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1. Introduction

Existing buildings and the technical systems within them are covered by the main themes:

1. energy performance standards for existing buildings, especially those undergoing major renovation;
2. energy performance of technical building systems in existing buildings, including their monitoring and control;
3. regular inspection of heating and air-conditioning systems; and
4. alternatives to regular inspection.

The scope of the EPBD in respect of these themes is set out under Article 7 *(Existing buildings)*, Article 8 *(Technical building systems)*, Articles 14 and 15 *(Inspection of heating and air-conditioning systems)*, and Article 16 *(Reports on the inspection of heating and air-conditioning systems)*. Other relevant parts are Article 4 *(Setting of minimum energy performance requirements)* in relation to existing buildings, and Article 6 *(New buildings)* for consideration of high-efficiency alternative systems on major renovation.

With a few exceptions, the provisions of the recast EPBD (Directive 2010/31/EU) were to be applied by MSs by July 2013. Since then, implementation activities by the MSs have mainly focused on refinement and consolidation, rather than on major changes. Other legislation, however, has some synergy with the EPBD in its aim to improve the energy performance of buildings, which suggests that an integrated approach to implementation may be beneficial. This includes the requirements of the EED for a long-term strategy for building renovation, for energy efficiency obligation schemes (for energy suppliers), for energy auditing (of consumers and enterprises), and for installation of smart meters. The RESD also contains relevant requirements, which are considered in the Central Team report on New Buildings. Furthermore, a new set of CEN standards has been prepared to assist implementation of the EPBD. These are undergoing formal vote in late 2016, and MSs will then decide how they are to be used in their regulations.

2. Objectives

The objectives are:

- to develop a wider understanding of the detailed requirements and options in the EPBD concerning performance standards for existing buildings, performance standards for technical building systems, intelligent monitoring and control, and inspection of heating and air-conditioning systems;
- within these themes, to identify and explore the topics currently of greatest interest to MSs, observe the progress made, and share experience of successful implementation and difficulties encountered;
- to consider the overlap with other directives, notably the EED and RESD, and investigate the potential for better integrated regulation and activities.

3. Analysis of Insights and Main Outcomes

3.A. Analysis and insights

3.A.1 Topics of concern for CA EPBD IV

MSs have already set the minimum performance requirements for existing buildings, including technical building systems, and have created regular inspection schemes or equivalent alternative measures. More recently, efforts have been made to improve them, and to fill any gaps. At the beginning of the CA EPBD IV, CA members were asked which topics were currently of greatest interest or concern to them, and this has helped to direct the subsequent work. The areas identified were:

- the overall ambitions and long-term objectives for the existing building stock, step-by-step renovation and the effectiveness of each step, goals for packages of renovation measures and energy efficiency measures in suburban and low-income areas where there is no investment capacity;
- ensuring that overall component requirements (as opposed to component requirements) do not become obstacles to refurbishment, raising the rate of refurbishment through incentives, motivating building owners, and making the EPBD more simple and transparent for building owners and tenants;
- dealing with the diversity of the building stock (types of construction, age, occupancy, etc.), allowing for the preservation of historic buildings, recognising occupants with special needs (e.g., the elderly);

- consideration of "*high-efficiency alternative systems*" for major renovations, renewable energy source technologies in existing buildings;
- what is "technically, functionally, and economically" feasible, realistic prediction of energy savings and calculation versus measurement;
- long-term retention and re-use of EPC data, achieving coherent results from EPC when a "new" building has become an "existing" building;
- other sources of data for existing buildings, the identification of qualifying buildings to ensure that regular inspection takes place, analysis of the data from EPC and regular inspections and wider usage of EPC databases;
- essential features of "intelligent metering" and "active control systems" for technical building systems and how they should work, the role and capabilities of building energy management systems;
- continuous monitoring of heating, ventilation and air-conditioning systems to assess the energy performance and reduce the need for regular inspection;
- alternative measures to replace regular inspection of air-conditioning, and evaluation to determine the equivalent impact.

The CA EPBD IV work on existing buildings has concentrated on these ten main areas of current interest.

Highlights of 3.A.1	At present, the general aim is to refine and improve existing policies, regulations, and schemes. The topics of interest for existing buildings are becoming more specific and, in many cases, more technically detailed. Overall, they comprise: renovation, feasibility and cost-effectiveness, monitoring and control, data management and analysis, inspection and alternatives to inspection.

3.A.2 Strategic objectives for renovation

The obligation to provide a long-term strategy for building renovation falls under the EED, but the EPBD also plays an important role in setting the minimum energy performance standards that apply to renovation work. The role of the EED in targeting low renovation rates is therefore complemented by the impact of the EPBD on the depth of renovation. Standards are expected to rise over time with the prospect of energy consumption for existing buildings, as well as for new buildings, falling to NZEB levels. Consequently, a long-term strategic outlook is also relevant to the regulations to implement the EPBD.

Strategies produced for the EED have to include measures to stimulate deep renovations of buildings, including staged deep renovations, where "*deep renovation*" means work leading to a very high energy performance, and reduction of energy consumption by a significant percentage. However, the EPBD legislates for "*major renovations*", defined by reference to the total cost (relative to building value), or by the affected proportion of the surface area of the building envelope. Neither deep renovation nor major renovation is required to go beyond what is cost-effective.

DG Energy, with the support of the JRC, has assessed the first national renovation strategies[1] due in 2014 and found that, at present, only a few MSs reported "*planned*" measures for energy efficiency in buildings, while the vast majority reported only existing policies. The section related to forward-looking perspective to guide investment received the lowest average rating in the assessment exercise. This seems to indicate that most renovation strategies lack a clear long-term vision. Few include research and development, though that could be the key to cost-optimality and lower costs, generally.

Discussion at the CA EPBD shows that the over-riding problem for many MSs is the legacy of a large amount of housing, especially multi-apartment blocks, that is in poor condition and suffering from neglect and weak management. The immediate need is for stricter regulation and building codes to raise standards significantly, though not to such an extent that it becomes too expensive to comply with them. Experience has shown that it is possible to reduce energy demand in older housing from about 200 kWh/m^2.year to less than 70 kWh/m^2.year, but there are many technical and financial barriers to overcome.

Some of the barriers are:

- the difficulty for building owners in carrying out renovation projects, particularly because of the large amount of time and organisation needed;
- lack of confidence in predicted savings;
- payback times are too long to form an effective incentive for private finance;
- funding schemes are not available, or are too limited;
- reluctance to take out loans;
- distrust of administrative procedures and officials;
- different interests of stakeholders in buildings under shared ownership or with multiple tenants.

Solutions include making procedures simpler and more transparent, and using IT platforms to hold data, record progress, and link stakeholders. Financial models need good guidelines, standardised contracts and other documents. More needs to be done to reduce the burden on building owners. MSs feel that more research and development is necessary, especially to establish what is cost-effective under different circumstances.

Where there has been a long history of energy efficiency policies, supported by tax incentives and subsidies, it has been possible to set more ambitious targets. In Denmark, strong regulations aim for a 35% reduction in energy consumption by 2050 (Figure 1), with building codes setting limits of 30 kWh/m^2.year in existing buildings and 20 kWh/m^2.year for new buildings. One novel idea has been to build a "*library*" of typical buildings for which standardised solutions can be adopted during renovation.

The costs of widespread renovation programmes may be too high for governments to bear, and more needs to be done to encourage building owners to pay for this themselves. In housing, the cost may well exceed 20,000 € for deep renovation of a typical home. Key components of programmes designed to motivate building owners are:

- information: more about potential benefits, e.g., greater comfort, as well as savings in energy costs;
- investment: convincing homeowners that renovation will add value to the property and produce a positive return;
- trust: raising confidence in the ability of contractors to carry out improvement works competently and at competitive prices, assisted by codes of practice for the building trade and standardised improvement packages where possible.

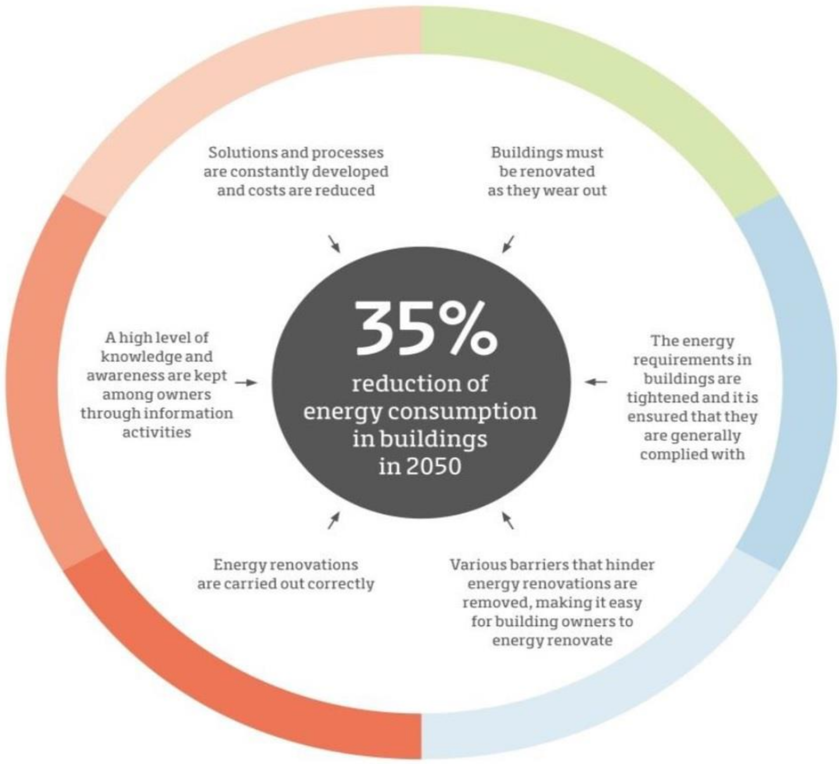

Figure 1. Activities in long-term renovation plans.

Questions for further investigation include:

- ensuring that targets for overall performance (as opposed to component/elemental performance) of individual buildings do not become a deterrent to action;
- how longer-term goals should be expressed, and their level of ambition;
- relationships with other policies; for example on fuel or energy poverty, and needs of the elderly;
- whole "*policy packages*" for renovation.

Highlights of 3.A.2	Difficulties that have been found when implementing renovation strategies are: • the legacy of many buildings in poor condition, suffering from neglect and poor management; • balancing available funding against the longer term horizon of deep renovation and NZEB; • persuading building owners to invest in energy efficiency measures themselves; • simplifying procedures, and providing help for building owners to follow them; • raising confidence in the quality and competence of renovation contractors; • developing standard solutions to reduce the costs in typical cases.

3.A.3 Expanding the use of databases

The majority of MSs have been using databases to keep EPC and reports from regular inspection of heating and air-conditioning systems since these schemes were introduced for the EPBD about 10 years ago. A large amount of data has now been collected, which can be used to show the condition of the building stock, engage the general public, and encourage further investment in energy efficiency. It can also be used to examine the rate of change, assess the impact of existing policies, inform future policy development, and support research.

Earlier CA EPBD work indicated that there is value in having strong linkages between databases for the EPBD and others that hold building data for different reasons. Linkage gives an opportunity to fill gaps and check consistency wherever there is duplication. Questions then arise about definitions, compatibility, and accuracy. There are also privacy and disclosure concerns when links are made between databases holding data that has been gathered for different purposes.

Databases are in use across the MSs, but in many cases they are not being used beyond the minimum requirements of the EPBD. However there are some known examples of:

- ***EPC/inspection databases being used to provide input data for other databases:***
  property valuation and taxation databases, building stock statistics, monitoring and quality controls, planning procedures, and reporting of progress in National Energy Efficiency Action Plans;
- ***existing databases (other than EPC) used to provide input data to the EPC database:***
  property identification details, including address, building type, names of owners and former owners, maps, local climate correction factors, and the credentials of the energy expert who produced the EPC;
- ***databases used to help achieve national policy targets, or implement EU directives other than the EPBD:***
  development of building codes, the renovation strategy for the EED, setting energy-saving goals for different stakeholders, energy-saving targets and planning, and other actions to evaluate and improve the quality of buildings;
- ***databases used to support research:***
  databases of EPC and inspection reports have already become a valuable source of national building data. One example (in the UK) is a research project into the national stock of air-conditioning systems, in which it was possible to analyse 500 inspection reports and EPC for the same buildings.

Some drivers towards combining databases are to answer questions about buildings (in the absence of other sources of knowledge), inform policy development, improve quality controls, avoid unnecessary duplication, increase the motivation for building improvements, engage the market, and to support social research.

The drawback is that development of complex databases is seen as expensive, and gathering more data is expected to lead to more complicated inspection procedures and calculations. A single database containing all building information would be ideal, but the reality of trying to achieve this poses many problems. The data sources were constructed at different times by different agencies and for different purposes, meaning that underlying assumptions may be incompatible, and content and data formats different. Barriers and risks are illustrated in Figure 2.

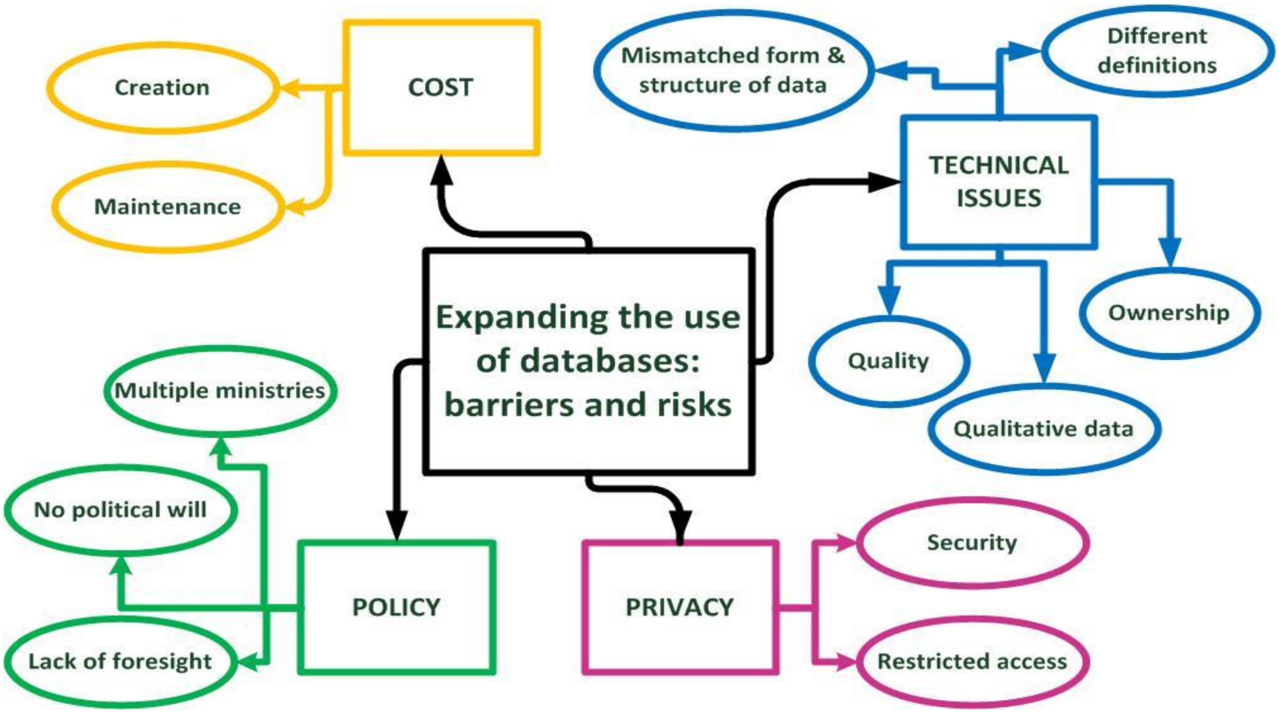

Figure 2. Expanding the use of databases: barriers and risks.

The main difficulties experienced by MSs in setting up, maintaining, and combining databases for buildings include:

- changing or conflicting rules (e.g., EPC rating scale, different definitions of treated floor area);
- privacy barriers to free circulation of information;
- not being able to locate all buildings, or all heating and air-conditioning systems;
- building ownership data not sufficiently up to date;
- low level of assessors' technical skills;
- industry resistance to supplying new information demands;
- independent control systems (and quality control more generally) for databases, and successfully applying sanctions.

Some MSs are creating open source databases, which can be used by anyone for any purpose. Others see the opportunities of such a system but find it difficult to implement owing to issues of data privacy. MSs generally have a cautious approach to expanding the use of databases.

The following ideas are among those being considered:

- use of data for strategic thinking and planning of long-term energy savings;
- more accurate and useful information for building occupants; recommendations could be made for a building at the point of sale based on data from case studies of similar properties; larger mortgages would be made available for a buyer wanting to carry out the improvements;
- innovation, gap analysis and data mining would provide opportunities for the development of new energy efficiency solutions;
- open data: information could be opened up to anyone who wants access via a simple, government-provided gateway; the market would be expected to find novel uses for this data.

It is usually necessary to refine and combine raw EPC information with other data before use in a wider context. Understanding and compensating for errors and incompatibility at a technical level (e.g., definitions and measurement conventions) is necessary to produce coherent data sets. Statistical data can be used to fill in gaps and provide a complete "*address-level*" data set. Aggregated data is of little commercial value, as it does not identify the buildings in need of particular energy efficiency measures.

To exploit buildings data successfully there is a need for vision and careful planning, and it is important to understand the requirements when mining data. Many common barriers exist across MSs. The potential advantages of combining databases must be weighed against the cost. Although many ideas have been put forward for developing and using coherent datasets, most have not yet been put into practice.

Highlights of 3.A.3	Databases of EPC and inspection reports are currently in widespread use across MSs but they are generally being used only to support the minimum requirements of the EPBD. There are many interesting possibilities to expand their use, including strategic thinking, information for building occupants, data mining, support for research projects, and open data. There are significant barriers when doing this, in terms of multiple ownership, disparate purposes, technical issues, privacy, cost of development, and the ongoing costs of reconciling data from different sources.

3.A.4 Heritage buildings

Heritage buildings present a particular set of challenges, as upgrading to improved levels of energy performance may be intrusive, visible, and unacceptable. Alterations to the building fabric can lead to a change of character; for example, insensitive use of exterior wall insulation on old buildings in France has been observed and illustrated in a journal article[3]. Although MSs apply minimum performance standards to major renovation work, the EPBD allows exemption to be given to buildings of special architectural or historical merit. The obligation to renovate public buildings under Article 5 of the EED contains a similar exemption, insofar as compliance with minimum energy performance requirements would unacceptably alter their character or appearance.

MSs are aware that meeting the same performance standards at renovation for heritage buildings entails much higher costs, as well as having to deal with numerous organisations and authorities with a strong interest in building preservation. There is a considerable amount of available guidance on renovation of special buildings, as well as a range of technical solutions such as concealment of sensors, wireless links, automatic window control, underfloor heating. Some MSs (notably Germany) have taken a numeric approach to the relaxation of standards, in which targets for heat loss through components in W/m^2.K, or overall energy intensity in kWh/m^2.year, are modified according to the type of building and difficulty of renovation. Targets can be reduced as a proportion of those applicable to a reference building (Figure 3).

Enquiries have shown that about two-thirds of the MSs have a recognised definition of heritage buildings and have established principles to be followed concerning preservation of their external appearance. A similar number allow exemption, to some degree, from the minimum performance standards that would normally apply during major renovation. Fewer than half have published guidance or rules concerning energy efficiency improvements to heritage buildings. For some MSs, heritage buildings are not a priority, while in others a mild climate means that improvement of the thermal envelope is not always necessary.

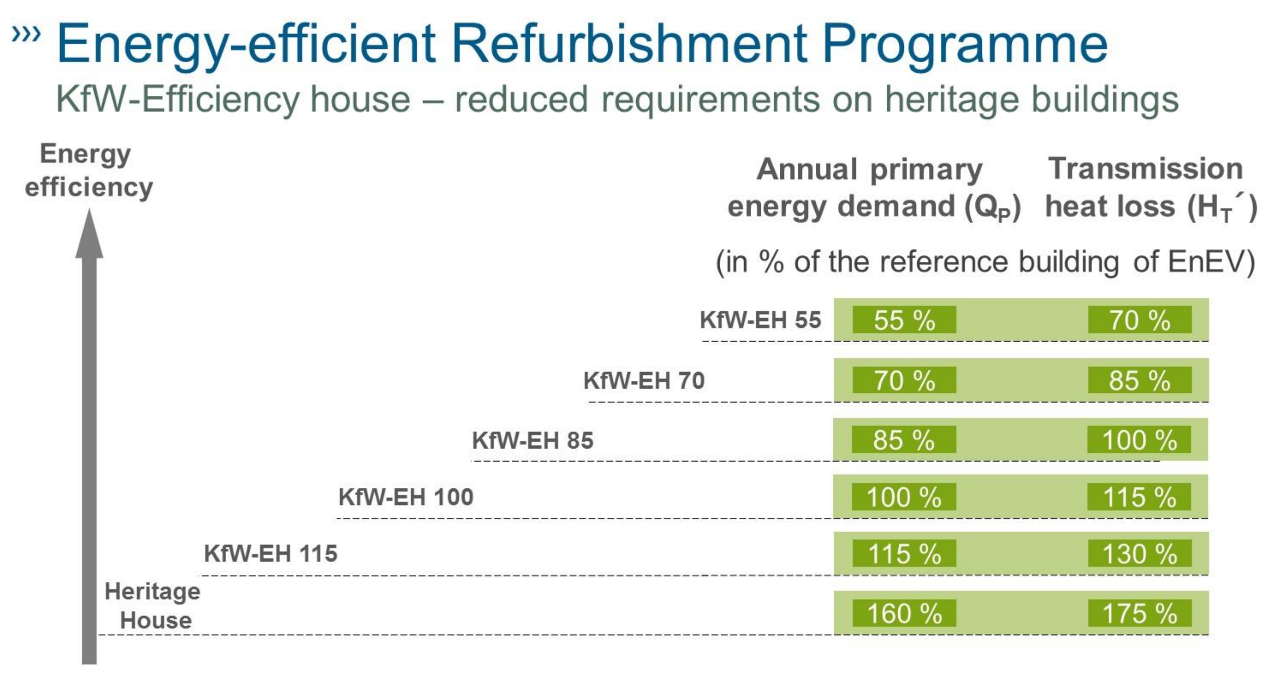

Figure 3. Reduction of targets by proportion.

One concern is funding schemes linked to increases in energy performance, under which heritage buildings do badly in comparison with others. Seen as an investment, the benefit/cost ratio is relatively poor. Most countries do not allow for special rules (a "*heritage factor*") when energy efficiency projects are competing for funds, and if they have to compete then it is on equal terms. There is no such competition where national funding for heritage buildings is treated separately.

An integrated approach to take account of the EPBD, EED, and RESD is seen as advisable, though the aim of renovation projects is usually not limited to saving energy and reducing environmental impact. Renovation extends the life of the building, and raises the quality of living and working spaces as well as improving occupant satisfaction. However, efficiency and cultural heritage are often the responsibility of different ministries. This requires a holistic approach and planning (Figure 4) with co-operation between technical and cultural experts in different teams. In monumental buildings, energy performance may be considered a minor aspect, while factors such as tourism play a much bigger role. This is acknowledged in the Namur Declaration on the objectives and priorities for a common European Heritage Strategy[2], which places a high value on the contribution of heritage to quality of life, the living environment, and Europe's attractiveness and prosperity.

A thorough assessment of an historic building and its energy consumption is necessary before a renovation project is planned. One successful approach is to categorise the different types of historic construction: this helps to identify suitable and cost-effective solutions that have worked in the past and to generate guidance for the future. This has allowed historic renovation to become somewhat simpler and less expensive.

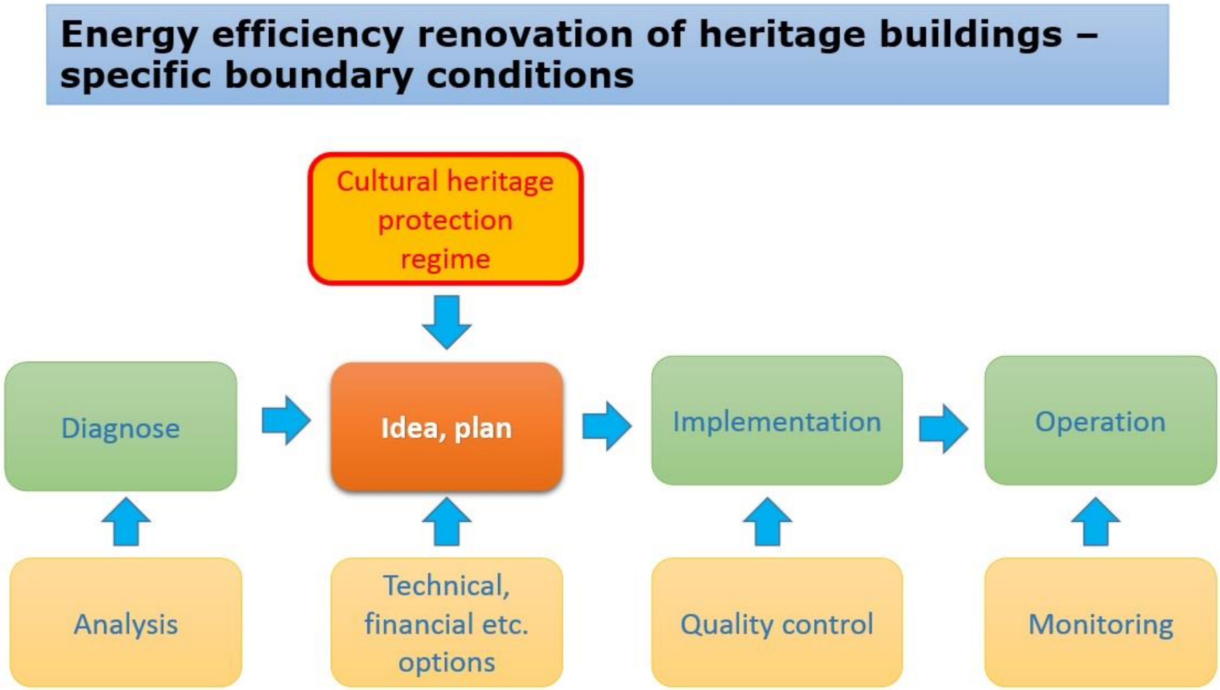

Figure 4. Planning for renovation of heritage buildings.

Some future prospects are:

- wider categorisation of historic building types, with corresponding guidance and best practice;
- further development of renovation guidelines by reference to previous experience based on building categories;
- attention to the greater importance of technical building systems and energy management systems where it is not feasible to improve insulation and airtightness of the building fabric;
- specific guidance for installation of renewable energy source technologies in sensitive buildings;
- climate-specific solutions, applicable across a number of countries;
- better co-ordination of government departments responsible for energy, culture, and heritage.

Highlights of 3.A.5	Renovation of heritage buildings is restricted in scope and it is relatively expensive to achieve a high level of energy performance. Funding for renovation is difficult to obtain if competing on the basis of the benefit/cost ratio. Some relaxation of the minimum performance standards is necessary. Energy efficiency and heritage are the responsibilities of different government departments and good working relationships are needed. Categorisation of building types helps to identify suitable and cost-effective solutions, leading to better guidance for future projects.

3.B. Main Outcomes

Topic	Main discussions and outcomes	Conclusion of topic	Future directions
Objectives for renovation of the building stock	• renovation strategy is required by EED; • "*deep renovation*" and "*major renovation*" have different definitions; • "*major renovation*" needs not be planned but is subject to minimum standards; • legacy of housing in poor condition; • NZEB standards for the longer term	• strategies not yet linked to the NZEB vision; • payback times too long to attract private investment; • difficult for building owners to initiate renovation projects, even with available funding	• simplification of procedures; • better information and help for building owners; • progress towards standardised solutions; • raising trust and confidence in contractors
Expanding the use of databases	• databases not used except to support the basic requirements of the EPBD; • significant barriers: technical issues, privacy, and cost of development	• many possibilities to expand database use; • need for vision and good planning to ensure value is provided	• using data for strategic thinking and planning for long-term energy savings; • providing information for building occupants; • wider access to open data
Improvement of heritage buildings	• restricted opportunities; • higher costs to achieve good energy performance; • energy efficiency often a minor aspect of renovation projects	• need for clear definitions and guidance, some relaxation of standards, different funding streams or rules, coordination between different departments	• categorisation of construction types to facilitate reference to earlier solutions; • greater attention to technical building systems when fabric alterations are not feasible

4. Lessons Learned and Recommendations

Minimum standards on building renovation, and renovation strategies (required for the EED), should look forward to NZEB levels of performance as the long-term objective. While that may be relatively straightforward in the MSs with a long history of regulations to improve energy performance, it is more difficult in those that have a large legacy of buildings in poor condition and limited funding programmes. The more urgent short-term requirement is to renovate to reasonable standards, as widely and as quickly as possible, without the additional expense and technology risk that accompanies "*deep*" renovation. However, that may perpetuate sub-optimal performance over the longer term. For private investment in building renovation, more needs to be done to simplify the process, help and encourage building owners, develop "*standard*" solutions for typical buildings, and increase confidence in contractors.

There is a need for vision and effective planning to expand the use of databases and exploit their full value, in particular to target building renovation programmes, improve compliance with building codes and support stronger and better quality schemes for energy performance certification. The potential advantages of combining databases must be weighed against the cost. Combined databases are already used in several MSs, for example to provide input data to EPC, and using EPC data for monitoring of property value, planning purposes, and building stock statistics. A number of barriers such as incompatible data conventions, conflicting rules, different updating cycles, and privacy restrictions are common across most MSs. A thorough understanding of the limitations, with compensation for errors and incompatibility at a technical level, is necessary to produce coherent and reliable data sets.

For heritage buildings, it is more expensive to renovate to the same standards, and sometimes impossible without unacceptable changes to appearance and building character. Exemption is permissible under the EPBD and EED, but relaxation, rather than total exemption, is preferable. Schemes that set proportionately reduced performance targets on a numerical basis, according to circumstances, can be used widely without having to consider too many special cases. Categorisation and "*standard*" solutions, when possible, help to reduce costs. Where changes to the building fabric are not acceptable, greater attention should be given to obtaining very high performance from technical building systems to compensate.

Endnotes

1. Synthesis report on the assessment of Member States' building renovation strategies, http://iet.jrc.ec.europa.eu/energyefficiency/

2. 6th Conference of Ministers Responsible for Cultural Heritage, April 2015, http://www.coe.int/nl/web/chairmanship/belgium-news/-/asset_publisher/QLBOlIyuxE9F/content/6th-conference-of-ministers-responsible-for-cultural-heritage/16695

3. Société pour la Protection des Paysages et de l'Esthétique de la France, http://www.sppef.fr/2016/11/15/sites-monuments-n-223/ and their article "Isolation Thermique par l'Extérieur: Deux Ans de Combat, de la Loi au Décret", http://www.sppef.fr/wp-content/uploads/2016/11/sppef_article-ite-sites-monuments-n%C2%B0223.pdf

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