CONCERTED ACTION
ENERGY PERFORMANCE OF BUILDINGS

(CT3) Existing Buildings
Status in 2022

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KEYWORDS
Deep renovation, Building Renovation Passport, Building valuation, Monetising energy efficiency, Technical Building Systems, Inspection, Decarbonisation

1. Introduction

This report provides an overview of the work performed on the topic 'Existing Buildings' during the fifth phase of the Concerted Action (CAV) of the Energy Performance of Buildings Directive (EPBD). Specifically, the Core Team (CT) for Existing Buildings considered the relevant EPBD articles and their transposition and implementation by Member States, especially in view of the provisions of the amending Directive 2018/844/EU and the overall goal of achieving a carbon neutral Europe by 2050 (Green Deal[1]). The CT prepared topics for discussion with Member States in close coordination and collaboration with colleagues from other CTs, in order to effectively identify linkages and overlaps, not only with other CAV CTs, but also with earlier sessions in one of the predecessor Concerted Actions. The process was also well facilitated by a thematic working group consisting of representatives of Member States who volunteered to support the work.

As the current report builds on previous work of the CA EPBD, it is recommended that readers interested in Existing Buildings in the context of the EPBD could read the thematic reports available from the fourth phase of the Concerted Action EPBD and even earlier phases as well. All reports are easy to find on the CA EPBD website[2].

2. Objectives

The objective of this report is to provide information about existing buildings, especially on effective ways to increase the rate of deep renovations, in order to address Nearly-Zero Energy Buildings (NZEB) requirements and the Building Renovation Passport to facilitate deep renovations, technical building systems, and financial aspects.

In contrast to single energy efficiency measures, deep renovations aim for a substantial improvement of the building energy performance, which effectively means to strive for NZEB targets. NZEB requirements have already demonstrated the important combination of renewable energy systems with energy efficiency measures in achieving high performance buildings. The amending Directive (EU) 2018/844 has strengthened the role of renewable energy systems by including them in the definition of technical building systems.

With regard to technical building systems, energy efficiency potentials are reviewed by looking at EPBD article 8(1) and 8(9) on assessment and enforcement of systems requirements, and the user-friendliness of inspection reports for heating and cooling systems (EPBD articles 14 and 15). Decarbonisation options based on district energy supply for heating and cooling and electricity-based technologies for phasing-out fossil fuels at individual building level, are also investigated.

Financial aspects consider monetising the effects of building energy performance at the micro-economic (private finance) level. Technical building properties have to be translated into monetary units, for example, to determine real estate values for investment decisions, or to valuate energy related investments.

3. Analysis of Insights

3.1 Deep renovation of existing buildings and the Building Renovation Passport

Basically, there are two main options to achieve a deep renovation, not only from the technical point of view, but also in terms of economic feasibility:

1. **In a short time carried out at once**, for instance with prefabricated elements improving the energy efficiency of the building envelope, including the implementation of renewable energy systems;
2. **Over a longer period of time**, based on the step-wise implementation of renovation measures in the correct sequence, following a renovation plan, which is also called 'renovation roadmap', and using the so-called 'logbook' to store building data and record the interventions over time.

EPBD Article 19a looks at the possibility of introducing a voluntary Building Renovation Passport (BRP) to stimulate deep renovation in residential buildings and other building types in situations where the budget is not available to carry out deep renovations all at once. The BRP is one of the instruments that can stimulate cost-effective renovation in the form of a 'long-term, step-by-step deep 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'.

The concept of the BRP builds on the fact that default values and simplified methods are needed for issuing the Energy Performance Certificate (EPC) of existing buildings, because of lack of data and costly data acquisition procedures, but also to create standard conditions that make it possible to assess whether a building complies with minimum energy performance requirements and that allow purchasers to compare one building with another. Recommendations for improving building energy performance are included in the EPC, but they are not always detailed enough to be useful for actual renovation planning. Therefore, in some Member States, there is already a voluntary extension of the mandatory EPC with fixed input values (for the comparison of buildings) to a building-specific supplement. This allows adjustment to the building's actual boundary conditions and actual data to be used for planning building renovations, and can be used to assess the cost-effectiveness of improvements for the current occupants.

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3.1.1 Deep step-wise renovation: Building Renovation Passport

The BRP concept builds on national initiatives, such as the *Passeport efficacité énergétique* (Passport for Energy Efficiency) P2E[3] in France, and European initiatives like the iBRoad[4] project funded by Horizon 2020. Similar concepts are currently also applied in Denmark, Belgium and Germany, with funding from both the private and public sectors.

The iBRoad project has developed an Individual Building Renovation Roadmap for single-family houses. This tool looks at the building as a whole and provides a customised renovation plan (iBRoad-Plan) over a long-term horizon (15-20 years). The renovation roadmap is, at its core, a home-improvement plan which considers the occupant's needs and specific situation (e.g., age, financial situation, composition and expected evolution of the household, etc.) and avoids the risk of 'lock-in' future renovation solutions due to a lack of foresight. It is combined with a repository/logbook of building information (iBRoad-Log).

The aim is for the iBRoad-Plan to take data directly from the national EPC software and the iBRoad-Log to have links with other services such as financial databases and one-stop shops. Expected benefits of the tool include maintaining an overview of the building's history, concrete planning of renovation steps, achieving deep renovation over a long-term horizon, and enabling access to finance. The goal is to increase the number of individual deep renovations and enable the adoption of future policies in support of energy performance and decarbonisation of the building stock.

Analyses of current projects and initiatives and discussions offer the following conclusions to be considered when elaborating the BRP concept:

1. It is important to specify the purpose of the BRP to avoid false expectations; detailed provisions will probably vary, depending on the target group and building type. Owners of single-family buildings will have different needs compared to facility managers of multi-unit residential buildings.
2. It is important to integrate elements (e.g., logbook) which have already been established in some countries, and not to impose a new scheme.
3. Any differences from EPC recommendations should be made clear.
4. Actual implementation of measures needs specific planning, and this requires considerable effort, which needs to be paid for.
5. Step-by-step renovation requires suitable financing tools.

While the iBRoad concept addresses residential buildings, and in particular single-family houses, the ALDREN project[5] addresses step-by-step renovations for non-residential buildings, especially offices and hotels. ALDREN developed the concept of a Building Renovation Passport attached to the European Voluntary Certification according to EPBD Article 11(9), including a method for monetising the effects of deep renovations (more details see chapter 3.2).

3.1.2 Deep renovation in one go: Prefabrication and industrialisation

There are technical and economic approaches for the cost-effective renovation of the building stock to NZEB level using prefabrication. Prefabrication can reduce the cost and time, ensure good quality and enhance market integration. Prefabrication can be done individually, with substantial reduction in the duration of renovation works and improvement of the quality of the works by simply reducing the incidence of mistakes on the construction site. In terms of cost reductions, however, only industrialised prefabrication will realise the full potential through economies of scale. Industrialisation consists of the following elements:

- Industrialisation of the fabrication process
  - Pre-manufactured components
  - Modules with integrated components
- Digitalisation of process
  - Digital scanning of the buildings
  - Digital performance monitoring
- Standardisation of process
  - Offers
  - Financing
  - Planning

Energiesprong[6] and other initiatives demonstrate how successful and efficient the process can be: the short implementation phase means that users do not need to move during renovation, and there are fewer construction errors. However, prefabrication still needs promotion of market uptake to realise the potential for greater cost reduction through industrialisation. Prefabrication also needs aggregation of renovation projects in order to achieve economies of scale.

In addition to the technical solution, Energiesprong provides a business model needed to overcome split incentives; e.g., a 30-year guarantee by the construction company while energy savings are used to pay back the investment cost. Such a business model is applied by Energy Service Companies (ESCO).

While Energiesprong offers the whole package including both the technical solution and financing, other companies that deliver nearly zero-energy renovations based on pre-fabrication rely on financing provided by banks and are subject to their rules. For example, the Austrian GAP solution[7] has been successfully implemented several times within the past decade and, in 30 years, the renovated buildings will still be in top condition regarding energy performance as well as visual appearance: materials used are stable without aging as only glass and aluminum are used on the outside. Maintenance and energy costs are very low, and all materials can be recycled. If the financing period is 25 to 30 years, and provided that the financing cost is very low, investment will be recovered by the energy savings. However, for an existing building, the usual financing period is only 15 to 20 years, while the usual financing period for new buildings is 40 to 50 years. Building owners and users are very satisfied with the renovations, and several buildings have been renovated, although they have generally been public sector buildings that have needed public support. Due to unfavourable financing conditions as well as the lack of economies of scale, the potential has not been fully exploited so far.

Highlights of 3.1	• The Energiesprong initiative demonstrates that there is a business model for deep renovations based on the Energy Service Company (ESCO) approach and making use of prefabrication. • There are several pilot projects on step-wise building renovation, demonstrating different aspects of the Building Renovation Passport as the new instrument for effective implementation of this type of deep building renovation.

Main Outcomes of 3.1
• Deep renovation of existing buildings can be achieved mainly through two approaches: renovation in one go, and incremental renovation supported by new instruments such as the Building Renovation Passport. • Cost-effective one-go deep renovations can be based on industrialisation, involving pre-fabricated building components and integrated elements, as well as digitalisation and standardisation of the process. • Pilot projects on step-by-step renovation have been carried out to explore possible ways of implementing the Building Renovation Passport.

3.2 Technical Building Systems and energy efficiency potential

Technical building systems have the potential to save very large amounts of energy because there are many old, inefficient and poorly maintained, heating and cooling systems in existing buildings.

Therefore, intervention is vital when technical building systems are upgraded, and not only when major building renovations are undertaken, as provided for in article 8 of Directive 2010/21/EU. EPBD articles 8(1) and 8(9) require the application and assessment of energy performance requirements with relation to technical building systems, including documentation to be passed on to the building owner which can be used to verify compliance with minimum requirements. This requires methods to assess the energy performance of systems, as opposed to the energy performance of a product or the building as a whole.

With a view to increasing energy efficiency of technical building systems in existing buildings, inspections for heating and cooling systems according to EPBD articles 14 and 15 play an important role, as well. This topic was discussed in many meetings throughout various phases of the Concerted Action EPBD, and was taken up again after changes were introduced by the amending Directive (EU) 2018/844, among others, also to focus on the user-friendliness of inspection reports, as raised in previous meetings.

In addition to increasing technical building system efficiency, decarbonisation of technical building systems brings municipality and district-based heating and cooling approaches to the fore because of the opportunity to undertake deep renovation at a larger scale unit than a single building.

Due to electricity-based replacement technologies for the gradual phase-out of fossil fuels, there is a connection with the Renewable Energy Communities under the Renewable Energy Directive 2018/2001/EU that must be observed when deciding on emission factors to be used for EPCs.

3.2.1 Simple and reliable approaches for technical building system requirements

Measuring the efficiency of products in isolation, without accounting for real conditions, is not sufficient. Other factors affecting the heat demand and system efficiency include building fabric and airtightness, weather conditions, dimensioning and controls. Further, the capability of the heat generator relative to demand determines how much time is spent in full-load and part-load conditions and this influences the final consumption.

So, the key words in EPBD article 8(1) are '***set system requirements*** *in respect of the overall energy performance, the proper installation, and the appropriate dimensioning, adjustment and control*'. A separate set of requirements is needed for each technical building system type, namely space heating, space cooling, ventilation, domestic hot water, built-in lighting, building automation and control, and on-site electricity generation. Article 8(9) of amending Directive (EU) 2018/844 is a new requirement stating that the energy performance of newly installed or upgraded technical building systems must be assessed:

'*Member States shall ensure that, when a technical building system is installed, replaced or upgraded, the overall energy performance of the altered part, and where relevant, of the complete altered system, is assessed. The results shall be documented and passed on to the building owner, so that they remain available and can be used for the verification of compliance with minimum requirements*'.

However, it is difficult **to assess the overall energy performance of a system**. The 'system performance', as opposed to 'product performance' or 'building performance', takes into account the overall energy performance, the proper installation, the appropriate dimensioning of the system, and appropriate adjustments and controls, including documentation and regulation.

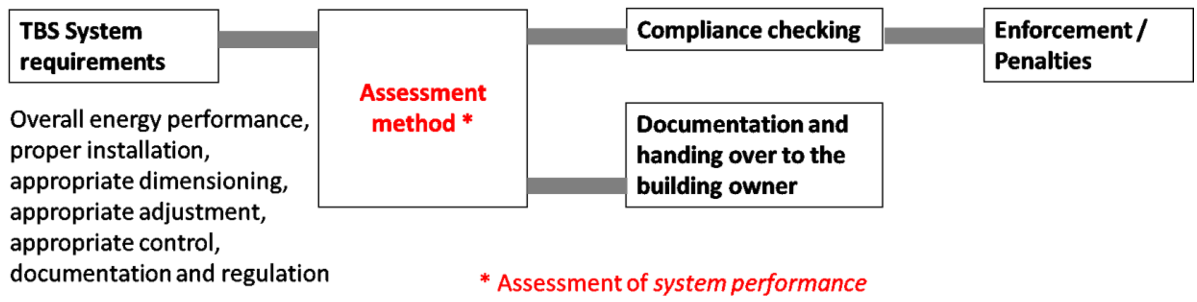

Figure 1: Overview of assessing system performance of technical building systems.

Efficiency can be expected to vary significantly under different conditions, e.g.:

- building fabric and airtightness (affects heat demand);
- weather conditions (affects heat loss and hence heat demand, also affects instantaneous efficiency of ASHPs[8]);
- dimensioning (capability of heat generator, relative to demand, determines how much time is spent in full-load and part-load conditions);
- controls / commissioning / adjustment (affect response to changing levels of demand).

In this context, it should be noted that the systems in article 8(1) in the EPBD directive are not addressed by the EU legal framework on Ecodesign and Energy Labelling. The scope of Ecodesign and Energy Labelling generally stops at the packaged product level and does not extend to other aspects of the technical building system that it connects to. For example, boiler, and controls sold as part of the boiler, do not contain or take into account the heat distribution system including correct balancing, heat emitters, zonal issues and room controls, programmers, occupancy detection, weather compensation, optimal stop/start, etc., the system sizing, installation/commissioning, and operation. These elements can have a significant impact on the energy efficiency of the technical building system as a whole, and therefore a 'system' - or more integrated approach - is crucial. Possible system-related linkages should be taken into account in the Ecodesign requirements. Otherwise, there could be unintended negative consequences at the system level and under real climatic conditions, and options for optimisation may be lost. Ecodesign requirements for ventilation units are currently being revised[9], and it is necessary to monitor developments to ensure that a system approach is more appropriate. An installation company needs specific data to know which system is best. The heat loss characteristics of the building are needed in order to choose the right-sized system and understand when it is at full or at part load. This information could be addressed through EPCs, for example in the form of an indicator for heating energy demand which in turn reflects the transmission losses of the building envelope. The EPC could also provide information particularly relevant to the installer (e.g., oversized gas boiler). However, EPCs for existing buildings can be based on simplified procedures using default values and, since EPCs have a validity of 10 years, the information they contain may be outdated if something has changed during the validity period. The renovation roadmap and building logbook as developed by the iBRoad project are potentially helpful tools to address these challenges.

There are CEN standards that specify methods for assessing system performance, but generally, they are not simple and may need a lot of data that is difficult to access. Even if the data are stored on an EPC database, the data may not be readily accessible or easy to extract and use. In theory, doing a real dimensioning analysis would be the best approach. Calculating the heating requirements before choosing a new system is a quite common approach for non-residential buildings, but it is unusual for single-family houses because installers are not sufficiently skilled. Assessing the overall energy performance of a system is particularly challenging for smaller buildings that do not fall under the Building Automation and Control Systems (BACS) requirements (EPBD Art. 14(4) /15 (4)). As it is often the case that the replacement of systems in smaller buildings needs to be done quickly and without additional expenses, there is a need for simplified assessment approaches that produce meaningful results in a cost-effective way without reliance on data that may not be available and would be hard to obtain. Similarly, there is a need for effective approaches for documenting the results and passing them onto the building owner. One possible solution would be a sort of checklist for installers, where they are required to check whether each individual component meets the requirements, as opposed to calculating an overall performance. The Information would then be stored on a portal accessible via the internet which can return tailored information for the installer to choose an appropriate system. The checklist and information can be linked with the building renovation passport.

Continuous monitoring can mitigate system performance assessment limitations but there are questions about the configuration of the continuous monitoring. It might be mistakenly assumed that BACS is sufficient to ensure minimum levels of good performance. Once you install a BACS, it can solve the issue of technical system efficiency by monitoring, but it does depend on the design and installation.

In June 2019, the European Commission recommendations on the decarbonisation of buildings suggested various approaches for assessing the performance but leave the responsibility to Member States to clarify which approaches should be followed. One of the suggestions is based on the simulation of system performance at the time it is designed. A helpful document is the technical assistance study for ensuring optimal performance of technical building systems under the EPBD (ENER/C4/2019-468/04)[10]. As part of this study, task 4 provides technical guidelines for establishing and enforcing technical building system requirements and for system performance assessment and documentation.

3.2.2 User-friendly inspection reports

The following standards provide further guidance for inspections and reports **for heating and cooling systems according to EPBD articles 14 and 15**: EN standards EN15378-1:2017 and EN15378-2:2017 on Energy performance of buildings – Heating systems and DHW in buildings; EN16798-17:2017 and EN16798-18:2017 on Requirements and Guidelines for Inspection of Ventilation and Air Conditioning systems.

The inspection data for heating and air-conditioning systems is extremely valuable, especially for policy development and national plans. Currently, a major problem is that there is no enforced formal structure for the report that the inspector has to produce defined in the EPBD. Without a formal structure imposed, inspectors can create anything within the limits defined by each Member State. At the same time, this is a possibility for the individual Member State to develop an optimised format, which could perhaps lead to further EPBD requirements if some Member States take this up and document the potential as well as the solutions.

Some Member States have already chosen to store all inspection reports in a database, which might be the same database that holds EPCs. Inspection reports and EPCs, where both exist, can be linked through the building reference. A central database holding both EPCs and regular inspection reports can facilitate the control system by the relevant authorities, and can be used for long term planning based on real data. The cost of this storage process should be considered depending on whether the reports are just stored as an image, or whether the database allows extraction of crucial data from the report, which would open the possibility of automatic study and analysis. That would make it possible to retrieve data from the reports, which can be valuable to policy development and national plans. It would also allow comments on particular installations to be stored over long periods of time, allowing tracking of which/ whether recommendations and advice (from the inspection reports) have been acted upon.

There were discussions about regular inspections that are required as part of the EPBD and energy audits required as part of the EED. There are some notable overlaps between the directives, and many apparent similarities. There is a lot of interest combining these inspections and audits regimes. Despite the similarities, when reviewed in detail, it is apparent that the two regimes cannot be easily combined because there are large differences in scope, different compliance requirements, and different types of inspector/auditor. Nevertheless, there is some potential for combining the two schemes, even if it is only at an administrative level.

Inspection reports are an important requirement under the EPBD. The current format of the report is left to Member States and there are large differences. Inspection reports tend to be between 2 and 300 pages, often in the range of around 20 pages. They can have a checklist format with limited space for adding free text, and the option to include specific user-oriented information to customise the inspection report. They are issued by independent experts following a specific qualification scheme. As the inspection report is a technical document, it is mainly addressed to technicians who manage the plant. This compromises the user-friendliness of the report for building owners. The inspection reports are passed either as physical or electronic copy to the building owner and/or the technical manager of the plant. There is generally no procedure in place for monitoring if proposed recommendations have been implemented.

Experience shows that building owners tend to ignore the recommendations in the reports for many reasons, such as the complexity of the used technical language, the accessibility of the report and the report's contents. Effort should be focused on encouraging owners to read and act upon the report, otherwise the inspection has failed. Some countries have a template or prescribed format, primarily for describing technical characteristics rather than constructing a persuasive message to the building owner.

It is a challenge to find the right balance between the technical side (required for the experts), and the user-friendly side (required for the building owner). Effectiveness of the inspection scheme could be improved by making the benefits more visible to the owners and using understandable and simple presentation. Furthermore, it would be beneficial to periodically measure equipment performance.

3.2.3 Decarbonisation of Technical Building Systems

The renovation of existing buildings aims to reduce energy consumption but should also factor in the decarbonisation of the energy supply, reflected in the CO_2 indicator which could be included in the EPC.

To achieve decarbonisaiton of the building stock, also decarbonisation of heating systems is an important strategy. If gas and oil boilers are withdrawn from sale to meet decarbonisation requirements, clear national policies are needed to support their replacement.

In 2021, a survey was conducted among Member States on their plans for phasing-out the use of fossil fuels for heating and cooling. The most prevalent near-zero heating system replacements are found to be heat pumps or heat pumps combined with solar panels (PV), together with district heating that can also be based on large heat pumps. The market for replacing fossil fuel boilers with heat pumps is developing.

With regard to electricity-based heating and cooling systems, 'Renewable Energy Communities' are gaining importance as producers and suppliers of electricity. Electricity delivered to a building by an Energy Community will probably be treated like the European electricity mix or a national electricity mix, where the corresponding amount of CO_2-equivalent and primary energy per KWh electricity is allocated based on the composition and characteristics of the power plant fleet. However, it is also possible that the primary energy factor and CO_2-equivalent for electricity delivered by an Energy Community could be defined by the way that electricity is produced within the community and it would be different from the European electricity mix or a national electricity mix. This is considered a better option in order to incorporate more Renewable Energy Sources (RES) in the community. The outstanding question is how (and where) credit should be given for the renewable electricity generation system.

Regarding the phasing out of oil-fired boilers there are two options: the direct ban (prohibiting the selling, installation or use of boilers) and the indirect ban (obligation to use renewable energy systems). As for the removal and replacement of oil-fired boilers in existing buildings, some Member States have set timeframes prescribing when these boilers can no longer be installed or when they have to be replaced by non-fossil fuel systems. For gas-fired boilers, to date there is no ban of the installation of new or replacement boilers in existing buildings and there is no set date for their replacement with non-fossil fuel systems. In relation to boiler bans, there are comprehensive and well-coordinated support packages in some countries such as group-specific grants. There are also several strategies for making the use of fossil fuel boilers undesirable or difficult, for example, through taxes on fossil fuels and high emission weighting factors that bring down an EPC rating.

Municipalities can have an important role because they can be empowered through legislation to connect buildings to the district heating system. Generally, a larger scale unit such as a district or a municipality becomes much more important than single buildings, as indicated by the amending Directive (EU) 2018/844 under article 19. A district approach would not completely replace the single-building requirements because the 'energy efficiency first' principle must be respected. Extending from the building to the district level, introduces new opportunities but also new challenges, such as how to make the district energy supply option mandatory for buildings owners, how to deal with different building owners within a district approach to renovation, and which programmes best facilitate a district approach to improving the performance of existing buildings.

An example is the 'Programme for Natural gas-free Neighbourhoods'[11], which is a knowledge and learning programme in the context of the Dutch National Climate Agreement that has been running in the Netherlands for a few years now. This national programme funds municipalities willing to carry out district renovations that include both categories of measures: measures to improve the energy efficiency of the building envelope, and measures to change the technical building systems including the heating system. Energy efficiency measures are planned specifically for individual buildings, and there are no additional minimum requirements to be met as a precondition to change to the new energy supply for heating, because the existing building stock is so diverse. Municipalities are responsible for motivating building owners to participate in the district renovation. This programme is an excellent example of how to address the challenge of different types of building ownership and how to deal with the challenge of implementing the energy efficiency first principle in the context of decarbonising the energy supply at district level.

The general discussion on the district approach showed that in practice, the energy-efficiency-first principle is often neglected because it is much easier to substitute fossil fuel systems with heat pumps without improving the building envelope. This causes other problems with the electricity grid and security of supply.

There are similar approaches in several other Member States based on new funding and financing models for projects that include multiple buildings.

Determination of system boundaries becomes important. A method must be chosen to apportion primary energy, global warming potential, and similar energy metrics between multiple outputs from an ‘energy transformation’ process used within an area or across system boundaries. This includes the situation where an actual or potential application exists for an output that would otherwise be considered as ‘waste’ energy - for example waste heat from a cooling application or from an industrial process which is supplied directly to a building or district heat system. Concerted Action EPBD has committed to further discuss solutions, e.g., the use of a procedure that is currently used to allocate primary energy and carbon to heat and electricity from cogeneration plants.

Highlights of 3.2	• Improving technical building systems in existing buildings is a challenging task. However, guidance is available and there are examples of promising simplified approaches to ensure technical building systems performance. • Inspection reports can provide valuable information, and some Member States have chosen to store all inspection reports in a database, which might be the same database that holds EPCs. It is essential that the databases are interoperable and allow for extracting data for further use. • There is great interest in decarbonising the energy supply not only at the building level but also at larger scale. District heating and cooling systems and electricity-based technologies (heat pumps) are the preferred options in many Member States, and there are already some exemplary instruments addressing renovation at a district level.

Main Outcomes of 3.2
• Setting technical building system requirements and enforcing them during upgrading or replacement works is a useful approach for increasing energy efficiency but poses difficulties in practice, mainly due to the lack of data needed for re-dimensioning the system. Guidelines are available for assessing and documenting technical building system performance, and there are some examples of simplified checklist-based approaches. Several Member States are discussing how to store and retrieve technical building system documentation in a searchable database. • Inspection reports are technical and oriented more to technical experts than building owners who decide whether to implement measures. Building owners tend to ignore the recommendations and there is insufficient monitoring of how or whether recommendations are implemented. Minimum content of inspection reports should be defined by Member States, also

Main Outcomes of 3.2
with a view to using software tools for inspection that have an XML interface to a searchable database. This would also allow for better monitoring of the implementation of measures. • Decarbonisation of energy supply for heating and cooling systems is a high priority, at building level as well as at the district level. At the district level, instruments exist to facilitate the renovation of several buildings in one project in a defined area. It is crucial to respect the energy-efficiency-first principle and the procedure of initiating the district renovation approach. There is a physical dimension and a political dimension to determining system boundaries, for example, to apportion primary energy and emission factors. Interlinkages with the Renewable Energy Directive 2018/2001/EU must be addressed in future discussions.

3.3 Monetising the effects of Energy Efficiency

'We have all the technologies to deliver healthy, sustainable and decarbonised buildings. Still, the transformation is not happening. One of the reasons is the financing gap, the lack of trust and common language among building professionals and investors.' (REHVA 2019)[12].

In fact, there is a 'language gap', and 'translation' work is necessary. For example: what is the effect of the technical building quality on monetary yields, on costs and returns (i.e., the influence on rental income), vacancy, supply, administration, insurance, taxes, subsidies, maintenance, risk and financing?

Sector	Language	Bridging the language gap
Building professionals	kWh, U-values, etc.	Monetisation of technical building properties
Investors and real estate valuators	Monetary units, such as EUR	

Table 1: Facilitating the communication between sectors.

Monetising the effects of energy efficiency is used to bridge this gap and takes place at **macro-economic (public finance)** and at **micro-economic (private finance)** levels. A translation of technical building properties into monetary units is always required. The monetary value provides the basis for designing funding programmes, and helps to determine property values for purposes such as investment decisions.

Monetising the impact of energy efficiency on the level of public finance:

Energy efficiency initiatives need to be assessed to determine the monetary value of health benefits from reduced air pollution to improved indoor air quality and higher productivity, which creates additional jobs. Benefits have been quantified as well as monetised in some cases, for example, by the COMBI project[13] financed under Horizon 2020. Results can be used to estimate the economic benefit to public finances and should help convince national finance ministries to agree that their governments should invest in such programmes.

Monetising the impact of energy efficiency on the level of private finance:

The effects of energy efficiency measures on the building value can be measured. The capitalised earnings value assesses the value of a building based on the total rental income expected to be realised over the economic life of the building.

Factors influenced by renovation for adjusting the discounted net income (net present value) are:

- rental rate;
- occupancy (vacancy);
- maintenance costs;
- remaining useful life of the building;
- capitalisation rate (representing the risk concerning the realisation of the expected income).

Deep renovations can extend the useful life of the building, decrease maintenance costs, bring direct benefits from energy costs saving but also indirect non-energy benefits such as health and well-being improvements. If this is reflected in the financing risk assessment and property valuation, it will also impact the building value or value of investment in renovation. It is clear that investments in deep renovations will only pay-off if the remaining useful life of the building is sufficiently long. It makes a significant difference whether the remaining life is 15, 20 or 30 years.

The EPC is the central document providing information about a building's energy performance. At micro-economic level, the real estate sector can make use of the EPC in mainly two ways (the second way is explored in more detail later in this report):

- EPCs must be presented and handed over when a building or building unit is rented or sold. They can be used to analyse the energy performance of buildings in real estate transactions, and to show the price premium achieved by energy efficient buildings compared with average buildings, if any. Several studies have demonstrated this price premium under certain conditions, and a factsheet summarising them was developed in the fourth phase of the CA EPBD[14]. However, if the rating based on the A to G scale is used for such an exercise, the reliability of the input data for the calculation of the energy performance is crucial. The aim is to avoid room for interpretation that allows a building to be classified in a better or worse energy performance class.
- EPCs, including those issued in the course of major renovations, can be used to identify outliers compared with the average of buildings, to identify the backlog in maintenance and repair and the implication for the remaining use life, and the vacancy risk due to specific characteristics of the building, such as poor comfort and indoor air quality. The EPC can be a valuable tool to help determine the building value. However, the EPC must meet certain requirements to be actually useful for this exercise.

The real estate valuation process and its possible link with the EPC is explained by means of the following Austrian example, in order to make the energy experts aware of the aspects which are critical from the real estate valuers' point of view.

3.3.1 Facilitating deep renovations: the EPC as a supporting tool in the real estate valuation process

In Austria, real estate valuation is regulated by law and, in addition, there are several Austrian standards, including further instructions for the valuation process.

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Before starting, a check needs to be done to determine if additional laws or business agreements are applicable and must be considered during the valuation process, e.g., there are some additional regulations for agricultural and forest real estate as well as for business activities.

Following §3 to 5 of the Austrian Real Estate Valuation law, there are three valuation approaches:

1) Comparable approach

The comparable approach requires that a main unit must be defined and a representative sample of similar properties must be collected for comparison. Next, the valuator has to check the quality of the data. Based on the results, the value of the property is increased or reduced according to its specifications and differences, e.g., the condition of the building, the energy performance of the building, the remaining useful life, technical equipment, location, different market situations, etc. **This approach is mainly used for condominiums and private houses (one family dwellings or terraced houses).**

2) Valuation of physical assets

In this case, the building valuation is based on the technical characteristics of the property, such as defects in construction, energy performance of the building, and all repair works, so that the effective age of the building can be determined. This is added to the value of the land to calculate the value of the total real estate. **This method is mainly used for empty or completely vacant properties.**

3) The capitalised earning value

Based on a pre-calculated interest rate and the assumed remaining useful life of the building, a multiplication factor is generated to calculate the capitalised earning value, based on the expected income from rent. **This method is mainly used for multi-storey dwellings, office buildings and buildings for commercial use.**

All three approaches are based on field observation in order to check the condition and location, and whether the local situation matches the documentation and plans that were approved by the authorities. The current status of the property has to be recorded by photo documentation.
There is some important information for property valuators that the EPC could provide:

- The EPC should show the technical status of the building, i.e., whether the building, from a technical point of view, is state-of-the-art or outdated; and, if required health and safety standards are met.
- Recommendations should refer to upgrading the building in connection with further technical requirements.

The EPC must meet some criteria to be acceptable for property valuation purposes, particularly for existing buildings. If an EPC is to be used for real estate valuation, it will have to meet the following criteria:

- It has to represent the actual guidelines for calculating the EPC.
- It has to be issued by a qualified engineer.
- It has to be based on a site visit.
- It is based on the actual condition and construction of the building, which means it has to be specific for that building.

- The EPC should not be older than one year, due to the fact that buildings age.
- In addition, information on the measured energy consumption would be useful, as this indicator is directly related to the cost of operating the building, which is taken into account in the evaluation procedure.

The last points imply a dynamic energy performance certificate, which is based on a database and is updated when relevant changes occur. Such concepts are under development, e.g., funded by European programmes, like the D^2EPC project[15].

3.3.2 Selected activities facilitating monetisation of energy efficiency at micro-economic level

The ALDREN project (1 November 2017 to 30 April 2020) developed the **ALDREN-TAIL index**[16] **for indoor air quality (IEQ) and productivity, which can be taken into account in the capitalisation rate in building valuation**. The index is used to document IEQ in a building before and after renovation and consists of four major components of IEQ, namely:

- thermal environment (T);
- acoustic environment (A);
- indoor air quality (I);
- luminous (visual) environment (L).

For each of these components, several indicators were determined.

The European Standard ValERI[17]provides a method for identifying wider benefits of Energy Related Investments (ERI) and how to consider them in the valuation report.

'Energy quality' in the German Real Estate Valuation Regulation

The German Real Estate Valuation Law (ImmoWertV[18]) stipulates that the energetic condition of a building should be taken into account in the valuation report, but it does not say how. In the Capitalised Earnings Value method, the rent can be used to assess the value of a building. In Germany, municipalities have the legal right according to § 588c and § 588d BGB (Civil Law Code) to issue Municipal Rent Schedules (*Mietspiegel*), and so-called Qualified Municipal Rent Schedules (*qualifizierter Mietspiegel*) which can take into account specific aspects considered relevant, provided they are developed based on scientific evidence.

The appropriate consideration of energy aspects in rent indexes has been increasingly under discussion in recent years by local authorities, tenants' associations and representatives of the housing industry. The Tenancy Law Amendment Act of 11 March 2013 (BGBl. I, p. 434) clarified, with an addition in § 558 (2) BGB, that energy-related characteristics of the condition and equipment of dwellings must also be taken into account when determining the comparative rent. This legal amendment came into force on 1 May 2013, and the German Federal Office BBSR (*Bundesinstitut für Bau-, Stadt- und Raumforschung*) issued a brochure to promote the appropriate consideration of energy-related features in the compilation of rent comparisons. The brochure is intended to serve as a working aid for the municipal preparation of so-called energy-related rent comparisons. Methodological notes and examples were offered as implementation aids. They should facilitate implementation against the background of the respective municipal representative list of rents in qualified and simple representative lists of rents for each municipality[19].

For example, Darmstadt issued a Qualified Municipal Rent Schedule in 2018[20] which lays the foundation for rent increases for privately financed apartments over the next two years. It makes a major contribution to the transparency of the rental price structure in the non-price-fixed residential portfolio in order to avoid disputes between the parties to the rental agreement. It also contains references to the consideration of the energetic condition, also with reference to the EPC as shown in Tables 2 and 3.

Highlights of 3.3	• Monetisation of energy efficiency at the micro-economic level must comply with the legislation on real estate valuation. The ALDREN project has developed guidelines for this at both EU and national level. • If Member States create a specific framework including guidelines, like Germany's, this will support monetisation of energy efficiency at the micro-economic level in practice. • There is a link between the EPC and the real estate valuation process, as the EPC can provide useful information to valuators.

Main Outcomes of 3.3
• If the EPC meets some defined quality criteria, the EPC will provide useful information for monetising building energy efficiency in the course of the valuation process. Among others, EPC recommendations should refer to upgrading the energy efficiency of the building in connection with further technical requirements. • There is a clear link with the new Building Renovation Passport. Future specifications regarding the Building Renovation Passport should also ensure its usefulness for the real estate valuation procedure. • Valuators will also benefit from an EPC database expanded by the Building Renovation Passport and cross-linked with other databases through improved data availability.

New building (construction year from 1995)	**5% surcharge**
Passive house standard, OR	
Three-pane glazing, OR	
Use of renewable energy (heat pump, solar thermal system), OR	
Very well insulated outer wall (minimum 13 cm insulation or U-value maximum 0.26), OR	
Energy Performance Certificate: Final energy indicator (maximum 80 kWh/m^{2}year including hot water, 53 kWh/m^2.year without hot water)	
Existing building (construction year until 1995)	**5% surcharge**
Passive house standard, OR	
Minimum 12 points from measure in table below, OR	
Energy Performance Certificate: Final energy indicator (maximum 80 kWh/m^{2}year including hot water, 53 kWh/m^2.year without hot water)	

Table 2: Surcharge in rent for energy performance.

Walls	Points	Technical building system	Points
Insulation of outer wall, minimum 6 cm but less than 13 cm	3	Renewal of boiler between 1987 and 1994	1
Insulation of outer wall, minimum 13 cm but less than 20 cm	4	Renewal of boiler from 1995 on	2
Insulation of outer wall, minimum 20 cm	5	Condensing boiler (in addition to Renewal of boiler after 1995)	1
Insulation of roof or upper ceiling, minimum 6 cm	2	Connection with district heating	1
Insulation of basement ceiling, minimum 4 cm	1	Heat pump as main heating source	1
Windows	**Points**	Solar thermal system	1
Two-pane window, double glazing	2	Mechanical ventilation with heat recovery system	1
Two-pane window, thermal insulation glazing	3		
Three-pane thermal insulation glazing (passive house window)	5		

Table 3: Improvement measures and allocated points.

4. Main Outcomes

Topic	Main discussions and outcomes	Conclusion of topic	Future directions
3.1	Deep renovation of existing buildings can be achieved mainly through two approaches: renovation in one go, and incremental renovation supported by new instruments such as the Building Renovation Passport.	The best approach to deep renovation depends on the specific conditions.	Based on pilot projects and good examples, further exchange of experience among Members States could be useful.
3.1	Cost-effective one-go deep renovations can be based on industrialisation, involving pre-fabricated building components and integrated elements, as well as digitalisation and standardisation of the process.	There is still scope for development in exploiting the potential for industrialisation of deep renovation of existing buildings.	EU-funded projects could support the integrated further development of sustainable solutions.
3.1	Pilot projects on step-by-step renovation have been carried out to explore possible ways of implementing the Building Renovation Passport.	A lot of information from projects is available to help Member States to conceptualise, implement, and/or improve a Building Renovation Passport concept suitable for their conditions.	Based on pilot projects and good examples, further exchange of experience among Members States could be useful.

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Topic	Main discussions and outcomes	Conclusion of topic	Future directions
3.2	Guidelines are available for assessing and documenting technical building system performance, and there are some examples of simplified checklist-based approaches.	Availability of data regarding factors affecting the heating and cooling demand and hence the system efficiency is a challenge. Retrieving data from a searchable database and storing the technical building system documentation in such a database is under discussion as an appropriate solution.	Further exchange on methods suitable for assessing and documenting the replacement of systems in existing buildings is suggested. It is important that consideration will be given to product-related Ecodesign requirements, to make sure that they do not contradict the system approach and are suitable for different climates (example ventilation units).
3.2	Inspection reports are technical and mainly oriented to technical experts rather than to building owners who decide on the implementation of measures. Building owners tend to ignore the recommendations and there is insufficient monitoring of the implementation of recommendations.	Minimum content of inspection reports should be defined, also with a view to using software tools for inspection that have an XML interface to a searchable database. This would also allow for better monitoring of the implementation of measures.	Technical building systems and inspection reports should be further discussed with regard to integrating into the Building Renovation Passport under development.
3.2	Decarbonisation of energy supply for heating and cooling systems is a high priority, at the building level but also at the district level. At the district level, instruments exist to facilitate the renovation of several buildings in one project in a defined area.	Decarbonisation based on electricity-based systems and district energy supply options is an important topic. There is a physical dimension and a political dimension of determining system boundaries, e.g., in terms of apportioning primary energy and emission factors.	Decarbonisation needs renewable energy for the gradual phase-out of fossil fuels, and therefore there is a connection with the Renewable Energy Directive 2018/2001/EU that must be observed in future discussions. Attention must be paid to ensuring the energy-efficiency-first principle.
3.3	If the EPC meets some specifically-defined quality criteria, the EPC will provide useful information for monetising building energy efficiency in the course of the	Collaboration with the real estate sector is essential to ensure that the EPC can be used for monetising energy efficiency.	Cost-optimality of recommendations considers neither the costs of required health and safety requirements, nor other benefits that could help make deep renovation

Topic	Main discussions and outcomes	Conclusion of topic	Future directions
	valuation procedure. Among others, EPC recommendations should refer to upgrading the energy efficiency of the building in connection with further technical requirements.		more feasible. This should be investigated more closely.
3.3	There is a clear link with the new Building Renovation Passport. Future specifications regarding the Building Renovation Passport should also ensure its usefulness for the real estate valuation procedure.	It is important to develop the strategy for implementation of the Building Renovation Passport together with the real estate sector to exploit the full potential of step-wise deep renovation.	EU-funded projects could support the joint development of sustainable solutions.
3.3	Valuators will benefit from an EPC database expanded by the Building Renovation Passport and cross-linked with other databases through improved data availability.	Once more, building and energy related databases and data access are proving to be of central importance.	Compliance with the General Data Protection Regulation (GDPR) must be ensured. Exchange of experience among Member States could be useful.

4.1 Deep renovation of Existing Buildings and the Building Renovation Passport

The BRP would need to be connected in some way to the EPC in order to use the data that the EPC gathers, whether calculated or real energy consumption. The EPC also contains reliable data such as the size and age of the building and could form part of the base of the passport. It is, however, imperative to capture data from other databases already available if the data are reliable, such as heating system inspections or other sources of building data/information. Links to these databases should be automated.

The BRP must convey additional benefits above and beyond the recommendations and information provided in the EPC. The passport is seen as going one step further by establishing a timeline for the steps of the renovation. Questions were raised over the use of real data for the BRP, i.e., actual energy consumption of the building. This would enable the calculation of real savings that could be realised by following the steps outlined in the renovation roadmap. Information on real savings would be important for the passport and demonstrates how it has a different purpose than the EPC. BRPs could enable the pooling of houses in a neighbourhood for retrofits, which may help with access to finance. However, collecting the information would be a challenge for the energy auditor given the pressure to cut prices.

In considering whether the BRP should be mandatory, it is important to account for its cost. Mandatory provisions must only impose additional cost if there is a very strong justification. It was suggested that there is a need to differentiate between the logbook and the roadmap. The former is labour intensive and perhaps only justified for multi-family buildings and non-domestic cases. However, for large/complex buildings, the logbook can be a valuable tool, especially if combined with inspections, in order to document and track all technical interventions having occurred in a building. The combination of the logbook with inspections should be investigated further. The renovation roadmaps are tools for all types of buildings because they put recommendations for improving energy efficiency into the correct sequence.

4.2 Technical Building Systems and energy efficiency potential

Assessing the overall energy performance of a technical building system requires information about the building – such as the heat loss characteristics of the building - that could be available in the EPC. However, the EPC might not be accessible for the installer doing the work, and it is probably outdated. While a complete re-dimensioning can be realistic for large non-residential buildings, simplified solutions are needed for small residential buildings, in order to cope with missing or out-of-date data. There are, however, good examples for such checklist-based approaches to assess the individual parts of the technical building systems.

Also, the systems approach can build on Ecodesign requirements if possible system-related interactions are taken into account. This is important to ensure that seemingly appropriate requirements at product level do not have unintended negative consequences at the system level and under real climatic conditions.

Inspection is an important instrument to increase energy efficiency of heating and cooling systems. Currently, **inspection reports** too often target a technical audience and not the owners of the systems who make the final decisions on investments in energy efficiency. Here, additional information might be needed on financial indicators and wider benefits, for example regarding health, such as noise reduction or reduced air movement. A clear summary of what the building owner should do could be added. In general, a standard format with minimum information to be presented could be useful.

In both respects, the BRP could facilitate the successful implementation of the respective parts in EPBD articles 8, 14 and 15.

Decarbonisation of energy supply for heating and cooling based on district supply solutions and heat pumps using electricity opens new opportunities at a larger scale. This topic raises the question of **how to determine the system boundaries** both at the physical level in terms of affected buildings, and the allocation of primary energy factors and emission factors to energy services provided by making use of waste energy and electricity delivered across system boundaries.

In practice, there is the challenge of different types of building ownership and how to deal with implementing the energy-efficiency-first principle in the context of decarbonising the energy supply at district level. The energy-efficiency-first principle is often neglected, because it is much easier to substitute heat pumps for fossil systems without improving the building envelope – which causes other problems (electricity grid, security of supply).

4.3 Monetising the effects of Energy Efficiency by means of the EPC

Energy performance in building valuation can be included in the maintenance backlog, in the risk of loss of rent, in the yield and in the amount of rent.

The EPC is a source of information for the valuator provided that it is not calculated with predefined default values, but with actual values, i.e., **actual data of the building structure and the technical condition of the**

individual technical components and reflects the current condition of the building. This means that the EPC must not be older than one year.

The EPC can help to assess the condition of the building in comparison with average buildings of that age. Outliers can be identified.

From the valuation point of view, the EPC would have to contain information on the condition of the building compared to typical buildings of this age. If this results in a backlog of investment or maintenance and this is backed up with costs, the expert can take this into account in the valuation.

The EPC would have to recommend which improvement measures should be taken, how much energy efficiency increase can be achieved, and which costs would result from this, i.e., as a forecast for the maintenance to be carried out in the next few years.

Whoever takes care of the building, whether it be homeowners themselves or property management companies, will take into account what maintenance is needed in the next few years. Measures planned or scheduled in the near future can be taken into account as a backlog of maintenance and the cost of these measures will help the valuation expert to determine the value of the backlog of maintenance. **Real estate valuation does not differentiate between maintenance backlog due to poor substance or lack of energy saving measures. The fundamental question is whether an energy efficiency measure will significantly increase the life span of the building.**

Buildings from the 1970s today often have an estimated remaining useful life of 30 years. In theory, the remaining useful life can be increased to 50 years through the thermal insulation on the façade; however, the building will generally be in such bad condition that the façade would need to be repaired and the windows would be a large part of a maintenance backlog. Thus, an improvement of a 1970s building with only thermal insulation will not significantly increase the remaining life span of the building. If you mainly had to renovate the main supply lines, then this would increase the life span, but not necessarily the energy efficiency.

A completely renovated building can often be the same as a new building, especially in terms of the full lifetime of such an object. The assessment is based on what is offered on the local market on other comparable buildings. Considering the property class on the one hand and the local market on the other, the question is **how to improve the old building to reach a comparable standard with full lifetime.**

The entire façade and windows are a large part of a renovation and typically all the building services are massively involved in the quality of the building but do not necessarily increase the remaining useful life. It is generally assumed that the building services of a building have to be renewed every 15-30 years anyway, depending on the type of building and the technical equipment. The more complex the equipment is, the more often it will have to be replaced; while, where there are fewer mechanical parts involved, there will be less need for replacement.

Cost-optimality of recommendations is a good approach, but the method also has to show the costs of required health and safety requirements. For example: if an old façade is insulated with a polystyrene product, it might be necessary to install further fire protection systems. **Currently, this is not reflected in the cost-optimal methodology, nor are other benefits that could help make deep renovation more feasible**.

It is important to note that real estate valuation takes the market into account, that is, how much demand there is for this type of building at the given location. If properties are in poor technical condition and there is a high demand for properties to rent or buy, then these properties will almost certainly be rented or sold. If the demand is decreasing and there are vacancies, the property manager will consider what measures would be needed to reduce these vacancies. These are not necessarily the measures that reduce the operating costs or improve the energy performance.

5. Lessons Learned and Recommendations

Two options for building renovation should be considered: **step-by-step renovations** for improving the building energy performance can be a good option for specific cases, while **deep renovations** carried out at once can be more feasible in other cases. A full assessment will determine the most suitable approach.

The district approach to renovation extends the scope beyond the single building and includes the decarbonisation of energy supply at a larger scale. The focus on decarbonising technical building systems at district level poses specific challenges for the implementation of the energy-efficiency-first principle. On the other hand, the Dutch example, 'Programme for Natural gas-free Neighbourhoods,' demonstrates how to successfully address such challenges.

The Energiesprong model not only addresses deep renovations but also provides a solution to the split-incentive-dilemma (investor/user conflict), which is a pressing issue in many countries. The Energiesprong model was developed by bringing the four key stakeholder groups together in order to discuss and develop feasible solutions: construction companies, building owners, financing institutions and regulatory bodies. This procedure could be replicated in other countries to overcome the split-incentive-dilemma which could eventually result in an increase in the rate of deep renovations; relevant demonstrations are underway in several other countries.

Nevertheless, if a step-by-step renovation is envisaged, the BRP has good potential because:

- it can reduce lock-in effects;
- it could be a good tool as part of a larger scheme of building management (however, not so much as a stand-alone instrument).

A BRP could also provide a solution to some challenges related with the successful implementation of article 8(1) and 8(9) provisions on **technical building systems performance.**

In summary, the success of implementing these provisions depends on the availability of specific and reliable information about the building to the installer responsible for upgrading or replacing the technical building system, and how this information is communicated to the building owner. It is clear that the EPC, under certain conditions, could provide valuable information, namely availability of the required indicators, up-to-date building specific and reliable data, and easy access to this information. This shows the importance of EPC databases that are interoperable with other databases storing technical building system documentation, inspection reports and other useful information. It also shows the importance of regulating the access to this information. Ideally, there is a single electronic depository for a building where all relevant data is stored, and owners are in a position to grant access to the information about their building to companies conducting the renovation works. Companies should be able to access the electronic single-building depository after receiving authorisation from the owner or the responsible authority. In practice, this is still an unusual situation. The long validity (10 years) of the energy performance certificate is an issue as individual measures to improve energy efficiency may have been implemented without updating the energy performance certificate. In this and other respects, the BRP offers some advantages: data quality could improve due to the mandatory on-site visits, and the step-by-step renovation plan could ensure the correct sequence of measures and the availability of relevant and up-to-date information to the installer. In this regard, it is equally important not only to plan but to also document the implementation of measures.

The known methods for calculating system efficiencies (such as described in CEN standards) are generally complicated and require extensive data which may not be readily available. However, systems often must be replaced with some urgency, following for example a breakdown. Simplified approaches exist, based on checklists and there are also other suggestions, such as using the product performance figures and adapting them for some specified conditions. If it is too difficult to measure system efficiency in real conditions, it will still be possible to model it by linking the profile of load conditions over a typical year to the knowledge of the product performance under the spectrum of testing load conditions. It may help to introduce a plant size ratio (PSR), which gives an indication of efficiency relative to demand.

System performance requirements can build on product-related Ecodesign requirements, but it has to be ensured that product requirements do not jeopardise the performance of the system the product is connected to. While for products such as electric household appliances there is minimal interaction with the building and the climate, such interaction exists for technical building system related products such as ventilation units. In such cases, better alignment between EPBD and Ecodesign policy would be useful.

The Building Renovation Passport scheme has the potential **to support establishing a link between the inspection reports and other tools,** such as monitoring the long-term progress of the implementation of recommendations. To be effective, heating and air-conditioning inspection reports need to be further developed and the adoption of recommendations needs to be encouraged. The areas to prioritise include:

- Increasing the user friendliness of inspection reports for non-technical building owners
  - o add clear instructions what the building owner should do
  - o show the benefits of implementing the recommendations to the building owner

- Storing of inspection reports in a database, in a standardised format, that allows for data to be easily extracted
  o define the mandatory format and use an inspection software with an interface to transfer data into the database
  o solve the software problem of how to determine the unique identity of buildings and unique identity of the plants within a building.

While the first recommendation is in the sphere of communication and should be addressed by communication and marketing experts, the second one should be dealt with in the context of Building Information Modelling (BIM). It is highly recommended that reports be stored on a single digital database with searchable fields, so that information can be easily extracted. Some level of standardisation in format and content across all Member States will be beneficial as this could, for example, help in the development of systems. It is important that when each Member State revisits the inspection report content or format, these considerations are taken into account. The inspection data for heating and air-conditioning systems is extremely valuable, especially for policy development and national plans.

With regard to further developing the concept of the BRP, in order to be effective, there should be a clearer explanation of how the BRP adds value in relation the recommendations in the EPC, including: the level of detail compared with the recommendations in the EPC, cost, and how this can be financed. A lot of specific details are needed to ensure actual implementation of measures and custom-made solutions are necessary, but they are expensive. This can hardly be done in half a day as suggested by one example of

BRP schemes that were analysed. Schemes certainly must be sufficiently detailed to demonstrate the reduction of risk to financing institutions. It would be necessary to adapt financing schemes to the step-by-step renovation approach.

Also, the long-term perspective could create some challenges, for example, the situation of the building owner might change over time, requiring adaptations so that the BRP avoids becoming obsolete.

The scope and objective of the BRP must be adapted to the different types of buildings as well as the related challenges. This is demonstrated by ongoing initiatives in countries which already employ elements of the BRP, such as the Building Dossier in Latvia for multi-unit residential buildings (a kind of logbook). The German BRP clearly addresses uninformed homeowners of single-family homes with the objective of developing an integrated home improvement plan together with them, where energy performance is just one element among many others. Sweden is discussing having a logbook in order to make information about poor building performance available. There is also discussion of a carbon certificate for the construction of buildings. It would be designed to show the investment in EUR as well as the result in CO_2-equivalent emissions, following the European Standard 15804 on creating Environmental Product Declarations (EPDs). The BRP concept needs to be adapted to individual countries and regions, in order to make sure that existing initiatives can be incorporated.

When further developing the elements of the BRP concept, it should be considered that the Renovation Roadmap and Logbook as (voluntary) parts of the EPC **could provide the information that real estate valuers seek**, provided that the requirements described in the previous chapters are met (actual building information, on-site visit and documentation, recent up-to-date information). From the real estate valuers' perspective, the ideal solution would be to see a maintenance and repair plan displaying the possibilities for energy performance upgrades and an estimation of associated cost. This is quite close to the Renovation Roadmap (showing the sequence of renovation measures) and the Logbook (documenting the intervention over time). With this information it would be possible for real estate valuers to determine the backlog in maintenance, repair and technological upgrade that could have an impact on the remaining useful life, with limited effort. Deeply renovated buildings that come up to the standards of up-to-date buildings available on the real estate market will increase in value while the backlog of maintenance, repair and technical upgrade will be easier to determine and more likely be properly reflected in the valuation.

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Special thank goes to Austrian real estate valuation experts having supported us with expert interviews:

Martina Hoffmann, Expert for Real Estate Management and Energy Performance Certificates at University of Applied Sciences FH Wien der WKW

Rainer Altmann, Valuator and Course Director 'Real Estate Management' at University for Continuing Education Krems

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement Nº 820497.