INSTITUTE OF CIRCULAR ECONOMY

Reducing lifecycle carbon emissions of buildings in Czechia

Policy paper: The role of the circular economy and building renovations in reducing embodied carbon

Authors:

Andrea Veselá
Benjamin Hague

September 2024

The authors would like to thank the European Climate Foundation for supporting this project. The interpretation of the data, the sources used, and the conclusions and recommendations contained in this policy paper are the sole responsibility of the authors.

Supported by:

European Climate Foundation (ECF)
Buildings Programme

Table of contents

Executive summary

Embodied carbon - new challenges for decarbonising buildings
The construction sector has a significant impact on the environment, accounting for half of all extracted material consumption and a third of all waste production in the EU. Key building materials such as concrete and steel have a large carbon footprint due to the processes involved in their production, transport and use in construction. These emissions, classified as **embodied carbon**, account for a substantial part of the total greenhouse gas emissions from the EU building stock. In 2020, total life cycle emissions from buildings accounted for more than 40% of total EU greenhouse gas emissions, with embodied carbon accounting for more than 20% of emissions related to buildings. With the decarbonisation of the energy sector and the operation of buildings by switching to renewable energy sources and increasing energy efficiency, embodied carbon will dominate the Whole Life Carbon (or WLC) of new buildings by 2040.

Embodied carbon and the circular economy
The application of circular economy (CE) principles and measures is essential for reducing embodied carbon in buildings and other structures. Potential annual reductions under current modelled scenarios for the EU range between 35-60% by 2050, which can be achieved by extending the lifetime of buildings, increasing the material efficiency of buildings, increasing the use of recycled or biomass-based materials, and encouraging renovation of existing buildings.

The 'double circularity' of renovation of existing buildings
As renovations and refurbishments can reduce the demand for new construction, they represent a higher order "circularity" strategy. With significantly lower material inputs, the carbon footprint of renovating and refurbishing a building can be around 50-75% lower than an equivalent new build, while demolition can be postponed for decades. Renovations are also associated with their own material and embodied carbon footprint and should be carried out using circular principles to optimise the use of materials and minimise embodied carbon in the renovation work itself.

An updated EU policy framework for embodied carbon and circularity of buildings
Policies and legislative initiatives to decarbonise the built environment have so far focused on reducing operational emissions from buildings (from energy consumption). However, embodied carbon in building materials and products is now becoming an integral part of decarbonisation targets for both policy makers and key actors along the building value chain in the transition to carbon neutrality by 2050. In this policy paper, we describe a comprehensive set of relevant provisions that have been adopted in relation to embodied carbon and CE in various EU legislative policy

initiatives for buildings in the context of the Green Deal for Europe, including the 'Fit for 55' package, the sustainable finance framework and the New Circular Economy Action Plan initiatives.

Czechia National Policy Framework

At the national level, a number of strategic documents, plans and policies are being updated that will directly influence the national implementation of EU policy objectives, commitments and actions in the area of whole life carbon in buildings and CE in construction. These include the National Climate and Energy Plan, the Climate Protection Policy, the Waste Management Plan, the Secondary Materials Policy and the Concept for the Introduction of BIM in Public Administration. Several new documents have also been released in recent years, including the Strategic Framework and Action Plan "Circular Czechia 2040" and, this year, the National Public Procurement Strategy and the Raw Materials Policy for Wood. While these documents refer to each other, related measures are often not clearly linked and coordinated across ministries. Additional work to be done over the next two years includes the drafting of a new National Building Renovation Plan, a unified methodology for the national calculation of WLC, a draft technical standard for pre-demolition audits and a Sustainable Purchasing Action Plan, including harmonised minimum standards for responsible public procurement in various sectors including construction.

Challenges and opportunities in WLC and building circularity in Czechia

The adopted recast of EPBD 4 leaves considerable flexibility and discretion to Member States, particularly with regard to building renovation. This presents an opportunity for policy makers to leverage private sector initiatives, national research programmes and international best practices to develop an ambitious national implementation of regulatory measures on WLC and circularity of buildings in the country.
In the chapter "Towards a national approach to embodied carbon" we summarise the key activities and outputs of these projects and initiatives. For example, the Zero Carbon Roadmap (CZGBC) maps current barriers and proposes priority actions across the building sector, including those aimed at reducing embodied CO_2 emissions in buildings. We also summarise the experience to date of several European countries that have already developed roadmaps, are planning or have already implemented policies for calculating the WLC of new buildings or even introducing WLC thresholds for new buildings to accelerate their transition to low carbon construction over their life cycle. These leading countries have laid the groundwork and offer inspiration and insights for effective national implementation in the country in the coming years.

Priority areas for implementation of embodied carbon policies in Czechia

In the final chapter of this document, we propose a set of recommended actions for the following 10 priority areas in terms of embodied carbon and its future reduction in the context of Czechia. For each area, we provide related actions from this year's CZGBC Zero Carbon Roadmap, relevant (adopted) national policies, plans and strategies, and additional INCIEN recommendations.

1. Common interpretation and gradual transition to circular economy criteria as a primary framework for a "significant contribution" to the EU Taxonomy objectives

The EU Taxonomy is an essential framework motivating the early introduction of WLC calculations and greater circularity of buildings ahead of the mandatory measures in the recast EPBD. The recently published *Common Interpretation of the EU Taxonomy Technical Screening Criteria* from Czech Green Building Council (CZGBC) currently focuses on large buildings (over 5,000 m2 of usable floor area) and climate change mitigation as the Taxonomy target for "significant contribution". The circular economy transition target for Taxonomy compliance under the delegated environmental act is currently considered a lower priority and too difficult to achieve, so has not yet been included in the interpretation. There have already been calls at EU level for closer alignment of the GWP (global warming potential) and CE criteria in the Climate and Environmental Acts of the Taxonomy for Buildings to accelerate the phasing in of the calculation and reporting of WLCs before they become mandatory under the requirements of EPBD 4, and to encourage wider uptake of the EPD and the application of circular building design principles under the EU Level(s) framework.

2. Preparation for LCA calculation and subsequent WLC reduction

Mandatory WLC (life cycle GWP) calculations for new buildings is a significant new requirement introduced by the revised EPBD 4, which has so far received relatively little attention in preparation for national implementation of the Directive. Although, at the time of writing, we are three and a half years away from the entry into force of the first mandate (from 2028 for buildings with a useful floor area of more than 1,000 m2), thorough preparation is needed now to ensure effective, orderly and manageable implementation of these new requirements.

3. Provision of construction product data to support WLC calculations

Input data on the life cycle GWP of building materials and products is a key prerequisite for a good WLC calculation of buildings and comparability of calculations between buildings in different typologies. According to the recommendations of the Nordic Sustainable Construction initiative as well as the Czech INDICATE project, GWP data at least for high impact products in each national market (typically constituting 80% of the GWP in modules A1-5 - product phase and construction process) should be based on national EPDs and should be publicly and freely available in a national GWP database for building products. At the same time, manufacturers of construction products should prepare for the new requirements of the revised CPR

to issue a Declaration of Performance and Conformity, which will also indicate the environmental sustainability of their construction product on a life cycle basis (for new products, in the case of GWP already in the second half of 2025).

For detailed recommendations on areas 2 and 3 we refer to the results of the Czech INDICATE project (CTU UCEEB, CZGBC and Chance for Buildings).

4. Incorporation of WLC and circular economy measures into the draft NBRP

According to the EPBD 4 principles, "the life-cycle performance of buildings should be taken into account not only for new construction but also for renovation, by integrating policies aimed at reducing life-cycle greenhouse gas emissions into Member States' national building renovation plans". Without embodied carbon measures for building renovation, the long-term climate targets for the EU building stock will not be met. Under the "Renovation Wave", embodied carbon from energy renovations has the potential to increase several-fold by 2050 (in particular from building technical and electrical equipment and materials and products related to the building envelope) and repair and replacement activities already account for almost 20% of the embodied carbon of the EU building stock (e.g. coatings and adhesives). The preparation of the National Buildings Renovation Plan (NBRP) therefore offers an opportunity to progressively reflect these parameters and related indicators and solutions in the objectives and measures for the renovation of the building stock in Czechia.

5. Reducing the number of unoccupied flats by utilising them in the framework of housing policy

International roadmaps and strategies on embodied carbon in the building sector emphasise that demand-side measures aimed at reducing the consumption of primary building materials through increased use, adaptive reuse, renovation, repair or refurbishment of existing sites and buildings and extending their lifetime, including the reuse of structures, components and materials within them, should be a starting point. The recent MRD analysis on unoccupied dwellings provides a robust basis for setting policies and measures to reduce the number of unoccupied dwellings in the country based on international practice.

6. Promoting increased recycling of CDW and reuse of building structures

Increased use of waste materials from construction and demolition would contribute significantly to reducing the emissions intensity of building materials production by saving feedstock and processing requirements. In the period 2017-2020, according to the ISOH database (MoE), the annual production of construction and demolition waste in Czechia was 20-22 million tonnes. Material sources suitable for recycling are mainly concrete waste (approx. 1.8-2.1 million tonnes), brick waste (approx. 0.7-0.8 million tonnes) and their mixtures (2-2.2 million tonnes), in total 4.5-5 million tonnes. Although 70 % of this quantity is already 'recycled', it is mainly used for backfilling, sub-backfilling and reinforcement of temporary roads on construction sites and the remainder for reclamation of mainly mining areas, landscaping and landfill

technology. ARSM estimates the potential for the use of concrete and brick waste as filler for concrete at 30-50% (1.5-2.5 million tonnes) of the above quantities. Other important streams are metals (steel, aluminium), glass, insulation materials and wooden structures, including their reuse potential. The issue of brownfields has been a focus of efforts by public administration in Czechia for 30 years. Revitalisation of brownfields is itself a circular strategy, and circular principles and measures for increased reuse or recycling of materials, structures and products from brownfields need to be explicitly explored and applied as part of their revitalisation or other construction projects.

7. Promoting low-carbon and circular building materials and products

A prerequisite for not only calculating but also actually reducing embodied carbon in buildings is to support (subsidy, education, research) the development, production and marketing of building materials and products that have a low carbon footprint on a full life cycle basis and a high recycled content while meeting all performance and safety requirements for the application area. At the same time, these products are often uncompetitive in price and/or perceived to be of lower quality, or their use implies a change in current construction practices.

8. Support for the use of natural renewable building materials

Another important aspect is increasing the proportion of natural building products used in the construction of new and renovation of existing buildings. For example, the adoption of the Raw Materials Policy for Wood provides an important framework for supporting increased use of timber in the construction sector by reducing existing normative barriers and helping to set up tools and measures to transparently assess different materials and building solutions in terms of their carbon footprint and other impacts throughout the life cycle of buildings. Timely and effective implementation of policy measures related to timber buildings and the use of wood waste streams as a secondary raw material for construction and other products can also be key. For example, when scaling up timber buildings, it is important to embed circular principles and address their potential in terms of modularity, material efficiency, digitalisation, adaptability during the lifetime of the building, deconstruction at the end of life and reuse.

9. Application of LCA in BIM tools

In July 2024, an update to the BIM Concept was adopted in relation to the draft Construction Information Management, Building Information Models and Built Environment Bill. Although the Regulatory Impact Assessment of the Bill mentions the potential of BIM to reduce construction waste and facilitate improvements in the environmental performance of buildings on a lifecycle basis, the updated Concept and the wording of the Bill lack an explicit link between digitisation, material efficiency, embodied carbon and the concept of buildings as material banks.

10. Stimulating demand for low-carbon solutions in green public procurement

Green public procurement is a key tool for stimulating demand for environmentally friendly building materials and products with a low carbon footprint on a life cycle basis. As part of the preparation and implementation of the Sustainable Purchasing Action Plan, the MRD plans to develop a Methodology for incorporating sustainability principles (ESG and Taxonomy) into public procurement in the construction sector by June 2025 to provide practical guidance to contracting authorities.

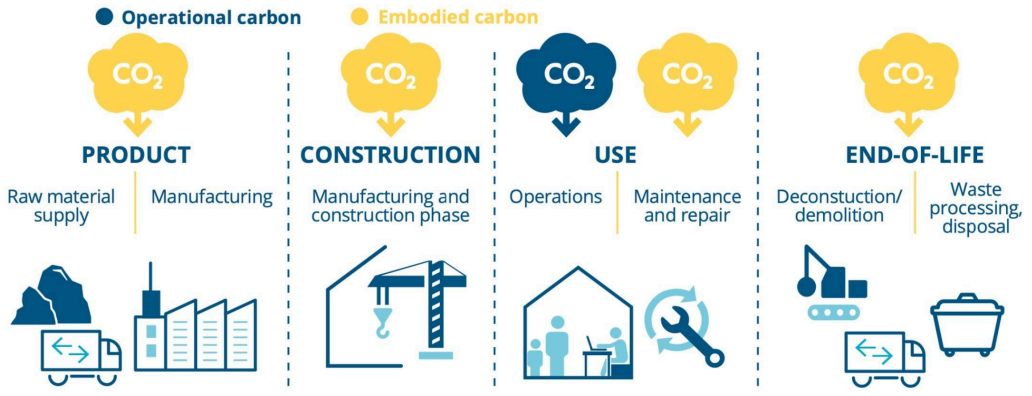
This methodology should also prioritise the carbon footprint of emission-intensive materials and products (cement and concrete, steel, aluminium, plastics) and incentivise the selection of low lifetime GWP options while meeting all relevant performance and safety conditions.

Embodied carbon - a new frontier for buildings decarbonisation

From a life cycle perspective, the buildings sector in the EU accounts for half of the consumption of extracted materials and a third of all waste produced. Major building materials (especially cement/concrete and steel) carry a large carbon footprint from the extraction of primary raw materials, the combustion of fuels and process reactions during production, as well as from the transport of raw materials and finished products. Additional emissions are then generated during the construction process, in refurbishments, replacements and repairs and finally upon demolition or deconstruction and processing or disposal of materials at the end of a buildings' lifetime. The aggregate category for these CO2 emissions linked to building materials is **embodied carbon**.

As shown in Figure 1, the **Whole Life Carbon** (WLC) of a building represents the sum of operational and embodied GHG emissions across a building's lifecycle.

Figure 1: Operational versus embodied carbon of buildings



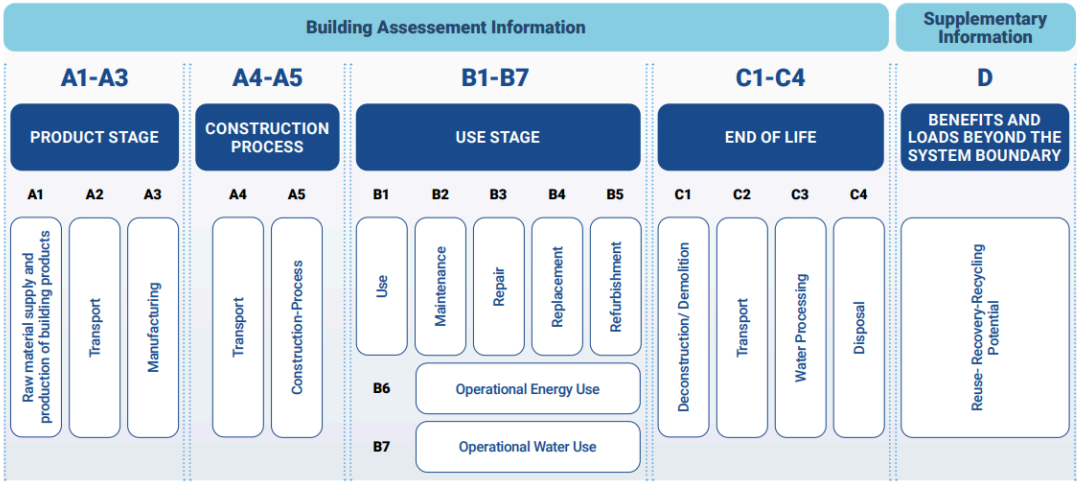
Source: Whole-life carbon: challenges and solutions for highly efficient and climate-neutral buildings (Building Performance Institute Europe, May 2021), p. 6

Annual lifecycle emissions of the EU building stock in 2020 are estimated at over 40% of total EU GHG emissions, corresponding to 1,360 $MtCO_2$. Of this total building stock WLC, embodied carbon currently represents just over 20%. As the energy sector and the operation of buildings are decarbonised, by shifting to renewable energy sources and improving energy efficiency, embodied carbon will come within the 2030s to occupy a dominant share in total WLC of new buildings. Indeed, at the level

of individual building types, embodied carbon already accounts on average for 43% of WLC in new buildings, and 66-74% for very high energy performance buildings.[1]

With reference to Figure 2, 61% of embodied carbon arises from the "upfront" production of construction materials (A1-3) (of which approx. 60% from the production of cement/concrete, steel and insulation) and a further 7% from transport and installation (A4-5). Renovation and refurbishment activities account for 13% (B5), repair and replacement for 19% (B3, B4) and end-of-life only 0.2% (C1-4).[2]

Figure 2: Life cycle assessment of buildings



Source: WGBC, Whole Life Carbon Reporting and Targets, 2023

Tackling embodied carbon through the circular economy

In the context of WLC and embodied carbon, the role of the Circular Economy (CE) in decarbonisation of industrial materials and their use in the built environment has been quantified and increasingly recognised in recent years through a growing body of international research.[3] **These studies have modelled the potential reduction in embodied carbon in buildings from circular interventions at between 35% to over 60% by 2050**.

The hierarchy of circular interventions in terms of their impact on the reduction of embodied carbon in the buildings sector is shown in the "carbon footprint reduction curve" for buildings in Figure 3. There are three main strategies to decarbonise the material cycle of buildings (mapping to six interventions shown in the curve):

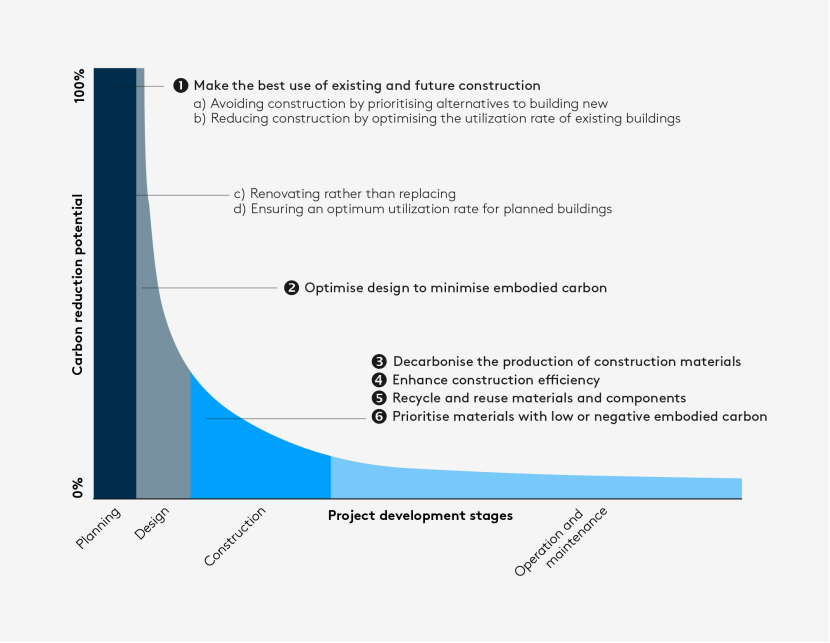
[1] European Commission, Directorate-General for Environment, Le Den, X., Steinmann, J., Kovacs, A. et al., Supporting the development of a roadmap for the reduction of whole life carbon of buildings – Final technical report, Publications Office of the European Union, 2024
[2] Ibid
[3] Material Economics (McKinsey & Company), EMF, IEA, IRP, Ramboll, PEEB, WBCSD, Agora Industry, Circle Economy, EEA et al.

1. Reducing demand for new construction by increasing utilisation of existing buildings, adapting them for other uses or expanding their lifespans through renovation (1).
2. Material efficiency in the design and construction of buildings, to reduce the unit consumption of emission-intensive materials (e.g. per m2 of useful floor area) (2).
3. Reducing the carbon footprint of input materials (3, 4, 5, 6).

Perhaps most attention today is given to the third strategy. INCIEN has assessed these material input strategies in separate studies on wood, steel and cement. Material efficiency strategies have also long been a focus of attention for architects and designers and an active topic in the context of the development of technical standards in construction and digital tools (e.g. BIM).

However, there is a consensus across a number of international roadmaps and strategies on embodied carbon in the building sector[4] that the starting point should be demand-side measures to reduce consumption of primary building materials through intensified use, adaptation or refurbishment of existing buildings and the extension of their lifetime, including reuse of structures, components and materials within them.

Figure 3: Carbon footprint reduction curve for buildings
The greatest potential is in the planning and design phases



Source: UK Green Construction Board (graphics); Shifting Paradigms (2023). Embodied carbon regulation in the European construction sector - An analysis of the economic impact (list of measures)

The principle of maximum reuse of the existing building stock starts at the level of the whole building or a large part of the building in order to adapt to a similar

[4] For example, UNEP (2023), WGBC (2023, 2019), UKGBC (2022), PEEB (2021)

or new use ('adaptive reuse', e.g. from industrial to mixed application), i.e. by renovating existing buildings.[5] This is followed by recovering elements and materials on site or from another location and incorporating them into new construction as part of the reuse process. In the event that the materials cannot be reused on site, they should be sent to an intermediary for further reuse or back to the material supplier for refurbishment, adaptation for another purpose or (as a last resort) recycling.

According to a recent study by the Czech Ministry for Regional Development, there were 860,000 unoccupied dwellings across Czechia in 2021 (double the number compared to 30 years ago), reaching 16% of the total residential building stock in the country. Of these, 577, 000 were unoccupied on a long-term basis. Of these, 377,000 were family houses and 200,000 apartments, a 40% increase since 2011. These figures show a clear need for renovations in Czechia, while adopting circular strategies. The ministry has decided to allocate 8 billion Czech crowns from European funds to be used in renovations of such dwellings from 2025.[6] In the area of brownfields, the national database maintained by CzechInvest records over 4,300 brownfields with a total area exceeding 13,200 ha. This is a relatively large number of abandoned and neglected buildings and sites, reflecting the industrial heritage of Czechia, the central planning of the former regime, the historical displacement of the population from the Sudetenland and the wave of privatisation of state-owned enterprises in the 1990s.[7]

The "double circularity" of building renovations

A key concept in the EU's corporate sustainability reporting framework is "double materiality", which considers both an organisation's impact on sustainability factors as well as the impact of those factors on the organisation. In a similar way, renovations both have an impact on and are impacted by circularity and embodied carbon. We could refer to this as the "double circularity" of renovations for buildings decarbonisation.

- In so far as they reduce demand for new construction, renovations represent a higher order "circular" strategy. Due to significantly lower material inputs, the carbon footprint of a building renovation may be roughly 50–75% lower than that of an equivalent new build, while delaying demolition potentially for decades.[8]
- At the same time, renovations also carry their own material and embodied carbon footprint and should be implemented using circular principles to optimise material use and minimise embodied carbon in the renovation works themselves.

[5] For this activity, the environmental delegated act of the EU Taxonomy sets, as a threshold, the criterion of preserving at least 50% of the gross external floor area of the original building.
[6] Struktura neobydlených bytů v Česku a nástroje pro jejich aktivaci využívané v zemích OECD (MRD, December 2023)
[7] https://www.brownfieldy.cz/en/about-brownfields/ (CzechInvest)
[8] Building materials and the climate: Constructing a new future – UNEP (September 2023)

Buildings in the EU are relatively old. On average, 22% of them were built before 1945, 45% before 1969 and 75% before 1990.[9] 75% of existing buildings are energy inefficient and over 85% are likely still to be in use in 2050. Furthermore, about 15% of Europeans live in houses or flats with leaking roofs or damp walls, floors or foundations. Between 5% and 39% of Europeans live in buildings with rotting window frames or floors.[10] Buildings need to be regularly maintained and renovated also to improve their standard and safety, which is why in practice energy renovation and non-energy renovation of buildings are often done at the same time. The renovation option should always be assessed with regard to the specific characteristics of the building stock and the 'moral lifetime of buildings', after which further renovation or modernisation will no longer meet the functional needs or will not be economically feasible.

Over the next 25–30 years, the building renovation rate is expected to accelerate significantly under the EU's policies regarding the energy performance of buildings (see next chapter). In Czechia, only 0.6–0.8% of buildings have been deeply retrofitted every year in recent years (with the EU average being about 1%). According to studies by BPIE (at EU level) and Šance pro budovy (at Czechia level), these percentages need to be increased at least threefold to meet the EU's climate targets for reducing operational emissions and buildings energy consumption.

Although the main goal of the EU's "Renovation Wave" strategy is to reduce emissions from buildings' operational energy use, it is important to ensure that circular measures and solutions to reduce the consumption of primary materials and embodied emissions are implemented as part of the energy retrofitting of buildings and related renovations. This represents a critical opportunity to extend the impact of the Renovation Wave to also reduce overall embodied carbon across new construction and renovations and boost the overall circularity of the sector.

Scenarios for the reduction of buildings embodied carbon to 2050

In February 2024, the European Commission published a final technical report co-authored by Ramboll, BPIE and KU Leuven to support the development of a roadmap for the reduction of WLC of buildings.[11] In the study, the authors developed three scenarios for the future development of WLC and embodied carbon of the EU buildings stock: a Business-as-usual (BAU) scenario, a TECH-Build scenario and a LIFE-Build scenario (Table 1 and Figure 4).

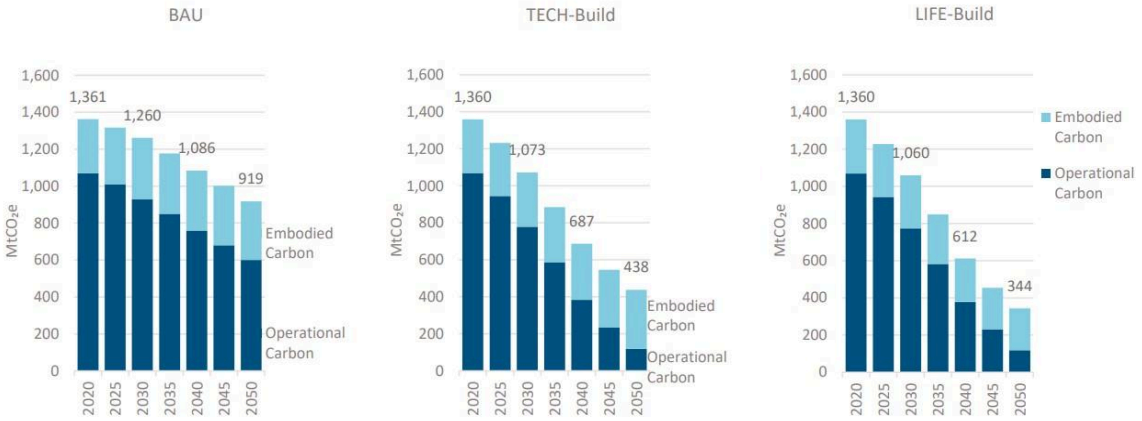
[9] European Construction Sector Observatory – Improving energy and resource efficiency (November 2018)
[10] Briefing no. 12/2022: Linking circular economy and climate change mitigation in building renovation (EEA, July 2022)
[11] European Commission, Directorate-General for Environment, Le Den, X., Steinmann, J., Kovacs, A. et al., Supporting the development of a roadmap for the reduction of whole life carbon of buildings – Final technical report, Publications Office of the European Union, 2024

Table 1: Scenarios for reduction of WLC of buildings in the EU to 2050

Scenario	Annual building stock WLC reduction 2020-2050	Description and key assumptions
Business-as-usual (BAU)	**32%**	Assumes a slight increase in annual embodied carbon from new construction and renovations, with a projected increase of 40% in total floor area of buildings by 2050 and a more than doubling of embodied carbon from renovation activities. Building stock WLC falls as a result of planned decarbonisation of the energy sector and the impact of renovations on energy use (based on policy targets prior to the Fit for 55 package and ETS 4), with the split between embodied carbon and operational carbon stabilising at 35% and 65% respectively.
TECH-Build	**68%**	Approaches emission reduction through implementation of technological solutions and material efficiencies ("improve" and "shift" strategies), while taking into account the potential and limitations of circular measures. Embodied carbon falls until 2025, and then remains stable until 2050. A 50% reduction in upfront embodied carbon from new construction is offset by increased embodied carbon from renovations.
LIFE-Build	**75%**	Complements the technical solutions of TECH-Build with "avoid" or "sufficiency" strategies that reflect the systemic changes to lifestyle and social norms needed to reduce WLC as close as possible to net zero, for example by reduction of floor area per person or avoiding new construction through the use of existing buildings. These additional measures help reduce reliance on technological solutions, provide additional time for their development and efficient deployment at scale, mitigate the risks of delays and lock-in effects and reduce associated costs. The stated WLC reduction factor (75%) assumes that these "avoid" solutions are applied subsequently to the "improve" and "shift" solutions in the TECH-Build scenario. If they were applied concurrently, their impact on WLC would be significantly greater than the additional 7% reduction currently indicated.

Source: Ramboll, BPIE and KU Leuven (February 2024)

Figure 4: Reduction in WLC of buildings in the EU to 2050 by scenario



Source: Ramboll, BPIE and KU Leuven (February 2024)

Modelled solutions for embodied carbon reduction (Table 2) are practical measures implemented by market actors with direct GHG emission reduction impacts by avoiding new construction (sufficiency), improving building design (material efficiency), or shifting to low-carbon materials.

Table 2: Embodied carbon reduction solutions to avoid, improve and shift

Avoid new construction	Improve building design	Shift to low-carbon materials
• Optimise the use of space in offices and residential buildings. • Use existing assets that are currently unused instead of new buildings. • Renovate instead of building new.	• Design based on light construction methods instead of massive construction. • Design for adaptability, resilience and extended lifespan, which could also lead to reduced demand for new construction. • Design for disassembly. • Reduce concrete demand by use of void formers in concrete slabs. • Use carbon-cured concrete. • Carbon capture in cement production.	• Reuse existing building components and materials. • Full timber construction. • Hybrid structures in new construction. • Use other bio-based materials. • Use other industry by-products instead of clinker in cement. • Use alternative cementitious materials instead of cement in concrete. • Use recycled concrete and other by-products for new concrete. • Use recycled steel in steel production. • Use recycled glass in glass production. • Use renewable energy in production of cement, steel, other metals and glass.

Source: Ramboll, BPIE and KU Leuven (February 2024)

The authors highlight several limitations in the modelling that result in the WLC reduction scenarios being **significantly underestimated** relative to their full potential. The BAU scenario does not include emissions reductions in materials production from Phase 4 of the EU ETS (2021-2030) or accelerated decarbonisation of the energy sector under the European Green Deal's "Fit for 55" and REPowerEU packages. In relation to embodied carbon, decarbonisation options for some materials (e.g. aluminium, paints and adhesives, or plastics) are not fully captured. The study uses

a 0/0 approach to accounting for the biogenic carbon content of bio-based building materials (i.e., no biogenic carbon storage is taken into account). As discussed in the next section, the potential for embodied carbon savings in renovations will be significantly greater, as the modelling focuses on new construction and only a limited set of options are addressed for low carbon renovations. Finally, some solutions (e.g. circular design for disassembly or extended lifespan) will not deliver emissions savings until after 2050.

Potential material and embodied carbon savings from circular building renovations

The technical report discussed in the previous section highlights that without embodied carbon measures for building renovations, climate targets for the EU building stock will not be met. Under the TECH-Build scenario, renovation embodied carbon would increase fourfold to nearly 170 MTCO2e per annum by 2050 (despite a 20% reduction in embodied carbon per square metre). Repair and replacement activities are ongoing and spread across almost the entire building stock, accounting for almost 20% of embodied carbon in the 2020 base year, with paint and glue as surprising carbon hotspots. For energy renovations, in addition to building envelope-related materials and products, technical and electrical building services can make up 50% or more of the embodied carbon in advanced energy renovations across regions and building types.

A study by Metabolic for the European Environment Agency modelled the potential savings in primary materials and embodied emissions from applying 10 “circular renovation measures” to the EU-27 building stock in three “clusters” and three scenarios (Table 3).[12] The ranges reflect modelling scenarios ranging from a reference baseline to a “policy compliant” to an ambitious scenario.

Total embodied carbon reduction potential from circular renovation actions is modelled at up to 1.4 billion tons CO2e in an ambitious scenario over a 28 year period, or up to 50 Mt CO2e on an annualised basis to 2050. As circular measures for new construction (such as design for long lifespan, adaptability and disassembly) will only deliver emissions savings in the long term beyond 2050, the study also emphasises the **importance of addressing circularity and lifecycle carbon in renovation of the existing building stock** in order to secure shorter term benefits.

[12] Briefing no. 12/2022: Linking circular economy and climate change mitigation in building renovation (EEA and Metabolic, July 2022).

Table 3: Modelling cumulative savings from circular renovation measures (EU-27)

Cluster	Measure	Primary material savings (total 2022–2050), Mt (weight)	Reduction of embodied emissions (total 2022–2050), Mt CO2e
Lifetime extension	– Higher space utilisation – Change in use of buildings – Durable materials and products – Renovation (repair)	655	400
Material consumption reduction	– Design for deconstruction (DfD) – Maximum reuse – Maximum recyclate content	346 - 642	195 - 595
Innovative materials	– Prefabricated facades – Biomaterials and products – Green roofs and facades	64 - 85	114 - 259 (114 - 425)**

** Savings, accounting for biogenic and lifetime carbon storage

Source: EEA and Metabolic (July 2022)

The highest potential for primary material and embodied carbon savings is offered by the **lifetime extension** cluster, by lowering demand for (or growth of) new construction. In the second cluster (primary material consumption reduction), use of renovation materials with a **high recycled content** is the most significant measure, especially in an ambitious scenario in which renovation is significantly accelerated.

In the third cluster, use of **bio-based materials** and **green solutions** results in greater material weight consumption than current conventional materials due to higher mass and/or shorter lifespans but the risk of resource depletion is low as they are renewable (provided they are sourced and produced sustainably). Bio-based materials and products and prefabricated facade solutions are the main source of embodied carbon savings, especially in the event that dynamic LCA approaches that take biogenic carbon storage into account are applied. An increase in weight and embodied carbon in green facades and roofs is offset by their other benefits including climate adaptation to heat stress, cooling and energy efficiency, carbon sequestration, stormwater management and increased biodiversity.

The study's modelling is focused on technical solutions and does not address the wider socio-economic aspects of their implementation, including financing, skills requirements, user preferences, associated costs, availability of resources or land use for producing building materials or planned decarbonisation efforts in the EU. Both this study and the technical report referenced in the previous section stress **the need for additional research, data collection and regulation to address the WLC mitigation potential of renovations**.

An updated EU policy framework for embodied carbon and buildings circularity

Policies and legislative mandates aimed at decarbonising the built environment have until now focused on reducing operational emissions of buildings (from energy use). However, the embodied carbon in building materials and products is now becoming an integral part of decarbonisation goals both for policymakers and key actors across the buildings value chain in the transition to carbon neutrality by 2050. Voluntary frameworks and, in the coming years, mandatory requirements are gradually being introduced at EU and national level to measure and in time reduce embodied carbon in the context of WLC.

One of the strategic priorities of the European Green Deal launched in December 2019 was *"Building and renovating in an energy and resource efficient way"*. The 2019-2024 European Commission's flagship initiative in this area, the **Renovation Wave** strategy of October 2020, set out plans to at least double the annual energy renovation rate of the European building stock by 2030 while prioritising the following areas: (i) tackling energy poverty and worst performing buildings; (ii) renovation of public buildings; and (iii) decarbonisation of heating and cooling.[13] Although focused predominantly on energy performance of buildings, the strategy's seven key principles for building renovation towards 2030 and 2050 include *"life-cycle thinking and circularity"*. This comprises *"making the construction ecosystem fit to deliver sustainable renovation, based on circular solutions, use and reuse of sustainable materials, and the integration of nature-based solutions"*, promoting the *"development of standardised sustainable industrial solutions and the reuse of waste material"*, developing a 2050 roadmap for reducing WLC of buildings, including through the use of bio-based products, and reviewing material recovery targets set in EU legislation for construction and demolition waste (CDW).

To support implementation of the Renovation Wave and its associated actions, the European Commission also launched in October 2020 the **Level(s)** common European framework, after five years of development. The main aims of Level(s)

[13] A Renovation Wave for Europe - greening our buildings, creating jobs, improving lives (Communication from the European Commission, 14.12.2020)

are to provide a “common language for assessing and reporting on the sustainability performance of buildings” and “a simple entry point for applying circular economy principles in our built environment”. The framework consists of six macro-objectives including “greenhouse gas emissions along a building’s life cycle” and “resource efficient and circular material life cycles”.[14]

The **EU Taxonomy** provides a set of sustainability criteria for the construction, renovation and acquisition of buildings. Compliance of buildings and construction projects with the Taxonomy’s technical screening criteria is not mandatory but defines a common standard against which investors, property developers, asset owners and construction companies can raise finance for projects on favourable terms or issue green or sustainability bonds. While the Taxonomy’s “climate” delegated act (DA) focuses on the energy performance of buildings and related investments, the new “environmental” DA expands criteria for calculating WLC to cover all new buildings and renovation works and introduces more ambitious CE criteria for a “substantial contribution” to the Taxonomy’s environmental objectives.

Starting from the 2024 financial year (or in subsequent years, depending on the company size or type), companies in the scope of the **Corporate Sustainability Reporting Directive (CSRD)**[15] are required to report the Taxonomy eligibility and then alignment of their activities related to turnover, capital investment and operating expenses. They will also report the “Scope 3” greenhouse gas emissions from their upstream and downstream value chains. In the case of construction companies and property developers, the purchase of building materials typically accounts for 80% or more of their Scope 3 emissions. According to the E5 standard of the European Sustainability Reporting Standards (ESRS), covering Resource Use and Circular Economy, companies for which this is a “material” topic need also to report on their operations’ material inflows and outflows (both waste streams and final products), including the proportion of primary, secondary and bio-based materials in inflows and recovery (reuse, recycling) versus disposal in waste streams.[16]

As also proposed in the Renovation Wave strategy, the European Commission’s Joint Research Centre has been working since 2022 on a revision of existing voluntary **Green Public Procurement (GPP)** criteria for Office Buildings. As part of this revision, criteria may be expanded to cover other types of public sector buildings such as schools and social housing while aiming for greater alignment with other elements of the EU policy framework for buildings (in particular Level(s) and the EU Taxonomy).[17]

---

[14] Level(s) - European framework for sustainable buildings
[15] Directive (EU) 2022/2464 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
[16] Commission Delegated Regulation (EU) 2023/2772 of 31 July 2023 supplementing Directive 2013/34/EU of the European Parliament and of the Council as regards sustainability reporting standards
[17] Project website for the revision of the Green Public Procurement (GPP) criteria for "Office Buildings" (European Commission - Joint Research Centre - Product Bureau)

If the Taxonomy, CSRD and GPP are intended to serve as "carrots" to motivate companies to measure and gradually improve the sustainability performance of buildings, a timetable for introduction of mandatory targets and measures ("sticks") is now in place through the 2024 recast of the **Energy Performance of Buildings Directive (EPBD 4)** and the revised **Construction Products Regulation (CPR)**. The new **Ecodesign of Sustainable Products Regulation (ESPR)** will also establish through delegated acts minimum ecodesign requirements for intermediate products including iron and steel, aluminium and chemicals as well as final products such as paints and energy-related products (e.g. HVAC equipment). While the EPBD 4 introduces mandatory calculation of WLC for new buildings starting from 2028, the CPR and ESPR will set carbon footprint (GWP) parameters for industrial materials and construction products as inputs into new buildings and renovations and empower the Commission to adopt implementing acts specifying mandatory minimum requirements related to GPP.

The following sections outline the relevant provisions that have been adopted in relation to embodied carbon and circularity in the different components of the EU policy framework for buildings under the European Green Deal, including the "Fit for 55" package, the sustainable finance framework and the legislative initiatives of the New Circular Economy Action Plan.

EU Taxonomy - The "Environmental" Delegated Act

One of the technical screening criteria for the "climate" DA of the EU Taxonomy for the construction of new buildings (with effect from January 2022) is the calculation of WLC (GWP) for buildings with a useful floor area greater than 5,000 m2 and its communication to investors and clients on request. CE is a "do no significant harm" (DNSH) objective that is limited to ensuring that at least 70% of CDW (excluding hazardous waste) is prepared for reuse or recycling, including the utilisation of waste material for backfilling on construction sites.

In the new "environmental" DA (with effect from January 2024),[18] the WLC calculation criterion applies to **all construction and renovation projects regardless of the size of the building's useful floor area**. Moreover, the "transition to a circular economy" is the primary category for a "substantial contribution" to the Taxonomy's environmental objectives for both the construction of new buildings and renovations, comprising the following technical screening criteria:

- At least 90% of CDW (excluding hazardous waste) is prepared for reuse or recycling, excluding waste used for backfilling.

[18] Commission Delegated Regulation (EU) 2023/2486 of 27 June 2023 supplementing Regulation (EU) 2020/852 of the European Parliament and of the Council

- Minimum thresholds for the proportion of secondary (recycled) materials for the three heaviest categories of material used in the construction of new buildings and renovations (ranging from 20-80% depending on the material category).
- Application of design principles for adaptability and renovation according to Level(s) (indicator 2.3, level 2);
- Application of design principles for deconstruction, reuse and recycling according to Level(s) (indicator 2.4, level 2);
- Use of digital tools to describe a building's characteristics, including materials and components used for the purposes of future maintenance, recovery and reuse, and preserving this information long after the building's lifetime has ended.

The above criteria of the environmental DA mark a significant increase in ambition for addressing WLC and CE parameters of buildings over the climate DA. However, the gap between the two DAs in these two areas creates the risk that market actors reporting the Taxonomy alignment of their activities will continue to choose the less ambitious WLC and CE criteria under the climate mitigation objective for "substantial contribution", limiting the impact of the environmental DA and missing an opportunity to accelerate efforts by the construction and real estate sectors to take action on WLC and CE ahead of mandatory measures in the EPBD, CPR and ESPR.[19]

Recast of the Energy Performance of Buildings Directive (EPBD 4)

The recast of the Energy Performance of Buildings Directive is the central legislative initiative of the European Commission's Renovation Wave strategy and the key element of the "Fit for 55" package related to buildings. The European Commission published its legislative proposal for the EPBD recast on December 15, 2021. The European Council under the Czech EU Presidency agreed a general approach on October 25, 2022. On February 9, 2023, the European Parliament's Industry, Research and Energy (ITRE) Committee adopted its position on the recast, proposing a number of significant changes to the Commission's proposal. A trialogue between the Commission, Council and Parliament subsequently took place on October 12, 2023, leading to a provisional agreement on the text on December 7, 2023. The Parliament endorsed the provisional agreement on March 12, 2024, followed by the Council on April 12. The final act was signed on April 24 and entered into force on May 28, 2024.[20]

The main objectives of the recast EPBD are to at least double the annual energy renovation rate of buildings by 2030, increase the depth of buildings renovations, improve information on energy performance and sustainability of buildings, and ensure that all buildings will be in line with 2050 climate neutrality requirements.

[19] Why does the taxonomy miss the mark on construction? (ECOS, November 2023)
[20] Directive (EU) 2024/1275 of the European Parliament and of the Council of 24 April 2024 on the energy performance of buildings (recast)

The recast sets new or updated targets for zero-emission performance of new buildings, zero on-site emissions from fossil fuels for new buildings, the fitting of rooftop photovoltaic or solar thermal installations, minimum energy performance standards for non-residential buildings, primary energy use reduction in residential buildings, and the phasing out of fossil fuel boilers by 2040.

Whole life carbon regulation

While the Renovation Wave and the EPBD target primarily the reduction of operational greenhouse gas emissions, the recast importantly introduces the first steps to address WLC (referred to as "life-cycle GWP") by introducing **mandates to calculate WLC for new buildings and subsequently set limit values on total cumulative WLC of all new buildings**.

According to Annex III of the Directive, the total life-cycle GWP is to be communicated as a numeric indicator for each life-cycle stage expressed as kgCO2e/m2 (of useful floor area) over a reference study period of 50 years. It should be calculated in accordance with EN 15978:2011 for the scope of building elements and technical equipment defined in indicator 1.2 of the Level(s) common framework. Where a national calculation tool or method exists, or is required for making disclosures or for obtaining building permits, that tool or method may be used to provide the required disclosure. Other calculation tools or methods may be used if they fulfil the minimum criteria laid down by Level(s).

Key mandatory provisions related to WLC are as follows:

- The European Commission is empowered to adopt delegated acts to set out a Union framework for the national calculation of life-cycle GWP with a view to achieving climate neutrality, the first to be adopted by **December 31, 2025**.
- By **January 1, 2027**, Member States are required to develop national roadmaps "*detailing the introduction of limit values on the total cumulative life-cycle GWP of all new buildings and set targets for new buildings from 2030, considering a progressive downward trend, as well as maximum limit values, detailed for different climatic zones and building typologies*", in line with EU climate neutrality targets.
- The life-cycle GWP is subsequently to be calculated in accordance with Annex III of the Directive and disclosed through the energy performance certificate of buildings as of:
    - **January 1, 2028**, for all new buildings with a useful floor area over 1,000 m2;
    - **January 1, 2030**, for all new buildings.
- Article 28 stipulates that the Commission will review the Directive by **December 31, 2028**. As part of this review, it "*shall also assess the national roadmaps and in particular the planned limit values for the life-cycle GWP of new buildings [...] and shall consider whether additional measures promoting a sustainable built environment are needed*".

The recast also sets out the following optional measures related to WLC (life-cycle GWP) at the discretion of individual Member States:

- The definition of an A+ energy performance class for buildings with a maximum threshold for energy demand which is at least 20% lower than that for zero-emission buildings, and which generates more renewable energy on-site annually than its total annual primary energy demand. For existing buildings renovated to this A+ class, life-cycle GWP must be estimated and disclosed through the energy performance certificate of the building.
- The gathering and storing of data on embodied emissions and life-cycle GWP in addition to operational emissions in the national databases that Member States are required to set up for the energy performance of individual buildings and the overall energy performance of the national building stock.
- The inclusion of life-cycle GWP of buildings, where available, in information on the share of buildings in the national building stock covered by energy performance certificates and aggregated or anonymised data on energy performance of buildings. Member States are required to make this information publicly available at least twice a year.
- Taking into account the life-cycle GWP in national calculations on "*cost-optimal levels of minimum energy performance requirements in new buildings and existing buildings undergoing major renovation and for individual building elements*." The Commission is to revise the methodology for these calculations by **June 30, 2025**. Member States will then update and submit regular reports to the Commission on input data, assumptions and resulting calculations using a common template, with the first due by **June 30, 2028**.

Building renovations

As argued by the Buildings Performance Institute Europe (BPIE), a WLC approach to buildings ultimately supports the "energy efficiency first" principle at the heart of the EPBD and should also be phased in for building renovations.[21] A WLC calculation requirement for renovations would also stimulate demand for renovation and renewable energy solutions with low lifecycle impacts that are directly related to operational energy performance, including insulation materials, solar energy installations and HVAC and other technical building systems.

The preamble to the EPBD 4 states that the "*whole-life-cycle performance of buildings should be taken into account not only in new construction, **but also in renovations** through the inclusion of policies for the reduction of whole-life-cycle greenhouse gas emissions in Member States' national building renovation plans.*" However, mandates to calculate WLC of buildings and reduce aggregate WLC of the building stock over time are limited to new buildings in the final text.

[21] The EU needs a whole-life carbon roadmap for buildings (BPIE, December 2022)

The main framework for implementing the EPBD 4 at national level are **National Building Renovation Plans** (NBRP), which will replace the existing long-term renovation plans (LTRP). Member states are to prepare and submit their NBRP every five years, with the first draft NBRPs due by **December 31, 2025**, and the finalised first NBRPs a year later, by **December 31, 2026**.

In the NBRP, Member States have the flexibility to set their own building renovation targets, providing an outline of financial measures and investment and administrative needs for successful implementation. Based on the template in Annex II of the Directive, the NBRP will include an overview of the national building stock, a roadmap including national targets (for 2030, 2040 and 2050), an overview of implemented and planned policies and measures and a set of indicators to enable the evaluation of progress towards a decarbonised building sector, with existing buildings reaching climate neutrality by 2050.

Among the the mandatory indicators to be included in the overview of policies and measures are those related to:

- prevention and high-quality treatment of **construction and demolition waste** in line with Directive 2008/98/EC, in particular as regards the waste hierarchy, and the objectives of the circular economy;
- reduction of life-cycle GWP for the construction, **renovation**, operation and **end of life of buildings**, and the uptake of carbon removals;
- promotion of district and neighbourhood approaches and integrated renovation programmes at district level, which may [...] take into account local and regional resources, **circularity** and **sufficiency**;
- promotion of **modular** and industrialised solutions for construction and renovation.

The EPBD 4 also requires Member States to introduce a scheme for **renovation passports** as a tool to provide building owners with a roadmap for staged renovations and determine the optimal timing and scope for different renovation interventions. The scheme will be voluntary for owners of buildings and building units, **unless the Member State decides to make it mandatory**. Requirements on mandatory and optional information to be included in renovation passports is detailed in Annex VIII of the Directive. With regard to WLC and circularity, the passport must include "*general information on available options for improving construction products' circularity and for reducing their whole lifecycle greenhouse gas emissions, as well as wider benefits related to health and comfort, indoor environmental quality and the improved adaptive capacity of the building to climate change*". Where available, the passport may also include, for each step of a building's renovation roadmap, the reference values on the life-cycle GWP for the materials and equipment, and a link to the relevant webpage where they can be found.

A revised Construction Products Regulation

Following the provisional agreement reached between the European Parliament and the Council on December 13, 2024, the revised **Construction Products Regulation (CPR)** was adopted by the European Parliament on April 10, 2024. At the time of writing, it awaited formal adoption by the European Council and publication in the EU Official Journal.[22]

The main objectives of the CPR are to establish: (i) harmonised rules on how to express the environmental and safety performance of construction products in relation to their essential characteristics, including life cycle assessment; and (ii) environmental, functional and safety requirements for construction products in the EU.

Mandatory disclosure of environmental impacts

Manufacturers will now be required to provide **declarations of performance and conformity** that also disclose their construction product's environmental sustainability performance on a life cycle basis for predetermined characteristics listed in Annex II of the Regulation. Information on a product's life-cycle GWP (climate change effects - in total; fossil fuels; biogenic; and land use and land use change) will apply within 12 months of the CPR's entry into force (**second half of 2025**), followed by a second set of environmental characteristics[23] within 4 years (**2029**) and a third set[24] within six years (**2031**). As stated in Annex III of the EPBD 4, these product declarations will be used in the calculation of life-cycle GWP of new buildings, when available.

The calculated life cycle impact of new products should include all stages from raw material acquisition or generation from natural resources, to final disposal, including potential benefits outside the boundary limits. The impact of used and remanufactured products should start with de-installation from a construction work and include all following stages until final disposal.

- **Used** construction products should be subject to long-term harmonisation by establishing the possibility to develop dedicated harmonised technical specifications that will apply to used products for as long as the used product is not waste or has ceased to be waste. Products directly re-used in a construction work should not be considered as placed on the market again and will not be subject to any measures in the CPR.
- **Remanufactured** products should benefit from not having to include events before the products' last de-installation when calculating its environmental

[22] European Parliament legislative resolution of 10 April 2024 on the proposal for a regulation of the European Parliament and of the Council laying down harmonised conditions for the marketing of construction products, amending Regulation (EU) 2019/1020 and repealing Regulation (EU) 305/2011
[23] Ozone depletion; acidification potential; eutrophication aquatic freshwater; eutrophication aquatic marine; eutrophication terrestrial; photochemical ozone; abiotic depletion – minerals, metals; abiotic depletion – fossil fuels; and water use.
[24] Particulate matter; ionising radiation, human health; eco-toxicity, freshwater; human toxicity, cancer; human toxicity, non-cancer; and land use related impacts.

impact over its life cycle. Remanufactured products should also benefit from requirements or incentives that promote a high recycled content.

A construction digital product passport system

The Commission is empowered to adopt a delegated act (DA) under the CPR to set up a **construction digital product passport system**, which will be "*compatible with, interoperable with and based upon the product passport established by* [the Ecodesign of Sustainable Products Regulation], *without compromising interoperability with Building Information Modelling (BIM), and taking into account the specific characteristics and requirements related to construction products*". The detailed parameters and requirements of the system are described in Articles 75, 76, 77, 78, 79 and 80 of the Regulation. The system is to be fully operational within six months after the entry into force of the delegated act and manufacturers will be required to make available passports available for their products within 18 months. The system may be used by manufacturers in the interim period on a voluntary basis.

Mandatory minimum GPP criteria

The Commission is also empowered to adopt DAs to specify **mandatory minimum environmental sustainability requirements** for construction products, which contracting authorities and entities will then apply for procurement procedures in the scope of the EU's public procurement directives[25] in the form of technical specifications, selection criteria, contract performance clauses or contract award criteria (Article 83 of the CPR). Contracting authorities and entities will be free to establish more ambitious or additional environmental sustainability requirements by requesting higher performance on relevant product characteristics while respecting harmonised standards.

By **December 31, 2026**, the Commission is to launch a first impact assessment on establishing these mandatory minimum requirements, and will consult with experts designated by each Member State and relevant stakeholders, taking into consideration the value and volume of public contracts, potential environmental benefits, support for uptake of environmentally sustainable products, economic feasibility, the market situation and competitive environment for different products, the need of SMEs, Member States' regulatory needs and different climate conditions.

Contracting authorities and entities will be allowed to **opt out** of mandatory minimum requirements in exceptional cases where there is lack of alternative suppliers for a given product, no suitable tenders or requests to participate were submitted in response to a previous public procurement procedure, or the application of the minimum requirements for a given product would either incur "disproportionate" costs ("*estimated contract value differences above 10%, based on objective and transparent data*"), or result in incompatibility or technical difficulties.

[25] Directives 2014/24/EU or 2014/25/EU.

A new Ecodesign for Sustainable Products Regulation

Following the provisional agreement reached between the European Parliament and the Council on December 5, 2024, the **Ecodesign for Sustainable Products Regulation (ESPR)** was adopted by the European Parliament on April 23, 2024, by the European Council on May 27, 2024, entered into force on July 20, 2024 and is directly applicable in all Member States.[26]

With some exceptions[27] the ESPR applies to "*any physical goods that are placed on the market or put into service, including components and intermediate products*". Its key objectives are to:

- (i) establish a framework for setting of ecodesign requirements to improve the environmental sustainability of products, reduce their **life-cycle carbon footprint and environmental footprint**, and ensure free movement of sustainable products within the EU internal market;
- (ii) establish a **digital product passport**;
- (iii) provide for setting of **mandatory green public procurement requirements**; and
- (iv) create a framework to prevent unsold consumer products from being destroyed.

Mandatory product ecodesign requirements

The ESPR will define mandatory performance requirements for relevant parameters of different product groups (as described in Annex I of the Regulation) in the form of minimum or maximum performance levels and/or non-quantitative requirements to improve performance. Parameters may include (a) durability; (b) reliability; (c) reusability; (d) upgradability; (e) repairability; (f) the possibility of maintenance and refurbishment; (g) the presence of substances of concern; (h) energy use and energy efficiency; (i) water use and water efficiency; (j) resource use and resource efficiency; (k) recycled content; (l) the possibility of remanufacturing; (m) recyclability; (n) the possibility of the recovery of materials; (o) **environmental impacts, including carbon footprint and environmental footprint**; and (p) expected generation of waste.

Within nine months of the ESPR's entry into force, i.e. by spring 2025, the Commission is required to adopt the first Working Plan for priority product groups. Groups of relevance to the buildings sector include **iron and steel**, **aluminium**, **paints**, **chemicals** and **energy-related products** (e.g. HVAC equipment). The Commission is

[26] Regulation (EU) 2024/1781 of the European Parliament and of the Council of 13 June 2024 establishing a framework for the setting of ecodesign requirements for sustainable products

[27] Excluded from the ESPR are food, feed, medicinal products, veterinary medicinal products, living plants, animals and microorganisms, products of human origin, products of plants and animals relating directly to their future reproduction and vehicles.

then empowered to adopt DAs to establish ecodesign requirements for each group. The first DAs are anticipated by **Q4 2025** or **Q1 2026** (in any event not earlier than 12 months after the ESPR's entry into force) and the first product requirements will enter into force not earlier than 18 months after adoption of the DAs, provisionally by **mid-2027**, with textiles and **steel** expected first.[28]

Although **construction products** will be covered under the revised CPR, in cases where the ESPR is complementary to the CPR for a given product group, the ESPR DA for that product group will specify the conformity assessment procedure while taking into account its characteristics, relevant ecodesign requirements and the cost for economic operators. In line with current practice, the CPR will give prevalence to sustainability requirements set under the ESPR for **energy-related products that are also construction products**, for example heaters, boilers, heat pumps, water and space heating appliances, fans, cooling and ventilating systems and photovoltaic products, excluding building-integrated photovoltaic panels.

In other cases, the ESPR should only set requirements for construction products where the CPR is deemed unlikely to fulfil the environmental sustainability objectives of the ESPR. A specific "backstop" clause has been included for **cement** in view of its climate impact (4 % of EU CO2 emissions). If the CPR process does not establish "*adequate performance requirements and information requirements concerning the environmental footprint and carbon footprint of cement*" by 2028, the Commission is to set ecodesign requirements for cement in a DA under the ESPR not earlier than December 31, 2028 and not later than January 1, 2030, i.e. **in 2029**.

Digital product passports

Use of **digital product passports (DPP)** will be made mandatory through the DA of each regulated product group. The detailed parameters and requirements of DPPs are described in Chapter III of the ESPR (Articles 9 to 15). Adoption of DPPs is intended to make available detailed information on products (subject to access rights) across all relevant actors, including customers, manufacturers, importers, distributors, dealers, repairers, refurbishers, remanufacturers, recyclers, market surveillance authorities, customs authorities, civil society organisations, trade unions and others. In particular, DPPs should help to improve procurement strategies of manufacturers and other contracting entities and support design of sustainable final products through access to products' environmental performance on relevant parameters.

Mandatory minimum GPP criteria

Whether for public procurement of products in the scope of the ESPR or for public works or services contracts that use those products, the Commission is empowered to set **mandatory minimum GPP requirements** through implementing acts in the form

[28] Position paper – Ecodesign for Sustainable Products Regulation, analysis of final text (ECOS, 16.4.2024)

of technical specifications, award criteria, contract performance conditions or targets (Article 65 of the ESPR).

These requirements will reflect the two highest performance classes, the highest scores or, when not available, the best possible performance levels set in the DA for the product group in question. They will also take into account "*the value and volume of public contracts awarded for the relevant product groups and the economic feasibility for contracting authorities and contracting entities to buy more environmentally sustainable products without entailing disproportionate costs*".

Award criteria will, where appropriate, have a minimum weighting of 15 to 30% in the award process in order to have a significant impact on tendering outcomes and help support selection of the most environmentally sustainable products. In the case of targets, the most environmentally sustainable products should account for at least 50% of procurement by contracting authorities or entities, or at an aggregated national level, on an annual or multi-annual basis.

As with the CPR, minimum requirements at an EU level do not prevent Member States from introducing or maintaining national GPP measures for product groups where EU level GPP requirements have not yet been set under the ESPR, or from introducing stricter national requirements than those at the EU level, provided they are in compliance with EU law.

Czechia's national policy framework

WLC and embodied carbon

In response to the increased energy and climate ambitions of the EU's "Fit for 55" package, EU Member States have been preparing updated **National Energy and Climate Plans (NECPs)**, the drafts of which were due to be submitted to the European Commission by June 30, 2023 and the final version by summer 2024. Updated NECPs are to be aligned with the higher targets in the EPBD recast and the Renovation Wave strategy to accelerate the energy renovation and decarbonisation of buildings. Czechia's draft updated NECP[29] references the circular economy in relation to waste management but does not include goals or measures related to WLC or embodied carbon of buildings or related circular economy interventions. INCIEN submitted proposals for textual amendments to the draft as part of the public consultation in February 2024 to reflect these aspects of the EPBD recast.

In parallel with the update of the NECP, the national **Climate Protection Policy** is also being updated for the period 2024 to 2050.[30] Section 5.3 on sectoral policies and measures for buildings details the current status of sector emissions, a vision for transformation of the sector, existing policies and measures and proposed measures for the implementation of climate protection policies in the coming years. The policy is expected to be adopted in the second half of 2024. The February 2024 draft of the policy focuses on energy consumption of buildings for both new build and renovations but includes an action to adopt a **common methodology for calculating the WLC of buildings** in order to meet the requirements of the EPBD recast.

Following the Commission's adoption of a DA at the latest by December 31, 2025 to set an EU methodology for national calculation of WLC (life-cycle GWP) with a view to achieving climate neutrality, Czech authorities will have one year (until January 1, 2027) to publish a **national roadmap for the introduction of limit values on total cumulative WLC of all new buildings** and the setting of targets for new buildings from 2030.

[29] Draft update of the Czech Republic's National Energy and Climate Plan (MIT, October 2023)
[30] MŽP aktualizovalo Politiku ochrany klimatu v ČR. Do roku 2030 budeme získávat třetinu energie z obnovitelných zdrojů a spotřebu snížíme o pětinu (MoE, 6.2.2024)

Building renovations

Under the provisions of the previous EPBD (2018), the Czech Ministry of Industry and Trade (MIT) published a **Long-Term Renovation Strategy (LTRS)**, aimed at decarbonising the national building stock by 2050, with milestones for 2030 and 2040.[31] The LTRS was intended to guide the implementation of national energy efficiency targets for the building sector, as set out in Czechia's first NECP.[32] WLC, embodied carbon and circular economy measures were not within the scope of the strategy. The LTRS included three renovation scenarios: business-as-usual (BAU), optimal and hypothetical (or "ideal"). A 2021 assessment by the European Commission's Joint Research Centre rated the ambition level of the Czechia LTRS as low on the basis that the optimal scenario was close to the BAU and hence conservative, especially considering the above average heat consumption of the building sector.[33]

In Czechia's draft updated NECP, the modelling reflects the "hypothetical" renovation scenario in the LTRS under which there is a doubling of the overall energy renovation rate across segments and a threefold increase in the share of deep energy renovations to 85% by 2030 relative to the 2020 base year. As a result, the majority of buildings would undergo deep renovation by 2050. Buildings where this is not technically possible would undergo only light or medium energy renovation, with 5% of buildings remaining unrenovated (e.g. listed buildings). The proposed increase in the depth and rate of energy renovation would reduce buildings operational energy consumption by 166 PJ (44%) by 2050.

Based on the requirements of the EPBD recast, the MIT will now need to update the LTRS by preparing a draft **National Building Renovation Plan (NBRP)** by December 31, 2025 followed by a final version by December 31, 2026. By 29 May 2026, it will also need to introduce a **scheme for renovation passports**, which will be voluntary unless determined otherwise.

Circular economy for buildings

The **Circular Czechia 2040 Strategic Framework** was adopted in November 2021 and sets out priority policy areas, major challenges to be addressed and potential measures across different sectors for the transition to a circular economy.[34]
For construction, policy measures may include innovation for the circular design of buildings, support for digitalisation including the creation of material passports, the

[31] Long-term renovation strategy to support the renovation of the national stock of both public and private residential and non-residential buildings (MIT, May 2020)
[32] National Energy and Climate Plan of the Czech Republic (MIT, November 2019)
[33] Zangheri, P. et Al., Progress of the Member States in implementing the Energy Performance of Building Directive, Publications Office of the European Union, Luxembourg, 2021, EUR 30469 EN, ISBN 978-92-76-25200-9, doi:10.2760/914310, JRC122347, p. 32
[34] Strategický rámec cirkulární ekonomiky České republiky 2040 (MŽP, December 2021)

development of EPR systems for construction and demolition waste, support for selective demolition procedures and increased recycled content in building materials and use of Level(s) for life cycle assessment in public procurement. The first **Action Plan Circular Czechia 2040 for the period 2022-2027** has set two actions for the construction sector: (i) evaluation and preparation of a technical standard for pre-demolition audits to facilitate selective demolition (MoE, by end of 2027); and (ii) information campaigns on the advantages of Building Information Modeling (BIM) tools for both public and private sectors (MIT, by end of 2025).[35]

The two main national policy documents guiding the management of construction and demolition waste (CDW) and use of recycled building materials are the **Waste Management Plan (WMP)** and the **Secondary Raw Materials Policy (SRMP)**. The main objective of the WMP is to analyse anticipated flows by waste category, determine required waste treatment capacities in accordance with the waste hierarchy and develop an investment plan to address the identified gaps. The SRMP is intended to provide a policy framework to support higher demand for recycled materials and industrial by-products in manufacturing, construction and other demand sectors. Updates of both documents are being finalised at the time of writing for the periods 2025-2035 and 2024-2027 respectively.

Bio-based construction

After two years of preparation and in response to industry appeals for a strategic approach to the use of national timber resources, the Czech government adopted in late June 2024 a new **Raw Material Policy for Wood**.[36] The policy is supportive of timber-based construction and highlights that wood is a strategic commodity with many advantages, especially in the context of climate change due to its ability to store biogenic carbon. The strategic priorities of the policy are to ensure a long-term sustainable supply of available wood for the domestic wood processing industry, promote the use of wood as a renewable raw material in economic sectors and everyday life, continuously increase the production of higher value-added wood products and increase domestic consumption to enhance the use of raw and primary processed wood.

Objectives set in the policy related to timber construction and cascading use of wood include:

- O21.1 Adjust legal regulations in construction to increase wood use.
- O21.2 Implement steps to establish a mandatory rate of wood use in projects and construction through public procurement.
- O21.3 Promote wood use through economic instruments, including state tax policy.

[35] Akční plán Cirkulární Česko 2040 pro období 2022-2027 (MŽP, November 2022)
[36] Surovinová politika pro dřevo (MoA, MIT, MoE, June 2024)

- O23.2 Focus research and development on broader wood application possibilities in construction and architecture elements and integrate findings into practice.
- O31.1 Support secondary wood processing.
- O31.2 Utilise wood-containing waste for further raw material processing.

Specific **measures** to implement the policy in relation to timber construction are summarised in the chapter "Recommendations for the implementation of WLC and embodied carbon policies in Czechia".

A Permanent Working Group on the Raw Materials Policy for Wood at the Government Council for Energy and Raw Materials Strategy is to evaluate the implementation of the policy's objectives at least once every six months and propose further measures to the Government.

Implementation of the BIM method

The Department for the BIM Concept at the Czech Agency for Standardization (ČAS) was set up in 2018 to support implementation of the 2016 **Concept for implementation of the BIM method** in the public sector. In cooperation with the MIT, it prepares standards, methodologies, guidelines and recommendations on selected measures of the BIM Concept, provides methodological support for public procurement and carries out educational programmes to popularise the BIM method.[37] An update of the BIM Concept is scheduled for adoption in the second half of 2024 in conjunction with a new **Act on Building Information Management and Building and Built Environment Information Models**.[38] The proposed Act introduces an obligation to acquire and maintain a building information model for publicly financed buildings recorded in the land registry or regional digital map with an estimated value or acquisition price exceeding the threshold amount[39] for a public works contract, with effect from **July 1, 2025**. Although the RIA for the bill mentions the potential for BIM to reduce construction waste and facilitate improvements to the ecological parameters of buildings on a life cycle basis, a more explicit connection between digitalisation, material efficiency, embodied carbon and the concept of buildings as material banks for urban mining is still lacking in the updated BIM Concept and the wording of the bill.[40]

Public procurement of construction works

Public procurement is an important driver of both the EU and Czech national economy. The value of public procurement in Czechia in 2022 was CZK 990 billion (EUR 40

[37] https://www.koncepcebim.cz/
[38] Snížení nákladů na nové stavby a jejich provoz. Vláda schválila aktualizaci koncepce zavádění metodiky BIM (MIT, 24.7.2024)
[39] Set at CZK 135,348,000 for 2024-2025 (or EUR 5,538,000). Source: MRD
[40] Based on the bill presented for final consultation on May 9, 2024 (ODok Portál).

billion), approximately 15% of GDP (the same percentage as at the EU level), of which 43% fell within the scope of the Czech Public Procurement Act (PPA). Of that, 45% constituted contracts for construction works, including the building and maintenance of (especially transport) infrastructure.[41]

An amendment to the PPA was approved on December 1, 2020, with effect from January 1, 2021, including a provision requiring contracting authorities to "*comply with the principles of socially responsible procurement, environmentally responsible procurement and innovation within the meaning of this Act*, provided that the nature and purpose of the contract permits." **Environmentally responsible procurement** is defined as a practice "*in which the contracting authority is obliged to take into account, for example, the environmental impact, sustainable development, the life cycle of the supply, service or works and other environmentally relevant considerations associated with the procurement*". However, the application of this requirement remains negligible and difficult to enforce in practice due to a prevailing preference for lowest bid prices as a primary or sole selection criterion and an unclear division of responsibility for its implementation between different ministries (MoLSA, MoE, MRD).[42]

In February 2024, the MRD published a **National Public Procurement Strategy** to drive improvements in efficiency, digitalisation, innovation and sustainability of public procurement over the period 2024 to 2028. Part of the strategy is the development of an **Action Plan for Sustainable Purchasing** to establish a database of harmonised minimum standards for responsible procurement in various sectors, including construction. One of the strategy's goals for public construction contracts is to ensure that they are prepared and implemented "*in accordance with the principles of sustainability, including the principles of the circular economy, ESG and the EU taxonomy, from the very beginning of the preparation of the investment*". To that end, the MRD plans to develop by June 2025 a **Methodology for integrating sustainability principles (ESG and taxonomy) into public procurement in the construction sector** to provide practical guidance to contracting entities.[43]

[41] Národní strategie veřejného zadávání v ČR pro období 2024-2028 (MRD, February 2024), p. 12
[42] Výroční zpráva o elektronizaci a stavu veřejných zakázek v ČR za rok 2022 (MRD), pp. 46-47
[43] Národní strategie veřejného zadávání v ČR pro období 2024-2028 (MRD, February 2024), pp. 42, 80, 82

Towards an national approach to embodied carbon in Czechia

The adopted text of the EPBD 4 leaves considerable flexibility and decision-making up to the Member States, especially regarding building renovations. This presents an opportunity for policy makers to draw upon private sector initiatives, national research programmes as well as international best practice to develop an ambitious national implementation for WLC regulation and circularity of buildings in Czechia.

National building sector initiatives on WLC and circularity

To provide a comprehensive energy and climate strategy for the buildings and construction sector, the Czech Green Building Council (CZGBC) published a **Zero Carbon Roadmap** in January 2024, in cooperation with the World Green Building Council and national stakeholders.[44] INCIEN also contributed to the Roadmap as a co-author and member of the Steering Committee. The Roadmap is intended to provide a pathway for the achievement of climate neutral buildings in Czechia. Going beyond existing national policy documents, it is the first document of its kind to address **the whole life cycle of buildings in Czechia**, covering both operational and embodied carbon. For embodied carbon the Roadmap provides a comprehensive baseline analysis (sections 4.4.2 and 4.4.3), outlines a vision for reduction of embodied emissions (section 5.2), maps key barriers and measures (chapter 6) and sets out a net-zero roadmap for proposed actions to reduce embodied emissions by key stakeholder and time frame (short term 2025, medium term 2030 and long term 2050). The main barriers related to WLC, embodied carbon, materials and building renovations are summarised in Table 4.

[44] Zero Carbon Roadmap - Pathway to Climate-Neutral Buildings in the Czech Republic (CZGBC, January 2024)

Table 4: Overview of selected barriers according to the Zero Carbon Roadmap

Category	WLC and embodied carbon in materials	Renovation and reconstruction
Technical	• 6.1.1. Difficulties in reducing the emission intensity of the production of traditional materials • 6.1.2. Insufficient pace of new product introduction and limited capacity to produce alternative materials with a low carbon footprint • 6.1.3. Untapped potential of waste materials • 6.1.4. Reserves in material efficiency in production • 6.1.5. Lack of readily available data on construction materials • 6.1.8. Lack of availability and widespread use of tools for environmental assessment of buildings	• 6.1.7. Lack of data on the building stock • 6.1.11. High degree of individual approach in the assessment of building renovations from the point of view of conservation
Economic	• 6.2.1. Unclear conditions for financing low-carbon construction projects in relation to the EU Taxonomy • 6.2.3 Financing the decarbonisation of building materials production	• 6.2.2. Non-conceptual long-term financing of renovation of buildings owned by the state and local governments • 6.2.5 Financing building renovation to reduce emission burdens
Legislative	• 6.3.1. Lack of a binding methodology for reporting and assessing GHG emissions at building level • 6.3.2. Lack of a legislated requirement for disclosure of product information • 6.3.3. Legislative restrictions on recycling in the construction industry	• -
Knowledge	• 6.4.1. Insufficient expertise in building design • 6.4.4. Insufficient knowledge of decarbonisation issues on the part of material and technology manufacturers and implementation companies	• 6.4.5. Insufficient expertise on the part of building managers, operators and owners
Administrative	• 6.6.1. Disregard of emissions intensity in public procurement	• 6.6.2. Non-conceptual preparation of renovation investment projects • 6.6.3. Insufficient renovation of central government buildings

Source: CZGBC (January 2024)

CZGBC also published in May 2024 a **Common interpretation of the EU Taxonomy's technical screening criteria** for buildings, covering the climate change mitigation objective for buildings with over 5,000 m2 of useful internal floor area, with the intent to secure its adoption as a standard assessment methodology for Taxonomy compliance of buildings. At the current stage of market development, the authors concluded that the "Do no significant harm" (DNSH) criteria (including those related to

the transition to a circular economy) are too extensive and costly to be applied to smaller buildings without significant simplification. Even for larger buildings, the authors recommend applying the Climate Change Mitigation framework as the Taxonomy's "substantial contribution" objective for new construction, refurbishment and acquisition of buildings, as they consider it "the most important and credible pathway given the urgency of climate change". The document includes guidance on the primary criterion related to calculation of life-cycle GWP and the DNSH criteria related to 70% recovery of CDW for recycling and reuse and design principles for disassembly and adaptability, as these criteria are considered to be adequately defined. However, the use of the Circular Economy framework as the "substantial contribution" objective for building assessment according to the Taxonomy's Environmental Delegated Act is currently considered too difficult to achieve and has not yet been included.[45]

In response to growing international interest in WLC of buildings and future mandates under the EPBD recast, the University Centre for Energy Efficient Buildings (UCEEB) of the Czech Technical University in Prague published in July 2023 a **methodology for assessing the life-cycle GWP of buildings** with the support of the European Climate Foundation's Building Programme, including the preparation of preliminary case studies and benchmarks.[46] As part of the of the international **INDICATE** LCA data accelerator project[47] and in cooperation with CZGBC and Chance for Buildings, UCEEB has continued in 2024 with further analysis of its existing LCA case studies, refinement of its WLC calculation methodology and the development of an additional 50 case studies to help build **more robust WLC benchmarks** for Czechia's building stock. The project has used the international One Click LCA database while applying localised input values where available and developing a unified approach to WLC calculation aligned with the Level(s) common framework. The project outputs include recommendations on the usability of different LCA databases for construction products in the Czech context, a first proposal of benchmark WLC values for different types of buildings in the future national WLC roadmap, and WLC calculation methodology manuals for buildings in Czechia for both policy makers and construction professionals.

In parallel with the development of the new Raw Material Policy for Wood and in the context of ESG reporting under the CSRD, sustainability criteria in the EU Taxonomy and future WLC disclosure requirements under the EPBD 4 and revised CPR, several private sector stakeholder groups have also been set up to help **accelerate the uptake of mass timber construction**, including the Platform for Sustainable Timber Construction, the CZGBC's new Task Group for Timber and a Wood Processing

[45] Společný výklad technických screeningových kritérií EU Taxonomie (CZGBC, May 2024)
[46] Připravujeme české stavebnictví na dekarbonizaci (ČVUT UCEEB, July 2023)
[47] https://www.indicatedata.com/

Industry Section at the Czech Chamber of Commerce (the latter two both set up in May 2024).[48]

Several ongoing or recently completed **international R&I and regional cooperation projects** involving project partners from Czechia address different aspects of the circular economy in relation to the construction industry and are a source of practical methodologies, tools, best practice guidelines and training materials for implementation of circular construction practices. A summary of these projects is shown in Table 5.

Table 5: Selected international projects focusing on circular construction with Czech partners

Project	Programme	Timeframe	CZ partner(s)	Focus areas and key outputs
BUS-GoCircular	Horizon 2020	09/2021 - 02/2024	INCIEN CTU Prague - Faculty of Civil Engineering	• Qualification framework for circular construction skills, with a pilot application to multifunctional green roofs, facades and interior elements. • Train-the-Trainer programme. • Mentoring programme. • Training material packs for MSPs. • Policy brief for public procurement.
RECONMATIC	Horizon Europe	07/2022 - 06/2026	CTU Prague - Faculty of Civil Engineering	• Integration of CDW waste management into processes throughout the life cycle of buildings and construction. • Development of new automation and digitisation tools or solutions to prevent waste and increase reuse and recycling across the value chain.. • Solutions to achieve cleaner CDW material flows and further improve logistics and organisation of CDW treatment to achieve higher waste recovery. • 6 demonstrators including 2 in Czechia.
Circon4Climate	EUKI	12/2022 - 03/2025	CTU Prague - UCEEB	• Development of guideline documents and educational materials on circular construction, including circular procurement, building design, materials selection, material cadastres and safe use of secondary materials, using best practices from Germany. • Recycling Academy course and a pilot semester course for university students.

[48] Platforma pro udržitelné stavebnictví ze dřeva (UBM Development); Pracovní skupina TIMBER (CZGBC); Sekce dřevozpracujícího průmyslu (Hospodářská komora ČR)

Project	Programme	Timeframe	CZ partner(s)	Focus areas and key outputs
ReBuilt	Interreg Central Europe	04/2023 - 03/2026	CZGBC	• Development of a “Fit for Circular and Digital Construction” Massive On-line Open Course (MOOC). • Development of joint technical and digital solutions for circular construction. • Creation of a Central European Strategy for Circular and Digital Construction. • Solution as a Service (SaaS) implemented by hubs in 9 Central European countries providing educational, technical, digital and information services to promote digital and circular construction.
Circular DigiBuild	Interreg Danube Regional Programme	01/2024 - 06/2026	INCIEN	• Creation of a Danube Circular Construction Network: at least 30 members (MoUs) from 13 countries to reduce barriers and close the innovation gap in the Danube region. • Regional analysis of sector readiness and opportunities for greater circularity and innovation in CE based on digitalisation. • Dissemination of transferable RIS3 best practices from the Danube region to support improvement of policy instruments. • Development of a transnational strategy for the Danube region on digitally-led innovation in construction with specific targets and key performance indicators. • Policy recommendations to support an accelerated twin green and digital transition and a "better policies annex".

Existing WLC initiatives in frontrunner European countries

Several European countries have developed roadmaps or have planned or already implemented policies for mandatory calculation of WLC of new buildings or even the introduction of limit values on WLC of new buildings to accelerate their transition to life cycle low-carbon construction. These frontrunner countries have laid the groundwork and offer inspiration and insights for an effective national implementation in Czechia in the coming years.

In 2018, **the Netherlands** was the first country to introduce LCA-based limit values, using a metric called MPG (MilieuPrestatie Gebouwen) or EPB (Environmental Performance of Buildings) and covering new offices with a useful floor area over 100 m² and new-build homes. MPG converts 11 different indicators into a single weighted value for the environmental impact of the materials used in a building. The initial MPG limit value was set at 1.0 and lowered to 0.8 from July 2021 for residential buildings. From January 2025, the number of indicators will be increased to 19 based on an adjusted weighting and the overall limit value will be further tightened for both categories of building, although no limit values specifically for WLC are currently planned.[49]

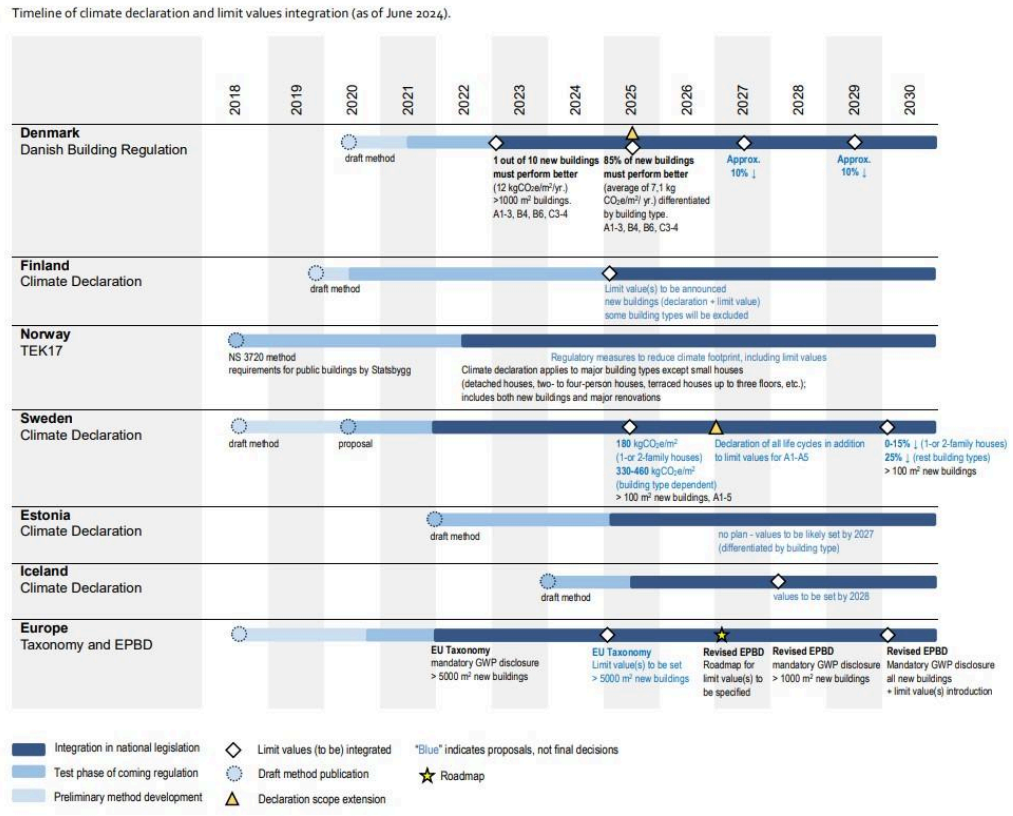
In **France**, the LCA approach, calculation of WLC and introduction of limit values have been in place since 2022 under the expanded "**RE2020**" Environmental Regulation. This followed the introduction in November 2016 of a voluntary sustainability label to test an LCA methodology, develop knowledge and engage stakeholders for adoption of mandatory climate declarations.[50] RE2020 requires separate reporting of (and limits on) life cycle emissions for building operations, embodied carbon in building materials and equipment and on-site activities. For embodied carbon, limit values in effect from 2022 for family homes, multi-occupant residential buildings, office buildings and primary and secondary schools will be further reduced every three years (in 2025, 2028 and 2031). The total embodied carbon reduction between 2022 and 2031 is 35-39%. In addition, the RE2020 introduces dynamic LCA which takes into account the temporality of emissions and biogenic carbon storage effects in wood and bio-based materials.[51] In support of circularity, France has moved early to implement **Extended Producer Responsibility (EPR)** for collection, recycling and reuse of CDW and end-of-life products. As of May 2023, companies placing (finished) construction products and materials on the French market are required to register with at least one of four authorised EPR organisations, make monthly declarations on sales volumes by product code and pay eco-modulation fees towards end-of-life collection and

[49] MilieuPrestatie Gebouwen - MPG (Netherlands Enterprise Agency)
[50] Énergie Positive & Réduction Carbine (E+C–) voluntary labelling scheme
[51] Environmental regulation RE2020

treatment.[52] With about one-fifth of buildings in France either unoccupied or used for rentals or as a second home, the government also **encourages renovation of existing buildings over new construction** by applying variable VAT rates for construction work (20% for new building work, 10% for renovations, 5.5% for energy-efficient renovations) and prohibiting construction of new commercial spaces over 10,000 m2 if the surrounding soil is turned into an artificial surface.[53]

Countries in the **Nordic region** have been pursuing proactive WLC policies over the last several years. A timeline of national initiatives for climate declarations of buildings in the region as of June 2024 is shown in Figure 5. All five Nordic countries (Denmark, Finland, Iceland, Norway and Sweden) and Estonia have either already introduced or are planning mandatory climate declarations for new buildings and are expected to publish a preliminary national calculation methodology by the end of 2024. By the time that mandatory WLC declarations for buildings over 1,000 m2 are introduced under the EPBD recast in 2028, all Nordic countries will have had at least two years of experience with mandatory national WLC regulation.[54]

Figure 5: Timeline of climate declarations and limit values integration for buildings in the Nordics



Source: Nordic timeline regulations updated (Nordic Sustainable Construction, June 2024)

[52] Décret n° 2021-1941 du 31 décembre 2021 relatif à la responsabilité élargie des producteurs pour les produits et les matériaux de construction du secteur du bâtiment
[53] How Green Building Regulations Are Shaking Up the French Construction Industry (BGC, April 2024)
[54] Harmonised Carbon Limit Values for Buildings in Nordic Countries: Analysis of the Different Regulatory Needs (Nordic Innovation, March 2024), pp. 12-15

Mandatory declarations were introduced in **Sweden** under the Climate Declaration Act from the start of 2022 concurrently with the EU Taxonomy's climate change mitigation technical screening criterion for calculation of the life-cycle GWP of large buildings. Boverket (the Swedish National Board of Housing, Building and Planning) has also proposed introducing mandatory limit values for new buildings from mid-2025 and climate declarations for renovations from 2027.

In **Norway**, mandatory LCA requirements were included in the national building code (TEK17) from mid-2022. Although the government is still seeking a consensus with the construction industry on introduction of limit values, Norway is so far the only Nordic country where mandatory LCA declarations are also required for existing buildings undergoing major renovation.

In January 2023, **Denmark** was the first Nordic country to introduce mandatory declarations together with limit WLC values for new buildings, the latter set at 12 kg CO2/m2/yr for buildings with floor area over 1,000 m2. At the end of May 2024, a political agreement was reached on progressive tightening of limits every two years to 2029, while introducing additional building types, varied limits by building type and expanding the LCA scope to include emissions from the construction process (modules A4 and A5). The average limit is set to fall by more than 50% by 2029 to 5.8kg CO2/m2/yr. As part of the associated revision of building regulations, the parties to the agreement are also investigating new rules to promote remodelling, renovation, and changed use of existing structures over demolition and new construction, including adjusting energy requirements for transformations of existing buildings to match the requirements for major renovations and municipal schemes placing stricter conditions on demolition permits or charging a demolition fee to owners for the associated environmental and climate impacts.[55]

Despite the progress made in several European countries to introduce life cycle thinking into building design and environmental declarations, an analysis by Ramboll has highlighted inconsistencies between various national LCA methods currently in use and **the need for greater harmonisation and compliance**. These inconsistencies arise from significant variations in the scope of different LCA methodologies, including the system boundary, the building element groups, floor area definitions and metrics, the reference study period and the impact categories used. Other areas of discrepancy include the design stage used for the LCA, varying skills and experience of LCA practitioners, use of standardised GWP values for materials and variable availability of EPDs, the calculation software used, the treatment of biogenic carbon and assumptions on the inclusion of future decarbonisation impacts on life cycle calculations.[56]

---

[55] Danish Political Agreement Tightens the Limit Values for New Buildings and Extends the Impact (Nordic Sustainable Construction, June 2024)
[56] Which life cycle assessment? Managing the risk of inconsistent building assessments across regions (Ramboll, July 2023)

Since 2022, the Nordic countries have been working to align their approaches to life cycle assessment of buildings through the **Nordic Sustainable Construction** programme, an initiative of the Nordic Ministers of Construction and Housing and funded by Nordic Innovation.[57] In September 2023, the programme published a roadmap for harmonising Nordic building regulations concerning climate emissions. It has since followed up with additional reports on the operating environment of building LCA and BIM and regulatory needs for harmonising carbon limit values for buildings, leading in June 2024 to a detailed set of recommendations for a common Nordic approach to mitigating the life cycle climate impact of new buildings.[58]

In general, the recommendations stress the need for a **harmonised methodology and scenario settings** for data and calculation methods to ensure comparability of results across both Nordic and other EU countries. This includes harmonisation of the GWP indicator used in EPDs. Specific recommendations are provided for each module of the LCA framework. While common approaches for collection of source data can be applied across countries, GWP data at least for high-impact products in each national market (typically accounting for 80% of GWP across modules A1-5 - product stage and construction process) should be based on national EPDs and be publicly and freely available in a national GWP database for construction products. Scenario settings for Modules B and C covering use and end-of-life stages need to be harmonised according to decarbonisation scenarios from the European Commission and national regulators that describe an improved future climate impact. Common formats, naming and classifications need to be adequately defined for interoperability of databases. In particular, to facilitate integration of LCA data into BIM tools, EPDs should be machine readable and generic data provided in a common format, for example through the use of data templates.[59]

The recommendations are also intended to provide input on how Nordic data can contribute to a potential EU-wide database and to influence the definition of common rules for GWP calculations at a product level in the EU framework for national WLC calculation that the Commission will develop by the end of 2025. Benchmarks and specific recommendations for a national WLC calculation methodology for Czechia are provided in the outputs of the Czech INDICATE project.

[57] https://www.nordicsustainableconstruction.com/
[58] Nordic Sustainable Construction Knowledge Centre - Life Cycle Assessments
[59] Recommendations for a Common Nordic Approach to Combat New Buildings Life Cycle Climate Impact (Nordic Innovation, June 2024)

Recommendations for the implementation of embodied carbon policies in Czechia

In this chapter we propose a set of recommended actions for the following 10 priority areas in terms of embodied carbon and its future reduction in the context of Czechia. For each area we present related actions from this year's CZGBC Zero Carbon Roadmap, relevant (adopted) national policies, plans and strategies and additional recommendations from INCIEN.

1. Common interpretation and gradual transition to circular economy criteria as a target for a "significant contribution" to the EU Taxonomy objectives

The EU Taxonomy is an essential framework motivating the early introduction of WLC calculations and greater circularity of buildings ahead of the mandatory measures in the recast EPBD. The recently published *Common Interpretation of the EU Taxonomy Technical Screening Criteria* (CZGBC) currently focuses on large buildings (over 5,000 m2 of useful floor area) and climate change mitigation as the Taxonomy target for "significant contribution". The circular economy transition target for Taxonomy compliance under the delegated environmental act is currently considered a lower priority and too difficult to achieve, so has not yet been included in the interpretation. There have already been calls at EU level for closer alignment of the GWP (global warming potential) and CE criteria in the Climate and Environmental Acts of the Taxonomy for Buildings to accelerate the phasing in of the calculation and reporting of WLCs before they become mandatory under the requirements of EPBD 4, and to encourage wider uptake of the EPD and the application of circular building design principles under the EU Level(s) framework.

INCIEN Recommendation:

- CZGBC, MF and stakeholders: Update the *Common Interpretation* of the EU Taxonomy to bridge the described gap and propose a gradual extension of the GWP and CE criteria to apply first to new buildings with a useful floor area above 1,000 m2 and then to all new buildings and major renovations.

Related recommendation - Zero Carbon Roadmap (CZGBC):

- Czech Government: develop a methodological interpretation of the EU Taxonomy and DNSH rules for specifying and checking criteria for subsidy programmes.
- MF: In cooperation with the Ministry of the Environment, the Ministry of Regional Development, or the CBA, ensure a uniform internationally harmonised interpretation of the SFDR and CSRD directives and the EU Taxonomy and DNSH technical criteria for construction, renovation and energy saving projects and negotiate simplified criteria for smaller construction projects (6.2.1).

2. Preparation for LCA calculation and subsequent WLC reduction

Mandatory WLC (life cycle GWP) calculations for new buildings is a significant new requirement introduced by the revised EPBD 4, which has so far received relatively little attention in preparation for national implementation of the Directive. Although at the time of writing there are three and a half years to go before the first mandate enters into force (from 2028 for buildings with a useful floor area of more than 1,000 m2), thorough preparation is needed now to ensure effective, orderly and manageable implementation of these new requirements.

Related recommendation - Zero Carbon Roadmap (CZGBC):

- MIT: Establish a consistent methodology for reporting emissions [throughout the life cycle of new buildings] under EPBD IV (6.1.8). The methodology developed by CTU-UCEEB for the ECF project in 2023 can be used as a basis.
- MIT: Prepare a timetable for the implementation of the EPBD IV revision, including the requirements for measuring the carbon footprint of buildings (6.7.1). Legislatively anchor the calculation methods and ensure the availability of tools for assessing and reporting the carbon footprint of buildings.
- MIT: Ensure the establishment of a sufficiently representative statistical sample of WLC building case studies according to the national methodology for robust determination of GWP limit values (CO2eq/m2).
- MIT: Introduce legislative limits on embodied CO2eq/m2 for new buildings, following the introduction of a uniform methodology and database used to assess the building stock (6.1.8).
- MoE: Clarify offset schemes (possible until 2030) (6.1.1). Inform about offset schemes possible from 2030 (Union Certification Framework for Carbon Removals) to avoid greenwashing.

3. Provision of construction product data to support WLC calculations

Input data on the life cycle GWP of building materials and products is a key prerequisite for a good WLC calculation of buildings and comparability of calculations between buildings in different typologies. According to the recommendations of the Nordic Sustainable Construction initiative as well as the Czech INDICATE project, GWP data at least for high impact products in each national market (typically constituting 80% of the GWP in modules A1-5 - product phase and construction process) should be

based on national EPDs and should be publicly and freely available in a national GWP database for building products. At the same time, manufacturers of construction products should prepare for the new requirements of the revised CPR to issue declarations of performance and conformity, which will also indicate the environmental sustainability of their construction product on a life cycle basis (for new products, in the case of GWP already in the second half of 2025).

Related recommendations - Zero Carbon Roadmap (CZGBC):

- MoE: Ensure the creation of a national LCA database of building products containing generic data for use in the early stages of building design and specific data for individual building products (6.1.5). It would also be helpful for the development of LCA tools if EPD data were published in the CENIA database in a machine-readable format.
- MoE: Promote the use of construction products with verified environmental impact assessment (including other indicators in addition to CO2) using EPDs. Extend subsidies for the use of products with EPDs to other subsidy schemes (6.1.2).
- MoE: In cooperation with the MIT and industry organisations, ensure awareness raising among manufacturers and importers of building materials of the new obligations arising from the new CPR update (6.3.2).
- MIT: Provide methodological support to SMEs for the certification of new products, possibly with vouchers or financial instruments to support the processing of EPDs for construction products (6.1.2).

For detailed recommendations on areas 2 and 3 we refer to the results of the Czech INDICATE project (CTU UCEEB, CZGBC and Chance for Buildings).

4. Incorporation of WLC and circular economy measures into the draft NDPB

According to the EPBD 4 principles, "the life-cycle performance of buildings should be taken into account not only for new construction but also for renovation, by integrating policies aimed at reducing life-cycle greenhouse gas emissions into Member States' national building renovation plans". Without embodied carbon measures for building renovation, the long-term climate targets for the EU building stock will not be met. Under the "Renovation Wave", embodied carbon from energy renovations has the potential to increase several-fold by 2050 (in particular from building technical and electrical equipment and materials and products related to the building envelope) and repair and replacement activities already account for almost 20% of the embodied carbon of the EU building stock (e.g. coatings and adhesives). The preparation of the National Plan for the Renovation of Buildings (NPRB) offers an opportunity to progressively reflect these parameters and related indicators and solutions in the objectives and measures for the renovation of the building stock in the country.

INCIEN recommendations:

- MIT: Systematically take into account the measures and indicators in the overview of policies and measures in the draft National Plan for Renovation of Buildings for.
    - Prevention and quality treatment of construction and demolition waste,
    - Life-cycle GWP reduction in the construction, renovation, operation and end-of-life of buildings and the use of carbon removal,
    - promoting modular and industrial solutions for construction and renovation.
- MIT: Take GWP indicators and data into account in the optional measures of EPBD 4.
    - Definition of energy performance class A+ for buildings with maximum energy performance threshold (mandatory GWP calculation for existing buildings).
    - Collection and storage of GWP data in databases that Member States are obliged to establish for the energy performance of buildings.
    - Inclusion of building GWP, where available, in the information on the share of buildings in the national building stock covered by PENB.
    - Consideration of GWP in national calculations of 'cost-optimal levels of minimum energy performance requirements for new buildings and existing buildings undergoing deep renovation and for individual building elements'.

Related recommendation - Zero Carbon Roadmap (CZGBC):

- Government: develop a system to collect the necessary data on the national building stock. Identify a national data integrator, which could be the Czech Statistical Office or the MIT (6.1.7.)
- Government: systematically map the state building stock and ensure continuous preparation of quality energy saving projects. Use the obligation under Article 5 of the EED to annually renovate 3% of the total floor area of heated or cooled buildings owned and used by central government institutions as an opportunity to create exemplary renovations of high architectural quality in a zero-energy standard.
- MIT: Anonymised access to data from the MIT ENEX database and link to the cadastral register RÚIAN (Register of Territorial Identification, Addresses and Real Estate). Prepare the MIT ENEX database for the collection of EPBD IV data, including new data on the emission performance of buildings (6.1.7).

5. Reducing the number of unoccupied flats by utilising them in the framework of housing policy

International roadmaps and strategies on embodied carbon in the building sector emphasise that the starting point should be demand-side measures aimed at reducing the consumption of primary building materials through increased reuse, adaptive reuse, refurbishment, repair or reconstruction of existing sites and buildings and

extending their useful life, including the reuse of structures, components and materials within them. The MRD analysis on unoccupied dwellings provides a robust basis for setting policies and measures to reduce the number of unoccupied dwellings in Czechia based on international practice.

INCIEN recommendations:

- MRD: Implement the recommendations from the analytical study "Structure of unoccupied dwellings in Czechia and tools for their activation used in OECD countries" (see below).

Related recommendation - Structure of unoccupied dwellings in Czechia and tools for their activation used in OECD countries (MRD):

- Create a register of housing stock in RÚIAN with regular updates and revisions.
- Continue to collect data on unoccupied dwellings in the SLDB (Census of Population, Houses and Dwellings).
- Set up a method to verify data on unoccupied housing stock and the reasons for its unoccupancy.
- Set up a regular more comprehensive real estate market survey to identify long-term unoccupied dwellings on the real estate market and the reasons for their vacancy.
- Set up a regular survey of landlords and landladies on motivations and barriers to renting available apartments.
- Examine the application of selected support and motivational measures from the foreign research in the specific socio-economic and legislative environment of Czechia.

6. Promoting increased recycling of CDWs and reuse of building structures

Greater use of waste materials from construction and demolition would contribute significantly to reducing the emissions intensity of building materials production by saving feedstock and processing requirements. In the period 2017-2020, according to the ISOH database (MoE), the annual production of construction and demolition waste in Czechia was 20-22 million tonnes. Material sources suitable for recycling are mainly concrete waste (approx. 1.8-2.1 million tonnes), brick waste (approx. 0.7-0.8 million tonnes) and their mixtures (2-2.2 million tonnes), in total 4.5-5 million tonnes. Although 70 % of this quantity is already 'recycled', it is mainly used for backfilling, sub-backfilling and reinforcement of temporary roads on construction sites and the remainder for reclamation of mainly mining areas, landscaping and landfill technology. ARSM estimates the potential for the use of concrete and brick waste as filler for concrete at 30 to 50 % (1.5-2.5 million tonnes) of the above quantities. Other important streams are metals (steel, aluminium), glass, insulation materials and wooden structures, including their reuse potential.

The issue of brownfields has been a focus of activities by the public administration in Czechia for 30 years. The revitalisation of brownfields is itself a circular strategy, and

circular principles and measures for increased reuse or recycling of materials, structures and products from brownfields need to be explicitly explored and applied as part of their revitalisation or other construction projects.

Related recommendations - Zero Carbon Roadmap (CZGBC):

- MoE: In accordance with the Circular Economy Action Plan 2040, in cooperation with the MIT, adjust the legislative environment for the use of material from demolition sites as secondary raw material.
    - By 2027, evaluate options and subsequently propose a technical standard setting out requirements for conducting pre-demolition audits for selective demolition.
    - In cooperation with the MRD, define the obligation for builders to prepare a pre-election audit for certain types and sizes of buildings. (6.1.3)
- MIT and CAS: Modify standards to enable the safe use of products with a recycled component. (6.1.1)
- MIT in cooperation with industry organisations (as part of the update of the Secondary Raw Materials Policy).

INCIEN recommendation:

- MIT, CzechInvest and other stakeholders: link and take into account relevant measures from the Waste Management Plan, the Secondary Raw Materials Policy and the Circular Czechia 2040 Action Plan in the next update of the National Strategy for Brownfields Regeneration and related subsidy programmes.

7. Promoting low-carbon and circular building materials and products

Support (subsidies, education, research) for the development, production and marketing of building materials and products that have a low life-cycle carbon footprint and a high recycled content while meeting all performance and safety requirements for the application area is a prerequisite not only for calculation but also for real reduction of embodied carbon in buildings. At the same time, these products are often uncompetitive in price and/or perceived to be of lower quality, or their use implies a change in current construction practices.

Related recommendations - Zero Carbon Roadmap (CZGBC):

- Government of the Czech Republic: Provide systematic support to manufacturers of building products targeting decarbonisation plans and initiating the implementation of necessary measures (6.1.1, 6.2.3).
- MIT: Map the readiness of building materials producers for decarbonisation and inform them about available support programmes (6.1.1, 6.1.2).
- MoE and MIT: Increase support for research and development of new building products with low carbon footprint and high recycled content, including their marketing (TAČR Environment for Life Programme 2, OP TAK) (6.1.2).

- MoE: In cooperation with the MoF and industry organisations, prepare an awareness-raising campaign targeting smaller construction companies and smaller producers of construction products to inform them about the obligations associated with the introduction of CSRD (6.5.4).
- MoE: Support research, development and deployment of CCUS technologies in Czechia (6.1.1).

8. Support for the use of natural renewable building materials

Another important aspect is increasing the proportion of natural building products used in the construction of new and renovation of existing buildings. For example, the adoption of the Raw Materials Policy for Wood provides an important framework for supporting increased use of timber in the construction sector by reducing existing normative barriers and helping to set up tools and measures to transparently assess different materials and building solutions in terms of their carbon footprint and other impacts throughout the life cycle of buildings. Timely and effective implementation of policy measures related to timber buildings and the use of wood waste streams as a secondary raw material for construction and other products can also be key. For example, when scaling up timber buildings, it is important to embed circular principles and address their potential in terms of modularity, material efficiency, digitalisation, adaptability during the lifetime of the building, deconstruction at the end of life and reuse.

Related measures - Raw material policy for timber:

- MIT; MV - DG Fire Service; Office for Technical Standardization, Metrology and State Testing: Modify the relevant standards of CSN 73 08 series, or CSN 73 0540, as appropriate, in favour of increased use of wood in construction (O21.11).
- MRD and MoH, in cooperation with MoE and MIT: Analyse the possibility and, on the basis of this, take into account the increase in the share of wood use in public procurement in the preparation of the Action Plan for Sustainable Purchasing and Minimum Standards for Responsible Public Procurement for Construction Works as an implementation measure of the National Public Procurement Strategy (O21.21).
- MoH: Achieve a minimum use rate of 20% of wood or other renewable materials in construction contracts for buildings and their renovation awarded by the MoH and its line organisations, establishing an example of good practice and its wider recommendation to government and the professional community (O21.22).
- MoF: In the next revision of tax regulations, consider tax benefits for wooden buildings (e.g. through the Real Estate Tax Act) (O21.31).
- MoE: Within the criteria for support for new buildings from MoE subsidy programmes, give preference to support for energy passive wooden buildings (O21.32).

- GAČR, TAČR, NAZV, Grant Service of LČR: Ensure more frequent calls for projects within grant agencies in favour of increased use of wood in construction and new technologies in the use of wood (O23.21).
- MoE: Develop a uniform methodology for calculating the life cycle carbon footprint of buildings made of different materials (O23.31).
- MoE: Effective promotion of material recycling of wood-containing waste by setting indicative targets for material recovery of wood-containing waste in updates of Waste Management Plans (O31.21).

INCIEN recommendations (from its "Closing the Loop on Wood" study):[60]

- Industry stakeholders stress the continuing need to raise public awareness and expand training and qualifications in timber construction and to avoid misconceptions about fire safety and other performance characteristics.
- Given the strong growth potential of timber buildings in Czechia, the principles of the circular economy should be evaluated and embodied in sector policy, decarbonisation roadmaps and industry practice at all levels of the value chain, from design for adaptability, retrofit, deconstruction, reuse and recycling of timber buildings, to requirements for pre-demolition audits of buildings at end-of-life and subsequent selective demolition and dismantling to promote change of use of buildings and longer-life structures and recovery of timber components for reuse or recycling.
- The current Norwegian sirkTRE and CircWood programmes represent a strategic and coherent national initiative to map, develop and implement a wide range of circular technologies, processes, business models and policies across the wood industry and stakeholder value chain. These projects are ongoing, but offer inspiration and sources of best practice and knowledge transfer, including through potential bilateral cooperation on circular strategies for wood buildings.

9. Application of LCA in BIM tools

In July 2024, an update to the BIM Concept was adopted in relation to the draft Construction Information Management, Building Information Models and Built Environment Bill. Although the Regulatory Impact Assessment of the Bill mentions the potential of BIM to reduce construction waste and facilitate improvements in the environmental performance of buildings on a lifecycle basis, the updated BIM Concept and the wording of the Bill lack an explicit link between digitisation, material efficiency, embodied carbon and the concept of buildings as material banks.

Recommendations from INCIEN and the INDICATE project:

- CSA: Establish a uniform data standard for BIM LCA. Ensure the development of a robust methodology to enable the effective and widespread use of BIM in

[60] Closing the Loop on Wood: Circular Bioeconomy Opportunities in the Value Chain for Forest Products and Wood in Czechia (INCIEN, May 2023)

construction practice, including a focus on the application of circular design principles, material efficiency and WLC reduction measures.

10. Promoting demand for low-carbon solutions in green public procurement
Green public procurement is a key tool for stimulating demand for environmentally friendly building materials and products with a low carbon footprint on a life cycle basis. In February 2024, MRD published the National Public Procurement Strategy 2024-2028. The strategy includes the development of a Sustainable Purchasing Action Plan, which aims to create a database of harmonised minimum standards for responsible public procurement in various sectors, including construction. To this end, the MRD plans to develop a Methodology for incorporating sustainability principles (ESG and taxonomy) into public procurement in the construction sector by June 2025 to provide practical guidance to contracting authorities. This methodology should also prioritise the carbon footprint of emission-intensive materials and products (cement and concrete, steel, aluminium, plastics) and incentivise the selection of options with low lifetime GWP while meeting all relevant performance and safety conditions.

Related recommendations - Zero Carbon Roadmap (CZGBC):

- MRD: Provide a methodology with specific wording of possible technical requirements and evaluation criteria for tender documentation and subsequent evaluation, ensure mandatory carbon footprint reporting for larger projects in construction public procurement, and pilot the introduction of requirements for the use of low carbon footprint products in public procurement (6.6.1, 6.3.2).