

BUILDING FOR THE FUTURE:

- Why EU member states must take ambitious steps in implementing the whole life carbon requirements in the EPBD



Green
Transition
Denmark



RECOMMENDATIONS FOR EFFECTIVE IMPLEMENTATION IN MEMBER STATES

Green Transition Denmark believes that the following 5 actions are crucial to fully unlock the potential of the WLC requirements within the EPBD:

- **Initiate the uptake of the national roadmap immediately**, with mandatory limit values starting no later than 2028. Do not wait for 2027 and 2030 to establish the national roadmap and introduce limit values and targets for new buildings. The WLC requirements in Denmark, Finland, Estonia, France, the Netherlands, and Sweden show that it is possible. Experience from other instances of regulation show, that the sooner the regulations are presented, the faster the industry will adapt. At the same time, informing the industry about the upcoming requirements will benefit the industry, as it will allow sufficient time for the transition.
- **Include a voluntary sustainability class** with even higher ambitions in the roadmap. In that way, a carrot is introduced for developers to choose more ambitious paths, enabling them to communicate the aspect further. At the same time, it creates the opportunity to gather experience and drive the transition of low carbon construction further.
- **Make calculations for all new buildings' mandatory from 2028.** Several of the countries which already have or plan to set requirements for WLC in buildings, have chosen to include all new buildings from the outset. It is therefore possible to raise the bar and get the entire industry onboard from the beginning. Therefore, the goal should be to implement calculations in 2028 at the latest.
- **Initiate the collection of data for life-cycle GWP of buildings immediately.** This can be done by implementing a test phase for the sustainable voluntary-class, as is the case in Denmark. Ensuring a broad and robust data framework for the life-cycle GWP of buildings is important as a basis for policy decisions. The more accurate data, the greater the opportunity for the member states to set representative and ambitious limit values. Preferably the data collection should aim at collecting data for all stages and modules. Moreover, it is important to collect and analyse data for different building typologies to ensure the best possible basis for setting differentiated limit values for different building typologies.
- **Make reused building materials count for zero in the calculation** until more accurate data is in place.

INTRODUCTION

The construction and operation of buildings emit significant amounts of CO₂ throughout their entire life cycle. In fact, the building sector in the EU is responsible for around 36 per cent of the EU's total CO₂ emissions¹. It is also a highly resource-intensive industry, consuming large quantities of materials such as sand, wood, and steel, while contributing to substantial amounts of waste². This underscores the urgent need to scale up decarbonisation efforts and significantly accelerate the pace of the transformation within the building sector across the EU.

For many years, the focus has been on reducing operational emissions, mainly from energy consumption during a building's use phase. However, it is no longer sufficient to concentrate solely on this aspect. Instead, reducing emissions throughout the entire life cycle of buildings must be at the centre of attention.

Fortunately, in recent years, there has been a shift in focus toward the significant emissions associated with the production of building materials and the construction process itself. These emissions are also known as embodied carbon, which are estimated to account for 10-20 percent of building's total carbon footprint³ - a proportion that is expected to rise as operational carbon emissions decrease through efficiency improvements.

Therefore, several EU member states, including Denmark, France and the Netherlands, have introduced regulations that address both operational and embodied carbon emissions – also called whole life carbon (WLC). Following, the EU has now incorporated WLC requirements into the revised Energy Performance of Buildings Directive (EPBD), which entered into force in May 2024. With this, member states are required to introduce WLC requirements for new buildings in national law. These requirements are expanded upon in the following paragraph.

This is a pivotal development, as embodied carbon, unlike operational carbon which can be reduced over time, is 'locked in' once a new building is constructed or an existing one is renovated, making it impossible to mitigate later on. When looking at the potential to reduce CO₂ emissions and resource consumption stemming from the construction of new buildings, it is clearly the WLC requirements that will have the biggest impact. Tackling embodied carbon emissions is therefore essential to achieve a full decarbonization of the construction sector.

While the revised EPBD with the inclusion of WLC requirements is a major step forward, its full potential can only be realized through ambitious national implementation. Each member state must take decisive action now – without waiting for the mandatory requirements of developing a WLC roadmap to come into effect in 2027. This is important, as embracing ambitious implementation now, can ensure that the EU meets its carbon reduction targets and accelerates the green transition in the construction sector across Europe. Now is the time for decisive action.

Green Transition Denmark has, therefore, prepared this briefing document to outline the process of implementing WLC requirements in Denmark, aiming to inspire and support stakeholders in member states as they work to adopt these requirements under the EPBD in the coming years. The report underscores the importance of ambitious implementation to reduce CO₂ emissions in the construction sector and provides recommendations on how to effectively implement the policy.

¹ European Parliament Press Release; Energy efficiency of buildings: MEPs adopt plans to decarbonise the sector; March 2024: <https://www.europarl.europa.eu/news/en/press-room/20240308IPR19003/energy-efficiency-of-buildings-meps-adopt-plans-to-decarbonise-the-sector>

² European Commission; Internal Market, Industry, Entrepreneurship and SMEs: Buildings and construction: https://single-market-economy.ec.europa.eu/industry/sustainability/buildings-and-construction_en

³ Bellona; European Parliament takes first encouraging steps toward regulating embodied carbon; 2023: <https://bellona.org/news/cities-and-transport/2023-02-european-parliament-takes-first-encouraging-steps-toward-regulating-embodied-carbon>

ENERGY PERFORMANCE OF BUILDINGS

DIRECTIVE: WHAT, WHEN AND HOW

Since 2002, the EPBD has provided the regulatory framework for the energy performance of buildings across the EU. The primary purpose of the regulation has thus been to minimise energy consumption in buildings in the EU by imposing regulatory requirements for improving energy efficiency and accelerating the uptake of renewable energy.

The revision of the EPBD, which was adopted in April 2024, and entered into force in May 2024, is part of the EU Commission’s Renovation Wave Strategy, which aims to bring the EU closer to the objectives of the European Green Deal. The revision of the EPBD is thus intended to contribute to the goal of a 60 percent reduction in the buildings sector’s emission by 2030, compared to 2015 levels, and to achieve climate neutrality by 2050.

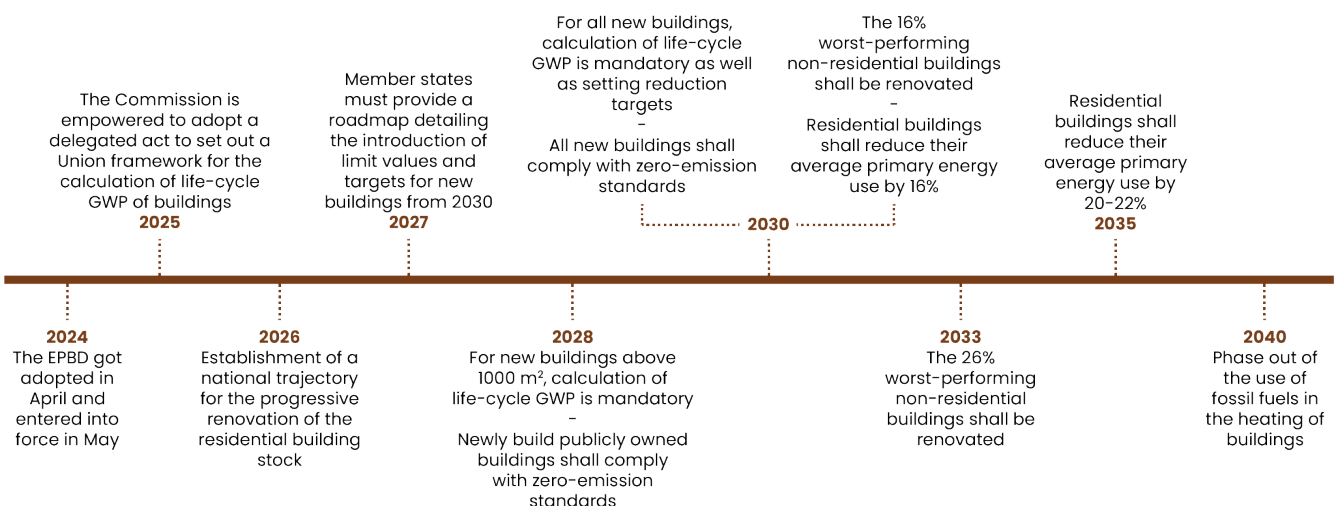
As such, there is a great focus on tightening the regulation of energy consumption from buildings in the EU i.e. the operational carbon. This is important as buildings in the EU account for around 40 percent of the EU’s energy consumption. The requirements apply to both publicly and privately owned existing and new building stocks and take a holistic approach to the building mass in the respective country. For example, the EPBD ensures the implementation of national goals for renovating the building stock, establishes methods for measuring and calculating building energy efficiency, and sets targets for phasing out fossil fuels in the building stock. See Figure 1.

HOW WILL THE EPBD SHAPE THE FUTURE OF BUILDINGS?

Taking all the EPBD requirements into account, we look ahead to a future where buildings must:

- be energy efficient – taking into account cost optimisation
- be supplied with efficient renewable energy
- have a good and healthy indoor climate
- be functional and robust for different uses
- have technical systems that promote, monitor, alert and correct energy efficiency and indoor climate
- be able to respond to flexibility to the environment, including energy price, grid load and climate
- be able to be supplied with electric powered transport
- be affordable – also for poor households and when renovating
- use climate-friendly materials and processes for new buildings and renovation
- have a low resource consumption – especially of scarce resources

Figure 1: Implementation overview of climate requirements in the EPBD⁴



⁴ Nordic Climate Forum for Construction 2024 – presentation 1 of 3; 2024: <https://www.youtube.com/watch?v=JUXK9oYTPlo>

WLC REQUIREMENTS IN THE EPBD: CALCULATIONS, LIMIT VALUES AND TARGETS

Alongside strengthening requirements for buildings' operability, the EPBD is also introducing measures to reduce carbon emissions of buildings over their entire lifecycle. This includes addressing both operational carbon and embodied carbon by introducing requirements related to buildings' life-cycle global warming potential (GWP). These measures are addressed in Article 7⁵, which specifies that:

- As of January 1st, 2030, the life-cycle GWP of all new buildings in the EU must be calculated and disclosed. For buildings larger than 1000 square meters, the life-cycle GWP must be calculated and disclosed starting from January 1st, 2028. The calculation must be expressed as kg CO₂e/m²/year, and follow the guidelines set out in Annex III. See textbox 1.
- As of January 1st, 2027, member states are required to publish a roadmap outlining how they will implement and establish maximum limit values for the total cumulative life-cycle GWP from all new buildings, as well as set reduction targets for new buildings starting from 2030. The roadmap must reflect a progressive downward trend in emissions and maximum limit values for different climatic zones and building typologies.

The requirements necessitate that all member states start to consider how they will implement measures to meet the WLC requirements of the EPBD starting today. This involves ensuring that the necessary tools, data and regulations are in place to enable the construction industry to calculate the life-cycle GWP of buildings as well as comply with limit values and achieve reduction targets. In this process, it would be valuable to draw on the approaches and experiences of other member states to ensure the most effective implementation.

Textbox 1:

HOW TO CALCULATE THE LIFE-CYCLE GWP OF BUILDINGS?

The calculation of the life-cycle GWP must be included in the energy performance certificate and must adhere to the main principles set out in Annex III, where the calculation is based on a lifetime of 50 years for a building⁵. Existing national methods can be used as long as they meet the minimum requirements set by the Level(s) common EU framework. Additionally, the Commission is empowered to adopt a delegated act to amend Annex III and establish a Union Framework by 31 December 2025.

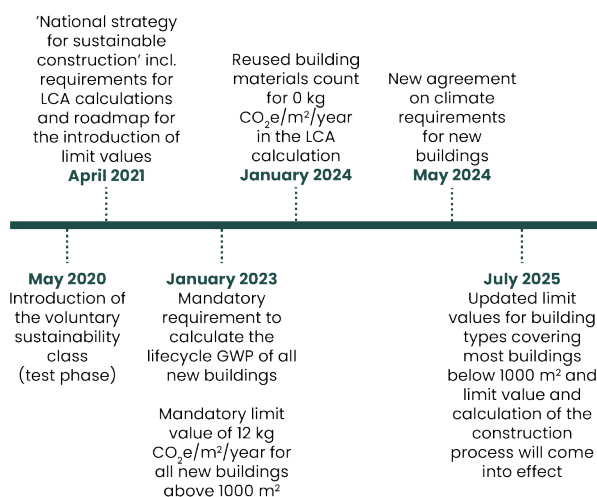
According to Annex III, calculations should be performed following the EN 15978 standard and the EU framework Level(s). This means that the data selection, scenario definition and calculations must align with the guidelines set by the EN 15978.

⁵ Council directive 2024/1275; Directive (EU) 2024/1275 of the European Parliament and of the Council of 24 April 2024 on the energy performance of buildings: <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32024L1275>

WLC REQUIREMENTS IN DENMARK: FROM TEST-PHASE TO MANDATORY REQUIREMENTS

Denmark is one of the relatively few EU member states that has successfully implemented WLC requirements. This regulation has been underway for several years, with a line of actions paving the way for the introduction of these requirements in 2023, followed by revisions in 2024. See figure 2. The subsequent section outlines the overall steps taken toward implementation.

Figure 2: Implementation overview of the WLC requirements in Denmark



Collecting knowledge and experience through a voluntary test phase

In May 2020, it was decided to introduce a test phase for a voluntary sustainability class. This initiative aimed, among other things, to gather practical experiences in sustainable construction, which could help “establish the national level for future sustainability requirements in the building code”. The voluntary sustainability class was defined in the “Guidance on the Voluntary Sustainability Class” published by the Danish Transport, Construction and Housing Authority⁶.

Originally, the test phase for the voluntary sustainability class was planned to last for two years, during which developers were invited to test the sustainability requirements on specific new constructions, renovations, and transformations. However, this test phase extended

beyond the initial timeline to ensure the collection of as many experiences as possible and was ultimately completed 1st of November 2023⁷.

Participation in the voluntary sustainability class was, as the name suggest, optional. However, developers who chose to participate, were required to adhere to and document on a number of requirements. It was permissible for developers to participate even if their construction projects did not fully comply with all the requirements, provided they had generally followed the requirements and had documentation explaining why they were unable to comply with certain requirements.

The requirements in the voluntary sustainability class related to:

- Life cycle assessment – the building’s overall climate impact
- Resource use on the construction site
- Total economic analysis – costs of construction, operation and maintenance
- Operation and maintenance plan for maintenance of indoor climate
- Documentation of problematic substances
- Emissions related to indoor climate
- Detailed verification of daylight levels
- Noise from ventilation systems in residences
- Room acoustics in residences

In addition to the above requirements, a case bank was established to showcase various construction projects, thereby facilitating the sharing of knowledge and experiences related to sustainable construction projects. Participation in this case bank was, however, voluntary.

Roadmap detailing the introduction of limit values

As the test phase approached its one-year mark, the National Strategy for Sustainable Construction was released in April 2021⁸. This strategy presented a roadmap for implementing requirements for life cycle assessment (LCA) calculations and limit values for new buildings. See Figure 3.

The roadmap stated that LCA calculations for all new buildings would become mandatory as of January 1,

⁶ Trafik-, Bygge- og Boligstyrelsen; Vedledning om den frivillige bæredygtighedsklasse; 2020: [https://www.bredygtighedsklasse.dk/Media/Vejledning om den frivillige bæredygtighedsklasse maj 2020.pdf](https://www.bredygtighedsklasse.dk/Media/Vejledning%20om%20den%20frivillige%20baeredygtighedsklasse%20maj%202020.pdf)

⁷ Videnscenter om Bygningers Klimapåvirkninger; Den frivillige bæredygtighedsklasse; 2024: <https://byggeriogklima.dk/klimakrav/den-frivillige-baeredygtighedsklasse/>

⁸ Indenrigs og boligministeriet; National strategi for bæredygtigt byggeri; April 2021: [https://www.sbst.dk/Media/National strategi for bæredygtigt byggeri.pdf](https://www.sbst.dk/Media/National%20strategi%20for%20baeredygtigt%20byggeri.pdf)

2023, along with a limit value of 12 kg CO₂e/m²/year for all new buildings above 1,000 m² from the same date. Additionally, the roadmap indicated that new constructions below 1,000 m² should be included from January 2025.

Besides specifying the limit value applicable from 2023, the roadmap detailed a potential pathway for reducing the limit values through gradual tightening every two years, beginning in 2023 and continuing until 2029. This gradual tightening was set with the aim that 1/3 of new constructions should perform better than the current average by 2025, 3/4 by 2027, and 9/10 should perform better than the current average by 2029. It was also indicated that specific limit values should be set by the involved political parties every two years. The first negotiation regarding revised limit values was scheduled for late 2023, followed by subsequent negotiations in late 2025 and 2027. Through this approach, the roadmap indicated the future trajectory of requirements, enabling the construction value chain to better prepare for forthcoming requirements.

Additionally, as part of the WLC requirements, a voluntary sustainability class was introduced, starting with a limit value of 8 kg CO₂/m²/year from 2023, with plans for further reductions towards 2029 as outlined in the

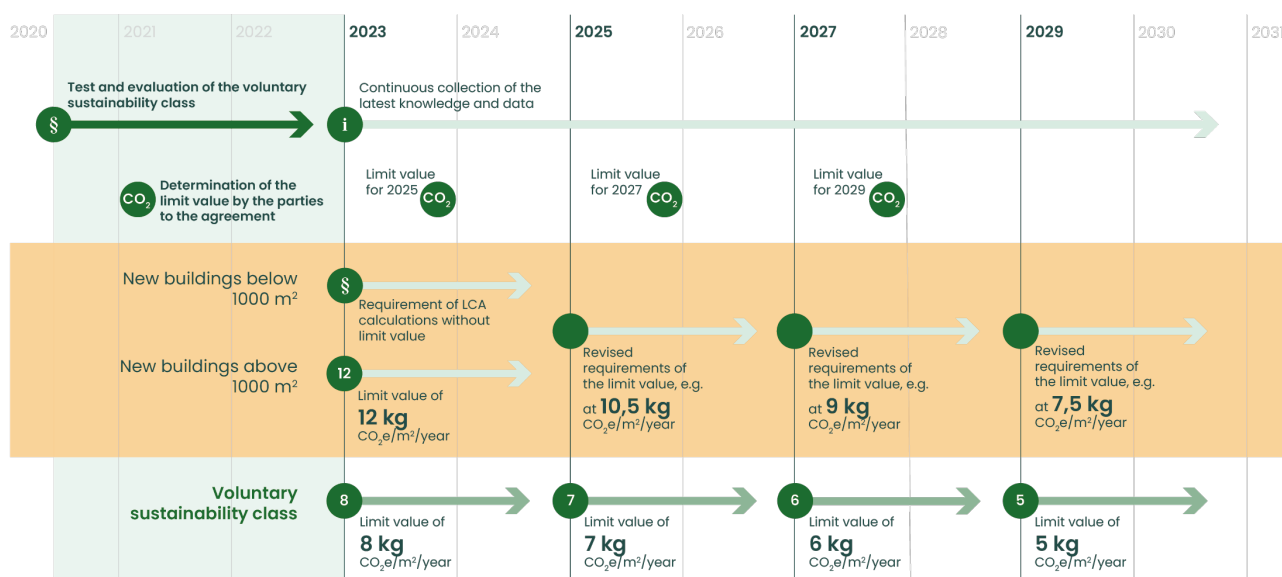
roadmap. This initiative aimed to encourage developers to raise their ambitions above what is required by law. It has proved effective in incentivising greater climate reductions from buildings, with both private and public developers in Denmark, such as PensionDanmark⁹ and the Municipality of Aarhus¹⁰, have adopted this voluntary sustainability class in their building projects, demonstrating its effectiveness in incentivising greater reductions.

A wish for higher ambitions

The WLC requirements, however, have been the subject of considerable debate. While there has been minimal vocal opposition to the regulation itself, criticism has focused on the method behind the LCA calculation and the lack of ambition regarding the limit values. One point of contention has been the absence of a climate discount for using reused building materials. This meant that reused materials in the original regulation were assigned the same CO₂ footprint as brand-new ones, which removed the incentive to incorporate reused building materials in buildings – thus a key opportunity to reduce both the climate impact and resource consumption of buildings has been missed.

Figure 3: **The previous Danish roadmap for the introduction of limit values**

Gradual phase-in of climate requirements for buildings in Denmark. The roadmap was introduced in 2021 as part of the Danish strategy “National strategy for sustainable buildings”⁸.



⁹ NCC; NCC afleverer kontorbyggeri på Marmormolen i Nordhavn til PensionDanmark;

2023: <https://www.ncc.dk/medier/pressrelease/2023/d553a9a781304989/d553a9a781304989/>

¹⁰ Teknik og Miljø – Aarhus Kommune; Miljø- og energirigtigt byggeri i Aarhus Kommune; 2022: <https://aarhus.dk/media/21ukdvoo/miljoe-og-energirigtigt-byggeri-2022.pdf>

In response, Danish politicians introduced an additional agreement, stipulating that, starting from January 2024, reused building materials would be assigned a value of 0 kg CO₂e/m²/year¹¹ in the calculation of a building's climate impact. This provision was set to remain in effect until the end of 2025, after which further decision will be made, based on ongoing work on data and calculation methods for reused building materials.

Another significant criticism was that the 12 kg CO₂/m²/year limit value and the planned reduction pathway for future limit values were not stringent enough. This criticism stemmed from the fact that buildings in Denmark emit around 9.5 kg CO₂e/m²/year¹² on average, significantly lower than the current limit value. Additionally, effective from 2025, the majority of new buildings will automatically achieve a reduction of 1.8 kg CO₂e/m²/year, due to the introduction of more renewable energy in the energy mix¹³. As a result, the CO₂ emissions of new buildings will decrease further without requiring changes in practice by the construction industry, further widening the gap between average CO₂ emissions of buildings and the limit of 12 kg CO₂e/m²/year.

As a result, a large proportion of the industry called for much stricter requirements during the renegotiation of the limit values in 2023/24. A key initiative driving this forward was the Reduction Roadmap¹⁴, launched in September 2022, which outlined the reduction pathway needed to keep the construction sector aligned with the Paris Agreement. In 2023, Reduction 2.0 was released with updated figures, reflecting the halving of the global carbon budget since the release of the first roadmap.

However, both Reduction Roadmap 1.0 and 2.0 highlighted that the limit values presented in the National Strategy for Sustainable Construction were far from sufficient to meet the Paris Agreement. According to Reduction Roadmap 2.0, the limit would need to be reduced to 5.8 kg CO₂e/m²/year by 2025 and to 0.3 kg CO₂e/m²/year¹⁵ by 2029 to align with climate science.

A central element of the roadmap has been the ongoing mobilisation of the construction industry, which helped demonstrate widespread support for more stringent limit values. Currently, more than 630 stakeholders¹⁶ from the Danish building and construction sector have signed the Reduction Roadmap, backing the call to lower the limit values to 5.8 kg CO₂/m²/year in 2025. This broad endorsement reflects the industry's recognition that more stringent requirements are necessary. For instance, Ramboll voiced its support, stating on LinkedIn that "The

industry already has the solutions. Political action can align and boost green demand, prompting investors, manufacturers, suppliers, and consultants to commit to ambitious climate requirements that reflect the science and comply with the Paris Agreement"¹⁷. The Reduction Roadmap has thus played a key role to showcase the industry's support for tightening the regulation and changing the status quo.

Stricter requirements, new modules and division into building typologies in the revised agreement

In May 2024, the new limit values were introduced. The negotiations took a long time coming, which resulted in the introduction of the new limit values, originally set to take effect on January 1, 2025, being moved up by six months to July 1, 2025.

The new agreement not only tightens the limit values to 7.1 kg CO₂e/m²/year on average in 2025, but it also includes several other adjustments. See figure 4. These are¹¹:

- Differentiation of the limit values based on building types
- Expansion of the scope to include almost all new constructions, except for critical infrastructure and unheated buildings under 50 m²
- Introduction of a separate limit value for the construction process (A4-5).
- Revision of the building code to address the interplay which will arise between existing requirements for building safety and health and the new CO₂e requirements
- Easing of the energy requirements for the conversion of existing buildings

¹¹ Tillægsaftale om national strategi for bæredygtigt byggeri; May 2023: https://www.sm.dk/Media/638561114773055917/Tillaegsaftale_om_national_strategi_for_baeredygtigt_byggeri_UA.pdf

¹² Mester Tidende; Skrappere krav til CO₂-udledning: "Byggeriet skal tage et større ansvar"; June 2024: https://www.mestertidende.dk/announcement/view/685161/skrappere_kvav_til_co2udledning_byggeriet_skal_tage_et_storre_ansvar

¹³ Dagens Byggeri; Kritik af regeringens klimaudspil: "Vi kan bare fortsætte, som vi plejer"; May 2024: <https://dagensbyggeri.dk/gronnere-byggeri/kritik-af-regeringens-klimaudspil-vi-kan-bare-fortsaette-som-vi-plejer/>

¹⁴ Reduction Roadmap: <https://reductionroadmap.dk/>

¹⁵ Reduction Roadmap; Baggrund for Reduction Roadmap og oplæg til skærpet grænseværdi for bygningers klimapåvirkning; 2023: https://Baggrund+for+Reduction+Roadmap+2.0_.pdf

¹⁶ Reduction Roadmap; Reduction Roadmap 2.0: <https://reductionroadmap.dk/reduction-roadmap-2>

¹⁷ Rambøll; November 2023: https://www.linkedin.com/posts/ramboll_reductionroadmap-lets-close-the-gap-activity-medium=member_desktop

Figure 4: **Supplementary agreement with new limit values and methodologies**

As part of the supplementary agreement, key aspects have been tightened and adjusted, e.g., new limit values and a differentiation of limit values based on building types¹⁸



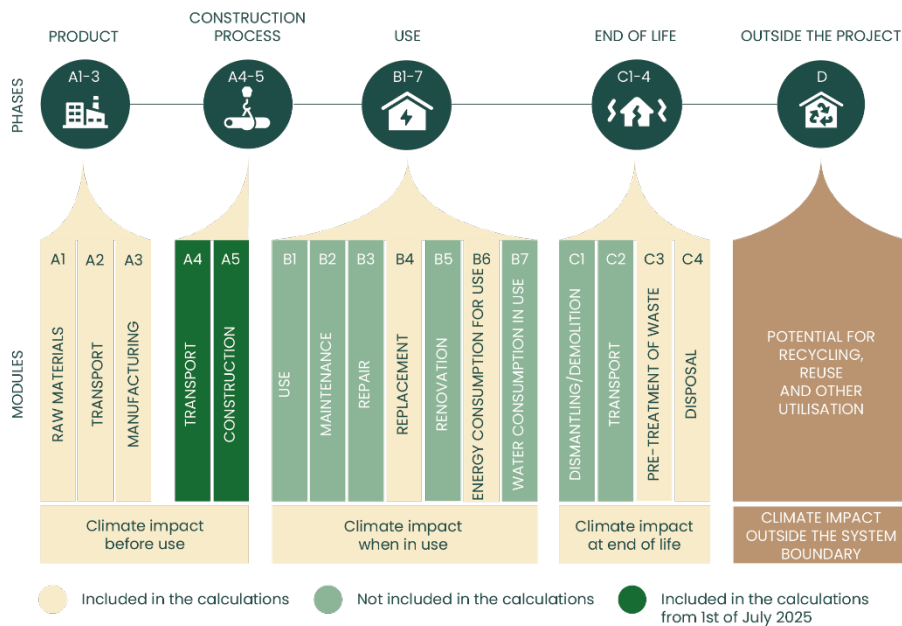
¹⁸ Social- Bolig- og Ældreministeriet; Tillægsaftale om national strategi for bæredygtigt byggeri; May 2023; https://www.sm.dk/Media/638560336830794358/Till%C3%A6gsaftale_om_stramning_af_CO2e-krav_til_bygninger_UA.pdf

With these updates, the regulatory framework has been improved, tightening the requirements for the industry. This is an important step forward, however, a continued focus among Danish politicians to be even more ambitious, is crucial.

Valuable lessons can be drawn from the Danish process of implementing WLC requirements and the update of the roadmap, e.g.:

1. The mechanism, that ensures politicians must set concrete limit values every two years, plays a crucial role in making sure that the WLC requirements, including the limit values, calculation methods, etc., are based on the latest knowledge and innovations. This provides greater potential to introduce more ambitious requirements as we approach 2029, while also keeping the industry informed about the future regulations they can expect,
2. The inclusion of the construction process in the regulation is an essential step toward reducing emissions from the building and construction sector,
3. The mobilization of the building and construction industry is crucial in pushing for stricter requirements and ensuring the sector is prepared to meet these more demanding targets.

Figure 5: **Modules and phases in LCA calculations**¹⁹



¹⁹ Bygningsreglementet; Energiforbrug og klimapåvirkning (§ 250- § 298) - Bygningsreglementets vejledning om bygningers klimapåvirkning; https://www.bygningsreglementet.dk/tekniske-bestemmelser/11/brv/version-2-bygningers-klimapaavirkning/kap-1_1/

BUILDING WITH REDUCED CLIMATE IMPACT IS POSSIBLE

Although the introduction of WLC provisions and requirements for new construction is relatively new in Denmark, and buildings below 1,000 m² will not be included until July 2025, there are already several examples today of buildings being constructed with significantly lower CO₂ emissions.

Living Places house with each component being optimised individually

The Living Places concept²⁰ has Denmark's lowest CO₂ footprint. It has been built using existing technologies and materials, demonstrating that we do not have to wait for future technology to build far more sustainable homes. Each material, design, and building technique has been carefully considered to reduce environmental impact and improve human health.

The Living Places house is CO₂-negative through most of its lifetime – partly because of the stored biogenic carbon in the trees used as building materials.

The Living Places concept has almost 3x lower CO₂ footprint than an average Danish single-family house at 3.85 kg CO₂e/m²/year compared to 11.10 kg CO₂e/m²/year for an average new build, Danish single-family house.

LIVING PLACES HOUSE IN DENMARK

CO ₂ e	3,85 kg CO ₂ e/m ² /year
Year	2023
Use	Housing
Floors	3 (many typologies)
Floor area	147

Sensory house minimising the use of cement-based products

Snoezel house is an example of a 195 m² single-story building, constructed in bio-based and renewable materials in 2022. The house is designed like a single-family home, tailored for sensory experiences. It is used publicly by 1-2 users and companions at a time for a few hours each day. Given its purpose, additional fire safety measures have been implemented.

The house is supported by a screw foundation. The ground

deck features wooden cassettes insulated with wood fibre, cement particle boards over a ventilated cavity, and is topped with a vapor barrier and wood fibre board containing underfloor heating.

The house is constructed with load-bearing wooden structures and a roof in a truss structure with steel plate roofing. The walls are in a diffusion-open design, using wood fibre for insulation and wind barriers, with spruce cladding on the exterior and natural vapor barriers and fibre gypsum on the interior. Additional measures have also been added to further optimize indoor air quality and reduce particle pollution.

Overall, special efforts have been made to avoid cement-based products as well as products made from oil and natural gas. This can be seen, for example, in wet rooms, where special wood-based panels are used.

As a result, the building's environmental impact is calculated at 5,47 kg CO₂e/m²/year²¹.

SNOEZEL HOUSE IN DENMARK

CO ₂ e	5,47 kg CO ₂ e/m ² /year
Year	2022
Use	Institution/housing
Floors	1
Floor area	195 m ²

Terraced houses with a focus on space optimisation and modular construction

Core houses (Kernehusene) are two-story terraced houses built using modular construction in 2023 for housing purposes²². The houses are built based on insights from user analysis and focus groups, showcasing a desire for a space-optimized home with minimal maintenance.

Throughout the development, focus has been on building airtight houses with low energy consumption and carefully selecting materials with consideration for environmental impact. Therefore, the use of concrete has been minimized and the terraced houses are primarily built with materials that have a low carbon footprint and high degree of recyclability. In this regard, certified wood from responsible forestry has been a primary material in the construction of Core houses. Wood construction offers advantages both in reducing CO₂ emissions and contributes to a healthy indoor environment.

²⁰ Living Places. A new way of thinking about buildings; VELUX Group; 2023: <https://buildforlife.velux.com/media/im3c5rrk/living-places-case-study.pdf>

²¹ Garnow, A. et al.; Boligbyggeri fra 4 til 1 planet: 24 best practice cases. (2 udg.); Institut for Byggeri, By og Miljø (BUILD), Aalborg Universitet; 2024: https://vbn.aau.dk/ws/portalfiles/portal/Boligbyggeri_fra_4_til_1_planet_-_24_best_practice_cases.pdf

²² Kernehusene; <https://www.kernehusene.dk/>

Core houses hold a DGNB Gold certification²³, which emphasises the accomplishment of meeting high standards within energy efficiency, use of low carbon materials, and overall performance in reducing environmental impact.

As a result, the building's environmental impact is calculated at 4,5 kg CO₂e/m²/year²⁴.

CORE HOUSES IN DENMARK

CO ₂ e	4,5 kg CO ₂ e/m ² /year
Year	2023
Use	Housing
Floors	2
Floor area	86-112 m ²

Mixed office space and housing with load-bearing wooden structures

N11 solar house (N11 Direktgewinnhau) is a five-story building, with mixed use. The lowest three floors are used for office space and the highest floors are for residential use. The total floor area is 536 m².

The building is supported by a slab foundation in reinforced concrete with a surface of rammed earth. It is constructed with load-bearing structures made of glulam columns and cross-laminated timber. The floor separations consist of a composite material of concrete and wood, hemp insulation, and an anhydrite surface. The exterior walls and the sloped roof are insulated with hemp fibre, and vertical surfaces are of rammed earth. Solar panels cover the roof surface.

The building is designed to capture heat from residents and appliances while utilizing solar heat through its choice of materials, compactness, and orientation. This approach aims to avoid mechanical heating systems. However, to ensure the apartment can be heated, there is installed a wood stove.

As a result, the building's environmental impact is calculated at 6,93 kg CO₂e/m²/year²¹.

N11 SOLAR HOUSE IN SWITZERLAND

CO ₂ e	6,93 kg CO ₂ e/m ² /year
Year	2014
Use	Office space & housing
Floors	5
Floor area	536 m ²

Multi-storey residential building is designed for easy disassembling

Ripple Residence is a large-scale, multi-story residential building, currently under construction, with 13.100 m² divided among 115 apartments²⁵. The building features an ambitious goal of an expected CO₂ emissions of 5 kg CO₂e/m²/year.

Wood is the focal point²⁶, ensuring a CO₂ emission significantly lower than any other Danish building over four stories. Most of the building's core components are constructed with wood instead of traditional steel or concrete structures. This applies to load-bearing structures, walls, and partial facades, but also smaller elements such as bathroom pods, elevator shafts, and stair cores that are made from wooden materials.

Emphasis has been placed on designing the building so it can easily be disassembled and recycled if the building is ever demolished. Additionally, the building will be nearly self-sufficient in energy due to geothermal heating systems, a heat pump, and solar panels.

While the project is ground-breaking in terms of CO₂ reductions, the multi-story building will be based on construction traditions that the industry is familiar with, making it easy to replicate and scale. All initiatives are continuously evaluated and shared with the industry to inspire others and promote a greener future for the entire real estate sector through knowledge sharing.

Due to its ambitious goals, a minimum of DGNB Gold certification is expected, but DGNB Platinum and Planet are anticipated.

RIPPLE RESIDENCE IN DENMARK

CO ₂ e	5,00 kg CO ₂ e/m ² /year
Year	2024-2026
Use	Multi-story buildings
Floors	6
Floor area	13.100 m ²

²³ DGNB; About the DGNB system: <https://www.dgnb.de/en/certification/important-facts-about-dgnb-certification/about-the-dgnb-system>

²⁴ Børsen; Arkitekter skaber klimavenligt byggeri; 2023: <https://borsen.dk/nyheder/baeredygtig/cases/ejendomsudviklere-skaber-klimavenligt-byggeri>

²⁵ Ripple Residence: <https://ripple-residence.dk/>

²⁶ NREP; Ripple Residence: Den stærkeste CO₂-profil for et dansk etagebyggeri: <https://nrep.dk/projekter/ripple-residence/>

OTHER MEMBER STATES ARE MOVING AHEAD

Denmark is not the only country implementing WLC requirements. The Netherlands and France are also ahead of the EPBD requirements, while a number of Nordic countries are currently taking steps to implement

requirements for GWP disclosure for all buildings and limit values in the years to come. See table 1.

This demonstrates that it is both feasible and possible to implement WLC requirements well in advance of the mandatory requirements set out in the EPBD.

27 28 29 30

Table 1: **Overview of countries implementing or preparing to implement WLC requirements**



²⁷ Balouktsi, M., Francart, N. & Kanafani, K.; Harmonised Carbon Limit Values for Buildings in Nordic Countries; Nordic Sustainable Construction; 2024: <https://pub.norden.org/us2024-415/1-existing-pathways-to-limit-values.html>

²⁸ Gerrard, N.; The countries that are amending building codes to limit construction carbon emissions; Construction Briefing; April 2023: <https://www.constructionbriefing.com/news/the-countries-that-are-amending-building-codes-to-limit-construction-carbon-emissions/8027521.article>

²⁹ Nordic Sustainable Construction; Timeline updated overview; 2024: https://www.nordicsustainableconstruction.com/Timeline_updated_overview.pdf

³⁰ Broer, R., Simjanovic, J. & Toth, Z.; Implementing the Paris Agreement and reducing greenhouse gas emissions throughout the life cycle of buildings: European public policies, tools and market initiatives; BPIE; 2022: <https://www.bpie.eu/wp-content/uploads/2022/01/SPIPA-LCA-2022FINAL.pdf>

CLEAR CLIMATE AND ECONOMIC POTENTIALS

It makes sense to regulate buildings embodied carbon to gain CO₂-reductions, as several studies show that clear CO₂-reduction can be gained by regulating the embodied carbon of buildings. However, it is not just the climate which benefits from setting ambitious requirements. Studies show, how regulating embodied carbon of buildings in the EU also brings significant economic advantages.

A study from Shifting Paradigms based on 72 case-studies, show on average, how reductions of embodied carbon by 41% can reduce the price by 9% compared to a business-as-usual scenario. Furthermore, the study shows that the most effective way to reduce both embodied carbon and the price is to already include embodied carbon in the design phase. This is done by the following elements:

- Decarbonise the production of construction materials
- Optimise design to minimise embodied carbon
- Prioritise materials with low or negative embodied carbon
- Recycle and reuse materials and components
- Improve construction efficiency

The same applies in the UN's annual status report on the construction sector³¹ from 2022. The report highlights the lack of measures and focus on the material consumption and the climate footprint of materials, as the primary reasons why construction is currently not on the right track. They state: "Embodied carbon in buildings – all emissions associated with materials and construction processes – need to be tackled soon to avoid undermining the carbon reductions achieved from energy saving measures."

It is therefore essential for member states to take action now, by establishing requirements and roadmaps for the introduction of limit values and reduction targets. Several countries have demonstrated that it is possible to introduce requirements well ahead of the mandatory requirements set by the EPBD. There are also numerous examples showing that it is possible to reduce the CO₂e emissions from buildings already today.

³¹ UNEP; 2022 Global Status Report for Buildings and Construction; 2022: [https://www.unep.org/resources/publication/2022-global-status-report-buildings-and-construction-text=The 2022 Buildings-GSR finds,2021. above pre-pandemic levels.](https://www.unep.org/resources/publication/2022-global-status-report-buildings-and-construction-text=The%2022%20Buildings-GSR%20finds,2021%20above%20pre-pandemic%20levels)

ABOUT THE REPORT

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The report is part of a broader effort by Green Transition Denmark focused on the implementation of WLC requirements in Denmark and the EU.

The report is funded by the European Climate Foundation.

MORE INFORMATION

Circular Construction: From dream to political practice in EU

<https://rgo.dk/udgivelse/circular-construction-from-dream-to-political-practice-in-eu/>

<https://rgo.dk/projekt/bygninger-og-gron-omstilling/>

<https://rgo.dk/projekt/transformation-af-bygningsmassen/>



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Green Transition Denmark is an independent non-profit environmental organisation that has been advising on the green transition for over three decades. As a green solution think tank, we are committed to delivering concrete, achievable, and ambitious proposals designed to accelerate the shift toward a absolute sustainable society.

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