DEEP RENOVATION:

SHIFTING FROM EXCEPTION TO STANDARD PRACTICE IN EU POLICY

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EXECUTIVE SUMMARY

The Renovation Wave sets the objective to at least double the annual energy renovation rate by 2030 as well as to foster deep energy renovations. But what are these deep energy renovations? While the concept is high on the political agenda, clarity is missing from the current EU legal framework, where no definition of deep renovation can be found. Instead, the absence of a common understanding of what it is and, more importantly, of what it should deliver has led to a mushrooming of concepts at national level, and to an EU policy ecosystem which is not fit to deliver. The current annual deep renovation rate stands at only 0.2% on average in the EU. If the EU is to achieve both its 2030 climate target and climate neutrality by 2050, this figure must drastically (by a factor of 15) increase to reach 3% by 2030 and be maintained up to 2050. Deep renovation also holds the potential to deliver on multiple other benefits for individuals and society. This makes a paradigm shift on deep renovation even more important.

This paper investigates what deep renovation is, and dives into ways to define it, based on an overview of national examples and existing concepts, where key parameters are outlined. Deep renovation is a multidimensional concept but guided by one overarching principle: the need to achieve climate neutrality by 2050. It sets a path for every building to be climate proof.

Deep renovation is a process of capturing, in one or, when not possible, a few steps (maximum number to be defined), the full potential of a building to reduce its energy demand, based on its typology and climatic zone. It achieves the highest possible energy savings and leads to a very high energy performance, with the remaining minimal energy needs fully covered by renewable energy. Deep renovation also delivers an optimal level of Indoor Environmental Quality to the building occupants. It ensures the building, at each step of the process, contributes its full potential to the achievement of the collective climate targets, and is on track to be climate-proofed, in line with climate-neutrality by 2050. Deep renovation considers key building elements to cover, and when it cannot be completed in one step, carefully plans renovation steps – for example by using Building Renovation Passports, which outline the selection of energy-saving measures and renewable energy installations to be executed, avoiding any lock-in, and can possibly be linked to progressive financial support. Deep renovation should lean towards a minimal carbon footprint for both operational and embodied emissions.

Deep renovation needs a legally binding, clear and ambitious definition at EU level. But beyond giving a definition to the concept, what is crucial is to shift the deep renovation paradigm and practice by making it the default approach in all policymaking and on the ground. The EU needs to recalibrate its renovation ecosystem of policy, advisory and financing measures by going full speed on deep renovation. The moment is now, as the revision of the Energy Performance of Buildings Directive provides the perfect opportunity to operationalise this paradigm shift. This paper includes a list of concrete policy recommendations to realise this opportunity.

INTRODUCTION

The Renovation Wave put forward by the European Commission in October 2020 aims to at least double the annual energy renovation rate by 2030 as well as to foster deep energy renovation.[1] If the EU wants to achieve its 2030 climate target and climate-neutrality by 2050, it must boost both the rate and the depth of renovation. According to BPIE calculations, this means the buildings sector greenhouse gas (GHG) emissions should decrease by 60% by 2030, and the annual deep energy renovation rate must be at 3% as soon as possible and no later than 2030.[2]

This number stands in stark contrast with the current situation, where the annual deep energy renovation rate is 0.2% on average in the EU.[3] Renovation activity in the EU is clearly not on track with longer-term targets, and this is even more the case for deep renovation, which represent a tiny proportion of the number of energy renovations taking place every year in Europe. This lack of progress on the ground persists, even though the importance of deeply renovating the entire building stock by 2050 has been recognised politically with the 2018 revision of the Energy Performance of Buildings Directive (EPBD), which sets for all Member States the objective of "a highly energy efficient and decarbonised building stock by 2050, facilitating the cost-effective transformation of existing buildings into nearly zero-energy buildings."[4]

Leaving aside the analysis of some traditionally well-known barriers to renovation,[5] this briefing tackles the implications of the absence of a legal definition for deep renovation at EU level. It investigates how the absence of a common understanding of what deep renovation means, and what it is meant to achieve, has led to an EU policy ecosystem which is not designed to deliver on it.

Cracking the deep renovation nut is not only crucial for the EU to reach its climate targets. It is also essential from a societal point of view if the Renovation Wave is to be delivered in a just and fair way, as deep renovation of buildings brings with it many benefits and avoids lock-in of further energy and carbon savings. This paper maps existing approaches to deep renovations (notably at national level), extracts best practices, and identifies key parameters to be included in the definition. It also argues that a more uniform approach at EU level is needed to adopt the right definition of deep renovation, but more importantly, to implement a set of policy measures (with a specific focus on the EPBD revision) which will deliver on this objective.

> Renovation activity in the EU is clearly not on track with our longer-term targets, and this is even more the case for deep renovation, which represents a tiny proportion of the number of energy renovations taking place every year in Europe.

WHY IS DEEP RENOVATION CRUCIALLY IMPORTANT?

THE CRITICAL PATH TO ACHIEVING THE EU 2030 AND 2050 CLIMATE TARGETS

To achieve its 2030 climate target and climate-neutrality by 2050, the EU must address the energy consumption of its buildings sector. **There is no climate-neutrality possible by 2050 without fully decarbonising the buildings sector**. First, if the buildings sector is not addressed, it will leave a gap in terms of GHG emissions reduction –a gap for which other sectors cannot compensate for.

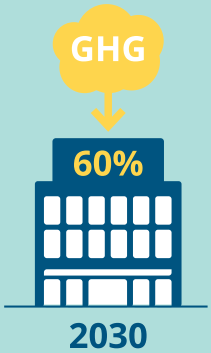
> **If the building sector fails to deliver its share of GHG emission cuts, it will leave a GHG reduction gap of 10 to 14 percentage points (i.e., GHG emissions are only reduced to 86% to 90% below 1990 level). This gap cannot be filled even if other sectors were to decarbonise fully.[6]**

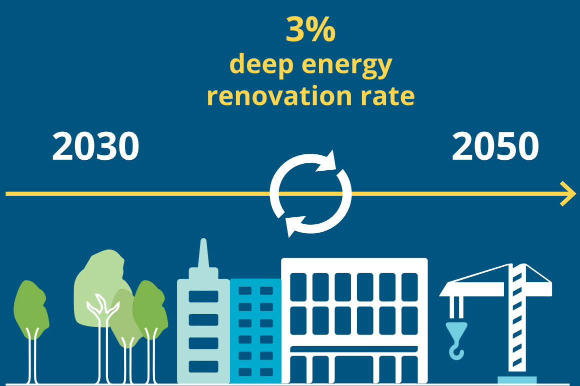
Second, if the buildings sector is not addressed, and its GHG emissions reduced, it will have the ripple effect that other decarbonisation pathways in the overall energy system cannot be followed. The crucial importance of the buildings sector for decarbonisation, both for the GHG emissions reduction it delivers on its own, but also for its positive enabling role in the energy system (easing integration of renewable energy sources in the energy system), cannot be replaced.[7] Finally, the many multiple benefits (see section 1.2) of a highly energy efficient and decarbonised building stock can also not be delivered by anything other than drastically reducing energy consumption and GHG emissions from buildings.

Addressing the energy consumption of the building stock means drastically reducing its energy needs. To that end, the EU needs to boost both the rate and the depth of building renovation. Deep renovation should become the default approach to renovation, representing the majority of works undertaken. Existing buildings represent most of the building stock of the future – around 90% of today's buildings will still be standing in 2050, and a vast majority were built before 2001.[8] Without a deep renovation of the existing building stock, the sector will not be fully decarbonised by 2050.

For 2030, the Renovation Wave aims to at least double the annual energy renovation rate as well as to foster deep energy renovations.[9] BPIE calculated that to contribute to the reduction of GHG emissions by at least 55% by 2030, GHG emissions from the buildings sector should decrease by 60% by 2030 compared to 2015. This means that the deep energy renovation **rate should reach 3% per year** as soon as possible before 2030 and be maintained up to 2050. By 2030, **70% of the renovations taking place should be deep** (this modelling exercise used the metrics of 60-90% of energy savings to calculate the impacts of deep renovations on GHG emissions reduction). The remaining 30% of the renovation activities should result in medium-depth renovation, i.e., estimated at 40-60% energy savings in the modelling exercise. There is no room anymore for shallow/light renovations, estimated by the model to deliver less than 40% savings.[10] Overall, all renovation scenarios should consider deep renovations to be the majority.

To contribute to the reduction of GHG emissions by at least 55% by 2030, the buildings sector GHG emissions should decrease by 60% by 2030 compared to 2015.





This means that the deep energy renovation rate should reach 3% per year as soon as possible before 2030 and be maintained up to 2050.

By 2030, 70% of the renovations taking place should be deep.

Those numbers stand in stark contrast with the current situation, where the average annual deep energy renovation rate in the EU is at 0.2%. There is a relatively small variation between Member States, with Cyprus (0.4%), Spain and Italy (0.3%) being the only countries scoring slightly above the EU average.[11] Deep renovation activity in the EU is clearly not on track with our longer-term climate targets and still represents a tiny proportion of the number of energy renovations taking place every year in Europe. For example, between 2012 and 2016, it is estimated that more than €127bn was spent annually on energy renovations (on average for all renovation levels), with 66.3% of these investments going to light renovations (3-30% savings), 28.3% to medium renovations (30-60% savings) and only 5.4% to deep renovations (more than 60% savings).[12] This trend in investments and activities must be reversed if the EU wants to achieve its 2030 and 2050 climate targets.

Much more should be invested each year in building renovation activities throughout Europe, and specifically, much more should be invested in deep renovations. According to BPIE calculations, the total renovation investment opportunity in the EU is estimated at €243bn per year to bring the building stock in line with climate-neutrality by 2050. This €243bn per year should only fund medium and deep renovations.[13] If this is compared to the €43bn spent annually between 2012 and 2016 on medium and deep renovations, it means we have an investment gap of €200bn per year and the spending on medium and deep renovations should be multiplied by a factor of five at least. The European Commission also highlighted the need to direct much more investment towards the buildings sector, as it estimated that an additional annual investment up to €75bn is needed. This is higher than for industry or transport, making tertiary and residential sector investments combined the largest demand-side investment gap to achieve the EU energy and climate targets.[14]

THE KEY TO MULTIPLE OTHER BENEFITS

Beyond being crucial to the achievement of the EU 2030 climate target and climate neutrality by 2050, deep renovation of buildings holds multiple other benefits. These are well known, ranging from microeconomic to wider social benefits.

To give a few examples, transforming hospitals to nearly zero-energy buildings (nZEBs) will reduce the average length of stay of patients, potentially saving the EU health sector €42bn every year. Bringing offices to nZEB levels can boost employee productivity by up to 12%, worth up to €500bn a year across the EU. Doing the same for schools would accelerate educational performance of students by up to two weeks per year.[15] Deeply renovating schools can also lead to improved indoor air quality, which in turn positively impacts well-being, health and attendance. Each year, respiratory diseases caused by badly performing buildings cause students to miss 1.7 million school days across the EU.[16] Building renovation also boosts growth and job creation. For every €1m invested in building renovation, 18 jobs are created on average across the EU.[17] Building renovation also leads to lower energy bills for consumers, thereby reducing their vulnerability to the volatility of energy prices – one of the most tangible benefits of renovation.

All these additional benefits make a strong case for renovation. While increasing the rate is crucial to achieve our targets, it is key to understand that the depth of renovation is decisive in how and to what extent these benefits accrue, and therefore how renovation is perceived.

THE BENEFITS OF DEEP RENOVATION

There are some specific benefits of undertaking deep renovations compared to other types of renovations.

First, for building owners and tenants, the significantly higher achieved energy performance in deep renovations leads to more substantial energy savings and greater benefits compared to shallower renovations. Beyond this positive "volume effect", deep renovations, especially if completed in a relatively short period of time, hold the potential to avoid lock-in effects, as they tend to target many building elements simultaneously. The risk of lock-in is usually higher with multi-staged shallow renovations, when low efficiency measures from previous stages of the renovation hamper the deployment of more efficient elements in the future, which prevents the full benefits of renovation from being realised.[18]

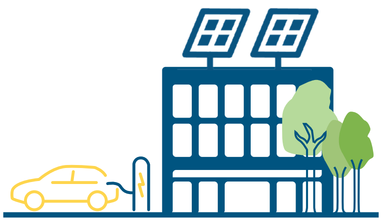
> **The risk of lock-in is usually higher with multi-staged shallow renovations, when low efficiency measures from previous stages of the renovation hamper the deployment of more efficient elements in the future... [and] deep renovation of the building stock constitutes the key enabler for a quicker and cheaper decarbonisation of the energy system.**

Second, going for deep renovations enables building owners, occupants and society as a whole to **reap more benefits over time,** as they are available more quickly and for a longer period. This is linked to the fact that some energy efficiency measures in the buildings sector, especially touching the building shell, have a long lifetime and bring energy savings for decades. This **positive cumulative effect** of deep renovation is especially important in fighting energy poverty, as energy-poor households mostly occupy buildings with the worst energy performance.[19] Energy savings achieved thanks to deep renovation will reflect in even lower energy bills compared to multi-staged shallow renovations, and sooner rather than later. Deep renovation, especially if done in a few steps or in a short timeframe, can lift populations out of energy poverty completely – anything less will not, though it may slightly reduce energy bills. Similarly, only relying on fuel switching will not lead to decreased energy bills – a comprehensive deep renovation is needed to shield households from energy poverty. With rising energy prices and the possible prospect of carbon pricing on heating fuels,[20] it becomes even more urgent to **quickly protect the most vulnerable groups in our societies** – something deep renovations would do, not only by lifting them out of energy poverty, but also by reducing air pollution and improving their health. Deeply renovating the worst-performing buildings occupied by low- and middle-income households would reduce their vulnerability to the volatility of energy prices but would also make the EU as a whole less dependent on external energy suppliers – an important advantage in terms of energy security.[21]

WHY IS DEEP RENOVATION OF BUILDINGS IMPORTANT?

Deep renovations are available more quickly and for a longer period, providing building owners, occupiers and society access to substantially more energy savings and significantly higher energy performance compared to shallow renovations. Key energy efficiency measures touching the building shell have a long lifetime and bring energy savings for decades. When done all at once, this can avoid lock-in effects, which could hamper full benefits of renovation being realized.

With rising energy prices and the prospect of carbon pricing on heating fuels, energy savings from deep renovation will lift citizens out of energy poverty and protect the most vulnerable groups through reduced air pollution and improved health.



Deep renovation of the building stock is the key enabler for a quicker and cheaper decarbonisation of the energy system. The integration of renewable energy sources is made easier once energy needs have been reduced and additional flexibility given to the power sector.

Deep renovation will boost innovation and investments in the entire construction value chain. Deep(er) renovations imply a need for competence and technical knowledge of high efficiency solutions and processes. Increasing the rate of deep renovation is an opportunity to develop industrialised solutions to renovation and to create even more high-quality jobs and boost the green economy. If deep renovation policies gain appropriate support and become mainstream, the construction sector could experience an important and stable boost comparable to Europe's post-war reconstruction in the 20th century.

Third, from a societal perspective, deep renovation holds special benefits in terms of its contribution to a more effective decarbonisation of the building stock, as shown in section 1.1. Boosting only the rate of renovation without increasing the depth will lead to missed potential and benefits – though only increasing the depth of renovation without boosting the rate would also lead to a sub-optimal result. What is needed is both at the same time, so increasing the deep renovation rate. Deep renovation of the building stock constitutes the key enabler for a quicker and cheaper decarbonisation of the energy system,[22] as the integration of renewable energy sources is made easier once energy needs have been reduced and additional flexibility given to the power sector (as demand for heat and electricity can be balanced over time, without impacting the indoor temperature and therefore the comfort level in buildings).[23] Reducing the energy needs of the buildings sector will reduce peak loads, making some infrastructure and related investments unnecessary. According to calculations used by CLIMACT, in scenarios where buildings are transformed into "highly efficient heat electrified smart buildings", "peak demand reductions [...] were estimated at 30% on average [...]. This leads to power network and operational cost savings of up to 40%".[24] Finally, deep renovations can simultaneously address mitigation and adaptation concerns, as there are more opportunities to look at the different building elements in a holistic manner. Deep renovating the building stock means making it climate proof and resilient.

Lastly, going for deep rather than shallow renovations will **boost innovation and investment** in the entire construction value chain.[25] This is because deep(er) renovations imply a need for competence and technical knowledge of high efficiency solutions and processes. The demand for skilled workers, companies with experience and know-how in complex renovations, and high volumes of appropriate materials will increase.[26] **Increasing the rate of renovation might expand these markets but boosting the depth of renovation will transform them at the same time.** This is an opportunity to develop industrialised solutions to renovation and to create even more high-quality jobs. The European Commission has identified this positive effect as a priority in the Renovation Wave strategy, especially in the post-Covid recovery period. If deep renovation policies gain appropriate support and become mainstream, the construction sector could experience an important and stable boost comparable to Europe's post-war reconstruction in the 20th century.

But where do we stand today on deep renovations? Are all these benefits in reach?

WHERE ARE WE ON DEEP RENOVATION? STATE OF PLAY IN EUROPE

LEGAL CLARITY IS MISSING FROM THE CURRENT EU FRAMEWORK

The EU legal framework does not, to date, provide a definition of what qualifies as a deep renovation. The EPBD, which is the main legislation at EU level on building performance, does not offer an official definition. Also, its specific provisions are no longer fit-for-purpose considering the current climate targets, and do not deliver on deep renovation.

What the Directive defines is 'major renovation'. Article 2.10 states that this is a *"renovation of a building where: (a) the total cost of the renovation relating to the building envelope or the technical building systems is higher than 25% of the value of the building, excluding the value of the land upon which the building is situated; or (b) more than 25% of the surface of the building envelope undergoes renovation." The provision also gives the freedom to Member States to choose between option (a) and (b) in setting their own definition.* **'Major renovation' first and foremost categorises renovations based on size (cost or surface criteria) and does not include a parameter based on energy performance. What the renovation achieves in terms of energy performance is secondary and is triggered as an application of the definition, but is not part of the definition per se.**

This definition, which was introduced in 2010 to ensure some minimum quality requirements are met in all Member States when buildings are renovated, now presents several flaws, in a new context with updated climate targets:

- First, it is very restrictive in the sense that it can only be applied to a few renovation projects.
- Second, it merely serves as a condition to know when to apply Minimum Energy Performance Requirements (MEPR). These requirements follow the cost-optimality methodology set out in accordance with the EPBD, which is now out-of-date considering the objective of climate neutrality by 2050.[27] Besides, the requirements are set at national level, which entails the risk of high divergence between Member States.
- Third, it lacks ambition, as it does not lead to renovations in line with the current climate targets, but only complying with minimum requirements.

The EPBD also gives a **definition to nZEBs** in its Article 2.2: *"'a building that has a very high energy performance [...]. The nearly zero or very low amount of energy required should be covered to a very significant extent by energy from renewable sources, including energy from renewable sources produced on-site or nearby"*. However, nZEB applies to new buildings built as of 1 January 2021, not to existing buildings being renovated. Moreover, as nZEB standards are defined at national level, based on an EU level definition which is too vague, Member States have very different applications and differing ambition levels both in terms of maximum level of energy consumption as well as share of renewable energy sources.[28]

While not defining it, the EPBD refers to deep renovation in provisions linked to the national Long-Term Renovation Strategies (Recital 9 and Article 2A §1c). These provisions underline that an increase in deep renovations will be needed to achieve the 2050 goal of a highly energy efficient and decarbonised building stock and the transformation of existing buildings into nZEBs. The possibility to undertake deep renovation in stages is also mentioned. While EU legislation acknowledges the crucial role deep renovation plays in the achievement of the 2050 vision, **no link is drawn to how this should then affect the design of specific policy measures which would deliver it.**

Finally, the EPBD outlines (Annex I) a method to calculate and express energy performance. **This methodology does not include (anymore) 'energy needs' amongst its key criteria,** but only 'primary energy use'. This is problematic, because both indicators are essential to operationalise the 'Energy Efficiency First' principle in the buildings sector and to incentivise deep renovations. Energy needs, expressed in kWh/m²/year, give information about the intrinsic efficiency of the building fabric (i.e., absence of energy losses) and are an important design feature for the heating supply. The total primary energy use then describes the amount of energy required to cover those energy needs, including the losses in the system. Energy needs (providing the right comfort levels) should be reduced as much as possible to avoid any energy waste, no matter the supply. Even though energy needs are mentioned in CEN standards, this step is absent in the regulatory framework (EPBD). Thus, there is a risk that a large potential for energy savings and a source of thermal comfort will be overlooked, as there is no indicator in the Directive related to the intrinsic efficiency of the building regardless of the energy supply.[29] **The regulatory framework set out in the EPBD therefore does not foster deep renovations which would minimise energy needs. This is because these are not in the focus of the method to calculate and express the energy performance of buildings laid out in Annex 1.**

Considering the lack of definition for deep renovation in the EPBD, several definitions have emerged in other legislative and non-legislative files, leading to some confusion and opening doors to misinterpretations.

For example, the 2012 **Energy Efficiency Directive** (EED)[30] contains in its Article2.44 a concept which could be related to deep renovation. This provision defines 'substantial refurbishment' as "a refurbishment whose cost exceeds 50% of the investment cost for a new comparable unit". But this definition, also based on a size criterion, does not apply to buildings but to electricity generation installations. A conceptualisation of deep renovation appears in EED Recital 16, related to national Long-Term Renovation Strategies (LTRS). The recital states that "cost-effective deep renovations [...] lead to a refurbishment that reduces both the delivered and the final energy consumption of a building by a significant percentage compared with the pre-renovation levels, leading to a very high energy performance. Such deep renovations could also be carried out in stages." However, the concept being included in a recital only, it is not legally binding.

This mushrooming of diverse though closely related concepts, leading to inconsistent application, could be avoided if the EPBD included a clear definition of deep renovation, to which other pieces of legislation or communication could simply refer.

Although there is no legal definition in EU legislation, the European Commission has often referred to the **proxy of '60% primary energy savings'** for determining what is a deep renovation. This is notably the case in the Staff Working Document accompanying the European Commission's report on financial support for energy efficiency in buildings (2013).[31] The Commission Recommendation on building renovation (2019) refers to *"interventions leading to refurbishment that reduces both the delivered and final energy consumption of a building by a significant percentage compared with pre renovation levels, leading to very high energy performance"* in order to define deep renovation.[32] The Recommendation also refers to a classification used in the context of the EU Building Stock Observatory that categorises renovations according to the volume of primary energy savings (light meaning less than 30%, medium 30 to 60%, and deep over 60%). The Commission recommends Member States use these categories as indicators in the context of the LTRS when reporting on the transformation of their building stock. It also adds that *"transformation into nZEBs could be another indicator [and that] more generally, 'deep renovation' should result in both energy and greenhouse gas efficiency"*.[33] However, both these documents (Staff Working Document and Recommendation) are **not legally binding**.

While the EU framework does not provide a clear and legally binding answer to the question of what a deep renovation is, **recent policy discussions and political context have become loaded with references to the concept.** The European Commission refers to deep renovation in the Renovation Wave strategy, when setting the objectives for the buildings sector in the years to come. Both the European Parliament and the Council also address deep renovation in their latest official positions (more details in Annex 1). It is positive to see that the importance of deep renovation is politically recognised but worrying to observe a potential divide being drawn between deep renovations and staged renovations. Staged renovations consist of renovation works being undertaken in several steps, which improve the building performance progressively over time. It is concerning to see that deep renovation seems to be depicted in the political discussions as 'another type of renovation' which would be opposed to staged renovations, while it should not be an either/or discussion. A renovation should not be either deep or staged: renovation should be deep, and one way of delivering this could be in stages, for example when it is not possible to do it in one step. It is urgent to address the issue of the lack of definition at EU level – something the European Commission has recognised, as it intends to introduce a deep renovation standard in the framework of the EPBD revision.

As deep renovation is a topic high on the political agenda, it is all the more important to better define it and draw implications of what it means for building renovation policies. Could some inspiration and lessons be drawn from the national level?

A MULTITUDE OF NATIONAL EXAMPLES AND CONCEPTUALISATIONS

While the EU-level framework does not provide a clear or legally binding definition for deep renovation, some Member States have used the concept when elaborating their LTRS or defined "deeply renovated / highly energy performing buildings" in recent policy developments. This section provides an overview of all definitions which the analysis came across in an attempt to be exhaustive and outlines a short selection of conceptualisations which can be useful to define deep renovation.

At least seven Member States and two regions provide some sort of a definition of deep renovation in their 2020 LTRS, although with some variation in how it is defined, at which ambition level it is set, and how it is used.

Table 1: Deep renovation definitions in selected national LTRS	
Belgium – Flanders[34]	EPC label A (100 kWh/m²/year)
Belgium – Wallonia[35]	75-100% energy consumption reduction Czechiai
Czechia[36]	EPC label A or B (<107 kWh/m²/year, expected to be reduced to 79 kWh/m²/year as of 2022)[37]
Denmark[38]	60% primary energy consumption reduction
Estonia[39]	EPC label C (<150 kWh/m²/year)[40]
France[41]	Reference to Bâtiment Basse Consommation (BBC) Effinergie Renovation Label (80 kWh/m²/year) and to a scenario of 'rénovation performante' being equal to BBC stepwise renovation
Luxembourg[42]	Reference to renovation quality with EPC A/A to B/B and average 72% energy savings
Spain[43]	Primary energy savings > 60%
Sweden[44]	Level 3 'total energy renovation' = 50% improvement of energy efficiency for residential buildings and 40% for offices

Other Member States such as **Austria**[45] and **the Netherlands**[46] **mention deep renovation several times in their LTRS, but do not provide a definition** in the document itself. In the Netherlands, a study from the Environmental Assessment Agency providing different scenarios to decarbonise the building stock suggests that to achieve a deep renovation scenario, 45% of the building stock needs to be renovated to achieve Energy Performance Certificate (EPC) label B (< 190 kWh/m²/year) and the remaining 55% of the stock must be self-sufficient (no fossil primary energy consumption).[47] Finland refers to deep renovation, but only when describing which building components need to be addressed during a renovation (e.g. ventilation, domestic hot water, exterior walls, floors, etc.), and stating that when everything is implemented at once, it can be considered a deep renovation.[48]

Other Member States do not use the term deep renovation but **refer to nZEBs or major renovations.** An example of this is the **Greek LTRS**, which refers to intense or major renovation that achieves an nZEB level, defined as reaching an EPC ranging from B to A+.[49] The **German LTRS** mentions that in the future update the 'refurbishment efficiency' will be better defined, and instead refers to minimum efficiency house standard requirements.[50] Ireland refers to a minimum level for all major renovations that must achieve a building energy rating (BER/EPC) B level (75-150 kWh/m²/year), whereas a pilot for scaling deep renovations required the buildings to achieve an EPC A rating.[51] The Estonian LTRS refers to class C as minimum performance levels for major renovations as well.[52]

Even though several Member States refer to deep renovation and define it, **the ambiguity of the term is also reflected in the varying usage and ambition level of the definitions.** Some countries only use it to build and model scenarios describing different building decarbonisation pathways, but do not choose it as their long-term objective. And when the 'deep renovation scenario' is given priority in terms of ambition to follow, it is not always supported by the necessary policies to achieve it. In 2021, the Joint Research Centre analysed 15 LTRS and concluded that although the ambition to achieve a decarbonised building stock by 2050 is high in many, only a few present a comprehensive roadmap and policies to actually reach it.[53]

Next to deep renovation definitions in the LTRS, **several efficiency standards and renovation labels/certifications show how a deep renovation can be conceptualised** (more detail in Annex 2). One aspect all standards have in common is their focus on fostering high energy performance and low carbon buildings. How to achieve that nevertheless varies considerably, regarding the metrics used, building elements targeted, the integration or not of renewables, and the possibility (or not) of staged renovations. The NOM standard,[54] for example, explicitly includes on-site renewable energy generation to become net zero carbon, whereas the Passive House standard focuses on reducing the primary energy consumption to very low levels (<15 kWh/m²/year). The French BBC Effinergie label combines primary energy metrics (kWh/m²/year) with carbon metrics (kgCO2/m²/year) for operational energy. The Net-Zero Label from the UK distinguishes itself by expanding the scope beyond operational energy and integrating embodied carbon from materials and construction. Other concepts like the Zero-Carbon Ready from the International Energy Agency (IEA) have a long-term perspective, rewarding energy efficient buildings while acknowledging that net zero emissions can only be achieved in the coming decades once the energy supply is completely decarbonised.

Finally, recent political discussions in **France** surrounding the concept of ***'rénovation performante'*** show that basing a definition on EPC classes entails other underlying issues, i.e., the need to make sure EPCs are of a high quality and that ratings are at the right ambition levels. Interestingly, the *'rénovation performante'*, which defines a renovation as bringing the building to EPC class A or B (equivalent to BBC level, i.e., 80 kWh/m²/year), also states that six building elements (wall insulation, floor insulation, roof insulation, window replacement, heating and hot water, and ventilation) should be considered. This requirement to consider a certain number of building elements also holds for the derogation where buildings for which it is technically difficult to reach EPC class A/B qualify for the *'rénovation performante'* when they reach an EPC at least two classes higher than before the renovation.

Altogether, the variety of these national examples of deep renovation definitions and other concepts also illustrates to what extent **the definition of deep renovation can influence how the regulations are drafted and implemented, and ultimately whether climate objectives are met or not.** This shows how crucial it is to develop a well thought-out and consistent definition of deep renovation.

WHAT IS DEEP RENOVATION? DEEP DIVE ON WAYS TO DEFINE IT

A MULTIDIMENSIONAL DEFINITION GUIDED BY 2050 CLIMATE-NEUTRALITY

As section 2.2 shows, **there are many ways to define deep renovation,** and there is a wide variety of parameters to choose from when designing such a definition. A definition of deep renovation cannot rely on one indicator only. For example, while the reduction of energy demand is a key component of the concept, a definition limited only to this factor would leave out other important aspects. As every parameter has its limits, using only one would give an incomplete picture of what a deep renovation could be.

Moreover, relying on a unique parameter to define deep renovation entails the risk of adopting policies and measures that only act on one aspect or lever of a much more complex issue, leading to inadequate results. The definition of deep renovation is thus multidimensional and should be based on a coherent combination of parameters. This is for example the path chosen for nZEBs, which are defined in the EPBD using two parameters (maximum level of primary energy consumption + minimum share of renewables-based supply for the remaining low energy demand).

The question is then how to choose this coherent set of parameters to be included in a definition of deep renovation, and how to calibrate them. One solution would be to look at Member States that have a definition and identify the parameters they use to simply replicate them at EU level. However, considering the very low deep energy renovation rates delivered on average in the EU but also at national level, deriving an EU definition for deep renovation based on the example of one or a few Member States which would over-perform compared to others is not a workable approach. The guiding principle to determine a definition of deep renovation is that it should climate-proof all buildings and contribute to the delivery of a climate-neutral (net zero energy and carbon) building stock by 2050.

BPIE therefore adopted its own approach to deep renovation, both in terms of how to define it and how to deliver it.

Box 1: Suggested BPIE approach to deep renovation

Definition	Delivery
Deep renovation is a process capturing, in one or, when not possible, a few steps (maximum number to be defined), the full potential of a building to reduce its energy demand, based on its typology and climatic zone. It achieves the highest possible energy savings and leads to a very high energy performance, with the remaining minimal energy needs fully covered by renewable energy. Deep renovation also delivers an optimal level of Indoor Environmental Quality to the building occupants.	Deep renovation ensures the building is, at each step of the process, contributing its full potential to the achievement of the collective climate targets, and is on track to be climate-proofed, in line with climate neutrality by 2050. Deep renovation considers key building elements to cover, and when it cannot be completed in one step, carefully plans renovation steps – for example by using Building Renovation Passports, which outline the selection of energy-saving measures and renewable energy installations to be executed, avoiding any lock-in, and can possibly be linked to progressive financial support. Deep renovation should lean towards a minimal carbon footprint for both operational and embodied emissions.

A SUBTLE CALIBRATION EXERCISE BETWEEN DIFFERENT OPTIONS FOR COMBINING PARAMETERS

Deep renovation is a multidimensional concept driven by the objective of climate neutrality by 2050 and the need to future-proof buildings. Determining the definition and delivery approach is a calibration exercise between several parameters which can be combined in different ways.

The methodology used in this research is the following:

1. Derive from analysed national examples and concepts a list of parameters that can be included in the definition.
2. Assess those parameters in view of their added value, limits and feasibility (see Annex 3).
3. Based on the evaluation of parameters as well as expert knowledge, select which parameters are deemed relevant for inclusion in the definition, by differentiating the must-have parameters and some complementary ones.

The table below summarises which indicators were retained, and at which level of priority.

Table 2	Must-have parameters	Complementary parameters
Metrics	• Reduction in primary energy consumption (expressed in percentage of energy savings compared to benchmark, usually pre-renovation level) • Thresholds for maximum level of energy needs (maximum level of primary energy consumption expressed in kWh/m^2/year) • Share of renewable energy supply, on-site or nearby (expressed in percentage of total supply)	• Link with EPC ratings • Whole-life carbon ceiling (expressed in maximum kgCO2e/m2/year) • Indoor Environmental Quality (IEQ) metrics
Quality parameters	• Differentiated thresholds per building type and climatic zone • Compliance/alignment with long-term climate targets • Defined number of renovation steps • Link to Building Renovation Passports (BRPs), notably for consideration of key building elements to cover • Link with (progressive) financial support	• Requirement to achieve measured metrics (beyond calculated) – focus on actual delivered performance

As laid down in the suggested definition, deep renovation achieves the full potential of a building to reduce its energy demand. This can be expressed either as percentage of energy savings or as threshold for maximum energy needs. The two metrics could be used separately or simultaneously. The question is therefore: **what is the optimal choice of metrics to express the reduction of energy demand in a deep renovation?**

One option would be to use only one of the two metrics. The advantage is that of clarity and simplicity of calculations. The drawback is that **choosing only one metric over the other necessarily leads to gaps as every metric has advantages but also limits.** If the maximum level of primary energy consumption (kWh/m²/year) is chosen, it sends the right signal in terms of ambition level and can be easily aligned to climate neutrality by 2050. However, it does not consider the starting point and potential of each building, with the risk of putting a disproportionate effort on certain parts of the stock. On the other side, if the reduction of primary energy consumption (percentage of energy savings) metric is chosen, it might not give a clear indication of whether the deep renovation would align the building with the 2050 ambition and make it climate proof.

One way forward would be to still prioritise one metric over the other, but in a more nuanced approach, i.e., **choosing the most suitable metric depending on certain building criteria.** But then, which metrics to apply, when and to what? This choice could depend on the pre-renovation status of buildings. For example, the percentage of energy savings metric could be applied to worst-performing buildings, while the kWh/m²/year metric could be applied to buildings which already achieve a moderate level of energy performance. For example:

		Option A	Option B
		Applying 75% energy savings requirement	**Applying requirement based on maximum level of energy consumption fixed at 60 kWh/m²/year**
Case 1	Worst-performing building (450 kWh/m²/year)	= 112.5 kWh/m²/year	= 87% energy savings
Case 2	Moderate energy performing building (90 kWh/m²/year)	= 9 kWh/m²/year	= 33% energy savings

Reaching a high percentage of energy savings is challenging for a moderate performing building (A2). On the other side, for worst-performing buildings, achieving a high level of energy savings is possible, but the result in terms of kWh/m²/year is higher than what could be considered a highly energy performing building (A1).

Choosing one metric over the other depending on the building pre-renovation status would also entail addressing some potentially complex questions. As a prerequisite, buildings would need to be divided into two categories (worst performing, and others), to know which metrics to apply. Determining a threshold of what is a worst-performing building relies on a solid inventory of the building stock, including building typologies and their energy consumption. This should not be an issue as Member States are already required to do such exercises in their LTRS since 2014. The question is rather where to draw the line to determine what a worst-performing building is.

Another option would be to **combine the two metrics and use them simultaneously**. The advantage of using two metrics is to give a more comprehensive picture of what a deep renovation is. The drawback is complexity. Considering that the deep renovation definition should be guided by the objective of climate neutrality by 2050, it seems that **using both metrics would be more relevant, at least for worst-performing buildings.** Those should both achieve a very significant reduction of energy consumption (in percentage of energy savings) and aim at getting as close as possible to the goal of a low level of maximum primary energy consumption (expressed in kWh/m²/year). In the example outlined above, the 450 kWh/m²/year building would have a performance level of 112 kWh/m²/year after applying the 75% energy savings requirement, which is still higher than what could be considered a highly energy performing building; it could be required to go beyond this in order to achieve, for example, 80 kWh/m²/year (which would mean 82% energy savings).

Finally, beyond the choice of parameters, their combination and calibration, the level of ambition needs to be discussed to derive a more comprehensive definition of deep renovation. The next section explores how to set this ambition to climate-proof every building in alignment with climate-neutrality by 2050.

A PATH SET AT THE RIGHT LEVEL OF AMBITION TO CLIMATE-PROOF EVERY BUILDING

The guiding principle when setting the ambition level of the different metrics of the deep renovation definition should of course be alignment with the 2050 climate neutrality objective, which is legally enshrined in the Climate Law.[55] More importantly, the potential of every building towards being climate proof should be fully tapped, also considering the building typology and the climatic zone. This means that deep renovation should achieve the highest possible energy savings for each building renovated, expressed in percentage of energy savings (range could be 60 to 90%), with the possibility to do less only if the building reaches after renovation a maximum level of primary energy consumption expressed in kWh/m²/year (range could be between 60 and 80).

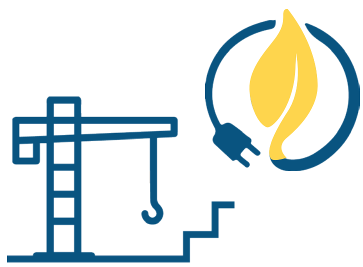
BPIE has used the reduction in primary energy consumption, expressed as a percentage of energy savings compared to the pre-renovation level, for its modelling work since 2011.[56] Expressing the 'energy savings' parameter as a range of values links to the need for a differentiated approach depending on the building type considered, as the savings potential might be different in different building segments and in different climatic zones. However, it can be derived from the range that a median value of 75% primary energy savings can be used to define deep renovation in line with the 2030 climate target.[57] This value was also put forward by several experts in 2013 who concluded that by "using state-of-the-art technologies, it is possible to reduce the energy consumption of a building by more than 75%".[58] **Not only is a 75% primary energy savings parameter needed for reaching our climate goals, but it is also technically feasible.**

Regarding the maximum primary energy consumption parameter, 90% of experts referred to previously and surveyed in 2013 found that energy performance after a deep renovation should be below 80 kWh/m²/year (a value in line with the 2020 French LTRS), and 60% of them thought the absolute target should be between 15 and 60 kWh/m²/year.[59] Other standards like NOM and Passive House show that it is technically feasible to achieve a level of performance below 60 kWh/m²/year. Based on these findings, a deep renovation definition could include **a range between 60 and 80 kWh/m²/year as maximum primary energy consumption level,** as a desirable and imaginable level of ambition. Finally, ambition levels for both metrics can be revised over time to adjust for technological improvements in the future.

All in all, deep renovation should minimise energy needs by capturing the full potential of the building while delivering adequate comfort levels to occupants. Then, the remaining low energy demand should be supplied by renewables, progressively increasing their share within the total supply, towards reaching 100% at the end of the deep renovation process and by 2050 latest. As intermediate steps, a modelling scenario done by BPIE at building stock level indicates that to be in line with 2030 climate targets, renewable energy should supply 53% of the sector's needs by 2030.[60]

DEEP RENOVATION should minimise energy needs by **capturing the full potential of the building** while delivering adequate **comfort levels to occupants.**

The remaining low energy demand should **be supplied by renewables,** progressively increasing their share within the total supply, **towards reaching 100% at the end of the deep renovation process**
and BY 2050 latest.



Finally, what impact would the different combinations and calibrations of the deep renovation definition have on the energy use of the entire building stock? This exercise does not aim to give a definitive answer as to the exact combination to choose but outlines different options and shows some trends in terms of impact on the entire building stock.

Box 2: examples of possible impacts on total useful energy of building stock (EU) of different options

The numbers below derive from internal BPIE calculations, based on data from Hotmaps.[61] As a disclaimer, energy levels are here expressed in useful energy (energy needs), not in primary energy consumption as for other examples throughout the paper. It should be recalled that primary energy consumption levels would be higher than the levels used below. As an indication, the average useful energy (demand for heating) is considered to be 106 kWh/m²/year on average for the entire EU building stock. Finally, this modelling exercise does not fully consider technical feasibility limitations at building level.

If all buildings were renovated with the unique requirement to reach 70 kWh/m²/year of useful energy (energy needs), no matter what it means in terms of percentage of energy savings, the overall useful energy in the entire stock would be reduced by 43%. If all buildings were renovated with a unique requirement to achieve 75% energy savings, no matter the end result in terms of level of energy consumption, the overall useful energy in the entire stock would be reduced by 75%. But these two scenarios do not consider the pre-renovation state of the different buildings. However, if we consider the requirement to achieve a certain percentage of energy savings, coupled with an objective in terms of maximum level of useful energy expressed in kWh/m²/year, we find the following:

Relative change in useful energy consumption at EU level for all buildings		Minimum renovation target (kWh/m2/year)				
		60	65	70	75	80
Relative reduction (% of energy savings)	60%	-45%	-42%	-40%	-38%	-35%
	65%	-47%	-44%	-41%	-39%	-36%
	70%	-48%	-45%	-42%	-39%	-36%
	75%	-49%	-46%	-42%	-39%	-36%
	80%	-49%	-46%	-42%	-39%	-36%
	85%	-49%	-46%	-42%	-39%	-36%
	90%	-49%	-46%	-42%	-39%	-36%

Requiring every building to achieve, for example, 75% of energy savings with the possibility to do less, as soon as it achieves 80 kWh/m²/year in useful energy would reduce the overall useful energy in the entire stock by 36%. By contrast, requiring every building to achieve 60% of energy savings with the possibility to do less, as soon as it achieves 60 kWh/m²/year of useful energy would reduce the overall useful energy in the entire stock by 45%. **The highest reduction in useful energy consumption at building stock level (-49%) takes place if every building is required to achieve between 75-90% energy savings, with the possibility to do less as soon as it achieves 60 kWh/m²/year.**

This table shows that in terms of impact on the overall useful energy of the entire stock, moving the ambition on the maximum level of energy allowed (in kWh/m²/year) would potentially have a bigger impact than increasing the ambition level in terms of percentage of energy savings. However, feasibility and costs might be more restrictive when moving up in terms of maximum level of energy (kWh/m²/year) compared to increasing the level of energy savings to be achieved. **One solution pathway could be to specify the criteria of energy demand reduction within the deep renovation definition as achieving at least 75% energy savings, with the possibility to do less if the building achieves 80 kWh/m²/year (and then tighten over time the second requirement on maximum energy level).**

A CONCEPT BENEFITING FROM USEFUL COMPLEMENTARY PARAMETERS

As explained above, deep renovation is a multidimensional concept which should be guided by the objective of climate neutrality by 2050 to put every building on a path to be climate proof. The definition could also greatly benefit from the addition of some complementary parameters (see table 2).

For example, **EPC ratings** seem to be a logical instrument to turn to when trying to define deep renovation. EPCs have existed in every Member State for several years and can be used to classify buildings into performance categories based on clear thresholds. Relying on EPC classes would be an easy and quick way to define deep renovation, either by using an EPC class as an end goal of the renovation, or by using 'jumps' from one EPC class to another as a good description of the deep renovation process. As they are labels, EPCs would be used as proxies for two other parameters (reduction of, or maximum, primary energy consumption). In this analysis however, they have been classified into the complementary parameters, which can be useful but should not be the only parameter to rely on. This is because EPCs are 'relative' compared to more 'objective' values of the 'must-have' parameters. EPC ratings are determined at national level and therefore differ considerably between Member States.[62] For example, *"the upper limit for class A may range between 15 and almost 300 kWh/m²/year, while lower limit for class G may range between 200 and 1150 kWh/m²/year. This may depend on the climate and on the end uses included in the calculation."*[63] Moreover, EPCs can be too easily modified or even manipulated to reduce the real ambition of deep renovation on the ground. For example, if a deep renovation is defined as moving two EPC classes up but the ranges underpinning each class are not broad enough, it will not lead to substantial energy savings. However, EPCs have certain advantages, as they act as a key information tool for a wide range of actors, can help deliver deep renovations in stages and hold the potential to integrate whole-life carbon considerations.[64] [65] EPCs can be considered as useful adds-on to 'translate' deep renovation to consumers, but should not form the basis of the definition.

A whole-life carbon ceiling can also be added as complementary parameter. The inclusion of whole-life carbon considerations (measurement and potential caps on embedded emissions) alongside operational energy metrics is essential to ensure that the energy efficiency improvements deliver an optimal contribution to carbon emissions reduction. Some experiences at national level show this is a feasible pathway, for both new and existing buildings. When setting requirements at EU level on whole-life carbon thresholds, a harmonised accounting methodology and reporting, based on the LEVEL(S) framework and the EN 15978 standard, should be used.

IEQ metrics are also useful complementary parameters, as they can greatly benefit building occupants as well as increase the climate adaptability of buildings (e.g., by ensuring that buildings can stay thermally comfortable during heatwaves). Adding them specifically to the 'must-have parameters' entails the risk of overloading the definition and losing the focus, but integrating IEQ metrics more broadly in energy performance calculations should be considered.[66]

As for quality parameters, there is a strong case for featuring them in the deep renovation definition to ensure good implementation and that all benefits are achieved. A specific analytical focus is given here to one of them: the **maximum number of steps in the case of a staged deep renovation, and how this could be linked to the Building Renovation Passport.** Due to financial constraints, technical incompatibility or disruption from a renovation, building owners often do not want to renovate their building deeply at once. The Passive House renovation certification, the NOM renovation and the French BBC renovation standard, for example, address this phenomenon by facilitating staged deep renovations. The Passive House standard does not define a minimum or maximum number of steps but provides pre-certification when a first step with 20% primary energy reduction is achieved.

The French Energy Agency ADEME argues that deep renovation at BBC level can only be done in one to three steps to ensure that renovation benefits and energy performance are achieved. Based on analysed national examples and concepts, the table below assesses the benefits and feasibility of different approaches when it comes to the number of steps in a deep renovation.

Table 3	Advantages	Feasibility and risks	Examples
One-step	• Maximises energy savings and achieves climate targets • Growth of the renovation market bringing benefits of scale, like cost reduction • Only one-time disturbance to building occupants • Reduces risks of quality of installation and of lock-in effects	• Depends on investment capacity of the building owners • Depends on available subsidies/financing programmes to cover high upfront costs • Depends on availability of skilled workforce	NOM, Efficiency House Germany
Staged deep (maximum number of steps with significant first step)	• High energy savings due to significant initial investment • Growth of the renovation market bringing benefits of scale, like cost reduction[67] • Renovation works can be • combined with regular maintenance/trigger points[68]	• Must be part of a comprehensive renovation plan (BRP) [69] • More steps increase complexity and require more coordination • Quality issues and risk of lock-ins can emerge between steps • Spreading the works might also disturb occupants multiple times and over a long(er) period of time • Might result in lower energy and emission savings (final stages may not be completed)[70]	ADEME, Passive House, French 'Tertiary Decree
Staged deep (more than 3 steps)	• Reduced initial costs of renovation • Renovation works can be combined with regular maintenance/trigger points[71]		Efficiency House Germany (with BRP), Brussels-Region five step renovation roadmap for reaching minimum energy performance by 2050 (2020 LTRS)[72]

One-step and staged renovations are not in competition with each other if they adopt a whole building approach and ultimately lead to the same savings and benefits outlined above in section 1.

But beyond determining a definition of deep renovation based on a coherent set of parameters, what does this mean more broadly, especially considering EU-level policy discussions?

HOW TO CHANGE THE DEEP RENOVATION PARADIGM AND PRACTICE

ADOPT A MORE UNIFORM APPROACH AT EU LEVEL

While a clearer picture of what deep renovation is emerges, the question also arises as to whether the concept should be dealt with and defined at national or at EU level.

As discussed above, the lack of a clear, common and legally binding definition at EU level has led to situation where Member States adopt different definitions (if any), with uneven and inadequate results. Some Member States have a definition of deep renovation or aim at clarifying the concept, but most do not. These national attempts at defining deep renovation result in many different approaches and a varying degree of ambition. In addition, the policy ecosystem that is supposed to deliver deep renovations remains inconsistent and ineffective. The flexibility left to Member States, because of the lack of definition and of an unfit-for-purpose policy ecosystem, translates into under-performance.

It is therefore high time to adopt a more uniform approach to deep renovation across the EU, considering its crucial importance for achieving the long-term climate targets and the current lack of progress on the ground. More guidance from the EU level is needed on what deep renovation is, what it is meant to achieve and how to deliver it. Deep renovation needs a legally binding, clear, and ambitious definition on its own at EU level, in accordance with subsidiarity, along the key parameters highlighted above. But more than designing and adopting a definition at EU level, what is needed is to change the deep renovation paradigm and practice.

> **Deep renovation needs a legally binding, clear, and ambitious definition on its own at EU level.**

SHIFT TO DEEP RENOVATION AS THE DEFAULT APPROACH IN ALL POLICYMAKING

Introducing a definition at EU level for deep renovation is a necessary addition to the current regulatory framework but it only constitutes the first step towards a more substantial change in how building renovation policies are considered. Introducing a definition without thinking about wider implications for the renovation policy ecosystem risks introducing wording which would only act as a 'threshold setter' in an 'in/out' approach. This would mean that some renovations would fall under the deep renovation definition, while others would be exempt. Thinking along those lines would imply that some sort of conditionality would be applied, creating instances when deep renovations should be carried out versus cases when other types of renovations should prevail. This approach, which simply mirrors what is currently in place with the 'major renovation' definition serving as condition to apply minimum energy performance requirements, is flawed and not up to the climate and social challenges of the buildings sector.

No matter the chosen definition of deep renovation, alternatives or exemptions should be limited. Introducing alternatives in legislation often leads to loopholes undermining the effectiveness and the impact of the policy measures, as shown by the experience with the EED Energy Efficiency Obligation Schemes or the renovation requirements for public buildings.[73] Deep renovation should be the default approach and any deviation from it should be duly justified. This mean the 'burden of proof' is reversed compared to the current practice. This shift to deep renovation as mainstream approach in policymaking should be applied to all aspects of it, from designing building standards to elaborating planning strategies, running a subsidy scheme, setting up advisory services, providing training to construction professionals, and more.

As described previously, the annual deep renovation rate should be multiplied by a factor of 15 between now and 2030 (from 0.2% to 3%) and deep renovations should represent 70% of all renovations carried out in less than a decade from now. What is needed is a massive upscaling of deep renovations in Europe, to ensure the Renovation Wave does not end up in a ripple. Beyond providing for a clear and legally binding definition, **the EU regulatory framework should move towards introducing a 'deep renovation standard'** which would fully guide policymaking, planning and investment decisions. This deep renovation standard would serve as the translation of the Energy Efficiency First principle for the buildings sector. Adopting such a standard would allow setting a long-term objective, while the deep renovation definition per se could be adapted over time and could possibly integrate additional parameters (such as climate adaptation or whole-life carbon indicators).

Setting deep renovation as the standard quality for renovation means that deep renovation will become the mainstream approach, rather than the exception (as is currently the case). Deep renovation should become standard thinking and standard practice across the construction value chain. While not all buildings can undergo a one-off deep renovation, this thinking should guide all renovations.

> Deep renovation should be the default approach and any deviation from it should be duly justified… [The] EU regulatory framework should move towards introducing a 'deep renovation standard' which would fully guide policymaking, planning and investment decisions. Deep renovation should evolve from a niche exception to mainstream excellence which everybody deserves.

TURN THE STANDARD INTO ACTION: POLICY RECOMMENDATIONS

Having the right definition legally in place and setting quality principles for deep renovation is a necessary but not sufficient condition. It will have clear impacts on regulatory provisions and financing frameworks if they are directly anchored to it, but it will not be enough to respond to the challenge of drastically increasing the annual deep renovation rate over the next decade and mainstreaming its practice. Policy measures alone will not deliver this goal, if not aligned to deep renovation thinking. **The EU needs to recalibrate its renovation ecosystem of policy, advisory and financing measures by going full speed on deeper renovations, and the moment is now.**

The revision of the EPBD provides the perfect opportunity to operationalise this paradigm shift. Concretely, how should the deep renovation standard be embedded and reflected within the EU regulatory framework? Some initial solutions are outlined below with an indication of the provision to be amended or added to existing legislation, particularly the EPBD.

Table 4: intervention points in EU framework to apply a deep renovation standard	
Definition and buildings standards	
Add the deep renovation definition and standard into legislation	**Introduce in EPBD Article 2 (definitions)**
Apply the deep renovation standard when any building undergoes renovation, to maximise energy performance and achieved savings	**Amend EPBD Articles 4 & 7 (setting minimum energy performance requirements for existing buildings)**
Introduce Minimum (Energy) Performance Standards designed in line with the deep renovation standard principles, to ensure compatibility of the MEPS 'trajectory approach' and end objective for the building stock with deep renovation	**Introduce as new EPBD provision**
Ensure public buildings lead by example and their renovations are deep	**Amend EPBD Article 2A §3 (LTRS) and refine EED proposal Article 6 (renovation of public buildings)**
Long-term planning and renovation advice	
Draw link between 2050 vision for the building stock and contribution of deep renovation to that vision, and require Member States to report on how LTRS policies and measures are aligned with the deep renovation standard	**Amend EPBD Article 2A §1c (LTRS)**

Require Member States to include the deep renovation standard in their EPC scale (where EPCs are used to communicate the deep renovation standard to consumers), and strengthen recommendations included in EPCs in accordance with the deep renovation standard	**Amend EPBD Article 11 (EPCs)**
Introduce Building Renovation Passports to guide renovation decisions in line with deep renovation standard	**Introduce as new EPBD provision, possibly based on Article 11 (EPCs)**
Financing and Technical Assistance	
Require Member States to put in place financing programmes for building renovation according to key quality principles: • Alignment with 2050 climate perspective • Consistency with LTRS policies and measures • Support to projects adopting a whole building approach vs. individual measures • Support to projects delivered by skilled professionals with a 'deep renovation' certification • Proportionality of financial support to achieved energy savings, with bonus for deep renovations done in one step or achieving a substantial amount of savings in the first step	**Amend EPBD Article 2A §3 (LTRS) & EPBD Article 10 (financing)**
Require Member States to introduce a plan, in collaboration with local authorities and in coordination with the LTRS, to ensure that all cities have access to One-Stop-Shop (OSS), organised in a network, providing unbiased renovation advice in line with the deep renovation standard. The European Commission should support these actions with Technical Assistance.[74]	**Amend EPBD Article 10 (financing)**
Use of public funds for building renovation programmes conditional to meeting deep renovation standard, with priority given to households in or at risk of energy poverty, vulnerable households and worst-performing buildings	**Refine EED proposal Article 22 (empowering and protecting vulnerable customers and alleviating energy poverty)**
Use the legally binding definition of deep renovation in connected areas	**Adapt Taxonomy Delegated Act + Climate, Energy and Environmental Aid Guidelines (CEEAG) + Recovery and Resilience Plans[75]**

Specific **enabling conditions** to foster change across the renovation supply chain (e.g., upskilling of workers, industrialisation of renovation models, prefabrication, etc.) in alignment with the deep renovation standard should accompany the suggested regulatory change.

CONCLUSION

Deep renovation is nowhere – absent from EU legislation and marginally delivered on the ground. Deep renovation should be everywhere. It is therefore crucial to make it standard practice, not only to achieve the EU climate targets, but also to seize its many benefits. There is an absolute necessity to shift the thinking around deep renovation from an exception to the default approach, in EU legislation, national policies and delivery on the ground. The revision of the Energy Performance of Buildings Directive provides a golden opportunity to trigger this shift by introducing a definition of deep renovation in the Directive and ensuring a consistent approach across all policies. This should not be missed.

ANNEX 1: REFERENCES TO "DEEP RENOVATION" IN CURRENT POLICY DISCUSSIONS

In the Renovation Wave Communication (October 2020), **the European Commission** recognises that *"across the EU, deep renovations that reduce energy consumption by at least 60% are carried out only in 0.2% of the building stock per year [...]. At this pace, cutting carbon emissions from the building sector to net-zero would require centuries. It is time to act."*[76] The strategy aims to double the renovation rate and to foster deep renovations, while recognising that *"deep renovation is not always achievable in one go. It is therefore important to create better conditions for staged renovation,"*[77] implying that there would be an opposition between deep and staged renovation. It is in this framework that the Commission decided, as part of the EPBD revision, to consider the introduction of a deep renovation standard, for financing and decarbonisation reasons.

On the side of **the European Parliament** there is strong appetite to push for deeper renovations to achieve the EU climate goals – see especially the Motion for Resolution on 'maximising the energy efficiency potential of the EU building stock' (July 2020).[78]

The Council of the EU, on its side, in its Conclusions on the Renovation Wave (June 2021), *"acknowledges the need [...] to promote deep energy renovations, which improve the energy performance of buildings and create energy and costs savings, promote the replacement of carbon intensive consumptions with renewable energy [...] and recognises that, in order to maximise the reduction in GHG emissions in the buildings sector as a whole, the massive increase in renovations, deep and partial ones where appropriate, should be accompanied by a circular, life cycle approach [....]".*[79] *Member States also recognised that "setting a deep renovation standard [...] can, in particular if accompanied by financial, advisory support and training and qualification schemes [...] be an efficient way of ensuring more extensive renovations."* The Council also calls for national circumstances to be considered when setting such a standard.[80]

ANNEX 2: CONCEPTS AND NATIONAL EXAMPLES OF DEEP RENOVATION

Bâtiment Basse Consommation (BBC) Effinergie Renovation Label (France): this label, which has existed since 2009 and which was updated in October 2021, is given to renovated buildings that have a low primary energy consumption (< 80kWh/m²/year, equivalent to EPC rating A/B)[81][82] but also low carbon emissions (<20kg-eqCO2/m²/year).[83] It also includes requirements for adaptation to climate change (thermal environment during heatwaves), ventilation systems, local renewable electricity production, biodiversity and sustainable mobility.[84]

ADEME 3-steps maximum renovation up to BBC level (France): in a study published in 2021, the French Energy Agency ADEME found that to achieve national climate objectives, complete (rather than staged) renovations up to BBC level are technically the most suitable. If this is not possible due to financial or social reasons, a renovation with a maximum of three steps is the optimal path. This three-step renovation must include a significant first step with multiple renovation measures, combined with a clear renovation plan to ensure climate targets are achieved and health of occupants is improved.[85]

'Rénovation Performante' (France): the Climate and Resilience Law, adopted in 2021, now legally defines a 'rénovation performante' as bringing the building to EPC class A or B (equivalent to a BBC level – 80/kWh/m²/year),[86] with six building elements being covered (wall insulation, floor insultation, roof insulation, window replacement, heating and hot water, and ventilation). By derogation for buildings where it is technically difficult, or complicated because of architectural or heritage value, to reach the EPC class A/B, a renovation can be deemed 'performante' if there is an improvement of at least two EPC classes (and the six buildings elements are covered). Another way to fulfil the 'rénovation performante' criteria is for buildings with EPC F/G to reach after renovation works a minimum EPC C rating. Finally, a 'rénovation performante' can qualify as 'global renovation' if works are carried out in an 18-to-24-month timeframe (depending on the building type).[87] In March 2021 an amendment was adopted in the French Parliament that lowered the ambition from A to C, with the possibility for the worst-performing buildings to also qualify as rénovation performante when they achieve an EPC D rating, instead of C.[88] French interest groups have expressed concerns about the lower ambition (from the initial +/- 80 kWh/m²/year to 180-250 kWh/m²/year), in particular because of risking lower quality renovations, misuse of public funding and incompatibility with the French climate targets.[89]

'Global Renovation' within MaPrimeRénov (France): in the framework of the French national renovation subsidy scheme, a renovation is deemed to be 'global' if it is done in one step and reduces primary energy consumption by 55%. There is a bonus when EPC A/B is achieved.[90]

Kreditanstalt für Wiederaufbau (KfW) Efficiency House Standard (Germany): the German KfW bank has developed an orientation standard for energy efficiency in buildings. Efficiency house standards are linked to financial support, whereby achieving a higher Efficiency House standard is rewarded with higher financial support. The standard provides a building with a rating based on the energy performance expressed in primary energy consumption and heat transmission of the building shell compared to a reference building. The reference building has been defined in the building energy law (GEG) and the KfW 100 standard is based on this definition.[91][92] While existing buildings can be renovated to the KfW 100 standard, since November 2020, the nZEB definition for new buildings in Germany corresponds to a theoretical Efficiency House 75 standard.[93] The highest available rating (KfW 40), however, represents only 40% of the primary energy consumption of the reference building. A 'renewable energy class' rating can be achieved when at least 55% of the energy sourced is renewable.[94] Germany has not defined deep renovation but introduced the 'best possible principle' for renovation advice. The energy advisor assesses what the best possible Efficiency House rating for a building is in terms of energy efficiency, rather than cost-optimality.[95] Other concepts in German speaking countries are the zero-energy house[96] and plus-energy house.[97] The plus-energy house standard refers to the KfW 40 standard to benchmark its performance.

Net-Zero Carbon Buildings (UK Green Building Council): the framework definition describes principles and metrics to be used as guidance to develop net-zero carbon renovations and new construction projects.[98] The framework defines fives steps to achieve net zero. A key element of the approach is the scope, which consists of net-zero carbon construction and net-zero carbon from operational energy usage. Net-zero carbon construction is defined in total embodied carbon (tCO_2 & $kgCO_2eq/m^2$) from construction (modules A1-A5 of EN15978) at completion, according to the Royal Institution of Chartered Surveyors whole-life carbon assessment requirements.[99] The net-zero operational carbon is expressed in tCO_2/m^2/year and is derived from direct (scope 1) and indirect emissions (scope 2) related to operation of the building. 'Net-zero carbon construction' broadens the scope of this construction/renovation definition, as it requires a whole-life carbon assessment for the construction process and includes the embodied carbon impact of construction materials. To be net zero, reduction of construction impacts, reduction of operational energy use and increase in renewable energy consumption are required for renovation projects, with offsetting any remaining carbon as a last resort. The current definition does not yet include net-zero emissions in the whole life of the building (including modules B1-5, B7, Module C and Module D from EN 15978) but this is expected to be implemented at a later stage.

NOM renovation (Netherlands): the Zero on the Meter (NOM) concept is awarded to renovation and construction projects that produce more energy than they consume. A NOM-certified building has a primary heat consumption of less than 50kWh/m^2/year for electric and low-temperature heating and generates more renewable energy on-site, usually solar PV, than it consumes.[100] For multistorey residential buildings, it is sometimes difficult to reach the NOM standard because of the lack of surface for on-site renewable energy generation. The NOM-ready standard has been designed to tackle these situations. A NOM-ready building has the same reduced primary energy demand as low-rise buildings but cannot yet meet the complete primary energy demand with renewables. This results in a staged renovation, where the NOM standard can be achieved when the heat and electricity supply are decarbonised.[101]

Passive House: this certification functions as a building standard applicable to any building and only awarded to highly energy efficient, comfortable and affordable projects. A building can only be labelled Passive House when it meets requirements related to space heating and cooling demand (<15kWh/m^2/year), renewable primary energy demand (<60kWh/m^2/year), airtightness and absence of thermal bridges.[102] Passive House renovations are popular in Germany and Austria but are also found in other Member States like Portugal[103] and the Netherlands[104]. Because not all building owners renovate their building in one go, the step-by-step EnerPHit Retrofit Plan has been developed.[105] Pre-certification can be awarded if the first step of the renovation achieves at least 20% energy savings. Other projects illustrate that Passive House renovations can be linked to whole-life carbon accounting.[106]

Tertiary Decree (France): this provision is applicable to large non-residential buildings with a floor area larger than 1000 m². The Decree requires building owners to achieve energy performance targets that rise in ambition over time (40% savings in 2030, 50% in 2040 and 60% in 2050, compared to pre-renovation level in a baseline year). The clearly outlined minimum performance standards for the coming decades can encourage the building owner to achieve the 2050 target in one step but leaves space for building owners to renovate in several.

Zero-carbon-ready building (International Energy Agency): zero-carbon-ready buildings are very energy efficient and have an energy supply of self-generated renewable energy or energy carriers that will be completely decarbonised by 2050. Once the supply is decarbonized, the building is net-zero carbon without further changes to building installations of fabric. To achieve the IEA's net-zero emissions by 2050 scenario, the share of zero-carbon-ready buildings must increase from less than 1% in 2020 to 25% in 2030 and over 85% in 2050.[107] Important considerations for the success are 'zero-carbon-ready building energy codes', covering scope 1 to 3 emissions from operation and embodied carbon from construction products. Moreover, energy demand must be reduced to reduce building operation and renewable generation costs.

ANNEX 3: ASSESSMENT OF RELEVANCE OF PARAMETERS FOR INCLUSION IN A DEEP RENOVATION DEFINITION

The two tables below outline a list of parameters that could be included in the definition of deep renovation. The first table focuses on the metrics that can be used, while the second table focuses on quality parameters. To choose whether to include the parameters in the definition or not, an objective evaluation needs to take place. All indicators are therefore assessed based on their added value, limits and feasibility. It is on this basis that it was decided whether to include the parameter in the definition or not.

Identification and assessment of relevance of 'metrics' parameters				
Metric	**Added value**	**Limits**	**Feasibility**	**Examples**
Reduction in primary energy consumption - energy savings (%) - benchmark	Single clear definition per building typology	Need to define a benchmark/ comparison point and way of measurement to enable comparison (e.g., X % energy savings compared to reference building, or to starting point of building itself, would lead to different requirements) Does not take into account all the energy savings potential of each building (especially for worst performing buildings) Does not give indication whether the building performance is aligned with 2050 ambition	The fact that the current (unofficial) definition is based on this metric would indicate that using it at a wider scale is feasible. A starting point/benchmark should be defined.	Efficiency House Standard (KfW), European Commission, Spain LTRS

kWh/m²/year – maximum primary and/ or final energy consumption (minimum energy needs)	Easy to clearly set (in light of longer-term climate ambition) and to compare between buildings	Might put disproportionate effort on certain building segments if starting point is not taken into account Does not ensure that low energy consumption is GHG emissions free	Many existing standards are defined based on this type of metric	NOM, BBC, Passive House
nZEB level	nZEB standards already exist at national level, which also allows for subsidiarity and differences of climatic conditions to be respected	nZEB standards were mostly developed for new builds (less for renovations) Lack of ambition at national level on maximum primary energy consumption and share of renewables (so lack of alignment with 2050 climate goals)	Linked to existing EU policy framework and national standards	Commission proposal (2021) to revise the Energy Efficiency Directive includes a requirement that at least 3% of the total floor area of buildings owned by public bodies should be renovated up to at least nZEB levels
EPC rating (either setting an EPC class as end goal or to describe the process by using minimum number of EPC class 'jumps')	Links to existing policy instrument, easy to set and to verify, good for subsidiarity	Difficult to compare ambition across Member States Not based on operational energy but calculations / asset rating (risk of performance gap) Not all buildings yet have an EPC Probably not aligned with 2050 targets (as setting the goal of an EPC A of today does not necessarily mean the building would qualify as A in the future or be fit for 2050)	EPC schemes are already implemented in many Member States, which could facilitate implementation. Flaws of the EPC schemes should be addressed to ensure effectiveness	*'Rénovation Performante'* (France)

Indoor Environmental Quality (IEQ)	Important metrics for building users as it relates to indoor air quality, air velocity, humidity, ventilation, light, acoustics, thermal comfort	Metrics not always included in calculations at national level and lack of harmonised guidance at EU level Risk of complicating the definition by adding too many additional indicators Risk of adding costs to the renovation by setting additional requirements Risk of trade-offs with energy efficiency measures	Possibility to include only a selection of parameters that are both important for building occupants and available in terms of easy-to-use metrics (e.g., ventilation, thermal comfort)	Passive House (for thermal comfort), BBC
Share of renewable energy supply, on-site or nearby (%) or fossil fuel phase-out requirements	Ensures that energy supply is also contributing to GHG emissions reduction	Difficulties for multi-family buildings, especially high-rise (because of space issues) to comply with requirement for a high share of (on-site) renewable energy supply Requirement set at building level but dependent on decarbonisation of energy supply systems	There is significant potential decarbonise the heating and cooling of buildings, although certain building types require specific support because of local conditions making technical feasibility more difficult	NOM, BBC, Net-Zero UK
Reduction in operational GHG emissions (%) - benchmark	Single clear definition per building typology	Does not necessarily lead to tapping all the potential of the building, notably in terms of reduced energy consumption and related benefits of energy efficiency Need to define a benchmark and way of measurement to enable comparison (with starting point) Does not indicate whether the building performance is aligned with 2050 ambition	Adds complexity to the calculations	

Maximum kgCO2/m^2/year (operational phase)	Ensures GHG emission reductions, easy to compare, sets decarbonisation objectives but leaves freedom to Member States on which decarbonised energy source to choose	Does not necessarily lead to tapping all the potential of the building notably in terms of reduced energy consumption and related benefits of energy efficiency Might put disproportionate effort on certain building segments if starting point is not considered,	The extra step to calculate the emissions (by linking primary energy use to carbon intensity of fuels and electricity supply) might make this option more complex to implement. Plus, to ensure completeness and effectiveness, this metric would have to be combined with a required primary energy consumption metric	BBC
Reduction in embodied carbon emissions (%) - benchmark	Incentivises GHG emissions reduction in the complete life cycle beyond operational energy	Methodological issues exist to reliably account for embodied carbon emissions Disclosure measures are not applicable yet in most Member States Need to define a benchmark Not all benefits of energy efficiency and energy savings may be achieved	Addressing embodied emissions is essential to achieve the 2050 targets, but a clear policy framework is not yet developed at EU level and in most Member States. Efforts to define how embodied carbon in renovations can be accounted for are still ongoing, which would complicate the integration of such a metric/requirement in the definition	BBC
Maximum kgCO2/m^2/ year (whole-life carbon ceiling)			Whole-life carbon ceilings would effectively bring down operational and embodied emissions over the lifetime of a building	Net-Zero UK

Identification and assessment of relevance of ‘quality’ parameters			
Parameter	**Added value**	**Preconditions**	**Example**
Alignment with long-term climate targets			
Compliance with 2030 climate target	Ensures compliance with policy requirements for long-term climate ambition Ensures the buildings sector contributes to achieving its targets in 2030/2050 Avoids lock-in: ensures that renovation works in case of step-by-step renovations are not shallow and don’t stop at step one	2030 climate target should be aligned with 2050 climate neutrality objective	BBC, Passive House, Net-Zero UK, NOM
Compliance with 2050 climate neutrality and net-zero energy and carbon buildings		Technological feasibility might be difficult for certain building types Need to balance long-term vision with immediate actions Need to balance setting now a clear definition having in mind 2050 and possible needs for adjustments up to 2050	NOM, Net-Zero UK, BBC, IEA
Policy framework			
Link with national LTRS	Establishes a clear path for national authorities of the contribution of deep renovations towards collective goals Links short- and mid-term measures to long-term goals	The ambition level of the LTRS should be rightly set at all milestones dates (2030, 2040, 2050)	NOM, BBC
Link with (progressive) financial support	Stimulates implementation of deep renovation measures Boosts (early) compliance	Might create unfair division of benefits between socio-economically strong households and energy poor households	Efficiency House Standard, Passive House
Link to BRP	Ensures effective staged-deep renovations Enables deep renovation, tailored to every building, and personalised to owners/occupants needs Creates awareness among building owners about renovation potential Allows link with financing	Building Renovation Passports are rolled out to worst-performing buildings first	Passive House

Technical aspects			
Differentiated definition per building type	Allows for differentiation per building type according to characteristics and use (e.g., non-residential, single-family house, multi-family buildings) ensuring deep renovation happens in all building segments, leaving no segment out of deep renovation	More granular approach based on good overview of the building stock	NOM, Passive House, Efficiency House (KfW), BBC
Defined number of (or specific) building elements to be targeted, possibly within certain timeframe	Could foster integration of energy efficiency and renewable measures Might help avoid lock in	Over-specifications on building elements should be avoided to limit risks to hamper market innovation Number of building elements covered should be sufficient to ensure truly holistic renovation.	NOM, Passive House, *Rénovation Performante* (France)
Defined number of renovation steps (some staged renovations can be considered 'deep')	Staged renovations allow for less disturbance Can be tied to natural trigger points in the life of the building Reduces direct upfront costs for owners	For staged renovations to be considered deep, they must be part of a clear renovation plan (Building Renovation Passports) in line with 2030/2050 climate targets to avoid lock-in, clearly establish energy savings to be achieved at the end of the renovation process, outline a maximum number of renovation steps and achieve ambitious minimum savings with the first step	NOM, Passive House, ADEME
Requirement to achieve measured savings (beyond calculated) – focus on delivered performance	Ensures that the envisioned energy performance is achieved	Might need to consider behavioural issues such as rebound effect (which might adversely affect energy poor households) and to include energy management and optimisation systems Requires using qualified installers and workers Need to solve issues linked to energy use data sharing	

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