The EU Energy Performance of Buildings Directive - Key Regulation for a Carbon-Neutral Building Stock by 2050

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ABSTRACT

In recent years, the European Union (EU) with its 27 Member States undertook a comprehensive overhaul of its energy and climate legislation. The 'European Green Deal' aims to transform the EU into a fair and prosperous society with net zero emissions of greenhouse gases in 2050. The European Climate Law makes this climate neutrality target legally binding.

The revision of the Energy Performance of Buildings Directive, EPBD, is the key regulatory upgrade for achieving a carbon-neutral building stock by 2050 in the EU. All 27 EU Member States will have to implement the EPBD's upgraded provisions.

This paper presents the policy process leading to the recent major revision of the EPBD, followed by a detailed overview on three landmark provisions of the upgraded directive, namely the most controversial Minimum Energy Performance Standards (MEPS), National Building Renovation Plans (NBRP), and Zero-Emission Buildings (ZEB).

In the past, decarbonizing existing buildings had not been the EPBD's primary focus. However, its NBRP and MEPS will create significant pressure on EU Member States' activities to decarbonize existing buildings in line with above mentioned EU climate neutrality target. Previous EPBD editions were strictly limited to energy use during operation, such as space heating and cooling. Another real novelty therefore is the new obligation to consider whole-life carbon emissions in ZEB, i.e., for all new buildings, from 2030 on.

Introduction

Wider EU Policy Context

Decarbonising the building stock represents a major challenge for meeting the EU's climate and energy targets. The buildings sector is the EU's largest energy consumer, contributing about 40% to the EU's energy use and more than a third of energy related greenhouse gas (GHG) emissions. In 2050, 85% to 95% of today's buildings will still exist. The current building stock is very heterogenous. Over 85% of buildings were built before the year 2000 (BSO, 2024), typically featuring poor energy performance. For this reason, ambitious energy renovations are key to meet the EU's energy and climate neutrality goals. Yet, both rate and depth of energy renovations fall short of what is needed (Esser et al., 2019).

In recent years, the EU comprehensively overhauled the entire bundle of energy and climate legislation with a view to align it with climate neutrality and energy efficiency goals. Table 1 presents an overview about the most relevant pieces of legislation.

Table 1. Most relevant updated EU regulations around energy efficiency of buildings

Title	Year	Topic
European Green Deal	2019	Green growth strategy for EU
Renovation Wave communication	2020	Strategy, putting renovation speed and depth in the focus, providing the mandate for the EPBD revision
Climate Target Plan	2020	Concrete interim GHG milestones
European Climate Law	2021	Legally binding GHG reduction
Energy Efficiency Directive (EED) proposal	2021	Whole economy targets for reduction of final energy and source energy; specific requirements for public buildings (exemplary role)
Renewable Energy Directive (RED) proposal	2021	Raising the bar for increasing the share of renewable energy
Energy Performance of Buildings (EPBD) proposal	2021	Comprehensive upgrade of existing requirements and overall alignment with climate-neutrality target
REPOwerEU plan	2022	Additional measures to push independency from fossil fuel imports and uptake of onsite renewable energy generation
Construction products regulation (CPR) revision	2023	Introduction of information on embodied GHG emission on construction product declarations
Ecodesign regulation update	2022	More stringent requirements on more energy related products
EU Emission Trading System 2	2027	Internalisation of external cost of GHG in fuel prices for buildings

In late 2019, the European Commission presented the European Green Deal. The Green Deal is a comprehensive growth strategy that aims to transform the EU into a fair and prosperous society, with a modern, resource-efficient and competitive economy, where there are no net emissions of greenhouse gases in 2050 and where economic growth is decoupled from resource use (European Commission [EC], 2019).

Subsequently, the Green Deal's climate neutrality target for 2050 was made legally binding with the adoption of the European Climate Law. The Climate Law also enshrines an interim target of reducing the EU's net GHG emissions by 55% by 2030 compared to 1990 (Regulation (EU) 2021/1119 of the European Parliament and of the Council of 30 June 2021 establishing the framework for achieving climate neutrality and amending Regulations (EC) No 401/2009 and (EU) 2018/1999, 2021). This is line with the European Commission's 2030 'Climate Target Plan' presented in September 2020 (EC, 2020a). The Climate Target Plan and accompanying documents dealing with assessing the impacts of that plan, foresee to reduce the building stock's direct GHG emissions between 2015 and 2030 by 60%, final energy consumption by 14%, and energy consumption for heating and cooling by 18%.

In 2020, the European Commission presented its 'Renovation Wave communication'. The Renovation Wave is a key action under the European Green Deal. It targets existing buildings, and embodies an action plan containing concrete regulatory, financing and enabling measures to align building renovation activities with climate, energy and environmental objectives (EC, 2020b). Most prominently the Renovation Wave aims to at least double the energy renovation rate of buildings by 2030 and to foster 'deep' renovations.

To deliver the European Green Deal, the Commission in 2021 presented a series of proposals to update and align its energy and climate legislation with its upgraded climate objectives. As part of this so called 'Fit for 55' package[1], the Commission presented proposals for significant revisions of three major Directives, all of which contain provisions directly relevant for the buildings sector[2]:

- the Energy Performance of Buildings Directive (EPBD) (Proposal for a Directive of the European Parliament and of the Council on the energy performance of buildings (recast) (EPBD), 2021)
- the Energy Efficiency Directive (EED) and
- the Renewable Energy Directive (RED)

Meanwhile, all these revised Directives have been adopted.

In light of Russia's war on Ukraine and its implications on EU energy markets, on top of the very ambitious 'Fit for 55' legislative package, the Commission adopted its 'REPowerEU' plan in spring 2022, aimed at ending the EU's dependency on Russian energy imports (European Commission, 2022). As part of REPowerEU, the Commission proposed amendments to several of its initial proposals of the 'Fit for 55' package, including revisions of EPBD, EED and RED (Proposal for a Directive of the European Parliament and of the Council amending Directive (EU) 2018/2001 on the promotion of the use of energy from renewable sources, Directive 2010/31/EU on the energy performance of buildings and Directive 2012/27/EU on energy efficiency, 2022).

The REPowerEU plan was accompanied by the 'EU Save Energy' communication which provides recommendations on how citizens and businesses can save energy and contribute to reducing the need for gas imports (EC, 2022). REPowerEU addresses the buildings sector specifically by envisaging a wide range of measures. This includes a possible strengthening of energy efficiency measures, notably phasing out Member States' (MSs') subsidies for fossil fuel boilers in buildings as of 2025; strengthening national and resource efficiency requirements of new buildings through heating system requirements and introducing zero-emission standards before 2030; tightening national heating requirements for existing buildings addressing major renovations and boiler replacements; introducing national bans for boilers based on fossil fuels in existing and new buildings.

Further EU policy developments relevant for the decarbonisation of buildings include initiatives aimed at fostering the wider sustainability (also beyond energy performance) of buildings and building components. These include the revision of the Construction Products Regulation (CPR); the expansion of Ecodesign requirements with the Ecodesign for Sustainable

[1] This refers to the interim target of reducing the EU's net GHG emissions by 55% by 2030 compared to 1990.
[2] Further policy measures of the package include revisions of the EU Emissions Trading Scheme (ETS) and the Alternative Fuels Infrastructure Regulation (AFIR), among others.

Products Regulation (ESPR), relevant for energy-consuming building systems and appliances; and the ongoing elaboration of an EU roadmap to address whole-life carbon in buildings.

Moreover, the 'EU-ETS-2' (Emission Trading System 2) to be launched in 2027 will affect the market conditions for building decarbonisation going forward. The ETS-2 will establish a Union-wide price and trading system covering fuel combustion in buildings, road transport and additional sectors not covered by the 'ETS-1'. ETS-1 only covers major power sector and industry facilities. Hence ETS-2 should help make alternatives to fossil fuels more attractive in those sectors and thereby make achieving the sector's climate targets more likely.

The EPBD is the main legislative instrument for promoting energy performance improvements in buildings in the EU. With a first version published in 2002, it was last revised in 2018 as part of the Commission's 'Clean Energy for all Europeans' package (Directive (EU) 2018/844).[3] In the context outlined in the section above, and based on a comprehensive Impact Assessment, the Commission presented a proposal for a significant revision of the EPBD in December 2021. The mandate for such significant revision was derived from the Renovation Wave strategy. For the first time, an EPBD revision had to deliver on effectively targeting the improvement of the energy performance of existing buildings.

Objectives Of The EPBD Recast[4]

The Commission's overarching objective with the EPBD revision is to reduce greenhouse gas (GHG) emissions and final energy consumption by 2030 and to set a long-term vision for buildings towards EU-wide climate neutrality in 2050. More specifically, the recast aims at:

- Increasing the rate and depth of building renovations
- Improving information on buildings' energy performance and sustainability
- Tackling energy poverty and worst-performing buildings
- Ensuring that all buildings will be in line with the 2050 climate neutrality requirements.

The revision further envisions strengthened financial support, modernisation and system integration as levers to deliver on these objectives. In sum, the revision is to upgrade the existing regulatory framework to reflect higher ambitions and more pressing needs in climate and social action, while providing EU countries with the flexibility needed to account for the differences in the building stock across Europe.

The EPBD Recast Process

Until the final recast was published in April 2024 in the Official Journal of the European Union, this had been the result of a thorough legislative process. As the European Union's executive, the European Commission's task is to initiate legislative proposals such as the revision of the EPBD. Yet the power of actual legislation is equally assigned to the European Parliament and the Council of the EU (or 'the Council'). This is why they are also referred to as 'co-legislators'. Members of the European Parliament are directly elected by European citizens, whereas the Council represents European governments.

[3] The last revision inter alia featured amendments to provisions on long-term renovation strategies, new buildings, technical buildings systems, e-mobility and inspections of heating and air conditioning systems.
[4] Based on the Commission's proposal.

Once a proposal such as the revision of the EPBD has been presented by the Commission, both Parliament and Council separately deliberate and each determine their position. Typically, this comprises amendments to the initial proposal, which both co-legislators will take as their starting points for the so-called 'trilogue' process. This is the actual negotiation between the Parliament and the Council to find a consensus based on their individual starting positions. The Commission is the third party to make that dialogue a trilogue. The trilogue typically has several sessions until a compromise is found all parties can agree to. In this process, the Commission mainly provides clarifications on its original proposal to avoid misunderstandings and facilitates the negotiation between Parliament and Council. Table 2 provides an overview of milestones that have led to the recent EPBD recast:

Table 2. Milestones of EPBD recast

Date	Milestone
October 2020	Commission presents 'Renovation Wave Communication', providing the mandate for revising the EPBD.
February 2021	Commission presents 'Inception Impact Assessment', providing the rationale why a revision is needed.
February – March 2021	Open Public Consultation on different aspects of the revision, where interested stakeholders can have their say.
December 2021	Commission publishes 'Proposal' and related 'Impact Assessment', after in-depth assessment of different options for main EPBD provisions to be revised.
May 2022	Commission presents amendment to initial proposal as part of REPowerEU[5].
October 2022	Council of the EU adopts its position on the EPBD proposal.
March 2023	European Parliament adopts its position on the EPBD proposal.
June -December 2023	Four trilogue sessions take place till final agreement is reached on December 7.
April 2024	Publication of revised EPBD in Official Journal of the EU.
May 2024	Entry into force of revised EPBD (20 days after publication in Official Journal).
May 2026	All 27 EU Member States must comply with all EPBD provisions by having brought into force the laws, regulations and administrative provisions necessary, within 24 months after entry into force of the revised EPBD

[5] Art. 9a on solar energy in buildings is added.

The New Elements of The EPBD Recast

Overview About Main Provisions

The 10 main provisions of the EPBD recast include:

1. The phased introduction of mandatory minimum energy performance standards (MEPS) to trigger renovation of the Worst Performing Buildings (WPB) in the stock of non-residential buildings (art. 9)
2. Significantly enhanced national long-term renovation strategies (LTRS), including a comprehensive reporting template; renaming of LTRS to 'National Building Renovation Plans' (NBRP) (art. 3, annex II)
3. A new energy efficiency standard for new buildings, called 'Zero-Emission Buildings' (ZEB) – compared to 'nearly Zero-Energy Buildings' (nZEB) in the previous EPBD (notably art. 7, art. 11 and annex III)
4. Mandatory deployment of active solar energy systems in buildings (art. 10)
5. Increased reliability, quality and digitalisation of Energy Performance Certificates (EPC) with energy performance classes to be based on common criteria and the EPC data to be gathered with other sources of data in national databases for the energy performance of buildings (art. 16-19, annex V)
6. A definition of deep renovation and the introduction of building renovation passports (BRP) (art. 2(19), art. 2 (20), art. 12)
7. New requirements on technical buildings systems (art.13)
8. New requirements on infrastructure for sustainable mobility (art. 14)
9. New provisions on the smart readiness indicator (art 15)
10. New provisions on financial incentives for energy renovations (art. 17)

The first three items will be presented in more detail in this paper. While many of the proposed changes are geared at enhancing and expanding existing EPBD requirements, the introduction of MEPS represents a step change in EU building energy law with a view to energy retrofits. It is the first time, where the EPBD does not just prescribe minimum energy performance requirements for cases, where a renovation decision has already been made. Now it prescribes cases, that require to make that decision pro energy retrofit, and, as before, prescribes minimum energy performance requirements for the related retrofit measures. Because of this, MEPS will be discussed in most detail in this paper, even if the original European Commission proposal has been watered down significantly during the trilogue negotiations.

Minimum Energy Performance Standards (MEPS)

The general idea of MEPS is an upper limit for the allowed (calculated or measured) energy use, where the limit gradually or stepwise decreases over time, and which applies to each building. The moment a building's energy use exceeds that limit, the building owner is to take measures to ensure an energy performance which is better than the current upper limit. Ultimately, this constitutes an obligation to retrofit as soon as a building's energy performance is worse than the allowed upper limit. The instrument ensures that the worst performing buildings will be covered by that obligation first. This makes sense from an economic, environmental and social viewpoint. Typically, the cost-benefit ratio of efficiency measures is best in worst

performing buildings, reduction of GHG emissions is highest and detrimental social impacts may be mitigated, such as energy poverty due to very high energy bills, or negative health impacts of mold growth on poorly insulated walls (European Commission 2021).

The introduction of MEPS – even if the final trilogue agreement partially deviates from the general idea explained above – is the first time an EPBD provision requires to do retrofit activities So far, EPBD requirements, e.g., on minimum energy performance, had only kicked-in the moment a retrofit decision had already been taken. For this reason, in all stages of this EPBD revision, MEPS have been the most controversial item. A first proposal elaborated by Directorate-General for Energy of the European Commission had been rejected internally by the so-called Scrutiny Board European Commission, amongst others because it found the principle of subsidiarity, which is a cornerstone of EU policy making, insufficiently applied. In a nutshell, the subsidiarity principle requires that only subjects should be regulated on EU-level, if this yields clear benefits over Member States regulating it individually. The question where the cut should be between MEPS elements to be decided on EU-level (such as an upper limit for energy use when directly governed by the EPBD) versus elements to be decided on Member-State level kept on being one of the hardest items to find a compromise in the trilogue. This was further fuelled by the European Parliament, who significantly increased the MEPS ambition in its starting position for the trilogue negotiations compared to the original Commission proposal, while the Council in its position had significantly weakened the EU-level part of MEPS, aiming for more room for manoeuvre at individual EU Member State level.

Specific background.

As pointed out above, in its 'Renovation Wave Communication' (EC, 2020b) the European Commission had stressed the two main objectives for existing buildings: At least double current renovation rates of public and private buildings by 2030; and to foster deep renovations.

For this, two major reasons had been put forward:

- Reach climate neutrality by 2050 and contribute to climate objectives for 2030: Concretely, with reference to the Climate Target Plan (European Commission (EC) 2020a), the renovation wave communication also presents concrete 2030 targets for buildings compared to 2015 levels: 'To achieve the 55% emission reduction target, by 2030 the EU should reduce buildings' greenhouse gas emissions by 60%, their final energy consumption by 14% and energy consumption for heating and cooling by 18%.' Furthermore it notes that the 'increased rate and depth of renovation will have to be maintained also post-2030 in order to reach EU-wide climate neutrality by 2050.' Concretely a doubling of the renovation rate is to be achieved according to the Renovation Wave communication.
- Alleviate energy poverty: The Commission considers its recommendation on energy poverty from 14 October 2020 (European Commission (EC) 2020c) as part of their renovation wave communication. Each Member State has to assess the number of households in energy poverty in its National Energy and Climate Plan (NECP). According to the EU Survey on income and living conditions (EU SILC), nearly 34 million Europeans are unable to keep their dwelling adequately warm (European Commission (EC) 2020b). Together with the increased significance of dwellings, for being home and workplace at the same time, the renovation wave aims to tackle the worst

performing buildings related to social housing as a high priority in order to reduce energy bills and reduce negative health impacts of such buildings. That priority is underlined by findings from a 2018 report on social infrastructure which assumed 800,000 social dwellings were to be renovated each year (Fransen et al. 2018).

Main provisions

In the context of the financial burden the COVID-19 pandemic had put on EU citizens, it turned out not to be politically feasible to address individual residential buildings with an obligation to retrofit, not even the very worst performing ones. Therefore, the compromise took different approaches for residential and non-residential buildings, as described in Table 3**Fehler! Verweisquelle konnte nicht gefunden werden.**.

Table 3. Split approach for non-residential and residential buildings in revised EPBD

	Non-residential buildings	Residential buildings
Addressee of obligation	All individual non-residential buildings	Whole stock of residential buildings
Label of obligation	Minimum energy performance standards	Trajectories for progressive renovation
Precondition for obligation	Two thresholds (upper limits) for the energy performance need to be determined: Threshold 1, which is exceeded by 16 % of the national non-residential building stock; Threshold 2, which is exceeded by 26 %. Thresholds may differ by building types. The thresholds may be expressed by a numeric indicator of primary or final energy use in kWh/(m2.y).	Member States shall establish a national trajectory for the progressive renovation of the residential building stock in line with the national roadmap and the 2030, 2040 and 2050 targets contained in the Member State's building renovation plan and with the transformation of the national building stock into zero-emission buildings by 2050. The trajectory shall be expressed as a decrease of the average primary energy use in kWh/(m2.y) of the whole residential building stock over the period from 2020 to 2050 and shall identify the number of buildings and building units or floor area to be renovated annually, including the number of worst performing buildings and building units or floor area.
Concrete obligation	1. By 2030 no more non-residential building above Threshold 1 2. By 2033 no more non-residential building above Threshold 2	From 2020 the average primary energy use in kWh/(m2.y) of the whole residential building stock: 1. by 2030 decreases by at least 16 % 2. by 2035 decreases by at least 20-22%

	Non-residential buildings	Residential buildings
	3. Member States shall establish specific timelines for non-residential buildings to comply with lower maximum energy performance thresholds by 2040 and 2050, in line with the pathway for transforming the national building stock into zero-emission buildings [see National Building Renovation Plans]	3. by 2040, and every 5 years thereafter, is equivalent to, or lower than nationally determined value derived from a progressive decrease of the average primary energy use from 2030 to 2050 in line with the transformation of the residential building stock into a zero-emission building stock. 4. At least 55 % of the decrease of the average primary energy use is achieved through the renovation of worst-performing residential buildings.

Consequences.

While the obligation for non-residential buildings looks very much straightforward, there are significant barriers to implement it.

The first challenge is determination of the 16% and 26% energy performance thresholds. In most EU Member States, information about the non-residential building stock is incomplete. This not only goes for the energy performance, but also for purely physical characteristics such as number of buildings and floor area by main building types (offices, educational buildings, hospitals, hotels & restaurants, sports facilities, wholesale & retail trade services buildings etc). Often, there are also uncertainties about the split between public and commercial non-residential buildings. Even if a Member State has a comprehensive energy performance certificate database (EPC), it won't necessarily provide a suitable representative sample. This is why many Member States first of all need to take measures to get a statistically proper overview of their non-residential building stock, allowing them to determine the 16% and 26% energy performance thresholds.

A second key challenges is that once the energy performance thresholds are defined, it is important to concretely identify buildings above threshold, for both providing targeted technical assistance or financial support, and also monitoring of compliance with the obligation. This turns out to be very tricky if information about the energy performance of each building is quite incomplete, as is the case in most Member States. Due to strict general data protection rules (GDPR) in the EU, e.g., utility data cannot be used for that purpose. Also, the idea of a short-term re-classification of energy performance certificate classes in all EU Member States from A-G – where G or F& G respectively would have corresponded to the 16% or 26% worst performing buildings – was rejected by Member States in the negotiations. Therefore, creative ways still need to be found to solve this issue in Most Member States.

For residential buildings, too, Member States face significant challenges. First, it is difficult to determine the trajectories for the whole building stock. The future development of the average primary energy use of the building stock which would be in line with the target of a zero-emission building stock by 2050, depends on a number of parameters which are uncertain: rates of new construction and demolition; speed of retrofit uptake; development of share of renewable energy or phasing out of fossil energy in the energy supply system. Scenarios have to be set up to

determine the most robust pathway that can serve as trajectory for specific use of primary energy.

Second, even if it has not been politically feasible to agree on retrofit obligations for residential buildings, energy efficiency improvements of these buildings will still be crucial to meet the trajectories that must be established by Member States. This means, in contrast to non-residential buildings - and to the original proposal of the European Commission - even the logical first step of this problem (improving worst performing buildings) has been transferred from the EU level to the Member State level. While this provides maximum flexibility to Member States to find most appropriate solutions considering their national context, it is still largely unsolved how this issue will be tackled by Member States without public overspending for financial incentives to, e.g., make private homeowners renovate their homes.

National Building Renovation Plans (NBRP)

Background.

'National Building Renovation Plans' (NBRP) replace what previously was labelled as 'Long-term Renovation Strategies' (LTRS). A major reason for upgrading National Building Renovation Plans is the learning, that 'Long-term Renovation Strategies' have failed to be an effective tool for monitoring retrofit progress in EU Member States (Hermelink & Bettgenhäuser, 2021). This was mainly due to provisions in the EPBD being rather vague as for the concrete content of LTRS, but also due to the very long reporting interval of 10 years. Another issue relative to LTRS reporting is as follows: even if ultimately all Member States handed in their LTRS to the European Commission, most Member States did so with significant delay. Only five out of altogether 29 reports[6] respected the reporting deadline March 2020, further 13 reports followed later in 2020, while 11 reports were even only submitted in 2021 or 2022 (Castellazzi, Paci, Zangheri, Maduta, & Economidou, 2022). A diplomatic summary of reasons to upgrade LTRS to NBRP is provided in the executive summary of the European Commission's Joint Research Centre's (JRC) assessment of the 2020 LTRS: *'…the level of ambition of LTRS is not always in line with the 2050 decarbonisation goals. This may suggest the opportunity for a revision of the Directive that reinforces MSs strategic planning and reporting tools to make them more focussed on actions, with clear, quantified, comparable and verifiable indication of objectives, milestones and resources. Improving template harmonization and providing additional support to MSs on the less addressed points of the LTRSs (e.g. progress monitoring, public consultation), are also important steps in the road to the 2050 building stock decarbonisation goal.*' (Castellazzi et al., 2022)

Main provisions.

In fact, a large part of JRC's criticism has been taken up in the revision of the EPBD. While LTRS were to '*support the renovation of the national stock of residential and non-residential buildings … into a highly energy efficient and decarbonised building stock by 2050*' (Consolidated version of Directive (EU) 2010/31/EU of the European Parliament and of the Council of 19 May 2010 on the energy performance of buildings (recast), 2018), NBRP now are not only to '*ensure'* that transformation, and not only pose significantly more but also

[6] In spite of having 27 Member States, the European Commission typically receives 29 reports, as Belgium hands in three reports for the regions Brussels, Wallonia and Flanders.

significantly more specified reporting requirements to Member States. This is also the reason, why NBRP indeed are meant to be a concrete retrofit ‘plan’ for a Member State’s building stock , rather than LTRS being a rather abstract ‘strategy’.

Member States have to deliver a first draft NBRP to the European Commission by 31 December 2025. Within six months after submission, the European Commission will assess the draft plans. If appropriate, the Commission is to issue tailored recommendations, which Member States have to take into account for their final NBRP to be submitted the latest by 31 December 2026.

In contrast to LTRS, NBRP have to be submitted to the European Commission every five years instead of every ten years. Concretely these are the main elements each NBRP shall encompass (Proposal for a Directive on the on the energy performance of buildings (recast) - Analysis of the final compromise text with a view to agreement, 2023):

- overview of the national building stock for different building types, including their share in the building stock, construction periods and climatic zones
- overview of market barriers and market failures and an overview of the capacities in the construction, energy efficiency and renewable energy sectors, and of the share of vulnerable households
- a roadmap with nationally established targets and measurable progress indicators, with a view to the 2050 climate neutrality goal, concretely including:
    - reduction of number of people affected by energy poverty
    - national targets for 2030, 2040 and 2050 as regards the annual energy renovation rate, the primary and final energy consumption of the national building stock and its operational greenhouse gas emission reductions
    - specific timelines for non-residential buildings to comply with lower maximum energy performance thresholds by 2040 and 2050 in line with zero-emission pathway for the building stock.
- an overview of implemented and planned policies and measures, supporting the implementation of the roadmap
- an outline of the investment needs for the implementation of the building renovation plan, the financing sources and measures, and the administrative resources for building renovation
- the operational greenhouse gas emissions and annual primary energy use of a new or renovated zero-emission building thresholds [see further explanations on ‘Zero-Emission Buildings (ZEB)’]
- minimum energy performance standards for non-residential buildings, based on maximum energy performance thresholds, in line with MEPS as explained before
- national trajectory for the renovation of residential buildings, including the 2030 and 2035 milestones for average primary energy use in kWh/(m2.y)
- an evidence-based estimate of expected energy savings, and wider benefits, including indoor environmental quality.

Another major criticism JRC made in their assessment of the 2020 LTRS is also mitigated by Annex II of the revised EPBD, as it features a comprehensive ‘Template for the National Building Renovation Plan’. On seven pages, the template provides a detailed list of mandatory and optional elements, Member States are to or can report respectively. This also

means a step change compared to LTRS, where only a European Commission guidance note provided non-binding further details to Member States.

Consequences.

Like MEPS, NBRP are another indicator for the step change the revised EPBD aims to make specifically with regard to triggering actual energy efficiency improvements and decarbonisation in the European building stock. NBRP, being the 'next generation LTRS', force Member States to set up comprehensive and concrete plans for getting the complete transformation of the European building stock done by 2050, because it is an indispensable element of abiding to the European Climate Law. Furthermore, much stricter reporting requirements are foreseen, which will enable much better monitoring possibilities for both Member States and the European Commission on where the retrofit stands compared to the needed trajectory. It will also allow evaluating how well different policy measures and market mechanisms work, as a precondition for adjustments in the policy mix.

Zero-Emission Buildings (ZEB)

Background.

Surprisingly, previous editions of the EPBD did not make direct reference to being an instrument for achieving climate targets. This has changed. The revised EPBD, in Article 1, describes its 'Subject matter' as follows (new amendments written in italics): 'This Directive promotes the improvement of the energy performance of buildings *and the reduction of greenhouse gas emissions from buildings* within the Union, *with a view to achieving a zero-emission building stock by 2050, ….*'.

So far the EPBD had a sole focus on operational energy, i.e. emissions and energy use from other life-cycle stages didn't play any role (Hermelink & Bettgenhäuser, 2021). Yet, above mentioned revision of the Construction Products Regulation (CPR) and specifically the ongoing elaboration of an EU whole-life carbon roadmap for buildings put significant pressure on legislators to address whole-life carbon in the revised EPBD, too. This is especially due to the fact, that in very low-energy buildings, the manufacturing stage alone can feature embodied energy or embodied emissions respectively, which exceed the corresponding values resulting from operation. This has been pointed out by science already more than 15 years ago (Hermelink, 2006, 2007, 2009).

Both aspects have been taken up by the new provision on 'Zero-emission buildings' (ZEB).

Main provisions.

The main provisions around ZEB are located in Art. 2(2) (Definitions), Art. 7 (New Buildings), Article 11 (Zero-emission buildings) and Annex III (Requirements for the calculation of life-cycle global warming potential (GWP). It should be mentioned that ZEB had been another major item of discussion throughout the trilogue negotiations. This was because of the original proposal of the European Commission. It had foreseen specific energy performance thresholds for new buildings in kWh/m2.y total primary energy for different European climate zones and building types. While the European Parliament in their position had increased the ambition for new buildings and added another set of thresholds for ZEB in existing buildings, which featured aggressive values equalling the ones originally proposed by the European Commission for new

buildings, the Council of the EU rejected the idea of concrete thresholds in the EPBD. In the following the trilogue compromise is presented.

Table 4. Main provisions on Zero-Emission Buidings (ZEB)

Main provision	Details
Definition of ZEB	Very high energy performance
	Zero on-site carbon emissions from fossil fuels
	Total primary energy use covered from onsite/nearby renewable sources, or RE, or efficient district heat, carbon free resources or grid
	Capacity to react to external signals and adapt its energy use, generation or storage
Entry into force	as of 1 January 2028, new buildings owned by public bodies need to be ZEB as of 1 January 2030, all new buildings need to be ZEB
Thresholds operation	Maximum level = life-cycle cost optimum for energy
	Maximum threshold for GHG emissions
Life cycle GWP	Must be on EPC for buildings > 1000 m2 from 2028
	Must be on EPC for all buildings from 2030

Consequences.

While there are no more maximum threshold values for the operational energy performance of ZEB in the revised EPBD as originally proposed by the European Commission, Member States have to define these thresholds nationally. There are two real step changes around ZEB. Number one is the ban of on-site fossil fuel use. Number two is what the EPBD calls 'life-cycle global warming potential' (GWP). While the original European Commission proposal included a merely informative GWP calculation, the final revised EPBD on top of that not only requires Member States to set up a roadmap for GWP with a downward trend – it also requires Member States to set maximum limit values. Today, GWP calculation still is a somewhat exotic exercise, with some lack of easy-to-handle tools and standard values. This will need to drastically change in the near future, at least for new buildings, as the new EPBD provisions will lead to a mainstreaming of whole-life carbon calculations.

Conclusion

While in the past, existing buildings did not appear to be the primary focus of the EPBD, its revision will create significant pressure on Member State activities to decarbonise existing buildings through renovations in line with the overarching EU target of achieving climate neutrality by 2050. The main new or upgraded instruments serving this purpose are MEPS and NBRP, the latter replacing former LTRS. Yet, also requirements for new buildings were upgraded by introducing 'Zero Emission Buildings' (ZEB). While banning the use of fossil fuels in new ZEB was a rather predictable new provision which reflects an already ongoing trend in new constructions, a rather unexpected novelty is the strong consideration of whole-life carbon emissions for all new buildings from 2030 on in contrast to the previous sole EPBD focus on operational energy.

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