FUTURE-PROOF BUILDINGS FOR ALL EUROPEANS

A GUIDE TO IMPLEMENT THE ENERGY PERFORMANCE OF BUILDINGS DIRECTIVE (2018/844)

BPIE

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INTRODUCTION

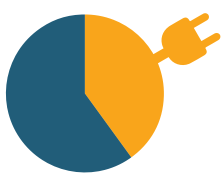
Buildings are responsible for approximately 40% of energy consumption and 36% of CO_2 emissions in the EU [1]. On average we spend 90% of our time indoors and the quality of the indoor environment affects our health and wellbeing [2]. Two-thirds (65%) of the European building stock was built before 1980: about 97% of the EU's buildings must be upgraded to achieve the 2050 decarbonisation goal [3], but only 0.4-1.2% are renovated each year [1]. A highly efficient, technically-equipped and smarter building stock could be the cornerstone of a decarbonised energy system. Buildings have the potential to be at the forefront of providing flexibility to the energy system, through energy production, control, storage and demand response, as well as green charging stations for electric vehicles. This can only happen if a systemic upgrade of the building stock is achieved.

UP TO
90%
OF A PERSON'S LIFE IS SPENT INDOORS

The recent amendments [2018/844] to the Energy Performance of Buildings Directive (EPBD) [2010/31/EU] set a clear direction for the full decarbonisation of the European building stock by 2050. It provides a clear goal for Member States and the tools to achieve it. However, implementation is rarely a straightforward affair that comes without challenges. This document provides guidance and examples of good implementation to support and inspire EU Member States to meet this challenge.

BUILDINGS IN THE EU
ARE RESPONSIBLE FOR APPROXIMATELY

40%
OF ENERGY CONSUMPTION



36%
OF CO_2 EMISSIONS

The amended text was published in the Journal of the European Union on 19 June 2018 and entered into force on 9 July 2018. Every Member State must transpose it into national law by 10 March 2020.

The revision processes introduced changes and updates to several key topics, including the following, which are the focus of this guidance:

1. **LONG-TERM RENOVATION STRATEGIES** (Article 2a)
2. **MOBILISING INVESTMENT IN RENOVATION** (Article 2a, 10)
3. **ENERGY PERFORMANCE CERTIFICATES AND BUILDING RENOVATION PASSPORTS** (Articles 10, 19, 19a, 20)
4. **SMART READINESS INDICATOR** (Article 8, Annex IA)
5. **CALCULATING ENERGY PERFORMANCE** (Annex I)

Other topics not covered by this guidance include changes relating to a charging infrastructure for e-mobility and technical building systems.

Some articles remain the same as in the 2010 Directive [2010/31/EU] and guidance on these topics has already been provided extensively in the past:

Nearly zero-energy buildings (nZEBs):

Implementation of nZEBs as the current building standard for new public buildings and from 2020 for all new buildings represents one of the biggest opportunities to maximise energy savings and minimise greenhouse gas emissions for new buildings. It could also help to accelerate the deployment of nZEB-ready technologies in renovation of existing buildings.

Supporting guidance:

- o European Commission – Guidelines for the promotion of nearly zero-energy buildings and best practices [4]
- o Buildings Performance Institute Europe (BPIE) – Factsheet: nZEB definitions in the EU Member States [5]
- o Buildings Performance Institute Europe (BPIE) – Principles for nearly zero-energy buildings [6]

Minimum energy performance standards based on a cost-optimal methodology:

This required, for the first time, that energy performance requirements should consider the global lifetime costs of buildings. This means not only looking at the investment costs but also taking account of the operational, maintenance, disposal and energy costs of buildings and building elements.

Supporting guidance:

- o Buildings Performance Institute Europe (BPIE) – Implementing the Cost-Optimal Methodology in EU countries: lessons-learnt from three case studies [7]
- o European Commission – Guidelines on establishing a comparative methodology framework for calculating cost-optimal levels of minimum energy performance requirements for buildings and building elements [8]

1

LONG-TERM RENOVATION STRATEGIES
(ARTICLE 2A)

The requirement to produce national renovation strategies was first introduced in 2012 in the EU Energy Efficiency Directive [EED] [2012/27/EU]. The requirement now moves from the EED to the EPBD in order to ensure greater alignment with other aspects of energy performance of buildings. It strengthens the requirement and seeks to make these strategies a tool to support the transition to a highly energy efficient and decarbonised building stock by 2050, facilitating the cost-effective transformation of existing buildings into nearly zero-energy buildings.

MAIN REQUIREMENTS

Each Member State must prepare a new comprehensive long-term renovation strategy (LTRS) that includes:

- **Milestones (indicative) for 2030, 2040 and 2050**
- **Explanation of the contribution to the overall EU energy efficiency target for 2030**
- **Overview of the national building stock**
- **Expected share of renovated buildings in 2020**
- **Approaches to renovation relevant to the building type and climatic zone, including potentially-relevant trigger points**
- **Policies and actions to stimulate cost-effective deep renovation of buildings, including staged-deep renovation, for example by introducing an optional scheme for building renovation passports**
- **Policies and actions to target the worst-performing segments of the national building stock, split-incentive dilemmas and market failures**
- **Actions that contribute to the alleviation of energy poverty**
- **Policies and actions to target all public buildings**
- **Initiatives to promote smart technologies and well-connected buildings and communities**
- **Initiatives to promote skills and education in the construction and energy efficiency sectors**
- **An estimate of expected energy savings and wider benefits, such as those related to health, safety and air quality**

Member States must also carry out a public consultation on the strategy, include a summary of the results of the consultation as an annex to the strategy, and continue inclusive consultation during implementation.

By 10 March 2020, Member States must provide their new renovation strategy to the European Commission. This should also include details on progress with implementation of the current strategy, which should have been provided to the European Commission in 2017. Member States will need to update their strategy by June 2024 as part of their integrated national energy and climate plan (NECP) (under the Governance Regulation) [9], and supply a further new and updated version by January 2029 as part of the second NECP.

Figure 1 – Timeline of requirements for new renovation strategies

The text of Article 2a as introduced by the amended text is below.

EPBD [2018/844] - Article 2a

Long-term renovation strategy

1. Each Member State shall establish a long-term renovation strategy to support the renovation of the national stock of residential and non-residential buildings, both public and private, into a highly energy efficient and decarbonised building stock by 2050, facilitating the cost-effective transformation of existing buildings into nearly zero-energy buildings. Each long-term renovation strategy shall be submitted in accordance with the applicable planning and reporting obligations and shall encompass:

(a) an overview of the national building stock, based, as appropriate, on statistical sampling and expected share of renovated buildings in 2020;

(b) the identification of cost-effective approaches to renovation relevant to the building type and climatic zone, considering potential relevant trigger points, where applicable, in the life-cycle of the building;

(c) policies and actions to stimulate cost-effective deep renovation of buildings, including staged deep renovation, and to support targeted cost-effective measures and renovation for example by introducing an optional scheme for building renovation passports;

(d) an overview of policies and actions to target the worst performing segments of the national building stock, split-incentive dilemmas and market failures, and an outline of relevant national actions that contribute to the alleviation of energy poverty;

(e) policies and actions to target all public buildings;

(f) an overview of national initiatives to promote smart technologies and well-connected buildings and communities, as well as skills and education in the construction and energy efficiency sectors; and

(g) an evidence-based estimate of expected energy savings and wider benefits, such as those related to health, safety and air quality.

2. In its long-term renovation strategy, each Member State shall set out a roadmap with measures and domestically established measurable progress indicators, with a view to the long-term 2050 goal of reducing greenhouse gas emissions in the Union by 80-95 % compared to 1990, in order to ensure a highly energy efficient and decarbonised national building stock and in order to facilitate the cost-effective transformation of existing buildings into nearly zero-energy buildings. The roadmap shall include indicative milestones for 2030, 2040 and 2050, and specify how they contribute to achieving the Union's energy efficiency targets in accordance with Directive 2012/27/EU.

5. To support the development of its long-term renovation strategy, each Member State shall carry out a public consultation on its long-term renovation strategy prior to submitting it to the Commission. Each Member State shall annex a summary of the results of its public consultation to its long-term renovation strategy.

Each Member State shall establish the modalities for consultation in an inclusive way during the implementation of its long-term renovation strategy.

6. Each Member State shall annex the details of the implementation of its most recent long-term renovation strategy to its long-term renovation strategy, including on the planned policies and actions.

7. Each Member State may use its long-term renovation strategy to address fire safety and risks related to intense seismic activity affecting energy efficiency renovations and the lifetime of buildings.'.

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GUIDANCE FOR IMPLEMENTATION

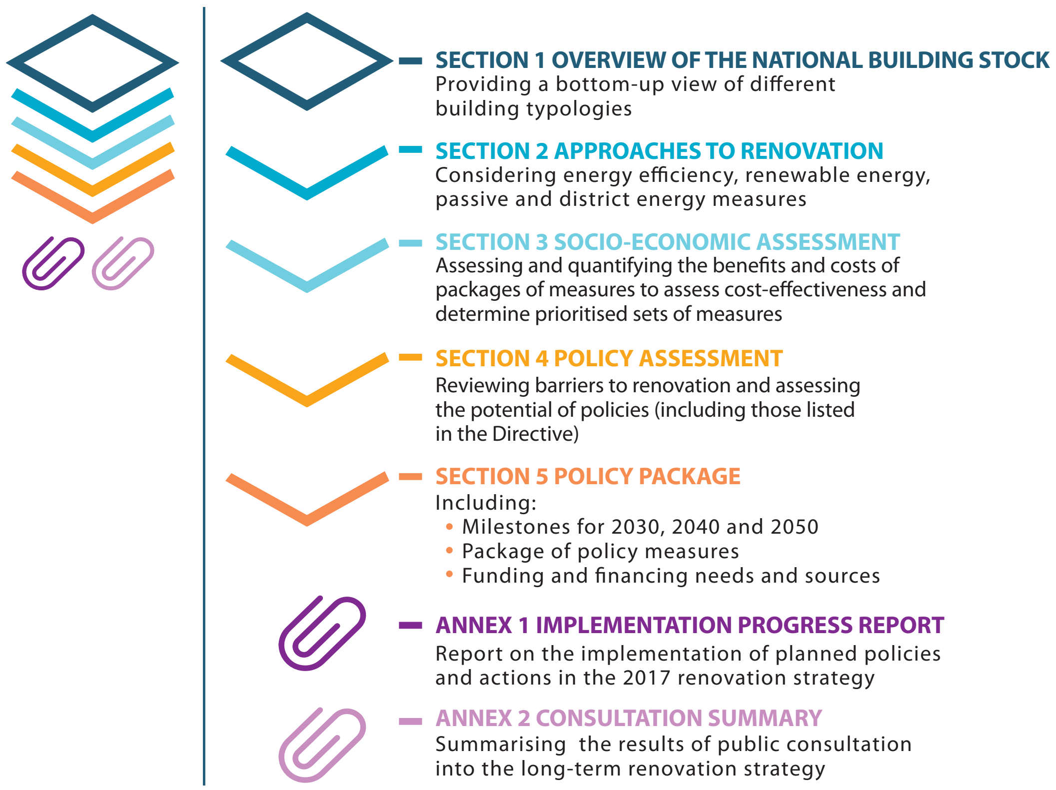
All Member States have developed national renovation strategies, with a first version in 2014 and a second version or update in 2017.

A number of reviews of the 2014 and 2017 strategies, by the European Commission's Joint Research Centre [10] and by BPIE [11]–[13], have revealed differing quality across Member States, with many not meeting the basic requirements as set out in the EED. The latest JRC report on the second long-term renovation strategies under the Energy Efficiency Directive, highlights a general improvement with respect to the first national renovation strategies, with only three strategy updates considered non-compliant [14]. While there is an overall improvement in terms of compliance, the updated strategies differ in quality and content: some Member States provided the 2014 strategy, with minor changes, some updated only some sections (at times without a link to the previous strategy) and others submitted a fully revised document. Most strategies are still not submitted as a single document including all the relevant requirements and measures, making it difficult to have a full overview. While individual sections of strategies by different Member States can be considered good practice, no single existing renovation strategy can be held up as exemplary in both content and ambition. Analysis by BPIE found that all national strategies could be improved. This guidance, which builds on previous guidance published by BPIE [15], describes the steps that should be taken and content that should be included to meet the new requirements to produce a thorough and successful strategy.

The list of elements to include in the renovation strategy, as set out in the Directive, provides a basic content outline. This has been structured to follow the phases of development and implementation (Figure 2).

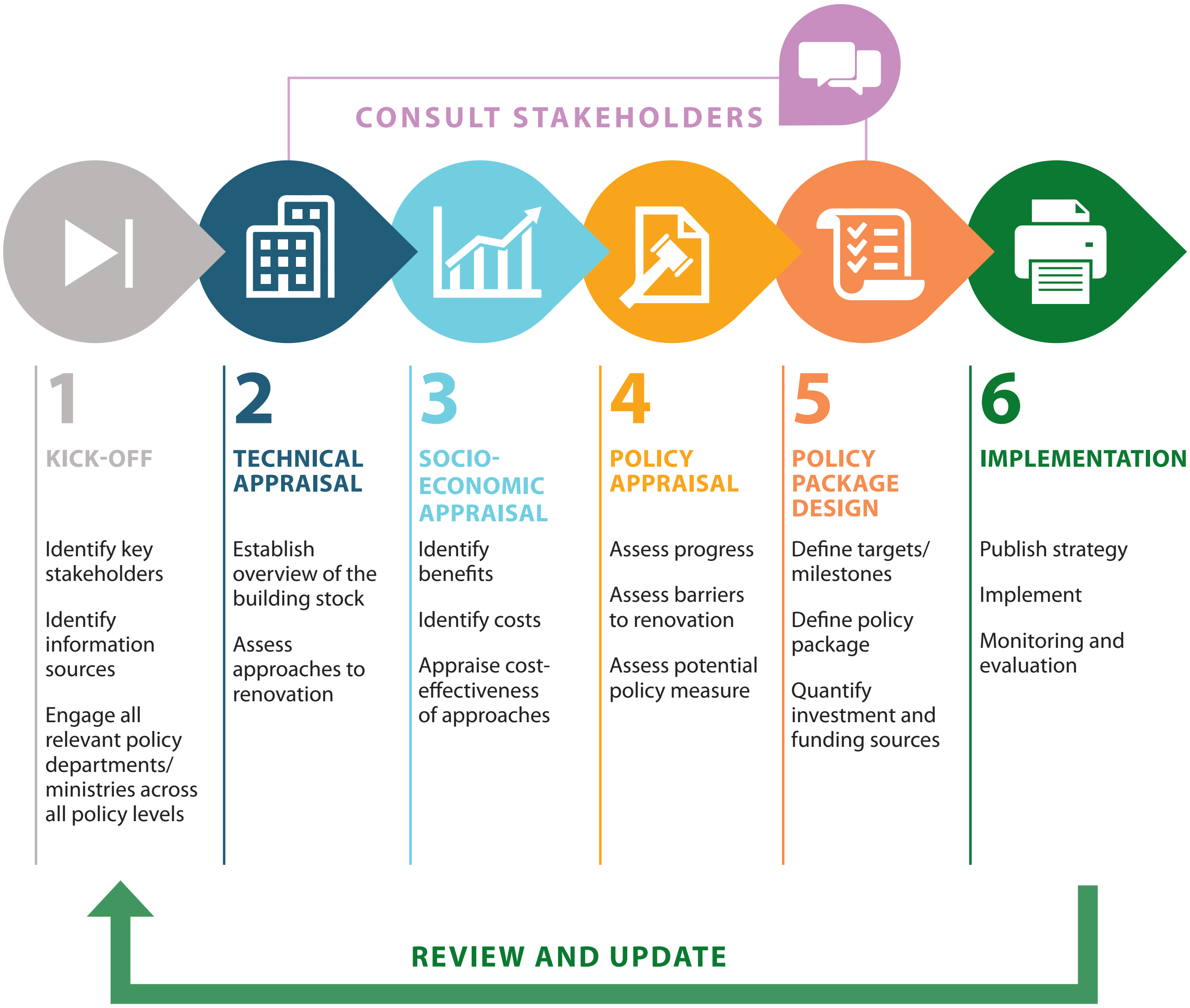
Table 8 at the end of this chapter provides a full structure which can be used as a template for a national long-term renovation strategy.

Figure 2 – Structure of a renovation strategy (Source: BPIE)



To develop and deliver a renovation strategy, Member States should complete all the sections and follow a series of key steps, divided into six phases (kick-off, technical appraisal, socio-economic appraisal, policy appraisal, policy package design and implementation). The steps also include a stakeholder consultation throughout the process and a feedback loop to review and regularly update the strategy (Figure 3).

Figure 3 – Phases in developing a renovation strategy (Source: BPIE)



National challenges and differences may mean that when developing the strategy some steps are undertaken in a different order. In the section below we describe the various phases; the sequence is a suggestion to ensure all elements are covered systematically and thoroughly.

PHASE 1 - KICK-OFF

Planning and preparation are vital to the creation of a good strategy. Identifying stakeholders and sources of information is an important first step.

A strategy development team should gather together key representatives from government ministries across all the relevant policy departments, including those responsible for energy, the building/housing sector, industry, economy, finance and health, and nominate a clear lead. The development team should build consensus around the strategy, ensuring societal support and the meaningful involvement of all political parties within the country. As a long-term renovation strategy must survive elections and changes in government, it is essential that the strategy enjoys full support across the political spectrum.

It is also important to engage across all vertical policy levels, meaning not only national level, but also regional, provincial, municipal, city and local levels, since detailed action plans will need to be designed and implemented at sub-national levels to deliver the national strategy. Successful policies and implementation experience at regional and local levels can also inspire national level policies.

Identifying stakeholders early ensures involvement and input from external stakeholders such as housing/building experts, the finance community, representative industry bodies, civil society as well as tenant and owner associations. This phase is also important given the new requirement to consult on the strategy prior to publication. This stage should identify which stakeholders to engage and how best to engage them and take the first step in engagement.[1] The following sub-chapter explains more on stakeholder engagement and consultation.

In addition, data and information gathering at this stage will underpin the subsequent phases. This means identifying sources of information on the building stock and reviewing available literature and studies on barriers to renovation and the effectiveness of existing or previous renovation initiatives. Gathering this information is also important in developing measures to target the worst-performing segments of the national building stock, which is a new requirement of the EPBD.

CONSULTING STAKEHOLDERS (PHASES 2-5)

Consulting with stakeholders is an ongoing activity throughout the process, with at least one wide and inclusive public consultation on the strategy. Consultation throughout the process of development and implementation will ensure that stakeholders are actively involved and will encourage cooperation in delivering a successful and effective strategy. It is also an opportunity to gather data and information from outside the government to strengthen the strategy. This should include establishing a wide stakeholder group as a forum for consultation, policy formulation and feedback on practical issues and barriers to renovation.

Sufficient time should be dedicated to the consultation process to ensure that stakeholders have time to engage and that their views are taken into account in the strategy development process.

The public consultation needs to be conducted prior to submitting the strategy to the European Commission. The results of this consultation should be summarised in an annex to the strategy itself. It is important to ensure that consultation is not a one-off event during the development phase of the strategy. The Directive specifically states there should be an inclusive consultation process during the implementation.

ANNEX 2 CONSULTATION SUMMARY

Summary of the results of the public consultation into the long-term renovation strategy, including:

- Summary of responses to consultation
- List of stakeholder groups consulted
- Explanation of the consultation process, including how inclusive the consultation has been ensured across all stages

[1] The Build Upon Horizon 2020 project (buildupon.eu) encouraged structured collaboration between renovation stakeholders and national renovation strategies.

1

Stakeholder consultation and involvement (Denmark)

DK

In Denmark, in preparation for the national renovation strategy in 2014 a broad range of stakeholders, including construction, finance, energy and manufacturing sectors, was included in the consultation process and encouraged to engage in drafting initiatives. In total, about 200 participants were involved.

Six working groups were created to support the formulation of initiatives for the renovation strategy (covering single-family houses, flats, public buildings, businesses, financing and economic security, and innovation and green business). These cross-cutting themes were chosen by the participants themselves during the kick-off meeting. An inter-ministerial task force was created to coordinate efforts and discuss cross-cutting initiatives and issues. Participants agreed to take part in the process without any financial compensation, which shows the value and benefits of the experience for them in terms of gaining knowledge and influencing the final strategy. Outcomes of the working group meetings were compiled in a catalogue of initial proposals. This formed the basis for developing the renovation strategy [16].

PHASE 2 - TECHNICAL APPRAISAL

Phase 2 involves the appraisal of the potential for improving the energy performance of buildings. It covers analysing the national building stock to establish a detailed overview, and analysing approaches to renovating the building stock in terms of potential energy efficiency and renewable energy measures.

The starting point is having a full understanding of the building stock through a bottom-up view of the different building typologies, construction styles, ages, climatic zones, occupancy and ownership patterns. This fulfils the first section of the strategy. It provides the information needed to identify the worst-performing buildings and their characteristics and prioritise their renovation. From the overview it is possible to consider and assess approaches to deploy different combinations of energy efficiency and renewable energy measures for each building category. A wide range of energy efficiency measures, such as insulation of the building envelope, and renewable energy measures such as solar hot water should be explored.

Table 1 lists the contents for this section.

Table 1 – Contents for section 1

SECTION 1 OVERVIEW OF THE NATIONAL BUILDING STOCK

Identify main building categories:

- Single-family houses
- Blocks of flats/apartments and other multi-residential dwellings
- Offices
- Educational buildings
- Hospitals/health establishments
- Hotels and restaurants
- Sports facilities
- Warehouses and retail premises
- Other types of energy-consuming buildings

Identify age bands which have a material bearing on building energy performance:

- Traditional construction types, including historic buildings (typically pre-1900)
- Buildings constructed prior to regulations on energy performance (e.g. 1901-1960)
- Early phase building regulations
- Mid-phase building regulations
- Latest building regulations

Quantify the number, type, size (floor area) of each combination of building type and age band

Identify the split by owner – public, private or mixed
Identify the split by tenure – owner occupied, rented, mixed
Identify the split by location – urban, suburban, rural

Identify the energy use and performance characteristics of each building combination:

1. Construction type and U-value of main building elements:
    - Floor
    - Walls
    - Windows and external doors
    - Roof
2. Air infiltration rate
3. Energy systems (and typical replacement lifecycles):
    - HVAC system type/performance level/controls
    - Hot water provision
    - Lighting system/controls
4. Maintenance (e.g. mandatory safety checks/servicing)
5. Energy use for:
    - Heating
    - Cooling
    - Ventilation
    - Hot water
    - Lighting
    - Appliances
6. Energy carriers:
    - Gas (natural gas or LPG)
    - Liquid fuels (oil, etc.)
    - Solid fuels (coal, etc.)
    - Renewable energies:
        - o Solar energy for hot water generation
        - o Solar PV
        - o Wind
        - o Heat pump (type and coefficient of performance)
        - o Biomass (wood chips, wood pellets)
        - o Other (specify)
7. District heating (identify energy carriers)

The inventory of public buildings that supports meeting the requirement to renovate 3% of central government buildings (Article 5 of the EED) could provide some of this data. In addition the reference buildings developed by Member States for calculating cost optimality (Articles 4 and 5 of the EPBD) may serve as a guide for the number and type of building categories. It may also be necessary and useful to consult with additional stakeholders, such as industry stakeholders, who may have access to other data that could be used in the overview.

From this overview it is possible to consider and assess approaches to deploy different combinations of energy efficiency and renewable energy measures for each building category.

Where district energy systems are in place or considered, aligning approaches to renovating the building stock and expanding district energy systems is important. There are many benefits and strong economic arguments for owners and occupants of buildings, district energy utilities and public authorities in such alignment. This approach can more effectively match the supply to the needs and thus avoid unnecessary investments and lock-in effects. It may also make it more cost-effective to pursue sustainable energy supply options, such as district energy using renewable energy or excess heat, for the remaining energy demand [17].

Table 2 – Contents for section 2

SECTION 2 APPROACHES TO RENOVATION
Identify opportunities for retrofit of energy efficiency measures for each building category: • Fabric measures – building envelope • Exterior windows and doors • Technical facilities – heating/ventilation/cooling/hot water • Air tightness / infiltration • Lighting • Appliances
Identify opportunities for retrofit of renewable energy measures: • Passive solar energy • Solar energy for hot water generation • Solar PV for electricity • Wind energy • Heat pumps • Biomass • Biogas • Geothermal hot water
Identify opportunities for retrofit of passive measures: • Shading • Natural ventilation • Natural cooling
Identify opportunities to align renovation and connecting/expanding/updating a district energy system
Identify packages of measures that can achieve at least 60% energy saving (deep renovation)

PHASE 3 - SOCIO-ECONOMIC APPRAISAL

Appraising the cost-effectiveness of measures is key to identifying a prioritised set of renovation measures. This means quantifying the costs and benefits of the measures beyond an economic angle, considering also the societal impacts. Policies can then be designed to drive forward these measures.

One of the key challenges when undertaking the socio-economic appraisal is access to good quality data on the costs and savings of renovation activities, and also forecasting these over the coming decades. Available information on the costs of deep renovation may be limited to demonstration or pilot projects, which may not be representative of the costs in a larger-scale rollout. Inevitably, certain assumptions will need to be made based on incomplete data. In order to improve the knowledge base for future revisions and updates to the strategy, it is recommended that Member States introduce or enhance data-gathering processes to enable a more accurate picture of the true costs and benefits of building renovation.

In any economic appraisal, the discount rate, or rate of return applied, is a very significant consideration [18]. Here, it is important to recognise the disparity between discount rates used by building owners and other potential investors which are typically far higher than societal discount rates. The challenge is to design a support regime that increases building owners' underlying propensity to invest in renovation. While financial support programmes can bridge some of the gap, regulatory measures will inevitably need to be developed and used extensively to drive renovation. These might include, for example, requiring energy renovation of the least efficient buildings or at change of ownership.

The monetary value of the wider benefits that arise in addition to the energy cost savings is often overlooked. The cost of a public subsidy provided to stimulate deep renovation may be more than offset by the benefits that result from it. Energy efficiency improvements can ease pressure on public finances (i.e. budgets of public authorities), by generating increased tax revenues through increased economic activity and by reducing expenditure on energy and unemployment benefits. Improvements in energy efficiency can also lead to improved indoor air quality and thermal comfort, which have knock-on productivity benefits [19]. These result from fewer days of work missed, shorter hospital stays and improved educational performance. There is a clear correlation between the quality of a building (office, school, factory etc.) and the number of sick days (absenteeism) reported. Studies report that a better building can result in 0.4-1.5 fewer sick days per employee per year [20] while another study concluded that every €1 invested in insulation results in €0.78 benefit in reduced sick days [21]. A better building can also improve performance by 11-16% in offices and 13-20% in schools due to better air quality, thermal comfort, light (electric and natural), acoustics and control [22]. Promoting the environmental benefits of energy efficiency improvements, in terms of reduced carbon emissions and energy use, can also enhance public relations with an improved organisational reputation [23]. There have been many studies looking at the multiple benefits of renovation and wider energy efficiency improvements, which can provide additional inspiration for this section.

The phase should culminate in determining a prioritised package of renovation measures for each building category based on their cost-effectiveness.

Table 3 – Content of section 3

SECTION 3 SOCIO-ECONOMIC APPRAISAL
Identify and quantify the benefits arising from different packages of measures for deep energy renovation, including: • Economic benefits: energy cost savings; increase in GDP; impact on economic activity, increase in property values; impact on public finances; reduction of energy import bill • Societal benefits: reduction in fuel poverty; health benefits; increased comfort/productivity • Environmental benefits: reduced greenhouse gas emissions; air quality improvements • Energy system benefits: increased energy security; avoided new generation capacity; reduced peak loads
Identify and quantify the costs: • Total cost of installing renovation measures, minus any avoided cost due to end-of-life replacement or by undertaking renovation alongside other building maintenance, new construction or modernisation measures • Transaction costs, including costs of temporary relocation of occupants
Determine prioritised renovation packages for each building category (based on the cost and benefit appraisal)

1

PHASE 4 - POLICY APPRAISAL

The purpose of the policy appraisal, is, firstly, to review the progress of implementation of the current renovation strategy and wider policy landscape related to building renovation. Secondly, it should identify the changes to existing policies and additional policies that will be necessary to unleash the building renovation market.

According to the amended text, the policy appraisal should be an annex of the long-term renovation strategy. This appraisal should evaluate progress towards national targets, contribution to EU energy efficiency targets for 2020 and 2030, and outcomes of existing policies in terms of energy savings delivered and impact on the renovation rate and depth. This is also an opportunity to review successes at regional and local levels which may provide inspiration for policy development at national level. Therefore, it is important to engage policymakers at the relevant regional, municipal and local levels at this stage to gather their input and experience.

Table 4 – Content of Annex 1

ANNEX 1 IMPLEMENTATION PROGRESS REPORT
Review of implementation progress of previous (2017) renovation strategy, including: • Progress towards national targets • Contribution to EU energy efficiency target for 2020 and 2030 • Outcomes of existing policies in terms of energy savings delivered and impact on the renovation rate and depth

Reviewing progress should also include analysing to what extent existing policies have addressed the barriers to renovation and where they are still present. Barriers include:

- Legislative and regulatory barriers: such as those due to the existing legal framework, including overlaps between laws and complex administrative processes, or lack of legislation.
- Fiscal and financial barriers: these include lack of funds, high transaction costs, subsidised low energy prices that affect investments decisions.
- Communication barriers: these include insufficient communication about the advantages of deep renovation and the resulting lack of awareness, particularly in the general public.
- Capacity barriers: such as insufficient technical capacity and/or knowledge to develop and implement measures and policies.
- Technical barriers: these include lack of knowledge on the existing building stock and lack of knowledge/skills regarding technical solutions and measures.
- Research and development (R&D) barriers: such as insufficient research or pilot projects, which results in lack of knowledge, data or experience.

The next step is to assess the potential of policies to overcome these barriers. BPIE has developed a checklist of possible actions which, together, provide a solid policy framework on which to base the renovation strategy (Figure 4).

Figure 4 – Checklist of potential policies (Source: BPIE)

LEGISLATIVE & REGULATORY	Identify trigger points and develop respective regulation that could be used to encourage, or require, building energy performance improvement
	Design Energy Efficiency Obligations (see Article 7a EED) that encourage the delivery of deep renovation
	Facilitate the upgrade of all social housing to high energy performance levels
	Address restrictive practices concerning local deployment of low/zero carbon technologies to ensure that a positive environment for building-integrated renewables is established
	Remove or implement measures to overcome restrictive tenancy laws which disincentivise or otherwise inhibit energy performance improvement
	Mandate improvement of least-efficient stock to higher energy performance level, e.g. through restrictions on sale or rental of buildings in lowest energy performance categories
TECHNICAL	Develop renovation standards that are progressively and regularly strengthened in response to experience and new technological solutions
	Analyse potential for district heating systems to provide efficient, low carbon energy, aligned with planning for building renovation
	Ensure proper monitoring and enforcement of compliance with building codes
	Develop packaged solutions that can be readily replicated in similar building types
	Introduce quality standards/certification systems for installers and products (including packaged solutions)
FISCAL/FINANCIAL	Develop funding vehicles, tailored to specific market segments, that provide a simple ("one-stop-shop") and commercially attractive source of finance for deep renovation
	Develop mechanisms to encourage deep renovation via third party financing e.g. ESCOs, EPCs
	Strengthen energy/carbon pricing mechanisms to provide the right economic signals
	Remove fossil fuel subsidies to eliminate perverse incentives that discourage investment
	Consider "bonus-malus" mechanisms, e.g. property taxation systems (which reward high energy performing buildings while penalising poorly performing ones) and energy pricing
COMMUNICATION AND CAPACITY BUILDING	Establish publicly accessible databases demonstrating energy performance of renovated buildings and information on how to undertake deep renovation
	Gear up skills and training programmes covering the key professions and disciplines
	Establish knowledge and experience-sharing networks across regions/Member States
	Encourage development of local supply chain industry for maximising macro-economic benefits and to minimise embedded CO_2 emissions
	Develop promotional and dissemination activities that sensitise building owners to opportunities for deep renovation and that provide stepwise support throughout the renovation process
	Communicate regularly and publicly on progress with the renovation strategy
R&D	Support research, development and demonstration projects into new and improved technologies and techniques to deliver deep renovation, including how to scale up best practice to multiple buildings

Some policies may not be applicable in all Member States and all will need tailoring to the specific national and market circumstances. It is unlikely that they could be introduced within a single policy cycle. Nevertheless, the list illustrates the wide range of actions that should be considered. Consultation with stakeholders could also identify additional possible actions.

The amended EPBD [2018/844] now requires specific measures to be considered related to:

- Targeting public buildings
- Alleviating energy poverty
- Identifying trigger points in the lifetime of a building which could be an opportunity for renovation
- Building renovation passports

The following sections provide guidance on these specific elements since they are newly-required considerations. A wider discussion on building renovation passports can be found in chapter 3.

Once all the policy options have been considered, section 4 of the strategy is completed (Table 5).

Table 5 – Content of section 4

SECTION 4 - POLICY ASSESSMENT
Identify barriers to deep renovation • Legislative and regulatory barriers • Fiscal and financial barriers, including split-incentive dilemmas and market failures • Communication and capacity barriers • Technical barriers • Research and development (R&D) barriers
Identify policies/measures to overcome identified barriers
Assess potential role of the following measures/policies/approaches: • Measures to target all public buildings • Targeting the worst-performing segments of the national building stock • Policies to alleviate energy poverty • Measures exploiting trigger points for energy renovation in the life-cycle of buildings • Policies and actions to stimulate cost-effective deep renovation of buildings, including staged deep renovation • Introducing building renovation passports • National initiatives to promote smart technologies and well-connected buildings and communities • National initiatives to promote skills and education in the construction and energy efficiency sectors

Policies and actions to target all public buildings

Renovating public buildings can help to build expertise and drive the renovation market. By focusing initially on the public sector, Member States will facilitate the build-up of the necessary skills, expertise and workforce that will be required to renovate the larger privately-owned stock.

National governments are already required to put in place measures to renovate 3% of buildings owned and occupied by central government annually or deliver equivalent savings (under Article 5 of the EED). Some Member States have also developed inventories of buildings owned and occupied by the central government as part of the requirement of Article 5. Table 6 shows some of the measures focusing on central government buildings that have been considered across Europe.[2] These could also be relevant for all public buildings.

In addition, data and information on public buildings should be readily available since Energy Performance Certificates (EPCs) are required for buildings (over 250m^2) occupied by public authorities and visited by the public.[3] This can be used to help to develop policies and actions targeting these buildings.

[2] This list of measures comes from the reports Member States submitted to the European Commission in 2015 on how they would achieve Article 5 of the EED (requiring either 3% renovation of central government buildings every year or to take measures to achieve the equivalent savings). Detail on how or if these measures have been implemented is currently not available.

[3] As required by Article 12 of the EU Energy Performance of Buildings Directive [2010/31/EU]

Energy performance contracting

The energy performance contracting model is a popular method to renovate public buildings. It addresses two of the main obstacles to energy efficiency investments for public authorities. First, it overcomes the financial barriers of accessing funds for longer-term investments by outsourcing some of the responsibility to an energy service company (ESCO). Secondly, it minimises the financial risk for the public authority as the ESCO takes on most of the risk (the risk sharing depends on the cost of the project, the length of the contract and the risks taken by the ESCO and the consumer).

Figure 5 – Business model of an energy service company (Source: BPIE)

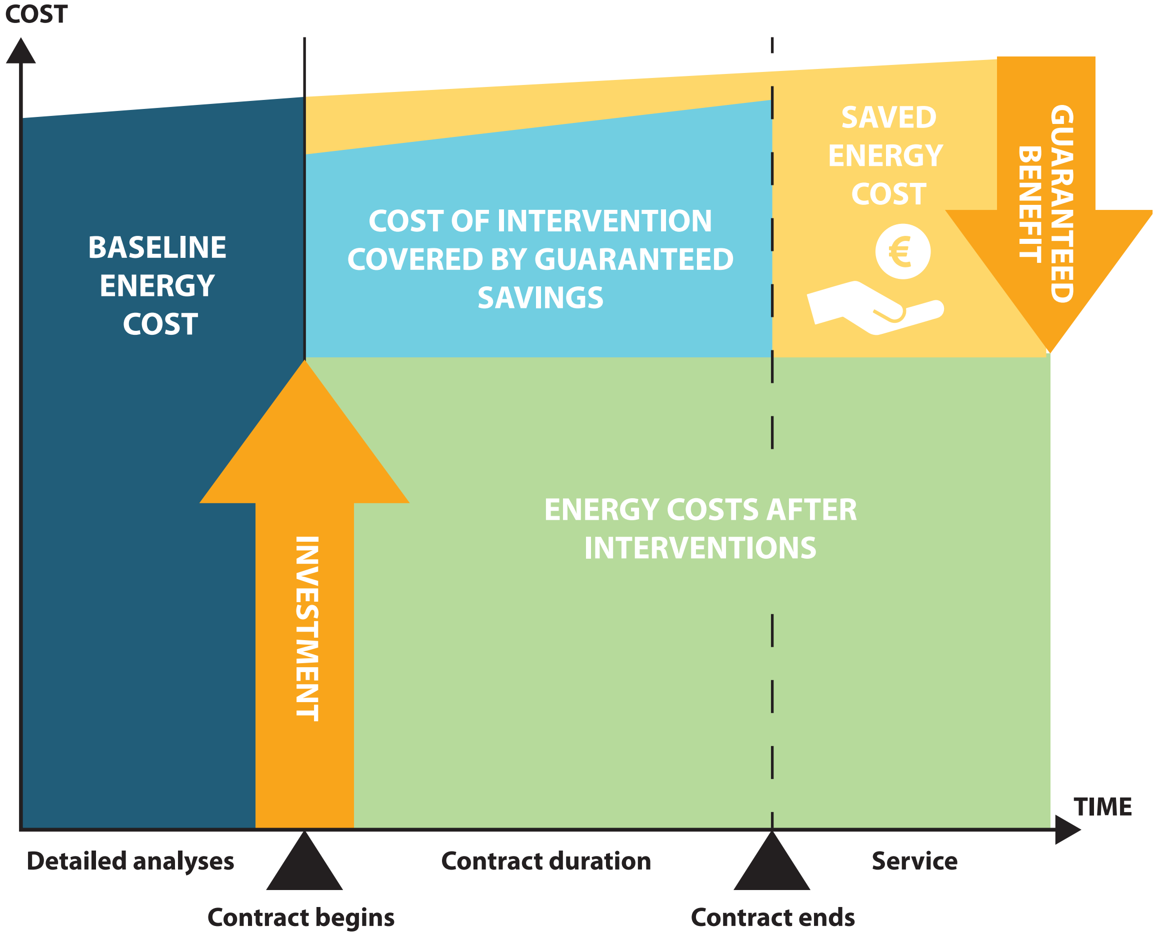


Table 6 – Examples of measures taken/planned targeting central government buildings (Source: BPIE)

TYPE OF MEASURE	EXAMPLES FROM EU COUNTRIES
Financing	• Energy performance contracting and ESCOs (Austria, Portugal, Croatia)
Renewable energy	• PV installations for own consumption (Malta, Poland)
Energy management	• Appointing energy officers in each building (Ireland, Portugal) • Operations optimisation (Denmark, Austria) • Metering for energy and water (Croatia) • Smart meter installation (Malta) • Control of air conditioning (Malta)
Inspections	• Inspections of downtime electricity use (Finland)
Property management	• Penalties and bonuses for energy efficiency in contracts with property management companies (Finland)
Public procurement / Sustainability procurement	• Switching to energy saving devices (Denmark) • Rental contracts being renewed become Green Lease contracts (Finland)
Behaviour change	• Raising awareness of building users (France, Denmark) • Large-scale behavioural change campaign (Ireland) • Behaviour change programme for employees (Netherlands)

EmBuild project: how to support public authorities to establish a long-term strategy for the renovation of public buildings

The EU Horizon 2020-funded EmBuild project supported public authorities at regional and municipal levels to develop and implement renovation strategies focused on public buildings. This included support with collecting data, identifying approaches and facilitating investment. The EmBuild Navigator provides guidance on navigating through the steps of preparing a renovation strategy [24].

Trigger points policy

Trigger points are key moments in the life of a building (e.g. rental, sale, change of use, extension, repair or maintenance work) when carrying out energy renovations would be less disruptive and more economically advantageous than at other moments [25]. Taking advantage of these occasions would facilitate investment decisions to undertake energy renovation works. They can be prompted by practical opportunities (e.g. need for repairs or maintenance, or building an extension), personal circumstances (e.g. a new-born in the family, retiring or children moving out), or change of ownership (e.g. new tenants, new owners, putting a property on sale). The demand for these works is usually not energy-led, but they offer the opportunity to include energy improvements with reduced additional cost and disruptions while avoiding the lock-in effect, and delivering additional benefits such as improved indoor air quality, with a positive impact for comfort, health and productivity.

Trigger point policies need to be carefully designed and applied to protect specific building types (such as public or historic buildings) or occupants (e.g. low-income households), as well as to ensure the appropriate financial support is provided. It is important to address concerns about gentrification and rent increases (e.g. the fear that introducing requirements for renovation may lead to unwarranted rent increase) and combine the interests of tenants with those of investors who wish for a short pay-back.

To guarantee the expected results, policies identifying trigger points should be tailored to the building type (e.g. single-family buildings vs. multi-family buildings, schools and kindergartens vs. office buildings, etc.), accompanied by additional targeted measures promoting deep renovation (such as building renovation passports and minimum energy performance requirements for specific building types, like commercial and public buildings), and properly integrated into medium- and long-term planning.

The following provides some details on trigger points being exploited in several countries across Europe.

BE

Conditions for renting out or selling a building unit with poor energy performance (Flanders region, Belgium)

In Flanders (Belgium), a new standard was introduced in January 2015, setting minimum requirements for roof insulation in residential buildings (single-family houses and multi-family apartments) when the building is to be rented out. If a residential building does not meet the minimum requirements, it receives penalty points. From 2020 if a building or apartment receives more than 15 penalty points, it will be ineligible for renting.

IT

Mandatory requirements in case of building extensions (Italy)

In the autonomous province of Bolzano, from 2019, owners of buildings will be allowed to expand the surface of their dwelling by up to 20%, or up to 200m², only if the refurbished building achieves an energy need for heating below 70kWh/m²/year.

PL

Improvement of energy performance in case of other works (Poland)

In Poland, in case of building renovation, the reconstructed elements must meet the existing levels of thermal insulation for new buildings. For example, if an external wall is rebuilt it must be insulated respecting current U-value requirements.

DK

Requirements in case of change of building use (Denmark)

In Denmark, minimum energy requirements are established for building components where a change of building use would result in significantly higher energy consumption (e.g. conversion of an outbuilding to accommodation, or conversion of usable roof space to accommodation).

FR

Mandatory renovation within a specific timeframe (France)

In France, the energy transition law[4] for green growth foresees a renovation obligation for private residential buildings whose primary energy consumption exceeds 330 kWh/m². This affects all buildings with an energy performance rating in either of the two lowest bands, F or G. These buildings, both rented and owner-occupied, must be renovated as follows:

- By 2025, all class F and G buildings must be renovated. Improvements should be close to the performance of a new building.
- By 2050, all buildings must be in class A or B (based on the French EPC), reaching BBC[5] levels or equivalent.

[4] Loi n° 2015-992 du 17 août 2015 relative à la transition énergétique pour la croissance verte.

[5] BBC =bâtiment à basse consummation, or low energy building

1

Measures to tackle energy poverty

National programmes renovating low income and energy-poor homes can be highly cost-effective considering the wider health, societal and economic benefits of renovation [26] [27]. Shifting public budgets from energy subsidies for the energy poor to energy renovation programmes will mobilise investment in renovation, which is a key aim of the national renovation strategies. Member States can use EU funds, such as Structural and Cohesion funds that aim to improve the welfare of EU countries, as sources of funding for programmes to renovate the homes of the energy poor.

The EU Energy Poverty Observatory, supported by the European Commission, aims to help Member States to combat energy poverty. It exists to improve the measuring, monitoring and sharing of knowledge and experience of policies and programmes tackling energy poverty.

LT

Grants for low-income families (Lithuania)

In 2009, the Lithuanian government and the European Investment Bank (EIB) established the Lithuanian JESSICA Holding Fund for multi-family building renovation, with an initial investment of €227 million – €127 million from the European Regional Development Fund and €100 million in national funding. The Fund offers long-term loans with a fixed interest rate (3%) for the improvement of energy efficiency in multi-family buildings, and for low-income families the loan can be converted into a grant. Up to 2015, renovation of some 1,055 buildings had been financed under the JESSICA Holding Fund, totalling around 29,500 apartments. Since May 2015, through JESSICA II, 3,300 apartments in 133 buildings have been renovated, with another 9,300 apartments already undergoing renovation.

IE

Energy poor targeted advice and fund (Ireland)

The Irish Warmer Homes Scheme targets vulnerable and energy-poor homes providing advice and funds for energy efficiency measures. From 2000 to 2013 over €82 million was distributed through the scheme and more than 95,000 homes were supported. The energy efficiency interventions include measures such as attic insulation, draught proofing, efficient lighting and cavity wall insulation. In 2010, the implemented measures saved 25 GWh and many beneficiaries were lifted out of energy poverty. The number of beneficiaries who found it difficult or impossible to pay utility bills on time decreased from 48% to 28%. The number of families with children that could keep a comfortable temperature at home increased considerably from only 27% to 71%. The number of beneficiaries who suffered from long-term illness or disorders decreased by a massive 88%. Recipients showed significant improvements in other health problems including heart attacks, high blood pressure/hypertension, circulatory problems, problems with joints/arthritis, headaches, and physical and mental disability.

PHASE 5 - POLICY PACKAGE DESIGN

Phase 5 brings together the previous phases to outline a holistic policy package. This includes setting targets and milestones, defining the package of policies which will form the strategy and providing a forward-looking perspective that identifies the needs and sources of investment to implement the strategy. This forms section 5 of the strategy (Table 7).

Defining policies should include at least a description of each policy and action, its scope, duration, allocated budget and expected impact. It should go beyond an inventory of measures to provide a long-term vision including the evolution and development of future policies.

Specifically, measurable progress indicators need to be established with milestones for 2030, 2040 and 2050. How they contribute to achieving the EU's energy efficiency target of 32.5% for 2030 (in accordance with the revised EED [28]) should be specified. They should consider the long-term EU goal of reducing greenhouse gas emissions in the Union by 80-95 % compared to 1990 by 2050 to ensure a highly energy efficient and decarbonised national building stock and to facilitate the cost-effective transformation of existing buildings into nearly zero-energy buildings (Article 2a, para 2). This means highly energy efficient buildings with a very low energy demand supplied by renewable energy sources and intelligently integrated into a decarbonised, flexible energy system.

The expected share of renovated buildings can be expressed in different ways, including percentage of buildings, absolute number and floor area renovated by building type.

To achieve these goals a holistic package of policies must be defined, building on the potential policies and approaches identified in the policy appraisal. There should be a particular focus on measures to be in place within the next 3-5 years (before the scheduled review and update of the strategy).

At this stage it is also crucial to identify the scale of investment required to deliver the strategy and potential sources of the investment needed. It is important to recognise the long-term nature of the strategy, which spans the period to 2050 and needs to be resilient to the fluctuating market conditions that will be encountered over time. Notwithstanding the long-term nature of the strategy, the action plan over the next few years, at least until the first milestone in 2030, should explicitly detail how renovation activity will be financed. At the same time as maximising the allocation of EU and other public funding sources to the renovation of buildings, it is important for Member States to identify ways to leverage high levels of private funding, including building owners' own resources and those of the investment community. Chapter 3 provides more detail on potential financing mechanisms, such as mechanisms to:

- aggregate projects, through investment platforms or groups
- reduce perceived risk of energy efficiency operations
- use public funding to leverage additional private-sector investment
- guide investments in the public building stock
- develop accessible and transparent advisory tools, such as one-stop-shops for consumers and energy advisory services

Article 2a also establishes that the European Commission will collect and disseminate best practices on successful public and private financing schemes for energy efficiency renovation and financial incentives to renovate from a consumer perspective. These may provide a source of inspiration for implementation, but the Directive gives no details about the timing.

Table 7 – Content of section 5

SECTION 5 - POLICY PACKAGE
Define a policy package based on socio-economic and policy appraisal, with a particular focus on measures to be introduced within the next five years
Set out roadmap with key dates, targets for the introduction of policies Include **milestones for 2030, 2040, 2050**
Define share of renovated buildings by 2020 (and 2030)
Define contribution of policies to achieving the EU 2030 energy efficiency target
Quantify total annual investment requirements to 2050 to deliver policy package
Identify existing sources of funding for building energy renovation • Local public funds • National public funds • EU Structural/Cohesion funds • Banks and other sources of finance, e.g. pension funds and investment trusts
Identify possible new funding sources, instruments and mechanisms, including: • Aggregating projects, through investment platforms or groups, or consortia of small and medium-sized enterprises • Reducing perceived risk of energy efficiency operations • Using public funding to leverage additional private-sector investment • Guiding investments into an energy efficient public building stock, in line with Eurostat guidance • Accessible and transparent advisory tools, such as one-stop-shops for consumers and energy advisory services

PHASE 6 - IMPLEMENTATION, ONGOING REVIEW AND UPDATE

The final phase, although by no means the end of the process, results in the strategy being published as a comprehensive policy document and kicks off implementation. Publishing the strategy is an opportunity to promote the benefits of renovation of buildings to stakeholders, including the wider public, to raise awareness and garner support for the strategy. This support is a vital component of ensuring strong, comprehensive implementation.

Implementation requires the development of regulation and support programmes. It includes developing the necessary legislative mechanisms to implement the strategy. This phase takes time and requires substantial political will and persistence. It may be useful to establish a taskforce including policy-makers from all departments and levels to take forward implementation. Inclusive consultation during implementation is also required.

At this stage monitoring and evaluation processes should be set up to check on progress of implementation and that the strategy is on track in terms of delivery and its planned impacts. This also feeds into reviewing and updating the strategy regularly. Establishing an independent committee to monitor and report progress on the strategy on an ongoing basis can be useful to gather recommendations for improvements and updates. The new renovation strategy is required by 10 March 2020 and must be updated by 30 June 2024, as part of the integrated national energy and climate plan (NECP) (under the Governance Regulation [9]). Another new version will be required by January 2029 as part of the second NECP. Each update should evaluate the impact of policies and measures to date and the potential of possible future measures.

Table 8 below summarises the full structure of the template for renovation strategies.

Table 8 – Full structured template of renovation strategies (Source: BPIE)

SECTION 1 OVERVIEW OF THE NATIONAL BUILDING STOCK

Identify main building categories:
- Single-family houses
- Blocks of flats/apartments and other multi-residential dwellings
- Offices
- Educational buildings
- Hospitals/health establishments
- Hotels and restaurants
- Sports facilities
- Warehouses and retail premises
- Other types of energy-consuming buildings

Identify age bands which have a material bearing on building energy performance:
- Traditional construction types, including historic buildings (typically pre-1900)
- Buildings constructed prior to regulations on energy performance (e.g. 1901-1960)
- Early phase building regulations
- Mid-phase building regulations
- Latest building regulations

Quantify the number, type, size (floor area) of each combination of building type and age band

Identify the split by owner – public, private or mixed
Identify the split by tenure – owner occupied, rented, mixed
Identify the split by location – urban, suburban, rural

Identify the energy use and performance characteristics of each building combination:
1. Construction type and U-value of main building elements:
   - Floor
   - Walls
   - Windows and external doors
   - Roof
2. Air infiltration rate
3. Energy systems (and typical replacement lifecycles):
   - HVAC system type/performance level/controls
   - Hot water provision
   - Lighting system/controls
4. Maintenance (e.g. mandatory safety checks/servicing)
5. Energy use for:
   - Heating
   - Cooling
   - Ventilation
   - Hot water
   - Lighting
   - Appliances
6. Energy carriers:
   - Gas (natural gas or LPG)
   - Liquid fuels (oil, etc.)
   - Solid fuels (coal, etc.)
   - Renewable energies:
     - o Solar energy for hot water generation
     - o Solar PV
     - o Wind
     - o Heat pump (type and coefficient of performance)
     - o Biomass (wood chips, wood pellets)
     - o Other (specify)
7. District heating (identify energy carriers)

SECTION 2 APPROACHES TO RENOVATION

Identify opportunities for retrofit of energy efficiency measures for each building category:
- Fabric measures – building envelope
- Exterior windows and doors
- Technical facilities – heating/ventilation/cooling/hot water
- Air tightness / infiltration
- Lighting
- Appliances

Identify opportunities for retrofit of renewable energy measures:
- Passive solar energy
- Solar energy for hot water generation
- Solar PV for electricity
- Wind energy
- Heat pumps
- Biomass
- Biogas
- Geothermal hot water

Identify opportunities for retrofit of passive measures:
- Shading
- Natural ventilation
- Natural cooling

Identify opportunities to align renovation and connecting/expanding/updating a district energy system

Identify packages of measures that can achieve at least 60% energy saving (deep renovation)

SECTION 3 SOCIO-ECONOMIC APPRAISAL

Identify and quantify the benefits arising from different packages of measures for deep energy renovation, including:
- Economic benefits: energy cost savings; increase in GDP; impact on economic activity; increase in property values; impact on public finances; reduction of energy import bill
- Societal benefits: reduction in fuel poverty; health benefits; increased comfort/productivity
- Environmental benefits: reduced greenhouse gas emissions; air quality improvements
- Energy system benefits: increased energy security; avoided new generation capacity; reduced peak loads

Identify and quantify the costs:
- Total cost of installing renovation measures, minus any avoided cost due to end-of-life replacement or by undertaking renovation alongside other building maintenance, new construction or modernisation measures
- Transaction costs, including costs of temporary relocation of occupants

Determine prioritised renovation packages for each building category (based on the cost and benefit appraisal)

SECTION 4 - POLICY ASSESSMENT

Identify barriers to deep renovation
- Legislative and regulatory barriers
- Fiscal and financial barriers, including split-incentive dilemmas and market failures
- Communication and capacity barriers
- Technical barriers
- Research and development (R&D) barriers

Identify policies/measures to overcome identified barriers

Assess potential role of the following measures/ policies/approaches:
- Measures to target all public buildings
- Targeting the worst-performing segments of the national building stock
- Policies to alleviate energy poverty
- Measures exploiting trigger points for energy renovation in the life-cycle of buildings
- Policies and actions to stimulate cost-effective deep renovation of buildings, including staged deep renovation
- Introducing building renovation passports
- National initiatives to promote smart technologies and well-connected buildings and communities
- National initiatives to promote skills and education in the construction and energy efficiency sectors

SECTION 5 - POLICY PACKAGE

Define a policy package based on socio-economic and policy appraisal, with a particular focus on measures to be introduced within the next five years

Set out roadmap with key dates, targets for the introduction of policies
Include **milestones for 2030, 2040, 2050**

Define share of renovated buildings by 2020 (and 2030)

Define contribution of policies to achieving the EU 2030 energy efficiency target

Quantify total annual investment requirements to 2050 to deliver policy package

Identify existing sources of funding for building energy renovation
- Local public funds
- National public funds
- EU Structural/Cohesion funds
- Banks and other sources of finance, e.g. pension funds and investment trusts

Identify possible new funding sources, instruments and mechanisms, including:
- Aggregating projects, through investment platforms or groups, or consortia of small and medium-sized enterprises
- Reducing perceived risk of energy efficiency operations
- Use of public funding to leverage additional private-sector investment
- Guiding investments into an energy efficient public building stock, in line with Eurostat guidance
- Accessible and transparent advisory tools, such as one-stop-shops for consumers and energy advisory services

ANNEX 1 IMPLEMENTATION PROGRESS REPORT

Review of implementation progress of previous (2017) renovation strategy, including:
- Progress towards national targets
- Contribution to EU energy efficiency target for 2020 and 2030
- Outcomes of existing policies in terms of energy savings delivered and impact on the renovation rate and depth

ANNEX 2 CONSULTATION SUMMARY

Summary of the results of public consultation into the long-term renovation strategy, including:
- Summary of responses to consultation
- List of stakeholder groups consulted
- Explanation of the consultation process, including how inclusive consultation has been ensured across all stages

RELATED GUIDANCE ON RENOVATION STRATEGIES

Buildings Performance Institute Europe (BPIE), "Aligning district energy and building energy efficiency," 2018.

EmBuild, "Experience of developing local renovation strategies," 2018.

Buildings Performance Institute Europe (BPIE), "Trigger points as a "must" in national renovation strategies – Factsheet," 2017.

Buildings Performance Institute Europe (BPIE), "Reducing energy poverty with national renovation strategies: a unique opportunity – Factsheet," 2017.

Buildings Performance Institute Europe (BPIE), "Alleviating fuel poverty in the EU – Investing in home renovation, a sustainable and inclusive solution," 2015.

Buildings Performance Institute Europe (BPIE), "Discount rates in energy system analysis – Discussion paper," 2015.

Buildings Performance Institute Europe (BPIE), "A guide to developing strategies for building energy renovation," 2013.

2

FINANCING RENOVATION

(ARTICLE 2A, 10)

One of the key aspects recognised by the new Article 2a of the EPBD is the need to facilitate financing and mobilise investment in building renovation, supporting the implementation of national renovation strategies. The Energy Efficiency Financial Institutions Group reported in 2015 [29] that investments of the order of €60-100 billion to 2020 are required to improve the energy performance of buildings in Europe, while the International Energy Agency (IEA) in its 2°C (450ppm) scenario estimates a requirement of US$1.3 trillion in the period 2014-2035 globally.

UP TO
€60-100
BILLION
TO 2020
ARE REQUIRED TO IMPROVE THE ENERGY PERFORMANCE OF BUILDINGS

MAIN REQUIREMENTS

The Directive introduced new requirements related to financing as part of the article on long-term renovation strategies (Article 2a) and on financial incentives and market barrier (Article 10(6)). The aim is to mobilise investment in renovation of national stocks of residential and non-residential buildings – both publicly and privately owned. The main requirements are that Member States shall facilitate access to appropriate mechanisms for:

- **Aggregating projects, including by investment platforms or groups, and by consortia of small and medium-sized enterprises, to enable investor access as well as packaged solutions for potential clients**
- **Reducing the perceived risk of energy efficiency operations for investors and the private sector**
- **Using public funding to leverage private-sector investment**
- **Guiding investments into an energy efficient public building stock, in line with Eurostat guidance**
- **Accessible and transparent advisory tools, such as one-stop-shops for consumers and energy advisory services, on relevant energy efficiency renovations and financing instruments**

Member States are also expected to link financial measures for energy efficiency improvements in the renovation of buildings to the targeted or achieved energy savings. Potential methods include installer certification or qualification, comparison of EPCs before and after renovation, energy audits or other comparable methods that could show the energy performance improvement (article 10(6)).

EPBD [2018/844]

Article 2a

3. To support the mobilisation of investments into the renovation needed to achieve the goals referred to in paragraph 1, Member States shall facilitate access to appropriate mechanisms for:

(a) the aggregation of projects, including by investment platforms or groups, and by consortia of small and medium-sized enterprises, to enable investor access as well as packaged solutions for potential clients;

(b) the reduction of the perceived risk of energy efficiency operations for investors and the private sector;

(c) the use of public funding to leverage additional private-sector investment or address specific market failures;

(d) guiding investments into an energy efficient public building stock, in line with Eurostat guidance; and

(e) accessible and transparent advisory tools, such as one-stop-shops for consumers and energy advisory services, on relevant energy efficiency renovations and financing instruments.

4. The Commission shall collect and disseminate, at least to public authorities, best practices on successful public and private financing schemes for energy efficiency renovation as well as information on schemes for the aggregation of small-scale energy efficiency renovation projects. The Commission shall identify and disseminate best practices on financial incentives to renovate from a consumer perspective taking into account cost-efficiency differences between Member States.

Article 10

(6) In Article 10, paragraph 6 is replaced by the following:

6. Member States shall link their financial measures for energy efficiency improvements in the renovation of buildings to the targeted or achieved energy savings, as determined by one or more of the following criteria:

(a) the energy performance of the equipment or material used for the renovation; in which case, the equipment or material used for the renovation is to be installed by an installer with the relevant level of certification or qualification;

(b) standard values for calculation of energy savings in buildings;

(c) the improvement achieved due to such renovation by comparing energy performance certificates issued before and after renovation;

(d) the results of an energy audit;

(e) the results of another relevant, transparent and proportionate method that shows the improvement in energy performance.

GUIDANCE FOR IMPLEMENTATION

The following guidance provides a description of some of the key financing methods and financial support schemes which could be or are being implemented in Member States.

AGGREGATING PROJECTS

The availability of a large-scale pipeline of bankable projects to feed investment platforms and financial instruments is key to upscaling and replicating successful projects, thereby reducing overall development costs. With this in mind, the European Commission has increased its budget for project development assistance (PDA) to €38 million per year as of 2017. At the same time, the European Commission encourages Member States to develop dedicated one-stop-shops for project developers [30]. These facilities should lead to more locally-developed project pipelines and partnerships with local actors (e.g. SMEs, financial institutions, energy agencies), the key being to connect the supply of finance with demand for it. Two of the key PDA facilities are:

- ELENA, managed by the EIB, supporting private and public promoters to develop and launch large-scale bankable sustainable energy investments (above €30 million), covering up to 90% of project development costs
- PDA Horizon 2020, helping public and private promoters develop model sustainable energy projects, focusing on small and medium-sized energy investments of at least €7.5 million and up to €50 million, covering up to 100% of eligible project development costs

Other examples of project aggregation include a municipality or several municipalities using an ESCO to renovate one or more multi-family buildings or their public buildings. Integrated renovation services such as BetterHome (see chapter 3) also create a one-stop-shop offering renovation services and financing, making it possible to finance several aggregated projects.

EE

Aggregation and use of public funds (Estonia)

KredEx, a state-owned foundation, has been running a scheme for many years to finance and support the comprehensive renovation of Estonian residential apartment buildings with a view to reducing their energy bills, carrying out essential repairs and modernising facilities. Some 200-250 projects are financed each year in Estonia. Available funding per project includes 50% towards preparation of the building design documentation, project management and supervision services, with a 15-40% grant (depending on the level of energy savings to be achieved) towards renovation costs. Renovation works can encompass a broad set of measures, including insulation of the building envelope, roof and new windows as well as replacement of heating systems. The total budget for the scheme is €340 million, of which around €100 million is from EU Cohesion Funds [31].

2

REDUCING RISK

Improving the energy performance of a building is a good long-term investment. However, the lending market has yet to fully recognise that it is a low-risk activity, and that the probability of default is lower than for other types of investment. Ongoing studies by the Energy efficient Mortgages Action Plan (EeMAP) initiative and the Energy efficiency Data Protocol and Portal (EeDaPP) project are seeking to validate two assumptions: firstly, that improving energy performance has a positive impact on property value, thereby reducing a bank's asset risk; and secondly, that borrowers have a lower probability of default as a result of more disposable income due to lower energy bills, reducing a bank's credit risk. However, it is still difficult for banks and investors to assess the risks associated with energy efficiency investments.

Under the auspices of the Energy Efficiency Financial Institutions Group (EEFIG), two products have been developed that aim to inform financial institutions, investors and project promoters about the real benefits and risks of energy efficiency investments:

- The De-risking Energy Efficiency Platform (DEEP) (deep.eefig.eu) is a pan-EU open-source database containing detailed information and analysis of over 10,000 industrial and buildings-related energy efficiency projects. It builds performance track records and helps project developers, financiers and investors to better assess the risks and benefits of energy efficiency investments across Europe. Member States should encourage all market players to support this initiative by sharing available data and performance track records, thereby enhancing the robustness of the platform and increasing the knowledge base.
- The EEFIG Underwriting Toolkit (valueandrisk.eefig.eu), a guide to value and risk appraisal for energy efficiency financing, was launched in June 2017. It aims to help financial institutions scale up the deployment of capital into energy efficiency. It also helps promoters develop bankable projects and can be used by public authorities to better assess energy efficiency projects that receive public funding.

USING PUBLIC FUNDS TO LEVERAGE PRIVATE INVESTMENT

The EU has increased the public funds available for energy efficiency. However, to meet the objectives of the Energy Union and support the transition to a clean energy system, there is a need to further unlock private financing, in particular for energy efficiency investments. According to the European Commission, an additional €177 billion per year will be necessary over the period 2021-2030 to reach the EU's energy and climate objectives for 2030 [32]. At the EU level, the European Structural and Investment Funds (ESIF) has allocated €18 billion to energy efficiency in the period 2014-2020, primarily through the European Regional Development Fund and the Cohesion Fund. Boosting investment in sustainable energy projects is also one of the strategic priorities of the European Fund for Strategic Investments (EFSI).

Member States can access the "fi-compass" platform (www.fi-compass.eu), which is an advisory service on financial instruments under ESIF.

In addition, a flexible guarantee facility, to be deployed primarily at national level, is being developed by the EIB. This instrument aims to encourage the combination of different public financing strands. It will allow financial intermediaries such as commercial banks to develop and deploy attractive financial products for the energy renovation of buildings, in particular home renovations. Furthermore, following a comprehensive review to ensure that EIB's lending in the energy sector reflects EU energy and climate policy, as well as current investment trends, its energy lending priorities are focused on energy efficiency, renewable energy and energy networks, as well as related research and innovation.

NL

FR

Leveraging public funding (The Netherlands)

In the Netherlands, some €800 million is made available annually for sustainable projects through the Green Funds Scheme, which came into force in 1995. Investors wishing to finance a green project apply to one of the participating banks. Qualifying projects that meet the requirements receive a green certificate. By availing themselves of an attractive, low-interest loan, investors have an affordable way to pay for sustainable measures as part of building renovation. Since the loan is repaid, the ultimate cost to the government is the value of the subsidised interest loan, plus administrative costs. In this way, the scheme has succeeded in leveraging more than €80 of private investment for every €1 of public funding spent [31].

One-stop-shop for consumers coupled with finance (France)

Zero-rated eco-loans for energy renovations have been available in France since 2009. Loans, of up to €30,000 for single-family housing and €10,000 per apartment in multi-family housing, can also be used to cover associated costs such as audits and professional fees. A renovation information service provides free advice on packages of appropriate measures for a specific building. Renovation works must be undertaken by qualified and approved professionals and achieve a required level of energy performance. Around 20 participating banks offer qualifying loans, which are available for a period of up to 15 years. Total government spending on the programme in 2015, including operation of the scheme and interest payments, was €40 million. This means that for every €1 of public support, €12 of private investment was stimulated [31].

GUIDING INVESTMENTS INTO AN ENERGY EFFICIENT PUBLIC BUILDING STOCK

Concerning public sector investments into an energy efficient public building stock, Eurostat, the Statistical Office of the European Commission, and the EIB launched a new Guide on the Statistical Treatment of Energy Performance Contracts in May 2018 [33]. This builds on the Eurostat Guidance Note on the Recording of Energy Performance Contracts in Government Accounts in 2017 [34]. The Guide explains in detail how these contracts work and gives a clear overview of the potential impact on government finances. This will assist public authorities in taking better-informed decisions when preparing and procuring their energy performance contracts. The Guide aims to provide clarity to public and private promoters in the context of the investment plan and remove perceived barriers to investment. In short, if an EPC contractor is bearing the majority of the risks and rewards associated with the use of an asset, it shall be regarded as the economic owner of this asset.

2

GB

RE:FIT - the retrofitting of London's public sector buildings

RE:FIT London was established in 2009 to help a range of public bodies including London boroughs, the health sector, central government departments, schools and other educational establishments, as well as cultural and heritage organisations, to implement building retrofit projects. It does this through:

1. The RE:FIT London Programme Delivery Unit, an expert team providing free end-to-end support needed to get projects up, running and successfully implemented
2. The RE:FIT framework of energy service companies, which saves time and resources when procuring retrofit services and works. As these are energy service companies, they guarantee energy and cost savings.

At the end of 2018, the project had supported the retrofit of over 550 buildings in UK's capital with an investment exceeding £100 million. Annual emission reductions of 35,000 tonnes of CO2 have been achieved, along with cost savings to the public sector of £8 million per year [35].

ADVISORY TOOLS

The European Investment Advisory Hub (EIAH) (eiah.eib.org) provides a single access point to various types of advisory and technical assistance services, including the identification, preparation and development of investment projects across the EU. Services, which are free to public sector organisations, include:

- Project development support throughout the stages of a project
- Financial advice to facilitate access to sources of financing
- Guidance and trainings, for example on how to carry out a tendering process or conduct a cost-benefit analysis

EU

The INNOVATE project

The INNOVATE project (www.financingbuildingrenovation.eu), funded under Horizon 2020, is developing one-stop-shops and attractive energy retrofit packages for homeowners in 11 cities and regions across the EU. It aims to address the barriers homeowners face when considering an energy refurbishment, from which measures to install to how to finance the investment. Project partners want to motivate homeowners to carry out deep energy retrofits of private residential buildings, both single-family houses and condominiums. In order to facilitate the process, they will develop and roll out attractive energy retrofit packages in each participating city/region.

RELATED GUIDANCE ON FINANCING RENOVATION

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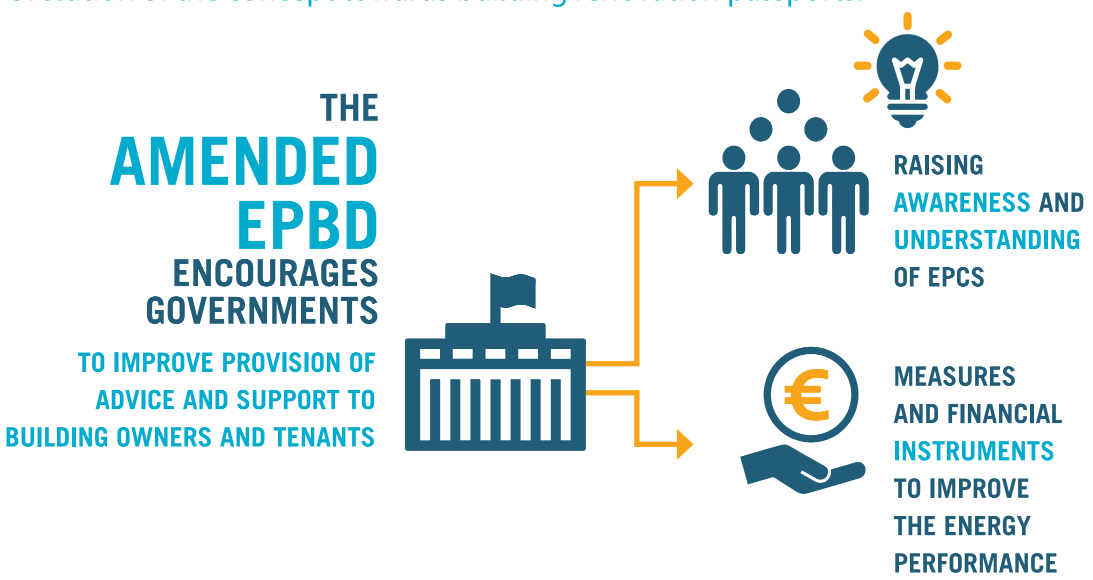
3

ENERGY PERFORMANCE CERTIFICATES AND BUILDING RENOVATION PASSPORTS

(ARTICLES 10, 19, 19A, 20)

Energy performance certificates (EPCs) have existed in some Member States since 2005 (following the first version of the EPBD) [36]. The amended text now encourages national governments to improve provision of advice and support to building owners and tenants both in terms of raising awareness and understanding of EPCs themselves and on measures and financial instruments to improve the energy performance of their buildings. In addition, the European Commission has started to explore the future of EPCs and evolution of the concept towards building renovation passports.



MAIN REQUIREMENTS

Member States should provide information to owners and tenants on the purpose and objectives of EPCs, energy efficiency measures and supporting financial instruments through accessible and transparent advisory tools such as direct advice and one-stop-shops.

Databases should assemble information on energy consumption of buildings from EPCs, at least from public buildings that have one. This data (at least when aggregated and anonymised) should be made available for statistical and research purposes and to the building owner.

The European Commission will assess the feasibility of introducing an optional building renovation passport. Following this, introduction of such schemes could be required or encouraged, but there is no legal expectation.

3

EPBD [2018/844]

Article 10

6a. Databases for energy performance certificates shall allow data to be gathered on the measured or calculated energy consumption of the buildings covered, including at least public buildings for which an energy performance certificate, as referred to in Article 13, has been issued in accordance with Article 12.

6b. At least aggregated anonymised data compliant with Union and national data protection requirements shall be made available on request for statistical and research purposes and to the building owner.'.

Article 19

The Commission shall, in particular, assess the need for further improvement of energy performance certificates in accordance with Article 11.'.

Article 19a

The Commission shall, before 2020, conclude a feasibility study, clarifying the possibilities and timeline to introduce … an optional building renovation passport that is complementary to the energy performance certificates, in order to provide a long-term, step-by-step renovation roadmap for a specific building based on quality criteria, following an energy audit, and outlining relevant measures and renovations that could improve the energy performance.'.

Article 20

'2. Member States shall in particular provide information to the owners or tenants of buildings on energy performance certificates, including their purpose and objectives, on cost-effective measures and, where appropriate, financial instruments, to improve the energy performance of the building, and on replacing fossil fuel boilers with more sustainable alternatives. Member States shall provide the information through accessible and transparent advisory tools such as renovation advice and one-stop-shops.'.

GUIDANCE FOR IMPLEMENTATION

ADVICE AND SUPPORT FOR BUILDING OWNERS AND TENANTS

The provision of advice and support to building owners and tenants is one measure often included in national renovation strategies to improve the energy performance of existing buildings. It is now required to provide information to owners and tenants on EPCs as well as possible measures and financial instruments.

Implementation steps

The following steps should be taken to enhance the provision of information, including on and through EPCs:

1. Review the existing information and advice given to building owners and tenants through EPCs and other channels
2. Assess the impact of information and advice given
3. Evaluate the gaps in the information and advice given
4. Design and tailor information to different audiences in order to boost the impact
5. Explore how the EPC and other channels can be developed (e.g. by adding new information) and how the information can be valorised.

Channels could include specific automated renovation advice, advice service via call centres and/or websites, and one-stop advice shops. National governments need to enable such approaches. This means setting a long-term approach via long-term renovation strategies (Chapter 1) to provide certainty to investors and businesses to develop new services, and collaborating with the building industry, building professionals and financial institutions to take a comprehensive approach to supporting renovation.

DK

One-stop-shop (Denmark)

One-stop-shops can provide a holistic service, providing building owners with all the advice they need to support the whole process of renovation, from initial ideas to sources of financing support and contact with architects and installers.

BetterHome is an industry-driven one-stop-shop model in Denmark [37]. BetterHome takes a service-orientated approach, partnering with key players in the construction value chain, financial institutions providing mortgages, utility companies with energy saving obligations, local governments, real-estate agencies as well as building professionals and installers, in order to deliver a comprehensive one-stop-shop solution. The homeowner is offered tailor-made solutions based on their specific preferences, covering energy improvements to the building envelope and heating, cooling, ventilation and hot water systems inside the building. The process is holistically planned, optimising the value chain by minimising efficiency losses and miscommunication issues and avoiding lock-in effects.

A home- or building-owner-centric renovation journey has two main mechanisms: structuring the process for the installers and increasing building owners' awareness. While the central aspects of the renovation journey are replicable on most European markets, the model must be adapted to the local context. Applying a similar model in other countries will require a greater focus on quality assurance and an integration of financial support into the model. In Denmark, quality assurance is heavily regulated, including guarantees for the building owners; most other European markets would require a more comprehensive quality and compliance scheme. Furthermore, the available financial subsidy scheme for energy renovations in Denmark is modest and rarely decisive for the building owners' decision to invest. In countries with substantial public support schemes for energy renovations, this can be incorporated into the business model.

BetterHome

WHAT
A cutting-edge one-stop-shop solution launched by supply-side actors: Danfoss, Grundfos, the ROCKWOOL and VELUX Groups

WHAT THEY OFFER
A burden-free renovation process, enabled by training and digital tools for the installers

WHEN
Started in 2014

WHERE
Denmark, and recently launched in Sweden

NETWORK
3500 installers (from 105 organisations), five banks and mortgage providers and four utilities

TARGET GROUP
Mainly single-family houses constructed between 1950 and 1990

INDIRECT TURNOVER
~ €13 million in 2017

NUMBER OF PROJECTS
~ 200 in 2016, but demand is growing rapidly

AVERAGE PROJECT SIZE
Mainly deep renovation projects, with investments of ~ €70 000 and energy savings of approximately 30-70%

BE

EPC+ in Flanders

EPC+ is the successor of the current EPC scheme in Flanders, Belgium, and was launched in January 2019. The EPC+ includes renovation advice and outlines, in order of priority, the actions the building owner should take to increase the current energy performance of a property. The tool includes recommendations for various elements (airtightness, ventilation etc.) and provides technical information to avoid lock-in effects.

DEVELOPING EPC DATABASES

The absence of reliable data, in many Member States, hampers effective policy-making. Inadequate data is a key barrier to better understanding the status of the European building stock. Standardised methodologies for data gathering and assessment as well as reporting of high-level data are therefore crucial. In addition, a centrally managed register for energy performance of buildings would help to monitor improvements over time and to design appropriate policies.

While it is not compulsory to set up a database for registering EPCs, 24 Member States have set up a system to collect EPC data voluntarily and two others have a database under development (Table 9). The new requirement encourages this as well as requiring that data collected is available for research purposes and to the building owner.

Table 9 – EPC databases development and data availability in EU Member States. (Source: [38])

Country	Status	Scope	Public availability
AT	Yes	Regional/ Central	Access for some organisations
BE	Yes	Regional	Depends on Region
BG	Yes	Central	No public access
CZ	under development		
DE	Yes	Central	No public access
DK	Yes	Central	Public access with protected privacy
EE	Yes	Central	Public access with protected privacy
EL	Yes	Central	No public access
ES	Yes	Regional	Depends on Region
FI	Yes	Central	No public access
FR	Yes	Central	Access for some organisations
HR	Yes	Central	No public access
HU	Yes	Central	Access for some organisations
HE	Yes	Central	Public access with protected privacy
IT	Yes	Regional	Depends on Region
LV	under development		
LT	Yes	Central	Public access with protected privacy
NL	Yes	Central	Public access with protected privacy
NO	Yes	Central	Public access with protected privacy
PL	Yes	Central	No public access
PT	Yes	Central	Public access with protected privacy
RO	Yes	Central	No public access
SK	Yes	Central	Public access with protected privacy
SI	Yes	Central	Access for some organisations
SE	Yes	Central	Public access with protected privacy
UK	Yes	Regional	Public access with protected privacy

Implementation steps

The following implementation steps are valid for both developing new and evolving existing EPC databases.

1. Review the information collected on EPCs

This includes reviewing data-gathering strategies to assess what information is available. This can include information available on existing EPCs or collected via on-site auditing. Much information can be (automatically) added through linking with existing databases. The credibility of EPCs depends on the reliability and quality of the data they use. Harmonisation of data collection methodologies, checklists for the auditors and training can be used to increase the quality. The same building should receive the same EPC rating from different EPC issuers.

2. Assess what information can be added to a public database

This includes reviewing regulatory hurdles (such as privacy laws) and identifying publicly available data. From this it is possible to identify potential data that can be integrated in a database. It is also important to identify what data users find most interesting and how it can be presented in an understandable way (most building owners have a limited understanding of U-values and CO_2 emissions).

As a minimum the database should include:

- General information (e.g. registration number, building type, year built)
- Buildings information (e.g. useful floor area, heated floor area)
- Type of EPC (i.e. calculated or measured, period of validity)
- Energy performance information (e.g. energy label, annual energy needs and energy use per building service)
- Recommendations and expected energy savings
- Energy assessor details (e.g. name, registration number)

And where available:

- Greenhouse gas emissions
- Renewable energy generation
- Energy losses
- Transaction price at time of sale

3. Consider use of tools for compliance

Centralised EPC registries are an effective tool to support quality control and compliance. In Portugal and Belgium compliance checks are performed on a random sample of EPCs. A basic check includes an automatic check of the data inserted in the EPC registry, followed by a simple verification of the basic methodologies. A more detailed check entails a full-data review of calculations and an on-site visit, to test compliance with requirements and methodologies.

4. Review accessibility of data

Data protection is a vital consideration, and alignment with data protection regulations must be ensured. However, in Member States like Portugal, Netherlands, Sweden, Denmark, Ireland and Belgium selected data is available for supporting policy-making and to a certain extent for private actors. Different levels of accessibility for different actors should be considered, since data can be used for research purposes, by policy-makers when developing policies for the building stock or by private actors developing business models (targeting a specific type of buildings). EPC data can also be used to increase interest in energy renovations by enabling owners to see what their neighbours did (how much energy they saved and even the effects on the house price).

The following examples demonstrate how databases have been set up and the benefits of doing so and builds on data from the Horizon 2020-funded project iBRoad.

PT

Portugal

In Portugal, the Portuguese Energy Agency ADENE designed, implemented and is currently managing the registry and database gathering the EPCs. Basic data (energy class, year, district and building type) is publicly available from around 1.3 million EPCs. An average of about 11,000 EPCs are registered every month. The EPC database is a useful tool to map and monitor the national building stock and to explore relevant information [39].

SE

Sweden

In Sweden, all EPCs are accessible by address on a public website (www.boverket.se). The information that can be obtained online is the (i) ID number of the EPC, (ii) date of issue, and (iii) energy performance rating (given as a single value of specific energy in kWh/m^2/year and energy class). Boverket, the National Board of Housing, Building and Planning in Sweden, is responsible for checking the validity of the EPCs. Input data is automatically controlled by software [40].

In contrast to other Member States, the Swedish EPCs are (partly) based on the measured energy use of the building, which is used as the input data for issuing the EPC for new buildings. Energy use has to be measured during a period of 12 consecutive months and entered into the database by an independent certified energy expert. The energy use is then corrected for the climate variability by using a reference year. The energy use is also "normalised", correcting for user-influence on energy consumption – for example, if the indoor temperature is different from the average indoor temperature of 22°C, or occupants use more domestic hot water than expected. The corrected value determines the energy class level of the EPC.

BE

Belgium

In Flanders, the EPC was made available for the sale of residential units on 1 November 2008 and for rental housing units on 1 January 2009. The most important value on the Flemish EPC is the energy score that reflects the calculated energy consumption in kWh/m^2/year of usable floor area.

Public authorities can acquire more detailed information from the database for policy-making reasons than is publicly available. VEA, the Flemish Energy Agency, manages the database and thus has access to all detailed information [41]. In general, the data is being used to evaluate the building stock, the default values in the EPC and the impact of the regulation and subsidy programmes.

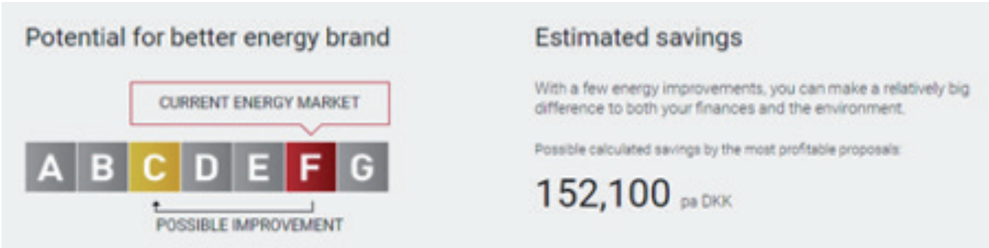
3

Denmark

DK

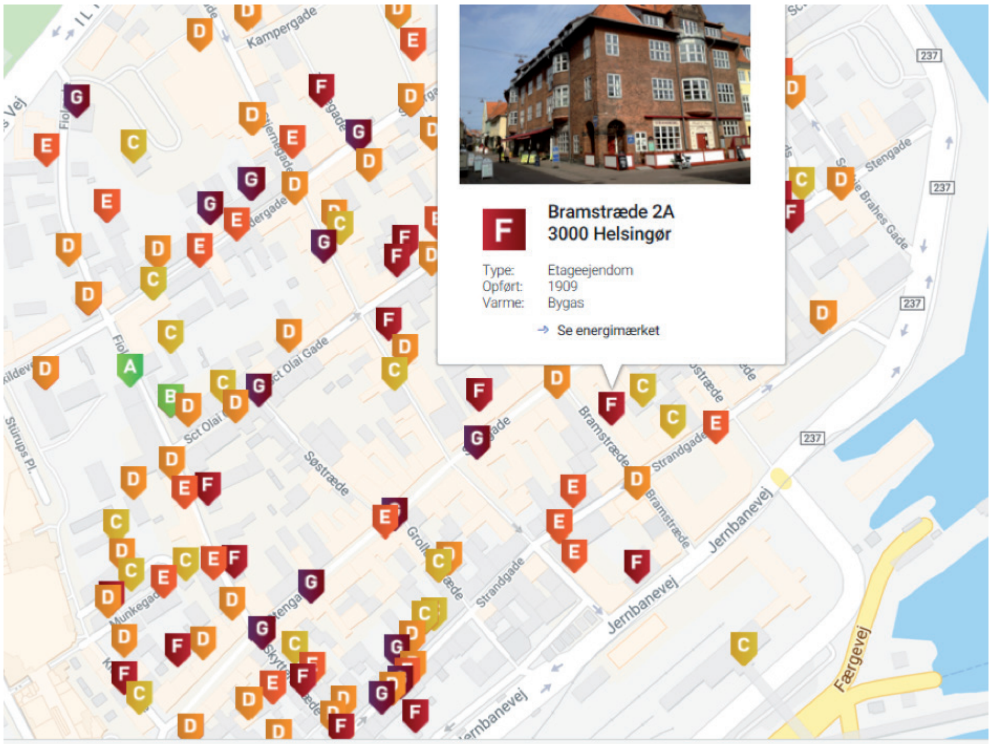
In Denmark, detailed building data is publicly available on the website[6] of the Danish Energy Agency. Based on the address, people can retrieve a detailed EPC (10-20 pages) for the specific building, comprising building data, heating source, details of the energy expert, picture of the building and recommendations. The information includes detailed recommendations on energy measures and savings and illustrates the potential improvement.

Figure 6 – Extract of information available in Denmark



The EPC database allows the users to compare with neighbours and similar buildings in the city.

Figure 7 – Extract of map of EPCs available on the Danish Energy Agency website

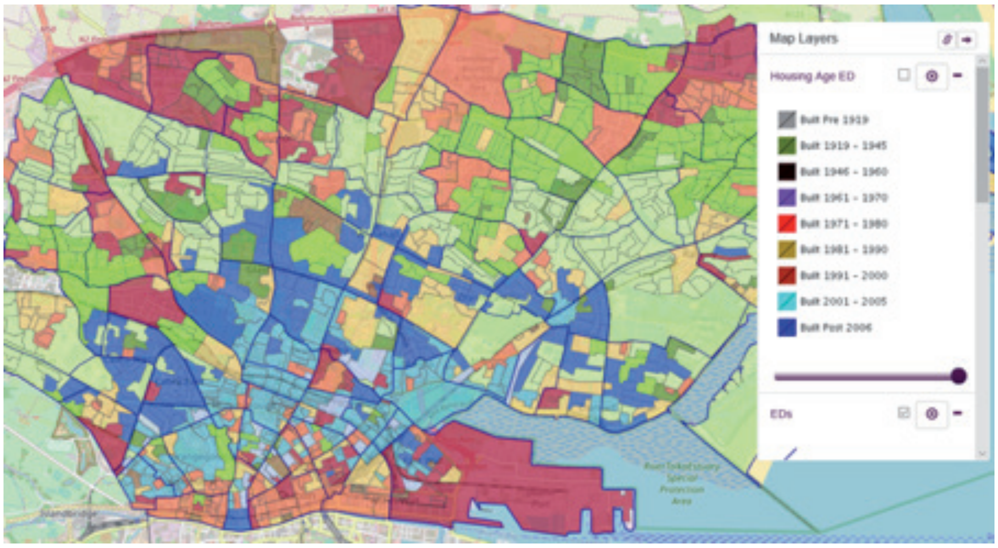


6 www.sparenergi.dk/forbruger/vaerktoejer/find-dit-energimaerke

Ireland

The Irish Energy Action project, in partnership with the EU project Episcope, has developed an EPC mapping tool. The interactive map of Dublin illustrates different building characteristics of different neighbourhoods [42]. The data is aggregated to defined boundaries, namely small areas and electoral divisions. Small areas typically comprise 50-200 dwellings and electoral divisions include clusters of small areas. This mapping allows for local policy-making and strategy development to alleviate energy poverty at a district level.

Figure 8 – Extract of map of aggregated data in Dublin



3

BUILDING RENOVATION PASSPORTS

A building renovation passport is an electronic or paper document outlining a long-term (up to 10 or 20 years) step-by-step renovation roadmap and logbook for a specific building. It is based on an on-site energy audit fulfilling specific quality criteria and indicators established during the design phase, following a dialogue with the building owners. It includes the expected benefits in terms of reduced heating bills, improved comfort and CO_2 savings, explained in a user-friendly way. The logbook is a repository of building-related information on aspects such as energy consumption and production, executed maintenance and building plans. This provides useful information for building owners which goes beyond the energy performance.

Under Article 19a of the EPBD, the European Commission is tasked with assessing how EPCs could be improved as well as exploring the concept of building renovation passports by 2020. This means that although building passports are not required at national level, the European Commission will conduct research to assess whether such schemes (including as an optional provision) could be feasible. This, depending on the assessed feasibility, could later result in a legal provision to require them nationally.

To take this forward, the European Commission[7] has undertaken the following actions:

1. Review existing building renovation passports and related schemes and initiatives in the EU and globally at national and regional level – this should develop an understanding of the characteristics and pros/cons of the various schemes and initiatives.
2. Analyse possible scope for EU measures including non-legislative ones (e.g. supporting the exchange of best practices, promoting standards, guidelines, etc.), legislative ones (inclusion of dedicated provisions under the EPBD), and a combination of both – highlighting their possible advantages and drawbacks including of costs of implementation.
3. Establish policy options for the possible introduction of additional (non-legislative and legislative) measures at EU level to support building renovation passports, including the introduction of an optional building renovation passport scheme under the EPBD and, for each option, an assessment of potential impacts. These may include possible extensions of EPCs and introduction of optional standalone building renovation passport schemes. Interactions with other provisions such as the smart readiness indicator will also be considered.

The experiences in Germany, France and Belgium offer valuable lessons about the route that leads to successful development and implementation of building renovation passports. The research conducted so far, and the feedback gathered directly from the initiators of the individual renovation roadmaps, has helped identify potential mistakes and pitfalls that should be avoided, and underlines the need for careful planning. The examples outlined below may also provide inspiration to other countries considering developing their own approach to building renovation passports, building on data and findings from the Horizon 2020-funded project iBRoad (redesigned by BPIE).

[7] In May 2018, the European Commission launched a tender to carry out the feasibility study (https://ted.europa.eu/udl?uri=TED:NOTICE:247384-2018:TEXT:EN:HTML&tabId=1).

DE

Individueller Sanierungsfahrplan, Germany

In Germany, the Sanierungsfahrplan (SFP) was first launched in the federal state of Baden-Württemberg in 2015 and a newly developed Individueller Sanierungsfahrplan (iSFP) was launched at the national level in 2017. In Germany, EPCs are not considered reliable enough to stimulate renovation and are often viewed as an administrative obligation. On the other hand, there is a strong culture of on-site energy auditing, but the very detailed reports delivered to building owners (up to 150 pages) are often left unread and do not promote renovations. The iSFP has been designed to be a user-friendly tool that includes both short- and long-term measures and suggests ways to avoid lock-in effects. As about 85% of the energy renovation measures funded in Germany concern only one building component, iSFP puts a strong focus on staged renovation and the interdependences between the stages. Behind this tool is the idea that building owners must be given the appropriate means to turn renovation from "a nuisance that I have to endure" (I have to renovate) into "an opportunity to improve my house and my living environment" (I want to renovate).

In Germany, the building owner is put at the very centre of the process, and the individual approach, including in-depth dialogues between the building owner and the energy auditors, is considered key for the instrument. As a result, the development of a renovation roadmap includes these steps:

ON-SITE VISIT

- Inspection of the building and meeting with the building's owner to discuss his/her wishes and needs (based on a checklist)
- Assessment of the current status of the building

DEVELOPMENT OF INDIVIDUAL SCENARIOS

- Development of different renovation scenarios based on the result of the on-site audit and overview of all the building components by the auditor, prioritising what needs to be renovated
- Discussion with the owner to select his/her preferred renovation options
- Detailed input into a software by the auditor and proposition of measures to implement

PRESENTATION OF RESULTS

- Presentation of the results to the owner during a second onsite meeting, where a decision on the final renovation options is reached (the auditor and the owner discuss the options together)
- Printing of the step-by-step renovation plan and delivery to the building owner by the auditor

Passeport Efficacité Énergétique, France

FR

The concept for the Passeport Efficacité Énergétique (P2E) was developed by the Shift Project together with a group of building specialists and professionals, between 2012 and 2014. The objective was to unlock the thermal renovation of residential buildings, identified as an imperative step towards decarbonising the economy.

P2E suggests a pragmatic approach to maximise the opportunities to trigger energy renovation every time maintenance work is done in a building. Using any type of renovation or maintenance work as a trigger to install energy-renovation measures helps to promote energy efficiency among building owners and professionals and may generate higher levels of renovation.

The passport provides a set of solutions ("performance combinations") that would enable the building to contribute to the national renovation target for 2050 ("Bâtiment Basse Consommation" (BBC) 2050, equivalent to 80kWh/m^2 of primary energy per year). It suggests combinations of measures based on specific features like building type, age, climate etc. that aim to provide a set of consistent solutions for all parts of the building, which, taken together, support the realisation of the final goal. By simplifying the choice among possible solutions and making it easier for the building owner, the system aims at "industrialising" the renovation process and achieving economies of scale.

In France, the P2E online platform links individuals, energy auditors and craftspeople. After contact between the owner and the energy auditor is established through the platform, three steps will follow:

INDIVIDUAL CONTACT BETWEEN THE AUDITOR AND THE OWNER (30 min,by phone)

- Explanation of the approach and the procedure of the audit
- General and contextual discussion on the renovation project
- Recovery of existing elements (plans, invoices, maintenance contract...)
- Quick plan of the building
- Completion of the questionnaire "General characteristics"

ON-SITE TECHNICAL VISIT (2h/2h30min)

- Wall inspection
- Inspection of opening elements (doors, windows, etc.)
- Floor inspection
- Roof inspection
- Systems inspection
- Evaluation of the airtightness

DIALOGUE (1h/1h30min)

Based on the technical characteristics of the buildings, the combinations available on the platform and the owner's needs, the auditor takes stock of the general state of the household and proposes several intervention options to the building owner. The plan presents a series of interventions to be completed by a specific date to achieve defined performance levels (compatible with the long-term energy consumption levels established by the energy transition law)

BE

Woningpas, Flanders, Belgium

The Flemish Energy Agency (VEA), in cooperation with a wide network of stakeholders, has designed and implemented the Renovation Pact (2014-2018), designed to lead to a thorough improvement of the energy performance of the region's building stock. Flanders established that by 2050 the existing building stock should become as energy efficient as the current requirements for new buildings (E60).

One of the main actions foreseen in the Renovation Pact is to develop the Woningpas (a logbook) and the EPC+ (a more user-friendly version of the EPC, including a clear overview of measures, ordered by priority, needed to reach the 2050 objective). The two instruments aim to provide building owners with useful, easy-to-understand information and long-term guidance. Through these instruments, the public authorities in Flanders also intend to contribute to the region's long-term objectives.

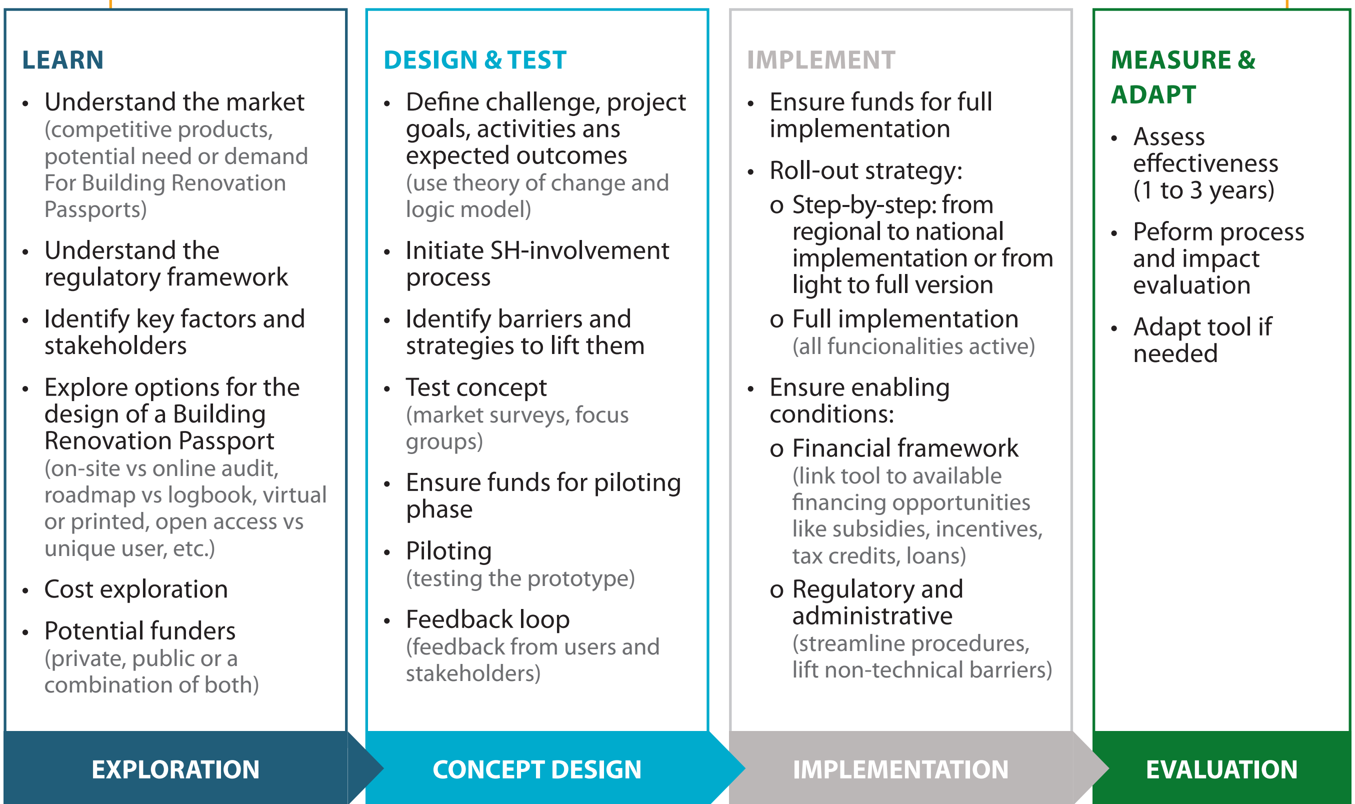
The Woningpas is a unique integral digital file of each individual building. The file can be retrieved by the building owner and by individuals who have been authorised access. The logbook features energy performance, renovation advice, the housing quality (such as stability, humidity, safety), data on the environment and, in the future, other building aspects such as durability, water, installations and building permits. The Woningpas, launched in December 2018, will make it possible to track the evolution of each individual building.

BE FR DE DK

iBRoad

The Horizon 2020-funded iBRoad project (ibroad-project.eu) has reviewed the process of creating the schemes in Flanders, France and Germany (as well as the BetterHome scheme in Denmark) and developed an overview of the process flow for creating an individual building renovation roadmap. Regardless of the nature of the originator (private, public or a combination of both) or its geographical coverage (municipal, regional or national), creating the conditions for a successful implementation of a building renovation passport requires careful planning. The process can be summarised in four main blocks (Figure 9): exploration, concept design, implementation and evaluation.

Figure 9 – Process flow of the creation of an individual building renovation roadmap
(Source: Based on [43], redesigned by BPIE)



In the **exploration phase**, it is important to get familiar with the landscape (the legislative framework, the renovation rate, innovation in the construction sector, the quality and awareness of energy auditing, etc.) and to identify the key market players and stakeholders to involve in the project. The results of this phase can be used to refine the initial idea and the internal process (**concept design**) to define the problem to solve, project goals, activities and expected outcomes, barriers and the target audience (who will use the final product). This phase may require the support of logic models and theory of change, market analysis and surveys to clearly define the overall project objectives and potential activities.

Concept design also includes piloting and testing. The duration of the testing phase may vary from a few weeks to several months and can be done on a small (a few dozen tests) or large scale (a few hundred). Testing should be used to get feedback from the potential users (e.g. building owners, auditors, public administrations, craftspeople and installers) to report bugs, errors and practical use (e.g. paper vs. online) to drive the refinement of the tool through a series of iterations and upgrades.

The complexity of this phase depends on many factors and local conditions, including the number and nature of stakeholders to involve, the technical, legislative, regulatory or financial barriers and the scale of the pilot phase.

After design and testing are completed, the tool is defined and ready to be put on the market (**implementation**). The implementation could be done step-by-step (from local to national level or by introducing a lighter version of the building renovation passport, followed by a complete version later) or in one go. During implementation, the enabling conditions for the successful use of the building renovation passport are also put to test: the availability and access to financial instruments (ease of access to financing opportunities), the regulatory and administrative framework (ease of access to a building renovation passport, ease of gaining permission to renovate) and the usability of the tool (information needed, ease of use).

An **evaluation** should be performed after the tool has been available on the market for one year (and every 2-3 years after that) to assess and measure the success of the tool, based on the conditions and objectives set in the concept design phase. Performance indicators, analytics and users' feedback can be used to adapt and evolve the tool to ensure its usability and added value over time.

RELATED GUIDANCE ON ENERGY PERFORMANCE CERTIFICATES AND BUILDING RENOVATION PASSPORTS

Buildings Performance Institute Europe (BPIE), "Innovation briefing - BetterHome," 2018.

iBROAD, "Country Factsheet Portugal," 2018.

iBROAD, "Country Factsheet Sweden," 2018.

iBROAD, "Country Factsheet Belgium," 2018.

iBROAD, "The Concept of the Individual Building Renovation Roadmap," 2018.

European Commission, "Impact Assessment for proposal for revision of EPBD," 2016.

Buildings Performance Institute Europe (BPIE), "Energy performance certificates across the EU," 2014.

4

SMART READINESS INDICATOR

(ARTICLE 8, ANNEX IA)

To foster the transition to smarter buildings, the European Commission will introduce a rating scheme for the "smart readiness" of buildings. It should assess the capabilities of a building to adapt its operation to the needs of the occupant and the grid, and to improve its energy efficiency and overall performance.

MAIN REQUIREMENTS

By 31 December 2019, the European Commission should establish an optional rating system for the smart readiness of buildings across the EU. This includes establishing the definition of the indicator, its calculation methodology and the technical modalities for implementation. Two articles of the EPBD relate to the smart readiness indicator: article 8 and Annex IA.

EPBD [2018/844] - Article 8

Technical building systems, electromobility and smart readiness indicator

10. The Commission shall, by 31 December 2019, adopt a delegated act in accordance with Article 23, supplementing this Directive by establishing an optional common Union scheme for rating the smart readiness of buildings. The rating shall be based on an assessment of the capabilities of a building or building unit to adapt its operation to the needs of the occupant and the grid and to improve its energy efficiency and overall performance.

In accordance with Annex Ia, the optional common Union scheme for rating the smart readiness of buildings shall:

(a) establish the definition of the smart readiness indicator; and

(b) establish a methodology by which it is to be calculated.

11. The Commission shall, by 31 December 2019, and after having consulted the relevant stakeholders, adopt an implementing act detailing the technical modalities for the effective implementation of the scheme referred to in paragraph 10 of this Article, including a timeline for a non-committal test-phase at national level, and clarifying the complementary relation of the scheme to the energy performance certificates referred to in Article 11.

EPBD [2018/844] - *Annex IA*

Common general framework for rating the smart readiness of buildings

1. The Commission shall establish the definition of the smart readiness indicator and a methodology by which it is to be calculated, in order to assess the capabilities of a building or building unit to adapt its operation to the needs of the occupant and of the grid and to improve its energy efficiency and overall performance.

   The smart readiness indicator shall cover features for enhanced energy savings, benchmarking and flexibility, enhanced functionalities and capabilities resulting from more interconnected and intelligent devices.

   The methodology shall take into account features such as smart meters, building automation and control systems, self-regulating devices for the regulation of indoor air temperature, built-in home appliances, recharging points for electric vehicles, energy storage and detailed functionalities and the interoperability of those features, as well as benefits for the indoor climate condition, energy efficiency, performance levels and enabled flexibility.

2. The methodology shall rely on three key functionalities relating to the building and its technical building systems:

   (a) the ability to maintain energy performance and operation of the building through the adaptation of energy consumption for example through use of energy from renewable sources;

   (b) the ability to adapt its operation mode in response to the needs of the occupant while paying due attention to the availability of user-friendliness, maintaining healthy indoor climate conditions and the ability to report on energy use; and

   (c) the flexibility of a building's overall electricity demand, including its ability to enable participation in active and passive as well as implicit and explicit demand response, in relation to the grid, for example through flexibility and load shifting capacities.

3. The methodology may further take into account:

   (a) the interoperability between systems (smart meters, building automation and control systems, built-in home appliances, self-regulating devices for the regulation of indoor air temperature within the building and indoor air quality sensors and ventilations); and

   (b) the positive influence of existing communication networks, in particular the existence of high-speed-ready in-building physical infrastructure, such as the voluntary 'broadband ready' label, and the existence of an access point for multi-dwelling buildings, in accordance with Article 8 of Directive 2014/61/EU of the European Parliament and of the Council ([*1]).

4. The methodology shall not negatively affect existing national energy performance certification schemes and shall build on related initiatives at national level, while taking into account the principle of occupant ownership, data protection, privacy and security, in compliance with relevant Union data protection and privacy law as well as best available techniques for cyber security.

5. The methodology shall set out the most appropriate format of the smart readiness indicator parameter and shall be simple, transparent, and easily understandable for consumers, owners, investors and demand-response market participants.

GUIDANCE FOR IMPLEMENTATION

CONTEXT

A more efficient, active and smarter building stock is the cornerstone of an affordable, reliable and decarbonised energy system. Increased integration of distributed energy, renewables, storage and the growing peak demand for electricity will drive the need for increased flexibility, demand-response capabilities and consumer empowerment. Buildings have the potential to be at the forefront of providing flexibility to the energy system, through energy production, control, storage and demand response, as well as through an interconnection with electric vehicles [44].

Smart technologies in buildings are crucial for an effective decarbonisation of the building and energy sectors. Buildings can function as highly efficient micro energy hubs that consume, produce, store and supply energy, making the system more flexible and efficient [45]. This will enable them to help balance the future energy system, characterised by a large share of variable renewables, through storage and demand responses. In order to achieve this, there is a need to boost building renovation investments and leverage smart, energy-efficient technologies. As importantly, smart buildings enable and ensure a healthy and comfortable living and working environment for the occupants [46].

The smart readiness indicator (SRI) is a policy instrument introduced by the European Commission, with the aim to facilitate and support the smart transformation of Europe's building stock [4]. The current proposal for an SRI, as developed by the consortium supporting the Commission in its definition, indicates the potential smartness of a property by evaluating the "functionality level" of various services present in a building These services are grouped into 10 domains: (i) heating, (ii) domestic hot water, (iii) cooling, (iv) mechanical ventilation, (v) lighting, (vi) dynamic building envelope, (vii) energy generation, (viii) demand side management, (ix) electric vehicle charging, and (x) monitoring and control. A higher functionality level is assumed to provide more beneficial impacts to the users of the building and/or the connected grid compared to a lower level. The smarter the services, the higher the SRI score [47].

The SRI should enable the end-user (building owner, occupant or investor) to understand what services the building can deliver and should contribute to the integration of the buildings sector into electricity systems and markets. It is intended to raise awareness of smart technologies in buildings, motivate consumers to invest in their buildings and support the uptake of technological innovation in the building sector. The SRI should further aim to improve the quality of life of building occupants and continuously ensure the effective operation of buildings. The general framework methodology of the SRI should also integrate aspects of indoor environmental quality to ensure a building can adapt to occupants' essential needs in terms of health, wellbeing and productivity in its operation [48].

Following the introduction of the SRI in the amended text, the European Commission relies on the support of contracted consortia for the development of technical studies before adopting legal (delegated and implementing) acts. A first technical study explored the potential characteristics of the indicator and was finalised in August 2018 [47]. A second technical study was launched in December 2018 to further define the SRI calculation methodology, explore policy options for the implementation of the SRI and evaluate their impact at EU level. Further consultation with stakeholders and reports on the topic are planned throughout the second technical study [49]. The delegated and implementing acts from the European Commission are expected to be published in 2020.

4

PRINCIPLES BEHIND THE SRI

BPIE suggests 10 principles (Figure 100) that should be in place to effectively achieve the transition to smart buildings. First and foremost, the potential to save energy through maximising energy efficiency should be fully exploited [45]. The SRI should build on these principles:

Figure 10 – Smart buildings in a decarbonised energy system – 10 principles to deliver real benefits for Europe's citizens (Source: [45])

As outlined in the amended text, the smart readiness of buildings is categorised into three key functionalities. The next steps explore how to integrate these into a rating and indicator system for the SRI. The three key functionalities are the abilities to:

1. **Maintain energy performance and operation** of the building through the adaptation of energy consumption, for example through use of energy from renewable sources
2. **Adapt its operation mode in response to the needs of the occupant** while paying due attention to the availability of user-friendliness, maintaining healthy indoor climate conditions and the ability to report on energy use
3. **Enable participation in active and passive as well as implicit and explicit demand response** in relation to the grid, for example through flexibility and load shifting capacities of a building's overall electricity demand.

The three functionalities set in the legal text broadly reflect the key elements that BPIE considers as defining smart buildings:

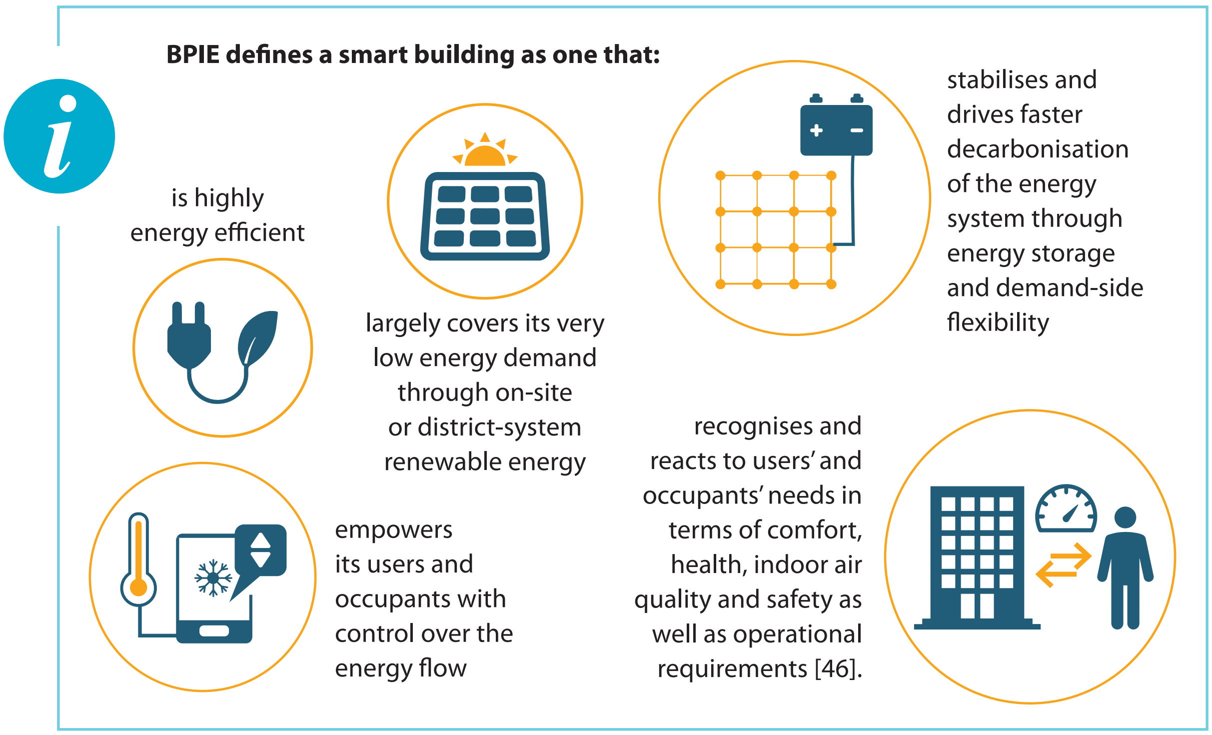


Figure 11 – Features of a smart building as defined by BPIE (Source [46])

HIGH BUILDING PERFORMANCE

through reduction of energy demand and greater use of locally-produced renewable energy, to ensure a healthy and comfortable indoor environment for users and occupants;

DYNAMIC OPERABILITY

to empower users and occupants with control over the energy flows and enhance the ability to optimise comfort, indoor air quality, well-being and operational requirements;

ENERGY-SYSTEM RESPONSIVENESS

to contribute to the optimum, smooth and safe operation of the energy system and district infrastructures to which the building is connected.

4

The SRI should promote the benefits of smart buildings for building users and occupants (e.g. cost savings, optimal indoor environmental quality), the energy system (e.g. reduced pressure on energy markets, security of supply, reduced need for investment in new capacity), the economy (e.g. creation of local jobs) and society as a whole (e.g. tackling climate change, reducing air pollution), by capturing the needs of building owners, occupiers, property valuers, financial institutions and facility managers.

The indicator should also improve policy linkages between energy, buildings and other policy segments and contribute to the integration of the buildings sector into future energy systems and markets. The SRI development must be contextualised in the EU's broad energy policy agenda. This includes increasing variable and decentralised energy production; offering new technological opportunities for consumers to actively participate in electricity markets through demand response, self-consumption and storage; and moving towards low carbon transport through electric cars and other e-mobility solutions. These objectives support, at a higher level, the decarbonisation of the energy system. In this sense, national policy-makers need to transpose the EPBD in alignment with the implementation of other provisions of the Clean Energy Package, such as the new provisions agreed in the Electricity Market Design (Electricity Directive and Regulation).

ACTION FROM MEMBER STATES

Technical support studies contracted by the European Commission will assist the development of the SRI and Member States are encouraged to actively engage as a stakeholder during the various planned consultations. Engaging and consulting with national stakeholders on a smart readiness indicator will prepare the ground for later implementation and gather input into its development.

Member States should keep in mind the benefits of smart buildings and the forthcoming indicator in developing their own approaches to improving the smartness of buildings. An overview of national initiatives to promote smart technologies and well-connected buildings and communities is required within national renovation strategies (see chapter 1 of this guide). The benefits of the SRI will be greater where policies supporting adoption of smart technologies and smart buildings are also in place. The SRI should fit into a system of regulations and incentives that drive the uptake of smart solutions and ensure the relevance of the indicator.

In addition, the SRI should integrate indoor environmental quality features such as indoor air quality. Smart buildings need to go beyond being energy efficient and healthy by recognising and reacting to users' and occupants' needs to optimise comfort, indoor air quality, wellbeing and operational requirements.

RELATED GUIDANCE ON SMART BUILDINGS AND SRI

Buildings Performance Institute Europe (BPIE), "Smart Buildings Decoded," 2018.

VITO, Waide Strategic Efficiency, ECOFYS, OFFIS, "Support for setting up a smart readiness indicator for buildings and related impact assessment – Final report", 2018.

Buildings Performance Institute Europe (BPIE), "Smart buildings in a decarbonised energy system – 10 principles to deliver real benefits for Europe's citizens," 2016.

5

CALCULATING ENERGY PERFORMANCE

(ANNEX I)

The new text revised the calculation methodology to assess and describe the energy performance of buildings, with the aim of increasing transparency and consistency.

This chapter presents Annex I of the EPBD and provides an overview of its main requirements, an explanation of the indicators Member States must consider when applying the new methodology and examples of how the different indicators can impact energy performance calculations.[8] Due to the nature of the topic discussed, this chapter is more technical than the others in this guide but the most important principles and concepts are presented in an illustrative way.

NOMENCLATURE

COP	Coefficient of Performance
f_{Pnren}	Non-renewable primary energy factor
f_{Pren}	Renewable primary energy factor
f_{Ptot}	Total primary energy factor

IMPORTANT NOTE: all the terms defined in ISO or EN Standards or the EU Directives are written in *underlined italics* in this text.

MAIN REQUIREMENTS

A new methodology to assess and describe the energy performance of buildings is set out – including how to count the use of renewable energy sources. Annex I of the Amended EPBD [2018/844] states that:

> ***EPBD [2018/844]*** *- Annex I*
>
> 1. The energy performance of a building shall be determined on the basis of calculated or actual energy use and shall reflect typical energy use for space heating, space cooling, domestic hot water, ventilation, built-in lighting and other technical building systems.
>
> The energy performance of a building shall be expressed by a numeric indicator of primary energy use in kWh/(m2.y) for the purpose of both energy performance certification and compliance with minimum energy performance requirements. The methodology applied for the determination of the energy performance of a building shall be transparent and open to innovation.
>
> Member States shall describe their national calculation methodology following the national annexes of the overarching standards, namely ISO 52000-1, 52003-1, 52010-1, 52016-1, and 52018-1, developed under mandate M/480 given to the European Committee for Standardisation (CEN). This provision shall not constitute a legal codification of those standards.

[8] This chapter partially draws from ongoing work in the EU-funded project AZEB (Affordable Zero Energy Buildings) Grant agreement ID: 754174. Authors L. Pagliano and A. Roscetti. https://cordis.europa.eu/project/rcn/210096/factsheet/en

Annex I of the amended text states that it is important to take due account of the quality of the indoor environment. It states that the *energy needs* "shall be calculated in order to optimise health, indoor air quality and comfort levels".

According to Annex I, Member States must ensure that the energy performance is expressed in primary energy use in kWh/(m^2·y) for the purpose of both energy performance certification and compliance with minimum energy performance requirements. Member States may also explore additional indicators to express the energy performance of a building.

Article 2 of the EPBD[9] defines primary energy in a way that corresponds to the more precise definition of *total primary energy* given e.g. in EN-ISO 52000-1 [50] and 52000-2 [51]. Standards EN-ISO 52000-1 and 52000-2 are among those developed under the mandate M/480 to the CEN, CENELEC and ETSI for the elaboration and adoption of standards for a methodology calculating the integrated energy performance of buildings and promoting energy efficiency. However, Annex I explicitly gives Member States the option to define additional numeric indicators in line with CEN/ISO Standards.

> Using multiple indicators to describe the energy performance of a building is necessary to avoid providing a misleading picture of the impact of various measures. One shortcoming of relying solely on a single primary energy indicator is that a better energy performance could be achieved by simply switching the energy supply of a building to renewable energy. However, doing so undermines the real benefits of improving the fabric of the building. This is particularly the case for thermal comfort which is best achieved by improving the quality of the building envelope (more uniform surface temperatures, no cold drafts, better availability of daylighting, etc.). Therefore, indicators of the *energy needs for heating and cooling* as well as *total primary energy*, are needed to avoid wasteful use of energy, even from renewable sources, and realise the full multiple benefits of a thermally more energy efficient building fabric.

GUIDANCE FOR IMPLEMENTATION

CALCULATION STEPS

The current approach of using separate national procedures and standards in different Member States, and indeed within different regions within a Member State, creates a market barrier for energy saving products, systems technologies and design strategies for new constructions and retrofits. The new set of EN-ISO building-related standards, which are to be implemented in all jurisdictions,[10] proposes well-grounded energy performance procedures that can be used to overcome this barrier. The application of these standards, although voluntary, will be conducive to stimulating innovative energy-saving solutions

9 EPBD Art2: "'primary energy' means energy from renewable and non-renewable sources which has not undergone any conversion or transformation process."

10 As stated in EPBD Annex I: "Member States shall describe their national calculation methodology following the national annexes of the overarching standards, namely ISO 52000-1, 52003-1, 52010-1, 52016-1, and 52018-1, developed under mandate M/480 given to the European Committee for Standardisation (CEN). This provision shall not constitute a legal codification of those standards."

that can be applied and adapted everywhere in Europe, because they will be evaluated according to the same principles in a transparent way.

The different indicators are presented here in the order in which they intervene in the calculation of overall performance, according to EN ISO standards, including EN ISO 52000 and the Cost Optimal Guidelines of EU Commission.

The first step in the calculation of the overall energy performance is to define the objective of the design in terms of *comfort category* based on the corresponding standard, EN 15251[11] [52]. Once the objective of the design in terms of *comfort category* according to one of the thermal comfort models (PMV[12] or adaptive[13]) has been chosen, the performance of the envelope in delivering that level of comfort can be evaluated in terms of the *energy needs for heating and cooling*, and the *energy needs for hot water* [53]. *Energy use for lighting* (by electric lighting systems), daylighting/visual comfort may also be addressed for some building types (e.g. school, offices, large buildings).[14]

The second step should be to evaluate the performance of systems (i.e. their efficiency in covering the *energy needs* starting from non-renewable or renewable sources) using the indicator *total primary energy* use.

The next step should be to calculate the *non-renewable primary energy* use, which accounts for the part of total primary energy not yet covered by renewable energy (whether generated *on-site*, *nearby* or at a *distant* location).

The final step should be to calculate the *total/renewable/non-renewable primary energy*, which is calculated by multiplying each stream of *delivered energy* for the respective *total/renewable/non-renewable primary energy factor*.

The indicators "*energy needs*" and "*total primary energy*" align with the "energy efficiency first" principle, while the parameter "*non-renewable primary energy*" aligns with the objective of "increasing the share of renewables" and "further decarbonise the building stock".

> It is very important that all actors involved, including regulators and policy-makers, consistently use the same set of physical concepts, definitions and nomenclature. This will ensure better results in terms of comfort levels and energy use and will be a pre-requisite for devising clear design and construction guidelines. It will also reduce the costs involved in miscommunication and misunderstandings leading to design and construction errors and subsequent costly remediation work.

The calculation of the delivered and primary energy may take into account the various *building energy services* (such as space heating, cooling, lighting, ventilation). The choice of the services considered depends on the specific building category. The use of partial indicators for single energy services provide possible additional leverage for increasing the efficiency of single specific *technical building systems*. For example, an indicator for evaluating the energy performance of lighting systems, expressed in kWh/(m^2·y), could be used for benchmarking, comparison between buildings, setting limit values, etc.

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[11] In March 2019 this should be replaced by "EN 16798-1:2019, Energy performance of buildings - Part 1: Indoor environmental input parameters for design and assessment of energy performance of buildings addressing indoor air quality, thermal environment, lighting and acoustics"

[12] PMV, predicted mean vote, as defined in EN ISO 7730:2005, Ergonomics of the thermal environment. Analytical determination and interpretation of thermal comfort using calculation of the PMV and PPD (predicted percentage of dissatisfied) indices and local thermal comfort criteria.

[13] Comfort categories and the adaptive comfort model applicable in Europe are defined in EN 15251:2007, Indoor environmental input parameters for design and assessment of energy performance of buildings addressing indoor air quality, thermal environment, lighting and acoustics. Calculations and visualisation of comfort categories are available online at http://comfort.cbe.berkeley.edu

[14] The scope of the EPBD is to set limits to the energy consumption of buildings and allow comparison between them through the certificate. Following the EPBD, lighting is already incorporated within the whole building energy calculation. A practically effective inclusion of the calculation for lighting systems consumption requires an indicator for the specific lighting consumption with a maximum allowable limit. The indicator or requirement shall support the improvement of the lighting systems in the design phase and for describing the quality of the systems installed. Source: "Tool for support of lighting in EPBD implementation", PremiumLight_Pro consortium.

5

Primary energy may additionally be calculated with or without compensation between different energy carriers and with or without compensation for renewable energy exported to the grid.[15] In the latter case, when divided by the floor area of the building, it is called _numerical indicator of non-renewable energy use with compensation_ in ISO 52000-1.

Total Primary Energy Factors (f_{Ptot}) were introduced to calculate how much primary energy is required to generate a unit of _delivered energy_ (sometimes called final energy), using usage indicators. The higher the difference between primary and final energy use, the higher the losses in the energy system. Table 10 shows example values of non-renewable, renewable and total primary energy factors taken from EN ISO 52000-1.

Table 10 – Default values of non-renewable (f_{Pnren}), renewable (f_{Pren}), and total primary energy (f_{Ptot}) factors from EN ISO 52000-1

Energy carrier Delivered from distant		non-renewable energy factor (f_{Pnren})	renewable energy factor (f_{Pren})	total primary energy factor (f_{Ptot})	K_{CO_2e} (g/kWh)
Delivered from distant	Solid	1.1	0	1.1	360
	Liquid	1.1	0	1.1	290
	Gaseous	1.1	0	1.1	220
Biofuels	Solid	0.2	1	1.2	40
	Liquid	0.5	1	1.5	70
	Gaseous	0.4	1	1.4	100
Electricity [a]		2.3	0.2	2.5	420
Delivered from nearby					
District heating [b]		1.3	0	1.3	260
District cooling		1.3	0	1.3	260
Delivered from on-site					
Solar	PV electricity	0	1	1	0
	Thermal	0	1	1	0
Wind		0	1	1	0
Environment	Geo-, aero-, hydrothermal	0	1	1	0
Exported					
Electricity [a c]	To the grid	2.3	0.2	2.5	420
	To non EPB uses	2.3	0.2	2.5	420

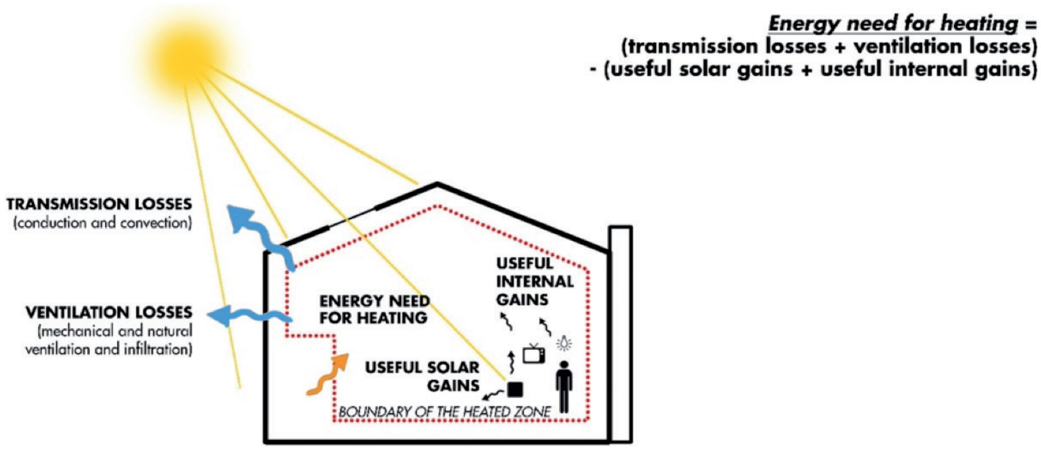
[15] Although the standards do not clearly recommend so, compensation between different energy carriers should be avoided as it will result in a distorted picture on the energy efficiency of a building. This is because the different energy factors between fossil fuels and exported electricity from PV would result in one unit of exported electricity compensating several units of e.g. gas consumed.

LIST OF INDICATORS

The overarching standard EN ISO 52000-1 states: "the use of only one requirement, e.g. the numerical indicator of primary energy use, can be misleading. In ISO 52000-1 different requirements are combined to a coherent assessment of nearly Zero-Energy Building." To avoid this misleading interpretation of the energy performance of a building, the standard explains which indicators should be used. The application of these indicators would promote transparency and facilitate the introduction of common procedures to measure energy performance across Member States:

- *Energy needs for heating and cooling* (for quantifying energy losses through the envelope and via air infiltration and ventilation). E.g. in winter it accounts for transmission losses plus ventilation losses minus free useful energy gains from appliances, people and solar radiation entering via the transparent elements.

Figure 12 – Description of the energy flows to take into account when calculating the *energy needs for heating* (Source: [54])



- *Total primary energy* use (for quantifying the inefficiencies in the systems – e.g. avoid burning biomass in an inefficient burner).
- *Non-renewable primary energy* use without compensation between energy carriers and without compensation for sales of renewable energy from the building to the grid. This indicator allows to quantify the non-renewable fraction within *total primary energy* use.
- *Numerical indicator of non-renewable energy use with compensation*. Only at this stage can compensation between different energy carriers or times[16] be taken into account (or not, depending on national choices). For example, cross-compensation[17] between gas and *on-site* renewable generation or the accounting of exported energy at a certain time as a compensation of energy use at another time (on an hourly, monthly or yearly basis).

[16] In certain countries, notably the USA, an energy balance over a year is calculated; yearly balance = total primary energy use minus renewable primary energy generation on site, without considering when energy is used and produced. If a building produces a lot of energy from PV in summer and consumes oil in winter, the two may sum up to zero in this unphysical balance. It assumes that 100% of PV energy is stored without losses from summer to winter. In reality, inter-seasonal storage is not available at the scale needed to transform buildings to nZEB and is extremely costly in material, embodied energy and energy storage losses.

[17] If in a certain time interval, a building uses a kWh of primary energy from natural gas and produces a kWh of primary energy from PV, an unphysical cross-compensation would mean that the primary energy use is 1-1=0. Obviously, the environmental impact is far from being zero. The cross-compensation accounting is a pure convention, which may induce a very misleading interpretation of what is actually happening, not only among the general public but also among professionals and the construction industry.

In order to ensure transparency, Member States should define minimum standards or requirements for the different indicators, used in the reported order and depending on the scope:

- The *energy needs* indicator, for improving the thermal quality of the building fabric (and the comfort level) in summer and winter and reducing the subsequent energy use by the active systems, thus ensuring the application of the "energy efficiency first" principle
- The *total primary energy* indicator, for improving the performance of the technical building systems and the quality of the related energy carrier(s)
- The *non-renewable primary energy indicator*, for reducing the impact of non-renewable energy (pushing towards more use of renewable energy)

!

There are several advantages of a unique calculation and evaluation procedure for all the actors involved in the process. Designers, consultants, authorities, policy-makers and consumers could compare buildings of different quality evaluated with the same methodology and indicators. For example, during the design phase it would be possible to estimate the extra effort for improving the energy performance (including to nZEB level) without having to refer to different evaluation procedures. It is then easier to compare buildings with different performance since all the indicators will be available in a consistent manner. The opportunity given in the revised Annex I to use additional numeric indicators in line with CEN/ISO standards allows for different actors to use different indicators, but the use of the CEN/ISO standard would ensure compatibility among Member States.

In order to describe the extent to which Member States might choose to consider the accounting of exported energy at a certain time as a compensation of energy use at another time, the standard introduces a k_{exp} factor, variable between 0 and 1. A value $k_{exp} = 0$ describes the absence of compensation, whereas a value $k_{exp} = 1$ describes the situation where each unit of energy exported compensates for one unit of energy used. Intermediary situations are possible. One of the disadvantages of actually using compensation is that it makes likely a double-counting of renewable energy which is generated on site and exported. It would be counted as a direct improvement of the building performance and at the same as an improvement of the f_{Pnren} of energy from the grid, which in turn intervenes in the calculation of the building performance. It also transfers costs for management of variable energy generation from the building to the grid, hence removing a price signal towards optimisation of demand loads.[18]

[18] If nZEBs are defined using compensation (where zero non-renewable energy use is the result of compensation), it will not be necessary to reduce the energy use (by efficiency improvements, which have a cost) or move it in time to better match with RES availability (via better envelope or the installation of energy storage, which have a cost). Thus, an nZEB will cost less, but the energy grid will bear the cost of this mismatch between time of use and time of RES generation. The national energy system will need to build new reserve generation capacity (probably fossil supplied) or energy storage to be activated quickly when needed.

Energy needs

Energy needs (in kWh/(m²·y)) gives information about the intrinsic efficiency of the building fabric (shape and orientation, form factor, insulation level, airtightness, solar protection, etc.). This requirement is useful for policy-makers to set the performance of the building envelope *per se*, before going on to consider the efficiency of the technical systems for heating and cooling.

The calculation of this specific indicator should follow ISO 52016-1:2017 [55]. This specifies calculation methods for the assessment of *energy need for heating and cooling*, latent energy need for (de-) humidification, the internal temperature, etc. ISO 52018-1:2017 [56] could also help to report the choices made for the definition of this partial indicator. ISO 52018-1:2017 deals with the usage as requirement of partial energy performance of buildings (EPB) indicators related to the fabric and thermal balance of the building.

Considering the thermal quality of the envelope (stationary and periodic thermal transmittance, solar protections and their controls, presence of summer night ventilation, typical operating temperatures, etc.), it is possible to calculate the *energy need for heating and cooling* of a defined building, expressed in kWh/(m²·y).

For policy-makers: setting specific limits to this indicator is necessary to address the efficiency of the building fabric per se, before considering technical systems. Missing this step would mean missing a large potential for energy savings and a unique source of thermal comfort.

The use of an additional specific index, in terms of energy use per square metre for inbuilt lighting systems (typically not used for residential buildings), will define the performance of the lighting systems. This should take into account the quality of the lighting design and the daylighting contribution for the reduction of lighting consumption, typically dependent on the project (the methodology is defined in EN 15193-1:2017).

EXAMPLES

For sake of simplicity, each example covers only one calculation interval (a year). More precise analysis for smaller time steps (monthly, hourly, etc.) is recommended, due to the dynamic nature of such calculations (seasonality of weather conditions, hourly change of solar heat gains, etc.).

A typical existing building in central Europe, with poorly insulated building fabric, old windows and no external shading systems, might have an *energy need for heating* in the order of 190 kWh/(m²·y), i.e. 160 kWh/(m²·y) for heating and a need of 30 kWh/(m²·y) for cooling.

An improved building, with high level insulation fabric, good windows, external shading systems and controlled ventilation with heat recovery, might have an *energy need* reduced to 40 kWh/(m²·y) of which 30 kWh/(m²·y) is for heating and 10 kWh/(m²·y) for cooling (or even lower, as in the case of PassivHaus certified buildings).

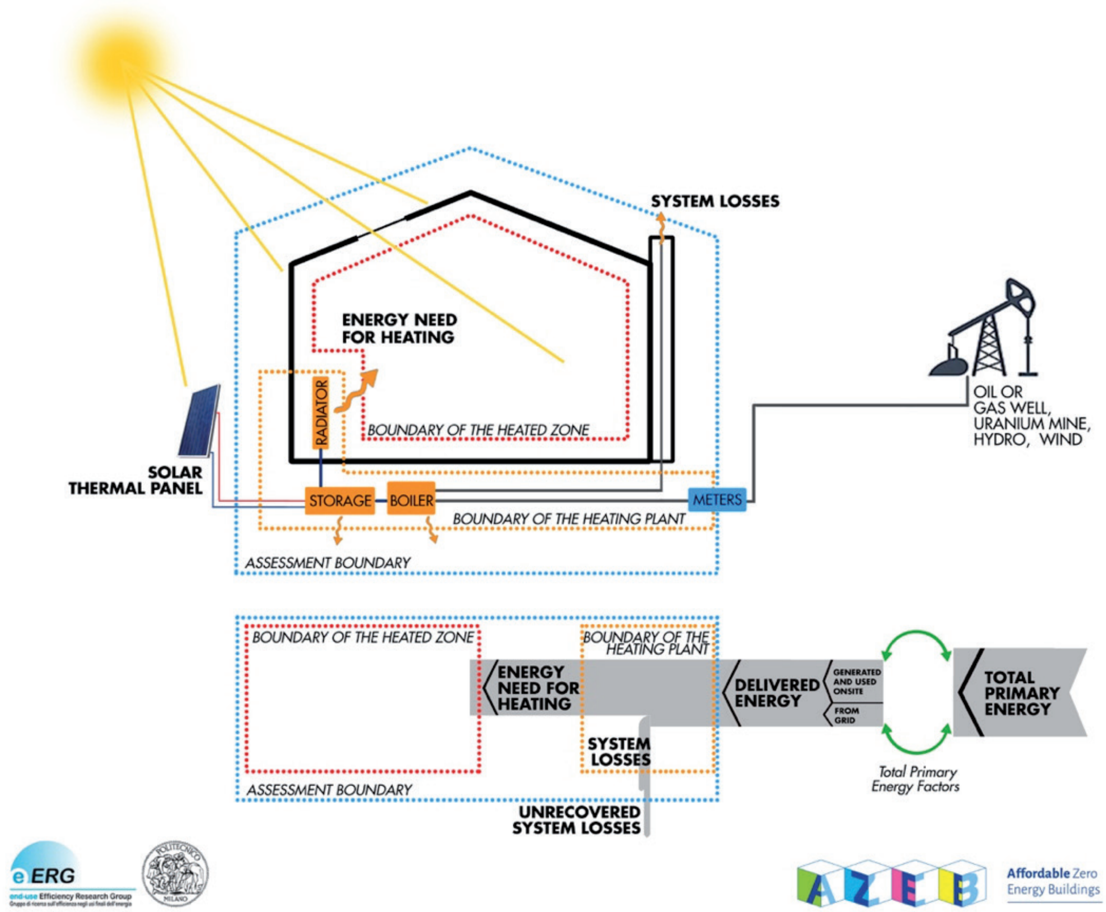
Total primary energy use

The second requirement, *total primary energy use*, includes technical building systems and considers the energy carriers that feed them.

This requirement is considered as the main indicator expressing the building energy performance in Annex I of the EPBD. It includes the energy used by each system (heating, cooling, ventilation) in order to cover the *energy needs* of the building in conjunction with a specified *comfort category*. The efficiency of the different technical systems is taken into account for calculating the amount of *delivered energy* flowing to the systems through the assessment boundary of the building from different sources (*on-site, nearby* and *distant*).

The *total primary energy* is the sum of all flows of *delivered energy* (renewable and non-renewable), each being weighted with their respective f_{Ptot}.

Figure 13 – Schematic description of the relation between *delivered energy* (sometimes called final energy) and *primary energy* use (Source: [54])



Examples of total primary energy use

The examples below show how the largest reduction in *total primary energy* is achieved by improving the *building fabric*, before any changes to the active systems.

a. The typical building is heated by a natural gas heater (efficiency 90%, f_{Ptot} for gas = 1.1) and cooled by a heat pump connected to the electric grid (COP = 3, f_{Ptot} for electricity = 2.5):
   - *The energy needs for heating* are 160 kWh/(m^2·y), for cooling 30 kWh/(m^2·y).
   - The *total primary energy* use indicator is [(160/0.9)*1.1)]+[(30/3)*2.5)]= 195.6+25 = 220.6 kWh/(m^2·y) of total primary energy.

b. The building with high quality building fabric and the same systems is heated by a natural gas heater (efficiency 90%, f_{Ptot} for gas = 1.1) and cooled by a heat pump connected to the electric grid (COP = 3, f_{Pto}t for electricity = 2.5):
   - The *energy needs for heating* are 30 kWh/(m^2·y), for cooling 10 kWh/(m^2·y).
   - The *total primary energy* use indicator is [(30/0.9)*1.1] + [(10/3)*2.5] = 36.7+8.3 = 45 kWh/(m^2·y) of total primary energy

c. The typical building is heated by a wood stove (efficiency 70%, f_{Ptot} for wood = 1.2) and cooled by a heat pump connected to a PV system able to cover the entire demand (COP = 3, f_{Ptot} for electricity generated on-site by PV and self-consumed = 1):
   - The *energy needs for heating* are 160 kWh/(m^2·y), for cooling 30 kWh/(m^2·y).
   - The total primary energy use indicator is [(160/0.7)*1.2]+[(30/3)*1]= 274.3+10 = 284.3 kWh/(m^2·y) of total primary energy.

d. The building with high quality building fabric is heated by a wood stove (efficiency 70%, f_{PTOT} for wood = 1.2) and cooled by a heat pump connected to a PV system able to cover the entire demand (efficiency of the HP 300%, f_{PTOT} = 1 for electricity generated *on-site* by PV and self-consumed):
   - The *energy needs for heating* are 30 kWh/(m^2·y), for cooling 10 kWh/(m^2·y).
   - The *total primary energy* use indicator is [(30/0.7)*1.2]+[(10/3)*1]= 51.4+3.3 = 54.7 kWh/(m^2·y) of total primary energy.

e. The building with high quality building fabric is heated by a natural gas heater (efficiency 90%, f_{PTOT} for gas = 1.1) and cooled by a heat pump connected to a PV system able to cover the entire demand (COP = 3, f_{PTOT} for electricity generated *on-site* by PV and self-consumed = 1):
   - The *energy needs for heating* are 30 kWh/(m^2·y), for cooling 10 kWh/(m^2·y).
   - The *total primary energy* use indicator is [(30/0.9)*1.1]+[(10/3)*1]= 36.7+3.3 = 40 kWh/(m^2·y) of total primary energy.

The introduction of a wood stove and PV system without improving the fabric leads to **an increase in total primary energy** use from 220.6 kWh/(m^2·y) (case a) to 284.3 kWh/(m^2·y) (case c) due to the lower efficiency of the wood stove compared to the gas boiler and the higher f_{Ptot} of wood.

In order to further clarify the role of Renewable Energy Sources (RES) another indicator is available and necessary, the *non-renewable primary* use.

Non-renewable primary energy (without compensation)

The third requirement, *non-renewable primary energy*, is similar to the second (*total primary energy* or simply primary energy) but uses a different set of conversion factors for primary energy, since it uses the f_{Pnren} instead of the f_{Ptot} when weighting the various streams of *delivered energy* that cross the *assessment boundary* of the building.

In doing so, it attributes a weight of zero to the energy captured by natural energy flows (renewables). Clearly, this an approximation, since the use of renewables also has an environmental impact, though generally lower than that of non-renewable sources (e.g. use of biomass can be a net emitter of CO_2 if it is harvested faster than it is growing; biomass burning emits PM10 and PM 2.5 and has implications for land use; PV and wind turbines require mining of materials for the physical infrastructure, use of land, landscape impacts, etc.).

The efficiency of the different technical systems is taken into account, as well as the *primary non-renewable energy factor* (f_{Pnren}) for each energy carrier. The f_{Pnren} is used to transform the delivered energy – used by the technical building systems for covering the building's needs – into primary energy, and is defined at country/regional level. Renewable energy generated on site and exported to the grid is not included in this calculation; only the self-consumed RES generation is counted, since it is this fraction which is delivered to the building.

> This requirement is useful for policy-makers to set the energy performance of the building, considering also the technical building systems, and the impact of the different energy sources.

Examples of non-renewable primary energy (without compensation)

In case (a) the typical building is heated by a natural gas heater (efficiency 90%, f_{Pnren} for gas = 1.1) and cooled by a heat pump connected to the electric grid (COP = 3, f_{Pnren} for electricity = 2.3):

- The *energy needs for heating* are 160 kWh/(m²·y), for cooling 30 kWh/(m²·y).
- The *non-renewable primary energy* use indicator is [(160/0.9)*1.1)]+[(30/3)*2.3)]= 195.6+23 = **218.6** kWh/(m²·y).

In case (b) the building with high quality fabric is heated by a natural gas heater (efficiency 90%, f_{Pnren} for gas = 1.1) and cooled by a heat pump connected to the electric grid (COP = 3, f_{Pnren} for electricity = 2.3):

- The *energy needs for heating* are 30 kWh/(m²·y), for cooling 10 kWh/(m²·y).
- The *non-renewable primary energy* use is [(30/0.9)*1.1)]+[(10/3)*2.3)]= 36.7+7.7 = **44.3** kWh/(m²·y).

In case (c) the typical building is heated by a wood stove (efficiency 70%, f_{Pnren} for wood = 0.2) and cooled by a heat pump connected to a PV system able to cover all the energy need for cooling (COP = 3, f_{Pnren} = 0):

- The *energy needs for heating* are 160 kWh/(m²·y), for cooling 30 kWh/(m²·y).
- The *non-renewable primary energy* use indicator is [(160*0.7)*0.2]+[(30/3)*0]= 45.7+0 = **45.7** kWh/(m²·y).

In case (d) the building with a high quality fabric is heated by a wood stove (efficiency 70%, f_{Pnren} for wood = 0.2) and cooled by a heat pump connected to a PV system able to cover all the energy needs for cooling (COP = 3, f_{Pnren} = 0 for PV generated on-site and self-consumed):

- The *energy needs for heating* are 30 kWh/(m²·y), for cooling 10 kWh/(m²·y).
- The *non-renewable primary energy* use is [(30/0.7)*0.2]+[(10/3)*0]= 8.6 + 0 = 8.6 kWh/(m²·y).

Improving only the *building fabric* reduces *non-renewable primary* use from 218.6 kWh/(m²·y) (case a) to 44.3 kWh/(m²·y), (case b). Leaving the building fabric unchanged and supplying with RES reduces *non-renewable primary use* from 218.6 kWh/(m²·y) to 45.7 kWh/(m²·y). Improving the building fabric and supplying 100% RES reduces *non-renewable primary use* from 218.6 kWh/(m²·y) to 8.6 kWh/(m²·y), which is the optimum result achieved.

The optimum result was achieved when first the *energy needs* were reduced by improving the condition of the *building fabric* and then the remaining demand was covered almost completely by RES, which proves the importance of the "energy efficiency first" principle.

Non-renewable primary energy use with compensation

The non-renewable energy indicator with compensation considers both the non-renewable primary energy used by the building and the exported *renewable primary energy*. At this stage compensation between different energy carriers may be taken into account, for example between gas and *on-site* RES production and the accounting of exported renewable energy as a compensation for energy use in another time period, on an hourly, monthly or yearly basis. In order to describe the extent to which Member States might choose to consider the accounting of exported energy as a compensation of energy use, the Standard introduces a kexp factor, variable between 0 and 1. As noted earlier, a value kexp = 0 describes the absence of compensation while a value kexp = 1 describes the situation where each unit of energy exported compensates for one unit of energy used. Intermediary situations are possible.

IT

Example:

Use of the indicator "non-renewable primary energy use with compensation" in Italy

In Italy, "DM 26 June 2015" defines how renewable energy generated on-site can be counted in the calculation of the yearly primary energy use:

- Only to contribute to the same energy carrier (e.g. electricity with electricity: no compensation between different energy carriers)
- Only as long as the monthly energy use of that carrier is covered. The excess RES production in one month (produced on site and exported, e.g. in July) cannot be used to compensate for energy use in another month (e.g. December) in excess of RES generation in that month. The choice of a month as minimum time interval is connected to the calculation procedure which is based on monthly average values of environmental variables

Since the calculation step is a month (and not e.g. an hour) there is no possibility to check if PV generated electricity in e.g. a certain hour is self-consumed in that hour or sold to the grid. Italian legislation assumes as self-consumed a part of PV energy generated in a month not higher than the energy use by the building, which is an overestimate. The PV-generated energy in excess of use in that month is assumed as sold to the grid, but it cannot be used to offset primary energy use in another month. For sake of simplicity we assume in our example below that 50% of the PV energy generated yearly which is sold to the grid intervenes in the compensation calculation, while 50% does not intervene in the performance of the building and is considered only in the energy mix of the grid. This avoids double counting.

In case (e), the building with the high quality envelope is heated by a gas boiler (efficiency 90%, f_{Pnren} for gas = 1.1) and cooled by a heat pump connected to a PV system able to cover all the _energy needs for cooling_ (COP = 3, f_{Pnren} = 0 for electricity from _on-site_ PV and self-consumed). The PV system generates a quantity of electricity of 10 kWh/(m^2·y). The fraction sold to the grid which can be considered for compensation is assumed to be 50% (in other terms, the kexp factor is assumed to be 0.5):

- The _energy needs for heating_ are 30 kWh/(m^2·y), for cooling 10 kWh/(m^2·y)
- The _non-renewable primary energy_ use is [(30/0.9)*1.1]+[(10/3)*0]= 36.7+0 = 36.7 kWh/(m^2·y).
- The PV production in excess and exported is 10-[(10/3)*1]= 6.7 kWh/(m^2·y).
- The k_{exp} is set at 0.5 hence the PV exported energy which is used for compensation is 6.7*0.5 kWh/(m^2·y) = 3.3 kWh/(m^2·y)

In case (f), the _non-renewable primary energy indicator with compensation_, as difference between the non-renewable primary energy use and the exported renewable energy: 36.7-3.3 = 33.4 kWh/(m^2·y).

Table 11 summarises all the examples above, showing the impact of the combination of the indicators in the calculation of the energy performance of a building.

Table 11 Summary of the examples presented in this chapter

	Example	Energy needs for heating, kWh/(m^2·y)	Energy needs for cooling, kWh/(m^2·y)	Total primary energy, kWh/(m^2·y)	Non-renewable primary energy, kWh/(m^2·y)	Non-renewable primary with compensation, kWh/(m^2·y)
Typical building fabric Gas boiler for heating HP for cooling	**a**	160	30	220.6	218.6	
Improved building fabric Gas boiler for heating HP for cooling	**b**	30	10	45.0	44.3	
Typical building fabric Woodstove for heating HP supplied 100% by PV	**c**	160	30	284.3	45.7	
Improved building fabric Woodstove for heating HP supplied 100% by PV	**d**	30	10	54.8	8.6	
Improved building fabric Gas boiler for heating HP supplied 100% by PV	**e**	30	10	40.0	36.7	
Improved building fabric Gas boiler for heating HP supplied 100% by PV Compensation for export from PV to grid	**f**	30	10	40.0	36.7	33.4

Having a common understanding of how to use which indicators and their relevance is essential to guarantee transparency and comparison among Member States. This will help ensure existing legislation is effectively implemented to achieve the 2050 target of a highly efficient and decarbonised building stock.

RELATED GUIDANCE ON CALCULATING ENERGY PERFORMANCE

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