessment method	WLC reduction framework
System boundaries	Target or limit values
Calculation method	Compliance governance
Product-level data on life cycle impacts	Connection of LCA results to the building
Building and life cycle models	Collection of LCA results

The process of engaging with academia, NGOs, industry and design practitioners in defining the exact elements of the EU-level legislation is a crucial prerequisite for the success of the legislation. We define **key requirements of the elements** identified that serve as a checklist for the quality of an EU policy model. The requirements for these elements include specific points of attention and guidance for the following WLC policy elements:

Support schemes will be needed to support countries and regions with low capacity. In anticipation of this, the proposed model suggests some mechanisms that should be considered to develop capacity across Europe and ensure a gradual uptake in countries with the lowest capacity. Relevant options to explore are

- A transitional limited building scope
- Developing LCA calculation tools
- Qualification of relevant expertise
- Simplified assessment during transition period

Process for the next steps

Policymakers – together with standardisation bodies and all other stakeholders – have to act to define a policy model that establishes a consistent framework for monitoring, assessing and reducing climate impacts caused by buildings beyond the existing focus on operational emissions. The addition of whole life carbon policies to the current focus on energy efficiency is urgently needed to make use of the full mitigation potential.

A series of steps are needed to overcome current challenges for WLC reduction and implement an approach that realises rapid and effective reduction across the EU.

The initial steps have to be taken by EU policymakers to enable the implementation of national policies and further harmonisation over time. In this process, the involvement of expert communities, stakeholders and calculation and reporting frameworks is essential to build on existing knowledge and structures for an easy-to-use approach. A possible simplified approach needs to be defined as part of this early on.

The defined approach needs to be integrated into the EPBD, either in a rapid revision or by already foreseeing provisions that link to its future existence. This also includes associated processes such as the preparation of Energy Performance Certificates and certifying bodies for WLC reporting. Ensuring the availability of product-level data, appropriate assessment methods, calculation tools, well-trained designers and experts and capacity development mechanisms have to be part of the initial actions by the EU as well.

At national level, the development of policies should take place at the latest once EU legislation and support is adopted. From there on, policy revision processes will need to drive the harmonisation process that levels up the comprehensiveness and ambition of WLC governance to a European standard that lives up to the dimensions of the challenge created by GHG emissions from buildings.

While the instruments and requirements in this report focus on new buildings, an expansion to renovation (also referred to as refurbishment) of existing buildings is necessary. This will ensure that absolute whole life carbon levels are reduced as much as possible across the building stock. Additional research and policy design is needed to prepare this extension of scope.

About Ramboll and KU Leuven

Ramboll is a global consultancy delivering sustainable change across 35 countries. With a civil engineering legacy, Ramboll also comprises management consulting, architecture, and environmental services to deliver a holistic take on the green transition – in the buildings sector and in similar industries.

Specifically in the building sector, Ramboll has worked to develop understanding of whole life carbon (WLC) in theory and contribute to its reduction in practice. Studies for the World Green Building Council, the Laudes Foundation, the European Commission's Directorate-General for Environment, and publications based on practical experience of working with Life Cycle assessment frameworks across Europe bring embodied and WLC to the centre of the industry-policy-research nexus. At the same time, Ramboll's experts help clients in the construction industry to understand life cycle impacts and costs and are pioneering low embodied carbon construction in building design across high-profile development projects to reduce embodied and operational carbon emissions.

KU Leuven is Europe's most innovative university. Located in Belgium, it is dedicated to education and research, and as such to service to society. KU Leuven is a founding member of the League of European Research Universities (LERU) and has a strong European and international orientation. Our scientists conduct basic and applied research in a comprehensive range of disciplines.

The Architectural Engineering research group aims for innovation in the design of buildings by approaching architecture from an engineering point of view. The emphasis is on the technical aspects of architecture – structure, materials, services and comfort requirements – are considered in a multidisciplinary setting in order to quantify, assess and improve the quality, cost and sustainability of buildings and the built environment. In order to achieve this goal, fundamental, applied and policy-oriented research is performed, and a continuous effort is made to bridge the gaps between research, education and practice. The research group offers deep expertise in life cycle environmental impact assessment and life cycle costing of the built environment. Various scale levels are focused on building materials, building elements, buildings, neighbourhoods and cities, as well as national and trans-national building stocks.

Ramboll and Martin Röck (KU Leuven) have cooperated with Aalborg University on the project "Towards embodied carbon benchmarks for buildings in Europe" funded by the Laudes Foundation. Currently, together with BPIE, Ramboll and KU Leuven are working on the ongoing study "Supporting the Development of a Roadmap for the Reduction of Whole Life Carbon of Buildings", contracted by the European Commission's DG ENV. More specific country-level information and reduction pathways will be developed in a starting project for the European Commission's DG GROW on the "Analysis of Life Cycle Greenhouse Gas Emissions and Removals of EU Buildings and Construction".

[1] Reports and additional information available at https://c.ramboll.com/lets-reduce-embodied-carbon and https://doi.org/10.5281/zenodo.6397514

[2] More information available at https://c.ramboll.com/whole-life-carbon-reduction

1. Introduction

With the EU's aim to decarbonise its economy and be fully climate-neutral by 2050, significant greenhouse gas (GHG) emission reductions will be required from all sectors and industries. The EU's construction and real-estate sectors are responsible for 36% of the EU's energy-related GHG emissions, of which embodied carbon – emissions from the construction phases and, most significantly, the manufacturing of the construction materials used in buildings, such as cement, steel, glass and insulation – is responsible for 10-20% of buildings' GHG footprint. In the life cycle of an energy-efficient building, the share of the embodied part is around or even beyond 50%.

So far, political and regulatory efforts in the EU and its Member States have focused on operational energy use and GHG emissions which are caused by the day-to-day operation of a building. A key policy in this respect is the Energy Performance of Buildings Directive (EPBD), which has been transposed and implemented in all EU countries.

In contrast to operational emissions, legislation on embodied emissions, or whole life carbon (WLC) as the sum of both emission categories, is rare. Only a few EU Member States have so far either already implemented or have plans in place for the implementation of different policies to regulate buildings' life cycle-related emissions more comprehensively. Of these countries, Denmark, France, Netherlands, Finland and Sweden are the most advanced in their legislative development, while some other countries, including Germany, have mature LCA methodologies and related funding programmes in place. Their experiences may prove valuable and relevant at the European level.

As a result of the Renovation Wave plan of the EU Commission, the EPBD is currently under revision. The proposed version and latest discussions introduce the indicator of whole life carbon to the Directive, which has so far focused on the improvement of the in-use energy efficiency of buildings. This has sparked a debate around the level of ambition, timeline and possible performance requirements. This report contributes to the debate by highlighting how ambitious policies could be designed.

In this context, policy instruments for the governance and reduction of building sector GHG emissions beyond operational ones are needed. This has to be based on a clear understanding of the specific challenges to overcome and the related objectives. From this, it will be possible to develop a policy model.

This report proposes a policy model to introduce WLC reduction policies at the EU level in a way that ensures whole life climate impacts are monitored and governed across all 27 EU countries. The work is part of the project "Whole Life Carbon Models for EU27 to Bring Down Embodied Carbon Emissions from New Buildings", funded by the European Climate Foundation (ECF). In a second step, the findings of this comparison will be used to develop and propose a model that could fit other EU Member States.

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2. Why are policy measures needed at eu level to reduce wlc emissions of buildings?

2.1 Targeted policy actions to reduce whole life carbon emissions of buildings are needed for Europe to achieve the targets set in the Paris Agreement and the EU climate law

The construction and real-estate sector is a substantial contributor to anthropogenic GHG emissions. Overall, this sector represents 36% of the EU's energy-related GHG emissions when considering the whole life cycle of buildings . Ongoing work by some of the authors of this report finds that embodied carbon accounts for 20-25% of building WLC emissions across the EU, which relates to a share of 8-10% of the overall EU's energy-related GHG emissions. For a building, 70-80% of embodied emissions are upfront, with the vast majority stemming from materials used in construction. In the European building stock, 55% of yearly embodied emissions stem from the construction of new buildings, even though new construction accounts for less than 2% of the floor area of the EU building stock in a given year. Maintenance, repair, refurbishment, or demolition cause the remaining share.

Therefore, the reduction of the climate impact of the building and real estate sector needs to go beyond operational emissions and include embodied carbon from a whole life perspective. However, the EU's measures so far only set requirements for the improvement of energy efficiency and the use of renewable energy.

These requirements mean that embodied emissions become more and more dominant in the climate footprint of the building and real estate sector following a macro-economic perspective, but are not covered so far.

However, **incentives for the reduction of embodied emissions and the associated external costs are sparse and a business case for action is lacking.** Contrary to energy efficiency in buildings the business case for investing in low embodied carbon buildings is less than obvious. Also, supply and decision-making chains are long and complex, which limits the immediate accountability of any single actor in the construction sector. Thus, the uptake of reduction strategies is slow, even if such strategies exist. This situation creates a need for policy intervention to ensure rapid decarbonization – in line with climate commitments and scientific findings about the emergency of mitigation action.

[1] UNEP. (2023). Global Status Report for Buildings and Construction. Available at: https://globalabc.org/resources/publications/2022-global-status-report-buildings-and-construction Whole life cycle emissions comprise the emissions caused by the construction (including material production, transport and construction processes), maintenance, replacement and refurbishment of the building, demolition and end-of-life treatment of the materials as well as energy needs during the building use.

[2] The numbers in this paragraph relate to a forthcoming report as part of the European Commission's initiative Supporting a Roadmap for the Reduction of Whole Life Carbon in Buildings. The mentioned findings originate from the modelled baseline quantification of WLC in the EU.

2.2 Policy efforts to reduce WLC exist in a few Member States only and are missing at the EU level

Yet, policy action beyond operational energy use is missing at the EU level so far. Recent instruments and proposals such as the EU Taxonomy and the proposed revision of the EPBD introduce the concept of WLC as a reporting requirement. However, a method for governing WLC based on a life cycle analysis (LCA) is not defined in this process so far.

In the absence of policy attention at the EU level, some Member States have developed national legislative measures and underlying calculation and assessment methods for reporting and reducing embodied carbon in addition to operational carbon. A recent study published by the authors of this report shows the approaches chosen by five EU countries with legislative requirements. A few additional countries have non-legislative instruments or are considering embodied carbon or WLC regulation. In the majority of countries where no such initiative exists, WLC is mostly addressed by voluntary industry initiatives, e.g., through sustainability certification schemes.

The result is a highly complex and incomplete coverage of buildings. In this scattered regulatory landscape, major shares of embodied emissions remain outside of the scope of the legislation.

Also, construction in most parts of Central and Eastern Europe, as well as Southern Europe, will likely not see systematic reduction efforts in the near to mid-term future.

This means that without EU action, decarbonisation commitments at the EU and national levels are put at risk. Continuously high and increasing embodied carbon levels could undermine the reduction efforts agreed in the EU Climate Law and Nationally Determined Contributions to achieving the targets set in the Paris Agreement.

The relevance of enhancing decarbonisation efforts in the building sector is acknowledged in multiple EU policies and strategies, where it is recognised that national approaches, following the subsidiarity principle, do not achieve the needed transformations in the required timeframe. Experiences made in measuring and reporting the energy efficiency of buildings show that a scattered landscape of approaches is difficult to overcome. A clear roadmap for the development of EU instruments, however, can provide direction and clarity on requirements that support an approach which is as harmonised across the EU as possible.

2.3 The missing harmonisation at EU level creates a lack of transparency and market inefficiency

Standards for the harmonisation of LCAs and key parameters for LCA calculation exist but are not up to date and lack prescriptive power. At the basis of all methods lies the EN 15978 standard which aims to provide harmonised calculation rules for the environmental performance of new and existing buildings. This standard defines key underlying principles but does not give a specific indication about how the calculation should be done. Moreover, it was developed in 2011 and does not provide answers to current challenges such as how to account for the on-site generation of renewable energy. The mentioned national legislative approaches and voluntary sustainability certification schemes such as BNB/DGNB, LEED, or the EU Level(s) framework have developed their own guidelines based on the EN 15978 standard. Therefore, all existing initiatives chose different ways of calculation, which means that the steps and results are not comparable without complex adjustments.

In addition, the scattered situation of WLC frameworks creates an increasing level of complexity.

Whether an LCA of a building is prescribed by national legislation or whether other initiatives may exist varies from one country to another. In addition, each instrument in national legislation or voluntary sustainability certification comes with a specific method for LCA calculation.

This situation is further complicated by competing initiatives to create comparable data on construction materials and products. The calculation and reporting according to the Product Environmental Footprint (PEF) is proposed by the EU Commission but hardly used among industry actors. In contrast, most existing product-level data is established according to Environmental Product Declarations (EPDs), for which a standard exists in EN15804 A2. However, the implementation is not entirely consistent, which creates problems with the reliability of the information presented. A clear definition of the format and information, as well as requirements for consistent and comparable data, is therefore highly needed.

Different calculation methods and definitions mean that critical indicators and criteria cannot be compared, even when their names are the same. For instance, the life cycle global warming potential (GWP) is crucial in understanding the climate impact of a building. However, different scopes, reference study periods or data sources on materials' emissions can impact this metric substantially. As a result, a transparent assessment of WLC reduction efforts against climate targets is extremely difficult, and comparisons of buildings across borders are nearly impossible.

As a consequence, developers and architects with projects in multiple countries face a complex landscape. This complexity may hinder both cooperation and competition and the identification of best practices in delivering low-carbon buildings. In addition, since the approaches taken by EU countries are based on different methodologies, which means that specific tools and databases are needed. Therefore, substantial additional costs occur for the industry. In case further countries adopt legislation with their own methodologies, the picture will only become more complex.

2.4 The lack of coordinated EU action means that some Members States and industry players are left behind

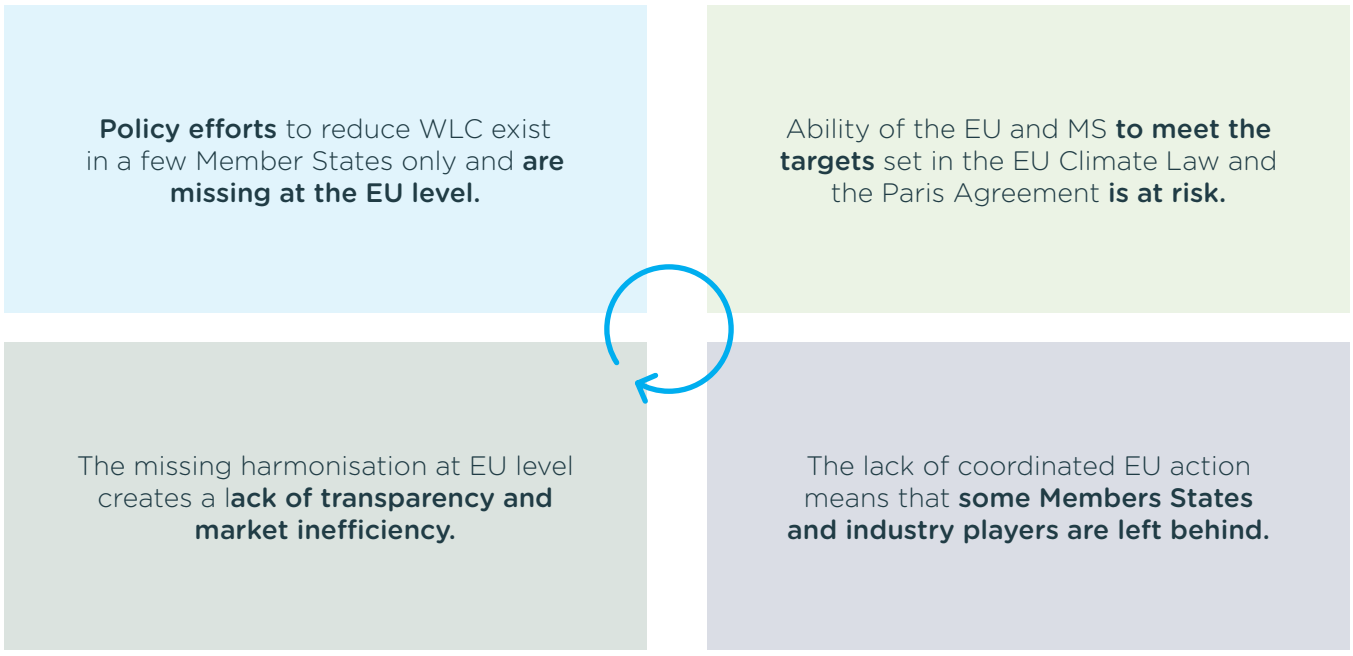
As a result of the described situation, awareness and skills to perform LCAs and reduce embodied together with WLC are also highly heterogeneous. This applies to both policymakers and public authorities as well as the actors in the construction and real-estate sector.

Where legislation has been introduced or sustainable building certification is common, capacity development can be already well-advanced. **However, in other EU countries, the capacity is still very low and needs to be built entirely to achieve WLC measuring and reduction.**

These countries risk being left behind and would benefit from consistent methodologies as well as targeted support to implement successful practices and overcome initial capacity barriers.

In summary, the four problems illustrated in Figure 1 underline the need for EU policy to bring down building sector emissions beyond operational carbon.

Figure 1: Four reinforcing problems call for an EU initiative for reducing whole life carbon emissions of buildings.

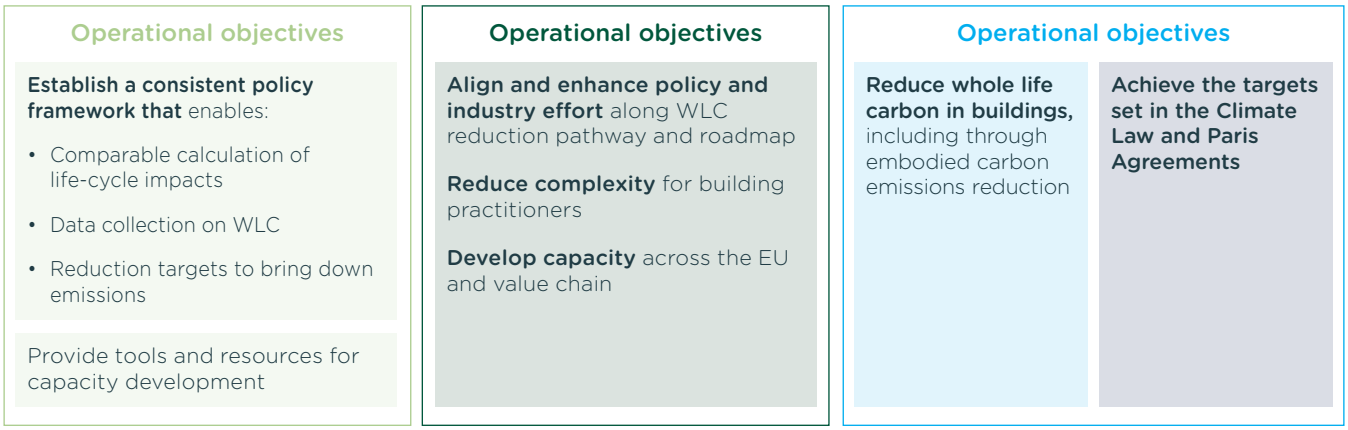


3. What objectives should EU legislation achieve?

The EU has a strong opportunity to overcome these challenges to ensure that embodied carbon as part of WLC is reduced. At the high level, general objectives directly relate to the challenges described above. Specific objectives outline the features that are needed to realise the general objectives.

Figure 2 summarises the objectives which are then outlined in the following. This chapter presents these objectives before Chapter 4 describes the proposed policy option to realise the necessary steps.

Figure 2: Intervention logic for an EU whole life carbon policy model



3.1 General objective

The overall priority is to ensure that embodied carbon is included in the EU's climate mitigation efforts in a way that is aligned with the overarching climate action ambition. Effectively, this means that the resulting policy should introduce an embodied carbon reduction framework to reduce WLC emissions from buildings in line with the EU's climate objectives of climate neutrality.

3.2 Specific objectives

As a first specific objective, these goals require aligning and enhancing efforts in policy and industry to reduce WLC emissions in line with the climate targets. Targets for global warming are linked to a GHG budget of remaining emissions that cannot be exceeded. As the construction and real estate sector causes substantial amounts of emissions at the moment, a transition is needed along a pathway. The definition of such a pathway needs to originate from a policy process to bridge climate necessity and practical feasibility. This way, a WLC policy creates the necessary predictability on future levels of ambition that are needed for planning and preparing investments.

Secondly, EU-level legislation provides the opportunity to reduce the complexity for practitioners in building construction. it simplifies the calculation of LCAs in the entire EU, especially for international investors and developers, and also facilitates benchmarking against best practices across borders. Moreover, it expands equal access to the single European market for sustainable construction products.

To support this, **an initiative on reducing WLC should be accompanied by instruments to support the capacity development** in Member States with the largest current lack of awareness and skills. This will ensure rapid implementation – and reduction – in all countries.

3.3 Operational objectives

At an operational level, these objectives can be translated into detailed steps that shape the development of a WLC instrument.

An instrument has to be established that enables the generation and sharing of data for measuring and reporting embodied emissions, as part of the emissions over the whole life cycle.

A transparent and harmonised calculation and assessment method for LCAs is necessary for reducing complexity and enabling monitoring. Therefore, the fundamental elements of the methodology need to be defined in a harmonised manner. This enables consistent monitoring and reporting of embodied and whole life carbon and thus allows governing those emissions. The targeted level of harmonisation should at least include the key calculation elements such as scope and system boundaries, the assumed service life and data sources on materials' emissions. The results of international academic collaboration can act as a starting point.

This includes **generating product-level data on life cycle impacts consistently and comparably.** Thus, a clear requirement for material producers to provide data in the form of EPDs according to the latest standard need to be defined rapidly to enable the calculation at the building level.

In addition to monitoring and reporting, **WLC reduction targets as benchmarks and mitigation pathways are needed to bring down emissions and ensure climate targets are met.** The policy instrument should therefore foresee and specify the introduction of limit values or similar mechanisms to require the reduction of embodied emissions along a reduction pathway over time.

Reducing the complexity further benefits from **creating consistent rules across the building and construction regulations in the EU and avoiding market distortions.** Also, alignment with building sector practices and digitalisation developments such as the bill of materials and building information modelling simplifies the adoption of LCA practices and reduces efforts for conducting such analyses.

Finally, the **necessary assessment tools and resources for developing the capacity in all of Europe need to be provided.** This allows stakeholders with no or limited experience in applying the LCA methods to familiarise themselves and learn about processes, data sources and good practices.

3.4 Considerations for an EU policy model

The EU has the opportunity to lead the process of developing the framework for the effective reduction of the climate impact of buildings beyond operational GHG emissions. For this, a specification of a series of building blocks of WLC reduction policies – and further subcomponents – is needed. This way, delays in addressing embodied carbon and a further fragmented and inconsistent landscape of measures can be prevented.

However, a full specification of all the parameters for LCA calculation is not considered realistic. For instance, beyond the basic calculation specifications, LCAs involve scenarios for life cycle stages beyond the upfront materials (A1-A3). Developing these scenarios depends on national market characteristics and infrastructure and therefore needs to be undertaken more granularly than at the EU level.

Most importantly, however, **many elements of the WLC reduction framework are best developed at the national level.** EU-level limit values or similar reduction measures cannot easily reflect existing policies and building practices in the Member States. If an EU-level framework of limit values was to be designed, the complexity would be immense, with multiple adjustment factors resulting in a higher burden for developers and authorities as well as limited benefits for transparency and comparability. Along those lines, a recent publication by OneClick LCA ranked simpler existing national approaches more open than the ones working with a substantial amount of correction factors to limit values.

Thus, an EU policy that reduces buildings' GHG emissions beyond operational carbon, needs to take a targeted approach to the harmonisation of LCA calculations and foresee reduction measures at the national level. This means that ensuring consistent reduction of emissions and improving the complex situation for the industry have to be balanced with flexibility for national policies and practices. The next chapter presents a proposal for such a targeted and balanced approach.

4. How could an EU policy model of targeted harmonisation look like?

Based on the previous considerations, an appropriate policy model should work around different tiers and stages that allow different speeds and complexities between frontrunner Member States and others which follow or have not yet started developing WLC awareness and capacity.

The principle of this option would be to lay a common foundation for WLC reduction by offering an EU method for calculating and reducing WLC as a basis for harmonisation over time. This would allow the EU to define a legal obligation for Member States to have a reduction policy for the climate impact of buildings beyond operational GHG emissions in place. Existing policies that are based on comparable principles could be kept, while harmonisation is pursued.

Therefore, the tiers of the policy models are the following:

1. **EU-level legislation** to define the elements necessary for WLC monitoring and governance in all EU countries, including those without existing WLC and LCA initiatives
2. **National policy models** that are based on European standards and satisfy legal requirements for effective decarbonisation
3. **Harmonisation process** to form comparable approaches and quality-proofed results all across the EU

In each of the three tiers, the building blocks need to be present and work together in a package. Developing an adequate methodology has to be a process based on stakeholder engagement and scientific exchange. Therefore, this proposal cannot provide all specific elements in detail. Ongoing and planned initiatives to revise and clarify EN 15978 as well as EU instruments like the EPBD and the CPR will be needed to develop the rules and guidelines of the essential parameters.

However, the following principles and mechanisms are considered highly relevant to drive and develop the policy framework beyond operational carbon towards a WLC reduction of building emissions.

The policy model presented here has been developed based on the research done by the authors in relation to existing national legislation, standards, and publications of recent research into LCA methods, WLC policies and roadmaps as well as targeted interviews with experts for EU building policy, standardisation, and product data infrastructure.

4.1 EU-level legislation

Our proposed model enables relatively quick and simple implementation in countries with little current capacity. This approach will be applied by all EU countries that do not have a robust and effective national approach by the time EU legislation on WLC enters into force. EU policymakers have to set this model in action as soon as possible to avoid delayed action. Based on this national implementation can be required by EU law to realise the objectives outlined above.

The policy model contains three building blocks. Each building block includes several elements or options for which guidance and requirements are defined in the following. The three building blocks are:

1. Life cycle assessment method and data
2. Whole life carbon reduction framework
3. Capacity development mechanism

The process of defining the exact elements of the EU-level legislation is a crucial prerequisite for the success of the legislation. As has been the case in existing national legislative processes, the engagement of the private sector, academia, existing reporting frameworks and NGOs will ensure acceptance and buy-in from these actors.

It is essential to align with the latest developments in European standard setting, product-level data collection, and calculation tools. The EU policy model should integrate these items into an operative approach. During this process, the potential need for revisions to other legal documents such as the EPBD, CPR, or the EU Taxonomy must be considered to create and maintain a consistent policy framework. None of these consultations, alignments and negotiations can be avoided. Therefore, our model lays out the main building blocks that are needed for the EU legislation together with directions for good practices.

The EPBD provides a relevant policy framework to support the sustainability of buildings in the EU, and its revision provides the opportunity to introduce the whole life carbon perspective. The EPDB is currently still under discussion in trialogue involving the European Council, the European Parliament and the European Commission. The proposal made by the EU Commission and the position adopted by the EU Parliament illustrate that this legislation constitutes a basis to expand the definition and requirement for key parameters of LCA calculation and assessment in addition to reducing operational energy use.

The relevance of product-level environmental data is moreover acknowledged in the current revision process of the CPR. However, the currently envisaged timeline conflicts with the rapid development of WLC policies, as Box 4.1 highlights. Yet, the wide coverage of standardised, comparable product-level data that can be achieved through this regulation is an important foundation. Therefore, active integration into the timeline of governing and reducing WLC is highly necessary.

Additionally, the Level(s) framework, developed by the European Commission has already initiated the work to operationalise the life cycle assessment of buildings at the European level. However, the impacts of Level(s) still need to be determined as it remains a recent and voluntary framework to this point, which takes a holistic perspective on building sustainability but has not seen widespread uptake in practice.

In the development process efforts should be made to create a balance between ambition and practicability. Comprehensiveness and accuracy of quantifications are relevant but need to be limited to the extent realistically feasible to limit administrative burden and enable rapid uptake of the model.

In the following, the key requirements of the first two building blocks are defined and the elements for necessary action are identified. This is intended as a checklist for the quality of an EU policy model. The requirements for these elements are presented in Table 2 The elements of the building blocks of the life cycle assessment method and performance framework need to go hand in hand for an effective impact.

Table 2: Necessary actions to develop life cycle assessment methods and a performance framework for an EU WLC policy

Life cycle assessment method	WLC reduction framework	Harmonisation
Building block No.1: Life cycle assessment method and data		
System boundaries	• Define system boundaries for buildings, building elements, and life cycle stages, **in a transparent and relevant manner at the European level** • Require LCA calculations from **all new buildings** as quickly as possible. **Prepare for the inclusion of major renovation** projects by supporting the development of specific quantification methods. • Include coverage of **key embodied emission drivers** (at the minimum: foundation, structural frame, façade, technical systems) and on-site **renewable energy generation installations** • Develop system boundaries in exchange with standardisation initiatives and stakeholders while operationalising **existing standards** (EN 15643 and upcoming EN 15978-1) and allowing to accommodate upcoming revisions	• Fully harmonised in EU legislation

Life cycle assessment method	WLC reduction framework	Harmonisation

Calculation and assessment methods	• Define reliable methods for calculating the whole life cycle impact that are **standardised at the EU level** and can be applied to different national contexts
	• Consider key elements:
	  • the definition of floor area,
	  • the reference study period
	  • the calculation of generated, self-used and exported renewable energy
	  • the approach to accounting for biogenic carbon content
	• Define the required **reporting structure of LCA results.** Intermediary results should be reported **per life cycle stage** to support design choices. **Aggregated results** may be more relevant for compliance measuring depending on limit values. Possible options for aggregation are:
	  • Fully aggregated A1-C4
	  • Aggregated for embodied and operational emissions
	  • Additional aggregation of upfront embodied emissions
	  • Specific reporting for defined system elements
	• Develop calculation methods in exchange with standardisation initiatives and stakeholders while operationalising **existing standards** (EN 15643 and upcoming EN 15978-1) and allow to accommodate upcoming revisions
		• Fully harmonised in EU legislation

Product-level data on life cycle impacts	• Define requirements that ensure that **reliable information** is available about the life cycle GWP of construction products, processes, transport and energetic performance (see Box 4.1) • Clarify the definition of emission factors (with or without upstream emissions) • Establish or promote **publicly available databases in each country** and ideally combined in an EU-level database that contains third-party **validated** data points for comprehensive coverage of construction inputs • Develop data requirements in exchange with standardisation initiatives and stakeholders while operationalising **existing standards** (EN 15804 A2, EN 15941, EN 15942, ISO 22057) and allow to accommodate upcoming revisions	• Harmonised criteria in EU legislation • National databases • Ideally combined in EU database in the future

Life cycle assessment method	WLC reduction framework	Harmonisation
Building and life cycle models	• Support the definition of **building and life cycle models per country or region** that allow for the calculation of the impact of LCA stages for which measured data cannot be provided at the time of construction • Account for the **decarbonisation** of energy and industry when developing the definition of scenarios • Develop life cycle models in exchange with standardisation initiatives and stakeholders while operationalising **existing standards** (EN 15643 and upcoming EN 15978-1) and allow to accommodate upcoming revisions	• Harmonised criteria for model definition in EU legislation • National models
Building block No. 2: Whole life carbon reduction framework		

Target or limit values	• Require the national definition of target or limit values as benchmarks for the **gradual reduction of WLC impacts** along pathways in line with overall decarbonisation commitments
	• Specify the reduction obligation **in relation to the system boundaries and calculation methods** defined (see above)
	• **Different formulations of target values are possible** if an effective reduction principle can be demonstrated:
	  • A **consistent and holistic WLC limit** is ideal for cutting GHG emissions across the entire life cycle. The target setting and reporting method will likely be more complex but is feasible as demonstrated by legislation in Denmark.
	  • If effective measures to reduce operational carbon are in place, **limit values on embodied carbon life cycle stages can be prioritised,** as is currently the case in France and Sweden.
	• Develop target value framework in exchange with standardisation initiatives and stakeholders while operationalising **existing standards** (ISO 21678) and allowing to accommodate upcoming revisions
		• National target values

Compliance governance	• Define **points in time** of the construction project at which the compliance with calculation requirements and target values are assessed. • Require compliance **along the project development** from early design based on assumptions and generic data for **obtaining the construction permit,** refined with product-specific data once available and finalised with an as-built assessment for **final confirmation**	• Principles defined in EU legislation but dependent on timing foreseen in national laws

Life cycle assessment method	WLC reduction framework	Harmonisation
Connection of LCA results to the building	• Define the instruments through which **information on WLC levels is available for future users or buyers** of a building • **Energy Performance Certificates (EPCs)** are the primary existing tool for sharing technical information on buildings. The inclusion of WLC levels can be included in this file as long as no other mechanism has been implemented. However, this requires **attention to ensure knowledge and capacity are available** across the certification bodies and individuals as well as accreditation institutions • **Digital Building Logbooks (DBLs)** could be a more appropriate instrument for sharing this and other technical information about a building in a way that is useful for experts and non-experts. However, the implementation of DBLs in the EU has not started so far.	• Principles defined in EU legislation • Implemented in a national certification context
Collection of LCA results	• Require the **central collection of data** in the Member States and create a central database for the LCA results of new buildings at the EU level • Collect data in an **anonymised** manner but with **granular** information levels (e.g. per building component, LCA stage, etc.) • Use collected data for **policy evaluation** and **development** purposes	• National collection • EU database to collect results from all countries

The proposed policy model relies on product-level data on the life cycle impact of construction products. This topic is also regulated in the CPR, which is currently in a revision process. For this reason, additional requirements may not be necessary as part of WLC legislation. However, for this purpose, the requirements of the revised CPR have to provide the data requirements of LCA calculation and WLC governance. Box 1 defines the challenges and requirements in more detail.

Box 1: Requirements for product-level data

A binding requirement for the determination and assessment of greenhouse gas emissions in the life cycle of buildings will not be successful if it is not supplemented by a binding requirement for the determination and publication of **life cycle assessment data for the construction products used in the building.** Unevaluated data (type III) in the B2B exchange format based on EN 15804 A2 is required. The application of this standard and the provision of corresponding data was and is still voluntary. The draft of the Construction Products Regulation (CPR) promises a change in the situation. It is planned to introduce an obligation to provide environmentally relevant product information. The information to be published is already based on EN 15804 A2.

However, the proposed schedule of the new CPR obligation is too long. WLC reduction legislation as proposed in this report requires high-quality product-level data before introducing target values and achieving effective reductions. In contrast, the provision of the required data could extend to 2045 under the current CPR proposal. Thus, there is a contradiction between the demand for assessment results (already introduced with Level(s) and in the proposed revision of the EPBD for 2027/2030) and the slow schedule foreseen in the CPR. The schedule should therefore be reconsidered to speed up the delivery of the data. Countries such as France that created a new obligation can be used as an example. The type and scope of the data to be provided must be **based on the planning stage:**

1. **Average values for building products are required in early planning and design phases,** preferably with an indication of ranges. Possible sources are generic data points and sectoral EPDs provided by industry associations. For more complex components, EPDs with integrated configurators should be made available. Such data provides the basis for assessment results “as planned/designed” at the time of building permit.
2. **Manufacturer- and product-specific data are required in later phases of design.** They deliver the assessment results “as built” at the time of completion/handover of the building.

It is important not only to concentrate on the indicators of the life cycle assessment but also to add information on the **biogenic carbon content** of products made from biomass. In the medium term, this should be expanded to include information on the overall carbon content for all product groups.

For a long time, the EU has supported efforts to provide uniform background data for the creation of EPDs - this process should be extended and promoted.

The implementation of such a policy will remain a challenge, even if the closest attention is paid to limiting the administrative burden. It can be assumed that there will be little concerns about the assessment and monitoring of operational climate impact. Here, the existence of the EPBD has created capacity and awareness. However, there may be a need for clarification when determining the building-integrated or building-related generation of renewable energy. Yet, experiences with quantifying and managing the embodied proportion of life cycle GHG emissions are concentrated in the countries of Western Europe, even if advances in academia have been made in all regions.

Therefore, support schemes will be needed to support countries and regions with low capacity, which constitutes the third building block. Table 3 presents some mechanisms that should be considered to develop capacity across Europe and ensure a gradual uptake in countries with the lowest capacity.

With these policy elements, an effective instrument to reduce WLC across Europe would be in place.

Table 3: Capacity development mechanisms

Life cycle assessment method	WLC reduction framework
Transitional building scope	• During a **transition period with a clearly defined and short timeline, a limited scope of new building projects could be mandated** to comply with LCA requirements and the performance framework. Focusing on large buildings (e.g. more than 1000m2 of gross floor area) means that developers with a higher capacity would be targeted, while smaller actors have more time to develop the necessary knowledge and processes.
LCA calculation tools	• **Provide adapted tools and aids** to enable a low-effort calculation process. Tools that help calculate the LCA and create reports in a format that allows **direct reporting and submission** reduce the effort for building designers and for public administration. Such tools exist for specific reporting requirements and would be highly relevant to the requirements developed for the EU policy model. The EU should define and financially support software solutions that enable access to data and make calculation processes accessible to a wide range of building designers.
Qualification of relevant expertise	• For the quantification of WLC based on LCAs, **building planners and designers** are the most suitable target beneficiaries, rather than existing energy consultants that focused on the optimisation of operational energy demand. • Yet, **training and awareness raising is needed in all market segments** to ensure requirements and their purpose are understood. Besides financing training and information events, this can also be supported through aids such as guidelines and catalogues that provide effective and accessible support to a large number of building design and construction professionals. • The **education and qualification** of LCA experts in public administration and the private sector can be **supported through EU funding instruments** such as the European Social Fund or the Just Transition Fund. • Countries with administrative experience can support countries with little experience or insufficient resources in the form of **country twinning**. In this process, relevant expertise can be developed, for instance through seminars.
Simplified assessment	• LCA modules **A1-A3, B4, B6** are the minimum requirements for the life cycle model. The temporary omission of modules C3-C4 and - separately - D1 can be considered. • Focus on **essential parts of the structure** (e.g. structural frame, load-bearing elements, slabs, roof) and the technical building equipment is conceivable. • As mentioned above, **software solutions** should be developed. Ideally, these can be adapted to the situation in individual countries. • However, the building-related share does not always have to be calculated using a software solution. Where such a process is not possible or too lengthy, **element catalogues** of standard impacts per common building component may provide a practical solution. • In the case of product data, information on **imported materials** and systems should be made available through other countries or at the EU level. In other cases, **generic data** for the specific national context should be provided via EU-funded research projects and accepted for use in calculations.

4.2 National policy models

As mentioned, some EU countries have existing legislation in place or are far advanced in the process of introducing it. These countries can **maintain their existing legislation as long as it meets all the requirements defined by the EU legislation.**

This mechanism ensures that pioneers can continue to use the policies that have followed intense negotiations, and development processes and are embedded in wider national legislation.

Such a mechanism also encourages further countries to adopt similar legislation before EU legislation can be agreed upon and all elements developed.

4.3 Harmonisation process

The policy model proposed introduces EU legislation to monitor and govern the reduction of whole life GHG emissions of buildings.

Still, **multiple approaches to some details will remain.** Differences between the exact system boundaries in national policies, the use of product-level data or the target value are acceptable at the start as long as they provide incentives and directions for effective reduction. However, **over time, these differences should be reduced** and increasing harmonisation be realised.

The magnitude of differences will only be visible once the requirements of the EU legislation are adopted. From this point, a comparison to existing national policies, as well as national implementations of the requirements, will reveal the range of variations remaining across the EU. With planned revision cycles in national policies and increasing capacities for LCA calculation in all countries, harmonisation at a high level of ambition will be feasible.

Thus, the EU policy should also foresee revision cycles that can be used to expand harmonised elements, integrate new developments in standardisation and increase the required ambition of WLC reduction.

Harmonisation means the use of methods that are largely standardised across the EU and apply comparable mechanisms, wherever standardisation is not possible. The result will be a level playing field for the national building sectors as well as effective WLC reductions across the EU.

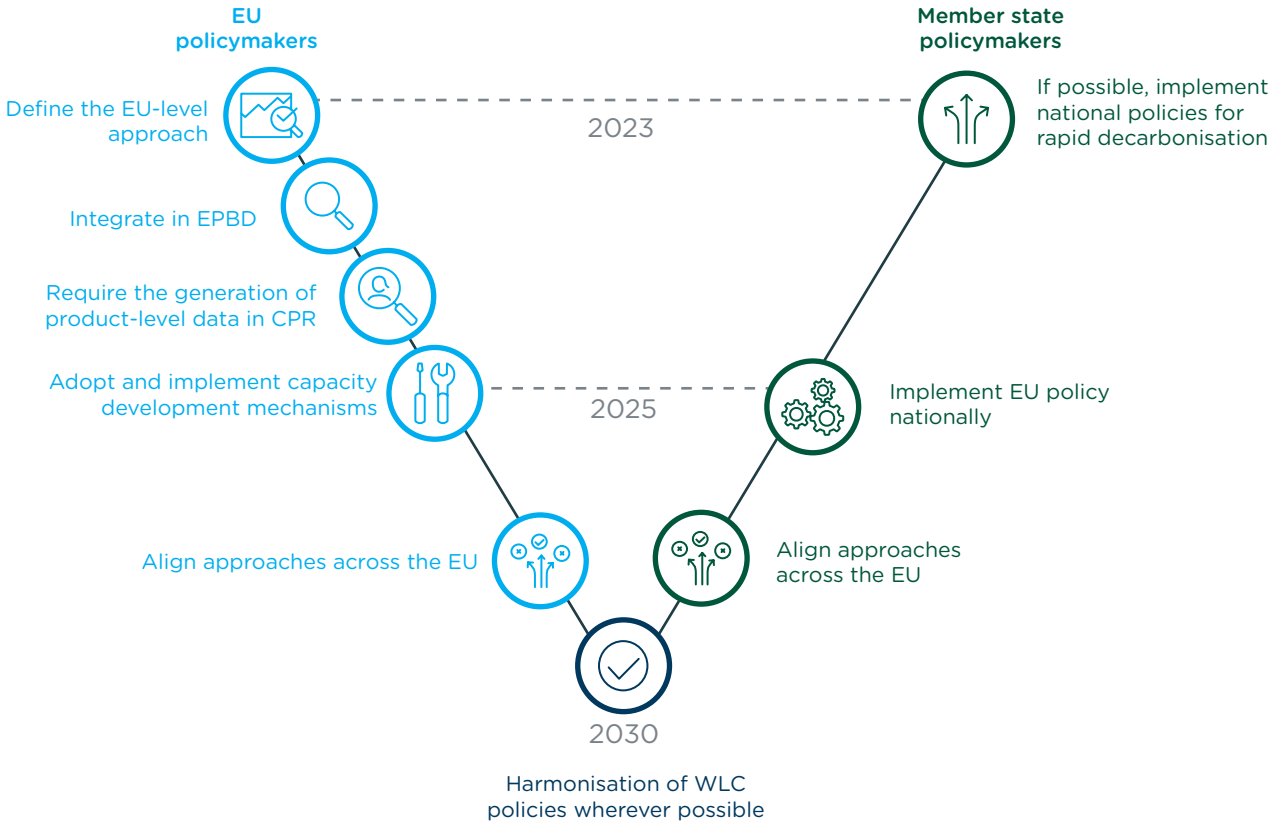
5. What next steps are necessary?

Establishing an effective reduction policy at the EU level is needed to achieve the climate neutrality target set for 2050. Policymakers – together with standardisation bodies and all other stakeholders – have to act to define a policy model that establishes a consistent framework for monitoring and reducing climate impacts caused by buildings beyond the existing focus on operational emissions.

The addition of whole life carbon policies to the current focus on energy efficiency is urgently needed.

A series of steps are needed to overcome current challenges for WLC reduction and implement an approach that realises rapid and effective reduction across the EU.

Figure 3: Next steps towards EU WLC policy



The initial steps have to be taken by EU policymakers to enable the implementation of national policies and further harmonisation over time, as Figure 3 illustrates. The EU-level approach needs to include definitions of the methodology for providing product data, calculating the life cycle impact of a building and the definition of the WLC reduction framework (see Table 2). In this process, the involvement of expert communities, stakeholders and calculation and reporting systems is essential to build on existing knowledge and structures for an easy-to-use approach. A possible simplified approach needs to be defined as part of this early on.

The defined approach needs to be integrated into the EPBD, either in a rapid revision or by already foreseeing provisions that link to its future existence. This also includes associated processes such as the preparation of Energy Performance Certificates and certifying bodies for WLC reporting. Ensuring the availability of product-level data and capacity development mechanisms have to be part of the initial actions by the EU as well.

At national level, the development of policies should take place at the latest once EU legislation and support is adopted. However, the approaches in Denmark, Finland, France, Netherlands and Sweden highlight that national policies are possible earlier. More rapid implementation and reduction should be highly encouraged and reflected in the future alignment and harmonisation process.

From there on, policy revision processes will need to drive the harmonisation process that levels up the comprehensiveness and ambition of WLC governance to a European standard that lives up to the dimensions of the challenge created by GHG emissions from buildings.

While the instruments and requirements in this report focus on new buildings, an expansion to the renovation of existing buildings (also referred to as refurbishment) is necessary. This will ensure that absolute whole life carbon levels are reduced as much as possible across the building stock. Additional research and policy design is needed to prepare this extension of scope.

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